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A request for correction of the claims has been filed pursuant to Rule 139 EPC. A decision on the request will be taken during the proceedings before the Examining Division (Guidelines for Examination in the EPO, A-V, 3.).

(54) **Method and device for reducing ship movements in rough sea**

(57) A method for reducing wave-induced motion of a ship in that water is conveyed into stabiliser tanks (20) in the hull of a ship (10) from outside the ship and that that the water level in the stabiliser tanks is allowed to settle freely or the water level in the stabiliser tanks is controlled by means of air valves (22). The stabiliser tanks may be equipped with hatches (23) located at the ship's waterline, the hatches being openable in the lateral direction. To reduce the roll motion even further, the ship's hull may also have underwater bilge protrusions (25).

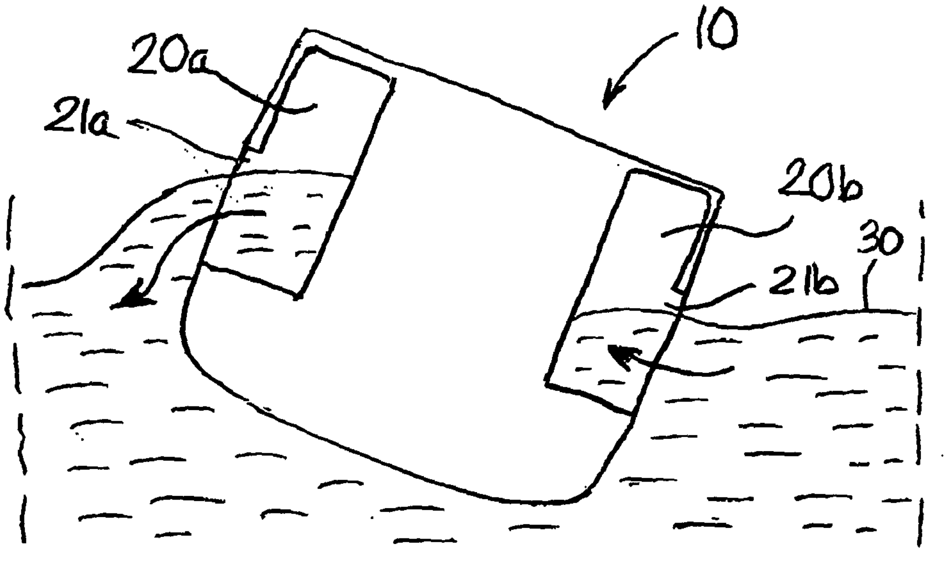

FIG.7

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Description

OBJECT OF THE INVENTION

[0001] The object of the invention is a method for reducing wave-induced ship motion. The roll motion of a ship in a swell is often a major problem when the ship is stationary, but also during movement. Particularly icebreakers and other vessels with a wide hull and a great initial stability of the hull, the roll motion of the ship in open water in an even slightly rougher swell poses a major problem. Attempts have therefore been made to reduce roll, pitch and other ship motions through various solutions, such as bilge keels and water tanks.

PRIOR ART

[0002] Anti-roll stabilisation systems installed in ships have been presented in publications GB-3405, GB-12,411, GB-380,051, GB-389,553, GB-410,820, GB-446,467, GB-451,995. A common characteristic of these solutions is that water tanks have been located in the side portions of a ship, and the amount of water in the tanks is controlled by valves. The tanks located in the ship's sides are connected with one another by channels fitted with valves. In some systems the amount of water in the tanks is controlled by moving water from one tank to another using a pump, for example. In other systems the tanks have tubes opening up under water, and the amount of water in the tanks in controlled by means of a valve in the air channel connecting the tanks. The solutions presented in the said publications are very complicated and often inefficient, however.

PURPOSE OF THE INVENTION

[0003] The purpose of the invention presented here is to create a simple and efficient solution for reducing wave-induced ship motion.

CHARACTERISTICS OF THE METHOD ACCORDING TO THE INVENTION

[0004] The method according to the invention is characterised in that

- water is allowed to flow into a stabiliser space located in the hull of a ship, close to the waterline or substantially at the height of the waterline, when this part of the ship is descending in the swell, and
- at least some of the water is allowed to flow out of the stabiliser space when this part of the ship rises upwards.

EMBODIMENTS OF THE METHOD ACCORDING TO THE INVENTION

[0005] A preferred embodiment of the method according to the invention is characterised in that

- water is allowed to flow into a stabiliser space located in the hull of a ship via an opening in the ship's side, opening in the lateral direction, when the side of the ship is descending,
- water is allowed to flow into the stabiliser space rapidly and powerfully so that the stabiliser space is overfilled, in other words more water comes into the stabiliser space than it would receive in calm waters, and
- at least some of the water is allowed to flow out of the said stabiliser space when the side of the ship rises upwards.

[0006] Another preferred embodiment of the method according to the invention is characterised in that water is allowed to flow into the stabiliser space through an opening in connection with the side of the ship, at the waterline or below the waterline, so that strong turbulences are created in the flow.

[0007] A third preferred embodiment of the method according to the invention is characterised in that water is conveyed into stabiliser tanks in the hull of a ship from outside the ship and that the water level in the stabiliser tanks is allowed to settle freely or the water level in the stabiliser tanks is controlled by means of air valves or similar.

[0008] A fourth preferred embodiment of the method according to the invention is characterised in that
- the roll motion of a ship in a swell is reduced by allowing water to flow into a space in both sides of the ship, at the waterline or substantially at the height of the waterline, and out of it, in accordance with the waves, and
- the roll motion of the ship is reduced by means of bilge projections on the sides of the hull.

DEVICE ACCORDING TO THE INVENTION

[0009] The object of the invention also includes a device for reducing wave-induced ship motion.

CHARACTERISTICS OF THE DEVICE ACCORDING TO THE INVENTION

[0010] The device according to the invention is characterised in that
- there is a stabiliser space in the hull of a ship, close to the waterline or substantially at the height of the waterline,
- in connection with the stabiliser space, there is an opening connecting the stabiliser space with the water outside the ship,
- water can be conveyed into the stabiliser space through the opening when the ship is heeling to the side of the opening, and that
- water can be conveyed out of the stabiliser space through the opening when the ship is heeling to the op-

posite side.

EMBODIMENTS OF THE DEVICE ACCORDING TO THE INVENTION

[0011] A preferred embodiment of the device according to the invention is characterised in that
- there are at least two stabiliser spaces in the hull of a ship, on opposite sides, in the side of the ship, close to the water level or substantially at the height of the waterline,
- the stabiliser spaces are provided with openings opening in the lateral direction, the openings being connected with the outside air,
- a strong flow of water can be conveyed into a stabiliser space, through an opening at the waterline of the ship, when the ship is heeling to the side of the opening, and
- at least some of the water in the stabiliser space exits through the opening when the ship is heeling to the opposite direction.

[0012] Another preferred embodiment of the device according to the invention is characterised in that the opening leading to a stabiliser space, at a ship's waterline, is equipped with a hatch which can be opened and closed and which can be turned open or slid open parallel to the side of the ship.

[0013] A third preferred embodiment of the device according to the invention is characterised in that there are stabiliser tanks in a ship's hull, the tanks being provided with openings or similar to convey water into the stabiliser tank from outside the ship and with air valves or similar to convey air out of or into the stabiliser tank.

[0014] A fourth preferred embodiment of the device according to the invention is characterised in that, in addition to stabiliser tanks, there are lengthwise, submerged bilge projections in the hull, on both sides of a ship, to reduce the roll motion of the ship.

[0015] According to the invention, such spaces for reducing a ship's motions include stabiliser tanks located in both sides of the ship's hull. A continuous stabiliser tank spanning the width of the ship can also be made. One solution is that the lower portion, top portion or another portion of a tank in the side of the ship is open, or that there is a perforated plate in the opening. A valve, flap etc. can also be placed in the stabiliser tank. In such case, water going into the stabiliser tanks in the sides will decrease the crosswise roll of the hull and similarly the stabiliser tanks in the bow and stern will decrease the lengthwise pitch of the hull. The volume of water in the stabiliser tanks at a specific moment and in various situations can be controlled by means of water inlet valves in the lower portion of a stabiliser tank, air valves in the upper portion of a stabiliser tank or by openings in the stabiliser tanks.

[0016] The stabilising method is a passive one if a selected number of holes in the lower portions or sides of the stabiliser tanks and the valves in the air pipes in the upper portion of the stabiliser tanks are allowed to be open. In such a case the excessive initial stability of the ship's hull decreases. Similarly, correct dimensioning of the spaces and their openings in connection with the ship's side will provide an exactly correct flow rate of water into and out of these spaces in various conditions so that wave-induced ship motions decrease.

[0017] In the active method, the water level is actively controlled by opening and closing the selected valves or hatches. When the air valve in the upper portion of a stabiliser tank is kept suitably open so that water comes into the tank's lower portion and, when the ship is rolling, the righting torque acting on the ship's hull on that side is increased and the torque on the opposite side of the ship's hull is correspondingly decreased. By using a compressor, water can also be transferred to the selected side to right the ship's heel. A similar effect can be created by controlling the flow of water into and out of the spaces in connection with the ship's sides by means of adjustable hatches.

[0018] The method according to the invention is especially well suited for icebreakers and multipurpose vessels, whose hulls are characterised by oversized breadth and stability. When travelling in ice, the stabiliser tanks are kept empty to provide the ship with a minimum of draught and to prevent the freezing of water in the tanks. Obviously no stabilising is required in ice. The stabilising method is applicable also in other vessels travelling through ice.

[0019] A stabilising method according to the invention is especially well suited also for merchant ships characterised by excessive stability in some loading situations and, as a result, a short roll period with violent motions. Such a loading situation can emerge, for example, when one of the higher cargo decks in a ship is empty or when the ship has an oversized breadth due to draught limitations or demands on the deck area. Such ships include ro-ro vessels and others with cargo in the lower hold, such as a bulk carrier.

[0020] On the other hand, if the ship has too much cargo on top, the stabiliser tanks according to the invention can be closed and emptied. This makes it possible to achieve, by means of better stability, a high usage of deck cargo, which also increases the displacement. By choosing a suitable number of side tanks to be used, a good seaworthiness and stabilisation in compliance with the regulations will be achieved in each cargo condition.

[0021] Opening the side tanks and filling them with water will not decrease the ship's resistance to ice or its structural soundness in case of a collision to the side.

[0022] The benefits of the method according to the invention in comparison with known stabiliser tanks installed permanently in a ship include:

- no cross ducts are required for the stabiliser tanks because, in a way, the sea acts as a cross duct between the stabiliser tanks, - even as a passive system, the method will not cause resonance problems because the stabilising water does not move between the stabiliser tanks

- the stabiliser tanks are easy to empty if more cargo capacity is needed or if the stabiliser tanks are required for storing recovered oil when combating oil pollution, for example.

[0023] A minor problem can emerge if the ship travels at a high speed, as the incoming new water must in part be accelerated to the ship's speed. In known systems, the tanks often have a closed system and fresh water, which is usually not pumped out even when the tank is not needed in winter. However, the problem often is that the water does not manage to travel from one tank to another quickly enough.

[0024] According to the invention, the tanks are not closed, but rather the water level in the tank rises along with the sea level in an open, passive system. The adjustments can also be made actively using various actuators, such as pumps. The stabilising methods bring about a preferred increase in the roll period of the vessel's hull.

[0025] A tank open to the sea decreases the ship's excessive initial stability to increase the roll period and improve seaworthiness. Side tanks are primarily used to decrease roll motion or the tanks in the bow and stern to decrease pitch. Secondarily, stabiliser tanks spanning crosswise across the ship can also be used.

[0026] The invention is also applicable in old icebreakers, which readily have double hull and watertight compartments. Only valves or holes are added to the tanks. If required, an active system can also be used.

[0027] Stabiliser tanks in connected with a vessel's side decrease the initial stability of the vessel. In decreasing the roll motion of a vessel it is also essential to determine how the exit of water from a tank located in the side rising up in the waves is controlled. According to one embodiment it is preferable that water only exits the stabiliser tank when the vessel has heeled almost entirely to the other side. In this case the water remaining in the said stabiliser tank creates a torque which rights the ship. According to one embodiment, it is also preferable for water to flow as late as possible into a stabiliser tank on the opposite side of the ship.

[0028] One way of controlling the flow is using side hatches with an optimised size, shape and location in the side tank. In this case the tank must be effectively filled up, but it is also essential that the exiting of the water is delayed as described above. It may be preferable in this case that the dimensions and shape of the side hatch create a threshold limiting the exit flow of water.

[0029] The size and shape of the side tank and the location and shape of the hatch have an significant effect also on the flow behaviour of the water, i.e. what the wave filling the stabiliser tank and the wave exiting it will be like. The wave formation has a significant influence on the speed and shape of the flow and on the stabilising effect it has on the ship's motion.

[0030] The above-mentioned size and location of an opening in a side tank can also be made adjustable. In such a case, the characteristics of the side tank may be fine-tuned to the ship's various loading situations, which prevents variations in the roll period. The size of the opening can be adjusted by doors sliding in different directions, for example. The doors may be separate sliding hatches, for example, there may additionally be separate shutter hatches, or these doors can simultaneously function also as actual shutter hatches.

[0031] The movement of water in a stabiliser tank can be determined beforehand by means of the stabiliser tank dimensions. It can also be controlled by installing plates controlling the water movements in the stabiliser tank, the plates being either fixed or adjustable.

[0032] The outlet flow of water can also be limited by shaping the threshold in the stabiliser tank opening. However, the shape of the threshold and the bottom portion of the stabiliser tank also create a compartment or shelf decreasing the roll motion, the compartment or shelf functioning in a fashion similar to a bilge keel or bilge protrusion. Particularly if the a stabiliser tank in connection with a ship and its hatch are long in the longitudinal direction of the ship, a stabilising system of the bilge keel or bilge protrusion type can be made significantly more effective by means of the stabiliser tank bottom, the long hatch and the threshold of the hatch. The flow of water can be controlled and the stabilising made more effective by the dimensioning of the threshold. A compartment or a shelf formed by a stabiliser tank can, however, function effectively also without a threshold.

[0033] It is preferable to design stabiliser tanks according to the invention and their hatches for a new ship, but they can perfectly well be installed in old ships as well. According to a preferred embodiment of the invention, the stabiliser tanks and their hatches are combined with spaces for oil recovery equipment in the ship's side portions.

[0034] According to the embodiment presented above, the space for stabiliser tanks in the ship's hull can preferably be utilised for two different purposes according to need. The space can either function as a closed tank or as an anti-roll stabilisation device opening up to the open water. As an anti-roll stabilisation device, there is a hatch in the stabiliser tank that is opened close to the water level, through which water can enter the stabiliser tank or a container and flow out of it in the swell. The effectiveness of stabilisation created by this type of stabiliser device is affected by a number of factors. These factors include the hatch size, shape and any threshold in it because they determine how and when water can enter the stabiliser tank. Another factor is the size and shape of the stabiliser tank; they determine how water advances into the stabiliser tank and in the stabiliser tank. A third important factor influencing the stabilisation is wave formation in the water moving in the stabiliser tank.

[0035] The above-mentioned stabiliser tank solution is particularly preferable in icebreakers and in other ships travelling in difficult ice conditions, in which no type of bilge keel can be used for anti-roll stabilisation. Bilge keels cannot withstand loads caused by ice blocks.

[0036] However, another highly preferred embodiment of the invention for reducing the roll motion of a ship is created by forming the above-mentioned stabiliser tanks in the sides of the ship, close to the waterline, so that they open up to open water, and underwater bilge protrusions are formed on the sides of the ship. A bilge protrusion differs from a fin-like bilge keel by being a structurally strong part of the vessel's solid hull and by being relatively thick and lacking any sharp edges. Various embodiments of bilge protrusions, which withstand icy conditions, and their functioning is presented in the publication WO 92/17367.

[0037] The combination of stabiliser tanks and bilge protrusions very effectively reduces the roll motion of a vessel, and the structure withstands loads caused by icy conditions. The effectiveness of the combination is based on both elements of the combination effectively complementing one another precisely in such special conditions in which neither is at its most effective on its own.

[0038] When the vessel travels forward the bilge protrusions are fairly effective, but as the speed of the vessel decreases their effect also decreases. Furthermore, the bilge protrusions do not have a major impact on the vessel's roll period. The stabiliser tanks, however, are effective also when the vessel is travelling at low speeds, and they increase the roll period. Therefore a combination of bilge protrusions and stabiliser tanks and their joint impact is effective both when the vessel is travelling forward and at lower speeds. The bilge protrusions improve the situation, i.e. decrease roll motion, also in loading conditions where the stabiliser tanks are closed.

[0039] The icebreakers with bilge protrusions built according to the above-mentioned publication WO 92/17367 do not have major rolling problems even in open water. The situation is different for conventional icebreakers with a wide hull shape and round bilges. Their roll characteristics in open water are very difficult for the crew. However, even conventional icebreakers can be modified according to the invention presented above so that bilge protrusions are built into their hull, under the waterline, and stabiliser tanks which can be opened by hatches are built into the sides of the hull, at the waterline.

EXAMPLES OF EMBODIMENTS

[0040] In the following, the invention is described using examples with reference to the appended drawings, in which

LIST OF FIGURES

[0041]

Figure 1 is a schematic top view of a ship according to the invention.

Figure 2 is a schematic cross section of a ship according to the invention.

Figure 3 is a schematic top view of another ship according to the invention.

Figure 4 is a schematic top view of a third ship according to the invention.

Figure 5 is a schematic cross section of a ship according to the invention in a swell.

Figure 6 is a schematic top view of a fourth ship according to the invention.

Figure 7 is a schematic cross section of the ship according to Fig. 6 in a swell.

Figure 8 is a schematic side view of a portion of a ship according to the invention.

Figure 9 is a schematic side view of a portion of another ship according to the invention.

Figure 10 is a schematic cross section of the ship according to Fig. 9 in a swell.

Figure 11 is a schematic top view of a portion of the ship according to Fig. 8.

Figure 12 is a schematic cross section of a fifth ship according to the invention.

Figure 13 is a schematic cross section of a sixth ship according to the invention.

Figure 14a is a schematic side and partly cross-sectional view of a seventh ship according to the invention.

Figure 14b is a schematic side and partly cross-sectional view of yet another ship according to the invention.

Figure 15 is a schematic view of a ship rolling while the stabiliser tank hatches are closed.

Figure 16 is a schematic view of a ship rolling while the stabiliser tank hatches are open.

DESCRIPTION OF THE FIGURES

[0042] Figure 1 shows a schematic view of a ship 10 with tanks 20a to 20d according to one embodiment of the invention in a ship's sides. The tanks 20a to 20d also have openings 21 a to 21 d opening in the lateral direction.

[0043] Fig. 2 shows that, in this embodiment of the invention, the tanks 20a to 20b are located in the ship's 10 sides so that, in still water, some of the tanks 20a to 20b are below the water level and some above the water level. The openings 21 a to 21 b opening in the lateral direction in the tanks 20a to 20b are located in the bottom portions of the tanks, completely under water, and the top portions of the tanks 20a to 20b have air openings 22a and 22b. In the embodiment of Fig. 3, the tank 20 spans the entire breadth of the ship 10. In Fig. 4, the tanks 20a to 20d are located in various parts of the ship 10 so that the tanks 20a and 20b located in the ship's sides reduce the roll motion of the ship 10 and the tanks 20c and 20d located in the bow and stern of the ship 10 reduce the surge and pitch motions of the ship 10.

[0044] Figure 5 shows the situation of the ship 10 in a swell. Here the ship 10 has heeled to the right in Fig. 5 so that water flows into a tank 20b through an opening

21 b below the water level. The weight of the water in the tank 20a on the opposite side of the ship 10 seeks to prevent the ship 10 from heeling. In this situation, water flows out of the tank 20a through an opening 21 a below the water level.

[0045] Figure 6 shows two spaces 20a and 20b on opposite sides of the ship 10, the spaces having hatches 23a and 23b which can be opened by turning so that water can enter into the spaces 20a and 20b through the openings 21 a and 21 b.

[0046] Figure 7 shows how water flows into a space 20b on the right side in the figure as the ship 10 heels and water flows out of a space 20a on the opposite side. The weight of the water in the space 20a reduces the heel of the ship 10, however. An essential detail in the water flow is also that when the ship heels and water starts to flow into the spaces 20a and 20b, the flow will continue even as the heeling stops. Then the space 20a or 20b, as it were, fills up more and higher than the surrounding water level 30, and simultaneously strong turbulence is created in the water flow. If the water flow duct is arranged so that it increases the turbulence even further, it binds a lot of energy. The energy expended to the turbulence in the water in turn binds the ship's roll energy, which makes the reduction of the ship's roll motion significantly more effective.

[0047] Figure 8 shows an opening 20 leading to a space 20 in a side of the ship 10, the opening being closable by a sliding hatch 23 moving in the lateral direction. In Fig. 9 the hatch 23 moves vertically.

[0048] Figure 10 shows how in this embodiment of the invention hatches 23a and 23b of spaces 20a and 20b form thresholds, which slightly reduce the flow of water out of spaces 20a and 20b. In addition to the effect of the weight of the water in the space 20, the roll motion of the ship 10 is reduced by bilge keels of sorts formed by the bottoms of the spaces 20a and 20b and the thresholds in the hatches 23a and 23b, which bilge keels increase the turbulence in the water flowing into and out of the spaces 20a and 20b, which effectively binds the ship's roll energy.

[0049] In Figure 11, plates 24a and 24b have been placed inside a space 20, the plates affecting the characteristics of the water flow inside the space 20. The plates 24a and 24b can be perpendicular to or be positioned obliquely against the walls of space 20. Their position may also be adjustable. The reduction of a ship's roll motion according to the invention is affected by a variety of factors. The factors affecting roll reduction include various arrangements which increase the effective filling of a stabiliser space 20a or 20b and/or the delay in the emptying of the stabiliser space 20a or 20b. It is preferable that a stabiliser tank is first suitably overfilled and then empties suitably slowly and thus rights the ship. Increasing turbulence in the water flowing into the stabiliser space 20a or 20b and out of it is another essential factor increasing roll reduction. The flow can be made turbulent by arranging the flow duct suitably and by adding members affecting the flow, such as plates. Energy spent in the turbulence in the water effectively impacts the ship's roll reduction.

[0050] Figure 12 shows a cross section of a ship 10 according to the invention, the ship being an icebreaking vessel. Here bilge protrusions 25a and 25b are arranged on the sides of the hull, under the waterline, lengthwise relative to the ship, which bilge protrusions reduce the roll motion of the ship during its travel. Because the effectiveness of the roll reduction by the bilge protrusions 25a and 25b decreases as the ship's 10 speed decreases stabiliser tanks 20a and 20b opening in the lateral direction are arranged in the ship's 10 sides, at the waterline, the stabiliser tanks opening into the open water via openings 21 a and 21 b. The openings 21 a and 21 b can be closed with hatches if required, as presented above. The hatches are not shown in Fig. 12, however. Stabiliser tanks 20a and 20b decrease the roll motion of the ship 10 also when the ship 10 is travelling at a low speed and when the ship 10 is stationary. Thus the combined operation of the bilge protrusions 25a and 25b and of the stabiliser tanks 21 a and 21 b provides effective roll reduction at all speed ranges and in all conditions.

[0051] Figure 13 shows a cross section of a conventional wide icebreaker 10 with rounded bilges and the entire hull is substantially round in shape. It has been found that the roll characteristics of such a ship in open water are very difficult for the crew. Therefore, in Fig. 13, underwater bilge protrusions 25a and 25b have been added to the round hull of the icebreaker 10 and, at the vessel's waterline, stabiliser tanks 20a and 20b opening in the lateral direction. By means of their joint operation, the roll motion of a conventional wide icebreaker 10 can be substantially reduced, which makes the vessel's behaviour in a swell substantially more pleasant.

[0052] Figure 14a shows a side view of an example of a ship's 10 hull with stabiliser tanks 20 according to the invention in both sides. The stabiliser tanks 20 are shown in Fig. 14a as a sectional view so that their size and shape can be seen clearly. In the example shown here, the stabiliser tanks 20 are located close to the waterline 30, somewhat astern from the midship.

[0053] The length of the stabiliser tank 20 shown in the example is 5 to 20%, most preferably approx. 10% of the ship's length. The height of the stabiliser tank 20 is 30 to 60%, most preferably approx. 50% of its length and the depth 20 to 50%, most preferably approx. 35% of the length of the stabiliser tank 20. In other words, the space for water flow is rather narrow.

[0054] Fig. 14a also shows that the opening 21 of the stabiliser tank 20 is not located in the middle of the stabiliser tank 20, but instead close to one of its ends. In Fig. 14a, the width and height of the opening 21 is 20 to 40%, most preferably approx. 30% of the length of the stabiliser tank 20. The height of the free water level is most preferably approx. at the 40 to 60% height from the lower edge of the opening 21 in the stabiliser tank 20. As the opening 21 is thus clearly smaller than the stabiliser tank 20 and at one end of the stabiliser tank 20, a flow of water is created through the opening 21 into the stabiliser tank 20, the flow having to change its direction. This also creates strong turbulence in the flow, which binds energy.

[0055] It should be noted that Fig. 14a shows one highly functional example of the dimensions for a stabiliser tank 20. The dimensions can also, in various cases, be different and vary considerably, however. It is essential that a specific frequency is provided for the stabiliser tank 20, the frequency being suitable when compared to the ship's roll period. When the dimensions of the stabiliser tank 20 are suitable, water discharges out of the stabiliser tank 20 more slowly.

[0056] The stabiliser tanks 20 used in the example presented here reduced the ship's 10 mean roll angle to approximately one half of what it would be without the stabiliser tanks 20. The stabilising effect was based on an increased anti-roll stabilisation, i.e. on the energy expended in the turbulence of the water, and on that in a swell the stabiliser tank 20 was first suitably overfilled and then suitably emptied, righting the ship.

[0057] An excellent benefit of the invention is that an effective reduction of roll motion is created even with relatively small stabiliser tanks. With small stabiliser tanks 20, the roll period remains nearly the same, but even so an effective reduction of rolling is provided. In the abovementioned example, the stabiliser tanks 20 reduced the ship's 10 mean roll angle to approximately one half of what it would have been without the stabiliser tanks and the roll period remained at approx. 8 seconds.

[0058] Figure 14a does not show the hatches in the openings 21 of the stabiliser tank 20, but most preferably there should be hatches on the openings 21. The hatches may be equipped with hinges, in which case the hatch opens by turning, as in Fig. 6. Alternatively, they can be equipped with rails, in which case the hatches open parallel to the ship's side, either horizontally, as in Fig. 8, or vertically, as in Fig. 9. By means of the hatches, the stabiliser tanks 20 may be converted tanks that can also be used for other purposes. Thus it is fully possible to construct the hatches 21 so that they withstand loads caused by ice.

[0059] If the effect required from the stabiliser tanks according to the invention is so effective that in addition to roll reduction, the roll period also increases, the size or the number of the tanks can then be increased.

[0060] Figure 14b shows an embodiment of the invention where a ship 10 has two stabiliser tanks 20a and 20b equipped with openings 21 a and 21 b in both of its sides. These dimensions already provide an increased roll period for the ship. There can be even more stabiliser tanks 20, and in principle all of the ship's sides could be equipped with stabiliser tanks. In practice such an effective stabilisation is not necessary, however.

[0061] Figure 15 shows a curve resulting from a model test where a model ship was heeled and allowed to roll freely in still water. During the rolling, the ship's roll angle (α) was measured as a function of time (t) when the stabiliser tanks were closed. Fig. 15 shows that the roll angle (α) remains nearly unchanged, i.e. no reduction of rolling took place.

[0062] Figure 16 shows a curve produced in a model test similar to Fig. 15, but this time the hatches in the model ship were open. Fig. 16 clearly shows that, contrary to the previous figure, the roll angle (α) is reduced very quickly and effectively.

ADDITIONAL NOTES

[0063] It is obvious to a person skilled in the art that the different embodiments of the invention may vary within the scope of the claims presented below.

LIST OF REFERENCE NUMBERS

[0064]

10	Ship
20	Stabiliser space, stabiliser tank
21	Opening
22	Air opening, air valve
23	Hatch
24	Plate
25	Bilge protrusion
30	Water level
31	Water in the tank

Claims

1. A method for reducing wave-induced motion of a ship (10), **characterised in that**

- water is allowed to flow into a stabiliser space (20) located in the hull of a ship (10), close to the waterline (30) or substantially at the height of the waterline, when this part of the ship is descending in the swell, and
- at least some of the water is allowed to flow out of the stabiliser space (20) when this part of the ship (10) rises upwards.

2. A method according to claim 1, **characterised in that**

- water is allowed to flow into a stabiliser space (20) located in the hull of a ship (10) via an opening in the ship's side, opening in the lateral direction, when the side of the ship is descending,
- water is allowed to flow into the stabiliser space (20) rapidly and powerfully so that the stabiliser space is overfilled, in other words more water comes into the stabiliser space than it would receive in calm water, and
- at least some of the water is allowed to flow

out of the said, overfilled stabiliser space (20) when the side of the ship (10) rises upwards.

3. A method according to any one of claims 1 or 2, **characterised in that** water is allowed to flow into the stabiliser space (20) through an opening (21) in connection with the side of the ship (10), at the waterline or below the waterline, so that strong turbulences are created in the flow.

4. A method according to any one of claims 1, 2 or 3, **characterised in that** water is conveyed into stabiliser tanks (20) in the hull of a ship (10) from outside the ship and that the water level in the stabiliser tanks is allowed to settle freely or the water level in the stabiliser tanks is controlled by means of air valves (22) or similar.

5. A method according to any one of claims 1 to 4, **characterised in that**

- the rolling of a ship (10) in waves is reduced by allowing water to flow into a stabiliser space (20) in both sides of the ship, at the waterline or substantially at the height of the waterline, and out of it, in accordance with the waves, and
- the roll motion of the ship (10) is also reduced by means of bilge projections (25) on the sides of the hull.

6. A device for reducing wave-induced motion of a ship (10), **characterised in that**

- there is a stabiliser space (20) in the hull of a ship (10), close to the waterline (30) or substantially at the height of the waterline,
- in connection with the stabiliser space (20), there is an opening (21) which connects the stabiliser space with the water (30) outside the ship (10),
- water can be conveyed into the stabiliser space (20) through the opening (21) when the ship (10) is heeling to the side of the opening, and that
- water can be conveyed out of the stabiliser space (20) through the opening (21) when the ship (10) is heeling to the opposite side.

7. A device according to claim 6, **characterised in that**

- there are at least two stabiliser spaces (20a, 20b) in the hull of a ship (10), on opposite sides, in the sides of the ship, close to the water level (30) or substantially at the height of the waterline,
- the stabiliser spaces (20a, 20b) are provided with openings (21 a, 21 b) opening in the lateral direction, the openings being connected to the outside air,
- a strong flow of water can be conveyed into a stabiliser space (20a, 20b), through an opening (21 a, 21 b) at the waterline of the ship (10), when the ship is heeling to the side of the opening, and
- at least some of the water in the stabiliser space (20a, 20b) exits through the opening (21 a, 21 b) when the ship (10) is heeling in the opposite direction.

8. A device according to claim 6, **characterised in that** the opening (21) leading to the stabiliser space (20), at the ship's (10) waterline, is equipped with a hatch (23) which can be opened and closed and that can be turned open or slid open parallel to the side of the ship.

8. A device according to claim 6, **characterised in that** there are stabiliser tanks (20) in a ship's (10) hull, the tanks being provided with openings (21) or similar to convey water into the stabiliser tank from outside the ship and with air valves (22) or similar to convey air out of or into the stabiliser tank.

9. A device according to any one of claims 6, 7 or 8, **characterised in that,** in addition to the stabiliser tanks (20), there are lengthwise, submerged bilge projections (25) in the hull, on both sides of the ship, to reduce the roll motion of the ship (10).

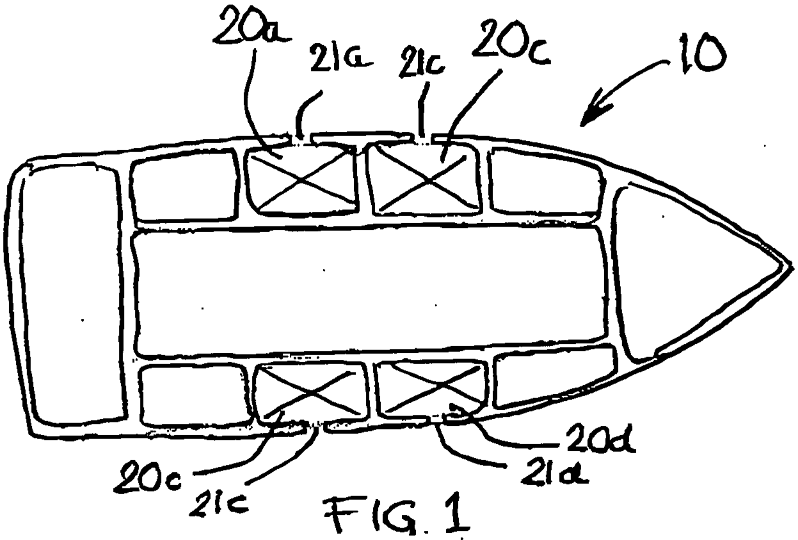

FIG. 1

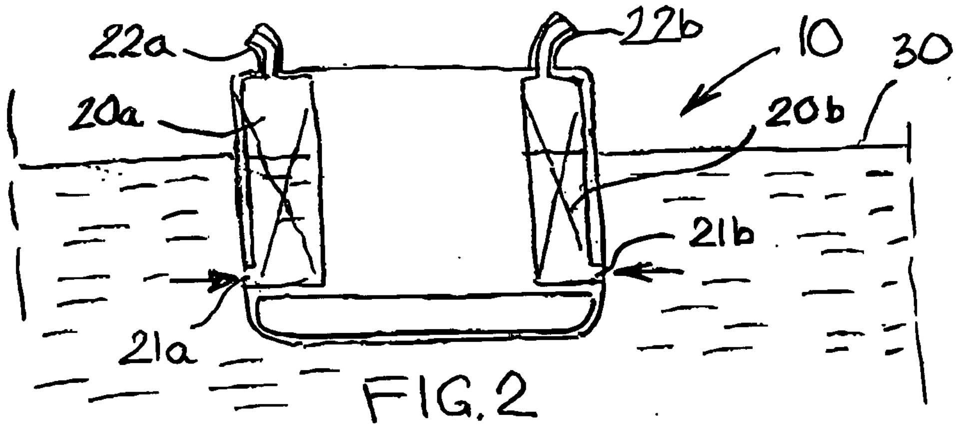

FIG. 2

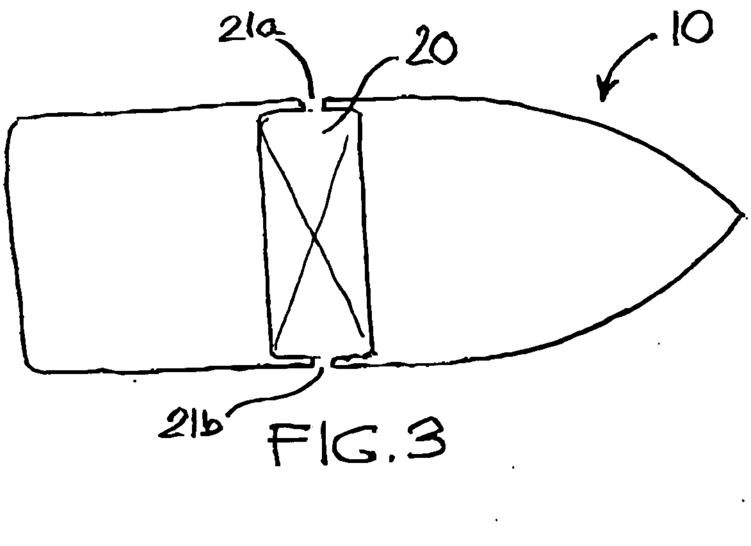

FIG. 3

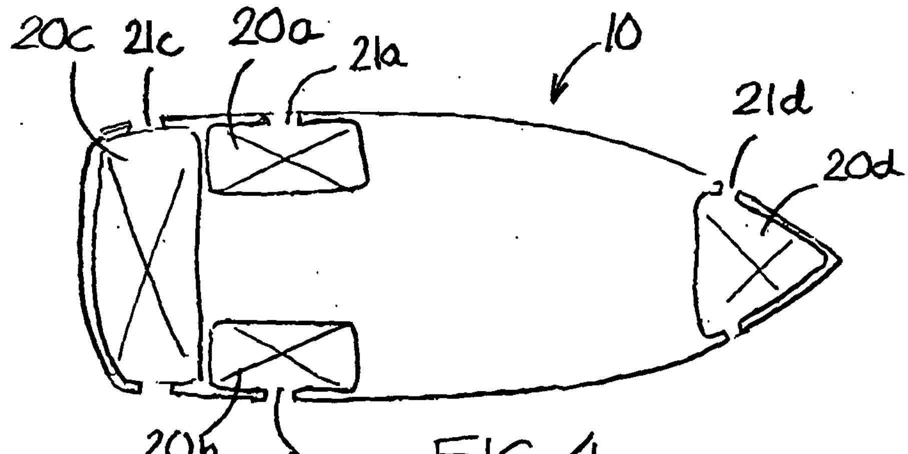
20c
21c
20a
21a
10
21d
20d
20b
21b

FIG. 4

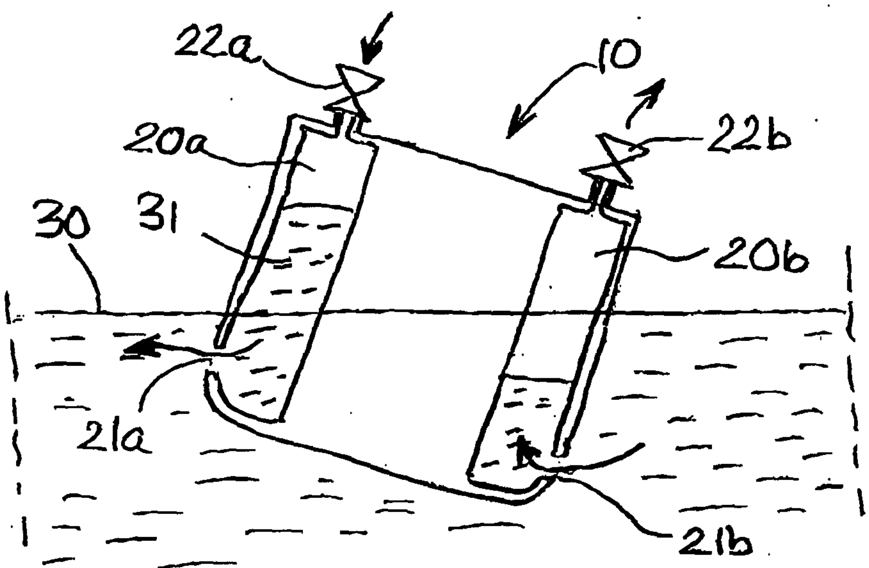
22a
10
22b
20a
30
31
20b
21a
21b

FIG. 5

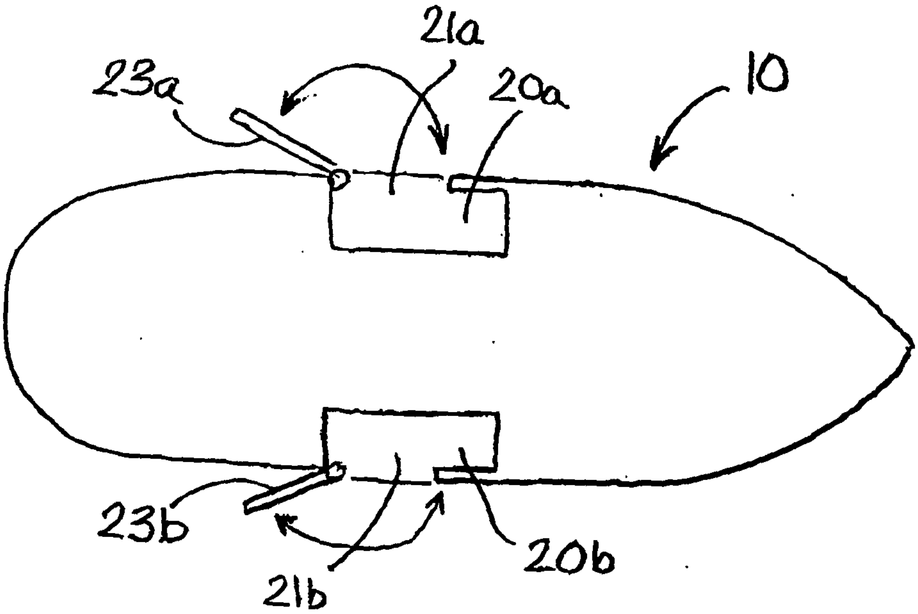

FIG. 6

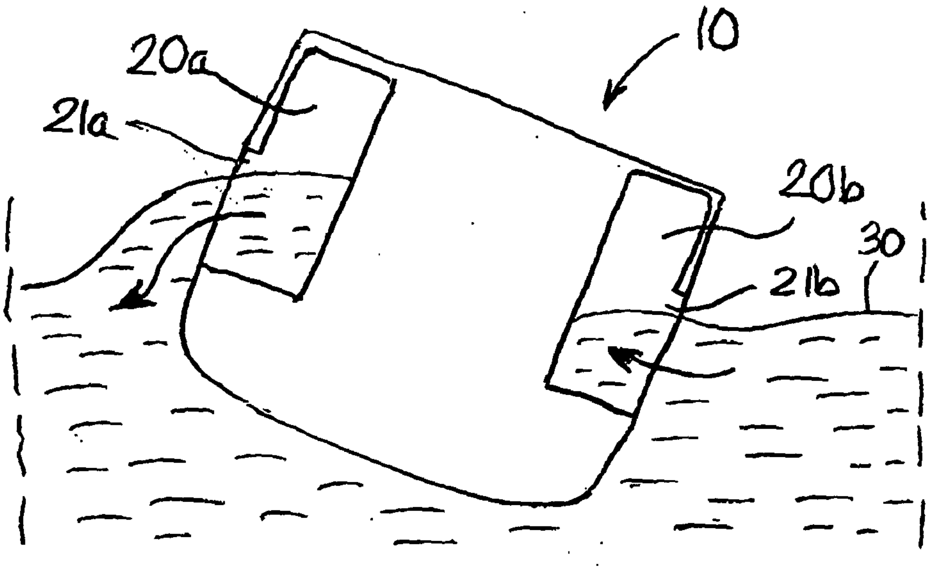

FIG. 7

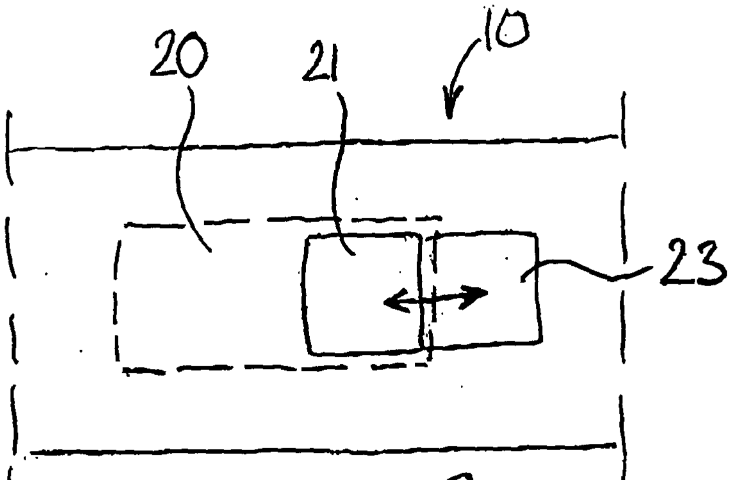

FIG. 8

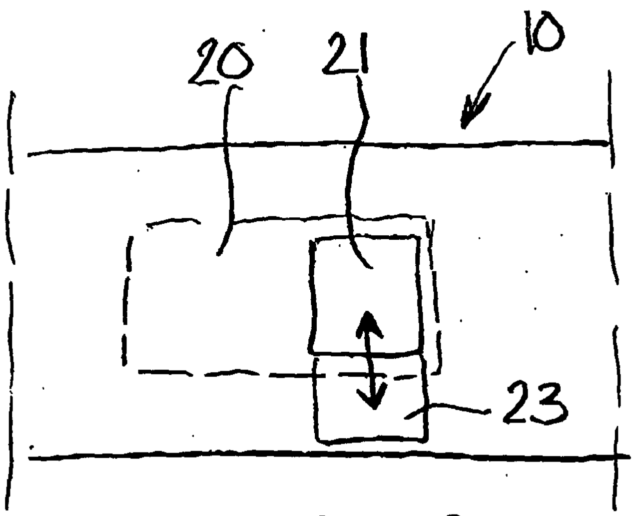

FIG. 9

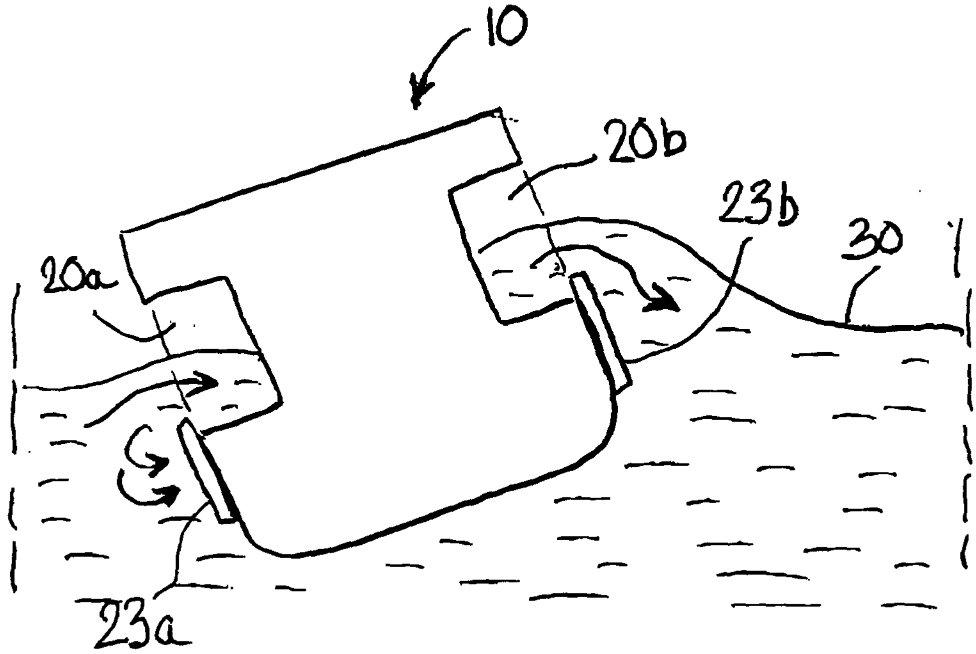

FIG. 10

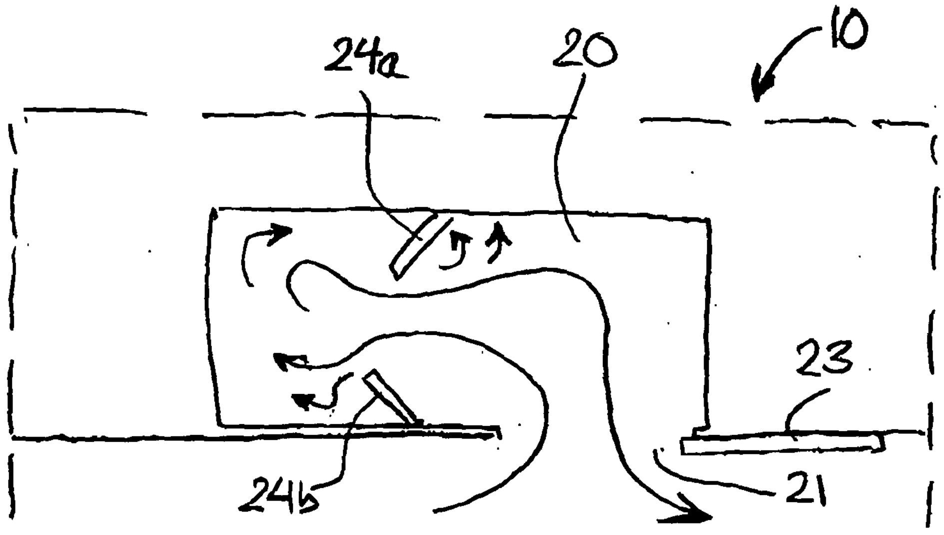

FIG. 11

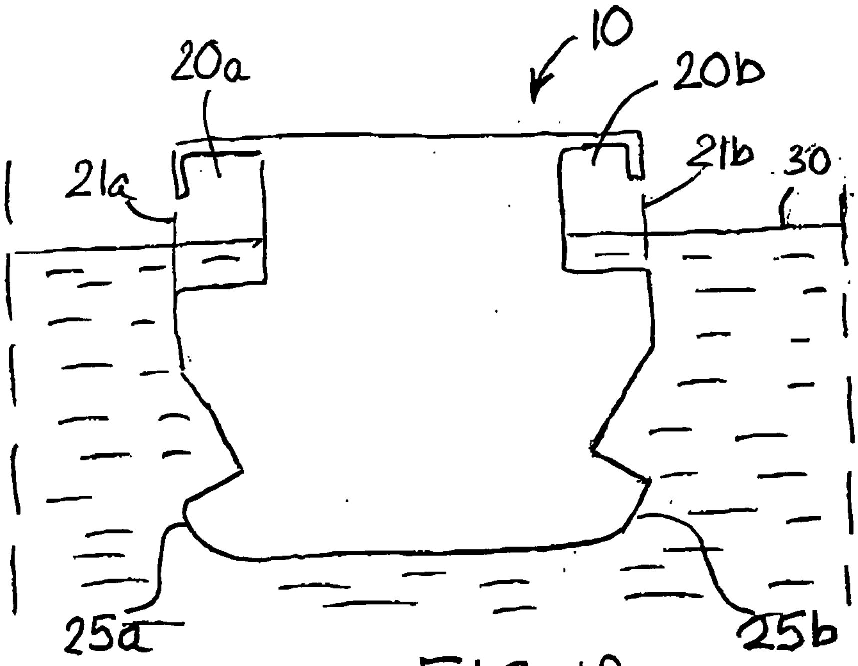

FIG. 12

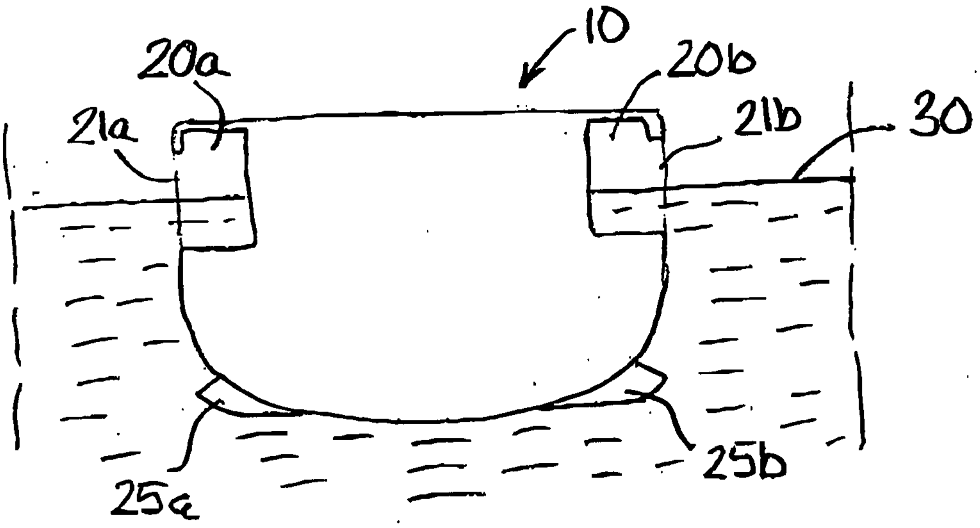

FIG. 13

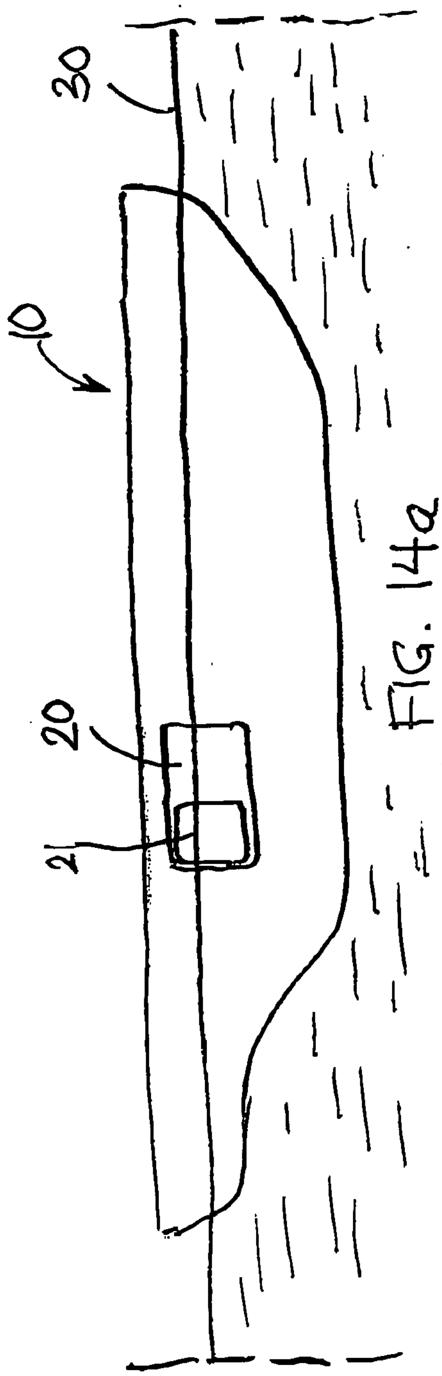

FIG. 14a

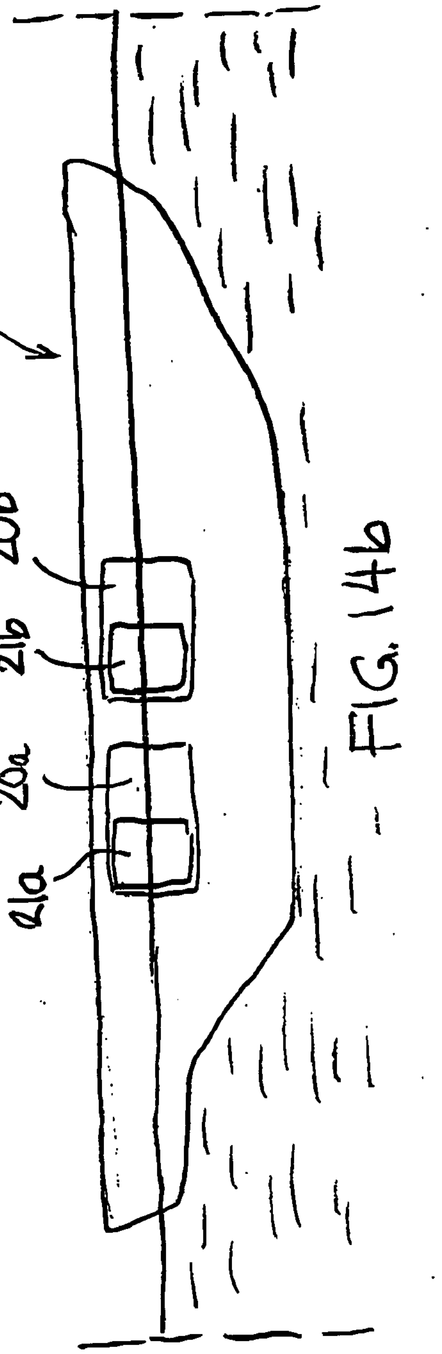

FIG. 14b

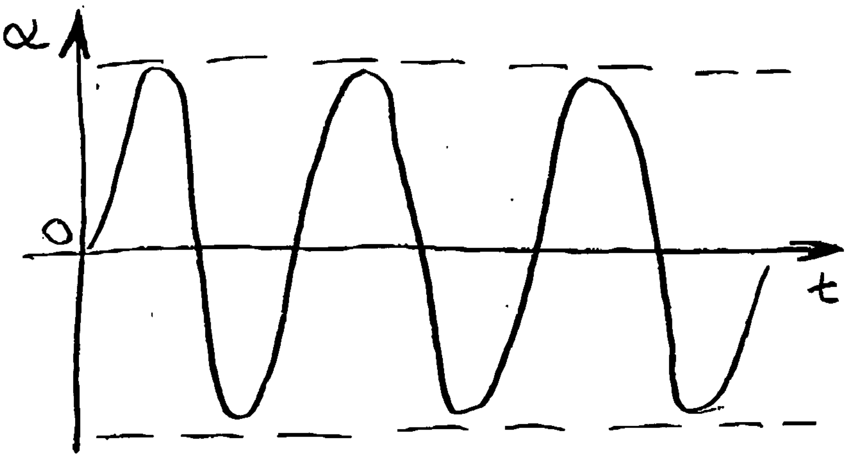

FIG. 15

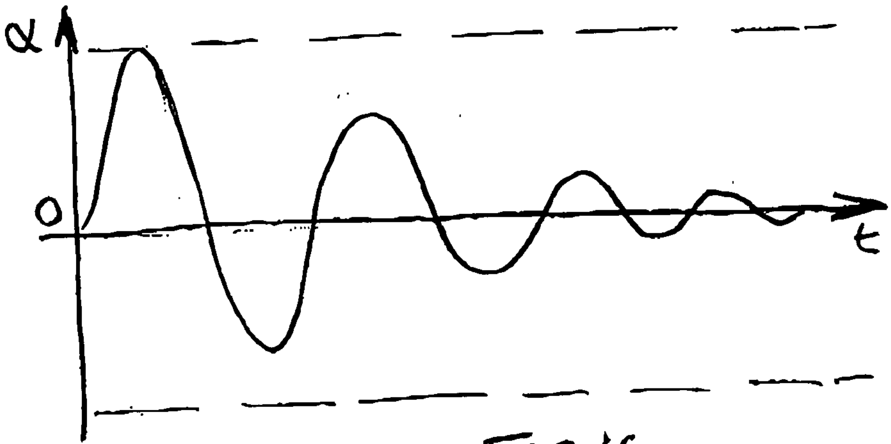

FIG. 16

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EUROPEAN SEARCH REPORT

Application Number
EP 08 39 6015

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The present search report has been drawn up for all claims

3

Place of search	Date of completion of the search	Examiner
Munich	21 January 2009	Ferranti, Max

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