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(54) **A HULL STRUCTURE FOR MULTI-HULL SHIPS**

RUMPFFORM FÜR MEHRRUMPFSCHIFFE

STRUCTURE DE COQUE POUR BATEAUX MULTICOQUES

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(56) References cited:
EP-A- 0 497 748
DE-A- 2 526 821
GB-A- 1 136 861

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Description

[0001] The present invention relates to a hull or a hull construction for use in connection with a multi-hull vessel. The invention relates particularly to a hull construction for use in connection with a vessel with two juxtaposed hulls which besides ensuring buoyancy gives improved sailing characteristics.

[0002] A great need of new types of vessels has arisen in connection with the development of vessels, especially for the transport of passengers, which vessels can at the same time achieve maximum safety for the passengers and sail with the highest possible speed with a minimum energy consumption, while taking into account the comfort of the passengers on board. Therefore, when developing new vessels special care must be taken of these four parameters which, however, are often contradictory. Thus it is difficult to ensure high passenger comfort in all weather conditions, while sailing at high speed.

[0003] Line navigation between two countries or two country regions with alternative connections necessitates vessels which are as fast as possible with minimum energy consumption so that the operation of the line is profitable and can compete on costs with the alternative forms of transport, as road or railway traffic over bridges or through tunnels. At the same time, the vessels must allow the loading of cargo of extremely different kinds, including vehicles. It has been acknowledged that especially catamarans can achieve the operational requirements demanded by the line operator, and great efforts are subsequently made to develop constructions of this kind presenting optimal technical characteristics.

[0004] There is a series of special parameters applying to a vessel in movement which influence the advance of the vessel through water and are included in the considerations of the ship constructor when forming the hulls which are a part of the multi-hull vessel construction. Among these parameters are water frictional drag and drag due to the weather conditions. Water frictional drag may usually be divided into still water drag and wave drag. Drag due to weather conditions includes contributions from drag and wind drag during sailing, but it should be mentioned that the wind drag acts on the superstructure of the vessel and therefore has normally no influence on dimensioning or configurating the hulls of the vessel.

[0005] The still water drag includes the actual frictional drag and the so-called wave drag. For a great number of vessels the frictional drag may constitute approx. 70% of the overall drag and it normally varies proportionally with the so-called wet surface of the vessel, i.e. the area of that part of the hull which is submerged at a certain moment. The wave drag is due to the waves provoked by the vessel itself, as the high pressure at the fore part of the hull results in a bow wave top and a system of so-called roaches is created at the aft part of the ship. These two wave systems will, depending on the hull configuration, either enhance or weaken each other. A correct configuration of the hull lines at the end of the foreship makes it possible to reduce the wave drag. The wave drag may be reduced partially by providing a so-called bulb, i.e. an approximately cylindrical device which is mounted at the prow under the water surface.

[0006] The sea drag is the contribution to the overall drag of the vessel by the movement thereof into the sea. This drag depends especially on the vessel's speed and course in relation to the direction of propagation of the waves and the relation between the wave length and the length of the vessel.

[0007] Further, it is essential for the comfort of the passengers that the hulls are configurated so that large vertical acceleration components are avoided when sailing, which is essential for the comfort experienced by the passengers during the journey, as it is known that vertical acceleration components in particular cause symptoms of seasickness. Further, the acceleration components are also essential for deciding whether to fasten or to lash the cargo on board the vessel. Thus, the vertical acceleration components are a particularly important parameter which is essential to the vessel's being accepted by line operators.

[0008] A series of different hull configurations has been tested in connection with the development of vessel hulls for use in multi-hull constructions, some of which have found practical use. One such example is the so-called SWATH-hull (SWATH: Small Water Area Twin Hull), which i.a. is described in US-A-3 447 502. This hull form is characteristic in that it includes an elongated, cylindrical underbody which is connected to that part of the hull which is above the waterline by means of a tapered and approximately vertical hull portion which cuts through the water surface. This configuration solves the vertical acceleration component problem to a certain degree but gives birth to new problems, as the wet surface of the vessel is large compared to conventional catamaran constructions. The construction also involves an increased draught, which limits its use in waters and harbours with little depth. Further, the vessel must be driven by means of a propeller assembly which is mounted at the end of the submerged, cylindrical parts.

[0009] During the 80's, as a further development of the so-called SWATH-hull, the Australian designer Lock Crowther developed two-hull vessel constructions where the fore part of the hull had a bulb-shaped cross-section. These hull constructions have the particularity that the underwater part of the hull continues into the part above water via an inflected curve, thus allowing the exterior half contour of the hull to be described as an S-shaped curve. The wet surface of the hull is thus reduced compared to the SWATH-hull, while the hull retains a relatively broad underwater part which is broader than the waterline sections that lie relatively close to the keel of the hull. At the same time, the hull has a hull portion which is relatively tapered at the contact point between the hull and the sea surface. However, this solution is a compromise solution, as the configuration involves a reduction of the wet surface of the underwater part compared to SWATH-vessels, which, as mentioned before, is advantageous, the frictional drag being thus reduced, but at the same time it has been proven that the hull shape becomes more sensitive to wave movements, thereby inducing higher accelerations as a consequence of the vertical wave force component which acts directly on the curved hull surfaces at the waterline.

[0010] So far it has been possible to establish only relatively few general directions for use by shipbuilders in dimensioning and configurating hull constructions for catamarans which must have optimal sailing characteristics. The development of hull constructions for use in catamarans must therefore preponderantly be carried out on an empirical basis using costly model tests in test tanks.

[0011] An advantageous propulsion means when sailing with catamarans is the so-called water jets which are built-in in the hull of the ship's stern below the waterline. The vessel is thus propulsed by means of water which is introduced into these water jets at the bottom of the vessel and subsequently ejected at the stern of the hull in the stern direction under high pressure. However, the utilization of water jets makes particular demands on the hull configuration, since they are voluminous, thereby requiring the hull to be shaped with a considerable stern breadth. Therefore, out of consideration for the ship's stability, the draught must be reduced uniformly from the prow to the broad stern.

[0012] German Patent No. 1 456 226 describes a two-hull ship construction which is designed taking into consideration the frictional drag and the wave drag. The hull construction in this publication is not configurated specifically in consideration of the vertical acceleration components of the vessel or the vessel's loading and unloading characteristics. The only thing described in the publication is a substantially S-shaped hull construction with a midship section with even sides, as for 85% of the hull frame, i.e. that frame which is placed at a distance of 85% of the ship's overall length calculated from the aft, it is indicated that the hull has a maximum bredth in its lower area which is bigger than the smallest bredth in an upper area. Consequently, the two hull sides are symmetrical in relation to a vertical longitudinal plane.

[0013] European Patent No. 0 497 748 describes a hull construction for a multi-hull vessel, especially for a catamaran, which construction supposedly constitutes an improvement in relation to the above mentioned SWATH-hull, in particular regarding stability. This known hull construction is described in more detail by a series of parameters defining the relation between the distance from the hull's base line to the centre of mass of the hull's underwater body, the hull draught, etc. However, the inventors in the present invention have determined by tests, according to the below mentioned, that the relations indicated in this European Patent do not lead to an optimal construction from the point of view of the minimization of the ship's drag and maximization of the ship's stability, and particularly stability in relation to vertical accelerations, optimal construction, and further, that other construction parameters certainly are of greater importance for achieving the above mentioned optimization of the hull construction from the point of view of the minimization of the ship's drag and maximization of the ship's stability.

[0014] In accordance with the findings of the present invention a hull construction for a multi-hull vessel is provided, which hull has body plan sections of the hull a generally symmetrical form and sides which each describe a substantially S-shaped curve, which construction is characterized in that the fore part of the of the hull has the feature that the inflection point V_1 for the lower part of the S-shaped hull curve is below the deadweight line and in a minimum height above the hull's base line amounting to 50% of the distance between the hase line and the deadweight line, and that the inflection point V_2 for the upper part of the S-shaped hull curve is above the deadweight line at a minimum height of 125% of the distance between the base line and the deadweight line.

[0015] In accordance with the teachings on which the present invention is based, not only are the constructive relations given in the above mentioned European Patent relevant for the frictional drag and stability of the finished hull construction, in particular stability with regard to vertical accelerations, but also the S-shaped hull contour curve defined at the turning points of the S-shaped curves are of essential importance for achieving the above mentioned optimization, as the tests carried out by the inventors have, in accordance with the data presented below, shown that the use of a hull construction according to the present invention will lead to an appreciable reduction in fuel consumption compared to the use of a hull construction built in accordance with the above mentioned European Patent, which reduction corresponds to a frictional drag reduction and a less pronounced sensitivity to vertical accelerations, and thus to better stability in rough sea for a vessel built as a multi-hull vessel with a hull construction according to the present invention.

[0016] Particularly advantageous positions of the inflection points are given in the dependent claims. The fore half of the hull may thus have the feature that the inflection point V_1 for the lower part of the S-shaped hull curve is at a height of 55-80% of the distance between the base line and the deadweight line, and that the inflection point V_2 for the upper part of the S-shaped hull curve is at a height of 130-155% of the distance between the base line and the deadweight line. The aft half of the hull may further have the feature that the inflection point V_1 for the lower part of the S-shaped hull curve is at a height of 55-110% of the distance between the base line and the deadweight line, and that the inflection point V_2 for the upper part of the S-shaped hull curve is at a height of 130-155% of the distance between the base line and the deadweight line.

[0017] There is a further advantage in the fact that the sides of the hull describe an approximately S-shaped curve along the whole length of the hull, as the inflection points may have a height above the base line which falls constantly towards the hull stern. Furthermore, the hull may advantageously have a flat bottom at the stern and be provided with a bulb.

[0018] The hull's 70%-frame defined similarly to the above mentioned 85%-frame may have the feature that the perpendicular distance from the hull's center line to the inflection V_1 for the lower part of the S-shaped hull curve is between 1.6% and 2.2% of the maximal length of the hull, preferably between 1.85% and 2.1%, and that the inflection point V_1 is at a height of between 50% and 75%, preferably between 55% and 70% of the distance between the base line and the deadweight line. Furthermore, it may have the feature that the perpendicular distance from the hull's center line to the inflection point V_2 for the upper part of the S-shaped hull curve may be between 0.8% and 1.2% of the maximal length of the hull, preferably between 1.85% and 1.1%, and that the inflection point V_1 is at a height of between 125% and 150%, preferably between 130% and 145% of the distance between the base line and the deadweight line.

[0019] The hull construction may advantageously take an amphora-like shape in its fore part, meaning that the sides converge relatively steeply toward the base line, constituting a sharp keel. The 70%-frame may at a height above the base line amounting to 25% of the distance between the base line and the deadweight line have the feature that the perpendicular distance from the hull's center line to the S-shaped hull curve is between 1.2% and 1.55% of the hull's maximum length, preferably between 1.3% and 1.45%.

[0020] Tests carried out with models in test tanks have shown that configurating a hull for use in a multi-hull ship construction in such a way ensures a number of advantages with regard to the line operators' demands. It has thus been proven that the use of the hull according to the present invention ensures improved features compared to the above mentioned known constructions, the indicated configuration of the hull's cross-section providing a reduction of the wet surface, thereby reducing the water drag as well as the wave drag. The overall drag acting on the hull is generally reduced, leading to a corresponding reduction of the energy consumption necessary for the propulsion of the vessel.

[0021] As a consequence of configurating the hull according to the present invention, a reduction of the vertical accelerations is achieved in the fore part of the vessel. The passengers' indoors rest areas may advantageously be placed in the fore part of the vessel. As sailing with this type of vessels usually induces a series of vibrations at the ship's stern, which phenomenon is unpleasant for the passengers, the above mentioned placing of the indoors rest areas combined with the reduction of vertical accelerations provided by the invention is particularly advantageous.

[0022] Utilization of an embodiment of the hull according to the invention and in connection with a multi-hull vessel construction with a superstructure for transport of both passengers and movable cargo, such as vehicles, further ensures particular advantages, particularly in connection with the ship's mooring in the harbour, when the vehicles, including trucks or automobiles, are loaded on board the vessel from the vessel's bow to the stern. As a consequence of the configuration of the hull, a vessel with a large trim momentum is provided, the trim alteration being little. When the automobiles move from the prow to the stern the vessel's rotation around a thwartships axis is limited to a great extent, which brings along advantages regarding the demands that must be made to the harbour installations, including the access ramps, which may thus be shorter.

[0023] It is worth noting that the discovery is not limited to hull constructions provided with a bulb. The reference "maximum length of the hull" in the present application is to be construed as the largest underwater length of the hull.

[0024] The invention will now be further described with reference to the accompanying drawings, in which

Fig. 1 shows an embodiment of the present invention shown as a series of frame sketches,

Fig. 2 shows comparative results of a friction test involving a hull embodiment according to the invention and a known hull,

Fig. 3 shows comparative results of acceleration measurements involving a hull embodiment according to the invention and a known hull,

Fig. 4 shows a multi-hull vessel or a semi-SWATH catamaran designed in accordance with the teachings of the present invention.

[0025] Fig. 1 shows an example of an embodiment of a ship's hull according to the present invention, described, in conformity with the shipbuilding industry, by a series of frame sketches which show the external contour of the hull in a series of chosen vertical sections which extend vertically through the length of the vessel. Frame sketches for the hull's aft half are shown to the left of the figure, i.e. left of the ship's vertical plane of symmetry. These frame sketches show the exterior contour of the hull in the sections 0, 2, 4, wherein line 0 shows the hull's aft contour, while line 4 shows the contour in the vicinity of the hull's half length. On the left side of the figure similar frame sketches are shown for sections 6-9 3/4, the last section being taken corresponding to a distance of 97.5% of the hull's overall length from frame sketch no. 0. The two sides of the ship's hull that are shown shown are symmetrical in relation to a vertical plane which extends along the ship's length through the center line CL.

[0026] In Fig. 1 the line BL designates the so-called base line which corresponds to a horizontal plane or waterline section which is parallel to the lowermost part of the hull's keel. The position of the so-called deadweight line, which is indicated in the figure by the designation DWL, is determined at the design stage and is represented by a line which extends parallel to a horisontal plane through the hull's base line BL and at a height that corresponds approximately to the ship's deepest draught in saltwater in a summer zone, the so-called summer load waterline. Sections parallel to the deadweight line are referred to as waterline sections and the area thereof is usually referred to as "water plane area". The distance between the base line and the deadweight line is indicated by the letter T.

[0027] The ship's hull shown in Fig. 1 may particularly be used in connection with two-hull vessel constructions for freight or passenger transport in unprotected waters. Two identical hulls of the above presented kind are thus placed in parallel and are used to support a ship's superstructure with a given, desirable load capacity, the hulls' buoyancy inclusive the specific dimensions of the ship's hulls being adapted to this load capacity. The way the ship's superstructure connects the hulls is not shown in greater detail.

[0028] As shown in the embodiment in Fig. 1, the ship's hull is provided at the prow with a bulb. This bulb may extend from approximately frame sketch 9 to frame sketch 10 and, moreover, serves to reduce the wave drag on the ship's hull at a given speed and draught in a usual way. As further shown, the hull's stern is relatively broad, the fitting of water jets being possible without any noteworthy problems.

[0029] It is characteristic for the shown embodiment of the invention that the hull sides may have a generally S-shaped contour from frame sketch no. 0 to about no. 9. In the aft half the sides are still slightly S-shaped, but here they have a flatter bottom. As shown in Fig. 1, any frame sketch has the feature that the lines that demarcate the hull have two inflection points V_1 and V_2. The inflection point V_1 in which the perpendicular distance from the center line to the exterior contour of the hull is the largest is below the DWL. As also shown in Fig. 1, the inflection point V_2, in which the perpendicular distance from the center line to the exterior contour of the hull takes on the minimum value, is considerably above the DWL. It is a characteristic feature of the hull according to the shown embodiment of the invention that the exterior contour of the fore part, i.e. from about frame sketch no. 5 to about frame sketch no. 9, has an amphora-like shape, since the hull has in any given perpendicular section a maximum breadth in an inflection point V_1 which is placed at a relatively large distance from the base line and close to the DWL, and that the hull frame sharpens uniformly towards the underside or the keel, the hull contour having in the same frame sketch an upper inflection point V_2 which is placed at a large height above the DWL. Configurating the hull in this manner provides a particularly seaworthy construction with a minimized wet surface and particularly advantageous sailing features, the water plane area in the section at the DWL being small. As indicated in Fig. 1, the local draught falls towards the stern where the hull may have an almost flat bottom. The upper as well as the lower inflection points may be connected by a continuous curve which is not necessarily straight, but may have a continuously increasing height above the base line towards the stern. The figure illustrates schematically the approximate position of the inflection points in the 80%-frame, i.e. the frame which is placed at a distance of 80% of the ship's overall length, measured from the aft.

[0030] Although applicant does not wish to be linked to a certain theory, the advantageous flow conditions which appear when sailing may be explained in the following way: The hull according to the invention is narrowed in the region in the immediate vicinity of the DWL, the water plane area being reduced in this region. The waves produced by the vessel when sailing cause, as mentioned before, a wave drag. The size of the resulting waves and, consequently, of the resulting wave drag depends on the water plane area. When the hull according to the invention moves through the water, the resulting wave drag will decrease with increasing wave heights. At the same time, an extension of the wet surface will take place when sailing, large areas of the hull being surrounded by water. However, the decrease in the resulting wave drag is larger than the corresponding increase in the frictional drag, and, consequently, the overall wave drag, which is the sum of the resulting wave drag and frictional drag, will decrease.

[0031] The particular configuration of the hull means that the longitudinal variation of the LCB, i.e. the longitudinal position of the buoyancy center, is small and limited between a position in which the ship is empty and, respectively, loaded. The vessel will thus be lying approximately horizontally both in a fully loaded state and in an empty state. This is advantageous, as the access ramps for automobiles may thus be built shorter, the vessel during unloading moving mainly only upwards, without heeling over, i.e. without the prow moving further upwards compared to the stern.

[0032] Comparative tests with a hull with S-shaped sides with lower and upper inflection points have been carried out, which inflection points have minimum heights of less than 50% and 125%, respectively, of the distance between the base line and the DWL, i.e. shaped in accordance with the present invention, and a hull produced in accordance with the construction shown and described in European Patent No. 0 497 748. Fig. 2 and Fig. 3 show curves for friction and acceleration, respectively, the curve corresponding to a vessel according to the present invention being indicated by a dashed line, and the curve relating to a vessel constructed according to the European Patent No. 0 497 748 being indicated by a continuous line. From Fig. 1 it thus results that a 10% reduction in friction, measured at the necessary power consumption for propulsion at a certain speed, is achieved for a hull in accordance with the principles of the present invention at all speeds, compared to the friction in the case of a hull construction described in the above mentioned European Patent. Comparatively, it also results from Fig. 3 that in the fore part of the vessel, i.e. approximately between frames 6 and 10, an evident reduction in the vessel's vertical accelerations is achieved, compared to the vertical accelerations which appear in a hull produced in accordance with the construction described in the above mentioned European Patent. This advantageous feature is used in connection with equipping the superstructure, allowing the passenger accomodation areas to be placed far from the parts of the vessel affected by vibrations, namely the stern, while ensuring the optimal comfort for the passengers.

[0033] The measurements shown in Fig. 3 are made at a typical wave height of 2 m and a period of 5.5 s.

[0034] Fig. 4 shows a semi-SWATH catamaran, i.e. a multi-hull ship which as a whole is referred to as 10. The multi-hull vessel 10 comprises two hulls, 12 and 14, which are connected to each other by means of a deck 24. The hull 10 defines a fore end or bulb 16, both hulls 12 and 14 at the backmost ends being provided with water jets 20 and 24. The deck 24 constitutes a car deck, whereupon there is placed a superstructure 26 comprising a restaurant, a cafeteria and a rest-room wherein the passengers may spend their time during the journey. Behind the superstructure 26 there is a platform 28, and opposite the platform 28 the ship hull has a bridge 30. Fig. 4 shows also a line along which the frames are designated the same referal numbers as in the Figs. 1 and 3.

Example

[0035] The following table presents values for the position of the inflection points V_1 and V_2 for the hull in Fig. 1 and for a maximum draught of 3.35 m and a hull length of 68.9 m. The position of the inflection points is indicated by the height $h_{inflection\ point}$ above the base line as a percentage of the maximum draught T and by the perpendicular distance $\beta_{inflection\ point}$ from the center line CL as a percentage of the maximum hull length. The indicated hull may be used in a two-hull construction with a superstructure designed to transport 120 automobiles and 450 passengers. The hull length is in this case determined as the distance from the stern to the tip of the bulb.

Above the waterline	$\beta_{inflection\ point}$	$h_{inflection\ point}$
Frame 0	2,83	162
Frame 1	2,83	162
Frame 2	2,83	162
Frame 3	2,68	151
Frame 4	2,39	146
Frame 5	1,99	143
Frame 6	1,52	139
Frame 7	0,94	136
Frame 8	0,44	135
Frame 8,5	0,22	135
Frame 9		
Frame 9,5		

Below the waterline	$\beta_{inflection\ point}$	$h_{inflection\ point}$
Frame 0	3,04	100
Frame 1	3,04	100
Frame 2	3,04	100
Frame 3	2,86	88
Frame 4	2,69	74
Frame 5	2,54	66
Frame 6	2,34	65
Frame 7	1,95	63
Frame 8	1,59	62

(continued)

Below the waterline	$\beta_{inflection\ point}$	$h_{inflection\ point}$
Frame 8,5	1,34	61
Frame 9	1,09	61
Frame 9,5	0,94	60

[0036] The hull described in detail in Fig. 1 and above is used in a semi-SWATH catamaran designed by applicant and having the following specifications: Overall length 76.10 m, beam 23.40 m, deadweight 250 t, vehicle deck area (24) 1520 m^2, car capacity 120 units, passenger capacity 450 persons, passenger seating capacity 500 persons, gas turbine engines 2 units, power 12.4 MW/unit, full load service speed 23.60 knots, fuel capacity 2 x 18 t, specific fuel consumption 241 g/kWh, range at maximum speed 240 nautical miles. The multi-hull vessel 10 shown in Fig. 4 is designed to be made of aluminium as an entirely welded hull.

Claims

1. A hull construction for a multi-hull vessel, which hull has body plan sections of a generally symmetrical form and sides which each describe a generally S-shaped curve, CHARACTERIZED in that the fore half of the hull has the feature that the point of inflection V_1 for the lower part of the S-shaped hull curve is below the deadweight line of the body plan and at a height above the hull's base line which is minimum 50% of the distance between the base line and the deadweight line, and the point of inflection V_2 for the upper part of the S-shaped hull curve is above the deadweight line at a height of minimum 125% of the distance between the baseline and the deadweight line.

2. A hull construction according to claim 1, CHARACTERIZED in that the fore half of the hull has the feature that the point of inflection V_1 for the lower part of the S-shaped hull curve is at a height of 55% to 80% of the distance between the baseline and the deadweight line, and that the point of inflection V_2 for the upper part of the S-shaped hull curve is at a height of 130% to 155% of the distance between the baseline and the deadweight line.

3. A hull construction according to claims 1 or 2, CHARACTERIZED in that the aft part of the hull has the feature that the inflection point V_1 for the lower part of the S-shaped hull curve is at a height of 55% to 110% of the distance between the baseline and the deadweight line, and that the point of inflection V_2 for the upper part of the S-shaped hull curve is at a height of 130% to 175% of the distance between the baseline and the deadweight line.

4. A hull construction according to claims 1, 2 or 3, CHARACTERIZED in that the sides of the hull describe an approximately S-shaped curve along the whole length of the hull, and that the inflection point V_2 for the upper part of the S-shaped hull curve has a height above the baseline which decreases uniformly from the aft part of the hull.

5. A hull construction according to claim 1, 2, 3 or 4, CHARACTERIZED in that the sides of the hull describe an approximately S-shaped curve along the whole length of the hull, and that the inflection point V_1 for the lower part of the S-shaped hull curve has a height above the baseline which decreases uniformly from the aft part of the hull.

6. A hull construction according to any of the preceding claims, CHARACTERIZED in that the hull has an approximately flat bottom at its aft part and is provided with a bulb at the fore part.

7. A hull construction according to any of claims 1 and 3-6, CHARACTERIZED in that the 70%-frame of the hull has the feature that the perpendicular distance from the hull's centre line to the inflection point V_1 for the lower part of the S-shaped hull curve is 1.6% to 2.2% of the maximum length of the hull, and that the inflection point V_1 is at a height of 50% to 75% of the distance between the baseline and the deadweight line.

8. A hull construction according to any of the claims 1 and 3-7, CHARACTERIZED in that the 70%-frame of the hull has the feature that the perpendicular distance from the hull's centre line to the inflection point V_2 for the upper part of the S-shaped hull curve is 0.8% to 1.2% of the maximum length of the hull, and that the inflection point V_2 is at a height of 125% to 150% of the distance between the baseline and the deadweight line.

9. A hull construction according to any of the preceding claims, CHARACTERIZED in that the fore half sides of the

hull have the form of an amphora.

10. A hull construction according to any of the preceding claims, CHARACTERIZED in that for the 70%-frame of the hull and at a height above the baseline amounting to 25% of the distance between the baseline and the deadweight line the perpendicular distance from the centre line of the hull to the S-shaped hull curve is 1.2% to 1.55% of the maximum length of the hull, preferably 1.3% to 1.45%.

11. A catamaran with a hull construction according to any of the preceding claims, CHARACTERIZED in that the passengers' areas are placed in the fore part of the vessel.

12. A catamaran according to claim 11, CHARACTERIZED in that the vessel is designed for transporting vehicles which can be loaded on the vessel in the fore part of the vessel.

Patentansprüche

1. Rumpfkonstruktion für ein Mehrrumpfschiff, wobei der Rumpf Spantenrißabschnitte mit im allgemeinen symmetrischer Form und Seiten, die jeweils eine im allgemeinen S-förmige Kurve beschreiben, aufweist, dadurch gekennzeichnet, daß die vordere Hälfte des Rumpfes das Merkmal besitzt, daß der Wendepunkt V_1 für den unteren Teil der S-förmigen Rumpfkurve unter der Deadweight-Linie des Spantenrisses und in einer Höhe über der Basislinie des Rumpfes liegt, die mindestens 50 % des Abstandes zwischen der Basislinie und der Deadweight-Linie entspricht, und der Wendepunkt V_2 für den oberen Teil der S-förmigen Rumpfkurve über der Deadweight-Linie in einer Höhe von mindestens 125 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt.

2. Rumpfkonstruktion nach Anspruch 1, dadurch gekennzeichnet, daß die vordere Hälfte des Rumpfes das Merkmal besitzt, daß der Wendepunkt V_1 für den unteren Teil der S-förmigen Rumpfkurve in einer Höhe von 55 % bis 80 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt, und daß der Wendepunkt V_2 für den oberen Teil der S-förmigen Rumpfkurve in einer Höhe von 130 % bis 155 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt.

3. Rumpfkonstruktion nach den Ansprüchen 1 oder 2, dadurch gekennzeichnet, daß der hintere Teil des Rumpfes das Merkmal besitzt, daß der Wendepunkt V_1 für den unteren Teil der S-förmigen Rumpfkurve in einer Höhe von 55 % bis 110 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt, und daß der Wendepunkt V_2 für den oberen Teil der S-förmigen Rumpfkurve in einer Höhe von 130 % bis 175 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt.

4. Rumpfkonstruktion nach den Ansprüchen 1, 2 oder 3, dadurch gekennzeichnet, daß die Seiten des Rumpfes eine ungefähr S-förmige Kurve entlang der gesamten Länge des Rumpfes beschreiben, und daß der Wendepunkt V_2 für den oberen Teil der S-förmigen Rumpfkurve eine Höhe über der Basislinie besitzt, die gleichförmig von dem hinteren Teil des Rumpfes abnimmt.

5. Rumpfkonstruktion nach Anspruch 1, 2, 3 oder 4, dadurch gekennzeichnet, daß die Seiten des Rumpfes eine ungefähr S-förmige Kurve entlang der gesamten Länge des Rumpfes beschreiben, und daß der Wendepunkt V_1 für den unteren Teil der S-förmigen Rumpfkurve eine Höhe über der Basislinie besitzt, die gleichförmig von dem hinteren Teil des Rumpfes abnimmt.

6. Rumpfkonstruktion nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß der Rumpf einen ungefähr flachen Boden an seinem hinteren Teil besitzt und am vorderen Teil mit einem Wulst ausgestattet ist.

7. Rumpfkonstruktion nach einem der Ansprüche 1 und 3-6, dadurch gekennzeichnet, daß der 70%-Rahmen des Rumpfes das Merkmal besitzt, daß der senkrechte Abstand von der Mittellinie des Rumpfes zum Wendepunkt V_2 für den unteren Teil der S-förmigen Rumpfkurve 1,6 % bis 2,2 % der maximalen Länge des Rumpfes beträgt, und daß der Wendepunkt V_1 auf einer Höhe von 50 % bis 75 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt.

8. Rumpfkonstruktion nach einem der Ansprüche 1 und 3-7, dadurch gekennzeichnet, daß der 70%-Rahmen des Rumpfes das Merkmal besitzt, daß der senkrechte Abstand von der Mittellinie des Rumpfes zum Wendepunkt V_2 für den oberen Teil der S-förmigen Rumpfkurve 0,8 % bis 1,2 % der maximalen Länge des Rumpfes beträgt, und daß der Wendepunkt V_2 auf einer Höhe von 125 % bis 150 % des Abstandes zwischen der Basislinie und der Deadweight-Linie liegt.

9. Rumpfkonstruktion nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Seiten der vorderen Hälfte des Rumpfes die Form einer Amphore aufweisen.

10. Rumpfkonstruktion nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß für den 70%-Rahmen des Rumpfes und auf einer Höhe über der Basislinie von etwa 25 % des Abstandes zwischen der Basislinie und der Deadweight-Linie der senkrechte Abstand von der Mittellinie des Rumpfes zur S-förmigen Rumpfkurve 1,2 % bis 1,55 % der maximalen Länge des Rumpfes, vorzugsweise jedoch 1,3 % bis 1,45 % beträgt.

11. Katamaran mit einer Rumpfkonstruktion nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die Passagierbereiche im vorderen Teil des Schiffes untergebracht sind.

12. Katamaran nach Anspruch 11, dadurch gekennzeichnet, daß das Schiff für den Transport von Fahrzeugen konstruiert ist, die im vorderen Teil des Schiffes auf das Schiff geladen werden können.

Revendications

1. Structure de coque pour un navire multicoques, cette coque ayant des sections planes de corps de forme généralement symétrique et des côtés qui décrivent chacun une courbe sensiblement en forme de S, caractérisée en ce que la moitié avant de la coque présente la caractéristique suivant laquelle le point d'inflexion V_1 pour la partie inférieure de la courbe de coque en forme de S est en-dessous de la ligne de portée en lourd du plan de corps et se trouve à une hauteur au-dessus de la ligne de base de la coque qui est au minimum égale à 50% de la distance entre la ligne de base et la ligne de portée en lourd, et le point d'inflexion V_2 pour la partie supérieure de la courbe de coque en forme de S est au-dessus de la ligne de portée en lourd à une hauteur qui est au minimum égale à 125% de la distance entre la ligne de base et la ligne de portée en lourd.

2. Structure de coque suivant la revendication 1, caractérisée en ce que la moitié avant de la coque a la caractéristique suivant laquelle le point d'inflexion V_1 pour la partie inférieure de la courbe de coque en forme de S est à une hauteur comprise entre 55% et 80 % de la distance entre la ligne de base et la ligne de portée en lourd, et le point d'inflexion V_2 pour la partie supérieure de la courbe de coque en forme de S est à une hauteur de 130% à 155% de la distance entre la ligne de base et la ligne de portée en lourd.

3. Structure de coque suivant la revendication 1 ou 2, caractérisée en ce que la partie de poupe de la coque présente la caractéristique suivant laquelle le point V_1 d'inflexion pour la partie inférieure de la courbe de coque en forme de S est à une hauteur comprise entre 55% et 110% de la distance entre la ligne de base et la ligne de portée en lourd, et le point d'inflexion V_2 pour la partie supérieure de la courbe de coque en forme de S est à une hauteur comprise entre 130% et 175% de la distance entre la ligne de base et la ligne de portée en lourd.

4. Structure de coque suivant la revendication 1, 2 ou 3, caractérisée en ce que les côtés de la coque décrivent une courbe approximativement en forme de S le long de toute la longueur de la coque, et en ce que le point V_2 d'inflexion pour la partie supérieure de la courbe de coque en forme de S a une hauteur au-dessus de la ligne de base qui diminue de manière uniforme à partir de la partie de poupe de la coque.

5. Structure de coque suivant la revendication 1, 2, 3 ou 4, caractérisée en ce que les côtés de la coque décrivent une courbe approximativement en forme de S le long de toute la longueur de la coque, et en ce que le point V_1 d'inflexion pour la partie inférieure de la courbe de coque en forme de S a une hauteur au-dessus de la ligne de base qui diminue de manière uniforme à partir de la partie de poupe de la coque.

6. Structure de coque suivant l'une quelconque des revendications précédentes, caractérisée en ce que la coque a un fond approximativement plat à sa partie de poupe et est munie d'une bulbe à la partie avant.

7. Structure de coque suivant l'une quelconque des revendications 1 et 3 à 6, caractérisée en ce que le cadre à 70% de la coque présente la caractéristique suivant laquelle la distance dans la direction perpendiculaire à partir de la ligne centrale de la coque jusqu'au point V_1 d'inflexion pour la partie inférieure de la courbe de coque en forme de S est comprise entre 1,6% et 2,2% de la longueur maximale de la coque, et le point V_1 d'inflexion est à une hauteur comprise entre 50% et 75% de la distance entre la ligne de base et la ligne de portée en lourd.

8. Structure de coque suivant l'une quelconque des revendications 1 et 3 à 7, caractérisée en ce que le cadre à 70% de la coque présente la caractéristique suivant laquelle la distance dans la direction perpendiculaire allant de la ligne centrale de la coque au point V_2 d'inflexion pour la partie supérieure de la courbe de coque en forme de S est comprise entre 0,8% et 1,2% de la longueur maximale de la coque, et le point V_2 d'inflexion est à une hauteur comprise entre 125% et 150% de la distance entre la ligne de base et la ligne de portée en lourd.

9. Structure de coque suivant l'une quelconque des revendications précédentes, caractérisée en ce que les côtés de moitié avant de la coque ont la forme d'une amphore.

10. Structure de coque suivant l'une quelconque des revendications précédentes, caractérisée en ce que pour le cadre à 70% de la coque et à une hauteur au-dessus de la ligne de base s'élevant à 25% de la distance entre la ligne de base et la ligne de portée en lourd, la distance dans la direction perpendiculaire allant de la ligne centrale de la coque à la courbe de coque en forme de S est comprise entre 1,2% et 1,55% de la longueur maximale de la coque, de préférence entre 1,3% et 1,45%.

11. Catamaran comportant une structure de coque suivant l'une quelconque des revendications précédentes, caractérisé en ce que les zones pour les passagers sont disposées dans la partie avant du navire.

12. Catamaran suivant la revendication 11, caractérisé en ce que le navire est conçu pour transporter des véhicules qui peuvent être chargés sur le navire dans la partie avant du navire.

Fig. 1

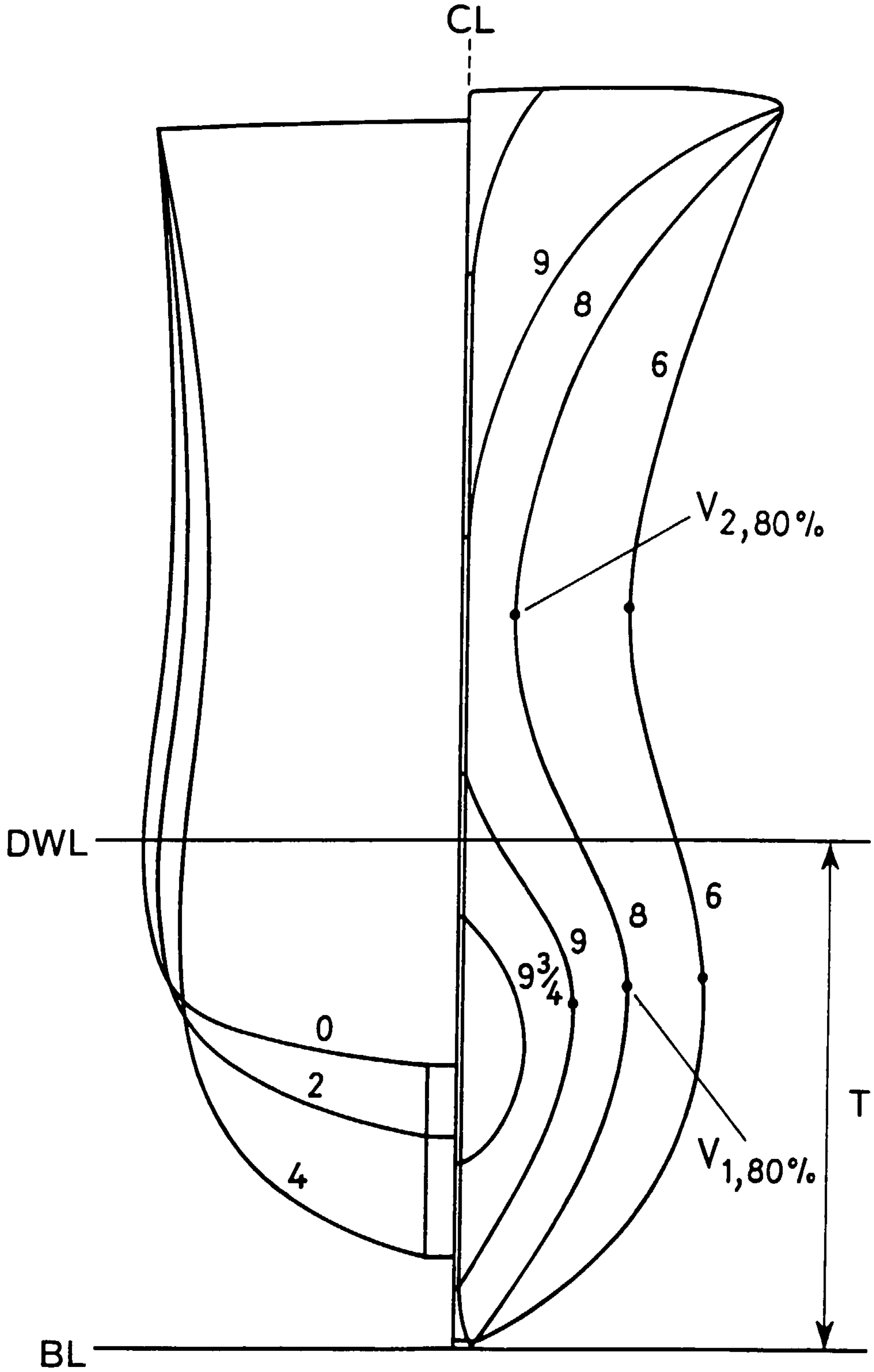

Fig. 2

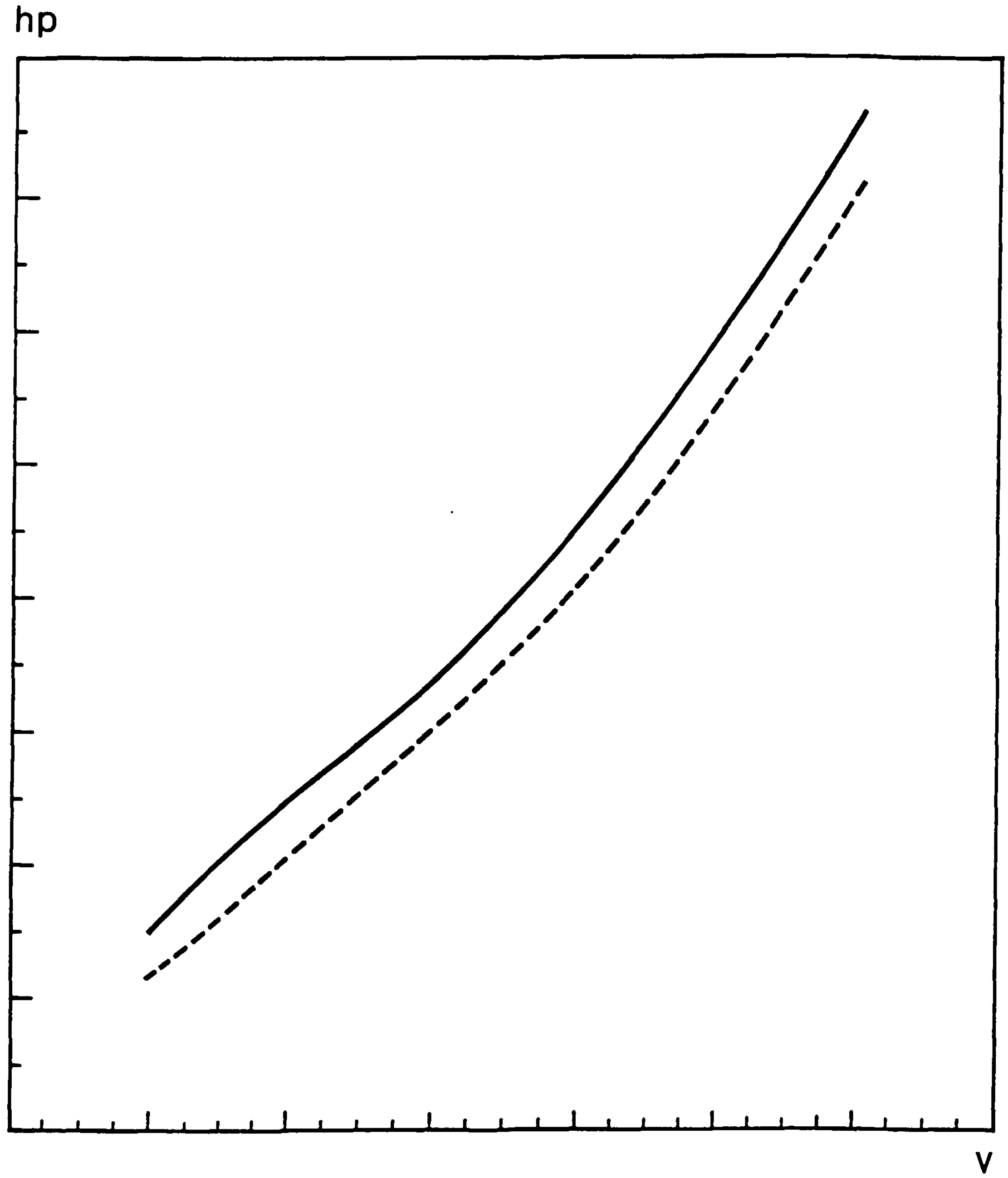

Fig. 3

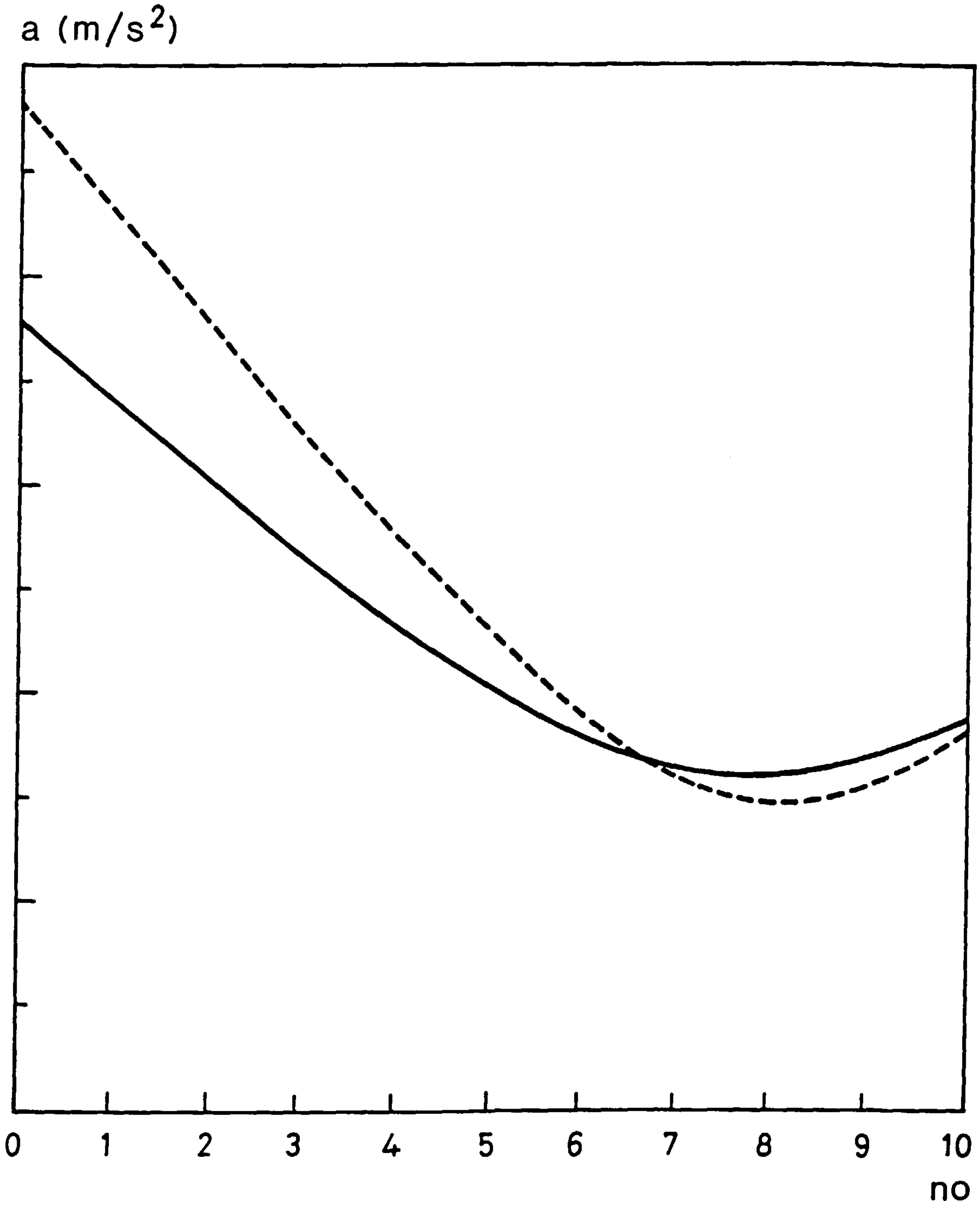

Fig. 4