1. ELECTROSTATIC MOTOR

Grisha Lutsenko
Georgian Lyceum of Science and Technology,
Tbilisi Gymnasium №7 Named After A.Razmadze

What is electrostatic field? This is a potential electric field caused by a unmovable electric charge, work in which on closed circuit is equal to zero. But if all charges are unmovable the motor will work without taking energy from source, but makes some work. So it is impossible to make such motor, because the energy's conservation law. But as known Coulombs law for moving charges:

$$F = \frac{q_1 q_2}{R^2\left(1-\frac{v^2}{c^2}\right)} \qquad (1)$$

As we can see the process is static if charge's speed is much less than speed of light.

Then motor, which works by mean of electrostatic field, is a device which converts potential energy of electrostatic field to the mechanic energy. There is possible to create many models of such motors. We made three working models of such motors. We called them rotor, ion and pendulum motor.

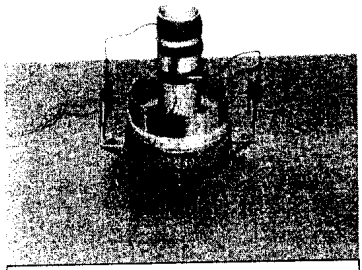


Fig1.Photo of Rotor Motor

Rotor motor consist of internal and external parts. Internal part consist of two plastic tubes with four contacts on each. Each contact on internal tube is connected with each external. The internal part can rotate with low friction. External part consist of two metal plates, to which is connected high voltage source, and two contacts, which are during the rotation of internal part are connecting to different contacts on internal tube. There happens attraction of external plates to the plates on the external tube. We don't explained parameters of this motor because low output power.

Let's look on ion motor. This is most difficult for understanding motor. It is founded on the phenomenon of ion wind. It's construction is very simple. There is metal axe in the center with cooper nails on it, directed perpendicularly, as shown on the picture. Also as you can see there is external tube to which is all this placed. To exclude influence of the current's magnetic field the tube and nails are made from cooper. The

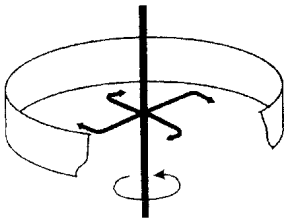


Fig3.Scheme of Ion Motor

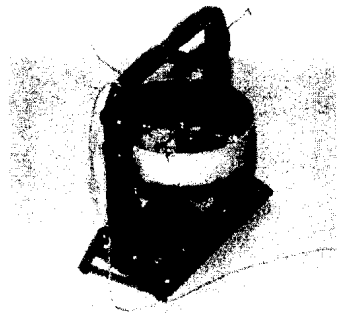
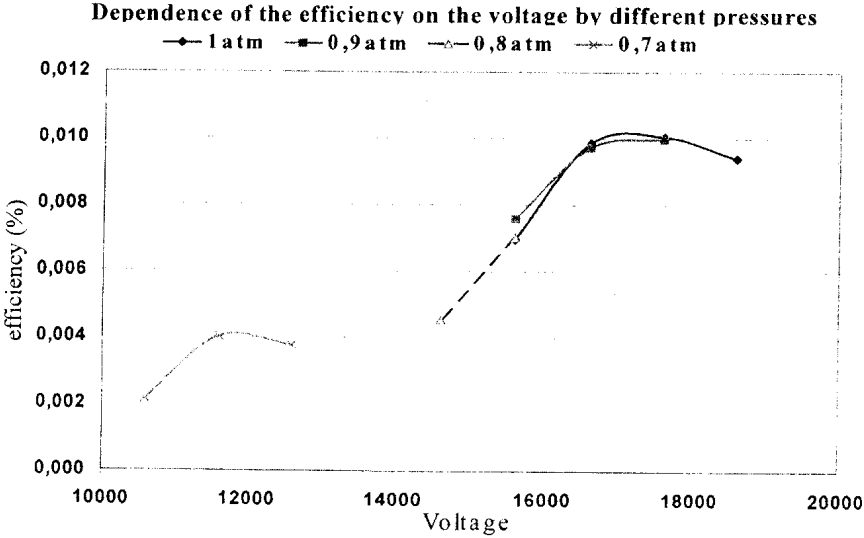
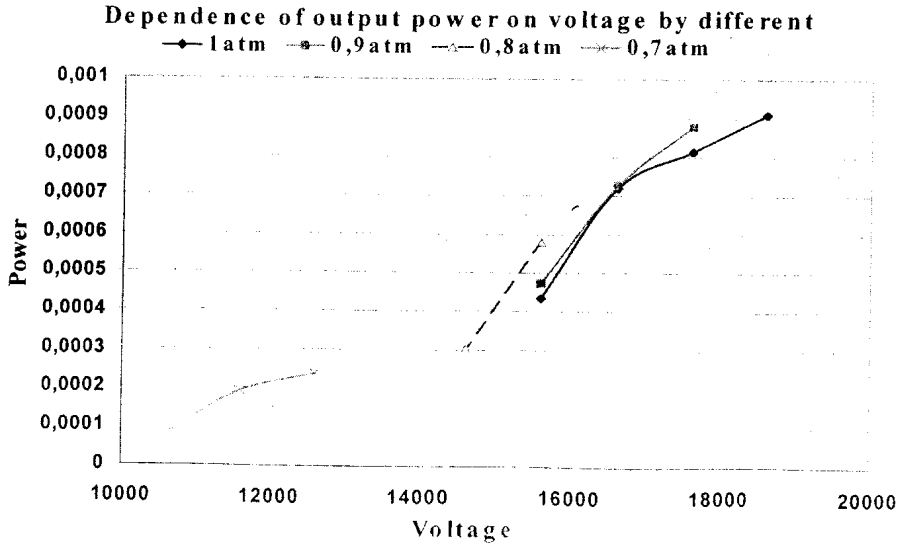


Fig2.Photo of Ion Motor

source of high voltage must be connected to metal axe and tube. On the ends of the nails happens crown discharge, by which happens appearing of ions. The ions begin motion by the electrostatic field between nails and tube, and ions are giving impulse to the internal part, by which happens the rotation of the internal part.

We think that the parameters , which are necessary for explaining are output power and efficiency, and their dependence on the external parameters. Useful power is power which we can use, for example work which goes on the lifting of the weight. Placing this motor to the vacuum camera we measured these parameters by different voltages and pressures. Maximum efficiency of ion motor in the air is 0,01%, in CO_2 – 0,02%. Difference of the efficiency in different gazes because masses of molecules are different, so by increasing of the mass causes increasing of the impulse. Also you can see dependence and power on voltage on the graphs.





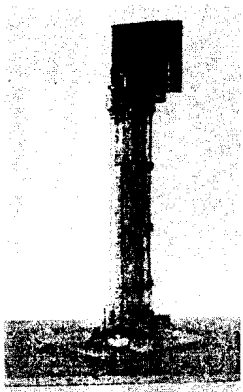


Fig4.Photo of Pendulum Motor

Pendulum motor – is the simplest of our motors and the most efficiency. It is a plane capacitor with metal plate fixed on the stick, flexibly fixed. To make it work is necessary to connect the source to the internal plates of the capacitor. By the gravity force the internal plate connects to the external one. On first look the power, the work, which is made by displacement of the internal plate can be calculated by the formula (2).

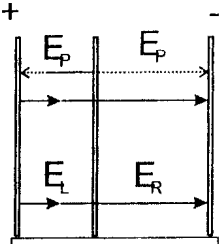


Fig5.Scheme of Pendulum Motor

$$A = eEd \quad (2)$$

But the charge of internal plate is comparable with charge of external plate, and there is EMF connected to the internal plates, the field caused by external plates changes in time. After some calculations, we got next formulas(3,4,5,6)where E– is strain of field caused by external plates, E_P – strain of field caused by internal plate, E_L and E_R – strains of fields between middle plate and left one, and between middle and right one, $\mathcal{E}$ – EMF, x – coordinate of internal plate, d – distance between external plates.

$$E_p = \frac{\sigma}{2\varepsilon_0} = \frac{\mathcal{E}}{2d} \quad (3) \qquad E_L = E - \frac{E}{2d} \quad (4)$$

$$E_R = E + \frac{\mathcal{E}}{2d} \quad (5) \qquad E = \frac{\mathcal{E}}{2d} + \frac{\mathcal{E}x}{d^2} \quad (6)$$

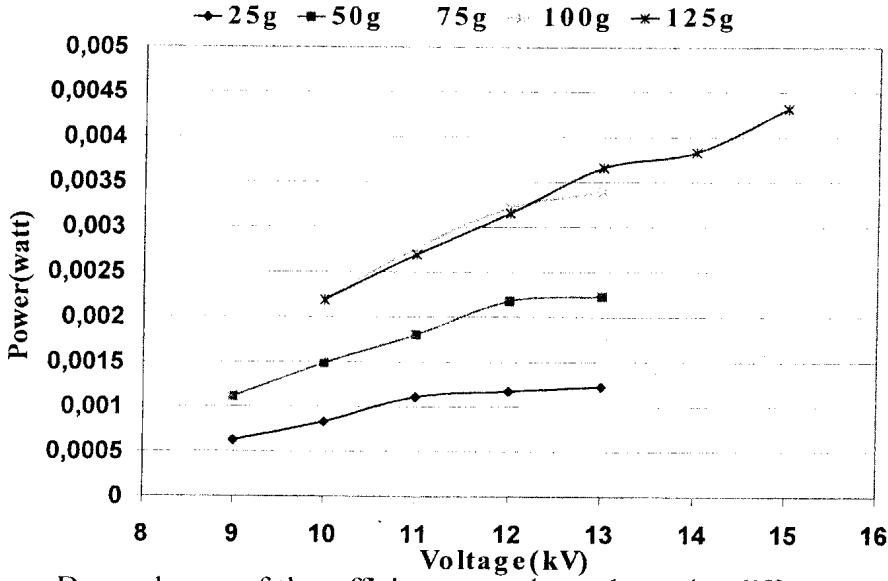
So the work made by field by moving the internal plate is equal to the integral (7), where C – is capacity of capacitor. For our motor C is 5,6 pF.

$$A = \int_0^d Eqdx = C\mathcal{E}^2 \quad (7)$$

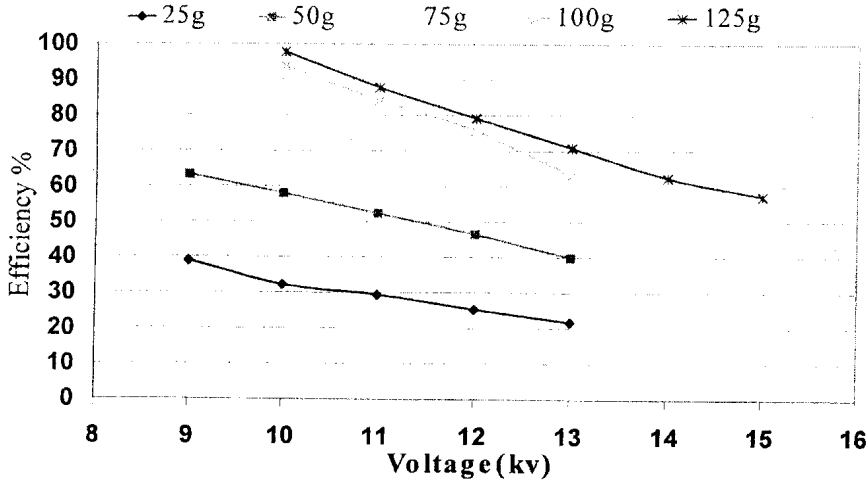
In the moment when internal plate comes near to the opposite charged plate, then on this external plate inducts charge, twice big than charge of internal one. So there all charge from external plate goes on the internal plate, by which don't happens losing of energy.

During the experiments we used some known weight on a thread to measure useful work, and measured number of pendulum's oscillations during the lifting of this weight on height 10 sm. So the efficiency of our motor can be calculated by next formula. Where m – is mass, N – number of oscillations, these parameters are measured experimentally. Efficiency of this motor depends on the lifting mass. This happens because if the mass is small the plate takes more kinetic energy, which cannot be used. For lifting small weights with big efficiency is necessary to make transmission to get the same load on the pendulum. Efficiency of this motor is very high – by mass 125 g it is 97%. Other parameters you can see on the graphs.

Dependence of the power on the voltage by different loads



Dependence of the efficiency on the voltage by different



Summary.

So, the target of our report was to show the possibility of creation of electrostatic motor and to show it's parameters. And we can say, that it possible, and as you saw they have rather good characteristics.

I would like to acknowledge Dr E. Kiziria for the very fruitful consultations.