Electrode Components of the Arc Discharge*

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With 35 Figures

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Introduction

The electric arc as a phenomenon of classical physics is well-known and has been for more than fifty years. Interest in the arc lies not only in its importance for the investigation of the principle laws of gaseous electronics but also in its wider application in industry and technology.

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We can, therefore, readily understand that during this time it has been the subject of more than a thousand special investigations. Some of these results have been summarised in comprehensive monographs.

If, in spite of all this, we still have an incomplete understanding of the arc discharge components at the electrodes, it must be because of the special problems this subject presents. It seems essential that we should be clear as to the nature of these problems, before starting our investigation.

Let us then recall, that in theoretical physics we meet two types of problems which are appreciably different.

In the first group fall all those problems, whose phenomena do not come within the framework of laws already known. The solution here requires not so much work, but rather a new idea based on ingenious intuition.

In the second group come those problems whose phenomena are governed by laws already well known. If in this case the theory is still incomplete it can only be because the problem is very complex and involved. Here the solution requires more consequent and tedious work than ingenious intuition.

Of course, there are problems which belong simultaneously to both groups. As long as there is no cogent reason to assume the contrary, we claim that the arc — as most of the problems of gaseous electronics — belongs to the second group.

The problem of the electrode components of the arc discharge is so particularly complex and involved because we have to handle simultaneously a large number of physical laws connecting an even larger number of variables and parameters. The mere formulation of a single one of these laws is difficult. To include all these laws in their mutual interplay for all possible parameter values seems like an almost insoluble problem. In order to reduce these difficulties, two ways prove to be successful.

First, it is necessary to restrict the variety of parameter values. That means we investigate certain typical cases which, of course, have to be suitably chosen to represent a large range of the phenomena.

Secondly there is the possibility of classifying the laws as “essential” or “negligible”. In this way we arrive at the concept of the model. Any region which can be described by a unified model we call a model zone. It is clear that the problem is much reduced, if one restricts oneself to the calculation of only one model zone. This procedure has been widely applied in the past.

Unfortunately, however, the “electrode discharge components of the arc”, our region of interest, is composed of several model zones which strongly interact with each other. In particular the description of the interacting boundaries of the model zones, the transition zones, within which both model conceptions are equally effective, cause great difficulties. A description of these transition areas can be evaded only in favourable circumstances by means of appropriate boundary conditions.