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PATENTS, DESIGNS & TRADE MARKS

27 FURNIVAL STREET
LONDON
EC4A 1PQ

TELEPHONE: 071-404 5921
TELEX: 267271 BOULT G
FACSIMILE: 071-405 1916
071-831 1768
DX 199 LDE

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19th March 1992

Dear Paul,

PROPOSED UNITED KINGDOM PATENT APPLICATION
IN THE NAME OF **PAUL HAMMANT** FOR A WINDMILL

I am enclosing a draft patent specification for your approval. Please check the specification carefully to ensure that it is both complete and accurate and let me have your comments by return.

Please also confirm that the application is to be filed in your name and that your full name and address is:-
Paul Hammant, Broad Oak, Two Tree Hil, Henley-on-Thames, Oxon, RG9 1RQ.

The scope of patent protection which is sought in the application is set out in the claims beginning on page 8 of which the broad claim 1 defines the invention in general terms. The claim refers to a turbine so as not to be restricted to either a windmill or watermill and encompasses both power generation and use when driven by a motor to provide a flow of fluid.

The dependent claims include features which could usefully be added into claim 1 during the prosecution of the application

Cont'd....

Mr Paul Hammant
WHEELBARROW SOFTWARE LTD
Broad Oak
Two Tree Hil
Henley-on-Thames
OXON
RG9 1RQ

in order to distinguish the invention over any documents cited by the Examiner as being relevant to the novelty and inventive step of the invention claimed. In particular claim 4 refers to the rate of rotation of the vanes as being one-half of the rate of rotation of the rotor.

Claim 1 as presently drafted is, I believe, sufficiently broad to encompass either gear mechanisms or any other form of transmission to rotate the vanes. This would include elliptical gear mechanisms.

The description beginning on page 1 first describes the general field of the invention and then recites the precise wording used in the claims with statements of advantages achieved by each aspect of the invention.

There then follows on page 4 onwards a description of a particular example of how the invention can be put into effect, in this instance a windmill as shown in Figures 1 and 2. The precise detail given in this description should not be regarded as limiting to the scope of the invention but is provided to meet the requirement that the specification should disclose at least one method of putting the invention into effect.

Finally on page 7 a number of alternative arrangements are mentioned so as to emphasise that the preceding example is not limited to the scope of the invention.

Also enclosed is a pre-payment request in respect of filing the application based on an approximate estimate of our costs in preparing the specification and our meeting on the 26th February 1992. Once I have received your comments on the specification and approval for filing the application together with pre-payment I shall then proceed to file the application without delay.

Please also indicate whether the application is to be filed together with a Request for Search and payment of the Official Search Fee to enable the Patent Office Search to proceed. The search request will add a further £225 to the filing costs.

Finally I must remind you that the invention should not be publicly disclosed before the filing date of your application.

I look forward to hearing from you by return.

Yours sincerely,

Chris Flegg
BOULT, WADE & TENNANT

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MR PAUL HAMMANT
WHEELBARROW SOFTWARE LTD
Broad Oak
Two Tree Hil
Henley-on-Thames
OXON
RG9 1RQ

DATE: 19th March 1992

ACC. NO: WHE02

INV. REF: CFF2932n

To our proposed services as follows:

For preparing and filing a patent application (not including Request for Search).

AMOUNT REQUESTED £1100

TERMS: PAYMENT WITH YOUR INSTRUCTIONS

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"A TURBINE"

This invention relates to a turbine and in particular but not exclusively to a turbine for use as a windmill generating mechanical power from a naturally occurring flow of air.

Conventional windmills of the type used for the generation of electrical power comprise two or more aerofoil shaped blades mounted for rotation about a horizontal axis on a supporting structure in the form of a tower. The size of such turbines is limited by the constraints of this configuration which requires the height of the tower to be greater than the radial extent of the blades so that typically the tower is a substantial structure which may nevertheless still be vulnerable to damage in adverse weather conditions.

According to the present invention there is disclosed a turbine for transferring power to or from a fluid flow comprising a rotor rotatably mounted on a supporting structure and having a rotation axis substantially at right angles to a nominal direction of fluid flow, a plurality of vanes each being mounted on the rotor for rotation relative to the rotor about a respective vane rotation axis which is parallel to and radially spaced from the rotor rotation axis, and vane rotating means operable to orient each vane relative to the rotor such that when the instantaneous movement of the vane rotation axis due to rotor rotation is parallel to and in the same direction as the nominal direction of fluid flow the vane presents to the flow a major face having a relatively large cross-section and when the movement is parallel to and contra to the nominal direction of fluid flow the vane presents to the flow an edge having a relatively small cross-section.

An advantage of such a turbine is that the vanes can be made of any convenient length without necessarily requiring the supporting structure to be of corresponding dimensions.

Preferably each vane comprises a planar sail the major face of which is oriented at substantially 90° to the nominal direction of fluid flow when the sail is moving parallel to and in the same direction as the nominal direction of fluid flow.

An advantage of this arrangement is that it is not necessary for the vane to have an aerofoil section.

Preferably the rotor has a vertical rotation axis and the vanes extend upwardly of the rotor.

This is particularly advantageous when the turbine is used as a windmill since the supporting structure is not required to be a tower of any appreciable height and can be made in a compact and robust form.

Conveniently the vane rotating means rotates each vane relative to the rotor at a rate which is one-half of the rate of rotation of the rotor relative to the supporting structrure and in the same sense of rotation.

Each 180° movement of the rotor thereby produces a 90° rotation of each vane, this being the required amount of rotation to turn a planar sail from its maximum cross-section to its minimum cross-section relative to the fluid flow. A further advantage of this arrangement is that, because the vanes rotate in the same sense of rotation as the rotor, this results in the vanes contributing to the torque applied to the rotor at locations intermediate the maximum and minimum cross-section positions relative to the fluid flow. At these intermediate positions the vanes are inclined to the fluid flow at an angle which results in the vanes experiencing a reaction to the fluid flow having a tangential component acting in the direction of rotor rotation.

Preferably the vane rotating means comprises a reduction gear mechanism which may comprise a spur gear fixed to a spindle which is fixedly mounted on the supporting structure and defining the rotor rotation axis, each vane having an associated drive shaft extending radially of the spindle and rotated by a respective crown gear in engagement with the spur gear, and a further gear train coupling the axle rotation to rotation of the vane about the vane rotation axis.

In a preferred embodiment the spur and crown gears provide a 2:1 reduction.

Preferably the turbine comprises directing means operable to vary the nominal direction of fluid flow so as to substantially align the nominal direction of fluid flow with an actual direction of fluid flow.

This is primarily of use when the turbine is transferring power from a fluid flow which is a naturally occurring current susceptible to variation in flow direction. The directing means may comprise means for sensing the actual direction of fluid flow and rotating the supporting structure so as to align the nominal direction with the flow.

The directing means may be a simple vane or rudder arrangement or may comprise a more elaborate arrangement in which the actual direction of fluid flow is sensed and a control mechanism is used to orient the vanes accordingly.

The turbine may alternatively be utilised to transfer power from a flow of water or other liquid to mechanical power.

The turbine may be alternatively used to generate a flow of fluid by using a motor to drive the rotor such that the vanes impel fluid.

Preferably the turbine comprises two vanes which are disposed on diametrically opposed sides of the rotor.

A preferred embodiment of the present invention will now be described by way of example only and with reference to the accompanying drawings of which:-

Figure 1 is a front elevation of a turbine for use as a windmill; and

Figure 2 is a plan view of the turbine of Figure 1.

In Figure 1 a turbine 1 constitutes a windmill for extracting mechanical power from a flow of air. The turbine 1 comprises a rotor 2 which is rotatably mounted on a supporting structure 3 which comprises a block 4 supporting a vertically upwardly extending spindle 5.

The rotor 2 comprises upper and lower beams 6 and 7 which are each journalled to the spindle 5 so as to be rotatable about the spindle in respective horizontal planes which are vertically spaced apart.

First and second vanes 8 and 9 extend vertically between the upper and lower beams 6 and 7 and are mounted on vertically extending shafts 10 and 11 which are journalled in the radial extremities of the upper and lower beams 6 and 7.

The shafts 10 and 11 include downwardly projecting portions 12 and 13 which are rotated relative to the rotor by a reduction gear mechanism 14.

The reduction gear mechanism 14 comprises a spur gear 15 fixed to the stationary spindle 5 and engaged by a crown gear 16 driving a horizontal drive shaft 17 extending radially of the spindle. The drive shaft 17 is coupled to the downwardly projecting portion 12 of shaft 10 by bevel gears 18 and 19 having equal numbers of teeth and arranged in a mitre configuration.

Crown gear 16 has twice the number of teeth of the spur gear 15 to provide a 2:1 gear ratio. When

When the rotor 2 is rotated relative to the supporting structure 3 the relative rotation between the spur gear 15 and the rotor causes the drive shaft 17 to be rotated at one-half the rotation speed of the rotor and this rotation is communicated by the bevel gears 18 and 19 to rotation of the first vane 8 relative to the rotor. The reduction gear mechanism 14 includes corresponding crown gear 20, drive shaft 21 and bevel gears 22 and 23 operable to rotate the second vane 9 in like manner.

An additional horizontal beam 24 extends beneath the vanes 8 and 9 and above the reduction gear mechanism 14 to provide rigidity to the rotor and avoid bending of the shafts 10 and 11.

Figure 2 shows the orientation of the vanes 8 and 9 in solid lines at a position corresponding to that of Figure 1 and in broken lines at three alternative positions of the rotor 2.

The turbine 1 is shown in Figure 2 at a position in which the beams 6 and 7 are at 90° to a nominal direction of fluid flow 25. In this position the first vane 8 presents an edge 26 to fluid flow in the nominal direction of fluid flow whereas the second vane 9 presents a major face 27 to fluid flow in the nominal direction of fluid flow. Since each of the vanes 8 and 9 is in the form of a planar sail the cross-section presented to the flow by the edge 26 and the major face 27 are respectively a minimum and maximum so that the effect of a fluid flow in direction 25 would be to rotate the rotor in the anti-clockwise direction as viewed from above.

For this rotation to be continued it is necessary for the orientation of the vanes 8 and 9 to be rotated through 90° for each 180° rotation of the rotor so that whichever of the vanes 8 and 9 appears to the left of Figure 2 a minimum cross-section is presented to the flow and a maximum cross-section is presented by the vane appearing at the right of Figure 2.

The necessary rotation to achieve this effect is achieved by the reduction gear mechanism 14 described above.

In Figure 2 the positions of the vanes shown in chain dot are representive of intermediate positions between the positions of maximum and minimum cross-section to the flow which in Figure 2 correspond to vanes 9 and 8 respectively.

At each of these intermediate positions the vanes experience a reaction to the flow which is at right angles to the plane of the major face 27. In each case it will be observed that this reaction has a tangential component in the direction in which the vane is rotating thereby contributing to the torque applied to the rotor.

The sense of rotation of the vanes 8 and 9 relative to the rotor is in an anti-clockwise direction as viewed from above, this being the same sense of rotation as that of the rotor relative to the supporting structure 3.

The actual direction of air flow 28 is shown in Figure 2 to be coincident with the nominal direction 25. Any deviation of the actual direction 28 from the nominal direction 25 will reduce the torque delivered to the rotor and in the present embodiment the nominal direction 25 can be made coincident with the actual direction 28 by rotating the supporting structure 3 through the required angle.

The same effect could be achieved by an alternative arrangement in which the spindle 5 was rotated through the required angle to align the nominal direction 25 with the actual direction 28. This could be carried out manually or automatically by means of a rudder arrangement (not shown) or an equivalent electromechanical device.

Mechanical power output can be derived from rotation of the rotor by any suitable means (not shown) and may be used to drive an electrical generator or a mechanical device such as a water pump.

The reduction gear mechanism 14 may alternatively comprise a pulley arrangement or equivalent construction employing a toothed belt, or a chain and cooperating cogs. Instead of conventional annular gears, the gears may alternatively be elliptical if required to provide a non-uniform rate of vane rotation. Alternatively the vanes may be oriented by means of electric motors operable to drive the shafts 10 and 11 relative to the rotor and controlled by an electronic control mechanism.

It is envisaged that a number of such turbines could be deployed in an array for the purpose of extracting mechanical power from wind (where the turbine acts as a windmill) or from water currents such as tidal flow (where the turbine acts as a water driven turbine), the primary objective being to generate electrical power.

One or more turbines in accordance with the present invention might alternatively be used as windmills driving a water pump to extract water from an underground source.

Such turbines may if required incorporate more than two vanes although preferably the number of vanes should be kept to a minimum to reduce turbulence effects. The number of vanes should preferably be an even number and evenly distributed about the rotor axis to avoid the generation of vibration about the central spindle.

CLAIMS:

1. A turbine for transferring power to or from a fluid flow comprising a rotor rotatably mounted on a supporting structure and having a rotation axis substantially at right angles to a nominal direction of fluid flow, a plurality of vanes each being mounted on the rotor for rotation relative to the rotor about a respective vane rotation axis which is parallel to and radially spaced from the rotor rotation axis, and vane rotating means operable to orient each vane relative to the rotor such that when the instantaneous movement of the vane rotation axis due to rotor rotation is parallel to and in the same direction as the nominal direction of fluid flow the vane presents to the flow a major face having a relatively large cross-section and when the movement is parallel to and contra to the nominal direction of fluid flow the vane presents to the flow an edge having a relatively small cross-section.

2. A turbine as claimed in claim 1 wherein each vane comprises a planar sail the major face of which is oriented at substantially 90° to the nominal direction of fluid flow when the sail is moving parallel to and in the same direction as the nominal direction of fluid flow.

3. A turbine as claimed in any preceding claim wherein the rotor has a vertical rotation axis and wherein the vanes extend upwardly of the rotor.

4. A turbine as claimed in any preceding claim wherein the vane rotating means rotates each vane relative to the rotor at a rate which is one-half of the rate of rotation of the rotor relative to the

supporting structure and in the same sense of rotation.

5. A turbine as claimed in claim 4 wherein the vane rotating means comprises a reduction gear mechanism.

6. A turbine as claimed in claim 5 wherein the reduction gear mechanism comprises a spur gear fixed to a spindle which is fixedly mounted on the supporting structure and defining the rotor rotation axis, each vane having an associated drive shaft extending radially of the spindle and rotated by a respective crown gear in engagement with the spur gear, and a further gear train coupling the axle rotation to rotation of the vane about the vane rotation axis.

7. A turbine as claimed in claim 6 wherein the spur and crown gears provide a 2:1 reduction.

8. A turbine as claimed in any preceding claim comprising directing means operable to vary the nominal direction of fluid flow so as to substantially align the nominal direction of fluid flow with an actual direction of fluid flow.

9. A turbine as claimed in claim 8 wherein the directing means comprises means for sensing the actual direction of fluid flow and rotating the supporting structure so as to align the nominal direction of fluid flow therewith.

10. A turbine as claimed in any preceding claim comprising a windmill operable to transfer power from a flow of air into mechanical power.

11. A turbine as claimed in any of claims 1 to 10 operable to transfer power from a flow of water to mechanical power in the form of rotation of the rotor.

12. A turbine as claimed in any of claims 1 to 9 comprising a motor operable to drive the rotor so as to create a flow of fluid.

13. A turbine as claimed in any preceding claim comprising two vanes which are disposed on diametrically opposite sides of the rotor.

14. A turbine substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

FIG. 1.

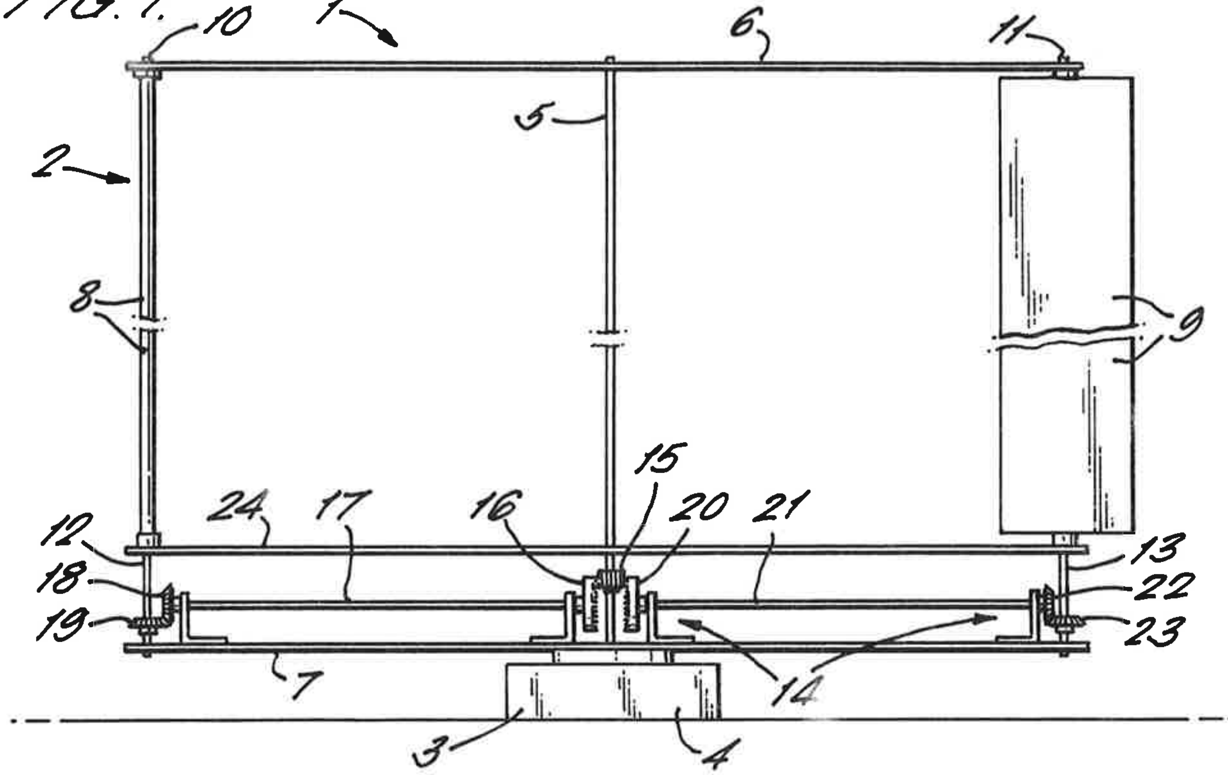
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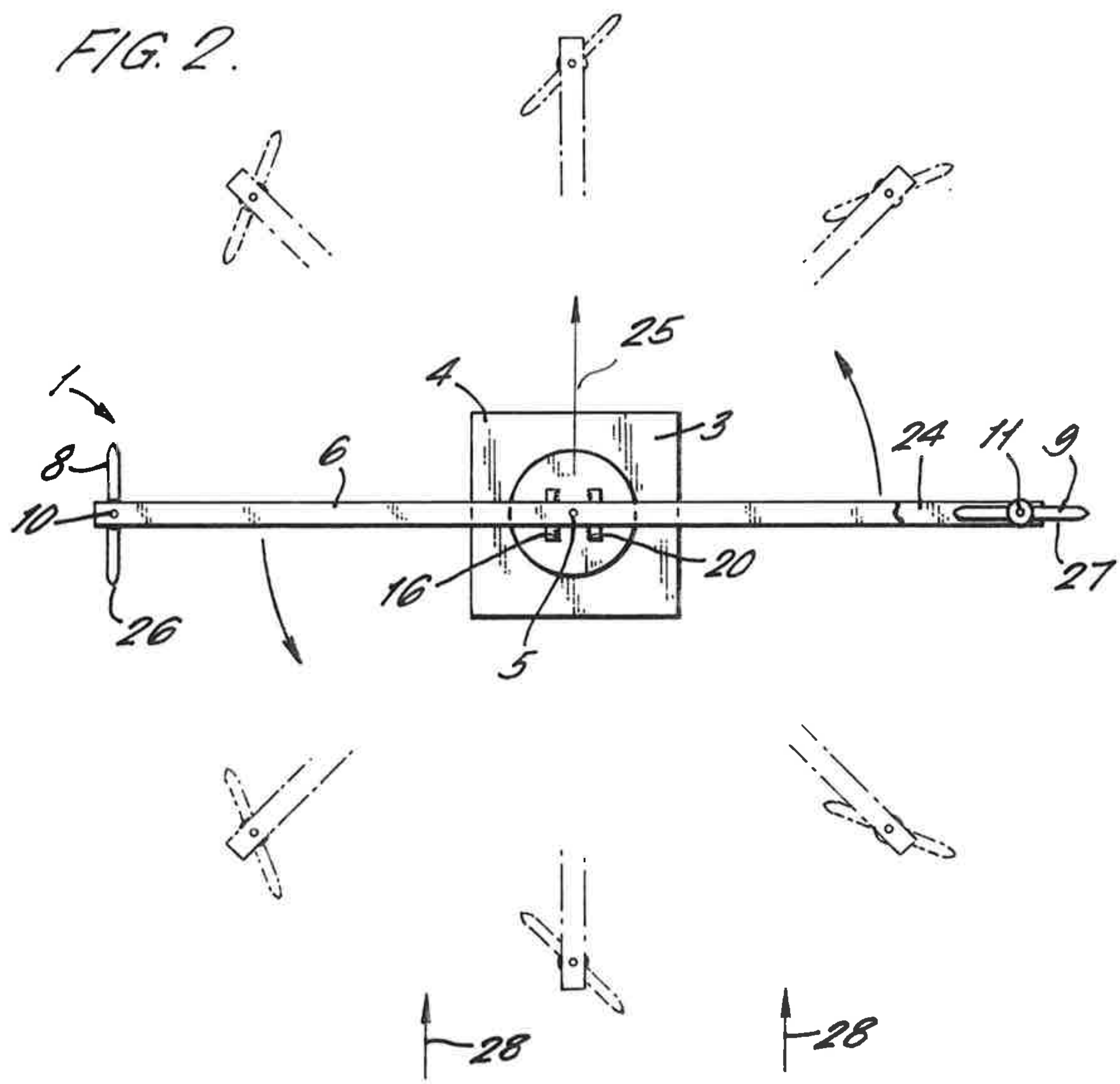
FIG. 2.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