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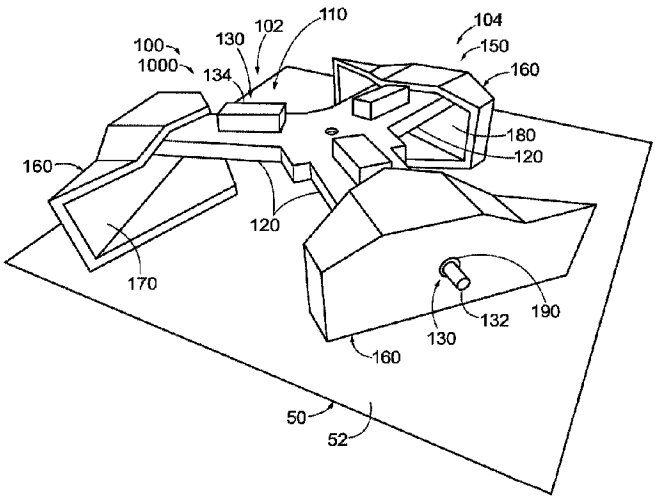

(57) Abrégé/Abstract:
A method and apparatus for transporting a payload with a vehicle involves engaging and disengaging the payload with a payload engagement system and transporting the payload with the vehicle. The apparatus includes a securement mechanism including at least one receptor including a securement receiver, on a vehicle supported portion or payload mounted portion, that selectively receives a corresponding at least one securement engager on an insert component of the payload mounted portion or the vehicle mounted portion, when the payload engagement system is in the engaged configuration. The vehicle supported portion is rotated relative to the payload mounted portion to transition the payload engagement system between a disengaged and an engaged configuration wherein in the engaged configuration the payload engagement system is at least partially restricted from transitioning into the disengaged configuration.

ABSTRACT

A method and apparatus for transporting a payload with a vehicle involves engaging and disengaging the payload with a payload engagement system and transporting the payload with the vehicle. The apparatus includes a securement mechanism including at least one receptor including a securement receiver, on a vehicle supported portion or payload mounted portion, that selectively receives a corresponding at least one securement engager on an insert component of the payload mounted portion or the vehicle mounted portion, when the payload engagement system is in the engaged configuration. The vehicle supported portion is rotated relative to the payload mounted portion to transition the payload engagement system between a disengaged and an engaged configuration wherein in the engaged configuration the payload engagement system is at least partially restricted from transitioning into the disengaged configuration.

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PAYLOAD ENGAGEMENT SYSTEMS, VEHICLES INCLUDING THE SAME, AND RELATED METHODS

FIELD

The present disclosure relates to payload engagement systems, vehicles including the same, and related methods.

BACKGROUND

Vehicles such as aircraft may be used to deliver payloads to a delivery site. For example, unmanned aerial vehicles (UAVs) may be used to transport packages substantially autonomously. However, such applications generally require human interaction to place a package in the UAV's cargo area and/or to otherwise couple the package to the UAV and/or uncouple the package from the UAV. Such human interaction with a UAV may necessitate the use of special procedures and/or apparatuses to ensure the safety of the human user, especially when the UAV is intended to interact with an untrained human user such as the end recipient of a delivered package. For example, human interaction with a UAV may require the UAV to land and/or power off to couple the package to the UAV and/or to uncouple the package from the UAV, resulting in downtime between delivery runs.

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SUMMARY

Payload engagement systems, vehicles including the same, and related methods are disclosed herein. A payload engagement system for selectively coupling a payload to a vehicle includes a vehicle supported portion configured to be supported by the vehicle and a payload mounted portion configured to be mounted on the payload. One of the vehicle supported portion and the payload mounted portion includes an insert component, and the other of the vehicle supported portion and the payload mounted portion includes a receptor component. The payload engagement system is configured to transition between a disengaged configuration and an engaged configuration at least partially via rotation of the insert component with respect to the receptor component. In the engaged configuration, the receptor component receives the insert component and engages the insert component such that the insert component is rotationally constrained within the receptor component to enable the vehicle to carry the payload.

A method of transporting a payload with a vehicle includes engaging the payload with a payload engagement system that includes a vehicle supported portion configured to be supported by the vehicle and a payload mounted portion configured to be mounted on the payload. The method further includes transporting the payload with the vehicle and disengaging the payload with the payload engagement system. The engaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from a disengaged configuration to an engaged configuration. The disengaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration.

In one embodiment, there is provided a payload engagement system for selectively coupling a payload to a vehicle. The payload engagement system includes a vehicle supported portion operable to be supported by the vehicle, a payload mounted portion operable to be mounted on the payload and a securement

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mechanism that includes at least one securement engager and at least one securement receiver. One of the vehicle supported portion and the payload mounted portion includes an insert component, the other of the vehicle supported portion and the payload mounted portion includes a receptor component. The payload engagement system is operable to transition between a disengaged configuration and an engaged configuration at least partially via rotation of the insert component with respect to the receptor component. In the engaged configuration, the receptor component receives the insert component and engages the insert component such that the insert component is rotationally constrained within the receptor component to enable the vehicle to carry the payload. The insert component includes the at least one securement engager and the receptor component includes the at least one securement receiver. Each securement receiver of the at least one securement receiver is operable to selectively receive a corresponding securement engager of the at least one securement engager when the payload engagement system is in the engaged configuration to at least partially restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

In one embodiment, there is provided a payload engagement system for selectively coupling a payload to a vehicle. The payload engagement system includes: a vehicle supported portion operable to be supported by the vehicle; and a payload mounted portion operable to be mounted on the payload. One of the vehicle supported portion and the payload mounted portion includes an insert component. The other of the vehicle supported portion and the payload mounted portion includes a receptor component. The payload engagement system is operable to transition between a disengaged configuration and an engaged configuration at least partially via rotation of the insert component with respect to the receptor component. In the engaged configuration, the receptor component receives the insert component and engages the insert component such that the insert component is rotationally constrained within the receptor component to enable the vehicle to carry the payload.

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The insert component may be configured to rotate with respect to the receptor component about at least one of an insert component central axis of the insert component, a receptor component central axis of the receptor component, and a vertical axis, when the payload engagement system transitions between the disengaged configuration and the engaged configuration.

The vehicle supported portion may include the insert component and the payload mounted portion may include the receptor component.

The vehicle supported portion may include the receptor component and the payload mounted portion may include the insert component.

The payload engagement system may be configured to transition between the disengaged configuration and the engaged configuration via translation of the insert component with respect to the receptor component along a/the vertical axis.

The payload engagement system may be configured to transition from the disengaged configuration to the engaged configuration via upward translation of the vehicle supported portion with respect to the payload mounted portion along the vertical axis subsequent to rotation of the insert component with respect to the receptor component, and the payload engagement system may be configured to transition from the engaged configuration to the disengaged configuration via downward translation of the vehicle supported portion with respect to the payload mounted portion along the vertical axis prior to rotation of the insert component with respect to the receptor component.

The upward translation of the vehicle supported portion with respect to the payload mounted portion may cause the insert component to be rotationally constrained within the receptor component.

The downward translation of the vehicle supported portion with respect to the payload mounted portion may cause the insert component to be free to rotate with respect to the receptor component.

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The insert component may include at least two insert arms.

The at least two insert arms may consist of one of two insert arms, three insert arms, four insert arms, and more than four insert arms.

The receptor component may include at least two receptor units corresponding to the at least two insert arms.

The at least two receptor units may consist of one of two receptor units, three receptor units, four receptor units, and more than four receptor units.

Each insert arm may be removed from a corresponding receptor unit when the payload engagement system is in the disengaged configuration, and each insert arm may be received within the corresponding receptor unit when the payload engagement system is in the engaged configuration.

The at least two insert arms may be distributed about a/the insert component central axis of the insert component. The at least two receptor units may be distributed about a/the receptor component central axis of the receptor component, and the insert component central axis and the receptor component central axis may be at least substantially parallel when the payload engagement system transitions between the disengaged configuration and the engaged configuration.

The insert component central axis and the receptor component central axis may be at least substantially collinear when the payload engagement system transitions between the disengaged configuration and the engaged configuration.

Each insert arm may extend radially from the insert component central axis.

Each of the at least two insert arms may extend within an insert component plane of the insert component. Each of the at least two receptor units may be positioned within a receptor component plane of the receptor component, and the insert component plane and the receptor component plane may be at least

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substantially parallel when the payload engagement system transitions between the disengaged configuration and the engaged configuration.

The insert component plane and the receptor component plane may be at least substantially coplanar with the payload engagement system transitions between the disengaged configuration and the engaged configuration.

In the engaged configuration, the insert component may engage the receptor component such that a weight of the payload is supported by the vehicle supported portion.

The payload engagement system may be configured to support a payload weight that is at least **10** Newtons (N), at least **30** N, at least **50** N, at least **100** N, at least **300** N, at least **500** N, at most **1000** N, at most **700** N, at most **200** N, at most **70** N, and at most **20** N while the vehicle carries the payload.

Each receptor unit may be configured to be mounted on an upper surface of the payload, optionally a generally planar upper surface of the payload.

Each receptor unit may include at least one side wall and at least one upper wall.

Each receptor unit may include a receptor base that extends from a/the upper surface of the payload when the receptor unit is mounted on the payload.

Each receptor unit may include a ramp portion that extends between the upper surface of the payload and a/the receptor base and oblique to the upper surface when the receptor unit is mounted on the payload.

Each ramp portion may be configured to facilitate a corresponding insert arm entering the receptor unit.

The corresponding insert arm may include an insert arm base, and the ramp portion may be configured to engage the insert arm base to at least partially guide

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the insert arm into the receptor unit when the payload engagement system is transitioned from the disengaged configuration to the engaged configuration.

The insert arm base may be at least partially rounded to facilitate the insert arm base entering and exiting the receptor unit via contact with the ramp portion.

Each receptor unit may include an antechamber and a locking chamber; wherein the antechamber has an antechamber height. The locking chamber may have a locking chamber height. The locking chamber height may be greater than the antechamber height.

The antechamber height may be measured between a/the receptor base and a/the upper wall in the antechamber and in a direction parallel to a/the receptor component central axis, and the locking chamber height may be measured between the receptor base and the upper wall in the locking chamber and in the direction parallel to the receptor component central axis.

The antechamber height may be measured between a/the upper surface of the payload and a/the upper wall in the antechamber and in a direction parallel to a/the receptor component central axis when the receptor unit is mounted on the upper surface of the payload, and the locking chamber height may be measured between the upper surface of the payload and the upper wall in the locking chamber and in the direction parallel to the receptor component central axis when the receptor unit is mounted on the upper surface of the payload.

Each insert arm may have an insert arm height, as measured in a direction parallel to a/the insert component central axis. At least one of the antechamber height and the locking chamber height may be at least one of at least **100**% of the insert arm height, at least **120**% of the insert arm height, at least **140**% of the insert arm height, at least **160**% of the insert arm height, at least **180**% of the insert arm height, at most **200**% of the insert arm height, at most **170**% of the insert arm height,

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at most **150**% of the insert arm height, at most **130**% of the insert arm height, and at most **110**% of the insert arm height.

The upper wall may include a transition region between the antechamber and the locking chamber, and the transition region may be at least one of ramped and smoothly curved.

The corresponding insert arm may be received in the locking chamber when the payload engagement system is in the engaged configuration.

The locking chamber may include a locking chamber recess configured to at least partially receive the corresponding insert arm when the payload engagement system is in the engaged configuration.

The locking chamber recess may be at least partially defined by at least one of a/the at least one side wall, a/the at least one upper wall, and a/the transition region.

The corresponding insert arm may pass through the antechamber when the payload engagement system is transitioned between the disengaged configuration and the engaged configuration.

When the payload engagement system is in the engaged configuration, the corresponding insert arm may be at least partially restricted from moving within the locking chamber by at least one of: a/the locking chamber recess; a/the at least one side wall; and a/the transition region of the upper wall.

The locking chamber height may be greater than the antechamber height by a recess depth that is at least one of at least **10**% of the locking chamber height, at least **20**% of the locking chamber height, at least **30**% of the locking chamber height, at least **40**% of the locking chamber height, at least **50**% of the locking chamber height, at most **55**% of the locking chamber height, at most **45**% of the locking chamber height, at most **35**% of the locking chamber height, at most **25**% of the locking chamber height, and at most **15**% of the locking chamber height.

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The insert component may include the at least one securement engager, and the receptor component may include the at least one securement receiver.

At least one insert arm may include the at least one securement engager, and a corresponding at least one receptor unit may include the at least one securement receiver.

Each securement engager may include at least one of a pin, a bolt, a latch, a hook, and a clasp.

Each securement receiver may include at least one of a hole, a circular hole, a slot, a vertical slot, an aperture, a bar, and a ledge.

Each securement receiver may be defined by at least one of a/the receptor base of the receptor unit, a/the side wall of the receptor unit, and a/the upper wall of the receptor unit.

The securement mechanism may be configured to be selectively transitioned between an unlocked configuration, in which the securement mechanism does not restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration, and a locked configuration, in which the securement mechanism at least partially restricts the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

The securement mechanism may be configured to transition between the unlocked configuration and the locked configuration when a/the insert arm is in a/the locking chamber.

The securement mechanism may be configured to transition between the unlocked configuration and the locked configuration only when the insert arm is received within a/the locking chamber recess of the locking chamber.

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Each securement engager of the at least one securement engager may extend through a corresponding securement receiver of the at least one securement receiver when the securement mechanism is in the locked configuration.

Each securement engager of the at least one securement engager may engage a/the corresponding securement receiver of the at least one securement receiver when the securement mechanism is in the locked configuration.

Each securement engager may be in an extended position when the securement mechanism is in the locked configuration, and wherein each securement engager is in a retracted position when the securement mechanism is in the unlocked configuration.

Each securement engager may be biased toward the extended position.

Each securement engager may be biased toward the retracted position.

The securement mechanism may further include at least one securement mechanism actuator configured to transition each securement engager between the extended position and the retracted position.

Each securement mechanism actuator may be configured to transition a single corresponding securement engager of the at least one securement engager between the extended position and the retracted position.

Each securement mechanism actuator may be configured to transition each of a plurality of securement engagers of the at least one securement engager between the extended position and the retracted position.

Each securement mechanism actuator may include at least one of a motor, a servomotor, a screw drive motor, a pneumatic actuator, and a hydraulic actuator.

The at least two insert arms may consist of three insert arms. The at least two receptor units may consist of three receptor units. The three insert arms are at least

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substantially evenly distributed about a/the insert component central axis. The three receptor units may be configured to be at least substantially evenly distributed about a/the receptor component central axis. Each insert arm may include a/the securement mechanism and a/the securement mechanism actuator. Each receptor unit may include a/the at least one upper wall that is supported by a/the at least one side wall. At least one upper wall may at least partially define a/the locking chamber recess. At least one side wall may at least partially define a/the locking chamber and may be configured to restrict a corresponding insert arm of the three insert arms from rotating out of the locking chamber. At least one side wall may at least partially defines the locking chamber and includes a/the securement receiver.

In another embodiment, there is provided a vehicle configured to transport a payload. The vehicle may include the vehicle supported portion of the payload engagement system described above or any of its variants.

The vehicle may be at least one of an aircraft, a land-based vehicle, a water vehicle, a submersible water vehicle, and a space vehicle.

The vehicle may be an unmanned aerial vehicle (UAV).

The UAV may be a remotely piloted UAV.

The UAV may be an autonomously controlled UAV.

The vehicle may be a rotorcraft.

The rotorcraft may include one of two rotors, three rotors, four rotors, and more than four rotors.

The vehicle may include an vehicle body, and the vehicle additionally may include a support structure that extends from the vehicle body and supports the vehicle supported portion of the payload engagement system.

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The support structure may include a gimbal configured to enable the vehicle supported portion to pivot with respect to the vehicle body.

The support structure may include a rotary element configured to rotate the vehicle supported portion about at least one of a/the insert component central axis and a/the receptor component central axis and with respect to the vehicle body.

In another embodiment, there is provided a method of transporting a payload with a vehicle. The method involves engaging the payload with a payload engagement system, transporting the payload with the vehicle and disengaging the payload with the payload engagement system. The payload engagement system includes a vehicle supported portion operable to be supported by the vehicle, a payload mounted portion operable to be mounted on the payload and a securement mechanism that includes at least one securement engager and at least one securement receiver. One of the vehicle supported portion and the payload mounted portion includes an insert component that includes the at least one securement engager and the other of the vehicle supported portion and the payload mounted portion includes a receptor component that includes the at least one securement receiver. The engaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from a disengaged configuration to an engaged configuration. The disengaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration. Each securement receiver of the at least one securement receiver is operable to selectively receive a corresponding securement engager of the at least one securement engager when the payload engagement system is in the engaged configuration to at least partially restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

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The payload engagement system may be the payload engagement system described above or any of its variants.

The vehicle may be the vehicle described above or any of its variants.

The engaging may include, prior to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration, aligning the insert component and the receptor component.

The aligning may include aligning such that a/the insert component central axis and a/the receptor component central axis are at least substantially parallel.

The aligning may include aligning such that the insert component central axis and the receptor component central axis are at least substantially collinear.

The aligning may include aligning such that a/the insert component plane and a/the receptor component plane are at least substantially parallel.

The aligning may include aligning such that a/the insert component plane and a/the receptor component plane are at least substantially coplanar.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration may include inserting each insert arm into a/the locking chamber of the respective receptor unit via a/the antechamber of the respective receptor unit.

The engaging may include, subsequent to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged

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configuration, lifting the vehicle supported portion with respect to the payload mounted portion such that each insert arm is at least partially received a/the locking chamber recess of a/the locking chamber of the respective receptor unit.

The lifting may include lifting such that each insert arm is rotationally constrained within the locking chamber recess of the respective receptor unit.

The lifting may include lifting such that each insert arm contacts a/the upper wall of the respective receptor unit.

The engaging may include securing the insert component in the engaged configuration via a/the at least one securement mechanism.

The securing may include transitioning each securement mechanism from a/the unlocked configuration to a/the locked configuration.

The securing may be performed subsequent to the lifting.

The securing may be performed prior to the lifting.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration may include rotating the vehicle with respect to the payload to rotate the insert component with respect to the receptor component.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration may include rotating the vehicle supported portion with respect to the vehicle with a/the rotary element to rotate the insert component with respect to the receptor component.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged

configuration to the engaged configuration may not include rotating the vehicle with respect to the payload mounted portion.

The transporting may include transporting such that a/the receptor component central axis remains at least substantially parallel to a/the vertical axis.

The transporting may include pivoting the vehicle supported portion with respect to the vehicle with a/the gimbal.

The pivoting may include pivoting the vehicle supported portion with respect to the vehicle such that the payload remains at least substantially upright as the vehicle tilts with respect to a ground surface.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration may include removing each insert arm from a/the locking chamber of the respective receptor unit via a/the respective antechamber of the respective receptor unit.

The disengaging may include, prior to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration, lowering the vehicle supported portion with respect to the payload mounted portion such that each insert arm is removed from a/the locking chamber recess of a/the locking chamber of the respective receptor unit.

The lowering may include lowering such that each insert arm contacts a/the receptor base of the respective receptor unit.

The disengaging may include releasing the insert component by transitioning each of a/the at least one securement mechanism from the locked configuration to the unlocked configuration.

The releasing may be performed subsequent to the lowering.

The releasing may be performed prior to the lowering.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration may include rotating the vehicle with respect to the payload to rotate the insert component with respect to the receptor component.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration may include rotating the vehicle supported portion with respect to the vehicle with a/the rotary element to rotate the insert component with respect to the receptor component.

The rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration may not include rotating the vehicle with respect to the payload mounted portion.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. **1** is a schematic front elevation view representing examples of payload engagement systems according to the present disclosure.

Fig. **2** is a schematic plan view representing examples of payload engagement systems according to the present disclosure.

Fig. **3** is a schematic front elevation view representing examples of receptor units according to the present disclosure.

Fig. **4** is a schematic front elevation view representing an insert arm transitioning from a disengaged configuration to an engaged configuration within a receptor unit according to the present disclosure.

Fig. **5** is a schematic side elevation view representing an insert arm received within a receptor unit and with a securement mechanism in an unlocked configuration according to the present disclosure.

Fig. **6** is a schematic side elevation view representing the insert arm and receptor unit of Fig. **5** with the securement mechanism in a locked configuration according to the present disclosure.

Fig. **7** is a side elevation view representing an insert arm with a securement engager in a retracted position according to the present disclosure.

Fig. **8** is a side elevation view representing the insert arm of Fig. **7** with the securement engager in an extended position according to the present disclosure.

Fig. **9** is a top perspective view representing a payload engagement system in a disengaged configuration according to the present disclosure.

Fig. **10** is a top perspective view representing the payload engagement system of Fig. **9** in an engaged configuration according to the present disclosure.

Fig. **11** is a side perspective view representing a payload engagement system in the locked configuration and with a securement mechanism in a locked configuration according to the present disclosure.

Fig. **12** is a flowchart depicting methods of transporting a payload with a vehicle according to the present disclosure.

DESCRIPTION

Figs. **1–12** provide illustrative, non-exclusive examples of payload engagement systems **100**, of vehicle **10** including portions of payload engagement systems **100**, and/or of methods **200** of transporting a payload with a vehicle, according to the present disclosure. Elements that serve a similar, or at least substantially similar, purpose are labeled with like numbers in each of Figs. **1–12**, and these elements may not be discussed in detail herein with reference to each of Figs. **1–12**. Similarly, all elements may not be labeled in each of Figs. **1–12**, but reference numerals associated therewith may be utilized herein for consistency. Elements, components, and/or features that are discussed herein with reference to one or more of Figs. **1–12** may be included in and/or utilized with any of Figs. **1–12** without departing from the scope of the present disclosure. Generally, in the figures, elements that are likely to be included in a given example are illustrated in solid lines, while elements that are optional to a given example are illustrated in dashed lines. However, elements that are illustrated in solid lines are not essential to all examples of the present disclosure, and an element shown in solid lines may be omitted from a particular example without departing from the scope of the present disclosure.

Figs. **1–2** are schematic illustrations of examples of payload engagement systems **100** and of payloads **50** according to the present disclosure. Fig. **1** additionally schematically illustrates an example of a vehicle **10** configured to

support at least a portion of payload engagement system **100** and to carry payload **50** via payload engagement system **100**. As schematically illustrated in Figs. **1–2**, a payload engagement system **100** for selectively coupling a payload **50** to a vehicle **10** (illustrated in Fig. **1**) includes a vehicle supported portion **102** configured to be supported by vehicle **10** and a payload mounted portion **104** configured to be mounted on payload **50**. One of vehicle supported portion **102** and payload mounted portion **104** includes an insert component **110**, and the other of vehicle supported portion **102** and payload mounted portion **104** includes a receptor component **150**. For example, in some examples of payload engagement system **100**, vehicle supported portion **102** includes and/or is insert component **110**, and payload mounted portion **104** includes and/or is receptor component **150**. However, this is not required to all examples of payload engagement system **100** according to the present disclosure, and it is additionally within the scope of the present disclosure that vehicle supported portion **102** includes and/or is receptor component **150** and that payload mounted portion **104** includes and/or is insert component **110**.

Payload engagement system **100** may be configured to be utilized in conjunction with any appropriate vehicle **10**. For example, and as schematically illustrated in Fig .**1**, vehicle **10** may include and/or be an aircraft **11**. However, this is not required to all payload engagement systems **100** according to the present disclosure, and it is additionally within the scope of the present disclosure that vehicle **10** may include and/or be any appropriate vehicle for carrying a payload, such as a land-based vehicle, a water vehicle, a submersible water vehicle, and/or a space vehicle.

In an embodiment of payload engagement system **100** configured to be utilized in conjunction with aircraft **11**, aircraft **11** may include and/or be any appropriate aircraft. As examples, aircraft **11** may include and/or be a rotorcraft, such as a rotorcraft that includes two rotors, three rotors, four rotors, or more than four rotors. Additionally or alternatively, aircraft **11** may include and/or be an unmanned aerial vehicle (UAV) and/or a drone. As more specific examples, aircraft

11 may be a remotely piloted UAV or may be an autonomously controlled UAV. Utilizing payload engagement system **100** in conjunction with aircraft **11** in the form of a UAV may facilitate transporting payload **50**, such as a package, with little or no human intervention needed to couple payload **50** to aircraft **11** or to uncouple payload **50** from aircraft **11**. Thus, for example, utilizing payload engagement system **100** in conjunction with aircraft **11** may facilitate coupling payload **50** to aircraft **11** or uncoupling payload **50** from aircraft **11** while aircraft **11** remains in flight, thereby increasing a delivery turnaround speed relative to a system in which aircraft **11** needs to land and/or power off between delivery runs.

Vehicle **10** may have any appropriate structure for supporting payload engagement system **100** and/or payload **50**. For example, and as schematically illustrated in Fig. **1**, vehicle **10** may include a vehicle body **12** and further may include a support structure **20** that extends from vehicle body **12** to support vehicle supported portion **102**. In such an embodiment, support structure **20** may include a gimbal **22** configured to enable vehicle supported portion **102** to pivot with respect to vehicle body **12**. Such a configuration may facilitate maintaining payload **50** in an upright orientation while vehicle **10** transports payload **50** independent of an orientation of vehicle **10**.

Payload engagement system **100** is configured to transition between a disengaged configuration and an engaged configuration at least partially via rotation of insert component **110** with respect to receptor component **150**. As an example, Fig. **2** schematically illustrates payload engagement system **100** in the disengaged configuration in dash-dot lines and schematically illustrates payload engagement system **100** in the engaged configuration in solid and dashed lines. Payload engagement system **100** may be configured such that insert component **110** rotates with respect to receptor component **150** about any appropriate axis. As an example, and as schematically illustrated in Figs. **1–2**, insert component **110** may have an insert component central axis **112**, and insert component **110** may be configured to rotate with respect to receptor component **150** about insert component central

axis **112** when payload engagement system **100** transitions between the disengaged configuration and the engaged configuration. Additionally or alternatively, and as additionally schematically illustrated in Figs. **1–2**, receptor component **150** may have a receptor component central axis **152**, and insert component **110** may be configured to rotate with respect to receptor component **150** about receptor component central axis **152** when payload engagement system **100** transitions between the disengaged configuration and the engaged configuration. As another example, and as further schematically illustrated in Figs. **1–2**, insert component **110** may be configured to rotate with respect to receptor component **150** about a vertical axis **106** when payload engagement system **100** transitions between the disengaged configuration and the engaged configuration.

In the engaged configuration, receptor component **150** receives and engages insert component **110** such that insert component **110** is rotationally constrained within receptor component **150** and such that a weight of payload **50** is supported by vehicle supported portion **102**. Stated differently, when payload engagement system **100** is in the engaged configuration, receptor component **150** engages insert component **110** such that vehicle **10** is enabled to lift payload mounted portion **104**, and hence payload **50**, via vehicle supported portion **102**. In this manner, the engagement between insert component **110** and receptor component **150** enables vehicle **10** to carry payload **50** when payload engagement system **100** is in the engaged configuration. As more specific examples, payload engagement system **100** may be configured to support a payload weight that is at least **10** Newtons (N), at least **30** N, at least **50** N, at least **100** N, at least **300** N, at least **500** N, at most **1000** N, at most **700** N, at most **200** N, at most **70** N, and/or at most **20** N while the vehicle carries payload **50**. The rotational constraint of insert component **110** within receptor component **150** when payload engagement system **100** is in the engaged configuration restricts payload engagement system **100** from transitioning to the disengaged configuration while vehicle **10** carries payload **50**.

Payload engagement system **100** may be configured to rotate insert component **110** with respect to receptor component **150** in any appropriate manner. As an example, payload engagement system **100** may be configured to transition between the disengaged configuration and the engaged configuration via rotation of vehicle **10** with respect to payload **50** about insert component central axis **112** and/or receptor component central axis **152**. Additionally or alternatively, and as schematically illustrated in Fig. **1**, support structure **20** may include a rotary element **24** configured to rotate vehicle supported portion **102** with respect to vehicle body **12** and about insert component central axis **112** and/or receptor component central axis **152**. In such an embodiment, vehicle **10** may not rotate with respect to payload **50** while payload engagement system **100** transitions between the disengaged configuration and the engaged configuration. By contrast, in an embodiment that lacks rotary element **24**, transitioning payload engagement system **100** between the disengaged configuration and the engaged configuration may require and/or correspond to a rotation of vehicle **10** and/or vehicle body **12** with respect to payload **50**. Stated differently, in an embodiment that lacks rotary element **24**, transitioning payload engagement system **100** between the disengaged configuration and the engaged configuration may require and/or correspond to vehicle body **12** and vehicle supported portion **102** rotating at least substantially in unison.

In some examples of payload engagement system **100**, payload engagement system **100** is configured to transition between the disengaged configuration and the engaged configuration via translation of insert component **110** with respect to receptor component **150** along (i.e., in a direction parallel to) vertical axis **106**. In such an example, the rotation of insert component **110** with respect to receptor component **150** and the translation along vertical axis **106** may take place sequentially. As a more specific example, payload engagement system **100** may be configured to transition from the disengaged configuration to the engaged configuration via upward translation of vehicle supported portion **102** with respect to payload mounted portion **104** along vertical axis **106** subsequent to rotation of insert component **110** with respect to receptor component **150**. Similarly, payload

engagement system **100** may be configured to transition from the engaged configuration to the disengaged configuration via downward translation of vehicle supported portion **102** with respect to payload mounted portion **104** along vertical axis **106** prior to rotation of insert component **110** with respect to receptor component **150**. In some examples of such an embodiment, the upward translation of vehicle supported portion **102** with respect to payload mounted portion **104** causes insert component **110** to be rotationally constrained within receptor component **150**, and the downward translation of vehicle supported portion **102** with respect to payload mounted portion **104** causes insert component **110** to be free to rotate with respect to receptor component **150**.

Insert component **110** and receptor component **150** may have any appropriate structure such that insert component **110** is selectively received within receptor component **150** as described herein. For example, and as schematically illustrated in Figs. **1–2**, insert component **110** may include at least two insert arms **120**, and receptor component **150** may include at least two receptor units **160** corresponding to the at least two insert arms **120**. As more specific examples, insert component **110** may include two insert arms **120**, three insert arms **120**, four insert arms **120**, or more than four insert arms **120**. Similarly, receptor component **150** may include two receptor units **160**, three receptor units **160**, four receptor units **160**, or more than four receptor units **160**.

As a more specific example, in some embodiments of payload engagement system **100**, insert component **110** includes three insert arms **120** and receptor component **150** includes three receptor units **160**. Such a configuration may produce a more stable and/or secure engagement between insert component **110** and receptor component **150** relative to an otherwise identical payload engagement system **100** that includes fewer insert arms **120** and/or fewer receptor units **160**. Such a configuration additionally may have a smaller weight and/or materials cost, and/or may permit a less strict manufacturing tolerance, relative to an otherwise identical payload engagement system **100** that includes more insert arms **120** and/or

more receptor units **160**. For example, an embodiment of payload engagement system **100** in which insert component **110** engages receptor component **150** at more than three points of contact (e.g., the points at which more than three insert arms **120** engage more than three respective receptor units **160**) may require precise manufacturing tolerances to ensure that each insert arm **120** remains in contact with a respective receptor unit **160** while vehicle **10** carries payload **50**. By contrast, an embodiment of payload engagement system **100** in which insert component **110** engages receptor component **150** at three points of contact (e.g., the points at which three insert arms **120** engage three respective receptor units **160**) may facilitate consistent contact between each insert arm **120** and each corresponding receptor unit **160** independent of slight variations in the positions of insert arms **120** and/or receptor units **160** relative to a manufacturing specification.

In the examples of payload engagement system **100** illustrated in Figs. **1–2** and **9–11**, the number of insert arms **120** is equal to the number of receptor units **160**. However, this is not required to all examples of payload engagement system **100** according to the present disclosure, and it is additionally within the scope of the present disclosure that payload engagement system **100** may include more insert arms **120** than receptor units **160** or fewer insert arms **120** than receptor units **160**.

Each receptor unit **160** may be configured to be coupled to and/or mounted to payload **50** in any appropriate manner. For example, and as schematically illustrated in Figs. **1–2**, each receptor unit **160** may be configured to be mounted on an upper surface **52** of payload **50**, such as a generally planar upper surface **52**. In some examples of payload engagement system **100** that include insert arms **120** and receptor units **160**, each insert arm **120** is removed from a corresponding receptor unit **160** when payload engagement system **100** is in the disengaged configuration, and is received within the corresponding receptor unit **160** when payload engagement system **100** is in the engaged configuration.

Payload engagement system **100** may be configured to transition between the disengaged configuration and the engaged configuration upon axial and/or vertical

alignment of insert component **110** and receptor component **150**. For example, and as schematically illustrated in Figs. **1–2**, in some embodiments of payload engagement system **100**, insert arms **120** are distributed about, and/or extend radially from, insert component central axis **112** of insert component **110**, and receptor units **160** are distributed about receptor component central axis **152** of receptor component **150**. In some examples of such an embodiment, insert component central axis **112** and receptor component central axis **152** are at least substantially parallel and/or at least substantially collinear when payload engagement system **100** transitions between the disengaged configuration and the engaged configuration. As another example, and as schematically illustrated in Figs. **1–2**, in some embodiments of payload engagement system **100**, each insert arm **120** extends within an insert component plane **114** of insert component **110**, and each receptor unit **160** is positioned within a receptor component plane **154** of receptor component **150**. In some examples of such an embodiment, insert component plane **114** and receptor component plane **154** are at least substantially parallel and/or at least substantially coplanar when payload engagement system **100** transitions between the disengaged configuration and the engaged configuration.

Fig. **3** schematically illustrates examples of receptor units **160**, and Fig. **4** schematically illustrates an example of a spatial relationship between receptor unit **160** and insert arm **120** while payload engagement system **100** is transitioned from the disengaged configuration to the engaged configuration. As schematically illustrated in Figs. **3–4**, receptor unit **160** generally includes and/or is at least partially defined by at least one side wall **162** and at least one upper wall **164**. Receptor unit **160** additionally may include a receptor base **166** that extends from upper surface **52** of payload **50** when receptor unit **160** is mounted on payload **50**. In such an embodiment, receptor unit **160** may be mounted to payload **50** via receptor base **166**, such as by affixing, adhering, and/or mechanically connecting receptor base **166** to upper surface **52**. However, this is not required to all examples of payload engagement system **100** according to the present disclosure, and it is additionally

within the scope of the present disclosure that receptor unit **160** may lack receptor base **166**, and or may be mounted to payload **50** via at least one side wall **162**.

In some examples of an embodiment of receptor unit **160** that includes receptor base **166**, and as schematically illustrated in Figs. **3–4**, receptor unit **160** additionally includes a ramp portion **168** that extends between upper surface **52** of payload **50** and receptor base **166** when receptor unit **160** is mounted on payload **50**. More specifically, when present, ramp portion **168** extends oblique to upper surface **52**, such as to facilitate insert arm **120** entering receptor unit **160** when payload engagement system **100** transitions from the disengaged configuration to the engaged configuration. As a more specific example, and as schematically illustrated in Fig. **4**, insert arm **120** may include an insert arm base **124** such that ramp portion **168** is configured to engage insert arm base **124** to at least partially guide insert arm **120** into receptor unit **160** when payload engagement system **100** is transitioned from the disengaged configuration to the engaged configuration. As a more specific example, and as additionally schematically illustrated in Fig. **4**, insert arm base **124** may be at least partially rounded, such as to facilitate insert arm base **124** entering and/or exiting receptor unit **160** via contact with ramp portion **168**.

Receptor unit **160** may have any appropriate form and/or structure for receiving insert arm **120**. For example, and as schematically illustrated in Figs. **3–4**, some examples of receptor unit **160** include and/or define an antechamber **170** and a locking chamber **180**. In such an embodiment, and as schematically illustrated in Fig. **3**, antechamber **170** may be characterized by an antechamber height **172**, and locking chamber **180** may be characterized by a locking chamber height **182** that is greater than antechamber height **172**. In some examples of such an embodiment, upper wall **164** of receptor unit **160** includes a transition region **165** between antechamber **170** and locking chamber **180**, such that upper wall **164** is ramped and/or smoothly curved within transition region **165**.

Antechamber height **172** and/or locking chamber height **182** may be measured in any appropriate manner. For example, in an embodiment in which

receptor unit **160** includes receptor base **166**, antechamber height **172** may be measured between receptor base **166** and upper wall **164** in antechamber **170** and in a direction parallel to receptor component central axis **152**. Similarly, in such an embodiment, locking chamber height **182** may be measured between receptor base **166** and upper wall **164** in locking chamber **180** and in the direction parallel to receptor component central axis **152**. Alternatively, in an embodiment in which receptor unit **160** lacks receptor base **166**, antechamber height **172** may be measured between upper surface **52** of payload **50** and upper wall **164** in antechamber **170** and in the direction parallel to receptor component central axis **152** when receptor unit **160** is mounted to upper surface **52**. Similarly, in such an embodiment, locking chamber height **182** may be measured between upper surface **52** of payload **50** and upper wall **164** in locking chamber **180** and in the direction parallel to receptor component central axis **152** when receptor unit **160** is mounted to upper surface **52**.

Antechamber height **172** and locking chamber height **182** may be any appropriate respective heights, such as relative to a dimension of insert arm **120**. For example, and as schematically illustrated in Fig. **4**, insert arm **120** may have and/or be characterized by an insert arm height **122**, as measured in a direction parallel to insert component central axis **112**, and antechamber height **172** and/or locking chamber height **182** each may be at least **100**% of insert arm height **122**, at least **120**% of insert arm height **122**, at least **140**% of insert arm height **122**, at least **160**% of insert arm height **122**, at least **180**% of insert arm height **122**, at most **200**% of insert arm height **122**, at most **170**% of insert arm height **122**, at most **150**% of insert arm height **122**, at most **130**% of insert arm height **122**, and/or at most **110**% of insert arm height **122**.

In an embodiment of receptor unit **160** that includes antechamber **170** and locking chamber **180**, and as schematically illustrated in Fig. **4**, receptor unit **160** generally is configured such that insert arm **120** passes through antechamber **170** when payload engagement system **100** is transitioned between the disengaged

configuration and the engaged configuration. As examples, in such an embodiment, insert arm **120** passes through antechamber **170** and subsequently enters locking chamber **180** when payload engagement system **100** transitions from the disengaged configuration to the engaged configuration, and insert arm **120** passes through antechamber **170** and subsequently exits receptor unit **160** when payload engagement system transitions from the engaged configuration to the disengaged configuration.

In an embodiment of receptor unit **160** that includes antechamber **170** and locking chamber **180**, locking chamber **180** generally is configured such that a corresponding insert arm **120** is received in locking chamber **180** when payload engagement system **100** is in the engaged configuration. More specifically, and as schematically illustrated in Fig. **4**, in an embodiment in which locking chamber height **182** is greater than antechamber height **172**, locking chamber **180** may be described as including a locking chamber recess **184** configured to at least partially receive insert arm **120** when payload engagement system **100** is in the engaged configuration. Locking chamber recess **184** may be at least partially defined by side wall **162**, upper wall **164**, and/or transition region **165**. In such an embodiment, locking chamber **180** and/or locking chamber recess **184** at least partially restricts insert arm **120** from moving within locking chamber **180** and/or rotating (such as about insert component central axis **112**) when payload engagement system **100** is in the engaged configuration. More specifically, when payload engagement system **100** is in the engaged configuration, insert arm **120** is at least partially restricted from moving within locking chamber **180** by locking chamber recess **184**, side wall **162**, upper wall **164**, and/or transition region **165**. In this manner, locking chamber **180** and/or locking chamber recess **184** may facilitate maintaining payload engagement system **100** in the engaged configuration while vehicle **10** carries payload **50**.

Locking chamber recess **184** may have any appropriate dimension, such as to securely receive insert arm **120** and/or to securely restrict motion of insert arm **120**. For example, and as schematically illustrated in Fig. **3**, locking chamber recess

184 may have and/or be characterized by a recess depth **186** that is at least **10**% of locking chamber height **182**, at least **20**% of locking chamber height **182**, at least **30**% of locking chamber height **182**, at least **40**% of locking chamber height **182**, at least **50**% of locking chamber height **182**, at most **55**% of locking chamber height **182**, at most **45**% of locking chamber height **182**, at most **35**% of locking chamber height **182**, at most **25**% of locking chamber height **182**, and/or at most **15**% of locking chamber height **182**. Additionally or alternatively, recess depth **186** may describe and/or correspond to a difference between locking chamber height **182** and antechamber height **172**.

When payload engagement system **100** is in the engaged configuration, insert arm **120** may be restricted from exiting locking chamber **180** in any appropriate manner. As an example, as vehicle **10** carries payload **50**, a force of gravity may at least partially retain insert arm **120** within locking chamber recess **184** by restricting insert arm **120** from translating vertically downward with respect to locking chamber recess **184**, as may be required for insert arm **120** to exit locking chamber **180** (and hence receptor unit **160**). Additionally or alternatively, and as schematically illustrated in Figs. **1–2** and **4–6**, insert component **110** may include a securement mechanism **130** configured to at least partially restrict payload engagement system **100** from transitioning from the engaged configuration to the disengaged configuration. More specifically, when present, securement mechanism **130** includes a securement engager **132** and a securement receiver **190** configured to selectively receive securement engager **132** to at least partially restrict payload engagement system **100** from transitioning from the engaged configuration to the disengaged configuration. When present, securement mechanism **130** is configured to be selectively transitioned between an unlocked configuration and a locked configuration. Specifically, in the unlocked configuration, securement mechanism **130** does not restrict payload engagement system **100** from transitioning from the engaged configuration to the disengaged configuration, whereas in the locked configuration, securement mechanism **130** at least partially restricts payload

engagement system **100** from transitioning from the engaged configuration to the disengaged configuration.

Securement mechanism **130** may be incorporated into payload engagement system **100** in any appropriate manner. For example, in some examples of payload engagement system **100**, insert component **110** includes securement engager **132**, and receptor component **150** includes securement receiver **190**. More specifically, at least one insert arm **120** may include securement engager **132**, and at least one corresponding receptor unit **160** may include securement receiver **190**. For example, securement receiver **190** may be defined by side wall **162**, upper wall **164**, and/or receptor base **166** of receptor unit **160**. In such an embodiment, securement receiver **190** receives securement engager **132** to at least partially restrict payload engagement system **100** from transitioning from the engaged configuration to the disengaged configuration.

Securement mechanism **130**, securement engager **132**, and/or securement receiver **190** may have any appropriate structure. As examples, securement engager **132** may include and/or be a pin, a bolt, a latch, a hook, and/or a clasp. As additional examples, securement receiver **190** may include and/or be a hole, a circular hole, a slot, a vertical slot, an aperture, a bar, and/or a ledge. Securement receiver **190** may be configured to receive securement engager **132** in any appropriate manner. For example, securement engager **132** may extend through securement receiver **190** and/or may engage securement receiver **190** when securement mechanism **130** is in the locked configuration.

Fig. **3** schematically illustrates examples of securement receiver **190** in the form of a circular hole (dashed lines in Fig. **3**) and a vertical slot (dash-dot lines in Fig. **3**), while Fig. **4** schematically illustrates an example of securement receiver **190** in the form of a circular hole. In an embodiment of securement mechanism **130** in which securement receiver **190** takes the form of a hole, and as schematically illustrated in Fig. **4**, securement mechanism **130** may be configured to transition between the unlocked configuration and the locked configuration only when insert

arm **120** is received within locking chamber recess **184**. Alternatively, in an embodiment of securement mechanism **130** in which securement receiver **190** takes the form of a vertical slot, securement receiver **190** may permit securement engager **132** to translate vertically within securement receiver **190**. Such an embodiment may permit securement mechanism **130** to be transitioned between the unlocked configuration and the locked configuration when insert arm **120** is in locking chamber **180**, regardless of whether insert arm **120** is in locking chamber recess **184**.

Fig. **5** schematically illustrates an example of a portion of payload engagement system **100** with securement mechanism **130** in the unlocked configuration, and Fig. **6** schematically illustrates the portion of payload engagement system **100** of Fig. **5** with securement mechanism **130** in the locked configuration. In the example of Figs. **5–6**, securement engager **132** takes the form of a pin and securement receiver **190** takes the form of a hole such that securement engager **132** extends through securement receiver **190** when securement mechanism **130** is in the locked configuration. As schematically illustrated in Figs. **5–6**, securement engager **132** may be described as being in an extended position when securement mechanism **130** is in the locked configuration (Fig. **6**), and may be described as being in a retracted position when securement mechanism **130** is in the unlocked configuration (Fig. **5**). Securement engager **132** may be biased toward the extended position, may be biased toward the retracted position, or may not be biased toward either of the extended position and the retracted position.

As further schematically illustrated in Figs. **5–6**, securement mechanism **130** additionally may include a securement mechanism actuator **134** configured to transition each securement engager **132** between the extended position and the retracted position. When present, securement mechanism actuator **134** is configured to transition a corresponding securement engager **132** between the extended position and the retracted position. For example, in an embodiment of securement mechanism **130** that includes more than one securement engager **132**, each securement engager **132** may be transitioned between the extended position and

the retracted position by a unique corresponding securement mechanism actuator **134**. Alternatively, in an embodiment of securement mechanism **130** that includes more than one securement engagers **132**, securement mechanism actuator **134** may be configured to transition each of a plurality of corresponding securement engagers **132** between the extended position and the retracted position. Securement mechanism actuator **134** may include and/or be any appropriate mechanism for selectively transitioning securement engager **132** between the extended position and the retracted position. As examples, securement mechanism actuator **134** may include and/or be a motor, a servomotor, a screw drive motor, a pneumatic actuator, and/or a hydraulic actuator.

Figs. **7–11** illustrate portions of a payload engagement system **1000**, which is an example of payload engagement system **100** according to the present disclosure. Specifically, in the example of Figs. **7–11**, vehicle supported portion **102** of payload engagement system **1000** includes insert component **110**, and payload mounted portion **104** of payload engagement system **1000** includes receptor component **150**. As seen in Figs. **7–8**, payload engagement system **1000** includes securement mechanism **130** with securement engager **132** in the form of a pin. Specifically, Fig. **7** illustrates securement engager **132** in the retracted position, and Fig. **8** illustrates securement engager **132** in the extended position.

As seen in Figs. **9–11**, payload engagement system **1000** includes three insert arms **120** and three receptor units **160**. Specifically, Fig. **9** illustrates payload engagement system **1000** in the disengaged configuration, while Figs. **10–11** illustrate payload engagement system **1000** in the engaged configuration. More specifically, Fig. **10** illustrates payload engagement system **1000** in the engaged configuration and with securement mechanism **130** in the unlocked configuration, while Fig. **11** illustrates payload engagement system **1000** in the engaged configuration and with securement mechanism **130** in the locked configuration.

Fig. **12** is a flowchart depicting methods **200**, according to the present disclosure, of transporting a payload with a vehicle. As shown in Fig. **12**, a method

200 includes engaging, at **210**, a payload (such as payload **50**) with a payload engagement system (such as payload engagement system **100**); transporting, at **230**, the payload with a vehicle (such as vehicle **10**); and disengaging, at **250**, the payload with the payload engagement system. Specifically, a method **200** includes utilizing a payload engagement system that includes a vehicle supported portion (such as vehicle supported portion **102**) that is supported by the vehicle and a payload mounted portion (such as payload mounted portion **104**) that is mounted to the payload. More specifically, one of the vehicle supported portion and the payload mounted portion includes and/or is an insert component (such as insert component **110**), and the other of the vehicle supported portion and the payload mounted portion includes and/or is a receptor component (such as receptor component **150**) such that the insert component is selectively received within the receptor component.

The engaging at **210** includes rotating, at **214**, the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from a disengaged configuration to an engaged configuration. Similarly, the disengaging at **250** includes rotating, at **254**, the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration. The rotating at **214** and the rotating at **254** may be performed in any appropriate manner. For example, the rotating at **214** and/or the rotating at **254** may include rotating the vehicle with respect to the payload to rotate the insert component with respect to the receptor component. Additionally or alternatively, the vehicle supported portion may be coupled to the vehicle via a rotary element (such as rotary element **24**), and the rotating at **214** and/or the rotating at **254** may include rotating the vehicle supported portion with respect to the vehicle with the rotary element to rotate the insert component with respect to the receptor component. In such an embodiment, the rotating at **214** and/or the rotating at **254** may not include rotating the vehicle with respect to the payload mounted portion.

Methods **200** may be performed with and/or utilize a payload engagement system in which the insert component includes at least two insert arms (such as insert arms **120**) and the receptor component includes at least two receptor units (such as receptor units **160**). More specifically, each receptor unit may include an antechamber (such as antechamber **170**) and a locking chamber (such as locking chamber **180**). In such an embodiment, and as indicated in Fig. **12**, the rotating at **214** may include inserting, at **216**, each insert arm into the locking chamber of a respective receptor unit via the antechamber of the respective receptor unit. Similarly, in such an embodiment, and as further indicated in Fig. **12**, the rotating at **254** may include removing, at **256**, each insert arm from the locking chamber of the respective receptor unit via the antechamber of the respective receptor unit.

As indicated in Fig. **12**, the engaging at **210** may include aligning, at **212**, the insert component and the receptor component, such as prior to the rotating at **214**. The aligning at **212** may include aligning along any appropriate dimension, such as vertically aligning and/or axially aligning. For example, the aligning at **212** may include aligning such that an insert component central axis (such as insert component central axis **112**) and a receptor component central axis (such a receptor component central axis **152**) are at least substantially parallel and/or collinear. Additionally or alternatively, the aligning at **212** may include aligning such that an insert component plane (such as insert component plane **114**) and a receptor component plane (such as receptor component plane **154**) are at least substantially parallel and/or coplanar.

As additionally indicated in Fig. **12**, the engaging at **210** may include, subsequent to the rotating at **214**, lifting, at **218**, the vehicle supported portion with respect to the payload mounted portion such that each insert arm is at least partially received in a locking chamber recess (such as locking chamber recess **184**) of the locking chamber of the respective receptor unit. The lifting at **218** may include lifting such that each insert arm is rotationally constrained within each respective locking chamber. Additionally or alternatively, the lifting at **218** may include lifting such that

each insert arm contacts an upper wall (such as upper wall **164**) of the respective receptor unit.

As further indicated in Fig. **12**, the engaging at **210** additionally may include securing, at **220**, the insert component in the engaged configuration via at least one securement mechanism (such as securement mechanism **130**). The securing at **220** may include transitioning each securement mechanism from an unlocked configuration to a locked configuration, such as to at least partially restrict the payload engagement system from transitioning to the disengaged configuration. The lifting at **218** and the securing at **220** may be performed in any appropriate sequence. As examples, the securing at **220** may be performed prior to the lifting at **218**, or may be performed subsequent to the lifting at **218**.

The transporting at **230** may be performed in any appropriate manner. For example, the transporting at **230** may include transporting such that the receptor component central axis remains at least substantially parallel to a vertical axis (such as vertical axis **106**). As a more specific example, and as indicated in Fig. **12**, the transporting at **230** may include pivoting, at **232**, the vehicle supported portion with respect to the vehicle with a gimbal (such as gimbal **22**), such as to maintain the receptor component central axis in an orientation that is at least substantially parallel to the vertical axis. As a more specific example, in an embodiment in which the vehicle includes and/or is an aircraft (such as aircraft **11**), such as a rotorcraft and/or a UAV, the aircraft may tilt relative to a ground surface toward a direction in which the aircraft travels. In such an embodiment, the pivoting at **232** may include pivoting the vehicle supported portion with respect to the aircraft such that the payload remains at least substantially upright as the aircraft tilts with respect to the ground surface.

The disengaging at **250** may be performed in any appropriate manner. For example, and with continued reference to Fig. **12**, the disengaging at **250** may include, prior to the rotating at **254**, lowering, at **252**, the vehicle supported portion with respect to the payload mounted portion. Specifically, the lowering at **252**, when

performed, includes lowering such that each insert arm is removed from the locking chamber recess of the respective receptor unit, such as to permit the insert arm to rotate with respect to the receptor unit. The lowering at **252** may include lowering such that each insert arm contacts a receptor base (such as receptor base **166**) of the respective receptor unit.

As further indicated in Fig. **12**, in an embodiment in which the insert component includes at least one securement mechanism, the disengaging at **250** additionally may include releasing, at **258**, the insert component by transitioning each securement mechanism from the locked configuration to the unlocked configuration. The releasing at **258** may include releasing such that the securement mechanism ceases to restrict the payload engagement system from transitioning to the disengaged configuration. The lowering at **252** and the releasing at **258** may be performed in any appropriate sequence. As examples, the releasing at **258** may be performed prior to the lowering at **252**, or may be performed subsequent to the lowering at **252**.

As used herein, the terms "adapted" and "configured" mean that the element, component, or other subject matter is designed and/or intended to perform a given function. Thus, the use of the terms "adapted" and "configured" should not be construed to mean that a given element, component, or other subject matter is simply "capable of" performing a given function but that the element, component, and/or other subject matter is specifically selected, created, implemented, utilized, programmed, and/or designed for the purpose of performing the function. It is also within the scope of the present disclosure that elements, components, and/or other recited subject matter that is recited as being adapted to perform a particular function may additionally or alternatively be described as being configured to perform that function, and vice versa. Similarly, subject matter that is recited as being configured to perform a particular function may additionally or alternatively be described as being operative to perform that function.

As used herein, the term "and/or" placed between a first entity and a second entity means one of (**1**) the first entity, (**2**) the second entity, and (**3**) the first entity and the second entity. Multiple entries listed with "and/or" should be construed in the same manner, i.e., "one or more" of the entities so conjoined. Other entities optionally may be present other than the entities specifically identified by the "and/or" clause, whether related or unrelated to those entities specifically identified. Thus, as a non-limiting example, a reference to "A and/or B," when used in conjunction with open-ended language such as "comprising," may refer, in one example, to A only (optionally including entities other than B); in another example, to B only (optionally including entities other than A); in yet another example, to both A and B (optionally including other entities). These entities may refer to elements, actions, structures, steps, operations, values, and the like.

The various disclosed elements of apparatuses and systems and steps of methods disclosed herein are not required to all apparatuses, systems, and methods according to the present disclosure, and the present disclosure includes all novel and non-obvious combinations and subcombinations of the various elements and steps disclosed herein. Moreover, one or more of the various elements and steps disclosed herein may define independent inventive subject matter that is separate and apart from the whole of a disclosed apparatus, system, or method. Accordingly, such inventive subject matter is not required to be associated with the specific apparatuses, systems, and methods that are expressly disclosed herein, and such inventive subject matter may find utility in apparatuses, systems, and/or methods that are not expressly disclosed herein.

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A payload engagement system for selectively coupling a payload to a vehicle, the payload engagement system comprising:

a vehicle supported portion operable to be supported by the vehicle;

a payload mounted portion operable to be mounted on the payload; and

a securement mechanism that includes at least one securement engager and at least one securement receiver;

wherein one of the vehicle supported portion and the payload mounted portion includes an insert component;

wherein the other of the vehicle supported portion and the payload mounted portion includes a receptor component;

wherein the payload engagement system is operable to transition between a disengaged configuration and an engaged configuration at least partially via rotation of the insert component with respect to the receptor component;

wherein, in the engaged configuration, the receptor component receives the insert component and engages the insert component such that the insert component is rotationally constrained within the receptor component to enable the vehicle to carry the payload;

wherein the insert component includes the at least one securement engager, wherein the receptor component includes the at least one securement receiver, and

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wherein each securement receiver of the at least one securement receiver is operable to selectively receive a corresponding securement engager of the at least one securement engager when the payload engagement system is in the engaged configuration to at least partially restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

2. The payload engagement system of claim **1**, wherein the vehicle supported portion includes the insert component and the payload mounted portion includes the receptor component.

3. The payload engagement system of claim **1** or **2**, wherein the payload engagement system further is operable to transition between the disengaged configuration and the engaged configuration via translation of the insert component with respect to the receptor component along a vertical axis.

4. The payload engagement system of any one of claims **1** to **3**wherein the insert component includes at least two insert arms, and wherein the receptor component includes at least two receptor units corresponding to the at least two insert arms.

5. The payload engagement system of claim **4**, wherein the at least two insert arms are distributed about an insert component central axis of the insert component; wherein the at least two receptor units are distributed about a receptor component central axis of the receptor component; wherein each insert arm extends radially from the insert component central axis; and wherein the insert component central axis and the receptor component central axis are at least substantially parallel when the payload engagement system transitions between the disengaged configuration and the engaged configuration.

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6. The payload engagement system of claim **4** or **5**, wherein each receptor unit includes a ramp portion to facilitate a corresponding insert arm entering the receptor unit, and wherein the ramp portion extends between the upper surface of the payload and a receptor base of the receptor unit and oblique to the upper surface.

7. The payload engagement system of any one of claims **4** to **6**, wherein each receptor unit includes an antechamber and a locking chamber; wherein the antechamber has an antechamber height; wherein the locking chamber has a locking chamber height; wherein the locking chamber height is greater than the antechamber height; and wherein a corresponding insert arm is received in the locking chamber when the payload engagement system is in the engaged configuration.

8. The payload engagement system of any one of claims **4** to **7**, wherein the securement mechanism is selectively transitioned between an unlocked configuration, in which the securement mechanism does not restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration, and a locked configuration, in which the securement mechanism at least partially restricts the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

9. The payload engagement system of claim **8**, wherein each securement engager of the at least one securement engager extends through a corresponding securement receiver of the at least one securement receiver when the securement mechanism is in the locked configuration.

10. The payload engagement system of claim **9**, wherein:

each securement engager of the at least one securement engager includes at least one of a pin and a bolt; and

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each securement receiver of the at least one securement receiver includes at least one of a hole and an aperture through which the corresponding securement engager extends when the securement mechanism is in the locked configuration.

11. The payload engagement system of claim **8** or **9**, wherein:

each securement engager is in an extended position when the securement mechanism is in the locked configuration;

each securement engager is in a retracted position when the securement mechanism is in the unlocked configuration; and

the securement mechanism further includes at least one securement mechanism actuator operable to transition each securement engager between the extended position and the retracted position.

12. A vehicle operable to transport a payload, wherein the vehicle includes the vehicle supported portion of the payload engagement system of any one of claims **1** to **9**.

13. The vehicle of claim **12**, wherein the vehicle is an unmanned aerial vehicle (UAV).

14. The vehicle of claim **13**, wherein the vehicle includes a vehicle body, wherein the vehicle additionally includes a support structure that extends from the vehicle body and supports the vehicle supported portion of the payload engagement system, and wherein the support structure includes a rotary element operable to rotate the vehicle supported portion about at least one of an insert component central axis and a receptor component central axis and with respect to the vehicle body.

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15. A method of transporting a payload with a vehicle, the method comprising:

engaging the payload with a payload engagement system;

transporting the payload with the vehicle; and

disengaging the payload with the payload engagement system;

wherein the payload engagement system includes:

a vehicle supported portion operable to be supported by the vehicle;

a payload mounted portion operable to be mounted on the payload; and

a securement mechanism that includes at least one securement engager and at least one securement receiver;

wherein one of the vehicle supported portion and the payload mounted portion includes an insert component that includes the at least one securement engager; wherein the other of the vehicle supported portion and the payload mounted portion includes a receptor component that includes the at least one securement receiver;

wherein the engaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from a disengaged configuration to an engaged configuration;

wherein the disengaging includes rotating the vehicle supported portion with respect to the payload mounted portion to transition

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the payload engagement system from the engaged configuration to the disengaged configuration; and

wherein each securement receiver of the at least one securement receiver is operable to selectively receive a corresponding securement engager of the at least one securement engager when the payload engagement system is in the engaged configuration to at least partially restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration.

16. The method of claim **15**, wherein one of the vehicle supported portion and the payload mounted portion includes an insert component; wherein the other of the vehicle supported portion and the payload mounted portion includes a receptor component; and wherein the engaging includes, prior to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration, aligning the insert component and the receptor component.

17. The method of claim **15**, wherein one of the vehicle supported portion and the payload mounted portion includes an insert component; wherein the other of the vehicle supported portion and the payload mounted portion includes a receptor component; wherein the insert component includes at least two insert arms; wherein the receptor component includes at least two receptor units corresponding to the at least two insert arms; wherein each receptor unit includes an antechamber and a locking chamber; wherein the antechamber has an antechamber height; wherein the locking chamber has a locking chamber height; wherein the locking chamber height is greater than the antechamber height; and wherein the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged

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configuration includes inserting each insert arm into the locking chamber of a respective receptor unit via a respective antechamber of the respective receptor unit.

18. The method of claim **15**, wherein the engaging includes, subsequent to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the disengaged configuration to the engaged configuration, lifting the vehicle supported portion with respect to the payload mounted portion such that each insert arm is at least partially received in a locking chamber recess of the locking chamber of the respective receptor unit.

19. The method of claim **18**, wherein the disengaging includes, prior to the rotating the vehicle supported portion with respect to the payload mounted portion to transition the payload engagement system from the engaged configuration to the disengaged configuration, lowering the vehicle supported portion with respect to the payload mounted portion such that each insert arm is removed from the locking chamber recess of the locking chamber of the respective receptor unit.

20. The method of claim **15**, wherein the securement engager is operable to engage the securement receiver when the payload engagement system is in the engaged configuration to at least partially restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration; wherein the securement mechanism is operable to be selectively transitioned between an unlocked configuration, in which the securement mechanism does not restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration, and a locked configuration, in which the securement mechanism at least partially restricts the payload engagement system from transitioning from the engaged configuration to the disengaged configuration; and wherein the engaging includes securing the insert component in the

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engaged configuration by transitioning the securement mechanism from the unlocked configuration to the locked configuration.

21. The method of claim **20**, wherein the disengaging includes releasing the insert component by transitioning the securement mechanism from the locked configuration to the unlocked configuration.

22. The method of claim **15**, wherein the securement mechanism is operable to be selectively transitioned between an unlocked configuration, in which the securement mechanism does not restrict the payload engagement system from transitioning from the engaged configuration to the disengaged configuration, and a locked configuration, in which the securement mechanism at least partially restricts the payload engagement system from transitioning from the engaged configuration to the disengaged configuration; wherein each securement engager is in an extended position when the securement mechanism is in the locked configuration; wherein each securement engager is in a retracted position when the securement mechanism is in the unlocked configuration; and wherein the securement mechanism further includes at least one securement mechanism actuator operable to transition each securement engager between the extended position and the retracted position.

23. The method of claim **22**, wherein the engaging includes securing the insert component in the engaged configuration via the securement mechanism; and wherein the securing includes transitioning the securement mechanism from the unlocked configuration to the locked configuration with the at least one securement mechanism actuator.

24. The method of claim **15**, wherein the securement mechanism is operable to be selectively transitioned between an unlocked configuration, in which the securement mechanism does not restrict the payload engagement system from transitioning from the engaged configuration to the disengaged

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configuration, and a locked configuration, in which the securement mechanism at least partially restricts the payload engagement system from transitioning from the engaged configuration to the disengaged configuration; wherein each securement engager of the at least one securement engager includes at least one of a pin and a bolt; and wherein each securement receiver of the at least one securement receiver includes at least one of a hole and an aperture through which the corresponding securement engager extends when the securement mechanism is in the locked configuration.

25. The method of claim **24**, wherein the engaging includes securing the insert component in the engaged configuration via the securement mechanism; and wherein the securing includes transitioning the securement mechanism from the unlocked configuration to the locked configuration such that each securement engager of the at least one securement engager extends through a corresponding securement receiver of the at least one securement receiver.

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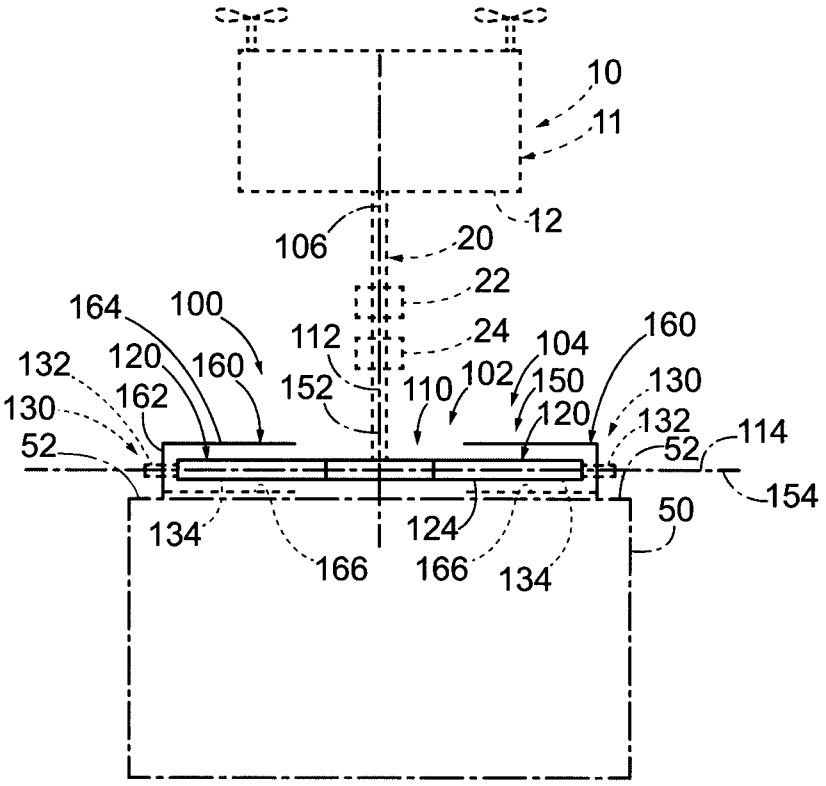
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FIG. 1

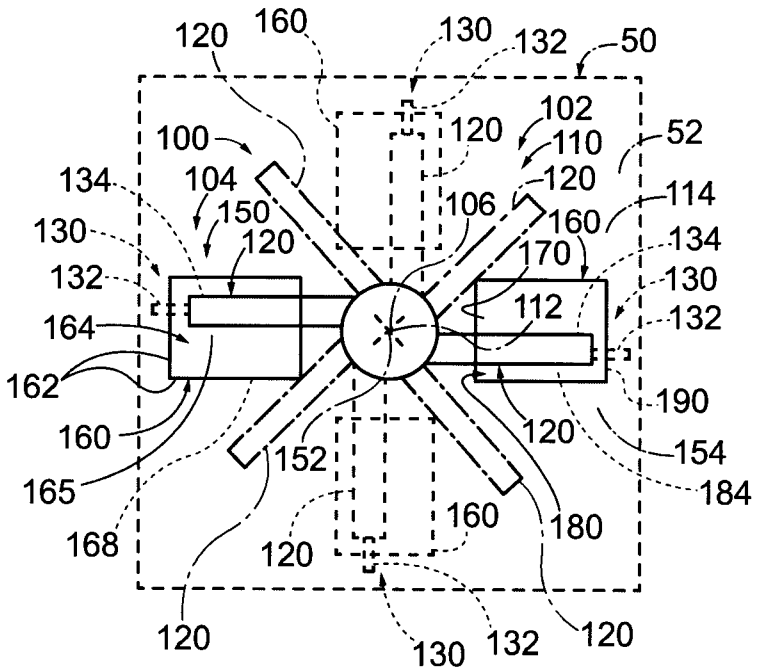
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FIG. 2

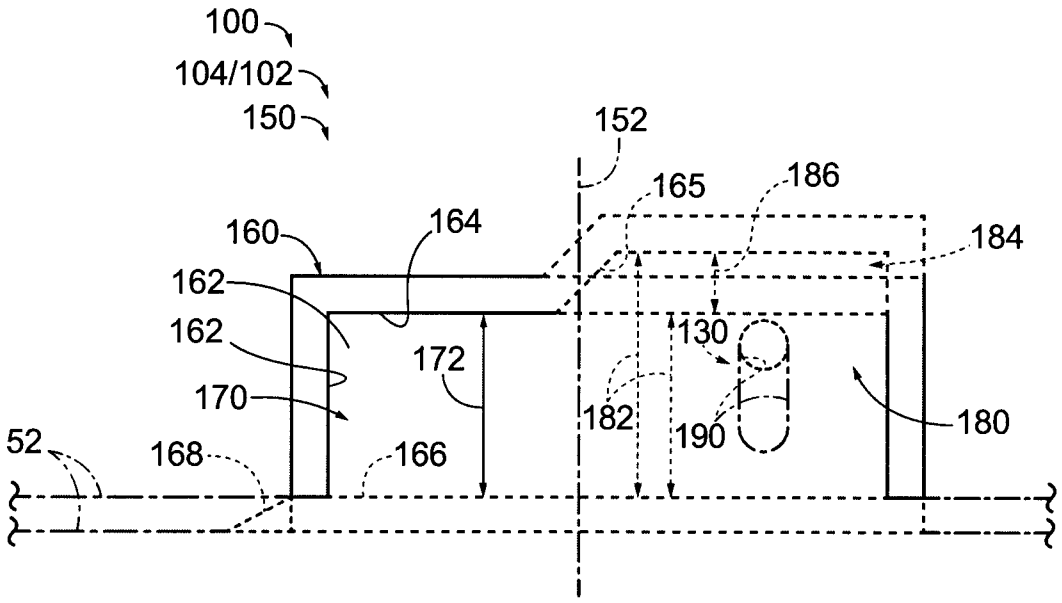
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FIG. 3

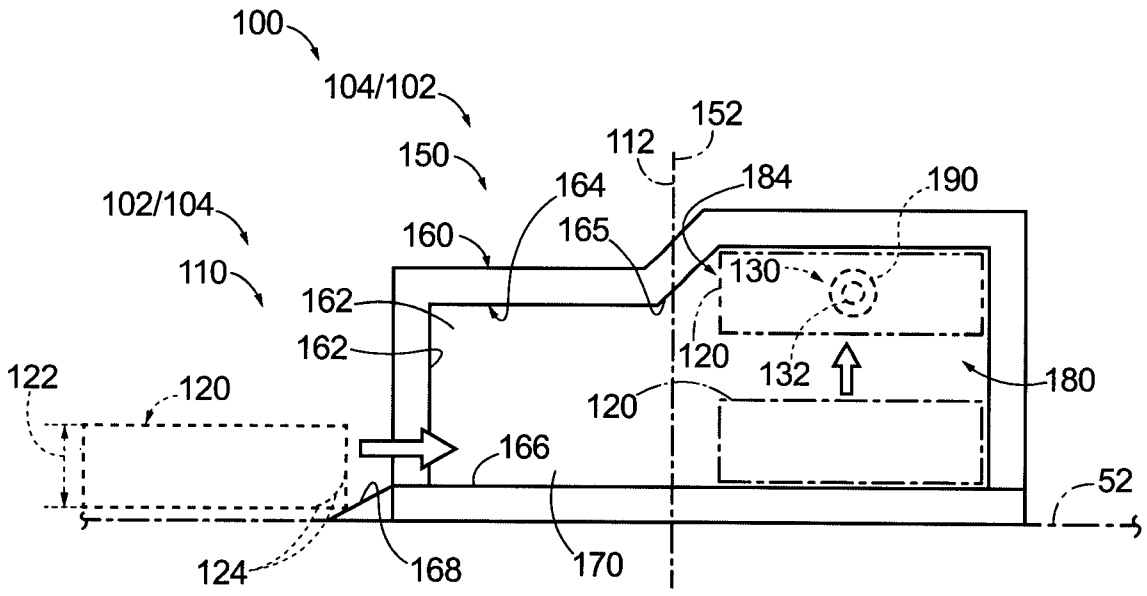
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FIG. 4

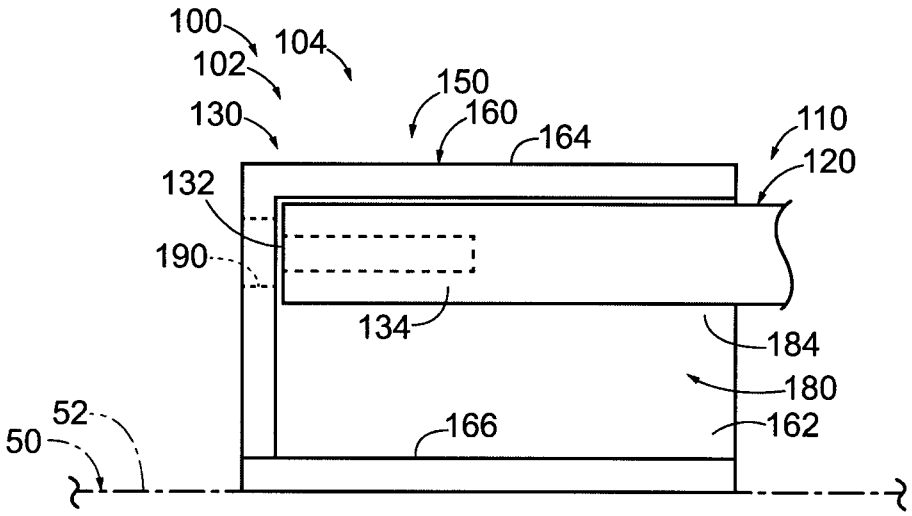
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FIG. 5

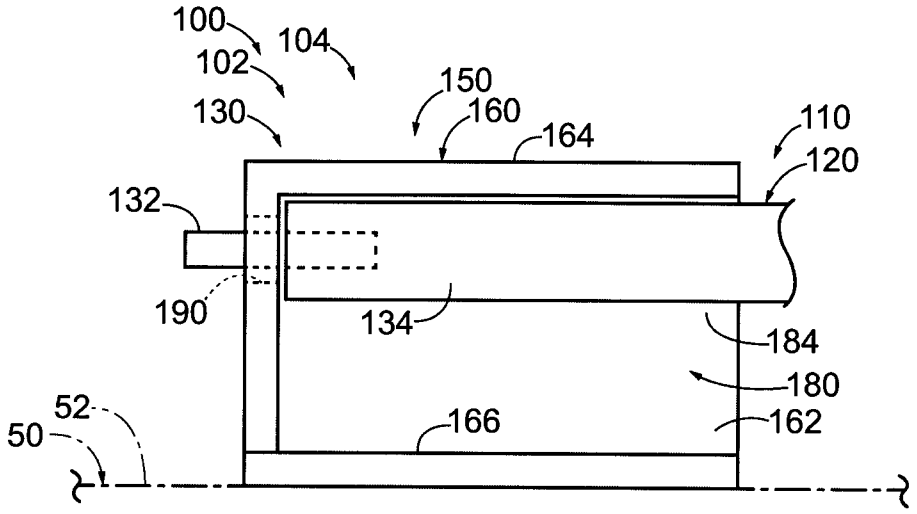
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FIG. 6

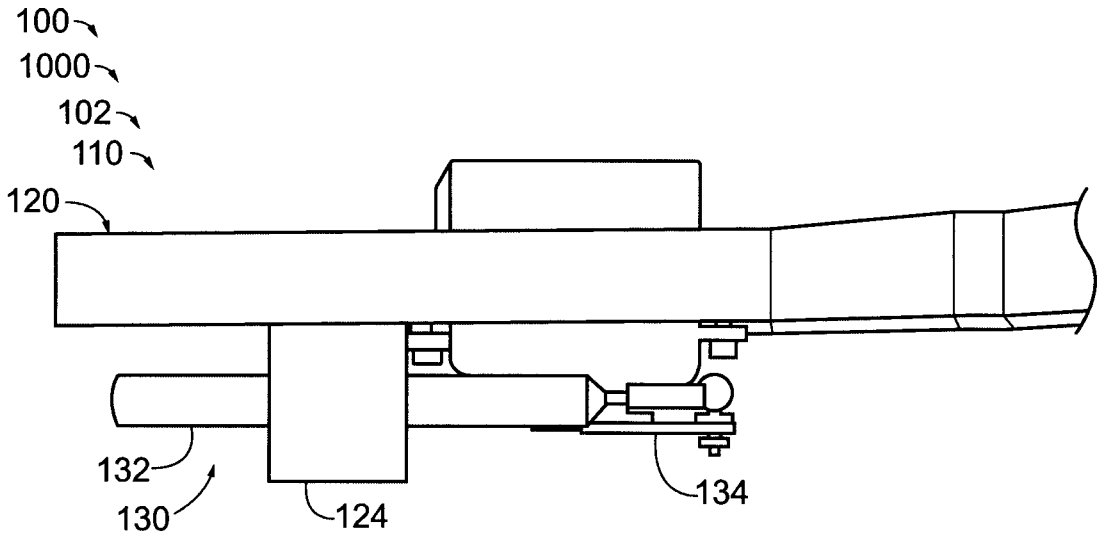
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FIG. 7

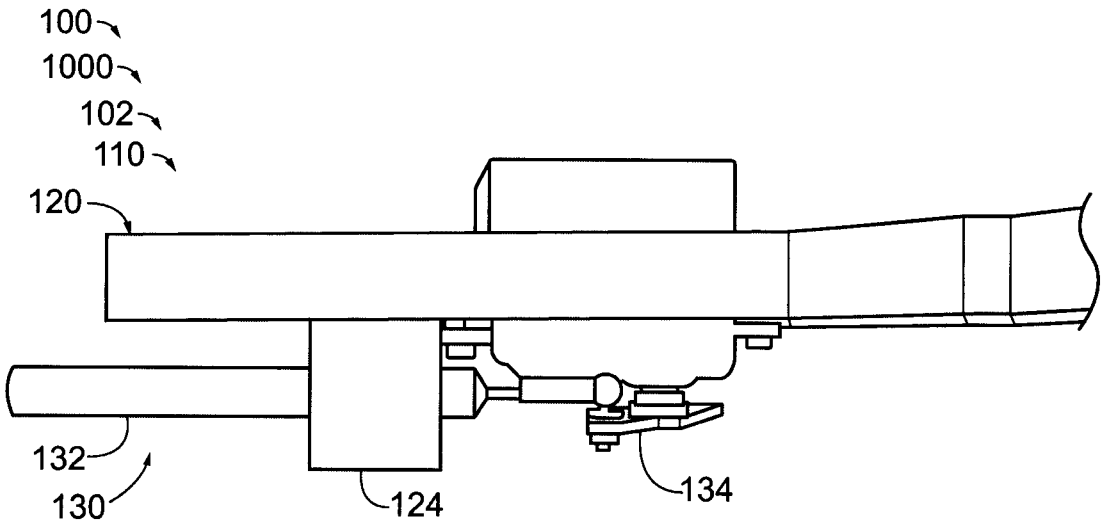
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FIG. 8

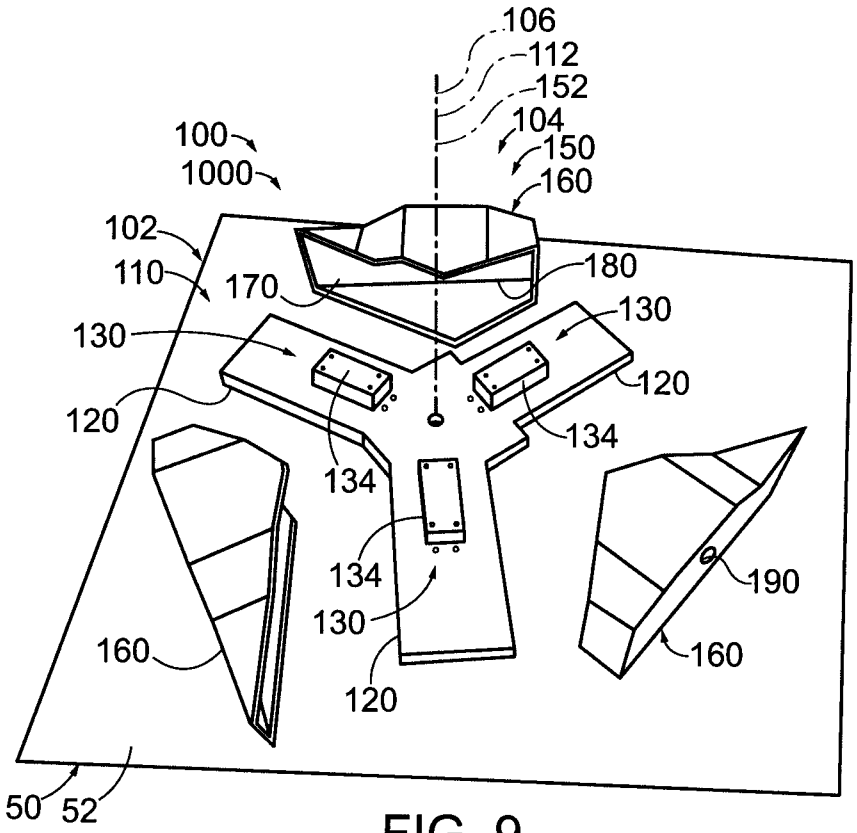
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FIG. 9

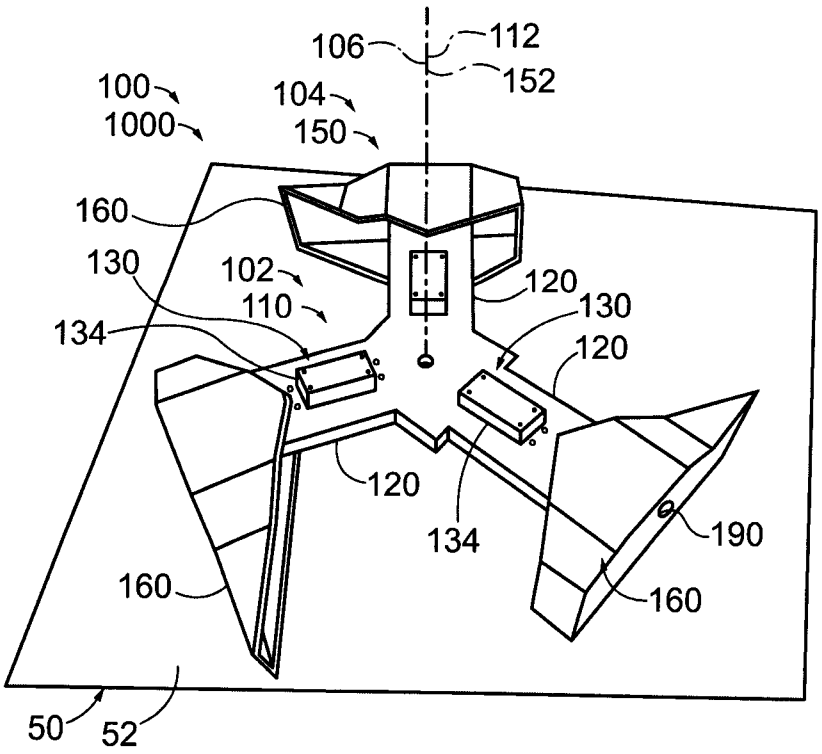
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FIG. 10

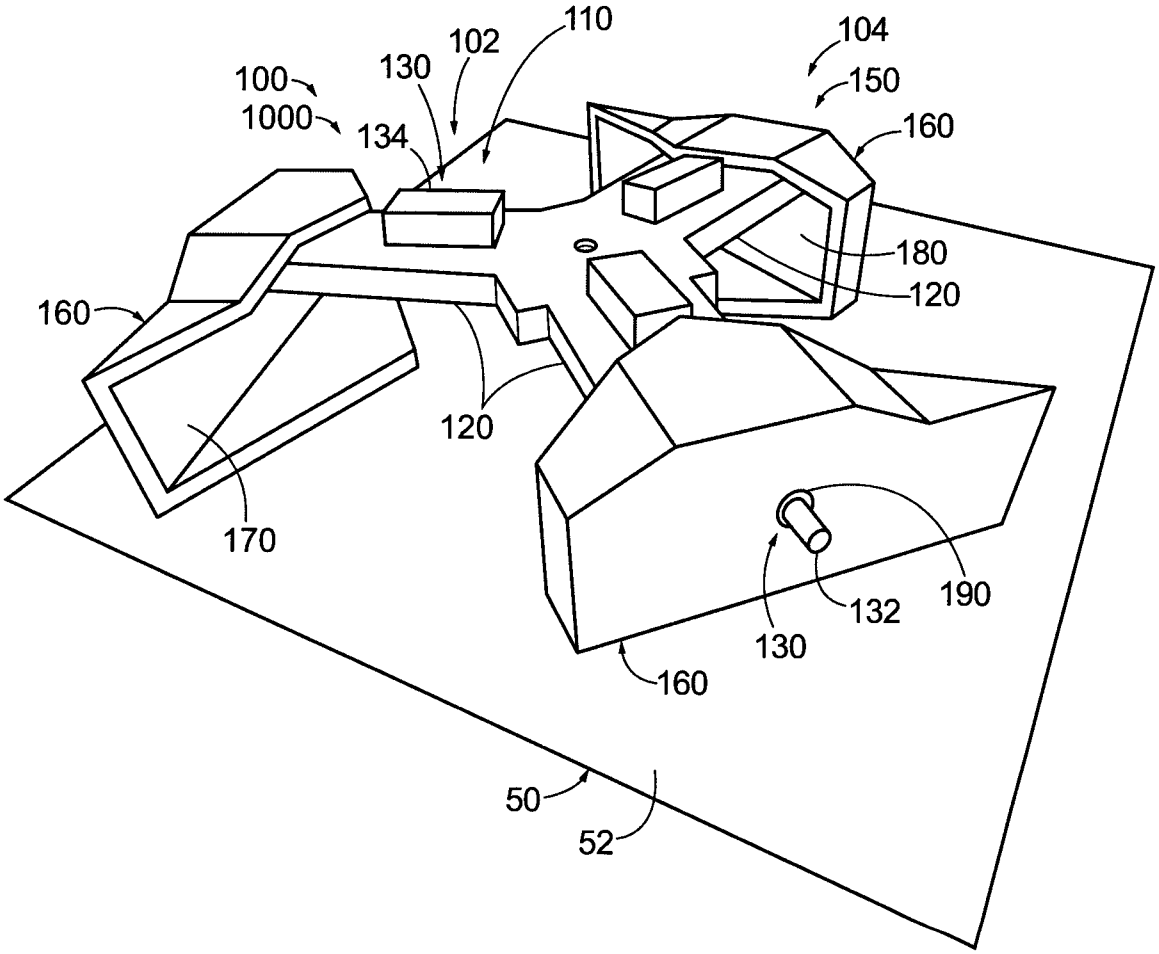
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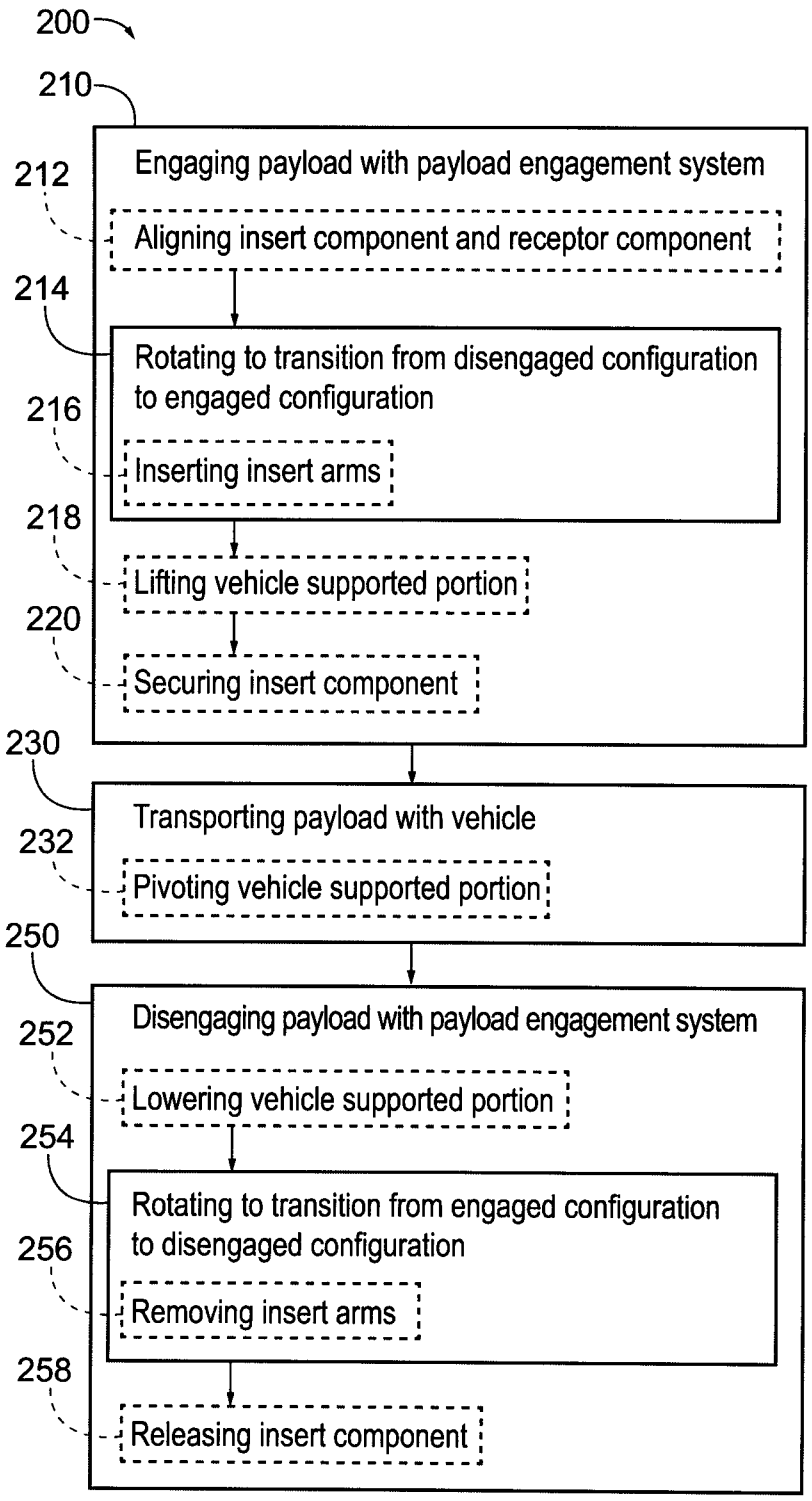
FIG. 11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Engaging payload with payload engagement system
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Aligning insert component and receptor component
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Rotating to transition from disengaged configuration to engaged configuration
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Inserting insert arms
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Lifting vehicle supported portion
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Securing insert component
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Transporting payload with vehicle
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Pivoting vehicle supported portion
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Disengaging payload with payload engagement system
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Lowering vehicle supported portion
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Rotating to transition from engaged configuration to disengaged configuration
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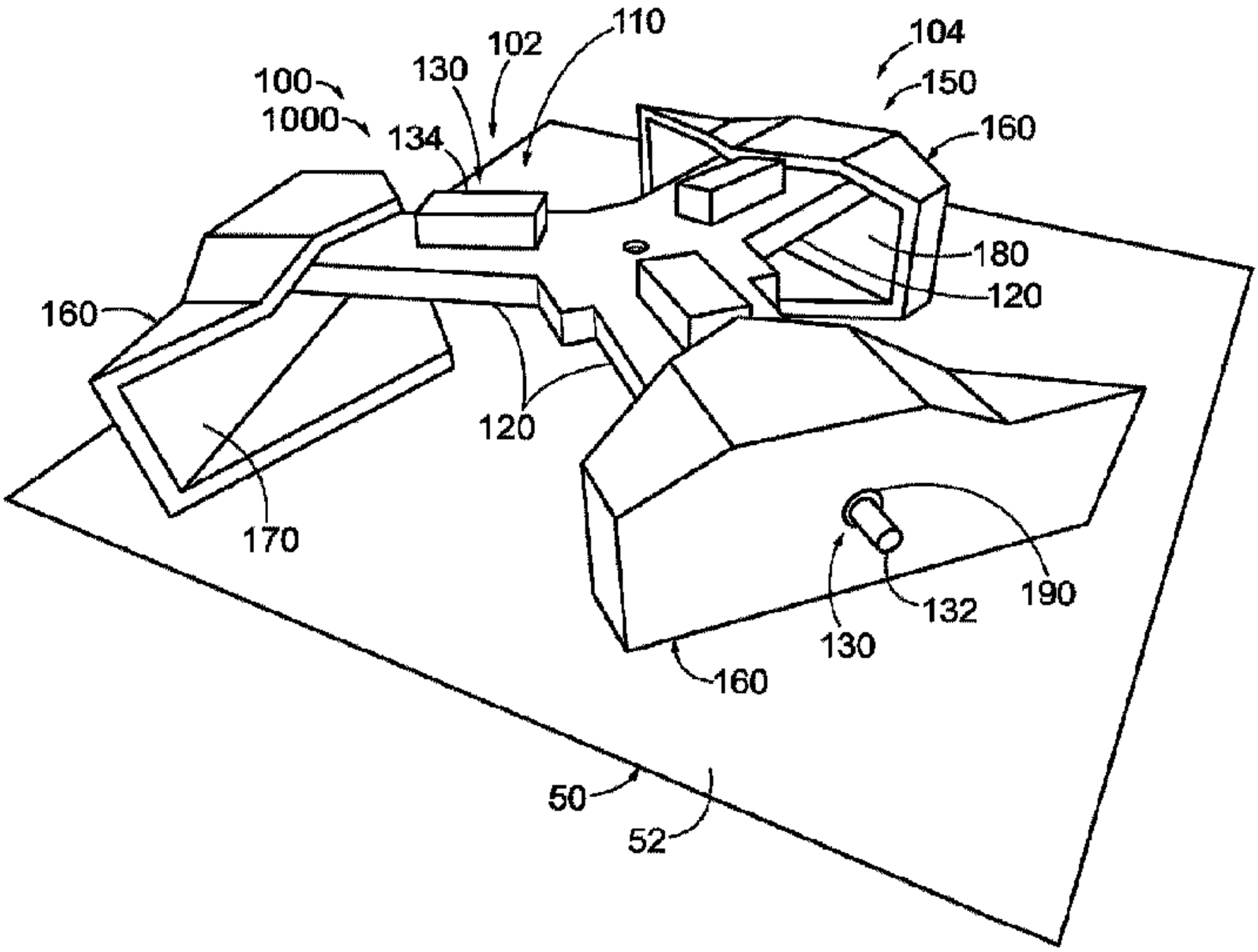
Removing insert arms
258
Releasing insert component

FIG. 12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