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(54) **Roll-bonded panel and process for producing roll-bonded panels**

Durch Aufblähen hergestellte Platte und Verfahren zur Herstellung von Platten durch Aufblähung
Panneau créé par gonflage et procédé pour la fabrication par gonflage de panneaux

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(56) References cited:
DE-A- 3 443 797 **US-A- 2 874 942**
US-A- 3 334 398

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• **PATENT ABSTRACTS OF JAPAN vol. 13, no. 305**
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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a roll-bonded panel comprising the features of the preamble of claim 6, and to a process for producing roll-bonded panels comprising the features of the preamble of claim 1. Such a panel and a process is known, for example, from DE-A-3 443 797 and used in heat exchangers such as refrigerator evaporators.

[0002] It is already known to prepare a roll-bonded panel by printing a pattern corresponding to a fluid circuit on one surface of one of a pair of aluminum plates with a parting agent, superposing the other aluminum plate on the printed surface, roll-bonding the resulting assembly and thereafter inflating nonbonded portions to a tubular form with a fluid pressure. Roll-bonded panels of the type described are in use which differ variously in circuit arrangement or passage width. The circuit of known panels includes, for example, a main passage and a hairpin shunt passage having a smaller width than the main passage and comprising a straight first shunt passageway branching from one portion of the main passage, a straight second shunt passageway branching from another portion of the main passage and a curved passageway provided between the two shunt passageways.

[0003] When air of high pressure is applied to the non-bonded portion to produce a roll-bonded panel having such a hairpin shunt passage, the portion of main passage of large width is first inflated, and the portion of shunt passage is then inflated. In the shunt passage, the two straight shunt passageways are formed first, and the curved passageway is finally formed.

[0004] The air of high pressure forming one of the straight shunt passageways by inflation therefore collides with the high-pressure air forming the other straight shunt passageway at the portion of curved passageway which is lower than the portions of straight passageways in pressure-resistant strength. Accordingly, the conventional roll-bonded panel formed with the hairpin shunt passage has the problem that the portion of curved passageway with a small curvature is ruptured by the impact involved in inflation, or is not inflated as designed since this portion is inflated finally. This problem becomes pronounced in producing roll-bonded panels which have a shunt passage of small width and require air of increased pressure for forming the circuit by inflation.

[0005] Further, it is known (DE 34 43 797 A1) to prepare a pair of metal plates roll-bonded to each other over the hole contact surface except for portions which should be inflated for forming a fluid circuit. The fluid circuit pattern comprises an outer ring shaped fluid circuit and an inner fluid circuit connected to the outer one by a passageway.

[0006] For producing a roll-bonded panel the pair of roll-bonded plates is arranged between two first and

second platen of a suitable press. Thereafter the outer ring shaped fluid circuit is inflated so that a pressure tight seal for the volume between the platen of the press is provided. Then the airtight volume on one side of the panel is pressurized and thereupon the inner fluid circuit pattern is inflated by air pressure supplied via a passageway serving as a delay line for inflating pressure.

[0007] A similar process is known from US 3,334,398. In this process of producing roll-bonded panels the pressure for inflating the inner fluid circuit is supplied via a pressure restrictor which is used for delaying pressure supply instead of a delay line.

[0008] Furthermore, a known heat exchanger unit comprises two sheets of pressure-weldable material pressure welded together along a continuous weld adjacent periphery of a tubing of a fluid circuit. The tubing has two straight portions and a curved portion connecting them. In addition, a reduced cross section bypass between the straight portions of the tubing is provided in order to make total cross sectional area of the bypass and the curved portion at least equal to the cross section of the straight portions of the tubing. The bypass may be straight or curved.

[0009] An object of the present invention is to provide a process for producing roll-bonded panels free of faults such as the rupture of the curved passageway portion or failure in inflating the passageway portion as designed.

[0010] Another object of the present invention is to provide an improved roll-bonded panel.

[0011] These objects are achieved by a method according to claim 1 and the roll-bonded panel according to claim 6.

[0012] With the process of the invention for producing roll-bonded panels, air of high pressure is applied to a nonbonded portion to form a circuit in the panel, whereby a main passage of large width is formed first by inflation, and a shunt passage is subsequently formed similarly. In forming the shunt passage by inflation, one of first and second shunt passageways which is larger in width is formed first, a curved passageway is then formed, and the other shunt passageway which is the smaller in width is finally formed (see FIG. 2). Accordingly, the process is free of the problem that the curved passageway portion will be ruptured by impact involved in inflation, and is also free of the problem of failure in inflating the curved passageway portion as designed because this portion is inflated finally.

[0013] Preferably, the difference between the width of the nonbonded portion to be made into the first shunt passageway and the width of the nonbonded portion to be made into the second shunt passageway is not smaller than 0.2 mm.

[0014] The present process is very effective in the case where a U-shaped passage or V-shaped passage is formed by a portion of the first shunt passageway proximate to the curved passageway, the curved passageway and a portion of the second shunt passageway

proximate to the curved passageway.

[0015] Preferably, air having a pressure not lower than 80 kg/cm² to not higher than 130 kg/cm² is introduced into the nonbonded portions for inflation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a perspective view showing an embodiment of roll-bonded panel obtained by the production process of the invention;

FIG. 2 is a fragmentary plan view showing how a workpiece is inflated into the roll-bonded panel according to the invention;

FIG. 3 is a plan view corresponding to FIG. 2 and showing how a conventional roll-bonded panel is formed; and

FIG. 4 is a perspective view showing another embodiment of roll-bonded panel obtained by the production process of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Embodiments of the present invention will be described below with reference to the drawings.

[0018] FIG. 1 shows a roll-bonded panel obtained by the production process of the invention. The roll-bonded panel 1 is produced by printing a pattern corresponding to a fluid circuit on one surface of one of a pair of upper and lower aluminum plates with a parting agent (bonding preventing agent), roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and thereafter inflating nonbonded portions to a tubular form with air of high pressure introduced into these portions. This embodiment has an inflated tube on one side thereof over the entire area. The upper aluminum plate only is inflated, and the lower aluminum plate is flat.

[0019] The fluid channel of the roll-bonded panel 1 comprises a main passage 3 and a shunt passage 2 having a smaller width than the main passage 3. The shunt passage 3 comprises first and second shunt passageways 4, 5 branching from the main passage 3 and parallel to each other, and a curved passageway 6 interconnecting the forward ends of these shunt passageways 4, 5. A U-shaped passage is formed by the portion 4a of the first shunt passageway 4 proximate to the curved passageway 6, the curved passageway 6 and the portion 5a of the second shunt passageway 5 proximate to the curved passageway 6.

[0020] The pattern of the parting agent is so printed on the aluminum plate that the width W1 of the nonbonded portion to be made into the first shunt passageway 4 is smaller than the width W3 of the nonbonded portion to be made into the straight passage 3, and that the width W2 of the nonbonded portion to be made into

the second shunt passageway 5 is smaller than the width W1 of the nonbonded portion to be made into the first shunt passageway 4. The pattern portion for forming the curved passageway 6 is so printed that this portion gradually increases in width from the second passageway 5 toward the first passageway 4. The difference between the width W1 of the first straight shunt passageway 4 and the width W2 of the second straight shunt passageway 5 is 0.3 mm.

[0021] When air with a pressure not lower than 80 kg/cm² to not higher than 130 kg/cm² is introduced into an outlet 7 of the circuit to form the roll-bonded panel 1 by inflation, the circuit is inflated from portion to portion in the order of decreasing width. In the portion of the hair-pin shunt passage 2, the main passage 3 is formed first, and the first shunt passageway 4 is then formed. The second shunt passageway 5 is slightly smaller than the first shunt passageway 4 in width and is therefore formed later than the first passageway 4. After the first passageway 4 has been formed, accordingly, the curved passageway 6 is formed first, and the second passageway 5 is formed finally (see FIG. 2).

[0022] For comparison, FIG. 3 shows how a conventional example is formed by inflation wherein first and second two shunt passageways 24, 25 are equal in width. With the conventional panel, a main passage 23 is formed first, and the two shunt passageways 24, 25 are thereafter formed at the same time. A curved passageway 26 is formed finally with a portion of high-pressure air from the first passageway 24 and with a portion of high-pressure air from the second passageway 25. Consequently, the air portions collide with each other in the portion of curved passageway 26, which is lower than the portions of shunt passageways 24, 25 in pressure-resistant strength and therefore ruptures. The problem of rupture of the curved portion becomes more pronounced when the circuit can not be formed by inflation unless the air pressure is at least 100 kg/cm².

[0023] With the embodiment shown in FIG. 2, the second shunt passageway 5 is formed eventually by inflation, so that collision of high-pressure air portions produces an impact in the second passageway 5, whereas the portion of the second passageway 5 is unlikely to rupture since the portions of passageways 4, 5 are sufficiently greater than the portion of curved passageway 6 in pressure-resistant strength.

[0024] FIG. 4 shows another embodiment of roll-bonded panel 11 obtained by the production process of the present invention. With reference to this drawing, the roll-bonded panel 11 has a fluid circuit which comprises a main passage 13 and a shunt passage 12 with a smaller width than the main passage 13. The shunt passage 12 comprises first and second shunt passageways 14, 15 branching from the main passage 12, and a curved passageway 16 interconnecting the forward ends of these shunt passageways 14, 15.

[0025] The second embodiment differs from the first with respect to the following. The first and second shunt

passageways 14, 15 are not parallel to each other. A V-shaped passage is formed by the portion of the first passageway 14 proximate to the curved passageway 16, the curved passageway 16 and the portion of the second passageway 15 proximate to the curved portion 16. The first shunt passageway 14 is not straight and is held in communication with the main passage 13 by a straight passageway 14b connected to the passageway 14 approximately perpendicular thereto. As in the first embodiment, a pattern of parting agent is so printed in this case that the width W4 of the nonbonded portion to be made into the first shunt passageway 14 is smaller than the width W6 of the nonbonded portion to be made into the main passage 13, and that the width W5 of the nonbonded portion to be made into the second shunt passageway 15 is smaller than the width W4 of the nonbonded portion to be made into the first passageway 14. This eliminates the faults that would otherwise occur in the portion of curved passageway 16.

[0026] With the foregoing two embodiments, the portion of curved passageway 6 (16) can be effectively rendered free from faults if the difference between the width W1 (W4) of the first shunt passageway 4 (14) and the width W2 (W5) of the second shunt passageway 5 (15) is not smaller than 0.2 mm. Preferably, the main passage 3 (13) is usually not smaller than 8 mm to not larger than 12 mm in width, and the second shunt passageway 5 (15), which has the smallest width, is not smaller than 4 mm in width.

Claims

1. A process for producing a roll-bonded panel (1, 11) having a fluid circuit by printing a pattern corresponding to the fluid circuit on one surface of one of a pair of aluminum plates with a parting agent, roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and thereafter inflating nonbonded portions to a tubular form with a fluid pressure, **characterized in** that the fluid circuit includes a main passage (3, 13) and at least one shunt passage (2, 12) smaller than the main passage (3, 13) in width, and the shunt passage (2, 12) comprises a first shunt passageway (4, 14) branching from one portion of the main passage (3, 13), a second shunt passageway (5, 15) branching from another portion of the main passage (3, 13) and a curved passageway (6, 16) provided between the two shunt passageways (4, 5) and (14, 15), wherein the width (W2, W5) of one of the nonbonded portions to be made into one of the shunt passageways (5, 15; 4, 14) is smaller than the width (W1, W4) of the other of the nonbonded portions to be made into the other of the shunt passageways (4, 14; 5, 15) and the nonbonded portion to be made into the curved passageway (6, 16) gradually increases in width from the one of the nonbonded portions to be made into the one of the shunt passageways (5, 15; 4, 14) toward the other of the nonbonded portions to be made into the other of the shunt passageways (4, 14; 5, 15), **and wherein when forming the shunt passage by inflation, the shunt passageway which is larger in width is formed first, the curved passageway is then formed, and the shunt passageway which is the smaller in width is finally formed.**
2. A production process as defined in claim 1 **characterized in** that the difference between the width (W1, W4) of the nonbonded portion to be made into the first shunt passageway (4, 14) and the width (W2, W5) of the nonbonded portion to be made into the second shunt passageway (5, 15) is not smaller than 0.2 mm.
3. A production process as defined in claim 1 or 2 **characterized in** that a U-shaped passage is formed by a portion (4a) of the first shunt passageway (4) proximate to the curved passageway (6), the curved passageway (6) and a portion (5a) of the second shunt passageway (5) proximate to the curved passageway (6).
4. A production process as defined in claim 1 or 2 **characterized in** that a V-shaped passage is formed by a portion (14a) of the first shunt passageway (14) proximate to the curved passageway (16), the curved passageway (16) and a portion (15a) of the second shunt passageway (15) proximate to the curved passageway (16).
5. A production process as defined in any one of the claims 1 to 4 **characterized in** that air having a pressure not lower than 80 kg/cm² to not higher than 130 kg/cm² is introduced into the nonbonded portions for inflations.
6. A roll-bonded panel (1, 11) formed of a pair of aluminum plates by printing a fluid circuit pattern on one surface of one of the aluminum plates with a parting agent, roll-bonding the aluminum plates with the other aluminum plate superposed on the printed surface, and thereafter inflating nonbonded portions to a tubular form with a fluid pressure, **characterized in** that the fluid circuit includes a main passage (3, 13) and at least one shunt passage (2, 12) smaller than the main passage (3, 13) in width, and the shunt passage (2, 12) comprises a first shunt passageway (4, 14) branching from one portion of the main passage (3, 13), a second shunt passageway (5, 15) branching from another portion of the main passage (3, 13) and a curved passageway (6, 16) provided between the two shunt passageways (4, 5) and (14, 15), **wherein the width of one of the nonbonded portions to be made**

into the second shunt passageway is smaller than the width of the other of the nonbonded portions to be made into the first shunt passageway, and that the curved passageway gradually increases in width.

Patentansprüche

1. Verfahren zum Herstellen einer durch Walzbonden hergestellten Leitungstafel (1, 11) mit einem Fluidkreis durch Aufdrucken eines dem Fluidkreis entsprechenden Muster auf eine Oberfläche einer Platte eines Paares von Aluminiumplatten mittels eines Trennmittels, durch Walzbonden der Aluminiumplatten in solcher Weise, dass die andere Aluminiumplatte auf die bedruckte Fläche aufgelegt ist, und durch anschließendes Aufblasen unverbundener Abschnitte zu Rohrform mittels Fluiddruck, **dadurch gekennzeichnet**, dass der Fluidkreis einen Hauptkanal (3, 13) und mindestens einen Nebenschlusskanal (2, 12) mit kleinerer Weite als der des Hauptkanals (3, 13) aufweist, und der Nebenschlusskanal (2, 12) einen ersten Nebenschlusskanalteil (4, 14), der von einem Abschnitt des Hauptkanals (3, 13) abzweigt, einen zweiten Nebenschlusskanalteil (5, 15), der von einem anderen Abschnitt des Hauptkanals (3, 13) abzweigt, und einen gekrümmten Kanalteil (6, 16) zwischen den zwei Nebenschlusskanalteilen (4, 5 und 14, 15) aufweist, wobei die Weite (W2, W5) eines der unverbundenen Abschnitte, der zu einem der Nebenschlusskanalteile (5, 15; 4, 14) auszubilden ist, geringere Weite (W1, W4) als der andere der unverbundenen Abschnitte aufweist, der zum anderen der Nebenschlusskanalteile (4, 14; 5, 15) auszubilden ist, und die Weite des unverbundenen Abschnitts, der zum gekrümmten Abschnitt (6, 16) auszubilden ist, allmählich von einem der unverbundenen Abschnitte, der zum einen der Nebenschlusskanalteile (5, 15; 4, 14) auszubilden ist, zum anderen der unverbundenen Abschnitte zunimmt, der zum anderen der Nebenschlusskanalteile (4, 14; 5, 15) auszubilden ist, und wobei beim Herstellen des Nebenschlusskanalteils durch Aufblasen als Erstes derjenige der Nebenschlusskanalteile ausgebildet wird, der die größere Weite aufweist, dann der gekrümmte Kanalteil ausgebildet wird und abschließend der Nebenschlusskanalteil ausgebildet wird, der die kleinere Weite aufweist.
2. Herstellverfahren nach Anspruch 1, **dadurch gekennzeichnet**, dass der Unterschied zwischen der Weite (W1, W4) des unverbundenen Abschnitts, der zum ersten Nebenschlusskanalteil (4, 14) auszubilden ist, und der Weite (W2, W5) des unverbundenen Abschnitts, der zum zweiten Nebenschlusskanalteil (5, 15) auszubilden ist, nicht kleiner als

0,2 mm beträgt.

3. Herstellverfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, dass durch einen Abschnitt (4a) des ersten Nebenschlusskanalteils (4) angrenzend an den gekrümmten Kanalteil (6), diesen gekrümmten Kanalteil (6) und einen Abschnitt (5a) des zweiten Nebenschlusskanalteils (5) angrenzend an den gekrümmten Kanalteil (6) ein U-förmiger Kanal ausgebildet wird.
4. Herstellverfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, dass durch einen Abschnitt (14a) des ersten Nebenschlusskanalteils (14) angrenzend an den gekrümmten Kanalteil (16), diesen gekrümmten Kanalteil (16) und einen Abschnitt (15a) des zweiten Nebenschlusskanalteils (15) angrenzend an den gekrümmten Kanalteil (16) ein V-förmiger Kanal ausgebildet wird.
5. Herstellverfahren nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet**, dass Luft mit einem Druck nicht unter 80 kg/cm² bis nicht über 130 kg/cm² zu Aufblaszwecken in die unverbundenen Abschnitte eingeleitet wird.
6. Durch Walzbonden hergestellte Leitungstafel (1, 11), die aus einem Paar Aluminiumplatten dadurch hergestellt wurde, dass ein Fluidkreismuster mittels eines Druckmittels auf eine Oberfläche einer der Aluminiumplatten aufgedruckt wurde, die Aluminiumplatten durch Walzbonden so verbunden wurden, dass die andere Aluminiumplatte auf der bedruckten Oberfläche lag, und danach unverbundene Abschnitte durch Fluiddruck zu Rohrform aufgeblasen wurden, **dadurch gekennzeichnet**, dass der Fluidkreis einen Hauptkanal (3, 13) und mindestens einen Nebenschlusskanal (2, 12) mit kleinerer Weite als der des Hauptkanals (3, 13) aufweist, und der Nebenschlusskanal (2, 12) einen ersten Nebenschlusskanalteil (4, 14), der von einem Abschnitt des Hauptkanals (3, 13) abzweigt, und einen zweiten Nebenschlusskanalteil (5, 15), der von einem anderen Abschnitt des Hauptkanals (3, 13) abzweigt, und einen gekrümmten Kanalteil (6, 16) zwischen den zwei Nebenschlusskanalteilen (4, 5 und 14, 15) aufweist, wobei die Weite eines der unverbundenen Abschnitte, der zum zweiten Nebenschlusskanalteil auszubilden ist, kleiner als die Weite des anderen der unverbundenen Abschnitte ist, der zum ersten Nebenschlusskanalteil auszubilden ist, und dass die Weite des gekrümmten Kanalteils allmählich zunimmt.

Revendications

1. Procédé pour fabriquer un panneau laminé (1, 11)

- présentant un circuit de fluide, en gravant un dessin correspondant au circuit de fluide sur une surface d'une première plaque d'aluminium à l'aide d'un agent de séparation, en laminant ladite plaque d'aluminium avec une seconde plaque d'aluminium posée sur la surface gravée, puis en dilatant les parties non assemblées pour définir une forme tubulaire à l'aide d'une pression de fluide, **caractérisé** en ce que le circuit de fluide comprend un passage principal (3, 13) et au moins un passage de dérivation (2, 12) moins large que celui-ci, et le passage de dérivation (2, 12) comprend un premier passage de dérivation (4, 14) partant d'une partie du passage principal (3, 13), un second passage de dérivation (5, 15) partant d'une autre partie du passage principal (3, 13), et un passage courbe (6, 16) défini entre les deux passages de dérivation (4, 5) et (14, 15), étant précisé que la largeur (W2, W5) d'une première partie non assemblée à transformer en premier passage de dérivation (5, 15 ; 4, 14) est inférieure à la largeur (W1, W4) de la seconde partie non assemblée à transformer en second passage de dérivation (4, 14 ; 5, 15), et que la partie non assemblée à transformer en passage courbe (6, 16) a une largeur croissante de la première partie non assemblée à transformer en premier passage de dérivation (5, 15 ; 4, 14) vers la seconde partie non assemblée à transformer en second passage de dérivation (4, 14 ; 5, 15), et étant précisé que lors de la formation du passage de dérivation par dilatation, le passage de dérivation le plus large est formé en premier, puis le passage courbe, et enfin le passage de dérivation le moins large.
2. Procédé de fabrication selon la revendication 1, **caractérisé** en ce que la différence entre la largeur (W1, W4) de la partie non assemblée à transformer en premier passage de dérivation (4, 14) et la largeur (W2, W5) de la partie non assemblée à transformer en second passage de dérivation (5, 15) n'est pas inférieure à 0,2 mm.
3. Procédé de fabrication selon la revendication 1 ou 2, **caractérisé** en ce qu'un passage en U est défini par une partie (4a) du premier passage de dérivation (4) située près du passage courbe (6), par ledit passage courbe (6) et par une partie (5a) du second passage de dérivation (5) située près du passage courbe (6).
4. Procédé de fabrication selon la revendication 1 ou 2, **caractérisé** en ce qu'un passage en V est défini par une partie (14a) du premier passage de dérivation (14) située près du passage courbe (16), par ledit passage courbe (16) et par une partie (15a) du second passage de dérivation (15) située près du passage courbe (16).
5. Procédé de fabrication selon l'une quelconque des revendications 1 à 4, **caractérisé** en ce que de l'air présentant une pression de 80 kg/cm² minimum et de 130 kg/cm² maximum est introduit dans les parties non assemblées, en vue de la dilatation.
6. Panneau laminé (1, 11) formé à partir de deux plaques d'aluminium grâce à la gravure d'un dessin de circuit de fluide sur une surface d'une première plaque d'aluminium à l'aide d'un agent de séparation, au laminage des plaques d'aluminium, la seconde plaque étant posée sur la surface gravée, puis à la dilatation des parties non assemblées pour définir une forme tubulaire à l'aide d'une pression de fluide, **caractérisé** en ce que le circuit de fluide comprend un passage principal (3, 13) et au moins un passage de dérivation (2, 12) moins large que celui-ci, et le passage de dérivation (2, 12) comprend un premier passage de dérivation (4, 14) partant d'une partie du passage principal (3, 13), un second passage de dérivation (5, 15) partant d'une autre partie du passage principal (3, 13), et un passage courbe (6, 16) défini entre les deux passages de dérivation (4, 5) et (14, 15), étant précisé que la largeur d'une partie non assemblée à transformer en second passage de dérivation est inférieure à la largeur de l'autre partie non assemblée à transformer en premier passage de dérivation, et que le passage courbe a une largeur croissante.

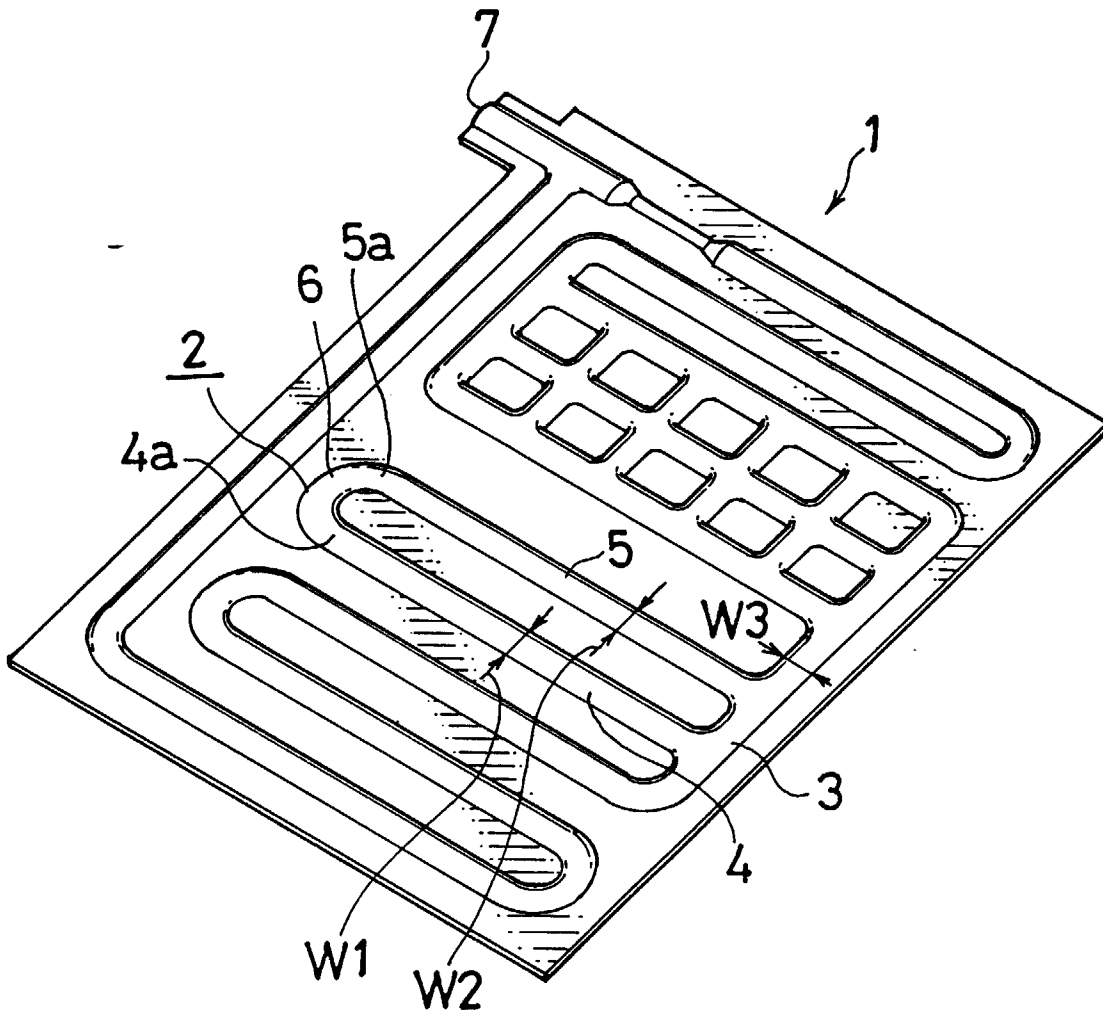


FIG. 1

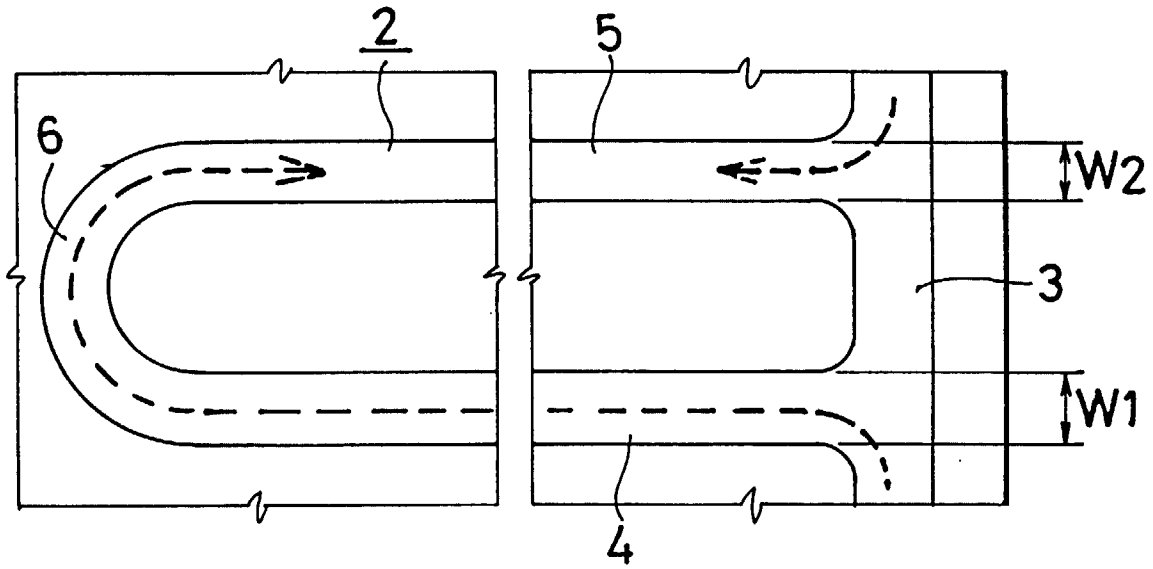


FIG. 2

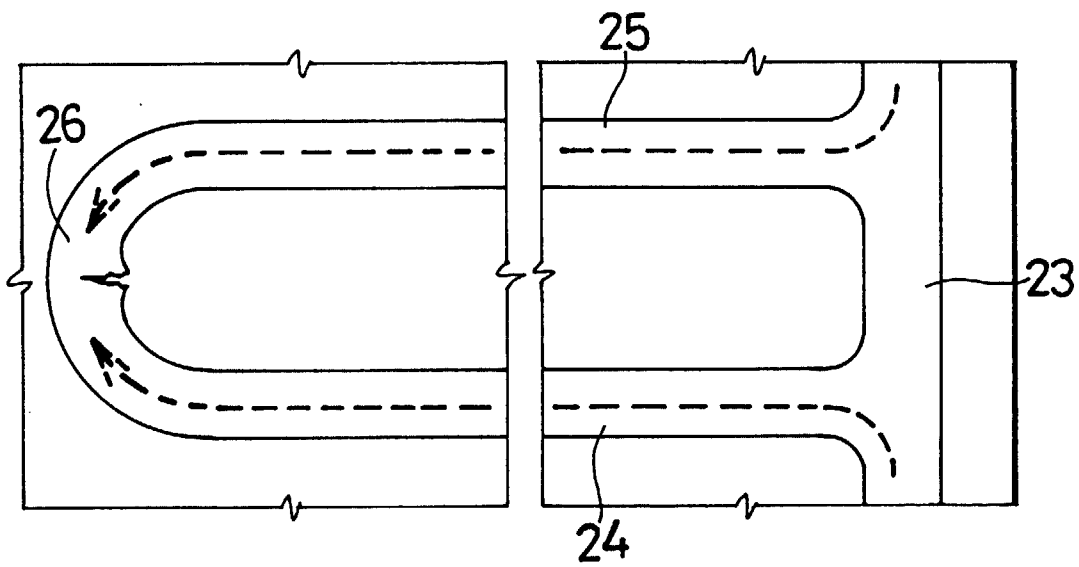


FIG. 3

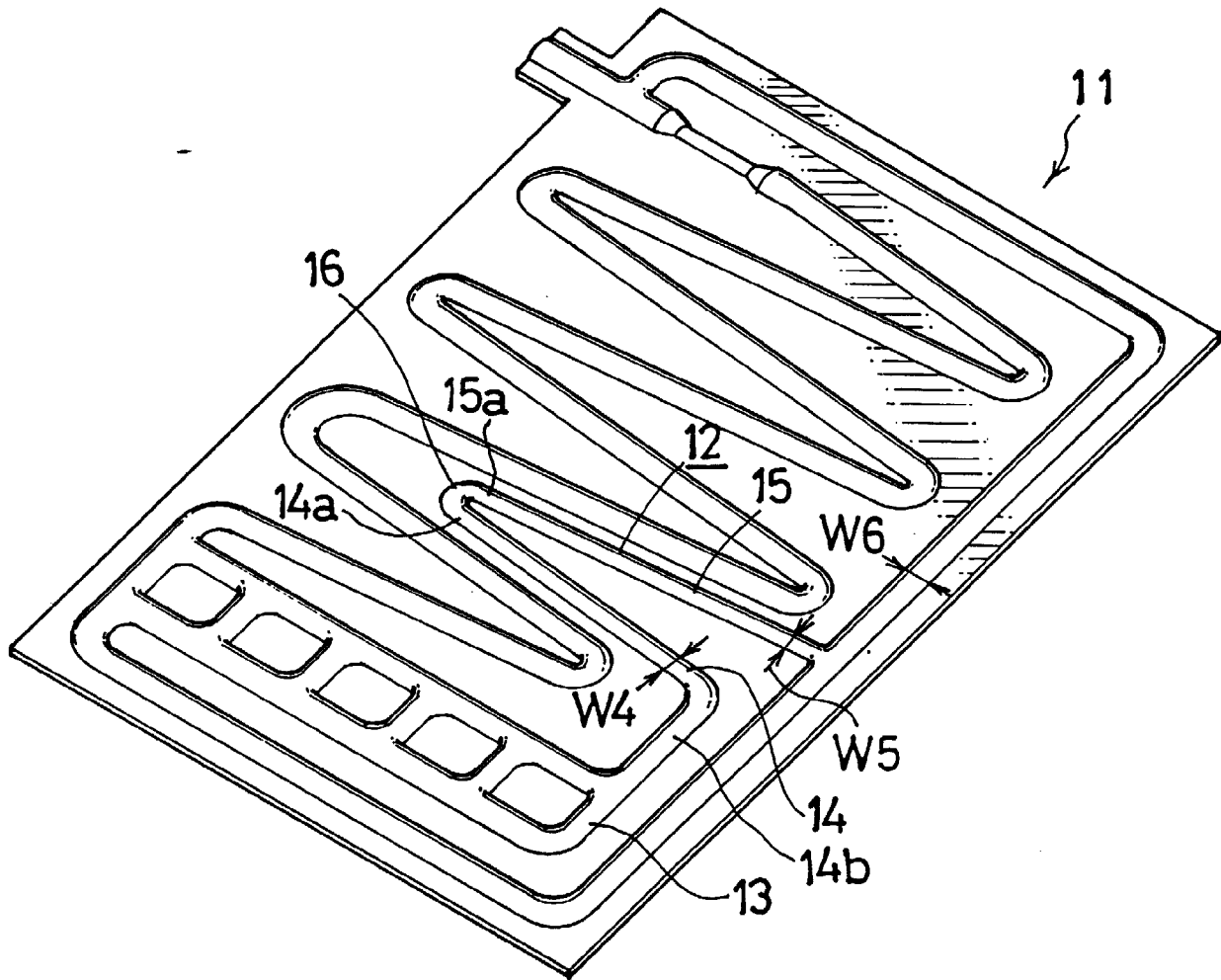


FIG.4