Chapter 1. The Generator Construction

Contents

1. Principal Layout of plant

The plant shown on Fig. 1, includes:

1. generator,
2. axle of generator,
3. reversible electrical machine,
4. axle of reversible electrical machine
5. electromagnetic half-coupling.

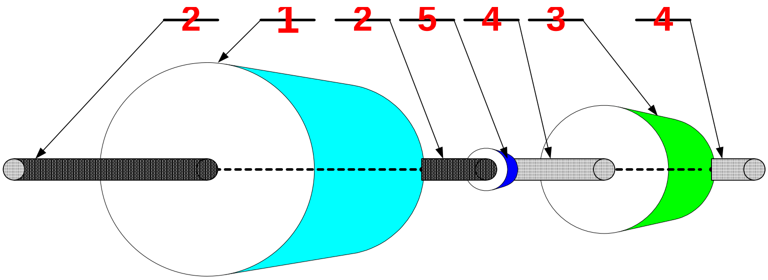

Fig. 1

Generator 1 contains stator and rotor, on which permanent magnets and electrodes are located. There are several variants of their location.

2. Functioning of plant (from User's Point of View)

The plant functions as follows.

1. First the reversible electrical machine 3 is switched on in the motor mode (using the energy of an external electrical energy source) and
2. Вначале обратимая электромашина 3 включается в режиме двигателя (электроэнергии) and speeds up the generator 1, transferring the rotation from axle 4 through half-coupling 5 to the axle 2.
3. After some time the generator 1 speeds up to a certain rotation speed, and the half-coupling 5 disconnect it from the elctrical machine 3.
4. After that the generator speeds up spontaneously, using energy from the environment (it is accompanied by temperature fall of the environment) and transforming it into kinetic energy of its own rotation.
5. The electrical machine 3 is switched to energy generation mode and again becomes connected by half-coupling 5 to the generator 1. On this stage generator 1 serves as a motor for electrical machine 3, transferring to it the mechanical (kinetic) energy. The electrical machine 3 transforms this energy into electrical energy, which is consumed by electric energy demand.
6. To stop the generator 1 the energy demand of electrical machine 3 should be increased so that its energy would exceed the energy consumed by the generator 1 from the environment.

3. Static Characteristic of Electrical Machine.

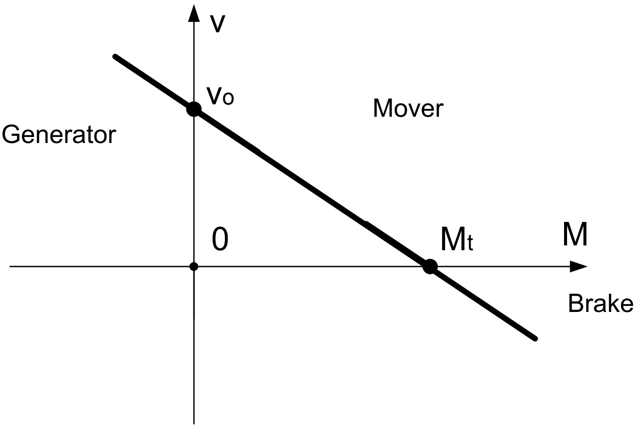

Fig. 2.

The static characteristic of direct current electrical machine - DCEM [4] is depicted on Fig.. 2, where M – outer moment on the DCEM axle, v - DCEM speed of rotation. The following variants are possible:

- For $0 < M < M_t$ the torsion torque developed by DCEM, exceeds the outer retarding torque, and DCEM rotates with the speed $0 < v < v_o$ in a certain direction, which we shall consider as positive.
- In the absence of outer moment *(M=0)* the flitting speed of DCEM is $v = v_o$.
- For $M = M_t$ the rotation speed is $v = 0$, i.e., the outer moment is equal and opposite to the DCEM inhibitory moment.
- The condition $M > M_t$ means that the outer moment exceeds the torsion torque developed by DCEM, and DCEM rotates in the opposite direction, i.e., $v < 0$. So DCEM is an obstacle with respect to outer moment.
- The condition $M < 0$ means that the outer moment rotates the DCEM, which produces electrical energy. In this case $v > v_o$.

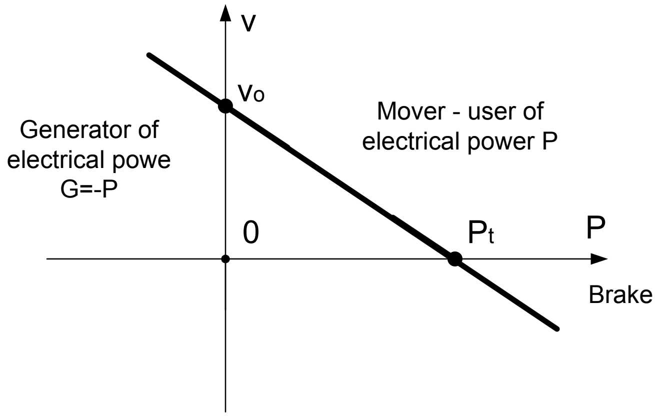

Fig. 3.

The torsion torque developed by DCEM, $M_e = -M$. It is proportional to the current keeper I and for direct voltage U is proportional to the power consumption of DCEM, $P = I \cdot U$. In this case the previous variants may be interpreted as follows (se also Fig. 3):

- For $0 < P < P_t$ DCEM rotates with the speed $0 < v < v_o$, transferring the power consumption to the axle (to outer mechanical load).

- With the absence of outer mechanical load (outer moment is *M=0)* the DCEM flitting speed is $v = v_o$, and power consumption is $P = 0$.
- For $P = P_t$ the rotation speed is $v = 0$ and power consumption is used for the DCEM heating.
- The condition $P > P_t$ means that the outer moment exceeds the torsion torque developed by DCEM, and DCEM rotates in the opposite direction, i.e. $v < 0$. In this case the electric power consumed by DCEM, and mechanical power, transferred by the outer element, are used for the DCEM heating.
- The condition $P < 0$ means that the outer moment rotates the DCEM, which produces electrical power $G = -P$. In this case $v > v_o$.

Therefore, the static characteristic of DCEM may be expressed as

$$v = v_o\left(1 - P/P_t\right) \tag{1}$$

or

$$P = P_t\left(1 - v/v_o\right). \tag{2}$$

Thus, in the beginning DCEM consumes electrical energy $0 < P < P_t$ and speeds up the generator to the speed $0 < v < v_o$. This electrical energy is consumed by the generator as mechanical energy. Then the generator for speed $v > v_o$ begins to produce mechanical energy, which is used by DCEM to produce electrical energy with the power $G = -P$.

Returning to formula (1), let us note that, as it is well known, [12],

$$v = A \cdot U + B \cdot P/U\ , \tag{2a}$$

where A and B are certain constants, determined by DCEM construction. So, from (1, 2) we find

$$v_o = A \cdot U\ , \tag{3}$$

$$P_t = -AU^2/B\ . \tag{4}$$

These formulas will be useful for us in future.