EJECTOR RACK

TECHNOLOGICAL FIELD

The presently disclosed subject matter relates to devices for carrying and releasing stores from a vehicle, in particular to ejector racks for carrying and releasing a store with respect to an air vehicle. The presently disclosed subject matter in particular relates to ejector racks that are actuated using pressurized gas.

BACKGROUND ART

References considered to be relevant as background to the presently disclosed subject matter are listed below:

- GB 2,414,782
- US 4,050,656
- WO 2016/199132

Acknowledgement of the above references herein is not to be inferred as meaning that these are in any way relevant to the patentability of the presently disclosed subject matter.

BACKGROUND

Stores, such as for example bombs and missiles, are commonly carried by air vehicles, with a requirement to enable the stores to be released when required by the pilot or other aircrew. Conventionally, such carrying and release functions are provided by devices for carrying and releasing stores, typically in the form of ejector racks, in which actuation thereof to release the stores is by ignition of gas cartridges to provide a pressurized gas.

By way of non-limiting example, GB 2,414,782 discloses an ejector release system for an aircraft-mounted store, which comprises a reservoir for containing a pre-

charged gaseous ejection medium, an actuation cylinder connected to the reservoir for effecting ejection of the store and a control valve between the reservoir and actuation cylinder, in which a snap-action pressure relief valve is mounted between the control valve and cylinder to allow excess pressure in the system downstream of the reservoir to be vented or diverted when the pressure exceeds a predetermined threshold pressure. The pressure relief valve may include a piston which is stepped to define an annular shoulder between larger and smaller diameter parts the shoulder constituting a marginal surface area which causes the piston to be urged towards the forwards position under gas input pressure, a vent passage which is out of registration with the inlet and outlet passages at the rearwards position of the piston but is in registration in the forwards position being provided in the piston. One or more resiliently-loaded balls urged into engagement with a corresponding detent formed in the piston in the rearwards or pressure-retaining position provide the snap action.

Further by way of non-limiting example, US 4,050,656 discloses an ejector rack that is attachable to an aircraft and is for supporting and selectively releasing and/or ejecting a store that is carried internal of the aircraft, i.e., in a bomb bay. The store can be released from the ejector rack, and from the aircraft, in either of two ways, namely: by pushing on a manually operated release handle; or, by forced ejection, the only way used during flight of the aircraft. Forced ejection is achieved by sending an electrical impulse to either or both of two cartridges in the breech of the ejector rack, igniting the cartridge(s). Gas is generated thereby; and, the resultant pressure that is built up in a gas system in the rack provides force that acts upon an unlocking piston, causing the piston to move out of its "locked" position. In turn, the moving piston provides a force on a slide, rotating a latch that allows the main linkage bellcrank to rotate and thus to open two hooks which are holding the store, thereby releasing the suspended store. Concurrently, gas pressure is manifolded to two sway brace ejection piston cylinders, and the ejection pistons therein are forcefully extended, causing positive and forcible ejection of the store by the ejection pistons.

GENERAL DESCRIPTION

According to a first aspect of the presently disclosed subject matter, there is provided a support and release device for releasably supporting a store, the store having at least one lug for enabling selective removable engagement of the store with respect to the device, the device comprising a housing accommodating:

a lug engagement release system, comprising a hook element;

an actuator system, operatively coupled to the lug engagement release system; and

a safety system comprising a safety lock, said safety lock being configured for selectively coupling or uncoupling with respect to at least the lug engagement release system to alternately provide a coupled mode and a decoupled mode, respectively,

wherein:

the lug engagement release system is configured for alternately providing:

- an engaged configuration, in which the lug engagement release system is, or can be engaged, i.e. is capable of being in an engaged relationship, with respect to the lug via said hook element, and
- a disengaged configuration, in which the lug engagement release system is selectively disengaged with respect to the lug, responsive to selective operation of the actuator system wherein the actuator system selectively provides pressurized gas to said lug engagement release system, concurrent with the safety lock being in uncoupled mode;

wherein:

- in the coupled mode the safety lock is coupled with respect to the lug engagement release system such as to prevent the lug engagement release system, in the engaged configuration, from providing the disengaged configuration, irrespective of operation of the actuator system; and
- in the decoupled mode the safety lock is decoupled with respect to the lug engagement release system enabling the lug engagement release system to provide the disengaged configuration from the engaged configuration responsive to operation of the actuator system;

and wherein the safety system is configured for enabling venting of the pressurized gas from the actuator system to an external environment under conditions where the actuation system is operated concurrent with the safety lock being in coupled mode.

For example, said actuator system comprises a fluid conduit connectable to a pressurized gas source, the pressurized source configured for providing pressurized gas to said lug engagement release system during operation of said device, and wherein said safety system comprises a venting arrangement configured for providing fluid communication between said fluid conduit and the external environment when the safety lock is in said coupled mode, and to prevent fluid communication between said fluid conduit and the external environment when the safety lock is in uncoupled mode. Additionally, for example, said actuator system comprises an actuation piston reciprocably mounted with respect a cylinder, the cylinder being in fluid communication with said fluid conduit, the piston being displaceable with respect to the cylinder responsive to said pressurized gas being applied to the piston and concurrent with the safety lock being in uncoupled mode. Additionally, for example, the piston is operatively coupled to the lug engagement release system, such that as the piston is displaced with respect to the cylinder between a first position and a second position, the lug engagement release system goes from the engaged configuration to the disengaged configuration.

Additionally or alternatively, for example, said safety system comprises a venting arrangement comprising at least one fluid venting conduit, each said fluid venting conduit having at least one inlet in selective fluid communication with said fluid conduit, and at least one outlet in selective fluid communication with the external environment.

Additionally, for example, for at least one said fluid venting conduit, and concurrent with the safety lock being in said coupled mode, the respective said at least at least one inlet is in free fluid communication with said fluid conduit and at least one outlet is in selective fluid communication with the external environment.

Additionally or alternatively, for example, for the respective at least one said fluid venting conduit, and concurrent with the safety lock being in said uncoupled mode there fluid communication is prevented between said at least at least one inlet and said fluid conduit.

Additionally or alternatively, for example, for the respective said at least one said fluid venting conduit, and wherein concurrent with the safety lock being in said uncoupled

mode fluid communication is prevented between said at least one outlet and the external environment.

Additionally or alternatively, for example, the respective said fluid venting conduit, the respective said at least one inlet, and the respective at least one outlet are provided in said piston, and wherein said cylinder comprises at least one cylinder opening corresponding to each said outlet. Additionally, for example, said cylinder openings are located on the cylinder at respective positions such as to be in registry with said outlet openings when said piston is at or close to said first position thereby providing is free fluid communication between the external environment and the fluid conduit, via the fluid venting conduit and cylinder openings.

Additionally or alternatively, for example, said cylinder openings are located on the cylinder at respective positions such as not to be in registry with the outlet openings when the piston has moved significantly away from said first position in a direction towards said second position, and until said second position to thereby block fluid communication between external environment and the fluid conduit.

Additionally or alternatively, for example, said venting arrangement further comprises a plunger member reciprocably mounted with respect to plunger casing, the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position and a second plunger positon. Additionally, for example, a second said fluid venting conduit, a respective second said at least one inlet, and a respective second at least one outlet are provided in said plunger member, and wherein said plunger casing comprises at least one casing opening corresponding to each said second outlet. Additionally, for example, said casing openings are located on the plunger casing at respective positions such as to be in registry with said second outlet openings when said plunger member is at or close to said first plunger position thereby providing is free fluid communication between the external environment and the fluid conduit, via the second fluid venting conduit and casing openings. Additionally or alternatively, for example, said casing openings are located on the plunger casing at respective positions such as not to be in registry with the second outlet openings when the plunger member has moved significantly away from said first plunger position in a

direction towards said second plunger position, and until said second position to thereby block fluid communication between external environment and the second fluid conduit.

Additionally or alternatively, for example, said plunger member comprises a plunger head and lower projection.

Additionally or alternatively, for example, the venting arrangement further comprises a biasing spring that biases the plunger member in a direction towards an extraction axis of the safety lock.

Additionally or alternatively, for example, in said first plunger position, and an upper end of said plunger member projects out of the plunger casing and into the fluid conduit, such as to allow free fluid communication between the second said inlets and the fluid conduit. Additionally, for example, in said second plunger position, the upper end is retracted into the plunger casing, thereby sealing off the plunger casing from the fluid conduit, and such as to prevent fluid communication between the second said inlets and the fluid conduit.

In at least another example, for example, said venting arrangement comprises a plunger member reciprocably mounted with respect to plunger casing, the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position and a second plunger positon. Additionally, for example, said fluid venting conduit, said at least one inlet, and said at least one outlet are provided in said plunger member, and wherein said plunger casing comprises at least one casing opening corresponding to each said second outlet. Additionally, for example, said at least one outlet are provided in said plunger member such as to be in registry with said outlet openings when said plunger member is at or close to said first plunger position thereby providing is free fluid communication between the external environment and the fluid conduit, via the fluid venting conduit and said casing openings.

Additionally or alternatively, for example, said casing openings are located on the plunger casing at respective positions such as not to be in registry with the outlet openings when the plunger member has moved significantly away from said first plunger position in a direction towards said second plunger position, and until said second position to thereby block fluid communication between external environment and the fluid conduit.

Additionally or alternatively, for example, said plunger member comprises a plunger head and lower projection.

Additionally or alternatively, for example, the venting arrangement further comprises a biasing spring that biases the plunger member in a direction towards an extraction axis of the safety lock.

Additionally or alternatively, for example, in said first plunger position, and an upper end of said plunger member projects out of the plunger casing and into the fluid conduit, such as to allow free fluid communication between the said inlets and the fluid conduit. Additionally, for example, in said second plunger position, the upper end is retracted into the plunger casing, thereby sealing off the plunger casing from the fluid conduit, and such as to prevent fluid communication between the said inlets and the fluid conduit.

Additionally or alternatively, for example, the device is further configured for selectively ejecting forcibly the store therefrom, the device comprising an ejector system comprising at least one ejection module, each ejection module configured for providing an ejection force generated under action of gas pressure provided by the actuation system. Additionally, for example, each ejection module comprising a tubular housing accommodating a telescopic plunger element comprising an end wall at a first longitudinal end thereof having a small opening, the telescopic plunger element being closed at a second longitudinal end thereof. Additionally, for example, said second longitudinal end comprises a padded abutment element, configured for abutting against the stores when this is engaged with the device.

Additionally or alternatively, for example, the device further comprises at least one sway braces.

Additionally or alternatively, for example, said lug engaging and releasing mechanism comprises a first kinematic chain and a second kinematic chain. Additionally, for example, said first kinematic chain comprises a first stressed link, a coupling plate, a first link, and said hook element. Additionally, for example, said second kinematic chain comprises an anvil member, a second link, a pivoting member, and a second stressed link. Additionally, for example, said coupling plate and said anvil member are pivotable mounted to said housing coaxially about a pivot axis.

According to a second aspect of the presently disclosed subject matter, there is provided an air vehicle comprising at least one support and release device as defined in herein regarding the first aspect of the presently disclosed subject matter.

According to a third aspect of the presently disclosed subject matter, there is provided a method for releasably supporting a store, the store having at least one lug, the method comprising:

(a) providing at least one support and release device as defined in herein regarding the first aspect of the presently disclosed subject matter; and

(b) engaging the lug with respect to the lug engagement release system to thereby urge the lug engagement release system to the engaged configuration;

(c) coupling the safety lock with respect to the device to provide the coupled mode.

For example, the method further comprises:

(d) decoupling the safety lock with respect to the device to provide the decoupled mode;

(e) selectively operating the actuator system to thereby actuate said lug engagement release system to enable the lug engagement release system to adopt the disengaged configuration, thereby enabling the lug engagement release system to release the lug therefrom.

A feature of at least one example of the presently disclosed subject matter is that a support and release device can be designed to cope with a design condition in which the pressure within the actuator system, in particular the fluid conduit thereof, begins to increase, for example as a result of the actuation system being actuated (either by accident or because of a malfunction, for example). In such a design condition, the safety system can provide an escape for the gas pressure, which otherwise (i.e., under alternative conditions in which the safety system is absent or non-operational) would increase, for example to the actuation pressure or greater.

Another feature at least one example of the presently disclosed subject matter is that the safety system can prevent the pressure within the actuator system, in particular the fluid conduit thereof, from reaching the actuation pressure and in particular from

significantly exceeding the increasing actuation pressure, and thus enables the housing to be designed with a considerably reduced safety margin, as regards capability for holding large internal pressure, as could otherwise be required under such alternative conditions.

Another feature at least one example of the presently disclosed subject matter is that the safety system can be configured such that at the aforementioned design condition, shortly after such an event of the actuation system being actuated while the safety lock is concurrently in coupled mode, the pressure within the fluid conduit of the actuator system causes full displacement of the piston to be resisted by the lug engagement release system, which in turn is effectively locked by the safety lock when in coupled mode.

Another feature at least one example of the presently disclosed subject matter is that the safety system can be configured such that at the aforementioned alternative conditions with the safety lock in coupled mode could otherwise result in excessive pressure buildup within the actuator system.

Another feature at least one example of the presently disclosed subject matter is that the safety system can be configured such that at the aforementioned alternative conditions with the safety lock in coupled mode could otherwise result in excessive loads being applied to the hook element (and therefrom to the stores) and/or excessive loads being applied to the stores via the ejector system.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better understand the subject matter that is disclosed herein and to exemplify how it may be carried out in practice, examples will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 shows in aft/top/side isometric view a support and release device according to a first example of the presently disclosed subject matter, in engaged configuration with a store.

Fig. 2 shows in front/top/side isometric view the example of Fig. 1 with the store removed.

Fig. 3 shows in front/top/side isometric cross-sectional view the example of Fig. 2.

Fig. 4 shows in transverse cross-sectional view the example of Fig. 2, taken along section J-J.

Fig. 5 shows in transverse cross-sectional view a detail of the example of Fig. 4.

Fig. 6(a) shows in transverse cross-sectional view a detail of the example of Fig. 4 in which the lug engagement release system is in engaged configuration; **Fig. 6(b)** shows in transverse cross-sectional view the detail of the example of Fig. 6(a) in which the lug engagement release system is in disengaged configuration; **Fig. 6(c)** shows in transverse cross-sectional view the detail of the example of Fig. 6(a) in which the lug engagement release system has just begun to go move from engaged configuration; **Fig. 6(d)** shows in transverse cross-sectional view the detail of the example of Fig. 6(a) in which the anvil member locks with the pivot plate.

Fig. 7 shows in transverse cross-sectional view the example of Fig. 4 in which the lug engagement release system is in disengaged configuration and in which the ejector system has been actuated.

Fig. 8 shows in cross-sectional view the example of Fig. 4, taken along section K-K.

Fig. 9 shows in cross-sectional view a support and release device according to a second example of the presently disclosed subject matter.

Fig. 10 shows in transverse cross-sectional view a detail of the example of Fig. 9 in which the lug engagement release system is in engaged configuration and the safety lock is in coupled mode.

Fig. 11 shows in transverse cross-sectional view the example of Fig. 10 in which the safety lock is in uncoupled mode.

DETAILED DESCRIPTION

Referring to Figs. 1 to 5 a support and release device (also referred to interchangeably herein as a suspension and release device, and/or also referred to interchangeably herein as a carrying and release device) according to a first example of the presently disclosed subject matter, generally designated **100,** comprises a lug engagement release system **300**, actuation system **600**, and safety system **700** comprising safety lock **799**.

As will become clearer herein, the lug engagement release system **300** is operatively coupled to actuator system **600**.

Also as will become clearer herein, the safety lock **799** is configured for selectively, and alternately, coupling and decoupling with respect to at least the lug engagement release system **300** to provide a coupled mode and a decoupled mode, respectively.

Furthermore the lug engagement release system **300** is configured for:

- selectively engaging a lug (for example, of a store) in an engaged configuration; and
- selectively disengaging the lug from the engaged configuration to provide a disengaged configuration (the disengaged configuration allowing for release of the store) in response to selective actuation of lug engagement release system **300** via the actuator system **600**, concurrently with the safety lock **799** being in decoupled mode.

Also as will become clearer herein:

- when the safety lock **799** is in coupled mode, the lug engagement release system **300** is locked and is thereby prevented from going from the engaged configuration to the disengaged configuration, irrespective of operation of the actuator system **600**; and
- when the safety lock **799** is in decoupled mode, the lug engagement release system **300** is thereby unlocked and is thereby enabled to go from the disengaged configuration to the engaged configuration responsive to operation of the actuator system **600**.

Also as will become clearer herein, the actuator system **600** is configured for being actuated based on an actuation pressure **AP** being applied thereto, and safety system **700** is configured for preventing said actuation pressure **AP** being applied to the actuator system **600** when the safety lock **799** is in coupled mode.

In the Figures, the directional designations "Fore", "Aft", “Side”, "Up" and "Down" are shown, together with an arrow for each designation, to facilitate comprehension. Referring to an orthogonal axes system (x-y-z), the fore and aft directions are parallel to a longitudinal axis “x”; the side directions are parallel to the lateral axis “z”; the up and down directions are parallel to the vertical axis “y”. However, it is to be noted that the above directional designations are for ease of comprehension and are not necessarily limiting.

The support and release device **100** finds particular application in the form of an ejector rack (and is thus interchangeably referred to herein as an ejector rack, or as a stores ejector rack, or as a rack), for carrying a store, on or in an air vehicle, and in particular for releasably supporting such a store. According to a first aspect of the presently disclosed subject matter, the support and release device **100** is configured for carrying the store in suspended configuration, and for selectively releasing the store from the air vehicle.

For example, such a store can be a bomb, missile, rocket, external fuel tank, and so on, and an example thereof is illustrated in Fig. 1 and designated with the reference numeral **10**. The store **10** is in any case characterized in being equipped with at least one lug **15** (Fig. 4), by which the store **10** is releasably engaged to and suspended from, i.e., with respect to, the device **100.** In this example, the store **10** has a single lug **15**, and thus the device **100** only requires a single lug engagement release system **300,** as will become clearer herein. However, in alternative variations of this example, the store may instead have several lugs, and the support and release device can correspondingly comprise a similar number of lug engagement release system **300**, for example.

For the purpose of facilitating comprehension of the presently disclosed subject matter, an example of engagement release mechanism **300**, which is per se novel, is disclosed below.

Referring in particular to Figs. 2 and 3, the device **100** comprises a housing **110,** including two parallel laterally spaced side plates (also referred to interchangeably herein as

side walls or side panels) **120, 130,** integrally connected at the forward longitudinal ends thereof to forward end block **140** and aft end block **150,** respectively to form a box-like structure. In alternative variations of this example, the two parallel laterally spaced side plates **120, 130,** are otherwise non-integrally connected at the forward longitudinal ends thereof to forward end block **140** and aft end block **150,** respectively, for example via welding, screws or other fasteners, to form the box-like structure.

A bottom plate (not shown) can optionally be provided between the lower edges of the two side plates **120, 130,** having an opening in registry with hook element **320,** to enable a lug **15** of the store (not shown in Figs. 2 and 3) to be inserted from outside the device **100** into the space **Q** between the side plates **120, 130** and engage vertically with hook element **320.**

The housing **110** accommodates lug engagement release system **300.** Referring to Figs. 4 and 5 in particular, lug engagement release system **300** comprises hook element **320** pivotably mounted with respect to side plates **120, 130** at about lateral pivot axis **355**, via pin **357**, to allow pivoting of the hook element **320** about lateral pivot axis **355.** The lateral pivot axis **355** is fixed with respect to the housing **110.**

Hook element **320** comprises a C-shaped or U-shaped engagement portion **322,** defined by lower arm **321,** base **323** and upper arm **325,** which together partially circumscribe a space **326.** The lower arm **321** is generally parallel to the upper arm **325,** and facing in a general aft direction, and pivot axis **355** is located proximal to the connection between the upper arm **325** and the base **323.** The hook element **320** further comprises an arm extension **330** that projects generally aft from upper arm **325**, i.e., in a direction opposed to that of the lower arm **321** or upper arm **325**. The extension **330** is pivotably connected at the end thereof to a first end **351** of a first link **350** via pin **353**.

The upper arm **325** of hook element **320** extends in a forward direction such as to enable contact between the lug and the arm in the "open" configuration shown in Fig. 6(b), when the lug engagement release system **300** is in the disengaged configuration.

The lug engagement release system **300** further comprises a coupling plate **360**, pivotably mounted with respect to side plates **120, 130** about pivot axis **365** via a pin**,** to allow pivoting thereof about lateral pivot axis **365,** which is fixed with respect to the housing

110. The coupling plate **360** comprises a first arm **361** radially projecting outwardly with respect to pivot axis **365**, and a second arm **362** also radially projecting outwardly with respect to pivot axis **365** but angularly displaced from the first arm by an angle θ. In this example, angle θ is in the range of 20° and 160°, and more specifically about 90°.

The free end **366** of the first arm **361** is pivotably connected to the second end **352** of first link **350** via pin **356**.

The free end **336** of second arm **362** is pivotably connected to a first stressed link **340** at its free end **346** via pin **349.**

The first stressed link **340** is pivotably mounted between side plates **120, 130** about lateral pivot axis **345** via a pin, to allow pivoting thereof about lateral pivot axis **345,** which is fixed with respect to the housing **110.** The free end **346** of the link **340** is reciprocably displaceable in a radial direction with respect to pivot axis **345.** First stressed link **340** is pre-stressed, comprising a pre-stressed helical spring **348** that biases the free send **346** in a direction towards pivot axis **345.**

In alternative variations of this example the helical spring **348** can be replaced with a two or more than two spring elements, in each case each spring element being for example a helical spring or any other suitable spring capable of storing elastic potential energy when compressed.

The lug engagement release system **300** further comprises an anvil element **380**, pivotably mounted with respect to side plates **120, 130**, coaxially with respect to coupling plate **360**, to also allow pivoting of the anvil element **380** about said lateral pivot axis **365,** which, as already mentioned, is fixed with respect to the housing **110.** The anvil element **380** comprises a first arm **382** radially projecting outwardly with respect to pivot axis **365**, and a second arm **384** also radially projecting outwardly with respect to pivot axis **365** but angularly displaced from the first arm **382** by an angle α. In this example, angle α is in the range of 200° and 160°, and more specifically about 180°.

According to an aspect of the presently disclosed subject matter, the anvil element **380** can be pivoted about said lateral pivot axis **365** with respect to coupling plate **360** about a limited angular displacement; thereafter, additional angular displacement of the anvil

element **380** about said lateral pivot axis **365** causes the coupling plate **360** to concurrently be displaced with the anvil element **380**.

The anvil element **380** comprises a cam surface **383**. A roller (not shown) connected to a microswitch (not shown) follows the cam surface **383**, and thereby enables the microswitch to provide suitable control signals to a controller (not shown) indicative of whether the lug engagement release system **300** (via the angular position of the anvil element **380)** is in the engaged configuration or the disengaged configuration.

The free end **386** of the first arm **382** of the anvil element **360** projects in a general forward direction.

The second arm **384** of the anvil element **380** projects in a general aft direction, and is freely pivoted at end **388** to one end **392** of second link **390** at pin **391.**

A pivoting member **370** is pivotably mounted with respect to side plates **120, 130** to allow pivoting thereof about lateral pivot axis **395,** which is fixed with respect to the housing **110.** The pivoting member **370** has a first arm **371** and a second arm **374** projecting away from lateral pivot axis **395** in generally opposite directions.

As best seen in Figs. 6(a) and 6(b) a mechanical stop **377** is provided in the housing **110** in proximity to the pivoting member **370**, limiting clockwise pivoting of the pivoting member **370** to an angular position when the second arm **374** abuts the mechanical stop **377** (as seen in Fig. 6(a)), and limiting counter clockwise pivoting of the pivoting member **370** to an angular position when the first arm **371** abuts the mechanical stop **377** (as seen in Fig. 6(b)).

The other end **394** of second link **390** is freely pivoted to second arm **374** via a pin, and the first arm **371** is freely pivoted to a free end **242** of a second stressed link **240** at its free end **346** via a pin**.**

Second stressed link **240** is pivotably mounted with respect to side plates **120, 130** to allow pivoting of the second stressed link **240** about lateral pivot axis **245,** which is fixed with respect to the housing **110.** The free end **242** of the second stressed link **240** is reciprocably displaceable in a radial direction with respect to pivot axis **245.** Second stressed

link **240** is pre-stressed, comprising a pre-stressed helical spring **248** that biases the free end **246** in a direction towards pivot axis **245.**

The free end **386** of first arm **382** of the anvil element **360** includes a roller **387**, and is selectively actuable by the actuation system **600** to cause the lug engagement release system **300** to be actuated from the engaged configuration to the disengaged configuration, but only when the safety lock **799** of the safety system **700** is in the decoupled mode.

Thus, and referring in particular to Fig. 4, a first kinematic chain **A** is provided by the first stressed link **340,** the coupling plate **360**, the first link **350** and the hook element **320**. Referring also to Fig. 6(a) and Fig. 6(b), the first kinematic chain **A** has two stable relative positions that minimize the potential energy of the spring **348,** and in which the pin **349** is at a maximum distance from an imaginary line **L1** joining the pivot axis **345** and the pivot axis **365.**

The first stable position is illustrated in Fig. 6(a), in which the pin **349** is above line **L1**, and in which the hook element **320** is rotated clockwise to the closed or engaged position, enabling engagement with a lug.

The second stable position is illustrated in Fig. 6(b), in which the pin **349** is below line **L1**, and in which the hook element **320** is rotated counter clockwise to the open or disengaged position, enabling release of a lug previously engaged thereto, or enabling a lug **15** to be inserted into space **326** for subsequent engagement via the lug engagement release system **300**.

The first kinematic chain **A** essentially thus operates as a lug engagement and release mechanism.

In order to load and engage a store **10**, the first kinematic chain **A** must be in the second stable position shown in Fig. 6(b), allowing the lug **15** to be vertically inserted into the bottom of housing **110** along vertical axis **LA** (Fig. 4). As the lug is thus inserted and pushes against the upper arm **325,** hook element **320** is caused to rotate in a clockwise direction about pivot axis **355** to the first stable position shown in Fig. 6(a), causing the lower arm **321** to enter into the lug **15** and come into load supporting contact therewith, the lug being accommodated in space **326.**

Referring again to Fig. 4 in particular, a second kinematic chain **B**, defined by anvil member **380,** second link **390**, pivoting member **370**, and second stressed link **240**. The second kinematic chain **B** operates as a geometrical locking and unlocking mechanism for the first kinematic chain **A**.

The second kinematic chain **B** has two stable relative positions that minimize the potential energy of the spring **348,** and in which the free end **242** is at a maximum distance from an imaginary line **L2** joining the pivot axis **245** and the pivot axis **395.**

The first stable position is illustrated in Fig. 6(a), in which the free end **242** is on the forward (left) side of line **L2**, and in which the pivoting member **370** is rotated clockwise to the geometrical locked position, thereby geometrically locking the first kinematic chain **A**.

The second stable position is illustrated in Fig. 6(b), in which the pin **349** is on the aft (right) side of line **L2**, and in which the pivoting member **370** is rotated counter clockwise to the unlocked position, thereby unlocking the first kinematic chain **A**, which can then go from the engaged configuration to the disengaged configuration.

Referring in particular to Figs. 1 and 4, the actuation system **600** is configured, in operation of the support and release device **100**, for operating under the action of gas pressure, and comprises an inlet port **610** connectable to a pressurized gas source **690**. For example, the gas source **690** can comprise one or more pressurized gas bottles filled with a suitable gas at high pressure, for example nitrogen gas. Alternatively, the gas source can include a pyrotechnic device that generates high pressure on ignition of pyrotechnic materials therein.

Referring in particular to Figs. 4 and 7, actuation system **600** comprises piston **650** reciprocally mounted in cylinder **620** between a nominal first position **P1** and a second positon **P2**.

The actuation system **600** also comprises a conduit **680** extending between the inlet port **610** and the cylinder **620**, providing fluid communication therebetween and thus providing fluid communication between the pressurized fluid source **690** (when connected to the inlet port **610**) and the piston **650**. The cylinder **620** can thus be considered as an extension of the fluid conduit **680**, and piston **650** is thus reciprocally mounted with respect to the conduit **680**.

The actuator system **600** is configured for selectively providing an actuation operation such as to cause the lug engagement release system **300** to go from engaged configuration to the disengaged configuration (concurrent with the safety lock **799** being in uncoupled mode). This actuation operation is responsive to the aforementioned actuation pressure **AP** being applied within the actuator system **600** via gas provided by the pressurized gas source **690**.

Referring again to Figs. 3, 4, 7, the support and release device **100** is optionally configured for forcibly ejecting the store **10** away from the device **100**, and thus away from the air vehicle, when disengaged therefrom. In this connection, the support and release device **100** comprises an ejector system **500**.

The device **100** can be operated absent the ejector system **500**, and thus allows the stores to drop away therefrom under the influence of gravity once released from the hook element.

However, in the present example, the support and release device **100** is configured for forcibly ejecting the store away from the device **100** and thus away from the air vehicle. Thus, alternatively, and optionally, the device **100** can be operated together with ejector system **500,** configured for forcibly ejecting the store away from the device **100** and thus away from the air vehicle, once the stores **10** is released from the device **100.**

The ejector system **500** in at least this example comprises at least one ejection module **560** configured for forcibly ejecting a store away from the device **100.** In particular, each ejection module **560** is configured for providing an ejection force generated under action of gas pressure provided by the actuation system **600**.

In this example, the ejector system **500** comprises two ejection modules **560,** which are essentially identical to one another, and thus, only one shall be described herein. In alternative variations of this example, the ejector system **500** can instead comprise one or more than two ejection modules **560.** In this example one ejection module **560** is accommodated in the forward end block **140** and the other ejection module **560** is accommodated in aft end block **150**.

In a first example, the ejection module **560** comprises a tubular housing **562,** extending along a longitudinal axis **501.** The tubular housing **562** accommodates a telescopic

plunger element **564**, which in alternative variations of this example can optionally include a plurality nested telescopic elements. The telescopic plunger element **564** comprises an end wall at a first longitudinal end **561** thereof having a small opening **569,** and is closed at a second longitudinal end **563** thereof.

The second longitudinal end **563** comprises a padded abutment element **566**, configured for abutting against the stores **10** when this is engaged with the device **100**.

In the present example, the support and release device **100** further comprises sway braces **570**, fixed to the forward end block **140** and to the aft end block **150**.

The first longitudinal end **561** is in open fluid communication with the conduit **680** via opening **569**, and thus with the pressurized gas source **690** when this is connected to the inlet **610**. Thus, when the actuator system **600** is operated to apply the actuation pressure to the piston **650** via the conduit **680**, pressure is also applied to the plunger element **564**, which then extend out of their respective housings **562**, thereby pushing off the stores **10** away from the device **100**.

Referring in particular to Fig. 2, safety lock **799** is, in at least this example, in the form of a pin that is reversible insertable into the housing **110** along extraction axis **EA** via aligned lateral openings **119** in the side plates **120, 130**. The safety lock **799** is selectively inserted in the housing **110** along extraction axis **EA** to provide the coupled mode, and the safety lock **799** selectively extracted from the housing **110** along extraction axis **EA** to provide the decoupled mode.

Referring in particular to Fig. 3, an arm **389** is rigidly affixed to the anvil element **380** radially projecting away from axis **365** in a general direction towards the extraction axis **EA**. In particular, when the safety lock **799** is in the coupled mode, the arm **389** abuts the safety lock **799**, and thus the arm **389**, together with the anvil element **380**, are prevented from pivoting about pivot axis **365**, thereby preventing the lug engagement release system **300** from going to the disengaged configuration, even if the actuator system **600** is operated to provide the actuation pressure **AP**.

On the other hand,, when the when the safety lock **799** is removed from the housing **110** and the safety lock **799** is thus in the uncoupled mode, the arm **389** together with the anvil element **380**, are now able to pivot about pivot axis **365**, thereby allowing the lug

engagement release system **300** to go to the disengaged configuration, responsive to the actuator system **600** being operated to provide the actuation pressure **AP**.

As mentioned above, the safety system **700** is configured for preventing said actuation pressure **AP** being applied to the actuator system **600**, in particular to the piston **650**, when the safety lock **799** is concurrently in coupled mode.

In the engaged configuration, the piston **650** is in the nominal first position **P1** (Fig. 4). When the actuation operation is initiated by the actuator system **600**, and the safety lock **799** is concurrently in uncoupled mode, gas pressure at actuation pressure **AP** is applied to the piston **650**, causing the piston **650** to be displaced to position **P2** (Fig. 7).

In doing so, the piston **650**, which abuts the roller **387** at the first arm **382**, applies a torque to the anvil member **380**, initially pivoting the anvil in a counter clockwise direction (as seen in Fig. 6(a)) about pivot axis **365** through a first angular displacement. Thereafter, and referring to Fig. 6(d), the anvil member **380** locks onto the coupling plate **360**, and together pivot by a further angular displacement about axis **365** until the geometric lock between the second link **390** and pivoting member **370** is unlocked, thereby pivoting the first stressed link **340** past the line **L1**, which then results on the first stressed link **340** to continue to pivot to its second position, concurrently causing the hook element **320** to pivot about axis **355** and thus to open, thereby disengaging the lug **15** and thus allowing the lug **15**, and thus the stores **10**, to be released.

The safety system **700** is configured for providing free fluid communication between the inlet port **610** (and thus between the pressurized gas source **690**) and the external environment **E** (typically the atmosphere) when the removable safety lock **799** is in said coupled mode. The safety system **700** is further configured for preventing free fluid communication between the inlet port **610** and the external environment **E** when the removable safety lock **799** is in the coupled mode.

In this example, and as best seen in Fig. 6(a) and Fig. 8, the piston **650** comprises a piston head **658** having an upper face in fluid communication with the conduit **680**, and a lower projection **659** configured for abutment with respect to the anvil member **380**, in particular the roller **387** thereof. The piston head **658** further comprises a peripheral wall **655** facing an inside of the cylinder **620**. The piston head **658** further comprises a peripheral

groove **657** on peripheral wall **655** in which a suitable ring seal **656** is accommodated for providing a suitable seal between the piston head **658** and the cylinder **620**.

In this example, safety system **700** is in the form of a fluid venting arrangement, and comprises a fluid venting conduit **710** provided in the piston **650**. The fluid venting conduit **710** comprises an inlet opening **712** provided at the top face **652** of the piston **650**, and two outlet openings **714**, **716** provided on the peripheral wall **655**. There is open fluid communication between inlet opening **712** and the conduit **680**, and thus between inlet opening **712** and the inlet port **610**, and thus between inlet opening **712** and the pressurized gas source **690**.

There is also open fluid communication in fluid venting conduit **710** between inlet opening **712** and the two outlet openings **714**, **716**.

In this example, safety system **700** further comprises two cylinder openings **112**, **114**, provided in the cylinder **620**, passing through the thickness of the cylinder **620**.

The cylinder openings **112**, **114** are located on the cylinder **620** at positions:

- such as to be in registry with the outlet openings **714**, **716**, when the piston **650** is at or close to position **P1**, in at particular position **P3** (Fig. 6(c)) so that there is free fluid communication between the external environment **E** and the fluid conduit **680**, via the fluid venting conduit **710** and cylinder openings **112**, **114**;

and

- such as not to be in registry with the outlet openings **714**, **716**, when the piston **650** is has moved significantly away from position **P3** in a direction towards position **P2**, past position **P4** and until position **P2** (see also Fig. 6(d)), and thus part of the side plates **120, 130** are continuously in registry with the outlet openings **714**, **716** and thereby block fluid communication between external environment **E** and the conduit **680**; in other words, from when the piston **650** is has moved significantly away from position **P3**, has moved through and past position **P4,** and until position **P2**, the outlet openings **714**, **716**, are effectively closed and do not allow venting of the pressurized gas to the external environment **E**.

Thus, at position **P1**, and more particularly at position **P3**, the and concurrent with the safety lock **799** being in coupled mode, the safety system **700** is designed to cope with a design condition in which the pressure within the conduit **680** begins to increase, for example as a result of the actuation system **600** being actuated (either by accident or because of a malfunction, for example). In such a design condition, the safety system **700** provides an escape for the gas pressure, by venting the pressurized gas, which otherwise (i.e., under alternative conditions in which the safety system **700** is absent or non-operational) would increase, for example to the actuation pressure **AP** or greater. The safety system **700** thus prevents the pressure in the conduit **680** from reaching the actuation pressure **AP** and in particular from significantly exceeding the increasing actuation pressure **AP**, and thus enables the housing **110** to be designed with a considerably reduced safety margin, as regards capability for holding large internal pressure, as could otherwise be required under such alternative conditions.

It is to be noted that under nominal operating conditions, the safety lock **799** is uncoupled from the coupled mode to the uncoupled mode prior to take off, for example by ground crew. At some later point in the mission when it is required to eject the stores **10**, the actuation system **600** is actuated, the pressure within the conduit **680** increases up to the actuation pressure **AP**. As the piston **650** moves from position **P1** to position **P3** under the action of the gas pressure, some gas is vented to the external environment **E** via the safety system **700**, i.e., via the outlet openings **714**, **716** which are, in position **P3**, temporarily in registry with cylinder openings **112**, **114** and thus open with respect to the external environment **E**. Nevertheless, since the safety lock **799** is in the uncoupled mode, the piston **650** continues to move quickly past position **P3**, past position **P4** and towards position **P2,** responsive to the actuation pressure **AP** being applied thereto. This is because in the uncoupled mode, the anvil member **380** is no longer prevented from pivoting and thus from preventing further displacement of the piston **650**. The actuation pressure **AP** is sufficient, in the uncoupled mode, to further displace the piston **650** past position **P3** so that the outlet openings **714**, **716**, are no longer in registry with the cylinder openings **112**, **114**, i.e., the outlet openings **714**, **716**, are effectively closed with respect to the external environment **E**, and thereby further venting of the pressurized gas to the external environment **E** from the conduit **680** is halted, preventing any further venting of gas from the actuator system **600** via the safety system **700**. This also enables the full actuation pressure **AP** to be applied to

the piston **650** which can then be fully displaced, first to position **P4** (Fig. 6(d)) and thereafter to position **P2**, concurrently actuating the engagement release system **300** to cause this to go from engaged configuration to the disengaged configuration. While the piston **650** is being partially displaced from position **P3** towards position **P4**, the anvil member **380** is rotated about axis **365** until it comes into abutting contact with, and the anvil member **380** locks onto, the coupling plate **360**. Thus in the time period corresponding to movement of the piston **650** from position **P3** to position **P4**, it is possible for pressure in the actuation system **600** to rise, for example up to or close to the actuation pressure **AP**, as pressurized gas is provided via the conduit **680**, prior to the coupling plate **360** being activated by the anvil member **380**. At position **P4**, the anvil member **380** locks onto the coupling plate **360**, and together pivot by a further angular displacement about axis **365** until the geometric lock between the second link **390** and pivoting member **370** is unlocked, responsive to further displacement of the piston **650** from position **P4** to position **P2**.

Concurrently, the actuation system **600** also actuates the ejector system **500** causing the telescopic plunger elements **564** to be extended from the respective tubular housings **562** under action of gas pressure provided by the actuation system **600**, thereby providing an ejection force to the stores **10** after this has been disengaged from the device **100**.

On the other hand, and at the aforementioned design condition, shortly after such an event of the actuation system **600** being actuated while the safety lock **799** is concurrently in coupled mode, the pressure within the conduit **680** causes the piston **650** to be displaced from position **P1** to position **P3**, and the piston **650** remains at position **P3** since further displacement of the piston **650** is resisted by the anvil element **380**, which is prevented from pivoting by abutment of the arm **389** against the coupled safety lock **799**. By the piston **650** remaining at position **P3**, the fluid venting conduit **710** allows venting of the pressurized gas from the pressurized source **690**, and the pressure within the conduit **680** reduces and eventually settles at around ambient pressure (i.e., the pressure of the external environment **E**). Accordingly, under such conditions there is insufficient gas pressure within the actuation system **600** to cause the engagement release system **300** to go to disengaged configuration. Similarly, under such conditions there is insufficient gas pressure within the actuation system **600** to cause the telescopic plunger elements **564** to be extended from the respective tubular housings **562** , thereby avoiding the application of an undesired mechanical load on the stores **10** while still engaged to the device **100**. It is then safe to decouple the safety lock

799 to uncoupled mode (for example by ground crew, once the air vehicle lands), without risk of the actuation system **600** actuating the engagement release system **300** to cause this to go from the engaged configuration to the disengaged configuration. It is also then possible to replace the pressurized gas source **690** with another pressurized gas source, for example, and to enable the air vehicle to once again resume the mission with the same stores.

Such aforesaid alternative conditions with the safety lock **799** still being in coupled mode could result in excessive pressure buildup within the actuator system **600**, which is considered undesirable, and moreover would requires the housing **110**, and in particular the conduit **680** to be designed to contain such excess pressure over a long period.

Furthermore, such alternative conditions of such pressure buildup with the safety lock **799** still being in coupled mode can also result in excessive and/or undesirable mechanical loads being applied to the stores via the hook element **320**, and/or via the ejector system **500**.

Furthermore, such alternative conditions of pressure buildup with the with the safety lock **799** still being in coupled mode can also present a risk element, since subsequent uncoupling of the safety lock **799** to the uncoupled mode (which typically is carried out by the grounds crew, well before the aircraft takes off) can then cause the stores **10** to be ejected, in particular forcibly ejected, with the aircraft still on the ground, which can have serious or even catastrophic consequences, particularly if the stores **10** is a bomb or a fuel tank, for example.

Furthermore, such alternative conditions of such pressure buildup with the safety lock **799** still being in coupled mode can also result in a number of procedures having to be implemented to subsequently de-pressurize the conduit **680** to safe conditions, and to replace the pressurized gas source **690** with another pressurized gas source, for example.

The outside of the cylinder **620**, in this example, is inside the housing **110** but still in free fluid communication with the outside environment **E**. In alternative variations of this example, the outside of the cylinder **620**, can instead be partially or fully outside the housing **110** and in any case in free fluid communication with the outside environment **E**.

In the example of Figs. 1 to 8, the actuating piston **650** itself of the actuation system **600** also includes part of the safety system **700**, in particular the fluid venting conduit **710** that is used for venting pressurized gas.

However, in alternative examples of the presently disclosed subject matter, the safety system **700** can be structurally and/or functionally independent of the actuation system **600**.

For example, and referring to Figs. 9, 10 and 11, a support and release device according to a second example of the presently disclosed subject matter, generally designated **1100,** is similar to the device **100** according to the first example, with some differences as discussed herein, *mutatis mutandis*.

In the second example, the device **1100** comprises a lug engagement release system **1300**, actuation system **1600**, and safety system **1700** comprising safety lock **1799**, respectively corresponding to the lug engagement release system **300**, actuation system **600**, and safety system **700** and safety lock **799** as disclosed herein for the first example, *mutatis mutandis*.

In the second example, the device **1100** comprises housing **1110,** and optionally further comprises an ejector system **1500** and/or sway braces **1570**, which can be similar to the housing **110,** the ejector system **500** and/or sway braces **570**, respectively, as disclosed herein for the first example, *mutatis mutandis*.

In the second example the lug engagement release system **1300** comprises as single kinematic chain **D** for the purpose of maintaining the device compact, in view of the structure and layout of the actuation system **600**, and safety system **700**, but it is to be noted that the device **1100** can instead replace the lug engagement release system **1300** with the lug engagement release system **300** of the first example, *mutatis mutandis*. Similarly, it is to be noted that the device **100** of the first example can instead replace the lug engagement release system **300** with the lug engagement release system **1300** of the second example, *mutatis mutandis*. It is also to be noted that according to an aspect of the presently disclosed subject matter, the safety system **700** of the first example, or the the safety system **1700** of the second example, can be implemented in any one of variety of support and release devices, in which the respective lug engagement release system can be conventional or non-conventional and in any case actuated via a pressurized gas based actuation system. For

example, the lug engagement release system **300** of the first example, or the lug engagement release system **1300** of the second example, can each be replaced with the combination of the first kinematic chain **A** and the second kinematic chain **B** as disclosed in pages 9 to 20 of WO 2016/199132, *mutatis mutandis*, and the contents of WO 2016/199132, in particular pages 9 to 20 thereof, are incorporated herein by reference.

Referring again to Figs. 9, 10 and 11, the lug engagement release system **1300** comprises a single kinematic chain **D**, including a first stressed link **1340,** pivot axis **1355**, pivot axis **1365,** a coupling plate **1360**, a first link **1350** and a hook element **1320**, which are similar to the first stressed link **340**, the pivot axis **355**, the pivot axis **1365**, the coupling plate **360**, the first link **350** and the hook element **320**, respectively, as disclosed herein for the first kinematic chain **A** of first example, *mutatis mutandis*, with the following difference. It is to be noted that the coupling plate **1360** comprises a first arm **1361** radially projecting outwardly with respect to pivot axis **1365**, and a second arm **1362** also radially projecting outwardly with respect to pivot axis **1365**, in a similar manner to the radially projecting first arm **361** and second arm **362** of coupling plate **360** of the first example, *mutatis mutandis*. However, in the lug engagement release system **1300**, instead of including the second kinematic chain, the coupling plate **1360** further comprises a third arm **1382** radially projecting outwardly with respect to pivot axis **1365**, and the free end **1386** of the third arm **1382** projects in a general forward direction.

The free end **1386** of third arm **1382** of the coupling plate **1360** includes a roller **1387**, and is selectively actuable by the actuation system **1600** to cause the lug engagement release system **1300** to be actuated from the engaged configuration to the disengaged configuration, but only when the safety lock **1799** of the safety system **1700** is in the decoupled mode.

In a similar manner to the first kinematic chain **A** of the first example, *mutatis mutandis*, the single kinematic chain **D** also has two stable relative positions that minimize the potential energy of the spring **1348,** and in which the pin **1349** of the first stressed link **1340** (corresponding to the spring **348,** and in which the pin **349**, respectively, of the first stressed link **340** of the first example, *mutatis mutandis*) is at a maximum distance from an imaginary line **L1'** joining the pivot axis **1345** and the pivot axis **1365.**

The first stable position is illustrated in Fig. 10, in which the pin **1349** is above line **L1'**, and in which the hook element **1320** is rotated clockwise to the closed or engaged position, in which it is or can be in engagement with a lug.

The second stable position is not illustrated in the figures but corresponds to the second stable position of the first kinematic chain **A** of the first example illustrated in Fig. 6(b), in which the pin **1349** is below line **L1'**, and in which the hook element **1320** is rotated counter clockwise to the open or disengaged position, enabling release of a lug previously engaged thereto, or enabling a lug to be subsequently inserted into the hook element **1320** and engaged via the lug engagement release system **1300**.

Thus, in a similar manner to the first kinematic chain **A**, *mutatis mutandis*, the single kinematic chain **D** essentially also operates as a lug engagement and release mechanism.

In order to load and engage a store **10**, the single kinematic chain **D** must be in the second stable position allowing the lug to be vertically inserted into the bottom of housing **1110** along vertical axis **LA'**. As the lug is thus inserted and pushes against the upper arm of the hook element **1320,** hook element **1320** is caused to rotate in a clockwise direction about pivot axis **1355** to the first stable position shown in Fig. 11, causing the lower arm of the hook element **1320** to enter into the lug and come into load supporting contact therewith.

The actuation system **1600**, in a similar manner to the actuation system **600** of the first example, *mutatis mutandis*, is configured, in operation of the support and release device **1100**, for operating under the action of gas pressure, and comprises an inlet port **1610** connectable to a pressurized gas source **1690**, piston **1650** reciprocally mounted in cylinder **1620** between a nominal first position **P1'** and a second positon **P2'**, and a fluid conduit **1680** extending between the inlet port **1610** and the cylinder **1620**, providing fluid communication therebetween and thus providing fluid communication between the pressurized fluid source **1690** (when connected to the inlet port **1610**) and the piston **1650**, which in this example are similar to the inlet port **610**, pressurized gas source **690**, piston **650**, cylinder **620**, nominal first position **P1**, second positon **P2**, fluid conduit **680**, respectively, of the first example, *mutatis mutandis*.

In a similar manner to the actuator system **600** of the first example, *mutatis mutandis,* the actuator system **1600** of the second example is also configured for selectively providing

an actuation operation such as to cause the engagement release system **1300** to go from engaged configuration to the disengaged configuration (concurrent with the safety lock **1799** being in uncoupled mode). This actuation operation is responsive to the aforementioned actuation pressure **AP** being applied within the actuator system **1600** via gas provided by the pressurized gas source **1690**.

Referring in particular to Fig. 10, safety lock **1799** is, also in this example, in the form of a pin that is reversible insertable into the housing **1110** along extraction axis **EA'** via aligned lateral openings in the side plates of the housing **1110**. The safety lock **1799** is selectively inserted in the housing **1110** along extraction axis **EA'** to provide the coupled mode, and the safety lock **1799** selectively extracted from the housing **1110** along extraction axis **EA'** to provide the decoupled mode.

Referring again to Fig. 10, the extraction axis **EA'** is in close proximity to the first arm **1361** of the coupling plate **1360,** and is located in the path of the arm **1361** as the coupling plate **1360** is pivoted about axis **1365** from the first stable position towards the second stable position of kinematic chain **D**. Thus, when the safety lock **1799** is in the coupled mode, the first arm **1361** abuts the safety lock **1799**, and thus the coupling plate **1360** via the first arm **1361**, is prevented from pivoting about pivot axis **1365**, thereby preventing the lug engagement release system **1300** from going towards the disengaged configuration, even if the actuator system **1600** is operated to provide the actuation pressure **AP**.

On the other hand, when the when the safety lock **1799** is removed from the housing **1110** and the safety lock **1799** is thus in the uncoupled mode (Fig. 11), the first arm **1361**, together with the rest of the coupling plate **1360**, are now able to pivot about pivot axis **1365**, thereby allowing the lug engagement release system **1300** to go to the disengaged configuration, responsive to the actuator system **1600** being operated to provide the actuation pressure **AP**.

In a similar manner to the safety system **700** of the first example above, *mutatis mutandis*, the safety system **1700** in the second example is configured for preventing said actuation pressure **AP** being applied to the actuator system **1600**, in particular to the piston **1650**, when the safety lock **1799** is concurrently in coupled mode.

Referring in particular to Fig. 11, in the engaged configuration of the lug engagement release system **1300**, the piston **1650** is in the nominal first position **P1'**. When the actuation operation is selectively initiated by the actuator system **1600**, and the safety lock **1799** is concurrently in uncoupled mode, gas pressure at actuation pressure **AP** is applied to the piston **1650**, causing the piston **1650** to be displaced to position **P2'**.

In doing so, the piston **1650**, which abuts the roller **1387** at the first arm **1382**, applies a torque to the pivoting member **1360**, pivoting the pivoting member **1360** in a counter clockwise direction (as seen in Fig. 11) about pivot axis **1365** through an angular displacement, thereby pivoting the first stressed link **1340** towards and past the line **L1'**, which then results on the first stressed link **1340** to continue to pivot to its second position, concurrently causing the hook element **1320** to pivot about axis **1355** and thus to open, thereby disengaging the lug and thus allowing the lug, and thus the stores, to be released.

In this example, the safety system **1700** is configured for providing free fluid communication between the fluid conduit **1680** (and thus between the pressurized gas source **1690**) and the external environment **E** (typically the atmosphere) when the removable safety lock **1799** is in said coupled mode. The safety system **1700** is further configured for, conversely, preventing free fluid communication between the fluid conduit **1680** and the external environment **E** when the removable safety lock **1799** is in the coupled mode.

In this example, and as best seen in Fig. 10 and Fig. 11, the safety system **1700** comprises a fluid venting arrangement **1800** that is independent of and different from, structurally as well as functionally, piston **1650**. As will become clearer herein, the venting arrangement **1800** is nevertheless coupled to the actuator system **1600**.

The venting arrangement **1800** comprises a plunger member **1850** reciprocably mounted with respect to plunger casing **1820,** the plunger member **1850** being reciprocably displaceable with respect to the plunger casing **1820** between a nominal first plunger position **S1'** and a second plunger positon **S2'**. The plunger member **1850** comprises a plunger head **1858** and lower projection **1859**.

In this example, plunger member **1850**, in particular the plunger head **1858**, comprises one or more lateral inlets **1812**, outlet openings **1714**, **1716,** and a fluid venting

conduit **1710** providing open fluid communication between the one or more lateral inlets **1812** and outlet openings **1714**, **1716**.

The plunger head **1858** has an upper end **1852** in selective fluid communication with the conduit **1680**, via the lateral inlets **1812**. The lower projection **1859** projects out of the plunger casing **1820** and is configured for selective abutment with respect to the first arm **1361** of the coupling plate **1360**. The plunger head **1858** further comprises a peripheral wall **1855** facing an inside of the plunger casing **1820**. The outlet openings **1714**, **1716** are provided on the peripheral wall **1855.** The plunger head **1858** can optionally further comprises a one or more ring seals for providing a suitable seal between the plunger head **1858** and the cylinder **1820**. The venting arrangement **1800** further comprises a biasing spring **1810** that biases the plunger member **1850**, in particular lower projection **1859**, in a direction towards the extraction axis **EA'**.

In position **S1'** (Fig. 10), the upper end **1852** projects out of the plunger casing **1820** and into the conduit **1680**, such as to allow free fluid communication between the lateral inlets **1812** and the conduit **1680** (by thereby exposing the lateral inlets **1812** to the conduit **1680**).

In position **S2'** (Fig. 11), the upper end **1852** is retracted into the plunger casing **1820**, effectively sealing off the plunger casing **1820** from the conduit **1680**, such as to prevent fluid communication between the lateral inlets **1812** and the conduit **1680** (by thereby blocking the lateral inlets **1812** via the walls of the plunger casing **1820**).

In this example, safety system **1700**, in particular the venting arrangement **1800**, further comprises two plunger casing openings **1814**, **1816**, provided in the plunger casing **1820**, passing through the thickness of the wall of plunger casing **1820**. The outside of the plunger casing **1820**, in this example, is inside the housing **1110** but still in free fluid communication with the outside environment **E**. In alternative variations of this example, the outside of the plunger casing **1820**, can instead be partially or fully outside the housing **1110** and in any case in free fluid communication with the outside environment **E**.

The lateral inlets **1812** are located on plunger head **1858**, and the plunger casing openings **1814**, **1816** are located on the plunger casing **1820,** at respective positions such that:

- the plunger casing openings **1814**, **1816** are in registry with the outlet openings **1714**, **1716**, respectively, and the lateral inlets **1812** are in fluid communication with the conduit **1680** - when safety lock **1799** is concurrently in coupled mode (Fig. 10), so that there is free fluid communication between the external environment **E** and the conduit **1680**, via the lateral inlets **1812**, fluid conduit **1710**, outlet openings **1714**, **1716,** and plunger casing openings **1814**, **1816**;

and

- the plunger casing openings **1814**, **1816** are in not in registry with the outlet openings **1714**, **1716**, and the lateral inlets **1812** are not in fluid communication with the conduit **1680** - when safety lock **1799** is concurrently in uncoupled mode (Fig. 11) so that fluid communication is blocked between the external environment **E** and the conduit **1680**.

Thus, at position **S1'**, and concurrent with the safety lock **1799** being in coupled mode, the safety system **1700** is designed to cope with a design condition in which the pressure within the conduit **1680** begins to increase, for example as a result of the actuation system **1600** being actuated (either by accident or because of a malfunction, for example). In such a design condition, the safety system **1700** provides an escape for the gas pressure, which otherwise (i.e., under alternative conditions in which the safety system **1700** is absent or non-operational) would increase, for example to the actuation pressure **AP** or greater. The safety system **1700** thus prevents the pressure in the conduit **1680** from reaching the actuation pressure **AP** and in particular from significantly exceeding the increasing actuation pressure **AP**, and thus enables the housing **1110** to be designed with a considerably reduces safety margin, as regards capability for holding large internal pressure, as could otherwise be required under such alternative conditions.

It is to be noted that under nominal operating conditions, the safety lock **1799** is uncoupled from the coupled mode to the uncoupled mode prior to take off, for example by ground crew. At that point, the spring **1810** causes the plunger member **1850** to move from position **S1'** to position **S2'**, thereby freeing the pivoting member **1360** from the pivoting block. At some later point in the mission when it is required to eject the stores **10**, the actuation system **1600** is actuated, the pressure within the conduit **1680** increases up to the actuation pressure **AP**. The piston **1650** moves from position P**1'** to position **P2'** responsive

to the actuation pressure **AP** being applied thereto. This is because in the uncoupled mode, the pivoting member **1360** is no longer prevented from pivoting and thus from preventing further displacement of the piston **1650**. The actuation pressure **AP** is sufficient, in the uncoupled mode, to displace the piston **1650** to be fully displaced to position **P2'**, concurrently actuating the lug engagement release system **1300** (by applying a torque thereto via roller **1387** and third arm **1382**) to cause the lug engagement release system **1300** to go from engaged configuration to the disengaged configuration. Concurrently, the actuation system **1600** also actuates the ejector system **1500** causing the corresponding telescopic plunger elements to be extended from the respective tubular housings under action of gas pressure provided by the actuation system **1600**, thereby providing an ejection force to the stores **10** after this has been disengaged from the device **1100**.

On the other hand, and at the aforementioned design condition, shortly after such an event of the actuation system **1600** being actuated while the safety lock **1799** is concurrently in coupled mode, the plunger member **1850** remains at position **S1'**, since displacement to position **S2'** is prevented by the coupled safety lock **1799**, thereby blocking the pivoting member **1360** from the pivoting about the axis **1365**.

As pressure within the conduit **1680** increases towards actuation pressure **AP** the piston **1650** nevertheless remains at position **P1** since further displacement of the piston **1650** is resisted by pivoting member **1360**, which is prevented from pivoting by abutment of the arm **1361** against the coupled safety lock **1799**. However, by the plunger member **1850** remaining at position **S1'**, the fluid venting conduit **1710** allows venting of the pressurized gas from the pressurized source **1690** to the external environment **E**, and the pressure within the conduit **1680** reduces and eventually settles at around ambient pressure (i.e., the pressure of the external environment **E**). Accordingly, under such conditions there is insufficient gas pressure within the actuation system **1600** to cause the engagement release system **1300** to go to disengaged configuration, even if the safety lock **1799** is subsequently uncoupled to uncoupled mode. Similarly, under such conditions there is insufficient gas pressure within the actuation system **1600** to cause the telescopic plunger elements of the ejector system **1500** to be extended from the respective tubular housings, thereby avoiding the application of an undesired mechanical load on the stores **10** while still engaged to the device **1100**. It is then safe to decouple the safety lock **1799** to uncoupled mode (for example by ground crew, once the air vehicle lands), without risk of the actuation system **1600**

actuating the engagement release system **1300** to cause this to go from the engaged configuration to the disengaged configuration. It is also then possible to replace the pressurized gas source **1690** with another pressurized gas source, for example, and to enable the air vehicle to once again resume the mission with the same stores.

Such aforesaid alternative conditions with the safety lock **1799** still being in coupled mode could otherwise result in excessive pressure buildup within the actuator system **1600**, which is considered undesirable, and moreover would requires the housing **1110**, and in particular the conduit **1680** to be designed to contain such excess pressure over a long period. Furthermore, such alternative conditions of pressure buildup with the with the safety lock **1799** still being in coupled mode can also present a risk element, since subsequent uncoupling of the safety lock **1799** to the uncoupled mode (which typically is carried out by the grounds crew, well before the aircraft takes off) can then cause the stores **10** to be ejected, in particular forcibly ejected, with the aircraft still on the ground, which can have serious or even catastrophic consequences, particularly if the stores **10** is a bomb or a fuel tank, for example.

Furthermore, such alternative conditions of such pressure buildup with the safety lock **1799** still being in coupled mode can also result in a number of procedures having to be implemented to subsequently de-pressurize the conduit **1680** to safe conditions, and to replace the pressurized gas source **1690** with another pressurized gas source, for example.

It is to be noted that in alternative variations of the second example of the presently disclosed subject matter, the safety system **1700** can also incorporate the safety system **1700** of the first example. For example, in the device **1110** illustrated in Figs. 9, 10, 11, the piston **1650** can optionally further include a fluid conduit having an inlet opening provided at the top face of the piston **1650**, and in open fluid communication with outlet openings provided on the peripheral wall **1655** of the piston **1650**, for example similar to fluid venting conduit **710,** inlet opening **712** provided at the top face **652** of the piston **650**, and outlet openings **714**, **716,** as disclosed herein with reference to the first example, *mutatis mutandis*. This arrangement also thus provides open fluid communication between inlet opening of the piston **1650** and the conduit **1680**, and thus between inlet opening of the piston **1650** and the inlet port **1610**, and thus between inlet opening of the piston **1650** and the pressurized gas source **1690**. In this variation of the second example, safety system **1700** further comprises

two cylinder openings provided in the spaced side plates of the housing **1110**, passing through the thickness of each of the spaced side plates, for example similar to the cylinder openings **112**, **114** as disclosed herein with reference to the first example, *mutatis mutandis*.

In the method claims that follow, alphanumeric characters and Roman numerals used to designate claim steps are provided for convenience only and do not imply any particular order of performing the steps.

Finally, it should be noted that the word "comprising" as used throughout the appended claims is to be interpreted to mean "including but not limited to".

While there has been shown and disclosed examples in accordance with the presently disclosed subject matter, it will be appreciated that many changes may be made therein without departing from the spirit of the presently disclosed subject matter.

CLAIMS:

1. A support and release device (100) for releasably supporting a store (10), the store having at least one lug (15) for enabling selective removable engagement of the store with respect to the device, the device comprising a housing (110) accommodating:

- a lug engagement release system (300), comprising a hook element (320);
- an actuator system (600), operatively coupled to the lug engagement release system; and
- a safety system (700) comprising a safety lock (799), said safety lock being configured for selectively coupling or uncoupling with respect to at least the lug engagement release system to alternately provide a coupled mode and a uncoupled mode, respectively,

wherein the lug engagement release system (300) is configured for alternately providing:

- an engaged configuration, in which the lug engagement release system is capable of being in an engaged relationship with respect to the lug (15) via said hook element (320), and
- a disengaged configuration, in which the lug engagement release system is selectively disengaged with respect to the lug (15), responsive to selective operation of the actuator system (600) concurrent with the safety lock (799) being in uncoupled mode, wherein the operation of the actuator system (600) is responsive to an actuation pressure (AP) applied within the actuator system (600) via gas provided by a pressurized gas source (690);

wherein:

- in the coupled mode the safety lock (799) is coupled with respect to the lug engagement release system (300) such as to prevent the lug engagement release system, in the engaged configuration, from providing the disengaged configuration, irrespective of operation of the actuator system (600); and
- in the uncoupled mode the safety lock (799) is uncoupled with respect to the lug engagement release system (300) enabling the lug engagement release system to provide the disengaged configuration from the engaged configuration responsive to operation of the actuator system (600);

wherein said actuator system (600) comprises a fluid conduit (680) connectable to the pressurized gas source (690);

wherein said actuator system comprises an actuation piston (650) reciprocably mounted with respect a cylinder (620), the cylinder being in fluid communication with said fluid conduit (680), the piston being displaceable with respect to the cylinder responsive to said pressurized gas being applied to the piston and concurrent with the safety lock (799) being in uncoupled mode;

wherein the safety system (700) is configured for enabling venting of the pressurized gas from the actuator system (600) to an external environment under conditions where the actuation system is operated concurrent with the safety lock (799) being in coupled mode;

wherein said safety system (700) comprises a venting arrangement configured for providing fluid communication between said fluid conduit (680) and the external environment (E) when the safety lock (799) is in said coupled mode, and to prevent fluid communication between said fluid conduit (680;1680) and the external environment (E) when the safety lock (799) is in uncoupled mode;

wherein the venting arrangement comprises at least one fluid venting conduit (710), each said fluid venting conduit having at least one inlet (712) in free fluid communication with said fluid conduit (680) and at least one outlet (714; 716) in selective fluid communication with the external environment (E);

and wherein

the respective said fluid venting conduit (710), the respective said at least one inlet and the respective at least one outlet (714; 716) are provided in said piston (650), and wherein said cylinder comprises at least one cylinder opening (112; 114) corresponding to each said outlet.

2. The device according to claim 1, wherein the piston (650) is operatively coupled to the lug engagement release system (300), such that as the piston is displaced with respect to the cylinder (620) between a first position and a second position, the lug engagement release system goes from the engaged configuration to the disengaged configuration.

3. The device according to claim 1 or 2,

- wherein for at least one said fluid venting conduit, and concurrent with the safety lock being in said coupled mode, the respective said at least one inlet (712) is in free fluid

communication with said fluid conduit and said at least one outlet (714; 716) is in selective fluid communication with the external environment.

4. The device according to any one of claims 1 to 3,

- wherein for the respective said at least one said fluid venting conduit, and wherein concurrent with the safety lock being in said uncoupled mode, fluid communication is prevented between said at least one outlet (714, 716) and the external environment (E).

5. The device according to any one of claims 2 to 4, including at least one of the following:

- wherein said cylinder openings (112, 114) are located on the cylinder (620) at respective positions such as to be in registry with said outlet openings (714, 716) when said piston (650) is at or close to said first position thereby providing free fluid communication between the external environment (E) and the fluid conduit (710), via the fluid venting conduit and cylinder openings;
- wherein said cylinder openings (112, 114) are located on the cylinder (260) at respective positions such as not to be in registry with the outlet openings (714, 716) when the piston (650) has moved significantly away from said first position in a direction towards said second position, and until said second position to thereby block fluid communication between external environment (E) and the fluid conduit (680).

6. The device according to any one of claims 1 to 5, wherein said cylinder comprises at least one cylinder opening (112, 114) corresponding to each said outlet, and, wherein said cylinder openings are located on the cylinder at respective positions such as to be in registry with said outlet openings when said piston is at or close to said first position thereby providing is free fluid communication between the external environment and the fluid conduit, via the fluid venting conduit and cylinder openings, and, wherein said cylinder openings are located on the cylinder at respective positions such as not to be in registry with the outlet openings when the piston has moved significantly away from said first position in a direction towards said second position, and until said second position to thereby block fluid communication between external environment and the fluid conduit.

7. The device according to any one of claims 1 to 6, including at least one of the following:

- wherein said venting arrangement further comprises a plunger member (1850) reciprocably mounted with respect to plunger casing (1820), the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position (S1') and a second plunger position (S2');

- wherein said venting arrangement further comprises a plunger member (1850) reciprocably mounted with respect to plunger casing (1820), the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position (S1') and a second plunger position (S2'), and, wherein a second said fluid venting conduit, a respective second said at least one inlet (1812), and a respective second at least one outlet (1714, 1716) are provided in said plunger member, and wherein said plunger casing comprises at least one casing opening (1814, 1816) corresponding to each said second outlet;

- wherein said venting arrangement further comprises a plunger member (1850) reciprocably mounted with respect to plunger casing (1820), the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position (S1') and a second plunger position (S2'), and, wherein a second said fluid venting conduit, a respective second said at least one inlet (1812), and a respective second at least one outlet (1714, 1716) are provided in said plunger member, and wherein said plunger casing comprises at least one casing opening (1814, 1816) corresponding to each said second outlet, and wherein said casing openings are located on the plunger casing at respective positions such as to be in registry with said second outlet openings when said plunger member is at or close to said first plunger position thereby providing free fluid communication between the external environment and the fluid conduit, via the second fluid venting conduit and casing openings;

- wherein said venting arrangement further comprises a plunger member (1850) reciprocably mounted with respect to plunger casing (1820), the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position (S1') and a second plunger position (S2'), and, wherein a second said fluid venting conduit, a respective second said at least one inlet (1812), and a respective second at least one outlet (1714, 1716) are provided in said plunger

member, and wherein said plunger casing comprises at least one casing opening (1814, 1816) corresponding to each said second outlet, and, wherein said casing openings are located on the plunger casing at respective positions such as not to be in registry with the second outlet openings when the plunger member has moved significantly away from said first plunger position in a direction towards said second plunger position, and until said second position to thereby block fluid communication between external environment and the second fluid conduit;

- wherein said venting arrangement further comprises a plunger member (1850) reciprocably mounted with respect to plunger casing (1820), the plunger member being reciprocably displaceable with respect to the plunger casing between a nominal first plunger position (S1') and a second plunger position (S2'), and, wherein a second said fluid venting conduit, a respective second said at least one inlet (1812), and a respective second at least one outlet (1714, 1716) are provided in said plunger member, and wherein said plunger casing comprises at least one casing opening (1814, 1816) corresponding to each said second outlet, and wherein said casing openings are located on the plunger casing at respective positions such as to be in registry with said second outlet openings when said plunger member is at or close to said first plunger position thereby providing free fluid communication between the external environment and the fluid conduit, via the second fluid venting conduit and casing openings, and, wherein said casing openings are located on the plunger casing at respective positions such as not to be in registry with the second outlet openings when the plunger member has moved significantly away from said first plunger position in a direction towards said second plunger position, and until said second position to thereby block fluid communication between external environment and the second fluid conduit.

8. The device according to claim 7, including at least one of the following:

- wherein said plunger member (1850) comprises a plunger head (1858) and lower projection (1859);

- wherein the venting arrangement further comprises a biasing spring (1810) that biases the plunger member in a direction towards an extraction axis of the safety lock;

- wherein in said first plunger position (S1'), and an upper end (1852) of said plunger member projects out of the plunger casing (1820) and into the fluid conduit

(1680), such as to allow free fluid communication between the second said inlets (1812) and the fluid conduit;

- wherein in said first plunger position (S1'), and an upper end (1852) of said plunger member (1850) projects out of the plunger casing (1820) and into the fluid conduit (1680), such as to allow free fluid communication between the second said inlets (1812) and the fluid conduit, and, wherein in said second plunger position (S2'), the upper end (1852) is retracted into the plunger casing (1820), thereby sealing off the plunger casing from the fluid conduit, and such as to prevent fluid communication between the second said inlets (1812) and the fluid conduit.

9. The device according to any one of claims 1 to 8, further configured for selectively ejecting forcibly the store therefrom, the device comprising one of the following:

- an ejector system (500) comprising at least one ejection module (560), each ejection module configured for providing an ejection force generated under action of gas pressure provided by the actuation system (600; 1600);

- an ejector system (500) comprising at least one ejection module (560), each ejection module configured for providing an ejection force generated under action of gas pressure provided by the actuation system (600; 1600), each ejection module comprising a tubular housing (562) accommodating a telescopic plunger element (564) comprising an end wall at a first longitudinal end thereof having a small opening, the telescopic plunger element being closed at a second longitudinal end thereof;

- an ejector system (500) comprising at least one ejection module (560), each ejection module configured for providing an ejection force generated under action of gas pressure provided by the actuation system (600; 1600), each ejection module comprising a tubular housing (562) accommodating a telescopic plunger element (564) comprising an end wall at a first longitudinal end thereof having a small opening, the telescopic plunger element being closed at a second longitudinal end thereof, wherein said second longitudinal end comprises a padded abutment element (566), configured for abutting against the stores (10) when this is engaged with the device

10. The device according to any one of claims 1 to 9, further comprising at least one sway braces (570).

11. The device according to any one of claims 1 to 10, including at least one of the following:

(i) wherein said lug engaging and releasing mechanism comprises a first kinematic chain (A) and a second kinematic chain (B);

(ii) wherein said lug engaging and releasing mechanism comprises a first kinematic chain (A) and a second kinematic chain (B), and including at least one of the following:

- wherein said first kinematic chain (A) comprises a first stressed link (340), a coupling plate (360), a first link (350), and said hook element (320);
- wherein said first kinematic chain (A) comprises a first stressed link (340), a coupling plate (360), a first link (350), and said hook element (340), and, wherein said second kinematic chain (B) comprises an anvil member (380), a second link (390), a pivoting member (370), and a second stressed link (240);
- wherein said first kinematic chain (A) comprises a first stressed link (340), a coupling plate (360), a first link (350), and said hook element (320), and, wherein said second kinematic chain (B) comprises an anvil member (380), a second link (390), a pivoting member (370), and a second stressed link (240), and, wherein said coupling plate and said anvil member are pivotable mounted to said housing coaxially about a pivot axis.

12. An air vehicle comprising at least one support and release device as defined in any one of claims 1 to 11.

13. A method for releasably supporting a store (10), the store having at least one lug (15), the method comprising:

(a) providing at least one support and release device as defined in any one of claims 1 to 11; and

(b) engaging the lug (15) with respect to the lug engagement release system (300; 1300) to thereby urge the lug engagement release system to the engaged configuration;

(c) coupling the safety lock (799; 1799) with respect to the device to provide the coupled mode.

14. A method according to claim 13, further comprising:

(d) uncoupling the safety lock (799; 1799) with respect to the device to provide the uncoupled mode;

(e) selectively operating the actuator system to thereby actuate said lug engagement release system (300; 1300) to enable the lug engagement release system to adopt the disengaged configuration, thereby enabling the lug engagement release system to release the lug therefrom.