# CATHODE RAY TUBE MICROFON SURVEY

August 12, 1957

## I. Ediswan Factory Visit:

The Cosmos factory had been in operation one day after a three day holiday. This plant is the smaller of two, the larger being at Sunderland with an alleged capacity of 10,000 tubes (television) per week. Mr. Hershberger a new manager at Sunderland visited with the group. The following is a more or less random commentary on what looked like important points.

### A. Bulb Making:

Ediswan seals funnels to faces using a corruption of the Corning process. Three phase 50~ power is used. Only the power conducting fires oscillate with the bulb contour. The heat up fires are stationary. The result is a little sloppy. Pressed funnels are used, so the necks are Chinese hatted on a multi-head vertical sealer. All bulbs are Lehr annealed.

### B. Bulb Wash;

Standard gear. One machine is used only for rework. The factory manager Bill Jones was vehement against strong acid solutions. No one seemed to know what concentration and volume was being used at the moment.

### C. Screening: (All Tilt Table.)

Their tables are simply dumped over against the action of a hydraulic dash pot. They buy Joseph Crossfield Grade 53 and run daily lot acceptance tests on silicate. Apparently they have trouble with Pot. Silicate because this piece of conservatism is not common to handling of barium acetate or phosphor.

It is the practice to roll 5% dry (by wt.) Calcium Borate with the phosphor before measuring the powder for dispensing. This is supposed to help wet adhesion. Machine lines appear when they eliminate this.

A typical formulation for a 12" bulb:

765 ml Barium Acetate
6500cc Cushion
620cc 1.1 Kasil 22
6 gram (Phosphor + Calcium Metaborate)

The dispensing is done through a standard funnel with a uniform array of holes in the tip. Powder is weighed out for each tube and laboriously folded up in little papers. The scale is a home made self-balancing balance. Phosphor is introduced to one side of the teeter-totter, when it overbalances, a trip throws a micro-switch which dispenses the load to the operator's paper.

Screens are inspected from inside with incandescent lamp lonly. Vac check and V.V. stations exist but are not used for anything except engineering evaluation.

D. Filming (Three Operations)

1. The screens are loaded on a simple rotating head and are wet with water from a gentle hose up-tap.

2. An 8% solution of normal grate Merthaculate laquer is dispersed up through a piece of 1/16" I.D. tubing on a slowly rotating head. An awful excess of laquer is used. The amount is said to be non-critical. The bulbs are removed and piled on a rack to dry.

3. Before complete drying, the bulbs are placed on a third rotating head where a water wash is used to remove excess laquer from the funnel. Drying is then completed over air rods.

E. Aluminizing:

Stationary buggies and carousels similar to ours are used. Silicone oil is used and is a matter of like controversey. Engineering uses observation of interference patterns when evaporating aluminum in a non-screened bulb to set the Al. weight and calibrate a grid dip oscillator. The operator then uses the oscillator to cut off the evaporation when the aluminum thickness reaches the equivalence of 700 $A^{o}$.

F. Inside paint was done before aluminizing. The job was done in a messy manner, using too much dag and requiring an excess of wiping afterward.

G. Gun Seal:

Single head sealers. Rotating fires. Nitrogen flush is used to reduce oxidation of G1 and cathode.

H. Guns are made in Sunderland to our exact current $1\frac{1}{2}$" neck standards. They are not yet struggling with $110^{o}$ or small necks.

I. Exhaust: *

Manually operated port valves on the fine vac. Tip-off is by hand. Parts are water cooled and protrude reasonably far up into oven trough.

J. I have reported earlier on aging.

K. Spark - Mostly A.C. (Tester Coil) D.C. is available to 30 KV but is not used.

L. Test:

Three positions are used to pre-load and preheat the tubes. The heads are mounted on a rotary table which cycles the tubes into the set for the operator. The screens are of very good quality by our standards. No signs of yellow centers or edges. A dot pattern is being installed in the equipment to try to control electrostatic focus tubes. A scheme for test and limits have not been set. No formal quality test is in force.

M. General - This plant is being used as an engineering pilot for Sunderland.

* Exhaust Insert:

Thermocouple cement for oven curves - Sauereisen
Type pumps - Metro-Vickers

Life Test Conditions:

| | |
|---|---|
| Heater Voltage: | 12.3 (Normal voltage for them) |
| Anode Voltage: | 16KV |
| Anode Current: | 50ua (300 for certain Engineering tests) |
| Anode Resistance: | ? |
| G2 Voltage: | 450 |

Tubes have heaters only cycled on and off at night. 55 minutes on, 10 minutes off.

Further EMI Information:

I. VCR x 360:

This tube presents a problem. I have it in my possession and am having trouble getting it about. It's about 40" long when packed! We spent the better part of a day setting the tube up and operating it. I have very complete typed notes on the procedure and will discuss only additional information.

This is a recent model and incorporates one extra mesh on the reading side which operates very nearly at reading wall electrode potential. Its purpose is to help colimate the reading beam and reduce shading. It also reduces writing beam breakthrough to a degree. The actual potentials set up on the tube follow:

| I. Reading Gun: | | II. Writing Gun: | |
|---|---|---|---|
| Vk | 0Volts | Vk | 3.0Kv |
| Vl | 500 | Vh | 3.5V |
| Vw | 230 | Ih | .75V |
| Vh | 4.0) | | |
| Ih | .85) (dc) | | |

| III. Misc. Potentials: | | |
|---|---|---|
| Vmi | +10 | (w/respect to Vw) |
| Vd | -130 | |
| Vms | 0 | |
| Vme | +300 | (store condition) |
| Vme | -150 | (erase condition) |
| Vmv | 300 | |

The critical voltages are Vms and Vu which are set up with a calibrated oscilloscope. The largest problems for us is the fact that the reading gun uses the large CPS EMITRON components. We can probably salvage some from Abrams Chromocoder project. Chafaris should really be overjoyed with this as he has tried for almost a year to weedle a working model of this tube. In any event, they have also furnished drawings of the yokes and necessary components.

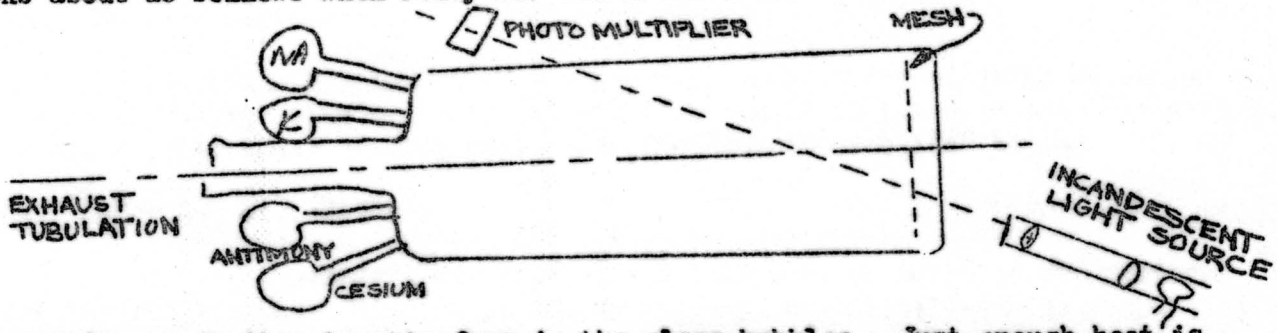
II. Photo Emission Screens (Photocathode)

If one remembers that the photocathode of the RCA image orthicon is Silver & Bismuth with Cesium the following comments will make more sense.

For camera work EMI is quite opposed to the I.O. for several reasons:

1. The target burns in
2. The gamma is poor (poor grey scale)
3. Charging under the collector mesh limits resolution. RCA (and others) have civilized the EMITRON for
    a. Poorer gain (10:1)
    b. Shading (a result of poor collecting of electrons from the photocathode)

A new photocathode jointly worked on by EMI & RCA has been developed. Summer stated the work at EMI, later left to join RCA. Details of the techniques are published in the Journal of Scientific Instruments. The presence of Sodium in the formula prevents RCA from using it in the I.O. It has a better response and greater yield of 2-3:1, better than Silver Bismuth. This brings the sensitivity of the IMI tube to 5:1 of the RCA. The process is miserable. Remember that EMI pre-exhausts at high temperature all camera tubes then cut them open to mount the meshes and photosurfaces. They then exhaust and bake at low temperature. The tube looks about as follows when ready for final exhaust.




The metals are in the chromate form in the glass bubbles. Just enough heat is applied to the bubble to evaporate a bit of the pure metal up the little constriction. A tungsten filament outside the constriction then finally evaporates the material. After the initial activation of the bubbles, the following sequence is followed:

1. Evaporate antimony until the exterior incandescent lamp gives a light extrusion to the photomultiplier of about 50%
2. The screen is raised to 180° C (inside)
3. With the tube now operating as a phototube, sublime in enough Potassium to bring the sensitivity to .5u amp Lumen
4. Raise temperature to 200°C
5. Sublime in Sodium for maximum sensitivity (two much will cause the sensitivity to drop off)
6. Cool to 150°C
7. Flash in Cesium
8. Increase temperature and bake to maximum sensitivity (once again too much will cause sensitivity to drop)

The result is a truly lovely phtocathode.

They demonstrated the tube next to the I.O. and the grey scale rendition is lovely by comparison. Even when attenuation was added to simulate home receiver operation the difference was striking.

The early shading problems have been eliminated by the addition of a 1000/inch mesh 1mm from the photocathode.

EMI also makes phto tubes & multipliers by exactly similar processes with the following esponses. (I have more literature)

1. 3000-6200 $A^0$ SbCs (50ua/Lumen)
2. Same as above with much improved response below3000
   SbCs in Quartz (50ua/Lumen)
3. 3200-5700 Sb-Cs(s) (25ua/Lumen)
4. 3400-6500 Bi Ag Cs (30ua/Lumen)

III. Storage Surfaces:

Time was spent in making several evaporations of CaF12 on silver meshes. One sample I have with me. When attempts were made to increase the thickness over .5 micron, the usual crazing resulted. The experience helped no end.

IV. Infra Red Pick Up Devices:

Dr. Lubszynski has started a little work on improved red response for the EMI vidicon. When about 20% by wt. antimony triselinide is evaporated with the usual antimony trisulfide, about 25% of the resulting response is above 7000 $A^0$. The only testing they have done so far is through a Wratter 87 filter. The resulting dark current is about .035uamp. Some earlier work using Silver Oxide & Cesium in the EMITRON was poor.

V. Photo Conductors - Cds has been tried with little succdess in vidicon. Long lag - dark current - charge redistribution due to internal scattering were all objections. This led to the selenide work described under IV above.

VI. Glass:

A very interesting quartz to pyrex seal is being used on some phto tubes:

| Quartz | | | Pyrex | |
|---|---|---|---|---|
| GEC | WQ31 | | Plouder & Thompson | Dial 36 |
| GEC | WQ34 | also | " " | " 43 |
| GEC | H428 | | 7052 (Kovar sealing) | |

Pyrex

Data on all glasses can be obtained from:

The British Glass Industry Res. Association
Elmfield
Northumberland Road
Sheffield 10, England

Unfortunately, all the glasses mentioned come in rod form the EMI people make the tubing, then the seals. "Really very easy don't you know."

I still have a visit to 20th Century Electronics to make and some details at EMI. Although I feel that EMI is drained for our present charter--any work in the photo-surface area would make a tremendous start here.

Geographical Note:

London is grand - Lots of plays, ballet, etc. Asride in the surrounding countryside is lovely. It is a country of open fields, little villages, narrow roads, and drivers that go like hell in the smallest tighest little cars imaginable.

At EMI where they can see Windsor Castle at a distance of some 5 miles there is a saying:

"If you can see Windsor Castle, it will rain in a little while.
If you can't see it, it's already raining."

We have enjoyed steady rain for 4 days.

I am chasing after Dr. Gabor but it looks as if I shan't have a chance to see him (vaction). Have spoken to Dr. McGee however (formerly EMI). He could add little to what Webley & Lodge had contributed. (He used to be their boss).

Final Chapter London Coming

/s/ Frederick

August 13.
London