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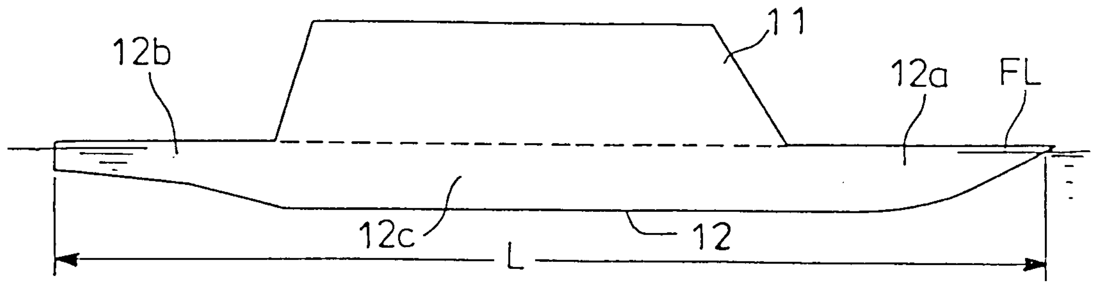
(54) **Catamarans.**

(57) A catamaran includes a main body (11) supported on twin hulls (12). The length L of a catamaran along the water line (FL) in metres and its displacement V in tons are related by the formula

$L/V^{1/3}$ = 11 to 15.

Fig. 4



EP 0 483 948 A1

The present invention relates to catamarans.

In general, ships or boats capable of navigating or sailing at high speeds are planing or semi-planing boats, hydrofoils, surface-effect ships or the like which are relatively small and have a low displacement. Due to their shape such high speed ships or boats are subject to substantial water or wave making resistance at low speeds and tend to be influenced by high waves. Because of their requirement of being light, they are not suitable as large ships or vessels. Large vessels are heavy and cannot navigate at high speeds.

Displacement type catamarans are known to have a high degree of navigation stability largely uninfluenced even by a beam sea.

Figures 1 and 2 are a schematic side view and a schematic front view, respectively of a conventional catamaran which includes a frame 2 which interconnects twin hulls 1a and 1b and which rises gradually to some extent towards the bow. If the frame 2 were to rise too high this would reduce the strength of the hull structure.

In order to improve the service rate, that is to say the proportion of time when the catamaran can safely be used notwithstanding the presence of waves, of a catamaran, the height of the interconnecting frame 2 must be increased over the whole length between the bow and stern.

However, in the displacement type catamaran described above, the twin hulls 1a and 1b are almost submerged in the water so as to effect a large displacement (i.e. buoyancy) when sailing at low speed. Even if the propulsive power of the catamaran were increased to increase the sailing speed, a considerable resistance would be produced near its last hump and mutual interference of the waves would be produced between the hulls 1a and 1b so that the wave making resistance would increase, thereby rendering high speed impossible. The "last hump" is the point where the wave making resistance becomes a maximum due to the interference of waves produced at the bow and at the stern whilst the vessel is navigating. It is generated where the Froude number is about 0.5.

Furthermore, increasing the height of the interconnecting frame 2 to increase the service rate of the catamaran will result in an increase of the overall height H, shown in Figure 2, and thus an increase in the weight of the hulls. On the other hand, in order to produce a high speed navigation capability, the catamaran must be of lightweight construction. No solution at all to such contradictory problems has been proposed.

The inventors have therefore conducted extensive studies and experiments with a view to increasing the service rate of a catamaran without substantially increasing its weight and found out that the range of positions at which waves are produced by the hulls along their length during navigation can be specifically defined and consequently if the height of the interconnecting frame is increased only within that range, the service or navigability rate can be increased without increasing the size and weight of the catamaran. More specifically, the inventors conducted experiments using catamaran models in a tank in order to investigate the height of the waves made by the twin hulls of the model and obtained the experimental data shown in Figure 3. The graph shown in this Figure plots the height of the waves produced against their position expressed as a fraction of the length of the catamaran from stern to bow. This graph indicates that the maximum height of the waves produced on the interconnecting frame 2 along the centre line of the model is about 18cm as indicated by line I; the maximum height of the waves produced on the inside surfaces of the twin hulls is about 10cm as indicated by line II. Furthermore, it was found that the highest waves along the centre line of the model and on the inside surfaces of the twin hulls are produced within a certain range toward the bow, that is to say between points which are 6/10 to 8/10 of the way along the length of the catamaran towards the bow. The inventors have realised that since waves wash over the catamaran when the waves made by it and the natural waves are greater than the spacing between the twin hulls, increasing the height of the interconnecting frame 2 in the above-mentioned range of 6/10 to 8/10 of the way along the length of the catamaran towards its bow can eliminate the washing over by the waves and thus increase the service rate.

It is therefore a primary object of the present invention to provide a catamaran with decreased displacement, which would otherwise be an impediment to an increase of the navigation speed, and with reduced wave making resistance over a wide range of speeds.

A further object of the present invention is to provide a catamaran with increased service or navigability rate whose weight is not substantially increased.

According to the present invention a catamaran of the type including a main body supported on twin hulls is characterised in that the length L of the catamaran along the waterline in metres and its displacement in tons are related by the formula

$L/V^{1/3}$ = 11 to 15.

It is found that when this relationship is satisfied the wave making resistance of the catamaran is minimised over a wide range of speeds, that is to say from low speed to high speed. The length of the catamaran is measured in metres and the displacement is measured in tons, i.e. tons-force (1000kg).

In accordance with a further aspect of the present invention a catamaran of the type including twin hulls which extend parallel to one another and are interconnected by a connecting frame is characterised in that a predetermined portion of the connecting frame offset from the longitudinal centre thereof towards the bow is of increased height compared to the remainder of the frame. The predetermined portion is preferably from 6/10 to 8/10 of the way along the length of the catamaran towards the bow.

In the predetermined portion, the central portion may be higher than its edges, that is to say than the height of the inside portions of the hulls.

Thus in this aspect of the present invention only that portion of the connecting frame at which the waves made by the hulls are of maximum height is of increased height so that these waves do not wash over or strike against the connecting frame. As a result, even when the waves are high, the service rate of the catamaran can be improved. Since only a portion of the connecting member is of increased height the weight of the vessel is not substantially increased. Since the waves made by the twin hulls are particularly high along the centre line of the catamaran, an increase in the height of the frame along the centre line of the catamaran contributes to the enhancement of the service rate.

Further features and details of the present invention will be apparent from the following description of certain specific embodiments which is given by way of example with reference to Figures 4 to 10 of the accompanying drawings, in which:-

Figure 4 is a schematic side view of a first embodiment of a catamaran in accordance with the present invention;

Figure 5 is a plan view thereof;

Figure 6 is a graph illustrating the relationship between EHP and $L/V^{1/3}$ obtained in experiments;

Figure 7 is a schematic side view of a second embodiment of a catamaran in accordance with the present invention;

Figure 8 is a schematic front view thereof;

Figure 9 is a schematic side view of a third embodiment of a catamaran in accordance with the present invention; and Figure 10 is a schematic front view thereof.

Figures 4 and 5 illustrate a catamaran including a main body 11 integrally mounted on twin hulls 12 which extend lengthwise from the bow to the stern such that the entire body is above the full load water line FL. The twin hulls 12 are unusually long to provide an extremely elongated catamaran and the ratio of length L of the catamaran along the water line to its displacement V raised to the lower 1/3 is within the range of 11 to 15.

Each of the twin hulls 12, whose construction is substantially the same, extends beyond the main body 11 in both the fore and aft directions and has a unitary structure comprising a relatively sharp or pointed bow and stern 12a,12b, respectively, and an intermediate portion 12c, all of which have substantially the same width.

In the catamaran described above, the full load water line FL extends along the upper portion of the side plates of each hull 12 so that in principle almost all of each hull 12 beneath the main body 11 is submerged in the water. As a result, the catamaran of the present invention has a buoyancy competitive or similar to that of the conventional displacement type catamaran referred to above and is inherently stable due to the twin hulls 12.

At the level of the full load water line FL, the ratio of the length of the twin hulls 12 along the water line to the displacement raised to the power of 1/3 is between 11 to 15, as described above, so that the catamaran can cleave through the waves to suppress the wave making resistance. As a result, even though the catamaran in accordance with the present invention may be classified as a displacement type catamaran, it can navigate at high speeds and the wave making resistance can be suppressed over a wide speed range, that is to say from low to high speeds.

Figure 6 shows the results if the experiments conducted to obtain the relationship between $L/V^{1/3}$ and EHP (effective horse-power, i.e. the power necessary to propel the vessel) when a 3500 ton catamaran navigated at a speed of 40 knots. ①, ② and ③ indicate the results with large catamarans with L = 155m, 169m and 200m, respectively, and 4 , 5 and 6 , the results with small catamarans with L = 16m, 20m and 24m, respectively. As is clear from the experimental results, both the large and small catamarans can have an EHP lower than 3000 due to the suppressing of the wave making resistance when the ratio $L/V^{1/3}$ is between 11 and 15. When the ratio $L/V^{1/3}$ is in excess of 15, the submerged surface area of the hulls 12 is too great; when the ratio $L/V^{1/3}$ is less than 11, the suppression of the wave making resistance cannot be expected. It follows therefore that when the ratio $L/V^{1/3}$ is selected between 11 and 15, the effectiveness of the use of the propulsive power is increased and high speed navigation becomes possible due to the enlarged speed limit range.

Figures 7 and 8 illustrate a second embodiment of the present invention in which, based on the distribution of the heights of the waves made by the twin hulls during navigation, which was determined and confirmed by the inventors as shown in Figure 3, a predetermined portion of the interconnecting frame 2 towards the bow at which the height of the waves is highest, is raised from the water line 3 between the twin hulls. Thus only the portion A situated from 6/10 to 8/10 of the way along the length of the hulls towards the bow is raised in height from the water line 3 between the hulls. The increased height is only slightly greater at that portion where the highest waves occur. For instance, when the height h of the interconnecting frame 2 from the water line 3 between the hulls is 63cm, the height of only the portion A in the aforementioned portion A is further raised by 25cm at the most so that the height from the water line 3 is 63cm + 25cm = 88cm. The increase in weight of the catamaran due to the raised height of the interconnecting frame 2 is negligible.

In general, service of ships is often suspended when the waves are high. For instance, the decision as to whether a catamaran service is to be suspended or not may be dependent upon whether its interconnecting frame 2 is struck by waves with a height of1.25m, or more. In this case, when the height h of the interconnecting frame 2 from the water line 3 between the twin hulls of a conventional catamaran is at a constant height of 63cm, waves do strike against the frame 2 since the height of the waves caused by the hulls is about 18cm at the centre of the portion 7/10ths of the way along the hulls. As shown in the Table relating to wave frequency shown below, the service suspension rage is 16.6% (= 10.0% + 4.4% + 1.9% + 0.3%) when the wave height is in excess of 1.25m.

Table

frequency (sec) / wave height (m)	2.50	3.50	4.50	5.50	6.50	7.50	8.50	9.50	Total
0.25	2.3%	14.6%	16.9%	11.7%	3.7%	0.7%	0.1%	0.0%	50.0%
0.75	0.3%	9.5%	7.5%	7.1%	5.3%	2.7%	0.9%	0.1%	33.4%
1.25		0.4%	3.2%	3.7%	1.5%	0.6%	0.4%	0.2%	10.0%
1.75			0.2%	3.0%	1.0%	0.2%	0.10%		4.4%
2.25				0.8%	0.9%	0.2%			1.9%
2.75					0.2%	0.10%			0.3%

The above Table shows the service suspension rate when a catamaran about 30m in length makes a ferry service between two predetermined ports.

According to the present invention, only a predetermined portion A towards the bow of the interconnecting frame 2 is increased in height by 25cm as compared with a conventional catamaran so that waves beating or striking against the frame can be avoided at a wave height of 1.25m. As a result, the service suspension rate becomes 6.6% (= 4.4% + 1.9% + 0.3%) so that, as compared with the conventional catamaran, the service rate can be increased by 10%.

Figures 9 and 10 illustrate a third embodiment of the present invention. Since the experimental results shown in Figure 3 reveal that the waves are especially high along the centre line at positions between 6/10 and 8/10 of the way along the hulls towards the bow and are lower at the corresponding inside surfaces of the twin hulls, the centre line portion C of the predetermined area A is further increased in height.

In the third embodiment, the height of the interconnecting frame 2 from the water line 3 between the hulls is 63cm and the height of the centre line portion C corresponding to the 6/10 - 8/10 section is increased by 25cm so that its height from the water line 3 is 88cm. In addition, the height of the inside surfaces 4 of the twin hulls in that section is raised by about 15cm with the peak being at the 8/10 position so that its height from the water line 3 is 78cm. Then, as in the above embodiments, the catamaran can sail even when the wave height is 1.25m so that, as compared with the conventional catamarans, the service rate can be increased.

It is to be understood that the present invention is not limited to the above described embodiments and that various modifications may be made within the scope of the present invention.

As described above, according to the present invention, the twin hulls of the catamaran are elongated lengthwise so as to provide an extremely elongated ship and the ratio of length of the catamaran along the water line to the displacement raised to the 1/3 power is within a range of 11 to 15. As a result, not only is the stability inherent to the catamaran positively ensured, but also the wave making resistance can be decreased over a wide speed range irrespective of the size of the ship so that the propulsive power is effectively utilised for high speed navigation.

Using the inventors' experimental finding that a range of positions at which the highest waves are produced by the hulls along their length during navigation can be specifically defined, the catamaran according to the present invention has an interconnecting frame whose height is locally raised in that range so that even when the waves are high, the phenomenon of the waves made by the twin hulls striking or beating against the interconnecting frame can be avoided, thereby enhancing the service rate. In addition, when the centre portion of the interconnecting frame in the above-mentioned range is particularly increased in height, the service rate can be effectively increased since the waves made by the twin hulls are highest along the centre portion of the catamaran.

Claims

1. A catamaran including a main body supported on twin hulls, characterised in that the length L of the catamaran along the water line (FL) in metres and its displacement V in tons are related by the formula

   $L/V^{1/3}$ = 11 to 15.

2. A catamaran including two hulls which extend parallel to one another and are interconnected by a connecting frame, characterised in that a predetermined portion (A) of the connecting frame (2) offset from the longitudinal centre thereof towards the bow is of increased height compared to the remainder of the frame.

3. A catamaran as claimed in claim 2, characterised in that the predetermined portion (A) is from 6/10ths to 8/10ths of the way along the length of the catamaran towards the bow.

4. A catamaran as claimed in claim 2 or claim 3, characterised in that in the portion (A), the central portion of the frame is higher than its edges.

Fig. 1

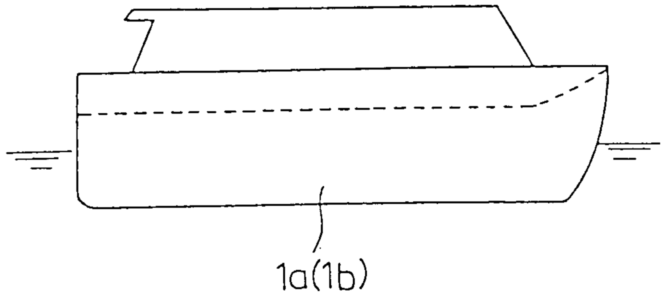


Fig. 2

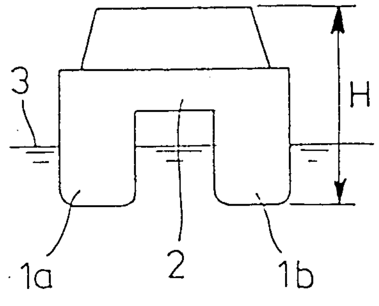


Fig. 3

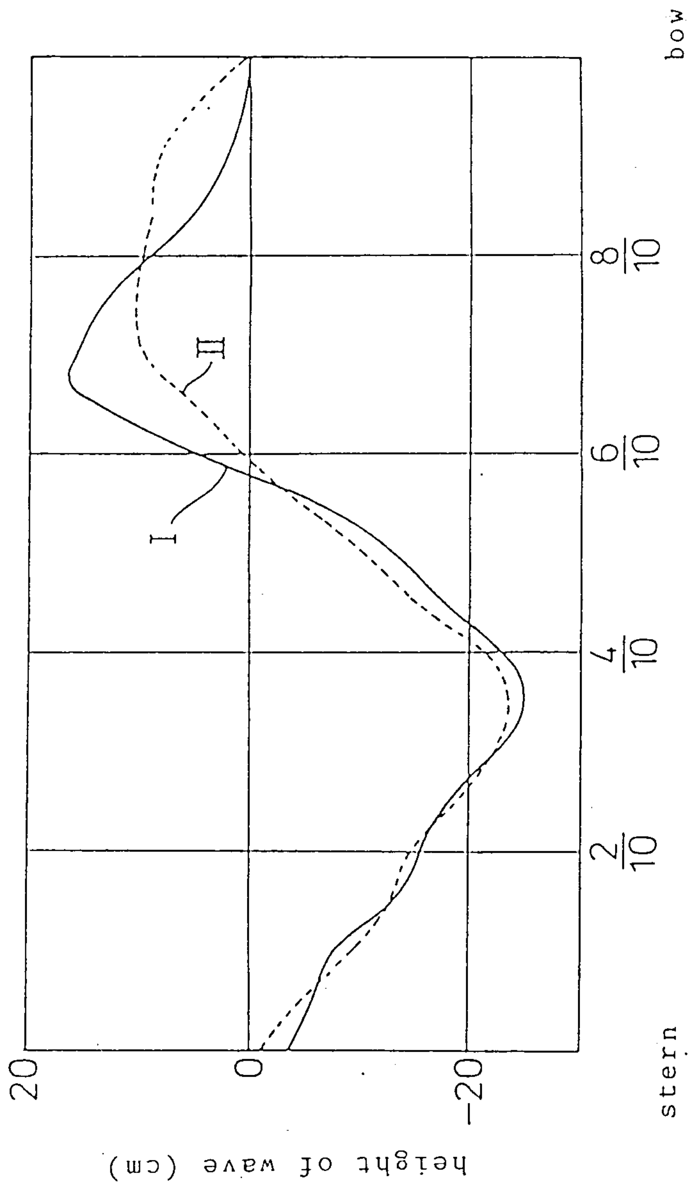


Fig. 4

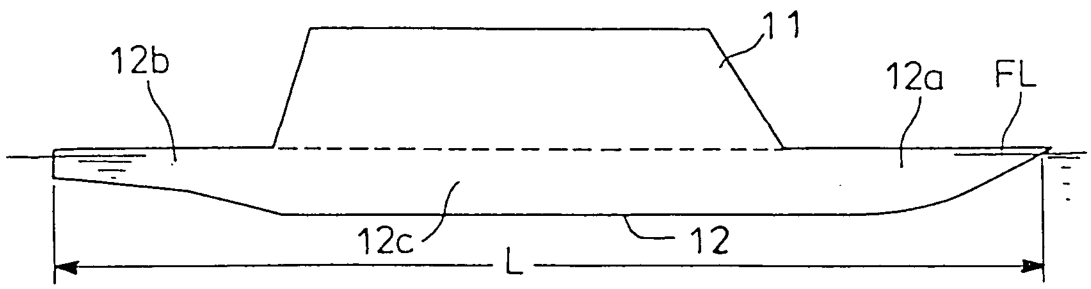


Fig. 5

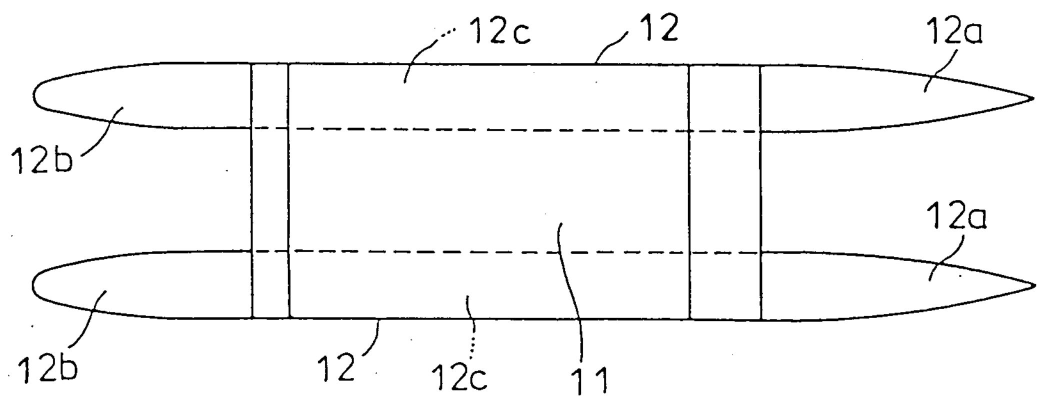


Fig. 6

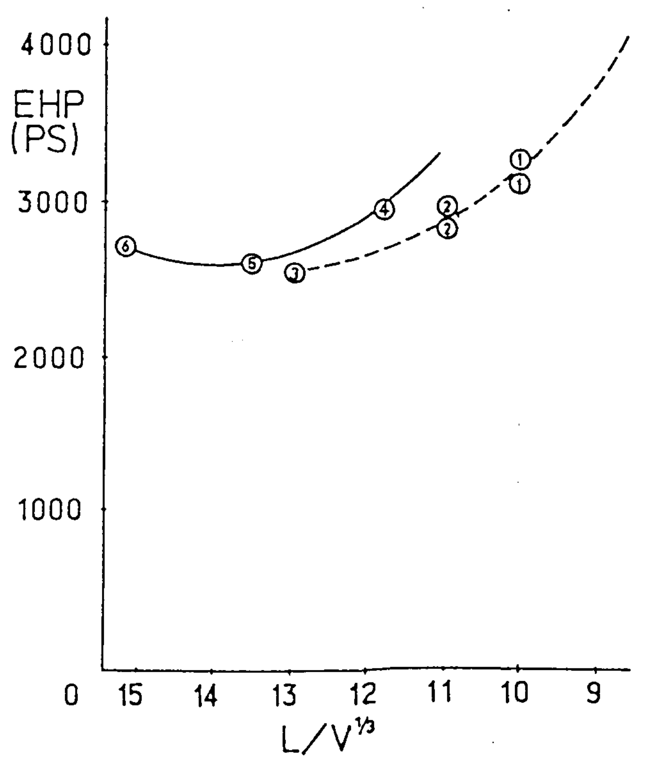


Fig. 7

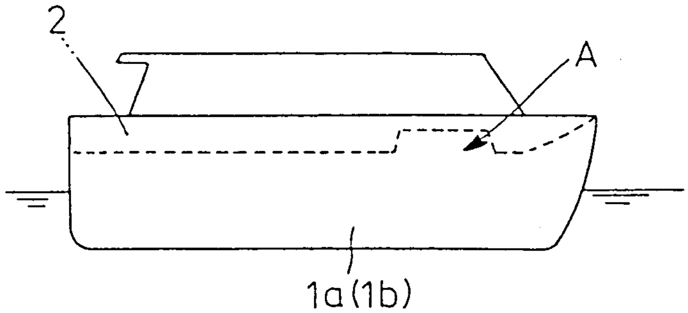


Fig. 8

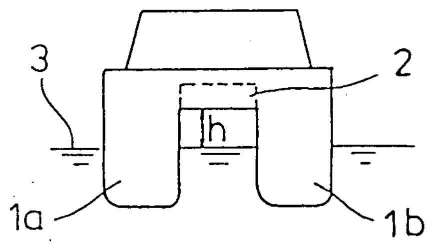


Fig. 9

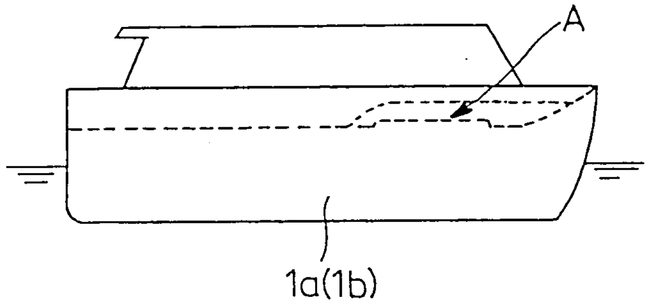
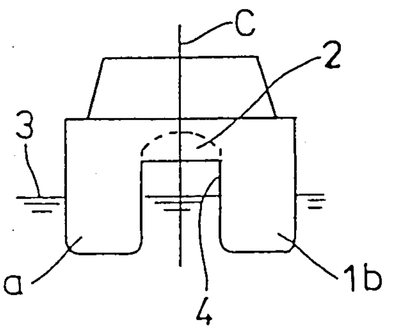


Fig. 10



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EUROPEAN SEARCH REPORT

Application Number

EP 91 30 5389

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	FR-A-2 514 718 (CONSTRUCTIONS NAUTIQUES EDEL,S.A.) * figures 1,6 * ---	1	B63B1/12
Y	EP-A-0 108 004 (PEYRE) * page 3, line 30 - line 35; figures 1-6 * ---	2-4	
Y	GB-A-991 091 (CARROSSERIE TORSA,SCHALLBRETTER & CIE,S.A.) * page 1, line 75 - page 3, line 27; figures 1-5 * ---	2-4	
A	US-A-3 937 164 (AUSTIN) * column 4, line 8 - line 39; figures 1--3 * ---	2-4	
A	US-A-3 221 697 (ALLEGRETTI) * figure 7 * ---	2-4	
A	US-A-4 926 773 (MANOR) * the whole document * -----	2-4	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B63B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 FEBRUARY 1992	DESENA Y HERNANDOREN

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