THE OPEN-ARC METHOD OF EXCITING THE BALMER SERIES

WHEN a steady stream of hydrogen is passed into a copper arc the Balmer series of lines is excited. The series is also obtained if instead of hydrogen, a stream of coal-gas or steam is used. In fact, with steam more lines of the series appear and their intensity is even greater than with hydrogen. In all these cases, however, the lines are very broad compared to what are obtained with an ordinary discharge tube. A series of experiments with different metallic arcs run at various current strengths brought out two significant facts: (*i*) The Balmer series is excited only with the copper arc and no trace of the series is to be observed with iron, zinc, aluminium or carbon arcs. (*ii*) Along with the hydrogen lines, the OH Bands $^2\Sigma \rightleftharpoons {}^2\Pi$ at λλ 3064 and 2811, also appear and as regards occurrence and intensity these bands and the Balmer series of lines go *pari passu*.

That the excitation of the hydrogen lines is not a pure temperature phenomenon becomes obvious. Two explanations suggest themselves. First, in the case of the arcs where the hydrogen lines are not excited, the hydrogen supplied is used up in reducing the oxides of the electrodes formed. With copper arc, copper being less easily oxidised, a free supply of hydrogen becomes available for excitation. Second, and what seems more plausible, the excitation of the hydrogen atom is due to some collision processes taking place in the copper arc.

In the case of copper it is well known that the electronic configuration $3d^{10}\ 4s$, gives the series of normal doublet levels, while the configuration $3d^9\ 4s^2$ gives a system of inverted doublet and quartet levels. Some of these latter levels lie in the continuum above the limit of the level $3d^{10}\ {}^1S_0$. If an excited copper atom in one of these levels makes an inelastic collision with a hydrogen atom and comes down to the level $^1S_0$, the energy so liberated may be sufficient to raise the hydrogen atom from the second to the higher orbits thus giving rise to the Balmer series. Alternatively, a collision between a copper atom

in the $3d^9$ $4s$ level and a hydrogen atom may result in bringing the copper atom to the $3d^{10}$ level and exciting the hydrogen atom to higher levels.

It is also observed that the injection of steam or hydrogen greatly modifies the intensity of a number of copper lines, especially in the region below λ 3000. A detailed analysis of the lines which are so modified will give a clue to the nature of the collision processes involved in the arc.

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