May 27, 1930. C. W. HALL 1,760,644

LANDING GEAR FOR AIRPLANES

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Fig. 1.

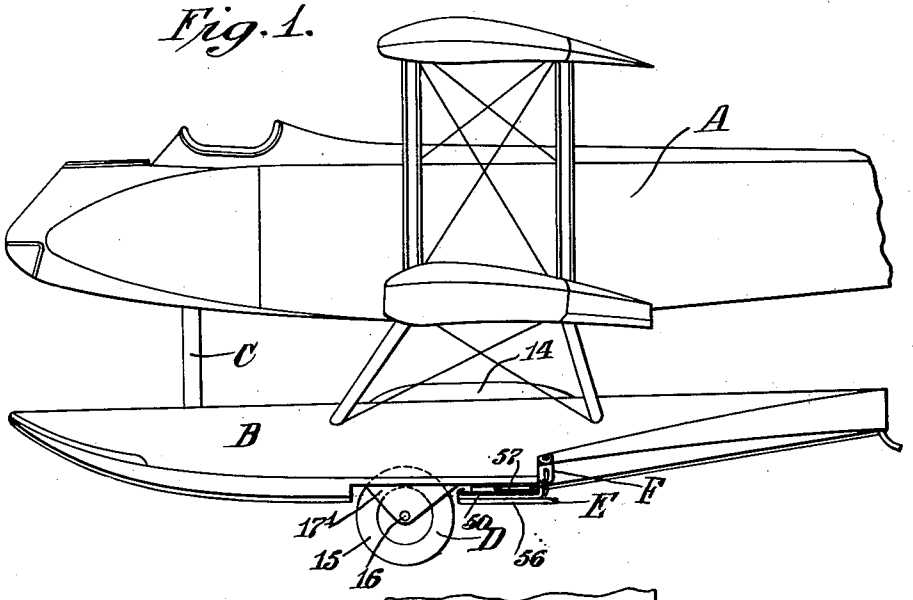
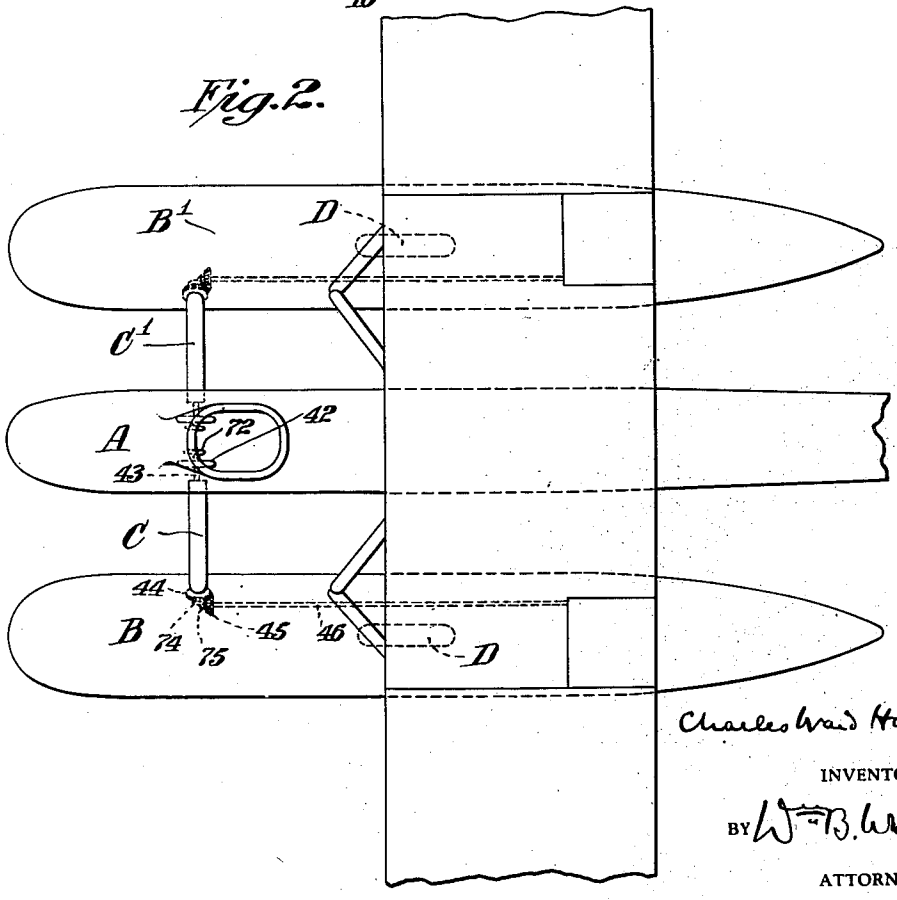


Fig. 2.



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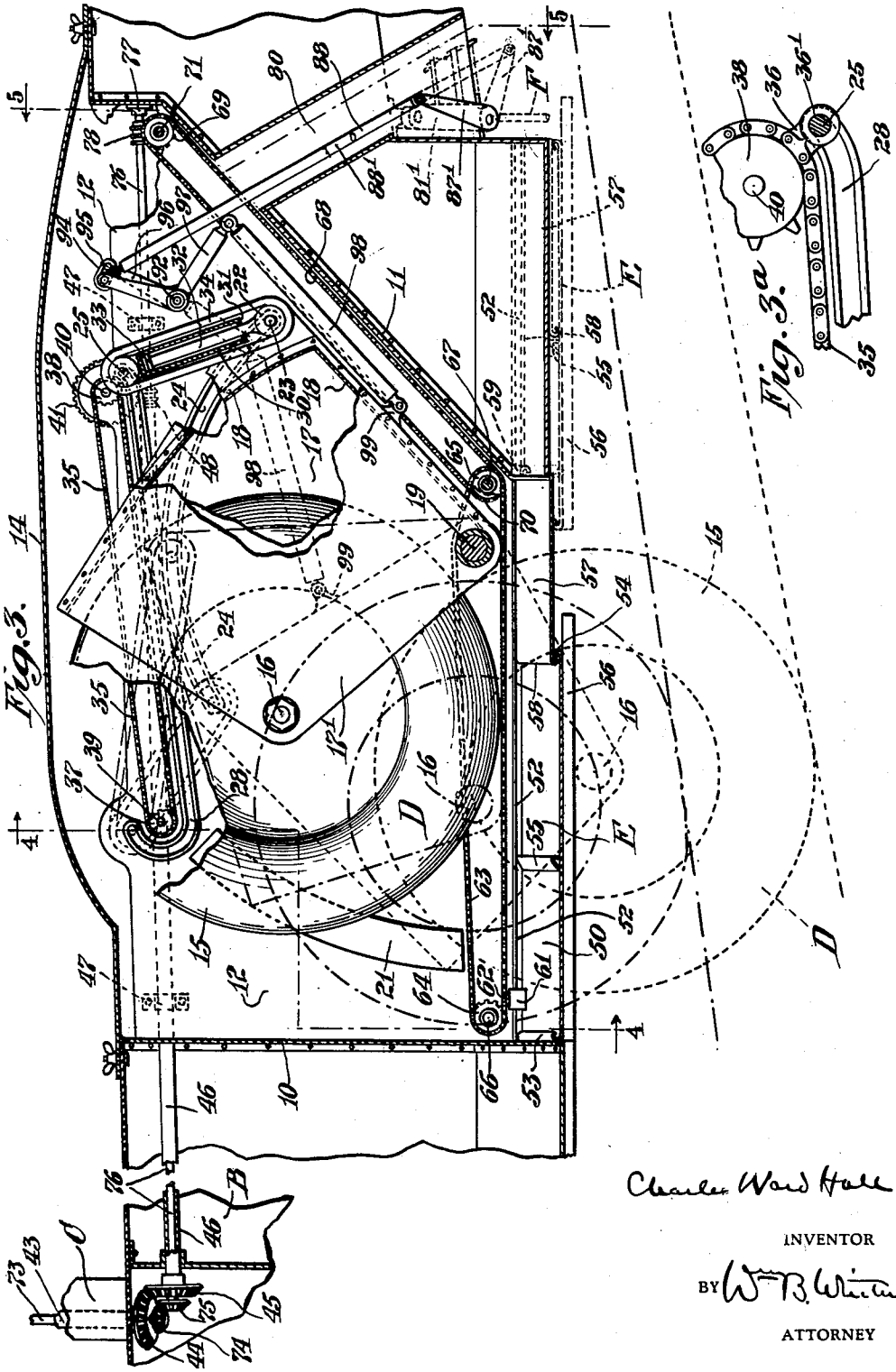


Fig. 3.

Fig. 3a.

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LANDING GEAR FOR AIRPLANES

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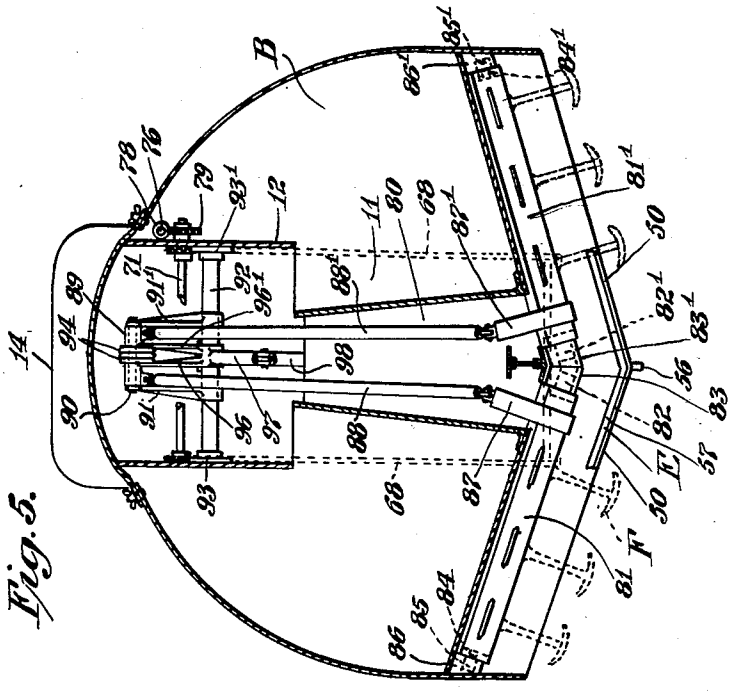


Fig. 5.

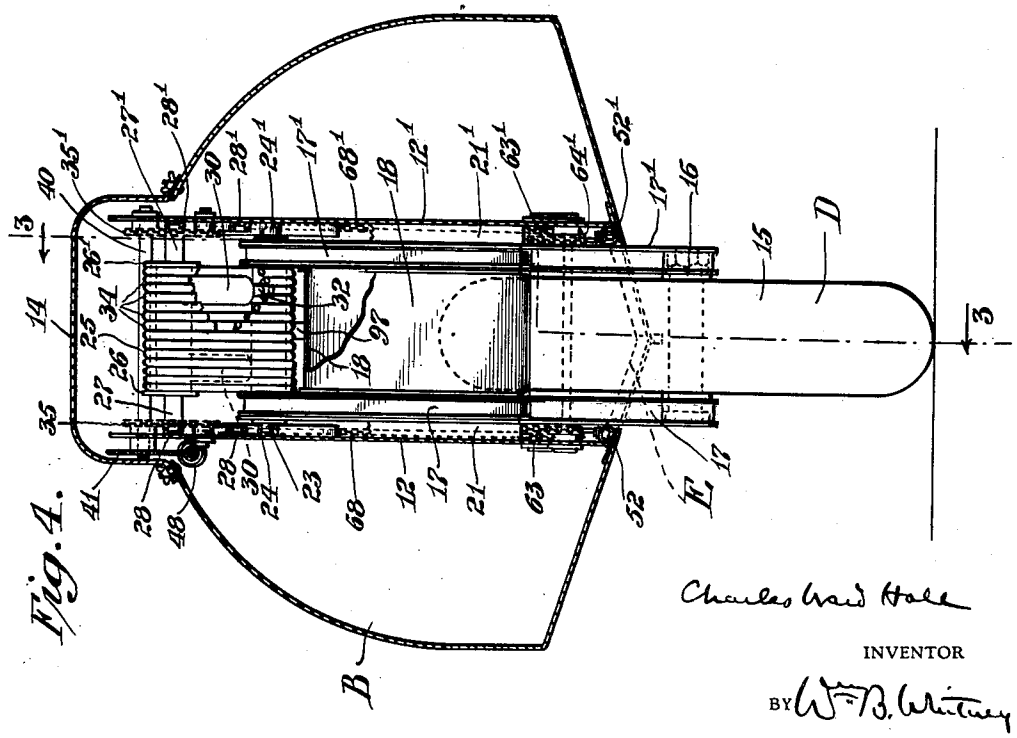


Fig. 4.

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LANDING GEAR FOR AIRPLANES

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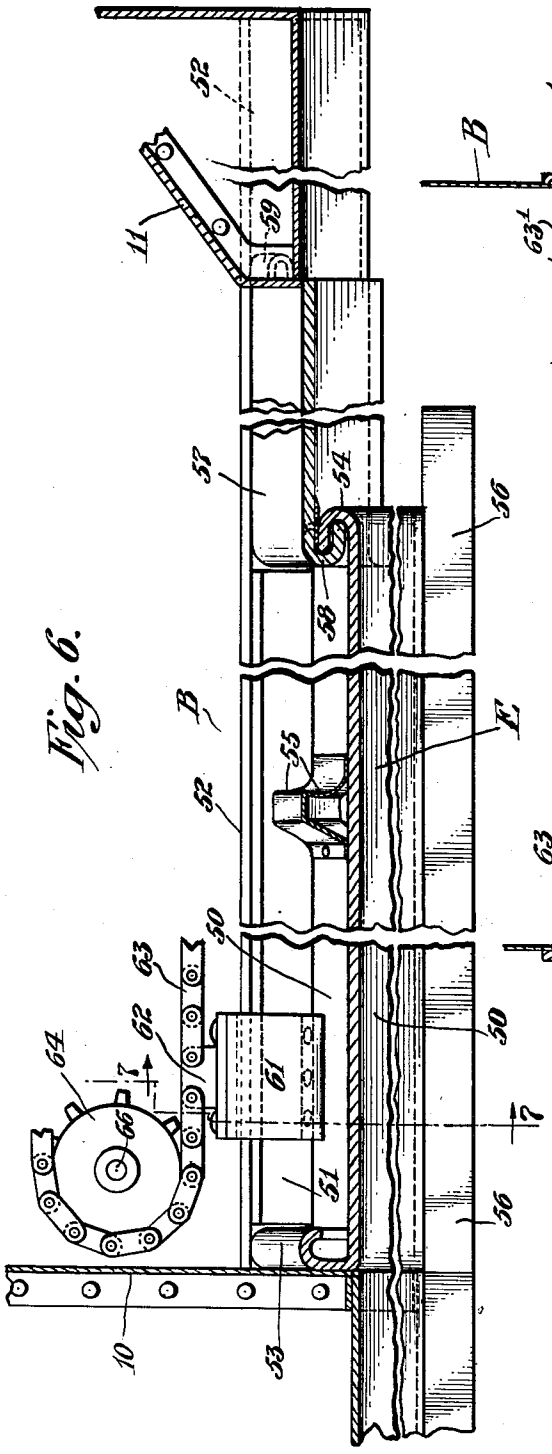


Fig. 6.

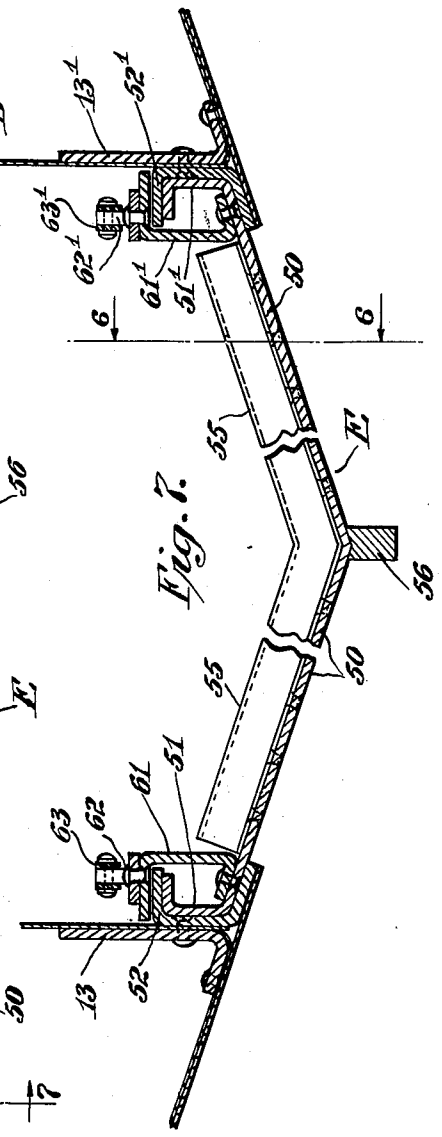


Fig. 7.

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Patented May 27, 1930

1,760,644

UNITED STATES PATENT OFFICE

CHARLES WARD HALL, OF LARCHMONT, NEW YORK

LANDING GEAR FOR AIRPLANES

Application filed June 11, 1927. Serial No. 198,028.

This invention relates to airplanes, and the object thereof is to provide an improved landing gear, of the retractable type, applicable alike to land and water planes but designed more particularly for use in connection with water planes, to thereby enable such planes to alight on and to take off from the land or the deck of a ship as required.

To this end the invention comprises, as its principal feature, a landing wheel journaled in a carriage or frame which is retractably mounted within an open-bottomed well housing built therefor into the fuselage of a land plane or into the boat body, or each of the floats, of a water plane so that, under control of an operator in the cockpit of the machine, the carriage and wheel can be lowered down to and locked in extended operative position and can be withdrawn either wholly or, in the case of a land plane, at least partially within the well.

Another feature is a closure for the open bottom of the wheel well, also controllable from the cockpit of the machine, whereby, when the landing wheel has been drawn up therein, the bottom of the well can be closed, to thereby lessen the drag of the machine in and so facilitate it in taking off from the water as well as to reduce resistance in flight.

A further feature consists in the provision of landing hooks or grapples which are so connected with the carriage or frame of the landing wheel that they will be automatically extended to operative position on the lowering of the wheel and will be raised out of the way when the landing wheel is retracted.

Still other features are found in the various novel structural details hereinafter described and particularly pointed out in the appended claims.

One practical embodiment of the invention is shown, by way of illustration and not of limitation, in the accompanying drawings, in which—

Figures 1 and 2 are views, more or less diagrammatic, showing in side elevation and in plan respectively the major portion of a double-float water plane in which are combined the several features of my invention; Fig. 3 is a longitudinal section through the well and adjacent portions of one of the floats substantially on the line 3 3 of Fig. 4, showing the landing gear and the landing hooks, mostly in side elevation but with parts broken away and in section, as the same appear when the landing wheel is in its retracted position and the bottom of the well is closed; Fig. 3ª is an enlarged detail; Fig. 4 is a transverse section on the line 4 4 of Fig. 3, looking aft, but showing the bottom of the well open and the landing gear extended therefrom to operative position, all of the framework and braces of the float outside of the well being omitted for the sake of clarity; Fig. 5 is a similar transverse section on the line 5 5 of Fig. 3, looking forward, showing the landing hooks and the actuating mechanism therefor in the same retracted position in which they are shown in Fig. 3; and Figs. 6 and 7 are enlarged details showing the closure for the bottom of the landing gear well in longitudinal section on the line 6 6 of Fig. 7 and in transverse section on the line 7 7 of Fig. 6, respectively.

Referring to the drawings, A is the fuselage and B B′ are the floats of the water plane. The fuselage and two floats are connected in the usual or in any suitable manner, and, in addition, the interior of the fuselage is connected with the interior of each of the floats by hollow stream-line fairings C C′ through which pass the shafts controlling the landing gear. These parts preferably are of an all metallic frame and structural skin construction similar to that shown and described in Letters Patent No. 1,609,468, bearing date December 7, 1926. The reference letters D, E and F indicate generally the landing gear, the closure for the bottom of the landing gear well, and the landing hooks, respectively, with which each of the floats is equipped.

As shown in Figs. 3 and 4, the well housing for the landing gear, which in each float is located just forward of the step in its bottom, is formed by a vertically disposed transverse bulkhead 10 and a downwardly and forwardly inclined transverse bulkhead 11, constituting its front and rear walls, and by two parallel plates 12 12′ which provide its side walls. The flanged edges of the two

bulkheads are joined to the skin bottom and sides of the float as usual, and the two side plates are joined to the bulkheads by flanged ends and along their lower edges to spaced parallel frame members 13 13′ to the flanges of which the bottom skin of the float is joined, all of the joints being made watertight in the usual or in any suitable manner. The top of the well is covered by a low-domed plate 14, which is removably secured in place at its flanged edges in any suitable way—for instance, by bolts fitted with butterfly nuts similar to those used to secure the hood covering the engine of an automobile. The bottom of the well is provided with the sliding closure E hereinafter described in detail.

The single landing wheel 15, of the usual type, is journaled upon an axle 16 suitably fixed in one of the corners of two plates 17 17′, preferably plates built up of light sheets and spacer channels, which are joined along or near two of their sides by a flanged web 18 and constitute a carriage or frame for the wheel. The wheel carriage in turn is pivotally mounted, at a corner adjacent the corner carrying the axle of the landing wheel, upon an axle 19 the ends of which are fixed in the opposite side walls of the well, and is held in position centrally thereof by suitable journal fittings and, further, as it swings between them, by two arc-shaped rubbing strips 21 21′ fixed to the opposite walls of the well. In a third corner of the wheel carriage, diagonally opposite the axle of the wheel, is rotatably mounted between its two side plates, outside of the connecting web, a transverse member 22 consisting, for convenience, of a piece of tubing which is loosely mounted on a tubular rod 23 fixed at its ends in the sides of the wheel carriage. The end fittings of the rod 23 project beyond the carriage on either side into, and slide within, the slots of two segmental guides 24 24′ fixed to the opposite side walls of the well and curving in the arc of a circle about the pivot rod 19 as a center. A corresponding transverse member 25, which however can conveniently be made as a single piece, is provided with two spool-disks 26 26′ and, outside thereof, its end fittings 27 27′ extend into and slide and turn within the slots of two straight guides 28 28′, curved in the arc of a small circle slightly upward at their rear and upward and slightly back at their forward ends, which also are fixed to the opposite side walls of the well. These two members are yieldingly connected, so that they will normally be held in definite spaced relationship but may move apart to a limited extent, by two telescopic connections, each as shown consisting of a tubular section 30 which is secured at one end by a suitable fitting to the member 25 and is provided at its other end with an inwardly projecting shoulder 31 and slidably mounted therein a second section 32 which is locked against withdrawal therefrom by a head 33 and is similarly secured at its outer end to the member 22, and by a number of elastic shock-absorber bands 34 34 which are strung upon the members 22 and 25. The member 25 is, in addition, operatively connected on the opposite sides of the wheel carriage with two chains 35 35′, as here shown by the insertion in each chain of a special outwardly-projecting link 36 provided with an opening 36′ through which an end fitting 27 is passed, which chains are respectively carried in fixed parallel relationship with the upper guides 28 28′ on sprocket-wheels 37 38 and 37′ 38′ fixed on shafts 39 and 40 the latter extending across the well and both journaled in bearings in its side walls. The shaft 40, which extends through the well wall 12 and outside thereof carries a worm-gear 41, is rotatable from the cockpit of the machine by means of a hand-wheel 42 therein fixed to the end of a tubular shaft 43 which extends down through the fairing C into the float and is there connected by bevel-gears 44 and 45 with a second tubular shaft 46, which latter shaft, journaled in suitable bearings 47 attached to the outside of the well wall 12 and to the frame of the float forward of the well, carries at its rear end a worm 48 in mesh with the worm-gear 41.

The landing wheel in each float is manipulated and operates as follows: To extend or to retract the wheel, the hand-wheel 42 is turned to rotate the shaft 40 until the member 25 has been shifted by the sprocket chains either forwardly and up to the extreme forward ends of the slots in the upper guides, thereby shifting the member 22 forwardly within the lower guides to the forward ends thereof and so swinging the wheel carriage and landing wheel downwardly, or rearwardly to the extreme rear ends of the upper guide slots, to thereby shift the member 22 rearwardly to the rear ends of the lower guides and so raise the wheel carriage and landing wheel. In either position, whether retracted and with the various parts positioned as shown in full lines in Fig. 3 or extended to thereby shift the parts to the position indicated in dotted lines in Fig. 3, the weight of the wheel is transmitted through the wheel carriage and the connections provided to the member 25 and produces in such member an upward thrust, beyond the center of the curved ends of the guides, which holds it seated against the ends of the slots therein; and when, on effecting a landing, the extended wheel is forced up within the well to the position indicated by the dash and dot lines, Fig. 3, and the thrust of the member 25 has been converted by the stretching of the rubber bands from an upward thrust to a downward and rearward

pull, this member is still and even more firmly held seated against the ends of the slots in the forward curved ends of the guides. Thus, whether the landing wheel is extended or retracted, the thrust transmitted therefrom to the member 25 will in all cases be directed against and be sustained by the walls of the slots in the guides, in a manner to lock the wheel in the position in which it has been set, without strain upon the sprocket chains.

Furthermore, it is to be noted that, since the wheel carriage is mounted to rock about an axle located at the rear end of the well, the axis of the landing wheel when the wheel is lowered to operative position will be shifted first forwardly and then rearwardly to a position below the axis of the carriage. Hence, when under the absorbing shock on landing the wheel is pressed upwardly (i. e., back within the well) it will at the same time be shifted forwards and so increase the angle from the center of gravity of the machine to the axis of the wheel, usually between 13° and 17°, and thereby give increased landing stability to heavily loaded airplanes.

The sliding door E here provided for the closure of the bottom of the wheel well in each float is of sheet metal, of a V-section conforming to that of the bottom of the float, and, because of the lack of space between the rear end of the well and the step and to avoid an extension thereof when open beyond the step, is made in two sections which overlap and slide one upon the other. The forward section 50 is upset along each side to provide parallel upwardly projecting slide-bearings 51 51′ which fit loosely within track channels 52 52′, which channels throughout the length of the well are secured through its side walls to the frame members 13 13′ and, extending rearwardly therefrom to the step, outside of the bottom skin, are suitably secured through the skin to the frame of the float. This section is also upset upwardly at both ends, to provide at the forward end a stiffening flange 53 and at its rear end a hooked lip 54 serving both as a stiffener and as an interlock; and, in addition, has fixed to its upper side a shaped transverse strike 55, and to its lower side a central longitudinal keel member 56, which constitutes a continuation of the keel of the float and which projects rearwardly beyond the rear end of the section for the purpose hereinafter specified. The rear door section 57, of suitable width, is upset at its forward end, which overlaps the rear end of the forward section, to form an upwardly-projecting hooked interlock lip 58 adapted both to cooperate with the lip 53 of the forward section and to provide at each end thereof slide-bearings loosely fitting within the slide-bearings of the forward section, and at its rear end to provide on its opposite sides slide-bearings 59 (one only shown) fitting loosely within the two track channels. For the opening and closing of the door, the forward section 50 is rigidly secured at each side, by a suitably shaped connection 61, to a special link 62 set into each of two chains 63 63′ which are carried, on the opposite sides of the well, upon sprocket-wheels 64 65 and 64′ 65′ fixed respectively on shafts 66 and 67 journaled in bearings in the sides of the well. The rear shaft 67 is driven from an upper shaft 71, likewise journaled in bearings in the sides of the well, by a chain 68 which is carried on sprocket-wheels 69 and 70 fixed respectively on the shafts 67 and 71. Although not necessary, a similar chain and sprocket connection may be provided, if desired, on the opposite side of the well. The shaft 71 is in turn driven, from the cockpit of the machine, by means of a hand-wheel 72 fixed therein to the end of a shaft 73 extending through the tubular shaft 43 and connected by bevel-gears 74 and 75 with a shaft 76, which latter shaft extends through the tubular shaft 46 and carries adjacent its rear end, suitably supported in a bearing 77 on the bulkhead 11, a worm 78 meshing with a worm-gear 79 fixed on the end of the shaft 71, outside the well wall 12.

Thus, as is apparent, when the hand-wheel 72 is turned in one direction, to open the door, the forward door plate will be shifted rearwardly beneath the rear plate until the strike engages the forward end of the latter and then will push that plate backward with it, and that, when the rotation of the hand-wheel 72 is reversed, the forward door plate will be shifted forwardly beneath the rear plate until its rear hooked lip engages the hooked lip of the latter and so draw it forward to close the well. The closure provided is not watertight, but for all practical purposes such a closure is not necessary. There should, however, be no leakage of water from the well into the interior of the float. Hence, the bearings for the shafts 66 and 67, if carried through the walls of the well, should be provided with stuffing boxes or otherwise suitably enclosed. The bearings of the shaft 71, which is located above the water line, need not be watertight.

The landing hooks F, with which each float is here equipped, are rigidly carried by two transverse rock-bars 81 81′ which are mounted on the bottom of the float, on the opposite sides of its keel, immediately behind the step, and for their operative connection with the carriage of the landing wheel there is provided a subsidiary well 80 which at its upper end opens into the main well through the rear bulkhead 11 and at the lower end, open to the bottom of the float, its walls are joined to the bottom skin by watertight joints. Preferably tubular as shown, these rock-bars are provided at their adjoining inner ends with reduced fittings 82 82′ which

are journaled in bearing-blocks 83 83′ secured to the frame of the float and at their outer ends are provided with fittings 84 84′ bored to receive the ends of screw-pins 85 85′ set into threaded openings in bearing-blocks 86 86′ also secured to the frame of the float, and they carry horns 87 87′ fixed at their inner ends. To the outer ends of these horns are pivoted links 88 88′ which, extending up through the subsidiary well, are in turn pivoted between lugs on a tubular head 89 rotatable upon a pin 90 set into and connecting the outer ends of two horns 91 91′ which are loosely mounted upon a transverse shaft 92 journaled in bearings 93 93′ fixed to the sides of the main well. The head 89 is yieldingly connected by elastic shock-absorber bands 94 to a tube 95 set into and connecting the outer ends of two horns 96 96′ which, with an integral horn 97 forming therewith a bell-lever, are fixed to the shaft 92 between the horns 87 87′. The horn 97 is pivotally connected at its outer end by a link 98 to a lug 99 fixed centrally on the connecting web 18 at the back of the wheel carriage. Accordingly, when the wheel carriage is swung forwardly and downwardly to lower the landing wheel to operative position, the rock-bars will be so rocked as to swing the landing hooks perpendicularly downward into their operative position, and the retraction of the landing wheel will likewise swing the hooks back and up, out of the way, against the bottom of the float. Moreover, since the door of the well must be opened before the landing wheel and with it the hooks can be lowered, the projecting rear end of the keel member carried by the forward door section will be in a position, slightly lower than and extending past the hooks when lowered, to press down, and so prevent the hooks from catching, the landing cables which are usually stretched transversely across the landing surface. The links 88 88′ and the link 98 are, like the rock-bars, preferably made of tubing, to which are secured the necessary end fittings.

Whenever this single landing wheel is applied to the central fuselage of a land plane or to the central boat body of a water plane such plane is, of course, to be provided with suitable lateral balancing wheels or floats as the case may be; and the plane, if it carries landing hooks, must also be equipped with a long-shanked arresting hook as shown, for example, in Letters Patent No. 1,562,549, bearing date November 24, 1925.

While the construction shown and described has proven entirely satisfactory and is the construction now deemed best suited for the purpose, it is to be understood that each of its several features may be variously modified in their structural details, as by the substitution of equivalents, and that one or more of these features may be used without the others, within the scope of the appended claims, without departing from the spirit or sacrificing the substantial advantages of the invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an airplane, the combination of a body member, a landing wheel movably mounted therein, means for shifting the wheel downwardly and yieldingly securing it in operative position partially extended below the bottom of the body member and for withdrawing it within said body member, and means for directing the upward and downward movement of the wheel whereby when in extended operative position the axis of the wheel will be shifted forwardly with respect to the center of gravity of the machine in absorbing the shock on landing.

2. In an airplane, a retractably mounted landing wheel, a plurality of retractably mounted landing hooks, and means controllable by the operator of the machine and including an operative connection between wheel and hooks for simultaneously effecting the extension and retraction of said wheel and said hooks.

3. In an airplane, the combination of a body member provided with a well housing open at the bottom thereof, a landing wheel retractably mounted within said housing, a sliding closure for the bottom of said housing, and separate means each controllable by the operator of the machine for effecting the actuation of said sliding closure and for extending and retracting said wheel.

4. In an airplane, the combination of a body member provided with a well housing open at the bottom thereof, a landing wheel retractably mounted within said housing, a closure for the bottom of said housing, a plurality of landing hooks retractably mounted on the bottom of said body member, and means controllable by the operator of the machine both for effecting the actuation of said closure and for simultaneously extending and retracting said wheel and said hooks.

5. In an airplane, the combination of a body member, a housing centrally located in the body member and open at the bottom thereof, a landing wheel movably mounted within said housing to rock about a transverse axis adjoining the rear end thereof and slightly above the bottom of the body member, and means controllable by the operator of the machine whereby the landing wheel can be swung downwards to and yieldingly secured in operative position partially extended below the bottom of the body member, with its own axis substantially below the axis about which it rocks, and can be retracted and supported within said housing.

6. In a water plane, the combination of a flotation body, a centrally located well housing in said body open at the bottom thereof, a single landing wheel movably mounted

within said well housing, and means controllable by the operator of the plane whereby the landing wheel can be moved downwardly to and yieldingly secured in operative position partially extended below the bottom of the body and can be retracted and supported within the well housing, the wheel being so mounted that in reacting to landing shocks when secured in operative extended position its axis will be shifted forwardly with respect to the center of gravity of the machine.

7. In a water plane, the combination of a flotation body, a well housing in said body open at the bottom thereof, a landing wheel movably mounted within the well housing, means controllable by the operator of the machine whereby the landing wheel can be lowered to and yieldingly secured in operative position partially extended below the bottom of the body and can be retracted and supported within the well housing, and a sliding closure for the open bottom of the well housing and means also controllable by the operator of the machine for shifting said closure to open and closed positions independently of the raising and lowering of the landing wheel.

8. In an airplane, the combination of a body member, a housing in said body member open at the bottom thereof, a landing wheel movably mounted within said housing, means controllable by the operator of the machine whereby the landing wheel can be moved downwardly to and secured in operative position partially extended below the bottom of the body member and can be retracted and supported within said housing, a transverse series of landing hooks rotatably mounted on the bottom of the body member, and operative connections between said wheel and said hooks whereby the hooks will be extended downwardly when the wheel is in extended operative position and will be raised when the wheel is retracted.

9. In a water plane, the combination of a flotation body, a housing in the body open at the bottom thereof, a landing wheel movably mounted within the housing, a closure for the open bottom of the housing, a series of landing hooks pivotally mounted on the bottom of the body, means controllable by the operator of the machine whereby said closure can be actuated, means also controllable by the operator of the machine whereby said landing wheel can be moved downwardly to and secured in operative position partially extended below the bottom of the body and can be retracted and supported within the housing, and operative connections between said landing wheel and said landing hooks whereby when the wheel is extended to operative position the hooks will be swung down to operative position and when the wheel is retracted the hooks will be swung up out of operative position.

10. In an airplane, the combination of a body member having an opening in the bottom thereof, a landing wheel, a carriage for said wheel pivotally mounted at its rear end within the body member to swing between fixed limits in a vertical plane parallel to the longitudinal axis of said body member, to thereby extend the wheel first forwardly and then rearwardly downwards partially through the opening in, and to raise it above the bottom of, the body member, means controlled from the cockpit of the machine and operable to rock the wheel carriage up and down and to yieldingly secure it at the limit of its downward movement and to support it at the limit of its upward movement.

11. In an airplane, the combination of a body member, a housing built in said body member and open at the bottom thereof, a landing wheel, a carriage for said wheel pivotally mounted at its rear end within the housing to swing the landing wheel between fixed limits forwardly and then rearwardly downwards through the open bottom of and forwardly and then rearwardly upwards within the housing, a member operatively connected with the wheel carriage and slidably movable within fixed limits in the housing, in one direction to thereby swing the wheel carriage to the limit of its downward movement and to yieldingly hold it locked thereat and in the opposite direction to thereby swing the wheel carriage to and support it at the limit of its upward movement, and means controllable from the cockpit of the machine for shifting said member from one to the other limit of its movement.

12. In an airplane, the combination of a body member having an opening in the bottom thereof, a landing wheel, a carriage for said wheel pivotally mounted within the body member to swing within fixed limits in a vertical plane parallel to the longitudinal axis of the body member to thereby extend the wheel downwardly through the opening in and to raise it above the bottom of the body member, a member mounted within the body member to travel forward and back above the wheel carriage in guides limiting the extent both of its forward and rearward movement, connections between said member and the wheel carriage whereby the latter is yieldingly held in fixed spaced relationship with said member but is permitted to move to a limited extent away therefrom, and means controllable by the operator of the machine for shifting said member within the guides from the one extreme to the other of its movement therein, the ends of the guides being so shaped and located that all thrust transmitted from the landing wheel through the wheel carriage and connections to said member will

be directed against and sustained by the walls of the guides.

13. In an airplane, the combination of a body member, a well housing in the body member open at the bottom thereof, a landing wheel, a carriage for the wheel pivotally mounted within the housing to swing therein to a limited extent, to extend the wheel partially through the opening in and below the bottom of the body member and to retract it within the housing, horizontal slotted guides mounted on opposite sides of the housing above the wheel carriage, a member mounted to slide forward and back within the slots of the guides between the ends thereof, means controllable by the operator of the machine for shifting said member from one end to the other of the slotted guides, and connections between said member and the wheel carriage permitting a limited movement thereof to and from each other and yieldingly holding them at the limit of their movement towards each other, the several parts being so related that when said member and said wheel carriage are at the limit either of their forward or of their rearward movement within the well housing the thrust transmitted through the wheel carriage to said member will be in a direction to hold the latter seated against the walls of the slots at the ends of the guides.

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