US 20070068653A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2007/0068653 A1

Kondou et al. (43) Pub. Date: Mar. 29, 2007

(54) LIQUID COOLING APPARATUS

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(21) Appl. No.: **11/527,399**

(22) Filed: **Sep. 27, 2006**

(30) **Foreign Application Priority Data**

Sep. 28, 2005 (JP) P2005-282890
Feb. 28, 2006 (JP) P2006-053568
Sep. 25, 2006 (JP) P2006-258960

Publication Classification

(51) **Int. Cl.**
F28D 15/00 (2006.01)

(52) **U.S. Cl.** **165/80.4**; 165/104.32

(57) **ABSTRACT**

a liquid cooling apparatus provided on an apparatus having a heat unit generating heat, and configured to cool the heat unit by coolant includes; a coolant tank configured to store the coolant; a radiator configured to cool the coolant; and a coolant pipe which is a flow path of the coolant and connecting the coolant tank and the radiator. The coolant tank is arranged adjacent to the radiator in a horizontal direction when the apparatus disposed statically. A size of the coolant tank in a vertical direction is larger than a size of the coolant tank in a horizontal direction when the apparatus is disposed statically.

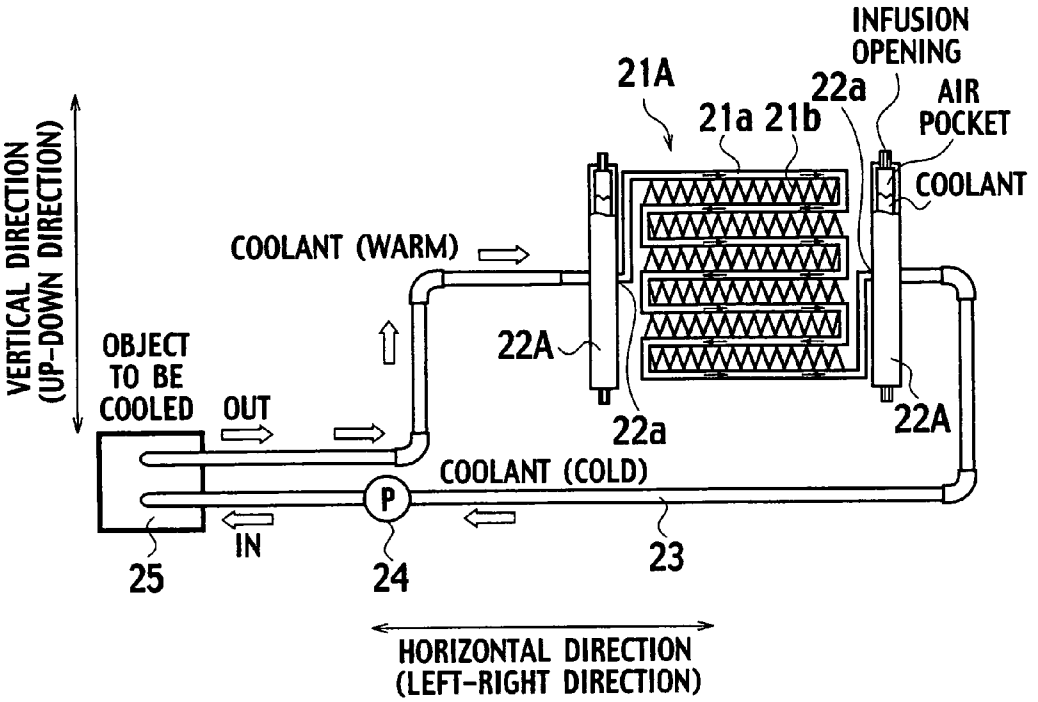


FIG. 1
RELATED ART

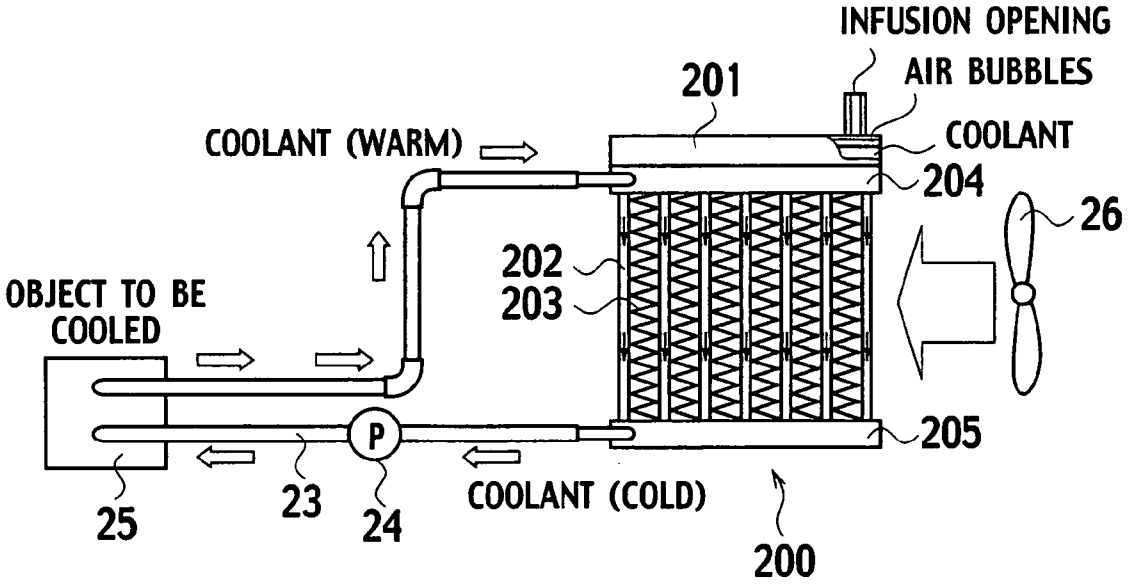


FIG. 2A

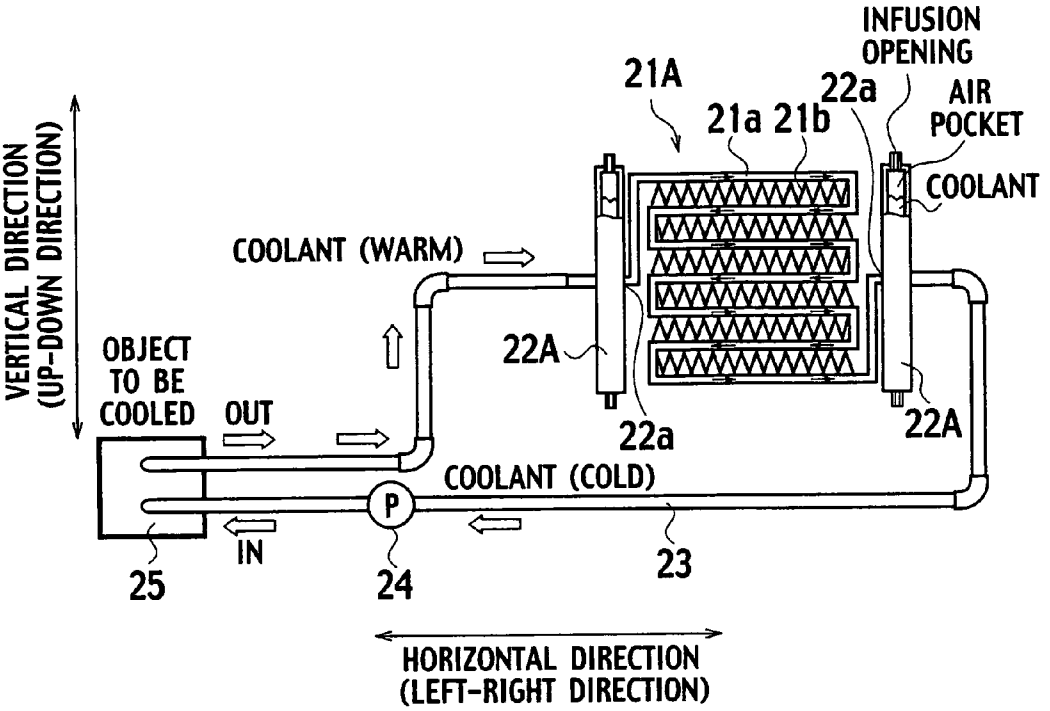

INFUSION OPENING
21A
22a
AIR POCKET
21a 21b
COOLANT
VERTICAL DIRECTION (UP-DOWN DIRECTION)
COOLANT (WARM)
OBJECT TO BE COOLED
OUT
22A
22a
22A
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 2B

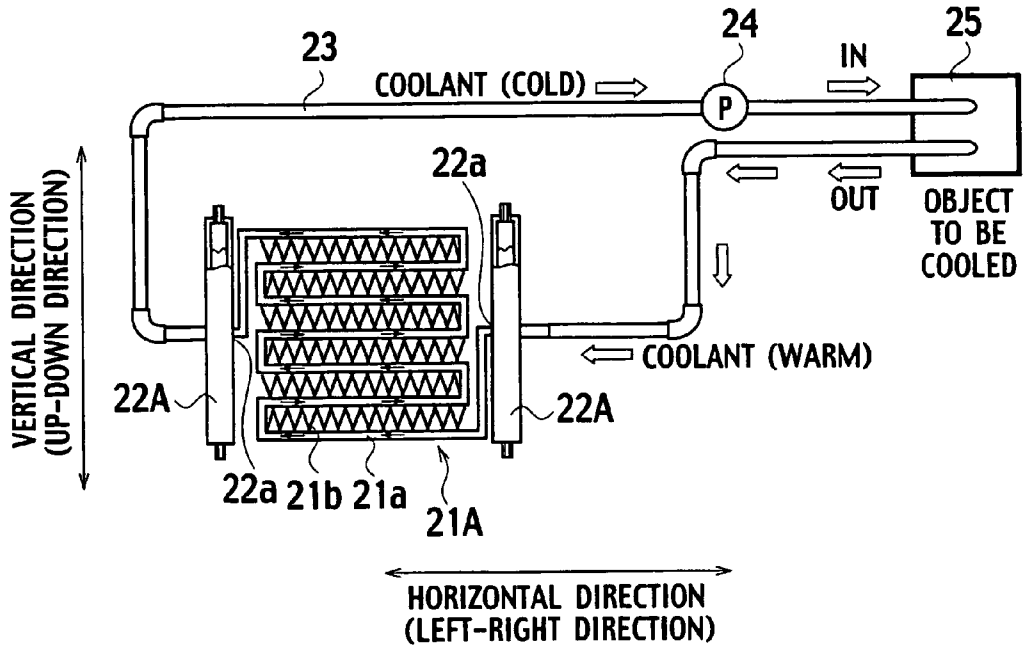

23
24
25
IN
COOLANT (COLD)
P
22a
OUT
OBJECT TO BE COOLED
VERTICAL DIRECTION (UP-DOWN DIRECTION)
COOLANT (WARM)
22A
22A
22a 21b 21a
21A
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 3A

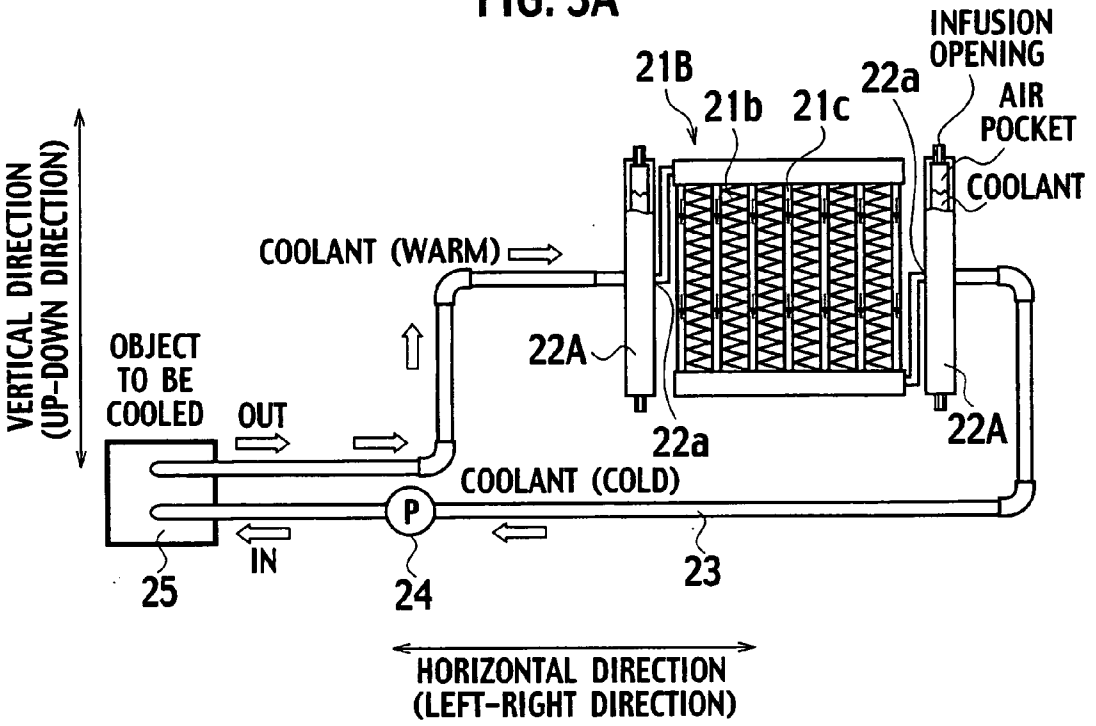

INFUSION OPENING
21B
21b
21c
22a
AIR POCKET
COOLANT
COOLANT (WARM)
VERTICAL DIRECTION (UP-DOWN DIRECTION)
OBJECT TO BE COOLED
OUT
22A
22a
22A
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 3B

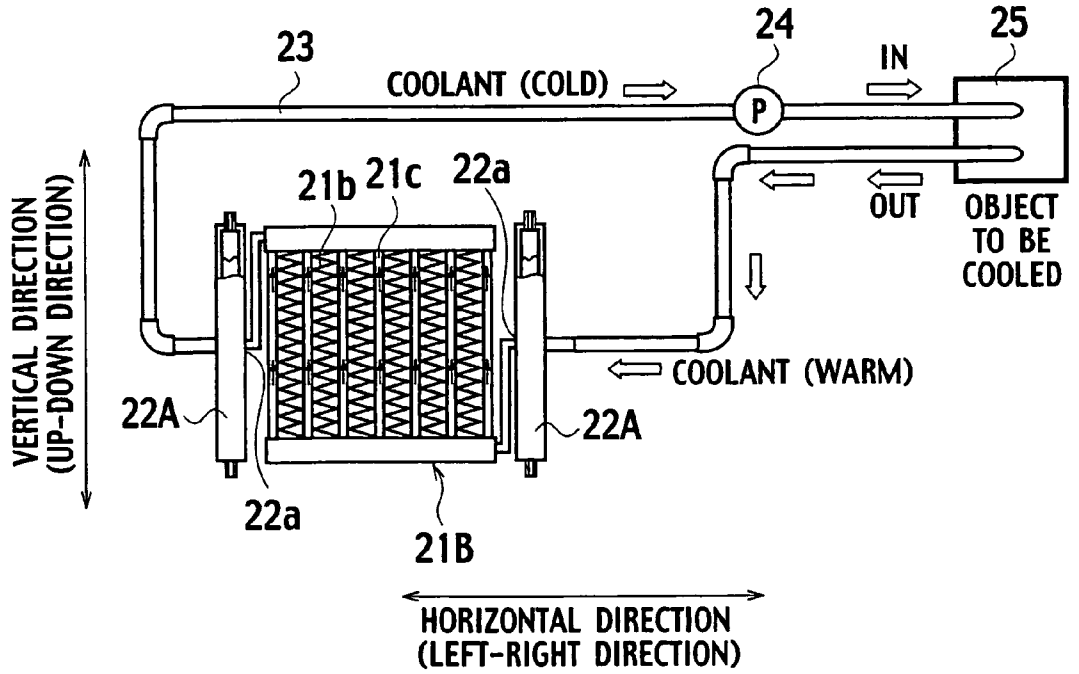

23
24
25
IN
COOLANT (COLD)
P
21b
21c
22a
OUT
OBJECT TO BE COOLED
VERTICAL DIRECTION (UP-DOWN DIRECTION)
COOLANT (WARM)
22A
22A
22a
21B
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 4A

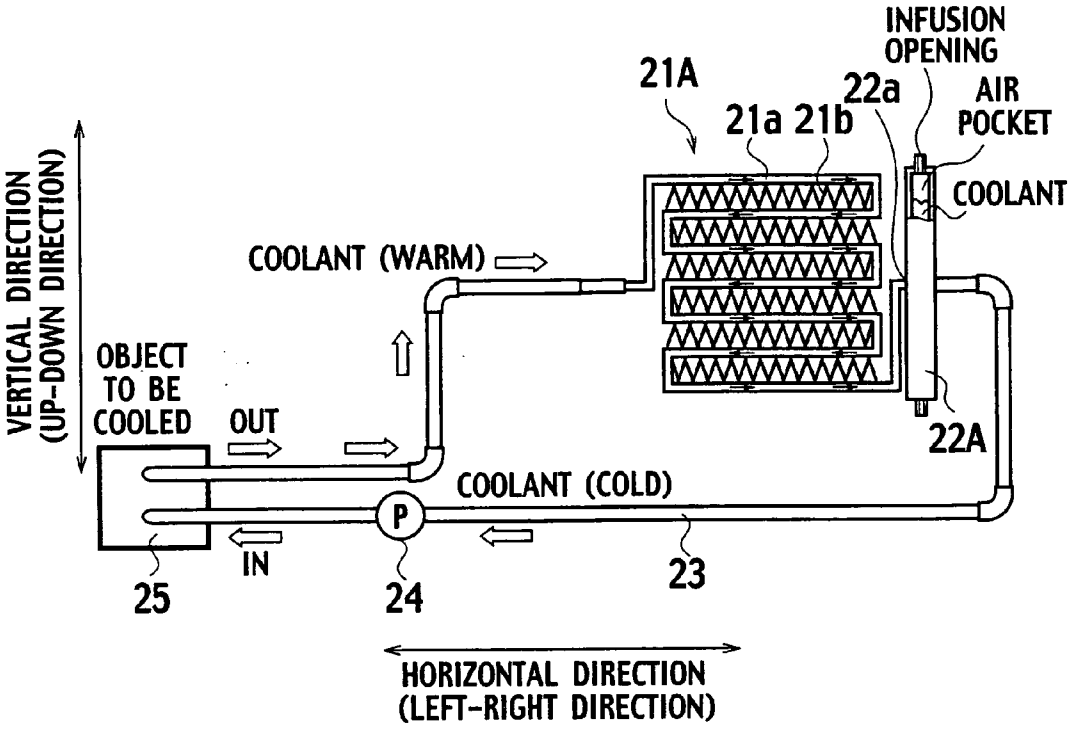

INFUSION OPENING
21A
22a
AIR POCKET
21a 21b
COOLANT
COOLANT (WARM)
VERTICAL DIRECTION (UP-DOWN DIRECTION)
OBJECT TO BE COOLED
OUT
22A
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 4B

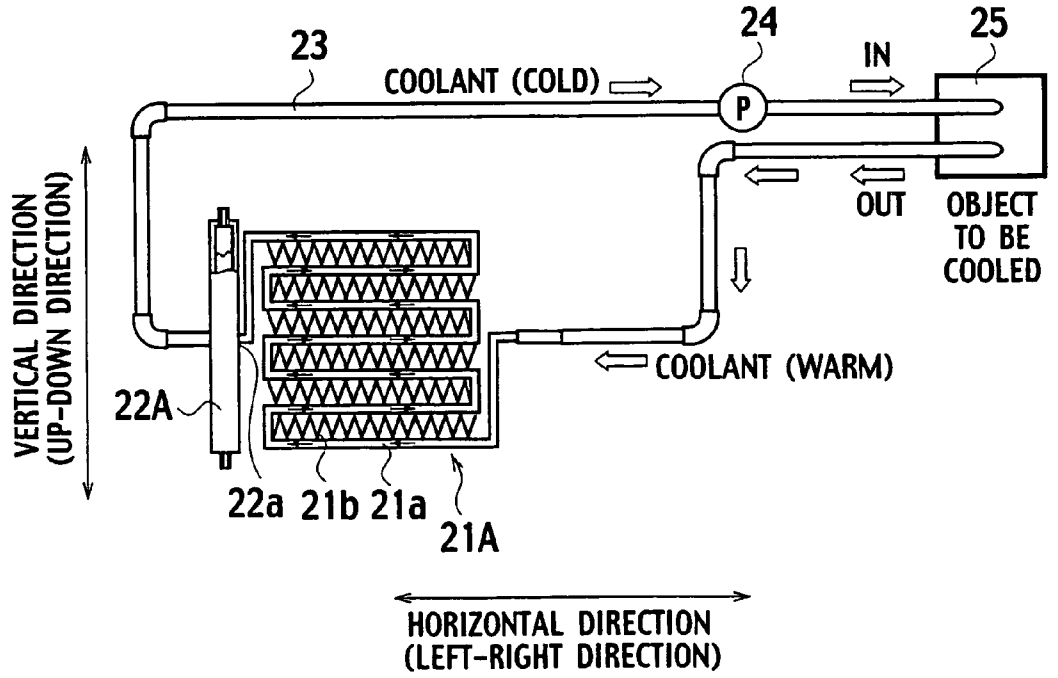

23
24
25
COOLANT (COLD)
P
IN
OUT
OBJECT TO BE COOLED
VERTICAL DIRECTION (UP-DOWN DIRECTION)
COOLANT (WARM)
22A
22a 21b 21a
21A
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 5A

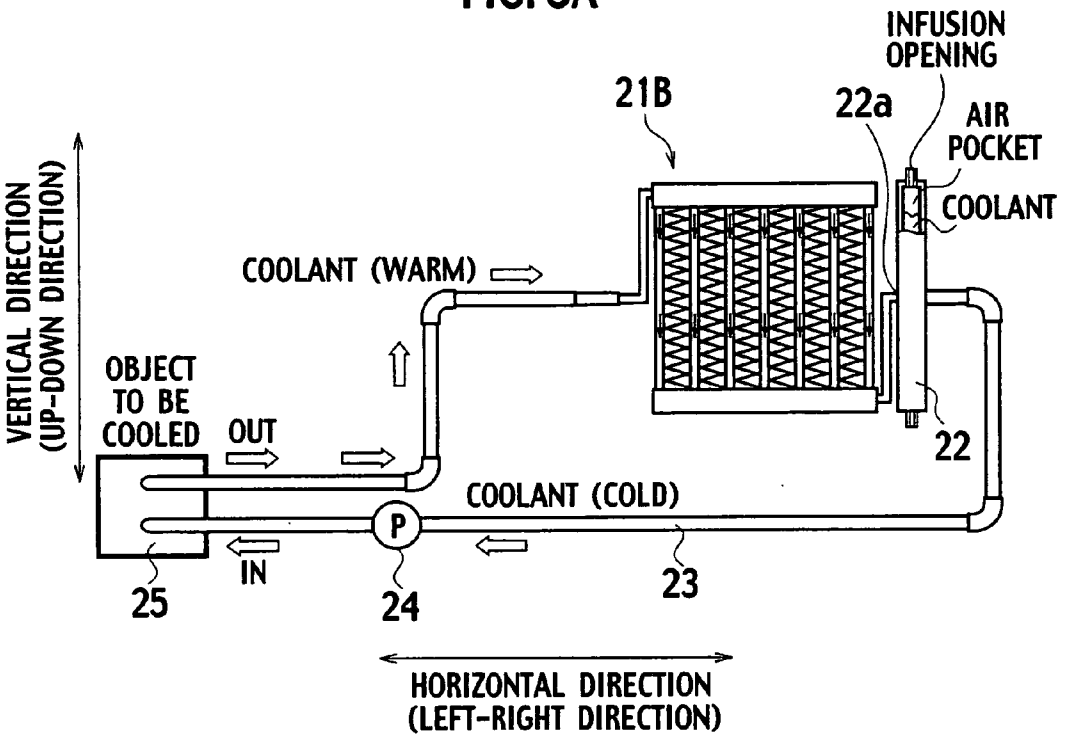

INFUSION OPENING
21B
22a
AIR POCKET
COOLANT
COOLANT (WARM)
VERTICAL DIRECTION (UP-DOWN DIRECTION)
OBJECT TO BE COOLED
OUT
22
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 5B

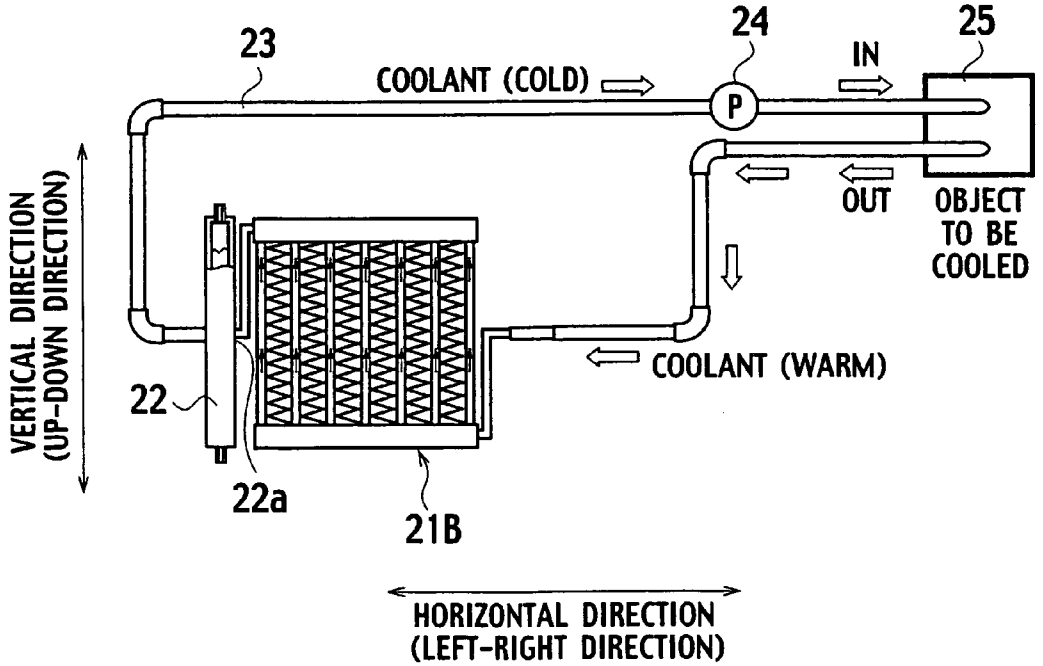

23
24
25
COOLANT (COLD)
P
IN
OUT
OBJECT TO BE COOLED
VERTICAL DIRECTION (UP-DOWN DIRECTION)
COOLANT (WARM)
22
22a
21B
HORIZONTAL DIRECTION (LEFT-RIGHT DIRECTION)

FIG. 6

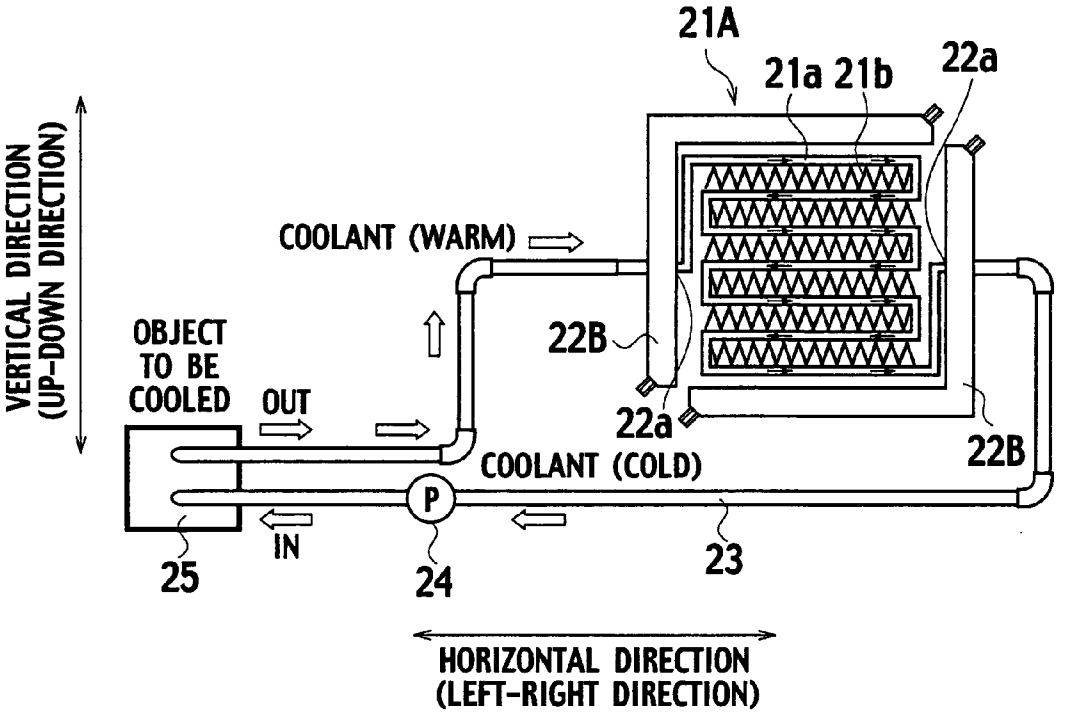

21A
21a 21b
22a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
COOLANT (WARM)
OBJECT
TO BE
COOLED
OUT
22B
22a
22B
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 7

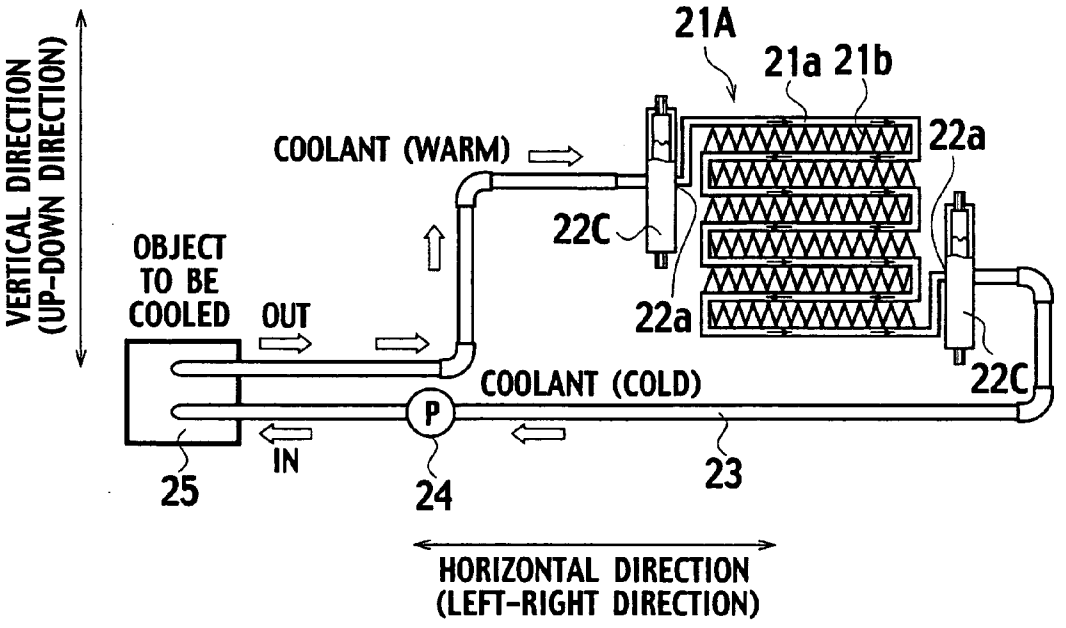

21A
21a 21b
22a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
COOLANT (WARM)
22C
OBJECT
TO BE
COOLED
OUT
22a
22C
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 8

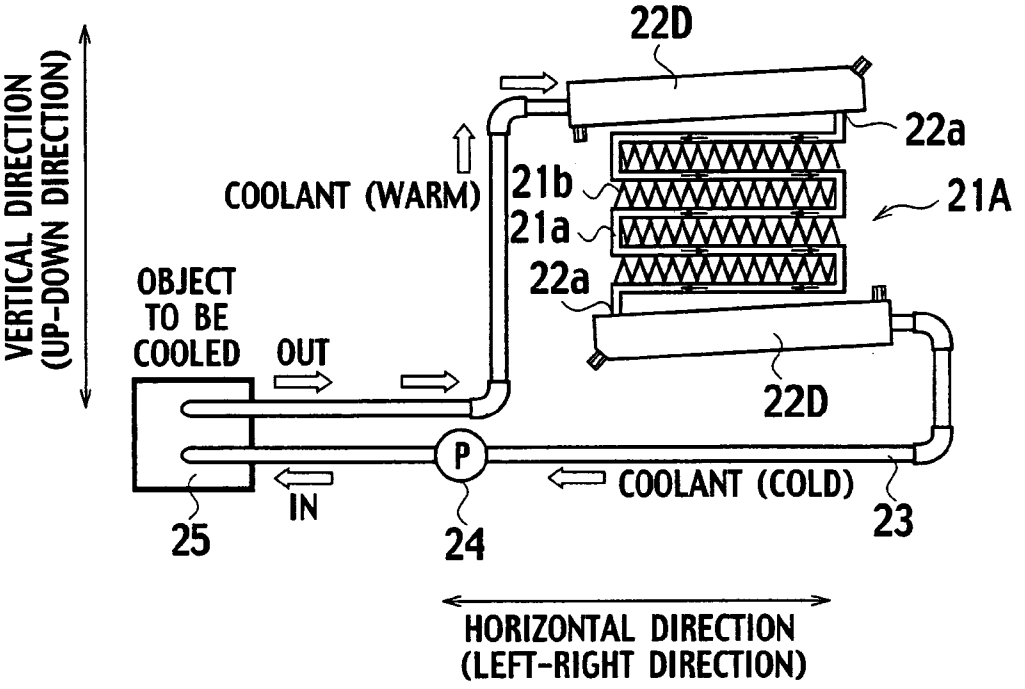

22D
22a
21b
21A
21a
22a
COOLANT (WARM)
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
OBJECT
TO BE
COOLED
OUT
22D
P
COOLANT (COLD)
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 9

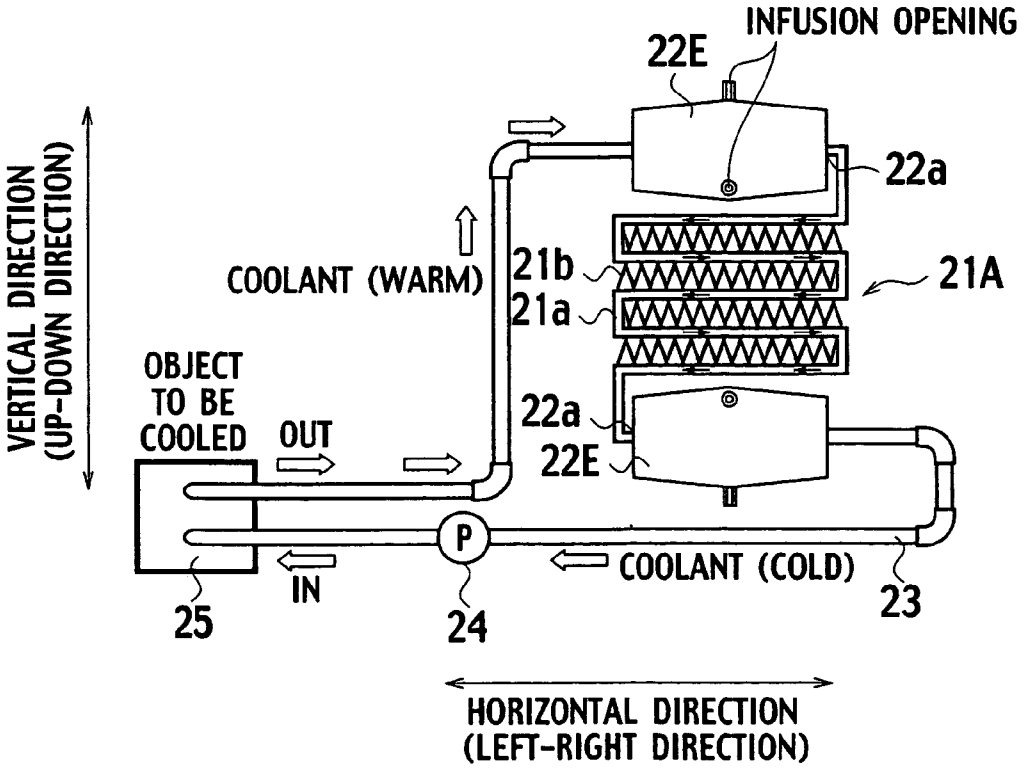

INFUSION OPENING
22E
22a
21b
21A
21a
COOLANT (WARM)
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
OBJECT
TO BE
COOLED
OUT
22a
22E
P
COOLANT (COLD)
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 10

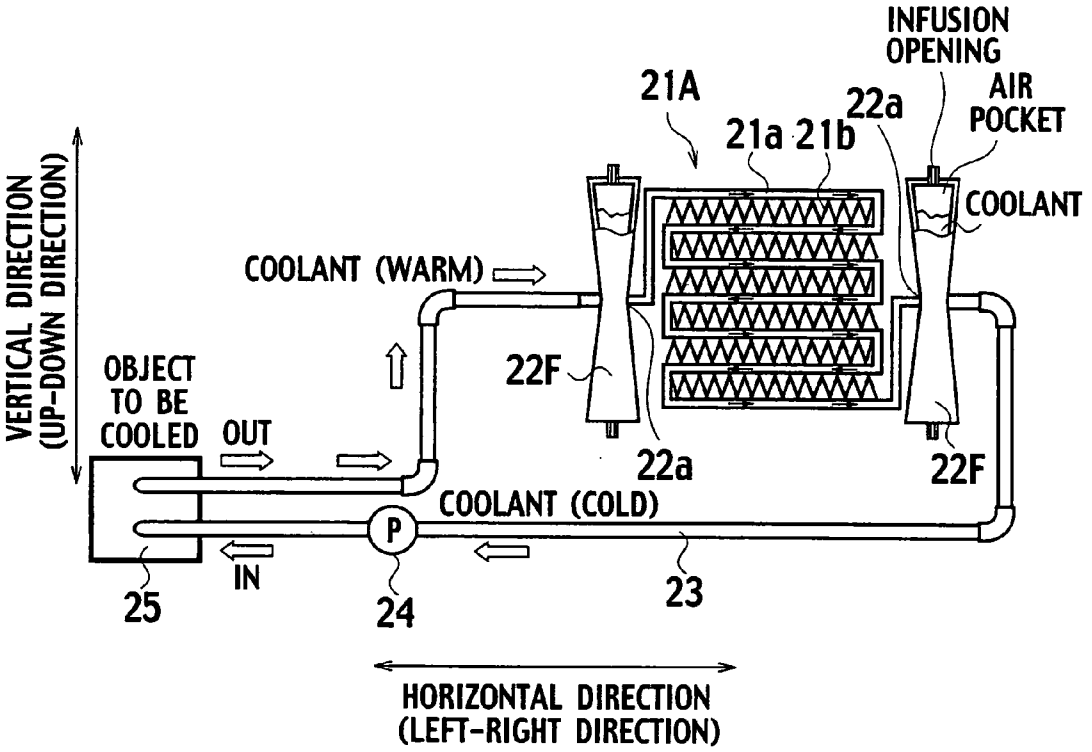


FIG. 11A FIG. 11B FIG. 11C FIG. 11D

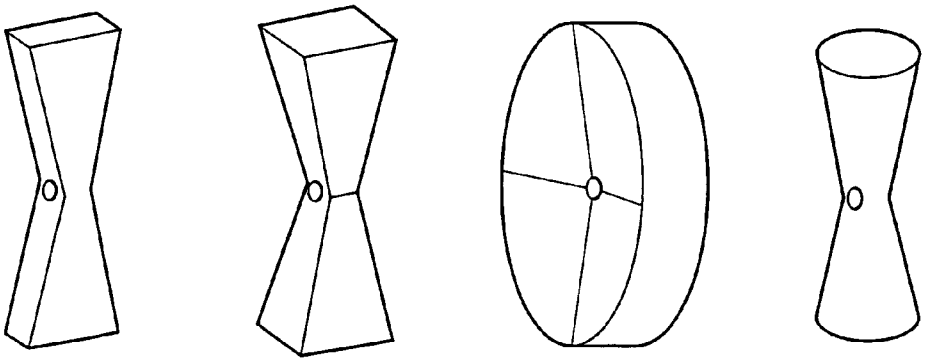


FIG. 12A

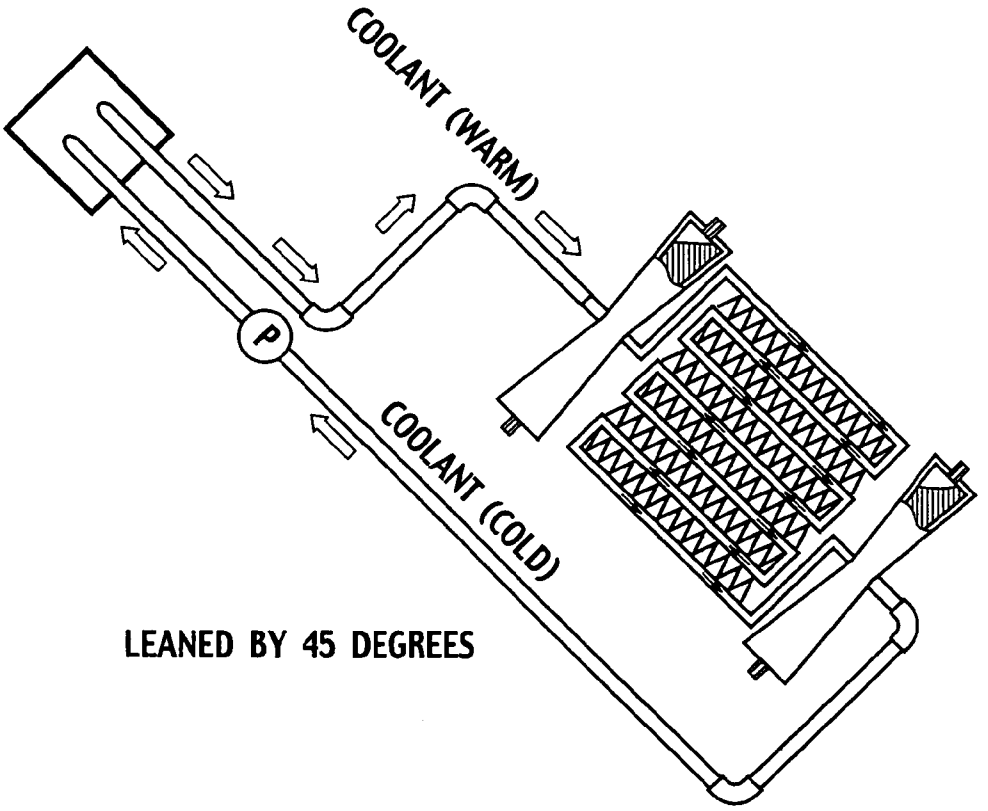


FIG. 12B

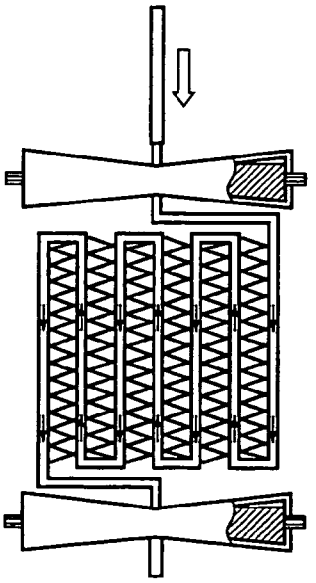


FIG. 13A

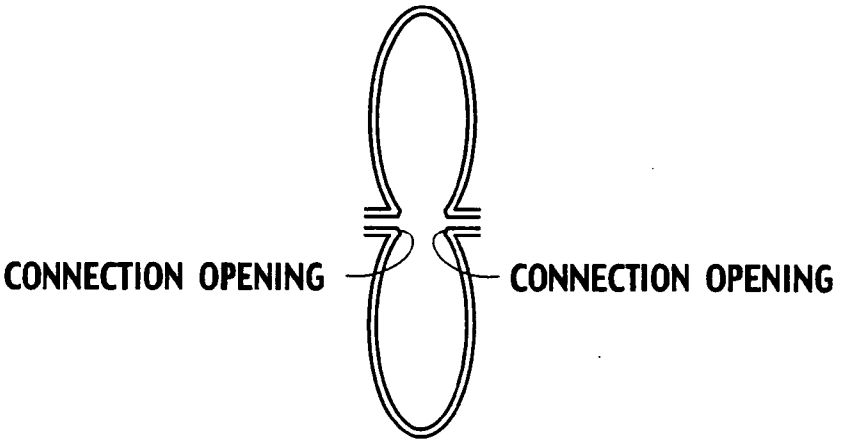


FIG. 13B

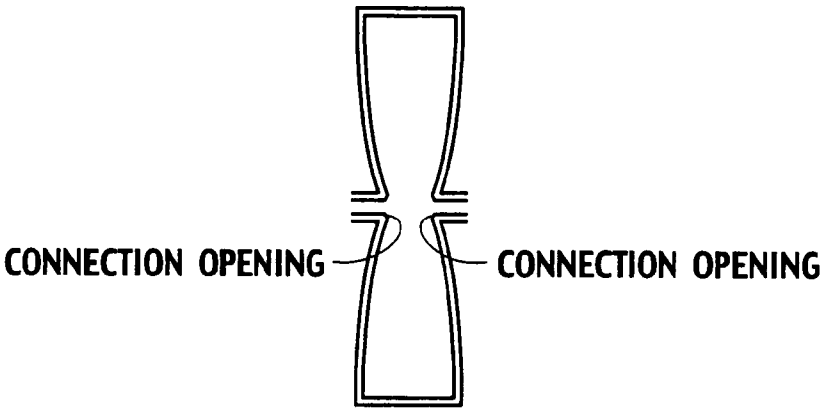


FIG. 13C

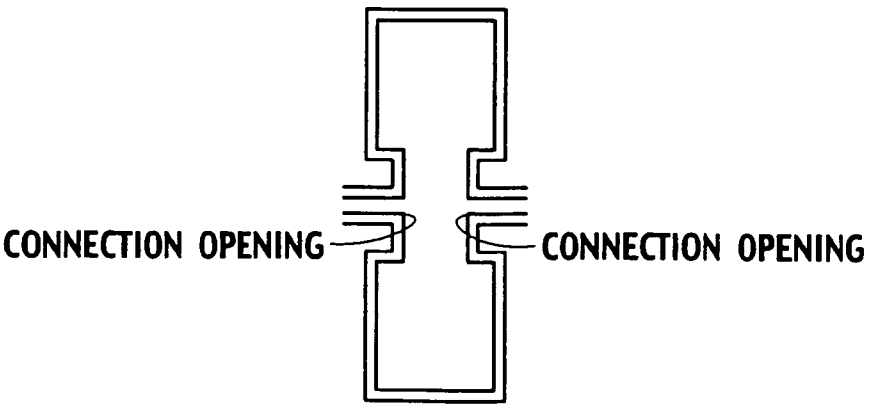


FIG. 14

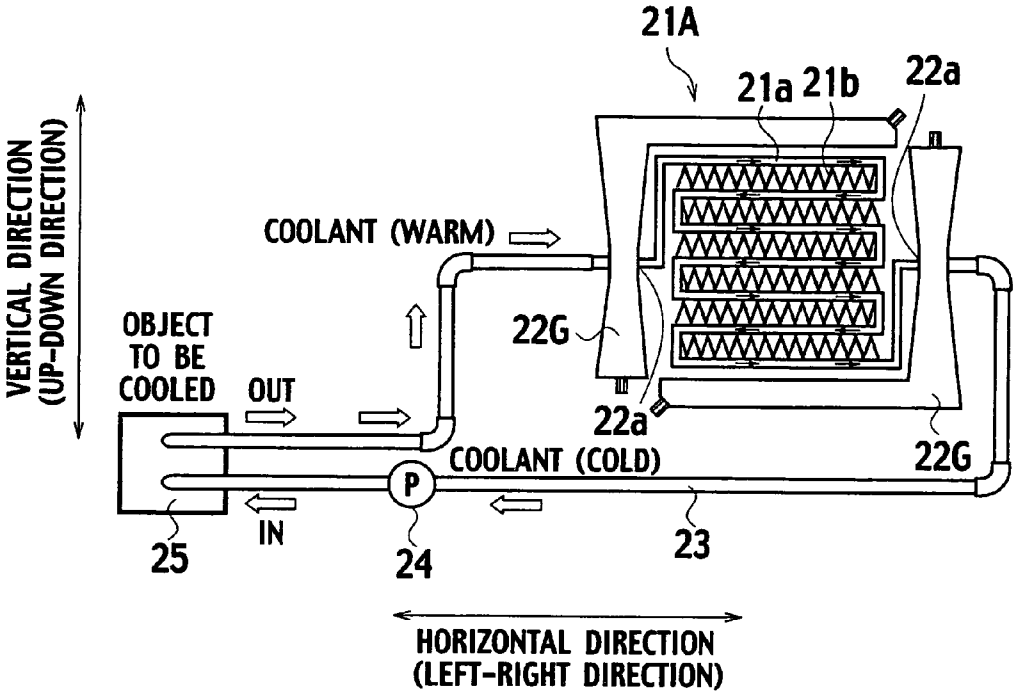

21A
21a
21b
22a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
COOLANT (WARM)
OBJECT
TO BE
COOLED
OUT
22G
22a
22G
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 15

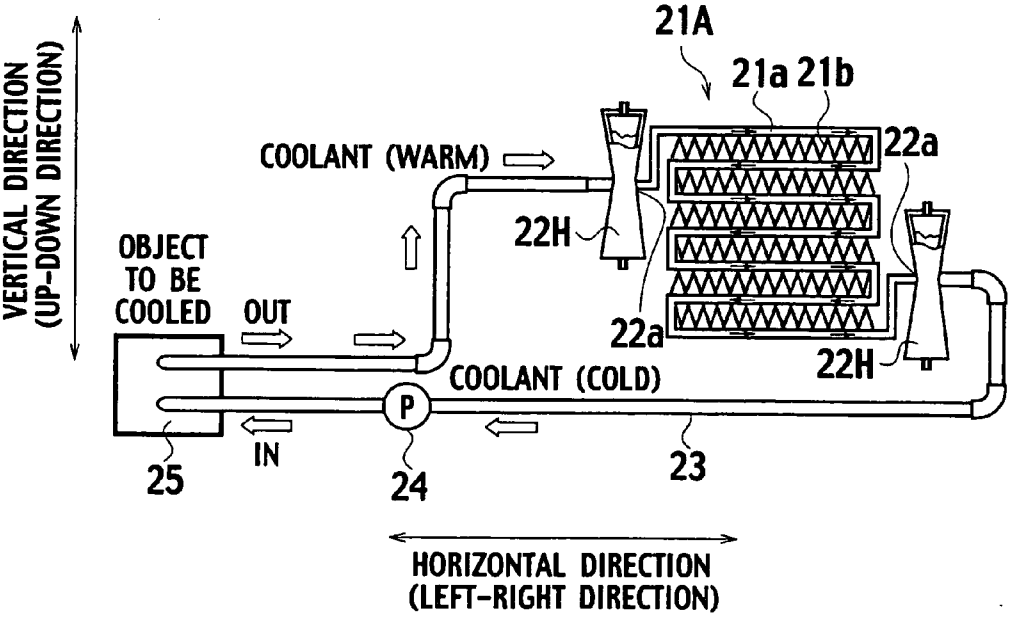

21A
21a
21b
22a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
COOLANT (WARM)
OBJECT
TO BE
COOLED
OUT
22H
22a
22H
COOLANT (COLD)
P
IN
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 16

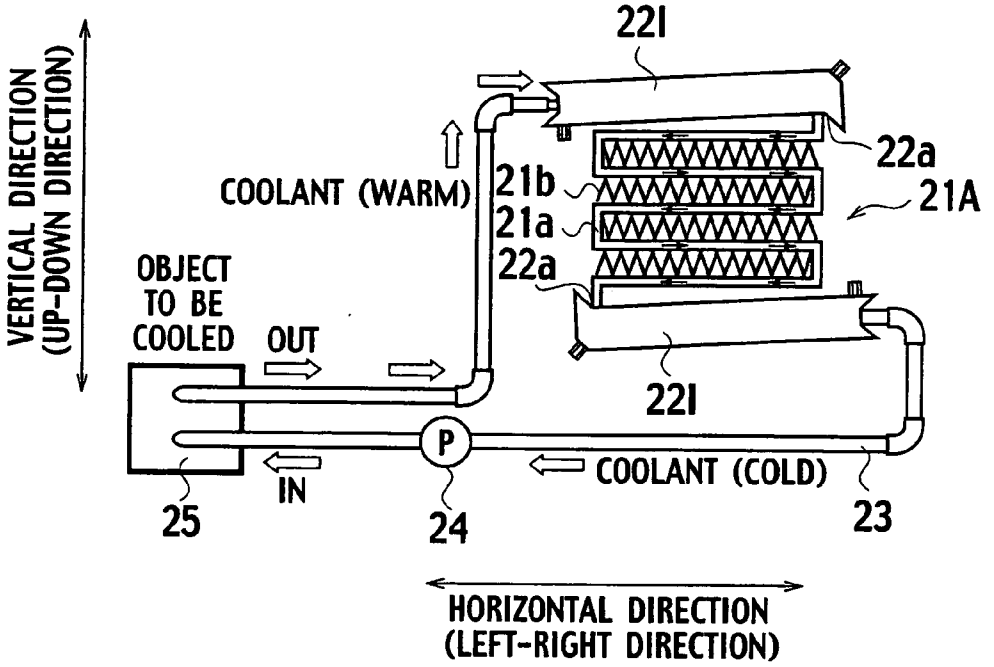

22I
22a
21b
21A
COOLANT (WARM)
21a
22a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
OBJECT
TO BE
COOLED
OUT
22I
P
IN
COOLANT (COLD)
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 17

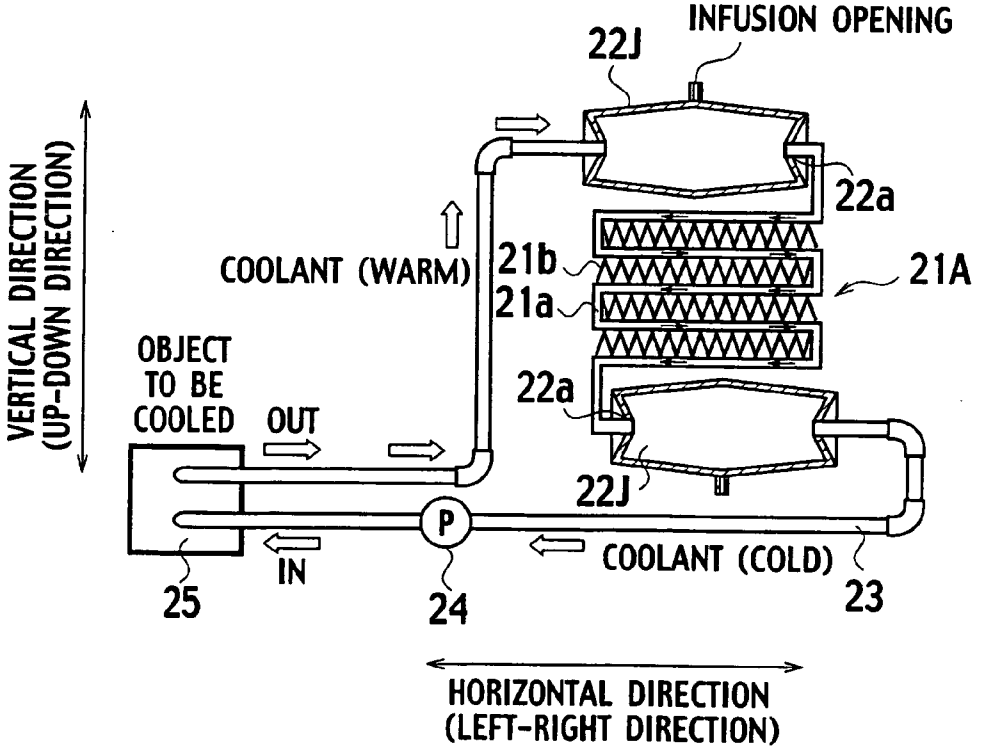

INFUSION OPENING
22J
22a
21b
21A
COOLANT (WARM)
21a
VERTICAL DIRECTION
(UP-DOWN DIRECTION)
OBJECT
TO BE
COOLED
OUT
22a
22J
P
IN
COOLANT (COLD)
25
24
23
HORIZONTAL DIRECTION
(LEFT-RIGHT DIRECTION)

FIG. 18

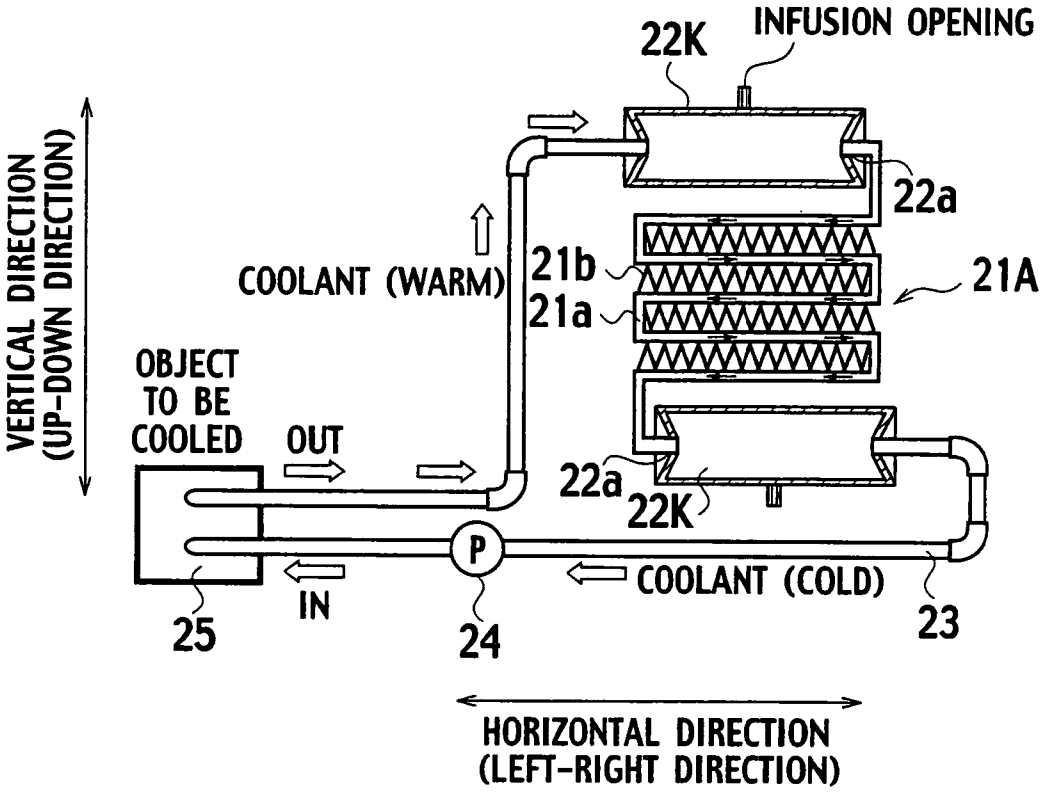


FIG. 19A

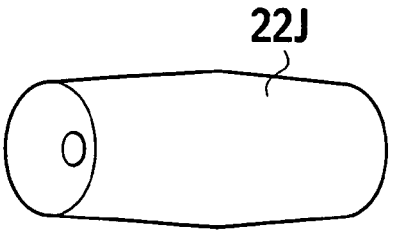


FIG. 19B

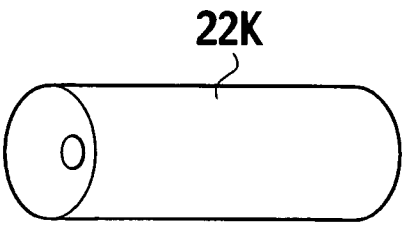


FIG. 20

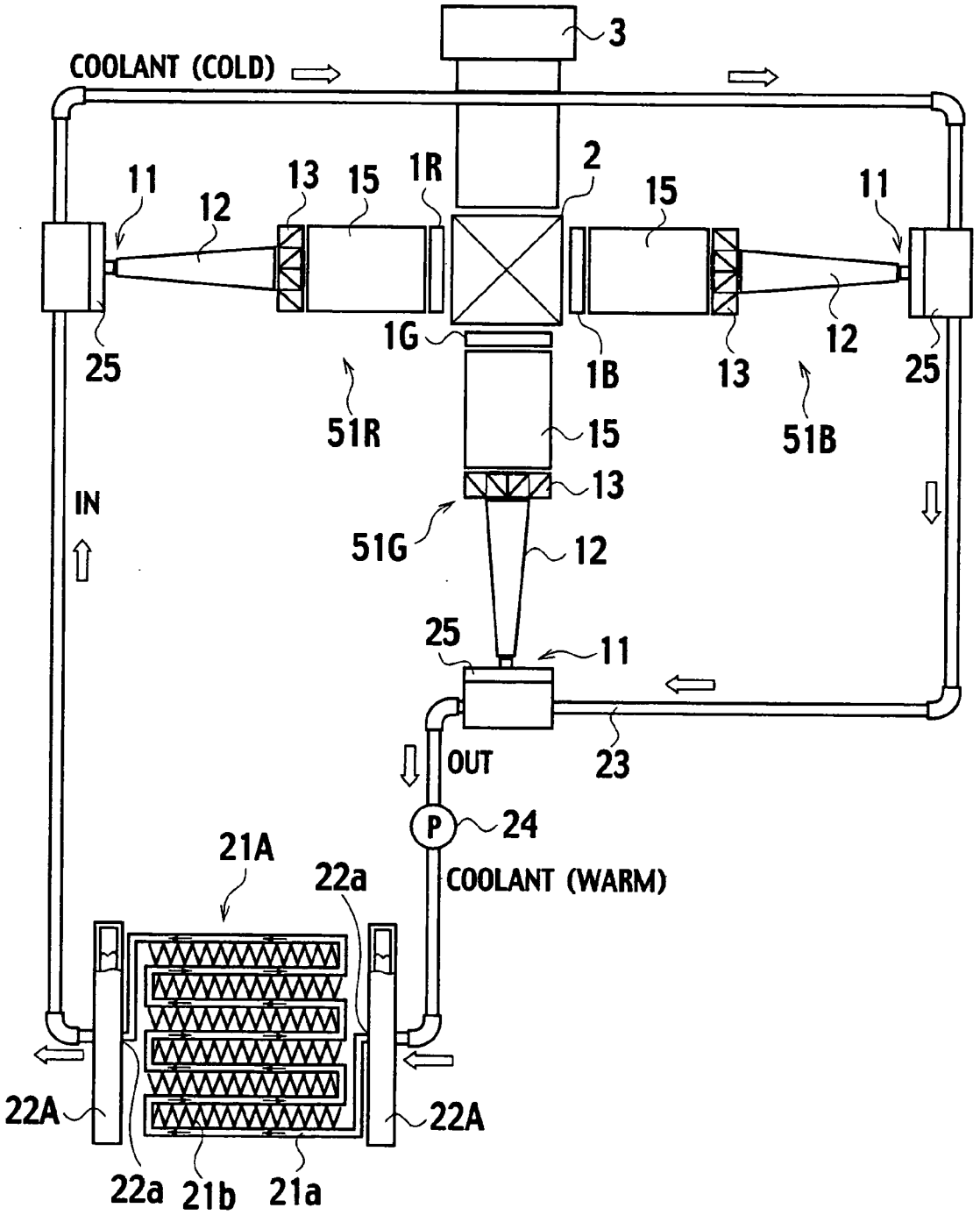

3
COOLANT (COLD)
11
12
13
15
1R
2
15
11
25
1G
1B
13
12
25
51R
15
51B
IN
13
51G
12
25
11
OUT
23
P
24
21A
22a
COOLANT (WARM)
22A
22A
22a
21b
21a

FIG. 21

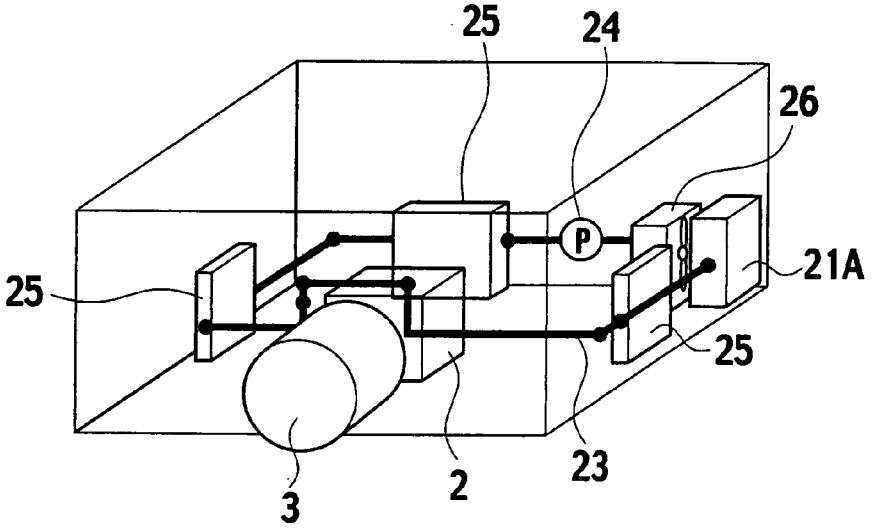

25
24
26
P
21A
25
25
23
2
3

FIG. 22

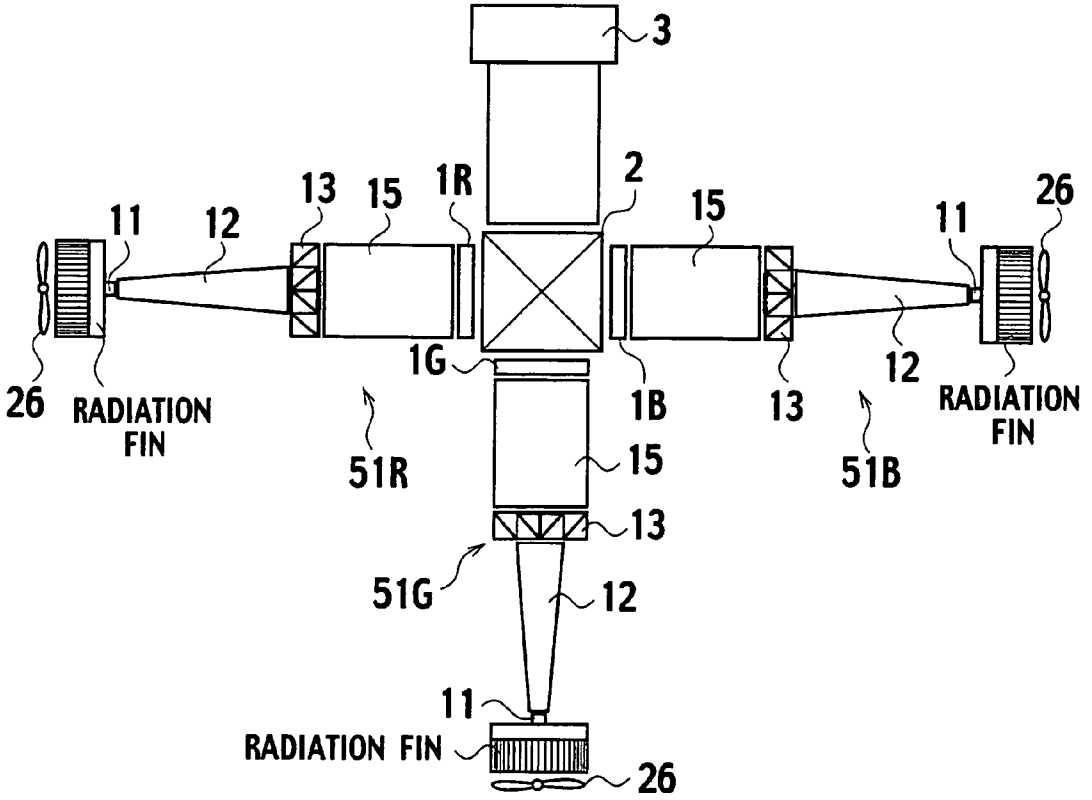

3
2
13
15
1R
15
11
12
11
26
26
RADIATION FIN
1G
1B
13
12
RADIATION FIN
51R
15
51B
13
51G
12
11
RADIATION FIN
26

FIG. 23

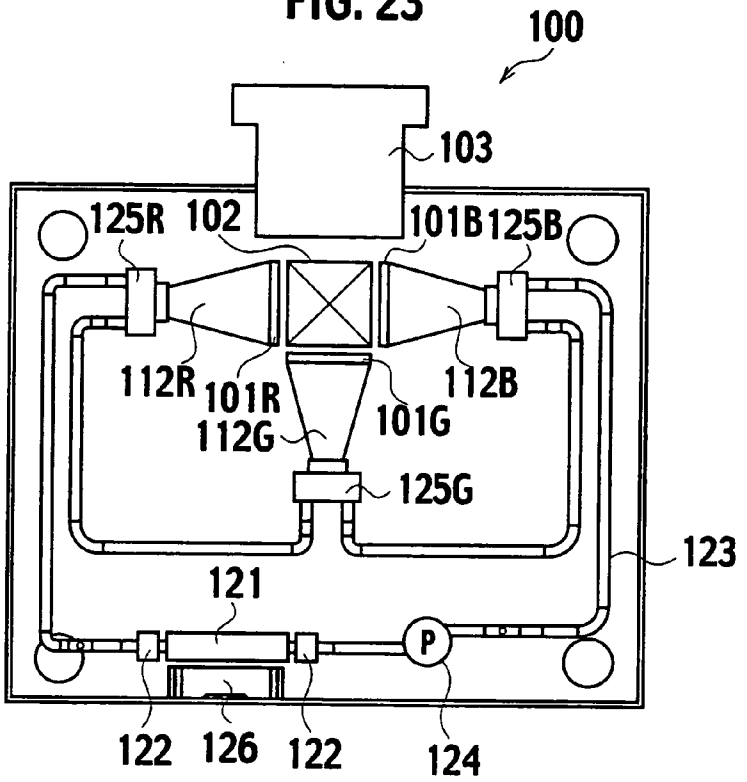

100
103
125R
102
101B
125B
112R
101R
112G
101G
112B
125G
123
121
P
122
126
122
124

FIG. 24

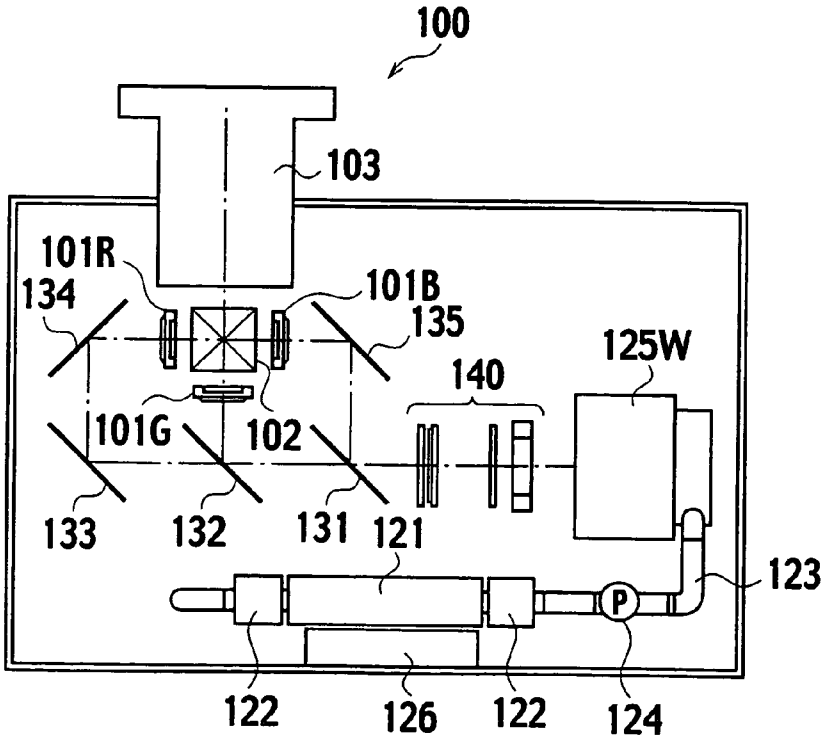
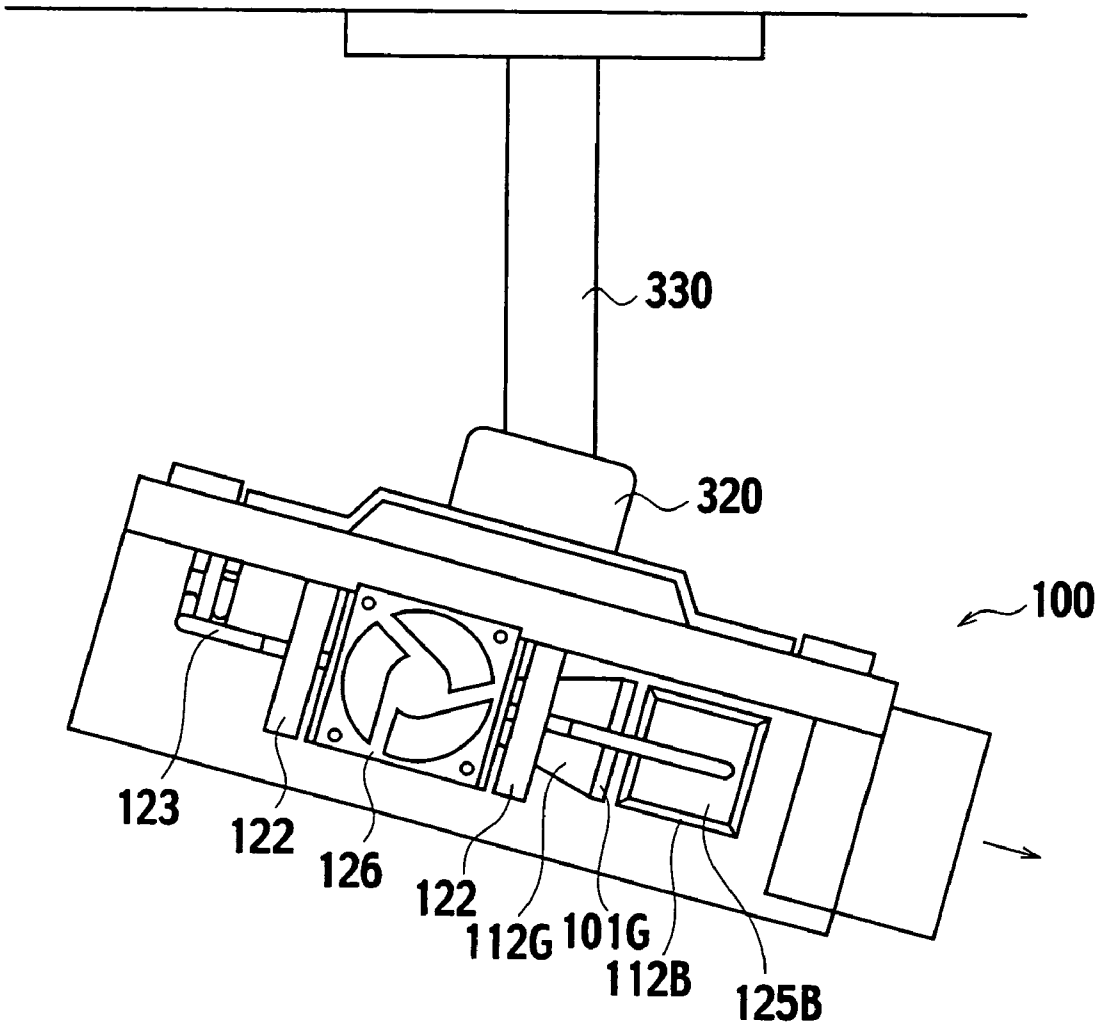

100
103
101R
134
101B
135
125W
140
101G
102
133
132
131
121
123
P
122
126
122
124

FIG. 25



LIQUID COOLING APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2005-282890, filed on Sep. 28, 2005; prior Japanese Patent Application No. 2006-053568, filed on Feb. 28, 2006; and prior Japanese Patent Application No. 2006-258960, filed on Sep. 25, 2006; the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid cooling apparatus configured to cool a heat unit generating heat, by coolant.

[0004] 2. Description of the Related Art

[0005] A projection-type image display apparatus provided with a light source such as a lamp emitting the high brightness light and a projection lens projecting the light emitted from the light source on a screen is generally known. The projection type image display apparatus has a liquid cooling apparatus for cooling the light source by a coolant, for efficiently suppressing affection caused by heat that the light source generates.

[0006] Specifically the liquid cooling apparatus has a flow path where the coolant flows and a radiator cooling the coolant warmed. The liquid cooling apparatus also has a reserve tank (hereinafter, upper reserve tank) for temporarily storing the coolant flowed into the radiator and a reserve tank (hereinafter lower reserve tank) for temporarily storing the coolant flowed out from the radiator.

[0007] The liquid cooling apparatus will be described bellow with reference to FIG. **1**. As shown in FIG. **1**, the liquid cooling apparatus has pipe **23** connecting an object to be cooled **25** such as light source and a radiator **200**. The object to be cooled **25** is cooled by circulating coolant through the pipe **23**. As a pump **24** pump out the coolant into the pipe **23**, the coolant circulates between the object to be cooled **25** and the radiator **200**.

[0008] The radiator **200** has inner radiator pipes **202** where the coolant passes through, and a heat radiation fin **203** cooling the coolant. The heat radiation fin **203** is cooled by the wind that blew to the heat radiation fin **203** from fan **206**.

[0009] The liquid cooling apparatus has an upper reserve tank **204** for temporarily storing the coolant flowed into the radiator and a lower reserve tank **205** for temporarily storing the coolant flowed out from the radiator.

[0010] The upper reserve tank **204** is arranged on upper side of the radiator **200** and the lower reserve tank **205** is arranged on lower side of the radiator **200**, assuming a vertical direction as an up-down direction when the projection-type image display apparatus disposed statically. Accordingly, a load of the pump **24** pumping out the coolant into the pipe **23** will be decreased.

[0011] Since, a size of the projection-type image display apparatus in the up-down direction is restricted, sizes of the upper reserve tank **204** and the lower reserve tank **205** in the up-down direction are difficult to be enlarged. On the contrary, a capacity (a volume) of the upper reserve tank **204** and the lower reserve tank **205** need to be enlarged for saving enough amount of the stored coolant.

[0012] Therefore, sizes of the upper reserve tank **204** and the lower reserve tank **205** in a left-right direction (horizontal direction) are generally larger than the sizes of the upper reserve tank **204** and the lower reserve tank **205** in the up-down direction (vertical direction).

[0013] A coolant tank **201** storing the coolant is provided on upper side of the upper reserve tank **204**, the coolant infused from an infusion opening. A layer of air is provided in upper portion of the coolant tank **201** to improve circulation characteristics of the coolant (for example, Unexamined Japanese Application No. 2002-357803).

[0014] As the projection-type image display apparatus, projection-type image display apparatuses of hanging from ceiling type and of mobile type exist. In the projection-type image display apparatuses of hanging from ceiling type and of mobile type, since directions of the projection-type image display apparatuses are changeable, air may go into the pipe **23** or the like. As the air goes into the pipe **23**, a flow amount of the coolant will be decreased. Accordingly, efficiency for cooling the object to be cooled **25** is deteriorated.

[0015] Especially, in the upper reserve tank **204** described above, since the size in the up-down direction (vertical direction) is smaller than the size in the left-right direction (horizontal direction), the air will easily go into the pipe **23** when the direction of the projection-type image display apparatus (that is, the liquid cooling apparatus) varies.

SUMMARY OF THE INVENTION

[0016] An aspect of a liquid cooling apparatus provided on an apparatus having a heat unit generating heat, and configured to cool the heat unit by coolant includes; a coolant tank configured to store the coolant; a radiator configured to cool the coolant; and a coolant pipe which is a flow path of the coolant and connecting the coolant tank and the radiator. The coolant tank is arranged adjacent to the radiator in a horizontal direction when the apparatus disposed statically. A size of the coolant tank in a vertical direction is larger than a size of the coolant tank in a horizontal direction when the apparatus is disposed statically.

[0017] "Disposing the apparatus statically" is to dispose the apparatus on the horizontal surface without leaning the apparatus.

[0018] According this aspect, since the size of the coolant tank in a vertical direction is larger than the size of the coolant tank in a horizontal direction, the air merely goes into the coolant pipe, if the direction of the liquid cooling apparatus varies. The volume of the coolant tank can be sufficiently kept.

[0019] In an aspect of the liquid cooling apparatus according to above described aspect, the coolant pipe connects to a center portion of the coolant tank in a vertical direction when the apparatus is disposed statically.

[0020] According to this aspect, since the coolant pipe connects to a center portion of the coolant tank in a vertical direction, the air merely goes into the coolant pipe, if the liquid cooling apparatus is disposed upside down.

[0021] In an aspect of the liquid cooling apparatus according to above described aspect, the coolant tank has a shape expanding from the center portion to upper side and expanding from the center portion to lower side, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

[0022] According to this aspect, since the coolant tank has the shape expanding from the center portion to upper side and expanding from the center portion to lower side, the air merely goes into the coolant pipe, not only if the liquid cooling apparatus is disposed upside down but if the direction of the liquid cooling apparatus changes to various directions.

[0023] An aspect of the liquid cooling apparatus according to above described aspect further includes infusion openings for infusing the coolant into the coolant tank. The infusion openings are arranged on upper portion and lower portion of the coolant tank, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

[0024] According to this aspect, since the infusion openings are arranged on upper portion and lower portion of the coolant tank, one of the infusion openings faces toward upper side, if the liquid cooling apparatus is disposed upside down. Accordingly, the coolant is easily infused into the coolant tank.

[0025] In an aspect of the liquid cooling apparatus according to above described aspect, the coolant tank includes a pair of cooling tanks, and the pair of cooling tanks are arranged on the both side of the radiator.

[0026] According to this aspect, since the pair of cooling tanks are arranged on the both side of the radiator, the air merely goes into the radiator.

[0027] An aspect of a liquid cooling apparatus provided on an apparatus having a heat unit generating heat, and configured to cool the heat unit by coolant includes; a pair of coolant tanks configured to store the coolant; a radiator configured to cool the coolant; and a coolant pipe which is a flow path of the coolant and connecting the coolant tank and the radiator. The pair of coolant tanks includes an upper tank arranged on upper side of the radiator and a lower tank arranged on lower side of the radiator, assuming a vertical direction as up-down direction when the apparatus is disposed statically. One part on an upper surface of the upper tank expands upper than other part on the upper surface of the upper tank, and one part on a lower surface of the lower tank expands lower than other part on the lower surface of the lower tank. A shape of the upper tank is identical with a shape of the lower tank

[0028] According to this aspect, since the one part on the upper surface of the upper tank expands upper than the other part on the upper surface of the upper tank, the air gathers around the one part on the upper surface of the upper tank which expands upper than the other part on the upper surface of the upper tank. Therefore, the air merely goes into the coolant pipe, if the direction of the liquid cooling apparatus varies.

[0029] Since the shape of the upper tank is identical with the shape of the lower tank, the air merely goes into the coolant pipe, if the liquid cooling apparatus is disposed upside down.

[0030] In an aspect of the liquid cooling apparatus according to above described aspect, one part on a lower surface of the upper tank expands lower than other part on the lower surface of the upper tank, and one part on an upper surface of the lower tank expands upper than other part on the upper surface of the lower tank.

[0031] According to this aspect, since the one part on an upper surface of the lower tank expands upper than the other part on the upper surface of the lower tank, the air gathers around the one part on the upper surface of the lower tank which expands upper than the other part on the upper surface of the lower tank. Therefore, the air merely goes into the coolant pipe, if the direction of the liquid cooling apparatus varies.

[0032] Since the shape of the upper tank is identical with the shape of the lower tank, the air merely goes into the coolant pipe, if the liquid cooling apparatus is disposed upside down.

[0033] In an aspect of the liquid cooling apparatus according to above described aspect, the coolant pipe respectively connects to center portions of the upper tank and the lower tank in a vertical direction when the apparatus is disposed statically. The upper tank and the lower tank respectively have shape expanding from the center portion to upper side and expanding from the center portion to lower side, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

[0034] According to this aspect, since the upper tank and the lower tank respectively have the shape expanding from the center portion to upper side and expanding from the center portion to lower side, the air merely goes into the coolant pipe, not only if the liquid cooling apparatus is disposed upside down but if the direction of the liquid cooling apparatus changes to various directions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] FIG. **1** is an explanatory diagram showing a liquid cooling apparatus related to the present invention.

[0036] FIGS. **2**A and **2**B are explanatory diagrams showing a liquid cooling apparatus of an embodiment of the present invention. FIG. **2**A shows the normal arrangement, and FIG. **2**B shows the upside down arrangement.

[0037] FIGS. **3**A and **3**B are explanatory diagrams showing another example of the liquid cooling apparatus of the embodiment of the present invention. FIG. **3**A shows the normal arrangement, and FIG. **3**B shows the upside down arrangement.

[0038] FIGS. **4**A and **4**B are explanatory diagrams showing still another example of the liquid cooling apparatus of the embodiment of the present invention. FIG. **4**A shows the normal arrangement, and FIG. **4**B shows the upside down arrangement.

[0039] FIGS. **5**A and **5**B are explanatory diagrams showing still another example of the liquid cooling apparatus of the embodiment of the present invention. FIG. **5**A shows the normal arrangement, and FIG. **5**B shows the upside down arrangement.

[0040] FIG. **6** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0041] FIG. **7** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0042] FIG. **8** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0043] FIG. **9** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0044] FIG. **10** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0045] FIGS. **11**A to **11**D are perspective views respectively showing examples of the shapes of a coolant tank **22**F.

[0046] FIG. **12**A is an explanatory diagram showing a 45° oblique arrangement of the liquid cooling apparatus shown in FIG. **10**, and FIG. **12**B is an explanatory diagram showing a 90° oblique arrangement of the liquid cooling apparatus shown in FIG. **10**.

[0047] FIGS. **13**A to **13**C are cross sectional views respectively showing examples of the sectional shapes of the coolant tank **22**F.

[0048] FIG. **14** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0049] FIG. **15** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0050] FIG. **16** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0051] FIG. **17** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0052] FIG. **18** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention.

[0053] FIG. **19**A is a perspective view showing an example of the shape of a coolant tank **22**J, and FIG. **19**B is a perspective view showing an example of the shape of a coolant tank **22**K.

[0054] FIG. **20** is an explanatory diagram showing an example in which the liquid cooling apparatus of the present invention is applied to a projection-type image display apparatus.

[0055] FIG. **21** is an explanatory diagram showing an example in which the liquid cooling apparatus of the present invention is applied to a projection-type image display apparatus.

[0056] FIG. **22** is a reference diagram showing a case where an air cooling apparatus is applied to the projection-type image display apparatus.

[0057] FIG. **23** is an explanatory diagram showing an example in which the liquid cooling apparatus of the present invention is applied to a projection type image display apparatus.

[0058] FIG. **24** is an explanatory diagram showing an example in which the liquid cooling apparatus of the present invention is applied to a projection type image display apparatus.

[0059] FIG. **25** is an explanatory diagram showing an example of an attachment structure of a projection type image display apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0060] Hereinafter, a liquid cooling apparatus of an embodiment of the present invention will be described based on FIGS. **2** to **25**. Incidentally, for convenience of description, the same reference numerals are respectively given to the same constituents as the constituents of the liquid cooling apparatus of the conventional example shown in FIG. **1**, and the description thereof is be omitted in some cases.

[0061] A vertical direction when the apparatus provided with the liquid cooling apparatus is disposed statically will be described as an up-down direction, and a horizontal direction when the apparatus provided with the liquid cooling apparatus is disposed statically will be described as a left-right direction. "Disposing the liquid cooling apparatus" is to dispose the liquid cooling apparatus on the horizontal surface without leaning the liquid cooling apparatus.

FIRST EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0062] FIGS. **2**A and **2**B are explanatory diagrams showing an example of a liquid cooling apparatus of an embodiment of the present invention. This liquid cooling apparatus is configured to circulate the coolant between the liquid cooling jacket unit **25** and a radiator **21**A. The radiator **21**A includes an inner radiator pipe **21***a*, and a radiation fin **21***b* with a zigzag shape around this inner radiator pipe **21***a*. Moreover, at the both of the right and left sides of this radiator **21**A, coolant tanks **22**A each with a shape such as a vertically long square cylinder or a vertically long circular cylinder are arranged. Each of the coolant tanks **22**A has substantially the same length (height) as the length of the side faces of the radiator **21**A. Connection openings (ports) **22***a* to be connected to the inner radiator pipe **21***a* are respectively formed at substantially central positions in the longitudinal direction of the respective coolant tanks **22**A. A size of the coolant tank **22**A in the up-down direction is larger than a size of the coolant tank **22**A in the left-right direction. Moreover, connection openings (ports) to be connected to a coolant circulation pipe **23** (a coolant pipe) are also respectively formed at the substantially central positions in the longitudinal direction of the respective coolant tanks **22**A. That is, portions to serve as air pockets in the respective coolant tanks **22**A exist above the respective connection openings (ports). An infusion opening, where the coolant infused, is provided at each of the upper and lower ends of each of the coolant tanks **22**A. The coolant circulation pipe **23** is provided with a pump **24**, and by means of this pump **24** the coolant is circulated inside the coolant circulation pipe **23** and the inner radiator pipe **21***a*. The coolant cooled by the radiator **21**A is led to a liquid cooling jacket unit **25**. An object to be cooled (a heat unit generating heat) is arranged on top of this liquid cooling jacket unit **25**.

The coolant whose temperature increased by absorbing the heat from the object to be cooled is led to the radiator **21**A through the coolant circulation pipe **23**. The heat transmitted to the radiation fin **21***b* of the radiator **21**A is taken away by air blown from a fan (not shown).

[**0063**] With the liquid cooling apparatus of the above-described configuration, the portions to serve as the air pockets in the respective coolant tanks **22**A will always exist above the respective connection openings (ports), either in the regular arrangement of the radiator **21**A shown in FIG. **2**A or in the upside down arrangement of the radiator **21**A shown in FIG. **2**B. Accordingly, it is possible to use the liquid cooling apparatus in the upside down arrangement as well. Moreover, as for the whole system of the liquid cooling apparatus (a set including the radiator, the pump and the like), modification such as reversing the rotation of the pump and the like will not be needed even if the liquid cooling apparatus is arranged upside down. It should be noted that, in the case of the liquid cooling apparatus, each of the coolant tanks **22**A is not limited to have substantially the same length (height) as the length of the side faces of the radiator **21**A, and may have a shorter length (height). Moreover, the connection openings may be positioned slightly off the respective central positions described above. Moreover, the coolant tank may be incorporated with the radiator or may be attached to the radiator separately. Moreover, the fan may also be incorporated with the radiator or may be attached to the radiator separately. Also in the configuration examples shown below, the situation is the same.

SECOND EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[**0064**] FIGS. **3**A and **3**B are explanatory diagrams showing another example of the liquid cooling apparatus of the embodiment of the present invention. This liquid cooling apparatus differs from the liquid cooling apparatus shown in FIG. **2** in that it is provided with a radiator **21**B. This liquid cooling apparatus has the configuration in common with the liquid cooling apparatus shown in FIG. **2** in every other respect. The radiator **21**B includes a plurality of radiator pipes **21***c* arranged in parallel between the upper port portion and the lower port portion, and the radiation fin **21***b* around the radiator pipes **21***c*. Moreover, the inner radiator pipe **21***a* extended from the left end face of the upper port portion of the radiator **21**B is connected to the connection opening (port) **22***a* positioned at the substantially central position in the longitudinal direction of the left coolant tank **22**A, and the inner radiator pipe **21***a* extended from the right end face of the lower port portion of the radiator **21**B is connected to the connection opening (port) **22***a* positioned at the substantially central position in the longitudinal direction of the right coolant tank **22**A. With the liquid cooling apparatus of this configuration, the portions to serve as the air pockets in the respective coolant tank **22**A will always exist above the respective connection openings (ports), either in the regular arrangement of the radiator **21**B shown in FIG. **2**A or in the upside down arrangement of the radiator **21**B shown in FIG. **2**B. Accordingly, it is possible to use the liquid cooling apparatus in the upside down arrangement as well.

THIRD EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[**0065**] FIGS. **4**A and **4**B are explanatory diagrams showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. **2** is that the inner radiator pipe **21***a* is directly connected to the coolant circulation pipe **23** without having one of the two coolant tanks **22**A provided. With the liquid cooling apparatus of this configuration, the portion to serve as the air pocket in the single coolant tank **22**A will always exist above the connection opening (port), either in the regular arrangement of the radiator **21**A shown in FIG. **4**A or in the upside down arrangement of the radiator **21**A shown in FIG. **4**B. Accordingly, it is possible to use the liquid cooling apparatus in the upside down arrangement as well. It should be noted that the inner radiator pipe **21***a* to be directly connected to the coolant circulation pipe **23** may be formed straight and connected thereto.

FOURTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[**0066**] FIGS. **5**A and **5**B are explanatory diagrams showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. **3** is that one of the two coolant tanks **22**A is not provided. In addition, the inner radiator pipe **21***a* extended from the left end face of the upper port portion of the radiator **21**B is directly connected to the coolant circulation pipe **23**. With the liquid cooling apparatus of this configuration, the portion to serve as the air pocket in the coolant tank **22**B will always exist above the connection opening (port), either in the regular arrangement of the radiator **21**B shown in FIG. **5**A or in the upside down arrangement of the radiator **21**B shown in FIG. **5**B. Accordingly, it is possible to use the liquid cooling apparatus in the upside down arrangement as well. It should be noted that the inner radiator pipe **21***a* to be directly connected to the coolant circulation pipe **23** may be formed straight and connected thereto.

FIFTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[**0067**] FIG. **6** is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. **2** is that two coolant tanks **22**B are respectively provided in place of the two coolant tanks **22**A. One coolant tank **22**B is arranged in the shape of a hook extending from the left side to the upper side of the radiator **21**A. Another coolant tank **22** is arranged in the shape of a hook extending from the right side to the lower side of the radiator **21**A. Moreover, the side portions as well as the upper and lower side portions of the respective coolant tanks **22**B have substantially the same length (height) as the length of the side faces of the radiator **21**A. The connection openings (ports) **22***a* to be connected to the inner radiator pipe **21***a* are respectively formed at the substantially central positions in the longitudinal direction of the respective side portions. Moreover, the connection openings (ports) to be connected to the coolant circulation pipe

23 are also respectively formed at the substantially central positions in the longitudinal direction of the respective side portions. Moreover, each of the coolant tanks 22B has oblique faces substantially perpendicular to an oblique 45° line therebetween, and has infusion openings respectively in these oblique face portions. With the liquid cooling apparatus of this configuration, it is possible to use the liquid cooling apparatus not only in the upside down arrangement but also in a leaned arrangement, for example, at oblique 45°. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22B. The infusion openings may be respectively provided at places in the vertical faces or horizontal faces without forming the oblique faces. Moreover, the lengths of the side portions as well as the upper and lower side portions of the respective coolant tanks 22B may be shorter than the length of each side of the radiator 21A.

SIXTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0068] FIG. 7 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 2 is that two coolant tanks 22C are provided diagonally opposite to one another. Each of the coolant tanks 22C has a square cylindrical shape or a circular cylindrical shape. Each of the coolant tanks 22C has the length (height) shorter than the length of the side faces of the radiator 21A. The connection openings (ports) 22*a* to be connected to the inner radiator pipe 21*a* are respectively formed at substantially central positions in the longitudinal direction of the respective coolant tanks 22C. Moreover, the connection openings (ports) to be connected to the coolant circulation pipe 23 are also respectively formed at the substantially central positions in the longitudinal direction of respective the coolant tanks 22C. That is, the portions to serve as the air pockets in the respective coolant tanks 22C always exist above the respective connection openings (ports). In addition, this configuration may include the radiator 21B or may not include one of the coolant tanks 22C.

SEVENTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0069] FIG. 8 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 2 is that coolant tanks 22D are respectively provided in the upper and lower sides of the radiator 21A. Each of the coolant tanks 22D has substantially the same length (width) as the length of the upper and lower sides of the radiator 21A, and is arranged obliquely upward to the right. At the right edge of each of the coolant tanks 22D, the highest part of the coolant tank 22D is formed, and this part serves as the air pocket in the regular arrangement. Moreover, at the left edge of each of the coolant tanks 22D, the lowest part of the coolant tank 22D is formed and this part serves as the air pocket in the upside down arrangement. That is, one part (right edge) on the upper surface of the coolant tank 22D expands upper than the other part (left edge) on the upper surface of the coolant tank 22D. One part (left edge) on the lower surface of the coolant tank 22D expands lower than the other part (right edge) on the lower surface of the coolant tank 22D. The connection openings (ports) connected to the coolant circulation pipe 23 are respectively formed at the substantially central positions in the longitudinal direction of the respective coolant tanks 22D. Moreover, in the upper coolant tank 22D, the connection opening (port) 22*a* to be connected to the inner radiator pipe 21*a* is formed in the rightmost lower face, whereas in the lower coolant tank 22D it is formed in the leftmost upper face. That is, the portions to serve as the air pockets in the respective coolant tanks 22D always exist above the respective connection openings (ports). It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22D.

EIGHTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0070] FIG. 9 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 8 is that coolant tanks 22E are respectively provided in the upper and lower sides of the radiator 21A. Each of the coolant tanks 22E has a substantially square cylindrical shape or a substantially circular cylindrical shape or the like, the center of which protrudes upward and downward. That is, the highest part and the lowest part of each of the coolant tanks 22E are formed at the central position of the coolant tank 22E. The highest portions respectively serve as the air pockets in the regular arrangement, whereas the lowest portions respectively serve as the air pockets in the upside down arrangement. The connection openings (ports) to be connected to the coolant circulation pipe 23 are respectively formed at the substantially central positions in the respective side faces of the respective coolant tanks 22E. Moreover, the connection openings (ports) 22*a* to be connected to the inner radiator pipe 21*a* are also formed at the substantially central positions in the respective side faces of the respective coolant tanks 22E. That is, the portions to serve as the air pockets in the respective coolant tanks 22E always exist above the respective connection openings (ports). It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22E.

NINTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0071] FIG. 10 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 2 is that in place of the coolant tanks 22A each having a straight shape, coolant tanks 22F each having a shape whose central portion (the portion at which the connection openings are formed) is narrowed are provided. The portions to serve as the air pockets and the portions to possibly serve the air pockets in the respective coolant tanks 22F extend to the right and left from the corresponding connection openings, i.e., connection opening 22*a* between the inner radiator pipe 21*a* and the coolant tank 22F; and the connection opening between the coolant circulation pipe 23 and the coolant tank 22F.

[0072] Each of the coolant tanks 22F has one of shapes shown in FIGS. 11A to 11D, for example. The coolant tank

22F shown in FIG. 11A has a shape formed by narrowing a center part of a flat square cylinder from two directions (two faces which are not narrowed are in parallel to each other). The coolant tank 22F shown in FIG. 11B has a shape formed by narrowing a center part of a square cylinder from four directions. The coolant tank 22F shown in FIG. 11C has a flat cylindrical shape (disk shape) around the connection openings, and the connection openings exist inside the edge positions of the circumferential faces of the flat cylindrical shape. The coolant tank 22F shown in FIG. 11D has a shape formed by narrowing a central position of a vertically long circular cylindrical shape, and the connection openings are formed at this central position (narrowed position).

[0073] FIGS. 12A and 12B show the states where the liquid cooling apparatus shown in FIG. 10 is leaned. As previously described, the portions to serve as the air pockets and the portions to possibly serve as the air pockets in the respective coolant tanks 22F extend to the right and left from the corresponding connection openings, i.e., the connection opening 22*a* between the inner radiator pipe 21*a* and the coolant tank 22F; and the connection opening between the coolant circulation pipe 23 and the coolant tank 22F. By this configuration, even if the radiator 21A is arranged not only at ±90 degrees but also obliquely at other angles, either or both of the portions to serve as the air pockets and the portions to possibly serve as the air pockets exist above the connection opening. Accordingly, air will gather in the air pockets in whatever way the liquid cooling apparatus is leaned, and thus air can be almost securely prevented from going into the piping from the connection openings.

[0074] The shape of the coolant tank 22F is not limited to the shapes shown in FIG. 11 and may have a sectional shape shown in FIG. 13A, a sectional shape shown in FIG. 13B, or a sectional shape shown in FIG. 13C, for example. That is, it suffices that the portion to serve as the air pocket and the portion to possibly serve as the air pocket in the coolant tank 22F extend to the right and left from the connection openings. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22F.

TENTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0075] FIG. 14 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 6 is that coolant tanks 22G are provided in place of the coolant tanks 22B. While each of the coolant tanks 22G has a hook shape as in the case of the coolant tank 22B, the portion to serve as the air pocket in the side portion of one of the coolant tanks 22G and the portion to possibly serve as the air pocket in the side portion of another of the coolant tanks 22G extend to the right and left from the connection openings as in the case of the coolant tank 22F described above. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22G.

ELEVENTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0076] FIG. 15 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 7 is that coolant tanks 22H are provided in place of the coolant tanks 22B. While the two coolant tanks 22H are arranged diagonally opposite to one another as in the case of the coolant tanks 22C, the portions to serve as the air pockets and the portions to possibly serve as the air pockets of the respective coolant tanks 22H extend to the right and left from the connection openings as in the case of the coolant tanks 22F described above. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22H.

TWELFTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0077] FIG. 16 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 8 is that coolant tanks 22I are provided in place of the coolant tanks 22D. While the two coolant tanks 22I are respectively arranged in the upper and lower sides of the radiator 21A as in the case of the coolant tanks 22D, the portions to serve as the air pockets and the portions to possibly serve as the air pockets of the respective coolant tanks 22I extend to the right and left from the connection openings as in the case of the coolant tanks 22F described above. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22I.

THIRTEENTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0078] FIG. 17 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 9 is that coolant tanks 22J are provided in place of the coolant tanks 22E. While the two coolant tanks 22J are respectively arranged in the upper and lower sides of the radiator 21A as in the case of the coolant tanks 22E, the portion to serve as the air pocket and the portion to possibly serve as the air pocket of the coolant tanks 22J extend to the right and left from the connection openings as in the case of the coolant tank 22F described above. Although each of the coolant tanks 22J has a substantially beer barrel shape (circular sectional shape) as shown in FIG. 19A, it may have a square sectional shape or the like. It should be noted that this configuration may include the radiator 21B or may not include one of the coolant tanks 22J.

FOURTEENTH EMBODIMENT

(Configuration of Liquid Cooling Apparatus)

[0079] FIG. 18 is an explanatory diagram showing still another example of the liquid cooling apparatus of the embodiment of the present invention. The difference from the liquid cooling apparatus shown in FIG. 9 is that coolant tanks 22K are provided in place of the coolant tanks 22E. While the two coolant tanks 22K are respectively arranged in the upper and lower sides of the radiator 21A as in the case of the coolant tanks 22E, the portion to serve as the air pocket and portion to possibly serve as the air pocket of the

coolant tanks **22**K extend to the right and left from the connection openings as in the case of the coolant tanks **22**F described above. Although each of the coolant tanks **22**K has a substantially circular cylindrical shape (circular section) as shown in FIG. **19**B, it may have a square cylindrical shape or the like. It should be noted that this configuration may include the radiator **21**B or may not include one of the coolant tanks **22**K.

[**0080**] Moreover, in the liquid cooling apparatuses described above, each of the coolant tanks includes two infusion openings respectively used for the regular arrangement and for the upside down arrangement, however, it also serves a purpose that the coolant tank is configured to include only one infusion opening, or that the coolant tank itself is configured not to include a infusion opening. Moreover, the coolant tank may be positioned not only in the surroundings of the radiator **21**, but also, away from the surroundings, in front of or behind the radiator **21** (positions should keep out of the way of a fan or air blown by the fan).

FIFTEENTH EMBODIMENT

(Configuration of Projection-Type Image Display Apparatus)

[**0081**] FIG. **20** is an explanatory diagram showing a configuration example in which the liquid cooling apparatus is applied to a projection-type image display apparatus of a three-plate type. This projection-type image display apparatus includes three illuminators **51**R, **51**G and **51**B. Each of the illuminators **51** includes an LED (light emitting diode) **11**, a tapered rod integrator **12**, a polarization converter **13**, and a rod integrator **15** substantially shaped like a rectangular parallelepiped. The LEDs **11** are respectively arranged on top of the liquid cooling jackets **25**. The coolant circulation pipe **23** is connected to the liquid cooling jackets **25** in series. The coolant coming out of the radiator **21**A is circulated in the following sequence: the liquid cooling jacket **25** used for the red LED **11**, the liquid cooling jacket **25** used for the blue LED **11**, and the liquid cooling jacket **25** used for the green LED **11**. By passing lights of the respective colors emitted from the respective illuminators **51** through liquid crystal display panels **1**R, **1**G and **1**B used for the respective colors, image lights of the respective colors are generated. Then, the image lights of the respective colors are combined by means of a cross dichroic prism **2** to provide a color image light. This color image light is projected by means of a projection lens **3**.

[**0082**] Although, in the configuration example shown in FIG. **20**, the coolant circulation pipe **23** is linked to the three liquid cooling jackets **25** in series, the three liquid cooling jackets **25** may be connected in parallel. Moreover, the lowest temperature coolant coming out of the radiator **21**A is led to the liquid cooling jacket **25** used for the red LED **11**, but is not limited thereto. For example, the lowest temperature coolant may be supplied to an LED (Light emitting diode) or an LD (laser diode) whose emission characteristic is likely to change with temperature fluctuation. Moreover, the liquid cooling apparatus of the present invention is also applicable to a projection-type image display apparatus of a single plate type. The liquid cooling apparatus of the present invention is also applicable to a projection-type image display apparatus whose light source is a lamp. Not only the radiator **21**A but also other type of radiator or the like may be used.

[**0083**] FIG. **21** is an explanatory diagram showing an example of the arrangement relationship among the optical elements and the constituents of the liquid cooling apparatus in a configuration in which the liquid cooling apparatus is applied to a projection-type image display apparatus, and this view corresponds to the configuration shown in FIG. **20**. Incidentally, FIG. **22** shows a configuration example for reference in a case where an air cooling is carried out to the projection-type image display apparatus shown in FIG. **20**. Although an air cooling apparatus requires three sets of apparatuses (three fans are needed), it is possible to configure a single set of apparatus in the case of the liquid cooling apparatus.

SIXTEENTH EMBODIMENT

[**0084**] Hereinafter, a sixteenth embodiment of the present invention will be described with reference to the drawing. Note that the difference from above described fifteenth embodiment will be described mainly.

[**0085**] Specifically, in the above described fifteenth embodiment, the coolant circulation pipe is arranged so as to step over the projection lens. On the contrary, in the sixteenth embodiment, the coolant circulation pipe is connects each LEDs in series without stepping over the projection lens.

(Configuration of Projection-Type Image Display Apparatus)

[**0086**] Hereinafter, a configuration of the projection-type image display apparatus according to the sixteenth embodiment of the present invention will be described. FIG. **23** shows the projection-type image display apparatus **100** according to the sixteenth embodiment.

[**0087**] As shown in FIG. **23**, the projection-type image display apparatus **100** includes a plurality of light sources (a red light source **125**R, a green light source **125**G, and a blue light source **125**B), a plurality of tapered rod integrators (a tapered rod integrator **112**R, a tapered rod integrator **112**G, and a tapered rod integrator **112**B), a plurality of liquid crystal panel (a liquid crystal panel **101**R, a liquid crystal panel **101**G, and a liquid crystal panel **101**B), a dichroic prism **102**, and a projection lens **103**.

[**0088**] The red light source **125**R is such as an LED emitting the red light. Similarly, The green light source **125**G is such as an LED emitting the green light and the blue light source **125**B is such as an LED emitting the blue light. The red light source **125**R, the green light source **125**G, and the blue light source **125**B are heat units generating heat (objects to be cooled).

[**0089**] The tapered rod integrator **112**R unifies the red light emitted from the red light source **125**R. Similarly, the tapered rod integrator **112**G unifies the green light emitted from the green light source **125**G and the tapered rod integrator **112**B unifies the blue light emitted from the blue light source **125**B.

[**0090**] The liquid crystal panel **101**R modulates the red light unified by the tapered rod integrator **112**R. Similarly, the liquid crystal panel **101**G modulates the green light unified by the tapered rod integrator **112**G and the liquid crystal panel **101**B modulates the blue light unified by the tapered rod integrator **112**B.

[0091] The dichroic prism **102** combines the red light went out from the liquid crystal panel **101**R, the green light went out from the liquid crystal panel **101**G, and the blue light went out from the liquid crystal panel **101**B. The dichroic prism **102** guides the combined light toward the projection lens **103**.

[0092] The projection lens **103** projects the combined light combined by the dichroic prism **102** on a screen or the like.

[0093] Here, the projection-type image display apparatus has one of the liquid cooling apparatuses described in the first to fourteenth embodiments. Specifically, the liquid cooling apparatus has the radiator **121**, the coolant tank **122**, the coolant circulation pipe **123**, and a pump **124**.

[0094] The radiator **121** cools the coolant warmed by the heat unit such as the red light source **125**R, the green light source **125**G, or the blue light source **125**B, by means of the heat radiation fins. A fan **126** facing outside of the projection-type image display apparatus **100** cools the heat radiation fins provided on the radiator **121**. The fan **126** cools not only the heat radiation fins but also inner of the projection-type image display apparatus **100** entirely.

[0095] The coolant tank **122** stores the coolant. As described in the first to fourteenth embodiment, various arrangements and shapes can be adopted as the arrangement and the shape of the coolant tank **122**,

[0096] The coolant circulation pipe **123** is a flow path of coolant provided around the heat unit such as the red light source **125**R, the green light source **125**G, and the blue light source **125**B. The coolant circulation pipe **123** connects to the radiator **121**, the pair of coolant tanks **122**, and pump **124**. The coolant circulation pipe **123** connects jacket unit (not shown) where the red light source **125**R, the green light source **125**G, and the blue light source **125**B are arranged.

[0097] The pump **124** pumps out the coolant into the coolant circulation pipe **123**.

[0098] The coolant circulation pipe **123** is preferably arranged so that the coolant cooled by the radiator **131** cools the light source having the high energy in sequence, when the light sources are cooled in series. The fan **126** preferably arranged around the radiator **121**.

SEVENTEENTH EMBODIMENT

[0099] Hereinafter, a seventeenth embodiment of the present invention will be described with reference to the drawing. Note that the difference from above described sixteenth embodiment will be described mainly.

[0100] Specifically, in the above described sixteenth embodiment, the projection-type image display apparatus has the plurality of the light sources. On the contrary, in the seventeenth embodiment, the projection-type image display unit has single white lamp for the replacement of the plurality of the light sources.

(Configuration of Projection-Type Image Display Apparatus)

[0101] Hereinafter, a configuration of the projection-type image display apparatus according to the sixteenth embodiment of the present invention will be described. FIG. **24** shows the projection-type image display apparatus **100** according to the sixteenth embodiment. Note that, compositions similar to the above described sixteenth embodiment (FIG. **23**) are designated by the similar reference numerals.

[0102] As shown in FIG. **24**, the projection-type image display unit includes a white light source **125**W for the replacement of the red light source **125**R, the green light source **125**G and the blue light source **125**B.

[0103] The white light source **125**W is such as an UHP lamp emitting the white light. The white light source is a heat unit generating heat (an object to be cooled).

[0104] The projection-type image display unit includes a unifying means **140** for the replacement of the tapered rod integrator **112**R, the tapered rod integrator **112**G, and the tapered rod integrator **112**B.

[0105] The unifying means **140** is configured of fly-eye lens, condenser lens, or the like, and unifies the white light emitted from the white light source **125**W. The unifying means may be includes a PBS (Polarized Beam Splitter) integrates a polarization direction of the white light emitted from the white light source **125**W.

[0106] The projection-type image display unit includes a separating means (a mirror **131** through a mirror **135**). The mirror **131** through the mirror **135** may be dichroic mirrors configured to reflect light having specific wavelength, and may be polarized mirrors configured to reflect light having specific polarization direction.

EIGHTEENTH EMBODIMENT

[0107] Hereinafter, an eighteenth embodiment of the present invention will be described with reference to the drawing. In the eighteenth embodiment, the projection-type image display apparatus hanged from the ceiling will be described.

(Attachment Structure of Projection-Type Image Display Apparatus)

[0108] Hereinafter, the attachment structure of the projection-type image display apparatus **100** according to the eighteenth embodiment of the present invention will be described. FIG. **25** shows the attachment structure of the projection-type image display apparatus **100** according to the eighteenth embodiment of the present invention. Note that, compositions similar to the above described sixteenth embodiment (FIG. **23**) are designated by the similar reference numerals.

[0109] As shown in FIG. **25**, the projection-type image display apparatus **100** is provided with a hanging furniture **320**. The hanging furniture **320** is attached to an arm unit **330** fixed to the ceiling or the like.

[0110] According to the respective embodiments, since the size of the coolant tank **122** in the up-down direction is larger than the size of the cooling tank **122** in the horizontal direction, the air merely goes into the coolant circulation pipe **123**, assuming the vertical direction as the up-down direction when the projection-type image display apparatus **100** disposed statically.

[0111] Therefore, the decrease in cooling efficiency by the coolant can be suppressed, and the volume of the coolant tank **122** can be kept sufficiently.

OTHER EMBODIMENTS

[0112] Moreover, the liquid cooling apparatus of the present application is not limited to applications to the projection-type image display apparatus, but can be applied to other apparatuses such as a personal computer including heat generating members (LED, CPU and the like). Particularly, the liquid cooling apparatus of the present application can be used suitably in devices such as: a device which is turned upside down even temporarily at the time of assembly; a device which may be loaded upside down at the time of transportation; a device which may be used upside down in some cases (for example, an image display device of a ceiling suspension type and the like); and an on-vehicle device (the apparatus will also be leaned due to the inclination of the vehicle). Moreover, by combining the plurality of above-described projection-type image display apparatuses arranged normally (rear projection television) with the plurality of above-described projection-type image display apparatuses arranged upside down on top of the projection-type image display apparatuses arranged normally, a large-sized image display device with a multi-screen may be realized. Alternatively, by combining the plurality of above-described projection-type image display apparatuses arranged normally (LCD projector) with the plurality of above-described projection-type image display apparatuses arranged upside down on top of the projection-type image display apparatuses arranged normally, an LCD projector for displaying a high definition image may be realized.

What is claimed is:

1. A liquid cooling apparatus provided on an apparatus having a heat unit generating heat, and configured to cool the heat unit by coolant comprising:

a coolant tank configured to store the coolant;

a radiator configured to cool the coolant; and

a coolant pipe which is a flow path of the coolant and connecting the coolant tank and the radiator; wherein,

the coolant tank is arranged adjacent to the radiator in a horizontal direction when the apparatus disposed statically, and

a size of the coolant tank in a vertical direction is larger than a size of the coolant tank in a horizontal direction when the apparatus is disposed statically.

2. The liquid cooling apparatus according to claim 1,

wherein, the coolant pipe connects to a center portion of the coolant tank in a vertical direction when the apparatus is disposed statically.

3. The liquid cooling apparatus according to claim 2,

wherein, the coolant tank has a shape expanding from the center portion to upper side and expanding from the center portion to lower side, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

4. The liquid cooling apparatus according to claim 2, further comprising infusion openings for infusing the coolant into the coolant tank,

wherein, the infusion openings are arranged on upper portion and lower portion of the coolant tank, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

5. The liquid cooling apparatus according to claim 1, wherein,

the coolant tank includes a pair of cooling tanks, and

the pair of cooling tanks are arranged on the both side of the radiator.

6. A liquid cooling apparatus provided on an apparatus having a heat unit generating heat, and configured to cool the heat unit by coolant comprising:

a pair of coolant tanks configured to store the coolant;

a radiator configured to cool the coolant; and

a coolant pipe which is a flow path of the coolant and connecting the coolant tank and the radiator; wherein,

the pair of coolant tanks includes an upper tank arranged on upper side of the radiator and a lower tank arranged on lower side of the radiator, assuming a vertical direction as up-down direction when the apparatus is disposed statically,

one part on an upper surface of the upper tank expands upper than other part on the upper surface of the upper tank,

one part on a lower surface of the lower tank expands lower than other part on the lower surface of the lower tank, and

a shape of the upper tank is identical with a shape of the lower tank.

7. The liquid cooling apparatus according to claim 6, wherein,

one part on a lower surface of the upper tank expands lower than other part on the lower surface of the upper tank, and

one part on an upper surface of the lower tank expands upper than other part on the upper surface of the lower tank.

8. The liquid cooling apparatus according to claim 6, wherein,

the coolant pipe respectively connects to center portions of the upper tank and the lower tank in a vertical direction when the apparatus is disposed statically, and

the upper tank and the lower tank respectively have shape expanding from the center portion to upper side and expanding from the center portion to lower side, assuming a vertical direction as up-down direction when the apparatus is disposed statically.

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