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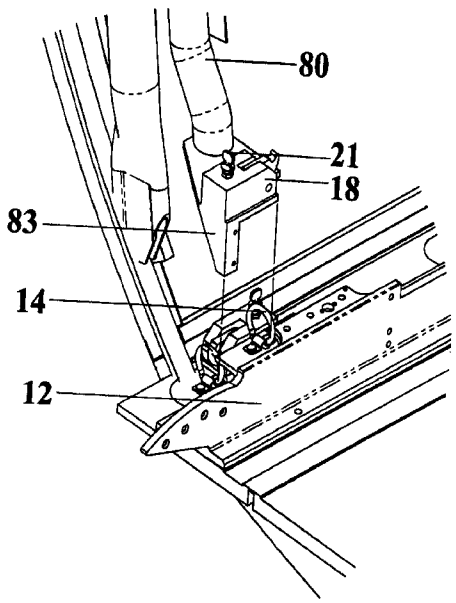


FIGURE 7

(57) Abstract: The system and apparatus of the present invention is generally comprised of a non-dedicated, temporarily installed, aircraft observer bubble door, chair, sonotube ejection system, mission electronics LRU rack and workstation assembly which are affixed to the Air Deployment System (ADS) rails, cargo tie down "D" rings, seat belt restraint ring bolt sockets, and litter bar of a host aircraft, thereby precluding the requirement for dedicated airframe modifications. One embodiment of the present invention also utilizes a multi-axis, articulated, foldable chair temporarily installed in conjunction with a segmented or one piece pressurized observer bubble door plug and door retraction system. The door plug assembly is designed to accommodate the simultaneous use of a sonotube stores launch system, a missile defense system, and an observer bubble window. The door plug also accommodates fitment around the envelope of a special mission strut which extends through the interior to the exterior of the host aircraft beneath the door plug's lower periphery. The door plug is also moveably mounted within a temporary retraction rail system which interfaces mechanically to the permanent door retraction rails and the aircraft floor or ADS rail system. When the host aircraft is not equipped with an ADS rail system, the retract rails, chair stanchion, mission electronics racks, and workstation assemblies are mounted to an adaptive floor plate (AFP) which can be modified to interface with various cargo floor "D" rings, or other cargo tie down mechanisms and bolt patterns such that several types of dissimilar aircraft can utilize the subject apparatus either with or without ADS rails installed. Once installed the subject apparatus can be stowed outboard of the fuselage cargo transit envelope to permit use of the ADS rail system in-flight, without affecting normal air drop operations, crew egress, the flight performance envelope, or emergency procedures of the host aircraft.

WO 2009/051711 A1

A TEMPORARILY INSTALLED AIRCRAFT OBSERVER DOOR PLUG, CHAIR, SONOTUBE EJECTION AND CONTROL SYSTEM

Richard L. K. Woodland & Ross Neyedly

This application claims priority to Provisional Application No. 60/998,959 filed on October 15, 2007, the entirety of which is hereby incorporated by reference.

FIELD OF THE INVENTION

This invention relates to a temporarily mounted, portable, modular, aircraft-based scanner chair, bubble door plug, sonotube ejection and workstation assemblies which do not require airframe modifications to accommodate the temporary installation of the manned observation, stores jettisoning, and control systems.

BACKGROUND OF THE INVENTION

aircraft-based platforms are ideally suited for time sensitive emergency, as well as routine, sensing, search, monitoring, surveillance and response activities. Among the various types of equipment and methodologies employed to maximize the effectiveness of aircraft employed in these roles include the launch and telemetry control of sonotube compliant stores which can include air launched Miniature Unmanned Aerial Vehicles (MUAV's), smoke markers, illumination flares, communication radios, and Self Locating Data Marker Beacons (SLDMB's) common to those engaged in Search And Rescue operations (SAR). Other aircraft enhancements in support of these missions can also include manned observation systems which utilize specially positioned scanning chairs in conjunction with enlarged glazing surfaces typical of those used for SAR, aerial refueling, and missile scanning functions.

By way of example the Canadian Department Of Defense (DND) operates Lockheed Martin C-130 aircraft which are routinely engaged in SAR operations. DND achieves a limited capability to eject sonotube compliant stores and to undertake manned observation from these aircraft by utilizing a pallet mounted, paratroop door located, temporarily installed, chair and un-pressurized door plug which can be equipped with a hand launched sonotube port and large flush glazed window. Unfortunately, precision stores deployment, Global Positioning System (GPS) location, payload control, and data, audio, or video telemetry from the stores is not possible without undertaking substantial modification to these aircraft. Further, DND cannot achieve Human Factors Engineering (HFE) compliance with Military Standard 1472 using the current palletized chairs or manned

scanning techniques employed within the paratroop door plug flush mounted glazing system requires that the chair be positioned forward into the door plug for the SAR technician to achieve peripheral search maximization. The anthropomorphic problems associated with this abnormal and at times prolonged physical position when the observer cannot project his feet beyond the curvature of the fuselage are numerous. By way of contrast the United States Coast Guard (USCG) also uses the Lockheed Martin C-130 for SAR missions. However, the USCG has undertaken substantial Group "A" or permanent modification of their aircraft rear ramps to achieve precision sonotube delivery, telemetry, and control. The USCG also employs a forward pressurized flat glazing observation system with dedicated sonotube launch system located at the observer chair positions forward of the wings abreast both sides aft of the C-130 cockpit bulkhead. Although the USCG has achieved a degree of HFE compliance, again the chair positioning and flat glazing, limit the visual acuity of the observer.

Further, although competent companies like Benson Lund, of Essex, England have designed other observer chairs for stanchion posts, the challenge of integrating a temporarily installed chair with extensive multi-axis HFE compliant positioning capabilities, which can fold away out of the cargo space, and can be sufficiently restrained to the aircraft structure to meet crashworthy loading criteria, does not currently exist.

Further underscoring current deficiencies associated with the control of jettisonable sonotube stores, new technologies exist which enable a host aircraft to launch and receive video and data telemetry from small MUAV's comparable to those manufactured by Advanced Ceramics Research, Inc. of Tucson, Arizona USA, or as described in U.S. Patent No. 6,056,237, entitled "Sonotube Compatible Unmanned Aerial Vehicle And System" issued May 2, 2000 to Richard L. K. Woodland, and incorporated herein by reference. The sonotube control interfaces currently employed on USCG aircraft and like C-130 aircraft do not permit the visual analysis or advanced user interface and control of the deployed sonotube payload systems unless a palletized control system comparable to the Palletized Radar Operating System (PROS) currently used by the USCG on their HC-130 "Casper" aircraft can be employed wherein the air drop functions are again compromised due to the co-location of the control system pallet in the rear of the host aircraft cargo bay.

Similar deficiencies in other mission areas also exist wherein U.S. Air Force (USAF) Lockheed Martin MC-130's and U.S. Marine Corp (USMC) KC-130 aircraft regularly engage in nighttime air to air helicopter refueling operations. These missions require that a loadmaster or other crew member visually monitor the refueling operation from the paratroop door location through a small flush window, often in turbulent flight conditions wearing NVG's on a simple fold away non-crashworthy

seat which can be also attached to the door. Under these conditions aerial refueling accidents have occurred resulting in lost and damaged aircraft.

Other situations involving hostile missile launch against large slower aircraft comparable to the Boeing C-17 during the critical take-off phase have also resulted in lost and damaged aircraft. In order to counter the vulnerability of aircraft to low altitude man portable missile launch, the USAF air Mobility Command's (AMC) Battle Lab has released a requirement for a manned bubble window observation system to substantially enhance the probability of undertaking successful evasive maneuvers or timely activation of other counter measures.

Further, although several types of aircraft are currently operated with bubble windows and sonotube ejection systems, typically these systems involve dedicated modifications that require a fleet of aircraft be modified to maintain mission readiness. Hence in most cases because these manned observation and sonotube mission kits are costly to install and upgrade, they are usually undertaken in the context of "minimum but adequate" and suffer performance deficiencies in light of optimal capabilities which could be achieved with fewer advanced technologies that are not permanently dedicated to one aircraft.

In pursuit of a prior solution, an aircraft door compatible manned observation and sonotube ejection system was described in U.S. Patent No. 5,927,648, entitled "aircraft Based Sensing, Detection, Targeting, Communications, and Response Apparatus" issued July 27, 1999 to Richard L. K. Woodland, and incorporated herein by reference. Although the Woodland invention can be able to accommodate temporary mounting of the system described in U.S. Patent No. 5,927,648 without incurring airframe modifications, it is completely reliant on a "mounting pallet" for installation which compromises all other backend air drop operations when the system is installed. Further, the Woodland patent does not address the temporary installation of an integrated door plug retraction system, multi-axis articulation of the observer chair, collapsible workstation, or unique form factor electronics and processing racks independent of a pallet assembly.

Currently prior art, and practices associated with resolution of the aforementioned deficiencies are inadequate, costly, preclude simultaneous air drop operations, inhibit upgrade, increase the probability of aircraft accidents during refueling operations and leave large slow moving cargo aircraft vulnerable to low altitude missile threats. Accordingly there is an on-going, unaddressed need to achieve a flexible, rapidly installed, non-dedicated airborne manned observation and sonotube launch and control system mounting methodology for fixed and rotary wing cargo aircraft that does not interfere with air drop operations, and does not require a pallet for installation.

SUMMARY OF THE INVENTION

The apparatus and system of the present invention solves the aforementioned problems associated with temporarily mounted, aircraft manned observation and sonotube launch and control systems without compromising air drop functionality by utilizing a variety of rapidly installed adaptive mounting plates which interface with the host aircraft's Air Deployment System (ADS) rails, the cargo floor tie down rings, seatbelt ring sockets and the emergency crew litter bar, thereby precluding the requirement for a mounting pallet. The various mounting plate apparatus(s) can also be configured to match the cargo floor tie down rings or tie down ring bolt socket patterns of a given host aircraft in lieu of an ADS rail interface. In accord with the foregoing, one embodiment of the present invention integrates the simultaneous mounting, use, and stowage for in flight cargo aircraft operations of a pressurized bubble door plug, a door plug retraction system, an articulated multi-axis observer chair, a sonotube launch system, one or more electronics LRU racks, a collapsible workstation, and a chair mounted collapsible remote operator control interface.

As the initial and primary component of the assembly summation, the bubble door plug of the present invention can be indented about its lower periphery to accommodate the simultaneous mounting and transit under the door of a special mission strut and pod assembly described under a separate patent refereneced herein as being simultaneously filed with the U.S. Patent And Trademark Office (USPTO) by Neyedly and Woodland. When not using the strut assembly, the orifice created in the lower part of the pressurized door plug can be sealed with a close out panel to permit aircraft pressurization. The door plug can also be segmented into two interlocking panels which permit modularity and rapid re-configuration of the respective panels in minutes. The HFE designed door assembly in either single or segmented configurations when using an observation bubble incorporates a segmented two part window with a bubble window in the upper section, a solid kick panel in the lower part of the bubble for the observers feet, and also accommodates the installation within the door plug of a heater/cooler unit manufactured by Cox & Co. of New York, NY, USA, which provides temperature controlled air to a diffuser located within the bubble window. A spring loaded counterbalance door plug retraction system has also been devised for use with one embodiment of the current invention which can be temporarily installed and used without removing the permanent aircraft door or retraction system. The door plug also accommodates the simultaneous mounting of ballistic armor protection, a guided weapon infra red/radar Electronic Warfare Self Protection (EWSP) system, a stowable sonotube iris valve and launch tube, a black out curtain, a night vision

goggle (NVG) compatible gooseneck light, a stowable observer leaning bar, and an environmental/lighting control panel.

As an additional component comprising the assembly summation, a sonotube launch system can be attached to the door which incorporates an iris valve which can be engaged or disengaged to permit launch of various payloads while the aircraft is in a pressurized or un-pressurized condition. The sonotube launch system incorporates a simple air bag expansion technology housed within a small compressed air cartridge which was developed by Sea Corp, of Middletown, Rhode Island, USA for the U.S. Navy LAMPS Helicopter. The Sea Corp mechanism eliminates the requirement for large bulky sonotube pressurization systems or dangerous pyrotechnic discharge devices which are currently used on U.S. Navy Lockheed Martin P-3's and other aircraft. The sonotube launcher can be also hinged and can be stowed in flight on the side of the door or removed completely when not required or air drop activities are in progress.

One embodiment of the present invention further incorporates a multi-axis HFE designed stanchion post mounted observer chair as manufactured by Benson Lund of Essex, England and AirDyne R & D of Calgary Alberta, Canada, which can be stowed completely outboard of the cargo transit envelope in the rear of the aircraft, and deployed for use in several positions as may be required by the mission or aircraft operational requirements. For example, for take-off and landing the chair can be positioned rearwards to comply with crashworthy 16 "G" requirements, or forward to use a workstation, or facing outboard for search operations, or 45 degrees aft or forward for aerial refueling and missile scanning functions. The chair being HFE compliant also incorporates operator controlled vertical, horizontal, lumbar, and armrest adjustment devices. Other attributes of the current chair of the present invention include ballistics armor, and the ability to mount remote sonotube or sensor system control interfaces on the armrests without permanently modifying the aircraft.

One embodiment of the present invention also incorporates simultaneous mounting and use of various mission electronics LRU rack assemblies, and a collapsible workstation with a collapsible remote chair mounted user control interface. The workstation assembly can be mounted to the top of a reduced height mission electronics LRU rack and can be further articulated and divided into four modules which are hinged such that the workstation can be disconnected for removal in whole or part, or can also be stowed when not in use to permit air drop operations. Due to crew survivability requirements and the possibility of mounting the workstation assembly at varying locations within a host aircraft, the workstation of one embodiment of the present invention also incorporates a self contained recessed operator oxygen supply, mask, and control system.

The integrated system of one embodiment of the present invention also incorporates connectivity to and utilization of, other ditching hatches on the host aircraft which serve as temporary non-dedicated mounting surfaces for Over The Horizon (OTH), or Line Of Sight (LOS) antennas in support of communications, navigation, and positioning support requirements without sacrificing emergency crew egress or requirement for interfacing with the mission LRU rack assemblies and the onboard aircraft electronic data bus. Further the complete system of the present invention may utilize various iron lung, medical litter, missile, winch, auxiliary or other existing electrical power interface receptacles to drive the various components and mission systems of the present invention on the host aircraft negating the requirement for dedicated electrical system modifications.

The simultaneous installation of the assembly as described herein comprising one embodiment of the present invention can be removable, stowable, modular, rapidly installed, does not interfere with backend aircraft operations, does not compromise emergency crew egress, and does not require a pallet or aircraft modifications to enable its use on the ground or in flight. The integration of the aforementioned components and assemblies in the non-dedicated manner embodied within the overall manned observation and sonotube launch and control system described herein, resolves the cited deficiencies to provide the desired portability, commonality, and modularity to enable cost effective utilization of advanced technologies incorporated within the invention, across multiple aircraft types.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the complete assembly of all primary components of the subject system apparatus depicted with a special mission strut mounted beneath the pressurized two piece segmented and indented door plug with all components in the deployed and operable position as could normally be installed on the left side of the host aircraft.

FIG. 2 is a perspective view of the complete assembly of all primary components of the subject system apparatus with attachment details, for an ADS rail equipped aircraft, depicted with all components in the retracted and stowed position utilizing a single piece indented door plug with close out panel installed as depicted in the open position on the left side of the host aircraft.

FIG. 3 is a perspective view of the complete assembly of all primary components of the subject system apparatus with attachment details, depicted in the deployed and operable

position as mounted to the cargo floor restraint rings of a host aircraft not equipped with ADS rails.

FIG. 4 is an exterior perspective view of a segmented, interlocking, two piece pressurized observer door plug with an electronic warfare aircraft self protection system mounted in the lower door plug panel.

FIGS. 5A-5E are interior perspective views of the observer pivot arm stanchion chair assembly depicting the adjustable motion paths about the subject axis of the chair and stanchion post.

FIG. 6 is a perspective view of the workstation control assembly in the deployed position depicting the oxygen supply reservoir, control system, and user mask.

FIG. 7 is a perspective view of the aft lower door plug retraction system attachment details more fully delineating the temporary connection methodologies employed.

FIG. 8 is a perspective view of the forward lower door plug retraction system attachment details more fully delineating the temporary connection methodologies employed.

FIG. 9 is a perspective view of the mission LRU rack attachment plate more fully delineating the temporary connection methodologies employed.

FIG. 10 is a perspective view of the temporary stanchion chair attachment plate more fully delineating the temporary connection methodologies employed.

DETAILED DESCRIPTION OF THE INVENTION

The invention is now described in terms of the FIGURES to more fully delineate in detail the scope, materials, components, conditions, and methods associated with the design, and deployment of the present invention. Many of the parts and components of the present invention are hereinafter described as being "assemblies". As used herein, the word "assembly" or "assemblies" refers to the totality of related parts and pieces associated with a given component and its operability and is not to be construed as limiting to a particular piece, part, or operation.

The description herein is made with the understanding that the skilled person in the field of designing and using aircraft-based platforms for sensing, search, monitoring, surveillance and response activities, is familiar with standard aircraft features such as various structural elements including side doors, side door operations, floor tie down elements and systems, air deployment system (ADS) rails, and the like, primarily as utilized on C-130 aircraft. No detailed description of such features is believed necessary to enable one skilled in the art to understand and implement the present invention.

In general the invention comprises a novel design and integration approach to the configuration, capability, and installation of an aircraft independent, portable, manned observation and sonotube launch and control assembly as used in SAR, oil spill characterization, aerial refueling, missile scanning, and other airborne missions.

A representative system architecture is depicted in **FIGS. 1** through **3** showing one embodiment of the present invention that can include an ADS rail, cargo floor mounted non-dedicated manned observation and sonotube launch and control system, and can include primary sub assemblies which can be used for functionality and employment of the present invention. Sub assemblies include an aircraft, mounting interface assembly, strut assembly, pressurized plug assembly, door plug retract assembly, and a chair assembly, a workstation and control interface assembly. Combined, these various sub assemblies can enable a standard cargo aircraft to be rapidly re-configured as a SAR mission platform, or alternatively, to enable an aircraft to be equipped with a rapidly installed advanced Electronic Warfare Self Protection (EWSP) system which could otherwise not be installed due to the high cost of the systems or dedicated airframe modifications.

As shown in **FIG's 1** and **2**, the apparatus can be used aboard the host aircraft **1**, such as a Lockheed-Martin C-130 aircraft. The existing aircraft door **4** can be removed or opened vertically upward and stowed in the locked position without being removed. The present invention provides the

benefit of eliminating the need for palletized systems by incorporating mounting plates that attach to existing aircraft ADS rails and/or cargo tie down rings. As depicted in FIG's 9 through 10, Installation of the illustrated embodiment of the present invention can begin with attachment of an aft lower rail attachment fitting 83, which is connected to the aft end of the ADS rail 12, using an adjustable CAM lock 18, as depicted in FIG. 7 and further a forward lower rail strut fitting 84, can be connected using multiple restraint bolt 21, means fastened tot eh ADS rail 12, at which point an LRU rack mounting plate **19**, can be connected using a plurality of self tightening chock 23, means and a pair of restraint bolt 21, means, connected to several seat belt socket 24 means, and the upper surface of the ADS rail 12, by means of multiple adjustable CAM lock 18 means, and finally a stanchion post mounting plate **20**, which is also mechanically connected to the upper surface of the existing ADS rail **12**, by means of adjustable CAM lock 18, means to multiple cargo tie down ring(s) **14**. Attachment can be by use of conventional aircraft adjustable cam locks **18**, tension restraint devices, or by other means familiar to those skilled in the art of aircraft cargo restraint methodologies. If necessary, for example, when installed on Lockheed-Martin C-130 aircraft, mounting plates such as the LRU rack mounting plate **19** can be further connected to the host aircraft **1** by removing the temporary web seating bars and seat belt restraint ring **15** and inserting multiple restraint bolts **21**. The stanchion post **99**, can be connected to the side of the host Lockheed-Martin C-130 aircraft **1** fuselage at its upper end by means of an upper stanchion brace **102**, which can be bolted to a fuselage structural flange **17** by multiple restraint bolts **21**.

Mounting plates can be made of any suitable material, such as aluminum or steel, depending on strength and weight constraints. Mounting places can be made in any suitable shape, with the only design requirement being that they provide a surface for mounting the various components of the present invention and can be attachable to the aircraft's existing ADS or cargo tie down rings.

After the various mounting plates and braces are installed, attachment of a door plug retraction rail assembly **80**, can be undertaken by connecting upper rail support struts **81** to the existing aircraft door retraction rail guides **6**, by means of multiple upper rail attachment fittings **82**. The lower part of the temporarily installed door plug retraction rail assembly **80** can be then connected to an existing ADS rail **12** by means of two lower rail attachment fittings **83** and multiple restraint bolts **21**. As depicted in **FIG's 1** through **3**, the retraction rail assembly **80** may also be pre-assembled as a kit, and installed on the host aircraft with either the one or two piece door plugs positioned within the retraction rail assembly **80**.

As depicted in **FIG. 3**, where an aircraft is not equipped with an ADS rail **12**, the present invention may utilized by installing one or multiple adaptive floor plates **13** together with the use of restraint bolts **21** or conventional aircraft adjustable cam locks **18** for tension restraint. The adaptive floor plate **13** can include aircraft type specific bolt patterns unique to the host aircraft, for example an EADS CN-235 aircraft.

After installation of the mounting plates and braces installation of various functional mission assemblies may be undertaken using multiple sequential orders. Alternative functional mission assemblies can be pre-assembled as complete sub assemblies for rapid deployment. Examples of sub assemblies which can be pre-assembled include the chair assembly which can be pre-assembled to the stanchion post **99**, the upper stanchion brace **102**, and the stanchion post mounting plate **20**.

As depicted in **FIG's 1** through **4** the current invention can include a pressurized observer door plug assembly comprised of either a single piece door plug **51**, or a segmented two piece door plug incorporating a segmented door plug upper panel **54**, and a segmented door plug lower panel **55**. In both configurations the pressurized observer door plug assembly utilizes a door strut indent **52**, located along its lower periphery to accommodate the installation of a fixed or articulated strut **30** for special mission sensors antennas or other equipment exterior of the aircraft. The pressurized observer door plug assembly accommodates the transit of the fixed or articulated strut **30** from the interior side of the single piece door plug **51**, or segmented door plug lower panel **55**, to the exterior of the host aircraft while forming a pressurized seal around the fixed or articulated strut **30**. When the pressurized observer door plug assembly is used without the installation of a fixed or articulated strut **30**, then a door plug close-out panel **53** can be installed within the strut indent **52** to fill in the vacant area and permit either aircraft to be pressurized. As depicted in **FIG. 2**, mechanical retention and securement of the door plug close-out panel **53** can be achieved by a plurality of operator controlled close out panel latches **77**, which can activate a plurality of close out panel lock pins **78**, which when extended in the single piece door plug **51**, or the segmented door plug lower panel **55**, the door strut indent **52** becomes effectively sealed to the outside air permitting the host aircraft to be pressurized.

As depicted in **FIG's 1** through **4**, the pressurized observer door plug assembly **4.0**, incorporates elements required for manned observation common to both the single piece door plug **51**, and a segmented two piece door plug. These elements as installed within either the single piece door plug **51**, or the segmented door plug upper panel **54**, include a segmented bubble window **63**, which incorporates clear glazing in the upper portion of the bubble and a metallic or composite door plug kick panel **58** within the lower portion of the bubble assembly. The segmented bubble window **63**

assembly can also provide for a hinged door plug leaning bar **65** and a bubble window air diffuser **64**, which can be mechanically ducted and electrically connected to a door plug heater/AC unit **60**, and heater, diffuser, light control **61**, unit mounted within the observer door plug assembly. Either the single piece door plug **51** or the segmented door plug upper panel **54** can provide for various door plug access panels **62** to gain entrance to the interior of the door for maintenance purposes and the mounting of a gooseneck or other type of NVG compatible door plug light **59**. The observer door plug assembly can be powered by various means including a battery or 28 volt DC power coming from the aircraft via a temporarily installed cable harness connected to a floor winch, iron lung or other receptacle familiar to those skilled in the art of aircraft electrical engineering.

As part of the mission hardware suite, and as depicted in **FIG's 1** through **4**, the observer door plug assembly can also incorporate a sonotube launch system **67**, comprised of a door plug tube port **66**, which provides an orifice through either the single piece door plug **51**, or the segmented door plug upper panel **54**, to enable ejection of sonotube compliant stores. The door plug tube port **66** orifice can be connected to a sonotube iris valve **68** located on the inside of the host aircraft which can be manipulated between the open and closed positions to permit the pressurized ejection of various sonotube compliant stores while the aircraft is pressurized. When not in use, or when required for air drop activities, the sonotube launch system **67**, can be equipped with a sonotube hinge **69** and sonotube stowage latch **70** which permits the operator to stow the sonotube launch system **67** along the upper section of either the single piece door plug **51**, or the segmented door plug upper panel **54**.

The single piece door plug **51** and the segmented door plug upper panel **54** can also be equipped with door plug lift handles **57** and door plug lock pins **56**, which effectively emulate the permanent aircraft door **4** lock mechanisms into the fuselage doorway. The two piece door plug configuration can also incorporate two or more interlocking latches **71** which enable the segmented door plug lower panel **55** and segmented door plug upper panel **54** to be joined for the purpose of sealing the door, pressurizing the aircraft, and allowing the segmented door plug lower panel **55** to be disengaged from the segmented door plug upper panel **54** when a payload has been installed on the segmented door plug lower panel **55**. One embodiment of the present invention also incorporates the mounting of a modified segmented door plug lower panel **55** equipped with an EWSP missile countermeasures fairing **74**, which can be configured for infra-red, radar, and/or RF countermeasure electronics.

As depicted in **FIG's 1** through **3** and **FIG. 5** one embodiment of the present invention incorporates an observer chair assembly for the purpose of engaging in manned search, missile scanning, aerial refueling and other operations. The crashworthy observer chair **95** has been designed

to articulate vertically about a stanchion post **99** by means of a telescoping pivot arm **97** which can be attached to a stanchion post translation coupling **100** enabling rotation and elevation adjustment about the vertical axis of the stanchion post **99**. The chair **95** can also be moved closer to or away from the stanchion post **99**, in the horizontal axis by means of a telescoping pivot arm sleeve **104**, housed within the outer sleeve of the telescoping pivot arm **97**. The observer chair **95**, incorporates a translation control lever **98**, which enables the chair, and thereby the system operator, to articulate 360 degrees about the vertical axis at the end of the telescoping pivot arm **97**. Further, an adjustable slide plate **101** assembly allows the operator to adjust his position away from or closer to the vertical axis centerline at the end of the telescoping pivot arm **97**, permitting the observer to move forward into the segmented bubble window **63**. Several other aircraft interior mounting locations have been contemplated for the chair assembly, which by way of example and not limitation could include mounting the chair assembly stanchion post **99** and stanchion post mounting plate **20** in onto an aircraft floor **2**, and to an alternate upper structural flange **17**, on a lowered rear ramp of a Lockheed-Martin C-130 aircraft **1**, for rearward vision through the aft cargo area. Other features currently deemed as common practice within the aircraft military chair industry could also provide for the integration of armor, foot rests, heating pads, and other components related to crew comfort and survivability.

As depicted in **FIG's 1** through **3** and **FIG. 6** a workstation & control interface assembly can be incorporated within the current invention for the purpose of launching/controlling various sonotube based payloads, undertaking mission specific data processing, communications, EWSP activities and other unique mission systems control functions. The hardware suite required to undertake the control interface functionality and permit stowage outboard of the host aircraft ADS rail **12** can include a collapsible workstation **112**, one or more remotely located collapsible armrest mounted control interfaces **121**, and at least one or more mission electronics LRU racks **111** housed within a crashworthy cabinet frame.

One embodiment of the present invention as disclosed in FIG's 1 and 6, include a form fitted reduced height LRU rack **125** and a full height mission electronics LRU rack **111**, both of which can be contoured to comply with the fuselage curvature typical of the host aircraft. For example, on a Lockheed-Martin C-130 aircraft **1**, the components can be contoured so as to accommodate fitment outboard of the ADS rail **12**, and cargo transit envelope where a removable web bench seat could normally be located. The reduced height LRU rack **125**, and mission electronics LRU rack **111**, can be connected to the LRU rack mounting plate **19** by a plurality of restraint bolts **21** and when required, stabilized vertically by a plurality of attachment clamps **22**, temporarily affixed to the host

aircraft litter bar **16**. The reduced height LRU rack **125** and mission electronics LRU rack **111** generally occupy two mounting positions approximately consistent with the 21 inch electronics LRU mounting rack standard. The LRU rack positions can be able to accommodate either two full height mission electronics LRU racks **111**, or one collapsible workstation **112** mounted to the upper surface of a reduced height LRU rack **125**.

One embodiment of the current invention also accommodates the temporary mounting and utilization of the collapsible workstation **112**, consisting of an upper display module **113**, a lower display module **114**, a tactile interface module **115**, and an overhead module **116**, The modules being physically connected and appropriately hinged so as to enable collapse and stowage using a plurality of module locking hinges **117**. All modules incorporated within the collapsible workstation **112** can be equipped with self-locking deployed/stowed hinge devices using operator induced module hinge release actuators **118** and other slide rail devices and hinges common to those skilled in the field of flight mechanics, to enable collapse and stowage of the collapsible workstation **112** outboard of the aircraft cargo transit envelope as to permit air drop activities. The collapsible workstation **112**, accommodates common control, display, sound and input devices such as a joystick **129**, keyboard, track ball, pointing stylus, audio speakers, and display screens. The joystick **129**, is described herein as being removable to enable stowage underneath either the left or right side hinged wrist pad **126** within a wrist pad bin **127**. To compensate for turbulence induced injuries, and fatigue exerted on the operator, the forward edges of the tactile interface module **115**, and the overhead module **116**, can be equipped with a chamfered foam edging **128** to provide a soft anthropomorphic interface between the operator and the solid frame of the collapsible workstation **112**.

Further as depicted In **FIG. 6**, as several aircraft types do not have a supplementary oxygen supply, mask, and control system for special mission crew members, the collapsible workstation **112** can incorporate the integration of a self contained oxygen cylinder means housed within the frame of the tactile interface module **115**, accessible from a panel below, and a set of oxygen controls **124** housed underneath the left or right side hinged wrist pad **126**, within a wrist pad bin **127**, and an oxygen mask **122** housed within a rapid access bin on the underside of the tactile interface module **115**. The oxygen systems can be typical of the MA-1 assembly manufactured by Scott Aviation of Lancaster, New York, USA.

Further as depicted In **FIG's 1** through **3**, due to the fact that the collapsible workstation **112** system operator may rotate his chair position between the collapsible workstation **112** and the side looking observer position located in the aircraft doorway, or because flight crew members located in

the cockpit, or at other locations on the host aircraft may require remote control interface means and remote electronic connectivity to the workstation & control assembly, the present invention incorporates the integration of one or more collapsible armrest mounted control interfaces **121** connected to the collapsible workstation **112** by data/power cabling familiar to those skilled in the art of aircraft electrical engineering.

In one embodiment of the current invention as it relates to the workstation & control assembly, the invention components can also be electronically interfaced to the aircraft data bus or connected to a modified temporarily mounted, ditching hatch plug **72** (as shown in FIG. 1), equipped with various types of hatch mounted RF antennas **73** and GPS antennas **75** located topside on the fuselage for mission specific line of sight (LOS) and satellite based over the horizon (OTH) communications and telemetry without permanent modification to the host aircraft. The modified ditching hatches are of the type routinely employed on USAF C-130 aircraft and typical of those manufactured by Aerospace Integration Corp, of Crestview, Florida, USA.

METHOD OF OPERATION

The method of operation is described in conjunction with **FIG's 1** through **6** and includes methodologies generally known in the art of cargo restraint methodologies, sonotube ejection systems, manned observation systems, communications, telemetry and control of the sonotube compliant payloads. Therefore, details known to those skilled in the art of aircraft cargo restraint, aircraft payload loading, restraining, and use, are not described in exhaustive detail herein.

In general, the mounting plates of the present invention can be mounted first on their respective components, or they can be mounted first on the aircraft, such as on the aircraft's ADS rail. In the methodology described herein, the various mounting plates are considered to have been already attached to their respective mission components. The methodology of installation and operation as described herein is divided into seven functional areas. The installation of a temporarily mounted fixed or articulated strut **30**, although referenced briefly herein, is not described further with regard to operation as it is described in detail in a parallel patent filed by Woodland & Neyedly with the U.S. Patent & Trademark Office (USPTO) as part of a family of related special mission inventions undergoing simultaneous filing. Further, although the present

invention can be utilized on various types of aircraft, the methodology below is described with respect to a rear-loading C-130 type aircraft.

System Transport & Loading - Upon notification of a mission, a ground crew that can be comprised of two individuals could ship the present invention within a plurality of man portable, ruggedized transport cases to the host aircraft. After an initial confirmation that the host aircraft is flight ready, the rear ramp could be lowered and the transport cases loaded onto the aircraft. In one embodiment of the invention, the loading can be achieved without the use of a mechanized loader, the components and assemblies being light enough that two individuals can undertake the loading and installation.

Aircraft Preparation - Initially the install crew could open, stow, or remove one or more side door(s), such as a left side paratrooper door, to create an orifice with which to accommodate fitment of the pressurized observer door plug assembly. One or more of the upward host aircraft ditching hatches **5**, could also be removed to accommodate one or more specialized ditching hatch plugs **72** to provide specialized mission telemetry, and communications capabilities. Once the host aircraft ditching hatch **5** has been removed, the web seating bench located forward of the paratroop door(s) can be removed and stowed. If a fixed or articulated strut **30** is used with the present invention then a section of the existing ADS rail **12** could also be removed to accommodate its installation abreast of the open doorway.

Workstation And Control Interface Assembly – The installation of the various electronics and user interface assemblies of the present invention begins with the mission electronics LRU rack **111**, and reduced height LRU rack **125**, wherein as stated in the operational description, these components can be pre-connected to the LRU rack mounting plate **19**, which in turn is temporarily attached to the host aircraft floor **2**, and host aircraft fuselage **3**, by means of an ADS rail **12**, or an adaptive floor plate **13**. The fastening methodologies used as described herein can include a plurality of aircraft cargo tie down rings **14** and removal of the seat belt restraint rings **15**, a litter bar **16**, using a plurality of restraint bolts **21** and attachment clamps **22**. Once the reduced height LRU rack **125** is installed together with a collapsible workstation **112**, the installation crew could attach it to the top of the reduced height LRU rack **125**, using a plurality of collapsible workstation slide rails **130**. The installation crew could then extend the collapsible workstation **112** by releasing a plurality of module locking hinges **117** by depressing multiple module hinge release actuators **118**. Once fully extended and secured to the top of the reduced height LRU rack **125**, one crew member

could lift the hinged wrist pad **126**, and remove the joystick **129**, from wrist pad bin **127**, to insert in either a left or right hand joystick socket **131**, located on the tactile interface module **115**. At this point in the installation process, the collapsible workstation **112**, mission electronics LRU rack **111**, reduced height LRU rack **125**, and the ditching hatch plug **72**, can be inter-connected by a power and data relay/control cable and approved electrical power from the host aircraft using materials and methods familiar to those skilled in the art of aircraft electrical engineering.

Observer Chair Assembly – The observer chair **95**, equipped with a pair of chair armrests **96**, a translation control lever **98**, and an adjustable slide plate **101**, could be pre-assembled with the stanchion post **99**, integrating in one assembly the stanchion post translation coupling **100**, telescoping pivot arm **97**, and upper stanchion brace **102**, with the observer chair **95**. The size and weight of this assembly can be quite manageable by two crew members who can connect the stanchion post mounting plate **20** to the host aircraft floor **2**, using adjustable cam lock **18**, means interfaces to a plurality of cargo tie down ring **14**, means mounted on the surface of an ADS rail **12**, or an adaptive floor plate **13**. The stanchion post **99** also can be secured at the upper end to the host aircraft fuselage **3** by an upper stanchion brace **102** and a plurality of restraint bolts **21**, which can be connected to a structural flange **17** on the host aircraft. Once the observer chair **95** is installed the crew can mount the collapsible armrest mounted control interface **121**, and the chair armrest **96**, and connect them to the collapsible workstation **112** by means of a power and data cable harness. Depending on the nature of the mission(s) and the requirement for user interfaces, the collapsible armrest mounted control interface **121** may be positioned simultaneously at multiple locations in the aircraft necessitating a variety of temporarily installed cable harness configurations familiar to those skilled in the art of aircraft electrical engineering.

Pressurized Observer Door Plug Assembly – Installation of the temporary observer door plug and retraction rail assembly **80** for the purposes of this description of methodology assumes that either of the the single piece door plug **51** or the two piece door plug comprised of a segmented door plug upper panel **54** and a segmented door plug lower panel **55** is pre-assembled with the retraction rail assembly **80**, and does not require placement of a door plug close-out panel **53**, or operation of the door plug lock pins **56**. In one embodiment of the present invention, the design addresses the installation of the complete door plug assembly by two individuals by aligning the upper rail support struts **81**, of the retraction rail assembly **80**, with the existing aircraft door retraction rail guides **6**, and secures a plurality of upper rail attachment fitting **82** using restraint bolts **21** or other attachment clamps **22**, or rotating cam means familiar to those skilled in the art of aircraft mechanical systems

engineering. The lower parts of the retraction rail assembly **80** are connected to the to the host aircraft floor **2** using a pair of fore and aft lower rail attachment fittings **83**, which can interface to the door retract mounting plate(s) **11**, and are secured by several adjustable cam locks **18**, and/or restraint bolts **21** interfaced to a plurality of cargo tie down rings **14** mounted on the surface of an ADS rail **12** or an adaptive floor plate **13**. Once the pressurized observer door plug assembly has been installed, the sonotube launch system **67** can be removed from its case and attached to the sonotube iris valve **68** mounted within either the single piece door plug **51** or segmented door plug upper panel **54**. The tube comprising the majority of the sonotube launch system **67** can be physically attached to the sonotube iris valve **68** using a plurality of bayonet latches which secure the tube in place once it has been inserted into the bayonet recesses and rotated, which locks the sonotube launch system **67** in place.

System Functionality Check – The installation completed, the crew could then undertake a self diagnostics status verification test of the collapsible workstation **112** and the onboard LRU processing system. This could include all displays, input and output devices, cable connections to the hatch mounted RF Antenna **73**, GPS Antenna **75**, EWSP Missile Countermeasures Fairing **74**, telemetric links to the payload stores of the sonotube launch system **67**, one or more the collapsible armrest mounted control interface **121**, and the aircraft data bus (if required). Additional status verification could include physical inspection and operability of the self contained oxygen system within the collapsible workstation **112** by lifting the hinged wrist pad **126**, to expose the oxygen controls **124**, and removing the oxygen Mask **122**, to verify the oxygen cylinder **123**, was providing the requisite oxygen at the specified flow rates. Additional functional testing could be undertaken to assess operability of the door plug Retract assembly **5.0**, to verify pressurized closure of the fuselage door plug lock pins 56, the segmented door plug interlocking latches **71**, and the heater, diffuser, light control **61**, could also be tested for operability and secure detent positioning. The door mounted sonotube launch system **67**, could also be schecked for rated pressurization of the launch cylinders, clearances of FOD from door plug tube port **66**, Operability of the sonotube iris valve **68**, and operability of the sonotube hinge **69**, and sonotube stowage latch **70**, assemblies. The functionality of the observer chair **95**, in all its operable axis and adjustment modes is also undertaken and the telescoping pivot arm **97**, extended to the bubble window observation position, A final inspection of all system electrical cable harnesses, and structural interface attachment points which have been fitted with temporary restraint bolt **21**, means, attachment clamps **22**, and adjustable cam lock **18**, can be undertaken prior to approval for flight.

In Flight Operation – With the system of the present invention in the deployed position aboard the host aircraft, the crew can engage in manned search or scanning operations. As depicted In **FIG's 5A, 5B, 5C, 5D, 5E, and 5F,** the observer chair **95** can be rotated about the stanchion post **99** to move back and forth between the collapsible workstation **112**, and the segmented bubble window **63**. The operator is also able to rotate his chair through 360 degrees about the end of the telescoping pivot arm **97** to achieve various viewing positions including positions advantageous for take-off or landing, lateral mission scanning, or 45 degrees in either forward or aft positions. Further, depending on height adjustment the chair can be elevated in the vertical about the stanchion post **99** by means of the stanchion post translation coupling **100**. When viewing subjects of opportunity from the segmented bubble window **63** the operator can adjust the chair forward and back into the window envelope using an adjustable slide plate **101** and translation control lever **98**. All adjustments and articulations can be achieved by known means as known in the art.

As depicted in FIG **2,** when the chair is not required, or when back end air drop missions are being undertaken, the observer chair **95**, collapsible workstation **112**, and sonotube launch system **67** can be folded away outboard of the ADS rail **12** or cargo envelope to allow pallets and other cargo to egress towards the rear of the aircraft. When the host aircraft is engaged in paratroop drop operations through the door which the present invention is mounted in, then the pressurized observer door plug assembly lock mechanisms can be disengaged by the door lock handle **76** located towards the upper left of the door assembly, which can be opened upward as it could normally operate to allow the paratroopers to egress without being constrained by the various components and appendages of the present apparatus.

When utilizing the sonotube launch system **67**, images from various jettisoned sonotube compatible payloads can be received by the host aircraft. With the workstation & control assembly installed, dynamically launched MUAV's can be tasked, and data analyzed by the host aircraft and then relayed to other aircraft, surface assets, or to distant control centers using OTH telemetry provided by the specially equipped ditching hatch plug **72**. Further, when deploying multiple sonotube buoys or like packages the ditching hatch plug **72**, provides GPS location data such that a grid of coordinated positions can be determined for precision delivery of the sonotube packages, particularly if sonotube launch system **67**, is equipped with multiple launch tubes, or incorporates a cartridge system similar that being developed by Sea Corp of Rhode Island, USA.

It could be obvious to those skilled in the art of aircraft special mission systems that the overall system of the present invention as described herein has extensive ability to interface with and

otherwise accommodate numerous other missions when augmented with external sensors, communications, electronic warfare systems, unmanned vehicles or other stores, not described in detail within this patent. While certain embodiments have been shown and described, various substitutions and modifications may be made without departing from the spirit and scope of the invention. Accordingly it is to be understood that the present invention has been described by way of illustration and not limitation.

WHAT IS CLAIMED IS:

1. An aircraft based observer chair, bubble door plug and door plug retraction mechanism equipped with a sonotube stores launch system, temporarily installed using the host aircraft floor cargo tie down rings and/or the air deployment system (ADS) rails, moveably mounted within the orifice of a side door opening without the use of a pallet, or permanent airframe modifications, the apparatus comprising:
   a) one or more aircraft floor and ADS rail mounting plates,
   b) a pressurized, observer bubble door plug,
   c) a door plug retraction mechanism,
   d) a sonotube stores launch system,
   e) a collapsible workstation, mission LRU and control system, and,
   f) a horizontally articulated, stanchion post pivot arm operator chair attached to an aircraft floor or ADS rail mounting plate.
2. The apparatus of Claim 1, wherein the aircraft is a fixed wing aircraft.
3. The apparatus of Claim 1, wherein the aircraft is a rotary wing aircraft.
4. The apparatus of Claim 1, wherein the apparatus is installed on the host aircraft using one or more temporary mounting plates affixed to the cargo floor tie down rings.
5. The apparatus of Claim 1, wherein the apparatus is installed on the host aircraft using one or more temporary mounting plates affixed to the aircraft ADS rail system.
6. The apparatus of Claim 1, wherein the observer bubble door plug retraction mechanism is temporarily affixed to the existing door retraction rails.
7. The apparatus of Claim 1, wherein the pressurized observer door plug incorporates a hinged, removable leaning bar.
8. The apparatus of Claim 1, wherein the pressurized observer door plug incorporates an integrated observer heating, cooling and bubble defogging system.

integrated observer heating, cooling and bubble defogging system.

9. A one piece pressurized aircraft observer bubble door plug which incorporates a segmented two piece clear observation bubble using transparent glazing in the upper part connected to a composite or metal protruding kick panel in the lower part.

10. A one piece pressurized aircraft door plug which is contoured and indented about its lower proximity to accommodate the pressurized seal around the periphery of an articulated or fixed position payload strut which transits from the interior to the exterior of the aircraft under the door plug.

11. A pressurized aircraft door plug segmented into two interlocking pieces which incorporates an upper and lower panel wherein the lower panel is contoured and indented to accommodate the pressurized seal around the periphery of an articulated or fixed position payload strut which transits from the interior to the exterior of the aircraft under the lower door plug panel.

12. A pressurized aircraft bubble door plug segmented into two interlocking pieces which incorporates an upper and lower panel wherein at least one panel is equipped with a video sensor system, an infra-red, RF, or radar based missile detection and laser counter measures system housed within a fairing attached to the exterior surface of the lower door panel.

13. The apparatus of Claim 1, wherein the pressurized door plug incorporates at least one or more, sonotube compatible stores launch systems

14. The apparatus of claim 13 wherein the sonotube launch system stows outboard of the host aircraft ADS rails to permit air drop activities.

15. The apparatus of Claim 1, wherein the collapsible workstation, mission LRU and control system is temporarily installed using a mounting plate secured to the ADS rail system and host fuselage seat belt sockets.

16. The apparatus of Claim 1, wherein the collapsible workstation, mission LRU and control system is temporarily installed using a mounting plate secured to the host aircraft floor cargo

rings and fuselage seat belt sockets.

17. The apparatus of Claims 15 and 16, wherein the workstation unit is divided into modules and incorporates a plurality of quick disconnect locking hinges which can be disengaged to permit separation of the individual modules, removal of the entire workstation from the mission LRU rack, or collapse of the all modules for stowage.

18. The apparatus of Claim 17, wherein one or more of the collapsible workstation modules incorporates a self contained operator oxygen supply, control system, and quick release oxygen mask means.

19. The apparatus of claim 15, 16, and 17 wherein the collapsible workstation, stows outboard of the host aircraft ADS rails to permit air drop activities.

20. The apparatus of Claim 1, wherein the collapsible workstation, mission LRU and control system accommodates a collapsible secondary user interface means temporarily installed on one or more crew chair armrests remotely located away from the collapsible workstation and mission LRU rack.

21. The apparatus of Claim 1, wherein the mounting plate installed stanchion post pivot arm operator chair achieves articulation through; a) 360 degrees about the stanchion post at the base of the pivot arm, b) 360 degrees rotation about the vertical axis at the end of the pivot arm, c) adjustment in the horizontal axis by a telescoping pivot arm sleeve and lock bolt, d) adjustment in the vertical axis about the stanchion post by a moveable collar, and e) horizontal adjustment at the end of the pivot arm to allow the observer to move forward or back from the protruding door plug bubble envelope.

22. The apparatus of Claim 25, wherein the articulated pivot arm chair is foldable for stowage outboard of the host aircraft ADS rails to permit air drop activities.

23. The system of Claim 1, wherein the temporarily installed workstation and mission LRU electronics are connected to one or more pressurized, removable, aircraft ditching hatches which are equipped with positioning, satellite communication or other antennas affixed to the

exterior surface of the temporarily installed special mission ditching hatches

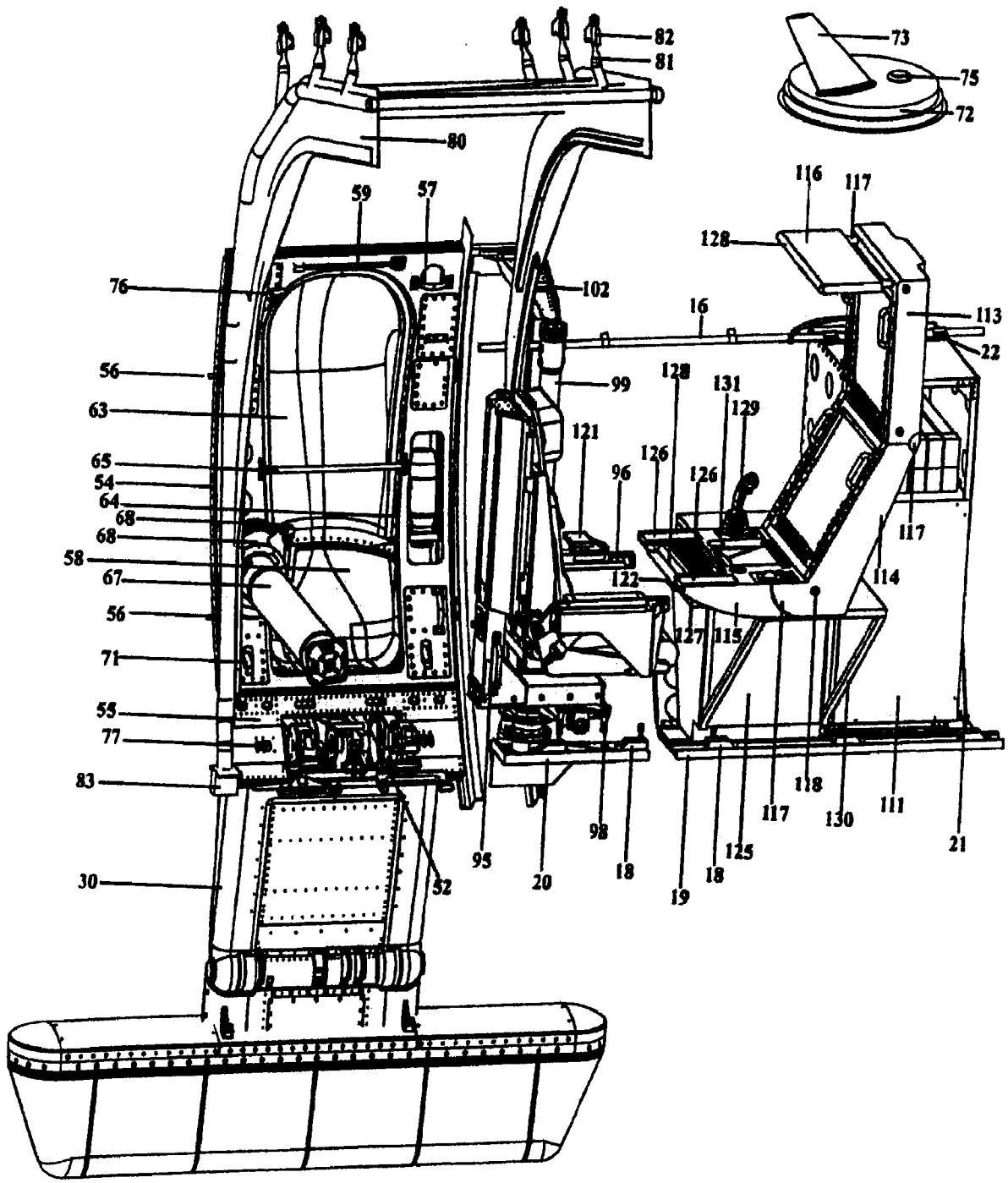

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FIGURE 1

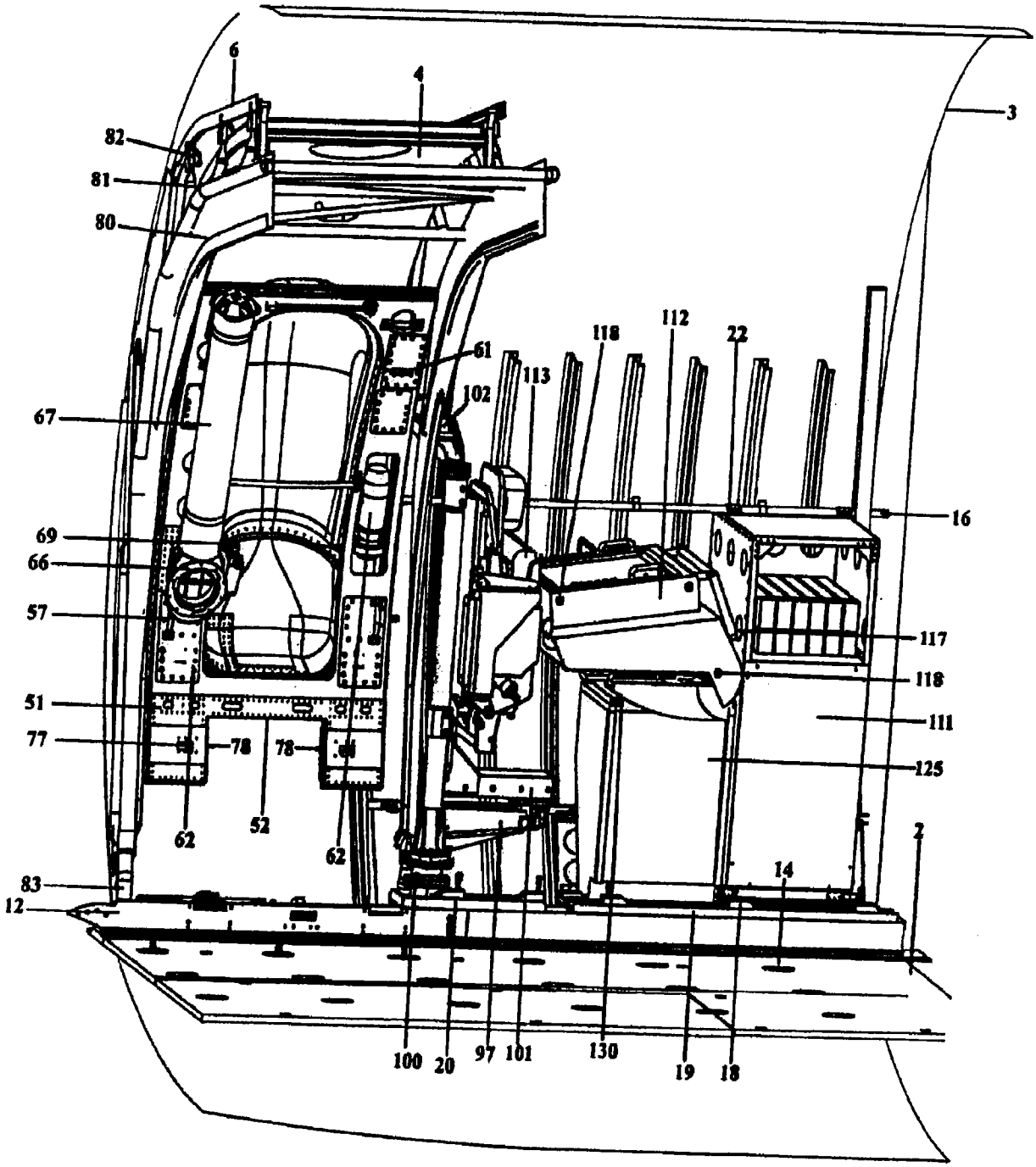

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FIGURE 2

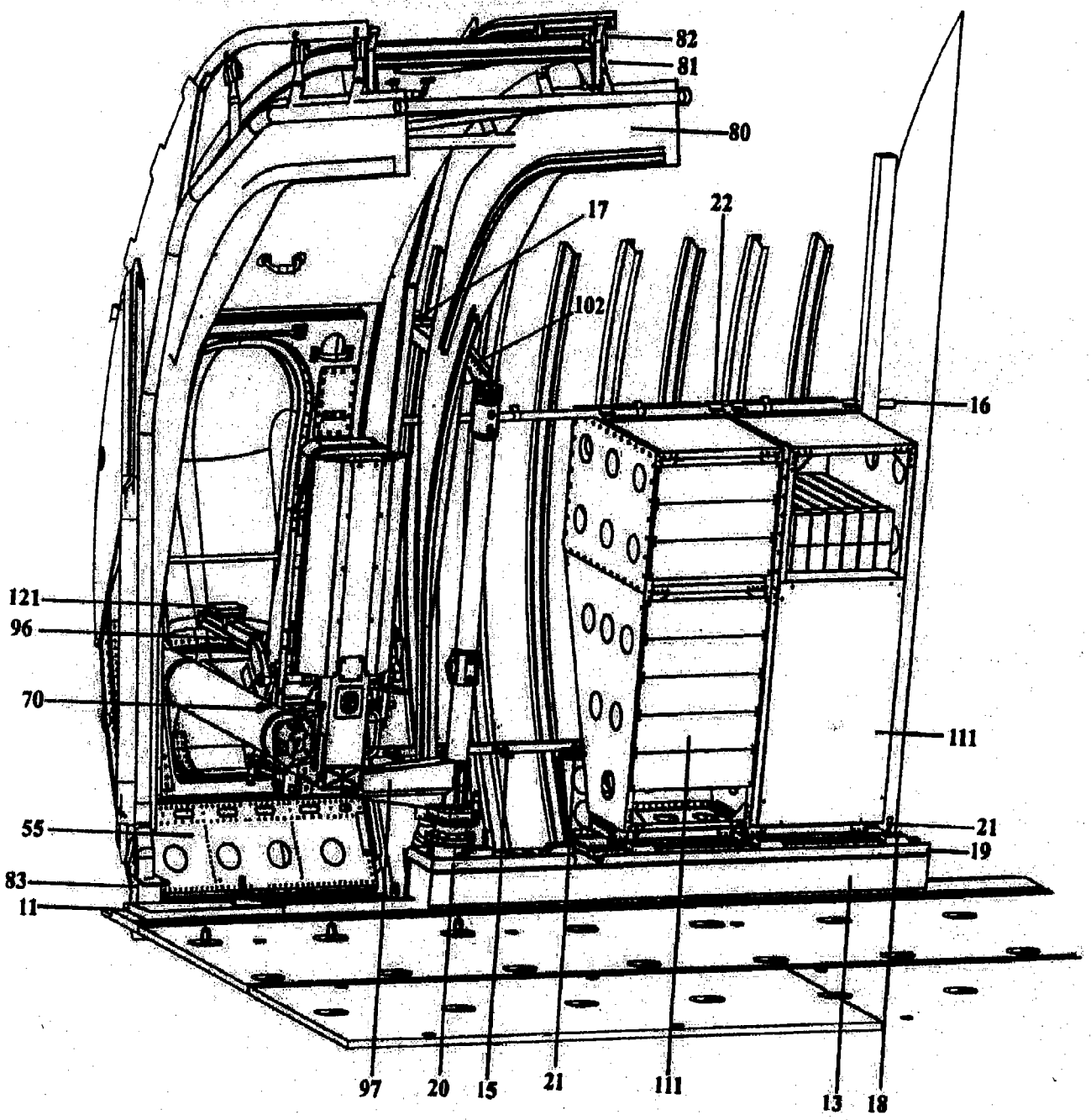

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FIGURE 3

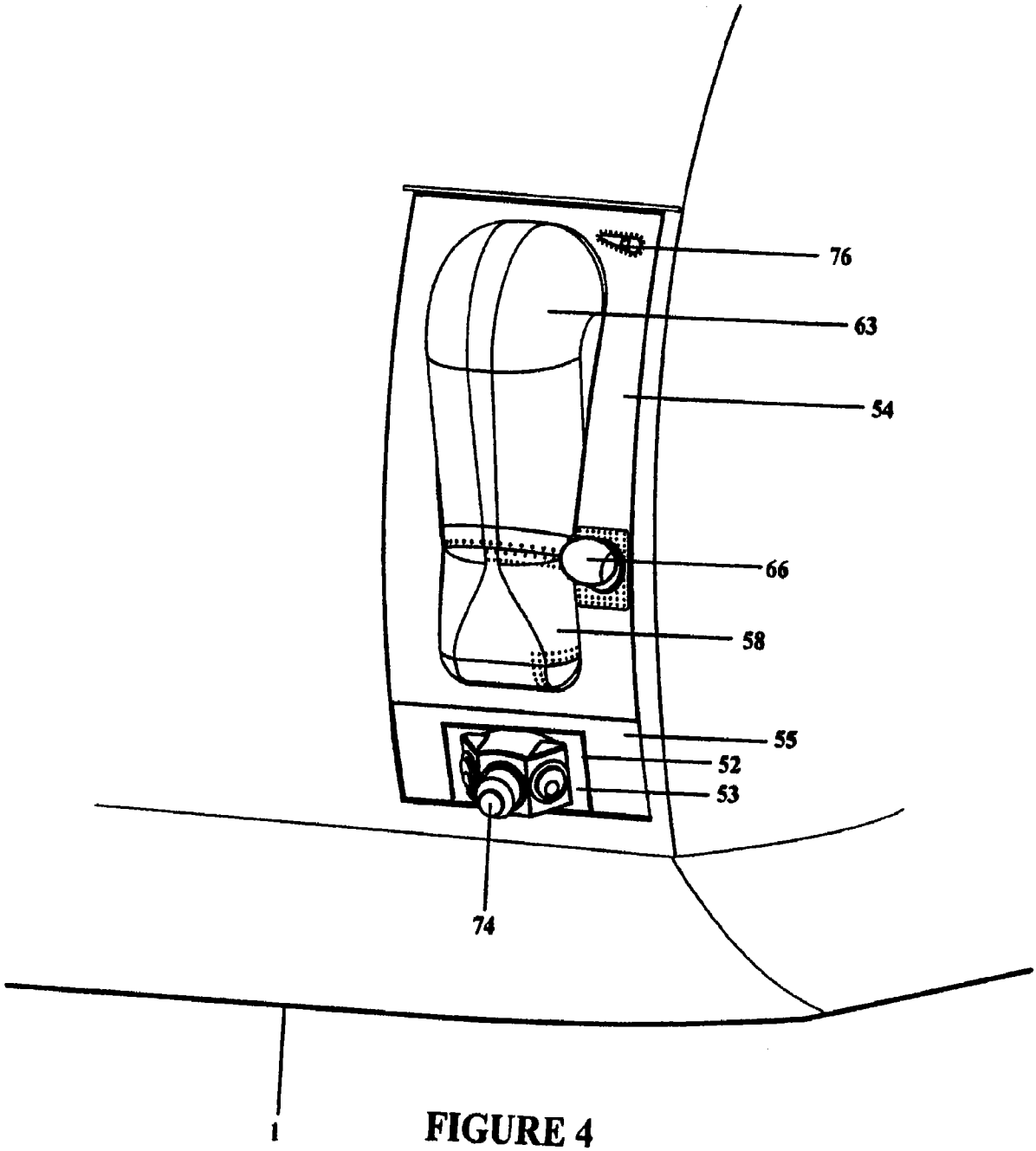


FIGURE 4

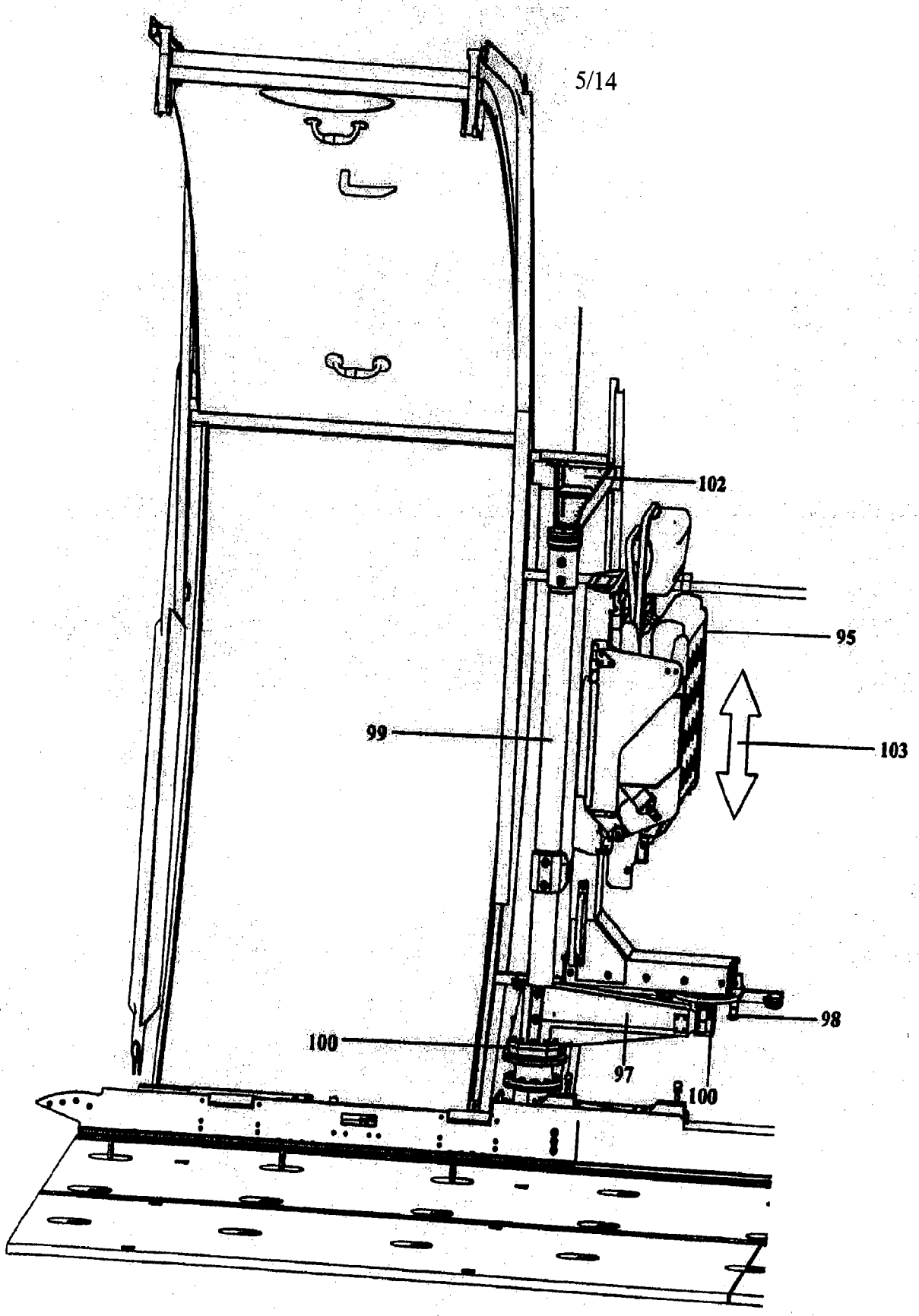


FIGURE 5A

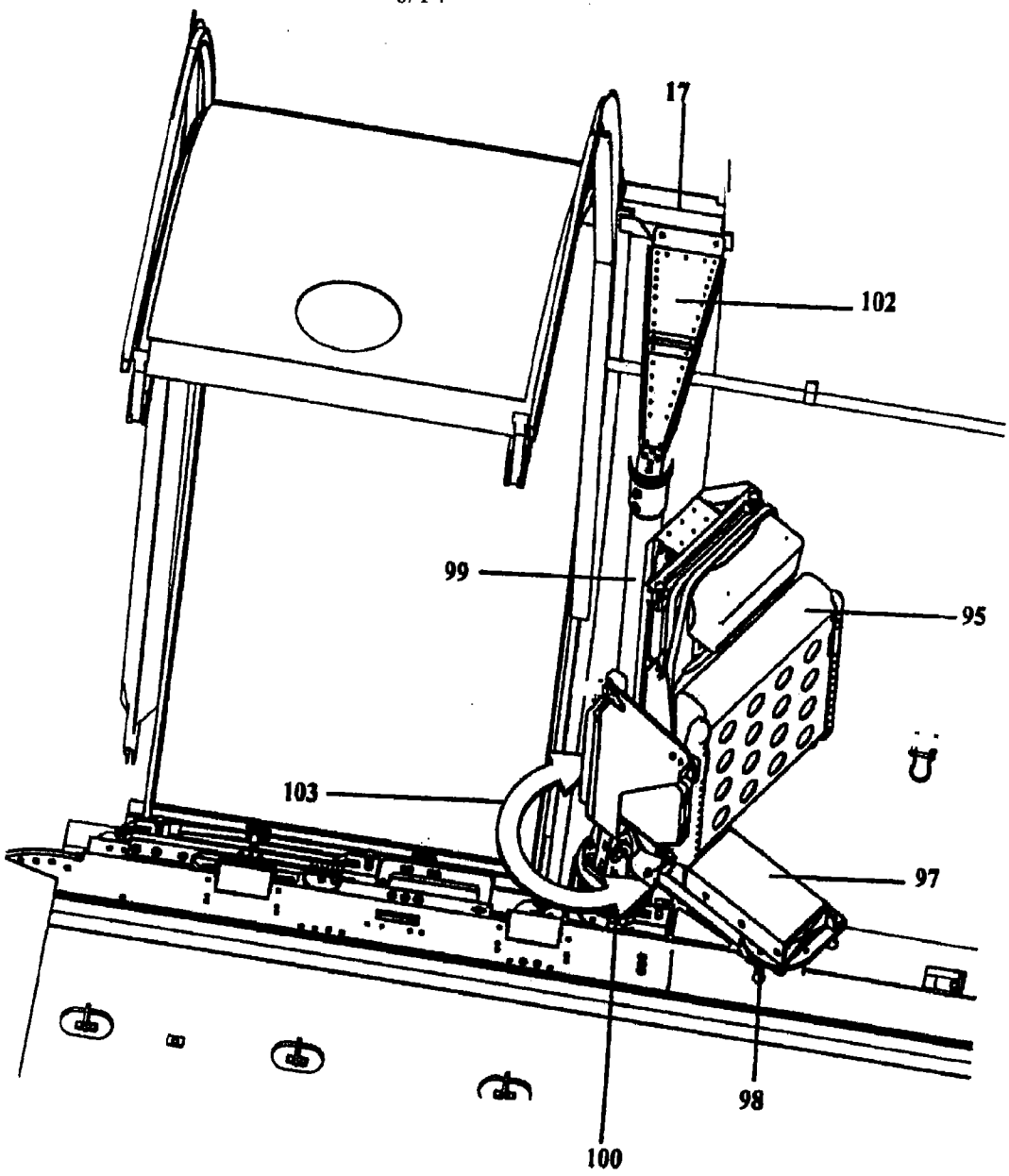


FIGURE 5B

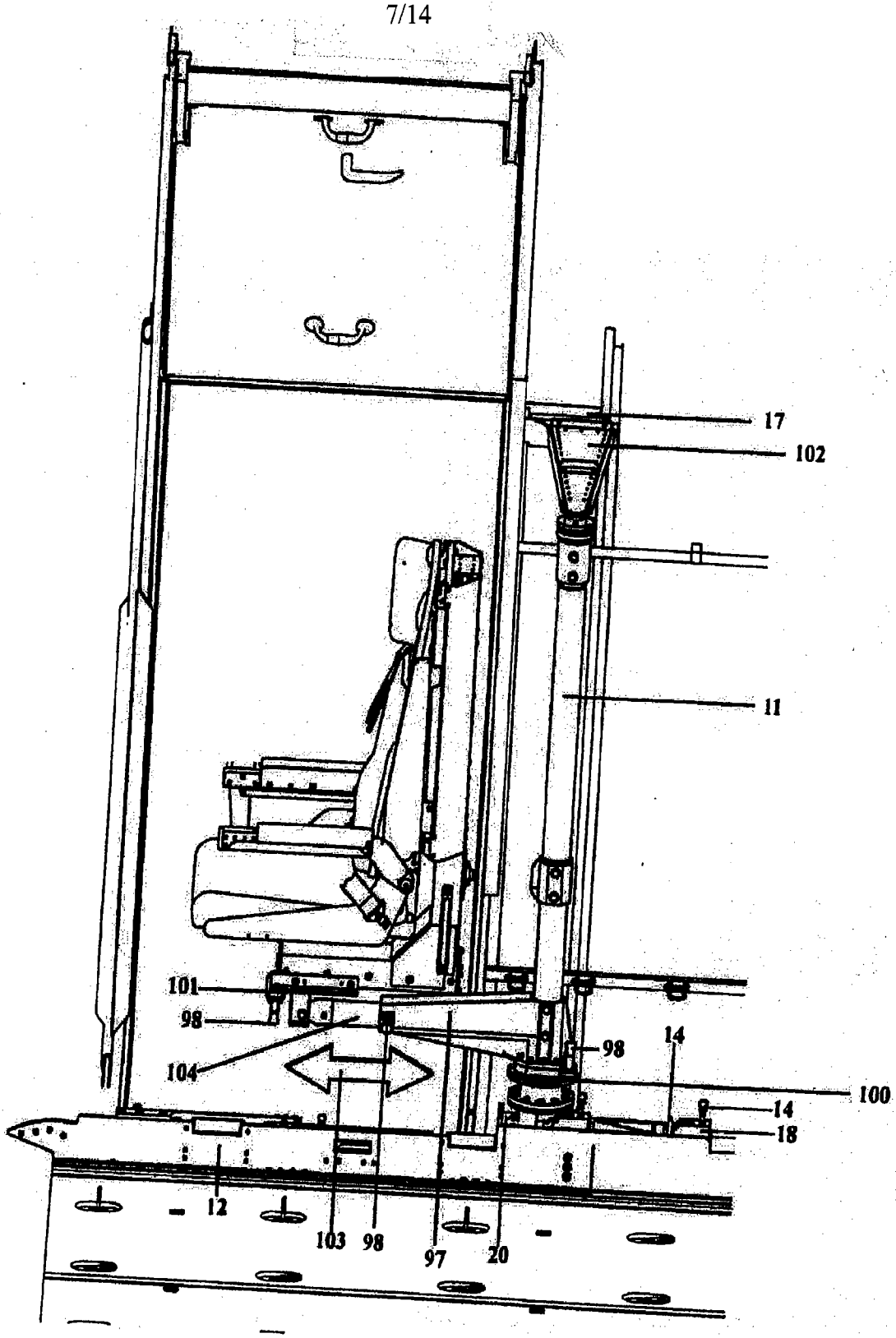


FIGURE 5C

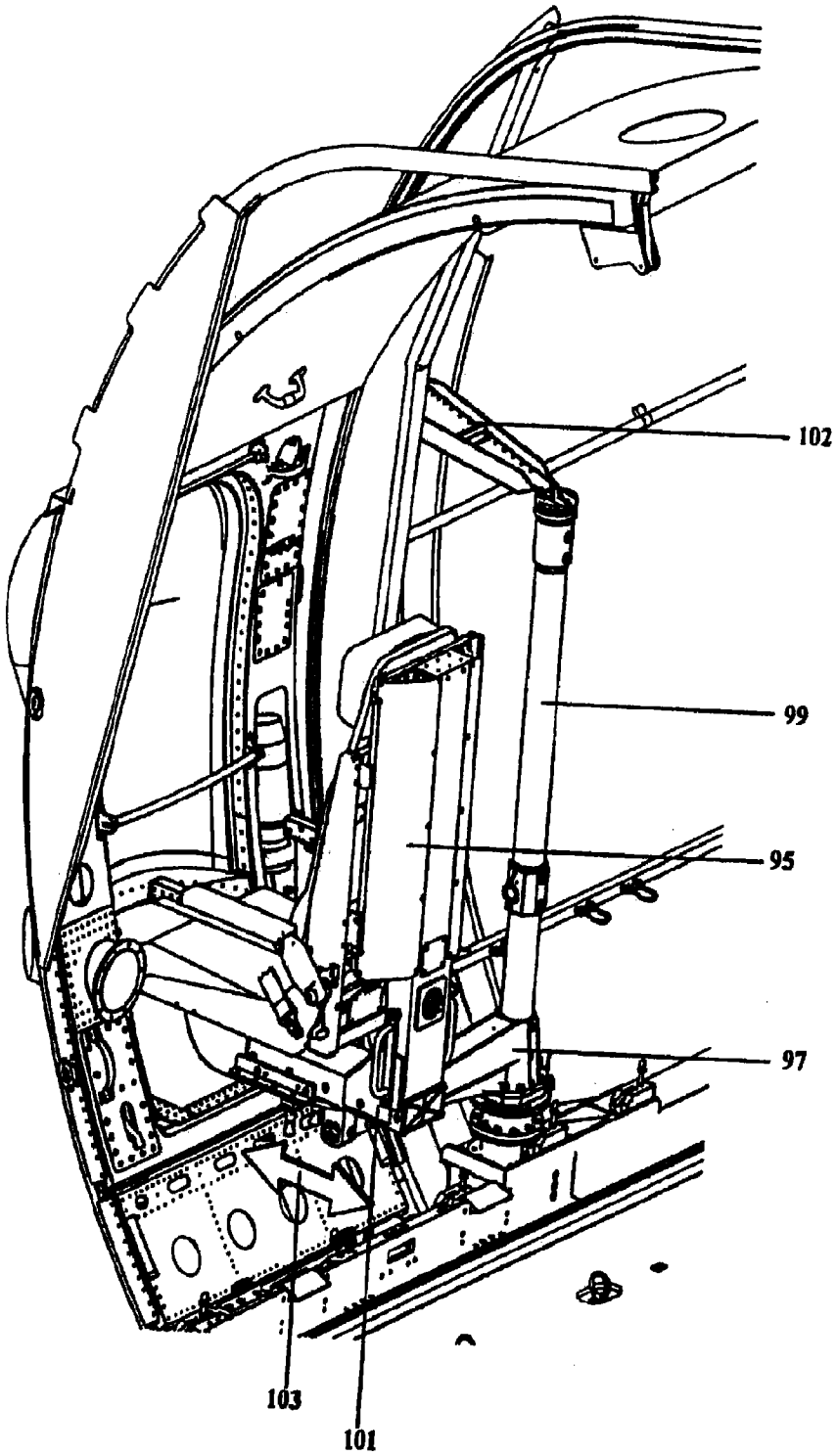


FIGURE 5D

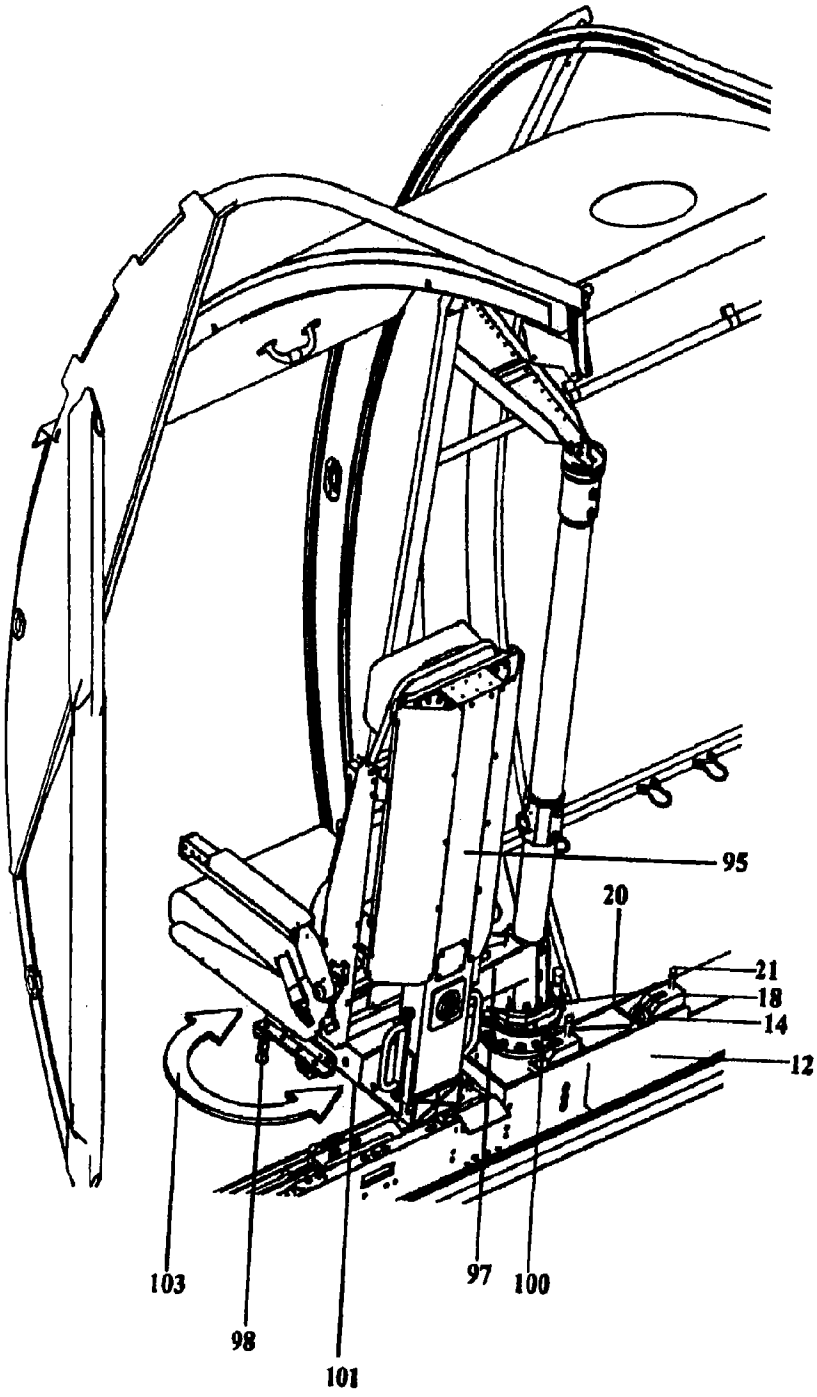


FIGURE 5E

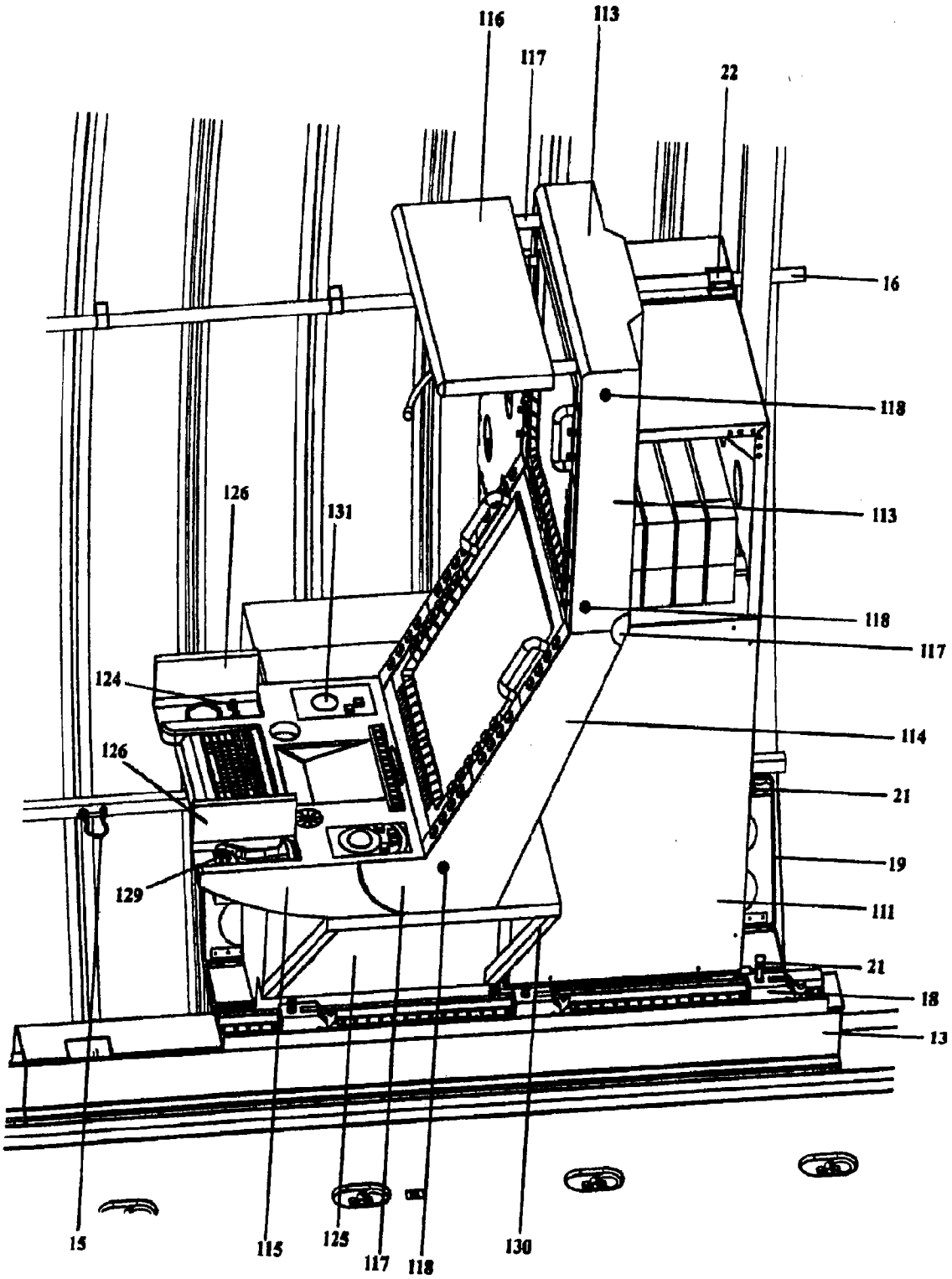

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FIGURE 6

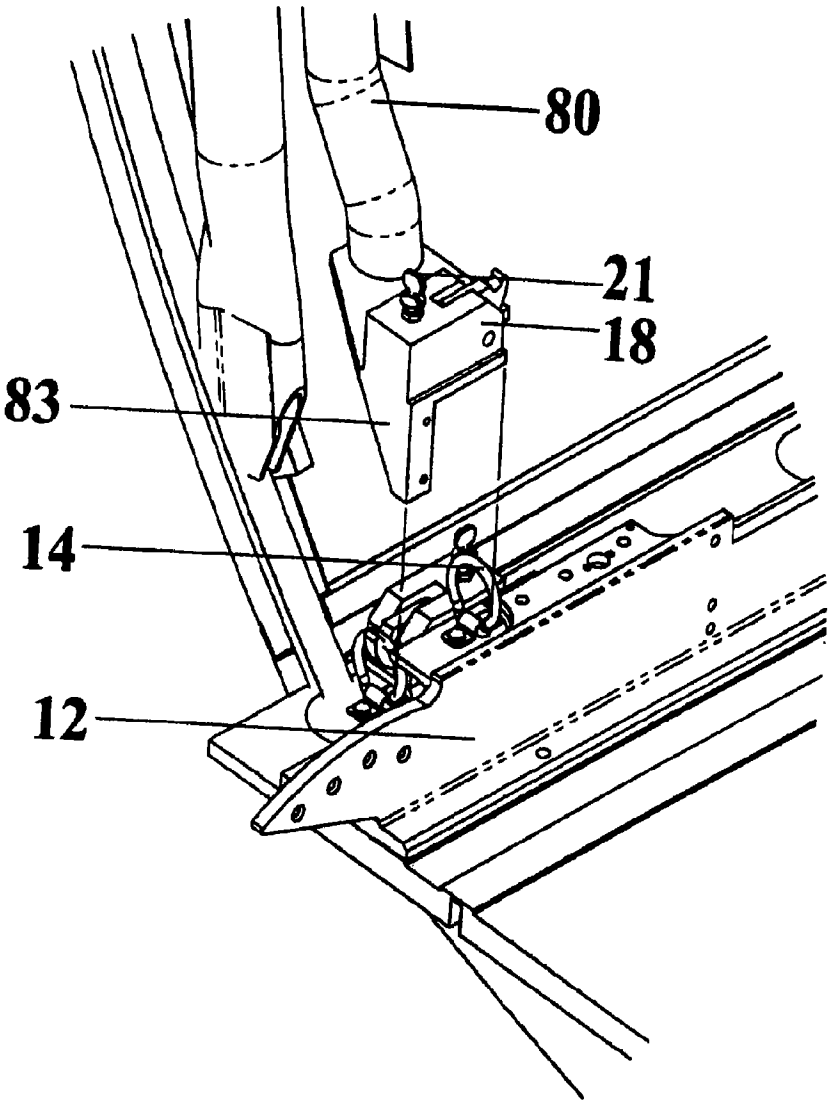


FIGURE 7

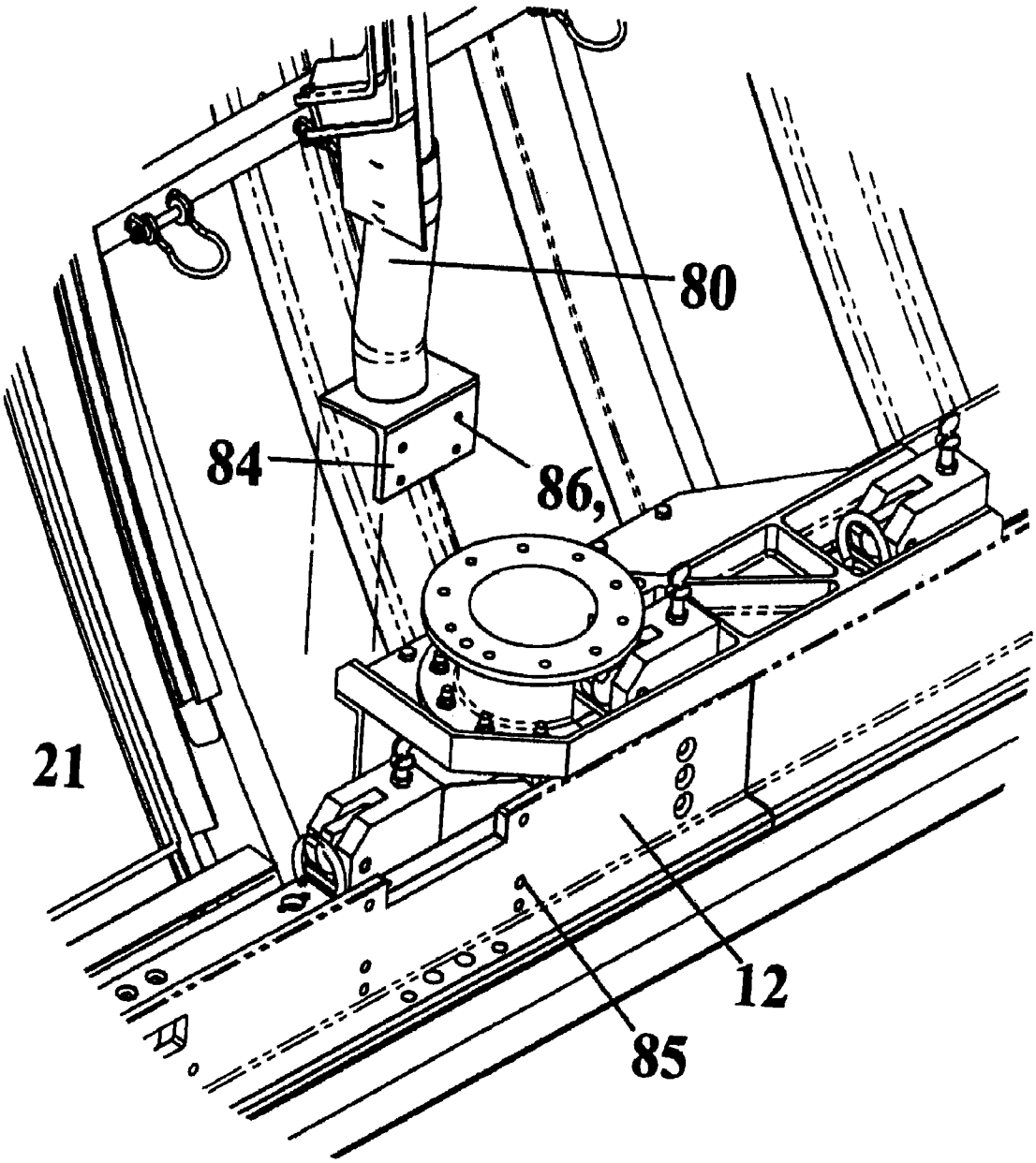


FIGURE 8

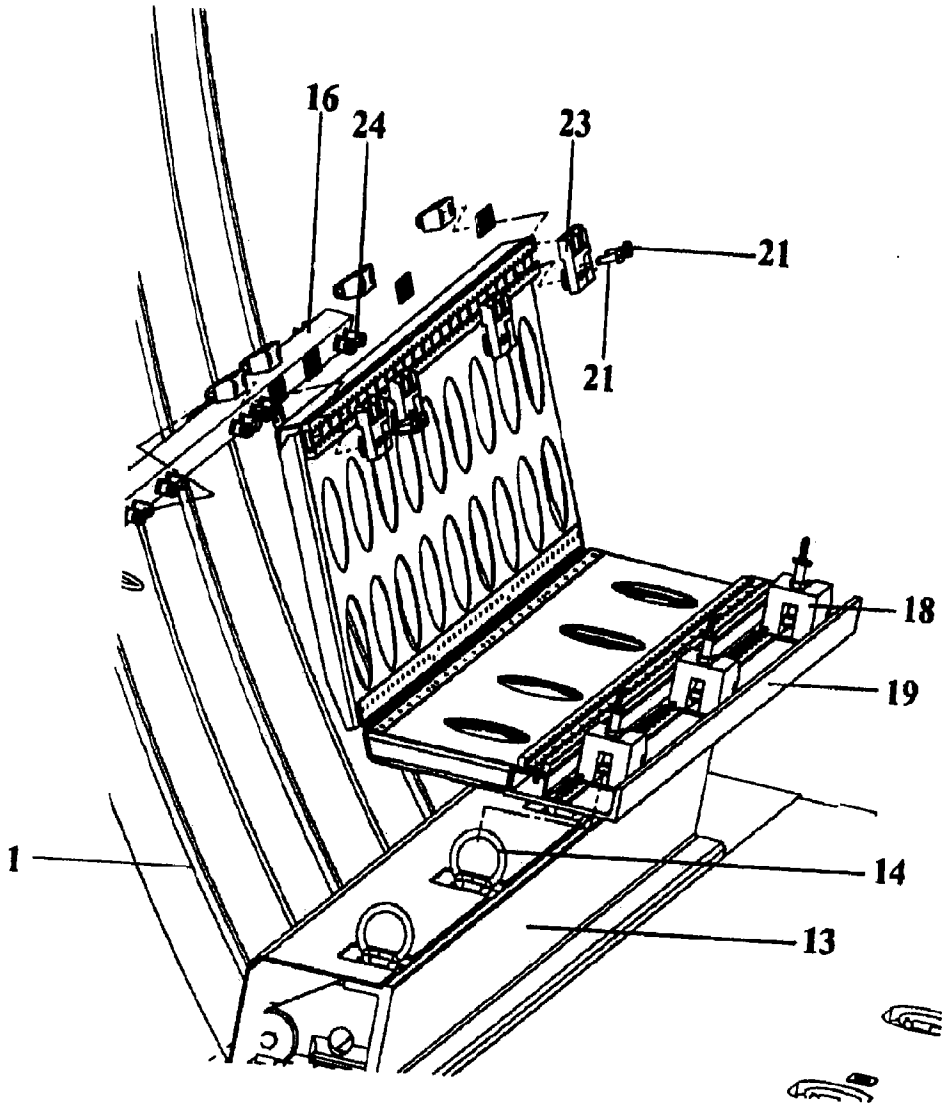


FIGURE 9

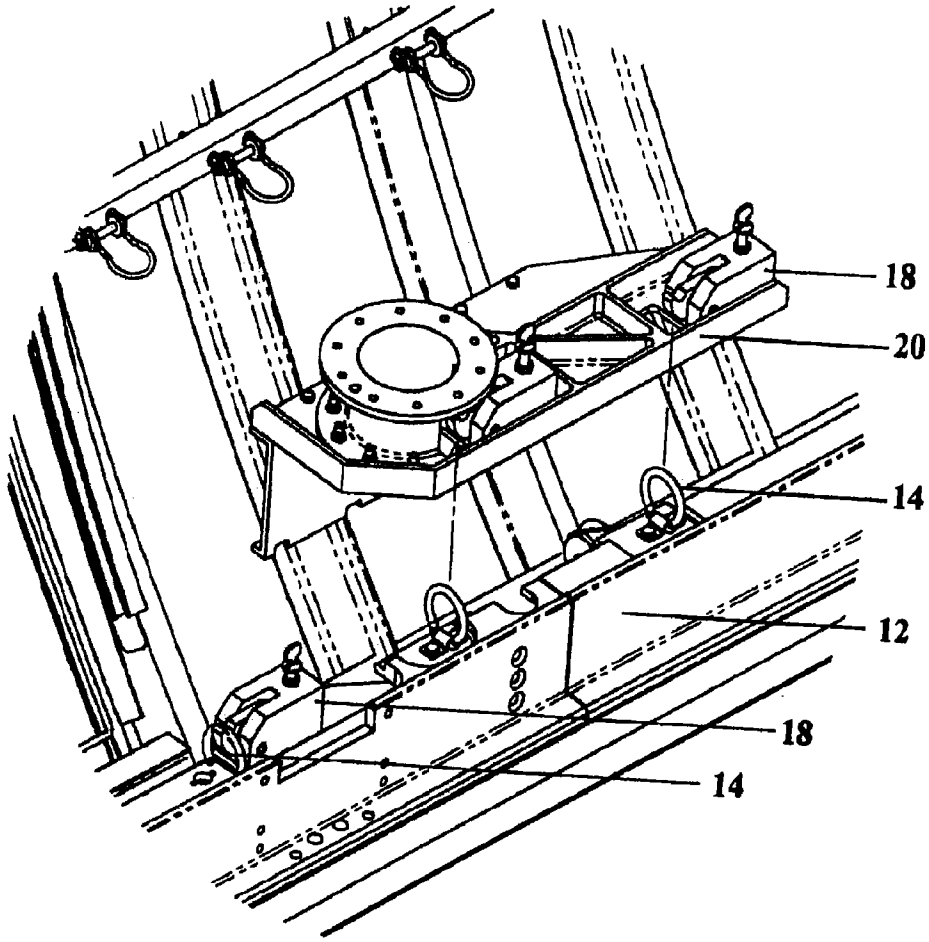


FIGURE 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/11747

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - B64C 1/14 (2009.01)
USPC - 244/129.5
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)
IPC(8) - B64C 1/14 (2009.01)
USPC - 244/129.5

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8) - B64C 1/14 (2009.01)
USPC - 244/129.5, 244/3.1, 244/117, 244/119, 244/121, 244/129.4

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Electronic Databases Searched: Google Scholar; PubWest (US Patents full-text, US PGPubs full-text, EPO Abstracts, and JPO Abstracts) Search Terms Used: airplane, aircraft, observer, chair, seat, gunner, hinge, oxygen, armrest, fold, foldable, hinged, bar, leaning, belt, seat, socket, control, work, station, defogging

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,927,648 A (WOODLAND) 27 July 1999 (27.07.1999) entire document especially Fig. 1, Fig. 3, Fig. 7, Fig. 9, abstract, col 5 , ln 34-35, col 6, ln 52-57, col 8 , ln 10-20, col 9 , ln 14-18, col 9, ln 18-24, col 9, ln 47-58, col 14, ln 64-67, col 33, ln 33-42	1-3, 5-6, 9-11, 13-14, 20, 23
Y		4, 7-8, 12, 15-16, 21-22
Y	US 6,056,237 A (WOODLAND) 02 May 2000 (02.05.2000) Fig. 14, Fig. 18, col 10, ln 1-6, col 11, ln 10-14	4, 12
Y	US 4,453,684 A (HANKS) 12 June 1984 (12.06.1984) Fig. 4, col 6, ln 1-5	7
Y	US 4,004,388 A (STEFANIK) 25 January 1977 (25.01.1977) col 1, ln 48-54	8
Y	US 4,097,009 A (BARNES) 27 June 1978 (27.06.1978) Fig. 2, col 3, ln 39-44	15-16
Y	US 5,651,514 A (GRILLIOT et al.) 29 July 1997 (29.07.1997) Fig. 5, col 6, ln 30-43	21
Y	US 4,109,885 A (PENDER) 29 August 1978 (29.08.1978) Fig. 57, col 10, ln 61-68, col 11, ln 1-2	22

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
February 6 2009 (02.06.2009)	17 FEB 2009
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 08/11747

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 17-19
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.