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(54) **PLATE HEAT EXCHANGER**

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USPC **165/166**

(57) **ABSTRACT**

Heat transfer plates are stacked, each being provided with a plurality of passage holes, a flow-path forming gasket is interposed between peripheries of each adjacent ones of the heat transfer plates, thereby alternately forming a first flow path to pass a high-temperature fluid, a second fluid to pass a low-temperature fluid, and communicating paths to cause the fluids to flow in and out of the first flow path and the second flow path on opposite sides of each heat transfer plate, and communicating-path forming gaskets surrounding the passage holes are interposed between adjacent ones of the heat transfer plates, thereby forming a communicating path to cause a fluid to flow in and out of the first flow path and a communicating path to cause a fluid to flow in and out the second flow path. Each communicating-path forming gasket is made up of inner and outer gasket members arranged in two lines, the inner gasket member surrounding the passage holes while the outer gasket member surrounding the inner gasket member.

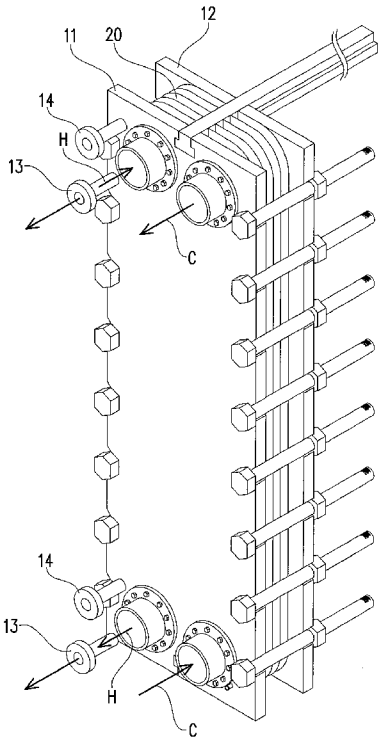
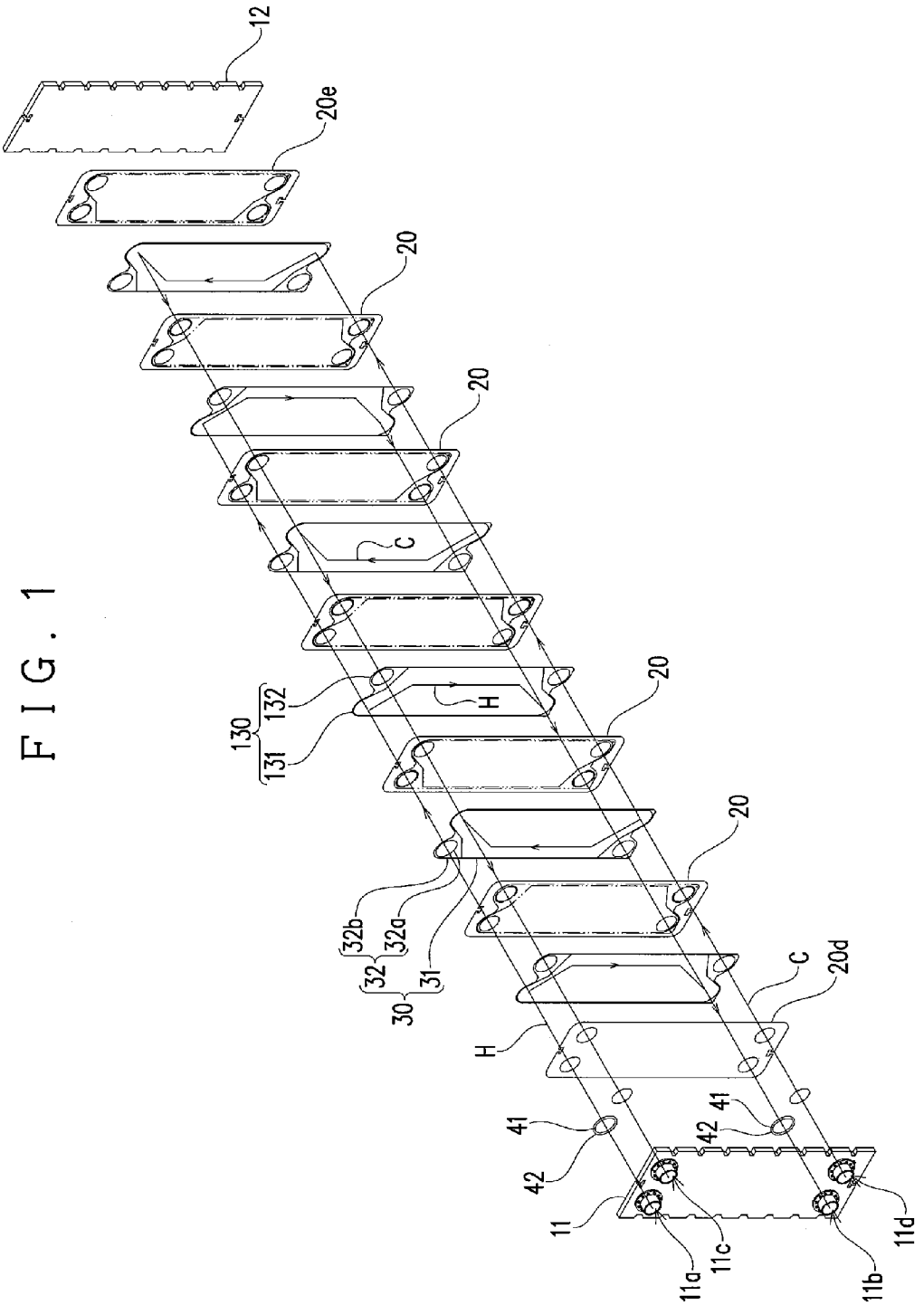


FIG. 1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20e
20
20
C
20
H
132
130
131
20
32b
32a
32
31
30
20
C
20d
H
41
42
41
42
11
11a
11c
11b
11d

FIG. 2

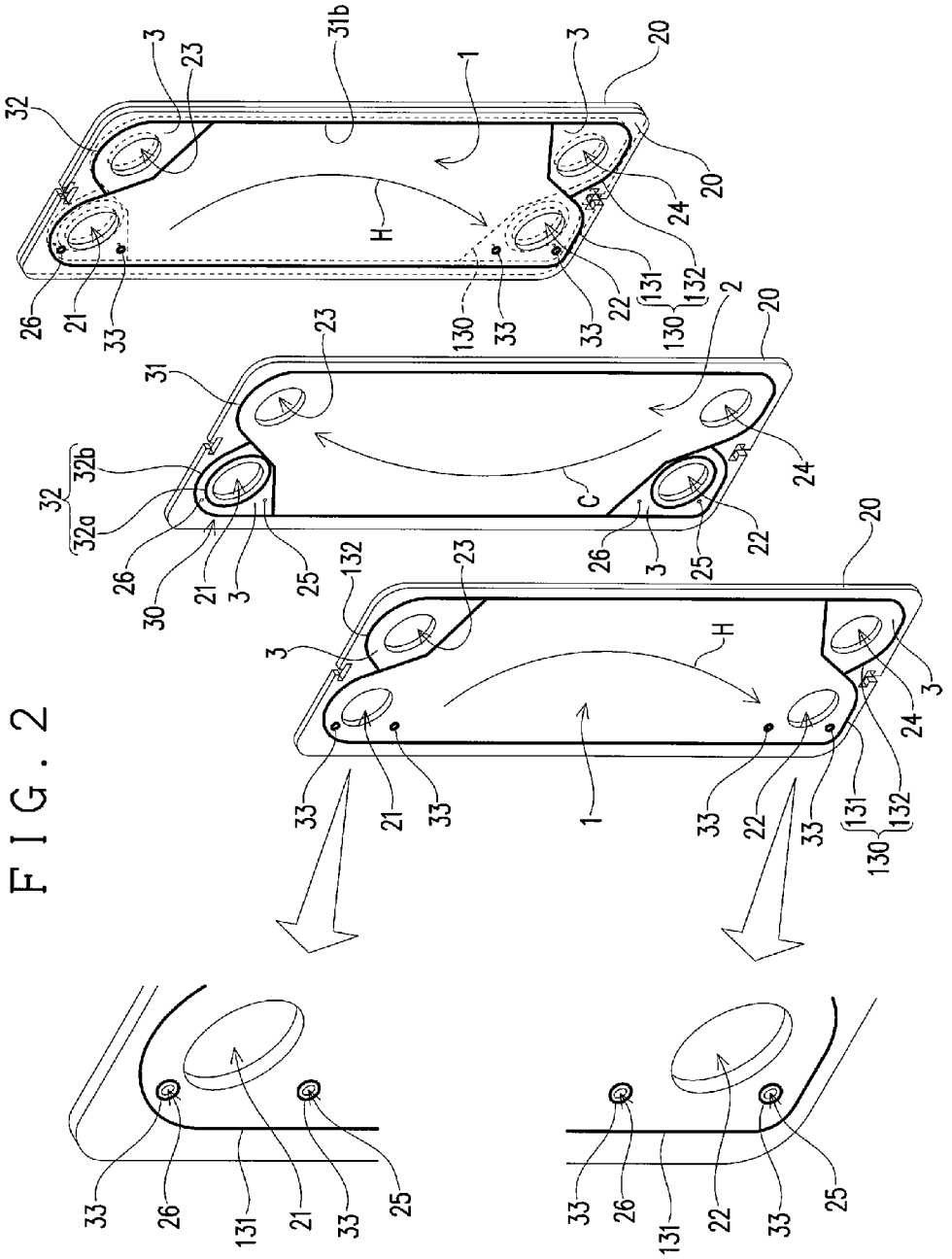
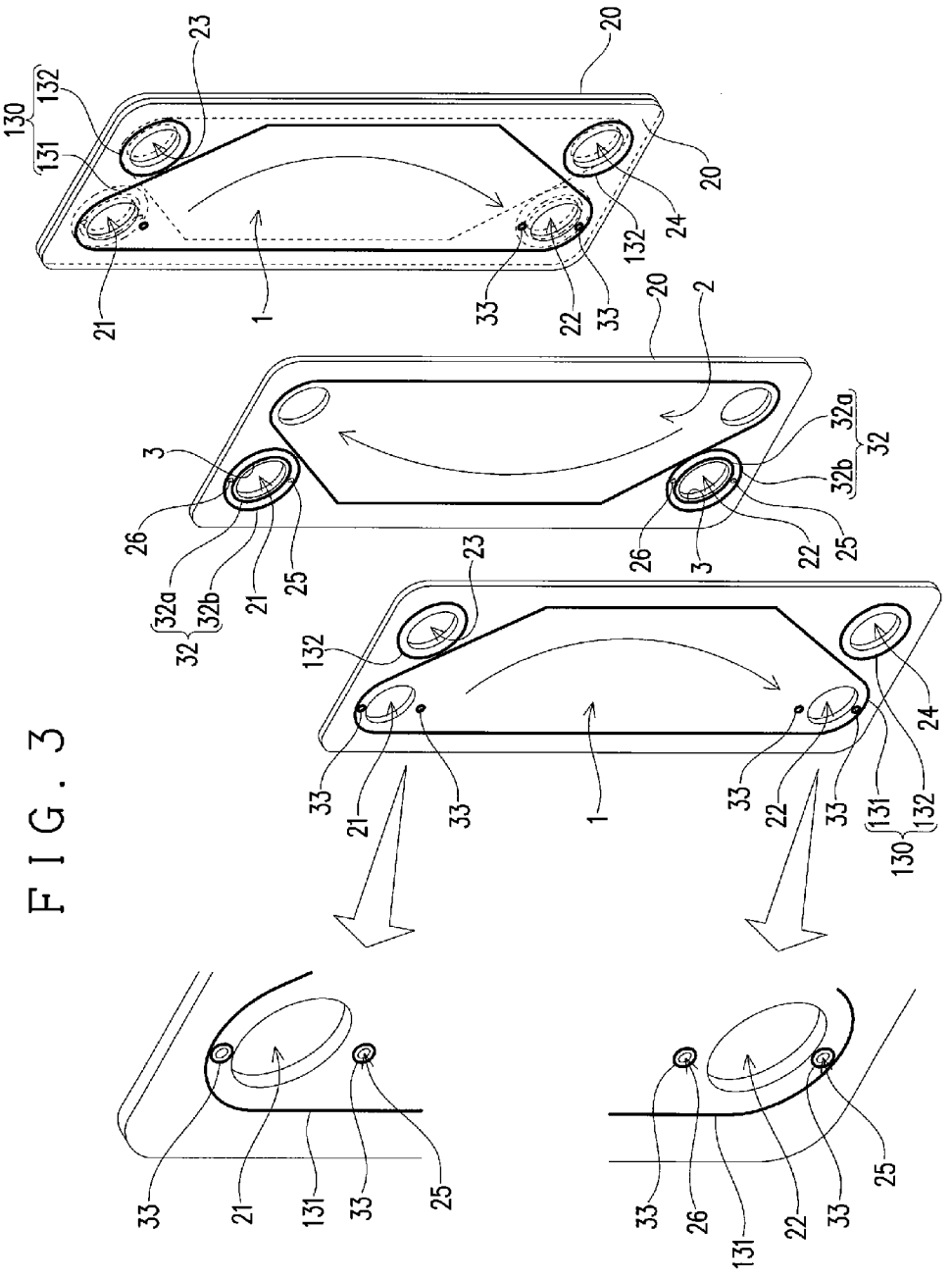

3
23
31b
1
3
20
32
H
20
24
26
21
33
130
33
33
22
131
132
130
2
20
31
23
24
32
32b
32a
C
26
30
21
3
25
132
23
26
3
25
22
20
3
H
24
3
33
21
33
1
33
22
33
131
132
130
33
26
131
21
33
25
33
26
131
22
33
25

FIG. 3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20
130
132
131
20
24
132
21
1
33
22
33
20
2
3
32a
32
32b
26
25
26
3
22
25
32a
32b
32
21
25
23
132
24
33
21
33
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33
25
33
26
131
22
33
25

FIG. 4

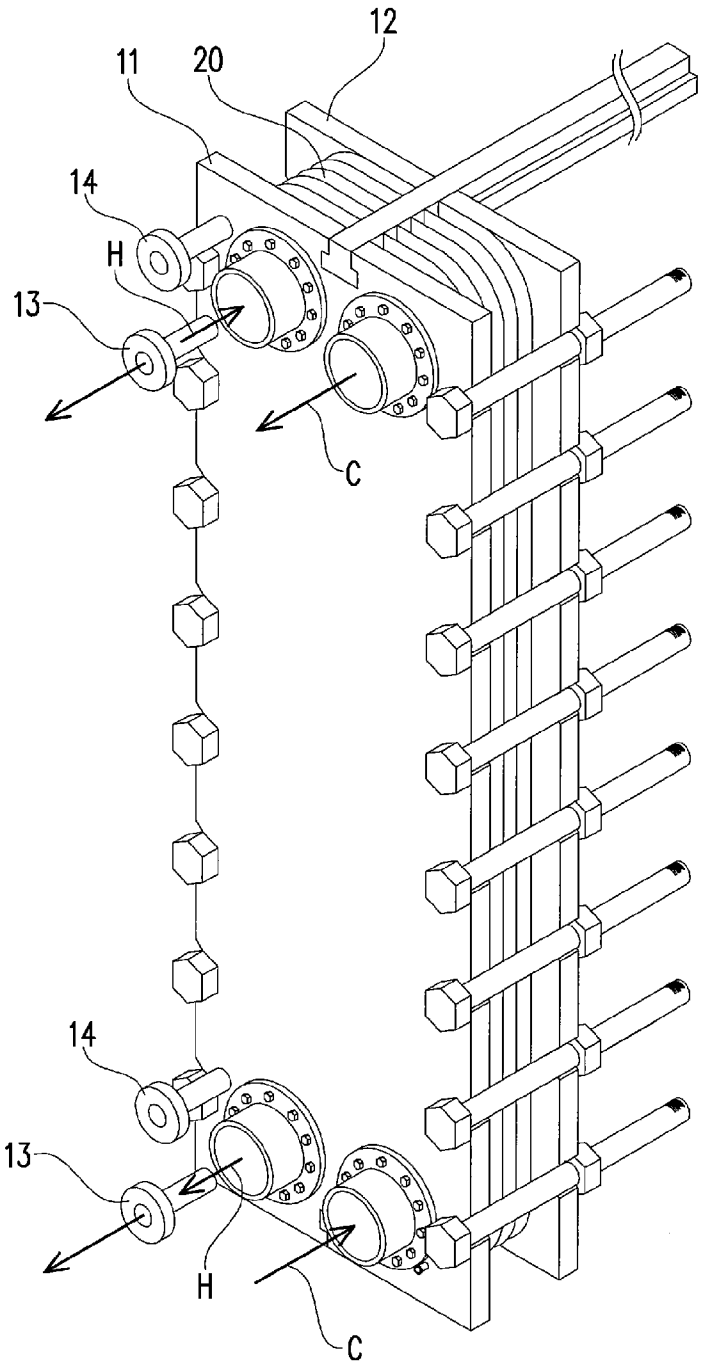

FIG. 5

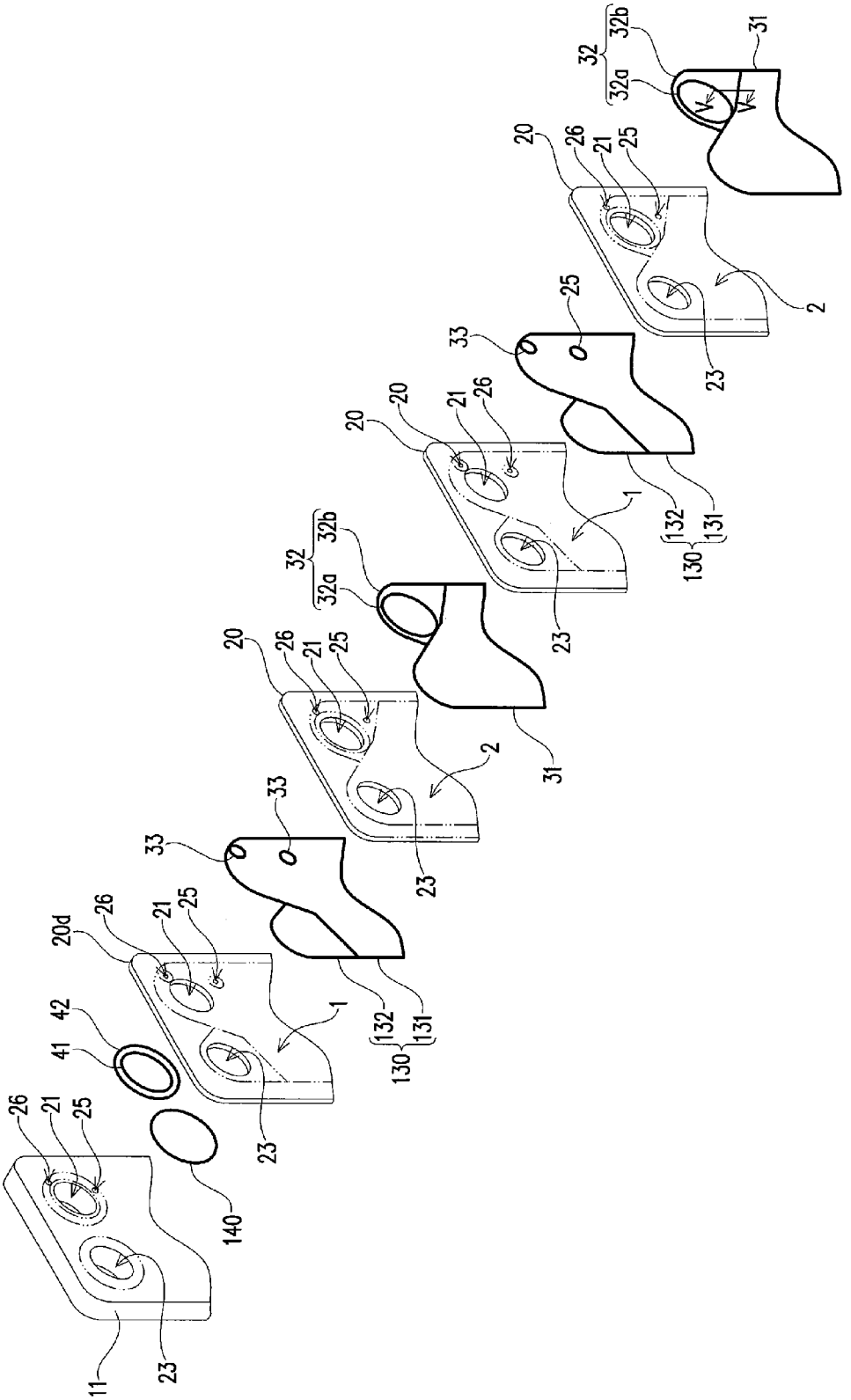
11
23
140
26
21
25
20d
42
41
1
23
33
130
132
131
20
26
21
25
2
23
33
32
32a
32b
31
20
21
26
1
23
25
33
130
132
131
20
26
21
25
2
23
32
32a
32b
31

FIG. 6

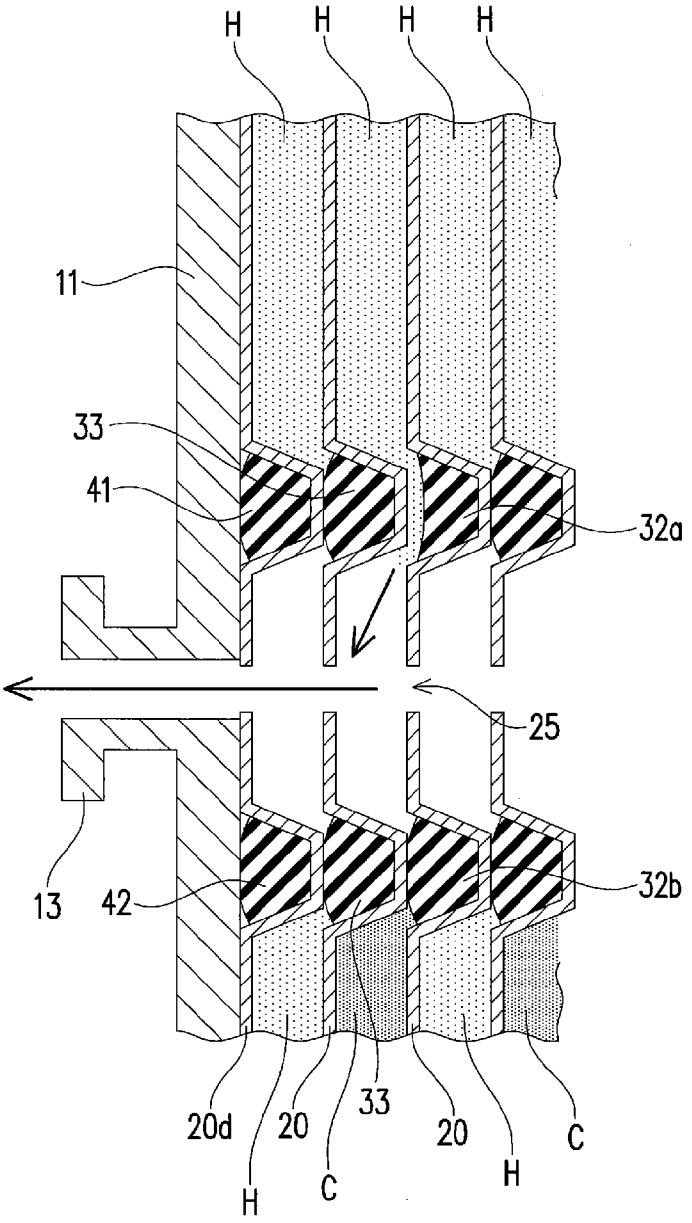

FIG. 7

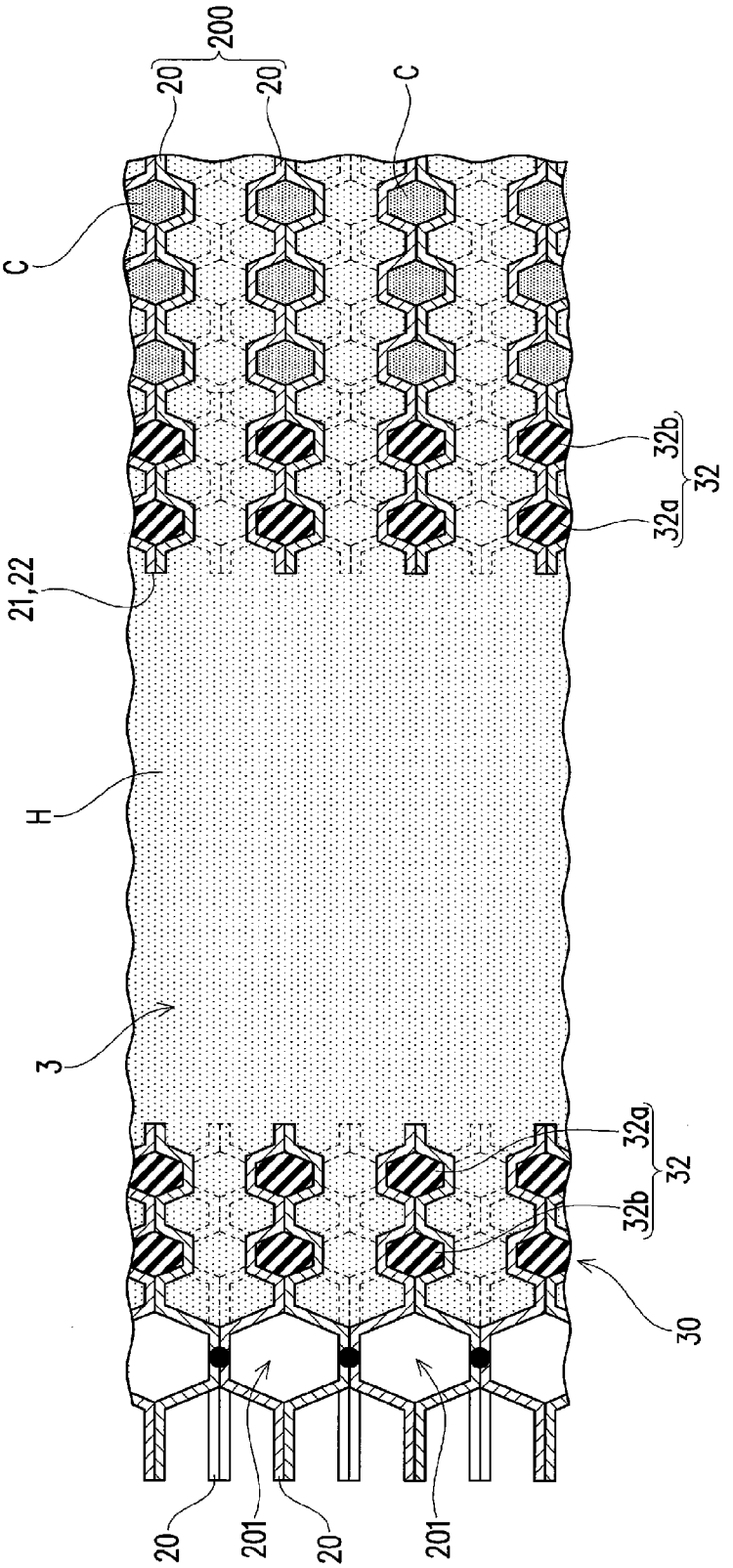

FIG. 8

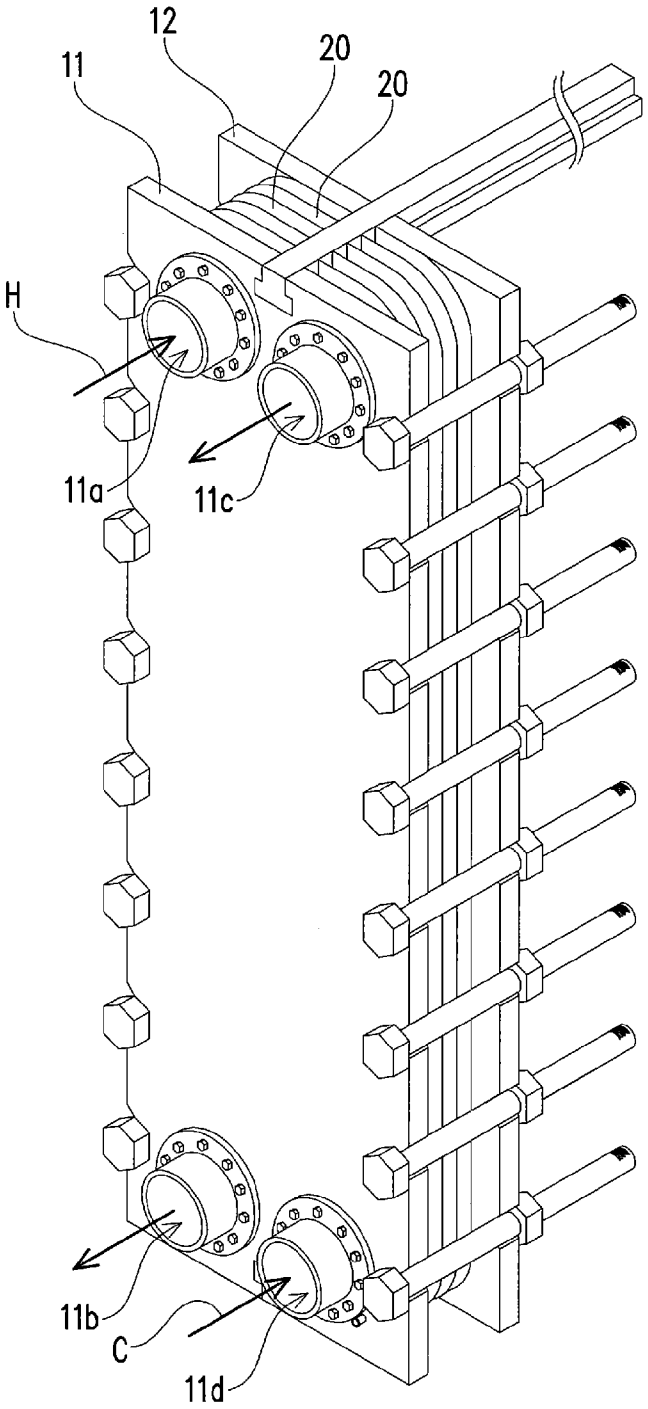

FIG. 9

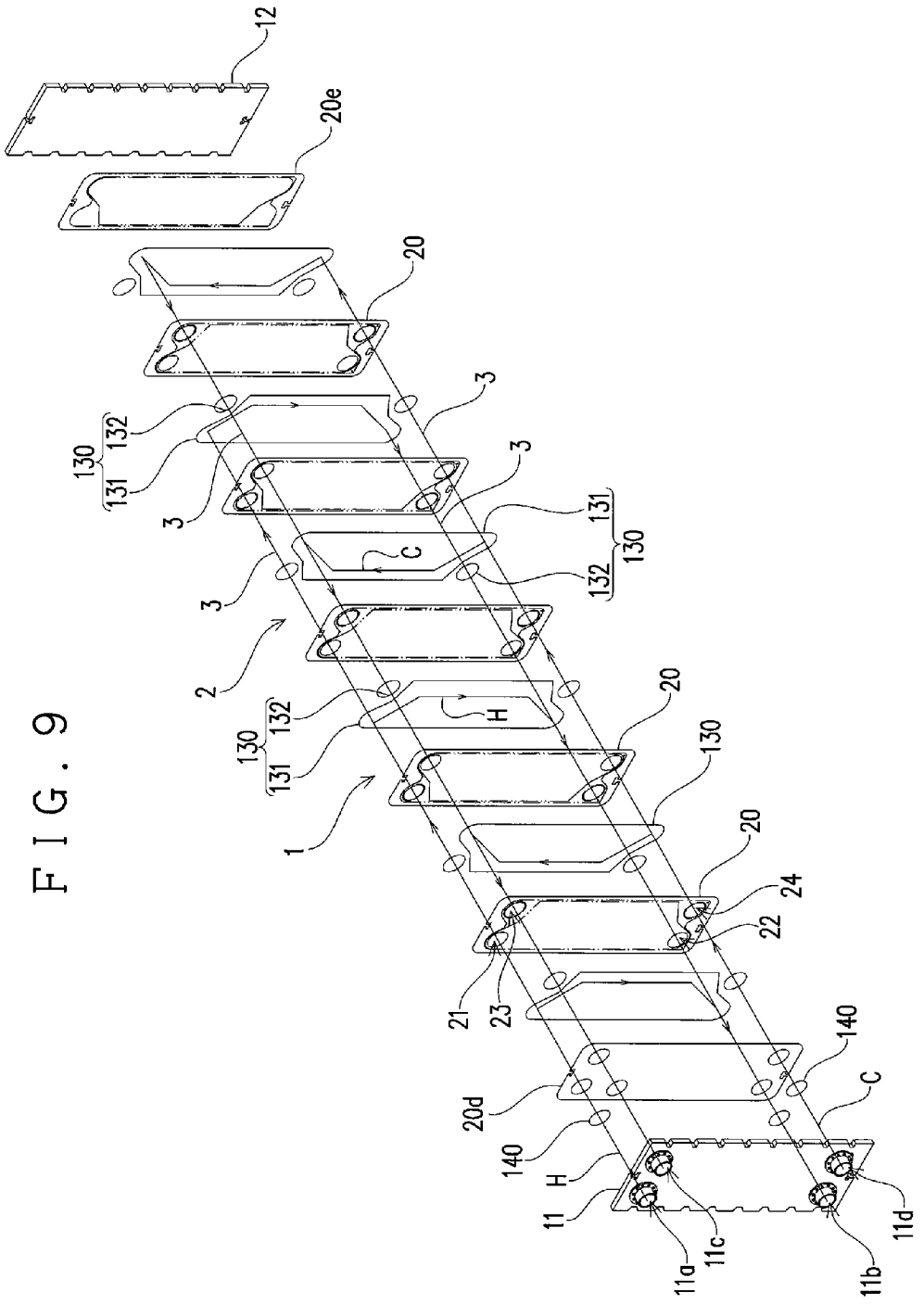

FIG. 10

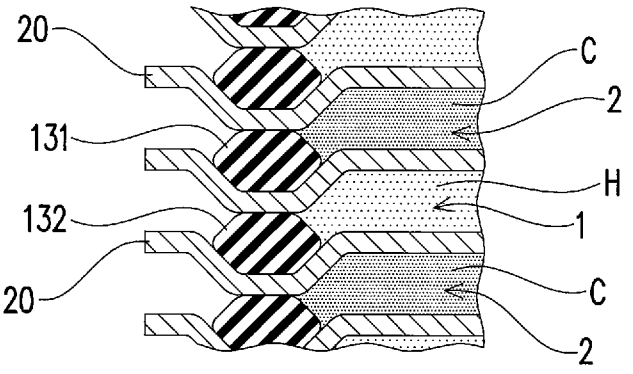

PLATE HEAT EXCHANGER

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority to Japanese Patent Application No. 2011-233098, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to a plate heat exchanger for exchanging heat between a high-temperature fluid and a low-temperature fluid. More particularly, the present invention relates to a plate heat exchanger in which by stacking plural heat transfer plates and interposing a gasket between peripheries or the like of each adjacent ones of the heat transfer plates, a flow path adapted to pass a high-temperature fluid and a flow path adapted to pass a low-temperature fluid are formed alternately between each adjacent heat transfer plates.

RELATED ART

[0003] In a plate heat exchanger, plural heat transfer plates **20** are stacked in an upright posture between a plate-shaped rectangular fixed frame **11** in an upright posture and a plate-shaped rectangular movable frame **12** in an upright posture as shown in FIG. **8**, a first flow path **1** and a second flow path **2** are formed alternately between the heat transfer plates **20** as shown in FIG. **9**, and a high-temperature fluid H is passed through the first flow path **1** while a low-temperature fluid C is passed through the second flow path **2**, thereby exchanging heat between the high-temperature fluid H and low-temperature fluid C.

[0004] Passage holes **11***a* to **11***d* serving as inlet ports and outlet ports for the fluids H and C are provided in four corners of the fixed frame **11**, whereas no passage hole is provided in the movable frame **12**. Also, respective dedicated plates (hereinafter referred to as a "D plate" and "E plate") **31** and **32** are overlaid on the fixed frame **11** and the movable frame **12**. Passage holes (not numbered) are provided in four corners of the D plate **31**, and a gasket (hereinafter referred to as a "D gasket") **140** is interposed between the D plate **31** and the fixed frame **11**, surrounding the passage holes. Note that no passage hole is provided in the E plate **32**.

[0005] Also, passage holes **21** to **24** serving as inlet ports and outlet ports for the fluids H and C are provided in four corners of each of the heat transfer plates **20**, a heat transfer portion (not numbered) is provided in an intermediate portion of the heat transfer plate **20**, and a gasket **130** is interposed between each adjacent ones of the heat transfer plates **20**, for example, such that the upper and lower left passage holes **21** and **22** are communicated with the heat transfer portion while the upper and lower right passage holes **23** and **24** are closed to the heat transfer portion, or vice versa.

[0006] The gasket **130** is made up of a flow-path forming gasket **131** configured to surround a periphery (inner side of an outer peripheral edge) of each heat transfer plate **20** and communicating-path forming gaskets **132** configured to surround circumferences of the passage holes **21** to **24**, where the flow-path forming gasket **131** and communicating-path forming gaskets **132** may be formed either separately or integrally (not shown).

[0007] In the plate heat exchanger, the upper and lower right communicating-path forming gaskets **132** surround the upper and lower right passage holes **23** and **24**, thereby forming communicating paths **3** isolated from the upper and lower left passage holes **21** and **22** as well as from the first flow path **1**, and the flow-path forming gasket **131** surrounds the upper and lower left passage holes **21** and **22** as well as the heat transfer portion, thereby forming the first flow path **1** adapted to pass the high-temperature fluid H.

[0008] Also, in the plate heat exchanger, the upper and lower left communicating-path forming gaskets **132** surround the upper and lower left passage holes **21** and **22**, thereby forming communicating paths **3** isolated from the upper and lower right passage holes **23** and **24** as well as from the second flow path **2**, and the flow-path forming gasket **131** surrounds the upper and lower right communicating-path forming gaskets **132** as well as the heat transfer portion, thereby forming the second flow path **2** adapted to pass the low-temperature fluid C therethrough.

[0009] Thus, in FIG. **9**, the high-temperature fluid H flows downward through the first flow path **1** from the upper left passage hole **21** and is discharged through the lower left passage hole **22** while the low-temperature fluid C flows upward through the second flow path **2** from the lower right passage hole **24** and is discharged through the upper right passage hole **23**, thereby exchanging heat between the two fluids H and C.

[0010] Also, although not illustrated, Patent Literature 1 and the like describe a joined plate heat exchanger in which plural cassette plates constructed by permanently joining peripheries or other portions of two heat transfer plates by laser welding, brazing, or the like are stacked in an upright posture and gaskets are interposed on peripheries of the cassette plates, thereby forming a first flow path or second flow path in the cassette plates and forming the second flow path or first flow path between the cassette plates.

[0011] On the other hand, Patent Literature 2 describes a plate heat exchanger comprising a flow-path forming gasket and a communicating-path forming gasket which are integrated into a single gasket and interposed between heat transfer plates, in which part of the flow-path forming gasket and part of the communicating-path forming gasket are arranged side-by-side to provide double (two) gaskets in a border between a heat transfer portion and passage holes. In the plate heat exchanger, the double gaskets are firmly fixed to the heat transfer plates without using an adhesive and in other part, the gasket is bonded to the heat transfer plates using an adhesive.

[0012] The double gaskets are interposed between every other pair of the stacked heat transfer plates (alternately), thereby forming a flow path configured to communicate the heat transfer portion and passage holes without double gaskets. Those heat transfer plates which lack double gaskets are subject to deformation due to internal pressure, but since the double gaskets are not bonded to the heat transfer plates with an adhesive, pressure tightness of the plate heat exchanger is improved.

CITATION LIST

Patent Literature

[0013] Patent Literature 1: JP 2005-106412 A

[0014] Patent Literature 2: JP 9-72686 A

[0015] However, the conventional plate heat exchanger shown above in FIGS. **8** and **9** have problems such as described below.

[0016] In the plate heat exchanger, as shown in FIG. **9**, the high-temperature fluid H flowing into the first flow path **1** flows through the communicating path **3** formed by the communicating-path forming gasket **132** which surrounds the passage hole **21**. Since the communicating-path forming gasket **132** which forms the communicating path **3** through which the high-temperature fluid H flows has its inner side (wetted side) placed in contact with the high-temperature fluid H in a hot, humid environment as shown in FIG. **10**, thermal degradation such as hardening or softening proceeds with long-term use.

[0017] Also, main component of the communicating-path forming gasket **132** is polymer (RH). Consequently, when the communicating-path forming gasket **132** is heated by the high-temperature fluid H, the polymer reacts with oxygen (O_2) to generate alkyl radicals (R.). Since an outer side (non-wetted side) of the flow-path forming gasket **131** contacts the atmosphere, alkyl radicals (R.) react with oxygen to generate peroxy radicals (ROO.). The peroxy radicals (ROO.) react with polymer (RH) to generate peroxide (ROOH). The peroxide (ROOH) is unstable and readily decomposes itself into alkoxy radicals (RO.) and hydroxyl radicals (OH.).

[0018] In short, the communicating-path forming gasket **132** which forms the communicating path **3** through which the high-temperature fluid H flows has its wetted side placed in contact with the high-temperature fluid H, and its non-wetted side placed in contact with the atmosphere. Consequently, high molecules which make up a main component break down due to oxidative degradation reactions, increasing the number of radicals and causing breakage of molecular chains and cross-linking reactions to proceed. This results in a loss of elasticity intrinsic to rubber. At the same time, since the communicating-path forming gasket **132** is structurally in a compressive environment, compression set increases, resulting in insufficient surface pressure, and cracks develop, resulting in a rupture. Then, as a result of the rupture, the high-temperature fluid H may leak from the communicating path **3** into the second flow path, mixing with the low-temperature fluid C.

[0019] Also, double gaskets are interposed inside the plate heat exchanger described in Patent Literature 2. However, the communicating-path forming gasket **132** which forms the communicating path **3** through which the high-temperature fluid H flows does not have two lines, and thus oxidative degradation can occur, resulting in external leakage of the high-temperature fluid H.

[0020] When the high-temperature fluid H is a dangerous chemical solution, leaking out of the high-temperature fluid H from the plate heat exchanger may cause secondary accidents. If the gaskets are replaced a little earlier to prevent secondary accidents, this will increase running costs. Also, a method is conceivable which inhibits oxidative degradation and prevents the high-temperature fluid H from flowing out, by covering the entire plate heat exchanger with an airtight sheet or the like or inserting rubber or the like into gaps among outer peripheral portions of the stacked heat transfer plates, but such a method is not adopted because of problems in terms of costs and quality.

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

[0021] Thus, an object of the present invention is to provide a plate heat exchanger that is less likely to cause degradation of communicating-path forming gaskets which form a communicating path through which a high-temperature fluid flows.

Means for Solving Problems

[0022] In a plate heat exchanger according to the present invention, a plurality of heat transfer plates are stacked, each being provided with a plurality of passage holes; a flow-path forming gasket is interposed between peripheries of each adjacent ones of the plurality of heat transfer plates, thereby alternately forming a first flow path adapted to pass a high-temperature fluid and a second fluid adapted to pass a low-temperature fluid on opposite sides of each heat transfer plate; communicating-path forming gaskets surrounding the passage holes are each interposed between each adjacent ones of the plurality of heat transfer plates, thereby forming a communicating path adapted to cause a fluid to flow in and out of the first flow path and a communicating path adapted to cause a fluid to flow in and out the second flow path; and each of the communicating-path forming gaskets is made up of an inner gasket member and an outer gasket member arranged in two lines, the inner gasket member surrounding the passage holes while the outer gasket member surrounding the inner gasket member.

[0023] Here, as one aspect of the plate heat exchanger according to the present invention, the communicating-path forming gasket may be arranged in two parallel lines only between the heat transfer plates which form the communicating path through which the high-temperature fluid flows.

[0024] In a plate heat exchanger according to the present invention different from the one described above, a plurality of cassette plates are stacked, each being made up of two heat transfer plates which are provided with a plurality of passage holes and are permanently joined on peripheries; a flow-path forming gasket is interposed between peripheries of each adjacent ones of the plurality of cassette plates; communicating-path forming gaskets surrounding the passage holes are each interposed between each adjacent ones of the plurality of heat transfer plates, thereby alternately forming a first flow path adapted to pass a high-temperature fluid and a second flow path adapted to pass a low-temperature fluid inside each cassette plate and between the cassette plates, wherein each of the communicating-path forming gaskets is made up of an inner gasket member and an outer gasket member arranged in two lines, the inner gasket member surrounding the passage holes while the outer gasket member surrounding the inner gasket member.

[0025] Also, as one aspect of the plate heat exchanger according to the present invention, a configuration can be adopted in which a drain hole is formed in the heat transfer plates between the inner gasket member and the outer gasket member of each of the communicating-path forming gaskets.

[0026] Also, as another aspect of the plate heat exchanger according to the present invention, a configuration can be adopted in which a gas supply hole is formed in the heat transfer plates between the inner gasket member and the outer gasket member of each of the communicating-path forming gaskets; and an enclosed space surrounded by the inner gasket member, the outer gasket member, and the heat transfer plates is filled with an inert gas.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** is a schematic exploded perspective view showing a plate heat exchanger according to first and second embodiments of the present invention.

[0028] FIG. **2** is a schematic exploded perspective view showing principal part of the plate heat exchanger according to the first and second embodiments of the present invention.

[0029] FIG. **3** is a schematic exploded perspective view showing principal part of the plate heat exchanger according to a variation of the first and second embodiments of the present invention.

[0030] FIG. **4** is a perspective view showing the plate heat exchanger according to the second embodiment of the present invention.

[0031] FIG. **5** is an enlarged exploded perspective view showing principal part of the plate heat exchanger according to the second embodiment of the present invention.

[0032] FIG. **6** is an enlarged sectional view along the line V-V in FIG. **5**, showing principal part of the plate heat exchanger according to the second embodiment of the present invention.

[0033] FIG. **7** is an enlarged sectional view showing principal part of the plate heat exchanger according to the third embodiment of the present invention.

[0034] FIG. **8** is a schematic perspective view showing a conventional plate heat exchanger.

[0035] FIG. **9** is a schematic exploded perspective view showing the conventional plate heat exchanger.

[0036] FIG. **10** is an enlarged sectional view of principal part showing principal part of the conventional plate heat exchanger.

DESCRIPTION OF EMBODIMENTS

[0037] A plate heat exchanger according to a first embodiment of the present invention is described below with reference to FIGS. **1** to **3**. The same components as conventional components are described by the same reference numerals as the corresponding conventional components. In the following description, terms such as upper, lower, right, and left are exemplary in each embodiment, and, needless to say, may represent different positions depending on actual usage.

[0038] As is conventionally the case, the plate heat exchanger according to the first embodiment is an apparatus in which a first flow path **1** and a second flow path **2** are formed alternately between heat transfer plates **20** as shown in FIGS. **1** to **3**, a high-temperature fluid H is passed through the first flow path **1** while a low-temperature fluid C is passed through the second flow path **2**. The first flow paths **1** and the second flow paths **2** are formed by respective gaskets **30** interposed between the heat transfer plates **20**.

[0039] The gaskets **30** each are made up of a flow-path forming gasket **31** configured to surround a periphery of each heat transfer plate **20** and a communicating-path forming gasket **32** configured to surround circumferences of the passage holes **21** to **24**, so that the flow-path forming gasket **31** and the communicating-path forming gasket **32** may be formed either integrally (shown in FIGS. **1** and **2**) or separately (shown in FIG. **3**). The gasket **30** in which the flow-path forming gasket **31** and the communicating-path forming gasket **32** are formed integrally is based on shared use of a border between a heat transfer portion and the passage holes **21** to **24**, as shown in FIG. **2**.

[0040] In the plate heat exchanger according to the first embodiment, as shown in FIG. **2**, the communicating-path forming gasket (hereinafter, referred to as "double-line gasket") **32** provided with a communicating path **3** through which a high-temperature fluid H is passed is made up of an inner gasket member **32***a* and an outer gasket member **32***b* arranged in two lines. Consequently, each heat transfer plate **20** is double-grooved to correspond to the inner gasket member **32***a* and the outer gasket member **32***b* of the double-line gasket **32**.

[0041] The inner gasket member **32***a* is formed annularly so as to surround the passage holes **21** and **22**. The outer gasket member **32***b* is formed in the shape of a modified trapezoid and its border with the second flow path **2** is shared with the flow-path forming gasket **31**.

[0042] As shown in FIG. **3**, when the flow-path forming gasket **31** and the communicating-path forming gasket **32** are formed separately, the double-line gasket **32** is configured by arranging the annular inner gasket member **32***a* and the annular outer gasket member **32***b* concentrically in two parallel lines, the inner gasket member **32***a* surrounding the passage holes **21** and **22** while the outer gasket member **32***b* surrounding the inner gasket member **32***a*. Therefore, no part of the outer gasket member **32***b* is shared with the flow-path forming gasket **31**.

[0043] Thus, the double-line gasket **32** surrounds the upper and lower left passage holes **21** and **22**, thereby forming the communicating path **3** through which the high-temperature fluid H flows. The communicating path **3** through which the low-temperature fluid C flows is formed by the communicating-path forming gasket **132**, which is a conventionally-used typical gasket (hereinafter referred to as a "single-line gasket") **130**, surrounding the upper and lower right passage holes **23** and **24**. However, the communicating path **3** may be formed by the double-line gasket **32** surrounding the upper and lower right passage holes **23** and **24**.

[0044] Then, the first flow path **1** adapted to pass the high-temperature fluid H is formed by the communicating-path forming gasket **132**, which is a single-line gasket **130**, being interposed between a pair of heat transfer plates **20** such that the communicating-path forming gasket **132** isolates the upper and lower right passage holes **23** and **24** and that the flow-path forming gasket **131** surrounds the upper and lower left passage holes **21** and **22**, and the heat transfer portion.

[0045] Note that although not illustrated, the flow-path forming gasket **131** which forms the first flow path **1** may also be made up of an inner gasket member and an outer gasket member arranged in two parallel lines. This can prevent the gasket which forms the first flow path from oxidative degradation. Furthermore the flow-path forming gasket **131** which forms the second flow path **2** may be also made up of an inner gasket member and an outer gasket member arranged in two parallel lines. This makes it possible to assemble the first flow path **1** and the second flow path **2** without distinguishing therebetween.

[0046] As the gasket **30** and the single-line gasket **130** are interposed between adjacent heat transfer plates **20** alternately, the high-temperature fluid H flows through the first flow path **1** from the upper left passage hole **21** and is discharged through the lower left passage hole **22** while the low-temperature fluid C flows through the second flow path **2** from the lower right passage hole **24** and is discharged through the upper right passage hole **23**, thereby exchanging heat between the high-temperature fluid H and the low-temperature fluid C.

[0047] In so doing, the high-temperature fluid H flows into the first flow path **1** by passing through the upper left communicating path **3**. The high-temperature fluid H in the communicating path **3** contacts the inner gasket member **32***a* of the double-line gasket **32**, but the inner gasket member **32***a*,

whose circumferences are surrounded by the outer gasket member **32***b*, does not contact the atmosphere, and is thus less prone to oxidative degradation reactions.

[0048] Since the high-temperature fluid H flowing through the lower left communicating path **3** has been lowered in temperature by exchanging heat with the low-temperature fluid C, the gasket **32** which forms the lower left communicating path **3** may be configured to have a single line rather than two lines. Even if the communicating paths **3** used to communicate the upper and lower right passage holes **23** and **24** is formed by the communicating-path forming gasket **132** configured to be a single-line gasket **130**, the communicating paths **3**, through which the low-temperature fluid C flows, do not get so hot as to cause oxidative degradation of the communicating-path forming gaskets **132**.

[0049] Thus, the plate heat exchanger is configured such that the double-line gaskets **32** will not crack and that the high-temperature fluid H will not leak from the communicating paths **3**.

[0050] Next, a plate heat exchanger according to a second embodiment of the present invention is described below with reference to FIGS. **2** to **6**. According to the second embodiment, a drain hole **25** and/or a gas supply hole **26** are provided in the heat transfer plate **20** sandwiched between the inner gasket member **32***a* and the outer gasket member **32***b* of the double-line gasket **32**.

[0051] In order to discharge the high-temperature fluid H leaking from the inner gasket members **32***a* of the double-line gaskets **32**, the drain hole **25** is made continuous by the annular gasket **33** interposed between each pair of heat transfer plates **20** where the first flow path **1** is provided.

[0052] Then, as shown in FIG. **4**, a nozzle **13** continuous with each drain hole **25** is mounted on the fixed frame **11**, making it possible to detect any leakage of the high-temperature fluid H from the nozzle **13** and hence detect any leakage from the inner gasket members **32***a* due to cracks, as shown in FIG. **6**.

[0053] FIGS. **5** and **6** also show how the double-line gasket **32** shown in FIG. **2** is interposed between each pair of the heat transfer plates **20** and how the communicating hole **21** is surrounded by double-line D gaskets **41** and **42** interposed between the fixed frame **11** and a D plate **20***d*, but the plate heat exchanger according to the second embodiment can use the double-line gasket **32** shown in FIG. **3** as well.

[0054] In either case, the gas supply hole **26** is formed to make the inner gasket member **32***a* still less prone to oxidative degradation reactions. In other words, an inert gas such as nitrogen is supplied from the gas supply hole **26** to an enclosed space surrounded by the inner gasket member **32***a* and the outer gasket member **32***b* of the double-line gasket **32** and the two heat transfer plates **20** so that the inner gasket member **32***a* does not contact oxygen at all.

[0055] Regarding the enclosed space, since the first flow paths **1** are placed next to one another via the heat transfer plates **20**, by interposing the annular gasket **33** continuous with the gas supply hole **26** between each pair of heat transfer plates **20** where the first flow path **1** is provided, an inert gas is supplied into the enclosed space through each nozzle **14** mounted on the fixed frame **11** and communicated with the gaskets **33**. As shown in FIG. **4**, the nozzles **14** for use to supply the inert gas are mounted on the fixed frame **11**.

[0056] The drain hole **25** and the gas supply hole **26** may be provided only in the upper left communicating path **3** through which the high-temperature fluid H flows at a high temperature, but when the drain hole **25** and the gas supply hole **26** are provided also in the double-line gasket **32** forming the lower left communicating path **3** through which the high-temperature fluid H flows at a lowered temperature, the heat transfer plate **20** can be assembled upside down. Thus, when the drain hole **25** and the gas supply hole **26** are provided in the upside-down position, the drain hole **25** is formed to serve as the gas supply hole **26** and the gas supply hole **26** is formed to serve as the drain hole **25**.

[0057] Next, a plate heat exchanger according to a third embodiment of the present invention is described below with reference to FIG. **7**. According to the third embodiment, double-line gaskets **32** are interposed between plural cassette plates **200** stacked in an upright posture.

[0058] The cassette plate **200** is constructed by permanently joining peripheries of two heat transfer plates **20** by laser welding, brazing, or the like (indicated by black dots in FIG. **7**), and the first flow path **1** adapted to pass the high-temperature fluid H or the second flow path **2** adapted to pass the low-temperature fluid C is provided therein.

[0059] Plural cassette plates **200** are stacked, and the second flow path **2** adapted to pass the low-temperature fluid C or the first flow path **1** adapted to pass the high-temperature fluid H is provided between each adjacent ones of the cassette plates **200**. The gaskets **30** are interposed between the peripheries of the stacked cassette plates **200**.

[0060] The gasket **30** is a combination of the flow-path forming gasket (not shown) interposed in the permanently joined peripheries of the cassette plate **200** and the double-line gasket **32** forming the communicating path **3**. The double-line gasket **32** is configured by arranging the annular inner gasket member **32***a* and the annular outer gasket member **32***b* concentrically in two lines, the inner gasket member **32***a* surrounding the passage holes **21** and **22** while the outer gasket member **32***b* surrounding the inner gasket member **32***a*. The outer gasket member **31***b* is installed inside the permanently joined portions as illustrated.

[0061] Alternatively, although not illustrated, the outer gasket member **32***b* may be installed in a space **201** between the permanently joined portions and the inner gasket member **32***a* may be installed inward from the permanently joined portion (a line on which the outer gasket member **32***b* is installed in FIG. **7**).

[0062] Since the high-temperature fluid H is passed through the first flow path **1** in the cassette plate **200**, the high-temperature fluid H also flows through the communicating paths **3**. The communicating paths **3** are formed by the double-line gaskets **32** which surround the passage holes **21** and **22**. Although the inner gasket members **32***a* of the double-line gaskets **32** are placed in contact with the high-temperature fluid H, reactions with oxygen in the atmosphere are inhibited, thereby inhibiting oxidative degradation.

[0063] Therefore, the plate heat exchanger configured by assembling the cassette plates **200** is also less prone to early leakage of the high-temperature fluid H, with settling or subsidence of the double-line gaskets **32** inhibited, where the settling could be caused by cracks and aging degradation. The plate heat exchanger can be configured such that the high-temperature fluid H will not leak even if the low-temperature fluid C is passed through the cassette plates **200** and the high-temperature fluid H is passed between the cassette plates **200**.

[0064] Thus, in the plate heat exchanger according to the present embodiment, the plurality of heat transfer plates **20**

are stacked, each being provided with the plurality of passage holes **21**, **22**, **23**, and **24**; the flow-path forming gasket **31** is interposed between peripheries of each adjacent ones of the heat transfer plates **20**, thereby alternately forming the first flow path **1** adapted to pass the high-temperature fluid H and the second fluid **2** adapted to pass the low-temperature fluid C on opposite sides of each heat transfer plate **20**; the communicating-path forming gaskets **32** surrounding the passage holes **21**, **22**, **23**, and **24** are interposed between adjacent ones of the heat transfer plates **20**, thereby forming the communicating path **3** adapted to cause the fluid H to flow in and out of the first flow path **1** and the communicating path **3** adapted to cause the fluid C to flow in and out the second flow path **2**; and each of the communicating-path forming gaskets **32** is made up of the inner gasket member **32***a* and the outer gasket member **32***b* arranged in two lines, the inner gasket member **32***a* surrounding the passage holes **21**, **22**, **23**, and **24** while the outer gasket member **32***b* surrounding the inner gasket **32***a*. Therefore, since the communicating-path forming gaskets **32**, each made up of the inner gasket member **32***a* and the outer gasket member **32***b* arranged in two parallel lines, surround the passage holes **21**, **22**, **23**, and **24**, forming the communicating paths **3**, although the inner gasket member **32***a* is exposed to the high-temperature fluid H, reactions with oxygen in the atmosphere are inhibited. Therefore, breakage of molecular chains and cross-linking reactions due to oxidative degradation reactions do not proceed in the inner gasket member **32***a* which maintains sealing and consequently increases in compression set and cracks are suppressed. Thus, the high-temperature fluid H flowing through the communicating paths **3** formed by the communicating-path forming gaskets **32** can be made less prone to leakage.

[0065] Also, in the plate heat exchanger according to the present embodiment, the communicating-path forming gasket **32** is arranged in two parallel lines only between the heat transfer plates **20** which form the communicating path **3** through which the high-temperature fluid H flows. Thus, in view of the fact that the communicating-path forming gasket **32** which forms the communicating path **3** through which the high-temperature fluid H flows is prone to degradation due to oxidative degradation reactions, only the communicating-path forming gasket **32** is configured to have two-line arrangement and the communicating-path forming gasket **32** which forms a flow path through which the low-temperature fluid C flows is configured to have a single-line arrangement.

[0066] Also, in the plate heat exchanger according to the present embodiment, the plurality of cassette plates **200** are stacked, each of the cassette plates **200** being made up of two heat transfer plates **20** which are provided with the plurality of passage holes **21**, **22**, **23**, and **24** and are permanently joined along peripheries; the flow-path forming gasket **31** is interposed between peripheries of each adjacent ones of the cassette plates **200**; the communicating-path forming gasket **32** surrounding the passage holes **21**, **22**, **23**, and **24** is interposed between the adjacent heat transfer plates **200**, thereby alternately forming the first flow path **1** adapted to pass the high-temperature fluid H and the second flow path **2** adapted to pass the low-temperature fluid C inside each cassette plate **200** and between the cassette plates **200**, wherein each of the communicating-path forming gaskets **32** is made up of an inner gasket member **32***a* and an outer gasket member **32***b* arranged in two lines, the inner gasket member **32***a* surrounding the passage holes while the outer gasket member **32***b* surrounding the inner gasket **32***a*. Since the communicating-path forming gasket **32** interposed between the cassette plates **200** is made up of the inner gasket member **32***a* and the outer gasket member **32***b* arranged in two lines, when the first flow path **1** adapted to pass the high-temperature fluid H is provided in the cassette plates **200** the communicating-path forming gasket **32** is less prone to oxidative degradation reactions, and consequently progress of gasket degradation can be suppressed, and leakage of the high-temperature fluid H from the communicating path **3** can be prevented from being easily caused.

[0067] Also, in the plate heat exchanger according to the present embodiment, the drain hole **25** is formed in the heat transfer plate **20** between the inner gasket member **32***a* and the outer gasket member **32***b* of the communicating-path forming gasket **32**. Since the drain hole **25** is formed in the heat transfer plate between the inner gasket member **32***a* and the outer gasket member **32***b*, even if the inner gasket undergoes settling or subsidence due to thermal degradation or aging degradation, the high-temperature fluid H leaking from the inner gasket member **32***a* can be discharged through the drain hole **25** in the outer gasket member **32***b*.

[0068] Also, in the plate heat exchanger according to the present embodiment, the gas supply hole **26** is formed in the heat transfer plate **20** between the inner gasket member **32***a* and the outer gasket member **32***b* of the communicating-path forming gaskets **32** and an enclosed space surrounded by the inner gasket member and the heat transfer plates **20** is filled with an inert gas. Since the enclosed space surrounded by the inner gasket member **32***a*, the outer gasket member **32***b*, and the heat transfer plates **20** is filled with an inert gas, it is possible to minimize oxidative degradation reactions of the inner gasket member **32***a* by eliminating air in the enclosed space.

[0069] Note that the present invention is not limited to the first to third embodiments described above and that various changes can be made to the embodiments. For example, the plate heat exchanger described in the third embodiment in which the cassette plates **200** are stacked may be provided with the exhaust hole and the gas supply hole **26** described in the second embodiment. Also, the communicating-path forming gasket **30** may be arranged in two lines only on the upstream side of the first flow path **1** as described in the first embodiment. Also, the nozzle **13** continuous with the drain hole **25** and the nozzle **14** continuous with the gas supply hole **26** may be installed on the movable frame **12** rather than on the fixed frame **11**.

REFERENCE SIGNS LIST

[0070] **1** . . . First flow path
[0071] **2** . . . Second flow path
[0072] **3** . . . Communicating path
[0073] **20** . . . Heat transfer plate
[0074] **21**, **22**, **23**, **24** . . . Passage hole
[0075] **25** . . . Drain hole
[0076] **26** . . . Gas supply hole
[0077] **30** . . . Gasket
[0078] **31** . . . Flow-path forming gasket
[0079] **32** . . . Communicating-path forming gasket (double-line gasket)
[0080] **32***a* . . . Inner gasket member
[0081] **32***b* . . . Outer gasket member
[0082] **200** . . . Cassette plate
[0083] C . . . Low-temperature fluid
[0084] H . . . High-temperature fluid

1. A plate heat exchanger wherein:

a plurality of heat transfer plates are stacked, each being provided with a plurality of passage holes;

a flow-path forming gasket is interposed between peripheries of each adjacent ones of the plurality of heat transfer plates, thereby alternately forming a first flow path adapted to pass a high-temperature fluid and a second flow path adapted to pass a low-temperature fluid on opposite sides of each heat transfer plate;

communicating-path forming gaskets surrounding the passage holes are each interposed between each adjacent ones of the plurality of heat transfer plates, thereby forming a communicating path adapted to cause a fluid to flow in and out of the first flow path and a communicating path adapted to cause a fluid to flow in and out the second flow path; and

each of the communicating-path forming gaskets is made up of an inner gasket member and an outer gasket member arranged in two lines, the inner gasket member surrounding the passage holes while the outer gasket member surrounding the inner gasket member.

2. The plate heat exchanger according to claim **1**, wherein the communicating-path forming gasket is arranged in two parallel lines only between the heat transfer plates which form the communicating path through which the high-temperature fluid flows.)

3. A plate heat exchanger wherein:

a plurality of cassette plates are stacked, each being made up of two heat transfer plates which are provided with a plurality of passage holes and are permanently joined on peripheries;

a flow-path forming gasket is interposed between peripheries of each adjacent ones of the plurality of cassette plates;

communicating-path forming gaskets surrounding the passage holes are each interposed between each adjacent ones of the plurality of heat transfer cassette plates, thereby alternately forming a first flow path adapted to pass a high-temperature fluid and a second flow path adapted to pass a low-temperature fluid inside each cassette plate and between the cassette plates;

wherein each of the communicating-path forming gaskets is made up of an inner gasket member and an outer gasket member arranged in two lines, the inner gasket member surrounding the passage holes while the outer gasket member surrounding the inner gasket member.

4. The plate heat exchanger according to claim **1**, wherein a drain hole is formed in the heat transfer plates between the inner gasket member and the outer gasket member of each of the communicating-path forming gaskets.

5. The plate heat exchanger according to claim **1**, wherein a gas supply hole is formed in the heat transfer plates between the inner gasket member and the outer gasket member of each of the communicating-path forming gaskets; and an enclosed space surrounded by the inner gasket member, the outer gasket member, and the heat transfer plates is filled with an inert gas.

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