

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
5 February 2009 (05.02.2009)

PCT

(10) International Publication Number
WO 2009/016372 A2

(51) International Patent Classification: **Not classified**

(21) International Application Number:
PCT/GB2008/002599

(22) International Filing Date: 30 July 2008 (30.07.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0714904.0 30 July 2007 (30.07.2007) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

(54) Title: WIND ENERGY GENERATION APPARATUS

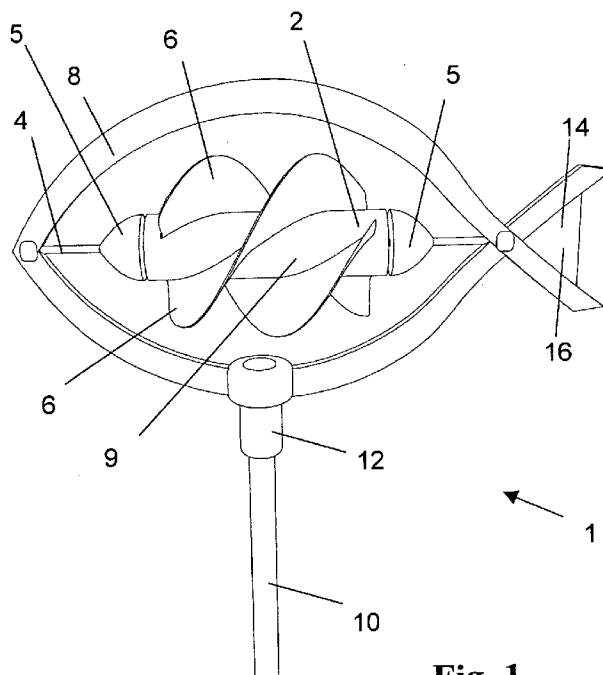


Fig. 1

(57) Abstract: A wind powered generator (1) has an axially extending turbine rotor (2) including at least one axially extending turbine blade (6). The turbine rotor (2) is mounted on a rotor shaft (4). A frame (8) supports the rotor shaft at each end of the rotor. At least one electrical generator is coupled to the rotor for generating electricity from the rotation of the rotor.

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WIND ENERGY GENERATION APPARATUS

The present invention relates to the provision of wind
5 powered generators for use in generating electricity from
wind energy.

The demand for small-scale decentralised power generating
units has increased in recent years and the trend is set
10 to continue as public attitude changes and as fossil fuel
supplies run out. If the generated power is derived from
renewable resources then it does not produce harmful
greenhouse gases or incur any significant running costs.
Decentralised (stand-alone) power units are of prime
15 importance in isolated areas without a grid connection as
well as in mobile transport units such as caravans and
yachts. Additionally stand-alone generation has the
advantage of removing transmission losses inherent in
long power lines and gives consumers independence and
20 control over their choice of generation.

Wind power is intermittent but is an abundant source of
extractable energy worldwide, notably so in many rural
areas in the United Kingdom. Domestic-scale, or "micro-
25 wind", turbines are available on the market and can be
used to charge batteries or plug into the electricity
grid to offset a user's supply. The most common types of
micro-wind generating systems available currently are
horizontal axis machines with a number of discrete
30 propeller blades. There are also a variety of designs
that operate as vertical axis machines.

Disadvantages of existing systems include: low
performance in turbulent air streams; high start-up

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torque reducing the output at low wind speeds;
difficulties of installation and maintenance partly due
to large blade diameters and complex heavy generators;
and noise pollution caused by the relatively high angular
5 velocity of propeller blade tips. There are also
arguments over aesthetic appeal.

It is an object of the present invention to provide a
wind powered energy generator that addresses at least one
10 of the above-mentioned problems.

According to a first aspect the present invention
provides a wind powered generator comprising; an axially
extending turbine rotor including at least one axially
15 extending turbine blade, said turbine rotor being mounted
on a rotor shaft; a frame which supports the rotor shaft
at each end of the rotor; and at least one electrical
generator coupled to said rotor for generating
electricity from the rotation of the rotor.

20

The rotor may be mounted onto the shaft using standard
bearings. Optionally there can be nose-cones mounted on
either end of the rotor assembly to act as aerodynamic
shapers to the flow of air.

25

In use the turbine rotor, associated shaft and electrical
generator(s) are mounted in a suitable location for
powering by wind. The frame, which supports the turbine
rotor, may be mounted on a suitable mast to raise the
30 assembly to a suitable height for extracting power from
the wind. For example, a simple post or a telescopically
extending post may be used as the mast. The frame is
connected to the mast by a swivel joint to allow rotation
of the frame and turbine rotor about a vertical or

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substantially vertical axis so that the turbine rotor may be directed into the wind for power extraction.

5 The frame may take a number of different forms, provided it allows secure mounting of the turbine rotor and generators in all anticipated wind conditions. At the same time it is important that the frame does not interfere excessively with the airflow around the turbine causing loss of power extraction.

10

Advantageously the frame may be made of a relatively small diameter rod or relatively thin sheet material or a member with a relatively thin box shape profile, to minimise interaction with the wind. For example the
15 frame may comprise a generally "U" shaped member of stiff sheet metal with each end of the U mounting one end of the rotor shaft. A mast (pole) attached at the bottom of the U supports the whole assembly at a selected height above the location where power is to be extracted.

20

Advantageously the frame comprises a complete loop member, passing around the turbine rotor and associated electrical generator(s). Preferably the loop member is positioned along the line of the longitudinal axis of the
25 turbine rotor, with the each end of the shaft mounted to opposite sides of the loop. Preferably the frame loop member has a generally elliptical shape, which conforms relatively closely to the turbine rotor and blade assembly. Such a loop member may be described as fish
30 shaped especially when provided with a vane or tail for directional control of the turbine rotor as described hereafter.

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A fish shaped frame has a number of advantages. The turbine rotor assembly (rotor, blades and electrical generator(s)) are supported at either end of the shaft giving secure strong support to the moving parts of the
5 wind-powered generator. As the frame loop member conforms relatively closely to the turbine rotor and associated blades the whole unit is compact. At the same time providing a complete loop around the turbine rotor assembly has additional, greater, strength than
10 alternatives such as a U shape, for example. Furthermore the frame loop member design allows the axis of rotation of the turbine rotor to be adjusted readily if the shaft is appropriately mounted to the frame.

15 The turbine rotor normally operates by rotating about a horizontal axis in use. Therefore the shaft will typically be aligned along a horizontal axis in use. However the shaft may be adjustable to be inclined at an angle to the horizontal via a tilting mechanism within
20 the support assembly. This mechanism may consist of a cradle above a swivel mechanism at the top of the mast into which the frame can be slotted then secured at a tilted angle. Alternatively the shaft can sit in a slot in the frame loop which allows the shaft assembly to be
25 secured at a tilted angle whilst the frame remains horizontally aligned.

Tilting the axis of rotation of the turbine rotor at an angle to the horizontal can be advantageous. For example
30 when the turbine is located in a position such as on a roof in an urban landscape the flow of wind may not be horizontal due to deflections from the surrounding buildings or the roof itself. Adjusting the axis of rotation from the horizontal can allow optimisation of

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energy extraction. Additionally, where the wind strength is excessive the turbine rotor may be moved out of optimum alignment with the wind to prevent damage due to rotation exceeding the design strength of the device.

5

Conveniently the rotor shaft may be hollow with the output wires from the electrical generator passed therein to be concealed and fed to the frame. The wiring can then be run down or inside the mast or other support used
10 for the frame.

Magnetic bearings may be used to increase the mechanical efficiency and reduce maintenance requirements.

15 A flywheel may be added to the assembly to increase the inertia and thus smooth out some of the irregularity in the rotational speed that may be caused by an unsteady flow of air.

20 The frame which houses the working part of the wind turbine is preferably fish-shaped and along the longitudinal axis as discussed above. It is designed to provide the necessary structural stiffness to support the turbine as well as render an aesthetic representation of
25 a fish. The width of the frame horizontally perpendicular to the rotational axis, at the central nose section especially, should be thin enough to cause minimal disruption to the prevailing flow of air.

30 Advantageously on the downstream edge of the frame of a wind power generator of the invention a vane or tail is present to catch the wind and thus cause the structure to self-orient towards the prevailing wind by means of a swivel joint provided between the mast and the frame.

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Advantageously the turbines of the invention may include a self furling mechanism such as are well known in the art. A self furling mechanism moves the turbine rotor
5 away from the usual optimum energy gathering position, head on into the wind, in the event of excessive wind speeds. This reduces the possibility of damage caused by excessive rotor speeds.

10 The output wires from the generator are concealed as much as is possible within the frame to protect them from exposure and to minimise visual obstruction

The tail may also comprise one or more solar panels that
15 generate a dc electrical output, preferably at a voltage that matches the rated voltage of the wind generator. The output wires from the solar panel(s) are fed into the frame and connected to the wind generator output for output from the device as described above.

20 The fish-shaped frame is typically connected to a vertical pole for mounting the turbine at a suitable height, either on top of a structure or as a free-standing unit. A swivel joint is used to connect said
25 frame and pole, to allow orientation of the longitudinal axis into the wind.

The frame consists preferably of a toughened plastic such as glass-reinforced plastic or a metal that is non-
30 corrosive or protected against corrosion such as aluminium or galvanised steel. Other suitably strong materials may be employed in the construction. Similarly the mast or pole, which supports the frame, consists preferably of a metal that is non-corrosive or

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protected against corrosion such as aluminium or galvanised steel. For ease of construction the frame preferably consists of two segments that are joined together during the assembly of the device.

5

Many existing small-scale wind turbines experience difficulty in starting up in low wind speeds and do not have a frontal blade area sufficient for extracting optimum energy from the wind according to the theoretical
10 Betz limit. The rotor design of the present invention allows greater extraction of energy by virtue of its axially extending turbine blade or blades, which may extend along the whole length of the rotor.

15 Therefore a rotor design is presented that preferably extends along the longitudinal axis to a length greater than its diameter, to allow greater extraction of energy from the wind in comparison to existing rotors that are effectively planar. The start-up torque requirement is
20 also reduced, due to the solid frontal area presented. The majority of existing wind turbines do not perform well in turbulent wind conditions or on rooftops where the incoming wind is at an angle to the rotational axis. However the rotor in the present invention takes
25 advantage of such conditions due to its multi-directional geometry, resulting in improved rotation. Also, the lack of discrete aerofoil-shaped blades as used in conventional turbines for energy generation reduces the amount of noise emitted during operation.

30

Preferably the said rotor will be of helical construction, consisting of one or a plurality of blades each forming a helix around a cylinder, the longitudinal axis of which forms the axis of rotation, which may be

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either horizontal in use or at an inclination to the horizontal. The shape of each blade may be described by a regular helix with a constant pitch and width; alternatively the pitch and the width of the helix may
5 follow a variable profile along the longitudinal axis. Advantageously the width of the blade or blades increases from the front of the rotor (i.e. the end of the rotor which faces into the wind in use) to increase the interaction of the blade(s) with the wind. In a
10 preferred arrangement the blade width increases from the front of the rotor towards the middle and then decreases towards the back end of the rotor.

Different turbine designs and blade shapes may be
15 employed depending on the characteristics of the device deployment such as wind profile, generator position, size limitations and power demand, as well as with due consideration to the cost and ease of manufacture.

20 Other, non-helical designs may be used for the turbine rotor. A person skilled in the art of turbine design will be able to consider the design of such a rotor.

The turbine blade or blades may be manufactured of any
25 material having appropriate strength and resilience. Preferably the turbine blades are constructed from a reinforced plastic or a composite material. Where the turbine comprises a blade or blades formed round a cylinder the cylinder may also be made of a reinforced
30 plastic or composite material. Alternative materials such as a metal or a metal alloy may be employed. Where the turbine rotor and blades are not constructed of a metal a metallic coating may be provided. This has the advantage that the device will act as a convenient

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reflector of radar signals. On small boats a radar reflector is often fitted to ensure that the craft is easily seen on radar. A boat provided with a metallic or metal-coated wind powered generator of the invention may
5 not require a separate reflector.

The electrical generator or generators coupled to the turbine rotor are designed to be small and simple so as to apply a minimal load to a support frame which mounts
10 the turbine and increase the ease of installation and maintenance. Preferably the generator, or a plurality thereof, is contained within a cylindrical section internal to the rotor, such that it is concealed from view. This arrangement has the benefit that the
15 generator or generators are provided in a single integrated compact package that is easy to mount on a shaft for location in suitable bearings for use. Alternatively a generator, especially a generator that is shorter in the axial direction may be mounted externally
20 to the rotor on the shaft, which also mounts the rotor. Two or more similar generators may be mounted on the shaft to one side or on either side of the rotor.

Preferably the generator is tubular. Preferably the
25 generator uses permanent magnets to generate flux that is directed through copper coils as the rotor spins, thus generating an electric current. In a preferable embodiment of the invention, a plurality of permanent magnets are mounted on a cylinder that is internal to and
30 coupled with the turbine rotor, producing a rotating radial magnetic flux that passes through a plurality of coils that are mounted on a stationary cylinder that is internal to and co-axial with the rotating cylinders. These coils are connected to form a three-phase output,

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and may be partitioned along the length of the cylindrical axis.

5 A generator thus described constitutes one example of a radial configuration; however other possible radial and axial configurations exist and may be known to those skilled in the art.

10 The generator configuration, number of permanent magnets, number of coils and wiring configuration may be selected to produce the desired electrical output characteristics.

15 The three-phase output wires from the generator are preferably fed internally through a hollow shaft to the frame that supports the turbine rotor and generator, then fed internally through the frame to a support mast or pole, then fed internally down the support pole and finally output from the device. The output wires may then be passed through a three-phase rectifier or a transformer or may require power conditioning to be
20 applied to the electrical output. Alternatively, rectification of the electrical output may be done prior to feeding the output wires into the frame. The output wires will be connected to a battery which will be
25 charged by the electrical output produced. The device may also be used in conjunction with a grid-tie inverter to supply electricity to an electrical grid system.

30 The generator may alternatively consist of a single dc generator, or a plurality thereof, driven by the turbine in order to generate a dc electrical output. This removes the need for a three-phase rectifier.

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A simple gearing system may be used to couple the generator or generators with the turbine rotor to increase the rotational speed of the generator or generators relative to the rotational speed of the turbine blade.

As described above the present invention can therefore provide a self-contained wind powered generator which can comprise an axially extended turbine rotor, internal to which is a tubular generator, both of which rotate on a shaft that may be on a horizontal axis or adjustable to an angle relative to the horizontal axis, all of these components being contained within a fish-shaped frame mounted on a pole with a swivel mechanism and down which output wires are fed for eventual distribution to an electrical conversion device such as a battery charger.

Generators of the invention can be easily deployed and dismantled allowing temporary use. For example, in a location where a turbine may be considered unsightly, it may be deployed at night to generate power and then be dismantled and hidden from view during the day.

These and other aspects of the present invention will now be described by way of example only and with reference to the accompanying Figures, in which:

Figure 1 shows a front elevation of an apparatus for generating energy in accordance with an embodiment of the present invention;

Figure 2 shows a plan view of the apparatus of Figure 1;

Figure 3 shows a perspective view of the apparatus of Figure 1;

Figure 4 shows a front elevation of an alternative apparatus of the invention; and

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Figure 5 shows the apparatus of figure 4 in end elevation.

A wind powered generator of the invention 1 is shown in figure 1. The apparatus has a turbine rotor 2 that is mounted on a shaft 4 that may be horizontal or may be inclined to the horizontal; in the example in the attached drawings the shaft is horizontal. Bearings used to mount the rotor 2 are not shown. Optional, nose-cones 5 are placed on the shaft 4 at either end of the rotor 2. The rotor 2 has a plurality of helical blades 6. Figure 1 shows a typical embodiment with three such helical blades 6.

The shaft 4 is secured to an fish-shaped frame 8 that provides structural support to the shaft assembly. The frame 8 is intended to represent the shape of a fish for aesthetic purposes whilst at the same time providing a strong yet compact support for the moving parts of the device. As can be seen from the plan view in Figure 2, the width of the frame in the direction horizontally perpendicular to the rotational axis is thin enough to cause minimal disruption to the prevailing flow of air while still providing the necessary lateral and torsional stiffness to support the moving parts.

A generator 9 is mounted on the shaft 4 internally to the rotor 2. The output wires (not shown) are fed into a hollow core internal to the shaft 4, feeding to the frame 8 that likewise channels the wires through an internal space to a mast which in this embodiment is a simple mounting pole 10 which connects to the fish shaped frame by means of a swivel joint 12. The wires are then fed down the pole 10 for eventual output from the device 1.

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The tail 14 consists of a vertically planar surface, shown in Figure 1 as a triangle 16, which will catch the wind and cause the device to rotate by means of the swivel joint 12 between the frame 8 and the pole 10, such
5 that the rotational axis of the turbine becomes aligned with the prevailing wind direction. Figure 3 shows the generator of figures 1 and 2 in perspective view.

Figure 4 shows an alternative design of the wind-powered
10 generator 1. The turbine rotor 2 mounts helical turbine blades 6 which increase in width from the front 18 of the rotor 2 to its middle 20 and then decrease in width towards the rear 22 of the rotor. The generator 1 of figure 4 is shown in end elevation in figure 5, which
15 shows the blade surfaces 24 that are presented to the direction of air flow in use of the generator 1

Claims

1. A wind powered generator (1) comprising; an axially
5 extending turbine rotor (2) including at least one
axially extending turbine blade (6), said turbine
rotor being mounted on a rotor shaft (4); a frame
(8) which supports the rotor shaft at each end of
the rotor; and at least one electrical generator (9)
10 coupled to said rotor for generating electricity
from the rotation of the rotor.
2. A wind powered generator (1) according to claim 1
wherein the frame (8) comprises a loop member,
15 passing around the turbine rotor (2) and electrical
generator (9).
3. A wind powered generator (1) according to claim 2
wherein the loop member is positioned along the line
20 of the longitudinal axis of the turbine rotor (2),
with the each end of the shaft (4) mounted to
opposite sides of the loop.
4. A wind powered generator (1) according to claim 3
25 wherein the loop member has a generally elliptical
shape, which conforms closely to the turbine rotor
(2) and blade (6) assembly.
5. A wind powered generator (1) according to claim 1
30 wherein the frame (8) comprises a U shaped member
with each end of the U mounting one end of the rotor
shaft.

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6. A wind powered generator (1) according to any one of claims 1 to 5 wherein the rotor shaft (4) is adjustable to be inclined at an angle to the horizontal via a tilting mechanism.

5

7. A wind powered generator (1) according to claim 6 wherein the wind powered generator further comprises a cradle into which the frame (8) may be slotted and then secured at a selected angle.

10

8. A wind powered generator (1) according to claim 6 wherein the rotor shaft (4) can be moved in a slot of the frame loop and secured at a selected angle.

15

9. A wind powered generator (1) according to any preceding claim further comprising a mast (10) connected to the frame via a swivel joint (12).

20

10. A wind powered generator (1) according to any preceding claim provided with nose-cones (5) mounted on either end of the turbine rotor (2) to act as aerodynamic shapers to the flow of air.

25

11. A wind powered generator (1) according to any preceding claim wherein the frame (8) is provided with a tail (14).

30

12. A wind powered generator (1) according to claim 11 wherein the tail (14) comprises one or more solar panels.

13. A wind powered generator (1) according to any preceding claim wherein the turbine rotor (2)

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extends along the longitudinal axis to a length greater than its diameter.

- 5 14. A wind powered generator (1) according to any preceding claim wherein the turbine rotor (2) is of helical construction, consisting of one or a plurality of blades (6) each forming a helix around a cylinder.
- 10 15. A wind powered generator (1) according to any preceding claim wherein the shape of each turbine blade (6) is described by a regular helix with a constant pitch and width.
- 15 16. A wind powered generator (1) according to any preceding claim wherein the shape of each turbine blade (6) is described by a helix of variable width and/or pitch.
- 20 17. A wind powered generator (1) according to any preceding claim wherein the width of the turbine blade or blades (6) increases from the front of the rotor.
- 25 18. A wind powered generator (1) according to any preceding claim wherein the width of the turbine blade (6) increases from the front of the rotor (2) towards the middle and then decreases towards the back end of the rotor.
- 30 19. A wind powered generator (1) according to any preceding claim wherein the turbine rotor has a metallic coating.

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20. A wind powered generator (1) according to any preceding claim where in the electrical generator (9), or a plurality thereof, is contained within a cylindrical section internal to the rotor (2).

5

21. A wind powered generator (1) according to any one of claims 1 to 20 wherein a plurality of permanent magnets are mounted on a cylinder that is internal to and coupled with the turbine rotor (2), producing a rotating radial magnetic flux that passes through a plurality of coils that are mounted on a stationary cylinder that is internal to and co-axial with the rotating cylinders.

10

15

22. A wind powered generator (1) according to any one of claims 1 to 19 wherein the electrical generator is mounted externally to the rotor (2) on the rotor shaft (4).

20

23. A wind powered generator (1) according to any preceding claim wherein a gearing system is used to couple the generator or generators with the turbine rotor (2) to increase the rotational speed of the generator (9) or generators relative to the rotational speed of the turbine blade (6).

25

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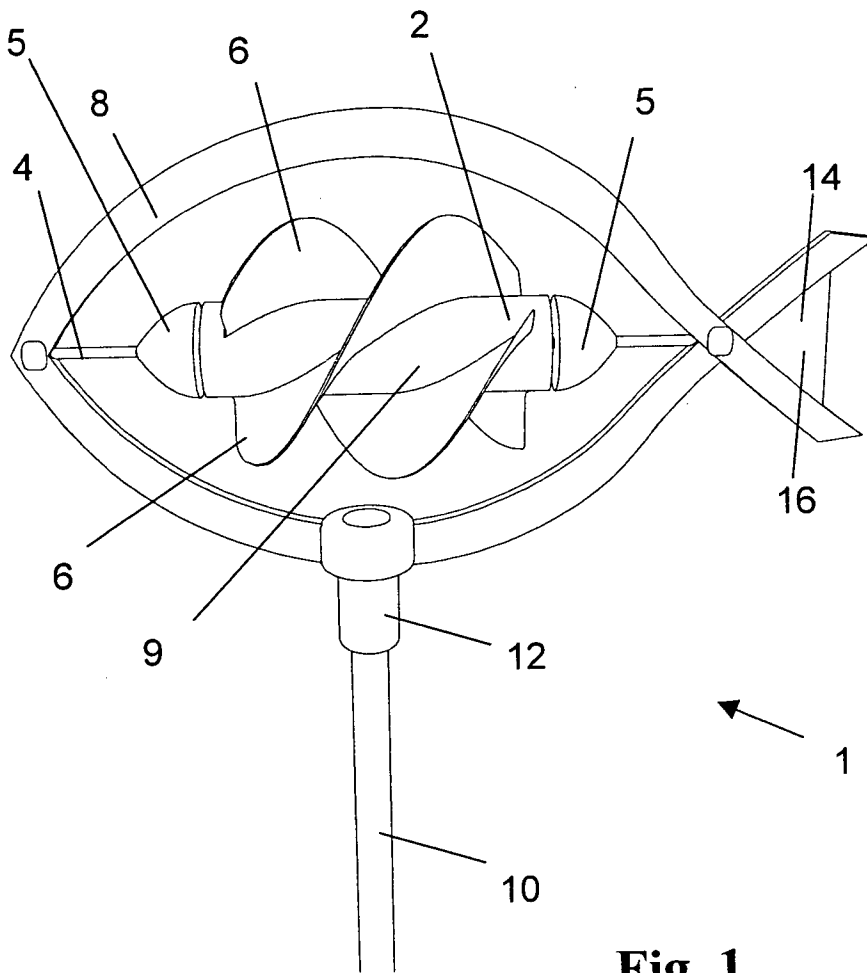


Fig. 1

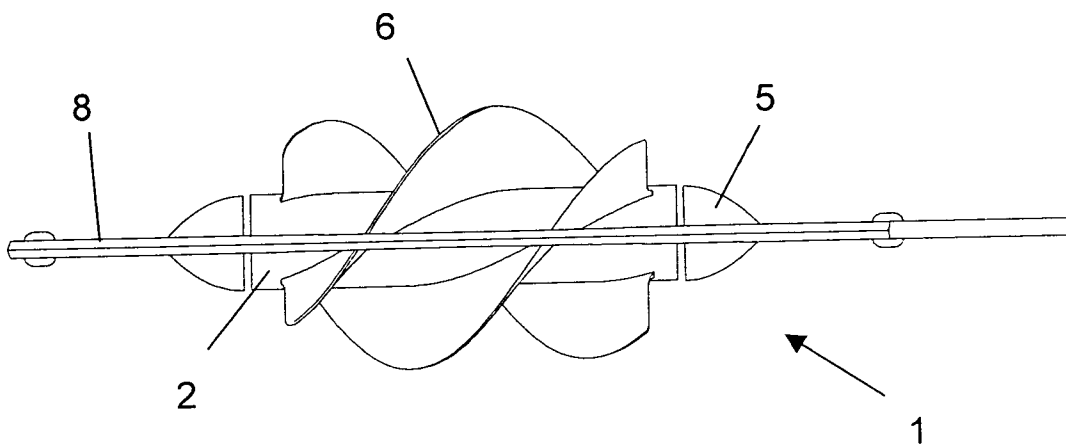


Fig. 2

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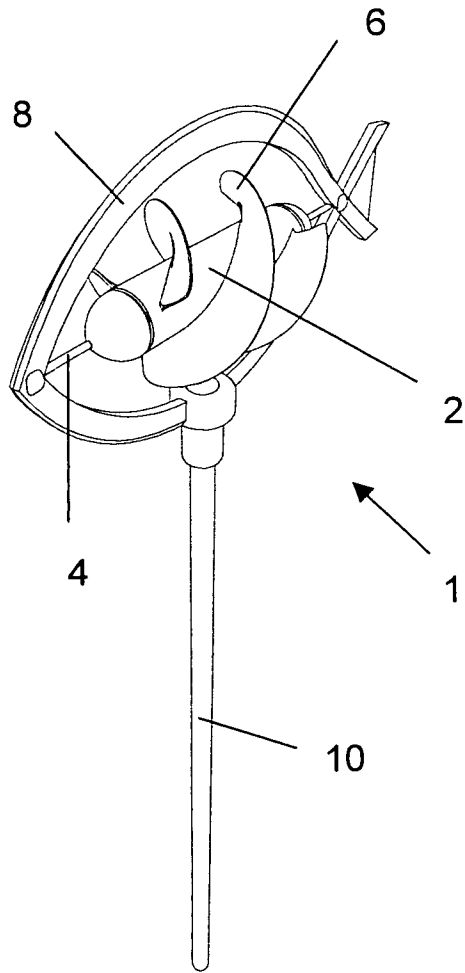


Fig. 3

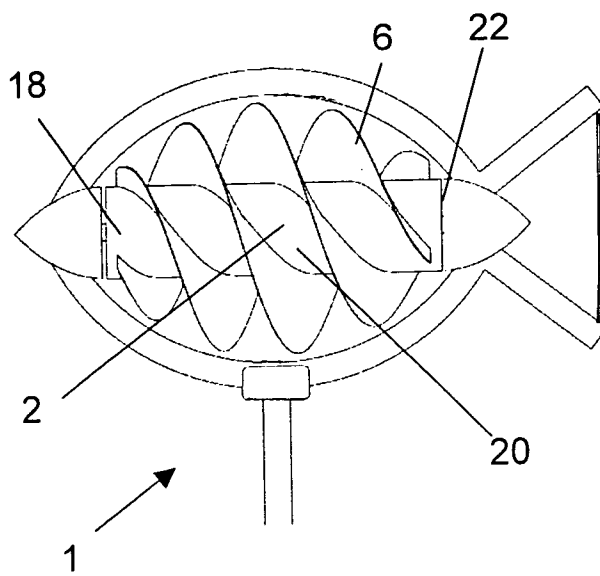


Fig. 4

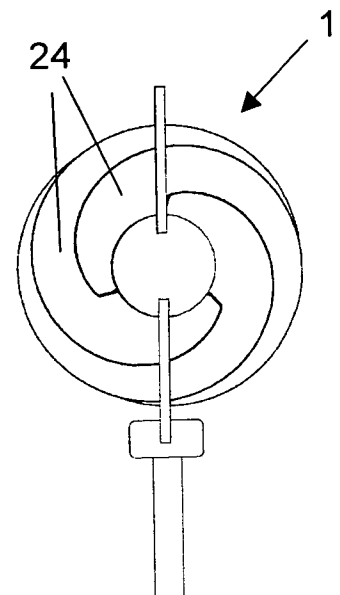


Fig. 5