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(54) **Vortex impeller for centrifugal fluid-dynamic pumps**

(57) Vortex impeller (10) for centrifugal fluid-dynamic pumps, provided with a central eye (16), an outer circumferential edge (18) and a plurality of blades (12, 12') having respective starting points (14, 14') arranged at said eye (16) of the impeller (10), each pair of contiguous blades (12, 12') defining a channel (22) arranged between them, characterised in that each of said blades (12, 12') has a profile in plan consisting of a plurality of arcs of circumference (24, 24', 24'') arranged in sequence and joined together, pairs of consecutive arcs of circumference (24, 24'; 24', 24'') having different bending radii.

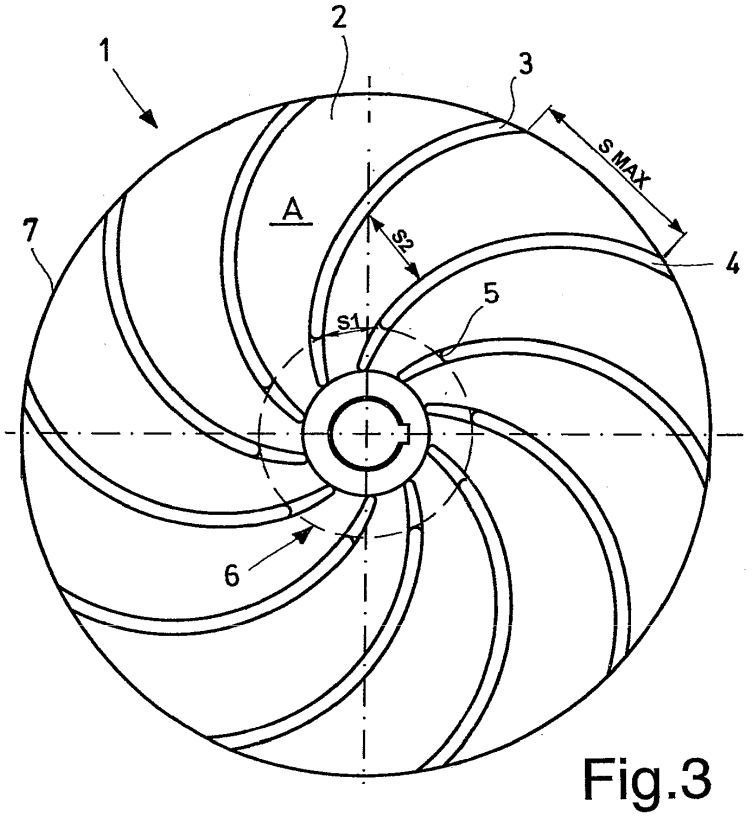

Fig.3

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Description

[0001] The present invention refers to a vortex impeller, able to be used on centrifugal fluid-dynamic pumps operating horizontally, vertically and submersible.

[0002] Centrifugal fluid-dynamic pumps are the pumps most commonly used both in industry and in civil applications. A centrifugal pump usually consists of a body on which an intake mouth for the liquid to be pumped and a delivery mouth for conveying the liquid in output are made, with a single impeller (single-stage pumps) or with many impellers arranged in series (multi-stage pumps) .

[0003] The impeller, which constitutes the main element of a centrifugal pump, is nothing other than a bladed wheel normally fitted onto a shaft actuated by a motor, generally electric. The function of the impeller is to convert the energy developed by the motor into kinetic energy for the liquid to be pumped.

[0004] When the liquid enters inside the pump body, the impeller projects such a liquid to the periphery of the body itself and through the centrifugal force produced by the rotation speed the liquid stores a potential energy in the form of pressure and then changed into kinetic energy, in other words the maximum head of the liquid pumped as well as generating a flow rate, i.e. the amount of liquid moved in a unit of time. Moreover, such centrifugal movement simultaneously causes a depression capable of sucking in the liquid to be pumped and connecting the pump with a delivery pipe, the liquid shall be easily channelled and pushed to the outside of the pump itself.

[0005] The impeller of a centrifugal fluid-dynamic pump can be made according to many constructive variants. Indeed, there are open impellers, closed impellers, semi-open impellers, single-channel impellers, multi-channel impellers, axial impellers, semi-axial impellers, spiral impellers, vortex recessed impellers, etc.

[0006] In the civil and industrial field pumps with open and semi-open recessed impellers operating upon the principle of the liquid vortex, also known as hydraulic joint, are widely used. This type of impeller is particularly suitable for pumping and transferring dirty liquids, loads containing solids in suspension, muds also containing gases from purification processes, industrial wastewater, rainwater and sewage water.

[0007] In literature and on the market there are numerous types of vortex recessed impellers, equipped with open or half-open blades with a straight or curved profile. All known vortex impellers of the aforementioned type share the characteristic of having a constantly increasing area and section of the channel, in other words the substantially concave zone shaped like a "pie-wedge" portion of a circle that is formed between one blade and the next blade, starting from the starting point of the blades, arranged at the eye of the impeller. Indeed, the area and section of the channel progressively increase towards the outside in the radial direction, until the maximum outlet size of the channel itself is reached at the outer circumferential edge of the impeller.

[0008] Whilst it has numerous advantages for the applications and services described above, all open or semi-open vortex recessed impellers according to the prior art do, however, suffer from a low hydraulic yield, especially compared to other types of single-channel and multi-channel centrifugal impellers. This is because the particular configuration of the blades and the position inside the pump body are such as to avoid to the greatest possible extent the blocking due to the type of filled liquids to be pumped.

[0009] The general purpose of the present invention is therefore to make a vortex recessed impeller for centrifugal fluid-dynamic pumps capable of achieving higher yields, in terms of flow rate and head and for the same power of the pump on which it is installed, with respect to all known vortex impellers, especially in the pumping of liquids with a high impurity content and/or containing a large amount of solid residue.

[0010] Another purpose of the present invention is to make a vortex impeller for centrifugal fluid-dynamic pumps that is simple and cost-effective to manufacture, as well as particularly functional and adaptable to different types of centrifugal pumps present on the market.

[0011] In view of the aforementioned purposes, according to the present invention, it has been thought of to make a vortex impeller for centrifugal fluid-dynamic pumps having the characteristics outlined in the attached claims.

[0012] The structural and functional characteristics of the present invention and its advantages compared to the prior art shall become even clearer from an examination of the following description, referring to the attached drawings, which show a vortex impeller for centrifugal fluid-dynamic pumps according to the innovative principles of the invention itself.

[0013] In the drawings:

figures 1 to 4 are plan views of vortex impellers with known blade profiles;
figure 4B is a section view obtained along the line A-A of figure 4;
figure 5 is a plan view of a vortex impeller for centrifugal pumps according to the present invention;
figure 5B is a section view obtained along the line A-A of figure 5;
figure 6 is a perspective view of the vortex impeller of figure 5; and
figures 7 and 8 show characteristic curves relative to different known impellers mounted on pumps of equal power, compared with the characteristic curve (10) relative to the use of a vortex impeller according to the present invention.

[0014] It should be specified that, in the following description and in the various figures of the attached drawings, elements that are the same or equivalent to one another are represented with the same reference numerals.

[0015] With reference to figures 1 to 4 of the attached drawings, some example embodiments of vortex impellers known in the state of the art are shown.

[0016] In particular, figure 1 shows an impeller with open blades having a straight profile orientated according to the spokes of the impeller itself, figure 2 shows an impeller with open blades having a straight profile inclined tangentially with respect to the eye of the impeller itself, figure 3 shows an impeller with open blades having a curved profile according to a single predetermined arc of circumference, whereas figure 4 shows an impeller with half-open blades, i.e. with blades provided with a lip (see the section view of figure 4B) and half-closed channels, again with a curved profile according to a single predetermined arc of circumference.

[0017] In all of the known embodiments illustrated here, both the vortex impellers 1 with straight blades, i.e. consisting of a straight segment (figures 1 and 2), and the vortex impellers 1 with curved blades, consisting of an arc of circumference (figures 3 and 4) and provided or not with a lip for partially covering the channels between the blades, share the characteristic of having the area A and the section S or width of the channel 2 that is formed between one blade 3 and the next blade 4 that constantly increase. Indeed, starting from the starting point 5 of each blade, arranged at the central eye 6 of the impeller 1, and progressively moving towards the outer circumferential edge 7 of the impeller 1 itself, the width S of each channel 2 shall take on ever increasing values (S_1, S_2, ..., S_n) until the maximum size S_{max} is reached right at the outer edge 7 of the impeller 1, or output edge of each channel 2.

[0018] Now with reference to figures 5 and 6 of the attached drawings, a vortex impeller for centrifugal pumps according to the present invention is shown, wholly indicated with reference numeral 10 and able to be made from metallic material (cast iron, steel, bronze) or else plastic.

[0019] The vortex impeller 10 is provided with a plurality of blades 12, 12' having respective starting points 14, 14' arranged at the central eye 16 of the impeller 10 itself. The impeller 10 also has an outer circumferential edge 18 at which the output profiles 20, 20' respectively of each blade 12, 12' are located. Each pair of contiguous blades 12, 12' thus defines an area 22 arranged between them, called the channel of the impeller 10.

[0020] According to the invention, each blade 12, 12' has a profile in plan consisting of a plurality of arcs of circumference 24, 24', 24" arranged in sequence and joined together, pairs of consecutive arcs of circumference 24, 24' or 24', 24" having different bending radii.

[0021] Such a profile for the blades 12, 12' of the impeller 10, equipped with a particular progressive inclination, makes it possible to obtain a section or size S of each channel 22 that does not constantly increase towards the outside, in other words towards the edge 18 of the impeller 10 itself, as does on the other hand occur for known vortex impellers (figures 1-4), where the maximum size S_{max} of the section of each channel 2 can be substantially defined at the outer edge 7 of the impeller 1.

[0022] On the other hand, in the vortex impeller 10 according to the present invention the maximum size S_{max} of the section of each channel 22 or, in other words, the maximum linear distance between pairs of blades 12, 12' contiguous to one another is reached in an intermediate point P situated between the starting point 14, 14' of each blade 12, 12' and the outer circumferential edge 18 of the impeller 10 itself. From such an intermediate point P, the size of the section thus starts to decrease both in the direction of the edge 18 (note for example the size S_2, smaller than the size S_{max}) and in the direction of the eye 16 of the impeller 10, until a size value S_3, measured at the output profile 20, 20' of each blade 12, 12', substantially equal or close to the size value S_1 measured at the starting points 14, 14' of each pair of contiguous blades 12, 12' is reached. In particular, in the illustrated example embodiment, the size values S_1 and S_3 also coincide with the minimum width of each channel 22 measured outside of the eye 16 of the impeller 10.

[0023] From experimental tests, as can be seen from the head and flow rate characteristic curved of figures 7 and 8, it has been found that, for the same power delivered and size of the delivery mouth, centrifugal pumps equipped with a vortex impeller 10 according to the present invention are able to reach yields about 20% ÷ 40% higher than when they operate, in the same operating conditions, with the known vortex impellers currently proposed on the market by the largest manufacturing firms. Although the comparison has been carried out using submersible centrifugal pumps, incremental values similar or equal to those displayed above can be reached by using the impeller 10 according to the invention even on surface pumps, whether they operate horizontally or vertically.

[0024] Nevertheless, it should be understood that although the particular profile of the blades of the impeller 10 according to the present invention has been illustrated and described relative to a completely open impeller, it is also possible to apply the same principle to half-open impellers, in other words of the type illustrated in figures 4 and 4B, in which there is a lip formed in a single piece with each blade that at least partially covers each channel.

[0025] From what has been described above with reference to the figures it is clear how a vortex impeller for centrifugal pumps according to the invention is particularly useful and advantageous. The purposes mentioned in the preamble of the description are thus achieved.

[0026] In particular, the purpose of obtaining greater yields, in terms of flow rate and head, compared to all known vortex impellers is accomplished, whereas in the pumping of liquids with high impurity content and/or containing a large amount of solid residues there is:

- the possibility of pumping liquids containing a substantial amount of gas without cavitation phenomena

occurring;

- the possibility of pumping liquids containing coarse solids and long fibres with less risk of clogging;
- less wear; and
- lower axial thrust, with consequent reduction in the stress on mechanical support and sealing parts on the shaft of the pump.

[0027] Of course, the shapes and sizes of the vortex impeller for centrifugal pumps according to the invention can be different to the one shown as a nonlimiting example in the drawings, just as the materials used can also be different.

[0028] The scope of protection of the invention is therefore defined by the attached claims.

Claims

1. Vortex impeller (10) for centrifugal fluid-dynamic pumps, provided with a central eye (16), an outer circumferential edge (18) and a plurality of blades (12, 12') having respective starting points (14, 14') arranged at said eye (16) of the impeller (10), each pair of contiguous blades (12, 12') defining a channel (22) arranged between them, **characterised in that** each of said blades (12, 12') has a profile in plan consisting of a plurality of arcs of circumference (24, 24', 24'') arranged in sequence and joined together, pairs of consecutive arcs of circumference (24, 24'; 24', 24") having different bending radii.

2. Vortex impeller (10) according to claim 1, **characterised in that** the output profiles (20, 20') of each of said blades (12, 12') are located at said outer circumferential edge (18) of the impeller (10).

3. Vortex impeller (10) according to claim 2, **characterised in that** the maximum linear distance between pairs of blades (12, 12') contiguous to one another, equal to the maximum size (S_{max}) of the section of each of said channels (22), is reached in an intermediate point (P) situated between said starting point (14, 14') of each blade (12, 12') and said outer circumferential edge (18) of the impeller (10).

4. Vortex impeller (10) according to claim 3, **characterised in that** the size (S) of the section of each of said channels (22) decreases, starting from said intermediate point (P), both in the direction of said outer circumferential edge (18) of the impeller (10) and in the direction of said eye (16) of the impeller (10).

5. Vortex impeller (10) according to claim 3, **characterised in that** the size (S_3) of the section of each of said channels (22) measured at said output profile (20, 20') of each of said blades (12, 12') is substantially equal or close to the size (S_1) of the section of each of said channels (22) measured at said starting points (14, 14') of each pair of blades (12, 12') contiguous to one another.

6. Vortex impeller (10) according to claim 5, **characterised in that** said size (S_3) and said size (S_1) coincide with the minimum width of each of said channels (22), measured outside of said eye (16) of the impeller (10).

7. Vortex impeller (10) according to any one of claims 1 to 6, **characterised in that** it is an open impeller.

8. Vortex impeller (10) according to any one of claims 1 to 6, **characterised in that** it is a semi-open impeller, provided with a plurality of lips formed in a single piece with each of said blades (12, 12') to at least partially cover each of said channels (22).

9. Centrifugal fluid-dynamic pump operating horizontally, vertically and/or submersible, **characterised in that** it comprises at least one vortex impeller (10) according to any one of the previous claims.

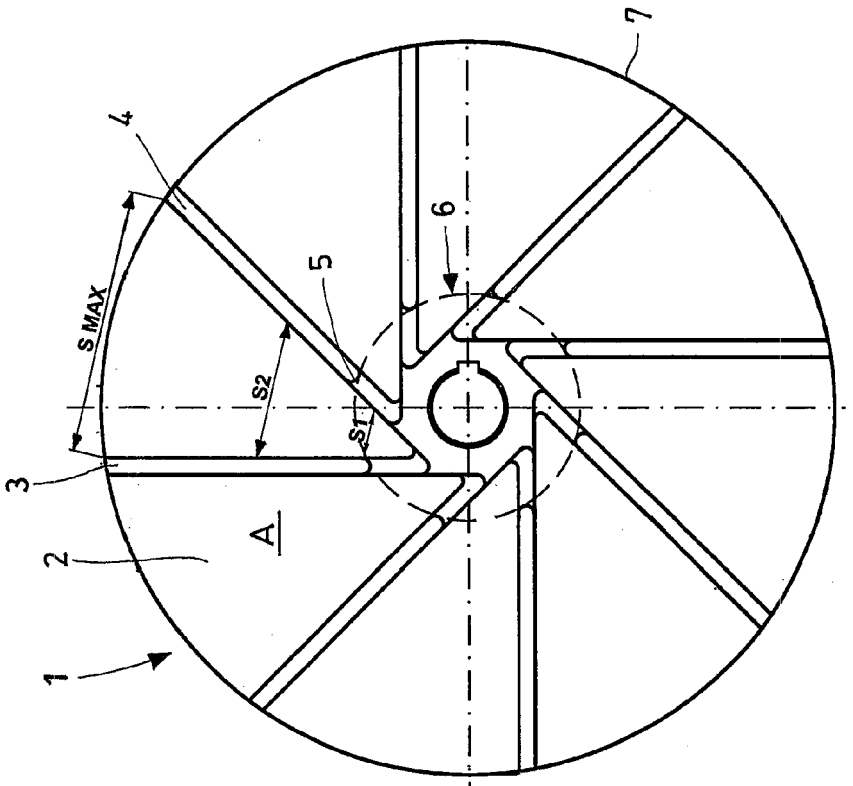

Fig.2

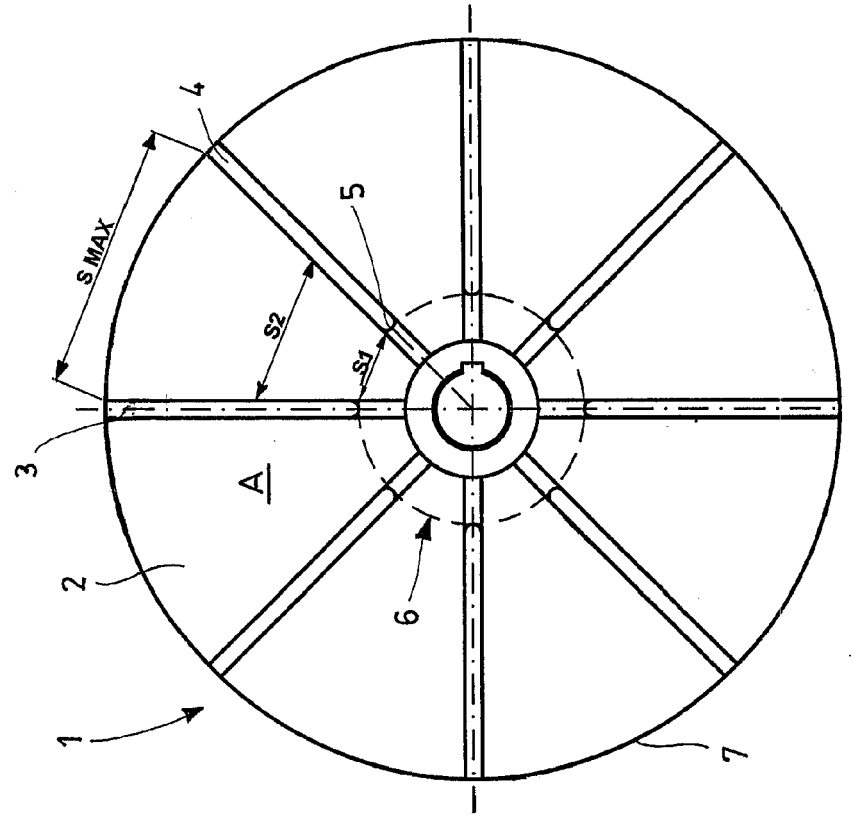

Fig.1

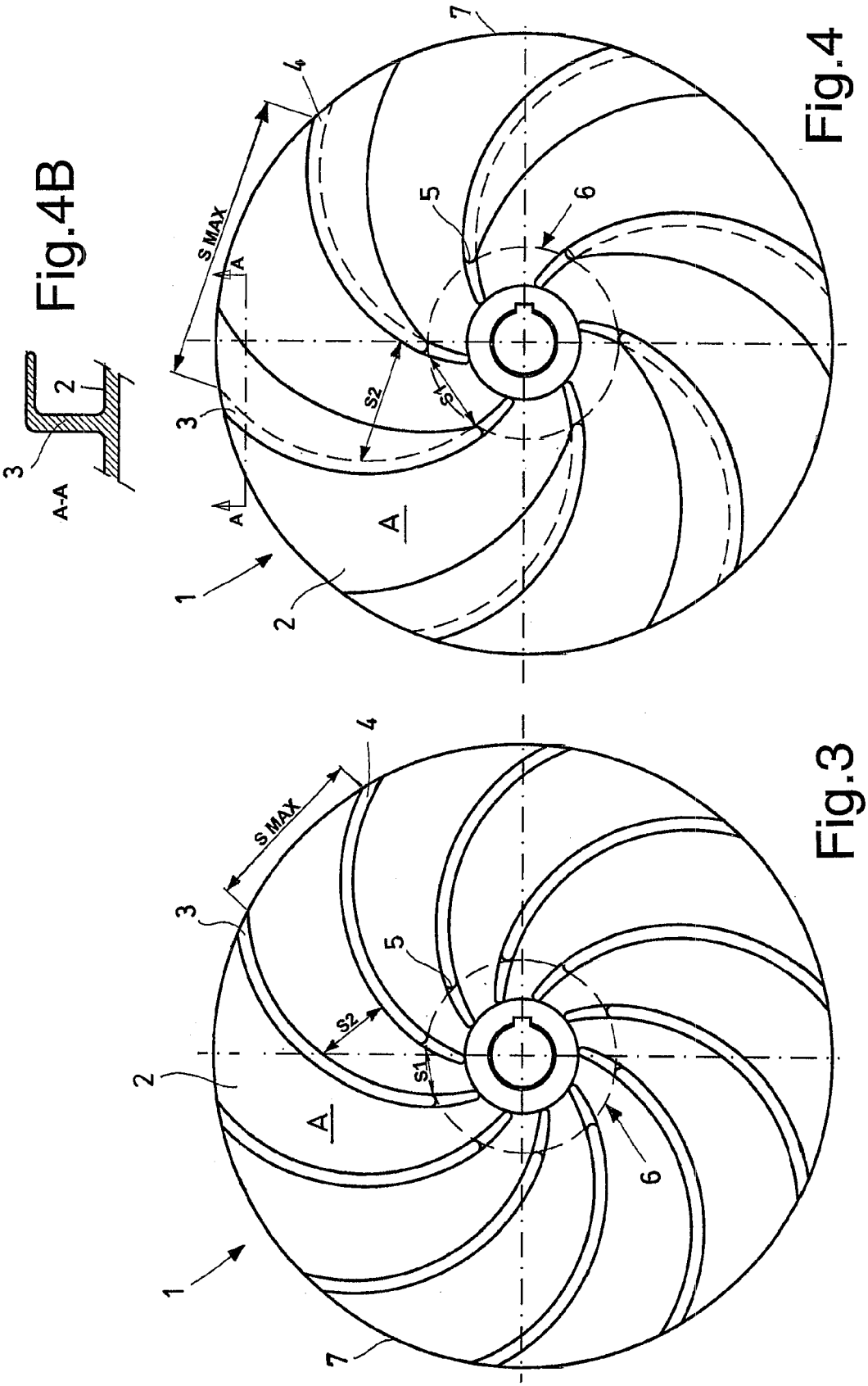
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Fig.3

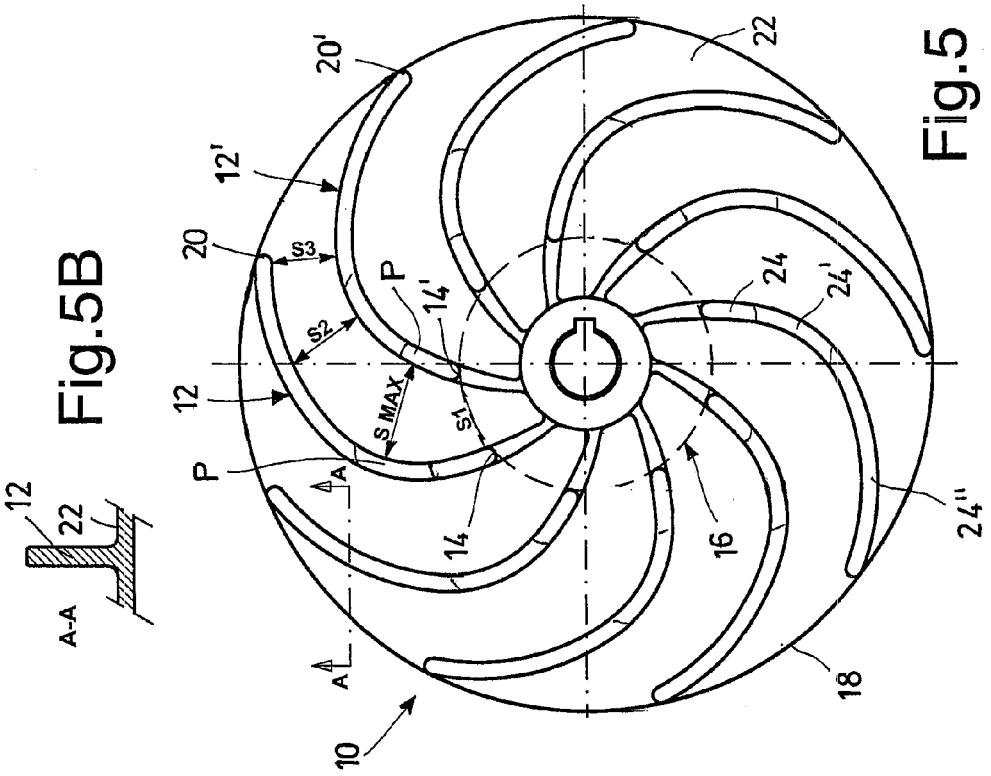


Fig.5

Fig.5B

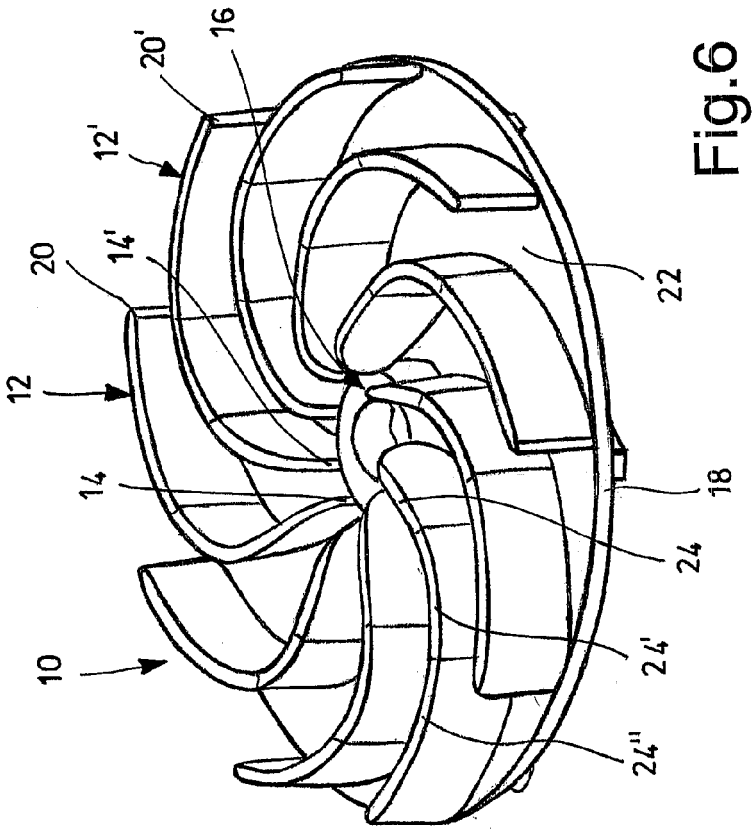
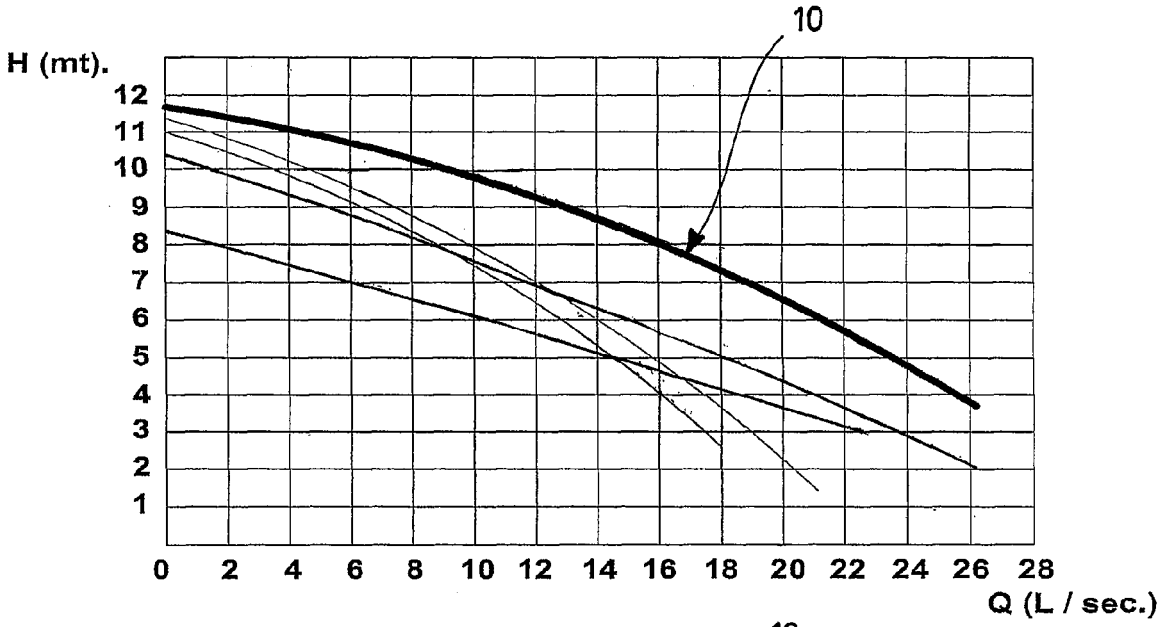


Fig.6

Fig.7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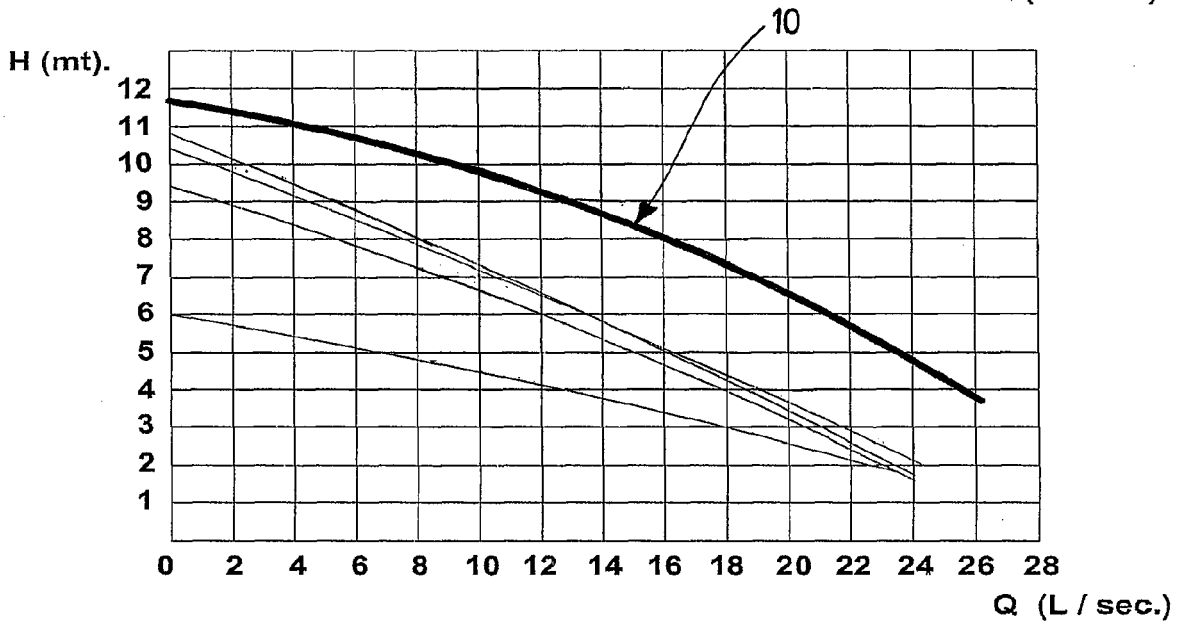
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Fig.8