Letters to the Editor

The Board of Editors does not hold itself responsible for opinions expressed in the letters published in this section. The notes containing short reports of original investigations communicated to this section should not contain many figures and should not exceed 500 words in length. The contributions reaching the Secretary by the 15th of any month may be expected to appear in the issue for the next month. No proof will be sent to the author.

4

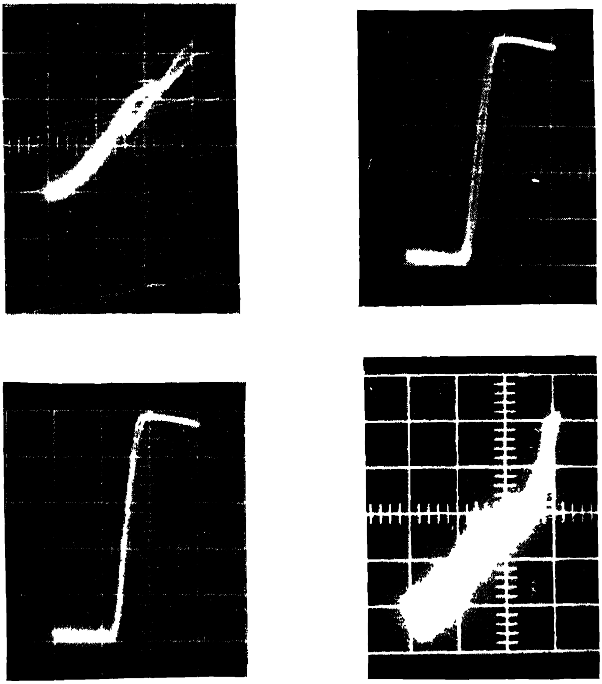
SOME PROBE DATA OF DUOPLASMATRON PLASMA

D. K. BOSE, N. K. MAJUMDAR AND S. N. SENGUPTA

SAHA INSTITUTE OF NUCLEAR PHYSICS, CALCUTTA, INDIA

(*Received January 17, 1966*)

The high performance of the duoplasmatron source is due to the mechanical and magnetic constraints (Burton, 1961). The magnetic field set in the interspace, intermediate electrode to anode, is so shaped that a magnetic mirror has been supposed to exist in this space (Burton, 1961, Moak *et al.* 1959) and under that circumstance, electrons have little chance of escape from this region excepting along the axis of the system. The experimental investigation of Popov (1961) on the distribution of magnetic field in this sapce actually confirms this view A Langmuir probe (length = ½mm, diameter — 0.06 mm) has been placed at the mouth of the anode orifice of our douplasmatron source (Bose, *et al.* 1965).to study the effect of magnetic field on the plasma state in this region under different operating conditions. The probe is operated by electrical pulses (Sengupta) The rising part of triangular pulses was used for the horizontal sweep of an oscilloscope and the other arm was blanked off Sweep duration was 1/60-th of a second and magnitude was 25 volts. Current voltage characteristics of the probe were recorded by photographs of the oscilloscope traces. The effect of the magnetic field is borne out by these photographs A stable well developed plasma (Figs. b, c) characterised by absence of any substantial potential gradient and a regular Maxwell-Boltzmann distribution is formed at high arc voltage ($\approx$ 150V) with the setting of the magnetic field in the interspace. If we consider that trapped electrons enhance the rates of ionisation (Popov, 1961) the mirror action should be noticeable by the setting of a stable plasma tip and hence the role of magnetic field is revealed in the sequence of these photographs (Figs. a, b, c). The electron temperatures have been determined for high arc voltage patterns (the semi-log plots show distinct uniform slopes) Increase of magnetic field has been accompanied by increase of T_e signifying increased collisions processes due to the trapped electrons At low arc voltages, equilibrium condition is not observed and the probe pattern shows preponderance of particles not coming from plasma (Ardenne; Chapman, *et al.* 1964). Application of magnetic field is however found to reduce fluctuations and a growth towards a Boltzmann distribution is discernible (Fig. d). The following table presents some features of these probe studies. Some of the photographs taken are shown in Figs. a, b, c, d.



Figs (a, b, c, d). Examples of oscilloscope records of the current-voltage characteristics as obtained by the pulsed probe technique. Each small division of the abscissa represents 1.7 volts and that of the ordinate represents 37μA current. (Details of the photos are given in table 1). From the regular patterns of the photographs it becomes evident that the ions of Duoplasmatron have small energy spread.

TABLE

Argon pressure 1×10^{-2} mm of Hg

Srl. No.	Filament current in Amperes	Arc Voltage in Volts	Arc Current in Amperes	Magnet current in Amperes	Floating potential in volts	Plasma potential in Volts	Te in ev	Remarks	Figure reference
1	15	145	0.7	0	—	—	—	Plasma not formed	*a*
2	15	145	0.7	0.5	−5.5	−12.0	0.6	Stable plasma	*b*
3	15	145	0.7	2.0	−5.5	+10.5	0.8	Stable plasma	*c*
4	17	60	1.42	0	—	—	—	Irregular pattern	
5	17	60	1.40	2.0	—	—	—	Shows admixture of direct electrons	*d*
6	17	25	0.5	1.0	—	—	—	Instability and Kinks in the pattern	
7	17	25	0.5	2.0	—	—	—	Instability and Kinks in the pattern.	
8	16	80	0.5	2.0	−4.09	+11.9	0.8	Plasma developed.	

Blank spaces in the columns indicate quantities not determinable in view of irregular shapes
The value of debye length clalculated is 0.07 mm

ACKNOWLEDGEMENT

The authors are grateful to Prof. B. D. Nagchaudhuri, Director, Saha Institute of Nuclear Physics, for guiding the work

REFERENCES

Burton, B. S. Jr., 1961, *Electrostatic Propulsion*, Academic Press, New York, London, Ardenne, M. V. *AERE* **232**, (TRANS), Report No 898

Bose, D. K. et. al, 1965, *Proc. Nucl. Physics and Solid State Physics, Symposium*, Calcutta, 367.

Burton, B S. Jr. 1961, *Electrostatic Propulsion*, Academic Press, New York, London, 21.

Chapman, R. A. et al, 1964, *J. Appl. Phys.* **33**, 2813.

Moak, C. D. 1959, et al, *R S I.* **39**, 694.

Popov, S. N. (1961), *Pribori i technika eksperimenta* **4**, 20.

SenGupta, S N. Saha Institute of Nuclear Physics, Calcutta, Unpublished