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Electric Generators of Mende

By F. F. Mende

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I. Introduction

Three are today known basic of the type of the electrostatic generators, utilized for obtaining the high voltages. The work of these generators is based on the use of laws of electrostatic induction. These are the dropper of Calvin [1], generator of Van de Graaf[2] and the electro-form generator of Wimshurst [3].

The simplest electrostatic generator is dropper of Calvin, its diagram is represented in Fig. 1.

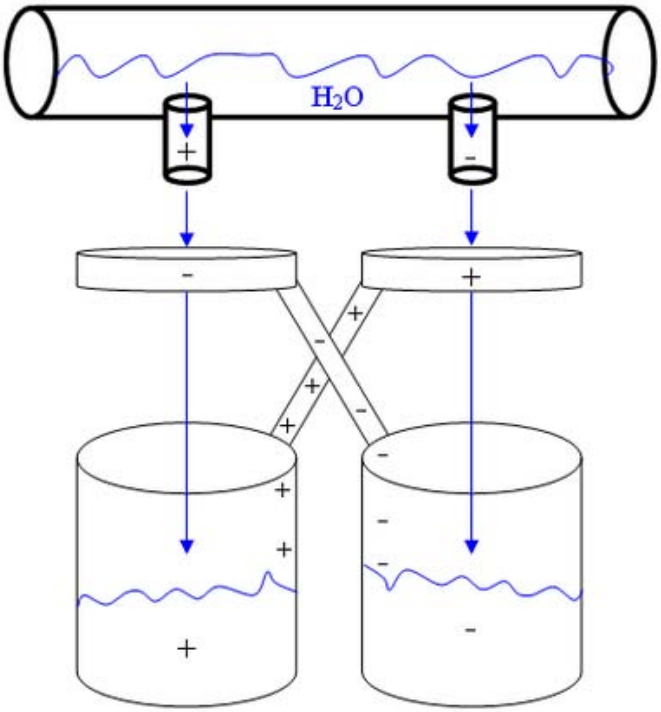

Fig. 1: Schematic of Calvin's dropper

Originally entire installation has neutral charge. It is unknown in view of the symmetry of installation and absence of charge, on which of the jars positive or negative charge will be accumulated. A small potential difference always is present because of different external actions between the left and right side of the installation, therefore the installation requires no starting charging of jars for the starting of system. By the force electrostatic induction ferrules direct in the reservoir with the water in that place, under which they are located, opposite charges. As a result a quantity of charges on the opposite edges of reservoir becomes different. After falling, drop they fall into the jar, which corresponds to its charge, thus increasing its charge, which creates still larger electric field near the rings, strengthening the separation of static charge and a potential difference between the banks it grows.

The electrical oscillator circuit of Van de Graaf is represented in Fig. 2.

Author: *e-mail: fedormende@gmail.com*

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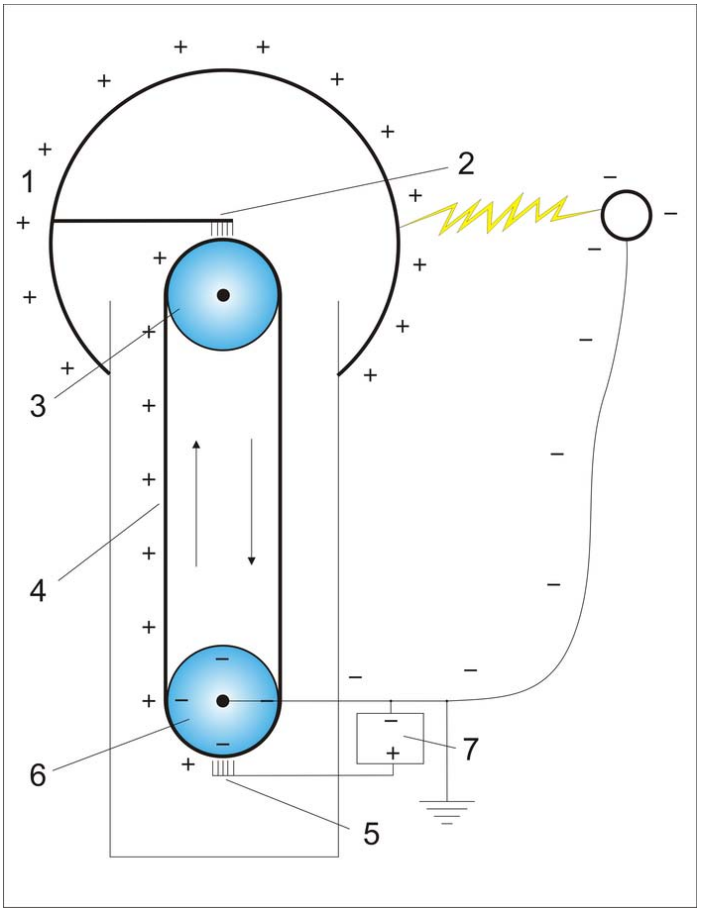

Ris. 2: Electrical oscillator circuit of Van de Graaf

Van de Graaf generator consists of the dielectric (silk or rubber) tape 4, of that revolving on the rollers 3 and 6, moreover upper roller dielectric, and lower metallic and is connected s by the earth. One it goes from the parts of the tape during the rotation of rollers in the metallic sphere 1. Two electrodes 2 and 5 in the form brushes are located at small distance from the tape on top and from below, moreover electrode 2 is connected with the internal surface of the sphere 1. Through the brush 5 air is ionized from the source of the high voltage 7. Resultant positive ions under the action Coulomb force they move to that grounded to roller they settle on the tape. The moving tape transfers charge inside the sphere, where it is removed by the brush, under the action Coulomb force charges are pushed out to the surface of sphere and field inside the sphere is created only by booster charge on the tape. Thus, on the external surface of sphere is accumulated electric charge. The possibility of obtaining the high voltage in this generator is limited by the corona discharge, appearing with the ionization air around the sphere.

Electro-form generator, developed by German scientist Wimshurst, is depicted in Fig. 3 and its name bears.

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Fig. 3: Electro-form generator of Wimshurst

In the generator there are two revolving in the opposite direction disks, made from a good insulator. To the disks the conducting plates, which form capacitors, are stuck with the plates of opposite disk. In the process of rotating the disks the capacitance of these capacitors changes, since. the area of the overlap of the conducting plates changes. In the process of rotating the disks along the conducting plates the brushes, which connect the oppositely placed plates on both disks, slide. On both sides disks are two pairs of point electrodes, located on the appropriate holders. These electrodes during the rotation of disks do not concern the conducting plates, but charges on these electrodes appear with the electrical breakdown between the contacts and the conducting plates. On the electrodes indicated are collected the charges of the opposite signs, with the aid of which are charged high-voltage capacitors (Leyden jars). The holders of ball-shaped discharger are located on the Leyden jars.

II. Electric Generators of Mende

a) *Dropper of Mende*

If we on the electrolyte put the electric field (Fig. 3), thus it is polarized, in this case on the left side the baths will be collected anions, and in its right part cations will be collected. Charged anions produced through the openings in the lower part of the bath and cations fall into the separate baths, forming two battery terminals, which manufactures current, if we between these poles include load.

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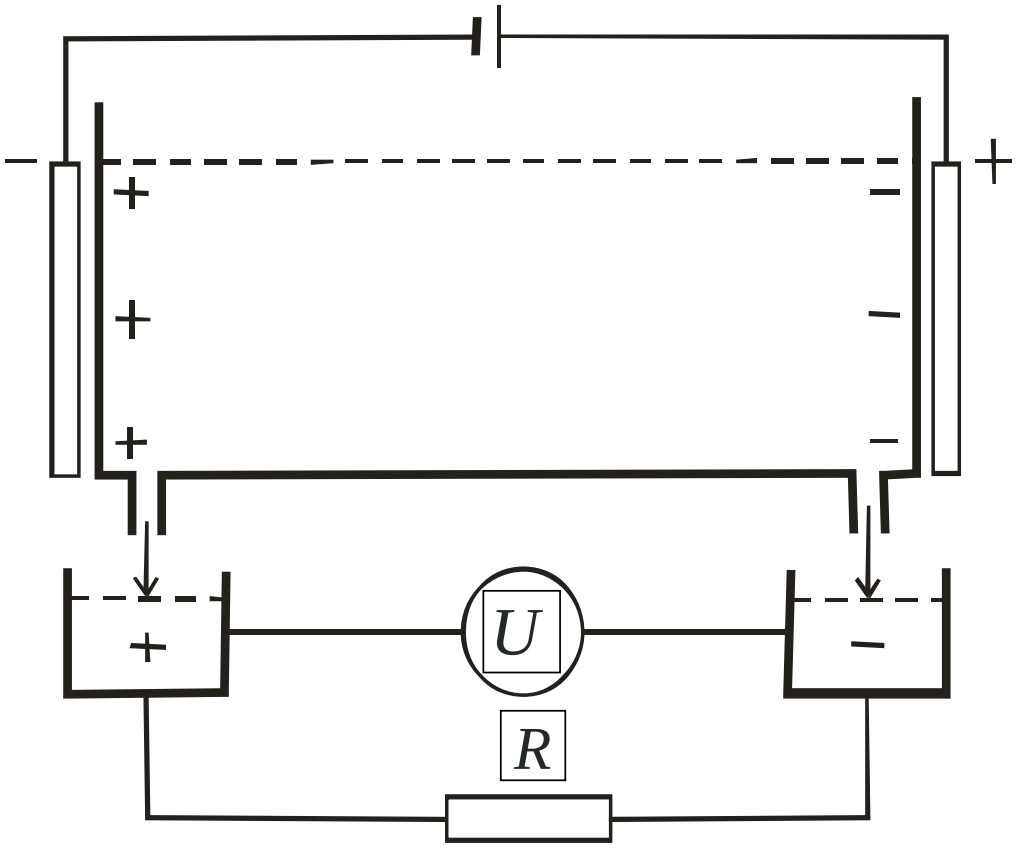

Fig. 3: Schematic dropper of Mende

A general view of the Mende dropper is shown in Fig. 4. Next to the dropper is an electroform generator, from which voltage is applied to the electrodes of the dropper.

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Fig. 4: General view of the Mende dropper

b) The electrostatic generator of Mende

Generators for separation and accumulation examined above of charges are used the laws of electrostatic induction, and magnetic fields in these processes of participation do not assume. Hall's law is at the same time known, who gives the possibility to separate the moving charges [1].

In the simplest examination the Hall effect is represented in Fig. 5. Through that conducting plate in the normal direction passes magnetic field with the induction B and it flows through the same plate the electric current with the density j under the action voltage E. It will slant magnetic field charge carriers different signs to one of the faces of plate.

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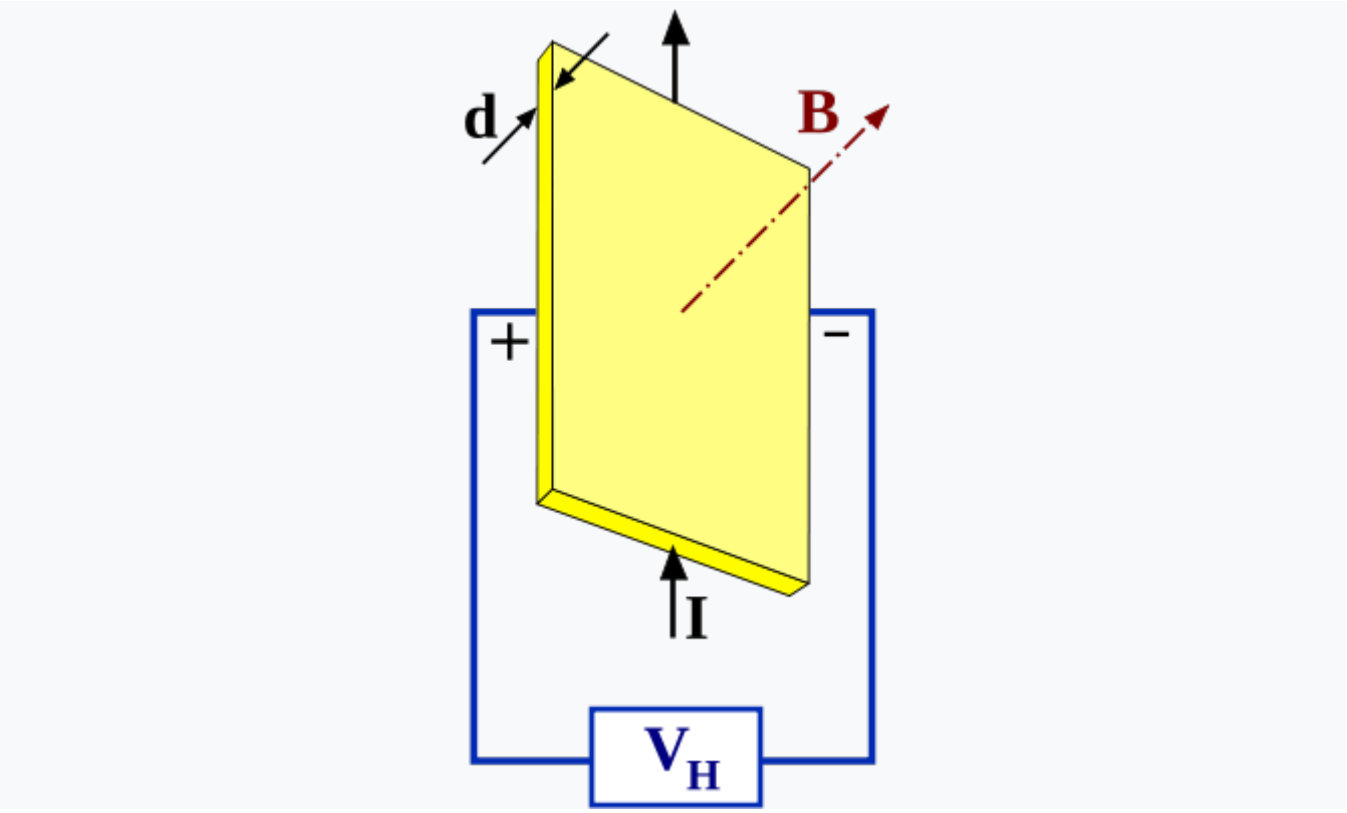

Fig. 5: Diagram of Hall effect

Thus, Lorentz force it will lead to the accumulation of negative charge near one face of plate, and positive- near the opposite face. The accumulation of charge will continue to those times, thus far arisen the electric field the charges E_1 it does not compensate for Lorentz force:

$$eE_1 = evB \text{ or } E_1 = vB,$$

where e - electric charge.

Usually Hall effect is used for measuring the magnetic field, but it can be used also for the separation of charges in the fluxion, for example to water. In the water there are always ions the dissolved in it salts. And it is possible to divide them with the aid of the Hall effect. If water will move normal to the direction magnetic field, then the ions of different signs will be accumulated on the different sides of flow. Dividing further flow to two parts, it is possible to obtain two separate flows, in which will be concentrated the ions of different signs. The circuit of separation of charges the method indicated is in Fig. 6.

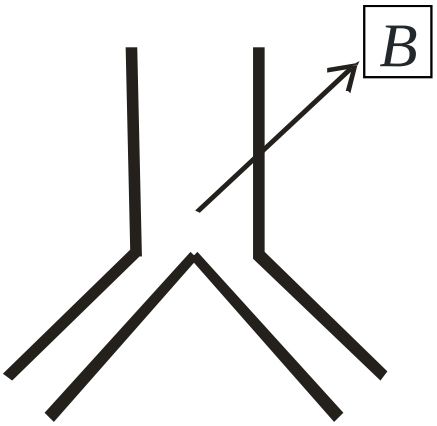

Fig. 6: Circuit of separation of charges with the magnetic separation

Gathering these flows into the different capacities, as is done in Calvin's dropper, it is possible to create the electrostatic generator (Fig. 7).

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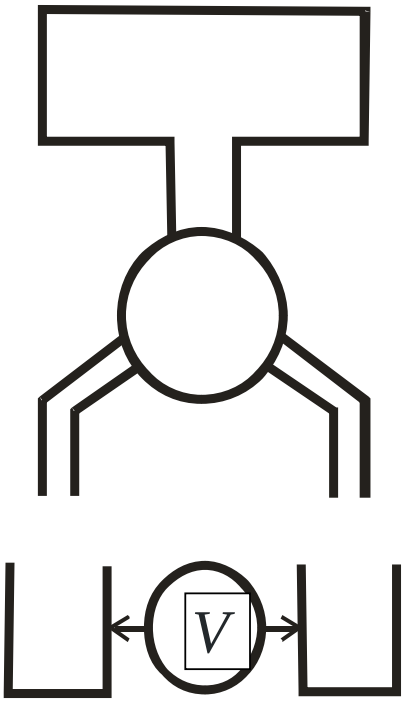

Fig. 7: Schematic of electrostatic generator with the magnetic separation of the charges

On the experimental installation with the use of two annular samarium magnets, between which magnetic induction composed 0,5T, was obtained a potential difference 50 kV.

The common form of electrostatic generator with the magnetic separation of charges is represented in Fig. 8.

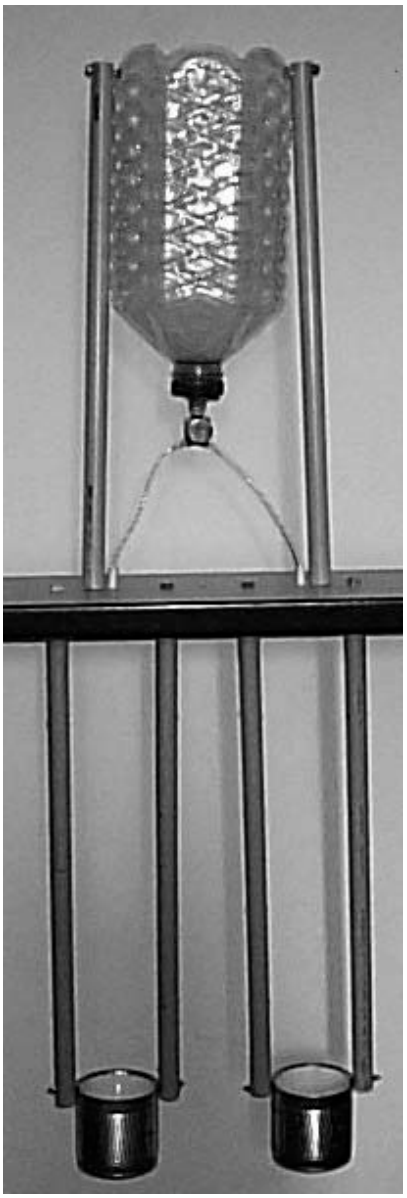

Fig. 8: The common form of electrostatic generator with the magnetic separation of the charges

c) Parametric generators of Mende

If there is a capacitor, whose capacity C, and this capacitor it is charged to a potential difference U, that the energy, accumulated in it, is determined by the relationship

$$W_C = \frac{1}{2} C U^2 \quad . \tag{2.1}$$

But charge Q, accumulated in the capacity, is equal

$$Q_{C,U} = CU \tag{2.2}$$

From relationship (2.1) it is evident that if the charge, accumulated in the capacity, remains constant, then voltage on it can be changed by changing the capacity. In this case is fulfilled the relationship

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$$Q_{C,U}=CU=C_0U_0=const,$$

whereof and - instantaneous values, and and - initial values of these parameters.

The voltage on the capacity and the energy, accumulated in it, will be in this case determined by the relationships:

$$U=\frac{C_0U_0}{C}=KU_0, \quad (2.3)$$

$$W_C=\frac{1}{2}\frac{(C_0U_0)^2}{C}. \quad (2.4)$$

Coefficient

$$K=\frac{C_0}{C} \quad (2.5)$$

can be named by the multiplication factor (transformation) of the constant voltage.

The schematic of voltage transformer, realizing the principle examined, is represented in Fig. 9

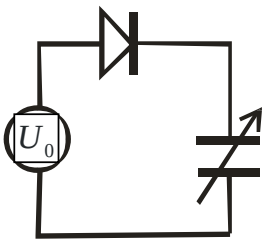

Fig. 9: Schematic of the transformer constant voltage

In this diagram to the variable capacitor by means of the diode the dc power supply is connected U_0

The incremental voltage, which can ensure this transformer, is determined from the relationship

$$\Delta U_C=\left(\frac{C_0}{C}-1\right)U_0 \quad (2.6)$$

As follows from the relationships (2.3) and (2.4) with the decrease of capacitance of capacitor on it increases not only voltage, but also the energy, accumulated in the Ger.

It should be noted that this transformer can work only in the regime of an increase in the voltage, since with the attempt to obtain the decrease of voltage across capacitor this cannot be made for that reason, that the diode the straight connection of the voltage source to the capacitor ensures and therefore voltage across capacitor decrease cannot.

An increase in the energy, accumulated in the capacitor, with a change in its capacity is determined from the relationship

$$\Delta W_C=\frac{1}{2}(C_0U_0)^2\left(\frac{1}{C}-\frac{1}{C_0}\right) \quad (2.7)$$

With a mechanical change in the capacitance of capacitor, the increase in the energy indicated ensures the spring mechanical energy source, Properties of the transformer of constant voltage is possible to use for creating the high-voltage source of the direct current, whose diagram is given in Fig. 10.

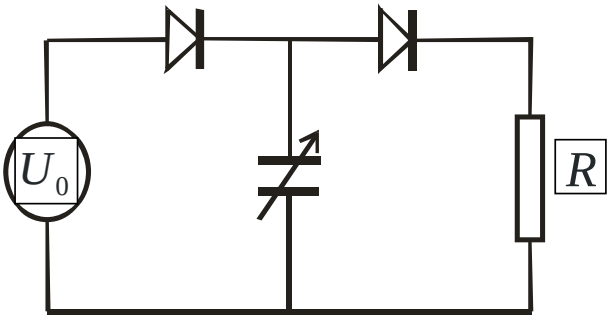

Fig. 10: Diagram of the high-voltage source of direct current

In this diagram is present still one diode and load resistance R.

In the initial state the capacitance of capacitor is equal C_0, and voltage on it equally U_0. At this time through the load resistance the current flows

$$I_0=\frac{U_0}{R}$$

In this case the energy, obtained by capacitor from the voltage source, comprises

$$W_0=\frac{1}{2}C_0U_0^2 \quad (2.8)$$

As soon as capacitance of capacitor will begin to decrease, the secondary voltage, assigned by the relationship will appear on it (2.5). This secondary voltage through the right diode enters the load resistance R. The additional energy, isolated in this case during the load resistance, is determined by the relationship (2.7).

The operating principle of the generator examined is such to the operating principle of the valve water pump, whose schematic is represented in Fig. 11.

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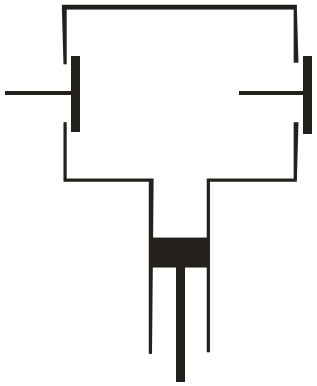

Fig. 11: Schematic of the valve water pump

With the displacement of piston downward left release valve is opened, and water is sucked in into the cavity of pump. With the displacement of piston upward the water through the right release valve is ejected outside.

The role of valves in the schematic of the described generator diodes play, while the role of cylinder with the being moved piston performs variable capacitor.

Hence it follows that the basic problem of the creation of the proposed generator is the development of the capacitor, whose capacity changes with mechanical method. In this case the capacitor must have the great significances of initial and final capacity and with the large relation of these values. This question can be solved by the way of using the technology of the creation of the ceramic capacitors, when titanate of barium, which has very large dielectric constant, is used as the dielectric between the capacitor plates. The construction of the generator, in which is used the principle indicated, it is shown in Fig. 12.

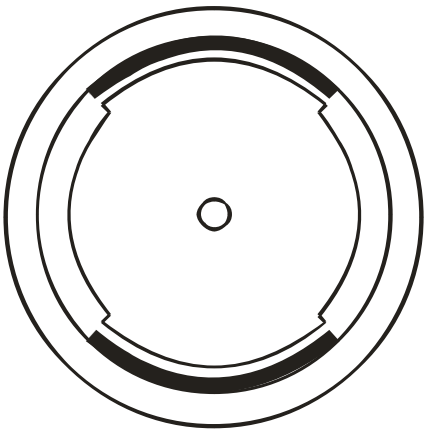

Fig. 12: The mechanical oscillator circuit, in which the inserts from titanate of barium are located on the internal surface of stator

In the given construction there is a figured rotor, and inserts from titanate of barium are located on the internal surface of cylindrical stator.

Let us calculate the practical construction of generator with the following parameters: the voltage of the voltage source $U_0 = 200\ V$, the diameter of the rotor $D = 0.5\ m$, clearance between the inserts of titanate of barium and the stator $d = 10\mu m$, the thickness of the inserts $25\ mm$, the depth of turnings on the rotor $25\ mm$, the speed of rotation of the rotor $n = 500\ \frac{1}{s}$ (this rotational speed it is characteristic for the gas turbines), the length of the generator $L = 1m$.

The power, manufactured by generator will comprise

$$P = \frac{\pi\varepsilon nKDLU_0^2}{2d}. \qquad (2.9)$$

During the record of this formula are taken into account the fact that in one revolution of rotor it occurs two cycles of a change in the capacity between the rotor and the stator.

The substitution of the assigned parameters into the formula (2.9) gives the power 34 kW.

The output voltage, which manufactures generator, calculated according to the formula (3.3) it will comprise $1\ MV$. This voltage will be developed between the stator-rotor unit when the capacity between them is minimum. In order in this case to avoid electrical breakdown, the internal cavity of generator must be filled with air or another gas under the high pressure.

None of the existing generators can ensure such high voltage without the use of the step-up transformers and rectifiers. Large simplicity of construction is the very great advantage of this generator.

The type of generator in the section is shown in Fig. 13.

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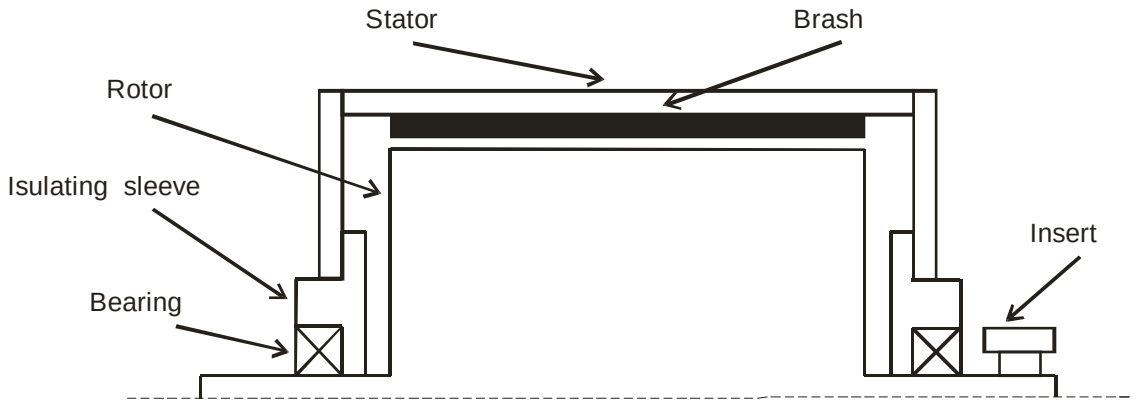

Fig. 13: Type of generator in the section

The insulating bush is located between the axis of rotor and the housing of stator. In this bushing the bearing is located. By lower its edge bushing slides along the axis of shaft, ensuring the vacuum seal between the internal cavity of generator and the atmosphere. The insert from titanate of barium is located on the internal part of the stator. The electrical contact between the axis of rotor and the external circuits brushes ensure.

d) Electro-form generator of Mende

The schematic of the work of elektro-form generator Mende is depicted in Fig. 14.

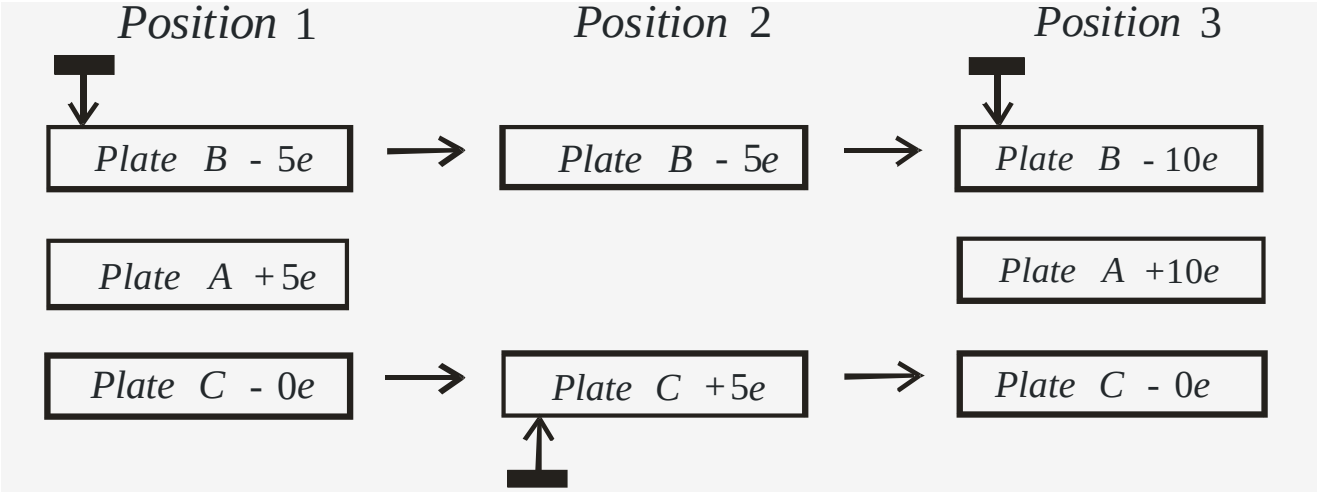

Fig. 14: Carry circuit and accumulation of charge in the generator

There are three plates of parallel-plate capacitor A, B and C, from which the plate B and C they can move in the direction, indicated with pointers, while average plate A it remains fixed.

In the position 1 the plate B by means of the contact sliding on it is connected with the earth. Plate C also by means of the sliding contact, which moves together with it, is connected with the plate A. On the plates there are designations, which indicate the instantaneous value of charges on them in the arbitrary units with the indication of the sign of charge. Initial magnitude of the charge can be other and depends on the the initial conditions.

Let us assume that in the initial position plate A bears on itself the charge +5e, and plates B and C begin to synchronously move to the right. In this case the plate v loses contact with the earth, and on it remains the charge – 5e.

In the position 2 the plate B preserves charge to -5e, and plate C acquires contact with the earth and on it is induced the charge +5e. After that, plates B and C continue to move in the direction indicated by the arrows.

In the position 3 of the platesCand A they are connected with the aid of the sliding contact, which moves together with the plate C, and plate B is connected to the earth. In this case the charge +5e from the plate C overflows into the plate A and its charge it becomes equal +10e, and the charge of plate C becomes equal to zero. In this case the plate A, which received the booster charge +5e, induces in the plate into the charge -10e, i.e. in comparison with the position 1 the charges of plates A and B also in double.

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It is evident that position 3 in the arrangement of plates and their connection differs in no way from the position 1, with the only difference that the magnitude of the charge of plates A also B in comparison with this position it was doubled, and the charge of the plate C it remained equal to zero. With the same following cycle the charges on the plates A and B also in again will be doubled and they will become respectively equal +20e and -20 e the doubling of charges with each subsequent cycle will continue. With this process of plate they will accumulate all increasing charge, which will lead to an increase in their potentials.

The automation of transfer and accumulation of charge thus can be realized, if capacitor plates are placed to the disks. The functional diagram of the automated transfer of charge is represented in Fig. 15.

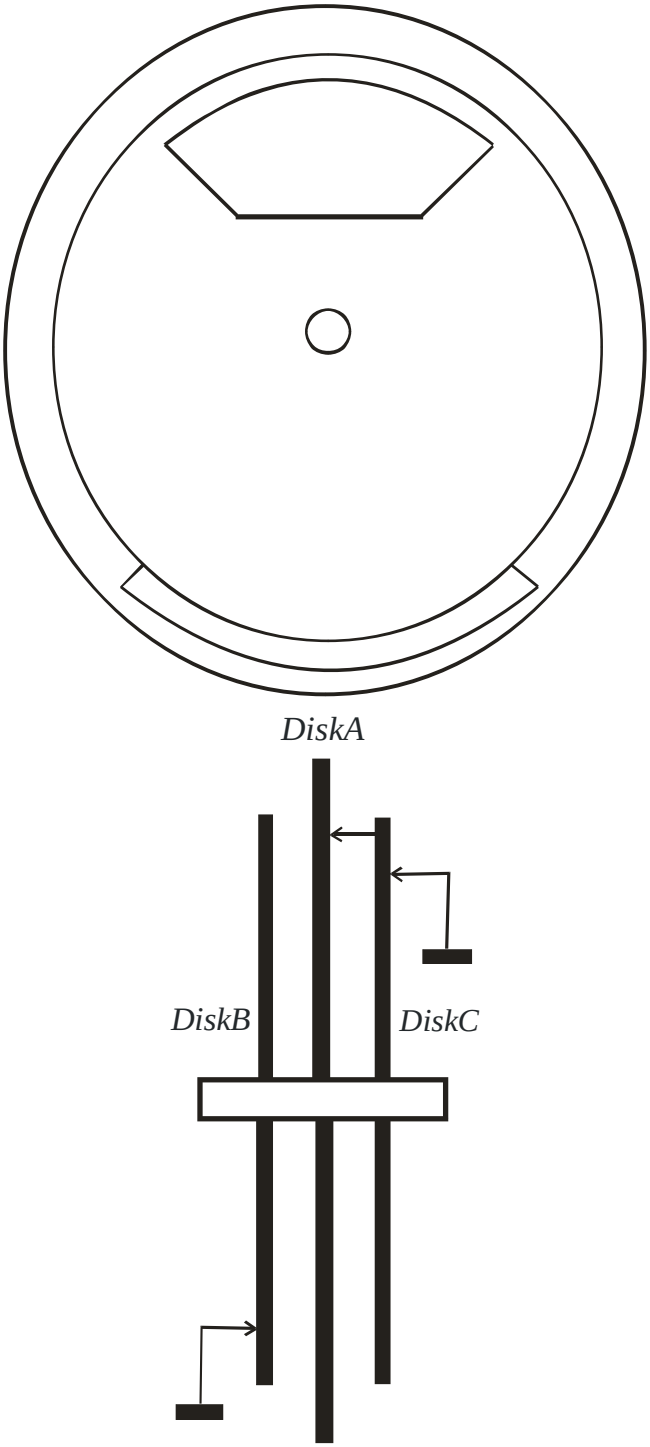

Fig. 15: The functional diagram of the automated transfer of the charge

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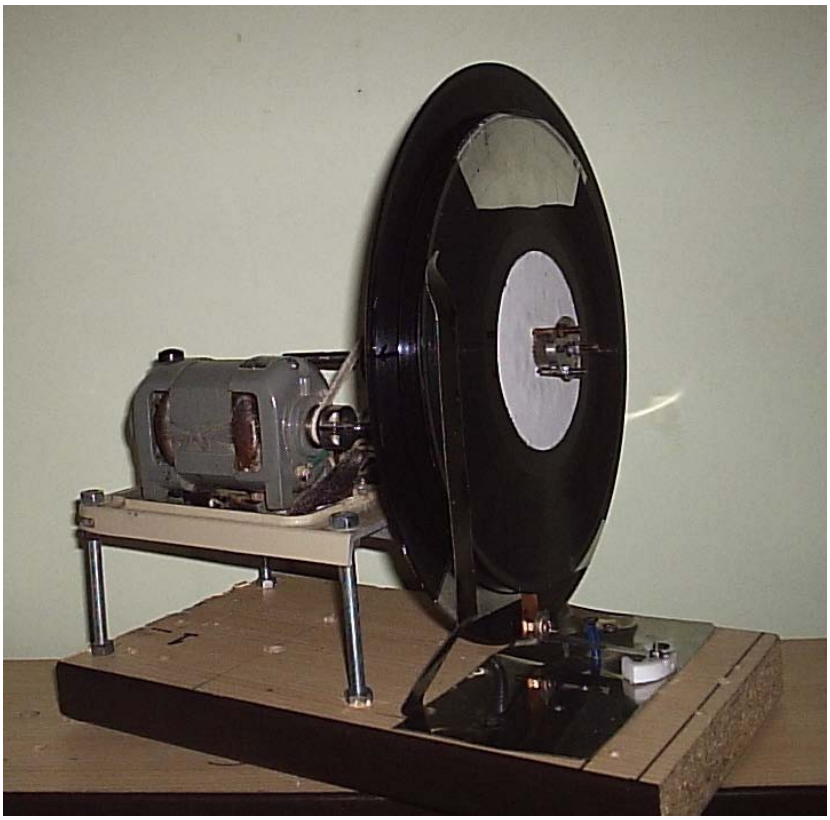
Structurally the generator is executed in the form three disks, on which are stuck the current-conducting plates of capacitors. Two external disks B and C it is tightly planted on the axis, which ensures their synchronous rotation. Stator is the fixed central disk A, which is also established on the axis, but the diameter of its opening is more than its diameter, which ensures its easy-push fit. The fixation of the position of stator is achieved with the aid of the corner, which from one side is attached to the disk, and with another - to the platform, on which is established the generator. In the experimental mock-up of the generator with the diameters of lateral disks and central disk of 250mm and 300 mm examined respectively, is obtained a potential difference 20 kV.

Design a difference in the generator from the generator examined Wimshurst lies in the fact that lateral disks revolve in one direction, and central disk is fixed, appearing by stator, while in the generator Wimshurst lateral disks they revolve in the different directions, and there is no fixed central disk.

A general view of the Mende electroform generator is shown in the following photo.



III. Conclusion

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