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# SYLVANIA TRIP REPORT

Factory contacts were made at Sylvania Electric Company to observe and study their methods and technique in practice on fabrication of the 17" metal rectangular tube. An additional purpose was to discuss and observe the screening process used in the Seneca Falls Plant.

The following persons were contacted:

Mr. Lamb - Manager
Mr. R. Gessford - Chief Engineer
Mr. J. Swan - Ass't Engineer
Mr. L. Evans - Section Engineer Chemical or Functional Section
Mr. T. Rychlewski - Engineer Chemical or Functional Section
Mr. G. Brennan - Foreman (bulb assembly)
Mr. G. Kautz - General Engineering
Mr. G. Cooper - Product Engineering

## I. Metal Bulb Processing

Messrs. Brennan, Kautz, and Cooper were the contacts on this process. The following steps and methods are in progress:

1. Sandblast - Pangborn Equipment using flint sand.

2. Cone Fritting and Firing

   The cones are then sprayed on the face sealing surface with a very thin coating of frit. The frit is 200 mesh and is purchased from Vitro Manufacturing Company, Pittsburgh, Pa., product #1 - D - 120341 - 36.

   The cones are next placed face downward on a 16 position (utilizing 6 heads) sealing machine. The cones fit into nichrome blocks with a notched step which restrains the cone from contracting beyond the original size after firing. The equipment was operating at 38 pcs/hr. with 1 position load and unload, 4 firing, and 1 cooling position. The equipment utilizes gas + $O_2$ burners type 814D (American Gas Company). The sealing lip had a very uniform light green color after the firing schedule. The tendency of the cones to contract after firing was noted. Several times a mallet was used to free the cones from the nichrome restraining blocks.

3. Neck Sealing

   The neck sealing was done on a standard 8 - head RCA machine. It uses gas + $O_2$ sealing with 1301-A burners (12 burners/sealing position).

3. <u>Neck Sealing (cont'd)</u>

The schedule was as follows:
Index - 40 seconds

Position 1 - preheat glass + cone
2 - oxidize 1050 - 1100$^{\circ}$C
3+4 - sealing 1100$^{\circ}$C
5 - stretch seal + anneal
6+7 - anneal (3/4" cannon burner-American Gas Company)
8 - load + unload

The quality of the neck seals appeared very good and they reported very low seal losses. It might be pointed out here that our high losses are caused by excessive length of H F washing (4-5 minutes) whereas Sylvania uses a 15-30 second HF rinse at bulb wash. This etching greatly reduces our seal strength.

Their bulb washing cycle is as follows - acid, acid, acid, tap water, hot caustic, tap water, deionized water, deionized water. The bulb remains in position 10 seconds - 5 seconds time is required to index from position to position. The acid is 5% HF and the caustic is 5-10% concentration.

4. <u>Face Sealing</u>

The face sealing equipment is an 8-head RCA sealer. The schedule is as follows:

Index - 90 seconds

Position 1 - load
2+3 - sealing-split manifold. Inner manifold has 15 burner tips, outer manifold has 24 tips (1301-A burner tips). The burner tips were directed at the corner radius of the short side.
4 - sealing -ring burner (814A burner tip). The burner tips on the ring burner were set 1½" from the bulb corners and then elevated approximately 15$^{\circ}$ from a plane just below the corner radius. The ring burner cuts off at approximately half way through the index.
5-8 - Anneal (Trent Electric Oven) 530$^{\circ}$ measured 2" above bulb face.

The bulbs after sealing appeared very good in sealing quality. The corners were well filled and the contours appeared excellent. Polariscope examination showed tangential compression on the sides with a smaller amount of the same in the corners. This amount, however small, was pointed out as absolutely essential to their process in order to prevent corner cracks.

II. Exhaust

Both glass and metal tubes were currently being exhausted in a rotary 32 position gas fired oven and an RCA, 32-position electric oven. The Sylvania position was that radiant heat during exhaust is practically essential for metal rectangulars. Their experience has shown that the temperature relationship between the glass and metal at the tube edge is very critical. The glass should be 10-20°C higher in temperature than the metal at all times. Keeping the center of the bulb face in equilibrium with the leading edge of the bulb was good practice in Sylvania's opinion. Their exhaust peak is 410°C max. with a 6-minute period over 370°C. The rotary oven is on a 2-minute index and the RCA equipment is on a 1-minute index. Each oven has 12 positions of heating and 20 positions of cooling.

The exhaust schedule for the 17CP4 is as follows:

Index time - 1 minute

Oven temperatures in the four zones is 410, 425, 320 and 115°C. Gun bombardment starts with position 19 and continues through position 29. The heater is turned on in position 24 and off in position 34.

The heater-lighting schedule is as follows:

| | | |
|---|---|---|
| Position - 24 | - .55 | amperes |
| 25 | - .65 | " |
| 26 | - .70 | " |
| 27 | - .70 | " |
| 28 | - .75 | " |
| 29 | - 0 | " |
| 30 | - .8 | " |
| 31 | - .75 | " |
| 32 | - .75 | " |
| 33 | - .70 | " |
| 34 | - .65 | " |

19AP4 exhaust schedule for 24-head rotary machine.

Index time - 2 minutes

Oven temperature for the 5 zones was 275, 390, 380, 290, 195 (bulb temperatures were within 10 degrees of oven temperatures). Bombardment and degassing of the gun is carried out in position 16 through 22 incl.

The heater-lighting schedule is as follows:

| Position- | Steps: 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 18 | .6 amps | .6 amps | .6 amps | .6 amps |
| 19 | .6 " | .6 " | .7 " | .7 " |
| 20 | .7 " | .7 " | .75 " | .75 " |
| 21 | .75 " | .75 " | .8 " | .8 " |
| 22 | .75 " | .75 " | .75 " | .7 " |
| 23 | .7 " | .7 " | .7 " | .7 " |

Lyle Evans reported that they had decreased cathode activation temperatures somewhat under the above figures to reduce high heater current from black heaters. They have traced this trouble to the particular lot of nickel used by Superior to make cathode sleeves.

We also discussed exhaust procedures in general and learned that it was their feeling that it was definitely important to hold the tube at maximum temperature for as long as possible. They did not appear to be concerned about oil backstreaming in their exhaust systems. One thing in particular that was noted was that they use a rotary disc vacuum valve with an O-ring seal on all their oil pumps. This valve is of their design and has worked out very well. Mr. Gessford indicated their willingness to sell us one of these valves for engineering tests if we desired.

They are building a new inline exhaust machine which has the oven extending around both ends with a small opening for the loading and removal of finished tubes. This exhaust machine has radient electric heaters on both sides and top of the oven.

III. Aging Speed 12'/min.

The following aging schedules were obtained:

Seneca Falls Plant

| Conveyor - Time | Filament Vltg. | #1 Grid Vltg. | #2 Grid Vltg. |
|---|---|---|---|
| 2 min. 30 sec. | 8 | 0 | 0 |
| 4 min. 10 sec. | 10 | 0 | 0 |
| 11 min. 40 sec. | 9 | 0 | 0 |
| 1 min. 40 sec. | 0 | 0 | 0 |
| 1 min. 40 sec. | 8 | 0 | 0 |
| 16 min. 40 sec. | 8 | 0 | + 300 |
| 12 min. 30 sec. | 8 | 0 | 0 |

| | Time | Filament Vltg. | #1 Grid Vltg. | #2 Grid Voltage |
|---|---|---|---|---|
| Bench aging | 2 min. | 9 | Cathode tied to grid #1 | |
| | 4 | 10 | | |
| | 12 | 9 | | |
| | 15 | 8 | | +300 |
| | 10 | 8 | | |
| Ottawa Ohio Plant | | | | |
| | 1 min. | 8½ | Cathode tied to grid #1 | |
| | 30 sec. | 9½ | | +300 |
| | 15 min. | 8½ | 0 | 0 |
| | 15 min. | 8½ | | +290 |
| | 15 min. | 7½ | 0 | 0 |

IV. Screening

An additional purpose was to discuss and observe the screening process used in the Seneca Falls Plant. Most of their conveyors were not in regular production as they had been turned over to engineering for experimental work. They had one conveyor running with 20" tubes on a 26 minute screening cycle. The panel spacing was approximately 22 inches and held three bulbs. This same machine when used for 17" bulbs has a panel spacing of 15 inches and moves at a speed of approximately 7 inches per minute.

The screening process in use is known as the acetic acid method and makes use of a 0.1 normal acetic acid mixture and a 0.1 normal potassium silicate solution. The dispensers are arranged such that 9 liters of acetic acid and 9 liters of potassium silicate solution are introduced simultaneously into the bulbs along with twenty ml. of a 1% solution of potassium permanganate. (The phosphor suspension is introduced shortly before all of the silicate acid mixture has run out of the mixing funnel. At the end of the conveyor an operator inserted a syphoning tube and removed the excess cushion water to a level approximately 2" below the anode button. Mr. Rychlewski and Mr. Evans believe that permanganate may have some merit in reducing water marks as it is an oxidizing agent and may prevent reduction of zinc ions to free zinc in the phosphor.

Their screening conveyor was built by RCA and appeared to be relatively steady and free from vibration.

Mr. Lyle Evans reported that their screening shrinkage was running 30 to 35% and consisted of holes and silica gel flakes or hairs. I inspected approximately 30 tubes and found that 25 to 30% of them had holes in the screen or small needle-shaped silica fibers imbedded in the phosphor. They believe that they can prevent these silica slivers by introducing the acetic acid and potassium silicate solution through separate tubes so it is mixed at the spray nozzle. Mr. Evans believes the washing of the silica acid mixture from the mixing bowl is not complete enough to prevent some formation of silica gel in the mixing bowl and that this is responsible for these slivers. Mr. Evans did not know the exact quantity of wash water used to flush the phosphor suspension from the bowl, but believed it to be about ½ liter. They control screen distribution by varying the bulb temperature and use no infra-red heating as we do. He claimed they could not get uniform screen distribution unless they filled the bulb almost full of solution. It was noticed that most of their screens had slight yellow edges which appeared to be slightly worse than our rejection limit.

Mr. Gessford said they were now adding 15% by weight of calcium magnesium silicate (titanium activated) phosphor to their regular screening mixture. This results in a reduction of approximately 15% in light output. However, it improves the resistance of their thin screens to X or spider burn, as they call it. They believe that the silicate phosphor added is useful in that it completely covers the glass and prevents it assuming a charge which eventually effects the overall screen potential. The use of this third component enables them to obtain acceptable screens with a phosphor weight of 4.5 milligrams per sq. cm.

Life tests at 20 Kv. of 20" tubes screened in this manner show that their screens are not completely free from X-burn, for at the end of 500 hours the X-burn is visible at anode potentials ranging between 11 and 14 Kv. They consider screens of this nature to be acceptable.

We also found that they had made a very intensive study of screen potentials and X-burn. The method used by Rychlewski was the one described by Nelson in the September issue of Journal of Applied Physics 1938. Briefly this method consists in operating the tube with anode at ground potential, the cathode being below ground. Screen potential is measured with a GE electrometer tube connected to the outside of the faceplate onto which is blown a stream of hot air to raise the faceplate temperature and decrease the glass conductivity below that of the input resistance of the detector. Ted Rychlewski showed me numerous curves and other design data which show that new tubes do not exhibit screen charging but that the charging develops during life of the tube. With their equipment they can measure screen anode potential differences as low as 10 volts. They have found that the screen weight and amount of silica present in the completed screen is extremely important in determining the rate of increase of screen charging and eventual spider burn.

They have lately made some 14" rectangular tubes with lime glass faceplates and have found that X-burn does not result. They report that X-burn is not a problem on the (17CP4) 17" metal rectangular tube.

During our general conversation on screens they mentioned that on glass tubes, a hole in the phosphor had to be limited to .015", otherwise the charging of the glass caused a small round dark area to appear which grew in size during the life of the tube. This phenomena was not nearly as bad on metal tubes and they could allow holes in the screen up to .040" without noticeable formation of a brown area.

They queried us in regards to the effect of barium nitrate on the life of metal tubes and reported that they had been unable to get satisfactory life test results on metal tubes made with sodium nitrate as an electrolyte. Consequently, they were extremely skeptical of our barium nitrate process.

V. Water System

Since my last visit they have installed some additional equipment in their water system to cut down regeneration in the 4-bed demineralizer. The system now used starts with tap water which is fed into a tank containing lime into which is fed continuously a small quantity of alum. This flocculates the algae and other impurities in the incoming water which is then filtered through a sand bed filter followed by an activated charcoal filter. From there the water goes to a 2-bed Illinois Company deionizer which does not remove $CO_2$. The $CO_2$ is removed by a blow-off tower which consists of two large wooden tanks the lower of which is about 9 feet high and 6 feet in diameter topped with another section about 10 ft. long and approximately 4 ft. in diameter. The water enters the top of this silo like chamber and sprays down through nozzles similar to a shower bath, while a jet of air is blown upwards through the water tower by a large furnace type blower. It is claimed this effectively removes $CO_2$. The water is then pumped to the Illinois Water Company's 4-bed demineralizers which are similar to the ones we use. Mr. Lyle Evans claimed that it was no longer necessary to regenerate the 3,000 g l. per hr. 4-bed units more often than once a week. Previously they had been limited in water supply by the down time required to regenerate these units every day or so.

VI. Faceplate Cleaning (low glare)

I noticed that following screening that they wash the faces of metal tubes with a 10% mixture of ammonium bifluoride and white powder which looks like Bon Ami. The operator rubbed the face of the tube for a few seconds as it moved down the conveyor line where it is automatically washed and rinsed. Timing is apparently rather critical on this operation. The faceplate is then dried by a jet of dry air.

VII. General Discussion

1. Sylvania has had considerable problems in the sealing of 17" rectangulars and their success has only resulted from concentrated effort on the problem. Mr. Brennan, bulb sealing foreman, has devoted 100% of his time to these problems. It seems evident to the writers that should we at GE enter into the metal rectangular production we should have similar department supervision.

2. Sylvania's opinion is that rectangular cone sealing is more efficient on rotary equipment than single head sealing and a better product can be produced. This is,of course, due to more flexibility of fire setting arrangements.

3. The use of fritting is in use at Sylvania but they are not completely convinced as to its need. Recent tests run by Mr. Brennan of 200 bulbs, one half of which were not fritted had showed approximately equal shrinkage totals. Incidentally, they have not used di-chromating methods due to the possible safety hazards to the employees.

4. The following are Sylvania's glass loss totals at various stations on 17" rectangulars.

| | Necks | Faces |
|---|---|---|
| Cone sealing | 1.5% | 3.0% |
| Bulb wash | 0.5 - 1.0 | Negligible |
| Screen bake (lehr) | Negligible | 5.0 |
| Exhuast | Negligible | 2.0 |

5. It is the writer's opinion that we are not yet ready to enter production on 21" rectangulars. Our cone sealing techniques as yet are in the development stage and we should not, for economy's sake, enter into what will be a factory development program. Our choice of face sealing technique (ring burner) is open to question and even our choice of burner tip does not agree with Sylvania. It is here suggested that we more thoroughly coordinate and organize our venture into this field of tube fabrication. Otherwise we shall not easily succeed in our program with resultant high losses and low production. Even now it is safe to predict that using present bulb washing techniques our neck losses will be 10 - 20 times that being experimnced at Sylvania. This program should not be lightly entered into for the penalties will be severe.

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8-21-51

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