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(71) Demandeur/Applicant:
ANDRITZ TECHNOLOGY AND ASSET MANAGEMENT GMBH, AT

(72) Inventeur/Inventor:
HAUGEN, JAN OTTO, NO

(74) Agent: BERESKIN & PARR LLP/S.E.N.C.R.L.,S.R.L.

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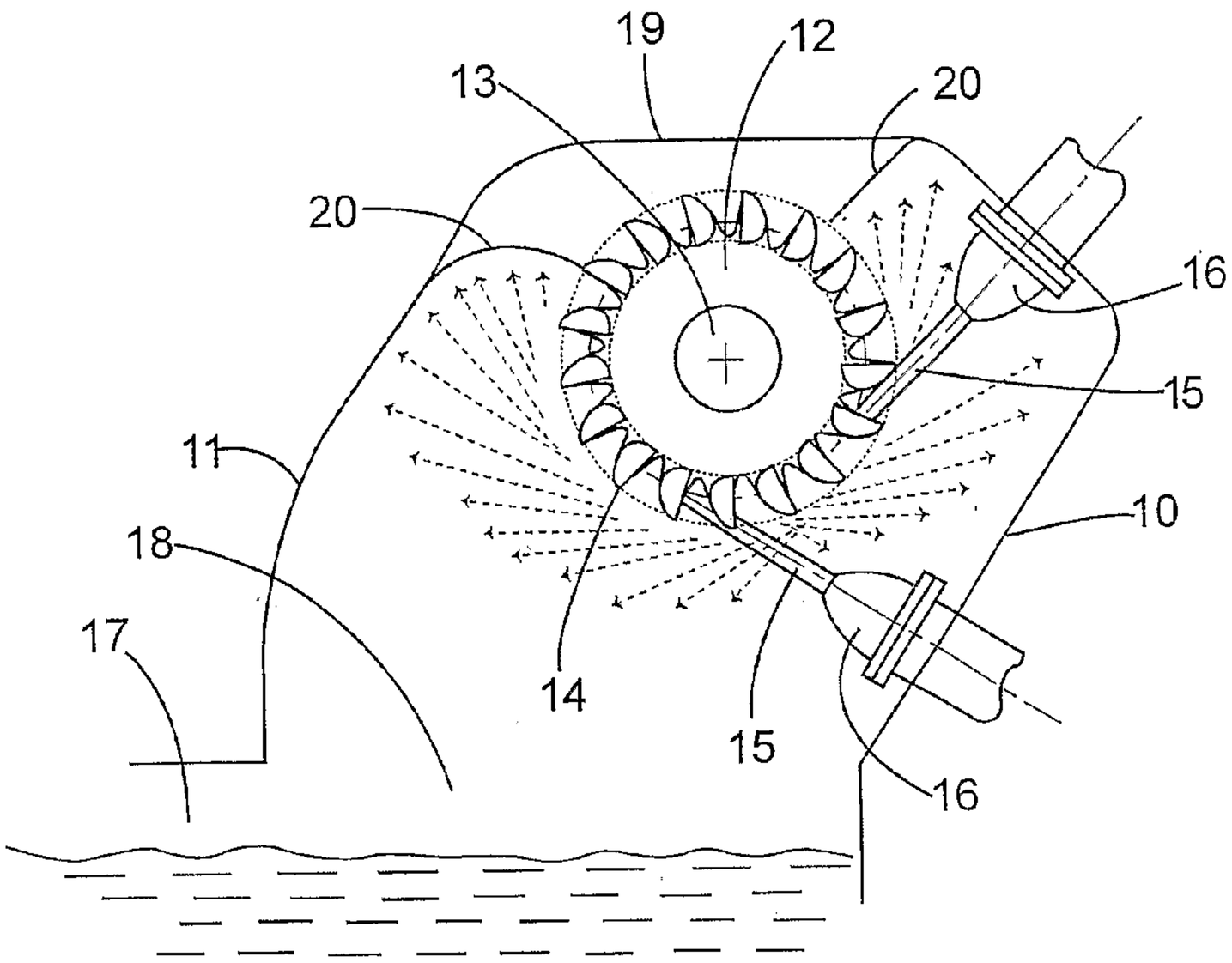

(57) Abrégé/Abstract:
The present invention relates to a method and means for enhancing the efficiency of water turbines, in particular Pelton turbines. The water turbine comprises a rotatable turbine wheel having a wheel disc and preferably a plurality of buckets fixed to the wheel disc, and further comprising at least one nozzle for expelling a water jet on the at least one bucket. The rotatable wheel and the at least one nozzle are arranged in a casing with a water outlet, and the interior of the casing is provided with means for reducing splash back of discharging water and detrimental water spray on the rotatable wheel. One or more energy damping devices is/are attached on stationary, water splash exposed parts inside the turbine casing in order to dissipate energy at least from water of high velocity leaving the buckets and/or dense pulverised water mist.

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(71) Applicant *(for all designated States except US)*: **GE ENERGY (NORWAY) AS** [NO/NO]; Gasevikveien 6, N-2027 Kjeller (NO).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **HAUGEN, Jan, Otto** [NO/NO]; Heimdalsveien 84, N-7080 Trondheim (NO).

(74) Agent: **J.K. THORSENS PATENTBUREAU A/S**; P.O. Box 9276 Grønland, Grønlandsleiret 31, N-0134 Oslo (NO).

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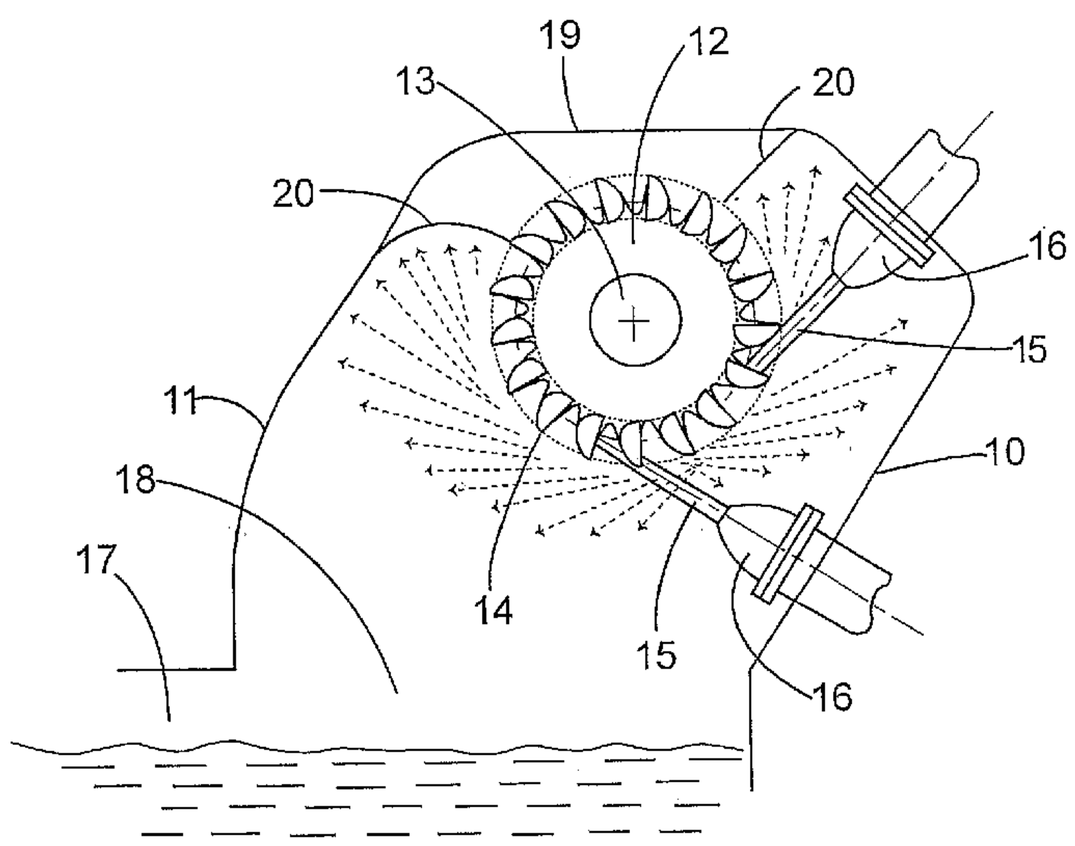

(57) **Abstract:** The present invention relates to a method and means for enhancing the efficiency of water turbines, in particular Pelton turbines. The water turbine comprises a rotatable turbine wheel having a wheel disc and preferably a plurality of buckets fixed to the wheel disc, and further comprising at least one nozzle for expelling a water jet on the at least one bucket. The rotatable wheel and the at least one nozzle are arranged in a casing with a water outlet, and the interior of the casing is provided with means for reducing splash back of discharging water and detrimental water spray on the rotatable wheel. One or more energy damping devices is/are attached on stationary, water splash exposed parts inside the turbine casing in order to dissipate energy at least from water of high velocity leaving the buckets and/or dense pulverised water mist.

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METHOD AND MEANS FOR ENHANCING THE EFFICIENCY OF WATER TURBINES

The present invention relates to a method and means for enhancing the performance and efficiency of water turbines, in particular, but not exclusively, Pelton turbines.

Generally, when water at high pressure and/or velocity hits the parts of the turbine intended to be rotated, water has a tendency to splash, causing spray on the casing walls and/or on other parts of the turbine intended to be rotated. In particular, Pelton turbines are exposed to secondary losses originating from water of high velocity leaving the buckets, hitting stationary parts inside of the turbine casing and causing losses generated from

i) splash back to the wheel and

ii) disturbances to the incoming jet of water.

Pelton turbines with wheels having a horisontal axis of rotation are in particular exposed to such losses. Such vagrant spray is detrimental and should be eliminated, or at least reduced.

Further, when water subjected to high pressure hits hard surfaces and obstructions at an angle, the water has a tendency to be highly pulverized, causing fine droplets and droplets of "compressed" mist inside the housing. Such droplets or mist of "compressed" droplets is another source of loss in a water turbine, causing so called "windage loss". "Windage loss" in a Pelton turbine comprises frictional losses and impact losses between rotating parts (running wheel) and particles in the atmosphere inside the casing surrounding the rotating parts. For a Pelton turbine, this means the rotational resistance which the wheel is subjected to inside the casing, caused by air containing "compressed" water droplets.

It has previously been proposed to keep vagrant water spray away from the turbine wheel and buckets on a Pelton turbine. In order to reduce vagrant spray on the rotating wheel and the buckets in a Pelton turbine having a horizontal axis of rotation, it has been proposed to provide the upper region of a turbine casing with vertical metal sheets parallel to the plane of the turbine wheel, while horizontal sheets are disposed opposite the high pressure nozzle in order to prevent water spray from reaching the upper region of the casing.

US patent Specification No. 4,950,130 discloses a Pelton turbine which includes a wheel disc with buckets, mounted within a casing on a rotatable shaft. At least one nozzle is provided for expelling a fluid jet tangentially of the disc onto the buckets. A partition divides the interior of the housing into a spray fluid and outlet region and an upper ventilation region. The partition is located so that more than half the turbine wheel rotates in the relatively dry ventilation region. The driving fluid falls from the buckets into a sump in the outlet region, while residual fluid is wiped off the turbine wheel by the partition. The ventilation region allows ventilation of the casing and also produces a flow of gas for increasing the pressure in the sump to improve outflow of fluid.

Internal flow observations by model testing of Pelton turbines reveal the existence of the physical loss phenomena due to internal water flow interactions inside the turbine casing. Development and design of flow guides by model testing is a common way to solve the problem. However, the process can be very time consuming, and sometimes gives only minor efficiency improvement.

Previous and existing approach to the problem of energy losses due to energy dissipation in water turbines due to splashing water, is to design and provide the turbine casing with physical flow guides and screens as described above. It is found by model testing, however, that even if flow guides are installed, only a minor part of the losses may be eliminated.

An object of the present invention is to improve the performance, reliability and the efficiency of a water turbine.

Another object of the invention is to reduce the required size and volume of the turbine casing.

A further object of the invention is to provide a solution which may also be applied to existing turbines, thereby improving their efficiency and performance in a low cost manner.

A still further object of the invention is to prevent vagrant water or secondary spray of water from hitting the rotating parts of the turbine.

An additional object of the invention is to improve the atmospheric conditions inside the turbine casing, reducing the "windage losses".

A still further object of the invention is to reduce vibration and noise originating from the turbine casing walls being exposed to water of high velocities and high frequency turbulences.

The objects and the enhancement of the present invention are achieved by the features specified in the characterizing part of the independent claims. According to the present invention a method and means for eliminating or at least reducing the secondary losses occurring inside a water turbine is provided.

According to the present invention the efficiency and the performance of water turbines are improved in general and on Pelton turbines in particular, by attaching one or more energy damping devices on stationary, water splash exposed parts inside the turbine casing in order to reduce the amount of detrimental spray water on the rotating turbine wheel, thereby dissipating energy at least from water of high velocity leaving the buckets and/or from dense pulverized water mist.

According to the present invention it is also feasible to enhance the efficiency and the performance of existing water turbines without having to perform extensive and expensive re-construction or up-grading of existing turbines.

By covering the exposed walls and other stationary parts inside the turbine casing with the energy dissipating device, the energy that always is left in the water will be dampened out and the water will fall down without causing any negative effects. For new Pelton turbines, energy dissipating wall covers make it possible to reduce the main casing dimensions and to simplify the casing design, and still maintain a high level of performance. For upgrading of old, existing turbines, wall covers, if needed, may compensate for more costly introduction of flow guides and screens, for example of the guiding ribs type or the like.

Secondary efficiency losses may vary from 0,5% for new turbines, to 1 - 5 % or more for old, existing turbines. Eliminating these losses will

1) improve the efficiency of the turbine,

2) increase reliability regarding given guarantees and

3) reduce production costs for high performance Pelton turbines.

Although production costs will increase somewhat due to the addition of the wall covers, the energy generation of the power plant in which the turbine is installed will increase due to increased efficiency, making such investment payable.

One embodiment of the proposed device may preferably be in the form of a simple, low-cost, standardized mat of a certain shape, width and thickness, preferably made from commercial materials. The mat is rolled out, trimmed to the actual wall or part dimension, and fixed to the walls. In addition to efficiency improvement, the mat also has a potential to reduce forces acting on stationary turbine parts at runaway conditions.

According to the present invention the atmospheric conditions inside the turbine casing is improved, causing reduction of the "windage losses", since the turbine casing walls being hit by water from the wheel buckets are covered by means for absorbing, dampening or dissipating energy.

Further, due to said means for absorbing, dampening or dissipating, the vibration and noise originating from the turbine casing exposed to water of high velocities and frequencies are reduced.

According to the present invention the detrimental effect of "aggressive" water is dampened by limiting detrimental back spray of water on to the running wheel and/or the water jet(s) leaving the water nozzles. Further, the so called "windage loss" is reduced.

The invention will in the following be described more detailed, with reference to the accompanying drawing, in which:

Fig. 1 shows schematically a vertical section through a horizontal Pelton turbine, indicating directions of water leaving the wheel;

Fig. 2 shows schematically the vertical section through the turbine shown in Fig. 1, indicating water exposed areas inside the turbine casing.

The turbine 10 shown in Figs. 1 and 2 comprises a casing 11, covering a running wheel 12 and a shaft 13, rotatably arranged in bearings (not shown) mounted in the walls of the casing 11. Along the periphery of the wheel 12, a large number of buckets 14 are

arranged. When subjected to jets of water 15 from nozzles 16, impacting the buckets 14 at high pressure and/or velocity, the wheel 12 rotates at a high speed. According to the embodiment shown in Fig. 1 two nozzles 16 are used to rotate the wheel 12.

At its lower end, the casing communicates openly with a sump 17 through a fluid outlet 18, for discharging spent water which has been ejected into the buckets 14. At its upper end, the casing is provided with a top cover 19 and an inner partition 20, preferably contoured so as to form a dividing seal inside the casing. The arrows shown in Fig. 1 indicate the direction of water leaving the buckets 14 subsequent to impacting said buckets 14.

Fig. 2 indicates typical surface areas 21A-21F inside the casing 11, subjected to detrimental splashing. It should be appreciated that also the inner surfaces of the inner partitions are subjected to such detrimental splashing. Further, there are other surface areas than those indicated in the Figs. which also may be subjected to such detrimental splashing.

According to the present invention, the surface areas prone to detrimental splashing may be provided with surfaces suited for damping the back-splashing. Such surfaces may incorporate means for damping the splashing. The means may for example be mats fixed to the surfaces 21A-21F in any suitable manner, the mats being of a material and having a surface suitable for dissipating the energy of the splashing water. The mats may be made of a plastic materials, metal plates and/or a composite, e.g. with a surface texture suitable for improving the damping effect.

According to an alternative embodiment of the present invention, it should be appreciated that the damping means in addition to or in lieu of mats, may comprise metallic damping means such as chains fixed to the inner surfaces and/or expanded metals, gratings or the like.

According to the present invention, "energy dissipating wall covers" attached to walls and stationary components exposed to water inside Pelton turbines, are used to reduce or eliminate secondary turbine efficiency losses.

The invention may be used on all Pelton turbines, especially horizontal types, and both new and existing ones. It should be appreciated, however, that the present invention may

also be used in any other type of water turbines where splashing or compressed droplets may be present, causing detrimental reduction of the efficiency of the turbine.

It should be appreciated that although the Figs. disclose a twin-jet Pelton turbine, the invention is also applicable for turbines having any number of nozzles, without deviating from the inventive idea.

The damping means may be made of chains, made of any suitable material, such as plastic materials, composite, metal or the like.

Alternatively, the damping means may comprise means such as expanded metal or grating, made of any suitable material, such as plastic materials, composites, metal or the like.

Alternatively, the damping means may comprise means such as cassettes of expanded metal or grating enveloping damping filling material chips made of any suitable material, such as plastic materials, composites, and/or metal or the like.

Claims

1. A method for enhancing the efficiency of a water turbine, in particular a Pelton turbine, the turbine comprising a rotatable turbine wheel having a wheel disc and preferably a plurality of buckets fixed to the wheel disc, and further comprising at least one nozzle for expelling a water jet on the buckets, the rotatable wheel and the at least one nozzle being arranged in a casing with a water outlet, and the interior of the casing being provided with means for reducing splash back of water leaving the wheel, or detrimental water spray on the rotatable wheel, c h a r a c t e r i z e d i n t h a t one or more energy damping devices are attached on stationary, water splash exposed parts inside the turbine casing in order to dissipate energy at least from water of high velocity leaving the buckets and/or dense pulverised water mist.

2. A method according to claim 1, wherein the damping device or devices is/are trimmed and adapted to the actual wall and/or part dimension.

3. A method according to claim 1, wherein one or more damping devices are attached to flow guides inside the turbine casing.

4. A method according to any of the claims 1 - 3, wherein the damping device or devices is/are attached to the interior surface of a single-jet or multi-jet Pelton turbine, the damping device or devices being configured to guide water away from the rotating wheel and/or the incoming water jet(s).

5. Means for enhancing the efficiency of a water turbine, in particular a Pelton turbine, the turbine comprising a rotatable turbine wheel having a wheel disc and preferably a plurality of buckets fixed to the wheel disc, and further comprising at least one nozzle for expelling a water jet on the buckets, the rotatable wheel and the at least one nozzle being arranged in a casing with a water outlet, and the interior of the casing being provided with means for reducing splash back of water leaving the wheel, or detrimental water spray on the rotatable wheel, c h a r a c t e r i z e d i n t h a t one or more energy damping devices are attached on stationary, water splash exposed parts inside the turbine casing.

6. Means according to claim 5, wherein the damping device or devices has/have a roughened exterior surface facing the space in which water spraying occurs.

7. Means according to claim 5 or 6, wherein the roughened surface is in the form of looped threads.

8. Means according to claim 5 or 6, wherein the damping device or devices comprises/comprise means such as chains, made of any suitable material, such as plastic materials, composite, metal or the like.

9. Means according to claim 5 or 6, wherein the damping device or devices comprises/comprise means such as expanded metal or grating, made of any suitable material, such as plastic materials, composites, metal or the like.

10. Means according to claim 5 or 6, wherein the damping device or devices comprises/comprise means such as cassettes of expanded metal or grating enveloping damping filling material chips made of any suitable material, such as plastic materials, composites, and/or metal or the like.

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FIG. 1

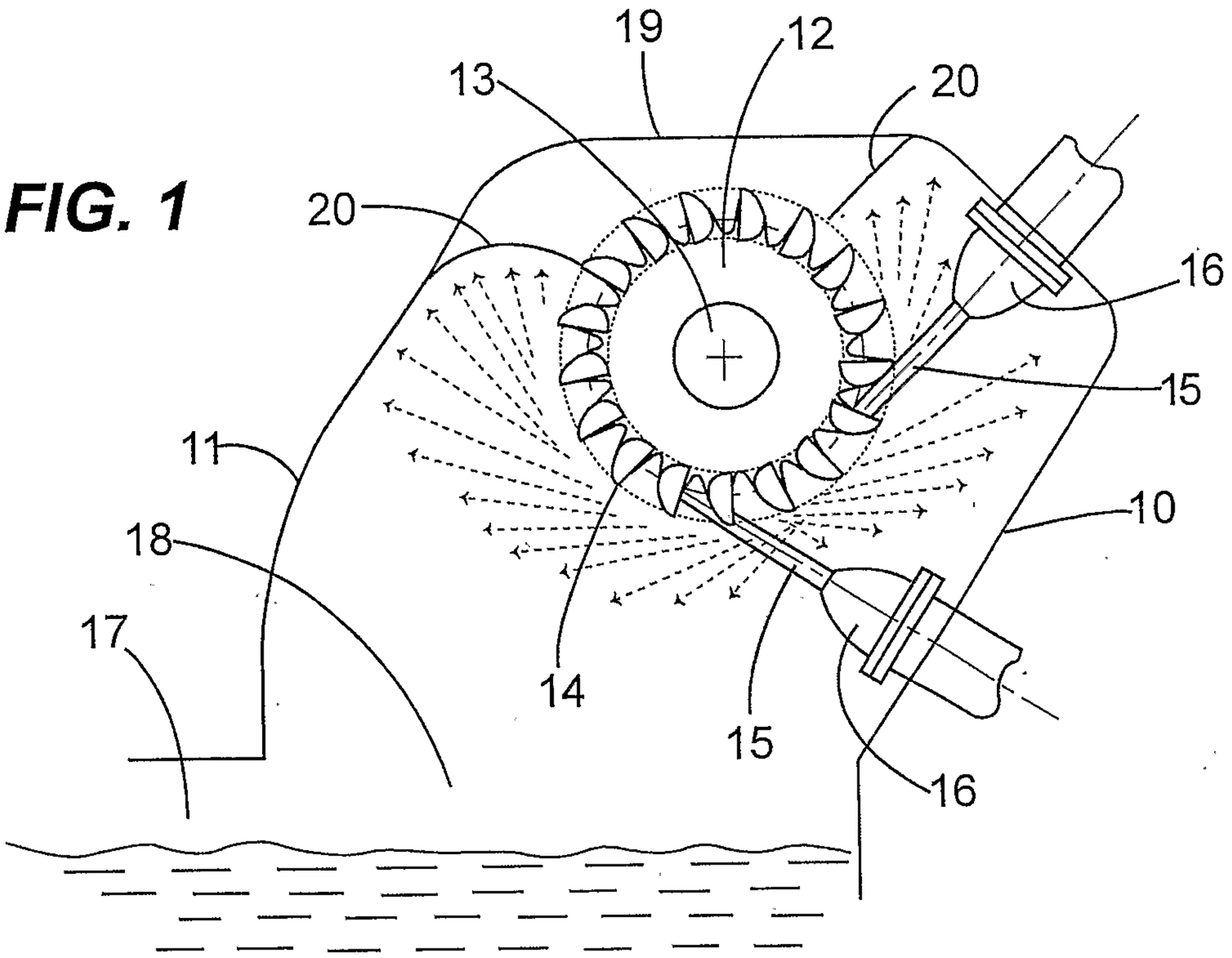
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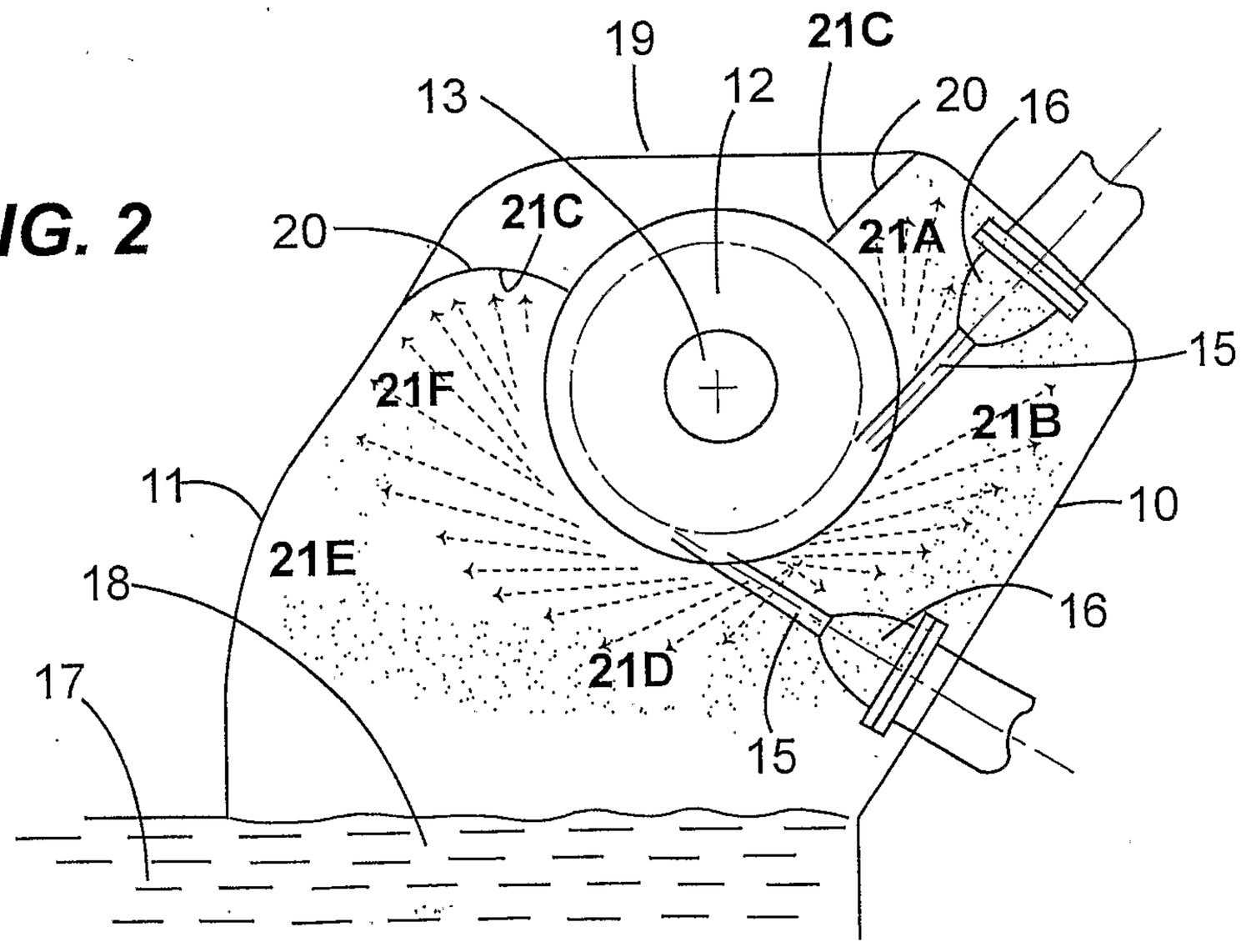
FIG. 2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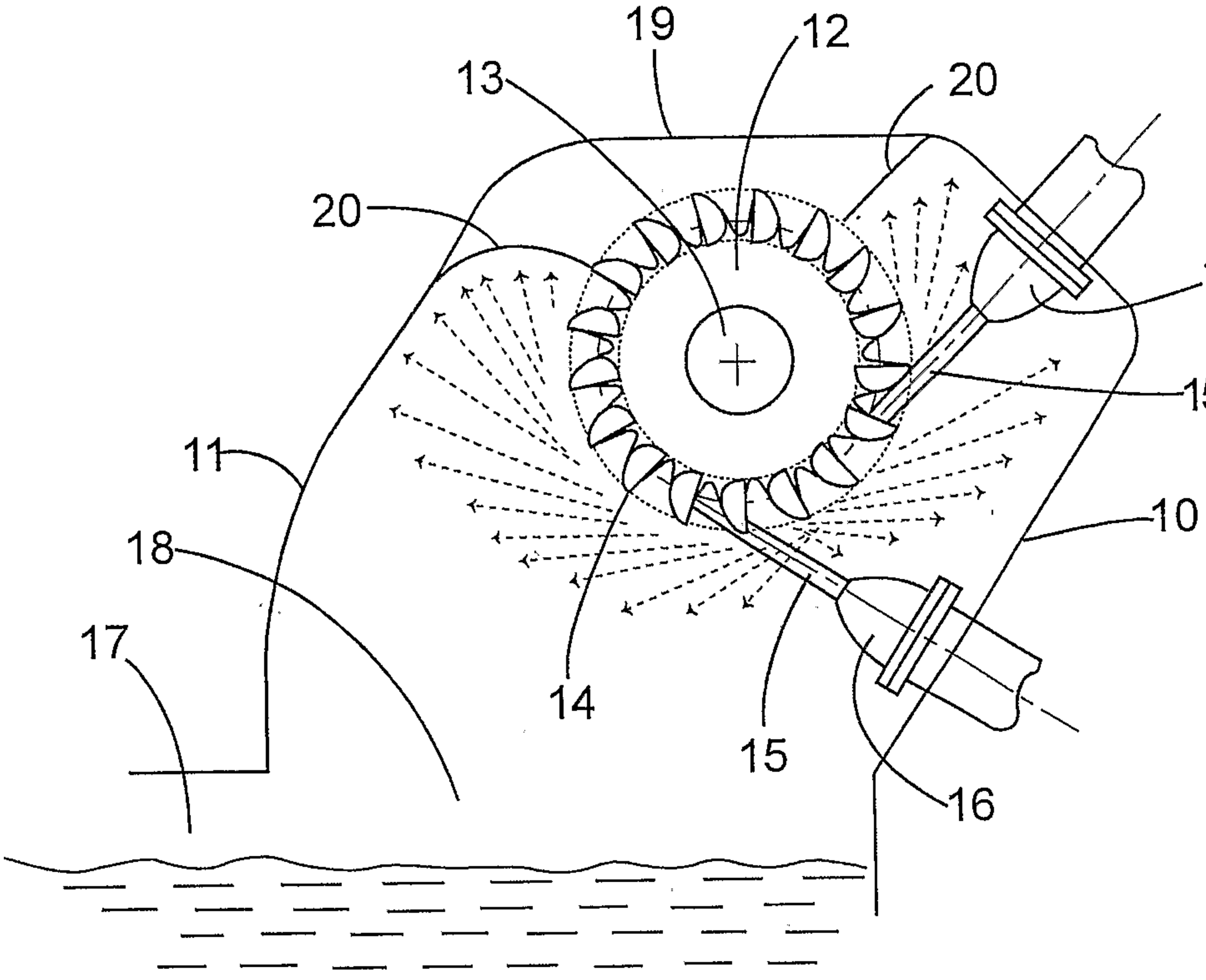
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