D. BÁNKI.

WATER TURBINE.

APPLICATION FILED MAY 23, 1919.

1,436,933. Patented Nov. 28, 1922.

3 SHEETS—SHEET 1.

Fig. 1.

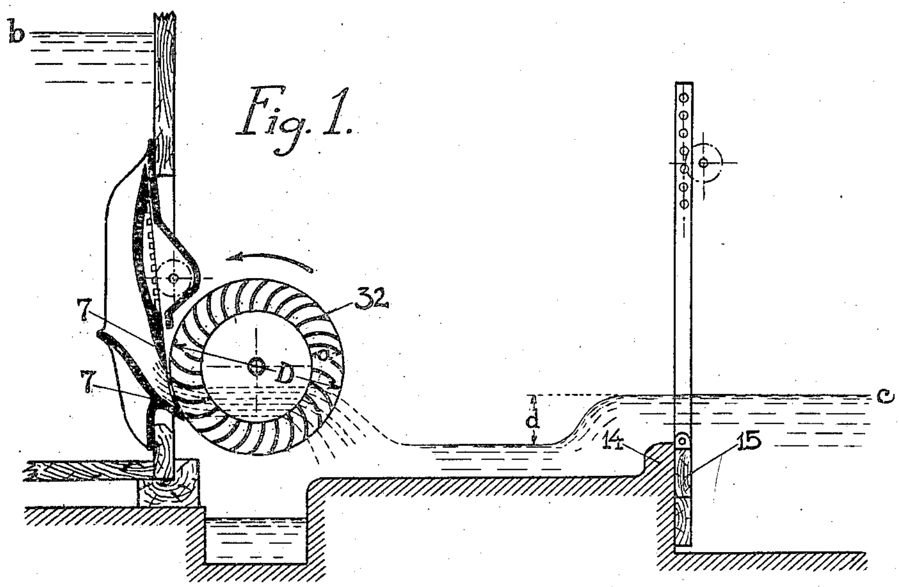
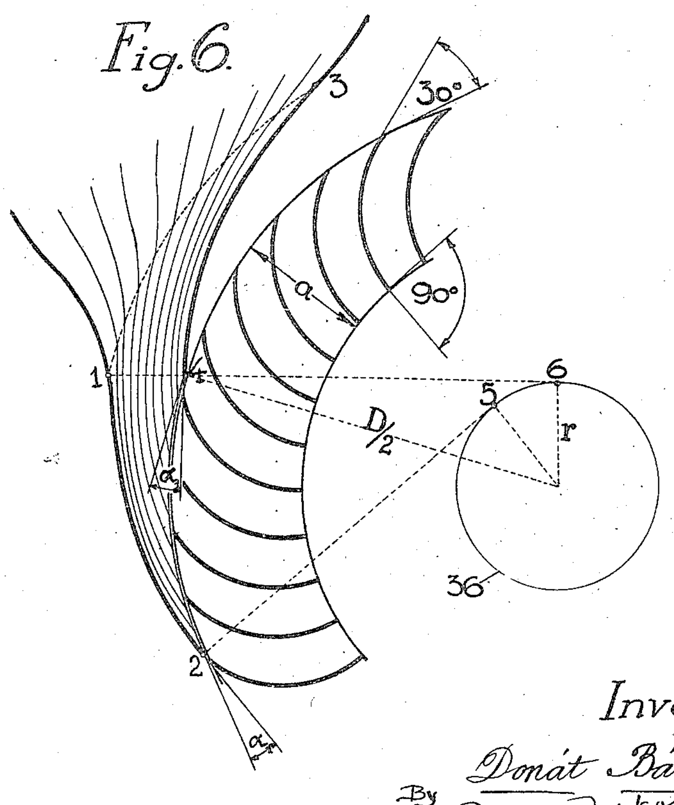


Fig. 6.



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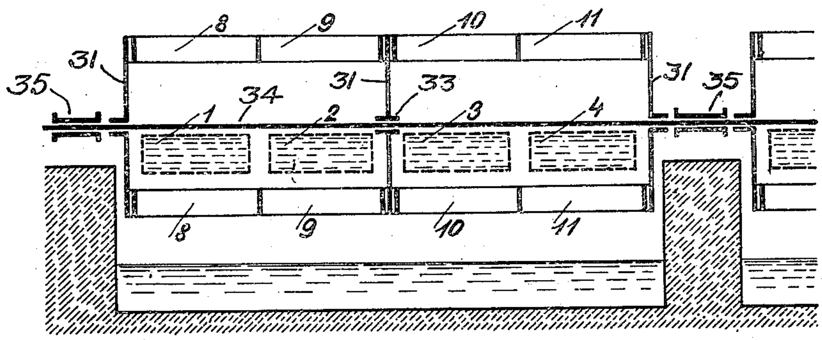
3 SHEETS—SHEET 2.

Fig. 2.



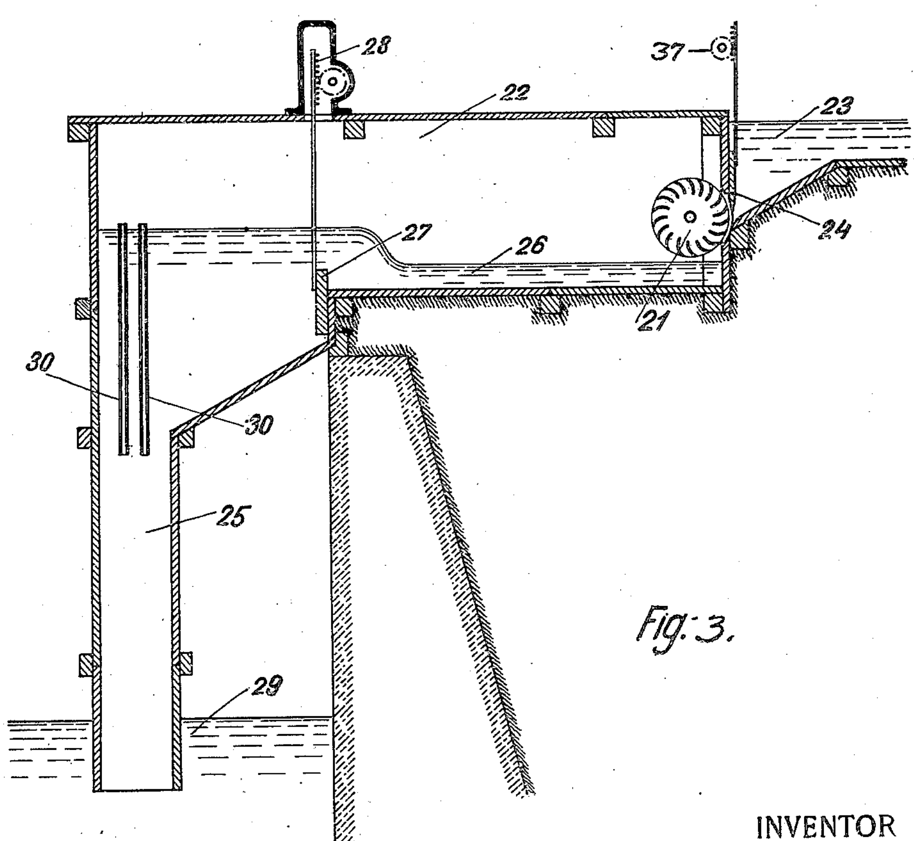


Fig. 3.

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3 SHEETS—SHEET 3.

Fig. 4.

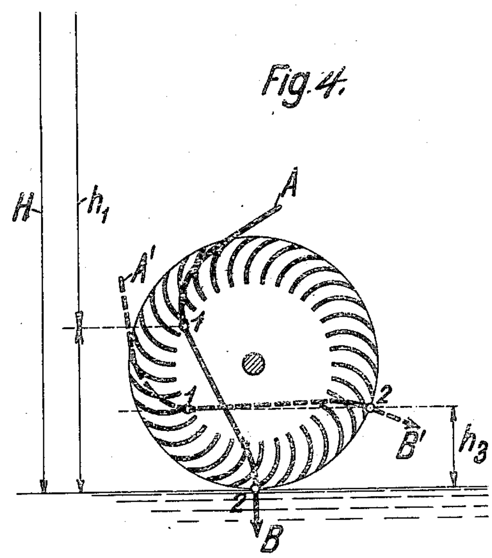
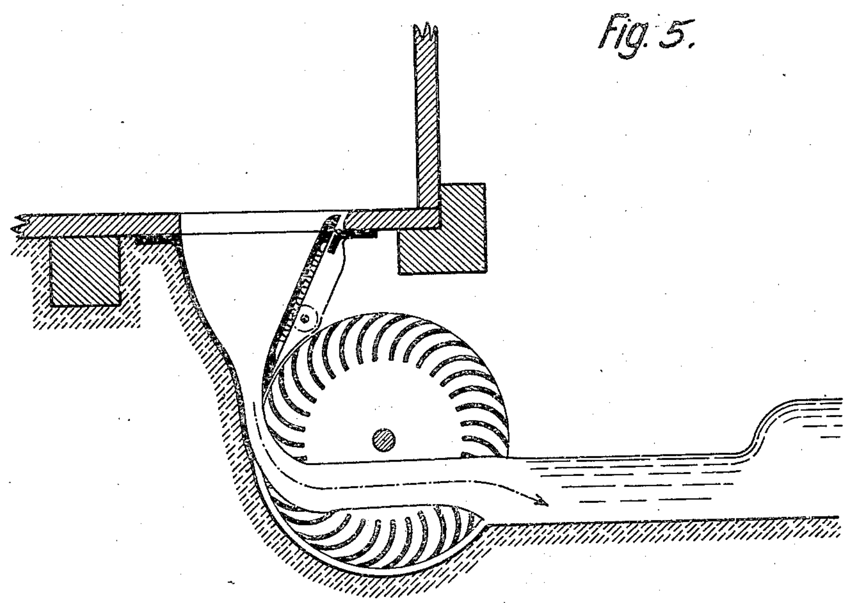


Fig. 5.



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UNITED STATES PATENT OFFICE.

DONÁT BÁNKI, OF BUDAPEST, HUNGARY.

WATER TURBINE.

Application filed May 23, 1919. Serial No. 299,377.

To all whom it may concern:

Be it known that I, DONÁT BÁNKI, a citizen of the Republic of Hungary, residing at II Rózsahegy-utca 6, Budapest, Hungary, having invented certain new and useful Improvements in Water Turbines, do hereby declare that the following is a full, clear, and exact description of the same.

The subject matter of the present invention relates to turbines, partially impinged externally in a radial direction by the actuating fluid and more particularly of that type wherein the fluid stream issuing within the wheel rim, again traverses the rim from within outward and leaves the wheel outwardly. Both the inflow and the outflow of the fluid, therefore, take place on the outer circumference of the wheel.

The embodiments of my invention are disclosed in the following drawings, wherein:

Figure 1 shows a cross section of the turbine taken at right angles to the wheel axis.

Fig. 2 shows a longitudinal section thereof.

Fig. 3 is a cross section of the device arranged within an air-tight chamber.

Figs. 4 and 5 show in cross section further embodiments of the invention for directing the flow of the fluid stream.

Fig. 6 diagrammatically shows the form of evolvent like surfaces and the manner in which the water impinges the turbine wheel.

In order to avoid the disadvantages which are inherent in the free stream turbine, in the turbine forming the subject matter of the present invention, I provide that the impact, instead of being caused by a free stream is controlled by guide channels, which convey the fluid to the wheel on evolvent like surfaces indicated by the numerals 7, 7 in Fig. 1, in such a way that all threads of the stream cut the circumference of the wheel at almost equal angles. In practical construction (as diagrammatically represented in Fig. 6) the evolutes are replaced by circular arcs 1—2 and 3—4 from the points 5 and 6 respectively on a basic circle 36 of radius $r=\frac{D}{2}\sin\alpha$, where D indicates the diameter of the turbine wheel and α, the absolute angle of entrance of the water stream. In Fig. 6 $\alpha_1=16°$ has been chosen. In said figure also the separate water threads have been indicated as they might run. As will be seen, it is assumed that all water threads cut the wheel circumference under an angle of 16 degrees. One would, therefore, attempt to maintain as large a stream deviation as possible and thereby to increase the utilization of the water energy, to maintain this absolute inflow angle as small as possible, yet for practical reasons one will not do well to go below about $\alpha_1=16°$. With this angle and under the most favorable circumferential velocity there results the respective inflow angle, that is, the external paddle angle approximating 30°.

In order to bring it about with these paddles or vanes with an outer angle of the paddles or vanes of approximately 30 degrees and an inner angle of the paddles or vanes of approximately 90 degrees (as illustrated in Fig. 6), that the outlet channel sections at the inner periphery of the wheelrim be completely filled with water without causing congestion, the radial length of the wheelrim must be suitably dimensioned. This requirement is attained if the paddles or vanes extend through approximately 0.17 of the diameter of the wheel, i. e., $a=0.17$ D (Figs. 1 and 6).

An embodiment of the turbine, according to the invention and according to the above mentioned principles, is illustrated in Fig. 1 in cross section and in Fig. 2 in longitudinal section. The turbine-wheel consists of two or more circular disks 31 (Fig. 2) and of paddles or vanes 32 (Fig. 1) which are arranged in annular series around the circumference of the wheel and between the disks, forming rim divisions 8, 9, . . . The disks 31 are provided with bosses 33 for mounting them on the shaft 34, which revolves in bearings 35. If the amount of water at disposal is very great then there must be employed a wheel of a very great axial width, which would require a long and therefore very strongly dimensioned shaft. In order to avoid this, instead of a single very wide wheel there are employed two or more smaller wheels side by side, each of which has its own shaft (Fig. 2). The impact water is conducted from several openings 1, 2, 3, . . . by means of conducting surfaces 7 under equal angles of all the stream threads onto the wheel which by disks or rim partitions is divided into as many parts as the number of impact openings amount to. The rim divisions (8, 9, . . .) are wider than the length of the openings, in order to leave between them and the ends of the mouths sufficient space for the airing.

In plants with water turbines of radial in and outflow the double passage of the water through the turbine brings it about that the respective outflow angle is of equal size with the respective inflow angle. The latter receives, as above stated, a size not very greatly varying from 30°, this, however, lies considerably higher than is usually assumed in turbines for the outflow angle. The result of this is that in turbines of this kind, the absolute outflow velocity of the water under similar conditions, is greater than in ordinary turbines, where this velocity must not be greater than is necessary for conducting away the water. To utilize this surplus speed I arrange the wheel deeper than the under water level—*c*—(Fig. 1), and I place in the discharge passage a weir, baffle or resistance 14 in order to produce a water leap by means of the outflow speed. By this way the fall between the upper water level—*b*—and the under water level—*c*—is increased with the difference—*d*—between the water level under the wheel and the under water level—*c*—. It is known that water flowing with a certain speed relatively to the deepness of the channel dashing against a weir is able to overleap the weir. For regulating and abutting of the water swell a gate 15 is provided.

If the turbine should be placed above the under water level in a greater height, then there is necessary, for avoiding a loss of fall which arises in this case, to arrange the same in an airtight closed chamber, in which the air is sufficiently rarefied to maintain the water level under the turbine upon a constant level. This arrangement is shown in Fig. 3, in which 22 indicates the air-tight chamber made of iron, cement, iron-concrete or wood, the shaft of the turbine 21 extending through the walls of said chamber in packings. The water from the upper water level 23 enters through a slider 24 which may be regulated with gear and rack mechanism 37. The discharged water flows for the purpose of separating the air from the water through a horizontal channel 26 and over a weir 27 (for the purpose of obtaining a water leap) which may be regulated by a rack 28 to the vertical exhaust pipe 25. The latter acts as an exhausting pipe and produces in the chamber 22 a sufficient vacuum. From there the water flows into the under water 29. For preventing the separated air from accumulating in the chamber and thus pressing down the water level therein, in the exhaust pipe 25 the sucking pipes 30 are arranged extending up to the water level. By these pipes the excess of air in the chamber 22 will be sucked away.

A further improvement in the turbines according to the present invention is to be explained from Figs. 4 and 5.

In order to avoid a loss of fall the impact of the divisionally impacted turbines is arranged so low that the outflow from the wheel takes place as near as possible to the lowest point of the wheel. According to the present invention in turbines with radial in and outflow on the circumference of the wheel and free passage through the wheel drum, in contradistinction from this arrangement which is advantageous in ordinary turbines, the middle of the outflow point is to be transferred to a point over the lowest point of the wheel.

For explaining and justifying the new arrangement in Fig. 4 of the accompanying drawing wherein the two arrangements are illustrated diagrammatically through the middle water threads, A B is the absolute water course of the middle thread in the case of the outflowing at the lowest point of the wheel, and A′ B′ the water-way in accordance with the new arrangement, wherein the outflow lies over the lowest point of the wheel by h_3, where consequently this fall h_3 is given as lost. On closer observation it appears, however, that of the two arrangements the latter is the more favorable, and, in fact, so much the more as the top position of the inner outflow point 1 approaches the top position of the outer outflow point 2. The best degree of efficiency is obtained if the two outflow points coincide in one horizontal. In order to explain this we must keep in mind that in the two different impacts the energy is not taken from the water in equal portions. With a paddle entrance angle of 30° on the first passage of the water through the wheel rim there is about 78% of the available fall made useful and on the second passage only about 22% of the fall available up to the respective outlet point.

Assuming that the transformation of energy into work in the two impacts takes place with equally great efficiency (η) then the energy of the turbine in the first arrangement can be expressed with

$$\eta_1 H = 0.78\ h_1 \div 0.22\ H \qquad (1)$$

designates the hydraulic efficiency of the turbine.

For the second arrangement, where consequently the outflow points fall into one horizontal, the hydraulic efficiency of the turbine becomes η_2 and its output

$$\eta_2 H = H - h_3 \qquad (2)$$

From the equations (1) and (2) it follows that the efficiency in the second arrangement is greater than that in the first, that is $\eta_2 > \eta_1$ if $h_3 < 0.78\ h_2$, which is, however, as a matter of fact the case since in reality approximately $h_3 = 0.45\ h_2$.

In Fig. 5 this new arrangement is shown for the case where the lower water level lies above the lower wheel crown point. In this case the new arrangement, as compared with the former, besides the higher efficiency offers still the advantage that the outflow velocity receives a more favorable direction for the production of a water spurt or leap.

Patent claims:

1. An inward-flow water turbine of the partially impacted type, comprising a wheel, a plurality of paddles or vanes mounted on the periphery of said wheel, a free passage through the centre of said wheel traversed by the water stream and guide channels conveying the water to the wheel, characterized by the fact that the walls of said channels are formed with involute-like faces, whereby all threads of the water stream will cut the circumference of the wheel at substantially the same angle.

2. An inward-flow water turbine of the partially impacted type, comprising a wheel, a plurality of paddles or vanes mounted on the periphery of said wheel, a free passage through the centre of said wheel traversed by the water stream and guide channels conveying the water to the wheel, the walls of which are formed with involute like faces, characterized by the fact that the paddles or vanes extend through approximately 0.17 of the diameter of the wheel, the outer ends of the paddles or vanes forming an angle of approximately 30 degrees with the outer periphery of the wheel rim, and the inner ends of said paddles or vanes extending rectangularly to the inner periphery of the wheel rim, whereby the outlet channel sections at the inner periphery of the wheel rim are completely filled with water without causing congestion.

3. An inward-flow water turbine as claimed in the claim 1, characterized by the fact that the channels between the paddles or vanes are in the direction of the axis broader than the length of the channels conveying the water to the wheel, in order to leave between the former and the ends of the water conveying guide channels a sufficient space for ventilation of the wheel.

4. An inward-flow water turbine as claimed in the claim 1, characterized by the fact that the inner outflow point and the outer outflow point of the water coincide in a substantially horizontal line.

5. An inward-flow water turbine as claimed in the claim 1, wherein the inner outflow point and the outer outflow point of the water coincide in a substantially horizontal line, characterized by the fact that the water wheel is arranged deeper than the under water level and a weir or baffle is placed in the discharge channel in order to produce a water spurt or leap.

6. An inward-flow water turbine as claimed in the claim 1, wherein the inner outflow point and the outer outflow point of the water coincide in a substantially horizontal line, in combination with an airtight closed chamber for the water wheel, a discharge channel below the water wheel leading to an exhaust pipe and a weir or baffle in said channel to produce a water spurt.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

DONÁT BÁNKI.

Witnesses:
SIGISMUND YERMANN,
EUGEN MOSKOVITZ.