ON THE ROLE OF AUXILIARY ELECTRODES
IN A.C. DISCHARGES*

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Only the phenomena taking place near the discharge-heated, oxide-coated electrode of low-pressure mercury-argon arcs are treated by the author for the case when two auxiliary electrodes of the same surface area, arranged parallel to each other protrude into the space around the electrode. The radial movement of the auxiliary electrodes and examination of the influence thereof on the space surrounding the electrode is facilitated by a discharge tube of special design made especially for this purpose. The current consumption of the auxiliary electrodes in their various positions is determined and the total currents as well as the variations of the tube voltage are measured. Starting from the results thus obtained, the influence of the auxiliary electrodes used in a.c. discharges on the space around the electrode is discussed. Using time distribution through the previously employed a.c. probe measurements, the instantaneous value of cathode fall and the mean value obtained from the cathode fall and anode fall relative to one half period are determined as functions of the position of the auxiliary electrodes. The results and functions obtained are compared with the relationships derived from the tests carried out hitherto with d.c. discharges.

1. Introduction

While the phenomena in the positive column of various gas and vapour discharges can be characterized with more or less accuracy through the sufficiently exact determination of the relevant micro and macro parameters, the description of the spaces surrounding the electrode gives rise to some difficulties strongly restricting the accuracy of the results of the measurements. To characterize the plasma of the positive column, there are several approximating methods available which are relatively quick and provide also for the general plasma diagnosis. However, the description of the spaces around the electrodes, and the "transition spaces" between the regions of the positive column and the electrodes involves several problems caused by the character and size of the spaces themselves. At the same time, these spaces are of primary importance as to the maintenance and design of the discharge but many, relatively unclear phenomena are encountered due to the difficulties in testing (above all the problem of measurement free of perturbations which could affect the discharge). One of these problems is the influence of the auxiliary electrodes made of conductive material and protruding into the proximity

of the electrodes on the discharge region. Though previous papers [1, 2] contained interesting statements, emphasizing the considerable influence of the auxiliary electrodes in some cases, detailed experimental, or theoretical results have not been published up to now.

HINMAN and FOX [1] pointed out that auxiliary electrodes conveniently arranged near the electrode may decrease the voltage fall across the region ahead of the electrode — and thus also the power loss taking place across the electrode — and this effect would be proportional to the auxiliary electrode surface area within a certain range. But this paper [1] contains no answer as to whether the phenomena occurring in the proximity of the electrode are subject to more significant influence of the auxiliary electrode at the cathode side or anode side of the a.c. discharge. This statement has not been supported by more detailed data obtained either theoretically or experimentally. The author participated earlier in experiments [2] carried out to classify the influence of the auxiliary electrodes on the cathode fall in the case of a.c. discharge. By means of these investigations [2] it could be shown that in the cathode half cycle the auxiliary electrode has a considerable effect because it reduces the cathode fall. In the same paper [2] the function of the auxiliary electrodes in d.c. discharges has also been treated.

The purpose of the present paper is to report the results of further investigations, determining the current consumption of the auxiliary electrodes of given size, arranged symmetrically to the main electrode, movable in radial direction, of equal surface area, shape and material, their influence in the case of the d.c. discharge both at the cathode and the anode sides, the variations on the tube voltage caused by the above influence and finally, the main deviations of the a.c. discharges which would take place in the cathode half-cycle relative to the examined electrode, likewise due to the above phenomena.

2. Experimental conditions, measuring methods

The design of the special tube used in the measurements is shown in Fig. 1. Glass-wall discharge tube $T$ has an inner diameter of 36 mm and an interelectrode distance of 1090 mm. At both ends of the tube, there are two tungsten double spirals of the same design coated with the electron emitting material $S$ to form the electrodes together with the corresponding current inlets $I$. Near the first electrode two radially movable auxiliary electrodes are built in. These plate-like auxiliary electrodes are made of nickel, with a thickness of 0.1 mm and with 7 and 12 mm sides. They are built symmetrically in the direction of the spiral axis. They are displaced by an electromagnet through the iron cores fastened to them. Any turning is prevented by an iron shoulder matching into the guide groove formed in the glass. Having been