The method of detecting the thermionic current in the cathode supply circuit in vacuum measuring devices

Keywords: measuring instruments, thermionic-emission electron source, electron energy, temperature distribution, electron source model, cathode current, signal processing, electron thermionic-emission current, stabilization

Abstract

The dissertation includes model analysis and experimental verification of the method of detection of the thermionic current in the cathode supply circuit. The static model of a thermionic-emission electron source for the Schottky current range was developed. The model based on the calculated temperature distribution and the density of the thermionic current along the cathode and is described by the original configuration of current sources and resistors. On the basis of the developed model, it was justified that the multiplicative-additive processing of voltage signals, directly proportional to the cathode current, enables the measurement the thermionic current in the cathode supply circuit. Model studies showed that the error of the processing method depends on the measuring resistors tolerance and the ratio I_K/I_e, which is a function of the work function and the apparent thermionic emission constant of the cathode material. To reduce the relative error of the method, materials with a relatively low work function and a high value of apparent thermionic emission constant should be used for the construction of cathodes. The prototype of the thermionic current to voltage converter was built on the basis of the configuration of instrumentation amplifiers with adjustable gain. It allows to reduce the sensitivity of the method error in relation to the tolerance of the measuring resistors. The results of the measurements of the step response of the thermionic current showed that the increase the resistance of the measuring resistors in the cathode supply circuit increases the time constant of the thermionic electron source system. The experimentally obtained cathode converter static characteristic, of the output voltage as a function of the thermionic current, confirms the implementation of the multiplicative-additive processing algorithm of voltage signals directly proportional to the cathode current to measure the thermionic current in the cathode supply circuit. Model-based demonstrated and experimentally verified method of detecting the thermionic current in the cathode supply circuit and the cathode converter, according to the author, be the subject of application research in thermionic current stabilization system, especially for measuring instruments using high-energy electron beams.