INFLUENCE OF ACCELERATED PARTICLES BEAMS ON FORMATION OF LONG SPARK DISCHARGES IN GASES

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Characteristic features of spark discharges of long (more than *5 cm*) gas gaps is the zigzag form of discharges and their trajectories in the gap never repeat each others. Numerous observations of natural lightnings and long laboratory sparks prove it.

It was considered for a long time that curvilinear sparks character was the integral property of long spark discharges. However, with appearing of powerful laser one learned to control the spatial location of discharges. So rectilinear discharges have been received each time when the narrow channals of low density that had had high electroconductivity have been generated between electrodes due to focused laser radiation before the supply of high voltage on a discharger [1].

A description of charges guided by laser beams is difficult because of incomplete information about initial conditions that characterize plasma state of channal that had been heated by laser in the moment of the supply of voltage on the discharger. Interpretation of processes in guided discharges would be easier if the beams of accelerated particles were used as an ionizator.

First experimental demonstration of possibility of the control of spark discharge form with the use of a beam was obtained in 1983 by electron linear accelerator with $E_e = 300\ MeV$ of Kharkov Phisical-Technical Institute [2]. There were two point electrodes near the route of electron beam in the experiment that had been brought out atmosphere and supply of pulse voltage on them had been synchronized with the time of plasma formation filament of the beam. As a result the development of discharge in a gap finished with linear spark discharge that coincided with the route of the beam. Various spark forms have been observed depending on synchronization (fig.1): *1* — uncontrollable discharge; *2* — partly guided discharge; *3* — guidation in all discharge gap $l = 9\ cm$ ($U = 150\ kV$). The spark form that is shown in the photo — *4* (fig.1) was achieved by the displacement of one of the electrodes.

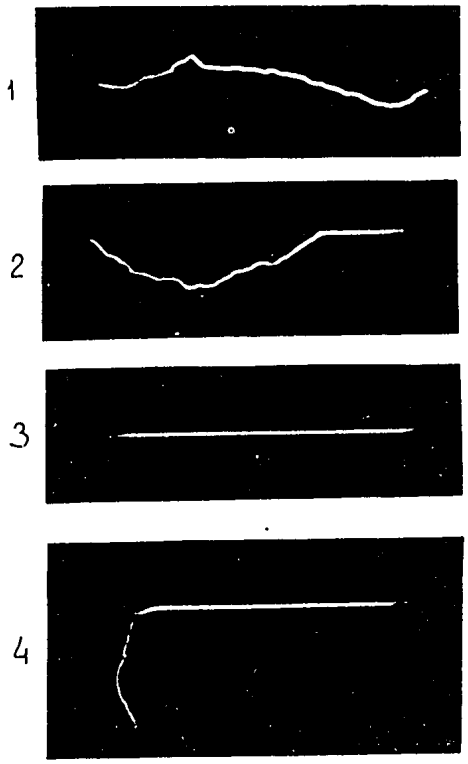

Fig.1. Various forms of spark discharges of atmoshere gap ($l = 9$ *cm*) under condition of it's pre-ionization by narrow electron beam at $Ee = 300$ *MeV* is shown. *1* — uncontrollable discharge; *2* — partly guided discharge; *3* — the guiding through discharge gap; *4* — picture of semi-self-maintained discharge when one of point electrodes is out of beam channel

A number of characteristics that is inherent to this method of guided discharges production were established in the series of experiments in 1983—1989. So three general stages of the discharges have been selected: *1* — semi-self-maintained discharge due to the drift of plasma electrons in the field with field intensity $E = U/l$; *2* — formation of an anode leader and its uniform motion to the opposite electrode; 3 —

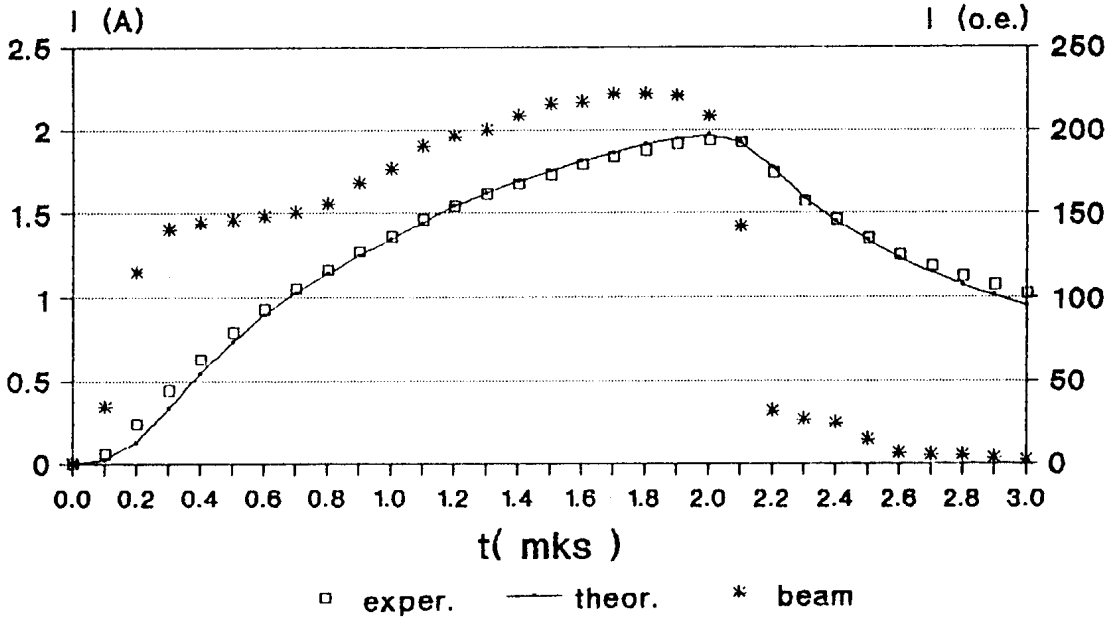

Fig.2. Calculation result for semi-self-maintained discharge current in comparision with experimental digitized oscillograms in nitrogen ($l = 9$ *cm*, $U = 18.2$ *kV* = const, $Ie = 50$ *mA*)

—prostrict spark discharge. More detailed interpretation of the results of the mentioned experiments is presented in [3].

A calculating model for the description of current impulse form of semi-self-maintained discharge has been devised. The model contains two free parameters: b, cm^3/s — coefficient of volume recombination; w, cm^{-1} — effective number of ion and electron couples that are formed by one particle of the beam on 1 cm of its run in gas. The values of the parameters are estasblished by the method of least squares due to experimental oscillograms, obtained at different initial conditions (beam current-Ie and voltage on the discharger-U). One can judge of the quality of fitting by fig.2 where culculating curves for $b = 1.7\times10^{-7}\ cm^3/s$ and $w = 49\ cm^{-1}$ are compared with the experimental oscillogram of current impulse in nitrogen. The form of current impulse of the electron beam, that is plasma source with concentration corresponding to space-temporal distribution of particles in the beam is presented in same fig.2 in relative units.

Values for b, obtained in calculations coordinate with the similar ones that have been obtained by other methods for nitrogen. On the base of it one would conclude that calculated concentration of plasma is similar to real distribution $n\ (r,t)$, that is formed in the discharge gap by the beam of fast electrons. Therefore, the initial conditions for discription of the second stage of discharge that is the motion of the leader, are defined.

References

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