UKRAINE

MINISTRY OF EDUCATION
AND SCIENCE OF UKRAINE

STATE DEPARTMENT OF
INTELLECTUAL PROPERTY

(19) **UA** (11) **90614** (13) **C2**
(51) **МПК** (2009)
**F03D** 7/00
**F03D** 1/00

## DESCRIPTION
## TO INVENTION PATENT

# (54) WIND-DRIVEN POWER PLANT WITH A WIND TURBINE WITH REMOVABLE AXLES

(21) a200901576
(22) 23.02.2009
(24) 11.05.2010
(46) 11.05.2010, Bull. No 9, 2010
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(56) SU 1242636, 07.07.1986
UA a200614065, 10.07.2008
UA a200614058, 10.07.2008
SU 1525298, 30.11.1989
SU 1813916, 07.05.1993
UA 62398, 15.12.2003
UA 62025, 15.12.2003
US 6548913, 15.04.2003
US 1982039, 28.08.1933
DE 3319165, 06.12.1984
JP 2001099045, 10.04.2001
(57) wind-driven power plant with a wind turbine with removable axles and tower with generator, reduction gear, slewing gear, mast, drivers for blade-slap angle correction, and wind turbine installed with the possibility of rotation on axles of a wind turbine of a blade, a takeoff shaft and connected mechanical transmissions with overall gear ratio 1, a stepping mechanism kinematically connected by mechanical transmissions with a takeoff shaft and rotating element of a wind turbine distinguished by each blade having a cone-shaped rim linked with a cone-shaped rim fixed coaxially on the axle fastened in the rotating element of the wind turbine and is parallel to the axis of its rotation, and connected with a mechanical transmission with overall gear ratio 1, stepping mechanism with mechanical transmissions connecting its input and output elements with the takeoff shaft and rotating element of the wind turbine installed directly inside the tower.

Under the current version of MKB, the wind-driven power plant with a wind turbine with removable axles falls into the section F03D. The installation belongs to the wind power industry.

There is the wind-driven power plant under (19) SU, (11) 1242636 containing a hollow shaft with a wind turbine with a hub installed, blade and power control unit fixed on the hub, and a torque pin and roller with transverse axes installed coaxially inside the shaft; with this, some ends are rigidly fixed one with another, and others are connected with the shaft and hub; the hub is hollow, a bevel gear is installed on a transverse axis, and a gearwheel is fixed on the shaft. A drawback of this design is the impossibility for blades to make additional movements by lifting force, and thus, the impossibility of conversion of such movements into additional rotation of the generator's shaft.

There is the wind-driven power plant under (19) SU, (21) a200808003 with a tower with generator, reduction gear, slewing gear, mast, drivers for blade-slap angle correction, and wind turbine with removable axles under 19) UA, (21) a 200614065, bodies installed with the possibility of rotation on axles of a wind turbine with removable axles and containing crank gears contacting with blades and kinematically connected with the fixed element; with this, bodies are directly kinematically connected with the takeoff shaft. As well this design contains the stepping mechanism serving for intermittent rotation of the wind turbine's element. The stepping mechanism is fastened on the fixed element displaced from the tower to the wind turbine, and it is kinematically connected with the takeoff shaft and wind turbine's element. A drawback of this design is presence of the fixed element and the stepping mechanism placed directly in the area of the wind turbine with replaceable axles; plus, massive bodies with crank gears and mechanisms kinematically connecting them with the fixed body.

The goal of this work is improvement of the design, reduction of sizes and requirements to the workability of units of the wind-driven power plant, which are capable of taking up and converting movements of blades of the wind turbine with replaceable axles they do by lifting force to the torque on the takeoff shaft.

The set goal is achieved by each blade containing a rim of the bevel gear contacting with the similar rim installed with the possibility of rotating on the collar parallel to the axis of rotation of the wind turbine's element and connected with mechanical transmission with overall gear ratio 1 kinematically connected with the takeoff shaft. Inside the tower of the wind-driven power plant the stepping mechanism is placed, and its input element is kinematically connected by mechanical transmission with the takeoff shaft, and the output element is connected by mechanical transmission with the wind turbine's element. When blades rotate, the torque is transmitted through brims of the bevel gear to the mechanical transmission with overall gear ratio 1 and further to the takeoff shaft rotating it. With this, when the wind turbine performs its operational cycle and blades rotate in the plane perpendicular to the plane of rotation, the projection of lifting force parallel to the axis of the collar, on which a blade is located, is able, at the expense of angular displacement of collars, generate an additional torque on the wind turbine's element, which then is transmitted through mechanical transmission to the output element of the stepping mechanism, then further to the input element and from it through mechanical transmission to the takeoff shaft increasing the torque generated by blades when rotating around axles, where they are installed. Blade-slap angle correction is performed by servo drives installed directly on blades, and power is supplied to servo drives by current-collecting devices.

In Fig. 1 a kinematic scheme of the wind-driven power plant with a wind turbine with replaceable axles is shown;

In Fig. 2 positions of elements 3, 10, 11, 12, 13 at dead cycle are shown;

In Fig. 3 positions of elements 3, 10, 11, 12, 13 at the end of dead cycle and the beginning of operational cycle are shown;

In Fig.4 position of elements 3, 4, 5 at the end of operational and the beginning of dead cycle is shown, front view;

In Fig.5 positions of elements 3, 4, 5 at the end of operational and the beginning of dead cycle are shown, top view;

In Fig.6 positions of elements 3, 4, 5 at the end of dead and the beginning of operational cycle are shown, front view;

In Fig.7 positions of elements 3, 4, 5 at the end of dead and the beginning of operational cycle are shown, top view;

In Fig. 8 positions of elements 15 and 17 at dead cycle are shown;

In Fig. 9 positions of elements 3, 10, 11, 12, 13 at operational cycle are shown;

In Fig. 10 positions of elements 15 and 17 at the beginning of operational cycle are shown;

In Fig. 11 positions of elements 3, 4, 5 in the middle of operational cycle are shown, front view;

In Fig. 12 positions of elements 3, 4, 5 in the middle of operational cycle are shown, side view;

In Fig. 13 positions of elements 15 and 17 in the middle of operational cycle are shown;

In Fig. 14 the diagram of effect of forces on elements 3,4,5 is shown;

In Fig. 15 the diagram of effect of forces on element 4 at the beginning of operational cycle is shown;

In Fig. 16 the diagram of effect of forces on element 4 at the moment of a turn of blades 3 at the angle α after the beginning of operational cycle is shown;

In Fig. 17 the diagram of effect of forces on element 4 at the middle of operational cycle is shown;

In Fig. 18 the diagram of effect of forces on element 4 at the moment of a turn of blades 3 at the angle γ after the beginning of operational cycle is shown;

In Fig. 19 the diagram of effect of forces on element 4 at the end of operational cycle is shown;

The wind-driven power plant (Fig.1) has a mast 1, tower 2, wind turbine with replaceable axles containing blades 3, rotational element of the wind turbine 4, axles of blades 5. Blades 3 contain servo drives 6 and are installed so they could turn over for blade-slap angle correction by servo drives 6. Each blade 3 contains a cone-shaped gear rim 7 installed coaxially with axles 5. Each cone-shaped gear rim 7 geared to the similar rim 8 installed coaxially on the axis 9 parallel to the axis of rotation of the wind turbine's element 4. Each gear rim 8 is connected with a gear wheel 10. Gear wheels 10 contact with middle gear wheels 11 geared to a gear wheel 12 installed on the takeoff shaft 13. Diameters of gear wheels 10 and 12 are equal, and together with the middle wheel 11 they form a mechanical transmission 14 with overall gear ratio 1. In the tower 2 of the wind-driven power plant the stepping mechanism is installed, and its input element 15 is kinematically connected by mechanical transmission 16 with the takeoff shaft 13, and the output element 17 is kinematically connected by mechanical transmission 18 with the wind turbine's element 4. Gear ratio of mechanical transmission 16 and 18 is so that at the takeoff shaft 13 turning at 180° the input element 15 turns at the angle corresponding to the cycle of motion or the dwell operation cycle of the output element 17, with that, the turning angle at the cycle of motion of the output element 17 shall ensure, together with mechanical transmission 18, turning of the wind turbine's element 4 at 360°.

When the wind-driven power plant with a wind turbine with removable axles operates, axles 3 of the wind turbine taking up the wind force turn around with a uniform angular velocity. At the dead cycle the wind turbine's element 4 does not turn around, when the blade 3 turns around at the angle α clockwise (Fig. 2 and 3) cone-shaped gear rims turn the gear wheel 10 at the same angle clockwise and the middle gear wheel 11 will turn at a certain angle depending on its diameter to the opposite side, and the gear wheel 12 with the same diameter as the wheel 10, together with the takeoff shaft 13, will turn at the angle α clockwise. Blades 3 at dead cycle will turn at 180° clockwise turning respectively the takeoff shaft and with this from their initial position (Fig. 5 and 6) they will take end position of the dead cycle (Fig. 7 and 8), which at the same time is the initial position of the operational cycle. During the dead cycle blades 3 turn around by the projection of lifting force on the plane perpendicular to the axis 5, on which a blade is located at angle β (Fig. 5 and 7) towards the plane perpendicular to the axis 9. While blades 3 perform the dead cycle, positions of elements of the stepping mechanism will correspond to Fig. 8, where the input element 15 turns around anti-clockwise, and the output element 17 remains motionless, and the wind turbine's element 4 does not turn, respectively. At operation cycle blades 3 continue turning clockwise and at the same time the wind turbine's element 4 starts turning around with twice greater angular velocity (Fig. 3 and 9). When blades 3 turn at the angle α gear rims 7 and 8 turn the gear wheel 10 at the angle α clockwise, and with this the element 4 turns at the angle 2α together with elements 10, 11, 12 of the mechanical transmission 14, the middle wheel 11 will turn anti-clockwise at the angle equal to the sum of two angles: the first one is conditioned by the angle of rotation of the gear wheel 10 (at equal diameters of wheels 10, 11 and 12 it will be α); another one is conditioned by the angle of rotation of the wind turbine's element and is equal to 2α. The gear wheel 12 will turn at the angle α clockwise together with the takeoff shaft 13. Rotation of the takeoff shaft 13 induces rotation, through the mechanical transmission 16, of the input element 15 of the stepping mechanism anti-clockwise (Fig. 10), and the value of the angle of rotation of the input element 15 shall ensure the motion cycle of the output element 17 at the time of rotation of blades 3 at the angle of 180° and, together with the mechanical transmission 18, turning the wind turbine's element at the angle of 360°. The output element 17 is turned by the input element 15 clockwise (Fig. 10) inducing clockwise rotation of the wind turbine's element 4. When the wind turbine's element 4 rotates, axes 5 of blades 3 change their position turning blades in the direction of action of the projection of lifting force (Fig. 7 and 5), with this the angle of blades turn in that direction (during the operational cycle) will be 2β, and in the middle of operational cycle elements of the wind-driven power plant will take positions as shown in Fig. 11, 12, 13. When blades 3 are at the operational cycle, the projection of lifting force Px (Fig. 14) on the plane intersecting the axis of a blade, and the axis of the axle 5 creates at the ends of the blade's hub installed on the axle 5 a pair of forces R1 and R2, and projections of these forces on the plane perpendicular to the axis of rotation of the wind turbine's element 4 are equal to $Rx1=R1\times\cos\beta$; $Rx2=R2\times\cos\beta$, and they create torques equal to the product of Rx1 and Rx2, respectively, and the shortest distance from the center of the wind turbine's element 4 to vectors of Rx1 and Rx2. At the beginning of the operational cycle (Fig. 15) torques from projections of forces Rx1 and Rx2 will be equal and balanced as distances from these vectors are equal and directions of their actions are opposite, so at the beginning of the operational cycle there is no additional torque at the wind turbine's element 4 and this element turns around by means of taking power off the takeoff shaft 13 through elements 15, 16, 17, 18. Further on, when blades 3 will turn at the angle α (Fig. 16), the torque from projection of Rx2 will exceed the torque from projection of Rx1 as the distance from the center of rotation to Rx2 is longer than that to Rx2, so the resulting torque is equal to $2\times MR\times 2 - 2\times MR\times 1$ effects the wind turbine's element 4 turning it clockwise, and with this it is transmitted from the wind turbine's element 4 to the mechanical transmission 18, and further to the output element 17, then the input element 15 of the stepping mechanism and through the mechanical transmission 16 to the takeoff shaft 13. Then, in the middle of the operational cycle (Fig. 17) projections of Rx1 balance one another, and the wind turbine's element 4 rotates by the torque from projection of Rx2 only. After torques from projections of Rx1 and Rx2 get balanced in a certain position, and with further increase of the angle γ torques from projections of Rx1 will be greater than torques from projections of Rx2 (Fig. 18), and the aggregate torque will continue to turn the wind turbine's element 4 clockwise increasing the power at the takeoff shaft 13. At the end of the operational cycle (Fig. 19) torques from projections of Rx1 and Rx2 get balanced, and the wind turbine's element 4 stops rotating without transmitting the torque to the takeoff shaft through elements 18, 17, 15 and 16.

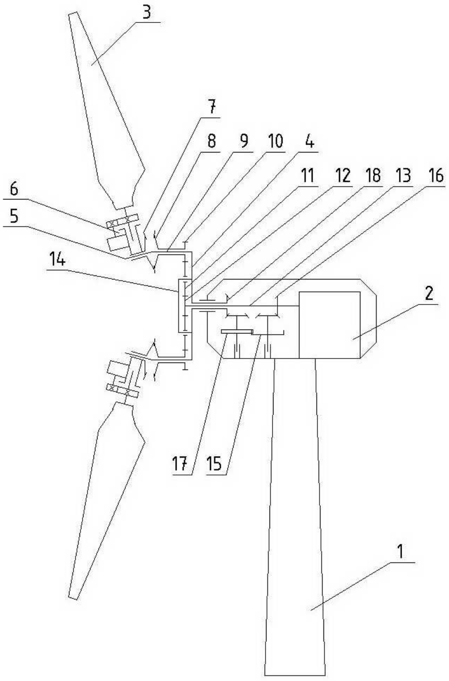


Fig 1

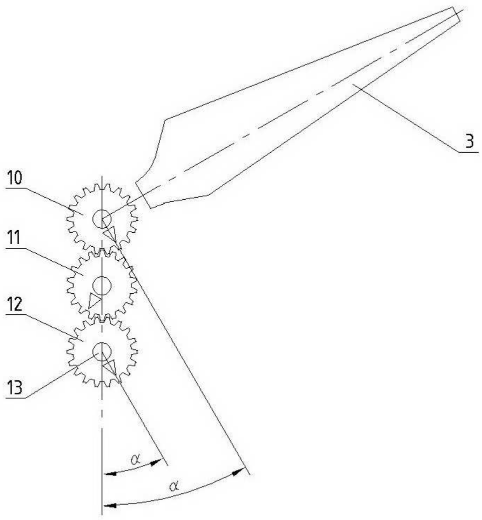


Fig 2

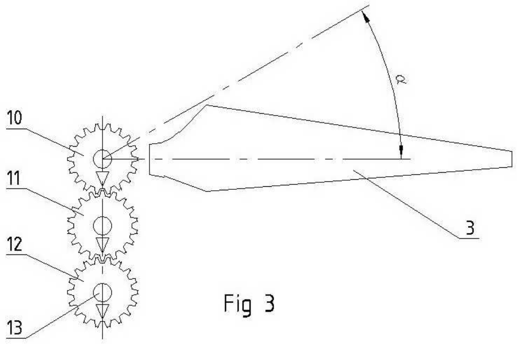


Fig 3

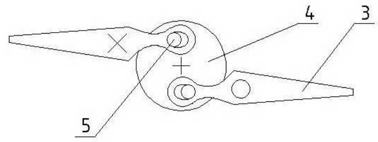


Fig 4

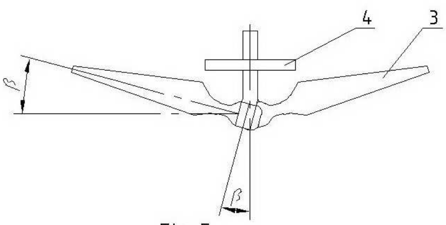


Fig 5

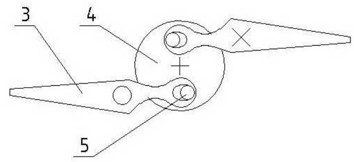


Fig 6

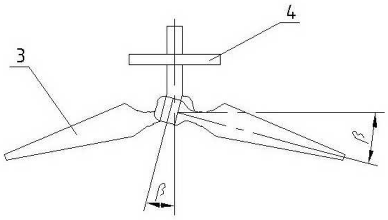


Fig 7

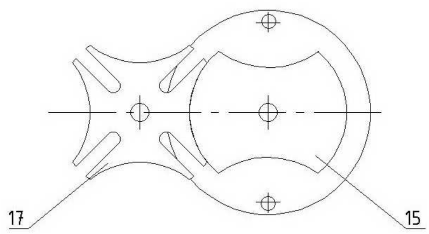


Fig 8

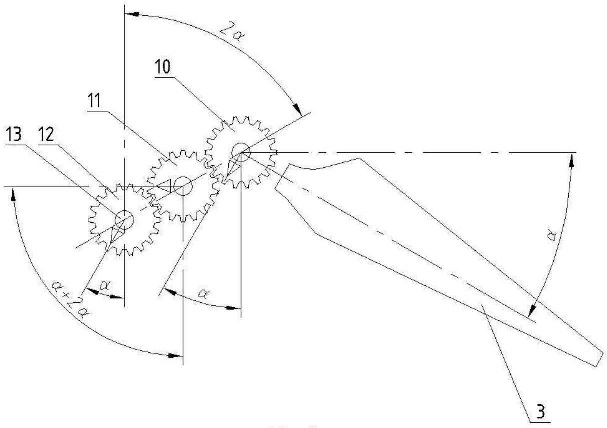

Fig 9

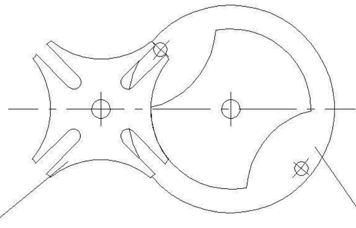

Fig 10

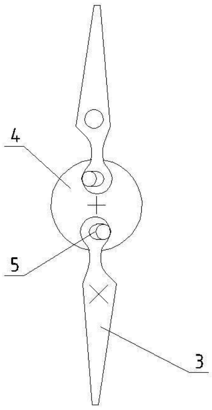

Fig 11

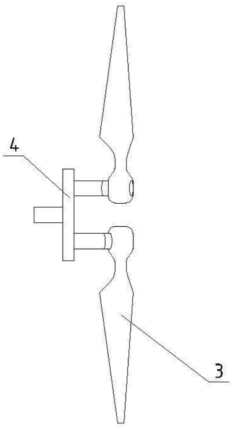

Fig 12

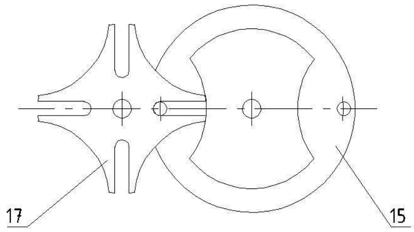

Fig 13

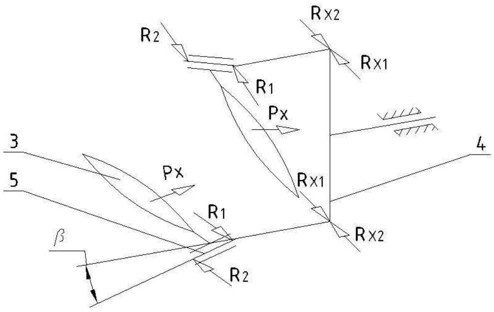

Fig 14

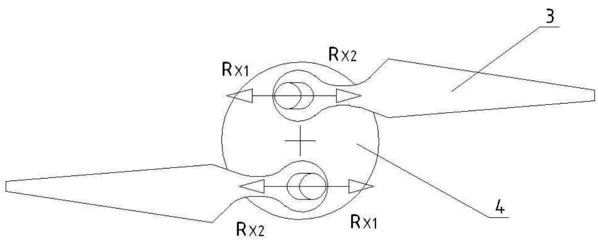

Fig 15

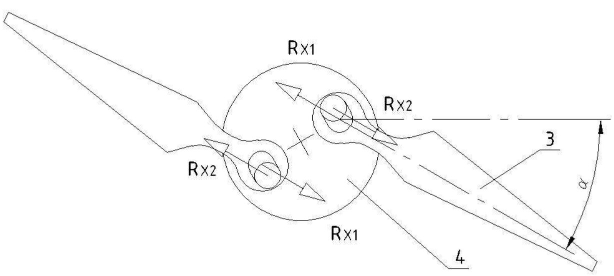

Fig 16

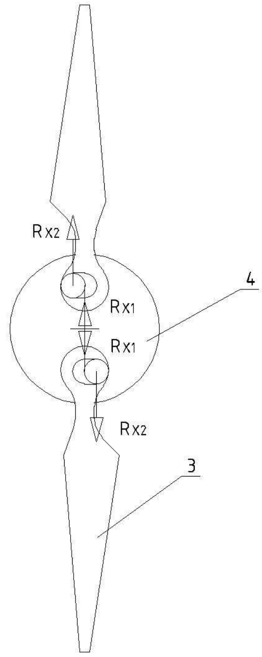


Fig 17

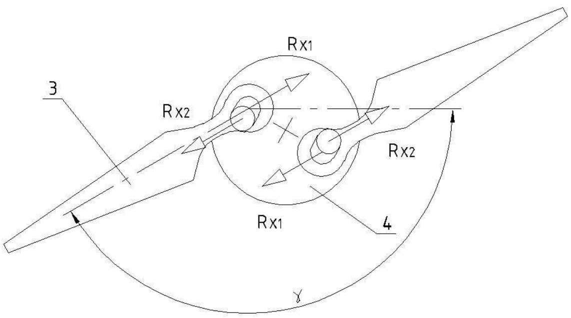


Fig 18

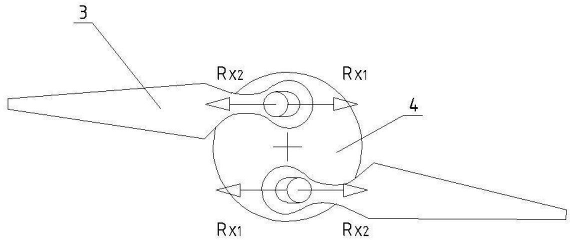


Fig 19