SELECTION OF CURRENT SENSOR POSITION IN HIGH-VOLTAGE POWER SOURCES OF WELDING GUNS

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Studied were spectral characteristics of current flowing in the plus circuit of electron beam sources of accelerating voltage operating on industrial frequency or with high-frequency transformation. Recommendations on the position of resistive current sensor are given.

Keywords: *electron beam welding, accelerating voltage sources, inverter voltage converter, resistive sensor of electron beam current*

A feature of most of the accelerating voltage sources designed for powering welding electron guns is application of resistive current sensors to close the beam current feedback.

Numerous attempts to mount this sensor in the plus circuit of the traditional power sources, generating rectified voltage directly from the mains of frequency $f = 50$ Hz without frequency transformation, failed, as the feedback signal is quite noisy, because of the flowing in this circuit parasitic capacitive currents of the high-voltage transformer and currents of recharging the filter capacities. Figure 1, *a* gives current oscillogram in the plus circuit of ELA-60 source, in which the high-voltage rectifier is assembled by the Larionov star-triangle connection diagram. Up to 30–50 % of total current, particularly in the range of small current values (from one to several percent of rated current) are made up of low-frequency ($f = 50$–600 Hz) variable components, for which the results of Fourier analysis are given in Figure 1, *b*. Suppression of these noises requires application of filters with cutoff frequency $f_{\mathrm{cutoff}} < 10$ Hz. For first order filters,

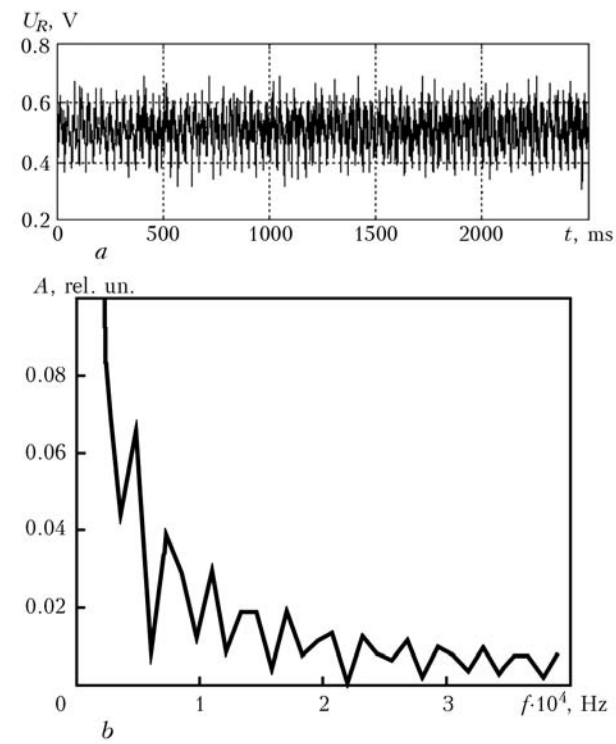

Figure 1. Oscillogram of voltage drop U_R on resistive current sensor with resistance $R = 10$ Ohm mounted in the plus circuit of accelerating voltage source ELA-60 (*a*), and spectrum of its variable component at load current 50 mA (*b*): A — voltage amplitude

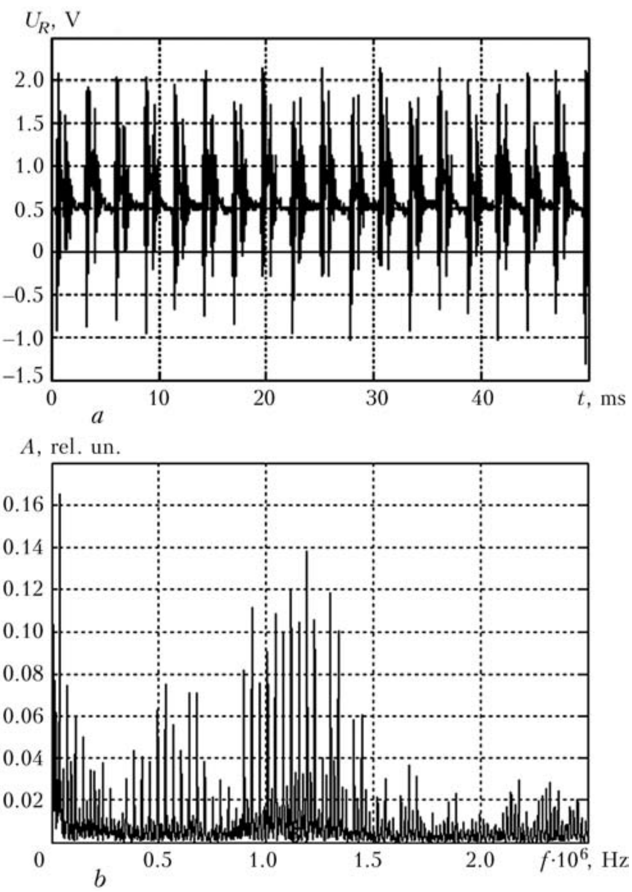

Figure 2. Oscillogram of voltage drop U_R across resistor with resistance $R = 10$ Ohm of current feedback in the plus circuit of inverter source of accelerating voltage ELAI-120/18 (*a*), and spectrum of its variable component at 50 mA load current (*b*)

in which $f_{cutoff} = (2\pi fRC)^{-1}$ (here, R, C are the resistance and capacity of the component elements), time constant is not less than 100 ms [1]. Here it turns out to be impossible to achieve the required fast control of beam current for welding with pulsed modulation of beam current, or apply secondary-electron systems of following the butt of the edges being welded in real time, when it is necessary to set and stabilize beam current during 5 ms pulse.

When resistive current sensor is mounted in the high-voltage circuit of these power sources, the feedback signal has a low noise level, the need for its filtration is eliminated, and fast control of beam current becomes possible. Such a solution, however, makes the equipment more complicated and less reliable [2].

In inverter power sources with high-frequency transformation of mains voltage mounting current feedback resistor in the plus circuit of the power source is applicable due to the fact that frequencies of the variable component lie in the high frequency region (f = 20–30 kHz) (Figure 2). Filters with 2–3 kHz cutoff frequency can be applied for filtering these components that corresponds to time constant $t <$ < 0.2 ms.

Thus, current feedback resistor in electron beam sources of accelerating voltage operating at industrial frequency should be mounted in the rectifier high-voltage circuit, and in inverter power sources with high-frequency transformation of mains voltage, it is rational to place it in the rectifier plus circuit.

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THESES FOR A SCIENTIFIC DEGREE

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On October 6, 2010, V.I. Dzykovich defended his thesis for Candidate of Sciences on «Investigations and development of the materials for wear-resistant surfacing based on spheroidized granules of the tungsten carbides».

The analysis of existing materials for surfacing of wear-resistant composite alloys based on fragmented particles of the tungsten carbide was carried out. It is shown that the spherical shape of particles due to maximum volume of spherical particle at minimum specific surface area is the most perspective for improvement of quality of deposited layer, decrease of a level of dissolution of reinforcing particles during surfacing, enhancement of operating abilities of the composite coatings and increase of a volume fraction of wear-resistant granules in the deposited layer.

The thesis substantiates selection of a method of thermocentrifugal sputtering of refractory materials for obtaining spherical tungsten carbide particles for their application as a wear-resistant phase in a composition of the materials for composite surfacing.

Using mathematical modeling of a method of thermocentrifugal sputtering of tungsten carbide the corresponding equations connecting the main parameters (thermal characteristics of heat source, speed of rotation) with the process efficiency and dimension of the forming tungsten carbide (relite) granules are proposed, and, as a result, the mechanism for control of granulometric composition of tungsten carbide $WC-W_2C$ spheroidized granules was developed. A formula for calculation of a rotation speed of spindle assembly of the unit for sputtering of material of the necessary granulometric composition was obtained.

The technology for melting of source materials with application of induction heating was developed that allows obtaining the ingots for the thermocentrifugal sputtering of high quality eutectic composition.

Investigations of influence of ingot quality for sputtering on structure, properties and stochiometric composition of obtained spherical particles of the tungsten carbides were carried out. In comparison of the spheroidized granules of tungsten carbides with analogues of the well-known foreign companies it was determined that the particles made using the thermocentrifugal sputtering have the maximum values of microhardness and uniformity of chemical and phase composition.

The technology for thermocentrifugal sputtering of refractory materials using plasma arc as a heat source, and commercial equipment were developed on the basis of obtained theoretical and experimental results. The optimum mode for sputtering of tungsten carbide ingots is welding current of 550–600 A at arc voltage of 38–40 V. At that, the optimum speed of vertical feed for ingot makes 0.12–0.18 mm/s. A speed of ingot rotation is the basic parameter influencing