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(54) **Arrangement for controlling the motion of a vessel hull**

(57) The present invention relates to an arrangement for controlling the motion of a vessel hull (15) comprising: a tapered fin (9) defining a span and having a swept leading edge (10), a generally vertical trailing edge (11) and being adapted for mounting on said hull (15); and an interceptor element (12) arranged at said trailing edge (11) and being adapted to be deployed in a direction which is generally perpendicular to the lon-

gitudinal extension of the fin (9) in order to generate forces for controlling said hull (15). According to the invention, said interceptor element (12) is adapted for providing a deployment so that the ratio $(h(s)/C(s))$ between its deployment distribution and the chord length distribution of said fin (9) along said span is essentially constant. By means of the invention, an improved arrangement for steering high-speed ships is provided.

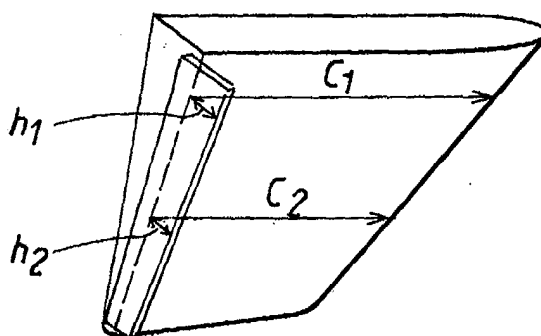


FIG. 3d

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Description

TECHNICAL FIELD:

[0001] The present invention relates to an arrangement for controlling the motion of a vessel hull comprising: a tapered fin defining a span and having a swept leading edge, a generally vertical trailing edge and being adapted for mounting on said hull; and an interceptor element arranged at said trailing edge and being adapted to be deployed in a direction which is generally perpendicular to the longitudinal extension of the fin in order to generate forces for controlling said hull.

[0002] The invention is intended in particular for manoeuvring hulls of high-speed vessels of the type which are waterjet-propelled, that is to say vessels with a water-free stern during operation, or other types of high-speed vessels such as smaller high-speed boats. It is also possible to use the invention for vessels or boats which are driven in other ways than by water-jet units.

[0003] The invention also relates to a bearing arrangement for allowing journalled movement of a first component in relation to a surface of a second component and along a predetermined direction.

BACKGROUND OF THE INVENTION:

[0004] The use of high-speed vessels for more efficient transport of cargo, vehicles and passengers has today become increasingly widespread. Such high-speed vessels are often driven and steered by means of waterjet units.

[0005] It is previously known that high-speed vessels of the type in question can be associated with certain problem, such as pitching and rolling tendencies, and also difficulties in maintaining the correct floating position while in motion. A contributory cause of such problems, for example with regard to passenger ferries, is that the load distribution between different journeys and/or trips can vary greatly depending on the number of cars or passengers and their positioning on board.

[0006] Various arrangements, such as hydrofoils and trimming flaps, which strive to counteract pitching and rolling motions and to maintain the correct floating position of the vessel hull while in motion, have therefore been known for a long time.

[0007] For example, the document WO 99/44885 teaches an arrangement for control of the course of a high-speed vessel hull. The arrangement comprises flap members, so-called interceptors, which are arranged on the stern of the hull so as to be displaced at an angle in relation to the water flow. In this manner, force components will be generated which bring about a change in the course of the vessel hull.

[0008] Although the system according to WO 99/44885 functions in a generally satisfactory manner there is a demand for improvements in systems for

steering of high-speed vessel hulls. According to what is previously known, steering of waterjet-driven vessels is effected by controlling the direction of the water jet using course-changing means in the form of rotatable nozzles and/or rotatable shutter-like or scoop-like members. The dimensions of these course-changing means must be adapted so as to provide sufficient course-changing effect both at low speeds, such as when the vessel is within a harbour area, and when travelling at higher speed.

[0009] Furthermore, the use of interceptors, such as shown in WO 99/44885, have been found to be suitable for steering of large high-speed hulls, i.e. hulls with wetted sides. The general principles for the operation of such interceptors are described in the document US 6006689, and rely on the fact that the interceptor can be displaced between different positions with respect to the hull. In this manner, the water pressure acting on the side of the hull can be increased in order to change the course of the vessel.

[0010] A further interceptor device is shown in the document WO 99/57007 and comprises an adjustable interceptor which is arranged on a hydrofoil wing. The interceptor defines a protrusion in relation to a surface on the wing so as to increase the local pressure acting on said surface when the wing is travelling through water.

SUMMARY OF THE INVENTION:

[0011] One object of the present invention is to provide an improved arrangement for steering of a high-speed water vessel hull.

[0012] This object is accomplished by means of an arrangement of the kind as mentioned initially, in which said interceptor element is adapted for providing a deployment so that the ratio between its deployment distribution and the chord length distribution of said fin along said span is essentially constant.

[0013] By means of the invention, a number of advantages is obtained. Firstly, it can be noted that the invention provides efficient steering of a vessel hull, with an arrangement which is compact and has a less complex design than previously known steering arrangements for vessels. Furthermore, the interceptor element can be mounted and operated in a manner so that a relatively small power device can be used, which also saves space and cost. Furthermore, the invention provides a deployment of the interceptor which in turn results in a high lift-drag ratio for the steering arrangement while providing good cavitation characteristics of the fin.

[0014] A further object of the invention is to provide an improved bearing device which is suitable for allowing a lateral displacement of a first component in relation to a second component.

[0015] This object is accomplished by means of a bearing arrangement as mentioned initially, said bearing arrangement comprising a plurality of rotatable and gen-

erally elongate rolls extending generally perpendicular with respect to said direction, said rolls being freely movable along a loop in a manner so that certain of said rolls extend slightly above said surface, thereby providing said journalled movement of said first component.

[0016] In the context of the present application, the term "high-speed vessel" or "high-speed ship" generally relates to boats and ships having a speed exceeding approximately 30 knots, which is normal as regards waterjet-driven ships. However, the principles of the invention is not limited to any particular speed range or ship type.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0017] The invention will now be described with reference to a preferred embodiment and the appended drawings, in which:

Fig. 1 shows a simplified perspective view of a ship according to prior art and having a fin aft;

Fig. 2a shows a side view of the fin according to Fig. 1;

Fig. 2b is a cross-sectional view of the fin according to Fig. 1;

Fig. 2c shows a rear view of the fin according to Fig. 1;

Fig. 3a shows, in a schematical manner, a side view of an arrangement in accordance with the present invention;

Fig. 3b is a cross-sectional view of the arrangement according to Fig. 3a;

Fig. 3c shows a rear view of the arrangement according to Fig. 3a;

Fig. 3d shows a perspective view of the arrangement according to Fig. 3a;

Fig. 4a shows a rear perspective view of an arrangement according to the invention, as implemented in accordance with a preferred embodiment and in a first operational condition;

Fig. 4b shows a front perspective view corresponding to Fig. 4a;

Fig. 5 shows a rear perspective view of the arrangement according to the preferred embodiment, but in a second operational condition;

Fig. 6 shows a side view of the arrangement according to the invention as mounted on a ves-

sel hull; and

Fig. 7 shows a bearing device in accordance with the invention.

PREFERRED EMBODIMENT:

[0018] With reference initially to Fig. 1, the principles of using a fin for a water vessel will now be described. Fig. 1 shows a vessel such as a ship 1, which in a known manner comprises a hull 2. In the aft section of the hull 2, a stern 3 is formed. Furthermore, a fin 4 is arranged in a manner so that it is generally aligned with the stern 3, i.e. the trailing edge of the fin 4 is generally aligned with the lowermost part of the stern 3. In a manner which is previously known, the fin 4 is arranged in a fixed manner, for increasing directional stability of the hull in the lateral direction, i.e. for obtaining a sufficient degree of stability when the hull 2 travels through water.

[0019] As shown in Fig. 2a, the fin 4 is designed with a tapered shape, with a swept leading edge 5 and a generally vertical trailing edge 6. The height of the trailing edge 6 defines the span S of the fin 4. Also, the distance between the leading edge 5 and the trailing edge 6 corresponds to the so-called chord length C of the fin 4. The chord length C is a function of the span (i.e. the spanwise coordinate s) of the fin 4, and consequently defines the so-called chord length distribution C(s) of the fin 4. Furthermore, the fin 4 comprises a root 7 which is intended to be mounted on the bottom of the hull (see Fig. 1) and a tip 8. In a manner which is known, the root 7 may be attached to the bottom for example by means of bolts or by welding.

[0020] According to Fig. 2b, which is a cross-sectional view of the fin 4, it can be noted that the fin 4 has a generally tapered or trapezoidal shape, with a leading edge 5 which is rounded and a trailing edge 6 which is generally flat. For example, the cross-section of the fin 4 can be wedge-shaped, half elliptical or the like. However, the invention is not limited to any specific cross-sectional shape. The shape of the fin is chosen so as to be suitable for ships having a maximum speed of approximately 30 knots or more.

[0021] As indicated in Fig. 2b, a basic principle behind the fin 4 is that it is designed in a manner so as to generate a zone 4a which is filled, either naturally or by force (for example by means of an air pump), with air when the fin 4 travels through water. Such a design of a fin is referred to as a base-ventilated fin.

[0022] Furthermore, with reference to Fig. 2c, which is a rear view of the fin 4, it can be noted that the trailing edge 6 has a shape which is tapered in a direction from the root 7 to the tip 8. More precisely, the trailing edge 6 can be said to define a width T which varies along the span. In this manner, a thickness distribution T(s) of the fin 4 can be defined.

[0023] Preferably, and according to what is previously known, the chord length distribution C(s) of the fin 4 (see

Fig. 2a) is a generally linear function of the spanwise coordinate s . In a similar manner, the thickness distribution $T(s)$ (see Fig. 2c) is a generally linear function of the spanwise coordinate s .

[0024] In Figs. 3a-3d, the general principles behind the invention are explained with reference to a side view, a cross-sectional view, a rear view and a perspective view, respectively, of a fin 9 according to a preferred embodiment of the invention. It should be noted that Figs. 3a-3d are simplified and that a more detailed explanation of an embodiment of the invention will be described below with reference to Figs. 4a, 4b and 5.

[0025] In contrast to the previously known fin 4 as shown in Figs. 1 and 2a-2c, which is intended for increasing directional stability of the hull 2, the present invention constitutes an arrangement which is primarily intended for steering a ship. For this reason, the fin 9 is intended not only for providing course stability. As shown in Fig. 3a, the fin 9 has a generally tapered or trapezoidal shape and is designed with a leading edge 10 and a trailing edge 11. The leading edge 10 is swept, i.e. it has a shape which is generally inclined with respect to an imaginary vertical line extending along the fin. In this regard, the so-called sweep angle is defined as the angle between said vertical line and the leading edge 10.

[0026] Immediately rear of the trailing edge 11, an interceptor element 12 is arranged. It is a general principle behind the present invention that the interceptor element 12 has outer dimensions which correspond essentially to the shape of the trailing edge 11, and also that the interceptor element 12 is preferably displaced along a plane which is generally perpendicular to the longitudinal direction of the fin 9. This means that the deployment of the interceptor element 12 is in a direction perpendicular to the direction of travel of the ship on which the fin 9 is mounted. In this manner, forces are generated as a result of an increase in pressure which is generated on the fin 9, in order to steer the ship.

[0027] The fin 9 is shaped with a root 13 and a tip 14. The root 13 is intended to be mounted on the bottom of a hull 15 (which is indicated by means of broken lines in Fig. 3a). This is preferably made in a manner so that the interceptor element 12 is aligned with the stern 16 of the hull 15. Furthermore, and as shown in Fig. 3a, the interceptor element 12 preferably extends along the trailing edge 11 of the fin 9 between the root 13 and the tip 14.

[0028] According to the top view shown in Fig. 3b, the interceptor element 12 can be displaced from an initial position immediately behind (and aligned with) the trailing edge 11 of the fin 9 to either one of two end positions, as shown with an arrow. These end positions are indicated in Fig. 3b with broken lines. This corresponds also to Fig. 3c, which is a rear view showing the displacement or deployment of the interceptor element 12. More precisely, Fig. 3c indicates that the interceptor element 12 has a tapered shape which is oriented along an imag-

ined axis of symmetry 17. In the initial position of the interceptor element 12, the axis 17 of symmetry extends in a vertical manner as shown in Fig. 3c. Furthermore, in a manner which corresponds to Fig. 2c, the interceptor element 12 (and the trailing edge 11) is shaped with a thickness distribution $T(s)$ which is a function of the span S of the fin 9. In particular, the thickness varies from a maximum value t_{root} closest to the root, to a minimum value t_{tip} at the tip of the fin 9. Also, the fin 9 according to the invention has a chord length distribution $C(s)$ as shown in Fig. 3a.

[0029] Furthermore, the trailing edge 11 is generally flat (i.e. as regarded along a plane which is generally perpendicular to the longitudinal extension of the fin and the ship). As mentioned above, this is referred to as a base-ventilated fin shape.

[0030] The deployment h of the interceptor element 12 depends on the lateral position of the interceptor element 12 in relation to the trailing edge 11 of the fin 9. In this manner, the deployment distribution $h(s)$ of the fin 9 as a function of the spanwise coordinate s is defined.

[0031] By means of the invention, steering of a ship's hull 15 is accomplished by means of a suitable degree of deployment of the interceptor element 12 in relation to the fin 9. In order to provide adequate steering of a hull, it is a general desire to obtain a so-called lift-drag ratio (L/D) which is as high as possible while at the same time avoiding or at least stabilizing (and making harmless) any cavitation resulting from the fin's 9 movements in water. In this regard, the lift of the steering arrangement corresponds to the lateral force being obtained during steering due to the deployment of the interceptor element 12, whereas the drag of the steering arrangement corresponds to the friction force resulting from the movement of the fin 9 through water and the pressure acting on the interceptor when it is deployed. In order to optimize the lift-drag ratio and the cavitation characteristics, it is an important principle behind the present invention that the interceptor element 12 is arranged in a manner so that the ratio between the above-mentioned deployment distribution $h(s)$ and the chord length distribution $C(s)$ of the fin 9 is generally constant along the span S , i.e.

$$h(s) / C(s) = \text{approximately constant}$$

[0032] This means that the interceptor element 12 is arranged so that the ratio between the degree of deployment of the interceptor element 12 (i.e. in relation to the fin 9) and the distance between the leading edge 10 and the trailing edge 11 is substantially constant along the fin 9, i.e. at every point along the span of the fin 9.

[0033] In order to provide the above-mentioned ratio $h(s) / C(s)$, which is generally constant, the invention is arranged so that the deployment of the interceptor element 12 is carried out in the form of a pivoting movement

about an imaginary pivoting point 18 which is positioned a certain distance below the interceptor element 12. This is indicated in Fig. 3c, which shows the deployment of the interceptor element from its initial position to either one of its two end positions.

[0034] The general principles of the invention have now been described in a schematical and slightly simplified manner with reference to Figs. 3a-3d. In the following, a preferred embodiment of the invention will now be described in detail, initially with reference to Fig. 4a, which is a perspective view of an arrangement according to the invention. As shown in Fig. 4a, the interceptor element 12 is mounted at the stern 16 of the hull 15 (shown by means of broken lines) by means of a housing 19.

[0035] The housing 19 is mounted at a lower part of the stern 16 and is designed with an interior space in which an upper portion of the interceptor element 12 is accommodated. The interceptor element 12 is preferably formed as an elongated element which is journalled for sideways deployment by means of three bearing devices 20, 21, 22, which are mounted in the interceptor element 12 as will be explained in greater detail below. The upper part of the interceptor element 12 is connected to a first end part of a first link arm 23 which is pivotably arranged about a drive axis 24. A power device (not shown in Fig. 4) is arranged on the inside of the hull 15 in order to cause a rotating motion of the drive axis 24 and, as a consequence, a rotating motion of the first link arm 23 also, when there is a desire to steer the hull 15 in either direction.

[0036] The other end part of the first link arm 23 is connected to a first end part of a second link arm 25, which is pivotably arranged about a further pivot point 26 in the housing 19. The other end part of the second link arm 25 is connected to the interceptor element 12, preferably at a connection point 27 located at approximately half the length of the interceptor element 12. The connections between the two link arms 23, 25 and the interceptor element 12 are of the type which are slidable, so that the deployment of the interceptor element 12 can be provided by rotating the drive axis 24.

[0037] In Fig. 4a, the interceptor element 12 is shown in a position in which it is fully deployed. Furthermore, Fig. 4b shows the arrangement according to the invention in a perspective view from generally the opposite direction as compared with Fig. 4a and also showing the interceptor element 12 in a fully deployed position. As indicated in Fig. 4b, the housing 19 is connected with a elongated element 28 having generally the same shape as the trailing edge 11 (see Fig. 3a) of the fin 9. Consequently, this elongated element 28 forms an extension of the trailing edge 11. Preferably, the housing 19 and the elongated element 28 are attached to each other so as to form a single unit. Also, in Fig. 4b, the drive axis 24 is shown as regarded from inside the hull 15. The drive axis 24 ends with a connection 29 which is intended to be coupled to an actuating device 30 which is in-

dicated in a schematical manner with broken lines. The actuating device 30 is preferably in the form of an electric servo intended for providing rotation of the drive axis 24 and consequently for providing the desired degree of steering. It is an advantage of the present invention that the actuating device 30 can be made with a relatively low power requirement in order to provide the steering operation.

[0038] In Fig. 5, the arrangement according to the invention is shown in a condition which essentially corresponds to Fig. 4a but in which the interceptor element 12 is in its initial position, i.e. without providing any steering of the hull. In this condition, the second link arm 25 is positioned in a generally vertical direction.

[0039] It can be noted that the interceptor element 12 is not pivoted about any rotation axis, for example toward the lower part of the of the fin 9. Instead, the interceptor element 12 is journalled in a manner so that it can be displaced in a lateral direction with the aid of the three bearing devices 20, 21, 22. Furthermore, in order to aid the lateral displacement of the interceptor element 12, it is generally shaped as a "T" (see Fig. 4a) with a generally vertical component and a generally horizontal component, of which the horizontal component is journalled on the two upper bearing devices 21, 22 carried by the interceptor element 12. Also, the housing 19 is preferably formed with a generally horizontal groove or recess (not shown) so as to define a track in which the horizontal component may be displaced.

[0040] Furthermore, the lower end portion of the interceptor element 12 can also be displaced in a lateral direction, more precisely by being guided by means of a streamlined bulb extension 31 a, i.e. an extension of a bulb 31 which is formed along the tip 14 of the fin 9. Said bulb 31 is shown in a schematical manner (with broken lines) in Fig. 4b. More precisely, the interceptor element 12 is guided during said displacement along a track or slot which is defined in the bulb extension 31 a in a manner so that the displacement is facilitated by the lower bearing device 20 in the interceptor element 12.

[0041] According to the embodiment shown in Figs. 4a, 4b and 5, the bulb extension 31 a is attached to the lower end portion of the elongated element 28. This means that the lower end portion of the interceptor element 12 is not pivotable about any fixed point. Instead, the deployment of the interceptor element 12 is carried out in a manner so that its imaginary axis of symmetry 17 (see Fig. 3c) is pivoting about an imaginary pivoting point 18 which is positioned below said interceptor element 12.

[0042] Fig. 6 shows a side view of an arrangement according to the invention as mounted on a vessel hull 15. In particular, the fin 9 is mounted on the bottom of the hull 15 and the interceptor element 12 is arranged as an extension of the stern 16 of the hull 15. Furthermore, the housing 19 is mounted on the lower part of the stern 16 so that the interceptor element 12 extends into said housing 19. Also, the lower end portion of the

interceptor element 12 is guided during its deployment in the track defined by the bulb extension 31 a. As shown in Fig. 6 also, the electric servo 30 is mounted on the inside of the hull 15, in a manner so that it is connected to the above-mentioned first link arm (not shown in Fig. 6) as explained above.

[0043] A bearing device 20 of the type as mentioned above is shown in detail in Fig. 7, which shows the basic principle involving two a first object 32 which is journaled in relation to a bearing device 20. It should be noted that the bearing device 20 is not limited to being used in the field of interceptor elements, but can be used in any application in which there is a desire to provide a bearing for an object which is to be displaced in a side-ways direction.

[0044] As shown in Fig. 7, the bearing device 20 comprises a housing 33 which is designed with a cavity 34. The cavity 34 is formed generally as a closed shape, i. e. a loop, and preferably as a rectangle or an oval which has a centrepiece 35 which is fixedly connected to the housing 33. In the generally oval space which is formed in the housing 33, a number of rolls 36 are placed. Furthermore, the housing 33 is formed with an upper surface 37 on which the object 32 is intended to be journaled. The distance between the centrepiece 35 and the upper surface 37 is slightly less than the diameter of each of the rolls 36. This means that the object 32 will be carried on a surface being constituted by a number of rolling rolls 36.

[0045] The principle of the bearing 20 as shown in Fig. 7 can be used for supporting the interceptor element 12 as shown in Figs. 4a, 4b, 5 and 7. This means that the interceptor element 12 can be deployed between its initial position and either one of its end positions with relatively low friction. This also contributes to the fact that only a relatively small actuating device, such as the above-mentioned electric servo 30, can be used for providing the steering of the hull.

[0046] With reference to Figs. 4a and 7, it can be noted that when the bearing element 20 is used for journaling the interceptor element 12, the above-mentioned "first object" 32 as shown in Fig. 7 corresponds to the aft part of the bulb extension 31 a, whereas the "housing" 33 in Fig. 7 corresponds to the lower end of the interceptor element 12 shown in Fig. 4a. The two remaining bearing devices 21, 22 shown in Fig. 4a are arranged in a similar manner so as to contact a bearing surface defined on the inside of the housing 19.

[0047] The invention is not limited to the embodiment described above, but may be varied within the scope of the appended claims. For example, the invention is not limited to any particular type of ship or boat.

[0048] Even though the fin 9 according to the invention is primarily intended for steering of a ship hull, it should be noted that the principles of the invention can be used in other ways, depending on in what manner the fin 9 is mounted on a ship. For example, the fin can be used for trimming purposes (if it is inclined by approx-

imately 45° with respect to the vertical direction as shown in Figs. 3a-3d), and can also be used as a hydrofoil. Also, the fin according to the invention can be used for controlling roll, heave and pitch movements of a hull. Consequently, the fin according to the invention can be used in a general manner for controlling the motion of a vessel hull.

[0049] Furthermore, the invention is not limited to deployment of the interceptor element along a plane which is perpendicular to the direction of the travel of the vessel, as discussed above. Alternatively, the interceptor element can be arranged so as to be deployed for example along a conical surface, in order to provide the necessary forces for controlling a vessel.

Claims

1. Arrangement for controlling the motion of a vessel hull (15) comprising:

a tapered fin (9) defining a span and having a swept leading edge (10), a generally vertical trailing edge (11) and being adapted for mounting on said hull (15); and

an interceptor element (12) arranged at said trailing edge (11) and being adapted to be deployed in a direction which is generally perpendicular to the longitudinal extension of the fin (9) in order to generate forces for controlling said hull (15),

characterized in that:

said interceptor element (12) is adapted for providing a deployment so that the ratio $(h(s)/C(s))$ between its deployment distribution and the chord length distribution of said fin (9) along said span is essentially constant.

2. Arrangement according to claim 1, **characterized in that** said interceptor element (12) is arranged along an imaginary axis (17) of symmetry and so as to be deployed in a manner so that said axis (17) is pivoting about an imaginary pivoting point (18) positioned below said interceptor element (12).
3. Arrangement according to claim 1 or 2, **characterized in that** said interceptor element (12) is accommodated in a housing (19) which is attached to said hull (15), said interceptor element (12) being movable by means of an actuating device (30) which is connected to said interceptor element (12) via a pivotable link arm (23).
4. Arrangement according to claim 3, **characterized in that** said pivotable link arm (23) has a first end section connected to said interceptor element (12)

and a second end section connected to a further link arm (25) being rotatably arranged in said housing (19), said further link arm (25) having an end section being connected to said interceptor element (12).

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5. Arrangement according to any one of the preceding claims, **characterized in that** said interceptor element (12) defines an upper end portion and a lower end portion, said end portions being journalled for displacement of the interceptor element (12) along a plane which is generally perpendicular to the direction of travel of said hull (15). 10
6. Arrangement according to claim 5, **characterized in that** said upper end portion carries at least one bearing device (21, 22) being in contact with said housing (19) for defining a bearing surface, and that said lower end portion carries at least one bearing device (20) being in contact with a bulb extension (31 a) defining a further bearing surface and a track along which said lower end portion is journalled when being deployed. 15 20
7. Arrangement according to claim 5 or 6, **characterized in that** said upper end portion of the interceptor element (12) extends into said housing (19) above the bottom of said hull (15). 25
8. Arrangement according to any one of claims 3 to 7, **characterized in that** said actuating device (30) is connected to said pivotable link arm (23) via a rotating axis (24) extending through a stern (16) of said hull (15). 30 35
9. Water vessel comprising an arrangement according to any one of the preceding claims.
10. Bearing arrangement (20) for allowing journalled movement of a first component (32) in relation to a surface (37) of a second component (33) and along a predetermined direction, **characterized in that** said bearing arrangement (20) comprises a plurality of rotatable and generally elongate rolls (36) extending generally perpendicular with respect to said direction, said rolls (36) being freely movable along a loop (34) in a manner so that certain of said rolls (36) extend slightly above said surface (37), thereby providing said journalled movement of said first component (32). 40 45 50

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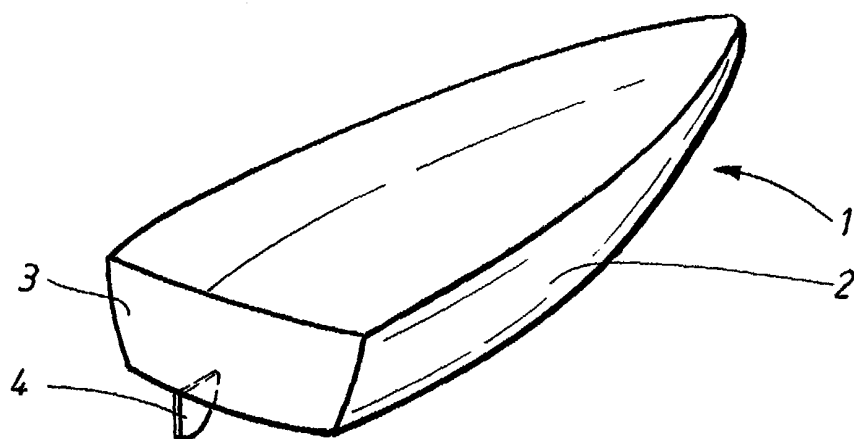


FIG. 1

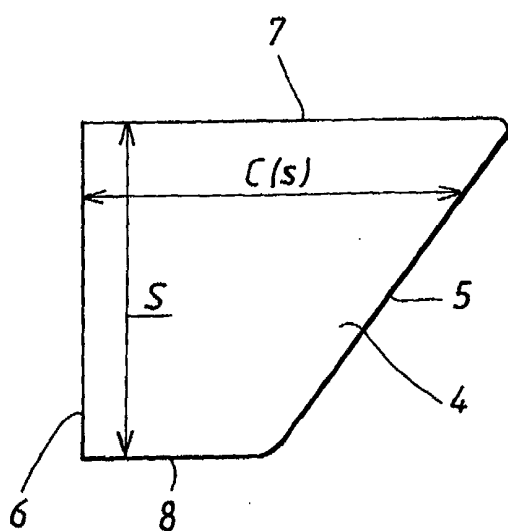


FIG. 2a

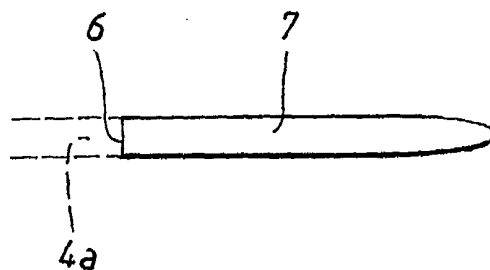


FIG. 2b

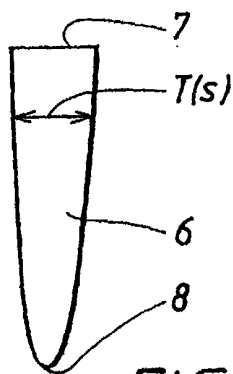


FIG. 2c

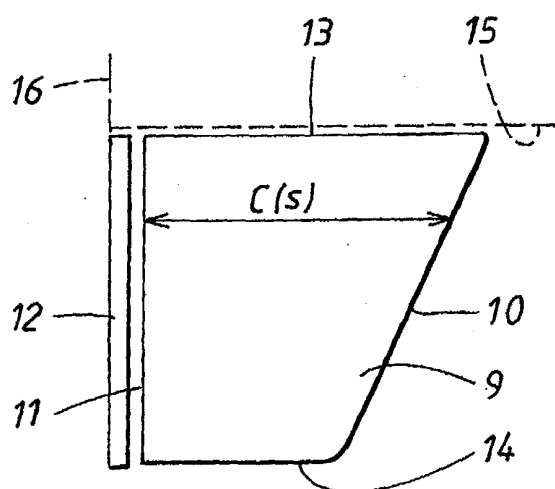


FIG. 3a

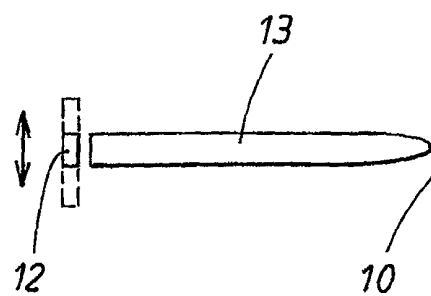


FIG. 3b

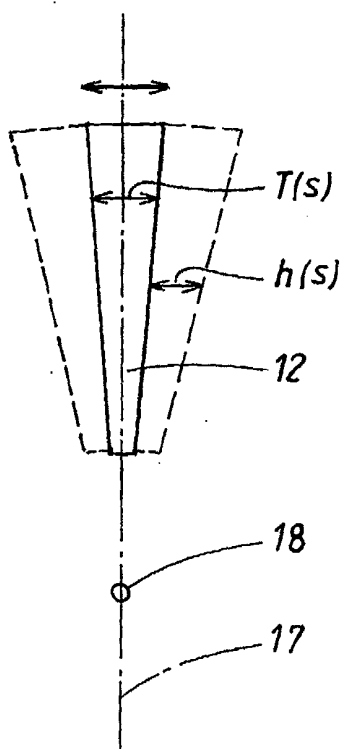


FIG. 3c

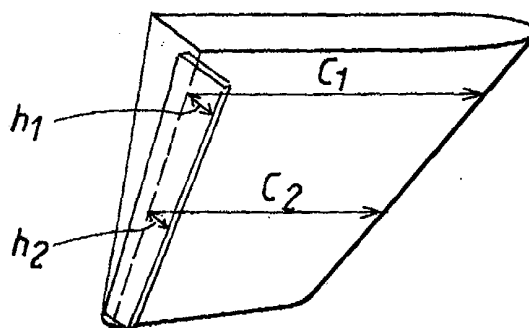


FIG. 3d

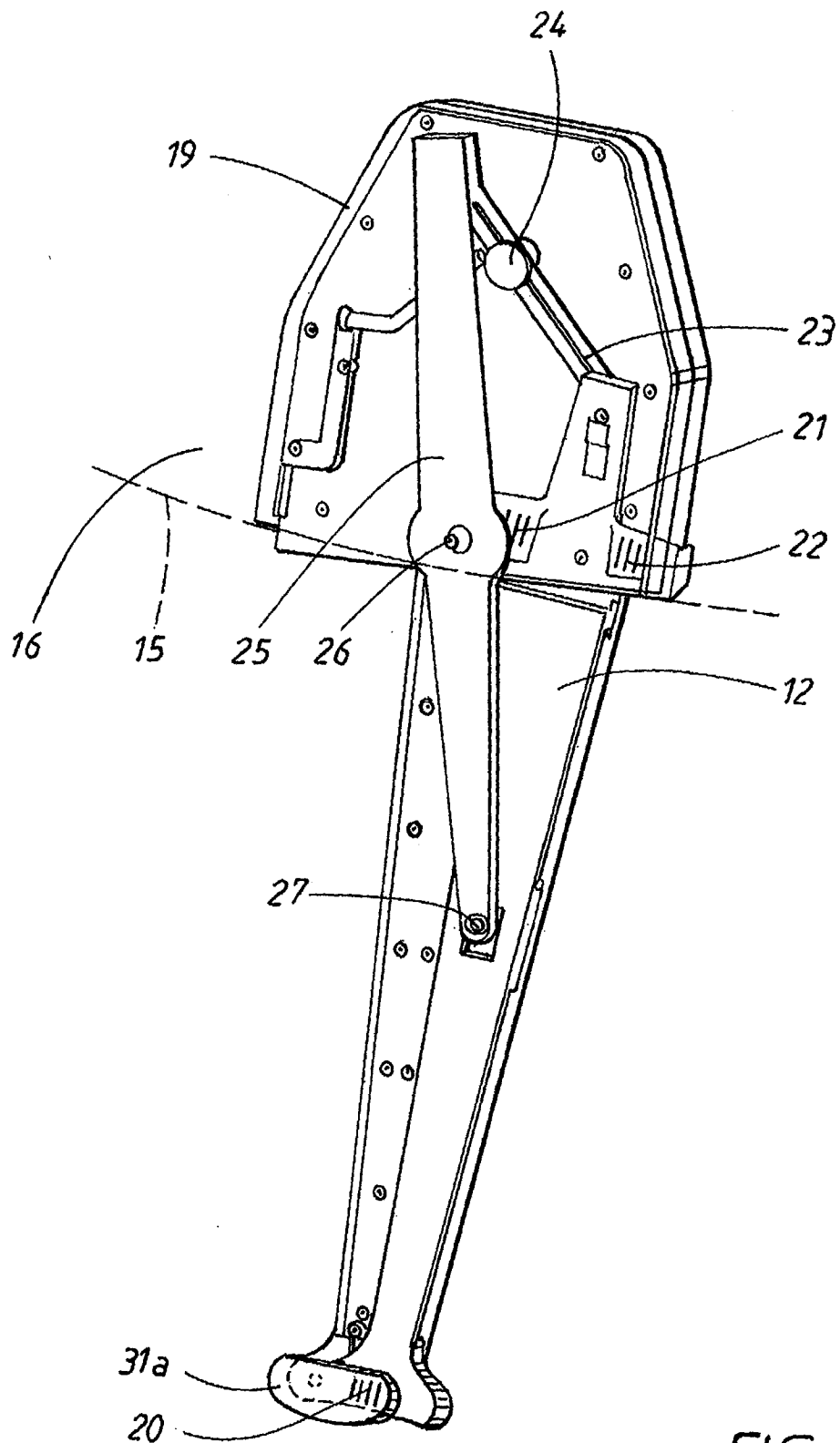
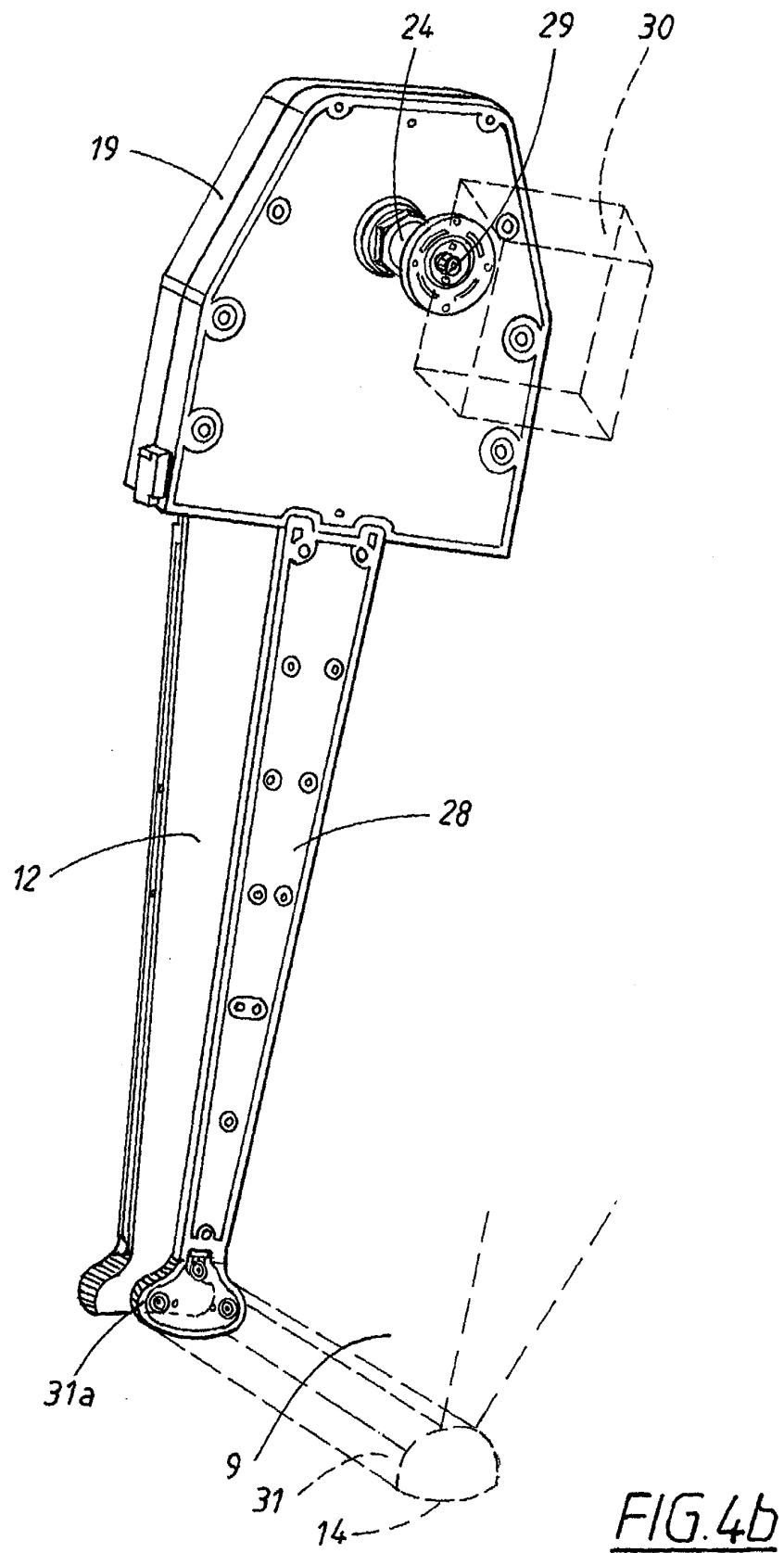


FIG. 4a



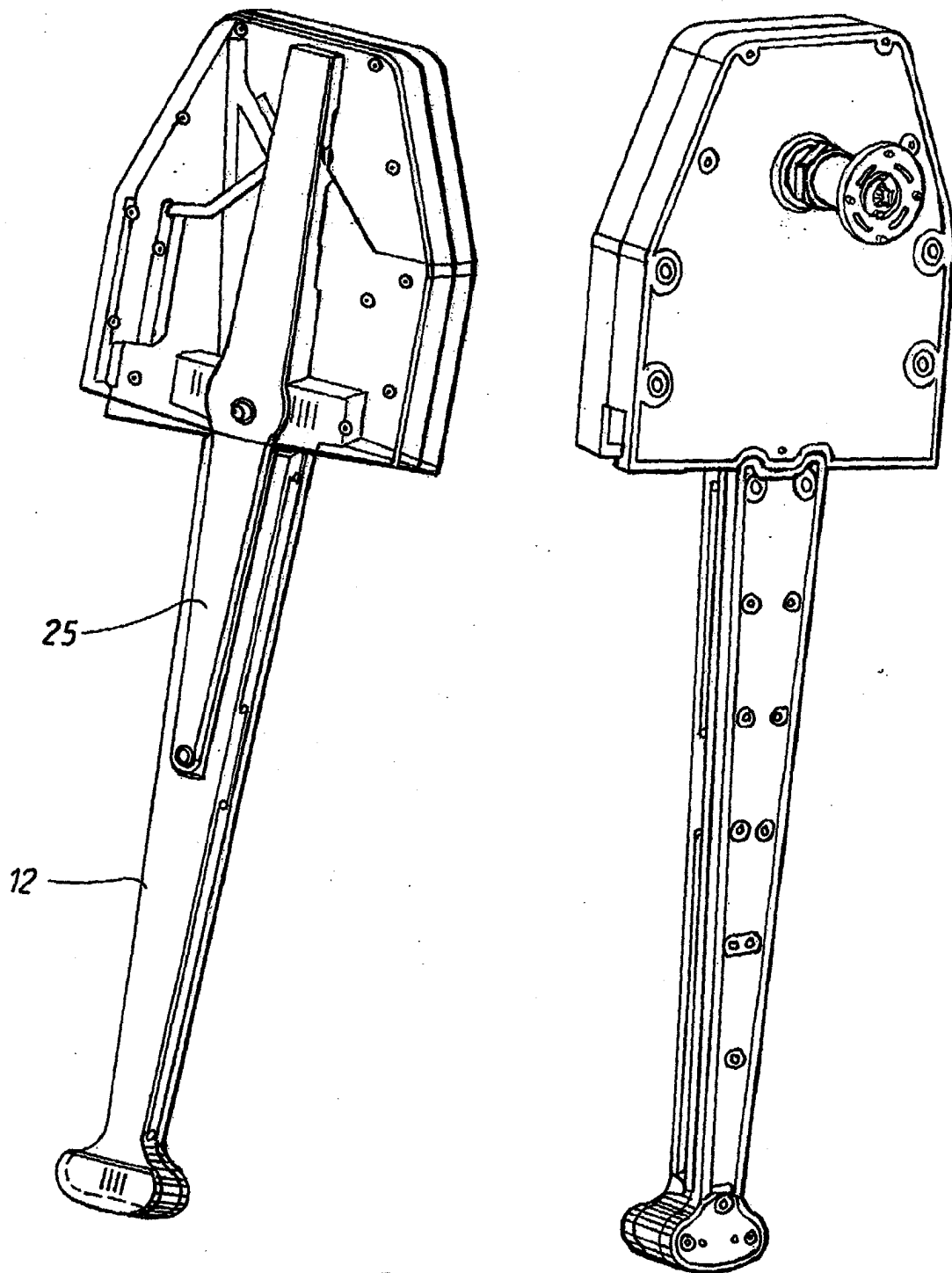


FIG. 5

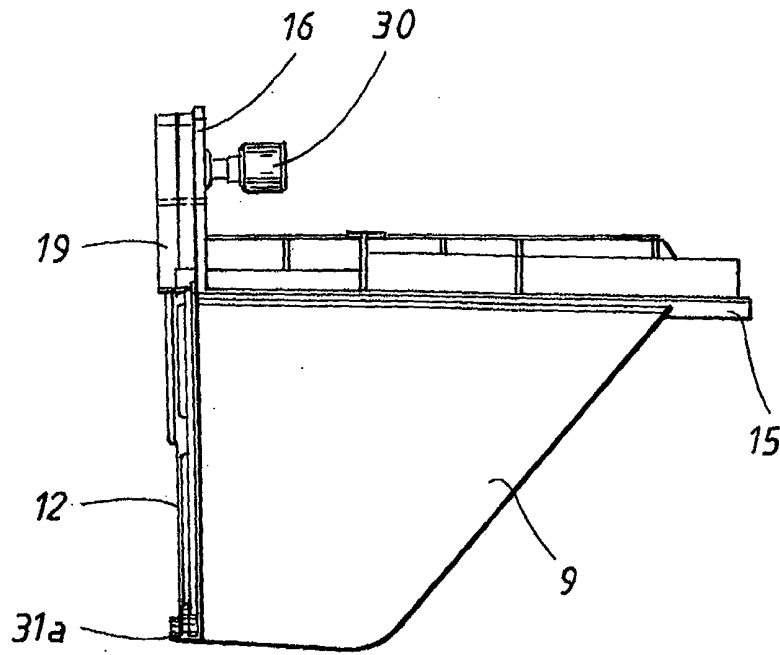


FIG. 6

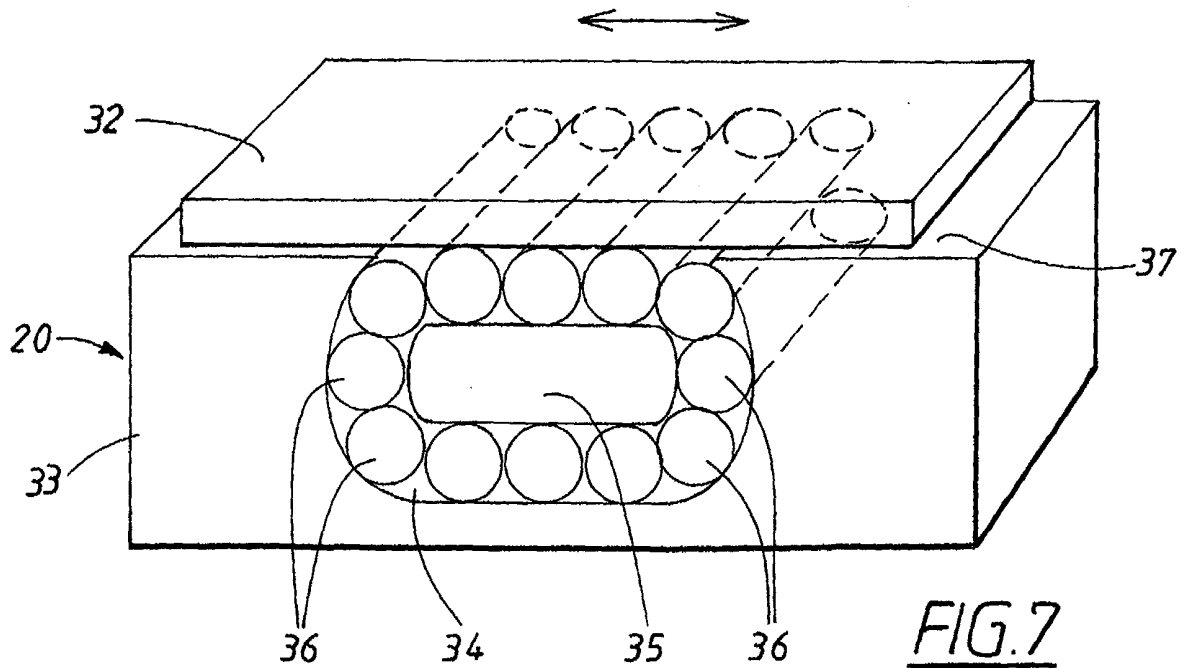


FIG. 7



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EUROPEAN SEARCH REPORT

Application Number
EP 03 07 6486

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.7)		
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Y	US 4 652 147 A (GEKA TOSHIKI) 24 March 1987 (1987-03-24) * abstract; figure 1A *	6	<table border="1"> <thead> <tr> <th>TECHNICAL FIELDS SEARCHED (Int.Cl.7)</th> </tr> </thead> <tbody> <tr> <td>B63H B53H B63B F16C</td> </tr> </tbody> </table>	TECHNICAL FIELDS SEARCHED (Int.Cl.7)	B63H B53H B63B F16C
TECHNICAL FIELDS SEARCHED (Int.Cl.7)					
B63H B53H B63B F16C					
-The present search report has been drawn up for all claims					
Place of search Munich		Date of completion of the search 8 October 2003	Examiner Moya, E		
<table border="0"> <tr> <td> CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document </td> <td> T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document </td> </tr> </table>				CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document	T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document	T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document				

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Application Number

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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:
- ☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-9



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**LACK OF UNITY OF INVENTION
SHEET B**

Application Number

EP 03 07 6486

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-9

Arrangement for controlling the motions of a vessel hull comprising a tapered fin and an interceptor element, both elements being inter-related by means of the ratio between interceptor deployment distribution and the fin chord length distribution.

2. claim: 10

Bearing arrangement between two elements containing a plurality of elongate rolls and being movable along a loop, certain rolls extending over the surface of one of the elements.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 07 6486

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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08-10-2003

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