MEMORANDUM ON THE VISIT TO LANCASTER FACTORY OF R. C. A., WEDNESDAY, MAY 5, BY

MESSRS. LINEHAN AND NEWMAN OF THE SCHENECTADY TUBE WORKS

People seen:		
	D. Y. Smith,	Factory Manager
	Earl Wood,	Manager of Manufacturing
	Sidney White,	Superintendent of Industrial & Power Tube Manufacture
	John Fitzpatrick,	General Foreman, Large Power Tube Manufacture
	John Hapgood,	Staff Engineer on Special Assignments for Mr. White

GENERAL:

We were greeted with extreme friendliness, if not almost enthusiasm, by everyone we met. Each person who talked to us, and the group who took us through the factory, seemed to go out of their way to call "tricks", techniques, clever fixtures, or newly developed processes to our attention. There was nowhere any reticence on anyone's part on getting information, data figures, process material. This was almost embarrassing at times, as a mere mention of a subject, or a production rate, conversation-wise would generally send one or two of our escort party scurrying for the records and they would return almost breathless in a short period of time with complete data on the points raised. Samples of various materials and assemblies were given us without our asking for them. A typical example of this friendly treatment may be seen from the way they acted in our discussion of their high current radio frequency brazing equipment. When they showed us the first setup, we pointed out that we had a somewhat similar one, but that we had had convection current difficulties which caused oxidation of some parts. They laughed a little and said, yes, they had the same trouble and finally solved it by putting a fine wire screen mesh in the top of their water-cooled, metal, glass-windowed hydrogen bottle. They said that they had quite some difficulty in getting a fine enough mesh and, therefore, insisted that we take back with us enough of this mesh for all of our needs.

The factory was running exceedingly smoothly. In no way was this smooth operation more pointedly demonstrated than by the fact that throughout our trip through the factory, we always had two or three of top supervision as guides with us, and these people were never called to a phone, or asked questions during the day. The only interruptions were an occasional request to sign a form of one sort or another.

PLANT FACILITIES AND PERSONNEL:

One is immediately impressed by the fresh greenness, cleanliness, quiet, and beauty of the Lancaster Valley setting of the R.C.A. plant. One is instinctively led to feel that tubes must be carefully and cleanly made from the plant setting and the exquisite housekeeping of the interior. Floors are polished daily and all overhead piping cleaned with vacuum cleaners once a month (Mr. Smith reported that he would like to do it once a week). There is no material left loosely on benches and the maple-block floors are spotless.

No hats, coats, or personal belongings are anywhere in evidence. Candy vending machinery, coffee pots, and the rest are taboo. Smoking is permitted grudgingly in the wash rooms and offices only. It is the cleanest and most orderly factory we have ever seen. There is a place for everything and everything is in its place.

The plant is "carefully" air conditioned, i.e., each "critical" section has its own air-conditioning system so as to keep contamination to a minimum. These are:

	Max. % Humidity
Photo Tubes	30
Cathode Ray Screening	50
Cathode Spraying	50
Offices	60
Rest of Plant	50

The factory temperature is kept below 85 degrees F in the summer.

Most of the direct labor employees receive a fixed hourly rate (96 cents for Women) for which they are required to do a certain number of units per hour as determined by careful time study techniques. No matter how much skill a woman develops, there is no way in which she can be paid more (factory management indicated that this was a difficult situation, but that it did permit immediate transfer of a girl from one operation to another). In spite of the absence of piece work, there seems great attention to work on the part of the operators, many of whom were working at very rapid rates. There is a tacit understanding that each operator may have a few minutes rest period either morning or afternoon, and in general, it was not abused. The cafeteria was clean and well attended. No crowding or rushing seemed necessary; each person was treated like a human being. This was also true of the Employee's Store, where, in a gayly decorated little showroom, records could be listened to, and purchases made in a friendly well-merchandised way.

Mr. White said that their experience indicated that for the type of manufacturing work they are engaged in, it was necessary to have approximately one supervisor for every fourteen direct labor people. This, of course, was not a hard and fast rule and receiving tube assembly required less supervision whereas certain transmitting tube jobs required more.

Extreme care was taken to insure employees' safety. Wearing Monogoggle type of safety glasses was a <u>must</u> after cathode ray tubes were exhausted. Also, safety glasses were worn by all glass workers and all other employees of the factory. Electrical interlocks on large electrical equipment were probably superior in their conception to ours. No large batches of acid (except plating solutions) were permitted in the chemical cleaning rooms. Each batch had to be made up fresh so that no errors which might effect safety could be made.

By and large, the equipment for manufacturing industrial and transmitting tubes seems better designed and engineered than ours. It was definitely better maintained, painted, cleaned up, and kept in what looked like tiptop shape. The electrical testing equipment for the newer and higher powered tubes was superb. Sets doing equivalent jobs to ours occupied about one-fifth of the floor area and were excellently designed from a testing and maintaining viewpoint. They also looked like real equipment. They were built by the Camden shops of the Company. All tubes were tested at tube rated frequencies and conditions.

Many of the small jigs and fixtures were quite clever. These were, in general, built by the factory rather than the Equipment Development Section. Apparently, the factory generally develops procedures and techniques and partially builds the prototype equipment. At this point, the Equipment Development Section is called in and well designed, easily maintainable equipment is then built.

Yields are very high, material efficiency excellent. Glass receiving tubes were running at over 95% and 10BP4 at 95%. The extremely intricate 8D21 (with its six individually water-cooled elements) had averaged 100% for the past three months!

The Factory was quite quality conscious. Tubes were bright, sparkling, well and beautifully built, and of apparent high electrical quality. As far as we could tell, only one standard of tube quality was maintained, and any tube not coming up to this standard was destroyed.

ORGANIZATION:

Besides the manufacturing section (under Earl Wood), there is a large Equipment Development group, a Tube Development section, Design Engineering, Standardizing and Parts Manufacturing section. The Manager of Manufacturing has a Quality Control group, Maintenance section, and Wage Rate section as well as Superintendents of Phototube, Glass Receiving tube, Cathode Ray tube and Industrial and Transmitting tubes (who also has charge of the Parts and Processing section).

The Superintendent of Industrial and Transmitting tubes has a General Foreman of 50-watt types, one for large power tubes, and one in charge of Parts. The test foreman reports directly to the superintendent. There are two "line" engineers in the 50-watt section and four in the large power tube section, as well as two engineers on methods work and at least one staff engineer reporting directly to the superintendent. There is also an engineer in charge, who reports to the superintendent.

Approximately 1700 people work in the plant. Except for the Cathode Ray section, these are almost entirely on the first shift. The first and second shifts are 8-hours, the third, 7-hour shifts. Six months ago, the Pennsylvania law was changed to allow girls to work second and third shifts. There is intense competition now for labor, and it was not felt economical to increase the force above its present size (a reserve of people is kept assembling receiving tubes until Cathode Ray absorbs them).

Factory engineers are trained with an aim to starting them on the road to manufacturing management; General Foremen being the next step.

TELEVISION PICTURE TUBE PRODUCTION:

Although we did not go down to see the television picture tube manufacturing (excepting the sealing of the 16-inch metal tube), Mr. Wood was so proud of his newly mechanized line that he insisted we spend two hours looking over this development. The manufacture of the 10BP4 at R.C.A. is probably the most mechanized of any tube being manufactured today. Plans seem to call for the unloading of the bulbs by hand labor at one point, and the loading of them again, hot, into the same boxes at the shipping platform practically "untouched by human hands" in between. It has almost reached that stage now. There is very little handling, excepting where some of the equipment has not been developed sufficiently, or an occasional partial breakdown, necessitating redesign of some segment of the line. The factory is mostly engaged now in increasing its facilities, but at the present production rates, they are making one good tube a minute, twenty-four hours a day, and, therefore, hope to ship somewhere between 35,000 and 40,000 10BP4's in May. Since some of their bottle-neck operations are being increased (doubling screening capacity and adding 50% to exhaust), it might be expected that the production will be in the neighborhood of 60,000 to 75,000 per month by the end of 1948.

A rough look at the automatic equipment indicates that in design, installation and cost, they probably have invested somewhere in the neighborhood of two million dollars since the war. If one were to assume a $20 "shop billing price" for the 10BP4 and a $7.00 material cost, an $0.80 direct labor, and $3.20 overhead, there might be $9.00 per tube available for writing off the equipment. Therefore, at 60,000 per month by the end of 1948, the equipment might be written off in four months!

Tube quality seems very good. .01% of the bulbs and tubes were lost due to purple spots (R.C.A. felt that discarding all metal parts in the powder mixing and dispensing unit has helped cure this defect -- they use lucite for much of their new unit). Screened bulbs are being inspected 100% by white light (no ultraviolet or vacuum seemed necessary). They were discarding less than 5% of the screened bulbs.

Testing was very rapid. Took less than one minute per tube.

We cannot see how anyone can hope to compete with R.C.A. on the 10BP4 or any other mass produced cathode ray tube without an equivalent expenditure in engineering, design, and equipment. Nor did it seem to us that the gain from an aluminized screen can make up in quality for the great cost advantage of this highly mechanized production line.

Approximately 1000/month of the 16-in. tube were being made. The straight line exhaust machine was exhausting 10- 16-in. tubes interchangeably. 5CP, 5TP4 and 4-in. projection and a few other types were being made.

The assembly of the gun mounts looked much like a receiving tube assembly line: speed and apparent lack of care.

TECHNICAL DEVELOPMENTS AND DETAILS:

1) Exhaust. Except on a few tube types which have been copied recently from General Electric (such as the 857B), no liquid air is used on any industrial, transmitting, or cathode ray tubes (for some purposes, ice water is sometimes used when exhausting directly from a Kinney).

Distillation Products Company oil-diffusion pumps filled with di-octal sebacate oil ("Monoplex") are used for all high vacuum purposes. No booster pumps are used. Large backing-up mechanical pumps are, however, required (the "Baby" Welsh being too small for most purposes). They believed they were getting much better vacuums in shorter time with lower maintenance cost, using this combination, than they have been able to obtain using mercury pumps. Mercury pumps are used however for all mercury-filled tubes.

Thoriated tungsten filaments are always exhausted by current rather than voltage (we were laughed at for asking this question -- "Don't you ever read any of the reports written by your Research Laboratory?"). The 8D21 (the new 5-kw, double beam tetrode, final-stage television tube) and some of the other newer tubes are bench exhausted "automatically", on extremely neat, well constructed, beautifully built exhaust benches. An oven is wheeled into place about the tube and connected to an automatic control panel. An ionization gage control is then preset by dial for any pressure and the oven temperature controlled so as not to increase the pressure about this preset value (usually 10u). When the oven has reached its pre-determined temperature, a bell rings and the operator "unwraps" the oven, placing the ionization gage control in a position to start the filament run which is similarly pressure controlled. In this way, extreme uniformity of degassing of the parts is obtained in the shortest possible time, utilizing the operator for a minimum period.

All mercury-filled tubes are exhausted without mercury vapor being present, and the metal either evaporated over at the end of the exhaust cycle, or added by means of pellets.

Synthetic compression rubbers are used. They smell like Neoprene.

2) Welding & Brazing. R.C.A. is using approximately 20 high frequency, high current brazing positions in hydrogen and forming gas bottles. These were scattered about the factory and mostly of the 15-kw size. A few were 5 kw and, at least one, a 150 kw. This latter not yet used for production purposes. The bottles were mostly 2 ft. in diameter, 2 1/2 ft. high, made of water-cooled brass, with a large glass window. The work, in one which we investigated closely, was movable on a compound head in three directions. The water-cooled work coil was fixed. Electric lamps, on the top, illuminated the work. The hydrogen was fed into the top of the bottle through a chamber separated from the rest with a fine (approximately 250) mesh screen. A small shield was placed under the work so that should particles of molten metal escape, they would not ignite the gas. A safety shield was also placed at the edge of the hydrogen bottle in front of the operator so that should the hydrogen ignite, it would tend to burn away from the operator. Initially, a gas flow of 200 cu. ft. an hour was specified. Forty cu. ft. per hour is, however, now found to be satisfactory.

Many tubes and parts were sealed together by using a fine pin flame of oxy-acetylene and a Purox 00 burner with a D2 size tip. The results of this sealing process looked much like the shielded helium arc and seemed extremely simple to operate. The oxygen and acetylene were individually, carefully controlled by two flow gages, and on the semi-automatic equipment, the speed of rotation of the parts were also carefully specified.

Use was also made of the high frequency metal melting welding technique. This was used for copper to fernico sealing as well as fernico to fernico.

Nowhere did we see tubes using a metal tubulation welded for sealing off purposes. Almost all of the tubes, particularly those designed by R.C.A. used a .020" OFHC copper wall tubulation, which was pinched off between 1/4" diameter dowel pins at from 3 to 15,000 lb. pressure. Tubulations of .150, .300, .400, and .600 inches in diameter were seen. Less than .005% of the tubes using these tubulations were lost due to leakers through the pinch off. The pinching off equipment most commonly used was a "Black Hawk", 7 ton, hydraulic press, model # R 75. The part is first coated with a little caster oil for lubrication and then squeezed off, the process taking about two seconds. It need not be specially cleaned, neither inside or out. The sharp edge is sometimes protected by dipping in glyptol and occasionally soldered, although the latter procedure was for some reason considered "dangerous".

Milk of magnesia is being used to stop the flow of copper for copper brazing purposes.

Instead of welding or brazing many parts, they are being pressed or peened into each other. This is particularly true of the wires of grid structures being peened into copper cones , or supports on the 7D21 type of tubes.

3) Emission.

The 5D21 uses a thoriated tantalum filament. This filament is prepared by spraying tungsten powder over the tantalum and then covering with thoria. It has a life of approximately 2000 hours, at 10 amperes per square centimeter ("as against 8000 hours, at 2 amperes per square centimeter for thoriated tungsten").

Tungsten filaments are formed by bending them over a resistance heated pin. The heating is done by means of a welding transformer and a large variable omhite resistance.

Filament flashing is frequently done in a forming gas atmosphere. Carbonizing is done using semi-automatic equipment which cuts the filament off at a preset resistance. (A copy of the carbonizing procedure may be obtained from the R.C.A. Standardizing Department.) Toluene is being used instead of benzene for the smaller power tubes. It has the advantage of much slower carbonizing speeds and, therefore, better and more uniform control. Acetylene is being used on most of the larger power tubes; (we did not see this process). For the small productions which are now being run, cold resistance is checked 100% after carbonizing; no readings are, however, taken before.

Thoriated tungsten wire is purchased almost exclusively from Callite. They do not believe there is any difference in emission life between a 1 and 2% thoria wire. No testing, inspection, or sample runs are made on the filament wire, excepting only that it is checked on the Geiger counter to see that it is thoriated and for weight per 200 mm.

4) Materials and Processing.

Fernico is treated by degreasing, polishing the edges with emery paper and rouge paper, then firing for one hour at 900 degrees in hydrogen with one to two per cent water vapor.

Graphite is air fired with high frequency at 1500 to 1800°C and then brushed, after which they are hydrogen fired at 1200°C for 10 to 30 minutes and again brushed.

Nickel-Clad Copper "Kool grid", is used for the outer lead on tubes like the 892. This keeps copper oxide out of the glass and also protects the leads.

Copper Radiators are cleaned after soldering by dipping the radiator in ammonium chloride solution for 3 to 4 minutes, dipping in water, keeping in a chromic acid solution for 8 minutes and washing water. The chromic acid helps to pacify the copper. One per cent hydrochloric acid is added to the ammonium chloride. Four cubic feet of solution will clean about 200-892 radiators. Water-cooled anodes are cleaned in the same solution previous to soldering.

Soldering Radiators was done with a corrosive flux, and it was found necessary to move the tube up and down in the molten solder of the radiator well a number of times so that the flux is floated to the top, otherwise large voids in the soldering exist.

Unichrome Stop Off is extensively used in the plating section for keeping plating off unwanted areas. It is a dark red color.

Zirconium Hydride is mixed with Fe_2O_3 for bonding the zirconium to iron or nickel. It also lowers the alloy temperature which is frequently desirable. If no tantalum is present in the tube, the anode is generally vacuum fired previous to exhaust. Metallic zirconium is being used in the 7024 and will probably be used more and more in the larger tubes.

Molybdenum Grid Wire is found to be critical for elongation and is tested 100% on a Scott tester. The specifications at the moment call for 8 to 12 % elongation for 50-watt type grid wire which is to be roller welded. Type 33-M-13Z (extremely ductal molybdenum) is used on large power tube grids. It seems to weld quite readily without embrittling too badly.

Heater Coating is applied to heaters of the cathode ray and lighthouse type cataphoretically using 400 milliamperes and 50 volts for the 10BP4 heater. An atmosphere of carbon dioxide covers the dish so that a spark does not ignite the flammable mixture. A timer (approximately 2 seconds) automatically turns the voltage off. A tweezer conducts the current to the leg of the heater and the operator uses the tweezer for bringing the filament out of the solution and washing it in a solvent, after which she places it on a card where it is permitted to dry.

Tungsten Leads are brought to a gold or pink color for vacuum seal work in the final seal, if they have been beaded, and to a mahogony shade, if they are not beaded.

High Conductivity Fernico for high frequency seals is made by plating the fernico with .0002 in. of copper and hydrogen firing. A plate .0005 to .001 inch of chromium is then added and the seal again hydrogen fired. The second firing besides stabilizing the plating, also oxides the chromium to get a good base for an adherent glass seal.

5) Notes on 892. A pure nickel stem shield is used on the 892 to avoid discoloration of the shield and the glass. The 892 is tested at 16 megacycles and if the glass is discolored, it tends to suck in at test. A fernico grid support has recently replaced the Housekeeper seal, since it was found that the copper work-hardened after approximately 2500 hrs. life and sheared off. A swing-arm dual indicator is used on the glass lathe to align the grid from a compound lathe chuck. Total exhaust time is about 5 1/4 hours. All tubes are X-rayed, although few, if any, rejects are found.

6) 857B

857B stems are made on a Kahle type, 6-hd. stem machine. Only one head is used and the machine is hand indexed by the operator, who manipulates the stem between two series of 8 American gas type cross fires. A vertical fire also heats the stem through the flare so as to obtain excellent contours and completely remove any line on the inside without blowing out the "bowl" with air. The tubulation is put in later on a horizontal lathe. Thirty-four stems an hour are obtained from this machine. Thirty minutes total of direct labor exists in each 857B stem.

The 857B looks much more dressed up than ours. The tungsten leads are sandblasted or etched, and the interior nickel parts are all wire brushed. A low pressure exhaust is used.

7) Age and Test. All tubes are tested at maximum frequency currents and voltage ratings. It is found necessary, however, on some tube types (such as 150 kw, 9C21) to test it also at lower frequency in that output cannot sometimes be obtained at this lower frequency rating. Twenty-five and 50-watt type test sets have all the dials in front of the set so that they may be rapidly changed from one tube type to another (by the operator). They look much like receiving tube type sets. They are calibrated by using standard tubes. Gas tests, which require 5 minute pre-heating, are made on an aging rack type of test set previous to the dynamic test, where a whole group of tubes may be gas tested at once. Shelves for these racks are of the plug-in type so that tubes using different types of basing and bases may be tested on the same equipment.

8) Copper Thimble Seals. Thimble seals are polished lightly with steel wool and painted with aluminum paint to protect them after the initial seal has been made.

9) 50-watt Line. The 50-watt section is laid out much like a receiving tube factory, with its assembly section, sealing, exhaust, aging and test moving across the floor to one wall. Very little activity was going on in this section, however, and apparently not enough business was available so that assembly teams could be used. Tubes were sealed and exhausted on separate 16-hd. equipment. Gloves were not worn unless for the operator's convenience. Liquid air, of course, was not used. The 807 (25-watt type) was "mount washed" in distilled water previous to sealing to improve static emission equipment. It was exhausted on a 16-hd. machine, using no diffusion pumps but getting down to approximately 4 or 5 microns (so R.C.A. thought), using four 5-5-6 Kinney pumps. The success of this exhaust procedure may lead to elimination of diffusion pumps on other types.

10) Copper Radiators. R.C.A. is now making all 891, 892 type radiators and have tools for the 889. The plan is to go into the radiator business on all types. They are anxious to sell them to us. We watched the assembly of the 892 type. It seemed quite simple, well engineered, and went together easily with about 20 minutes labor. We estimate that the total cost, including overhead, of this radiator is in the neighborhood of $25. An aluminum band

with die cast aluminum handles is used. A complete assembly and brazing equipment for this type radiator probably costs $200.

11) Cam Operated Annealers. Preheating and annealing flames are operated by simple inexpensive (estimate $70 each) Cam-operated valves. We found these in use on most of the glass lathe jobs and also for sealing the face plate on the 16-in. cathode ray tube. They allowed an operator to preheat his work while he was doing another job, to return, complete the sealing operation, set the Cam fires for annealing, and go off to another job. In this way, it was possible for one man to work two lathes and at the same time, obtain better controlled pre-heating and annealing conditions.

12) Many spinnings are used in R.C.A.'s tubes. The Newark Engineering Company is thought to be a large supplier of these parts.

13) A pressed copper grid is in use in at least two R.C.A. tubes. These seem to be made by pressing copper tubing on a lathe spinning form by applying pressure with an exterior roller. The copper is pressed paper thin in the desired sections and an acid etch removes the paper thin sections, giving a high electrical and heating conductivity, accurately formed grid structure for cylindrical configuration tubes.

14) Disc Sealing Techniques. R.C.A. seems to prefer butt sealing to edge sealing when dealing with fernico. They claim they have little difficulty. In the final sealing of a tube, much like the miniature 7D21, on a glass lathe, a hydrogen air flame is brought through the chuck to keep the cathode end at 600°C during the sealing process, while dry hydrogen is being blown through tubulation end of the tube. After sealing, the tube is wrapped in asbestos cloth and allowed to cool.

15) Sixteen-inch Cathode Ray Tube Sealing. The glass face plate is sealed almost exactly like the R.C.A. Standing Instructions, which we have a copy of. The pre-heating is done on the vertical lathe, using the Cam operation described above. In fact, all of the fires on the lathe are Cam operated. The extreme edge of the sandblasted chrome iron is heated to about 1050 degrees and air applied to keep the glass from sinking down too far. After two minutes, the burners are turned off and the air pressure kept inside until the seal edge becomes approximately 800 degrees C. When the edge becomes 700 degrees C, the bulb is removed to a 550° circulating air oven, where it is kept for 5 minutes. It is then removed from the oven and allowed to cool down in the air.

The neck bulb is sealed to the face plate and bulb assembly on a small (E type) Litton lathe. This operation is performed by a 90 lb. girl, who in four confident minutes completes the sealing cycle on one bulb. Excepting for a very small bushy fire applied to the glass face plate (which in turn is held in a three-jaw chuck), all of the fire is applied to the sandblasted, butt-seal surface of the chrome iron bulb. The glass bulb, after being diamond scratched and flame cracked apart on the lathe, is brought slowly closer to the heated chrome iron surface until it begins to flow, when it is pulled rapidly away and enlarged with a graphite tool to a slightly larger diameter than the base of the metal bulb. It is then sealed to the exterior of the metal bulb, heated, and drawn into the butt-seal surface of the metal with a sharp graphite tool and then blown back again where it is paddled to shape, pulled to length, cooled partly on the lathe, removed by the operator, where it has been permitted to cool in the air for 2 minutes approximately before going into the annealing Lehr.

16) Cathode Ray Tube 10BP4 Line. The following is the routing of production, a listing of equipment, and an estimate of costs of this post war development. Most of it is sheer guesswork. It is thought that the present line will make 40,000- 10BP4 (good) per month, and the proposed 60,000 - 75,000 per month.

Equipment	No. Used	No. Planned	Operators Used	Operators Planned	Estimated Development & Construction Cost
"Buttoning" Machine[k]	1	1	2	2	~~50,000~~ 125000
Lehr Conveyor & 2 transfer equipts.	1	1	0	0	110,000
Main Conveyor (for unsealed bulbs-over whole shop)	1	1	-	-	150,000
Bulb Washing Mach.[l]	1	1	2	1[a]	35,000
Powder mixing, silicate purification, etc.	-	-	1[b]	1[b]	10,000
Screening[c]	1	2	2	2[a]	150,000
Screen inspection	1	1	1	1	2,000
Screen Bake Out including transfers (2)	1	1	0	0	80,000
Coating Machines	2	3[d]	2	3[d]	20,000
Sealing Machine	2	3[d]	2	3	30,000
Exhaust & Seal Off	2	3	2	3	300,000
Conveyor & Transfer (to shipping)	1	3[d]	0	0	150,000
Basing Machine (soldering)	1	1[c]	1	1	5,000

k - see notes at end of this section.

Equipment	No. Used	No. Planned	Operators Used	Operators Planned	Estimated Development & Construction Cost
Aging Rack	5[d]	f	3[d]	0	25,000
Preheating Rack	3	f	-	0	600
Test Set	3	3[d]	3	3	45,000
Washing Machine	1	1	2	2	20,000
Painting "	1	1	1[b]	1[b]	3,000[b]
Packing Conveyor	1	1	3	4	5,000
Stem Machine	2[b]	2[b]	4[b]	4[b]	80,000
Stem Forming & Cut	1[b]	1[b]	1[b]	1[b]	4,000
Mounting Line	-	-	9[h]	13[h]	20,000[b]
Parts Making	-	-	-	-	50,000
Heater Coating	1	1	1[e]	1[e]	400
Hydrogen Firing	2	2	2	2	12,000
Cathode Spray	-	-	1[b]	1[b]	1,000[b]
Heater Wind	1[b]	1[b]	1[b]	1[b]	3,000[b]
Inspect & Test Mount	1	1	2[b]	2[b]	5,000[b]
Additional operators, inspectors, material handlers, etc.			10[b]	10[b]	634,000[i]
			58	65	$2,000,000
Total for 3 Shifts			174	195	

a) Could be transferred automatically. They may plan to.
b) Practically no basis for this estimate. Equipment not seen.
c) Ingenious 4 ton vibrationless machine. Bulbs held in cups by inflation of an "inner tube" lining the cup.
d) Seems reasonable -- but only a guess.
e) It is believed that they plan to do this infrared basing on a conveyor as it goes on its way to aging.
f) Will be done on a conveyor type rack.
g) Two used. One mainly for sale to licensee.
h) Just a guess. Per shift, if divided between the three shifts.
i) Additional estimated cost for development of equipment not used, and equipment not seen.
k) Preheats bulb, presses small iron thimble against glass from inside, heats with exterior HF coil, expendible thimble then is pushed through glass. Operator then guides chrome iron button into hole, and seals it.
l) Washes inside and out with hydrofluoric acid, followed with a caustic and a water rinse.

RWN:J
5/13/48

F. R. Linehan
R. W. Newman