



US00H002061H

(19) **United States**

(12) **Statutory Invention Registration** (10) **Reg. No.: US H2061 H**
Tunnell (43) **Published: Apr. 1, 2003**

(54) **DEVICE, SYSTEM, AND METHOD FOR SECURING AN IRREGULARLY SHAPED DEVICE, INCLUDING THOSE WITH DISCONTINUOUS CONTOURS, IN A FIXTURE**

5,975,512 A * 11/1999 Lin
5,988,618 A 11/1999 Meintrup et al.
6,032,348 A 3/2000 Hass et al.

* cited by examiner

Primary Examiner—Michael J. Carone

Assistant Examiner—M. Thomson

(74) *Attorney, Agent, or Firm*—Earl H. Baugher, Jr.; Laura R. Foster

(75) **Inventor: Jeffery J. Tunnell, Ridgecrest, CA (US)**

(73) **Assignee: The United States of America as represented by the Secretary of the Navy, Washington, DC (US)**

(21) **Appl. No.: 09/613,064**

(22) **Filed: Jul. 11, 2000**

(51) **Int. Cl.⁷ B60P 7/12**

(52) **U.S. Cl. 410/47; 410/44**

(58) **Field of Search 410/47, 49, 50; 269/287**

(57) **ABSTRACT**

Provided is an apparatus, system, method of use, and method of manufacturing said apparatus, for securing an object having an irregular outer contour, including those objects having a discontinuous contour, in a standard fixture. While secured in the standard fixture modified as in a preferred embodiment of the present invention, a secured object can easily be accessed at any point as pre-determined by the user.

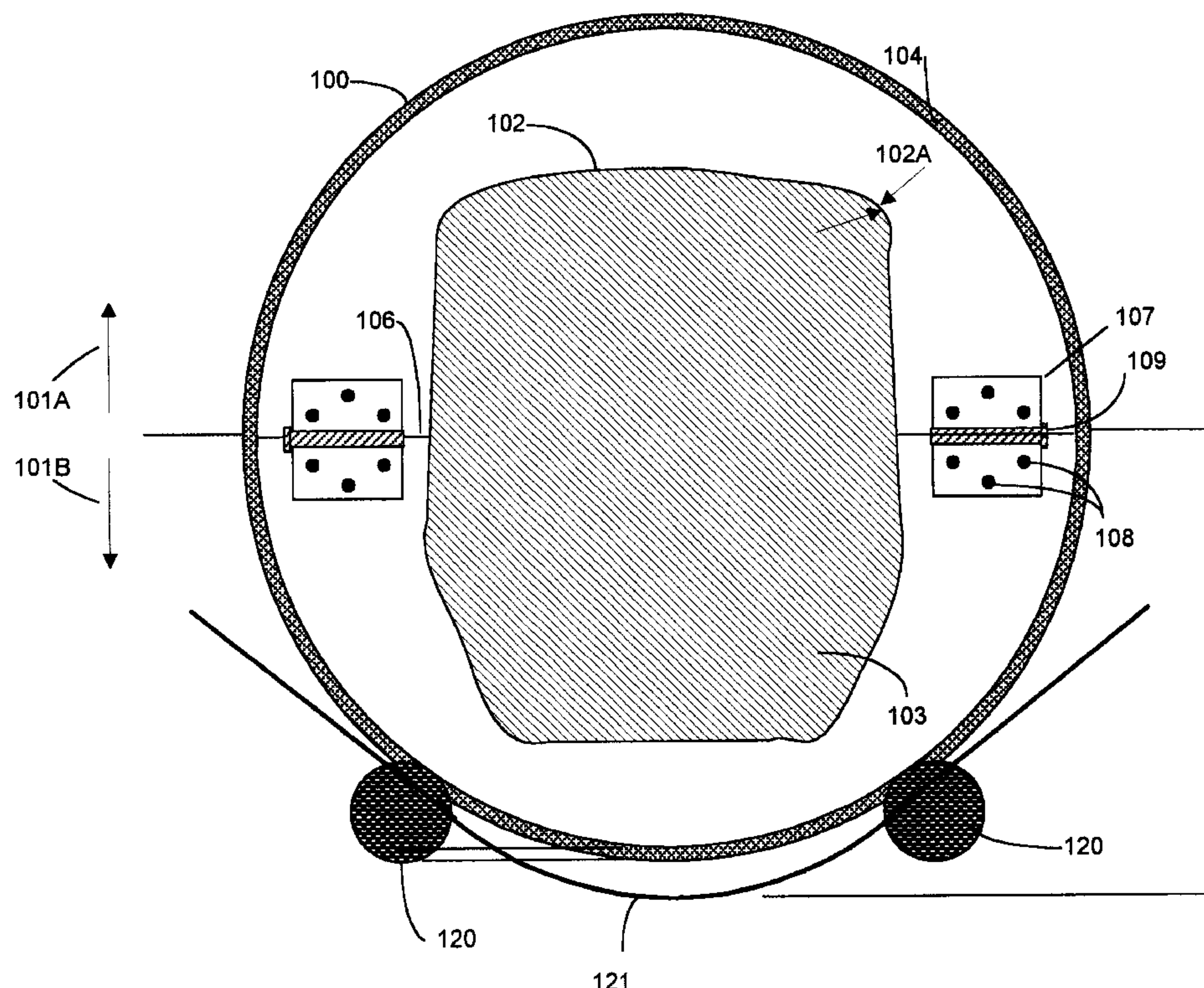
(56) **References Cited**

U.S. PATENT DOCUMENTS

2,006,451 A * 7/1935 Glidden
2,320,079 A * 5/1943 Hartwig
2,851,235 A * 9/1958 Henig
3,402,904 A * 9/1968 Paraskewik
3,521,875 A * 7/1970 Kapelsohn
3,868,101 A * 2/1975 Nozaki et al.
4,200,272 A 4/1980 Godding
4,218,051 A 8/1980 Stastny
5,904,347 A * 5/1999 Lin

6 Claims, 8 Drawing Sheets

A statutory invention registration is not a patent. It has the defensive attributes of a patent but does not have the enforceable attributes of a patent. No article or advertisement or the like may use the term patent, or any term suggestive of a patent, when referring to a statutory invention registration. For more specific information on the rights associated with a statutory invention registration see 35 U.S.C. 157.



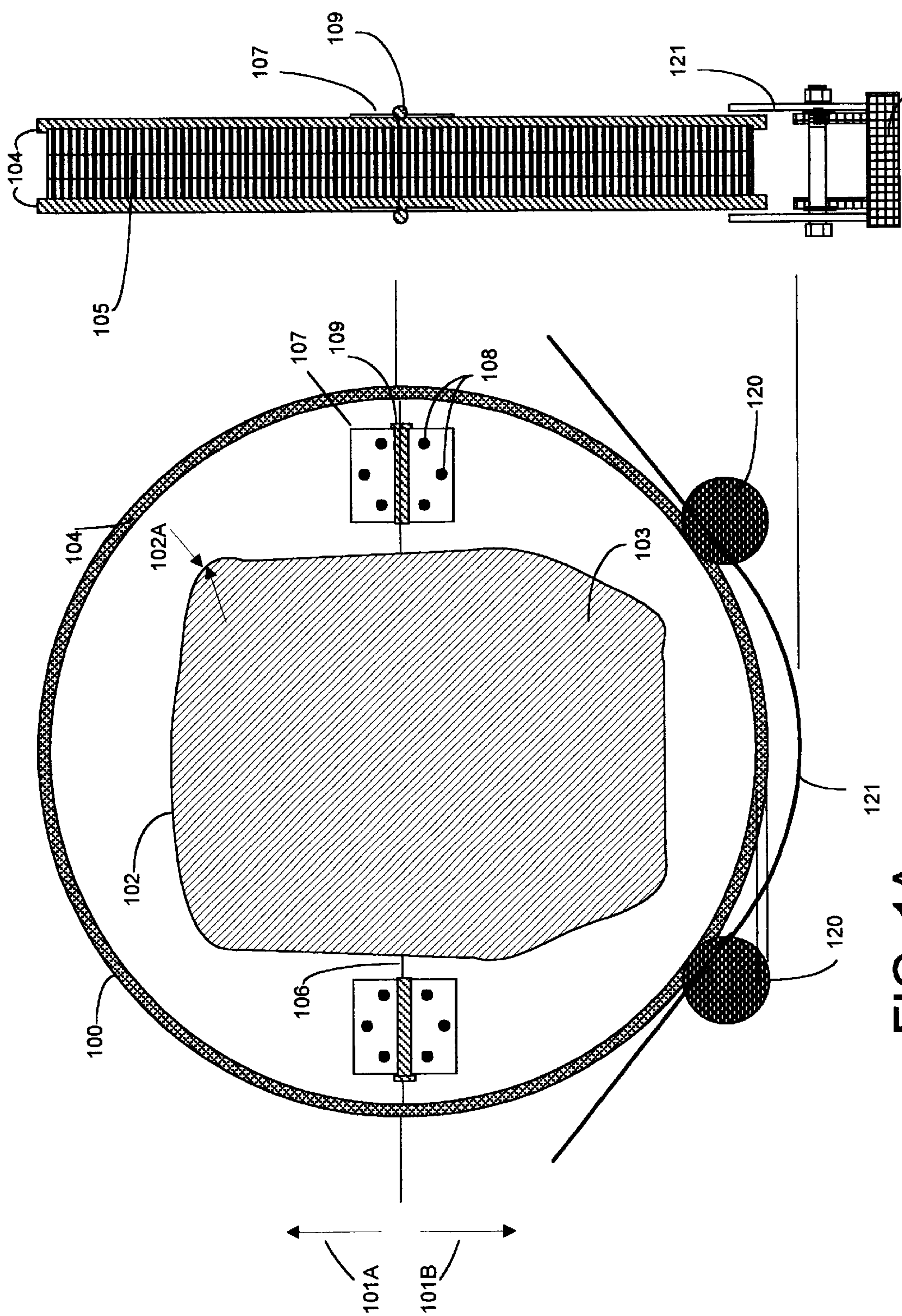


FIG. 1A

FIG. 1B

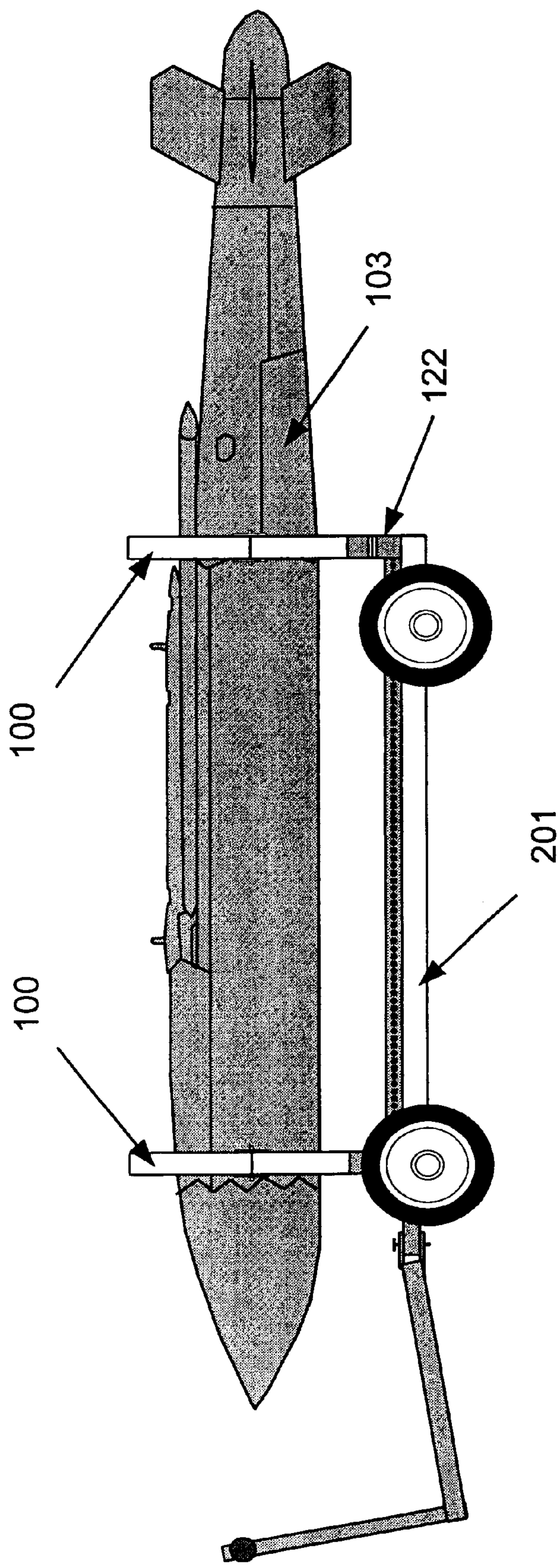


FIG. 2

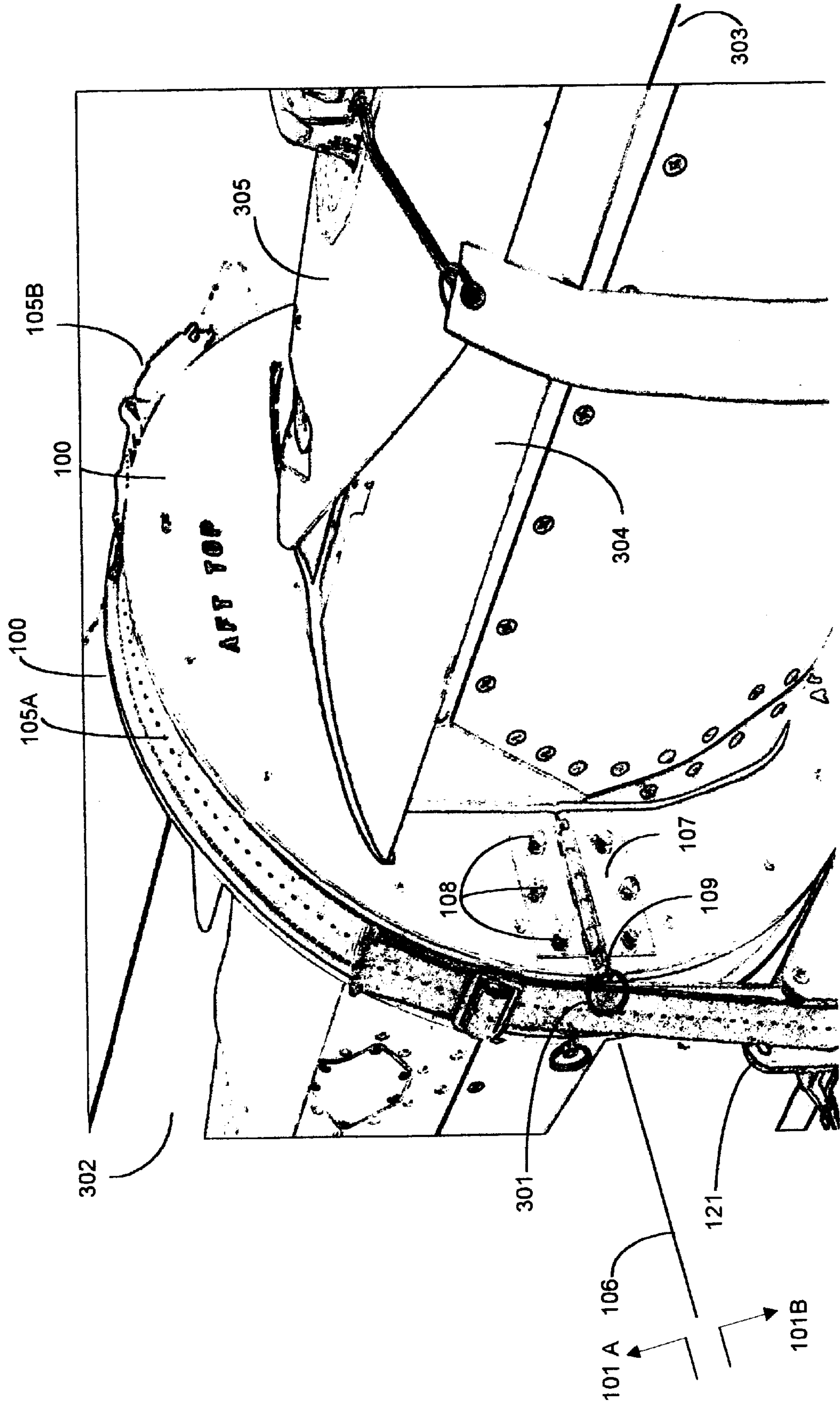


FIG. 3

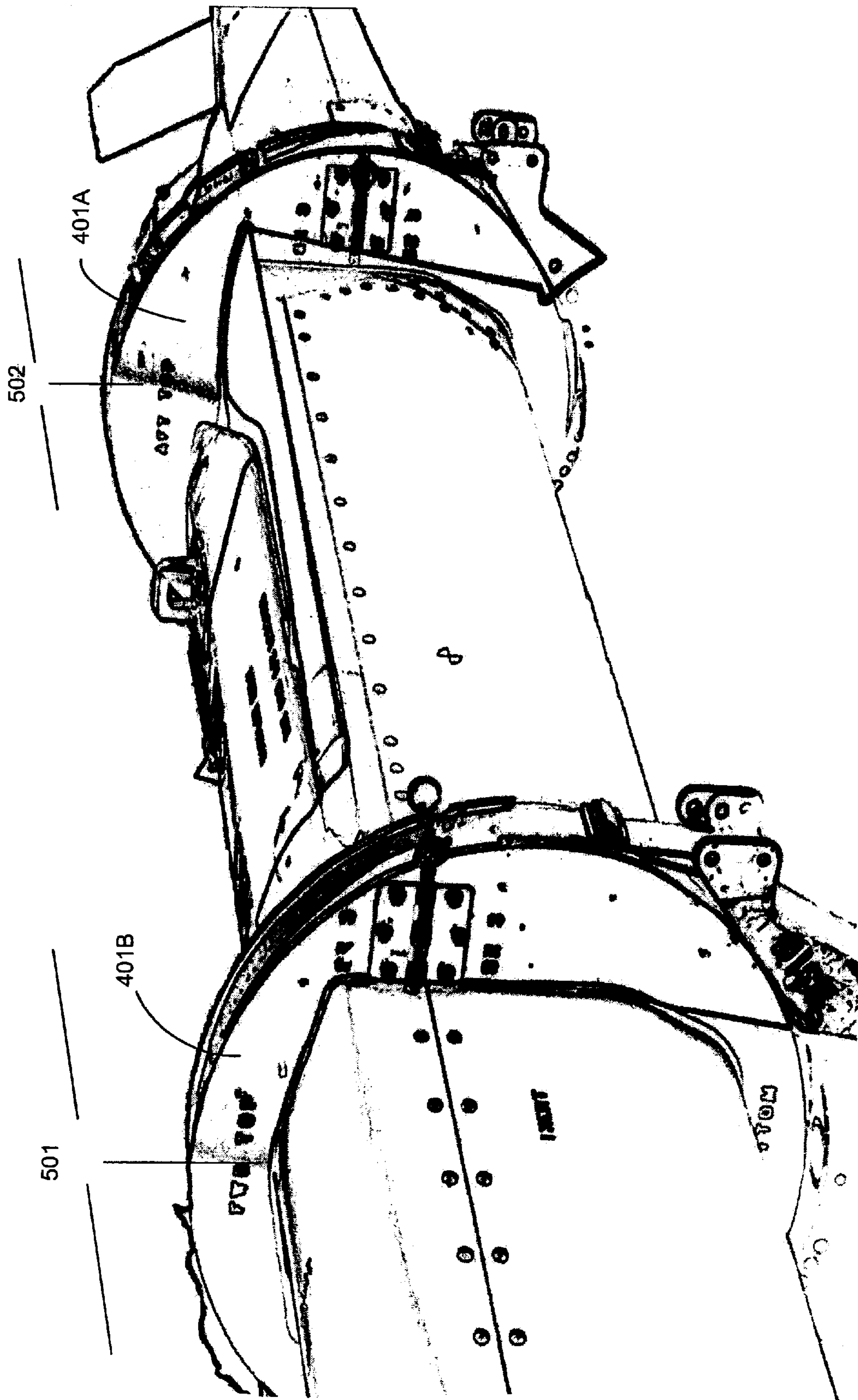


FIG. 5

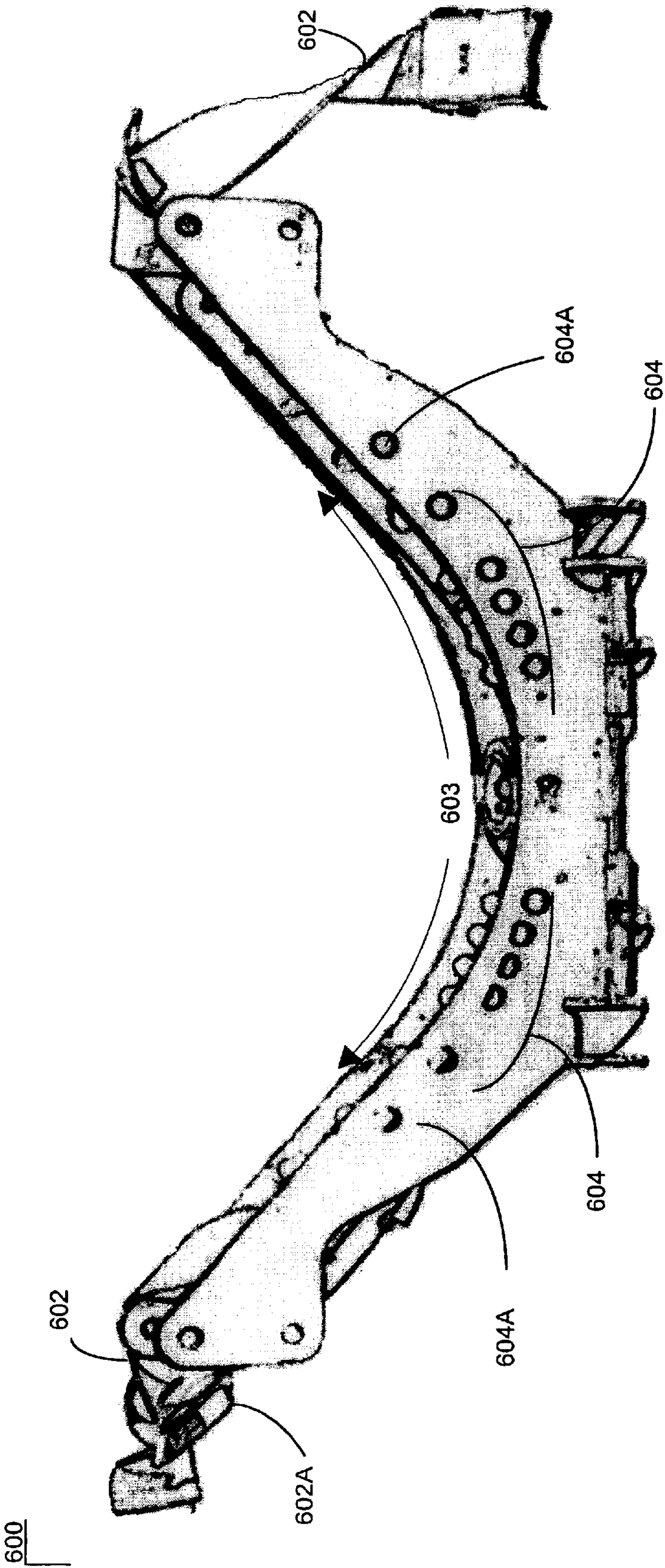


FIG. 6

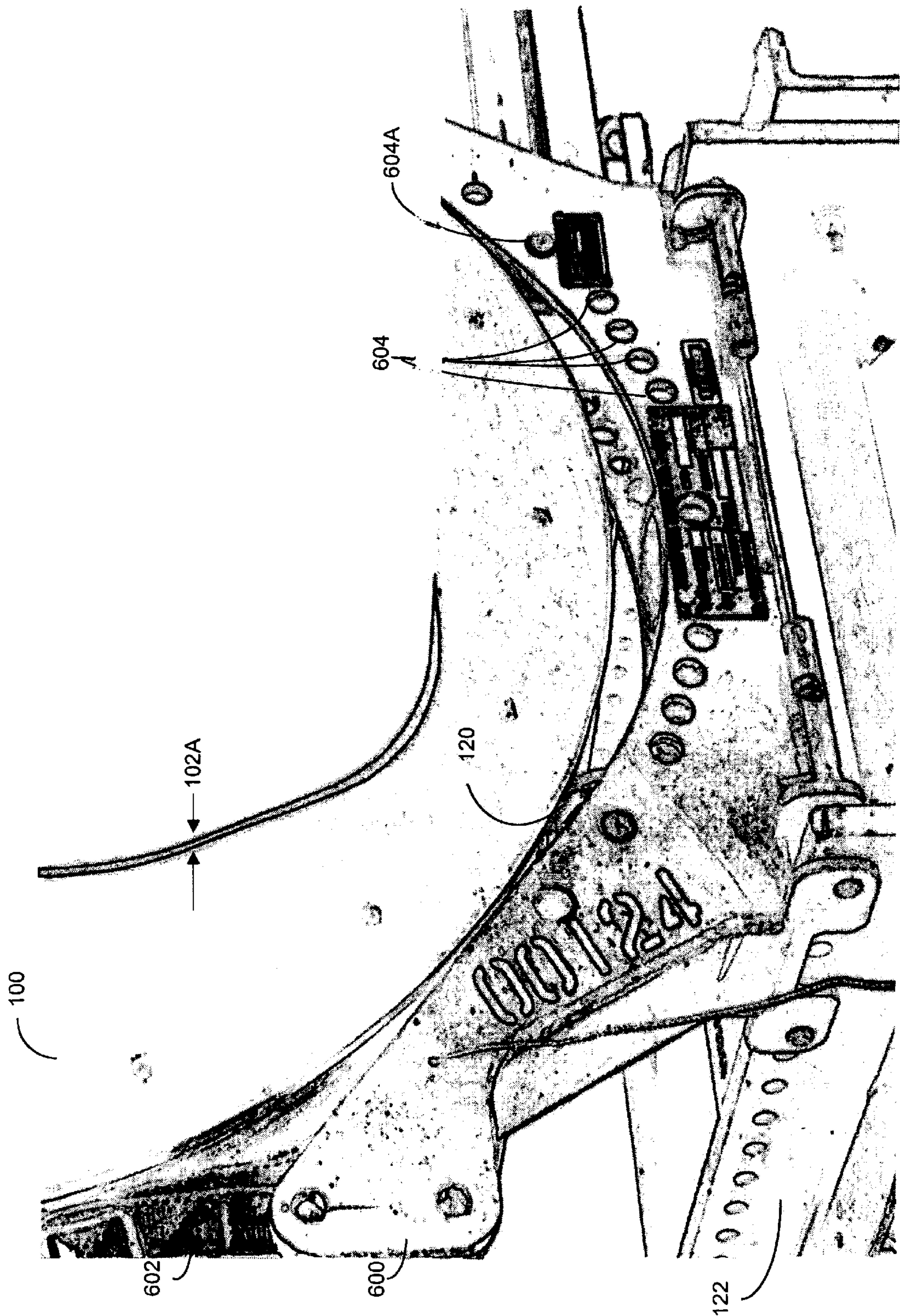


FIG. 7

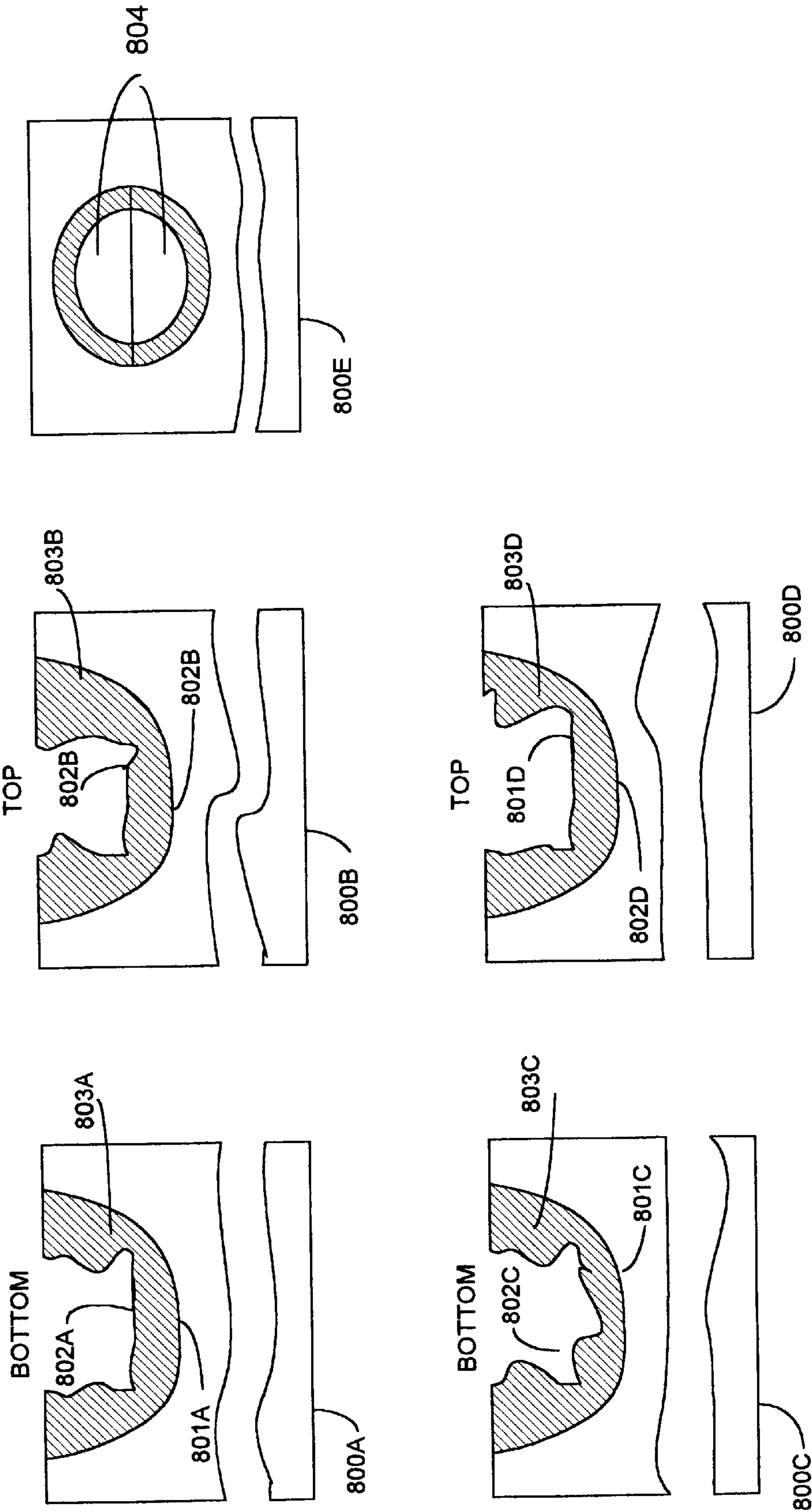


FIG. 8

1

DEVICE, SYSTEM, AND METHOD FOR SECURING AN IRREGULARLY SHAPED DEVICE, INCLUDING THOSE WITH DISCONTINUOUS CONTOURS, IN A FIXTURE

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

The invention described herein may be manufactured and used by or for the government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

FIELD OF THE INVENTION

A device for securing an irregularly-shaped object, including those objects having discontinuous contours, in a fixture, method of the device's use, and method of manufacture therefor.

BACKGROUND

A need for a means to secure irregularly shaped bulky objects, including those with discontinuous contours, in standard fixtures was summarized in the following criteria:

Capable of securing an object having an irregular external cross-section, that is not necessarily continuous, along an axis suitable for rotation of the object

Capable of fitting within overall outer dimension of existing fixture(s)

Capable of supporting an object that weighs within limits designed to be held by existing fixture(s)

Capable of permitting ready access to all areas of the object

Capable of meeting safety proof testing requirements to support handling equipment safety certification procedures, as per NAWCWPNS Memorandum 84E000D/001, Jan. 2, 1997, incorporated by reference herein.

There exist fixtures for supporting irregularly-shaped objects, including those having discontinuous contours, as disclosed in U.S. Pat. No. 4,200,272, *Holder for Irregularly Shaped Articles*, issued to Godding, Apr. 29, 1980 and U.S. Pat. No. 5,988,618, *Work-Holding Device*, issued to Meintrup et al, Jul. 27, 1998. The fixtures provided in the '272 and '618 patents do not have a provision for easily rotating the object so that all areas of the object can be easily accessed. U.S. Pat. No. 4,218,051, *Workpiece Holding Fixture*, issued to Stastay, Aug. 19, 1980, does provide a means for rotating an irregularly shaped object. However, the fixture is specifically manufactured for that purpose and is not readily adaptable to existing tooling or commercially available fixtures. Further, modular adjustable holding fixtures, such as those produced by the method detailed in U.S. Pat. No. 6,032,348, *Method of Forming a Modularized Adjustable Holding Fixture*, issued to Haas et al, Mar. 7, 2000, do not provide the accessibility required to meet the above stated criteria nor are they readily adaptable to existing commercially available fixtures. A preferred embodiment of the present invention, however, meets all of the criteria while providing an inexpensive, readily attainable solution.

SUMMARY OF THE INVENTION

A system for securing irregularly shaped objects, including those with discontinuous contours, that may be bulky, heavy, or both, is provided. Additionally, a method of use

2

and method of manufacture of the system is detailed. A preferred embodiment of the present invention provides a device for holding, stabilizing, and rotating an irregularly shaped object, including one with a discontinuous contour, in a cradle designed for holding, stabilizing, and rotating a regularly-shaped object such as a cylinder.

Provided as a component of a preferred embodiment is an insert or adapter for a fixture, preferably an equipment-handling cradle. Nominally incorporated as standard parts of a fitting that comprises a preferred embodiment of the present invention is at least one pair of structural elements that make up an insert or adapter. These two structural elements of the pair are secured together with at least one "quick release" fastener when the cradle is fitted with its intended irregularly shaped object. Specifically, the component has:

at least one two-piece member, nominally an upper portion and a lower portion, cut to snugly fit the inside contour of the cradle's structural element(s) and the outside contour of the irregularly-shaped object to be stabilized securely in the cradle by the two-piece member;

at least one "quick-release" connector for securing the two portions comprising the two-piece member; and an outside contour optimizing the use of holding elements of an existing fixture. (Holding elements may consist of at least one flexible strap with a ratcheting tightening means.)

Advantages of preferred embodiments, include permitting:

simplified testing by using COTS hardware as the basic holding fixture;

simplified maintenance on objects having an irregular configuration;

inexpensive fixtures that use inserts or adapters fitting standard COTS cradles;

improved safety by providing a simple, inexpensive, stabilizing holding fixture manufacturing of necessary inserts or adapters on site if need be;

reduced man-hours for maintenance and testing;

reduced tooling complexity;

reduced tooling inventory;

reduced tooling capital costs;

lower maintenance costs through improved productivity;

increased flexibility;

high reliability; and

ready upgradability.

Embodiments of the present invention can be applied to international weapons, such as:

Beyond Visual Range Air to Air Missile (BVRAAM) (Matra Bae Dynamics Ltd, France)

AA-6 Acrid (Russia)

Anti-Navire Nouvelle Generation (ANNG) (Aerospatiale, France)

Armiger (Bodenseewerk Geraetetechnik GmbH, Germany)

TAURUS (Lenkflugkörpersysteme GmbH and Bofors)

New Anti-Ship Missile (NSM) (Kongsberg and Aerospatiale)

3M54 and ASM-MS Alfa (Russia)

Kh-65SE/Ks-SD (Russia)

Modular/Multi-Purpose Stand Off Weapon (MUDSOW) H2/H3 (South Africa)

ASPM (Aerospatiale)
 Arme Propulsee A Charges Ejectables Submunitions Dis-
 penser Systeme
 (APACHE) (Aerospactiale, and Thompson-CSF)
 Kh-31 KRYPTON (Zvezda-Strela, Russia)
 Autonomous Free-Flight Dispenser System (AFDS)
 (LenkflugÖrpersysteme GmbH, Germany)
 Skyshark (Consorzio Armamenti Spendibili Multi Uso,
 Italy)
 BVRAAM (Raytheon)
 Air Intercept Missile (AIM) (Raytheon)
 Joint Air-to-Surface Standoff Missile (JASSM)
 (Lockheed-Martin)
 Stand-off Land Attack Missile-Extended Response
 (SLAE-ER) (Boeing)
 Joint Stand-Off Weapon (JSOW) (Raytheon)
 as well as numerous domestic and international aircraft-
 mounted gun pods.

Employment of a preferred embodiment of the present invention saves capital equipment, as well as training and maintenance, costs. Further, a preferred embodiment of the present invention may be used as inserts or adapters for commercially available units thus providing a ready source of base fixtures for adapting to any future holding require-
 ments.

Preferred embodiments are fully disclosed below, albeit without placing limitations thereon.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1A is an end view of a preferred embodiment of the present invention as installed in a cradle for supporting large cylindrical objects, such as missiles.

FIG. 1B is an edge view of a preferred embodiment of the present invention as installed in a cradle for handling large cylindrical objects, such as missiles.

FIG. 2 is a side view of an irregularly-shaped object as installed in a standard cradle with inserts that comprise a preferred embodiment of the system of the present inven-
 tion.

FIG. 3 represents a single component of a preferred embodiment of the present invention, as affixed to a standard cradle thus enabling the secure rotation of an irregularly shaped object.

FIG. 4 represents two inserts used in a preferred embodi-
 ment of the present invention as affixed to a standard cradle when viewed from the aft end of an irregularly-shaped object loaded in the fixture.

FIG. 5 represents two inserts used in a preferred embodi-
 ment of the present invention. as affixed to a standard cradle when viewed from the front end of the irregularly shaped object loaded in the fixture.

FIG. 6 depicts the standard cradle used in the modified fixture of FIGS. 3, 4 and 5.

FIG. 7 is a close-up view of the bottom half of a single component of a preferred embodiment of the present inven-
 tion while resting in the standard cradle of FIG. 6.

FIG. 8 depicts the cuts made in a standard piece of plywood for fabricating an insert to be used in a preferred embodiment of the present invention.

DETAILED DESCRIPTION

A system for securing irregularly shaped objects, includ-
 ing those objects with discontinuous contours, an example

of which may be bulky, heavy, or both, is provided. Additionally, a method of use and a method of manufacture of a preferred embodiment of the present invention are detailed.

Referring to FIG. 1, provided as a component of a preferred embodiment is an insert **100** for a fixture **121**, preferably an adjustable equipment-handling cradle **601** as shown in FIG. 6. Nominally incorporated as a standard fitting is at least one pair of structural elements **101A** and **101B** that are secured together to comprise an insert or adapter **100** with a "quick release" fastener **109** when the cradle **601** (or fixture **121**) is fitted with its intended load (shown as a cross-section end represented by the cross-hatched area **103** of FIG. 1), having:

at least one two-piece member **100**, nominally an upper portion **101A** and a lower portion **101B**, cut to snugly fit the inside contour of the fixture's structure **121**, optionally connected to a holding or transporter device **122**, and the outside contour **102** of the irregularly-shaped object **103** to be stabilized securely in the fixture **121** by the at least one two-piece member **100**, as secured using at least one "quick-release" connector **109** for securing the two portions **101A** and **101B** comprising the two-piece member **100**; and having an external contour **105** optimizing the use of holding elements (not separately shown in FIG. 1, but shown as straps **602** in FIG. 6) of an existing fixture **121**. Holding elements may consist of at least one flexible strap **602** with a ratcheting tightening means **602A**. Further, the outside contour may be de-limited by "lips" **104** that serve to ensure the holding elements, e.g., straps **602**, do not slide off the insert or adapter **100** during use.

A preferred embodiment of the present invention may be built as described below. The description in no way limits the manner in which a preferred embodiment of the present invention may be carried out, simply serving as an example of one method, many of which will be known to one of ordinary skill in the art.

Refer to FIG. 8. A piece of plywood **800A**, of suitable strength for the intended load, is scribed and a piece **803A** cut out so that the piece's external dimension **801A** snugly fits the inside dimensions of a fixture **121** for holding regularly-shaped objects, e.g., the adjustable cradle **601** of FIG. 6, and its internal dimension **802A** snugly fits the outside contour of a first portion, shown in FIG. 1 as the top part **101A**, of an irregularly-shaped object to be secured in the fixture **121**. The contour **102** of the irregularly shaped object may be taken using lead tape such as used in weighting golf clubs and then transferred to the plywood **800A**. The simplest example is the cradle **601** of FIG. 6 with an inside contour **603** tracing a semi-circle, and adjustable within limits, to support cylinders of varying diameters. For example, in the case of the adjustable cradle **601**, rotating balls **120** may be placed at varying locations **604** along the cradle's **601** perimeter, insuring symmetry by placing the rotating balls **120** in pairs at corresponding pre-determined positions. In cases where the object is heavy and is to be rotated in the fixture **121** for easy access to its various parts, it is desirable to provide a system for securing the irregularly shaped object during rotation. Using the adjustable cradle **601** as an example, a second piece of plywood **800B** of suitable strength is scribed and a piece **803B** cut similar to the first piece **803A** and is snugly fit to a second portion of the irregularly-shaped object, e.g., a portion tracing the bottom part **101B** of the contour **101** of FIG. 1. Note also, that the sections comprising the insert do not have to be

5

exact halves, but can be cut to join at locations along the object's long axis that would necessitate unequal sections so as to be convenient for user access. Compare the aft insert **401A** of FIG. 4 to the forward insert **401B**, for example.

For the example of a cradle **601** having an inside dimension **603** suitable for receiving objects having circular outer dimensions of varying diameters, the first and second pieces of plywood **800A** and **800B** are cut so that the two pieces **803A** and **803B** will meet along a chord or a diameter **106**. Note that the diameter of COTS cradles may be adjusted, within limits, so that a cylindrical object just fits the cradle's **601** inside dimension **603**. For example, adjustment may be accomplished by proper symmetrical placement of a pair of rotating balls **120** in one of the cradle's **601** pre-determined locations **604**. The inner contours **702A** and **702B** of the two pieces of plywood **703A** and **703B** snugly fit the complete outer contour **102** of the irregularly-shaped object **103** at the location along an axis, most likely a long axis, of the irregularly-shaped object that is to be secured in a standard fixture **121**, in the example, the cradle **601** of FIG. 6. Alternatively, the inside contour **102** of the "insert" may be lined with felt **102A**, or a similar non-abrasive material, to prevent scuffing or marring the irregularly shaped object **103**.

In those cases where the irregularly-shaped object is heavy, a second set of two pieces of plywood **800C**, a counterpart to piece **800A**, and **800D**, a counterpart to piece **800B**, are scribed and cut as above, yielding pieces **803C** and **803D**, respectively. The inside contours **802C** and **802D** of this second set **803C** and **803D** may be different from that of the contours **802A** and **802B** of the first two pieces **803A** and **803B** because the location of this second set **803C** and **803D** will be offset along the axis of the irregularly-shaped object **103** by a small amount as determined in the next step.

Two pieces of plywood **804**, of a thickness suitable for forming a "lip" around the outer dimension of the insert are cut with a diameter slightly longer than the insert, nominally 1" longer, from another piece of plywood **800E** to serve as a guide element along the support surface **105**, thus positioning a holding element such as a strap **602**. These are suitably affixed along the outer circumference **801A** and **801B** of pieces **803A** and **803B**, respectively, forming the lip **104** along one side. This configuration is then attached to the counterpart pieces **803C** and **803D**, respectively, using screws and glue, for example, thus completing a single two piece adapter or insert **100** with lip **104**. That is, these two pieces **804** join the two thicker flat pieces in making the upper section **101A** comprising pieces **803A**, **803C** and **704**, and in making the lower section **101B**, comprising pieces **803B**, **803D**, and **704**. The final step involves attaching suitable hinges **107** using through bolts **108** along the abutting portions of sections of **101A** and **101B** front and back and joining these hinge parts with "quick release" pins **109**, facilitating the loading and unloading of specific irregularly-shaped objects **103**. These hinges **107** are provided one on each side of each half of the insert **100** as viewed from one end of the long axis of the irregularly-shaped object **103**, and include corresponding hinges **107** on the "backs" (not observable when viewed end-on as in FIG. 1), the "back" hinges **107** connected by through-bolting with bolts **108** (of sufficient strength to meet load requirements) to the "front" hinges **107**. Each of the four "quick release" pins **109** per insert **100** may be provided with safety wires **301A** of FIG. 3, for example, to prevent inadvertent release of the irregularly shaped object **103**.

For production lots, suitable means for molding a material, such as fiberglass or a resinous material, into the

6

required contours can be effected to yield the same result. That is, an "adapter" or "insert" is formed for holding a specific irregularly-shaped (or contoured) object at a specific location, or locations, along an axis of an irregularly-shaped object, for example, its long axis, thus permitting secure rotation of the irregularly-shaped object **103** in a standard fixture **121** originally designed for securing only regularly-shaped objects. These adapters may be placed at multiple locations along an axis of the irregularly shaped object **103** as depicted in FIG. 5 at two locations **501** and **502**.

EXAMPLE

A preferred embodiment of the present invention, locally known as the "JSOW Rollover Fixture," a composite of components **401A**, **401B**, **402** and **600**, is depicted on end as the apparatus **100** of FIG. 1 and in plan view supporting the JSOW in two places, using inserts **401A** and **401B**, along its long axis **303** as in FIG. 4. It incorporates a pair of fixture inserts or adapters **401A** and **401B** that permit rotation of the AGM-154 (JSOW) weapon **302**, thus providing direct access to the onboard Test Instrumentation Kit (TIK) (not separately shown). The JSOW weapon **302** is heavy, bulky, irregularly shaped, and also discontinuous in contour in places along the contour of its long axis **303**. There are two parts to the interface **101A** and **101B** with the roller balls **120** of two AERO-58A Skid Adapters **600**, shown in FIG. 6 with roller balls **120** set on maximum spacing **604A**, in turn mounting to an MHU-191M Munitions Transporter **402** in FIG. 4.

The JSOW Rollover Fixture **401A**, **401B**, **402** and **600** is a non-lifting, non-powered system that adapts the AGM-154 **302** to the AERO-58A skid adapters **600** to allow the AGM-154 **302** to be rotated for safe access to the flight termination system. A preferred embodiment of the present invention as applicable to the JSOW munition of this example, is implemented as described below.

To secure the JSOW munition **302** in the modified fixture, the following steps are followed, assuming two fixture inserts **401A** and **401B**, one aft **401A** and one forward **401B** (as associated with a correlated aft and forward skid adapter AERO-58A **600**), the inserts **401A** and **401B** to be identical in function but most likely having differing inner contours **102**:

1. Position the forward AERO-58A skid adapter **600** in the most forward hole position (not separately shown) on the MHU-191/M **402**. Move the roller balls **120** of the AERO-58A **600** to the outermost (#6) positions **604A**. Release the nylon restraining strap **602** and remove the strap **602** from the roller ball area.
2. Position the aft AERO-58A skid adapter **600** in the most aft hole position (not separately shown) on the MHU-191/M **402**. Move the roller balls **120** of the AERO-58A **600** to the outermost (#6) positions **604A**. Release the nylon restraining strap **602** and remove the strap **602** from the roller area.
3. Remove four (4) pins **109** from the hinges **107** of the forward JSOW Rollover Fixture insert **401B**, and place the bottom half **101B** onto the roller balls **120** of the forward AERO-58A **600**. Place the top half **101A** and the pins **109** near the forward end of the MHU-191/M **402**.
4. Remove four (4) pins **109** from the hinges **107** of the aft JSOW Rollover Fixture insert **401A**, and place the bottom half **101B** onto the roller balls **120** of the aft AERO-58A **600**. Place the top half **101A** onto the AGM-154 **302** just aft of the folded wings **304**, and

slide the top half **101A** forward (encasing the wings **304**) to the aft end of the AGM-154 **302** wing cover **305**.

5. Lower the AGM-154 **302** into the lower halves **101B** of the fixture inserts **100**, positioning the weapon **302** such that the aft top half **101A** aligns with its corresponding bottom half **101B**. Install four (4) pins **109** into the aft fixture hinges **107**. 5
6. Place the top half **101A** of the forward fixture insert **401B** onto the AGM-154 **302**, aligning with its corresponding bottom half **101B**. Install four (4) pins **109** into the forward fixture hinges **107**. 10
7. Remove the hoisting equipment (not separately shown) from the AGM-154 **302**. 15
8. Invert the AGM-154 **302** by rotating it in its cradles **600**. 20
9. To gain access to the Test Instrumentation Kit (TIK) panel, remove four (4) pins **109** from the aft fixture insert **401A** and remove the corresponding bottom half **101B** of the aft fixture insert **401A**. 25
10. Reverse the above procedure to return the AGM-154 **302** to its upright position. 30

The above descriptions should not be construed as limiting the scope of the invention but as mere illustrations of preferred embodiments. For example, although examples discussed at length are airborne weapons and standard fixtures for holding cylindrical objects such as missiles, the method and apparatus is applicable to any shape, contour, or size that a user may need to secure. Specifically, a single insert or adapter (as opposed to the dual inserts of the above example) in keeping with the design of a preferred embodiment of the present invention may be all that is required when combined with compressible spring-loaded pins such as may be used with the '272 and '618 patents and a schnabel arrangement such as frequently used on railways or docks. Additionally, a single removable "quick release" pin per insert may suffice where alternatives to standard hinges are used. Further, although the above example was for a bulky and heavy object, the physical size, mass and shape of the irregularly-shaped object to be supported by an application of the present invention is immaterial. For example, a preferred embodiment of the present invention may be suitable for securing devices at the micron or nanometer scale. The scope shall be determined by appended claims as interpreted in light of the above specification. 35

I claim:

1. A system, having an inner and outer contour, for securing an irregularly shaped object, comprising:
 - at least one fixture, having inside and outside contours, incorporating an axis suitable for rotation thereabout;
 - an adapter having an insert, said insert incorporating at least two parts and having
 - an outside contour shaped to closely fit the inside contour of said fixture and
 - an inside dimension that closely fits the outside contour of the irregularly-shaped object to be supported in

said fixture and wherein said insert permits the irregularly shaped object to be secured and rotated about the axis suitable for rotation thereabout in a fixture that otherwise supports only an object having a regular specific outer contour;

at least one cradle, having an inner and outer contour, as part of said fixture,

wherein said insert is fitted to said cradle so as to hold the irregularly-shaped object while said irregularly-shaped object is being rotated about said axis suitable for rotation thereabout, said insert having said insert's outer contour snugly fitting said inner contour of said cradle and said insert's inner contour snugly fitting the outer contour of the irregularly-shaped object in at least one location along said axis suitable for rotation thereabout; and

at least one quick release connector in operable communication with each of said at least two parts of said insert,

wherein, the system permits the irregularly shaped object to be secured for rotation about said axis suitable for rotation thereabout.

2. The system of claim 1 wherein said at least one cradle is adjustable. 25

3. The system of claim 1 employing a transporting device as part of said fixture, wherein said transporting device supports said at least one cradle along at least a portion of said cradle's outer contour. 30

4. The system of claim 1 incorporating at least one hinge, operable through a removable bolt, as said at least one quick release connector,

wherein said removable bolt optionally incorporates a safety wire. 35

5. The system of claim 1 wherein said outside contour of said insert is shaped to snugly fit said fixture's inner contour and said inner dimension of said insert is shaped to snugly fit the outer contour of the irregularly-shaped object to be supported in said fixture, 40

wherein, said insert permits the irregularly shaped object to be secured and rotated about the axis suitable for rotation thereabout in a fixture that otherwise supports only an object having a regular specified outer contour; and

wherein said insert is easily separable into at least two component parts thus facilitating access to any section of the irregularly-shaped object while the irregularly-shaped object is secured in said fixture. 45

6. The system of claim 1 wherein said insert further comprises a non-abrasive material deployed over the inner contour of said insert, said non-abrasive material selected from the group consisting of: a natural felt, a foam, a manmade fabric, a coating initially applied in liquid form, and material suitable for isolating physical vibration. 50

* * * * *