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(71) Applicant: FINNYARDS OY
FIN-26101 Rauma (FI)

(72) Inventors:
- Lohi, Paavo
26100 Rauma (FI)
- Keinonen, Arno
RR-2, Calgary, Alberta, T2P 2G5 (CA)
- Reynolds, Alan
Vancouver B.C., V6R 4G5 (CA)
- Harjula, Arjo
02210 Espoo (FI)

(74) Representative: Lipsanen, Jari Seppo Einari et al
Seppo Laine Oy
Lönnrotinkatu 19 A
00120 Helsinki (FI)

(54) Propulsion device for an ice-going vessel

(57) The invention relates to a propulsion device for an ice-going vessel. Said device comprises a propulsion device attached to the hull (1b) of said vessel, power transmission means (2b) for transmitting power from the vessel's engine to said propulsion device, a propeller (3b) mounted in said propulsion device, and a nozzle (6b) enclosing the propeller (3b).

According to the invention, said power transmission means (2b) are placed to the rear side of said nozzle (6b) with respect to the flow direction.

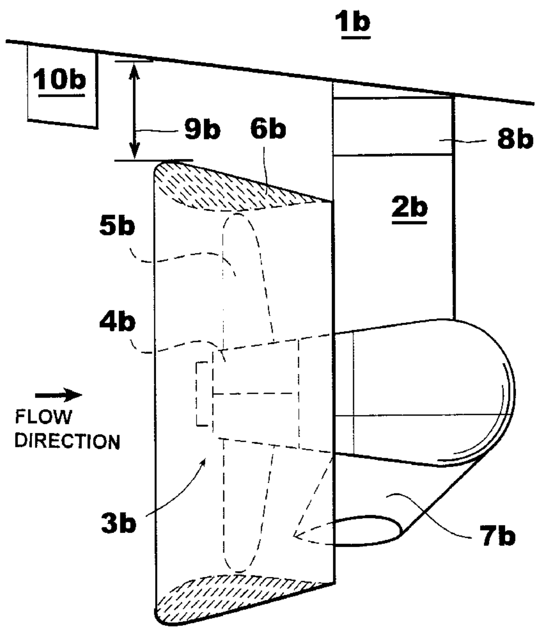

Fig. 2

EP 0 816 221 A2

Description

The invention relates to a propulsion device according to the preamble of claim 1 for use in an ice-going vessel.

Already for a number of years, propeller nozzles have been used in ice-breaking vessels. They offer the advantage of a significant increase (25 - 40 %) in bollard pull as compared to open propellers. Improvements in ice-breaking capacity have been based on high bollard pull in both breaking very thick ice and cutting loose a ship stuck in unpenetratable ice.

According to practical experiences, a problem of nozzles has been their tendency to plug during breaking ice, particularly thick ice. This has caused a clear discrepancy situation as the benefits and disadvantages of the propeller nozzle occur broadly under the same conditions.

Resultingly, the technology of using nozzle propellers in ice-breaking vessels has progressed slowly. In forward ice-breaking, astern-mounted nozzle propellers has in many cases proven a successful arrangement free from significant ice-plugging problems. However, ice-breaking vessels equipped with nozzle propellers have invariably had problems in running the vessel astern, whereby the nozzles have readily become plugged.

In the art is further known an icebreaker construction in which azimuth-type propulsion is implemented by mounting the nozzle of the propulsion device immediately close to the underside of the hull. However, this arrangement has been found to cause the following additional problems associated with the use of a propeller nozzle in ice. Namely, the broken ice which glides along the hull drifts against the nozzle, where it will become stuck in front of the nozzle, against the vertical stem of the propulsion device, and quite often, against the hull. Already when propulsion is used for forward drive, the tendency of nozzle plugging appears already when running at partial power. When an icebreaker is run in thick, homogeneous ice or in an old channel made in thick ice, nozzle plugging may occur when running at partial power and intermittently even at full power. When the vessel is run astern, nozzle plugging occurs more frequently.

It is an object of the present invention to overcome the disadvantages of the above-described technology and provide an entirely novel type of propulsion device for an ice-going vessel.

The goal of the invention is achieved by arranging the flow through the propulsion device so as to keep the passage of the inlet flow essentially free from any plugging obstacles. In a preferred embodiment of the invention, the hull clearance of the propulsion device is made essentially larger than the thickness of unbroken ice in the operating conditions of the vessel.

More specifically, the propulsion device according to the invention for an ice-going vessel is characterized by what is stated in the characterizing part of claim 1.

The invention offers significant benefits.

The inlet side of the propeller nozzle is kept fully free from obstacles that could hinder the passage of ice into the nozzle and therethrough.

Hydrodynamically, the suction side of the nozzle is designed to have no flow-disturbing parts.

The nozzle propeller according to the invention can pass practically all ice clumps with dimensions smaller than the length of the propeller blade. These ice clumps are approximately at least 50 % thicker than the ice clumps that conventional nozzle propulsion devices can pass without becoming plugged.

Owing to the use of the suction-type nozzle propeller propulsion device, the sensitivity of the nozzle to plugging at partial-power propulsion is reduced essentially. Resultingly, the operator of the ice-breaking vessel can be assumed to be able to use the suction-type nozzle propulsion practically without any problem of nozzle plugging even when running at partial power.

The hydrodynamic propulsion is estimated to increase as a result of the unobstructed suction-side flow pattern of the nozzle. According to practical experience, the additional flow resistance, which is caused by the support structures arranged to the outlet side of the nozzle, is smaller than the gain obtained by the unobstructed inlet-side suction flow.

In the following, the invention will be examined in greater detail with the help of the exemplifying embodiments illustrated in the appended drawings in which

Figure 1 is a side view of a conventional propulsion device; and

Figure 2 is a side view of a propulsion device according to the invention;

By virtue of adapting the novel suction-type azimuth propulsion in an ice-breaking vessel, the propulsion device may now be steered in any possible direction.

The invention concerns the conversion of a propeller nozzle of the type shown in Fig. 1 into a suction-type nozzle propeller used in an azimuth propulsion device.

According to the invention, the propeller and the nozzle are mounted for azimuth propulsion in front of the vertical shaft of the traction-force exerting propulsion device.

Referring to Fig. 1, therein is shown a conventional prior-art propelling-force exerting azimuth propulsion device for use on an ice-breaking vessel. The basic components of the device are:

1a	vessel hull
2a	vertical shaft of azimuth propulsion device
3a	propeller
4a	propeller hub
5a	propeller blade
6a	nozzle
7a	nozzle support strut

8a collar between vessel hull and nozzle
9a clearance between vessel hull and nozzle
10a vessel hull rear fin

In conventional structures, the vessel hull la is made flat over the entire attachment area of the azimuth propulsion device. The nozzle 6a is adapted immediately close to the hull la, thus permitting free azimuth steering of the propulsion device while keeping the hull clearance 9a to a minimum.

The vertical shaft 2a of the azimuth propulsion device is adapted to the front side of the nozzle 6a, and the nozzle is connected to the shaft by nozzle support struts 7a. The vertical shaft 2a blinds a relatively large portion of the nozzle suction area. Thereby the passage of ice through the nozzle is restricted as the shaft offers a backing surface to the approaching ice chunks.

The propeller 3a is located in the interior of the nozzle and throat clearance of the nozzle is slightly smaller than the length of the propeller blade 5a.

The support struts 7a of the nozzle 6a form in front of the nozzle such a structural restriction that by itself limits the maximum size of ice chunks passing through the nozzle.

In constructions of conventional technology, the diameter of the propeller hub 4a is relatively large thus also restricting the passage of ice chunks through the nozzle.

Shown in Fig. 2 is a pull-exerting azimuth propulsion device according to the invention.

The differences between conventional technology and the present invention are as follows:

In prior-art constructions, the vertical shaft 2a of the azimuth propulsion device is located in front of the nozzle. According to the invention, the vertical shaft 2b of the azimuth propulsion device is at the rear of the nozzle with respect to the flow.

In conventional technology, the nozzle support struts 7a are placed in front of the nozzle. According to the invention, the nozzle support struts 7b are at the rear of the nozzle, in the exit flow of the propeller, displaced from the inlet flow area.

According to prior-art techniques, the nozzle of the azimuth propulsion device is adapted immediately under the hull with the nozzle-to-hull clearance 9a reduced to the minimum value permitted by the construction.

According to the invention, the nozzle-to-hull clearance 9b of the nozzle is most advantageously slightly larger than the thickness of unbroken ice under the operating conditions of the vessel.

According to the invention, a slight extra benefit can be attained by adapting a collar 8b onto the vertical shaft of the azimuth propulsion device, between the hull and the nozzle. An advantageous shape of the nozzle can be, e.g., cylindrical, or alternatively, narrow-pointed in the direction of traction. The collar 8b may be provided with a hydrodynamically advantageous, smoothed envelope so shaped as to optimally guide the water flow into the propeller.

According to the invention, in conjunction with the use of a pulling or pushing propulsion device, the rear fin 10b of the vessel may be removed, with proper regard to the structural strength constraints of the propulsion device, from the hull, particularly when operating in multiyear ice.

The invention can be used with different types of nozzle profiles. According to the invention, most advantageously a nozzle is used which is optimized with respect to the traction force exerted by the nozzle in the traction direction.

According to the invention, the propeller hub 4b is most advantageously shaped on the suction side of the nozzle so as to permit easy passage of ice chunks through the nozzle. This means that the diameter of the hub 4b should be as small as possible on the front side of the propeller. Additionally, the hub design may be complemented with ice guides constructed on the hub that aid the passage of the ice chunks via the nozzle. Such guides act optimally by minimizing the power consumed in breaking the ice chunks and maximizing the increase of the longitudinal momentum component of the ice chunks as they pass through the nozzle.

The power transmission chain from the power source of the vessel to the propulsion device may be implemented in any suitable manner using either an electric, hydraulic or mechanical system.

Claims

1. A propulsion device for an ice-going vessel, said device comprising

- a propulsion device attached to the hull (1b) of said vessel,
- power transmission means (2b) for transmitting power from the vessel's engine to said propulsion device,
- a propeller (3b) mounted in said propulsion device, and
- a nozzle (6b) enclosing the propeller (3b),

characterized in that

- said power transmission means (2b) are placed to the rear side of said nozzle (6b) with respect to the flow direction.

2. A propulsion device as defined in claim 1, **characterized** in that the nozzle-to-hull clearance (9b) between said nozzle (6b) and said hull (1b) is arranged to be at least as large or larger than the thickness of unbroken ice in the operating conditions of the vessel.

3. A propulsion device as defined in claim 1, **characterized** in that a collar (8b) is adapted close to said hull (1b), in the vicinity of said power transmission means (2b).

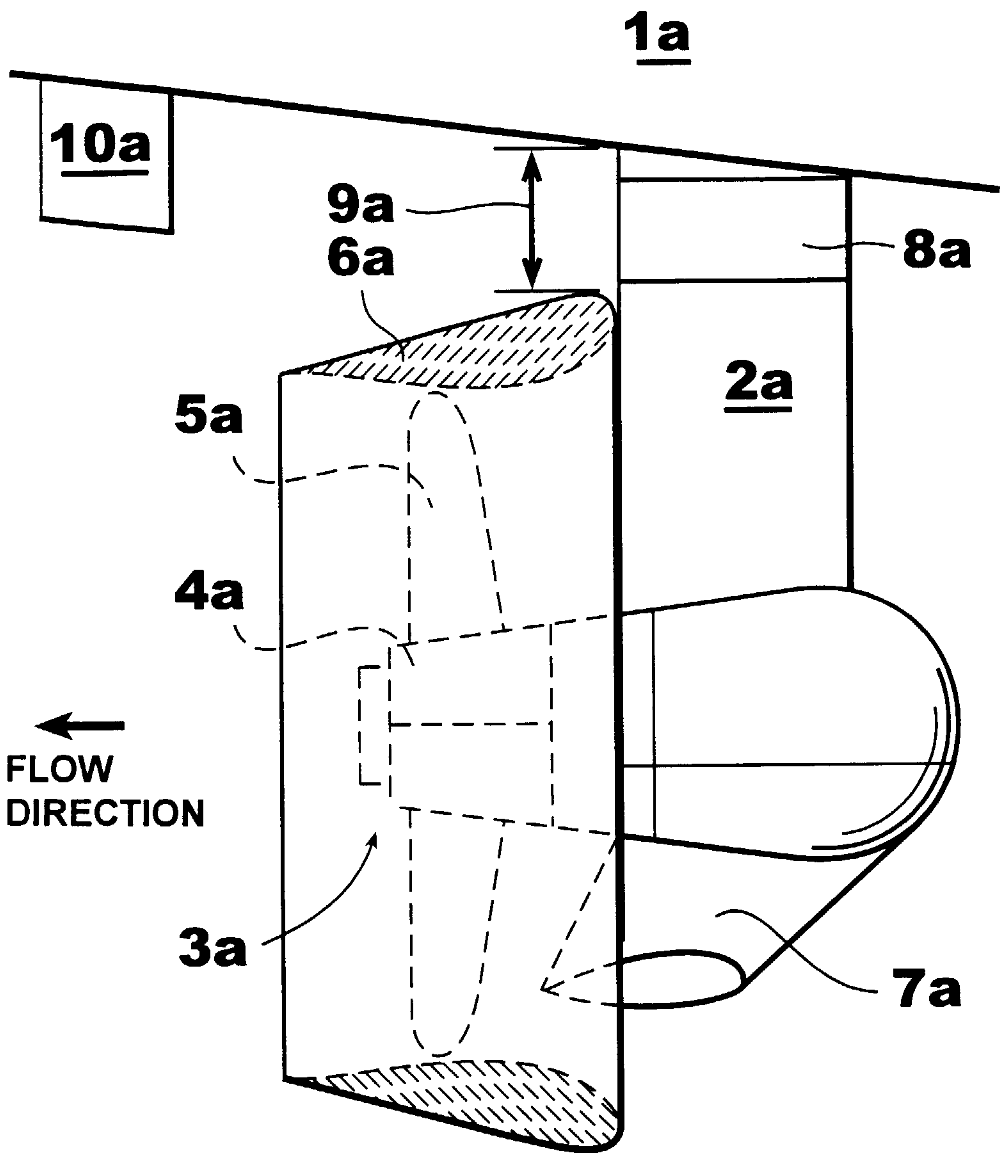

Fig. 1

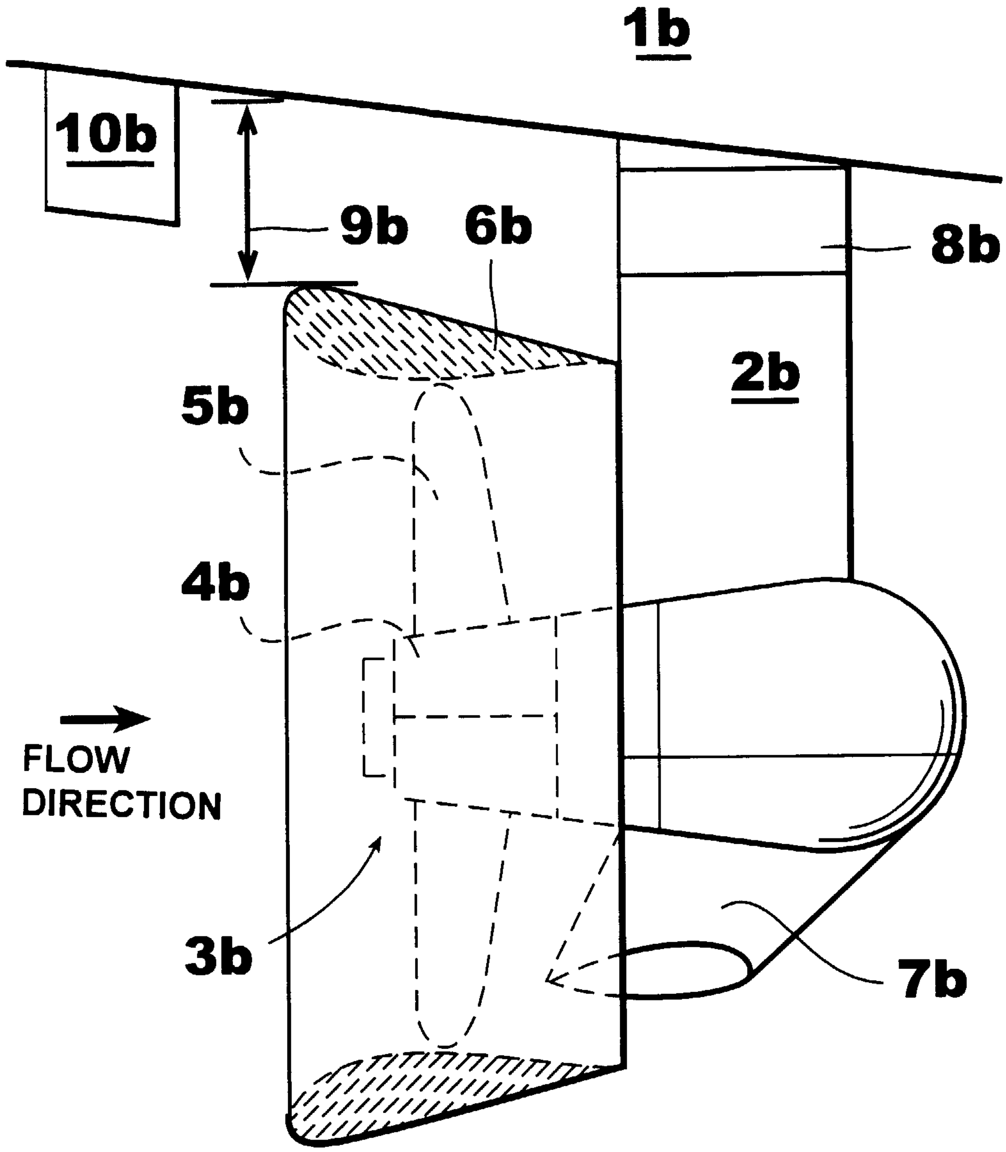

Fig. 2