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(54) Title: AIRCRAFT CARGO COMPARTMENT CONTAINER CRANE SYSTEM

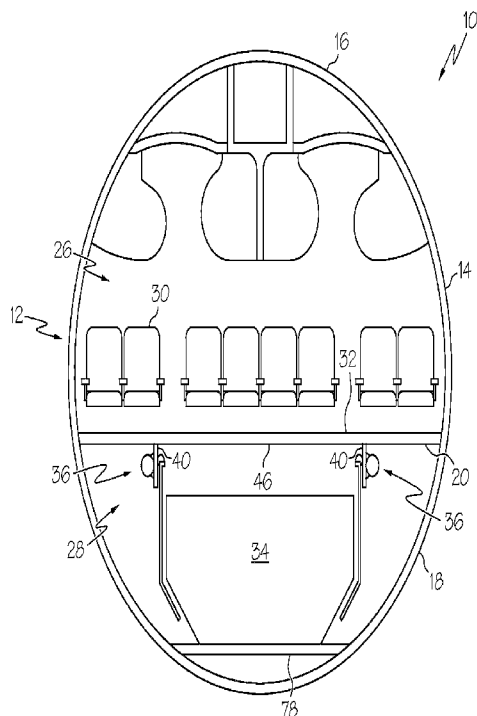


FIG. 1

(57) Abstract: An aircraft cargo compartment container crane system including an aircraft having an upper passenger compartment and at least one lower cargo compartment, wherein the passenger compartment and the cargo compartment are separated by a floor and a crane assembly connected to a structural element of the cargo compartment beneath the floor, wherein the crane assembly is configured to lift and move a cargo container within the cargo compartment along a longitudinal axis of the aircraft.

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**AIRCRAFT CARGO COMPARTMENT CONTAINER CRANE SYSTEM****FIELD**

The present disclosure generally related to carrying cargo in aircraft and, more particularly, to systems and methods for loading cargo containers in aircraft

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**BACKGROUND**

Commercial passenger aircraft commonly include a pressurized fuselage having a main upper deck for carriage of passengers and a lower deck exclusively for carriage of cargo during commercial flights. These cargo compartments are typically closed off areas located within the lower fuselage underneath the passenger deck floor. Such cargo compartments are traditionally  
10 filled with bulk cargo, which refers to any cargo that is not containerized, such as passenger suitcases manually loaded by baggage handling personnel into the cargo compartment. Many large aircraft employ quick loading containers known as Unit Load Devices (ULDs). A ULD is a container used to load luggage, freight, mail, or similar containerized items on wide-body aircraft and certain narrow-body aircraft. The ULDs allow for a large quantity of cargo to be  
15 bundled into a single unit, which leads to fewer load units and saves ground crews time and effort when loading the cargo compartment of the aircraft. Netted cargo pallets with defined base structure geometries are also specialized types of ULDs.

Cargo compartments include a ceiling, which corresponds to the passenger deck floor, and a floor which may be flat or curved to match the bottom contour of the fuselage. The floor  
20 of the cargo compartment typically includes rollers, power rollers, or ball mats to provide for movement of large cargo containers within the cargo compartment. This configuration requires a large number of rollers, stops, and locks on the floor surface in order to utilize and safely support cargo containers. Cargo compartments having floors that lack such rollers are not suitable for loading and carrying large cargo containers, and are provided on some aircraft to accommodate  
25 “bulk cargo,” such as manually loaded passenger baggage. Furthermore, the roller floors require the containers to be manually moved and positioned at a desired storage location within the cargo compartment.

Accordingly, there exists a need in the art for an improved means of container loading of aircraft cargo compartments.

## SUMMARY

In one embodiment, the disclosed aircraft cargo compartment container crane system may include an aircraft having an upper passenger compartment and at least one lower cargo compartment, wherein the passenger compartment and the cargo compartment are separated by a floor and a crane assembly connected to a structural element of the cargo compartment beneath the floor, wherein the crane assembly is configured to lift and move a cargo container within the cargo compartment along a longitudinal axis of the aircraft.

In another embodiment, the disclosed aircraft cargo compartment container crane system may include a crane assembly configured to operate within a cargo compartment under a passenger deck floor of an aircraft, the crane assembly including a pair of longitudinal tracks connected to a lower surface of the floor and a plurality of powered lift mechanisms, wherein at least one of the plurality of lifting mechanisms is connected to each track and configured to lift and translate a cargo container within the cargo compartment along a longitudinal axis of the aircraft.

In yet another embodiment, disclosed is a method of lifting and translating a cargo container axially along a longitudinal axis of a cargo compartment of an aircraft, the method may include the steps of (1) providing a crane assembly configured to operate within the cargo compartment under a passenger deck floor of the aircraft, the crane assembly including a pair of longitudinal tracks connected to a lower surface of the floor and a plurality of powered lift mechanisms, at least one of the plurality of lifting mechanisms connected to each track and configured to lift and translate the cargo container within the cargo compartment along a longitudinal axis of the aircraft, (2) providing at least one cargo container at an initial position within the cargo compartment, (3) translating the lift mechanisms over the cargo container, (4) lifting the cargo container, (5) translating the cargo container axially within the cargo compartment along the longitudinal axis to a storage location, and (6) lowering said cargo container.

Other embodiments of the disclosed aircraft cargo compartment container crane system will become apparent from the following detailed description, the accompanying drawings and the appended claims. The features, functions, and advantages that have been discussed can be achieved independently in various embodiments or may be combined in yet other embodiments, further details of which can be seen with reference to the following description and drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a front elevation view of one embodiment of the disclosed aircraft cargo compartment container crane system;

Fig. 2 is a front perspective view of a cargo container of the container crane system;

5 Fig. 3 is a side schematic view of an aircraft utilizing the disclosed the disclosed container crane system;

Fig. 4 is a side perspective view of the aircraft cargo compartment container crane system;

10 Fig. 5A is fragmented front elevation view of container crane system of Fig. 1, depicted in a preengaged position;

Fig. 5B is a fragmented front elevation view of the container crane system of Fig. 5A, depicted rotated into an engaged position;

Fig. 5C is a fragmented front elevation view of the container crane system of Fig. 5B, depicted in a rotated, engaged and lifted position;

15 Figs. 6A through 6H are schematic views of the operation of the disclosed container crane system; and,

Fig. 7 is an exploded front perspective view of one embodiment of a crane assembly of the disclosed aircraft cargo compartment container system;

20 Fig. 8 is a fragmented front elevation view of another embodiment of the disclosed aircraft cargo compartment container crane system;

Fig. 9A is fragmented front elevation view of another embodiment of the disclosed aircraft cargo compartment container crane system, depicted in a preengaged position;

Fig. 9B is a fragmented front elevation view of the container crane system of Fig. 10, depicted in an engaged position;

25 Fig. 9C is a fragmented front elevation view of the container crane system of Fig. 10, depicted in an engaged and lifted position; and

Fig. 10 is a fragmented front elevation view of yet another embodiment of the disclosed aircraft cargo compartment container crane system.

### DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings, which illustrates specific embodiments of the disclosure. Other embodiments having different structures and operations do not depart from the scope of the present disclosure. Like reference numerals may refer to the same element or component in the different drawings.

Referring to Fig. 3, an aircraft 12 may include a fuselage 14 that longitudinally extends along an axis **A** from proximate a front end 22 of the aircraft 12 to proximate a rear end 24 of the aircraft 12. The fuselage 14 may have a fuselage monocoque structure.

Referring to Fig. 1, the fuselage 14 may include an upper fuselage 16 and a lower fuselage 18. The upper and lower fuselages 16, 18 may be separated by a generally flat support floor 20 extending from the front end 22 to the rear end 24 of the aircraft 12 forming a passenger compartment 26 (i.e., upper deck) and a cargo compartment 28 (i.e., lower deck). The passenger compartment 26 may include a plurality of seats 30 affixed to an upper surface 32 of the floor 20 and carryon baggage storage compartments. The cargo compartment 28 may include a generally open area configured to hold one or more containers 34, bulk cargo, or a combination of both.

One embodiment of the aircraft cargo compartment container crane system, generally designated 10, may include one or more crane assemblies 36 provided within the lower deck cargo compartment 28 for lifting and translating a plurality of containers 34, one at a time or otherwise, to respective storage locations within the cargo compartment 28. As shown in Fig. 4, the crane assembly 36 may generally include a pair of powered lift mechanisms 38 which are configured to contact opposing sides of the container 34 in order to lift the container 34 and move it longitudinally within the cargo compartment 28.

Referring to Fig. 2, the container 34 may be any container capable of holding a quantity of cargo and being transported in the cargo compartment 28 of the aircraft 12. For example, the container 34 may be a unit load device (“ULD”), also known as a can or pod, which may be a closed container typically made of aluminum or combination of aluminum frame and thermoplastic walls. Other ULDs may be fabricated from various metallic, nonmetallic or composite materials, without limitation. The container 34 may be a box having six walls 52, 54,

56, 58, 60, 62 that define an internal volume for receiving a load. Opposed walls 52, 54 may define the front wall 52 and the rear wall 54 of the container 34. Opposed walls 56, 58 may define the right side wall 56 and the left side wall 58 of the container 34. Opposed walls 60, 62 may define the lower wall 60 and the upper wall 62 of the container 34. The front wall 52 may include a door or a removable panel 64 to provide access to the internal volume of the container 34.

The container may have contoured right and left side walls 56, 58. For example the container 34 may be a “two-wing” LD6 or LD8 type, full width container. The right and left side walls 56, 58 may include a generally vertical upper section 66 connected at an upper end to the upper wall 62 and an inwardly angled lower section 68 (i.e., a downwardly facing wall) connected to the lower wall 60. In another example, as shown in Fig. 10, the container 34' may be a “one-wing” LD1 or LD2 or LD3, half width container having one vertical side wall and one contoured side wall. In such an example, one side wall may include a generally vertical upper section connected at an upper end to an upper wall and an inwardly angled (downward facing) lower section connected to a lower wall. Shorter half-width containers, such as LD3-45 or LD3-46 containers (that are 45 or 46 inches tall, respectively) may be used. Also, “two-wing” versions of these containers, such as LD3-45W or LD3-46W, may also be used.

Referring next to Fig. 3, the aircraft 12 may include one or more cargo compartments disposed within the lower fuselage 18. Fig. 3 illustrates the aircraft 12 having a first (i.e., forward) cargo compartment 70 and a second (i.e., aft) cargo compartment 72, where each compartment 70, 72 may be suitably sized to accommodate a number (e.g., five) containers 34. Each cargo compartment 70, 72 may include a cargo door 74 to provide access for loading of containers 34. As illustrated, the forward cargo compartment 70 may include a cargo door 74 positioned at a mid-compartment location and the aft cargo compartment 72 may include a cargo door 74 positioned at a rear-compartment location. As illustrated in Fig. 3, in one implementation of the aircraft cargo compartment container crane system 10, crane assemblies 36 may be disposed in each cargo compartment 70, 72; however, it can be appreciated by one skilled in the art that the aircraft 12 may have a crane assembly 36 in only one cargo compartment 70 such that the other cargo compartment 72 may be used exclusively for bulk cargo. It can also be appreciated by one skilled in the art that the number of cargo compartments 28 and the total number of containers 34 accommodated by each cargo compartment 70, 72 may vary depending upon the size and type of aircraft 12, and is not meant to limit the scope of the

present disclosure. It can also be appreciated that the cargo door 74 of any cargo compartment 70, 72 may be indexed at different locations in the cargo compartments 70, 72.

In other embodiments of the container crane system 10, certain major components of the crane assemblies 36 may be easily removed from within the cargo compartments 70, 72 through the cargo door 74 for flights where containers 34 are not carried.

Referring now to Figs. 4, the crane assembly 36 may include a frame 40 having a left track 42 and a laterally spaced apart and parallel right track 44. The left track 42 may be positioned below a lower surface 46 of the floor 20 (Fig. 1) and may extend along a track axis **B**, which may be generally parallel with the longitudinal axis **A**, from a front end 22 to a rear end 24 of the aircraft 12 within the cargo compartment 28. The right track 44 may be positioned below a lower surface 46 of the floor 20 (Fig. 1) and may extend along a track axis **C**, which may be generally parallel with the longitudinal axis **A**, from a front end 22 to a rear end 24 of the aircraft 12 within the cargo compartment 28.

For example, the tracks 42, 44 may be attached to a plurality of main support beams 50 of the floor. The lift mechanisms 38 are movably connected to each track 42, 44, such that the lift mechanisms 38 may translate longitudinally within the cargo compartment 28. The lift mechanisms 38 may be driven along the tracks 42, 44 between the front and rear ends of the cargo compartment 28 by a motor 76, including the area directly adjacent an opening of the cargo door 74. The tracks 42, 44 may be appropriately positioned at an adequate height to accommodate lateral insertion of containers 34 into the cargo compartment 28 through the cargo door 74.

Each lift mechanism 38 may include a rail 80 designed to engage and ride along the tracks 42, 44. At least one lifting arm 82 (two lifting arms 82 are shown by example) may be pivotably attached to each rail 80 and may extend downwardly toward a container support floor 78 of the cargo compartment 28. Each lifting arm 82 may include a generally vertical upper end 84 and an inwardly angled lower end 86. The rail 80 may also include an actuating mechanism 88 mechanically connected to the upper end 84 of the lifting arm 82 to rotate the lifting arm 82 inwardly and outwardly.

Alternatively, when the container 34' includes only one downward facing surface, as shown in Fig. 10, one lifting arm 82 may include a generally vertical upper end and an inwardly

angled lower end to engage the downward facing surface, while the other lifting arm 82 may be substantially straight (since there is no downward facing surface on the other side of the container 34').

5 The container support floor 78 adjacent the opening of the cargo door 74 may include rollers, power rollers, a ball mat or a low friction surface, for example polytetrafluoroethylene (i.e., TEFLON), to facilitate lateral loading and unloading of the container 34 into the cargo compartment 28. Optionally, the cargo support floor 78 may longitudinally extend along the cargo compartment to laterally position and longitudinally slide the containers 34 along the surface of the floor 78. The cargo support floor 78 may be supported above the fuselage  
10 monocoque structure.

Referring next to Figs. 5A–5C and 6A–6H, a container 34 may be loaded into an initial position on the floor 78 within the cargo compartment 28 through the cargo door 74 (Fig. 6A). An optional load transfer unit or assembly may be used to initially load the container 34 through the cargo door 74 into the cargo compartment 28. For example, the load transfer unit may be (or  
15 may include) one or more of the following: a roller tray, a ball mat, a support surface with partially buried rollers, a support surface with a partially buried belt, a conveyor belt, and a low friction sliding surface.

The lift mechanisms 38 may be moved along the tracks 42, 44 over the container 34, such that the lifting arms 82 of each lift mechanism 38 are longitudinally aligned with opposing side  
20 walls 56, 58 of the container 34 (Fig. 6B). The lifting arms 82 may be positioned along the rail 80 such that the outermost lifting arms 82 of any plurality of lifting arms 82 are spaced apart at distance less than the width of the container 34 measured from front wall 52 to rear wall 54. The upper end 84 of the lifting arms 82 may downwardly extend from the rail 80 past the upper section 66 of the side wall 56, 58, such that the lower end 86 is positioned generally parallel to  
25 the lower section 68 of the side walls 56, 58. At this point the crane assembly 36 is in a preengaged position with the lifting arms 82 away from the container (Fig. 5A).

The rotary actuating mechanism 88 may be any suitably mechanism actuating device and may rotate the lifting arms 82 inwardly such that the lower ends 86 contact the lower sections 68 of the side walls 56, 58 of the container 34. At this point the crane assembly 36 is in an engaged  
30 position (Fig. 5B). An inner surface of the upper end 84 and the lower end 86 of the lifting arms 82 may be flat to make suitably flush contact with the exterior surfaces of the side walls 56, 58 of

the container 34. As the lifting arms 82 continue to rotate inwardly, the container 34 may be lifted off of the floor 78 as the lower sections 68 of the side walls 56, 58 slide upwardly upon the flat inner surface of the lower ends 86 of the lifting arms 82 in response to the force applied by the lifting arms 82. At this point the crane assembly is in an engaged and lifted position (Fig.

5C).

Once the container 34 has been lifted from the floor 78 (Fig. 6C), the motor 76 may mechanically act upon the rail 80, driving the lift mechanisms 38 along the tracks 42, 44 and moving the container 34 longitudinally within the cargo compartment 28 (Fig. 6D). The container 34 may be moved by the crane assembly 36 to a selected storage location within the cargo compartment 28 (Fig. 6E). Once the container 34 is positioned at the selected storage location, the actuating mechanisms 88 may lower the lifting arms 82 and/or rotate the lifting arms 82 outward. In the case of rotating lifting arms 82, as the lifting arms 82 begin to move away from the side walls 56, 58 of the container 34, the container 34 may slide downward upon the lower ends 84 of the lifting arms 82 until the container 34 rests upon the support floor 78 at the selected location (Fig. 6F). The lifting arms 82 may continue to rotate outwardly to the preengaged position no longer contacting the container 34.

Referring to Fig. 6F, an optional securement device 83 may secure the cargo container 34 after it has been positioned within the cargo compartment 28 as desired. The securement device 83 may prevent the cargo container 34 from axially sliding along the floor 78 of the cargo compartment 28 (i.e. a sliding motion). As one example, the securement device 83 may be (or may include) a stop, such as a fixed stop or a deployable stop. As another example, the securement device 83 may be (or may include) a lock, such as a manual lock or an automatic lock.

The motor 76 may drive the lift mechanisms 38 in an opposing longitudinal direction (Fig. 6G) until the lift mechanisms 38 are returned to an original position adjacent the opening of the cargo door 74 (Fig. 6H). This process may be repeated for subsequently loaded containers 34, which are lifted and moved to respective storage locations within the cargo compartment 28.

Referring to Fig. 7, the rails 80 may be movably connected to the tracks 42, 44 in any suitable manner and as such one skilled in the art can appreciate that the described embodiments merely represent certain possible configurations and are not meant to limit the scope of the present disclosure. For example, the tracks 42, 44 may include at least one groove or conduit

suitably sized to contain opposing top and bottom side edges of the rail 80. Alternatively, the rail 80 may be fastened to a support guide or slider mechanism mechanically connected internally to the tracks 42, 44. In another example, the rail 80 may also include a plurality of guide rollers rotationally supported within the tracks 42, 44. It can be appreciated by one skilled in the art that rollers may be attached to the rail 80 with a roller interface between the track 42, 44 or the rollers may be attached to the track 42, 44 with a track interface between the rail 80. In yet another example, the interface surface between the track 42, 44 and the rail 80 may include a low friction surface. In still another example, the tracks 42, 44 may include longitudinal screws and the rails 80 may include a ball screw mechanism mechanically connected to the screws of the tracks 42, 44 to linearly translate the lift mechanisms 38 along the tracks 42, 44.

The crane assembly 36 may include orbital gears, a rack and pinion assembly, chains, belts, worm gears, or any other suitable linear drive train connected between the motor 76 and the lift mechanism 38 to move the rail 80 relative the track 42, 44. The motor 76 may be attached to the track 42, 44 and mechanically connected to the rail 80 of the lift mechanism 38. Alternatively, the motor 76 may be attached to the rail 80 and mechanically connected to the track 42, 44. As illustrated by example in Fig. 7, the tracks 42, 44 may include a longitudinal channel 90 to provide access for the mechanical connection between the motor 76 and the lift mechanism 38.

The motor 76 may be any suitable electric, hydraulic, or pneumatic drive mechanism and may receive power from aircraft 12. The motor 76 may be electrically, hydraulically, or pneumatically connected to a suitable power supply within the aircraft 12. The motor 76 may also be operably connected to and may power the actuating mechanism 88 of the lift mechanism 38. Alternatively, the actuating mechanism 88 may include its own independent rotary drive mechanism and power supply. As one example, the motor 76 may be electrically connected to reel-out power cord which is also electrically connected to a power connection port of the passenger compartment 26. In another example, the tracks 42, 44 may include a plurality of electrical contacts which provide power to the motor 76 through track 42, 44 and rail 80 contact interfaces.

The container crane system 10 may also include a plurality of associated controls, including microprocessors electronically connected to the crane assembly 36 to energize the motor 76, to linearly move the lift mechanisms 38 to a selected location within the cargo

container 28, and to actuate the lifting arms 82. The controls may be any suitable electronic control panel having a human interface.

Optionally, the container crane system 10 may include a plurality of position and operation sensors mounted at specified locations on the tracks 42, 44 to provide signaling indications of the relative position of the lift mechanisms 38 on the tracks 42, 44 and relative operational conditions of the crane assembly 36. The controls may be programmed to respond in a specified manner when certain positional or operational conditions occur.

In other embodiments of the disclosed aircraft cargo compartment container crane system 10 the lower ends 84 of the lifting arms 82 may include additional features to further assist in engaging and lifting the containers 34. For example, the lower ends 84 of the lifting arms 82 may include a magnet or an electromagnet to magnetically engage a magnetic surface of the container 34. In another example, the lower ends 84 of the lifting arms 82 may include curved ends or hooks to hook and engage an exterior post or in interior slot disposed on side walls 56, 58 of the container 24.

Another embodiment of the disclosed container crane system may include the lift mechanism 38 having a rail 80 with a single rotary actuating mechanism 88 and a single, wide lifting arm 82 configured to span the majority of the width of the container 34. The lifting arm 82 may be pivotably attached to the rail 80 and may extend downwardly toward the container support floor 78 of the cargo compartment 28. As with the plurality of thinner lifting arms 82, the wide lifting arm 82 may include a generally vertical upper end 84 and an inwardly angled lower end 86. The actuating mechanism 88 may be mechanically connected to the upper end 84 of the lifting arm 82 to rotate the lifting arm 82 inwardly and outwardly. The upper end 84 of the lifting arms 82 may downwardly extend from the rail 80 past the upper section 66 of the side wall 56, 58 of the container 34 such that the lower end 86 may be positioned generally parallel to the lower section 68 of the side walls 56, 58 in the preengaged position.

Referring to Fig. 8, another embodiment of the disclosed container crane system 10 may include the frame 40 that may be supported by a plurality of stanchions 102 extending from the tracks 42, 44 to the lower fuselage 18. The plurality of stanchions 102 may be spaced apart and parallel throughout the cargo compartment 28. The stanchions 102 may be positioned perpendicularly relative to the tracks 42, 44 and floor 20 or may be positioned at an angle relative to the tracks 42, 44 and floor 20. Alternatively, the tracks 42, 44 may be supported

entirely by the stanchions 102 being attached to inwardly facing sides of upper ends of the stanchions 102.

Referring next to Fig. 9A through 9C, another embodiment of the disclosed aircraft cargo compartment container crane system 10 may include the crane assembly 36 having at least two linear lift mechanisms 104 to lift and move containers 34 within the cargo container 28. Each lift mechanism 104 may include a rail 106 designed to engage and ride along the tracks 42, 44. At least one lifting arm 108 may be attached to each rail 106 and may downwardly extend toward the container support floor 78 of the cargo compartment 28. Each lifting arm 108 may include a generally vertical upper end 110 and an inwardly angled lower end 112, similar to lifting arms 82 described above. The rail 106 may also include a linear actuating mechanism 114 mechanically connected to the upper end 110 of the lifting arm 108 to raise the lifting arm 108.

The upper end 112 of the lifting arms 108 may downwardly extend from the rail 106 past the upper section 66 of the side wall 56, 58, such that the lower end 86 is positioned generally parallel to the lower section 68 of the side walls 56, 58 in the preengaged position (Fig. 9A). The linear actuating mechanism 114 may lift the lifting arms 108 upwardly such that the lower ends 112 contact the lower sections 68 of the side walls 56, 58 of the container 34 in the engaged position (Fig. 9B). An inner surface of the lower end 112 of the lifting arms 108 may be flat to make suitably flush contact with the exterior surfaces of the side walls 56, 58 of the container 34. As the lifting arms 108 continue to move upwardly, the container 34 may be lifted off of the floor 78 in response to the upward force applied by the lifting arms 108 in the engaged and lifted position (Fig. 9C).

The linear actuating mechanism 114 may be any suitable linear actuating device in mechanical communication with the upper end 110 of the lifting arm 108. For example, the actuating mechanism 114 may be a screw jack, a scissor lift, a scissor jack, or a reel. The upper end 110 of the lifting arm 108 may include any suitable features corresponding with the mechanical connection with the actuator mechanism 114. The lift mechanisms 104 may be driven along the tracks 42, 44 between the front and rear ends of the cargo compartment 28 by a motor 116, including the area directly adjacent an opening of the cargo door 74.

As previously described, the crane assembly 36 may include orbital gears, a rack and pinion assembly, chains, belts, worm gears, or any other suitable linear drive train connected between the motor 116 and the lift mechanism 104 to move the rail 106 relative the track 42, 44.

The motor 116 may be attached to the track 42, 44 and mechanically connected to the rail 106 of the lift mechanism 1048.

Alternatively, the motor 116 may be attached to the rail 106 and mechanically connected to the track 42, 44. The motor 116 may be any suitable electric, hydraulic, or pneumatic drive mechanism and may receive power from aircraft 12. The motor 116 may be electrically, hydraulically, or pneumatically connected to a suitable power supply within the aircraft 12. The motor 116 may also be operably connected to and power the actuating mechanism 114 of the lift mechanism 104. Alternatively, the actuating mechanism 114 may include its own independent linear drive mechanism and power supply.

Further, the disclosure comprises embodiments according to the following clauses:

1. An aircraft cargo compartment container crane system comprising:

an aircraft comprising an upper passenger compartment and at least one lower cargo compartment, said passenger compartment and said cargo compartment being separated by a floor; and

a crane assembly connected to a structural element of said cargo compartment beneath said floor, said crane assembly being configured to lift and move a cargo container within said cargo compartment along a longitudinal axis of said aircraft.

2. The container crane system of Clause 1 comprising said cargo container.

3. The container crane system of Clause 2 wherein said cargo container is one of a unit load device, an LD3-45W container, an LD3-46W container, an LD6 container, an LD8 container, an LD3 container, an LD2 container and an LD1 container.

4. The container crane system of Clause 1 wherein said crane assembly comprises at least one lift mechanism configured to translate axially along said floor.

5. The container crane system of Clause 4 wherein said lift mechanism further comprises at least one lifting arm extending downwardly below said floor into said cargo compartment, said lifting arm being movable to engage said cargo container.

6. The container crane system of Clause 5 wherein cargo container comprises a downwardly facing wall, and wherein said lifting arm is movable to engage said downwardly facing wall.

5 7. The container crane system of Clause 5 wherein said lifting arm comprises a generally vertical upper end and an inwardly angled lower end configured to engage said cargo container.

8. The container crane system of Clause 5 wherein said lifting arm is linearly movable in a substantially vertical direction relative to said floor.

10 9. The container crane system of Clause 5 wherein said lifting arm is rotatably movable relative to said floor.

10. The container crane system of Clause 1 wherein said crane assembly comprises:

a longitudinal track in said cargo compartment; and,

15 a lift mechanism connected to said track and configured to translate along said track.

11. The container crane system of Clause 10 wherein said crane assembly further comprises a motor mechanically connected to said lift mechanism to move said lift mechanism along said track.

20 12. The container crane system of Clause 11 wherein said lift mechanism further comprises at least one lifting arm extending downwardly from said track, said lifting arm being movable to engage said cargo container.

25 13. The container crane system of Clause 12 wherein said lifting arm comprises a generally vertical upper end and an inwardly angled lower end.

14. The container crane system of Clause 12 wherein said lifting arm is linearly movable in a substantially vertical direction relative to said track.

30 15. The container crane system of Clause 12 wherein said lifting arm is rotatably movable relative to said track.

16. The container crane system of Clause 1 further comprising load transfer assembly for laterally loading said cargo container into said cargo compartment.

17. The container crane system of Clause 16 wherein said load transfer assembly comprises at least one of a roller tray, a ball mat, a support surface with partially buried rollers, a support surface with a partially buried belt, a conveyor belt, and a low friction sliding surface.

18. The container crane system of Clause 1 further comprising a securement device for preventing a sliding motion of said cargo container.

19. The container crane system of Clause 1, wherein said aircraft comprises a fuselage monocoque structure, wherein said cargo compartment comprises a cargo support floor, and wherein said cargo support floor is supported above said fuselage monocoque structure.

20. A method for loading a cargo container into an aircraft fuselage, said aircraft fuselage extending along a longitudinal axis and comprising a floor that defines a passenger compartment and a cargo compartment below said passenger compartment, said method comprising the steps of:

providing a crane assembly within said cargo compartment, wherein said crane assembly is configured to lift said cargo container and to translate along said longitudinal axis;

providing at least one cargo container at an initial position within said cargo compartment;

lifting said cargo container with said crane assembly;

translating said lifted cargo container along said longitudinal axis to a storage location;

and

lowering said cargo container.

21. The method of Clause 20 wherein said crane assembly comprises lifting arms.

22. The method of Clause 21 wherein said lifting arms rotate into engagement with said cargo container during said lifting step.

23. The method of Clause 21 wherein said lifting arms move linearly into engagement with said cargo container during said lifting step.

24. The method of Clause 21 wherein said lifting arms disengage said cargo container during  
5 said lowering step.

25. The method of Clause 20 further comprising the step of returning said crane assembly to said initial position after said lowering step.

10 Although various embodiments of the disclosed aircraft cargo compartment container crane system have been shown and described, modifications may occur to those skilled in the art upon reading the specification. The present application includes such modifications and is limited only by the scope of the claims.

What is claimed is:

1. An aircraft cargo compartment container crane system comprising:

an aircraft (12) comprising an upper passenger compartment (26) and at least one lower cargo compartment (28), said passenger compartment (26) and said cargo compartment (28) being separated by a floor (20); and

a crane assembly (36) connected to a structural element of said cargo compartment (28) beneath said floor (20), said crane assembly (36) being configured to lift and move a cargo container (34) within said cargo compartment (28) along a longitudinal axis of said aircraft (12).

2. The container crane system of Claim 1 comprising said cargo container (34); and wherein said cargo container (34) is one of a unit load device, an LD3-45W container, an LD3-46W container, an LD6 container, an LD8 container, an LD3 container, an LD2 container and an LD1 container.

3. The container crane system of any preceding Claim wherein said crane assembly (36) comprises:

at least one lift mechanism (38) configured to translate axially along said floor (20);

a longitudinal track (42, 44) in said cargo compartment (28);

a lift mechanism (38) connected to said track (42, 44) and configured to translate along said track (42, 44); and

a motor (76) mechanically connected to said lift mechanism (38) to move said lift mechanism (38) along said track (42, 44);

wherein said lift mechanism (38) further comprises at least one lifting arm (82) extending downwardly from said track (42, 44), said lifting arm (82) being movable to engage said cargo container (34); and

wherein said lifting arm (82):

comprises a generally vertical upper end (84) and an inwardly angled lower end (86);

is linearly movable in a substantially vertical direction relative to said track (42, 44); and is rotatably movable relative to said track (42, 44).

4. The container crane system of any preceding Claim wherein said crane assembly (36) comprises:

a lift mechanism (38) having at least one lifting arm (82) extending downwardly below said floor (20) into said cargo compartment (28), said lifting arm (82) being movable to engage said cargo container (34); wherein said cargo container (34) comprises a downwardly facing wall (68); and wherein said lifting arm (82):

is movable to engage said downwardly facing wall (68);

comprises a generally vertical upper end (84) and an inwardly angled lower end (86) configured to engage said cargo container (34);

is linearly movable in a substantially vertical direction relative to said floor (20); and

is rotatably movable relative to said floor (20).

5. The container crane system of any preceding Claim further comprising a load transfer assembly for laterally loading said cargo container (34) into said cargo compartment (28).

6. The container crane system of any preceding Claim further comprising a load transfer assembly having at least one of a roller tray, a ball mat, a support surface with partially buried rollers, a support surface with a partially buried belt, a conveyor belt, and a low friction sliding surface.

7. The container crane system of any preceding Claim further comprising a securement device (83) for preventing a sliding motion of said cargo container (34).

8. The container crane system of any preceding Claim, wherein said aircraft (12) comprises a fuselage monocoque structure, wherein said cargo compartment (28) comprises a cargo support floor (78), and wherein said cargo support floor (78) is supported above said fuselage monocoque structure.

9. A method for loading a cargo container (34) into an aircraft fuselage (14), said aircraft fuselage (14) extending along a longitudinal axis and comprising a floor (20) that defines a passenger compartment (26) and a cargo compartment (28) below said passenger compartment (26), said method comprising the steps of:

providing a crane assembly (36) within said cargo compartment (28), wherein said crane assembly (36) is configured to lift said cargo container (34) and to translate along said longitudinal axis;

5 providing at least one cargo container (34) at an initial position within said cargo compartment (28);

lifting said cargo container (34) with said crane assembly (36);

translating said lifted cargo container (34) along said longitudinal axis to a storage location; and

lowering said cargo container (34).

10 10. The method of Claim 9 wherein said crane assembly (36) comprises lifting arms (82).

11. The method of any of Claims 9 to 10 wherein said crane assembly (36) comprises  
15 lifting arms (82) configured to rotate into engagement with said cargo container (34) during said lifting step.

12. The method of any of Claims 9 to 11 wherein said crane assembly (36) comprises  
lifting arms (82) configured to move linearly into engagement with said cargo container (34)  
20 during said lifting step.

13. The method of any of Claims 9 to 12 wherein said crane assembly (36) comprises  
lifting arms (82) configured to disengage said cargo container (34) during said lowering step.

25 14. The method of any of Claims 9 to 13 further comprising the step of returning said crane assembly (36) to said initial position after said lowering step.

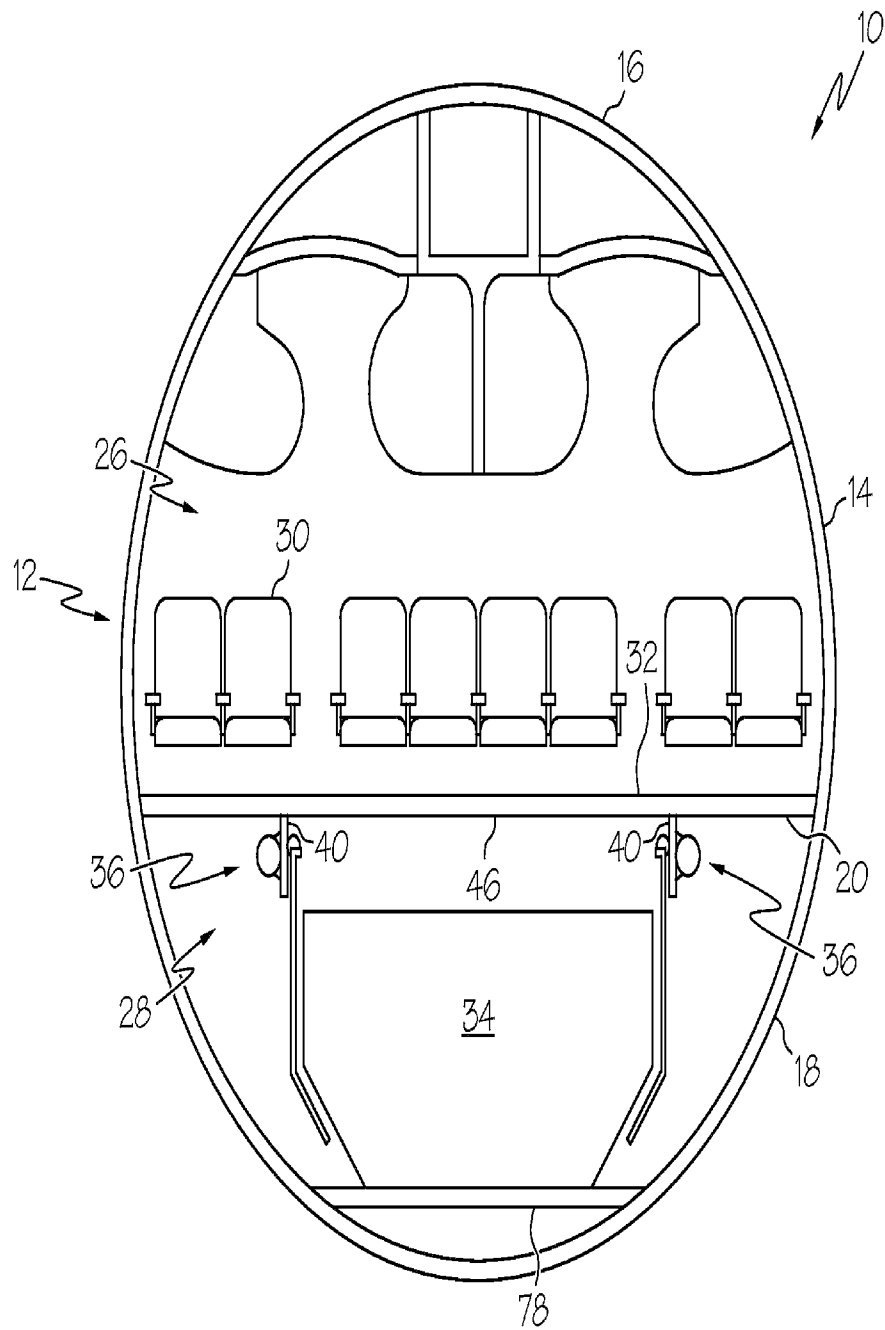
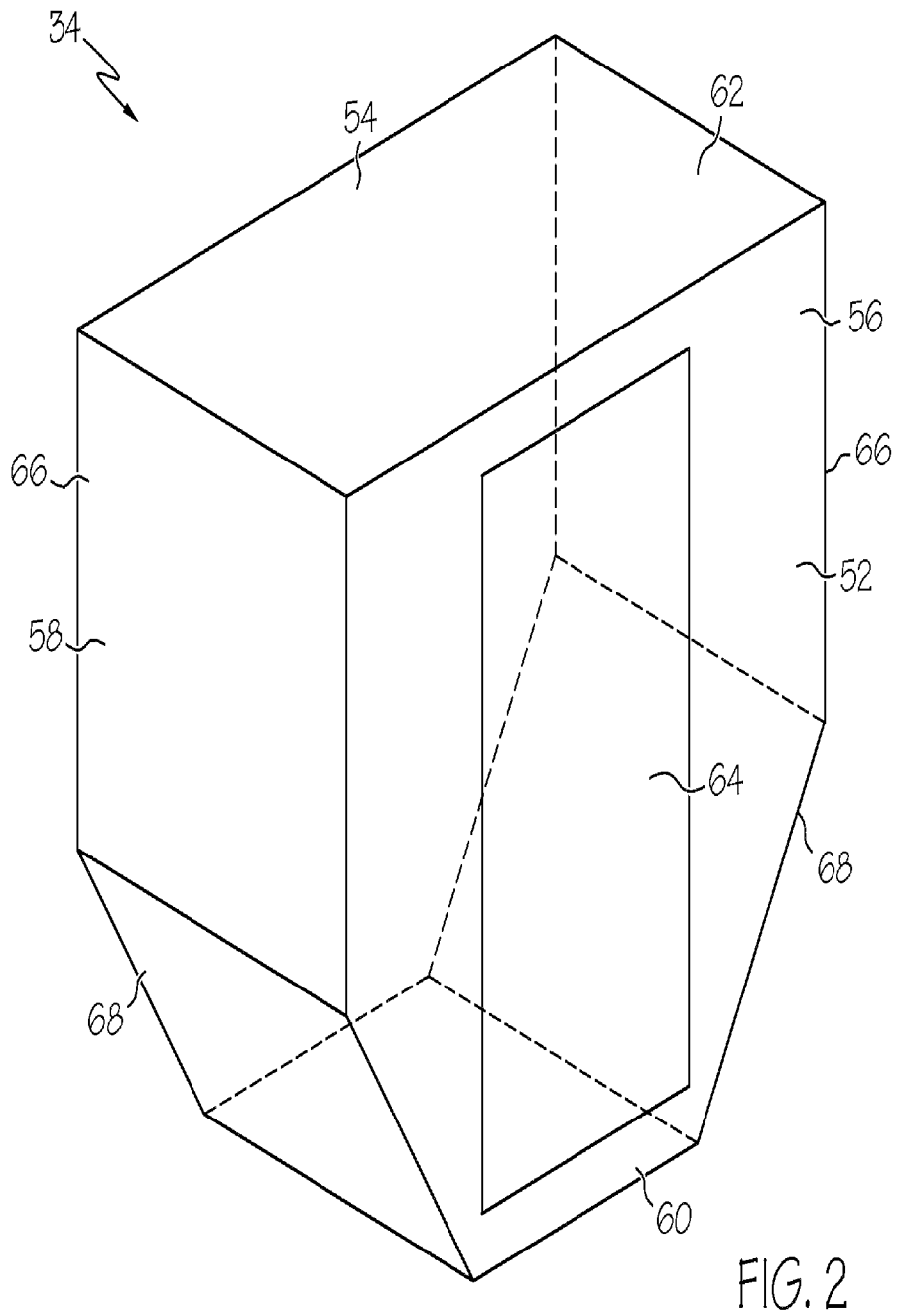


FIG. 1



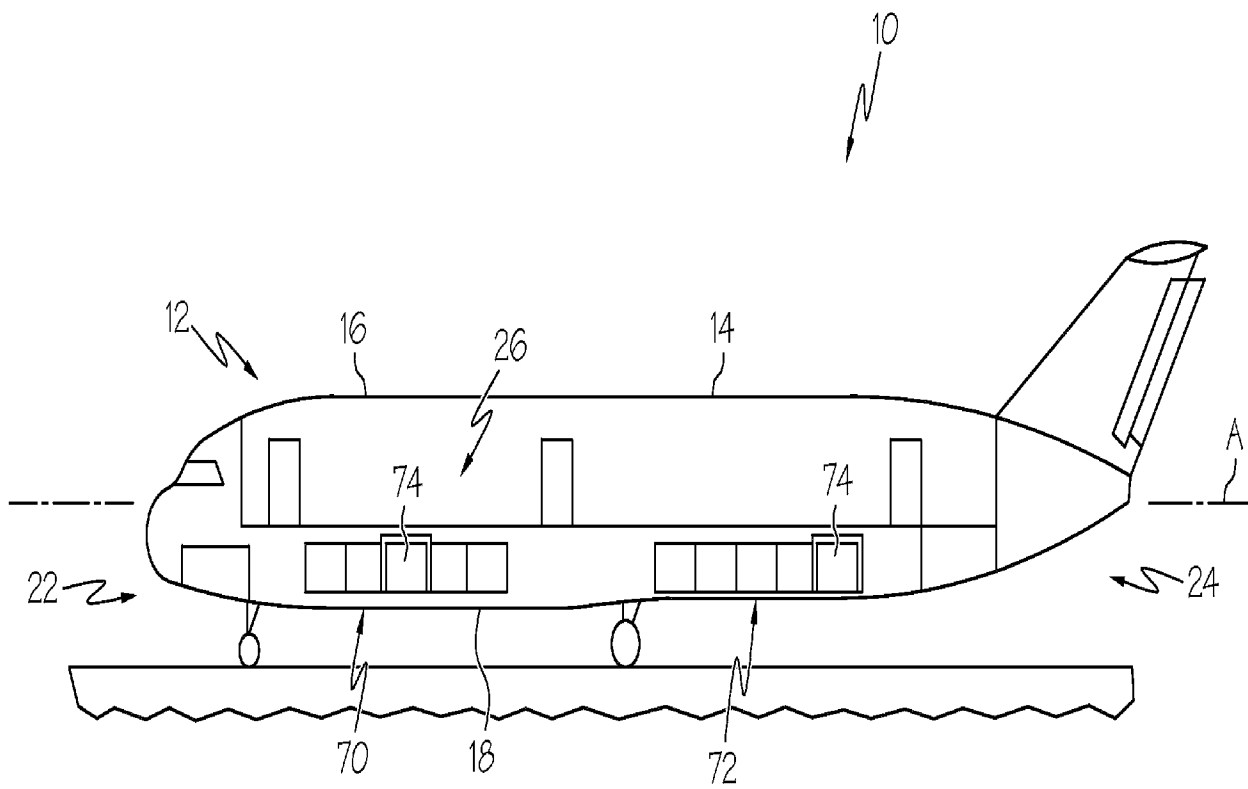
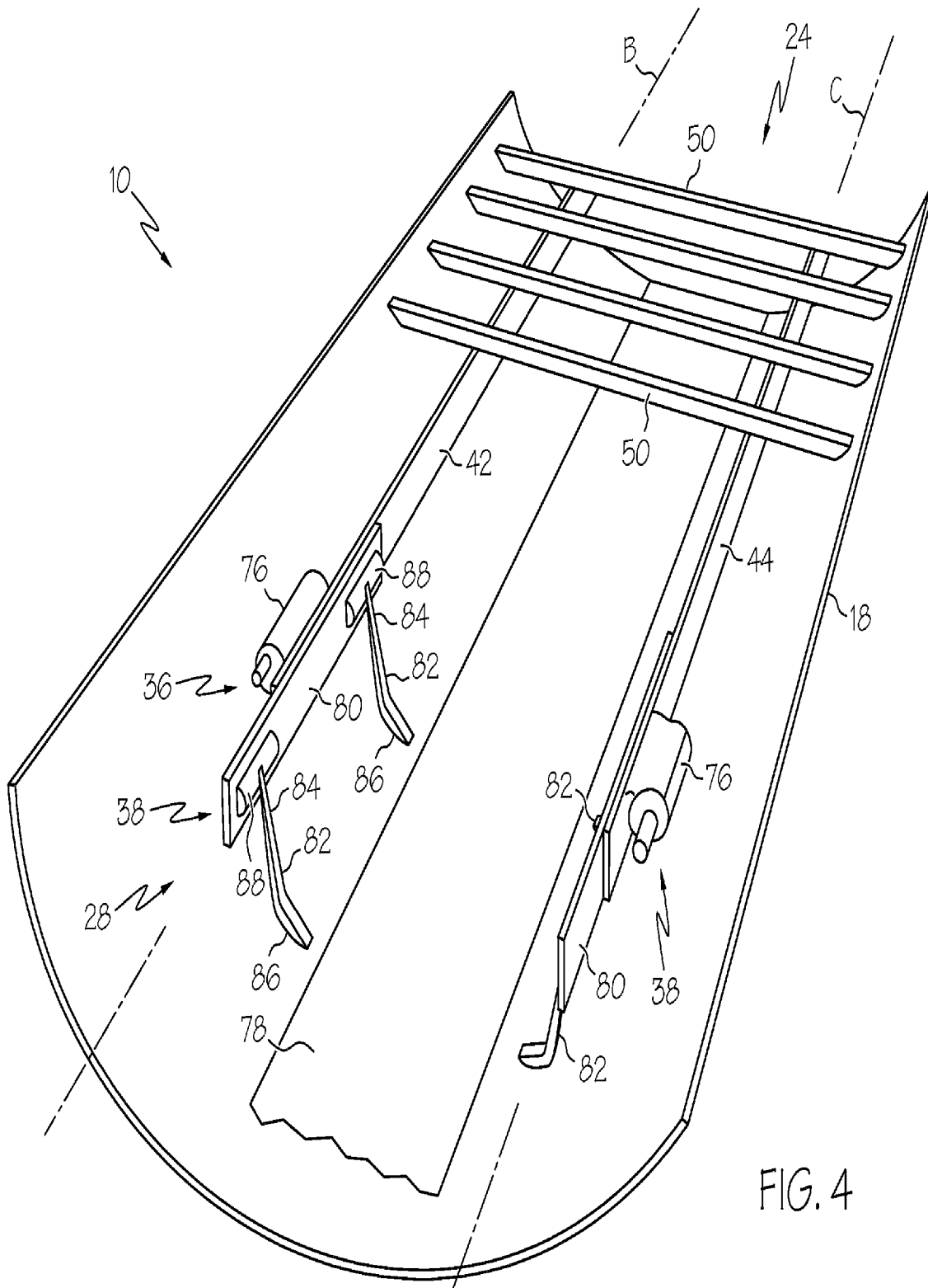


FIG. 3



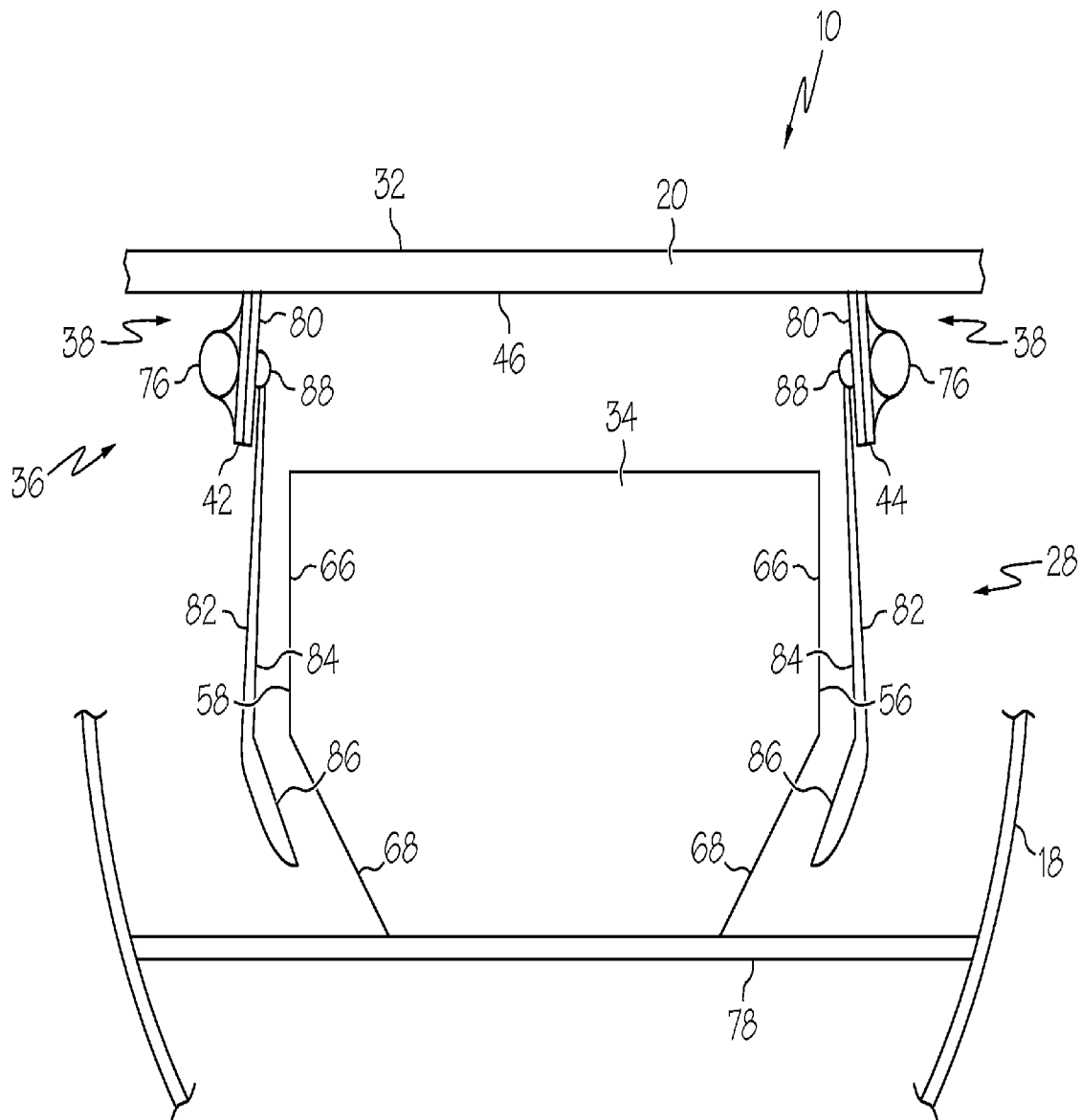


FIG. 5A

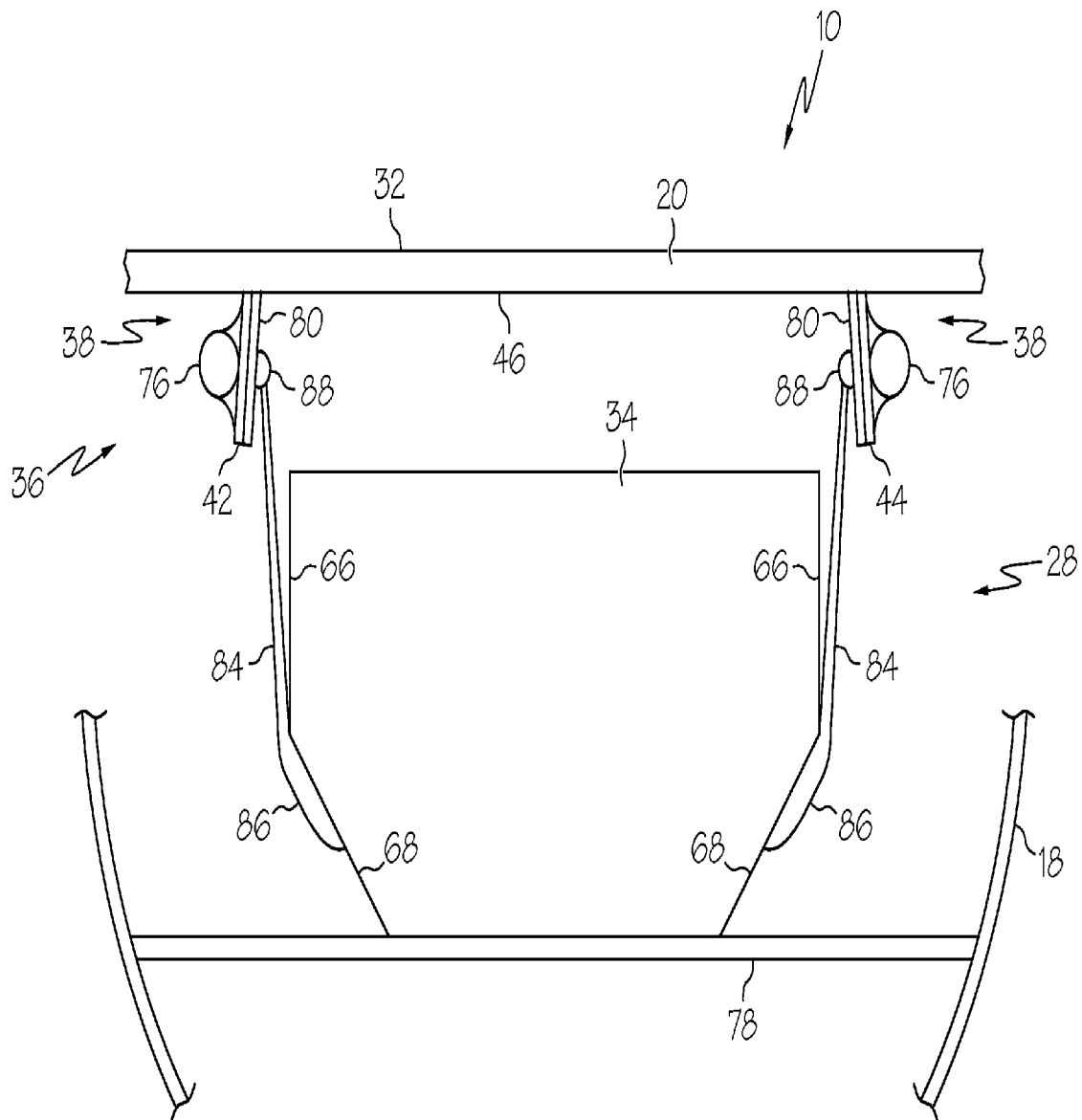


FIG. 5B

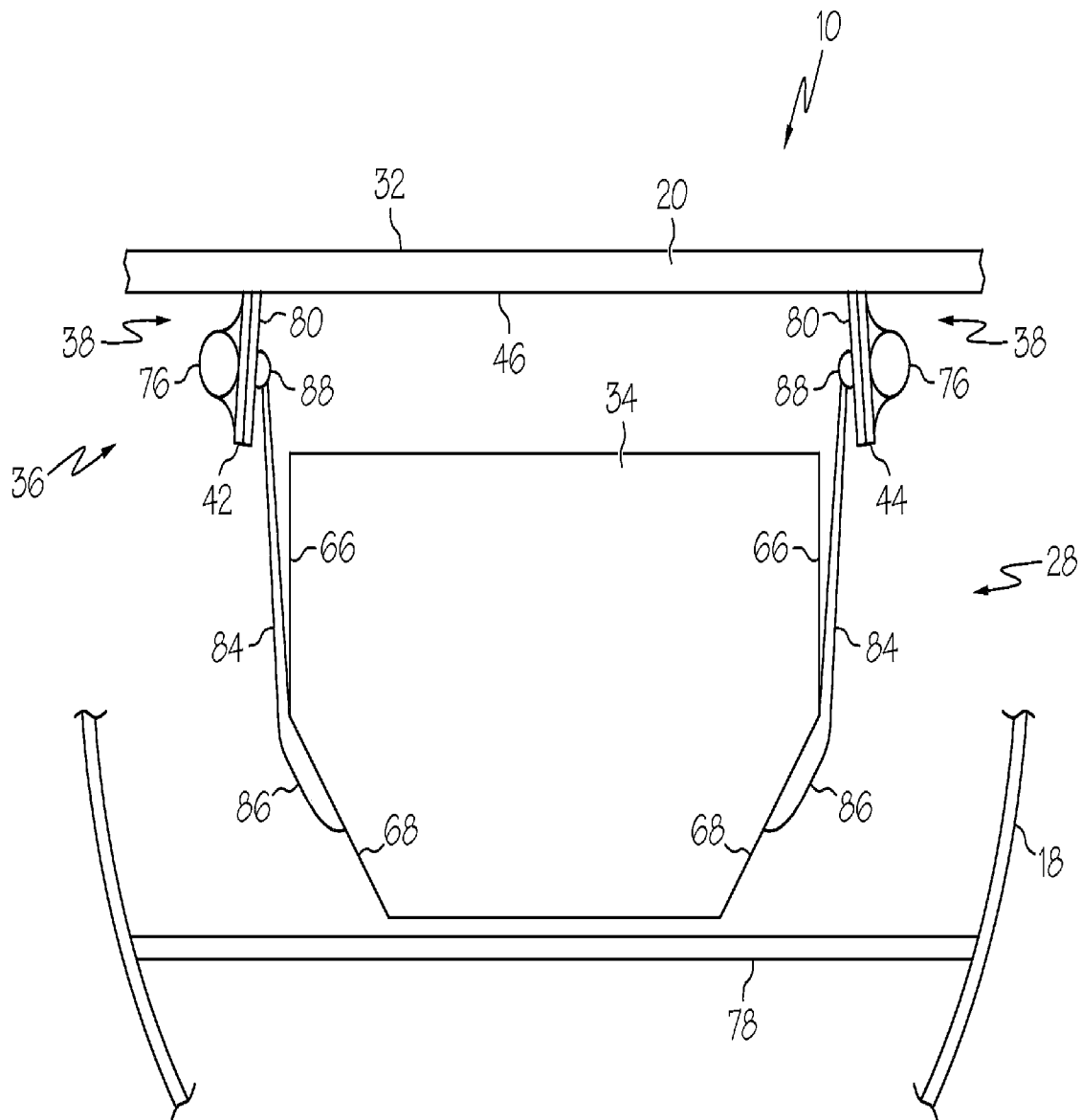
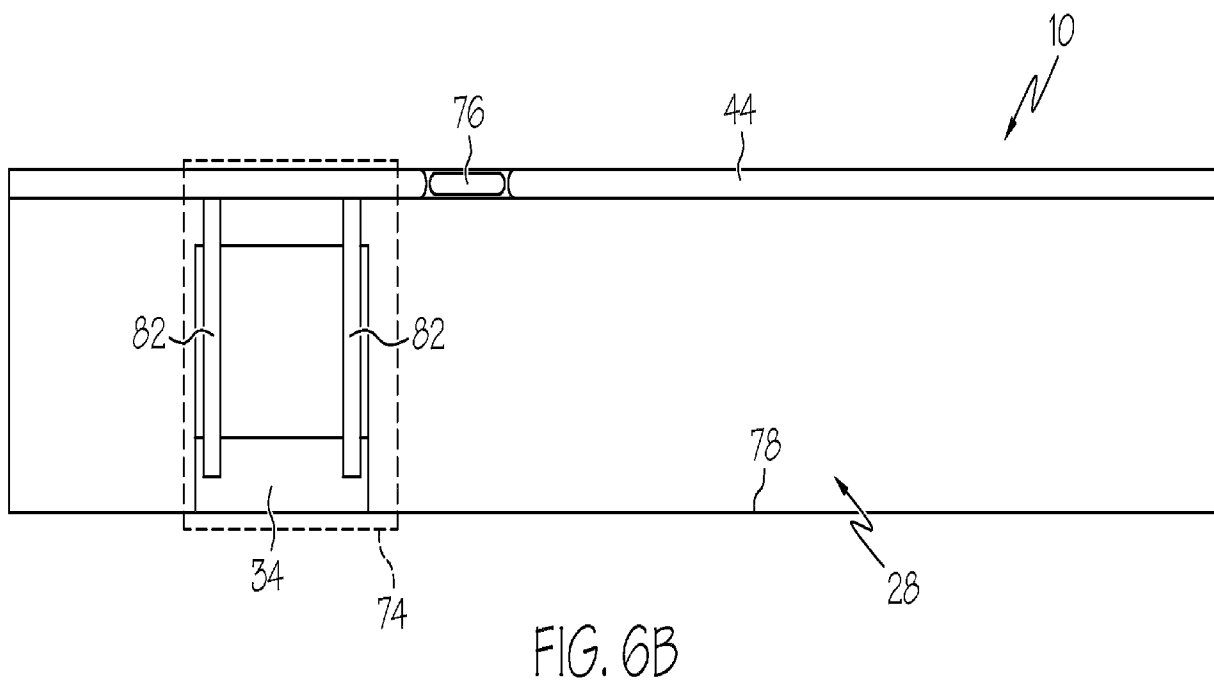
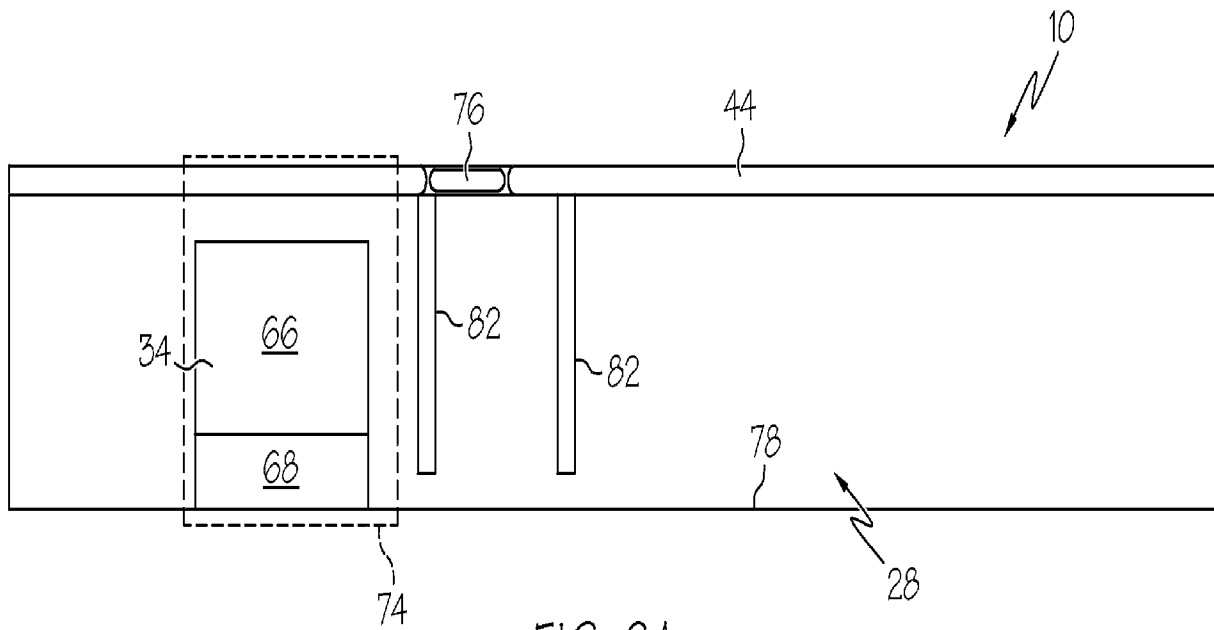


FIG. 5C



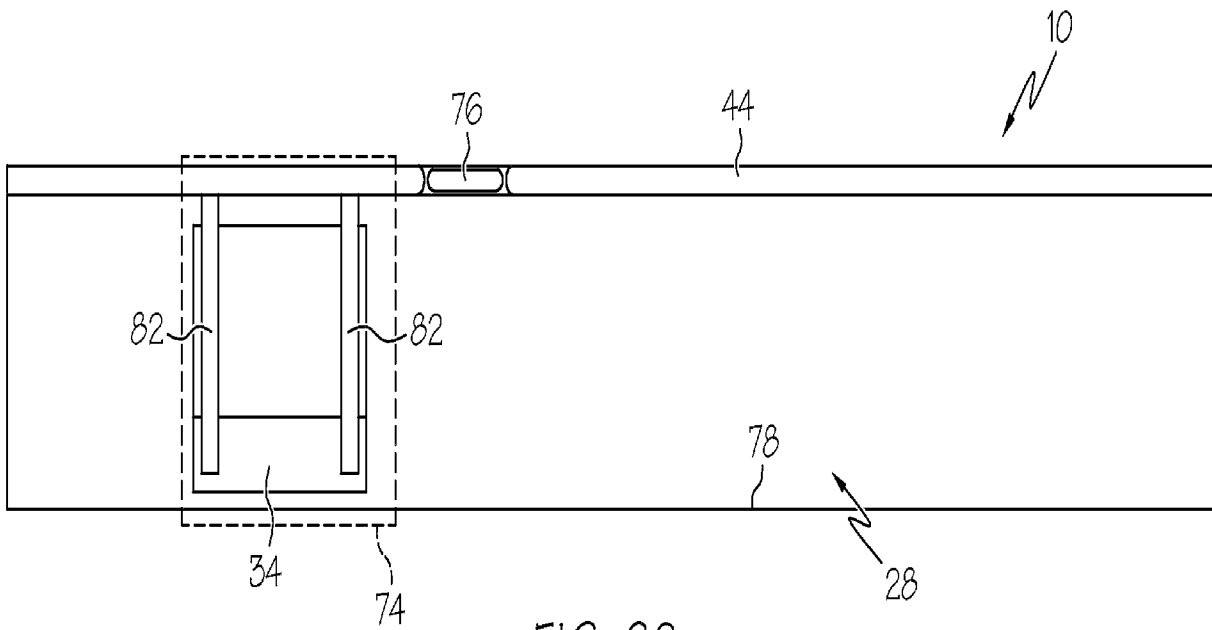


FIG. 6C

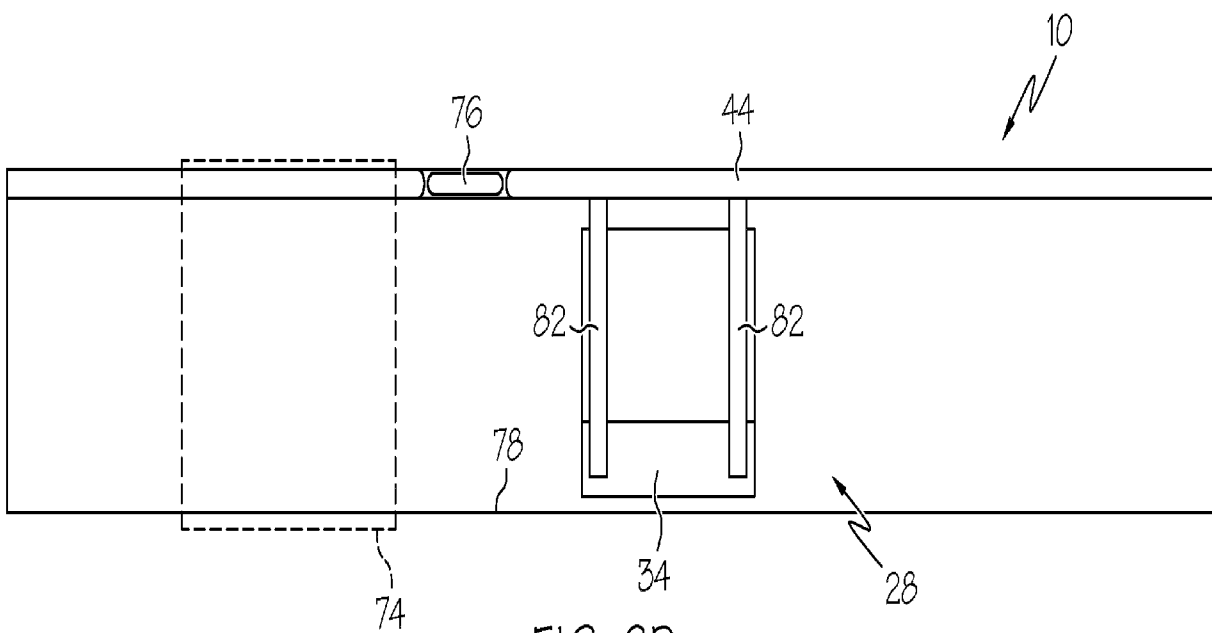


FIG. 6D

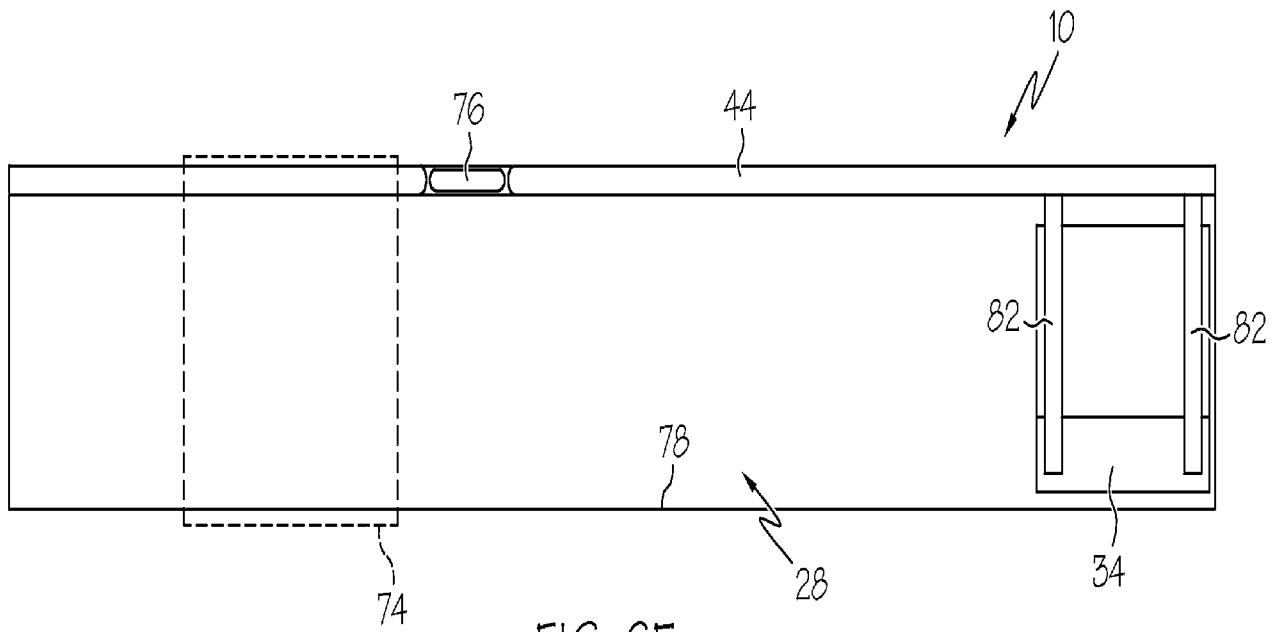


FIG. 6E

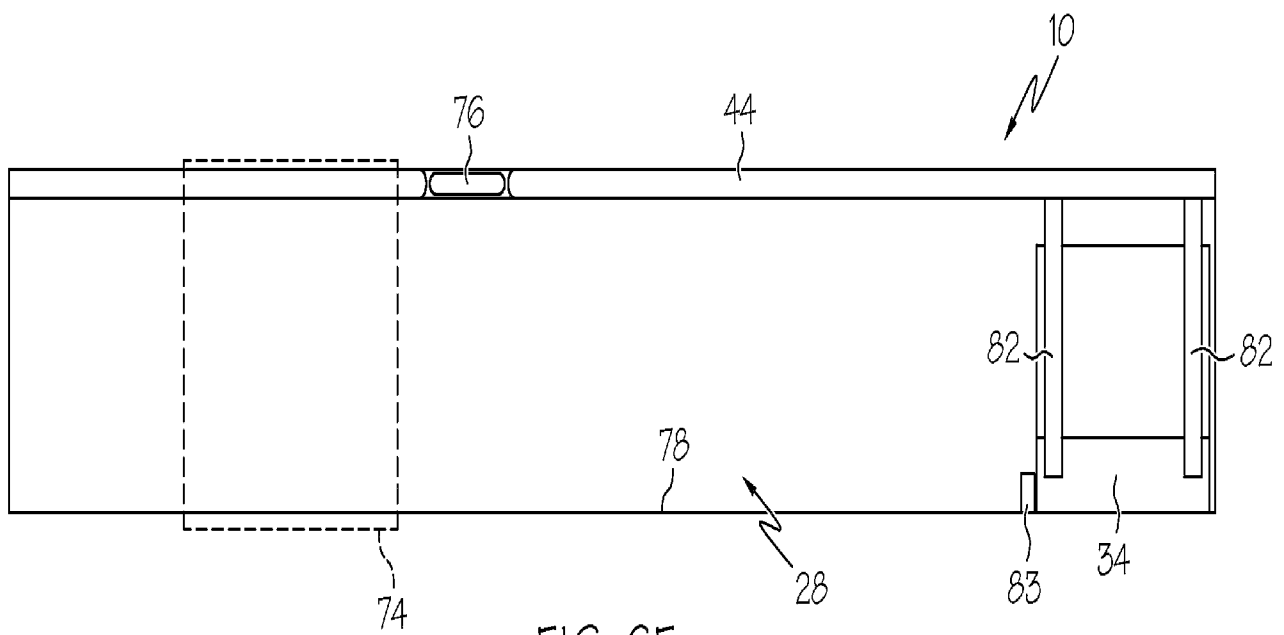


FIG. 6F

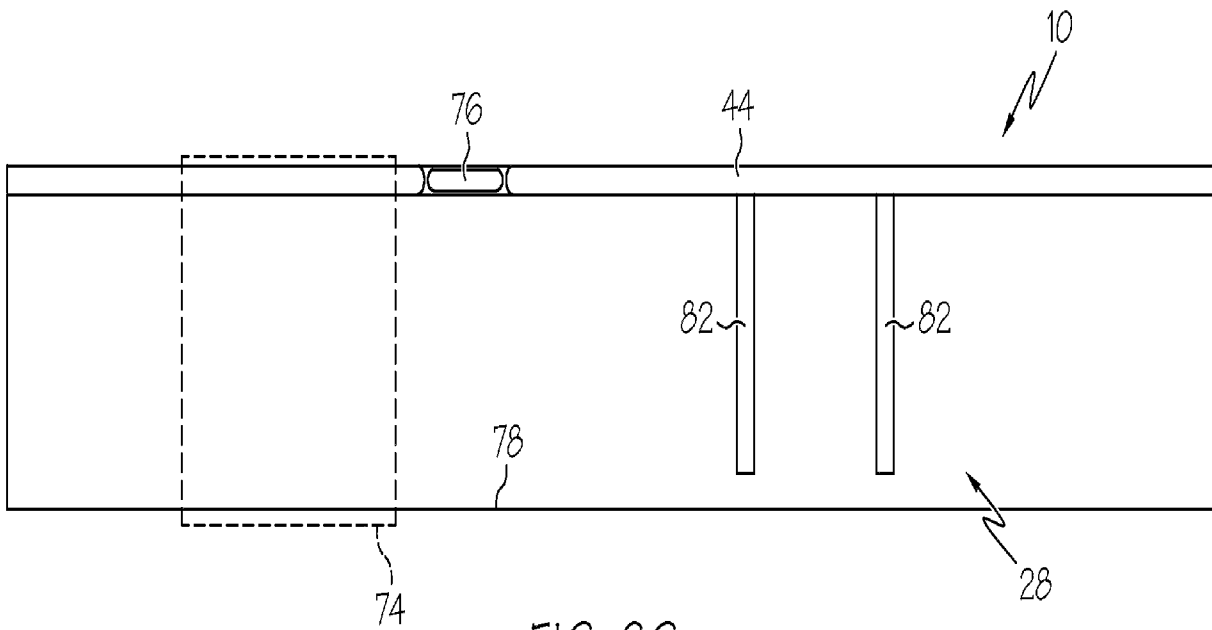


FIG. 6G

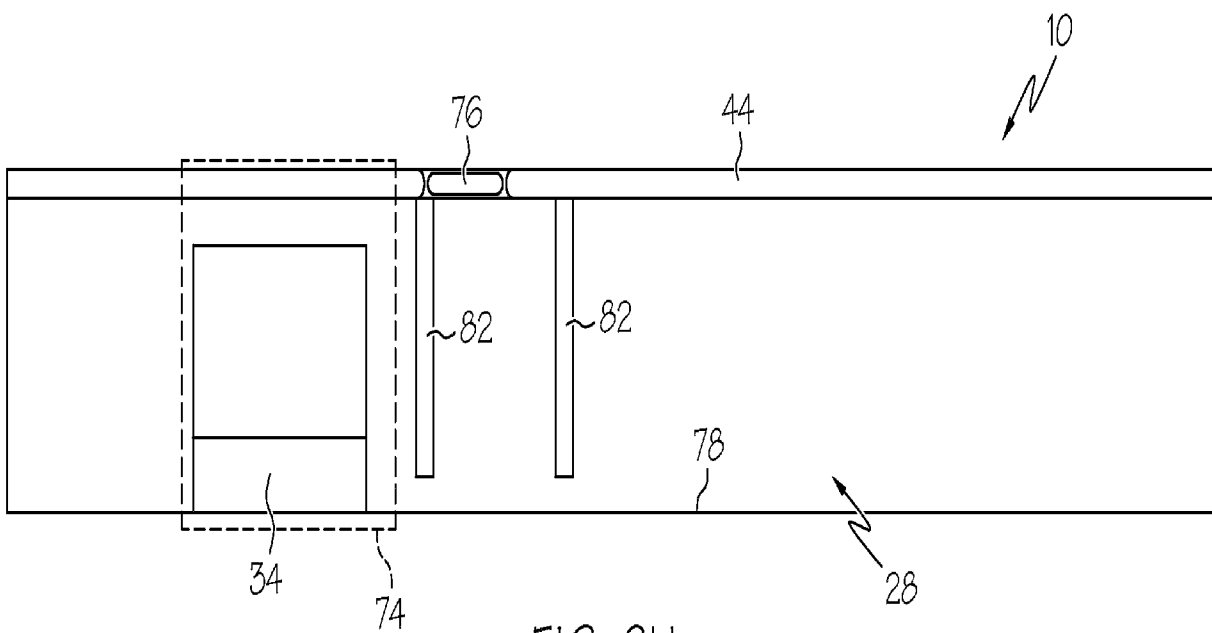


FIG. 6H

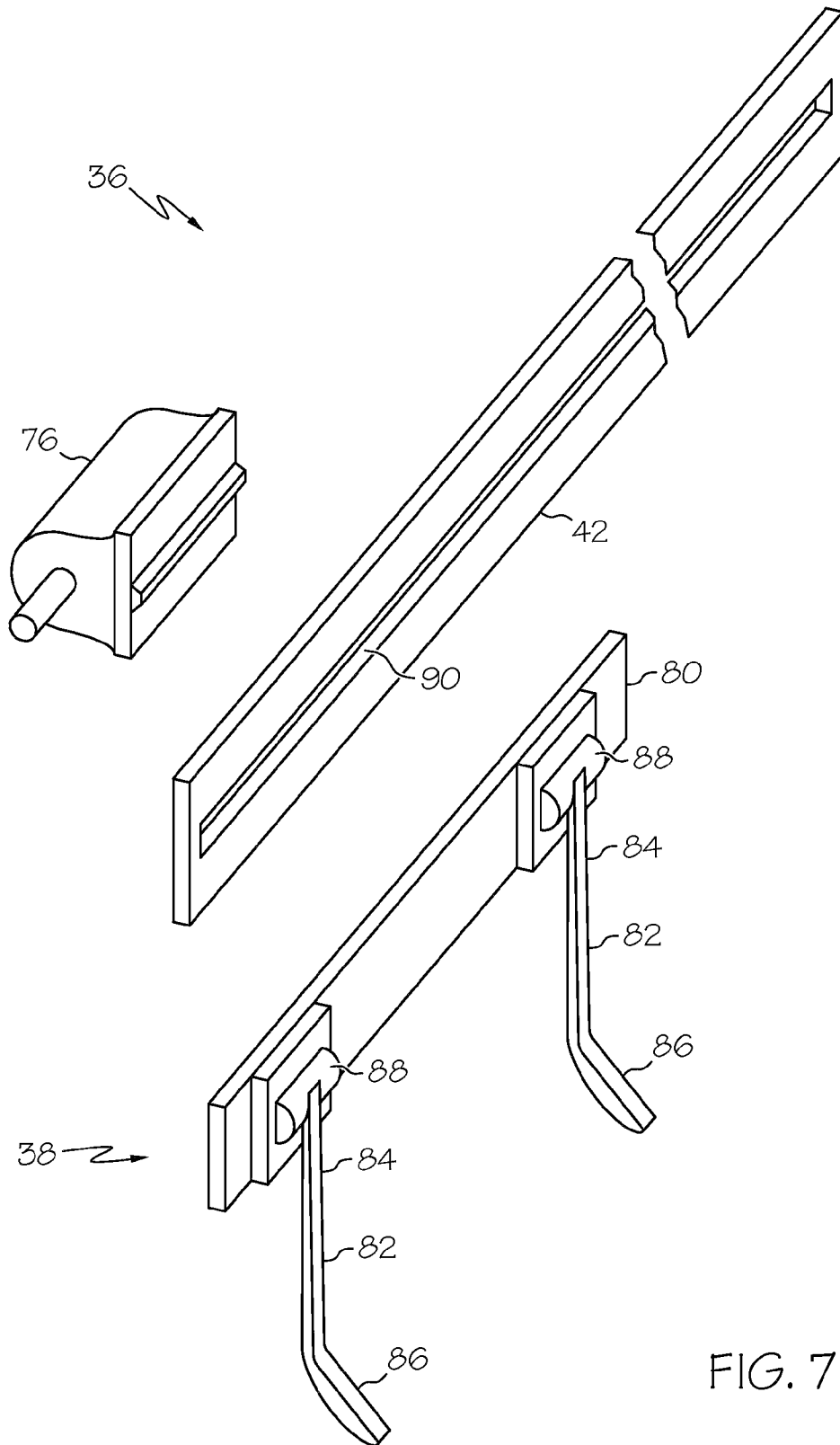


FIG. 7

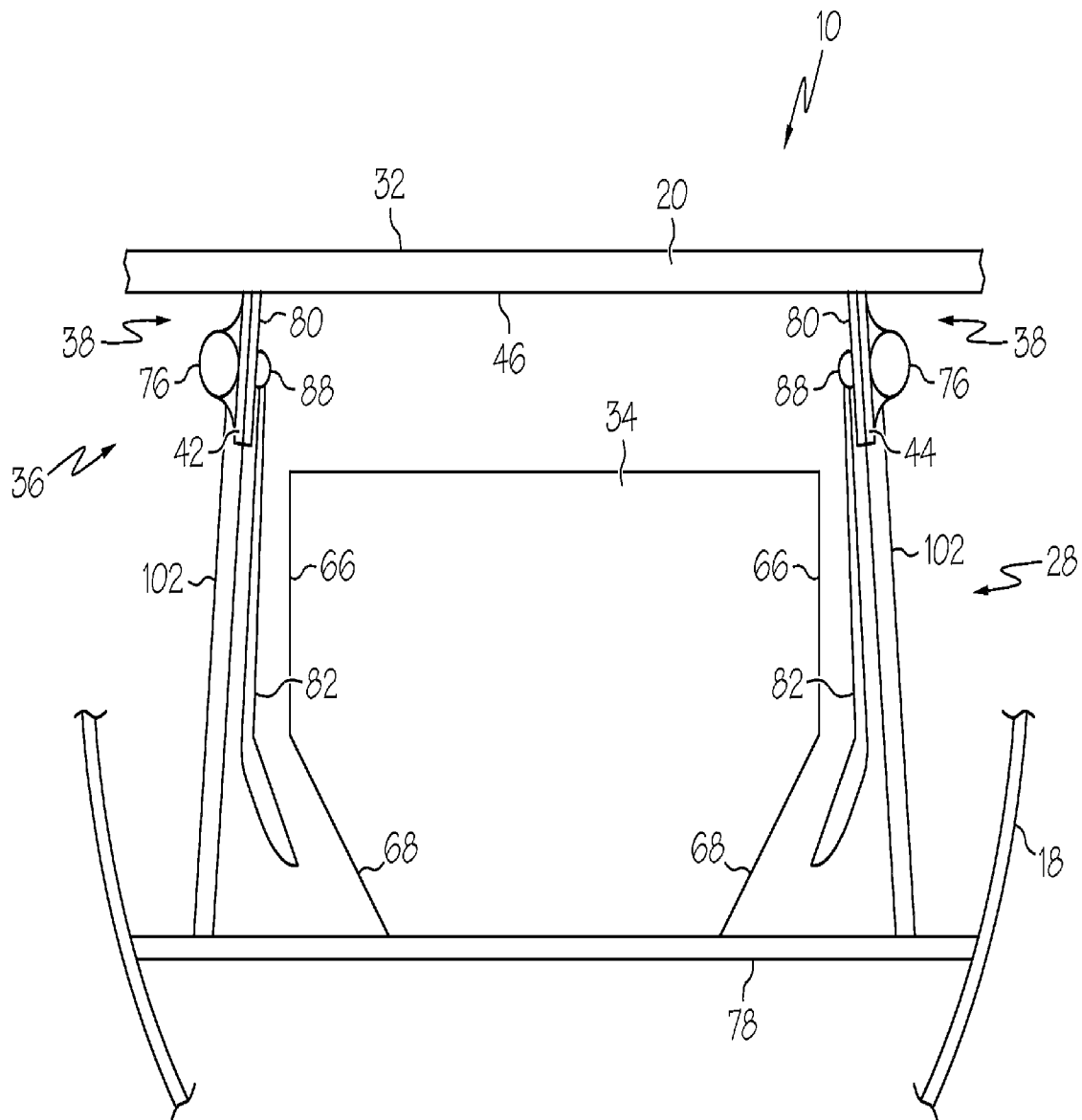


FIG. 8

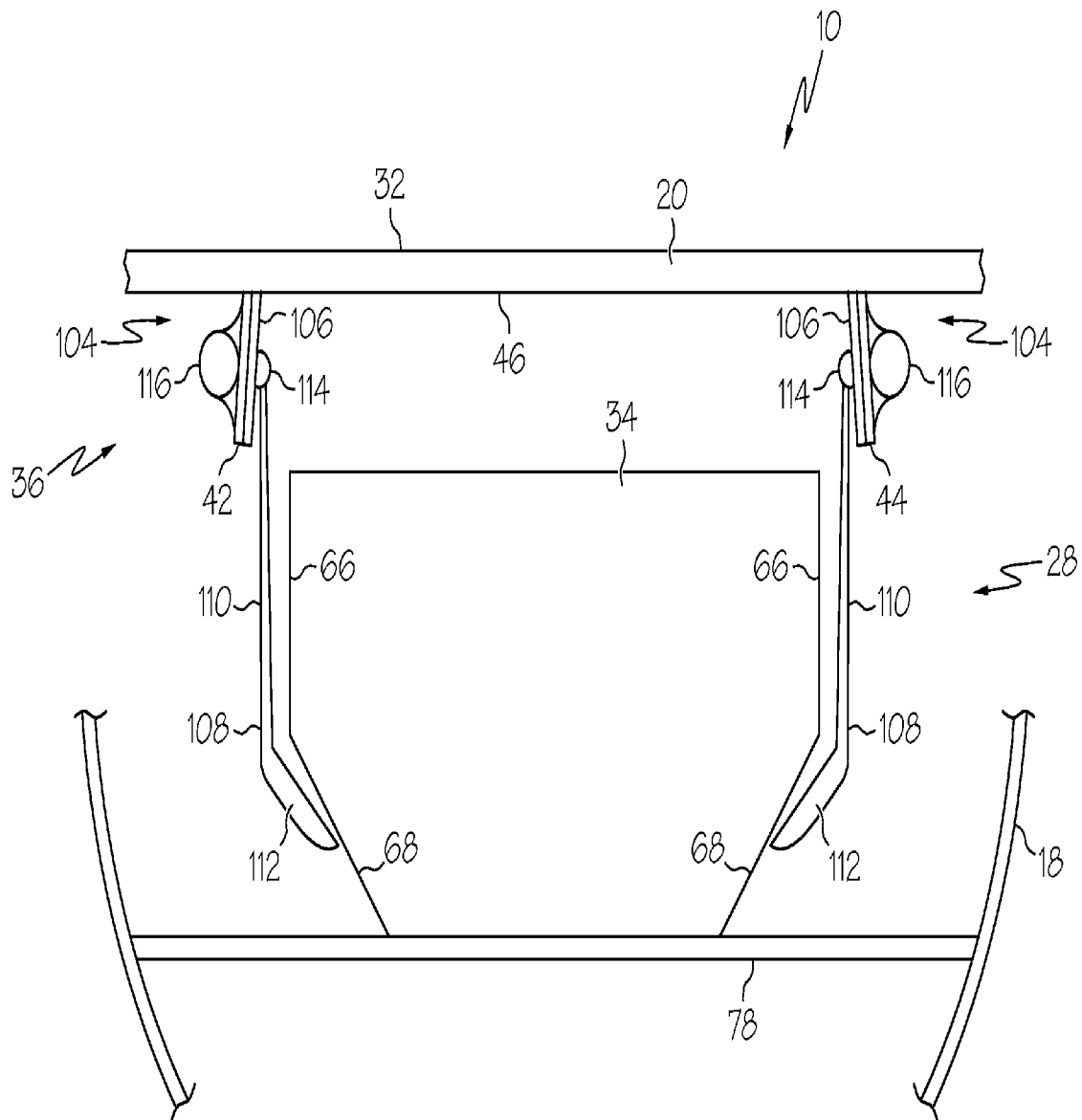


FIG. 9A

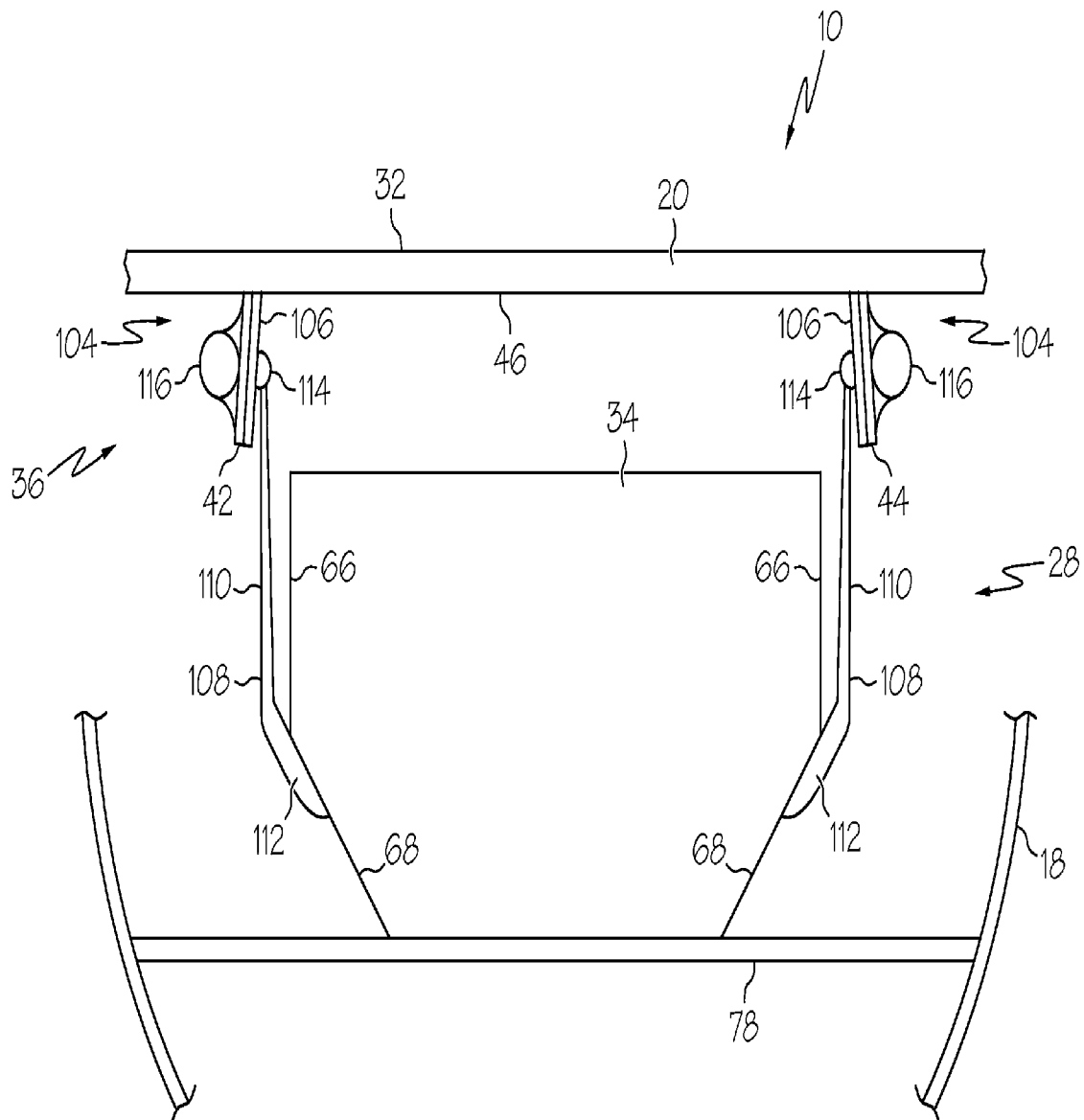


FIG. 9B

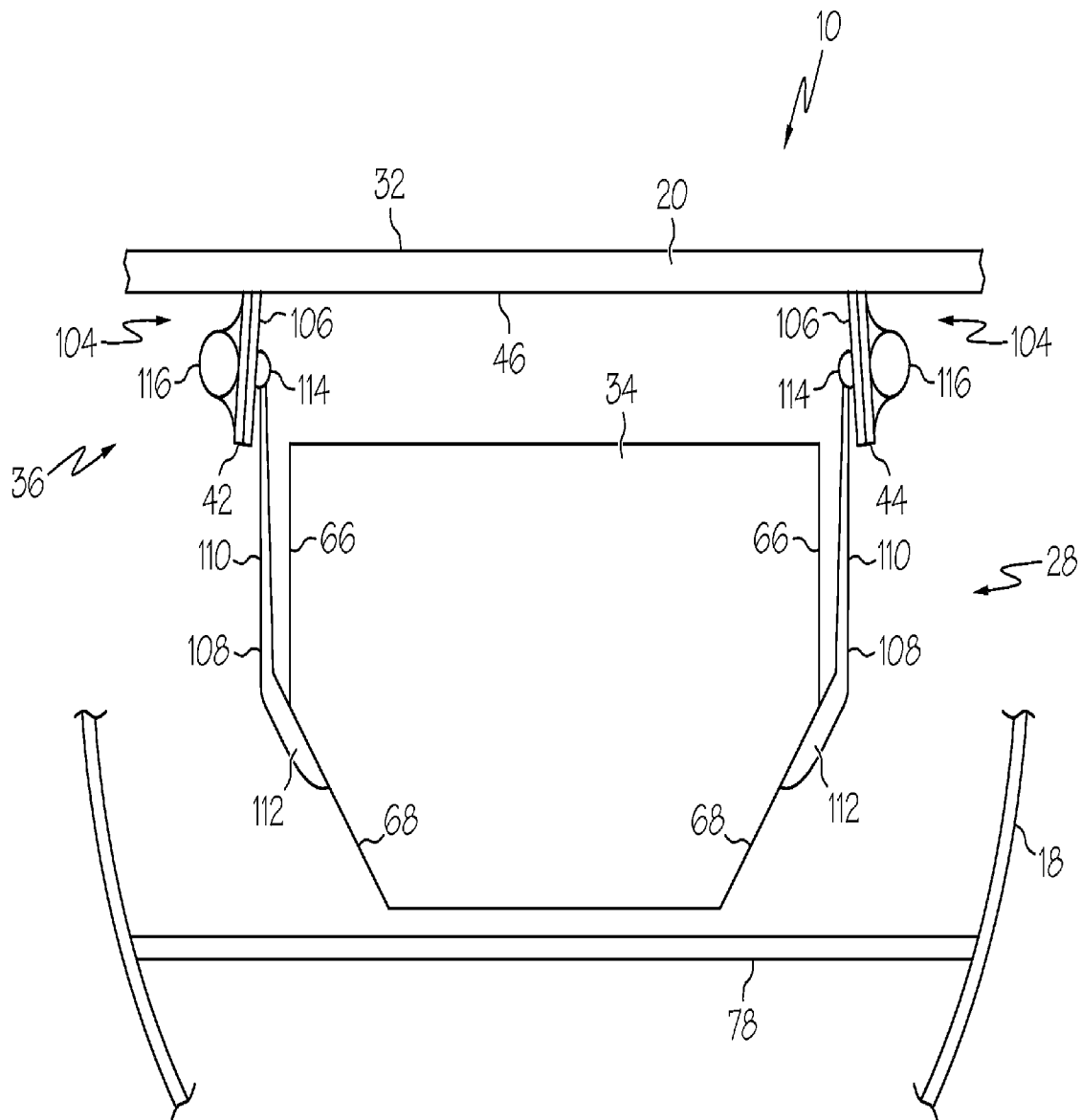


FIG. 9C

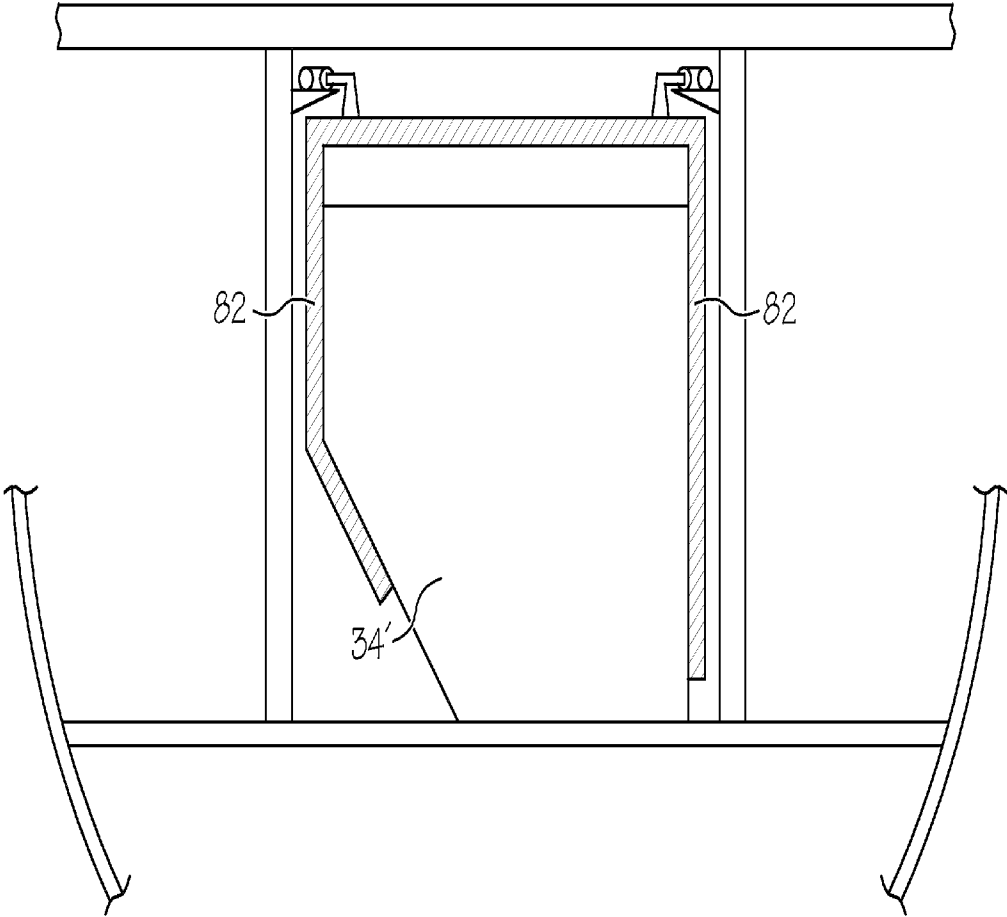


FIG. 10

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/061495

## A. CLASSIFICATION OF SUBJECT MATTER

INV. B64C1/22 B64D9/00 B66C17/06  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B64C B64D B66C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages              | Relevant to claim No.           |
|-----------|-------------------------------------------------------------------------------------------------|---------------------------------|
| X<br>A    | US 2 268 009 A (BABB CHARLES H ET AL)<br>30 December 1941 (1941-12-30)<br>the whole document    | 1,2,7-9,<br>14<br>3,4,<br>10-13 |
| Y<br>A    | -----<br>US 3 028 130 A (BURTON EDWARD F)<br>3 April 1962 (1962-04-03)<br>the whole document    | 1,9<br><br>3,4,<br>10-13        |
| Y<br>A    | -----<br>US 2 404 195 A (SCHLIEBEN ERNEST W)<br>16 July 1946 (1946-07-16)<br>the whole document | 1,5-7,9<br><br>3,4,<br>10-13    |
|           | -----<br>-/-                                                                                    |                                 |



Further documents are listed in the continuation of Box C.



See patent family annex.

## \* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

27 November 2013

Date of mailing of the international search report

04/12/2013

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Authorized officer

Pedersen, Kenneth

## INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/061495

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                                         |                          |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Category*                                            | Citation of document, with indication, where appropriate, of the relevant passages                                      | Relevant to claim No.    |
| Y<br>A                                               | US 3 552 587 A (WARREN ROBERT A)<br>5 January 1971 (1971-01-05)<br>the whole document                                   | 1,5-7,9<br>3,4,<br>10-13 |
| X,P                                                  | -----<br>EP 2 551 194 A2 (TELAIR INT GMBH [DE])<br>30 January 2013 (2013-01-30)<br>paragraph [0070]<br>figures<br>----- | 1,5,6,<br>8-11,14        |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/061495

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date         |
|-------------------------------------------|---------------------|----------------------------|-----------------------------|
| US 2268009                                | A                   | 30-12-1941                 | NONE                        |
| US 3028130                                | A                   | 03-04-1962                 | NONE                        |
| US 2404195                                | A                   | 16-07-1946                 | NONE                        |
| US 3552587                                | A                   | 05-01-1971                 | NONE                        |
| EP 2551194                                | A2                  | 30-01-2013                 | EP 2551194 A2 30-01-2013    |
|                                           |                     |                            | US 2013186999 A1 25-07-2013 |