GENERAL ELECTRIC
ELECTRONICS DIVISION

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

SUBJECT
• Trip Report

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November 13, 1958

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C. R. TUBE ENGINEERING - 2

Place Visited: General Electric Receiving Tube Plant
Owensboro, Kentucky

Dates: October 8-10, 1958

Purpose: Since mica construction will shorten the gun and its' use is being pressed by our competitors, we have a real interest in using this construction in cathode ray tube mounts. The Receiving Tube Dep't., because of their long experience with mica in receiving tubes, is able to provide us with information about the properties, processing and design of mica, heaters, cathodes and getters.

Persons Contacted:

R. E. Moe	Mgr., Engr.
W. Millis	Consultant
C. Hopper	Mgr., Special Prod. Des. Sect.
J. Tucker	Engr., Special Prod. Des. Sect.
C. C. Power	Supt., Process Control
J. C. Hickel	Supt., Phy. and Chem. Lab.
F. R. McNees	Engr., Dev. Engr.

Introduction:

On the morning of arrival we met Walt Millis, Engineering Consultant, who was our main contact. We discussed the mica gun structure designed by L. Swedlund, the 9QP4 gun and our present modified mica gun design. Included were discussions of the related components, heater, cathode, etc. After lunch, Claude Hopper, Manager of Special Product Design Engineering, and J. Tucker, Design Engineer of that section, joined the discussion. Later on that day we talked with C. C. Powers about heater and cathode processing.

The second day we talked about natural, synthetic and reconstituted micas with J. C. Hickel, Supervisor of the Physics and Chemistry Laboratory and Ray McNees, Engineer in the Lab. The remainder of our visit was spent

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in a series of tours thru the 5 star line, the ceramic tube section and the engineering design and development laboratories.

The information that follows is grouped under three main topics - micas, heaters and cathodes plus some miscellaneous topics. The subject of mica will be summarized next under the groupings of design, processing and properties.

Mica

<u>Design</u>
The best design is obtained by referencing the critical spacings and aperture alignments to the mica since punching of mica parts is done within an accuracy of 1/4 mil. A recess concentric with the Grid #1 aperture can be used to change Grid #1 to cathode spacing in a given design, however, the recess depth cannot be accurately controlled within the required 1/2 mil tolerance, and was therefore not recommended.

Both the triangular holes (Philco design) and the pressure fit type (9QP4) are standard mechanisms for holding alignment in the micas, see Fig. 1. The type employing a pressure fit requires a much tighter tolerance in both mica and the metal part.

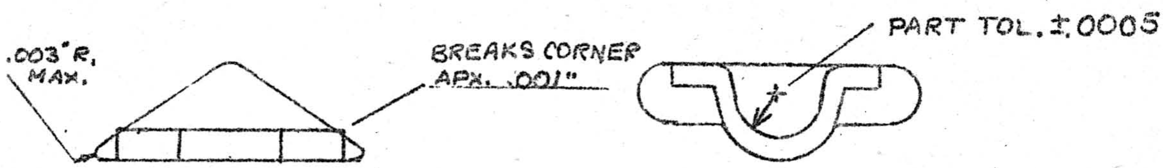
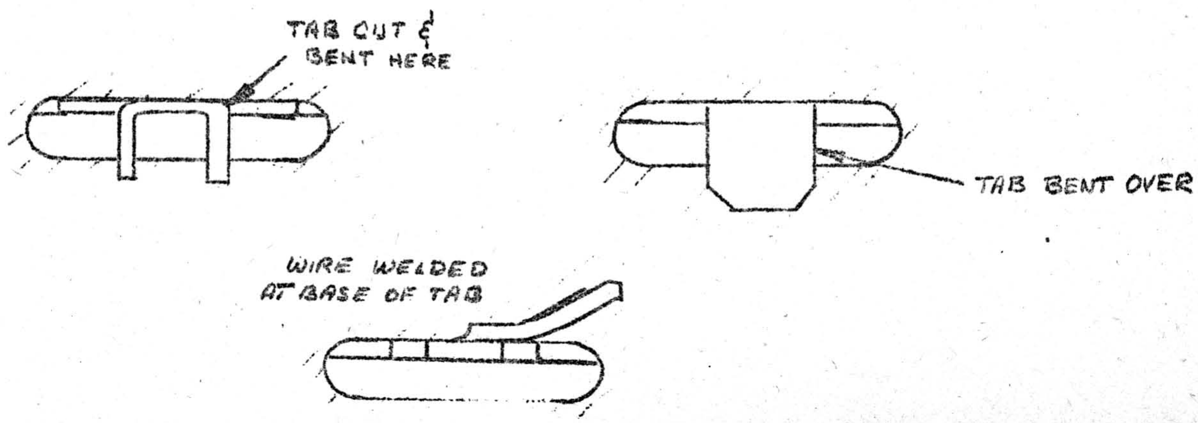


FIG. 1.

The minimum spacing between holes or to the edge of the mica is 15 mils. The maximum radius at the corners of the triangular holes is 3 mils.

There are three standard methods of locking the parts in the micas as shown below:



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The recommended mica thickness is between 6 and 9 mils. Thick micas are more expensive, more susceptible to delaminating and they cause more die maintenance. Thin micas do not have the required mechanical strength.

Leakage slots in the mica were recommended in preference to coating with magnesium oxide since the coating has a high affinity for water which may not be completely baked out during exhaust.

Shadowgraph templates for inspecting micas can be purchased from Sneider Marquart, manufacturer of mica dies. The cost is approximately $6.00 per hole.

An additional source of mica is Copeland Jenkins in London, England. When necessary, they can deliver micas in 10 days and at 1/2 to 1/3 less tool costs of local vendors.

Processing

The production cleaning schedule for natural mica is as follows:

1. Degrease with trichlorethylene.
2. Bake 4 hours at 500°C.
3. Coat.

It is felt that trichlorethylene may become entrapped in the laminations and that its elimination is advisable. The development laboratory recommends the following schedule:

1. Bake 1 hour at 500°C.
2. Coat.
3. Rebake 1/2 hour at 500°C.

Properties

All micas give off water of crystallization at elevated temperatures. Data from the Bell Laboratories show that muscovite begins to dissociate its water molecules at 400°C and a peak of 8800 micron liters/m^2 is reached at 800°C.

Phologipite is somewhat more stable than muscovite and has been used in receiving tubes. Experiment has shown that the total condensable gas evolved during heating is 2.7 units for phologipite as compared to 3.9 units for muscovite.

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Reconstituted mica promises to be more stable than natural and has higher insulation resistance. Samples of reconstituted mica were obtained from F. R. McNees. Also his report on reconstituted mica have been received.

Synthetic micas are not yet available. The crystal formations obtained are not, at the present state of development, large enough to be used in tubes.

Heaters

The people contacted who work with heaters were strongly in favor of the folded heater as opposed to the hairpin coil heater. Reasons given for favoring the folded heater were as follows:

1. More even temperature along the cathode.
2. Slightly lower cathode temperature.
3. Higher heater-cathode break-down potential.

The main problem encountered with heaters appears to be heater-cathode leakage. Methods which can be used to reduce heater-cathode leakage are as follows:

1. Early lighting of heater on exhaust (before RF).
2. Add 1% silica to heater coating (used by English).
3. Sprayed heater rather than cataphoritically coated heaters.

In designing a heater it is a general rule of thumb to use 1 watt of heater power for each 15 ma of peak cathode current needed. Also the maximum heater temperature should not exceed 1400C. This temperature is measured by the change in the resistance of the heater.

Their development lab. will furnish us with folded heaters of any desired specification if we contact J. Tucker.

Cathodes

Lock seam cathodes are being used wherever the cathode size permits. A lap seam is used on the smaller type cathodes. The lockseam cathode has the following advantages over the drawn cathode:

1. 1/3 to 1/5 the cost.
2. Has more mechanical strength.
3. Can be made with an intergial tab.

The average cathode loading for receiving tubes is 60-70 ma/^{2}cm. with a peak loading of 90 ma/^{2}cm. To insure excellent reliability, the 5 star line of tubes is designed for 30 ma/^{2}cm. At 1000 ua beam current and a .025 diameter grid 1 assuming a cosine square distribution, our C.R.T. tubes have approximately 500 ma/^{2}cm. loading.

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The recommended cathode temperature for receiving tubes is 750-800°C. Higher cathode temperatures cause rapid failure during life.

To prevent breaking of the cathode tab during life, a 42% nickel iron alloy is recommended in preference to a pure nickel tab.

Life Problem on 6AF4

Until recently the 6AF4 which uses the same heater and cathode as the 9QP4, had been failing on life test. By changing the heater and the cathode tab design Receiving Tube Product Engineering has increased the tube life from 500 hours up to 5000 hours. The improved life is due to:

1. Lowering of cathode temperature by changing from a hairpin coil heater to a folded heater and allowing the ends of the heater to protrude from the end of the cathode.
2. More even temperature along the cathode due to a smaller cathode tab and the folded heater.

To obtain closer control of the cathode nickel, the specification was changed from Inco 330 to Inco 220.

Reducing Atmosphere at Gun Seal

To prevent oxidation of the mount and cathode during gun seal, the mount and bulb is flushed with reducing gas. The reducing atmosphere is produced by bubbling nitrogen thru methanol.

Getters

The SAES Getters are used almost exclusively in the Owensboro Tube Plant. The SAES Getters appear to be satisfactory, but very little actual data was available.

A paste and a non-flash bulk getter are used on certain high voltage tubes. Mr. E. D. McCool, who has most of the information on getters, was away the two days of our visit so little information on the non-flash type of getter was obtained.

There is more specific information and experimental data available. The authors invite the inquiries of those interested in further information.

Elliott M. Krackhardt
Chester A. Perkins

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