Subject: Trip Report
Visit to Research Lab
11/28/62

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A discussion of experimental procedures and results was held with Dr. H. Glascock relating to thorium dispenser cathodes.

A number of questions had been raised at a meeting on 11/21/62 in PP Coppola's office. The following information is an attempt to answer these questions with the data available.

(A) Diode Tests

1. What processing procedure is used?

An oven bake of 400-450°C is used. After which the ionization gauge is outgassed. The hot titanium wire getter is run to obtain a vacuum in the low 10^{-7} torr region. When the pressure reaches this level the cathode is then warmed up.

2. Are getters used?

No flash type getters are used. Hot titanium wire is used before seal-off as mentioned above. It is sometimes used after tip-off if a leak develops.

3. Are pressure gauges used?

A Bayard-Alpert type ion gauge is used at lma. It is run continuously and is shut off only when a measurement is to be made of cathode current.

4. Are pumps attached?

No Pd pumps or vac ion pumps are attached. The only pump used is the ionization gauge mentioned above. The Ti getter is available but used only if a leak develops.

5. Results

Diode results on 38 1/2 pound ($\sim$90% density) and 28 1/2 pound ($\sim$80% density) cathodes showed close agreement of around 10 A/cm^2 at 1400°C Br, E anode $<$600 volts and pressure $<10^{-6}$ torr. The ?

pound (~ 65% density) cathodes have not been tested in the high vacuum diodes. V. Stout and H. Glascock both stated that they did not consider it necessarily pertinent that these be tested in good vacua as the emission may actually be worse than in poor vacua, because of the emission characteristic of bulk Thorium.

(B) Gun Tests

1. What gun is used?

Two or three type guns have been used for testing by Glascock. He has used the ceramic gun (Mark IV) and a glassed gun - W. Glenn's type.

2. What processing schedule is used?

The entire system (tube and accessories) minus the oil bottle are processed and receives a 400-450°C oven bake. The system is let down to helium, oil bottle attached and re-evacuated. During this re-evacuation no general bake is given, heater tapes are used locally.

3. Can a comparison be made of emission before and after introduction of oil?

The answer to this question is quite difficult. Glascock did not really try to measure the maximum beam current before oil was introduced because the anode was not suitable (his new tube has a molybdenum anode so that this measurement may be made). Also, most of his gun tests were of such a nature that he was attempting to get 3μA oil current at 10kv so that various conditions of temperature and bias were used making direct comparisons difficult, if not impossible.

Glascock does not use the technique of applying positive voltage to the grid as an indication of cathode activity so that no information is available using this method to compare before and after introduction of oil. He agreed that it would give a number for initial comparison of cathode activity but after the cathode had been run, this number would be meaningless due to emission coming from all over (tip, body, legs).

4. What results are obtained from gun tests?

The following is a brief summary of the gun tests using the two pound cathodes.

a) #286 - no oil, evaporated Cr all over, went to Ta snout.

b) #287 - before oil 1360°C Br Eg_1 = -10v I snout = 720μA I beam = 13μ
after oil " " Eg_1 = -75v I " = 250μA I " = 3μA
Maximum beam current after introducing oil was not measured. After 1/2 hour of operation bombarding oil a crack developed in glass by gun ending test.

c) #278 - A superficial test before introducing oil was made to show that a 3μA beam was possible. After introducing oil cathode was run for 9 hours with greater than 3μA at 10kv. Test ended due to poor heater leg connection. An X-ray pattern of tip of cathode showed the presence of Ta_2C on the surface but no Th was detected.

d) #279 - no oil, crack developed in tube.

5. Have the two pound cathodes been tested?

These cathodes have not been tested in the high vacuum diodes but have been run in gun tests (see above). As stated above, V. Stout and H. Glascock do not feel that the high vacuum test of these cathodes is pertinent. They do not think it necessary to evaluate the batches of these cathodes.

6. What data is available on I_k vs Pressure?

H. Glascock has not made a controlled test to determine the effect of pressure on cathode current. As stated previously he has been attempting to bombard the oil with a 3μA beam at 10kv and has varied bias voltage and temp to obtain this condition. On trying to plot some curves of I_k vs Pressure (using beam current) no definite conclusions could be drawn.

He states that generally speaking, for the more dense cathodes (28 1/2# and 38 1/2#) he found that he could not maintain 1-3μA current at pressures over 2-3 x 10^{-5} torr. He is not sure that this same statement applies to the two pound cathodes.

Plans for Immediate Future:

1) Continue to work on W-Th cathode. First oil test unsuccessful. Thinks that when brazing pre-fired porous W plug in place the WC flux filled the pores inhibiting emission. Will try using Th flux to braze at lower temperature.
2) Plans to make up a cathode with Ta tube and plug but with W and Th powder as fill in place of Th wire. He has hopes that the W will inhibit the attack of the Ta wall by the Th.
3) Will try to make a Th-W plug (~30% Th) and press this plug in place in W tube to see if it will be porous, to check its shrinkage, and check its emissive behavior.

Additional discussion dealt with the question of method of testing. To date all gun tests have been made under so called "standard" conditions, i.e., 3μA oil current at 10kv. The lab tests (Research Lab and CRT - excluding projectors) have been run to attain these conditions which usually means close to zero bias on the grid as opposed to the minus 200 or 300 volts applied in the projectors. A more definitive set of experimental conditions are required - e.g., what type gun should be used; what physical dimensions ($K\text{-}g_1$ spacing, aperture, distance of aperture to oil, etc.); what operating conditions should be set up for test (specify bias voltage and expected cathode current, etc.). Definite measurements must be made under established standard conditions so that comparisons can be made: before and after oil introduction, results between labs and also between lab tests and projector operations.

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