

MULTIPLE-HULL DISPLACEMENT WATER CRAFT WITH LIMITED
RIGHTING MOMENT AND REDUCED ADVANCE-RESISTANCE

The present invention relates to a particular embodiment of the quick works of a displacement water craft intended for high speed navigation and likely to be used for different purposes, i.e. in the very same manner for the production of commercial ships, military ships and/or pleasure boat.

In order to make high speed water crafts, it is known that it is advantageous to use hulls with a very great length/width ratio but, in order to obtain high performances, these hulls would be quite unstable and therefore not usable.

It is known in the art, in order to remedy this disadvantage, to use side floats, such as in the so-called trimaran water crafts including two side floats or sets of side floats.

The disadvantage of the trimaran water crafts resides in particular in the fact that their return moment for very small angles of list is extremely high with respect to that of a single hull ship of conventional construction. The result is that the water craft is made uncomfortable, that the efforts applied to its structure are increased and that it is made sensitive to a choppy sea of small amplitude.

The invention solves the foregoing problem by allowing

the production of displacement trimaran water crafts using a central float with a very large length/width ratio and side floats which generate, as a function of the angles of list, progressive return moments similar to the righting moments of a single hull water craft.

According to the invention, a water craft is provided according to the text of claim 1.

So constructed, the water craft becomes comfortable under rolling and is therefore particularly adapted to the transportation of passengers and of delicate goods.

Moreover, comfort is further improved by the addition of stabilizing fins on the inner face of the side floats. The attribute of the invention which provides the water craft with return moments as a function of the angle of list which are much smaller than for the other multihull water crafts, allows the installation of fins of small surface, therefore offering a small advance-resistance. Finally, since they can be positioned on the inner faces of the side floats, they do not need to be retractable, which reduces their cost.

Various other features of the invention will become more apparent from the following detailed description.

Embodiments of the object of the invention are shown, by way of non-limiting examples, in the accompanying drawings.

Fig. 1 is a side elevation view of a water craft making application of the invention.

Fig. 2 is frontal view from the front of the same water craft.

Figs. 3 and 4 are schematic illustrations of particular shapes that can have the side stabilizing hulls of the water craft.

Fig. 5 is a sectional schematic view taken along line V-V of Fig. 3 and showing that the horizontal sections of some of the hulls of the water craft may have particular shapes.

Fig. 6 is a schematic view, from above, of a water craft also embodying the invention but having a different number of side hulls.

Figs. 7 and 8 are schematic illustrations of particular features that can have the stabilizing side hulls of the water craft.

Fig. 9 is an elevation view similar to that of Fig. 1 of an alternative embodiment.

Fig. 10 is a frontal view corresponding to Fig. 9.

Figs. 11 and 12 are schematic views showing particular embodiments.

The water craft shown in the drawing, which is of the displacement type, includes a central float 2 connected to side floats 3, 4. The central float 2 supports a platform 1 which is advantageously used for providing a connection with the side floats 3, 4.

According to Fig. 1, the platform 1 supports a strong structure 1a that forms arms or arches 1b for a connection with the side floats.

5 The central float 2 or hull has, at least at the level of its water line for all navigation conditions, a great length/width ratio, this ratio being at least equal to 8. By way of example, for a water craft of an overall length on the order of 100 metres, the width of the water line at the main beam of the central float would advantageously be on the
10 order of 8 metres.

Within the scope of the invention, and so that the water craft does not list when stopped, it is necessary that, on each side of the central float, at least one side float is partially immersed at zero speed.

15 The side floats form stabilizers and are made so as to have as a whole a small displacement which has to be at most equal to 20 % of the total displacement of the water craft. Likewise, the surface of floatation of the side floats has to be small and has to correspond advantageously to at most 15 %
20 of the total surface of floatation of the water craft. Still further, in a static position, the initial useful length of the side floats 3, 4 is advantageously at most equal to 40 % of the length of floatation of the central float 2. Regarding the central float, the ratio of its width and draught has to
25 be more than 1 whatever the level of the water line and the navigation conditions, that is for any navigation water line.

According to the invention, it is essential that, for any horizontal section in the area extending over a height of at least 6 % of the distance between the axis or median plan x of the side floats and the axis or median plane X of the central float above and below any navigation water line of the water craft, the shapes of the horizontal sections of the side floats are such that the sum, for the whole of these floats, of the products for each float, of the surface expressed in square meters of its horizontal section multiplied by the square of the distance expressed in metres from its axis or median plane x to the axis or median plane X of the water craft does not exceed the product of 80 % of the weight expressed in metric tons of this water craft multiplied by the sum of the number 4 and of the distance expressed in metres between the centre of displacement B and the centre of gravity G of this water craft.

In other words, the water craft must correspond substantially to the inequality.

$$\sum_{i=1}^n S_i(d_i)^2 \leq 0.8 \Delta (4 + BG)$$

in which :

n - number of side hulls

S_1 - surface area of the side hull No. 1
at the floatation

d_1 - side distance between the longitudinal
axis of the hull No. 1 and the
longitudinal axis of the water craft

Δ - displacement or weight of the water craft

4 - module of stability

BG - distance between the center of
displacement B and the center of gravity
G of the water craft

Within the constraints of the above, it appears that
the shape of the horizontal cross sections of the side floats
can vary so as to be adapted to particular navigation or
construction conditions.

Fig. 3 shows that the side floats, for example the
float 3, may have, in elevation, a generally rectangular
shape and that its horizontal cross section, that is as seen
along line V-V, is made in the shape of a rectangle R with
small rounded or thinned-out sides in order to have suitable
hydrodynamic qualities. A shape of an O formed ovoid or
similar to a wing is also appropriate from a hydrodynamic
point of view.

Fig. 1 shows that in elevation the side floats can have complex shapes, for example a portion substantially rectangular R_1 extending on either side of the water line F , then, at the anterior portion, a stem 20 extended by an oblique portion 21.

Fig. 4 shows that the side floats can more simply have an immersed portion T substantially trapezoidal and extended by an inclined prow 22.

Fig. 7 shows that the side floats can define two contiguous volumes without progressivity.

Figs. 6 and 8 show that the side floats can be made of two non contiguous volumes.

Other shapes in elevation can be used as long as they do not modify the foregoing mentioned conditions, that is also as long as these shapes do not generate a high righting moment for small angles of list, but that this moment increases as the angle of list increases, i.e. in other words that each side float, or group of side floats, is at progressive floatability level, with :

- 1st level : at small angle of list, the first level of floatability, alone, intervenes on each side float,

- 2nd level : at larger angle of list, one of the floats can no longer be immersed and the other float, as a compensation, reaches an increased region of floatability.

In Figs. 1 and 2, the water craft is shown as including only two side floats 3, 4. This condition is not imperative.

5 Fig. 6 shows, by way of example, a central float 2 connected, at its rear portion to two side floats 3, 4 and, at its front portion, to two side floats 3a, 4a with a spacing which is advantageously but not necessary different that the spacing of the side floats 3, 4.

10 By way of example, the water craft shown in Figs. 1 and 2, includes advantageously a central hull 2 of an overall length of about 100 metres for a length at the water line of about 95 metres.

15 As previously mentioned, in that case, the water line width at the main beam of the central hull would be of the order of 8 metres, the axis or median plane x of the side hulls being substantially at 15 metres from the axis or median plane X of the central hull and the cross section of the rectangular portion R₁ would be substantially that of a rectangle of one metre in width and of a length of the order
20 of 10 to 30 metres.

The height of the side floats would in that case be of about 5 metres in their portion having a substantially uniform cross section.

25 As shown in Fig. 2, the side floats can be advantageously provided with roll stabilizers with fins 24, 25 placed preferably inside the floats.

In particular, since the construction according to the invention provides the water craft with return moment in function of the angle of list which are clearly smaller than for the other multihull ships, this allows the fins to be of small surface, and therefore offering a small advance-resistance. Since the fins can be placed on the inner faces of the side floats, they do not need to be retractable when the ship reaches a wharf, or is under other circumstances, which reduces their cost.

Likewise, Figs. 1 and 2 show that at least one pitch stabilizer 27 can be provided underneath the central hull, preferably in its front portion. The stabilizer 27 can be on an active type, that is with a mobile fin which is piloted and controlled by the pitch movements, or of a passive type, that is with a fixed fin. The above stabilizer can be combined with carrier planes as explained later on.

Another embodiment is shown in Figs. 9 and 10 according to which the central float 2 is made under the shape of a thin hull with a great length/width ratio (LB), the apex of which is connected, on the one hand, below the platform 1 or other connection means and, on the other hand, to the side floats 3, 4.

The connection between the central float 2 and the side floats is, preferably, provided by defining vaults 6, 7, and each float is, on the other hand, connected to the platform via an arch element 8, respectively 9.

It results from the foregoing that the side floats have a floatability which increases in a continuous manner up to the platform 1.

Each side float is made of a thin wall 10 at the lower end of which is provided a body 11 of substantially cylindrical shape of circular or elliptical cross section as shown in Fig. 10.

When the side floats are provided, at their lower portion, with bodies 11, it is advantageous that the axis 11a thereof (Fig. 9) is in alignment or substantially in alignment with the keel line 12 of the central float.

The means explained hereabove and the spacing of the side floats are chosen so that they provide the water craft with the transverse stability which is just necessary but optimum under normal navigation conditions, that is as long as the height of the waves does not reach the beginning of the vaults 6, 7 and of the arch elements 8 when these are provided.

The above arrangement makes that the central float can have water lines which are very fine and stretched, and favorable at a great displacement speed, and that the side floats of great height, for example from 5 to 10 metres for a water craft of 100 metres, are always sufficiently immersed so as to make the water craft little sensitive to the effects of swell. Moreover, the small width of the side floats which is advantageously of the order to 1 metre for a water craft of a

length of about 100 metres, makes that these side floats generate only a small quantity of waves, thereby facilitating the advance of the water craft.

Fig. 10 shows that the side floats have a small width which is practically constant over the major portion of their height. Thus, the hydrostatic return that they create as soon as the water craft is transversely inclined is not too great so that the water craft appears comfortable when rolling.

It is advantageous, as shown in the drawing, particularly in Fig. 9, that the stem 13 of the wall 10 is positioned rearwardly with respect to the front end of body 11 so as to form a bulb 14.

When the width of the side floats is of the order of 1 metre, that of the bodies 11 is of the order of 2 to 3 metres so that these bodies when completely immersed form damping elements as regards the rolling, pitch and pounding movements to which the water craft is subjected. The great length of the central float 2 and of the side floats 3, 4 forms on the other hand extremely efficient anti-drift surfaces which allow, in case of need, a propulsion of the water craft by sails.

In the drawing, particularly in Fig. 10, the floats 3, 4 are shown with a width substantially constant. In practice, the width can be variable.

The wall of each side float is shown as a single piece. If required, the wall can be partly opened or made of successive arms.

5 The propulsion of the water craft is essentially mechanical (propeller or water jet, for example) although a propulsion by sails could be easily provided since it is possible to act on the transverse stability by choosing in an appropriate manner the spacing between the central float and each of the side floats which can moreover be provided with
10 ballast establishing a lateral adjustable weight for compensating for list on one board.

An advantageous development of the invention, applicable to the described embodiments, consists, as shown in Fig. 11, in articulating the side floats 3, 4 about
15 longitudinal pins 28, 29, and controlling the position of the floats by cylinders 30, 31. According to the variant of Fig. 12, the side floats include telescopic portions 3₁, 4₁ controlled by cylinders 32, 33.

In addition to the preceding disclosure, according to
20 an advantageous development of the invention and in addition to the stabilizer 27, support surfaces 34, which are adjustable or not, can be placed on the side floats as well as on the central float, or hull, in order to create a dynamic lift enabling a partial sewing of the water craft and
25 also in order to cooperate with roll and pitch stabilizers by controlling the water craft trim. Moreover, flexible skirts

can be provided between the central float and the walls of the side floats in order to create air inlet tunnels so as to form lifting and damping cushions.

In the foregoing, according to an advantageous development of the invention, the platform 1 forms a load carrying hull. It is possible, for certain applications, to replace the platform by other connection means, for example arms 17, 18 (Fig. 12). The arms 17, 18 can indifferently be made of successive transverse beams or of a continuous web.

CLAIMS :

1. Displacement water craft with at least three hulls,
5 comprising a central float (2) connected to at least two side
floats (3, 4), characterized in that, for any horizontal
section in the area extending over a height of at least 6 %
of the distance between the median planes (x, and respective-
ly, X) of a float and of the water craft respectively, above
10 and below any navigation water line (F) of this water craft,
the shapes of the horizontal sections of the side floats (3,
4, 3a, 4a) are such that the sum for all these side floats,
of the product, for each float, of the surface expressed in
square metre of its horizontal cross section multiplied by
15 the square of the distance expressed in metres, from its
median plane (x) to the median plane (X) of the water craft,
does not exceed the product of 80 % of the water craft weight
expressed in metric tons by the sum of the number 4 and of
the distance expressed in metres between the centre of
20 displacement (B) and the centre of gravity (G) of the water
craft, in that, on each side of the central float at least
one side float is partially immersed at a zero speed, and in
that the central float has, for any navigation water line, a
width/draught ratio at least equal to 1 and a length/width
25 ratio at least equal to 8.



2. Water craft according to claim 1, characterized in that the displacement of the side floats (3, 4, 3a, 4a) is at most equal to 20 % of the total displacement of the water craft.

5 3. Water craft according to one of claims 1 and 2, characterized in that the side floats (3, 4, 3a, 4a) have altogether a floatation surface which is less than 15 % of the total floatation surface of the water craft.

10 4. Water craft according to one of claims 1 to 3, characterized in that the side floats have a length at most equal to 40 % of the floatation length of the central float.

15 5. Water craft according to one of claims 1 to 4, characterized in that the side floats have a horizontal cross section substantially constant over the major portion of their height.

20 6. Water craft according to one of claims 1 to 5, characterized in that the geometrical shape of the horizontal cross section of the side floats (3, 4) is near that of a rectangle or has an ovoid form or is wing-shaped or has an other shape adapted to hydrodynamism.

25 7. Water craft according to one of claims 1 to 6, characterized in that the side floats include a portion (R_1) which is of substantially rectangular shape in elevation and is ex-



tended by a stem (20) leading to a rectilinear or oblique portion (21) extending toward the front of the water craft.

5 8. Water craft according to one of claims 1 to 6, characterized in that the side floats have a rectangular shape in elevation.

10 9. Water craft according to one of claims 1 to 6, characterized in that the side floats have a trapezium-shaped portion (T) connected to an inclined prow (22).

15 10. Water craft according to one of claims 1 to 9, characterized in that the side floats each have, at their lower portion, a substantially cylindrical or elliptical body (11).

11. Water craft according to claim 10, characterized in that the body (11) of the side floats protrudes beyond the stem (13) of said floats so as to define a bulb (14).

20 12. Water craft according to claim 1, characterized in that the side floats are articulated, their movement about pins (28, 29) being controlled by means of cylinders (16).

25 13. Water craft according to claim 1, characterized in that the side floats comprise telescopic portions (3₁, 4₁) controlled by cylinders (32, 3₃).



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14. Water craft according to claim 1, characterized in that the floats comprise stabilizer and support surfaces (27, 34).

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15. Water craft according to claim 1, characterized in that the side floats contain ballasts.

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16. Water craft according to claim 1, characterized in that rool stabilizing fins (24, 25) are provided on the inner faces of the side floats.

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17. Water craft according to claim 1, characterized in that, for a water craft having an overall length of about 100 metres, the central float has a length at the level of the water line of about 95 metres for a main beam at the water line of 8 metres, the median plane (X) of this central float being spaced from the median plane (x) of the side floats by 15 metres, and the length of these side floats being on the order of 10 to 30 metres, while their width is on the order of 1 metre and their height is about 5 metres when they have a substantially rectangular cross section.

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