



- (51) **International Patent Classification:** Not classified
- (21) **International Application Number:**
PCT/JP2012/061161
- (22) **International Filing Date:**
19 April 2012 (19.04.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
2011-096507 22 April 2011 (22.04.2011) JP
- (71) **Applicant (for all designated States except US):**
PERMELEC ELECTRODE LTD. [JP/JP]; 2023-15,
Endo, Fujisawa-shi, Kanagawa, 2520816 (JP).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **HAMAGUCHI, Katsumi** [JP/JP]; c/o PERMELEC ELECTRODE LTD., 2023-15, Endo, Fujisawa-shi, Kanagawa, 2520816 (JP). **TAMAI, Akio** [JP/JP]; c/o PERMELEC ELECTRODE LTD., 2023-15, Endo, Fujisawa-shi, Kanagawa, 2520816 (JP). **KUNIMATSU, Akira** [JP/JP]; c/o PERMELEC ELECTRODE LTD., 2023-15, Endo, Fujisawa-shi, Kanagawa, 2520816 (JP). **SHIMIZU, Hideto** [JP/JP]; c/o PERMELEC ELECTRODE LTD., 2023-15, Endo, Fujisawa-shi, Kanagawa, 2520816 (JP).

(74) **Agents:** **KONDO, Rieko** et al.; Mitobe Building, 5th Floor, 1-13-1, Kandaizumi-cho, Chiyoda-ku, Tokyo, 1010024 (JP).

(81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

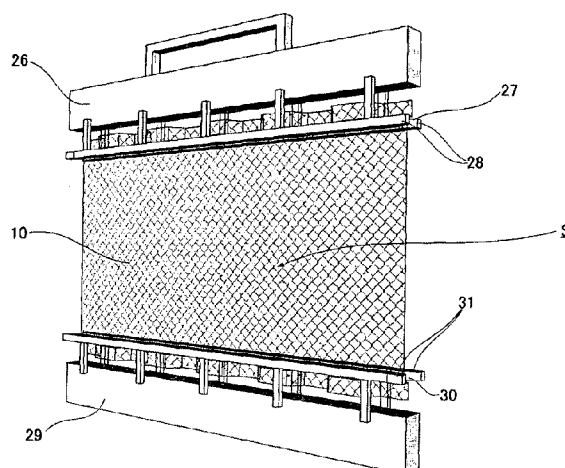
(84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) **Title:** EDGE BENDING JIG FOR MESH-TYPE ELECTRODE SUBSTRATE, EDGE BENDING METHOD FOR MESH-TYPE ELECTRODE SUBSTRATE, HANGING JIG FOR MESH-TYPE ELECTRODE SUBSTRATE AND HANGING METHOD FOR MESH-TYPE ELECTRODE SUBSTRATE

[Fig. 9]



(57) **Abstract:** To provide an edge bending jig for the mesh-type electrode, an edge bending method for the mesh-type electrode substrate, a hanging jig for the mesh-type electrode substrate, and a hanging method for the mesh-type electrode substrate, which do not bind the electrode substrate of the mesh-type electrode locally, allow hanging load to disperse, prevent the internal surface of the electrode from wrinkling in the baking process, and install the electrode substrate on the hanging jig with good working properties. A bending jig and a bending method by bending the top end and the bottom end, and the external surface of the convex part and the concave part at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part; and a hanging jig and a hanging method for the mesh-type electrode substrate in which the electrode substrate are hung by the electrode holding member without binding the electrode substrate, and the weight member is hung down on the bottom end of the electrode substrate without binding the electrode substrate.

DESCRIPTION

Title of Invention

EDGE BENDING JIG FOR MESH-TYPE ELECTRODE SUBSTRATE, EDGE
5 BENDING METHOD FOR MESH-TYPE ELECTRODE SUBSTRATE, HANGING
JIG FOR MESH-TYPE ELECTRODE SUBSTRATE AND HANGING METHOD
FOR MESH-TYPE ELECTRODE SUBSTRATE

Technical Field

10 The present invention relates to an edge bending jig for a mesh-type electrode
substrate an edge bending method for the mesh-type electrode substrate a hanging jig
for the mesh-type electrode substrate and a hanging method of the mesh-type electrode
substrate.

15 Background Art

As an electrode for an anode and a cathode for chlorine generation in the area of
chlor-alkali electrolysis, for oxygen generation in the processes including copper foiling,
metal winning and metal plating, and for other industrial electrolyses including water
electrolysis and water treatment, an expanded metal mesh electrode substrate or a mesh
20 electrode substrate is applied. The former is prepared in such a manner that a flat plate
is nicked and expanded so that continuous diamond-shape openings are formed over the
entire surface. The latter is metal wires woven in plain mesh. The surface of these
electrode substrates is coated with electrode catalyst by the thermal decomposition
process to manufacture an electrode.

25

In general, when an electrode is manufactured by coating electrode catalyst by the
thermal decomposition process on the surface of the expanded metal mesh electrode
substrate or the plainly woven mesh electrode substrate, with a certain thickness, such
processes as etching, coating, and baking are necessary for the electrode substrate.

During these operations, the electrode substrate is being hung with a hanging jig. The hanging jig used in the operations comprises an upper jig to hang the electrode substrate and a lower jig to function as a weight to prevent the electrode substrate from swinging, as necessary. For hanging, the electrode substrate is provided with holes for hanging or
5 pieces with a hole for hanging is welded on the electrode substrate and the electrode substrate is fixed to the upper jig and the lower jig using these holes, or the electrode substrate is wired on the hanging jigs.

When, applying the above hanging methods, the electrode is manufactured by
10 coating electrode catalyst by the thermal decomposition process on the surface of the expanded metal mesh electrode substrate or the plainly woven mesh electrode substrate, with a certain thickness, bending or traces of wrinkling or breaking have been seldom experienced during etching, coating or baking operations in the thermal decomposition process, as far as the substrate has a certain degree of thickness, weight and proper
15 rigidity,

Recently, however, an expanded metal mesh electrode substrate with a plate thickness as thin as 0.1 mm - 0.3 mm and a similar notch width, or a woven plain mesh electrode substrate with a wire diameter as small as 0.1 mm - 0.3 mm, and a nominal
20 size of the mesh as small as 30 - 50 appears. The nominal size of mesh indicates the number of wires or the number of meshes in a span of 25.4 mm (1 inch).

When the afore-mentioned hanging method was applied for an electrode to be manufactured by the thermal decomposition process using a thin expanded metal mesh
25 electrode substrate or a woven plain mesh electrode substrate with a small wire diameter, the final planarity or surface quality of the electrode was not secured, since the rigidity, as a characteristic of these substrates, is very small and bending, traces of wrinkling or breaking were experienced during etching, coating or baking operations in the thermal decomposition process.

Moreover, in case of a thin expanded metal mesh electrode substrate or a woven plain mesh electrode substrate with a small wire diameter, the afore-mentioned methods or jigs are not applicable because the holes for hanging of the electrode substrate deform or break due to very small rigidity of the electrode substrate. To solve this problem, a possible method may be that the electrode substrate is bound by the faces at the edge to disperse hanging load. In this case, however, working properties and efficiency deteriorate, causing increased man-power for binding and probability of occurrence of wrinkling and breaking. In particular, as an additional problem, wrinkle occurs not only at around the bound edge of the electrode substrate but also towards the inside of the electrode as an effect of thermal deformation during the baking process. Nevertheless, no patent literature has been found relating to the hanging of these kinds of the electrode substrate.

As a hanging method for a semiconductor substrate, Patent Literature 1 discloses a method for holding a semiconductor substrate horizontally, which cannot be applied as a hanging method for the electrode substrate as disclosed in the present invention.

Citation List

Patent Literature

PTL 1: JP2000-109392A

Summary of Invention

Technical Problem

In order to solve these problems, the present invention aims to provide an edge bending jig for the mesh-type electrode, an edge bending method for the mesh-type electrode substrate a hanging jig for the mesh-type electrode, and a hanging method for mesh-type electrode substrate, which neither hook the electrode substrate of mesh-type

electrode locally nor tie it with wires, but bind it by faces to allow hanging load to disperse, prevent the internal surface of the electrode from wrinkling in the baking process, and can install the electrode substrate on the hanging jig with good working properties.

5 In the present invention, the mesh-type electrode substrate indicates an expanded metal mesh electrode substrate in which a flat plate is nicked and expanded so that continuous diamond-shape openings are provided over the entire surface and the plainly woven mesh electrode substrate of metal wires.

10 **Solution to Problem**

The first means to solve the problems by the present invention to achieve the afore-mentioned purposes is to provide an edge bending jig for the mesh-type electrode substrate for processing the mesh-type electrode substrate by bending,

by which in both the top end and the bottom end which is one of the opposing two
15 sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by
20 bending the top end and the bottom end, and the external surface of the convex part 21, 23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10 comprising: a bending unit 1 with a square flat plate part 2 and the top end and the bottom end on any one of the opposing two sides of the square flat plate part 2,
25 respectively, a pair of rod-type upper pressing member 13 and the lower pressing member 14 provided with the convex part 16, 18 and the concave part 17, 19 having a configuration to engage, respectively, with the concave part 5, 7 and the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4, which are provided with the concave part 5, 7 and the convex part 6, 8 formed alternately on the top end and

the bottom end of the bending unit 1, respectively and a press shaping means to press to engage the convex part 16, 18 and the concave part 17, 19 of a pair of the rod-type upper pressing member 13 and the lower pressing member 14 with the concave part 5, 7 and the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4 of the bending unit 1 in a state that the mesh-type electrode substrate S is placed on the bending unit 1 and characterized in that the top face of the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4 project from the surface of the square flat plate part 2 and the bottom face of the concave part 5, 7 of a pair of the upper die member 3 and the lower die member 4 project from the surface of the square flat plate part 2 in opposite direction to the convex part 6, 8.

The second means to solve the problems by the present invention to achieve the afore-mentioned purposes is to provide an edge bending jig for the mesh-type electrode substrate, in which an alignment pin 9 is provided to the top face of the respective both ends of a pair of the upper die member 3 and the lower die member 4, and the opening 15 is provided to be engaged with the alignment pin 9 to the respective both ends of the rod-type upper pressing member 13 and the lower pressing member 14, so that the upper and the lower both ends of the mesh-type electrode substrate S are bent for press shape processing with the alignment pin 9 engaged with the opening 15.

20

The third means to solve the problems by the present invention to achieve the afore-mentioned purposes is to provide an edge bending method using the edge bending jig, in which in both the top end and the bottom end which is one of the opposing two sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by bending the top end and the bottom end, and the external surface of the convex part 21,

23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10.

5 The forth means to solve the problems by the present invention to achieve the afore-mentioned purposes is to provide a hanging jig for the mesh-type electrode substrate, by which in both the top end and the bottom end which is one of the opposing two sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by bending the top end and the bottom end, and the external surface of the convex part 21, 23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10 comprising: the upper jig 26 having the electrode holding member 28, 28 comprising two plates in parallel with the gap 27 at the center, which is a little wider than the thickness of the flat plate part 10 of the electrode substrate S and the lower jig 29 having the weight member 31, 31 comprising two plates in parallel with the gap 30 at the center, which is a little wider than the thickness of the flat plate part 10 of the substrate S, and having the construction that the gap at the gap 27 of the electrode holding member 28, 28 is adjusted to a width which can hold the electrode substrate S without binding, in a state that the vicinity of the top end of the electrode substrate S is pinched, by a plurality of the convex part 21 and the concave part 20 formed alternately on the top end of the electrode substrate S, and the gap at the gap 30 of the weight member 31, 31 is adjusted to a width which can hang the weight member 31, 31 without binding the electrode substrate S, in a state that the bottom end of the electrode substrate S is pinched, on the convex part 23 and the concave part 22 formed alternately on the bottom end of the electrode substrate S of the mesh-type electrode, and the electrode

substrate S can be hung without being bound on the electrode holding member 28, 28 and the electrode substrate S can be prevented from swinging without being bound.

The fifth means to solve the problems by the present invention to achieve the
5 afore-mentioned purposes is to provide a hanging method for the mesh-type electrode
substrate, by which in both the top end and the bottom end which is one of the opposing
two sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which
the top face of the convex part 21, 23 projects from the surface of the flat plate part 10
of the substrate S and the concave part 20, 22 in which the bottom face of the concave
10 part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface
of the flat plate part 10 of the substrate S are formed by two or more, respectively, by
bending the top end and the bottom end, and the external surface of the convex part
21,23 and the concave part 20, 22 at the top end and the bottom end are bent so as to
form a zigzag configuration alternately in relative to the front and rear faces of the flat
15 plate part 10; a plurality of the convex part 21 and the concave part 20 formed
alternately on the top end of the electrode substrate S is hung without the electrode
substrate S being bound by the electrode holding member 28, 28, by using the hanging
jig; and the weight member 31, 31 is hung on the convex part 23 and the concave part
22 formed alternately on the bottom end of the electrode substrate S of the mesh-type
20 electrode without the electrode substrate S being bound so as to prevent the electrode
substrate S from swinging.

Advantageous Effects of Invention

According to the present invention, the following advantages are obtained by
25 inserting the electrode substrate into the hanging jig:

- (1) Installation is performed with high working properties,
- (2) Hanging load can be dispersed over the entire width of the electrode, without concentration which could lead to deformation or wrinkling on the electrode substrate being hung, and

- (3) Formation of wrinkle inside the electrode can be reduced compared with the conventional methods, which bind the electrode substrate by welding, since the method by the present invention does not bind the electrode substrate and stress of thermal deformation in longitudinal direction of the hanging jig during the baking process can be easily released through dispersing hanging load.

Brief Description of Drawings

[Fig. 1] Fig. 1 illustrates the first process of an example of the bending method for the mesh-type electrode substrate applying a bending jig for the mesh-type electrode substrate by the present invention.

[Fig. 2] Fig. 2 illustrates the second process of an example of the bending method for the mesh-type electrode substrate applying a bending jig for the mesh-type electrode substrate by the present invention.

[Fig. 3] Fig. 3 illustrates the third process of an example of the bending method for the mesh-type electrode substrate applying a bending jig for the mesh-type electrode substrate by the present invention.

[Fig. 4] Fig. 4 illustrates the fourth process of an example of the bending method for the mesh-type electrode substrate applying a bending jig for the mesh-type electrode substrate by the present invention.

[Fig. 5] Fig. 5 is a perspective view of an example of the mesh-type electrode substrate bent by the bending method for the mesh-type electrode substrate by the present invention.

[Fig. 6(a)] Fig. 6(a) is a perspective view of an example of an upper jig of the hanging jig for the mesh-type electrode substrate by the present invention.

[Fig. 6(b)] Fig. 6(b) is a perspective view of an example of a lower jig of the hanging jig for the mesh-type electrode substrate by the present invention.

[Fig. 7] Fig. 7 is a process drawing of an example of the hanging process of the top end of the mesh-type electrode substrate by the hanging method for the mesh-type electrode substrate by the present invention.

[Fig. 8] Fig. 8 is a process illustration of an example of the hanging process of the bottom end of the mesh-type electrode substrate by the hanging method for the mesh-type electrode substrate and of the weighing process at the bottom end by the present invention.

5 [Fig. 9] Fig. 9 is a perspective view of an electrode substrate being hung by using the hanging jig for the mesh-type electrode substrate by the present invention.

[Fig. 10(a)] Fig. 10(a) is a partial elevation view of the woven plain mesh electrode as an example of the electrode substrate used in the present invention.

10 [Fig. 10(b)] Fig. 10(b) is a partial elevation view of the expanded metal mesh electrode as an example of the electrode substrate used in the present invention.

[Fig. 11(a)] Fig. 11(a) is an elevation view of an example of the mesh-type electrode substrate before the press shaping by the bending method using the bending jig by the present invention.

15 [Fig. 11(b)] Fig. 11(b) is an elevation view of an example of the mesh-type electrode substrate after the press shaping by the bending method using the bending jig by the present invention.

[Fig. 12(a)] Fig. 12(a) is a partial elevation view of the mesh-type electrode substrate as an example of the mesh-type electrode substrate bent by the bending method by the present invention.

20 [Fig. 12(b)] Fig. 12(b) is a partial side view of the mesh-type electrode substrate as an example of the mesh-type electrode substrate bent by the bending method by the present invention.

[Fig. 13] Fig. 13 illustrates an example of the hanging method of the electrode substrate used in the comparative example

25

Description of Embodiments

The embodiments by the present invention are explained, in detail, in the following descriptions in reference to the figures.

(1) Bending jig and bending method

Figs. 1-5 are process drawings showing an example of the bending jig for the mesh-type electrode substrate and the bending method for the mesh-type electrode substrate by the present invention. In Fig.1, the bending unit 1 comprises the flat plate part 2 with at least one pair of the opposing two sides being in parallel, each of which being the top end and bottom end, respectively, and the upper die member 3 is provided to the top end and the lower die member 4 is provided to the bottom end. The top face of the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4 project from the surface of the square flat plate part 2 and the bottom face of the concave part 5, 7 of a pair of the upper die member 3 and the lower die member 4 project from the surface of the square flat plate part 2 in opposite direction to the convex part 6, 8. S indicates the square flat plate mesh-type electrode substrate; 9 indicates the alignment pins which are installed at the both ends of the upper die member 3 provided on the top end of the flat plate part 2 of the bending unit and at the both ends of the lower die member 4 provided on the bottom end of the flat plate part 2 of the bending unit 1; and 10 indicates the flat plate part of the mesh-type electrode substrate S.

As shown in Fig.2, the mesh-type electrode substrate S is placed on the bending unit 1, on which the convex part 6, 8, extending upward from the surface of the flat plate part 2 and the concave part 5, 7, extending downward from the surface of the flat plate part 2 are formed in zigzag configuration. Then, the top end of the flat plate mesh-type electrode substrate S is pressed by the upper guide presser member 11 from its surface against the surface of the top end of the bending unit 1 and the top end of the mesh-type electrode substrate S is pressed to the internal surface of the convex part 6 of the upper die member 3 in zigzag configuration at the top end of the bending unit 1 to bend the top end of the electrode substrate S at 90 degrees upward and lightly outward; the top end of the mesh-type electrode substrate S is placed on the surface of the convex part 6 of the upper die member 3 in zigzag configuration at the top end of the bending unit 1; the bottom end of the mesh-type electrode substrate S is pressed by the lower guide presser member 12 from its surface against the surface of the bottom end of the bending unit 1 and the bottom end of the square plate mesh electrode substrate S is pressed to the

internal surface of the convex part 8 of the lower die member 4 in zigzag configuration at the bottom end of the bending unit 1 to bend the bottom end of the electrode substrate S at 90 degrees upward and lightly outward; and the bottom end of the mesh-type electrode substrate S is placed on the surface of the convex part 8 of the lower die member 4 in zigzag configuration at the bottom end of the bending unit 1.

In place of the upper guide presser member 11 and the lower guide presser member 12, a flat plate which fits between the upper die member 3 and the lower die member 4 can also be inserted.

As shown in Fig.3, the opening 15 provided at the edge of a pair of the rod-type upper pressing member 13 and the lower pressing member 14 of the electrode substrate S is engaged with the alignment pin 9 provided at the upper die member 3 and the lower die member 4 installed to the edges of the flat plate part 2 of the bending unit 1. Then, the convex part 6 and the concave part 5 in zigzag configuration of the upper die member 3 of the top end of the bending unit 1 are fitted with the concave part 17 and the convex part 16 in zigzag configuration on the rod-type upper pressing member 13 and the convex part 8 and the concave part 7 in zigzag configuration of the lower die member 4 of the bottom end of the bending unit 1 are fitted with the concave part 19 and the convex part 18 in zigzag configuration on the rod-type lower pressing member 14. Then, the both upper and lower ends of the electrode substrate S is pressed to the faces of the upper die member 3 and the lower die member 4, and the external surface of the convex part 21, 23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10.

As shown in Fig.4, the press shaping operation is carried out by using the upper compressing roller 24 and the lower compressing roller 25, which run in parallel along the top end and the bottom end of the flat plate part 2.

1) By means of the horizontal guide roller 40 and the vertical press roller 32, installed

on the upper compressing roller 24 and the lower compressing roller 25, the rod-type upper guide presser member 11 and the lower guide presser member 12 are forced to the electrode substrate S to form the right angle section 34, as shown in Fig.5 and Fig.12(b) at the boundary of the flat plate part 10 of the electrode substrate S and the upper die member 3 and the lower die member 4 provided at the top end and the bottom end of the flat plate part 2 of the electrode substrate S.

2) Simultaneously with the shaping of the right angle section 34, by means of the vertical press roller 33 and the horizontal guide roller 41 installed on the upper compressing roller 24 and the lower compressing roller 25, the rod-type upper pressing member 13 and the rod-type lower pressing member 14 are pressed to the electrode substrate S to form the mesh-type electrode substrate S, as shown in Fig.5, having, in zigzag configuration, the convex part 21, 23 extending upward from the surface of the flat plate part 10 of the electrode substrate S and the concave part 20, 22 extending downward from the surface of the flat plate part 10 of the electrode substrate S.

As an example of the present invention, a plain woven mesh-type electrode substrate prepared by using a wire with a diameter of 0.1 mm-0.3 mm, nominal size of mesh being 30-50 was applied, but the examples do not serve to limit the scope of the invention in any way.

Fig. 11(a) is an elevation view of an example of the mesh-type electrode substrate before the press shaping by the bending method by the present invention. The top end of the mesh-type electrode substrate S is inserted between the upper die member 3 provided to the flat plate part 2 and the upper pressing member 13.

Fig. 11(b) is an elevation view of an example of the mesh-type electrode substrate after the press shaping by the bending method by the present invention.

It is preferable that the inside width (a) of the concave part 5 of the upper die member 3 is 100 mm-200 mm, the outside length (b) of the concave part 5 of the upper die member 3 is +20 mm-50 mm to the inside width (a) of the concave part 5, the height (h) of the concave and convex is 3 mm-10 mm, the length (P) between the centers of

concave and convex is 250 mm-350 mm. Since the outside length (b) of the concave part 5 of the upper die member 3 is +20 mm-50 mm of the inside width (a) of the concave part 5, the top end of the mesh-type electrode substrate S inserted between the upper die member 3 provided at the top end of the flat plate part 2 and the upper pressing member 13 is prolonged at the edge in the concave part 5 of the upper die member 3 by press shaping, and formed diagonally, as shown in Fig.11 (b).

Meantime, the state of fitting between the lower die member 4 provided at the bottom end of the flat plate part 2 and the lower pressing member 14 is similar, and therefore the bottom end of the mesh-type electrode substrate inserted between the lower die member 4 at the bottom end of the flat plate part 2 and the lower pressing member 14 is similarly formed in shape to the top end of the mesh-type electrode substrate S.

The upper die member 3 provided at the top end of the flat plate part 2 and the lower die member 4 at the bottom end of the flat plate part 2 of the bending jig for the mesh-type electrode substrate by the present invention is preferably aluminum. The material for the rod-type upper pressing member 13 and the lower pressing member 14 can be either impact-resistant vinyl chloride or aluminum. Impact-resistant vinyl chloride with flexibility is suitable to press working by simple roller movement and was applied in the present trial manufacturing. On the other hand, aluminum is high in rigidity, which does not allow easy operation of press shaping for the present case and requires a press system that pushes the whole jig at a time.

In case of stainless steel, machining degree in thickness is large in view of jig dimensions, causing a large thermal deformation and therefore, stainless steel is not suitable for the upper die member 3 provided at the top end of the square flat plate part 2, the lower die member 4 provided at the bottom end of the square flat plate part 2, and a pair of upper and lower rod-type pressing member 13, 14.

(2) Hanging jig and hanging method

Figs. 6-9 are the process views of an example of the hanging jig for the mesh-type electrode substrate S and the hanging method for the mesh-type electrode substrate using the hanging jig by the present invention.

Fig. 6(a) shows an example of the upper jig 26 of the hanging jig by the present invention. The gap at the gap 27 of the electrode holding member 28, 28 is adjusted to a width which can hold the electrode substrate S without binding, in a state that the vicinity of the top end of the electrode substrate S is pinched, by a plurality of the convex part 21 and the concave part 20 formed alternately on the top end of the electrode substrate S. Namely, it is configured that the flat plate part 10 of the electrode substrate S of the mesh-type electrode is inserted into the gap 27 of the electrode holding member 28, 28, and is hung by the upper jig 26 at the convex part 21 projecting from the surface of the flat plate part 10 of the electrode substrate S on the top end of the electrode substrate S and the concave part 20 projecting in the opposite direction of the convex part 23 from the surface of the flat plate part 10 of the electrode substrate S on the top end of the electrode substrate S, formed in zigzag configuration.

Fig. 6(b) illustrates an example of the lower jig 29 of the hanging jig by the present invention. The gap at the gap 30 of the weight member 31, 31 is adjusted to a width which can hang the weight member 31, 31 without binding the electrode substrate S, in a state that the bottom end of the electrode substrate S is pinched, and the weight member 31, 31 is hung on the convex part 23 and the concave part 22 formed alternately on the bottom end of the electrode substrate S of the mesh-type electrode. Namely, the flat plate part 10 of the electrode substrate S of the mesh-type electrode is pinched in the gap 30 and the lower jig 29 comprising the weight member 31, 31 by two plates is hung on the convex part 23 projecting from the surface of the flat plate part 10 of the electrode substrate S and the concave part 22 projecting in the opposite direction of the convex part 23 from the surface of the flat plate part 10, formed in zigzag configuration on the bottom end of the electrode substrate S.

As shown in Fig.7 and Fig.8, the square flat plate part 10 of the electrode substrate S

is inserted into the gap 27 of the electrode holding member 28, 28 of the upper jig 26, the concave part 20 and the convex part 21 in zigzag state formed on the top end of the electrode substrate S are hung without binding the electrode substrate S; and the square flat plate part 10 of the electrode substrate S is inserted into the gap 30 of the weight member 31, 31 of the lower jig 29 so that the lower jig 29 hung on the concave part 22 and the convex part 23 formed in zigzag configuration at the bottom end of the electrode substrate S without binding the electrode substrate S functions as a weight to prevent the electrode substrate S from swinging. Fig. 9 is a perspective view of an electrode substrate S being hung by using the hanging jig comprising the upper jig 26 and the lower jig 29 for the mesh-type electrode substrate by the present invention.

Various kinds of construction can be applied for the upper jig 26 which hangs down the electrode substrate S at the concave part 20 and the convex part 21 formed in zigzag configuration at the top end of the electrode substrate S and the lower jig 29 which are provided with the concave part 22 and the convex part 23 formed in zigzag configuration at the bottom part of the electrode substrate S to prevent the electrode substrate S from swinging, without the electrode substrate S being bound.

As afore-mentioned, the hanging jig for the electrode substrate of the mesh-type electrode by the present invention can disperse hanging load and suppress thermal deformation in the baking process, minimizing wrinkle generation and breaking, under high working properties.

Because of a construction that the electrode substrate is inserted only, the hanging jig is provided with a suitably narrow gap for the gap 27, 30 so that the electrode substrate does not slip down through the gap of the hanging jig during the manufacturing of the electrode; in other words, any force to deform the press shaping part of the electrode substrate edge should not be applied; and the insertion should be carried out smoothly. The gap 27, 30 should be the gap through which the square flat plate part 10 of the electrode substrate S can be inserted smoothly. If the gap is wide,

the electrode A may slip down from the hanging jig. The gap is preferably 0.5 mm-1.5 mm.

Moreover, as afore-mentioned, any force to deform the press shaping part at the edge of the electrode substrate S should not be applied, and therefore, the corner of the electrode holding member 28, 28 and the weight member 31, 31 at which the right angle section 34 of the press shaping part at the edge of the electrode substrate S touches should be at right angle without chamfering. On the other hand, the entry should be chamfered for smooth insertion of the electrode substrate S.

10 Examples

The following explains examples of the present invention; however, the present invention shall not be limited to these examples.

<Example 1>

15 As the mesh-type electrode (object electrode), the woven plain mesh electrode of wires with a small diameter illustrated in Fig.10 (a) was used.

Material of the electrode substrate S : Nickel

Size of the electrode substrate S: 2500W×1 000L (mm)

Wire diameter of the electrode substrate: 0.20 mm dia.(Refer to Fig. 10(a).)

20 Nominal size of the mesh ¹⁾: 35

¹⁾ : the number of wires or meshes in 25.4 mm (1 inch) span

This mesh-type electrode substrate was bent by the method shown in Figs.1-4 using the edge bending jig for the mesh-type electrode substrate and suspended by the method shown in Figs.6-9 using the hanging jig for the mesh-type electrode substrate.

25 A plurality of the mesh-type electrodes were treated as follows on a hanger.

- Etching : HCl x 3 min.
- Coating solution : platinum group-metal salt solution
- Baking

Baking temperature : 400-600 degrees C.

Baking time : 1 0 min.-40 min.

Remarks: The bent part of the electrode edge was cut off at the last process.

The quality of the bent edge shape of the electrode substrate is affected by the basic dimensions of the bending jig, as shown below. To obtain the basic dimensions, two kinds of bending jigs were prepared and used for bending the edge of the electrode substrate for comparison. (Refer to Fig.11.)

Table 1 shows basic dimensions of the bending jig.

Table 1				(mm)
	P	a	b	h
Sample A	310	140	170	6
Sample B	274	126	148	6

The results obtained from the bending of the electrode substrate edge using the bending jig showed that Sample A could suppress the occurrence of wrinkle by bending more than Sample B, because Sample A having a longer P (pitch) had less number of bending per unit length. From these results, the dimensions of Sample A were applied as the basic dimension of the bending jig.

Also, from these results from Sample A, the standard shape ratios of the hanging jig were as mentioned below. Figs.12(a) and 12(b) show an example of the electrode substrate edge formed by the electrode substrate bending jig. The shape ratios of the following maintained a stable hanging state in the whole processes including the baking process in the present trial manufacturing.

- Stretching ratio ($= A' / A$) : approx. 1.00745
- Bending ratio ($= A : B : C$) : 155(1) : 15(0.0968) : 6(0.0387)
- Bending angle : 90 degrees

, where A is the pitch from the top to the bottom of the electrode substrate formed by bending, A' is the length after the bending, B is the longitudinal dimension of the bent

portion, and C is the dimension in right angle to the longitudinal bent portion. It has been demonstrated that these figures are properly adopted as the criteria to specify the shape of the electrode substrate bending jig.

5 <Example 2>

When an expanded metal mesh electrode, as shown in Fig.10 (b) was used in lieu of the woven plain mesh electrode of wires with a small diameter, as a mesh-type electrode as shown in Fig.10(a) of Example 1, similar results to those from Example 1 were obtained. In the case of Fig.10 (b), the applied mesh has the following specifications.

- 10 • Plate thickness T : 0.1 mm - 0.3 mm
 • Notch width W: 0.1 mm - 0.3 mm

<Comparative Example 1 >

For the woven plain mesh electrode of wires with a small diameter shown in Fig.10
15 (a) and the expanded metal mesh electrode shown in Fig.10 (b), used in Example 1 and Example 2, respectively, a plurality of holes 36 were provided at the hanging jig 35, through which wires or the hook 37 were threaded to hang the electrode substrate S for operations including etching, coating, and baking. As a result, deformation or wrinkle occurred at the hanging part, and also deformation during baking and swinging during
20 operations were observed and the electrodes were not able to be used as product.

Industrial applicability

The edge bending jig for the mesh-type electrode substrate, the hanging jig for the mesh-type electrode substrate, and the hanging method for the mesh-type electrode
25 substrate by the present invention can offer the following advantages by inserting the electrode substrate into the hanging jig: high working properties are achieved; hanging load, which causes deformation or wrinkle can be dispersed over the entire electrode width; the electrode substrate is not bound; thermal deformation in a longitudinal direction is released by dispersing hanging load during the baking process, suppressing

and the occurrence of wrinkle inside the electrode is suppressed. These advantages allow the technologies by the present invention to be applied to various kinds of mesh-type electrodes.

5 Reference Signs List

- S: square plate mesh electrode substrate
- 1 : bending unit
- 2: square flat plate part of the bending unit 1
- 3: upper die member
- 10 4: lower die member
- 5: concave part
- 6: convex part
- 7: concave part
- 8: convex part
- 15 9: alignment pin at the both ends of the upper die member 3 provided at the top end of the square flat plate part 2 and the lower die member 4 provided at the bottom end of the square flat plate part 2.
- 10: flat plate part of electrode substrate S
- 11 : upper guide presser member
- 20 12: lower guide presser member
- 13: rod-type upper pressing member
- 14: rod-type lower pressing member
- 15: opening to engage with alignment pin 9 provided at the both ends of the upper pressing member 13 and the lower pressing member 14
- 25 16: convex part
- 17: concave part
- 18: convex part
- 19: concave part
- 20: concave part

- 21 : convex part
- 22: concave part
- 23: convex part
- 24, 25: compressing roller
- 5 26: upper jig
- 27: gap
- 28, 28: electrode holding member
- 29: lower jig
- 30: gap
- 10 31, 31 : weight member
- 32: vertical press roller
- 34: right angle section
- 35: conventional hanging jig
- 36: a plurality of openings made in the hanging jig
- 15 37: wire or hook
- 40: horizontal guide roller
- 41: horizontal guide roller

CLAIMS

[Claim 1]

An edge bending jig for the mesh-type electrode substrate for processing the mesh-type electrode substrate by bending, by which in both the top end and the bottom end which is one of the opposing two sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by bending the top end and the bottom end, and the external surface of the convex part 21, 23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10 comprising: a bending unit 1 with a square flat plate part 2 and the top end and the bottom end on any one of the opposing two sides of the square flat plate part 2, respectively, a pair of rod-type upper pressing member 13 and the lower pressing member 14 provided with the convex part 16, 18 and the concave part 17, 19 having a configuration to engage, respectively, with the concave part 5, 7 and the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4, which are provided with the concave part 5, 7 and the convex part 6, 8 formed alternately on the top end and the bottom end of the bending unit 1, respectively; and a press shaping means to press to engage the convex part 16, 18 and the concave part 17, 19 of a pair of the rod-type upper pressing member 13 and the lower pressing member 14 with the concave part 5, 7 and the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4 of the bending unit 1 in a state that the mesh-type electrode substrate S is placed on the bending unit 1 and characterized in that the top face of the convex part 6, 8 of a pair of the upper die member 3 and the lower die member 4 project from the surface of the square flat plate part 2 and the bottom face of the concave part 5, 7 of a pair of the upper die member 3 and the lower die member 4 project from the surface of

the square flat plate part 2 in opposite direction to the convex part 6, 8.

[Claim 2]

The edge bending jig for the mesh-type electrode substrate as in claim 1, in which an
5 alignment pin 9 is provided to the top face of the respective both ends of a pair of the
upper die member 3 and the lower die member 4, and the opening 15 is provided to be
engaged with the alignment pin 9 to the respective both ends of the rod-type upper
pressing member 13 and the lower pressing member 14, so that the upper and the lower
both ends of the mesh-type electrode substrate S are bent for press shape processing with
10 the alignment pin 9 engaged with the opening 15.

[Claim 3]

The edge bending method using the edge bending jig as in claim 1 or 2,
by which in both the top end and the bottom end which is one of the opposing two sides
15 of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top
face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the
substrate S and the concave part 20, 22 in which the bottom face of the concave part 20,
22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat
plate part 10 of the substrate S are formed by two or more, respectively, respectively, by
20 bending the top end and the bottom end, and the external surface of the convex part 21,
23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a
zigzag configuration alternately in relative to the front and rear faces of the flat plate part
10.

25 [Claim 4]

A hanging jig for the mesh-type electrode substrate,
by which in both the top end and the bottom end which is one of the opposing two sides
of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top
face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the

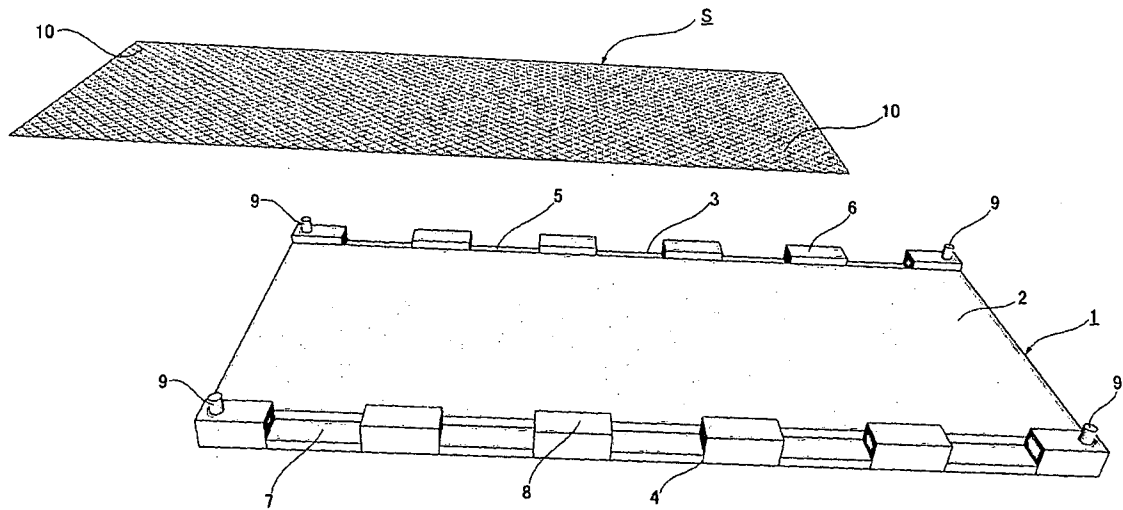
substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by bending the top end and the bottom end, and the external surface of the convex part 21, 23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately in relative to the front and rear faces of the flat plate part 10 comprising: the upper jig 26 having the electrode holding member 28, 28 comprising two plates in parallel with the gap 27 at the center, which is a little wider than the thickness of the flat plate part 10 of the electrode substrate S and the lower jig 29 having the weight member 31, 31 comprising two plates in parallel with the gap 30 at the center, which is a little wider than the thickness of the flat plate part 10 of the substrate S, and having the construction that the gap at the gap 27 of the electrode holding member 28, 28 is adjusted to a width which can hold the electrode substrate S without binding, in a state that the vicinity of the top end of the electrode substrate S is pinched, by a plurality of the convex part 21 and the concave part 20 formed alternately on the top end of the electrode substrate S, and the gap at the gap 30 of the weight member 31, 31 is adjusted to a width which can hang the weight member 31, 31 without binding the electrode substrate S, in a state that the bottom end of the electrode substrate S is pinched, on the convex part 23 and the concave part 22 formed alternately on the bottom end of the electrode substrate S of the mesh-type electrode, and the electrode substrate S can be hung without being bound on the electrode holding member 28, 28 and the electrode substrate S can be prevented from swinging without being bound.

[Claim 5]

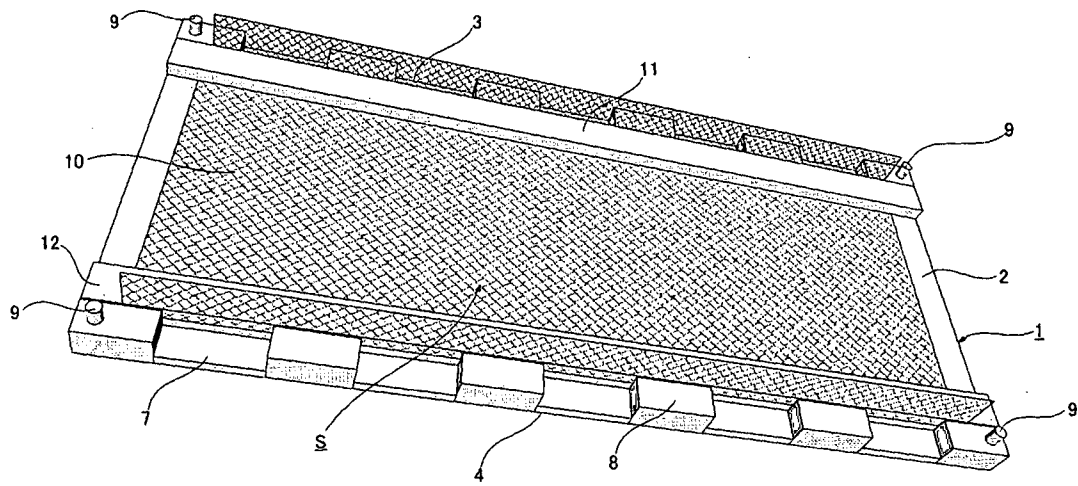
The hanging method for the mesh-type electrode substrate, by which in both the top end and the bottom end which is one of the opposing two sides of the square plate mesh electrode substrate S, the convex part 21, 23 in which the top face of the convex part 21, 23 projects from the surface of the flat plate part 10 of the substrate S and the concave part 20, 22 in which the bottom face of the concave part 20, 22 projects in the opposite

direction of the convex part 21, 23 from the surface of the flat plate part 10 of the substrate S are formed by two or more, respectively, by bending the top end and the bottom end, and the external surface of the convex part 21,23 and the concave part 20, 22 at the top end and the bottom end are bent so as to form a zigzag configuration alternately
5 in relative to the front and rear faces of the flat plate part 10; a plurality of the convex part 21 and the concave part 20 formed alternately on the top end of the electrode substrate S is hung without the electrode substrate S being bound by the electrode holding member 28, 28, by using the hanging jig as in claim 4; and the weight member 31, 31 is hung on the convex part 23 and the concave part 22 formed alternately on the bottom end
10 of the electrode substrate S of the mesh-type electrode without the electrode substrate S being bound so as to prevent the electrode substrate S from swinging.

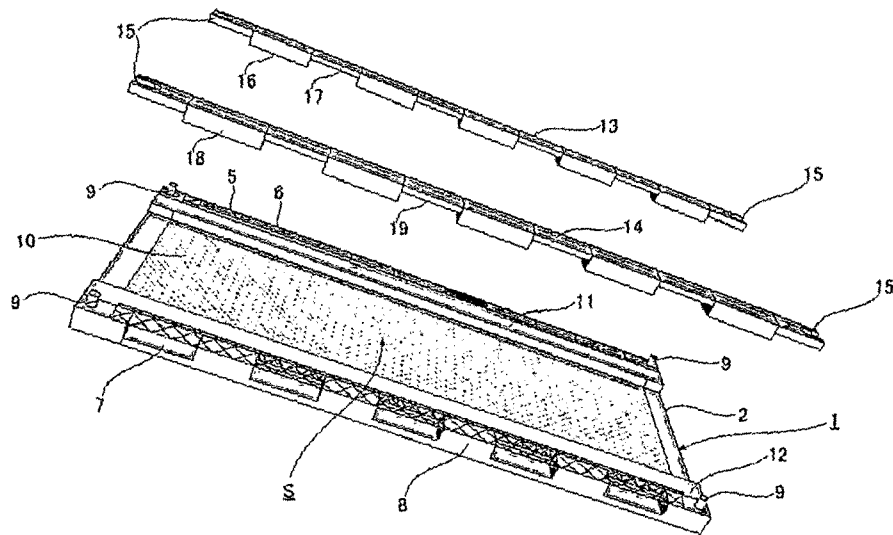
[Fig. 1]



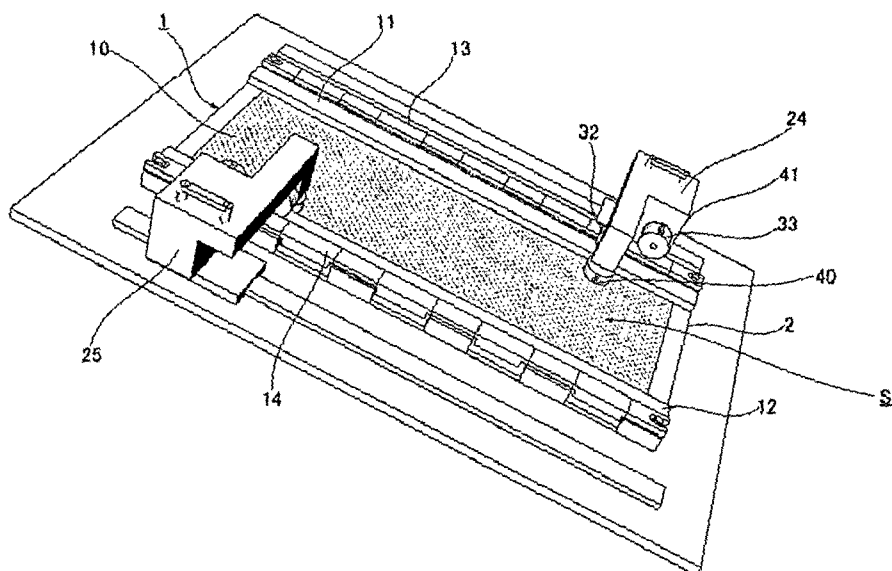
[Fig. 2]



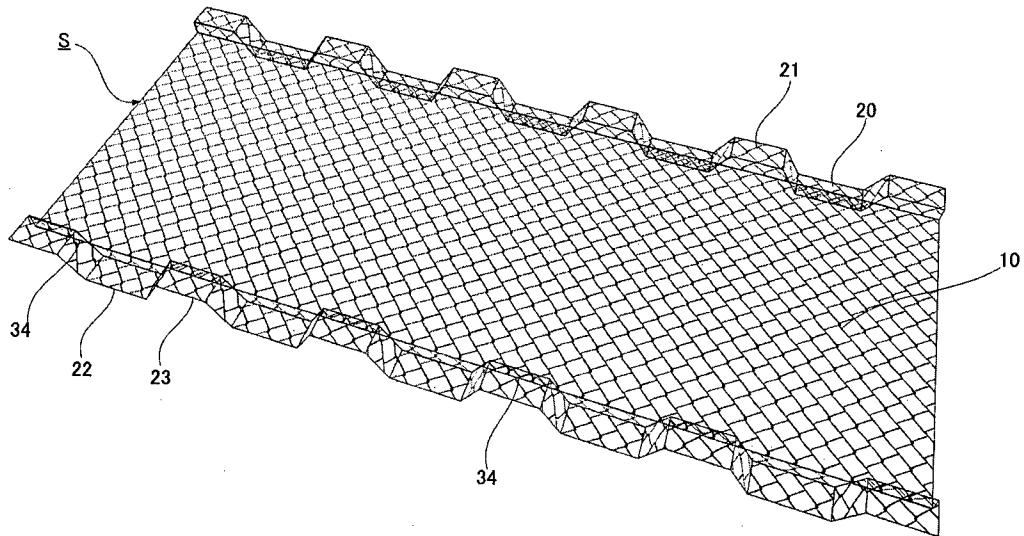
[Fig. 3]



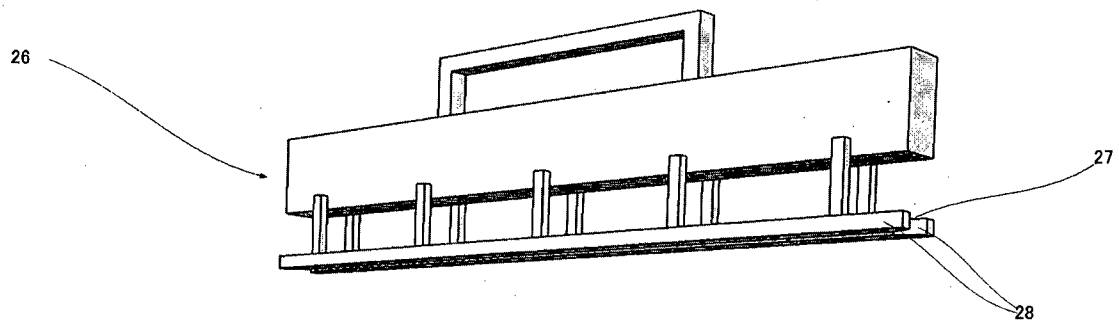
[Fig. 4]



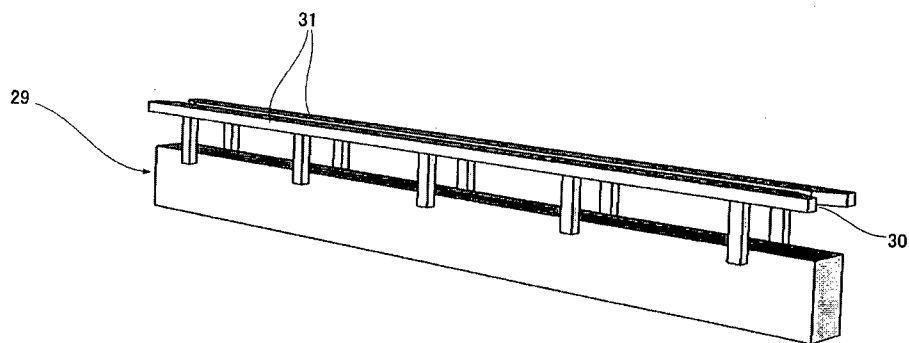
[Fig. 5]



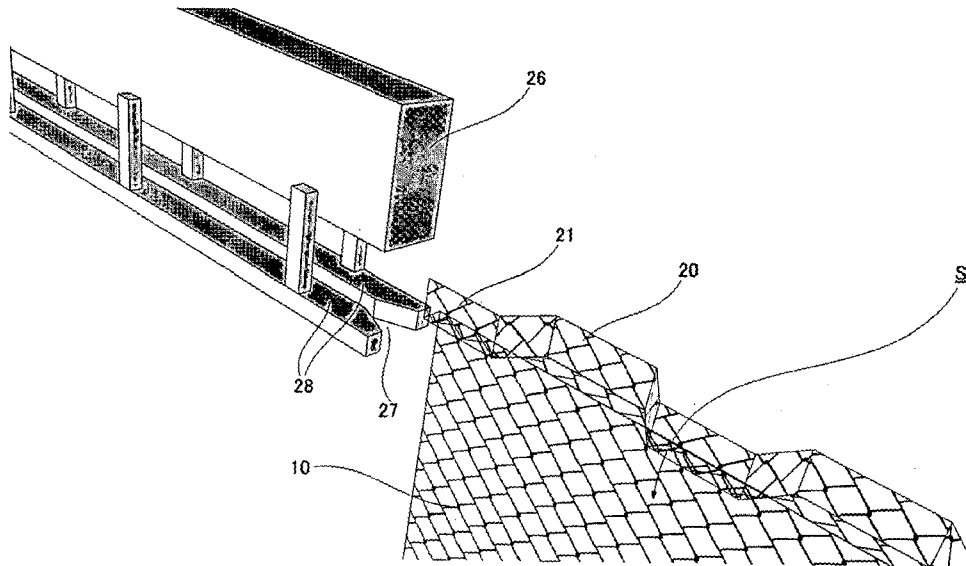
[Fig. 6(a)]



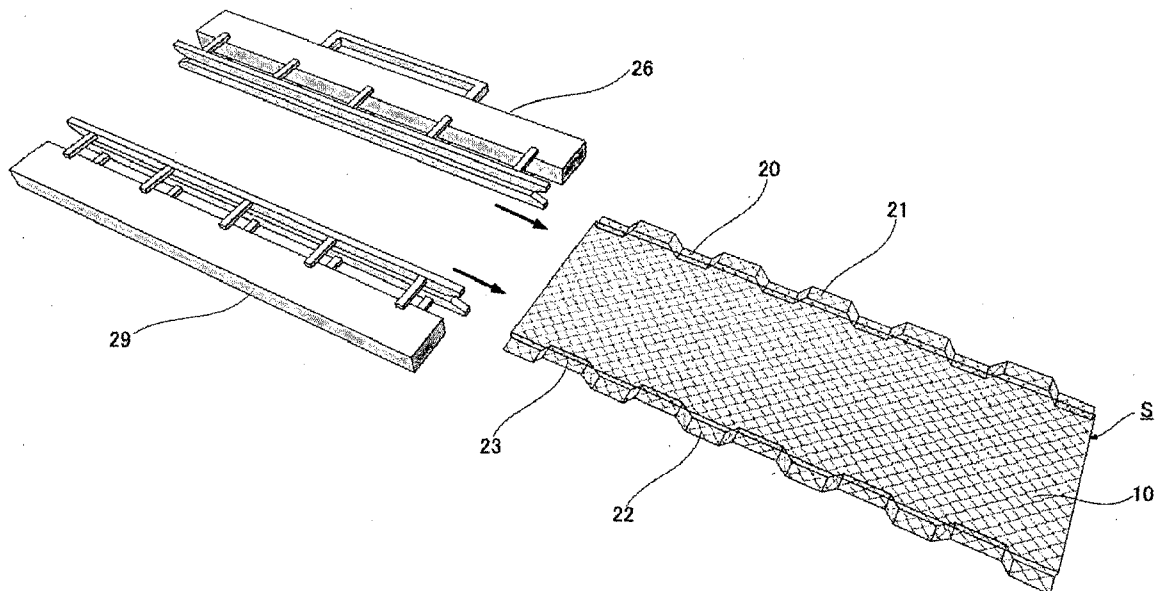
[Fig. 6(b)]



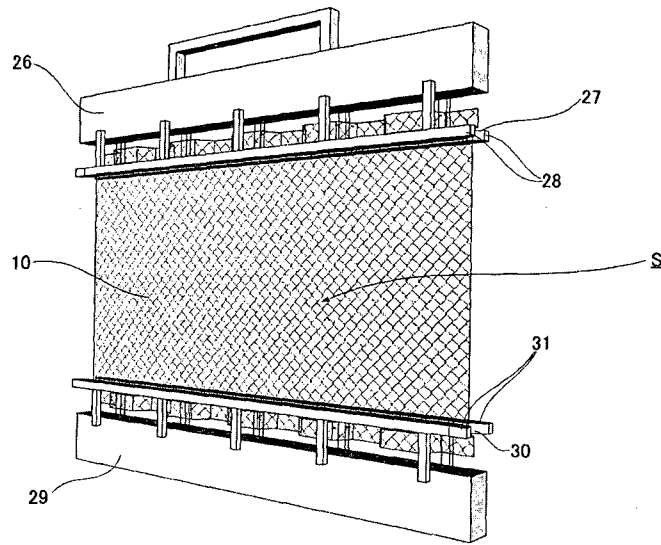
[Fig. 7]



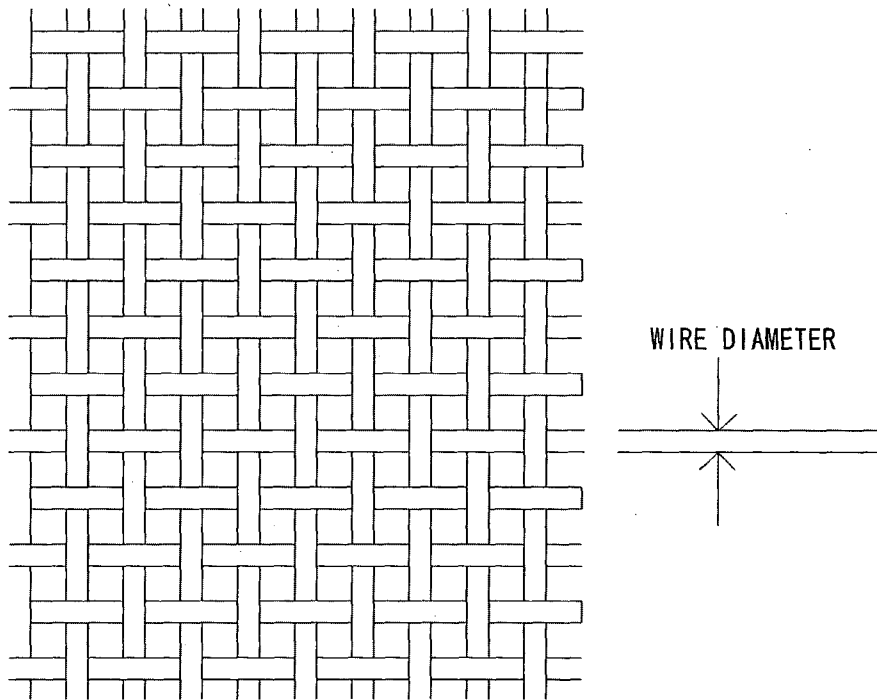
[Fig. 8]



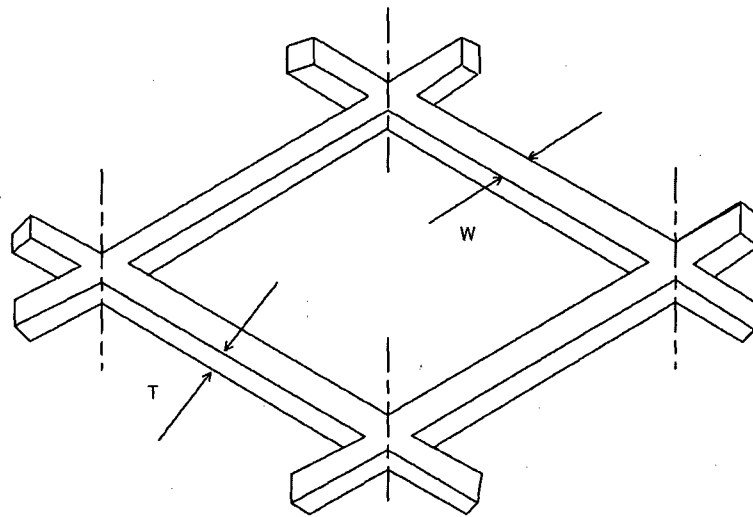
[Fig. 9]



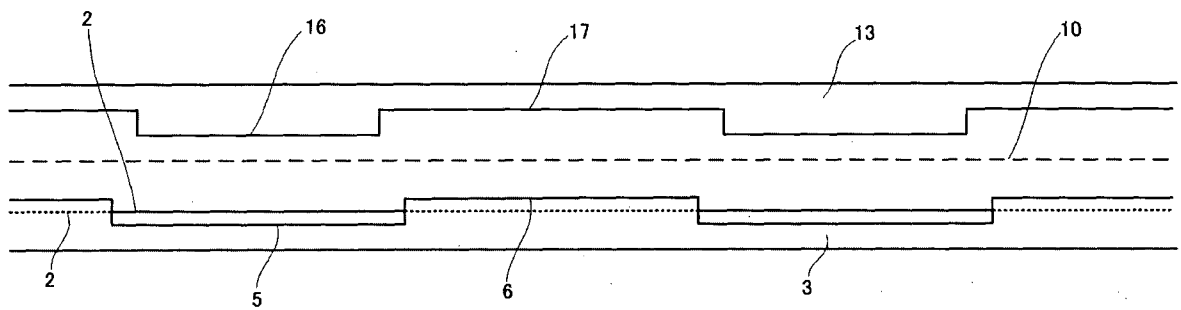
[Fig. 10(a)]



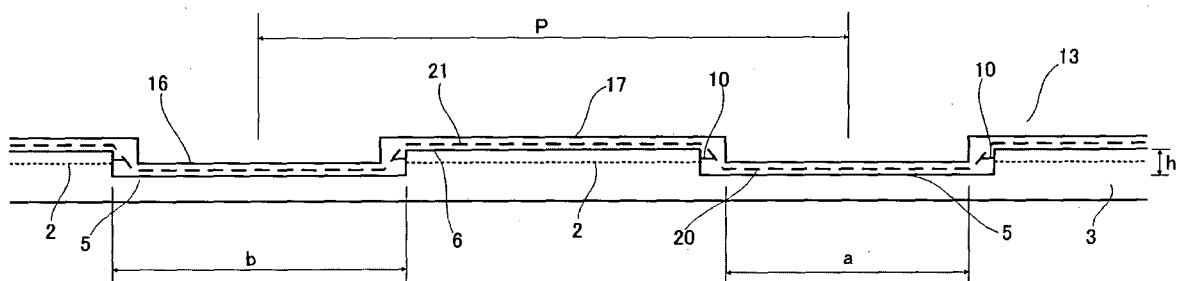
[Fig. 10(b)]



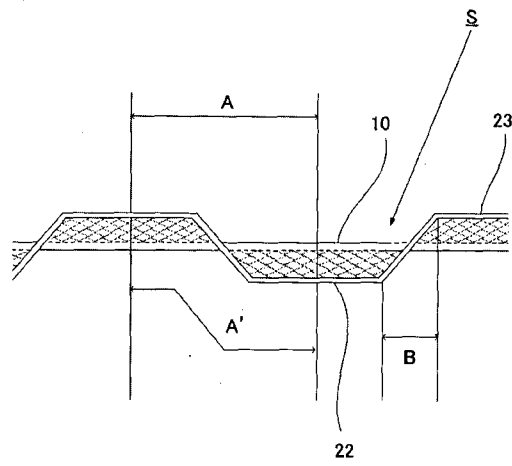
[Fig. 11(a)]



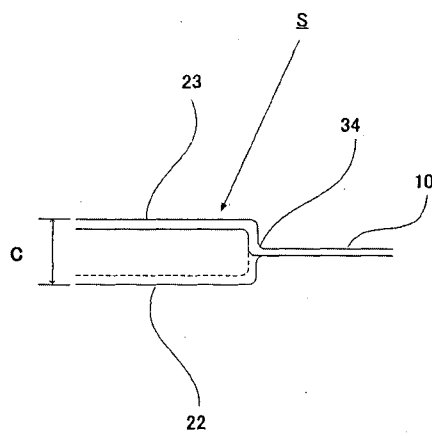
[Fig. 11(b)]



[Fig. 12(a)]



[Fig. 12(b)]



[Fig. 13]

