The Use of Wind Turbines in Ports and Sea Vessels

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Abstract. The technical result of the research of presented wind turbine is simplification and rise of the practical application of its main body – the rotor construction, which shall be achieved via transformation of wind shifting movement into rotating movement is implemented by rotor blades, which present bent or inclined shape plates and during rotation, these plates are not influenced with decelerating resistance of surrounding air.

The technical novelty of the turbine construction is presented with the following features: each profile blade of the rotor presents concave arc placed eccentrically towards its rotative axis, and the rotor may be equipped with one, two or more wings.

Keywords: power, turbine, shaft, hub, reactive force

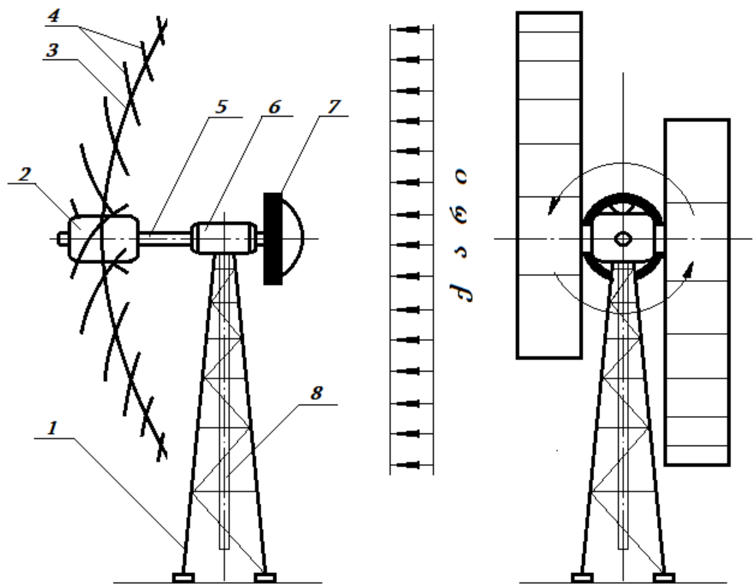
A permanent expansion of the industrial and domestic proceses on an international scale requires sufficient electro-energetic support, an issue that leads to global energy shortages and probable ecological devastation as an unfortunate byproduct. To resolve this problem inevitably and timely, the solution necessitates not only a way to reduce the carbon emissions from industrial plants but also a new, more efficient way of acquiring and using the present energy resources.

The transportation of cargo and civilians by the way of sea and rivers is assured by the obtained ressources found deep within the earth. It must be noted that the present massive urban and industrial expansion are taking a significant toll on the remaining reserves, allthewhile wreacking havoc on the environment. Consequently, to avoid devastating energy deficits and to preserve the ecology of our planet, the focus has shifted towards more renewable sources of energy that are abundant in nature on earth.

A discussion on the topic is perpetuated endlessly, often even by the mainstream media, with the main focus of the topic being the alternative, environmentally conscious sources of energy; one of which is the wind currents that possess kinetic energy that can be harvested and used. As such, an important decision must be made to substitute the more conventional, nuclear energy with wind-based renewable sources in all fields existing, or, at the very least, wherever possible.

The transformation of the wind’s kinetic energy into mechanical energy is made possible by the main ruddered rotor that the airstream forces into motion through physical contact. Consequently, the efficiency of the turbine will be in direct correlation to the quality of the rotor’s construction.

In this context, the Batumi National Naval Academy’s General Engineering department creative focus groups, accompanied by students as well, has created a prototype and is developing a multi-rudder wind turbine; the device will transform the aforementioned kinetic energy into rational mechanical energy more efficiently and will be usable by ports and naval vessels alike. The schematics show how the presented prototype is functionally different from the existing wind turbines. The blueprints for the said wind turbine are presented bellow (*Fig.1*).



ნახაზი 1.

ქარის მრავალნიჩბიანი ენერგოდანადგარი

1- საყრდენი; 2- მორგვი; 3- მზიდი კონსოლური მრუდი ძელი; 4- ნიჩბები; 5- ძირითადი ლილვი; 6- კორპუსი; 7- საპირწონე (რომელიც ერთდროულად ასრულებს მქნევარას ფუნქციას); 8- გამოსავალი ლილვი.

The prototype, which has the mentioned turbine is balanced by the support beam (1). The Upper part of the support holds the rotating chassis (6). The ball bearings situated on the chassis hold the main support of the turbine horizontally (5). One side of the base of the main support is fitted with and affixed by ball bearings (2); adjacent to the supports are the fulcrum and the fly-wheel (7). On the other side of the rudder, along the main support beams, heavyweight curved mills (3), which hold a certain number of plates that register impact more efficiently (4). From the chassis (6) the outward shaft (8) facing vertically downwards, which is kinetically connected to the main shaft (5).

The wind turbine functions as follows:

Upon impact, the rotating chassis displaces until the plates are facing the wind frontward.

The air current, upon impact, goes through them, gets reflected and leaves the turbine. Upon said reflection on the surface of the plates, a reactive force is generated.

These reactive forces create the momentum in relation to the main support beams, effectively bringing the windmill into motion, jumpstarting its functionality.

The main support, channelling the energy through a conic transmission, forces the outgoing support to rotate.

The attained mechanical energy created as a product is then used accordingly.

The main factors for the wind turbine are force, the rotation speed and geometric properties of the main mill which determine its construction.

Henceforth, for the establishment of the analytical link between the above-mentioned enterokinetic and force parameters, check the schematics of the turbine in question (pic.1)

The rotating part of the turbine, whose momentum of inertia equals $\mathscr{J}$, and spins with the angular velocity ω. The resistance of the rotation is ensured by calculating the angular vrlocity of the main shaft of the turbine when the following parameters are given:

- P – Force of the machinery:
- $\mathscr{J}$ – Inertia of the rotating part;
- V – Wind velocity;

The differential equation of the rotation:

$$\mathscr{J}\cdot \frac{d\omega}{dt} = T_b - T_c \qquad (1)$$

Where T_b – Momentum created from the impact with the wind,

T_c – Resistance

Resistance is presented by

$$T_c = \mathrm{k}\omega,$$

then (1) will take the form of

$$\mathscr{J}\cdot \frac{d\omega}{dt} = T_b - \mathrm{k}\omega \ .$$

By dividing and multiplying both variables with $(-\mathrm{k})$ and taking the appropriate integral

$$\int_{0}^{\omega} \frac{-\mathrm{k}d\omega}{T_b - \mathrm{k}\omega} = -\frac{k}{\mathcal{J}} \int_{0}^{t} dt$$

We get

$$\ell\mathrm{n}\, \frac{T_b - \mathrm{k}\omega}{T_b} = -\frac{k}{\mathcal{J}} \cdot t$$

or

$$\frac{T_b - \mathrm{k}\omega}{T_b} = e^{-\frac{k}{\mathcal{J}} \cdot t}$$

which results in

$$\omega = \frac{T_b}{k} (1 - e^{\frac{k}{\mathcal{J}} \cdot t})$$

$$\omega = \frac{T_b}{k}$$

Since the meaning of the k coefficient depends on many factors, determining its role analytically is difficult, however, its role can be determined through an experiment

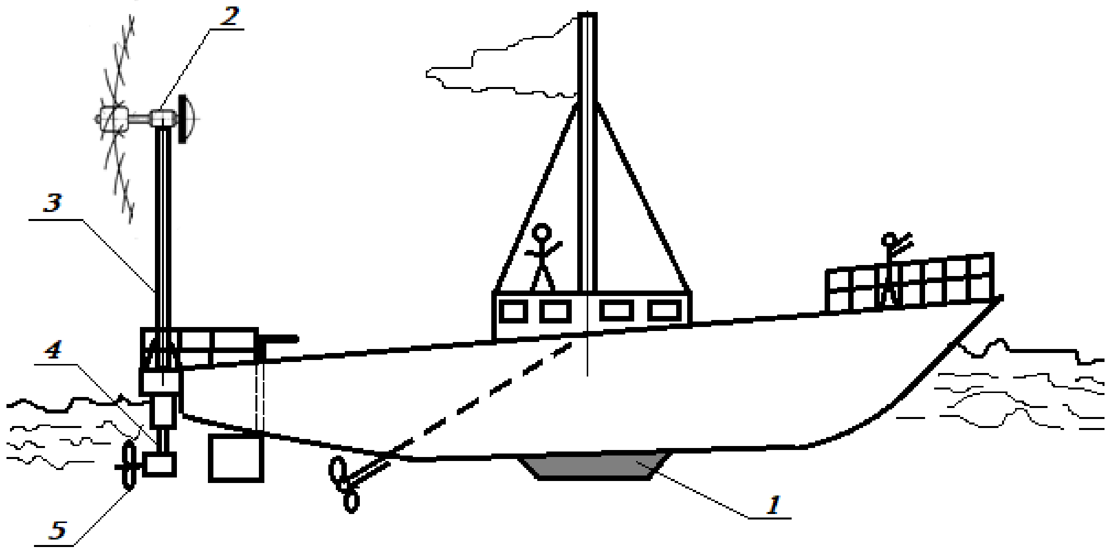
If ω is known, the power of the turbine can be determined

$$P = T_c \cdot \omega.$$

Field of use: By riding the air currents, the sailboats and old motorless sea-transports could relocate through the use of sails, however, these sails do not provide enough speed and therefore it is only logical that, instead, the vessels use wind turbines.

As wind turbines do not work efficiently in calm weather, the main motor should have a backup supply motor that runs on fuel.

The direction of the wind is not a detrimental factor to the rotation of the turbine, since the additional spaded screws (fig. 2) that ensure transportation in the desired direction, regardless of which direction.



ნახაზი 2

ტურისტული სასეირნო გემი

1- კილი; 2- ქარის ტურბინა; 3- საყრდენი ბოძი; 4- გამოსავალი ლილვი; 5- ნიჩბიანი ხრახნი.

In case of calm weathers or if the vessel needs to pick up speed, upon command, the main engine comes on, activating the spaded screws.

On sea/riverbound vessels, like the tourist tour boats or the cargo ships, the possibility to use the wind turbines effectively is apparent.

Using wind turbines for transportation of larger ships is a different issue, possibly for the future

Conclusion:

The use of wind turbines on sea/riverbound ships, as well as in ports and terminals bear the following perspectives:

- The use of cheaper, cleaner, more environment-friendly renewable energy for the day-to day operations;
- Fuel conservation;
- A more ecologically sound future.

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