TOROIDAL TYPE HEAT EXCHANGER

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The invention relates generally to heat exchange structures, and more particularly to a toroidal or annular type of heat exchanger especially adapted for gas to gas operations.

The invention has among its objects the production of a toroidal type heat exchanger which affords very efficient heat exchange characteristics with maximum compactness of structure, minimum weight, and in which the completed assembly may be constructed to extremely close dimensional tolerances even with limitations imposed by commercial tolerances on component parts. The present invention is therefore of particular value in heat exchange structures for use in cooling supercharged air in aircraft installations and the like.

Another object of the invention is the production of such a heat exchange structure in which novel means is provided for holding the sections of the assembly in operative position, as well as providing means for compensating for the slight dimensional differences resulting from the use of component parts having commercial tolerances, such means also being constructed to provide heat conductivity between the ends of adjacent sections for securing a substantially balanced heat flow in all passes of the heat exchange structure.

A further object of the invention is the production of a novel fluid pass construction having relatively high heat transfer efficiency in which a single sheet metal member is so formed that a series of the pass structures may be assembled together to form alternate passes having a generally trapezoidal cross section, and intermediate passes having a rectangularly transverse cross section, with the different passes extending transversely to one another. Thus, the heat exchanger sections may be constructed by means of a series of like members, thereby simplifying assembly, as well as resulting in a reduction in manufacturing cost.

A further object of the invention is the production of such a pass structure which is so designed that the intermediate and alternate passes are isolated from one another without the use of auxiliary closure devices or separate gaskets and which is so designed that automatic compensation is obtained for slight differences in the thickness of the material employed, and self-reinforcement is obtained.

A further object of the invention is the production of a toroidal or circular exchanger structure comprising a series of individual sections or units in combination with novel means for securing the same in operative relation, such means being constructed to provide suitable heat transfer between adjoining sections or units.

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 represent like or corresponding parts:

Fig. 1 is a top plan view of a toroidal heat exchanger embodying the present invention:

Fig. 2 is a side elevational view of the exchanger illustrated in Fig. 1:

Fig. 3 is a fragmentary top plan view similar to Fig. 1 of a portion of the exchanger structure with portions of the retaining rings broken away to disclose details of one of the wedge members employed.

Fig. 4 is a transverse sectional view through the heat exchange structure taken approximately on the line 4—4 of Fig. 3:

Fig. 5 is a sectional view similar to Fig. 4 taken approximately on the line 5—5 of Fig. 3 with portions of the wedge member broken away to show the details thereof;

Fig. 6 is an enlarged, elevational view of a portion of the structure illustrated in Fig. 2 illustrating the details of connection between the respective fluid pass housings;

Fig. 7 is an enlarged, sectional view taken approximately on the line 7—7 of Fig. 5;

Fig. 8 is a perspective view of one of the fluid pass housings and portions of the fin structures of adjoining fluid passes; and

Fig. 9 is a sectional view similar to Fig. 7 of a modified form of connection between assembled units.

In the past, conventional designs of heat exchangers of the general type here involved, contemplated the use of a ring of rectangular blocks of exchanger surface. Due to the polygonal periphery and the waste space at the ends of each block, such exchanger assembly required substantially larger volume than the true toroidal or annular shape, consequently such a design does not lend itself to a simple and compact method of ducting. While toroidal designs utilizing trapezoidal passes in the axial direction, and rectangular passes in the radial direction have been contemplated, such designs have not proved practicable as efforts have been primarily directed to the construction of a unitary heat exchanger structure of a toroidal shape, and as applications of this type of exchanger have normally required extremely close dimensional tolerances in the completed assembly, the commercial production of such a unit is impractical as the necessity of utilizing a relatively large number of components having commercial tolerances prevents the maintenance of close assembly tolerances, this being in a great measure due to the fact that the tolerances are cumulative in the assembly.

On the other hand, the use of a segmental or sectional heat exchange structure introduces complications in installing and fastening a plurality of individual sectors, as well as in maintaining a balanced heat flow in all passes of the structure. The present invention is particularly directed to a novel structure which overcomes the difficulties above mentioned, and enables the commercial production of heat exchangers of this type to operate with extremely close dimensional tolerances in the completed assembly despite the limitations of commercial tolerances on the component parts thereof.

These results are in part achieved by utilizing a fluid pass housing which forms the trapezoidal-shaped pass, from a single sheet of material which is so shaped that it may be assembled with a like housing to form a rectangular fluid pass between each pair of trapezoidal-shaped passes, the closure structure at opposite ends of each pass being formed by the cooperative pass housings without the use of additional members or elements, with the design being such that adequate reinforcement is provided, both in radial and axial directions, to form a very light-weight, compact, and durable structure.

Referring to the drawings, and particularly to Figs. 1,
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2, 4 and 9, the toroidal heat exchange assembly, indicated generally by the numeral 1, comprises a core assembly designated by the numeral 2, the assembly being annular in shape and supported between a pair of retaining rings 3 and 4 which are suitably designed for installation in the particular equipment on which the exchanger is to be used. As illustrated in Fig. 4, the core 2 is rectangularly shaped in a radial cross section with the rings 3 and 4 being axially spaced from one another and lying in substantially parallel planes. The core 2 is made up of a plurality of individual sectors or sections 5, with six sectors being utilized in the embodiment of the invention illustrated in Fig. 1.

Each of the retaining rings 3 and 4 comprise a pair of concentric, circular rim portions 6 and 7 and may be radially extending connecting members or bars 8 and 9, the bars 9 being radially spaced sixty degrees apart, whereby they are each positioned at the juncture of adjoining core sectors. The rings 3 and 4 may be of any suitable configuration, as for example, integral or suitably fabricated structures, and as illustrated in Fig. 4, each of the rim portions 6 and 7 of the respective rings are provided on their inner or opposed faces with annular-shaped flanges 11 adapted to receive and engage the inner and outer peripheral edges of the core structure.

Each of the core sectors or sections 5 comprise a plurality of fluid pass housing members, indicated generally by the numeral 12, each formed from a single, elongated piece of sheet metal bent intermittently its long axis to form a pair of side walls 13 and 14 integrally connected at their radial inner edges, relative to the assembled structure, by a connecting wall 15. The opposite connecting edges of the side walls 13 and 14 terminate in opposed flanges 16 and 17, with the flange 17 having an inwardly offset edge portion 18, the latter being inwardly offset approximatively the thickness of the metal employed, with the width of the flange 16 being such that it overflows the offset portion 18 of the flange 17. Thus, when the flanges 16 and 17 are suitably bonded together, an outer connecting wall is formed, the general plane of which extends substantially parallel to the plane of the inner wall 15.

Referring to Figs. 3, 7 and 8, it will be noted that the connecting wall 15 is of a lesser width than the wall 17 formed by the flanges 16 and 17, whereby the walls 13 and 14 lie in converging planes. Positioned in the fluid pass defined by the side walls 13 and 14 and the radially spaced connecting walls 15 is a suitable fin structure, indicated generally by the numeral 19, which in the embodiment of the invention illustrated comprises a sheet of substantially material formed with a plurality of corrugations 21 therein to produce a plurality of transversely extending fin surfaces between the side walls 13 and 14, with the height of the corrugations progressively decreasing radially inward toward the wall 15, so that the fin structure is of generally trapezoidal shape corresponding to the trapezoidal shape of the fluid pass formed by the housing.

Each of the generally radially extending edges of the side walls 13 and 14 which define the inlet and outlet of the trapezoidal pass are provided with outwardly extending flanges 22 and 23, the flanges 23 each being provided with an inwardly offset edge portion 24, with the amount of offset being approximately equal to the thickness of the metal employed, and as illustrated in Figs. 3 and 8, the flanges 22 and 23 are rectangular in shape. Thus, a series of housing members 12 may be assembled with the flanges 22 and 23 forming the outer edge of each retaining rings 24 of the flanges 23 of the adjacent member to form a rectangular-shaped fluid pass between each adjacent pair of trapezoidal passes, with the inlets and outlets of the rectangular passes extending transversely to those of the trapezoidal passes. The angle between the side walls 13 and 14 of each housing is such as to remove the circumferential difference between the difference in radius of the rims 6 and 7 of the respective ring members 3 and 4. Positioned in each of the rectangular, axially extending passes formed by the flanges 22 and 23 is a suitable fin structure 25, illustrated in the present embodiment of the invention as also being of corrugated design, and comprising a single sheet of material having a plurality of corrugations 26 of uniform size. As illustrated in Fig. 7, the end passes of each section are formed by special housing elements 27 and 28 which merely complete the particular end pass. For example, the housing member 27 is constructed without the flanges 22, so that the end of the housing element 27 is defined by the side walls 14. Like manner, the housing member 28 comprises a side wall 14' having merely the flanges 22', corresponding to the flanges 22, to thus complete the rectangular-shaped, radially extending pass, with the side wall 14' defining the end of such core sector. The individual pass housing members or closures 12 may be formed by stamping, or other suitable means, and to insure accurate radial dimensions, each housing may be struck in a die which sets any of the four circumferential edges of each member for distances greater than the dimensions of the flanges 11 on the rims 3 and 4 to the traverse required dimensions specified for the core sector or section will readily and accurately seat on the flanges 11. Each sector or segment following assembly may be brazed or otherwise bonded into an integral unit, whereby the finished segment or sector will be accurately as to radial dimensions with variations resulting from commercial tolerances involved, as well as any additional, as a result of compacting during the bonding operations being reflected in the arcuate length of the individual unit.

The respective core sectors or units are assembled between the rings 3 and 4, and positioned between the ends of each pair of adjacent core sectors is a ring spacer 29, with a core unit assembly being utilized generally by the numeral 29.

As clearly illustrated in Figs. 3, 5 and 7, each of the spacer members 29 in the embodiment of the invention illustrated comprise an annular-shaped body member 31 having radially extending portions or bars 32 connected by portions 33 to form a chamber 34. Each of the members 31 are secured to the cross ports 9 of the respective encasing rings 3 and 4 by bolts 34' passing through bores 35 in the cross members 9, and engaged in threaded bores 36 in the ports 32 of the member 31, the axial length of the portions 32 being substantially equal to the distance between the respective bars 33, which would be in a radial direction relative to the assembled structure, but is substantially retained in fixed axial relation with respect to the member 29.

The wedge member 37 is provided with a plurality of recesses or openings 38 thereof, three being employed in the construction illustrated, and communicating with each of the recesses 38 is a small bore 39, in each of which is positioned a bolt 41 which extends through a bore 42 in the upper bar 33, as viewed in Fig. 5, such bar being positioned in the completed assembly adjacent the inner face thereof. Referring to Fig. 7, it will be noted that the base member 29 tapers in cross section, through which the bolts 41 extend, and the side faces 43 of the wedge member 37 extend at the same angle with respect to one another as the corresponding faces of the member 29. Thus as the member 37 is moved radially inward toward the upper bar 33, the side faces 43 of the wedge member extend outwardly beyond the corresponding faces of the base member 29. Positioned adjacent each side face of the base
member 29 and wedge member 37 is a plate 44, the dimensions of which are substantially the same as the corre-5
sponding dimensions of the side walls 13 and 14 of the maintaining the same dimensions. The wedges are co-exten-sible with the respective ends of the adjacent core sectors or units, and are retained against planar move-20
ment by the shoulders 11 on the rim members 5 and 5 of the respective rings 3 and 4. Thus as the wedge member 37 is moved radially inward with respect to the assembly pressure is exerted upon the plates 44 and the ends of the respective core sectors, thereby firmly locking the respective core sectors in position between the rings, and preventing any circumferential movement of the sectors. Such radial movement of the wedge member 37 is obtained by means of the bolts 41, the free ends of the latter extending through respective, re-silient bushings 45 and washers 46. Threaded on the ends of the respective bolts are suitable nuts 47, the latter, in the construction illustrated, being of the type embodying a suitable plastic or fiber insert 48 therein to achieve a lock nut action, such types of nuts being readily commercially procurable. Thus, by rotating the bolts 41 in a direction to draw the nuts 47 down thereon, the wedge members may be drawn radially inward to exert a wedging action on the plates 43. As an additional safety factor, the bolts 41 may be provided with drilled heads 49 through which a suitable lock wire 49 may be passed to pro-25
vide a positive lock on the bolts 41. The positions of the nuts 47 and recesses or openings 38 in the wedge member 37 are so selected that rotation of the nuts 47 is prevented. It will be appreciated that the resilient sleeves 45 provide a cushion between the drawing action of the bolts 41 and the plates 43, thereby eliminating the danger of exerting sufficient force through the wedge member 37 on the ends of the core sectors to buckle, or otherwise damage the latter, which might occur if such a cushioning structure were not provided.

In fabricating the heat exchanger above described, the fluid pass housings 22 and fin structures 19 and 25 may be suitably fabricated from sheet metal by stamping or other suitable operation. As previously men-30
tioned, as the dimensions of the rings 3 and 4, and the distance therebetween in the final assembly are held to very close tolerances, to insure dimensional accuracy in the respective core sectors or units, each of the hous-ing members are preferably passed through a sizing die which is constructed to set the corner portions which would engage the rims 6 and 7 of the respective rings 3 and 4 to the desired dimensions. Following this opera-
35
tion, the components may be assembled to form the respective core sectors, housing members 27 and 28 being employed at the ends of each unit. Following the assembly of the respective units, the component parts thereof may be suitably bonded into an integral assembly. For example, if aluminum were employed in the construction of the pass housings and fin structures, an aluminum brazing operation may be performed to achieve the desired bonding. It will be noted that due to the construction of the fluid pass housings and fin structures, substantially all compacting forces result-39
ing from the bonding operation will be in a circumferen-tial direction relative to the entire assembly, in other words, between the ends of the respective units, and as a result of the sizing operation previously described, the core sectors or units may be readily fabricated to accurately fit the rings 3 and 4 within very close tolerances. The core sectors or units are then assembled between the rings 3 and 4, with a wedge assembly con-44
sisting of the members 29, 37, and plates 43 being posi-
tioned between the ends of each pair of adjacent sec-tors. As illustrated in Figs. 1, 3 and 5, the cross mem-
bers 9 connecting the rim portions 6 and 7 of each ring are so spaced that the respective wedge assemblies will be positioned adjacent each oppositely disposed pair of cross members 9, and as previously described, the body members 29 of each wedge assembly may be secured to the respective cross members by the bolts 34, thereby rigidly connecting the two ring members, and thereby maintaining the spacing and position of the rings. The incorporation of the wedge structure in the assembly, each of the bolts 41 are rotated in a counter-clockwise direction to position the nuts 47 adjacent the free ends of the bolts, and thereby position the wedge members 37 at the outer limit of their radial movement so that no forces are imparted to the plates 43. Following the assembly of the core sectors and rings, the bolts 41 are rotated in a clockwise direction to draw the wedge members radially inward, and thereby exert pressure on the plates 43 and the ends of the adjacent core sectors to firmly lock the latter in position between the rings 3 and 4. The adjustment of the bolts 41 is pref-erably so made that the three bolts in each wedge assembly will be uniformly tensioned to equalize the applied stresses on the wedge member and the adjacent sectors. Likewise, tension on the bolts 41 throughout the respective assembly is adjusted to equalize the stresses on the ends of all core units.

It will be noted that as the connecting or closure walls of all fluid passes either axially or radially, with the exception of the narrow integrally connected inner walls, are of overlapped construction, adequate strength is provided in the core sectors even though relatively light material is employed in the construction thereof. Likewise, as only two types of fin structures are employed, and only three different housing structures, the units may be readily fabricated upon a produc-tion basis at relatively low cost, with the number of individual components employed in the entire assembly being reduced to a minimum.

It will be noted that the wedge assembly, including the body or base members 29, wedge members 37, and plates 43, are so designed that the mass thereof is at a maximum, only sufficient spaces or recesses being incor-po-rated into the mass. Furthermore, the components thereof therefore serve four functions in the completed heat exchanger assembly: First, they provide a means of fastening the heat exchanger sectors rigidly in the rings due to the wedging action produced; Second, they provide a means of compensating for differences on the circumferential lengths of the heat transfer sectors resulting from normal commercial tolerances in the components thereof, both—those which are inherent in such com-
ponents, and those which may be introduced in the bonding process; Third, they provide means for accurately spacing the rings 3 and 4, and Fourth, they provide good heat transfer between the end passes of adjacent sectors to achieve the desired balanced heat flow in all passes. If for any reason additional adjustment is required or de-sired which cannot be accommodated by the length of travel of the wedge members 37, the plates 43 can be increased in thickness at the desired point to provide a fixed, combined circumferential length of the sector and plates 43. In some applications of the invention, it may be desirable to assemble the individual sections into a unitary structure. Such a construction is illustrated in Fig. 9, wherein a spacing member 29 is employed between ad-
joining sections 5. In the embodiment illustrated, the number 29 is formed with a series of corrugations 81. Desired portions of the corrugations contacting the respective end walls 14 and 14 of adjoining sections may be bonded to such walls by any suitable means, all of such portions being so secured in the embodiment il-lustrated. As the member 29 may not provide as great
an amount of heat transfer between adjacent fluid passes as that previously described, this type of construction is suitable for applications of this invention where this feature is not a critical factor. Likewise, a desired amount of resilience could be achieved in the member 29 by suitable designing of either or both the corrugations thereof with the end walls of the sections. Thus, the member 29 may function in a manner similar to the wedge member 29, exerting forces on the end walls of the sections as well as provide heat transfer means therebetween.

In mounting an exchanger, of the type illustrated in Fig. 9, between a supporting structure such as the rings 3 and 4; bolts S2, extending between adjacent corrugations may be employed, the bolts being of a length to connect two rings 3 and 4. Such bolts could be secured in place by suitable nuts or the free ends of the bolts could be threaded into the adjacent ring structure.

It will be apparent from the above disclosure that the present invention enables the production of a light-weight toroidal or circular type of heat exchanger of particular advantage in aircraft in connection with the cooling of supercharged air, and the like, in which highly desirable characteristics with respect to efficiency, size, weight, and the maintenance of extremely close dimensional tolerances are achieved despite the incorporation of a relatively large number of individual components which embody commercial tolerances.

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

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

1. A toroidal type heat exchange structure comprising a plurality of heat exchange sections, each of said sections provided with a substantially curved inner and a substantially curved outer face, said faces substantially concentric, said curved faces connected by a pair of axially spaced faces lying in respective parallel planes extending normal to the axis of generation of the curved faces, said sections arranged on a common radius with their corresponding axial faces lying in respective common planes, concentric frame supporting means adjacent the respective axial faces for restricting radial and axial movement of said sections, and frame spacer means positioned between the ends of each pair of adjacent sections rigidly connected by ams concentric frame supporting means adjacent the respective corresponding axial faces, and adjusting wedge means associated with said frame spacer means for applying compression forces to said adjacent sections in a circumferential direction.

2. A toroidal-type heat exchange structure for the exchange of heat between two fluids comprising a plurality of heat exchange sections, supporting frame means for supporting said sections with an end wall of each section positioned in adjacent relationship, one of said end walls in heat transfer relation with one of such fluids and the other end wall in heat transfer relation with the other of such fluids, and adjusting means positioned between the adjacent end walls of said sections including heat conducting portions extending between and contacting said end walls providing heat transfer therebetween and tending to compensate for unbalanced heat transfer between the two fluids in the respective end portions of the heat exchange sections.

3. A toroidal-type heat exchange structure comprising a plurality of heat exchange sections, each provided with a substantially curved inner and a substantially curved outer face, said faces substantially concentric and connected by a pair of axially spaced faces lying in respective parallel planes extending normal to the axis of generation of the curved faces, said sections arranged on a common radius with their corresponding axial faces lying in respective common planes, supporting means adjacent the respective axial faces and engaging portions of the radial faces and faces for restricting radial and axial movement of said sections, a generally wedge-shaped body member positioned between adjacent walls of a pair of said heat exchange sections and rigidly secured to said supporting means, said body member formed with an opening extending therethrough, a wedge-shaped member of heat conducting material positioned in said opening with the wedge faces thereof positioned in opposed relation with respect to respective adjacent walls of said pair of heat exchange sections, a cooperable member of heat conducting material positioned at and extending along each wedge face, each of said members having its respective faces formed to seat on the adjacent faces of the wedge member and the adjacent wall of one of the respective heat exchange sections, and means operatively connecting said body and wedge members for applying force to the latter in a direction to urge said cooperable members outwardly toward the respective walls of such heat exchange sections.

4. A toroidal type heat exchange structure comprising a plurality of arcuate-shaped heat exchange sections, each of said heat exchange sections formed from sheet metal, and comprising a pair of substantially co-extensive, rectangularly-shaped side walls, said rectangularly-shaped connecting wall integral with and connecting said side walls at a pair of opposed edges, a pair of cooperable oppositely disposed flanges at the opposite edges of said side walls, said flanges secured together to form a second substantially rectangularly-shaped connecting wall greater in width than said first connecting wall, said connecting walls extending substantially in parallel planes to form a trapezoidal-shaped fluid pass open at opposite ends thereof with the direction of fluid flow there-through parallel to the axis of the toroidal heat exchange structure, each of the edges of said side walls defining the open ends of said pass terminating in an outwards extending flange, the flanges associated with the same side walls lying in substantially parallel planes, the flanges on one side wall complementally formed to engage and cooperate with the complementally formed flanges on a side wall of a similar housing, said housings being arranged in spaced relation with the open ends thereof similarly positioned, with the corresponding flanges on adjacent pairs of housings secured together and with the side walls associated therewith forming a rectangularly-shaped intermediate fluid pass between the trapezoidal-shaped passes and with the direction of fluid flow through the rectangularly shaped intermediate fluid pass at right angles to the fluid flow through the trapezoidal-shaped fluid pass, said intermediate passes formed with radially spaced open ends extending transverse to the open ends of said first-mentioned passes, a trapezoidal-shaped corrugated member in each trapezoidal-shaped pass forming a plurality of axially extending fin elements in each trapezoidal pass, and a plurality of radially extending rectangular-shaped fin elements in each rectangular pass, said fin elements extending from one side wall to the other and secured thereto, said sections being arranged around a common axis with their corresponding axial faces lying in respective common planes, supporting means adjacent the respective axial faces and engaging portions of the radial faces and faces for restricting radial and axial movement of said sections, a generally trapezoidal-shaped body member positioned between adjacent end walls of each pair of adjoining pairs of heat exchange sections with the converging faces of such member extending in generally radial directions, opposite to the adjacent end walls, said body member having a transverse opening extending therethrough, a wedge-shaped member of heat conducting material positioned in said opening with the wedge faces thereof positioned in opposed relation with respect to respective adjacent walls of such a pair of heat exchange sections, a coop-
erable plate-like member of heat conducting material positioned at and extending along each wedge face, each cooperating member having its respective faces constructed to seat on the adjacent face of the wedge member and the adjacent wall of one of the respective heat exchange sections, and means operatively connecting said body and wedge members for applying force to the latter in a direction to urge said cooperating members outwardly toward the respective walls of such heat exchange sections and connecting means including a relatively resilient element.

5. A toroidal type heat exchange structure comprising a plurality of heat exchange sections, each having a substantially curved inner and a substantially curved outer face, said faces substantially concentric and connected by a pair of axially spaced faces lying in respective parallel planes extending normal to the axis of generation of the curved faces, said sections arranged on a common radius with their corresponding axial faces lying in respective common planes, frame supporting means adjacent the respective axial faces for restricting radial and axial movement of said sections, and radially extending and trapezoidal-shaped frame spacer means positioned between and secured to the ends of each pair of adjacent sections, rigidly connecting the frame supporting means adjacent the respective corresponding axial faces.

6. A heat exchange structure comprising a plurality of heat exchange sections, each of said sections having a substantially curved inner and a substantially curved outer face, said faces substantially concentric and connected by a pair of axially spaced faces lying in respective parallel planes extending normal to the axis of generation of the curved faces, said sections arranged on a common radius with their corresponding axial faces lying in respective common planes, frame supporting means adjacent the respective axial faces for restricting radial and axial movement of said sections, a radially extending corrugated trapezoidal-shaped member positioned between the ends of each pair of adjacent sections, and securing means rigidly connecting the frame supporting means adjacent the respective corresponding axial faces.

7. A fluid pass for a toroidal-type heat exchange structure comprising a pass housing formed from one piece of sheet metal, said pass housing comprising a pair of substantially co-extensive, rectangular-shaped side walls, a substantially rectangular-shaped connecting wall integral with and connecting said side walls at a pair of opposed edges, said sheet metal provided with a pair of complementally formed inwardly extending integral flanges at the opposite edges of said side walls, said flanges secured together forming a second substantially rectangular-shaped connecting wall greater in width than said first connecting wall, said connecting walls extending substantially in parallel planes providing a trapezoidal-shaped fluid pass open at opposite ends thereof and with the direction of fluid flow therethrough parallel to the axis of the toroidal-type heat exchange structure in which the fluid pass is assembled, each of the edges of said side walls defining the open ends of said pass terminating in an outwardly extending integral flange, said flanges connected with said side wall lying in substantially parallel planes, said flanges connected with said side wall lying in substantially parallel planes, said flanges on one side wall complementally formed and affixed to complementally formed flanges on a side wall of a similar housing, said housings arranged in spaced relation with the open ends thereof similarly positioned, with the corresponding flanges on adjacent pairs of housings secured together and with the side walls associated therewith providing a rectangular-shaped intermediate fluid pass between each pair of trapezoidal-shaped passes and the direction of flow through the rectangular-shaped intermediate fluid pass at right angles to the flow through the pair of trapezoidal-shaped passes, said intermediate passes having radially spaced open ends extending transverse to the open end of said first-mentioned passes, a corrugated member in each pass forming a plurality of axially extending fin elements in each toroidal-shaped pass, and a plurality of axially extending fin elements extending from one side wall to the other of said trapezoidal-shaped fluid pass and secured thereto.

8. A fluid pass for a toroidal-type heat exchanger including a pass housing formed from one piece of sheet metal, said pass housing comprising a pair of sub-stantially co-extensive, rectangular-shaped side walls, a substantially rectangular-shaped connecting wall integral with and connecting said side walls at a pair of opposed edges, said sheet metal provided with a pair of co-operable inwardly extending integral flanges at the opposite edges of said side walls, said flanges secured together forming a second substantially rectangular-shaped connecting wall greater in width than said first connecting wall, said connecting walls extending substantially in parallel planes providing a trapezoidal-shaped fluid pass open at opposite ends thereof with the direction of fluid flow therethrough parallel to the axis of the toroidal-type heat exchanger in which the fluid pass is assembled, each of the edges of said side walls defining the open ends of said pass terminating in an outwardly extending integral flange, said flanges connected with said side wall lying in substantially parallel planes, said flanges on one side wall complementally formed and affixed to similar flanges on a side wall of a similar housing, said housings arranged in spaced relation with the open ends thereof similarly positioned, with the corresponding flanges on adjacent pairs of housings secured together and with the side walls associated therewith providing a rectangular-shaped intermediate fluid pass between each pair of trapezoidal-shaped passes and the direction of flow through the rectangular-shaped intermediate fluid pass at right angles to the flow through the pair of trapezoidal-shaped passes, said intermediate passes having radially spaced open ends extending transverse to the open end of said first-mentioned passes, a corrugated member in each pass forming a plurality of axially extending fin elements in each toroidal-shaped pass, and a plurality of axially extending fin elements extending from one side wall to the other of said trapezoidal-shaped fluid pass and secured thereto.

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