Report No. A7644

FINAL SYSTEM TEST DATA

for

ANALYZER TUBE SERIAL 2C

NASA CR 71202

Contract Number NAS 5-3453
SDS Register Number 1-2655

Prepared by

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600 East Bonita Avenue
Pomona, California

For

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Goddard Space Flight Center
Greenbelt, Maryland

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SUMMARY

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Final system test results of the Analyzer Tube Serial 2C are contained in this report. The analyzer was tested for sensitivity, resolution and top to base, ratio, percent of transmission from source, electron beam width, center frequency of each mass, filament power versus time, current distribution versus voltage, and recording of the operating potentials. Several filament changes were made during the performance of the tests. The final filament was a tungsten-rhenium alloy wire.

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1. PRELIMINARY ADJUSTMENTS

The electron gun and ion source voltages were first adjusted for optimum operating conditions. This was performed after a stabilizing period of source and filament operation. The initial period was for 38 hours. During this period, the pressure was approximately 1×10^{-7} torr and the filament was cycled on and off a total of 50 times.

The electron gun and source voltages and currents were maintained as follows. At 58 turn-ons and ET of 41 hours, the system was vented in order to check the ion source for deposits and the filament for alignment. Both were determined to be proper and the system was put back on the vacuum system. At an elapsed time of 47 hours, it was decided to change the filament to uncoated rhenium wire. This was done in order to see if there was an effect, due to age, of uneven lanthanum coating. This was suspected, as the anode current had decreased to approximately 15 microamps and the rail current had gone up. The first filament lasted only two hours, at which time it fractured. This was the first time that a true 45° fracture of filament wire had been observed. The source was then returned to normal operation by the installation of the uncoated rhenium wire. Another filament was installed and a small slot milled through the filament shield so that the filament alignment could be checked optically after complete assembly. The system was subsequently found to operate normally and performance data taken.

This filament and another, each after approximately two hours of operation, fractured. The last filament installed was an uncoated tungsten-rhenium alloy 3 mil wire. Approximately three hours of operation were accumulated on this filament wire prior to shipment.

2. TESTING PROGRAM

The completed analyzer assembly, less the 150cc Varian Vacion pump and inlet leak assembly, was subjected to the following tests and measurements:

- Sensitivity
- Resolution and top to base ratio
- Percent transmission from source
- Electron Beam width
- Center frequencies of each mass (m/e 18, 28, 32, 40 and 44)
- Filament power versus time
- Current distribution versus voltage
- Recording of the operating potentials

All tests were performed with an anode current of 40-50 microamps and accelerator, repeller, and rail currents essentially zero.

The results of these tests are discussed in the following paragraphs.

2.1 SENSITIVITY

The sensitivity test was conducted using m/e 28 as the measuring standard. A scan was made for a series of pressures beginning with a background pressure of 8.9×10^{-8} torr.

A plot of this data is shown in Figure 2-1. Since the source was sensitive to pressure changes, the anode current was readjusted at each of the pressure settings to exactly 50 microamps.

2.2 RESOLUTION AND TOP-TO-BASE RATIO

A partial spectral scan was made following the introduction of an oxygen sample (see Figure 2-2). The measured top-to-base ratio from this scan is 0.395. The resolution based on the theoretical base width is one part in 20.

2.3 PERCENT TRANSMISSION FROM SOURCE

The current collected on the nozzle was compared to m/e 28 current at the collector end of the analyzer. Both measurements were made with Keithley electrometers. For an I_T of 100 microamps, the m/e 28 current was $.04 \times 10^{-10}$ amps, and the nozzle current was $.03 \times 10^{-10}$ amps. This represents approximately 50% transmission and is somewhat higher than measured on prior sources.

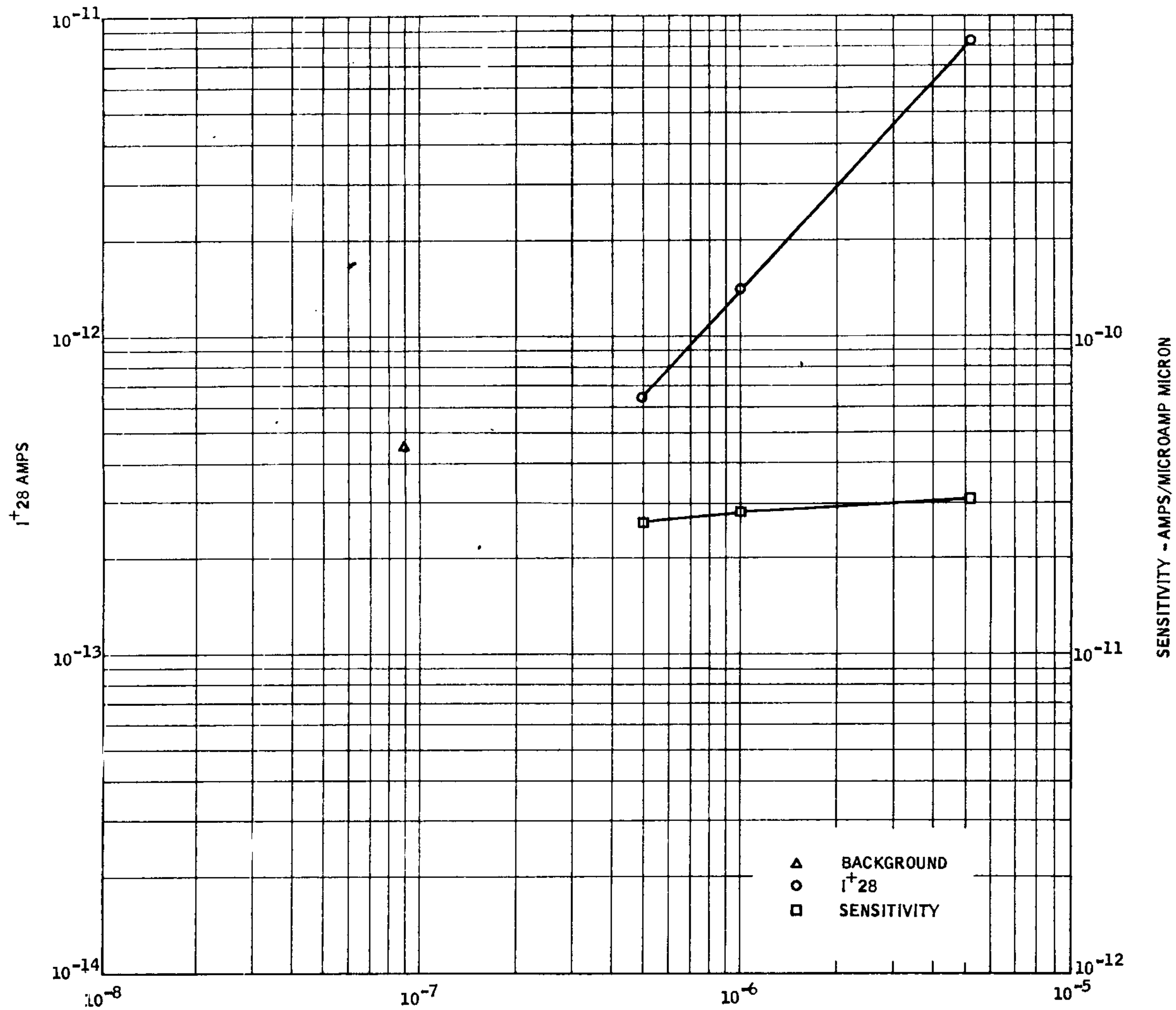

FIGURE 2-1
Check of Linearity vs Pressure

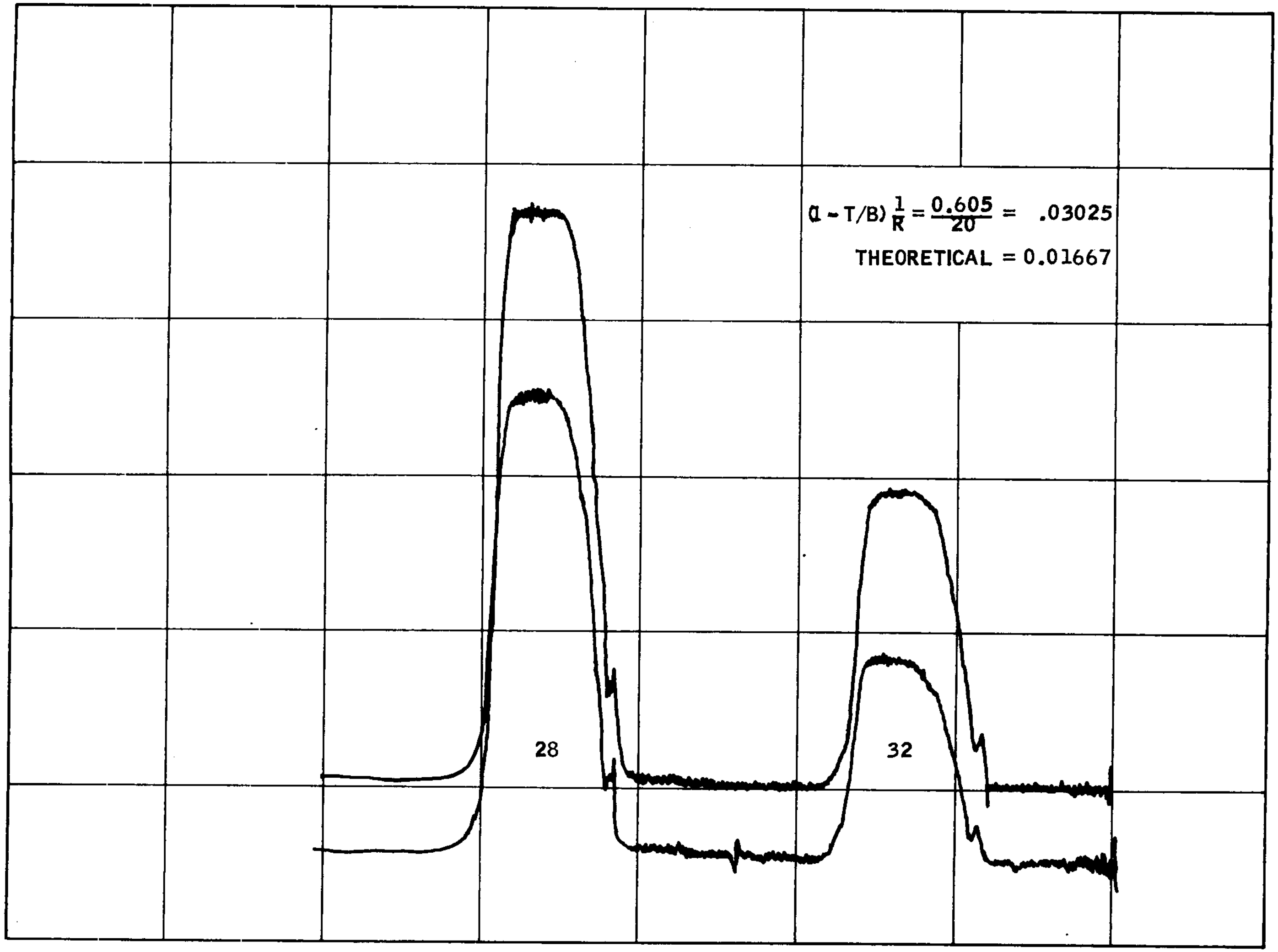

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FIGURE 2-2
Mass Spectrum Indication
Resolution and Peak Shape

2.4 ELECTRON BEAM WIDTH

The electron beam width was determined by adjusting the quadrupole bias voltage above the accelerator voltage to the point of mass peak cutoff. In this manner, the beam width was determined to be 19.0 volts.

Data showing the effect on system performance of varying quadrupole bias above accelerator potential is shown in Figure 2-3.

2.5 CENTER FREQUENCIES FOR EACH MASS

The system was adjusted for 50 microamps emission and appropriate gas samples introduced. The center frequency for each of the mass peaks was determined by measuring the frequency on either side of the peak top. The conditions of operation were:

$$V_{dc} = \pm 38 \text{ and } V_{ac} = 175 \text{ RMS}$$

The center frequencies were:

	Measured	Theoretical
m/e 18	Not measured	2.78 MH_z
m/e 28	2.236-2.211 = 2.223	2.23
m/e 32	2.082-2.051 = 2.066	2.04
m/e 40	Not measured	1.87
m/e 44	1.770-1.750 = 1.760	1.78

2.6 FILAMENT POWER

The filament power was recorded periodically but only as a function of the filament current required for 100 microamps total emission. This record began with 465 milliamps required for an ion source with nominal voltage settings. After the ion source and electron gun were tuned up and all voltage settings optimized, the filament current was reduced to 410 milliamps.

This filament current was obtained using a coated rhenium wire. Three uncoated rhenium wires were subsequently used. The filament current for these wires ranged from 780 to 800 milliamps. The instrument was shipped with a tungsten-rhenium filament (75% W - 25% Re) which required 890 milliamps filament current for 100 microamps total emission.

A plot of the results is shown in Figure 2-4.

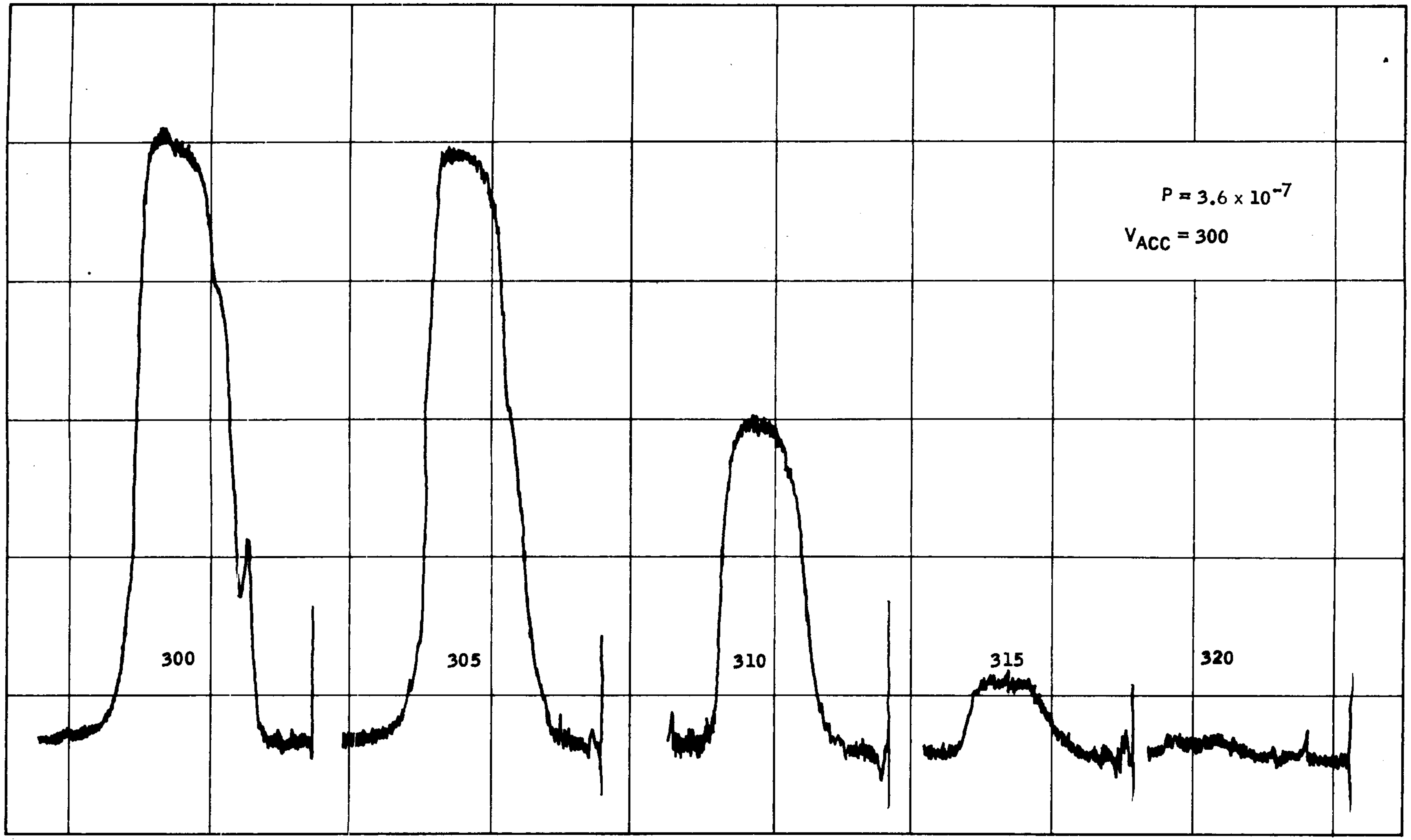

FIGURE 2-3
Ion Suppression Curve Using
the Quadrupole Bias Potential

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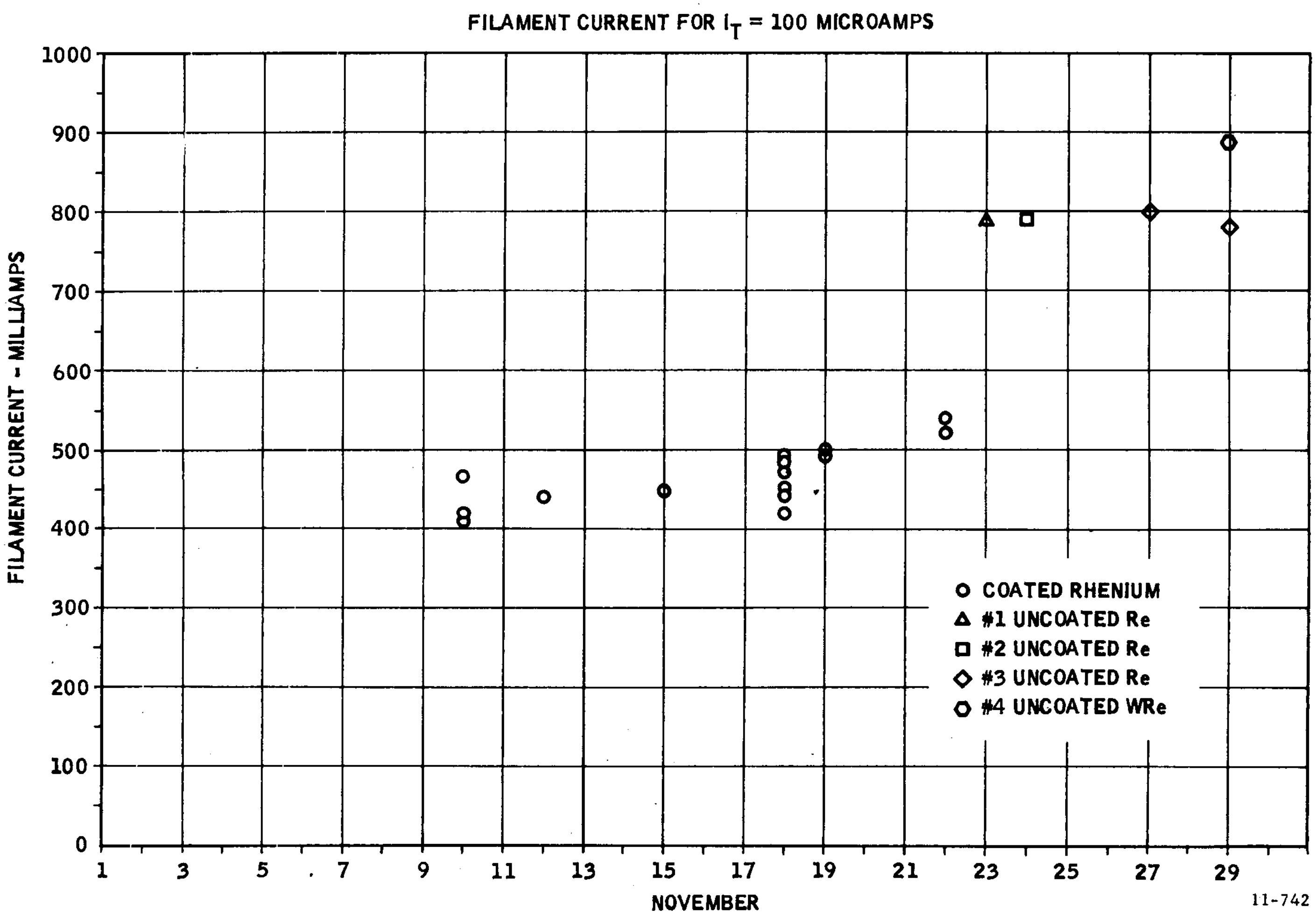

FIGURE 2-4
Variations in Filament
Emission Characteristics

2.7 CURRENT DISTRIBUTION VERSUS PRESSURE

The voltage potential of each electrode was varied to produce a ±10% change in I_{anode}. The results are noted in Table 2-1.

TABLE 2-1

	Voltage (Volts) Relative to Ground		
	Normal	+	-
Rail I	+308.2	317.1	300
Rail II	+312.4	316.8	300.3
Electron Focus I	+253.7	268.0	249.6
Electron Focus II	+264.4	267.4	250.4
Electron Accelerator - Accelerator	+306.4	310.1	302
Filament Shield	+193.6	196.8	189.8
Repeller	+334.5	335.3	333.3

2.8 OPERATING POTENTIALS

The potentials noted in the above table were recorded as normal for the instrument.

This filament current was obtained using a coated rhenium wire. Three uncoated rhenium wires were subsequently used. The filament current for these wires ranged from 780 to 800 milliamperes. The instrument was shipped with a tungsten-rhenium filament (75%W - 25% Re) which required 890 milliamperes filament current for 100 microamperes total emission.