



(51) International Patent Classification: Not classified

(21) International Application Number:
PCT/US2011/026892

(22) International Filing Date:
2 March 2011 (02.03.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/309,747 2 March 2010 (02.03.2010) US

(71) Applicant (for all designated States except US): **ENTE-GRIS, INC.** [US/US]; 129 Concord Road, Billerica, MA 01821 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **BURNS, John** [US/US]; 6046 Bow River Drive, Colorado Springs, CO 80918 (US). **KING, Jeffrey, J.** [US/US]; 5235 Iron Horse Trail, Colorado Springs, CO 80917 (US).

(74) Agents: **CHRISTENSEN, Douglas, J.** et al.; Patterson Thunte Christensen Pedersen, P.A., 4800 IDS Center, 80 South Eighth Street, Minneapolis, MN 55402-2100 (US).

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

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

Published:

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

(54) Title: SUBSTRATE TRANSPORT CARRIER

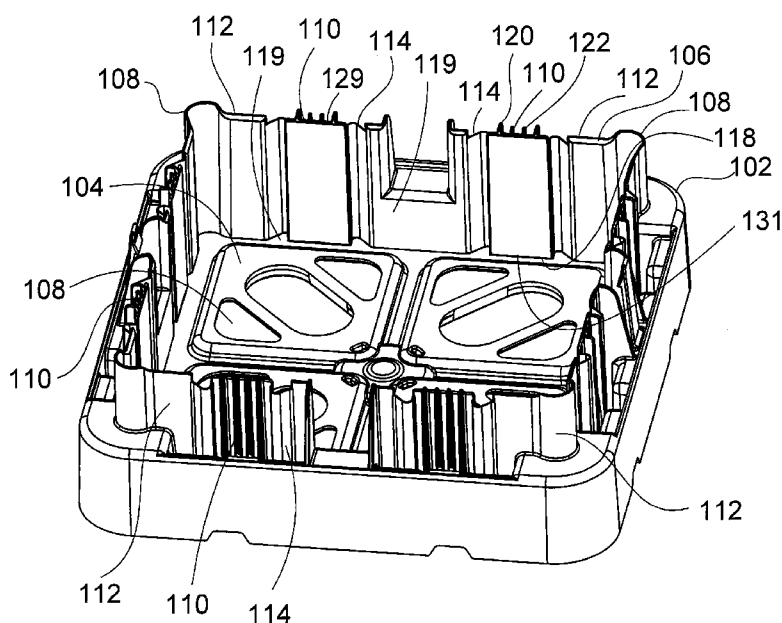


FIG. 1A

(57) Abstract: A transport container for substrates such as semiconductor wafers and solar cell substrates includes a cover and a base having a plurality of side walls including movable wall portions with vertically extending hinges or hinges that provide a pivot about a vertical axis. The hinges can be resilient movable polymer portions such as living hinges and can have an unconnected upper edge and an unconnected lower edge to allow the movable wall portions to move inwardly relative to a floor of the base. The cover can include a base engagement portion configured as a cam portion that engages a cover engagement portion on the movable wall portions as the cover is inserted onto the base. As the cam portions of the cover engage the cover engagement portions, the cam portions move the wall inwardly relative to the base to align the substrates.

SUBSTRATE TRANSPORT CARRIER

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application Serial No. 61/309,747, filed March 2, 2010 and which is incorporated by reference herein.

5

FIELD OF THE INVENTION

The present invention relates to a container for packaging items such as semiconductor wafers and solar cells. More particularly, the present invention relates to such a container with movable sidewalls for axially aligning substrates.

BACKGROUND OF THE INVENTION

10

Substrates such as semiconductor wafers and solar cells are often transported in transport containers that maintain substrates in axially aligned stacks of substrates. Such containers must securely contain the substrates in proper position to avoid damage during shipping and handling. The containers must also be adequately cushioned to absorb impacts and must securely contain the substrates to avoid relative movement of the substrates. When
15 used herein "substrates" include semiconductor wafers and solar cells, including the silicon wafers to be made into operational solar cells.

20

Substrates must be properly aligned in their axial stacks in order to properly interface with support and cushioning mechanisms and to prevent damage to the substrates. This can be difficult due to the conventional manner in which containers are filled with substrates. In
20 order for substrates to be inserted, the container must have an inside dimension that is greater than the outside dimension of the substrates. Therefore, as substrates are loaded into stacks, there is room for some variance between substrates in a stack and the substrates may be misaligned in the stack and vulnerable to damage.

25

Having a cover surface that slidingly engages the misaligned edges of a stack in order to align them can damage the edges of the substrates; this is particularly true for solar cell wafers which are extremely thin and fragile.

30

One approach to aligning substrates is manually align the substrates in the stack and to include a plurality of foam cushions to hold the substrates in the aligned axial arrangement within the container by applying forces that tend to resist lateral movement. However, it is
30 possible for more fragile substrates, particularly solar cells, to be damaged by the application

of such forces during shipping. It would therefore be desirable for a transport carrier to provide axial alignment of substrates while reducing the possibility of damage.

SUMMARY OF THE INVENTION

A transport container for semiconductor substrates and solar cell substrates includes a cover and a base having a plurality of side walls including movable wall portions with vertical pivot axis. Movable wall portions can be connected to upright support structure with resilient movable polymer portions such as living hinges and can have an unconnected upper edge and an unconnected lower edge portions to allow the movable wall portions to move inwardly relative to base portion. The cover can include a base engagement portion configured as a cam portion that engages a cover engagement portion on the movable wall portions as the cover is inserted onto the base. As the cam portions of the cover engage the cover engagement portions, the cam portions move the wall inwardly relative to the base to align the substrates. The inward movement includes the upper portion, the intermediate portion, and the lower edge. In particular embodiments, each of the two sides can move simultaneously. The action movable wall can be upper portion in first and then the lower portion or the action can be that the upper and lower portions move in harmony, that is simultaneously. Control of the action depends on the hinge configuration and the cam portion-movable wall portion configuration. In some embodiments, the cam portion can then drop into a clearance position where it is no longer forcing the movable wall inwardly. This allows the movable wall to move back near its original position via the living hinges to remove the lateral force on the substrates and allow the stack to be seated in the substrate carrier without lateral engagement of the sides of the stack. In other embodiments, the lower portion of the movable wall may be retained inwardly.

A feature and advantage of embodiments of the present invention is movable walls that allow alignment of axially stacked substrates within a transport container with only direct lateral engagement of the substrates, including solar cells. As the cover is engaged with the base, the cover engages the movable walls of the base causing them to move inwardly. This inward movement of the walls brings the stack of substrates into axial alignment with minimal chance of damage to the substrates.

A further feature and advantage of embodiments of the present invention is that the movable walls can release lateral pressure on the substrates after they have been axially aligned. After the movable walls have been moved inwardly by the cover, the engagement

portion of the cover can enter a clearance portion of the base such that it no longer is applying inward pressure on the movable walls. The movable walls then release the lateral pressure on the substrates by returning to near their original position via the living hinge.

BRIEF DESCRIPTION OF THE DRAWINGS

5 Figure 1a is perspective view of a base for a substrate transport container according to an embodiment of the present invention.

 Figure 1b is perspective view of a top cover for a substrate transport container according to an embodiment of the present invention.

10 Figure 2 is a perspective view of a substrate transport container according to an embodiment of the present invention.

 Figure 3 is a partial cross sectional view of a substrate transport container according to an embodiment of the present invention with the cover separated from the base.

 Figure 4 is a partial cross sectional view of a substrate transport container according to an embodiment of the present invention with the cover engaging the base.

15 Figure 5 is a partial cross sectional view of a substrate transport container according to an embodiment of the present invention with the cam portion of the cover engaging the mid portion of the movable wall.

20 Figure 6 is a partial cross sectional view of a substrate transport container according to an embodiment of the present invention with the cam portion of the cover engaging the lower portion of the movable wall.

 Figure 7 is a perspective view of a pair of substrate transport containers according to an embodiment of the present invention in a stacked configuration.

 Figure 8 is a detailed perspective view of a movable wall portion with two living hinges on opposite sides of the walls.

25 Figure 9 is a detailed perspective view of a movable wall portion with resilient hinges on only one side of the wall portion providing a horizontal moving wall.

 Figure 10 is a perspective view of another embodiment of a movable wall portion providing a horizontal moving wall.

DETAILED DESCRIPTION

Referring to Figures 1 and 2, a substrate transport container 100 for transporting substrates such as semiconductor substrates and solar cell substrates generally comprises a base 102 and top cover 103 to an embodiment of the present invention. Base 102 has support structure configured as four quadrants 104. Each quadrant 104 can include various types of substrate supports. Base 102 has a plurality of upwardly extending side walls 106, discussed further herein.

The base 102 can include one or more apertures 108 extending therethrough. Apertures 108 can have various geometric configurations. This allows base 102 to interface with automation equipment of various configurations. In one embodiment, a piston can enter through one or more of the apertures 108 and contact stack of substrates therein. The piston can then be used to incrementally raise the stack so that the substrates can be sequentially removed from the stack.

In one embodiment depicted in Figures 1 and 8, base 102 includes side walls 106, stationary walls 108, and eight movable side wall portions 110 positioned two on each side of base 102. Side walls 104 can each comprise a movable wall portion 110 that is connected to pair of stationary walls 112 with living hinges 114. At a bottom 116 of movable wall portions 110, base 102 is not connected to the movable wall portion except through the hinges. There may be a gap 118 between movable wall portions 110 and the floor 119 of the base. The movable wall portions 110 to be moved laterally relative to floor 119 of the base 102. The movable wall portions 110 define a stack receiving region 119. Each side wall 106 includes a cover guide portion 120 on each end of movable wall with a cover engagement portion 122 therebetween. In other embodiments the stationary walls may define a substrate stack receiving region with the movable wall portions displaced outwardly therefrom. Then upon lowering of the top cover, in such a configuration the movable wall portions can be urged to extend inwardly past the inner perimeter defined by the stationary wall portions to provide the alignment function and or a retaining function.

Figures 3-6 depict the interaction of base 102 and cover 103. Substrates such as solar cells 123 are illustrated schematically. The movable wall portion 110 has an outer retracted position R1 indicated where the wall portion is in Figure 3 and an extended position E1 illustrated with the dotted lines. Cover 103 includes a base engagement portion configured as a sliding cam portion 124 that includes a cam surface configured as wedge surface 126 and a

vertical flat surface 128. As shown in Figures 4 and 5, as the cover 103 is lowered onto base 102, the sliding cam portion 124, guided by cover guide portions 120, comes into engagement with cover engagement portion 122, a cam follower surface configured as ribs. Wedge surface 126 engages movable wall portion 110 as a cam follower surface configured as ribs 125, causing movable wall to begin to move inwardly. Because neither the upper edge 129 or the lower edge 131 of movable wall portion 110 is not connected to base 102, movable wall portion 110 moves inwardly relative to floor 119 of base 102, which remains stationary. This relative inward movement of movable wall portion 110 causes the movable wall portion to engage the stack 127 of solar cells or other substrates in the container to urge all substrates into proper alignment.

Wedge surface 126 slides along movable wall portion 110 until flat surface 128 engages cover engagement portion 122 as shown in Figures 4 and 5. Movable wall portion 110 continues to move inwardly relative to base to align the substrates as the flat surface 128 contacts cover engagement portion 122 as base 102 remains stationary. As base engagement portion 124 of cover 103 continues downward, it can enter a clearance section 134 of base 102 as illustrated in Figure 6. Cover engagement portion 122 of movable wall portion 110 can taper inwardly at 132 adjacent clearance portion 134 below the ribs 122, so that the cover 103 is no longer forcing the movable wall portion 110 inwardly into the stack of substrates. The movable wall portion 110 can then flex back to a position at or near its original position, of Figure 5, before it was engaged by the cover 103. By this process, the substrates within the stack have been aligned, but there is no longer a circumferential force pressing against the substrates, eliminating the possibility of damage to substrates from this force. In another embodiment, the movable wall portion 110 can remain engaged with substrate stack throughout shipping in order to provide increased resistance against lateral movement of substrates.

Figures 8 and 9 depict movable wall portions 110 according to various embodiments of the present invention. Figure 8 depicts a movable wall portion 110 connected to base 102 with a pair of standard living hinges 114 as illustrated in the figures previously discussed. Notably, the living hinges provide primarily as plurality of vertical axis of rotations a_1 , a_2 while also allowing some minimal rotation about a horizontal axis a_3 . The living hinges constrain movement of the movable wall portion to primarily inwardly and outwardly. Figure 8 depicts another embodiment of a movable wall portion 110.1 having a pair of resilient hinge

portions 140 and cover engagement portions 122. These resilient hinges 140 are configured as spring arms or fingers and provide a vertical axis of rotation a4. The two fingers limit the amount the wall portion can rotate about a horizontal axis. This movable wall portion can be moved as described in the previous embodiment by engagement of cam follower structure
5 with the cam portion extending from the top cover. The wall portion moves in an arc defined by the length of the spring arm and increasing the length of the spring arm will flatten the arc. In the above embodiments the movement of the wall portion is constrained by the configuration of the hinges/spring arms. In another embodiments, see Figure 10, the movable wall portion can be slidingly engaged with the base portion, such as a T-member 156 in a slot
10 158 or other structure on the base portion controlling the movement. Spring members can be connected to the movable wall portion to return the wall portion to an original position.

Referring to Figure 7, transport containers 100 can be configured to be stackable upon each other. Containers 100 can include a perimeter having a plurality of notches 140 that allows for stacking by accommodating a portion of the perimeter 142 of an adjacent
15 container. Containers 100 can be stackable at an angle to each other, as shown in Figure 7, or can be stackable aligned with one another. Stacking containers 100 at an angle to each other provides the advantage of being able to view colored information plug 144 associated with a container without having to displace the container above.

Although the figures illustrate a container for square substrates, the invention is also
20 equally applicable to transport containers for circular substrates; such containers are known as coin stack wafer containers.

The base and top cover may be conventionally injection molded. The hinges can be formed by thinner material or may be a different polymer adhered to the stationary wall and movable wall by coinjection techniques. Other materials may also be suitable such as pulp.

25 The present invention may be embodied in other specific forms without departing from the spirit of any of the essential attributes thereof. Therefore, the illustrated embodiments should be considered in all respects as illustrative and not restrictive, reference being made to the appended claims rather than to the foregoing description to indicate the scope of the invention.

CLAIMS

1. A transport container for a stack of substrates, the container having a base and a top cover, the base having a stack receiving region defined by a plurality of movable wall portions, the movable wall portions having a vertically extending hinge allowing the movable wall portions to be moved horizontally toward and away from the stack receiving region, each movable wall having a top cover engaging surface positioned opposite from the stack receiving region;

the top cover having a plurality of cam portion arranged to engage each of the movable wall portions as the top cover is lowered into engagement with the base whereby the movable wall portion are urged inwardly toward the substrate receiving region.

2. The transport container of claim 1 wherein each movable wall portion has a pair of sides and each side is attached to stationary wall portions by way of living hinges.

3. The transport container of claim 1 wherein each movable wall portion pivots about a vertical axis.

4. The transport container of claim 3 wherein each movable wall portion is connected to a stationary wall portion by a pair of resilient fingers.

5. The transport container of claim 1 wherein the floor, the stationary wall portions, the movable wall portions, and the hinges are all integral with one another.

6. A method of axially aligning substrates in a container, the method comprising the steps of:

placing a stack of not fully aligned substrates in a receiving region of a base of a transport container, the receiving region defined by a plurality of movable wall portions with a top edge and a bottom edge, the bottom edge separated from a floor of the base by a gap;

engaging the movable wall portions with cam portions attached to the top cover such that the movable wall portions are urged inwardly;

seating the top cover onto the base.

7. A substrate container comprising:

a base portion with a floor with a movable sidewall portion positioned above the floor with a gap there between, the movable sidewall portion flexible attached to a stationary wall portion, the movable wall portion having a top edge and a bottom edge whereby both are movable horizontally as the movable wall portion moves.

8. The substrate container of claim 7 further comprising a top cover that is engageable with the base portion, the top cover having members that engage a surface on the movable wall to move the wall portion horizontally.

6. A method of axially aligning substrates in a container, the method comprising the steps of:

placing a stack of not fully aligned substrates in a receiving region of a base of a transport container, the receiving region defined by a plurality of laterally movable wall portions with a top edge and a bottom edge, the bottom edges movable with respect to the floor of the base;

engaging the movable wall portions with cam portions attached to the top cover such that the movable wall portions are urged inwardly; and

seating the top cover onto the base.

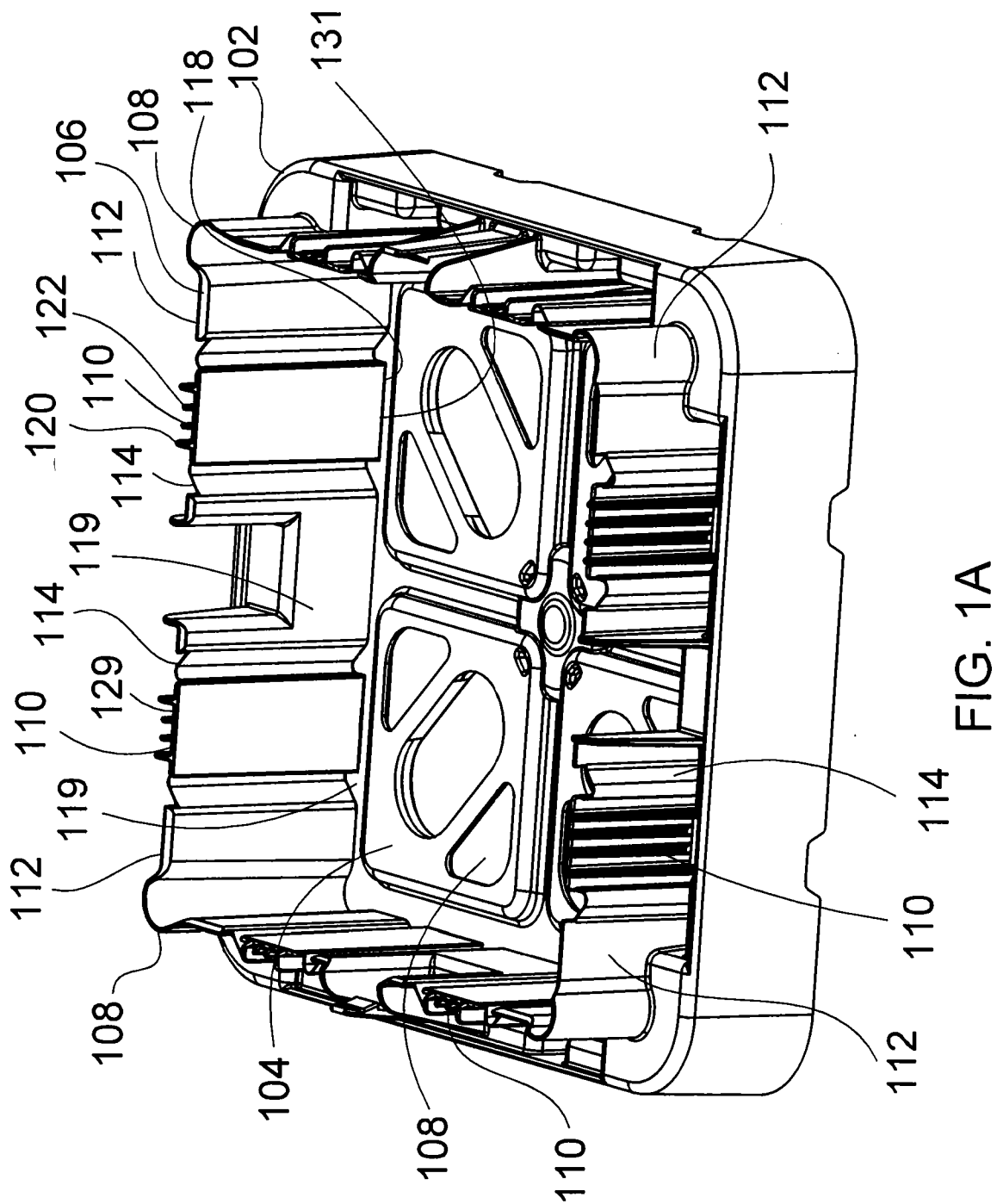


FIG. 1A

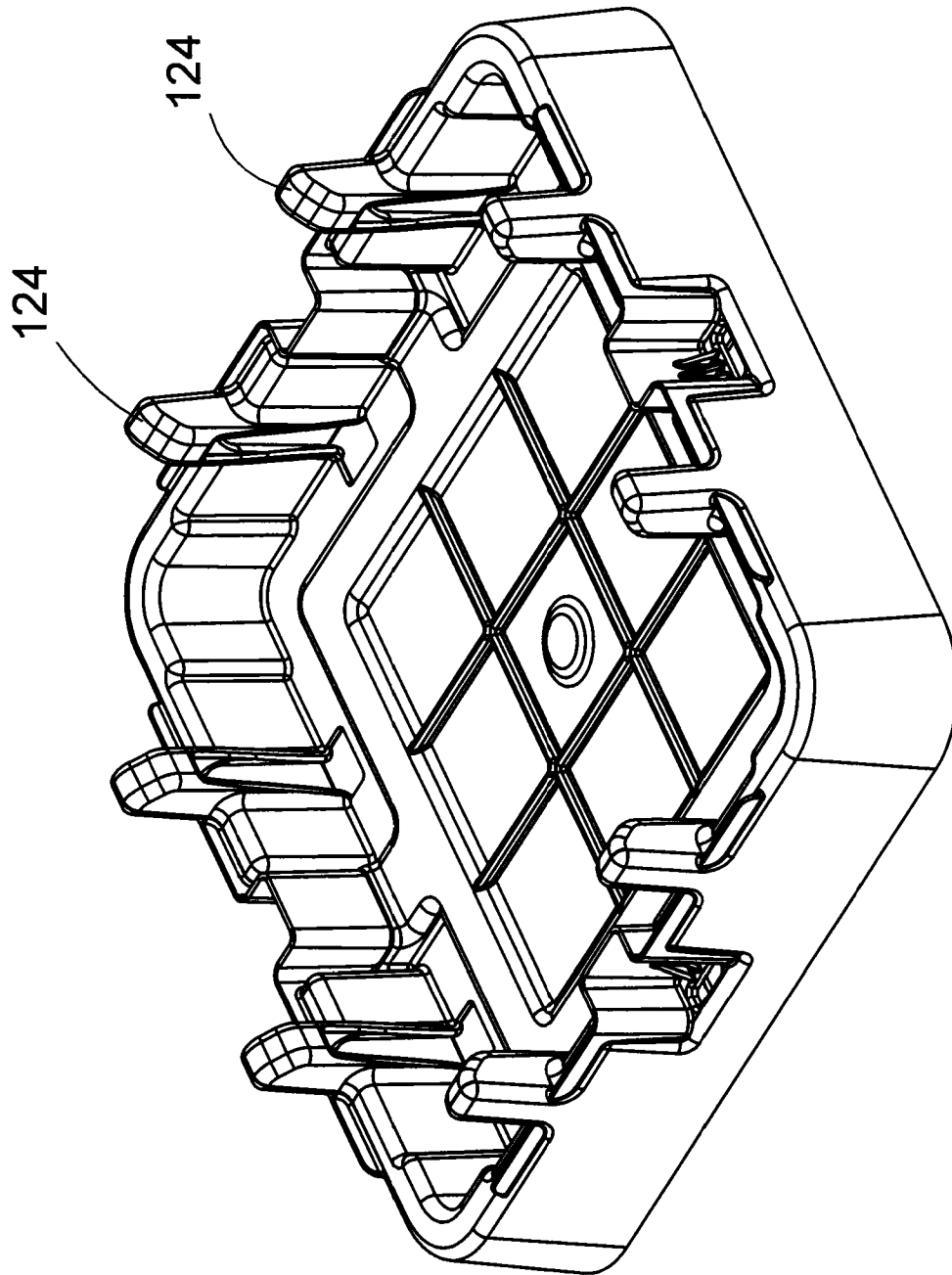


FIG. 1B

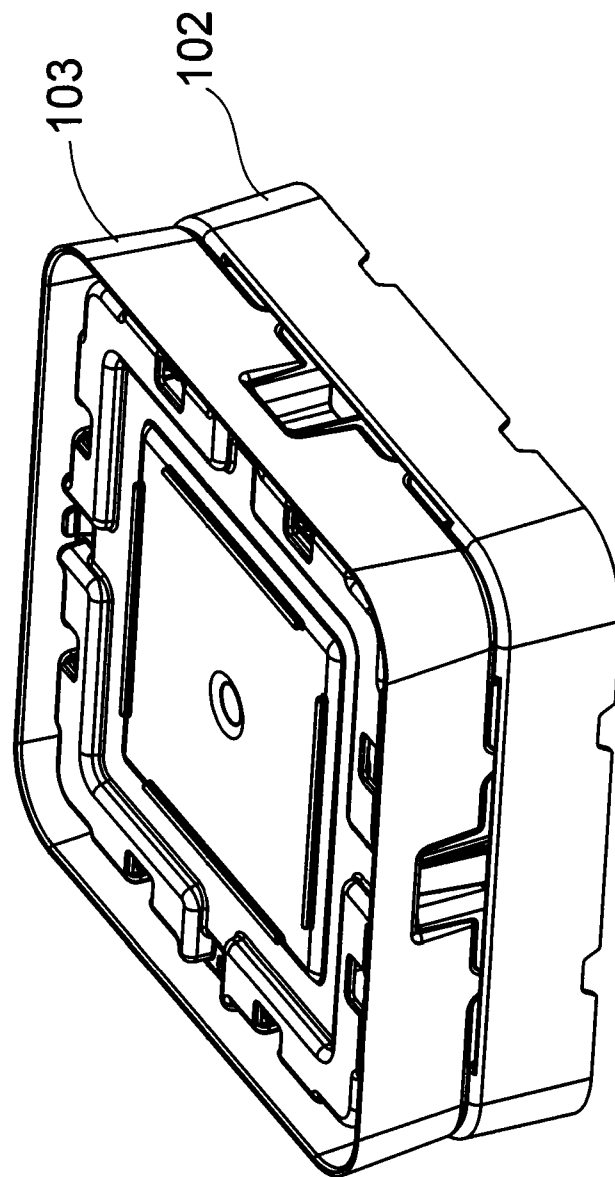


FIG. 2

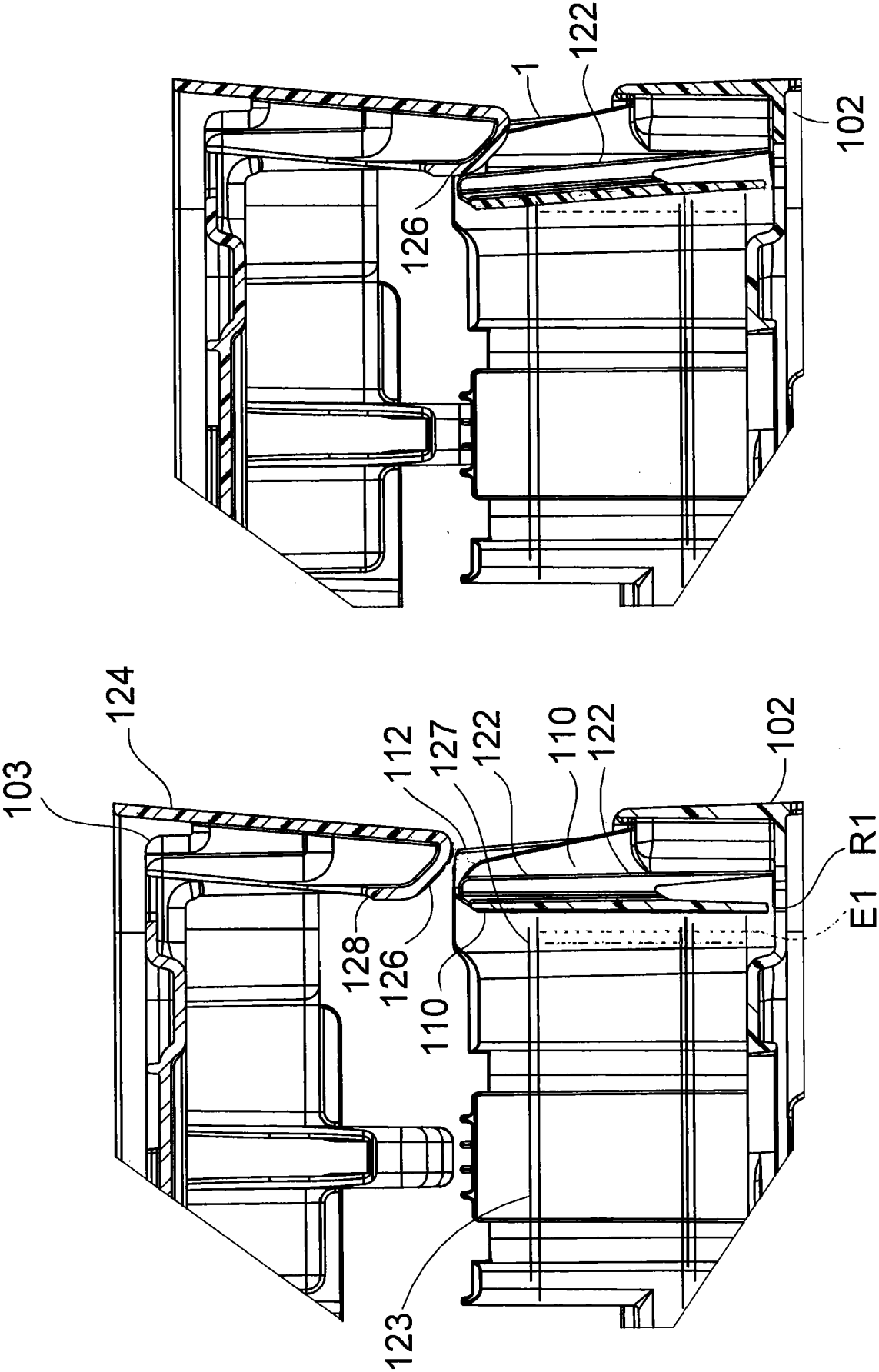


FIG. 4

FIG. 3

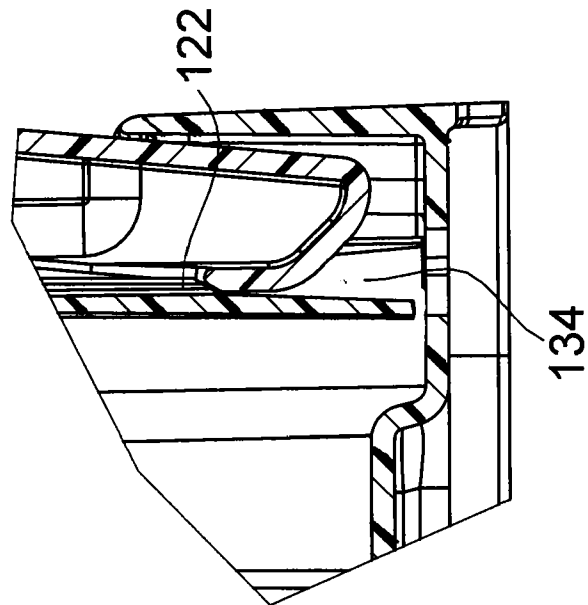


FIG. 6

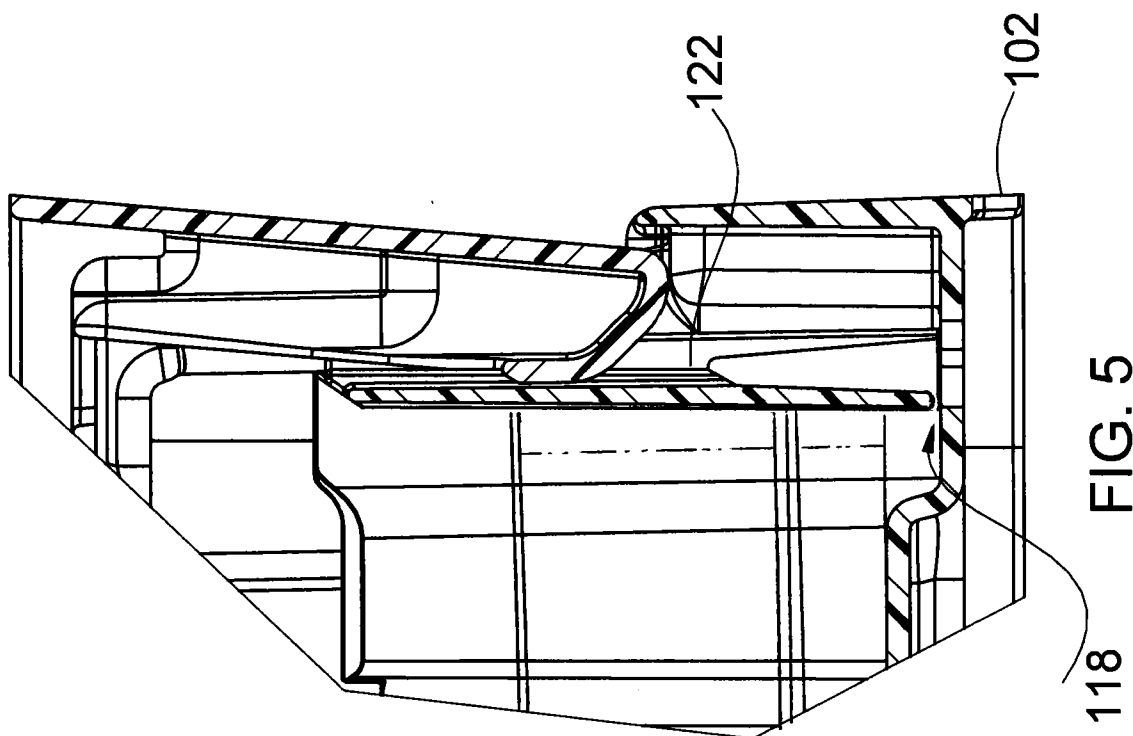


FIG. 5

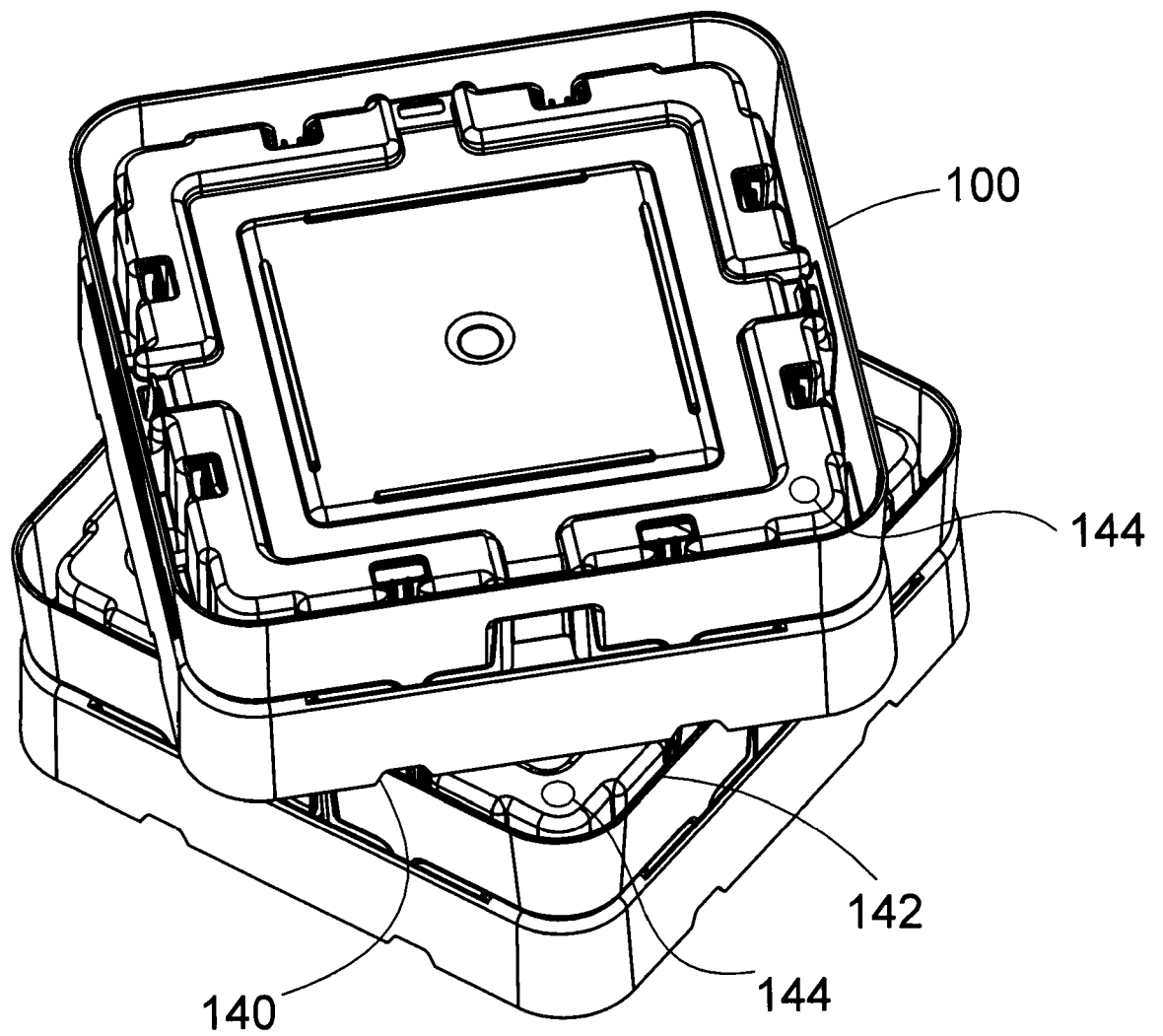


FIG. 7

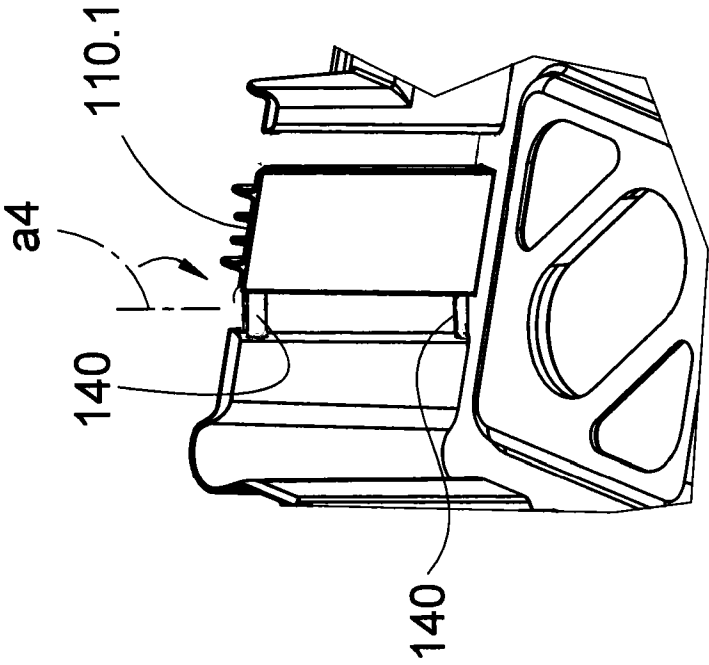


FIG. 9

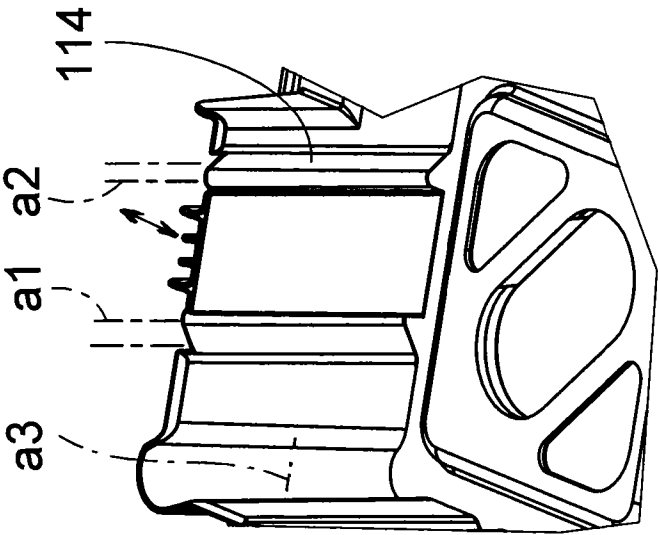


FIG. 8

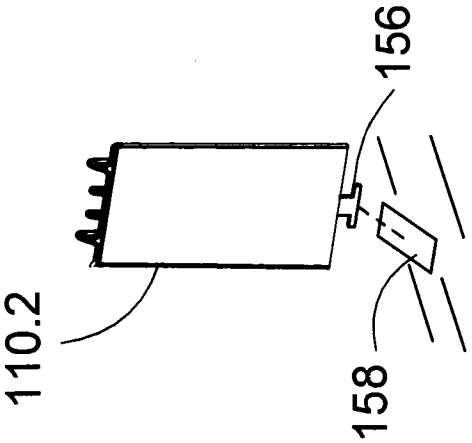


FIG. 10