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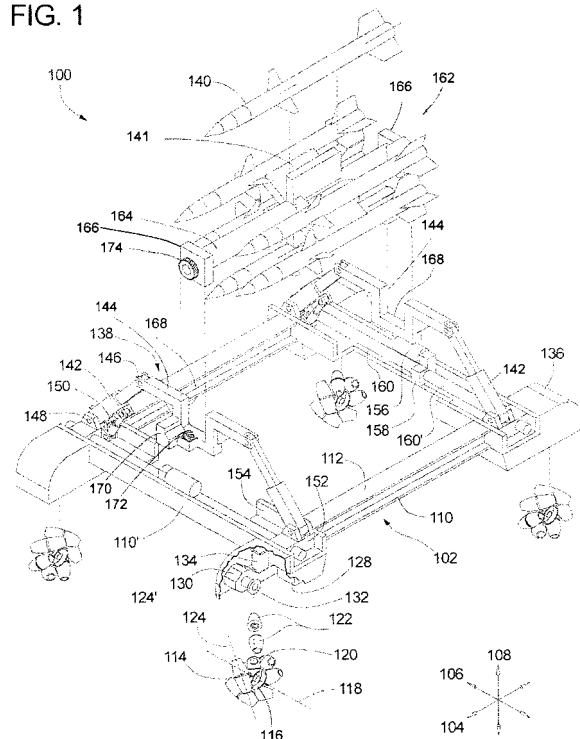
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(54) **Advanced weapons loader**

(57) A weapon handler (100) for transporting weapons and loading weapons onto aircraft or other vehicles is disclosed. The weapons handler (100) comprises a moveable base (102) having longitudinal (104), lateral (106) and vertical (108) axes, an articulated cradle (138) comprising one or more cradle members, and a weapons carousel rotatable about the longitudinal axis and adapted to hold a plurality of weapons, and a plurality of articulating members connecting the moveable base to the one or more cradle members. The articulating members are adapted to translate the articulated cradle (138) relative to moveable base along the lateral (106), longitudinal (104), and vertical (108) axes. According to another embodiment, a weapon gripper (400) for a weapon handling system is disclosed. The weapon gripper (400) comprises at least three contact surfaces, and a moveable linkage adapted to selectively move at least one of the at least three contact surfaces from a first position in which the at least three contact surfaces geometrically enclose a weapon, to a second position in which the at least three contact surfaces geometrically release the weapon.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to weapons handlers for loading weapons and equipment onto aircraft, and more particularly, to weapons handlers having multi-directional articulated platforms, weapons handlers having multi-weapon handling capability, and weapons handlers having omni-directional drive systems.

[0002] Conventional weapon loading systems face many drawbacks that hinder their ability to perform efficiently during times of conflict. For example, the current practice for loading weapons onto fixed wing aircraft involves one of two standard types of processes. First, a loading device may be used to transport and load the munition into a loading position. This type of loading device, sometimes referred to as a "jammer" vehicle, is typically used for ground based loading operations and suffers from the drawback that the loading process becomes a serial operation where only one munition can be transported and loaded at a time. Thus, after it has dispatched its munition, the loader must return to pick up another munition. Moreover, such jammer loading devices typically require 2 operators, a driver and a spotter, to properly position the munition in relation to the aircraft wing. This process is manpower and time intensive. Aircraft loading operations aboard sea-based platforms infrequently utilize jammer vehicles in favor of utilizing personnel to manually transport and lift the munitions into position for loading. Munitions are manually transported to the flight line aboard a large number of "bomb carts" which clutter the deck of the sea-based platform. This process is faster than using a jammer vehicle, but is extremely inefficient from a manpower perspective considering that it may take upwards of 2 to 7 people to lift a given munition into place under the aircraft wing. The intensive use and high cost of manpower for loading operations is not ideal, and exposes personnel, to a variety of hazards including lifting injuries or worse, the potentially harmful dropping of a munition during the loading process. Other processes used for loading munitions include the use of a winch to draw the munition into the proper loading position under the aircraft wing. Again, this procedure suffers from the same drawbacks that it is still manpower intensive and not efficient.

[0003] Therefore, an objective of the present invention is to provide weapons handlers for loading weapons and equipment onto aircraft that increase weapons loading throughput, enable faster sortie generation, improve the timeline on a combat turn, allow faster unloading of unused munitions, provide an increased economy of weight and space, and provide improved safety on the flight line through a fewer number of obstacles. The present invention further provides for a reduction in total ownership cost through an improved man-to-munition ratio for munitions loading operations. This is due to the capability

for the present invention and one or less operators to load a plurality of munitions. Although certain deficiencies in the related art are described in this background discussion and elsewhere, it will be understood that these deficiencies were not necessarily heretofore recognized or known as deficiencies. Furthermore, it will be understood that, to the extent that one or more of the deficiencies described herein may be found in an embodiment of the claimed invention, the presence of such deficiencies does not detract from the novelty or non-obviousness of the invention or remove the embodiment from the scope of the claimed invention.

SUMMARY OF THE INVENTION

[0004] The invention, according to one embodiment, relates to a weapons handler for transporting and loading weapons. The weapons handler comprises a moveable base having longitudinal, lateral and vertical axes, an articulated cradle comprising one or more cradle members, and a weapons carousel rotatable about the longitudinal axis and adapted to hold a plurality of weapons, and a plurality of articulating members connecting the moveable base to the one or more cradle members. The articulating members are adapted to translate the articulated cradle relative to moveable base along the lateral and vertical axes.

[0005] The invention, according to a second embodiment, relates to a weapons handler for transporting and loading weapons, the weapons handler comprising a moveable base having longitudinal, lateral and vertical axes, an articulated cradle, and a plurality of articulating members connecting the moveable base to the articulated cradle, the plurality of articulating members being adapted to translate the articulated cradle relative to moveable base along the lateral and vertical axes.

[0006] The invention, according to a third embodiment, relates to a weapon gripper for a weapon handling system, the weapon gripper comprising at least three contact surfaces, and a moveable linkage adapted to selectively move at least one of the at least three contact surfaces from a first position in which the at least three contact surfaces geometrically enclose a weapon, to a second position in which the at least three contact surfaces geometrically release the weapon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention can be more fully understood by reading the following detailed description of the presently preferred embodiments together with the accompanying drawings, in which like reference indicators are used to designate like elements, and in which:

FIG. 1 is an exploded isometric view of an illustrative weapons handler in accordance with one embodiment of the invention;

FIG. 2 shows an exemplary articulating member in accordance with a further embodiment of the invention;

FIGS. 3a and 3b show a partial end view and a side view of an exemplary weapons handler with articulating members in accordance with a further embodiment of the invention;

FIGS. 4a and 4b show an illustrative weapons carousel with a plurality of weapon mount points in accordance with a further embodiment of the invention;

FIGS. 5a and 5b show an illustrative weapon gripper in a first position and a second position, respectively, in accordance with one embodiment of the invention;

FIG. 6 shows a side, partial sectional view of an illustrative weapon gripper in accordance with one embodiment of the invention;

FIG. 7 is an illustrative weapon stand with a plurality of weapon grippers in accordance with one embodiment of the invention;

FIGS. 8a and 8b show an illustrative weapon gripper in accordance with another embodiment of the invention; and

FIGS. 9a, 9b and 9c show illustrative rollers in accordance with further embodiments of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0008] The present invention provides a weapons handling system for transporting weapons and loading weapons onto weapon mounts, such as those located on fixed- and rotary-wing aircraft and other military equipment. As used herein, the term "weapon" includes any type of military equipment that is desired to be mounted onto an aircraft or similar vehicle, including, but not limited to: munitions and ordnance (bombs, missiles, rockets, cannons and machine gun pods, and the like); electronic and surveillance equipment (electronic sensors and countermeasures systems, laser targeting devices, camera pods, and the like); and other miscellaneous equipment (weapon mounts, fuel tanks, leaflet dispensers, and the like). The term "weapon" also includes pre-assembled combinations of munitions, such as clusters of bombs (i.e. weapons packages) that are pre-assembled and may be mounted onto an unattached wing pylon or pylon mount. Referring now to the Figures, various embodiments of the invention will be described in more detail.

[0009] FIG. 1 is an exemplary embodiment of a weapons handler in accordance with the invention, shown in an exploded isometric view. The weapons handler 100 comprises a moveable base 102 having a longitudinal

axis 104, a lateral axis 106, and a vertical axis 108. The moveable base 102 is constructed from a number of frame members 110, 110'. In this embodiment, the two longitudinally-extending frame members 110 comprise I-beams, while the laterally-extending frame members 110' comprise open channels. The frame members 110, 110' form a rigid frame 112 that is preferably suspended on a number of wheels 114 to facilitate movement of the device. In one embodiment, the wheels 114 may comprise pneumatic tires or other conventional wheels (see e.g., wheel 330 in FIG. 3b) that are mounted on one or more axles and/or casters to facilitate turning the weapons handler 100. Conventional wheels are known in the art and shown, for example, in U.S. Pat. Nos. 4,213,624 to Sanders, 4,447,186 to Renfro *et al.* and 5,083,892 to Oswald *et al.*, which are incorporated herein by reference.

[0010] As shown in FIG. 1, wheels 114 comprise omni-directional wheels that allow the moveable base 102 to be maneuvered omni-directionally, that is, along either or both of the longitudinal and lateral axes 104, 106, and about any axis extending parallel to the vertical axis 108. It will be readily appreciated that omni-directional movement allows relatively precise positioning of the weapons handler 100, which minimizes the effort required to position weapons and other equipment during loading. Such movement capability is particularly useful for maneuvering in tight spaces or where the weapon loader must be maneuvered around obstacles to reach the mounting point, as is often the case on aircraft carriers, in crowded hangars, and in tightly-packed equipment storage areas.

[0011] As shown in FIG. 1, moveable base 102 has four omni-directional wheels 114. At the center of each omni-directional wheel 114 is a center hub 116 that can be rotated about a hub axis 118, and that has a plurality of roller brackets 120 extending perpendicularly therefrom. A roller 122 is mounted to each roller bracket 120 such that the roller 122 is free to rotate about a roller axis 124. The rollers 122 are arranged about the circumference of the hub 116, and their roller axes 124 are oriented in a helical pattern about the hub axis 118. The freely rotating rollers 122 are unable to transmit force vectors perpendicular to their respective roller axes 124. As such, when the hub 116 is rotated, the rollers 122 tend to thrust the hub at an angle parallel to the roller axis 124 of whichever roller 122 is presently contacting the ground.

[0012] In order to provide controlled movement of the weapons handler 100, four wheels 114 are placed in a rectangular pattern in the plane defined by the longitudinal and lateral axes 104, 106. The hub axes 118 extend generally along the lateral axis 106, and the wheels are oriented such that the roller axes 124 of the rollers 122 that are in contact with the ground form either a diamond pattern or an "X" pattern. In this configuration, the weapons handler 100 can be moved in any direction or about any axis simply by controlling the relative rotational speeds and directions of the four omni-directional wheels

114. The details of such operation are within the ordinary skill in the art, and are described, for example, in U.S. Pat. Nos. 3,746,112, 3,876,255 and 4,598,782 to Ilon, all of which are incorporated herein by reference. Other arrangements of omni-directional wheels 114 and rigid frames 112 that may be used with the present invention are shown, for example, in U.S. Pat. Nos. 4,907,692 and 4,981,209 to Sogge, U.S. Pat. No. 5,701,966 to Amico, and U.S. Pat. Nos. 6,134,734 and 6,477,730 to Marrero, all of which are incorporated herein by reference. While four omni-directional wheels 114 are preferred, fewer or more may be used instead. For example, it will be readily appreciated that, in some embodiments, moveable base 102 may be suspended on only three omni-directional wheels arranged in a triangular, planar fashion.

[0013] Various configurations of rollers 122 may also be used with the present invention. For example, the rollers 122 may comprise split rollers that extend from either side of the roller bracket 120, as shown in FIG. 1, or may comprise a single roller that is suspended between two brackets, as shown in U.S. Pat. No. 3,876,255. The former construction prevents the bracket from striking the ground when the edge of the wheel 114 encounters elevation changes, and is therefore preferred, but the latter construction also may be used. Various other features may be built into the rollers to reduce vibration, provide consistent ride height, reduce the maximum ground contact pressure, and increase the roller life, for example. These and other variations are described, for example, in U.S. Pat. Nos. 6,340,065, 6,349,203 and 6,547,340 to Harris, which are incorporated herein by reference.

[0014] Other types of omni-directional wheels may also be used with the invention. For example, omni-directional wheels having a plurality of circumferentially-oriented rollers may be used. In such devices, the axes of the rollers are arranged in the plane of the wheel and tangential to the wheel's circumference. Such devices may provide omni-directional movement capability with fewer than four wheels or with tracks rather than wheels. Examples of these and other omni-directional wheels are described, for example, in U.S. Pat. Nos. 3,789,947 to Blumrich, 4,715,460 to Smith, 5,186,270 to West, and 6,547,339 to Bandou *et al.*, which are incorporated herein by reference.

[0015] The omni-directional wheels 114 (or conventional wheels, if used) can be driven by any drive system. Examples of useful drive systems devices include: internal combustion engines, electric motors, torque converters, differentials, gear transmissions, belt and chain drives, and the like. When omni-directional wheels 114 are used, the device is simplified by using a separate drive system 128 to operate each wheel 114. In such an embodiment, the drive systems 128 may typically comprise an electric motor that is coupled to the wheel 114 by a drive shaft or a belt and pulley drive, and any necessary speed reducing or increasing gears (not shown). The drive shaft is contained within a swing arm 130 that

extends longitudinally from the rigid frame 112 and is pivotally mounted thereto such that it can swing vertically through an arc. The wheel 114 is mounted to a drive axle 132 that protrudes from the swing arm 130. In a preferred embodiment, the movement of the weapons handler 100 is controlled by an operator by way of a simple joystick or multiple-joystick controller, as described in the art incorporated herein.

[0016] It is also preferred, but not required, that the rigid frame 112 be suspended on the wheels 114 by way of a compliant suspension system that is adapted to conform to irregular (i.e., not perfectly flat) terrain, prevent undamped bouncing movements, and absorb at least some shock loads that would otherwise be transmitted to the rigid frame 112 and the attached structures and devices. Such a suspension is particularly preferred in embodiments using omni-directional wheels, in which case such wheels may not provide the same degree of shock absorption as pneumatic tires. Any suspension may be used, but it is preferred that the suspension be compact to minimize the size requirements of the device. Such suspension systems are generally known in the art, and exemplary spring/shock absorber devices include elastomeric block materials and combined metal springs and oil- or air-damped shock absorbers. As shown in FIG. 1, the suspension comprises simple combined spring/shock absorber units 134 that hold the rigid frame 112 above the swing arms 130 but allow some vertical wheel travel. A cowl 136 may be disposed around the wheels 114 to prevent potentially dangerous contact with other objects and protect the wheels and drive systems 128 from the elements. Alternatively, the cowls may be removed or replaced by simple bars that extend around the lower perimeter of the wheel to serve as wheel guards (see e.g., item 334 in FIG. 3b).

[0017] The weapons handler 100 also includes an articulated cradle 138 that is mounted to the moveable base 102 by a plurality of articulating members. Weapons 140 are carried on the articulated cradle 138, by means of the weapons carousel 162, and are moved into position for mounting by moving the moveable base 102 into the proper position, then providing finer positioning (if necessary) by moving the articulated cradle 138 relative to the moveable base 102. It is particularly preferred for the articulating members to be adapted to independently move the articulated cradle 138 relative to the moveable base 102 along the lateral and vertical axes 106, 108.

[0018] While it is known that vertical movement is useful for positioning weapons close to or at their mounting points (such as wing pylons), it has also been found that lateral movement is also useful for such mounting operations. Such lateral movement is particularly useful when it is desired to mount weapons onto wing pylons that are intended to hold the weapon on the side, such as when numerous weapons are clustered in a radial pattern on a single wing pylon. It has also been observed that in some cases omni-directional wheels, as described above, may vibrate or jostle the device upon which they

are mounted during lateral movement, and so finer control of weapon positioning may be available by using the articulating members to laterally translate the articulated cradle 138 relative to the moveable base 102, rather than moving the entire weapons handler 100 using the wheels 114. In still other cases, the ability to laterally translate the articulated cradle 138 relative to the moveable base 102 is useful when ground obstructions or obstructions with the aircraft (such as landing gear or other weapons) prevent the moveable base 102 from fitting in the proper mounting location to mount the weapons 140.

[0019] Referring to FIG. 1, vertical and lateral movement are provided by articulating members comprising four linear extension members 142. As shown, the linear extension members 142 comprise hydraulic pistons that can be linearly extended or retracted using well-known hydraulic drive systems. The linear extension members may alternatively comprise cable-operated or gear-operated extensible booms, scissoring linkages, or other structures adapted to extend and retract approximately along a linear path.

[0020] Each linear extension member 142 is connected at a first end to the articulated cradle 138 by an upper pivot 146, and at a second end to the moveable base 102 by a lower pivot 148 (these pivotal connections may be direct or through intervening structures, such as additional linkage members or through traversing members, as described below). In the present embodiment, the articulated cradle 138 comprises two cradle members 144 between which the weapons 140 are mounted on a weapons carousel 162. Alternatively, the articulated cradle 138 may comprise additional separate cradle members, or a single unified structure joined by longitudinal connecting members or other structural connections (not shown). Two of the linear extension members 142 are attached to one cradle member 144 to support one end of the weapons 140, and two linear extension members 142 are attached to the other cradle member 144 to support the other end of the weapons 140.

[0021] Each of the pairs of linear extension members 142, its associated cradle member 144 and the rigid frame 112 forms a 4-bar linkage connected by the respective pivots 146, 148. In this embodiment, each pivot 146, 148 comprises a bearing or pin that rotates primarily about the longitudinal axis 104, and has very little or no ability to rotate about the lateral or vertical axes 106, 108. As such, the cradle members have limited movement along the longitudinal axis 104. However, these 4-bar linkages will have uncontrolled degrees of freedom (*i.e.*, a given force input can create various different linkage movements) with respect to rotation and translation in the plane formed by the lateral and vertical axes 106, 108 unless movement about at least one of the pivots 146, 148 is prevented or selectively controlled. As such, in the embodiment of FIG. 1, the articulating members that form each of the 4-bar linkages also includes a support strut 150 that is used to selectively control rotation of one linear extension member 142 about that member's

lower pivot 148. The support strut 150 may comprise a hydraulic linear actuator, as shown, or may comprise a gear-driven device or any other type of device that is suitable for controlling the rotation of the 4-bar linkage about one of the upper or lower pivots 146, 148, as will be appreciated by those of ordinary skill in the art.

[0022] Movement of the two cradle members 144 is accomplished by selectively extending or retracting the linear extension members 142 and support struts 150. For example, the cradle members 144 are raised along the vertical axis (without rotation) by simultaneously extending each of the linear extension members 142 at the same rate, and extending the support struts 150 by an proportional rate that is appropriate to maintain the vertical movement rate of the upper pivots 146. Similarly, the articulated cradle can be translated along the lateral axis by contracting the linear extension members 142 on one side of the weapons handler 100, extending those on the other side, and either extending or contracting the support struts 150, depending on the desired direction of travel. Any combination of movements, including rotation about the longitudinal axis 104, can also be accomplished using the linear extension members 142 and support struts 150, as described with reference to FIG. 1. Furthermore, to the extent that the pivots 146, 148 allow some rotation about the lateral and vertical axes 106, 108, the two cradle members 144 can be moved relative to one another to provide some rotation about the lateral axis 106 to lift one end of the weapon 140 higher than the other, and to provide some rotation about the vertical axis 108 to laterally translate one end of the weapon 140 relative to the other end. Such movement, even if minor, can be useful to position the weapon 140 properly for attachment to the aircraft or other vehicle.

[0023] While the articulating members, as described thus far, are able to move the articulated cradle 138 along the lateral axis 106, further versatility can be incorporated into the present invention by mounting one or more of the linear extension members 142 to the moveable base 102 or the articulated cradle 138 by way of one or more traversing members that are adapted to move along the lateral axis 106. Such traversing members allow even greater control over the positioning of the weapons 140 by allowing additional lateral movement independent of the movement provided by the linear extension members 142.

[0024] As shown in FIG. 1, the articulating members further include four traversing members 152 that mount the second end of each linear extension member 142 to the moveable base 102. Each traversing member 152 comprises a lower pivot mount slidably located in a respective channel 154. One or more drive systems are provided to selectively move the traversing members 152, either together or independently from one another, along the channels 154. A motor 156 is provided for each pair of traversing members 152. Each motor 156 is connected to the respective pair of traversing members 152 by way of a gearbox 158 and a pair of drive screws 160,

160'. In a preferred embodiment, one drive screw 160 in each pair is right-hand threaded, while the other drive screw 160' is left-hand threaded. Each drive screw is journaled on appropriate bushings (not shown), and interfaces with an correspondingly threaded bore in the respective traversing member 152. When the motor 156 turns the respective drive screws 160, 160' in the same rotational direction, the respective traversing members 152 are moved toward or away from one another (depending on the direction) to raise or lower the articulated cradle 138. It is also preferred for each gearbox 158 to be equipped to counter-rotate the drive screws 160, 160' when desired so that the traversing members 152 can be moved in the same direction as one another to laterally traverse the articulated cradle 138 relative to the moveable base 102. The design of such motors, gearboxes and drive screws is within the ordinary skill in the art.

[0025] It will be appreciated that other drive configurations may be provided for the traversing members 152, and fewer or more than four traversing members may be used. For example, in one alternative embodiment, the four traversing members 152 are independently driven by four separate motors. In other embodiments, the traversing members may be driven by cables and pulleys, rack-and-pinion sets, hydraulic actuators, or other devices. The traversing members 152 (or their channels 154) also may be provided with devices to move them along the longitudinal axis 104. The traversing members 152 also may be mounted on tracks, rather than in channels 154. It is also envisioned that a single traversing member 152 may be provided for each cradle member 144. In still other embodiments, both linear extension members 142 associated with a single cradle member 144 may be mounted on a single traversing member, or the traversing members 152 may be mounted in the articulated cradle 138, rather than on the moveable base 102. Other useful variations will be apparent to those of ordinary skill in the art in view of the present disclosure and practice of the inventions described herein.

[0026] While the articulated cradle 138 may be moved by separately controlling the various linear extension members 142 and support struts 150 by hand, it is also within the scope of the invention to provide the weapons handler 100 with a pre-programmed or programmable control system that automatically calculates and implements the necessary movements of the linear extension members 142 and support struts 150 to accomplish any desired movement. For example, when an operator desires to move the articulating cradle upwards at a 45 degree angle, the control system may do so by automatically adjusting all of the articulating members according to pre-calculated tables or actively performed calculations (or a combination thereof). The calculations necessary to automate the movement of the articulated cradle are readily calculated using geometric and dynamic principles and equations, and such calculations are within the ordinary skill in the art of machine design. The particular calculations will be a function of the specific ge-

ometry of the embodiment of the invention, as will be understood by those of ordinary skill in the art.

[0027] Input for automated and manual movements may be received by any useful input device, such as one or more levers or joysticks. For example, in the case of a manually-controlled device, the linear extension members may be controlled by levers that operate hydraulic valves or mechanical transmissions. In the case of an automatically controlled device, one or more joysticks, a keypad or other input device to control multiple movement axes may be used as a compact controller. It is also envisioned that so-called "extender technology" may be implemented with the present invention to provide even greater controllability. Such technology uses input and feedback systems to allow an operator to spontaneously and dynamically control the movement of the controlled device, and such technology is described in detail in U.S. Pat. No. 6,272,924, which is incorporated herein by reference.

[0028] Still referring to FIG. 1, the articulated cradle 138 preferably further includes a weapons carousel 162 that is mounted between the two cradle members 144. The weapons carousel 162 comprises a rotating shaft 164 journaled to rotate in two mounting blocks 166. The mounting blocks 166 are selectively received in corresponding mounting block receivers 168 in the cradle members 144. Any type of releasable mechanical interface may be used for this junction, but it is preferred that the engagement be relatively easy to engage and disengage to allow the weapons carousel 162 to be quickly removed and replaced when all of the weapons 140 have been dispatched or attached as in the case of aircraft unloading operations. Aside from the mechanical interface, at least one of the cradle members 144 may accommodate an interface to allow the coupling of hydraulic, electric or other power from the moveable base 102 to the weapons carousel 162. This selectively engageable interface allows greater reloading speed, and may reduce the number of weapons handlers that are required to arm a given number of aircraft or other vehicles. It may be readily appreciated that a physical energy coupling between the carousel and base may be unnecessary for those embodiments where a suitable energy storage device is included with the carousel. Alternatively, the mounting blocks may be essentially permanently attached to the cradle members (at least for the duration of a typical use of the device machine), in which case the mounting blocks may simply comprise bearings in which the rotating shaft is journaled. Weapons carousel 162 further includes a plurality of weapon mount points 141 that attach weapons 140 to the rotating shaft 164 of the weapons carousel 162. The rotating weapons carousel 162 provides even greater flexibility to position weapons in their intended mounting locations, and also facilitates rapid weapon mounting operations.

[0029] The rotating shaft 164 is driven by a motor 170 mounted to either a cradle member 144, as shown in FIG. 1, or to a mounting block 320, as shown in FIG. 3a.

In FIG. 1, the motor 170 is adapted to rotate a drive gear 172 that engages with a corresponding driven gear 174 when the weapons carousel 162 is engaged with the cradle members 144. The driven gear 174 directly drives the rotating shaft 164, or does so through intermediate drive mechanisms such as gears, belts and chains. Of course, other drive arrangements may alternatively be employed. For example, the driven gear 174 may be replaced by a belt-driven pulley or a hydraulically driven device. The motor 170 may also be any type of motor, such as an electric motor, a hydraulic drive, or the like.

[0030] In other embodiments of the invention, it may also be desirable to be able to translate the entire articulating cradle along the longitudinal axis 104. Such movement capability may be useful when it is desired to position the weapons with finer control that is available from moving the weapons handler 100 using the wheels 114 or when it is not possible to position the moveable base 102 in the proper location to mount the weapons 140.

[0031] FIG. 2 shows an exemplary embodiment of an articulating member 202 that can be used in lieu of the previously described linear extension members 142 to provide longitudinal translation capability. The articulating member 202 comprises a linear extension member 204 that is mounted to the articulated cradle 138 at a first end by an upper pivot 206, and to frame 112 of moveable base 102 at a second end by a lower pivot 208. The upper and lower pivots 206, 208 allow rotation about the longitudinal axis 104, as in the embodiment of FIG. 1, and also allow significant rotation about the lateral and vertical axes 106, 108. Such joints, often called spherical joints, are well-known in the art. The longitudinal position of the articulated cradle 138 is controlled by a longitudinal support strut 210, which is similar in structure and operation to the support strut 150 previously described with reference to FIG. 1.

[0032] In this embodiment, the longitudinal support strut 210 can be selectively extended or contracted to pivot the linear extension member 204 rearward and forward along the longitudinal axis 104. Furthermore, when all four of the linear extension members are equipped as described in FIG. 2, the articulated cradle 138 can also be rotated about the lateral and vertical axes 106, 108. This additional positional control provides improved flexibility to align the weapon with the intended mounting point, and correct misalignments that often occur when irregularly-shaped weapons are being handled and when the aircraft or weapons handler is located on uneven ground.

[0033] It will be appreciated that other embodiments of the invention may have structures that are different than those described with reference to FIGS. 1 and 2. For example, FIGS. 3a and 3b show a partial end view and a side views of another embodiment of the invention in which the articulating members comprise two vertical extension members 302, 302' and two traversing members 304, 304'. A first vertical extension member 302 is

rigidly (i.e., not pivotally) mounted to a first traversing member 304, and a second vertical extension member 302' is rigidly mounted to the other traversing member 304'. Each vertical extension member 302, 302' comprises two linear actuators 306 that are adapted to extend and retract along the vertical axis 108. The traversing members 304, 304' are mounted on screws 308 so that they can be translated along the lateral axis 106.

[0034] In this embodiment, the articulated cradle 310 comprises two cradle members 312, 312' and a weapons carousel 314 that is pivotally suspended between the cradle members 312, 312'. The cradle members 312, 312' are fixed atop a respective vertical extension members 302, 302', and the weapons carousel 310 is suspended in the cradle members by two mounting blocks 320, each of which has pins 322 extending from the sides thereof. These pins 322 fit in bores in the first cradle member 312, and slots 324 in the second cradle member 312'. The use of a slot 324 in the second cradle member 312' allows some longitudinal displacement in the event one vertical extension member is raised higher than the other. This also provides the ability to rotate the articulated cradle about the lateral axis 106.

[0035] The weapons carousel 314 is adapted to rotate about the longitudinal axis 104 by operation of a motor 316 and gear set 318 mounted on one mounting block 320. The entire weapons carousel 314 may be removed by releasing the pins 322 from their respective bores and slots 324, or the entire articulated cradle may be removed by disengaging mounting bolts 326 or other fasteners that retain the cradle members 312, 312' on the vertical extension members 302, 302'.

[0036] The embodiment of FIGS. 3a and 3b provides both vertical translation, by extending the linear actuators 306, and lateral translation, by moving the traversing members 304, 304' on their respective screws 308. Furthermore, the use of pins 322 in slots 324 allows some rotation about the lateral axis 106. As with the embodiment of FIG. 1, the linear actuators 306 and screws 308 may be replaced by other mechanisms that provide the same type of movement, and the number of these devices may be increased or decreased from the number shown.

[0037] In further embodiments, longitudinal translation may also be provided using weapon mount points that are translatable relative to the weapon carousel along the longitudinal axis. As shown in FIGS. 4a and 4b, a weapon carousel 800 is provided with a rotating shaft 814 to which a first weapon mount point 842 and a second weapon mount point 844 are attached. A first weapon 802 is attached to the first weapon mount point 842 and a second weapon 804 is attached to the second weapon mount point 844. Both the first weapon mount point 842 and second weapon mount point 844 are further attached to respective translation devices 852, 854 that are adapted for controlling the longitudinal movement of the weapon mount points 842, 844 back and forth along the rotating shaft 814. Such translation devices may comprise a

linear actuator and screw arrangement, or similar mechanical device, as will be readily appreciated by those of ordinary skill in the art. As shown in FIG. 4a, the weapon mount points 842, 844 are arranged along the same longitudinal length around the rotating shaft 814, but in FIG. 4b, following operation of the respective translation devices 852, 854, first weapon mount point 842 (and consequently, first weapon 802) are disposed slightly rearwardly of second weapon mount point 844 (and consequently, second weapon 804). It will also be appreciated that in other embodiments, various weapons may be arranged around on weapon mount points attached to the rotating shaft such that at least two of the weapons are staggered along the longitudinal axis relative to one another, as shown in FIG. 3b, without the use of translation devices to form the staggered relationship.

[0038] It will be understood that, while the embodiments described herein generally depict six weapons being carried by the weapons carousel, other embodiments of weapons carousels may be adapted to carry greater or fewer weapons. It is also envisioned that the rotating shaft of the weapons carousel may assume other, non-cylindrical shapes, and may be equipped with universal weapon mounts so that it can be adapted to carry different numbers and types of weapons.

[0039] The various embodiments of the weapon handler described above provide an apparatus that is capable of increasing weapon throughput and loading efficiency. A further improvement to the weapon handler of the present invention involves the use of illustrative weapon grippers for securing the various weapons for loading or unloading, as intended by the skilled operator. For example, the weapon grippers may be used to secure a weapon until it reaches the mounting point for loading, or used to secure the weapon after it has been unloaded back onto the weapon handler. FIGS. 5a and 5b show an illustrative weapon gripper in accordance with one embodiment of the invention.

[0040] FIG. 5a shows the weapon gripper 400 in a first position wherein the weapon 140 is geometrically enclosed by the weapon gripper 400. On the other hand, FIG. 5b shows the weapon gripper 400 in a second position wherein the weapon 140 has been geometrically released by the weapon gripper 400. Weapon gripper 400 comprises a first moveable linkage 410 and a second moveable linkage 430. The first moveable linkage 410 includes a first link 412 having a first roller 414 and a second roller 416 rotatably attached thereto. The first roller 414 and second roller 416 provide a plurality of contact surfaces 414a, 416a adapted for contact with the outer surface, or circumference, of weapon 140 to help secure it in place when the weapon gripper 400 is in the first position. The first link 412 is pivotably mounted to weapon stand 402 by pin 404 so that first link 412 is rotatable around a first link axis 405 defined by the longitudinal axis of pin 404. The first moveable linkage 410 further comprises a first drive arm 418 pivotably coupled at one end to the first link 412 by first link pivot 420, and pivotably

coupled at the other end to driven gear 450 by first arm pivot 422.

[0041] The second moveable linkage 430 includes a second link 432 having a third roller 434 and a fourth roller 436 rotatably attached thereto. The third roller 434 and fourth roller 436 provide a plurality of contact surfaces 434a, 436a adapted for contact with the outer surface of weapon 140 to help secure it in place when the weapon gripper 400 is in the first position. The second link 432 is pivotably mounted to weapon stand 402 by pin 406 so that second link 432 is rotatable around a second link axis 407 defined by the longitudinal axis of pin 406. The second moveable linkage 430 further comprises a second drive arm 438 pivotably coupled at one end to the second link 432 by second link pivot 440, and pivotably coupled at the other end to driven gear 450 by second arm pivot 442. In some embodiments, the first link axis 405 is located along or perpendicular to a first imaginary line 419 between the first roller 414 and second roller 416, and second link axis 407 is located along or perpendicular to a second imaginary line 439 between the third roller 434 and fourth roller 436.

[0042] In the first position, as shown in FIG. 5a, the plurality of rollers 414, 416, 434 and 436 contact the outer surface of weapon 140 at contact surfaces 414a, 416a, 434a and 436a, and geometrically enclose it within the weapon gripper 400. As shown, the plurality of rollers 414, 416, 434 and 436 are arranged approximately evenly about the circumference of the enclosed weapon 140. It should be appreciated, however, that other arrangements of the rollers may be used to enclose the weapon 140, as well.

[0043] In the second position, as shown in FIG. 5b, the weapon 140 is geometrically released from the weapon gripper 400. To arrive at the second position, drive gear 460 is operated to selectively rotate driven gear 450, which in turn results in the movement of first drive arm 418 at first arm pivot 422 and second drive arm 438 at second arm pivot 442 about the gear axis of gear shaft 452. As shown in FIG. 5b, first arm pivot 422 is drawn to position at approximately 6 o'clock on driven gear 450, and second arm pivot 442 is drawn to position at approximately 12 o'clock on driven gear 450. This movement, in turn, causes the inward movement of first link 412 at first link pivot 420, and second link 432 at second link pivot 440. Consequently, first roller 414 and third roller 434 lose contact with the outer surface of weapon 140. Second roller 416 and fourth roller 436 remain in contact with weapon 140, and the resulting movement of first link 412 and second link 432 causes the weapon 140 to move upward along the vertical axis 108 (from the vertical height of the first position, represented by dotted line B in FIG. 5b). It will readily be appreciated that the above components may also be arranged to move in the clockwise direction, if desired.

[0044] FIG. 6 provides a side, partial sectional view of the weapons gripper 400 in further detail. As described above, drive gear 460 is operated to directly drive driven

gear 450. Drive gear 460 is selectively driven by motor 470 disposed in the support frame of the weapon stand 402. Motor 470 may be any type of motor, such as an electric motor, a hydraulic drive, or the like. A rotating shaft 452 is disposed through driven gear 450 and weapon stand 402 and is attached to a cooperating gear component in second rear moveable linkage 430', which shares similar components to that of second moveable linkage 430. The movement of driven gear 450 thus causes similar movement in second rear moveable linkage 430' to further geometrically release the weapon 140. It will be readily appreciated that in alternative embodiments, drive gear 460 may use intermediate drive mechanisms such as gears, belts and chains, or other drive arrangements to rotate driven gear 450, such as a belt-driven pulley or a hydraulically driven device.

[0045] The weapon carousel of the present invention may be adapted to hold a plurality of weapons using the illustrative weapon grippers, as shown and described with reference to FIG. 5a, 5b and 6, for the loading and unloading of multiple weapons. In some embodiments, a plurality of weapon grippers may be arranged around the rotating shaft of the weapons carousel through the use of an illustrative weapon stand, as shown in FIG. 7.

[0046] Weapon stand 500 comprises a support frame 510 having a plurality of longitudinal channel portions 512 defined in its outer perimeter, and adapted for placement of the weapon grippers, as shown in FIG. 5a and 5b. The support frame 510 of weapon stand 500 is coupled to the rotating shaft 580 of the weapons carousel for indexing movement in accordance with the use of the weapons handler. As shown in FIG. 7, several weapon grippers are attached to the support frame 510, identified as first weapon gripper 520, second weapon gripper 530, third weapon gripper 540, fourth weapon gripper 550, fifth weapon gripper 560, and sixth weapon gripper 570, respectively. First and second weapon grippers 520, 530 are shown in an open position, where no weapon is presently secured or supported by the respective weapon grippers. Alternatively, third, fourth, fifth weapon grippers 540, 550, 560, respectively, are each securing a weapon in the first (i.e., geometrically enclosed) position, as described above with reference to FIG. 5a. Sixth weapon gripper 570 is supporting a weapon in the second (i.e., geometrically released) position wherein the weapon is positioned for removal in accordance with the use of the weapons handler. It should be appreciated that, as desired or required based on the size, shape or type of weapon being secured, more than one weapon stand 500 may be disposed longitudinally along the rotating shaft 580 of the weapons carousel. It should further be appreciated that, in some embodiments, the weapons stand may be loaded by loading alternate weapons gripper to provide additional balance for the loaded stand, and reduce power needs for the carousel.

[0047] In further embodiments, the weapon gripper of the present invention may include a single moveable linkage, such as that shown in the FIG. 8a and 8b. The weapon

on gripper 600 comprises moveable linkage 610 that includes a first link 612 having a first roller 614 rotatably attached thereto. A second roller 632 and third roller 634 are rotatably mounted to the weapon stand 630. The rollers, first roller 614, second roller 632, and third roller 634, provide a plurality of contact surfaces 614a, 632a, 634a, respectively, that contact the outer surface of the weapon to help secure it in place when the weapon gripper 600 is in the first position. The first link 612 is pivotably mounted to weapon stand 630 by pin 616 so that first link 612 is rotatable around a first link axis 617 defined by the longitudinal axis of pin 616. The first link 612 is further pivotably coupled at pivot 618 to the first linear extension member 620. In this embodiment, linear extension member 620 comprises a hydraulic piston that can be linearly extended or retracted using well-known hydraulic drive systems. The linear extension member may alternatively comprise a cable-operated or gear-operated extensible boom, scissoring linkage, or other structure adapted to extend and retract approximately along a linear path. The linear extension member 620 is pivotably mounted, at its other end, by linear extension pivot 622 to weapon stand 630.

[0048] In the first position, shown in FIG. 8a, the linear extension member 620 is extended such that the end of first link 612 is driven outward and the first roller 614 is in contact with the weapon. In this arrangement, the weapon is geometrically enclosed by the first roller 614, second roller 632, and third roller 634. In a second position, as shown in FIG. 8b, the linear extension member 620 is retracted such that the end of first link 612 (at pivot 618) is drawn inward and the first roller 614 is no longer in contact with the weapon. In this arrangement, the weapon is geometrically released, and supported by the second roller 632 and third roller 634.

[0049] As shown in FIG. 6, the roller of the present invention may be a cylindrical, elongated member rotatably mounted between cooperating components on front and rear moveable linkages. FIG. 9a shows an illustrative roller, of the type shown in FIG. 6, in further detail. As shown, roller 700 includes a roller shaft 702 disposed axially through roller body 704. FIGS. 9b and 9c show alternative embodiments of illustrative rollers or roller devices for use in the weapon grippers in accordance with further embodiments of the invention. As shown in FIG. 9b, roller 710 is comprised of a roller shaft 712 attached to a roller frame 714, to which a pair of roller bodies 716 are rotatably mounted. In FIG. 9c, roller 720 is comprised of a roller shaft 722 disposed through the roller body 724. Roller body 724 is generally semi-circular shaped, with an inwardly concave surface 726 that may be adapted for contacting the outer surface or circumference of a weapon that it is used to secure. The material of construction of the roller body may be adapted to perform a compliant mounting function that may reduce shock or vibration between the weapon and the loader.

[0050] It will be readily appreciated that the mechanical devices of the present invention that provide for the con-

trolled movement of the various components of the weapon handler, drive system, articulating members, linear extension members, or weapon gripper components, may be directed by automated systems known in the art. For example, one or more pre-programmed or programmable control systems may be used to automatically calculate and implement the necessary movements of the invention components to accomplish any desired movement. Moreover, the calculations necessary to automate the movement of the invention components are readily calculated using geometric and dynamic principles and equations, and such calculations are within the ordinary skill in the art of machine design. Input for automated and manual movements may be received by any useful input device, such as one or more levers or joysticks, or keypads or the like. For example, in the case of a manually-controlled device, the invention components may be controlled by levers that operate hydraulic valves or mechanical transmissions. In the case of an automatically controlled device, one or more joysticks having multiple movement axes may be used as a compact controller.

[0051] Other variations will be apparent and practicable without undue experimentation, in light of the present disclosure and with practice of the invention. For example, various components of the weapons handler may receive input from or send output to a processing device machine to accomplish the desired function of the invention, such as the calculated movement of the articulating members for positioning of the weapons carousel. The weapons handler, or components thereof, may also receive commands from a controller workstation or other controller device through a processing device, or other mechanical components electronically coupled to or in communication with a processing device. As used herein, the term processing device is to be understood to include at least one processor that uses at least one memory. The memory stores a set of instructions. The instructions may be either permanently or temporarily stored in the memory or memories of the processing device. The processor executes the instructions that are stored in the memory or memories in order to process data. The set of instructions may include various instructions that perform a particular task or tasks, such as those tasks described above. Such a set of instructions for performing a particular task may be characterized as a program, software program, or simply software. As noted above, the processing device executes the instructions that are stored in the memory or memories to process data. This processing of data may be in response to commands by a user or users of the processing device, in response to previous processing, in response to a request by another processing device and/or any other input, for example. The processing device used to implement exemplary embodiments of the invention may also be a general purpose computer. However, the processing machine described above may also utilize any of a wide variety of other technologies including a special purpose computer, a computer system including a microcomputer, mini-computer

or mainframe, a programmed microprocessor, a microcontroller, an integrated circuit, a logic circuit, a digital signal processor, a programmable logic device, or any other device or arrangement of devices that is capable of implementing exemplary embodiments of the invention.

[0052] While the present invention has been described and illustrated herein with reference to various preferred embodiments it should be understood that these embodiments are exemplary only, and the present invention is limited only by the following claims. Furthermore, to the extent that the features of the claims are subject to manufacturing variances or variances caused by other practical considerations, it will be understood that the present claims are intended to cover such variances.

Claims

1. A weapons handler for transporting and loading weapons, the weapons handler comprising:

a moveable base having longitudinal, lateral and vertical axes;

an articulated cradle comprising:

one or more cradle members; and

a weapons carousel rotatable about the longitudinal axis and adapted to hold a plurality of weapons;

a plurality of articulating members connecting the moveable base to the one or more cradle members, the articulating members being adapted to translate the articulated cradle relative to moveable base along the lateral and vertical axes.

2. The weapon handler of claim 1, wherein the moveable base is omni-directionally movable along the longitudinal and lateral axes.

3. The weapon handler of claim 2, wherein the moveable base comprises a rigid frame suspended on four omni-directional wheels, each omni-directional wheel comprising:

a hub rotatable about a respective hub axis;

a plurality of roller brackets extending from the hub;

a plurality of rollers, each roller attached to a respective roller bracket and rotatable on the respective roller bracket about a respective roller axis;

wherein the roller axes are arranged in a helical pattern about the respective hub axis.

4. The weapon handler of claim 3, wherein the omni-

directional wheels are arranged in a rectangle in a plane defined by the longitudinal and lateral axes, and the hub axes extend along the lateral axis.

5. The weapon handler of claim 3, wherein the omni-directional wheels are separately driven by respective drive systems. 5
6. The weapon handler of claim 3, wherein the rigid frame is supported on the omni-directional wheels by a compliant suspension system. 10
7. The weapon handler of claim 3, wherein the roller axes of one or more of the omni-directional wheels are selectively moveable from the helical pattern to a circumferential pattern about the respective hub axis. 15
8. The weapon handler of claim 1, wherein the weapons carousel is selectively mounted to the one or more cradle members. 20
9. The weapon handler of claim 8, wherein the one or more cradle members comprises two carousel mounts, each carousel mount adapted to selectively receive one end of the weapons carousel. 25
10. The weapon handler of claim 8, wherein the articulated cradle further comprises a motor adapted to rotate the weapons carousel, the motor being mounted to the weapons carousel or the one or more cradle members. 30
11. The weapon handler of claim 1, wherein the weapons carousel comprises a plurality of weapon mount points, at least one of the weapon mount points being translatable relative to the weapons carousel along the longitudinal axis. 35
12. The weapon handler of claim 1, wherein the weapons carousel is adapted to hold a plurality of weapons such that at least two of the plurality of weapons are staggered along the longitudinal axis relative to one another. 40
13. The weapon handler of claim 1, wherein the weapons carousel comprises a plurality of weapon grippers, each weapon gripper comprising: 45

at least three contact surfaces; 50
a moveable linkage adapted to selectively move at least one of the at least three contact surfaces from a first position in which the at least three contact surfaces geometrically enclose a weapon, to a second position in which the at least three contact surfaces geometrically release the weapon. 55

14. The weapon handler of claim 13, wherein:

the moveable linkage comprises first and second links, each link pivotable about respective first and second link axes; and
the at least three contact surfaces comprise first and second rollers attached to the first link, and third and fourth rollers attached to the second link;
wherein the first, second, third and fourth rollers are arranged approximately evenly about a circumference of the enclosed weapon when the moveable linkage is in the first position.

15. The weapon handler of claim 14, wherein the first link axis is located along or perpendicular to a first imaginary line between the first and second rollers, and the second link axis is located along or perpendicular to a second imaginary line between the third and fourth rollers.

16. The weapon handler of claim 14, wherein the first link axis is located at the first roller, and the second axis is located at the third roller.

17. The weapon handler of claim 13, wherein:

the moveable linkage comprises a link mounted to a weapon stand, the link pivotable about a link axis; and
the at least three contact surfaces comprise first and second rollers attached to the weapon stand, and a third roller attached to the link;
wherein the first, second and third rollers are arranged approximately evenly about a circumference of the enclosed weapon when the moveable linkage is in the first position.

18. The weapon handler of claim 13, wherein the weapon is rotatable relative to the weapon gripper when the moveable linkage is in the first position.

19. The weapon handler of claim 13, wherein the weapon is not rotatable relative to the weapon gripper when the moveable linkage is in the first position. 45

20. The weapon handler of claim 1, wherein the articulating members are adapted to translate the articulated cradle relative to the moveable base along the longitudinal axis. 50

21. The weapon handler of claim 1, wherein the articulating members are adapted to rotate the articulated cradle relative to moveable base about at least one of the longitudinal axis, the lateral axis, and the vertical axis. 55

22. The weapon handler of claim 1, wherein the articu-

lating members comprise four linear extension members, each linear extension member being pivotally connected at a respective first end to the articulated cradle and pivotally connected at a respective second end to the moveable base.

23. The weapon handler of claim 22, wherein the articulating members further comprise at least one traversing member adapted to move relative to the moveable base along the lateral axis, and wherein at least one of the respective second ends of the linear extension members is attached to the traversing member

24. The weapon handler of claim 22, wherein the articulating members further comprise four traversing members adapted to move relative to the moveable base along the lateral axis, and wherein each of the second ends of the linear extension members is attached to a respective one of the traversing members.

25. The weapon handler of claim 1, wherein the plurality of articulating members comprise:

a first traversing member adapted to move relative to the moveable base along the lateral axis;
a first vertical extension member adapted to move relative to the moveable base along the vertical axis, and connecting the first traversing member to a first end of the articulated cradle;
a second traversing member adapted to move relative to the moveable base along the lateral axis; and
a second vertical extension member adapted to move relative to the moveable base along the vertical axis, and connecting the second traversing member to a second end of the articulated cradle.

26. A weapons handler for transporting and loading weapons, the weapons handler comprising:

a moveable base having longitudinal, lateral and vertical axes;
an articulated cradle; and
a plurality of articulating members connecting the moveable base to the articulated cradle, the plurality of articulating members being adapted to translate the articulated cradle relative to moveable base along the lateral and vertical axes.

27. The weapons handler of claim 26, wherein the moveable base is omni-directionally movable along the longitudinal and lateral axes.

28. The weapons handler of claim 27, wherein the move-

able base comprises a rigid frame suspended on four omni-directional wheels, each omni-directional wheel comprising:

a hub rotatable about a respective hub axis;
a plurality of roller brackets extending from the hub;
a plurality of rollers, each roller attached to a respective roller bracket and rotatable on the respective roller bracket about a respective roller axis; and
wherein the respective roller axes are arranged in a helical pattern about the hub axis.

29. The weapons handler of claim 28, wherein the omni-directional wheels are arranged in a rectangle in a plane defined by the longitudinal and lateral axes, and the hub axes extend along the lateral axis.

30. The weapons handler of claim 28, wherein the omni-directional wheels are separately driven by respective drive systems.

31. The weapons handler of claim 28, wherein the rigid frame is supported on the omni-directional wheels by a compliant suspension system.

32. The weapons handler of claim 28, wherein the roller axes of one or more of the omni-directional wheels are selectively moveable from the helical pattern to a circumferential pattern about the respective hub axis.

33. The weapons handler of claim 26, wherein the articulating members are adapted to translate the articulated cradle relative to the moveable base along the longitudinal axis.

34. The weapons handler of claim 26, wherein the articulating members are adapted to rotate the articulated cradle relative to moveable base about at least one of the longitudinal axis, the lateral axis, and the vertical axis.

35. The weapons handler of claim 26, wherein the articulating members comprise a plurality of linear extension members, each linear extension member being pivotally connected at a respective first end to the articulated cradle and pivotally connected at a respective second end to the moveable base.

36. The weapons handler of claim 35, wherein the articulating members further comprise at least one traversing member adapted to move relative to the moveable base along the lateral axis, and wherein at least one of the second ends of the linear extension members is attached to the traversing member.

37. The weapons handler of claim 35, wherein the articulating members further comprise a plurality of traversing members adapted to move relative to the moveable base along the lateral axis, and wherein each of the second ends of the linear extension members is attached to a respective one of the traversing members.

38. The weapons handler of claim 26, wherein the plurality of articulating members comprise:

a first traversing member adapted to move relative to the moveable base along the lateral axis; a first vertical extension member adapted to move relative to the moveable base along the vertical axis, and connecting the first traversing member to a first end of the articulated cradle; a second traversing member adapted to move relative to the moveable base along the lateral axis; and a second vertical extension member adapted to move relative to the moveable base along the vertical axis, and connecting the second traversing member to a second end of the articulated cradle.

39. A weapon gripper for a weapon handling system, the weapon gripper comprising:

at least three contact surfaces; a moveable linkage adapted to selectively move at least one of the at least three contact surfaces from a first position in which the at least three contact surfaces geometrically enclose a weapon, to a second position in which the at least three contact surfaces geometrically release the weapon.

40. The weapon gripper of claim 39, wherein:

the moveable linkage comprises first and second links, each link pivotable about respective first and second link axes; and the at least three contact surfaces comprise first and second rollers attached to the first link, and third and fourth rollers attached to the second link; wherein the first, second, third and fourth rollers are arranged approximately evenly about a circumference of the enclosed weapon when the moveable linkage is in the first position.

41. The weapon gripper of claim 40, wherein the first link axis is located along or perpendicular to a first imaginary line between the first and second rollers, and the second link axis is located along or perpendicular to a second imaginary line between the third and fourth rollers.

42. The weapon gripper of claim 40, wherein the first link axis is located at the first roller, and the second axis is located at the third roller.

43. The weapon gripper of claim 39, wherein:

the moveable linkage comprises a link mounted to a stand, the link pivotable about a link axis; and the at least three contact surfaces comprise first and second rollers attached to the stand, and third roller attached to the link; wherein the first, second and third rollers are arranged approximately evenly about a circumference of the enclosed weapon when the moveable linkage is in the first position.

44. The weapon gripper of claim 39, wherein the weapon is rotatable relative to the weapon gripper when the moveable linkage is in the first position.

45. The weapon gripper of claim 39, wherein the weapon is not rotatable relative to the weapon gripper when the moveable linkage is in the first position.

FIG. 1

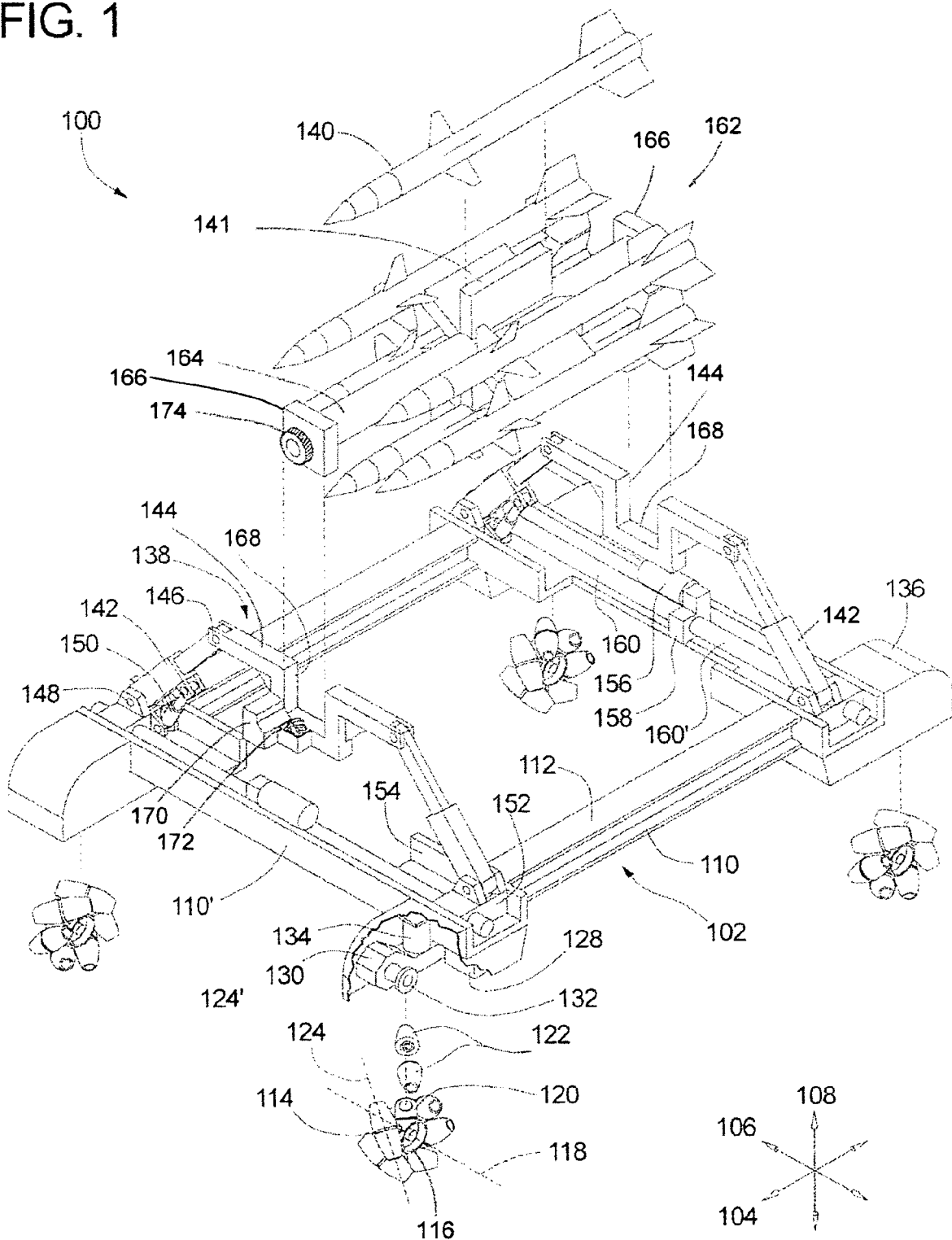


FIG. 2

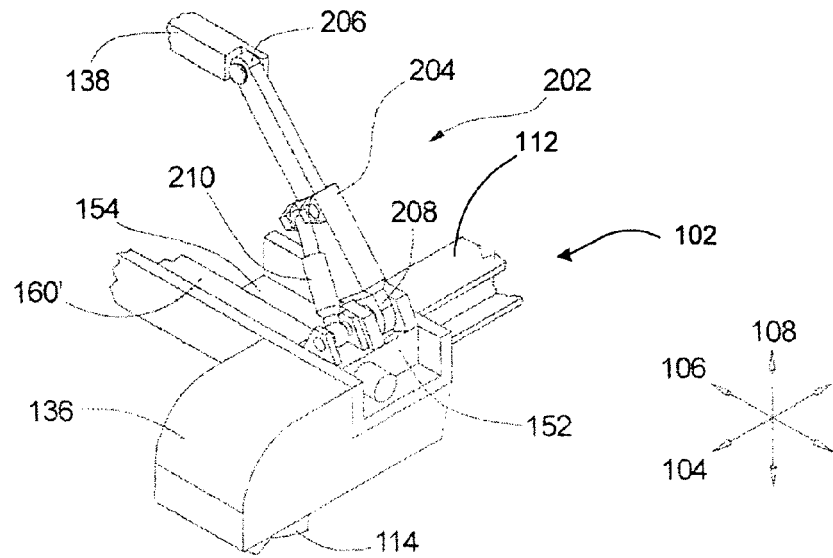


FIG. 3a

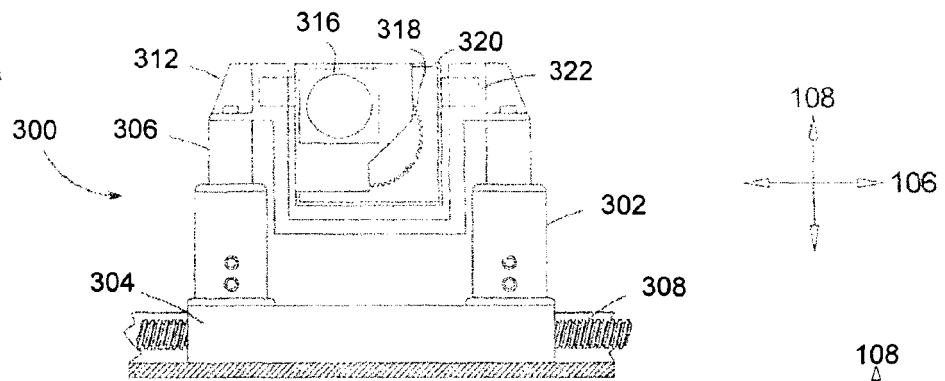


FIG. 3b

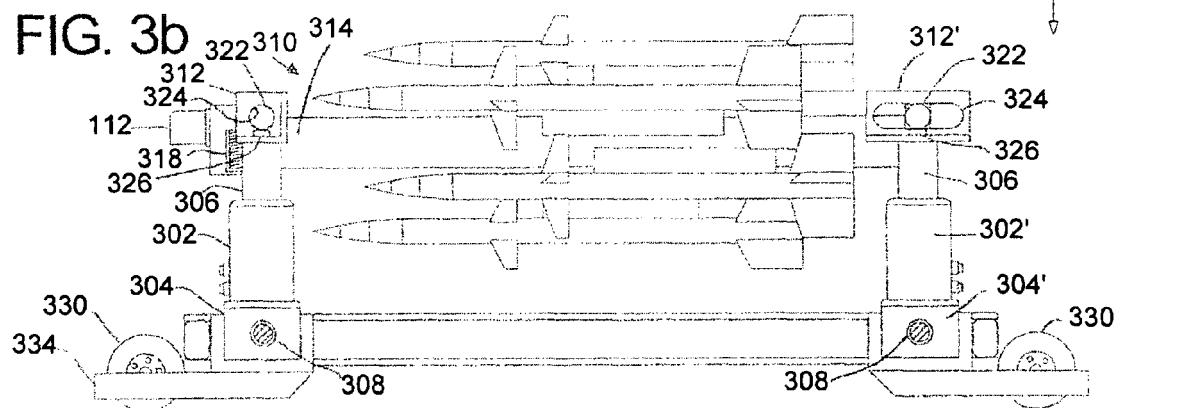


FIG. 4a

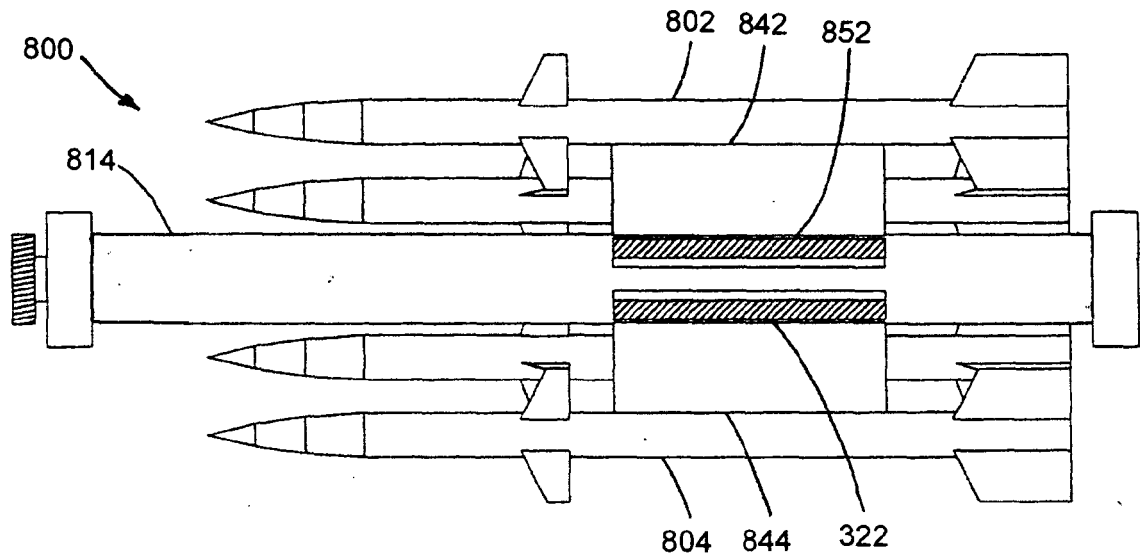


FIG. 4b

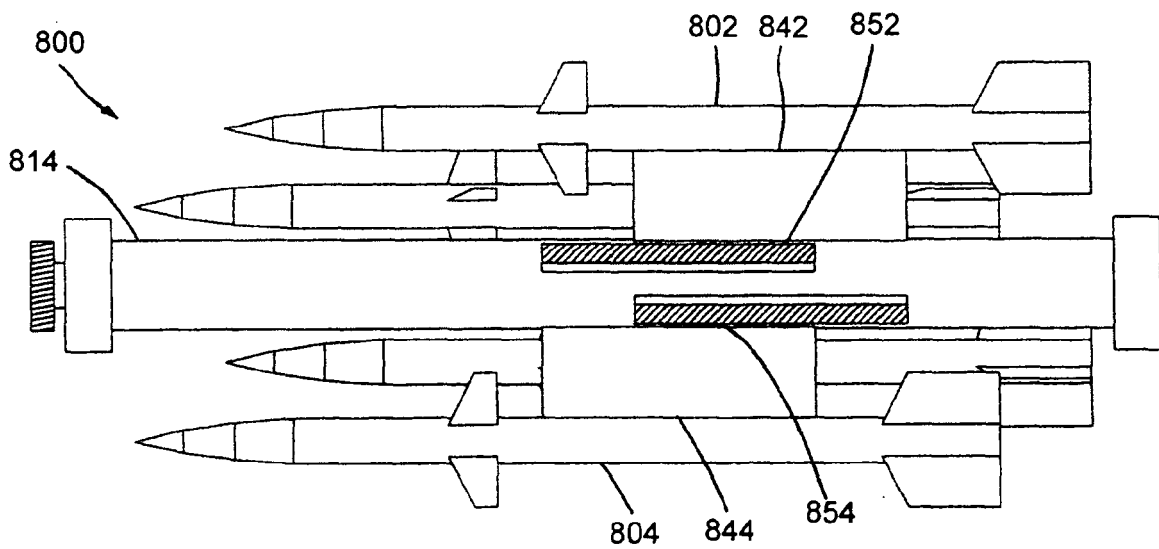


FIG. 7

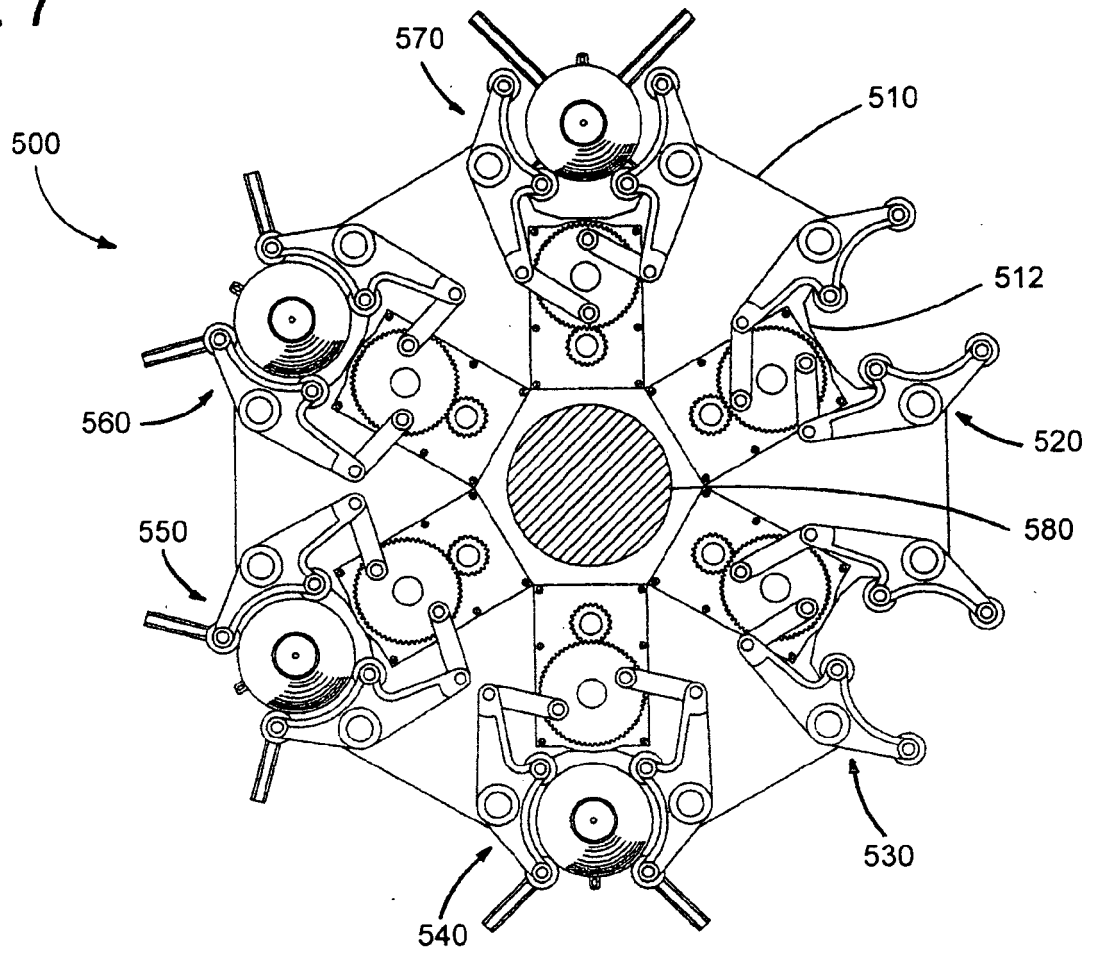


FIG. 6

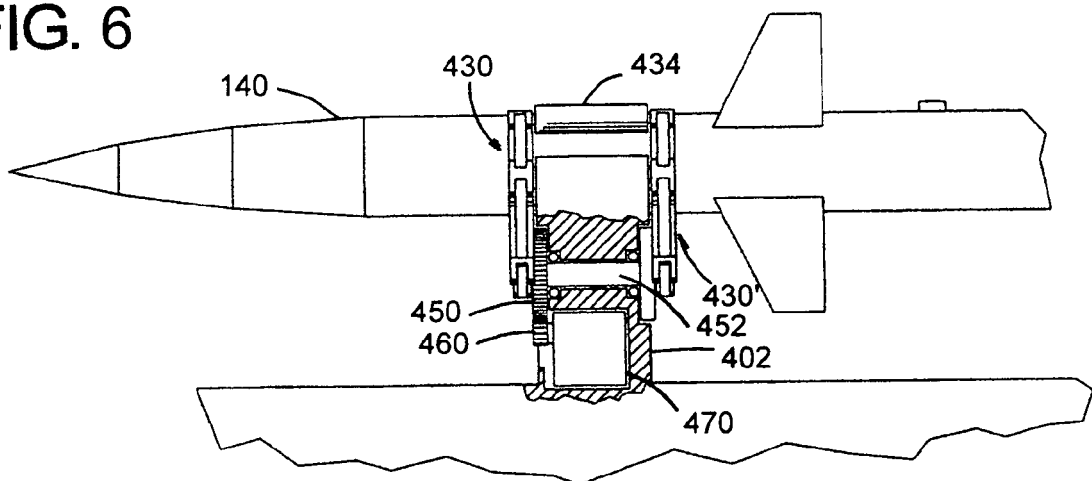


FIG. 8a

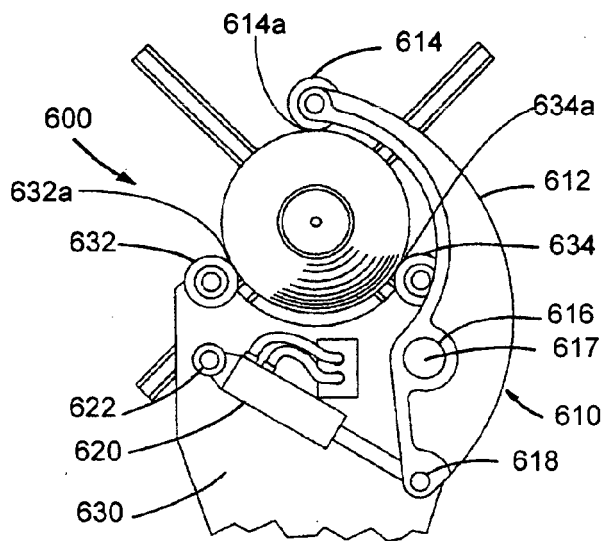


FIG. 8b

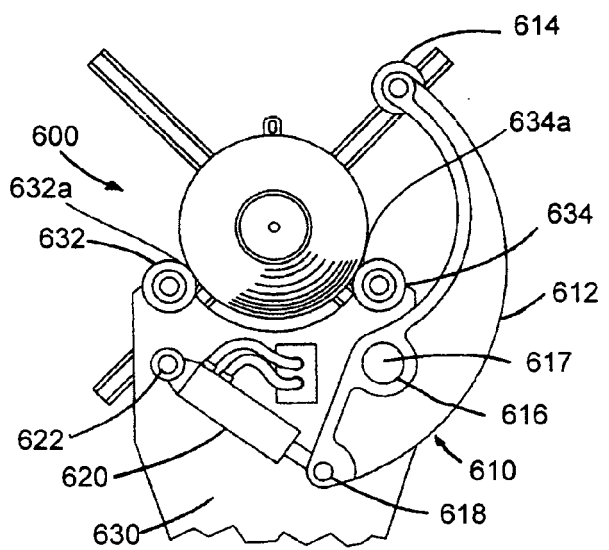


FIG. 9a

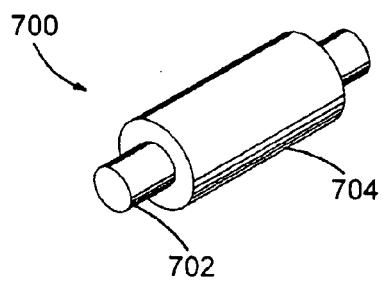


FIG. 9b

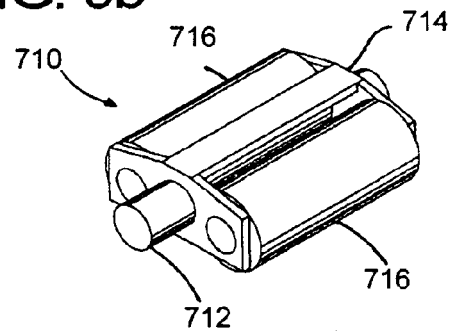


FIG. 9c

