

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
21 December 2007 (21.12.2007)

PCT

(10) International Publication Number
WO 2007/146019 A2

(51) International Patent Classification:
B65B 23/22 (2006.01)

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(21) International Application Number:
PCT/US2007/013359

(22) International Filing Date: 6 June 2007 (06.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/811,387 6 June 2006 (06.06.2006) US

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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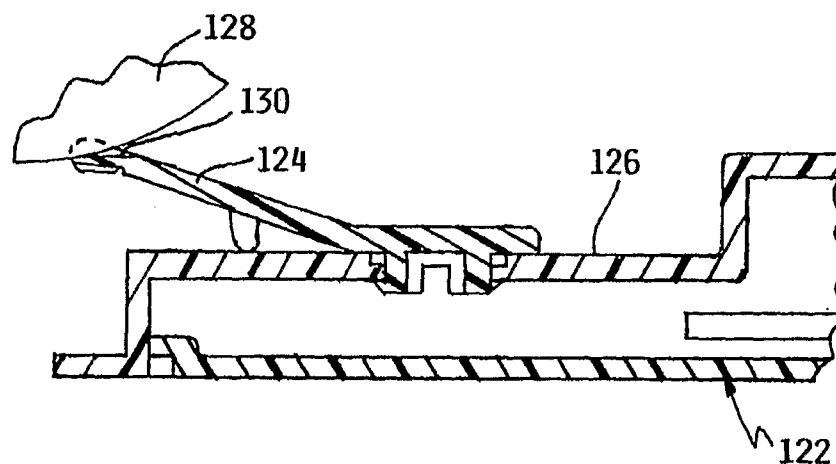
(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, 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*

[Continued on next page]

(54) Title: COMPOSITE SUBSTRATE CONTAINER WITH OVERMOLDED WAFER RETAINER



(57) Abstract: An overmolded wafer retaining structure for engaging the edges of wafers in a wafer container. The overmolded wafer retainer includes a base portion and an overmolded portion. The overmolded portion is injection molded onto the base portion to form a hermetic bond without need for external fasteners or adhesive. The wafer retainer is situated in a wafer container such as a standard mechanical interface (SMIF) pod or a front opening unified pod (FOUP) so that when the door is mounted to the container to form a closure, the retainer is brought into contact with an edge of the wafer or wafers.

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COMPOSITE SUBSTRATE CONTAINER WITH OVERMOLDED WAFER RETAINER

Related Application

5 The present application claims the benefit of U.S. Provisional Application No. 60/811,387 filed June 6, 2006, which is incorporated herein in its entirety by reference.

Field of the Invention

10 The invention relates to devices for confining memory disk, silicon wafers, and the like for transport, storage or processing. More particularly, the invention relates to a composite wafer retention structure.

Background of the Invention

15 Certain containers are utilized for transporting and storing batches of silicon wafers or magnetic disks before, during, and after processing of the disks or wafers. The wafers are processed into integrated circuits and the disks are processed into a magnetic storage disks for computers. "Wafers" as used herein refers to silicon wafers, magnetic substrates, and the like.

20 The processing of wafer disks into integrated circuit chips often involves several steps where the disks are repeatedly processed, stored and transported. Due to the delicate nature of the disks and their extreme value, it is vital that they are properly protected and securely retained throughout this procedure. Accordingly, wafer containers are generally configured to accommodate a wafer carrier that supports the wafers within slots or on shelf members near the peripheral edges of the wafers.

25 Some conventional containers are configured to hold an H-bar style carrier, such as a standardized mechanical interface (SMIF) pod. SMIF pods typically have a bottom opening door for accessing the H-bar carrier with wafers and generally include a wafer retainer that prevents a given wafer contained therein from sliding in a lateral direction with respect to its plane of registration. Such wafer retainers may include a channel-like structure operatively coupled with an actuating mechanism within the dome of a SMIF pod. The actuating mechanism rotates or translates the wafer retainer into contact with the edges of the wafers when the bottom or door is engaged. The wafer retainer is subject to direct and moving contact with the outer peripheral edges of the wafers contained in the SMIF pod.

30

The corners that are defined by the confluence of the outer peripheral edge and major surfaces of the wafers are often sharp. These sharp corners may cause local chipping or pitting of the wafer retainer upon contact, thereby contaminating the wafers in the container with particulates. Conversely, the sharp corners themselves may be subject to such chipping or pitting which may also contaminate the wafer. Even in scenarios where the wafer or wafer retainer does not pit or chip, the wafer retainer will generally slide axially or tangentially along the wafer edges at engagement, which can generate fine particulates that contaminate the wafers.

Summary of the Invention

A material that is well suited for fabrication of one part of a container may not be particularly well suited for a different part of the same container. For example, polyetheretherketone is a material that has ideal abrasion resistance characteristics ideal for wafer contact portions but is difficult to mold and may be expensive relative to other serviceable plastics. Thus, PEEK may not be as good a choice as other plastics, such as polycarbonate, for bulk or structural components of a wafer container.

Accordingly, a composite wafer retainer in various embodiments of the present invention comprises a support portion comprising a first material and an operative or overmolded portion comprising a different material to form a gapless hermetic interface that securely bonds the portions together. Various embodiments of the invention include wafer retainers with such overmolded portions and a process for manufacturing such wafer retainers.

In one embodiment, an overmolded wafer retainer for retaining a plurality of wafers in a wafer container comprises a base portion comprising a first material and including at least one rail portion having an edge for engaging the plurality of wafers in the wafer container. An overmolded portion comprising a second material may be disposed at least partially along the edge of the at least one rail portion, the second material being thermophysically bonded to the first material such that the overmolded portion is secured to the base portion without separate mechanical fasteners. The, the second material may be disposed on the first material to prevent chipping, pitting or abrasion of the first material.

In another embodiment, a container portion having a door frame cooperates with a door to form an enclosure. The enclosure may contain at least one wafer. An actuating

mechanism may be operatively coupled within the enclosure proximate an interior wall of the container portion. A distal portion of the actuating mechanism may extend away from the interior wall when the door is placed within the door frame. A wafer retainer may be operatively coupled with the actuating mechanism. The wafer retainer may include a base portion comprising a first material and an overmolded portion comprising a second material, the second material being thermophysically bonded to the first material such that the overmolded portion is secured to the base portion without separate mechanical fasteners. The overmolded portion is brought into contact with each of the edges of the at least one wafer when the distal portion of the actuating mechanism is extended away from the interior wall. The second material may be tailored to provide the overmolded portion with particular mechanical and/or electrical properties, e.g. softness, higher resistance to abrasion and electrical dissipative qualities.

An advantage of particular embodiments of the present invention is that a retainer mechanism may be formed that provides enhanced performance characteristics at minimal material and labor costs.

An additional advantage of particular embodiments of the present invention is that the dimension of the final part may be tuned to suit dimensional tolerances.

An additional advantage of particular embodiments of the present invention is that a substantially integral wafer retainer is created by two portions that are molded or fused together. The juncture between the two dissimilar materials may be gapless, hermetic and secure, thus mitigating the potential entrapment of contaminants or other chemicals between the materials.

Another advantage and feature of particular embodiments of the present invention is that the choice of overmolding material enables a reduction in friction, wear and particulate generation during operation.

Brief Description of the Drawings

FIG. 1A is a cutaway side elevation view of a wafer container having a wafer retainer that is disengaged from the wafers in an embodiment of the invention;

FIG. 1B is a cutaway side elevation view of the wafer container of FIG. 1A with the wafer retainer engaged with the wafers;

FIG. 1C is a perspective view of an actuation mechanism used in FIGS. 1A and 1B with the wafer retainer removed;

FIG. 2 is an elevation view of the wafer container of FIG. 1 with the rear wall cutaway to expose the wafer retainer and actuating mechanism;

5 FIG. 3 is a perspective view of the front face of an overmolded wafer retainer in an embodiment of the invention;

FIG. 4 is a perspective view of the rear of an overmolded wafer retainer of FIG. 3;

FIG. 5 is an end view of the overmolded wafer retainer of FIG. 3;

FIG. 6 is a front view of the overmolded wafer retainer of FIG. 3;

10 FIG. 7 is a side view of the overmolded wafer retainer of FIG. 3;

FIG. 8 is a rear view of the overmolded wafer retainer of FIG. 3;

FIG. 9 is a perspective view of the rear face of an overmolded wafer retainer of FIG. 3 with sprue attached;

15 FIG. 10 is a perspective view of the front face of the overmolded wafer retainer of FIG. 9;

FIG. 11 is an end view of an overmolded wafer retainer of FIG. 9;

FIG. 11A is an enlarged partial view of the overmolded portion of FIG. 11;

FIG. 12A is a plan view of a front opening unified pod in an embodiment of the invention;

20 FIG. 12B is the door of the front opening unified pod of FIG. 12A; and

FIG. 12C is an enlarged sectional view of one of the overmolded wafer retainer fingers in FIG. 12B.

Detailed Description of the Drawings

25 Referring to FIGS. 1A, 1B, 1C and 2, a wafer container 10 comprising a dome or container portion 12 and a door 14 is depicted in an embodiment of the invention. The particular embodiment depicted is a SMIF pod, with the container portion 12 being generally cubical in shape and having a front wall 20, a rear wall 16, two side walls 18 and 22, a top portion 24, and a bottom assembly 26. The bottom assembly 26 includes the door 14 that may be seated within a door frame 28 to form an enclosure 27. A plurality of

wafers 29 having edges 29.1 may be housed within the enclosure 27 and may be suspended by an H-bar carrier (not depicted).

In the embodiment depicted, an actuating mechanism 30 depends from the top portion 24 proximate an interior surface 31 of the rear wall 16. In other configurations, the actuating mechanism 30 may be operatively coupled with one of the walls 16, 18, 20 or 22, or to the door 14. The actuating mechanism 30 comprises a frame 32 that supports an upper spindle 34 and a lower spindle 36. A pair of braces 38 and 40 extend one each from the spindles 34 and 36, respectively. The braces 38 and 40 each define a distal portion 42 and 44 of the actuating mechanism 30, the distal portions 42, 44 each supporting a cylindrical pivot 46, 48, respectively. An overmolded wafer retainer 50 having a front face 51 and a back face 52 is operatively coupled with the cylindrical pivots 46 and 48.

Referring to FIGS. 3 through 8, an embodiment of the overmolded wafer retainer 50 is illustrated. The overmolded wafer retainer 50 may include a base portion 54 and an overmolded portion 56. The base portion 54 may be formed by an injection molding process, and may be made of a relatively hard polymer such as polycarbonate. The overmolded portion 59 may be formed from a different material possessing certain desirable physical properties such as relative softness, abrasion resistance and/or certain electrical dissipative characteristics. An exemplary and non-limiting material for the overmolded portion may be a thermoplastic such as polyetheretherketone (PEEK) or a material having certain electrically conductive properties such as carbon-doped or carbon-filled PEEK.

The base portion 54 may include a pair of rail portions 58 and 59 separated by cross members 61 through 66. In this embodiment, a central or longitudinal axis 67 is defined at the mid span of the cross members 61 – 66. An upper clip assembly 68 may extend from cross members 62 and 63, and may include two L-shaped fork members 70 and 72 that extend from cross member 60. A central bridge member 74 may extend between the cross members 62 and 63 and may include an arcuate portion 76 shaped to accommodate the cylindrical pivot 46 when the wafer retainer 50 is operatively coupled with the actuating mechanism.

Likewise, a lower clip assembly 78 may extend from cross members 64 and 65. The lower clip assembly 78 may be substantially similar to the upper clip assembly 68,

e.g. having two L-shaped fork members 80 and 82 and a central bridge member 84 with an arcuate portion 86 shaped to accommodate the cylindrical pivot 48.

In the embodiment depicted in FIG. 3, a bridge plate 87 extends between cross members 65 and 66. A standoff 88 may project off the back side 51 of the overmolded wafer retainer 50. The standoff 88 is depicted as extending from the cross member 65, but may extend from any part of the base portion 54. More than one standoff member 88 may be utilized. A wheel yoke 90 having a free end 92 extends from cross member 66 along the central axis 67, with a wheel 94 operatively coupled with the wheel yoke 90. In this configuration, the wheel 94 protrudes beyond the free end 92 of the wheel yoke 90.

The L-shaped fork members 70,72 and 80,82 cooperate with the arcuate portions 76 and 86 of the respective central bridge members 74 and 84 to securely clip the overmolded wafer retainer 50 to the cylindrical pivots 46 and 48 (FIGS. 1A, 1B, 1C and 2).

In the particular embodiment of FIG. 3, the rail portions 58 and 59 each comprise a proximal end portion 96 and a distal end portion 98. The proximal end portions 96 of the rail portions 58 and 59 may be connected to or integral with the cross members 61 – 66 and are may be substantially orthogonal to the cross members 61 – 66. In one embodiment, the distal end portions 98 extend from the proximal end portions 96, each projecting away from the central axis 67 at an angle 100 that is oblique with respect to the proximal end portion 96 and defining an edge 102 that faces substantially away from the central axis 67. A ridge portion 104 made of an overmolding material 105 may be disposed on the edge 102.

The overmolded portion 56 may be disposed on the base portion 56 using a thermoplastic injection mold process. An example of such a process is disclosed in U.S. patent application Ser. No. 11/092,528, filed on March 29, 2005, which is a continuation of U.S. patent application Ser. No. 10/213,282, filed on August 5, 2002, issuing as U.S. Pat. No. 6,871,741, which is a continuation-in-part of U.S. patent application Ser. No. 09/317,989, filed on May, 25, 1999, issuing as U.S. Pat. No. 6,428,729 on Aug. 6, 2002, which is based on U.S. Provisional Application Ser. No. 60/087,205, filed May 28, 1998. Each of these references, which are assigned to the assignee of the present application, may be related in subject matter and are hereby incorporated by reference in their entirety herein except for express definitions included therein. These patents disclose composite

wafer carriers and containers wherein a wafer support structure is made of a first thermoplastic material that is overmolded onto a second thermoplastic material that is different from the first. The overmolded component creates a gapless hermetic interface that securely bonds the portions together. Specifically, U.S. Patent No. 6,871,741
5 discloses the overmolding of transparent windows, latching mechanisms and wafer contact portions for supporting wafers.

In operation, the overmolded wafer retainer 50 engages the edges of the wafers 29 that are housed in the wafer container 10 to secure the wafers 29 within a wafer carrier such as an H-bar carrier (not depicted). With the door 14 off the overmolded wafer
10 retainer 50 is suspended over the opening of frame 28 in a retracted position (FIG. 1A), with the wheel 94 at the downward extremity. The standoff 88 registers against the interior surface (not depicted) of the rear wall 16 thus preventing hyperextension of the rotating members of the actuating mechanism 30 when in the retracted position. As the
15 door 14 is placed within the frame 28, the door 14 contacts the wheel 94 causing the overmolded wafer retainer 50 to be motivated upward toward top portion 24. The upward motion of the overmolded wafer retainer 50 causes the braces 38 and 40 to rotate about spindles 34 and 36, further causing the overmolded wafer retainer 50 to extend away from rear wall 16, and bringing the ridge portion 104 of the overmolded wafer retainer 50 into
20 contact with the peripheral edges of the wafers 29. The FIG. 1B illustration depicts the overmolded wafer retainer 50 in the extended or contact position. The wheel 94 allows the overmolded wafer retainer 50 to translate along the interior surface of the door 14 without undue generation of particulates. The bridge plate 87 effectively stiffens the cross member 66 to resist moment or torsional loads caused by reactive forces transferred to the wheel yoke 90 when the wheel 94 is engaged with the door 14.

25 It is further noted that other embodiments of the actuating mechanism 30 (e.g. mechanism that do not include a wheel 94) and overmolded wafer retainer 50 may be utilized and remain within the scope of the invention.

Referring to FIGS. 9 through 11, the process of overmolding the overmolded wafer retainer 50 is described in more detail. One method involves casting the base portion 54 in
30 a first mold, then transferring the base portion 54 to a second mold for overlay of the overmolded portion 56. The second mold is outfitted with an artery system 106 that allows the overmolding material 105 to access the edges 102 of the rail portions 58 and 59.

A second method involves a first mold that includes provisions for the artery system 106 that is optionally fitted with inserts (not depicted). During injection molding of the base portion 54, the inserts are placed in the passageways that define the artery system 106. After the base portion 54 is formed, the base portion 54 is removed from the mold and the inserts removed from the artery passageways. The base portion 54 is then reset within the first mold and the overmolding material 105 is injected through the now vacant passageways to form the artery system 106 that delivers overmolding material 105 to the edges 102 of the rail portions 58 and 59.

With either method, the mold may be comprised of an upper mold portion that cooperates with a lower mold portion having a parting line 108 positioned to encapsulate the base portion 54 and the artery system 106. It is noted that while the mold portions are not depicted, the upper portion is located in a region above the parting line 108 denoted by the letter "A", and the lower mold portion is located below the parting line in a region denoted by the letter "B".

The parting line 108 allows full definition of what is referred to as a "steel safe interface" 110 with the wafers 29. The steel safe interface includes the portion of the overmolded wafer retainer 50 that makes contact with the edges of the wafers 29. The steel safe interface is preferably free of sharp corners, and typically has a rounded face 112 that makes contact with the wafers 29. The steel safe interface 110 has a protruding dimension 114 that protrudes beyond the base portion in the direction of the wafers 29.

Operationally, the location of the parting line 108 enables the overmolded portion 56 to be fine tuned to an optimal dimension. The molding process is subject to biases that affect the size of the final component in an uncertain but generally repeatable way. One can "fine tune" the molding by removing metal from the mold until the desired dimensional tolerance of the final molded product is achieved. A component created from a mold that utilizes this process is referred to as a "steel safe" component because, despite the presence of the bias, the dimensional repeatability of products produced by the mold is generally quite good.

Hence, in one embodiment of the invention, one would undersize the cavity on the upper mold portion that defines the protruding dimension 114 so that the resulting steel safe interface 110 is undersized, taking into account shrinkage factors and other known effects. Based on the result, one may extrapolate an estimated amount of material to

remove from the cavity on the upper mold portion that defines the protruding dimension 114. Depending on the magnitude of the extrapolation, one may choose to remove slightly less material than calculated to assure that the resulting part will not be oversized. After two or three trimmings of the cavity, one may create a mold that produces a component that is within dimensional tolerance.

Referring to FIGS. 12A through 12C, a front opening unified pod (FOUP) 120 is depicted having a door assembly 122 with a plurality of overmolded wafer retainer fingers 124 in an embodiment of the invention. The overmolded wafer retainer fingers 124 in this embodiment are operatively coupled to an inside surface 126 of the door assembly 122. A distal end portion 130 of the wafer retainer fingers 124 may be overmolded with a material favorable for contact with a wafer or wafers 128 contained in the FOUP 120.

When the door assembly 122 is placed over the opening of the FOUP 120, the wafer retainer fingers 122 engage with the wafers 128 contained in the FOUP to securely bias them against wafer contact structures 132 within the FOUP 120. The overmolding material may be selected to protect both the wafer retainer fingers 120 and the wafers 128 from chipping, pitting and/or abrasion.

The foregoing discussion is directed to a SMIF pod and FOUP wafer containers. However, it is specifically noted that the concept is applicable to other wafer retainer structures. Accordingly, the embodiments disclosed herein are to 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.

For purposes of interpreting the claims for the present invention, it is expressly intended that the provisions of Section 112, sixth paragraph of 35 U.S.C. are not to be invoked unless the specific terms "means for" or "step for" are recited in the subject claim.

References to relative terms such as upper and lower, front and back, left and right, or the like, are intended for convenience of description and are not contemplated to limit the invention, or its components, to any specific orientation. All dimensions depicted in the figures may vary with a potential design and the intended use of a specific embodiment of this invention without departing from the scope thereof.

Each of the additional figures and methods disclosed herein may be used separately, or in conjunction with other features and methods, to provide improved devices, systems and methods for making and using the same. Therefore, combinations of

features and methods disclosed herein may not be necessary to practice the invention in its broadest sense and are instead disclosed merely to particularly describe representative embodiments of the invention.

Claims

What is claimed is:

1. A wafer container comprising:
 - a container portion having a door frame;
 - a door that cooperates with said door frame to form an enclosure, said enclosure containing at least one wafer, each of said at least one wafer having an edge;
 - an actuating mechanism operatively coupled within said enclosure and proximate an interior wall of said container portion, wherein a distal portion of said actuating mechanism extends away from said interior wall when said door is placed within said door frame; and
 - a wafer retainer operatively coupled with said actuating mechanism and including a base portion comprising a first material and an overmolded portion comprising a second material, said second material being thermophysically bonded to said first material such that said overmolded portion is secured to said base portion without separate mechanical fasteners, wherein said overmolded portion is brought into contact with each of said edges of said at least one wafer when said distal portion of said actuating mechanism is extended away from said interior wall, said second material being disposed on said first material to prevent chipping, pitting or abrasion of said first material.
2. The wafer container of claim 1 wherein said second material includes an electrically conductive composition.
3. The wafer container of claim 1 wherein said second material comprises a thermoplastic polymer.
4. The wafer container of claim 3 wherein said thermoplastic polymer comprises polyetheretherketone.
5. The wafer container of claim 1 wherein said first material comprises a polymer.
6. The wafer container of claim 5 wherein said polymer comprises polycarbonate.

7. The wafer container of claim 1 wherein said base portion includes at least one rail portion having an edge and wherein said overmolded portion is disposed at least partially along said edge of said at least one rail portion.
8. An overmolded wafer retainer for retaining a plurality of wafers in a wafer container, comprising:
a base portion comprising a first material and including at least one rail portion having an edge for engaging said plurality of wafers in said wafer container; and
an overmolded portion comprising a second material and being disposed at least partially along said edge of said at least one rail portion, said second material being thermophysically bonded to said first material such that said overmolded portion is secured to said base portion without separate mechanical fasteners, said second material being disposed on said first material to prevent chipping, pitting or abrasion of said first material.
9. The overmolded wafer retainer of claim 8 wherein said second material includes an electrically conductive composition.
10. The overmolded wafer retainer of claim 8 wherein said second material comprises a thermoplastic polymer.
11. The overmolded wafer retainer of claim 10 wherein said thermoplastic polymer comprises polyetheretherketone.
12. The overmolded wafer retainer of claim 8 wherein said first material comprises a polymer.
13. The overmolded wafer retainer of claim 12 wherein said polymer comprises polycarbonate.

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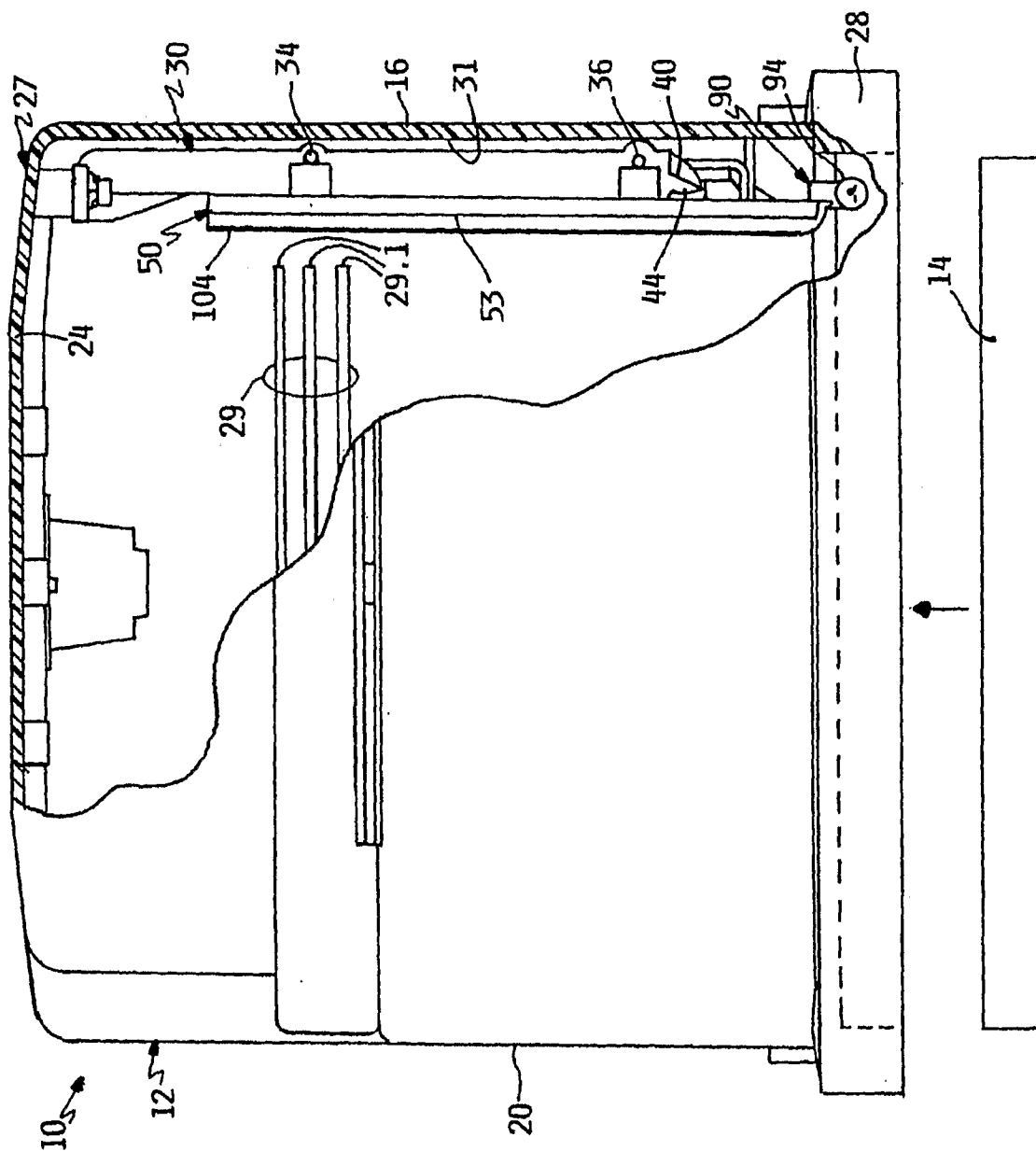


FIG. 1A

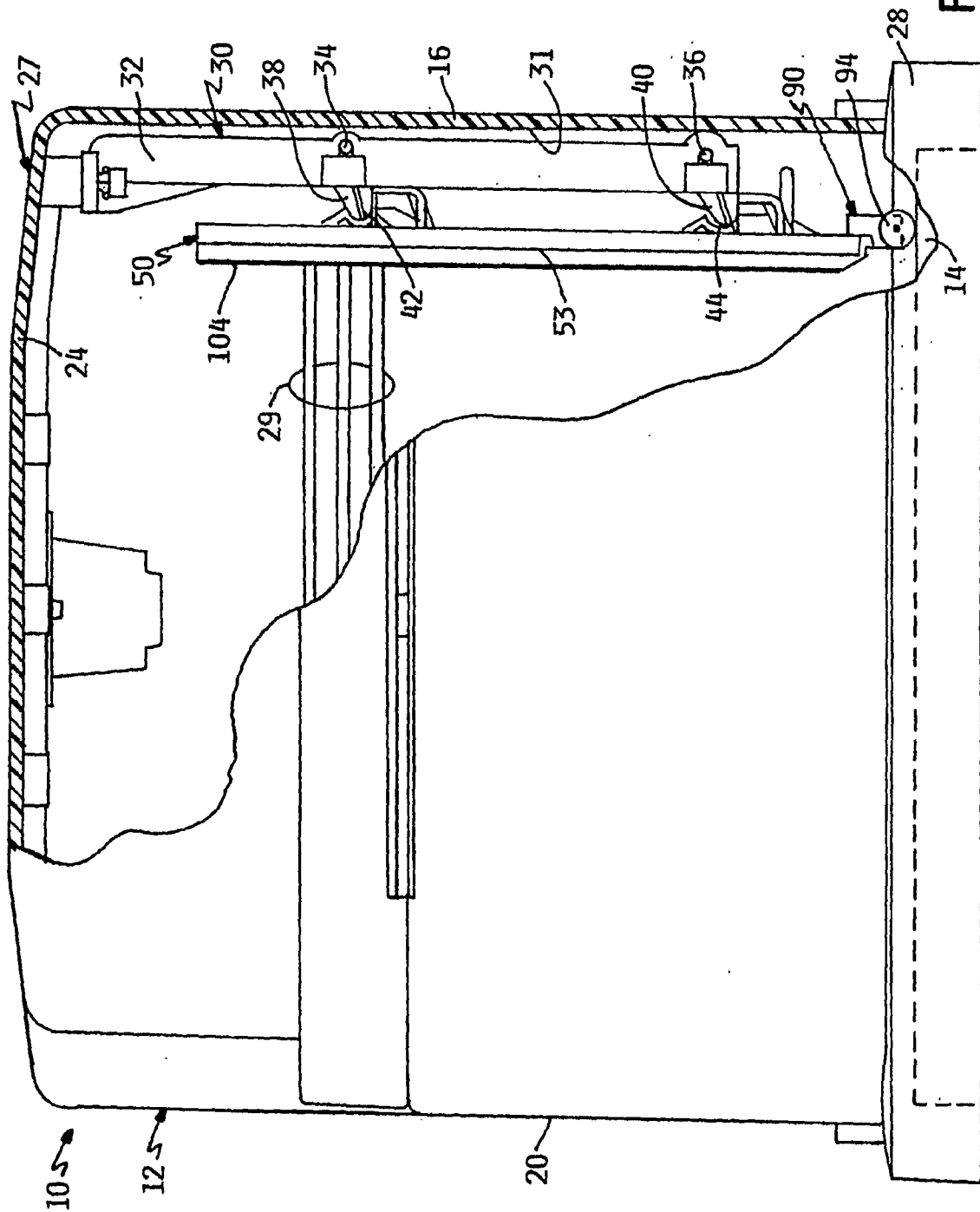


FIG. 1B

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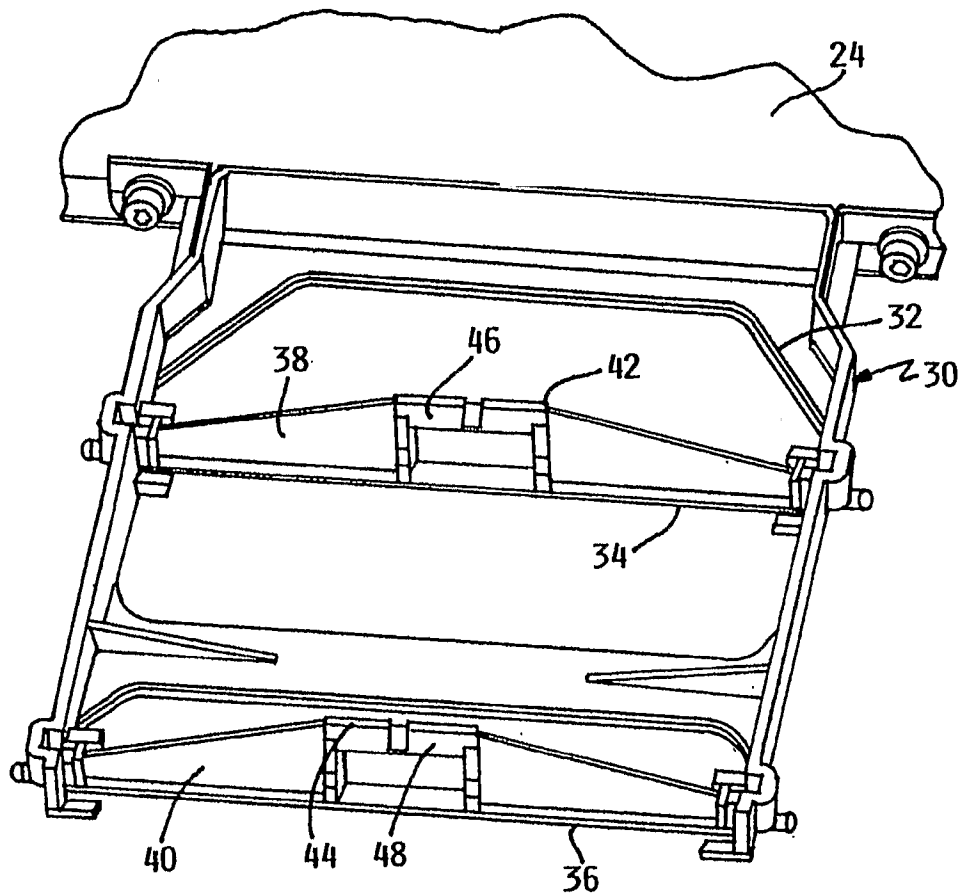


FIG. 1C

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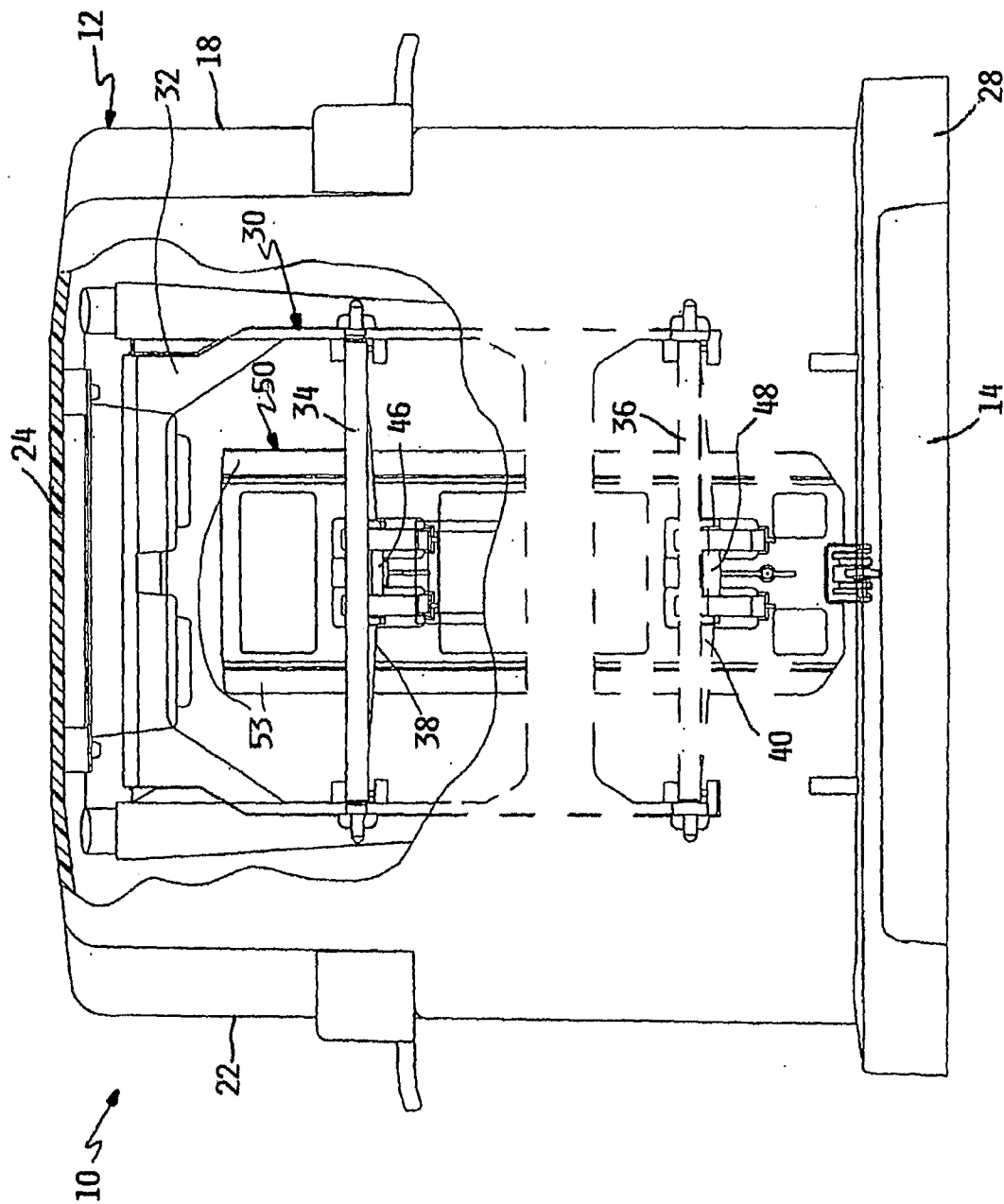
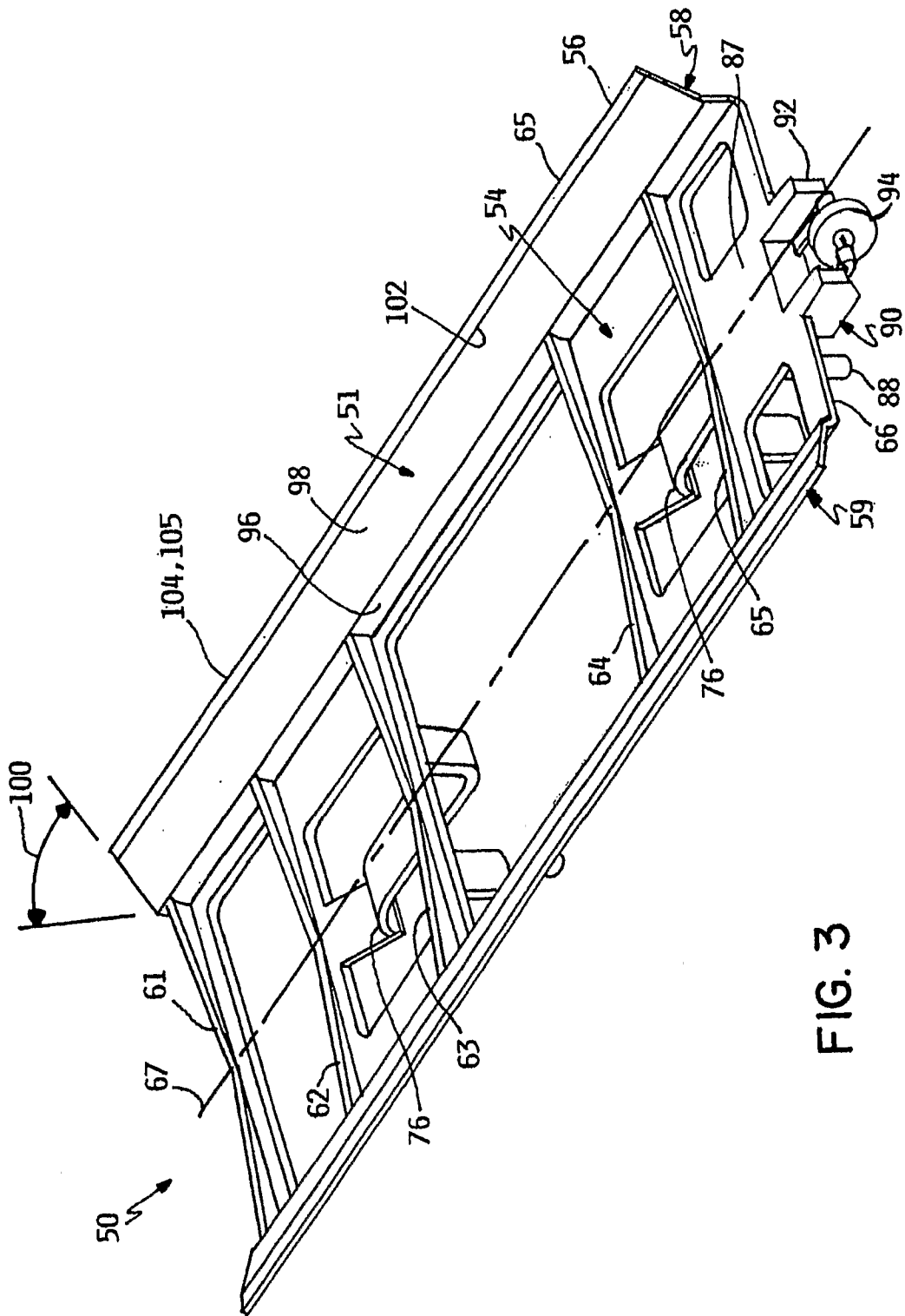


FIG. 2

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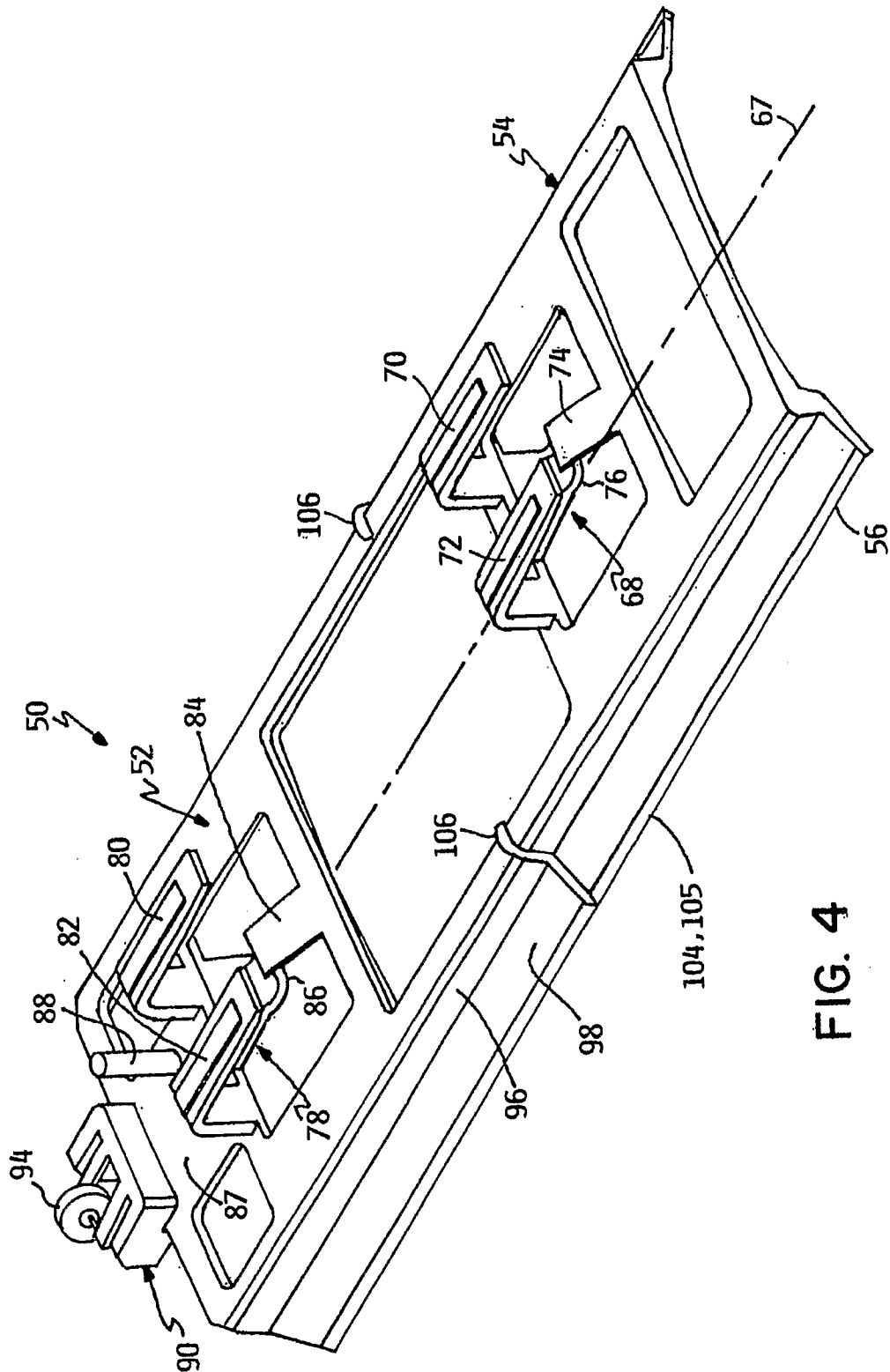


FIG. 4

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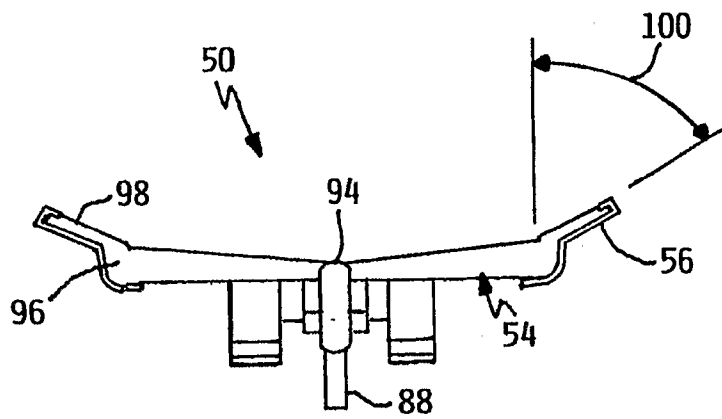
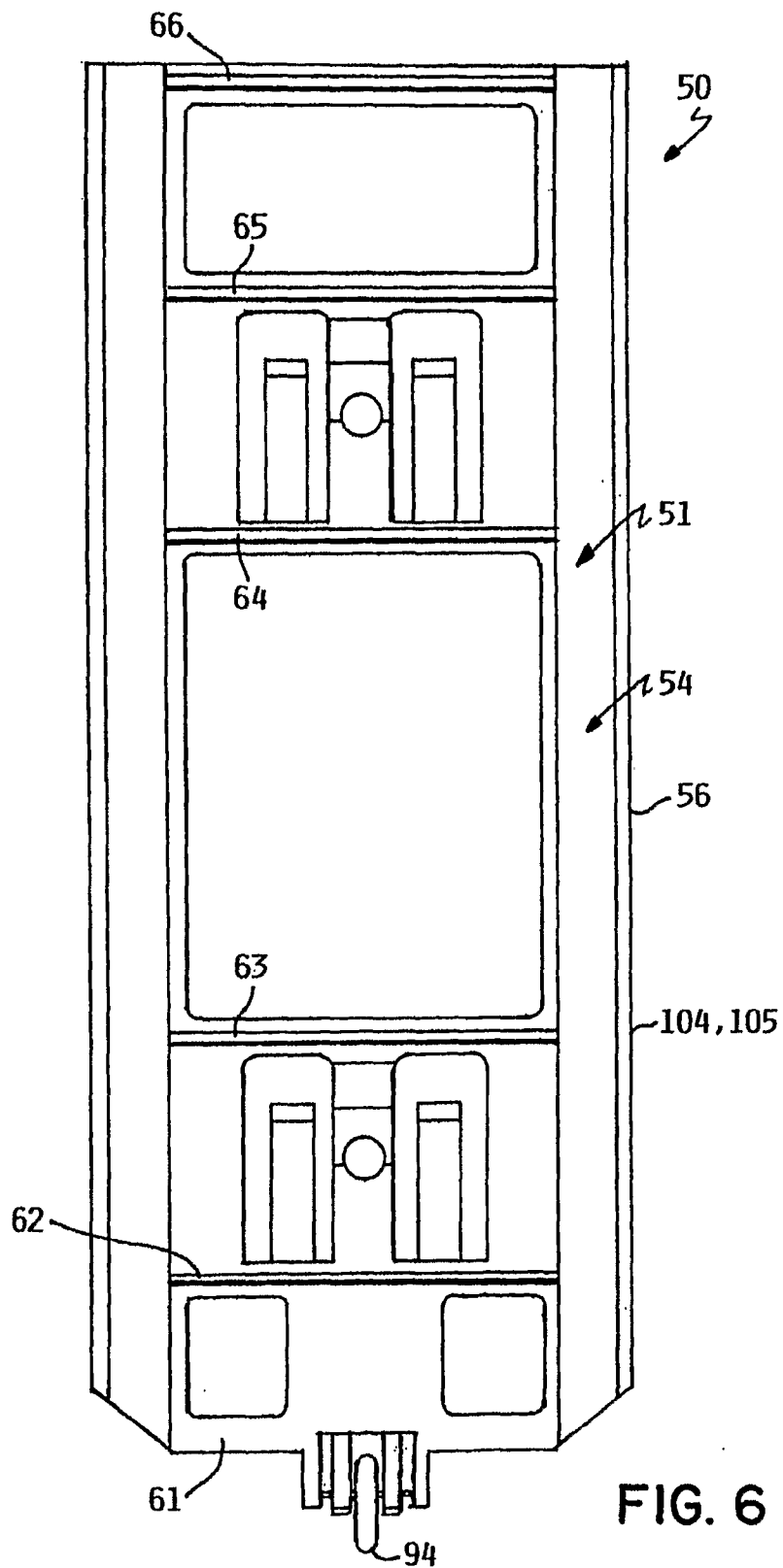


FIG. 5

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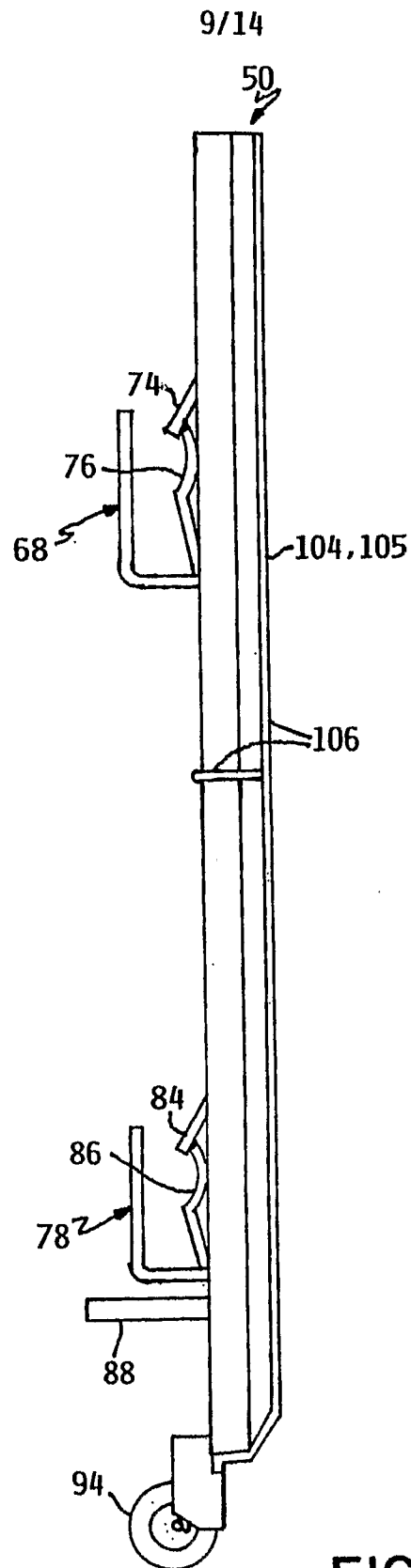


FIG. 7

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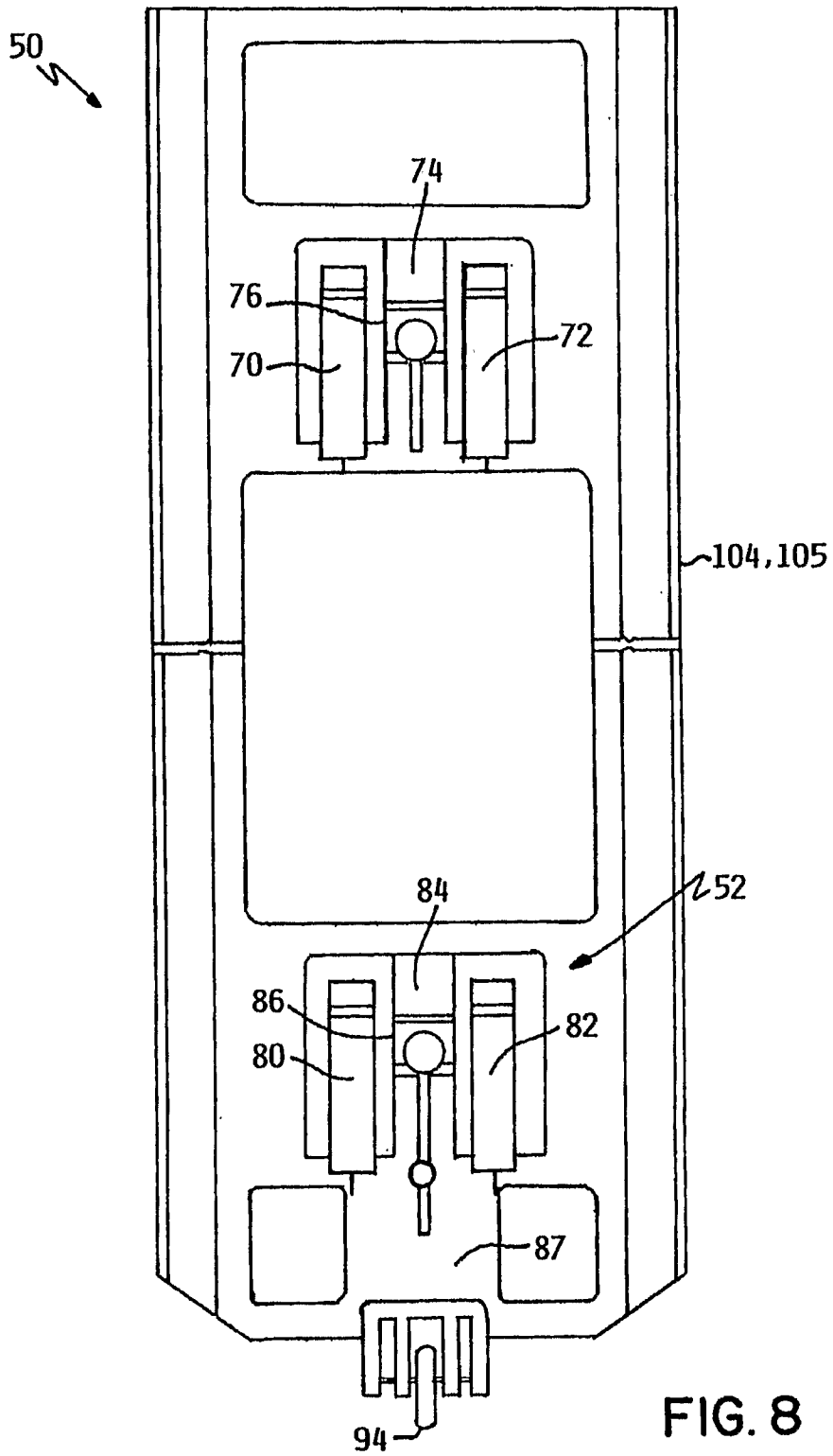


FIG. 8

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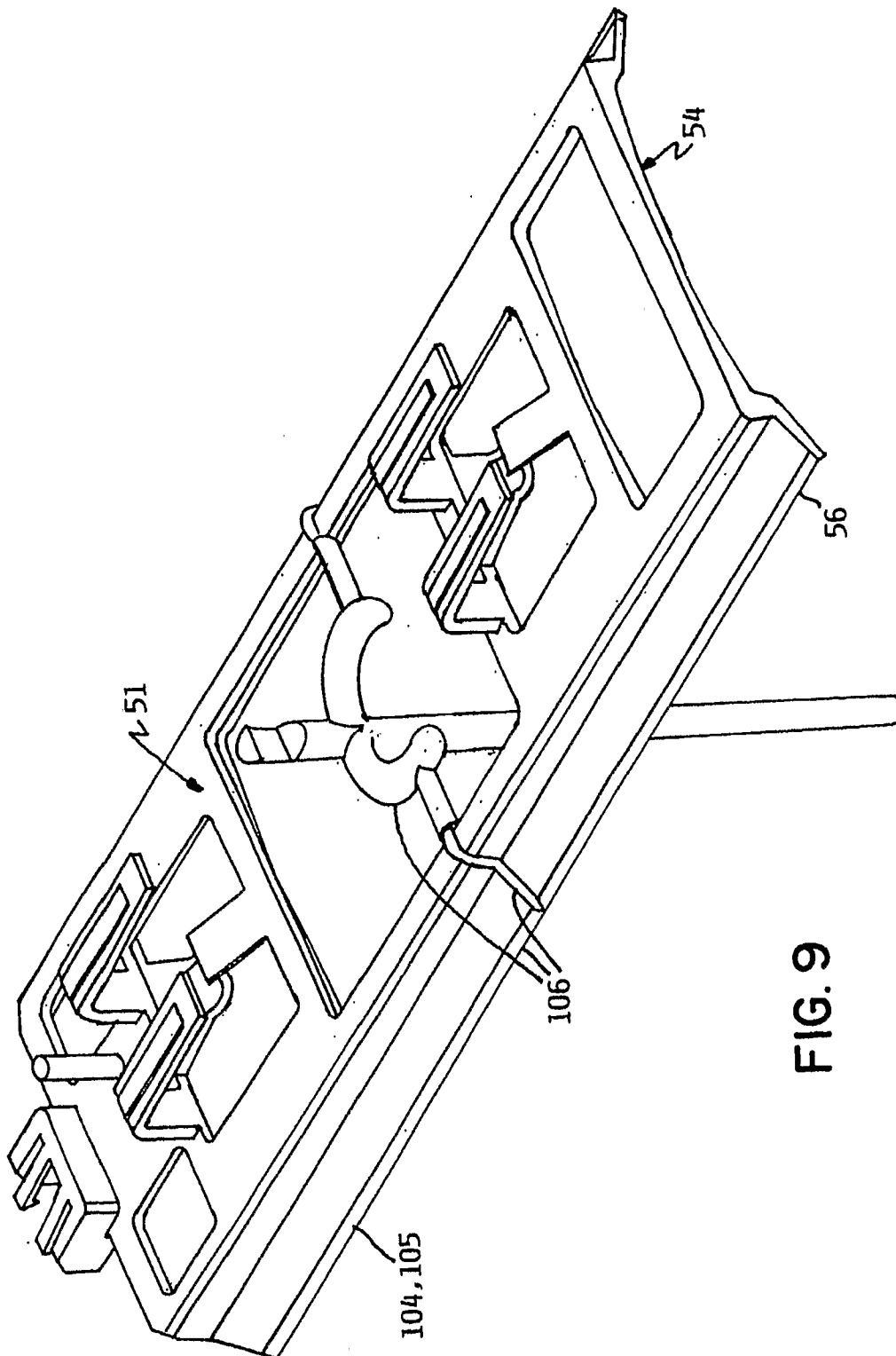


FIG. 9

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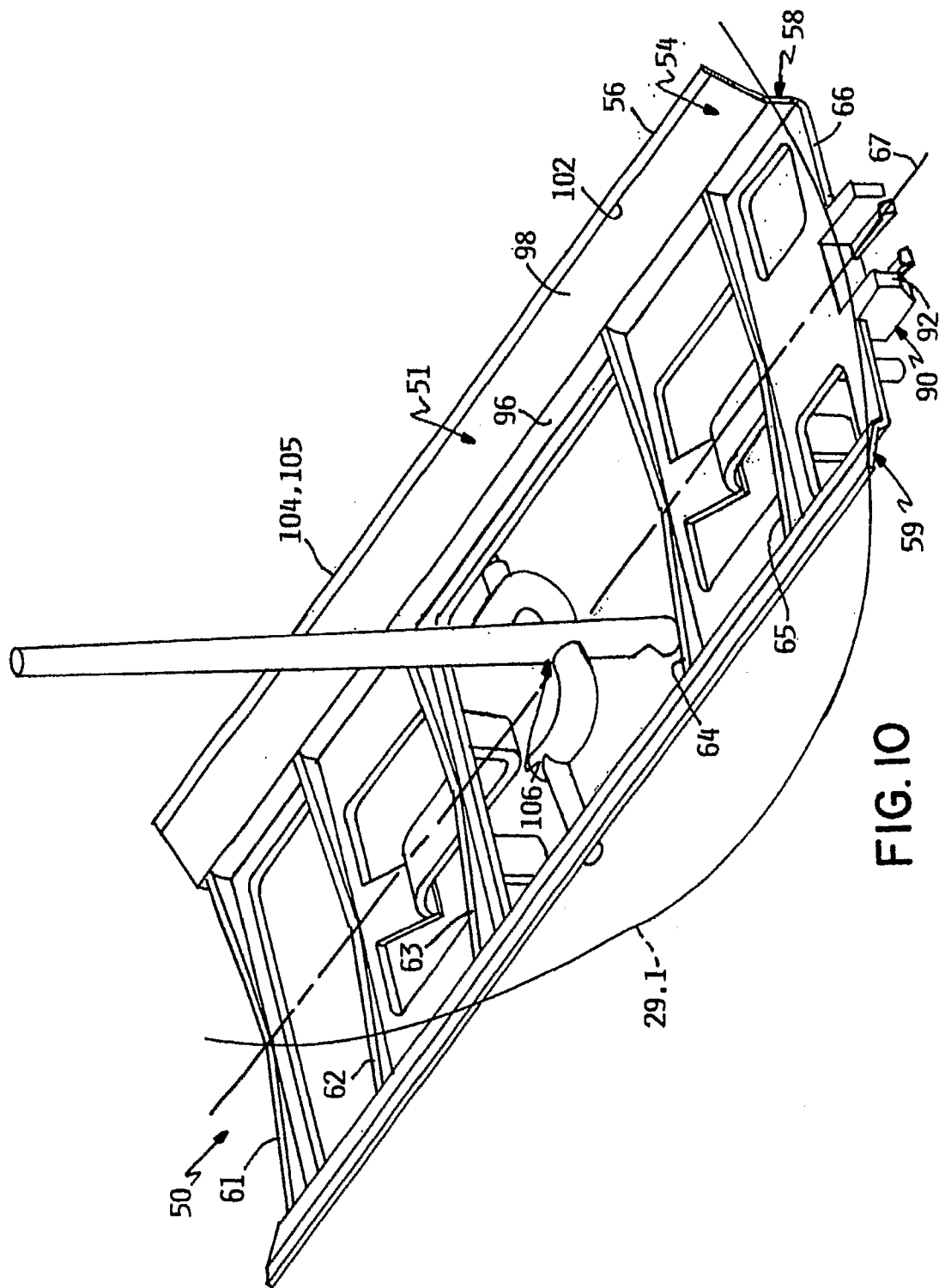


FIG. 10

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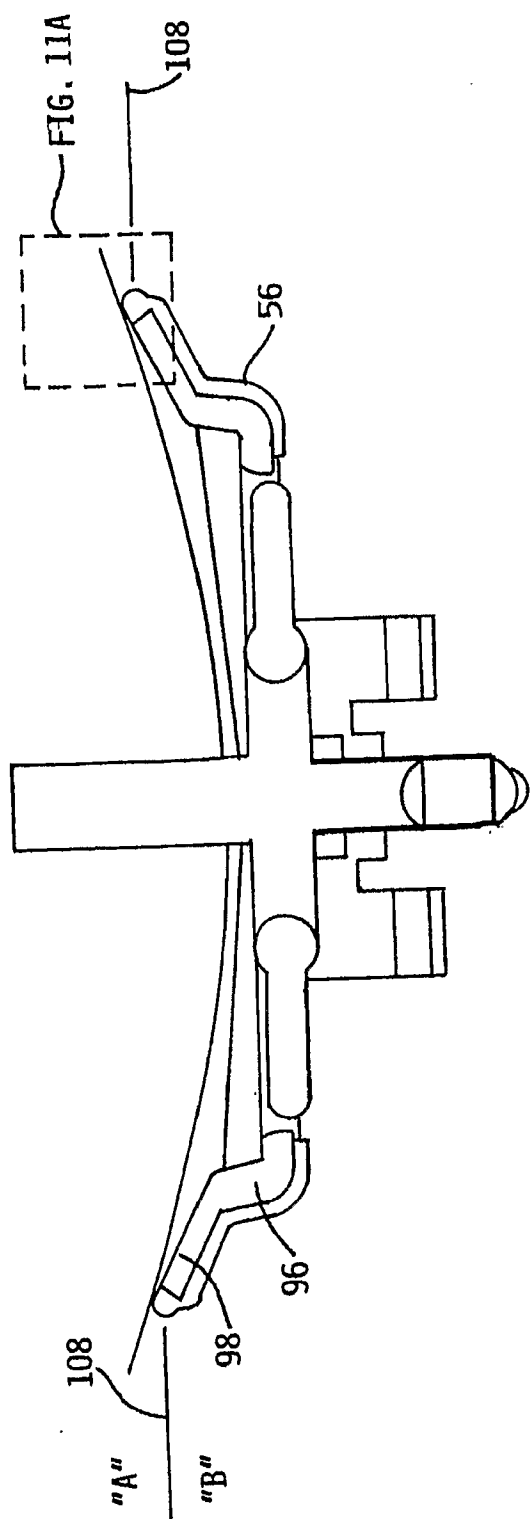


FIG. 11

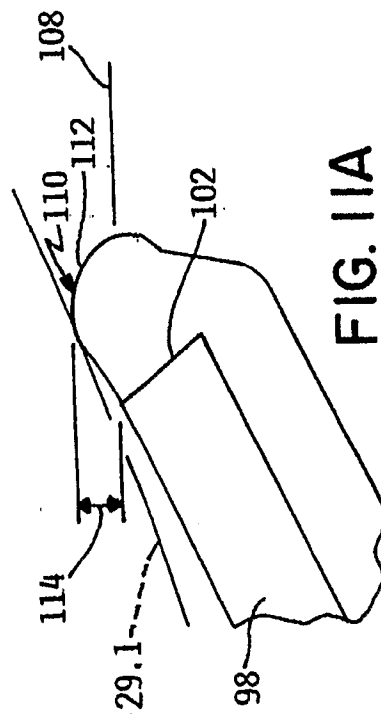


FIG. 11A

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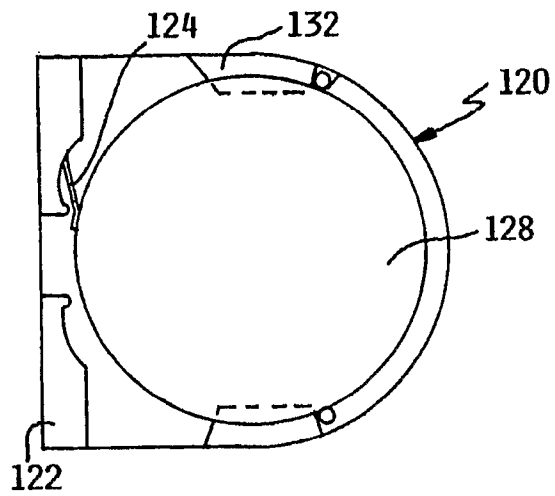


FIG. 12A

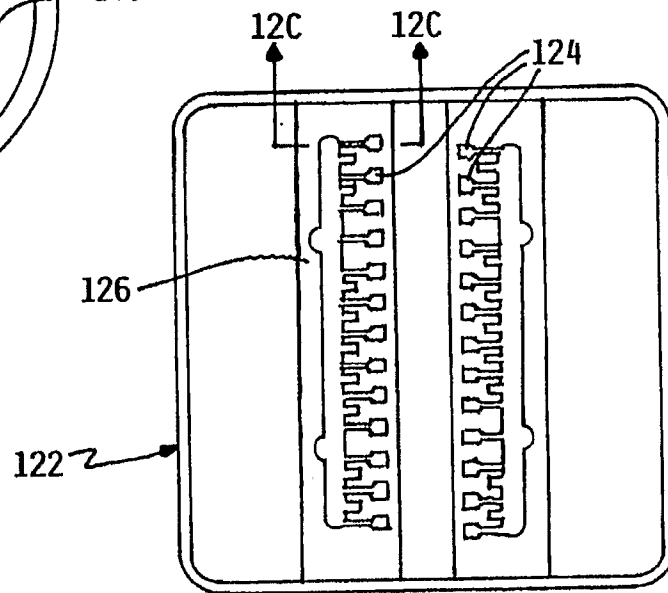


FIG. 12B

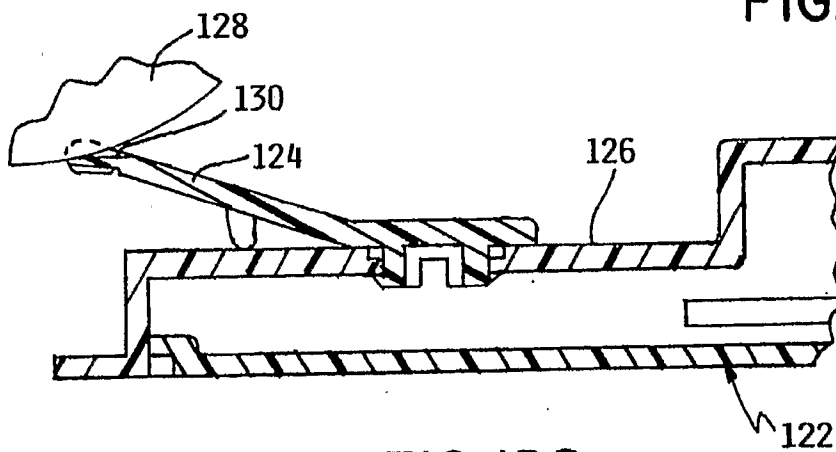


FIG. 12C