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Types of Ac Collector Machines

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***Abstract* —** *This article provides information on the types and operating modes of collector AC machines.*

Keywords — differential leakage, wound rotor, asynchronous machines, AC collector

Introduction

AC collector machines are usually used as motors, i.e. to convert the energy of a single-phase or three-phase current into mechanical energy. Accordingly, single-phase and three-phase collector AC motors are distinguished. Their rotor is made in the same way as the armature of a DC machine — with a loop or wave winding connected to the collector. The stator of the machines in question has an alternating magnetic field, so it is assembled from thin sheets of electrical steel, in contrast to the stator of DC machines, the yoke of which is usually made of cast or rolled steel.

Collector machines of alternating current, with the exception of single-phase motors of low power, are not widely used, They are used only in special installations. The disadvantages that prevent their wide distribution include: the complexity of manufacturing and relatively high cost, the need for careful care of the collector and brushes, less reliability in operation (due to deteriorated switching conditions). However, in some cases, they can solve some problems related to the operation of the electric drive in a more perfect way than contactless asynchronous motors. Compared to the latter, their advantages are that they allow economical and smooth adjustment of the rotation speed and can work with a better cos φ.

Single phase motor

Here we consider single-phase collector motors with sequential excitation. The diagram of one of these engines is shown on Fig. 1, where denote: *B*-the field winding placed at the main poles; *K* — the compensation winding placed in the slots of the stator and designed to compensate for the reaction of the armature (rotor); *I* — the armature (rotor) with brushes superimposed on the collector; *D* — the winding of additional poles, shunted by the active resistance *R*.

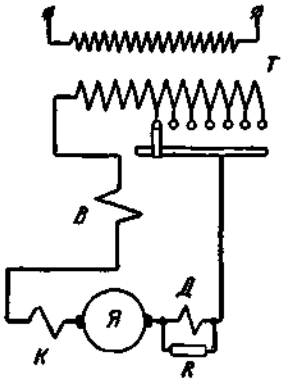

Fig. 1. Scheme of a single-phase motor of sequential excitation.

The torque in the motor is obtained as a result of the interaction of the field created by the field winding and the currents in the rotor winding. This moment is always directed in the same direction at alternating current, since simultaneously with the change in the direction of the magnetic field, the direction of the current in the rotor winding changes. Changing the direction of rotation of the rotor is carried out in the same way as for a DC motor, for example, by switching the ends of the field winding.

Shown on Fig.1 the circuit does not differ mainly from the circuit of a DC motor with serial excitation. However, for the latter, the compensation winding is used very rarely, only at very high power levels, whereas for single-phase motors it is used, starting from 10-15 kW and higher. It compensates for the reaction of the rotor (armature), reduces the flow coupling of the rotor winding and, therefore, its inductive resistance, which is necessary to improve the cos □ of the motor.

Additional poles, just like in DC machines, serve to improve switching. Switching conditions in a single-phase motor are more severe than in DC machines. This is its essential drawback. The degradation of switching here is caused by the occurrence in the switched section (the section closed by a brush) of transformer EMF, except for the reactive EMF and EMF rotation (from an external field in the switching zone). Transformer E. D. S. occurs due to pulsations of the flow of the main poles, with the axis of which the axis of the switched section coincides. This section is like a closed secondary winding of the transformer, the primary winding of which is the field winding. To compensate for transformer and reactive EMF, using EMF rotation, it is necessary to create a phase-shifted field in the switching zone relative to the rotor current, which is achieved by shunting the winding of additional poles with active resistance (Fig. 1). However, mutual compensation of E. D. S. in a switched section can only be achieved at certain values of the rotor current and its speed of rotation. In other modes of operation of the engine, the switching conditions deteriorate and become especially severe when starting up, since in this case the transformer EMF is not compensated (EMF of rotation is equal to zero). Great work on the study of switching in collector AC motors was carried out by the academician K. I. Schoenfer back in 1911-1914. They contributed to the improvement of these engines.

The transformer E. D. S. $e_t$induced in the switched section is defined in the same way as the E. D. S. of the secondary winding of the transformer:

$$E_T=4,44fw_c\Phi, \qquad (1)$$

where w_c— the number of turns of the armature winding section;
f — the current frequency;
f — the amplitude of the flow of the main poles.

To reduce E_t t t it is necessary to go to the reduction of the flow f, which at a given power is achieved by increasing the number of poles

In addition, for large engines, the number of turns in the section is taken to be equal to one ($w_c = 1$). All this leads to an increase in the number of collector plates and, consequently, the size of the collector. To reduce E_t, the frequency of the supply AC is also reduced. The speed of rotation of single-phase motors of sequential excitation can be regulated, for example, by means of a transformer T that has branches on the secondary side (Fig. 1). The transformer serves at the same time to reduce the voltage supplied to the motor, since the latter must work at a relatively low voltage on the brushes of the collector.

Single-phase motors of low-power serial excitation (up to 100-150 W) are widely used. They do not have any additional poles or compensatory winding, since switching conditions at low power and at 50 Hz are quite satisfactory, and cos φ does not play a significant role here. On Fig. 2 shows the diagram of one of these engines. They can operate from AC and DC, so they are called universal. At a power of more than 60-80 watts sometimes is an offshoot of the winding (shown by the dotted line in Fig.2), allowing for operation from alternating current having a field winding with fewer turns, which gives the same speed of rotation as and at a constant current, and increases the use of the engine. Universal motors are used for a wide variety of purposes: for power tools, sewing machines, drill presses, for small fans, vacuum cleaners, as Executive motors in automation schemes, etc.

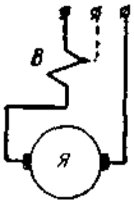

Fig. 2. Diagram of a universal engine.

Three-phase collector motors are collector asynchronous machines. They work in the presence of a rotating magnetic field with a speed generally different from the speed of the field. On their rotor is placed a winding made in the same way as the armature winding of a DC machine. From three-phase collector motors in practice, mainly the motor with parallel excitation, which receives power from the rotor side, has spread. The diagram of such an engine is shown on Fig. 3. Here denote: *1* — three-phase rotor winding (main) connected via slip rings and brushes to supply network three-phase current; *2* — the stator windings of each phase are connected with brushes on the manifold; *3* — collector winding, which is laid in the same slots of the rotor and main winding. The brushes of each phase of the stator can be shifted or moved apart, which is done by means of movable traverse bars, to which they are attached on Fig. 4 the right brushes are attached to one traverse, the left to the other. Both traverses can be rotated in opposite directions using different devices one of them is schematically shown on Fig. 5. If the brushes of each phase are placed on the same collector plates (figure 4), then the motor will run as an asynchronous motor. From a conventional asynchronous motor in this case, it will differ in that its primary winding will be the rotor winding, and the secondary-the stator winding Applying the right-hand rule and taking into account the relative movement of the stator conductors and the rotating field, we will find the direction of current induced in the stator conductors. According to the rule of the left hand, the direction of the electromagnetic force acting on the stator is determined. The force acting on the rotor has the opposite direction. From here we find that the rotor will rotate against the direction of rotation of the field. The speed of the field relative to the rotor is synchronous speed. The speed of the field relative to the stator is the sliding speed. It is equal to the difference in field velocities relative to the rotor and the rotor itself.

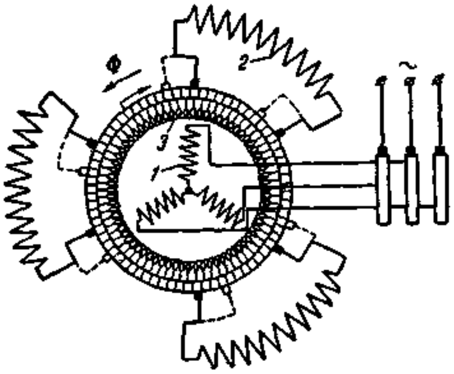

Fig. 3. Scheme of a three-phase collector motor of parallel excitation with power supply from the rotor side.

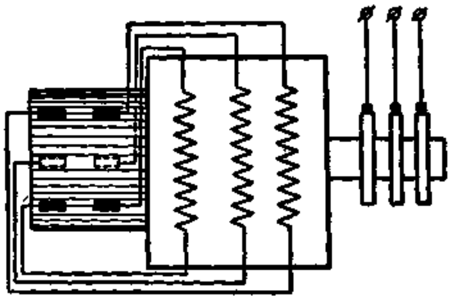

Figure 4. Three-phase collector motor (see Fig. 3).

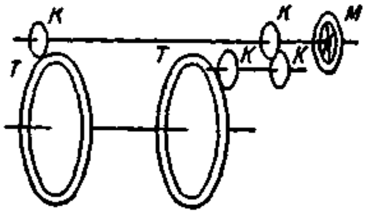

Figure 5. A device for turning brushes in mutually opposite directions.
K—small gear wheels; *T*—large gear wheels attached to the traverse; *M*- hand wheel.

When extending the brushes on them, the e.d. C. is obtained, which has the same frequency as the e. d. C. in the stator winding, i.e. the sliding frequency. This can be seen, given that the field relative to the part of the winding enclosed between the brushes (as if fixing in space this part of the winding), has the same speed as with respect to the stator winding. When specified on Fig. 3 connecting the brushes with the stator winding EMF on the brushes — plus e. d. E_{EXT} is inputted to the secondary circuit of the engine ,along with the EMF of the stator sE_2 causes a current interaction with the field determines the motor torque. HereE_2— E. D. S. phases of the stator with a fixed rotor, s — sliding of the motor. If the brushes are pushed apart so that $E1_{доб}$ is directed against sE_2, the slip will increase. The operating mode is set at some slip, when the resulting e. g. s. (sE_2- $E_{доб}$E. g.) causes a current sufficient to create a torque equal to the braking torque on the motor shaft. When $the_{\text{EQ is increased}}$ (with a large extension of the brushes), the rotation speed will decrease downwards from the synchronous one.

When regulating the speed of rotation of an ordinary asynchronous motor by introducing a rheostat into its secondary circuit, an unproductive power consumption in the rheostat is obtained. In the motor under consideration, the corresponding power enters the collector winding, since the phase shift between the current in the secondary circuit and the E. D. C. $E_{\text{is not greater}}$ than 90°. The power received from the stator by the collector winding is returned to the network through the transformer connection of the collector winding with the main winding of the rotor. This is due to the cost-effectiveness of regulating the speed of rotation of a three-phase collector motor by introducing an additional e. d. s. into its secondary circuit.

When the brushes are positioned as shown on Fig. 4, the rotor rotation speed is close to synchronous. If the brushes are pushed apart so that $E1_{доб}$ is directed in the same direction as sE_2 with a positive slip, the rotation speed will increase upwards from the synchronous one. In this case, the engine will operate with a negative slip, in which the E. D. S. sE_2 will change its direction. It will be directed against *the* $_{EA}$, but it will be smaller than the last one.

Thus, by spreading the brushes to one side or the other, you can adjust the speed of rotation of the motor down or up from synchronous.

The motor also allows you to adjust its cos φ. To do this, you need to change the phase of the e. d. s$E_{.\ \text{E.}}$, which is done by shifting the brushes of each phase, for example, to improve cos φ at a speed below the synchronous brush, you need to shift the rotor to the side opposite to the direction of rotation (shown as a dotted line on Fig. 3).

The considered three-phase collector motor is used in the textile industry (for ring spinning machines), in the printing industry (for rotary machines), sometimes for metal-cutting machines.

In this motor, as well as in other collector AC motors, the switching conditions are more severe than in DC machines. Here they are also defined by the value of the transformer E. D. S.E_t, inducted in the switched section by a rotating field. It can be calculated using the formula (1). Experience has shown that satisfactory switching conditions can be obtained if E_t In this regard, it becomes difficult to obtain an e-mail address.$E_{\text{т}}$Therefore, three-phase collector motors are usually not built for a power exceeding approximately 200-250 kW.

The idea of using an additional E. D. S. introduced into the secondary circuit of an asynchronous machine in order to economically regulate its speed of rotation and cos φ, can be implemented by using a collector machine placed outside the magnetic field of the asynchronous machine. In this case, we get so-called cascading inclusions of an asynchronous machine with collector machines, which, however, are rarely used in practice.

References

[1] Mirzaev, Uchkun and Abdullaev, Elnur, Mathematical Description of Asynchronous Motors (April 15, 2020). International Journal of Academic and Applied Research (IJAAR), 2020, Available at SSRN: https://ssrn.com/abstract=3593185 or http://dx.doi.org/10.2139/ssrn.3593185

[2] Mirzaev, Uchkun and Abdullaev, Elnur, Experiment of Open-circuit Voltage in 'EPH 2 Advanced Photovoltaics Trainer' Laboratory and Types of PV Cell (April 30, 2020). International Journal of Engineering and Information Systems (IJEAIS) Vol. 4, Issue 4, April – 2020, Pages: 41-46; ISSN: 2643-640X, Available at SSRN: https://ssrn.com/abstract=3623014

[3] Mirzaev, Uchkun and Abdullaev, Elnur, Study of the Electrical Characteristics of a Solar Panel for Multi-Residential Apartments Using a Computerized Measuring Stand 'Eph 2 Advanced Photovoltaic Trainer' (2020) . International Journal of Academic Engineering Research (IJAER) ISSN: 2643-9085 Vol. 4, Issue 4, April – 2020, Pages: 59-61 , Available at SSRN: https://ssrn.com/abstract=3622045

[4] Acarnley PP. Stepping Motors: A Guide to Modern Theory and Practice. 4th ed. London, IET; 2002. Pages: 85-86

[5] Hendershot JR, Miller TJE. Design of Brushless Permanent-Magnet Motors. LLC. Motor Design Books;