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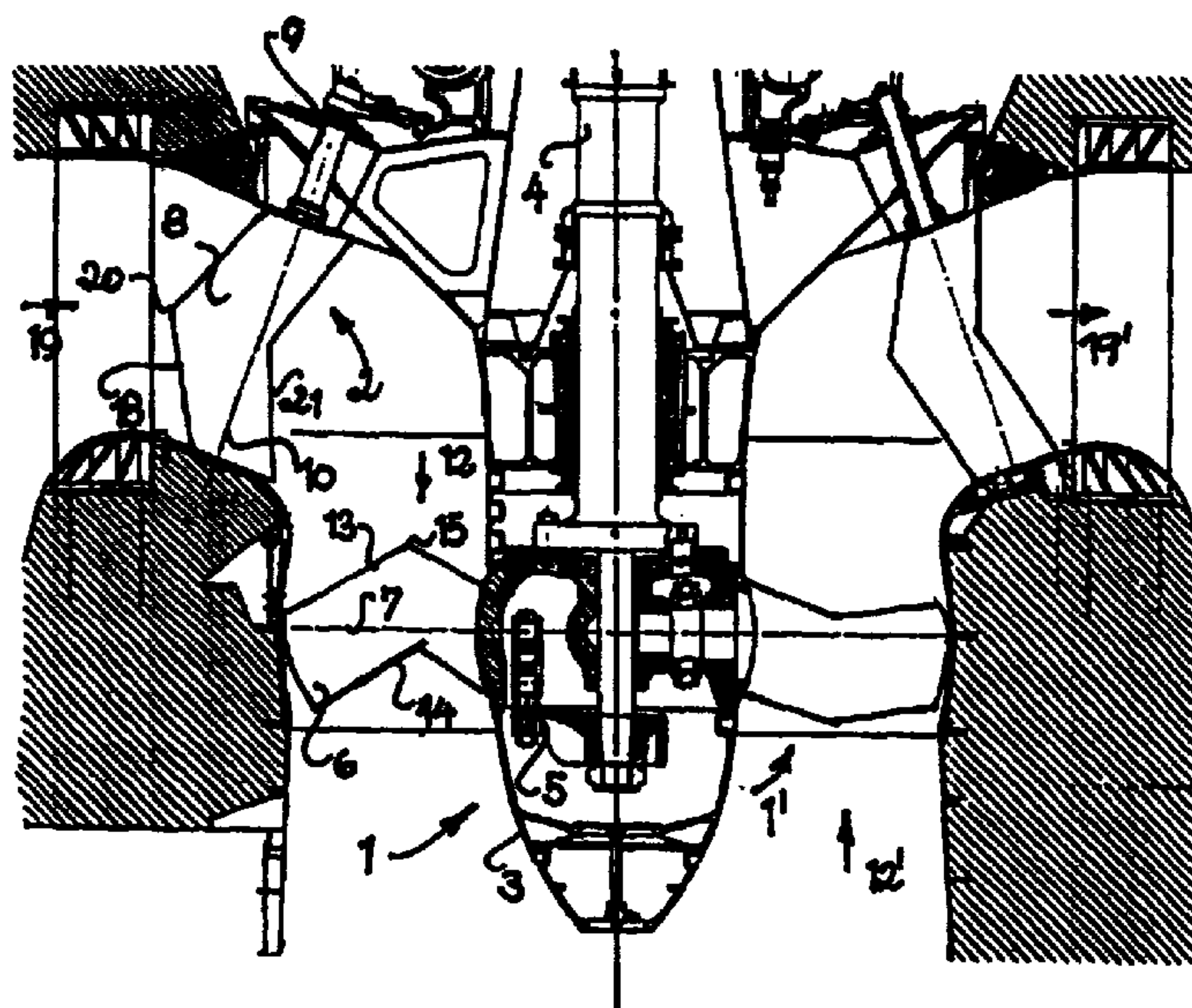
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(54) **TURBINE OU POMPE HYDRAULIQUE**

(54) **WATER TURBINE OR WATER PUMP**



(57) L'invention concerne une turbine ou une pompe hydraulique comprenant un rotor (1) et un distributeur (2). Les bords d'arrivée de flux (13) et les bords de départ de flux (14) au moins des pales (6) forment un angle (15) faisant saillie à l'encontre du sens de flux (12). Ainsi, une force de flux s'exerce sur les salissures qui se déposent sur les bords d'arrivée de flux (13), cette force produisant un effet d'autonettoyage. Malgré cela, la construction garantissant l'aptitude au réglage des pales reste inchangée dans une large mesure.

(57) Disclosed is a water turbine or water pump with a rotor (1) and a guide wheel (2). The inflow edges (13) and outflow edges (14) of at least the rotor blades (6) form a bend (15) protruding against the direction of flow (12). A flowing force is thereby exerted on impurities deposited on the inflow edges (13) causing a self-cleaning effect. However, the construction enabling adjustability of the rotor blades remains substantially unchanged.



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(54) Bezeichnung: WASSERTURBINE ODER -PUMPE

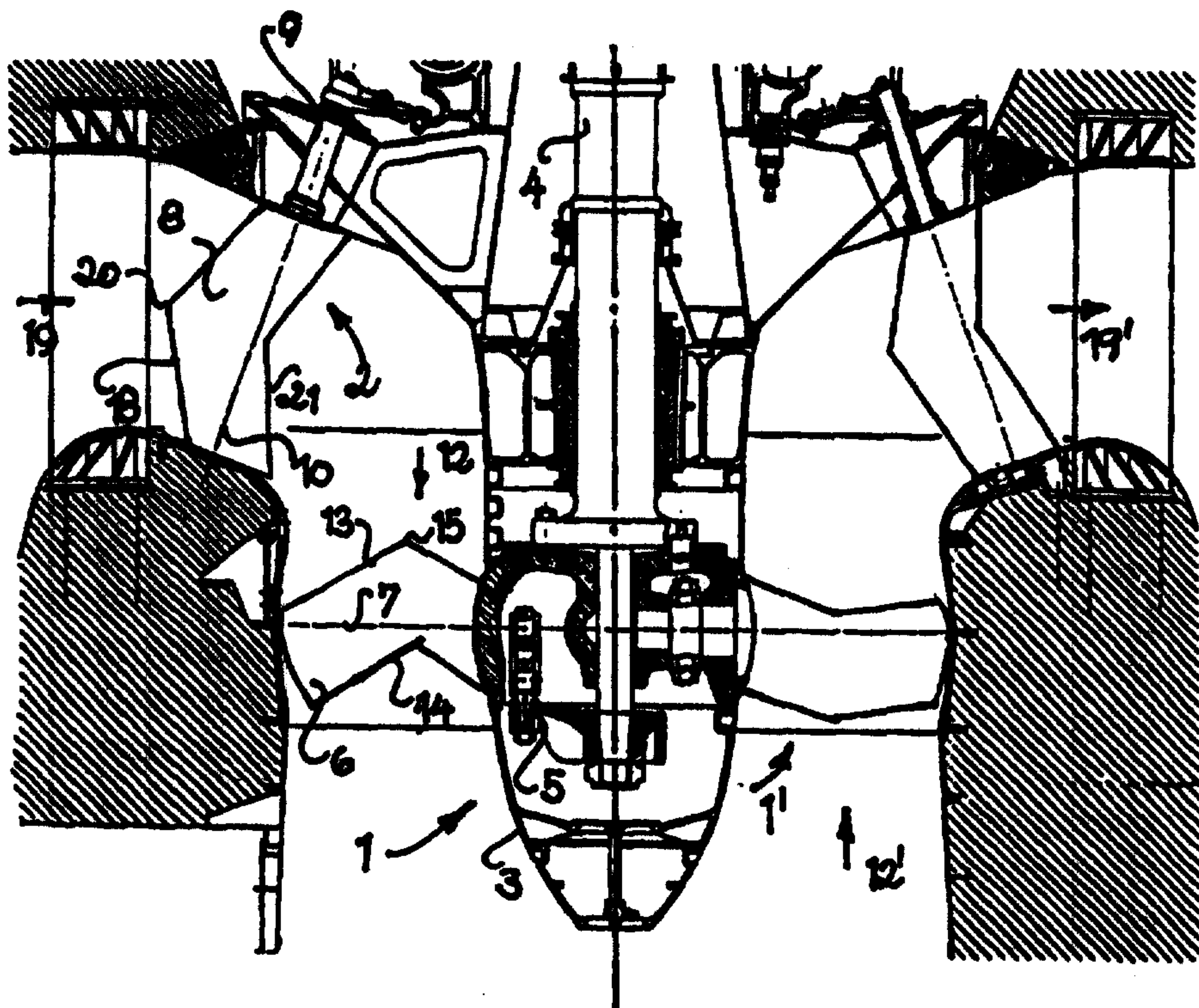
(57) Abstract

Disclosed is a water turbine or water pump with a rotor (1) and a guide wheel (2). The inflow edges (13) and outflow edges (14) of at least the rotor blades (6) form a bend (15) protruding against the direction of flow (15). A flowing force is thereby exerted on impurities deposited on the inflow edges (13) causing a self-cleaning effect. However, the construction enabling adjustability of the rotor blades remains substantially unchanged.

(57) Zusammenfassung

Eine Wasserturbine oder -pumpe mit einem Laufrad (1) und einem Leitrad (2). Die Anströmkanten (13) und die Abströmkanten (14) zumindest der Laufschaufeln (6) bilden einen entgegen der Strömungsrichtung (12) vorspringenden Knick (15). Dadurch wird auf an den Anströmkanten

(13) festsitzende Verunreinigungen eine Strömungskraft ausgeübt, die zu einem Selbstreinigungseffekt führt. Jedoch bleibt die die Verstellbarkeit der Laufschaufeln bewirkende Verstellkonstruktion weitgehend ungeändert.



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Water turbine or pump

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Description

The invention concerns a water turbine or pump having a rotor and a stator which are provided with rotor blades and stator blades respectively.

15 Water turbines of the Kaplan or Francis type and water pumps of a corresponding configuration are frequently adversely affected in function by leaves and foliage, grass, pieces and scraps of plastic material, lumps or the like which are entrained in the water. Those items which are entrained in the water stick to the leading or afflux edges of the rotor blades and
20 the stator blades and therefore considerably interfere with the flow around the cross-sectional profile of those blades. As a result the level of efficiency in part falls considerably and, in the case of water pumps, that, together with reductions in the through-flow rate, results in a sharp rise in the power draw. Those disadvantageous effects make themselves
25 particularly felt in relation to water turbines and water pumps of the specified kind, which are of medium or small size and in which consequently not only the trailing edges but also the leading edges, in the form of a profile nose, are comparatively sharp. For, those relatively sharp leading edges also already retain entrained fibres or leaves and foliage of
30 relatively small extent.

In order to reduce or entirely eliminate the tendency of the blades to retain solid body impurities and contaminants entrained by the water, it is already known for the leading edges of the rotor and/or stator blades to be

of a rearwardly curved configuration, as viewed in the direction of flow (EP-A 475 920). That arrangement, unlike the leading edges which generally extend substantially perpendicularly to the direction of flow, is intended to set the leading edges in relation to the flow direction in such a way that flow components are effective which are also parallel to the leading edge and foreign bodies which are thereby held fast thereby are swept away. In the case of blades which are non-adjustable in relation to the flow, as is the case for example with Francis turbines, a suitable configuration is relatively easy to implement. Particularly in the case of rotor blades which are adjustable in dependence on flow, as is the case with Kaplan turbines and water pumps of a corresponding configuration however the proposed rearward curvature gives rise to structural and operational disadvantages. Thus for example adjustability of the rotor blades of a Kaplan turbine about a blade axis which extends substantially radially with respect to the axis of rotation, and the variation which is caused thereby in the position of the blade tip in relation to the surrounding housing, require adaptation such that in the region of adjustment of the rotating blades, the housing is of a part-toric shape. That design configuration is intended to minimise the gap losses at the blade tip in all adjustment positions of the rotor blades. That toric configuration of the housing is at its smallest when the leading and trailing edges of the rotor blades, like also the adjustment axis, extend substantially radially with respect to the axis of rotation. Due to the proposed rearward curvature of the rotor blades however, if the substantially radial adjustment axis is retained, the consequence involved is a considerable pivotal travel of the blade tip, which results in a corresponding increase in the size of the toric part of the housing. Corresponding rearward pivotal displacement of the displacement axis such that ~~it is substantially matched in terms of its position to the~~ configuration of the leading edge requires re-designing of the corresponding drive in the hub and involves a considerably larger demand for space. In addition the blades due to the rearward curvature become corresponding

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is substantially matched in terms of its position to the configuration of
the leading edge requires re-designing of the corresponding drive in the hub
30 and involves a considerably larger demand for space. In addition the blades
due to the rearward curvature become corresponding longer and accordingly

the level of expenditure on material and the loading acting on the blades become greater.

Furthermore, for the purposes of affording the desired self-cleaning action for water turbines and pumps, it has also already been proposed that, in addition to the regular rotor and/or stator blades, special cleaning blades with a rearwardly curved leading edge should be provided and disposed upstream of the regular blades (EP-A 512 190). That is intended to provide that solid body impurities entrained by the flow are already engaged by the cleaning blades before they reach the leading edges of the regular blades, and are laterally deflected by virtue of the rearward curvature of the leading edges. The provision of additional cleaning blades however requires a considerable level of expenditure and complication and cannot be implemented in turbines and pumps with adjustable blades without a considerable limitation in terms of the adjustment travel.

In the case also of an axial rotary pump which is intended to convey liquids loaded with long-fiber additions therein, it is known for the entry edge of the rotor blades to be provided with a rearwardly directed curvature which increases from radially inward towards radially outward (DE-A 36 08 229). The curvature is so selected that, at any point on the entry edge, the resulting force arising out of the resistance force acting on a particle of liquid and the centrifugal force at least approximately forms a tangent to the entry edge. Accordingly that configuration of the rotor blade also gives rise to the above-discussed disadvantages inherent in a rearward curvature.

A similar proposal for the configuration of the rotor blade of rotary machines provides that at least the outermost quarter, as measured in the radial direction, of the blade entry edge is so inclined in opposite relationship to the direction of rotation that at that location the edge describes a logarithmic spiral (DE-C 647 053). That is intended to prevent grass, leaves and similar floating debris from being deposited at the entry edges of the rotor blade, when the operating water is severely contaminated. It is more specifically prescribed that, in the outermost quarter of the blade entry edge, the angle between the tangent to the entry edge and the

peripheral direction should be no greater than 40°. However, at least in the outer portion of the rotor blade, that again results in a severe rearward inclination which involves the same disadvantages as the proposals described hereinbefore.

5 Finally a rotary pump for conveying paper pulp is known, in which the entry edges of the rotor blades are inclined rearwardly in the flow direction. At the outer blade end each entry edge forms a recess in the flow direction, which is delimited towards the housing wall by a flange-like enlargement portion (US-A 22 02 790). That is intended to provide that fiber
10 material entrained in the pulp is deflected by the part of the entry edge, that is inclined rearwardly in the flow direction, and is collected in the recess at the blade edge in order to prevent it from penetrating into the gap between the blade end and the housing and thereby causing the pump to jam. That configuration of the rotor blade entry edge also affords a rotor
15 blade which is inclined rearwardly in the flow direction, with the disadvantages described hereinbefore.

For the drive propeller of a water craft, a proposal is known whereby at least the leading edge of the blades is of a multiply forwardly and rearward bent configuration so that it involves a contour which is serrated
20 in a sawtooth shape (US-A 52 75 535). Accordingly the leading edge has only edge portions which each extend inclinedly with respect to the flow direction without the blade overall thereby being set inclinedly relative to the flow direction. That is intended to reduce the generation of noise and the tendency to cavitation, without blade strength being impaired. The
25 tendency on the part of a blade of such a configuration to collect and retain fibrous impurities in contaminated water is considerably increased by virtue of the serrated edge contour.

A further known proposal for the design configuration of the leading edge of the blade of a water craft propeller is to the effect that it is to
30 be of a concavely curved configuration in the flow direction, with the blade surface being radially outwardly reduced so that it terminates in a tip forming a circular arc (GB-A 439 249). The arcuate configuration of the

outer blade end, which is shaped to form a tip, is intended to reduce the tendency on the part of the screw to pick up cables or ropes which are to be found in the water.

Therefore the object of the invention is so to design the blades of
5 water turbines or pumps that the desired self-cleaning effect can be achieved even in relation to water turbines or pumps with adjustable blades, in particular rotor blades, without involving a high level of expense.

In accordance with the invention that is achieved in that the leading edges and the trailing edges at least of the rotor blades form a bend
10 projecting in opposite relationship to the direction of flow.

The bend in the leading edge which occurs for example at the longitudinal center of the leading edge provides

leading edges which extend substantially perpendicularly to the flow direction.

As in addition the trailing edge has a bend in parallel relationship with the leading edge, the flow forces which are effective at the blade profile are not changed. For, the blade cross-sections can be imagined as
5 infinitesimally thin lamellae which, starting from the one blade end, are increasingly displaced relative to each other in opposite relationship to the flow direction and, from the bend, are again displaced increasingly with the flow direction.

10 The leading and trailing edges can extend in a straight or curved shape in order to form the bend which occurs in the longitudinal configuration thereof. The angle with which the leading and trailing edges deviate from the otherwise usual orientation which is substantially perpendicular to the flow direction should be so great that flow forces
15 acting on the foreign bodies which impinge on the leading edges are to be expected to be sufficient to sweep them away. It is desirably between 10° and 30° . In addition the angles at which the parts of the leading edge, which extend at both sides of the bend, are oriented with respect to the flow direction can be different. The endeavour however is to provide a
20 corresponding angular configuration and position of the bend, which is matched thereto, in the longitudinal configuration of the leading edge, such that the relative position of the two blade ends, particularly in the case of adjustable rotor blades, does not change or changes only immaterially, in comparison with conventional blades.

25 Embodiments of the invention are described in greater detail hereinafter with reference to the accompanying drawings in which:

Figure 1 is a view in axial section through a flow machine with the rotor being acted upon primarily axially, the left-hand half of the view showing the flow machine in the form of a Kaplan turbine and the right-hand
30 half showing it in the form of an axial pump of corresponding configuration, and

Figure 2 is a diagrammatic plan view of the rotor of the Kaplan turbine shown in Figure 1.

The left-hand half of Figure 1 shows a Kaplan turbine having a rotor 1 and a fixed stator 2. The rotor 1 is provided with a hub 3 to which there is
5 connected a shaft 4 leading to a generator (not shown). The hub 3 includes an adjusting device 5 which is known and which is therefore not illustrated in detail and which permits adjustment of the rotor blades 6 about a substantially radially directed adjustment axis 7.

The stator 2 includes a number of stator blades 8 which divert the
10 initially lateral (radial) feed flow of water axially and, depending on their respective setting, in the peripheral direction. For that purpose the stator blades 8 are also pivotable in known manner by way of an adjusting device 9 about an adjusting axis 10.

As can be seen from Figure 2 the rotor 1 in the Kaplan turbine 4 has
15 rotor blades 6 and rotates in the direction of the arrow 11. The flow direction is indicated by the arrow 12 and the leading edges 13 and the trailing edges 14 of the rotor blades 6 have a bend 15 which is directed in opposite relationship to that flow direction. The leading edges 13, starting from their point 13a which is closest to the hub 3, extend in a straight
20 configuration and inclinedly relative to the flow direction 12 to the bend 15 which is thus disposed upstream from the starting point at the hub 3. From the bend 15, the leading edge again extends straight and inclinedly relative to the flow direction 12, but with the flow direction, so that the point 13b of the leading edge 13, which is at the blade tip, and the point
25 13a of the leading edge, which is closest to the hub 3, lie on a substantially radially extending line 16 shown in broken line. The line 16 essentially corresponds to the radially extending leading edge of conventional Kaplan turbines.

The trailing edges 14 extend parallel to the leading edges 13 so that,
30 apart from the bend configuration, the cross-sectional profile of each rotor blade 6 is the same as the cross-sectional profile of conventional Kaplan turbines.

Similarly to the rotor blades 6, the leading edges 18 of the stator blades 8 have a bend 20 which projects in opposite relationship to the local flow direction (arrow 19) and from which the leading edge 18 extends inclinedly rearward to the blade ends. The trailing edges 21 extend parallel to the leading edges 18. In regard to the configuration of the leading edges 18 with respect to the flow direction, the foregoing description relating to the rotor blades 6 also applies.

The configuration of the flow machine in the form of a pump as illustrated in the right-hand half of Figure 1 in principle differs from that of the described Kaplan turbine only by virtue of the opposite flow directions 12' and 19' respectively and the position of the leading and trailing edges, which is correspondingly altered with the direction of rotation being the same. For that reason the foregoing description in connection with the Kaplan turbine correspondingly applies here.

In the above-described embodiments the bend on the rotor blades and the stator blades respectively is arranged substantially at the longitudinal center of the leading edges and the trailing edges respectively. In accordance therewith, the angular configuration of the edges in relation to the flow direction is the same at both sides of the respective bend. Particularly in the case of water turbines and pumps which rotate at a relatively high speed of rotation and at the rotor blades of which therefore a noticeable centrifugal force is operative, it is possible to envisage displacing the respective bend to closer to the rotor hub. The endeavour to keep the position of the blade tips substantially unchanged in comparison with conventional turbines or pumps results in this case in the angle of incidence of the leading edge or the trailing edge respectively with respect to the flow direction in the region which is between the rotor hub and the bend being greater than outside the bend. That affords a stronger flow component in the longitudinal direction of the leading edge, by which the oppositely acting centrifugal force is compensated.

The fact that the position of the blade tip of the rotor blades is substantially retained in comparison with conventional turbines or pumps

means that the configuration of a part-toric portion on the housing can also remain unaltered. Accordingly the concept of the invention is found to be particularly advantageous in relation to water turbines and pumps with adjustable rotor blades, but it is not limited thereto in terms of the
5 applicability thereof.

CLAIMS

1. A water turbine or pump comprising a rotor (1, 1') and a stator (2) which have rotor blades (6) and stator blades (8) respectively, characterised in that the leading edges (13, 18) and the trailing edges (14, 21) at least of the rotor blades (6) form a bend (15, 20) projecting in opposite relationship to the flow direction (12, 19; 12', 19') and are inclined rearwardly with respect to the flow direction starting from the bend to both ends of the blades.

2. A water turbine or pump as set forth in claim 1 characterised in that the bend is disposed approximately at the longitudinal center of the edge length.

3. A water turbine or pump as set forth in claim 1 or claim 2 characterised in that the leading and trailing edges (13, 14; 18, 21) extend straight towards and away from the bend (15, 20).

4. A water turbine or pump as set forth in one of claims 1 through 3 characterised in that the angle formed by the parts of the leading edges (13, 18) and trailing edges (14, 21) respectively, which are on both sides of the bend (15, 20), relative to the flow direction (12, 19; 12', 19'), is the same.

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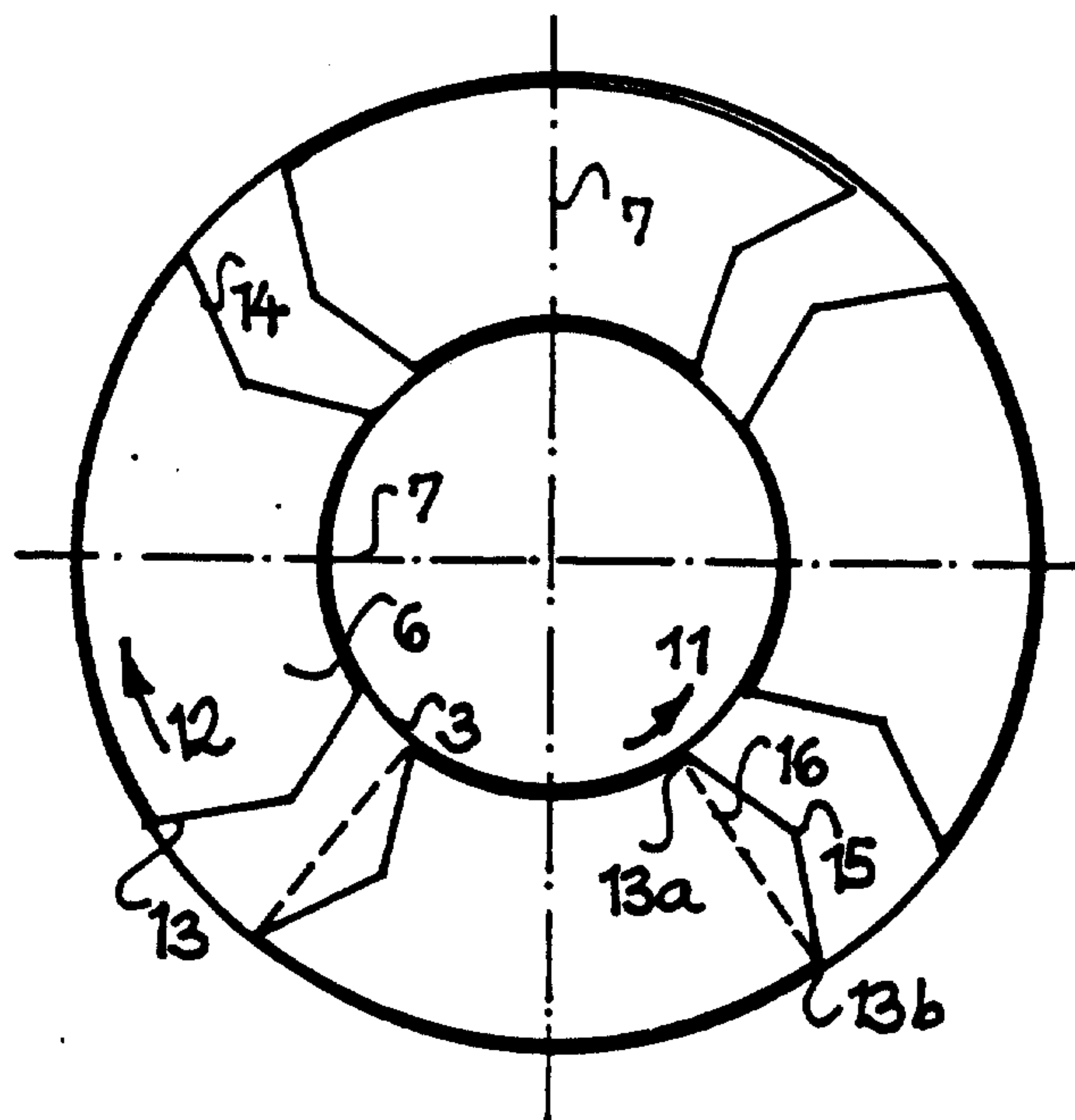


Fig. 2

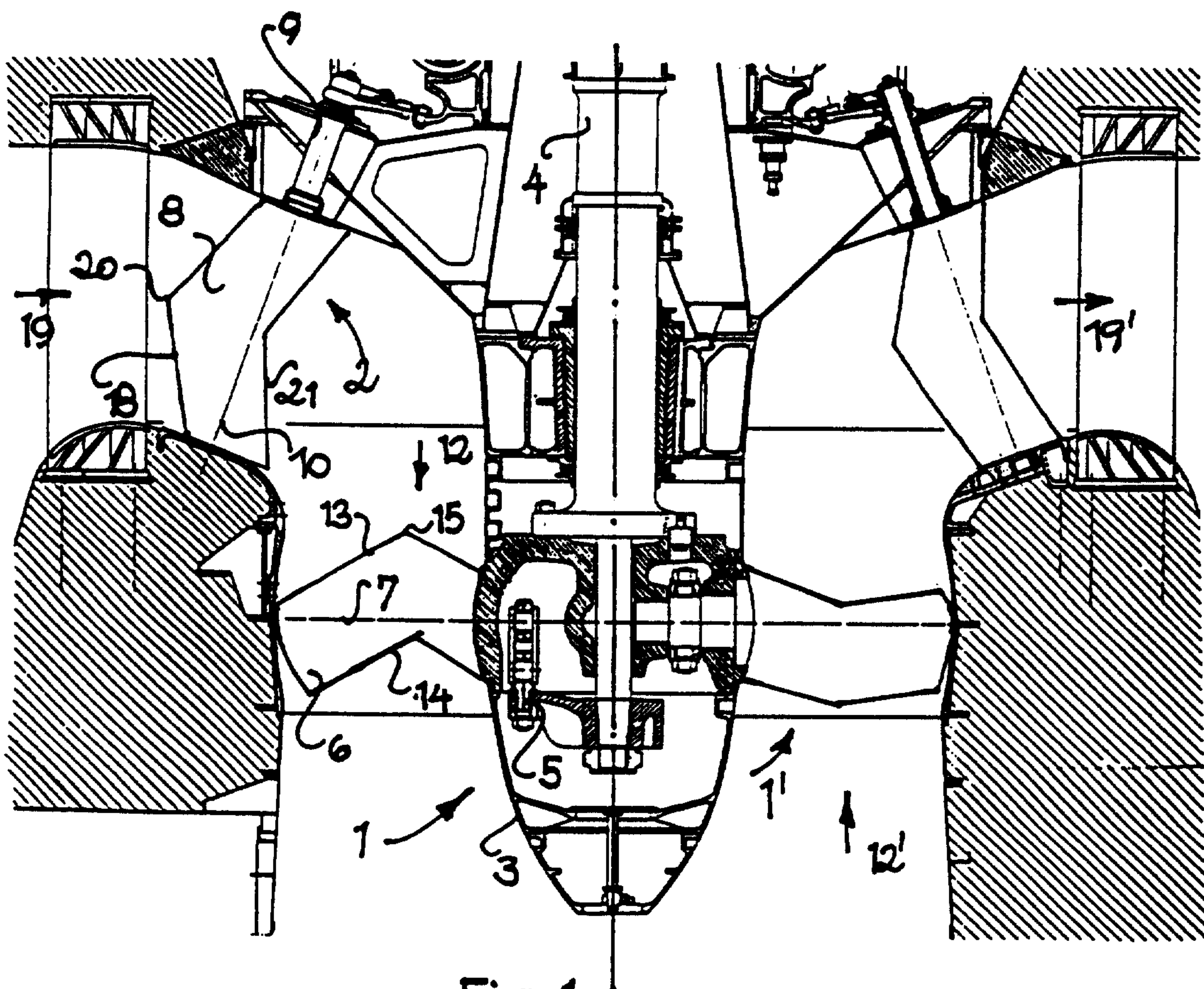


Fig. 1