SPLITTED ARC DISCHARGE OF HIGH PRESSURE

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Splitted arc contact with electrodes in plasmatrons with gas-vortex and magnetic stabilization is considered. It provides wear-resistivity of electrodes and is the base for various models of plasmatrons.

The paper is devoted to the problem of splitted arc contact with electrodes in plasmatrons with gas-vortex and magnetic stabilization of constant current arc [1]. This process was studied using linear scheme model plasmatrons of direct and indirect action with fixed and self-established arc length. External non-uniform magnetic field was created by magnetic lemses of special construction connected in series with arc current. Principal scheme of splitted arc discharge investigation is shown in Fig 1.

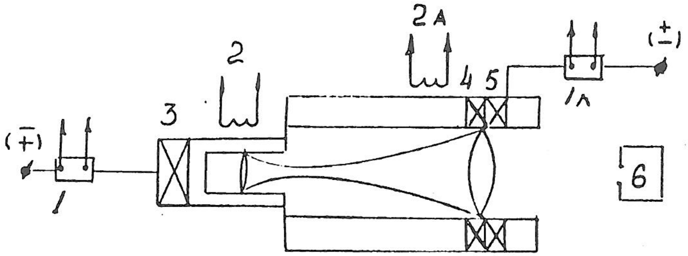

Fig. 1 Principal scheme. 1, 1a is a screw, 2,2a is Rogovskii belt, 3,4,5 are magnetic lenses, 6 is a photochamber.

In the experiments displacement of spots on electrodes was photorecorded, heat fluxes in electrodes were measured and electrode erosion was determined. Typical oscillograms of splitted arc current characterising frequency spectrum of arc discharge near electrodes for plasmatrons of indirect action are presented in Fig 2, the same characteristics for plasmatrons of direct action are given in Fig 3.

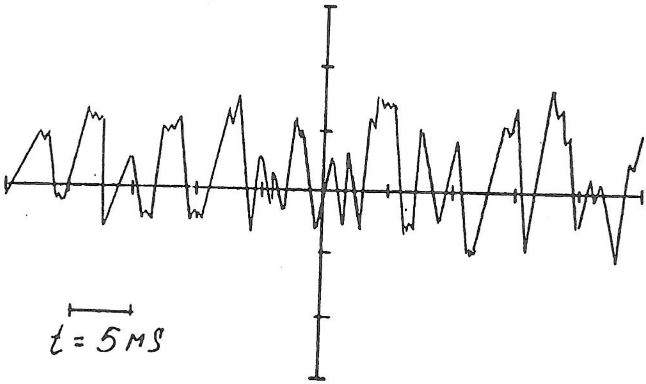

Fig 2. Arc current oscillogram for plasmatron of direct action.

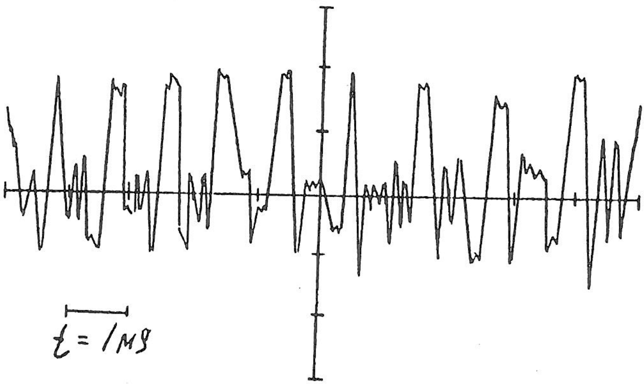

Fig 3. Arc current oscillogram for plasmatron of indirect action.

Analysis of oscillograms allows to make the following conclusions:

1. In auto-oscillation regime arc discharge on electrodes is dicrete, every peak corresponds to one spot modulated by higher harmonics.

2. Frequency of periodic oscillations depends on regime parameters and ranges from 1 to 100 kHertz, and higher harmonics frequency ranges from 1.5 to 3 mHertz.

3. Splitted arc in twisted gas flux possesses considerable intrinsic azimuthal-directed magnetic field, the strength of which depends on arc current J ,twist parameter of plasma-producing gas n, internal electrode diameter d. Action of intrinsic magnetic field on arc current can be expressed as :

$$F=n\mu_0 J^2/\pi d,$$

where **n** is the gas twist parameter, $\mu_0 = 4\pi\ 10^{-7}$ **H/m** is a magnetic constant, **d** is an internal electrode diameter, **J** is an arc current.

Similar case was described in [2], where periodic oscillations were obtained on the installation with quickly-rotating electrodes, but the author did not detect auto-oscillation regime. Existence of stable periodic oscillations in wide frequency range can be explained by the interaction of magnetic field with the spiral arc field. Asmagnetic lenses are connected in series with arc current, oscillating circuit with arc spiral with feedback is formed. Depending on the regime parameters feedback can be both positive and negative. In the case of positive feedback frequency of oscillations increase and correspondingly arc splitting increases forming separate current conducting channels. Negative feedback suppresses excitation and leads to the formation of large hardly-movable spot on electrode and correspondingly low frequency of oscillations ranging from 0.5 to 120 Hertz.

It was shown [3] that for certain regimes and geometrical parameters an arc splits into several separate channels but not more than 6. Oscillograms and simultaneous photorecording of electrode spot allow to make a conclusion that in our experiments mainly (2-6) x 10^2 channels are formed, each of the channels exists during (2-4) 10^{-5} sec. Specific energy in each spot amounts to (1-4) 10^{12} W/m, but in spite of this high specific energy erosion of copper electrode is small and amounts to about 10^{-10} kg/Q. Calorimetric measurements show reduction of heat losses on electrodes. For example, at currents lower than 400 A and voltage equal to 450 V heat losses amount to

10-15% from the power supply, what is equal to 0.9-0.85 efficiency. We explain these low erosion values by the large portion of auto-electron emission of electrodes. Thus, studying of electrode erosion for splitted arc showed little wear of electrodes in oxidized environment and, respectively, high resource of copper electrodes, for example, for current 300-600 A cathode and anode resource ranges from 500 to 1,000 hours.

The above results of experimental investigations of plasma arc discharge are the base for the construction of plasma generators - plasmatrons for various technological applications. The following types of plasmatrons were designed:

1. Plasmatrons for spraying of metallic and oxide powders. In these plasmatrons air and air-propane mixture is used as plasma-producing gas. In all of the modifications cathodes and anodes are manufactured of copper. Resource of cathode and anode operation ranges from 500 to 800 hours. Plasma jet speed amounts to 1,500 2,000 m/s and the temperature is uniformly distributed along the jet cross-section. Efficiency of metallic powders usage is about 99% and for oxide powders this value ranges from 85% to 88%. Adhesion of metallic powders is comparable with laser coatings, porosity is regulated.

2. Wide-torch plasmatron for plasma coating of large surfaces with 80-100 mm cross-section of plasma torch and specific heat flux 1-1.5 W/m at nozzle temperature 5-6 x 10 K. Temperature is uniformly distributed on torch cross-section with deviations 320-370 K at a distance of 5 mm. The speed of plasma torch is regulated within 0.5-20 m/s. Wide plasma torch is used for spraying the surface of construction materials as well as for model tests of refractory decorative materials.

3. Plasmatron for cutting of non-ferrous metals (copper, aluminium) and steel alloys of big thickness to 100 mm. The number of plasmatron runs is not restricted, copper electrode resource ranges from 500 to 600 hours.

References

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