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71 Applicant: **ASK CORPORATION**
5-5, Tsurumichuo 2-chome Tsurumi-ku
Yokohama-shi Kanagawa-ken(JP)

72 Inventor: **Kusunoki, Kokyo**
596-172 Ushikucho
Ushiku-shi, Ibaragi-ken(JP)
Inventor: **Suzuki, Hiroshi**
975-1 Miyazawacho, Seya-ku
Yokohama-shi, Kanagawa-ken(JP)
Inventor: **Morohashi, Kenji**
13-1 Tokodai 4-chome
Ishioka-shi, Ibaragi-ken(JP)
Inventor: **Akimoto, Yukio**
15-1 Ichikawa 2-chome
Ichikawa-shi, Chiba-ken(JP)

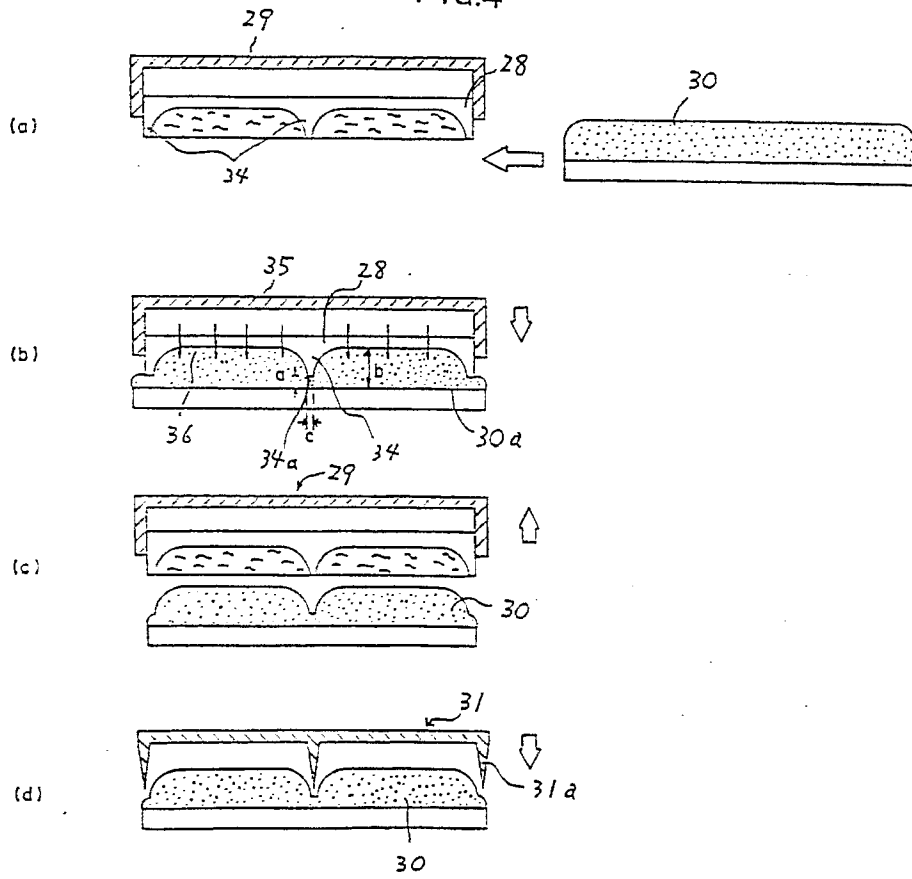
74 Representative: **Strehl, Schübel-Hopf,**
Groening
Maximilianstrasse 54 Postfach 22 14 55
D-8000 München 22(DE)

54 **Inorganic cured shape and method of producing the same.**

57 In the production of inorganic cured shapes for use as roofing, exterior walls, and interior walls, an inorganic molded material is formed and patterned using an air-permeable molding die (29, 28) to improve their releasability. The molded material (30) is pressure molded using a molding die having a projection (34) which forms a groove. Thereafter, these shapes are cut along the groove by a cutter (31). If a slit portion is formed in the inorganic molded material, a cutter or a cutter blade unit having a pusher cuts or punches the inorganic molded material to produce the shapes having cutting grooves on the surface, whereby the shapes are easy to handle and have good workability.

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FIG.4



Inorganic Cured Shape and Method of Producing the Same

Field of the Invention

This invention relates to an inorganic cured shape which is used as, for example, roofing, exterior walls, and interior walls, and a method for producing the same.

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Background of the Invention

Heretofore, inorganic cured materials used in roofing, exterior walls and interior materials have been produced from a water-curable inorganic composition mainly comprising cement, gypsum, and the like, which is molded by sheeting, extrusion molding, semi-dry molding, or the like, with or without subsequent pressure molding, to obtain an inorganic molding, which is further divided or cut into desired shapes, and then cured.

However, the prior art method for producing inorganic cured shapes has the following problems:

- (1) poor releasing from molding dies when an uncured inorganic molding material is molded,
- (2) when an uncured inorganic molding material is molded and cut, cracking tends to occur in the molding material,
- (3) when a slit is formed in an uncured inorganic molded material, the cutter blade tends to be warped or damaged, making it difficult to continue the production for an extended period of time, and
- (4) In the production of prior art inorganic cured materials, the material is cut into final shapes in the stage of an inorganic molded material, which are then cured one by one, requiring a tedious work, and when the inorganic cured materials are used in construction, these materials must be handled sheet by sheet, resulting in low efficiency.

With a view to eliminate the above-described prior art problems, it is a primary object of the present invention to provide an inorganic cured shape, and a method for producing it, which has good releasability and cutting properties when the shape is pressure molded prior to hardening and curing, thereby improving its handling efficiency and workability.

Summary of the Invention

In accordance with the present invention, the foregoing objects are attained by a first method for producing inorganic cured shapes by pressure molding a mixture comprising a water-curable inorganic composition by means of a molding die to obtain an inorganic molded material, and hardening and curing the inorganic molded material characterized in that at least a portion of the molding die contacting the material is air-permeable and, prior to hardening and curing the inorganic molded material, air is passed through the air-permeable material to an interface between the material and the portion of the molding die contacting the material, whereby the inorganic molded material is released from the molding die.

There is also provided, according to the present invention, a second method for producing inorganic cured shapes by pressure molding a mixture comprising a water-curable inorganic composition by means of a molding die, and hardening and curing the inorganic molded material, characterized in that, prior to hardening and curing the inorganic molded material, a pattern is provided on the surface of the inorganic molded material as needed, the mixture is pressure molded using a molding die having a projection to form a diagonal cut edge, and the inorganic molded material is cut using a cutter along a groove formed by a projection of the molding die.

There is further provided, according to the present invention, a third method for producing inorganic cured shapes by pressure molding a mixture comprising a water-curable inorganic composition by means of a molding die to obtain an inorganic molded material, and hardening and curing the inorganic molded material, characterized in that, prior to hardening and curing the inorganic molded material, the inorganic molded material is cut using a cutter comprising a pair of parallel blades to form a slit of a predetermined width. There is also provided a pusher movable in the slit in the moving direction of the blades and having nearly the same size as the blades in the width direction of the slit, which ejects cutting debris by movement of the pusher in the slit.

There is further provided, according to the present invention, a fourth method for producing inorganic cured shapes by pressure molding a mixture comprising a water-curable inorganic composition by means

of a molding die to obtain an inorganic molded material, and hardening and curing the inorganic molded material, characterized in that, prior to hardening and curing the inorganic molded material, a plurality of holes or grooves is discontinuously formed along the boundary between a slit removal portion in the inorganic molded material and a main portion of the inorganic molded material to form a slit. A cutter blade unit is used which has blades arranged in two rows along the longitudinal direction of the slit removal portion, the blades being offset from each other across the two rows of blades.

There is further provided, according to the present invention, a fifth method for producing inorganic cured shapes by pressure molding a mixture comprising a water-curable inorganic composition by means of a molding die to obtain an inorganic molded material, and hardening and curing the inorganic molded material, characterized in that, prior to hardening and curing the inorganic molded material, a plurality of holes or grooves is discontinuously formed in the inorganic molded material along a boundary between a slit removal portion and a main portion of the inorganic molded material to form a slit, by cutting one of two rows of the boundary along the longitudinal direction of the slit removal portion using one of cutter blade units, and then cutting the other of the two rows of the boundary using the other of the cutter blade units.

In accordance with the present invention, there is provided a first inorganic cured shape produced by pressure molding and curing a mixture comprising a water-curable inorganic composition, having grooves for fracture formed on the surface of the inorganic cured shape.

There is also provided, according to the present invention, a second inorganic cured shape produced by pressure molding and curing a mixture comprising a water-curable inorganic composition, having an integral slit removal portion adapted to form a slit in at least part of the inorganic cured shape, and a plurality of holes or grooves discontinuously formed in the inorganic molded material along a boundary between the slit removal portion and a main portion of the inorganic cured shape.

Brief Description of the Drawings

Fig.1 is a schematic cross sectional view of the molding die used in the flat press method of the present invention;

Fig.2 is a schematic enlarged view of the air-permeable material;

Figs.3(a) to 3(c) are schematic views showing the molding die used in the roll press method;

Figs.4(a) to 4(d) are schematic views showing the pressure molding process according to one embodiment of the present invention;

Fig.5 is a schematic perspective view showing the inorganic molded material;

Fig.6 and Fig.7 are respectively schematic cross sectional views of molding dies used in test examples;

Fig.8 is a schematic perspective view of a molding die viewed from the back;

Fig.9 is a schematic view showing the pressure molding and cutting process of the mixture;

Fig.10 is a schematic view showing a prior art pressure molding and cutting process;

Fig.11 is a schematic view showing the cutting step;

Figs. 12(a) to 12(d) are schematic views showing the cutting;

Fig. 13 is a schematic plan view of an inorganic cured shape;

Fig.14 is a schematic view showing a prior art method of formation of a slit in the inorganic molded material;

Fig.15 is a schematic perspective view showing cutter blades used to form holes in the inorganic molded material;

Figs.16 to 18 are schematic views showing slit formation according to the first method of the present invention;

Fig.19 is a schematic perspective view showing an inorganic molded material provided with fine circular perforations;

Fig.20 is a schematic perspective view showing an inorganic molded material provided with grooves;

Figs.21 to 26 are schematic views showing an example of slit formation according to the second method of the present invention;

Fig.27 is a schematic perspective view showing an inorganic cured shape according to the present invention;

Fig.28 is a schematic enlarged sectional view of part of the shape of Fig.27;

Fig.29 is a schematic perspective view showing an inorganic cured shape according to another embodiment of the present invention;

Fig.30 is a schematic enlarged sectional view of part of the shape of Fig.29;

Fig.31 is a schematic plan view of another inorganic cured shape according to the present invention.

Detailed Description of the Invention

5 In the present invention, the inorganic cured shapes refer to shapes such as those used in roofing, for exterior walls, and as interior materials, which are produced from a water-curable inorganic composition comprising cement and gypsum as main raw materials. The composition may be mixed as needed with silica-based material, a lime-based material, a reinforcing materials, aggregates, water-reducing agents, thickening agents, and the like, and is extrusion molded into a green sheet. Alternatively, it may be in the
10 form of a kneaded material, directly press molded by a molding die to obtain the inorganic molded material, which is then hardened and cured.

The mixed and kneaded material of the present invention refers to a material obtained by adding water in an appropriate amount to the water-hardenable inorganic composition, formed by various methods.

15 In the present invention, the porous material of which the portion of the molding die contacting the green sheet is composed comprises mainly sintered powder, resulting in an aggregate having numerous capillaries communicating with each other. For example, the porous material includes air-permeable ceramics, metal fine powders, and air-permeable sintered metals.

The air-permeable material, for example; an air-permeable sintered ceramic, is obtained by mixing a ceramic powder with a metal powder and a fiber, followed by sintering. A Suitable air-permeable sintered
20 metal is obtained by firing bronze or stainless steel powder. Both of these materials contain numerous pores 1 to 25 μ m in size formed during the firing process, which allow air to pass evenly, and can be further provided with fine patterns such as stone grain or wood grain on the die surface, which can be precisely transferred to the molded products. The air-permeable sintered metal can be welded to other metals and is thus superior in processability to the air-permeable sintered ceramic.

25 The molding die used in the present invention provides shaping and/or patterning of the water-hardenable inorganic composition, or a green sheet which is primarily formed into a plate after kneading. The kneaded material can be used in press molding processes such as flat pressing and roll pressing of ceramic materials.

The portion of the molding die contacting the kneaded material is the portion which closely and directly
30 contacts the material to be molded to provide the inorganic molded material with a pattern or the like. In the present invention, the contacting portion, at least in part, is composed of the air-permeable material, which is used in the press molding process.

Fig.1 and Fig.3(a) and 3(b) show examples of molding dies which use the air-permeable material.

Fig.1 is a schematic cross sectional view showing a molding die used in the flat pressing process.
35 Fig.3(a) is a schematic view showing a molding die used in the roll pressing process, and Fig.3(b) is a schematic cross sectional view of the die.

Referring to Fig.1, a molding die 10 comprises a green sheet contacting portion 12 which contacts a green sheet 11 and is made of the air-permeable material. An air chamber covers the entire green sheet contacting portion 12, and an air supply unit 15 introduces air into the air chamber 13 through a supply pipe
40 14, whereby the green sheet 11 which is transported by elevating means (not shown) is press molded.

Fig.2 is a schematic view showing the air-permeable material used in the green sheet contacting portion 12. This material is an aggregate of capillaries 17 formed by sintering, and air can be freely supplied through pores 18 of the capillaries 17.

45 When flat pressing is performed using the molding die 10 having the green sheet contacting portion 12, air can be supplied to air chamber 13 simultaneously with - or a little before - the completion of pressing to supply air to contact interface 16 between green sheet contacting portion 12 and green sheet 11, thereby releasing green sheet 11. The air pressure depends on the raw material and can be appropriately set according to the release condition of the material to be molded.

The molding die using the inventive air-permeable material in the kneaded material contacting portion
50 has good releasability with less tendency of the molded material to adhere to the die, and has the following additional advantages:

(1) Even deep patterns can be readily released by adjusting the pressure.
(2) Since air is passed every pressing cycle, the green sheet contacting portion has a reduced tendency to clog; this can be further improved if the pores of the air-permeable material are smaller than
55 the particle size of the raw material powder.

(3) Since air and water contained in the material escape through the fine pores in the air-permeable material during pressing, fine patterns can be precisely and sharply transferred.

A press molding process using the roll pressing method will now be described with reference to Fig.3.

A roll-formed green sheet contacting portion 21 of a molding die 20, rotatably mounted on ball bearings 19, is provided with a relief pattern, and is made of the air-permeable material. Cylindrical pipe-formed air chamber 22, which rotatably supports the green sheet contacting portion on the ball bearings 19 is provided with slit 25 formed in the axial direction of the air chamber 22 to supply air to a contact interface 24
 5 between green sheet 23 and green sheet contacting portion 21 (Fig.3(b)). Air chamber 22 is connected with air supply pipe 26, through which air is supplied from air supply unit 27 (Fig.3(c)).

The molding die using the inventive air-permeable material is not limited to the configuration of the above example, but the air-permeable material can be used in any portion of the die which contacts the inorganic molded material such as the green sheet or the kneaded material. For example, when the green
 10 sheet is pressed between an upper die portion and a lower die portion, green sheet contacting portions of both die portions can be made of the air-permeable material, thereby preventing the molded material from adhering to either die and achieving a remarkably improved releasability.

A second embodiment of the method for the production of the inorganic cured shapes according to the present invention, in which an inorganic molded material prior to hardening and curing is molded and cut,
 15 will now be described. Parts and components which are the same as those used in the first configuration are indicated by the same names and detailed description thereof is omitted.

The molding die used in the present invention, for example, is one which is shown in Fig. 8, in which molding die 41 has on its inner surface 41a a relief pattern to form a pattern on the resulting inorganic
 20 molded material and to form the molded material into a predetermined shape. Fig.8 is a perspective back view of the molding die, which is placed upside down in use to press against the green sheet.

The projection is a ridge-formed projection provided on the molding die to form a diagonal cut edge in the molded material. For example, as shown in Fig. 9(a), a projected portion 42 is formed so that a portion of molding die 41 is tapered. In press molding, as shown in Fig.9(b), it is preferable to press green sheet 43
 25 so that the ratio of distance a from the end of projection 42 to the bottom of green sheet 43 to thickness b of molded green sheet 43 after pressing is $a/b = 1/1$ to $1/5$, thereby preventing cracking during pressing.

The groove in the present invention refers to a portion such as groove 44a or step 44b formed in the kneaded material by the projection of the molding die, which is cut by a cutter. The cutter used in the present invention is one which is used to cut the inorganic molded material press formed by the molding die, for example, as shown in Fig.9(d). The green sheet 43, formed by molding die 41, is cut using blades
 30 46 of cutter 45 along groove 44a or step 44b to obtain inorganic molded material 33 having diagonal cut edge 32, as shown in Fig.5.

In the present invention, since the kneaded material is first press molded using the molding die having the projection and is then cut by the cutter along the groove formed in the kneaded material by the projection, there is no problem of cutting difficulty or the occurrence of crack 49 as seen in the prior art
 35 method in which, for example, as shown in Fig. 10, green sheet 48 is cut and patterned using molding die 47 having acute-angled cutting projection 47a.

A third embodiment of the method for the production of the inorganic cured shapes of the present invention, in which a slit portion is formed in the inorganic molded material prior to hardening and curing,
 will now be described.

Referring to Fig. 11, cutter 50 with a pusher used in the present invention comprises a pair of parallel blades 51a and 51b, slit 52 formed by blades 51a and 51b, pusher 53 which is movable within slit 52 in the
 40 pushing direction (downward in the Figure) of blades 51a and 51b and having almost the same length as blades 51a and 51b in the width direction, and actuator 55 to render pusher 53 movable in the vertical direction through shaft 54. When cutting, the cutter moves vertically to cut part of an inorganic molded material to form slit portion 57 as shown in Fig. 13.

During the formation of slit, the slit tends to get clogged with debris of inorganic molded material 56, but the debris is forcibly ejected by moving pusher 53 by actuator 55, thereby preventing the dimensions of blades 51a and 51b from changing. Actuator 55 can be an air cylinder, a coil spring, an oil cylinder, or the like.

Pusher 53 in slit 52 is preferably located at a position where it is not contacted by the cut material and is preferably made of a hard substance which does not readily deform, such as metal or plastic. When an oil cylinder is used, the position of pusher 53 may be the same as the blade tips since the cylinder is withdrawn when the material is put in the slit.

The use of cutter 50 having the pusher will now be described with reference to Figs. 12(a) to 12(d).

55 a) Inorganic molded material 56, patterned by the molding die, is transported to the cutting position (Fig.12(a)).

b) The entire cutter 50 moves downward to form slit portion 57 in part of the inorganic molded material. At this time, debris 56a enters slit 52 between blades 51a and 51b (Fig.12(b)).

c) Then the entire cutter 50 is moved upward. Actuator 55 is operated to remove debris 56a from slit 52 by pusher 53 (Figs. 12(c) and (d)).

The cutting process can be repeated without any changes in the dimensions of blades 59a and 59b or damage to blade 60 due to cutting debris 58, as is seen in the prior art method as shown in Figs. 14(a) to 14(c).

A fourth embodiment of the method for the production of the inorganic cured shapes of the present invention, in which a slit portion is formed in the inorganic cured shape prior to hardening and curing, will now be described.

With reference to Fig. 15 and Fig. 16, cutter blade unit 61 comprises blades 62 in two parallel rows along boundary Z between main portion 63a and slit removal portion 63b of inorganic molded material 63; the unit is peripherally disposed so that blades 62 are offset from each other.

A first slit formation method according to the present invention to form slit portion 64 in inorganic molded material 63 will now be described with reference to Fig. 16 through Fig. 18.

I-i) The entire cutter blade unit 61 is moved downward onto the surface of inorganic molded material 63 to form a plurality of holes 65 along boundary Z between main portion 63a and slit removal portion 63b to form slit portion 64 of inorganic molded material 63 (Figs. 16 and 17). In this case, the holes 65 are discontinuously formed, offset from each other in the two rows.

I-ii) The entire cutter blade unit 61 is moved upward, and then inorganic molded material 63 provided with holes 65 is hardened and cured.

I-iii) After curing, slit removal portion 63b surrounded by holes 65 is removed to form slit portion 64 (Fig. 18).

Due to the formation of holes 65 in Step I-i) above, no changes in dimensions, damage to the blades, or plugging of the material between the blades, as otherwise seen in the prior art, is noted.

Holes 65 are elongated, but the shape of holes 65 is not limited to this; but, for example, may be formed as fine circular perforations 66 as shown in Figs. 19(a) and (b). In the above-described slit formation method the holes 65 for slit formation formed in the inorganic molded material are through holes.

However, as another example of the present invention, one which is provided with non-penetrating grooves will now be described with reference to Figs. 20(a) and (b). As shown in these drawings, inorganic molded material 63 may be provided with a plurality of grooves 67 discontinuously formed, and slit removal portion 63b surrounded by grooves 67 is removed to form the slit portion. The above-described first slit formation method is one in which intermittent holes 65 are formed along boundary Z between main portion 63a and slit removal portion 63b of inorganic molded material 63 by a single punching.

A second slit formation method according to the present invention will now be described with reference to Figs. 21 through 25. This method, as shown in Fig. 21 and Fig. 22, uses a pair of cutter blade units 68a and 68b, each of which has a single row of blades 62 along boundary Z between main portion 63a and slit removal portion 63b of inorganic molded material 63.

Then, a process to form the slit portion 64 will be described.

II-i) Cutter blade unit 68a shown in Fig. 21 is moved down to the upper surface of inorganic molded material 63 (Fig. 23) to form a plurality of discontinuous holes 65 along one row of boundary Z for slit formation in inorganic molded material 63 (Fig. 24).

II-ii) Then, the other cutter blade unit 68b shown in Fig. 22 is moved down to form holes 65 along the other row of boundary Z in the same manner, so that slit removal portion 63b is surrounded by holes 65 (Fig. 25).

II-iii) Thereafter, inorganic molded material 63 with holes 65 formed along boundary Z is hardened and cured.

II-iv) After curing, slit removal portion 63b surrounded by holes 65 is punched out to obtain the inorganic cured shape with slit portion 64 formed as shown in Fig. 13. In this method, blades 62 are not necessarily offset to each other in the two rows.

Furthermore, as shown in Figs. 26(a), (b), and (c), slit portion 64 may be formed as follows. Using continuous blades, one side of the blades is driven in along boundary Z to form slot 69 (Fig. 26(a)), the other side is driven in to form slot 69 (Fig. 26(b)), and slit removal portion 63b surrounded by slots 69 is punched out to form slit portion 64 as shown in Fig. 26(c). The holes may alternatively be formed as grooves.

The inorganic cured shapes according to the present invention, which are easy to handle and have improved workability, will now be described.

Fig. 27 is a schematic perspective view of an example of an inorganic cured shape according to the present invention, and Fig. 28 is a schematic cross sectional view thereof. As shown in these drawings, inorganic cured shape 70 is provided on its surface with grooves 71 for cutting. The inorganic cured shape, prior to use, is cut along grooves 71 to obtain three pieces 72a, 72b, and 72c.

Cutting grooves 71 formed in the inorganic cured shape have acute-angled cutting portions 73 as shown in Fig. 28, and can be readily broken by only a single impact along grooves 71. It is preferable to form cutting grooves 71 in inorganic cured shape 70 at the time the shape is pressure molded. The plurality of pieces 72a to 72c, in the form adapted to actual use, can be molded, painted, packaged, and shipped at one time, thereby considerably improving their handling efficiency.

Heretofore, in the actual construction work, relatively small pieces have engendered low working efficiency because they used to be handled piece by piece. However, with the present invention, the inorganic cured shape is molded in a large size, and cut only when needed, thereby remarkably improving construction efficiency.

Another example of the present invention will now be described with reference to Fig.29 and Fig.30. Fig.29 is a schematic perspective view of another embodiment of the inorganic cured shape according to the present invention, Fig.30 is a cross sectional view thereof. As shown in these drawings, inorganic cured shape 70 is provided on its upper surface with three cutting grooves 71, which can be cut to obtain four pieces 72a, 72b, 72c, and 72d. As shown in Fig.30, groove 71 has cut-in 73 which functions to facilitate cutting.

Pieces 72a through 72d have differently shaped longitudinal side surfaces 74a and 74b, one side surface 74a being stepped, whereas other side surface 74b is flat, for a pleasing appearance.

Description of Preferred Embodiments

A preferred embodiment of the present invention will now be described with reference to the drawings.

The following raw materials were used to obtain a kneaded material having the composition shown in Table 1 (the same material is used throughout the preferred embodiments).

Raw materials used

Cement: ordinary Portland cement (from Onoda Cement, Blaine specific surface area: 3,300 cm²/g)

Quartzite powder: (from Chichibu Kogyo, Blaine specific surface area: 3,800 cm²)

Wollastonite: (tradename: Mighty 150 from Kao, a polycondensation product of naphthalene sulfonate salt)

Thickener: (tradename: Metholose 90SH-15000, from Shin-Etsu Chemical)

Fiber: Polypropylene (P.P.): (tradename: Toughlite, from Teikoku Sangyo, fiber length: 6 mm)

Table 1

Composition (part by weight)						
Fiber	Cement	Quartzite powder	Wollastonite	Water	Thickener	Water reducing agent
P.P.						
1.6	100	. 15	45	40	0.8	3

Embodiment 1

Molding method

Predetermined amounts of the powder and fiber were dry mixed in a mixer for approx. 3 min, and then wet mixed with water for approx. 10 min. Then, using an extrusion molding machine, the mixture was extrusion molded to a width of 250 mm and a thickness of 9 mm, followed by press molding to obtain an inorganic molded material with a thickness of 8 mm.

In this case, as shown in Figs.4(a) to (c), green sheet 30 was pressure molded using molding die 29

having green sheet contacting portion 28 comprising an air-permeable material, and cut by cutter 31 shown in Fig.4(d) to obtain inorganic molded material 33 having diagonally press cut edge 32 and a stone-grained surface.

After being molded, the molded material was steam cured (at 60 ° C for 24 hours), wet room cured at 20 ° C for one week as secondary curing, and then dried at 105 ° C until completely dry to obtain the inorganic cured shape.

The above pressure molding process will now be described in further detail.

10 (Pressure molding process)

(1) Green sheet 30, sheeted into a width of 250 mm and a thickness of 9 mm by an extrusion molding machine, was carried by transportation means to a pressing position of the molding die of a flat press (Fig.4(a)). Green sheet contacting portion 28 of the inventive flat press molding die 29 had a stone-grained pattern and was provided with projection 34 to form green sheet 30 with diagonally cut ends. A sintered metallic element (from SMC) was used as the air-permeable material.

(2) Green sheet 30 was then pressure molded by molding die 29. At the completion of pressing, air was supplied into air chamber 35 and fed air through air permeable contacting portion 28 to contact interface 36 between green sheet 30 and contacting portion 28, thereby releasing green sheet 30 (Figs.4(b) and (c)).

In the pressing step, distance a from front end 34a of projection 34 to bottom 30a of the green sheet and press thickness b from bottom 30a to the top of the green sheet were in the ratio of $a/b = 1/4$. Width c of front end 34a of projection 34 was equal to the thickness of blade 31a of cutter 31 used in a subsequent process step (Fig.4(b)).

(3) Then, all edges of the green sheet were cut using cutter 31 to obtain inorganic molded material 33 having diagonally cut edges 32 (Fig.5).

The thus obtained inorganic molded material 33 had stone-grained pattern sharply transferred onto the surface. A good result was also obtained when projection 34 was provided on molding die 29 to form a deep pattern and a diagonal cut edge, with no adherence of the material to the die.

Preferred test examples to show the effects of the present invention will now be described. Kneaded materials were prepared using the following raw materials in the compositions and at molding pressures shown in Table 2.

No.1 is an example which has an increased water ratio and low thickener content to confer fluidity on the raw materials.

No.2 is an example which has an increased thickener content to confer plasticity on the raw materials.

Cement: ordinary Portland cement

Sand: Toyoura standard sand

Fiber: polypropylene fiber, 6 mm long

Thickener: methylcellulose

Table 2

	Composition (part by weight)					Molding pressure (kg/cm ²)
	Fiber	Cement	Sand	Thickener	Water	
No.1	1.5	100	50	0.2	60	100
No.2	1.5	100	50	1.5	45	50

Kneaded materials of the above compositions were put into the molding die shown in Fig.7 and pressure molded with a male die having a deep pattern to obtain inorganic molded materials. In this case, male die 37 shown in Fig.6 made of metal, male die 38 shown in Fig.7 made of air-permeable material 39, and a sintered ceramic (tradename: Porceramics, from Shinto Kogyo) die were individually tested for adhesion of the kneaded material to the die. For the die using the air-permeable material, compressed air was supplied by an air compressor to the die after the predetermined molding was effected and

immediately before releasing the pressure.

The results are shown in Table 3.

Table 3

Adherence of kneaded material to the die		
Die type	Air-permeable material die	Metallic die
Composition		
No.1	Good, no adherence	Considerable adherence to the die
No.2	Good, no adherence	Unreleasable adherence to the die

As shown in Table 3, when the air-permeable material is used in the die, even high water-ratio materials or high-viscosity materials could be readily released from the die, without adherence of the materials. As described above with reference to the embodiment and test examples, with the present invention, the green sheet material can be readily released from the molding die without adherence to the die during molding prior to hardening and curing. Furthermore, even with fine and deep patterns provided on the molded materials, the present invention provides an improved releasability of the molded materials from the die.

Embodiment 2

An inorganic molded material was obtained using the same procedure as in Embodiment 1. In this case, as shown in Figs.9(a) through (c), green sheet 43 was pressure molded using molding die 41 having projections 42, and then cut by cutter 15 to obtain a stone-grained inorganic molded material 33 having diagonally cut edges 32 as shown in Fig.5. After molding, molded material 33 was steam cured at 60° C for 24 hours, wet room cured at 20° C for one week as secondary curing, and then dried until completely dry to obtain the inorganic cured shape.

The above pressure molding process will now be described in further detail.

(1) Green sheet 43, sheeted into a width of 250 mm and a thickness of 9 mm, was carried by a transportation means to a pressing position of flat press molding die 41 (Fig.9(a)). Flat press molding die 41 used in this embodiment was provided with peripheral projections 42 to give the inorganic molded material a stone-grained pattern and diagonally cut edges.

(2) Green sheet 43 was then pressure molded by molding die 41, and released (Figs.9(b) and (c)). In this embodiment, the ratio of distance a from front end 42a of projection 42 to bottom 43a of the green sheet to press thickness b from bottom 43a to the top of the green sheet was $a/b = 1/4$ (Fig.9(b)).

(3) Then, all edges of the green sheet were cut using cutter 45 to obtain inorganic molded material 33 having diagonally cut edges 32 as shown in Fig.5.

The thus obtained inorganic molded material 33 had a stone-grained pattern sharply transferred onto its surface. A good result was obtained, since molding die 41 had projections 42 to provide patterns and diagonally cut edges; then, inorganic molded material 33 was cut by cutter 45, with no cracking noted.

As described above in detail, with the present invention, the inorganic molded material can be cut to have diagonally cut edges without causing any anomalies such as cracking during cutting.

Embodiment 3

An inorganic molded material was obtained using the same procedure as in Embodiment 1. In this case, cutter 50 shown in Fig.11 was used to form two slit portions 57 having a width of 4 mm in part of the inorganic molded material.

After molding, the molded material was steam cured at 60° C for 24 hours, and wet room cured at 20° C for one week as secondary curing to obtain a tile (dimensions: a: 450 mm, b: 300 mm, c: 150 mm) having the two slit portions 57 as shown in Fig.13. The above cutting process alone was repeated using cutter 50, but there were noted no changes in dimensions or damages to the cutter blades.

As described above in detail, the present invention eliminates clogging of cutting debris between the blades and changes in dimensions and damage to the blades, thereby extending their service life; it is able to form the slit portions with no variations in dimensions for an extended period of use.

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Embodiment 4

An inorganic molded material was obtained using the same procedure as in Embodiment 1. Two cutter blade units 61 shown in Fig. 15 were used to form intermittent holes 65 along boundary Z in part of inorganic molded material 63. Inorganic molded material 63 was then cut into predetermined dimensions. After molding and cutting, the molded material was steam cured at 60 ° C for 24 hours, and wet room cured at 20 ° C for one week as secondary curing. Then, slit removal portion 63b surrounded by holes 65 was punched out to form slit portion 64, obtaining a tile having two slit portions 57 as shown in Fig. 13 (dimensions: a: 450 mm, b: 300 mm, c: 150 mm). The above cutting process alone was repeated using one and the same cutter, and no changes in dimensions or damages to the cutter blades were noted.

As described above in detail, the present invention eliminates clogging of cutting debris between the blades as well as changes in dimensions or damage to the blades; these are otherwise seen in prior art slit formation. Thereby the service life of the blades was extended, and they are able to form the slit portions with no variations in dimensions for an extended period of use.

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Embodiment 5

The following raw materials were used to obtain a kneaded material of the composition shown in Table 4.

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Raw materials used

- Cement: ordinary Portland cement (from Onoda Cement, Blaine specific surface area: 3,300 cm²/g)
- Quartzite powder: (from Chichibu Kogyo, Blaine specific surface area: 3,800 cm²)
- Thickener: (tradename: Metholose 90SH-15000, from Shin-Etsu Chemical)
- Fiber: Polypropylene (P.P.): (tradename: Toughlite, from Teikoku Sangyo) fiber length: 6 mm

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Table 4

Composition (part by weight)				
Fiber	Cement	Quartzite powder	Thickener	Water
P.P.				
1.8	100	20	0.8	2.4

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Molding method

Predetermined amounts of the powders and fiber were dry mixed in a mixer for approx. 3 min, and then wet mixed with water for approx. 10 min. Thereafter, using an extrusion molding machine, the mixture was extrusion molded to a width of 400 mm and a thickness of 9 mm, and then press molded in a flat press (100 t) under a pressure of 10 kg/cm² to obtain an inorganic molded material with a thickness of 8 mm.

In this flat pressing, the inorganic molded material was given a single cutting groove 71 as shown in the cross sectional view of Fig. 28. Then, the inorganic molded material was cut into a predetermined size, steam cured at 60 ° C for 24 hours, and wet air cured at 20 ° C for one week as secondary curing to obtain inorganic cured shape 75 having cutting groove 71 with cut-in 73.

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In this embodiment, two roof tiles were molded at one time, which provided a considerable reduction in processing and handling steps such as molding, painting, packaging, and shipment, along with improved

workability.

When used in construction, the inventive tiles were easy to handle because they did not require carrying up piece by piece as is necessary with the prior art products. Furthermore, the cut face along groove 71 can be hidden by overlapping or sealing the tiles in construction, thereby assuring good appearance.

As described above with reference to the specific embodiments, since the inorganic cured shapes according to the present invention are provided on their surfaces with cutting grooves, a plurality of pieces can be molded, painted, packaged, and shipped at one time, giving improved workability. Furthermore, the inventive inorganic cured shapes can be handled as an aggregate until immediately prior to use, at which time it is cut along the cutting grooves into pieces, thereby remarkably improving the construction efficiency.

Claims

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1. A method for the production of an inorganic cured shape by pressure molding a kneaded mixture containing a water-curable inorganic composition, said method comprising shaping said mixture in a mold (10, 20, 29, 41) to form an inorganic molded material (11, 23, 30, 43), and hardening and curing said material to obtain said shapes, wherein

20 a material contacting portion (12, 21, 28) of said mold (10, 20, 29, 41) is composed of gas permeable material and a gas is supplied through said portion (12, 21, 28) to a contact interface between said material (11, 23, 30, 43) and said portion (12, 21, 28), whereby said material (11, 23, 30, 43) is released from said mold (10, 20, 29, 41).

2. The method of claim 1, wherein said mold (10, 20, 29, 41) is provided with a pattern on its internal surface, whereby said pattern is reproduced on said shape.

3. The method of claim 1, wherein said mold is provided with at least one projection (34, 42) which forms a groove on said shape, said groove having sides which are at an angle other than 0° to a line normal to said shape.

4. The method of claim 3, wherein said shape is cut by a cutter (31, 45, 46) along said groove.

30 5. A method for the production of an inorganic cured shape by pressure molding a kneaded mixture containing a water-curable inorganic composition, said method comprising shaping said mixture in a mold (10, 20, 29, 41) to form an inorganic molded material (56), and hardening and curing said material to obtain said shapes,

cutting said material (56), prior to hardening and curing, by means of a cutter (50) comprising a pair of parallel blades (51a, 51b) spaced apart by a predetermined distance, said cutter (50) being pressed into said shape in a first direction, a pusher (53) between said blades (51a, 51b) and adapted for reciprocating movement in said direction and opposite thereto, whereby debris (56a) between said blades (51a, 51b) resulting from said cutting is ejected.

6. The method of claim 5, wherein the width of said pusher (53) is slightly smaller than the width of said blades (51a, 51b).

7. A method for the production of an inorganic cured shape by pressure molding a kneaded mixture containing a water-curable inorganic composition, said method comprising shaping said mixture in a mold (10, 20, 29, 41) to form an inorganic molded material (63), and hardening and curing said material to obtain said shapes, comprising

45 prior to hardening and curing, forming a plurality of discontinuous openings (65, 66, 67, 69) along a boundary (Z) between a slit removal section (63b) and a main part (63a) of said material (63) by means of a cutter (61, 68a, 68b) to form a slit area,

said cutter (61, 68a, 68b) having two rows of blades (62) along a longitudinal direction of said section, said blades (62) being offset longitudinally from each other.

50 8. A method for the production of an inorganic cured shape by pressure molding a kneaded mixture containing a water-curable inorganic composition, said method comprising shaping said mixture in a mold (10, 20, 29, 41) to form an inorganic molded material (11, 23, 30, 43, 56, 63) and hardening and curing said material to obtain said shapes, wherein

55 a material contacting portion (12, 21, 28) of said mold (10, 20, 29, 41) is composed of gas permeable material and a gas is supplied through said portion to a contact interface between said material and said portion, whereby said material is released from said mold,

driving a first cutter blade unit (68a) having a row of blades (62) along a longitudinal direction of a section (63b) into said material at a first of two rows of a boundary (Z), and thereafter driving a second cutter blade

unit (68b) having a row of blades (62) along said longitudinal direction into said material at a second of two rows of said boundary (Z).

9. The shape which is the product of the method of any of claims 1 to 8.

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FIG.1

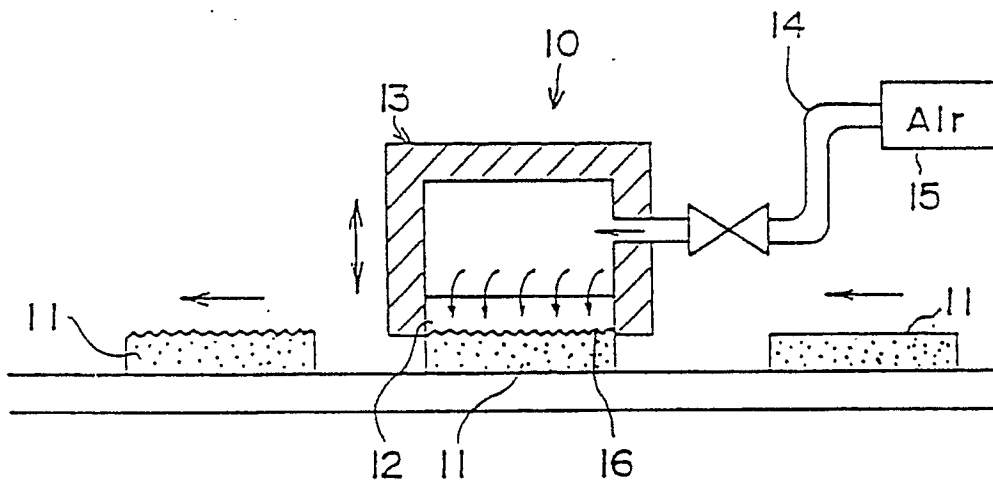


FIG.2

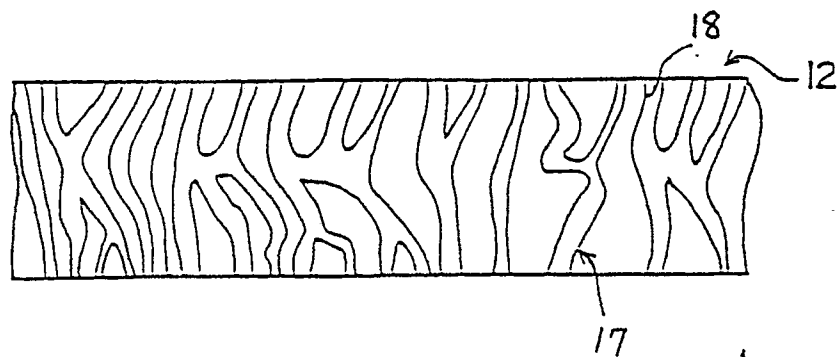


FIG.3

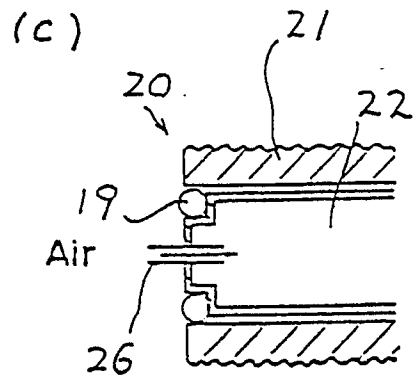
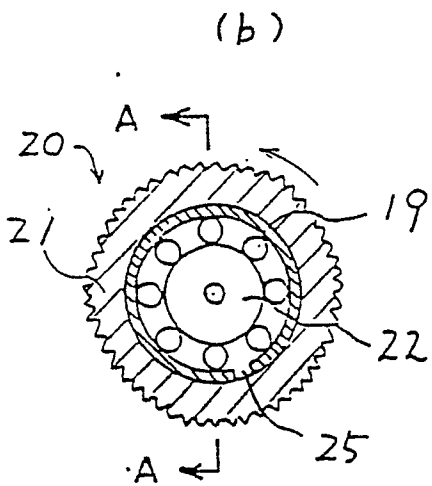
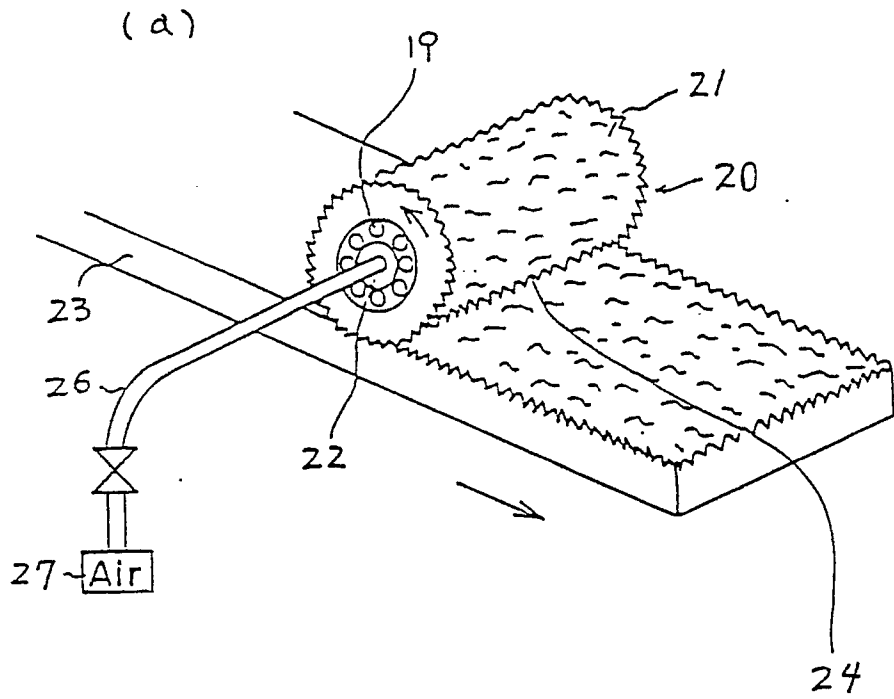


FIG.4

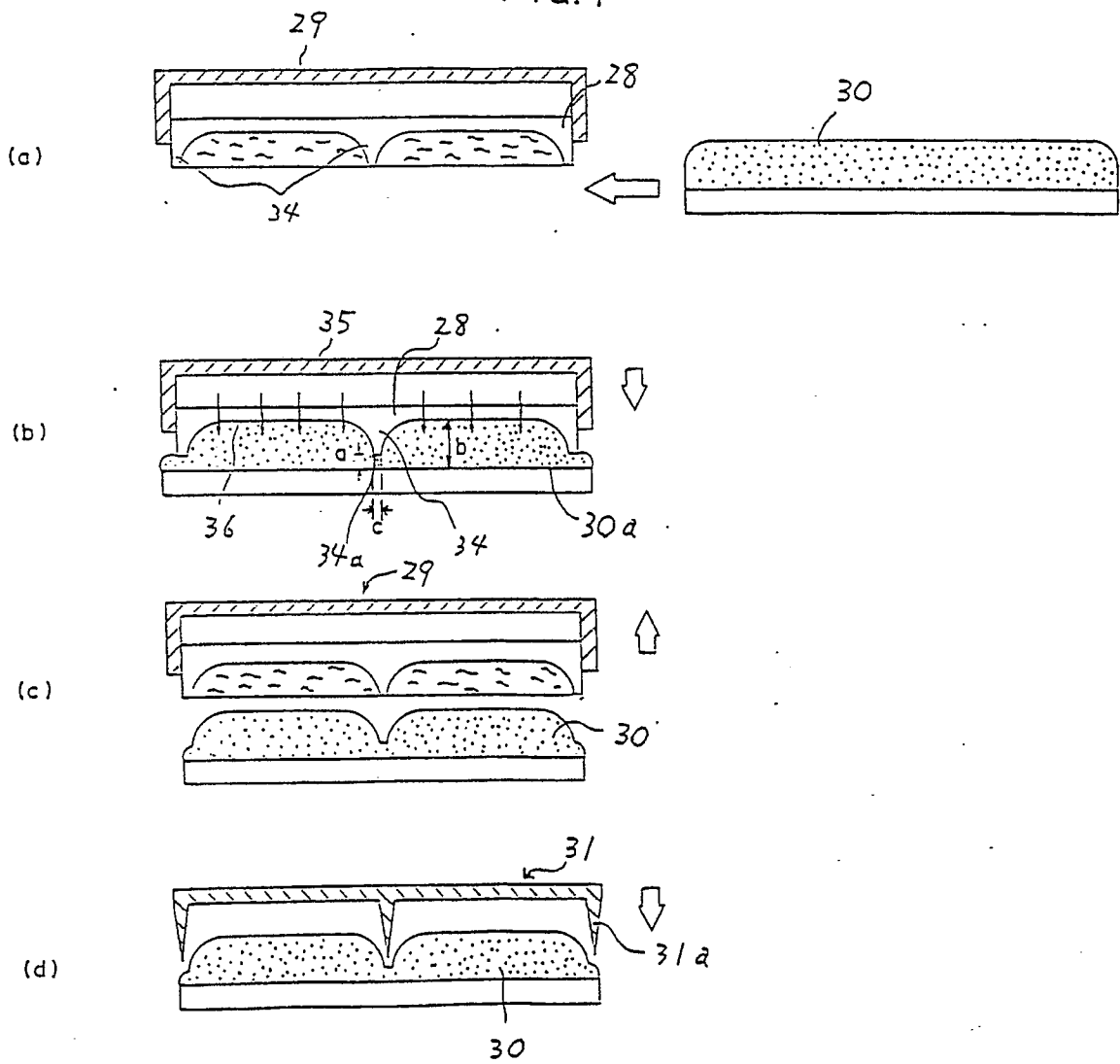


FIG.5

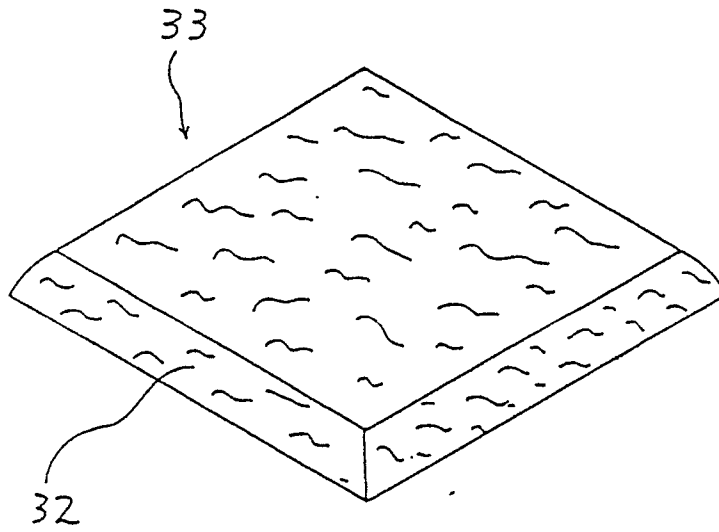


FIG.6

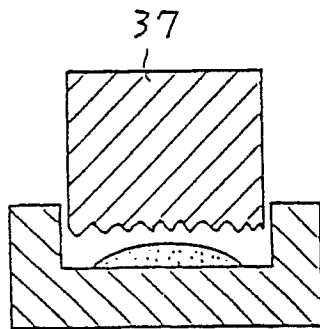


FIG.7

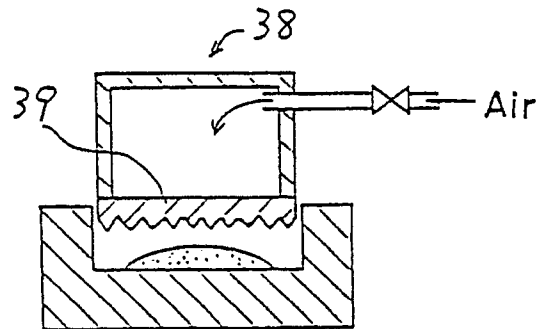


FIG.8

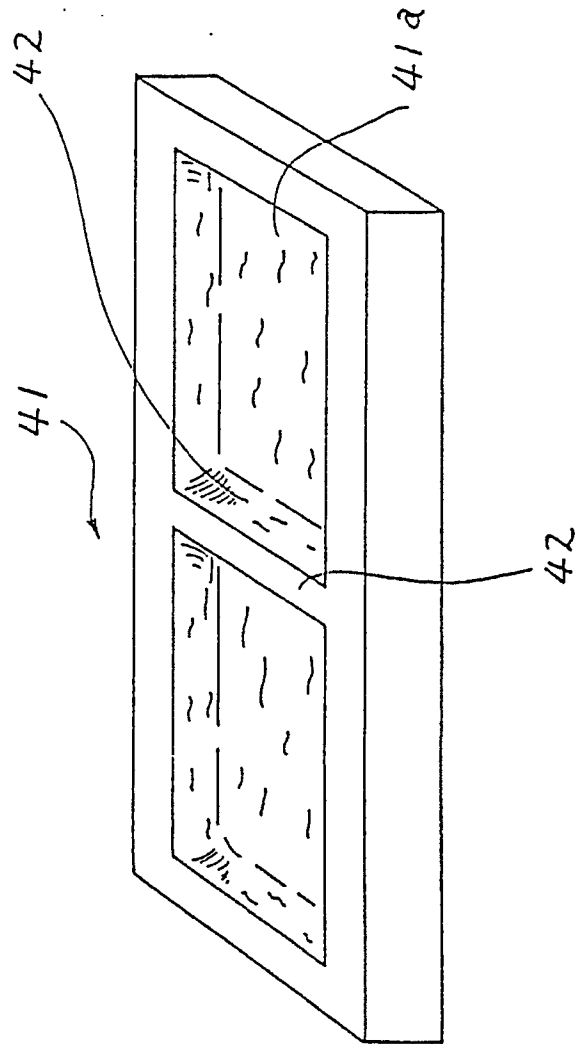


FIG.9

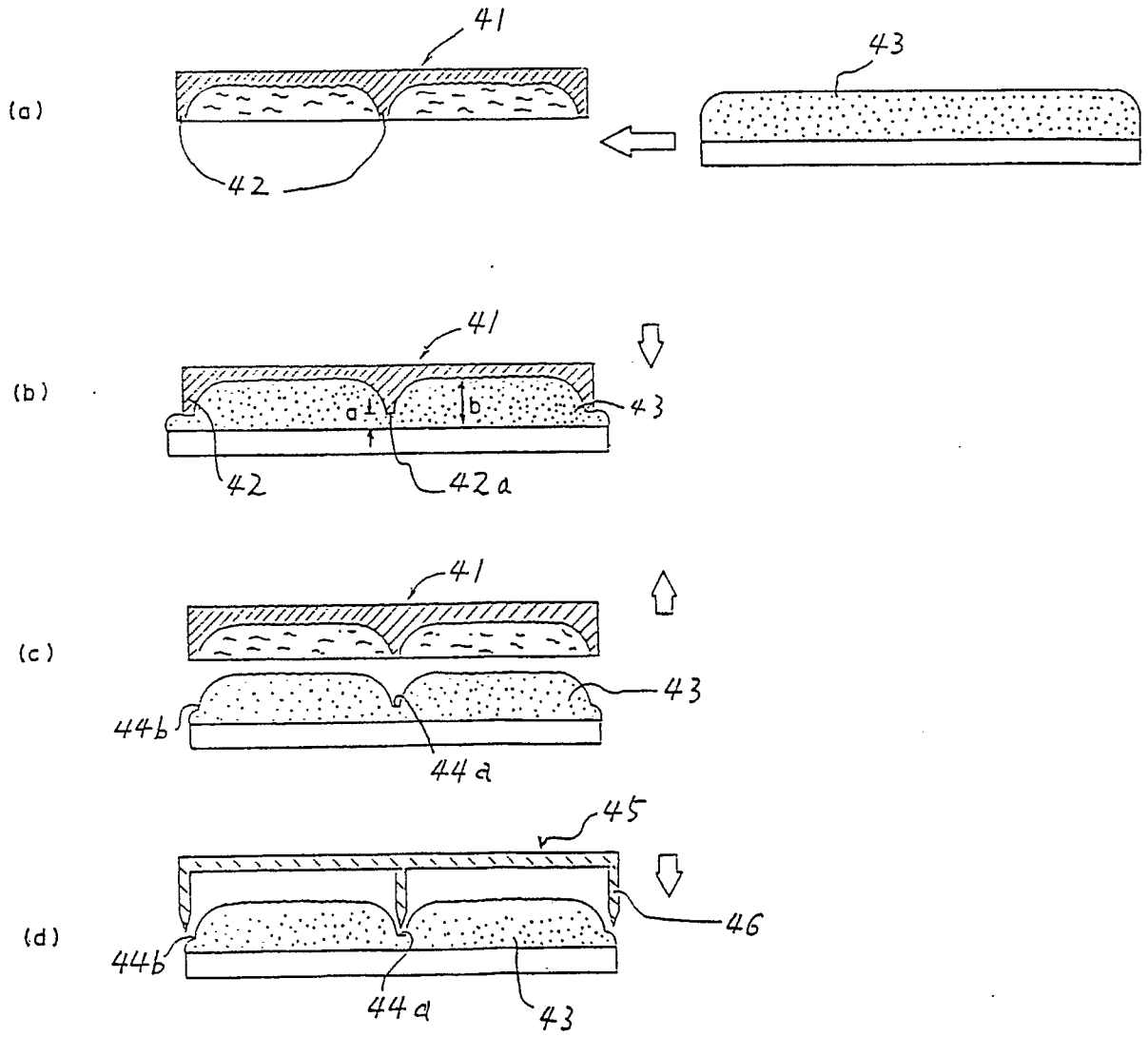


FIG.10

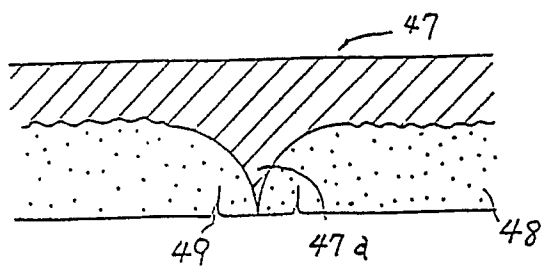


FIG.11

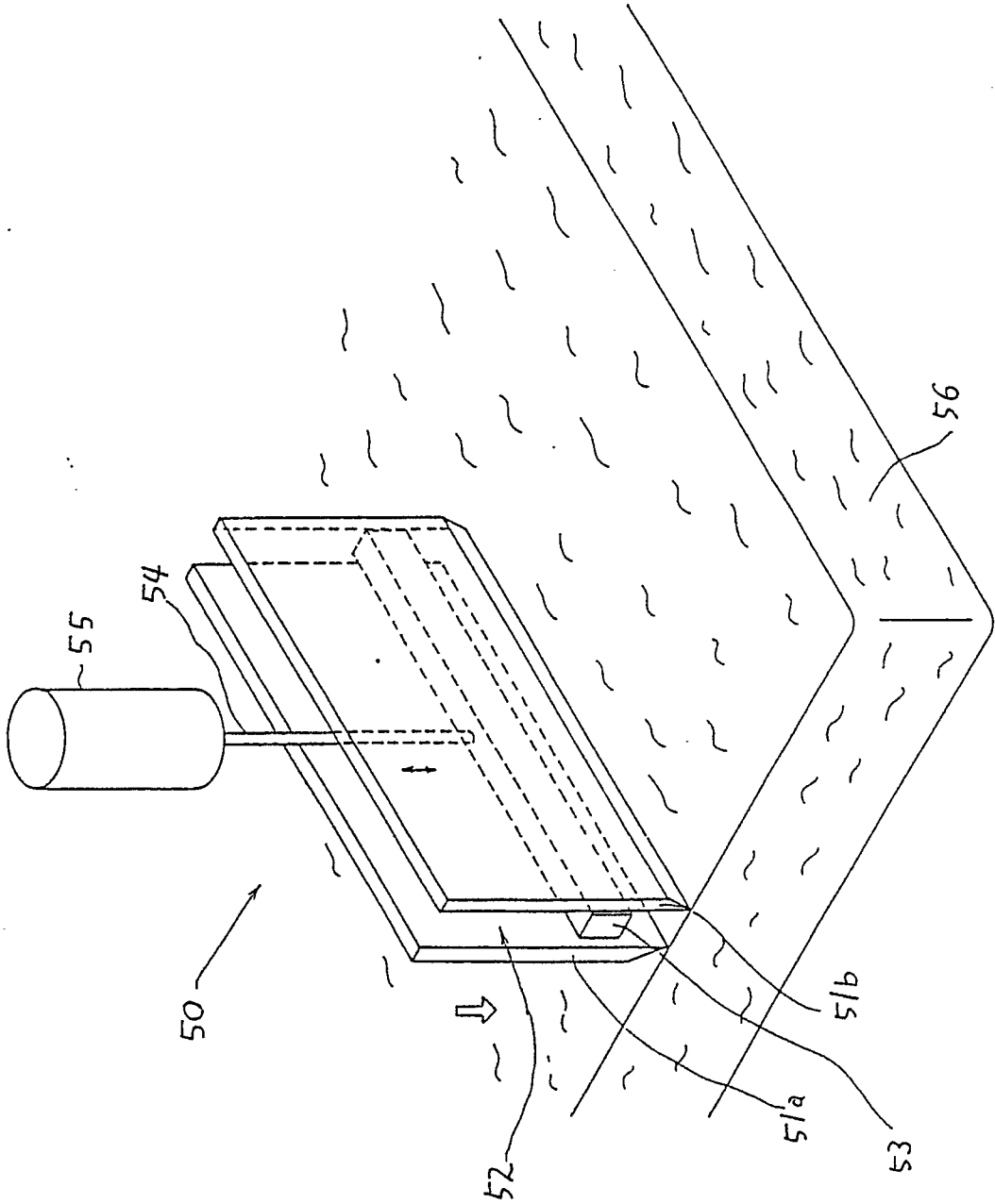
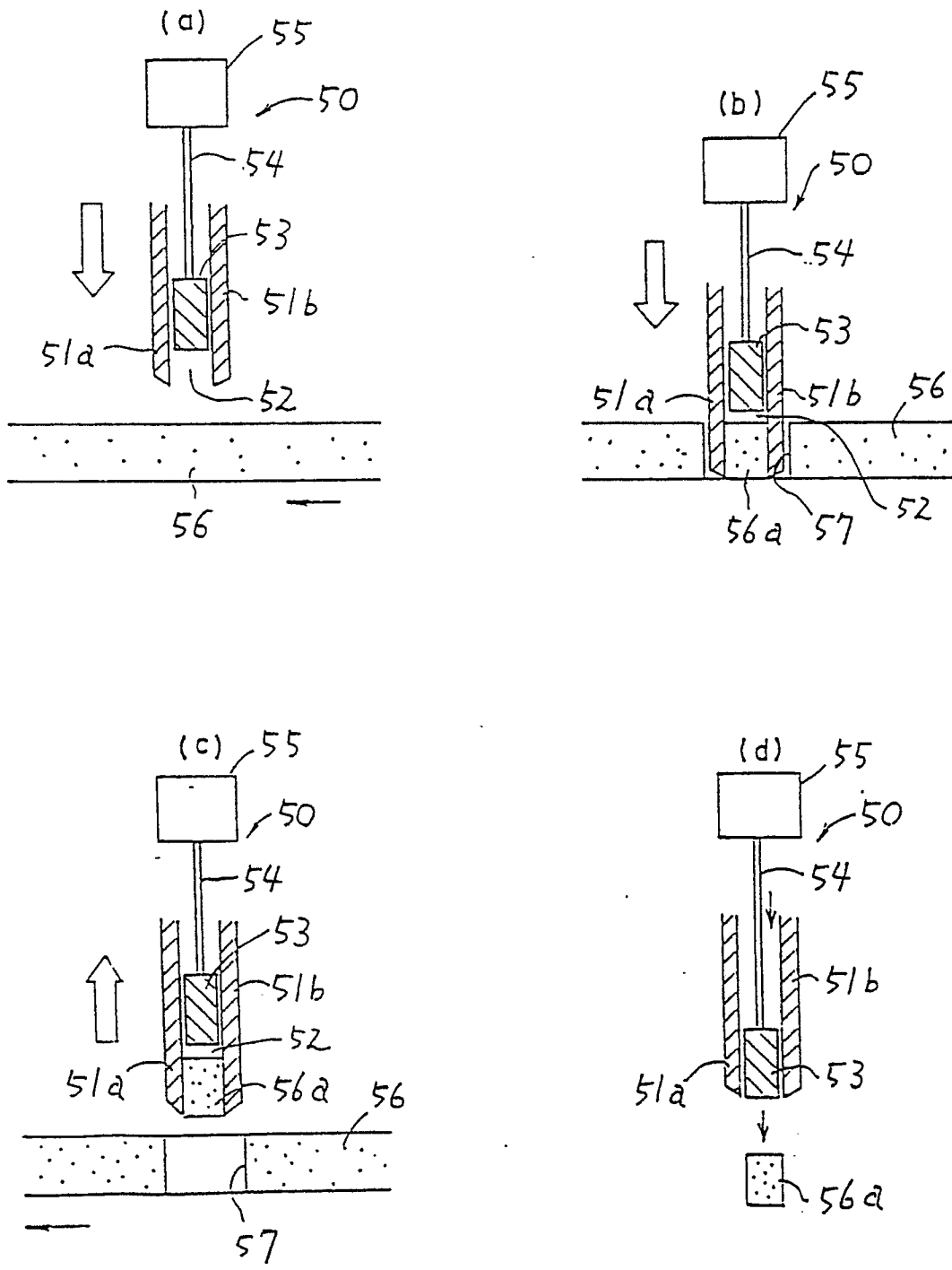


FIG.12



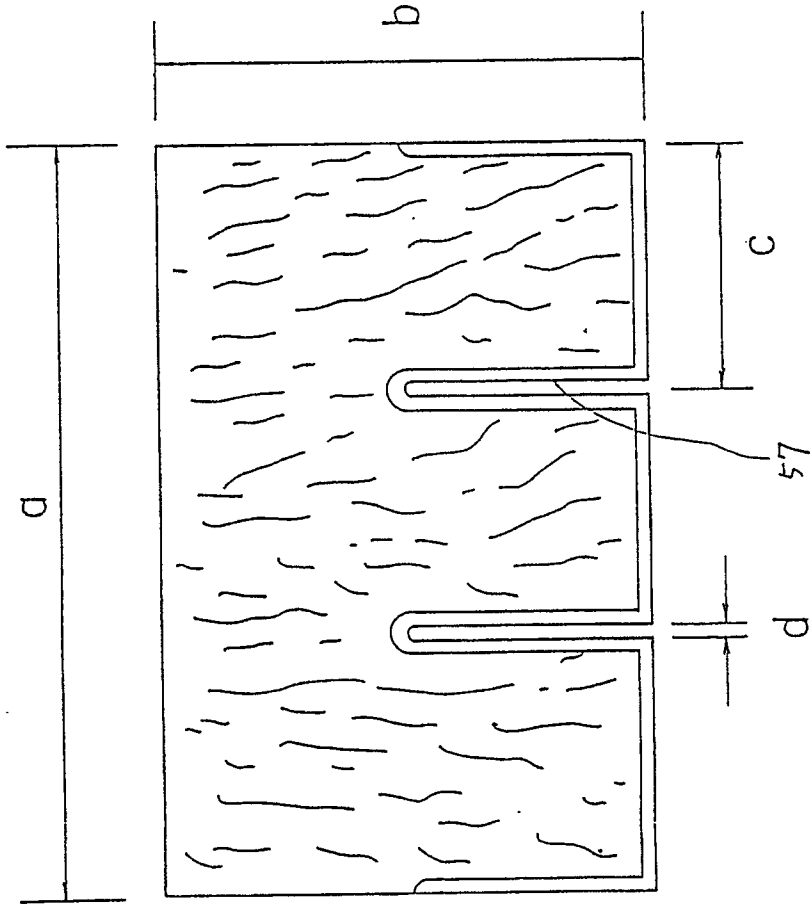


FIG. 13

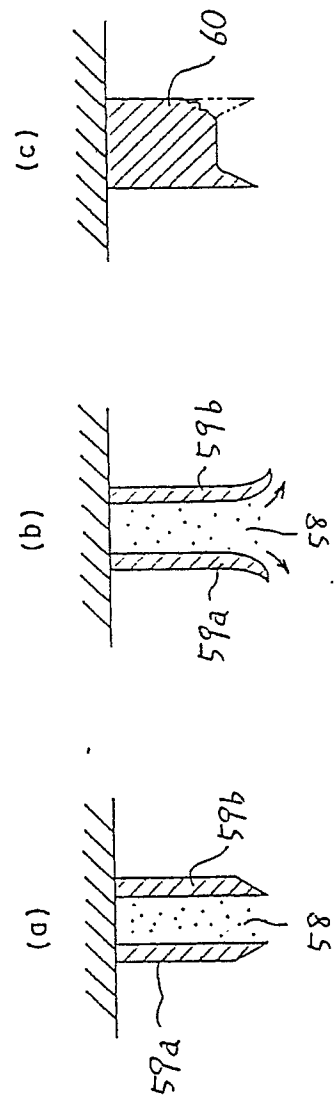


FIG. 14

FIG.15

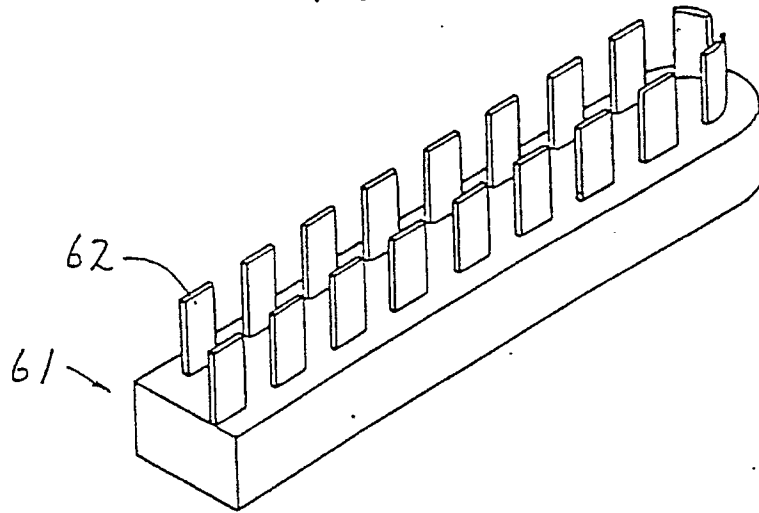


FIG.16

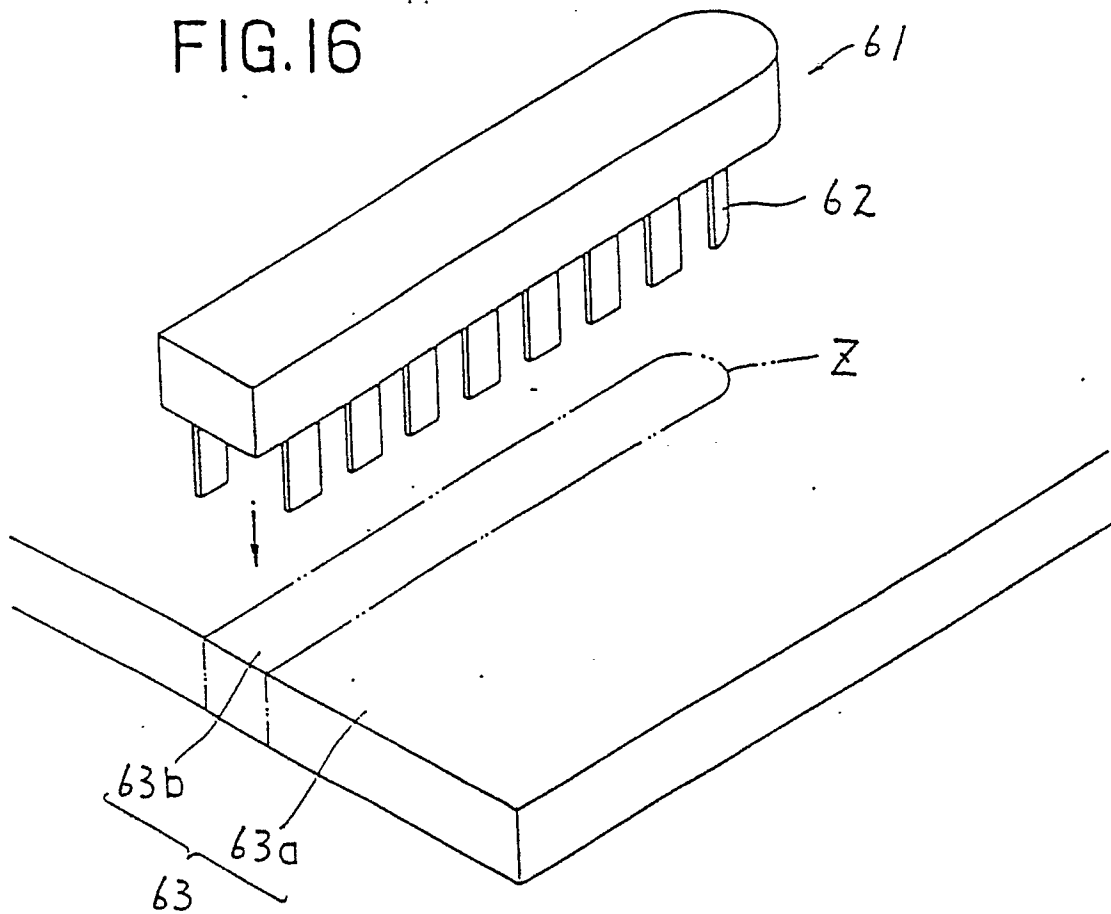


FIG.17

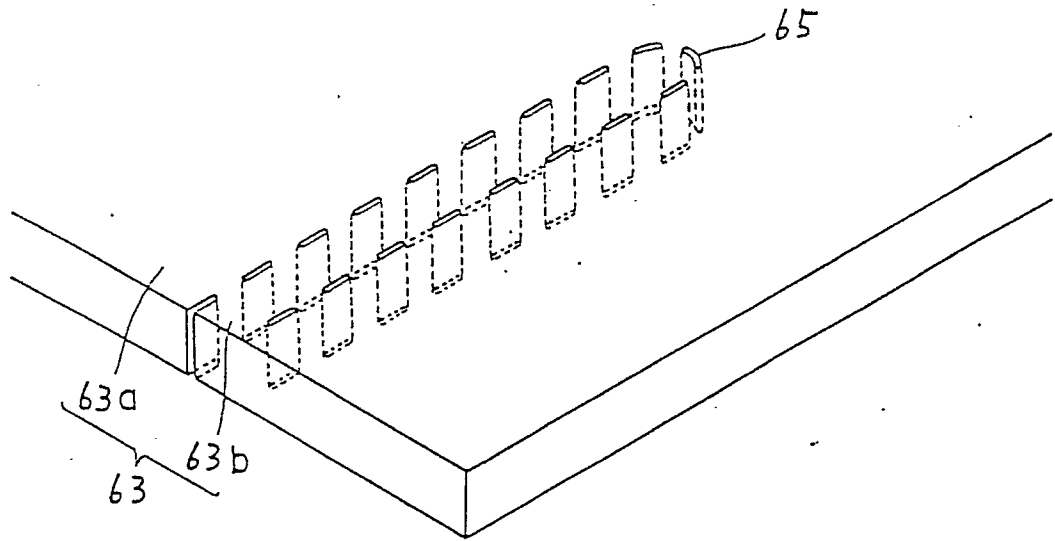


FIG.18

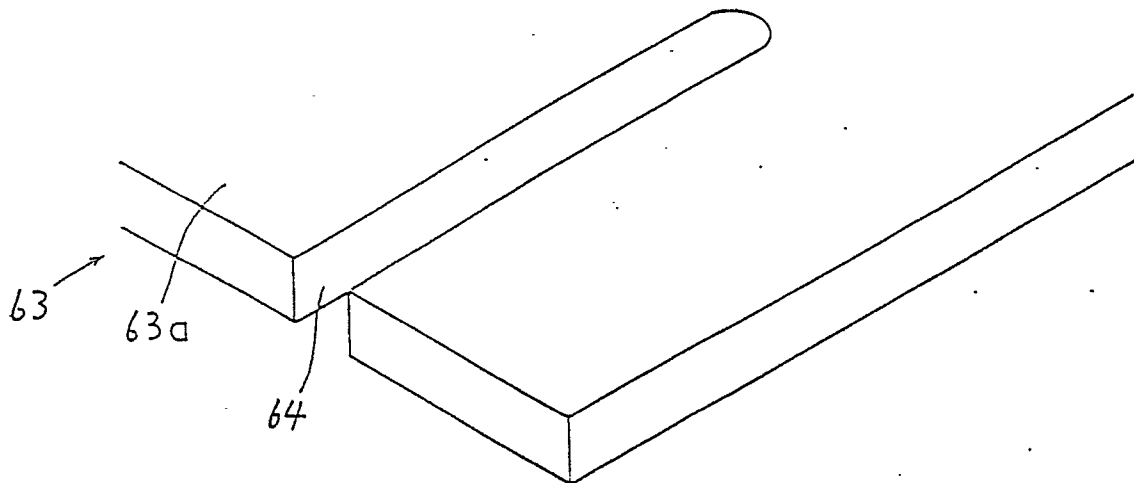
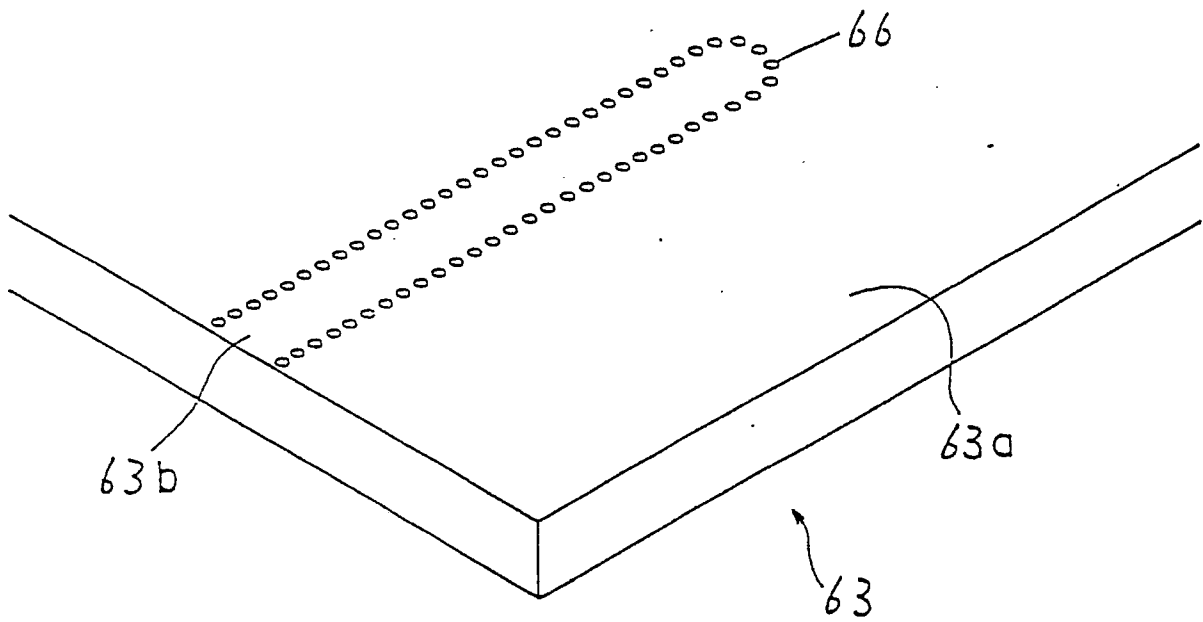


FIG.19

(a)



(b)

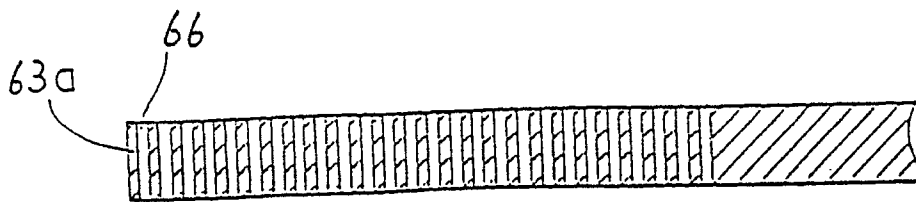
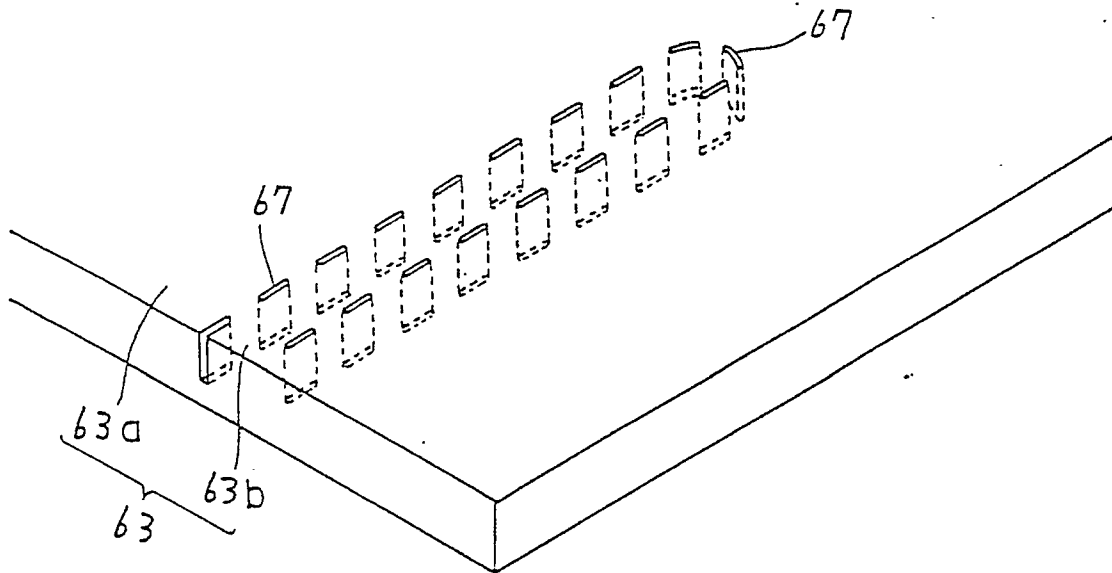


FIG.20

(a)



(b)

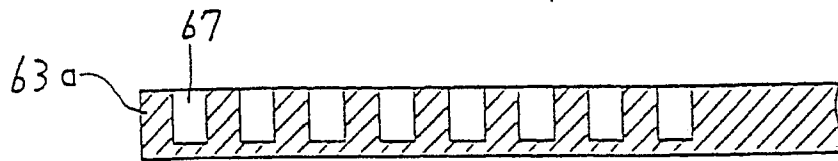


FIG. 21

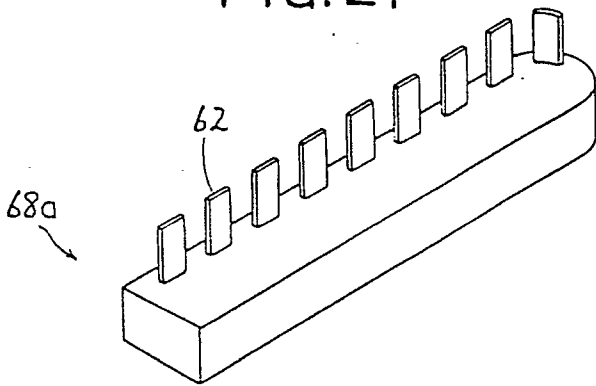


FIG. 22

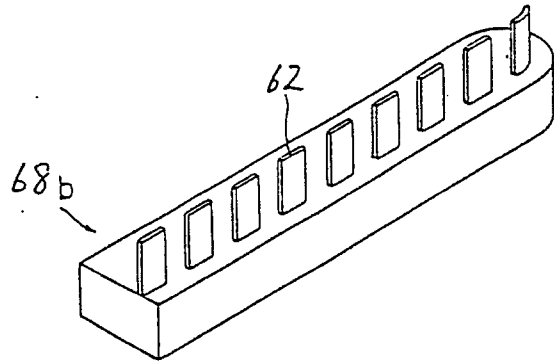


FIG. 23

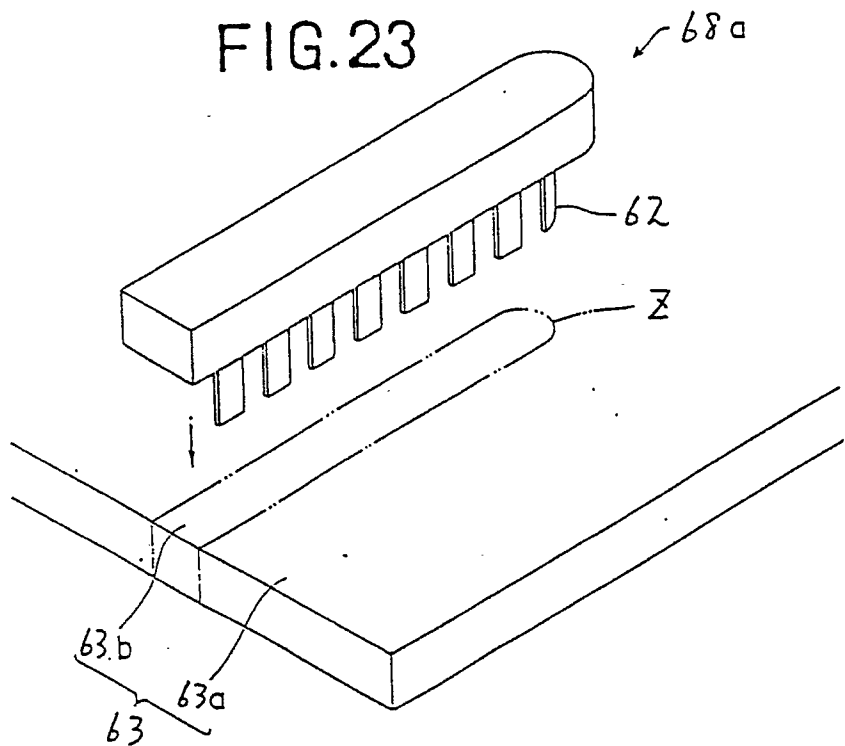


FIG. 24

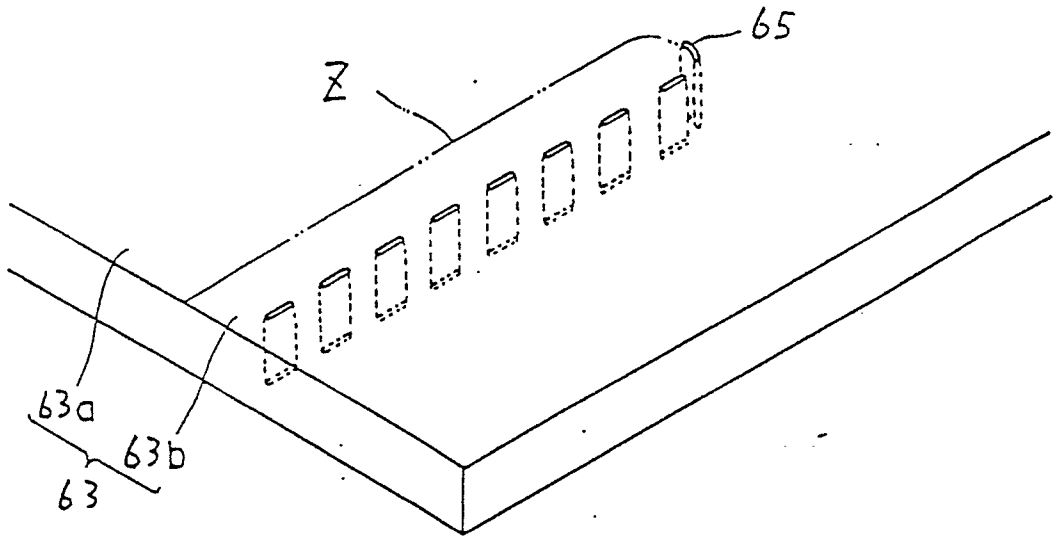


FIG. 25

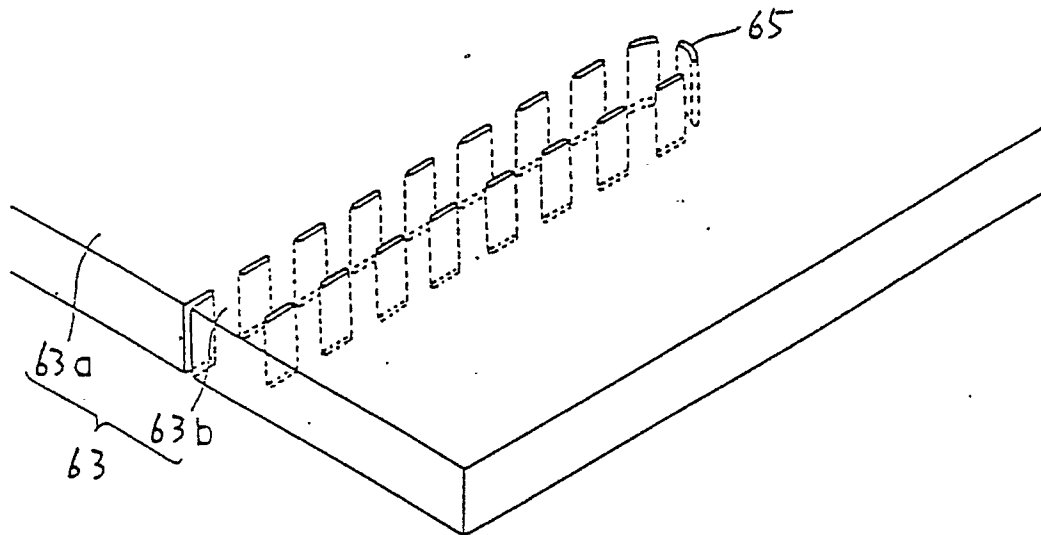
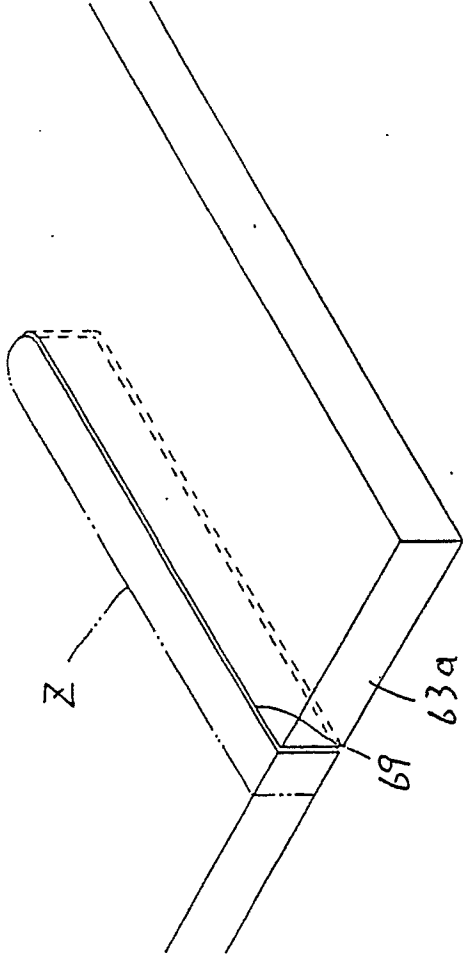
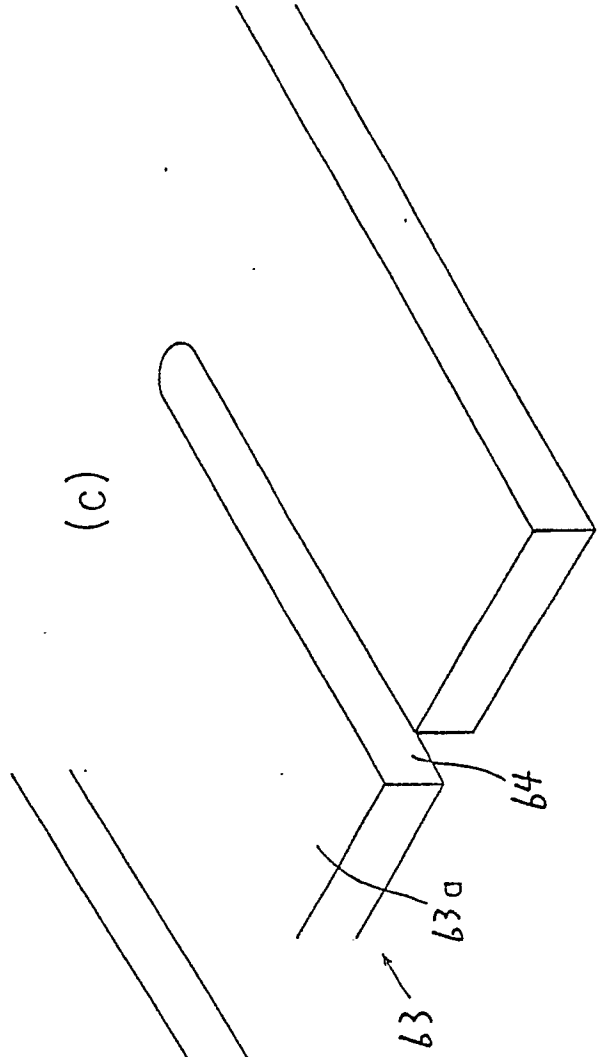


FIG.26

(a)



(c)



(b)

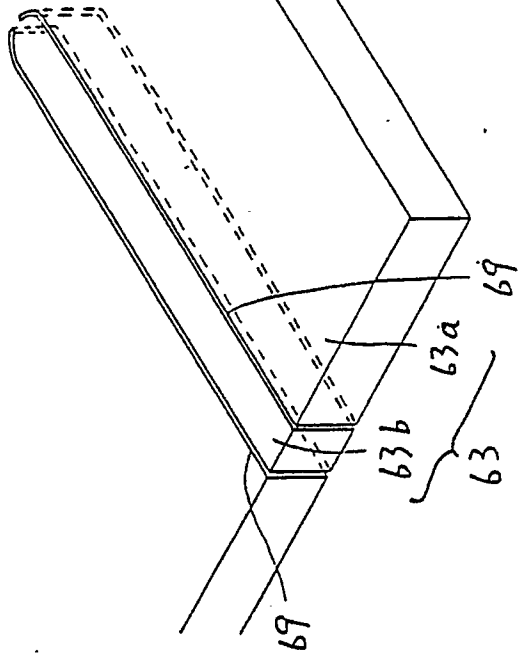


FIG.27

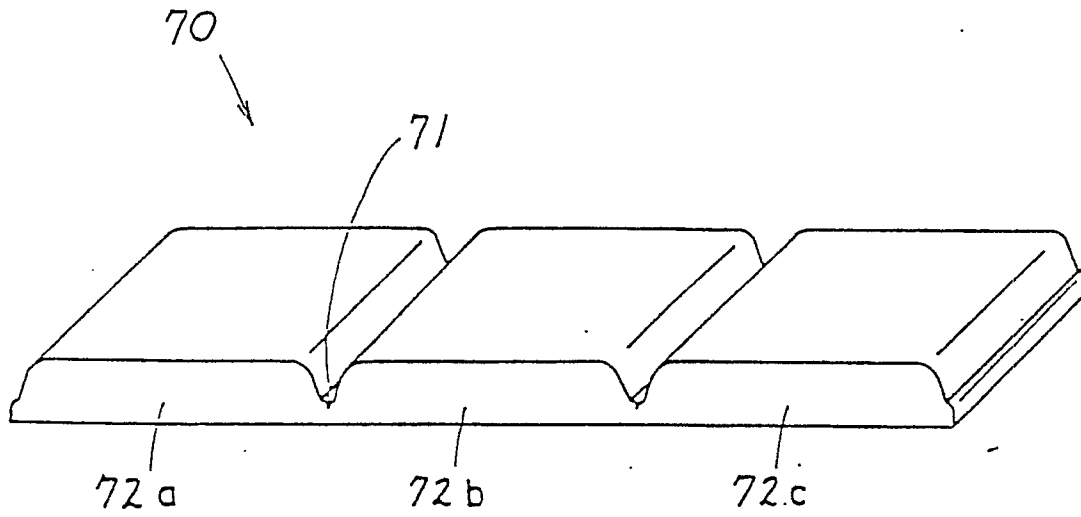


FIG.28

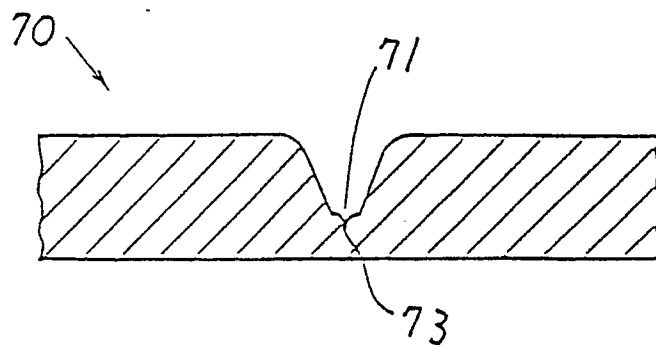


FIG. 29

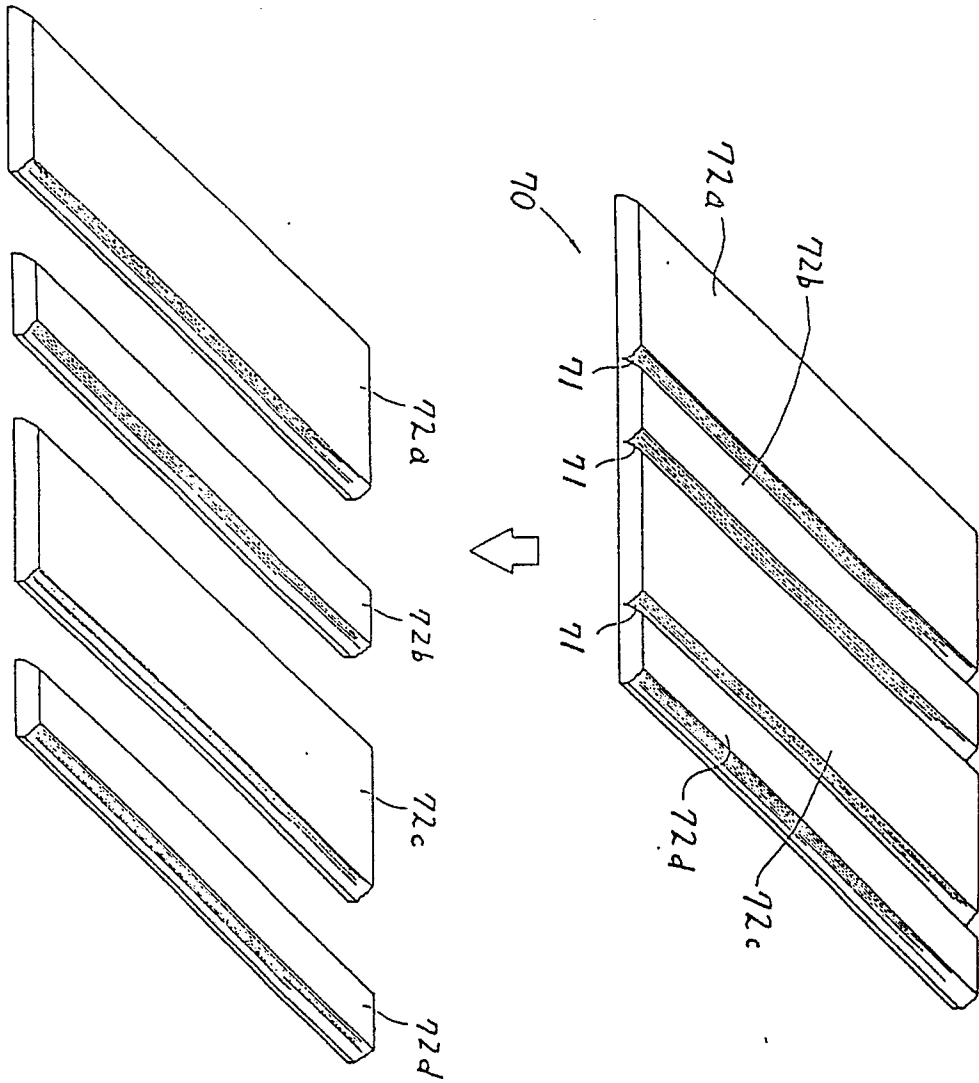


FIG.30

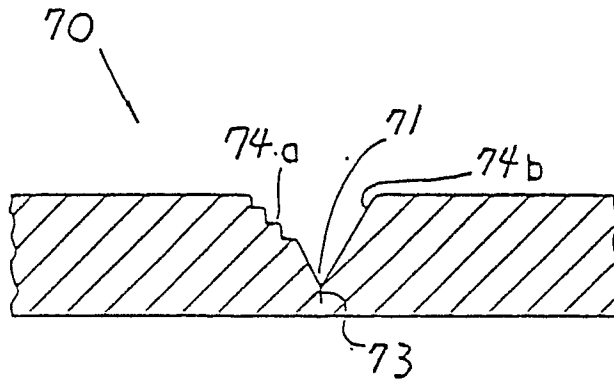


FIG.31

