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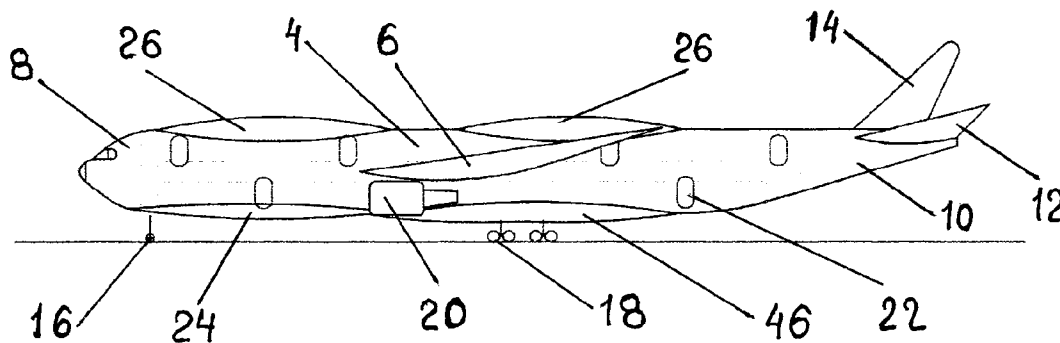


FIG. 1

(57) Abstract: The invention relates to multi deck passenger aircrafts, having passenger cabins and/or service facilities arranged on the upper and lower deck and inner load-bearing cell structure provided within aircraft body. The present invention is also directed toward methods for manufacturing derivative multi lobe aircrafts. Energy absorbing, floatable cargo containers (24) attached to fuselage belly. External fuel tanks (26) displaced to the top of fuselage. Center wing region of fuselage is using for arranging rows of seats and service facilities. Addition seating configuration for narrow and wide bodied aircrafts is provided. Multi deck seating configuration significantly reduces the per passenger operating cost over existing technology. Less fuel per passenger is required since there is less airframe weight and wetted area per passenger. Due to the lower overall cost per passenger seat within the multi deck seating structure, the net profit and return on investment in the aircraft are also increased.



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Description

MULTI DECK AIRCRAFT

[1] Technical Field

[2] The present invention refers to methods and embodiments for increasing seating capacity and the efficiency of passenger aircrafts by manufacturing derivative multi deck airplanes.

[3] Background Art

[4] One problem with adding passenger seating, sleeping cabins or other passenger service facilities to cargo decks is that lower decks typically provide insufficient standing height. One attempt to overcome this problem is disclosed in U.S. Pat. No. 5,752,673 assigned to Schliwa et al. This invention discloses lowering the floor in an aisle section of the lower deck to provide at least enough clearance for a standing person of normal height.

[5] Another problem with using lower cargo decks for passengers is providing sufficient structure beneath the lower decks to protect the passengers in the event of a crash landing. Regulations could require at least 30 inches of compressible structure beneath the lower deck if the lower deck is to be used to carry passengers. Lowering the floor of the lower deck as proposed by Schliwa compounds this problem because it further reduces the space beneath the lower deck. One approach to meet the compressible structure requirement is disclosed in U.S. Pat. No. 5,542,626 assigned to Beuck et al. This invention discloses an energy absorbing structural unit that is attached to the underside of an aircraft fuselage.

[6] The certification authorities' regulations stipulate that total emergency evacuation of an aircraft must be achieved within 90 seconds. The problem is even more serious if one considers the emergency evacuation of passengers when aircraft digging on water, since big cargo doors in lower lobe decrease waterproof of conventional airliners.

[7] The problem of dealing with bombs on board has not been solved. A plastic explosive device hidden inside checked luggage stored within Unit Load Devices (ULD) in a lower cargo hold can cause a rapid breakup of the aircraft. The walls of the container would have to be inordinately thick in order to contain the explosion.

[8] Low-wing passenger aircraft includes a large fairing in the wing-fuselage intersection, defining the lower aerodynamic surface of the fuselage in the area below the center portion of the wing that passes through the fuselage. The fairing increases the fuselage cross-section at precisely the longitudinal station where it would be desirable to reduce the fuselage cross-section, i.e., at the wing-fuselage intersection.

[9] Still another problem with using lower cargo decks for passengers is that aircraft fuel is typically carried in fuel vessels located within the central wing box of the aircraft

which engage a big space in lower fuselage lobe. The integral fuel tank must be sufficiently strong so as to tolerate the fatigue loads resulting from the motion of the airplane and from the liquid fuel splashing. There are accidents that were regrettably traced back to fires caused by kerosene leaking from an aircraft that had performed an emergency landing. Due to this, there may be a need for an aircraft having an improved fire protection by developing more safety fuel system.

[10] Thus, in view of safety considerations and efficiency using lower lobe for passengers there is a need for relocating cargo containers from lower lobe and fuel tank from central wing box to other safety place in aircraft.

[11] Disclosure of Invention

[12] In view of the above it is the aim of the invention to achieve the following embodiments and methods singly or in combination:

- [13] - to increase the passenger capacity of narrow and wide-body aircrafts in such a manner that passenger cabins or service facilities located in a lower deck can also be occupied by passengers and crew members during the take-off and landing phases of a flight and a sufficient standing height for passengers is achieved at in the lower deck, while simultaneously maintaining a functional freight loading system in the external cargo containers;
- [14] - to provide a raised portions in the upper deck of such an aircraft to form a passenger aisle in lower deck, having a sufficient standing height, while the lateral surface of the upper and lower decks is at a proper height to provide optional rows of seats arrangement;
- [15] - to elevate passenger seats regarding aisle floor in lower cabin of twin deck narrow and wide-body aircraft, to provide maximum width and distance from fuselage belly;
- [16] - to provide fuselage with tree-dimensional load-bearing inner cell structure included strengthened walls, decks, ceilings and struts of upper and lower cabins and integrated with conventional semi-monocoque fuselage shell structure to maintain the integrity of the upper and lower lobes of aircraft fuselage in flight and in the event of an emergency landing;
- [17] - to provide fuselage airframe shell primary structure comprises several longitudinally spaced, vertically oriented main ring frames, beams and angle braces to transfer the load from the fuselage shell to wings of the aircraft and undercarriage mounting;
- [18] - to provide such an energy absorbing and safety unit that can be specifically tailored and installed on conventional aircraft having different configurations, to ensure energy absorption and protection in those areas of a lower deck to be occupied by passengers or service facilities.
- [19] According to further detailed aspects of the invention, the energy absorbing and

safety unit essentially comprises a number of external, floatable cargo containers attached to aircraft frame structure. Every container is shaped to match or fit with the outer contour of the fuselage lower deck structure and extends from fuselage belly circuit downwardly and outwardly and is shaped to have a streamlined outer contour. These containers include doors for cargo loading - unloading.

- [20] The impact energy arising during emergency landing is absorbed in a controlled manner by the cargo containers and floatable bins, whereby the chances of survival of the people on board are considerably increased because a greater space is maintained by extending struts and walls beneath the lower deck. External floatable cargo containers and bins increase security and buoyancy of commercial aircraft.
- [21] External compartments attached on the top and/or on the bottom of aircraft, to the fuselage structure, for example, by means of screws, glue, rivets, welding, or the like. With this arrangement of the cargo containers, it is possible to attach the containers to the fuselage of an existing aircraft already in service. Thus it becomes possible to after-equip or re-fit existing aircraft with passenger cabins and service spaces in a variable or adjustable manner in the lower deck space below the main deck.
- [22] According to the next embodiment of the invention, there are providing detachable, watertight external cargo containers, connecting to the top or bottom of fuselage by conventional means like latch device operable by remote control system. The container is formed with an opening through which luggage and cargo can be placed in, or removed from.
- [23] In this invention, an external cargo container will reduce the damage caused by the explosion in two manners. The container has a venting devices mounted to the outer side of the container. This allows venting of the shock waves and high pressure to the exterior of the airplane. The second manner in which damage is reduced is by constructing the container so as to withstand projectiles from being propelled through the walls of the container into the interior of the aircraft. In order to handle this problem, the container is constructed of a composite reinforced material. Also, in a case of fire, certain detachable container will jettison by pilots or by automatic system.
- [24] The present invention achieves other advantages by providing a cargo handling system that is capable of efficiently and effectively transporting cargo containers between a loading dock and an aircraft. The system is capable of providing accurate alignment of the loading dock and aircraft. In addition, the system provides cars that transport cargo containers between the loading dock and aircraft. Moreover, the system provides a variety of mechanisms and sensors that ensure that the containers are both aligned and adequately secured to the aircraft fuselage.
- [25] Rapid evacuation of the passengers following a crash on the ground or water takes place laterally from upper and lower lobes, via the doors used for embarking and dis-

embarking passengers and via emergency exits from each side of the aircraft.

Emergency evacuation slides are associated with these various emergency exits. These slides usually consist of inflatable structures, which are stored folded inside top and bottom external bins near upper and lower lobe emergency exits. According to embodiment of the invention, an inflatable rafts automatically deploying from external bins near emergency exits in an emergency situation.

[26] Another object of the present invention is to provide safety fuel system for airplanes. According to embodiment of the invention, several external fuel tanks positioned on a top of aircraft fuselage, in the cavities of inner surface. Detachable fuel tanks have streamlined, curvilinear outer surface, which defines the aerodynamic outer surface of at least a portion of the airplane fuselage. In a case of fuselage and wing damage or disintegration during emergency landing, external fuel tanks which not integral with fuselage or wing structure, do not receive addition loads from other aircraft parts and will not break and leak.

[27] Safety fuel system includes a group of tanks having individual fuel inlet, fuel outlet, and vent manifolds. Each tank includes individual valves to control the inflow and outflow of fuel from the tank. Pneumatic pressure from an aircraft bleed air system can be individually provided to each of the tanks for fuel transfer. A single electric motor-driven fuel pump can be installed in each tank for transferring fuel out of the tank. Several external cargo containers and auxiliary fuel tanks have similar devices for connection with fuselage structure. The number and arrangement of the auxiliary fuel tanks depends by flight range and they should be relatively easy to install and remove so that the aircraft can be quickly changed into the desired configuration.

[28] A further object of the present invention is to provide a structure constructed in such a manner that there is a minimum of fasteners through load-bearing material. According to aspects of the invention commercial airplane fuselage, having inboard pressurized passenger cabin, includes load-bearing inner walls, enveloping said pressurized cabin area. Said internal structural skin attaching to a series of longitudinal stringers connected with inboard side of the frames that encircle a cabin area. Sidewall not airtight panels attaching to outboard side of said frames. Other aircraft components such as insulation, electrical conduits, ventilation ducting, control mechanisms, and the like installed along the inboard walls and between the frames, so that they may be enclosed between the inboard wall and the detachably curvilinear outboard panels. Preferable object of the present invention is that external, watertight compartments serving like fuel tanks, cargo containers and energy absorbing unit, detachably connected with fuselage shell structure, use like curvilinear outboard panels.

[29] According to further aspects of the invention, an airplane fuselage has a concave bottom for providing more lift and control at low speeds. Energy absorption structure

with set of inner strut members extending along fuselage belly for providing skids for the purpose of emergency landings. The external cargo containers, placed on airplane belly and using like absorbing members are converged at the forward and rear parts of fuselage, but are spaced apart at the middle of aircraft fuselage and coincident with landing gear bays fairings, thereof to prevent an aircraft from turning to one side or the other due to direct contact with the ground or water.

[30] In other aspect of the invention, there is providing a method for attaching aisle to the lower deck of narrow and wide body aircraft, having mezzanine plate in upper lobe and aperture in main deck. According this method aisle provided between walls supported this mezzanine plate and ladder attached to this aperture. According to this method of the invention service facilities include table or bed arranged in upper cabin on said mezzanine plate. Aisle and stairs provided in lower cabin below said table plate and/or bed plate.

[31] According to another aspect of the invention, method of increasing the seating capacity of twin deck wide body passenger aircraft, having two aisles in upper cabin and one aisle in lower cabin, by ensuring sufficient standing height in a lower cabin aisle is provided by means of manufacturing stepped upper deck structure above lower cabin aisle. The middle parts of transverse floor beams and middle floor plates are raised regarding lateral ends in a height about 5-50 cm to secure standing height about 200-250 cm in a lower cabin aisle.

[32] According to another aspect of the invention, method of increasing seating capacity of narrow and wide bodied aircraft, by building derivative multi lobe aircraft, with aircraft fuselage having oval or number eight cross section is provided by means of an increasing height of the aircraft fuselage by extending and connecting upper and lower fuselage segments lengthwise.

[33] According to another aspect of the invention, method of increasing the seating capacity of a narrow and wide bodied aircraft, by building derivative very wide body aircraft, with the aircraft fuselage having width bigger then height cross section is provided by means of an increasing width of the aircraft fuselage by extending and connecting lateral fuselage segments lengthwise.

[34] According to another aspect of the invention, method of increasing efficiency of multi-lobe aircraft, by minimizing fuselage shell thickness and weight, is provided by means of attaching struts, angle braces and walls of inner cells structure to support shell structure. The pitch of the struts, braces and walls is determined with respect to the spacing of the rows of seats or beds so as to ensure that each one of a majority of said struts and walls is located between adjacent seats or beds in a row to ensure maximum freedom of passenger movement between the rows.

[35] According to another aspect of the invention, method of increasing the efficiency of

commercial aircraft, by minimizing decks thickness and weight, is provided by means of manufacturing arch decks structure. The lateral parts of transverse arch beams are hidden in overhead luggage bins.

[36] In accordance with other aspect of the invention an aircraft have a module design with at least one forward, middle and aft regions housing a passenger cabins. Wing passes through the middle fuselage region, having cross section area smaller then forward and aft regions. This embodiment reduces the fuselage cross-section at the wing-fuselage intersection area and contributes substantially toward reducing aircraft drag at high subsonic flight Mach numbers.

[37] The present invention is directed toward multi deck tandem wing aircraft. The rear wing is sweep aft and forward. An inlet of turbofan engine positioned before of intersection of said wing leading edges. Duct of said engine fan extend above and below of the wing upper and lower surfaces. The forward and rear wings structure integrated with fuselage shell structure and inner cell structure.

[38] From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the invention.

[39] Brief Description of Drawings

[40] FIG. 1 shows side view of twin deck derivative aircraft;

[41] FIG. 2 shows front view of twin deck derivative aircraft;

[42] FIG. 3 shows side exploded view of twin deck derivative aircraft;

[43] FIG. 4 shows 3D section view of two lobe narrow body aircraft with rows of seats;

[44] FIG. 5 shows 3D section view of two lobe narrow body aircraft with wing structure;

[45] FIG. 6 shows 3D section view of circular body aircraft with wing structure;

[46] FIG. 7 shows 3D section view of twin deck aircraft with detachable compartments;

[47] FIG. 8 shows 3D section view of twin deck wide body aircraft with rows of seats;

[48] FIG. 9 shows 3D section view of twin deck wide body aircraft with wing structure;

[49] FIG. 10 shows 3D section view of arranging aisle and stairs in lower deck;

[50] FIG. 11 shows cross section view of aircraft with floatable cargo containers;

[51] FIG. 12 shows plan view of tandem wing aircraft;

[52] FIG. 13 shows cross section view of integrated wing and fuselage structure;

[53] FIG. 14 shows cross section view of very wide multi deck aircraft;

[54] FIG. 15 shows cross section view of multi deck aircraft with arch deck beams.

[55] Best Mode for Carrying Out the Invention

[56] FIGS. 1 and 2 show side and front view of derivative twin deck aircraft 2. Aircraft 2 includes oval fuselage 4, wing 6, nose portion 8 and tail portion 10 with horizontal 12 and vertical 14 stabilizers, forward landing gear 16, main landing gear 18 and turbofan engines 20 attached to the wing 6. Entrance and exit doors 22 and windows attached

after redesign and assembling fuselage. The energy absorbing external cargo containers 24 attached to aircraft belly and external fuel tanks 26 positioned on a top of fuselage 4, providing streamlined outer surface. Main landing gear 18 retracts in landing gear bays 46, shaped to have a streamlined outer contour with external containers 24. Detailed descriptions about passenger cabins show in FIGS. 4 and 8.

[57] FIG. 3 shows exploded view of the method for manufacturing twin deck derivative aircraft 2, using assemblies of conventional aircraft. These assemblies include: wing 6, nose 8 and tail 10 portions of the fuselage 4, upper 30 and lower 32 circular segments of fuselage 4. Upper 30 and lower 32 fuselage segments assemble in central fuselage portion by using connecting panels 36. Fuselage connecting panels 36 comprising a skin and support structure including a plurality of longitudinal stringer members and a plurality of frame members that are attached to and cooperate to support the skin. Nose 8 and tail 10 fuselage portions assembling to the central fuselage portion by using forward 42 and rear 44 combined circular-oval connection sections.

[58] FIG. 4 shows the embodiment for twin deck narrow body passenger aircraft. Number eight cross section fuselage portion 50 contain upper passenger cabin 52 above upper deck structure 54 and lower 56 passenger cabin below upper deck structure 54. Windows 58 attaching in upper 52 and lower 56 cabins. Rows of seats 60 arranging in upper 52 and lower 56 cabins include six seats in two groups of three each on either side of passenger aisles 62 and 64. Stepped lower deck structure 66 is displaced under seats 60 in the lower deck cabin 56. In lower cabin 56 seats 60 raised up regarding aisle 64 to provide maximum width and distance from fuselage belly. At least a normal standing height is provided in the centre of lower deck in the areas of the aisle 64. Rows of seats 60 arranged on said stepped deck 66 region and seats near the aisle 64 having bigger leg height than near windows 58 and folding foot support providing for undersized passengers and children. Outer skin 68 partly removed to show rows of seats 60. Plurality of struts 70 connected upper 54 and lower 66 decks structure to fuselage shell structure 72. The energy absorbing external cargo containers 24 attached to aircraft belly.

[59] FIG. 5 shows the embodiment for wing-fuselage intersection of twin deck passenger aircraft. Fuselage portion 80 consists of upper 52 and lower 56 circular shell lobes with cutting of lower and upper segments. An end of said shell arches 72 connected by intersection structure. Said intersection structure reinforced in the line of junction by longerons and serve as an outer boundary of upper deck 54. Wing spars 74 and 76 connected with the intersection structure of the upper 52 and lower 56 fuselage lobes by plurality of beams 88. Said beams 88 and spars 74 and 76 comprise lateral spar boxes. Fuselage arches 72, upper 54 and lower 66 decks structure, inner struts 70 and beams 88 comprise middle wing box, embracing upper 52 and lower 56 lobes and

integral with fuselage airframe shell and lobes intersection structure. Said lateral and middle wing boxes uses as space for placing rows of seats, galleys and/or service facilities in upper and lower passenger cabins. Set of struts 70 provides additional support to the fuselage 4, and in particular, to the lower deck stepped structure 66. Energy absorbing cargo containers 24 attached to aircraft frame structure 72. In this manner, the strength and integrity of the supporting structure is maintained during emergency landing. Latch means, operable by remote control devices, provided for detachably securing the containers 24 to the fuselage.

[60] FIG. 6 relates to a twin deck wide body aircraft, having circular fuselage cross section. Fuselage portion 90 contains upper passenger cabin 92 displaced above upper deck structure 94 and lower passenger cabin 96 displaced below upper deck structure 94. Each of the cabins 92 and 96 being vertically spaced apart such that each of the decks is equally suitable for carrying passengers or cargo without significant changing in fuselage design. The upper deck structure 94 essentially comprises a grid-like framework of lengthwise and cross-wise girders on which floor panels and the typical functional components of the seats connection system, are arranged. The upper deck 94 is raised in central area 98, so that a normal standing height of a passenger is provided in the lower deck cabin 96. Cross-wise stepped girders 100 of the upper deck 94 extends up substantially, whereby the side shanks of the girders 100 extends in the direction of the fuselage shell structure 108. Plurality of struts 104 and 106 connected upper 94 and lower 102 decks with fuselage shell structure 108. Wing spars 74 and 76 connected with the fuselage shell structure 108 and a number of internal beams 110. Space near said beams 110 and spars 74 and 76 uses for placing rows of seats, galleys and/or for service facilities in upper and lower passenger cabins.

[61] FIG. 7 relates to a twin deck wide-body aircraft, having circular fuselage cross section portion 120 with cutting of upper and lower segments for arranging external fuel tanks 26 on the top and detachable floatable cargo containers 24 on the bottom. Cutting ends of fuselage shell arches 122 connected by beams 124. Upper beams 124 coincident with upper cabin 92 ceiling and lower beams 124 coincident with lower deck 102. Plurality of struts 104 and 106 connected upper 94 and lower 102 decks with beams 124. Several external bins 126 attached to the underside of an aircraft fuselage. Said bins 126 shaped to have a streamlined outer contour with external cargo containers 24 and landing gear bays. Bins 126 may comprise retractable stairs for embarking and disembarking passengers via the lower lobe doors and evacuation slides and inflatable rafts which are stored folded and automatically deploying in an emergency situation near upper and lower lobe emergency exits. Detailed descriptions about bins 126 show in FIG. 11.

[62] FIG. 8 shows the embodiment for twin deck wide-body passenger aircraft having

circular fuselage cross section. Fuselage portion 140 contain upper passenger cabin 142 displaced above upper deck structure 144 and lower 146 passenger cabin displaced below upper deck structure 144. Rows of seats 60 are arranging in upper 142 and lower 146 cabins. In upper cabin 142 seat section can include seating rows having eight seats abreast, arranged in three groups of 2+4+2 separated by left and right aisles 150 and 152. Aisles 150 and 152 extend lengthwise through upper deck 144. In lower cabin 146 seat section may include seating rows having six seats 60 arranged in two groups on either side of aisle 154. In lower cabin seats 60 raised up regarding aisle 154 to provide maximum width and distance from fuselage belly. Set of struts 104 and 106 provides additional structural support to the fuselage and in particular, to stepped lower deck structure 148 displaced under seats 60 in the lower cabin 146. The arrangement of the struts 104 and 106 along two lobes endows the fuselage with the necessary resistance to internal pressure and to dynamic stresses and offer complete freedom of passenger movement within the cabins.

- [63] FIG. 9 shows the embodiment for twin deck wide-body passenger aircraft having resembled rectangle oval cross section fuselage. Cross section contour of fuselage portion 160 consist of one top and one bottom arcs, two lateral arcs and four arcs connecting lateral arcs with top and bottom arcs. Fuselage portion 160 comprising inboard pressurized upper 176 and lower 178 cabins with airtight walls 170. Inner airtight load-bearing walls or inner skin 170, are attached inside fuselage shell primary structure 172. Said inner walls 170 envelop inboard pressurized cabins 176 and 178. Fuselage shell outer structure 172 includes a series of vertically oriented frames 174 that encircle a cabins 176 and 178 area and a series of longitudinal stringers connected with said frames 174. Inboard airtight walls 170 attached to longitudinal stringers and said stringers attached with inboard side of the frames 174 of shell structure 172. Inner airtight walls 170 attached between inner fuselage cell structure includes deck beams 100 and struts 104 and 106 and series of outer vertically oriented frames 174. In this embodiment a minimum of fasteners through load-bearing walls 170 required. Sidewall not airtight panels attached to outboard side of the frames 174 to provide curvilinear external fuselage contour. It is preferable to use external fuel tanks 26, cargo containers 24 and other detachable compartments like outer fuselage panels. Other aircraft components such as insulation, electrical conduits, ventilation ducting, control mechanisms and the like may be enclosed between the inboard wall 170 and the detachably curvilinear outboard panels. Windows 58 extend through the space between the inner skin 170 and outboard panels. Wing spars 74 and 76 connected with fuselage shell structure 172 and number of upper deck beams 100.

- [64] With reference to FIG. 10 the principle for providing additional service facilities in twin deck aircraft explained. Fuselage portion 190 contains upper cabin 192 and lower

cabin 196. Upper deck 194 have aperture 198. Stairs 200 attaching near said aperture 198, providing access from upper cabin 192 to lower cabin 196 using narrow passage 206 under table plate 202 placed in cabin 192. Walls 204 support table plate 202 and embrace passage 206 under table plate 202. This embodiment increase space for service facilities in cabins 192 and 196.

- [65] FIG. 11 shows the embodiment for floatable cargo containers 24 attached to fuselage belly. Fuselage portion 140 contain upper passenger cabin 142 displaced above upper deck structure 144 and lower 146 passenger cabin displaced below upper deck structure 144. Upper cabin have two aisles 150 and 152 and lower cabin have one aisle 154. Floatable containers 24 provide ability for safety emergency landing on ground or water. Above said containers 24 attached several swinging out bins 126 comprising retractable stairs 210 for embarking and disembarking passengers via the lower lobe doors. Some bins 126 include evacuation slides and inflatable rafts 212 which are stored folded and automatically deploying in an emergency situation near upper and lower lobe emergency exits.
- [66] FIG. 12 shows top view of aircraft with tandem forward 214 and rear 216 wings. The rear wing 216 is sweep aft and forward. Wing portion near fuselage have leading edge sweeping back, middle and lateral wing portions have leading edge sweeping forward. Pair turbofan engines 20 partly arranged inside rear wing 216. Inlets of turbofan engines 20 positioned before of intersection of said wing leading edges. Fan duct 218 of said engine 20 extend above and below of the wing upper and lower surfaces. The forward and rear wings structure integrated with fuselage shell structure and inner cell load-bearing structure. Several fuel tanks 26 displaced on a top of fuselage 4.
- [67] FIG. 13 shows cross section view of integrated wing and fuselage portion, having turbofan engines 20 partly arranged inside wing. In this embodiment compressor and turbine of said engines 20 displaced inside wing structure 220 but fan ducts 218 extends from the wing upper and lower surfaces. Wing structure 220 embraces passenger cabin 222, having smaller cross section area then in other fuselage regions. Inner wing region 224 connected with fuselage region and uses for displacing service facilities.
- [68] FIG. 14 shows passenger cabins of three decks, oval body very wide aircraft. Fuselage portion 250 has width around 8-9 meters and height 6-7 meters. Said portion 250 have outer shell 226 structure, comprises two lateral circular segments 228 and two upper and lower connecting panels 230. Preferably embodiment has inner airtight load-bearing walls 232 regarding to embodiment shown in FIG. 9. Fuselage portion 250 having three passenger and/or cargo cabins spaced vertically. Upper 234 and lower 238 cabins have at least two aisles 240 and middle cabin 236 has at least three aisles 242. Said airplane have stepped upper 244, middle 246 and lower 248 decks and

ceiling structures integrated with fuselage outer shell 226. Stepped decks provide sufficient standing height in the upper, middle and lower cabin aisles 240, 242 and smaller height above rows of seats 60. In upper 234 and lower 238 cabins seat sections can include seating rows having ten seats 60 abreast, arranged in three groups separated by left and right aisles 240. In middle cabin 236 seat sections can include seating rows having fourteen seats 60 abreast, arranged in four groups separated by left, middle and right aisles 242. Plurality of struts 252 connected upper 244, middle 246 and lower 248 decks structures with fuselage shell structure 226 to form rigid structure. Rows of seats 60 arranged in central wing area. A wing unit 254 passes through the fuselage middle region. Wing spars 256 integrated and coincident with upper 244 and middle 246 decks structures. In preferable embodiment aircraft have middle region with width smaller than forward and aft regions. Minimizing fuselage width at the wing-fuselage intersection area contributes substantially toward reducing aircraft drag at high subsonic flight Mach numbers. External fuel tanks 26 positioned on top fuselage, providing streamlined outer surface on top of fuselage. External cargo containers 24 configured to fit within fuselage belly and define with fuselage a generally aerodynamically smooth, streamlined outer surface during normal operation of the aircraft and during water landing. This embodiment has cross section area similar with Airbus 380 and can accommodate 34 passengers in one section.

[69] FIG. 15 shows passenger cabins 260 of elliptical wide-body aircraft, similar to Airbus 380. Two additional passenger seats 60 provided in upper deck cabin 264 because of lowering upper deck 270. Girder 272 and/or plurality of angle braces 274 support upper cabin 264 ceiling. Plurality of arch beams 276 supports upper deck 270 structure. Plurality of angle braces 274 support middle deck 278 structures. Space 280 above upper cabin 264 is used for cables and ducts. Inside passenger cabins angle struts 274 and arch beams 276 hide between overhead bins 282. The strength and integrity of the supporting structure is maintained despite the decreasing the thickness and weight of upper and middle decks structure.

[70] Industrial Applicability

[71] The possibility of employing partial structures of pre-existing cylindrical shells constitutes an essential advantage of the invention since this avoids the need to undertake a very large number of studies and to design new tool components. Production costs may be substantially reduced by making use of parts which already exist in other types of aircraft. Similarly, it is an advantage to develop aircraft having identical subassemblies comprising many common parts since initial production tooling costs may accordingly be amortized over a larger series.

Claims

- [1] An aircraft for transporting passengers and cargo having fuselage, wing, landing gear and other assemblies, said fuselage have shell structure and consist at least one cabin for accommodating passengers, including a plurality of cabin doors for access to the internal space and an associated plurality of deployable escape slides for permitting the passengers to evacuate the cabin in an emergency situation, fuselage have inner load-bearing structure connected to the fuselage airframe shell to enable the fuselage to withstand operational stresses and internal pressurization, said inner structure, comprises: decks structure, connected with fuselage shell structure and dividing the internal fuselage space into lobes; an upper lobe ceiling structure connected with fuselage airframe structure; a number of wing spars that passes through the fuselage lobes and connected with fuselage airframe structure and a plurality of longitudinally-spaced inside fuselage struts, beams, angle braces and load-bearing walls, connected with fuselage airframe structure and decks structure.
- [2] An airplane according to claim 1 wherein internal load-bearing structure compose inner load-bearing cells structure, the pitch of the struts, beams, angle braces and walls is determined with respect to the spacing of the rows of seats and/or beds so as to ensure that each one of a majority of said struts, beams, braces and walls is located between adjacent seats and/or beds to ensure maximum freedom of passenger movement between the rows.
- [3] An aircraft according to claim 1, wherein said aircraft is narrow or wide body passenger airplane having oval or number eight fuselage cross section with at least one axis of symmetry and at least two passenger cabins spaced vertically.
- [4] An aircraft fuselage according to claim 3, having oval cross section consist of upper and lower circular shell lobes with cutting of lower and upper segments, wherein ends of said shell arches connecting by extending structure and said extending structure serving for connecting with upper lobe deck and lower lobe ceiling.
- [5] An aircraft fuselage according to claim 3, having number eight cross section fuselage consist of upper and lower circular shell lobes with cutting of lower and upper segments, wherein ends of said shell arches connecting by intersection structure and said intersection structure serving as an outer boundary of upper lobe deck and lower lobe ceiling.
- [6] An aircraft according to claim 1, wherein said aircraft is wide body passenger airplane having circular fuselage cross section and at least two passenger cabins spaced vertically.

- [7] An aircraft fuselage according to claim 6, having at least one circular shell region with cutting of upper and/or lower segments, wherein cutting ends of said shell lateral arches connected by linear or arch beams.
- [8] An aircraft according to claim 1 having circular or oval cross section wide body fuselage, at least two passenger cabins spaced vertically, lower cabin have one aisle and upper cabin have two aisles and main deck divide upper and lower fuselage lobes and a middle portion of the main deck structure is elevated lengthwise above lower lobe aisle, to provide sufficient standing height in the lower lobe aisle, wherein rows of seats arranged on said middle region.
- [9] An aircraft according to claim 1, having resemble rectangle oval cross section fuselage with at least one axis of symmetry and at least two passenger cabins spaced vertically.
- [10] An aircraft according to claim 9, wherein said aircraft is wide body passenger airplane having tubular shell contour, wherein oval consist of several arcs, comprises: one top and one bottom arcs, two lateral arcs and four arcs connecting lateral arcs with top and bottom arcs.
- [11] An aircraft according to claim 1, wherein said aircraft is very wide body passenger airplane having oval cross section fuselage with width bigger than height, at least one axis of symmetry and at least two passenger cabins spaced vertically.
- [12] An airplane fuselage according to claim 11, having tubular shell contour with width bigger than height; said oval consist of at least of two lateral semicircles, wherein ends of said lateral semicircle arches connected by linear or arch beams.
- [13] An airplane according to claim 1 with circular or oval cross section fuselage, having three passenger and/or cargo cabins spaced vertically, wherein said airplane have stepped upper, lower and middle decks and ceiling structures integrated with fuselage shell and inner walls to form inner cell structure and provide sufficient standing height in the upper, middle and lower cabin aisles, said means, comprises of: portions of the upper cabin deck is lowered lengthwise above middle cabin rows of seats; portions of the middle cabin ceiling is elevated lengthwise below upper cabin rows of seats; portions of the middle cabin deck is lowered lengthwise above lower cabin rows of seats and portions of the lower cabin ceiling is elevated lengthwise below middle cabin rows of seats.
- [14] An airplane according to claim 1, is blended wing body airplane, having fuselage with forward, middle and aft regions, said airplane comprises a wing unit that is integrated with the fuselage middle region, said wing have curvilinear spars structure embraced passenger cabin in middle region, wherein fuselage cross section area in the middle region is smaller than in front and aft regions and said

middle region uses for placing rows of seats and for service facilities.

- [15] An airplane according to claim 1 further comprising a stepped deck in the lower lobe to ensure substantial width within a lower lobe rows of seats, to support rows of seats and protect the passengers during flight and emergency landing and the lateral ends of transverse beams are elevated regarding aisle region, wherein rows of seats arranged on said stepped deck region and seats near the aisle having bigger leg height than near window seats and folding foot-supports providing for undersized passengers and children.
- [16] An airplane according to claim 1 having the fuselage shell structure comprises several longitudinally spaced, vertically oriented main frames, beams and angle braces to transfer the load from the fuselage shell to wings and undercarriage mounting of the aircraft, wherein said frames have circular contour in some regions of fuselage and oval contour in other regions of fuselage, said frames have different radius, height and width in several regions of fuselage.
- [17] An airplane according to claim 1 having the fuselage shell structure comprises several longitudinally spaced, vertically oriented dual main frames, connected by braces, to transfer the load from the fuselage shell to wings of the aircraft, wherein outer frame encircle outer contour of fuselage shell and inner frame encircle aisles in upper and lower lobes.
- [18] An airplane according to claim 1, having several lobes, comprises a wing unit that passes through the upper, middle or lower fuselage lobes, said wing unit including integral with fuselage central wing box located within passenger cabin, wherein said wing box using as space for placing rows of seats and/or for service facilities in passenger cabins.
- [19] An airplane according to claim 1 further comprises a wing unit that passes through the intersection structure of the upper and lower fuselage lobes, said wing unit including two lateral spar boxes and middle wing box, said middle wing box integral with fuselage airframe shell and said intersection structure, wherein said lateral and middle wing boxes using as space for placing rows of seats and/or for service facilities.
- [20] An airplane according to claim 1 have a number of external, watertight compartments attached to aircraft belly and/or placed in a cavities on a top of aircraft fuselage, said compartments are shaped to have a streamlined outer contour, wherein fuselage outer skin partly removed in regions between said compartments and fuselage shell airframe and curvilinear outer boundary of said compartments extend of fuselage tubular shall contour.
- [21] An airplane according to claim 20 wherein said compartments converged at the forward and rear parts of fuselage, but are spaced apart at the middle of aircraft

belly and coincident with landing gear bays fairings, said compartments provide a concave bottom to generate more lift and control at low speeds and emergency landing on the ground or water.

- [22] An airplane according to claim 20 wherein at least one compartment manufactured from composite materials and does not constitute a structural part of the airplane fuselage and wing.
- [23] An airplane according to claim 20 have external cargo containers, attached to aircraft structure, said containers have doors for placing luggage inside and latch means, operable by remote control devices, for detachably securing the containers to the fuselage, wherein airport system is provided for loading and unloading these external cargo containers.
- [24] An airplane according to claim 23, wherein cargo containers manufactured of a reinforced composite material and have venting devices mounted on the outer side of the container to direct the shock waves and high pressure to the exterior of the airplane in a case of bomb explosion inside container.
- [25] An airplane according to claim 20 have several energy absorbing and safety units that attached to fuselage belly and which are shaped to have a streamlined outer contour with landing gear bays, wherein said energy absorbing units comprises a number of external, floatable, watertight cargo containers and a number of floatable bins attached to fuselage bottom.
- [26] An airplane according to claim 20 have several external floatable bins attached to the fuselage, wherein said bins may comprise: retractable stairs for embarking and disembarking passengers via the lower lobe doors and evacuation slides and inflatable rafts which are stored folded and automatically deploying in an emergency situation near upper and lower lobe emergency exits.
- [27] An airplane according to claim 20 have safety fuel system, wherein several external detachable fuel tanks positioned in cavities on a top or/and on a bottom of aircraft fuselage.
- [28] The safety liquid fuel system according to claim 27, comprise sensors and valves for detaching external fuel tanks from airplane fuselage without fuel leaking during crash landing.
- [29] An airplane according to claim 20 have a number of external cargo containers and fuel tanks, wherein said containers and tanks have different cross section outer sizes, providing streamlined, curvilinear outer surface and reduced cross-section area at the wing-fuselage intersection region.
- [30] An airplane according to claim 20 have a number of interchangeably external cargo containers and auxiliary fuel tanks, having similar devices for connection with fuselage structure, wherein the number and arrangement of the auxiliary

fuel tanks depends by flight range and they should be relatively easy to install and remove so that the aircraft can be quickly changed into the desired configuration.

- [31] A commercial airplane according to claim 1 having fuselage with at least one internally pressurized passenger cabin, said cabin comprising inner load-bearing, airtight walls or inner skin, attached to inboard side of fuselage shell primary structure, wherein said inner walls envelope inboard pressurized cabin area.
- [32] A commercial airplane according to claim 31, having at least one internally pressurized passenger cabin, wherein said cabin shell comprising: a series of vertically oriented frames that encircle a cabin area; a series of longitudinal stringers connected with inboard side of said frames; an inboard load-bearing, airtight wall or internal skin attached to longitudinal stringers and sidewall not airtight panels attached to outboard side of the frames.
- [33] A commercial airplane according to claim 31 having at least one internally pressurized passenger cabin, said cabin comprising inner load-bearing, airtight walls or inner skin, said inner airtight walls attached between fuselage inner cell structure and series of outer vertically oriented frames that encircle a cabin area.
- [34] A commercial airplane according to claim 31 wherein, other aircraft components such as insulation, electrical conduits, ventilation ducting, control mechanisms and the like may be installed along the inboard walls and between the frames, so that they may be enclosed between the inboard wall and the detachably curvilinear outboard panels; windows extend through the space between the inner skin and outboard panels.
- [35] A commercial airplane according to claim 31, wherein at least one curvilinear outboard panel is external, watertight compartment serving like fuel tank, cargo container and/or energy absorbing unit detachably connected with fuselage shall structure.
- [36] A modular airplane according to claim 1, have fuselage including several internally pressurized passenger cabins with different cross sections, said cabins connected by their shell structure and inner load-bearing cell structure, to form longitudinal pressurized area, wherein detachably external compartments provide a streamlined outer fuselage contour.
- [37] A modular airplane according to claim 1, include several internally pressurized passenger cabins with different cross sections, having inner airtight walls, said cabins connected by their shell structure, inner load-bearing cell structure and internal walls providing longitudinal pressurized area with stepped inner airtight walls, wherein outboard panels form a streamlined outer fuselage contour.
- [38] An airplane according to claim 1 comprises a wing unit that passes through the

fuselage lobes, said airplane have at least one pair of turbofan engines attached to said wing, wherein fan ducts of said engines do not extends below external cargo containers attached to fuselage.

[39] An airplane according to claim 1, having wing unit that is integrated with the fuselage and at least one pair of turbofan engines placed inside said wing structure, wherein fan ducts extends forward, up and down regarding wing contour.

[40] A commercial airplane according to claim 1, is a tandem wing aircraft includes forward wing extends outwardly from the lower portion of the fuselage and rear wing is sweep aft and forward and positioned above of the aircraft centerline, wherein the forward and rear wings structure integrated with fuselage shell structure and inner load-bearing cell structure.

[41] An airplane according to claim 1, consists of an upper and lower cabins for accommodating passengers and/or service facilities, provided with at least one interior stairway for access from one lobe to another, have mezzanine region in the upper cabin and an aperture in upper deck below mezzanine plate, wherein aisle arranged between walls supported this mezzanine plate and stairs attached to this aperture.

[42] An airplane according to claim 41, having table, bed or other service facilities arranged in upper cabin on said mezzanine plate, wherein aisle and ladder provided in lower cabin below said table plate and/or bed plate.

[43] A method of increasing the efficiency of multi-lobe aircraft, by minimizing fuselage shell thickness and weight, is provided by means of manufacturing inner load-bearing tructure comprising: struts, angle braces and supporting walls, wherein the pitch of the struts, braces and walls is determined with respect to the spacing of the rows of seats and/or beds so as to ensure that each one of a majority of said struts and walls is located between adjacent seats and/or beds to ensure maximum freedom of passenger movement between the rows.

[44] A method of increasing the seating capacity of wide-bodied aircraft, having circular cross section fuselage with two aisles in upper cabin and one aisle in lower cabin, by manufacturing derivative twin deck aircraft, is provided by means of an elevating lengthwise a middle portion of the main deck above the lower lobe aisle, wherein rows of seats arranged on said middle deck region .

[45] A method of increasing the seating capacity of a narrow and wide-bodied aircraft, by manufacturing derivative multi-lobe aircrafts, is provided by means of an increasing the height of the aircraft fuselage by attaching lateral connecting panels lengthwise to the upper and lower circular fuselage segments.

[46] A method of increasing the seating capacity of a narrow and wide bodied

aircraft, by building derivative very wide body aircraft, is provided by means of an increasing the width of the aircraft fuselage by attaching upper and lower connecting panels lengthwise to the lateral circular fuselage segments.

[47] A method of increasing the efficiency of twin deck wide body passenger aircraft, by ensuring sufficient standing height in a lower cabin aisle is provided by means of manufacturing stepped upper deck structure above lower cabin aisle, wherein the middle parts of transverse beams and middle floor plates of said upper deck are raised regarding lateral ends to secure standing height about 200-250 cm in a lower cabin aisle.

[48] A method of increasing the efficiency of twin deck narrow and wide body passenger aircraft, by ensuring sufficient width within lower lobe rows of seats and sufficient standing height in a lower lobe aisle is provided by means of manufacturing stepped lower lobe deck structure, wherein the lateral beams are elevated regarding middle parts of lower lobe aisle and seats near the aisle having bigger leg height than lateral seats and folding foot-support providing for undersized passengers and children

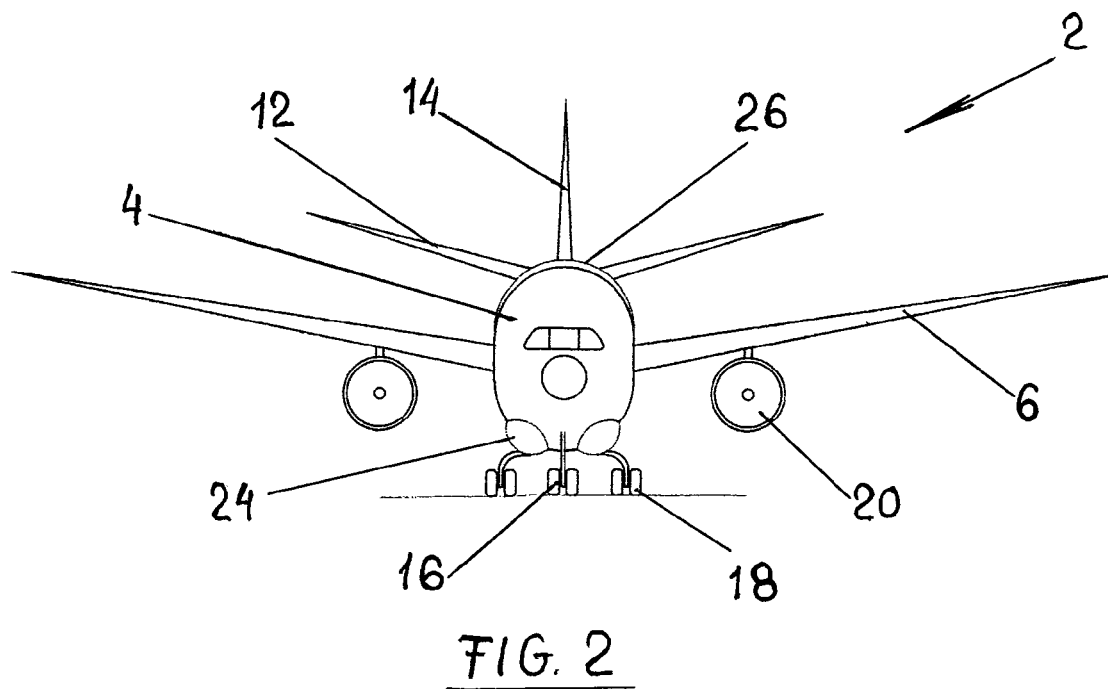
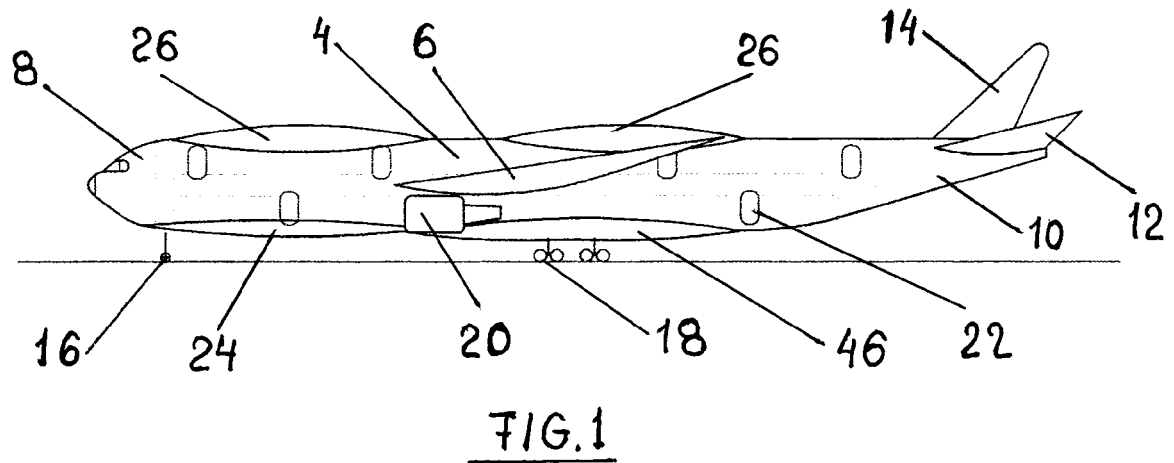
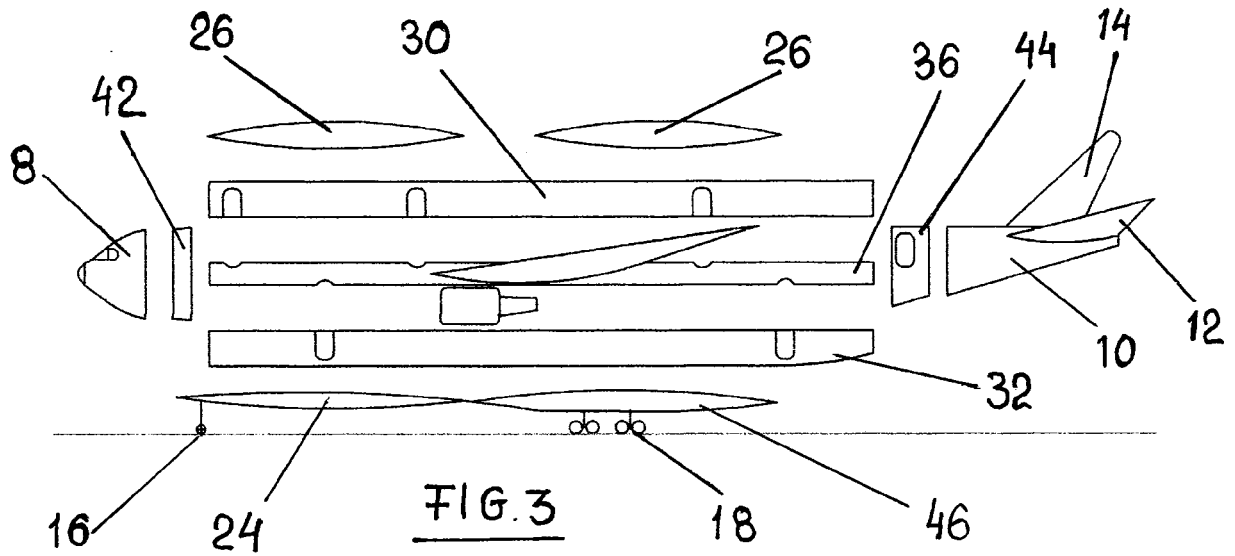
[49] A method of increasing the efficiency of very wide body passenger aircraft, having three passenger and/or cargo cabins spaced vertically, by ensuring sufficient standing height in all cabins aisles is provided by means of manufacturing stepped upper, lower and middle decks and ceiling structures integrated with fuselage shell and inner walls to form rigid structure integrated with wing structure.

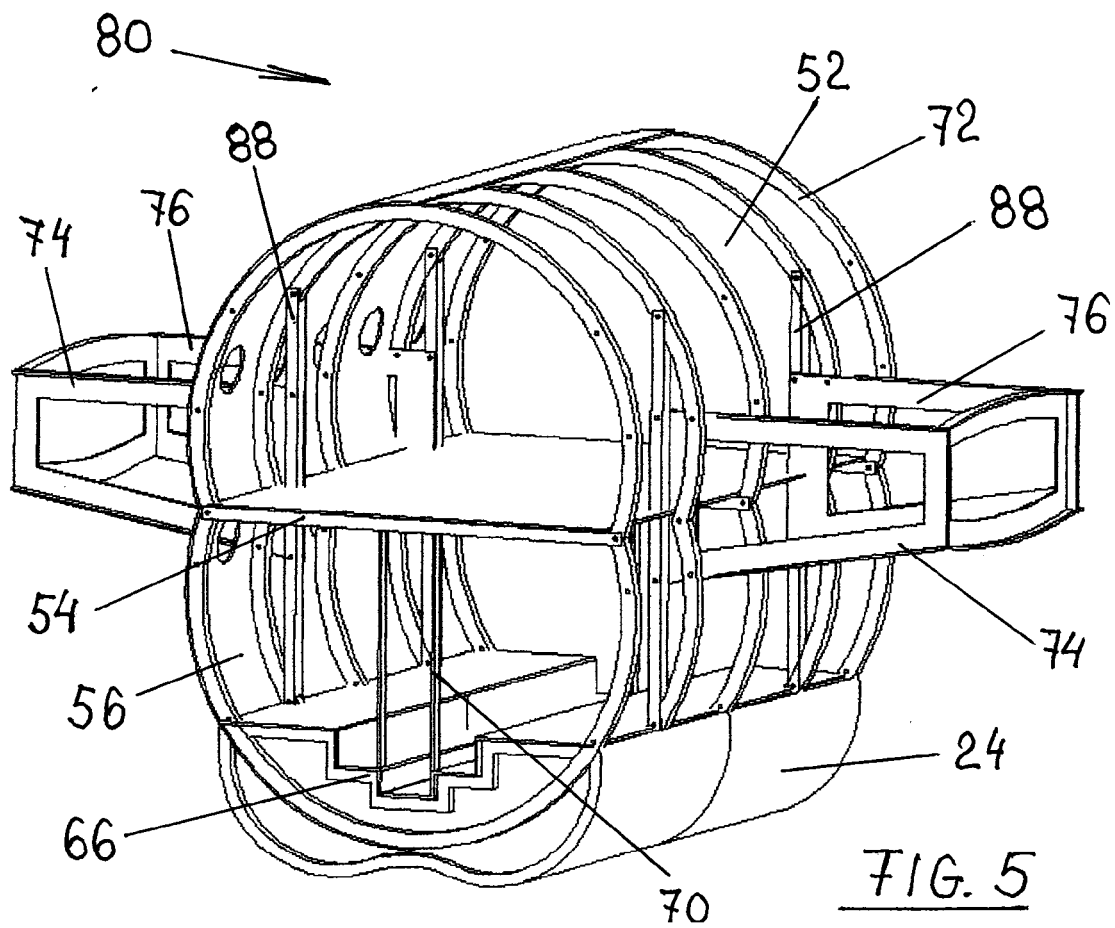
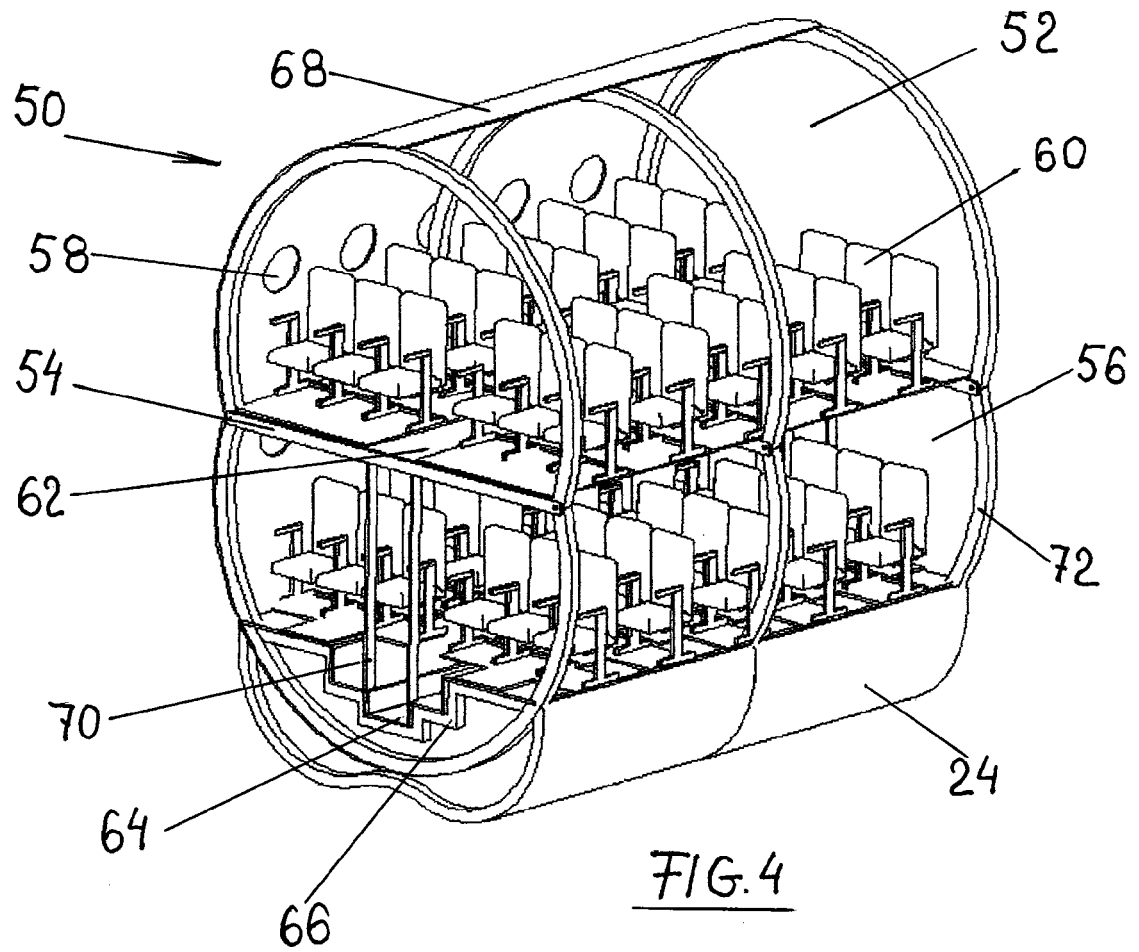
[50] A method of increasing the efficiency of commercial aircraft, by minimizing decks thickness and weight, is provided by means of manufacturing arch deck structure, wherein the lateral parts of transverse arch beams are hidden in overhead luggage bins.

[51] A method of increasing security and efficiency of commercial aircraft by arranging several external, watertight compartments, having a streamlined outer contour, on aircraft belly and/or in cavities on a top of aircraft fuselage, is provided, wherein at least one compartment does not constitutes a structural part of the airplane fuselage and wing and fuselage outer skin partly removed in regions between said compartments and fuselage shell.

[52] The method as defined in claim 51, in which at least one curvilinear compartment is serving like fuel tank, cargo container and/or energy absorbing and safety unit detachably connected with fuselage shell structure and which are shaped to have a streamlined outer contour, wherein the energy absorbing unit comprises a number of external, floatable, watertight cargo containers and a number of floatable bins attached to fuselage bottom.

- [53] A method of increasing security and buoyancy of commercial aircraft by using several external floatable cargo containers and bins attached to the fuselage structure, wherein said bins may comprise: retractable stairs for embarking and disembarking passengers via the lower lobe doors and evacuation slides and inflatable rafts which are stored folded and automatically deploying in an emergency situation near upper and lower lobe emergency exits.
- [54] A method of increasing security and efficiency of commercial aircraft by using safety fuel system is provided by arranging several external, fuel tanks, having a streamlined outer contour, on a top of aircraft fuselage, wherein said fuel system comprise sensors and valves for detaching external fuel tanks from fuselage without fuel leaking during crash landing.
- [55] A method of increasing efficiency of commercial aircraft by using interchangeably external cargo containers and auxiliary fuel tanks, having similar devices for connection with fuselage structure, wherein the number and arrangement of the auxiliary fuel tanks depends by flight range and they should be relatively easy to install and remove so that the aircraft can be quickly changed into the desired configuration.
- [56] A method for reducing the weight of an aircraft fuselage having at least one internally pressurized passenger cabin, by minimizing number fasteners through load-bearing material is provided by means of providing load-bearing inner walls or internal skin, enveloping inboard pressurized cabin area and attaching said inner walls to a series of longitudinal stringers connected with inboard side of the frames that encircle a cabin area.
- [57] The method as defined in claim 56, in which sidewall not airtight panels attaching to outboard side of said frames and other aircraft components such as insulation, electrical conduits, ventilation ducting, control mechanisms and the like installed along the inboard walls and between the frames, said components enclosed between the inboard wall and the detachably curvilinear outboard panels.
- [58] The method as defined in claim 56, in which at least one curvilinear outboard panel is external, watertight compartment serving like fuel tank, cargo container and/or energy absorbing unit detachably connected with fuselage shall structure.
- [59] A method of providing service facilities in narrow and wide body airplane, by placing stairs or ladder below mezzanine plate, wherein said mezzanine plate is table plate, bed plate or other service facilities plate and aisle and ladder or stairs provided in lower cabin below said plate.





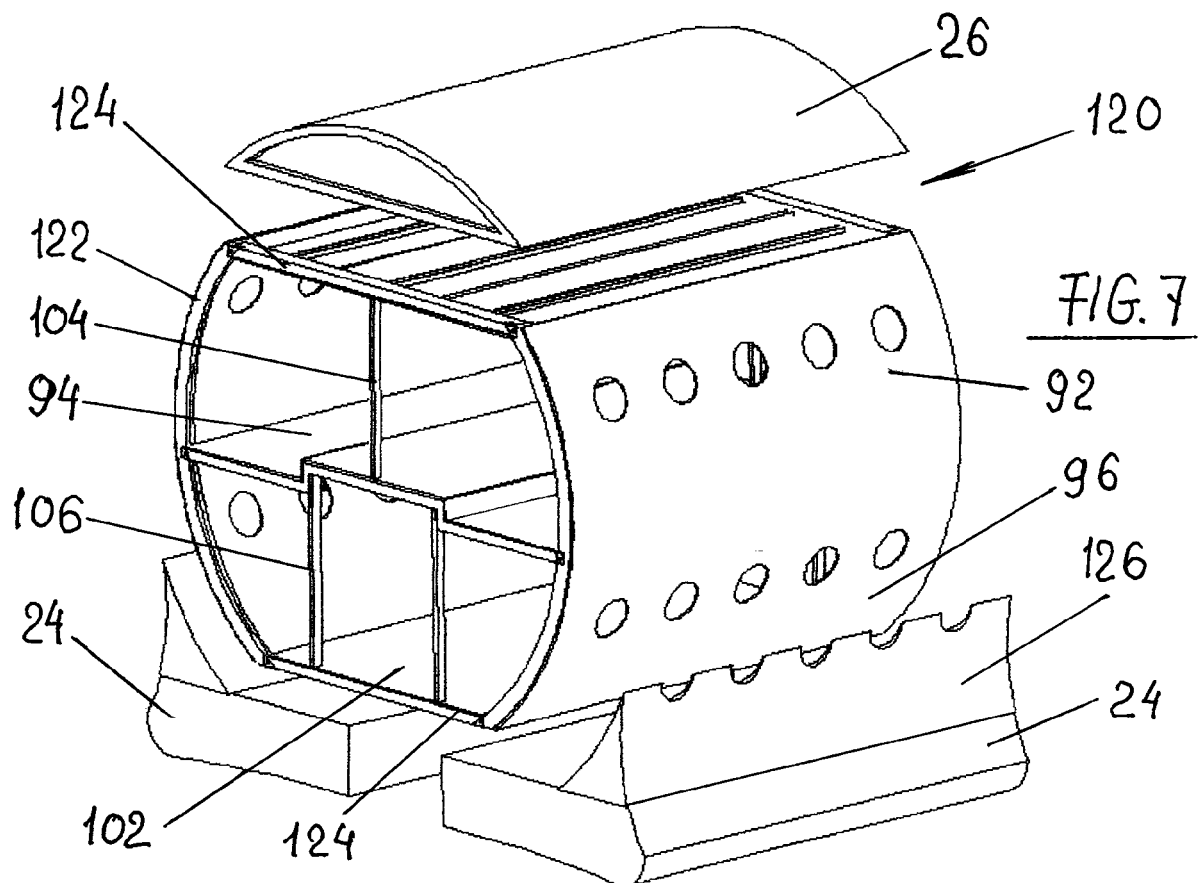
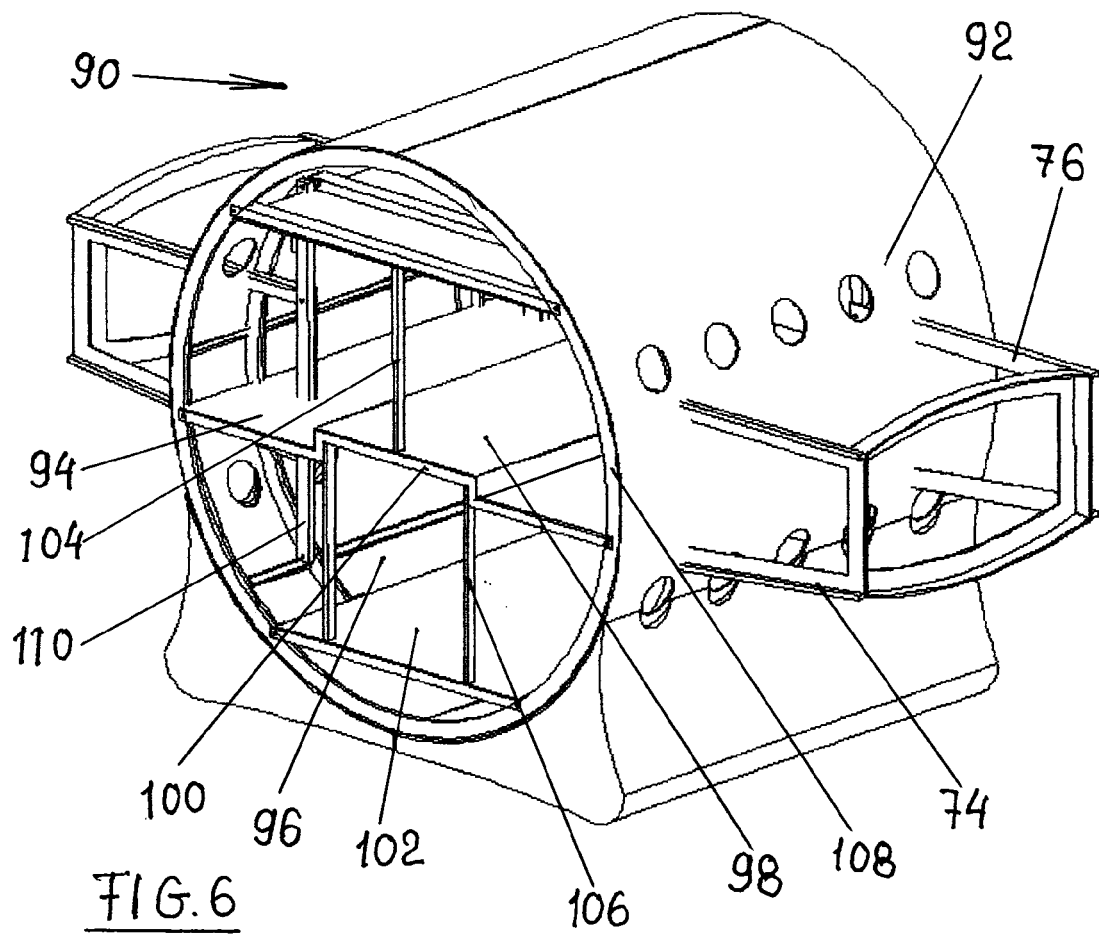
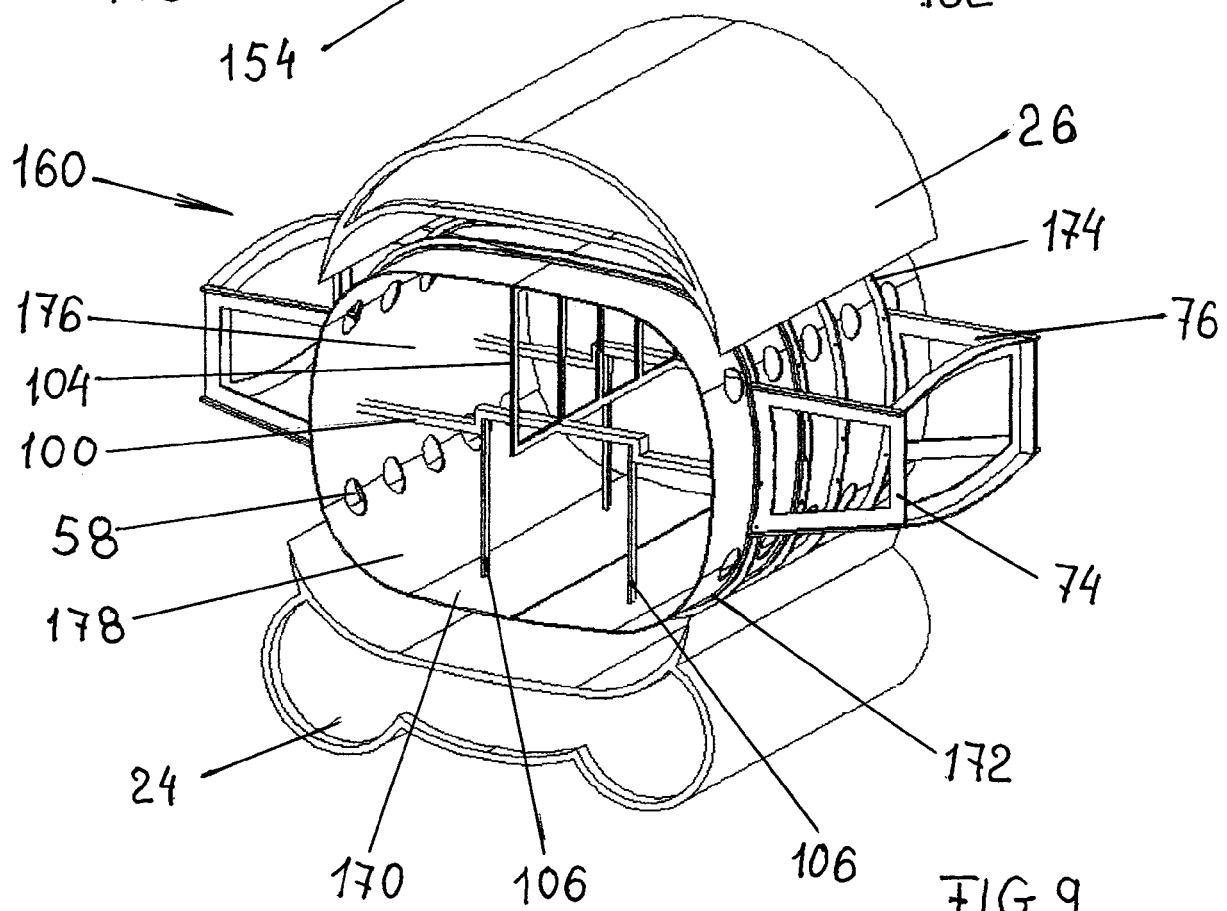
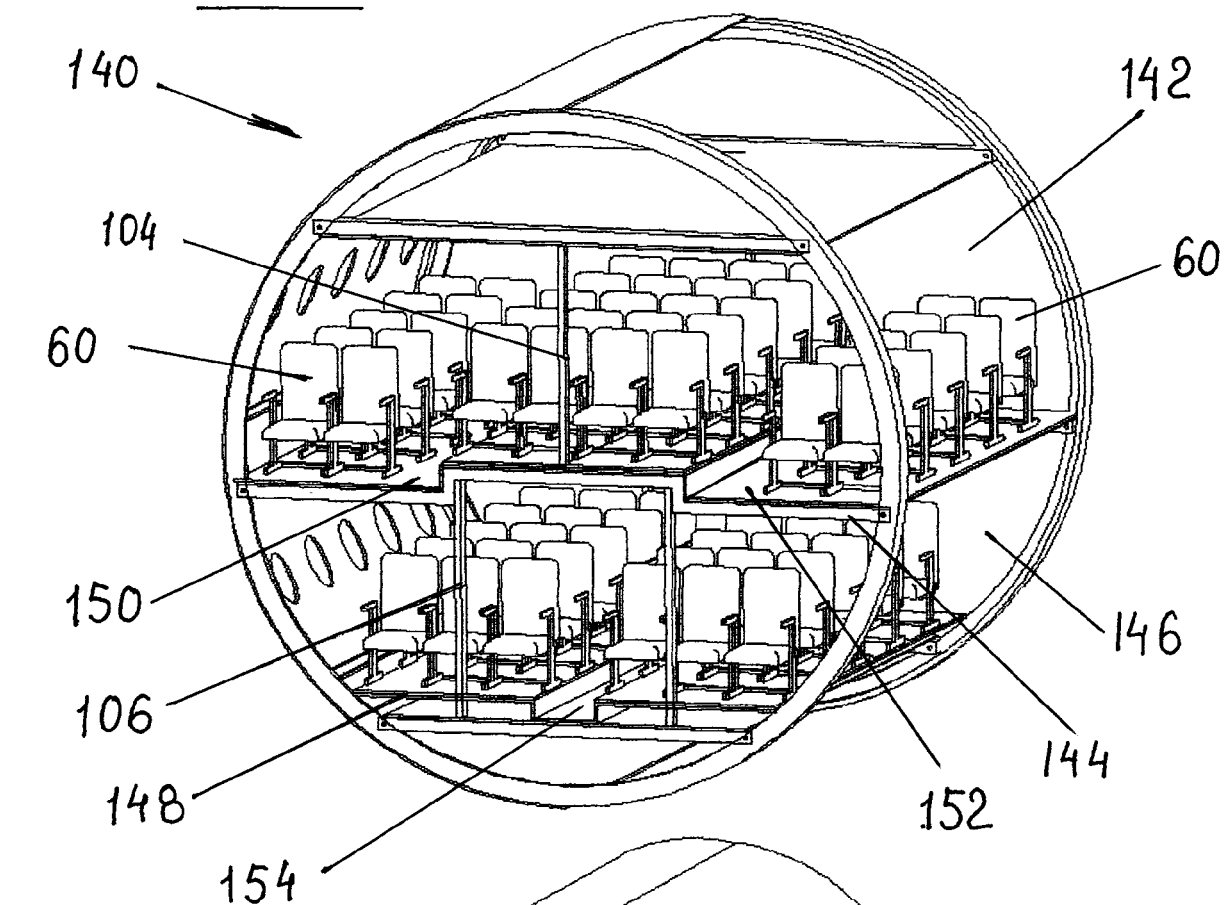
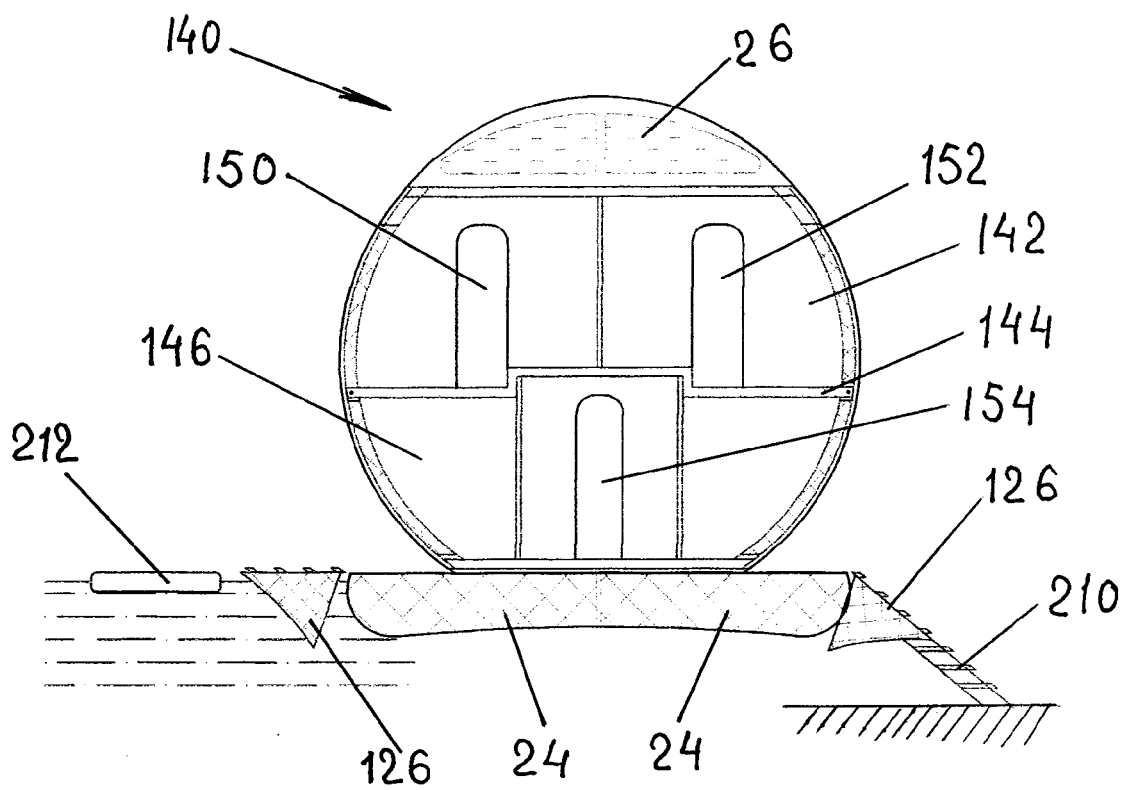
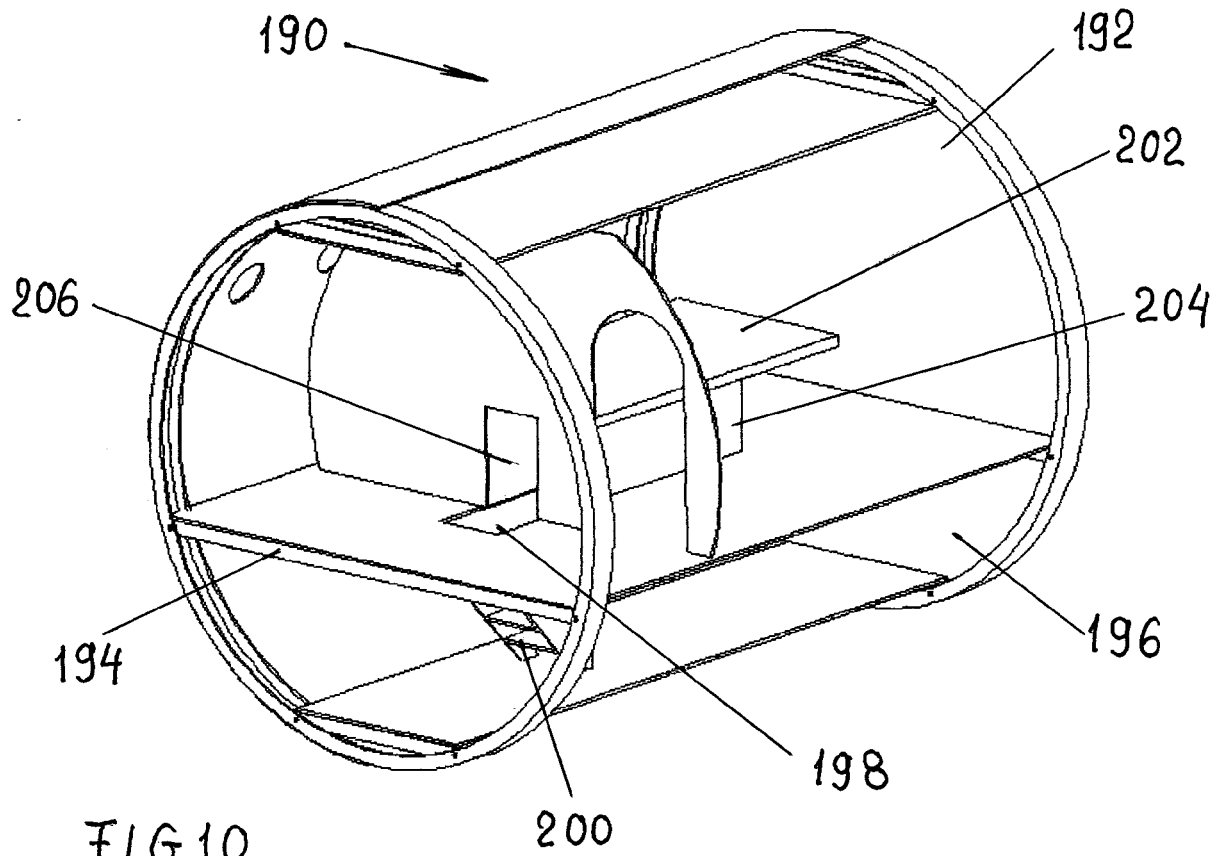


FIG. 8FIG. 9



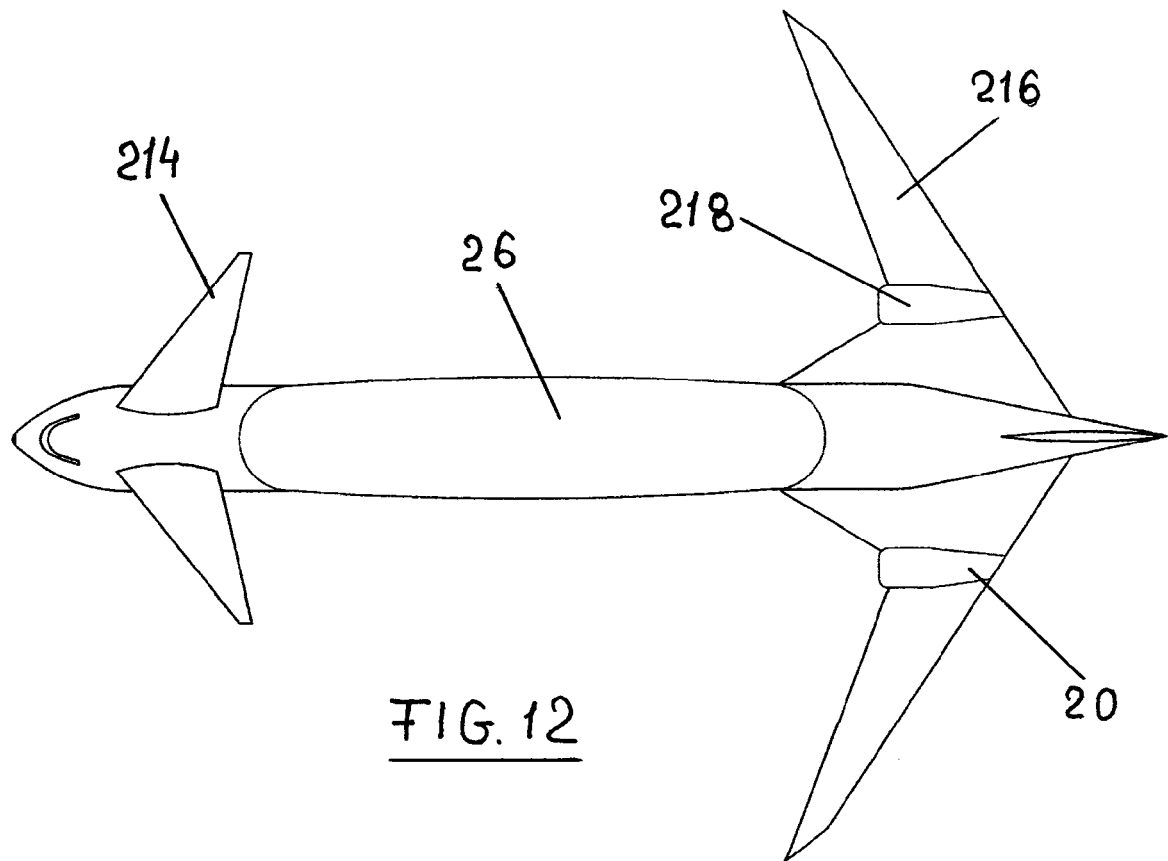


FIG. 12

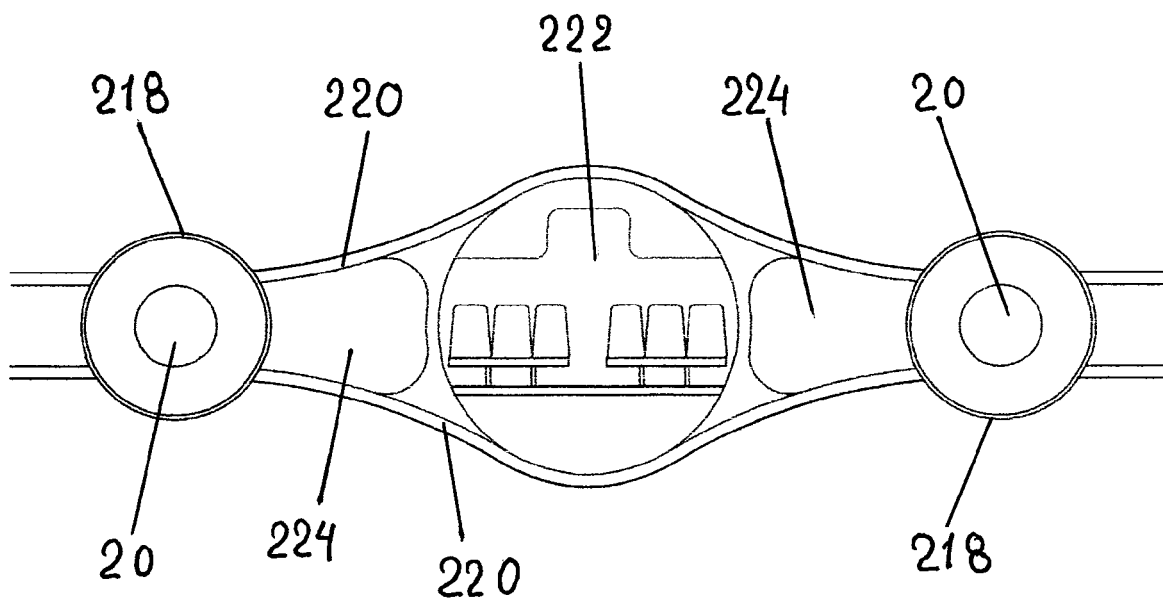


FIG. 13

