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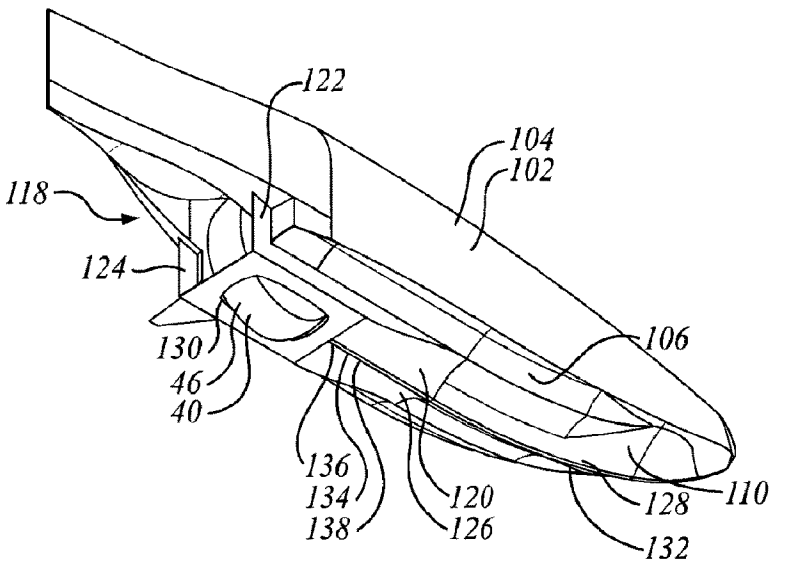

(57) Abrégé/Abstract:
A flying boat amphibious aircraft has a wheeled landing gear for landing on an airfield. The wheeled landing gear is fixed. It has a range of motion between an unloaded position and a fully loaded position. The landing gear is mounted within, and extends partially downwardly proud of, a movable housing that defines a water-engaging surface forwardly and laterally of the landing gear. The landing gear housing and the landing gear move together. The aircraft has a fuselage having a water-riding hull having a bow and a stern. The hull has laterally outboard sponsons to which respective landing gear are mounted. The landing gear has a deflector that extends forwardly of the wheel. The wheel and the deflector are mounted to move together, with the wheel protruding partially downwardly proud of the deflector.

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AIRCRAFT LANDING GEAR AND METHOD

Field of the Invention

This invention relates to the field of amphibious aircraft and to landing gear for aircraft.

Background

Amphibious aircraft are designed to land either on water or on land. Amphibious aircraft may typically be of two types, namely those with a pair of pontoons; and true flying boats with a water-tight hull. For fixed-wing aircraft, whether using skis or a hull, there will be a forward, or leading, direction, and a rearward or trailing direction.

In either instance it is possible to land, or to attempt to land, a fixed wing amphibious aircraft with the landing gear in an inappropriate configuration. That is, it is possible to make a landing on terrain with the wheeled landing gear retracted; and it is possible to make a landing on water with the wheeled landing gear extended. One cause of accidents in amphibious aircraft is landing in water with the wheels down. A water landing with wheeled gear extended may be catastrophic: as the gear descends into the water, it may tend to function as an oar or paddle that generates a substantial overturning moment on the aircraft, such as may tend to flip the aircraft over on its nose (if the gear plunges into the water symmetrically) or to spin and flip the aircraft, possibly in cartwheel fashion, if one wheel catches the water before the other. In either case the result may be very significant damage or personal injury, or both.

Alternatively, when the aircraft lands on terrain with the wheeled landing gear retracted, the effect may be that of a belly landing, with the possibility of doing significant damage to the aircraft hull (or pontoons). Damage may similarly occur if one or another wheel of the landing gear extends, while one or more other wheels remain retracted. As amphibious aircraft may, by their nature, fly to destinations that may have non-optimal field conditions, retrieving a damaged aircraft after an unintentional gear-up landing may itself become an undesired adventure.

Summary of the Invention

In an aspect of the invention there is a fixed-gear amphibian aircraft.

In another aspect of the invention there is a fixed gear amphibian aircraft having a movably mounted water-riding hull portion. In a feature of that aspect, the hull portion is resiliently mounted. In a further feature of that aspect, the water-riding hull portion is mounted

forwardly or, and as a shield for, a first wheel if the fixed gear. In another feature, the water-riding hull portion is mounted to move when the fixed gear deflects under load.

In another aspect of the invention there is an amphibian aircraft having at least a first fixed landing gear.

In a feature of that aspect of the invention, the aircraft has fixed main gear. In another feature, the aircraft has a fixed nose gear. In another feature, the aircraft has tricycle landing gear. In another feature, all of the landing gear is, or are, fixed landing gear. In another feature, the landing gear includes at least one resiliently mounted landing gear. In another feature, the aircraft has at least a first water riding member mounted to extend forwardly of the first fixed landing gear. In still another feature, the first water-riding member is movably mounted. In yet another feature, the first water-riding member is mounted to deflect when the first fixed landing gear deflects.

In another aspect of the invention, there is a landing gear for an amphibious aircraft. The landing gear includes a wheel for rolling contact with a landing surface, and a deflector. The deflector defines a water-riding hull extending predominantly forwardly of the wheel. The deflector has an accommodation in which the wheel is mounted. The wheel extends partially downwardly proud of the deflector. The wheel and the deflector are mounted to move together, with the wheel protruding partially downwardly proud of the deflector. The landing gear is a single position landing gear.

In a feature of that aspect of the invention, the wheel is resiliently mounted in a single position, and is resiliently movable in a range of motion in response to loading, the water-riding hull being correspondingly movable in co-operation with the wheel. In another feature, the range of motion has a first end of travel and a second end of travel. The first end of travel is a fully loaded position, and the second end of travel is an unloaded position. In another feature, immediately forward of the wheel the deflector has a centerline slope forwardly and upwardly of the wheel of less than 30 degrees from horizontal when the wheel is in the unloaded position. In still another feature, in the fully loaded position, immediately forward of the wheel the deflector has a centerline slope forwardly of the wheel that is tangent to horizontal.

In another feature, the deflector forms one leg of a four-bar linkage, and the wheel is carried in a seat defining at least one other leg of that four-bar linkage. In still another feature the wheel has a foremost exposed portion and at the foremost exposed portion of the wheel a tangent

to the wheel, when seen in side view has an angle of less than 45 degrees of arc from horizontal. In yet another feature the deflector has an opening formed therein, and the wheel protrudes through the opening. In another feature, the opening has a first edge portion running along a first sidewall of the wheel, and an opposed second edge portion running along a second sidewall of the wheel. In still another feature, the deflector has a first side portion, a second side portion, and a keel portion therebetween, the wheel being mounted between the first side portion and the second side portion. In another feature, the deflector extends at least three wheel diameters forward of the wheel. In yet another feature, immediately forward of the wheel the deflector has a centerline slope forwardly and upwardly of the wheel of less than 20 degrees from horizontal. In still another feature, the deflector has a sacrificial spine. In a further feature, the sacrificial spine is exposed and foremost, whereby in a gear-up landing the sacrificial spine is closer to the ground than any other non-wheel structure.

In another aspect of the invention, there is an amphibious aircraft having a wheeled landing gear for landing on a landing field. The wheeled landing gear is a fixed gear having a range of motion between an unloaded position and a fully loaded position. The landing gear is mounted within, and extends partially downwardly proud of, a movable landing gear housing, or housings, that define water-engaging surfaces forwardly and laterally of the landing gear and, when the landing gear moves within the range of motion, the landing gear housings and the landing gear move together, with the landing gear extending partially downwardly proud thereof.

In a feature of that aspect, the landing gear is a tricycle landing gear. In another feature, one of the landing gear wheels is a steerable nose gear. In a further feature, as installed on the amphibious aircraft the landing gear housing defines one bar of a four bar linkage. In another feature, the shell has a keel extending along the leading portion thereof. In another feature, the keel is a sacrificial wear member. In a further additional feature, the landing gear housing, or shell, has an external surface defining an external surface of the amphibious aircraft during both flight and water borne operation. In still another feature, the shell has at least one hydrofoil member mounted thereto.

It may be understood that the various aspects and features may be mixed and matched as may be appropriate. It may also be understood that the foregoing is not intended to be an exhaustive listing of aspects and features of the invention. These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations of a number of examples.

Brief Description of the Figures

The description is accompanied by a set of illustrative Figures in which:

Figure **1** is an isometric, general arrangement view of a portion of an amphibious aircraft shown in intermittent dashed line, with landing gear nose wheel and main gear housing assemblies shown in dashed lines, and landing gear transmission assembly members shown in solid lines for the purpose of establishing the general spatial arrangement of the various components of the aircraft;

Figure **2a** shows a side, or elevation, view of the amphibious aircraft portion of Figure **1**, with wheeled landing gear in the up or retracted position or condition;

Figure **2b** shows a side, or elevation, view of the amphibious aircraft portion of Figure **1**, with wheeled landing gear in the down or extended position or condition;

Figure **3a** is an isometric, general arrangement view of an enlarged detail of a steerable nose gear of the aircraft of Figure **1**;

Figure **3b** is a side, or elevation, view of the steerable nose gear of Figure **3a** in the retracted position;

Figure **4a** is an isometric, general arrangement view of an enlarged detail of the left main gear of the aircraft of Figure **1**;

Figure **4b** is a side, or elevation, view of the left main gear of Figure **4a** in the retracted position;

Figure **5a** shows an isometric, view of a main landing gear housing assembly of the aircraft of Figure **1** in a retracted position or condition seen from inboard, rearward and below;

Figure **5b** an isometric view of the landing gear housing assembly of Figure **5a** from outboard, rearward and below;

Figure **5c** shows a trailing end view of the landing gear housing assembly of Figure **5a** looking forward;

Figure **5d** is an outboard side view of the landing gear housing assembly of Figure **5a**;

Figure **5e** is an outboard side view of the landing gear housing assembly of Figure **5a**;

Figure **6a** shows an isometric, view of a main landing gear housing assembly of the aircraft of Figure **1** in an extended position or condition seen from inboard, rearward and below;

Figure **6b** an isometric view of the landing gear housing assembly of Figure **6a** from outboard, rearward and below;

Figure **6c** shows a trailing end view of the landing gear housing assembly of Figure **6a** looking forward;

Figure **6d** is an outboard side view of the landing gear housing assembly of Figure **6a**;
Figure **6e** is an outboard side view of the landing gear housing assembly of Figure **6a**;
Figure **7a** shows a perspective view of a steerable nose wheel landing gear housing assembly of the aircraft of Figure **1** in a retracted position as seen from one side, in front, and below;
Figure **7b** is a side view of the steerable nose wheel landing gear housing of Figure **7a**;
Figure **7c** is a front view of the nose wheel landing gear housing of Figure **7a**;
Figure **8a** shows a perspective view of a steerable nose wheel landing gear housing assembly of the aircraft of Figure **1** in a retracted position as seen from one side, in front, and below;
Figure **8b** is a side view of the steerable nose wheel landing gear housing of Figure **8a**;
Figure **8c** is a front view of the nose wheel landing gear housing of Figure **8a**;
Figure **9a** shows a simplified side view of the main landing gear of Figure **5a** in the retracted position; and
Figure **9b** shows the main landing gear of Figure **6a** in the extended position.
Figure **10a** shows an alternate embodiment to that of the aircraft of Figure **1**, with landing gear in an uncompressed position or condition;
Figure **10b** shows the aircraft of Figure **10a** with landing gear in a compressed or deflected position or condition;
Figure **11a** is a side view of the aircraft of Figure **10a**; and
Figure **11b** is a side view of the aircraft of Figure **10b**;

Detailed Description

The description that follows, and the embodiments described therein, are provided by way of illustration of an example, or examples, of particular embodiments of the principles, aspects or features of the invention. These examples are provided for the purposes of explanation, and not of limitation, of those principles and of the invention. In the description, like parts are marked throughout the specification and the drawings with the same respective reference numerals. The drawings may be taken as being to scale unless noted otherwise.

The terminology used in this specification is thought to be consistent with the customary and ordinary meanings of those terms as they would be understood by a person of ordinary skill in the aircraft industry in North America. The Applicant expressly excludes all interpretations that are inconsistent with this specification, and, in particular, expressly excludes any interpretation of the claims or the language used in this specification such as may be made in the USPTO, or in

any other Patent Office, other than those interpretations for which express support can be demonstrated in this specification or in objective evidence of record, (for example, earlier publications by persons not employed by the USPTO or any other Patent Office), demonstrating how the terms are used and understood by persons of ordinary skill in the art, or by way of expert evidence of a person or persons of at least 10 years' experience in the aircraft industry in North America or equivalent.

In terms of general orientation and directional nomenclature, for aircraft described herein the longitudinal or lengthwise direction is defined as being coincident with the fore-and-aft direction of flight of the aircraft in straight and level flight. In the case of a fixed wing aircraft, the longitudinal direction is parallel to the rolling direction of the wheeled landing gear and to the keel direction of the hull or pontoons, as may be. The leading direction, or leading edge lies toward the forward direction of travel; the rearward or trailing direction or trailing edge is oriented away from (i.e., backwards relative to) the normal direction of advance of the aircraft. Unless otherwise noted, vertical, or upward and downward, are terms that use the landing terrain (or, alternatively, undisturbed water level), as a datum. In the context of the aircraft as a whole, the terms cross-wise, lateral, spanwise, or laterally outboard, or transverse, or transversely outboard refer to a distance or orientation relative to the longitudinal centerline of the fuselage, or of the landing gear nacelles or sponsons or pontoons, as may be. The commonly used engineering terms "proud", "flush" and "shy" may be used herein to denote items that, respectively, protrude beyond an adjacent element, are level with an adjacent element, or do not extend as far as an adjacent element, the terms corresponding conceptually to the conditions of "greater than", "equal to" and "less than".

The directions correspond generally to a Cartesian frame of reference in which the x-direction is longitudinal, the y-direction is lateral, and the z-direction is vertical. Pitching motion is angular motion of the aircraft about a horizontal axis perpendicular to the longitudinal direction. Yawing is angular motion about a vertical axis. Roll is angular motion about the longitudinal axis. Given that the aircraft described herein may tend to have a longitudinal axis of symmetry, a description of one half of the aircraft may generally also be intended to describe the other half as well, allowing for differences between right hand and left hand parts. Also, it may be taken as a default that the structure of the aircraft is of aluminum fabrication except as otherwise shown in the illustrations or indicated in the text, although reinforced composite structure may also be employed. Other materials, such as stainless steel, or wood, might be also be used for some components.

In this discussion it may by understood that persons of ordinary skill are familiar with the aircraft construction and maintenance in North America, and may include aircraft maintenance engineers having knowledge of US Department of Transportation, Federal Aviation Administration publication EA-AC 43.13 – 1A & 2A "Acceptable Methods, Techniques and Practices, Aircraft Inspection and Repair", or any successor publication thereof, as updated at the date of priority filing of this specification. This specification is to be interpreted in a manner consistent with that publication.

The discussion herein pertains to amphibious aircraft. The terminology "amphibious aircraft" is understood to be, and is intended to be understood as being, interchangeable with the terms "amphibian aircraft" or simply "amphibian". An amphibious aircraft, or amphibian, by definition is an aircraft that is capable of landing on terrain in one mode, and also capable of landing on water in another mode.

There is also discussion herein, and distinction between "fixed gear" and retractable landing gear. For the purposes of this discussion, retractable landing gear is landing gear whose position is selectable between an extended or deployed, or "down" position, and a raised or retracted, or "up" position. In many aircraft, when the landing gear are "up" or retracted, the wheels of the lading gear are concealed within a faired housing or cowling, such as a nacelle or a hull blister. However, it is not necessary that the wheels be fully hidden. It is possible to have a retracted position in which the wheels are only partially concealed, or partially faired. In either case, the aircraft has a drive, or drive train or transmission system, or linkage or assembly that the pilot operates to select between a first position (e.g., the raised or "up" position) and a second position (e.g., the lowered, extended, or "down" position). The transmission may be a mechanical system of linkages, or an electrical system, or an hydraulic or pneumatic system, or a mixture or combination of electrical, mechanical or hydraulic elements.

In a "fixed" landing gear aircraft, there may tend not to be a landing gear drive or transmission, and the pilot is not able to select as between positions. The gear has a single mounting condition or position. While the term "fixed" may be used in the sense of a permanent mounting and lack of choice on the part of the pilot, the gear itself may nonetheless retain a degree of movement in respect of one or more degrees of freedom in the sense of tolerating deflection, as, for example, during landing on terrain. Most typically the deflection is a resilient deflection since the landing gear is sprung. The resilience may arise from the structure of the landing gear legs or struts, or from spring or spring-damper systems with which the landing gear is provided.

Figure **1** shows a portion of an aircraft, **20**. Aircraft **20** is an amphibious aircraft. Although principles, aspects, and features of the invention herein may be applied to rotary wing aircraft as may be appropriate in respect of landing gear apparatus for use in landings with non-trivial forward approach velocity, it may be taken that in the embodiment of Figure **1** aircraft **20** is a fixed-wing aircraft. Aircraft **20** may be a high-wing monoplane, with a fuselage indicated as **22** and the wing structure indicated as **24**, the join of wing structure **24** being at the top of fuselage **22**. Wing **24** extends laterally outboard to port and starboard of fuselage **22**.

Fuselage **22** of aircraft **20** may further include a lower portion **26** which may have formed on the underside thereof a hull **28** for use in water, hull **28** having a leading portion such as may be termed a bow, and a trailing portion, such as may be termed a stern, or step **30**. Hull **28** may be curved and, in the main portion thereof, may have a profile centrally downwardly and rearwardly curved to a central, longitudinally extending keel **32**. The tail **34** of aircraft **20** may extend rearwardly and generally upwardly of hull **28**.

Hull **28** may include lateral bulges **36** such as may tend to extend laterally outboard of the lower portions of fuselage **22**. Bulges **36** may also extend somewhat downwardly and may each define a sponson **38**. Sponson **38** may include, or may have mounted thereto, a main landing gear housing, or cowling, or apparatus, such as may be designated as main gear housing assembly **40**, which, may be either left hand or right hand. Although asymmetric aircraft are known, aircraft **20** may be generally symmetrical about its longitudinal centerline, such that the right hand main gear housing assembly is the mirror image of the left hand one, and the description of one is the same as the other but for their handedness. Hull **28** may also include a nose landing gear housing, or cowling, or apparatus such as may be designated as nose gear housing assembly **42**. The nose gear mounted within nose gear assembly **42** may be a steerable nose gear. The left and right hand main gear and the steerable nose gear may define a tricycle undercarriage, and, to the extent that they include respective main wheels **44** and nose wheel **46**, provide a tricycle landing gear for use on terrain, be it tarmac, hardpack, a prepared landing field, a beach, or other surface suited to wheeled motion. The landing gear may be extended, such as for a wheeled landing; or may be retracted, such as for a water-borne landing.

Referring to Figure **3a**, nose wheel **46** of assembly **42** is mounted in a clevis or yoke **52** having a central, vertically oriented pivot shaft that is pivotably mounted in a mating steering mount assembly **54**. Steering mount assembly **54** includes a pair of laterally spaced apart left and right side frames **56**, each of which may be substantially planar, the two being mutually parallel. When viewed in profile, side frames **56** have a generally four-sided shape, interrupted by a

rearwardly extending arm **58**. Side frames **56** are held in spaced relationship the rearwardly mounted box-structure of the steering head shaft mount **60**, and by a forward lateral shear web **60** mounted on, or across, the downwardly and rearwardly angled lower edge of side frames **56**.

Upper and lower linkages **62** and **64** are pivotally mounted at the upper and lower forward corners of sideframes **56**. Linkages **62** and **64** are of the same length. Each has a first end mounted to the aircraft structure, such as in the nose of the fuselage as at **66** and **68** respectively, that first mounting being a pivotal mounting having a single degree of freedom, namely pivotal motion about the **y**-axis. The second end also has pivotal mountings having axes of rotation in the **y**-direction. Since the respective first ends and second ends are spaced the same distance apart, the quadrilateral of the four bar linkage so formed (i.e., two linkages, the main aircraft fuselage structure, and sideframes **56**) defines a parallelogram such that while sideframes **56** follow the arc of the second ends (i.e., the ends distant from fixed structure) of linkages **62** and **64**, the angular orientation of sideframes **56** about the **y**-axis is constant. Thus the orientation of the **z**-axis of the steering stub shaft may tend to remain vertical. Steering yoke **52** has a laterally extending tiller or arm **70** and steering linkage **72** by which nose wheel **46** may be turned left and right, as appropriate.

The nose gear assembly, and therefore nose gear housing assembly **42** which moves with the nose gear, is driven up and down by a nose gear actuator assembly, indicated generally as **74**. Actuator assembly **74** includes a main shaft, or torque tube **76** that extends laterally across the fuselage (i.e., in the **y**-direction) between pivotal mountings mounted to the fuselage structure, such as bushings. Torque tube **76** is able to pivot in a single degree of freedom, namely angular rotation about the **y**-axis. An input arm **78** is mounted generally centrally to toque tube **76**, and may be pushed or pulled to create a moment couple driving torque tube **76** clockwise or counter-clockwise. Left and right hand output arms **80** extend forwardly and downwardly of torque tube **76** to straddle nosewheel **46**. A lateral cross-member **82** is rigidly mounted to, and across, sideframes **56**, and extends laterally from either side of the lower aft-ward corner thereof. Lateral cross-member **82** may be a shaft that is free to rotate about the **y**-axis. Drag links **84** extend between the respective ends of lateral cross-member **82** and the distal ends of output arms **80**, such that when torque tube **76** turns, the ends of arms **80** move clockwise or counter-clockwise, drawing (or pushing) on drag links **84**, thereby forcing shaft **86**, (and hence sideframes **56** and nose wheel **46**), to follow the arc of motion of links **62**, **64**. Assembly **42** may also include a return spring, or counter-weight spring, **88**, such as may tend to bias nose gear housing assembly **42** to the retracted position. When not being moved, the nose gear assembly, or actuator assembly **76**, as may be, has locks that retain the nose gear in either the up position or the down position,

with associated up-lock and down-lock indicators.

Nose gear housing assembly **42** is, not surprisingly, mounted at or near the nose of the aircraft. Nose gear housing assembly **42** may also have, or be, a nose gear shield, or deflector assembly, or shoe, which may be identified generally as nose gear deflector **90**. Deflector **90** is pivotally mounted to fuselage **22** at a pivot fitting location well forwardly of nose wheel **46**, as indicated at location **92**, and may be co-axially mounted with either first end **66** or first end **68** of linkages **62** or **64**, such that deflector **90** may follow the same arc. The axis (or respective axes) of rotation of the pivot fitting connection at location **92** (be it at **62** or **64**) runs horizontally cross-wise to the aircraft longitudinal centerline. Thus any point of nose wheel landing gear housing assembly **42** moves in an arc in a vertical plane parallel to the longitudinal centerline (and the presumed direction of forward motion) of aircraft **20** more generally. Deflector **90** may have the form of a hull or prow, or stem, or planing surface with a central ridge or stem, such as may tend to displace or ride over, water in the manner of a ski or planing hull. Although deflector **90** may have an aerodynamic or hydrodynamic form, deflector **90** is not a cosmetic cowling. It has the structural strength to support the aircraft when landing on water; it is also intended to have structural strength to support the aircraft in an unintentional gear-up landing on terrain, should the range of deflection on impact exceed the limits of deflection of nose wheel **46** alone while nose wheel **46** is in the retracted position. To that end, the longitudinal centerline of deflector **90** may have a central spine, or rib, or keel, or protector, or wear member, wear strip, such as may be in the nature of a sacrificial member or sacrificial keel **94** extending along the most exposed centerline portion thereof. In the event of a hard landing, or in the event of striking a floating object, sacrificial keel **94** may tend to contact the terrain or floating object first, and skid along or over it. To either side of sacrificial keel **94** extending obliquely rearwardly, upwardly and laterally inboard or outboard as the case may be, are first and second side portions identified as **93**. Which terminate rearwardly in substantially vertical sidewalls **95** that seat within the side edges of the well in fuselage **22** that accommodates nose wheel housing assembly **42** more generally. To the extent that sacrificial keel **94** is thereby damaged, it is intended that it may be replaced as necessary or suitable. Deflector **90** may be attached to, or suspended from, spring **88**.

As can be seen, deflector **90** extends forwardly of wheel **46** on a gentle curve that is more forwardly than upwardly, and that, at the point of intersection of the projected curve of the hull and the tangent of the profile of the tire is an oblique angle of perhaps something greater than 120 degrees. As can be seen, nose wheel **46** is mounted within nose gear housing assembly **42**, such that the bulk of wheel **46** is between the inboard and outboard sides of the housing, and the lowermost cusp or portion of wheel **46** extending through the accommodation, namely aperture

48, downwardly proud of the deflector centerline. In the case of a steerable nose-wheel, aperture **48** is of a shape (such as circular in plan view) to permit wheel **46** to turn. Nose gear housing assembly **42** has a main portion that extends forwardly of wheel **46**, but also side portions that extends alongside, and outwardly and upwardly, of the axle, and most of the sidewall of the body of wheel **46**. Thus wheel **46** is mounted within nose gear housing assembly **42**, generally toward the rearward or trailing end thereof distant from the pivot mounting at the forward or leading end of housing **42**.

In the example, the extent to which wheel **46** extends downwardly proud may by 4 – 6 inches. Expressed differently, the point of intersection of the curves may be somewhere between the 7 o`clock and 8 o`clock positions. Expressed differently again, the wheel may protrude proud of the surface a distance **S**, where **S** = **D**(1-Cos (**Theta**)), **D** being the outside diameter of wheel **46** and theta being the angle (measured from the six o`clock position of wheel **46**) at which the wheel profile intersects the deflector profile on the centerline. Theta may be in the range of perhaps 15 to 65 degrees, and, in one embodiment, may be in the range of 30 – 50 degrees. The general tangent slope at mid arc of deflector **90**, indicated as alpha, may be of the order of 15 – 40 degrees from the horizontal. In the embodiment shown, it may be 20 – 35 degrees, with the local tangent angle being closer to 15 or 20 degrees immediately forwardly of nose wheel **46**, and closer to 35 or 40 degrees in the neighbourhood of forward pivot point **68**. Expressed differently yet again, deflector **90** has a length L_{90} forwardly of the axle of nose gear wheel **46** that may be in the range of about 3 – 8 times the diameter of nose gear wheel **46**.

In general, deflector **90** provides a smooth lead-in-surface extending forwardly of wheel **46** for engaging, and riding upon, water - like a ski, or hull or slipper or shoe. In some embodiments, the surface of deflector **90** may also extend aftward of wheel **46** in a trailing edge tail. Wheel **46** extends partially downwardly proud of the profile of deflector **90**. The extent to which it stands downwardly proud may correspond to the expected deflection of the tire of wheel **46** during a normal landing, plus an allowance of extra travel, perhaps 50% of nominal normal landing load travel. In the event that aircraft **20** should land on water with the nose gear extended, nose wheel **46** can only partially immerse itself before the aftmost portion of deflector **90** also engages the water. At speeds of interest, the clock-wise counter-acting lift arising from deflector **90** planing on the water may tend to counter-act the counter-clockwise pitching moment generated by hydrodynamic drag on the exposed protruding portion of wheel **46**.

As illustrated in Figures **7a** and **8a**, the forward facing surface deflector **90** of housing assembly **42** defines a portion of the aerodynamic form, or fairing, of the nose of the aircraft in both the retracted and the extended conditions. As seen in Figure **7b**, in the retracted position

deflector **90** seats flush with the aftwardly extending keel of fuselage **22**.

In some embodiments, aircraft **20** may have hydrofoil members **96** such as may be mounted to the upstanding laterally spaced apart sidewalls **95** of housing assembly **42**. In the retracted position, hydrofoils **96** seat in accommodations **97** defined in fuselage **22**, such that hydrofoils **96** are substantially flush with the adjacent structure and form a relatively smooth, continuous streamline or continuous fairing surface as shown in Figures **7a**, **7b** and **7c**. In the extended position of the nose gear as shown in corresponding Figures **8a**, **8b** and **8c**, hydrofoil members **96** are exposed to passing water flow, and, upon contact with the water, may tend to exert a lifting force that is transmitted back through the structure to lift the nose of aircraft **20** (i.e., to give aircraft **20** a clockwise turning moment in the side view of Figure **7b** to counter-act the counter-clockwise over-turning moment such as may be generated by wheel **46** (or wheels **44** further aft, as may be). In the embodiment shown, hydrofoil members **96** are mounted abreast of wheel **46**, at a level comparable to, and in some embodiments slightly above, the axle centerline of wheel **46**.

Figure **4a** shows the landing gear transmission, identified generally as **100**. Many structural features have been omitted from this illustration for the purpose of making the landing gear components more easily visible. As with nose gear housing assembly **42**, main gear housing assembly **40** (be it port or starboard) has main gear wheel **44** installed in a landing gear housing generally indicated as **102**. Housing **102** has a stationary upper, or main, portion **104**,which is rigidly mounted to sponson **38**; and a co-operating, movable, or lower portion **106**, which may include a pivotally mounted main gear vane, or protector, deflector, or deflector assembly **110**. The pivot mounting may be at the first, or leading, end of housing **102**. Inasmuch as housing **102** may ultimately transmit the reactive force from the main gear to carry the aircraft structural load, housing **102** is structurally connected to a laterally extending spar or beam structure, indicated as **108**. Structure **108** may include an I-beam and a deep central frame assembly **98** as shown in Figure **4a**. The ends of beam-and-frame structure **98** are cantilevers, which have a measure of vertical flex, and the main gear loads are carried at the ends of the cantilevers. Main portion **104** may have an inboard wall **112**, an outboard wall **114**, and an upper wall or covering or cowling **116** all of which may be rigidly interconnected, and which may have a faired aerodynamic shape. Housing **102** is mounted to the outboard margin of sponson **38**, be it port or starboard. Sponson **38** is water tight, and the bottom wall of sponson **38** forms a portion of hull **28**. Housing **102** has a downwardly opening accommodation **118**. Accommodation **118** is generally rectangular, being much longer in the **x**-direction than wide in the transverse **y**-direction, such as may be co-operatively shaped matingly to work with the generally box-shaped main gear slipper, or shoe,

120 of lower portion **106**.

As seen in Figures **5a** to **5e**, and in Figures **6a** to **6e**, shoe **120** may have an inboard longitudinal wall **122**, an outboard longitudinal wall **124**, a bottom deflector plate **126**, joined together to form a generally U-shaped structure, with side walls **124**, **126** being generally vertical, parallel and spaced apart. Main gear wheel **44** is mounted between the inboard and outboard portions or walls of deflector shoe **120**. There may be lateral shear webs or shear frame braces **123** extending laterally therebetween forward of main gear wheel **44** to maintain walls **122** and **124** in spaced parallel relationship from each other. The forward end of shoe **120** is enclosed, as where bottom deflector plate **126** is curved forwardly and upwardly to define the forward tip of the ski or slipper, or vane, however it may be called. A pivot mount is located at the foremost tip of shoe **120**, being indicated as **128**, and is mounted in structural load spreading bushing assemblies in main portion **104**. The axis of rotation of the pivot mounting may be horizontal and cross-wise to the vertical plane of symmetry of the aircraft centerline. Bottom deflector plate **106** may be backed by reinforcements in the nature of longitudinal stringers and transverse frames suitable for maintaining its structural integrity in expected operation.

Bottom deflector plate **106** has a rearwardly located relief **107** near its trailing end to accommodate protrusion of main gear wheel **44**. As shown in Figures **5a** and **5b**, **6a** and **6b**, relief **107** may have the form of an accommodation **130** which may be a rectangular opening, or it may be a generally oval or rounded elongate opening corresponding to the shape of the tire of wheel **44**. The opening is such as to have a first edge portion forwardly of wheel **44**, and side portions running along the sidewalls of wheel **44**. Main gear wheel **44** seats, or is mounted within assembly **40** between the sidewalls thereof, with a portion, or cusp of wheel **44** protruding through relief **107**. Since wheel **44** moves and housing assembly **40** move together, wheel **44** protrudes from plate **106** in both the extended and retracted positions of the landing gear. Bottom deflector plate **106** may also have, or be formed to have, a lengthwise extending keel, **132**, which may have a replaceable sacrificial wear member or skid **134**. Skid **134** may be made of a consumable material such as stainless steel. As seen in Figure **5d** and **5e** keel **132** is gently upwardly angled, being nearly horizontal at the point at which the foremost portion of wheel **44** crosses the profile of keel **132**, and is formed forwardly curvedly with an increasing angle of slope toward the nose. As may be understood, in a normal landing, shoe **120** may tend to plane along the water. In an inadvertent gear-up landing on terrain, wheel **44** may contact the terrain first, and only to the extent that the landing is heavy will shoe **120**, and, in particular skid **134**, ride along the terrain. In an inadvertent gear-down landing on water, even as fully deployed in Figure **5e**, the clockwise overturning moment due to drag on the exposed portion of wheel **44** may

tend to be counteracted by the lift generated in planing as soon as leading portion **136** of shoe **120** immediately forward of wheel **44** begins to bear on the water surface. The protective presence of the slipper or shoe **120** forward of wheel **44** may tend to limit or counteract the overturning drag that can be developed by water drag on wheel **44**. Further, considering Figure **3a**, to the extent the nose gear deflector **90** may also engage the water, the counter-acting lifting force of deflector **90** planing on the water has a very long moment arm relative to wheel **44**.

The primary element of transmission **100** of Figure **4a** is a laterally extending shaft **140** that extends outboard to both port and starboard. At its most outboard extremity shaft **140** is connected to a co-axial outer tube **142**, which may be termed a torque tube. At its most inboard end, torque tube **142** terminates at a lever arm **144** that has a hollow center to permit the passage of shaft **140**. Arm **144** extends to the top end of a damper or spring-damper combination, identified as shock absorber **146**. The other end of shock absorber **146** is mounted to a bushing, which is itself mounted to a load spreading bracket (not illustrated) within the frame of the fuselage or sponson. An input arm **150** is mounted to a sleeve **152** on shaft **140**. As may be understood, moving input arm **150** clockwise and holding arm **144** stationary will cause shafts **140** and **142** to wind up as two torque springs in series.

As shown in Figure **4a**, the outboard end of torque tube **142** is carried in a bearing mounted to upper portion **104** of housing **102**. There may also be a central bearing at sleeve **152**, and another bearing mounted about torque tube **142** immediately outboard of arm **144**. At the outboard end of torque tube **142** is a first pair of matched rearwardly extending arms defining a first wishbone **154**. At the tips of the legs of first wishbone **154** is a cross-shaft **156** that ties the two tips together. A second wishbone **158** with hollow shaft mounted co-axially with cross-shaft **156**, and two extending legs (i.e., a fork or clevis, or wishbone) reach from shaft **156** to axle **160** of wheel **44**. The ends of axle **160** are mounted in seats or bushings that are themselves mounted to inboard wall **122** and outboard wall **124** respectively. The assembly so described defines a four bar linkage. That is, the first bar of the linkage is the fixed structure of the aircraft. The second bar of the linkage, effectively pivotally mounted to the fixed structure, is the first wishbone, **154**. The third bar of the linkage is the second wishbone **158**, and the fourth bar of the linkage is the deflector or slipper, or shoe, **120** which is pivotally mounted to the fixed structure of the first bar at pivot **128**. That is, relative to the fixed structure of the aircraft, shoe **120** defines the fixed radius arm constraining the arc of motion of wheel **46** and main gear bottom deflector plate **126**. Input to shaft **140** uniquely determines the position of first wishbone **154**, and therefore also the position of second wishbone **158** which functions as a drag link or slave link in this mechanism. Thus wheel **44** is limited to translation in a single degree of freedom along the circumferential arc

described by the axle bushings mounted to deflector **120**. Given the relative length of the arm defined by deflector **120**, and given the close to horizontal orientation of the arm, that motion is substantially, predominantly, upward-and-downward. Wheel **44** is movable between retracted and extended positions, as shown. There is an up-lock, and there is a down-lock, not shown. On landing, shaft **140** and torque tube **142** provide a somewhat resilient response, that response being damped by shock absorber **146**.

Transmission **100** is driven between retracted and extended positions by actuator assembly **170** mounted within hull **28**. Actuator assembly **170** includes a motor (and motor control) **172**, a gear reducer **174** driven by motor **172**; a worm drive **176** connected to the output of gear reducer **174**; and a reciprocally movable actuator **178** driven by worm drive **176**. As will be understood, driving motor **172** in a first direction will cause the jack of actuator **178** to extend, driving arm **144** clockwise with the effect of extending the main gear; driving motor **172** in the opposite direction will cause the jack of actuator **178** to retract, driving arm **44** counter-clockwise, with the effect of retracting the main gear. Other arrangements of drives could be used. In each case, deflector **120** moves with the main gear, or, expressed differently, the deflector and the wheeled landing gear move together.

Sleeve **152** also carries an output interface, or output arm **180**, which is connected to a drag link **182**, which drives a bell-crank **184**. The output of bell crank **184** is connected to a shock absorber **186**, which in turn carries the aftmost end of a connecting rod **188**. Connecting rod **188** has a foremost end mounted to input arm **78** which drives torque tube **76** of nose gear assembly **42**. Shock absorber **186** may tend to provide a measure of damping decoupling of the nose gear from the main gear. Thus motion of actuator **178** drives all three wheels of the tricycle assembly in a co-ordinated manner up and down. In each case, the action of the respective wheel carries the associated deflector up and down as well.

Referring again to the main gear, deflector **120** protects the forward side of main wheel **44**. As noted, deflector **120** has a long and thin shape, deployed leading main wheel **44**. The moving protective deflector, or vane, or shoe, may extend 2 – 8 wheel diameters forward of the main gear axle centerline, and, as above, it may be positioned and angled to leave exposed only a portion of main wheel **44**, as seen from looking aft along the wheel centerline.

Expressed differently, the point of intersection of the curves of the profile of deflector plate **126** and wheel **44** may be somewhere between the 7 o'clock and 8 o'clock positions. Expressed differently again, the wheel may protrude proud of the surface a distance **S**, where **S** = **D**(1 – Cos (**Theta**)), **D** being the outside diameter of wheel **44** and theta being the angle

(measured from the six o'clock position of wheel **44**) at which the wheel profile intersects the deflector profile on the centerline. Theta may be in the range of perhaps 15 to 65 degrees, and, in one embodiment, may be in the range of 30 – 50 degrees. The general tangent slope at mid arc of deflector plate **126** may be of the order of 15 – 40 degrees from the horizontal. In the embodiment shown, it may be 20 – 35 degrees, with the local tangent angle being closer to 15 or 20 degrees immediately forwardly of main gear wheel **44**, and closer to 35 or 40 degrees in the neighbourhood of forward pivot point **68**. Expressed differently yet again, deflector plate **126** has a length L_{126} forwardly of the axle of main gear wheel **44** that may be in the range of 2 – 10 times the diameter of main gear wheel **42**. Deflector **126** may provide a smooth lead-in-surface extending forwardly of wheel **44** for engaging, and riding upon, water - like a ski, or hull or slipper or shoe. Wheel **44** extends partially downwardly proud of the profile of deflector plate. The extent to which it stands downwardly proud may correspond to the expected deflection of the tire of wheel **44** during a normal landing, plus an allowance of extra travel, perhaps 50% of nominal normal landing load travel. In the event that aircraft **20** should land on water with the main gear extended, wheel **44** can only partially immerse itself before the aftmost portion of deflector plate **126** also engages the water. At any significant speed, the clock-wise counter-acting lift arising from deflector plate **126** planing on the water may tend to counter-act the counter-clockwise pitching moment generated by hydrodynamic drag on the exposed protruding portion of wheel **44**.

In an alternate, or additional, embodiment, main gear housing assembly **40** may include hydrofoil members, such as a first or outboard hydrofoil member **190** and a second or inboard hydrofoil member **192**, and, should the deflectors not be considered sufficient, hydrofoils **190** and **192** may tend also to generate a clockwise lifting moment tending to counteract the overturning moment arising from hydrodynamic drag. Hydrofoils **190** and **192** may be relatively small, and may have the appearance of relatively short "fins" extending laterally of the sponson structures respectively. Aircraft **20** may have respective outboard and inboard reliefs or rebates, or seats or accommodations **191** and **193** corresponding to hydrofoils **190** and **192**, such that in the retracted position of the landing gear, hydrofoils **190** and **192** are at least partially (in the case of hydrofoil member **190**) or fully (in the case of hydrofoil member **192**) concealed or seated in a position that is flush with the adjacent faired structure, giving a relatively smooth streamlined form. As above, in the extended position of the landing gear hydrofoils **190** and **192** are fully exposed. Hydrofoils **190** and **192** may be located generally abreast of wheel **44** and set at a level near the level of the axle of wheel **44**, such that in the event that a gear-down landing is made on water, and hydrofoils **190** and **192** may engage the water and begin to provide a lifting force even while the depth of wheel **44** in the water is relatively shallow.

In the event of a flat tire, or in the event of a gear transmission failure in which not all of the gear move to the selected position (be it up or down), the presence of nose deflector **90** and main gear deflector plates **126** may be such as to tend to provide a back-up skid surface for landing on terrain.

Nose wheel **46** has two rotational degrees of freedom – namely rotation about its axle, and pivoting rotation about its predominantly vertical steering shaft. Motion of the nose gear between retracted and extended positions is restricted to a single degree of freedom along the constrained arc of the parallelogram in the **x-z** plane. Deflector **90** has a single degree of freedom of motion – namely translation in the arc in the **x-z** plane associated with motion of the nose gear assembly generally. The up-and-down orientation of the nose gear steering shaft remains constant in the **x-z** plane.

Similarly, the main gear four bar linkage is constrained to motion in an **x-z** plane, and the wheel itself, while rotatable in the normal manner about its own axis of rotation to permit wheeled operation, is restricted to the single degree of freedom of travel along the arc traced by the bushings of shoe **120** relative to pivot point **128**.

The wheeled landing gear deflectors or shoes or slippers or protectors, however termed, shown and described herein are not to be confused with landing gear "spats". First, "spats" are aerodynamic fittings employed to reduce fixed landing gear drag that generally are not intended to, and typically do not, produce lift (aerodynamic or otherwise); the shoes described herein are hydrodynamic lift members. Second, true "spats" tend to be a feature of fixed landing gear rather than retractable landing gear. Third, "spats" are aerodynamic fairings of very light structure, as opposed to being structural members intended to take substantial dynamic loads such as landing loads. Fourth, spats tend to extend predominantly rearwardly of the axle of the wheel, with the form of a trailing edge of diminishing section to reduce rearward separation of airflow. The present hydro-dynamic deflectors or slippers or shoes extend predominantly forwardly of the gear, as opposed to aftward.

As described above, the anti-flip, or flip discouraging aspect is passive. That is, it does not rely on pilot intervention, or on electronic sensing or control systems to prevent landing in the wrong configuration. Of course, aircraft **20** may have such warning systems. However, even if they fail, the deflector may tend to work to protect against an overturning moment.

The deflector moves with the landing gear, and the forward facing surface of the deflector

also defines a portion of the exterior fairing of the aircraft in its normal operation in flight. That is, the deflector is not concealed behind other structure, or inside a nacelle in the retracted position, but rather forms a surface of the normal exterior of the aircraft. In the retracted position that surface may be flush with adjacent external surfaces to form a relatively smooth, streamlined form. The deflector protects its respective wheel in both the retracted and the extended position.

Also, as described, the wheel protrudes from the deflector, or shoe, structure in both the extended and the retracted position. In both positions the wheel is in its rolling orientation, i.e., the axle is horizontal and perpendicular to the line of forward motion of the aircraft. In both positions the shoe or deflector protects, or encloses, more than half of the wheel, with the sides of the shoe or deflector extending from the downward portion thereof upwardly and rearwardly or the axle. That is, the wheel is covered on both front and sides.

In the embodiment of Figures **10a**, **10b**, **11a** and **11b** there is an amphibious aircraft **220**, which, unless otherwise noted, may be taken as being the same, or substantially the same, as aircraft **20**, but that does not have a drive train, or actuator and mechanical transmission, for moving the landing gear from an extended (or "down") position to a retracted (or "up") position. That is, aircraft **220** is a fixed-gear amphibian, and, more particularly, a fixed gear flying-boat amphibian. It has a fixed, or single position, gear. The fixed gear is sprung, i.e., resiliently mounted, such that there is a range of motion of deflection of the wheels such as may be desired for lending on terrain, without a selection of positions. In respect of aircraft **220**, it may be taken that the views of Figures **5a** to **5e** and **6a** to **6e**, **7a** to **7c**, **8a** to **8c**, **9a** and **9b** apply to aircraft **220** as they do to aircraft **20**. However, rather than representing selected "up" and "down" positions, the two positions shown may be thought of as representing a range of travel from the passive, extended, or no-load position, to the passive, deflected position at full load during landing, e.g., landing on terrain. To see the differences between aircraft **220** and aircraft **20**, Figure **10a**, with the landing gear deflected upward as under load, and Figure **10b** with the landing gear in an unloaded condition may be compared with Figures **1**, **3a** and **4a**. Similarly, Figures **11a** and **11b**, the corresponding side views, may be compared with Figures **2a**, **2b**, **3a**, **3b** and **4b**.

The embodiment of aircraft **220** of Figures **10a**, **10b**, **11a** and **11b** may be thought of as being equivalent to the embodiment of Figure **1** with the gear selected "down", except that there is no selection. The gear has only a single "fixed" position. The fixed position nonetheless is the fixed position of a resilient suspension, the resilience of the suspension permitting deflection of the wheels. In this deflection, the leading cowlings, or protectors, or deflectors, or vanes, or shoes, however they may be termed, move with the wheels. The lead-in vane remains in the

position to engage water at all positions of travel of the wheels within their resilient range of motion. Expressed differently, aircraft **220** is an amphibian in which a portion of the water-riding hull is resiliently mounted to deflect on landing. Alternatively, it can be said that aircraft **220** is an amphibian in which a portion of the water-riding hull moves with, or deflects with, a wheel of the landing gear.

In terms of the nose gear, nose gear **222** may be generally similar to nose gear **42**. Nose gear **222** has a torque tube **226** corresponding to torque tube **76** of aircraft **20**. However, torque tube **226** is in a fixed position corresponding to the extended position of the nose gear as seen in Figure **3a** (and in Figure **10a**). Torque tube **226** does not have an input crank arm **78**, and is likewise not connected to a drive linkage such as connecting rod **188**. An input crank arm, analogous to input crank arm **78**, and having a distal end of the arm secured to fixed structure could be used in place of input arm **78** to secure torque tube **226** in the fixed position. Otherwise, nose gear **222** may be understood as being the same as, or substantially the same as nose gear **42**.

Considering the main gear, main gear assembly **230** is substantially the same as the main gear assembly of aircraft **20**. Main gear wheels **46** are resiliently sprung on a spring such as torque shaft assembly **232**. Torque shaft assembly **232** includes a laterally extending shaft **240** and respective left and right hand co-axial outer torque tubes connected at either ends thereof, (substantially the same as shaft **140** and tubes **142**). As before, left and right hand lever arms **144** are connected to respective shock absorbers, or spring dampers, **146**. In contrast to the structure of aircraft **20** shown in Figure **4a**, the main gear assembly of aircraft **220** does not a driven input arm **150**, but may have a fixed arm **250** secured in a position that may otherwise correspond to the "down" position of the main gear in aircraft **20**. Similarly, there is no transmission **100**, and no actuator **170** or its motor, worm drive linkages, or other features. Given that there is no nose gear transmission, parts **180**, **182**, **184**, **186** and **188** may be omitted as well. Thus, as can be seen, the resilient torque tube arrangement of the main gear suspension is retained, without the drive and transmission. This may permit a reduction in aircraft weight and complexity. As such, the landing gear may be termed a "single position" landing gear since there is no active choice of more than one position.

Alternatively, the aircraft may have a combination of fixed gear and retractable gear. In an alternate embodiment, the aircraft may have a retractable nose gear, as in aircraft **20**, and fixed main gear as in aircraft **220**. In a further alternative, the aircraft may have a fixed nose gear as in aircraft **220** and retractable main gear as in aircraft **20**.

As can be seen, aircraft **220** is a fixed-gear amphibian aircraft. It has a fixed gear having three movably mounted water-riding hull portions – one at the nose, and two at the main gear sponsons. Those hull portions are resiliently mounted. In a further feature of that aspect, the water-riding hull portion is mounted forwardly or, and as a shield for, a first wheel if the fixed gear. The water-riding hull portion is mounted to move when the fixed gear deflects under load.

The amphibian aircraft having at least a first fixed landing gear. The aircraft has fixed main gear. It has a fixed nose gear. It has tricycle landing gear. All of the landing gear is, or are, fixed landing gear. The landing gear includes at least one resiliently mounted landing gear. Aircraft **220** has a first water riding member mounted to extend forwardly of the first fixed landing gear. The first water-riding member is movably mounted. The first water-riding member is mounted to deflect when the first fixed landing gear deflects.

There description is of a landing gear for amphibious aircraft **220**. The landing gear includes a wheel for rolling contact with a landing surface, and a deflector. The deflector defines a water-riding hull extending predominantly forwardly of the wheel. The deflector has an accommodation in which the wheel is mounted. The wheel extends partially downwardly proud of the deflector. The wheel and the deflector are mounted to move together, with the wheel protruding partially downwardly proud of the deflector. The landing gear is a single position landing gear. The wheel is resiliently mounted in a single position, and is resiliently movable in a range of motion in response to loading, the water-riding hull being correspondingly movable in co-operation with the wheel. The range of motion of the wheel has a first end of travel and a second end of travel. The first end of travel is a fully loaded position, and the second end of travel is an unloaded position. Immediately forward of the wheel the deflector has a centerline slope forwardly and upwardly of the wheel of less than 30 degrees from horizontal when the wheel is in the unloaded position. In the fully loaded position, immediately forward of the wheel the deflector has a centerline slope forwardly of the wheel that is tangent to horizontal.

The deflector forms one leg of a four-bar linkage. The wheel is carried in a seat defining at least one other leg of that four-bar linkage. The wheel has a foremost exposed portion and at the foremost exposed portion of the wheel a tangent to the wheel, when seen in side view has an angle of less than 45 degrees of arc from horizontal. The deflector has an opening formed therein, and the wheel protrudes through the opening. The opening has a first edge portion running along a first sidewall of the wheel, and an opposed second edge portion running along a second sidewall of the wheel. The deflector has a first side portion, a second side portion, and a keel portion therebetween, the wheel being mounted between the first side portion and the second side portion.

The deflector extends at least three wheel diameters forward of the wheel. Immediately forward of the wheel the deflector has a centerline slope forwardly and upwardly of the wheel of less than 20 degrees from horizontal. The deflector has a sacrificial spine. The sacrificial spine is exposed and foremost, whereby in a gear-up landing the sacrificial spine is closer to the ground than any other non-wheel structure.

Aircraft **220** is an amphibious aircraft having a wheeled landing gear for landing on a landing field. The wheeled landing gear is a fixed gear having a range of motion between an unloaded position and a fully loaded position. The landing gear is mounted within, and extends partially downwardly proud of, a movable landing gear housing, or housings, that define water-engaging surfaces forwardly and laterally of the landing gear and, when the landing gear moves within the range of motion, the landing gear housings and the landing gear move together, with the landing gear extending partially downwardly proud thereof. One of the landing gear wheels is a steerable nose gear. The landing gear housing, or shell, has an external surface defining an external surface of the amphibious aircraft during both flight and water borne operation. The shell has an hydrofoil member mounted thereto.

It may be understood that the various aspects and features may be mixed and matched as may be appropriate. It may also be understood that the foregoing is not intended to be an exhaustive listing of aspects and features of the invention. These and other aspects and features of the invention may be understood with reference to the description which follows, and with the aid of the illustrations of a number of examples.

Various embodiments have been described in detail. Since changes in and or additions to the above-described examples may be made without departing from the nature, spirit or scope of the invention, the invention is not to be limited to those details.

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Claims

I claim:

1. A flying boat amphibious aircraft, comprising:
a fuselage having a water-riding hull having a bow and a stern;
said hull of said fuselage having laterally outboard sponsons;
said sponsons having respective landing gear mounted thereto;
said landing gear including, respectively, a wheel for rolling contact with a landing surface, and a deflector;
said deflector defining a water-riding housing extending forwardly of said wheel;
said deflector has an accommodation in which said wheel is mounted;
said wheel extending partially downwardly proud of said deflector;
said wheel and said deflector being mounted to move together, with said wheel protruding partially downwardly proud of said deflector; and
said landing gear being a single position landing gear.

2. The flying boat amphibious aircraft of claim 1 wherein said wheel is resiliently mounted in a single position, and is resiliently movable in a range of motion in response to loading, said water-riding housing being correspondingly movable in co-operation with said wheel.

3. The flying boat amphibious aircraft of claim 2 wherein said range of motion has a first end of travel and a second end of travel, said first end of travel being a fully loaded position, and said second end of travel being an unloaded position.

4. The flying boat amphibious aircraft of claim 3 wherein, immediately forward of said wheel, said deflector has a centerline slope forwardly and upwardly of said wheel of less than 30 degrees from horizontal when said wheel is in said fully unloaded position.

5. The flying boat amphibious aircraft of any one of claims 1 to 4 wherein immediately forward of said wheel said deflector has a centerline slope forwardly of said wheel that is tangent to horizontal.

6. The flying boat amphibious aircraft of any one of claims 1 to 5 wherein said deflector forms one leg of a four-bar linkage, and said wheel is carried in a seat defining at least one other leg of that four-bar linkage.

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7. The flying boat amphibious aircraft of any one of claims 1 to 6 wherein said wheel has a foremost exposed portion and at said foremost exposed portion of said wheel a tangent to said wheel, when seen in side view has an angle of less than 45 degrees of arc from horizontal.

8. The flying boat amphibious aircraft of any one of claims 1 to 7 wherein said deflector has an opening formed therein, and said wheel protrudes through said opening.

9. The flying boat amphibious aircraft of claim 8 wherein said opening has a first edge portion running along a first sidewall of said wheel, and an opposed second edge portion running along a second sidewall of said wheel.

10. The flying boat amphibious aircraft of any one of claims 1 to 9 wherein said deflector has a first side portion, a second side portion, and a keel portion therebetween, said wheel being mounted between said first side portion and said second side portion.

11. The flying boat amphibious aircraft of any one of claims 1 to 10 wherein said deflector extends at least three wheel diameters forward of said wheel.

12. The flying boat amphibious aircraft of any one of claims 1 to 11 wherein, immediately forward of said wheel said deflector has a centerline slope forwardly and upwardly of said wheel of less than 20 degrees from horizontal.

13. The landing gear of any one of claims 1 to 12 wherein said deflector has a sacrificial spine.

14. The flying boat amphibious aircraft of claim 1 wherein:

said deflector has a first side portion, a second side portion, and a keel portion therebetween, said wheel being mounted between said first side portion and said second side portion;

said deflector extends at least three wheel diameters forward of said wheel;

immediately forward of said wheel said deflector has a centerline slope forwardly and upwardly of said wheel of less than 20 degrees from horizontal; and

said deflector has a sacrificial spine, said sacrificial spine being closer to the ground than any other non-wheel structure.

15. The flying boat amphibious aircraft of any one of claims 1 to 14 wherein said water-riding hull has a central keel, a step, a tail extending upwardly and rearwardly of said hull, and said sponsons include a pair of sponsons extending laterally to either side of said water-riding hull, and said sponsons extend farther downwardly than said water-riding hull.

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16. The flying boat amphibious aircraft of claim 1 wherein said single position landing gear includes at least one resiliently mounted landing gear.

17. The flying boat amphibious aircraft of claim 16 wherein said single position landing gear includes a single position main landing gear.

18. The flying boat amphibious aircraft of any one of claims 16 and 17 wherein said single position landing gear-includes a nose gear.

19. The flying boat amphibious aircraft of any one of claims 16 to 18 wherein:
said flying boat amphibious aircraft has a rearwardly extending tail;
said fuselage has a step, said water-riding hull extends forwardly of said step; said tail extends rearwardly of said step;
said fuselage has bulges extending laterally to either side thereof, said bulges defining sponsons;
there being a main gear of said single position landing gear mounted to each of said sponsons; and
each of said sponsons having a lowermost water-riding surface that is positioned lower than said water-riding hull.

20. A flying boat amphibious aircraft having:
a wheeled landing gear for landing on a landing field, said wheeled landing gear being a fixed gear having a range of motion between an unloaded position and a fully loaded position;
said landing gear being mounted within, and extending partially downwardly proud of, a movable landing gear housing that defines a water-engaging surface forwardly and laterally of said landing gear; and
when said landing gear moves within said range of motion, said landing gear housing and said landing gear move together, with said landing gear extending partially downwardly proud thereof.

21. The flying boat amphibious aircraft of claim 20 wherein:
said flying boat has a fuselage that includes a hull for use in water, the hull having a bow and a stern;
said hull includes laterally outboard portions defining first and second sponsons; and

said landing gear is a tricycle landing gear in which said tricycle landing gear includes a first wheel mounted in said first sponson, and a second wheel mounted in said second sponson.

22. The flying boat amphibious aircraft of claim 21 wherein said flying-boat has a water-riding hull, said water-riding hull having a bow and a stern; and said wheeled landing gear includes a steerable nose gear mounted in said bow of said water-riding hull of said fuselage.

23. The flying boat amphibious aircraft of any one of claims 20 to 22 wherein, as installed on the flying boat amphibious aircraft the landing gear housing defines one bar of a four bar linkage.

24. The flying boat amphibious aircraft of any one of claims 20 to 23 wherein said landing gear housing includes a shell, said shell includes a leading portion and a trailing portion, and said shell has a keel, and said keel extends along said leading portion thereof.

25. The flying boat amphibious aircraft of claim 24 wherein said keel is a sacrificial wear member.

26. The flying boat amphibious aircraft of any one of claims 20 to 24 wherein said landing gear housing includes a shell, and said shell has an external surface that defines an external surface of the landing gear housing of the flying boat amphibious aircraft during both flight and water borne operation.

27. The flying boat amphibious aircraft of any one of the claims 20 to 24 and 26 wherein said housing includes a shell, and said shell has at least one hydrofoil member mounted thereto.

28. The flying boat amphibious aircraft of claim 20 wherein said flying boat amphibious aircraft has a fuselage having a water-riding hull having a central keel, a step, a tail extending upwardly and rearwardly of said hull, and a pair of sponsons extending laterally to either side of said water-riding hull, and said sponsons extend farther downwardly than said water-riding hull.

29. The flying boat amphibious aircraft of claim 25 wherein said shell has an external surface that defines an external surface of the landing gear housing of the flying boat amphibious aircraft during both flight and water borne operation.

30. The flying boat amphibious aircraft of claim 25 wherein said shell has at least one hydrofoil member mounted thereto.

Date Reçue/Date Received 2023-06-20

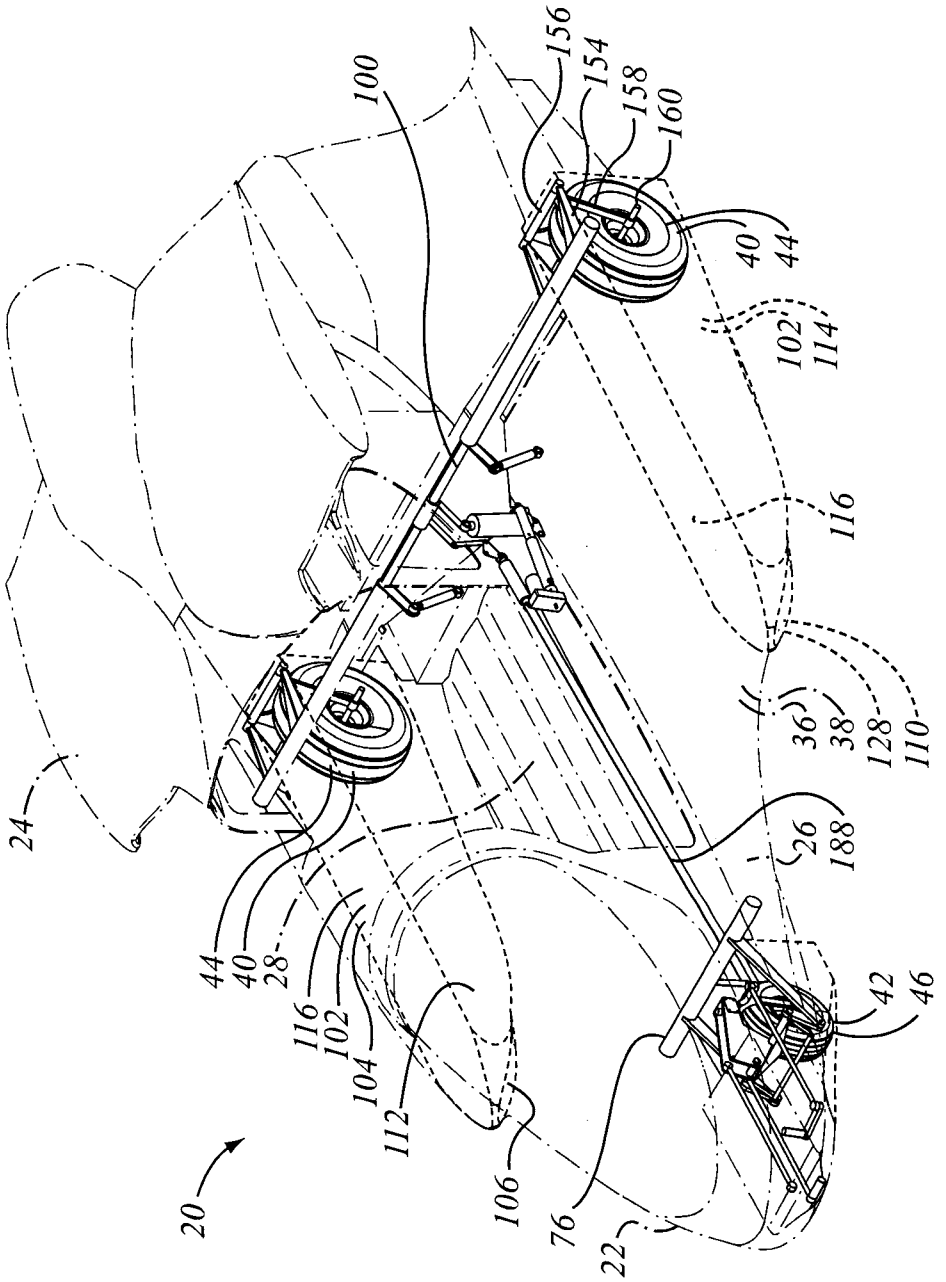
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FIG. 1

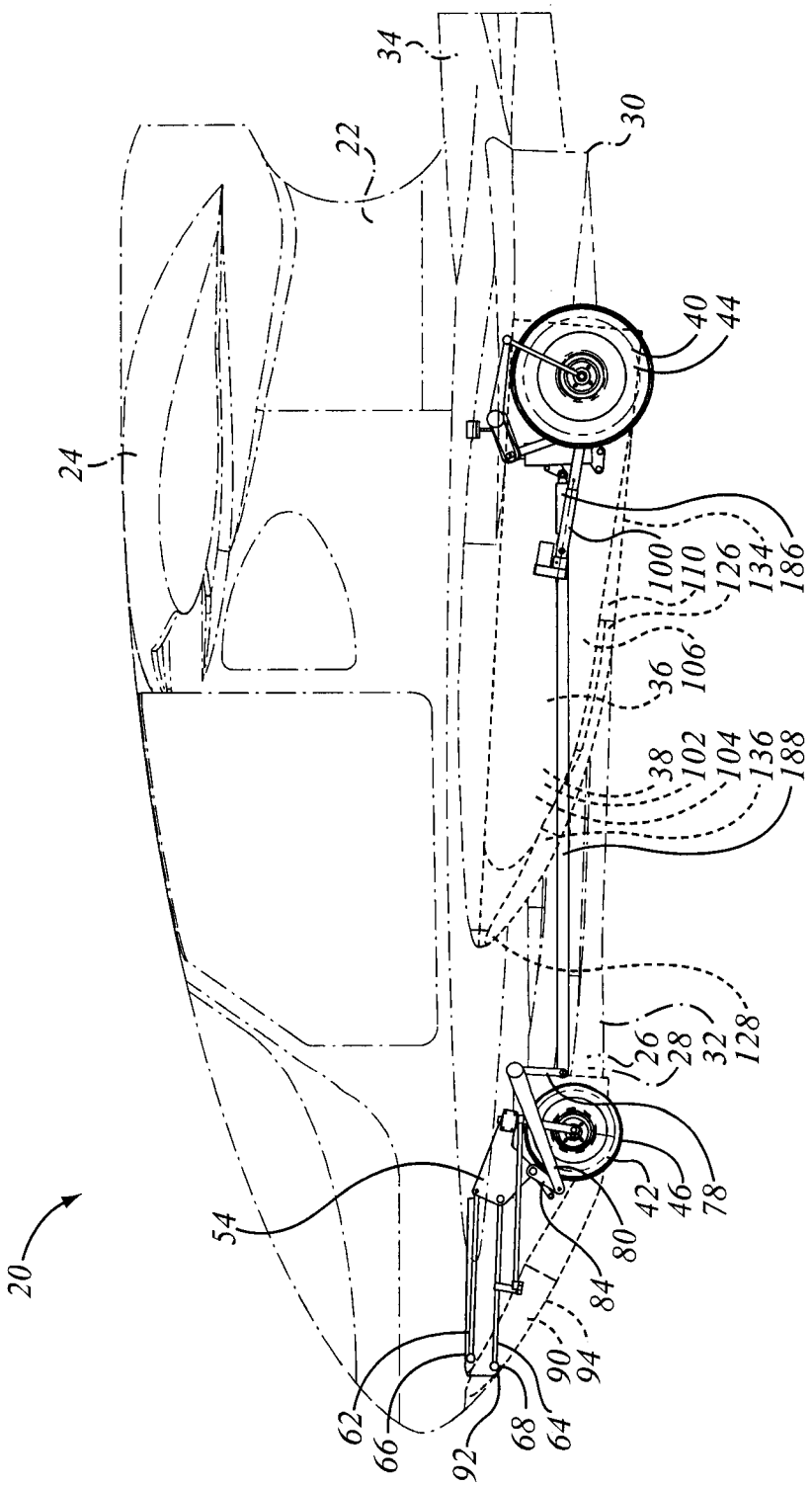
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FIG. 2a

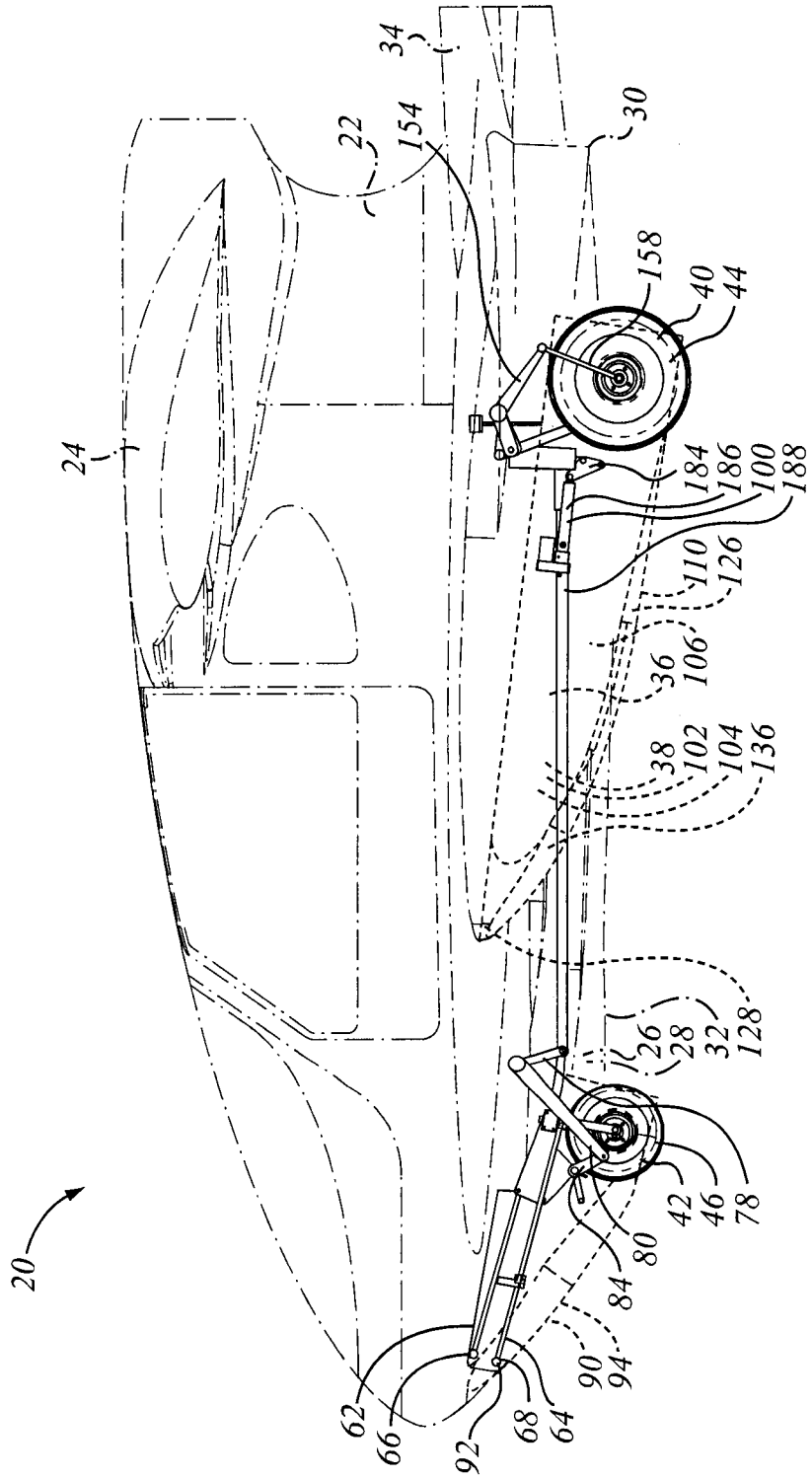
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FIG. 2b

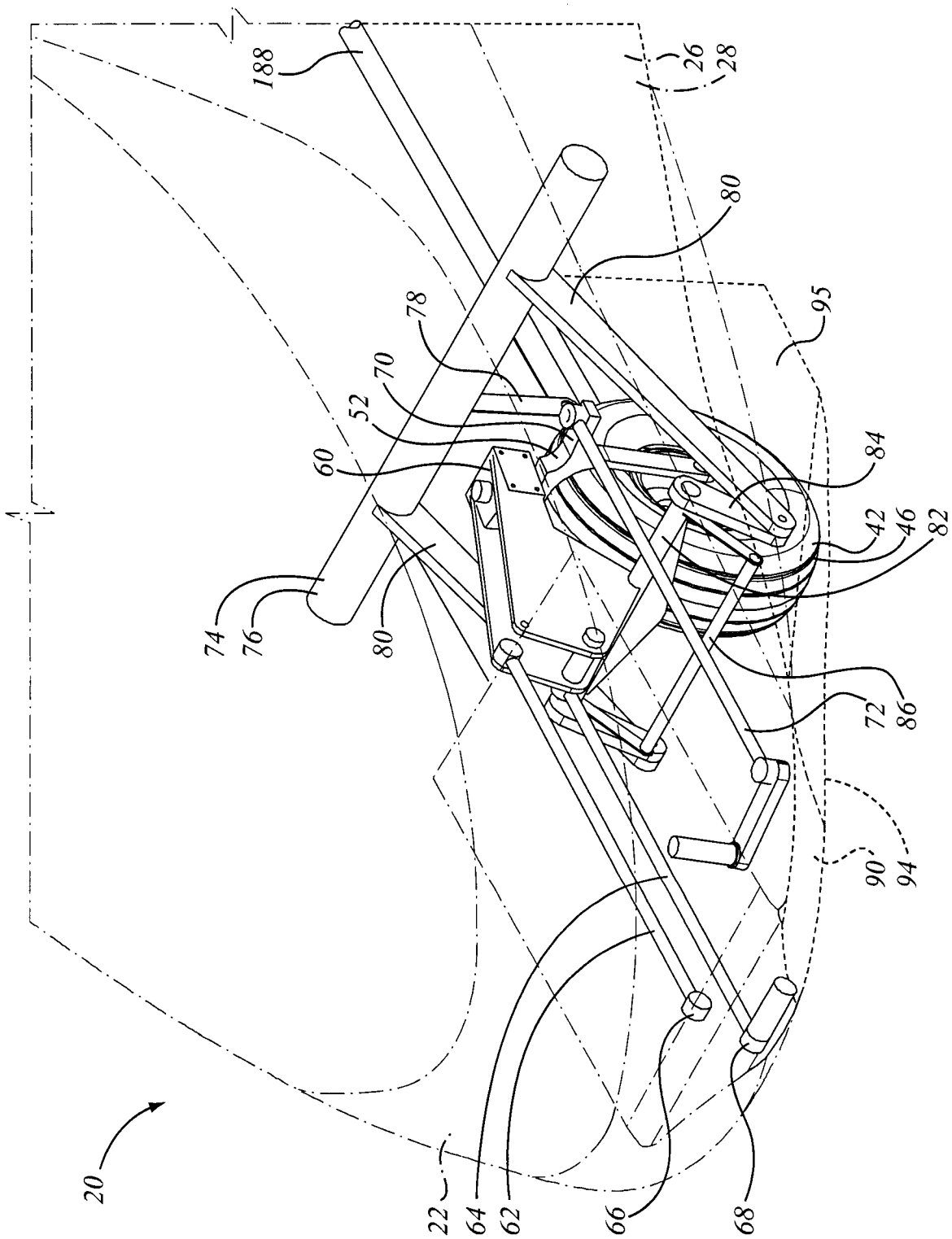
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FIG. 3a

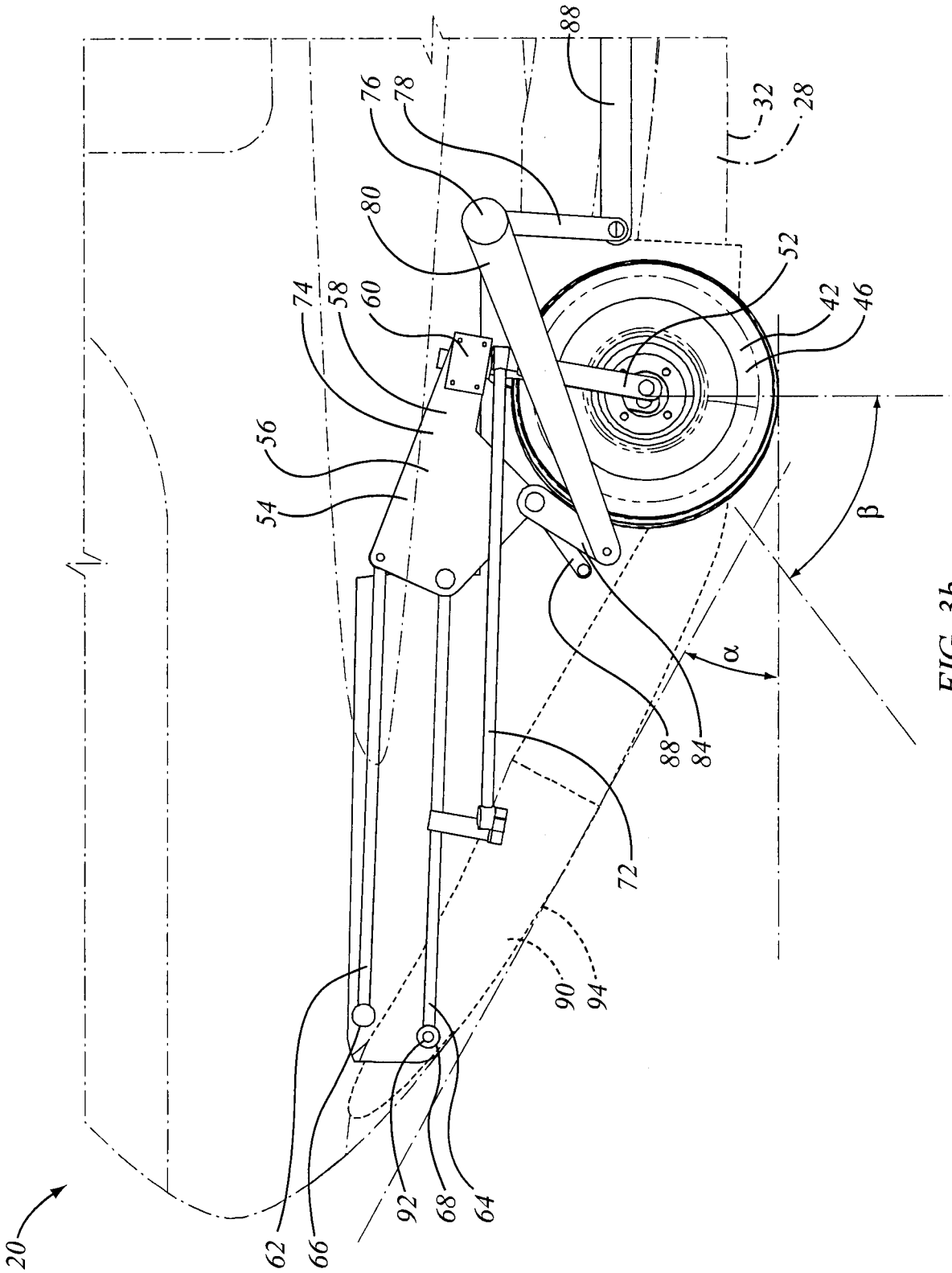
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FIG. 3b

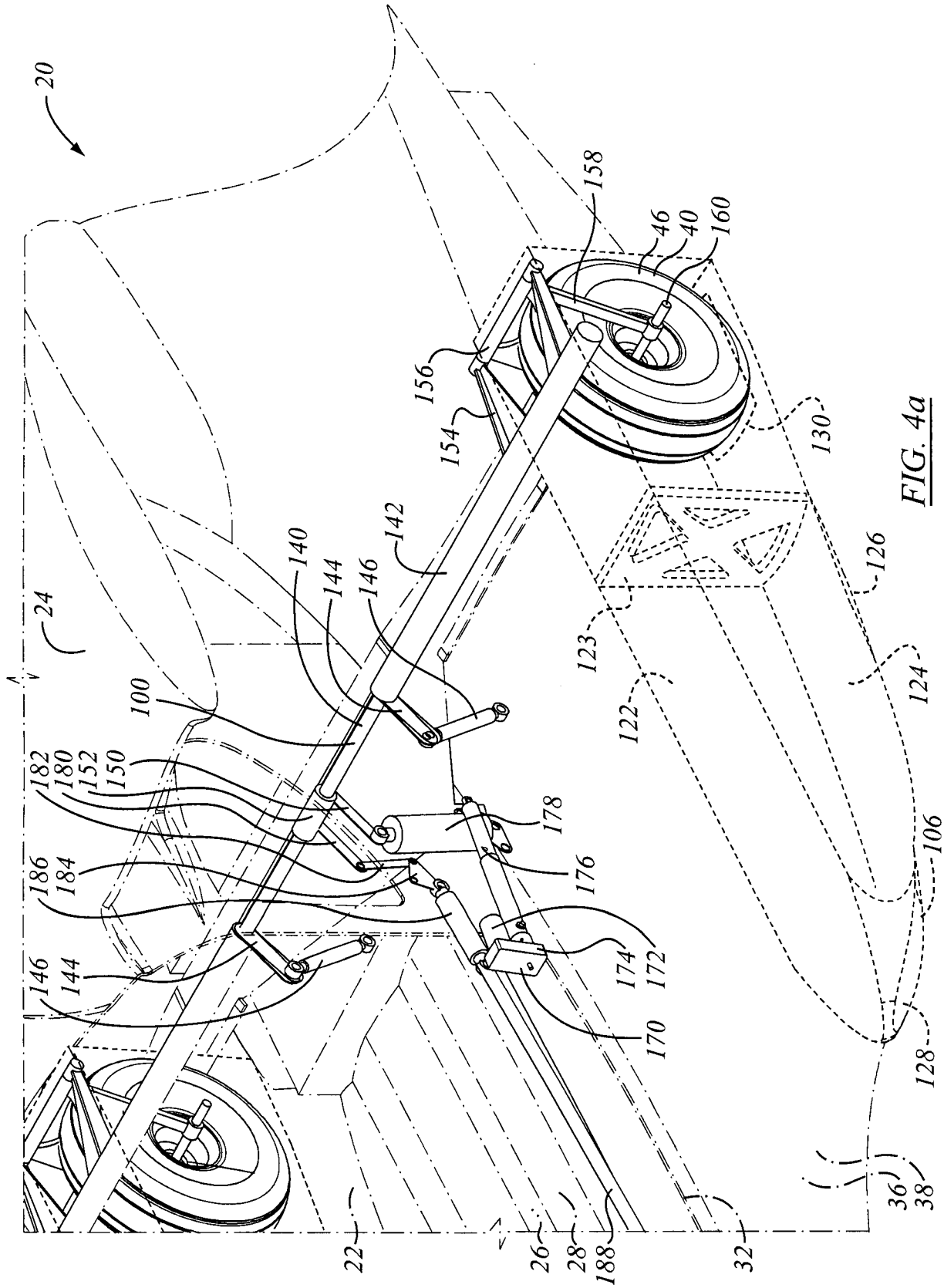
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FIG. 4a

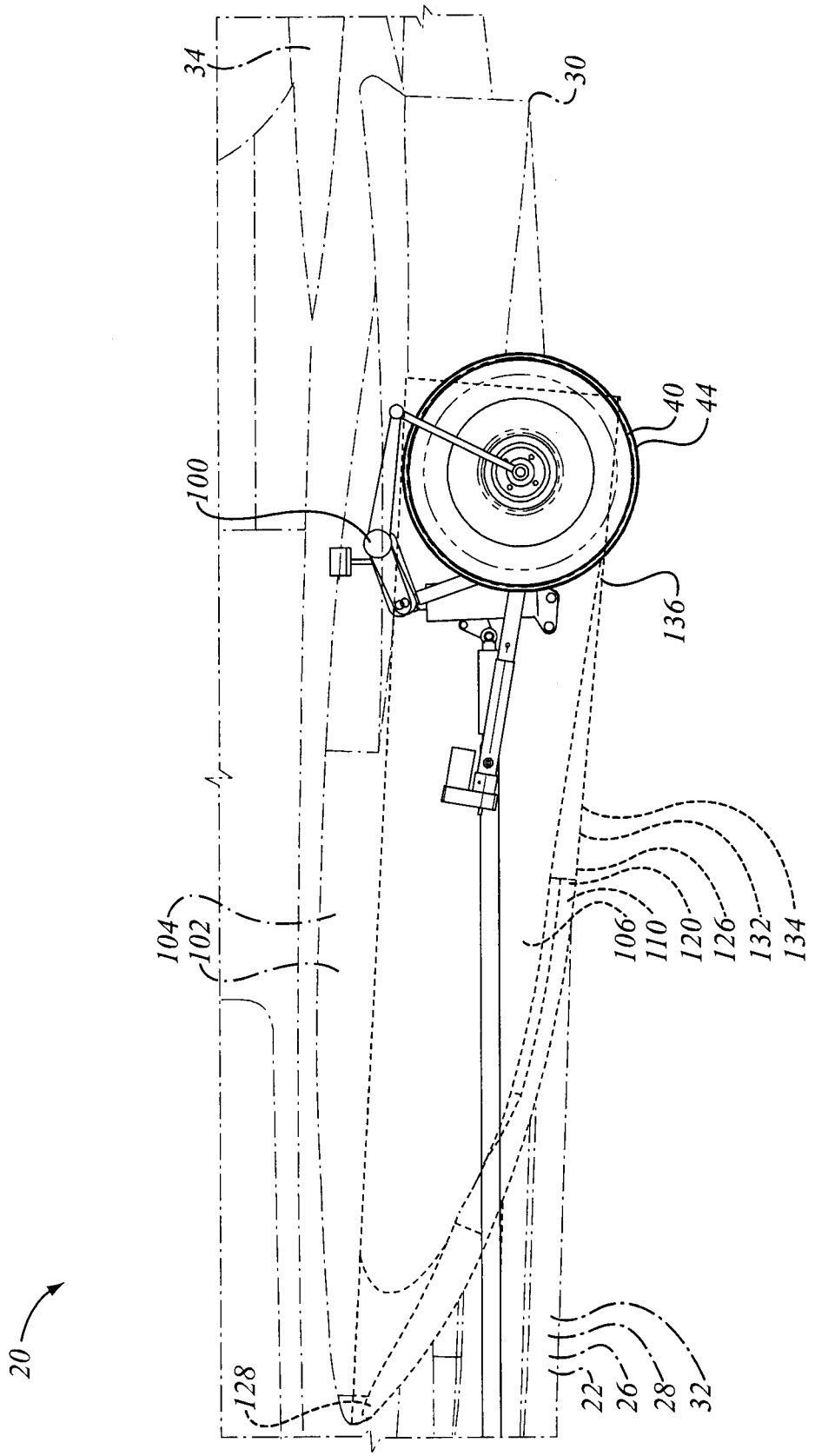
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FIG. 4b

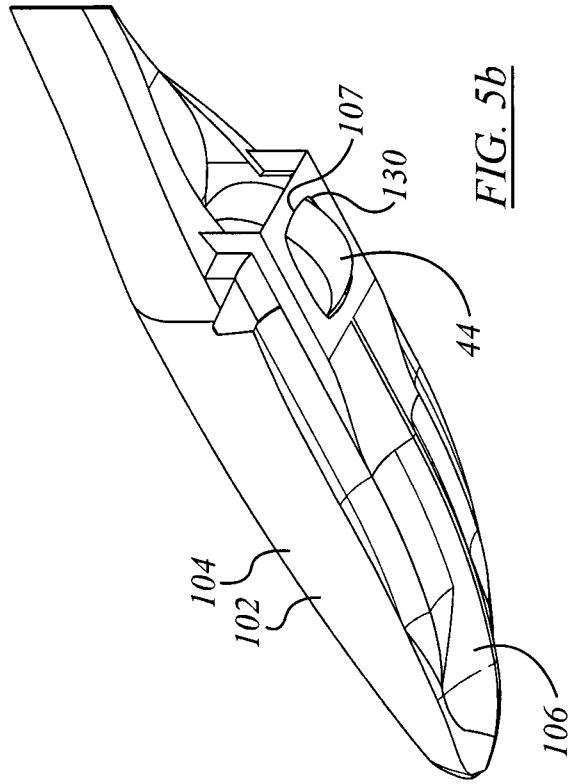

FIG. 5b

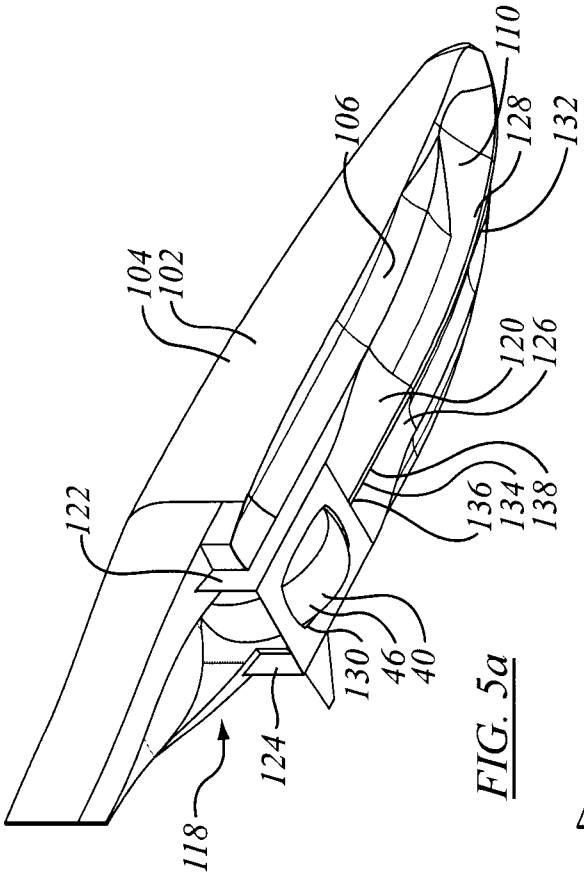

FIG. 5a

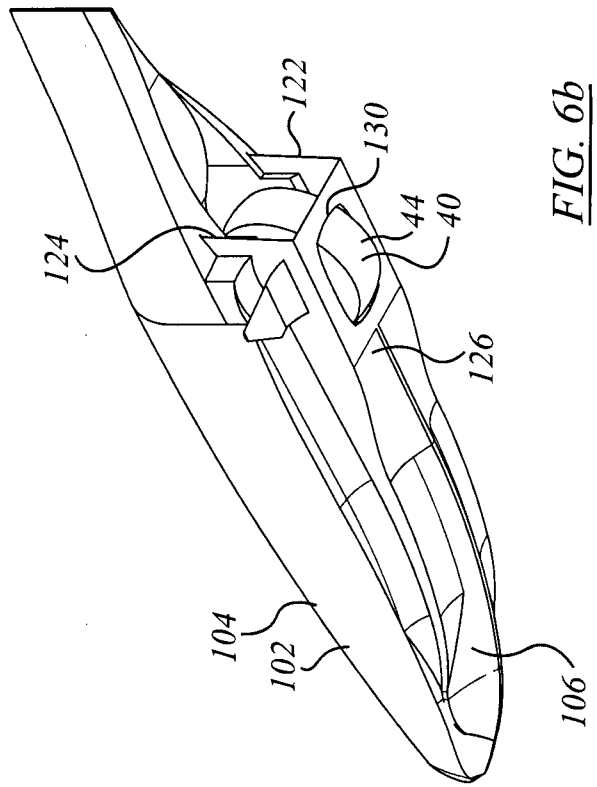

FIG. 6b

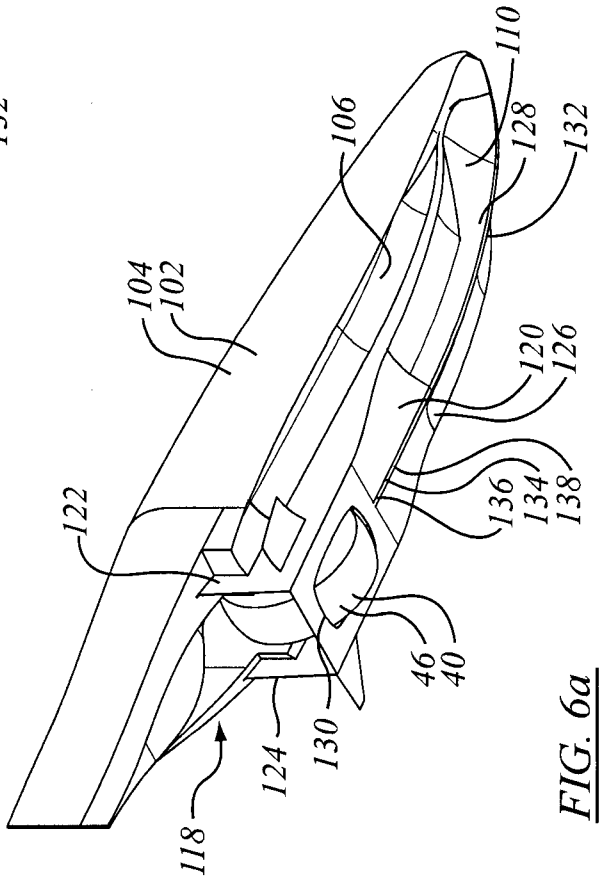

FIG. 6a

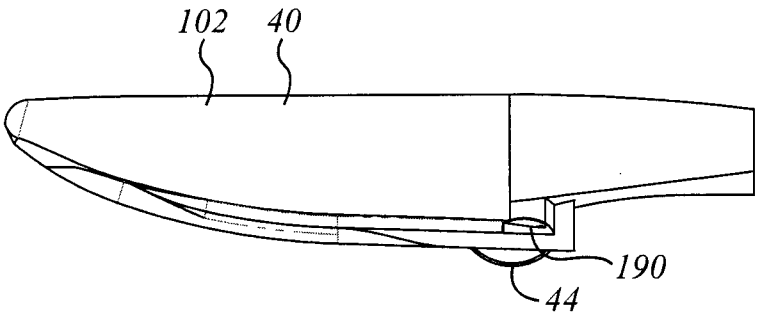

FIG. 5d

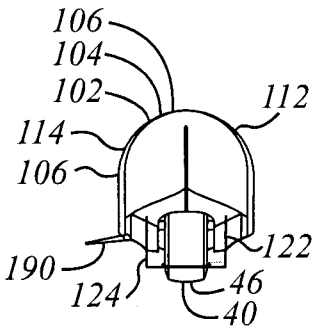

FIG. 5c

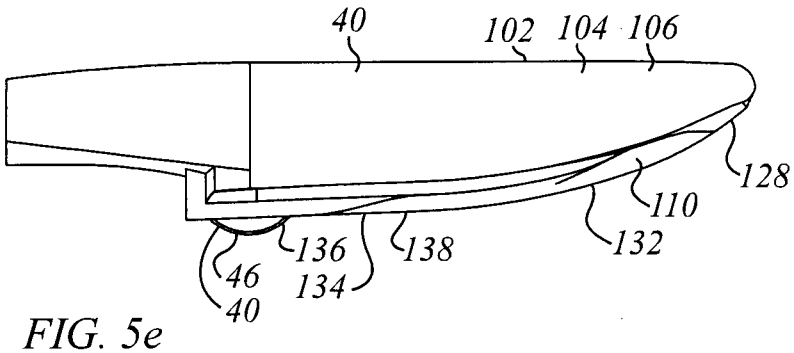

FIG. 5e

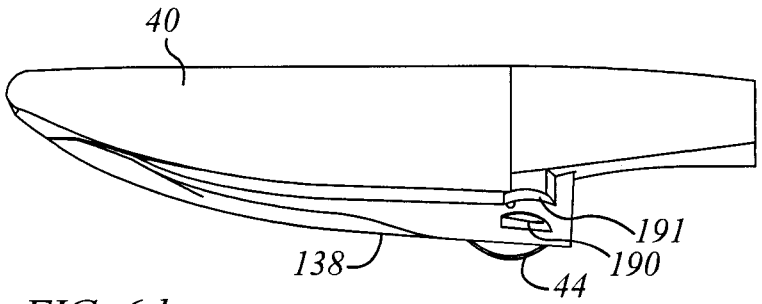

FIG. 6d

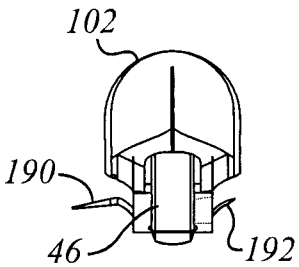

FIG. 6c

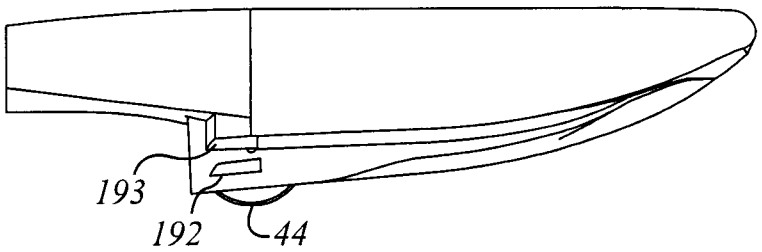

FIG. 6e

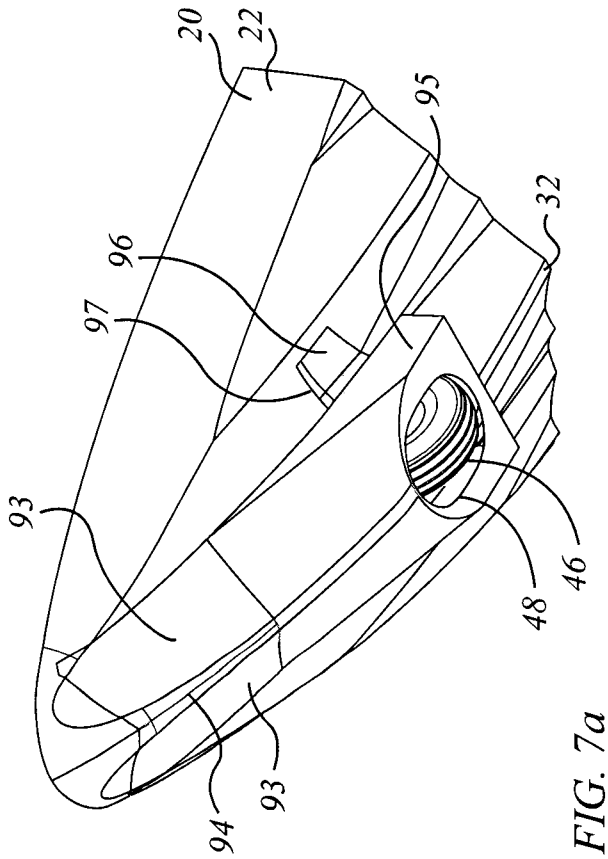

FIG. 7a

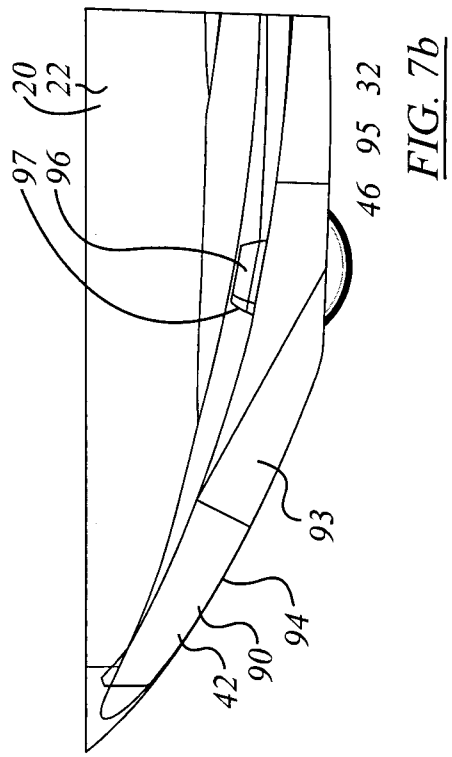

FIG. 7b

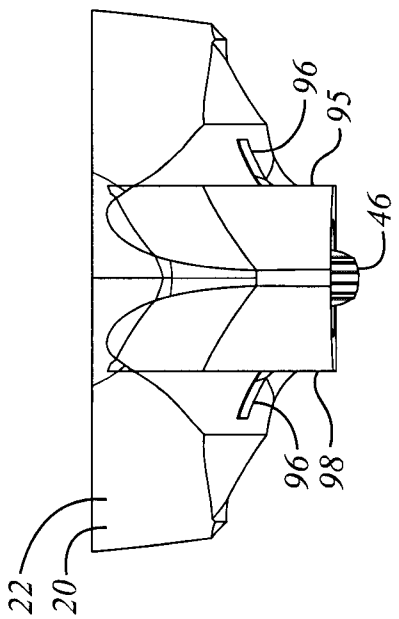

FIG. 7c

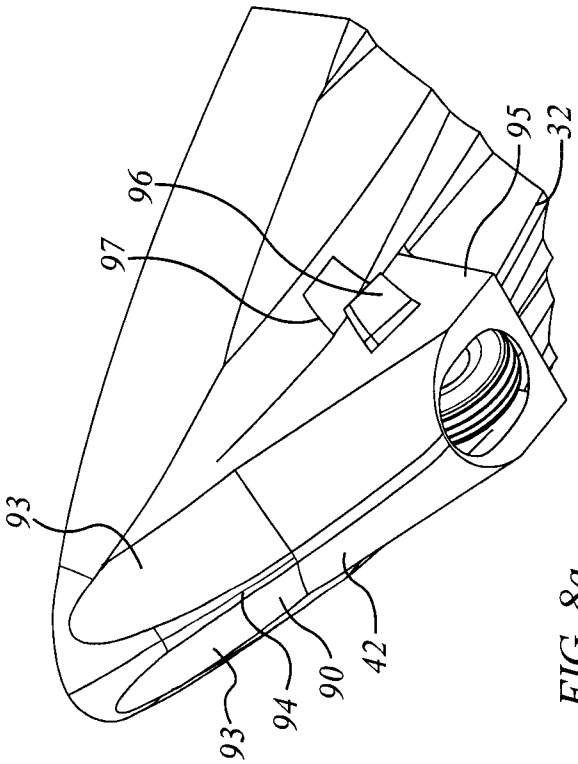

FIG. 8a

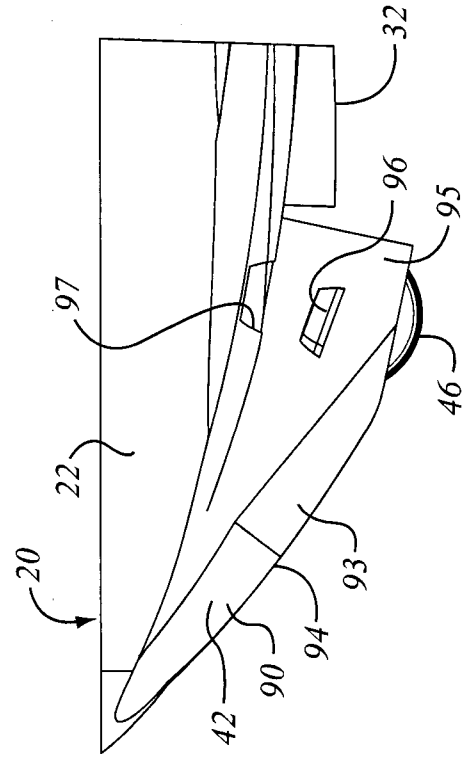

FIG. 8b

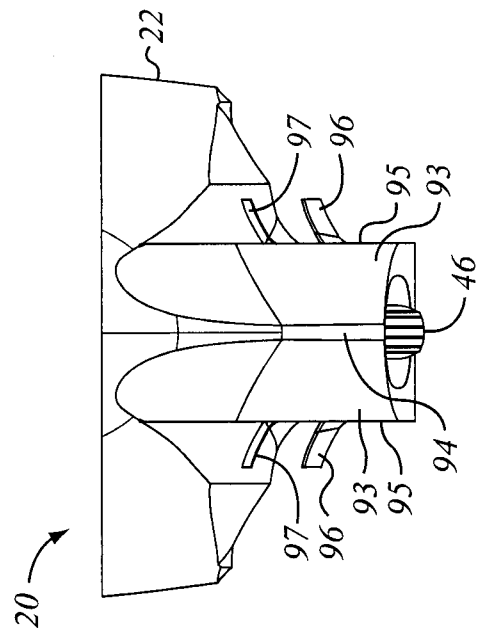

FIG. 8c

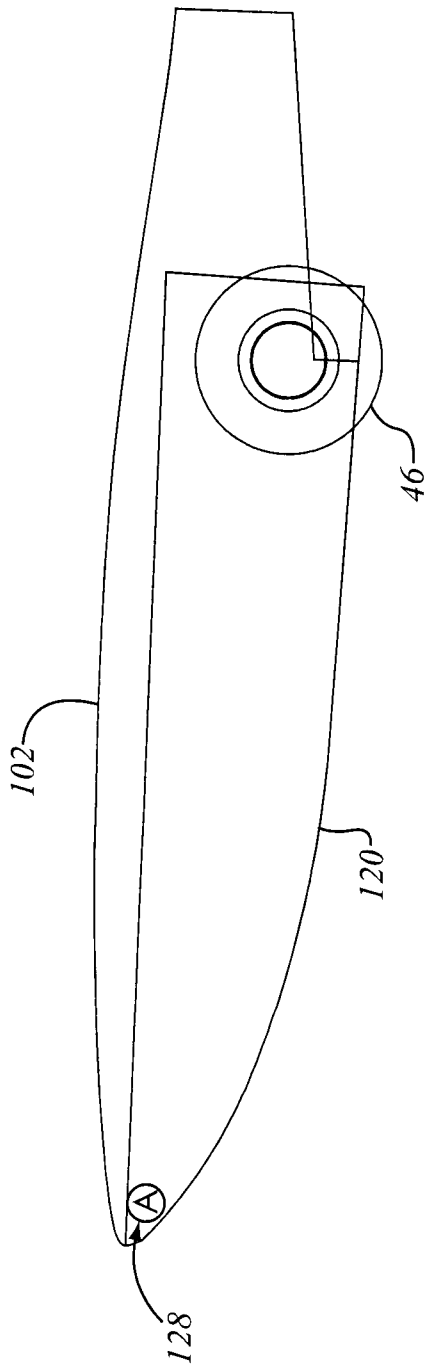

FIG. 9a

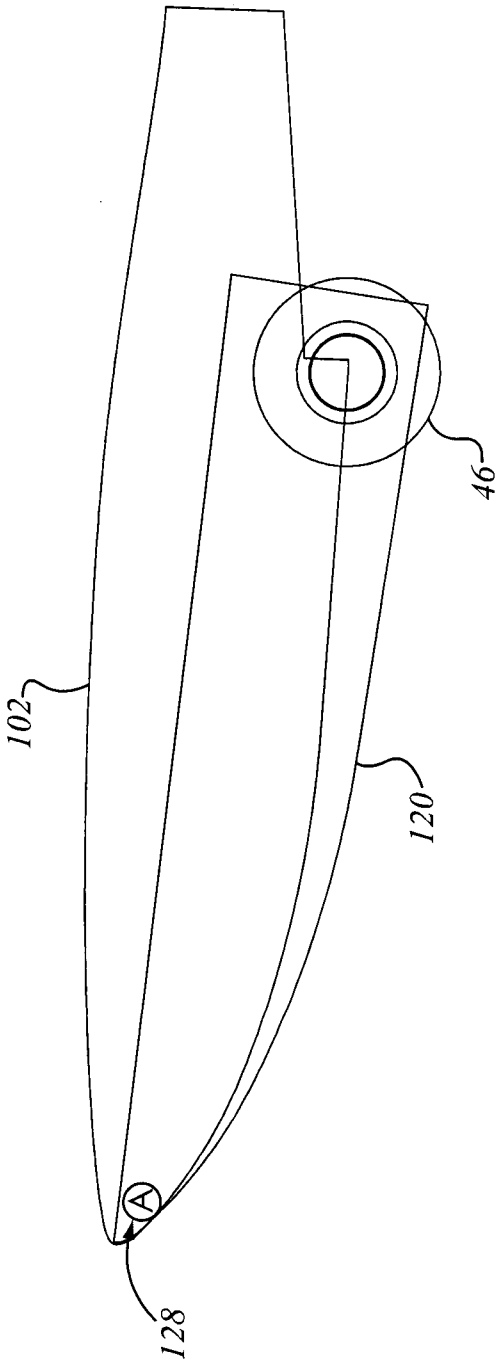

FIG. 9b

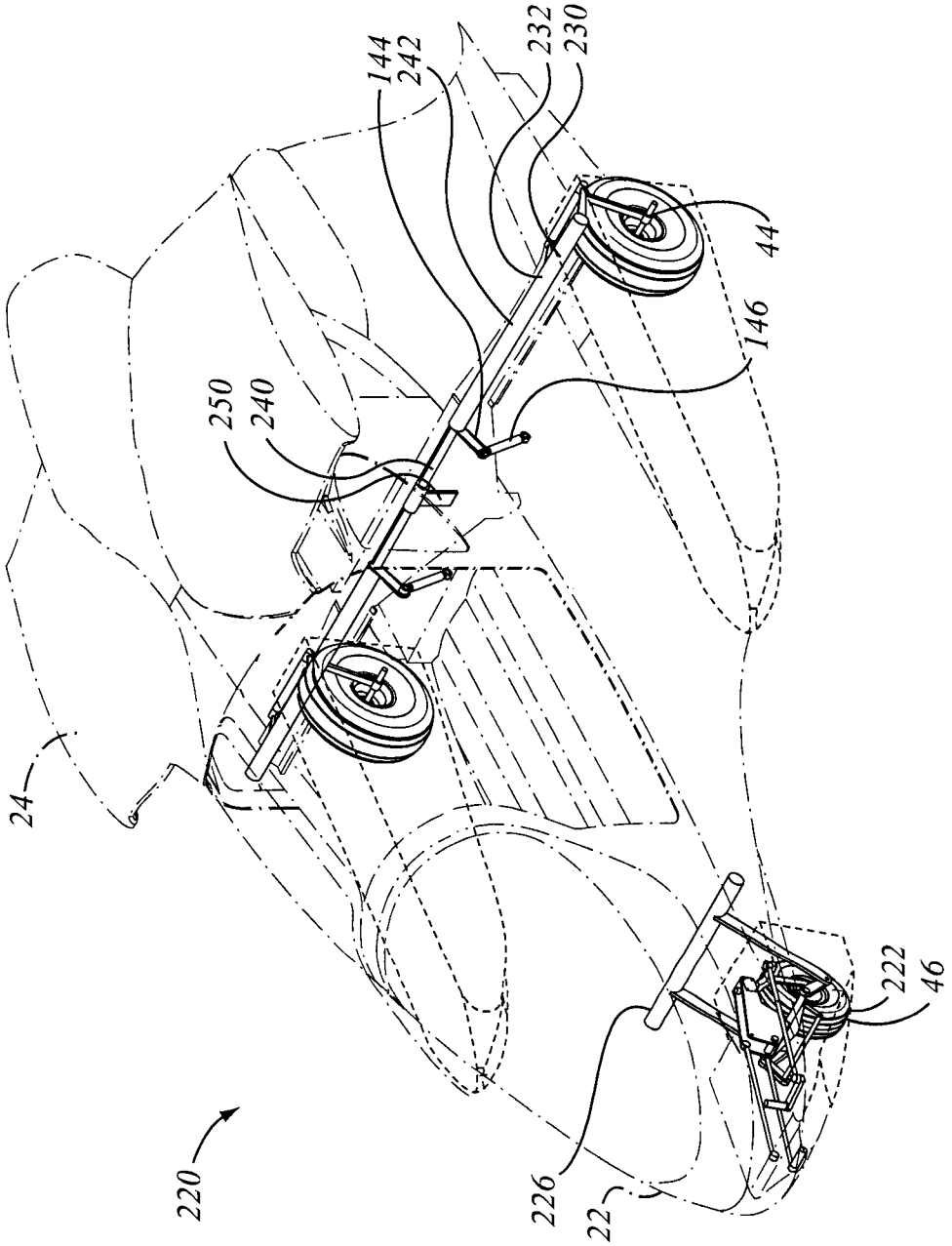

FIG. 10a

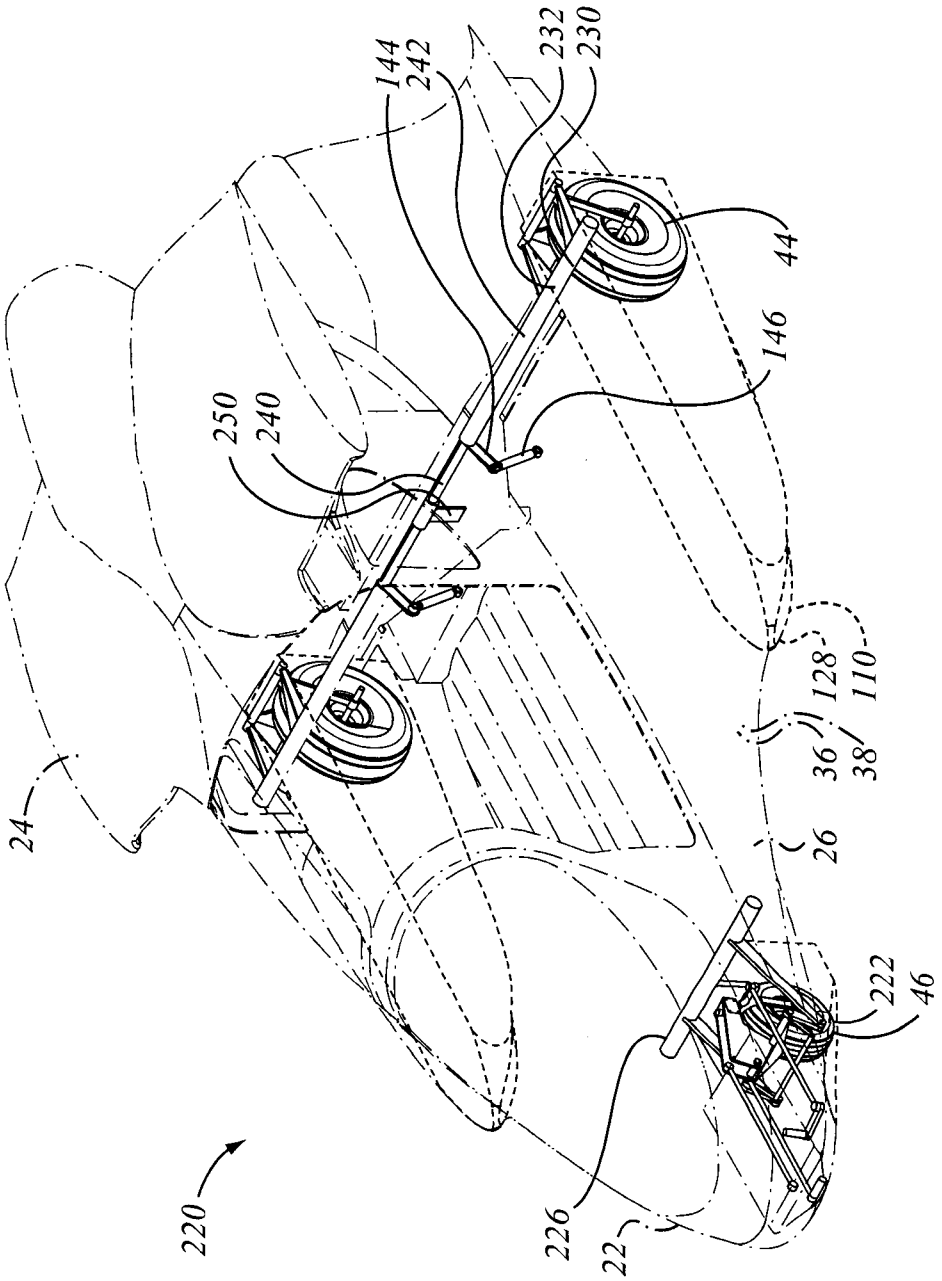
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FIG. 10b

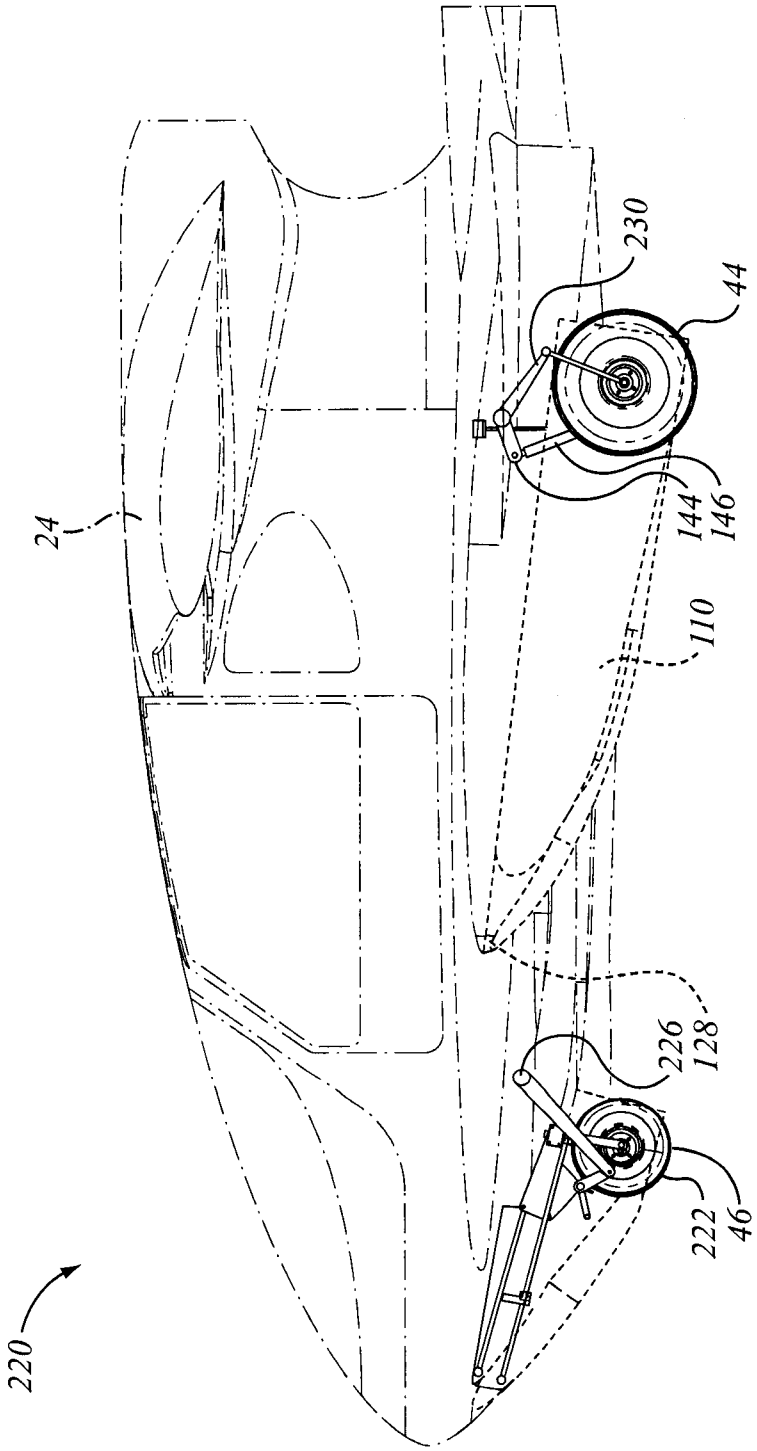


FIG. 11a

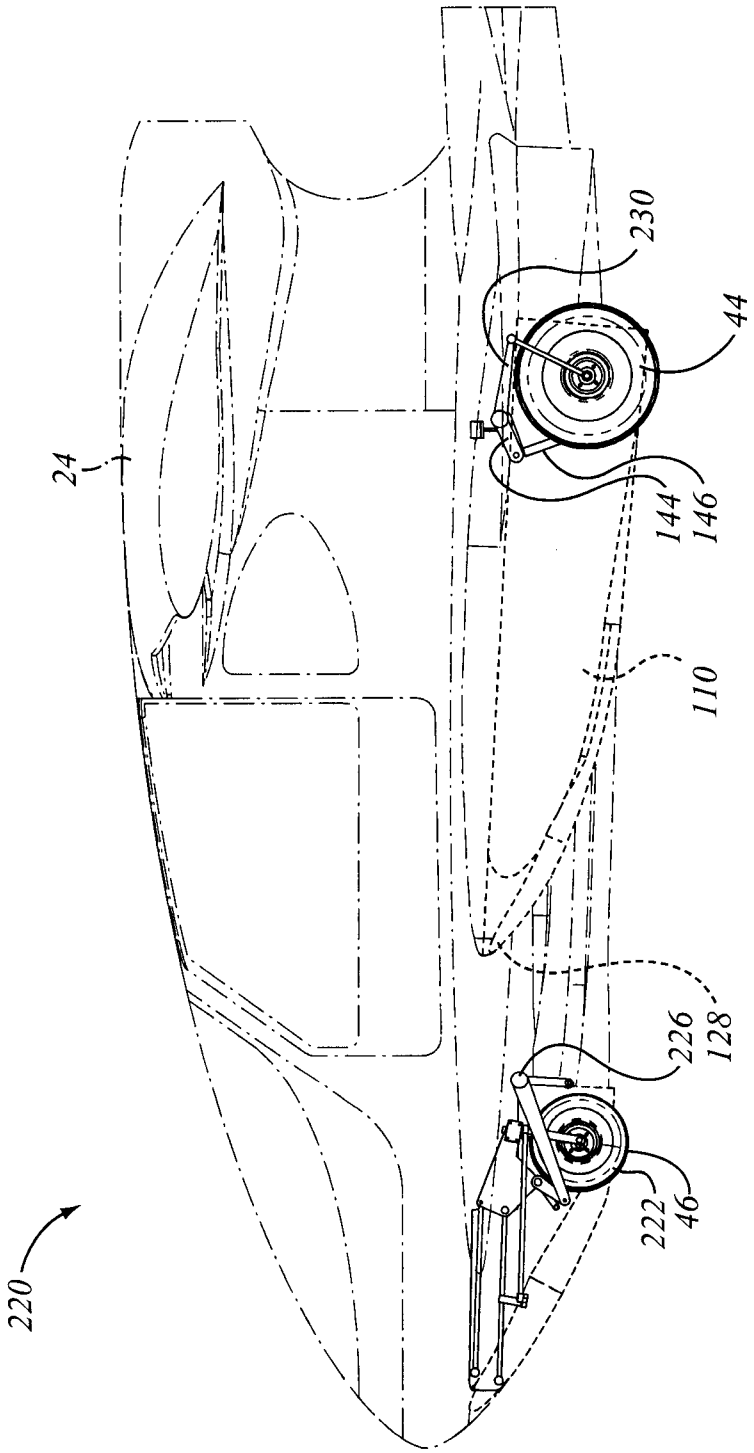
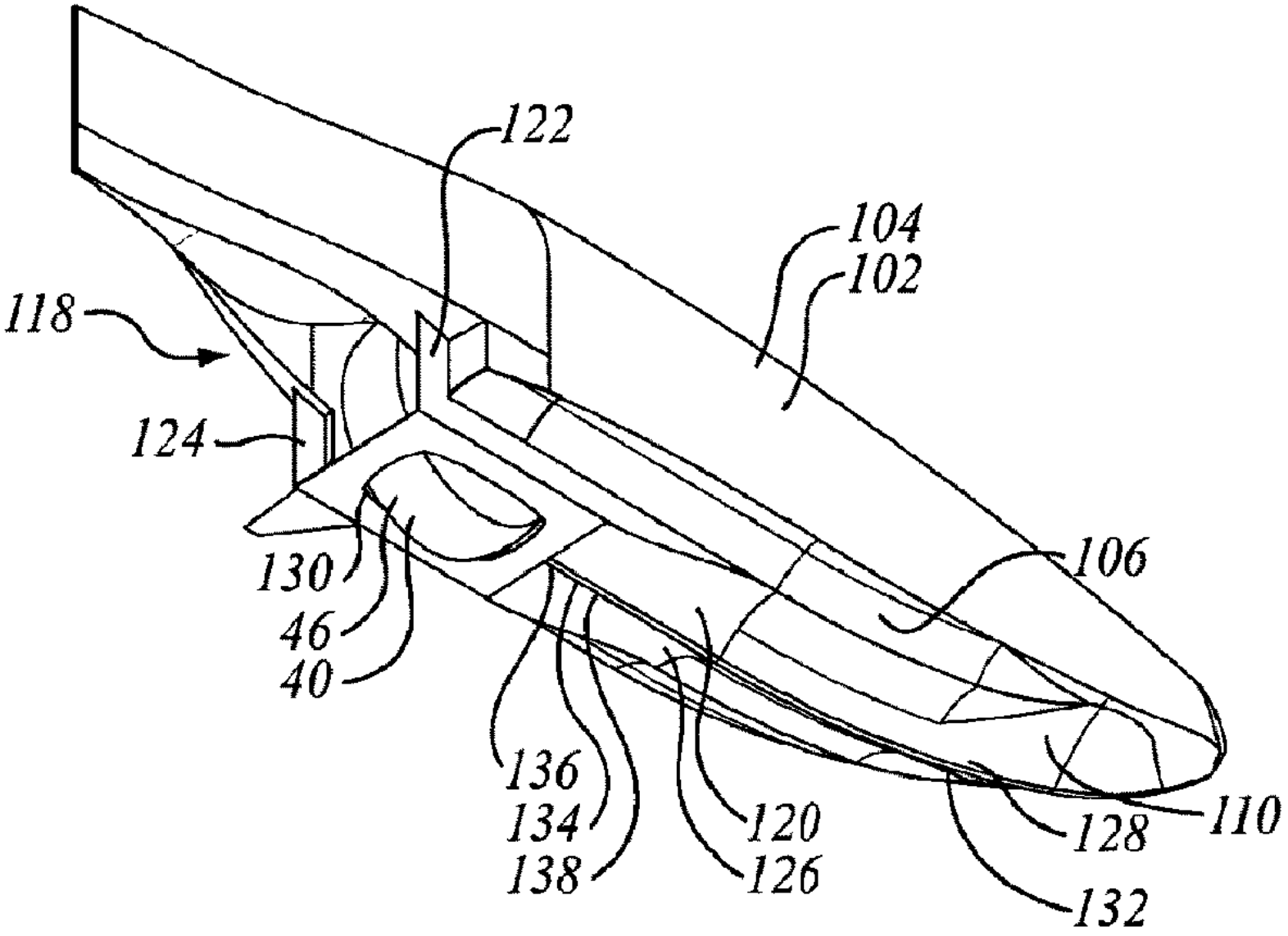


FIG. 11b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