



(19) **United States**

(12) **Patent Application Publication**

Kodumudi et al.

(10) **Pub. No.: US 2003/0159816 A1**

(43) **Pub. Date: Aug. 28, 2003**

(54) **HEAT EXCHANGER APPARATUS WITH INTEGRATED SUPPLY/RETURN TUBE**

(52) **U.S. Cl.** 165/176; 165/178

(75) Inventors: **Magesh V. Kodumudi**, Troy, MI (US);
Eric Jean LeRoy, Rochester Hills, MI (US); **Jean-Michel Haincourt**, Authon du Perche (FR)

(57) **ABSTRACT**

Correspondence Address:
Liniak, Berenato, Longacre & White
Ste. 240
6550 Rock Spring Drive
Bethesda, MD 20817 (US)

A heat exchanger apparatus includes a first and second coolant tanks spaced apart from each other, a plurality of heat exchanging tubes extending between the tanks for enabling coolant to flow from the first coolant tank to the second coolant tank and to be cooled in said tubes, and a coolant supply/return tube for enabling coolant to flow from the second coolant tank to the first coolant tank. The supply/return tube has a substantially circular cross-section. The supply/return tube has opposite end portions inserted into complementary openings in the inlet coolant reservoir and the first tank. In order to provide the proper, predetermined orientation of the supply/return tube in the heat exchanger apparatus, the supply/return tube has opposite locating members each adjacent to the end portions of the supply/return tube, so that a small, predetermined length of the end portions of the supply/return tube protrudes inside the supply/return tube.

(73) Assignee: **VALEO INC.**

(21) Appl. No.: **10/079,696**

(22) Filed: **Feb. 22, 2002**

Publication Classification

(51) **Int. Cl.⁷** **F28F 9/04; F28D 7/06**

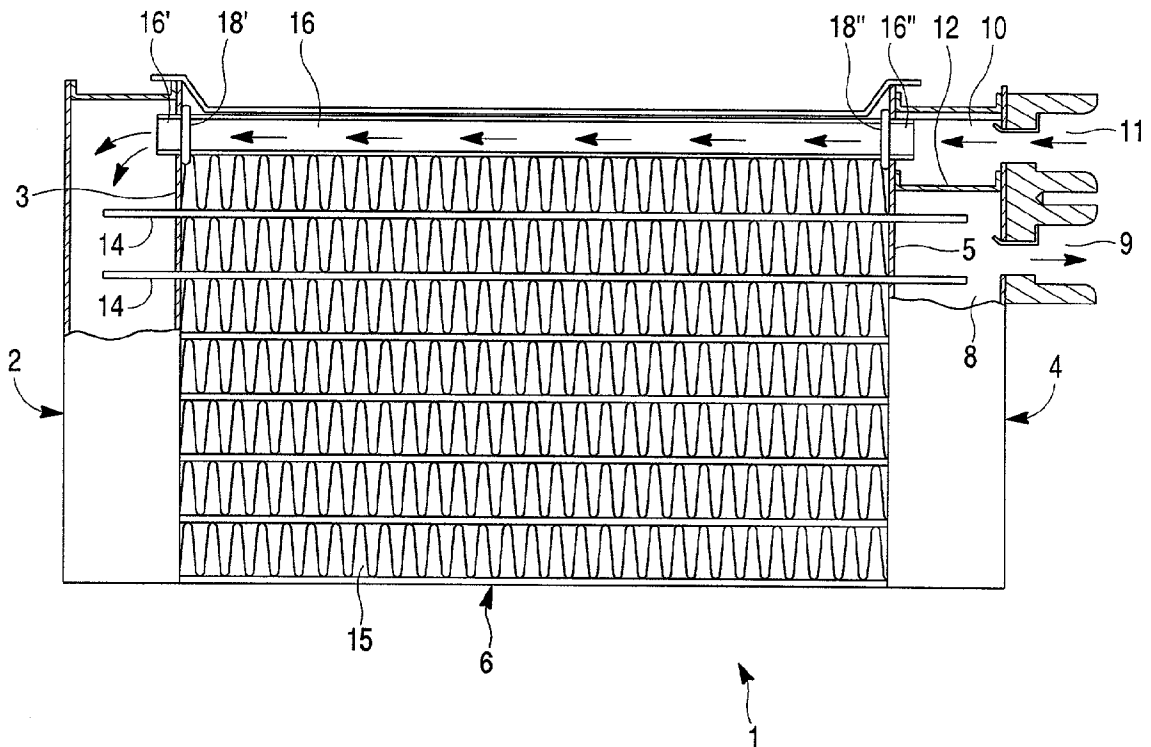


Fig. 3

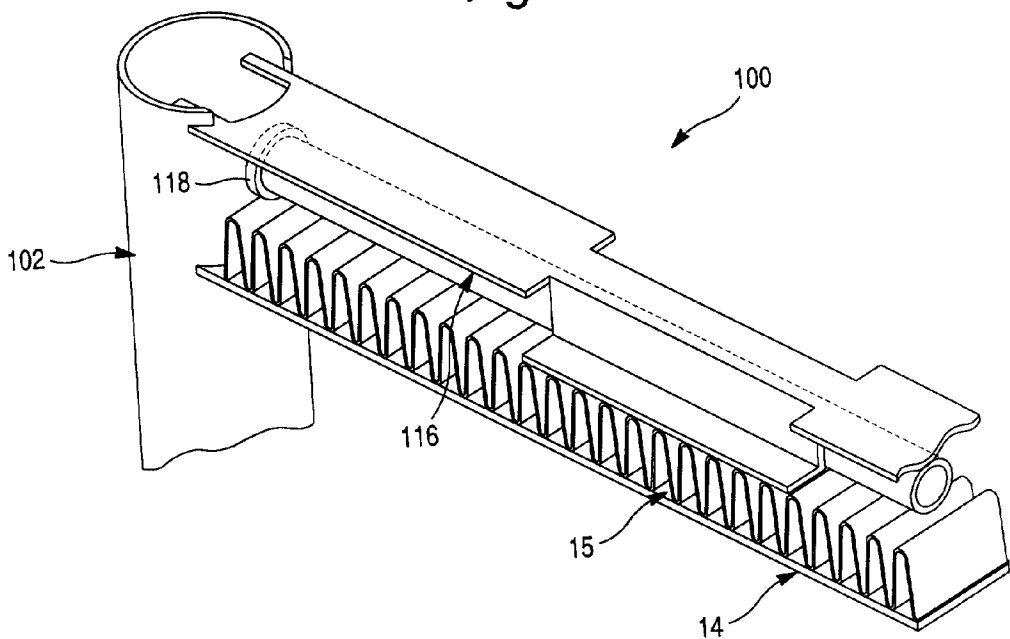


Fig. 4

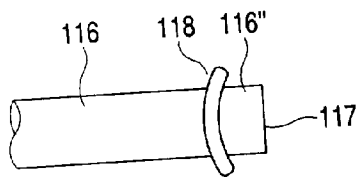


Fig. 5

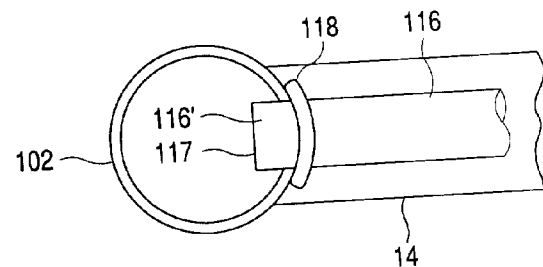
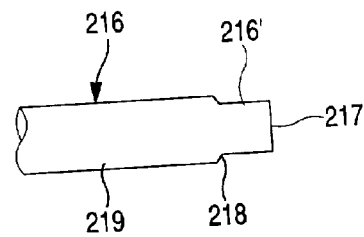


Fig. 6



HEAT EXCHANGER APPARATUS WITH INTEGRATED SUPPLY/RETURN TUBE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to heat exchangers, and more particularly to a heat exchanger apparatus having integrated fluid supply/return tube.

[0003] 2. Description of the Prior Art

[0004] In a conventional brazed aluminum single-pass compact heat exchanger, where the internal working fluid makes only one pass through the heat exchanger, the inlet and outlet ports are located on the opposite ends of the heat exchanger. In such single-pass heat exchangers, if the inlet and outlet ports are required to be on the same side of the heat exchanger (due to space, manufacturing or other constraints), then an additional supply/return tube is used to transport the fluid from one end to the other. This additional tube to transport the working fluid from one end to the other end of the heat exchanger could either be external to the heat exchanger (in which case, this tube is assembled to the heat exchanger in a secondary manufacturing operation after the heat exchanger is manufactured) or could be internal to the heat exchanger (in which case this tube is assembled to the exchanger prior to the brazing process). In the latter case, the tube is said to be integrated into the heat exchanger.

[0005] Using the external tube to transport the fluid from one end of the heat exchanger to the other poses various problems as described below:

[0006] 1. Since the supply/return tube is external to the heat exchanger, the tube needs to be supported and secured to the heat exchanger by means of additional clips, brackets and/or fasteners. These brackets, fasteners, etc. add piece cost and additional manufacturing and assembly costs.

[0007] 2. Since this tube is not part of the heat exchanger, one or more additional connection joints are required where the tube interfaces with the internal portion of the heat exchanger. Since these systems typically operate at relatively high internal pressures, these connections have to be designed to withstand these higher operating pressures. Typically connection designs include o-ring fittings, flare fittings, threaded fittings with thread sealants, etc. Such connections could become expensive. Further, every additional connection is a potential leak path and a potential failure spot.

[0008] 3. External tubes require additional manufacturing and assembly operations to assemble them to the heat exchanger. Further, any additional requirements like painting or corrosion protection coatings applied to the heat exchanger would be required for this external tube also. All these would make the assembly significantly more expensive.

[0009] 4. Typically, most such systems require the internal fluid-side pressure drop to be kept to a minimum. Adding additional connections to the heat exchanger increases internal pressure drop significantly (due to entrance and exit losses, losses due to reduced cross sectional flow areas and due to the flow directional changes). In applications such as automotive transmission oil cooling and engine oil cooling, the oil pumps have very low output power. A high internal

pressure drop in the heat exchanger, in such applications could lead to no oil flow through the exchanger and consequently a complete system failure.

[0010] 5. Since the tube is external with added brackets, clips, fasteners, etc., the part is more complex and hence, more prone to field failures, i.e., they are more likely to be less durable than an integrated tube design.

[0011] 6. Since the tube is not part of the heat exchanger, additional space is required to package it properly. In automotive application, for example, packaging constraints can be very tight, therefore an integrated tube design is likely easier to be packaged.

[0012] Thus, there is a need for a heat exchange apparatus that is simple and inexpensive to manufacture, and allows to withstand substantial internal pressure of the coolant flow without reinforcing the supply/return tube walls.

SUMMARY OF THE INVENTION

[0013] The present invention provides a novel arrangement of a heat exchanger apparatus having an integrated supply/return tube. The heat exchanger apparatus of the present invention comprises a first tank, a second tank and a heat exchanger core extending between the first tank and the second tank. The second tank is in turn divided into two hermetically separated reservoirs: a cooling reservoir and a supply/return reservoir, by a partition wall. The cooling reservoir is provided with an outlet port, while the supply/return reservoir is provided with an inlet port. The heat exchanger core comprises a plurality of heat transfer tubes spaced from each other in a substantially parallel arrangement, and a supply/return tube substantially parallel to the heat transfer tubes. Preferably, the supply/return tube has substantially circular cross-section, and is made of aluminum alloy. Furthermore, the supply/return tube is provided with opposite locating members integrally formed at the opposite end portions thereof in order to provide the proper, predetermined orientation of the supply/return tube in the heat exchanger apparatus. The supply/return tube extends for a small, pre-determined length past the locating members on the two opposite ends thereof. The position of these locating members determines the exact penetration of the supply/return tube into the first and second tanks.

[0014] The supply/return tube is mechanically assembled to the heat exchanger, then brazed to the heat exchanger, thus becoming an integral part of the heat exchanger.

[0015] When assembled, the supply/return tube firmly contacts adjacent fin on the heat exchanger, the end portions of the supply/return tube (past the locating members) penetrate into mating holes in the two tanks and the locating members make a positive contact with the tanks. Besides controlling the exact penetration depth of the tube extension into the tank, the locating member also makes a firm surface contact with the tank for obtaining good brazing and hence good joint integrity and quality.

[0016] In accordance with the first exemplary embodiment of the present invention, the first and second tanks have a generally rectangular cross-section, and the locating members are in the form of annular flanges integrally formed at the opposite ends of the supply/return tube.

[0017] In accordance with the second exemplary embodiment of the present invention, the first and second tanks have

a generally circular cross-section, and the locating members are in the form of substantially semi-cylindrical flanges integrally formed at the opposite end portions of the supply/return tube.

[0018] In accordance with the third exemplary embodiment of the present invention, the locating members are in the form of seat members each juxtaposed to the end portions of the supply/return tube. The seat members are formed by providing the end portions of the supply/return tube of reduced diameter as compared to a central portion thereof.

[0019] Therefore, the heat exchanger apparatus in accordance with the present invention represents a novel arrangement that is simple and inexpensive in manufacturing, easy to assemble, and allows to withstand substantial internal pressure of the coolant flow without reinforcing the supply/return tube walls.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] Other objects and advantages of the invention will become apparent from a study of the following specification when viewed in light of the accompanying drawings, wherein:

[0021] FIG. 1 is a partial sectional view of a heat exchanger apparatus in accordance with the first exemplary embodiment of the present invention;

[0022] FIG. 2 is a partial view of a supply/return tube in accordance with the first embodiment of the present invention;

[0023] FIG. 3 is a partial perspective view of the heat exchanger apparatus in accordance with the second exemplary embodiment of the present invention;

[0024] FIG. 4 is a partial view of a supply/return tube in accordance with the second embodiment of the present invention;

[0025] FIG. 5 is a partial sectional view of a connection between the supply/return tube and a first tank in the heat exchanger apparatus in accordance with the second exemplary embodiment of the present invention;

[0026] FIG. 6 is a partial view of a supply/return tube in accordance with the third exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0027] The preferred embodiments of the present invention will now be described with the reference to accompanying drawings.

[0028] FIG. 1 of the drawings illustrates the first exemplary embodiment of a heat exchanger apparatus in accordance with the present invention, generally indicated at 1, in accordance with the present invention. The heat exchanger apparatus 1 comprises a first tank 2, a second tank 4 and a heat exchanger core 6 extending between the first tank 2 and the second tank 4. The second tank 4 is divided into two hermetically separated reservoirs: an outlet coolant reservoir 8 and an inlet coolant reservoir 10, by a partition wall 12. The outlet coolant reservoir 8 is provided with an outlet port 9, while the inlet coolant reservoir 10 is provided with an

inlet port 11. Coolant, used with the heat exchanger apparatus of the present invention, may be oil, antifreeze, or any other appropriate coolant fluid, well known to those skilled in the art.

[0029] The heat exchanger core 6 comprises a plurality of heat transfer tubes 14 spaced from each other in a substantially parallel arrangement. Typically, the heat transfer tubes 14 have non-circular configuration, such as oval or rectangular. Between each two adjacent heat transfer tubes 14 there are fins 15 of corrugated sheet metal. The heat transfer tubes 14 fluidly interconnect the first tank 2 with the outlet coolant reservoir 8 of the second tank 4 in order to enable coolant to flow from the first tank 2 to the outlet coolant reservoir 8 and to be cooled in said tubes. Furthermore, the heat exchanger core 6 comprises a supply/return tube 16 spaced from the heat transfer tubes 14. The supply/return tube 16 fluidly interconnects the first tank 2 with the inlet coolant reservoir 10 of the second tank 4 in order to enable coolant to flow from the inlet coolant reservoir 10 to the first tank 2. It will be appreciated that the heat exchanger core 6 in accordance with the present invention may include more than one supply/return tube 16, such as two, three, etc. In accordance with the preferred embodiment of the present invention, the supply/return tube 16 has substantially circular cross-section. The circular supply/return tube would be a standard commercial tube requiring no special tooling or process to manufacture. The circular tube generally offers increased flow cross sectional areas. Thus, the internal pressure reduces significantly. Moreover, since a circular cross section has the best pressure-containing characteristic, reduction in tube wall thickness is possible. This significantly simplifies manufacturing process, reduces cost, and allows to withstand substantial internal pressure of the coolant flow without reinforcing the tube walls. Preferably, the supply/return tube 16 is made of aluminum or aluminum alloy. However, other shapes of the supply/return tube 16 and materials it is made of, are also within the scope of the present invention.

[0030] Moreover, the supply/return tube 16 has opposite end portions 16' and 16'' inserted into complementary openings in the inlet coolant reservoir 10 and in the first tank 2, respectively. More specifically, an inner wall 3 of the first tank 2 is provided with an opening receiving the end portions 16' of the supply/return tube 16. Correspondingly, an inner wall 5 of the second tank 4 is provided with an opening receiving the end portions 16'' of the supply/return tube 16.

[0031] In order to provide the proper, predetermined orientation of the supply/return tube 16 in the heat exchanger apparatus 1, the supply/return tube 16 has opposite locating members each adjacent to the end portions of the supply/return tube 16, so that a small, predetermined length d of the end portions 16' and 16'' of the supply/return tube 16 is provided between the locating member and end faces 17 of the supply/return tube 16. Thus, the position of the locating members on the supply/return tube 16 determines the exact penetration of the supply/return tube 16 into the first tank 2 and the inlet reservoir 10 of the second tank 4. Hence, the length of the supply/return tube 16 penetrating into the tanks 2 and 4 can be maintained as short as required. This completely eliminates the flow blockage where the supply/return tube penetrates into the tanks, thus resulting in a significant internal pressure drop reduction.

[0032] Furthermore, the locating members aid the supply/return tube 16 firmly seat on a surface of the tank. Thus, an excellent braze joint could be obtained.

[0033] In the first exemplary embodiment of the present invention, illustrated in FIGS. 1 and 2, the first and second tanks 2 and 4 have a generally rectangular cross-section, and the locating members are in the form of annular flanges 18' and 18" each integrally formed at the opposite ends of the supply/return tube 16. As shown in FIG. 1, the annular flange 18' of the supply/return tube 16 firmly contacts a flat inner wall 3 of the first tank 2 and is secured thereto by brazing. Similarly, the other annular flange 18" of the supply/return tube 16 firmly contacts a flat inner wall 5 of the second tank 4 and is secured thereto by brazing. Thus, the annular flanges 18' and 18" allow controlling the depth of penetration of the end portions 16' and 16" of the supply/return tube 16 into the first tank 2 and the inlet reservoir 10 of the second tank 4, respectively. Moreover, the annular flanges 18' and 18" provide firm contact between the supply/return tube 16 and the first and second tanks 2 and 4, thus ensuring strength and integrity of the heat exchanger apparatus 1.

[0034] In operation, coolant enters the inlet reservoir 10 of the second tank 4 through the inlet port 11, then flows to the first tank 2 via the supply/return tube 16. It then flows in the opposite direction to the outlet reservoir 8 of the second tank 4 through the plurality of the heat transfer tubes 14. Coolant leaves the heat exchanger apparatus 1 through the outlet port 9. It will be appreciated that the heat exchange apparatus of the present invention wherein the coolant flows in the opposite direction, e.g. from the outlet reservoir 8 through the heat transfer tubes 14 to the first tank 2, then back to the inlet reservoir 10 through the supply/return tube 16, is within the scope of the present invention.

[0035] FIGS. 3-5 of the drawings illustrate the second exemplary embodiment of a heat exchanger apparatus. Components, which are unchanged from, or function in the same way as in the first exemplary embodiment depicted in FIGS. 1-2 are labeled with the same reference numerals, sometimes without describing detail since similarities between the corresponding parts in the two embodiments will be readily perceived by the reader.

[0036] In the heat exchanger apparatus 100 of the second exemplary embodiment of the present invention, as illustrated in FIGS. 3 and 5, includes a first tank and a second tank (only the first tank 102 is shown in the accompanying drawings) which have a generally circular cross-section. A substantially cylindrical supply/return tube 116 fluidly interconnects the first and second tanks. The supply/return tube 116 has opposite end portions 116' and 116" inserted into complementary openings in an inlet coolant reservoir of the second tank (not shown) and into the first tank 102, respectively. In order to provide the proper, predetermined orientation of the supply/return tube 116 in the heat exchanger apparatus 100, the supply/return tube 116 has opposite locating members each adjacent to the end portions 116' and 116" of the supply/return tube 116.

[0037] In accordance with the second exemplary embodiment of the present invention, the locating members are in the form of substantially semi-cylindrical flanges 118 each integrally formed at the opposite ends 116' and 116" of the supply/return tube 116. The semi-cylindrical flanges 118 of

the supply/return tube 116 firmly contact outer walls of the cylindrical first tank 102 (as shown in FIG. 5) and the second tank, respectively, and are secured thereto by brazing. Thus, the flanges 118 allow controlling the depth of penetration of the end portions 116' and 116" of the supply/return tube 116 into the first tank 102 and the inlet reservoir of the second tank, respectively. Moreover, the flanges 118 provide firm contact between the supply/return tube 116 and the first and second tanks, thus ensuring strength and integrity of the heat exchanger apparatus 100.

[0038] In the third exemplary embodiment of a supply/return tube 216 in accordance with the present invention, illustrated in FIG. 6, the locating members are in the form of seat members 218 (only one is shown) each juxtaposed to the end portions 216' of the supply/return tube 216 opposite to the end face 217 thereof. More specifically, the seat members 218 are formed by providing the end portions 216' of the supply/return tube 216 of reduced diameter as compared to a central portion 219 thereof. Correspondingly, the openings in a first tank (not shown) and an inlet coolant reservoir (not shown) are adapted to receive the end portions 216' and 216" of the supply/return tube 216 only, as they are of substantially smaller diameter than the central portion 219 thereof. Thus, the seat members 218 allow controlling the depth of penetration of the end portions 216' of the supply/return tube 216 into the first tank and the inlet reservoir of the second tank, respectively. Moreover, the seat members 218 provide firm contact between the supply/return tube 216 and the first and second tanks, thus ensuring strength and integrity of the heat exchanger apparatus 1.

[0039] Therefore, the heat exchanger apparatus in accordance with the present invention represents a novel arrangement that is simple and inexpensive in manufacturing, easy to assemble, and allows to withstand substantial internal pressure of the coolant flow without reinforcing the supply/return tube walls. The heat exchanger apparatus of the present invention provides the following advantages over the heat exchangers of the prior art having external supply/return tubes:

[0040] 1. The supply/return tube is integrated into the heat exchanger and is one-shot brazed. This leads to the elimination of several secondary manufacturing operations.

[0041] 2. The integrated supply/return tube results in a significant reduction of components (fittings for the external tube, clips, brackets, fasteners required to secure the external tube to the heat exchanger, etc.).

[0042] 3. Reduction in design complexity and hence, cost (external supply/return tube with fittings is very expensive compared to the proposed integrated supply/return tube solution).

[0043] 4. Elimination of additional connections and joints. This leads to a reduction in the potential leak paths and failure spots.

[0044] 5. A significantly more compact design: integration of the supply/return tube into the heat exchanger leads to a significant reduction in the physical size.

[0045] 6. Significantly improved product durability compared to an external supply/return tube design.

[0046] 7. If any painting or corrosion protection coating is required, it could be applied all at once along with the heat exchanger. This leads to significant cost reductions.

[0047] The foregoing description of the preferred embodiments of the present invention has been presented for the purpose of illustration in accordance with the provisions of the Patent Statutes. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. The embodiments disclosed hereinabove were chosen in order to best illustrate the principles of the present invention and its practical application to thereby enable those of ordinary skill in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated, as long as the principles described herein are followed. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains. Thus, changes can be made in the above-described invention without departing from the intent and scope thereof. It is also intended that the scope of the present invention be defined by the claims appended thereto.

What is claimed is:

1. A heat exchanger apparatus comprising:

a first coolant tank;

a second coolant tank spaced apart from said first coolant tank, said second tank includes an inlet reservoir and an outlet reservoir; and

a heat exchanger core extending between said tanks, said heat exchanger core including:

a plurality of heat exchanging tubes fluidly interconnecting said first coolant tank and said outlet reservoir of said second coolant tank for cooling a coolant in said tubes; and

at least one coolant supply/return tube for fluidly interconnecting said inlet reservoir of said second coolant tank and said first coolant tank and for enabling coolant to flow between said coolant tanks in the direction opposite to flow of said coolant in said heat exchanging tubes.

2. The heat exchanger apparatus as defined in claim 1, wherein said inlet reservoir includes an inlet port, and said outlet reservoir includes an outlet port.

3. The heat exchanger apparatus as defined in claim 1, wherein said supply/return tube has substantially circular cross-section.

4. The heat exchanger apparatus as defined in claim 3, wherein each of said heat exchanging tubes has substantially non-circular cross-section.

5. The heat exchanger apparatus as defined in claim 1, wherein said supply/return tube has locating members each provided adjacent to opposite end portions of said supply/return tube so that a predetermined length of one of said end portions of said supply/return tube extends within said first tank and a predetermined length of another of said end portions of said supply/return tube extends within said inlet reservoir of said second tank.

6. The heat exchanger apparatus as defined in claim 5, wherein said locating members are in the form of substantially annular flanges integrally formed on said supply/return tube.

7. The heat exchanger apparatus as defined in claim 5, wherein said locating members are in the form of substantially semi-cylindrical flanges integrally formed on said supply/return tube.

8. The heat exchanger apparatus as defined in claim 7, wherein each said first coolant tank and said second coolant tank has substantially circular cross-section complementary to said semi-cylindrical flanges of said supply/return tube.

9. The heat exchanger apparatus as defined in claim 5, wherein each of said locating members is in the form of a seat member formed by reducing diameter of said end portion of said supply/return tube relative to a central portion thereof.

10. The heat exchanger apparatus as defined in claim 1, wherein said supply/return tube is made of aluminum.

11. The heat exchanger apparatus as defined in claim 1, wherein said supply/return tube is secured to said coolant tanks by brazing.

* * * * *