# EXPERIENCE IN SWITCHING KILOAMPERE DIRECT CURRENT BY MEANS OF LIQUID METAL

V. A. Boguslavskii, I. M. Tolmach, and E. I. Yantovskii

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The most promising of current designs of liquid-metal switching devices are devices in which an electrically conducting fluid enclosed in a closed vessel takes up the positions necessary for switching an electrical circuit as in response to the action of the magnetic field associated with the control currents. The absence of mechanical displacements of rigid bodies leads (see [1], for example) to high electrical and mechanical wear resistance and to noiseless operation. These devices can be classified under two headings: conductive devices in which the displacement of the electrically conducting fluid is brought about through the interaction between the control magnetic field and the control current flowing through the liquid-metal contact [2], and inductive devices where the effect is achieved through the interaction between the fluid and a pulsating field [3] or traveling field of control circuits.

Recent designs that have shown up on the scene [4] feature the use of a suspension of ferromagnetic particles in an electrically conducting fluid as the liquid-metal magnetically controlled contact for switching electrical circuits.

Below, we describe the results of experiments staged with an inductive device in which the electrically conducting fluid is displaced through its interaction with a rotating magnetic field.

This arrangement consists of a closed cylindrical vessel formed by an outer tube of asbestos-filled cement, an inner cylindrical carefully mixed magnetic circuit coated with an aluminum oxide base insulating compound, and two copper electrodes acting as the end face covers of the cylinder, placed in the stator of an asynchronous induction motor. The inner cavity of the vessel is partially filled with In–Ga–Sn electrically conducting fluid. When the stator is deenergized, the fluid acted upon by the force of gravity takes up a position which breaks the electrical circuit between the electrodes. If the control circuit voltage is placed across the stator, the fluid is brought to rotate through the action of the rotating field, and the fluid assumes the shape of a paraboloid and closes the electrodes.

The current, the voltage across the electrodes of the principal circuit, and the control circuit voltage were placed across oscillograph loops during the switching tests. A pressure gauge was employed to measure the pressure in the vessel.

On-off switching operations were carried out on an electrical circuit with parameters 220 V, dc 100, 200, 400, 600, 750, and 1000 A, and each operation was duplicated. The power drain of the control circuit attained 900 W. The pressure in the vessel rose in unison with the current, and was higher in "on" periods

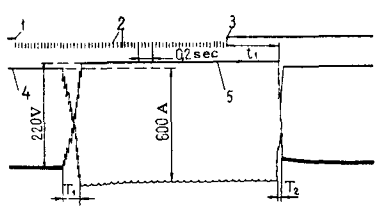


Fig. 1

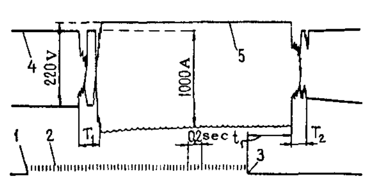


Fig. 2

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than in "off" periods. When 1000 A was switched, the pressure was 3 atm in the "on" position and 2.5 atm in the "off" position. One interesting point was that switching on and off proceeded almost noiselessly at all currents, including 1000 A.

Figures 1 and 2 show oscillograms of the on-off switching operations for a circuit with parameters 220 V and dc 600 A or 1000 A, respectively. In these diagrams, 1 and 3 denote the instants when the control circuit is switched on and off; 2 indicates the control circuit voltage; 4 and 5 indicate the zero lines for current and voltage in the control circuit; $T_1$ and $T_2$ are the times the arc is fired and subsequent ignitions when the circuit is switched on and off; $t_1$ is the time elapsed from the switching-off of control to the ignition of the arc.

It is clear from the oscillograms that repeated ignitions of the arc occur when the circuit is switched on and off.

## LITERATURE CITED


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