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54 **Hull configuration.**

57 A hull configuration of the displacement type providing improved deadweight tonnage, transverse stability and seagoing properties, and a reduced longitudinal moment of bending, wherein the waterlines (dwl, 1, 2, 3) are formed as squarely cut off, approximately harmonic sine waves with extremity points at about the hull's forward and aft ends, and where the base lines (O_{dwl} , O_1 , O_2 , O_3) of the waterlines below the design waterline (dwl) are displaced in the direction of forward propulsion such that an approximately oblique plane (s) through the waterlines' base lines (O_{dwl} , O_1 , O_2 , O_3) forms the termination of the stern half of the hull.

Mounted below the oblique plane (s) is a horizontal, transversely positioned, fixed or rotatable support plane (p) provided with several propulsion units (f) at the forward or aft edge of the support plane. The hull's design waterline (dwl) has its areal center of gravity (LCF) about 0.2 L astern of L/2, and the distance between the areal center of gravity (LCF) and the hull's volumetric center of gravity (LCB) to the design waterline (dwl) is about 0.075 L or larger.

The hull parameter $e = c_p/c_{dwl}$ is about 1 or greater than 1 and the length/breadth ratio L/B of the design waterline is about 2 or greater than 2.

Fig.2.

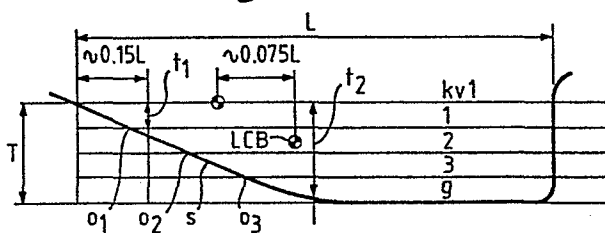
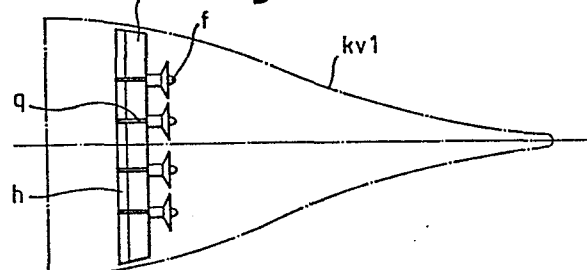


Fig.5.



The invention relates to a displacement-type hull configuration which makes it possible to improve a vessel's deadweight tonnage, transverse stability, navigational and sailing properties and to reduce stresses on the hull beam whether
5 the vessel is sailing in quiet water or into the waves.

At given main dimensions of length, breadth and depth to the design waterline, conventional hull configurations can obtain greater deadweight tonnage by increasing the roundness of the
10 underwater portion of the hull, thereby increasing the total displacement.

To improve the transverse stability of a conventionally formed hull, expressed as a higher initial metacenter, the
15 breadth of the hull can be increased to obtain a greater moment of inertia at the waterline, optionally also raising the volumetric center of gravity of the underwater hull.

However, changes of this nature (increasing roundness and
20 breadth), as demands for transverse stability and speed increase, will eventually result in an unacceptable increase in a conventional vessel's resistance to propulsion in quiet waters as well as in heavy waves.

25 To improve the seagoing properties of a conventional hull configuration, expressed as the vessel's angular movements about a transverse axis (pitching), vertical movements (heave) and the amount of increase in propulsion resistance compared to the resistance in quiet seas, one seeks to alter
30 the vessel's natural frequency of pitching and heaving so that this frequency insofar as possible does not coincide with the frequency of the wave lengths which the vessel encounters.

35 In the case of conventional hull designs, structural alterations result in only slight improvements in the seagoing properties of the vessel, and extreme pitching and heaving

movements and a great increase in the resistance to propulsion will occur when the ship is sailing into the waves when the prevailing wave length is approximately equal to the ship's length at the waterline.

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Depending on the type of vessel and its rate of speed, such synchronous movements always make it necessary for a conventional ship to reduce speed or alter course in relation to the waves, thereby altering the cycles of encounter with the waves so that the wave period does not coincide with the natural frequency of the vessel's pitching and heaving.

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Conventional hull configurations having an approximately rectangular displacement distribution will be subjected, as a function of increasing size, to bending and shear stresses which necessitate very large dimension materials and in special cases also restrict the distribution of cargo and/or ballast.

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In accordance with the present invention, the deadweight tonnage, transverse stability, seagoing properties and the magnitude of tolerable bending and shear stresses on the hull beam can all be improved without incurring the above drawbacks. The invention permits the hull to be made with rounder lines than conventional hull configurations, expressed by the term for leanness of line $L/V^{1/3}$, where L is the length of the hull at the design waterline corresponding to the depth T to the summer freeboard and V is the displacement volume of the hull at the design waterline, and where $L/V^{1/3}$ can be about 3 or greater than 3 without increasing the specific resistance to propulsion compared to conventional hull configurations, while at the same time the hull breadth B can be increased such that the L/B ratio can be about 2 or greater than 2, where B is the maximum breadth of the hull at the design waterline, whereby the height of the metacenter of the hull can be more than

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doubled in relation to conventional hull configurations of the same length.

At the critical wave length/hull length ratio for conventional
5 hull configurations sailing into the waves, the seagoing
properties of the hull configuration of the invention are
improved, such that the hull's pitching and heaving movements
are reduced compared to the movements of conventional hulls
traveling at the same rate of speed, and these movements are
10 also retarded such that the improved hull does not exhibit
correspondingly large movements until the wave length/hull
length ratio is more than twice as large, while at the same
time the improved hull's resistance to propulsion is reduced
to a similar degree.

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According to the invention, the displacement distribution in
the longitudinal direction approximates a Rayleigh wave
which with normal distribution of cargo will result in a
reduction of the longitudinal moment of bending on the hull
20 beam of around 50% compared to conventional hulls. To
obtain the abovesaid improvements, the hull configuration
according to the invention must be formed with squarely cut
off, approximately harmonic sinusoidal waterlines (dwl, 1, 2,
3) with extremity points at the ends of the hull fore and
25 aft, while at the same time the base lines of the waterlines
($0_{dwl}, 0_1, 0_2, 0_3$) from the design waterline (dwl) and at
increasing depths from this, gradually are displaced in the
direction of forward propulsion and shortened so that an
approximately oblique plane (s), straight or approximately
30 sinusoidal in longitudinal cross section and with extremity
points around $L/2$ and at the hull's stern end, forms a wide,
elevated surface (s) which comprises the stern half of the
hull, and which thus permits utilization of a propulsion
system characteristic for this hull configuration consisting
35 of a support plane (p) extending transversely in the hori-
zontal plane across the full breadth of the hull, having a
streamlined shape, and being fixed or rotatable about a

horizontal axis in connection with supports (q), optionally provided with one or more horizontal rudders (h) at the aft edge, and wherein a plurality of propulsion units (f) are mounted at the fore or aft edge of the support plane, above
 5 or beneath it.

According to the invention, a transverse section through the hull configuration below the design waterline (dwl) at a distance of about 0.15 L from the stern, will have a ratio
 10 between the breadth (B_1) at the design waterline and the depth (t_1) of the hull measured from the same waterline which will be about 3 or greater than the corresponding ratio for a section at L/2 where the breadth (B_2) and depth (t_2) are measured in the same way.

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As a result of the invention, the hull parameter $e = c_p / c_{dwl}$ will be about 1 or greater than 1, where c_p is defined as the hull's longitudinal prismatic coefficient expressed as the ratio between the displacement volume V to the design
 20 waterline and the volume of a body equal to the area of a transverse section up to the design waterline at L/2, designated $A_{L/2}$, multiplied by the design waterline L, which may be expressed by the equation $c_p = V / A_{L/2} \cdot L$, and where c_{dwl} is the waterline coefficient for the design waterline,
 25 defined as the ratio between the waterline area A_{dwl} and the product L·B where B is the maximum breadth at the waterline, which may be expressed by the equation $c_{dwl} = A_{dwl} / LB$.

As a result of the invention, the design waterline's areal
 30 center of gravity (LCF) will be located around 0.2 L aft of L/2 and the improved hull's volumetric center of gravity (buoyancy) (LCB) at the depth of the design waterline (dwl) around 0.075 L forward of the areal center of gravity, which may be expressed as $\overline{LCF} - \overline{LCB} \cong 0.075 L$.

35

The hull configuration according to the invention can in the region from the stern post and forward to about 0.3 L be

provided with turbulence-controlling appendages which may consist of fixed or flexible fin-like means (v) in the streamline direction mounted approximately perpendicular relative to the hull and located approximately at the transition between the bottom and sides of the hull, or as longitudinal grooves in the form of pointed, rectangular or wave-like grooves (x) which decrease in depth in the direction of forward propulsion and which at about 0.3 L terminate in and coincide with the even portion of the oblique plane (s) and whose depth (d) will usually be about 0.02 B.

The improved hull configuration of the invention is shown in the accompanying figures 1,2,3,4,5,6 and 7.

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Figure 1 shows the improved hull configuration's squarely cut off, approximately harmonic sinusoidal waterlines around the design waterline (dwl) with extremity points around the hull's bow and stern ends, with the areal center of gravity (LCF) about 0.2 L astern of L/2 and where the length/breadth ratio L/B of the design waterline is shown as being about 2.

Figure 2 shows the improved hull below the design waterline (dwl) in vertical section, where it may be seen that the base lines of the squarely cut off, approximately harmonic sinusoidal waterlines ($0_{dwl}, 0_1, 0_2, 0_3$) along the oblique plane (s), which are displaced in the direction of forward propulsion of the vessel, coincide with the base plane (g) at about L/2, and the distance between the areal center of gravity (LCF) and the buoyancy center of gravity (LCB) of the hull at the depth of the design waterline (dwl) is about 0.075 L.

Figure 3 shows the improved hull configuration of Figure 2 in horizontal projection with the waterlines dwl, 1,2,3 and g, in this example with a U-frame at the bow end of the

hull, but other known frame forms can also be utilized, as required.

Figure 3 also shows the characteristic ratio between breadth
5 and depth for a section around $0.1 L$ from the stern and at $L/2$, where the respective breadths and depths are designated B_1 and B_2 and t_1 and t_2 .

Figure 4 shows a vertical section near the center plane in
10 the hull's aft-section with the base plane (g), oblique plane (s), support (q), support plane (p), horizontal rudder (h), propulsion units (f) and vertical rudder (r), in this case shown with the propulsion unit (f) positioned in front of and underneath the support plane (p), but the
15 thrusters can also be mounted at the aft end or above the support plane.

Figure 5 shows a section parallel to and below the oblique plane (s), support plane (p), supports (q), horizontal
20 rudders (h), the overlying contour of the design waterline (dwl) and the propulsion units (f), in this example four in number and mounted at the forward edge of the support plane.

Figure 6 shows the improved hull configuration's design
25 waterline (dwl). On the upper half of the figure, an example of placement of the fin-like appendages (v) mounted in connection with the oblique plane (s) may be seen. On the lower half of the figure, an example may be seen of the groove-patterned portion (x) of the oblique plane (s).
30 Both of these are indicated by broken lines in the drawing. The line A-A in Figure 6 is a transverse section through the stern portion of the oblique plane (s), shown again in Figure 7 with turbulence-controlling, fixed or flexible appendages (v) on the left-hand side of the figure and an
35 example of longitudinally oriented grooves or ridges (x) on the right-hand side, showing the approximate depth (d) of the grooves in relation to the oblique plane (s).

Patent Claims

1. A hull configuration of the displacement type,
characterized by squarely cut off, approximately harmonic
5 sinusoidal waterlines with extremity points around the hull's
fore and aft end points, and wherein the waterlines' base
lines ($0_{dwl}, 0_1, 0_2, 0_3$) gradually, with increasing depth from
the design waterline (dwl), are displaced in the direction
of forward propulsion until they become tangential with the
10 base plane (g) at about $L/2$, whereby an approximately oblique
plane (s) through the base lines ($0_{dwl}, 0_1, 0_2, 0_3$) forms a
broad termination at the stern half of the hull, under which
there is mounted in the horizontal plane, transversely posi-
tioned, and fixed or rotatable about a transverse axis, a
15 support plane (p) provided with propulsion units (f) distri-
buted across the width of the support plane, mounted above or
below said plane at the forward or aft edge thereof.

2. A hull configuration according to claim 1,
20 characterized in that the displacement in the longitudinal
direction is distributed approximately on a Rayleigh curve.

3. A hull configuration according to claims 1 and 2,
characterized in that the hull parameter $e = c_p + c_{dwl}$ is
25 about 1 or greater than 1, where c_p is defined as the
longitudinal prismatic coefficient expressed as the ratio
between displacement volume V to the design waterline (dwl)
and the volume of a body constituted by a transverse section
up to the design waterline (dwl) and passing through its
30 half-length L , designated $A_{L/2}$, multiplied by the length L
of the design waterline, and where c_{dwl} is defined as the
waterline coefficient expressed by the ratio between the
area of the design waterline and the maximum length L of
the design waterline multiplied by its maximum breadth B .

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4. A hull configuration according to claim 1,
characterized in that the number representing leanness of

line $L/V^{1/3}$ is about 3 or greater than 3, wherein L is the length of the design waterline and V is the displacement volume of the hull configuration below the design waterline (dwl) to the maximum depth (T) for which the hull is designed.

5 5. A hull configuration according to claim 1, characterized in that the ratio between the hull's maximum length and the breadth measured at the waterline at the maximum depth (T) for which the hull is designed is about 2 or greater than 2.

6. A hull configuration according to claim 1, characterized in that the ratio between a transverse breadth (B_1, B_2) and depth (t_1, t_2) is at least three times larger at a section measured at about $0.15 L$ than at $L/2$, where L is the length of the waterline at the depth for which the hull is designed.

20 7. A hull configuration according to claim 1, characterized in that the oblique plane (s) in longitudinal section is formed approximately as a sine wave with extremity points at $L/2$ and the hull's stern end.

25 8. A hull configuration according to claim 1, characterized by one or more, fixed or flexible, plate-shaped appendages (v) mounted approximately perpendicular relative to the surface of the hull on both sides thereof at the transition between the bottom and sides of the hull, mounted in the streamline direction within about $0.3 L$ from the stern end of the hull.

9. A hull configuration according to claim 1, characterized in that the aft portion of the oblique plane (s) is made with longitudinally oriented, pointed, rectangular or wave-like grooves (x) which at about $0.3 L$ terminate in and become coincident with the oblique plane (s).

Fig.1.

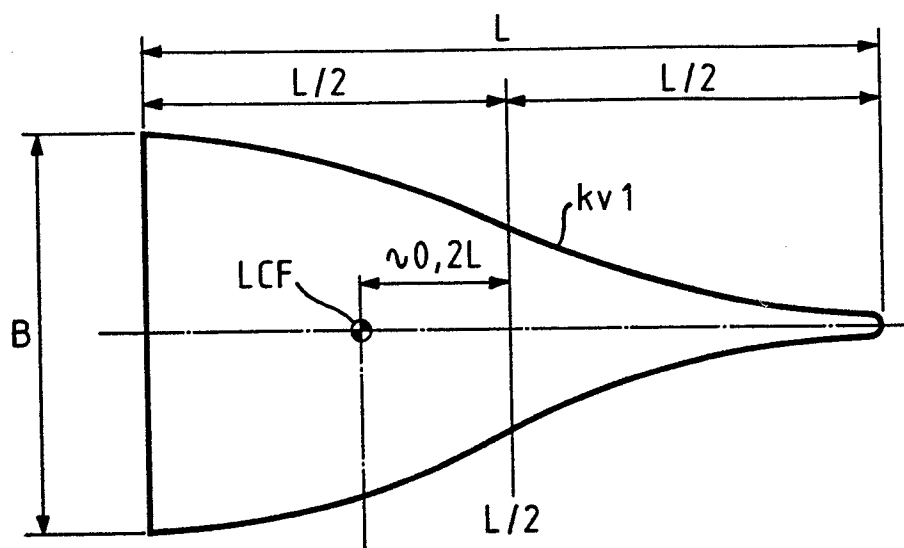


Fig.2.

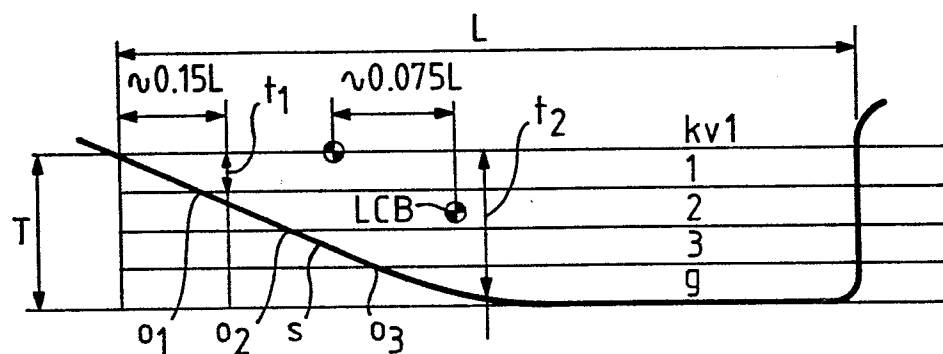


Fig.3.

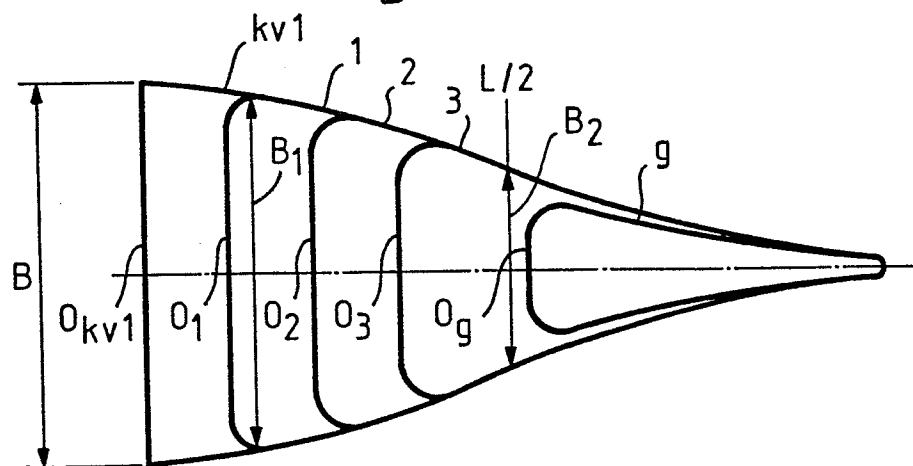


Fig.4.

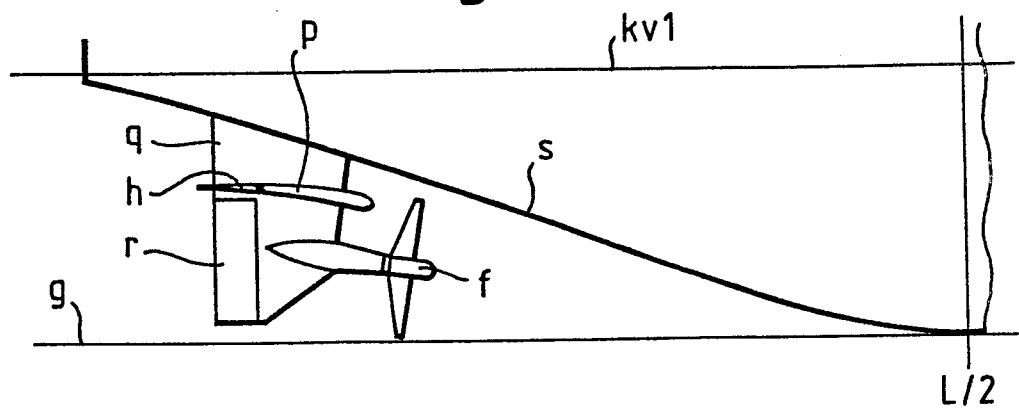


Fig.5.

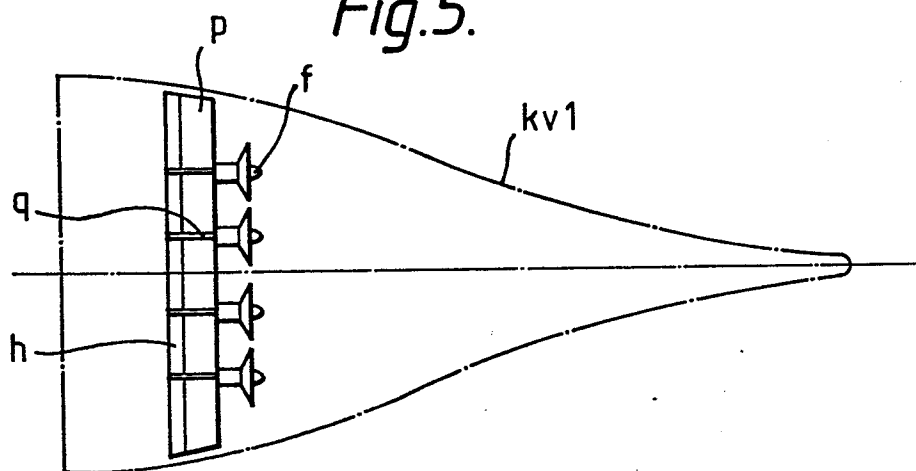


Fig.6.

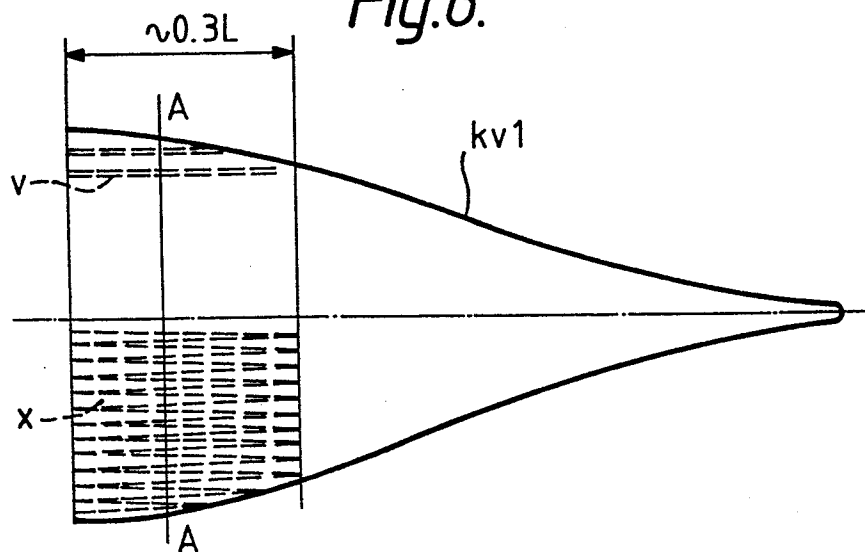
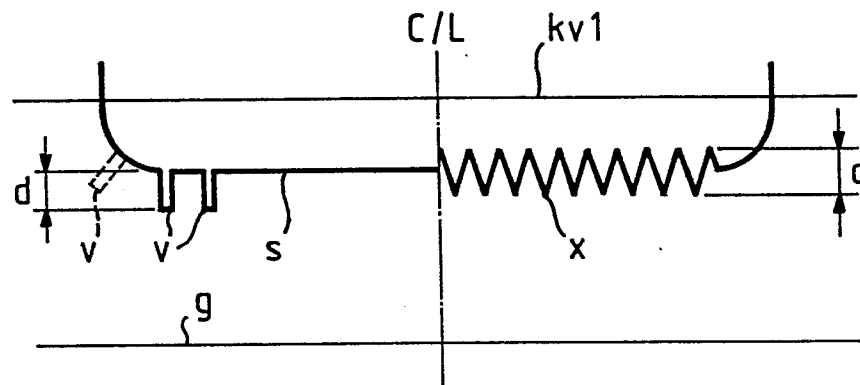


Fig.7.



European Patent
Office

EUROPEAN SEARCH REPORT

0134767

Application number

EP 84 85 0227

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.4)
A	FR-A-1 236 622 (CHAUDE) * Abstract; figures 1-6 *	1	B 63 B 1/00
A	DE-C- 103 483 (KRETSCHMER) * Claim; figures 1-6 *	1	
A	FR-E- 26 082 (VIGUIE) * Whole document *	1	
A	FR-A- 719 740 (YOURKEVITCH) * Whole document *	1	
A	THE MOTOR SHIP, vol. 48, November 1967, pages 361-362, London, GB; "Design concepts of the inland sea passenger vessel "Ivory Maru""	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 63 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 01-11-1984	Examiner VOLLERING J.P.G.
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