UKRAINE TEAM

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DEVICE FOR WAVE ENERGY TRANSFORMATION FOR THE DISTRIBUTED ELECTRICAL ENERGY GENERATION

PROBLEM STATEMENT

The potential of energy production using the world's oceans is almost not used. This method is still considered difficult and unprofitable. However, energy can be produced and used locally. For this, based on the scientific literature on similar mechanisms, a device design was created that will compensate for the disadvantages of past developments.

The purpose of the work is to create a design of the system for converting wave energy into electricity
Stages of the development:
- Analyze the features of mechanisms that use the mechanical energy of waves, types and characteristics of waves;
- Develop system design/concept;
- Based on this design, make calculations and create a prototype.

These buoy mechanisms can also be used for scientific measurements, just like conventional buoys. The extracted energy can be transported from node to node or used locally, for example, to extract hydrogen.
In this way, it can contribute to ocean research and the rational use of our planet's resources.

SOLUTION

A significant number of mechanisms have already been created to convert the energy of ocean waves into electrical energy. But such devices are still not common. This is due to a number of reasons. Those kind of problems were solved as follows:
- The generated energy will be used locally
- The system for generating electricity will consist of assemblies of small generators
- These generators will be buoy type mechanisms. Their dimensions will be optimal for absorbing medium-sized wave energy

The system consists of:
- Double action generator
- Pneumatic cells located like polygon faces
- Rigidly attached ballast
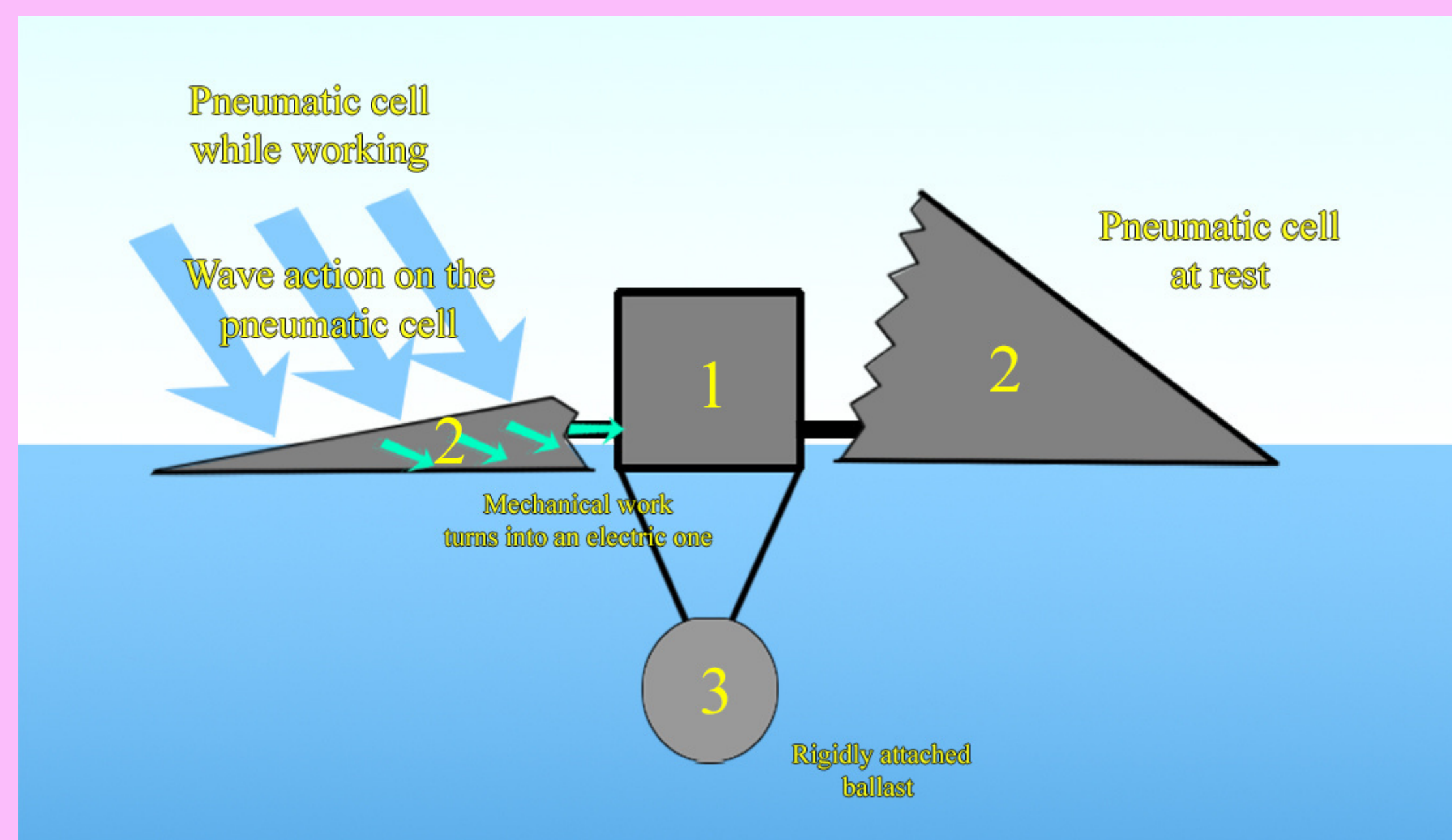
Structure and principle of operation of the system

The principle of operation of the first mode (periodic and chaotic waves of medium size):
- Under the action of the wave, the pneumatic cell is compressed, the air in it moves under pressure to the generator, where it acts as a working body.
- The working position of the mechanism is horizontal on the surface of the water, it is also supported by rigidly attached ballast.
- The size exceeds the size of an ordinary buoy only by several times. Working mechanisms are easy to manufacture and do not require a complex control system.
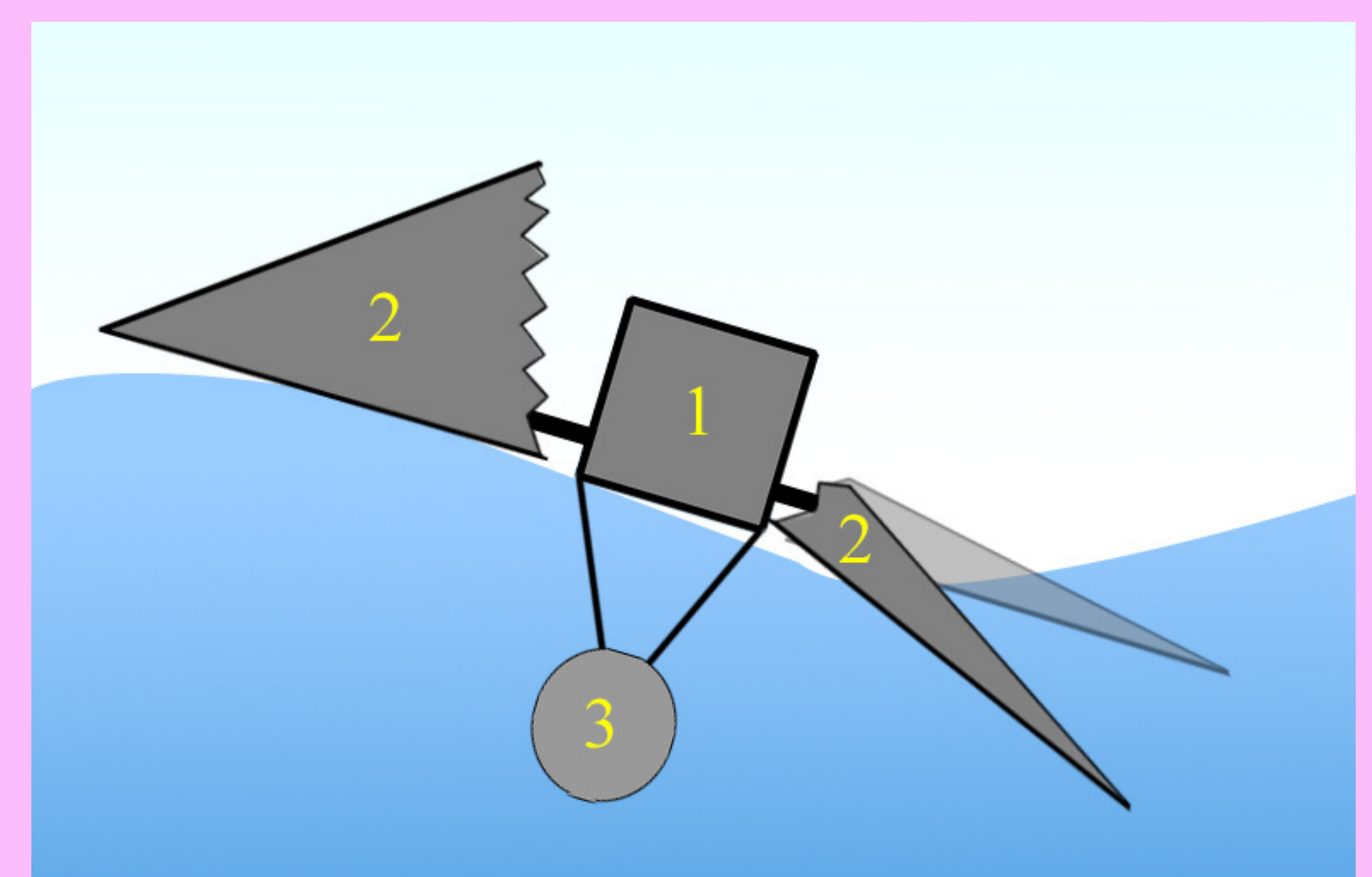
The principle of operation of the second mode

The principle of operation of the second mode:
Waves that significantly exceed the system in height affect not only the pneumatic cells, but the entire mechanism, so the usual way of working is not suitable. In this case, the pneumatic cells will act as a lever that will transfer the wave energy to the generator

EXPERIMENTAL PART

To determine the effectiveness of the mechanism, an experiment with a model of the pneumatic cell has been designed

$$E_{pw} = 7664 \, J/m$$

- We calculate the equivalent wave energy that will act on the pneumatic cell model. Taking the values of M and h that are convenient for us.

$$E_{eq} = Mgh = 10 \times 2 \times 9.8 = 196 \, J$$
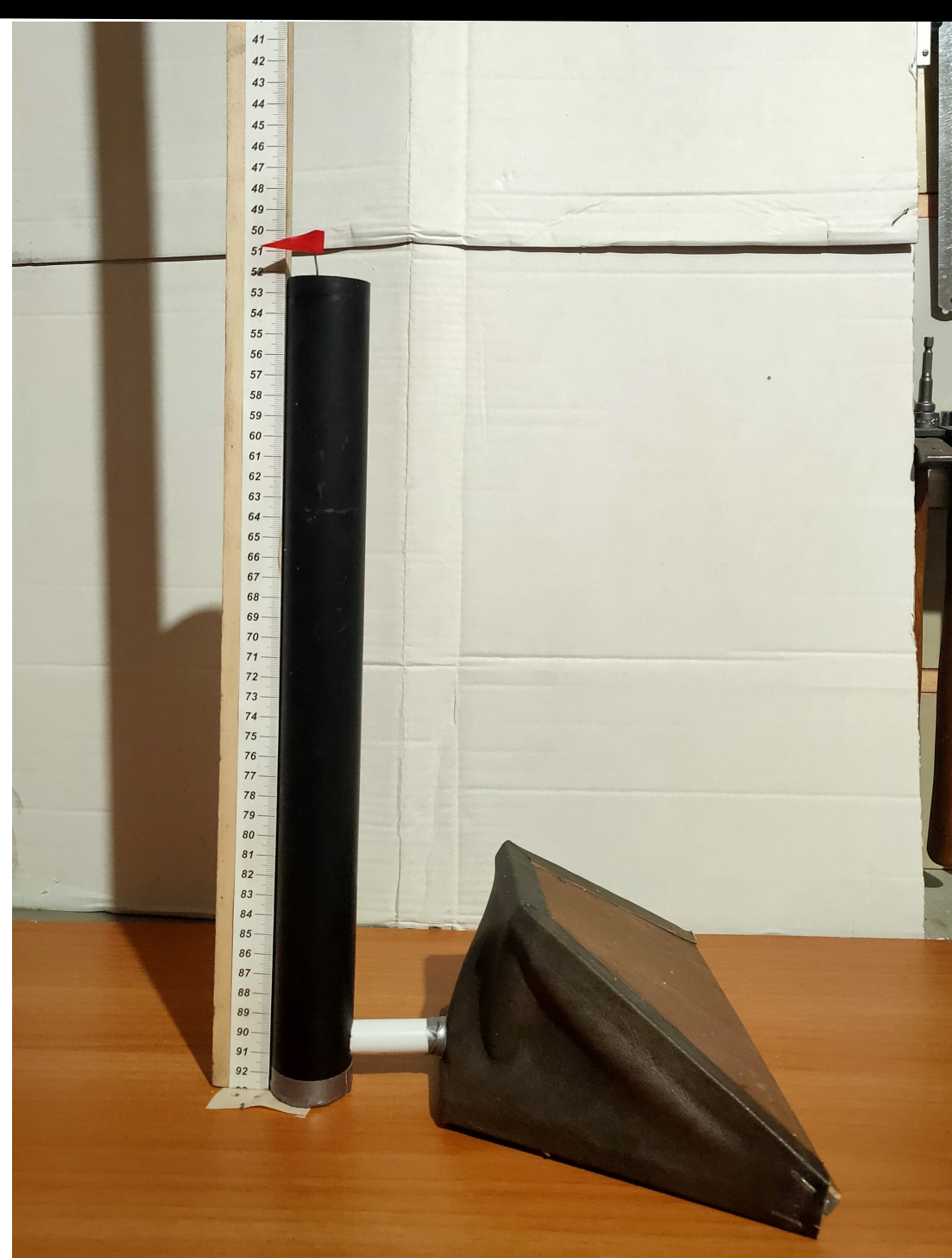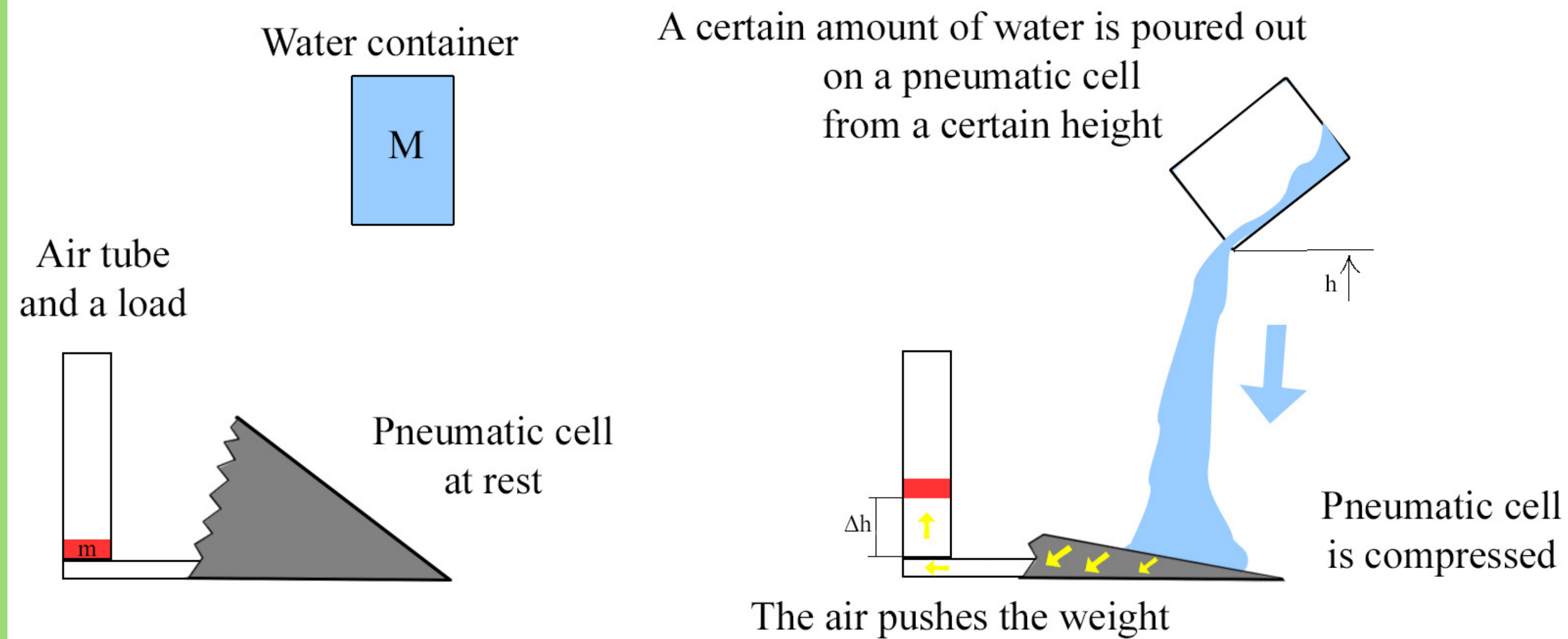
- Now we can calculate the required face area of the pneumatic cell.

$$S_{sector} = \frac{E_{eq}}{E_{pw}} = \frac{196}{7664} = 0.02557 \, m^2 = 256 \, cm^2$$

- After pouring a specified amount of water from a specified height onto a pneumatic cell, it is compressed and activates a simple mechanism. We record the movement of our load. Now we can calculate the energy converted by the pneumatic cell using the following formula:

$$A = mg\Delta h$$

- After that, we can determine the energy conversion efficiency of the pneumatic cell and scale the obtained results to the mechanism of real dimensions, taking into account the parameters of the generator.

Water container

Air tube and a load

Pneumatic cell at rest

A certain amount of water is poured out on a pneumatic cell from a certain height

The air pushes the weight

Pneumatic cell is compressed

CONCLUSIONS

1. Analysing the types of mechanisms that can be used for conversion of the energy of ocean waves, we have identified the assembly of multiple buoyant generators with pneumatic cells as the most promising.
2. A conceptual design of a buoy-type system for converting wave energy has been created, for two modes of use.
3. An experiment has been proposed for determination of the efficiency of the key parts of the system, using the constructed real-size model of a pneumatic cell.
4. The energy conversion efficiency estimation can be applied to a real-size mechanism to calculate the amount of electricity that the system can produce for different types and heights of the oceanic waves.