Experimental data on electric breakdown in a 0.35 mm high-vacuum gap due to rectangular high-voltage pulses is presented. In one system vacuum was achieved using an oil diffusion pump, in the other, using an ion-sorption pump.

It is shown that oil vapor and the cracking products of the oil formed during breakdown affect the probability distribution of breakdowns. Conditioning is linked to the dynamic processes of rupture and of re-establishing initiating centers on the electrode surface. A physical model is suggested for the conditioning processes.

According to most investigators, the breakdown voltage of a vacuum gap varies with increase in the number of strikes from zero to $N$, and then becomes stabilized. This phenomenon was named conditioning associated with vacuum breakdown.

In our investigation we used a generator of 140 nsec 50 kV rectangular pulses with 1 to 1.5 nsec rise-time. The pulses were applied to the vacuum gap. The breakdown and its time characteristics were recorded using capacitative and resistive dividers and two high-speed SO-1 oscillographs.

Two vacuum systems and two test chambers were used to investigate the effect of the means of producing vacuum on the breakdown characteristics. One chamber, made of copper and assembled with rubber seals, was evacuated to $5 \times 10^{-8}$ Torr by diffusion pump with two cold traps. The second chamber was turned from stainless steel, assembled with copper seals and evacuated by a titanium ion-sorption pump to about $1 \times 10^{-8}$ Torr. The chamber was thoroughly baked at 400°C for 100 hours. The high-voltage leads had kovar-glass seals. Both chambers were coaxial and matched to an electric circuit of 75 ohm impedance.

The construction of the discharge chamber permitted variation of the gap without affecting the vacuum. It could be reset to an accuracy of 0.001 cm. In both systems copper electrodes, a plane 22 mm in diameter and a hemisphere 11 mm in radius, were used, which ensured a uniform electric field for gaps up to 1 mm.

Before installation in the chamber, the electrodes were mechanically polished to a degree of micro-smoothness $R_g = 0.1 \mu$, pickled in orthophosphoric acid, and washed in distilled water, alcohol, and carbon tetrachloride. In all the tests the gap was set at 0.35 mm. Using two oscillographs, one adjusted for a 30 nsec sweep, the other for a 140 nsec sweep, current oscillograms were observed during breakdown starting from the initial pulse. The interval between pulses was $T = 5$ sec. Results for the discharge delay time $\tau$ and the discharge commutation time $\tau_c$ (at levels respectively of 0.1 and 0.9 pulse maximum [1, 2]) are given below.

Figure 1 shows the variation of breakdown probability with the number of trials in both vacuum systems. In an industrial-grade vacuum the breakdown probability increases with the number of trials, while in a "pure"
Fig. 3. Commutation time variation for breakdown in a 0.35 mm vacuum gap over a number of discharges; $U = 40$ kV, $p = 1 \cdot 10^{-6}$ Torr, copper electrodes in a uniform field.