The rapid growth of unit powers in the reactors of nuclear power stations calls for a great improvement in the reliability of the elements of reactor systems; this may be achieved by increasing the reliability of the individual elements of the system and also by keeping some elements in reserve. Elements which cannot be made more reliable by reservation include the executive mechanisms of the control and safety rods. The specific conditions of use of such mechanisms require the creation of highly reliable devices operating without repair or preventive maintenance.

The control and safety rod mechanisms are the only mechanisms in reactor building which, although subject to extremely severe conditions (high temperature, irradiation, absence of lubricants, difficulty of inspection and servicing, corrosive medium), have to operate throughout the whole campaign. Furthermore, the nuclear safety of the reactors is largely determined by the fault-free operation of the executive mechanisms of the control and safety rods. The reliability of these mechanisms may be qualitatively...
improved if we are able to create fundamentally new structural arrangements, simplifying the kinematics of
the mechanism and reducing the number of parts working in the corrosive medium.

One of the most promising ways of developing such mechanisms is the development of linear electro-
magnetic drives with discrete (step-type) action for the control and safety rods [1-4]; these may be based
on an electromagnetic mechanical system which will ensure a high accuracy in the displacement of the con-
trol device by a strictly specified distance and also the complete stability of this device when in the "parked"
position, as well as eliminating vibration under various hydrodynamical loads. In a number of cases the
mechanisms are required to move the control device at a variable velocity. This demand may be met by
changing the parameters of the electromagnetic field. The use of linear step mechanisms with pulse control
has facilitated the creation of new highly efficient discrete control systems, which improve the drive dynamics
and the quality of regulation and provide conditions suitable for computer control.

Since in a linear step drive the regulating device moves in strictly specified steps, even if the control
system is damaged the executive device cannot move more than one step. Furthermore, there is a high
probability that an absorbing unit will be fed into the active zone after any emergency signal (for example,
if the system is deenergized), and this improves the nuclear safety of the reactor.

Operating Principles of a Drive with a Linear Step Motor

The principal element of the linear step drive is a linear step (electric) motor which we shall sub-
sequently call an LSM, constituting a synchronous multiphase electric machine with a passive armature.

In reactor construction the four-phase LSM has become the most widely employed (Fig. 1). The stator
of this motor is made of four phase sections. Each phase has a magnetic conductor with a control winding.
Teeth are provided in the bore of the magnetic conductor of the stator. Similar teeth are provided in the
armature, which is connected to the regulating device. The sections are separated by nonmagnetic insertion
pieces.

Figure 2 illustrates the operating principles of the LSM. In each section (phase) only one tooth is
depicted in the figure. In order to ensure reversibility, the teeth in the stators of every succeeding phase
are displaced relative to one another by a quarter of the distance between the teeth (a quarter of a tooth
division τ). If we denote the width of a tooth by a, and the depressions by c, the tooth division
τ = a + c.

On connecting two phases (for example, I and II), the LSM remains in the parked position. The
armature is held by forces due to the magnetic fluxes closed through the stator teeth and armature. In
phase III the construction of the device ensures a certain overlap between the stator and armature teeth

\[ y = a - \frac{\tau}{m} \left( \frac{n-1}{2} + i \right), \]

where \( m \) is the number of phases, \( n \) is the number of simultaneously commutating phases, and \( i \) is the number
of the connected phase.

In order to move the armature, for example, "to the right" (Fig. 2), phases I and III are connected
simultaneously. The armature moves to a position of stable equilibrium, i.e., by one step. Further