I. PHYSICAL ELECTRONICS

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A. ELECTRON EMISSION PROBLEMS

1. A Redetermination of the Crystallographic Variation of Electron Field Emission from Tungsten

This work has been completed and will be presented in Technical Report No. 286.

A correction is necessary to the discussion of experimental results given in the Quarterly Progress Report of July 15, 1954. The discontinuity in slope at approximately 800°K noted in the preliminary emission vs. temperature measurements was found to be nonexistent when a more accurate temperature scale was used. The remainder of the discussion is still correct.

J. M. Houston

2. Growth of Single Crystals of Tantalum

Some rather large single crystals of tantalum have been grown by resistance heating and a moving temperature gradient. The moving temperature gradient is achieved by using mercury as the electrode, as shown in Fig. I-1. The tantalum ribbon is fastened to the upper electrode. The lower end of the ribbon is welded to a 5-cm length of 120-mil tungsten rod which is submerged in the mercury and serves to weight the ribbon sufficiently to overcome surface tension and maintain the ribbon vertical.

With the metal high-vacuum valve closed, enough air is admitted to the mercury reservoir through the stopcock to push mercury into the tube containing the ribbon. The metal valve is used as an adjustable slow leak to the forepump, which slowly exhausts the air from the mercury reservoir, thus lowering the level in the tube at the desired rate.

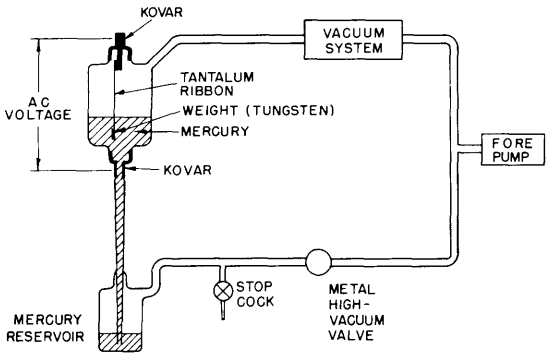

Fig. I-1
Tantalum crystal-growing setup.

The tantalum ribbon is 1 mil thick and 2-3 mm wide. We have obtained the largest crystals after a 3 per cent cold work, as first reported by Mrowca (1). We have cold-worked the tantalum by cold rolling rather than cold stretch. The percentage of cold roll is then measured by the elongation of the ribbon. With a

temperature of about 2400°K and a mercury lowering rate of approximately 8 mm/hr, at least one single crystal of approximately 1 cm in length is obtained on nearly every run of 6 to 8 hours.

W. J. Lange

References

1. B. A. Mrowca, J. Appl. Phys. 14, 684 (1943).

B. EXPERIMENTAL STUDIES

1. Ionization Gauge Control Circuit and Ionization Gauge

The ionization gauge control circuit has been constructed, modified, and used. The modifications include an additional negative feedback loop to reduce the input impedance, the time constant, and the zero drift (caused by line voltage variation). A diode limiter was also included to protect the electron current meter against accidental shorts. The circuit is still free from batteries. When the drawings and operating instructions have been completed, a more detailed description of the circuit will be given.

In order to test the operation of the control circuit, it was used to investigate the variation with geometry of the gauge sensitivity of the screened Bayard-Alpert type of ionization gauge. The sensitivity of the ion gauge is measured by: $K = 1/p\ (i_+/i_-)$, where i_+ and i_- are the ion and electron currents, and p is the pressure. The sensitivity, K, depends upon the nature of the gas, the electrode potentials, the electrode geometry, and is not supposed to depend upon electron current. The Bayard-Alpert ion gauge in our laboratory has two supposedly identical filaments: one used as the electron emitter, and the other as a flash filament and a spare. In operation, the flash filament is at electron collector potential, while the emitting filament is 100 volts negative with respect to the electron collector. Using the modified ion control circuit plus an appropriate switching circuit to quickly interchange the two hot filaments electrically, the relative values of the gauge constants for the two filaments were measured for various identical electron currents. Not only was a discrepancy found between the two gauge constants, where none was expected, but the discrepancy was a function of the electron current, and varied from approximately 20 per cent at 10 μa to 10 per cent at 10 ma for a sealed-off ion gauge. Incomplete measurements on another gauge indicate that the discrepancy can be as great as 40 per cent, and may cause a corresponding error in the pressure measurement. The discrepancy was reduced at high electron currents, probably because the higher space charge influenced the electron orbits more than the electrode geometry and made the difference in geometry less important.

The results indicate that the gauge constant K depends upon the electron current,

and that the ion current is therefore not exactly a linear function of electron current, as is commonly supposed. A method has been developed for measuring the dependence of ion current upon electron current in spite of the changes of pressure caused by changes of current to the electron collector.

S. Aisenberg

2. Infrared Radiation Pyrometer

Preliminary measurements taken with an optical bench model of the revised optical system described in the Quarterly Progress Report, July 15, 1954, indicate that the sensitivity and response are substantially the same as previously reported.

A pilot model of the complete revised optical system has been constructed; the prism has been procured, and when it is prepared this system will be aligned and further tests made.

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