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(71) Applicant: **DIXI HOLDING B.V.** [NL/NL]; Heuvelenweg 18, NL-7241 HZ Lochem (NL).

(71) Applicants and
(72) Inventors: **SIDLER, Hendricus, Franciscus, Antonius** [NL/NL]; Heuvelenweg 18, NL-7241 HZ Lochem (NL). **SIDLER, Martinus, Antonius, Waltherus** [NL/NL]; Achterom 63, NL-3995 EK Houten (NL).

(74) Agent: **CRANS, H., J., A.**; CraLink, Dishoekhof 8, NL-5043 GS Tilburg (NL).

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(54) **Title:** IMPROVED VERTICAL AXIS WATER TURBINE, CALLED HYDRO-TURBY

(57) **Abstract:** The invention relates to an improved vertical axis wind turbine (1), called Hydro-Turby, for, in an inventive and simple way, converting flow energy of water in a stream, river, tide channel and such into electric power, in which the water turbine (1) has at least one vertically shaped rotor body consisting of helix-shaped blades with wing-shaped cross-section (10) which are located at a constant distance R from the vertical rotation axis (2), in which the rotation axis (2) in its turn drives the generator (3) for generating the electric power, in which the generator (3) is connected to the user by means of a cable, in which the mentioned water turbines (1) can also be used in combination above or below each other for creating more electric power, in which the mentioned water turbines (1) are surrounded by mesh-shaped cage constructions for protection against floating objects in the mentioned water flow.

IMPROVED VERTICAL AXIS WATER TURBINE, CALLED HYDRO-TURBY

The present invention relates to a device for converting flow energy in fluid such as, for example, water into electric energy, in which the device is called water turbine or Hydro-Turby, in which the water current applies forces on the vertical arranged helix-shaped blades with wing-shaped cross-section, which are applied at a radial distance from a vertical placed axis, due to which the mentioned central axis starts to rotate and thus drives an electric generator.

Whilst developing the further improved vertical axis wind turbine (VAWT), called TURBY, the thought has risen that the mentioned wind turbine used with air current, should also be useable with fluid currents if adjusted hereto, in which the density of the fluid is much larger than air, while under normal circumstances the current is slower, so that the energy or capacity supply is almost the same, so that the current conditions and the occurring lift power are similar in character and size.

Therefore the TURBY from present applicator, the European Patent application number 020 79 432.7 DIXI Holding b.v., Heuvelenweg 18, 7241 HZ LOCHEM, The Netherlands and the inventors SIDLER, Hendrikus, Antonius, Heuvelenweg 18, 7241 HZ LOCHEM and SIDLER, Martines, Antonius, Watherus, Achterom 63, 3995 EK HOUTEN, with suitable and inventive adjustments is suitable in an efficient way for this purpose in flowing water.

The capacity of the wind or water turbine in a flow field is in formula:

$$Pw = ½.\eta.p.v^3.A.[W]$$

In which:

p = density of the medium [kg/m^3]

V = wind velocity [m/s]

A = considered surface perpendicular to the wind- or current direction.

η = aerodynamic or hydrodynamic output

When placed in a water current the p (rho) is approximately 1000x larger than that of air and the speed V is approximately 10% of the usual air velocity, through which, when mill dimensions remain equal, the capacity remains almost the same. Just like the wind turbine, the energy of the rotating axis is converted to electric power by means of a low speed generator.

The Norwegian company Hammerfest Strøm uses converted horizontal axis wind turbines, which are used as elements in fjords for a tide power station at suitable depth with regard to shipping traffic.

The known, thus converted wind to water turbines have a number of disadvantages with regard to the fact that the mill must constantly be turned 180 degrees from ebb to high tide, through which the electric power cables start to turn and twist, because the turbine generates electric power around a horizontal axis and the mill must turn 180 degrees around a vertical axis from ebb to high tide. Besides, the turbine is located far above the bottom of the water current, so that long cables are needed first to the bottom of the flow channel and then over or in the bottom towards the shore to be subsequently connected to an electricity power station. The water turbine or the present Hydro-Turby solution according to the invention can, for example, be put directly onto the bottom of the flow channel, as a result of which the cabling is much less vulnerable due to direct placement or laying on or in the ground of the flow channel. The known water turbines also have the disadvantage that, unlike the Turby they cannot be placed in small shallow streams and in small sea arms or bays. Further, the known water turbines must be turned towards the current for which vulnerable parts are needed, which are situated in an aggressive environment. In short, placing the known horizontal axis mill turbines in a water or fluid current has a number of disadvantages.

It is the aim of the present invention to provide such a water turbine that can be used in shallow water, in small flow channels and in ship channels at such a depth that the passing ships do not experience hinder or can damage the turbines, in which the water or fluid current applies forces on vertically set up helix-shaped blades with a wing-shaped cross-section of the vertical axis turbine with lift rotor, which blades are applied at a radial distance of a vertically central rotating axis, in which the mentioned vertically central rotating axis drives a generator and in which the aforementioned disadvantages are solved.

For this, a device for converting flow energy of a fluid current in electric power is developed in a very inventive way, characterized in that, the mentioned water turbine has at least one vertically shaped rotor body, constructed of, at a radial distance R from the mentioned central vertical rotation axis, several almost tangentially standing provided helix-shaped blades with wing-shaped cross-section over a height H and thus forms mentioned rotor body, in which the rotation velocity w of the central rotation axis, due to the shape and dimensions of the helix-shaped blades with wing-shaped cross-section and the current velocity V of the water, are adapted to each other by means of the so called tip speed ratio λ according to formula λ = w.R/V, in which the mentioned helix-shaped blades with wing-shaped cross-section are made of a strong, rigid and corrosion-proof material, in which the mentioned electric generator is of a low-speed type, in which the mentioned rotor body can be surrounded by a flow through a mesh-shaped cage construction with a mesh width BxB.

The advantage is a powerful and especially constant working water turbine, which gives little hinder for the ships, which is invisible and thus no visual hinder or horizon pollution is produced, and which can be placed in fluid currents in a rather simple way. Mentioned placement can be done on a concrete plate on the bottom of the river, or on a cable above the water surface or at the bottom of a bridge girder, and such.

Furthermore, the device according to the invention is further developed in such a way, that the cross-section of the mentioned helix-shaped blades with wing-shaped cross-section is an improved or adjusted NACA profile, and that the number of helix-shaped blades with wing-shaped cross-section is uneven and can be 3, 5, etc.

The advantages are a very uniform run in the fluid current and the possibility to adjust the rotation speed of the turbine to the current velocity of the fluid by adjusting the number of blades.

Furthermore, the device according to the invention is further developed in such a way, that the mentioned flow-through mesh-shaped cage construction has the shape of a pier cross-section with a mesh width B of approximately 0,10 m, in which the choice of material can be a reinforcement mat for concrete constructions and can have a pier shape.

The advantage is that no large floating objects can come into the current mill or water turbine.

The preferred construction of the invention will be described by way of example, and with reference to the accompanying drawing.

In which:

Fig. 1 shows a side view or approaching flow view in oblique projection of the adjusted water turbine which can be placed on a concrete bottom plate, according to a preferred embodiment of the invention;

Fig. 2 ditto as figure 1 but now placed on a larger concrete plate, in which the water turbine according to the invention is also provided with diffusers for increasing the fluid current;

Fig. 3 shows an approaching flow view in oblique projection of a series of in vertical sense coupled water turbines suspended from a supporting cable in or above flowing water according to the invention;

Fig. 4 ditto in horizontal sense coupled water turbines; and

Fig. 5 the graphic presentation of the relation between the vector representing current velocity of the fluid and the vector indicating the rotation direction and speed of the water turbine, in which the relation gives the tip speed ratio λ.

Figure 1 shows in side or approaching flow view and in oblique projection the water turbine 1, called Hydro-Turby, according to a preferred embodiment of the invention. Here, the water turbine 1 has a vertical rotation axis 2, which drives a generator 3, after which the generated electric power is transported to the user or electricity network via a cable 4. The water turbine 1 can be mounted with the generator on a concrete slab 5, which is placed on the bottom 6 of the streaming water 7. The cable 4 can be applied in or over the mentioned bottom 6. The top side 9 of the water turbine can be placed at a depth D, possibly adjusted to draught of ships. The wing-shaped blades 10 rotate at a constant distance R as a Darrieus- or lift- and/or aerodynamic rotor with a tip speed ratio $\lambda>2$ around the rotation axis 2 and in this way drives the generator 3. The wing-shaped blades 10 show a rotation over the height H, and the constant distance R is maintained by means of slim spoke profiles 11, which have a wing-shaped cross-section. The top and bottom spoke profiles 12 again have a wing-shaped cross-section. The height of the water turbine 1 is H, in which for R, H and D always suitable length dimensions can be chosen for the specific use concerned.

Figure 2 shows the same water turbine 1 as in figure 1, placed between two diffusers 13, of which the cross-section can have different shapes, such as circles, ellipses and such. By using diffusers, a concentrated or higher current velocity 7^1 will occur to drive the water turbine 1 in the rotation direction 14. Anyway, the same parts are indicated with the same reference numbers.

Figure 3 shows an approaching flow view in oblique projection, in which three water turbines are coupled to each other with vertical rotation axis 2 and suspended from a supporting cable 15 and supplied with a weight 16 at the bottom side or another way of anchorage. The discharge cable 17 for the generated electric power can now be mounted to the mentioned supporting cable 15 and both cables can be located below or above the water surface 8, depending on the owners requirements.

Figure 4 shows horizontally coupled water turbines 1 suspended from a supporting cable 18, in which the cable is placed in flowing water and above or below the water surface in the same way as in figure 3. The discharge cables 19, 20, 21 can be interconnected to a resulting power cable 22.

The bottom side of the water turbines 1 are made heavier with a weight 23. The water current 7^{111} causes the rotation 24 of the rotation axis 2 of the water turbines 1. The generators 3 are connected to the supporting cable 18 by means of a rotation-proof connection 25.

Figure 5 shows a graphic presentation of the relation between the vectors of the surface water 26 (Vw) and the rotation velocity 27 (λ.Vw) of the water turbine 1, in which λ is the so called tip speed ratio 28. The tip speed ratio λ is equal to the quotient of the blade velocity of the water turbine and the current velocity of the water.

Finally it has to be emphasized, that the above description constitutes a preferred embodiment of the present invention and that further variations and modifications are still possible without departing the scope of this patent description.

CLAIMS

1. Device for converting flow energy in fluid streams, such as, for example, water into electric energy, in which the device is called water turbine or Hydro-Turby, in which the water current applies forces on the vertically arranged helix-shaped blades with wing-shaped cross-section, which are applied at a radial distance from a vertically placed axis, due to which the mentioned central axis starts to rotate and as a result of which drives an electric generator, **characterized in that,** the mentioned water turbine (1) has at least one vertically shaped rotor body, constructed of, at a radial distance R from the mentioned central vertical rotation axis (2), several almost tangentially standing provided helix-shaped blades with wing-shaped cross-section (10) over a height H and thus forms mentioned rotor body according to the vertical axis turbine with lift rotor principle, in which the rotation velocity w of the central rotation axis (2), due to the shape and dimensions of the helix-shaped blades with wing-shaped cross-section (10) and the current velocity V of the water, are adapted to each other by means of the so called tip speed ratio λ according to formula $\lambda = w.R/V$, in which the mentioned helix-shaped blades with wing-shaped cross-section (10) are made of a strong, rigid and corrosion-proof material, in which the mentioned electric generator (3) is of a low-speed type, in which the mentioned rotor body can be surrounded by a flow through a mesh-shaped cage construction with a mesh width BxB.

2. Device as claimed in claim 1, **characterized in that,** the cross-section of the mentioned helix-shaped blades with wing-shaped cross-section (10) is an improved or adjusted NACA profile.

3. Device as claimed in claim 1 and 2, **characterized in that**, the number of helix-shaped blades with wing-shaped cross-section (10) is uneven and can be 3, 5, etc.

4. Device as claimed in claim 1, **characterized in that**, the tip speed ratio λ is larger than 2.

5. Device as claimed in claim 1, **characterized in that,** the mentioned values for R and H of a single water turbine (1) can be approximately 1,00 and 2,00 m, in which, in vertical sense, according to the water depth, stacking of the mentioned water turbines can be done, through which a generator (3) can be driven more forcefully.

6. Device as claimed in claim 1, **characterized in that,** the mentioned corrosion-proof material is a kind of stainless steel.

7. Device as claimed in claim 1, **characterized in that,** the mentioned corrosion-proof material is a rigid and strong composite construction.

8. Device as claimed in claim 1, **characterized in that,** the mentioned flow-through mesh-shaped cage construction has the shape of a pier cross-section with a mesh width B of approximately 0,10 m, in which the choice of material can be a reinforcement mesh for concrete constructions and can have a pier shape.

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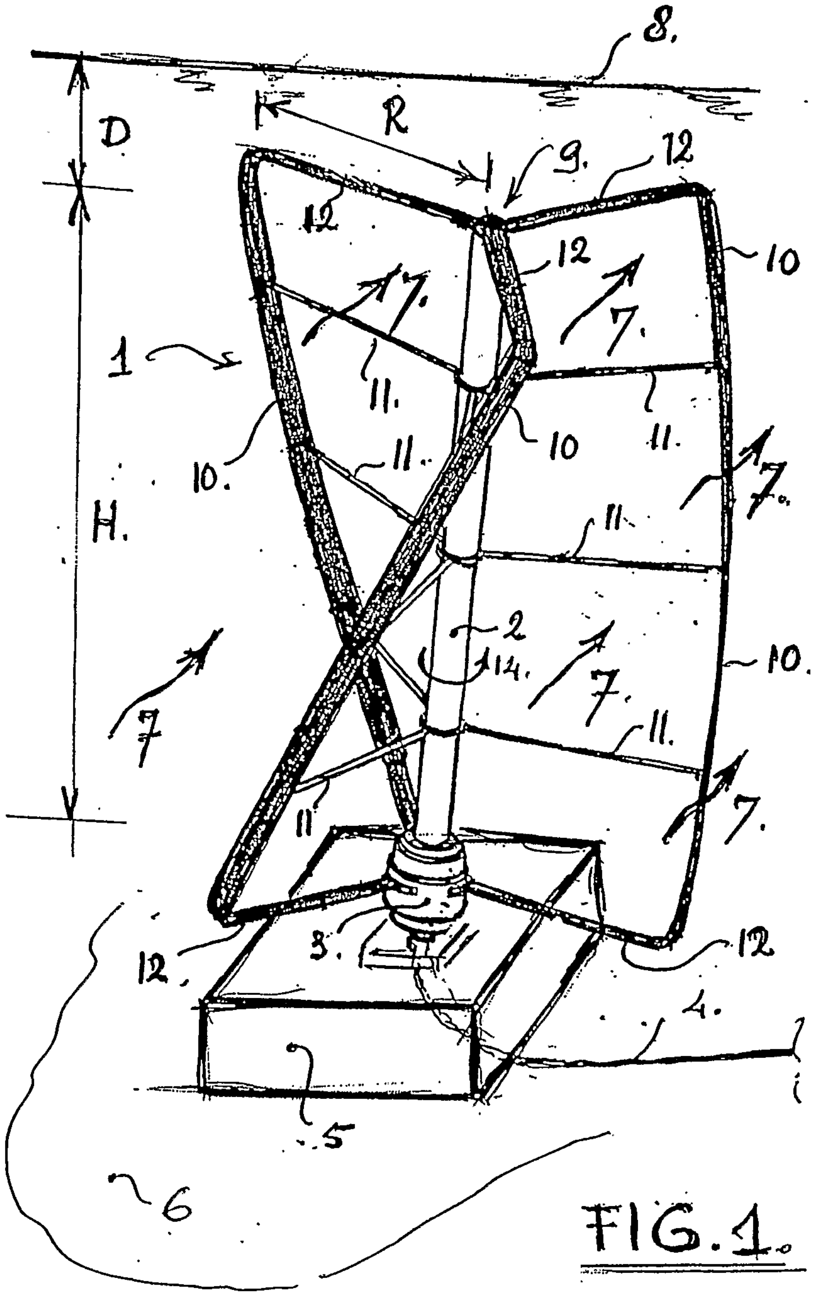
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FIG.1.

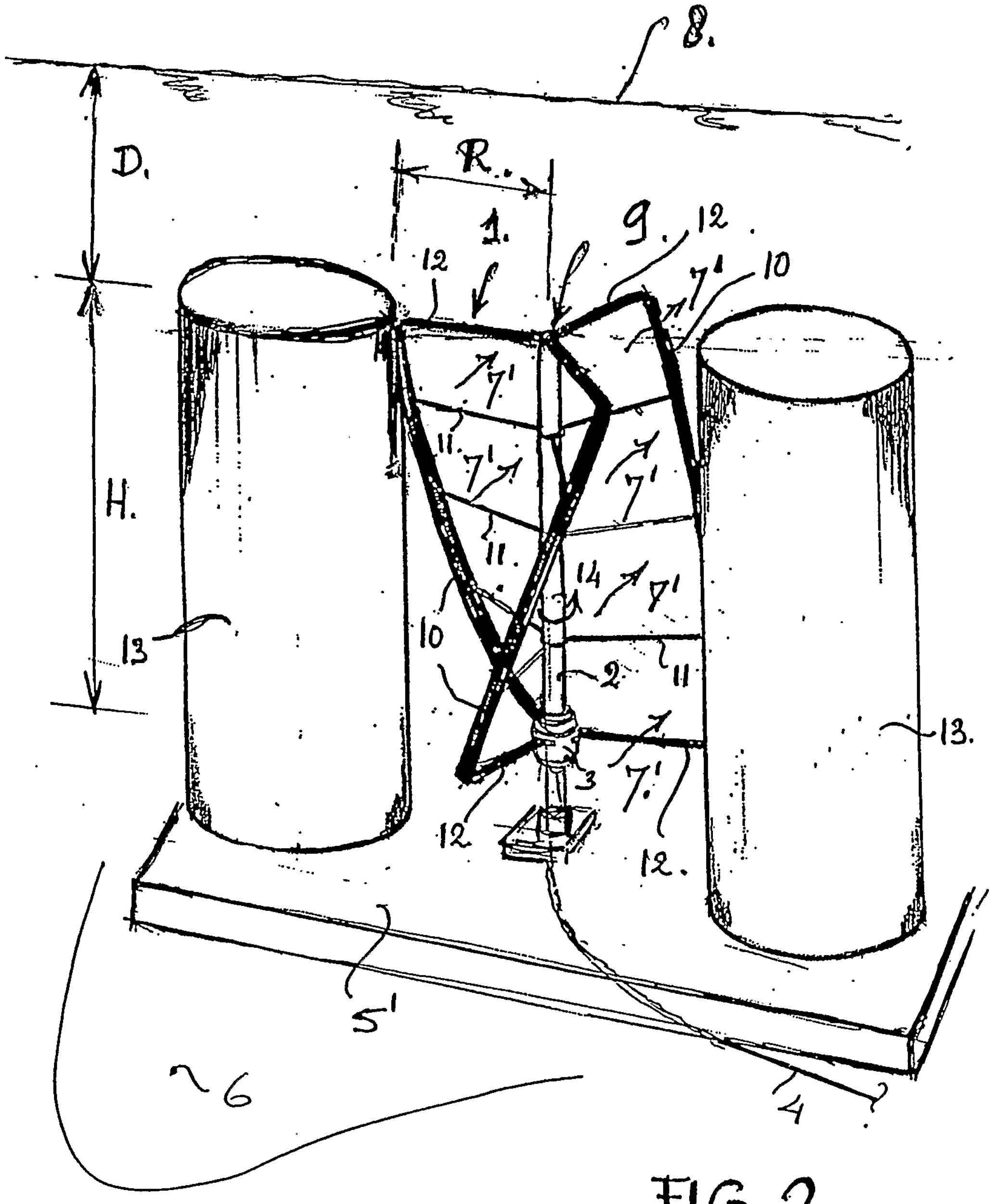

FIG. 2.

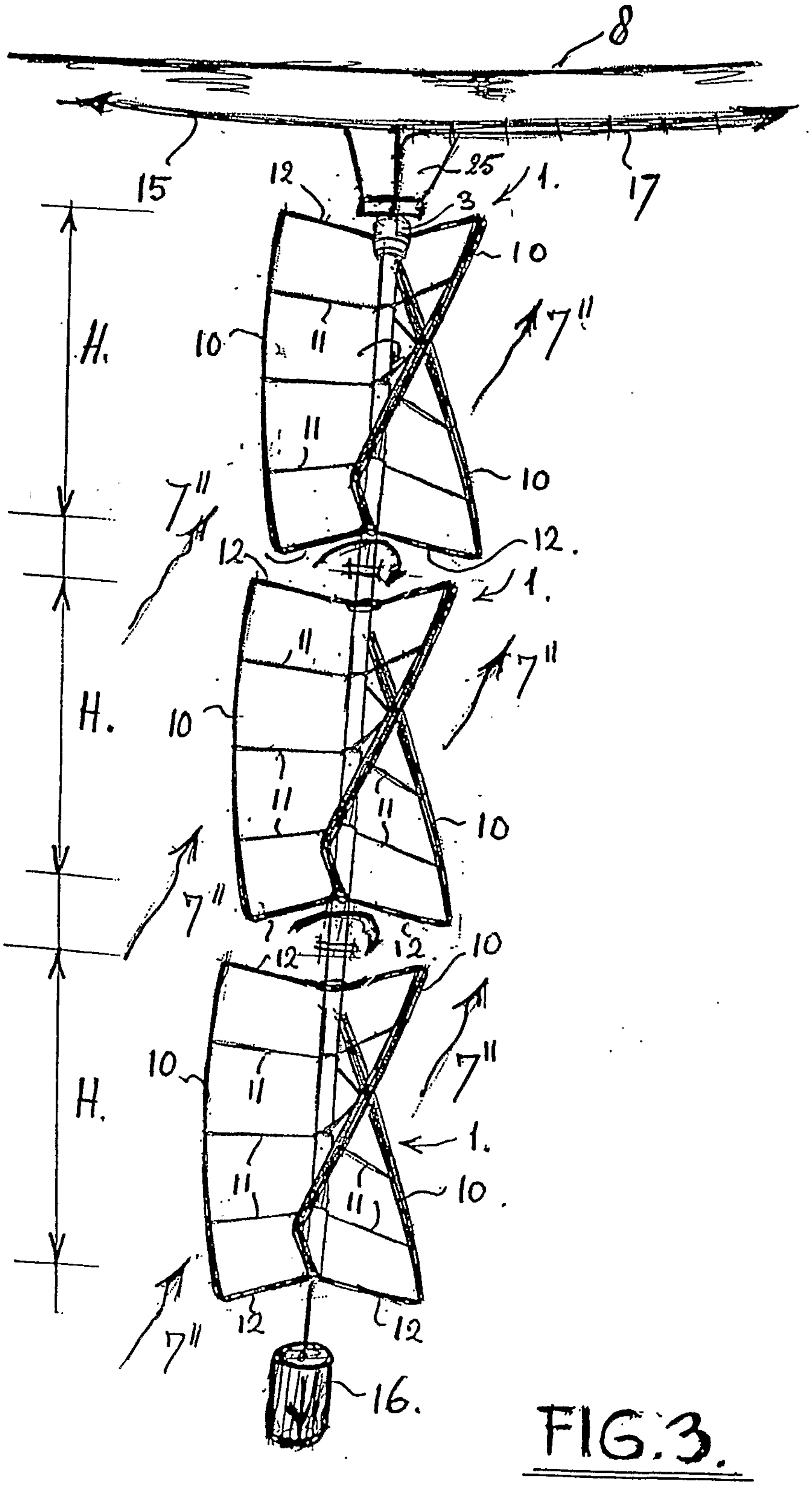
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FIG.3.

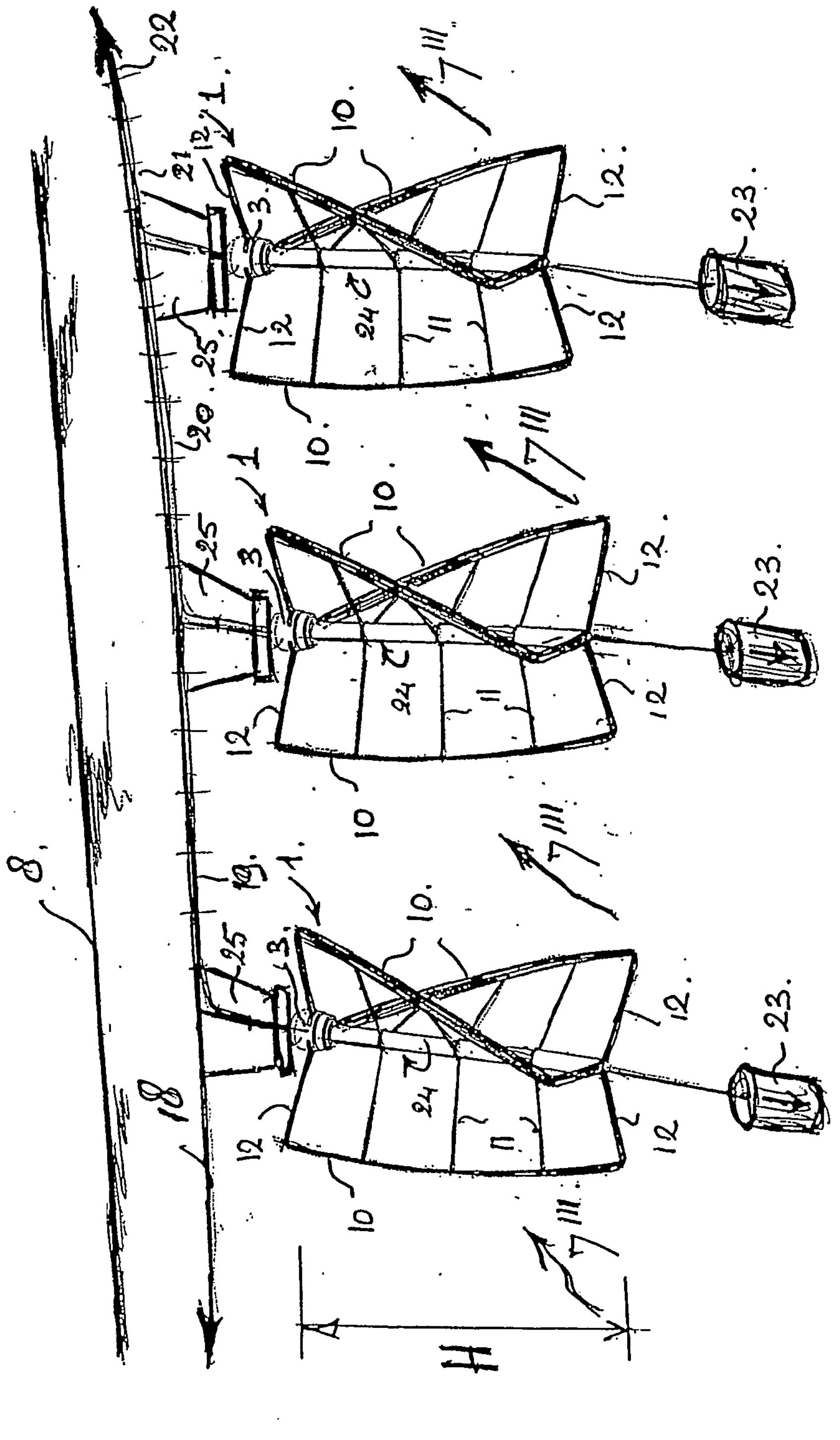

FIG. 4.

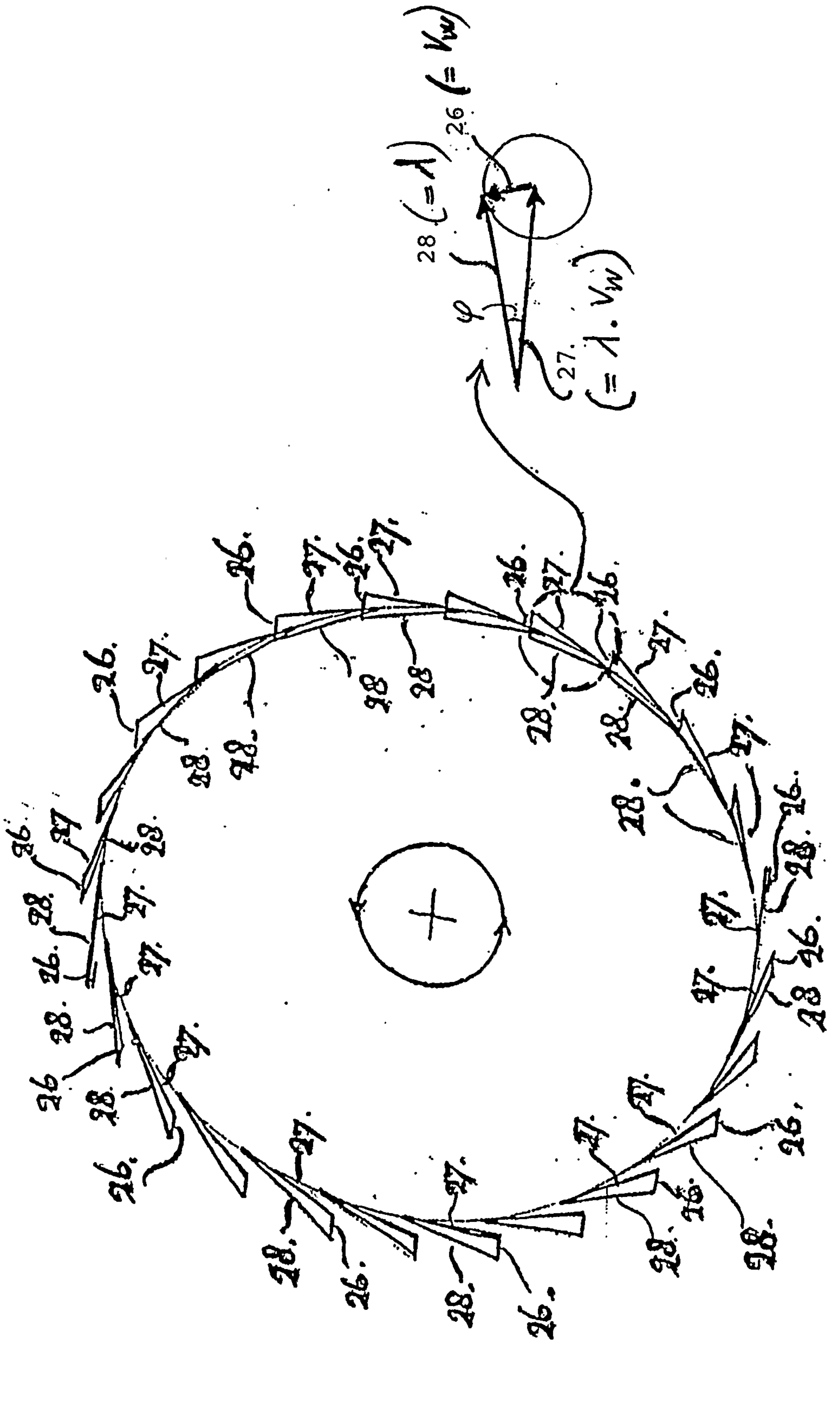

FIG. 5.