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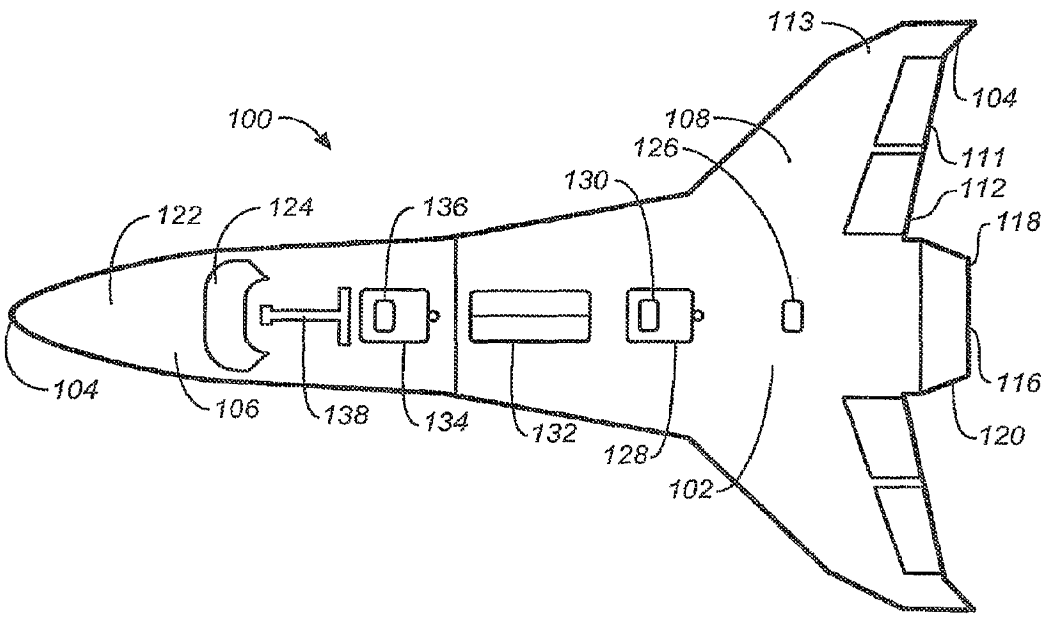
(54) Title: REUSABLE SPACE LAUNCH, ORBITAL, AND RE-ENTRY VEHICLE



(57) Abstract: A reusable space vehicle for launch, orbital, and re-entry operations in a space transportation system program. The vehicle includes a unitary, single molded hull bottom mated to an airframe with embedded electronic circuitry. An internal component systems module and a crew cabin module are attached to the hull, with the crew cabin including a rocket-away attachment system which employs mechanical latches and rapidly depolarizing electromagnetic seals, and an independent propulsion and maneuvering system.

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Reusable Space Launch, Orbital, and Re-Entry Vehicle

BACKGROUND OF THE INVENTION

Technical Field

[0001] The present invention relates generally to spacecraft, and more particularly to Earth-orbiting and re-entry space vehicles, and still more particularly to an improved reusable, returnable, launch, orbital, and re-entry vehicle for manned space missions and shuttle trips to Earth-orbiting space stations.

Background Art

[0002] Some space experts estimate that by the year 2018 there may be as many as seven manned space stations orbiting the planet. The Americans, the Russians, the Chinese, and the European Space Agency are all currently producing versions of a small manned industrial complex. The current International Space Station, or "ISS," is an industrial space research complex that can sustain three to eight astronauts for months at a time. By 2018, there could be as many as forty people continuously employed in space research and manufacturing at these various stations.

[0003] There are many reasons other than mere tourism to go into space as a commercial venture. Manufacturing some kinds of articles may be considerably easier to accomplish in zero gravity environment – perfect micro spheres, for instance. Building simple automated and manned manufacturing plants in space may come to have a much greater commercial viability and overall usefulness than is commonly envisioned. The Russian Space Agency (RSA), for instance, has manufactured pure crystals at its Mir Space Station in a micro gravity environment. They proved that space manufacturing is not only possible but profitable as well. In this micro-gravity environment in a low earth orbit it is possible to manufacture things that cannot be manufactured on Earth: Pure chemical substances, mixtures, silicon chips, bearings, nano-machines, a whole range of things that are just now being conceptualized could be brought to reality in orbit.

[0004] The countries involved in the International Space Station project are currently pioneering the techniques of space manufacturing in the form of the Japanese JEM Module. Because space has proven and continues to promise a manufacturing and research environment with advantages over the gravity environment of Earth, it would be highly desirable to have a workable commercial space vehicle system with the capability to do contract work in space. Furthermore, in view of the catastrophic losses of the Challenger and Columbia shuttles in the NASA Space Transportation System program, it would be desirable to have such a space vehicle that also includes features and systems that vastly increase crew safety.

[0005] As with any venture of this scale, there is a drive to reduce costs in developing and deploying space systems. Additionally, there is increasing confidence that enterprises in the private sector can participate competitively in developing low cost, efficient, safe space transportation systems, while advancing manufacturing, research, and even entertainment interests. To that end numerous space shuttle systems have been conceived and shared with the public, many through United States Letters patent. In addition to the four well-known space shuttles in the NASA program, the following alternative systems, among many others, merit consideration.

[0006] U.S. Pat. No. 4,834,325, to Faget, et al., discloses an expandable modular spacecraft system adapted for orbital flight, each module of which is capable of independent operation. Each spacecraft module comprises a spacecraft body, at least one solar array extendible outwardly from the spacecraft body, and at least one structural interface means for connecting one spacecraft module to another spacecraft module. Methods for deployment of a spacecraft module and for assembly of a modular spacecraft system utilizing a reusable space vehicle are also disclosed.

[0007] U.S. Pat. No. 6,446,905, to Campbell, et al., teaches a reusable spacecraft system having two substantially identically reusable return flight space vehicles, one of which is preferably a booster and the other an orbiter, each of which have identical flight control and propulsion systems and have identical but selectively installable components, such as thermal protection disposed on the orbiter but not on the booster. Each vehicle includes identical payload bays for mission-specific payloads.

[0008] U.S. Pat. Nos. 6,557,803 and 6,666,409, to Carpenter, et al., teach a returnable and reusable space vehicle including a main body separate from and releasably mounted to a booster rocket assembly. The dual return booster/orbiter combination of the launch system is essentially identical to that proposed by Campbell et al. However, a crew compartment module is also provided that is separate from and releasably mounted to the main body. A propellant system is operably coupled to the crew compartment module which will propel the crew compartment module from the main body during an emergency procedure. An orientation control system is coupled to the propellant system to maintain proper attitude of the crew compartment during the emergency procedure.

[0009] U.S. Pat. No. 6,612,522, to former astronaut Buzz Aldrin, et al., teaches a flyback booster including an aircraft housing a launch vehicle stage as a removable rocket propulsion module and several space launch vehicles using variations of the flyback booster. The flyback booster functions as the first stage of a multistage space launch vehicle. The stage used in the flyback booster and the upper stages of the multistage space launch vehicle are selected to optimize the launch cost for a specific payload.

[0010] U.S. Pat. No. 6,827,313, to Aldrin, discloses a system for launching a space vehicle having multiple separate crew modules mounted in the launch vehicle. The multiple crew modules are nested around the circumference of the launch vehicle. Alternatively or additionally, there are multiple separate crew modules located in a pod relatively directed along the length of the launch vehicle.

[0011] U.S. Pat. No. 5,526,999, to Meston, shows a spacecraft with a crew escape system, comprising a crew compartment disposed between fin struts under the top tailplane of a vehicle fuselage having a movable center conical body. The crew escape system comprises an escape module which is a recoverable ballistic capsule held to the end face of the tail portion of the fuselage. The capsule communicates with the crew compartment through a tunnel having means for crew transfer from the crew compartment to the capsule. The system is clearly not well suited for a rapid escape.

[0012] U.S. Pat. No. 6,776,373 to Talmage, Jr., discloses an Aircraft Escape system (AEC) for manned atmospheric or space vehicles with a purported fly away capability at any time during the flight of the parent aircraft. The AEC houses the crew, passengers, life support systems, aircraft flight controls, propulsion, navigation instruments, communications equipment, and deceleration devices to permit safe landing of the escape cabin on land or water. A rocket or mechanical device provides the means to actively separate the escape cabin from the parent aircraft during an emergency.

[0013] The foregoing patents reflect the current state of the art of which the present inventor is aware. Reference to, and discussion of, these patents is intended to aid in discharging Applicant's acknowledged duty of candor in disclosing information that may be relevant to the examination of claims to the present invention. However, it is respectfully submitted that none of the above-indicated patents disclose, teach, suggest, show, or otherwise render obvious, either singly or when considered in combination, the invention described and claimed herein.

Disclosure of Invention

[0014] The multi-use, manned reusable space launch, orbit, and re-entry vehicle of the present invention is a fully orbital low earth orbit/geostationary orbit flight service designed to support NASA fleet operations starting in the year 2014. (The vehicle presently bears the proprietary name of the ASC-Spaceplane, and will be referred to herein by that term or its shorter alternative, "Spaceplane".) The ASC-Spaceplane flight system architecture is fully compliant with DOD, DOT/FAA, NASA, and DOC, protocols. International over-flight and rescue protocols are compliant with ESA, RSA, JAXA and the United Nations Treaty on the Peaceful Uses of Outer Space.

[0015] The ASC-Spaceplane will fill a gap that has long existed in the U.S. Space vehicle inventory. Because of a new approach to manufacturing, the ASC-Spaceplane will provide service that will make it suitable and useful for a variety of missions throughout the next decade and beyond.

[0016] The ASC-Spaceplane is particularly well-suited for space station shuttle operations. And only private industry can provide low-cost, highly reliable access to space.

[0017] The ASC-Spaceplane is also designed to be mass-produced. It will employ a single piece thermal protection system, which is a technical concept ripe for full exploitation. By implementing this technology, the ASC-Spaceplane will be the first space vehicle of its kind, and a revolutionary breakthrough in manufacturing. The inventive vehicle will be launched initially by a Heavy Lift Vehicle (HLV) booster rocket. The Spaceplane is a "power on descent" hypersonic glider with some very advanced flight characteristics. It can land at a number of selected sites around the world.

[0018] Integrated Modular Construction: The ASC–Spaceplane features a revolutionary development in the structure of composite ceramic technologies, a single piece hull bottom. The fully assembled hull (or vehicle shell) is built in phases and entirely with ceramic and composite materials. The internal airframe, which is made out of a titanium/beryllium alloy or similarly lightweight and conductive material, is embedded in the ceramic thermal protection material. This makes the vehicle virtually "solid state." There are numerous advantages to this structural feature.

[0019] To begin with, the electrical conduits for the entire Spaceplane are printed or etched into the frame itself with high grade copper or other high grade electrical conducting metals. This virtually, if not entirely, eliminates the need for wires in the vehicle. All the electrical energy necessary to sustain full power is transmitted through the frame. In manufacture, the electrical conduits are sealed as thermal protection material is poured around the frame in a mold. The thermal protection material protects the conduits from heat and doubles as electrical insulating material.

[0020] In addition, the entire hull bottom of the ASC-Spaceplane is a single and unitary piece of pressed carbon-carbon composite material. The only seams in the hull bottom are for the landing gear doors.

[0021] Electrical power for the ASC-Spaceplane is provided by hydrogen fuel cells and internal auxiliary power units (APUs). The power is routed through the airframe by means of a series of integrated circuit pathways layered as part of the internal airframe structure. The outer portion of the hull is made of a proprietary ceramic thermal protection material that surrounds the airframe. The internal structure airframe has layers of radiation protection material and electrical insulation material. The embedded electrical system distributes power to ship systems in exact and precise amounts from 1000 VAC to 9 VDC, and into the microvolt range for main computer systems. Electrical servomotors for flight control surfaces are digital and direct.

[0022] The idea of an embedded airframe surrounded by a thermal protection material is a primary feature of the structure of the ASC-Spaceplane. This provides a virtually seamless surface which greatly improves the aerodynamic and thermal characteristics of the vehicle. Because the main pieces are molded, there are a number of collateral advantages. Examples include the ease with which electrical circuit pathways and fiber optic sensors can be distributed throughout the entire structure of the airframe. Another benefit is the complete distribution of essential environmental conduits. The layers of the materials used in the construction of ASC Spaceplane make it virtually a flying integrated circuit capable of hundreds of thousands of simultaneous flight functions.

[0023] Emergency Escape System (EES): The crew cabin of the ASC-Spaceplane is built primarily with molded, extremely heat resistant ceramic materials. It is in essence a self-contained, pressurized, heat shield. Several critical phases of the launch and ascent of the vehicle to orbit require protective systems designed for exact and precise points in the flight plan. At launch the vehicle is at risk of a catastrophic failure of the first stage rocket engine. To deal with the most dire contingencies, the EES of the present invention provides a virtually instantaneous “rocket away” crew cabin that employs a system of crew controlled small solid rocket motors and a parafoil parachute landing system (PPLS) which the crew can deploy. Release of the crew cabin attachment system and firing of the ejecting rockets is automatic in response to predetermined conditions which signify certain and wholesale destruction of the vehicle. In the event the crew must punch out from the launch vehicle, the bottom of the crew cabin has a secondary "heat shield section" that makes it possible for the crew cabin to eject at altitudes up to 400,000 feet. The EES system can even be deployed with the vehicle still on the launch pad.

[0024] In flight, the orbiter section of the vehicle can be separated from its docking adapter on the second stage by an emergency firing of an orbital maneuvering engine (OME). Because the orbiter section sits on top of the rocket stages it remains in the correct airstream configuration even in the case of a failure of the main rocket stages. The OME can be fired at any point in the flight ascent to separate the vehicle from the rocket stages.

[0025] At launch, the ASC-Spaceplane sits entirely above and atop the rocket stages, which keeps the leading edges of the wings free of falling debris on ascent to orbit.

[0026] ASC-Spaceplane on Orbit Operations Rendezvous and Dock Operations: The ASC-Spaceplane is designed specifically for "on orbit" operations. It is an independent mission capable spacecraft. It is also capable of interfacing with a variety of other space vehicles, such as the International Space Station and the Russian "Progress" spacecraft. The docking adapter employed in the ASC-Spaceplane makes the internal airlock interface connection between vehicles. The design also makes provisions for future use of an orbital transfer vehicle.

[0027] A solar panel array can be deployed once the vehicle reaches a stable orbit. It is capable of producing 25 Kilowatts of electrical energy in a 24 hour period. (The amount of energy consumed by the average American household for a day) The solar power array manufactures more than enough energy to maintain all spacecraft systems at full power.

[0028] The inventive vehicle is designed to handle a crew of two and six passengers in a shirt sleeve environment. It is anticipated that it will be able to take 110 lbs (approx. 50kg) cargo per person into orbit. Current design specifications show that it has a maximum takeoff weight of approximately 75,452 lbs (34,224 kg), a wing span 39.5 ft (12 m) and a length of 68 ft (20.7 m).

[0029] Flight Profile: The Spaceplane is designed for launch from any launch facility capable of hosting a two-stage liquid rocket engine for a mach 25 ascent to earth orbit. The vehicle will rendezvous and dock with an orbiting space station using a host interface single person airlock universal docking adapter with atmosphere and power connections. After undocking from the space station, the Spaceplane will return to Earth using a power-on hypersonic glider re-entry and descent, and will land at any airfield with runways approved for Boeing 747 landings. If necessary, it may effect an emergency survivable abort and rescue at any point in the mission independently for a duration of ten days; dependently for a duration of 21 days with host-provided power. It includes internal life support and orbital stabilization capabilities and has all electrical control surfaces.

[0030] Accordingly, it is a first and primary object of the present invention to provide a novel reusable launch, orbital, and re-entry vehicle (LOR) for use in an ongoing commercial and/or governmental space transportation program or space transportation system (STS).

[0031] It is another object of the present invention to provide a reusable LOR that is capable of landing at any 747-capable airport.

[0032] Yet another object of the present invention is to provide a reusable LOR that has a universal docking adapter capable of interfacing with a variety of orbiting space stations and other orbiting space vehicles.

[0033] Still another object of the present invention is to provide a reusable LOR having a hull fabricated entirely from ceramic and composite materials.

[0034] It is a further object of the present invention to provide a reusable LOR having a lightweight alloy airframe embedded in thermal protection material.

[0035] A still further object of the present invention is to provide a reusable LOR in which all or nearly all wires are eliminated from the vehicle.

[0036] Yet another object is to provide a reusable LOR having a belly or bottom fabricated from a one-piece carbon-carbon composite, so as to eliminate all seams in the belly panel other than the landing gear doors.

[0037] Another object of the present invention is to provide a reusable LOR having a rocket-away crew cabin that will detach, jettison, and rapidly separate from the vehicle before destruction by a catastrophic event.

[0038] A still further object of the present invention is to provide a reusable LOR having all digital fly-by-wire controls and all electrical control surfaces.

[0039] There has thus been broadly outlined the more important features of the invention in order that the detailed description that follows may be better understood, and in order that the present contribution to the art may be better appreciated. Additional objects, advantages and novel features of the invention will be set forth in part in the description as follows, and in part will become apparent to those skilled in the art upon examination of the following. Furthermore, such objects, advantages and features may be learned by practice of the invention, or may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

[0040] Still other objects and advantages of the present invention will become readily apparent to those skilled in this art from the following detailed description, which shows and describes only the preferred embodiments of the invention, simply by way of illustration of the best mode now contemplated of carrying out the invention. As will be realized, the invention is capable of modification in various obvious respects without departing from the invention. Accordingly, the drawings and description of the preferred embodiment are to be regarded as illustrative in nature, and not as restrictive.

Brief Description of the Drawings

[0041] Fig. 1 is a perspective view of the reusable space launch, orbital, and re-entry vehicle of the present invention;

[0042] Fig. 2A is a side view in elevation thereof;

[0043] FIG. 2B is a rear view in elevation thereof, particularly showing the bulkhead;

[0044] Fig. 3 is a side view in elevation showing the modular rocket-away crew cabin detaching from the crew cabin cut out;

[0045] Fig. 4 is a bottom view showing the lowest layer of the molded thermal protection system and integrated modular construction of the inventive space plane;

[0046] Fig. 5 is an exploded schematic side view in elevation showing various layers of the molded modular construction of the inventive space vehicle;

[0047] Fig. 6 is a top plan view showing the second primary component of the integrated modular construction and the molded thermal protection system of the present invention, namely the internal airframe and embedded circuit pathway layers;

[0048] Fig. 7 is a top plan view showing the integration of the internal component systems, including the secondary flight deck, cryonic fuel tanks, rocket engine, and aft thruster array;

[0049] Fig. 8A is a side view in elevation of the abort-survivable crew cabin;

[0050] Fig. 8B is a top plan view of the crew cabin;

[0051] Fig. 8C is a front view in elevation thereof (i.e., viewed from the forward bulkhead);

[0052] Fig. 8D is a rear view in elevation thereof (i.e., viewed from the aft bulkhead);

[0053] Fig. 8E is a top plan view of the top molding TPS layer for the crew cabin;

[0054] Fig. 9 is a detailed side view in elevation showing the attachment structures connecting the crew cabin to the vehicle frame, and also showing the structural and operational elements of the emergency escape system;

[0055] Fig. 10 is a top plan view showing the poured fused silica top moldings of the integrated modular construction and thermal protection system; and

[0056] Fig. 11 is a schematic side view in elevation showing the inventive reusable space launch, orbital, and re-entry vehicle of the present invention mounted atop a Titan IV commercial launch vehicle in preparation for launch.

Best Mode for Carrying Out the Invention

[0057] Referring first to Figs. 1 through 2B, wherein like reference numerals refer to like components in the various views, there is shown a novel vehicle for use as a launch, LEO/GEO orbital, and re-entry vehicle in a space transportation system. After full assembly, the inventive vehicle, denominated generally as **100** herein, comprises a main body fuselage **102**, a nose section **104**, a crew cabin portion **106**, a pair of wings **108** located generally aft in the main body. Each of the wings have elevons **111**, flaps **112**, wing tip fins **113**, and vertical stabilizers **114**. An orbital maneuvering engine **116** is disposed aft in the main body, and includes aft thrusters rear **118**, an aft thruster **119**, aft thrusters side **120**, and exhaust ports **121**.

[0058] Next, the vehicle includes a forward thruster array **122**, a windscreen **124**, a fuel tank door **126**, an airlock door **128** having an airlock door window **130**, space access doors **132**, a crew access door **134** having a crew access door window **136**, an emergency parachute system **138** disposed in the crew cabin portion, and a center horizontal stabilizer **140**.

[0059] The landing gear system includes aft main landing gear doors **142**, forward landing gear doors **144**, and corresponding aft and forward landing gear assemblies **146**, **148**, respectively.

[0060] As seen in Fig. 3, the Spaceplane of the present invention includes a break-away or rocket-away crew cabin that is selectively and detachably affixed to the other body portions of the vehicle. This feature will be described in detail in connection with the discussion of Figures 8 and 9.

[0061] The inventive vehicle comprises four principal portions: A hull bottom, which is the vehicle's first thermal protection system (TPS) layer; a titanium/beryllium airframe with embedded electronic circuitry and circuit pathways etched into and/or microbonded to the airframe itself; an internal component system module; and a crew cabin module.

[0062] Referring to Figs. 4 and 5, there is shown the first, or lowest portion **150** of the integrated and molded vehicle thermal protection system (TPS) of the present invention. This first TPS portion comprises the hull bottom and is a single, unitary piece of pressed or coined carbon-carbon mixed with a poured fused silica material. The first TPS (hull bottom) portion includes a bottom surface which covers the entire belly **152** of the vehicle, a nose portion **154** which extends upwardly to comprise an upper front portion of the vehicle nose section, a forward wheel bay cut out **156**, aft wheel bay cut outs **158**, lower wing portions **160** integral with the fuselage belly, and a horizontal stabilizer **140**. Because the hull bottom portion is a unified and monolithic structure, all but landing gear bay and bay door seams are eliminated from the surfaces of the vehicle that will be most subjected to high temperatures and pressures during re-entry procedures.

[0063] In production, the material of the hull bottom is pressed between engraved mold plates, sealed, and put under high pressure and heat. The resulting workpiece is very smooth and highly heat resistant. Once out of the mold, the first TPS portion can be further shaped by suitable cutting tools, such as COsub.2 lasers.

[0064] Under high temperatures the exposed ceramic materials provide considerable thermal insulation and respond favorably to high kinetic heating and thermal shock, as well as dissipating and redistributing heat effectively, and resisting erosion and ablation. The smooth surface complements and compounds the material advantages of the selected mold material by providing heat reduction and improved surfaces for flight control.

[0065] Referring now to Figs. 5 and 6, it will be seen that a second principal element of the inventive Spaceplane is an internal titanium/beryllium airframe **200** with embedded electrical circuit pathways **202** etched into and/or microbonded to the airframe. A honeycombed radiation shielding layer **204** is laid over and welded to the airframe, followed by a top, poured fused silica layer **206**. This layering creates a large scale solid state electrical system in which all of the electrical conduits are printed or etched into the airframe with high grade electrical conducting metals. The electrical conduits are sealed with thermal protection material poured around the frame in a mold. At any point or place in the airframe structure where connections will be needed for coupling to the internal vehicle component systems module and the crew cabin module, suitable exposed connectors are provided.

[0066] In manufacture, once the alloy airframe is connected to the hull bottom, the airframe and the carbon-carbon hull bottom are placed into a large injection mold. The mold is injected with fused silica fibers in a semi-liquid state at 600 degrees F. After the injection molded piece is finished, the entire hull is heated to 5000 degrees F in a large ceramic kiln. The result of this process is a spacecraft shell that has a smooth aerodynamic surface. When the internal system module and the crew cabin modules are attached, each having thermal protection system top surfaces, the result is a space vehicle built from only four major pieces, and which can withstand 3750 degrees F during the re-entry phase of the flight, which typically lasts between 12 to 18 minutes of extreme thermal exposure to the vehicle.

[0067] Referring back to Fig. 5, after connection of the hull bottom and the alloy airframe, the remainder of the vehicle is systematically mated and electronically welded to the now unitary principal two layers. The remaining elements of the integrated modular system include the modular integrated internal component systems **300**, and the modular selectively detachable rocket-away crew cabin **400**.

[0068] Referring next to Fig. 7, the internal component system module **300** is next physically connected and electrically coupled to the electronic circuits **202** of the embedded airframe **200** and, where appropriate, physically connected to the hull bottom **150**. This module includes the secondary flight deck **302**, the airlock and universal docking adapter (UDA) **304**, the vehicle power plant and propellant system, preferably in the form of a liquid rocket engine **306**, aft thruster fuel canisters **308**, hydrogen fuel cells **310** (for supplying power to the electronic circuit layer), and a radiation and electromagnetic shielding layer **312**. At this point in assembly and production, a crew cabin cutout portion **314** remains.

[0069] Referring to Fig. 10, the internal component system module has a molded top section **316**, which includes a space access door cutout **318**, a top wing surface molding **320** and top TPS surfaces for the control surfaces on the wings **322**, an airlock access door cutout **324**, a parachute recovery system cutout **326**, a fuel access door cutout **328**, and an aft thruster array cutout **330**.

[0070] Referring next to Figs. 8A-D and Fig. 9, the modular "rocket-away" crew cabin **400** is next installed. It comprises a crew cabin pressure vessel or pressurized cabin shell **402**, a secondary carbon-carbon heat shield surface **404**, which extends from the floor through the forward bulkhead, crew seating **406**, a windscreen **408**, an aft crew access door **410**, a top crew access door **412**, an environmental processor **414**, a forward electronics compartment **416**, and flight controls **418**. All of the environmental and flight control components are electronically connected to the embedded electronic circuitry in the airframe through one or more module connectors.

[0071] Referring now to Fig. 8E and Fig. 10, the top molded thermal protection layer of the TPS system for the crew cabin includes a molded shell **420** having a windscreen cutout **422**, a crew access door cut out **424**, and an emergency parachute compartment cover **426**.

[0072] The crew compartment module is connected to the primary layers using a combination of mechanical latches **428** and electromagnetic seals **430**. When electrical power is provided to the airframe, the opposing surfaces **432**, **434**, of the airframe and the crew cabin are polarized to one another and form a complete and robust airtight electromagnetic seal which supplements the coupling force provided by the mechanical latches. In an emergency event, the polarity of the airframe is reversed so as to set up strong magnetic repulsion between the crew cabin and the airframe, the mechanical latches are released, and a series of solid rocket motors **436** are ignited. This provides effectively instantaneous detachment, strong jettison, and rapid separation of the crew cabin from the remainder of the vehicle.

[0073] Referring now to Fig. 10, the internal component system module and the crew cabin module are each provided with a top molding layer of poured fused silica, which completes the TPS of the Spaceplane. The later molding is earlier described in connection with Fig. 8E. It will also be seen that the first TPS portion (the carbon-carbon bottom hull section) includes a nose portion **154** having a cut out **123** for the forward thruster array **122**.

[0074] Fig. 11 shows the inventive Spaceplane **100** disposed atop a Titan IV Commercial Launch Vehicle CLV **500** and situated alongside the launch tower **520** at the launch pad **504** prior to tower roll back. While the top crew access door **412** is shown at the end of a tower loading/unloading platform **506**, effectively all of the preflight preparation of the CLV can be completed without the crew cabin connected to the LOR or to the launch vehicle. It may be preferable to situate the crew in the crew cabin in a horizontal orientation and insert and connect the crew cabin at the last possible minute. At that time, the electrical connections can be made, the mechanical latches fastened and electromagnetic seals activated, and final preflight checks completed. This will minimize crew anxiety and discomfort

[0075] Having fully described several embodiments of the present invention, many other equivalents and alternative embodiments will be apparent to those skilled in the art. These and other equivalents and alternatives are intended to be included within the scope of the present invention.

CLAIMS

What is claimed as invention is:

1. A reusable space vehicle for launch, orbital, and re-entry operations in a space transportation system program, comprising:

a hull, including a molded bottom hull portion and an airframe affixed to said bottom hull portion and having embedded electronic circuits for electrical systems in said vehicle;

an internal component system module physically and electronically coupled to said airframe;

aerodynamic lifting wings connected to said hull;

a power plant and propellant system disposed in said internal component system module; and

a selectively detachable crew cabin physically attached to said hull and electronically connected to said electronic circuits.

2. The space vehicle of claim 1, wherein said hull bottom is fabricated from carbon-carbon.

3. The space vehicle of claim 1, wherein said hull bottom is a single, unitary piece of molded material.

4. The space vehicle of claim 1, wherein said airframe and said hull bottom are jointly covered by a layer of carbon-carbon material mixed with poured fused silica fibers.

5. The space vehicle of claim 1, wherein said hull includes a crew cabin cutout for selection insertion and connection of said crew cabin with said hull.

6. The space vehicle of claim 5, further including a crew cabin propellant and maneuvering system operatively connected to said crew cabin.

7. The space vehicle of claim 1, wherein said wings have bottom portions integral with said hull.

8. The space vehicle of claim 1, wherein said airframe is fabricated from a metal alloy comprising titanium and beryllium.

9. The space vehicle of claim 1, further including a radiation shielding layer welded to said airframe.

10. The space vehicle of claim 1, wherein said internal component system module includes a secondary flight deck, an airlock and docking adapter, said vehicle power plant and propellant system, thruster fuel canisters, a vehicle electrical power supply, and a radiation and electromagnetic shielding layer.

11. The space vehicle of claim 10, wherein said internal component system module includes a molded thermal protection system top.

12. The space vehicle of claim 1, wherein said crew cabin is a pressure vessel and includes a secondary carbon-carbon heat shield surface, crew seating, a windscreen, an aft crew access door, and flight controls.

13. The space vehicle of claim 12, further including mechanical latches disposed on said hull, at least one hull electromagnet disposed on said hull, at least one crew cabin electromagnet disposed on said crew cabin, and wherein said crew cabin is attached to said hull with said mechanical latches and further by electromagnetic seals formed when said hull electromagnets and said crew cabin electromagnets are energized.

14. The space vehicle of claim 13, wherein said electromagnetic seals are formed by

providing said hull electromagnets with a polarity and said crew cabin electromagnets with the opposite polarity.

15. The space vehicle of claim 14, wherein in an emergency event, said mechanical latches are rapidly released and a strong magnetic repulsion can be created between said crew cabin electromagnets and said hull electromagnets by reversing the polarity of one or the other of the hull electromagnets and the crew cabin electromagnets.

16. The space vehicle of claim 1, wherein said crew cabin includes a propulsion system independent of said power plant and propulsion system.

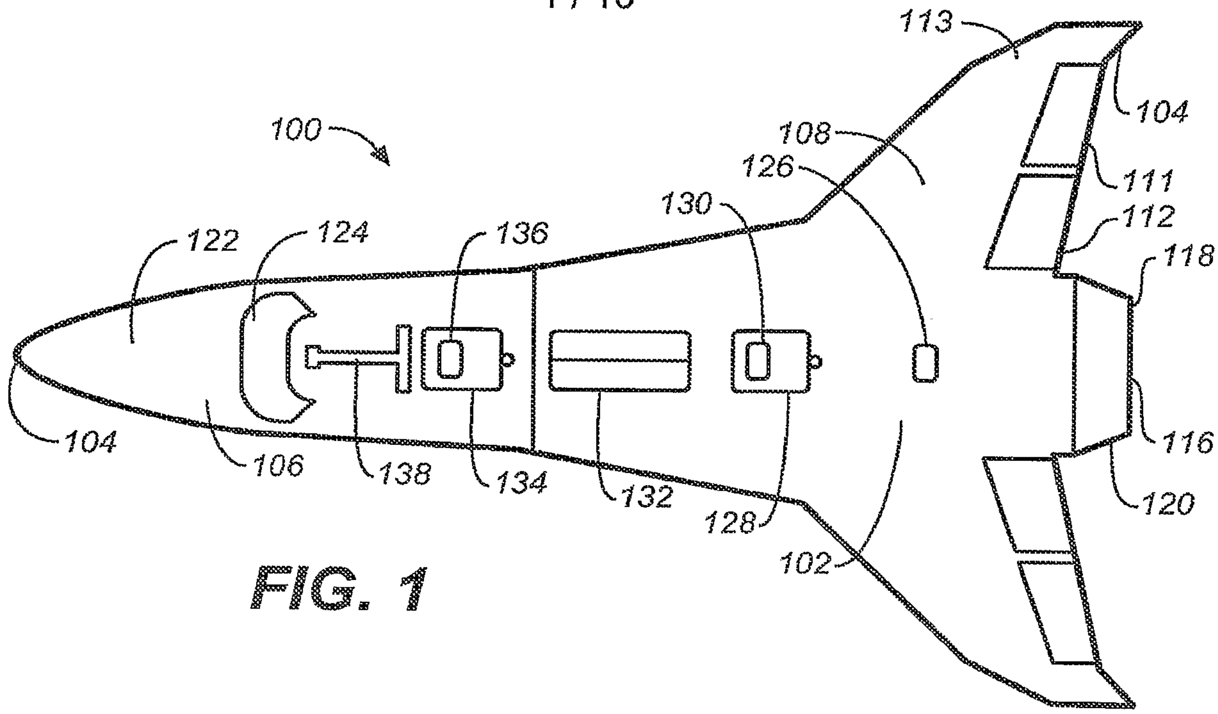


FIG. 1

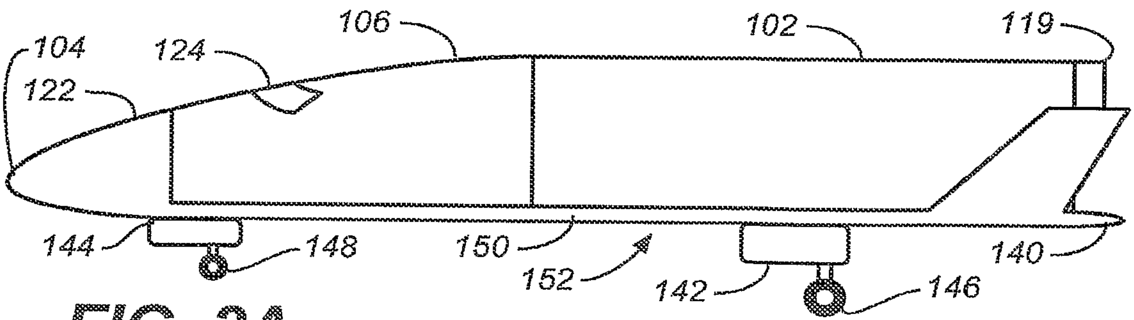


FIG. 2A

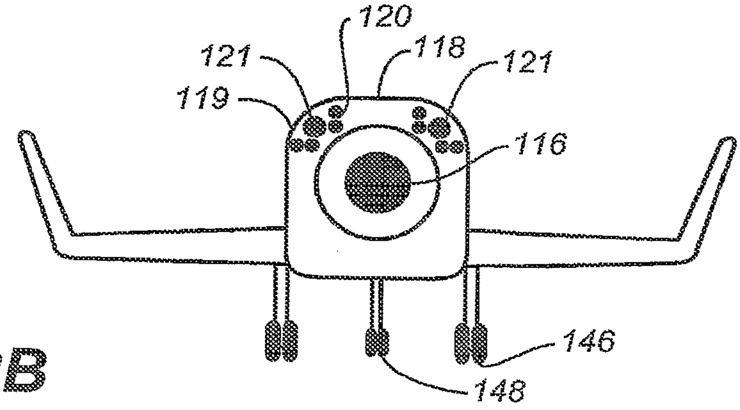


FIG. 2B

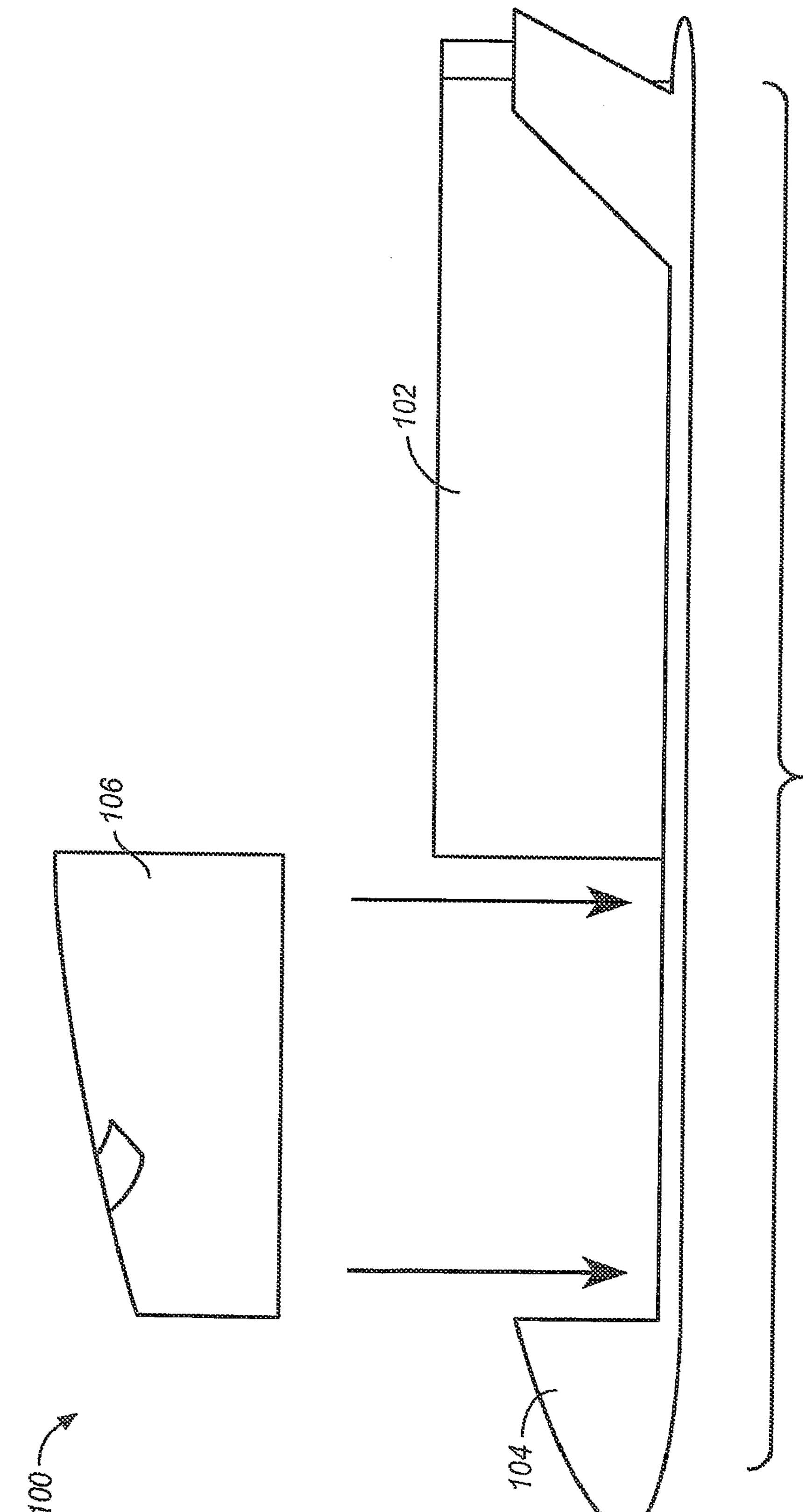
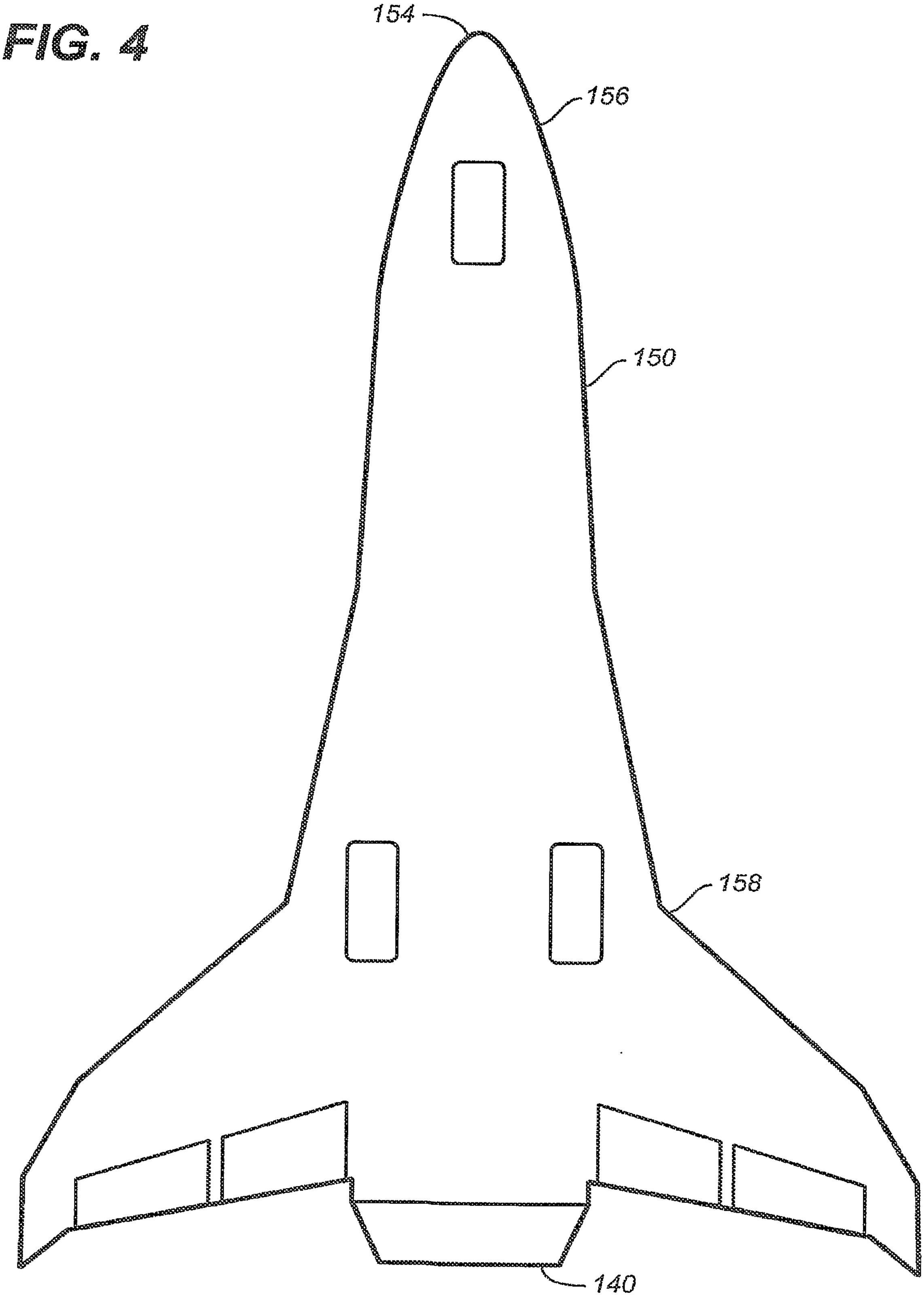


FIG. 3

FIG. 4



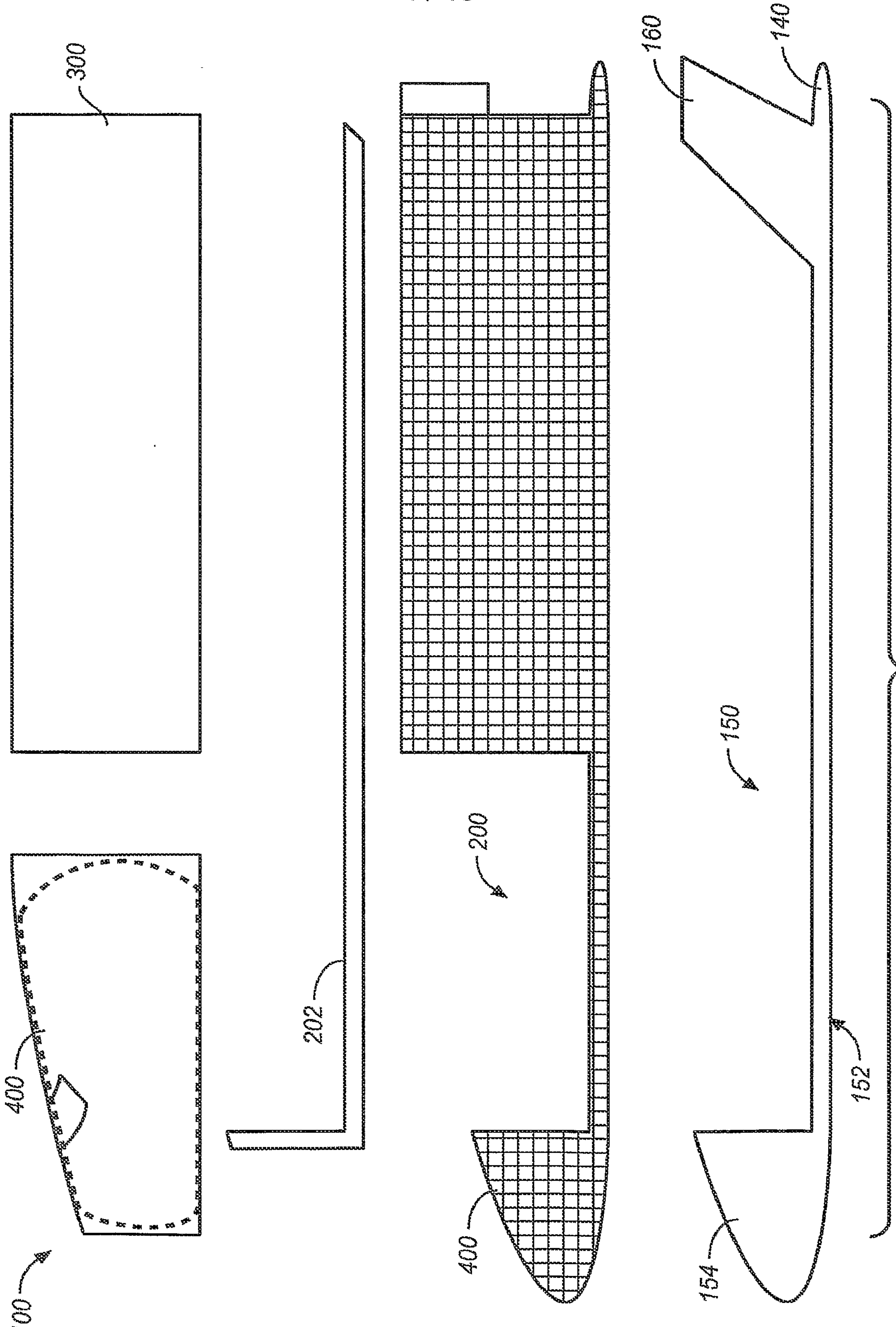


FIG. 5

FIG. 6

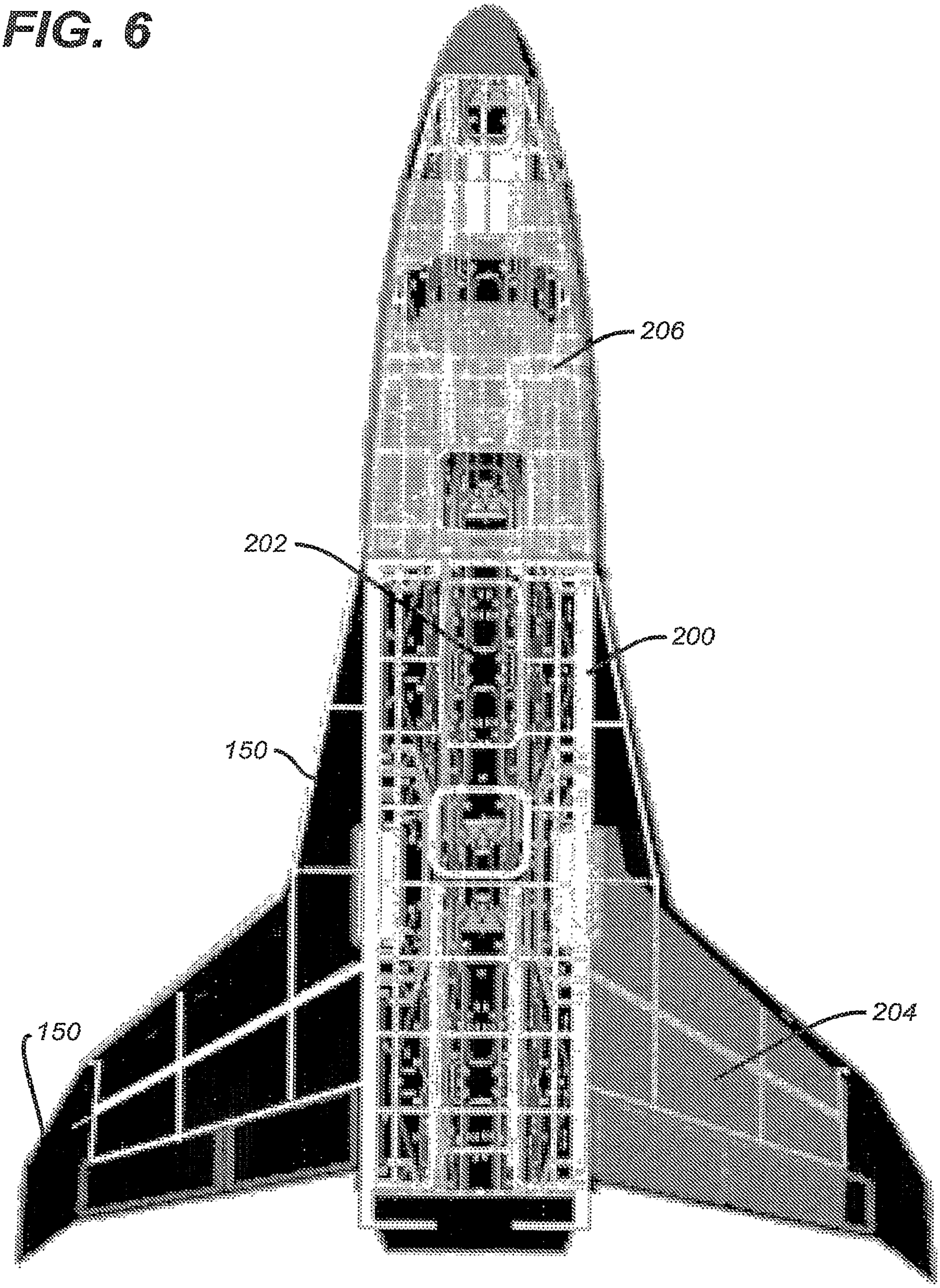
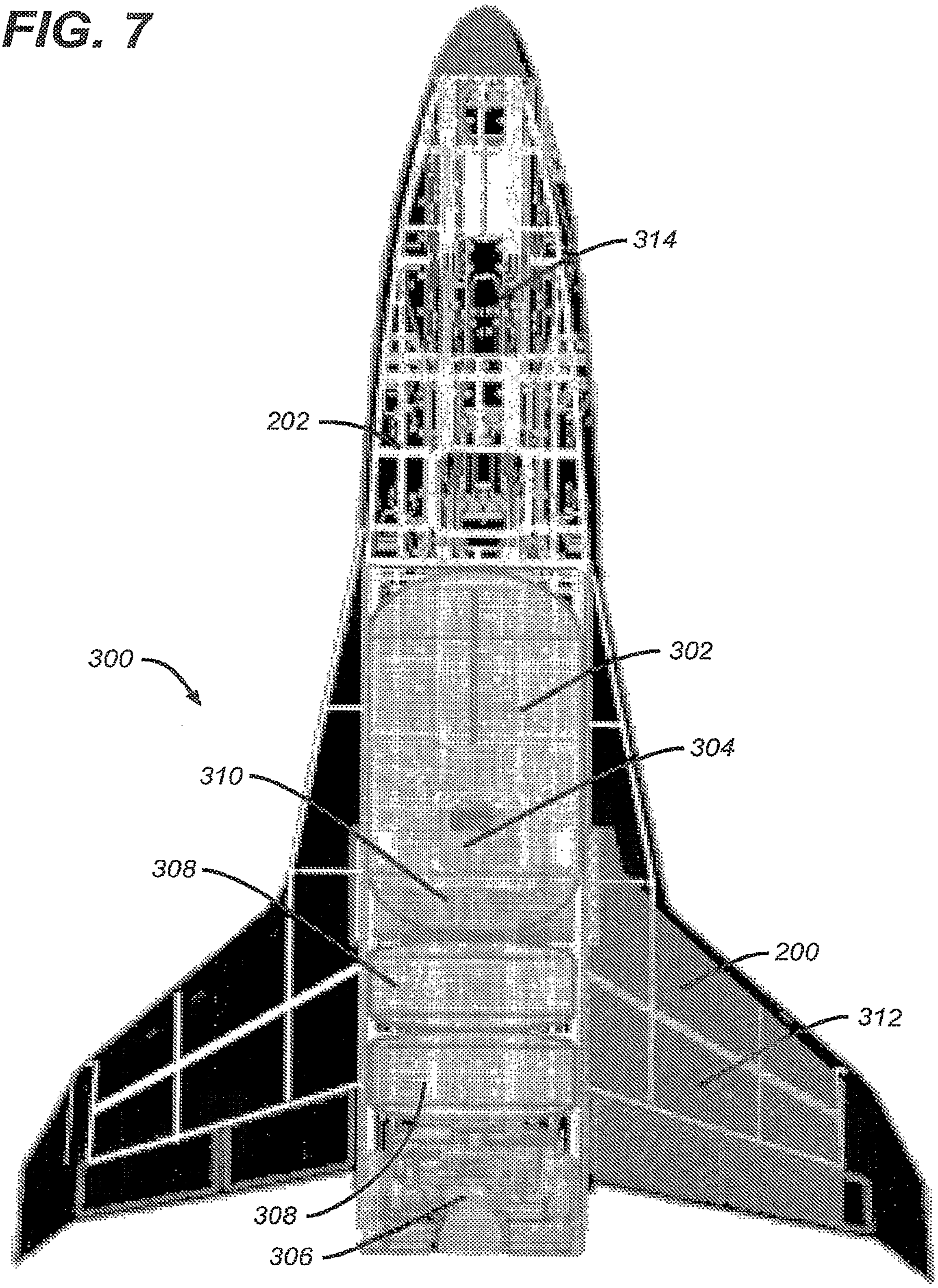


FIG. 7



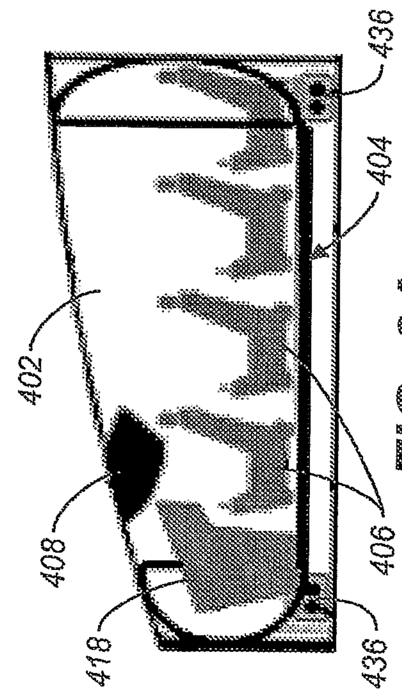


FIG. 8A

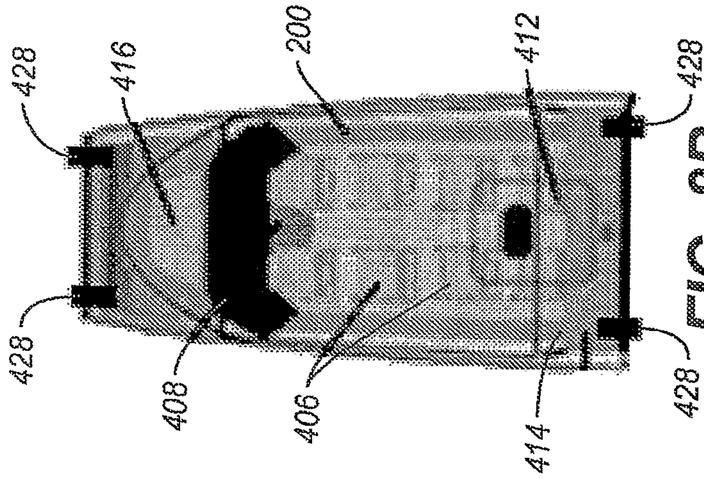


FIG. 8B

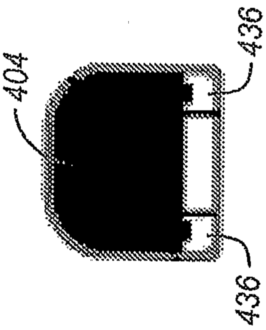


FIG. 8C

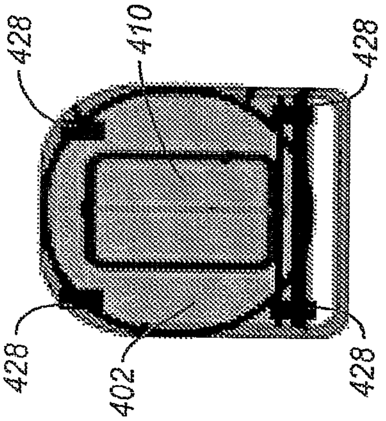


FIG. 8D

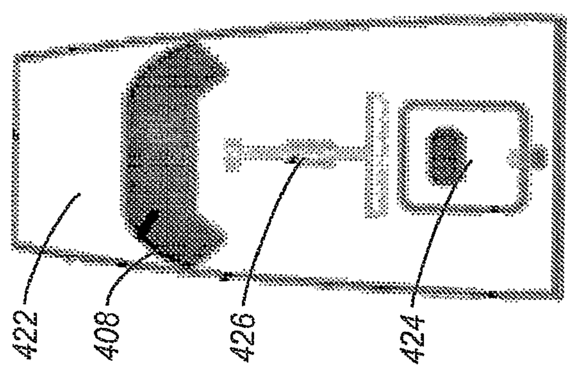


FIG. 8E

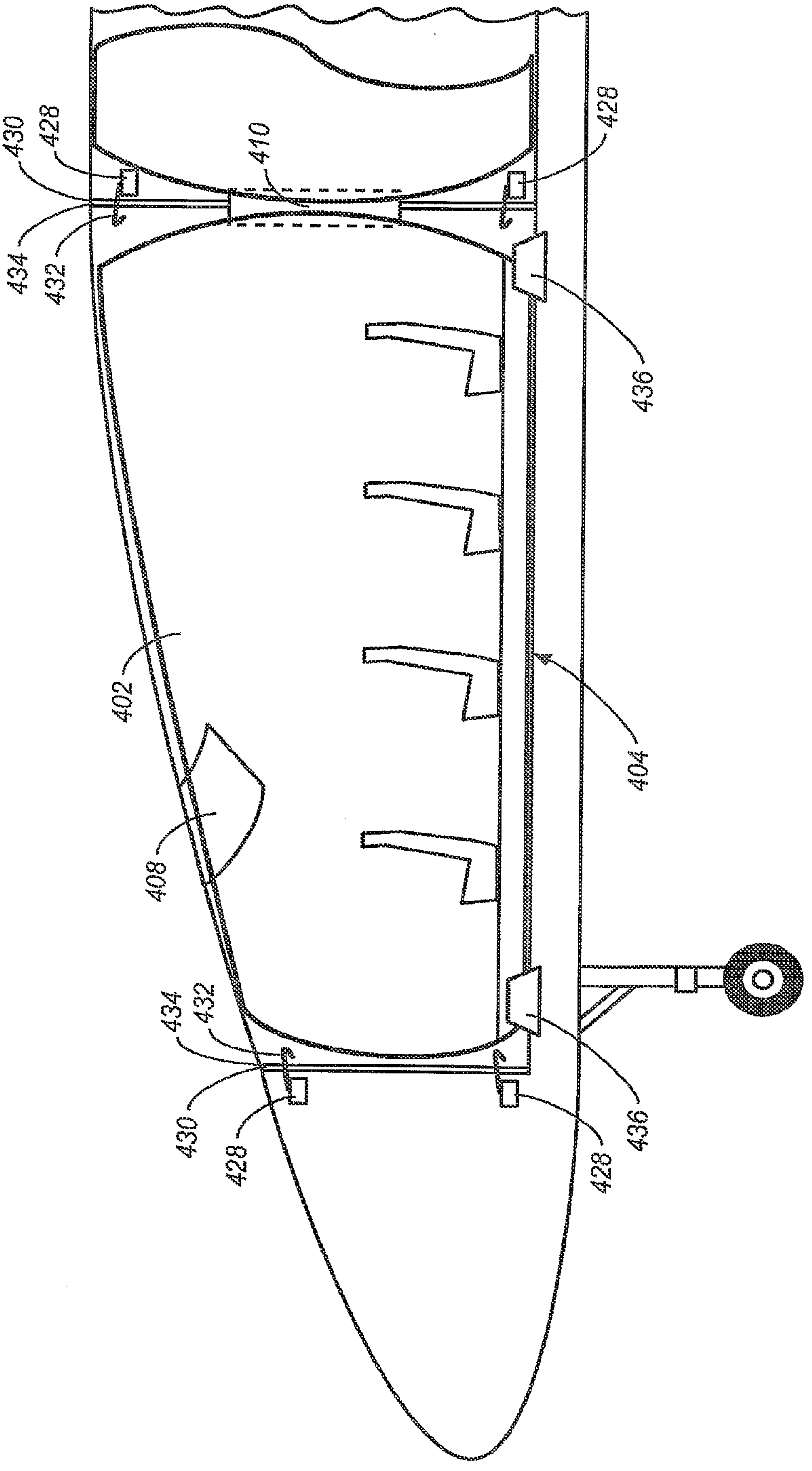


FIG. 9

FIG. 10

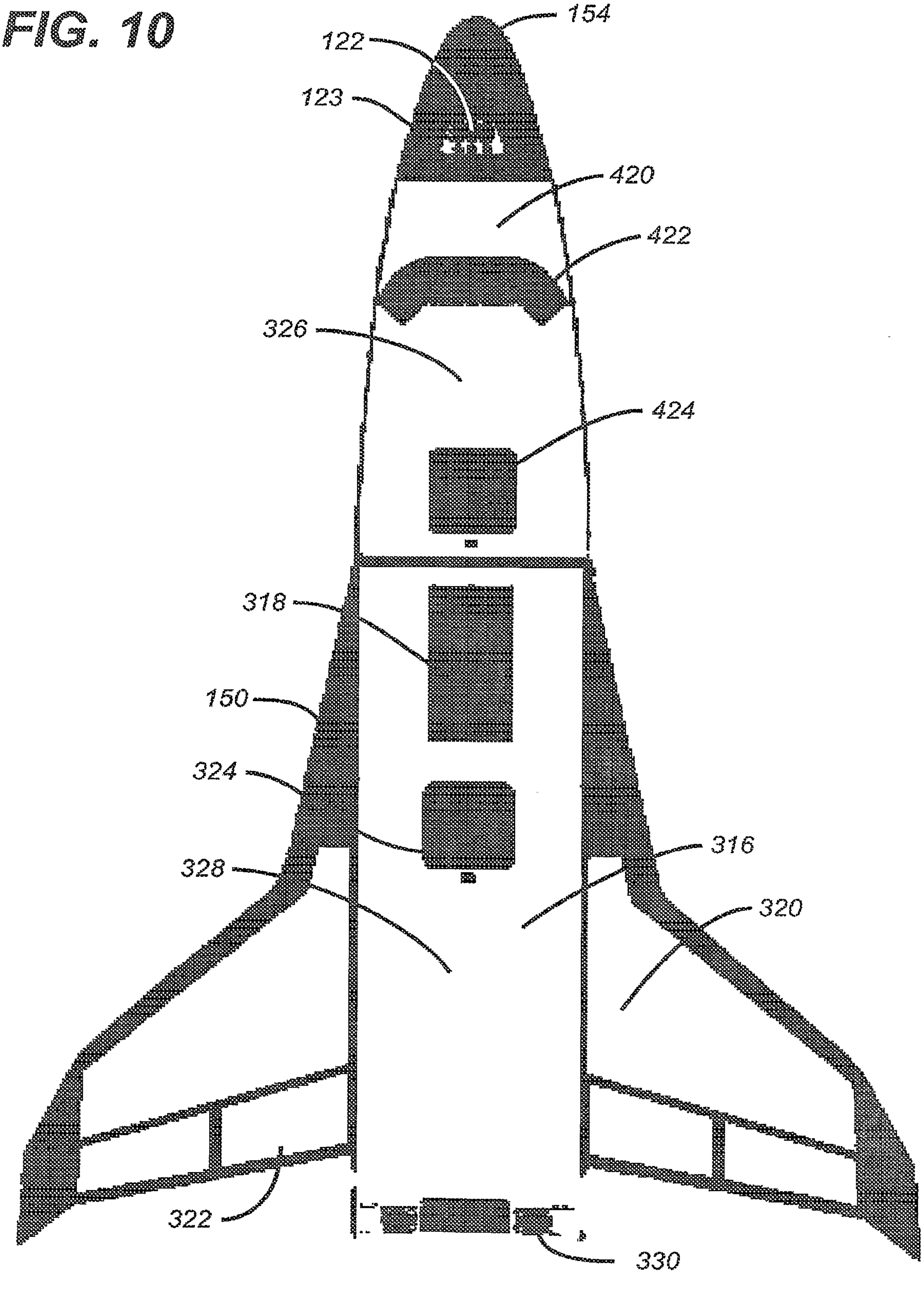


FIG. 11