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Justification Of The Basic Design Of A Linear Motor.

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ABSTRACT

The article describes the method of substantiating the basic design of a linear electric motor. This method allows you to select the initial data for the design and shows the principle of developing new designs of linear motors.
Keywords: a linear electric motor, electric actuator, the amplitude of displacement, the magnetizing coil anchor.

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INTRODUCTION

In machine building, agricultural engineering, medicine, hydro- and pneumotechnics, there is a huge number of executive mechanisms that perform reciprocating movements of a given amplitude. Basically, such devices are miniaturized and require the creation of smooth movements. The most promising way to control their movement is the electric drive. To this type of drive are linear electric motors, the movable part of which is directly connected with the masses being moved [1, p. 37]. Drives with linear motors are built into the equipment and designed specifically to solve specific technological problems. Their use in comparison with serial electric motors creates additional difficulties connected with the need for individual design development for each device separately. But with this approach, the efficiency of the technological equipment as a whole increases, and it also becomes possible to optimally use the resources of the electric drive [2, p. 206].

The main condition in the described case is the smoothness of the displacement, which is possible with a hyperbolic traction characteristic. It is created by linear electric motors with a rectangular pole shape of the armature and magnetic circuit [3, p. 68]. This design of the magnetic system is chosen as the base one. A common classification of the designs of magnetic systems of linear electric motors does not exist, therefore the basic construction will be characterized by terms used by authoritative authors. According to the proposed classification in [4, p. 49], the hyperbolic form of the traction characteristic is provided by a design of two symmetric cylindrical magnetic circuits with a flat forward-running armature. Using the terminology of [5, p. 15], the basic construction can be characterized as consisting of two symmetric neutral magnetic systems of the solenoid type. According to [6, p. 63], the basic construction is characterized as an external disk anchor.

The basic design of any linear motor has the following features [4, p. 58]:

- materials for its manufacture are common for electric machines;
- the dimensions of the magnetic system of the motor are calculated in such a way that there is a directly proportional relationship between its equivalent inductance and the equivalent air gap size;
- Anchor starting current at rated mechanical load is 40% of nominal;
- Bearing elements are made of non-magnetic materials to avoid anchoring of the anchor.
- In addition, linear electric motors are becoming increasingly popular due to the following [3, p. 18]:
- Some experience has been accumulated in the development and manufacture of linear electric motors for specific mechanisms;
- The industry produces soft magnetic materials that have a large induction of saturation and have a relatively high specific electrical resistance, which reduces the loss of magnetization reversal and Foucault currents;
- modern level of technology allows mass production of this equipment;
- high level of development of electronic components, allowing to develop control systems for any technological processes.

RESULTS AND DISCUSSION

Taking into account the experience of developing the described structures of magnetic systems and the requirements imposed on them, the basic design of a linear electric motor is proposed (Figure 1). This construction was developed using the method described above [7, p. 5]. The linear electric motor consists of two cylindrical magnetic circuits 5 with magnetizing coils 4 and 7. The rod 3 is attached to the axial hole of the magnetic circuits 5, on which the armature 6 is anchored. The anchor 6 consists of two magnetic disks 1 and a non-magnetic layer 2. The linear electric motor works as follows. When the coil 7 is turned on, the current flowing in it induces a magnetic field whose field lines are closed through the magnetic core 5 and the magnetic insert 1. This generates a force that moves the armature 6 upward. The force at anchor 6 is transmitted through the rod 3 to the actuator. An increase in the current on the coil 7 leads to an increase in the speed of movement of the armature 6. The current entering the coil 4 creates a magnetic field, under which the armature 6 tends to descend. The increase in current on coil 4 disturbs the balance between forces and the armature 6 descends. Thus, by feeding currents of a certain value to coils 4 and 7, the position of the armature 6 can be changed. By setting the dynamics of the armature movement, it becomes possible to control the movement of the actuator. The power of the coils 4 and 7 is carried out using the pulse width modulation, the average value of the current in them is determined by the duty cycle of the pulse width modulation. In order to achieve smooth and predictable movement of the motor armature under the action of the magnetomotive force, two circuits of negative feedback are organized in the control unit circuit. An indirect parameter of the current position of the armature is the effective value of the current flowing in the coils of the linear motor.

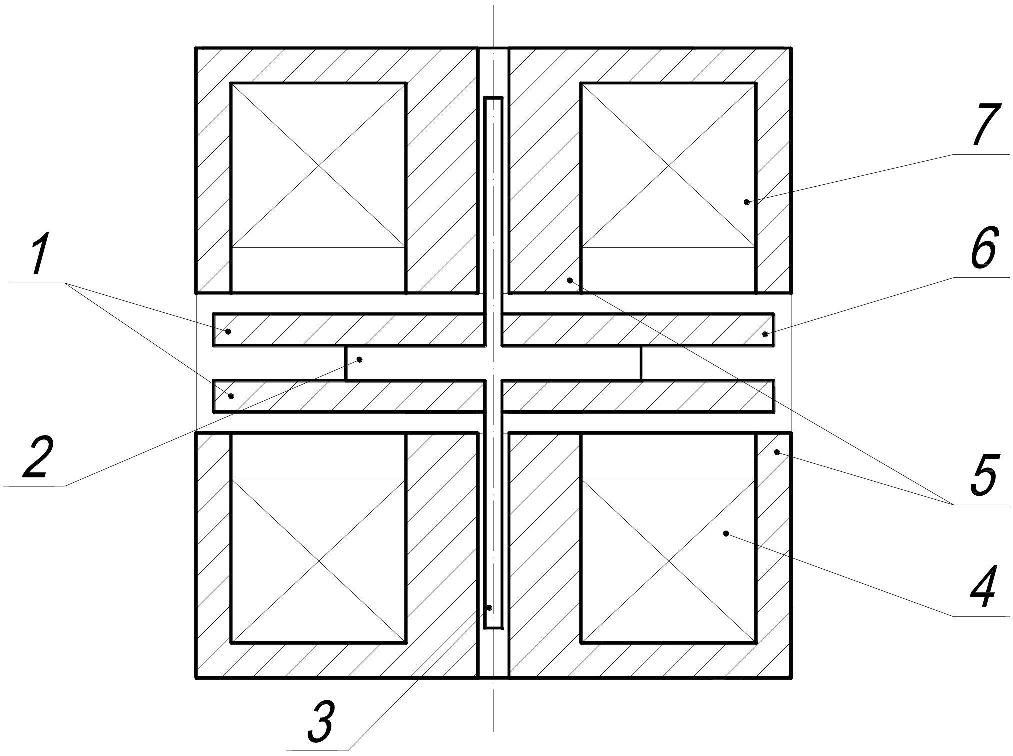

Figure 1: Linear electric motor for driving the pulsator valve mechanism: 1 - magnetically conductive disks; 2 - non-magnetic layer of the anchor; 3 - stock; 4, 7 - magnetizing coils; 5 - magnetic cores; 6 - anchor

CONCLUSION

The described method allows to substantiate the basic design of a linear electric motor in the development of actuators performing reciprocating movements of a given amplitude. In this case, designers need to take into account the condition of creating the maximum force by the electric motor with the minimum costs of steel for the manufacture of parts of the magnetic system and copper for magnetizing coils.

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