(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 885 203 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
15.02.2017 Bulletin 2017/07

(21) Application number: **13753301.4**

(22) Date of filing: **13.08.2013**

(51) Int Cl.:
B63H 1/16 *(2006.01)* ***B63H 1/26*** *(2006.01)*
B63H 5/125 *(2006.01)*

(86) International application number:
PCT/EP2013/066925

(87) International publication number:
WO 2014/026993 (20.02.2014 Gazette 2014/08)

(54) **RING PROPELLER WITH FORWARD SKEW**

DÜSENPROPELLER MIT VORWÄRTS SKEW

HELICE DE PROPULSEUR AVEC DEVERS AVANT

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **14.08.2012 NO 20120899**

(43) Date of publication of application:
24.06.2015 Bulletin 2015/26

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EP 2 885 203 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] The present invention relates to a ring propeller and a thruster comprising a ring propeller which is driven by a permanent magnet motor.

[0002] This type of thruster with a ring propeller driven by means of a permanent magnet motor is employed on different types of vessels. Known permanent magnet-driven ring propellers, however, have been designed without much skew.

[0003] The French document FR 68 426 E discloses a ring propeller for a thruster comprising a ring, a centre element and propeller blades extending between the centre element and the ring. Figure 1 of the publication indicates that the propeller blades may be provided with a forward skew although the description does not mention it. The leading edge has a slight bulge in the middle which is rounded, for example with an elliptical shape. This rounded shape of the blades allows, according to the description, for an improved attack in the water and increases the width of the blades in the zone of the blade of optimal work. The rounded shape of the leading edge means that a middle portion of the blade is the portion of the blade that will first meet water with changed speed, i.e. the middle portion of the blade meets zones in the water of changed speed earlier than the outer portion of the blade.

[0004] In developing the present ring propeller and thruster which are driven by a permanent magnet motor, an object has been to provide a permanent magnet-driven thruster with greater efficiency than known thrusters.

[0005] It has been a further object to provide a permanent magnet-driven thruster with a ring propeller which offers better control of when cavitation sets in and the extent of the cavitation.

[0006] These objects are achieved with the present ring propeller as defined in claim 1, a thruster as defined in claim 6 and an application of the ring propeller as defined in claim 7. Further embodiments of the ring propeller are defined in claims 2-5.

[0007] A ring propeller is provided for a thruster. The ring propeller comprises a ring, a centre element and at least one propeller blade extending between the centre element and the ring and attached to the centre element and the ring. The propeller blade has a leading edge profile and a trailing edge profile and is provided with forward skew. The leading edge profile of the at least one propeller blade, moreover, has an S-shape in a cross section perpendicular to the ring propeller's axis of rotation with a concave shape in a portion at a point of attachment to the ring such that a tangent to the leading edge profile at the point of attachment to the ring propeller's encompassing ring and the tangent to the encompassing ring at the same attachment point form an angle which is greater than 0° and less than 90°.

[0008] The at least one propeller blade's trailing edge profile may also have an S-shape in a cross section perpendicular to the ring propeller's axis of rotation. The combination of the S-shape on the at least one propeller blade's leading edge profile and possibly trailing edge profile and the forward skew of the at least one propeller blade provide better cavitation conditions, i.e. reduced cavitation.

[0009] The leading edge has a leading edge profile viewed in a section perpendicular to the ring propeller's axis of rotation. Correspondingly, the propeller blades' trailing edge will then naturally be the edge on the opposite side of the propeller blade with a trailing edge profile viewed in a section perpendicular to the ring propeller's axis of rotation. The fact that the ring propeller's blades have a forward skew means that the propeller tip, which is attached to the ring, is skewed forwards towards the propeller's normal direction of rotation, with the result that the outermost part of the blade meets zones with altered speed earlier. In connection with the forward skew of the propeller blades, a skew angle can be defined. The skew angle is the greatest possible angle, viewed in a cross section perpendicular to the ring propeller's axis of rotation, measured between the straight line drawn from the point where the propeller blade's centre chord line/skew line meets the ring propeller's encompassing ring and the axis of rotation and a line tangential to a point on the propeller blade's centre chord line and the axis of rotation. The propeller blade's centre chord line and the skew angle of a propeller blade on the present ring propeller are shown in the attached figures.

[0010] In an embodiment of the invention the S-shaped trailing edge profile may also have a concave shape in a portion at the point of attachment to the ring. In the same way as above, this means that the tangent to the trailing edge profile at the point of attachment to the ring propeller's encompassing ring and the tangent to the encompassing ring at the same attachment point form an angle which is greater than 0° and less than 90°.

[0011] With regard to the strength of the blades, they have preferably been given a thickened shape (a fillet) in the transition to the propeller ring. By employing a concave shape on the outermost part of the blades, space is provided for a slimmer fillet and thereby better hydrodynamic conditions on the outermost part of the propeller.

[0012] In an embodiment of the present invention the ring propeller's ring is preferably provided with permanent magnets, where the permanent magnets form a part of a permanent magnet motor when the ring propeller is mounted in the thruster.

[0013] A thruster is also provided comprising a ring propeller and a permanent magnet motor. The thruster comprises a ring propeller as described above and a thruster housing which encloses the ring propeller's ring and comprises the permanent magnet motor's stator windings. A permanent magnet motor is thereby provided for driving the ring propeller. The thruster's ring propeller is otherwise preferably designed as described above and may advantageously be used on a vessel.

[0014] A non-limiting embodiment of the present invention will now be described with reference to the figures,

in which

Figure 1 is a cross section of a thruster with a ring propeller according to the present invention perpendicular to the ring propeller's axis of rotation A.

Figure 2 illustrates the same figure as above, but where the angles between the ring and the leading edge profile and the trailing edge profile respectively are indicated.

[0015] Figure 1 illustrates a thruster 10 according to the present invention. The thruster 10 comprises a thruster housing 13 and a ring propeller 12 which may be rotatably mounted in the thruster housing 13 about the axis of rotation A. The ring propeller 12 comprises a ring 15 and a centre element 16. Between the ring 15 and the centre element 16 a number of propeller blades 18 are preferably mounted, attached to the centre element 16 and the ring 15. The ring propeller 12 is therefore a monoblock where the propeller blades 18 have fixed pitch. The thruster 10 is arranged for attachment to a vessel (not shown in the figures). For this purpose the thruster 10 may be provided with an attachment element 17, thereby enabling the thruster 10, for example, to be screwed, bolted or welded to the vessel.

[0016] The ring propeller 12 further comprises permanent magnets (not shown in the figures) which are preferably mounted in the ring 15. In the thruster housing 13 stator windings (not shown in the figure) are similarly provided, with the result that the ring propeller is driven by a permanent magnet motor. Electric power for the permanent magnet motor may, for example, be supplied via the attachment element 17.

[0017] The propeller blades 18 have a leading edge profile 19 and a trailing edge profile 20 in a section perpendicular to the ring propeller's 12 axis of rotation A as indicated in figure 1. The leading edge profile 19 and the trailing edge profile 20 are defined in relation to the ring propeller's 12 direction of rotation R as illustrated in figure 1.

[0018] The propeller blades 18 have an imaginary centre chord line 24 extending from the centre element 16 to a point 27 where the centre line intersects the ring 15. The centre chord line 24 is the imaginary line located at the same distance from the leading edge profile 19 as from the trailing edge profile 20 on the propeller blade 18.

[0019] As indicated in the figures, the propeller is designed with forward skew, i.e. the propeller blades 18 are skewed forwards in the direction of the propeller's normal direction of rotation R, with the result that the outermost part of the blade meets zones with changed speed earlier. The degree of forward skew may be indicated by means of the skew angle V. The skew angle V is the greatest angle formed between a first line 25 through the axis of rotation A and a point 27 where the centre line 24 crosses the ring's 15 internal diameter and a second line 26 through the axis of rotation A and a point 28 on the centre line 24. Depending on the propeller blade's degree of forward skew, the point 28 on the centre line may vary. In figure 1 the point 28 on the centre line 24 which will give the greatest angle, i.e. the skew angle V, is right in at the centre element 16. In other designs the point 28 may be located somewhere on the centre line between the centre element 16 and the ring 15. By providing the ring propeller 12 with forward skew in this manner, the ring propeller 12 will acquire better cavitation properties since the tip of the propeller blades 18 takes a smaller part of the total thrust.

[0020] As illustrated in the figures the propeller blades' 18 leading edge profile 19 is designed with a slight S-shape. This means that in the transition to the ring 15, it will be possible to design the propeller blades 18 with a slim section, giving a good hydrodynamic effect while at the same time providing sufficient strength. The trailing edge profiles may also be designed with a slight S-shape as indicated in the figures.

[0021] In the transition between the propeller blades' leading edge profile 19 and the ring 15, the propeller blades 18 preferably have a concave shape. This is illustrated in greater detail in figure 2 where the tangent 30 to the propeller blade's leading edge profile 19 in the attachment point 37 and the tangent 31 to the ring 15 in the attachment point 37 to the ring are indicated. Due to the fact that the propeller blades 18 have a concave shape, the angle 35 opening on to the ring is less than 90° and greater than 0°.

[0022] In a similar manner, in the transition between the propeller blades' trailing edge 19 and the ring 15, the propeller blades 18 preferably have a concave shape. This is also illustrated in figure 2 where the tangent 32 to the propeller blade's trailing edge profile 20 in the attachment point 38 and the tangent 33 to the ring's 15 attachment point 38 to the ring are indicated. Due to the fact that the propeller blades 18 have a concave shape, the angle 36 opening on to the ring is also less than 90° and greater than 0°.

Claims

1. A ring propeller (12) for a thruster (10), which ring propeller (12) comprises a ring (15), a centre element (16) and at least one propeller blade (18) extending between and attached to the centre element (16) and the ring (15) respectively, which at least one propeller blade (18) has a leading edge profile (19) and a trailing edge profile (20) in a cross section perpendicular to the ring propeller's (12) axis of rotation A, the at least one propeller blade (18) being provided with forward skew,
characterised i n that the outermost part of the blade (18) meets zones with changed speed earlier and in that the leading edge profile (19) of the at least one propeller blade (18) has an S-shape with a concave shape in a portion at a point of attachment (37) to

the ring (15) such that a tangent to the leading edge profile at the point of attachment to the ring propeller's encompassing ring and the tangent to the encompassing ring at the same attachment point form an angle which is greater than 0° and less than 90°.

2. A ring propeller according to claim 1, **characterised i n** that the at least one propeller blade's (18) trailing edge profile (20) has an S-shape in a cross section perpendicular to the ring propeller's (12) axis of rotation A.

3. A ring propeller according to one of the claims 2, **characterised i n** that in a portion of the propeller blade (18) at the trailing edge's attachment point (38) to the ring (15), the at least one propeller blade's S-shaped trailing edge profile (20) has a concave shape.

4. A ring propeller according to one of the claims 1-3, **characterised i n** that the ring propeller's ring (15) is provided with permanent magnets, which permanent magnets form a part of a permanent magnet motor when the ring propeller (12) is mounted in the thruster (10).

5. A ring propeller according to one of the claims 1-4, **characterised i n** that the ring propeller (12) is a monoblock where the propeller blades (18) have fixed pitch.

6. A thruster (10) comprising a ring propeller (12) and a permanent magnet motor, **characterised i n** that the thruster (10) comprises a ring propeller (12) according to one of the claims 1-5 and a thruster housing (13) which encloses the ring propeller's (12) ring (15) and which comprises the permanent magnet motor's stator windings.

7. The use of a ring propeller (12) according to one of the claims 1-5 in a thruster (10) on a vessel, where the ring propeller (12) is driven by a permanent magnet motor.

Patentansprüche

1. Ringpropeller (12) für ein Strahlruder (10), welcher Ringpropeller (12) einen Ring (15), ein Mittenelement (16) und mindestens einen Propellerflügel (18) aufweist, der sich jeweils zwischen dem Mittenelement (16) und dem Ring (18) erstreckt und am Mittenelement (16) und am Ring (15) befestigt ist, welcher mindestens eine Propellerflügel (18) ein Vorderkantenprofil (19) und ein Hinterkantenprofil (20) in einem Querschnitt senkrecht zur Drehachse A des Ringpropellers (12) hat, wobei der mindestens eine Propellerflügel (18) mit einer nach vorn gerichteten Schrägstellung versehen ist, **dadurch gekennzeichnet, dass** der äußerste Teil des Flügels (18) früher auf Bereiche mit veränderter Geschwindigkeit trifft, und dass das Vorderkantenprofil (19) des mindestens einen Propellerflügels (18) eine S-Form mit einer konkaven Form in einem Teilbereich an einem Befestigungspunkt (37) am Ring (15) dergestalt hat, dass eine Tangente zum Vorderkantenprofil am Befestigungspunkt am Umfassungsring des Ringpropellers und die Tangente zum Umfassungsring am selben Befestigungspunkt einen Winkel bilden, der größer als 0° und kleiner als 90° ist.

2. Ringpropeller nach Anspruch 1, **dadurch gekennzeichnet, dass** das mindestens eine Hinterkantenprofil (20) des Propellerflügels (18) eine S-Form in einem Querschnitt senkrecht zur Drehachse A des Ringpropellers (12) hat.

3. Ringpropeller nach Anspruch 2, **dadurch gekennzeichnet, dass** in einem Teilbereich des Propellerflügels (18) am Befestigungspunkt (38) der Hinterkante am Ring (15) das mindestens eine S-förmige Hinterkantenprofil (20) des Propellerflügels eine konkave Form hat.

4. Ringpropeller nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** der Ring (15) des Ringpropellers mit Permanentmagneten versehen ist, welche Permanentmagnete einen Teil eines Permanentmagnetmotors bilden, wenn der Ringpropeller (12) im Strahlruder (10) montiert ist.

5. Ringpropeller nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** der Ringpropeller (12) ein Monoblock ist, wobei die Propellerflügel (18) eine feste Steigung haben.

6. Strahlruder (10) mit einem Ringpropeller (12) und einem Permanentmagnetmotor, **dadurch gekennzeichnet, dass** das Strahlruder (10) einen Ringpropeller (12) nach einem der Ansprüche 1 bis 5 und ein Strahlrudergehäuse (13) umfasst, das den Ring (15) des Ringpropellers (12) umschließt und die Statorwicklungen des Permanentmagnetmotors umfasst

7. Verwendung eines Ringpropellers (12) nach einem der Ansprüche 1 bis 5 in einem Strahlruder (10) auf einem Fahrzeug, wobei der Ringpropeller (12) durch einen Permanentmagnetmotor angetrieben wird.

Revendications

1. Hélice avec anneau (12) pour un propulseur (10), laquelle hélice avec anneau (12) comprend un an-

neau (15), un élément central (16) et au moins une pale d'hélice (18) s'étendant entre et fixée à l'élément central (16) et à l'anneau (15) respectivement, laquelle au moins une pale d'hélice (18) a un profil de bord d'attaque (19) et un profil de bord de fuite (20) dans une section transversale perpendiculaire à l'axe de rotation A de l'hélice avec anneau (12), la au moins une pale d'hélice (18) étant prévue avec un dévers avant,
caractérisée en ce que la partie située le plus à l'extérieur de la pale (18) rencontre des zones avec une vitesse modifiée plus tôt et **en ce que** le profil de bord d'attaque (19) de la au moins une pale d'hélice (18) a une forme de S avec une forme concave dans une partie au niveau d'un point de fixation (37) à l'anneau (15) de sorte qu'une tangente par rapport au profil de bord d'attaque au niveau du point de fixation par rapport à l'anneau englobant de l'hélice avec anneau et la tangente par rapport à l'anneau englobant au même point de fixation, forment un angle qui est supérieur à 0° et inférieur à 90°.

2. Hélice avec anneau selon la revendication 1,
caractérisée en ce que le profil de bord de fuite (20) de la au moins une pale d'hélice (18) a une forme de S dans une section transversale perpendiculaire à l'axe de rotation A de l'hélice avec anneau (12).

3. Hélice avec anneau selon l'une des revendications 2,
caractérisée en ce que, dans une partie de la pale d'hélice (18) au niveau du point de fixation (38) du bord de fuite, par rapport à l'anneau (15), le profil de bord de fuite en forme de S (20) de la au moins une pale d'hélice a une forme concave.

4. Hélice avec anneau selon l'une des revendications 1 à 3,
caractérisée en ce que l'anneau (15) de l'hélice avec anneau est prévu avec des aimants permanents, lesquels aimants permanents forment une partie d'un moteur à aimant permanent lorsque l'hélice avec anneau (12) est montée dans le propulseur (10).

5. Hélice avec anneau selon l'une des revendications 1 à 4,
caractérisée en ce que l'hélice avec anneau (12) est un monobloc dans lequel les pales d'hélice (18) ont un pas fixe.

6. Propulseur (10) comprenant une hélice avec anneau (12) et un moteur à aimant permanent, **caractérisée en ce que** le propulseur (10) comprend une hélice avec anneau (12) selon l'une quelconque des revendications 1 à 5 et un boîtier de propulseur (13) qui enferme l'anneau (15) de l'hélice avec anneau (12) et qui comprend les enroulements de stator du moteur à aimant permanent.

7. Utilisation d'une hélice avec anneau (12) selon l'une des revendications 1 à 5 dans un propulseur (10) sur un bateau, où l'hélice avec anneau (12) est entraînée par un moteur à aimant permanent.

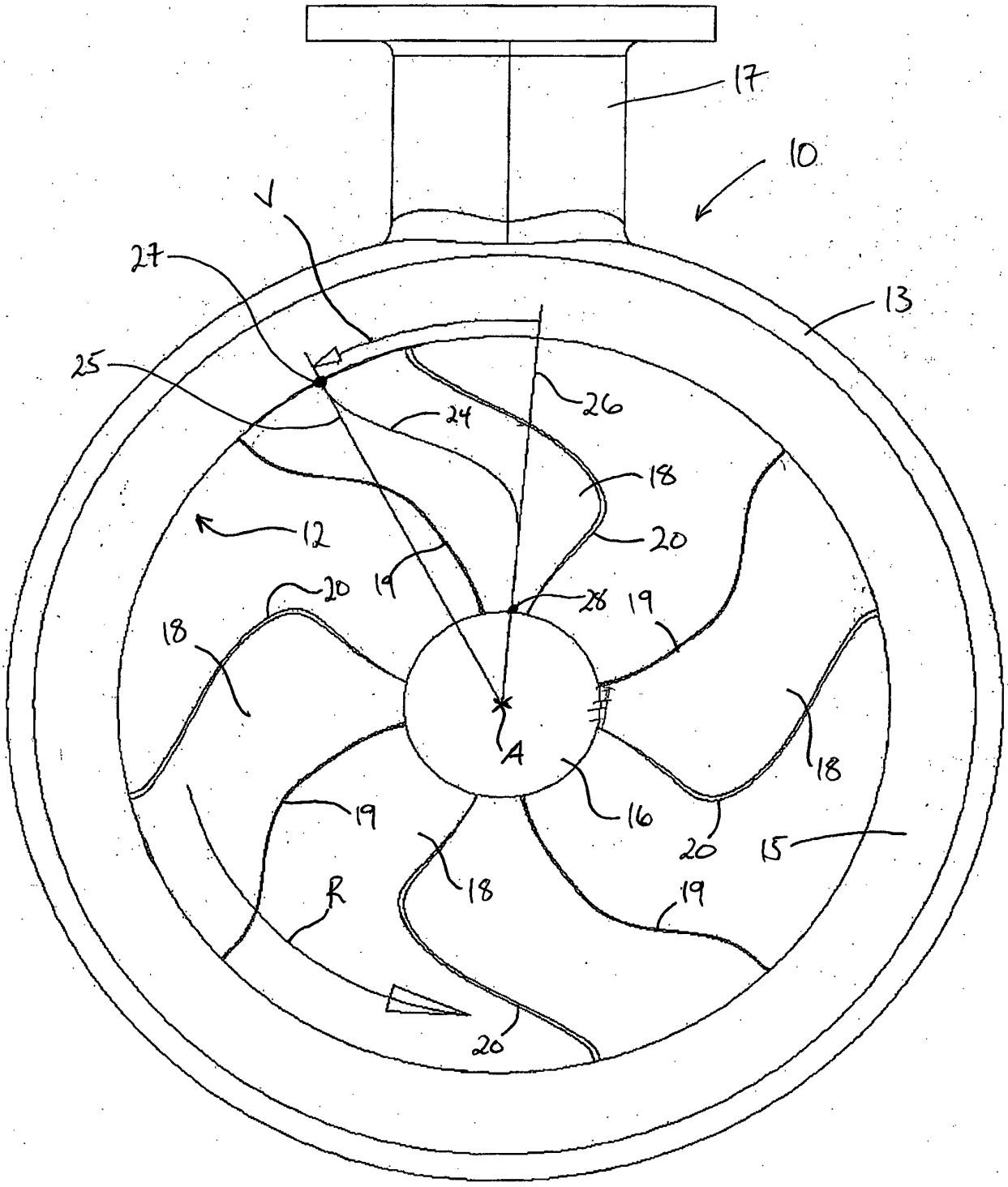
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FIG. 1

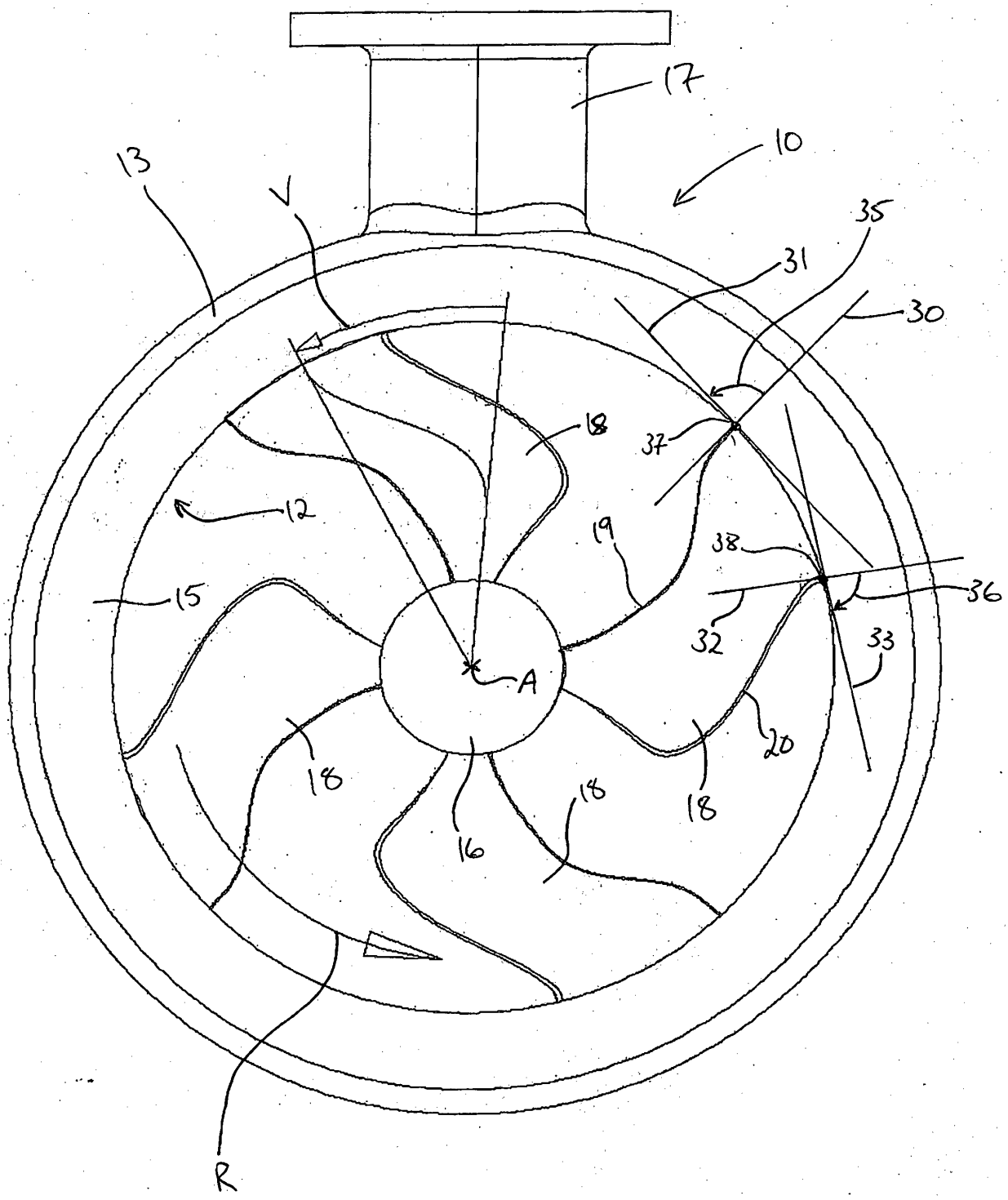

FIG. 2

REFERENCES CITED IN THE DESCRIPTION

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