The invention relates to a water jet propulsion apparatus for a vessel or a watercraft, in which the pump impeller (8) is fed with sea water only in its lower half through a water-inlet opening (15) provided at the forward end of the tubular impeller housing (1) underneath the level of the axis of the impeller shaft (7). If necessary, also the upper half of the pump impeller (8) may be fed with the exhaust gases from the motor, and/or with the motor-cooling water through an auxiliary inlet opening (16) provided over the level of the axis of the impeller shaft (7).
The invention relates to a water jet propulsion apparatus for a vessel or a watercraft, comprising a rearwardly projecting water jet nozzle, a motor-driven impeller pump, whose impeller is arranged in a tubular housing and is fixed to the rear end of an forwardly extending motor-driven shaft, a delivery duct connecting the rear end of the impeller housing with the water jet nozzle, and a forwardly extending water-intake channel connecting a water-inlet opening at the forward end of the impeller housing with a water-intake opening which communicates with the water surrounding the vessel. A water jet propulsion apparatus of this kind is known from the documents US-A-3.757.728, US-A-3.934.538 and US-A-3.943.876.

In the known water jet propulsion apparatuses of this kind, the water-inlet opening connected with the water-intake channel and provided in the rear end of the impeller housing extends over the whole cross-section of the impeller housing, so that the pump impeller will receive water in the whole circular area thereof, both under and over the level of the axis of the impeller shaft. This brings about some troubles in the water flow through the water-intake channel, with the effect of reducing the propulsive efficiency of the water jet propulsion apparatus.

The object of the invention is to provide a water jet propulsion apparatus for a vessel or watercraft, of the type as disclosed above, whereby owing to the features of its quite simple and not much expensive construction, a better propulsive efficiency is ensured, jointly with a reduced noise and a lesser air pollution.

According to the invention, in a water jet propulsion apparatus as stated in the preamble of claim 1, the problem arising from a reduction in the propulsive efficiency of the water jet propulsion apparatus, is solved by the feature that the water-inlet opening provided at the forward end of the impeller housing and connected with the water-intake channel, lies exclusively underneath the level of the axis of the impeller shaft.

Therefore, in the water jet propulsion apparatus according to the invention, the pump impeller receives water from the sea only in its lower half, so that it is fed with sea water only in its half lying underneath the level of the axis of the impeller shaft.

Owing to this feature of the water jet propulsion apparatus according to the invention, the wet surface of the water inlet opening in the forward end of the impeller housing, and then also any resulting friction, are sensibly reduced. This prevents any troubles from being produced in the sucked water flow through the water-intake channel. These troubles are further eliminated according to another improvement of the invention, by the feature that when navigating under a normal load, the water line arrives substantially at the level of the axis of the impeller shaft, and/or the impeller shaft is rotatably supported in a bushing arranged as close as possible to the forward end of the impeller housing, so that only a very short length of the shaft carrying the pump impeller, projects into the impeller housing.

The forward end of the impeller housing can be closed, with the exception of the water-inlet opening lying underneath the level of the axis of the impeller shaft.

According to a further improvement of the invention, an auxiliary inlet opening can be provided at the forward end of the impeller housing over the level of the axis of the impeller opening, and this auxiliary opening communicates with a duct which is connected or connectable with the ambient air and/or with the exhaust manifold of the motor and/or with the discharging duct for the motor-cooling water.

The fact that the exhaust gases from the motor can be conveyed into the impeller housing at the forward end thereof, renders it possible to have the exhaust gases mixed with the sucked sea water flow. This causes the flux density of the pumped water flow to be reduced, so that the vibrations affecting the pump impeller and the resulting noises are reduced. Moreover, the exhaust gases from the motor are efficaciously scrubbed and cooled, whereby a lesser air pollution is ensured.

The water-inlet opening provided at the forward end of the impeller housing, and connected with the water-intake channel, may be shaped and arranged as desired. In one particularly advantageous embodiment of the invention, the said water-inlet opening is formed as a sector of a circle, the center of which lies on the axis of the impeller shaft, semicircle underneath a substantially horizontal diameter intersecting the axis of the impeller shaft.

Also the auxiliary inlet opening provided at the forward end of the impeller housing, over the level of the axis of the impeller shaft, may be shaped and arranged as desired. In one particularly advantageous embodiment of the invention, the said auxiliary inlet opening is formed as a sector of a circle, the center of which lies on the axis of the impeller shaft, or as a semicircle over a substantially horizontal diameter intersecting the axis of the impeller shaft.

Other advantageous improvements according to the invention form the object of the other dependent claims.

The particular features of the invention and the advantages arising therefrom, will appear more in detail in the specification of two preferred embodiments, which are shown by way of non-limiting
examples in the accompanying drawings, in which:

Figure 1 is a sectional view showing one embodiment of the water jet propulsion apparatus for a vessel or watercraft, according to the invention, in which the tubular housing of the pump impeller is arranged inside the bottom of the vessel.

Figure 2 is a sectional view taken on line II-II in Figure 1.

Figure 3 is a sectional view showing a further embodiment of the water jet propulsion apparatus according to the invention, in which the tubular housing of the pump impeller consists of a tubular body which is external to, and is attached to the vessel's or watercraft's bottom.

Diagrammatically shown in Figure 1 is the astern region of a vessel or watercraft, within which a tubular housing 1 is fitted, and is arranged at such a level that approximately the lower half thereof will be filled with water, as indicated by arrow L. A delivery duct 22 terminating with a nozzle 2, extends from the aft end side of, and is substantially coaxial to the tubular housing 1. The said delivery duct 22 is arranged in the fore-and-aft direction of the vessel or watercraft, and extends out of the transom board 3 thereof. The water jet for propulsion of the vessel or watercraft is ejected from the rear end nozzle 2 of the delivery duct 22. The tubular housing 1 has its fore end side connected with a lower water-intake channel 4 which is directed toward the vessel's or watercraft's head. The rear end of the lower water-intake channel 4 is connected with a water-inlet opening 15 at the forward end of the tubular housing 1. The forward end of the water-intake channel 4 is connected with a water-intake opening 14 which is provided in the vessel's or watercraft's bottom for sucking the water surrounding the vessel. The said lower water-intake channel 4 is inclined downward and is directed toward the vessel's or watercraft's head. The tubular housing 1 is further provided at its fore end side with an auxiliary upper inlet opening 14 connected with a duct 5 which in turn is connected or connectable with the ambient air, and/or with the exhaust manifold, and/or with the duct for discharging the water cooling the vessel- or watercraft-propelling engine or engines.

In the illustrated embodiment, the water-inlet opening 15 provided at the forward end of the tubular housing 1 and connected through the water-intake channel 4 with the water-intake opening 14, is formed as a semicircle underneath a substantially horizontal diametrical wall which separates this lower water-inlet opening 15 from the auxiliary upper inlet opening 16. Also the auxiliary inlet opening 16 provided at the forward end of the tubular housing 1 and connected with the upper duct 5, is formed as a semicircle over the substantially horizontal diametrical wall, between the two openings 15 and 16.

A pump impeller 8 is arranged in the tubular housing 1 and is secured to an impeller shaft 7 rotatably supported in a bushing 6 which is fixed on the partition wall between the two openings 15 and 16. The impeller 8 is formed as a propeller and constitutes the rotor of the suction pump of the water jet propulsion apparatus of the vessel or watercraft. Owing to the propeller 8 being arranged as close as possible to the forward end of the housing 1, the propeller-driving shaft 7 does not extend, or extends only in a slight degree into the tubular housing 1, as it clearly appears in Figure 1.

Through a thrust bearing 9 and further means known per se, the shaft 7 driving the propeller 8 is connected as usual to the shaft of the not shown engine or engines. A stator 10 with spaced diffuser vanes is advantageously provided in the delivery duct 22 by which the tubular housing 1 is connected to the nozzle 2. When navigating under a normal load, the water-line L arrives substantially at the level of the propeller shaft 7.

Therefore, in the above-disclosed water jet propulsion apparatus the impeller 8 is fed with sea water only in part, and only into its lower half, through the water-inlet opening 15 that lies underneath the level of the axis of the propeller shaft 7, and is connected with the water-intake opening 14 through the water-intake channel 14. The upper half of the pump impeller 8 can be fed at will by means of the duct 5, or can be even left unfed. More particularly, the upper duct 5 can be closed and opened at will, and can be connected with the exhaust manifold of the motor, and at the same time also with the motor-cooling water discharge duct, or it can be connected only with the exhaust manifold of the motor, or only with the motor-cooling water discharge duct. The said upper duct 5 can be simply connected to the ambient air, or it may be even omitted and, in this instance, the forward end of the impeller housing 1 can be entirely closed over the bushing 6 and over the level of the axis of the impeller shaft.

According to a further embodiment of the invention, at the aft end side of the delivery duct 22 with the nozzle 2, a means is provided for orienting the water jet for propulsion of a vessel or watercraft, so that it performs the function of a rudder. This means consists of a water jet-orienting sleeve 11 which by means of diametrically opposite arms 111 is pivotably connected to the free aft end side of the delivery duct 22 ending with the nozzle 2, so as to be angularly movable in a horizontal plane, in both directions relative to the longitudinal axis of the nozzle 2. The water jet-orienting sleeve 11 is provided on the lower portion of its peripheral wall with a downwardly inclined, reverse motion duct 12.
which is turned toward the vessel's or watercraft's head. A shutter member 13 is provided in the water jet-orienting sleeve 11 and is hingedly connected to the downstream rim portion - relative to the direction in which a propulsive water jet is ejected, of the opening between the solidarized reverse motion duct 12 and water jet-orienting sleeve 11. The hinged shutter member 13 is so mounted as to be swingable from a position in which it closes the reverse motion duct 12, into a position shown by dash-and-dot lines, in which it closes the water jet-orienting sleeve 11, and deflects the water jet flow through the reverse motion duct 12, whereby a vessel or watercraft is imparted a backward thrust.

Thus, thanks to the device comprising the angularly movable water jet-orienting sleeve 11, with the reverse-motion duct 12 and the shutter member 13, the motion is not reversed by reversing the direction of rotation of the pump impeller 7, or by reversing the inclination of the blades of the pump impeller 7, when the said impeller is in form of a propeller with rotatable blades, but the motion is reversed simply by moving the shutter member 13 from the position shown by solid lines in Figure 1, into the position shown by dash-and-dot lines in the said Figure 1. Both during the forward and the reverse motion, the pump impeller receives sea water always in the same direction, and sends the sea water into the delivery duct 22 through its end nozzle 2. Both when the vessel or watercraft is moved forward or backward, either at low or at a high speed, the pump impeller 8 is fed with sea water always through the water-inlet opening 15 lying underneath the level of the axis of the impeller shaft.

In the embodiment of the water jet propulsion apparatus for a vessel or watercraft, according to Figure 3, the propeller 8 that constitutes the pump impeller of the water jet propulsion apparatus, is caused to protrude from the vessel's or watercraft's transom board 3, close to the area at which the transom board is connected with the vessel's or watercraft's bottom. In this instance, the propeller 8 may be a propeller emerging partly from the water line L. More particularly, the axis of rotation of propeller 8, and then the propeller-driving shaft 7, are inclined upwardly from the horizontal plane. The tubular housing 20 in which the propeller 8 is arranged, consists in this embodiment of a tubular body, which is attached to the transom board 3 lower portion connected with the vessel's or watercraft's bottom. Like the impeller housing 1 according to the former embodiment, the tubular body 20 is provided on its aft end side with a delivery duct 22 terminating with a nozzle 2 and which is substantially equal to the delivery duct of the former embodiment. Also the said delivery duct 22 with the nozzle 2, carries a water jet-orienting sleeve 11 which is like the above described one, wherefore the members of this latter sleeve are designated by the same reference numerals.

The tubular body 20 of the impeller housing is provided on its fore end side with a tubular lower extension arranged below the vessel's or watercraft's bottom, whereby the forward open, water-intake channel 24 is formed together with the underside of the vessel's or watercraft's bottom. The water-intake channel 24 is connected with the lower portion lying under the water of the impeller housing 20, and the upper duct 25 for venting the exhaust gases and/or for discharging the engine-cooling water is provided inside the aster region of a vessel or watercraft and is connected with the upper portion of the tubular impeller housing 20. Therefore, also in this embodiment, the propeller 8 dips partly into the water (arrow L indicating the water line) at least when navigating, and preferably substantially by its lower half. The exhaust gases from the engine or engines and/or the engine-cooling water may be fed to the propeller upper half and are thus mixed with the sucked water flow from which the propulsive water jet is formed. This second embodiment turns particularly to advantage, because it permits to easily convert any type of conventional propeller drive into a water jet propulsion apparatus.

The water jet propulsion apparatus according to the invention, affords a higher efficiency in that any troubles in the water flow through the water-intake channel are eliminated. Thanks to the possibility of having the exhaust gases from the engine or engines mixed with the sucked water flow from which the propulsive water jet is formed, the flux density of the discharge water flow is reduced, so that any vibrations affecting the pump impeller, and so any noise generation when navigating, are abated. On the other hand, the exhaust gases from the engine or engines are also more efficaciously cooled and scrubbed by the considerable outputs of sucked water, so that a lesser air pollution will be produced.

Claims
1. A water jet propulsion apparatus for a vessel or a watercraft, comprising:
   a) a rearwardly projecting water jet nozzle (2),
   b) a motor-driven impeller pump, whose impeller (8) is arranged in a tubular housing (1,20) and is fixed to the rear end of a forwardly extending motor-driven shaft (7),
   c) a delivery duct (22) connecting the rear end of the impeller housing (1,20) with the water jet nozzle (2),
5. The apparatus according to any of Claims 1 to 4.

6. The apparatus according to any of the preceding Claims, characterized in that the auxiliary inlet opening (15) provided at the forward end of the impeller housing (1,20) over the level of the axis of the impeller shaft (7) is formed as a sector of a circle, the center of which lies on the axis of the impeller shaft (7), or as a semicircle over a substantially horizontal diameter intersecting the axis of the impeller shaft (7).

7. The apparatus according to any of the preceding Claims, characterized in that when navigating under a normal load, the water line L arrives substantially at the level of the axis of the impeller shaft (7).

8. The apparatus according to any of the preceding Claims, characterized in that the impeller shaft (7) is rotatably supported in a bushing (6) arranged as close as possible to the forward end of the impeller housing (1,20), so that only a very short length of the shaft (7) carrying the pump impeller (8) projects into the impeller housing (1,20).

9. The apparatus according to any of the preceding Claims, characterized in that the pump impeller (8) is a propeller.

10. The apparatus according to any of the preceding Claims, characterized in that the impeller housing (1), the forward directed water-intake channel (4) and the auxiliary duct (5) are arranged within the astern region of the vessel's or watercraft's bottom, just before the transom board (3), and the delivery duct (22) with the water jet nozzle (2) extends out of the transom board aft side.

11. The apparatus according to any of the preceding Claims 1 to 9, characterized in that the impeller (8) is caused to protrude from the transom board (3), and the impeller housing consists of a tubular body (20) which is attached externally to the vessel's or watercraft's bottom, and is provided on its aft end side with the delivery duct (22) and with the water jet nozzle (2), and on its fore end side with a forward directed, tubular lower extension, that forms the water-intake channel (24) together with the underside of the vessel's or watercraft's bottom, particularly in the area at which the transom board (3) is connected with the vessel's or watercraft's bottom.

12. The apparatus according to any of the preceding Claims, characterized in that in the delivery duct (22) of the impeller pump a stator (10) with spaced diffuser vanes is provided.

13. The apparatus according to any of the preceding Claims, characterized in that a water jet-orienting means (11,12,13) is provided at the aft end of the water jet nozzle (2), which functions as a rudder and as a motion reverser.
14. The apparatus according to Claim 13, characterized in that the means for orienting the propulsive water jet consists of a water-jet orienting sleeve (11), which is pivotally connected to the free aft end side of the delivery duct (22) ending with the water jet nozzle (2) so as to be angularly movable in a horizontal plane, in both directions relative to the longitudinal axis of the said delivery duct (22) and its water jet nozzle (2), the water jet-orienting sleeve (11) being provided with a lower reverse motion duct (12) which is inclined downwardly and is turned forwardly and being also provided with a hingedly connected shutter member (13), which is alternately swingable into a position in which it closes the reverse motion duct (12), and into a position in which it closes the water jet-orienting sleeve (11) and deflects the water jet flow through the said reverse motion duct (12).
### DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
<th>Category</th>
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