New Model of Wave Energy Converter

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Abstract - The attempt to use the water wave energy goes about two centuries back. According to the US Patent database we are familiar approximately with the 2000 patents in the domain of the water wave energy use directly as well as partly. Only a few of them have been implemented even as an experiment.
http://peswiki.com/energy/Directory:Ocean_Wave_Energy).

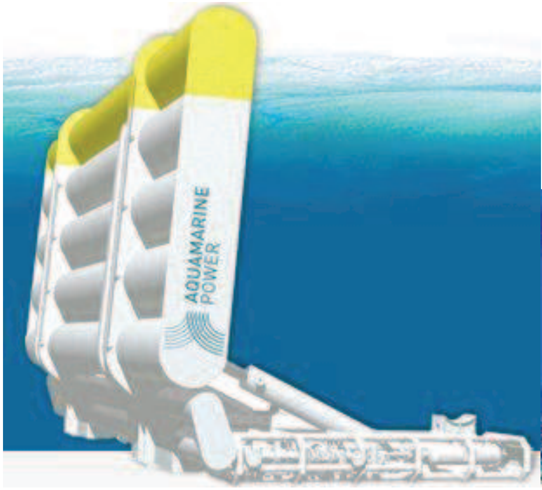
Nowadays, there are probably several dozens of working models, among of which only 5-6 types may have industrial purpose.

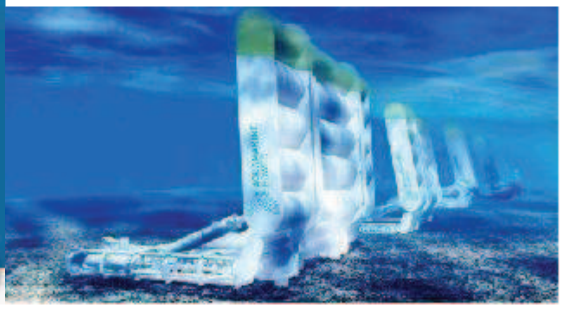
In order to overcome contemporary problems connected to energy, special importance is given to the use of renewable energy, including of water wave energy.

According to the experiment data, the resources of sea and ocean wave energy constitutes 40% of the total consumed energy in the world.

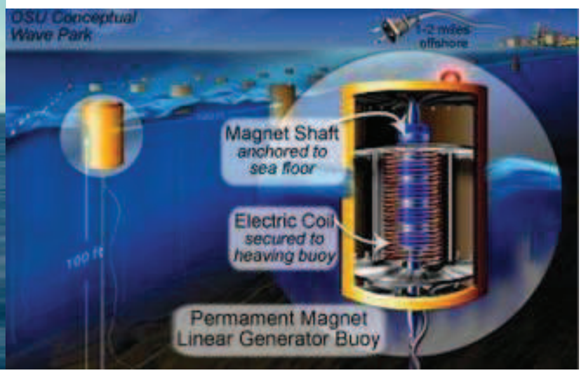
For this reason, all scientific and practical research organizations aimed at using renewable, namely, water wave energy, assiduously strive to create new and improve existed models.

Pelamis - wave energy converter

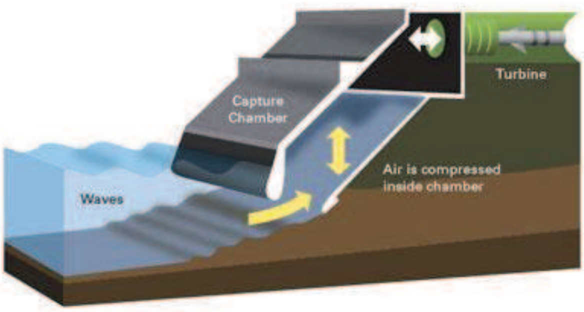




Oyster



Buy

Wells turbine

I. Introduction

Our goal is the creation of such energy device that would be easy to construct, reliable, requiring much less expenses for its production. At the same time it should be ecologically clean. Besides, it should be able to use the energetic capabilities of unbroken wave flow (current) as much as it is possible.

One model turbine, Wales Turbine has two circling momentum of direct and backward motion, the turbine turns only in one direction. (Fig.1).

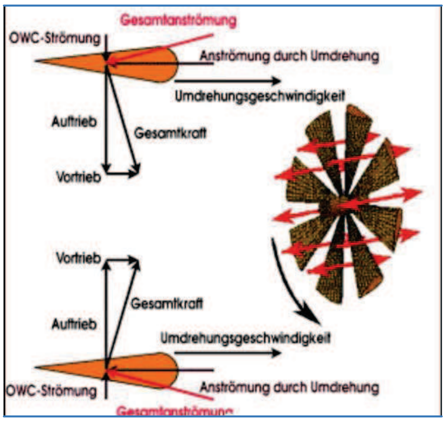


Fig.1

We offer new model of Wave Energy Converter, which is based on totally new principle (2).

We have changed wings of the Wales Turbine with the flexible material. The redesigned turbines we have fixed on one axis and thus we got a MULTITURBINE (Fig. 2).

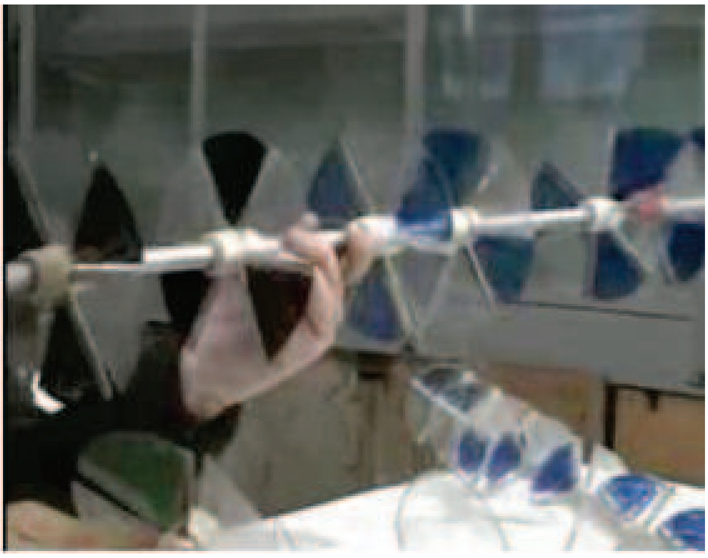


Fig. 2

If such floating multi/turbine is directed towards the wave propagating direction and it’s length is more then the wave length, then the power distributed on axis will be balanced; except the circling momentum, which will be arithmetical sum of circling momenta of each turbine

According to this, the axis length could be changed (made longer), until we get desired momentum. The momentum can be limited to the durability twist of the axis (3) .

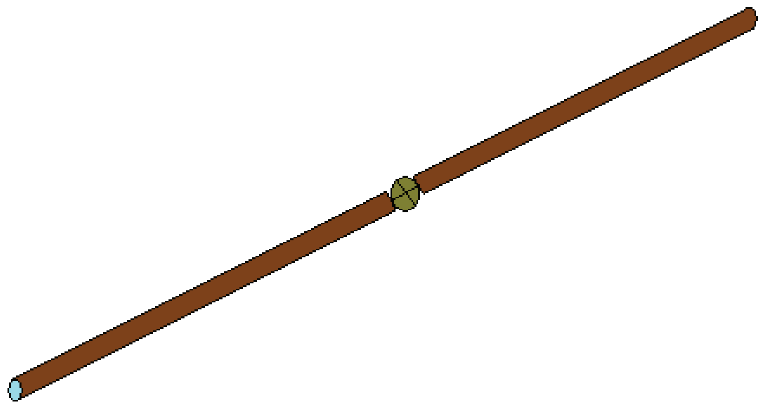
II. experimental conditions

Presented work aims to work-out and understand a cheap, highly cost-effective wave energy converting turbine and make it's industrial model' sample.

We have built an experimental sample for laboratory trial. The trials were done with help of artificial wave-generator, in specially designed pool.
Size of the pool is: 10m X 0,35m X 0,75m
The waves were of 3 types: H=8cm; L=(50,100,150)cm; T= (0.7, 1, 2)sec.
Length of the turbine axis: 230 cm.
Quantity of the engine: 16 units
Diameter of the engine: 12 cm
Diameter of an axis: 1.4 cm

III. Elements of the model:

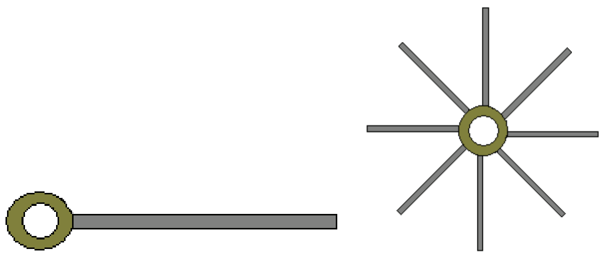
1. The **axis** is a driving element of the mechanism. It can be one rigid rod or a continuous axis formed by the Cardan joint of rigid cylinder-shaped elements. The axis collects rotational momentum of each Wells turbine detail connected to it.



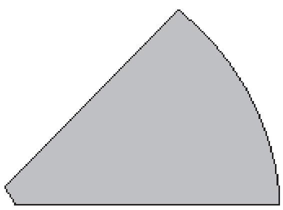
1.1 The average density of the axis and the elements attached to it should be close to the water density. This requirement is easy to obtain and allows for horizontal alignment of the construction.
1.2 The diameter of an axis depends on the height of the wave. According to preliminary calculations, the optimal length of the diameter should equal to 10-25 percents of the height of the wave. The exact length of the diameter depends on the amount of energy and reliability of the energy produced.
1.3 The optimal length of an axis contains several wave-lengths. The rotational momentum is directly proportional to the wave-length. Also, the length of the axis should be chosen so that it can resist the bending that results from the integral momentum exerted on it.
1.4 The axis can be constructed with a wide spectrum of the materials.

1.5 The edge of the axis closer to the shore can be directly connected to the generator on the shore. Such a mechanism is cheaper and simpler than models with generators located in the water.
1.6 The other end of the axis can be tied to the buy in a way allowing for its free rotation in the direction of the wave propagation.
1.7 The axis may be located closer to the water surface to protect the wings from the water pressure.
1.8 The depth at which the reverse motion of the particles is significant is optimal for placing the axis.

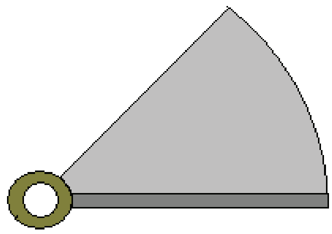
2. The reverse turbine is a set of coplanar rigid rays connected to the axis. The plane formed by the rays is perpendicular to the axis. Each ray has a flexible sector-shaped **scale** attached to it. The scale is tied to the ray along one radius with its vertex facing the axis.
2.1 **The ray** and the scale form the main element of the turbine, called the **wing.** Under the influence of direct and / or reverse current, the scale bends relative to the ray, thus forming a one directional rotational momentum.
2.2 The length of the ray and the number of the wings depend on the diameter of the axis. In other words, the height of the wave determines these parameters. The longer the diameter of the axis, longer rays in greater quantities are needed.
2.3 The space between rays is practically filled with the scales. However, the scale, while deformed, should not touch the neighboring ray.
2.4 The endpoints of the rays are equidistant.
2.5 The material for the rays should be selected by taking into account the expected loading.



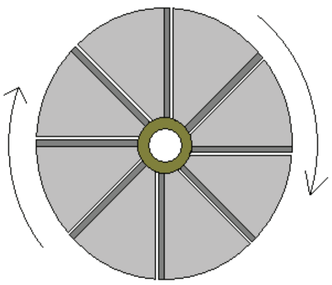
3. **Scale** is part of the wing. Its parameters (material, thickness and shape) should be determined in each specific case taking into consideration characteristics of the wave.



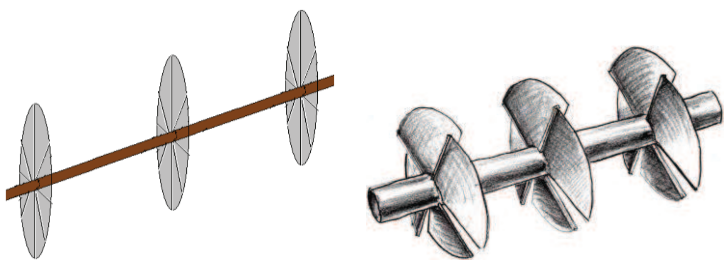
4. **The wing** is a sector-shaped flat detail, consisting of **a ray** and **a scale**. Its dimensions and shape (the central angle of a sector) depend on the diameter of the axis and the height of the wave. The quantity of the wings increases with the height of the wave and the diameter of the axis, whereas the angle of the sector-shaped scale decreases correspondingly.



5. **The actuator** is a set of coplanar wings located perpendicular to the axis.
5.1 Direct and/or reverse flaw resulting from a circular motion of water particles transmits a single direction rotational momentum to the actuator.
5.2 Each actuator transmits momentum to the axis.
5.3 The distance between actuators depends on the height of the wave. According to our calculations, this distance varies between one to three wave-lengths.



6. Actuators and the axis form **a turbine.**



IV. Results of Experiment

After the general observation, it was concluded that with such model it is possible to:

- Wave energy transformation is made simultaneously in all phases along several wave-lengths.
- The energy can be produced closer to or farther away from the shore, near the water surface or deeper into the water.
- Such models can be located parallel to each other and interconnected, thus forming a unified system.

- Such models system not only provides efficiency of energy generation, but also is an excellent tool for the shore protection.

V. Conclusion

The proposed turbine has following advantages as compared to the already existed models:

1. Since the energy generation happens simultaneously at all phases along several wave-lengths, the axis and the wings of the turbine **do not require high stability,** as opposed to other models that generate energy in one phase of the wave only (e.g. “Buy”).

2. Force exerted on the turbine wings by the pressure of the water current breaks in two components: the force along the axis and the rotational momentum (tangential) force. Exactly after each half-phase the axis component changes its direction into the opposite one, while the tangential component and the rotational momentum stay the same and add up on the axis. **Therefore, forces exerted on the turbine compensate one another, except for the rotational momentum, which is the sum total of the momentums of the actuators.**
3. It is possible to increase the number of the actuators until the desired momentum on the axis is attained.
4. The construction is eco-friendly, quiet and safe for the ocean fauna, since its rotational velocity is relatively low. It does not consist of complex knots, which represent potential pollution threat.
5. As the construction is small, it does not intrude in the view of the environment.
6. Due to the flexibility of scales, a turbine designed for waves of average strength at a specific location can easily operate under the pressure of higher waves. Also, in case of a storm or a Tsunami, the turbine can be temporarily drowned to the safe depth, because its average density is close to the water-density.
7. The construction can be made of a wide range of materials. It does not require high precision, semi-precious or rare materials or special technological processes.
8. The construction is relatively simple, easily repairable. The exploitation expenses are quite low.
9. This newly suggested model is more profitable than the existing ones.

References

1. http://peswiki.com/energy/Directory:Ocean_Wave_Energy

2. Patent: **(10) AU 2009 11199 U (51) Int. Cl. (2006) F 03 B 13/00**
(21) AU 2009 011199 (22) 2009 04 01
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3. http://www.youtube.com/watch?v=D1u0vjM3cAY