

June 16, 1942.

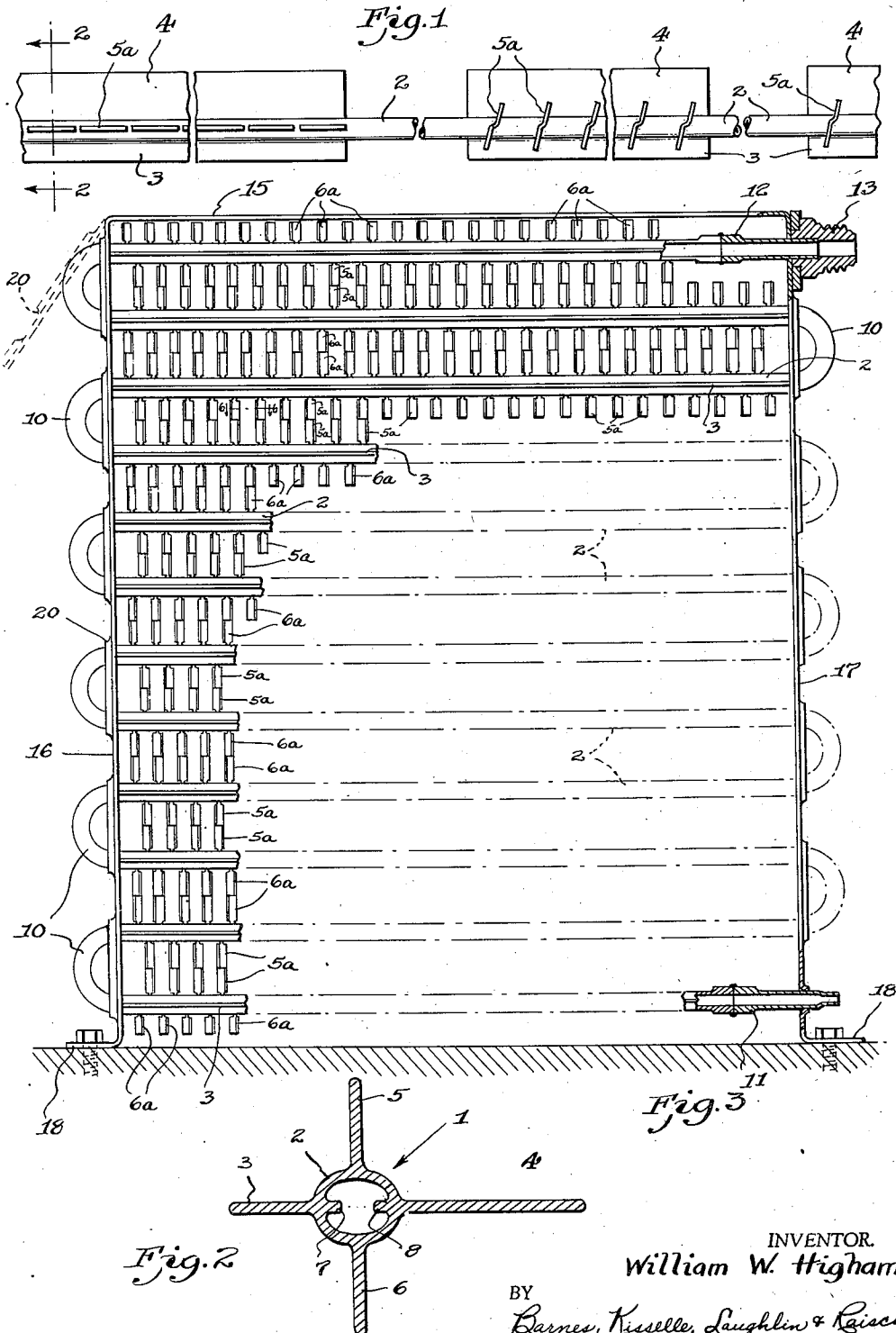
W. W. HIGHAM

2,286,271

HEAT TRANSFER DEVICE

Filed March 7, 1940

3 Sheets-Sheet 1



June 16, 1942.

W. W. HIGHAM

2,286,271

HEAT TRANSFER DEVICE

Filed March 7, 1940

3 Sheets-Sheet 2

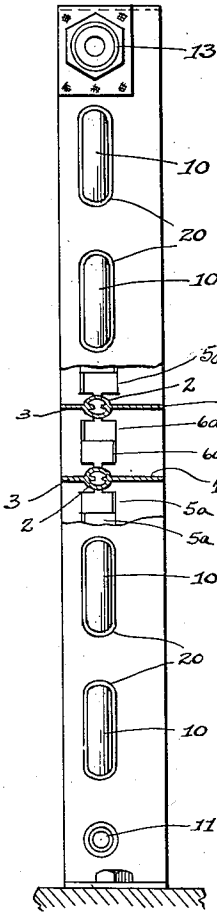


Fig. 5

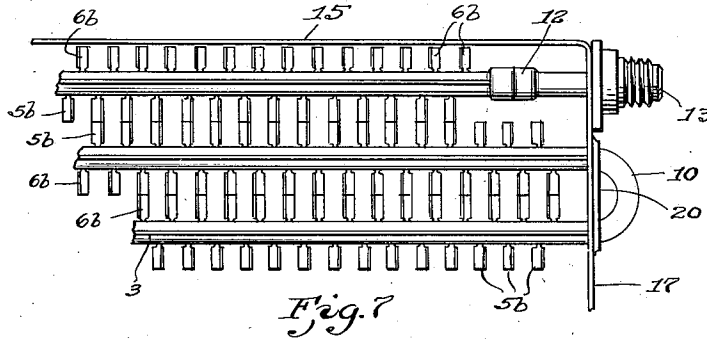


Fig. 7

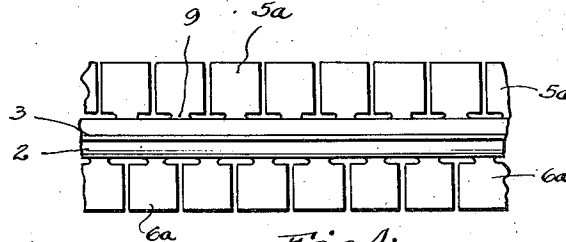


Fig. 4

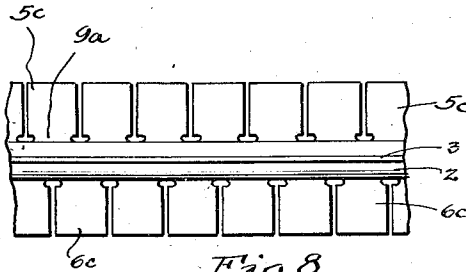


Fig. 8

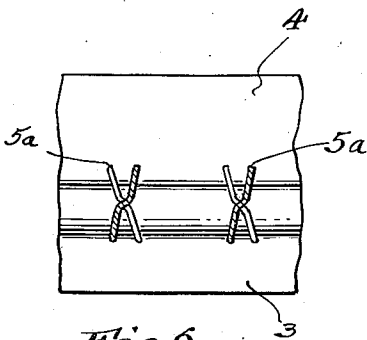


Fig. 6

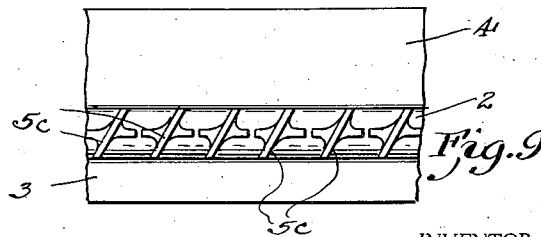


Fig. 9

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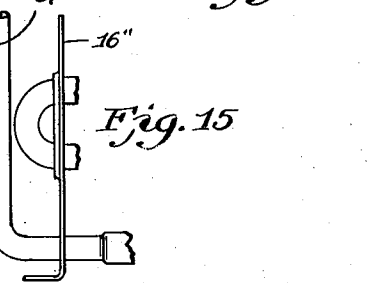
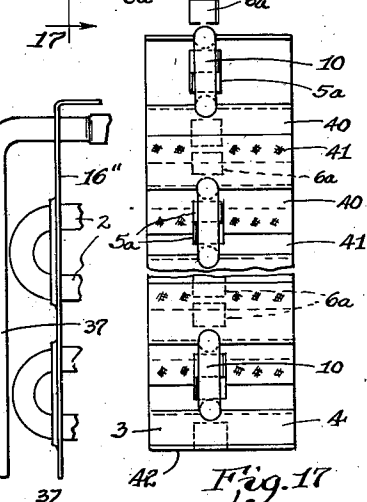
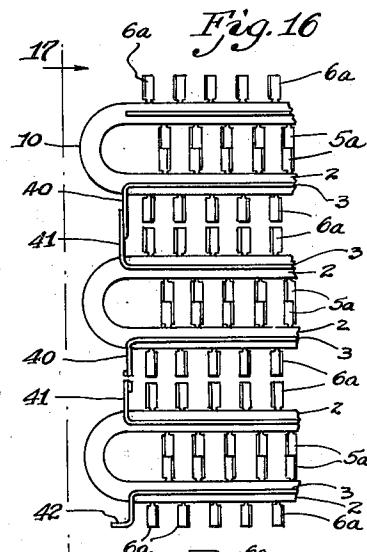
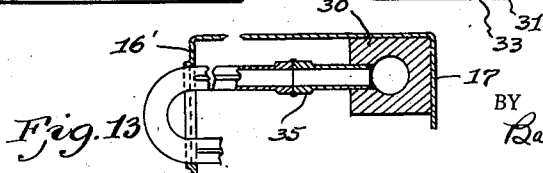
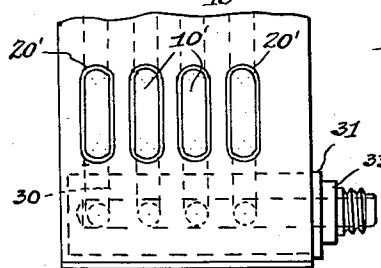
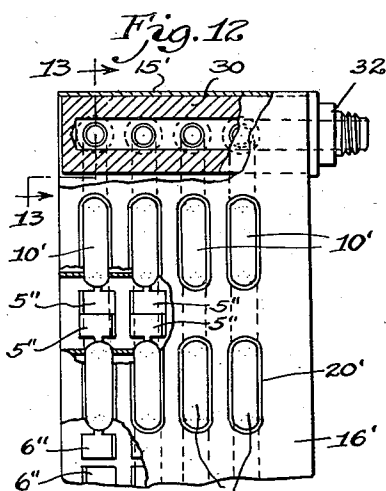
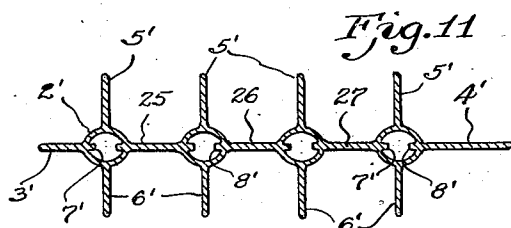
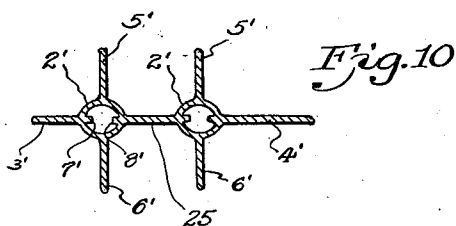
Barnes, Kesselle, Laughlin & Rausch
ATTORNEYS

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,286,271

HEAT TRANSFER DEVICE

William W. Higham, Detroit, Mich., assignor to
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corporation of Michigan

Application March 7, 1940, Serial No. 322,689

11 Claims. (Cl. 257-149)

This invention relates to a heat transfer device, and particularly one believed to be useful for heat transfer in connection with refrigeration or air conditioning.

Among the objects of the invention is the provision of an efficient heat transfer device, the basic structure of which comprises a single length of material, which provides one or more conduits for a fluid and a large number of radiating elements integral therewith, and which afford a large area for contact with the ambient atmosphere or other fluid. The structure is preferably such that the ambient atmosphere or other fluid is deflected or given a certain turbulence, as it is caused to pass by or through the device. Other objects will become better appreciated as the detailed description progresses in conjunction with the accompanying drawings which show devices for carrying out the invention.

Fig. 1 is a plan view of a strip of material for the making of a heat exchange unit.

Fig. 2 is an enlarged cross sectional view taken substantially on line 2-2 of Fig. 1.

Fig. 3 is a side elevational view with parts in cross section showing a device constructed in accordance with the invention.

Fig. 4 is a view of a portion of a length of stock prior to the formation of the heat transfer fins.

Fig. 5 is an end view of the device as shown in Fig. 3, with some parts cut away and parts shown in section.

Fig. 6 is an enlarged detailed view taken substantially on line 6-6 of Fig. 3.

Fig. 7 is a view illustrating a modified arrangement of heat transfer wing or fin.

Fig. 8 is a view of a portion of a strip illustrating another modified arrangement of heat transfer fin or wing.

Fig. 9 is a view of the fin structure formed from the modified arrangement of Fig. 8.

Fig. 10 is a cross sectional view of a strip of stock similar to Fig. 2 but illustrating a double conduit formation.

Fig. 11 is a view similar to Fig. 10 showing a further increased number of conduits.

Fig. 12 is a partial side elevational view, with some parts cut away and some in section, showing a heat exchange unit formed of a strip of stock with multiple conduits.

Fig. 13 is a sectional view taken substantially on line 13-13 of Fig. 12.

Fig. 14 is an end view of a device illustrating a series connection of multiple tubes.

Fig. 15 is a view taken substantially at right angles to Fig. 14.

Fig. 16 is a partial side elevational view showing a modified form of frame arrangement for the device.

Fig. 17 is a view looking substantially in the direction of arrows 17-17 of Fig. 16.

The basic structure of the heat exchange unit preferably comprises a single length of stock which in cross section presents a tubular formation to constitute a conduit and certain fin or wing structure. Where the stock can be made in adequate lengths, a heat exchange unit will comprise essentially one integral piece of stock, although it is to be understood that where desired or where the size of the heat exchange unit is large, that two or more pieces of such stock may be united. This piece of stock is preferably extruded and is preferably aluminum or aluminum alloy, or other metals which are adaptable to the extrusion process. The strip is generally indicated at 1, and, as shown in Fig. 2, has a hollow or tubular formation 2. It likewise has opposite flanges 3 and 4 and opposite flanges 5 and 6 with internal flanges of projections 7 and 8. These flanges run lengthwise of the extruded stock.

A length of this stock is shaped into the desired form as will presently be indicated, but prior to such shaping some of the flanges, such as the flanges 5 and 6, are treated and fashioned so as to form heat transfer devices which may be termed wings or fins. As shown in Fig. 4 the flanges 5 and 6 are preferably cut or slotted with a T-shaped slot to thus provide separate wings 5a and 6a integrally connected with the tube by the metal lying between the ends of the cross bars of the T slots, this metal being indicated at 9. The wings thus formed are now twisted or fashioned until they are given a shape substantially as illustrated in Fig. 2; that is to say, a portion of the wing is bent upwardly and a portion is bent downwardly as Fig. 2 is viewed. This treatment is continued for the length of the stock. Moreover, the external flanges are removed at spaced points as indicated in Fig. 2.

A strip of stock thus treated may now be fashioned to form a relatively compact heat exchange body, the preferred form being illustrated in Fig. 3. The strip is fashioned by being bent at the locations, where the flanges are removed, through substantially 180°, and this provides a plurality of substantially parallel runs joined by the bends which are indicated at 10. Considering the lowermost run of Fig. 3, the wings 6a are shown on

the lower side of the tube and the wings 5a on the upper side. When the stock is reversely bent to form the run next above, the wings 5a on the next above run are caused to substantially register with the wings 5a on the lowermost run as indicated. In the run second from the bottom, the wings 5a are on the under side of the tube formation, and the wings 6a on the upper side. This condition reverses itself for the third run and so on through the device. In other words, the wings 5a on some runs substantially register with wings 5a on adjacent runs and the wings 6a on some runs substantially register with wings 6a on adjacent runs. In this form all of the wings are fashioned or bent in the same manner, with the result that when the wings on opposite runs are substantially registered with each other, their relative condition is reversed and they more or less cross each other after the manner shown in Fig. 6.

Suitable couplings or connections may be made at the ends of the tubular formation, and to this end terminal pieces 11 and 12 may be secured to the ends by means of a welding, brazing or similar process, and a fitting 13 may be placed on one or both ends. A frame structure may be placed over this arrangement to aid in the support thereof, and this advantageously may take the form of a strip of sheet metal fashioned to form a top 15 and legs 16 and 17, provided with supporting feet 18. The legs are apertured, as shown at 20, for the passage of the bends 10 therethrough. The fitting 13 may be applied to the outside of the frame after the frame has been located. While the part 15 has been termed the top of the frame with reference to Fig. 3, it is, of course, understood that the device may be used in such a position that the part 15 is on the side or even at the bottom.

In use of this structure, a fluid is passed through the tubular form 2, and another fluid, such as the ambient atmosphere, is caused to pass across or through the structure, say from left to right as Figs. 2 and 5 are viewed. The fluid within the tube contacts with the internal fins 7 and 8, as well as the tube wall, while the atmosphere or other fluid first contacts with the flange 3 and directly with the tube 2 and the flange 4. The flange 4 may advantageously be of greater extent than the flange 3 to provide, so to speak, sort of a trailing edge for contact with the air or other fluid. At the same time the air contacts with the fins 5a and 6a, and due to their angular disposition, the air is deflected or given a turbulence and thus a contact is made for efficient transfer of heat. The two fluids are separated by integral metal parts with the result that heat is efficiently transferred from one to the other. The heat is conducted directly through the integral metal comprising the tube walls, and the fins 3 and 7, and 4 and 7, and the fins 5a and 6a. No joint or separation is present in the metal. Where this device is used as a condenser in the refrigerating or air conditioning system, the refrigerant may be passed through the tube formation and atmosphere caused to pass through the open-like structure as viewed in Fig. 3, either by the means of a forcing device such as a fan or the like, or by a natural flow due to convection currents or otherwise. Where the device is used, for example, as a cooling unit, say of a commercial refrigerator or an air conditioning apparatus, the refrigerant may pass through the tubular formation and the air passed over and through the outside for cooling purposes.

In Fig. 7 a modified fin arrangement is shown. In this form the direction of the bending or fashioning of the wings 6b is reversed for each section or run; likewise, the direction of bending or fashioning of the wings 5a is reversed for each run. For purposes of clarity it will be noted that the leading edge of the wing 6b in the upper run of Fig. 7 is nearest the observer, while the leading edge of the next lower run is away from the observer; and the same thing is true of the wings 5b, and this condition exists throughout the unit. As a result, as indicated, the meeting wings 5b and 6b, instead of crossing each other as shown in Fig. 6, substantially align with each other and extend in the same direction. This arrangement, it is believed, would create a lesser agitation of the air or fluid passing through the device. Other parts shown in Fig. 7 which are the same as those previously described bear the same reference characters.

A further modification is shown in Figs. 8 and 9. Here the T slots between the wings have quite a short cross bar to provide an increased amount of integral metal 9a, which connects the wings 5c and 6c, to the tubular formation. This additional metal provides for more transference of heat. The wings thus formed cannot be bent so abruptly as those previously described because of the excess of the metal at 9a. But in this case the wings are fashioned with a more or less progressive twist, as indicated in Fig. 9, the wings thus having sort of a helical formation.

The structure may be formed from strip stock having two or more tubular formations, and this form of the invention is shown in Figs. 10 to 15. In Fig. 10, an extruded metal form having two tube formations is shown, the tubular formations being illustrated at 2' and the leading and trailing flanges at 3' and 4', with the internal flanges at 7' and 8', while the wing-forming flanges are at 5' and 6', there being an integral interconnecting web 25. Fig. 11 shows a similar structure with four tubular formations to which the same characters are applied as are used in Fig. 10, this structure having, in addition to the web 25, two other webs 26 and 27.

Fig. 12 is a view of a unit fashioned from the four-tube type, and it will be understood that this unit is made in the same manner as the unit fashioned from a single strip previously described, the flanges being removed for the return bends 10' and the flanges 5' and 6' cut to form wings 5'' and 6''. The frame structure may be the same as that shown in Figs. 3 and 5, except it is of increased width to accommodate the wider stock, and having a top strip 15' and side legs 16' and 17' provided with openings 20' for the bends in the stock. The tubular formations may be connected in parallel or in series. In Fig. 12 a header 30 is shown at one end of the stock and a header 31 at the other into which the ends of the tubular formations connect, and the headers may be equipped with inlet and outlet couplings 33 and 34. The connection into the headers may be made by terminal pieces 35, as indicated in Fig. 13. The series connection is shown in Figs. 14 and 15, these views showing the double stock, although it will be readily understood by those skilled in the art that the same arrangement may be performed with strip stock having more than two tubular formations. In this form one side of the frame is shown at 16'', while the inlet fitting is at 35, and the outlet fitting is at 36. Fluid entering at 35 passes down one tubular form and then through

a connecting tube 37 extending from the lower end of one tubular formation to the upper end of the next, as indicated. The inlet end and the outlet ends may be reversed.

In Figs. 16 and 17 an arrangement is shown which dispenses with the separate frame. For the purpose of this illustration the stock employed is the single tubular formation stock, although stock with multiple tubular formations may be so arranged. The reference characters employed are the same as those employed on corresponding parts in the form shown in Fig. 3. Instead of entirely removing the flanges 3 and 4 at the bends 10, they are merely cut or severed from the tube and remain attached. The flanges on one run are turned downwardly (as Fig. 16 is viewed) as at 40, while the flanges on other runs are turned upwardly as at 41. And these portions are preferably arranged to overlap as indicated and are secured together as by means of spot welding or the like as indicated. The lowermost run may have its flanges fashioned downwardly and then formed to provide a supporting foot 42. Thus with this structure the parts of a unit are reduced to practically a minimum comprising only the tubular formation with its integral fins or wings with the necessary terminals.

The structure of the heat transfer device thus described is comprised of a minimum number of parts, is simple in construction and can be manufactured with considerable feasibility. In addition to that, a large area for contact with the outside air or fluid is provided with some turbulence or agitation given thereto, while at the same time the metal through which the heat transfer is made is integral, there being no joints or breaks through which the heat must pass. This, of course, leads to high efficiency in the transfer of heat. It is thought that this arrangement is particularly useful as a condenser for refrigerating apparatus or air conditioning apparatus, as well also as an evaporator or cooling unit for certain types of refrigerators and refrigerated show cases and the like. Of course, the apparatus is not to be limited to such uses. In some claims reference is made to the device being for refrigeration, and this is to include air conditioning.

I claim:

1. A heat transfer device comprising, a length of metal stock having a tubular formation fashioned into a plurality of spaced runs with the runs connected by reversely bent parts of the stock, said stock having flanges the runs thereof positioned so that the flanges extend into the spaces between runs and being free of said flanges at the bends, said flanges on the runs being severed transversely at a plurality of locations to provide wings spaced longitudinally of the stock, and the wings on adjacent runs extending toward each other crosswise of the space between adjacent runs, said wings being fashioned into an angular position for deflecting and setting up turbulence in the ambient fluid.

2. A heat transfer device comprising, a length of metal stock having a tubular formation fashioned into a plurality of spaced runs with the runs connected by reversely bent parts of the stock, said stock having flanges on the runs thereof positioned so that the flanges extend into the spaces between runs and being free of said flanges at the bends, said flanges on the runs being severed transversely at a plurality of loca-

tions to provide a plurality of wings along the length of the stock, and the wings on adjacent runs extending toward each other crosswise of the space between adjacent runs, said wings being fashioned into oppositely angular positions for deflecting and setting up turbulence in the ambient fluid.

3. A heat transfer device comprising, a strip of metal stock having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the bends, and said two flanges on the runs being severed to provide wings, said wings being fashioned out of the normal plane of the corresponding flange to provide passageways for ambient fluid between the runs and to provide surfaces for contact with the fluid.

4. A heat transfer device comprising, a strip of metal stock having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the bends, and said runs being so spaced that the said two flanges normally substantially meet edge to edge, the said two flanges being cut at spaced locations to provide wings, and said wings being fashioned to provide passageways for ambient fluid through the spaces between the runs.

5. A heat transfer device comprising, a strip of metal stock having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the bends, and said two flanges on the runs being severed to provide wings, said wings being fashioned out of the normal plane of the corresponding flange to provide passageways for ambient fluid between the runs and to provide surfaces for contact with the fluid, and said wings being angularly disposed for deflecting and setting up turbulence in the fluid passing therethrough.

6. A heat transfer device comprising, a strip of metal stock having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the bends, said two flanges on the runs being severed to provide wings, said wings being fashioned out of the normal plane of the corresponding flange to provide passageways for ambient fluid between the runs and to provide surfaces for contact with the fluid, and said wings being oppositely angularly disposed for deflecting and setting up turbulence in the fluid passing therethrough.

7. A heat transfer device comprising, a strip of metal stock having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the

bends, said two flanges on the runs being severed to provide wings, said wings being fashioned out of the normal plane of the corresponding flange to provide passageways for ambient fluid between the runs and to provide surfaces for contact with the fluid, one of said other flanges which faces the on-coming flow of the ambient fluid being relatively short, and the opposite other flange being relatively long for providing surface contact with the ambient fluid as it passes from the device.

8. A heat transfer device comprising, a strip of extruded metal stock of aluminum or aluminum alloy having a tubular formation and with four longitudinally extending flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs, with the runs connected by reversely bent parts of the stock, two of the flanges which lie on the inside and outside of the bends being removed at the bends, and said two flanges on the runs being severed to provide wings, said wings being fashioned out of the normal plane of the corresponding flange to provide passageways for ambient fluid between the runs and to provide surfaces for contact with the fluid.

9. A heat transfer device comprising, a strip of metal stock of extruded aluminum or aluminum alloy having a plurality of tubular formations with a web connecting the formations, each tubular formation having longitudinally extending flanges which, together with the web, are all spaced substantially 90° apart, said stock being fashioned into a plurality of spaced runs with the runs connected by reversely bent portions of the stock, the flanges, being on the sides of the tubular formation so as to extend into the spaces between runs, and the reversely bent portions being free of flanges, the said flanges on the runs being cut at a plurality of locations and fashioned to provide heat transfer wings, the wings on adjacent runs being substantially in contact

with each other, the ends of the tubular formations being arranged for the inlet and outlet of a fluid, said wings providing a contact area for an ambient fluid.

10. A heat transfer device comprising, a strip of metal stock of extruded aluminum or aluminum alloy having a plurality of tubular formations with a web connecting the formations, each tubular formation having longitudinally extending flanges which, together with the web, are all spaced substantially 90° apart, said stock being fashioned into a plurality of spaced runs with the runs connected by reversely bent portions of the stock, the flanges being on the sides of the tubular formation so as to extend into the spaces between runs, and the reversely bent portions being free of flanges, the said flanges on the runs being cut at a plurality of locations and fashioned to provide heat transfer wings, the wings on adjacent runs being substantially in contact with each other, the ends of the tubular formations being arranged for the inlet and outlet of a fluid, said wings providing a contact area for an ambient fluid, and a frame having side portions with apertures therein through which the reversely bent portions extend.

11. A heat transfer device or the like comprising, a strip of metal stock having a tubular formation with four exterior flanges thereon spaced substantially 90° apart, said stock being fashioned into a plurality of runs with the runs connected by reversely bent parts of the stock, two of the flanges which are on the inside and the outside of the bends being removed from the bends and said two flanges on the runs being cut to provide integral heat transfer fins, the other two flanges of the stock being partially severed from the stock at the bends and being fashioned to extend in a direction substantially perpendicular to the runs and being secured together adjacent the bends to form a frame structure.

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