

Nov. 29, 1966

G. S. PADIAL

3,288,236

HYDRO-AIR CUSHION VESSELS

Filed Jan. 5, 1965

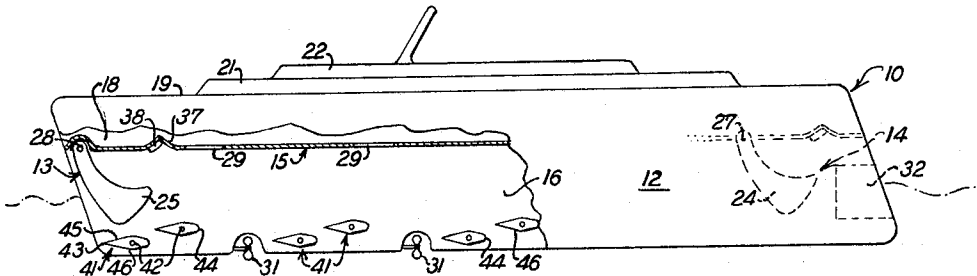


Fig. 1

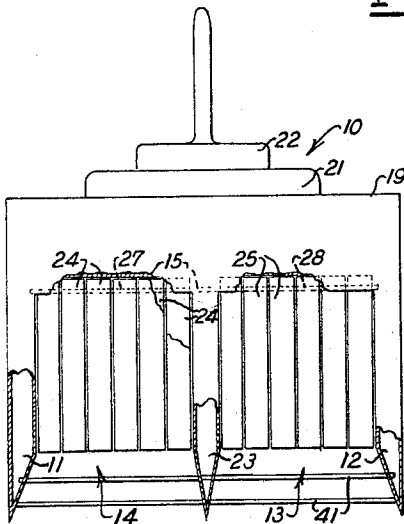


Fig. 2

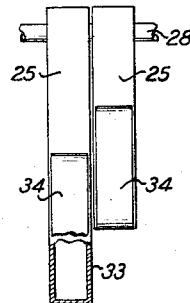


Fig. 4

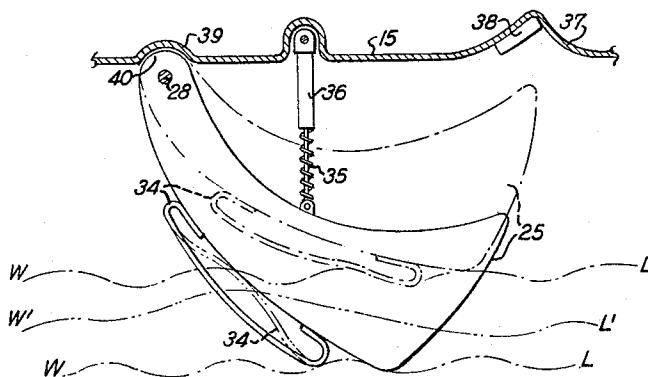


Fig. 3

INVENTOR

G. SOLOMON PADIAL

BY

John F. Hart
ATTORNEY

1

3,288,236

HYDRO-AIR CUSHION VESSELS
Guillermo Solomon Padial, Apartado 13068,
Madrid, Spain
Filed Jan. 5, 1965, Ser. No. 423,418
2 Claims. (Cl. 180-7)

This invention relates to air cushion vehicles and more particularly to a high sea going air cushion vessel especially adapted to carrying high payloads at high speeds in rough waters.

In the past numerous air cushion vehicles have been devised both for use on land and on water. Of the latter variety, the vehicles or vessels have only proved satisfactory in calm waters at low speeds. The deficiencies in prior vessels have been primarily traced to ineffective sealing of the air chambers at the bows and sterns of the vessels.

Generally the bows and sterns of vessels of the indicated type have been sealed with various types of pivotally mounted doors. These doors, together with the sides of the vessel, form completely enclosed air chambers in which air cushions are maintained. The vessels ride on the air cushions with the doors and the sides of the vessel submerged in the water. The doors must be pivotal to permit debris to pass under the vessels. Moreover since V-hulls are not ordinarily used, the doors must swing to let high waves in rough seas pass through the air chambers without upsetting the vessels or causing severe rolling which would upset the cargo. Prior known doors have been single units which when opened permit large amounts of air to escape thus destroying the air cushions. This is especially serious in rough seas or in debris loaded areas, because it is necessary to swing the door open so often, that the air seals are completely destroyed and the efficiency of the vessels is at a minimum. Furthermore, rough waves and debris banging away at the doors of such vessel soon deteriorate the doors and cause severe shock waves to be transmitted throughout the vessels, which shock waves cause damage both to the cargo and to the vessels. In order to eliminate the above-mentioned difficulties, it is necessary that new and improved bow and stern doors be provided that are capable of absorbing shock and allowing waves and debris to constantly pass through an air chamber without destroying the air cushion.

It is the primary object of this invention to provide new and improved doors for sealing the bows and sterns of hydro-air cushion vessels.

It is another object of this invention to provide for such vessels bow and stern sealing doors which have facilities for absorbing shock and instrumentalities for regulating the force necessary to open the doors.

It is a further object of this invention to provide bow and stern sealing doors constructed in such a way that various portions of the doors are separably openable.

With these and other objects in view, the present invention contemplates a hydro-air cushion vessel having bow and stern doors formed from a series of separately movable skids. The skids may be independently pivotally mounted and placed in close proximity to one another to minimize air loss. Regulating means, for example, hydraulic cylinders, may be provided for each skid to regulate the force necessary to pivot a skid open. Shock absorbers, such as collapsible leaf springs, may be attached to the impact receiving surface of each skid. Additionally the underside of the vehicle may be provided with impact absorbers in case the skids contact the underside of the vehicle.

With the foregoing structure, rough seas only pivot the skids open in the area of greatest impact. Since only a

2

relatively small portion of the door is opened, air loss is minimized and the air cushion is retained. The shock absorbers also minimize the deleterious effects of waves and debris contacting the doors. Therefore, both the vehicle and its cargo are effectively isolated from shock waves.

A more complete understanding of the present invention will be had by reading the following detailed description in conjunction with the drawing wherein:

FIGURE 1 is a partially sectioned side elevational view of an air cushion vessel having bow and stern doors formed from separately movable skids constructed in accordance with the principles of the present invention;

FIGURE 2 is a front end view of the vessel shown in FIGURE 1 and particularly illustrates the skids which form the doors of the vessel, one half of the front door being omitted in this view to provide a view of the skids in the rear door;

FIGURE 3 is an enlarged side elevational view of two of the skids and illustrates the means for regulating the force necessary to pivot a skid and a shock absorber for absorbing impact of waves and debris on the skids; and

FIGURE 4 is a front elevational view, partly in section, of the skids shown in FIGURE 3.

Referring now to FIGURES 1 and 2, an air cushion vessel 10 is shown having a catamaran hull construction. Vessel 10 includes spaced almost nonbuoyant vertical outer walls 11 and 12, bow and stern doors 13 and 14, and a horizontal floor 15 which define an enclosed air chamber 16. A fully enclosed cargo carrying area 18 is provided intermediate a horizontal floor 15 and the main deck 19. On the main deck, two enclosed areas 21 and 22 are provided for housing living quarters and a pilot house.

As shown in FIGURE 2, an intermediate vertical almost nonbuoyant hull section 23 is provided. To the left of the hull section 23 one half of the bow door 13 is omitted to expose a portion of the stern door 14 which is formed of a series of skids 24 placed adjacent to one another. As is shown to the right of hull section 23, the front or bow door 13 is shown to be also formed from a series of skids 25 placed adjacent to one another. The skids 24 are pivotally mounted on a horizontal shaft 27 which extends through hull section 23 and is secured at its ends in outer walls 11 and 12. Skids 25 are similarly pivotally mounted on a shaft 28 supported by outer walls 11 and 12 and hull section 23.

When the vessel 10 is resting in water fully loaded with cargo, the vessel is designed to float by water displacement in the manner common to boats. The height of walls 11 and 12 and section 23 will vary with the gross tonnage capacity or size of the vessel. Thus, if the vessel is designed for a gross tonnage of 5,000 tons, the height of walls 11 and 12 may be about 10 feet. While if the vessel is designed for a gross tonnage of 50,000 tons, the height of walls 11 and 12 may be about 30 feet. The upward buoyant force provided by the walls 11 and 12 and section 23 almost provides but enough buoyancy to carry their own weight when completely submerged. Consequently, when the vessel is at rest, walls 11, 12 and section 23 will be completely submerged, and the weight of the vessel will be supported in major part by the water displacement of the body of the ship above the floor 15.

After the vessel is loaded and ready for voyage, air must be forced into chamber 16 to build up an air cushion. As is known to the art, air for this purpose is supplied by fans (not shown) through one or more openings 29 in the floor 15 communicating with the air chamber 16. One such system of fans for producing an air cushion is disclosed in U.S. Patent 3,066,753. Such a fan system can readily be housed in the cargo carrying area

18. There are other fan systems known to the art for the indicated purpose.

The vehicle is propelled by a plurality of motor driven propellers 31 nested within the hull section 23. Propellers may also be nested within the lower ends of walls 11 and 12. In FIGURE 1, a steering rudder 32 is shown which forms an integral part of wall 11. A similar rudder may also be provided at the rear of wall 12. During navigation stability is provided by automatically adjustable hydrofoils 41 which may be secured on shafts 42 extending between walls 11 and 12 (compare FIGURES 1 and 2). The hydrofoils are positioned on the shafts with the edges 43 and 44 thereof on a horizontal plane. The surfaces 45 and 46 of hydrofoils 41 are symmetrical with respect to the horizontal and therefore help maintain the vehicle horizontal at any given depth. Also, the hydrofoils may be hollow to support some of the weight of the vehicle.

It will be understood from the foregoing, that when the vessel is in dock without air in the chamber 16, the weight of the vessel is supported substantially by water displacement in the usual fashion. When the vessel is moving slowly as in entering or leaving port, maneuvering, etc., it may be supported completely either by water displacement, or by an air cushion built up in the chamber 16 to a thickness of one or two feet in which condition the major portion of the walls 11 and 12 and section 23 will still be submerged and thus provide a substantial stabilizing action on the vessel. When the vessel picks up speed, the hydrofoils 41 function as weight supporters causing the vessel 10 to move upward out of the water thus enabling the air cushion to be built up. As the air cushion in the chamber 16 builds up, the vessel will move upward out of the water until a predetermined height of walls 11 and 12 and section 23 remain submerged. This height will be determined by conditions present at that time, such as the roughness of the water, among other things, and will be such that the air cushion will not be broken. Some of the air in chamber 16 will escape past the skids, but if the skids 24, 25 are properly positioned relatively close to one another, only negligible amounts of air will escape and can readily be taken care of by the fan system. In this condition of the ship the combined action of the stabilizing fins 41 and the speed of the vessel stabilize the vessel and maintain it on an even keel. The air cushion however, supports most of the weight of the vessel.

Referring now to FIGURES 3 and 4 which show by way of example a more detailed view of the construction of a pair of skids 25 as illustrative of the construction and arrangement of all the skids 24 and 25, the skids 25 are shown positioned adjacent to one another with a spacing, for example of $\frac{3}{4}$ of an inch. The skids are hollow (note FIGURE 4) and therefore support their own weight. The skids are of rectangular cross-section and have a thin wall 33 formed from a suitable material. The width of each skid specially at its free end is substantially greater than its thickness to permit the skids to swing relative to one another a substantial distance under the action of the waves without breaking the air seal. Thus, as is shown in FIGURE 3, the partially dotted skid 25 in the rear is shown raised relative to the other skid due to the action of the water, the levels of which are indicated by wavy lines W-L. Because of the widths and profile of the skids it will be noted that they can be pivoted substantial amounts relative to each other without disrupting the $\frac{3}{4}$ inch spacing therebetween and consequently will still function as an effective barrier against substantial leakage of the air in the air cushion. It will be understood that the remaining skids in each door may be relatively displaced in a similar fashion by the action of the waves or by debris without affecting the air seal. Each skid may be provided with an oval leaf spring 34 fixed to the impact receiving side of the skid. The manner in which these leaf springs 34 function is

indicated by the dotted line condition of the leaf spring shown on the front skid in FIG. 3 under the impact of a surge of water indicated by the dotted line W'-L'. Additionally each skid can be provided with a regulator, for example, the hydraulic cylinder 36 shown in FIGURE 3, to regulate the force necessary to swing a skid upward. When vehicle 10 is navigating in rough water or in debris littered areas, the regulators are adjusted to arrive at a balance between rough riding and air loss. This adjustment is normally governed by the experience of the captain of the vehicle, but may be automatically regulated. Of course, the skids must be partially submerged in the water to maintain an air seal. The floor 15 of the vessel also is shown having a recess 37 provided with an impact absorber 38, for example, a rubber block, to absorb shock if in the extreme case a skid should hit the underside of floor 15. Also, floor 15 may have a contoured portion 39 which complements ends 40 of skids 25 to minimize air loss.

It will be understood from the foregoing that when waves and debris contact the leaf springs 34, the springs give as shown in dotted lines in FIGURE 3 thus absorbing the initial impact. Next, regulators 36 absorb such shock and if the force is sufficient the skids are pivoted upward and permit the waves and debris to pass under the skids and into or out of the air chamber. The skids after being pivoted upward then immediately return into the water to again effect a seal. The weight of the skids cause a quick return of the skids to the water. The return of the front skids is assisted to some extent by the pressure of the air in the chamber 16. If quicker return of the skids to the water is desired, regulators 36 may be provided with springs 35 or other devices to apply a restoring force to the skids. In the construction illustrated the springs 35 will cooperate with the regulators 36 to cushion the impact of the shocks on the skids.

Of course, while a skid or skids are pivoted open, air is lost from the chamber. However, since only a relatively small portion of the door is opened, the air loss is extremely small. The waves and debris then pass through the chamber and contact the stern skids. Again the skids may or may not be pivoted open depending upon the force exerted by the waves or debris and the setting of the regulators, if used.

While I have disclosed a specific embodiment in which my invention may be practiced, it will be understood by those skilled in the art that numerous modifications may be made which fall within the spirit of the invention and the scope of the appended claims.

I claim:

1. A large, ocean-going, hydro-air cushion vessel having a hull with bow and stern ends and including a pair of spaced vertical side walls, a horizontal floor extending between the walls and spaced from the lower edges of the walls a sufficient distance so that the vessel when fully loaded and supported by compressed air will float with such floor above the water, a transverse series of skid members located at the bow of the hull, and a transverse series of skid members located at the stern of the hull, said skid members being individually pivotally mounted at their upper ends adjacent to the underside of the floor at the bow and stern of the hull and depending from such pivotal mounting to a point above the lower edges of the walls, said skid members in each of said series at the bow and stern ends of the hull having flat side walls and being adjacent to one another and extending between the walls to form substantially air-tight doors, said skid members, walls and floor forming an air chamber for supporting the vessel on an air cushion, means for introducing air into the chamber to form an air cushion, and said skid members being of lightweight construction and extending downwardly and rearwardly from the pivotal mountings thereof so that their lower ends trail during the movement of the vessel, said skid members having a width substantially greater than their thickness and such that the skid

5

members may be pivoted in the direction of their widths relative to one another a substantial distance and still overlap one another to maintain the air cushion in said chamber, each of said skid members increasing in width from the upper pivoted end thereof to the lower free trailing end thereof and having a substantially triangularly-shaped water engaging end portion, the apex of which is disposed downwardly and is located in spaced trailing relation to the pivotal mounting of said skid member, the forward edge of each skid member being convexly-shaped and of substantially greater radius of curvature than the edge of the apex in said triangularly-shaped end portion, and a plurality of horizontal stabilizers located in spaced relation longitudinally of the vessel and extending transversely from one of said walls to the other of said side walls, means pivotally supporting said stabilizers on the lower edge portions of said side walls, said stabilizers being automatically adjustable about their pivots to stabilize the vessel during the operation thereof.

2. A large, ocean-going, hydro-air cushion vessel having a hull with bow and stern ends and including a pair of spaced vertical side walls, a horizontal floor extending between the walls and spaced from the lower edges of the walls a sufficient distance so that the vessel when fully loaded and supported by compressed air will float with such floor above the water, a transverse series of skid members located at the bow of the hull, and a transverse series of skid members located at the stern of the hull, said skid members being individually pivotally mounted at their upper ends adjacent to the underside of the floor at the bow and stern of the hull and depending from such pivotal mounting to a point above the lower edges of the walls, said skid members in each of said series at the bow and stern ends of the hull having flat side walls and being adjacent to one another and extending between the walls to form substantially air-tight doors, said skid members, walls and floor forming an air chamber for supporting the vessel on an air cushion, means for introducing air into the chamber to form an air cushion, and said skid members being of lightweight construction and

6

extending downwardly and rearwardly from the pivotal mountings thereof so that their lower ends trail during the movement of the vessel, said skid members having a width substantially greater than their thickness and such that the skid members may be pivoted in the direction of their widths relative to one another a substantial distance and still overlap one another to maintain the air cushion in said chamber, each of said skid members increasing in width from the upper pivoted end thereof to the lower free trailing end thereof and having a substantially triangularly-shaped water engaging end portion, the apex of which is disposed downwardly and is located in spaced trailing relation to the pivotal mounting of said skid member, the forward edge of each skid member being convexly-shaped and of substantially greater radius of curvature than the edge of the apex in said triangularly-shaped end portion, and means for regulating the pivotal movements of each skid member during the operation of the vessel, said regulating means including means connected to the hull of the vessel and to the rear edge of each said skid member and automatically operative to cushion the rearward and upward movements of said skid member about its pivot and to tend to return the same to normal position.

References Cited by the Examiner

UNITED STATES PATENTS

2,631,794	3/1953	Warner.	
3,027,860	4/1962	Priest	180—7 X
3,137,262	6/1964	Tibbetts et al.	180—7 X
3,141,436	7/1964	Cathers et al.	180—7 X
3,146,752	9/1964	Ford	180—7 X
3,204,715	9/1965	Maloof	180—7

FOREIGN PATENTS

3,191,705	7/1965	Great Britain.
-----------	--------	----------------

A. HARRY LEVY, *Primary Examiner.*