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(54) COMBINED PROPELLER CAP FOR REDUCING ROTATING FLOW AND HUB VORTEX AND ENHANCING PROPULSION EFFICIENCY

KOMBINIERTE PROPELLERABDECKUNG ZUR VERRINGERUNG VON ROTATIONSFLUSS UND NABENWIRBEL UND ZUR ERHÖHUNG DER ANTRIEBSEFFIZIENZ

CÔNE D’HÉLICE COMBINÉ POUR RÉDUIRE UN ÉCOULEMENT ROTATIF ET UN TOURBILLON DE MOYEU ET AMÉLIORER L’EFFICACITÉ DE PROPULSION

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Description

Technical Field

[0001] The present invention relates to the structure of a propeller cap and, more particularly to a combined propeller cap for reducing rotational flow and hub vortex and enhancing propulsive efficiency, whereby the propeller cap reduces noise and vibration in a vessel by decreasing hub vortex cavitation behind a propeller for propelling the vessel, prevents erosion and corrosion of a rudder, and enhances propulsive efficiency to save fuel.

[0002] Further, the present invention relates to a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap being capable of reducing hub vortex cavitation that is generated behind a propeller by using a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap in order to solve the problem with a PBCF (Propeller Boss Cap Fin) in the related art, which is difficult to manufacture and is expensive due to precise machining for designing and manufacturing fins caused by a configuration of attaching a plurality of small fins to a propeller cap to reduce hub vortex, and being capable of being easily manufactured with a low cost in a simple structure as compared with the PBCF.

[0003] Further, the present invention relates to a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap being capable of additionally reducing hub vortex cavitation by forming a combined propeller cap structure, in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, and by attaching plate-shaped guide fins at a contractive section or between an contractive section and a diffusive section of the propeller cap, whereby it can reduce rotational flow and hub vortex cavitation that are generated behind a propeller and can be easily manufactured at a low cost in a simple configuration, as compared with an existing PBCF.

Background Art

[0004] In general, sea vessels are moved forward by a thruster such as a propeller that generates propulsion and such a propeller type thruster is connected to a rotary shaft of an engine of a vessel and rotated by power from the engine.

[0005] In detail, a propeller type thruster is largely includes a propeller cap connected to the rotary shaft of an engine to form the body of a propeller and a plurality of blades formed around the propeller cap, and propulsion and torque is generated by the flows passing the blades, whereby a vessel is moved forward by the propulsion with the torque offset by power from the engine.

[0006] In general, the propellers of vessels use only 70% of the power from a main engine as propulsion for moving the vessels forward and the other power from the engine is wasted as friction, a thermal loss, a vortex behind the propeller, and a propeller hub vortex.

[0007] In these factors, the rotational flow and the hub vortex behind the propeller consume about 5 ~ 7% and 1 ~ 3% of the power. Further, a strong hub vortex generates hub vortex cavitation, which causes problems such as noise, vibration, erosion and corrosion of a rudder. Accordingly, various devices have been developed in the related art to solve problems with restoration of wasted energy and cavitation.

[0008] For example, a "Ship propulsion device and ship with same" has been disclosed in Korean Patent Application Publication No. 10-2011-0120267 to increase propulsion and save fuel by decreasing hub vortex cavitation behind a propeller.

[0009] In detail, Korean Patent Application Publication No. 10-2011-0120267 relates to a ship propulsion device that has fins formed on a propeller boss cap mounted at the rear of a propeller boss of a screw propeller and disposed behind and between the blades of the propeller and that can be easily manufactured with high efficiency and low weight by cutting straight the rear end of the propeller boss cap or, by recessing the rear end of the propeller boss cap within 20% of the entire length of the propeller boss cap from the edge, making the entire length of the propeller boss cap 0.28 ~ 0.76 times the diameter of the front end of the cap, and by making the diameter of the rear end of the propeller boss cap 0.35 ~ 0.95 times the diameter of the front end of the cap, and a ship equipped with the ship propulsion device.

[0010] Further, a "Propeller boss cap of the ship" for improving propulsion and saving fuel by reducing hub vortex cavitation behind a propeller has been disclosed in Korean Patent Application Publication No. 10-2012-0134647.

[0011] In detail, the propeller boss cap for a ship disclosed in 10-2012-0134647 is designed to be mounted on the rear side of a propeller boss, which is connected to the shaft of a propeller, to prevent corrosion of a rudder by suppressing hub vortex cavitation due to a flow behind the propeller without increasing additional resistance by the boss cap, by forming a boss groove deep such that the center and the edge thereof are not at the same level, on a rudder-side surface of the boss cap.

[0012] As described above, there have been various studies for increasing propulsion and saving fuel by decreasing rotational flow and hub vortex cavitation. However, according to these methods of the related art, propeller caps are formed in specific shapes different from those existing before or forming a plurality of fins separate from the blades of propellers, so the configuration is complicated, whereby it is difficult to design and manufacture a propeller, and the manufacturing cost is also increased.

[0013] In detail, as for a device for restoring rotational energy behind a propeller, as described above, there are a CRP (Contra-Rotating Propeller), a pre-swirl stator, a postswirl stator, a vane-wheel, and a rudder thrust (bulb) fin). These devices have been known to save energy by about 2 ~ 5%, but they are relatively large structures, so they are expensive to install and mount and have a structural danger.

[0014] Further, for example, there is a PBCF (Propeller Boss Cap Fin) and a rudder bulb that are devices for overcoming the problem with hub vortex cavitation by a propeller. These devices have an energy saving effect of about 1 ~ 3% and have a small and simple configuration, as compared with the devices for restoring rotational energy behind a propeller, so they can be easily mounted and manufactured at low cost.

[0015] The PBCF, which was been developed in the 1970s, improves propeller efficiency about 1 ~ 3% by absorbing hub vortex energy using small fins on a propeller cap on the hub at the rear portion of a propeller and, reduces noise and erosion and corrosion of a rubber due to hub vortex cavitation by decreasing hub vortex cavitation by the propeller.

[0016] However, the fins for the PBCF have to be designed in different ways every time to have appropriate characteristics, depending on the types of vessels and the use environment, require very precise design, and should be manufactured substantially in the same way as a propeller after being designed. Accordingly, a large manufacturing cost is needed, as compared with the rudder bulb.

[0017] Therefore, in order to solve the problems with the methods of reducing hub vortex cavitation by a propeller using the PBCF that requires precise design for each vessel, which should be manufactured in the same way as propellers, and thus is not easy to manufacture and which increases the manufacturing cost, it is required to develop a new propeller structure that can be manufactured at a low cost with a simpler configuration, can reduce hub vortex cavitation generated behind the propeller, thereby being able to reduce noise and vibration in a vessel, prevent erosion and corrosion of a rudder, and save fuel by improving propulsive efficiency.

[0018] A combined propeller cap according to the preamble of claim 1 is known from JP H03 2895 U.

Documents of Related Art

[0019]

(Patent Document 1) Korean Patent Application Publication No. 10-2011-0120267 (Nov. 03, 2011)
(Patent Document 2) Korean Patent Application Publication No. 10-2012-0134647 (Dec. 12, 2012)
(Patent Document 3) Japanese Utility Patent Application Publication No. H03 2895 (Jan. 11, 1991)

Disclosure

Technical Problem

[0020] An object of the present invention is to provide a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap being capable of reducing hub vortex cavitation that is generated behind a propeller by using a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap in order to solve the problem with a PBCF (Propeller Boss Cap Fin) in the related art, which is difficult to manufacture and is expensive due to precise machining for designing and manufacturing fins caused by a configuration of attaching a plurality of small fins to a propeller cap to reduce hub vortex cavitation, and being capable of being easily manufactured with a low cost in a simple structure as compared with the PBCF.

[0021] Another object of the present invention is to provide a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency that is configured not only to reduce hub vortex cavitation that is generated behind a propeller through a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, but also to additionally reduce hub vortex cavitation by attaching plate-shaped guide fins to the contractive section or between the contractive section and the diffusive section of the propeller cap, whereby it is possible to reduce rotational flow and hub vortex cavitation that are generated behind a propeller, to easily manufacture the propeller cap at a low cost in a simple configuration, as compared with the existing PBCF, to reduce noise and vibration in a vessel and prevent erosion and corrosion of a rudder, and to save fuel by improving propulsive efficiency.

Technical Solution

[0022] In order to achieve the objects of the present invention, according to an aspect of the present invention, there is provided a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency.

[0023] According to an aspect of the present invention, there is provide a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency. The combined propeller cap has: a first diffusive section having a diameter that increases from an end of a propeller as it goes away from the propeller; a straight section horizontally extending from the first diffusive section; a contractive section extending from the straight section and having a diameter that decreases as it goes away from the propeller; and a second diffusive section extending from the contractive section and having a diameter that increases as it goes away from the propeller, in which the combined propeller cap is formed at a front portion by the first diffusive section having the diameter that increases from the end of the propeller as it goes away from the propeller, so pressure at a pressure side of the propeller increases and propulsive efficiency is improved, pressure of a flow passing the propeller cap from the propeller is recovered by the contractive section, so the propulsive efficiency is improved, and rotational flow (vortex) of a flow from the propeller is weakened by the second diffusive section, so hub vortex cavitation is reduced.

[0024] The inclination angles of the first diffusive section and the second diffusive section may be set to 0 ~ 40°.

[0025] A side of the contractive section may be formed straight, or the side of the contractive section may be curved to be convex outwardly with a predetermined curvature, or the side of the contractive section may be curved to be convex inwardly with a predetermined curvature.

[0026] According to another aspect of the present invention, there is provided a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency. The combined propeller cap has: a first diffusive section having a diameter that increases from an end of a propeller as it goes away from the propeller; a straight section horizontally extending from the first diffusive section; a contractive section extending from the straight section and having a diameter that decreases as it goes away from the propeller; a second diffusive section extending from the contractive section and having a diameter that increases as it goes away from the propeller; and a plurality of guide fins formed in a thin plate shape having a rectangular or curved cross-section with a predetermined uniform thickness and, disposed with regular intervals at the contractive section or between the contractive section and the diffusive section, in which the combined propeller cap is formed at a front portion by the first diffusive section having the diameter that increases from the end of the propeller as it goes away from the propeller, so pressure at a pressure side of the propeller increases and propulsive efficiency is improved, pressure of a flow passing the propeller cap from the propeller is recovered by the contractive section, so the propulsive efficiency is improved, rotational flow (vortex) of a flow from the propeller is weakened by the second diffusive section, so hub vortex cavitation is reduced, and rotational flow by rotation of the propeller is changed into a straight flow in a rotational axial direction, so the hub vortex cavitation is further reduced.

[0027] The inclination angles of the first diffusive section and the contractive section may be set to 0 ~ 40°.

[0028] A side of the contractive section may be formed straight, or the side of the contractive section may be curved to be convex outwardly with a predetermined curvature, or the side of the contractive section may be curved to be convex inwardly with a predetermined curvature.

[0029] The guide fins may be formed in a thin rectangular plate shape and attached between the contractive section and the second diffusive section of the propeller cap by simple welding, and a size of the guide fins may be determined to correspond to the diameter of the diffusive section in order to avoid an increase in resistance due to the guide fins.

[0030] The guide fins may be formed in a thin pentagonal plate shape and attached between the contractive section and the second diffusive section of the propeller cap by simple welding, and a length of a portion extending from an end of the second diffusive section may be within two times the diameter of the second diffusive section.

[0031] The guide fins may be formed in a thin trapezoidal plate shape and attached between the contractive section and the diffusive section of the propeller cap by simple welding, and a length of a shortest portion of portions extending from a side of the contractive section may be within two times the diameter of the second diffusive section.

[0032] Two to eight guide fins may be disposed at the contractive section or between the contractive section and the second diffusive section of the propeller cap, and the guide fins may be attached with a tolerance of +10 ~ -10 degrees or +20 ~ -20 degrees with respect to 0 degree when seen from vertically above.

[0033] According to another aspect of the present invention, there is provided a propeller for a vessel, which uses the combined propeller caps described above, in which as compared with existing propellers, energy loss due to hub vortex cavitation and a propeller cap shape is prevented and propulsive efficiency is improved, vibration and noise are reduced, and erosion and corrosion of a rudder by the hub vortex cavitation are prevented, and in comparison to existing PBCFs, manufacturing cost is reduced.

Advantageous Effects

[0034] According to the present invention, there is provided a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap being capable of reducing hub vortex cavitation that is generated behind a propeller and being capable of being easily manufactured at a low cost in a simple configuration, as compared with the existing PBCF, through a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, whereby it is possible to solve the problem with a PBCF (Propeller Boss Cap Fin) in the related art, whereby manufacturing is difficult and expensive due to precise machining for designing and manufacturing fins caused by a configuration of attaching a plurality of small fins to a propeller cap to reduce hub vortex cavitation.

[0035] Further, according to the present invention, as described above, there is provided a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency that is configured not only to reduce hub vortex cavitation that is generated behind a propeller through the combined propeller cap in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, but also to additionally reduce hub vortex cavitation by attaching plate-shaped guide fins to the contractive section or between the contractive section and the diffusive section of the propeller gap. Accordingly, it is possible to reduce rotational flow and hub vortex cavitation that are generated behind a propeller, to easily manufacture the propeller cap at a low cost in a simple configuration, as compared with the existing PBCF, to reduce noise and vibration in a vessel and prevent erosion and corrosion of a rudder, and to save fuel by improving propulsive efficiency.

Description of Drawings

[0036]

FIG. 1 is a view schematically showing the structure of a propeller cap of the related art.
FIG. 2 is a view schematically showing the entire configuration of a combined propeller cap according to a first embodiment of the present invention.
FIG. 3 is a view schematically showing the entire configuration of a combined propeller cap according to a second embodiment of the present invention.
FIG. 4 is a view comparing efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap according to the first embodiment of the present invention shown in FIG. 2.
FIG. 5 is a view schematically showing the entire configuration of a combined propeller cap according to a third embodiment of the present invention.
FIG. 6 is a view schematically showing the entire configuration of a combined propeller cap according to a fourth embodiment of the present invention.
FIG. 7 is a view comparing efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller caps according to the third and fourth embodiments of the present invention shown in FIGS. 5 and 6.
FIG. 8 is a view schematically showing the entire configuration of a combined propeller cap according to a fifth embodiment of the present invention.
FIG. 9 is a view comparing propulsion, torque, and efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap according to the fifth embodiment of the present invention shown in FIG. 8.
FIG. 10 is a view schematically showing the entire configuration of a combined propeller cap according to a sixth embodiment of the present invention.
FIG. 11 is a view schematically showing the entire configuration of a combined propeller cap according to a seventh embodiment of the present invention.
FIG. 12 is a view comparing efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap according to the seventh embodiment of the present invention shown in FIG. 11.
FIG. 13 is a view schematically showing the entire configuration of a combined propeller cap according to an eighth embodiment of the present invention.
FIG. 14 is a view schematically showing the entire configuration of a combined propeller cap according to a ninth embodiment of the present invention.
FIG. 15 is a view schematically showing the entire configuration of a combined propeller cap according to a tenth embodiment of the present invention.
FIG. 16 is a view comparing propulsion, torque, and efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap according to the ninth embodiment of the present invention shown in FIG. 14.

Best Mode

[0037] Hereinafter, detailed embodiments of a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency according to the present invention are described with reference to accompanying drawings.

[0038] It should be understood that the following description is just an example for accomplishing the present invention and the present invention is not limited thereto.

[0039] Further, it should be understood that components that is determined as being the same as or similar to those in the related art or as being easily understood and achieved by those skilled in the art are not described in detail for simple description in the following description about embodiments of the present invention.

[0040] Further, in the following description about embodiments of the present invention, it should be understood that the same or similar components are given the same reference numerals and are not described in detail for simple description.

[0041] Further, as described below, the present invention relates to a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap being capable of reducing hub vortex cavitation that is generated behind a propeller by using a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap in order to solve the problem with a PBCF (Propeller Boss Cap Fin) in the related art, whereby manufacturing is difficult and expensive due to precise machining for designing and manufacturing fins caused by a configuration of attaching a plurality of small fins to a propeller cap to reduce hub vortex cavitation, and being capable of being easily manufactured with a low cost in a simple structure as compared with the PBCF.

[0042] Further, as described below, the present invention relates to a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency that is configured not only to reduce hub vortex cavitation that is generated behind a propeller through a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, but also to additionally reduce hub vortex cavitation by attaching plate-shaped guide fins to the contractive section or between the contractive section and the diffusive section of the propeller cap, whereby it is possible to reduce rotational flow and hub vortex cavitation that are generated behind a propeller, to easily manufacture the propeller cap at a low cost in a simple configuration, as compared with the existing PBCF, to reduce noise and vibration in a vessel and prevent erosion and corrosion of a rudder, and to save fuel by improving propulsive efficiency.

[0043] Hereinafter, detailed embodiments of a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency according to the present invention are described with reference to accompanying drawings.

[0044] First, referring to FIG. 1, FIG. 1 is a view schematically showing the structure of a propeller cap of the related art.

[0045] As shown in FIG. 1, generally, a propeller cap of the related art can be largely classified into three types: a contraction type propeller cap shown in FIG. 1a, a straight type propeller cap shown in FIG. 1b, and a diffusion type propeller cap shown in FIG. 1c.

[0046] In detail, the contraction type propeller cap has high propulsive efficiency, but large hub vortex cavitation is caused by concentration of motion of the hub in the cap, so noise and vibration are increased and erosion and corrosion of a rudder may become severe.

[0047] On the other hand, the diffusion type propeller cap has low propulsive efficiency, but hub vortex cavitation is weakened, so noise and vibration can be reduced and erosion and corrosion of a rudder can be attenuated.

[0048] Accordingly, in general, vessels that sail at high speeds such as a container ship are usually equipped with the diffusion type propeller cap due to the problem of corrosion of a rudder due to hub vortex cavitation and are additionally equipped with an additional device such as a PBCF to overcome reduction of propulsive efficiency, thereby improving the propulsive efficiency and coping with hub vortex cavitation.

[0049] On the contrary, tank ships that sail low speeds are usually equipped with the contraction type propeller cap because they generate weak hub vortex cavitation.

[0050] When a container ship using a diffusion type propeller is equipped with a PBCF that is a device for saving fuel to prevent reduction of propulsive efficiency, the fins of the PBCF are designed and manufactured in the same way as the existing propellers, so the manufacturing cost is high relative to the size.

[0051] Therefore, the inventor(s) has proposed a new propeller cap structure that can improve propulsive efficiency with low hub vortex cavitation, similar to the PBCF, and can achieve an effect similar to the PBCF even at a very low manufacturing cost in comparison to the manufacturing cost of the PBCF by simplifying the configuration.

[0052] Further, referring to FIG. 2, shown is a view schematically showing the entire configuration of a combined propeller cap 20 according to a first embodiment of the present invention.

[0053] In detail, as shown in FIG. 2, the combined propeller cap 20 according to the first embodiment of the present invention includes a contractive section 21 of which the diameter decreases as it goes away from a propeller and a diffusive section 22 that extends from the contractive section and of which the diameter increases as it goes away from the propeller.

[0054] That is, the combined propeller cap 20 according to the first embodiment of the present invention, as shown in FIG. 2, has a shape of which the diameter gradually decreases from the end of a propeller and increases at the end portion of the propeller cap.

[0055] The inclination angle α of the contractive section 21 may be set, for example, to 0 ~ 40°.

[0056] When the inclination angle of the contractive section 21 exceeds 40 degrees, the performance rapidly drops due to flow separation, that is, when flow separation is generated, pressure is not recovered on the propeller cap, so resistance increases.

[0057] In more detail, referring to the following Table 1, Table 1 shows changes in performance due to changes in the inclination angle α of the contractive section 22.

[Table 1]

Angle (α)	10	20	30	40	50	60
Performance change (%)	+1.0	+1.0	+0.9	+0.7	+0.2	+0.2

[0058] The result in Table 1 shows estimated values of propulsive performance according to changes in the inclination angle α of the contractive section 22, as compared with a propeller equipped with a diffusion type propeller cap of the related art.

[0059] Further, referring to FIG. 3, FIG. 3 is a view schematically showing the entire configuration of a combined propeller cap 30 according to a second embodiment of the present invention.

[0060] In the following description of the second embodiment of the present invention, the same or similar components as in the first embodiment are not described and only other different components are described for simple description.

[0061] That is, as shown in FIG. 3, the combined propeller cap 30 according to the second embodiment of the present invention has a contractive section 31 of which the diameter decreases as it goes away from a propeller and a diffusive section 32 that extends from the contractive section 31 and of which the diameter increases as it goes away from the propeller, which is the same as the first embodiment shown in FIG. 2. However, the propeller cap 30 according to the second embodiment of the present invention is characterized in that the contractive section 31 is not formed straight, as in the first embodiment, but curved with a predetermined curvature.

[0062] That is, the combined propeller cap 30 according to the second embodiment of the present invention is characterized in that the contractive section 31 is curved to be convex outwardly with a predetermined curvature, as shown in FIG. 3a, or is curved to be convex inwardly with a predetermined curvature, as shown in FIG. 3b.

[0063] The curvature of the contractive section 31 can be appropriately determined, depending on the type or the use of a propeller or a ship, and other parts are the same as those in the first embodiment, so they are not described in detail.

[0064] Accordingly, as the propeller cap is formed in a shape of which the diameter decreases and increases again, when a propeller is operated, pressure is recovered and propulsive efficiency is improved by the shape of which the diameter decreases to the contractive sections 21 and 31 at the middle portion of the propeller caps 20 and 30 and a strong rotational flow (vortex) is weakened by the shape of which the diameter increases over the diffusive sections 22 and 32 at the end of the propeller caps 20 and 30, whereby it is possible to reduce hub vortex cavitation.

[0065] Further, energy loss due to hub vortex and a cap shape is prevented accordingly, so the propulsive efficiency can be improved in comparison to the existing diffusion type propellers (1 ~ 3%), vibration and noise due to hub vortex can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0066] In more detail, referring to FIG. 4, shown is a view comparing propulsive efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap 20 according to the first embodiment of the present invention shown in FIG. 2.

[0067] That is, it can be seen from FIG. 4 that the propeller equipped with the combined propeller cap 20 according to the first embodiment of the present invention had propulsive efficiency similar to that of the contraction type propeller cap of the related art, but side effects due to hub vortex cavitation can be greatly reduced and the propulsive efficiency was considerably improved as compared with the diffusion type propeller cap.

[0068] That is, as described above, according to the configuration of the combined propeller caps 20 and 30 of the first and second embodiments of the present invention, the propulsive efficiency is improved by pressure recovery due to the shape from a propeller to the contractive sections 21 and 31 and a strong rotational flow (vortex) is weakened by the diffusive sections 22 and 32 while the flow from the propeller passes over the ends of the caps, whereby hub vortex cavitation can be suppressed. Accordingly, energy loss due to hub vortex and a cap shape is prevented, so the propulsive efficiency of a vessel can be improved by about 1 ~ 3% in comparison to the existing diffusion type propeller. Further, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented, as compared with the contraction type propeller caps.

[0069] Further, according to the configuration of the combined propeller caps 20 and 30 of the first and second embodiments of the present invention described above, there is an advantage that it is possible to reduce hub vortex cavitation, similar to the existing diffusion type propeller caps used for container ships, and it is possible to improve propulsive efficiency in comparison to the existing diffusion type propeller cap. Further, there is another advantage that it is possible to obtain propulsive efficiency similar to the contraction type propeller caps when it is applied to tank ships, but it is possible to greatly reduce hub vortex cavitation.

[0070] Further, since the shapes of the combined propeller caps 20 and 30 of the first and second embodiments of the present invention described above are simple in structure, they can be easily manufactured, so there is also an advantage that it is possible to remarkably decrease the manufacturing cost, which was over one hundred million South Korean won due to precise machining of the fins of the PBCF in the related art, to within thirty million South Korean won similar to the existing propeller caps.

[0071] Further, referring to FIG. 5, FIG. 5 is a view schematically showing the entire configuration of a combined propeller cap 50 according to a third embodiment of the present invention.

[0072] In detail, the combined propeller cap 50 according to the third embodiment of the present invention has a first diffusive section 51 of which the diameter increases from the end of a propeller, a straight section 52 that horizontally extends from the first diffusive section 51, a contractive section 53 that extends from the straight section 52 and of which the diameter decreases as it goes away from the propeller, and a second diffusive section 54 that extends from the contractive section 53 and of which the diameter increases again as it goes away from the propeller.

[0073] That is, the combined propeller cap 50 according to the third embodiment of the present invention, as shown in FIG. 5, has a shape of which the diameter gradually decreases from the end of a propeller to a predetermined portion, but increases at the end portion of the propeller cap.

[0074] In more detail, since the combined propeller cap 50 according to the third embodiment of the present invention is formed at the front portion by the first diffusive section 51 of which the diameter increases from the end of the propeller, as shown in FIG. 5, the pressure at the pressure side of the propeller increases, thereby improving the propulsive efficiency.

[0075] That is, the propeller cap 50 according to the third embodiment of the present invention for reducing hub vortex cavitation and improving propulsive efficiency is additionally improved in propulsive efficiency by pressure recovery due to the shape from the propeller to the contractive section 53 at the middle portion, as shown in FIG. 5, and can reduce hub vortex cavitation by decreasing a strong rotational flow (vortex) through the second diffusive section 54 while the flow from the propeller passes over the end of the diffusive cap.

[0076] Further, as hub vortex cavitation is reduced, as described above, it is possible to improve propulsive efficiency in comparison to the existing diffusion type propeller caps and it is also possible to prevent vibration and noise due to hub vortex cavitation and erosion and corrosion of a rudder. Further, it is possible to more efficiently prevent vibration and noise and, erosion and corrosion of a rudder and to improve propulsive efficiency, as compared with the existing contraction type propeller caps.

[0077] The inclination angles α and β of the first diffusive section 51 and the contractive section 53, respectively, may be set, for example, to 0 ~ 40°.

[0078] When α and β exceed 40 degrees, the performance rapidly drops due to flow separation, that is, when flow separation is generated, pressure is not recovered on the propeller cap, so resistance increases.

[0079] In more detail, referring to the following Table 2, Table 2 shows changes in performance due to changes in the inclination angles α and β of the first diffusive section 51 and the contractive section 53.

[Table 2]

Angle (α)	10	20	30	40	50	60
Performance change (%)	+1.1	+1.1	+1.1	+1.0	+0.7	+0.7
Angle (β)	10	20	30	40	50	60
Performance change (%)	+1.1	+1.1	+1.1	+0.8	+0.3	+0.2

[0080] In Table 1, when α was changed, β was fixed at 30 degrees, while when β was changed, α was fixed at 30 degrees. Further, the result in Table 2 shows estimated values of propulsive performance according to angle changes, as compared with a propeller equipped with an existing diffusion type propeller cap.

[0081] Further, referring to FIG. 6, FIG. 6 is a view schematically showing the entire configuration of a combined propeller cap 60 according to a fourth embodiment of the present invention.

[0082] In the following description of the fourth embodiment of the present invention, the same or similar components as in the third embodiment are not described and only other different components are described for simple description.

[0083] That is, as shown in FIG. 6, the combined propeller cap 60 according to the fourth embodiment of the present invention has a first diffusive section 61 of which the diameter increases from the end of a propeller, a straight section

62 that horizontally extends from the first diffusive section 61, a contractive section 63 that extends from the straight section 62 and of which the diameter decreases as it goes away from the propeller, and a second diffusive section 64 that extends from the contractive section 63 and of which the diameter increases again as it goes away from the propeller, so the diameter increases from the end of the propeller to a predetermined portion, but increases again at the rear end portion of the propeller cap, which is the same as the third embodiment shown in FIG. 5.

[0084] However, in the combined propeller cap 60 according to the fourth embodiment of the present invention, the contractive section 63 is not straight as in the third embodiment shown in FIG. 5, but is curved with a predetermined curvature.

[0085] That is, the combined propeller cap 60 according to the fourth embodiment of the present invention is characterized in that the contractive section 63 is curved to be convex outwardly with a predetermined curvature, as shown in FIG. 6a, or is curved to be convex inwardly with a predetermined curvature, as shown in FIG. 6b.

[0086] The curvature of the contractive section 63 can be appropriately determined, depending on the type or the use of a propeller or a ship, and other parts are the same as those in the third embodiment, so they are not described in detail.

[0087] Therefore, according to this configuration, it is possible to not only reduce hub vortex cavitation with a simple configuration, but further improve propulsive efficiency in comparison to propeller caps in the related art.

[0088] In more detail, referring to FIG. 7, shown is a view comparing efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller caps 50 and 60 according to the third and fourth embodiments of the present invention shown in FIGS. 5 and 6.

[0089] That is, it can be seen from FIG. 7 that the efficiency of the propellers equipped with the propeller caps 50 and 60 according to embodiments of the present invention was improved, as compared with the existing contraction type propeller cap and the diffusion type propeller cap.

[0090] As described above, according to the combined propeller caps 50 and 60 of the third and fourth embodiments of the present invention, since the first diffusive sections 51 and 61 are formed such that the front potions of the propeller caps are formed with the diameter that is increasing from the end of a propeller, the pressure at the pressure side of a propeller increases and the propulsive efficiency is improved. Further, the propulsive efficiency is further improved by pressure recovery due to the shapes of the contractive sections 53 and 63 at the middle portions.

[0091] Further, as a strong rotational flow (vortex) is weakened by the second diffusive sections 54 and 64 while the flow from the propeller passes over the diffusive cap end, hub vortex cavitation can be reduced, the propulsive efficiency of a vessel can be improved about 1 ~ 3% in comparison to the existing diffusion type propeller, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0092] That is, according to the configuration of the combined propeller caps 50 and 60 of the third and fourth embodiments of the present invention described above, there is an advantage that it is possible to reduce hub vortex cavitation, similar to the existing diffusion type propeller caps used for container ships, and it is possible to improve propulsive efficiency in comparison to the existing diffusion type propeller cap. Further, there is another advantage that it is possible to obtain propulsive efficiency similar to the contraction type propeller caps when it is applied to tank ships, but it is possible to greatly reduce hub vortex cavitation.

[0093] Further, since the shapes of the combined propeller caps 50 and 60 of the third and fourth embodiments of the present invention described above are simple in structure, they can be easily manufactured, so there is also an advantage that it is possible to remarkably decrease the manufacturing cost, which was over one hundred million South Korean won due to precise machining of the fins of the PBCF in the related art, to within thirty million South Korean won similar to the existing propeller caps.

[0094] Further, referring to FIG. 8, FIG. 8 is a view schematically showing the entire configuration of a combined propeller cap 80 according to a fifth embodiment of the present invention.

[0095] In more detail, as shown in FIG. 8, the combined propeller cap 80 according to the fifth embodiment of the present invention has a contractive section 81 of which the diameter decreases as it goes away from a propeller, a diffusive section 82 that extends from the contractive section 81 and of which the diameter increases as it goes away from the propeller, and a plurality of guide fins 83 that is formed in a thin plate shape having a rectangular or curved cross-section with a predetermined uniform thickness and is disposed with regular intervals between the contractive section 81 and the diffusive section 82.

[0096] That is, in the combined propeller cap 80 according to the fifth embodiment of the present invention, as shown in FIG. 8, the diameter gradually decreases from the end of a propeller and increases again at the rear end portion, in which the guide fins 83 having a triangular plate shape are added at the contractive section 81 or between the contractive section 81 and the diffusive section 82 of the propeller cap 80.

[0097] In this configuration, the inclination angle α of the contractive section 81 may be, for example, set to 0 ~40°, and when the inclination angle of the contractive section 81 exceeds 40 degrees, the performance rapidly drops due to flow separation. Further, when flow separation is generated, pressure is not recovered on the propeller cap, so resistance increases.

[0098] In more detail, referring to the following Table 3, Table 3 shows changes in performance due to changes in the inclination angle α of the contractive section 81.

[Table 3]

Angle (α)	10	20	30	40	50	60
Performance change (%)	+1.2	+1.2	+1.1	+0.9	+0.3	+0.2

[0099] The result in Table 3 shows estimated values of propulsive performance according to changes in the inclination angle α of the contractive section 81, as compared with a propeller equipped with a diffusion type propeller cap of the related art.

[0100] Accordingly, as the propeller cap is formed in a shape of which the diameter decreases and increases again, when a propeller is operated, pressure is recovered and propulsive efficiency is improved by the shape of which the diameter decreases to the contractive section 81 at the middle portion of the propeller cap 80 and a strong rotational flow (vortex) is weakened by the shape of which the diameter increases over the diffusive section 82 at the end of the propeller cap 80, whereby it is possible to reduce hub vortex cavitation.

[0101] Further, energy loss due to hub vortex is prevented accordingly, so the propulsive efficiency can be improved in comparison to the existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller cap.

[0102] Further, the guide fins 83, as shown in FIG. 8, for example, are formed in a thin triangular plate shape to be fitted in the recession between the contractive section 81 and the diffusive section 82 of the propeller cap 80 and attached with regular intervals simply by welding. Accordingly, a vortex induced by rotation of a propeller not only weakens over the diffusive section 82, but weakens in advance before the diffusive section 82 of the propeller cap 30, so the vortex due to the rotation of the propeller changes into a straight flow in the rotational axial direction, whereby hub vortex cavitation can be additionally reduced.

[0103] The number of the guide fins 83 may be appropriately changed, for example, within 2 ~ 8 and the size of the guide fins may be determined in accordance with the diameter of the diffusive section 82 to avoid an increase in resistance due to the guide fins.

[0104] Further, the guide fins 83 are attached with a manufacturing tolerance of +20 ~ -20 degrees, preferably +10 ~ -10 degrees with respect to 0 degree when seen from vertically above.

[0105] In more detail, according to the propeller cap 80 of the fifth embodiment of the present invention, the propulsive efficiency is improved by pressure recovery due to the shape from the propeller to the contractive section 81 at the middle portion and a strong rotational flow (vortex) is weakened by the diffusive section 82 while a flow from the propeller passes over the diffusive cap end, so hub vortex cavitation can be reduced. Further, since the guide fins 83 having a triangular plate shape are attached between the contractive section 81 and the diffusive section 82 of the propeller cap 80, as described above, a vortex induced by rotation of the propeller is weakened by the guide fins 83 before it reaches the diffusive section 82 of the propeller cap 80, so the vortex by the rotation of the propeller is changed into a straight flow in the rotational axial direction, whereby hub vortex cavitation can be further reduced, thus rotational flow and hub vortex cavitation by rotation of the propeller both can be reduced. Accordingly, energy loss due to hub vortex is prevented, so the propulsive efficiency of a vessel can be improved about 1 ~ 3% in comparison to the existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0106] That is, according to the principle of the combined propeller cap 80 of the fifth embodiment of the present invention having the configuration described above, the propulsive efficiency is improved by pressure recovery from the propeller to the contractive section 81 at the middle portion by the shape and a strong rotational flow (vortex) is weakened by the diffusive section 82 while the flow generated by the propeller flows over the end of the cap, so hub vortex cavitation is reduced. Further, since the guide fins 83 having a plate shape are attached between the contractive section 81 and the diffusive section 82 of the propeller cap 80, the vortex induced by rotation of the propeller is weakened by the guide fins 83 before reaching the diffusive section 82 of the propeller cap 80, so the vortex by the rotation of the propeller is changed into a straight flow in the rotational axial direction, thus rotational flow and hub vortex cavitation can be reduced.

[0107] Therefore, according to the combined propeller cap 80 of the fifth embodiment of the present invention having the configuration described above, not only hub vortex cavitation is reduced by the diffusive section 82 of the propeller cap 80, but the vortex induced by rotation of a propeller is slightly weakened by the guide fins 83 before reaching the diffusive section 82 of the propeller cap 80, thereby changing the vortex by the rotation of the propeller into a straight flow in the rotational axial direction, so hub vortex cavitation can be additionally reduced. Accordingly, it is possible to improve propulsive efficiency by preventing energy loss due to hub vortex, reduce vibration and noise due to hub vortex cavitation, and prevent erosion and corrosion of a rudder.

[0108] Further, since the combined propeller cap 80 according to the fifth embodiment of the present invention having the configuration described above has a very simple shape and structure and, the guide fins 83 are formed in a simple plate shape, so they can be easily manufactured and attached by simple welding, it is possible to considerably decrease the high manufacturing cost due to precise machining of the fins of a PBCF in the related art.

[0109] In more detail, referring to FIG. 9, shown is a view comparing propulsive efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap 80 according to the fifth embodiment of the present invention shown in FIG. 8.

[0110] That is, it can be seen from FIG. 9 that the propeller equipped with the propeller cap 80 according to the fifth embodiment of the present invention had propulsive efficiency higher than that of the contraction type propeller of the related art and side effects due to hub vortex can be greatly reduced and, the propulsive efficiency was considerably improved as compared with the diffusion type propeller cap.

[0111] That is, according to the propeller cap 80 of the fifth embodiment of the present invention, the propulsive efficiency is improved by pressure recovery due to the shape from the propeller to the contractive section 81 at the middle portion and a strong rotational flow (vortex) is weakened by the diffusive section 82 while a flow from the propeller flows over the diffusive cap end, so hub vortex cavitation can be reduced. Further, since the guide fins 83 having a triangular plate shape are attached between the contractive section 81 and the diffusive section 82 of the propeller cap 80, as described above, a vortex induced by rotation of the propeller is weakened by the guide fins 23 before it reaches the diffusive section 82 of the propeller cap 80, so the vortex by the rotation of the propeller is changed into a straight flow in the rotational axial direction, whereby hub vortex cavitation can be further reduced, thus rotational flow and hub vortex cavitation by rotation of the propeller both can be reduced. Accordingly, energy loss due to hub vortex is prevented, so the propulsive efficiency of a vessel can be improved about 1 ~ 3% in comparison to the existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0112] That is, according to the configuration of the propeller cap 80 of the fifth embodiment of the present invention, similar to diffusion type propeller caps that are used by container ships in the related art, hub vortex cavitation can be reduced and the propulsive efficiency is greatly improved as compared with the diffusion type propeller caps of the related art. Further, the propulsive efficiency is high and hub vortex cavitation can be remarkably reduced in comparison to the existing contraction type propeller caps when the propeller cap 80 is applied to tank ships. Further, as described above, since the guide fins 83 having a triangular plate shape are attached between the contractive section 81 and the diffusive section 82 of the propeller cap 80, rotational flow and hub vortex cavitation are additionally reduced, so vibration and noise due to hub vortex cavitation can be reduced and erosion and corrosion of a rudder can be prevented.

[0113] Further, precise machining for manufacturing the fins of a PBCF was a problem because it increased the manufacturing cost, but the propeller cap 80 according to the fifth embodiment of the present invention can be easily manufactured in simple shape and structure, so there is also an advantage that it is possible to remarkably decrease the manufacturing cost, which was over one hundred million South Korean won due to precise machining of the fins of the PBCF in the related art, to within thirty million South Korean won similar to the existing propeller caps.

[0114] Further, referring to FIG. 10, shown is a view schematically showing the entire configuration of a combined propeller cap 100 according to a sixth embodiment of the present invention.

[0115] In the following description of the sixth embodiment of the present invention, the same or similar components as in the fifth embodiment are not described and only other different components are described for simple description.

[0116] That is, as shown in FIG. 10, the combined propeller cap 100 according to the sixth embodiment of the present invention has a contractive section 101 of which the diameter decreases as it goes away from a propeller, a diffusive section 102 that extends from the contractive section 101 and of which the diameter increases as it goes away from the propeller, and guide fins 103 that are attached between the contractive section 101 and the diffusive section 102, which is the same as the fifth embodiment shown in FIG. 8.

[0117] However, in the combined propeller cap 100 according to the sixth embodiment of the present invention, the contractive section 101 is not straight as in the fifth embodiment shown in FIG. 8, but is curved with a predetermined curvature.

[0118] That is, the combined propeller cap 100 according to the sixth embodiment of the present invention is characterized in that the contractive section 101 is curved to be convex outwardly with a predetermined curvature, as shown in FIG.10a, or the contractive section 101 is curved to be convex inwardly with a predetermined curvature, as shown in FIG. 10b.

[0119] The curvature of the contractive section 101 can be appropriately determined, depending on the type or the use of a propeller or a ship, and other parts are the same as those in the fifth embodiment, so they are not described in detail.

[0120] Further, a combined propeller cap according to a seventh embodiment of the present invention is described with reference to FIG. 11.

[0121] That is, referring to FIG. 11, shown is a view schematically showing the entire configuration of a combined propeller cap 110 according to the seventh embodiment of the present invention.

[0122] In detail, as shown in FIG. 11, the combined propeller cap 110 according to the seventh embodiment of the present invention has a first diffusive section 111 of which the diameter increases from the end of a propeller, a straight section 112 that horizontally extends from the first diffusive section 111, a contractive section 113 that extends from the straight section 112 and of which the diameter decreases as it goes away from the propeller, a second diffusive section 114 that extends from the contractive section 113 and of which the diameter increases again as it goes away from the propeller, and a plurality of guide fins 115 that is formed in a thin plate shape and disposed with regular intervals between the contractive section 113 and the second diffusive section 114.

[0123] That is, in the combined propeller cap 110 according to the seventh embodiment of the present invention, as shown in FIG. 11, the diameter first gradually increases and decreases from the end of a propeller to a predetermined portion and then increases again at the rear end portion, in which the guide fins 115 having a triangular plate shape are added between the contractive section 113 and the second diffusive section 114 of the propeller cap 110.

[0124] The inclination angle α and β of the first diffusive section 111 and the contractive section 113 respectively, may be set, for example, to 0 ~ 40°.

[0125] When α and β exceed 40 degrees, the performance rapidly drops due to flow separation, that is, when flow separation is generated, pressure is not recovered on the propeller cap, so resistance increases.

[0126] In more detail, referring to the following Table 4, Table 4 shows changes in performance due to changes in the inclination angles α and β of the first diffusive section 111 and the contractive section 113.

[Table 4]

Angle (α)	10	20	30	40	50	60
Performance change (%)	+1.3	+1.3	+1.3	+1.2	+0.9	+0.9
Angle (β)	10	20	30	40	50	60
Performance change (%)	+1.3	+1.3	+1.3	+1.0	+0.4	+0.4

[0127] In Table 4, when α was changed, β was fixed at 30 degrees, while when β was changed, α was fixed at 30 degrees. Further, the result in Table 4 shows estimated values of propulsive performance according to angle changes, as compared with a propeller equipped with an existing diffusion type propeller cap.

[0128] Therefore, according to the combined propeller cap 110 of the seventh embodiment of the present invention, as shown in FIG. 11, since the front potion of the propeller cap is formed by the first diffusive section 111 of which the diameter increases from the end of a propeller, the pressure at the pressure side of a propeller increases and the propulsive efficiency is improved. Further, the propulsive efficiency is further improved by pressure recovery due to the shape of the contractive sections 113 at the middle portion.

[0129] Further, the combined propeller cap 110 according to the seventh embodiment of the present invention is additionally improved in propulsive efficiency by pressure recovery due to the shape from the propeller to the contractive section 113 at the middle portion, as shown in FIG. 11, and can reduce hub vortex cavitation by decreasing a strong rotational flow (vortex) through the second diffusive section 114 while the flow from the propeller passes over the end of the diffusive cap.

[0130] Further, energy loss due to hub vortex is prevented accordingly, so the propulsive efficiency of a vessel can be improved about 1 ~ 3% in comparison to existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0131] Further, the guide fins 115, as shown in FIG. 11, for example, are formed in a thin triangular plate shape to be fitted in the recession between the contractive section 113 and the second diffusive section 2 of the propeller cap 110 and attached with regular intervals simply by welding. Accordingly, a vortex induced by rotation of a propeller not only weakens over the second diffusive section 114, but weakens in advance before the second diffusive section 114 of the propeller cap 110, so the vortex due to the rotation of the propeller changes into a straight flow in the rotational axial direction, whereby hub vortex cavitation can be additionally reduced.

[0132] The number of the guide fins 115 may be appropriately changed, for example, within 2 ~ 8 and the size of the guide fins may be determined in accordance with the diameter of the second diffusive section 114 to avoid an increase in resistance due to the guide fins.

[0133] Further, the guide fins 115 are attached with a manufacturing tolerance of +20 ~ -20 degrees, preferably +10 ~ -10 degrees with respect to 0 degree when seen from vertically above.

[0134] In more detail, according to the principle of the propeller cap 110 for reducing a rotational flow and hub vortex and improving propulsive efficiency of the seventh embodiment of the present invention, the propulsive efficiency is improved by pressure recovery due to the shape from the propeller to the contractive section 113 at the middle portion and a strong rotational flow (vortex) is weakened by the second diffusive section 114 while a flow from the propeller passes over the diffusive cap end, so hub vortex can be reduced. Further, since the guide fins 115 having a triangular plate shape are attached between the contractive section 113 and the second diffusive section 114 of the propeller cap 110, as described above, a vortex induced by rotation of the propeller is weakened by the guide fins 115 before it reaches the second diffusive section 114 of the propeller cap 110, so the vortex by the rotation of the propeller is changed into a straight flow in the rotational axial direction, whereby hub vortex cavitation can be further reduced, thus rotational flow and hub vortex cavitation by rotation of the propeller both can be reduced. Accordingly, energy loss due to hub vortex is prevented, so the propulsive efficiency of a vessel can be improved about 1 ~ 3% in comparison to the existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0135] That is, according to the principle of the combined propeller cap 110 of the seventh embodiment of the present invention having the configuration described above, the propulsive efficiency is improved by pressure recovery from the propeller to the contractive section 113 at the middle portion by the shape and a strong rotational flow (vortex) is weakened by the second diffusive section 114 while the flow generated by the propeller flows over the end of the cap, so hub vortex is reduced. Further, since the guide fins 115 having a triangular plate shape are attached between the contractive section 113 and the second diffusive section 114 of the propeller cap 110, the vortex induced by rotation of the propeller is weakened by the guide fins 115 before reaching the second diffusive section 114 of the propeller cap 110, so the vortex by the rotation of the propeller is changed into a straight flow in the rotational axial direction, thus rotational flow and hub vortex cavitation can be reduced.

[0136] Therefore, according to the combined propeller cap 110 of the seventh embodiment of the present invention having the configuration described above, not only hub vortex cavitation is reduced by the second diffusive section 114 of the propeller cap 110, but the vortex induced by rotation of a propeller is slightly weakened by the guide fins 115 before reaching the second diffusive section 114 of the propeller cap 110, thereby changing the vortex by the rotation of the propeller into a straight flow in the rotational axial direction, so hub vortex cavitation can be additionally reduced. Accordingly, it is possible to improve propulsive efficiency by preventing energy loss due to hub vortex, reduce vibration and noise due to hub vortex cavitation, and prevent erosion and corrosion of a rudder.

[0137] Further, since the combined propeller cap 110 according to the seventh embodiment of the present invention having the configuration described above has a very simple shape and structure and, the guide fins 115 are formed in a simple plate shape, so they can be easily manufactured and attached by simple welding, it is possible to considerably decrease the high manufacturing cost due to precise machining of the fins of a PBCF in the related art.

[0138] Further, referring to FIG. 12, shown is a view comparing efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap according to the seventh embodiment of the present invention shown in FIG. 11.

[0139] That is, it can be seen from FIG. 12 that the propeller equipped with the propeller cap 110 according to the seventh embodiment of the present invention had propulsive efficiency higher than that of the contraction type propeller cap of the related art and side effects due to hub vortex can be greatly reduced and, the propulsive efficiency was considerably improved as compared with the diffusion type propeller cap.

[0140] That is, according to the combined propeller cap 110 of the seventh embodiment of the present invention, since the first diffusive section 111 is formed such that the front potion of the propeller cap is formed with the diameter that is increasing from the end of a propeller, the pressure at the pressure side of a propeller increases and the propulsive efficiency is improved. Further, the propulsive efficiency is further improved by pressure recovery due to the shapes of the contractive section 113 at the middle portion.

[0141] Further, since the strong rotational flow (vortex) is weakened by the second diffusive section 114 while the flow from the propeller passes the diffusive cap end, hub vortex cavitation can be reduced. Further, as described above, since the guide fins 115 having a triangular plate shape are attached between the contractive section 113 and the second diffusive section 114 of the propeller cap 110, as described above, rotational flow and hub vortex cavitation can be additionally reduced. Accordingly, energy loss due to hub vortex is prevented, the propulsive efficiency can be improved about 1 ~ 3% in comparison to the existing diffusion type propellers, vibration and noise due to hub vortex cavitation can be reduced, and erosion and corrosion of a rudder can be prevented in comparison to the existing contraction type propeller caps.

[0142] That is, according to the configuration of the combined propeller cap 110 of the seventh embodiment of the present invention, similar to diffusion type propeller caps that are used container ships in the related art, hub vortex cavitation can be reduced and the propulsive efficiency can be improved as compared with the diffusion type propeller caps of the related art. Further, the propulsive efficiency is similar and hub vortex cavitation can be remarkably reduced in comparison to the existing contraction type propeller caps when the propeller cap 110 is applied to tank ships. Further, as described above, since the guide fins 115 having a triangular plate shape are attached between the contractive section 113 and the second diffusive section 114 of the propeller cap 110, rotational flow and hub vortex cavitation are additionally reduced, so vibration and noise due to hub vortex cavitation can be reduced and erosion and corrosion of a rudder can be prevented.

[0143] Further, precise machining for manufacturing the fins of a PBCF was a problem because it increased the manufacturing cost, but the combined propeller cap 110 according to the seventh embodiment of the present invention can be easily manufactured in simple shape and structure, so there is also an advantage that it is possible to remarkably decrease the manufacturing cost, which was over one hundred million South Korean won due to precise machining of the fins of the PBCF in the related art, to within thirty million South Korean won similar to the existing propeller caps.

[0144] Further, referring to FIG. 13, shown is a view schematically showing the entire configuration of a combined propeller cap 130 according to an eighth embodiment of the present invention.

[0145] That is, as shown in FIG. 13, the combined propeller cap 130 according to the eighth embodiment of the present invention has a first diffusive section 131 of which the diameter increases from the end of a propeller, a straight section 132 that horizontally extends from the first diffusive section 131, a contractive section 133 that extends from the straight section 132 and of which the diameter decreases as it goes away from the propeller, a second diffusive section 134 that extends from the contractive section 133 and of which the diameter increases again as it goes away from the propeller, and guide fins 135 that are coupled to an end of the second diffusive section 134, which is the same as the seventh embodiment shown in FIG. 11.

[0146] However, in the combined propeller cap 130 according to the eighth embodiment of the present invention, the contractive section 133 is not straight as in the seventh embodiment shown in FIG. 11, but is curved with a predetermined curvature.

[0147] That is, the combined propeller cap 130 according to the eight embodiment of the present invention is characterized in that the contractive section 133 is curved to be convex outwardly with a predetermined curvature, as shown in FIG. 13a, or the contractive section 133 is curved to be convex inwardly with a predetermined curvature, as shown in FIG. 13b.

[0148] The curvature of the contractive section 133 can be appropriately determined, depending on the type or the use of a propeller or a ship, and other parts are the same as those in the seventh embodiment, so they are not described in detail.

[0149] Further, referring to FIGS. 14 and 15, FIG. 14 is a view schematically showing the entire configuration of a combined propeller cap according to a ninth embodiment of the present invention and FIG. 15 is a view schematically showing the entire configuration of a combined propeller cap according to a tenth embodiment of the present invention.

[0150] In detail, although the guide fins are formed in a triangular shape and attached in the recession between the contractive section and the diffusive section, and have a size corresponding to the diameter of the diffusive section in order not to protrude at the end of the diffusive section in the fifth to eighth embodiments of the present invention, the present invention is not limited to this configuration, that is, the present invention may be configured, as shown in FIG. 14, such that guide fins 143 are formed in a not triangular, but thin pentagonal plate shape are attached by simple welding between the contractive section 141 and the diffusive section 143 of the propeller cap 140 to extend from an end of the diffusive section 142.

[0151] In this configuration, the size of the guide fins 143 may be determined such that the length L of the portion extending from the end of the diffusive section 142 is within two times the diameter D of the diffusive section (that is, $L \leq 2D$).

[0152] Alternatively, the present invention may be configured, as shown in FIG. 15, such that guide fins 153 are formed in a thin trapezoidal shape and attached to a contractive section 151 of a propeller cap 150 by simple welding.

[0153] In this configuration, the size of the guide fins 153 may be determined such that the length L2 of a shorter portion of the portions extending from the side of the contractive section 151 is within two times the diameter of the diffusive section 152 (that is, $L2 \leq 2D$), but other factors L1 and W are not specifically limited.

[0154] Further, the other configurations except the guide fins 143 and 153 can be achieved in the same way as the fifth to eighth embodiments, so they are not described in detail.

[0155] Examples of applying the guide fins 143 and 153 to the propeller cap according to the first embodiment shown in FIG. 2 are shown in FIGS. 14 and 15, but the present invention is not limited thereto, that is, it should be noted that the guide fins 143 and 153 shown in FIGS. 14 and 15 can be applied in the same way not only to the first embodiment shown in FIG. 2, but to the second to fourth embodiments.

[0156] Further, referring to FIG. 16, shown is a view comparing propulsion, torque, and efficiency of a propeller equipped with a propeller cap of the related art and a propeller equipped with the combined propeller cap 140 according to the ninth embodiment of the present invention shown in FIG. 14.

[0157] That is, it can be seen from FIG. 16 that the propeller equipped with the propeller cap 140 according to the ninth embodiment of the present invention had propulsive efficiency higher than that of the contraction type propeller cap of the related art and side effects due to hub vortex can be greatly reduced and, the propulsive efficiency was considerably improved as compared with the diffusion type propeller cap. Further, it can be seen that the propulsive efficiency was improve as compared with the first, fifth, and seventh embodiments too.

[0158] Therefore, according to the configuration, it is possible to achieve a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency according to the present invention.

[0159] Further, according to the present invention, as a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency according to the present invention is achieved, it is possible to reduce hub vortex cavitation that is generated behind a propeller through a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, so a combined propeller cap that can be easily manufactured at a low cost in a simple configuration, as compared with the existing PBCF, for reducing rotational flow and hub vortex and improving propulsive efficiency. Further, a plurality of small fins is attached to the propeller cap to reduce hub vortex cavitation, so it is possible to solve the problem with the existing PBCF (Propeller Boss Cap Fin) in that manufacturing is difficult and the manufacturing cost is high due to precise machining for designing and manufacturing fins.

[0160] Further, according to the present invention, as described above, there is provided a combined propeller cap for reducing rotational flow and hub vortex and improving propulsive efficiency that is configured not only to reduce hub vortex cavitation that is generated behind a propeller through a combined propeller cap structure in which a diffusion type propeller cap is coupled to the end of a contraction type propeller cap, but also to additionally reduce hub vortex cavitation by attaching plate-shaped guide fins to the contractive section or between the contractive section and the diffusive section of the propeller cap. Accordingly, it is possible to reduce rotational flow and hub vortex cavitation that are generated behind a propeller, to easily manufacture the propeller cap at a low cost in a simple configuration, as compared with the existing PBCF, to reduce noise and vibration in a vessel and prevent erosion and corrosion of a rudder, and to save fuel by improving propulsive efficiency

[0161] Although combined propeller caps for reducing rotational flow and hub vortex and improving propulsive efficiency according to embodiments of the present invention were described above, the present invention is not limited to the embodiments and may be changed, modified, combined, and replaced in various ways, depending on necessities in design and other various factors by those skilled in the art.

<Description of the Reference Numerals in the Drawings>

[0162]

20: Propeller cap
21: Contractive section
22: Diffusive section

30: Propeller cap
31: Contractive section
32: Diffusive section

50: Propeller cap
51: First diffusive section
52: Straight section
53: Contractive section
54: Second diffusive section

60: Propeller cap
61: First diffusive section
62: Straight section
63: Contractive section
64: Second diffusive section

80: Propeller cap
81: Contractive section
82: Diffusive section
83: Guide fin
100: Propeller cap
101: Contractive section
102: Diffusive section
103: Guide fin

110: Propeller cap
111: First diffusive section

112: Straight section
113: Contractive section
114: Second diffusive section
115: Guide fin

130: Propeller cap
131: First diffusive section
132: Straight section
133: Contractive section
134: Second diffusive section
135: Guide fin

140: Propeller cap
141: Contractive section
142: Diffusive section
143: Guide fin
150: Propeller cap
151: Contractive section
152: Diffusive section
153: Guide fin

Claims

1. A combined propeller cap (50, 60, 110, 130) for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap (50, 60, 110, 130) has:

- a contractive section (53, 63, 113, 133) having a diameter that decreases as it goes away from a propeller; and
- a second diffusive section (54, 64, 114, 134) extending from the contractive section (53, 63, 113, 133) and having a diameter that increases as it goes away from the propeller,

characterized in that,
the combined propeller cap (50, 60, 110, 130) further comprises:

- a first diffusive section (51, 61, 111, 131) having a diameter that increases from an end of the propeller as it goes away from the propeller; and
- a straight section (52, 62, 112, 132) horizontally extending from the first diffusive section (51, 61, 111, 131);
the contractive section (53, 63, 113, 133) extending from the straight section (52, 62, 112, 132) and having the diameter that decreases as it goes away from the propeller; and
the second diffusive section (54, 64, 114, 134) extending from the contractive section (53, 63, 113, 133) and having the diameter that increases as it goes away from the propeller,
wherein the combined propeller cap (50, 60, 110, 130) is formed at a front portion by the first diffusive section (51, 61, 111, 131) having the diameter that increases from the end of the propeller as it goes away from the propeller, so pressure at a pressure side of the propeller increases and propulsive efficiency is improved,
pressure of a flow passing the propeller cap (50, 60, 110, 130) from the propeller is recovered by the contractive section (53, 63, 113, 133), so the propulsive efficiency is improved, and
rotational flow (vortex) of a flow from the propeller is weakened by the second diffusive section (54, 64, 114, 134), so hub vortex cavitation is reduced.

2. The combined propeller cap (50, 60, 110, 130) of claim 1, wherein inclination angles of the first diffusive section (51, 61, 111, 131) and the second diffusive section (54, 64, 114, 134) are set to 0 ~ 40°.

3. The combined propeller cap (50, 60, 110, 130) of claim 1, wherein a side of the contractive section (53, 113) is formed straight, or
the side of the contractive section (63, 133) is curved to be convex outwardly with a predetermined curvature, or
the side of the contractive section (63, 133) is curved to be convex inwardly with a predetermined curvature.

4. A combined propeller cap (110, 130) for reducing rotational flow and hub vortex and improving propulsive efficiency, the combined propeller cap (110, 130) having:

- a contractive section (113, 133) having a diameter that decreases as it goes away from a propeller; and
- a second diffusive section (114, 134) extending from the contractive section (113, 133) and having a diameter that increases as it goes away from the propeller,

characterized in that,
the combined propeller cap (110, 130) further comprises:

- a first diffusive section (111, 131) having a diameter that increases from an end of the propeller as it goes away from the propeller; and
- a straight section (112, 132) horizontally extending from the first diffusive section (111, 131);

the contractive section (113, 133) extending from the straight section and having a diameter that decreases as it goes away from the propeller;
the second diffusive section (114, 134) extending from the contractive section (113, 133) and having the diameter that increases as it goes away from the propeller; and
the combined propeller cap (110, 130) further comprises:

- a plurality of guide fins (115, 135) formed in a thin plate shape having a rectangular or curved cross-section with a predetermined uniform thickness and, disposed with regular intervals at the contractive section (113, 133) or between the contractive section (113, 133) and the diffusive section (114, 134),
wherein the combined propeller cap (110, 130) is formed at a front portion by the first diffusive section (111, 131) having the diameter that increases from the end of the propeller as it goes away from the propeller, so pressure at a pressure side of the propeller increases and propulsive efficiency is improved,
pressure of a flow passing the propeller cap (110, 130) from the propeller is recovered by the contractive section (113, 133), so the propulsive efficiency is improved,
rotational flow (vortex) of a flow from the propeller is weakened by the second diffusive section (114, 134), so hub vortex cavitation is reduced, and
rotational flow by rotation of the propeller is changed into a straight flow in a rotational axial direction, so the hub vortex cavitation is further reduced.

5. The combined propeller cap (110, 130) of claim 4, wherein inclination angles of the first diffusive section (111, 131) and the contractive section (113, 133) are set to 0 ~ 40°.

6. The combined propeller cap (110, 130) of claim 5, wherein a side of the contractive section (113) is formed straight, or the side of the contractive section (133) is curved to be convex outwardly with a predetermined curvature, or
the side of the contractive section (133) is curved to be convex inwardly with a predetermined curvature.

7. The combined propeller cap (110, 130) of claim 6, wherein the guide fins (115, 135) are formed in a thin rectangular plate shape and attached between the contractive section (113, 133) and the second diffusive section (114, 134) of the propeller cap (110, 130) by simple welding, and
a size of the guide fins (115, 135) are determined to correspond to the diameter of the diffusive section (114, 134) in order to avoid an increase in resistance due to the guide fins (115, 135).

8. The combined propeller cap (110, 130) of claim 6, wherein the guide fins (115, 135) are formed in a thin pentagonal plate shape and attached between the contractive section (113, 133) and the second diffusive section (114, 134) of the propeller cap (110, 130) by simple welding, and
a length of a portion extending from an end of the second diffusive section (114, 134) is within two times the diameter of the second diffusive section (114, 134).

9. The combined propeller cap (110, 130) of claim 6, wherein the guide fins (115, 135) are formed in a thin trapezoidal plate shape and attached between the contractive section (113, 133) and the diffusive section (114, 134) of the propeller cap (110, 130) by simple welding, and
a length of a shorter portion of portions extending from a side of the contractive section (113, 133) is within two times the diameter of the second diffusive section (114, 134).

10. The combined propeller cap (110, 130) of claim 6, wherein two to eight guide fins (115, 135) are disposed at the

contractive section (113, 133) or between the contractive section (113, 133) and the second diffusive section (114, 134) of the propeller cap (110, 130), and
the guide fins (115, 135) are attached with a tolerance of +10 ~ -10 degrees or +20 ~ -20 degrees with respect to 0 degree when seen from vertically above.

Patentansprüche

1. Kombinierte Propellerabdeckung (50, 60, 110, 130) zur Verringerung einer Drallströmung und eines Nabenwirbels und zur Verbesserung einer Vortriebseffizienz, wobei die kombinierte Propellerabdeckung (50, 60, 110, 130) aufweist:

   - einen kontrahierenden Abschnitt (53, 63, 113, 133), welcher einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller verkleinert; und
   - einen zweiten diffusen Abschnitt (54, 64, 114, 134), welcher sich von dem kontrahierenden Abschnitt (53, 63, 113, 133) erstreckt und einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller vergrößert,

   dadurch gekennzeichnet,
   dass die kombinierte Propellerabdeckung (50, 60, 110, 130) darüber hinaus umfasst:

   - einen ersten diffusen Abschnitt (51, 61, 111, 131), welcher einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller von einem Ende des Propellers vergrößert; und
   - einen geraden Abschnitt (52, 62, 112, 132), welcher sich horizontal von dem ersten diffusen Abschnitt (51, 61, 111, 131) erstreckt;

     wobei sich der kontrahierende Abschnitt (53, 63, 113, 133) von dem geraden Abschnitt (52, 62, 112, 132) erstreckt und den Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller verkleinert; und
     wobei sich der zweite diffuse Abschnitt (54, 64, 114, 134) von dem kontrahierenden Abschnitt (53, 63, 113, 133) erstreckt und den Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller vergrößert,
     wobei die kombinierte Propellerabdeckung (50, 60, 110, 130) an einem vorderen Teil durch den ersten diffusen Abschnitt (51, 61, 111, 131) ausgebildet ist, welcher den Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller von dem Ende des Propellers vergrößert, so dass sich ein Druck an einer Druckseite des Propellers erhöht und eine Antriebseffizienz verbessert wird,
     wobei ein Druck einer Strömung, welche die Propellerabdeckung (50, 60, 110, 130) passiert, von dem Propeller durch den kontrahierenden Abschnitt (53, 63, 113, 133) wiedergewonnen wird, so dass die Antriebseffizienz verbessert wird, und
     wobei eine Drallströmung (Wirbel) einer Strömung von dem Propeller durch den zweiten diffusen Abschnitt (54, 64, 114, 134) abgeschwächt wird, so dass eine Nabenwirbelkavitation verringert wird.

2. Kombinierte Propellerabdeckung (50, 60, 110, 130) nach Anspruch 1, wobei Neigungswinkel des ersten diffusen Abschnitts (51, 61, 111, 131) und des zweiten diffusen Abschnitts (54, 64, 114, 134) auf 0 ~ 40° eingestellt sind.

3. Kombinierte Propellerabdeckung (50, 60, 110, 130) nach Anspruch 1, wobei eine Seite des kontrahierenden Abschnitts (53, 113) geradlinig ausgebildet ist, oder
   die Seite des kontrahierenden Abschnitts (63, 133) nach außen mit einer vorbestimmten Krümmung konvex gebogen ist, oder
   die Seite des kontrahierenden Abschnitts (63, 133) nach innen mit einer vorbestimmten Krümmung konvex gebogen ist.

4. Kombinierte Propellerabdeckung (110, 130) zur Verringerung einer Drallströmung und eines Nabenwirbels und zur Verbesserung einer Antriebseffizienz, wobei die kombinierte Propellerabdeckung (110, 130) aufweist:

   - einen kontrahierenden Abschnitt (113, 133), welcher einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller verkleinert; und
   - einen zweiten diffusen Abschnitt (114, 134), welcher sich von dem kontrahierenden Abschnitt (113, 133)

erstreckt und einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller vergrößert,

dadurch gekennzeichnet,
dass die kombinierte Propellerabdeckung (110, 130) darüber hinaus umfasst:

- einen ersten diffusen Abschnitt (111, 131), welcher einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller von einem Ende des Propellers vergrößert; und
- einen geraden Abschnitt (112, 132), welcher sich horizontal von dem ersten diffusen Abschnitt (111, 131) erstreckt;

wobei sich der kontrahierende Abschnitt (113, 133) von dem geraden Abschnitt erstreckt und einen Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller verkleinert;
wobei sich der zweite diffuse Abschnitt (114, 134) von dem kontrahierenden Abschnitt (113, 133) erstreckt und den Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller vergrößert; und
wobei die kombinierte Propellerabdeckung (110, 130) darüber hinaus umfasst:

- mehrere Führungsrippen (115, 135), welche in einer dünnen Plattenform ausgebildet sind, die einen rechtwinkligen oder gebogenen Querschnitt mit einer vorbestimmten gleichförmigen Dicke aufweist, und welche sich in gleichmäßigen Abständen an dem kontrahierenden Abschnitt (113, 133) oder zwischen dem kontrahierenden Abschnitt (113, 133) und dem diffusen Abschnitt (114, 134) befinden,

wobei die kombinierte Propellerabdeckung (110, 130) an einem vorderen Abschnitt durch den ersten diffusen Abschnitt (111, 131) ausgebildet ist, welcher den Durchmesser aufweist, der sich mit zunehmendem Abstand von dem Propeller von dem Ende des Propellers vergrößert, so dass sich ein Druck an einer Druckseite des Propellers vergrößert und eine Antriebseffizienz verbessert wird,
wobei ein Druck einer Strömung, welche die Propellerabdeckung (110, 130) von dem Propeller passiert durch den kontrahierenden Abschnitt (113, 133) wiedergewonnen wird, so dass die Antriebseffizienz verbessert wird,
wobei eine Drallströmung (Wirbel) einer Strömung von dem Propeller durch den zweiten diffusen Abschnitt (114, 134) abgeschwächt wird, so dass eine Nabenwirbelkavitation verringert wird, und
wobei eine Drallströmung durch eine Rotation des Propellers in eine geradlinige Strömung in eine Drehachsenrichtung verändert wird, so dass die Nabenwirbelkavitation weiter verringert wird.

5. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 4, wobei Neigungswinkel des ersten diffusen Abschnitts (111, 131) und des kontrahierenden Abschnitts (113, 133) auf 0 ~ 40° eingestellt sind.

6. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 5, wobei eine Seite des kontrahierenden Abschnitts (113) geradlinig ausgebildet ist, oder

die Seite des kontrahierenden Abschnitts (133) nach außen mit einer vorbestimmten Krümmung konvex gebogen ist, oder
die Seite des kontrahierenden Abschnitts (133) nach innen mit einer vorbestimmten Krümmung konvex gebogen ist.

7. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 6, wobei die Führungsrippen (115, 135) in einer dünnen rechtwinkligen Plattenform ausgebildet sind und zwischen dem kontrahierenden Abschnitt (113, 133) und dem zweiten diffusen Abschnitt (114, 134) der Propellerabdeckung (110, 130) durch einfaches Schweißen angebracht sind, und
ein Ausmaß der Führungsrippen (115, 135) bestimmt ist, um dem Durchmesser des diffusen Abschnitts (114, 134) zu entsprechen, um eine Vergrößerung bei einem Widerstand aufgrund der Führungsrippen (115, 135) zu vermeiden.

8. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 6, wobei die Führungsrippen (115, 135) in einer dünnen fünfeckigen Plattenform ausgebildet sind und zwischen dem kontrahierenden Abschnitt (113, 133) und dem zweiten diffusen Abschnitt (114, 134) der Propellerabdeckung (110, 130) durch ein simples Schweißen angebracht sind, und eine Länge eines Teils, welches sich von einem Ende des zweiten diffusen Abschnitts (114, 134) erstreckt, innerhalb eines Zweifachen des Durchmessers des zweiten diffusen Abschnitts (114, 134) liegt.

9. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 6, wobei die Führungsrippen (115, 135) in einer dünnen trapezförmigen Plattenform ausgebildet sind und zwischen dem kontrahierenden Abschnitt (113, 133) und dem diffusen Abschnitt (114, 134) der Propellerabdeckung (110, 130) durch ein einfaches Schweißen angebracht sind, und
wobei eine Länge eines kürzeren Teils von Teilen, welche sich von einer Seite des kontrahierenden Abschnitts (113, 133) erstrecken, innerhalb eines Zweifachen des Durchmessers des zweiten diffusen Abschnitts (114, 134) liegen.

10. Kombinierte Propellerabdeckung (110, 130) nach Anspruch 6, wobei zwei bis acht Führungsrippen (115, 135) an dem kontrahierenden Abschnitt (113, 133) oder zwischen dem kontrahierenden Abschnitt (113, 133) und dem zweiten diffusen Abschnitt (114, 134) der Propellerabdeckung (110, 130) angeordnet sind, und
wobei die Führungsrippen (115, 135) mit einer Toleranz von +10 ~ -10 Grad oder +20 ~ -20 Grad bezüglich 0 Grad, wenn es vertikal von oben betrachtet wird, angebracht sind.

Revendications

1. Cône d'hélice combiné (50, 60, 110, 130) pour réduire l'écoulement rotatif et un tourbillon de moyeu et améliorer l'efficacité de propulsion, le cône d'hélice combiné (50, 60, 110, 130) a :

   - une section de contraction (53, 63, 113, 133) ayant un diamètre qui diminue au fur et à mesure qu'elle s'éloigne d'une hélice ; et
   - une seconde section de diffusion (54, 64, 114, 134) s'étendant à partir de la section de contraction (53, 63, 113, 133) et ayant un diamètre qui augmente au fur et à mesure qu'elle s'éloigne de l'hélice,

   <u>**caractérisé en ce que**</u> **:**
   le cône d'hélice combiné (50, 60, 110, 130) comprend en outre :

   - une première section de diffusion (51, 61, 111, 131) ayant un diamètre qui augmente à partir d'une extrémité de l'hélice au fur et à mesure qu'elle s'éloigne de l'hélice ; et
   - une section droite (52, 62, 112, 132) s'étendant horizontalement à partir de la première section de diffusion (51, 61, 111, 131) ;

     la section de contraction (53, 63, 113, 133) s'étendant à partir de la section droite (52, 62, 112, 132) et ayant le diamètre qui diminue au fur et à mesure qu'elle s'éloigne de l'hélice ; et
     la seconde section de diffusion (54, 64, 114, 134) s'étendant à partir de la section de contraction (53, 63, 113, 133) et ayant le diamètre qui augmente au fur et à mesure qu'elle s'éloigne de l'hélice,
     dans lequel le cône d'hélice combiné (50, 60, 110, 130) est formé au niveau d'une partie avant par la première section de diffusion (51, 61, 111, 131) ayant le diamètre qui augmente à partir de l'hélice au fur et à mesure qu'elle s'éloigne de l'hélice, donc la pression d'un côté de pression de l'hélice augmente et l'efficacité de propulsion est améliorée,
     la pression d'un écoulement passant par le cône d'hélice (50, 60, 110, 130) depuis l'hélice est recouverte par la section de contraction (53, 63, 113, 133), donc l'efficacité de propulsion est améliorée, et
     l'écoulement rotatif (tourbillon) d'un écoulement de l'hélice est affaibli par la seconde section de diffusion (54, 64, 114, 134), donc la cavitation de tourbillon de moyeu est réduite.

2. Cône d'hélice combiné (50, 60, 110, 130) selon la revendication 1, dans lequel les angles d'inclinaison de la première section de diffusion (51, 61, 111, 131) et de la seconde section de diffusion (54, 64, 114, 134) sont de 0 ~ 40°.

3. Cône d'hélice combiné (50, 60, 110, 130) selon la revendication 1, dans lequel un côté de la section de contraction (53, 113) est formé droit, ou bien
le côté de la section de contraction (63, 133) est incurvé pour être convexe vers l'extérieur avec une courbure prédéterminée, ou bien
le côté de la section de contraction (63, 133) est incurvé pour être convexe vers l'intérieur avec une courbure prédéterminée.

4. Cône d'hélice combiné (110, 130) pour réduire l'écoulement rotatif et le tourbillon de moyeu et améliorer l'efficacité de propulsion, le cône d'hélice combiné (110, 130) ayant :

- une section de contraction (113, 133) ayant un diamètre qui diminue au fur et à mesure qu'elle s'éloigne d'une hélice ; et
- une seconde section de diffusion (114, 134) s'étendant à partir de la section de contraction (113, 133) et ayant un diamètre qui augmente au fur et à mesure qu'elle s'éloigne de l'hélice,

caractérisé en ce que :
le cône d'hélice combiné (110, 130) comprend en outre :

- une première section de diffusion (111, 131) ayant un diamètre qui augmente à partir d'une extrémité de l'hélice au fur et à mesure qu'elle s'éloigne de l'hélice ; et
- une section droite (112, 132) s'étendant horizontalement à partir de la première section de diffusion (111, 131) ;

la section de contraction (113, 133) s'étendant à partir de la section droite et ayant un diamètre qui augmente au fur et à mesure qu'elle s'éloigne de l'hélice ;
la seconde section de diffusion (114, 134) s'étendant à partir de la section de contraction (113, 133) et ayant le diamètre qui augmente au fur et à mesure qu'elle s'éloigne de l'hélice ; et

le cône d'hélice combiné (110, 130) comprend en outre :

- une pluralité d'ailettes de guidage (115, 135) formées dans une forme de plaque fine ayant une section transversale rectangulaire ou incurvée avec une épaisseur prédéterminée uniforme et disposée avec des intervalles réguliers au niveau de la section de contraction (113, 133) ou entre la section de contraction (113, 133) et la section de diffusion (114, 134),

dans lequel le cône d'hélice combiné (110, 130) est formé au niveau d'une partie avant par la première section de diffusion (111, 131) ayant le diamètre qui augmente à partir de l'extrémité de l'hélice lorsqu'elle s'éloigne de l'hélice, donc la pression du côté de la pression de l'hélice augmente et l'efficacité de propulsion est améliorée,
la pression d'un écoulement passant par le cône d'hélice (110, 130) depuis l'hélice est recouverte par la section de contraction (113, 133), donc l'efficacité de propulsion est améliorée,
l'écoulement rotatif (tourbillon) d'un écoulement de l'hélice est affaibli par la seconde section de diffusion (114, 134), donc la cavitation de tourbillon de moyeu est réduite, et
l'écoulement rotatif par la rotation de l'hélice est modifié en écoulement droit dans une direction axiale de rotation, donc la cavitation de tourbillon de moyeu est davantage réduite.

5. Cône d'hélice combiné (110, 130) selon la revendication 4, dans lequel les angles d'inclinaison de la première section de diffusion (111, 131) et de la section de contraction (113, 133) est de 0 ~ 40°.

6. Cône d'hélice combiné (110, 130) selon la revendication 5, dans lequel un côté de la section de contraction (113) est formé droit, ou bien
le coté de la section de contraction (133) est incurvé pour être convexe vers l'extrémité avec une courbure prédéterminée, ou bien
le côté de la section de contraction (133) est incurvé pour être convexe vers l'intérieur avec une courbure prédéterminée.

7. Cône d'hélice combiné (110, 130) selon la revendication 6, dans lequel les ailettes de guidage (115, 135) sont formées en une forme de plaque rectangulaire fine et fixées entre la section de contraction (113, 133) et la seconde section de diffusion (114, 134) du cône d'hélice (110, 130) par simple soudage, et
une taille des ailettes de guidage (115, 135) est déterminée pour correspondre au diamètre de la section de diffusion (114, 134) afin d'éviter une augmentation de résistance due aux ailettes de guidage (115, 135).

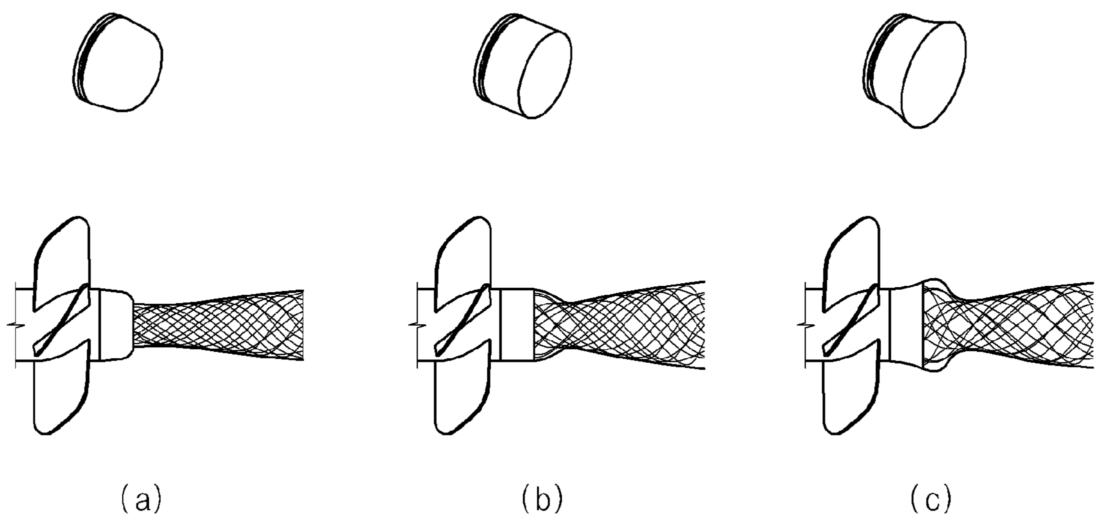
8. Cône d'hélice combiné (110, 130) selon la revendication 6, dans lequel les ailettes de guidage (115, 135) sont formées en une forme de plaque pentagonale et fixées entre la section de contraction (113, 133) et la seconde section de diffusion (114, 134) du cône d'hélice (110, 130) par simple soudage, et
une longueur d'une partie s'étendant à partir d'une extrémité de la seconde section de diffusion (114, 134) est dans la limite de deux fois le diamètre de la seconde section de diffusion (114, 134).

9. Cône d'hélice combiné (110, 130) selon la revendication 6, dans lequel les ailettes de guidage (115, 135) sont

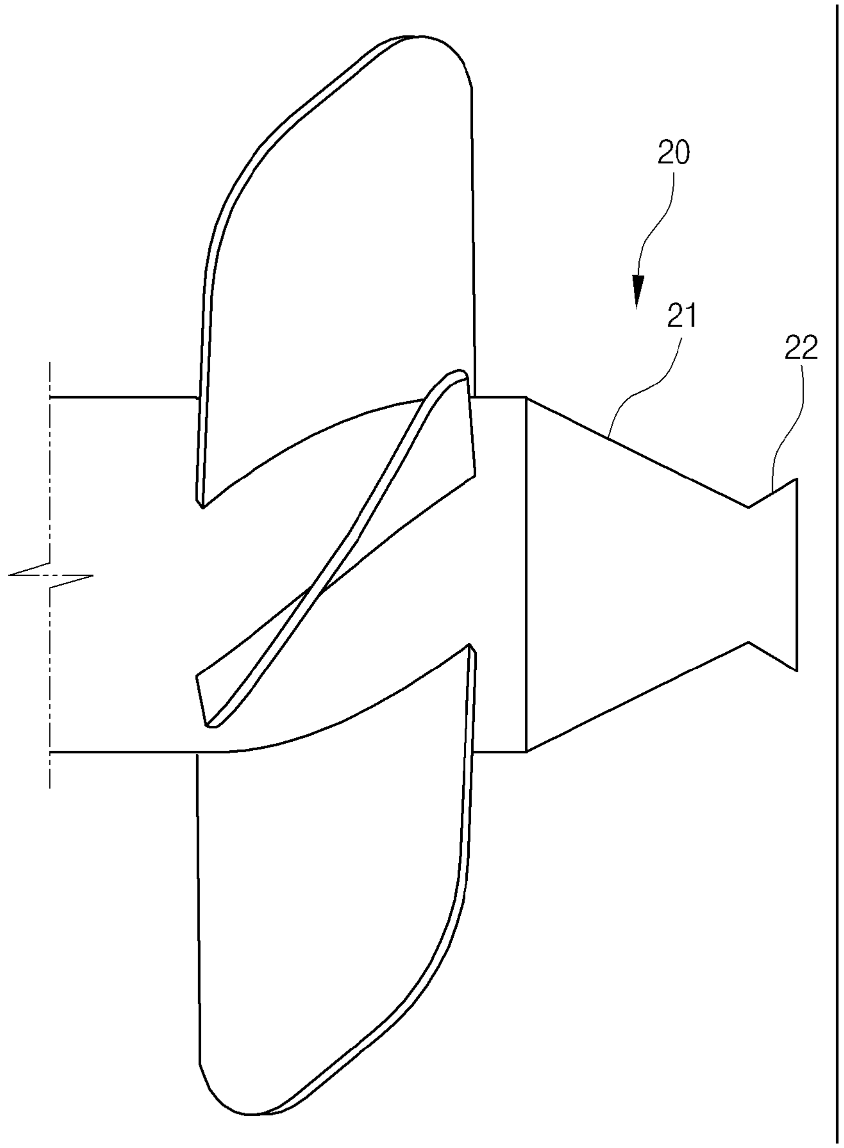
formées en une forme de plaque trapézoïdale et fixées entre la section de contraction (113, 133) et la section de diffusion (114, 134) du cône d'hélice (110, 130) par simple soudage, et
une longueur d'une partie plus courte des parties s'étendant à partir d'un côté de la section de contraction (113, 133) est dans la limite de deux fois le diamètre de la seconde section de diffusion (114, 134).

10. Cône d'hélice combiné (110, 130) selon la revendication 6, dans lequel on dispose de deux à huit ailettes de guidage (115, 135) au niveau de la section de contraction (113, 133) ou entre la section de contraction (113, 133) et la seconde section de diffusion (114, 134) du cône d'hélice (110, 130), et
les ailettes de guidage (115, 135) sont fixées avec une tolérance de +10 ~ -10 degrés ou +20 ~ -20 degrés par rapport à 0 degré lorsqu'elles sont observées verticalement de dessus.

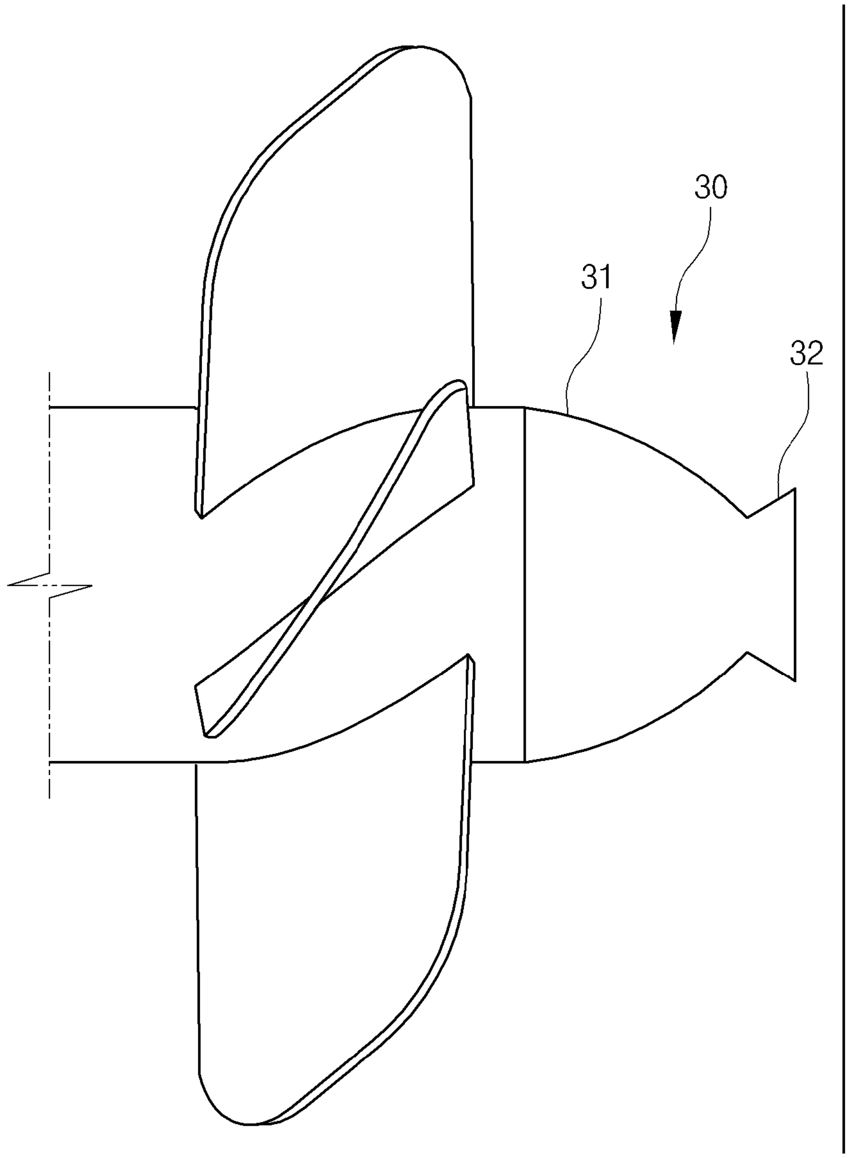
【Figure 1】



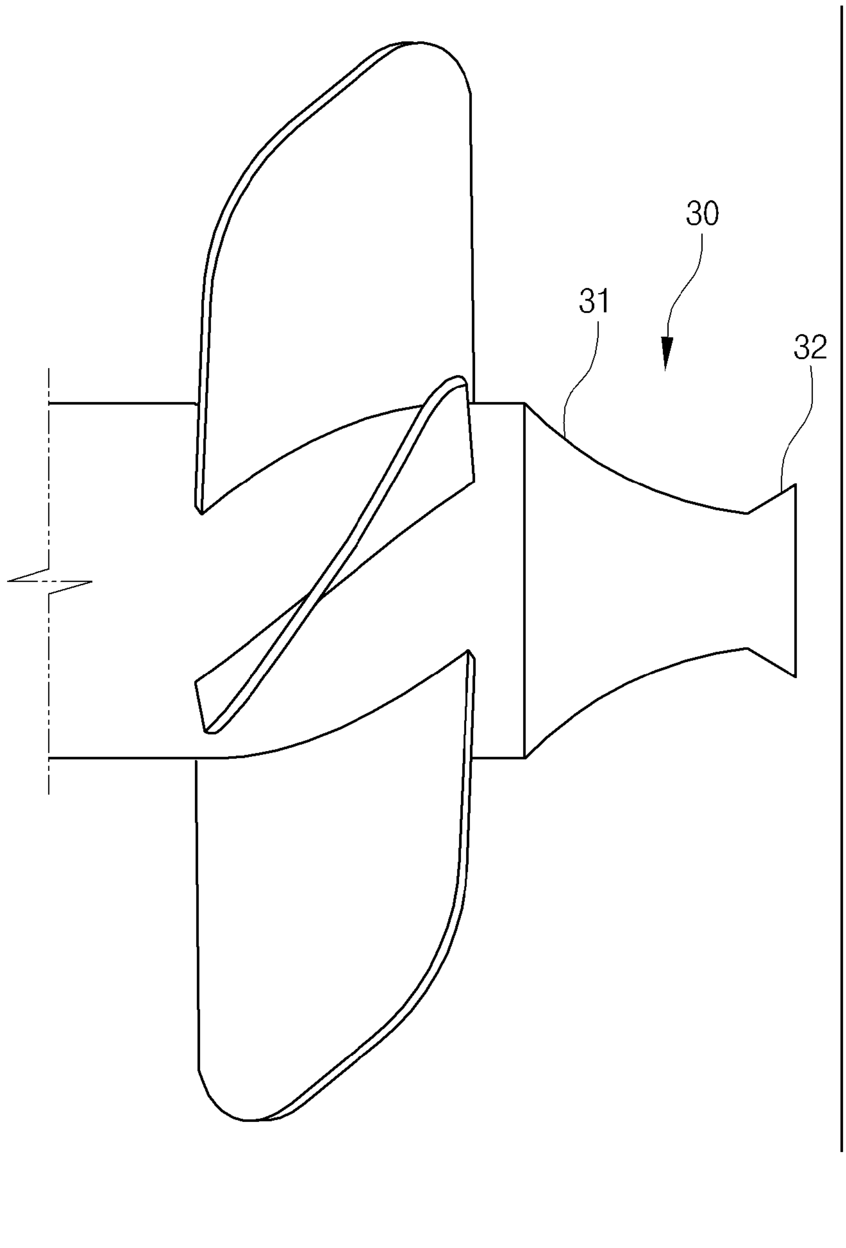
【Figure 2】



【Figure 3a】



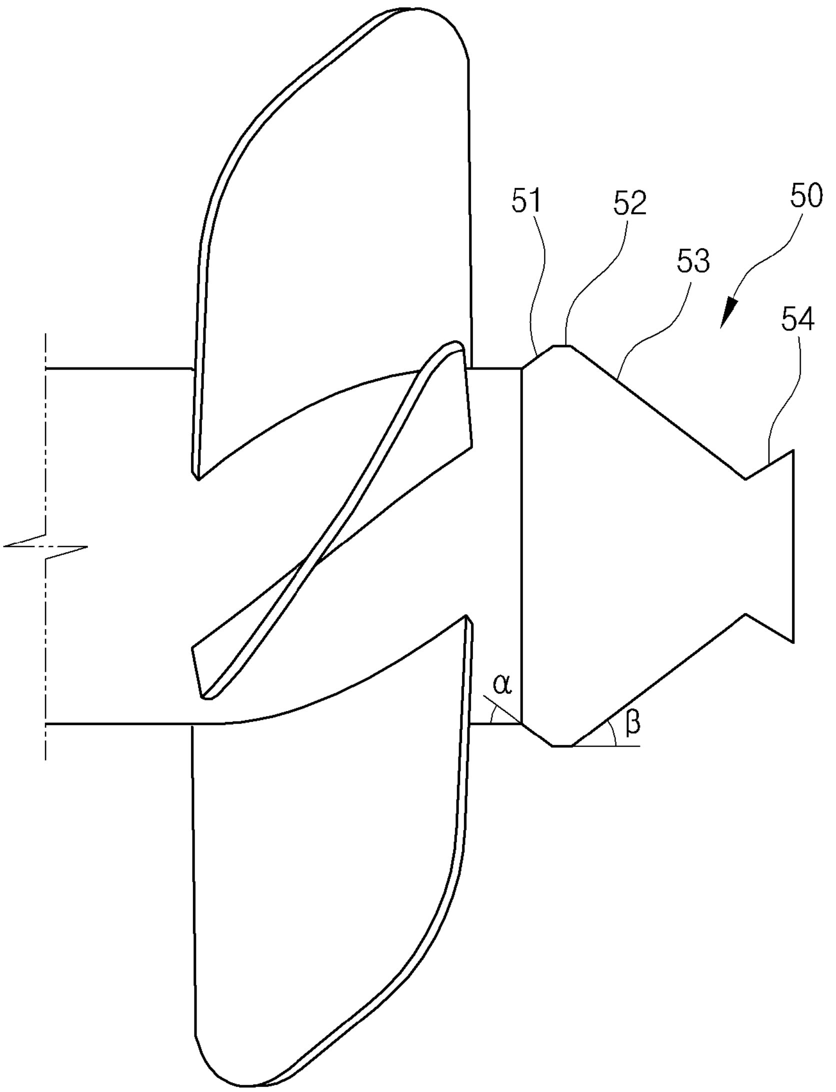
【Figure 3b】



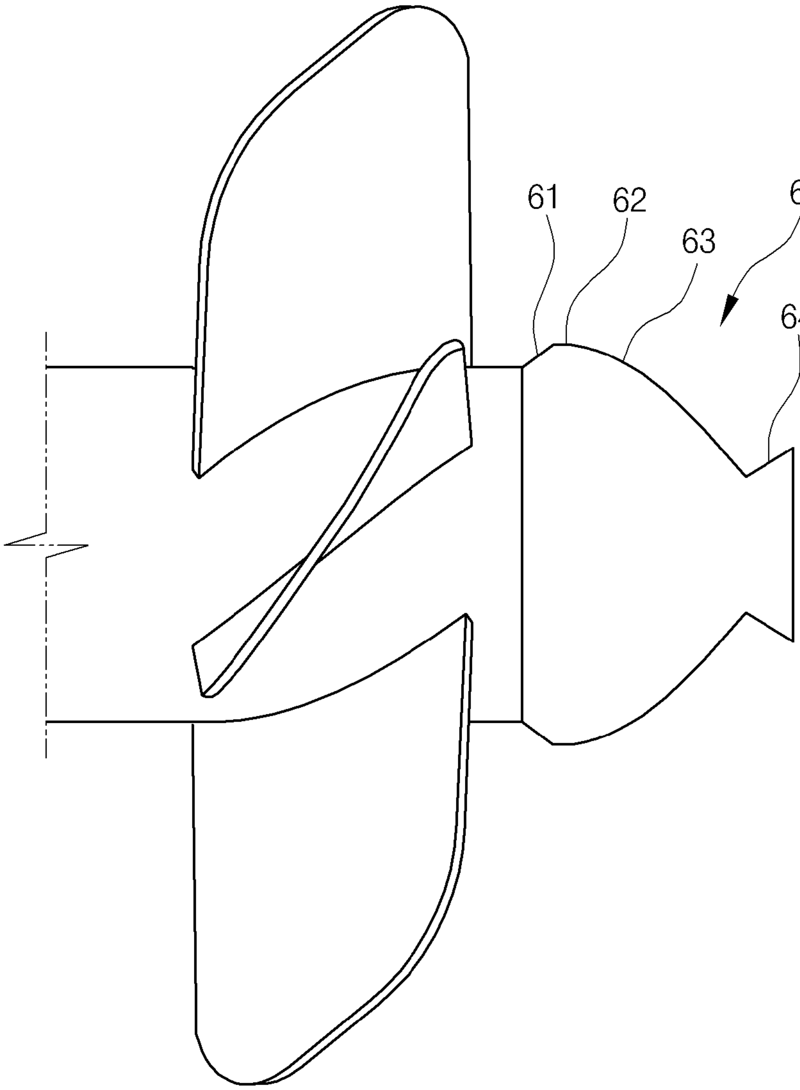
【Figure 4】

	contraction type	diffusion type	Embodiment 1
Efficiency of single propeller	+ 1.0%	base(0)	+ 1.0%

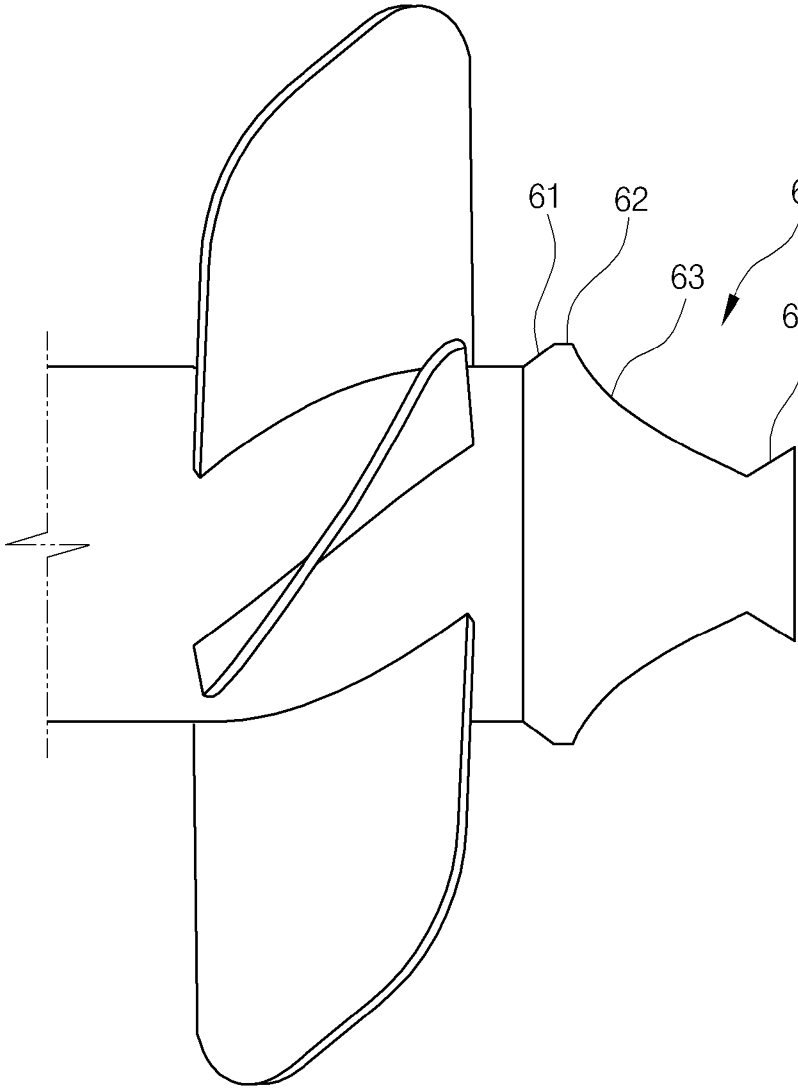
【Figure 5】



【Figure 6a】



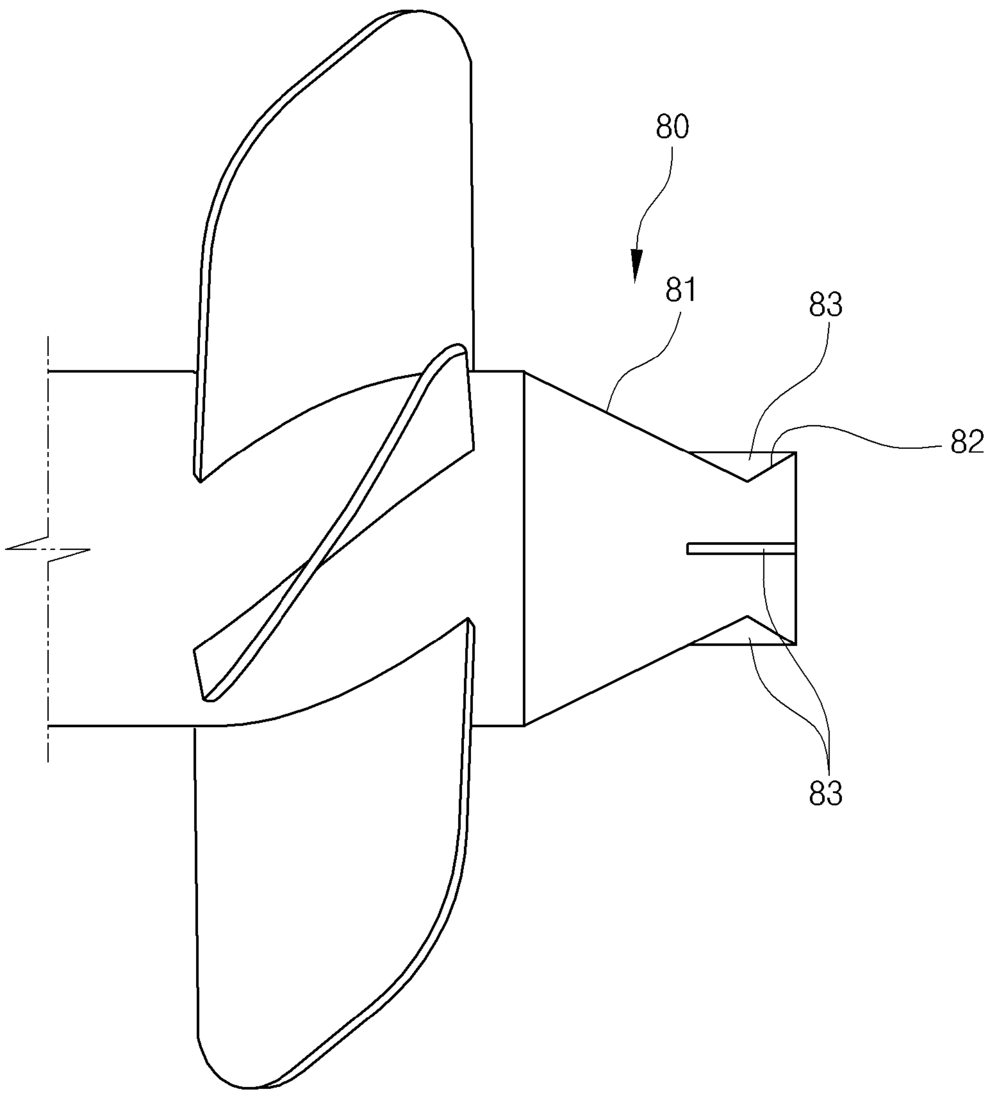
【Figure 6b】



【Figure 7】

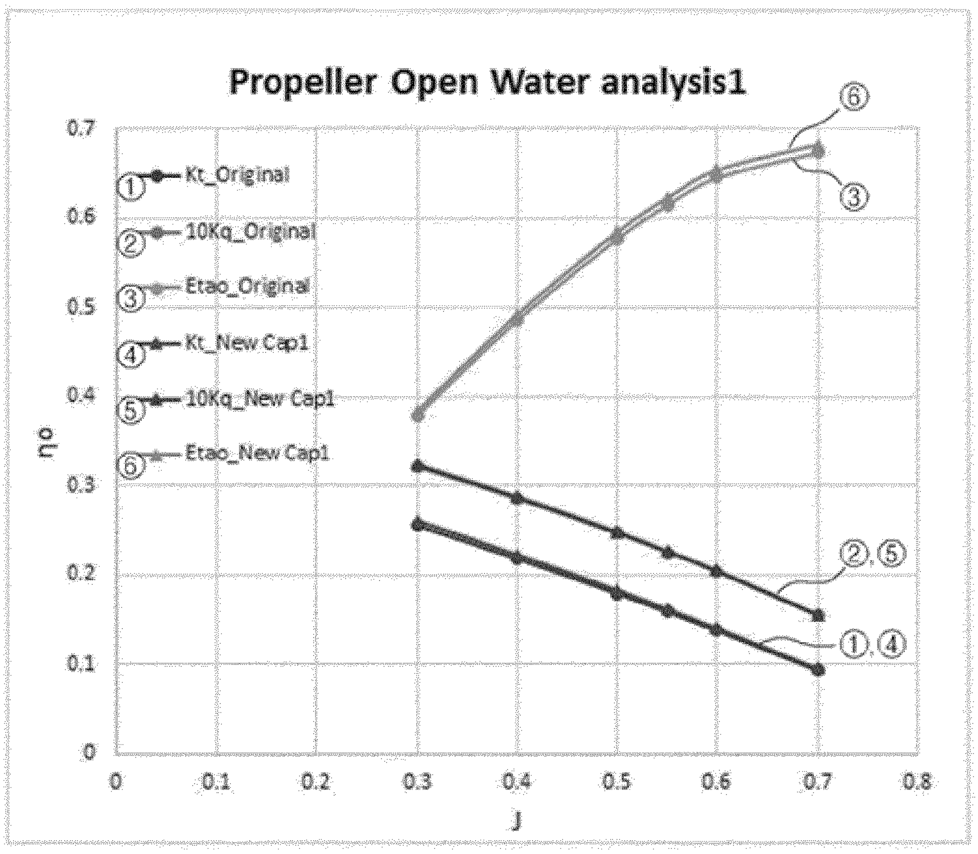
	contraction type	diffusion type	Embodiment 3	Embodiment 4
Efficiency of single propeller	+ 1.0%	base(0)	+ 1.1%	+ 1.1%

【Figure 8】

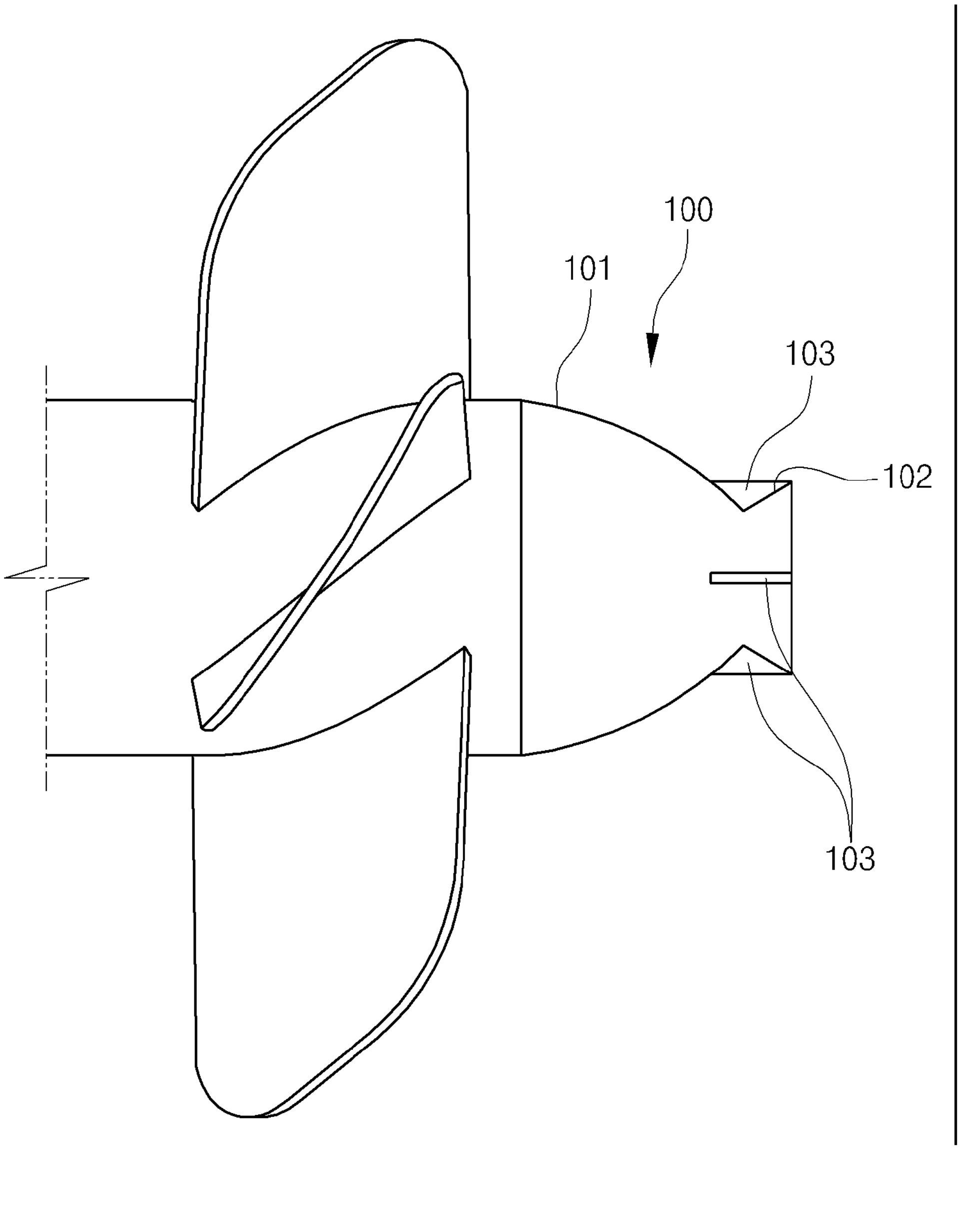


【Figure 9】

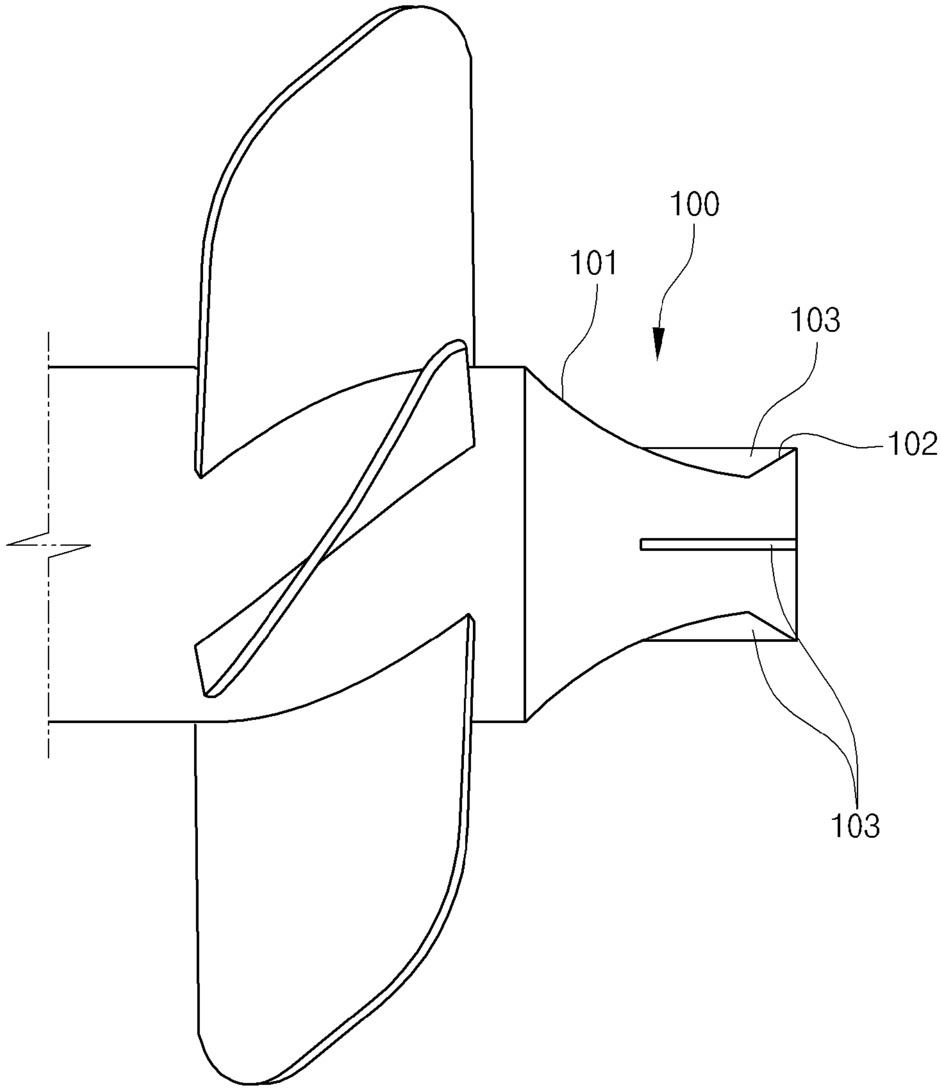
	contraction type	diffusion type	Embodiment 5
Efficiency of single propeller	+ 1.0%	base(0)	+ 1.2%



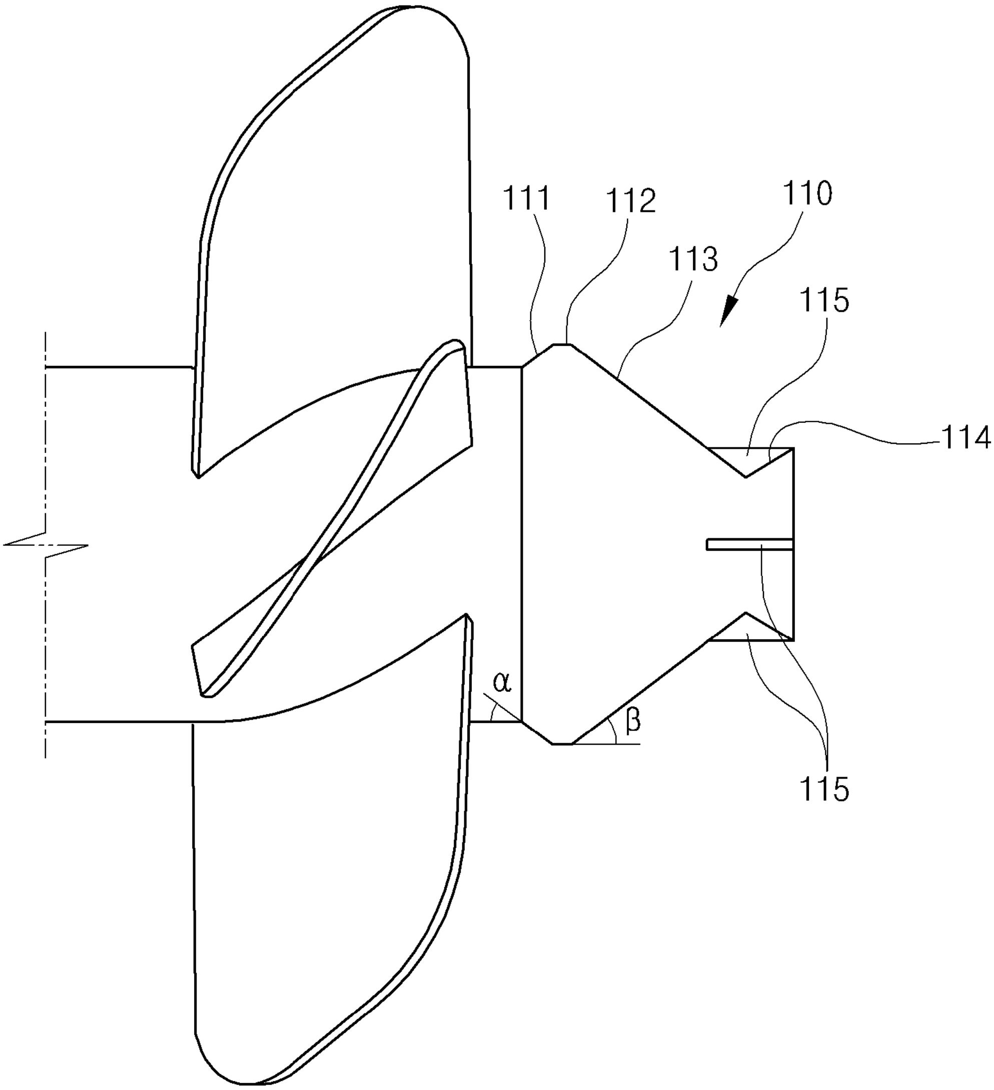
【Figure 10a】



【Figure 10b】



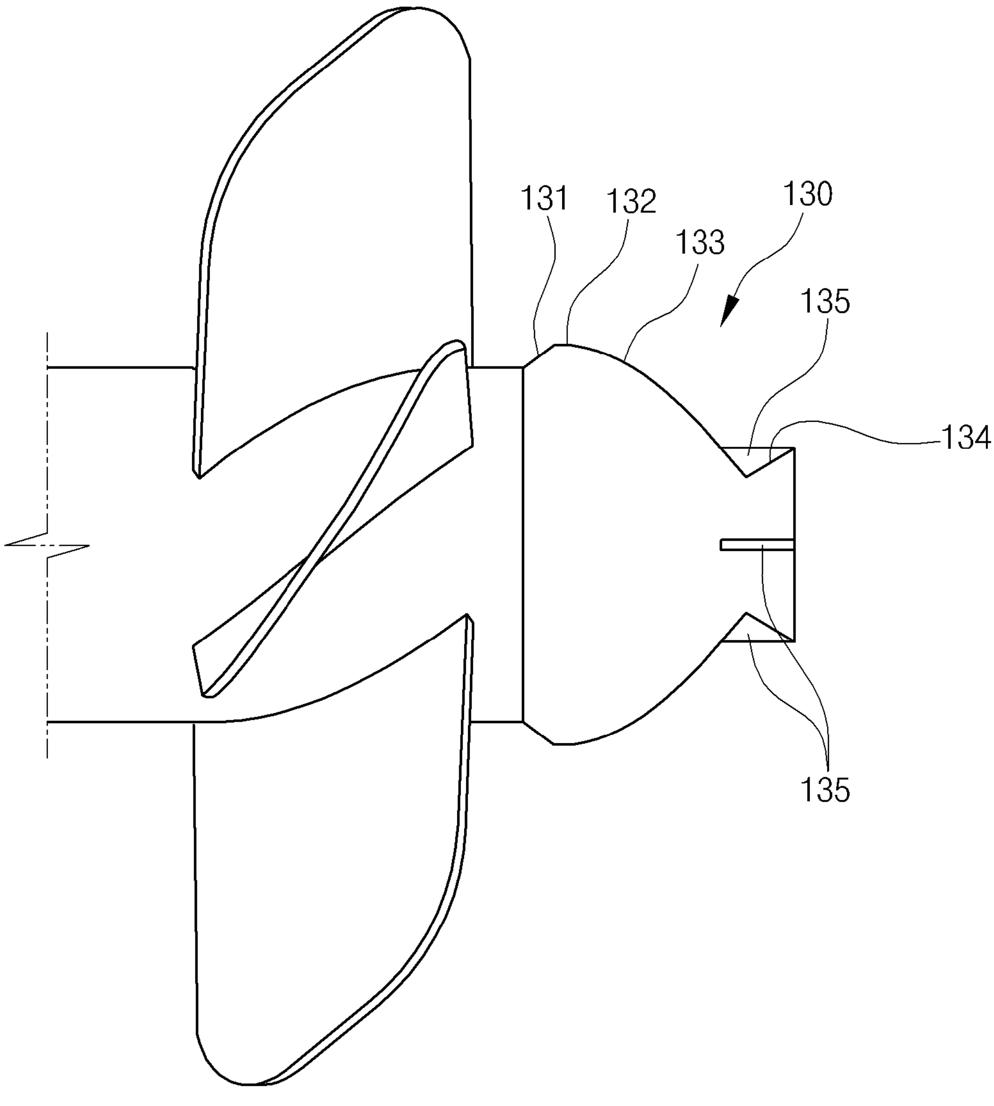
【Figure 11】



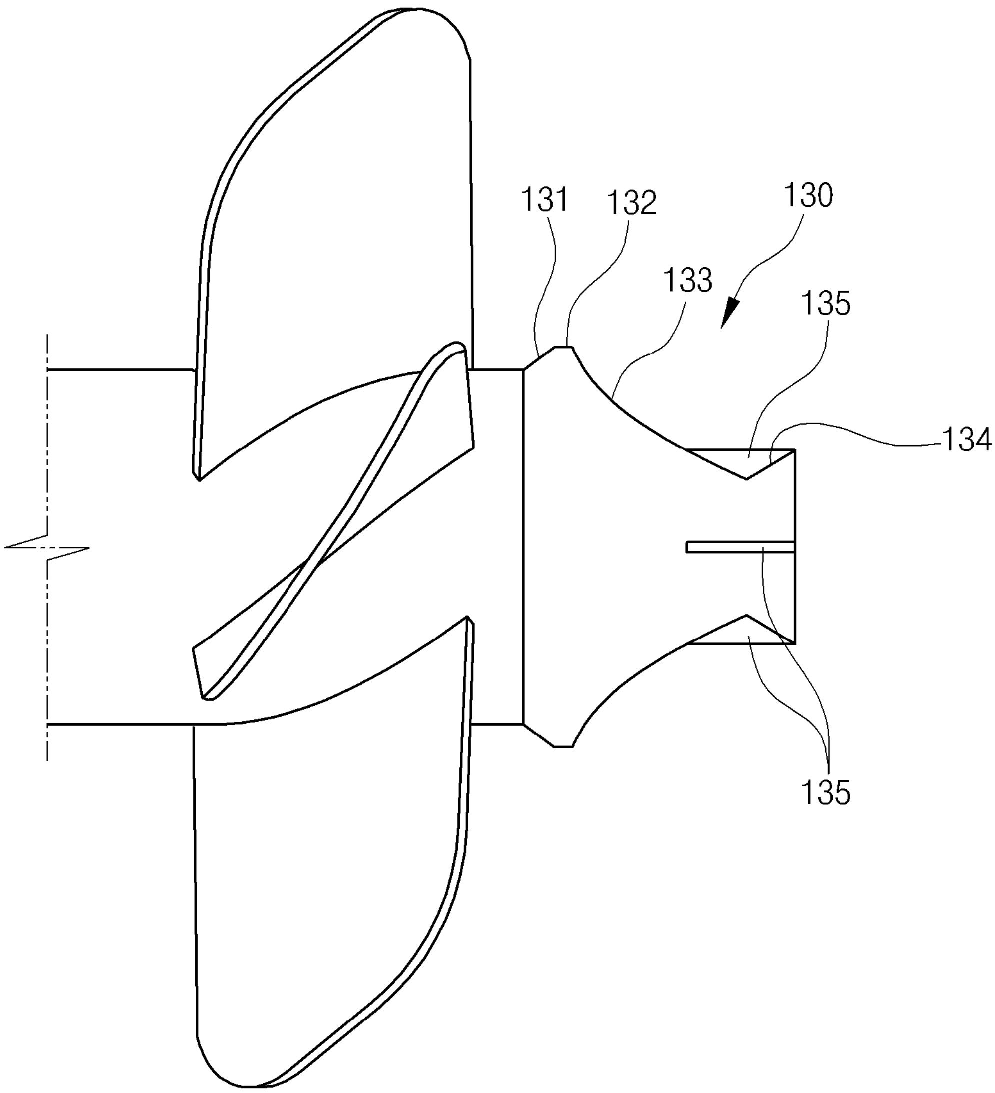
【Figure 12】

	contraction type	diffusion type	Embodiment 7
Efficiency of single propeller	+ 1.0%	base(0)	+ 1.3%

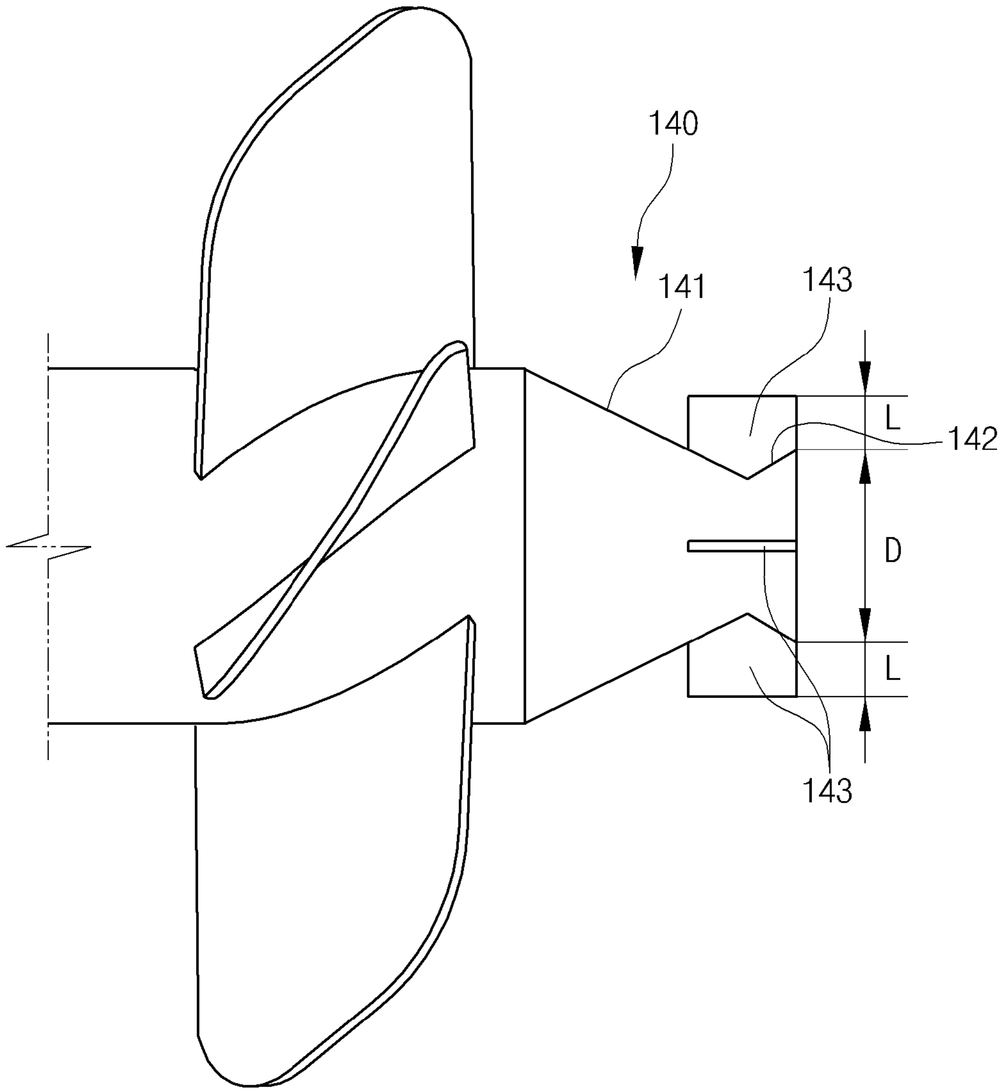
【Figure 13a】



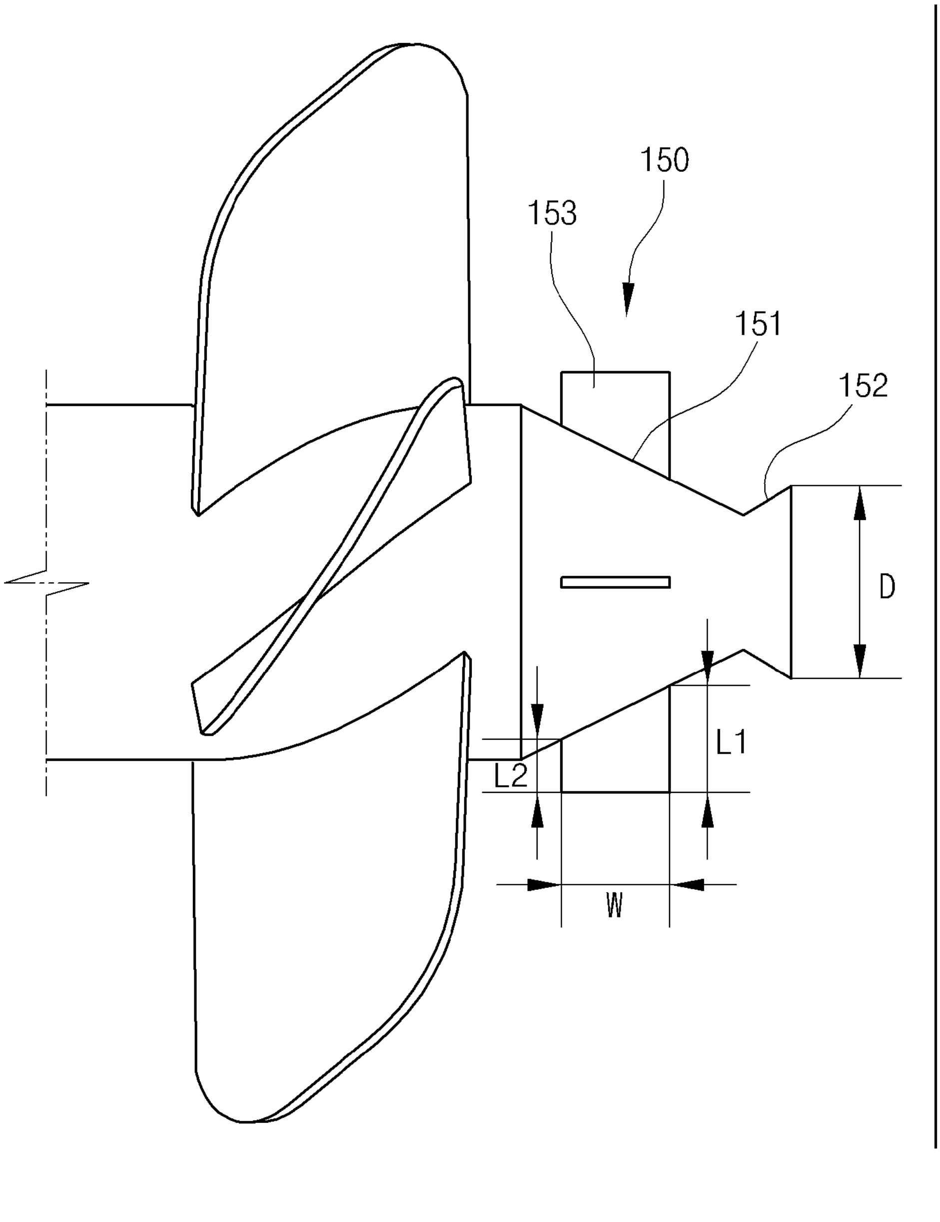
【Figure 13b】



【Figure 14】

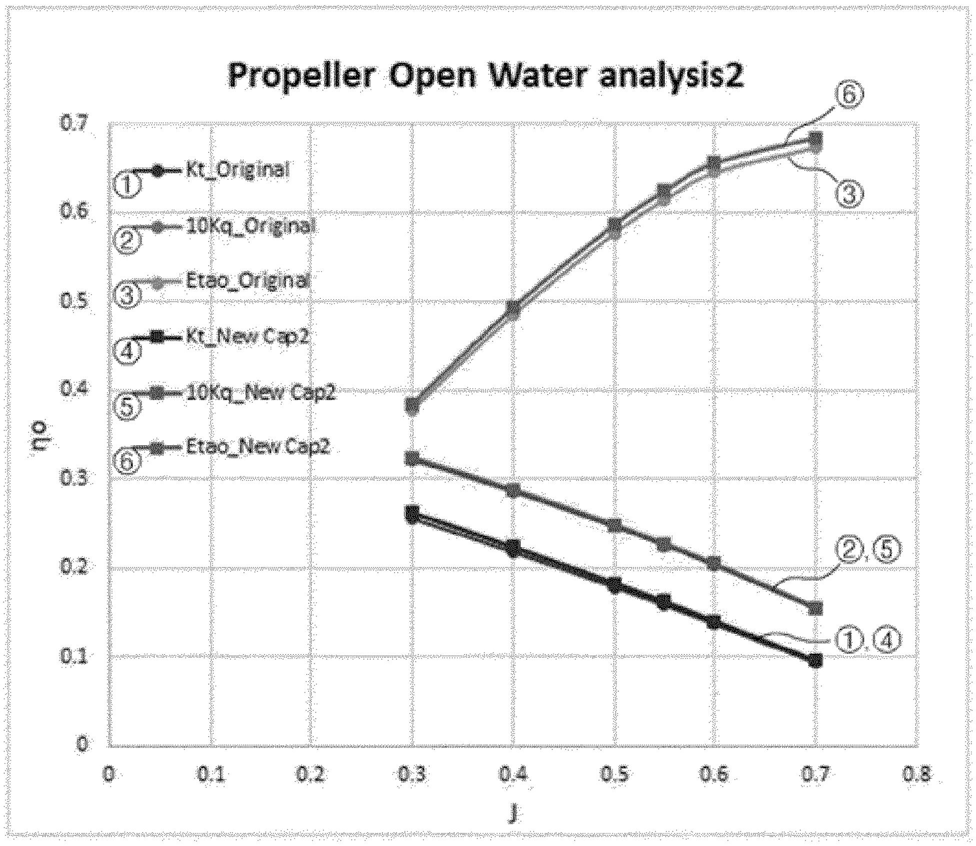


【Figure 15】



【Figure 16】

	contraction type	diffusion type	Embodiment 9
Efficiency of single propeller	+ 1.0%	base(0)	+ 1.7%



REFERENCES CITED IN THE DESCRIPTION

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