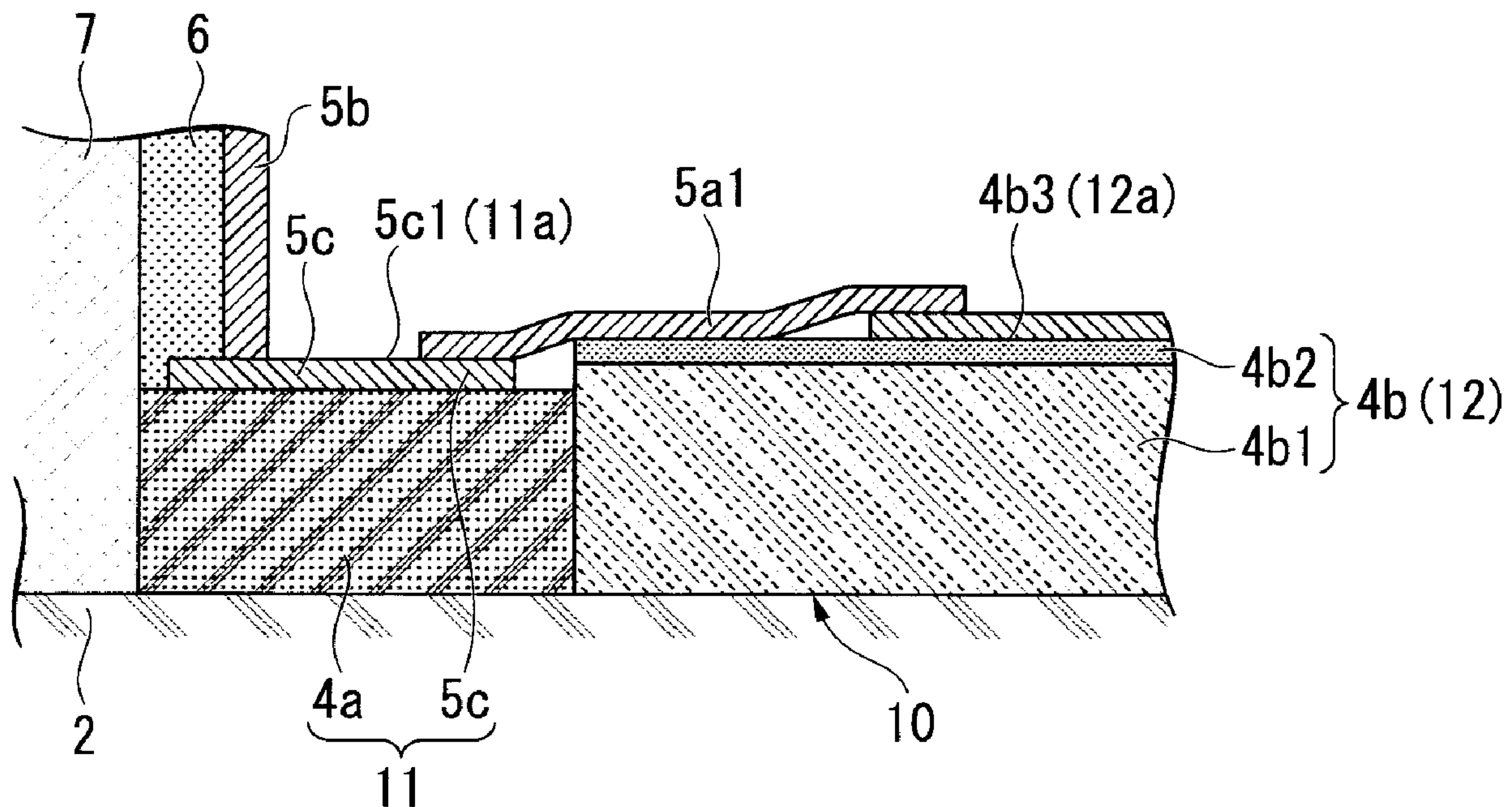




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(54) **Titre : RESERVOIR DE LIQUIDE A BASSE TEMPERATURE**
(54) **Title: LOW TEMPERATURE LIQUID TANK**



(57) **Abrégé/Abstract:**

A low temperature liquid tank (1) includes: a storage tank (5) having a bottom portion (5a) obtained by joining a plurality of bottom plates (5a1); and a support portion (10) supporting the bottom portion, in which the support portion includes: an outer support portion (11) supporting a margin of the storage tank including a sidewall of the storage tank; and an inner support portion (12) disposed inside the outer support portion and having a heat insulation (4b1) in which creep occurs when a load is applied to the heat insulation, and an initial height of an upper surface of the inner support portion is set so that, during a service life of the low temperature liquid tank, maximum bending stress applied to the bottom plates due to a difference between a height of the upper surface of the inner support portion and a height of an upper surface of the outer support portion remains equal to or smaller than an allowable bending stress of the bottom plates.

ABSTRACT

A low temperature liquid tank (1) includes: a storage tank (5) having a bottom portion (5a) obtained by joining a plurality of bottom plates (5a1); and a support portion (10) supporting the bottom portion, in which the support portion includes: an outer support portion (11) supporting a margin of the storage tank including a sidewall of the storage tank; and an inner support portion (12) disposed inside the outer support portion and having a heat insulation (4b1) in which creep occurs when a load is applied to the heat insulation, and an initial height of an upper surface of the inner support portion is set so that, during a service life of the low temperature liquid tank, maximum bending stress applied to the bottom plates due to a difference between a height of the upper surface of the inner support portion and a height of an upper surface of the outer support portion remains equal to or smaller than an allowable bending stress of the bottom plates.

1

DESCRIPTION

Title

LOW TEMPERATURE LIQUID TANK

5

Technical Field

[0001]

Embodiments described herein relate to a low temperature liquid tank.

10 Background Art

[0002]

Tanks (low temperature liquid tanks) in which a low temperature liquid is stored, such as liquefied natural gas (LNG) tanks or liquefied petroleum gas (LPG) tanks, are each equipped with a storage tank in which the low temperature liquid is stored and a support portion that supports the storage tank. To prevent heat from being input from the ground, a heat insulation is included in the support portion (bottom cold insulating structure).

15

[0003]

Conventionally, foam glass, which has high rigidity and in which the effect of creep caused by a load applied from above is negligible in a manner similar to concrete, has been used as the heat insulation included in the support portion. Further, in recent years, a technique in which a margin including a sidewall of a storage tank is formed of a material in which the effect of creep is negligible, such as concrete, and a water- or

20

cyclopentane-foamed heat insulation having higher cold insulating performance as shown in Patent Documents 1 and 2 is arranged inside the margin has also been proposed.

5 Citation List

Patent Documents

[0004]

Patent Document 1: Japanese Unexamined Patent Application, First Publication
No. 2007-2118

10 Patent Document 2: Japanese Unexamined Patent Application, First Publication
No. 2000-171148

Summary

[0005]

15 However, unlike foam glass, a water-or cyclopentane-foamed heat insulation does not have high rigidity. For this reason, there is a possibility of creep occurring during the service life of a low temperature liquid tank and of an upper surface of the support portion that supports the storage tank gradually sinking.

[0006]

20 If the upper surface of the middle portion of the support portion including the water- or cyclopentane-foamed heat insulation sinks in this way, a great level difference occurs between the upper surface of the middle portion and the upper surface of portions supporting the margin of the storage tank. Due to the level difference, the bottom portion of the storage tank is bent. Thus, bending stress occurs, and a great load is

applied to the bottom portion of the storage tank. For this reason, during the use of the low temperature liquid tank, a possibility of a need to perform large-scale maintenance on the bottom portion of the storage tank arising is increased.

[0007]

5 In the tanks in which low-temperature liquids are stored at a low temperature with no change in temperature, including but not limited to LNG tanks and LPG tanks, the heat insulation is included in the support portion that supports the storage tank. Thus, when the water- or cyclopentane-foamed heat insulation is used as the heat insulation, the same problems occur.

10 [0008]

The present disclosure has been made in consideration of the aforementioned problems, and an object of the present disclosure is to provide a low temperature liquid tank that inhibits a great load from being applied to a bottom portion thereof while in use.

15

[0009]

The present disclosure employs the following structures as means of addressing the above-described problems.

[0010]

20 A first aspect of the present disclosure provides a low temperature liquid tank that includes: a storage tank having a bottom portion obtained by joining a plurality of bottom plates; and a support portion supporting the bottom portion, in which the support portion includes: an outer support portion supporting a margin of the storage tank including a sidewall of the storage tank; and an inner support portion disposed inside
25 the outer support portion and having a heat insulation in which creep occurs when a load is

applied to the heat insulation, and an initial height of an upper surface of the inner support portion is set so that, during a service life of the low temperature liquid tank, maximum bending stress applied to the bottom plates due to a difference between a height of the upper surface of the inner support portion and a height of an upper surface of the outer support portion remains equal to or smaller than an allowable bending stress of the bottom plates.

[0011]

A second aspect of the present disclosure is configured such that, in the first aspect, the initial height of the upper surface of the inner support portion is set to be higher than that of the upper surface of the outer support portion.

[0012]

A third aspect of the present disclosure is configured such that, in the first or second aspect, the inner support portion has a height setting plate that prescribes the initial height of the upper surface of the inner support portion.

[0013]

A fourth aspect of the present disclosure is configured such that, in the third aspect, the height setting plate is a heat-resistant board disposed on the heat insulation.

[0014]

A fifth aspect of the present disclosure is configured such that, in any one of the first to fourth aspects, an edge of the outer support portion which is adjacent to the inner support portion is chamfered.

[0015]

A sixth aspect of the present disclosure is configured such that, in any one of the first to fifth aspects, the heat insulation is a rigid plastic foam.

[0016]

In the present disclosure, the initial height of the upper surface of the inner support portion is set such that the maximum bending stress applied to the bottom plates due to the difference between the height of the upper surface of the inner support
5 portion and the height of the upper surface of the outer support portion during a service life of the low temperature liquid tank does not exceed the allowable bending stress of the bottom plates. For this reason, according to the present disclosure, the difference between the height of the upper surface of the inner support portion and the height of the upper surface of the outer support portion may not be great enough to have an
10 influence on the bottom plates during the service life of the low temperature liquid tank. Accordingly, according to the present disclosure, the low temperature liquid tank can inhibit a great load from being applied to the bottom while in use.

Brief Description of Drawings

15 [0017]

FIG. 1 is a sectional view schematically showing a general constitution of an LNG tank in an embodiment of the present disclosure.

FIG. 2A is an enlarged view of an area A of FIG. 1.

FIG. 2B is an enlarged view of the area shown in FIG. 2A after a service life
20 has lapsed.

FIG. 3A is an enlarged view in a modification of the LNG tank.

FIG. 3B is an enlarged view of the area shown in FIG. 3A after a service life has lapsed.

Description of Embodiments

[0018]

Hereinafter, an embodiment of a low temperature liquid tank according to the present disclosure will be described with reference to the drawings.

5 Note that in the drawings, a scale of each member is adequately changed such that each member has a recognizable size. Further, in the present embodiment, as the low temperature liquid tank, a liquefied natural gas (LNG) tank will be described by way of example.

[0019]

10 FIG. 1 is a sectional view schematically showing a general constitution of an LNG tank 1 of the present embodiment. As shown in FIG. 1, the LNG tank 1 of the present embodiment is a ground-type metal double shell tank, and is equipped with a base plate 2, an outer tank 3, a bottom cold insulating mechanism (support portion) 4, an inner tank (storage tank) 5, a blanket 6, and a lateral cold insulation 7.

15 [0020]

The base plate 2 is a disc-like member formed of concrete, and supports the outer tank 3, the bottom cold insulating mechanism 4, the inner tank 5, the blanket 6, and the lateral cold insulation 7. The outer tank 3 is a cylindrical container formed of carbon steel, and is erected on the base plate 2 so as to surround the bottom cold
20 insulating mechanism 4, the inner tank 5, the blanket 6, and the lateral cold insulation 7. The bottom cold insulating mechanism 4 is disposed under the inner tank 5 inside the outer tank 3, and is adapted to support the inner tank 5. The bottom cold insulating mechanism 4 is a member equivalent to the support portion in the present disclosure, and details thereof will be described below.

25 [0021]

The inner tank 5 is a cylindrical container in which LNG is stored, and is erected on the bottom cold insulating mechanism 4. The inner tank 5 is made up of a bottom portion 5a and a sidewall 5b formed of nickel steel, an annular plate 5c connecting the bottom portion 5a and the sidewall 5b (see FIGS. 2A and 2B), and a ceiling 5d that is formed of aluminum steel and is supported in a suspended state. The bottom portion 5a of the inner tank 5 is formed in such a manner that a plurality of bottom plates 5a1 (see FIGS. 2A and 2B) formed of nickel steel are joined. The annular plate 5c is a part of the inner tank 5 as described above. However, in the present embodiment, the annular plate 5c serves as a part of the support portion of the present disclosure. The blanket 6 is disposed to cover the sidewall 5b of the inner tank 5 from the outside, has a cold insulating function, and absorbs thermal deformation of the inner tank 5. The lateral cold insulation 7 is filled between the blanket 6 and the outer tank 3, and is formed of, for example, perlite.

[0022]

FIGS. 2A and 2B are enlarged views of an area A of FIG. 1. Note that it is shown in FIGS. 2A and 2B that each member is changed particularly in height among actual dimensions in order to emphasize a difference in the height of each member. As shown in FIGS. 2A and 2B, the bottom cold insulating mechanism 4 is made up of a peripheral section 4a disposed under the sidewall 5b of the inner tank 5, and a midsection 4b disposed inside the peripheral section 4a.

[0023]

The peripheral section 4a supports the annular plate 5c of the inner tank 5, is formed of concrete, and is provided along the sidewall 5b of the inner tank 5 in an annular shape. The midsection 4b is formed by a heat insulating layer 4b1 installed on the base plate 2, and a plurality of calcium silicate boards 4b2 provided on the heat

insulating layer 4b1.

[0024]

The heat insulating layer 4b1 is a member for preventing heat from being input to the inner tank 5 from the ground. In the present embodiment, the heat insulating layer 4b1 is formed of a rigid plastic foam, in which, unlike concrete or foam glass, creep occurs due to a load from above. To be more specific, the heat insulating layer 4b1 may be formed of a rigid urethane foam, a rigid polyisocyanurate foam, or a rigid polyvinyl chloride foam.

[0025]

The calcium silicate boards 4b2 are heat-resistant boards, and upper surfaces 4b3 thereof serve as supporting surfaces which support the bottom plates 5a1 that form the bottom portion 5a of the inner tank 5. These calcium silicate boards 4b2 prevent a heat effect on the underlaid heat insulating layer 4b1 when the bottom plates 5a1 are welded to each other while the LNG tank 1 is under construction.

[0026]

As shown in FIG. 2A, the bottom portion 5a (i.e., the bottom plates 5a1) of the inner tank 5 is in contact with an upper surface 5c1 of the annular plate 5c at a margin of the inner tank 5, and is in contact with the upper surfaces 4b3 of the calcium silicate boards 4b2 at the midsection of the inner tank 5. That is, the bottom portion 5a of the inner tank 5 is supported by the bottom cold insulating mechanism 4 and the annular plate 5c. In the LNG tank 1 of the present embodiment, a structure made up of the bottom cold insulating mechanism 4 and the annular plate 5c is referred to as a support portion 10. Further, a peripheral section of the support portion 10 is made up of the peripheral section 4a of the bottom cold insulating mechanism 4 and the annular plate 5c, and supports the margin of the inner tank 5 including the sidewall 5b of the inner tank 5.

Hereinafter, the peripheral section of the support portion 10 is referred to as an outer support portion 11. In addition, a midsection of the support portion 10 is made up of the midsection 4b of the bottom cold insulating mechanism 4. Hereinafter, the midsection of the support portion 10 is referred to as an inner support portion 12. That is, the LNG tank 1 of the present embodiment includes the outer support portion 11 that supports the margin of the inner tank 5 including the sidewall 5b of the inner tank 5, and the inner support portion 12 that is disposed inside the outer support portion 11 and that has the heat insulating layer 4b1 formed of the heat insulation in which creep occurs when a load is applied.

10 [0027]

FIG. 2A shows a state immediately after construction of the LNG tank 1 of the present embodiment is completed. As shown in FIG. 2A, in the LNG tank 1 of the present embodiment, an upper surface 12a (i.e., the calcium silicate boards 4b2) of the inner support portion 12 has an initial height set to be higher than a height of an upper surface 11a (the upper surface 5c1 of the annular plate 5c) of the outer support portion 11. In the LNG tank 1 of the present embodiment, since the heat insulating layer 4b1 formed of rigid plastic foam is included in the bottom cold insulating mechanism 4, when the heat insulating layer 4b1 receives a load from above due to weight of LNG stored in the inner tank 5, creep occurs in the heat insulating layer 4b1. For this reason, in the LNG tank 1 of the present embodiment, the heat insulating layer 4b1 is gradually compressed due to long-term use, and the upper surface 12a of the inner support portion 12 sinks. As a result, after the service life of the LNG tank 1 has lapsed, the upper surface 12a of the inner support portion 12 is, as shown in FIG. 2B, located below the upper surface 11a of the outer support portion 11.

25 [0028]

Here, in the LNG tank 1 of the present embodiment, an extent value to which the upper surface 12a of the inner support portion 12 sinks after the service life of the LNG tank 1 has lapsed is obtained through experimentation or simulation in a design step, and the initial height of the upper surface 12a of the inner support portion 12 is set based on the obtained value so as not to affect a great effect on the bottom plates 5a1. To be specific, a difference between the height of the upper surface 12a of the inner support portion 12 and the height of the upper surface 11a of the outer support portion 11 is obtained from an amount of sinkage of the upper surface 12a of the inner support portion 12. Maximum bending stress applied to the bottom plates 5a1 is obtained from this difference, and is compared with allowable bending stress of the bottom plates 5a1 (stress at which the bottom plates 5a1 can be estimated not to need repair during the service life of the LNG tank 1). The initial height of the upper surface 12a is set such that the maximum bending stress does not exceed the allowable bending stress of the bottom plates 5a1. The initial height is naturally set such that the maximum bending stress applied to the bottom plates 5a1 by the difference between the height of the upper surface 12a of the inner support portion 12 and the height of the upper surface 11a of the outer support portion 11 at an initial stage does not exceed the allowable bending stress of the bottom plates 5a1.

[0029]

As described above, in the LNG tank 1 of the present embodiment, the initial height of the upper surface 12a of the inner support portion 12 is set such that the maximum bending stress applied to the bottom plates 5a1 due to the difference between the height of the upper surface 12a of the inner support portion 12 and the height of the upper surface 11a of the outer support portion 11 during the service life of the LNG tank 1 remains equal to or smaller than the allowable bending stress of the bottom plates 5a1.

For this reason, according to the LNG tank 1 of the present embodiment, the difference between the height of the upper surface 12a of the inner support portion 12 and the height of the upper surface 11a of the outer support portion 11 does not become great enough to have an influence on the bottom plates 5a1 during the service life of the LNG tank 1.

5 Accordingly, according to the LNG tank 1 of the present embodiment, it is possible to inhibit a great load from being applied to the bottom portion 5a of the inner tank 5 during the use of the LNG tank 1.

[0030]

Further, the initial height of the upper surface 12a of the inner support portion 12
10 may be adjusted, for instance, by changing thicknesses of the components (i.e., in the present embodiment, the heat insulating layer 4b1 and the calcium silicate boards 4b2) of the inner support portion 12 or by raising the base plate 2. Also, the height of the upper surface 12a of the inner support portion 12 may be adjusted by newly installing on the inner support portion 12 a height setting plate for prescribing the height of the upper
15 surface 12a. However, since it is easy to adjust the thicknesses of the calcium silicate boards 4b2, the calcium silicate boards 4b2 are preferably used as the height setting plate.

[0031]

While a preferred embodiment of the present disclosure has been described with reference to the attached drawings, it goes without saying that the present disclosure is
20 not limited to the above embodiment. All the shapes and combinations of the components shown in the aforementioned embodiment are only examples and can be variously modified based on design requirements without departing from the spirit and scope of the present disclosure.

[0032]

25 For example, as shown in FIG. 3A, a constitution in which an edge 11b of the

outer support portion 11 which is adjacent to the inner support portion 12 is chamfered
may also be employed. As a result of employing this constitution, as shown in FIG. 3B,
even when the upper surface 12a of the inner support portion 12 sinks and is located
below the upper surface 11a of the outer support portion 11, the edge of the outer support
5 portion 11 can be prevented from colliding with the bottom plates 5a1 and high stress can
be prevented from being locally applied to the bottom plates 5a1.

[0033]

Also, in the above embodiment, the constitution in which the outer support
portion 11 is made up of the peripheral section 4a of the bottom cold insulating
10 mechanism 4 and the annular plate 5c, the bottom plates 5a1 are supported by the upper
surface of the annular plate 5c, and the annular plate 5c and each bottom plate 5a1
overlap and are welded together is employed. However, the present disclosure is not
limited to this constitution. For example, a constitution in which the bottom plates 5a1
are directly supported by the upper surface of the peripheral section 4a of the bottom cold
15 insulating mechanism 4 and each bottom plate 5a1 and the annular plate 5c are butted
and welded may also be employed.

In this case, the bottom plates 5a1 are supported by the upper surface of the
peripheral section 4a of the bottom cold insulating mechanism 4. For this reason, the
outer support portion is configured of only the peripheral section 4a of the bottom cold
20 insulating mechanism 4, and the upper surface of the peripheral section 4a becomes the
upper surface of the outer support portion.

[0034]

Also, in the above embodiment, the constitution in which the inner support
portion 12 is made up of the heat insulating layer 4b1 formed of the rigid urethane foam
25 and the calcium silicate boards 4b2 is employed. However, the present disclosure is not

limited to this constitution, and the inner support portion 12 may also have a different structure. For example, a constitution in which a second heat insulating layer formed of, for example, foam glass is included in the inner support portion 12 may be employed. Also, foam glass may be disposed at an upper layer, and the calcium silicate boards 4b2
5 may be removed. When the structure of the inner support portion 12 is changed, the component having a surface supporting the bottom plates 5a1 is also modified.

[0035]

Also, in the above embodiment, the constitution in which the heat insulating layer 4b1 is formed of the rigid urethane foam has been described. However, the heat
10 insulating layer is not limited to the rigid urethane foam, and any foamed plastic may be used as the heat insulating layer.

[0036]

Also, in the above embodiment, the example in which the low temperature liquid tank of the present disclosure is applied to the LNG tank 1 has been described.
15 However, the low temperature liquid tank of the present disclosure may also be applied to an LPG tank or other low temperature liquid tanks.

[0037]

In addition, in the present disclosure, the initial height of the upper surface of the inner support portion is not necessarily higher than that of the upper surface of the outer
20 support portion. For example, the initial height of the upper surface of the inner support portion may be flush with that of the upper surface of the outer support portion.

Industrial Applicability

[0038]

25 The low temperature liquid tank can inhibit a great load from being applied to

the bottom portion while in use.

Reference Signs List

[0039]

5	1: LNG tank (low temperature liquid tank)
	2: base plate
	3: outer tank
	4: bottom cold insulating mechanism
	4a: peripheral section
10	4b: midsection
	4b1: heat insulating layer (heat insulation)
	4b2: calcium silicate board (height setting plate)
	4b3: upper surface
	5: inner tank (storage tank)
15	5a: bottom portion
	5a1: bottom plate
	5b: sidewall
	5c: annular plate
	5c1: upper surface
20	5d: ceiling
	6: blanket
	7: lateral cold insulation
	10: support portion
	11: outer support portion
25	11a: upper surface

15

11b: edge

12: inner support portion

12a: upper surface

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A low temperature liquid tank comprising:
 - a storage tank having a bottom portion obtained by joining a plurality of bottom plates; and
 - a support portion supporting the bottom portion, wherein the support portion includes:
 - an outer support portion supporting a margin of the storage tank including a sidewall of the storage tank; and
 - an inner support portion disposed inside the outer support portion and having a heat insulation in which creep occurs when a load is applied to the heat insulation, and
 - an initial height of an upper surface of the inner support portion is set so that, during a service life of the low temperature liquid tank, maximum bending stress applied to the bottom plates due to a difference between a height of the upper surface of the inner support portion and a height of an upper surface of the outer support portion remains equal to or smaller than an allowable bending stress of the bottom plates;wherein the initial height of the upper surface of the inner support portion is set to be higher than that of the upper surface of the outer support portion.
2. The low temperature liquid tank according to claim 1, wherein the inner support portion has a height setting plate that prescribes the initial height of the upper surface of the inner support portion.
3. The low temperature liquid tank according to claim 2, wherein the height setting plate is a heat-resistant board disposed on the heat insulation.
4. The low temperature liquid tank according to any one of claims 1 to 3, wherein an edge of the outer support portion which is adjacent to the inner support portion is chamfered.

5. The low temperature liquid tank according to any one of claims 1 to 3, wherein the heat insulation is a rigid plastic foam.
6. The low temperature liquid tank according to claim 4, wherein the heat insulation is a rigid plastic foam.

1/3

FIG. 1

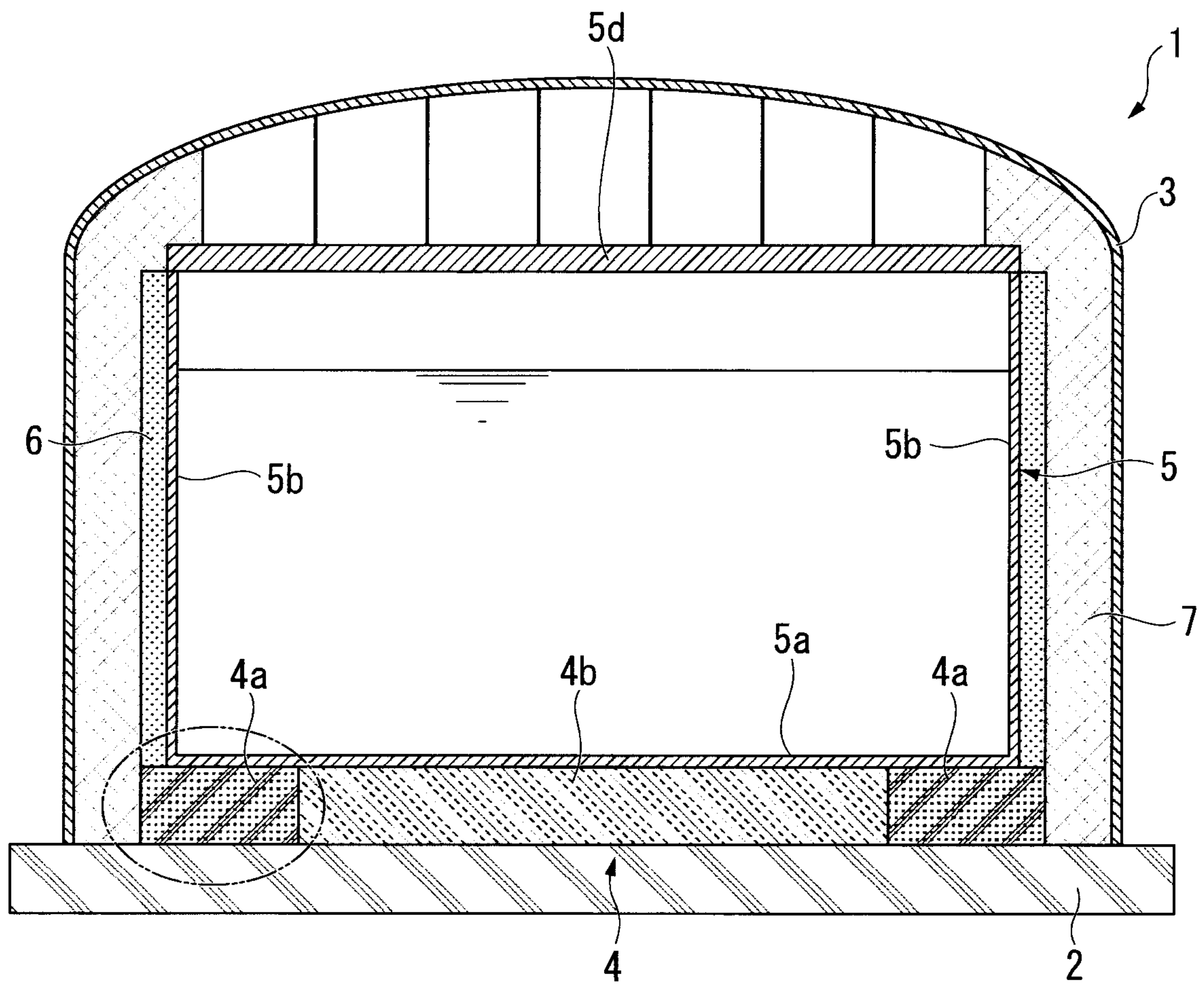


FIG. 2A

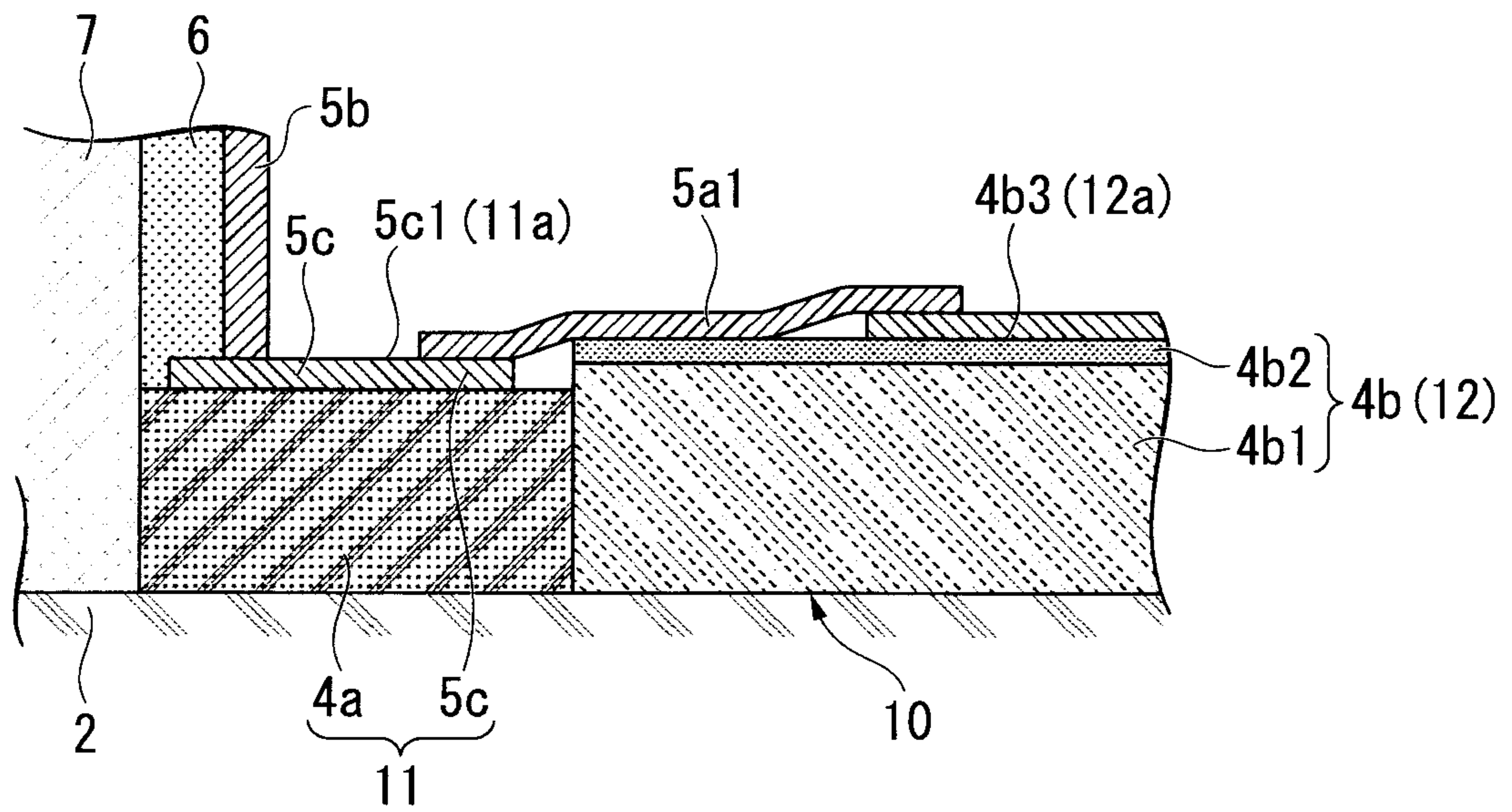


FIG. 2B

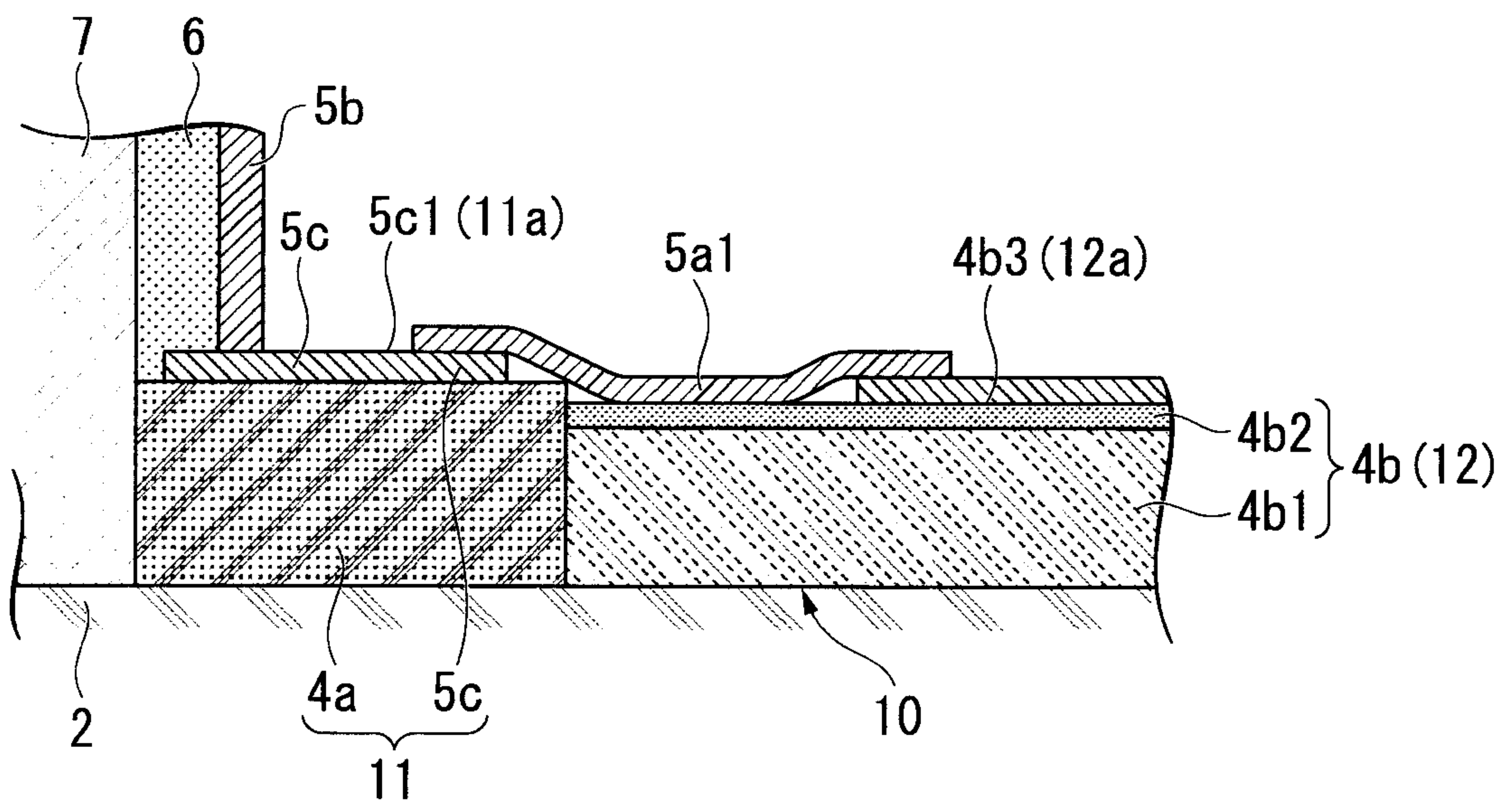


FIG. 3A

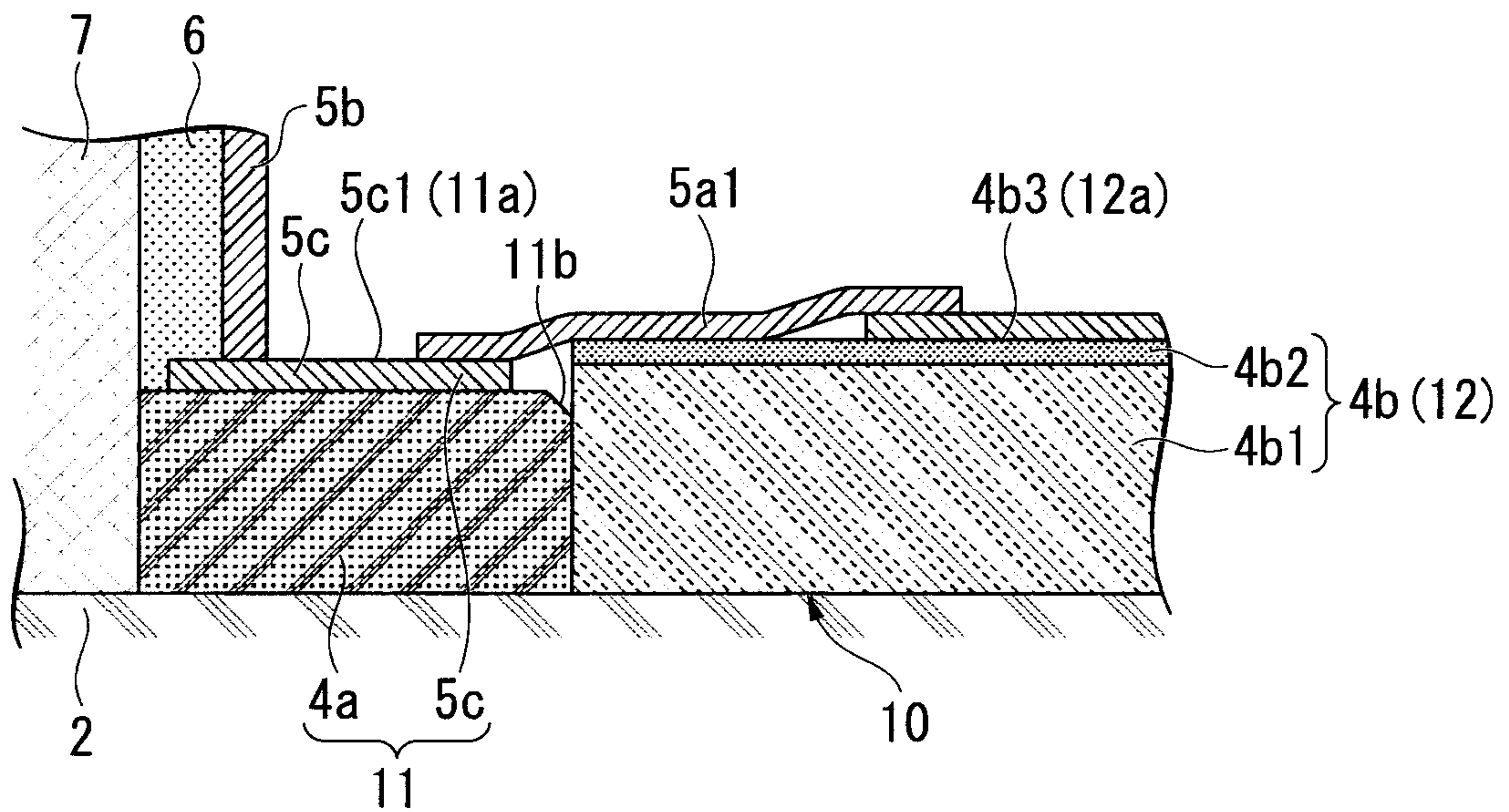


FIG. 3B

