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(71) Applicant: **Kabushiki Kaisha Kobe Seiko Sho (Kobe Steel, Ltd.)**
Kobe-shi, Hyogo 651-8585 (JP)

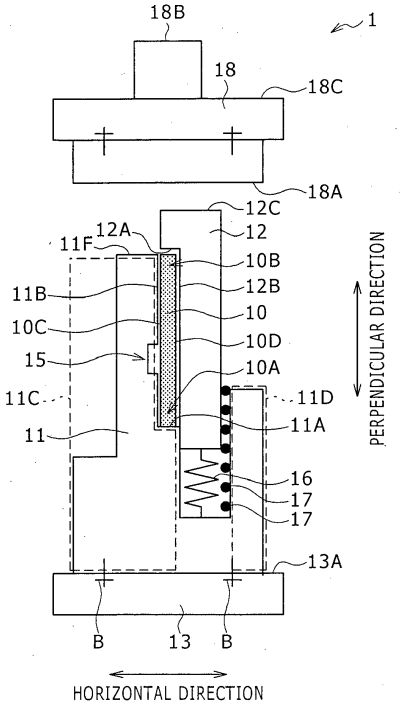
(72) Inventors:
- **Sakamoto, Kazuki**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Hayashida, Yasuhiro**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Watanabe, Kenichi**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Naitou, Junya**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Funada, Kensuke**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Kimura, Takayuki**
  Kobe-shi Hyogo, 651-2271 (JP)
- **Iwaya, Jiro**
  Nagoya-shi Aichi, 451-0045 (JP)

(74) Representative: **Müller-Boré & Partner Patentanwälte PartG mbB**
Friedenheimer Brücke 21
80639 München (DE)

(54) MANUFACTURING METHOD OF PRESS-MOLDED ARTICLE AND PRESS MOLDING APPARATUS

(57) A manufacturing method of press-molded article of the present invention comprises a step of placing a member to be pressed in a press molding apparatus and a step of pressing a flat plate portion (10) of the member to be pressed by bringing a first press portion (11A) and a second press portion (12A) closer to each other. A first opposing surface (11B) and a second opposing surface (12B), while facing to each other, keep in contact with the flat plate portion (10) during pressing. In the press step, a thick part is formed on the flat plate portion (10) by allowing a part of a material of the flat plate portion (10) to flow, in a press direction, into a thickened portion-forming section (15) formed on the first opposing surface (11B). The second opposing surface (12B) is moved to the press direction as the flat plate portion (10) is pressed by the first press portion (11A) and the second press portion (12A). A press molding apparatus (1) suitable for carrying out the method is also descreibed.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

(FIELD OF THE INVENTION)

[0001] The present invention relates to a manufacturing method of press-molded article and a press molding apparatus.

(DESCRIPTION OF THE RELATED ART)

[0002] There has been conventionally known a technique of manufacturing a metal plate used in a vehicle skeleton part of automobile and the like by press molding. In the above uses, there are growing demands on not only a metal plate having a fixed thickness, but also a metal plate having a thickness difference by partially forming a thickened portion. A manufacturing apparatus and method of the metal plate having such a thickened portion by press molding are disclosed in the following patent documents, JP 2014-166645 A, JP 2007-14978 A, and JP 2008-296252 A.

[0003] In the press molding apparatuses disclosed in JP 2014-166645 A and JP 2007-14978 A, both main surfaces of a metal plate are held by a top and bottom pair of dies and the metal plate is pressed in a direction parallel to the main surfaces while maintaining this condition. By this operation, a material of the metal plate flows into a concave portion provided on a part of a holding surface of the die to form a thickened portion. Further, in JP 2008-296252 A, a metal plate folded into a U-shape has an extension portion in one part thereof in a longitudinal direction and a thickened portion is formed on the part in the longitudinal direction when the extension portion is pressed.

[0004] In the press molding apparatuses disclosed in the above patent documents, JP 2014-166645 A and JP 2007-14978 A, the both main surfaces of the metal plate are held by the top and bottom pair of dies and the metal plate is pressed in a direction parallel to the main surfaces under a condition where positions of the dies are fixed. In this configuration, friction force generated by sliding between the dies and the metal plate increases and pressing force, which is required for pressing, increases excessively. On the other hand, in the press molding apparatus disclosed in the above patent document, JP 2008-296252 A, there is a large gap between the dies and the metal plate, thereby sometimes causing folding of the metal plate during pressing. When the folding occurs to the metal plate, a flow direction of the material of the metal plate becomes out of control, thus making it difficult to form the thickened portion having a desired shape.

[0005] The present invention has been made in view of the foregoing problems, and an object thereof is to provide a manufacturing method of press-molded article and a press molding apparatus, capable of forming a thickened portion having a desired shape while reducing pressing force.

SUMMARY OF THE INVENTION

[0006]

(1) A manufacturing method of press-molded article according to one embodiment of the present invention is a method for manufacturing a press-molded article by molding a member to be pressed including a flat plate portion. The method comprises:

> a step of placing the member to be pressed in a press molding apparatus in a manner such that a first main surface of the flat plate portion is opposed to a first opposing surface and a second main surface of the flat plate portion, directing opposite to the first main surface, is opposed to a second opposing surface; and
> a step of pressing the flat plate portion by bringing a first press portion opposing to a first end portion of the flat plate portion and a second press portion opposing to a second end portion of the flat plate portion, the second end portion being located on an opposite side of the first end portion, closer to each other. The first opposing surface and the second opposing surface, while facing to each other, keep in contact with the flat plate portion during pressing. In the press step, a thick portion is formed on the flat plate portion by allowing a part of a material of the flat plate portion to flow, in a press direction, into a thickened portion-forming section formed on at least one of the first opposing surface and the second opposing surface, and at least one of the first opposing surface and the second opposing surface is moved to the press direction as the flat plate portion is pressed by the first press portion and the second press portion.

In the above method, when the flat plate portion is pressed by bringing the first press portion and the second press portion closer to each other, the opposing surface opposing to the main surface of the flat plate portion is moved to the press direction. Thus, as compared to a conventional case where the press is performed while the opposing surface is fixed without moving, friction force generated by sliding between the main surface of the flat plate portion and the opposing surface can be further reduced. As a result, necessary pressing force can be further reduced.

Further, in the above method, the thick portion, of which a thickness is increased, can be formed on the flat plate portion by pressing the flat plate portion using the first press portion and the second press portion and allowing a part of the material of the flat

plate portion to flow, in the press direction, into the thickened portion-forming section. During this process, the first opposing surface and the second opposing surface, while facing to each other, keep in contact with the flat plate portion during pressing, thus enabling to prevent an occurrence of folding to the flat plate portion during pressing and suppress the non-uniformity of a flow direction of the material. As a result, the material of the flat plate portion can be reliably flown into the thickened portion-forming section to form the thickened portion having a desired shape.

The term "first end portion and second end portion" herein refers to both ends of the flat plate portion in the press direction.

(2) In the above manufacturing method of press-molded article, in the step of placing the member to be pressed, the flat plate portion may be placed between a die provided with the first press portion and the first opposing surface and a die provided with the second press portion and the second opposing surface.

Having such a configuration can further simplify an apparatus structure in comparison with a case where the first press portion and the first opposing surface are provided in separate members and the second press portion and the second opposing surface are provided in separate members.

(3) In the above manufacturing method of press-molded article, the die provided with the first opposing surface may include a first divided portion and a second divided portion formed separately from the first divided portion. The first press portion may be formed in the first divided portion and the second press portion may be formed in the second divided portion. In the press step, the first divided portion ma y be moved to the press direction of the first press portion as the flat plate portion is pressed by the first press portion, and the second divided portion is moved to the press direction of the second press portion as the flat plate portion is pressed by the second press portion.

In this configuration, the first and second end portions of the flat plate portion can be pressed by the first and second press portions, respectively, by bringing the first divided portion and the second divided portion closer to each other. Thus, the first opposing surfaces can be moved to the press directions of the first and second press portions accordingly and friction force generated between the main surface of the flat plate portion and the opposing surfaces can be further effectively reduced. As a result, pressing force can be further reduced.

(4) In the above manufacturing method of press-molded article, the first divided portion and the second divided portion may have a comb-teeth shape so as to mesh with each other. In the press step, the first divided portion and the second divided portion may come close to each other in such a manner that the both comb teeth mesh with each other.

In this configuration, the flat plate portion can be press-molded in a state of being further stably supported.

(5) In the above manufacturing method of press-molded article, in the step of placing the member to be pressed, the member to be pressed may be placed so as to arrange the first main surface and the second main surface of the flat plate portion along a perpendicular direction.

Having such a configuration can reduce an installation area of the press molding apparatus, thereby saving a space, in comparison with a case where the first main surface and the second main surface are arranged along a horizontal direction.

(6) In the above manufacturing method of press-molded article, in the step of placing the member to be pressed, positions of the first main surface and the second main surface may be maintained along the perpendicular direction by supporting the flat plate portion using a temporarily supporting member.

Having such a configuration can stably support the flat plate portion to prevent it from falling when the first main surface and the second main surface of the flat plate portion are vertically arranged along the perpendicular direction.

(7) In the above manufacturing method of press-molded article, in the press step, pressing force may be applied to the material of the flat plate portion flowing into the thickened portion-forming section.

Having such a configuration can further effectively prevent an occurrence of folding to the flat plate portion in the process of forming a thick part by allowing the material of the flat plate portion to flow into the thickened portion-forming section.

(8) In the above manufacturing method of press-molded article, the member to be pressed may be molded by a hot press.

The above method enables to press the flat plate portion without causing folding as described above, thus a flow direction of the material can be further reliably controlled even when the hot press is used.

(9) A press molding apparatus according to another embodiment of the present invention is a press molding apparatus for molding a member to be pressed including a flat plate portion. The press molding apparatus comprises: a first press portion opposing to a first end portion of the flat plate portion; a second press portion opposing to a second end portion of the flat plate portion, the second end portion being located on an opposite side of the first end portion; a first opposing surface opposing to a first main surface of the flat plate portion; a second opposing surface opposing to a second main surface of the flat plate portion, the second main surface directing opposite to the first main surface; and a driving section

for bringing the first press portion and the second press portion closer to each other to press the flat plate portion. A thickened portion-forming section is formed on at least one of the first opposing surface and the second opposing surface for forming a thick part on the flat plate portion by allowing a part of a material of the flat plate portion to flow into the thickened portion-forming section. The first opposing surface and the second opposing surface are, while facing to each other, configured to keep in contact with the flat plate portion during pressing. At least one of the first opposing surface and the second opposing surface is configured to move to a press direction as the flat plate portion is pressed by the first press portion and the second press portion.

In the above press molding apparatus, the opposing surface opposing to the main surface of the flat plate portion can be moved to the press direction as the flat plate portion is pressed by bringing the first press portion and the second press portion closer to each other. Thus, as compared to a conventional case where the press is performed while the opposing surface is fixed without moving, friction force generated by sliding between the main surface of the flat plate portion and the opposing surface can be further reduced. As a result, necessary pressing force can be further reduced.

Further, in the above press molding apparatus, the thickened portion, of which a thickness is increased, can be formed on the flat plate portion by pressing the flat plate portion using the first press portion and the second press portion and allowing a part of the material of the flat plate portion to flow, in the press direction, into the thickened portion-forming section. During this process, the first opposing surface and the second opposing surface, while facing to each other, keep in contact with the flat plate portion during pressing, thus the flat plate portion can be prevented from being folded during pressing and a flow direction of the material can be suppressed from becoming non-uniform. As a result, the material of the flat plate portion can be reliably flown into the thickened portion-forming section to form the thickened portion having a desired shape.

(10) In the above press molding apparatus, the first press portion and the first opposing surface may be provided in a same die. The second press portion and the second opposing surface may be provided in a same die.

Having such a configuration can further simplify a structure of press molding apparatus in comparison with a case where the first press portion and the first opposing surface are provided in separate members and the second press portion and the second opposing surface are provided in separate members.

(11) In the above press molding apparatus, the die provided with the first opposing surface may include a first divided portion and a second divided portion formed separately from the first divided portion. The first press portion may be formed in the first divided portion and the second press portion may be formed in the second divided portion.

In this configuration, the first and second end portions of the flat plate portion can be pressed by the first and second press portions, respectively, by bringing the first divided portion and the second divided portion closer to each other. Thus, the first opposing surfaces can be moved to the press directions of the first and second press portions accordingly and friction force generated between the main surface of the flat plate portion and the opposing surfaces can be further effectively reduced. As a result, pressing force can be further reduced.

(12) In the above press molding apparatus, the first divided portion and the second divided portion may have a comb-teeth shape so as to mesh with each other.

In this configuration, the flat plate portion can be press-molded in a state of being further stably supported.

(13) In the above press molding apparatus, the first opposing surface and the second opposing surface may be arranged along a perpendicular direction.

Having such a configuration can reduce an installation area of the press molding apparatus, thereby saving a space, in comparison with a case where the first and second opposing surfaces are arranged along a horizontal direction.

(14) The above press molding apparatus may comprise a temporarily supporting member for supporting the flat plate portion to maintain positions of the first main surface and the second main surface along the perpendicular direction.

Having such a configuration can stably support the flat plate portion to prevent it from falling even when the first main surface and the second main surface are vertically arranged along the perpendicular direction.

(15) The above press molding apparatus may comprise a back-pressure applicator for applying pressure force to the material of flat plate portion flowing into the thickened portion-forming section.

Having such a configuration can further effectively prevent an occurrence of folding to the flat plate portion in the process of forming the thick part by allowing the material of the flat plate portion to flow into the thickened portion-forming section.

[0007] The above press molding apparatus enables to press the flat plate portion without causing folding as described above, thus a flow direction of the material can be further reliably controlled even when a hot press is used.

[0008] The present invention can provide the manufacturing method of press-molded article and the press molding apparatus, capable of forming the thickened por-

tion having a desired shape while reducing pressing force.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1 is a schematic view of a configuration of a press molding apparatus according to a first embodiment of the present invention.
FIG. 2 is an enlarged view around a thickened portion-forming section of the above press molding apparatus.
FIG. 3 is a flowchart showing procedures of a manufacturing method of press-molded article according to the first embodiment of the present invention.
FIG. 4 is a diagram showing how a member to be pressed is heated by an electric furnace.
FIG. 5 is a diagram showing how a flat plate portion is pressed to form a thickened portion.
FIG. 6 is a schematic view of a press-molded article.
FIG. 7 is a graph showing measured results of a molding load and a pressing load.
FIG. 8 is a schematic view of a configuration of a press molding apparatus according to a first modification of the above first embodiment.
FIG. 9 is a diagram showing how a flat plate portion is pressed to form a thickened portion in the above first modification.
FIG. 10 is a schematic view of a configuration of a press molding apparatus according to a second embodiment of the present invention.
FIG. 11 is a diagram showing how a flat plate portion is pressed in the above second embodiment.
FIG. 12 is a diagram showing how the flat plate portion is pressed to form a thickened portion in the above second embodiment.
FIG. 13 is a schematic view of a configuration of a press molding apparatus according to a first modification of the above second embodiment.
FIG. 14 is a schematic view of the configuration of the press molding apparatus according to the first modification of the above second embodiment.
FIG. 15 is a schematic view of a configuration of a press molding apparatus according to a second modification of the above second embodiment.
FIG. 16 is a diagram showing how a flat plate portion is pressed to form a thickened portion in the second modification of the above second embodiment.
FIG. 17 is a schematic view of a configuration of a press molding apparatus according to a third embodiment of the present invention.
FIG. 18 is a diagram showing how a flat plate portion is arranged between dies in the above third embodiment.
FIG. 19 is a diagram showing how the flat plate portion is pressed to form a thickened portion in the above third embodiment.
FIG. 20 is a schematic view of a configuration of a press molding apparatus according to a first modification of the above third embodiment.
FIG. 21 is a diagram showing how a flat plate portion is arranged between dies in the first modification of the above third embodiment.
FIG. 22 is a diagram showing how the flat plate portion is pressed to form a thickened portion in the first modification of the above third embodiment.
FIG. 23 is a schematic view of a configuration of a press molding apparatus according to a second modification of the above third embodiment.
FIG. 24 is a diagram showing how a flat plate portion is pressed to form a thickened portion in the second modification of the above third embodiment.
FIG. 25 is a schematic view of a configuration of a press molding apparatus according to a third modification of the above third embodiment.
FIG. 26 is a diagram showing how a flat plate portion is pressed to form a thickened portion in the third modification of the above third embodiment.
FIG. 27 is a schematic view of a configuration of a press molding apparatus according to a fourth modification of the above third embodiment.
FIG. 28 is a diagram showing how a flat plate portion is pressed to form a thickened portion in the fourth modification of the above third embodiment.
FIG. 29 is a diagram showing a configuration of divided portions in another modification of the above third embodiment.
FIG. 30 is a schematic view of a configuration of a press molding apparatus according to a fourth embodiment of the present invention.
FIG. 31 is a diagram showing how a flat plate portion is pressed in the above fourth embodiment.
FIG. 32 is a diagram showing how the flat plate portion is pressed to form a thickened portion in the above fourth embodiment.
FIG. 33 is a schematic view of a configuration of a press molding apparatus according to a first modification of the above fourth embodiment.
FIG. 34 is a diagram showing how a flat plate portion is pressed in the first modification of the above fourth embodiment.
FIG. 35 is a diagram showing how the flat plate portion is pressed to form a thickened portion in the first modification of the above fourth embodiment.
FIG. 36 is a schematic view of a configuration of a press molding apparatus according to another embodiment of the present invention.
FIG. 37 is a diagrammatic illustration for describing partial electric heating.
FIG. 38 is a diagrammatic illustration for describing press-molding of a flat plate portion subjected to the partial electric heating.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

(First Embodiment)

[Configuration of press molding apparatus]

[0011] First of all, a configuration of a press molding apparatus 1 according to a first embodiment of the present invention will be described by mainly referring to FIG. 1.

[0012] The press molding apparatus 1 is an apparatus for press-molding a member to be pressed including a flat plate portion 10, such as a metal plate having a fixed thickness, so as to partially form a thick part (thickened portion) on the flat plate portion 10. The press molding apparatus 1 comprises a first die 11, a second die 12, a supporting member 13, a press member 18, and a drive section 18B.

[0013] The member to be pressed is, for example, a metal plate made of a material, such as hard steel, soft steel, or aluminum. In an example shown in the drawing, the whole member to be pressed is constituted by the flat plate portion 10.

[0014] It is noted that, in the present invention, the whole member to be pressed is not necessary to be constituted by the flat plate portion 10, and the member to be pressed may include the flat plate portion 10 at one part. The flat plate portion 10 comprises a first main surface 10C, a second main surface 10D, directing opposite to the first main surface 10C, a first end portion 10A, and a second end portion 10B, which is located on an opposite side of the first end portion 10A.

[0015] The first die 11 is fixed on a mount surface 13A of the supporting member 13 by a fixing member such as a bolt B. The first die 11 comprises an opposing portion 11C opposing to the flat plate portion 10, and a guide portion 11D for guiding a movement of the second die 12, arranged with an interval from the opposing portion 11C.

[0016] The opposing portion 11C comprises a first opposing surface 11B opposing to the first main surface 10C and a first press portion 11A opposing to the first end portion 10A. In this configuration, the first press portion 11A and the first opposing surface 11B are provided in the same first die 11. The first opposing surface 11B is connected to an upper surface 11F at its upper end and vertically arranged along a perpendicular direction (parallel to perpendicular direction). The first press portion 11A is connected to a lower end of the first opposing surface 11B and formed flatly along a horizontal direction (parallel to horizontal direction).

[0017] A thickened portion-forming section 15 as a concave groove is formed near a center of the first opposing surface 11B. The thickened portion-forming section 15 is provided to form a thickened portion, of which a thickness is increased, on the flat plate portion 10 by allowing a part of a material of the flat plate portion 10 in a press direction during press-molding. The thickened portion-forming section 15 is surrounded by a pair of horizontal sidewall surfaces, stretching horizontally, and a bottom wall surface connecting between inner side end portions of the pair of sidewall surfaces, and recessed in a direction away from the flat plate portion 10. The thickened portion-forming section 15 is formed on one part of the first opposing surface 11B in the press direction.

[0018] It is noted that a shape of the thickened portion-forming section 15 is not limited thereto and can be appropriately changed according to a shape of the thickened portion formed on the flat plate portion 10. For example, the shape may have a semi-circular cross section, a triangular cross section, and the like. Further, the first opposing surface 11B may include a plurality of the thickened portion-forming sections 15. Further, the thickened portion-forming section 15 needs not be formed in the center.

[0019] A plurality of guide rollers 17 are arranged on an inner surface of the guide portion 11D. The second die 12 has its lower end part between the guide portion 11D and the opposing portion 11C and moves to the perpendicular direction according to contraction of a spring 16. During this process, the guide rollers 17 comes into contact with a side surface of the second die 12, thereby guiding a movement of the second die 12 in the perpendicular direction.

[0020] The second die 12 is connected to an upper end of the spring 16 at its lower surface and has its lower end part between the opposing portion 11C and the guide portion 11D. Before the press-molding is started (FIG. 1), an upper surface 12C of the second die 12 is located higher than an upper surface 11F of the first die 11.

[0021] The second die 12 comprises a second opposing surface 12B opposing to the second main surface 10D and a second press portion 12A opposing to the second end portion 10B. In this configuration, the second press portion 12A and the second opposing surface 12B are provided in the same second die 12. The second opposing surface 12B is connected to the second press portion 12A at its upper end and vertically arranged along the perpendicular direction (parallel to perpendicular direction). The second press portion 12A is formed flatly along the horizontal direction (parallel to horizontal direction).

[0022] The second die 12 is arranged in a manner such that the second opposing surface 12B is opposed to the first opposing surface 11B in the horizontal direction across the flat plate portion 10 and the second press portion 12A is opposed to the first press portion 11A in the perpendicular direction across the flat plate portion 10. In this configuration, the flat plate portion 10 can be arranged between the first die 11 and the second die 12.

[0023] In FIG. 2, a thickness of the flat plate portion 10 is represented by T1, a distance between the first and

second opposing surfaces 11B and 12B is represented by D1, and a distance between a bottom wall surface 15A of the thickened portion-forming section 15 and the second opposing surface 12B is represented by D2. In the press molding apparatus 1, the distance D1 is adjusted according to the thickness T1, so that a ratio of distance D1 (mm)/thickness T1 (mm) becomes 1.1 or lower. For example, when the flat plate portion 10 having the thickness T1 of 1.4mm is pressed, the distance D1 is adjusted to 1.6mm. Further, the distance D2 is adjusted to 2.2mm.

[0024] As shown in FIG. 2, before the pressing is started (i.e., before the flat plate portion 10 is pressed by the first and second press portions 11A and 12A), a gap between the flat plate portion 10, and the first opposing surface 11B and second opposing surface 12B may be formed unless the gap causes folding during pressing. In another words, the first opposing surface 11B and the second opposing surface 12B are opposed to each other with the distance D1 sufficient to avoid the folding of the flat plate portion 10 during pressing. The term "folding of the flat plate portion 10" herein refers to a condition where the flat plate portion 10 is folded to such a degree that a flow of the material of the flat plate portion 10 caused by pressing is disturbed, and does not include a minute swell of the flat plate portion 10 caused during pressing unless it affects the flow of the material.

[0025] Then, during pressing, the first opposing surface 11B and the second opposing surface 12B, while facing to each other, keep in contact with the flat plate portion 10. However, the flat plate portion 10 needs not always contact with the first opposing surface 11B or the second opposing surface 12B during pressing. Further, the whole flat plate portion 10 needs not contact with the first opposing surface 11B or the second opposing surface 12B.

[0026] As shown in FIG. 1, the supporting member 13 is a metallic member having a rectangular parallelepiped shape and comprises the flat mount surface 13A on which a lower surface of the first die 11 is placed. The mount surface 13A of the supporting member 13 is laterally arranged along the horizontal direction and fixed on the first die 11 by a fixing member such as the bolt B.

[0027] A press member 18 is a member that presses the upper surface 12C of the second die 12 to move the second die 12 downward in the perpendicular direction. The press member 18 having a press surface 18A is moved downward in the perpendicular direction by operating a driving section 18B. Then, the upper surface 12C of the second die 12 is pressed by the press surface 18A, so that the second die 12 can move downward in the perpendicular direction.

[0028] The driving section 18B is arranged in contact with an upper surface 18C of the press member 18. The driving section 18B comprises, for example, a hydraulic or electric piston and presses the upper surface 18C to move the press member 18 downward in the perpendicular direction.

[0029] In the above press molding apparatus 1, first of all, the press member 18 is lowered by operating the driving section 18B, so that the press surface 18A is brought into contact with the upper surface 12C of the second die 12. The press member 18 is further lowered to move the second die 12 downward in the perpendicular direction while maintaining this state, so that the second press portion 12A is brought closer to the first press portion 11A. Then, the flat plate portion 10 is pressed by the first press portion 11A and the second press portion 12A from the both end portions 10A and 10B in a direction parallel to the main surfaces 10C and 10D (FIG. 5). By this operation, a part of the material of the flat plate 10 is flown, in the press direction, into the thickened portion-forming section 15 to form the thickened portion.

[0030] In this configuration in the above press molding apparatus 1, the second opposing surface 12B is moved to the press direction as the pressing is performed by the first and second press portions 11A and 12A. That is, the second opposing surface 12B is slid toward the same direction as the press direction of the flat plate portion 10. Thus, friction force generated by sliding between the second main surface 10D and the second opposing surface 12B can be reduced and pressing force required for molding the flat plate portion 10 can be reduced.

[Manufacturing method of press-molded article]

[0031] Next, a manufacturing method of press-molded article using the above press molding apparatus 1, according to the present embodiment, will be described along a flowchart shown in FIG. 3. First of all, a member to be pressed is prepared in a step S10. In the step S10, the member to be pressed including the flat plate portion 10, such as a metal plate having a fixed thickness, is prepared and heated with a predetermined temperature by an electric furnace F (FIG. 4). By this operation, the whole flat plate portion 10 becomes softened. In the present embodiment, a press-molded article is manufactured by a hot press, in which the whole flat plate portion 10 is heated to be softened and then molded. It is noted that the present invention is not limited to the case where the hot press is performed, and may adopt a cold working without performing the step S10.

[0032] Next, the member to be pressed is placed in a step S20. In the step S20, the flat plate portion 10 softened in the above step S10 is placed between the first die 11 and the second die 12 (FIG. 1). More specifically, the flat plate portion 10 is placed in such a manner that the first main surface 10C is opposed to the first opposing surface 11B along the perpendicular direction and the second main surface 10D is opposed to the second opposing surface 12B along the perpendicular direction. During this process, the first opposing surface 11B and the second opposing surface 12B, while facing to each other, keep in contact with the flat plate portion 10 during pressing to prevent an occurrence of folding to the flat plate portion 10 in a following press step S30.

[0033] Next, the member to be pressed is pressed in a step S30. In the step S30, first of all, the press member 18 is lowered by operating the driving section 18B, so that the press surface 18A is brought into contact with the upper surface 12C of the second die 12. Then, the press member 18 is further lowered to press the upper surface 12C of the second die 12, so that the second die 12 is moved downward and the second press portion 12A is brought closer to the first press portion 11A. By this operation, the flat plate portion 10 is pressed by the first press portion 11A and the second press portion 12A from the both end portions 10A and 10B in the direction parallel to the main surfaces 10C and 10D. Then, a part of the material of the flat plate portion 10 is flown into the thickened portion-forming section 15 in the press direction (arrows in FIG. 5) to form the thickened portion, of which a thickness is increased, on the flat plate portion 10. Subsequently, the operation of the driving section 18B is stopped at the time when the press surface 18A comes into contact with the upper surface 11F of the first die 11.

[0034] In the step S30, the second opposing surface 12B is moved (slid) toward the press direction as the flat plate portion 10 is pressed by the first press portion 11A and the second press portion 12A. That is, the second opposing surface 12B is moved to the same direction as the press direction of the flat plate portion 10. Thus, friction force generated by sliding between the second main surface 10D and the second opposing surface 12B can be reduced during pressing and the flat plate portion 10 can be molded with less pressing force.

[0035] Further, the first and second opposing surfaces 11B and 12B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. This can prevent the flat plate portion 10 from being folded during pressing, thereby suppressing the non-uniformity of the flow direction of the material. Thus, the material of the flat plate portion 10 can be reliably flown into the thickened portion-forming section 15 from the both end portions 10A and 10B. As a result, the thickened portion can be formed in a desired shape in accordance with the shape of the thickened portion-forming section 15.

[0036] Finally, the press-molded article is taken out in a step S40. In the step S40, the press member 18 is moved up by operating the driving section 18B after completing the press-molding of the flat plate portion 10 in the step S30. Then, a press-molded article 100 having a thickened portion 100A formed thereon (FIG. 6) is taken out. Through the above steps S10 to S40, the manufacturing method of press-molded article according to the present embodiment is completed.

[Advantageous effects]

[0037] Next, representative configurations and advantageous effects of the above press molding apparatus 1 will be described.

[0038] The above press molding apparatus 1 comprises the first press portion 11A, the second press portion 12A, the first opposing surface 11B, the second opposing surface 12B, and the driving section 18B that brings the first press portion 11A and the second press portion 12A closer to each other. The first opposing surface 11B includes the thickened portion-forming section 15 for forming the thick part on the flat plate portion 10. The first opposing surface 11B and the second opposing surface 12B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. The thickened portion-forming section 15 is configured in such a manner that the part of the material of the flat plate portion 10 is flown, in the press direction, into the thickened portion-forming section 15 as the flat plate portion 10 is pressed by the first press portion 11A and the second press portion 12A. The second opposing surface 12B is configured to move to the press direction as the flat plate portion 10 is pressed by the first press portion 11A and the second press portion 12A.

[0039] In the above press molding apparatus 1, the second opposing surface 12B can be moved to the press direction as the first press portion 11A and the second press portion 12A come closer to each other to press the flat plate portion 10. Thus, as compared to a conventional case where the pressing is performed while the opposing surface is fixed without moving, friction force generated by sliding between the second main surface 10D and the second opposing surface 12B can be further reduced. As a result, necessary pressing force can be further reduced.

[0040] A graph in FIG. 7 shows an effect of load reduction achieved in the present embodiment, in which the pressing is performed while moving the opposing surface. In the graph in FIG. 7, columns 1 and 2 show values of a molding load and a pressing load in a case where the pressing is performed without moving the opposing surface and a case where the pressing is performed while moving the opposing surface, respectively. The term "molding load" refers to a load required for press-molding the flat plate portion 10, while the term "pressing load" refers to a load required for fixing a clearance between the dies. As is evident from the graph, the molding load is significantly reduced (reduced up to about one-tenth) when the pressing is performed while moving the opposing surface as compared to the case where the pressing is performed without moving the opposing surface.

[0041] Further, in the above press molding apparatus 1, the thickened portion 100A, of which a thickness is increased, can be formed on the flat plate portion 10 by pressing the flat plate portion 10 by the first press portion 11A and the second press portion 12A and allowing the part of the material of the flat plate portion 10 to flow into the thickened portion-forming section 15 in the press direction. During this process, the first opposing surface 11B and the second opposing surface 12B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. This can prevent the non-uniformity of the flow direction of the material caused by folding generated in the flat plate portion 10 during pressing.

That is, it becomes possible to control the flow of the material. Thus, the material of the flat plate portion 10 can be reliably flown into the thickened portion-forming section 15, thereby enabling to form the thickened portion 100A having a desired shape.

[0042] In the above press molding apparatus 1, the first press portion 11A and the first opposing surface 11B are provided in the same first die 11, and the second press portion 12A and the second opposing surface 12B are provided in the same second die 12. This can further simplify a structure of the press molding apparatus 1 in comparison with a case where the first press portion 11A and the first opposing surface 11B are provided in separate members and the second press portion 12A and the second opposing surface 12B are provided in separate members.

[0043] In the above press molding apparatus 1, the first opposing surface 11B and the second opposing surface 12B are arranged along the perpendicular direction. This can reduce an installation area of the press molding apparatus 1, thereby saving a space, in comparison with a case where the first opposing surface 11B and the second opposing surface 12B are arranged along the horizontal direction.

[First Modification]

[0044] Next, a press molding apparatus 1A according to a first modification of the above first embodiment will be described with reference to FIG. 8 and FIG. 9. In the press molding apparatus 1A according to the first modification, the opposing portion 11C of the first die 11 and the guide portion 11D are provided separately from each other. Further, the press member 18 comprises a main body portion 18D, which has the upper surface 18C in contact with the driving section 18B, and a press portion 18E fixed on a lower surface 18G of the main body portion 18D. The press portion 18E is made from a shape in which a press portion main body 18H, fixed on the lower surface 18G by a fixing member such as a bolt B, is connected to a first supporting portion 18F and a second supporting portion 18I. The press portion 18E is formed in an upside down U-shape in a cross sectional view.

[0045] The press portion main body 18H comprises a press surface 18J that presses the upper surface 12C of the second die 12. The first supporting portion 18F and the second supporting portion 18I extend downward in the perpendicular direction from both end portions of the press portion main body 18H in the horizontal direction.

[0046] A first inner surface 18K is formed inside the first supporting portion 18F and a second inner surface 18L is formed inside the second supporting portion 18I. A horizontal distance between the first inner surface 18K and the second inner surface 18L is made slightly larger than that between side surfaces of the first die 11 (opposing portion 11C) and the second die 12. In this configuration, when the press member 18 is lowered to press the flat plate portion 10 as shown in FIG. 9, the first die 11 (opposing portion 11C) and the second die 12 can be placed between the first and second supporting portions 18F and 18I. This can further reliably prevent displacement of the first and second dies 11 and 12 during pressing.

(Second Embodiment)

[0047] Next, a press molding apparatus 2 and a manufacturing method of press-molded article according to a second embodiment of the present invention will be described with reference to FIG. 10 to FIG. 12. It is noted that only the parts in which the second embodiment differs from the above first embodiment will be described in detail.

[Configuration of press molding apparatus]

[0048] The press molding apparatus 2 comprises a first die 21, a second die 22, a supporting member 26, and a driving section 28B. The first die 21 is formed in an approximately rectangular parallelepiped shape and comprises a first opposing surface 21B opposing to the first main surface 10C, a first side surface 21C directing opposite to the first opposing surface 21B, and a first press portion 21A opposing to the first end portion 10A. In this configuration, the first press portion 21A and the first opposing surface 21B are provided in the same first die 21. The first side surface 21C of the first die 21 is fixed on a fixed surface 26A of the supporting member 26 by a fixing member such as a bolt B.

[0049] The first opposing surface 21B is connected to an upper surface 21F at its upper end and arranged along the perpendicular direction. The first press portion 21A is connected to a lower end of the first opposing surface 21B so as to form an acute angle at the point of intersection. A thickened portion-forming section 25 as a concave groove is formed near a center of the first opposing surface 21B and used for forming a thickened portion by allowing a part of the material of the flat plate portion 10 to flow into the thickened portion-forming section 25 during pressing.

[0050] The second die 22 comprises a second die main body 28 and a die fixing member 29 connected to an upper surface of the second die main body 28. The second die main body 28 is formed in a rectangular parallelepiped shape, having a size capable of being inserted into a die space 26B formed in the supporting member 26. The second die main body 28 comprises a second opposing surface 22B opposing to the second main surface 10D, a second side surface 22C directing opposite to the second opposing surface 22B, and a second press portion 22A opposing to the second end portion 10B. In this configuration, the second press portion 22A and the second opposing surface 22B are provided in the same second die 22. The second opposing surface 22B is connected to the second press portion 22A at its upper end and arranged along the perpendicular direction. The sec-

ond press portion 22A intersects with the second opposing surface 22B so as to form an acute angle. The die fixing member 29 has the approximately same width as the supporting member 26 and fixed to the upper surface of the second die main body 28 by the bolt B.

[0051] The second die main body 28 is inserted into the die space 26B (FIG. 11), so that the second opposing surface 22B is arranged to be opposed to the first opposing surface 21B across the flat plate portion 10 in the horizontal direction and the second press portion 22A is arranged to be opposed to the first press portion 21A across the flat plate portion 10 in the perpendicular direction. Thus, the flat plate portion 10 can be placed between the first die 21 and the second die 22. In this configuration, the first opposing surface 21B and the second opposing surface 22B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. Further, the second side surface 22 C comes into contact with guide rollers 27, thereby guiding a movement of the second die main body 28 in the perpendicular direction.

[0052] The supporting member 26 is a metallic member and includes the die space 26B having a concave shape, to which the second die main body 28 is inserted. The supporting member 26 comprises the fixed surface 26A to which the first die 21 is fixed, a bottom surface 26C opposing to a lower surface 22D of the second die main body 28, and a guide surface 26D on which a plurality of the guide rollers 27 are arranged.

[0053] The driving section 28B is arranged in contact with an upper surface 29A of the die fixing member 29. The driving section 28B comprises, as in the above first embodiment, a hydraulic or electric piston and moves the second die 22 downward in the perpendicular direction by pressing the upper surface 29A.

[Manufacturing method of press-molded article]

[0054] Next, explanation is given to a manufacturing method of press-molded article using the above press molding apparatus 2. First of all, a member to be pressed including the flat plate portion 10 is softened by heating to be prepared (FIG. 3: S10). Next, the flat plate portion 10 is placed in the first die 21 while the second die 22 is positioned above the first die 21 (FIG. 10). Then, the second die 22 is lowered by operating the driving section 28B, so that the second die main body 28 is inserted into the die space 26B, and the second press portion 22A is brought into contact with the second end portion 10B (FIG. 11). By this operation, the member to be pressed is placed in a manner such that the first main surface 10C is opposed to the first opposing surface 21B and the second main surface 10D is opposed to the second opposing surface 22B (FIG. 3: S20). During this process, the first and second main surfaces 10C and 10D are arranged along the perpendicular direction. Further, the first opposing surface 21B and the second opposing surface 22B, while facing to each other, keep in contact with the flat plate portion 10 during pressing.

[0055] Next, the second die 22 is further lowered by operating the driving section 28B, so that the second press portion 22A is brought closer to the first press portion 21A. By this operation, the flat plate portion 10 is pressed by the first press portion 21A and the second press portion 22A in a direction parallel to the main surfaces 10C and 10D, and a part of the material of the flat plate portion 10 is flown into the thickened portion-forming section 25 (FIG. 12). By this operation, the thickened portion, of which a thickness is increased, is formed on one part of the flat plate portion 10 (FIG. 3: S30). During this process, as in the above first embodiment, the second opposing surface 22B is moved toward the press direction as the flat plate portion 10 is pressed by the first press portion 21A and the second press portion 22A. Then, after the press of the flat plate portion 10 is completed, the second die 22 is moved up by operating the driving section 28B and a press-molded article is taken out (FIG. 3: S40).

[0056] In the above second embodiment, as in the above first embodiment, the second opposing surface 22B is moved toward the press direction as the flat plate portion 10 is pressed by the first press portion 21A and the second press portion 22A in the perpendicular direction. Thus, friction force generated by sliding between the second main surface 10D and the second opposing surface 22B can be reduced during pressing and the flat plate portion 10 can be molded with less pressing force. Further, the first opposing surface 21B and the second opposing surface 22B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. This can prevent the non-uniformity of the flow direction of the material of the flat plate portion 10 caused by folding generated during pressing, thus the material of the flat plate portion 10 can be reliably flo wn into the thickened portion-forming section 25. Further, in the configuration of the above second embodiment, the first side surface 21C of the first die 21 is fixed to the supporting member 26 and the second die 22 (second die main body 28) is inserted into the die space 26B of the supporting member 26, thus displacement of the first and second dies 21 and 22 can be further reliably prevented during pressing.

[First Modification]

[0057] Next, a press molding apparatus 2A according to a first modification of the above second embodiment will be described with reference to FIG. 13 and FIG. 14. The press molding apparatus 2A according to the first modification further comprises a temporarily supporting member 26E, which prevents the flat plate portion 10 from falling.

[0058] The press molding apparatus 2A comprises a pair of the temporarily supporting members 26E each having a thin plate shape. As shown in FIG. 14, each temporarily supporting member 26E is provided outside of an insertion region of the second die 22. Each temporarily supporting member 26E is formed in an elongate

shape extending from a lower end to an upper end, and the upper end is bent in a direction away from the flat plate portion 10 while the lower end is attached to the supporting member 26 by a fixture 26F. The temporarily supporting members 26E contact with both end parts of the second main surface 10D of the flat plate portion 10, thereby supporting the flat plate portion 10 so as to maintain the first main surface 10C and the second main surface 10D along the perpendicular direction.

[0059] In the above press molding apparatus 2A, first of all, the flat plate portion 10 is placed between the first die 21 and the temporarily supporting members 26E. During this process, the flat plate portion 10 is supported by the temporarily supporting members 26E and thus maintained in a vertical condition where the first and second main surfaces 10C and 10D are arranged along the perpendicular direction. Subsequently, the second die 22 (second die main body 28) is inserted into the die space 26B and the flat plate portion 10 is arranged between the first die 21 and the second die 22. In this manner, before the flat plate portion 10 is arranged between the first die 21 and the second die 22, the temporarily supporting members 26E can stably support the flat plate portion 10 and prevent it from falling.

[Second Modification]

[0060] Next, a press molding apparatus 2B according to a second modification of the above second embodiment will be described with reference to FIG. 15 and FIG. 16. The press molding apparatus 2B according to the second modification comprises a back-pressure applicator 25E that applies pressure force to the material of the flat plate portion 10 flowing into a thickened portion-forming section 25A.

[0061] The thickened portion-forming section 25A is formed as a hole that penetrates in the horizontal direction at a substantially center of the first die 21. A through hole 26G is formed in the supporting member 26 and communicates with the thickened portion-forming section 25A.

[0062] The back-pressure applicator 25E comprises a pad portion 25B, an elastic member 25C, and a supporting portion 25D. The pad portion 25B is formed in a convex shape and arranged inside the thickened portion-forming section 25A. The elastic member 25C is constituted by a spring that energizes the pad portion 25B and arranged inside the through hole 26G. The elastic member 25C is arranged between the pad portion 25B and the supporting portion 25D. Both ends of the elastic member 25C may or may not be connected to the pad portion 25B and the supporting portion 25D. The supporting portion 25D is integrally fixed to the supporting member 26.

[0063] When the flat plate portion 10 is pressed by the first press portion 21A and the second press portion 22A, the material of the flat plate portion 10 flows into the thickened portion-forming section 25A while pushing the pad portion 25B and thereby causing compression of the elastic member 25C. During this process, restoring force of the elastic member 25C is imparted, via the pad portion 25B, to the material flowing into the thickened portion-forming section 25A. That is, the material of the flat plate portion 10 flows into the thickened portion-forming section 25A while the pressure force is applied to the material by the back-pressure applicator 25E. In this manner, an occurrence of folding to the flat plate portion 10 can be further effectively prevented in the process of flowing the material into the thickened portion-forming section 25A by pressing the flat plate portion 10.

(Third Embodiment)

[0064] Next, a press molding apparatus 3 and a manufacturing method of press-molded article according to a third embodiment of the present invention will be described with reference to FIG. 17 to FIG. 19. It is noted that only the parts in which the third embodiment differs from the above first embodiment will be described in detail.

[Configuration of press molding apparatus]

[0065] The press molding apparatus 3 comprises a first die 33, a second die 34 arranged above the first die 33, a supporting member 39 on which the first die 33 is placed, a press member 38, and a driving section 38B. The first die 33 is constituted of a first divided portion 31 and a second divided portion 32 formed separately from the first divided portion 31. The first divided portion 31 and the second divided portion 32 are arranged to be opposed to each other in the horizontal direction.

[0066] The first divided portion 31 comprises a first portion 31D to be pressed, which is pressed by the press member 38, a first press portion 31E for pressing the flat plate portion 10, and a first mount portion 31F on which the flat plate portion 10 is placed. A first surface 31C to be pressed, formed on an upper part of the first portion 31D to be pressed, is pressed by a first press surface 38F. A first press portion 31A, formed on a side part of the first press portion 31E, is opposed to the first end portion 10A of the flat plate portion 10. A first opposing surface 31B, formed on an upper part of the first mount portion 31F, is opposed to the first main surface 10C of the flat plate portion 10.

[0067] The second divided portion 32 has a symmetrical shape to the first divided portion 31. That is, the second divided portion 32 comprises a second portion 32D to be pressed, which is pressed by the press member 38, a second press portion 32E for pressing the flat plate portion 10, and a second mount portion 32F on which the flat plate portion 10 is placed. A second surface 32C to be pressed, formed on an upper part of the second portion 32D to be pressed, is pressed by a second press surface 38G. A second press portion 32A, formed on a side part of the second press portion 32E, is opposed to the second end portion 10B of the flat plate portion 10.

A first opposing surface 32B, formed on an upper part of the second mount portion 32F, is opposed to the first main surface 10C of the flat plate portion 10. Further, the first opposing surfaces 31B and 32B are laterally arranged along the horizontal direction (parallel to horizontal direction).

[0068] The first and second mount portions 31F and 32F have a comb-teeth shape so as to mesh with each other. Specifically, as shown by arrows in FIG. 17 (B), the comb teeth of the first mount portion 31F are inserted into gaps between the comb teeth of the second mount portion 32F, and vice versa, as the first and second mount portions 31F and 32 are brought closer to each other.

[0069] The second die 34 is formed in an approximately rectangular parallelepiped shape and comprises a second opposing surface 34B opposing to the second main surface 10D of the flat plate portion 10. The second opposing surface 34B is laterally arranged along the horizontal direction (parallel to horizontal direction). A thickened portion-forming section 35 is formed as a concave groove near a center of the second opposing surface 34B, so that a thickened portion, of which a thickness is increased, can be formed on the flat plate portion 10 by allowing a part of the material of the flat plate portion 10 to flow into the thickened portion-forming section 35 during pressing. Further, when the flat plate portion 10 is arranged between the first and second dies 33 and 34 (FIG. 18), the first opposing surfaces 31B and 32B, and the second opposing surface 34B, while facing to each other, keep in contact with the flat plate portion 10 during pressing.

[0070] The supporting member 39 is a member made of metal, formed in a rectangular parallelepiped shape, and used for mounting the first die 33. A plurality of guide rollers 37 are arranged on an upper surface of the supporting member 39, and allows the first and second divided portions 31 and 32 to slide in the horizontal direction.

[0071] The press member 38 presses the first and second divided portions 31 and 32, thereby sliding them in the horizontal direction. The press member 38 comprises a main body portion 38A in contact with the driving section 38H and a press portion 38B fixed on a lower surface of the main body portion 38A. The press portion 38B is made from a shape in which a press portion main body 38C, fixed on the lower surface of the main body portion 38A by the bolt B, is connected to a first extension portion 38D and a second extension portion 38E. A cross section of the press portion 38B cut with a plane including a width direction (right/left direction in FIG. 17(B)) of the flat plate portion 10 and the perpendicular direction has an upside down U-shape. A lower surface of the press portion main body 38C is connected to an upper surface of the second die 34 by a plurality of (two) springs. The first press surface 38F for pressing the first divided portion 31 is formed at a tip of the first extension portion 38D, while the second press surface 38G for pressing the second divided portion 32 is formed at a tip of the second extension portion 38E.

[0072] The driving section 38H is arranged in contact with the upper surface of the press member 38 (main body portion 38A). The driving section 38H comprises, as in the above first embodiment, a hydraulic or electric piston, and moves the press member 38 downward in the perpendicular direction by pressing.

[Manufacturing method of press-molded article]

[0073] Next, explanation is given to a manufacturing method of press-molded article using the above press molding apparatus 3. First of all, a member to be pressed including the flat plate portion 10 is softened by heating to be prepared (FIG. 3: S10).

[0074] Next, the flat plate portion 10 is placed on the first and second divided portions 31 and 32 with the first main surface 10C turned downward (FIG. 17), while the second die 34 is positioned above them (FIG. 17). Next, the press member 38 is lowered by operating the driving section 38H, so that the second die 34 fixed to the press member 38 is also lowered. By this operation, as shown in FIG. 18 (A), the flat plate portion 10 is placed in a manner such that the first main surface 10C is opposed to the first opposing surfaces 31B and 32B, and the second main surface 10D is opposed to the second opposing surface 34B (FIG. 3: S20). During this process, the first opposing surfaces 31B and 32B, and the second opposing surface 34B, while facing to each other, keep in contact with the flat plate portion 10 during pressing.

[0075] Next, the press member 38 is further lowered by operating the driving section 38H, so that the first and second press surfaces 38F and 38G are brought into contact with the first and second surfaces 31C and 32C to be pressed, respectively (FIG. 19(A)). When the press member 38 is further lowered while maintaining this state, the first press surface 38F, while sliding on the first surface 31C to be pressed, makes the first divided portion 31 slide to a side of the second divided portion 32, and the second press surface 38G, while sliding on the second surface 32C to be pressed, makes the second divided portion 32 slide to a side of the first divided portion 31. By this operation, the first and second divided portions 31 and 32 approach each other so as to cause tips of the comb teeth of one divided portion to abut gaps between the comb teeth of the other divided portion (FIG. 19(B)). In this manner, when the first and second divided portions 31 and 32 approach each other, the first and second press portions 31A and 32a also come close to each other and the flat plate portion 10 is pressed from the both sides of the end portions 10A and 10B in the horizontal direction. During this process, a part of the material of the flat plate portion 10 is flown into the thickened portion-forming section 35 in the press direction, thereby forming a thickened portion, of which a thickness is increased, on the flat plate portion 10.

[0076] In the press step, the first divided portion 31 moves to the press direction of the first press portion 31A

(direction from left to right in drawing) as the first press portion 31A presses the flat plate portion 10. Further, the second divided portion 32 moves to the press direction of the second press portion 32A (direction from right to left in drawing) as the second press portion 32A presses the flat plate portion 10. Thus, the first opposing surface 31B is moved to the press direction of the first press portion 31A as the flat plate portion 10 is being pressed, and the second opposing surface 32B is moved to the press direction of the second press portion 32A as the flat plate portion 10 is being pressed. Then, after the press of the flat plate portion 10 is completed, the press member 38 and the second die 34 are moved up by operating the driving section 38H and a press-molded article is taken out (FIG. 3: S40).

[0077] In the above third embodiment, the first die 33 is divided into the first divided portion 31 and the second divided portion 32. By bringing them closer to each other, the first and second end portions 10A and 10B of the flat plate portion 10 can be pressed by the first and second press portions 31A and 32A, respectively. In this configuration, the first opposing surface 31B and the first opposing surface 32B can be moved in the opposite directions to each other according to the press directions of the first and second press portions 31A and 32A. As a result, friction force generated between the first main surface 10C, and the first opposing surfaces 31B and 32B can be further effectively reduced and pressing force can be further reduced. Further, the first and second divided portions 31 and 32 ar e formed in the comb-teeth shape so as to mesh with each other, thus the flat plate portion 10 can be press-molded while being stably supported.

[First Modification]

[0078] Next, a first modification of the above third embodiment will be described with reference to FIG. 20 to FIG. 22. In a press molding apparatus 3A according to the first modification, a plurality of (two) thickened portion-forming sections 35 are formed at intervals from each other on the second opposing surface 34B. In this configuration, by pressing the flat plate portion 10 using the first and second press portions 31A and 32A, the material of the flat plate portion 10 can be flown into each of the plurality of the thickened portion-forming sections 35 (FIG. 22(A)), thereby enabling to manufacture a press-molded article having a more complicated shape.

[0079] It is noted that a shape and size of each thickened portion-forming section 35 may be the same or different from each other. Further the intervals between the thickened portion-forming sections 35 can be appropriately designed according to a shape of the press-molded article.

[Second Modification]

[0080] Next, a second modification of the above third embodiment will be described with reference to FIG. 23 and FIG. 24. A press molding apparatus 3B according to the second modification comprises, as described in the second modification of the above second embodiment, a back-pressure applicator 35D that applies pressure force to the material of the flat plate portion 10 flowing into a thickened portion-forming section 35A.

[0081] The thickened portion-forming section 35A having a hole shape is formed near a center of the second opposing surface 34B. The back-pressure applicator 35D comprises a pad portion 35B and an elastic member 35C. The pad portion 35B is formed in a convex shape and arranged inside the thickened portion-forming section 35A. The elastic member 35C is constituted by a spring that energizes the pad portion 35B, and one end of the elastic member 35C is connected to the pad portion 35B and the other end is connected to a hole wall surface of the second die 34.

[0082] As shown in FIG. 24, when the flat plate portion 10 is pressed by the first and second press portions 31A and 32A, the material of the flat plate portion 10 presses the pad portion 35B while flowing into the thickened portion-forming section 35A. During this process, restoring force of the elastic member 35C is imparted to the material flowing into the thickened portion-forming section 35A via the pad portion 35B. That is, the material of the flat plate portion 10 flows into the thickened portion-forming section 35A, while pressure force is applied to the material by the back-pressure applicator 35D. In this manner, an occurrence of folding to the flat plate portion 10 can be further effectively prevented in the process of flowing the material of the flat plate portion 10 into the thickened portion-forming section 35A.

(Third Modification)

[0083] Next, a third modification of the above third embodiment will be described with reference to FIG. 25 and FIG. 26. In a press molding apparatus 3C according to the third modification, the first divided portion 31 and the second divided portion 32 are connected to each other by a spring 33A.

[0084] The first divided portion 31 comprises a first mount portion 31G of a quadrangular shape in a plan view (FIG. 25(B)) and a first protrusion 31H projected from a side surface of the first mount portion 31G. A first opposing surface 31B is formed on an upper part of the first mount portion 31G. The first protrusion 31H is provided to the first mount portion 31G with a difference in height, so that an upper surface of the first protrusion 31H is located lower than the first opposing surface 31B (FIG. 25(A)).

[0085] The second divided portion 32 comprises a second mount portion 32G of a quadrangular shape, of which an area is smaller than that of the first mount portion 31G, in a plan view (FIG. 25(B)). A first opposing surface 32B is formed on an upper part of the second mount portion 32G. Further the second divided portion 32 is provided with a hollow portion 32H, in which the first protrusion

31H can be inserted. That is, the hollow portion 32H is formed to be larger than the first protrusion 31H. The flat plate portion 10 is placed on the first opposing surfaces 31B and 32B so as to cross over the first and second divided portions 31 and 32 (FIG. 25(A)).

[0086] In this configuration, the first and second divided portions 31 and 32 are connected to each other by the spring 33A, thus a positional relation between the first and second divided portions 31 and 32 can be further reliably maintained. Further, in this configuration, the first protrusion 31H can be inserted into the hollow portion 32H, thereby enabling to guide the movement of the first and second divided portions 31 and 32 in horizontal direction during pressing.

(Fourth Modification)

[0087] Next, a fourth modification of the above third embodiment will be described with reference to FIG. 27 and FIG. 28. In a press molding apparatus 3D according to the fourth modification, the first divided portion 31 comprises a first mount portion 31I of an approximately right-angled triangle shape in a plan view (FIG. 27(B)). The first opposing surface 31B is formed on an upper part of the first mount portion 31I. Further, the second divided portion 32 comprises a second mount portion 32I of an approximately right-angled triangle shape, symmetric to that of the first mount portion 31I, in a plan view (FIG. 27(B)). The first opposing surface 32B is formed on an upper part of the second mount portion 32I. By bringing the first and second mount portions 31I and 32I closer to each other, slopes 31J and 32J of the right-angled triangles come in contact with each other to form a mount surface having a quadrangular shape in a plan view (FIG. 28). Also in this modification, as is the case using the comb-teeth shape described in the above third embodiment, the flat plate portion 10 can be pressed while being stably supported.

[0088] It is noted that the shapes of the first and second divided portions 31 and 32 are not limited to the comb-teeth shape and the right-angled triangle shape as described above. Specifically, various shapes of the first and second divided portions 31 and 32 can be adopted as long as such a shape allows the first and second divided portions 31 and 32 to overlap each other, at least partially, in the press direction at a time point when the thickened portion is formed on the flat plate portion 10 by pressing.

[0089] Further, when the comb-teeth shape is adopted, both comb teeth need not be completely inserted to each other at the time of completion of the pressing, as shown in FIG. 19 (B). For example, as shown in FIG. 29, in a region R, to which a pair of meshing portions are externally contacting at the time of completion of the pressing, there may be gaps S of size not causing an inflow of the material or folding during press-molding.

(Fourth Embodiment)

[0090] Next, a press molding apparatus 4 and a manufacturing method of press-molded article according to a fourth embodiment of the present invention will be described with reference to FIG. 30 to FIG. 32. It is noted that only the parts in which the fourth embodiment differs from the above first embodiment will be described in detail.

[Configuration of press molding apparatus]

[0091] The press molding apparatus 4 comprises a first die 41, a second die 42, a die opening prevention portion 43, a press member 48, and a driving section 48B.

[0092] The first die 41 comprises a first portion 41D to be pressed, which is pressed by the press member 48, a first press portion 41E for pressing the flat plate portion 10, and a first mount portion 41F, on which the flat plate portion 10 is placed. A first surface 41C to be pressed, formed on an upper part of the first portion 41D to be pressed, is pressed by a first press surface 48F. Further, the first portion 41D to be pressed is provided at each end located at a front side and a rear side of the drawing. A first press portion 41A, formed on a side part of the first press portion 41E, is opposed to the first end portion 10A of the flat plate portion 10. A first opposing surface 41B, formed on an upper part of the first mount portion 41F, is opposed to the first main surface 10C of the flat plate portion 10. In this manner, the first press portion 41A and the first opposing surface 41B are provided in the same first die 41. The first opposing surface 41B is laterally arranged along the horizontal direction, and the first press portion 41A is connected to an end part of the first opposing surface 41B so as to make an acute angle with the first opposing surface 41B. Further, a thickened portion-forming section 45 as a concave groove is formed on the first opposing surface 41B and used for forming a thick part on the flat plate portion 10 by allowing a part of the material of the flat plate portion 10 to flow into the thickened portion-forming section 45 during pressing.

[0093] The second die 42, arranged above the first die 41, has a structure approximately symmetrical to the first die 41. That is, the second die 42 comprises a second portion 42D to be pressed, which is pressed by the press member 48, a second press portion 42E for pressing the flat plate portion 10, and a second opposing portion 42F opposing to the flat plate portion 10. A second surface 42C to be pressed, formed on the second portion 42D to be pressed, is pressed by a second press surface 48G. Further, the second portion 42D to be pressed is provided at each end located at a front side and a rear side of the drawing. A second press portion 42A, formed on a side part of the second press portion 42E, is opposed to the second end portion 10B of the flat plate portion 10. A second opposing surface 42B, formed on a lower part of the second opposing portion 42F, is opposed to the second main surface 10D of the flat plate portion 10. In this

manner, the second press portion 42A and the second opposing surface 42B are provided in the same second die 42. The second opposing surface 42B is laterally arranged along the horizontal direction, and the second press portion 42A is connected to an end part of the second opposing surface 42B so as to make an acute angle with the second opposing surface 42B.

[0094] The first opposing surface 41B and the second opposing surface 42B, while facing to each other, keep in contact with the flat plate portion 10 during pressing. Further, a plurality of guide rollers 47 are arranged on a lower part of the second die 42, so that the second die 42 can slide on the first die 41 in the horizontal direction.

[0095] The die opening prevention portion 43 is a member that prevents die opening of the first die 41 and the second die 42 and is formed a rectangular shape enclosing the first die 41 and the second die 42. The die opening prevention portion 43 comprises a part positioned on an upper side of the second die 42 and a part positioned on a lower side of the first die 41, and prevents the die opening of the first die 41 and the second die 42 by vertically clamping them. Further, the die opening prevention portion 43 comprises an inside upper surface 43A and an inside lower surface 43B, which are provided with a plurality of upper guide rollers 47A and a plurality of lower guide rollers 47B, respectively. An upper surface 41G and a lower surface 41H of the first die 41 are brought into contact with the upper guide rollers 47A and the lower guide rollers 47B, respectively, thereby enabling to slide the first die 41 in the horizontal direction. Further, an upper surface 42G and the guide rollers 47 of the second die 42 are brought into contact with the upper guide rollers 47A and the first die 41, respectively, thereby enabling to slide the second die 42 in the horizontal direction in a similar manner.

[0096] The press member 48 presses the first and second dies 41 and 42, thereby sliding them in the horizontal direction. The press member 48 comprises a main body portion 48A in contact with a driving section 48H and a press portion 48B fixed to a lower surface of the main body portion 48A. The press portion 48B is made from a shape in which a press portion main body 48C, fixed on the lower surface of the main body portion 48A by the bolt B, is connected to a first extension portion 48D and a second extension portion 48E. The press portion 48B is formed in an upside down U-shape in a cross sectional view. The first press surface 48F for pressing the first die 41 is formed at a tip of the first extension portion 48D, while the second press surface 48G for pressing the second die 42 is formed at a tip of the second extension portion 48E. Further, both the first and second extension portions 48D and 48E are provided at each end located at a front side and a rear side of the drawing.

[0097] The driving section 48H is arranged in contact with an upper surface of the press member 48 (main body portion 48A). The driving section 48H comprises, as in the above first embodiment, a hydraulic or electric piston and moves the press member 48 downward in the perpendicular direction by pressing.

[Manufacturing method of press-molded article]

[0098] Next, explanation is given to a manufacturing method of press-molded article using the above press molding apparatus 4. First of all, a member to be pressed including the flat plate portion 10 is softened by heating to be prepared (FIG. 3: S10). Next, the flat plate portion 10 is placed between the first die 41 and the second die 42. By this operation, as shown in FIG. 30, the member to be pressed is placed in a manner such that the first main surface 10C is opposed to the first opposing surface 41B and the second main surface 10D is opposed to the second opposing surface 42B (FIG. 3: S20). During this process, the first opposing surface 41B and the second opposing surface 42B, while facing to each other, keep in contact with the flat plate portion 10 during pressing.

[0099] Next, the press member 48 is lowered by operating the driving section 48H, so that the first and second press surfaces 48F and 48G are brought into contact with the first and second surfaces 41C and 42C to be pressed, respectively (FIG. 31). When the press member 48 is further lowered while maintaining this state, the first press surface 48F, while sliding on the first surface 41C to be pressed, makes the first die 41 slide in the horizontal direction, and the second press surface 48G, while sliding on the second surface 42C to be pressed, makes the second die 42 slide in the horizontal direction. By this operation, the first and second press portions 41A and 42A approach each other and the flat plate portion 10 is pressed from the both sides of the end portions 10A and 10B in the horizontal direction. During this process, a part of the material of the flat plate portion 10 is flown into the thickened portion-forming section 45 in the press direction, thereby enabling to form a thickened portion, of which a thickness is increased, on the flat plate portion 10 (FIG. 3: S30).

[0100] In the press step, the first opposing surface 41B is moved to the press direction as the flat plate portion 10 is pressed by the first press portion 41A and the second opposing surface 42B is moved to the press direction as the flat plate portion 10 is pressed by the second press portion 42A. That is, both the first and second opposing surfaces 41B and 42B are moved to the press directions as the flat plate portion 10 is being pressed. In this manner, both friction force generated by sliding between the first main surface 10C and the first opposing surface 41B and friction force generated by sliding between the second main surface 10D and the second opposing surface 42B can be reduced. Thus, pressing force required for molding the flat plate portion 10 can be further reduced. Then, after the press of the flat plate portion 10 is completed, the press member 48 is moved up by operating the driving section 48H and a press-molded article is taken out (FIG. 3: S40).

(First Modification)

[0101] Next, a first modification of the above fourth embodiment will be described with reference to FIG. 33 to FIG. 35. As shown in FIG. 33, in a press molding apparatus 4A according to the first modification, the thickened portion-forming section 45 is formed on the second opposing surface 42B, instead of the first opposing surface 41B. In this configuration, as shown in FIG. 34 and FIG. 35, a press-molded article having a thickened portion formed on the second main surface 10D side can be manufactured by pressing the flat plate portion 10 with the first and second press portions 41A and 42A and allowing the material of the flat plate portion 10 to flow into the thickened portion-forming section 45. Further, when the thickened portions are formed both on the first main surface 10C and the second main surface 10D, the thickened portion-forming sections 45 may be formed both on the first opposing surface 41B and the second opposing surface 42B.

(Other Embodiments)

[0102] Finally, other embodiments of the present invention will be described. The present invention can be applied not only to a member to be pressed, in which the whole member to be pressed is constituted with a single flat plate portion, as described above, but also to a member to be pressed including the flat plate portion in one part thereof. For example, as shown in FIG. 36, the present invention can be applied to a member 10E to be pressed of a bent shape, having a plurality of (two) flat plate portions 10F.

[0103] More specifically, a press molding apparatus 7 comprises an upper die 71 including first and second upper dies 71A and 71B and a lower die 72 including first and second lower dies 72A and 72B. The member 10E to be pressed is placed between the upper die 71 and the lower die 72. A first press portion 71C opposing to the first end portion 10A of the flat plate portion 10F is formed on the first upper die 71A, and a first opposing surface 71D opposing to the first main surface 10C of the flat plate portion 10F is formed on the second upper die 71B. Further, a second opposing surface 72D opposing to the second main surface 10D of the flat plate portion 10F is formed on the first lower die 72A, and a second press portion 72C opposing to the second end portion 10B of the flat plate portion 10F is formed on the second lower die 72B.

[0104] As shown by arrows in FIG. 36, by lowering the first upper die 71A, the flat plate portion 10F is pressed by the first press portion 71C and the second press portion 72C in the direction parallel to the main surfaces 10C and 10D, and a material of the flat plate portion 10F is flown into a thickened portion-forming section 75 to form a thickened portion. During this process, when the first lower die 72A is pressed by the first upper die 71A and lowered, the second opposing surface 72D is moved to the press direction. Thus, friction force generated by sliding between the second main surface 10D and the second opposing surface 72D can be reduced and, as in the cases for the above first to fourth embodiments, pressing force required for molding the flat plate portion 10F can be reduced.

[0105] Further, the present invention is not limited to the case where the whole flat plate portion 10 is heated by the electric furnace F (FIG. 4). As shown in FIG. 37, a plurality of electrodes 101 may be arranged at intervals from each other on the main surface of the flat plate portion 10 and a temperature rising portion 102 by heating is partially formed on the flat plate portion 10 by supplying electric current to the plurality of electrodes 101 (partial electrical heating). Then, as shown in FIG. 38, a thickened portion may be formed by pressing the flat plate portion 10 in a state of being arranged between dies 91 and 92 and allowing a material located at the temperature rising portion 102 by heating to flow into a thickened portion-forming section 95. In this manner, remaining parts of the flat plate portion 10 other than the temperature rising portion 102 by heating are kept at a low temperature without being heated, thus such low-temperature parts are not softened and retain high strength. This enables to further reduce a friction coefficient between the dies 91 and 92, and the flat plate portion 10 during pressing. Further, instead of performing the partial electrical heating, the whole flat plate portion 10 may be subjected to electrical heating.

Claims

1. A manufacturing method of press-molded article by molding a member to be pressed including a flat plate portion, the method comprising:

   a step of placing the member to be pressed in a press molding apparatus in a manner such that a first main surface of the flat plate portion is opposed to a first opposing surface and a second main surface of the flat plate portion, directing opposite to the first main surface, is opposed to a second opposing surface; and

   a step of pressing the flat plate portion by bringing a first press portion opposing to a first end portion of the flat plate portion and a second press portion opposing to a second end portion of the flat plate portion, the second end portion being located on an opposite side of the first end portion, closer to each other,

   wherein:

   the first opposing surface and the second opposing surface, while facing to each other, keep in contact with the flat plate portion during pressing; and

in the press step:

a thick part is formed on the flat plate portion by allowing a part of a material of the flat plate portion to flow, in a press direction, into a thickened portion-forming section formed on at least one of the first opposing surface and the second opposing surface; and

at least one of the first opposing surface and the second opposing surface is moved to the press direction as the flat plate portion is pressed by the first press portion and the second press portion.

2. The manufacturing method of press-molded article according to claim 1, wherein, in the step of placing the member to be pressed, the flat plate portion is placed between a die provided with the first press portion and the first opposing surface and a die provided with the second press portion and the second opposing surface.

3. The manufacturing method of press-molded article according to claim 1 or 2, wherein:

the die provided with the first opposing surface includes a first divided portion and a second divided portion formed separately from the first divided portion;

the first press portion is formed in the first divided portion;

the second press portion is formed in the second divided portion; and

in the press step, the first divided portion is moved to the press direction of the first press portion as the flat plate portion is pressed by the first press portion, and the second divided portion is moved to the press direction of the second press portion as the flat plate portion is pressed by the second press portion.

4. The manufacturing method of press-molded article according to claim 3, wherein:

the first divided portion and the second divided portion have a comb-teeth shape so as to mesh with each other; and

in the press step, the first divided portion and the second divided portion come close to each other in such a manner that the both comb teeth mesh with each other.

5. The manufacturing method of press-molded article according to any one of claims 1 to 4, wherein, in the step of placing the member to be pressed, the member to be pressed is placed so as to arrange the first main surface and the second main surface of the flat plate portion along a perpendicular direction.

6. The manufacturing method of press-molded article according to claim 5, wherein, in the step of placing the member to be pressed, positions of the first main surface and the second main surface are maintained along the perpendicular direction by supporting the flat plate portion using a temporarily supporting member.

7. The manufacturing method of press-molded article according to any one of claims 1 to 6, wherein, in the press step, pressing force is applied to the material of the flat plate portion flowing into the thickened portion-forming section.

8. The manufacturing method of press-molded article according to any one of claims 1 to 7, wherein the member to be pressed is molded by a hot press.

9. A press molding apparatus for molding a member to be pressed including a flat plate portion, comprising:

a first press portion opposing to a first end portion of the flat plate portion;

a second press portion opposing to a second end portion of the flat plate portion, the second end portion being located on an opposite side of the first end portion;

a first opposing surface opposing to a first main surface of the flat plate portion;

a second opposing surface opposing to a second main surface of the flat plate portion, the second main surface directing opposite to the first main surface; and

a driving section for bringing the first press portion and the second press portion closer to each other to press the flat plate portion,

wherein:

a thickened portion-forming section is formed on at least one of the first opposing surface and the second opposing surface for forming a thick part on the flat plate portion by allowing a part of a material of the flat plate portion to flow into the thickened portion-forming section;

the first opposing surface and the second opposing surface, while facing to each other, keep in contact with the flat plate portion during pressing; and

at least one of the first opposing surface and the second opposing surface is moved to the press direction as the flat plate portion is pressed by the first press portion and the second press portion.

10. The press molding apparatus according to claim 9,

wherein:

the first press portion and the first opposing surface are provided in a same die; and
the second press portion and the second opposing surface are provided in a same die.

11. The press molding apparatus according to claim 9 or 10, wherein:

the die provided with the first opposing surface includes a first divided portion and a second divided portion formed separately from the first divided portion;
the first press portion is formed in the first divided portion; and
the second press portion is formed in the second divided portion.

12. The press molding apparatus according to claim 11, wherein the first divided portion and the second divided portion have a comb-teeth shape so as to mesh with each other.

13. The press molding apparatus according to any one of claims 9 to 12, wherein the first opposing surface and the second opposing surface are arranged along a perpendicular direction.

14. The press molding apparatus according to claim 13, comprising a temporarily supporting member for supporting the flat plate portion to maintain positions of the first main surface and the second main surface along the perpendicular direction.

15. The press molding apparatus according to any one of claims 9 to 14, comprising a back-pressure applicator for applying pressure force to the material of flat plate portion flowing into the thickened portion-forming section.

FIG. 1

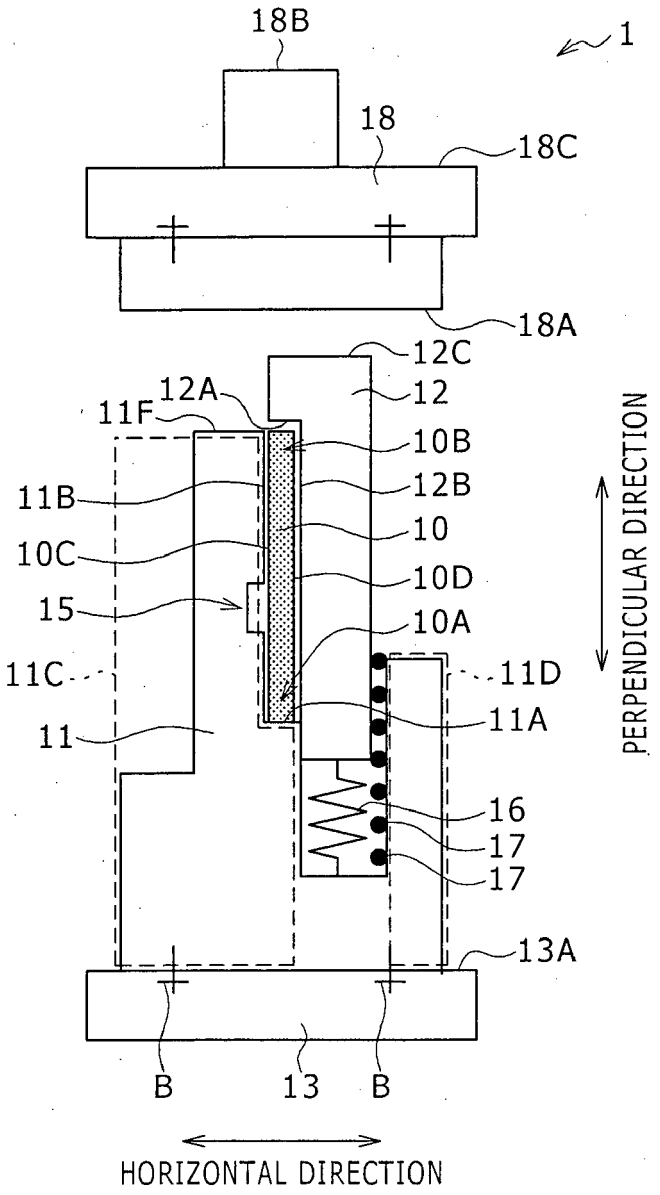

18B
1
18
18C
18A
12C
12A
12
11F
10B
11B
12B
10
10C
10D
15
10A
11C
11D
11
11A
16
17
17
13A
B
13
B
PERPENDICULAR DIRECTION
HORIZONTAL DIRECTION

FIG. 2

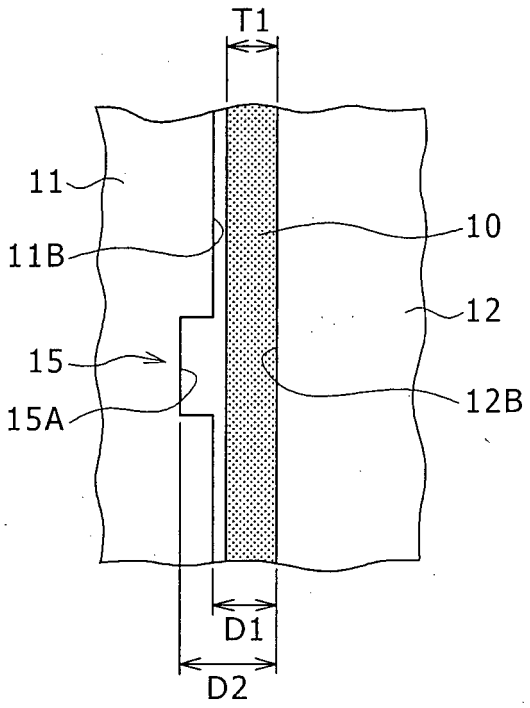


FIG. 3

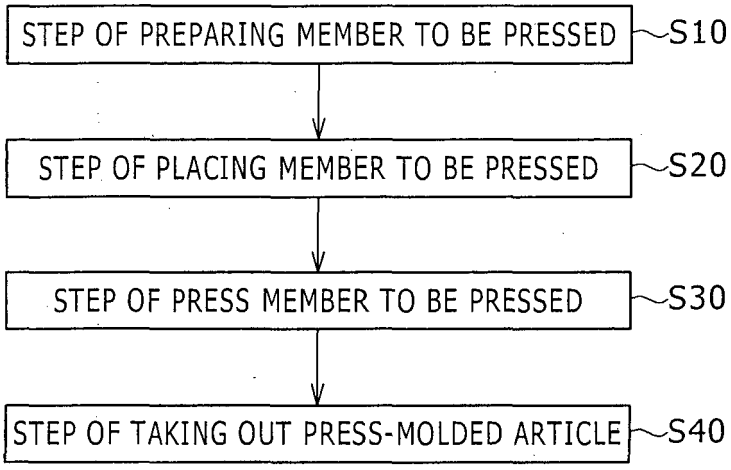

STEP OF PREPARING MEMBER TO BE PRESSED
S10
STEP OF PLACING MEMBER TO BE PRESSED
S20
STEP OF PRESS MEMBER TO BE PRESSED
S30
STEP OF TAKING OUT PRESS-MOLDED ARTICLE
S40

FIG. 4

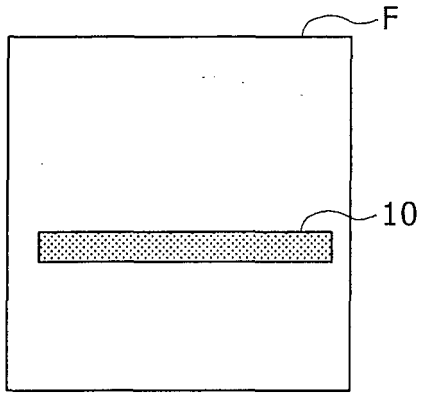

F
10

FIG. 5

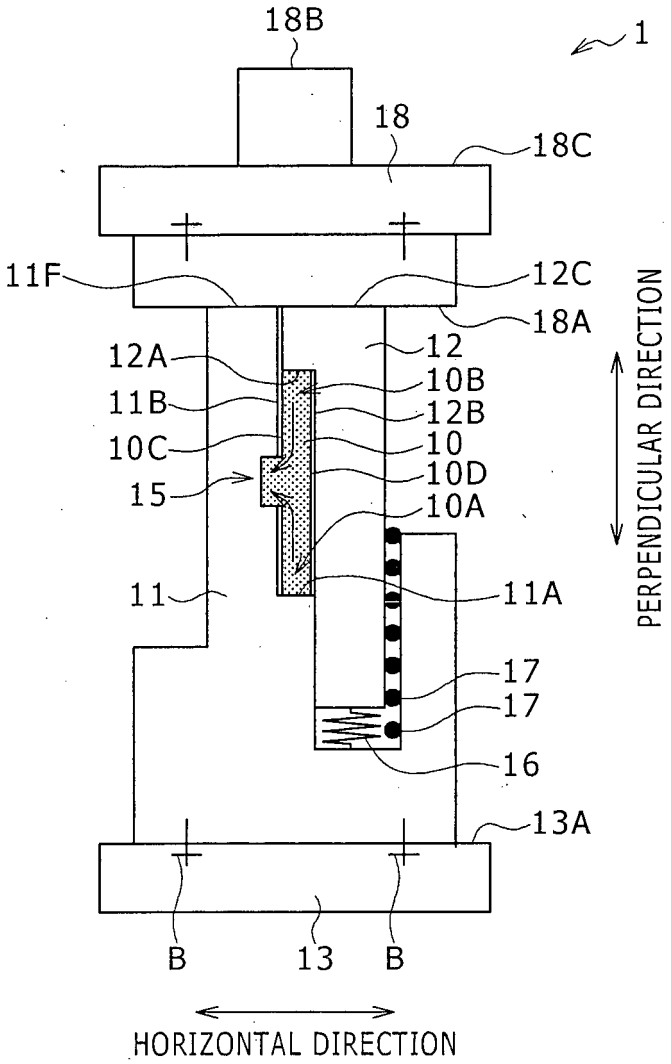

18B
1
18
18C
11F
12C
18A
12A
12
10B
11B
12B
10C
10
10D
15
10A
11
11A
17
17
16
13A
B
13
B
PERPENDICULAR DIRECTION
HORIZONTAL DIRECTION

FIG. 6

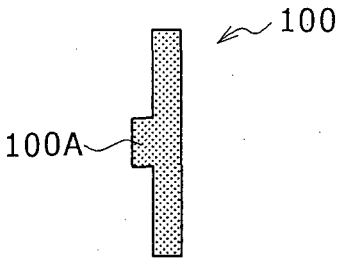

100
100A

FIG. 7

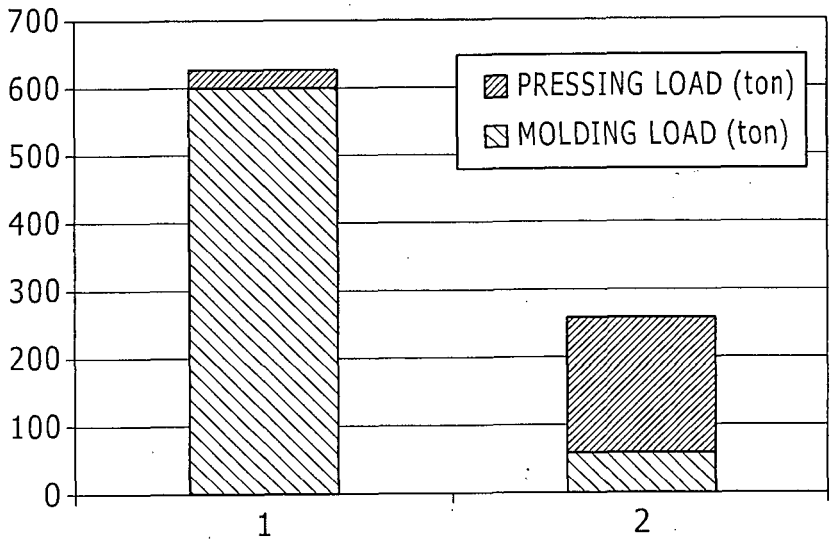

700
600
500
400
300
200
100
0
1
2
PRESSING LOAD (ton)
MOLDING LOAD (ton)

FIG. 8

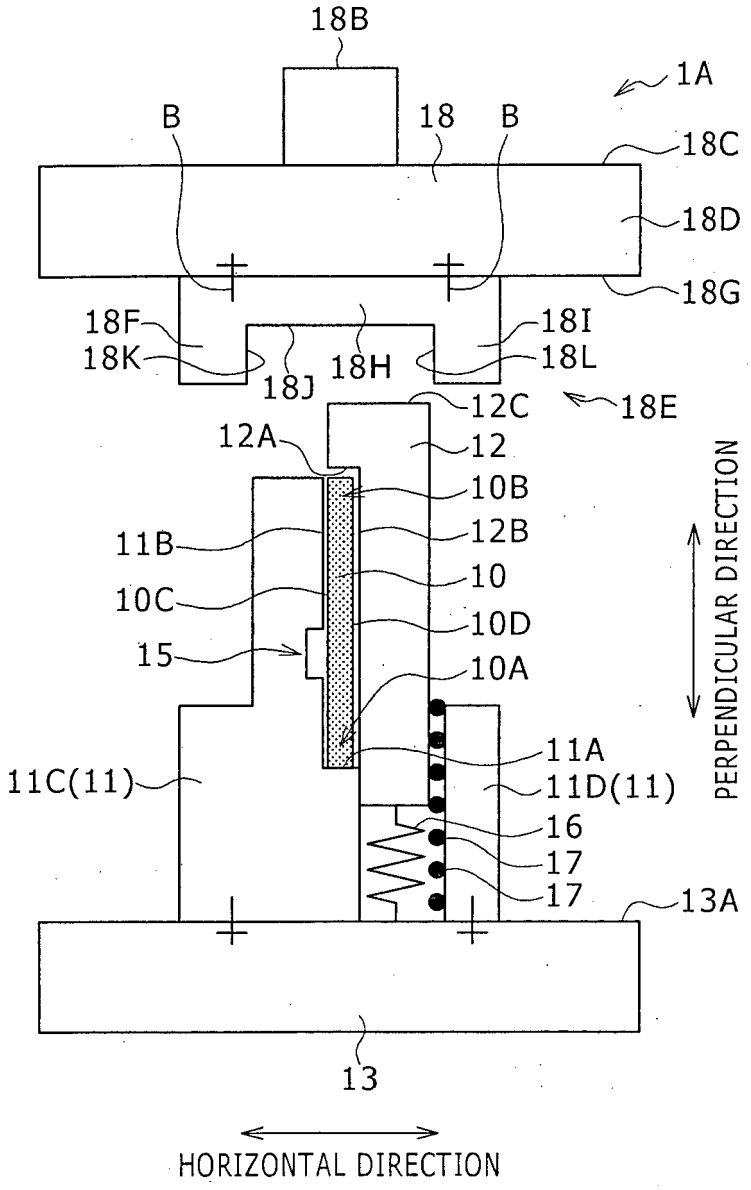

18B
1A
B
18
B
18C
18D
18G
18F
18K
18J
18H
18I
18L
12C
18E
12A
12
10B
11B
12B
10C
10
15
10D
10A
11A
11C(11)
11D(11)
16
17
17
13A
13
PERPENDICULAR DIRECTION
HORIZONTAL DIRECTION

FIG. 9

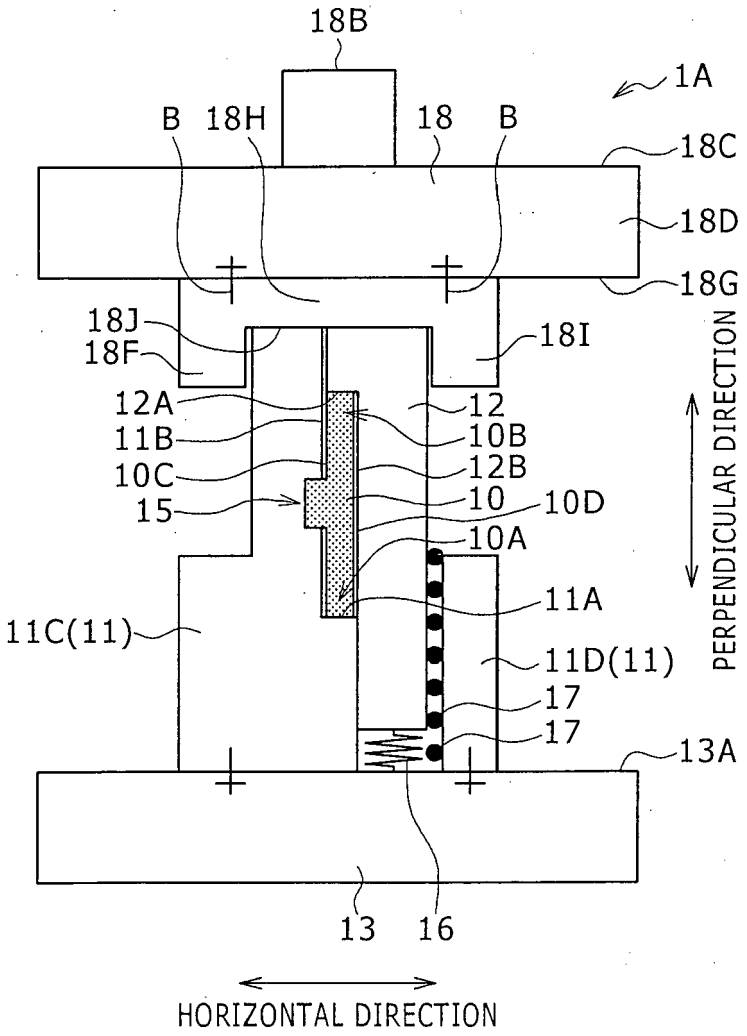

18B
1A
B
18H
18
B
18C
18D
18G
18J
18F
18I
12A
11B
10C
15
12
10B
12B
10
10D
10A
11A
11C(11)
11D(11)
17
17
13A
PERPENDICULAR DIRECTION
13
16
HORIZONTAL DIRECTION

FIG. 10

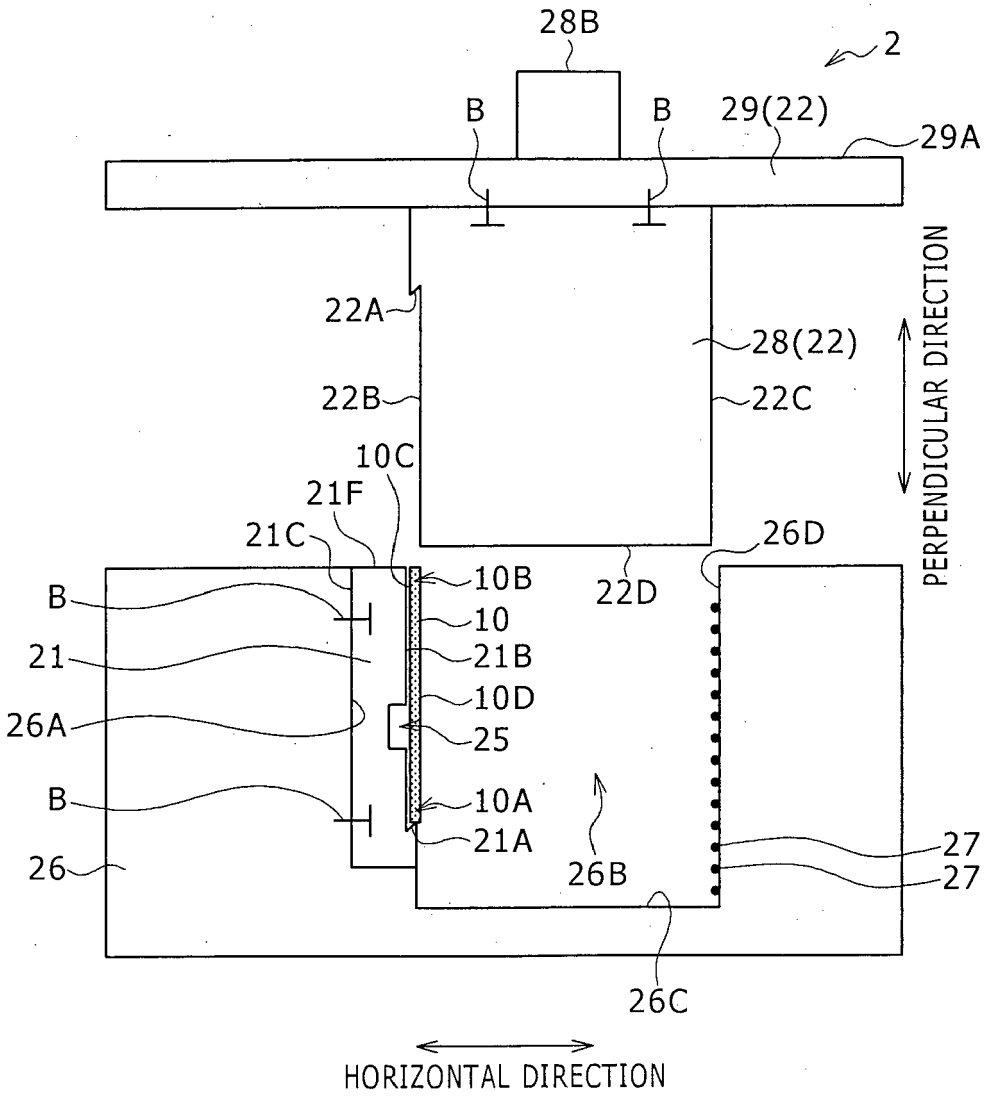

28B
2
B
B
29(22)
29A
22A
28(22)
22B
22C
10C
21F
21C
26D
PERPENDICULAR DIRECTION
B
10B
22D
10
21
21B
10D
26A
25
B
10A
21A
26B
27
26
27
26C
HORIZONTAL DIRECTION

FIG. 11

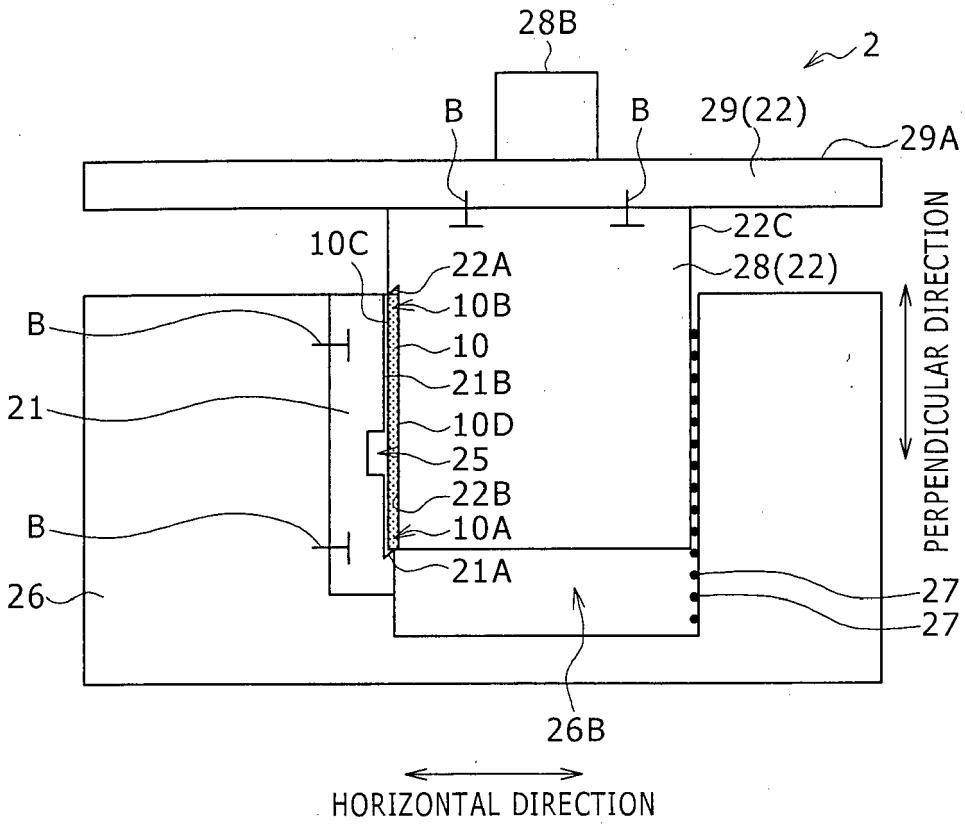

28B
2
B
B
29(22)
29A
10C
22A
22C
28(22)
10B
B
10
21B
21
10D
25
22B
B
10A
21A
26
27
27
PERPENDICULAR DIRECTION
26B
HORIZONTAL DIRECTION

FIG. 12

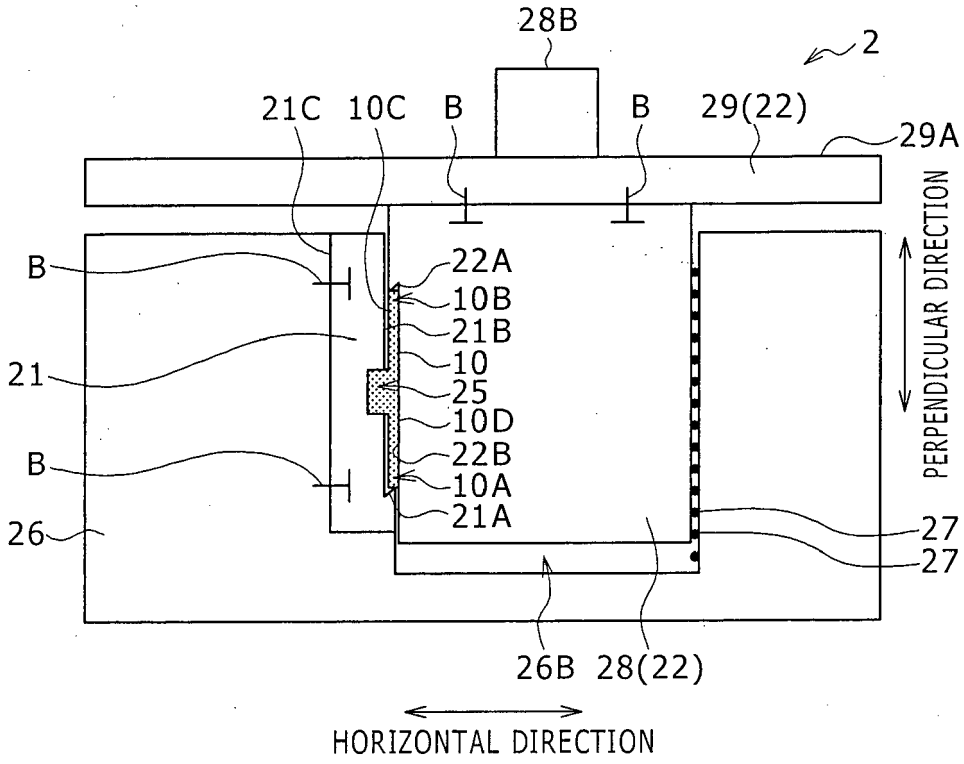

28B
2
21C
10C
B
B
29(22)
29A
PERPENDICULAR DIRECTION
B
22A
10B
21B
21
10
25
10D
B
22B
10A
21A
26
27
27
26B
28(22)
HORIZONTAL DIRECTION

FIG. 13

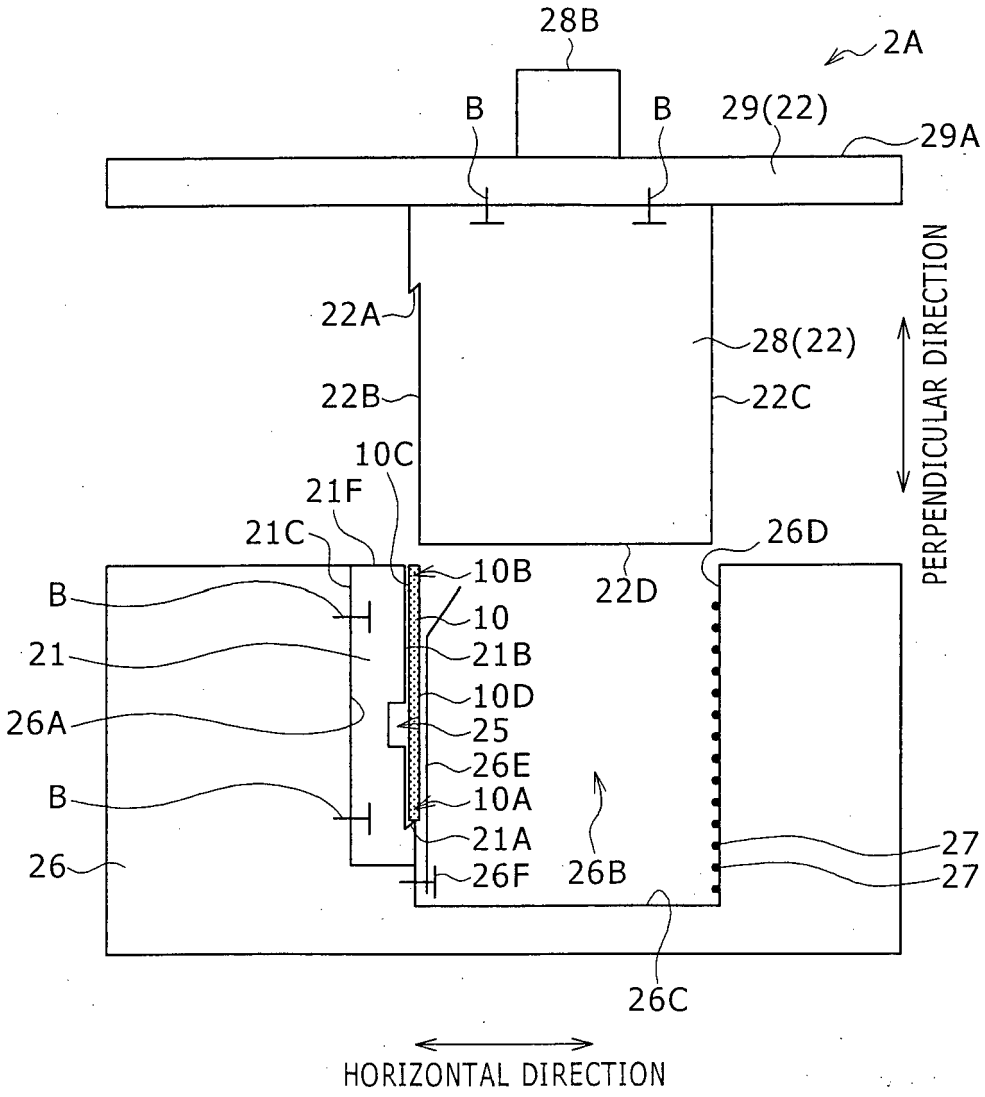

28B
2A
B
B
29(22)
29A
22A
28(22)
22B
22C
PERPENDICULAR DIRECTION
10C
21F
21C
26D
10B
22D
B
10
21
21B
10D
26A
25
26E
B
10A
21A
27
26
26F
26B
27
26C
HORIZONTAL DIRECTION

FIG. 14

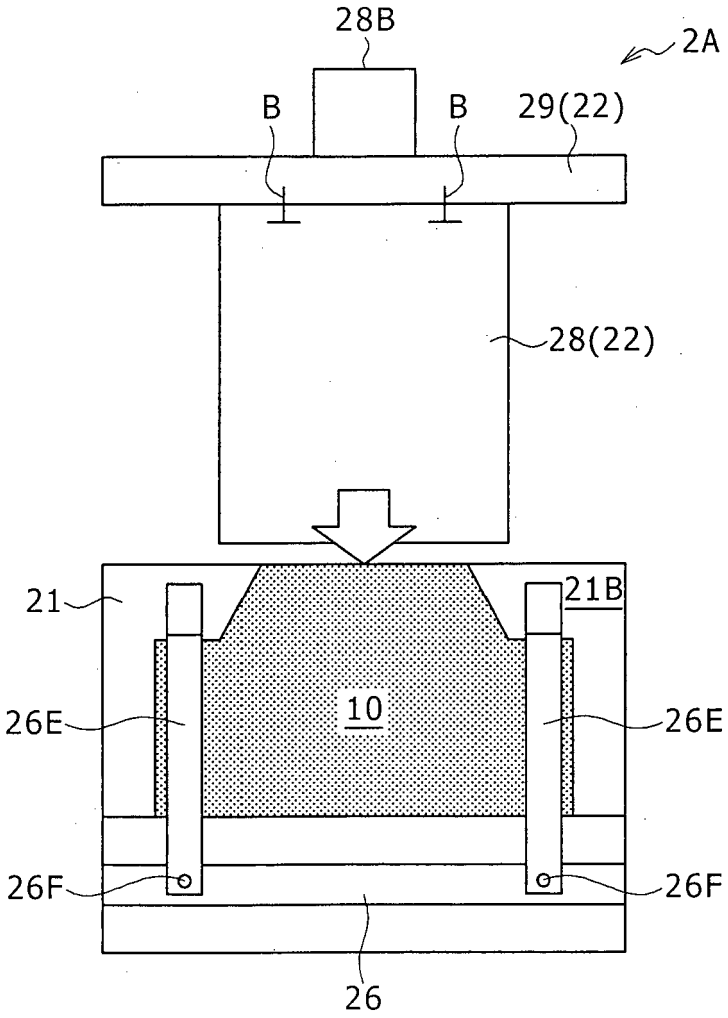


FIG. 15

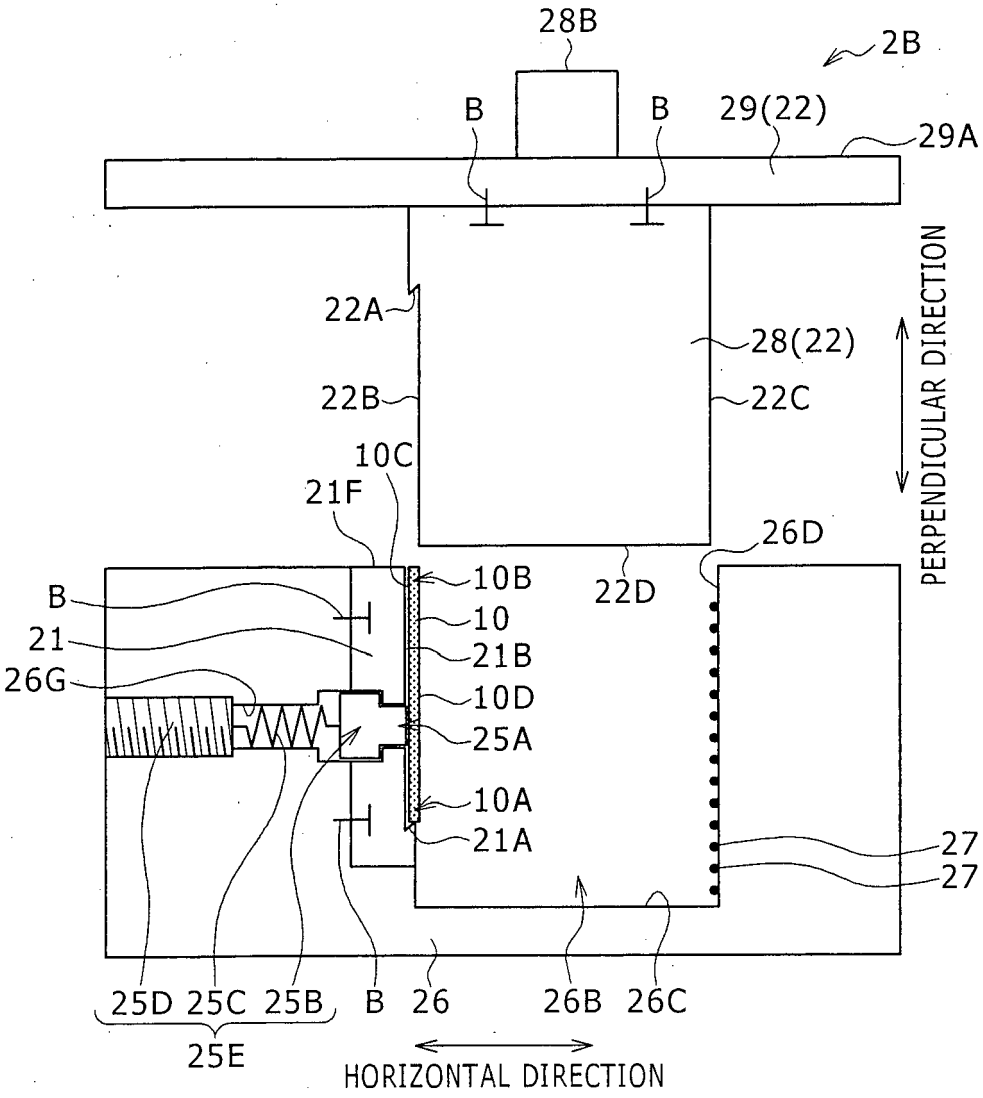
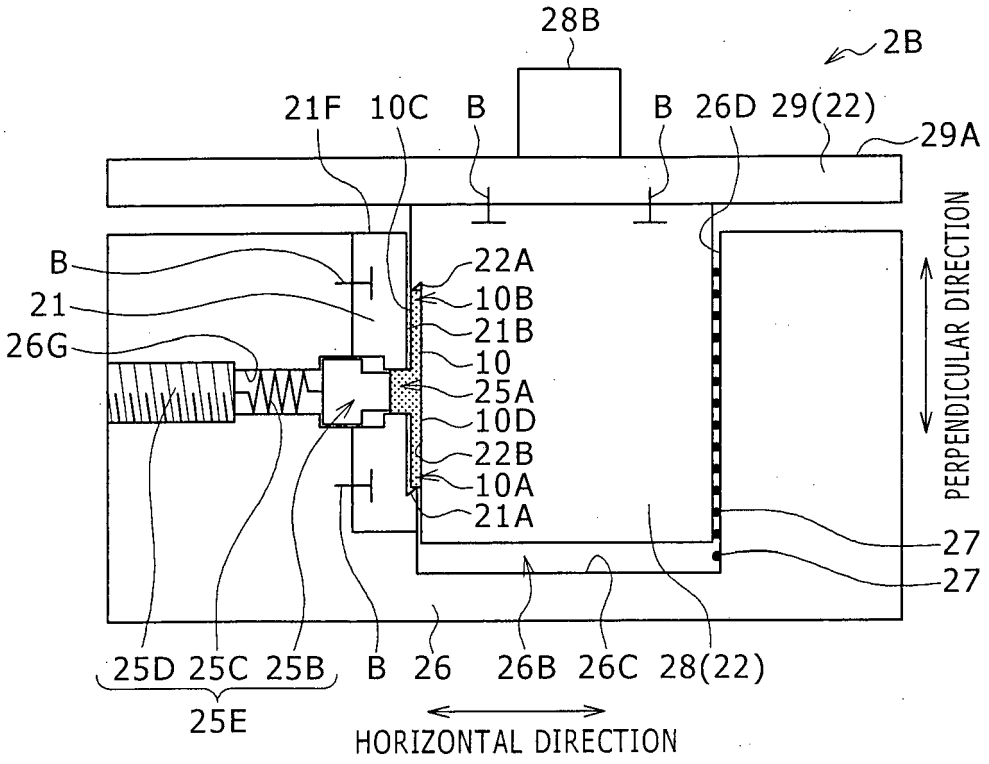

28B
2B
B
B
29(22)
29A
22A
28(22)
22B
22C
10C
21F
PERPENDICULAR DIRECTION
26D
22D
10B
B
10
21
21B
26G
10D
25A
10A
21A
27
27
25D 25C 25B
B
26
26B
26C
25E
HORIZONTAL DIRECTION

FIG. 16


28B
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10C
B
B
26D
29(22)
29A
B
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26G
22A
10B
21B
10
25A
10D
22B
10A
21A
PERPENDICULAR DIRECTION
27
27
25D
25C
25B
B
26
26B
26C
28(22)
25E
HORIZONTAL DIRECTION

FIG.17A

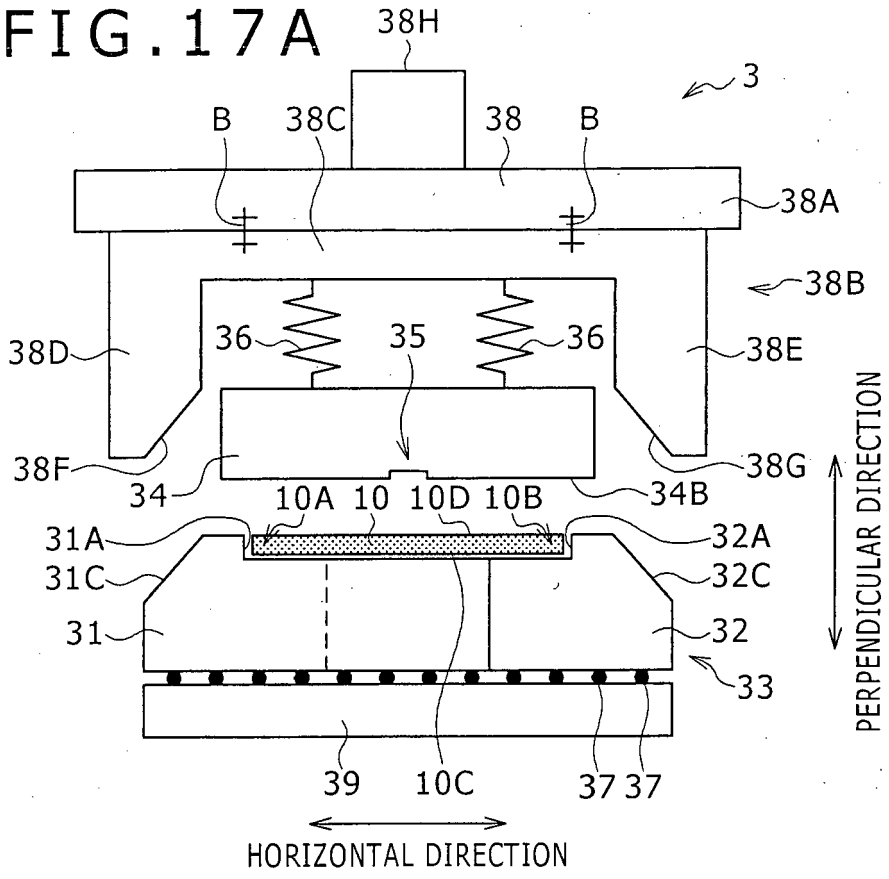


FIG.17B

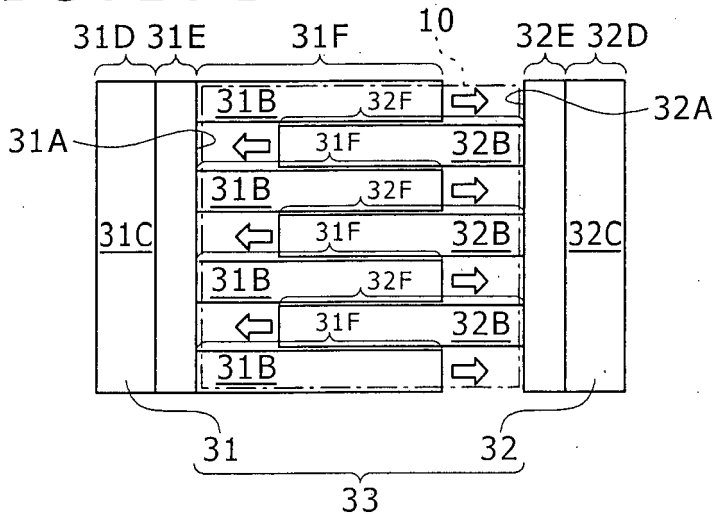


FIG.18A

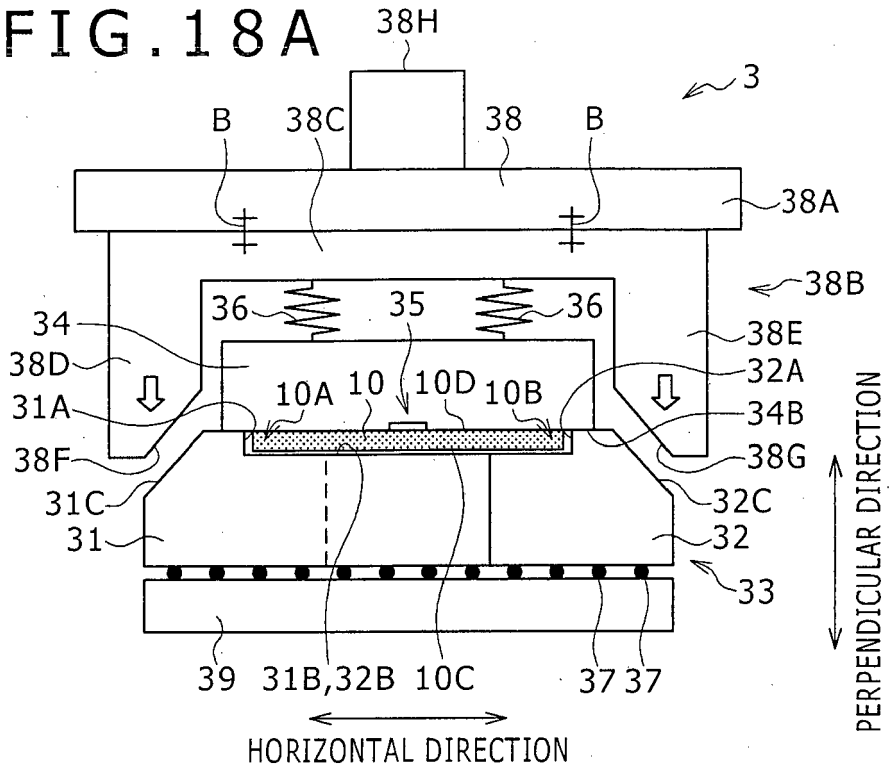


FIG.18B

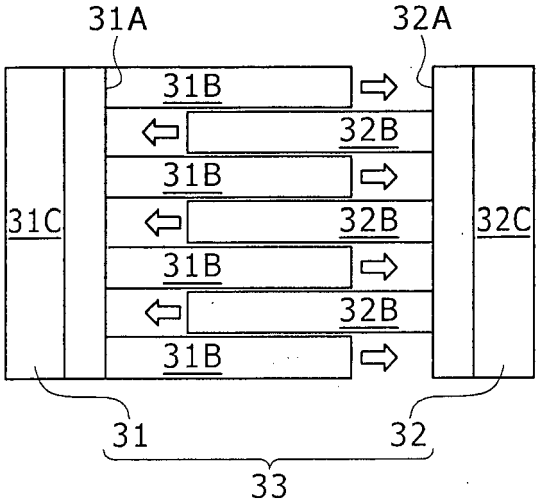


FIG. 19A

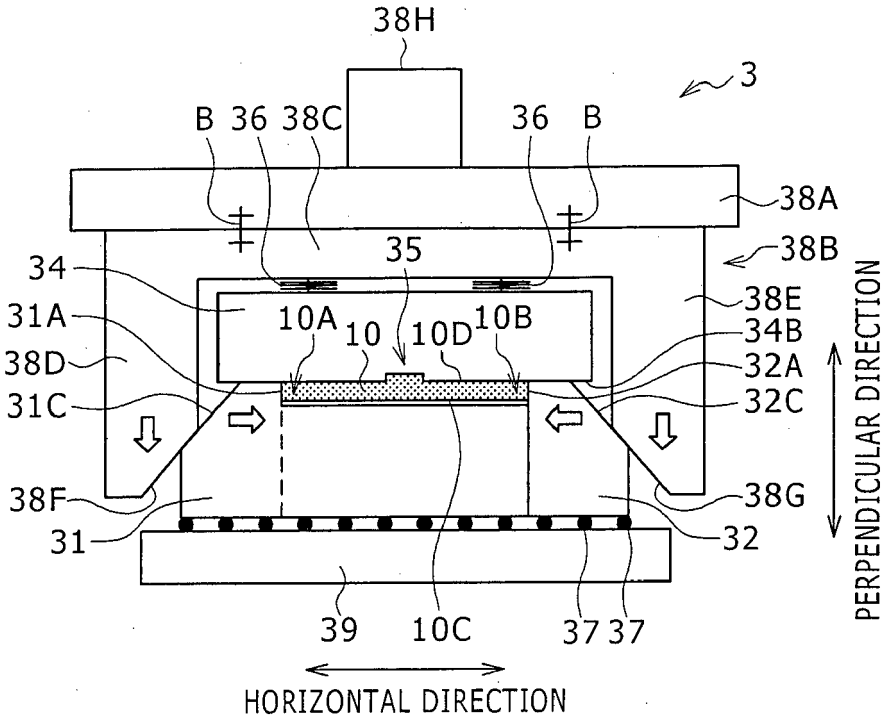


FIG. 19B

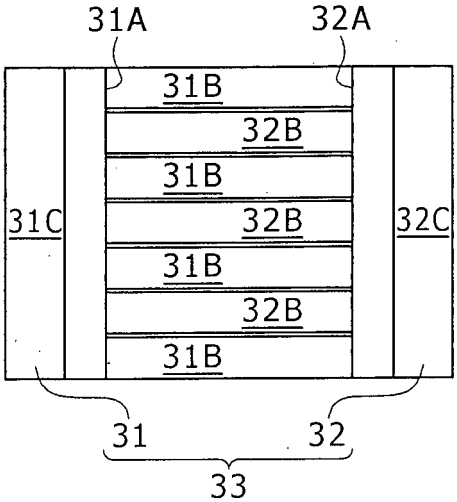


FIG.20A

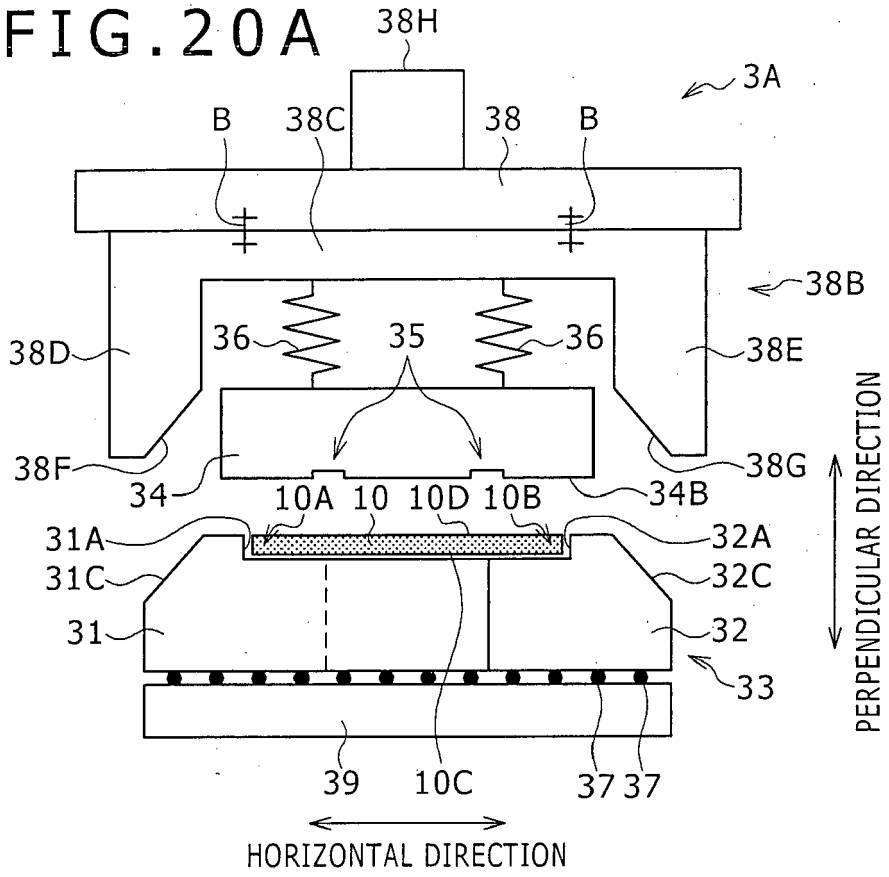


FIG.20B

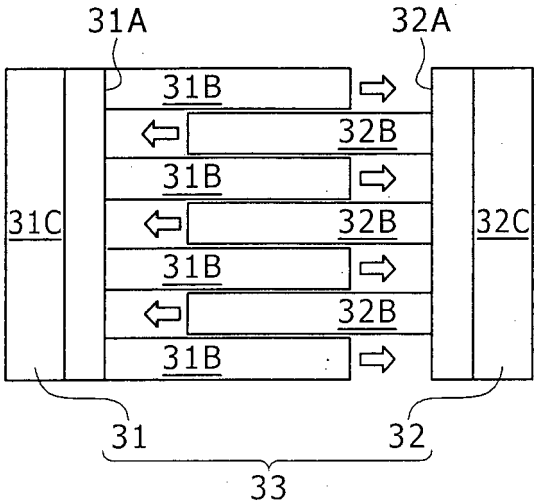


FIG.21A

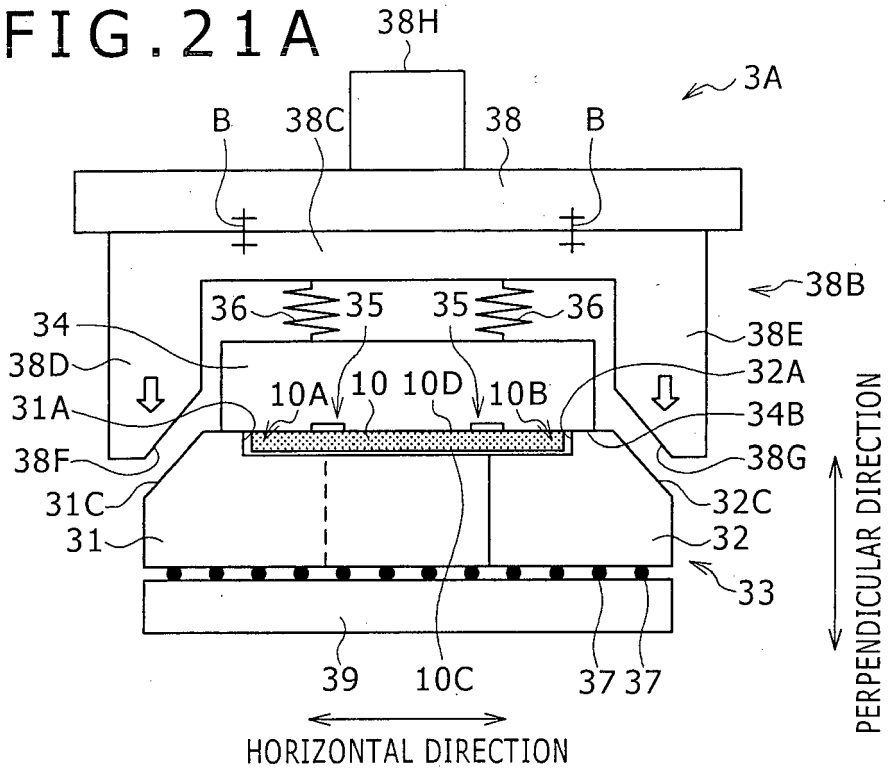


FIG.21B

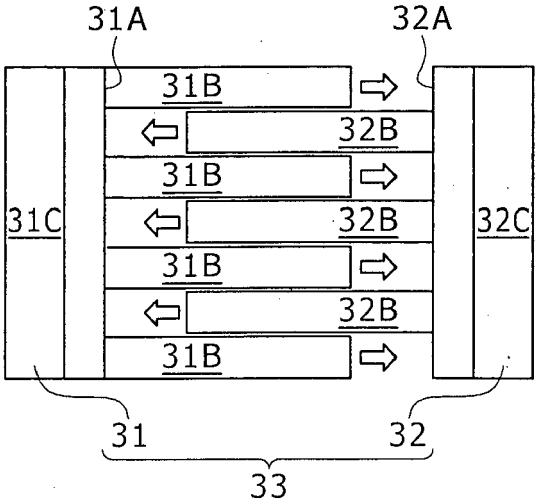


FIG. 22A

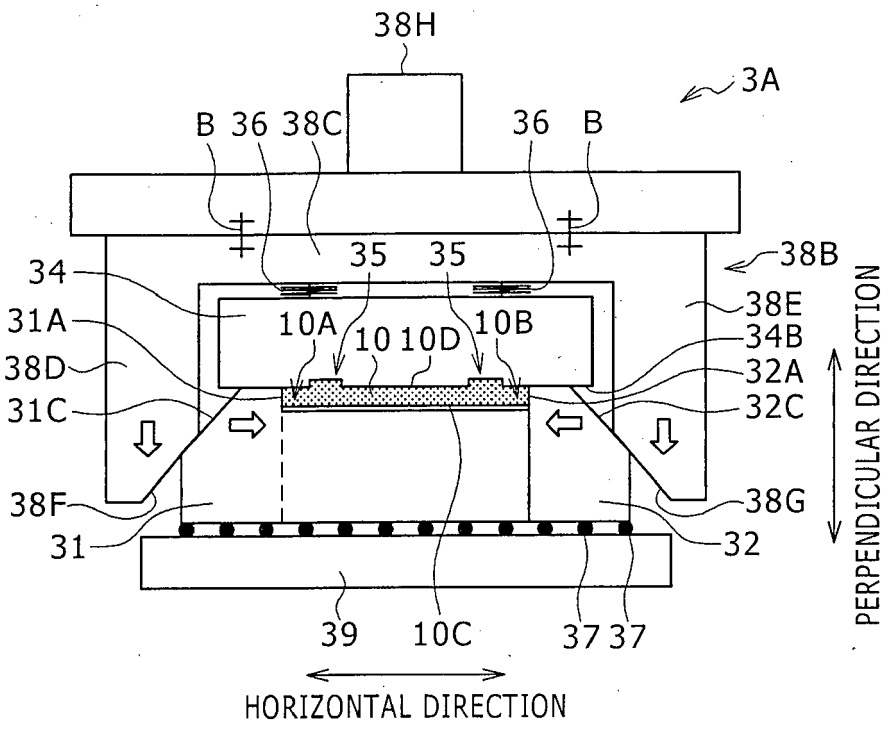


FIG. 22B

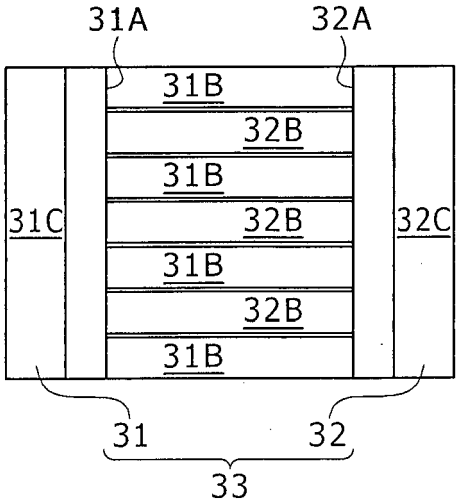


FIG. 23A

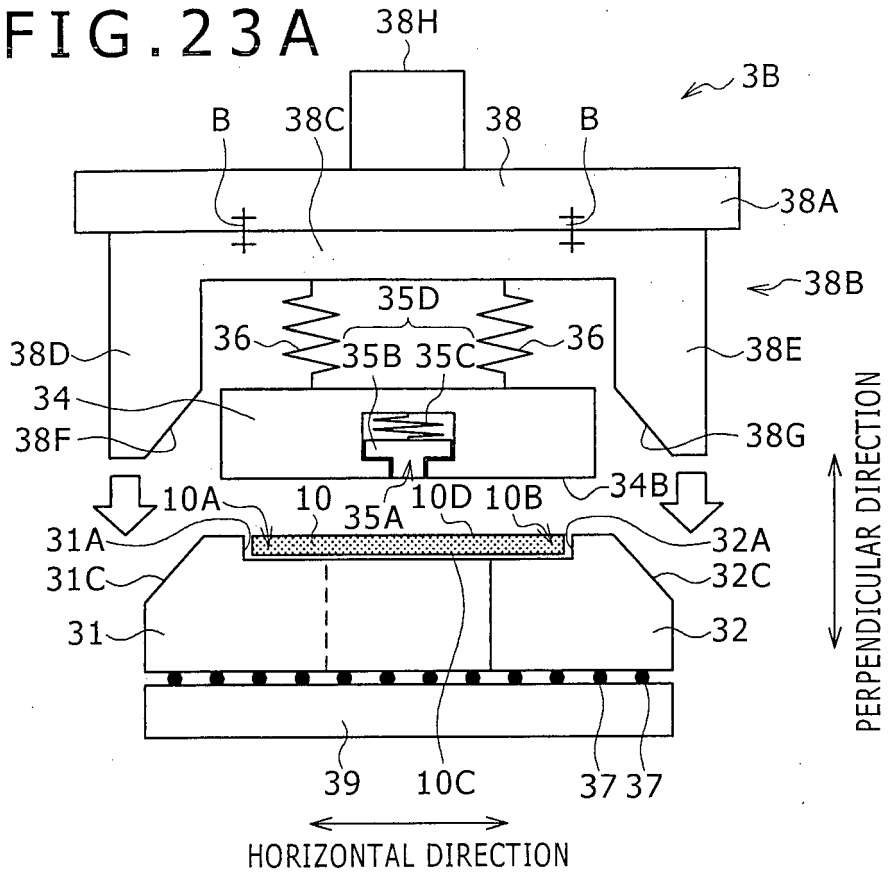


FIG. 23B

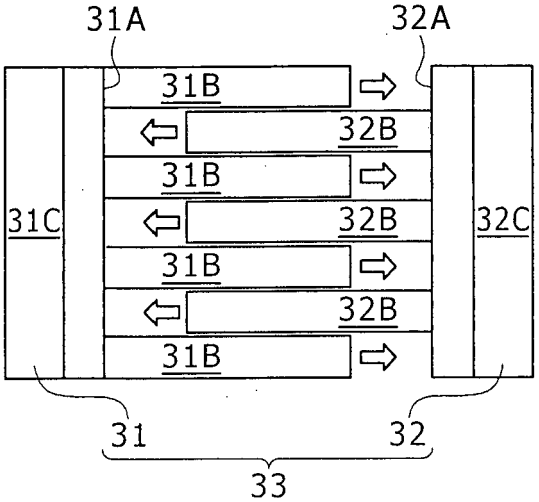


FIG. 24A

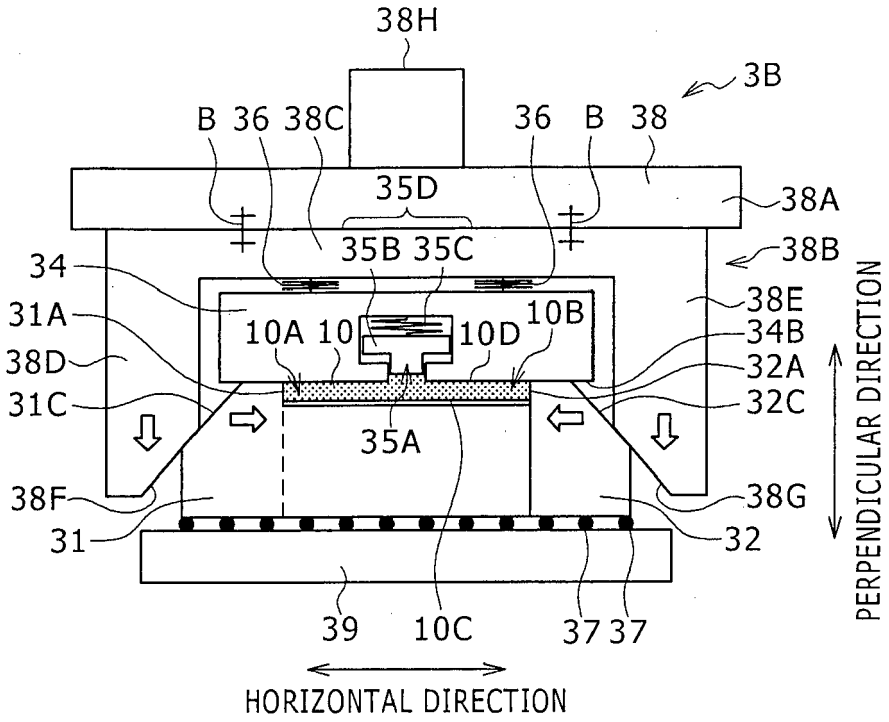


FIG. 24B

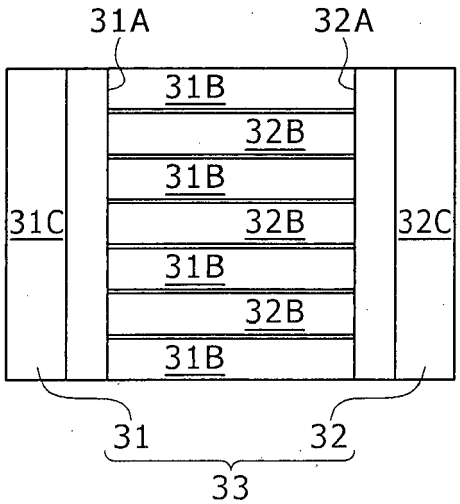


FIG.25A

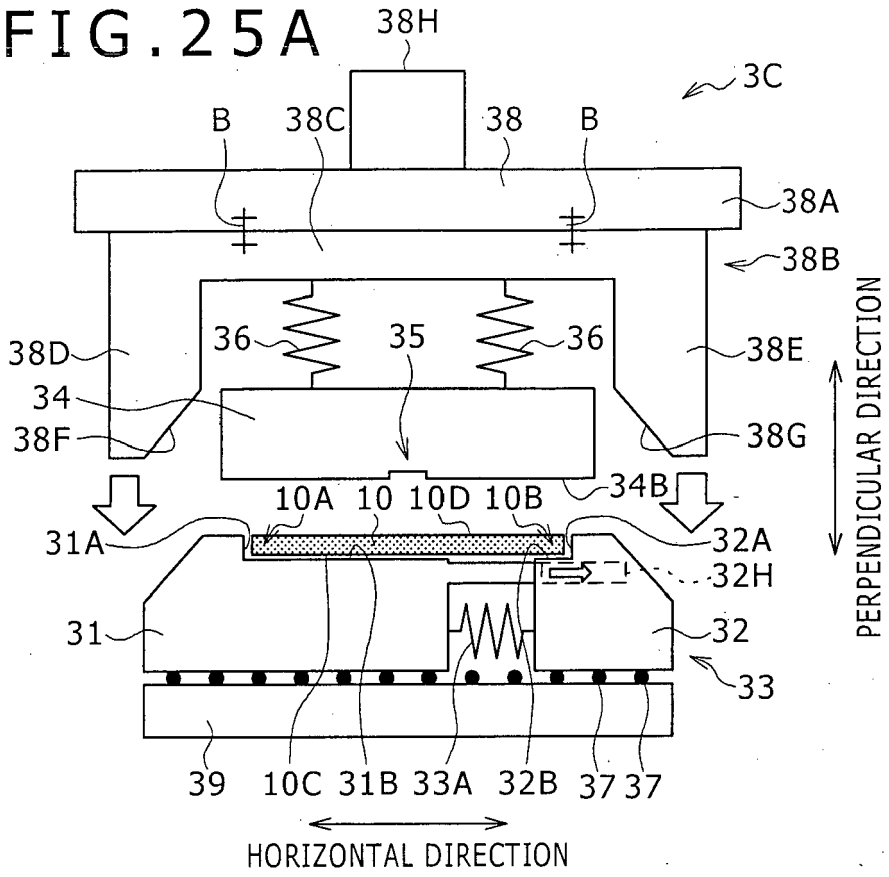


FIG.25B

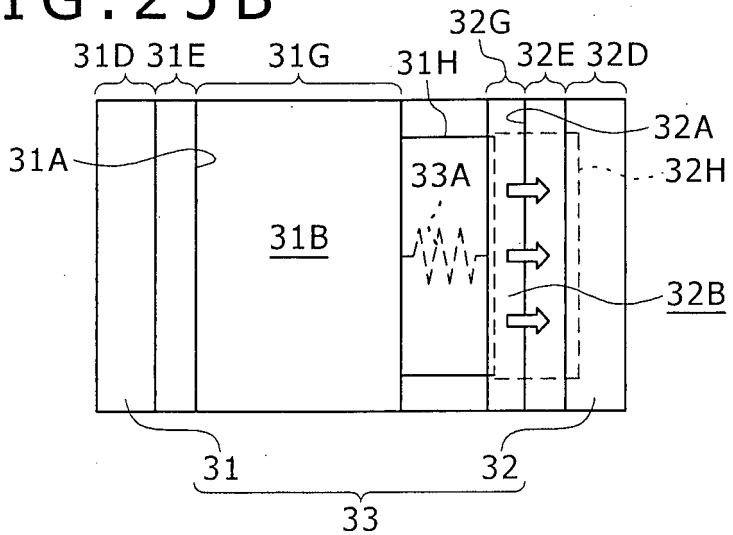


FIG. 26A

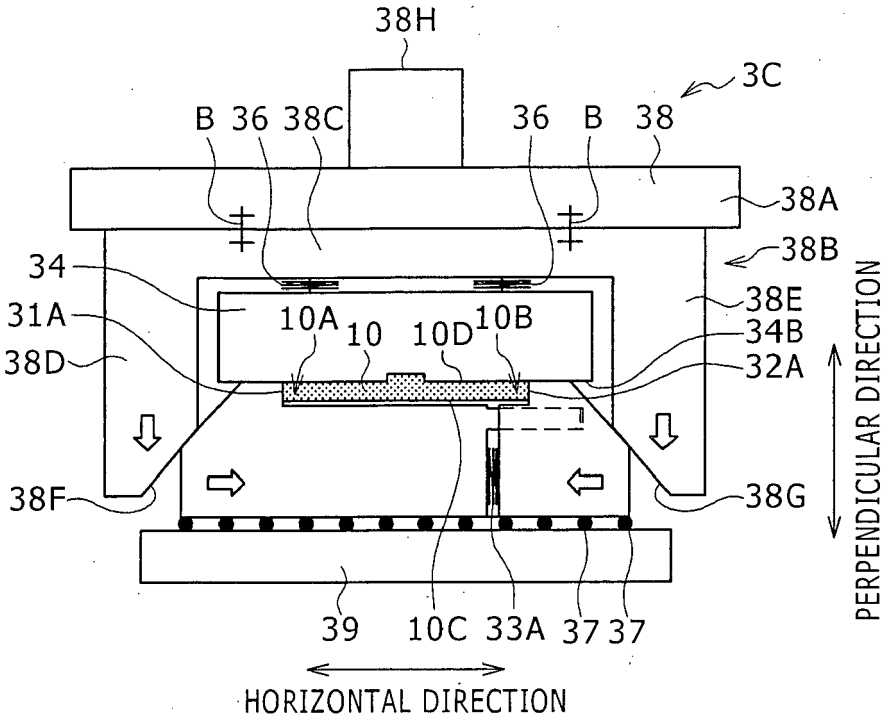


FIG. 26B

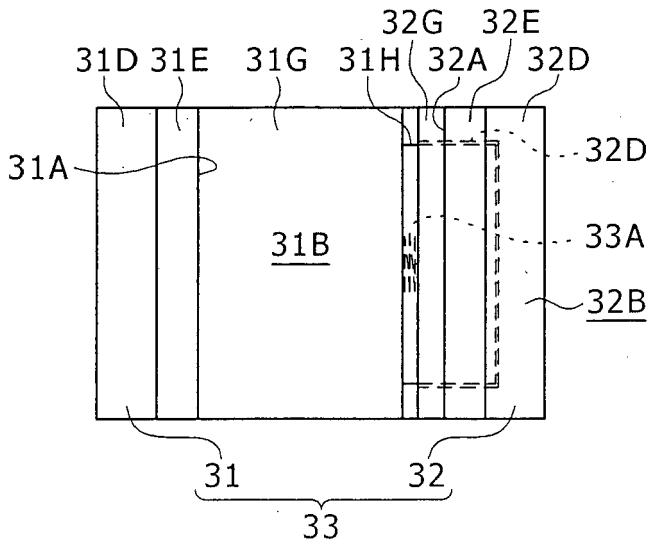


FIG.27A

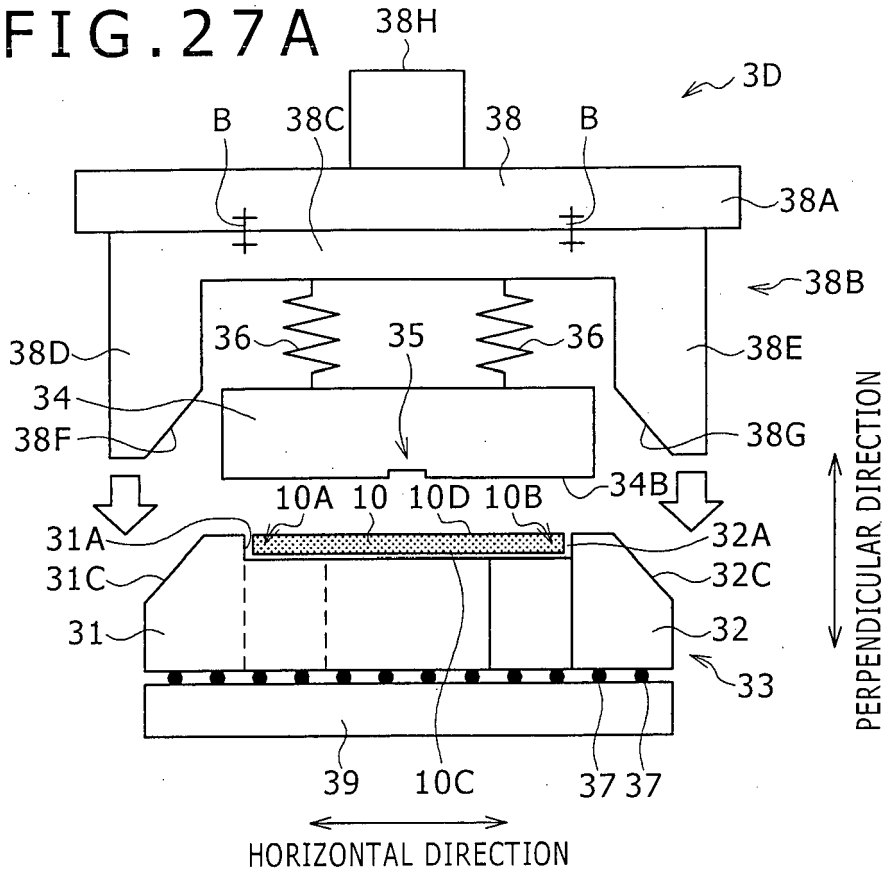


FIG.27B

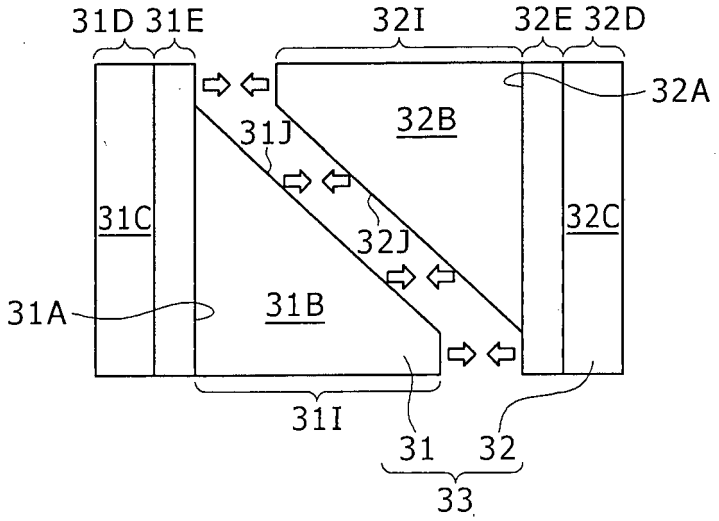


FIG.28A

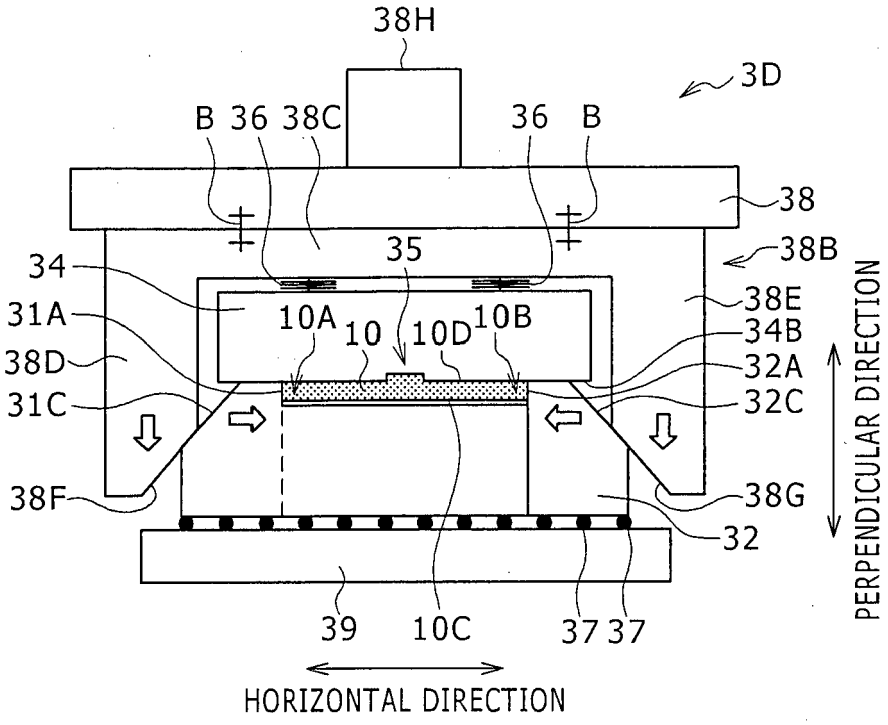


FIG.28B

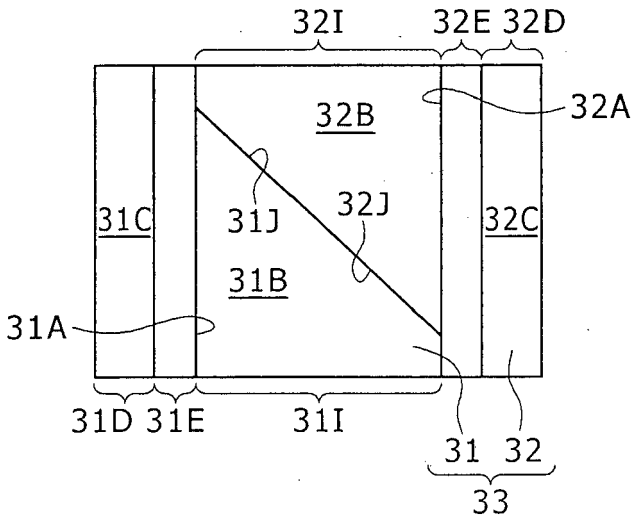


FIG.29

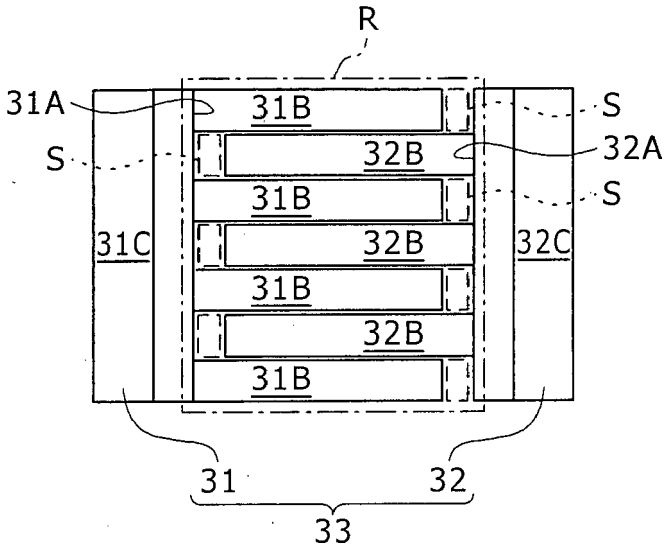
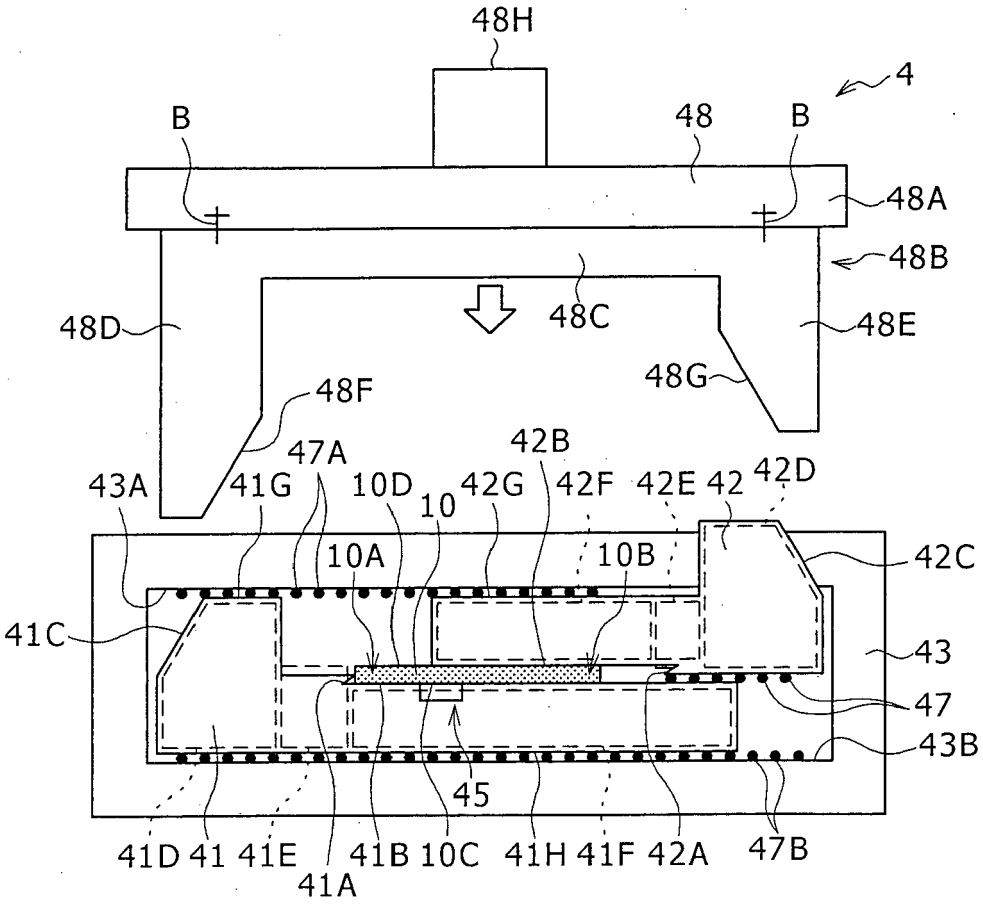


FIG. 30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4
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48A
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10B
42C
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41D
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41F
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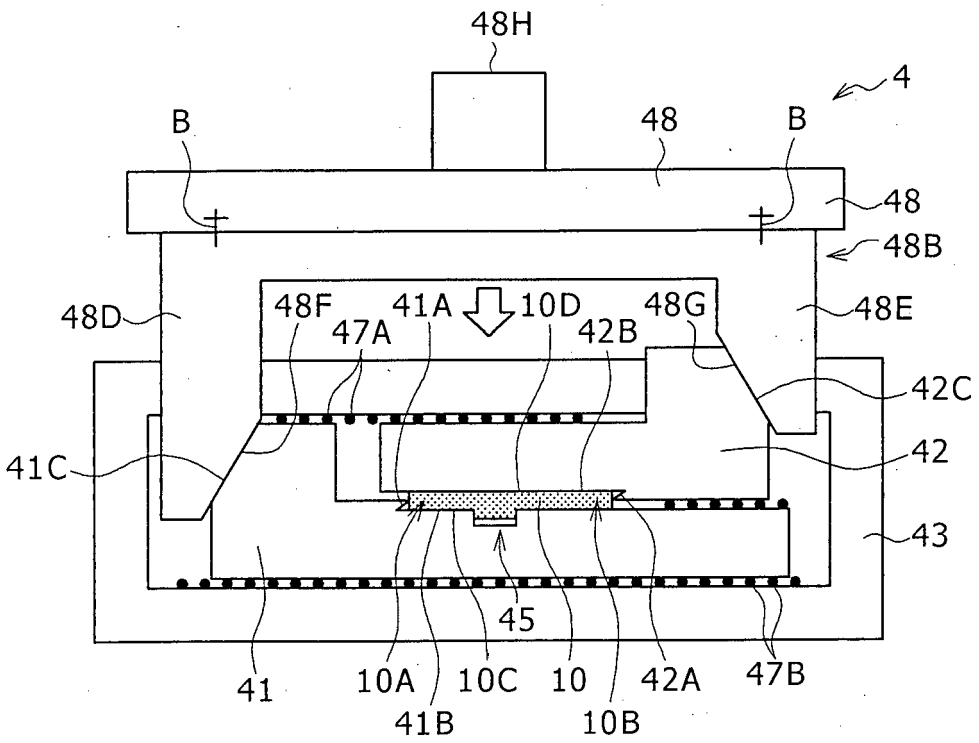
FIG. 31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41B
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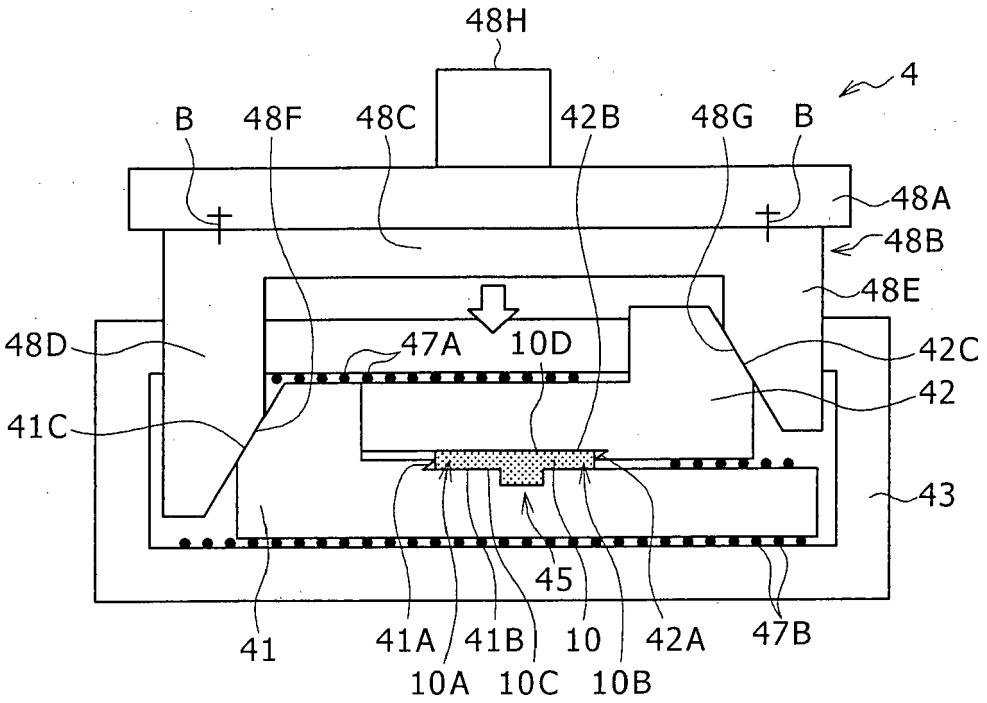
10B
42A
47B

FIG. 32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42A
47B
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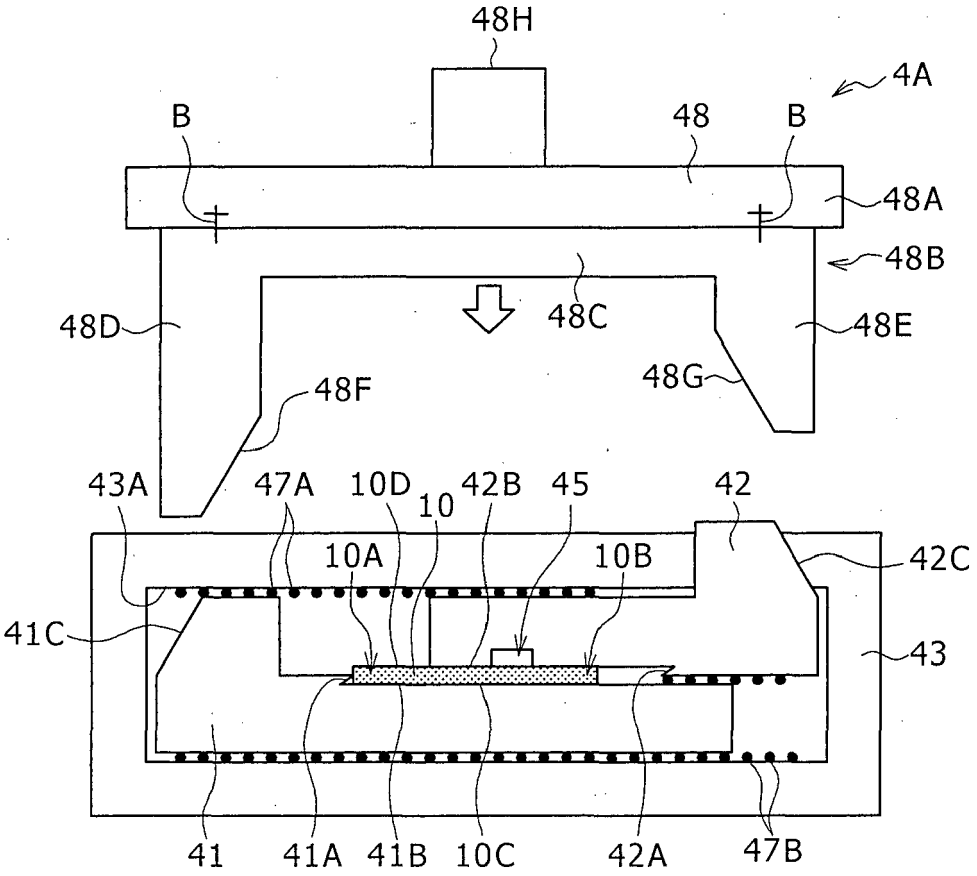
10C
10B

FIG. 33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41A
41B
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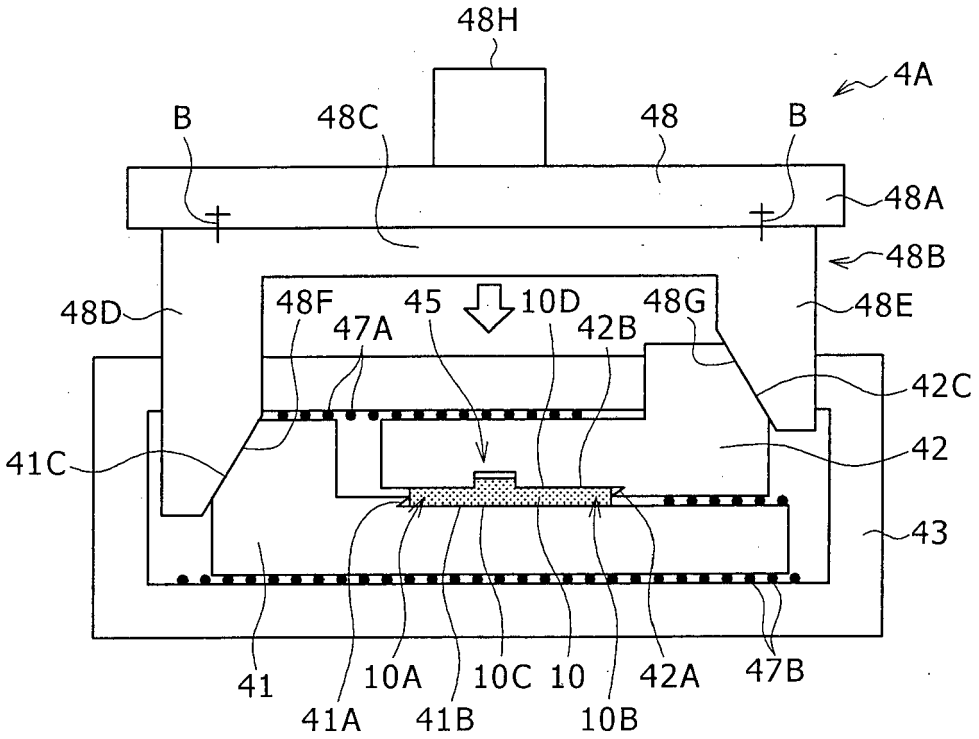
42A
47B

FIG. 34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10A
41B
10C
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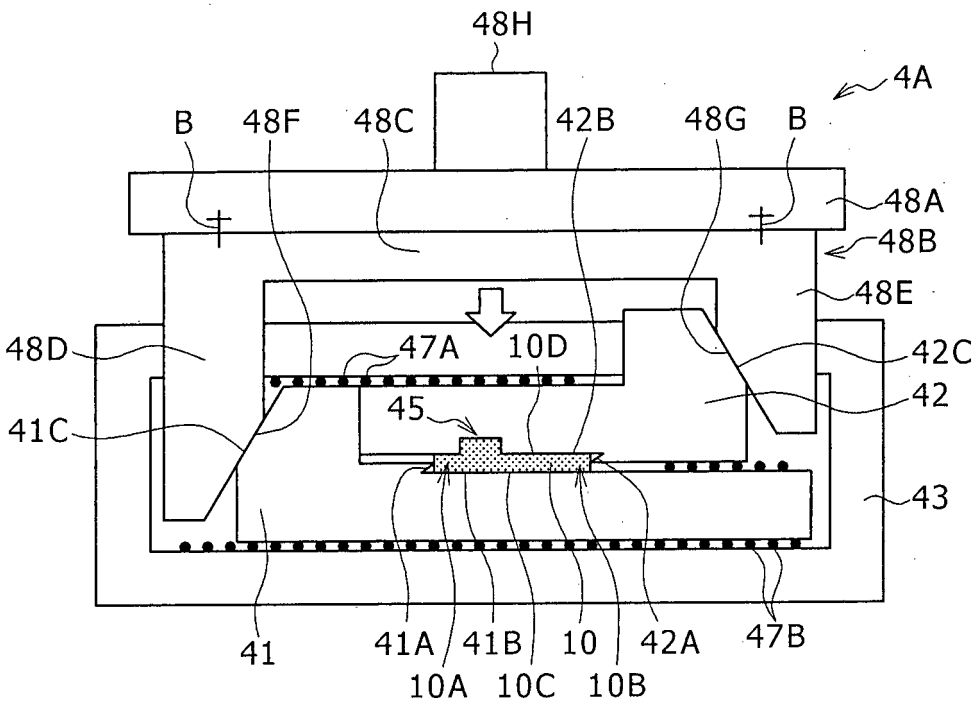
10B
42A
47B

FIG. 35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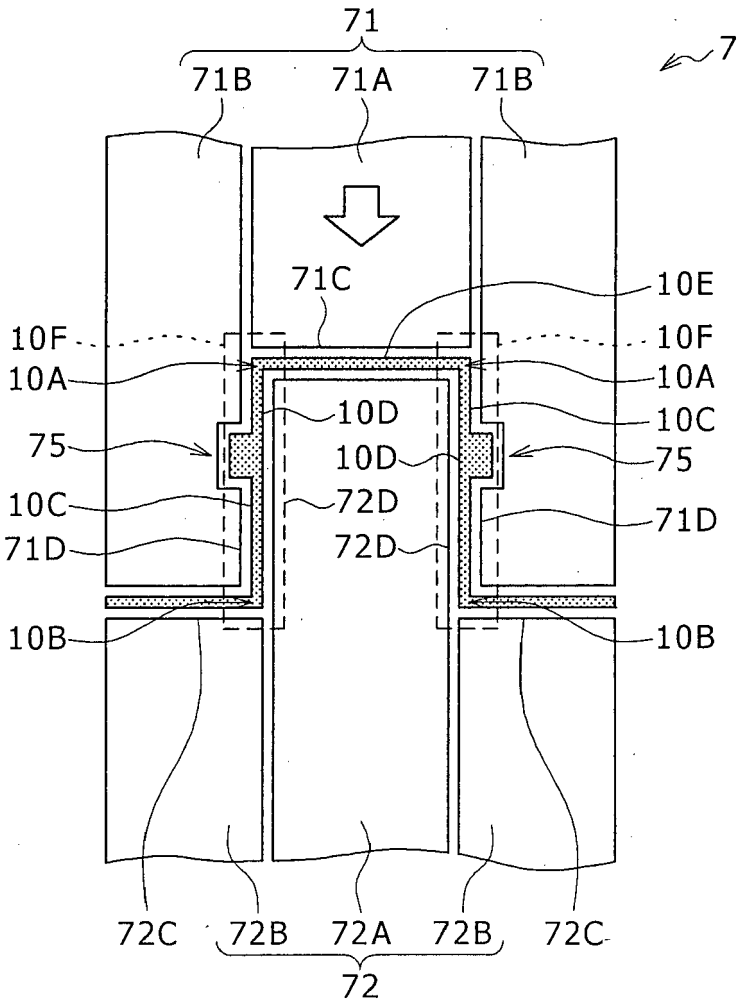
10C
10B

FIG.36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72C
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FIG. 37

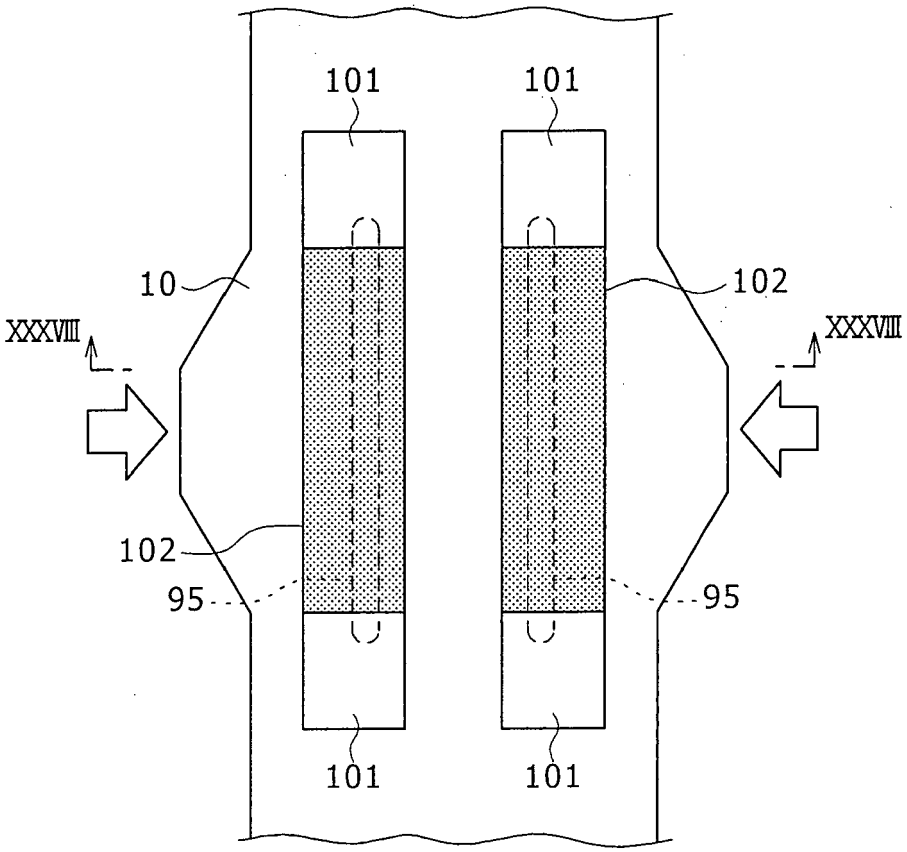
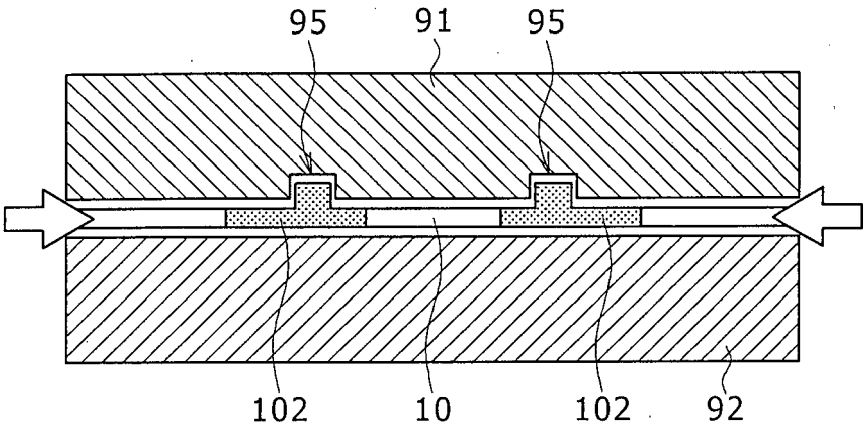


FIG.38



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EUROPEAN SEARCH REPORT

Application Number
EP 16 00 2386

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2004/216505 A1 (KNAUP HANS-JURGEN [DE]) 4 November 2004 (2004-11-04)	1,2,5, 7-10,13, 15	INV. B21D22/02 B21J5/08
A	* paragraph [0020] - paragraph [0023]; claims 1,6,10; figures 1,2 *	3,4,6, 12,14	B21D49/00 B21D35/00
A,D	JP 2014 166645 A (DAIHATSU MOTOR CO LTD) 11 September 2014 (2014-09-11) * figures 2a-2e,3a,3b *	1-15	
A	US 4 571 977 A (UENO KEII [JP] ET AL) 25 February 1986 (1986-02-25) * figures 1-4 *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

B21D
B21J
B21C
B21K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 May 2017	Vinci, Vincenzo

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10-05-2017

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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- JP 2007014978 A **[0002] [0003] [0004]**
- JP 2008296252 A **[0002] [0003] [0004]**