In a combined heat exchanger including first and second heat exchanging portions, a pair of first and second header tanks are connected to two longitudinal ends of first and second tubes of the first and second heat exchanging portions. One end of a pipe member is connected to the first header tank at a position communicating with the second heat exchanger portion, and the other end thereof extends toward the second header tank. A side plate is connected to the outermost second tube in a tube stacking direction and to the first and second header tanks. Furthermore, a divided portion is provided to divide the side plate into a first part connected to the first header tank and a second part connected to the second header tank, and the pipe member is fixed to the side plate at a position between the divided portion and the first header tank.
FIG. 2

TOP AIR FLOW DIRECTION

TUBE LONGITUDINAL DIRECTION

BOTTOM
COMBINED HEAT EXCHANGER

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2007-245015 filed on Sep. 21, 2007, the contents of which are incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a combined heat exchanger having a plurality of heat exchanging portions.

BACKGROUND OF THE INVENTION

[0003] A vehicle is generally provided with plural heat exchangers including an oil cooler and an intercooler in addition to a refrigerant condenser and a radiator. The condenser is located in a refrigerant cycle to cool and condense refrigerant of the refrigerant cycle, and the radiator is located in an engine coolant circuit to cool engine coolant. The oil cooler is located to cool oil in a torque converter for an automatic transmission, and the intercooler is located to cool intake air of the engine pressurized in a supercharger.

[0004] A combined heat exchanger having first and second heat exchanging portions which are independent from each other in a single heat exchanging core is proposed (e.g., U.S. Pat. No. 6,394,176). For example, in the combined heat exchanger, a refrigerant condenser and an oil cooler are combined to be integrated. The size of the condenser is generally set larger as much as possible in a vehicle in order to improve heat radiation performance in the condenser because the power consumed in a compressor of the refrigerant cycle and the refrigerant pressure on a high-pressure side of the refrigerant cycle are dependent on the heat radiation performance of the condenser. When the size of the condenser is set larger, the oil cooler integrated with the condenser is also set larger to have the same width dimension of the condenser. In this case, the width dimension of the oil cooler becomes larger, and thereby the flow resistance of oil is increased in the oil cooler.

[0005] An air-cooled combined heat exchanger is described in JOURNAL OF DENSO TECHNICAL DISCLOSURE No. 144-037 on Jul. 15, 2004. In the air-cooled combined heat exchanger, oil flows in the combined heat exchanger in one way so as to increase an oil flow area and reduce an oil flow resistance. In this case, an oil inlet and an oil outlet are located in the combined heat exchanger such that a heat exchanging core portion is interposed between the oil inlet and the oil outlet. Furthermore, one end of an oil return pipe is connected to the oil outlet, and the other end of the oil return pipe is positioned on a side of the oil inlet so as to improve pipe arrangement.

[0006] However, in the combined heat exchanger described in JOURNAL OF DENSO TECHNICAL DISCLOSURE No. 144-037, the oil return pipe is difficult to be fixed to the combined heat exchanger in a limited space of the vehicle with a simple structure while reducing a thermal stress applied to tubes. The thermal stress applied to the tubes is generated by a thermal-fluid temperature difference between the oil cooler and the condenser or a temperature difference between the oil cooler and a side plate.

SUMMARY OF THE INVENTION

[0007] In view of the foregoing problems, it is an object of the present invention to provide a combined heat exchanger which can be easily mounted on a small space while reducing a thermal stress applied to tubes.

[0008] It is another object of the present invention to provide a combined heat exchanger in which a pipe member can be easily fixed to a side plate of the combined heat exchanger while reducing a thermal stress applied to tubes of the combined heat exchanger.

[0009] According to an aspect of the present application, a combined heat exchanger includes: a first heat exchanging portion including a plurality of first tubes stacked in a stacking direction, in which a first fluid flows, and configured to cool the first fluid by performing a heat exchange with air; a second heat exchanging portion including a plurality of second tubes stacked in the stacking direction, in which a second fluid flows, and configured to cool the second fluid by performing a heat exchange with air; a pair of first and second header tanks connected to both longitudinal end portions of the first and second tubes to extend in the stacking direction; a pipe member having one end connected to the first header tank at a position communicating with the second heat exchanging portion and the other end extending toward the second header tank; a side plate connected to the outermost second tube in the stacking direction and to the first and second header tanks; a fixing member configured to fix the pipe member to the side plate. Generally, the second fluid has a temperature different from that of the first fluid. In the combined heat exchanger, the side plate has a divided portion configured to divide the side plate into first and second parts connected to the first header tank and a second part connected to the second header tank, and the pipe member is fixed to the side plate by the fixing member at a position between the divided portion and the first header tank.

[0010] Accordingly, the pipe member is connected to the first part of the side plate connected to the first header tank at which the one end of the pipe member is connected, without being directly connected to the second part of the side plate. Thus, when the second tubes are thermally expanded, the first and second parts of the side plate are not completely restricted but are movable so as to absorb the thermal expansion of the second tubes. As a result, a thermal stress due to the thermal expansion of the second tubes can be reduced. Therefore, the pipe member can be fixed to the side plate while the thermal stress applied to the second tubes can be reduced. Furthermore, the pipe member can be easily arranged adjacent to the side plate, and thereby it is possible to arrange the combined heat exchanger in a small space.

[0011] For example, the first heat exchanger may be a refrigerant cooling portion in which a refrigerant of a refrigerant cycle flows to be cooled, and the second heat exchanger may be an oil cooler configured to cool oil for a device mounted on a vehicle.

[0012] Alternatively, the first header tank may be configured to distribute the second fluid flowing from the pipe member into the second tubes, and the second header tank may be configured to collect the second fluid flowing out of the second tubes. Alternatively, the fixing member may include a receiving portion and a cover portion which are configured to pinch and fix the pipe member, and the side plate may have a through hole into which an engagement claw of the receiving portion of the fixing member is engaged.

[0013] The combined heat exchanger may be provided with a partition plate located between the first tube and the second tube adjacent to each other in the stacking direction so as to partition the first heat exchanging portion and the second heat
exchanging portion from each other. In this case, the second header tank has a cutout portion at a position corresponding to the partition plate in the stacking direction. Furthermore, each of the first and second header tanks may be partitioned into two parts respectively corresponding to the first heat exchanging portion and the second heat exchanging portion at a position where the partition plate is located in the stacking direction.

[0014] The pipe member may have an extending portion extending from the one end of the first header tank toward the second header tank, approximately in parallel with the side plate at a position adjacent to the side plate. In this case, the extending portion of the pipe member is fixed to the side plate by using the fixing member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Additional objects and advantages of the present invention will be more readily apparent from the following detailed description of preferred embodiments when taken together with the accompanying drawings. In which:

[0016] FIG. 1 is a schematic sectional diagram showing a combined heat exchanger according to an embodiment of the present invention; and

[0017] FIG. 2 is an enlarged perspective view showing a side plate and a fixing member in the combined heat exchanger according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] A combined heat exchanger 1 according to an embodiment of the present invention will be described with reference to FIGS. 1 and 2. In the present embodiment, the combined heat exchanger 1 is used for a vehicle which is traveled by using an internal combustion engine as a drive source.

[0019] As shown in FIG. 1, the combined heat exchanger 1 includes a single core portion 4, and a pair of header tanks 5 located at left and right ends of the core portion 4. The core portion 4 includes a plurality of tubes 2, and a plurality of fins 3 located between adjacent two tubes 2.

[0020] The tubes 2 are stacked in a tube stack direction that corresponds to the top-bottom direction of FIG. 1 in the present embodiment. For example, the tubes 2 are flat tubes having a major diameter dimension in an air flow direction in cross-section. In the example of FIG. 1, the air flow direction corresponds to the paper face-back direction of FIG. 1, and the tube longitudinal direction corresponds to the horizontal direction. The plural tubes 2 are arranged in parallel with each other to be stacked in the top-bottom direction (vertical direction) such that the tubes 2 extend in the horizontal direction. The fins 3 are corrugated fins, for example. Each of the fins 3 is configured to contact two flat surfaces of the adjacent tubes 2 so as to improve a heat exchanging area of air. Therefore, the fins 3 can facilitate heat exchange between a thermal fluid and air passing through the core portion 4.

[0021] A pair of header tanks 5 are located at the longitudinal ends of each tube 2 and extend in a direction perpendicular to the tube longitudinal direction to communicate with the plural tubes 2. Each header tank 5 includes a core plate 5a having plural tube insertion holes into which the end portions of the tubes 2 are inserted, and a tank body portion 5b which is connected to the core plate 5a to form and define therein a tank space. In the example of FIG. 1, the header tank 5 positioned on the right side of the core portion 4 is used as a first header tank 51, and the header tank 5 positioned on the left side of the core portion 4 is used as a second header tank 52.

[0022] The core portion 4 includes a condenser portion 100 and an oil cooler portion 200. The condenser portion 100 is configured to cool refrigerant in a refrigerant cycle of the vehicle by performing heat exchange between the refrigerant and air passing therethrough. The oil cooler 200 is configured to cool oil in a torque converter for an automatic transmission of the vehicle by performing heat exchange between the oil and air passing therethrough. In the example of the combined heat exchanger 1 of FIG. 1, the condenser portion 100 is located at a lower side of the oil cooler portion 200.

[0023] Side plates 6 are located at two end portions of the core portion 4 in the tube stacking direction to reinforce the core portion 4. The side plates 6 extend to the tube longitudinal direction in parallel with the tubes 2, and are connected to the header tanks 5.

[0024] The plural tubes 2 are constructed with a plurality of first tubes 21 in which the refrigerant of the refrigerant cycle flows, and a plurality of second tubes 22 in which the oil flows. The first tubes 21 are used for the condenser portion 100, and the second tubes 22 are used for the oil cooler portion 200. The condenser portion 100 is one example of a first heat exchanging portion of the present invention, and the oil cooler portion 200 is one example of a second heat exchanging portion of the present invention.

[0025] Two first separators 71 are located in each of the first header tank 51 and the second header tank 52 at a boundary portion between condenser portion 100 and the oil cooler portion 200. The boundary portion between the condenser portion 100 and the oil cooler portion 200 corresponds to a partition portion between the first tubes 21 and the second tubes 22. The two first separators 71 are located in each header tank 5 to have a predetermined distance therebetween in the tank longitudinal direction (i.e., tube stacking direction) so that an inner portion of the header tank 5 is divided into three space portions in the tank longitudinal direction.

[0026] That is, the inner portion of each header tank 5 is separated by the two first separators 71 into a first space 50A positioned on a lower side of the two first separators 71, a second space 50B positioned on an upper side of the two first separators 71, and a third space 50C positioned between the two first separators 71. The first space 50A is provided to communicate with the first tubes 21 of the condenser portion 100, the second space 50B is provided to communicate with the second tubes 22 of the oil cooler portion 200, and the third space 50C is provided without communicating with any of the first and second tubes 21, 22. Therefore, the third space 50C is used as a heat insulation space for heat-insulating between the first space 50A and the second space 50B in each header tank 5.

[0027] Thus, the tube (or tubes) communicating with the third space 50C, in which a thermal fluid such as the refrigerant or the oil does not flow, is a dummy tube 8 positioned between the first tubes 21 and the second tubes 22. A cutout portion 53 is provided in the tank body portion 5b of the second header tank 52 at a position corresponding to the third space 50C to be cut in the tube longitudinal direction.

[0028] Next, the structure of the oil cooler portion 200 will be described. The oil cooler portion 200 includes the second tubes 22 in which the oil flows in one way. That is, the oil
The modulator 80 is formed into approximately a cylindrical shape and extends in the tank extending direction (i.e., tube stacking direction) at an outside of the first header tank 51 opposite to the core portion 4, as shown in FIG. 1. The modulator 80 is configured to separate the refrigerant into gas refrigerant and liquid refrigerant and to store therein the separated liquid refrigerant. The modulator 80 is bonded to the first header tank 51. In the example of FIG. 1, the modulator 80 extends from the bottom portion of the first header tank 51 to a position of the first oil header portion 51a in the tube stacking direction.

A refrigerant inlet 81 and a refrigerant outlet 82 are provided for the modulator 80 at an upper and lower sides of the third separator 73 so that the modulator 80 communicates with the first refrigerant header portion 51a via the refrigerant inlet 81 and the refrigerant outlet 82 at two different positions. More specifically, the refrigerant inlet 81 is provided at the upper side of the third separator 73 such that the upper side space of the third separator 73 within the first refrigerant header portion 51 communicates with an inner space 83 of the modulator 80 via the refrigerant inlet 81. Furthermore, the refrigerant outlet 82 is provided at the lower side of the third separator 73 such that the lower side space of the third separator 73 within the first refrigerant header portion 51b communicates with the inner space 83 of the modulator 80 via the refrigerant outlet 82. The refrigerant inlet 81 is positioned upper than the refrigerant outlet 82 in the modulator 80.

The refrigerant flowing into the inner space 83 via the refrigerant inlet 81 is separated into gas refrigerant and liquid refrigerant, and the separated liquid refrigerant is temporarily stored in the lower side of the inner space 83 of the modulator 80 by the gravity difference between the gas refrigerant and the liquid refrigerant. A filter 84 is located in a lower portion of the inner space 83 of the modulator 80 so as to remove a foreign material such as dust.

One end portion of a return pipe 9 in which oil flows is connected to the oil inlet joint 31 of the first header tank 51 so that the return pipe 9 communicates with the second tubes 22 via the first oil header portion 51a of the first header tank 51. The return pipe 9 is a pipe member in which the oil flows. The return pipe 9 is bent approximately in a Z shape from the one end portion of the return pipe 9, and passes an upper side of the core portion 4 that is, passes one side (upper side) of the oil cooler portion 200 such that the other end portion of the return pipe 9 is positioned on a side of the second header tank 52, as shown in FIG. 1. The other end portion of the return pipe 9 is the end side without being directly connected to the oil inlet joint 31.

FIG. 2 is an enlarged perspective view showing the side plate 6 and the fixing member 90. As shown in FIG. 2, the side plate 6 includes a base portion 61 extending approximately in parallel with the tube longitudinal direction, and a pair of ribs 62 protruding approximately perpendicular to the base portion 61. The base portion 61 has a flat surface that is approximately in parallel with the flat surface of the tube 2. The pair of ribs 62 protrude toward outside of the core portion 4 in the tube stacking direction (top-bottom direction in FIG. 2), from two ends of the base portion 61 in an air flow direction. A divided portion 63 extending in the air flow direction is provided in the side plate 6 so that the side plate 6 is divided into two parts in the tube longitudinal direction. In the present
embodiment, the divided portion 63 is located approximately at a center area of the side plate 6 in the tube longitudinal direction.

[0040] The fixing member 90 for fixing the return pipe 9 is connected to the side plate 6 at a position between the divided portion 63 and the first header tank 51. In the embodiment of FIG. 2, the fixing member 90 is located near the divided portion 63 of the side plate 6 between the divided portion 63 and the first header tank 51.

[0041] The fixing member 90 includes a receiving portion 91 and a cover portion 92 which are configured to pinch and fix the return pipe 9. That is, the return pipe 9 is inserted between the receiving portion 91 and the cover portion 92 to be fixed theretwixt. The receiving portion 91 has a first engagement portion 910 at one end of the receiving portion 91 in the air flow direction, and the cover portion 92 has a second engagement portion 920 configured to be engaged with the first engagement portion 910. After the return pipe 9 is inserted between the receiving portion 91 and the cover portion 92, the second engagement portion 920 is fitted into the first engagement portion 910 to be engaged with the first engagement portion 910 so that the return pipe 9 is fixed between the receiving portion 91 and the cover portion 92 by using the first and second engagement portions 910, 920.

[0042] A pair of through holes 64 are formed respectively in the pair of ribs 62 of the side plate 6, and engagement claws 93 provided in the receiving portion 91 of the fixing member 90 are engaged respectively with the through holes 64. The engagement claw 93 has a key-like protruding portion 93a at its tip end. Each of the through holes 64 has an elongated rectangular-shaped hole extending in the tube longitudinal direction. The key-like protruding portions 93a of the pair of engagement claws 93 are inserted into the through holes 64 to be engaged with periphery ends of the through holes 64 positioned on the open side (upper side in FIG. 2) of the side plate 6, and thereby the fixing member 90 is fixed to the side plate 6.

[0043] Generally, the oil has a high temperature (e.g., about 120° C.) than that of the refrigerant. Therefore, a thermal expansion amount of the second tubes 22 becomes larger than that of the first tubes 21. However, a thermal expansion amount of the side plate 6 is generally small as compared with that of the second tubes 22, and thereby a heat stress due to restriction of the thermal variation of the second tube 22 by the side plate 6 may be caused. In the present embodiment, because the second tube portion 53 (recess portion) is provided in the tank body portion 5b of the second header tank 52 at a position corresponding to the third space 50c, a force for restricting the variation of the second tubes 22 can be reduced while the second tubes 22 are thermally expanded. Furthermore, the divided portion 63 (recess portion) extending in a direction (i.e., air flow direction) perpendicular to the tube longitudinal direction is provided in the side plate 6 so as to divide the side plate 6 into the two parts in the tube longitudinal direction. Thus, when the second tubes 22 are thermally expanded, the divided parts of the side plate 6 divided at the divided portion 63 move respectively in the tube longitudinal direction in accordance with the thermal expansion of the second tubes 22, so as to absorb the thermal expansion of the second tube 22 and reduce the thermal stress due to the thermal expansion of the second tubes 22.

[0044] In the present embodiment, the return pipe 9 is fixed to the side plate 6 by using the fixing member 90. However, the return pipe 9 is fixed such that the restriction force due to the fixing of the return pipe 9 is not applied to the tubes 22. That is, the fixing member 90 is fixed to one divided part of the side plate 6 on a side of the first header tank 51 at which the return pipe 6 is fixed by using the oil inlet joint 31. Therefore, the return pipe 6 is fixed to the one divided part of the side plate 6, directly connected to the first header tank 51 at which the return pipe 6 is fixed by using the oil inlet joint 31. Thus, when the second tubes 22 are thermally expanded, both the divided parts of the side plate 6 divided at the divided portion 63 are not restricted, but are respectively movable in the tube longitudinal direction. Accordingly, the thermal expansion of the second tubes 22 can be absorbed thereby reducing the thermal stress due to the thermal expansion of the second tubes 22. As a result, the return pipe 9 can be fixed to the side plate 6 while the thermal stress applied to the second tubes 22 can be reduced.

[0045] The viscosity of the oil becomes lower as the temperature of the oil becomes higher. In the present embodiment, because the return pipe 9 is connected to the first oil header portion 51a from which the oil is distributed into the second tubes 22, the oil having a high temperature before being heat-exchanged in the oil cooler portion 200 flows in the return pipe 9. Therefore, the flow resistance of the oil in the return pipe 9 can be reduced, and heat exchanging performance of the oil cooler portion 200 can be improved.

Other Embodiments

[0046] Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art.

[0047] For example, in the above-described embodiment, the condenser portion 100 in which the refrigerant of the refrigerant cycle flows is used as the first heat exchanging portion in the combined heat exchanger 1. However, the first heat exchanging portion is not limited to the condenser portion 100 and may be suitably changed. For example, the first heat exchanging portion is a radiator in which engine coolant is heat exchanged with air to be cooled. That is, when a thermal fluid flowing in the first heat exchanging portion is different from a thermal fluid flowing in the second heat exchanging portion, the first heat exchanging portion can be suitably changed. Furthermore, the fluid passage structure of the first heat exchanging portion is not limited to the example of the condenser portion 100 shown in FIG. 1. For example, the first heat exchanging portion may be one-path type in which the thermal fluid flows through all the tubes in one way.

[0048] In the above-described embodiment, as the second heat exchanging portion, the oil cooler portion 200 for cooling the oil in the torque converter for the transmission of the vehicle is used. However, as the second heat exchanging portion, an oil cooler portion for cooling an engine oil, an oil cooler portion for cooling a power steering oil, and an intercooler for cooling intake air to be introduced into an engine by performing heat exchange with air, or the like may be used.

[0049] In the above-described embodiment, the condenser portion 100 includes the refrigerant condensing portion 110 and the refrigerant super-cooling portion 120. However, the condensing portion 100 may be constructed only by the refrigerant condensing portion 110 without providing the refrigerant super-cooling portion 120.

[0050] In the combined heat exchanger 1 of the above-described embodiment, the oil cooler portion 200, the refriger-
The combined heat exchanger may comprise:

1. A first heat exchanging portion configured to cool a first fluid by performing a heat exchange with air, the first heat exchanging portion including a plurality of first tubes stacked in a stacking direction, in which the first fluid flows;

2. A second heat exchanging portion configured to cool a second fluid by performing a heat exchange with air, the second heat exchanging portion including a plurality of second tubes stacked in the stacking direction, in which the second fluid flows, wherein the second fluid having a temperature different from that of the first fluid;

3. A pair of first and second header tanks connected to both longitudinal end portions of the first and second tubes to extend in the stacking direction;

4. A pipe member having one end connected to the first header tank at a position communicating with the second heat exchanging portion, and the other end extending toward the second header tank;

5. A side plate connected to the outermost second tube in the stacking direction and to the first and second header tanks; and

6. A fixing member configured to fix the pipe member to the side plate, wherein

7. The side plate has a divided portion configured to divide the side plate into a first part connected to the first header tank and a second part connected to the second header tank, and

8. The pipe member is fixed to the side plate by the fixing member at a position between the divided portion and the first header tank.

The combined heat exchanger according to claim 1, wherein

9. The first heat exchanger is a refrigerant cooling portion in which a refrigerant of a refrigerant cycle flows to be cooled; and

10. The second heat exchanger is an oil cooler configured to cool oil for a device mounted on a vehicle.

The combined heat exchanger according to claim 1, wherein

11. The first header tank is configured to distribute the second fluid flowing from the pipe member into the second tubes, and

12. The second header tank is configured to collect the second fluid flowing out of the second tubes.

The combined heat exchanger according to claim 1, wherein

13. The fixing member includes a receiving portion and a cover portion which are configured to pinch and fix the pipe member, and

14. The side plate has a through hole into which an engagement claw of the receiving portion of the fixing member is engaged.

The combined heat exchanger according to claim 1, further comprising

15. A partition plate located between the first tube and the second tube adjacent to each other in the stacking direction so as to partition the first heat exchanging portion and the second heat exchanging portion from each other, wherein the second header tank has a cutout portion at a position corresponding to the partition plate in the stacking direction.

The combined heat exchanger according to claim 1, wherein

16. Each of the first and second header tanks is partitioned into two parts respectively corresponding to the first heat exchanging portion and the second heat exchanging portion at a position where the partition plate is located in the stacking direction.

17. The combined heat exchanger according to claim 1, wherein

18. The pipe member further has an extending portion extending from the one end of the first header tank toward the second header tank, approximately in parallel with the side plate at a position adjacent to the side plate, and

19. The extending portion of the pipe member is fixed to the side plate by using the fixing member.