# TECHNOLOGICAL ASPECTS OF THE PRODUCTION OF SPARK GAP-SHARPENERS FOR VOLTAGE UP TO 500 KV

*D.S. MAKHANKO*

*PLASMA, JSC Research Institute of Gas-Discharge Devices, Ryazan, Russia*

The purpose of this work is to provide basic information about the manufacturing technology of sealed-off spark gaps-sharpeners in metal-ceramic design with hydrogen filling and pressures up to 120 atmospheres providing minimum geometric dimensions at voltages up to 500 kV, subnanosecond response times and a resource of at least $3x10^6$ inclusions in a given operating mode.

Uncontrolled spark gaps-sharpeners are one of the main elements of any high-voltage pulse generator designed to generate high-voltage pulses with amplitudes of hundreds of kilovolts and a leading edge duration of units and tenths of a nanoseconds. The fields of application of spark gaps-sharpeners as part of high-voltage pulse generators are portable X-ray machines, accelerator technology, sources of pumping gas-discharge lasers of superatmospheric pressure, electron-optical converters and photo recorders of pico- and femtosecond radiation processes.

This paper describes the relationship between the structural elements of the spark gap-sharpener and the electrical strength of the ceramic insulator to breakdowns on its surface, as well as the breakdown of the gap between the high-voltage output and the body of the spark gap.

To ensure high rates of switching characteristics in spark gap-sharpeners, hydrogen is used as a working medium at pressures up to 120 atmospheres. High pressure values impose very strict requirements on the mechanical strength of both individual components and the design of the spark gap-sharpener as a whole. It is also necessary to correctly select the electro-vacuum materials used, which ensure high mechanical strength and vacuum density of metal - ceramic junctions. It should be noted that the use of ceramic insulators imposes certain restrictions on their design, in particular in the form of a truncated cone.

The main technological process of soldering the cathode metal-ceramic unit using silver solder PSr 72, the process manufacturing the anode unit using the two-stage soldering method, and describes the filling and training of the spark gap-sharpener with electronegative gas to increase the electrical strength are given.

Soldering at elevated temperature according to the mode described in this work contributes to better wetting of the soldered surfaces with solder, its faster spreading and filling of the covering seams, and also provides capillary filling of the edge seams. With a sharp change in the soldering temperature, the solder in the edge joint begins to melt from the outside to the inside of the seam. Moving the molten solder from the outside to the inside of the seam significantly improves the structure of the seam and, as a result, the mechanical and thermal characteristics of the ceramic-metal connection.

A promising direction for improving the quality of manufactured spark gap-sharpeners and other complex structures of devices with simultaneous use of both edge and covering metal-ceramic and metal junctions is the use of the technology of soldering of metal-ceramic assemblies given in this article with a significant excess of the soldering temperature, the rate of temperature change and exposure during soldering, depending on the design features of the products. This method of manufacturing a gas-filled metal-ceramic spark gap-sharpener made it possible to ensure high reliability and tightness of the device. Additional training of high-voltage spark gap-sharpeners in $SF_6$ gas or its mixtures with inert gas and/or nitrogen can significantly increase the electrical strength of the spark gap-sharpeners.

The industrial production of a series of spark gap-sharpeners of the RO – 48, – 43, – 49, – 72 type has been mastered for operating voltages from 100 to 500 kV for use mainly in pulsed X-ray technology. Using the manufacturing method described in this work, the percentage of usable products increased to 95% during the mass production of spark gap-sharpeners.

Measurements of the switching characteristics of spark gaps were carried out on a stand, in which instead of an X-ray tube, were set low-inductive resistors of the TVO-60 type and a resistive current shunt with R=0.01 Ohms were installed. A constructive capacitive divider was used to register the temporary behavior of the voltage on the spark gap.