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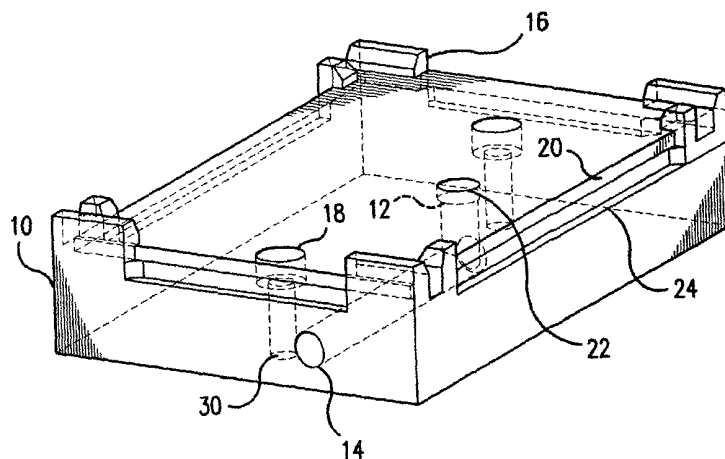
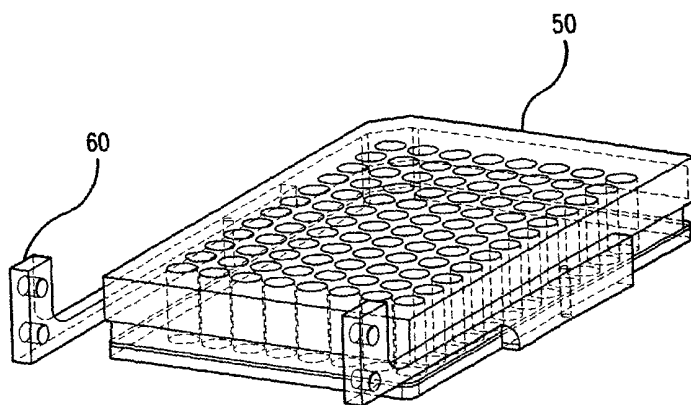
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(54) Title: APPARATUS FOR GRIPPING MICROPLATES



(57) Abstract: An apparatus suitable for securely gripping and holding a microplate or other containers during robotic de-lidding operations. A microplate placed on the apparatus is held by a vacuum (30) drawn through the base (10) thereof allowing the lid (50) of the microplate to be removed without movement of the plate. Afterwards, the vacuum can be discontinued and the plate removed from the apparatus.



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TITLE OF THE INVENTION

APPARATUS FOR GRIPPING MICROPLATES

BACKGROUND OF THE INVENTION

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Microplates, sometimes referred to as micro-titer plates, are generally utilized in the performance of biological assays, wherein the effects of a drug, bacteria or virus on living cells is characterized, e.g. toxicity, metabolism, etc. Microplates are also utilized to store chemical compounds. More particularly, biological assays are utilized to determine the inter-reaction of pharmaceutical compositions.

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Due to the vast amount of pharmaceutical drug candidates under evaluation as well as the abundance of assays performed to determine the activity and safety of a drug candidate, microplates will generally contain a large matrix of sample collection wells. For example, the microplates can be arranged in matrices of 5x6, 6x8, 8x10, 8x12, etc. After samples are collected in microplate wells, a lid is generally placed thereupon to prevent evaporation and contamination, and the microplate can be held in cold storage until ready for screening.

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Today, computer-controlled processes and robotics are available to manage every facet of collecting, storing and screening biological assays. Heretofore, robotic de-lidding of a microplate, after removal from cold storage and/or prior to sample analysis, has presented several problems. Associated with the de-lidding operation has been the problem of providing an automated apparatus for holding a microplate while removing the lid and immediately releasing it thereafter, so that a robotic mechanism can deliver the microplate to a screening station.

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The present invention provides an apparatus that can be automated for utilization with robotic handling systems to securely grip and hold a container such as a microplate during lid removal, mixing or oscillation operations. As will become apparent to those skilled in the art, the apparatus of the invention can also be adapted to grip and hold a variety of containers, e.g. microplates, jars, vials, dishes, etc., while removing lids, rotating, oscillating, agitating, removing samples therefrom, and other operations as will become apparent to those skilled in the art.

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SUMMARY OF THE INVENTION

An apparatus for gripping and holding a container during de-lidding, mixing or oscillating operations, comprising:

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a) a horizontally positioned, flat surfaced base comprising: i) a vertical aperture partially extending through the top of the base, ii) a horizontal aperture extending through a side of the base and intersecting the vertical aperture, iii) a plurality of intermittent, vertical, raised edges on the top of the base, and iv) means for attaching the base to a support;

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b) a flat, elastic plate gasket, conforming to the shape of the base, resting on top of the base between the raised edges, the gasket having a vertical aperture therethrough aligning with the vertical aperture of the base, wherein the height of the raised edges extend above the height of the plate gasket; and

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c) vacuum means attached to the horizontal aperture on the side of the base,

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wherein a flat, bottom container having a lid thereon and conforming to the shape of the base being placed on top of the plate gasket, fitting within and abutting against the raised edges of the base, and a vacuum being applied to the base, the container is suctionally pulled down towards the base and securely held there without loss of vacuum while means for removing the lid is being applied thereto.

25 BRIEF DESCRIPTION OF THE DRAWINGS

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FIG. 1 is an isometric view in elevation of the microplate gripping apparatus illustrating a lidded microplate being held by robotic fingers, wherein the microplate is aligned with and positioned above the apparatus;

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FIG. 2 is a side view in elevation of the the microplate gripping apparatus illustrating aligned vertical apertures through the base and plate gasket, and a horizontal aperture through the base that intersects with the vertical aperture of the base;

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FIG. 3 is an isometric view in elevation of the gripping apparatus, wherein the raised, vertical edges, apertures, and attachment means are shown; and

FIG. 4 is an isometric view in elevation of a lidded microplate resting on the apparatus, wherein the robotic fingers are positioned against the plate.

DETAILED DESCRIPTION OF THE INVENTION

The invention described herein is a static apparatus for gripping and securely holding a microplate during an automated or robotic process of removing a lid from the top of the plate to expose fluid samples in the wells of the plate. The shape of the apparatus will generally conform to the shape of a microplate, e.g. square, oval or rectangular. Typically, the shape of a microplate will be square or rectangular.

Referring to **FIG. 1**, the apparatus for gripping and securely holding a rectangular-shaped, microplate during robotic de-lid operations can be characterized as:

- a) a horizontally positioned, rectangular-shaped, flat-top base **10** comprising: i) a centrally positioned, vertical aperture **12** partially extending through the top of the base, ii) a horizontal aperture **14** partially extending through a side of the base and intersecting the vertical aperture to form a conduit, iii) vertical, raised edges **16** proximal to the corners of the top of the base, and iv) means for attaching **18** the base to a support, e.g. a chemical adherent, bolts and nuts, screws or clamps;
- b) a flat, rectangular-shaped, elastic, plate gasket **20** resting on top of the base **10** having a vertical aperture **22** therethrough aligning with the vertical aperture **12** of the base, wherein the shape of the plate gasket conforms to and fits within the shape of the base, the height of the raised edges **16** extending above the height of the plate gasket, wherein horizontal, outer ledges **24** are formed along the sides of the base between the vertical edge of the plate gasket and the vertical edge of the base; and

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c) vacuum means **30** attached to the horizontal aperture on the side of the base, wherein a lidded, flat, bottom microplate, the lid **50** having bottom edges protruding from the side of the plate, the plate being held on opposing sides by robotic, fingers **60**, the microplate being placed on top of the plate gasket, the bottom of the fingers proximal on the ledge of the base, the microplate fitting within and abutting against the raised edges, a vacuum being drawn on base, the microplate being suctionally pulled towards the base and securely held there without loss of vacuum, the robotic fingers releasing the microplate, and the fingers being raised to contact the protruding, bottom edges of the lid, and the fingers being raised to remove the lid.

Referring to **FIG. 2**, a side view in elevation of the microplate gripping apparatus **10** illustrating the conduit utilized for applying the vacuum means formed by vertical aperture **12** and horizontal aperture **14** extending through the base is shown. More particularly, the horizontal aperture is bored through a side of the base, extending partially through, and intersects the vertical aperture bored through the top of the base, extending partially therethrough. The two apertures intersect to form a conduit having a first end on the top of the base and a second end on the side of the base. To the side aperture, the vacuum means, in the form of a vacuum pump or other vacuum device can be connected. The plate gasket also has vertical aperture **22** completely bored therethrough, wherein the aperture aligns with the horizontal aperture of the base. The vacuum means can be automatically controlled by a solenoid valve programmed to operate in sequence with the robotic fingers. That is, the solenoid valve can be timed to apply a vacuum after the microplate has been placed on the apparatus, and release the vacuum after the fingers have removed the lid of the microplate. Once the vacuum means is applied to the apparatus, a flat, bottom microplate placed between the raised edges onto the plate gasket will be suctionally held in place by a vacuum force. The vacuum force actually pulls the plate onto the plate gasket, wherein the elastic material of the plate gasket compresses, wherein none of the vacuum is lost and the microplate is gripped and held securely.

Referring to **FIG. 3**, an isometric view of the apparatus illustrates the raised edges **16** proximal to the corners of gripping apparatus **10**, wherein the edges have a height greater than the base. Generally, these raised edges will exhibit a height

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of at least about one-half or greater than the height of the microplate placed thereon. Typically, the raised edges of the base will possess inwardly angled chamfers, wherein the chamfers will angle downward towards the top of the base at an angle of from about 30° to about 60°; preferably the chamfers will be at an angle of about 45°.

- 5 Preferably, the height of the lower side of the chamfer edge will partially extend up the side of the top of the microplate. Since the robotic fingers will not always release the microplate exactly within the raised edges, the chamfered, raised edges are designed to guide the microplate down onto the apparatus after the robotic fingers release the plate.

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- Referring to **FIG. 4**, there is illustrated an isometric view in elevation of lidded microplate **10** resting on the gripping apparatus. Ledges **24**, defined as the horizontal spacing between the vertical edges of base and vertical edges of the plate gasket, are shown as being adjacent to the outer perimeter of the base. These ledges
15 are adapted for abutting and protecting robotic fingers **60** from damage if the fingers are mis-aligned as they deliver and retrieve the microplate. Generally, the surface area dimensions of the microplate and base (within the raised edges) should be similar so that the microplate will fit on top of the plate gasket without any overhang. Typically, the robotic fingers should be about equal to the thickness of the plate
20 gasket. Thus, during the operation of delivering and retrieving the microplate, the leading edge of the bottom of the fingers will align with the outer vertical edge of the plate gasket.

- Generally, the plate gasket will be constructed of a flexible, resilient
25 material such as natural and synthetic rubbers, nitrile, ethylene-propylene-diene monomer, silicon or thermoplastic elastomers. Suitable thermoplastic elastomers will include polypropylene, polyethylene and polyurethane. Generally, the base of the apparatus will be constructed of a solid, non-flexible material such a metals or non-elastic, thermoplastic materials. The metallic material of constructions can consists of
30 pure metals, e.g. copper, zinc, magnesium, etc., or alloys thereof, such as aluminum, brass, various steels, e.g. stainless steel. The thermoplastic materials can include polyvinylchloride, polyacetals, polycarbonates, polyamides, polyimides, and nylons.

- The principles, preferred embodiments and modes of operation of the
35 present invention have been described in the foregoing specification. However, the

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invention disclosed and intended to be protected is not to be construed as limited to the particular embodiments disclosed. The embodiments are to be construed as illustrative rather than restrictive. It is recognized, however, that departures may be made therefrom within the scope of the invention, and that obvious modifications may

5 occur to a person skilled in the art.

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WHAT IS CLAIMED IS:

1. An apparatus for gripping and holding a container during de-
lidding, mixing or oscillating operations, comprising:

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d) a horizontally positioned, flat surfaced base comprising: i) a vertical aperture partially extending through the top of the base, ii) a horizontal aperture extending through a side of the base and intersecting the vertical aperture, iii) a plurality of intermittent, vertical, raised edges on the top of the base, and iv)
10 means for attaching the base to a support;

e) a flat, elastic plate gasket, conforming to the shape of the base, resting on top of the base between the raised edges, the gasket having a vertical aperture therethrough aligning with the vertical aperture of the base, wherein the height
15 of the raised edges extend above the height of the plate gasket; and

f) vacuum means attached to the horizontal aperture on the side of the base,

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wherein a flat, bottom container having a lid thereon and conforming to the shape of the base being placed on top of the plate gasket, fitting within and abutting against the raised edges of the base, and a vacuum being applied to the base, the container is suctionally pulled down towards the base and securely held there without loss of vacuum while means for removing the lid is being applied thereto.

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2. The apparatus according to Claim 1, wherein the shape of the base conforms to the container, said base being selected from rectangular, square and oval shapes.

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3. The apparatus according to Claim 2, wherein the shape of the base is rectangular.

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4. The apparatus according to Claim 3, wherein the top of the raised edges of the base consist essentially of chamfers angling inwardly and down toward the base.

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5. The apparatus according to Claim 4, wherein the plurality of raised edges are located along the corners of the base.

6. The apparatus according to Claim 5, wherein the plate gasket is constructed from an elastic material selected from rubbers, silicon, and thermoplastic elastomers.

7. The apparatus according to Claim 6, wherein the plate gasket is constructed from silicon.

8. The apparatus according to Claim 7, wherein the chamfers of the raised edges are angled at about 45°.

9. The apparatus according to Claim 8, wherein the vacuum means is a vacuum means.

10. The apparatus according to Claim 9, wherein the container is selected from the group consisting of a microplate, jar, vial and dish.

11. An apparatus for gripping a rectangular-shaped, microplate during robotic de-lid operations, comprising:

- a) a horizontally positioned, rectangular-shaped, flat-top base comprising: i) a centrally positioned, vertical aperture partially extending through the top of the base, ii) a horizontal aperture partially extending through a side of the base and intersecting the vertical aperture to form a conduit, iii) vertically, raised edges along the corners of the top of the base, and iv) means for attaching the base to a support;
- b) a flat, rectangular-shaped, elastic, plate gasket resting on top of the base having a vertical aperture therethrough aligning with the vertical aperture of the base, wherein the shape of the plate gasket conforms to and fits within the to the shape of the top of the base, the height of the raised edges extending above the height of the plate gasket, wherein horizontal, outer ledges are

formed along the sides of the base between the vertical edge of the plate gasket and the vertical edge of the base; and

c) vacuum means attached to the horizontal aperture on the side of the base,

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wherein a lidded, flat, bottom microplate, wherein the lid having bottom edges protruding from the side of the plate, being held on opposing sides by robotic fingers while being placed on top of the plate gasket, the fingers being proximal to the ledge of the base and edges of the plate gasket, the microplate fitting within and abutting against the raised edges, a vacuum being drawn on base, the

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microplate is suctionally pulled towards the base and securely held there without loss of vacuum, the robotic fingers releasing the microplate, and the fingers being raised to contact the protruding, bottom edges of the lid, and the fingers being raised to remove the lid.

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12. The apparatus according to Claim 10, wherein the top of the raised edges of the base consist essentially of chamfers angling inwardly and down toward the base.

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13. The apparatus according to Claim 11, wherein the chamfers of the raised edges are angled at 45°.

14. The apparatus according to Claim 12, wherein the plate gasket is constructed from an elastic material selected from the group consisting of rubbers, silicon, and thermoplastic elastomers.

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15. The apparatus according to Claim 13, wherein the plate gasket is constructed from silicon.

16. The apparatus according to Claim 14, wherein the base is constructed from a material selected from the group consisting of metals and thermoplastic polymers.

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17. The apparatus according to Claim 15, wherein the base is constructed from metal.

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18. The apparatus according to Claim 16, wherein the vacuum means is a vacuum means.

5 19. The apparatus according to Claim 17, wherein the vacuum means is operated by a computer controlled solenoid valve.

10 20. The apparatus according to Claim 18, wherein the ledges are suitably adapted for the bottom portion of the robotic fingers holding the microplate to be within proximal distance to the ledges while lowering and releasing the microplate onto the apparatus.

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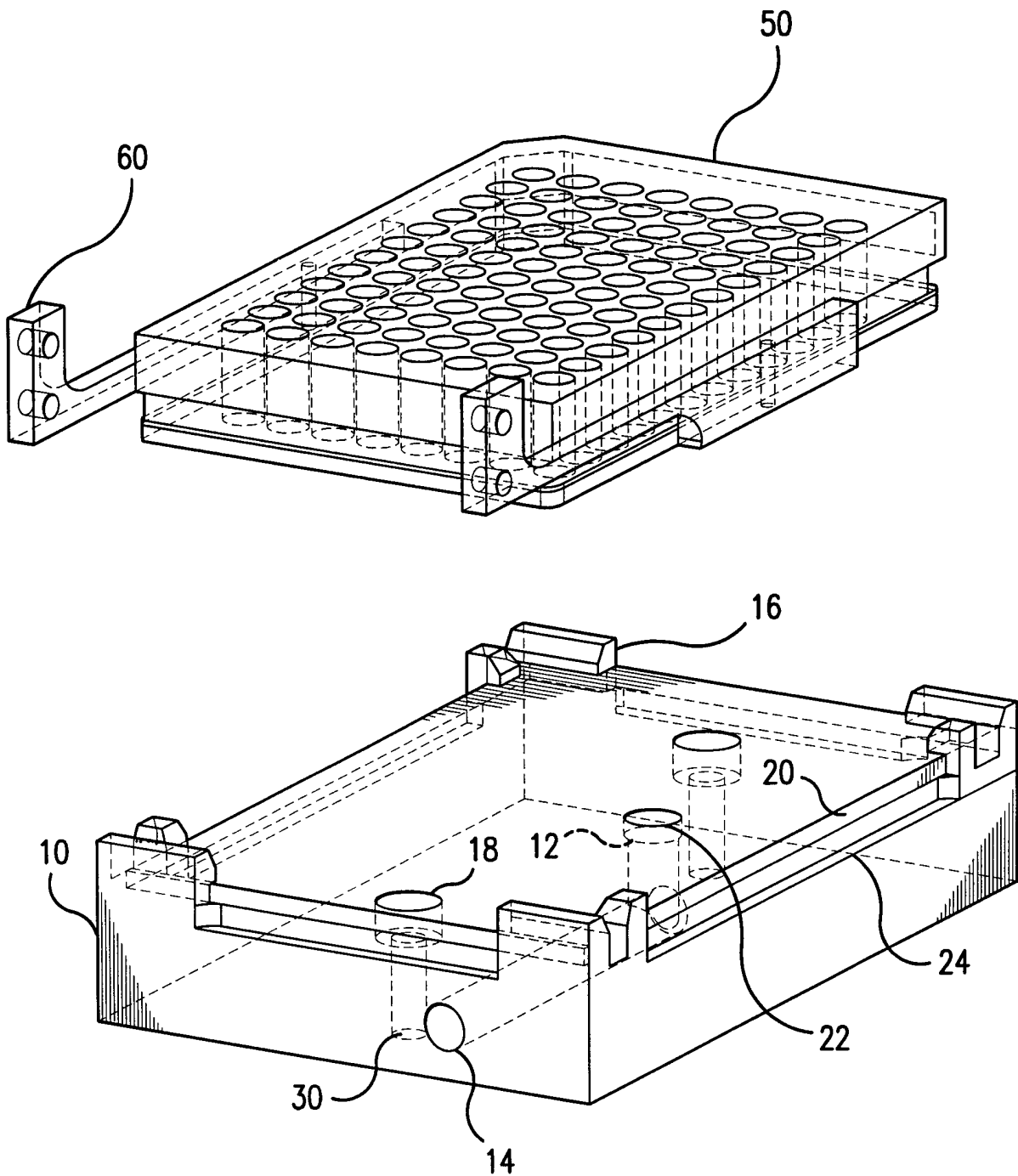


FIG.1

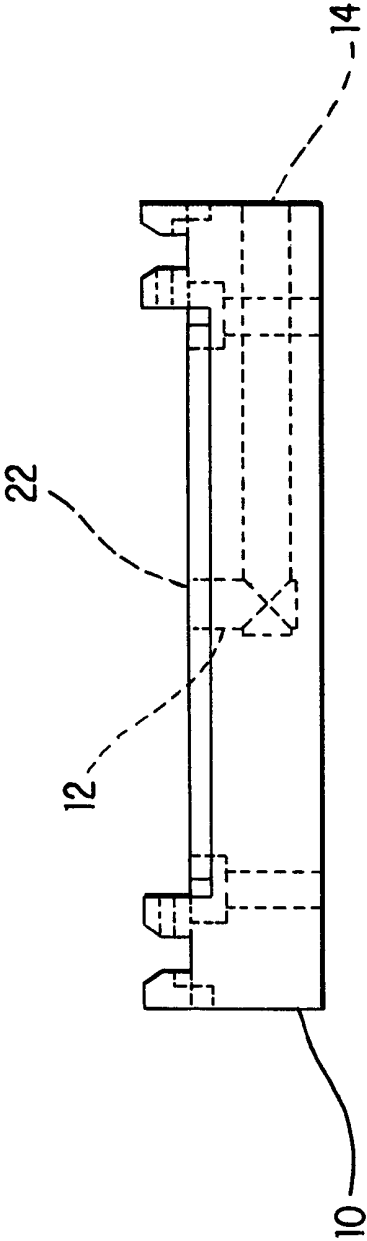


FIG. 2

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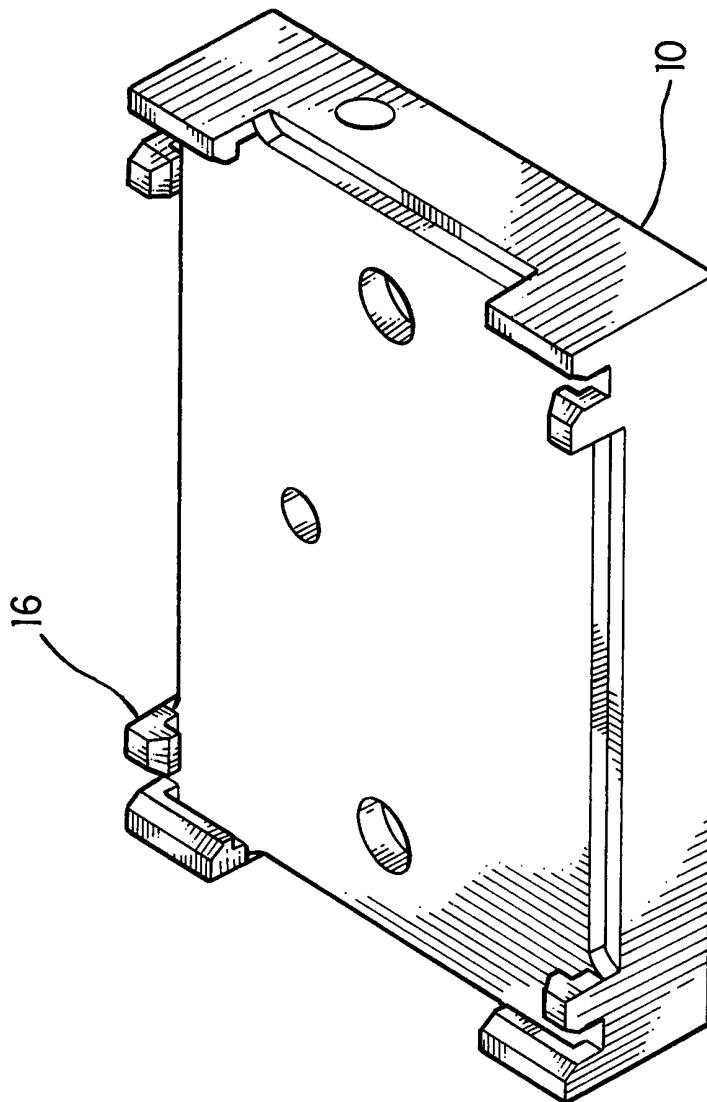


FIG. 3

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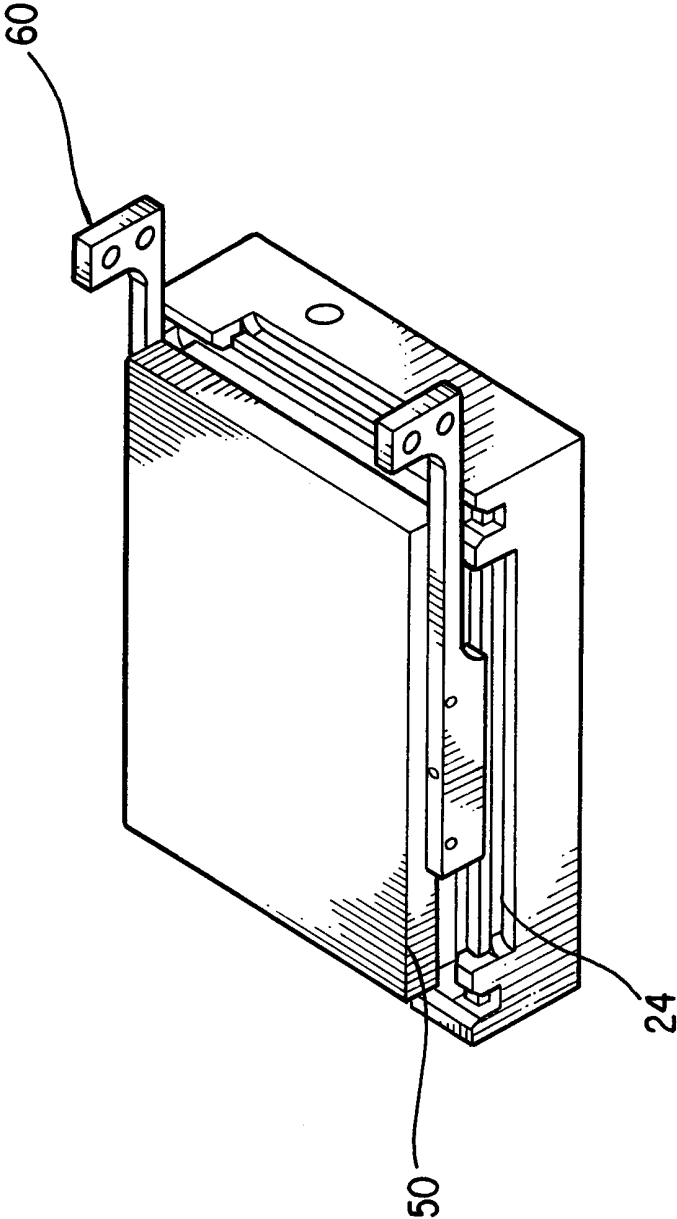


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/28781

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :B25B 11/00

US CL : 294/64.1; 269/21; 901/40

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 294/64.1, 64.2, 64.3, 65; 269/21; 901/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3,584,859 A (Siron) 15 June 1971, see entire document.	
A	US 3,617,045 A (Da Costa et al.) 02 November 1971, see entire document.	
A	US 5,201,696 A (Kinback et al.) 13 April 1993, see entire document.	
A	US 5,857,667 A (Lee) 12 January 1999, see entire document.	

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Further documents are listed in the continuation of Box C.

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See patent family annex.

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P document published prior to the international filing date but later than the priority date claimed	

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