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PRODUCTION OF CONTINUOUS HIGH-CURRENT DISCHARGES IN GASES

by

J. E. ALLEN and F. MAGISTRELLI
(C.N.E.N.)

1963

Work performed under the Euratom contract No. 002-60-1 FUAI

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Production of Continuous High-Current Discharges in Gases

THE properties of high-current arcs under stationary conditions have been studied, in general, using low-pressure mercury vapour. Thonemann and Cowhig[1], for example, have made probe measurements in a mercury arc at currents up to 100 amp. Much higher currents are used in technical devices such as rectifiers and inverters.

The reason for the use of mercury is that a cathode spot on a mercury pool can supply virtually unlimited currents. Furthermore, the cathode is indestructible since the mercury which is blasted away from the spot afterwards returns to the pool.

It is possible, however, to utilize the properties of a mercury pool to obtain a high electron current which is then sent into a gas other than mercury. This can be done by introducing the gas into a mercury vapour discharge tube in which a cold trap prevents the mercury from entering the part of the tube which contains the anode.

The experimental tube (Fig. 1) is of 'Pyrex' and has a water-cooled principal anode A_1, a mercury pool cathode C and an auxiliary anode A_2. U is an umbrella which shields the main discharge space from jets of mercury emanating from the cathode spot and

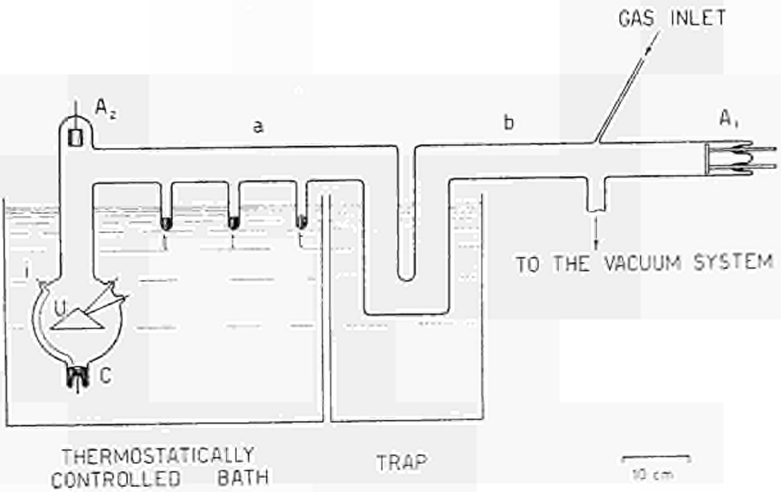

Fig. 1

i is an electrode which is used to start the discharge. The bulb containing the cathode pool and the three tubes t containing further mercury are submerged in a thermostatically controlled bath. The large U-bend, which is surrounded by a vessel containing dry ice, constitutes the trap. The discharge tube is connected to a two-stage mercury diffusion pump through a liquid nitrogen trap.

Using a suitable optical system, light from regions a and b of the discharge (Fig. 1) illuminates respectively the lower and the upper parts of the entrance slit of a Hilger–Barfit constant deviation spectrometer. Thus the two spectra can be viewed simultaneously through an eyepiece. The measurements presented

Table 1. INTENSITY OF SPECTRAL LINES IN ARBITRARY UNITS

Wave-length (Å.)	Light from a	Light from b	Light from both a and b
5876 (He)	0·0	2·0	2·0
5770/91 (Hg)	3·5	0·0	3·5
5461 (Hg)	16·0	0·0	16·0
5016 (He)	0·0	8·0	8·0
4922 (He)	1·0	2·0	3·0
4713 (He)	0·0	1·5	1·5
4471 (He)	0·5	0·5	1·0
4358/39 (Hg)	28·0	0·0	28·0

here were obtained using a photomultiplier which views individual lines through a slit.

Experiments have been carried out using helium. The pressure of the latter was 10μ mercury, and the mercury vapour pressure was 2·6μ mercury, corresponding to a bath temperature of 30° C. The arc current was 1 amp. and the arc voltage 190 V. Measurements were made of the intensity of the light arriving from region a, from region b and from both regions together. The first two measurements were made by blocking the light beam from part b and part a respectively. Typical results are given in Table 1. These measurements have not been corrected to allow for the variation of the sensitivity of the photomultiplier with the wave-length of the incident light. The figures given are galvanometer readings, which are to the nearest 0·5 division. Successive series of measurements, however, indicate that the error is somewhat greater than this.

It is seen from Table 1 that the light emitted from part a is due almost entirely to excitation of mercury atoms. The essential result, however, is that there is no mercury in part b of the tube, within the limits of experimental error. By analogy with normal vacuum practice it is clear that a discharge tube with a more sophisticated trap system would be even more efficient.

In the present experiment a current of only 1 amp. was used but the method can be extended to much higher currents.

We thank Prof. B. Brunelli for his interest.

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[1] Thonemann, P. C., and Cowhig, W. T., *Proc. Phys. Soc.*, B, **64**, 345 (1951).

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