

THERMIONIC GUN CATHODE-GRID ASSEMBLY TEST PROCEDURE

1. INTRODUCTION.

The thermionic gun at the injector in Sector 0 (CID) was developed for SLC in the early 1980s. It uses the Eimac Y-796 cathode-grid assembly. This assembly is received from Eimac sealed in a pinched off vacuum vessel. This vacuum is normally good for many years. The emission performance of each cathode-grid assembly should be tested within a few days of being received. If no or limited emission is shown when tested in the shipping vacuum vessel (Method 1), this performance failure could be caused by poor vacuum (which probably permanently poisons the cathode when the filament is heated), or the cathode-grid assembly itself could have been defective. In either case a non-performing assembly will be replaced by Eimac if within a short period after receiving.¹ Once tested, the assembly should be stored and not tested again, at least not tested again in the original vacuum vessel, in case the vacuum later gets too poor.²

An alternative testing method (Method 2) that can be done at anytime and as many times as wanted is to transfer the cathode-grid assembly to the SLAC-built vacuum vessel that has a holding pump with it. To achieve an adequate vacuum, this vessel must first be baked while pumping with a turbo pump. After baking, the holding (ion) pump is activated and the pressure read with it. An adequate pressure for testing is 10^{-8} Torr.

Testing for emission after the assembly is installed in a gun is similar to this alternative method. Be sure the gun is fully insulated from ground. At CID, the pulser and leads must be removed, also the grounding strap between gun and HV deck.

2. REQUIRED EQUIPMENT:

1. Tektronix *Curve Tracer* Model 577 with Tektronix Standard Test Fixture 177
2. Special SLAC-made electrical and air tube *Testing Connector*
3. Fan with flexible hose
4. Power supply, either:
 - a) DC power supply – at least 10V, 10A, non-grounded output, with built-in (ammeter and voltmeter for measuring output; or
 - (b) AC power supply consisting of:
 - 1) Metered General Radio Co. VARIAC Type W10MT3A Autotransformer
 - 2) Filament transformer P6461, 120V:10V
 - 3) Precision resistor 0.01Ω , 25W, 1%

¹ Eimac normally does the test described in the procedures outlined below before shipping.

² A poor vacuum environment does not hurt the cathode unless the filament is heated.

- 4) General purpose AC voltmeters (2 ea.)
5. Miscellaneous interconnecting wiring with male banana plug terminations
6. Selection of alligator test leads
7. Eimac Y-796 cathode grid assembly to be tested. The assembly is wired as follows:
 - a) Large center conductor is filament
 - b) Ring of fingers is cathode+filament (this is filament return)
 - c) Grid is connected to the structure

3. SETUP:

Connect *Testing Connector* to back of Y-796 assembly and set up fan to cool by inserting flexible plastic tube from fan into the *Testing Connector*

Plug in fan and verify that it works

If using DC power supply:

- Connect positive lead to filament (center).
- Connect negative lead to cathode/filament (ring).
- Set voltage knob to 0, current control knob to 8A.

If using AC power supply:

- Connect series resistor between transformer secondary and cathode/filament
- Connect other side of transformer secondary to filament
- Connect one DVM across transformer secondary to monitor filament voltage. Set scale to 10V AC
- Connect second DVM across series resistor to monitor filament current. Set scale to 100mV AD
- Connect transformer primary to Variac. Set Variac toggle switch to "LOW" range, knob to "0" (fully CCW)

Set up *Curve Tracer*:

- Connect emitter (E) to cathode/filament (ring)
- Connect collector (C) to grid (housing)
- Test connections (C,B,E) toggle switch should be left or right depending on which set of input test points are chosen above
- Set collector supply knob to 25V Max Peak Volts at 9W Max Peak Power
- Set collector (horizontal) scale to 2V/cm
- Set collector (vertical) scale to 50mA/cm
- Set Collector Supply Polarity to "AC"
- Set Variable Collector% knob to "0" (fully CCW)

4. REVIEW SETUP FOR ANY SAFETY CONCERNS

Using a DC power supply limited to 50 V or lower avoids the issue of electrical hazards.

5. TESTING:

Turn on Curve Tracer:

Allow a few minutes for the *Curve Tracer* to warm up. The *Curve Tracer* puts out an AC voltage between E and C, the collector voltage, which is applied to the horizontal sweep of the CRT. The current drawn by the collector is applied to the vertical sweep. When the CRT trace appears on the screen, adjust the beam to a focused horizontal trace across the screen (total of how many divisions?) approximately 1 division from the bottom of the screen. There should be no current drawn from the collector when the filament supply is off.

Turn on DC Power Supply (Method 1) or plug in Variac:

Slowly raise the voltage until reaching 4A.

Wait approximately 30 seconds and then adjust to current to 4.5A.

Wait another 30 seconds and adjust the current output to 5A.

Keep adjusting the current output to 5A every 30 seconds until to power supply output is a constant 5A at 5V (25 W).

WARNING: Do not operate the filament at 25 W for >5 minutes unless the vacuum vessel is being cooled by the fan.

Observation:

Once the filament power reaches 25 W, there should be emission from the cathode. The emission should be proportional to the voltage applied between the grid and cathode with the Variable Collector% knob, but only during the positive part of the AC cycle. Turn the % knob CW until the emission current, I_g , displayed on the CRT begins to increase. The collector voltage, V_g , will decrease as more current is drawn. Final values of $I_{g,max} = 7$ divisions (350 mA) and $V_{g,min} = 2.5$ divisions (5 V) are typical for a good cathode-grid assembly.

WARNING: Do not keep the emission current on longer than necessary. Do not exceed power to grid of more than ~1 W.

Recording:

Record date and serial no. of the cathode-grid assembly, and scales being used (V/div, mA/div). Enter the time, pressure (if Method 2) and observed values of filament voltage, V_{Fil} , and current, I_{Fil} , as the filament power is increased. When measuring emission, also record $I_{g,max}$ and $V_{g,min}$. Always record raw data, e.g., number of divisions on CRT display. If possible, obtain a photograph of the CRT trace and paste it in the logbook. Add any other relevant comments.

6. FINISH

Once the measurement is completed, slowly reduce the filament power supply to zero volts and turn off (or slowly turn Variac to zero (fully CCW) and unplug).

7. EXAMPLE

10/31/2007 Checkout Backup Cathode-Grid Assembly S/N GVH056J at B006

a. Setup:

Filament: 5 VDC x 5 ADC

Horiz scale: 2 V/div

Vert scale: 50 mA/div

Max Pk Voltage: 25V

Max Pk Power: 9W

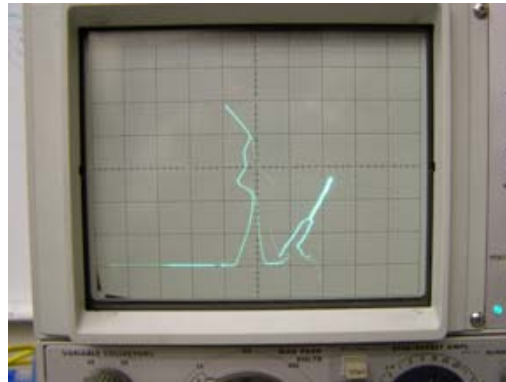
Variable Collector%: ~38

Data: 1.5 div \rightarrow 3V

2.5 div \rightarrow 125mA

Conclusion: $3V/0.125A=24\Omega$

$P_{g,avg} = 0.09W$



b. As in “a” except Max Pk Power: 100W

Data: 3 div \rightarrow 6V

7 div \rightarrow 350 mA

Conclusion: $6V/0.35A = 17\Omega$

Avg $P_{grid} = 0.5W$



c. As in “a” except Variable Collector% increased

Data: 3 div \rightarrow 6V

7 div \rightarrow 350 mA

Conclusion: $6V/0.35A = 17\Omega$

$P_{g,avg} = 0.5W$



APPENDIX A. TEST VOLTAGE STAND-OFF INTEGRITY

This procedure will test the voltage stand-off integrity of the cathode-grid assembly and also of the connections at the *Testing Connector*. The procedure can be with filament power on or off.

1. Set Collector Supply Polarity to “-“
2. Set Horizontal scale to 50V/div
3. Set Max Peak Volts to 400V
4. Turn Variable Collector% knob CW until CRT horizontal sweep shows 300V
 - a. There should be no vertical deflection, i.e., no conduction indicated
 - b. Take photo for logbook
5. Turn % knob back to “0” (fully CCW) and turn off *Curve Tracer*

APPENDIX B. CALIBRATION OF CURRENT SCALE

The vertical scale of the *Curve Tracer* can be checked by putting a 50Ω, 1W resistor between C and E. The slope should be 1/50→20 mA/V.

10/30/2007 Calibration of Tektronix Curve Tracer Model 577

Setup:

Horiz scale: 2 V/div

Vert scale: 50 mA/div

50Ω resistor between C and E

Increased Max Pk Power to 100 W

Data: 5 div → 10V

4 div → 200mA

Conclusion: 10V/0.2A = 50 Ω

$P_{g,avg} = 0.5W$



APPENDIX C. CALCULATION:

Average power dissipated in grid, $P_{g,avg} = I_{g,max}/2 \times V_{g,min}/2$

For a good emission, expect $P_{g,avg} = 350/2 \text{ mA} \times 5/2 \text{ V} \sim 0.5 \text{ W}$

APPENDIX D. ACTIVATION SCHEDULE Y-796

See the EIMAC Activation Schedule for Y-796 (undated) at

<http://www.slac.stanford.edu/grp/ad/source-grp/Procedures/EIMAC.pdf>.

FIG.1 CATHODE EMISSION TEST SET-UP

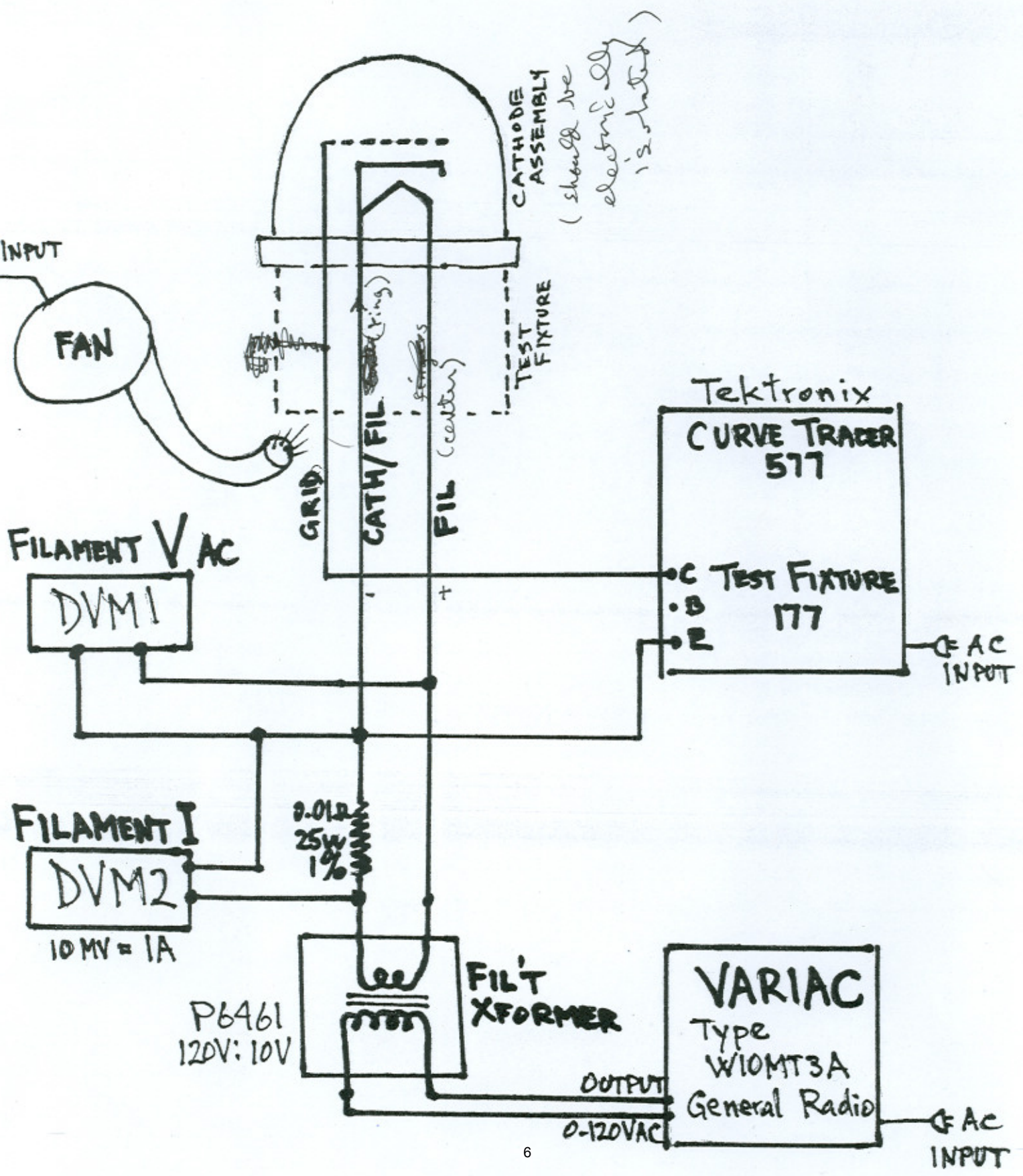
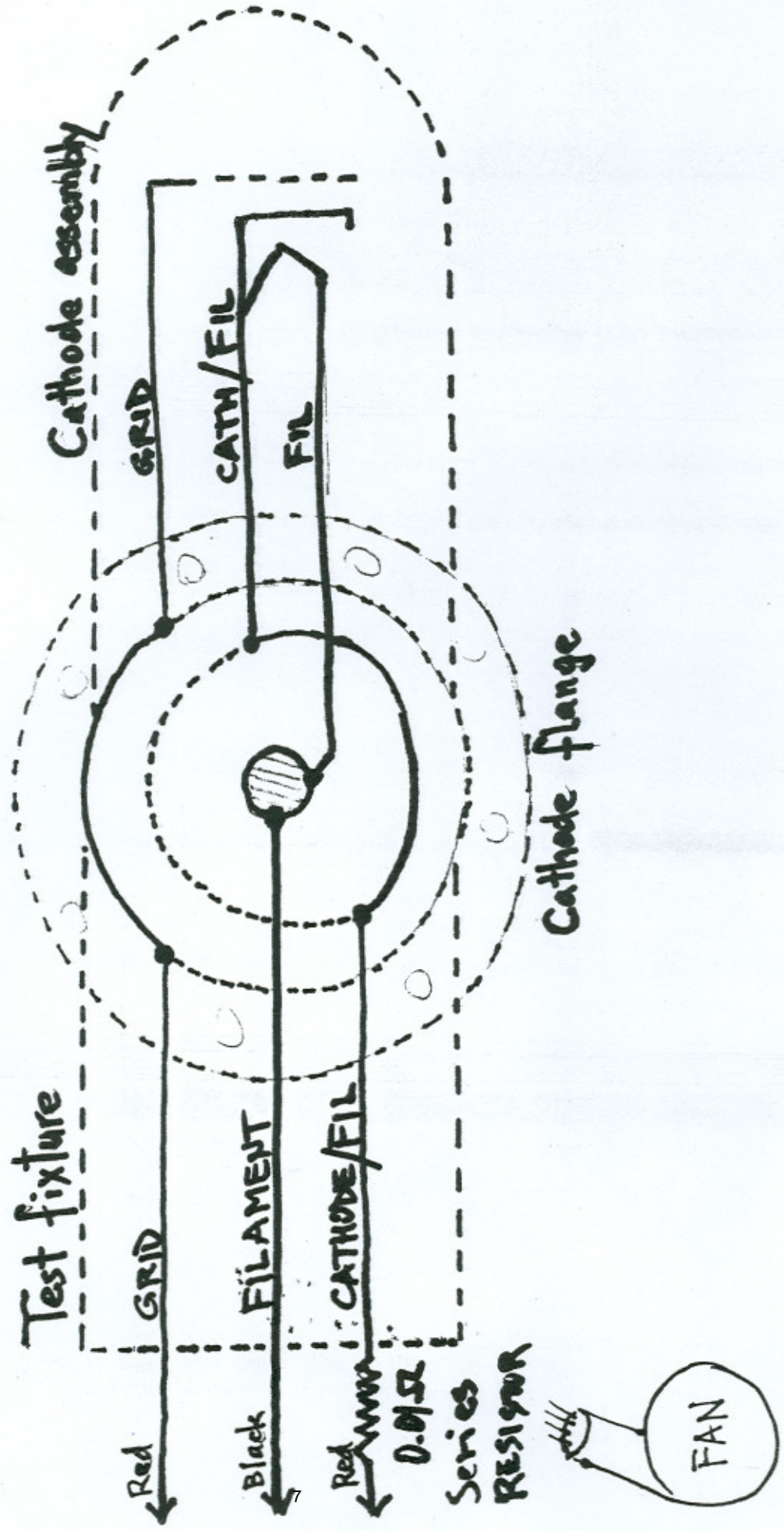


FIG. 2 TEST FIXTURE
connected to CATHODE ASSEMBLY



Need photos/sketches:

1. Photo of front (used) and back of cathode-grid assembly with filament, cathode, and grid identified
2. Photo of testing connector
3. Sketch showing internal connections of cathode-grid assembly (like Sodja Fig. 2)
4. Photos of Curve Tracer with proper settings
5. Sketch of wiring schematic with DC PS and with Variac (like Sodja Fig. 1)
6. Photo of CRT screen with Voltage Stand-Off trace