A store ejection system that can be "blind-loaded" without the need to have physical access to the ejector rack. This invention provides the ability to carry certain unique weapon shapes that cannot be carried on current ejector racks due to the lack of access to the rack once the weapon is raised into position.
STORE EJECTOR RACK

BACKGROUND

[0001] 1. Field of the Invention

This invention relates generally to store carriers for mounting a releasable store on an aircraft and, more particularly, to a store ejection system capable of ejecting stores of various size and shapes.

[0002] 2. Background of the Invention

The store referred to herein may be used to contain munitions or to contain other material to be dropped from an aircraft. Military aircraft used to dispense bombs, rockets, and other stores in flight usually include racks located beneath the wings and fuselage, or in weapon bays designed to release the stores upon command.

[0003] At the time of target acquisition, a release mechanism is activated which results in mechanical release and subsequent forcible ejection of that weapon away from the aircraft. Presently, most state of the art bomb ejection racks utilize pyrotechnic (explosive) cartridges which, on ignition, generate high pressure gas for actuating the mechanical release mechanism, as well as for providing high pressure to ejection rams which forcibly eject the store from the aircraft.

[0004] Many new stores being developed cannot be carried on conventional stores ejection systems because these weapons typically have fins, strokes, or protrusions that may hide or blanket access to the ejector rack once the store is raised into position, especially in weapon bays where access is limited.

[0005] Current bomb ejection racks require direct access during the store loading process so that cartridges can be inserted, swaybraces can be tightened, and safety pins can be installed and/or removed. New generation weapon designs have larger fins as compared to previous weapon. Also, newer aircraft are being designed with smaller weapon bays. This combination results in minimal, to no, access being available to physically reach the bomb ejector rack. Loading of weapons has become cumbersome and time consuming. In some cases, the ability to carry certain types of weapons has been lost.

[0006] Accordingly, what is needed is a stores ejection system for mounting jettisonable stores on an aircraft, where access to the stores ejection system is not required.

SUMMARY OF THE INVENTION

[0007] The present invention provides a stores ejection system that can be “blind-loaded” without the need to have physical access to the ejector rack.

[0008] The invention provides the ability to carry certain unique weapon shapes that can not be carried on current ejector racks due to the lack of access to the rack once the weapon is raised into position. The present invention incorporates a pneumatic ejection system which eliminates the need for using pyrotechnic cartridges. Moreover, the present invention allows for non-manual tightening of swaybrace arms and eliminates the need to install and remove safety pins.

[0009] In one aspect of the invention, a stores ejection system is provided including an adjustable swaybrace configured to be moved between a free hanging position and a store secure position; and a tightening screw for containing movement of the store when the adjustable swaybrace is in the store secure position.

[0010] In another aspect of the invention, a stores ejection system is provided including an adjustable swaybrace configured to be moved between a free hanging position and a store secure position; a tightening screw for containing movement of the store when the adjustable swaybrace is in the store secure position; and a hook opening mechanism which secures the store when the adjustable swaybrace is in the store secure position.

[0011] In yet another aspect of the invention, a method is provided for mounting a store to an aircraft using a store ejection system. The method includes hoisting a store into contact with a swaybrace; moving the swaybrace between a free hanging position and a store secure position using an electro-mechanical actuation device; and adjusting a tightening screw for containing movement of the store when the swaybrace is in the store secure position.

[0012] In one aspect of the invention, a stores ejection system is provided including an adjustable swaybrace configured to be moved between a free hanging position and a store secure position; a tightening screw for containing movement of the store when the adjustable swaybrace is in the store secure position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings are included to provide further understanding of the invention, illustrate various embodiments of the invention, and together with the description serve to explain the principles and operation of the invention. In the drawings, the same reference numerals have the same reference numerals. The illustrated embodiment is intended to illustrate, but not to limit the invention. The drawings include the following Figures:

[0014] FIG. 1 is a simplified cross sectional view of an internal arrangement of a weapon ejector rack in accordance with an embodiment of the present invention;

[0015] FIGS. 2A and 2B are simplified illustrations of a swaybrace structure in accordance with an embodiment of the present invention;

[0016] FIG. 3 is a simplified cross sectional view of a swaybrace arm tightening mechanism in accordance with an embodiment of the present invention;

[0017] FIGS. 4A, 4B and 4C are simplified illustrations of a Safety Lock/Unlock mechanism in accordance with an embodiment of the present invention;

[0018] FIGS. 5A and 5B are simplified illustrations of components of forward and aft release systems in accordance with an embodiment of the present invention; and

[0019] FIGS. 6A-6D are exemplary illustrations of a remote control panel in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] FIG. 1 is a simplified cross sectional view of an internal arrangement of a weapon ejector rack 100 in accordance with an embodiment of the present invention. As shown in FIG. 1, the internal components of ejector rack 100 include fore and aft swaybrace structures ("structures") 102a and 102b (swaybrace structure 102b shown in cut-away cross-section), electro-mechanical actuators 112, safety lock...
mechanisms 104 and 106 (shown in left and right side views, respectively) and manual release motor 114. Each of these components has been designed to operate using an integration of electro-mechanical devices to drive the presently manually driven systems.

[0024] A pneumatic ejection system 108 is included in ejector rack 100 to provide energy for forcible ejection of store 110. As previously discussed, most weapon ejection systems now use pyrotechnic cartridges to provide energy for forcible ejection. Pneumatic ejection system 108 eliminates the need for using pyrotechnic cartridges. Instead, energy for forcible ejection is provided by high pressure air which is generated from an on-board compressor. In one embodiment, pressurization is automatic upon application of aircraft power to the ejector rack. An operational embodiment of an exemplary pneumatic ejection system is described in U.S. Pat. No. 5,583,312, which is herein incorporated by reference for all purposes.

[0025] FIGS. 2A and 2B illustrate cross-sectional end views of ejector rack 100 further illustrating an embodiment of forward swaybrace structure 102a before and after store loading. It should be understood that swaybrace structure 102a is identical to swaybrace structure 102a. Swaybrace structure 102a includes swaybrace arms 302 that extend out substantially perpendicular from a swaybrace arm 316 at about the center of swaybrace arms 302. Each swaybrace arm 302 further includes a tightening screw 308, which is used to position store 110 and counter movement of store 110.

[0026] In one embodiment, since store 110 typically has a substantially round shape, tightening screw 308 may be mounted at an angle to centerline 304 of ejector rack 100. The angled positioning of tightening screw 308 allows the tightening screw to be directed toward the center of store 110. In this manner, mounting pads 314 may make flush contact with store 110 when store 110 is raised into position. In addition, each mounting pad 314 may include the ability to swivel to further ensure that tightening screw 308 approximates a flush contact onto store 110.

[0027] In one embodiment, tightening screw 308 is adjustable between a full-up position 310 and a full-down position 312. Accordingly, depending on the type of store 110 to be mounted, tightening screw 308 may be adjusted to accept a given store 110 diameter. For example, if store 110 has a 16 inch diameter, then tightening screws 308 may be adjustable such that each mounting pad 314 contacts the surface of store 110 in a flush manner.

[0028] Swaybrace structure 102a also includes a structural housing 318 which defines a bore 320 that is positioned along centerline 304 of ejector rack 100. Bore 320 is configured to receive column 316 within housing 318. Thus, in one embodiment, column 316 may be moved in and out from housing 318 allowing swaybrace arm 302 to be moved vertically along centerline 304 a variable distance represented at 322.

[0029] In operation, as illustrated in FIG. 2A, column 316 may be placed in a hanged free position prior to the loading of store 110. As shown in FIG. 3, a swaybrace stop down 328 may be used to limit the “free hanging” travel of column 316 out from bore 320 when store 110 is not present.

[0030] Referring to FIG. 2B, store 110 is hoisted upward using ground equipment (not shown) that lifts store 110 upward to contact tightening screws 308. As store 110 continues to be hoisted, column 316 moves upward into housing bore 320 until suspension hooks 404a and 404b, shown in FIG. 1, engage and close around a complimentary attachment feature 330 located on store 110 to secure store 110 to ejector rack 100. Once suspension hooks 404a and 404b are closed, the ground equipment can be removed allowing the weight of store 110 to be supported by suspension hooks 404a and 404b.

[0031] In one embodiment, as shown in FIGS. 2B and 3, an electro-mechanical actuator 112 is used to rotate a threaded member 324, which acts like a screw jack, to tighten swaybrace arm 302 down against store 110 to secure store 110 from moving. Electro-mechanical actuator 112 may be any suitable motor, for example, a high torque gear drive motor. Once a particular tightening load is reached, motor 112 is stopped and store 110 is secure.

[0032] Referring now to FIGS. 4A, 4B and 4C, safety lock mechanism 106 is shown, including a Safety Lock/Unlock mechanism 400, suspension hook 404, and hook over-center latching system 408 (FIG. 1) in accordance with an embodiment of the present invention. Both suspension hook 404 and hook over-center latching system 408 are conventional mechanisms, the operations of which are well known to those of ordinary skill in the art.

[0033] As shown in FIG. 4A, Safety Lock/Unlock mechanism 400 further includes, safety shaft 402, and an electro-mechanical actuator 406, which may be a solenoid or a motor, used to rotate safety shaft 402 to either a safety lock position or a safety unlock position.

[0034] In one embodiment (as illustrated in FIG. 1), separate safety shafts 402a and 402b are designed to engage with separate hook over-center latching systems 408 (not shown forward in FIG. 1) and forward suspension hook 404a and aft suspension hook 404b, respectively, to ensure that safety shafts 402a and 402b lock only the suspension hook that it is made to engage.

[0035] In operation, referring again to FIGS. 4A, 4B and 4C electro-mechanical actuator 406 is operated to provide a rotational movement to safety shaft 402. When rotated to a first position as shown in FIG. 4A, a feature 410 of safety shaft 402 engages a feature 412 of hook over-center latching system 408 to block movement of hook over-center latching system 408 and thus prevent the opening of suspension hook 404.

[0036] Upon further rotation of safety shaft 402 to a second position as shown in FIG. 4B, feature 412 from hook over-center mechanism 408 disengages from feature 410 of safety shaft 402 allowing hook over-center mechanism 408 to rotate. Accordingly, free rotation of hook over-center mechanism 408 allows suspension hook 404 to open as shown in FIG. 4C.

[0037] Prior systems typically use a “manual release” system to offload a store 110. This is typically done when an aircraft returns from a mission and store 110 has not been ejected or used over a target. Prior systems use a manual method to release the suspension hooks, which requires physical access to the rack.

[0038] The present invention provides a release system 500, shown in FIG. 1, where access to ejector rack 100 is not required. The following exemplary embodiment of release system 500 is described as if Safety Lock/Unlock mechanism 400 is in the second position (as shown in FIG. 4B) to allow the opening of suspension hooks 404. It should be understood that release system 500 may be used with ejector rack 100 whether or not Lock/Unlock mechanism 400 is a part of the ejector system.

[0039] Release system 500 operates to release both forward suspension hook 404a and aft suspension hook 404b (FIG. 1).
Thus, for clarity, FIG. 5A provides an illustration of the components used to release forward suspension hook 404a (hereafter forward release system 500a) and FIG. 5B provides an illustration of the components used to release aft suspension hook 404b (hereafter aft release system 500b).

As shown in FIG. 5A, in one embodiment, forward release system 500a includes hook opening striker crank 510, linear actuator 506, hook opening link 508a and hook opening crank 510.

In operation, hook opening striker crank 504 is coupled to shaft 502, using for example, pin 512. Retraction of linear actuator 506 imparts rotation to shaft 502 causing hook opening striker crank 504 to rotate. As hook opening striker crank 504 rotates, a feature 516 on hook opening striker crank 504 contacts boss 514 on hook opening crank 510 and forces hook opening crank 510 to rotate. When hook opening crank 510 rotates it drives hook opening link 508a. Hook opening link 508a is coupled to over-center latching system 408 (see FIG. 1) and thus movement of hook opening link 508a rotates over-center latching system 408 resulting, in the opening of suspension hook 404a.

As shown in FIG. 5B, in another embodiment, aft release system 500b includes hook opening striker crank 530, hook opening link 508b, and hook opening crank 536, used with linear actuator 506.

In operation, retraction of linear actuator 506 imparts rotation into hook opening striker crank 530 causing a feature on hook opening striker crank 530 to make contact with linkage pin 512 and impart rotation into hook opening striker crank 530. When hook opening striker crank 530 rotates it moves hook opening link 508b. Hook opening link 508b is coupled to over-center latching system 408 (see FIG. 1) and thus movement of hook opening link 508b rotates over-center latching system 408 resulting, in the opening of suspension hook 404b.

Generally, the electro-mechanical actuators described above as used in the present invention are commanded to function by electrical switch logic from a remote panel. As shown in FIGS. 6A-6D, remote panel 602 may be a combination of switches, indicators and logic that may be used to drive various actuated mechanisms associated with ejector rack 100. Remote panel 602 may be located in any convenient location on the aircraft and wired to the electro-mechanical actuators. Alternatively, remote panel 602 may be portable and have mating connectors which allow remote panel 602 to be plugged in to ejector rack 100 when loaded at any convenient location. Remote panel 602 may also be wireless and use wireless technology.

In one exemplary embodiment, shown in FIG. 6A, remote panel 602 includes lock status lights 604, forward lock status indicator light 605, aft lock status indicator lights 607, forward hook status indicator lights 606, aft safety lock control switch 612, forward safety lock control switch 614, sway brace operation/tighten control switch 608 and manual release switch 610.

FIG. 6A depicts remote panel 602 configuration as store 110 is hoisted to couple to ejector rack 100 (FIG. 1). Aft lock status indicator lights 604 and forward lock status indicator lights 605 indicate unlocked while aft lock status indicator lights 607 and forward hook status indicator lights 606 indicate open. Aft safety lock control switch 612 and forward safety lock control switch 614 are in the unlocked position. Swaybrace operation loosen/tighten control switch 608 is in the loosen position. Manual release switch 610 is in the closed position.

FIG. 6B depicts remote panel 602 configuration as forward and aft suspension hooks 404a and 404b are engaged complementarily attachment feature 330 of store 110 (FIG. 1). Forward and aft suspension hooks 404a and 404b are closed. Aft lock status indicator lights 604 and forward lock status indicator lights 605 indicate unlocked. Aft hook status indicator lights 607 and forward hook status indicator lights 606 indicate closed. Aft safety lock control switch 612 and forward lock control switch 614 are in the locked position. Swaybrace operation loosen/tighten control switch 608 is in the locked position. Manual release switch 610 is in the closed position.

FIG. 6C depicts remote panel 602 configuration as forward and aft suspension hooks 404a and 404b are locked (FIGS. 4c, 4b and 4c). Aft lock status indicator lights 604 and forward lock status indicator lights 605 indicate closed. Aft hook status indicator lights 607 and forward hook status indicator lights 606 indicate closed. Aft safety lock control switch 612 and forward safety lock control switch 614 are in the locked position. Swaybrace operation loosen/tighten control switch 614 are in the locked position. Manual release switch 610 is in the closed position.

FIG. 6D depicts remote panel 602 configuration as an operator engages the swaybrace structure 102a (FIGS. 1, 2a, 2b and 3). Aft lock status indicator lights 604 and forward hook status indicator lights 606 indicate closed. Aft safety lock control switch 612 and forward safety lock control switch 614 are in the locked position. Swaybrace operation loosen/tighten control switch 608 is in the tightest position. Manual release switch 610 is in the closed position.

Typically, visual inspection of forward and aft suspension hooks 404a and 404b have been made to determine if suspension hooks 404a and 404b are closed. As visual inspection may not be possible with certain stores, the present invention provides independent Safety Lock/Unlock mechanisms 400 at each suspension hook. Referring to FIG. 4A, Safety Lock/Unlock mechanism 400 is configured such that safety shaft 402 can only be placed to “locked” or “safe” position when suspension hook 404 is fully closed. That is, feature 410 of safety shaft 402 can only be engaged with feature 412 of hook over-center latching system 408 if suspension hook 404 is fully closed. Accordingly, this configuration provides a means to determine if suspension hook 404 is closed absent the ability to make a visual inspection.

It will be apparent to those skilled in the art that various modifications and variations can be made to the present invention without departing from the spirit and scope of the invention. Thus it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

1. A stores ejector rack comprising:
   an adjustable swaybrace structure including a first swaybrace arm and a second swaybrace arm each extending substantially perpendicular to a centerline of the adjustable swaybrace structure, a plurality of tightening screws disposed on each of the swaybrace arms to position a store and counter movements of the store while mounted to the adjustable swaybrace structure;
   a first suspension hook and a second suspension hook for releasably retaining the store, the first and second sus-
a second adjustable swaybrace arm configured to be moved between a store free hanging position and a store secure position; and

10. (canceled)

11. A stores ejection system comprising:

a first adjustable swaybrace arm configured to be moved between a store free hanging position and a store secure position, and including a plurality of tightening screws for containing movement of the store;

a second adjustable swaybrace arm configured to be moved between a store free hanging position and a store secure positions and including a plurality of tightening screws for containing movement of the store;

a first threaded member driven by a first electro-mechanical actuator to cause the first adjustable swaybrace arm to move between the store free hanging position and the store secure position;

a second threaded member driven by a second electro-mechanical actuator to cause the second adjustable swaybrace arm to move independently from the first adjustable swaybrace member between the store free hanging position and the store secure position; and

at first and second suspension hooks coupled to a suspension hook opening system including a plurality of linking members driven by first and second linear actuators, wherein the linear actuators move the at least one suspension hook between an open position and a closed position to secure the store, and

wherein the first and second electro-mechanical actuators are commanded to function by electrical switch logic from a remote panel.

12. (canceled)

13. A stores ejector rack as in claim 11, wherein said plurality of tightening screws are positioned at an angle relative to a centerline of said ejection system.

14. A stores ejector rack as in claim 11, wherein said plurality of tightening screws each comprise a mounting pad that is configured to swivel to allow the mounting pad to sit substantially flush on the store.

15. (canceled)

16. A stores ejector rack as in claim 11, wherein said suspension hook opening system comprises a safety lock mechanism that provides an indication that the at least one suspension hook is in a closed position.

17. A method for releasing a store from a store ejector rack for the purpose of ground store removal, said method comprising:

moving a first swaybrace arm vertically between a store secure position where the store is in contact with a plurality of tightening screws disposed on the swaybrace arm and a free hanging position where the store is not in contact with the plurality of tightening screws using a first actuation device;

moving a second swaybrace arm vertically and independently from the first swaybrace arm between a store secure position where the store is in contact with a plurality of tightening screws disposed on the second swaybrace arm and a free hanging position where the store is not in contact with the plurality of tightening screws using a second actuation device;

adjusting a plurality of linking members to open a first suspension hook and a second suspension hook used to release said store using at least one linear actuation device; and

controlling the first and second actuation devices by electrical switch logic from a remote panel.

18. (canceled)

19. The method as in claim 17, wherein said first and second actuation devices each drive a threaded member moving said first swaybrace arm and said second swaybrace arm between said free hanging position and said store secure position.

20. (canceled)