

Kort nozzle

This invention relates to a Kort nozzle, in particular a Kort nozzle which is configured rotatable about the rudder axis of a ship.

A Kort nozzle is a conically tapered tube in which the propeller of a ship is placed. The tube also forms the wall of the Kort nozzle. Due to the taper of the tube to the stern of the ship, the Kort nozzles can transmit an additional thrust to the ship without the output having to be increased. Besides the propulsion improving properties of the Kort nozzle, pitching by rough sea is thus reduced so that by sea disturbance the loss of velocity can be reduced and the directional stability can be increased. Since the inherent resistance of the Kort nozzle increases approximatively quadratically as the speed of the ship increases, its advantages are effective in particular for slow ships which have a big propeller thrust (for example tugboats, fishing vehicles, etc.).

Besides fixed Kort nozzles behind which normally a rudder is placed in flow direction for the control of the ship, there are so-called "Kort rudder nozzles" for which the Kort nozzle is rotatable about the rudder axis of the ship which is in vertical direction. For this purpose, bearings are normally provided on the upper and lower side of the Kort nozzle on the outside of its wall for the rotatable positioning. In contrast, the propeller is still fixed so that the Kort nozzle also rotates around the propeller. Frequently, the Kort nozzle is connected with the rudder post and positioned in the rudder heel. It is normally swivellable

about a vertical axis of rotation or about the rudder axis by approximately 30° to 35° to both sides. Thus, the Kort nozzle is a combination of propulsion improving means and rudder since a rudder effect is achieved by the excursion of the propeller jet at an angle to the ship longitudinal axis. For excursed rudder nozzles, the stern of the ship is pushed by the jet reaction propulsion.

Fig. 5 illustrates an embodiment of a Kort nozzle 200 positioned rotatable about the rudder axis of a ship with a fixed propeller placed therein as it is known from the prior art. The Kort nozzle 200 is placed around the fixed ship propeller 210 of a ship (not represented here). Here the Kort nozzle is pivoted under an angle α of approximately 30° about the ship longitudinal axis 220. The arrow 221 represents the flow direction of the sea water or salt water. A fixed flap 230 is provided in flow direction behind the propeller on the Kort nozzle 200, through which the flow properties of the Kort rudder nozzle are positively influenced. Due to a reduced wall thickness, the inlet area 201 (with respect to the direction of the flow passing through the Kort nozzle 200) is configured widened with respect to the remaining area of the Kort nozzle 200. This means that the inner diameter of the inlet area is bigger than the inner diameter in the remaining area of the Kort nozzle 200. The water flow through the Kort nozzle 200 is increased which in turn increases the propulsion efficiency of the Kort nozzle.

Comprehensive calculations, tests and simulations of the applicant resulted in that, for certain twisting angles of a conventional Kort nozzle, swirls or recirculations of the flow

form in the area directly behind the propeller. These recirculations or swirls have a disadvantageous effect on the power of the Kort nozzle. They develop in particular directly behind the propeller in the side area of the propeller to which the Kort nozzle is turned. Due to the recirculations the flow rate of the water flowing through is considerably reduced in this area so that the driving power of the Kort nozzle is reduced. Since the recirculations occur only in a locally limited side area and the flow runs substantially laminarly in the other areas as usual, considerable vibrations which can be transmitted to the hull of the ship and which have also a disadvantageous effect adjust. Reference is made hereunder to the fig. 6a and 6b for illustrating this problem.

Fig. 6a shows schematically the topview of a cut Kort nozzle 200 as it is known from the state of the art. The arrows in fig. 6a and 6b constitute the course of the flow. The ship propeller 210 is drawn only schematically for reasons of clarity. For this Kort nozzle 200, contrary to the Kort nozzle of fig. 5, a movable or swivellable flap 231 is placed in flow direction behind the propeller 210. The Kort nozzle 200 is swivelled with an angle of approximately 15° with respect to the ship longitudinal axis. The rear part of the wall 202a of the Kort nozzle 200 has been rotated against the flow direction, i.e. to the propeller 210, while the opposed part of the wall 202b has been rotated with the flow direction accordingly.

The lower part area of the Kort nozzle 200 which is marked in fig. 6a is depicted enlarged in fig. 6b. It can be recognized therein that, due to the angular position of the Kort nozzle 200

with respect to the propeller 210 or to the ship longitudinal axis 220, a swirl or recirculation of the flow forms in the outer edge area in flow direction directly behind the propeller 210. Due to this recirculation, the mean flow rate in the main flow direction 221 is reduced to a minimum in this local area. Measurements and simulations in this area showed that there is a mean flow rate of 0,2 to 2 m/s in the main flow direction 221. Compared to this, the mean flow rate is situated within a range of 12 to 16 m/s in the area between the flap 231 and the wall area 202 b.

The water which flows laminarly outside along the wall 202a flows around the rounded-off edge of the wall of the Kort nozzle end area 203 to the inside and hits there the flow produced by the propeller 210 which is directed in the main flow direction 221. A part of the outer flow is directed to the inside against the main flow direction 221 and flows on the inner side of the wall 202 against the main flow direction 221 to the area behind the propeller 210 and from there back again through the propeller 210. Thus, a local circulation or recirculation of the flow is formed and the mean flow rate in the main flow direction 221 in this area is around zero. Therefore, the disadvantages described above occur.

Starting from the prior state described above, the object of this invention is to provide a Kort nozzle for which the occurrence of recirculations or swirls is avoided or reduced even with an angular position with respect to the ship longitudinal axis and which has a uniform over-all flow pattern. This object is achieved by a Kort nozzle with the characteristics of claim 1.

Accordingly, the core idea of this invention consists in that at least one opening is provided in the wall of the Kort nozzle. In this context, with openings, basically any opening of any configuration in the wall of the Kort nozzle is to be considered. The opening extends through the whole wall and thus consists of an inner and of an outer opening area and a central area connecting these two areas. It is decisive that a flow connection is created for the sea water or the salt water from outside the Kort nozzle through the at least one opening into the inside of the Kort nozzle.

The wall of the Kort nozzle is formed by the nozzle ring which envelops the stationary ship propeller. Basically the at least one opening can be provided at any location of the wall of the Kort nozzle. However, preferably it is provided in a lateral area of the Kort nozzle, either on the starboard side, or on the port side. It is decisive that the at least one opening is configured provided or placed in the wall in such a manner that, due to the at least one opening, sea water or salt water can flow from outside the Kort nozzle throughout this opening into the inside of the Kort nozzle in such a manner that the recirculations or swirls which develop at certain swivelling angles of the Kort nozzle are suppressed or considerably reduced. Tests of the applicant resulted in that, due to such openings, the thrust of the Kort nozzle has been increased in the side areas in which typically swirls or recirculations occur by up to 20%. Furthermore, the vibrations transmitted to the hull have been reduced.

Due to the at least one opening, a laminar flow is thus introduced from outside to the critical side areas of the Kort

nozzle in which the swirls typically occur at certain swivelling angles. This laminar flow avoids that a recirculation flow can be formed in the side areas against the main flow direction. The thrust and the working stability and thus the efficiency of the Kort nozzle are considerably improved herewith.

Preferred embodiments of the invention are characterized in the dependent claims.

In order to be able to suppress the occurrence of swirls in any swivelling direction, it is appropriate to provide at least two openings in the wall of the Kort nozzle. Advantageously, both openings are placed substantially opposite each other. Appropriately, both openings are moreover to be placed respectively in a side area of the Kort nozzle since normally the strongest swirls develop there for conventional Kort nozzles. It is thus guaranteed that the risk of the occurrence of swirls or recirculations is reduced for a swivelling to the starboard side as well as for a swivelling to the port side.

With respect to the height of the Kort nozzle, according to a preferred embodiment of the invention, the at least one opening is disposed in a central area. This being, the central area ranges from one third of the height of the Kort nozzle to approximately two thirds of the Kort nozzle, preferably from two fifths to three fifths of the height of the Kort nozzle. It is thus achieved that the at least one opening is placed in an area in which the swirls typically occur. Thus, the laminar flow flowing through the at least one opening can develop an optimal effect and can suppress the swirl as much as possible. According to

the invention, it is particularly preferred to provide a central arrangement of the at least one opening with respect to the height of the Kort nozzle. This being, the height of the Kort nozzle corresponds to its vertical extension when mounted, i.e. to the distance between the opposed wall areas of the Kort nozzle along its vertical axis or along the rudder axis.

The central areas of the Kort nozzle extend in their longitudinal extension over the whole length of the Kort nozzle. There are thus two central areas which are placed opposite to each other. According to another preferred embodiment of the invention, at least two openings are disposed in at least one of these two central areas. Furthermore, these at least two openings are placed in longitudinal direction of the Kort nozzle the one behind the other and/or in vertical direction lying above one another. Depending on the configuration of the Kort nozzle and of the propeller as well as the respective swivelling angle, the result to be achieved can thus be optimized, namely the improvement of the thrust and of the quiet running of the Kort nozzle. For this embodiment too, at least two openings are respectively provided in both central areas, whereby the openings of both central areas are advantageously placed opposite to each other.

With respect to the length of the Kort nozzle, i.e. the dimensions of the Kort nozzle, when the Kort nozzle is not swivelled about the ship longitudinal axis, according to another preferred embodiment, the at least one opening is disposed in an area from one third to two thirds of the length, preferably from two fifths to three fifths of the length, particularly preferably in the

middle. The effect of the at least one opening can again be optimized by this measure too.

For a swivellable Kort nozzle with a fixed ship propeller placed therein, it is furthermore preferred to configure the at least one opening in such a manner that it is placed, for a swivelling angle of 10° , 15° or 20° , with its inner opening area substantially adjacent to the propeller. It is thus guaranteed that, for the above mentioned typical swivelling angles, the laminar flow which comes out of the inner opening area of the at least one opening, flowing from the outside to the inside into the Kort nozzle, hits directly the swirl area. The laminar flow can thus directly act against the recirculation flow and the effect of the at least one opening is further improved. Should in some cases other swivelling angles, for example 25° or 30° , be employed, the arrangement of the at least one opening can naturally be adapted accordingly.

For the further optimization of the effect of the at least one opening for the efficiency of the Kort nozzle, it is provided in a further preferred embodiment of the invention to configure the at least one opening as an oblong slit. Moreover, it is advantageous that the slitlike opening substantially extends in the vertical direction. It is thus achieved that a vertically orientated flow band flows into the Kort nozzle from the outside to the inside and thus positively influences the critical area in which normally swirls develop. Furthermore, such an opening can be produced relatively easily.

Furthermore, it is preferred that the at least one opening extends obliquely from the outside to the inside with respect to the main flow direction through the wall. This means that the middle line of the openings is orientated with a predetermined angle to the main flow direction or to the longitudinal axis of the Kort nozzle. It is thus guaranteed that the outer laminar flow flows from the outside to the inside into the Kort nozzle and that no water flows from the inside to the outside through the at least one opening.

It is preferred in particular to configure the at least one opening with respect to the longitudinal axis of the Kort nozzle with an angle of 10° to 60° , preferably 20° to 45° , particularly preferably 30° to 35° . The indications of angles refer to the angle between the longitudinal axis of the Kort nozzle and the middle line of the at least one opening which extends from the outside to the inside through the at least one opening.

For a further preferred embodiment of the invention, it is provided that the at least one opening tapers from the outer side of the wall or from its outer opening area to its inner opening area on the inner side of the wall. The speed of the flow which flows from outside into the Kort nozzle can thus be increased so that the overall efficiency of the Kort nozzle and the risk of the occurrence of turbulences or recirculations are further reduced.

Alternatively, the at least one opening can be configured substantially constant over its whole extension.

Appropriately, at least one of the admission edges and/or at least one of the discharge edges of the at least one opening is to be configured rounded-off. In the flow direction, each opening has, for example for a slitlike vertically orientated opening, two vertically orientated admission edges and two vertically orientated discharge edges. The admission through the opening into the Kort nozzle is thus improved in so far as the risk that unwished swirls can occur on the admission or discharge edges due to a breakaway of the flow is reduced.

Different embodiments of the invention will be explained in more detail below with reference to the figures represented in the drawings.

Fig. 1a shows schematically a perspective view of a Kort nozzle with two opposite openings which are positioned swivellable on the hull of a ship.

Fig. 1b shows schematically a sectional view of a portion of the Kort nozzle of fig. 1a.

Fig. 2a shows schematically a perspective view of a Kort nozzle swivellably positioned on a hull of a ship for which two openings situated in succession in a horizontal direction are placed in each central area.

Fig. 2b shows schematically a sectional view of the Kort nozzle of fig. 2a.

Fig. 3 shows schematically a perspective view of a Kort nozzle swivellably positioned on the hull of a ship with respectively three openings situated in succession in a vertical direction in each central area.

Fig. 4 shows schematically a sectional top view of a portion of a Kort nozzle with an opening with figured flow lines.

For the different embodiments represented below, the same components are provided with the same reference numerals.

Fig. 1a shows a perspective view of a Kort nozzle 100 which is positioned swivellable on the hull 10 of a ship. The hull 10 of a ship is depicted only partially for reasons of clarity. The Kort nozzle is connected with the hull 10 by a bearing 12 and is rotatable about the rudder axis 11. The rudder axis 11 corresponds to the vertical axis. The Kort nozzle 100 is furthermore connected with the hull in its lower area by a further bearing (not represented here). Considering the flow direction 13, a movable or controllable flap 14 follows at the end of the Kort nozzle 100. The Kort nozzle 100 comprises a ring-shaped configured wall 15 which is configured conically and which tapers in the flow direction 13. An opening 16 is placed respectively in the central side areas 15a, 15b of the wall 15 with respect to the height of the Kort nozzle. The openings 15 are placed substantially in the middle with respect to the height. The openings 16 extend obliquely from the outside to the inside, this being considered in the flow direction 13. They consist in a slit extending substantially vertically which tapers from the outside to the inside. Thus, the openings 16 have an

approximately shovel-type appearance since the outer opening area 16a is wider than the inner opening area 16b because of the taper of the opening 16. The propeller is omitted in fig. 1a for reasons of clarity but is placed, when mounted, inside the Kort nozzle 100.

Fig. 1b shows a sectional view of a portion of the Kort nozzle 100 of fig. 1a. In particular, the wall of the Kort nozzle 100 of fig. 1b is cut in the area of an opening 16. It can be recognized that the opening 16 extends in flow direction obliquely from the outside to the inside and that it tapers to the inside. Correspondingly, the outer opening area 16a is wider than the inner opening area 16b. Among the two horizontally extending admission edges 17a, 17b of the opening 16, the rear admission edge 17a is configured rounded-off while the front admission edge 17b is configured angular. In the same way, the rear discharge edge 18a is rounded-off in flow direction 13 while the front discharge edge 18b is angular. When considered from the side, the outer opening area 16a and the inner opening area 16b of the opening are offset to each other, in particular they are placed offset laterally to each other. Thus, the inner opening area 16b is covered by the obliquely extending side walls of the opening 16 or by the wall 15, with respect to a side view of the Kort nozzle 100. In other words, the opening is configured as a slitlike channel which extends obliquely from the outside to the inside in flow direction 13.

Fig. 2a shows a perspective view of a further embodiment of a Kort nozzle according to the invention 100. It can be recognized in fig. 2a that the flap 14 is supported in the upper rudder

bearing 12 as well as in a lower flap bearing on the Kort nozzle 100. Furthermore, two openings 16 are respectively placed in the central areas 15a, 15b of the wall 15, openings which are situated one behind the other in a ship longitudinal direction, when the Kort nozzle is not deviated, or in the longitudinal direction of the Kort nozzle. It can be recognized in fig. 2a that only the outer opening area of the openings 16 can be seen from the outside and the inner opening area is covered. Correspondingly, the outer and the inner opening area of the opening 16 are placed one behind the other in flow direction 13.

Fig. 2b shows a sectional view of the Kort nozzle 100 of fig. 2a. It can be recognized that the openings 16 are placed respectively opposite each other in both central areas 15a, 15b of the wall 15. Moreover, these openings 16 extend obliquely from the outside to the inside in flow direction 13. The single openings 16 are moulded respectively identical and thus extend parallel to each other.

Fig. 3 shows a further embodiment of a Kort nozzle 100 according to the invention. For this embodiment, three openings 16 placed one above the other in a vertical direction are provided in each central area 15a, 15b of the wall 15. The openings 16 are placed respectively in the middle with respect to the longitudinal direction of the Kort nozzle 100. The distance between the single openings 16 of a central area 15a, 15b is respectively approximately the same.

Fig. 4 shows a flow pattern of a side area of a Kort nozzle 100 with a portion of a schematically depicted propeller 20. Overall,

the depiction of fig. 4 is similar to that of fig. 6b, whereby contrary to the depiction of fig. 6b a Kort nozzle according to the invention with an opening 16 has been used. The represented arrows symbolize the flow course of the water flowing through the Kort nozzle. As it can be recognized, water flows from the outside to the inside through the opening 16. As soon as it passes the inner opening area 16b of the opening 16 it flows further along the inner side of the wall 15 until it finally leaves the Kort nozzle 100. Thus, no back circulation or swirl can form in the area between the outside of the propeller 20 and the end side of the Kort nozzle 100 with respect to the flow direction 13. On the contrary, the whole flow flows laminarly inside the Kort nozzle 100 and also outside on the edge of the Kort nozzle 100.

List of reference numerals

100	Kort nozzle
10	Hull of a ship
11	Rudder axis
12	Bearing
13	Flow direction
14	Flap
15	Wall
15a	Central area of the wall
15b	Central area of the wall
16	Opening
16a	Outer opening area
16b	Inner opening area
17a	Admission edge
17b	Admission edge
18a	Discharge edge
18b	Discharge edge
19	Flap bearing
20	Propeller
200	Kort nozzle (prior art)
201	Opening area
202a	Wall of the Kort nozzle
202b	Wall of the Kort nozzle
210	Ship propeller
220	Ship longitudinal axis
221	Flow direction
230	Flap (fixed)
232	Flap (movable)

Claims

1. Kort nozzle (100) configured rotatable about a vertical axis of rotation (11),
wherein the Kort nozzle (100) comprises a single nozzle ring, which forms the wall (15) of the Kort nozzle (100) and envelops a ship propeller,
wherein at least two openings (16) are provided in the wall (15) of the Kort nozzle (100) which are disposed substantially opposite each other,
wherein the nozzle ring is conically tapered,
wherein the at least two openings (16) have an inner and an outer opening area, are both substantially completely open, extend obliquely from the outside to the inside through the wall (15) with respect to the main flow direction and with an angle of 10° to 60° with respect to the longitudinal axis of the Kort nozzle (100), and create a flow connection from outside the Kort nozzle (100) to the inside of the Kort nozzle (100),
wherein the at least two openings (16) are each entirely disposed in a central area (15a, 15b) with respect to the height of the Kort nozzle (100), said central area (15a, 15b) ranging from one third to two thirds of the height of the Kort nozzle (100), wherein in the other areas of the Kort nozzle (100) there are no other openings, and
wherein at least two openings (16) are disposed in each central area (15a, 15b) of the Kort nozzle (100), wherein the at least two openings (16) of each central area (15a, 15b) are arranged in a longitudinal direction of the Kort nozzle (100) one behind the other or in a vertical direction above one another.
2. Kort nozzle according to claim 1, wherein the central area (15a, 15b) ranges from from two fifths to three fifths of the height of the Kort nozzle (100).
3. Kort nozzle according to any of the preceding claims, characterized in
that the at least one opening (16) is disposed with respect to the length of the Kort nozzle (100) in an area from one third to two thirds of the length, preferably in an area from two fifths to three fifths of the length, particularly preferably in the middle.

4. Kort nozzle according to any of the preceding claims, wherein
the Kort nozzle (100) is configured rotatable about the rudder axis (11) of a ship and wherein a fixed propeller (20) of a ship is disposed in the Kort nozzle (100), characterized in
that the at least one opening (16) is disposed in such a manner that it is disposed with its inner opening area (16b) substantially adjacent to the propeller (20), preferably for a swivelling angle of 10°, 15° or 20°.
5. Kort nozzle according to any of the preceding claims, characterized in
that the at least one opening (16) is configured as an oblong slit extending in vertical direction.
6. Kort nozzle according to any of the preceding claims, characterized in
that the at least one opening (16) extends with an angle of 20° to 45°, with respect to the longitudinal axis of the Kort nozzle (100).
7. Kort nozzle according to any of the preceding claims, characterized in
that the at least one opening (16) extends with an angle of 30° to 35°, with respect to the longitudinal axis of the Kort nozzle (100).
8. Kort nozzle according to any of the preceding claims, characterized in
that the at least one opening (16) is configured in such a manner that it tapers from the outer side of the wall (15) to the inner side of the wall (15).
9. Kort nozzle according to any of the claims 1 to 7, characterized in
that the dimensions of the at least one opening (16) are substantially constant over its whole extension.
10. Kort nozzle according to any of the preceding claims, characterized in
that the admission edges (17a,17b) and/or the discharge edges (18a, 18b) of the at least one opening (16) are configured rounded-off.

11. Ship,
characterized in
that a Kort nozzle (100) according to any of the preceding claims is provided on
the ship, in particular at its stern.