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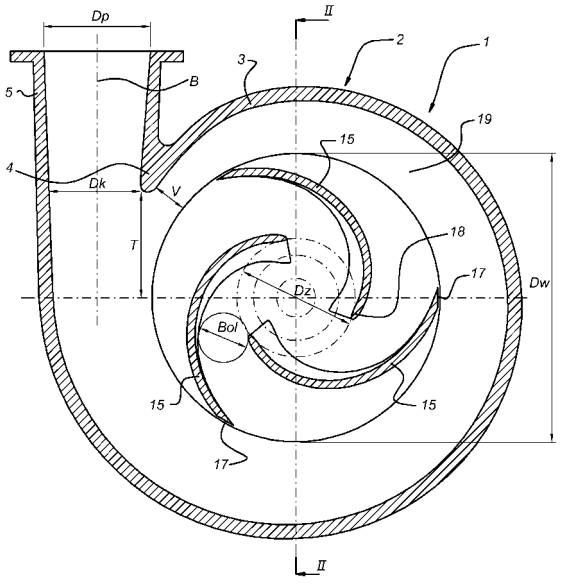
(54) Centrifugal pump, and use thereof

(57) A centrifugal pump, in particular for the pumping of a mixture of substances possibly including stones and/or pebbles, comprises a volute pump housing which is provided with an axial inlet and a spout-shaped outlet attached tangentially to the circumferential wall of the pump housing. A rotor is attached in the pump housing such that it may rotate about an axial rotation axis. The rotor is provided with a central boss, a shaft shield fastened to the boss, a suction shield attached so as to be axially set apart from the shaft shield. The suction shield has an axial supply aligned with the axial inlet of the pump housing. The rotor comprises a plurality of rotor blades which arc fastened between the shields and each extend substantially transversely to the centre line of rotation between a radial outer end and a radial inner end. The rotor has an outermost diameter D_w, whereas the shields define a width B_w of the rotor extending between the mutually facing surfaces of the shaft shield and the suction shield. The axial supply of the rotor has a suction diameter D_z, and the rotor blades define a spherical diameter Bol corresponding to the diameter of the largest sphere which may be introduced between the rotor blades. The ratio between the spherical diameter Bol and the suction diameter D_z is greater than 0.43. The ratio between the width B_w of the rotor and the suction diameter D_z is greater than 0.43. The ratio between the external diameter D_w of the rotor and the suction diameter D_z is between 2.3 and 2.5. These values provide a centrifugal pump having a special hydraulic design.

Fig 1



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Description

[0001] The invention relates to a centrifugal pump, in particular for the pumping of a mixture of substances possibly including stones and/or pebbles, comprising:

- a volute pump housing which is provided with an axial inlet and a spout-shaped outlet attached tangentially to the circumferential wall of the pump housing,
- a rotor which is attached in the pump housing such that it can rotate about an axial rotation axis, which rotor is provided with a central boss, a shaft shield fastened to the boss, a suction shield attached so as to be axially set apart from the shaft shield, which suction shield has an axial supply aligned with the axial inlet of the pump housing, and a plurality of rotor blades which are fastened between the shields and each extend substantially transversely to the rotation axis between a radial outer end and a radial inner end, and which rotor has an outermost diameter D_w, and which shields define a width B_w of the rotor extending between the mutually facing surfaces of the shaft shield and the suction shield, and which axial supply of the rotor has a suction diameter D_z, and which rotor blades define a spherical diameter Bol corresponding to the diameter of the largest sphere which may be introduced between the rotor blades.

[0002] A centrifugal pump of this type is known. During operation, the rotor rotates about the axial rotation axis. Between the rotor blades, the mass to be pumped is forced radially outward into the pump housing under the influence of centrifugal forces. Said mass is then entrained in the circumferential direction of the pump housing toward the tangential outlet spout of the pump housing. The junction between the inner wall of the tangential outlet and the inside of the circumferential wall of the housing defines what is known as a cutwater. The pumped mass which, after leaving the rotor, is entrained in the circumferential direction of the housing flows largely out of the tangential outlet of the housing. A small amount of the entrained mass recirculates, i.e. flows along the cutwater back into the pump housing.

[0003] Said centrifugal pump can be used in dredging operations. If the centrifugal pump is located on board a dredging ship, such as a cutter suction dredger, the centrifugal pump has to fetch a loose mixture of substances, possibly including stones and/or pebbles, from the sea floor. The pump must have sufficient suction capacity to do this. Said mixture of substances, possibly including stones and/or pebbles, then flows through the centrifugal pump. In order to prevent blockage, said stones and/or pebbles have to be able to pass through the pump. A wide pump having few blades is suitable for this purpose. However, by widening the pump and reducing the number of blades, the suction characteristics are adversely affected.

[0004] An object of the invention is to provide an improved centrifugal pump.

[0005] According to the invention, this object is achieved in that the ratio between the spherical diameter Bol and the suction diameter D_z is greater than 0.43, and the ratio between the width B_w of the rotor and the suction diameter D_z is greater than 0.43, and the ratio between the external diameter D_w of the rotor and the suction diameter D_z is between 2.3 and 2.5.

[0006] As a result of these design parameters, the centrifugal pump according to the invention has a special hydraulic configuration. The pump has a larger spherical passage and better suction characteristics than known pumps having a comparable suction diameter. The centrifugal pump according to the invention is accordingly suitable for conveying very coarse materials, while the risk of blockage is minimal.

[0007] According to the invention, it is possible for the ratio between the spherical diameter Bol and the suction diameter D_z to be approximately 0.5. Preferably, the ratio between the width B_w of the rotor and the suction diameter D_z is approximately 0.5, whereas the ratio between the external diameter D_w of the rotor and the suction diameter D_z is approximately 2.4. These values were found after extensive testing to be particularly beneficial.

[0008] In an embodiment of the centrifugal pump according to the invention, the spout-shaped outlet of the pump housing has a narrowest passage with a throat diameter D_k, the ratio between the throat diameter D_k of the spout-shaped outlet and the suction diameter D_z being between 0.5 and 0.7. Said ratio between the throat diameter D_k of the spout-shaped outlet and the suction diameter D_z is, for example, approximately 0.68.

[0009] The spout-shaped outlet may, at the head end thereof, define a press diameter Dp, the ratio between the press diameter Dp and the suction diameter D_z being greater than 0.7 or 0.75.

[0010] The invention also relates to the use of a centrifugal pump as described above. The specific rotational speed N_s of a pump is defined by:

$$N_s = \frac{n\sqrt{Q}}{H^{3/4}}$$

wherein *n* is the rotational speed of the rotor in revolutions per second, *Q* is the flow rate in m^3/s and *H* is the pressure differential over the pump in kPa. When the centrifugal pump according to the invention is used, the specific rotational speed of the pump is, for example, between 0.05 and 0.12. For example: if the rotational speed of the rotor is 302 revolutions per second, the flow rate 4.4 m^3/s and the pressure differential 610 kPa, then the specific rotational speed is 0.086.

[0011] The invention will now be described in greater detail with reference to an illustrative embodiment represented in the drawings, in which:

Figure 1 is a front view in cross section of a centrifugal pump according to the invention; and

Figure 2 is a side view in cross section along the line II - II in figure 1.

[0012] The centrifugal pump according to the invention is denoted in its entirety in figures 1 and 2 by reference numeral 1. The centrifugal pump 1 comprises a pump housing 2 shaped like a volute (spiral casing). The pump housing 2 has a circumferential wall 3 and a spout-shaped outlet 5 attached tangentially to the circumferential wall 3 of the pump housing 2. The junction between the inner surface of the tangential outlet 5 and the inner surface of the circumferential wall 3 of the pump housing 2 defines what is known as a cutwater 4. The pump housing 2 also has an axial inlet 6.

[0013] A rotor 7 is attached in the pump housing 2 such that it may rotate about an axial rotation axis A. The rotor 7 has a central boss 9 which may be fastened to a drive shaft (not shown). A shaft shield 11 extends from the central boss 9. The shaft shield 11 forms a first wall for delimiting the flow within the rotor 7. Axially set apart from the shaft shield 11, the rotor has a suction shield 12 which defines a second wall for delimiting the flow within the rotor 7. The suction shield 12 has an axial supply 14 which is aligned with the axial inlet of the pump housing 2.

[0014] A plurality of rotor blades 15 are fastened between the shields 11, 12. In this illustrative embodiment, the rotor 7 comprises three rotor blades 15. The rotor blades 15 each extend substantially radially to the rotation axis A. Each rotor blade 15 comprises a radial inner end 18 and a radial outer end 17. Between the radial outer ends 17 of the rotor 7 and the inner surface of the circumferential wall 3 of the pump housing 2 there is a circumferential channel 19. The circumferential channel 19 has a passage surface area which increases somewhat in the circumferential direction from the cutwater 4 toward the outlet 5.

[0015] The characteristic dimensions of the centrifugal pump 1 are indicated in figures 1 and 2. These characteristic dimensions largely determine the characteristics of the pump. The rotor 7 has an outermost diameter D_w which is defined by the radial outer edges of the shields 11, 12. The rotor 7 has a width B_w extending between the mutually facing surfaces of the shaft shield 11 and the suction shield 12. The axial supply 14 of the rotor 7 defines a suction diameter D_z. An inlet pipe can be connected to the axial inlet 16 of the pump housing 2. The centrifugal pump 1 also has what is known as a spherical passage Bol which is defined by the diameter of the largest sphere able to pass between the rotor blades.

[0016] Also indicated in figure 1 is a throat diameter D_k which is defined by the narrowest passage of the spout-shaped outlet 5 of the pump housing 2. Said narrowest passage is located in proximity to the cutwater 4. The spout-shaped outlet 5 also has a press diameter Dp located at the tip thereof. The distance, extending parallel to the centre line B of the outlet 5, between the crossing 4 and the level of the rotation axis A is indicated by the parameter T. The thickness of the circumferential channel 19 at the location of the cutwater 4 is represented in Figure 1 by V.

[0017] According to the invention, the characteristic dimensions of the centrifugal pump 1 are matched to one another in such a way that the ratio between the spherical diameter Bol and the suction diameter D_z is greater than 0.43, the ratio between the width B_w of the rotor and the suction diameter D_z is greater than 0.43, and the ratio between the external diameter D_w of the rotor and the suction diameter D_z is between 2.3 and 2.5. In particular, the ratio between the spherical diameter Bol and the suction diameter D_z and the ratio between the width B_w of the rotor and the suction diameter D_z are both approximately 0.5, whereas the ratio between the external diameter D_w of the rotor and the suction diameter D_z is approximately 2.4.

[0018] Moreover, the ratio between the throat diameter D_k of the spout-shaped outlet and the suction diameter D_z is between 0.5 and 0.7 - in this illustrative embodiment, approximately 0.68. The ratio between the press diameter D_p and the suction diameter D_z is in this case greater than 0.75. The V/D_z value is, in accordance with the invention, preferably greater than 0.285 - for example, 0.3. Furthermore, it is beneficial if the T/D_z value is greater than 0.9. The distance T is, for example, almost as great as the suction diameter D_z.

[0019] According to this illustrative embodiment, the characteristic dimensions of the centrifugal pump 1 are, in particular:

Parameter	D_w	B_w	D_z	D_p	D_k	V	T	Bol
Dimensions (mm)	2640	550	1100	850	750	330	1095	550

[0020] Obviously, these values are intended merely by way of example. These values are not only dependent in all cases on the suction diameter D_z but can also differ from one another.

[0021] As a result of the above-mentioned values of the characteristic parameters, the centrifugal pump 1 has a hydraulic design which is particularly suitable for the pumping of a dredging mixture including stones and/or pebbles. Compared to known pumps, comparatively large stones and/or pebbles are able to pass through the centrifugal pump 1, so the risk of blockage is reduced. At the same time, this special hydraulic design of the centrifugal pump 1 ensures that the suction capacity thereof is sufficiently great to be able to pick up stones and/or pebbles of this type from the sea floor.

Claims

1. Centrifugal pump (1), in particular for the pumping of a mixture of substances possibly including stones and/or rocks, comprising:

   - a volute pump housing (2) which is provided with an axial inlet (6) and a spout-shaped outlet (5) attached tangentially to the circumferential wall (3) of the pump housing (2),
   - a rotor (7) which is attached in the pump housing (2) such that it can rotate about an axial rotation axis A, which rotor (7) is provided with a central boss (9), a shaft shield (11) fastened to the boss (9), a suction shield (12) attached so as to be axially set apart from the shaft shield (11), which suction shield (12) has an axial supply (14) aligned with the axial inlet (6) of the pump housing (2), and a plurality of rotor blades (15) which are fastened between the shields (11, 12) and each extend substantially transversely to the rotation axis A between a radial outer end (17) and a radial inner end (18),

   and which rotor (7) has an outermost diameter D_w, and which shields (11, 12) define a width B_w of the rotor (7) extending between the mutually facing surfaces of the shaft shield (11) and the suction shield (12), and which axial supply (14) of the rotor (7) has a suction diameter D_z, and which rotor blades (15) define a spherical diameter BoI corresponding to the diameter of the largest sphere which may be introduced between two adjacent rotor blades (15), **characterised in that** the ratio between the spherical diameter BoI and the suction diameter D_z is greater than 0.43, and the ratio between the width B_w of the rotor (7) and the suction diameter D_z is greater than 0.43, and the ratio between the external diameter D_w of the rotor (7) and the suction diameter D_z is between 2.3 and 2.5.

2. Centrifugal pump according to Claim 1, wherein the ratio between the spherical diameter BoI and the suction diameter D_z is approximately 0.5.

3. Centrifugal pump according to Claim 1 or 2, wherein the ratio between the width B_w of the rotor (7) and the suction diameter D_z is approximately 0.5.

4. Centrifugal pump according to one of the preceding claims, wherein the ratio between the external diameter D_w of the rotor (7) and the suction diameter D_z is approximately 2.4.

5. Centrifugal pump according to one of the preceding claims, wherein the spout-shaped outlet (5) of the pump housing (2) has a narrowest passage with a throat diameter D_k, and wherein the ratio between the throat diameter D_k of the spout-shaped outlet (5) and the suction diameter D_z is between 0.5 and 0.7.

6. Centrifugal pump according to Claim 5, wherein the ratio between the throat diameter D_k of the spout-shaped outlet (5) and the suction diameter D_z is approximately 0.68.

7. Centrifugal pump according to one of the preceding claims, wherein the spout-shaped outlet (5) defines, at the head end thereof, a press diameter Dp, and wherein the ratio between the press diameter Dp and the suction diameter D_z is greater than 0.7.

8. Centrifugal pump according to Claim 7, wherein the ratio between the press diameter Dp and the suction diameter D_z is greater than 0.75.

9. The use of a centrifugal pump (1) according to one of the preceding claims.

Fig 1

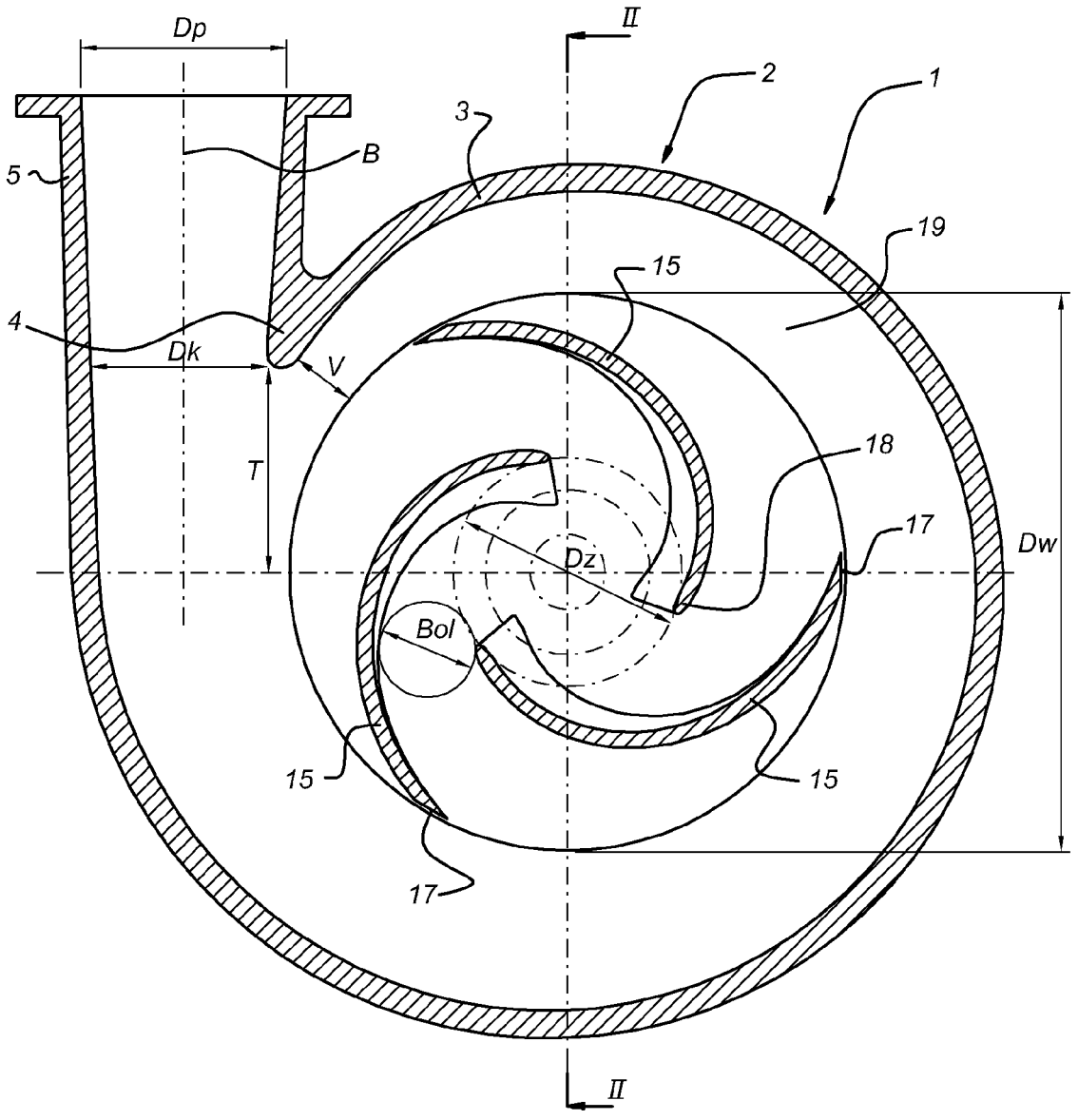
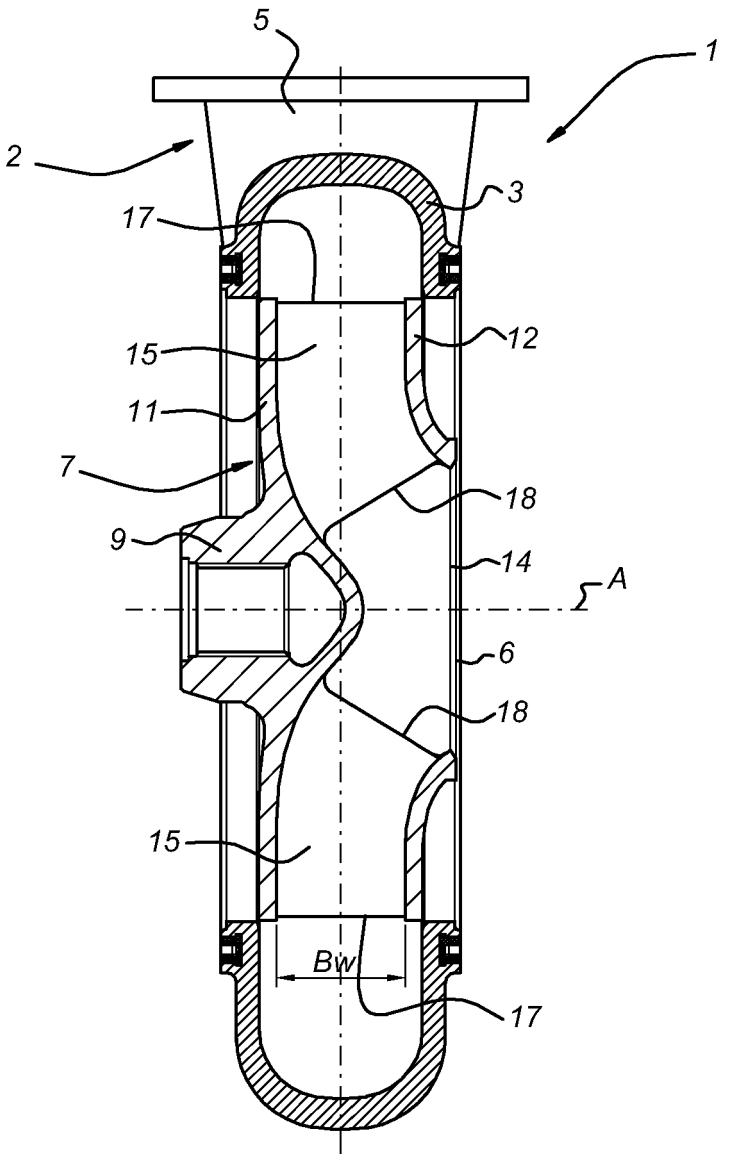


Fig 2



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EUROPEAN SEARCH REPORT

Application Number
EP 06 12 0843

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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