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IMPROVED CORONA TRIODE VOLTAGE REGULATING SYSTEM

C. M. Turner

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Berkeley, California

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Ashby and Hanson introduced the concept of grid controlled corona[1] and

1 R. M. Ashby and A. O. Hanson, R.S.I. 13, 128 (1942)

suggested its possible application for regulating the voltage of the high potential electrode of a Van de Graaff electrostatic generator. McKibben developed the system for regulation of the voltage of the 2.5 Mev Van de Graaff at Los Alamos[2] and Figure 1

2 J. L. McKibben, D. H. Frish, J. M. Hush, Phys. Rev. 70, 117(A), (1946)

shows the essential features of the system. Needles, N, project slightly through holes, effectively in the tank wall toward the high voltage electrode, and a high voltage tube is connected between the needles and ground. Corona to the high voltage electrode from N charges the plate of tube, T, to a positive potential depending on the control grid voltage. A voltage error signal obtained from a deflected ion beam, applied to the grid of T, controls the corona feed back to the high voltage electrode by varying the potential of N with respect to ground. While this system has been made to work quite satisfactorily, it has the disadvantages: (1) that the axial position of N has to be adjustable to permit proper operation over a range of voltages on the machine, and (2) this system is reported to be unusable in machines operated with a negative high voltage terminal, since the presence of the needles induces sparking across the air gap.

These disadvantages are avoided by the corona triode arrangement shown in Figure 2 where a true grid, G, is situated between needles, N, and plate, P. A potential E_G applied between N and G causes corona discharge from N and a fraction

of this can be collected on P, depending on the potential of P and the grid transmission. The presence of the grid makes the corona discharge from the needles N completely independent of the potential of P. It is found desirable to stabilize the corona discharge by inserting a resistor of a few megohms in series with each needle as indicated.

Figure 3 shows how the corona triode is used to regulate the potential of a positive high voltage terminal. Grid G is insulated from the tank wall and held at a positive bias sufficient to give a maximum corona current of 100-200 microamperes from the needles. A series control tube again regulates the flow of corona current from the needles in accordance with an error signal. The operation of this system is relatively independent of the potential of the high voltage electrode, but any necessary adjustments can be made by adjusting the grid bias voltage E_G rather than moving the needles. In the Berkeley Van de Graaff generator, operating at a tank pressure of 100 p.s.i.g. and a normal freon concentration of about 5°/o by weight, a bias voltage of about 17 kilovolts is required on the grid, and under these conditions the control characteristic is shown by Figure 4.

Figure 5 shows a circuit arrangement which, although it has not been tried by the author, should give satisfactory control with a negative high voltage terminal. The problem of sparking from the needles to the high voltage electrode should be eliminated by the complete shielding of the needles by the grid.

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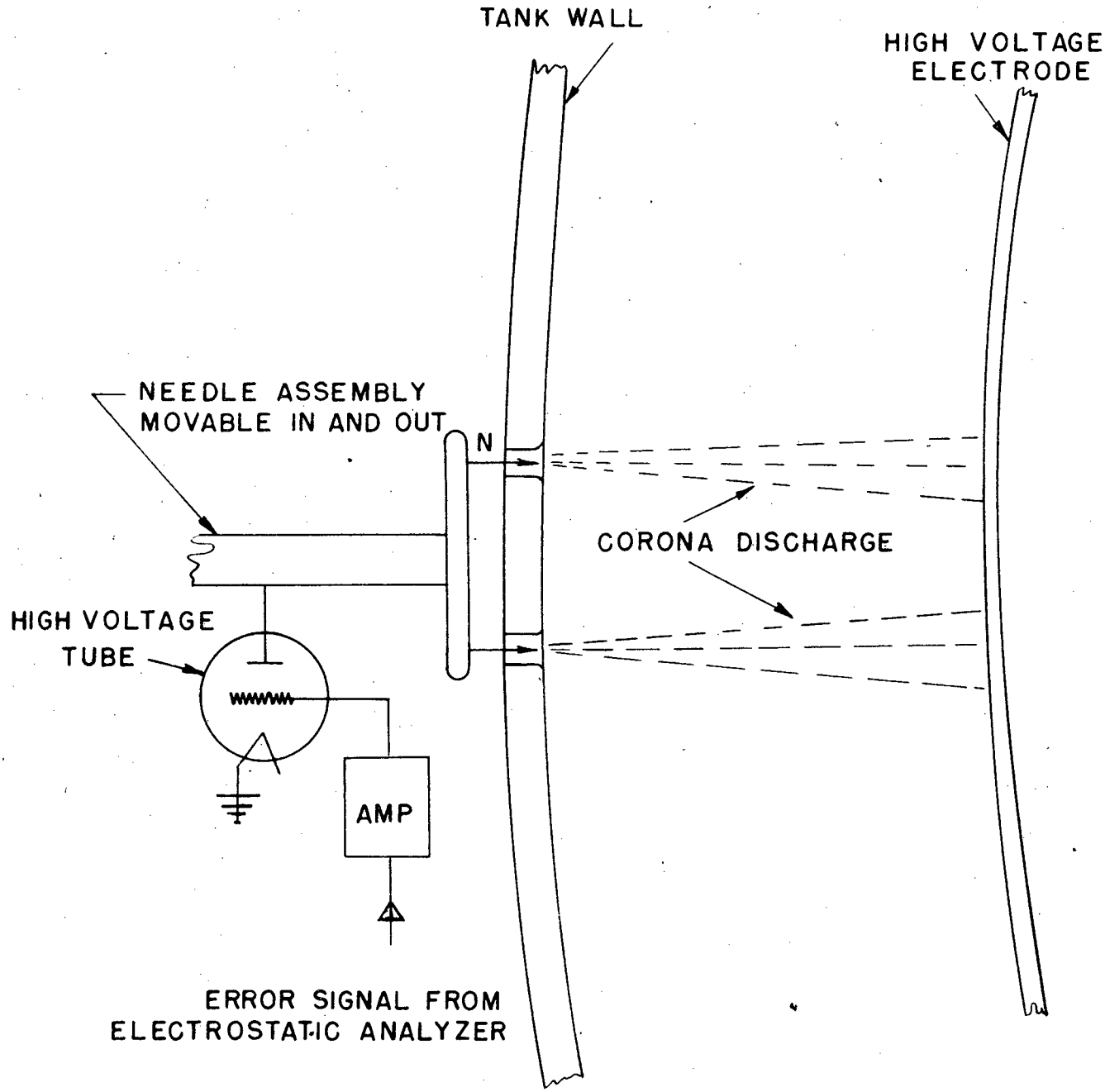
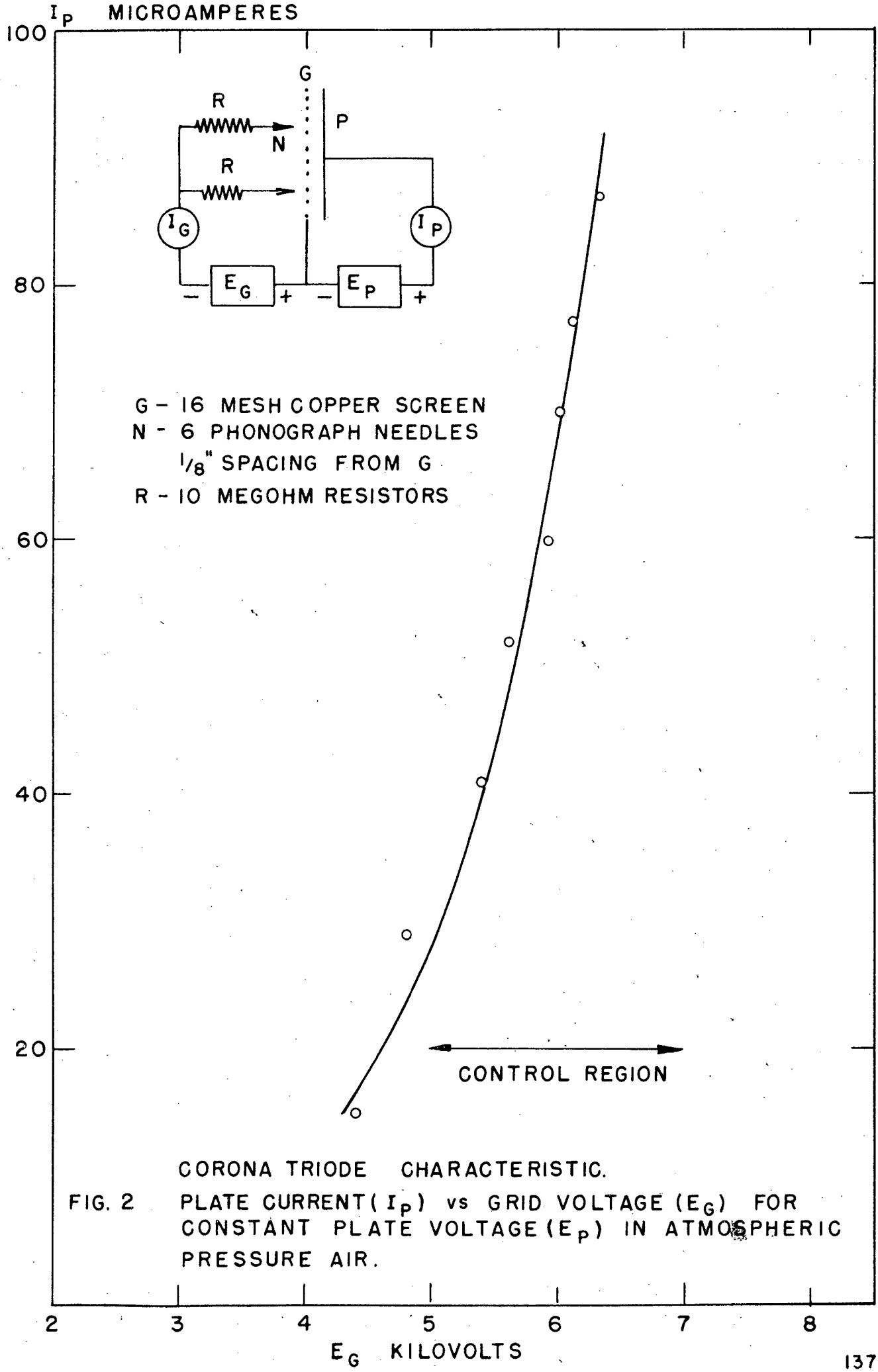


FIG. 1 SCHEMATIC SHOWING PRINCIPLE OF OPERATION OF STANDARD CORONA CONTROL SYSTEM



CORONA TRIODE CHARACTERISTIC.

FIG. 2 PLATE CURRENT (I_P) vs GRID VOLTAGE (E_G) FOR CONSTANT PLATE VOLTAGE (E_P) IN ATMOSPHERIC PRESSURE AIR.

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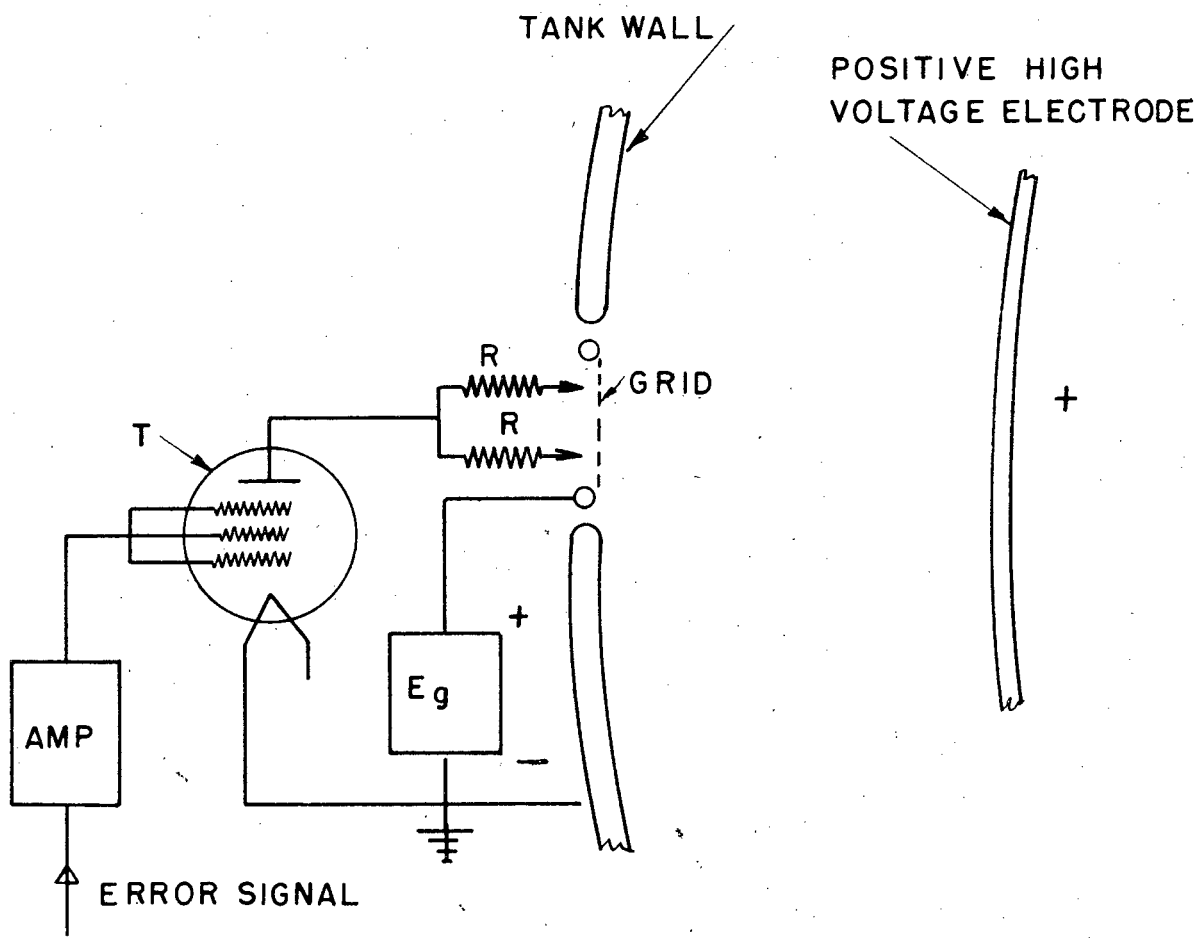

R – 10 MEGOHM RESISTORS

T – 4E27 VACUUM TUBE OR EQUIVALENT

FIG. 3 CIRCUIT ARRANGEMENT USING THE CORONA TRIODE TO REGULATE VOLTAGE OF A POSITIVE HIGH VOLTAGE TERMINAL.

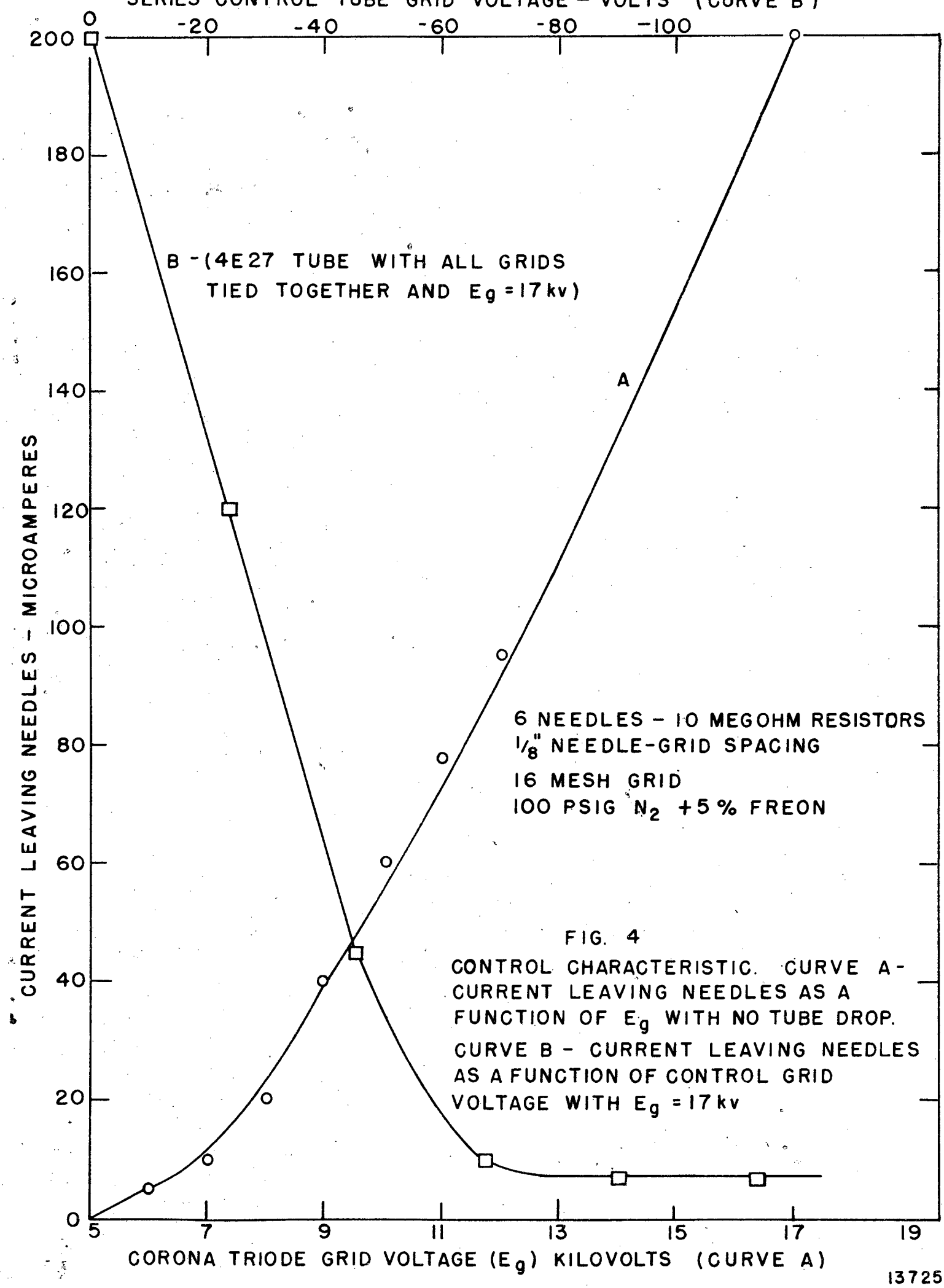

FIG. 4

CONTROL CHARACTERISTIC. CURVE A - CURRENT LEAVING NEEDLES AS A FUNCTION OF E_g WITH NO TUBE DROP.

CURVE B - CURRENT LEAVING NEEDLES AS A FUNCTION OF CONTROL GRID VOLTAGE WITH E_g = 17 kv

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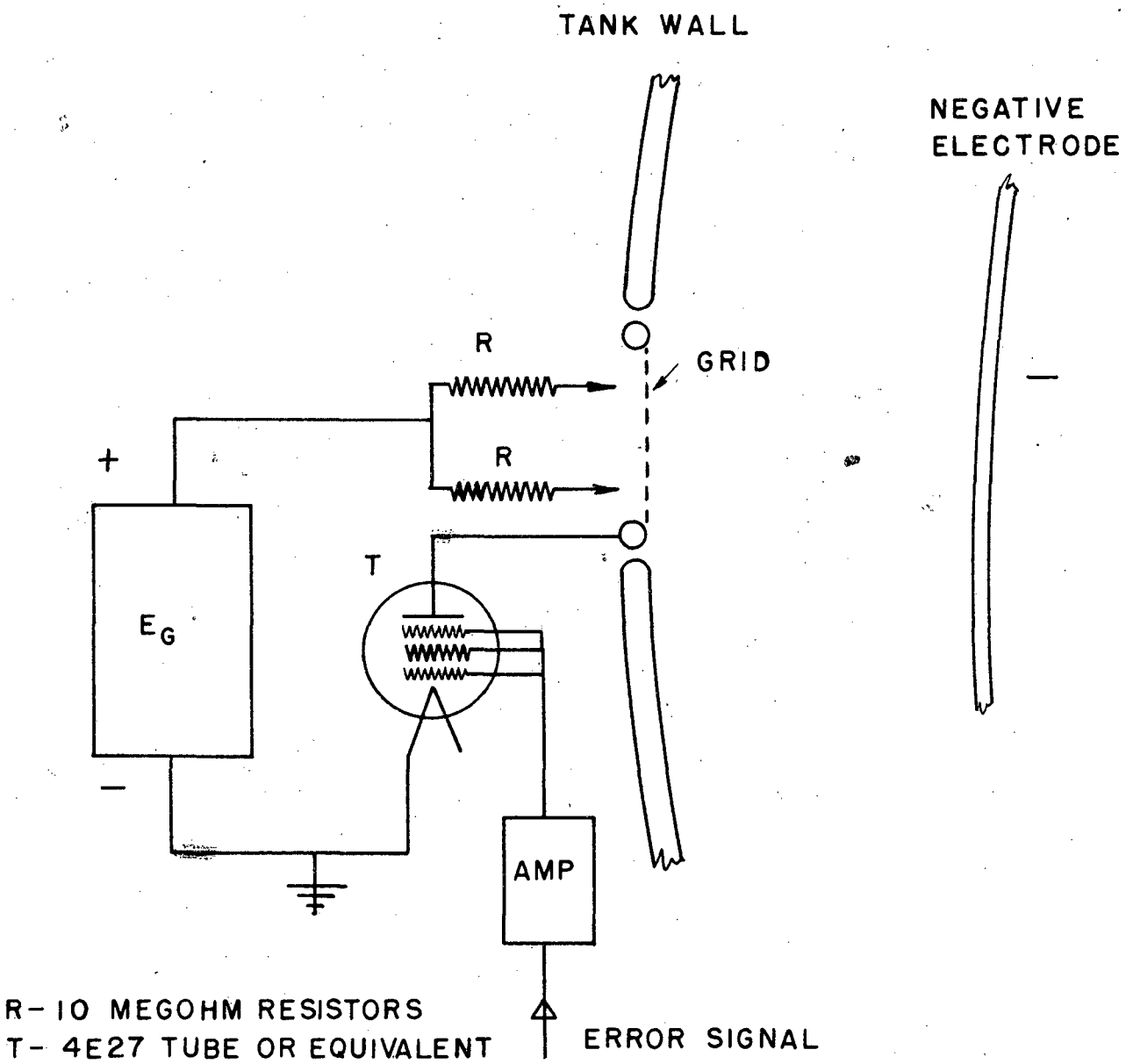

FIG. 5 CIRCUIT ARRANGEMENT USING CORONA TRIODE TO REGULATE VOLTAGE OF A NEGATIVE HIGH VOLTAGE TERMINAL.

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