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(54) HEAT EXCHANGER ASSEMBLY

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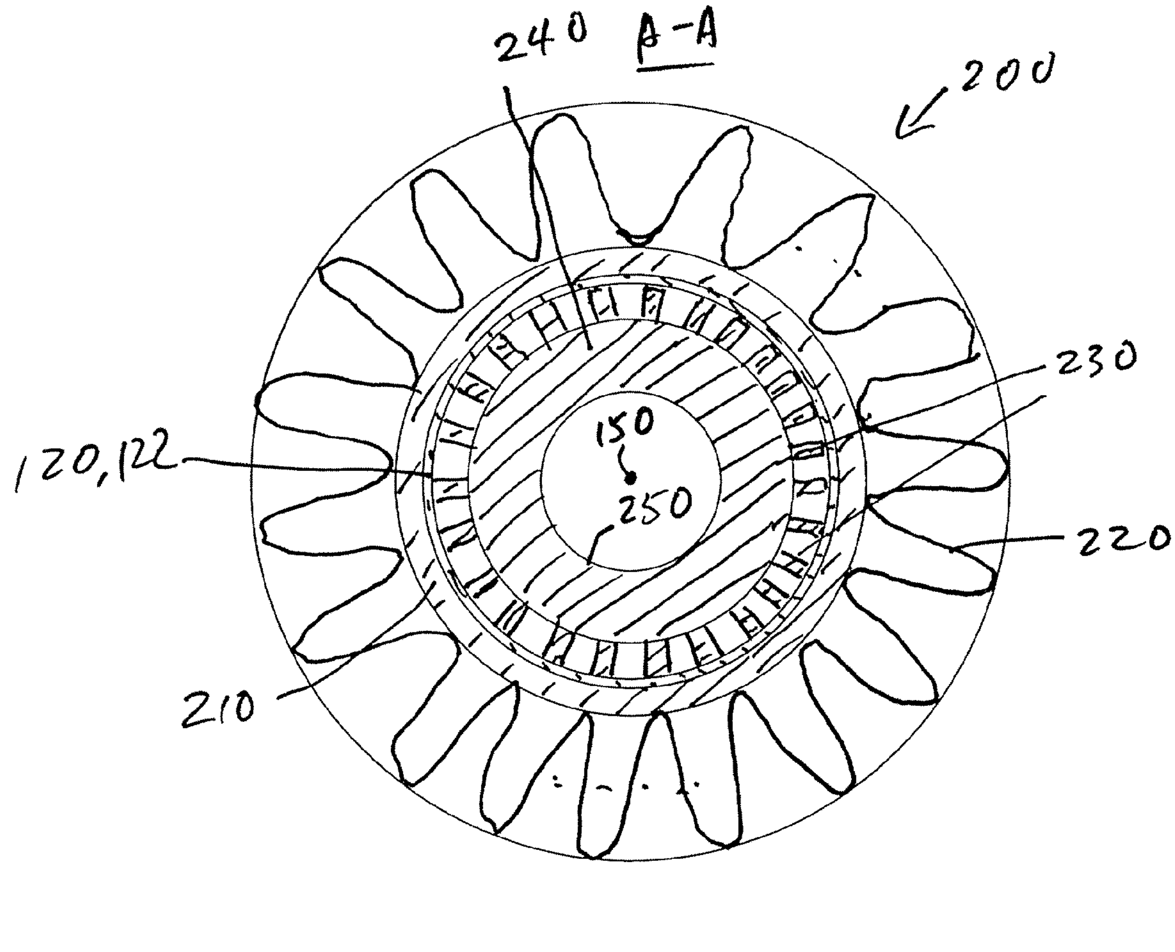
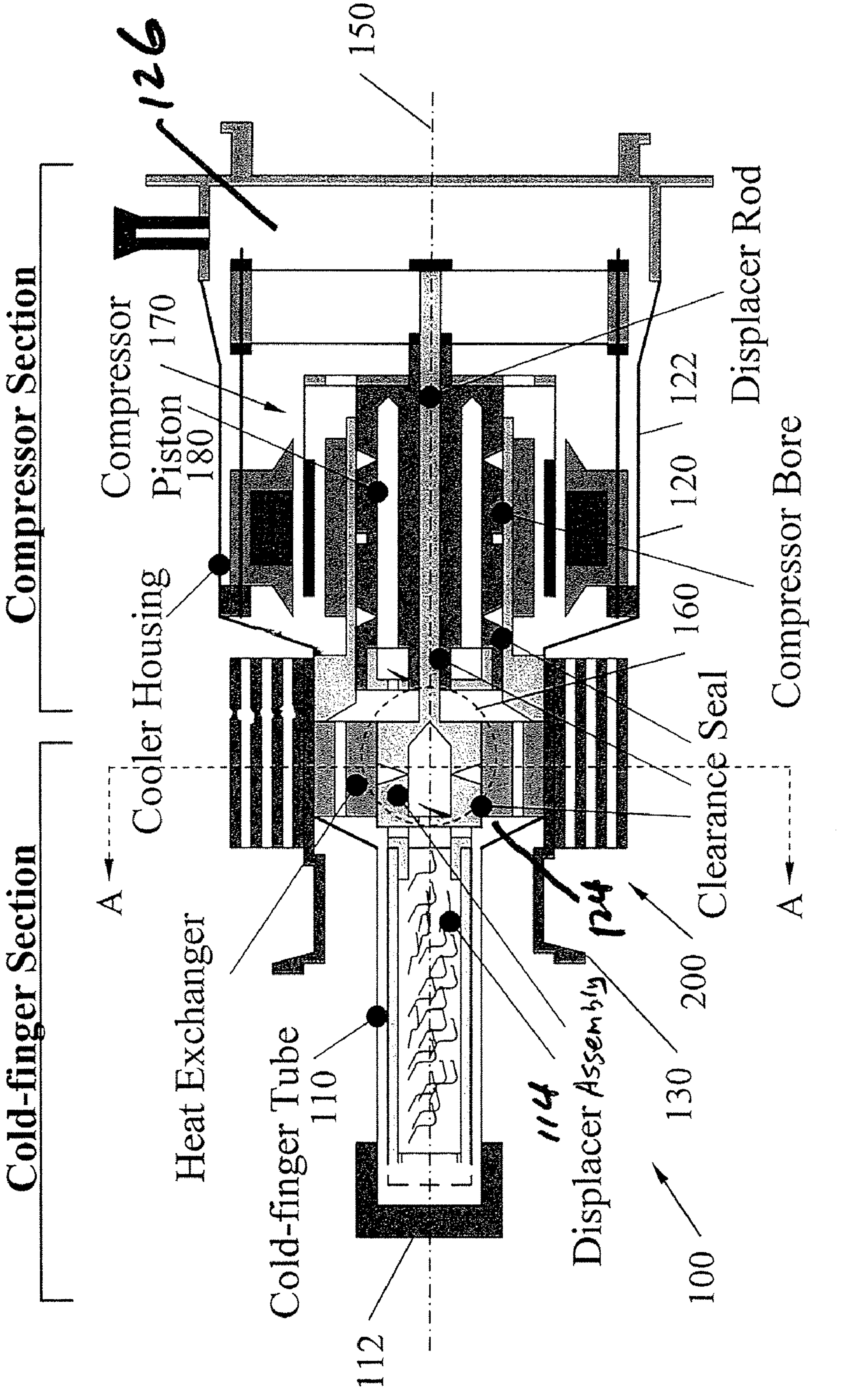
(57) **ABSTRACT**

A heat exchanger assembly for transferring heat across a wall of a housing is disclosed. The assembly comprises an outer heat exchanger having an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall; an inner support disposed inside the housing and having an exterior surface; and a plurality of inner heat fins connecting the exterior surface of the inner support to an interior surface of the wall of the housing.




Compressor Section
Cold-finger Section
150
126
Compressor
170
Piston
180
Cooler Housing
Heat Exchanger
Cold-finger Tube
110
112
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100
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124
Clearance Seal
160
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Displacer Rod
Compressor Bore
A
A

FIG. 1

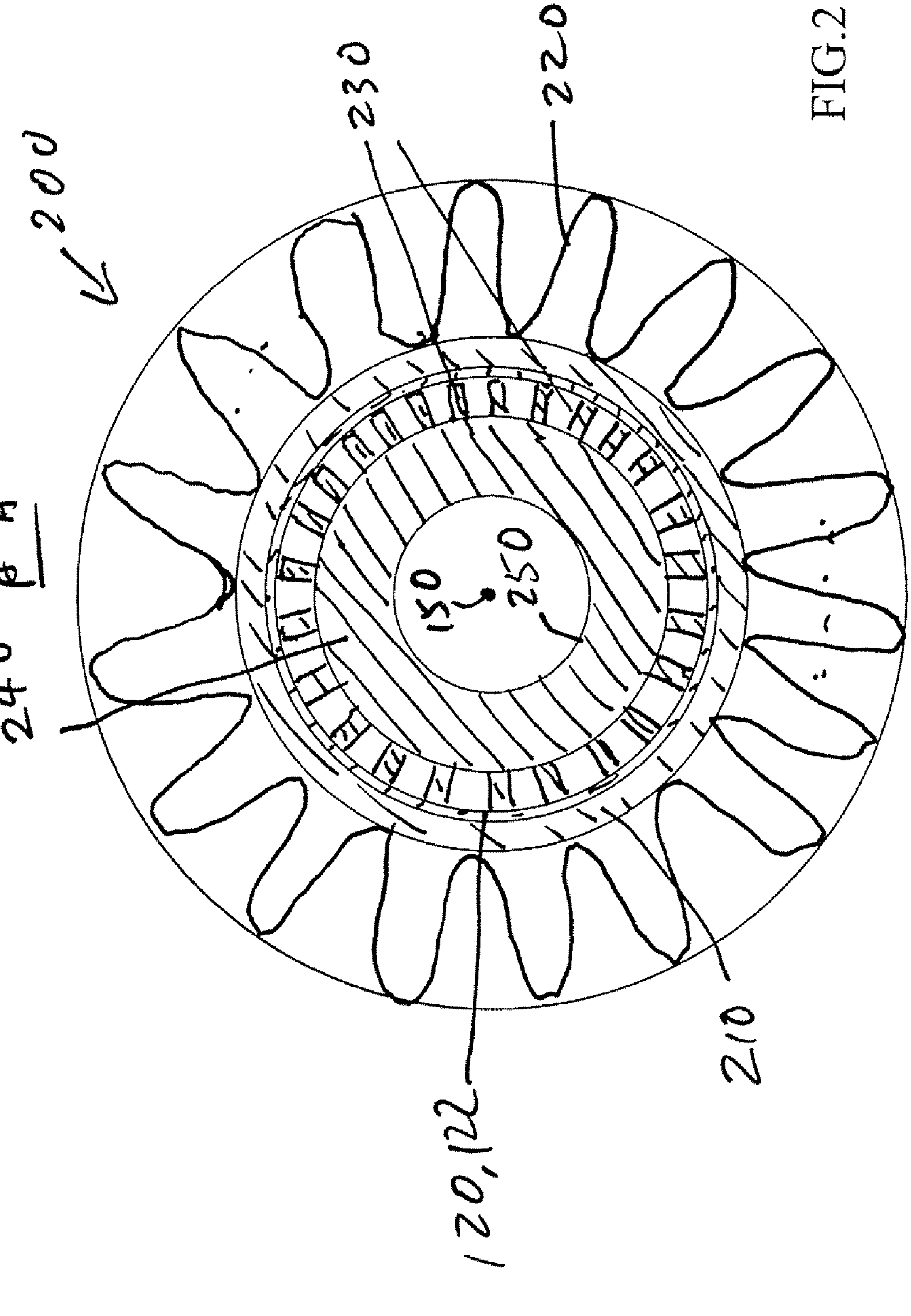

FIG.2

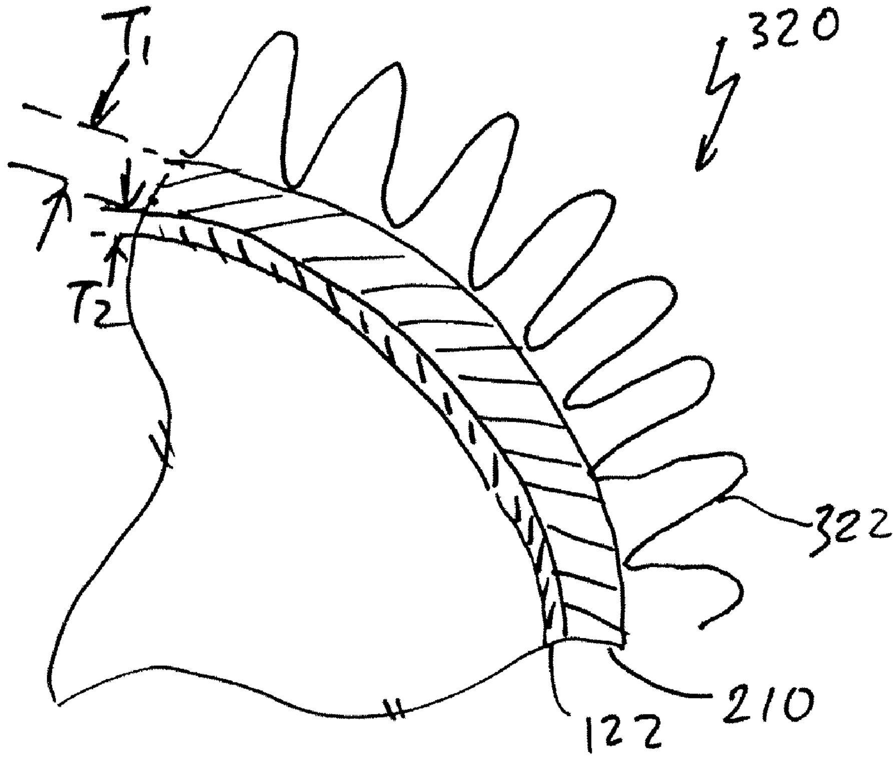

Fig. 3

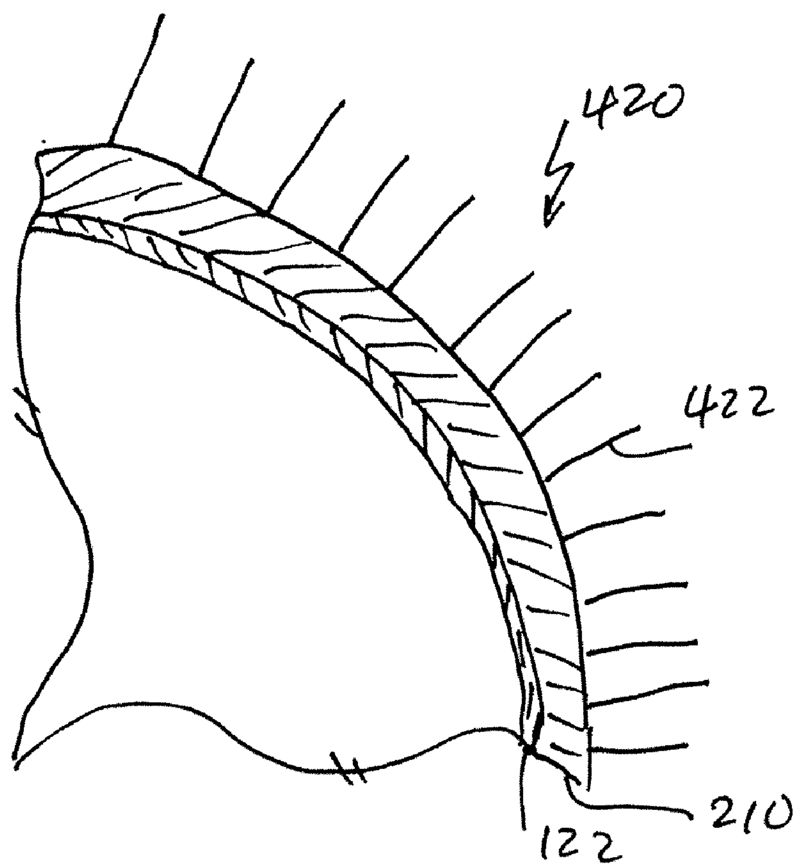

Fig. 4

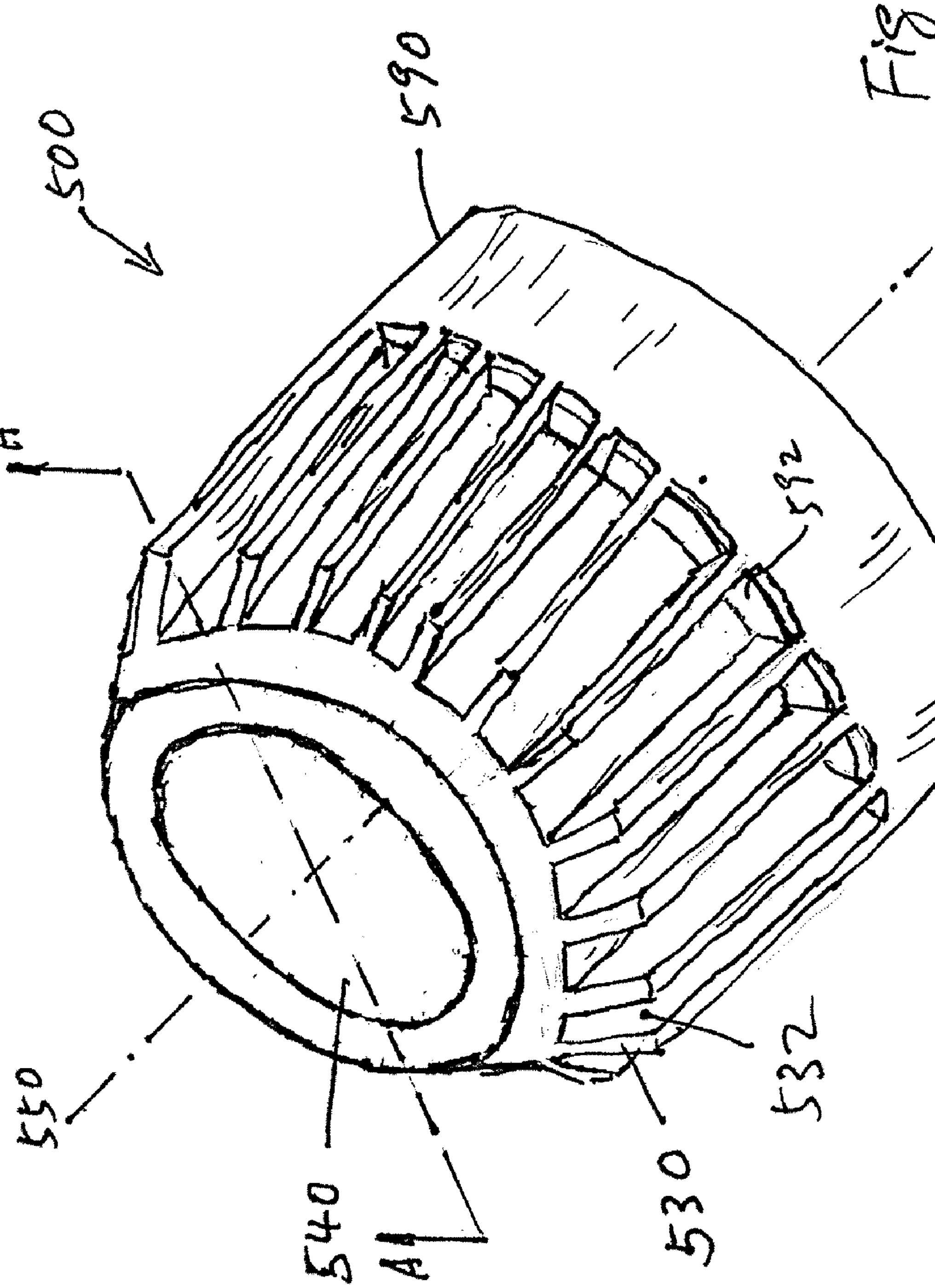

Fig. 5

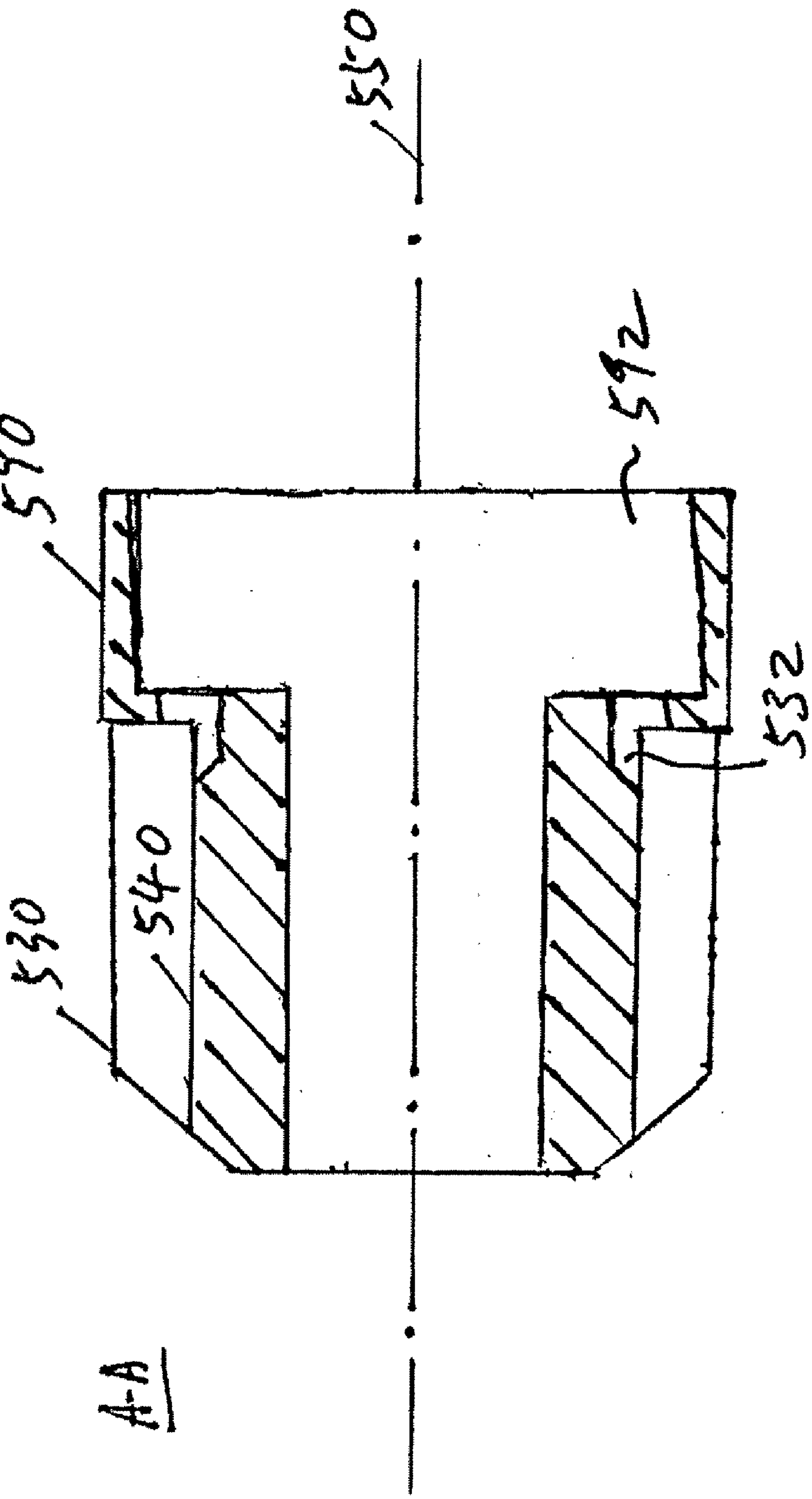

Fig. 6

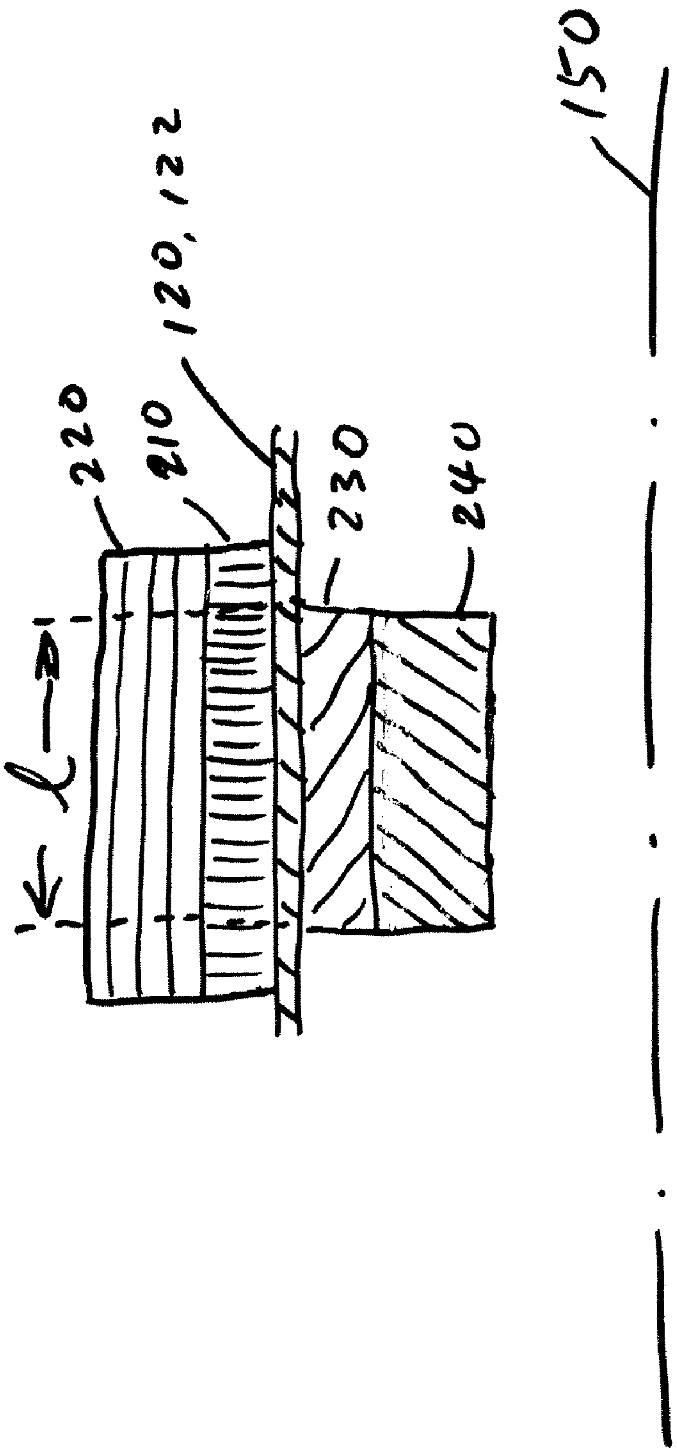

Fig. 7(a)

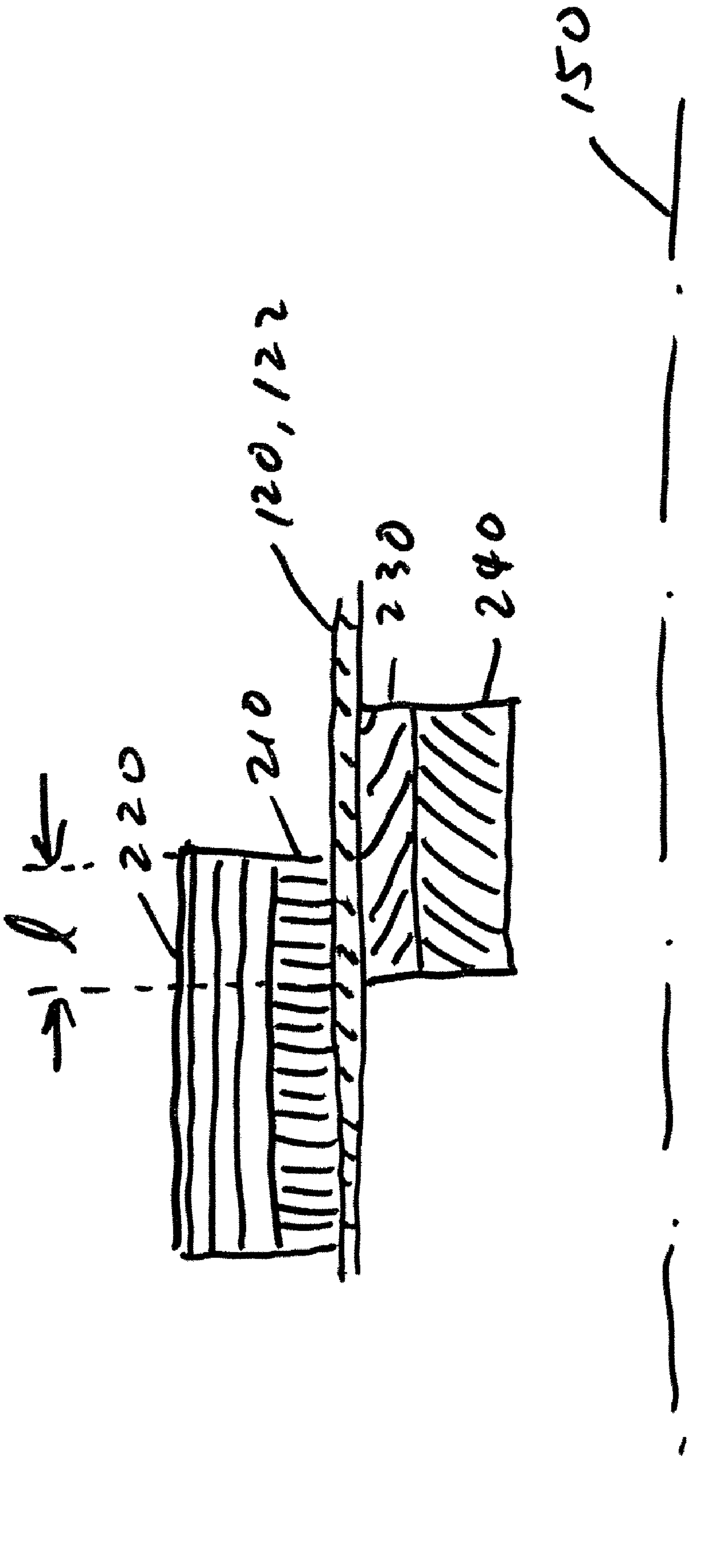

Fig. 7(b)

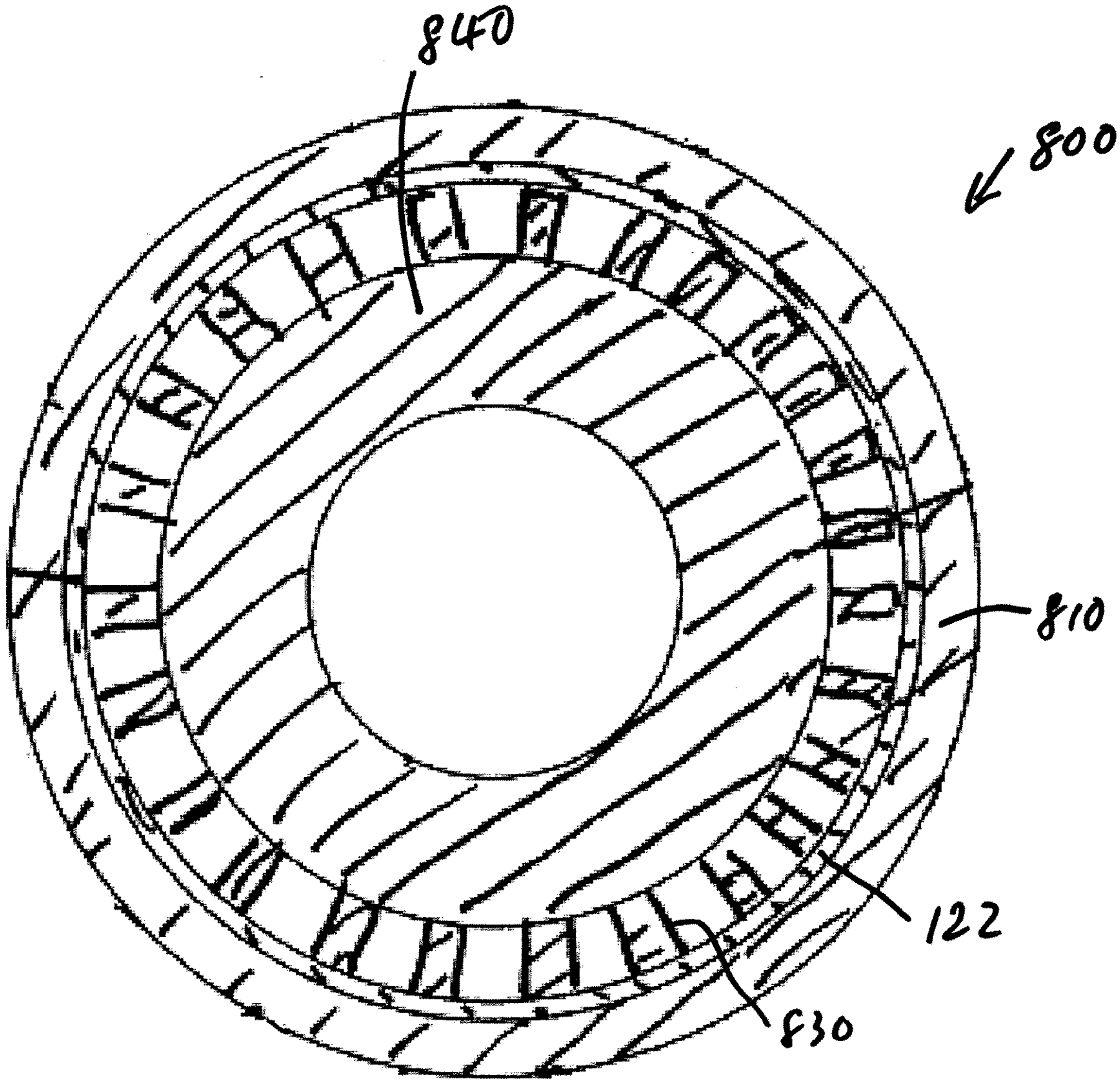

FIG. 8

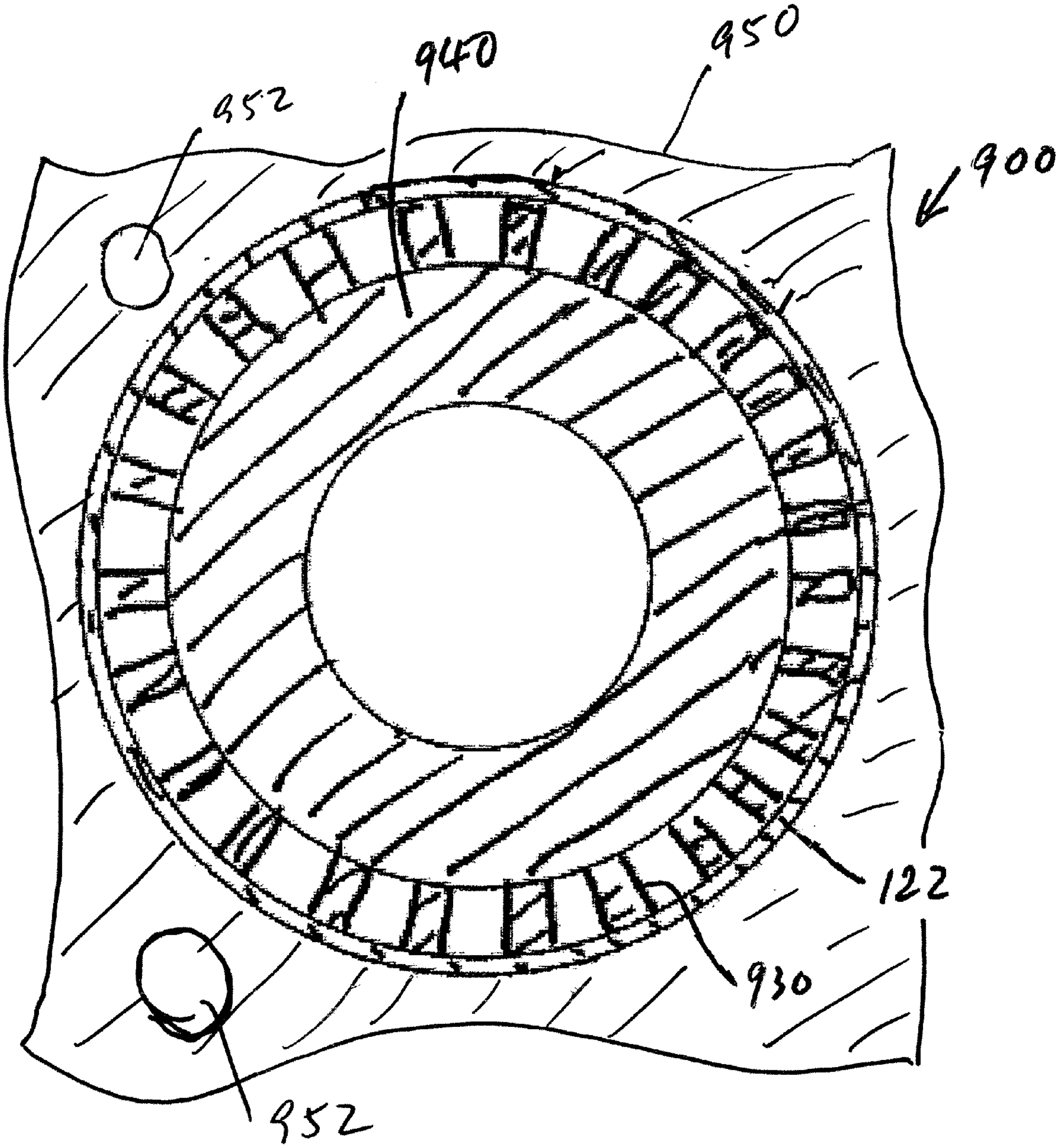

Fig. 9

HEAT EXCHANGER ASSEMBLY

RELATED APPLICATIONS

[0001] This application claims the benefit of the U.S. Provisional Application Ser. No. 60/802,174, filed on May 19, 2006. The aforementioned U.S. Provisional Application Ser. No. 60/802,174 is incorporated herein by reference.

BACKGROUND

[0002] The application relates to heat exchangers. More particularly, the invention relates to a heat exchanger assembly for transferring heat between the interior and exterior of a housing through a portion of the housing wall.

[0003] Heat exchangers are typically used to conduct heat between two media without intermixing between the media. In a typical environment where a heat exchanger may be used, a first medium is isolated from a second medium by a wall. A heat exchanger is attached to at least one side of the wall and has a structure, such as heat fins, that provides a sufficiently large surface area for establishing the desired heat exchange rate with the surrounding medium.

[0004] As an example, in a Stirling cycle machine, such as a Stirling cryocooler or a Stirling engine, a sealed housing contains a working gas, a portion of which is periodically compressed and expanded. The heat generated by the compression and other sources is to be transferred to the outside of the housing and dissipated. The effectiveness of the heat exchangers has a significant impact on the efficiency of a Stirling cycle machine relative to the Carnot efficiency. A variety of designs for heat exchangers exist for Stirling cycle machines. For example, in certain cryocoolers for refrigerating superconductor filter circuits used in base stations for wireless telephone networks, the heat exchanger assembly for dissipating heat from the working gas includes an external heat exchanger. The external heat exchanger includes heat fins circumferentially distributed around a columnar segment of the cryocooler housing and radially projecting from the segment. The heat fins are made from one or more pleated sheets of thermal conductors such as sheet copper and affixed to the housing by welding, brazing or the use of an adhesive. An internal heat exchanger is typically also used to transfer heat from the working gas to the housing.

[0005] A cryocooler housing for such applications is typically constructed with stainless steel, which is a poor thermal conductor compared to copper and aluminum. The housing wall is therefore typically thin (wall thickness typically less than **1** mm) in order to minimize the radial temperature gradient inside the wall thus allowing a maximum thermal conduction and an optimum heat removal in the area of the heat exchanger. However, a reduced thickness of the housing wall results in a relatively high thermal resistance or poor thermal conductivity in circumferential directions. High resistance to circumferential heat conduction is undesirable because heat needs to be adequately conducted in circumferential directions to the bases of the heat radiating structures for a heat exchanger to function properly.

[0006] U.S. Pat. No. 6,446,336 ("the '336 patent") discloses a heat exchanger for transferring heat across a housing wall. The heat exchanger has an outer ring seated against the exterior surface of a portion of the housing and supporting radially outwardly projecting external heat fins. The heat exchanger further has an inner ring seated against the interior surface of the portion of the housing wall and supporting radially inwardly projecting internal heat fins. The disclosed heat exchanger has certain advantages over prior art in heat transfer and structural characteristics. However, in certain applications, it is desirable to have rigid internal heat fins such as machined heat fins. It is very difficult to make such heat fins in an inwardly projecting configuration, as disclosed in the '336 patent. Further, in some applications, it is desirable to have an internal passageway, defined by the tips of the internal heat fins, to be highly concentric with the housing and/or other components, such as the compressor bore, of the Stirling cycle machine to. For example, such precise alignment is often needed to achieve desired close tolerances between stationary and moving components, such as between an internal heat exchanger and a displacer in a Stirling cycle machine and between the compressor bore and the compression piston, which is coaxial with the displacer. With the configuration disclosed in the '336 patent, it is difficult to achieve the desired precision in alignment.

[0007] For these and other reasons, there is a need for an improved heat exchanger assembly.

SUMMARY

[0008] This application discloses an improved heat exchanger assembly. In one embodiment of the invention, an outer ring made of a thermal conductor, such as copper, or aluminum, is positioned between external heat fins and an exterior surface of the housing wall, thereby providing improved heat distribution from the housing wall to the external heat fins. An inner support made of a thermal conductor, such as copper, or aluminum, is positioned inside the housing wall and supports inner heat fins, which abut an interior surface of the housing wall. At least a portion of the outer ring and at least a portion of the inner heat fins sandwich at least a portion of the housing wall. The inner support provides the structural backing that enables the inner heat fins to be in direct contact with the housing wall by a variety of methods, including shrink-fitting. The inner heat fins can be press-fitted, shrink-fitted, or otherwise bonded, to the housing wall, and the outer ring can be press-fitted, shrink-fitted, or otherwise bonded, to the housing wall.

[0009] In another embodiment of the invention, a component of a Stirling cycle machine comprises a housing comprising a wall defining an interior gas volume and adapted to seal within the interior gas volume a working gas, the interior working gas volume comprising a compression region where the working gas is subject to intermittent compression and expansion; an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall; a plurality of outer heat fins projecting from the outer ring; an inner support disposed inside the housing and having an exterior surface; and a plurality of inner heat fins connecting the exterior surface of the inner support to an interior surface of the wall of the housing. At least a portion of the outer ring and at least a portion of the inner heat fins sandwich at least a portion of the housing wall.

[0010] In another embodiment of the invention, a heat exchanger assembly comprises an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall; a plurality of outer heat fins outwardly projecting from the outer ring; and a plurality of inner heat fins projecting inwardly from the interior surface of the wall. At least a portion of the outer ring and at least a portion of the inner heat fins sandwich at least a portion of the housing wall. The inner heat fins can be attached to the interior surface of the housing wall by methods including brazing and soldering.

[0011] In another embodiment of the invention, a method for making a heat exchanger assembly for transferring heat across a wall of a housing comprises positioning an outer ring outside the housing such that an interior surface of the outer ring is in contact with an exterior surface of the wall; positioning a plurality of outer heat fins on the outer ring; positioning an inner support inside the housing; and connecting an interior surface of the wall and an exterior surface of the inner support using a plurality of inner heat fins such that at least a portion of the inner fins and at least a portion of the outer ring sandwich at least a portion of the housing wall. The inner heat fins can be shrink-fitted to the housing wall, and the outer ring can be shrink-fitted on the housing wall.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Other objects and advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0013] FIG. **1** schematically shows a Stirling cryocooler in an embodiment of the invention;

[0014] FIG. **2** shows a cross-sectional view of the heat exchanger assembly of the Stirling cryocooler shown in FIG. **1**;

[0015] FIG. **3** shows a portion of an outer heat fins in another embodiment of the invention;

[0016] FIG. **4** shows a portion of an outer heat fins in an alternative embodiment of the invention;

[0017] FIG. **5** is a perspective view of an internal heat exchanger in an alternative embodiment of the invention;

[0018] FIG. **6** is a cross-sectional view of the internal heat exchanger shown in FIG. **5**;

[0019] FIG. **7**(*a*) is a schematic cross-sectional view of a portion of the Stirling cryocooler in an embodiment of the invention, showing the outer ring and inner heat fins sandwiching a portion of the house wall; and

[0020] FIG. **7**(*b*) is a schematic cross-sectional view of a portion of the Stirling cryocooler in an embodiment of the invention, showing a portion of the outer ring and a portion of the inner heat fins sandwiching a portion of the house wall

[0021] FIG. **8** shows a schematic cross-sectional view of a further alternative embodiment of the invention.

[0022] FIG. **9** shows a schematic cross-sectional view of another alternative embodiment of the invention.

[0023] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

[0024] Various embodiments will be described in detail with reference to the drawings, wherein like reference numerals represent like parts and assemblies throughout the several views. Reference to various embodiments does not limit the scope of the claims attached hereto. Additionally, any examples set forth in this specification are not intended to be limiting and merely set forth some of the many possible embodiments for the appended claims. In particular, while the embodiments illustrated herein are described in the context of Stirling cycle machines such as Stirling cryocoolers, other embodiments not limited to Stirling cycle machines are possible.

[0025] Referring to FIG. **1**, in an embodiment of the invention, a heat exchanger assembly is employed in a Stirling cycle machine, which is configured as a cryocooler **100** includes sealed columnar housing **120**, with sections of various diameters disposed along a longitudinal axis **150**. The gas space inside the housing **120** is generally divided into a working space **124** and a bounce space **126** by seals. The housing **120** includes at one end a cold finger **110**, which houses a displacer assembly **114**. The cold finger **110** also includes a cold heat exchanger, or heat acceptor unit, **112**, which serves to transfer heat from the exterior of the housing **120** to a working gas confined in the working space **124**. The cryocooler housing **120** also encloses in its interior volume a linear motor **170** and a piston **180** driven by the motor for compressing and expanding a portion of the working gas in a compression region **160**. The cryocooler **100** further includes a vacuum flange **130**, which is also used for positioning the heat acceptor unit **112** in a vacuum chamber. In addition, a warm heat exchanger assembly **200** is positioned to be in thermal contact with the compression region **160** for dissipating heat from the working gas to the exterior of the housing **120**.

[0026] The general structures and operation of Stirling cycle machines, including those of Stirling cryocoolers, are well known in the art. For example, a Stirling cryocooler with a housing section having different diameters drawn from a single piece of stainless steel is disclosed in the U.S. patent application Ser. No. 10/729,719, filed Dec. 5, 2003, and issued on Nov. 21, 2006, as U.S. Pat. No. 7,137,259. The aforementioned U.S. Pat. No. 7,137,259 is incorporated herein by reference.

[0027] Referring to FIG. **2**, the warm heat exchanger assembly **200** in this illustrative embodiment includes outer heat fins **220** outside the housing wall **122** of the housing **120**, an outer ring **210**, which is seated against an exterior surface of the housing wall **122** and supports the outer heat fins **220**. The assembly further includes inner heat fins **230** inside the housing wall **122** of the housing **120**. The assembly **200** further includes an inner support member **240**, which is disposed inside, and in contact with, the inner heat fins **230**. At least a portion of the outer ring **210** and at least a portion of the inner heat fins **230** sandwich at least a portion of the housing wall. That is, at least a portion of the outer ring **210** and at least a portion of the inner heat fins **230** occupy the same axial position range (I, in the examples shown in FIGS. **7**(*a*) and **7**(*b*)) along the longitudinal axis **150**.

[0028] In the illustrative embodiment of the invention, the inner support member **240** is integral with the inner heat fins **230**. That is, both the inner support member **240** and the inner heat fins **230** are fabricated out of a single starting piece. For example, the fins can be formed on the inner support member **240** by removing material from the starting piece by machining, water cutting, laser cutting, chemical etching and other suitable techniques. The integral structure of the inner heat fins **230** and the inner support member **240** can also be formed by mold casting, powder metallurgy and any other suitable techniques for making metal parts. Alternatively, inner heat fins can be fabricated separately from the inner support member **240** and attached to the inner support member **240** by any suitable technique, including welding, brazing and soldering.

[0029] The inner heat fins **230** can be affixed to the housing wall **122** by a variety of suitable methods, including press-fitting, shrink fitting and bonding with a conductive adhesive. In this illustrative embodiment, the inner heat fins **230** are affixed to the housing wall **122** by shrink-fitting. The requisite rigidity to withstand the shrink-fitting process is supplied by the combined structure of the inner heat fins **230** and the inner support member **240**. The inner support member **240** and inner heat fins **230** in this case are made of aluminum, which has a higher thermal expansion coefficient than the housing wall **122**, which is made of a stainless steel. Other suitable material combinations can also be used. For example, copper, its alloys or other materials that have higher thermal conductivities can be used. In cases, such as for copper, where the thermal expansion coefficient of the inner fins is similar to that of the housing wall such that shrink-fitting may be unsuitable, other methods such as press-fitting and bonding can be used to affix the inner heat fins **230** to the housing wall **122**. In attaching the inner heat fins **230** to the housing wall **122** by shrink-fitting, the assembly of the heat fins **230** and inner support **240** are placed in a medium, for example liquid nitrogen, having a lower temperature than the housing wall **122** before positioned inside the housing wall **122**. Upon being warmed up, the assembly of the heat fins **230** and inner support **240** become shrink-fitted to the housing wall **122**. Alternatively, the housing wall **122** can be heated before being slid over the inner heat fins **230** and then allowed to cool. Shrink fitting allows the inner heat fins **230** to be attached to the housing wall **122** without the need for other joining techniques such as welding, brazing and soldering, which tend to introduce non-uniform deformation into the components being joined.

[0030] For certain applications, such as in a Stirling cycle machine having a displacer, an interior surface **250** can be formed in the inner support **240**, as shown in FIG. **2**, to accommodate a sliding member (erg., the displacer) moving through the aperture defined by the interior surface **250**. Moreover, the interior surface **250** in an illustrative embodiment is ground or honed to be concentric with the housing **120** and/or other components, such as the compressor bore, of the Stirling cycle machine and sufficiently smooth to act as a seal and/or a bearing surface for the sliding member. For example, in an embodiment for a Stirling cryocooler, the interior surface **250** is sized to accommodate a displacer and has the requisite tolerance and smoothness to form a displacer seal and for realizing a displacer gas bearing, which has gas ports for discharging pressurized gas in between the displacer surface and the interior surface **250** of the inner support **240**.

[0031] Referring again to FIG. **2**, the outer ring **210** is disposed between, and in contact with, the housing wall **122** and the outer heat fins **220**. In this illustrative embodiment of the invention, the outer ring **210** is a cylindrical annular ring circumferentially surrounding the housing wall **122**. The outer ring **210** in this illustrative embodiment is made of a material having a higher thermal conductivity, than the thermal conductivity of material for the housing wall **122**. For example, the housing wall is typically made of a stainless steel. In such a case, copper, aluminum or their respective alloys or other materials that have higher thermal conductivities can be used for the outer ring.

[0032] As noted above, low heat flow resistance in circumferential directions is important for the proper functioning of a heat exchanger, and the prior art addresses this issue by using both an external and internal rings. In this respect, the illustrative embodiments of the invention employ a single outer ring **210** to achieve the same functionality as two rings used in the prior art, thereby reducing the components needed and simplifying the manufacturing process.

[0033] The outer ring **210** can be affixed to the housing wall **122** by a variety of methods. For example, an adhesive with good thermal conduction properties, such as a thermo-conductive adhesive, which has metal particles embedded in the resin, can be used to bond the outer ring **210** to the housing wall **122**. The outer ring **210** can also be press-fitted, shrink-fitted, or otherwise connected, to the housing wall **122** in a similar way as discussed above for shrink-fitting the inner heat fins inside the housing. For example, an aluminum outer ring **210** can be heated prior to being slipped over a portion of a stainless steel housing **120** and then cooled to shrink-fit on the housing **120**. In another embodiment of the invention, a sealant is applied between the outer ring **210** and the housing wall **122** prior to shrink-fitting to seal any gap between the outer ring **210** and the housing wall **122**. This is useful in applications where the outer ring is connected to, or used as part of, a flange for a gas-tight chamber (e.g., a vacuum flange in a Stirling cryocooler). A variety of sealants well known in the art can be used to suit particular applications.

[0034] In addition to conducting heat away from housing wall **122**, the outer ring **210** also serves to enhance the structural integrity of the housing wall **122**, which is typically very thin, as mentioned above. In Stirling cooler applications, the interior of housing **120** is typically pressurized. It is therefore particularly desirable and typically more effective to reinforce the housing wall **122** from outside in Stirling cooler applications.

[0035] The outer heat fins **220** can be affixed to the outer ring **210** by a variety of methods, including welding, brazing and bonding with an adhesive. Instead of affixing the outer heat fins **220** to the outer ring **210**, the outer heat fins **220** can be made from the same starting piece of material as the outer ring **210** in similar ways as described above for the inner heat fins **230**.

[0036] As alternatives to the structures described above, the heat fins **220**, **230** can be constructed from one or more pleated sheets of thin metal, such as copper. They can be shaped in a variety of ways as need to suit the particular design. For example, with further reference to FIG. **3**, the outer heat fins **220** comprise fins **322** constructed from one or more pleated sheets of thin copper, but can be constructed from other thermal conductors and in other forms suitable for the specific application. For example, as show in FIG. **4**, the heat fins **422** of the outer heat fins **420** can be constructed from individual sheets of copper.

[0037] In a further illustrative embodiment of the invention, as shown in FIGS. **5** and **6**, an internal heat exchanger **500** includes inner heat fins **530** and inner support member **540** similar to the internal heat exchangers in the illustrative embodiments discussed above. In addition, an annular ring portion **590** is connected to the inner heat fins **530** and inner support member **540**. The annular ring portion **590** in this embodiment is radially coextensive with the heat fins **530** on the outside and defines a chamber **592** on the inside and in fluid communication with the channels **532** between the inner heat fins **530**. The annular ring portion **590** and the housing wall **122** form a seal between the working space and bounce space when the internal heat exchanger **500** is installed in the housing **120**, with the longitudinal axis **550** of the heat exchanger **500** aligned with the longitudinal axis **150** of the housing **120**.

[0038] In this example, the heat exchanger **500**, the annular ring portion **590**, the inner heat fins **530** and the inner support member **540** are an integral piece, made by cutting channels **532** (i.e., spaces between the inner heat fins **530**) in a cylindrical stock partially through the length of the stock. Non-integral configuration of the annular ring portion **590**, the inner heat fins **530** and the inner support member **540** can also be used.

[0039] As in certain other embodiments described above, the internal heat exchanger **500** can be affixed to the housing **120** by press-fitting, shrink-fitting, or other bonding methods, with both the inner fins **530** and the annular ring portion **590** in contact with the housing wall **122**. In the example where the annular ring portion **590**, the inner heat fins **530** and the inner support member **540** are an integral piece, the entire heat exchanger **500** can be affixed to the housing **120** as a whole. In cases where non-integral configurations of the annular ring portion **590**, the inner heat fins **530** and the inner support member **540** are used, the annular ring portion **590** and the inner heat fins **530** can be affixed to the housing **120** by press-fitting, shrink-fitting, or other bonding methods. The inner support member **540** can further be press-fitted, shrink-fitted or otherwise bonded to the interior of the inner heat fins **530**. Further, as with the outer ring **210**, a sealant can be applied between the annular ring portion **590** and the housing wall **122** to eliminate any gap between them to further ensure a gas-tight seal.

[0040] In another embodiment of the invention, the inner support member **540** is omitted, with the inner heat fins **530** entirely supported by the annular ring portion **590**.

[0041] A further alternative embodiment of the invention is schematically shown in FIG. **8**. In this embodiment, the heat exchanger assembly **800** includes is similar to that (**200**) shown in FIG. **2** but without the external heat fins. The exchanger assembly **800** in this illustrative embodiment includes an outer ring **810**, which is seated against an exterior surface of the housing wall **122**. The assembly **800** further includes inner heat fins **830** inside the housing wall **122**. The assembly **800** further includes an inner support member **840**, which is disposed inside, and in contact with, the inner heat fins **830**.

[0042] Optionally, the embodiment shown in FIG. **8** can further include additional heat transfer structures, or provisions for attaching additional heat-transfer structures, for transferring heat to or from the outer ring **810**. Symbolically indicated at label **850** in FIG. **8**, these structures and provisions can include tubings mounted on the surface of the outer ring **810**, or channels formed within the outer ring **810**, for carrying heat transfer fluids, such as water. The structures and provisions can also include heat sinks such as a volume of material with a large thermal mass. Further examples include recesses, protuberances or other structures on the outer ring **810** for affixing heat-transfer structures.

[0043] In another illustrative embodiment of the invention, schematically shown in FIG. **9**, a heat exchanger assembly **900** includes inner heat fins **930** inside the housing wall **122**, and an inner support member **940**, which is disposed inside, and in contact with, the inner heat fins **930**. Unlike certain other illustrative embodiments, the heat exchanger assembly **900** in this case is without an ring-shaped outer heat exchanger portion. Instead, the heat exchanger assembly **900** includes other outer heat transfer structures, or provisions for attaching outer heat-transfer structures, for transferring heat to or from the housing wall **122**. Symbolically indicated at label **950** in FIG. **9**, these structures and provisions can include tubings mounted on the outer surface of the housing wall **122**. The structures and provisions can also include heat sinks such as a volume of material with a large thermal mass. The volume material can further include channels **952** for carrying a heat transfer fluid, such as water, other fluids or gasses. Further examples include recesses, protuberances or other structures on the housing wall **122** for affixing heat-transfer structures.

[0044] Thus, the illustrative embodiments of the invention offer several advantages over prior art devices and methods. Among the advantages are the ease of manufacturing of inner heat fins that project outwardly from the inner support, the compatibility with shrink-fitting process for contacting the inner heat fins with the housing, and the compatibility with precision alignment of an interior surface of the inner support for forming gas bearing or seal, or both, with a sliding member movably disposed through the interior surface.

[0045] All patents and publication referred to above are incorporated herein by reference. The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

1. A heat exchanger assembly for transferring heat across a wall of a housing, the assembly comprising:

an outer heat exchanger comprising an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall;

an inner support disposed inside the housing and having an exterior surface; and

a plurality of inner heat fins connecting the exterior surface of the inner support to an interior surface of the wall of the housing, at least a portion of the outer ring and at least a portion of the inner heat fins sandwiching at least a portion of the housing wall.

2. The heat exchanger assembly as set forth in claim **1**, wherein the inner heat fins are integral with the inner support.

3. The heat exchanger assembly as set forth in claim **2**, wherein the outer ring is shrink-fitted on the housing and the inner support and inner heat fins are shrink-fitted in the housing.

4. The heat exchanger assembly as set forth in claim **3**, wherein the outer ring, inner support and inner heat fins are made of a material having a higher thermal expansion coefficient than the wall.

5. The heat exchanger assembly of claim **4**, wherein the outer ring, inner support and inner heat fins are made of aluminum.

6. The heat exchanger assembly as set forth in claim **1**, wherein the outer heat exchanger further comprises a plurality of outer heat fins outwardly projecting from the outer ring.

7. The heat exchanger assembly as set forth in claim **6**, wherein the outer heat fins are welded, soldered or bonded by a thermo-conductive adhesive to the outer ring.

8. The heat exchanger assembly as set forth in claim **1**, wherein the inner support further comprises an interior surface.

9. The heat exchanger assembly as set forth in claim **8**, wherein the interior surface of the inner support is adapted to form a gas bearing or a seal portion, or both, with a sliding member movably disposed through interior surface of the inner support.

10. The heat exchanger assembly as set forth in claim **8**, further comprising a solid annular ring portion connected to the inner support or the inner fins and having an outer surface configured to be in contact with the interior surface of the wall of the housing when the annular ring portion is installed in the housing.

11. The heat exchanger assembly as set forth in claim **10**, wherein the annular ring portion is integral with the inner support or the inner heat fins, or both.

12. The heat exchanger assembly as set forth in claim **11**, further comprising a sealant on the outer surface of the annular ring portion.

13. A component of a Stirling cycle machine, comprising:

a housing comprising a wall defining an interior volume and adapted to seal within the interior volume a working gas, the interior volume comprising a compression region where the working gas is subject to intermittent compression and expansion;

an outer heat exchanger comprising an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall;

a plurality of outer heat fins connected to the outer ring;

an inner support disposed inside the housing and having an exterior surface; and

a plurality of inner heat fins connecting the exterior surface of the inner support to an interior surface of the wall of the housing, at least a portion of the outer ring and at least a portion of the inner heat fins sandwiching at least a portion of the housing wall.

14. The component as set forth in claim **13**, wherein the inner heat fins are integral with the inner support.

15. The component as set forth in claim **14**, wherein the outer ring is shrink-fitted on the housing and the inner support and inner heat fins are shrink-fitted in the housing.

16. The component as set forth in claim **15**, wherein the outer ring, inner support or inner heat fins are made of a material having a higher thermal expansion coefficient than the wall.

17. The component as set forth in claim **15**, further comprising a sealant between the outer ring and the housing.

18. The component of claim **16**, wherein the outer ring, inner support or inner heat fins are made of aluminum, and wherein the housing wall is made of stainless steel at least in portions in contact with the outer ring and plurality of inner heat fins.

19. The component as set forth in claim **13**, wherein the inner support comprises an interior surface.

20. The component as set forth in claim **19**, wherein the interior surface of the inner support is adapted to form a gas bearing or a seal portion, or both, with a sliding member movably disposed through interior surface of the inner support.

21. A heat exchanger assembly for transferring heat across a wall of a housing, the assembly comprising:

an outer ring disposed outside the housing and having an interior surface in contact with an exterior surface of the wall;

a plurality of outer heat fins outwardly projecting from the outer ring; and

a plurality of inner heat fins extending inwardly from the interior surface of the wall, at least a portion of the outer ring and at least a portion of the inner heat fins sandwiching at least a portion of the housing wall.

22. The heat exchanger assembly as set forth in claim **21**, wherein the inner heat fins are brazed, soldered or bonded with a thermo-conductive adhesive to the interior surface of the wall.

23. The heat exchanger assembly as set forth in claim **21**, wherein the inner heat fins are shrink-fitted to the housing.

24. The heat exchanger assembly as set forth in claim **21**, wherein the outer heat fins are shrink-fitted to the outer ring.

25. The heat exchanger assembly as set forth in claim **21**, further comprising a solid annular ring portion connected to the inner fins and having an outer surface configured to be in contact with the interior surface of the wall of the housing when the annular ring portion is installed in the housing.

26. The heat exchanger assembly as set forth in claim **25**, wherein the annular ring portion is integral with the inner heat fins.

27. A method for making a heat exchanger assembly for transferring heat across a wall of a housing, the method comprising:

positioning an outer heat exchanger comprising an outer ring outside the housing such that an interior surface of the outer ring is in contact with an exterior surface of the wall;

positioning a plurality of outer heat fins on the outer ring;

positioning an inner support inside the housing; and

connecting an interior surface of the wall and an exterior surface of the inner support using a plurality of inner heat fins such that at least a portion of the inner heat fins and at least a portion of the outer ring sandwich at least a portion of the housing wall.

28. The method as set forth in claim **27**, further comprising constructing the inner support and the plurality of inner heat fins from the same piece of material.

29. The method as set forth in claim **28**, wherein constructing comprises forming an integral body comprising the inner support and inner heat fins by removing material from the piece.

30. The method as set forth in claim **29**, wherein removing comprises machining.

31. The method as set forth in claim **27**, further comprising forming an aperture through the inner support.

32. The method as set forth in claim **27**, wherein positioning the outer ring comprises shrink-fitting the outer ring on the housing; and connecting the interior surface of the wall and the exterior surface of the inner support using the inner heat fins comprises shrink-fitting the inner heat fins and the inner support inside and against the housing wall.

33. The method as set forth in claim **32**, wherein shrink-fitting the outer ring on the housing comprises subjecting the outer ring to a higher temperature than the housing, and subjecting the inner heat fins and inner support to a lower temperature than the housing.

34. The method of claim **32**, further comprising shrink-fitting a plurality of outer heat fins to the outer ring.

35. The method of claim **32**, further comprising applying a sealant between the outer ring and the housing wall.

36. The heat exchanger assembly of claim **1**, wherein the outer heat exchanger further comprises a heat-transfer structure in thermal contact with the outer ring and adapted to transfer heat from or to the outer ring.

37. The heat exchanger assembly of claim **36**, wherein the heat-transfer structure comprises a tubing or channel adapted to carry a heat-transfer fluid.

38. The heat exchanger assembly of claim **1**, wherein the outer ring comprises a mounting structure adapted to affix a heat-transfer structure to the outer ring.

39. A heat exchanger assembly for transferring heat across a wall of a housing, the assembly comprising:

an inner support disposed inside the housing and having an exterior surface; and

a plurality of inner heat fins connecting the exterior surface of the inner support to an interior surface of the wall of the housing.

40. The heat exchanger assembly of claim **39**, further comprising an outer heat transfer structure in thermal contact with an exterior surface of the housing wall, at least a portion of the outer heat-transfer structure and at least a portion of the inner heat fins sandwiching at least a portion of the housing wall.

41. The heat exchanger assembly of claim **40**, wherein the heat-transfer structure comprises a tubing or channel adapted to carry a heat-transfer fluid.

42. The heat exchanger assembly of claim **39**, further comprises a mounting structure adapted to affix a heat-transfer structure to the housing wall.

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