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(54) DEVICE FOR PROPELLING SHIPS, AND A NOZZLE USED IN THE DEVICE

EINRICHTUNG ZUM ANTRIEB VON SCHIFFEN UND DÜSE HIERFÜR

DISPOSITIF POUR LA PROPULSION DE BATEAUX, ET BUSE UTILISEE DANS CELUI-CI

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Description

[0001] The invention relates to a device according to the preamble of Claim 1 and claim 11. Such a device is known, inter alia, from patent specification GB 1 318 868 and from patent application NL 1004558 of the same applicant.

[0002] In the case of the known device with nozzle the nozzle has the special characteristic that when the screw propeller rotates in the opposite direction, during which the water stream flows from the rear side of the nozzle to the front side, a greater braking force is exerted upon the ship. However, the profile used for this purpose, with radius of curvature and parabolic profile at the rear side of the nozzle, was found to have an adverse effect on the thrust, and thus on the propulsion efficiency during travel in the forward direction.

[0003] In order to avoid the abovementioned disadvantage, the device is designed according to the characterizing part of Claim 1. As a result, the inflow of the water into the nozzle at the front side is improved, so that the thrust during travel in the forward direction is increased and the propulsion efficiency is therefore greater. It has been found that the braking force is not reduced when the screw propeller is rotating in the opposite direction.

[0004] According to a further improvement, the device is designed according to Claim 2. This makes a further increase in thrust possible.

[0005] According to various improvements, the device is designed according to one of Claims 3-10. The improvements relate to various embodiments.

[0006] The invention also relates to a nozzle according to Claim 11.

[0007] The invention is explained below with reference to an exemplary embodiment by means of a drawing. In the drawing:

Figure 1 shows an exemplary embodiment of a stern of a ship, and
Figure 2 shows a cross section of the profile of a nozzle used in the device according to Figure 1.

[0008] Corresponding parts as far as possible are always indicated by the same reference numerals in the two figures.

[0009] Figure 1 shows a stern 1 with a screw propeller 3 which is rotatable about an axis of rotation. A nozzle 2 is fitted around the screw propeller. The rotating screw propeller 3 causes a water stream F and pushes water backwards in the direction of a rudder 4, with the result that thrust is exerted upon the ship and the ship will move forwards, which means to the left in Figure 1. As far as possible, the nozzle 2 is designed all round without obstructions and in the plane through the axis of rotation of the screw propeller 3 as far as possible always has the same profile. Locally there are deviations on the outside of the profile in particular, because supports by means of which the nozzle 2 hangs on the stern 1 are provided on the nozzle. In order to avoid corrosion, anodes 5 are provided on the stern 1, the nozzle 2 and the rudder 4.

[0010] In the embodiment shown, the nozzle 2 is fastened to a stern 1. Embodiments in which the nozzle, screw propeller and possibly the rudder are assembled to form a rudder propeller are also known. The nozzle according to the invention can likewise be used for these and also other embodiments.

[0011] Figure 2 shows a cross section through the nozzle 2, which cross section shows the profile of the nozzle 2 in the plane through the axis of rotation of the screw propeller 3. The nozzle 2 is placed concentrically around the screw propeller 3, which is indicated in Figure 2 by a contour 10 of broken lines. The screw propeller 3 has a diameter D_4. At the position of the screw propeller 3 the nozzle 2 has a cylindrical inner surface 7. The cylindrical inner surface 7 has an internal diameter D_3, which is approximately 0.8% larger than the diameter D_4 of the screw propeller 3. With smaller diameters of screw propeller 3 the internal diameter D_3 is at least 10 to 20 mm greater than the external diameter D_4 of the screw propeller 3. If the screw propeller 3 is adjustable, the gap between the screw propeller 3 and the nozzle 2 is generally kept larger. Rotation of the screw propeller 3 produces the water stream F, the direction of which corresponds to that indicated in Figure 1.

[0012] The nozzle 2 has at the front side a cylindrical outer surface 11 with an external diameter D_1, which cylindrical outer surface has a length L_4 and merges towards the back into a conical outer surface 6, the diameter of the outer surface 6 becoming smaller towards the back and forming an angle of taper α with the axis of rotation of the screw propeller 3. The external diameter D_1 is approximately 1.2 to 1.3 times the diameter D_4 of the screw propeller 3, and is preferably 1.25 times the diameter D_4. The length L_4 of the cylindrical outer surface can vary from zero to 0.032 times the diameter D_4 of the screw propeller 3, and is preferably 0.016 times the diameter D_4. The angle of taper α can vary from four to seven degrees, and is preferably approximately 5.6 degrees.

[0013] At the front side of the nozzle 2 the cylindrical outer surface 11 merges with an inlet radius R_1 into an inlet surface 8 which connects to the cylindrical inner surface 7. The inlet radius R_1 is approximately 0.019 to 0.023 times the diameter D_4 of the screw propeller 3, and is preferably 0.021 times D_4. The inlet length L_2 from the front side of the nozzle 2 to the cylindrical inner surface 7 is approximately 0.19 to 0.23 times the diameter D_4 of the screw propeller 3, and is preferably 0.21 times the diameter D_4. The cylindrical inner surface 7 has a length of 0.11 to 0.14 times the diameter D_4 of the screw propeller 3, so that the distance from the front side of the nozzle 2 to the centre of the cylindrical surface 7 is a length of 0.25 to 0.29 times the diameter D_4 of the screw propeller 3, and is preferably 0.27 times the diameter D_4. The profile of the inlet surface 8 is designed in such a way that near the inlet radius R_1 the profile has a radius which corresponds to the inlet radius R_1, and has a line of contact there which is also more or less tangential to the inlet radius R_1, and near the cylindrical inner surface 7 has a very large to infinite radius, and has a line of contact there which runs more or less parallel to the cylindrical inner surface 7. The profile of the inlet radius 8 preferably runs parabolically.

[0014] At the rear side of the nozzle 2 the conical outer surface 6 merges with an outlet radius R_2 into an outlet surface 9 which connects to the cylindrical inner surface 7. The outlet radius R_2 is approximately 0.015 to 0.019 times the diameter D_4 of the screw propeller 3, and is preferably 0.017 times D_4. The outlet length L_3 from the rear side of the nozzle 2 to the cylindrical inner surface 7 is approximately 0.15 to 0.19 times the diameter D_4 of the screw propeller 3, and is preferably 0.17 times the diameter D_4. The profile of the outlet surface 9 is designed in such a way that the profile near the outlet radius R_2 has a radius corresponding to the outlet radius R_2, and has a line of contact there which is also more or less tangential to the outlet radius R_2, and near the cylindrical inner surface 7 has a very large to infinite radius and has a line of contact there which runs more or less parallel to the cylindrical inner surface 7. The profile of the outlet radius 9 preferably runs parabolically.

[0015] The inlet radius R_1 and the outlet radius R_2 are preferably designed as round bar material or round tubing rolled in a circle, which gives a strong construction. The material is carbon steel. The inlet surface 8, the cylindrical inner surface 7 and the outlet surface 9 are made of stainless steel, so that corrosion is avoided. In addition to the design mentioned above, all parts of the nozzle can also be made of stainless steel or carbon steel, or parts can be made of these or other suitable materials, depending on their use.

[0016] The nozzle 2 has a length L_1 which is equal to approximately 0.5 times the diameter D_4 of the screw propeller 3. The length of the cylindrical inner surface 7 is approximately 0.125 times the diameter D_4 of the screw propeller 3. The centre of the outer periphery of the screw propeller 3 corresponds more or less to the centre of the cylindrical inner surface 7. It has been found that the position of the centre of the outer periphery of the screw propeller should preferably be placed approximately 0.55 times the length L_1 of the nozzle 2 from the front side of the nozzle 2. Embodiments in which the dimensions of the profile are adapted slightly are possible. In this case the length of the cylindrical inner surface 7, for example, can be longer, the length L_4 of cylindrical outer surface 11 and the length L_1 of the nozzle 2 being increased by the same value. Other profile adaptations can result in adaptations in the various diameters of the angle of taper α, in which case the inlet radius R_1 and/or the inlet length L_2 will always remain greater than the outlet radius R_2 and/or the outlet length L_3. The shape of the outer surface 6 shown, which for production reasons is conical, can also be adapted and, viewed in the lengthwise direction, can be given, for example, a slightly curved profile. The efficiency of the nozzle according to the invention does not suffer any adverse effects if the shape of the outer surface 6 is designed in such a way that no inadmissible disruptions such as local separation of the flow from the outside wall of the nozzle 2 occur.

[0017] It has been found from experiments that by making the improvement according to the invention the propulsion efficiency can be improved by 4%. By using the nozzle according to the invention, a considerable saving is achieved for the user of a ship, while the required braking power, where during backward thrust, for example, a ship must be at a standstill within its length, remains at least the same.

Claims

1. Device for propelling ships and the like, comprising a screw propeller (3), which can be rotated about an axis of rotation by means of a drive, and a nozzle (2) mounted concentrically around the screw propeller (3), for guiding the water (F) which is set in motion by the rotating screw propeller, the nozzle being provided on the inside with a first cylindrical surface (7) which has an internal diameter (D_3) which is a gap width greater than the external diameter (D_4) of the screw propeller (3), and the nozzle being provided on the outside with an outer surface (6) which has the greatest external diameter (D_1) near the front side of the nozzle, the nozzle also having a profile in an arbitrary plane through the axis of rotation, with radii of curvature which profile connects with an inlet radius (R_1) to the outer surface at the front side and with an outlet radius (R_2) to the outer surface at the rear side of the nozzle, which radii of curvature of the profile on the inside of the nozzle connect with more or less parabolic (8, 9) profiles to the first cylindrical surface (7), **characterized in that** the radius of curvature (R_1) at the front side of the nozzle and the distance (L_2) from the front side of the nozzle to the first cylindrical surface (7) are greater than the radius of curvature (R_2) at the rear side of the nozzle and the distance (L_3) between the rear side of the nozzle and the first cylindrical surface respectively and going backwards the radius of curvature increases from the front side where it corresponds to the inlet radius (R1) to a very large to infinite radius near the cylindrical inner surface (7) and going forwards from the rear side the radius of curvature increases from the rear side where it corresponds to the outlet radius (R2) to a very large to infinite radius near the cylindrical inner surface (7).

2. Device according to Claim 1, **characterized in that**

at the front side of the nozzle (2) the radius of curvature (R_1) merges on the outside into a second cylindrical surface (11), which connects to the outer surface (6).

3. Device according to Claim 1 or 2, **characterized in that** the length (L_1) of the nozzle is approximately half the diameter (D_4) of the screw propeller (3).

4. Device according to Claim 2 or 3, **characterized in that** the radii of curvature (R_1, R_2) are greater than 0.015 times the diameter (D_4) of the screw propeller (3).

5. Device according to one of the preceding claims, **characterized in that** the radius of curvature (R_1) at the front side is approximately 0.019 to 0.023 times the diameter (D_4) of the screw propeller, and is preferably 0.021 times the diameter (D_4) of the screw propeller (3).

6. Device according to one of the preceding claims, **characterized in that** the distance from the front side of the nozzle to the centre of the first cylindrical surface (7) is approximately 0.25 to 0.29 times the diameter (D_4) of the screw propeller (3), and is preferably 0.27 times the diameter (D_4) of the screw propeller (3).

7. Device according to one of the preceding claims, **characterized in that** the greatest diameter (D_1) of the outer surface (6) or the diameter of the second cylindrical surface (11) is approximately 1.2 to 1.3 times the diameter (D_4) of the screw propeller (3), and is preferably 1.25 times the diameter (D_4) of the screw propeller (3).

8. Device according to one of the preceding claims, **characterized in that** the smallest diameter (D_2) of the outer surface (6) is approximately 1.16 times the diameter (D_4) of the screw propeller.

9. Device according to one of the preceding claims, **characterized in that** the length of the first cylindrical surface (7) is approximately 0.11 to 0.14 times the diameter (D_4) of the screw propeller (3), and is preferably 0.125 times the diameter (D_4) of the screw propeller (3).

10. Device according to one of the preceding claims, **characterized in that** the outer surface (6) is largely conical, with an angle of taper (α) of approximately four to seven degrees.

11. Nozzle for use in a device for propelling ships and the like, said nozzle being provided on the inside with a first cylindrical surface (7) and on the outside with an outer surface (6) which has the greatest external diameter (D_1) near the front side of the nozzle, the nozzle also having a profile in an arbitrary plane through the axis of rotation, with radii of curvature which profile connects with an inlet radius (R_1) to the outer surface at the front side and with an outlet radius (R_2) to the outer surface at the rear side of the nozzle, which radii of curvature of the profile on the inside of the nozzle connect with more or less parabolic (8, 9) profiles to the first cylindrical surface (7), **characterized in that** the radius of curvature (R_1) at the front side of the nozzle and the distance (L_2) from the front side of the nozzle to the first cylindrical surface (7) are greater than the radius of curvature (R_2) at the rear side of the nozzle and the distance (L_3) between the rear side of the nozzle and the first cylindrical surface respectively and going backwards the radius of curvature increases from the front side where it corresponds to the inlet radius (R1) to a very large to infinite radius near the cylindrical inner surface (7) and going forwards from the rear side the radius of curvature increases from the rear side where it corresponds to the outlet radius (R2) to a very large to infinite radius near the cylindrical inner surface (7).

Patentansprüche

1. Vorrichtung für Schiffe mit Antriebsschraube und dergleichen mit einem Schraubenpropeller (3), der mittels eines Antriebs um eine Drehachse gedreht werden kann, und einer Düse (2), die konzentrisch um den Schraubenpropeller (3) angebracht ist, um das Wasser (F), das durch den sich drehenden Schraubenpropeller in Bewegung gesetzt wird, zu leiten, wobei die Düse an der Innenseite mit einer ersten Mantelfläche (7) versehen ist, die einen Innendurchmesser (D_3) hat, der eine Spaltbreite größer als der Außendurchmesser (D_4) des Schraubenpropellers (3) ist, und wobei die Düse an der Außenseite mit einer äußeren Oberfläche (6) versehen ist, die den größten Außendurchmesser (D_1) nahe der Stirnseite der Düse hat, wobei die Düse außerdem in einer beliebigen Ebene durch die Drehachse ein Profil mit Krümmungsradien aufweist, wobei das Profil mit einem Einlassradius (R_1) an die äußere Oberfläche an der Stirnseite und mit einem Auslassradius (R_2) an die äußere Oberfläche an der Rückseite der Düse anschließt, wobei die Krümmungsradien des Profils an der Innenseite der Düse mit mehr oder weniger parabolischen Profilen (8, 9) an die erste Mantelfläche (7) anschließen, **dadurch gekennzeichnet, dass** der Krümmungsradius (R_1) an der Stirnseite der Düse und der Abstand (L_2) von der Stirnseite der Düse zur ersten Mantelfläche (7) größer als der Krümmungsradius (R_2) an der Rückseite der Düse bzw. der Abstand (L_3) zwischen der Rückseite der Düse und der er-

sten Mantelfläche sind und der Krümmungsradius von der Stirnseite aus, wo er dem Einlassradius (R_1) entspricht, in Richtung der Rückseite zu einem sehr großen bis unendlichen Radius nahe der inneren Mantelfläche (7) zunimmt, und der Krümmungsradius von der Rückseite aus, wo er dem Auslassradius (R_2) entspricht, in Richtung der Stirnseite zu einem sehr großen bis unendlichen Radius nahe der inneren Mantelfläche (7) zunimmt.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** an der Stirnseite der Düse (2) der Krümmungsradius (R_1) an der Außenseite in einer zweiten Mantelfläche (11) aufgeht, die an die äußere Oberfläche (6) anschließt.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Länge (L_1) der Düse ungefähr die Hälfte des Durchmessers (D_4) des Schraubenpropellers (3) ist.

4. Vorrichtung nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die Krümmungsradien (R_1, R_2) größer als 0,015 mal der Durchmesser (D_4) des Schraubenpropellers (3) sind.

5. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Krümmungsradius (R_1) an der Stirnseite ungefähr 0,019 bis 0,023 mal der Durchmesser (D_4) des Schraubenpropellers ist und vorzugsweise 0,021 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist.

6. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Abstand von der Stirnseite der Düse zum Zentrum der ersten Mantelfläche (7) ungefähr 0,25 bis 0,29 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist und vorzugsweise 0,27 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist.

7. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der größte Durchmesser (D_1) der äußeren Oberfläche (6) oder der Durchmesser der zweiten Mantelfläche (11) ungefähr 1,2 bis 1,3 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist und vorzugsweise 1,25 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist.

8. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der kleinste Durchmesser (D_2) der äußeren Oberfläche (6) ungefähr 1,16 mal der Durchmesser (D_4) des Schraubenpropellers ist.

9. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Länge der ersten Mantelfläche (7) ungefähr 0,11 bis 0,14 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist und vorzugsweise 0,125 mal der Durchmesser (D_4) des Schraubenpropellers (3) ist.

10. Vorrichtung nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die äußere Oberfläche (6) stark kegelförmig ist, mit einem Kegelwinkel (α) von ungefähr vier bis sieben Grad.

11. Düse zur Verwendung in einer Vorrichtung für Schiffe mit Antriebsschraube und dergleichen, wobei die Düse an der Innenseite mit einer ersten Mantelfläche (7) und an der Außenseite mit einer äußeren Oberfläche (6), die den größten Außendurchmesser (D_1) nahe der Stirnseite der Düse hat, versehen ist, wobei die Düse außerdem in einer beliebigen Ebene durch die Drehachse ein Profil mit Krümmungsradien aufweist, wobei das Profil mit einem Einlassradius (R_1) an die äußere Oberfläche an der Stirnseite und mit einem Auslassradius (R_2) an die äußere Oberfläche an der Rückseite der Düse anschließt, wobei die Krümmungsradien des Profils an der Innenseite der Düse mit mehr oder weniger parabolischen Profilen (8, 9) an die erste Mantelfläche (7) anschließen, **dadurch gekennzeichnet, dass** der Krümmungsradius (R_1) an der Stirnseite der Düse und der Abstand (L_2) von der Stirnseite der Düse zur ersten Mantelfläche (7) größer als der Krümmungsradius (R_2) an der Rückseite der Düse bzw. der Abstand (L_3) zwischen der Rückseite der Düse und der ersten Mantelfläche sind und der Krümmungsradius von der Stirnseite aus, wo er dem Einlassradius (R_1) entspricht, in Richtung der Rückseite zu einem sehr großen bis unendlichen Radius nahe der inneren Mantelfläche (7) zunimmt, und der Krümmungsradius von der Rückseite aus, wo er dem Auslassradius (R_2) entspricht, in Richtung der Stirnseite zu einem sehr großen bis unendlichen Radius nahe der inneren Mantelfläche (7) zunimmt.

Revendications

1. Dispositif pour la propulsion de bateaux et similaires, comprenant une hélice à vis (3), qui peut être tournée autour d'un axe de rotation à l'aide d'un entraînement, et une buse (2) montée de manière concentrique autour de l'hélice à vis (3), pour guider l'eau (F) qui est mise en mouvement par l'hélice à vis rotative, la buse étant munie en son intérieur d'une première surface cylindrique (7) qui possède un diamètre interne (D_3) qui est une largeur d'écartement supérieure au diamètre externe (D_4) de l'hélice à vis (3), et la buse étant munie à l'extérieur d'une surface externe (6) qui possède le plus grand diamètre externe (D_1) à proximité du côté avant de la buse, la buse possédant également un profil dans un plan arbitraire via l'axe de rotation, avec des rayons de courbure, ledit profil étant relié, avec un rayon d'entrée (R_1), à la surface externe sur le côté avant, et, avec un rayon de sortie (R_2), à la surface externe sur le côté arrière de la buse, lesdits rayons de courbure du profil à l'intérieur de la buse reliant plus ou moins de profils paraboliques (8, 9) à la première surface cylindrique (7), **caractérisé en ce que** le rayon de courbure (R_1) sur le côté avant de la buse et la distance (L_2) du côté avant de la buse jusqu'à la première surface cylindrique (7) sont supérieurs au rayon de courbure (R_2) du côté arrière de la buse et à la distance (L_3) entre le côté arrière de la buse et la première surface cylindrique respectivement, et **en ce que**, en allant vers l'arnère, le rayon de courbure augmente, en partant du côté avant où il correspond au rayon d'entrée (R_1), jusqu'un très grand rayon, jusqu'à un rayon infini à proximité de la surface interne cylindrique (7), et, en allant vers l'avant, à partir du côté arrière, le rayon de courbure augmente à partir du coté arrière, où il correspond au rayon de sortie (R_2), jusqu'à un très grand rayon, jusqu'à un rayon infini à proximité de la surface interne cylindrique (7).

2. Dispositif selon la revendication 1, **caractérisé en ce que**, sur le côté avant de la buse (2), le rayon de courbure (R_1) rejoint, à l'intérieur, une seconde surface cylindrique (11), qui est reliée à la surface externe (6).

3. Dispositif selon la revendication 1 ou 2, **caractérisé en ce que** la longueur (L_1) de la buse est d'environ la moitié du diamètre (D_4) de l'hélice à vis (3).

4. Dispositif selon la revendication 2 ou 3, **caractérisé en ce que** les rayons de courbure (R_1, R_2) sont 0,015 fois supérieurs au diamètre (D_4) de l'hélice à vis (3).

5. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** le rayon de courbure (R_1) au niveau du côté avant est d'environ 0,019 à 0,023 fois le diamètre (D_4) de l'hélice à vis, et est de préférence de 0,021 fois le diamètre (D_4) de l'hélice à vis (3).

6. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** la distance depuis le côté avant de la buse jusqu'au centre de la première surface cylindrique (7) est d'environ 0,25 à 0,29 fois le diamètre (D_4) de l'hélice à vis (3), et est de préférence de 0,27 fois le diamètre (D_4) de l'hélice à vis (3).

7. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** le diamètre le plus grand (D_1) de la surface externe (6) ou le diamètre de la seconde surface cylindrique (11) est d'environ 1,2 à 1,3 fois le diamètre (D_4) de l'hélice à vis (3), et est de préférence de 1,25 fois le diamètre (D_4) de l'hélice à vis (3).

8. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** le diamètre le plus petit (D_2) de la surface externe (6) est d'environ 1,16 fois le diamètre (D_4) de l'hélice à vis.

9. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** la longueur de la première surface cylindrique (7) est d'environ 0,11 à 0,14 fois le diamètre (D_4) de l'hélice à vis (3), et est de préférence de 0,125 fois le diamètre (D_4) de l'hélice à vis (3).

10. Dispositif selon l'une des revendications précédentes, **caractérisé en ce que** la surface externe (6) est largement conique, avec un angle de conicité (α) d'environ quatre à sept degrés.

11. Buse pour utilisation dans un dispositif pour propulser des bateaux et similaires, ladite buse étant munie, à l'intérieur, d'une première surface cylindrique (7) et, sur l'extérieur, d'une surface externe (6) qui possède le plus grand diamètre externe (D_1) à proximité du côté avant de la buse, la buse possédant également un profil dans un plan arbitraire via l'axe de rotation, avec des rayons de courbure, ledit profil étant relié, avec un rayon d'entrée (R_1), à la surface externe sur le côté avant, et, avec un rayon de sortie (R_2), à la surface externe sur le côté arrière de la buse, lesdits rayons de courbure du profil à l'intérieur de la buse reliant plus ou moins de profils paraboliques (8, 9) à la première surface cylindrique (7), **caractérisé en ce que** le rayon de courbure (R_1) sur le côté avant de la buse et la distance (L_2) du côté avant de la buse jusqu'à la première surface cylindrique (7) sont supérieurs au rayon de courbure (R_2) du côté arrière de la buse et à la distance (L_3) entre le côté arrière de la buse et la première surface cylindrique respectivement, et **en ce que**, en allant vers l'arrière, le rayon de courbure augmente, en partant du côté avant où il correspond au rayon d'entrée (R_1), jusqu'à un très grand rayon, jusqu'à un rayon infini à proximité de la surface interne cylindrique (7), et, en allant vers l'avant, à partir du côté arrière, le rayon de courbure augmente à partir du coté arrière, où il correspond au rayon de sortie (R_2), jusqu'à un très grand rayon, jusqu'à un rayon infini à proximité de la surface interne cylindrique (7).

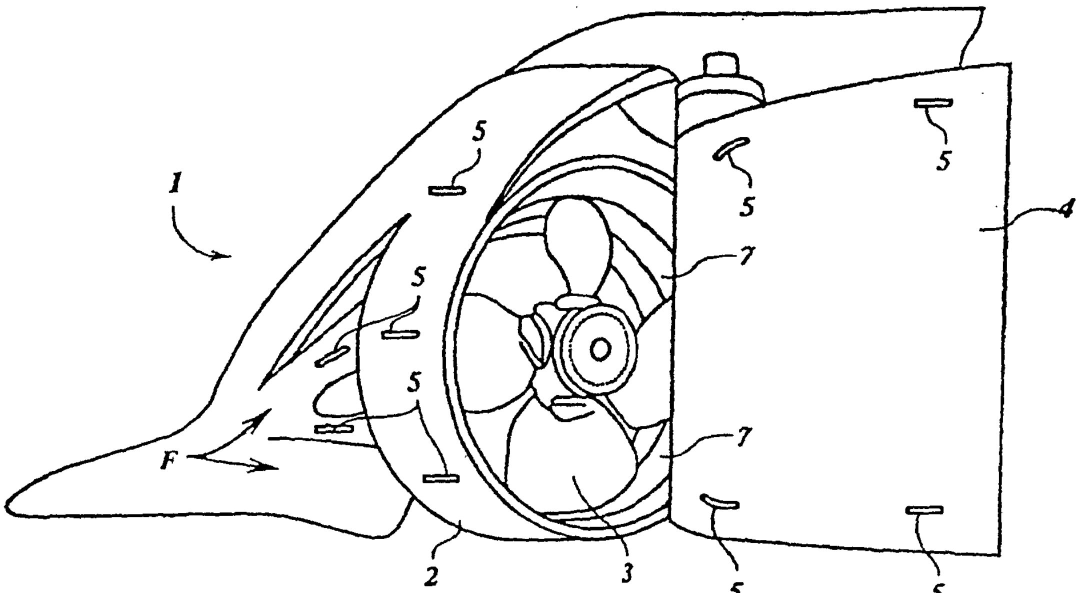

Fig. 1

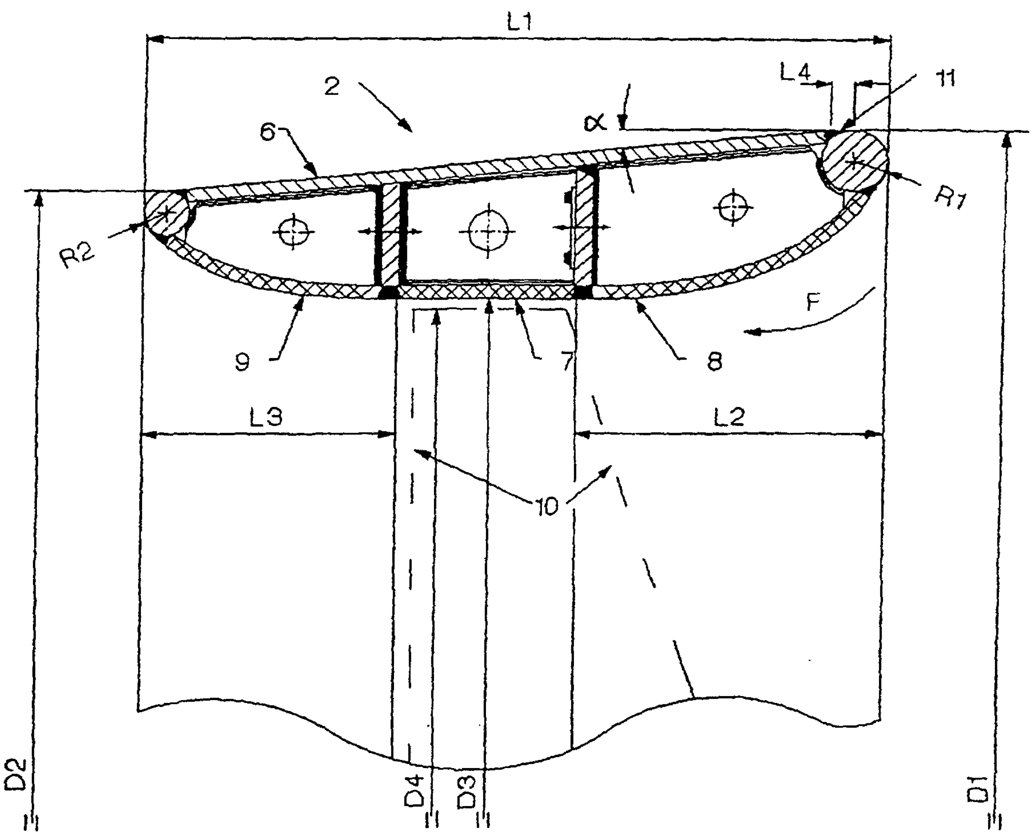

Fig. 2