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AD 606324

DEVELOPMENT OF AN IMPROVED JAN 6299

FINAL REPORT

1 May 1961 through 30 June 1964

CONTRACT NO. DA-36-039-SC-85953

ORDER 6008-PP-61-81-81

Industrial Preparedness Group

USASSA

Philadelphia, Pennsylvania

TUBE DEPARTMENT

GENERAL ELECTRIC

OWENSBORO, KENTUCKY

DEVELOPMENT OF AN IMPROVED JAN 6299

FINAL REPORT

1 May 1961 through 30 June 1964

OBJECTIVE: (1) To obtain better performance and greater reliability from the JAN 6299 by evaluating and adapting the latest tube technological advancements.

(2) To build 1000 tubes capable of passing Signal Corps Technical Requirements SCS-90 dated 1 July 1960.

CONTRACT NO. DA-36-039-SC-85953

SIGNAL CORPS TECHNICAL REQUIREMENTS
SCS-90, 1 July 1960

Report Prepared By:

D. L. Cook

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ABSTRACT

The period covered by this report is from 1 May 1961 through 30 June 1964. No work was performed from 30 April 1962 to 17 September 1962 when manufacturing facilities were being transferred from Scranton, Pennsylvania to Owensboro, Kentucky.

The pilot run has been completed; test data is shown in Project VIII.

Results from improved alignment and concentricity, optimization of cathode coating and improved exhaust fixturing are now being applied to regular production tubes.

Best results during humidity test have been obtained by improving plating techniques and controls to minimize metal shell corrosion.

The improved tubes have given superior life test results with the anode seal temperature at 225° C.

The inverted cathode support ring results in cathode subassemblies with better uniformity and increased ruggedness.

The temperature controller has been shown to decrease operator skill necessary to perform uniform exhaust cycles.

The extended life test has completed 1795 hours. The complete data and failure analysis will be presented in an addendum to the Final Report.

PURPOSE

The purpose of this contract is to evaluate certain areas of advanced tube manufacturing techniques and apply them where feasible to JAN 6299 to result in a more reliable and better performing tube. The objective requirements for the improved tube are Signal Corps Technical Requirement SCS-90 (Improved JAN 6299) and operation at a tube temperature rating of 225° C. The areas investigated were:

1. Improved alignment, concentricity and ceramic strength.
2. Improved anode to ceramic seal.
3. Temperature control at exhaust.
4. Improved application of cathode coating.
5. Improved cathode mounting.
6. Improved processing for higher temperature operation.
7. Improvement in humidity testing.
8. Improved exhaust fixturing.
9. Extended life test and tube failure analysis.

NARRATIVE

Project I IMPROVED ALIGNMENT, CONCENTRICITY, AND CERAMIC STRENGTH

All eccentricity dimensions presently listed for JAN 6299 are measured with respect to the centerline of the tube using a go, no-go type of gauge as outlined in the existing MIL-E-1/484B specification. Since actual eccentricity measurements would be required for a proper evaluation of improved tube alignment as a result of using tighter dimensioned parts, it was decided to build a gauge capable of providing this type of information. For reasons of simplicity in gauge construction, the grid terminal of the tube was used as a reference and the eccentricity of the anode, cathode, getter, and heater pin terminals were measured from this point. An illustration is shown in Figure 1.

In an effort to improve the alignment and concentricity of the tube, the ceramics and metal parts have been made to tighter tolerences. The ceramic composition has been changed from forsterite to 96% alumina in the heater, getter, and anode ceramics for greater strength. The cathode ceramic, when changed to 96% alumina, produced a median Cgk of 4.81 pf. This is an increase of 31.8% over the bogy value of 3.65 pf. Redesign of the cathode ceramic to compensate for a change of this magnitude, it is felt would be a major design change.

The improvements made in this project enable improved exhaust fixturing (Project IX) to further improve alignment and concentricity of the tube.

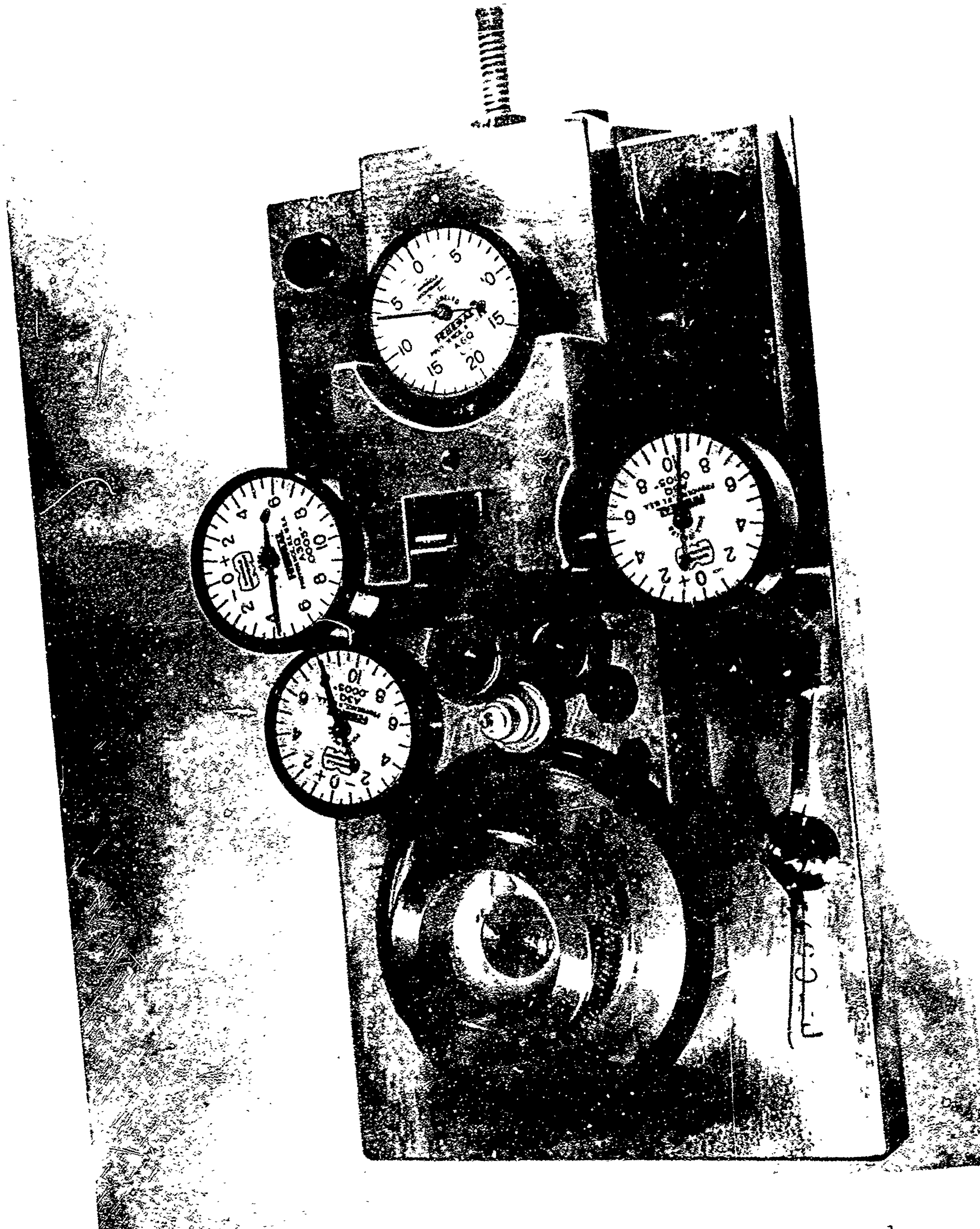


Figure 1

Eccentricity Gauge

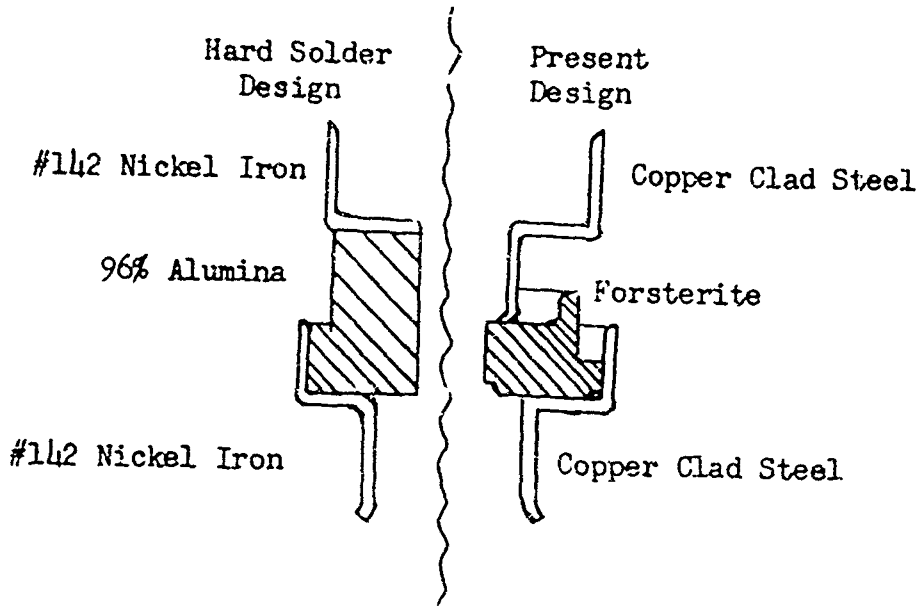
Project II IMPROVED ANODE SEAL

The general configeration of the present design and the hard solder designs is shown in Figure 2.

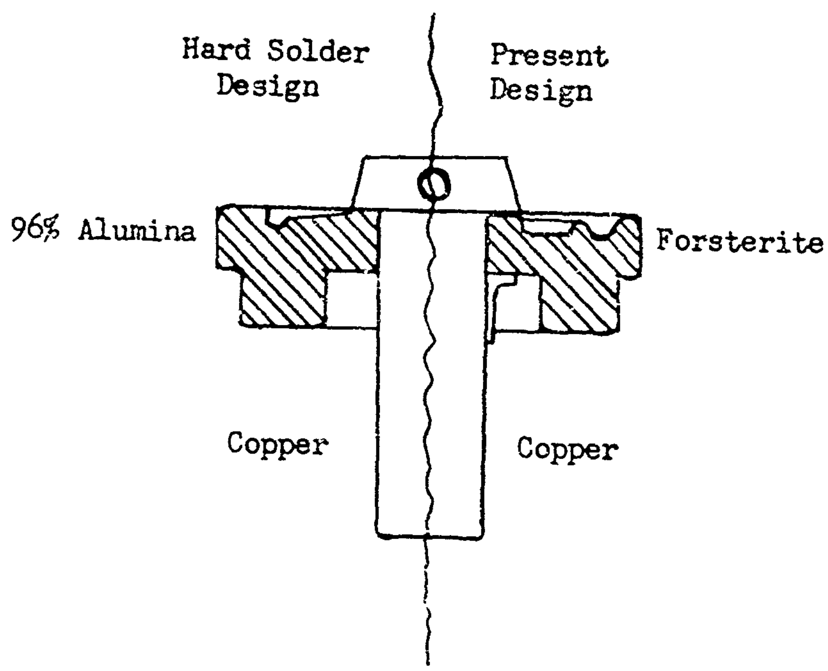
The getter ceramic was redesigned to provide a better sealing surface for the hard solder seals. The material was changed from forsterite to 96% alumina for improved strength. The two metal shells were changed from copper clad steel to #142 nickel-iron alloy to obtain a closer expansion match. A new getter assembly was obtained to fit the new configeration. The butt seals were obtained utilizing silver-copper eutectic.

The anode seal is a butt seal using silver-copper eutectic. Care must be taken when metalizing this seal to prevent grid-plate capacitance from being too high.

It was found during the course of the contract that the metalizing was not giving consistently strong seals. A much better seal was obtained by using a metalizing mix of finer particle size to give better adhesion to the ceramic at the butt seals.



CATHODE & GETTER SHELL ASSEMBLY



ANODE ASSEMBLY

CONFIGURATION OF PRESEAL AND ANODE SEALS Figure 2

Project III TEMPERATURE CONTROL AT EXHAUST

One of the major factors contributing to the variation experienced in tubes is the lack of temperature control at exhaust. A molybdenum oven encloses the tubes in a fixture and RF energy is used to heat the oven, outgassing and sealing the tubes.

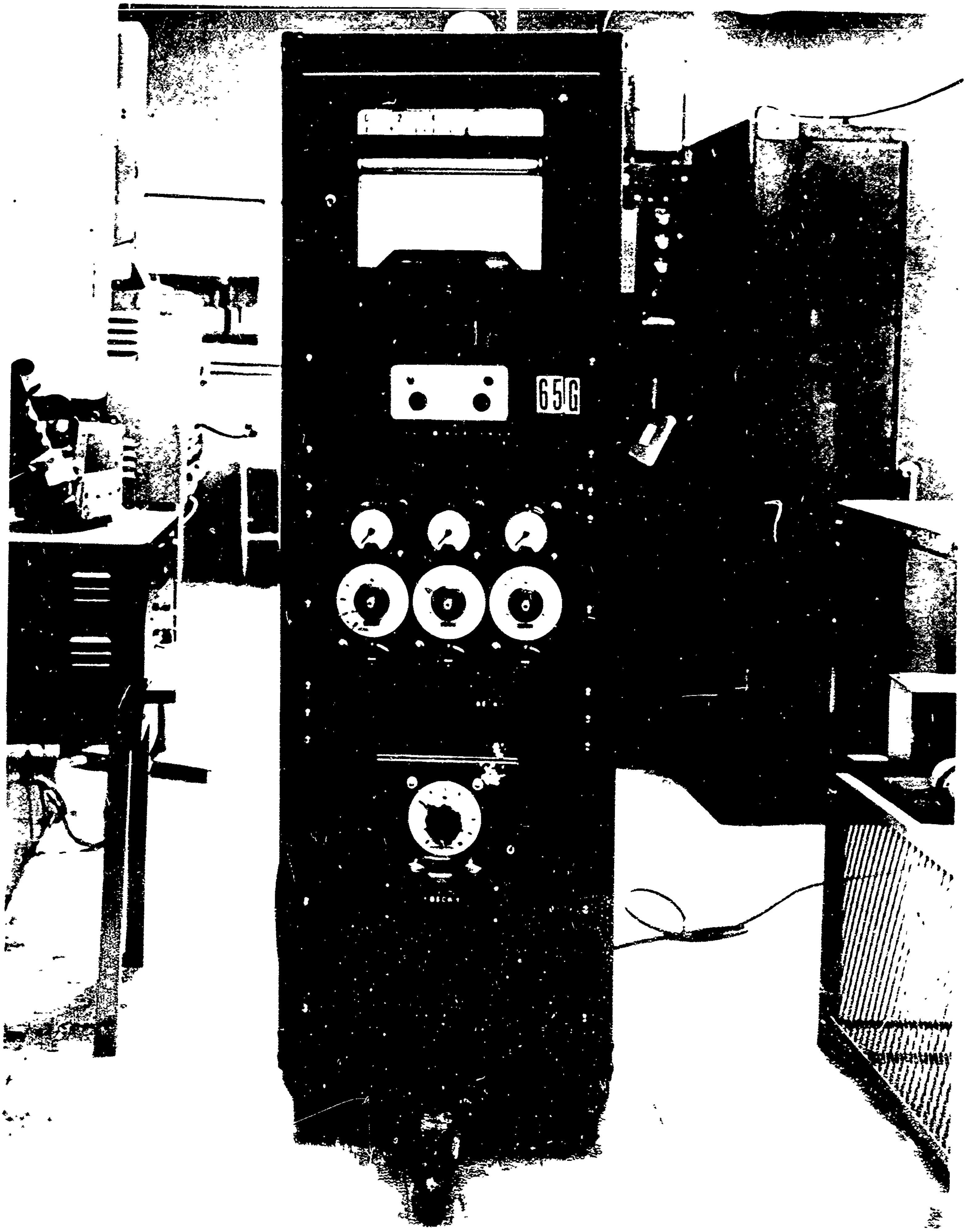
The temperature controller shown in Figure 3 was used to regulate the RF energy input during exhaust processing. Several trial heating schedules were examined, with the best results obtained using a schedule approximating the schedule being used in production.

The temperature controller was used to control processing on two exhaust sets during the day shift and the method of observation of Isobutyl Methacrylate and titanium hydride pressure breakdowns was used to indicate the manual settings on the night shift as in the last quarter.

An evaluation was undertaken of the difference in exhaust losses by the two methods. There were 2320 tube mounts exhausted by the manual method and 1580 tube mounts exhausted in conjunction with the temperature controller. The temperature controller method had 2.3% less exhaust shrinkage than the manual method. This would indicate the temperature controller gives more consistent processing at exhaust resulting in better uniformity of seals.

Test data was tabulated for 1293 of the tubes processed at exhaust by the temperature controller and 1800 tubes which were processed at exhaust by the manual control method. The tubes with exhaust processing regulated by the temperature controller had a 5.6% improvement in yield. This also indicates improved processing which is resulting in more consistent tube quality.

The temperature controller does decrease the operator skill required to perform a uniform exhaust cycle and therby insures a more consistently uniform product.

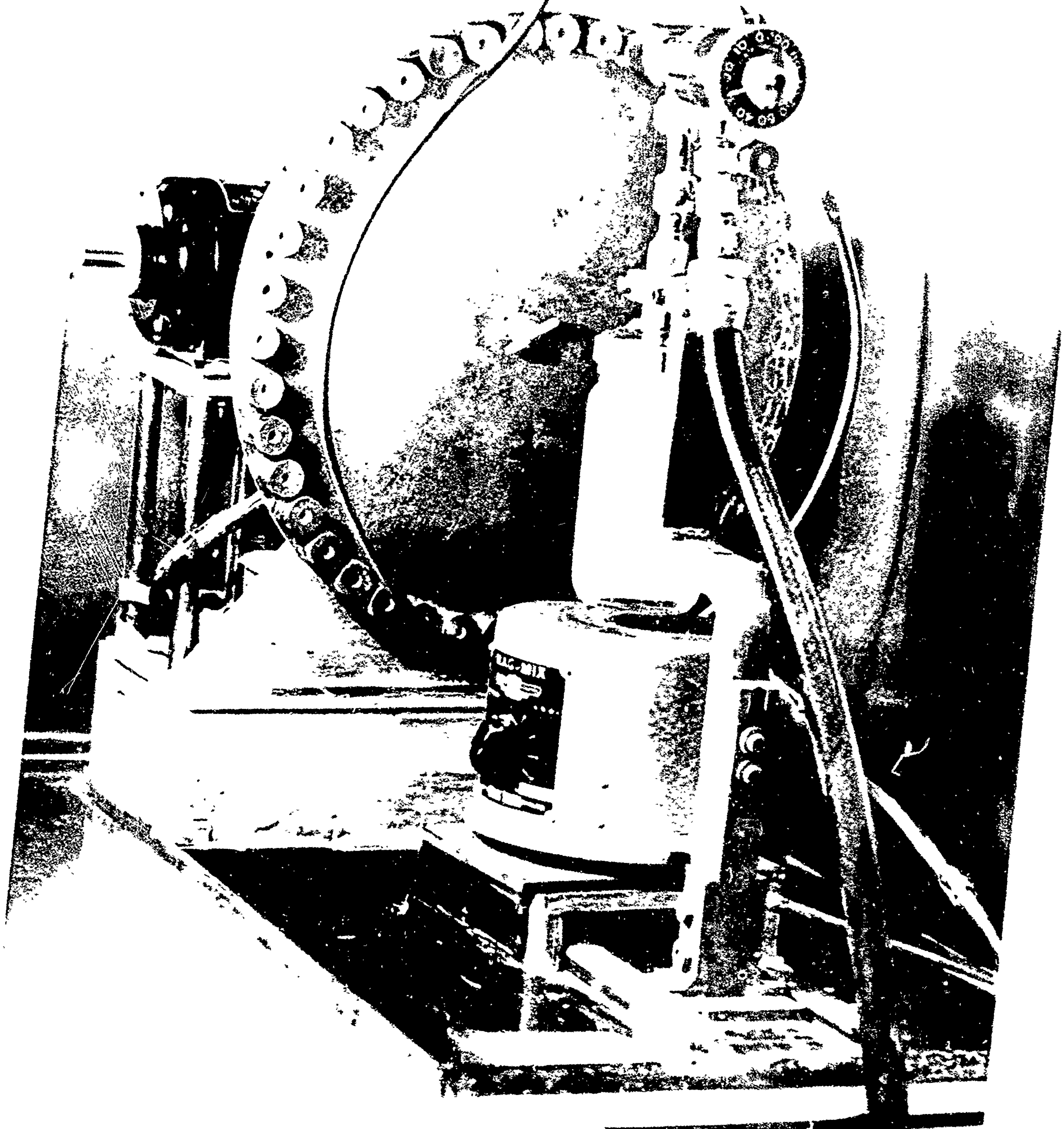


Temperature Control System

Project IV OPTIMIZE CATHODE COATING

In order to reduce variations in cathode coating density, an evaluation of cathode spray guns, spray fixtures and cathode density was undertaken. A Paasche A - Automatic spray gun was composed with the DeVilbiss spray gun in use and found to give more uniform results. An improvement was made in fixturing used to hold the cathode during the spraying operation to prevent over spray. Production controls were established to maintain the proper spray density.

The Paasche A - Automatic spray gun along with the improved spray fixtures continue to give uniform results in production. An illustration of the spray booth is shown in Figure 4. The life rack used for evaluation of this project is shown in Figure 5. The spray density life tests indicated for favorable life test results, the density should be greater than 1.0 mg/mm^3. Cathode spray density has been adjusted from 0.9 - 1.05 mg/mm^3 to 1.25 - 1.35 mg/mm^3 on production tubes. The 1.25 - 1.35 mg/mm^3 density gave good life test results and is easier to activate than the higher density groups. The spraying of the higher cathode densities are also more difficult to control in production with the present cathode spray equipment. In view of data derived in this test, coupled with manufacturing experience, it is felt that the 1.25 - 1.35 mg/mm^3 density group will greatly improve the quality of the tube.



Cathode Spray Booth

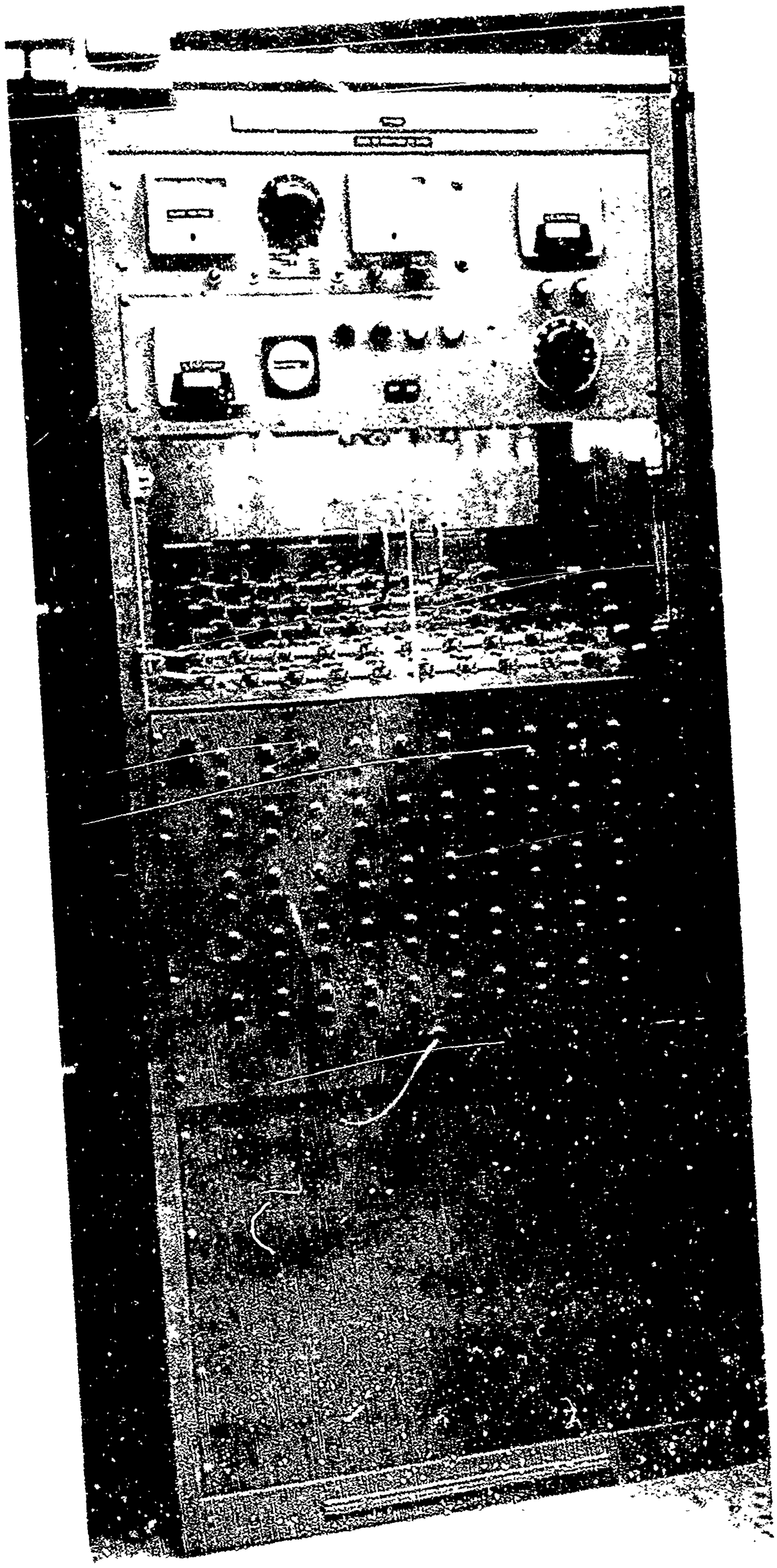


Figure 5

Life Rack

Project V IMPROVED CATHODE MOUNTING

Two methods of improving cathode mounting were investigated, a brazed cathode support ring assembly and a welded cathode support ring assembly. These two constructions were built with various cathode foil thicknesses and cathode temperature was measured for each construction. These were then compared with the present construction 6299. The most promising construction of each type was then sealed into tubes. The construction where the cathode is welded to the cathode support ring could not be made with satisfactory yields although cathode temperature appeared to be correct. The cathode assembly with the cathode support ring brazed to the cathode gave satisfactory results. This construction utilized .00045" cathode foil material. A more rugged assembly with better contact to the cathode shell is realized by use of this method. The variations due to tilting and canting of the individual clips of the old method of assembly are eliminated.

Project VI HIGH TEMPERATURE OPERATION

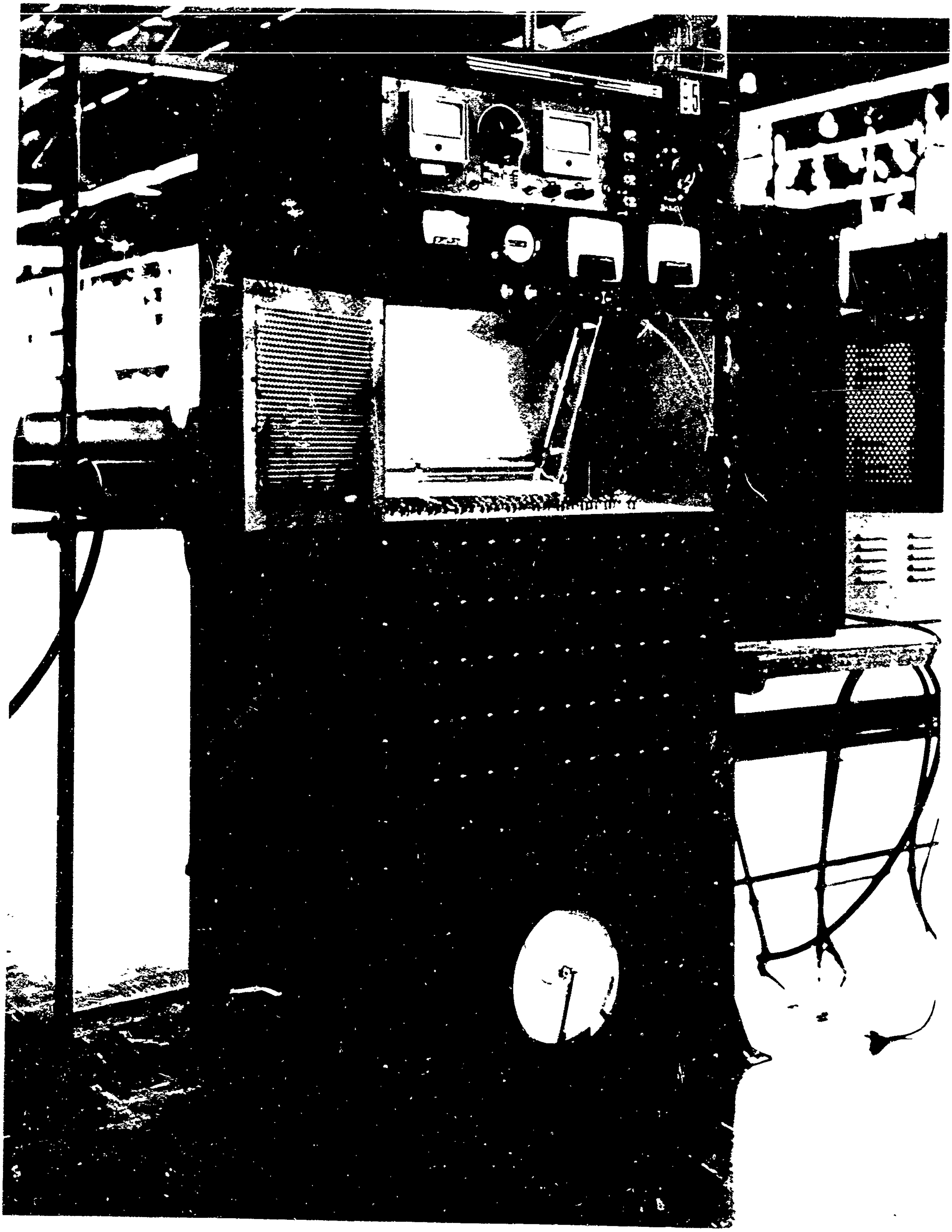
An evaluation was performed on tubes to obtain satisfactory operation with the anode seal at 225° C. A major problem encountered was deterioration of the plating. During high temperature life, the copper plating diffuses through the gold plating of the JAN 6299. This causes a very poor contact surface which results in degradation in high frequency performance. The solution to the diffusion of plating was to plate nickel over the copper, then gold over the nickel. This nickel barrier prevents the deterioration of the plating and good high frequency results are obtained.

Most failures due to air leakers of the regular construction 6299 during the evaluation were found to be at the anode seal. To eliminate this weakness, the hard solder seals at the anode and preseals were utilized. This increases reliability of the tube under high temperature life conditions.

A. C. aging will be used to process tubes for high temperature life. Results have been good using this type aging. The cathode structure is rather cool for this tube to operate adequately as an R.F. oscillator from field results where it was used in this application. R.F. aging is more expensive initially and maintenance is of a higher cost.

Life test results have shown the construction with three of the seals of hard solder construction is superior to the regular construction on life when the anode seal is run at 225° C.

An illustration of the high temperature life rack is shown in Figure 6.



High Tempera+ure Life Rack

Figure 6

Project VII HUMIDITY TESTING

It has been demonstrated by gas cooling curves and mass spectrometric gas content analysis that the failure mechanism of the JAN 6299 when subjected to a temperature of 100° centigrade and 100% humidity is due to a build up of hydrogen gas pressure in the tube. The increased mobility of the hydrogen gas as compared to air causes a marked increase in heater current over that found in a tube which is an air leaker.

The conclusion reached after work on this problem is the failure mechanism is due to hydrogen permeation of the JAN 6299's metal shell. The shell material is .010" thick 10-80-10 copper clad AISI 1010 steel alloy. After processing of the tube is complete, a copper-gold electroplating is performed. If there is the slightest pinhole in the protective coating, the base metal of the metal shell will corrode when subjected to the conditions of the humidity test chamber. The hydrogen generated by the corrosion reaction diffuses through the steel wall and recombines as H_2 inside the tube if no barrier exists. Tubes that show obvious corrosion but no indication of hydrogen, probably have long diffusion paths as a result of the location of the corrosion and/or the presence of a continuous copper layer on the inside surfaces which acts as a fairly effective barrier at the temperature in question.

The hydrogen must be formed at the base metal in order to permeate into the tube. Examination of lead-metal and lead-ceramic boundaries of tubes before and after humidity test have not shown any change in condition. Since lead's susceptibleness to hydrogen permeation is very slight or nil at these temperatures, it is felt that seal corrosion does not contribute to hydrogen permeation. Also tests in which the seal areas were covered with a protectant, showed no significant improvement over other tests. In fact, several groups where there is doubt of the curing of a silicone which was used, an apparent severe attack upon the plating over the tube in general was observed (confinement of the silicone to the seal area only being difficult - a considerable amount came in contact with the metal shell). Failure rates were very high. In general, when lower corrosion rates were observed on the metal shell there were lower failure rates due to hydrogen permeation.

Several lots of tubes which showed good results on humidity test had different processing dates up to the plating operation. With a common plating operation, good results were obtained.

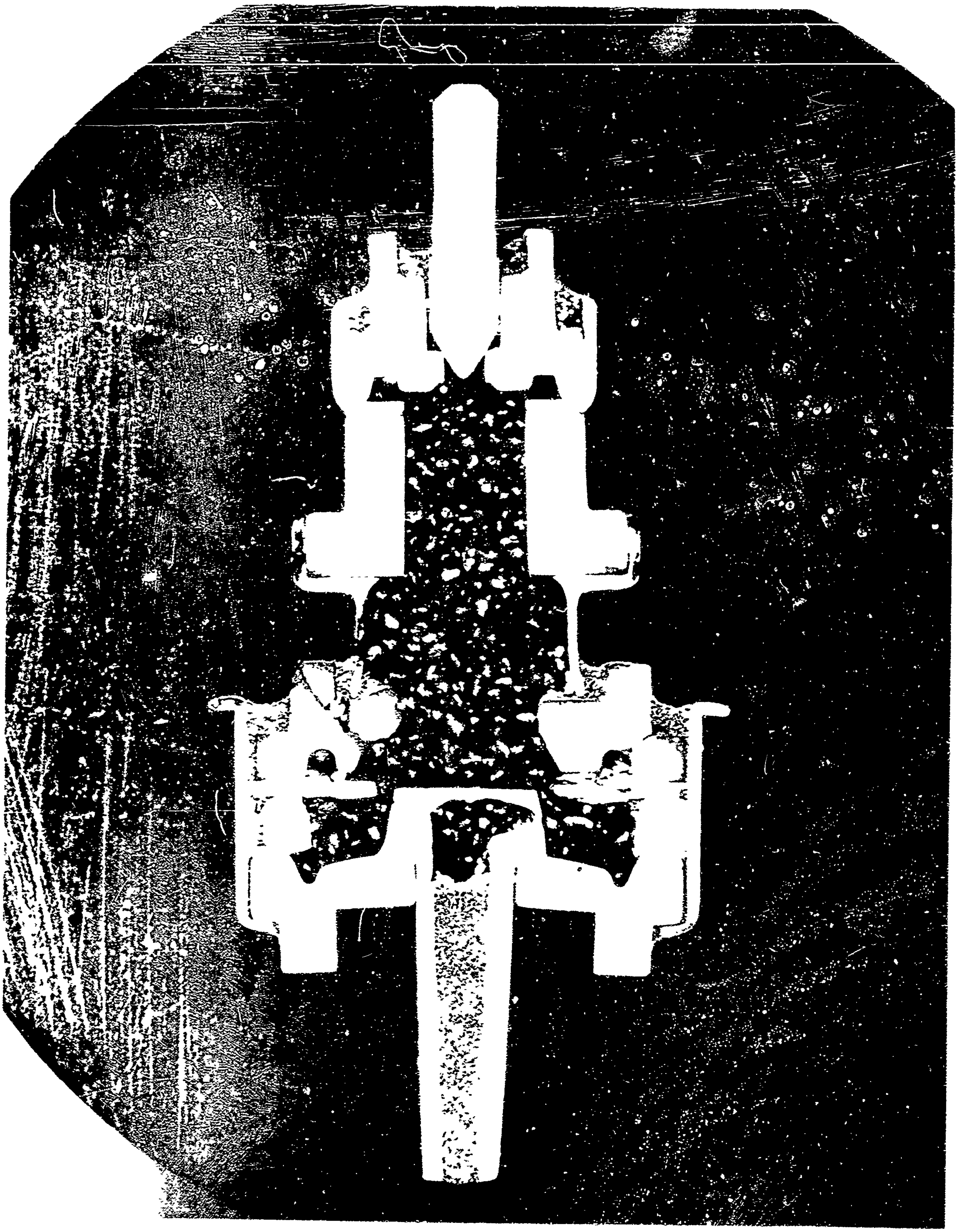
A noted improvement was obtained in humidity test results when the gold plating bath was corrected to give a better plating. The gold content had been allowed to drop to a low level by an inaccurate method of measuring gold content. When this was corrected, corrosion of tube subjected to humidity test was reduced.

During the plating operation, hydrogen also permeates into a percentage of tubes. The hydrogen forms at the base metal due to the plating reaction and if a suitable diffusion path exists, the tube will become filled with hydrogen.

In order to reduce this plating hydrogen permeation and also to give more copper barrier for the resistance of hydrogen penetration during the humidity test conditions an improved method of removing excess lead from the metal parts has been developed. The existing method was to chuck the tube to a motor and while rotating at a high speed, remove the lead with a file. This was highly dependent on operator technique and in most cases much of the outer copper clading was removed, allowing the base metal to become exposed. The improved method utilizes a rotating wire brush. The lead is removed by this brush and very little copper clading is removed.

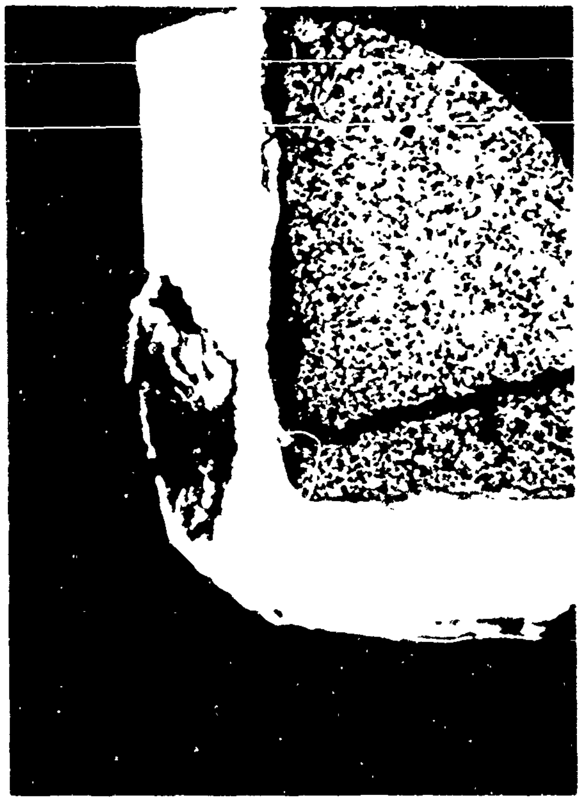
Shown in Figure 7 are some illustrations of corrosion and possibile flaws in the platings and copper clading. The grid flange shown where virtually all clading has been removed was cleaned by the old method of using a file on the tube.

In summary, the failure of the 6299 during humidity test has been found to be due to hydrogen permeation of the base metal of the tube's shell. Best minimization of this problem has been obtained by improved cleaning methods and improved plating techniques which give protection to the base metal of the tube's shell.

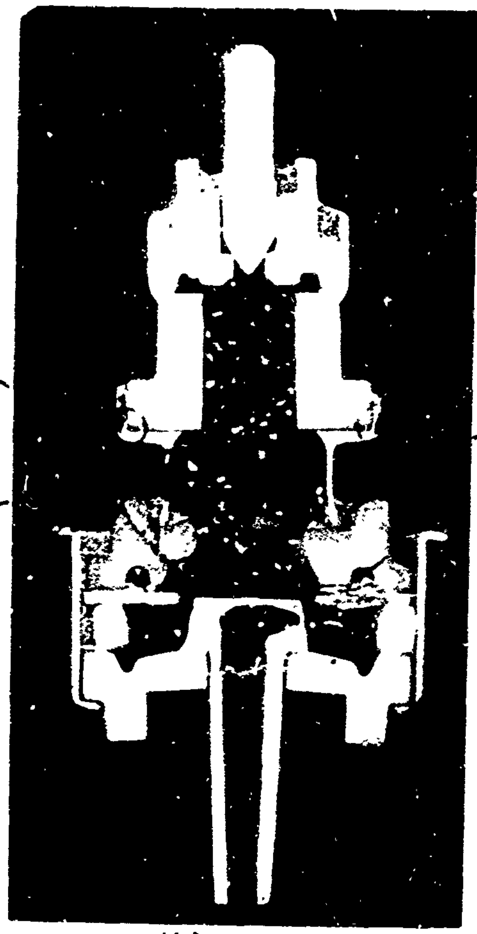


Surface Conditions and Corrosion
Of The 6299 During Humidity Test

Figure 7 A



50X



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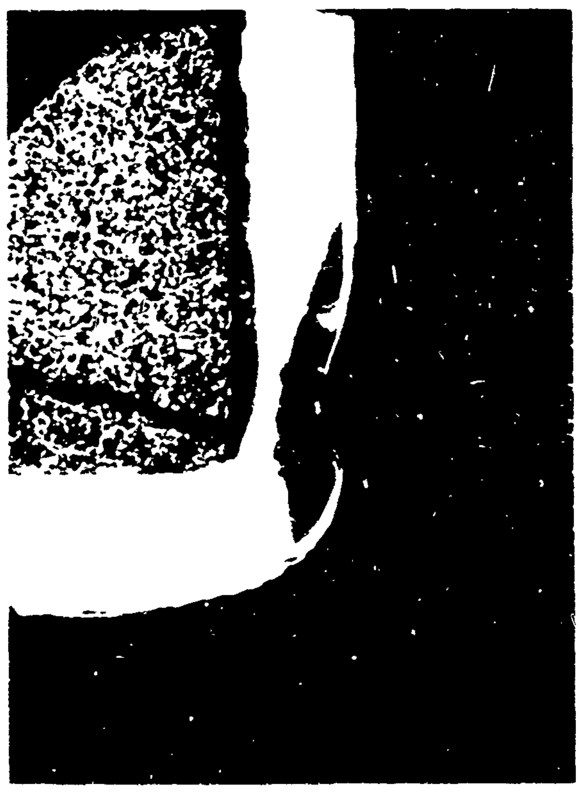
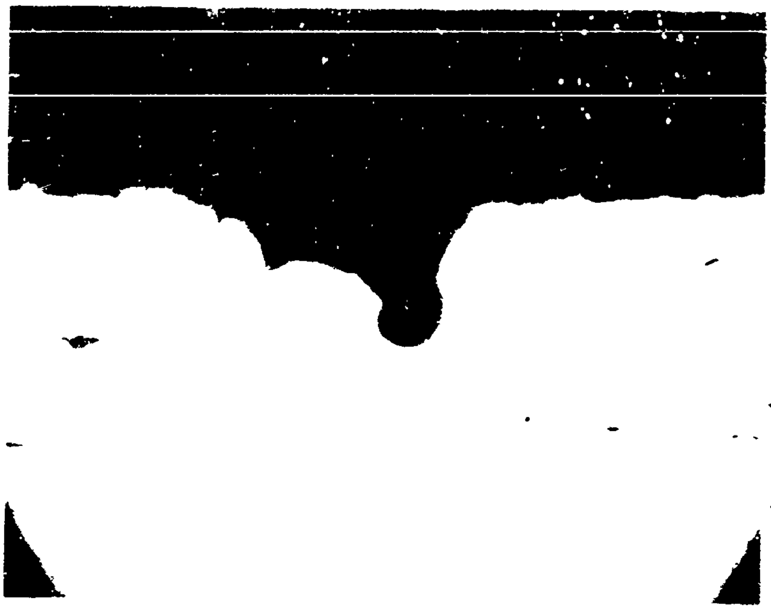
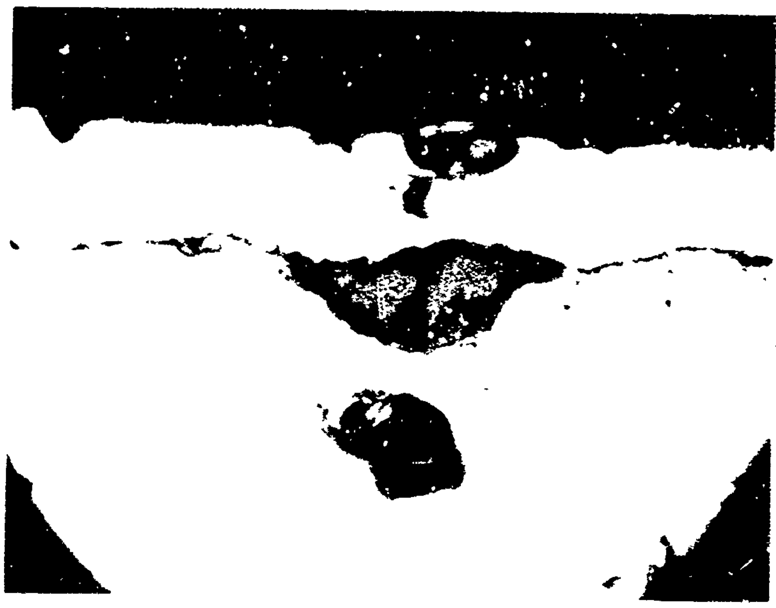


6299 tube - Cu clad 1010 with
~~Cu~~ Ni electroplate + immersion Au.
39 days at 100°C., 100% humidity.
Localized base metal corrosion
has progressed nearly through
thickness of flange.

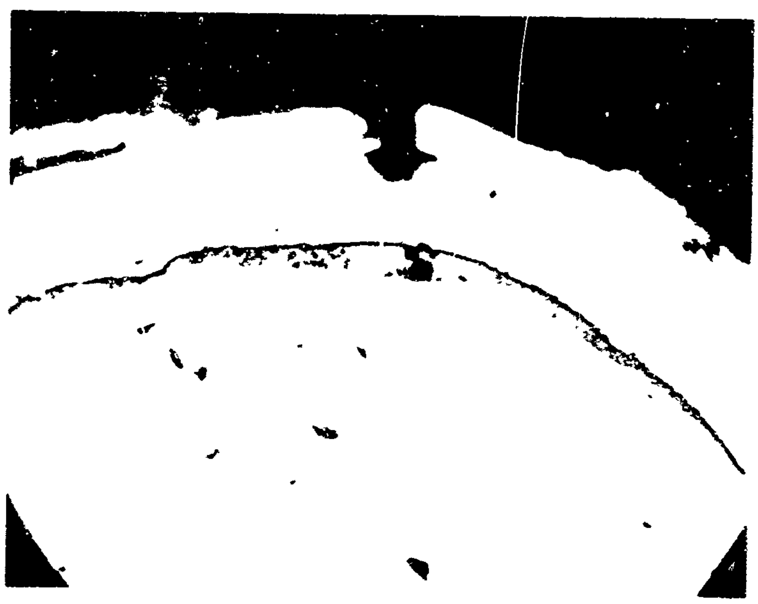
Figure 7 B



Cu clad 10K braze
Cu + Ni electroplate
+ ~~immersion~~ electroplated Au.
The discontinuity in the Cu cladding is typical of several areas in one cross sectional plane.
Etchant: $NH_4OH + H_2O_2$
500X.

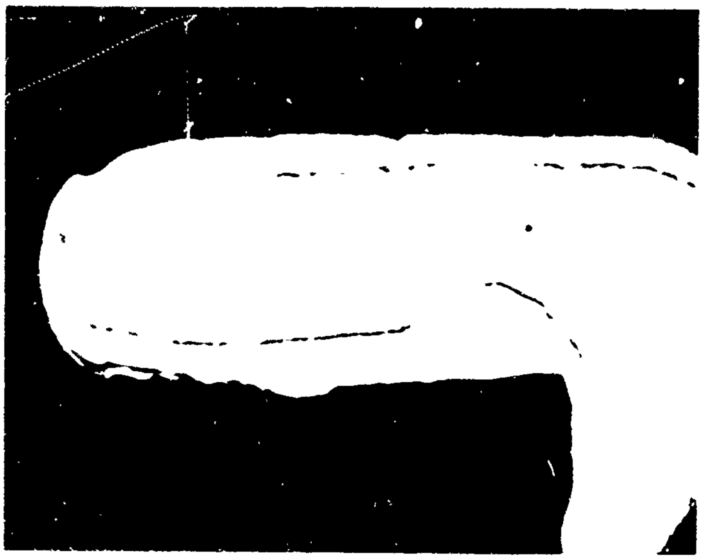


Same as above, but different area.
Note absence of Cu cladding.
Base metal has oxidized under the electroplate.
Note base metal grain distortion at surface.
Etchant: $NH_4OH + H_2O_2$
Nital
500X.

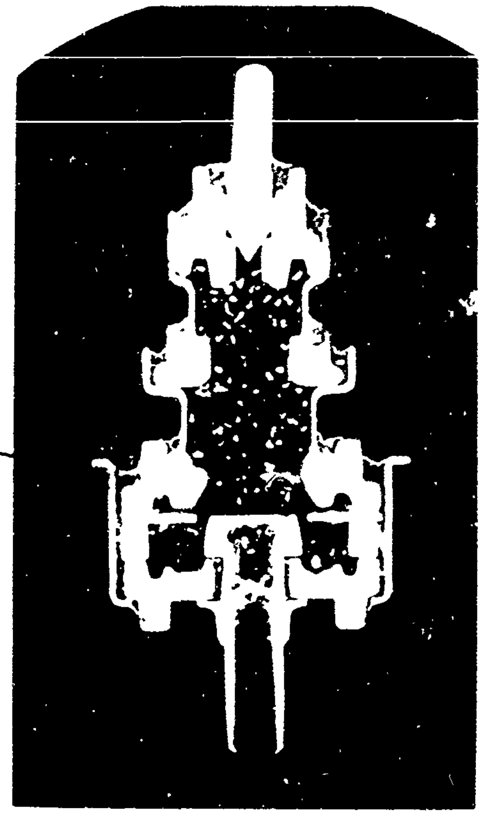


Cu clad 430 stainless steel base metal
Cu + Ni electroplate
+ ~~immersion~~ electroplated Au.
Note absence of Cu cladding.
Penetration of moisture and air through a defect in the plating has caused corrosion of base metal
Etchant: $NH_4OH + H_2O_2$
500X.

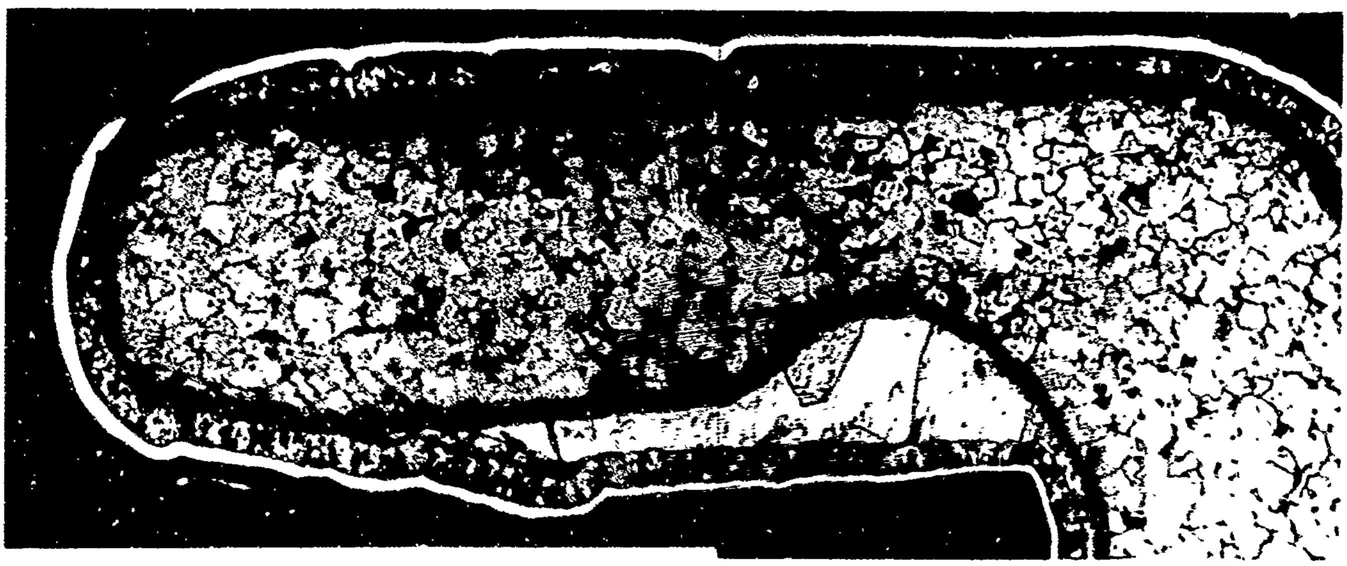
Note: None of the tubes with alumina ceramics showed any Cu plating - Ni plated directly



100X



Cross-section at 6247.



200X

Cu clad 1010 base. Cu+Ni electroplate + ~~immersion~~ electroplated Au.

Note variation in cladding and electroplating over a relatively small area.

Etchant: $NH_4OH + H_2O_2$; Nital.

Figure 7

Project VIII ENGINEERING SAMPLES AND PILOT RUN

Engineering samples were submitted in April, 1962. After transfer of facilities from Scranton to Owensboro, another group of engineering samples were submitted in February, 1963 showing work done to that point.

Preproduction samples were constructed incorporating the improvements made under the various projects.

Alumina heater, getter, and anode ceramics were used with hard solder seal construction being utilized for the preseal assembly and anode seals. Parts were used with the tightened tolerances. The improved cathode construction was used and the cathode spray techniques developed were used in coating the cathode. The tubes were exhausted in the improved exhaust fixturing in conjunction with the temperature controller. The wire brush method of cleaning was used to remove excess lead after exhaust. The tubes were d-c and a-c aged and copper-nickel- gold plated.

A mutually acceptable working specification was established for preproduction and pilot run testing. This specification is shown in the appendix. The preproduction run conformed to the test specification.

The pilot run was started on 24 January and was terminated on 16 February due to poor yields. The tubes had very poor emission and this was caused by the cathode temperature being approximately 50° C. too cool. This problem was caused by increased copper flow while brazing the cathode assembly. The length of the legs of the cathode support ring was shortened and cathode temperature has been adjusted to the proper value. Considerable delay and excessive subassembly and tube losses were experienced due to inconsistent metalizing of the high alumina ceramics used in the hard solder seals. Stronger and much more consistent hard solder seals have been obtained by using finer particle size in the metalizing mix.

The 2000 tubes produced in the pilot run were scrapped as well as in-process cathode, anode and preseal subassemblies.

A new pilot run was begun with the cathode temperature corrected to the normal value and with the three hard solder seals utilizing the finer particle size metalizing mix.

Table I

ELECTRICAL CHARACTERISTICS
6299 PEM Pilot Run

Tube No.	If ma	-Eg Vdc	Sm umhos	Mu	Eb Vdc	Gain 1200 Mc db	NF 1200 Mc db	Gain 3000 Mc db	NF 3000 Mc db	Cin Pf	Cgp Pf	Cout Pf	Rgk Megohm	Rgp Megohm	Evib Ep	Ik mA
1	304	.50	15.6	114	136	18.0	7.2	11.8	13.1	3.70	1.66	.015	5+	50+	3	6.2
2	308	.40	15.0	136	150	18.0	7.8	10.4	13.4	3.35	1.70	.012	5+	50+	10	7.6
3	308	.60	14.4	106	136	17.0	7.8	11.4	13.2	3.28	1.84	.016	5+	50+	3	5.4
4	304	.50	13.6	118	138	17.6	7.6	11.6	12.8	3.50	1.70	.014	5+	50+	2	5.6
5	300	.40	12.4	118	160	17.6	8.0	11.0	13.3	3.05	1.74	.013	5+	50+	3	5.6
6	300	.40	13.6	118	170	18.4	7.5	11.8	12.8	3.30	1.74	.014	5+	11	3	5.4
7	304	.40	13.8	124	150	17.6	7.7	11.8	12.8	3.28	1.66	.013	5+	50+	4	6.2
8	304	.40	13.8	122	150	17.2	7.5	11.[illegible]	13.0	3.30	1.95	.013	5+	50+	3	6.0
9	308	.45	15.2	128	140	18.0	7.3	10.4	12.6	3.05	1.80	.018	5+	50+	2	8.0
10	310	.50	12.4	110	140	17.2	8.0	11.0	13.3	3.28	1.80	.014	5+	50+	2	6.8
11	300	.50	14.4	114	140	18.4	7.6	11.4	13.3	3.50	1.66	.015	5+	50+	2	6.0
12	300	.45	12.8	110	150	17.2	7.7	11.2	13.0	3.30	1.76	.014	5+	50+	2	5.6
13	304	.45	13.2	106	150	17.6	7.5	12.0	12.8	3.40	1.80	.015	5+	50+	2	5.2
14	308	.50	14.0	114	160	18.0	7.8	11.6	12.8	3.50	1.76	.014	5+	50+	2	7.6
15	304	.40	14.0	128	150	18.0	7.8	11.4	13.1	3.20	1.66	.012	5+	50+	3	7.6

Table II

HUMIDITY TEST DATA

6299 PEM Pilot Run

Days	0	5	6	9	10
Tube No.					
1	305	305	308	310	310
2	309	310	310	310	308
3	308	305	305	305	305
4	310	318	315	310	310
5	307	310	308	308	305
6	309	310	309	307	308
7	304	305	305	310	308
8	310	320	312	312	312
9	314	320	315	313	313
10	315	318	313	312	313
11	319	322	320	320	318
12	310	310	310	310	310
13	309	310	308	307	308
14	300	300	302	302	303
15	311	310	310	310	311
16	301	300	300	400	720
17	311	310	310	310	310
18	306	300	305	303	305
19	310	305	306	308	308
20	307	305	312	310	310

% Rejects (10 Days) = 1/20 = 5%

Table III

HIGH TEMPERATURE LIFE TEST DATA

6299 PEM Pilot Run
ELECTRONIC TUBE LIFE TEST DATA

Life Test Conditions: Eb-200 VDC Ambient Temp.=75° C.
Ef=6.3V RK/Ib=10Ma

Test Characteristic/Tube No. 1

Accum. Hrs.	0	500
If	307	307
RGK	5+	5+
RGP	50+	50+
Eg	.40	.30
Gm	14.9	13.7
Mu	129	131
Ik	7.3	6.2
Eb	149	157
N	7.5	7.6
G	18.8	17.2
Cin	3.49	3.50
Cgp	1.68	1.69

Test Characteristic/Tube No. 2

Accum. Hrs.	0	500
If	303	306
RGK	5+	5+
RGP	50+	50+
Eg	.59	.65
Gm	14.3	13.2
Mu	11[illegible]	115
Ik	4.1	4.4
Eb	124	121
N	7.9	8.6
G	17.1	17.0
Cin	3.93	3.82
Cgp	2.00	2.13

HIGH TEMPERATURE LIFE TEST DATA

6299 PEM Pilot Run
ELECTRONIC TUBE LIFE TEST DATA

Life Test Conditions: Eb-200 VDC Ambient Temp.=75° C
Ef=6.3V RK/Ib=10Ma

Accum. Hrs.	0	500
Test Characteristic/Tube No. 3		
If	301	303
RGK	5+	5+
RGP	50+	50+
Eg	.45	.39
Gm	14.9	12.8
Mu	118	118
Ik	4.4	3.3
Eb	144	150
N	8.4	8.3
G	17.6	17.6
Cin	3.43	3.20
Cgp	1.71	1.72
Test Characteristic/Tube No. 4		
If	314	307
RGK	5+	5+
RGP	50+	50+
Eg	.26	.70
Gm	13.9	15.9
Mu	126	124
Ik	5.5	7.2
Eb	144	111
N	7.7	7.5
G	18.1	18.0
Cin	3.42	3.33
Cgp	1.68	1.68

Table IV

6299 PEM Pilot Run

1000 Hour Life Test Data

Life Test Conditions: Eb - 200 VDC
Ef = 6.3 V Rk/Ib = 10 Ma

Accum. Hrs.	0	140	558	1009
Test Characteristic/Tube No. 1				
If	307			311
RGK	5+	5+	5+	5+
RGP	50+	50+	50+	50+
Eg	.50		.30	.17
Gm	16.2	15.9	15.5	14.3
Mu	120			123
Ik	8.6			6.0
Eb	133			159
Noise	7.6	7.4	8.0	7.6
Gain	19.1			18.0
Cin	3.54			3.44
Cgp	1.75			1.78
Test Characteristic/Tube No. 2				
If	309			311
RGK	5+	5+	5+	5+
RGP	50+	50+	50+	50+
Eg	.45		.35	.24
Gm	15.9	16.0	15.9	15.5
Mu	127			127
Ik	5.5			4.6
Eb	143			150
Noise	7.3	7.3	7.6	7.4
Gain	19.4			18.8
Cin	3.56			3.51
Cgp	1.68			1.68

6299 PEM Pilot Run

1000 Hour Life Test Data

Life Test Conditions: Eb - 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	140	558	1009
Test Characteristic/Tube No. 3				
If	306			310
RGK	5+	5+	5+	5+
RGP	50+	50+	50+	50+
Eg	.45		.39	.26
Gm	13.7	13.6	13.3	12.4
Mu	112			112
Ik	6.5			5.0
Eb	143			150
Noise	7.9	7.6	7.9	7.6
Gain	17.7			17.8
Cin	3.41			3.40
Cgp	1.69			1.69

Project IX IMPROVED EXHAUST FIXTURING

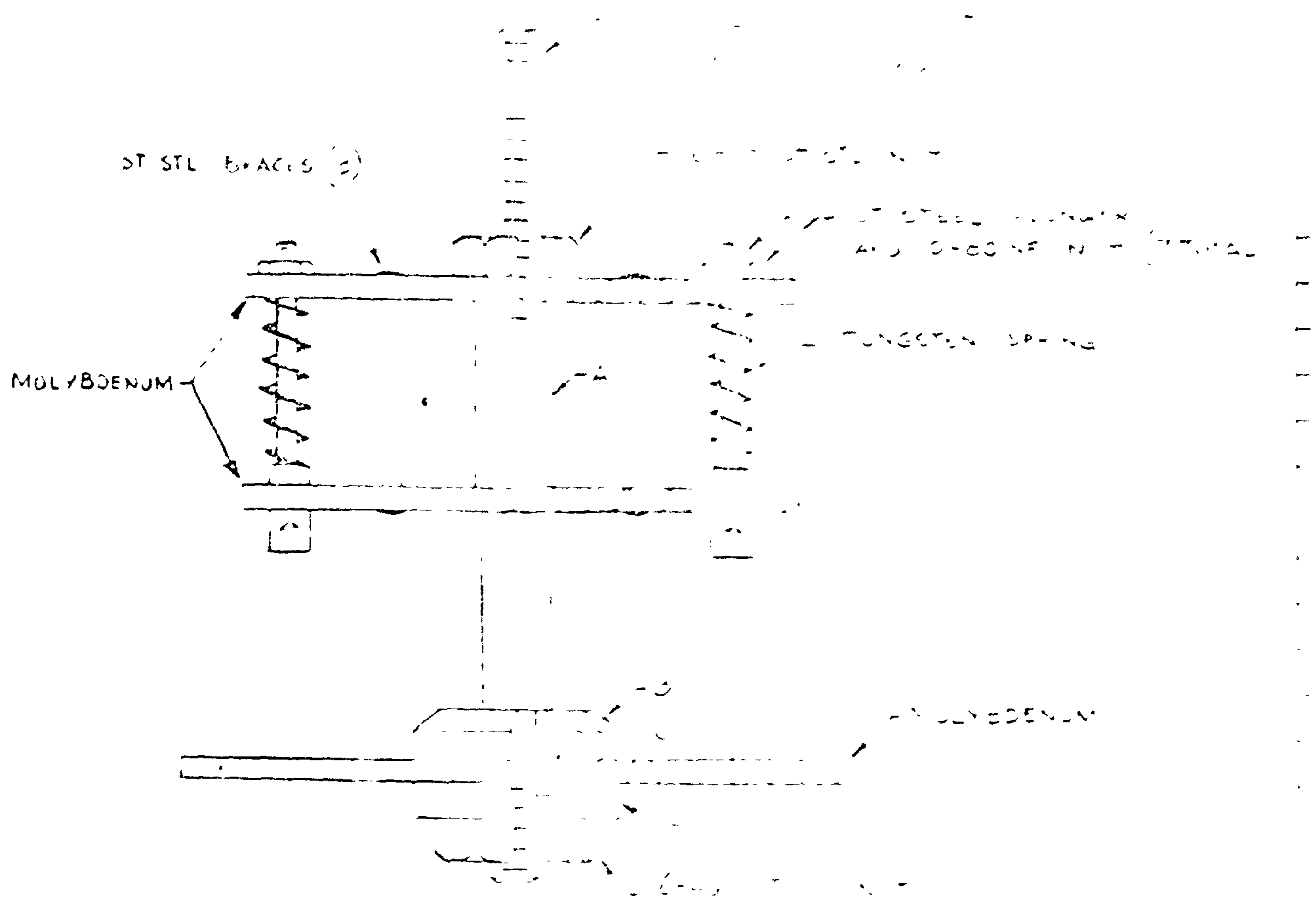
The purpose of this project is to further improve alignment and concentricity of the tube beyond that attained in Project I. Improvements made in Project I were attained by reductions in tolerences of tube parts. The basic limitation in making this improvement is the fixtures used to hold the tube's parts during the exhaust and sealing cycle. Materials and design of fixtures were such that warping of the fixture took place during exhaust.

The improved exhaust fixture shown in Figure 8 was selected from six designs as giving best results. The center shaft immediately below the fixture top was turned down to allow increased pressure on the tubes during the exhaust cycle.

Cathode, getter, and heater pin eccentricity data were taken on 102 regular production tubes selected at random. After a familiarization and debugging run, 110 tubes were exhausted in the improved exhaust fixtures and eccentricity data was taken. Eccentricity data was taken with the eccentricity gauge (P69087-2390591 Rev 0) as presented in the Second Quarterly Report. Probability plots of that data are shown in Figures 9, 10, and 11.

The data shows the greatest improvement in heater pin eccentricity. This is the area where the most deterioration was caused by the old exhaust fixtures. The getter eccentricity appears to have improved by having less tubes with very large eccentricities. Anode eccentricity should not be effected by the improved exhaust fixturing.

There appears to be little difference in cathode eccentricities. A successful reduction of cathode eccentricity should also further improve getter and heater pin eccentricity.



A
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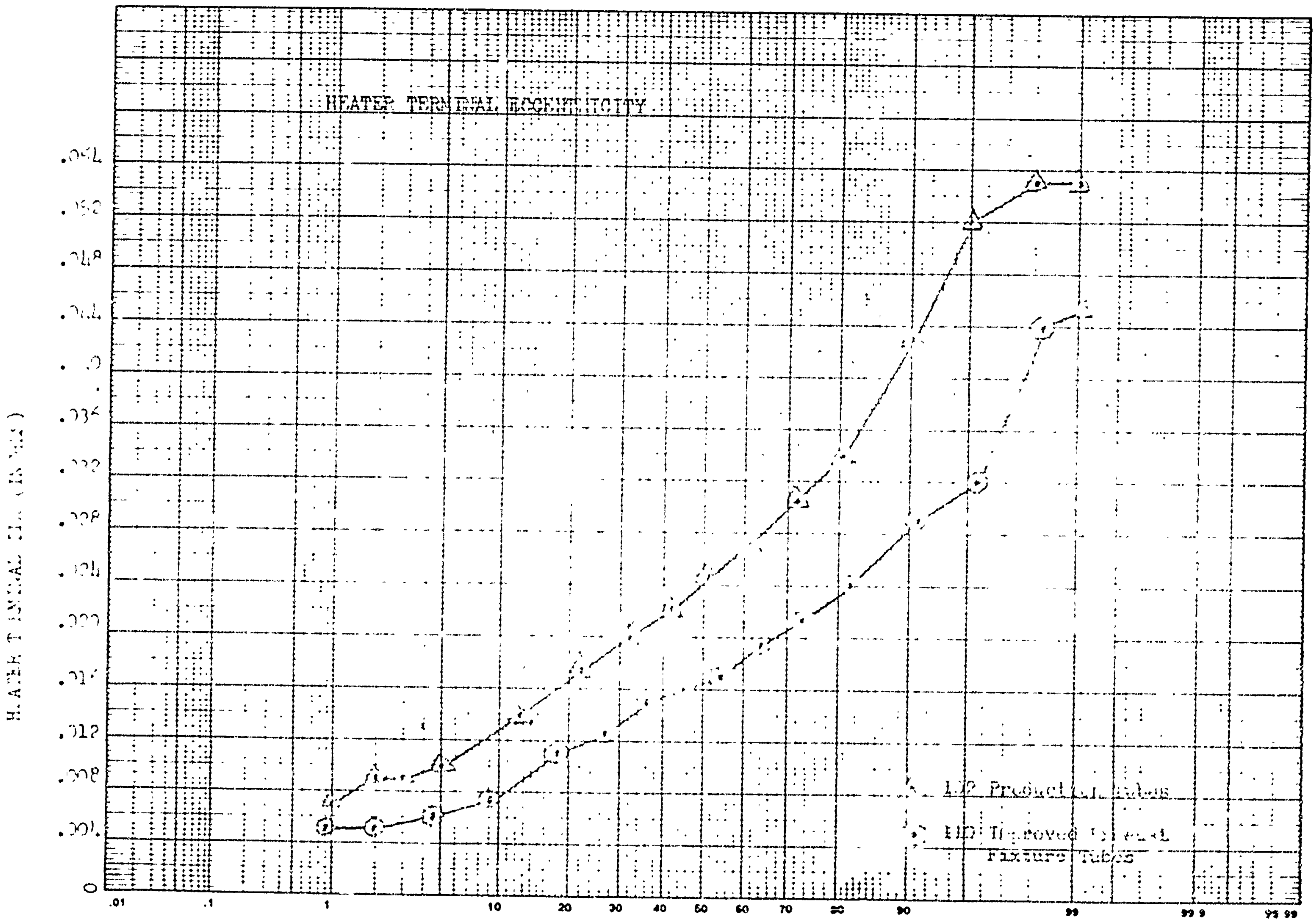
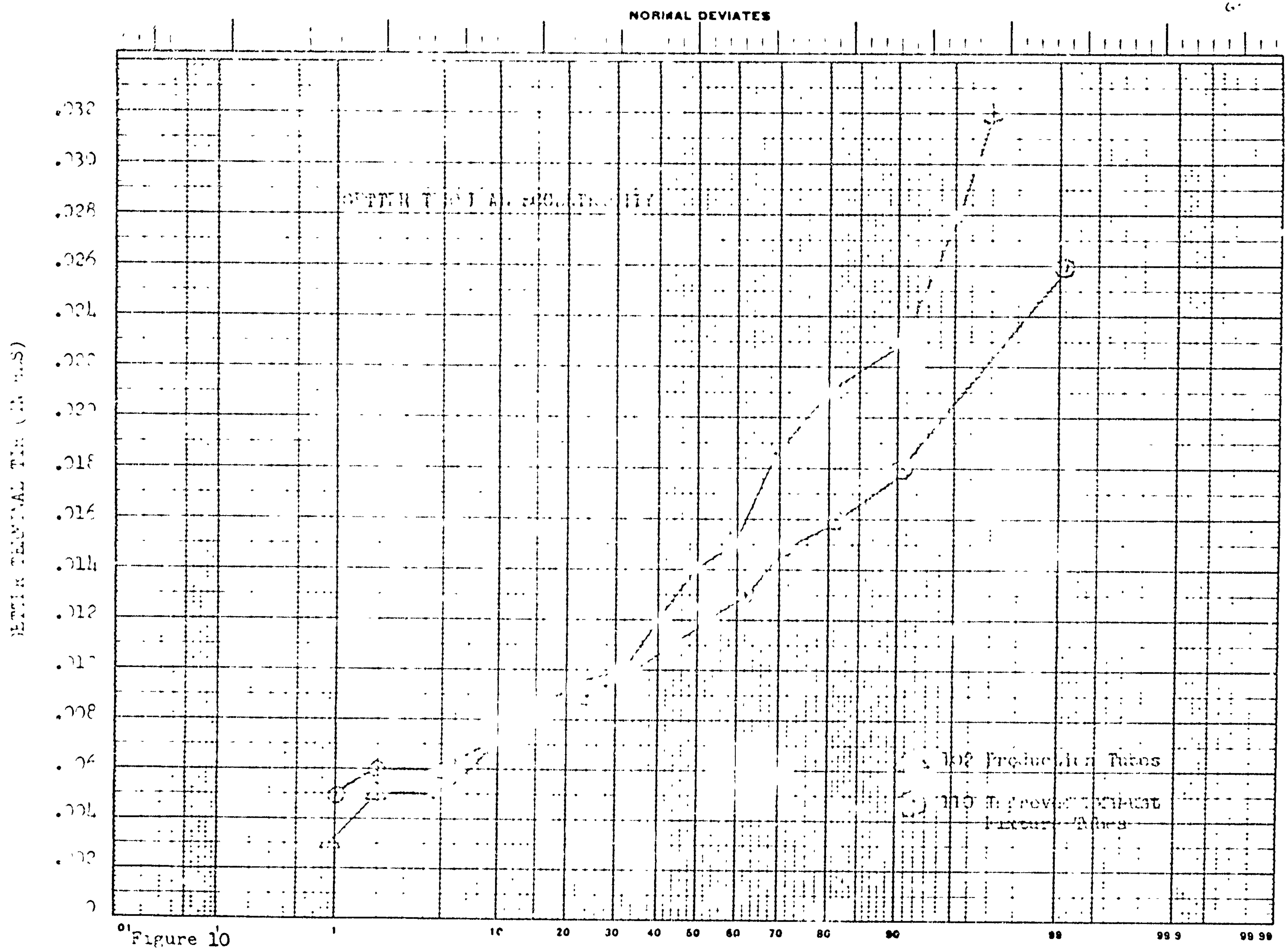


Figure 9


NORMAL DEVIATES
PERCENTAGE
01
1
10
20
30
40
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60
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80
90
99
99.9
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.012
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.016
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.026
.028
.030
.032

Figure 10

-35-

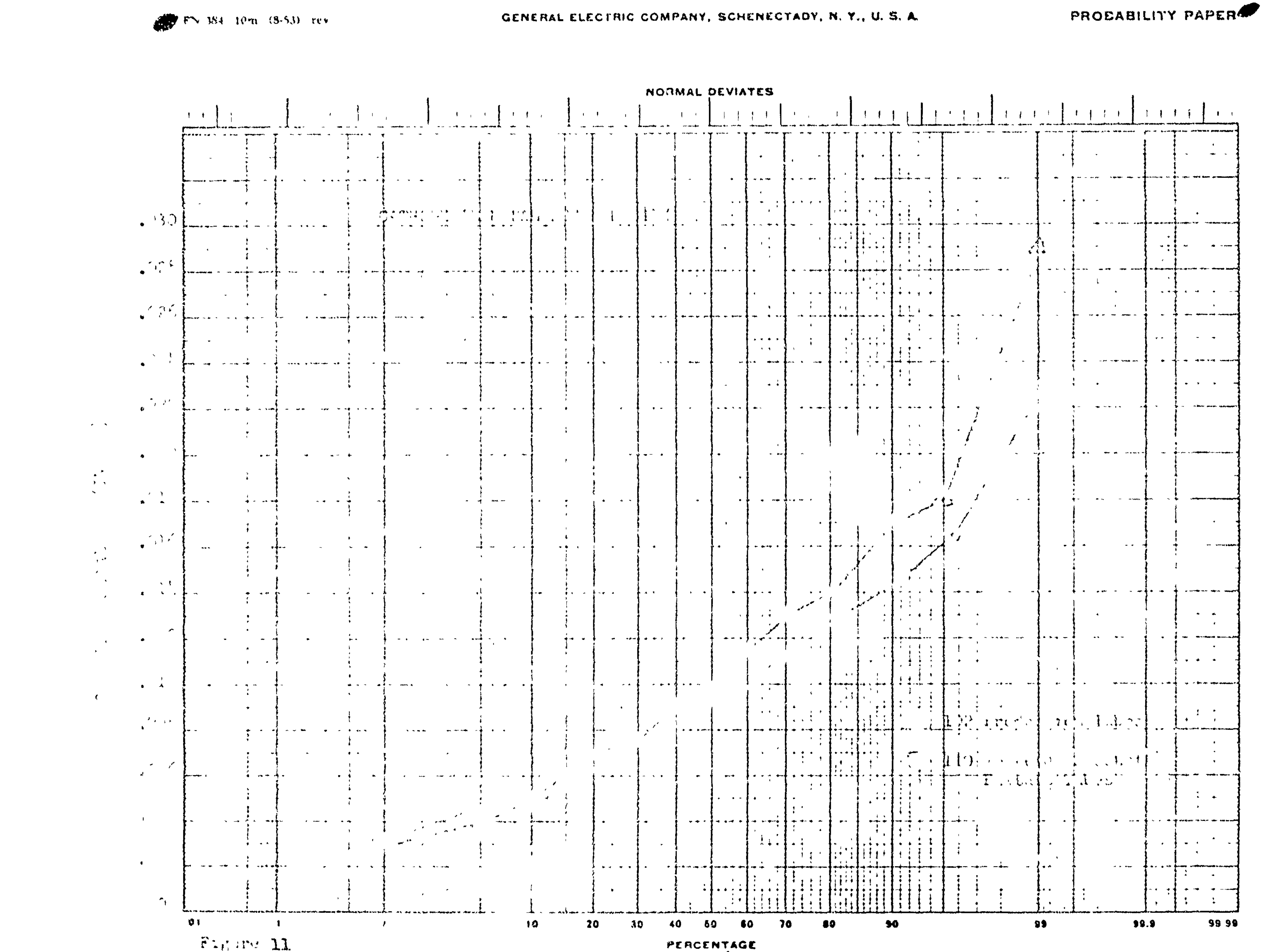
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., U. S. A.
PROBABILITY PAPER
NORMAL DEVIATES
.01
1
10
20
30
40
50
60
70
80
90
99
99.9
99.99
PERCENTAGE

Figure 11

Project X EXTENDED LIFE TESTING

This contract and the present MIL specification on the JAN 6299 specify 1000 hour life test. It is well recognized that much longer life than 1000 hours of operation is desired in many Signal Corps equipments. The purpose of this project is to determine the life results of the improved tube to 5000 hours and to determine the nature of any resulting failures so that information can be made available for possible tube or manufacturing improvements.

Control tubes were constructed for extended life testing. These tubes are standard JAN 6299's; however, they do include some of the benefits of the improved cathode spray project. Cathodes were sprayed with the Paasche A-automatic spray gun and the improved masking fixtures were used. The cathodes were sprayed to the density being used prior to optimization of cathode spray.

Tubes were constructed utilizing the improvements developed during the contract. These tubes and the control tubes were placed on life test.

Life test has now completed 1795 hours. Tube No. 8 of the test group failed as an air leaker at 566 hours. These tubes were constructed before the improvements in metalizing techniques were achieved. The hard solder seals are now stronger as a result of the change to finer particle size of the metalizing mix.

All remaining tubes still meet the 1000 hour life test end point. The improved tubes show 7% less median transconductance degradation than the control tubes. The grid voltage degradation is about 20% more in the improved tube. Noise figure, capacitances, and amplification factor are generally stable for both groups of tubes. Life test data is shown in Table V.

The complete 5000 hour life test data and the analysis of mode of failure will be presented in an addendum to the Final Report.

Table V

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 1					
If	308				
Eg	.75	.65	.60	.59	.45
Mu	110	107	108	110	112
Sm	16.1	16.0	15.9	15.8	15.4
Ik	7.0				
Eb	115				
Gain	18.4				
Noise	7.4	7.6	7.6	7.8	7.6
Cin	3.83	3.89	3.91	3.91	3.92
Cgp	1.72	1.72	1.72	1.71	1.73
Cpk	.016	.016	.016	.015	.017
Test Characteristic/Tube No. 2					
If	305				
Eg	.39	.39	.39	.38	.30
Mu	108	108	108	109	109
Sm	12.5	12.6	12.4	12.4	12.0
Ik	6.8				
Eb	152				
Gain	17.6				
Noise	8.0	8.3	7.8	8.3	8.1
Cin	3.61	3.61	3.61	3.61	3.62
Cgp	1.79	1.79	1.78	1.78	1.79
Cpk	.012	.003	.012	.011	.013

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristic/Tube No. 1						
If			306			
Eg	.59	.50	.59	.59	.38	.36
Mu	112	113	115	114	115	113
Sm	15.4	15.3	15.6	14.7	14.4	13.0
Ik			7.9			
Eb			128			
Gain			18.3			
Noise	7.8	7.6	7.5	7.7	7.3	7.2
Cin	3.92	3.91	3.90	3.87	3.86	3.87
Cgp	1.73	1.72	1.72	1.72	1.72	1.72
Cpk	.016	.016	.016	.017	.016	.015
Test Characteristic/Tube No. 2						
If			300			
Eg	.39	.39	.30	.39	.30	.11
Mu	109	110	110	111	111	109
Sm	11.8	11.8	11.6	11.4	11.0	10.0
Ik			7.0			
Eb			15.3			
Gain			17.4			
Noise	8.2	8.0	8.0	8.3	7.7	7.9
Cin	3.61	3.61	3.60	3.60	3.59	3.59
Cgp	1.79	1.79	1.79	1.78	1.78	1.78
Cpk	.012	.014	.011	.013	.011	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 3					
If	305				
Eg	.70	.65	.65	.65	.65
Mu	106	105	106	107	105
Sm	15.9	16.3	15.8	15.6	15.8
Ik	7.6				
Eb	121				
Gain	18.8				
Noise	6.8	6.9	6.8	7.3	7.2
Cin	3.90	3.89	3.89	3.87	3.90
Cgp	1.77	1.77	1.78	1.77	1.79
Cpk	.016	.016	.016	.015	.017
Test Characteristic/Tube No. 4					
If	308				
Eg	.45	.39	.30	.30	.15
Mu	119	119	118	120	121
Sm	14.5	14.4	13.5	14.0	11.7
Ik	4.0				
Eb	142				
Gain	18.2				
Noise	7.5	7.3	7.3	7.5	7.4
Cin	3.88	3.87	3.56	3.87	3.87
Cgp	1.71	1.70	1.70	1.70	1.72
Cpk	.014	.014	.014	.014	.016

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristic/Tube No. 3						
If			301			
Eg	.65	.59	.65	.60	.59	.52
Mu	107	106	106	108	107	105
Sm	15.7	15.4	15.2	15.0	14.5	14.2
Ik			7.2			
Eb			124			
Gain			18.8			
Noise	7.0	7.0	7.0	7.1	7.0	6.9
Cin	3.90	3.90	3.90	3.89	3.88	3.88
Cgp	1.79	1.78	1.78	1.78	1.78	1.78
Cpk	.016	.017	.016	.016	.015	.016
Test Characteristic/Tube No. 4						
If			303			
Eg	.30	.30	.39	.39	.25	.26
Mu	120	120	120	120	121	119
Sm	13.8	14.0	14.0	13.9	13.4	13.8
Ik			4.7			
Eb			54			
Gain			18.4			
Noise	7.5	7.4	7.2	7.4	7.1	7.3
Cin	3.86	3.86	3.85	3.84	3.84	3.84
Cgp	1.71	1.71	1.71	1.71	1.71	1.71
Cpk	.015	.010	.016	.015	.015	.015

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 5					
If	308				
Eg	.45	.39	.39	.28	.30
Mu	127	125	124	127	125
Sm	14.0	13.9	13.9	13.8	13.5
Ik	5.7				
Eb	149				
Gain	18.2				
Noise	7.6	7.3	7.2	7.5	7.7
Cin	3.60	3.61	3.60	3.60	3.62
Cgp	1.70	1.71	1.71	1.70	1.71
Cpk	.012	.013	.013	.012	.013

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 6					
If	309				
Eg	.39	.39	.30	13.1	.12
Mu	114	114	110	115	114
Sm	13.3	13.0	12.8	13.1	10.8
Ik	7.6				
Eb	146				
Gain	18.0				
Noise	7.6	7.7	7.6	7.8	7.9
Cin	3.53	3.53	3.53	3.52	3.54
Cgp	1.75	1.75	1.75	1.75	1.76
Cpk	.012	.013	.012	.012	.013

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Test Characteristic/Tube No. 5

Accum. Hrs.	726	866	1004	1286	1490	1795
If			301			
Eg	.19	.25	.25	.30	.25	.10
Mu	127	127	127	128	128	125
Sm	13.3	13.1	13.0	13.0	12.4	12.0
Ik			6.6			
Eb			163			
Gain			17.5			
Noise	7.5	7.6	7.5	7.8	7.3	7.8
Cin	3.59	3.59	3.58	3.58	3.56	3.56
Cgp	1.72	1.71	1.71	1.71	1.72	1.71
Cpk	.012	.013	.012	.014	.013	.013

Test Characteristic/Tube No. 6

Accum. Hrs.	726	866	1004	1286	1490	1795
If			307			
Eg	.30	.20	.30	.30	.19	.13
Mu	115	116	115	116	115	111
Sm	12.6	12.4	12.1	12.1	10.9	11.6
Ik			7.6			
Eb			162			
Gain			17.2			
Noise	7.9	7.7	8.1	8.1	7.5	7.6
Cin	3.52	3.52	3.51	3.50	3.50	3.49
Cgp	1.76	1.75	1.75	1.75	1.76	1.75
Cpk	.013	.008	.012	.014	.010	.012

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566

Test Characteristic/Tube No. 7

If	304				
Eg	.55	.65	.59	.55	.3[illegible]
Mu	113	111	109	113	113
Sm	16.2	16.7	16.3	16.5	16.2
Ik	7.5				
Eb	128				
Gain	18.8				
Noise	6.8	7.2	7.0	7.1	7.[illegible]
Cin	3.84	3.86	3.86	3.87	3.89
Cgp	1.72	1.72	1.72	1.72	1.73
Cpk	.015	.015	.015	.014	.015

Test Characteristic/Tube No. 8

If	313				
Eg	.99	.60	.90	.90	.79
Mu	87.0	88.9	86.4	87.[illegible]	88.7
Sm	14.0	16.3	13.2	13.7	12.6
Ik	7.2				
Eb	106				
Gain	18.2				
Noise	7.3	7.3	7.2	7.7	7.9
Cin	3.64	3.66	3.65	3.65	3.65
Cgp	1.88	1.89	1.89	1.88	1.[illegible]0
Cpk	.018	.018	.018	.018	.019

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristic/Tube No. 7						
If			300			
Eg	.50	.50	.59	.59	.50	.40
Mu	114	114	113	114	114	113
Sm	15.9	15.3	15.9	15.8	15.3	15.2
Ik			8.5			
Eb			132			
Gain			17.9			
Noise	7.1	7.0	7.0	7.3	7.0	7.0
Cin	3.89	3.89	3.88	3.88	3.86	3.86
Cgp	1.73	1.72	1.72	1.72	1.72	1.72
Cpk	.012	.015	.014	.016	.015	.015
Test Characteristic/Tube No. 8						
If			309			
Eg	.85	.85	.85	.89	.80	.71
Mu	87.8	98.0	86	88.5	89.0	88.0
Sm	13.0	13.0	12.7	12.7	12.2	12.0
Ik			6.3			
Eb			114			
Gain			16.4			
Noise	7.7	7.2	7.3	7.7	7.2	7.5
Cin	3.64	3.63	3.61	3.60	3.58	3.58
Cgp	1.90	1.90	1.90	1.90	1.90	1.90
Cpk	.018	.018	.017	.012	.019	.018

EXTENDED LIFE TEST

6299 Control Tubes

Eb = 200 VDC
Life Test Conditions: Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 9					
If	305				
Eg	.65	.70	.65	.65	.65
Mu	98.3	97.2	97.9	98.2	98.7
Sm	13.6	14.1	13.9	14.0	13.4
Ik	6.0				
Eb	127				
Gain	18.1				
Noise	7.2	7.3	7.4	7.4	7.3
Cin	3.69	3.69	3.69	3.69	3.70
Cgp	1.78	1.78	1.78	1.77	1.79
Cpk	.016	.016	.016	.015	.010

Test Characteristic/Tube No. 10					
If	309				
Eg	.39	.59	.50	.45	.15
Mu	118	116	115	116	116
Sm	12.7	13.9	13.2	13.8	11.6
Ik	5.3				
Eb	140				
Gain	17.8				
Noise	7.8	8.4	8.2	7.9	7.8
Cin	3.86	3.80	3.80	3.80	3.81
Cgp	1.74	1.75	1.75	1.75	1.75
Cpk	.014	.014	.014	.013	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristic/Tube No. 9						
If			301			
Eg	.65	.59	.59	.60	.45	.37
Mu	100	99.4	100	100	100	100
Sm	13.3	12.9	12.7	12.5	11.4	11.5
Ik			6.4			
Eb			131			
Gain			18.3			
Noise	7.3	7.3	8.1	7.3	7.3	7.6
Cin	3.70	3.69	3.69	3.68	3.67	3.67
Cgp	1.79	1.78	1.79	1.79	1.79	1.78
Cpk	.016	.017	.016	.016	.016	.016
Test Characteristic/Tube No. 10						
If			305			
Eg	.30	.45	.49	.45	.45	.31
Mu	116	116	116	116	115	115
Sm	13.0	13.7	13.8	13.5	12.9	12.6
Ik			8.0			
Eb			141			
Gain			18.6			
Noise	7.7	7.7	7.5	7.7	7.3	7.6
Cin	3.80	3.77	3.79	3.78	3.76	3.76
Cgp	1.76	1.75	1.75	1.75	1.75	1.75
Cpk	.015	.015	.014	.013	.010	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 11					
If	310				
Eg	.50	.50	.55	.48	.45
Mu	129	127	124	127	125
Sm	16.5	16.8	17.0	16.6	16.5
Ik	6.1				
Eb	125				
Gain	18.4				
Noise	7.3	7.3	7.4	7.5	7.4
Cin	3.92	3.93	3.93	3.95	3.96
Cgp	1.72	1.72	1.72	1.72	1.73
Cpk	.013	.014	.013	.013	.014
Test Characteristic/Tube No. 12					
If	309				
Eg	.45	.39	.39	.39	.19
Mu	112	112	112	113	113
Sm	13.2	13.1	13.0	13.0	11.[illegible]
Ik	6.8				
Eb	149				
Gain	17.7				
Noise	7.4	7.4	7.7	7.8	7.6
Cin	3.65	3.64	3.63	3.64	3.64
Cgp	1.71	1.71	1.71	1.70	1.71
Cpk	.014	.014	.014	.014	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristic/Tube No. 11

Accum. Hrs.	726	866	1004	1286	1490	1795
If			288			
Eg	.50	.50	.59	.50	.45	.32
Mu	125	125	124	127	126	124
Sm	16.6	16.2	16.7	16.0	15.9	15.5
Ik			7.5			
Eb			179			
Gain			19.6			
Noise	7.3	7.3	7.3	7.6	7.1	7.3
Cin	3.95	3.96	3.95	3.95	3.95	3.94
Cgp	1.73	1.73	1.72	1.72	1.73	1.72
Cpk	.014	.013	.012	.014	.014	.011

Test Characteristic/Tube No. 12

Accum. Hrs.	726	866	1004	1286	1490	1795
If			303			
Eg	.25	.30	.25	.30	.19	.14
Mu	114	113	114	115	115	112
Sm	11.9	12.6	12.1	12.0	10.9	11.0
Ik			6.1			
Eb			166			
Gain			18.2			
Noise	7.6	7.5	7.3	7.7	7.3	7.1
Cin	3.65	3.62	3.62	3.62	3.61	3.61
Cgp	1.71	1.71	1.71	1.71	1.71	1.71
Cpk	.014	.010	.013	.014	.011	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 13					
If	309				
Eg	.65	.60	.40	.59	.50
Mu	104	104	102	105	103
Sm	14.1	14.0	14.0	13.8	13.8
Ik	5.8				
Eb	125				
Gain	18.1				
Noise	7.5	7.7	7.6	7.7	7.6
Cin	3.90	3.89	3.89	3.89	3.91
Cgp	1.76	1.76	1.76	1.76	1.78
Cpk	.015	.015	.015	.015	.016
Test Characteristic/Tube No. 14					
If	309				
Eg	.50	.50	.45	.39	.35
Mu	117	116	114	118	117
Sm	14.8	14.8	14.7	14.6	14.2
Ik	6.6				
Eb	135				
Gain	18.1				
Noise	7.3	7.1	6.9	7.4	7.3
Cin	3.46	3.45	3.45	3.45	3.46
Cgp	1.74	1.74	1.74	1.73	1.77
Cpk	.014	.014	.014	.014	.015

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristic/Tube No. 13

Accum. Hrs.	726	866	1004	1286	1490	1795
If			306			
Eg	.59	.59	.50	.60	.45	.40
Mu	106	105	104	104	105	105
Sm	13.7	13.6	13.4	13.5	13.1	13.0
Ik			6.9			
Eb			137			
Gain			17.5			
Noise	7.4	7.5	7.2	7.7	7.5	7.3
Cin	3.90	3.89	3.68	3.88	3.88	3.88
Cgp	1.77	1.73	1.77	1.78	1.77	1.78
Cpk	.015	.015	.016	.014	.015	.014

Test Characteristic/Tube No. 14

Accum. Hrs.	726	866	1004	1286	1490	1795
If			309			
Eg	.39	.39	.45	.45	.25	.21
Mu	118	118	118	119	119	119
Sm	13.5	13.6	13.9	13.8	12.6	12.8
Ik			5.9			
Eb			145			
Gain			18.3			
Noise	7.7	7.1	7.1	7.1	7.0	6.9
Cin	3.44	3.44	3.43	3.44	3.43	3.42
Cgp	1.76	1.74	1.74	1.74	1.74	1.74
Cpk	.014	.015	.015	.014	.015	.014

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristic/Tube No. 15					
If	308				
Eg	.50	.50	.45	.39	.29
Mu	111	110	109	110	110
Sm	13.2	13.2	13.2	12.9	12.1
Ik	7.1				
Eb	137				
Gain	17.5				
Noise	7.5	7.6	7.7	7.8	7.6
Cin	3.57	3.57	3.59	3.58	3.62
Cgp	1.76	1.76	1.76	1.76	1.78
Cpk	.014	.014	.014	.013	.013

EXTENDED LIFE TEST

6299 Control Tubes

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristic/Tube No. 15						
If			301			
Eg	.35	.30	.30	.39	.19	.15
Mu	111	111	112	112	113	109
Sm	12.5	12.0	11.7	11.8	10.3	10.8
Ik			7.4			
Eb			160			
Gain			18.6			
Noise	7.7	7.7	7.7	7.8	7.6	7.9
Cin	3.59	3.60	3.59	3.58	3.57	3.57
Cgp	1.78	1.76	1.77	1.77	1.77	1.77
Cpk	.014	.013	.014	.013	.014	.014

Table V

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristics/Tube No. 1					
If	301	-			
Eg	.50	.55	.45	.45	.30
Mu	108	109	108	110	110
Sm	14.0	14.2	13.0	13.6	12.9
Ik	5.9				
Eb	136				
Gain	18.2				
Noise	7.3	7.3	7.6	7.4	7.4
Cin	3.50	3.45	3.47	3.46	3.48
Cgp	1.80	1.80	1.78	1.78	1.81
Cpk	.015	.015	.015	.015	.016
Test Characteristics/Tube No. 2					
If	303				
Eg	.30	.19	.25	.20	.19
Mu	124	124	122	125	124
Sm	13.2	13.4	13.1	13.7	13.3
Ik	4.2				
Eb	163				
Gain	17.6				
Noise	7.7	7.2	7.4	7.6	7.7
Cin	3.42	3.41	3.41	3.41	3.43
Cgp	1.70	1.69	1.69	1.69	1.70
Cpk	.014	.013	.013	.014	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC; Ef = 6.3 V; RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristics/Tube No. 1						
If			301			
Eg	.19	.39	.45	.48	.30	.30
Mu	110	110	110	110	110	108
Sm	10.9	12.8	13.3	13.4	12.6	12.9
Ik			3.8			
Eb			147			
Gain			18.2			
Noise	7.3	7.3	7.0	7.9	7.6	7.3
Cin	3.47	3.48	3.46	3.46	3.46	3.46
Cgp	1.81	1.81	1.81	1.81	1.81	1.81
Cpk	.015	.016	.016	.016	.016	.016
Test Characteristics/Tube No. 2						
If			301			
Eg	.17	.20	.25	.25	.19	.09
Mu	125	124	125	125	125	124
Sm	13.0	13.0	13.2	13.3	13.0	13.0
Ik			3.4			
Eb			169			
Gain			17.7			
Noise	7.8	7.8	7.5	7.8	7.7	7.8
Cin	3.43	3.42	3.43	3.43	3.42	3.41
Cgp	1.70	1.70	1.69	1.69	1.69	1.70
Cpk	.015	.015	.014	.014	.015	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566

Test Characteristics/Tube No. 3

If	302				
Eg	.45	.29	.25	.20	.15
Mu	127	127	125	129	129
Sm	15.5	15.6	15.0	15.2	14.3
Ik	8.5				
Eb	139				
Gain	17.6				
Noise	7.8	7.9	8.3	7.9	7.8
Cin	3.34	3.35	3.32	3.36	3.38
Cgp	1.71	1.71	1.71	1.71	1.72
Cpk	.013	.012	.013	.012	.014

Test Characteristics/Tube No. 4

If	303				
Eg	.59	.45	.45	.39	.30
Mu	105	105	105	106	106
Sm	13.0	13.2	13.3	13.0	12.6
Ik	6.8				
Eb	135				
Gain	17.4				
Noise	7.6	7.8	8.1	7.8	7.8
Cin	3.31	3.30	3.32	3.30	3.32
Cgp	1.82	1.82	1.82	1.82	1.83
Cpk	.014	.014	.014	.014	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/Tube No. 3

Accum. Hrs.	726	866	1004	1286	1490	1795
If			289			
Eg	.19	.25	.25	.25	.19	.05
Mu	128	128	129	129	129	127
Sm	14.3	14.3	14.4	14.2	13.3	13.2
Ik			8.1			
Eb			180			
Gain			17.4			
Noise	8.1	8.0	7.8	7.9	7.9	7.9
Cin	3.37	3.37	3.36	3.36	3.35	3.33
Cgp	1.73	1.72	1.72	1.72	1.72	1.72
Cpk	.014	.013	.014	.014	.015	.013

Test Characteristics/Tube No. 4

Accum. Hrs.	726	866	1004	1286	1490	1795
If			301			
Eg	.38	.39	.39	.39	.25	.19
Mu	106	106	106	106	107	105
Sm	12.3	12.3	12.2	12.1	11.4	11.5
Ik			6.4			
Eb			153			
Gain			17.0			
Noise	7.7	7.7	7.9	8.1	7.7	7.7
Cin	3.32	3.33	3.32	3.32	3.31	3.31
Cgp	1.84	1.83	1.83	1.84	1.84	1.85
Cpk	.015	.015	.014	.014	.015	.014

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566

Test Characteristics/Tube No. 5

If	302				
Eg	.55	.45	.40	.40	.33
Mu	113	113	113	114	114
Sm	16.0	15.8	15.8	15.9	15.3
Ik	6.7				
Eb	132				
Gain	18.2				
Noise	7.3	8.2	7.9	8.1	8.2
Cin	3.43	3.46	3.45	3.44	3.45
Cgp	1.69	1.69	1.70	1.68	1.70
Cpk	.015	.015	.015	.015	.015

Test Characteristics/Tube No. 6

If	308				
Eg	.59	.50	.59	.50	.45
Mu	113	111	110	112	112
Sm	16.5	16.4	16.1	16.3	16.2
Ik	5.6				
Eb	123				
Gain	18.5				
Noise	7.2	7.5	7.6	7.7	7.3
Cin	3.56	3.55	3.57	3.55	3.56
Cgp	1.73	1.73	1.76	1.73	1.75
Cpk	.017	.016	.016	.016	.017

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/Tube No. 5

Accum. Hrs.	726	866	1004	1286	1490	1795
If			300			
Eg	.39	.39	.45	.45	.39	.20
Mu	114	114	115	114	115	115
Sm	15.3	15.0	15.2	15.1	14.6	14.5
Ik			5.9			
Eb			148			
Gain			17.8			
Noise	7.6	7.7	7.6	7.6	7.4	7.4
Cin	3.45	3.45	3.43	3.44	3.44	3.43
Cgp	1.70	1.70	1.70	1.70	1.70	1.70
Cpk	.016	.016	.016	.016	.016	.015

Test Characteristics/Tube No. 6

Accum. Hrs.	726	866	1004	1286	1490	1795
If			305			
Eg	.50	.50	.49	.59	.40	.41
Mu	113	113	114	112	114	111
Sm	15.6	15.8	15.3	15.3	14.9	14.8
Ik			5.2			
Eb			136			
Gain			19.0			
Noise	7.4	7.6	7.4	7.4	7.1	7.3
Cin	3.56	3.59	3.56	3.54	3.53	3.54
Cgp	1.76	1.75	1.75	1.75	1.75	1.76
Cpk	.016	.017	.016	.017	.016	.018

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/Tube No. 7

Accum. Hrs.	0	108	245	406	566
If	309				
Eg	.49	.49	.30	.30	.25
Mu	114	114	114	115	115
Sm	13.9	13.9	13.2	13.9	13.3
Ik	5.8				
Eb	139				
Gain	17.6				
Noise	7.2	7.1	7.6	7.7	7.7
Cin	3.27	3.26	3.27	3.27	3.26
Cgp	1.72	1.72	1.73	1.72	1.74
Cpk	.014	.014	.014	.014	.015

Test Characteristics/Tube No. 8

Accum. Hrs.	0	108	245	406	566
If	305				
Eg	.50	.49	.25	.40	.10
Mu,	113	113	112	114	86
Sm	13.2	13.4	12.8	13.9	0
Ik	4.6				
Eb	146				
Gain	17.9				
Noise	7.5	7.1	8.1	7.6	
Cin	3.25	3.23	3.24	3.27	3.26
Cgp	1.68	1.68	1.68	1.68	1.69
Cpk	.014	.014	.014	.014	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/<u>Tube No. 7</u>

Accum. Hrs.	726	866	1004	1286	1490	1795
If			307			
Eg	.25	.30	.30	.59	.30	.19
Mu	115	115	116	113	115	114
Sm	13.4	13.2	13.4	11.5	13.4	13.0
Ik			4.6			
Eb			158			
Gain			18.4			
Noise	7.5	7.3	7.3	7.7	7.3	7.3
Cin	3.27	3.29	3.27	3.26	3.27	3.27
Cgp	1.74	1.74	1.73	1.73	1.73	1.74
Cpk	.015	.015	.014	.015	.015	.015

Test Characteristics/<u>Tube No. 8</u>

If	
Eg	
Mu	
Sm	
Ik	
Eb	SLOW AIR LEAKER
Gain	
Noise	
Cin	
Cgp	
Cpk	

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V, RK/Ib = 10 Ma

Accum Hrs.	0	108	245	406	566

Test Characteristics/Tube No. 9

If	305				
Eg	.85	.75	.70	.70	.65
Mu	100	100	100	100	100
Sm	15.1	15.1	14.6	15.0	15.0
Ik	3.9				
Eb	110				
Gain	18.3				
Noise	7.4	7.2	7.9	7.4	7.2
Cin	3.93	3.90	3.90	3.89	3.90
Cgp	1.70	1.71	1.71	1.70	1.72
Cpk	.020	.020	.020	.020	.021

Test Characteristics/Tube No. 10

If	303				
Eg	.40	.45	.39	.39	.39
Mu	114	114	113	115	115
Sm	14.2	13.9	13.9	14.0	14.0
Ik	6.7				
Eb	148				
Gain	18.1				
Noise	7.6	7.4	7.7	7.6	7.6
Cin	3.09	3.06	3.06	3.05	3.06
Cgp	1.69	1.69	1.70	1.69	1.70
Cpk	.014	.014	.014	.013	.014

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/Tube No. 9

Accum. Hrs.	726	866	1004	1286	1490	1795
If			303			
Eg	.70	.70	.70	.70	.59	.56
Mu	100	100	100	100	100	100
Sm	14.7	14.7	14.7	14.5	14.6	14.5
Ik			3.8			
Eb			121			
Gain			18.2			
Noise	7.6	7.2	7.0	7.4	7.0	6.9
Cin	3.91	3.90	3.88	3.88	3.88	3.87
Cgp	1.73	1.72	1.71	1.78	1.72	1.72
Cpk	.021	.021	.020	.021	.021	.021

Test Characteristics/Tube No. 10

Accum. Hrs.	726	866	1004	1286	1490	1795
If			299			
Eg	.39	.19	.38	.30	.39	.24
Mu	115	120	115	115	115	114
Sm	13.6	11.5	13.0	12.9	13.1	13.0
Ik			6.7			
Eb			171			
Gain			17.6			
Noise	7.4	7.2	7.3	7.6	7.6	7.8
Cin	3.08	3.08	3.05	3.05	3.04	3.02
Cgp	1.71	1.71	1.70	1.70	1.70	1.70
Cpk	.014	.014	.014	.014	.010	.014

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristics/Tube No. 11					
If	309				
Eg	.39	.30	.30	.39	.25
Mu	119	119	118	120	120
Sm	15.0	15.1	14.2	15.0	14.3
Ik	3.8				
Eb	148				
Gain	18.9				
Noise	7.6	7.1	7.7	7.3	7.2
Cin	3.51	3.51	3.56	3.49	3.51
Cgp	1.62	1.61	1.62	1.61	1.62
Cpk	.015	.015	.015	.017	.016
Test Characteristics/Tube No. 12					
If	305				
Eg	.50	.50	.45	.40	.45
Mu	105	105	104	105	105
Sm	14.2	14.2	14.1	14.0	14.0
Ik	5.4				
Eb	139				
Gain	18.0				
Noise	8.4	7.4	8.1	7.8	7.6
Cin	3.50	3.50	3.50	3.40	3.50
Cgp	1.72	1.73	1.73	1.72	1.74
Cpk	.017	.017	.016	.018	.017

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795

Test Characteristics/Tube No. 11

If			307			
Eg	.30	.39	.39	.39	.30	.24
Mu	120	120	120	120	120	119
Sm	14.4	15.1	14.5	14.6	14.2	14.2
Ik			4.0			
Eb			156			
Gain			18.3			
Noise	7.1	7.1	7.1	7.1	7.3	6.9
Cin	3.53	3.53	3.52	3.51	3.52	3.51
Cgp	1.63	1.62	1.62	1.62	1.62	1.62
Cpk	.017	.015	.016	.017	.017	.016

Test Characteristics/Tube No. 12

If			303			
Eg	.45	.49	.45	.45	.40	.34
Mu	105	105	105	105	105	105
Sm	13.9	13.5	13.9	13.4	13.3	13.2
Ik			5.5			
Eb			147			
Gain			17.7			
Noise	7.7	7.3	7.4	7.7	7.3	7.5
Cin	3.49	3.49	3.50	3.49	3.40	3.50
Cgp	1.75	1.74	1.74	1.74	1.74	1.74
Cpk	.017	.017	.014	.016	.018	.018

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC; Ef = 6.3 V RK/IB = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristics/Tube No. 13					
If	308				
Eg	.39	.25	.20	.19	.19
Mu	119	118	117	120	119
Sm	12.5	12.5	12.0	12.6	11.3
Ik	5.6				
Eb	152				
Gain	17.0				
Noise	8.4	8.1	8.1	8.2	8.2
Cin	3.14	3.14	3.15	3.15	3.15
Cgp	1.74	1.75	1.76	1.74	1.76
Cpk	.012	.012	.012	.004	.013
Test Characteristics/Tube No. 14					
If	301				
Eg	.45	.45	.30	.39	.29
Mu	123	122	121	123	122
Sm	14.7	15.3	15.0	15.2	14.6
Ik	6.2				
Eb	142				
Gain	18.4				
Noise	7.3	7.2	7.7	7.3	7.3
Cin	3.17	3.20	3.19	3.18	3.20
Cgp	1.73	1.73	1.73	1.73	1.75
Cpk	.014	.013	.014	.015	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC, Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	726	866	1004	1286	1490	1795
Test Characteristics/Tube No. 13						
If			310			
Eg	.19	.19	.15	.19	.19	.06
Mu	119	119	119	110	119	119
Sm	12.0	11.7	11.2	11.1	11.8	11.6
Ik			5.5			
Eb			178			
Gain			17.3			
Noise	8.0	7.8	7.7	8.1	7.7	7.8
Cin	3.19	3.19	3.17	3.15	3.15	3.14
Cgp	1.76	1.76	1.70	1.75	1.75	1.76
Cpk	.012	.013	.013	.014	.014	.014
Test Characteristics/Tube No. 14						
If			300			
Eg	.39	.19	.39	.45	.39	.29
Mu	122	123	124	123	124	123
Sm	15.1	11.0	14.4	14.7	14.6	14.7
Ik			6.6			
Eb			148			
Gain			18.4			
Noise	7.2	7.2	7.3	7.3	7.1	7.2
Cin	3.20	3.20	3.18	3.19	3.19	3.20
Cgp	1.76	1.75	1.75	1.75	1.76	1.76
Cpk	.012	.014	.015	.014	.014	.014

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Accum. Hrs.	0	108	245	406	566
Test Characteristics/Tube No. 15					
If	300				
Eg	.45	.45	.39	.39	.30
Mu	110	109	103	110	109
Sm	14.1	15.1	14.0	15.0	14.9
Ik	8.1				
Eb	151				
Gain	17.6				
Noise	7.5	7.5	8.2	7.8	7.5
Cin	3.44	3.44	3.43	3.43	3.45
Cgp	1.88	1.90	1.91	1.92	1.95
Cpk	.015	.015	.015	.015	.015

EXTENDED LIFE TEST

Improved 6299

Life Test Conditions: Eb = 200 VDC
Ef = 6.3 V RK/Ib = 10 Ma

Test Characteristics/Tube No. 15

Accum. Hrs.	726	866	1004	1286	1490	1795
If			305			
Eg	.39	.19	.39	.45	.39	.30
Mu	110	112	110	110	110	108
Sm	14.4	14.2	14.1	14.2	13.4	13.7
Ik			8.3			
Eb			150			
Gain			17.1			
Noise	7.8	7.5	7.5	7.7	7.8	8.0
Cin	3.43	3.44	3.42	3.42	3.42	3.41
Cgp	1.95	1.95	1.95	1.96	1.96	1.97
Cpk	.015	.016	.016	.016	.015	.015

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CONCLUSIONS

The temperature controller does decrease the operator skill required to perform an uniform exhaust cycle and thereby insures a more uniform product.

The inverted cathode support ring with .00045" cathode foil will give proper cathode temperature and result in better uniformity, increased ruggedness and a better cathode-to-cathode shell connections.

Tubes with three seals of the hard solder construction with copper-nickel-gold plating and a-c aging have shown good results or life test with the anode seal at 225° C. Tubes of this construction are superior to the regular 6299 on high temperature operation.

Failure of the 6299 during humidity testing has been found to be due to hydrogen penetration of the base metal of the tube's shell. The best results in minimizing hydrogen penetration has been obtained by a good plating of the tube.

Results from improved alignment and concentricity, optimization of cathode coating, and improved exhaust fixturing are now being applied to regular production tubes. Improved cleaning and plating resulting from humidity testing is also now standard practice.

Increased strength and uniformity in hard solder seals has been obtained by using a finer particle size in the metalizing mix used to coat the high alumina ceramics.

The pilot run has been completed and conforms to the test specification.

The extended life test has completed 1795 hours. The complete 5000 hour life test data and the analysis of mode of failure will be presented in an addendum to the Final Report.

PUBLICATIONS, LECTURES

REPORTS AND CONFERENCES

PUBLICATIONS - None

LECTURES - None

REPORTS - Monthly Narrative Reports Nos. 1 - 8
Development Of An Improved JAN 6299
by F. A. Marra for the period from
1 May 1961 through 31 December 1961.

Monthly Narrative Reports Nos. 9 - 12
Development Of An Improved JAN 6299
by F. S. Sawicki for the period from
1 January 1962 through 30 April 1962.

Monthly Narrative Reports Nos. 13 - 34
Development Of An Improved JAN 6299
by D. L. Cook for the period from
15 September 1962 through 30 June 1964.

Quarterly Progress Reports Nos. 1 - 3
Development Of An Improved JAN 6299
by F. A. Marra for the period from
1 May 1961 through 31 January 1962.

Quarterly Progress Report No. 4
Development Of An Improved JAN 6299
by F. S. Sawicki for the period from
1 February 1962 through 30 April 1962

Quarterly Progress Reports Nos. 5 - 10
Development Of An Improved JAN 6299
by D. L. Cook for the period from
17 September 1962 through 31 March 1964

CONFERENCES - 1. Organization and personnel present:

USASSA
H. P. Blodgett

General Electric Company
A. T. Tomko, J. D. Secord, F. A. Marra

C

CONFERENCES - 1. Place and date:

General Electric Company
Receiving Tube Department
Scranton, Pennsylvania

September 11, 1961

Subject:

Review status of the contract.

2. Organization and personnel present:

USASSA
L. Coblentz

General Electric Company
J. E. Campbell, J. T. Duncan, F. S. Sawicki
J. D. Secord, H. L. Thorson, A. T. Tomko

Place and date:

General Electric Company
Receiving Tube Department
Scranton, Pennsylvania

February 15, 1962

Subject:

Discuss what effect the transfer of Production Engineering measures Contract No. DA-36-039-SC-85953 (Type 6299) to Owensboro, Kentucky, would have on performance.

3. Organization and personnel present:

USASSA
F. Vitali, L. Coblentz

General Electric Company
D. L. Cook, L. K. LaDue, F. S. Sawicki,
J. D. Secord, A. T. Tomko

Place and date:

General Electric Company
Receiving Tube Department
Scranton, Pennsylvania

April 10, 1962

CONFERENCES - 3. Subject:

?eview status of contract and discuss what effect the transfer of Production Engineering measures Contract No. DA-36-039-SC-85953 (Type 6299) to Owensboro, Kentucky will have on performance.

4. Organization and personnel present:

USASSA
L. Coblentz

General Electric Company
L. Cook, E. L. Davis, J. T. Duncan, A. T. Tomko

Place and date:

General Electric Company
Receiving Tube Department
Owensboro, Kentucky

September 12, 1962

Subject:

Review status of the contract and discuss the effects of the transfer of Production Engineering measures Contract No. DA-36-039-SC-85953 (Type 6299) to Owensboro, Kentucky.

5. Organization and personnel present:

USASSA
L. Coblentz

General Electric Company
L. L. Cook, E. L. Davis, J. N. McClanahan, A. T. Tomko

Place and date:

General Electric Company
316 East Ninth Street
Owensboro, Kentucky

January 15, 1963

Subject:

Review status of the contract.

 - 6. Organization and personnel present: CO

USASSA
Leonard Coblentz

General Electric Company
D. L. Cook, E. L. Davis, A. T. Tomko

Place and date:

General Electric Company
Receiving Tube Department
Owensboro, Kentucky

April 24, 1963

Subject:

Review status of the contract

7. Organization and personnel present:

USAERDL
Helmuth Kaunzinger

General Electric Company
D. L. Cook, E. L. Davis, A. T. Tomko

Place and date:

General Electric Company
Receiving Tube Department
Owensboro, Kentucky

June 26, 1963

Subject:

Review status of the contract

8. Organization and personnel present

USASSA
Leonard Coblentz

General Electric Company
D. L. Cook, E. L. Davis, D. L. Dyke, A. T. Tomko

CONFERENCES - 8. Place and date:

General Electric Company
Tube Department
Owensboro, Kentucky

October 16, 1963

Subject:

Review status of the contract

9. Organization and personnel present

USAEMSA
Simon Zucker

General Electric Company
D. L. Cook, E. L. Davis, A. T. Tomko

Place and date:

General Electric Company
Tube Department
Owensboro, Kentucky

November 14, 1963

Subject:

Discuss specification for testing of preproduction samples.

10. Organization and personnel present

USASSA
Stan Sockalov

General Electric Company
D. L. Cook, E. L. Davis, M. R. Speray, A. T. Tomko

Place and date:

General Electric Company
Tube Department
Owensboro, Kentucky

January 24, 1964

Subject:
Review status of the contract and view pilot run facilities.

IDENTIFICATION OF TECHNICIANS

A. MAN POWER EFFORT

TECHNICAL

Barrass, Martha	17
Childs, C. G.	19
Cook, D. L.	1637
Crawford, S. C.	23
Dyke, D. L.	62
Grady, B. I.	28
Haberkern, R. J.	45
Jeffery, L. F.	2
Kirby, P.	19
LaDue, L. K.	250
Marra, F. A.	744
McClanahan, J. N.	127
McDowell, J. K.	8
Moore, G. E.	10
Moredock, D.	2
Morris, M. E.	[illegible]
Owsley, W. F.	364
Ringland, R. S.	10
Sawicki, F. S.	320
Speray, M. R.	18
Stephens, P.	18
Tomko, A. T.	471
Winkler, R. H.	20

BIOGRAPHICAL INFORMATION - TECHNICAL

Cook, D. L.

A native of Potosi, Missouri, Mr. Cook received a Bachelor's Degree in Electrical Engineering from Missouri School of Mines and Metallurgy in 1960.

He has been associated with the General Electric Company since that time starting as an Engineering and Science Program trainee.

Since 1961, he has worked in Planar tube manufacturing except for a three month assignment in Planar Product Design Engineering.

Mr. Cook had responsibility for technical cognizance and guidance of the contract for the period from 15 September 1962 through the completion of the contract.

LaDue, L. K.

Mr. LaDue is a native of New York State where he graduated in 1955 from St. Lawrence University. He joined the General Electric Company, Electronic Division Physics Training Program briefly prior to entering the military service.

From 1956 through 1960 he served as a lieutenant in the U. S. Army Corps of Engineers.

Upon leaving the service in early 1961 he joined the Receiving Tube Department's Planar Design Section. He was with the Receiving Tube Department's Scranton planar production facility for approximately one year assigned to small ceramic lighthouse transmitting tubes. In 1962 he was transferred to the Owensboro location as Planar Design Engineer.

Marra, F. A.

A native of Jessup, Pennsylvania, Mr. Marra earned his Bachelor's Degree in Electrical Engineering from the Pennsylvania State University in 1956.

He has been associated with the General Electric Company since that time starting as a Manufacturing Training Program trainee.

From 1957 to 1961, his assignments have been that of a Factory Engineer responsible for the manufacture of Thyratrons and Ceramic Lighthouse tubes.

Mr. Marra had responsibility for technical cognizance and guidance of the contract for the period from 1 May 1961 through 31 December 1961.

McClanahan, J. N.

Mr. McClanahan, a native of Kansas, received his Bachelor's Degree in Electrical Engineering from the University of Kansas in June, 1962.

Upon graduation, he joined the Planar and Thyratron Section as a Process Control Engineer, working primarily on the Miniature Ceramic Lighthouse tubes for one year.

Morris, M.E.

Mr. Morris is a native of Lancaster, Kentucky. He served as an Airborne Radio and Radar Repairman in the U.S.A.F. from 1954 to 1958.

He spent two and one half years at Valparaiso Technical Institute where he received an associate degree in Electronic Engineering.

Upon leaving school in June, 1960, he joined the General Electric Company in Owensboro, Kentucky, serving as an engineering aide in the Miniature Ceramic Section.

Morris, M. E. (Cont'd)

In December 1963, he joined the Ceramic Lighthouse Section, serving as a Tube Engineering Technician.

During his tenure at General Electric, he has continued work toward a B.S. by way of night school.

Owsley, N. F.

Mr. Owsley has over 25 years experience as a chemist in electron tube manufacturing operations. He is presently chemist for General Electric Planar-Thyratron manufacturing operations, located at Owensboro, Kentucky.

He was employed by the Engineering section - chemical laboratory and chemical preparations Ken-Rad Tube and Lamp Corporation, Owensboro, Kentucky, in 1933. His assignments were: analytical chemist, chemical preparations, process development and control.* In 1936 he was transferred to factory engineering as Process Control Engineer. He left the Ken-Rad organization in 1938.

Between 1938 and 1942 he was employed in crude oil production, initially setting up and operating a field laboratory for checking and controlling the salt content of crude oil purchased for shipment to refineries.

He returned to the Ken-Rad organization, February, 1942, as chief chemist for Ken-Rad Transmitting Tube Corporation of Owensboro, Kentucky. His assignments were to set up and supervise the operation of a chemical preparations section, to develop and control processes related to the production of transmitting and cathode-ray tubes, included were electro-plating operations.

Owsley, W. F. (Cont'd)

Mr. Owsley became associated with the General Electric Company through its purchase of the Ken-Rad installations in 1945. He continued with General Electric as a chemist supervising the operation of the chemical laboratory and chemical preparation section serving all of the Owensboro manufacturing operations. He was assigned special projects related to process development and control and in new materials evaluation in the production of metal and glass receiving tubes.

In mid 1951 he was transferred to the General Electric Anniston Tube Plant organization as chief chemist, later becoming Supervisor of process control. The balance of 1951, he spent in the planning and procurement of laboratory and chemical preparation facilities for establishment in the new plant. He transferred to the Anniston, Alabama location March 31, 1952.

Mr. Owsley was transferred to the Owensboro Planar-Thyratron Operation February 1963. His present position title: Engineer, Chemical Process Control.

* As related to the manufacturing of metal and glass receiving tubes.

Sawicki, F. S.

A native of Scranton, Pennsylvania, Mr. Sawicki attended the University of Scranton, where he received his bachelor's degree in Electronics in 1958.

He has been associated with General Electric Company since 1954.

From 1959 through 1962 as Factory Engineer, he was responsible for the manufacturing of Magnetrons and Ceramic Lighthouse tubes. This interval

Sawicki, F. S. (Cont'd)

included a six months period as Process Control Engineer assigned to Ceramic Lighthouse tubes.

During 1957 through 1959 his assignments included engineering Assistant assigned to Magnetrons and Gap tubes.

From 1953 through 1956 Mr. Sawicki served as Electronic Technician for a two and one half year period.

Mr. Sawicki had the responsibility for technical cognizance and guidance of the contract from the period from 1 January 1962 through 30 April 1962.

Tomko, A. T.

Mr. Tomko attended Villanova University and received his Bachelor's Degree in Electrical Engineering in 1950.

Following graduation he was recalled to active duty with the Air Force assigned to the Armed Forces Special Weapons Project at Sandia Base, New Mexico and the Los Alamos Scientific Laboratories at Los Alamos, New Mexico.

Upon completion of his tour of active duty he joined the Power Tube Department in 1952 as Line Engineer on Hydrogen Thyratrons. During the next three years this responsibility was extended to include the production engineering of Inert Gas and Mercury Industrial Control Thyratrons. In 1955 he was appointed Engineer-General Foreman of the Ceramic Lighthouse Manufacturing.

In 1957 he was appointed Manager, Manufacturing of the Ceramic Lighthouse Sub-section. From January 1961 through May 1964 he was assigned as Manager, Manufacturing Engineering, Planar-Thyratron Operation.

APPENDIX A

Proposed by
General Electric Company
Owensboro Kentucky
2 December 1963

MIL-E-1/__ ____(EL)

MILITARY SPECIFICATION SHEET

ELECTRON TUBE, UHF PLANAR TRIODE

6299

This specification sheet forms a part of the latest issue of Military Specification MIL-E-1.

DESCRIPTION: Low Noise class A amplifier

FI = 3,000 megacycles

ABSOLUTE-MAXIMUM RATINGS

Parameter:	Ef	Eb	Ec	Ib	Pp	tk	Cooling	T (seal)	Alt
Unit:	V	Vdc	Vdc	mAdc	W	Sec	---	°C	ft
Maximum:	6.6	200	0	12	2.0	---	Conduction	225	Unlimited
Minimum:	6.0	---	-10	---	---	---	---	---	---
	(see note 1)		(see note 2)				(See notes 3 and 4)	(See note 4)	(See notes 3 and 5)
TEST CONDITIONS:	6.3	175	Adjust	10	---	180 (see note 6)	Conduction	---	---

PAR. NO.	TEST	CONDITIONS	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL	SYMBOL	LIMITS Min.	LIMITS Max.	UNIT
	General							
3.1	Qualification	Required for JAN marking	---	---	---	---	---	---
3.6	Performance	(See note 7)	---	---	---	---	---	---
4.5	Holding period	t = 7 days min	---	---	---	---	---	---
4.9.2	Dimensions	(See fig. 1)	---	---	---	---	---	---
	Qualification inspection (see note 8)							
4.9.20.5	Shock test	No voltages, hammer angle = 20° (see note 9)	---	---	---	---	---	---
	Acceptance inspection part 1 (production)							
4.8	Insulation of electrodes	Ebb = -500 Vdc, Ehk = +45 Vdc, grid grounded (see note 11)			Rgk Rgp	0.25 5.0	--- ---	Meg Meg
4.10.1.1	Emission	Eb = 0, Ef = 5.5 V (max), eb = 390 v peak-to-peak 60 cycles, Ec = -18.0 Vdc, eg = 46 v peak-to-peak 60 cycles, Rg = 470 ohm, Rk = 10 ohms (see note 12)	(See note 10)	(See note 10)	Is	3.5	---	mAdc
4.10.5.3	Plate voltage	Eb/Ib = 10 mA, Ec = 0 (see note 13)			Eb	75	175	Vdc

PAR. NO.	TEST	CONDITIONS	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL	SYMBOL	LIMITS Min	LIMITS Max	UNIT
	Acceptance inspection part 1 (production) - (Contd)							
4.10.8	Heater current				If	280	320	mA
4.10.9	Transconductance				Sm	11,500	---	µmhos
---	Power gain (1)	Eb/Ib = 10.0 mAdc, Ec = 0, F = 1,200±5 Mc, bandwidth = 10 Mc min (see notes 13 and 14)	(See note 10)	(See note 10)	gain	13.0	---	db
---	Noise figure (1)	Eb/Ib = 10 mA, Ec = 0 F = 1,200±5 Mc (see notes 13 and 14)			NF	---	8.5	db
	Acceptance inspection part 2 (design)							
4.9.	Low-frequency vibration	Eb/Ib = 10.0 mAdc, Ec = 0 Rp = 10,000 ohms (see note 15)	6.5	L6	Ep	---	100	mV
4.10.11.1	Amplification factor		6.5	L6	Mu	85.0	140	---
4.10.14	Direct interelectrode capacitance	No voltages (see note 16)	6.5 6.5 6.5	L6 L6 L6	Cgk Cgp Cpk	3.0 1.5 ---	5.0 2.0 0.025	µµf µµf µµf
---	Power gain (2)	Power gain (1), F = 3,000±5 Mc (see notes 13 and 17)	6.5	L6	Gain	10.0	---	db
---	Noise figure (2)	Noise figure (1), F = 3,000±5 Mc (see notes 13 and 17)	6.5	L6	NF	---	13.5	db
	Acceptance inspection part 3 (life)							
---	Humidity Test	(See note 20)	10.0		ΔIf	---	10	%
4.11 and 4.11.3.4	Life test (1)	Eb = 200 Vdc, Rk/Ib = 10 mA, group B	---	---	t	1000	---	hr
4.11.4	Life-test(1) end points	Transconductance	---	---	ΔSm	---	25.0	% decrease
		Noise figure (1)	---	---	ΔNF	---	1.0	db increase
4.11 and 4.11.3.5	Life test (2)	Eb = 200 Vdc, Rk/Ib = 10 mA, Group C, TE = 225°C(min)			t	500	---	hr
4.11.4	Life test(2) end points	Transconductance			ΔSm	---	25.0	% decrease
		Noise figure (1)			ΔNF	---	1.0	db increase
4.9.18	Container drop	Required						
5.	Preparation for delivery	(See note 18)						

NOTE

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NOTES:

1. Heater may be operated at 6.3 volts ±10 percent. Tube life and noise figure may be affected by this wider variation. The tube is not rated for series heater string operation.

2. Grid shall not draw current. Excessive grid-cathode voltage may cause damage due to extremely small spacing.

3. a. Tube cannot be cooled by free radiation and convection, means for conducting and dissipating heat must be provided in order to prevent excessive seal temperatures.

   b. Applications at high altitudes shall be examined carefully to assure that sufficient provision for dissipation of heat has been made.

4. Sufficient conduction or convection cooling, or both, must be provided for heater, cathode, grid, and anode seals to limit the maximum envelope temperatures to the specified maximum of 225°C under all operating conditions. Where emphasis is placed on long and reliable life, lower tube envelope temperatures should be used.

5. Altitude is unlimited as the maximum rating of 200 volts is insufficient to cause voltage breakdown at any altitude.

6. The heater preheating may be 6.6 volts maximum, unless otherwise specified.

7. In addition to the paragraphs specified hereon, only the following test and requirements listed in 3.6 shall apply: 3.3, 3.3.1, 3.7, 3.7.7, 3.8, 4.1, 4.3, 4.4, 4.6, 4.8, 4.9.1, 4.9.21.

8. All tests listed hereon shall be performed during qualification, however, this shock test is normally performed during qualification inspection only.

9. Apply the force perpendicular to the plane of the grid from the cathode end. Use fixture as shown on Drawing 274-JAN, or equivalent. Electrical tests after shock shall include transconductance and electrode insulation.

10. The AQL of the combined defectives for attributes in acceptance inspection, part 1 (production), excluding inoperatives and mechanical, shall be 1 percent. A tube having one or more defects shall be counted as one defective. Standard MIL-STD-105, inspection level II, shall apply.

11. Anode and cathode voltages shall not be applied simultaneously. Allowable circuit resistance is 1,000 ohms per volt of supply voltage.

12. Preheat 1 minute minimum at Ef = 5.5 V. Voltages eb and eg must be in phase. Read average cathode current. If the current exceeds the minimum limit and is increasing, the tube is a[illegible] If the current exceeds the minimum limit and is decreasing, the reading shall be allowed to [illegible]ze, and the tube is acceptable if the stable reading exceeds the minimum limit. Provision must be made in the test equipment so that switching transients of plate voltage apply no more voltage than the amount specified.

13. Preheat 1 minute minimum at 6.3 volts.

14. Test in cavity as shown on Drawing 271-JAN, or equivalent. An approved noise source, or equivalent, shall be used for noise figure measurements. Power input level shall be about -75 dbm.

15. Test in fixture as shown on Drawing 273-JAN, or equivalent. Vibrate in plane perpendicular to the plane of the grid.

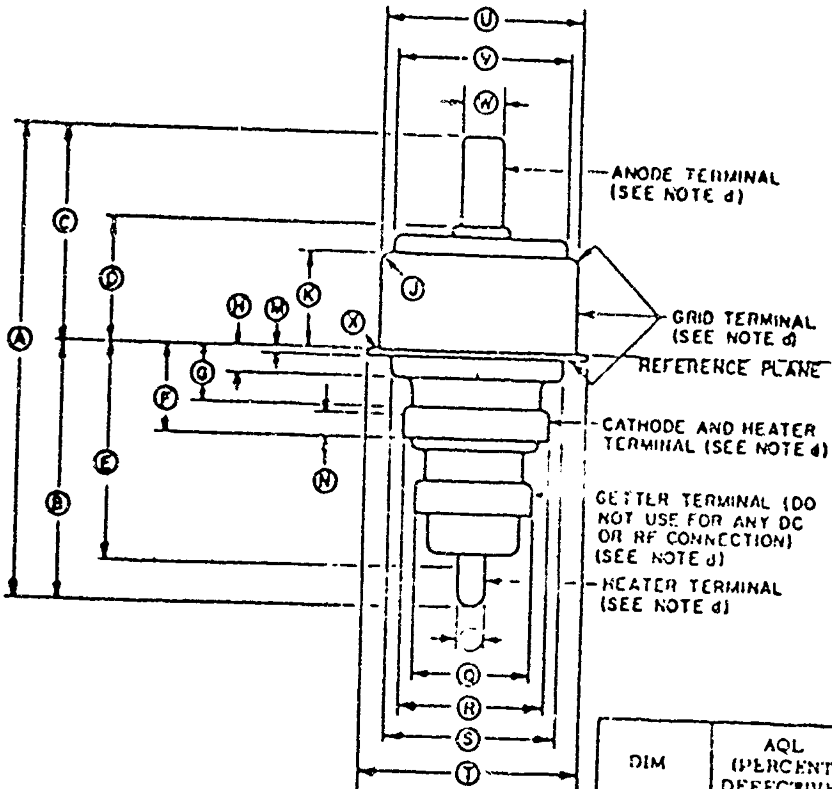
16. Test in fixture as shown on Drawing 270-[illegible], or equivalent.

17. Test in cavity as shown on Drawing 272-JAN, or equivalent. An approved noise source, or equivalent shall be used for noise figure measurements. Power input level shall be about -75 dbm.

18. Tubes shall be prepared for domestic or overseas shipment as specified in the contract or order, in accordance with Specification MIL-E-7[illegible] [illegible] (container drop) test [illegible] and container size D shall apply.

19. Referenced documents shall be of the issue in effect on the date of invitation for [illegible]

20. Test tubes first pro[illegible] [illegible] tubes for this test may be electrical or mechanical [illegible] size for this test shall be C[illegible] Letter E, MIL-STD-105, Single Sampling. Test time, 10 days at 95-100% humidity and 95 - 100° C.



DIM	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL	LIMITS Min	LIMITS Max
ACCEPTANCE INSPECTION, PART 2 (DESIGN)				
[illegible]	[illegible]	L6	0.9[illegible]0	1.0[illegible]0
[illegible]	[illegible]	L6	0.[illegible]30	0.[illegible]00
C	[illegible]	L6	0.410	0.470
D	[illegible]	L6	---	0.[illegible]72
[illegible]	6.5	L6	---	0.475
F	6.5	L6	0.[illegible]	0.103
ACCEPTANCE INSPECTION, PART 3 (PERIODIC) (SEE NOTE b)				
G	---	---	0.0[illegible]	[illegible]
[illegible]	---	---	---	[illegible]
[illegible]	---	---	---	0.[illegible]5 R
[illegible]	---	---	0.[illegible]00	0.210
[illegible]	---	---	0.0[illegible]8	0.0[illegible]2
N	---	---	0.[illegible]40	0.070
[illegible]	---	---	0.0[illegible]3 dia	0.0[illegible]5 dia
Q	---	---	---	0.[illegible]5 dia
R	---	---	0.3[illegible]0 dia	0.3[illegible]4 dia
[illegible]	---	---	---	0.3[illegible]5 dia
[illegible]	---	---	0.4[illegible] dia	0.4[illegible]7 dia
[illegible]	---	---	0.4[illegible] dia	0.4[illegible] dia
V	---	---	---	0.3[illegible] dia
W	---	---	0.0[illegible] dia	0.0[illegible]4 dia
X	---	---	---	0.008 R

Notes:

a. All dimensions in inches.

b. Preship test all tubes for TIR.

c. Test these dimensions on 10 tubes per month when in continuous production. Failure of more than one tube to meet the tolerance for any of these dimensions shall cause that dimension to become a 6.5 AQL, L6 Design Test for all lots in process.

d. Eccentricity of contact surfaces shall be gaged from center line of reference, and shall be as follows. Note b shall apply.

Contact Surface	TIR, maximum	Reference
Anode	0.015	Grid
Cathode	0.020	Grid
Getter	0.030	Grid
Heater	0.045	Grid

Figure 1. Outline drawing.

APPENDIX B

Limited Production Equipment

LIMITED PRODUCTION EQUIPMENT

The following is a description of the limited production equipment listed under Sub-Item 1-2 of the contract.

1. A-C aging rack (2)

   Dimensions:

   33" wide
   76" high
   24" deep

   Approximate weight: 325 pounds
   Voltage input: 115V A-C
   Purpose: Specialized equipment for a-c aging of electron tube type 6299.
   Prints: 13700K T6-27-41 (4 sheets)

2. High temperature life rack with recorder (1)

   Dimensions:

   33" wide
   76" high
   24" deep

   Approximate weight: 350 pounds
   Voltage input: 115V A-C
   Purpose: Specialized equipment for the life testing at 225 C. anode seal temperature of electron tube type 6299.
   Prints: 13700K T5-23-41

3. 50 position life rack (1)

   Dimensions:

   33" wide
   76" high
   24" deep

   Approximate weight: 310 pounds
   Voltage input: 115V A-C
   Purpose: Specialized equipment to perform d-c life testing of electron tube type 6299.
   Prints: 13700K T5-23-42

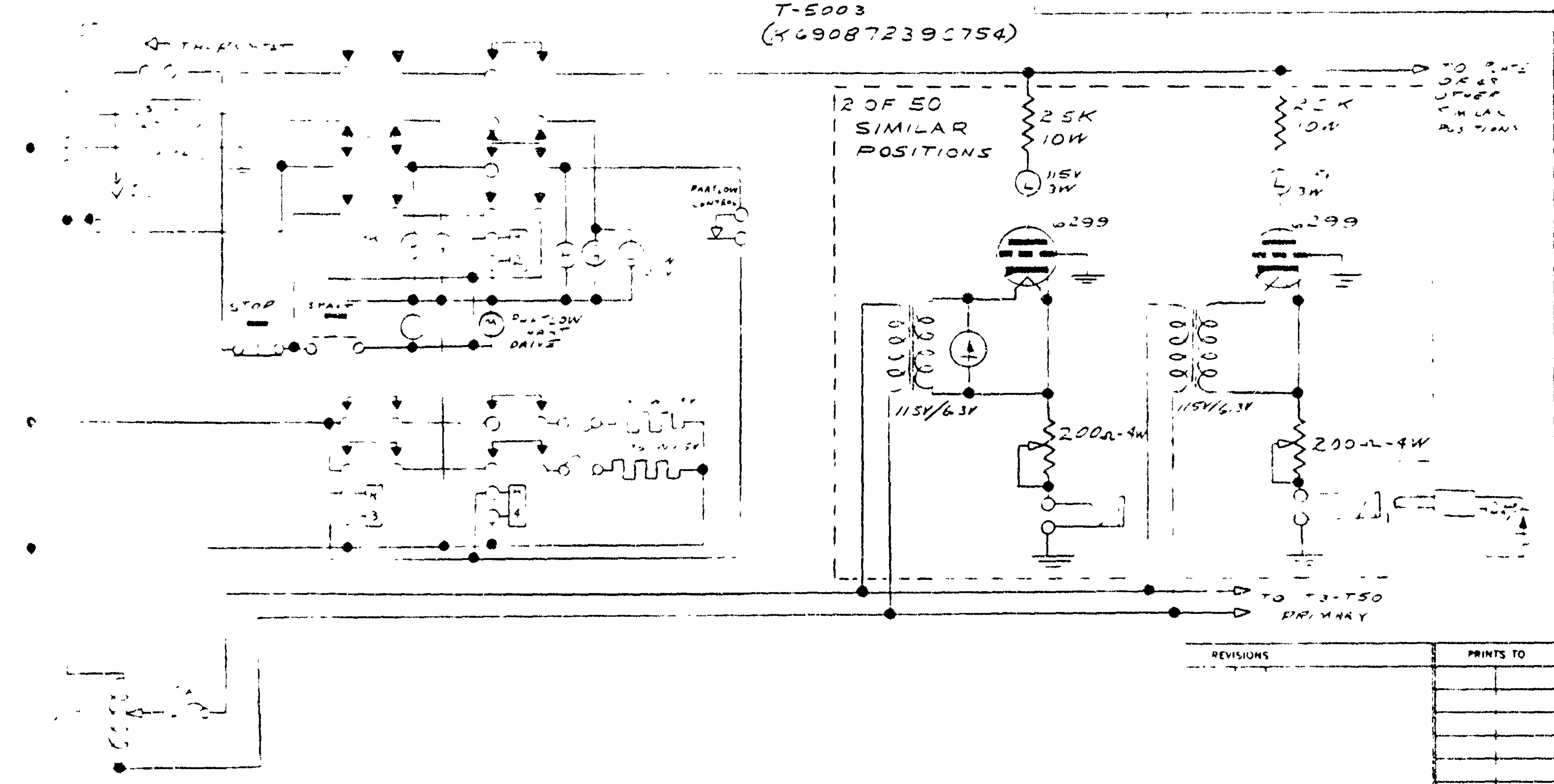
LIMITED PRODUCTION EQUIPMENT (CONT'D)

Note 1: Equipment should be calibrated every three (3) months when in use.

Note 2: Faulty positions should be reported for maintenance.

GENERAL ELECTRIC
TITLE 13700K-TS-63-41
HI-TEMPERATURE LIFE TEST
FIRST MADE FOR 6299
CONT ON SHEET 5

T-5003
(K69087239C754)



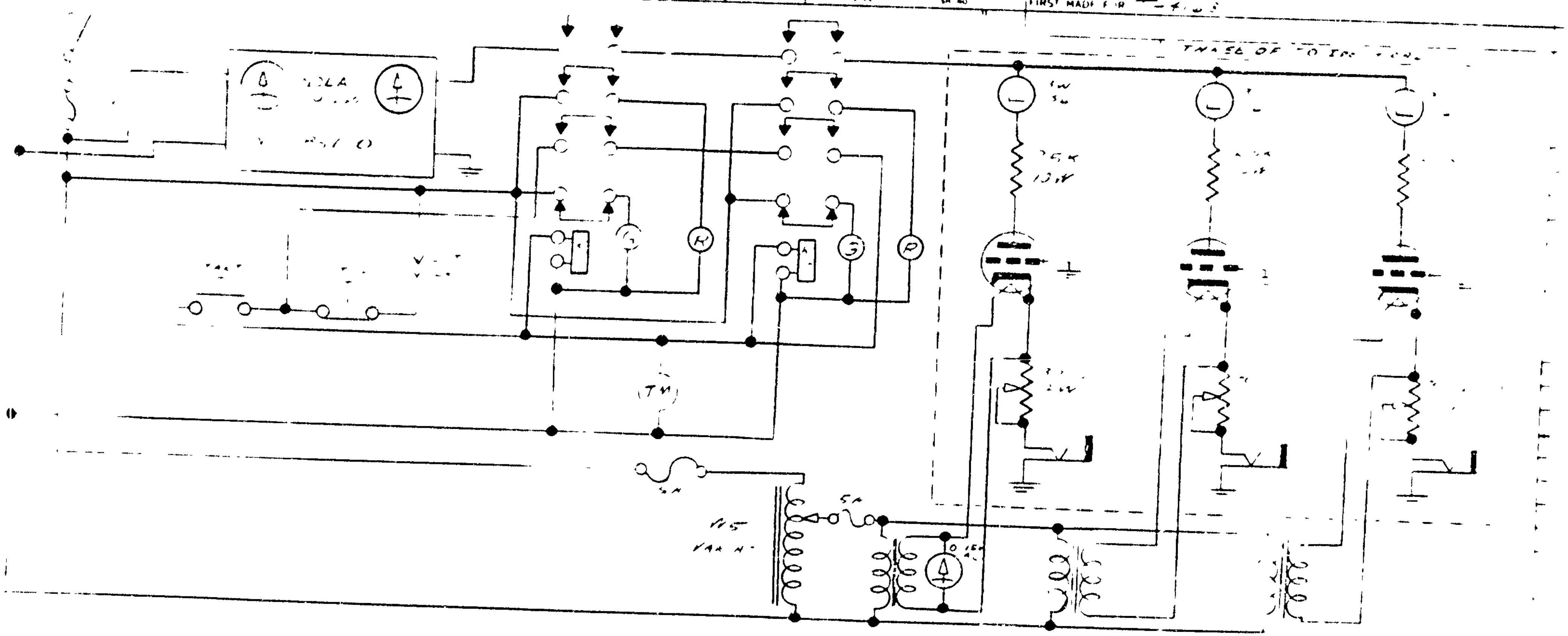
MADE BY HEC 2-7-63
ISSUED
APPROVALS
REVISIONS
PRINTS TO
MADE BY HEC 2-20-63
ISSUED

GENERAL ELECTRIC

TITLE 12700K-T5-23-42

6299 · 50 P

FIRST MADE FOR



(FORMERLY K6708723 5(73))

REVISIONS

PRINTS TO

MADE BY HEC 3-20-63

ISSUED

APPROVALS

PRINTED IN U.S.A.

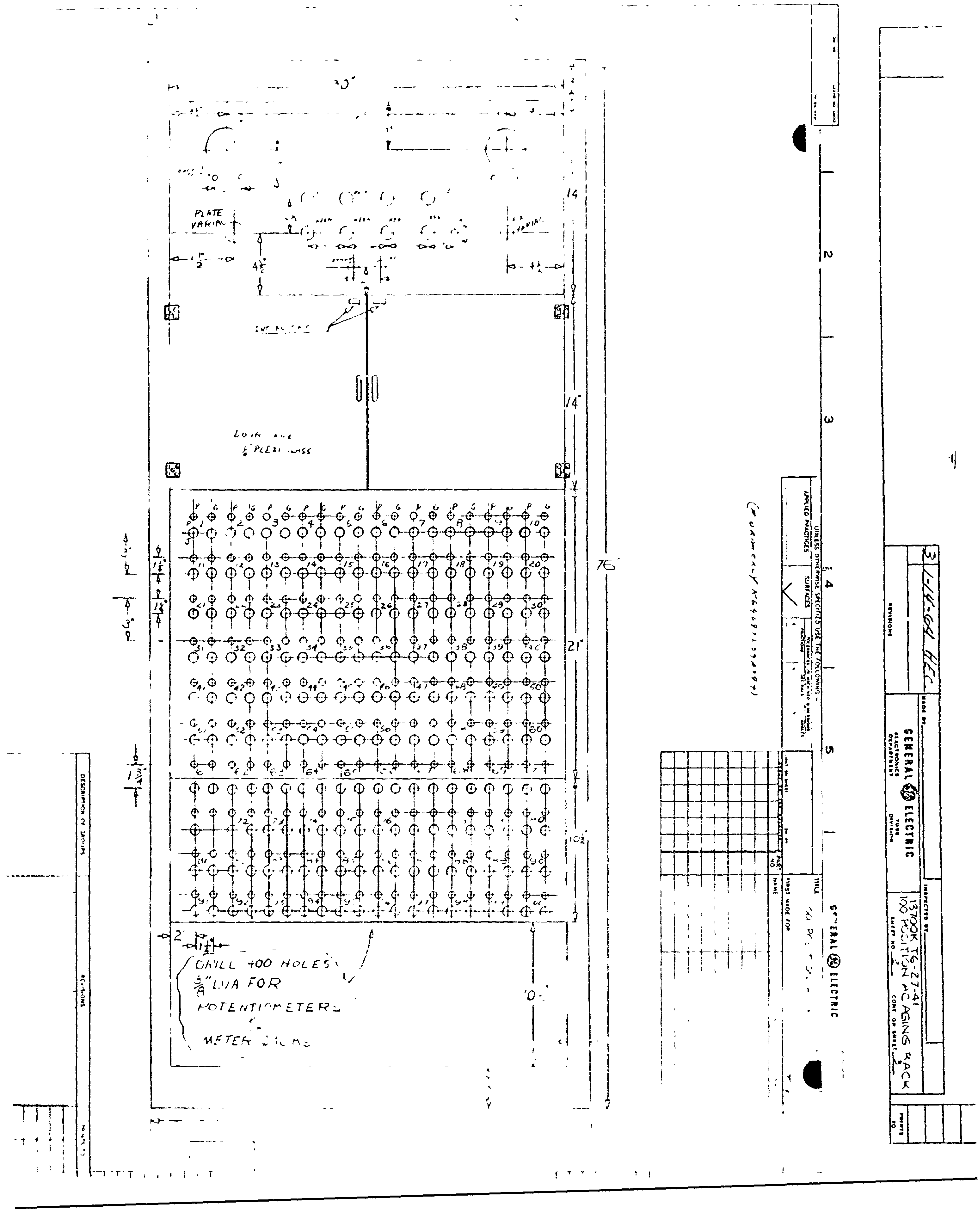
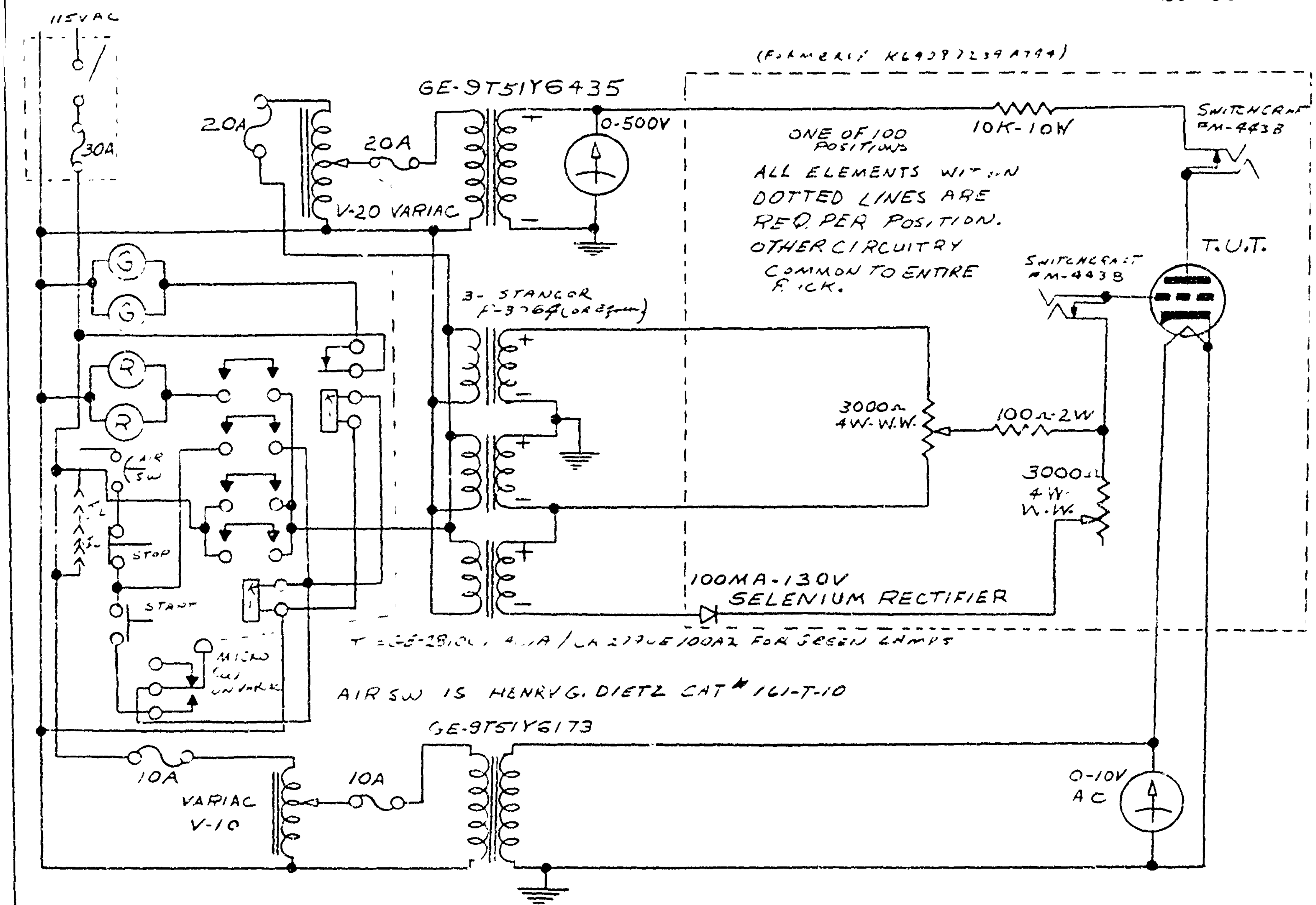
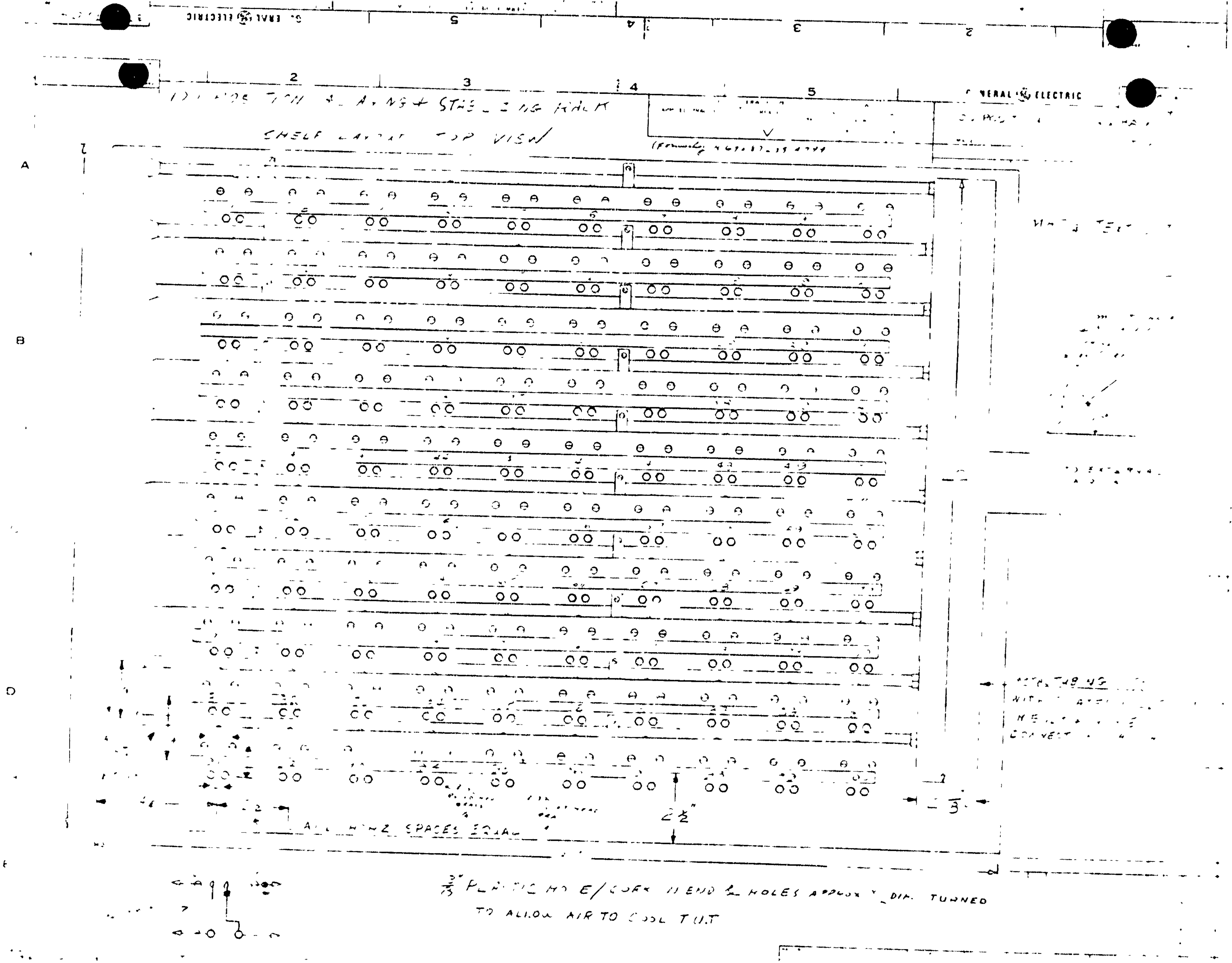
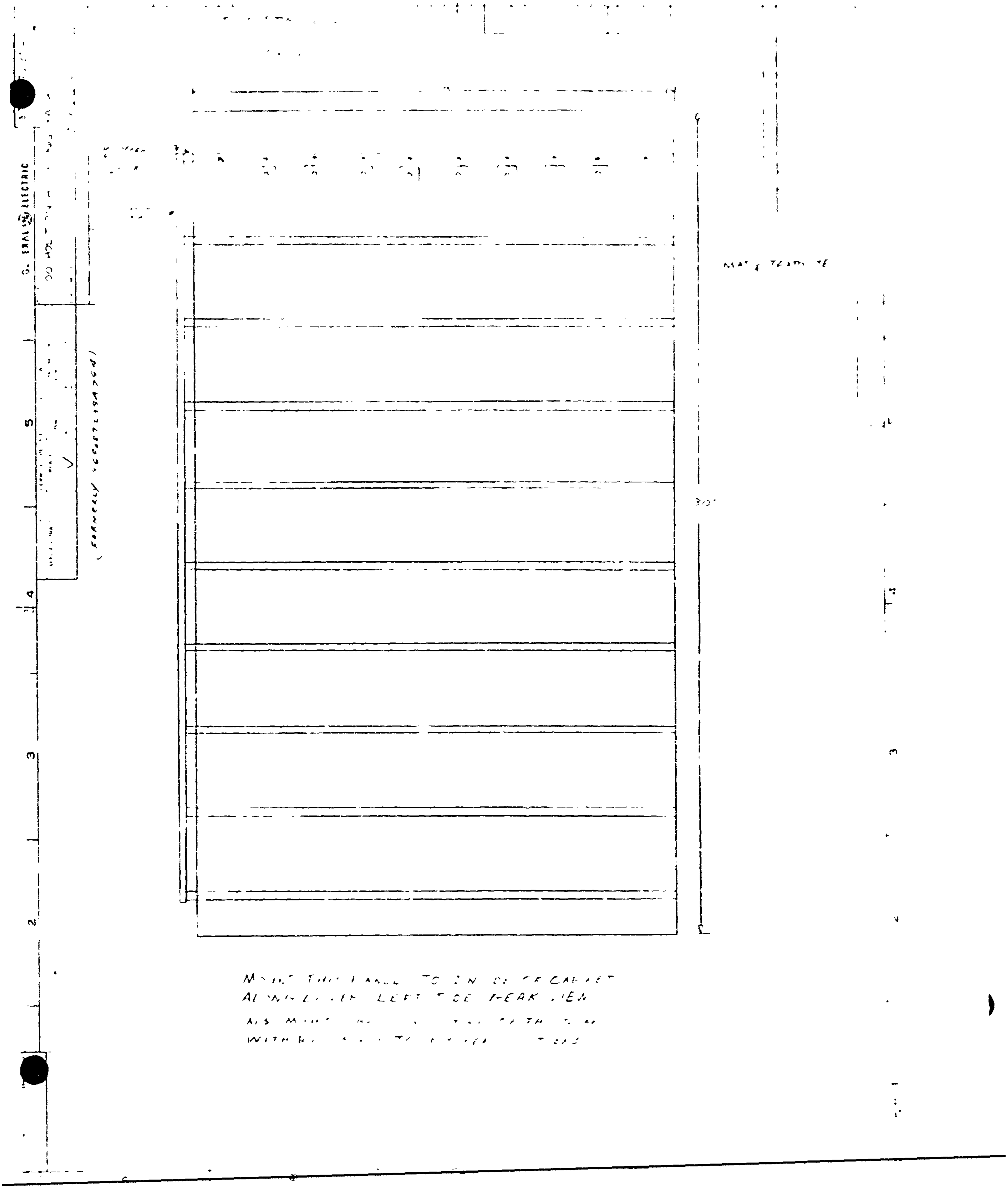


PLATE VARIAC
VARIAC
INT. RL
1/4" PLEXIGLASS
14"
21"
76"
10 1/2"
4 1/2"
1 1/4"
3"
1 3/4"
2"
DRILL 400 HOLES 3/8" DIA FOR POTENTIOMETERS & METER JACKS
(FORMERLY K6409137A1971)
UNLESS OTHERWISE SPECIFIED USE THE FOLLOWING
APPLIED PRACTICES
SURFACES
TITLE
FIRST MADE FOR
PART NO
NAME
GENERAL ELECTRIC
REVISIONS
MADE BY
3/1-14-64 HEC
INSPECTED BY
GENERAL ELECTRIC
ELECTRONICS DEPARTMENT
TUBE DIVISION
13700K T6-27-41
100 POSITION AC AGING RACK
SHEET NO 2
CONT ON SHEET 3
DESCRIPTION OF REVISIONS
REVISIONS
PRINTS TO



3	1-14-64 HEC	MADE BY
		GENERAL ELECTRIC


SHELF LAYOUT TOP VIEW
ALL HORZ SPACES EQUAL
2½"
3"
GENERAL ELECTRIC
TO ALLOW AIR TO COOL T.U.T


ELECTRIC

APPENDIX C

Processing Specification

PROCESSING SPECIFICATION

The processes developed or proven for use on the 6299 in the performance of this contract are as follows:

I. Hard Solder Anode Seal Assembly

A.

	Component Part		Processes
1.	S-K-K586 Pt. 1	Solder Washer	C1-1B, C6-3C
2.	KR3703	Anode Ceramic	C1-3E, F3-1P, J1-1A, F2-4G 1330C. 45 min. R1E/SCR-1, 20 amp. 30 min. F2-1 950C 15 min.
3.	KR60102	Anode	Normal processing

B.1. Anode ceramic is placed in brazing fixture. Solder washer is placed on anode ceramic. Anode is inserted in anode ceramic and brazing weight is placed on anode. Fixtures are taken to furnace area.

2. Anode assemblies are brazed F2-1 in a belt furnace with a belt speed of 0.4 feet per minute at 850C.

3. Anode assemblies are removed from brazing fixtures.

4. Anode assemblies are inspected 100% on helium leak detector to check quality of hard solder seals.

I

II. Hard Solder Preseal

A.

	Component Part		Processes
1.	SK-K-586 Pt. 2	Brazing Washer	C1-1B, C6-3C
2.	SK-K-586 Pt. 3	Brazing Washer	C1-1B, C6-3C
3.	SK-K-584	Getter Shell	C1-1B, C4-1A C1-2L, F2-4A 1000C 30 min C4-1A, C5-1A/SCR1 R1E/SCR1, 25 amp 60 min. (1200 parts with metal pins) F2-1 850C 30 min.
4.	KR70384	Cathode Shell	C1-1E, C4-1A C1-2L, F2-4A 1000C 30 min. C4-1A, C5-1A/SCR1 R1E/SCR1 25amp 60 min. (800 parts with 3mm plastic balls) F2-1 850C 30 min
5.	K-582	Getter Insulator	C1-2E, F3-1P J11A, F2-4G 1330C R1E/SCR1 20amp. 10 min. F2-1 850C 15 min.

B. 1. Cathode shell is placed on brazing fixture followed by #3 brazing washer, getter ceramic, #2 brazing washer, and getter shell. Brazing weight is placed on stock taking care to keep alignment. Fixture is taken to furnace area. IV

2. Preseal assemblies are brazed F2-1 in belt furnace at 850C with a belt speed of 0.4 feet per minute.

3. Preseal assemblies are removed from brazing fixture.

4. Preseal assemblies are inspected 100% on helium leak detector to check quality of hard solder seals.

III. Improved Cathode And Insulator Assemblies

A.

	Component Part		Processes
1.	KR3735	Cathode Ceramic	C1-3E, F3-1P Dip Coat moly manganese F2-2D/S1
2.	KR70473	Cathode Support Ring	C1-1B, C4-1A C5-2E/SCR1, C6-3D R1A/SCR3
3.	N11606DA	Cathode Assembly	Normal Processing

B. 1. Cathode ceramic is placed on brazing fixture. Cathode assembly is inserted in cathode ceramic. Cathode support ring is inserted with legs between cathode assembly and cathode ceramic. Brazing fixture is placed in the cathode boat. When boat is loaded, the boat is transferred to the furnace area.

2. Cathode and insulator assemblies are brazed F2-1 1110C four minutes in box furnace.

3. Cathode and insulator assemblies are removed from brazing fixture and examined under a 10x microscope for brazing quality.

4. Clean C1-2C

5. Spray J1-1P

IV. Heater Ceramic — C1-3E, F3-1P Coat with titanium hydride

V. Final Assembly N11606

Plating Processing

[illegible]-1 (with metal pins - 4 x 30 min,
CAP 30 min.) C6-3D R1E/3 (metal pins
200 tubes 40 amp. 60 min. R1M/S1
(metal pins 200 tubes 10 amp. 120 min.)
C6-3D 1 min. R1P/1 metal pins 100 tubes
20 amp 1 min
10 amp 10 min
R1P metal pins 100 tubes
6 amp 20 sec.
4 amp 1 min.
2 amp 18 min.

Barrel Burnish (metal pins & AP2X

VI. A-C Aging Schedule (6299)

EQUIPMENT

100 position a-c aging rack

1. Place tubes in fixtures. Make certain a positive connection is made on all elements.

2. Turn on low pressure air for moderate cooling.

3. Adjust filament voltage to 7.0 volts a-c. Allow one minute warm-up time.

4. Press plate voltage start button and adjust to 310 a-c.

5. Adjust grid current to 8 ma and plate current to 10 ma on each tube.

6. If a tube fails to draw current, check its position in the fixture and/or check its characteristics in the static test set. Reject those tubes which are inoperative.

7. Repeat Step 5 at 1 hour and 6 hours.

8. After 24 hours adjust filament voltage to 6.3 volts a-c.

9. Adjust grid current to 6.0 ma and maintain plate current at 10 ma on each tube.

10. Tubes are to be removed after 24 hours.

11. Report faulty positions so they may be repaired.

Aging Conditions

Step 1

E_f 7.0 vac	I_g = 8.0 ma/tube
E_{bb} = 310 vac	I_b = 10.0 ma/tube
Time = 24 hours	

Step 2

E_f = 6.3 vac	I_g = 6.0 ma/tube
E_{bb} = 310 vac	I_b = 10.0 ma/tube
Time = 24 hours	

C1-1B

DEGREASING WITH CHLORINATED HYDROCARBON SOLVENTS

Vapor Degreasing (cool solvent immersion

PURPOSE

This method is used to remove non-oxidized oils, greases, fats and such lubricants as are used during forming or other manufacturing operations, or are placed on the work to protect it from corrosion during storage.

MATERIALS

Acetone

EQUIPMENT

1. Two Dip Immersion Degreaser

2. Baskets

PROCEDURE

1. Give the parts a cursery examination for paints or tapes used for color coding. If these materials are present, remove them by washing in acetone before proceeding.
2. Parts are thoroughly dried.
3. Parts are placed in the basket so they drain easily and liquid solvent is not trapped in the parts.
4. Basket of parts is placed in the vapor chamber until the vapor no longer condenses to a liquid on the parts.
5. Parts are slowly transferred to the rinse chamber and immersed for at least 30 seconds.
6. Parts are again placed in the vapor chamber until the vapor no longer condenses to a liquid on the parts.
7. If necessary parts are tilted or retated while still in the vapor chamber to encourage solvent drainage.
8. Parts are removed from the degreaser.

Cl-2C/SCRl

CLEANING WITH WATER, ACETONE AND/OR ALCOHOL

PURPOSE
This method is used to remove dust and particles.

MATERIALS
Denatured ethyl alcohol
Dry Acetone

EQUIPMENT
1. Ultra-Sonic cleaning unit
2. Suitable holder
3. Container for solvent
4. Culture dish
5. Tweezers

PROCEDURE
1. Alcohol or Acetone is poured into container to a height of 2".
2. Parts are assembled onto the holder, so that the open end of the eyelet is pointing towards the center.
3. Holder is placed into the container with the denatured ethyl alcohol so that the parts are just under the surface of the liquid.
4. The generator is allowed to operate for three minutes.
5. The holder is removed and parts are removed with tweezers.
6. Parts are blown dry with low pressure filtered air.
7. Parts are stored in a covered culture dish.

CLEANING WITH WATER, ACETONE AND/OR ALCOHOL

Ultra-Sonic Cleaning With Acetone

MATERIALS

Acetone

EQUIPMENT

1. Suitable holder or container
2. Ultra-sonic generator (GE Cat. #8665966 G-3)
3. Container for solvent
4. Watch glass cover for holder

PROCEDURE

1. Acetone is poured into container to a height of 2".
2. Parts are assembled onto the holder or container.
3. Holder is placed into the container with the acetone so that the parts are just below the surface of the liquid. A watch glass cover is used to keep cleaning solvent from evaporating.
4. The generator is operated at 150 ma. for 3 minutes.
5. Holder is removed and parts are spread on lint-free paper to dry.

PRECAUTIONS

1. Cleaner should be kept covered when not in use.
2. Use fresh cleaning agent for each cleaning.
3. Use only clean containers for cleaning agent.

C1-3E

CLEANING WITH WATER, ACETONE OR ALCOHOL

(Ultrasonic-Acetone, Deionized Water-Nitric Acid - Ceramics)

PURPOSE

The purpose of this process is to clean dense ceramic insulators in such a manner that all conceivable contaminants are anticipated to be present on the parts before cleaning and are effectively removed, and that the resulting ceramic parts are clean to the degree required for use in the making of high quality, reliable electronic tubes. This process uses ultrasonic cleaning of dense ceramic insulators with acetone and deionized water coupled with acid cleaning in HNO_3.

MATERIALS

NOTE: Deionized Water Used Throughout

ath Composition	Composition Ratio	Chemical Grade	No. Baths Required
A. Acetone	Acetone alone, rm. temp.		4 (2 Ultrasonic
B. Deionized H_2O	Water alone, rm. temp.	1,000,000 ohm min.	4 (1 Ultrasonic)
C. Igepal (850) detergent or equivalent	Added to first deionized water bath	Andora Chemicals General Analine & Film Company 135 Hudson Street New York 14, N.Y.	5-10 cc/gal.
D. Nitric Acid	30% HNO_3 - rm. temp.		

EQUIPMENT

A. Suitable tanks, beakers or other containers for the required baths.
B. Suitable basket or other perforated container for holding parts. Should be preferably non-metallic, such as nylon, diallyl phthalate or polyvinyl chloride, or a metallic basket lined with clean ceramic chips so that ceramic parts do not contact the metal.
C. Ultrasonic generator; transducer, either built into tank or suitable for immersion into bath. Capacity - 50 watt/gal. liquid, minimum.
D. Nitric acid resistant perforated basket lined with clean ceramic chips, if metallic.

BASIC PROCESS

Because at the present state of the art it is not possible to accurately and exactly specify and measure the desired end result of this process, it is necessary to specify the process itself in detail. The described process is a compilation of the best thinking of those dealing with the cleaning of ceramic insulators within the department and is supported by actual and successful application of the process, in detail, within the department. In order to guarantee the attainment of success theretofore obtained with the process, it is necessary that it be carried out as specified and departures from the process not be made without being sure of the necessity for any modifications.

PROCEDURE

Note: Ceramic parts should never be handled with bare hands, with woven gloves, with paper over fingers or with metallic tools. It is important to use handling tools or equipment provided with approved non-metallic contact surfaces.

A. Thoroughly rinse in acetone. Ultrasonorate in acetone. Remove parts from bath with ultrasonic power on.
B. Ultrasonorate in deionized water to which a quantity of Igepal 85C detergent, or equivalent, about 5-10 cc/gal. has been added. Remove parts from bath with ultrasonic power on.
C. Rinse in three-step deionized water bath for at least 15 seconds in each step.
D. Transfer parts to nitric acid resistant perforated basket, if not already so contained, lined with clean ceramic chips if metallic, and soak in 30% nitric acid for 5 minutes.
E. Thoroughly rinse parts in the three step deionized water bath for at least 15 seconds in each step.
F. Ultrasonic clean in deionized water for 5 minutes.
G. Parts are rinsed in two separate acetone baths for at least five seconds in each bath.
H. Infra-red dry.

PRECAUTIONS AND CONTROLS

A. Successful processing of parts according to this instruction will depend in large measure upon proper control of the solvents, solutions and equipments called for. Necessary control procedures should be incorporated in corresponding specific standing instructions.
B. In order to make the cleaning action most effective in the ultrasonic baths, the ultrasonic generator should be adjusted for each case and each batch of parts to produce optimum cavitation within the bath.

PRECAUTIONS AND CONTROLS (CONT'D)

D. In order to preserve the processed parts in their cleaned condition, it is advisable that they be placed in clean, covered containers after this processing and be so stored or transported to the next operation.

MEASURABILITY OF END RESULT

Parts which have been properly cleaned per this basic process will look thoroughly clean to the naked eye and under a magnifying lens, with no evidence of any stain, soil or "water marks".

ALKALINE CLEANING

Clepo #64

PURPOSE

This method is used to remove heavy metal soaps as well as oxidized organic compounds which are not removed by vapor degreasing.

MATERIALS

Bath Composition	Control Limits	Composition Ratio	Engineering Data: Chemical Grade	Engineering Data: Conc. in Container
Solution #1				
Clepo #64	5-10 oz./gal	8 oz.	Gum Chemical Co.	100% powder
Deionized water		1 gal.	500,000 ohms or greater	
Solution is used at boiling temperature.				
Solution #2				
Hydrochloric acid		1 part		37% HCl
Deionized water		3 parts	500,000 ohms or greater	
Solution is used at room temperature.				
Solution #3				
Ammonium hydroxide		1 part		28% NH_3
Deionized water		3 parts	500,000 ohms or greater	
Solution is used at room temperature.				
Solution [illegible]				
Hydrochloric acid		acid only		37% HCl

EQUIPMENT

1. Tanks - Solution #1 should be used in stainless steel tanks, solution #2 in Pla-Tank plastic crocks or earthenware crocks and solution #3 in earthenware crocks.
2. Baskets - Stainless steel baskets should be used.

PROCEDURE

1. A basket large enough to allow free movement of parts for thorough agitation is selected. A much greater level of agitation is provided if the work is completely withdrawn from the cleaning and rinsing baths and then reimmersed rather than by merely swishing the work about.

PROCEDURE (CONT'D)

2. Parts are immersed in solution #1 for a minimum of 10 minutes. Clepo solution must be 90-100C in order to clean parts thoroughly.
3. Parts are agitated in hot water for at least 15 seconds with inlet faucet wide open. Hot rinse water must be 90-100C to dissolve all of the lepo solution.
4. Parts are agitated in cold water for at least 15 seconds with inlet faucet wide open.
5. Parts to receive further aqueous cleaning, omit Steps 6 to 11.
6. Parts with visible heavy rust are soaked in Solution #4 until clean. Other parts are agitated in Solution #2 until clean.
7. Parts are agitated in cold water for at least 15 seconds with inlet faucet wide open.
8. Parts are agitated in Solution #3 for at least 15 seconds.
9. Parts are agitated in cold water for at least 15 seconds with inlet fau t wide open.
10. Parts are agitated in hot water for at least 15 seconds with inlet faucet wide open. Parts are shaken to remove excess water.
11. Parts are rinsed in acetone for at least 15 seconds.
12. Parts are dried with compressed air.

TROUBLE SHOOTING

Dirty parts - parts remaining dirty during the process could be caused by:

1. Operating temperature of solution #1 is not at temperature specified.
2. Hot water rinse is not hot enough.
3. Solutions #1, #2, or #3 are contaminated.
4. Degreasing prior to caustic cleaning often sets up the drawing compound making it difficult to remove.
5. Caustic cleaning will not remove a carbon smut.

CLEANING WITH ACID COMBINATIONS

Nitric, Sulfuric (Bright Dip)

PURPOSE

This method is used to remove stains from molybdenum, copper, nickel or monel. Parts should be bright when cleaned by this method. Fernico or iron are not left bright. Oxides are not removed by this process, or they are removed so slowly that pitting results.

MATERIALS

Note: Deionized water used throughout

Bath Composition	Composition Ratio	Chemical Grade	Engineering Data Conc. In Container
Solution #1			
Nitric Acid	1 Part		70% HNO_3
Sulfuric Acid	1 Part		98% H_2SO_4
Deionized Water	1 Part	1, 000,000 ohms or greater	

Solution is used at room temperature.

Suitable containers for deionized water.

EQUIPMENT

1. Tanks - Pla-Tank plastic crocks or earthenware crocks can be used for tanks.
2. Baskets - Stainless steel basket should be used.

PROCEDURE

1. A basket large enough to allow free movement of parts for thorough agitation is selected. Cylinders may be handled with a hooked rod or strung on a wire to prevent contact between them.
2. Basket of parts is agitated in solution #1 for 2-5 seconds.
3. Parts are agitated in cold deionized water for at least 15 seconds.
4. Parts are agitated in hot deionized water for at least 15 seconds.
5. Parts are agitated in cold deionized water for at least 15 seconds.
6. Parts are rinsed in a 3 step deionized water bath for at least 15 seconds in each step.

Note: If next step in processing is plating then omit operations 7 and 8 and go directly to plating bath.

7. Parts are agitated in 2 separated acetone rinses for at least 5 seconds in each rinse.

PROCEDURE (CONT'D)

8. Parts are infra-red dried.

Parts should not be redipped if metal thickness is held to a close tolerance, since continual dipping reduces the thickness. Not more than 24 hours shall elapse between cleaning and assembly of parts.

PRC

CLEANING WITH HYDROCHLORIC ACID

(Immediately Before Plating)

PURPOSE

Removal of oxide films and tarnish films - This instruction describes a preferred method for removing oxides and films from steel and fernico parts.

Appearance of part after cleaning - After cleaning the part with hydrochloric acid, the part should have a clean surface free from oil or discoloring stain. The clean metal may be etched or shiny.

MATERIALS

Bath Composition	Composition Ratio	Engineering Data: Chemical Grade	Engineering Data: Conc. in Container
Solution #1			
Acetone			
Hydrochloric acid	1 Part		37% HCl
Igepal 630	1 cc/l	General Aniline & Film	
Deionized water	1 part	500,000 ohms	

Solution is used at room temperature.

Bath Composition	Composition Ratio	Chemical Grade	Conc. in Container
Solution #2			
Sodium Cyanide	60 g/l	90% DuPont Special Quality	
Igepal 630	1 cc/l	General Aniline & Film	
Deionized water		500,000 ohms	

Solution is used at room temperature.

Bath Composition	Composition Ratio	Chemical Grade	Conc. in Container
Solution #3			
Ammonium hydroxide	1 part		30% NH_3
Deionized water	3 parts	500,000 ohms	

Solution is used at room temperature.

EQUIPMENT

1. Tanks - Pla-Tank plastic crocks and earthenware crocks can be used for hydrochloric acid, sodium cyanide and ammonium hydroxide solutions.
2. Baskets - Baskets are stainless steel, nickel, monel, or polyvinyl chloride coated mesh baskets.

PROCEDURE

1. A basket large enough to allow free movement of parts for thorough agitation is selected.
2. Parts are cleaned in Solution #1 according to the instruction number on the process cards which describes the operation following cleaning.

Operation Following Cleaning	Immersion Time	Agitation Time	Steps Following Step (2)
R1J	10-30 min.	2 min	(3)(4) (6)(7)
R1E	10-30 min.	2 min	(3) (4)(6)(7)
R1M	10-30 min.	2 min	(3)(4)(5)
R1F	2-10 min.	2 min	(3)(4)(5)
R1A, R1B, R1L	2-10 min.	2 min	(3)(4)(6)(7)
All other parts	10-30 min.	10-30 sec	(3)(4)
(Assembly parts)			(3A)(4A)(5A)(6A)

Parts which are to be plated:

3. Parts are rinsed in cold water for at least one minute. Parts must be kept in motion during rinsing. Inlet faucet must be wide open.
4. Parts are rinsed in hot water for one minute with the inlet faucet wide open.
5. Parts to receive nickel plating operation can now be placed in the plating tank.
6. Parts to receive copper, silver or cadmium plating operation are placed in Solution #2 for one to ten minutes. Crocks used for sodium cyanide (Solution #2) will be labeled:

"Solution #2, C5-2E for R1J only"
and
"Solution #2, C5-2E"

Parts which do not receive operation R1J should not be placed in the crocks designated "For R1J only".
7. Parts to receive copper, silver or cadmium plating operations are placed in their respective plating tanks.

All other parts:

3A. Parts designated as "All other parts" (assembly parts in the table) are rinsed in Solution #3 for 15 seconds.
4A. Parts are rinsed in cold water for 15 seconds with inlet faucet wide open. Parts are shaken to remove excess water.
5A. Parts are rinsed twice in acetone. Discard the acetone when the specific gravity increases to 0.82. Specifice gravity should be measured with a lab hydrometer in the range desired.
6A. Parts are dried with compressed air.

C6-3C

CLEANING WITH SALTS

(Sodium Cyanide)

PURPOSE

This method is used for removing sulfides from silver and silver solder.

SAFETY

1. It is important that containers of cyanide are not located near any acid. If acids come in contact with cyanide, a deadly gas, hydrocyanic acid, is formed.
2. Do not discard cyanide down the drain, pour into the steel barrel marked for that purpose which will be sent to the Erie Plant for disposition.

MATERIALS

Bath Composition	Composition Ratio	Chemical Grade
Solution #1		
Sodium cyanide	1 part	96% DuPont Co.
Deionized water	16 parts	500,000 ohms or greater
Solution is used at room temperature		
Solution #2		
Acetic acid, glacial 99.5%	1 part	Reagent Grade
Deionized water	19 parts	500,000 ohms or better
Deionized water		500,000 ohms or better
Acetone		

EQUIPMENT

1. Tanks - Pla-Tank plastic crocks or earthenware crocks can be used. PVC lined steel tanks.
2. Baskets - Stainless steel, monel or nichrome baskets can be used.

PROCEDURE

1. A basket large enough to allow free movement of parts for thorough agitation is selected.
2. Parts are agitated in Solution #1 for at least 30 seconds.
3. Parts are agitated in cold water for at least 15 seconds with inlet faucet wide open.
4. Parts are agitated in solution #2 for 15 seconds.
5. Parts are rinsed in cold water for 15 seconds, with inlet faucet open.
6. Parts are rinsed with agitation in hot deionized water for 15 seconds with inlet faucet open.
7. Parts are rinsed in acetone for 15 seconds.
8. Parts are dried with compressed air.

C6-3D

CLEANING WITH SALTS

Sodium Cyanide

PURPOSE

This method is used to neutralize parts prior to plating.

SAFETY

1. It is important that containers of cyanide are not located near any acid. If acids come in contact with cyanide, a deadly gas, hydrocyanic acid is formed.
2. Do not discard cyanide down the drain. Pour into steel barrel marked for that purpose.

MATERIALS

Bath Composition	Composition Ratio	Chemical Grade
Solution #1		
Sodium cyanide	1 part	96% DuPont Co.
Deionized water	16 parts	500,000 ohms or greater
Igepol 630	1/1000 part	General Aniline and Film

Solution is used at room temperature

EQUIPMENT

1. Tanks - Pla-Tank plastic crocks or earthenware crocks can be used.
2. Baskets - Stainless steel, monel or nichrome baskets can be used.

PROCEDURE

1. A basket large enough to allow free movement of parts for thorough agitation is selected.
2. Parts are immersed in Solution #1 for 1-40 minutes.
3. The parts can be transferred directly to a cyanide plate solution if there is no possibility of dripping onto the floor or into other solution. Otherwise, the parts must be rinsed in cold tap water.
4. When this operation is followed by a plating operation, parts are transported in a container of Solution #1 and must be allowed to dry or partially dry before being placed in the plating solution.

DRY HYDROGEN FIRING

EQUIPMENT

1. Suitable hydrogen furnace
2. Thermocouple and meter
3. Optical pyrometer or equivalent
4. Sutiable firing boats
5. Rod to push boats through furnace and hooked rod to remove boats from cooler.
6. Clean white gloves to wear when handling fired parts.
7. Source of dry hydrogen - Dew Point - 60F to - 90F. Line hydrogen may be purified and dried by running it through a copper chip furnace (maintained at 650C) and an alumina dryer (maintained at 35F) or Catalytic Oxidizer, "Deoxo" purchasable from Baker Chemical Co., Philipsburg, New Jersey, or equivalent.

PROCEDURE

Parts are loaded in the firing boats then pushed into the hot zone where they are fired at the specified temperature for the specified time.

LIMITATION

The specified times and temperatures appear on the appropriate Standardizing Notice and in all cases indicate the period of time for which the parts are to be held in the heat zone. When temperature only is specified parts are to be brought up to that temperature then pushed into the cooling section. A tolerance of ± 25C is allowed on all specified temperatures. All stated times are in minutes unless otherwise specified.

Parts are pushed into the cooler and then removed when cooled.

F2-2D/S1

SPECIAL HYDROGEN FIRING

(Coated Ceramic Cylinders)

PURPOSE

To issue instructions for firing coated ceramic cylinders used in metal-ceramic seals.

EQUIPMENT

Hydrogen furnace, opening 6" high x 8" wide with dry hydrogen cooling chamber.
Source of wet hydrogen
Source of dry hydrogen with dew point of -60 to -90F.
Molybdenum firing boats with covers 12" x 6" x 5 1/2" high
Molybdenum spacer sheets 11 1/2" x 5 1/2" x .020" - .030" thick
Fire brick, Babcock & Wilson #28

Note: Alundum chips (Al4) may be used in the bottom of the firing boat in place of the fire brick.

PROCEDURE

1. Bottom of boat is lined with 3/4" layer of fire brick and covered with a spacer sheet. Cylinders are placed on sheet with the axis vertical, isolated from each other and from side of boat. (More layers may be built with spacer sheets between if cylinder lengths permit.) The boat is covered.

Note: For ceramic cylinders having wall thickness greater than 1/8" or for ceramics having large mass, all sides of boats should be lagged.

2. The filled boat is preheated for 15 minutes on the fore-hearth just inside the furnace door.
3. The boat is then heated for 45 minutes at 1300C in the hot zone.
4. The boat is pushed into the cooler and left to cool for 30 minutes. (H_2O temperature 120F.)
5. Cooling chamber door (between firing zone and cooling chamber) should be closed when firing or cooling because wet hydrogen is run in the box portion of the furnace while dry hydrogen is run into the cooling chamber.

F2-4A

FIRING IN WET HYDROGEN

EQUIPMENT

1. Suitable furnace.
2. Wet hydrogen supply, having a dew point of +60 to +95F.

   Wet hydrogen may be obtained by bubbling hydrogen through water just before it enters the furnace.

PROCEDURE

1. Parts are fired in wet hydrogen for specified time at specified temperature.
2. Parts are pushed into cooling chamber to cool to approximately 80C.

HYDROGEN FIRING METALIZED CERAMICS

PURPOSE

Hydrogen firing metalized ceramics serves six purposes:

A. Creates positive bond between metalizing and ceramic
B. Sinters metalizing to permit strong leak-tight seals.
C. Removes metalizing binder by converting it to gaseous products.
D. Causes oxidation in metalizing to insure maximum bond
E. Degasses both ceramic and metalizing.
F. Cleans up minor contamination on both ceramic and metalizing.

MATERIALS

Ceramic insulators as specified on the drawing.

EQUIPMENT

A. Hydrogen furnace 6" x 8" wide opening, hydrogen atmosphere cooling chamber, or retort type furnace for larger pieces or high production runs.
B. Source of wet hydrogen (preferably from passing dry line hydrogen through water bubbler).
C. City gas pilot line for pilot flame and flame curtains (hydrogen dew point -60 to -90F.).
D. Thermocouple and controller-recorder.
E. Seals Flo-Scope gauges for measuring hydrogen entering muffle and and cooler end of furnace.
F. Molybdenum firing boats, 12" x 6" x 5 1/2" high
G. Alundum chips, minus 20 mesh, Norton Co.
H. Timer, electric or windup.
I. Rod to push boats through furnace with brackets to store rod in and keep it off the floor.
J. Asbestos gloves.
K. Hooked hollow rod connected nitrogen line for flushing boats before bringing through flame curtain.

PROCEDURE

Caution: At no time are ceramic parts to be handled or exposed to the building atmosphere. The audit check during metalizing, proper location of parts in boat after metalizing, careful transport of boat to and from furnace area, and the inspection which follows will result in entirely satisfactory audit of metalizing and firing.

A. All boats will be loaded and unloaded in the metalizing area by metalizing personnel. These boats will be of molybdenum with the bottoms lined with at least 1/2 inch of alundum chips. Each layer of parts to be fired will be supported above the previous layer with spacers. When the boat is properly loaded, the correct processing card should be added to it and then it should be hand carried to the furnace area for firing.

PROCEDURE (CONT'D)

Note: Extreme care should be exercised in handling loaded boats since the metalized insulators tend to slide rather easily. This will cause sticking and subsequent rejection of parts.

B. Check that the furnace is at temperature as called for on the processing card.
C. See that the water level is to red line as marked on bubbler, and H2 is bubbling through it. If below line, add water. If above line, call foreman.
D. Preheat boat on fore-hearth just inside furnace door for time as specified on process card.
E. Move boat to hot zone of furnace for time specified on planning and processing ticket counting from time boat is first pushed into the hot zone.
F. Push boat into cooling chamber and leave there for time as specified.
G. Purge hydrogen from boat with nitrogen and then pull boat through flame curtain.
H. Check off operation completed and initial process card.

DISPOSITION

After firing operation is completed, boats will be picked up by Metalizing personnel, carried to metallizing area, unloaded and reloaded with more parts.

INSPECTION

Metalized ceramic parts are sorted as called for in Standing Instruction N3-23.

PROCESS CONTROL

A. See that all hydrogen entering hot zone is passed through bubbler and furnace flushed 20 min. with wet H_2 before each firing shift begins.
B. Hydrogen flow according to Selas Floscopes should be 75 cubic feet per hour to the hot zone and 50 cubic feet per hour to the cooler whenever parts are being fired. Lower flow rates will not maintain sufficient atmospheric control in furnace.
C. Use furnace, firing boats, and spacer plates for firing metalized ceramics exclusively. If used for other purposes, do not use them for firng ceramics again. This furnace must be free from iron and other metal contaminants before it will give good ceramic parts.

Boats are provided to be used exclusively for firing metalized ceramic insulators. These boats should not be used to sinter the copper or nickel plated insulators as boat contamination may result.

D. When new boats or spacer plates are to be put into use for firing ceramics, fire them at the regular ceramic firing cycle before using them with ceramic parts.

PROCESS CONTROL (CONT'D)

E. Mark the position of the rod used for pushing boat into hot zone and come to this position each time a boat is moved to the hot zone. This will increase firing reproducibility.

F. When converting from line hydrogen (-60 to-70F dew point) to wet hydrogen (through water bubbler) or vice versa, be sure furnace is purged for 20 minutes with 75 cubic feet per hour going to the hot zone and 50 cubic feet per hour going to the cooler.

TROUBLE SHOOTING

A. Air may enter the furnace in the following ways:

1. While a boat is being removed from the cooler. Flame curtain at end of tube tends to minimize this.
2. A leak in the furnace.
3. Insufficient flushing or preheating of closed or covered boats.

B. This air may make parts unusable as follows:

1. Free oxygen will cause scale on metal parts or bands.
2. Air from a leak or admittance through cooling chamber will cause a spectrum color on fired parts.
3. Internal explosion and part distortion or rupture if diffusion is restricted too much.

C. Remove covered boats from the cooling chamber with care as a combustibal mixture of hydrogen and air may form inside. This will be minimal if the boat is properly flushed with nitrogen.

23. D. Dust on boats fixtures or parts usually means sluff accumulations on the hearth. Cool furnace and clean hearth.

E. All parts must be covered with molybdenum trays. City gas used in the flame curtains has a tendency to leave soot and, or sulpher deposits. If parts are contaminated, it may be necessary to substitute hydrogen for city gas in the pilot flame lines.

F. Cooling chamber temperatures are important. Keep it high enough to avoid condensate accumulation along the floor of the cooler. Under a hot boat this condensate converts to steam which oxidizes work being cooled. Avoid this condition at all times.

G. If lack of reproducibility in seal strength is a problem, it may be the result of not using wet hydrogen for this firing or not purging enough before firing shift is started.

MAINTENANCE

A. Cleaning - During normal operation, furnaces are bound to get crudded up one way or another. Soot and sulpher deposits will build up at both ends of the furnace due to the constant burning of city gas. Rust accumulates in the cooler sections because of the unavoidable sweating problem which crops up every once in a while. Boat lagging

MAINTENANCE

A. Cleaning (Cont'd)

material covers the bottom of the furnace because boats have gaps or holes in them. If the furnaces are not cleaned on a periodic basis a serious degradation in parts' quality will result. Furnaces should be cleaned at least twice a year. The following procedure is recommended:

1. Shut furnace down as outlined in procedure under "starting and stopping".
2. Wire brush entire cooling chamber to remove all rust, scale, and dust.
3. Check all furnace doors for cracks and/or missing pieces. Rebuild or replace if necessary.
4. Check cooling chamber for water leaks. Patch and/or replace if necessary.
5. Check elements and all brick work. If brick work is badly cracked, and has the "ready to cave in" look, a major rebricking job is suggested.
6. Vacuum clean the entire interior of the furnace.

B. Calibrating - Furnace controls must be calibrated periodically to insure the validity of their readings. All work of this type must be handled by the electrical service group. An accurate millivolt source is hooked to the input terminals of the recorder and a set procedure is followed to insure reproducibility of results. There is no need to check thermocouples or thermopiles since they are accurate until they short out. At that time, the indicator will climb past the limit point and the furnace will be shut off automatically. The recorders will be calibrated every second month with the calibrated millivolt source. The person doing this will then label the furnace with date calibration was completed and his initials. Also, every sixth month a traveling thermocouple will be run through the furnace with resulting readings being checked against the furnace controls. This should be done after shut down periods and before parts are started through the furnace again.

Note: The electrical service group is responsible for the accuracy of the furnaces. It is important that they be notified whenever a furnace controller seems to be acting up. No controls should be tampered with by anyone except people from this electrical service group.

C. Starting and stopping

1. Ignition of eight inch hydrogen box furnaces.

C. Starting and stopping (Cont'd)

a. Close end doors of furnace and open cooler door.
b. Purge furnace for two hours with nitrogen. Use a flow of 100 cfh. on each hydrogen flow scope.
c. Turn power switch from off to instrument.
d. After two hours of nitrogen purging, light pilot lights. Check flame curtains. Open water valve to cooler and close off the water bypass.
e. Increase nitrogen flow for five minutes to a reading of 200 cfh. on each hydrogen flow scope.
f. Simultaneously, introduce hydrogen and shut off nitrogen to the furnace. Regulate to 75 cfh. of hydrogen in the hot box and to 50 cfh. of hydrogen in the cooler.
g. Purge with hydrogen for one hour.
h. After one hour close the cooler door.
i. Turn power switch from instrument to heat. Reactrol unit should be reading approximately 80.
j. Bring furnace to desired temperature in intermediate steps. That is, hold heat constant at various stages to allow brick-work to reach thermal equilibrium.

2. Idling of eight inch hydrogen box furnaces.

a. Open cooler door.
b. Decrease flow of hydrogen to 35 cfh. in the cooler section.
c. Turn off all hydrogen leading into the hot box. Maintain 35 cfh. in cooler section.
d. Bring temperature down to 900C or 1000C.

3. To prepare for operation

a. Increase flow of hydrogen to 50 cfh. in the cooler.
b. Flow 75 cfh. of hydrogen in the hot box.
c. Close the cooler door.
d. Adjust to desired temperature.

4. Shutting down of eight inch hydrogen box furnaces.

a. Turn power switch from heat to instrument.
b. Open cooler water bypass. Regulate water flow until it is coming out warm.
c. Open cooler door.
d. Allow temperature to drop below 400C.
e. Simultaneously, open up nitrogen and turn off the hydrogen. Regulate nitrogen flow to 200 cfh. on each hydrogen flowscope.
f. When hydrogen is no longer burning off at either end of the furnace, shut off nitrogen and allow the furnace to go to air.

4. Shutting down of eight inch hydrogen box furnaces (Cont'd)

g. Turn off pilot lights.
h. Open both end doors.

F3-1P

AIR FIRING CERAMICS

PURPOSE

The purpose of air firing ceramics is threefold:

A. To oxidize all organic and carbonaceous materials and convert them to gaseous products which go off into the furnace atmosphere.
B. To drive undesirable volatiles out of the body of the ceramic and replace them with air gases which can be removed relatively easily at exhaust without altering crystal phases.
C. To oxidize any iron deposits and show them as stains or color variations in the piece.

This instruction, therefore, is written to provide a means of accomplishing these purposes on ceramic materials.

MATERIALS

Ceramic parts as specified on the drawing.

EQUIPMENT

Suitable tunnel kil capable of reaching 1100C
Silicon carbide saggers
Portable indicator with thermocouple leads.

PROCEDURE

A. Parts come to furnace loaded in carbide saggers covered with mullite lids.
B. Parts are fired in a tunnel kil with air forced through furnace against the movement of the ceramics. The parts are 7 hours up to maximum temperature and 7 hours of cooling down from maximum temperature. Maximum temperature is 1100C.

DISPOSITION

Send boats to next station on processing ticket, still covered (usually inspection).

INSPECTION

After the boat has cooled to room temperature, lift the cover vertically without tilting or moving it away from covering area over the parts. Give the parts a cursory visual examination for obvious spots, cracks, chips, areas of discoloration or contamination without touching or removing the fired parts. If no defects are observed, replace the cover and send the boat to the next planned station. If defects are noted, call foreman.

PROCESS CONTROL

A. The furnace used for firing ceramics shall not be used for firing any other materials at any time.

B. Use boats for firing ceramics only. Firing other parts in them only leads to contamination of several batches of ceramics.

TROUBLE SHOOTING

A. If parts show spots, it indicates:

1. The boats are contaminated with something that is being transferred to the parts during firing.
2. Parts were not clean when placed in boats after acetone wash.
3. The oven is contaminated with something which is dropping or being splashed on parts during firing.
4. Something near the surface of the ceramic body is being converted to a colored product by air firing (such as iron deposits from the die used in making the part).

B. Larger discolorations on the parts indicates:

1. Contaminated furnace.
2. Contaminated parts.
3. Non-uniform milling lot at vendors plant.
4. Diffused iron deposits left on parts by vendor's processing.

C. Parts coming from the furnace cracked, chipped or broken show:

1. Incipient cracks in the part as received from the vendor.
2. Incipient cracks from rough handling in our plant.
3. Thermal shock - oven temperature too high when parts placed in oven or removed from oven.

D. Air firing was first started to oxidize the iron left by vendor and show it up as discoloration areas in the part. Since the problem has been largely corrected, the firing has been continued to insure against falling into the same trouble again. Occasionally one or two are found in a lot of 100 or more pieces.

E. Conical recrystallization is a condition which vendors have not yet found means of controlling. It is, however, strictly their problem.

MAINTENANCE

A. Check the furnace temperature at the beginning of each shift as the first job is run in the furnace.

Procedure

1. Set furnace at 1000C (corrected to latest controller calibration factor) and record setting in log book.

MAINTENANCE (CONT'D)

Procedure

2. When the furnace has reached equilibrium temperature, insert the thermocouple leads from a portable indicator.
3. When this has reached equilibrium, record in a log book the extremes of the temperature cycle against the furnace number, setting and the date.
4. If extreme readings are between 985C and 1015C continue firing.
5. If extreme readings are not within 985C to 1015C, stop firing and notify foreman.

B. Calibrate both portable indicator and controller-indicators according to the controller-indicator calibration schedule and tabulate the calibration correction factory and date of calibration on a tag attached to the instrument and in a book kept in the furnace area.

C. Whenever a firing of some lot of ceramics in these furnaces causes large volumes of volatiles to pour out of the oven (high boiling solvent, body contaminants, etc.) remove it from service until the furnace can be thoroughly cleaned by firing empty furnace at 1100C for 1/2 hr. before it is used again at 1000C for ceramics. Do this once in 3 months as regular practice to insure no buildup of contamination.

SILK SCREEN COATING
(Silk Screen Metalizing Machine)

PURPOSE

To butt or end coat ceramic insulators with a uniform, smooth, controllable layer of metalizing mix.

MATERIALS AND EQUIPMENT

1. Jig or fixture to hold insulators stationary at some fixed height.
2. Jig or fixture to hold screen taunt and in a fixed position.
3. Stainless steel mesh screen of proper mesh size and wire diameter.
4. Teflon tipped squeegee to spread paint evenly on the screen and also to force the paint through the screen and to the insulators.
5. Properly adjusted moly-manganese mix.
6. Small oven to dry coating after being applied to the insulator.
7. Molybdenum trays to load parts on for drying and firing.
8. Two 100 ml beakers, one for the mix and the other for acetone or other cleaning solvent.
9. Cotton swabs for touch up cleaning on ceramic insulators.
10. Pliers for setting the moly trays into the drying oven and also for pulling them out.
11. Two sided tape for holding insulators down and in a fixed position.

PROCEDURE - SETUP

1. Place a clean piece of two sided tape down on the parts holding fixture.
2. Lay five (5) parts to be coated on the tape in the following pattern. ⁚·⁚
3. Lay the .040" shim stock across three of the insulators.
4. Lay a flat surfaced object on the shim stock and across two of the micro-adjustment nuts.
5. Adjust each nut until it just barely touches the flat surface.
6. Lay the flat surfaced object across the other two adjustment nuts and on the shim stock.
7. Repeat Step 5.
8. Set the stainless steel screen supported by the screen fixture into proper position. The two pins in the parts fixture should come through the screen fixture and the bottom of the screen fixture should rest on top of all four micro-adjustment nuts.
9. Check the screen fixture for wobble and make necessary adjustments.
10. Place proper number of ceramic insulators to be coated on the sticky tape. The only criteria for loading is that no part should touch any other part.

PROCEDURE - SETUP CONT'D

11. Pour enough mix on the screen to allow coverage of the entire area.
12. With the teflon tipped squeegee wipe the paint into the screen using firm but not hard pressure. Continually turn the screen over so that all the screen holes are filled with mix. The last wipe should be made on the bottom side of the screen.
13. Place the screen fixture on the parts jig and make one pass with the squeegee.
14. Remove screen, examine parts, and made adjustments where necessary.

PROCEDURE - PRODUCTION

1. Place proper number of ceramic insulators on the parts fixture.
2. Put the screen fixture in place and draw the squeegee across the screen.
3. Remove the screen fixture, add paint to the screen if necessary, and work the paint into the screen until all meshes are filled with mix.
4. Take the coated insulators from the fixture with tweezers and load them on the molybdenum trays.
5. Place loaded tray in the drying oven for approximately 15 minutes.

PROCESS CONTROL

1. Use nothing but properly adjusted screen mix.
2. Do not place excess coating on the screen. It will tend to run on the fixture and eventually on the operator and the insulators.
3. Do not leave the mix lying on the screen for long periods of time. The vehicles and binders will separate from the metallic particles and an inhomogeneous mix will result. The screen should be clean of all mix at lunch break and again at the end of a shift.
4. The teflon on the end of the squeegee will tend to wear over a period of time. When the insulators on the outermost rows are not coating the teflon should be squared off.

TROUBLESHOOTING

1. Mix not adhering to the ceramic insulator
    a. Binder has not been added to the mix.
    b. The oven is too hot and the binder is being burned off
2. Gritty particles in the mix.
    a. The rolling time was not sufficient to take all the Lucite 46 into solution.
    b. The ball milling cycle was not correct. Particles of metal have not been reduced in size.
3. Mix is not working properly into the screen.
    a. The mix is too thick. Check viscosity and add Butyl Carbitol Acetate if necessary.

TROUBLESHOOTING CONT'D

4. Mix running on the sides of the parts.
   a. Temperature of the room is too high.
   b. Viscosity of the mix is too low. Discard and start using from a new bottle.

J1-1P

SPRAYING CATHODES
(Emission Coating)

PURPOSE

To provide instructions for applying a uniform coating to the entire cathode surface of cathode and insulator assemblies.

MATERIALS

1. Cathode assemblies per drawing list.
2. Triple carbonate suspension specified on drawing list.
3. Acetone

EQUIPMENT

1. Vented spray booth with spraying disc, motor and other fixtures mounted.
2. Paasche spray gun.
3. Binocular microscope with light.
4. Spraying fixtures.
5. Post grinder with carboloy cutter.
6. Dial gauge.
7. Tweezers
8. Cathode dummies
9. Precison scales

PROCEDURE

1. The assemblies are ready for use as received from the previous ultrasonic cleaning operation.
2. The assemblies are placed in the spraying fixtures face down and carefully centered so the cathode is in the hole in the face of the fixture. The back is then screwed on.
3. The magnetic fixtures are arranged around the circumference of the spraying disc. Two cathode dummies are included with each load to check spray density.
4. Cathodes are sprayed until .0025" to .0035" of coating has been deposited. If uncertain of spray gun setting, a run containing only dummies should be performed and coating density and height checked.
5. Cathode dummies are removed and checked for spray coating thickness. These must be within specified limits.
6. Cathode assemblies are removed from spraying fixtures and placed in trays.
7. Cathode assembly is grasped by back of ceramic with tweezers and run through track of post grinder, applying light pressure against the cutter. The coating thickness is gauged. If within the drawing tolerance the part is placed in a tray, coating side up for future inspection. If coating is too thick, the part is run through the cutter and regauged, if too thin either the cutter is not properly

PROCEDURE (CONT'D)

adjusted or one of the braze joints on the cathode assembly has come loose. Each assembly must be gauged.

8. The cathode assembly is inspected under microscope for proper coverage of coating, chipped edges, gauges, tilts, etc.

9. After spraying is completed, the jar of coating is removed and a beaker is filled with acetone and the gun is thoroughly flushed out.

RlA/SCR3

COPPER STILL PLATING

(Basket)

PURPOSE

To provide an adherent copper flash on small nickel tubing and wire leads (less than 1/16" diameter x 1" long) for brazing purposes.

MATERIALS

Material	New Bath Content	Control Limits
Copper Cyanide	902 oz	5-6 oz/gal
Sodium cyanide	1320 oz	1.5-2.0 oz/gal (Free)
Sodium carbonate	328 oz	2.0-610 oz/gal
Sodium hydroxide	246 oz	pH 12-13
"Rocheltex"		6-10% (volume)
Deionized water to make up to 164 gallons		500,000 ohms or greater

Operating temperature 140-160 F

Anode to cathode area = 1:1
(Adjust as required to maintain copper cyanide content)

Current density - See Plating Process Cards

EQUIPMENT

1. Plating Tank - Plastisol or Koroseal lined steel 24" x 24" x 72" working volume 164 gallons equipped with steam heating coil and indicating automatic temperature control.

2. Rectifiers - separate unit for each of four positions 50 amp. 10 v.

3. Stainless steel anodes - size and number as required.

4. Rinse Tanks - stainless steel

5. Baskets - stainless, approximately [illegible]" x [illegible]" dia.

6. Filter - immersion type with impeller pump.

7. Vapor Exhaust Venting System.

MAINTENANCE

1. Maintain solution at working volume - at determined point approximately 3 1/2 inches below top of tank by addition of deionized water as required.

2. Anode Maintenance - Proper copper ion content of plating bath will be maintained by use of one copper anode and two stainless anodes on each of two anode bars. Adjustment in anodes will be required as copper anodes errode and are reduced in area. Adjust to maintain approximately the initial balance between area of copper and stainless anodes.

3. Anode Area - Maintain 4 on each of 2 bars. Copper 1" x 4" x 15".

PROCEDURE

1. Parts are placed in nickel mesh basket.
2. Parts are cleaned thoroughly before plating.
3. Parts are copper flashed at about 3v for 2 to 3 minutes with agitation of parts to prevent sticking together. (Negative contact is made directly to the basket by means of a wire-clip combination.)
4. Parts are rinsed thoroughly in cold running water, 10 sec.
5. Parts are rinsed in hot running water, 10 sec.
6. Parts are rinsed in acetone for 10 sec. and drained.
7. Parts are blown dry with carefully directed compressed air.

INSPECTION

All parts should be covered with copper plating.

NICKEL PLATING

(Barrel)

PURPOSE

1. To provide an adherent nickel plate to tube parts. Stainless steel, tungsten and molybdenum is struck with nickel from nickel strike, bath to provide a surface for further plating because other plates do not adhere to these metals.
2. Plating is to be uniform, unstained, unblistered and of the specified thickness.

MATERIALS

1. Strike Bath

Bath Composition	Chemical Grade	New Bath Content With Solution Level 3" Below Top Of Tank	Control Limits
Nickel Chloride	Udylite Corp.	26,400 g	220-260 g/l
Hydrochloric Acid		13,750 cc	100-150 cc/l
Deionized Water to make up volume			500,000 ohms or greater

Temperature - Room

2. Plate Bath

Bath Composition	Chemical Grade	New Bath Content With Solution Level 3" Below Top Of Tank	Control Limits
Nickel Sulfate (22.1% Ni)	Udylite Corp	13,200 g	135-155 g/l
Ammonium Chloride		2,800 g	20-30 g/l
Boric Acid		3,300 g	25-35 g/l
Deionized Water to make up volume			500,000 ohms or greater
pH			5.4-6.0

Temperature - Room

EQUIPMENT

1. Tank

Construction Material	Capacity At Solution Level 3" Below Top Of Tank	Overall Dimension (inches)
Koroseal Lined Steel	110 liter	22 x 24 x 16 deep
Koroseal Lined Steel	110 liter	22 x 24 x 16 deep

2. Barrels

Belke-Porto Plater with 3/4 inch diameter slug contact for nickel plating = 2 quarts.

MAINTENANCE

1. Solution Level - Maintain level at ± 1/2 inches below the top of the tank. A marker is located on each tank to indicate the 3 inch level.
2. Filtering Plating Solution - To determine the cleanliness of a solution, fill a bottle with the solution and observe the solution by holding it up to the light.
3. Anode Area - Maintain anode areas as follows:

Type Of Plate	Size Of Anode (inches)	Anode Metal	Chemical Grade	No. Of Anodes
Nickel Strike	1/4 x 5 x 8	Nickel	99+% Chemical Co.	4 on each of 2 bars
Nickel Strike	1/4 x 5 x 8	Nickel	Rolled Depolarized or cast in carbon	4 on each of 2 bars

4. Barrel Maintenance -

a. Deplate cathode chain contacts used in the Belke-Porto Platers once a day.
b. Use Belke-Porto Platers for all nickel deplating.

PROCEDURE

1. The number of parts to be plated in barrel are weighed out.
2. Parts are cleaned thoroughly before plating. Only parts which are uniformly clean looking should be plated. Send back any parts having dirt stains or nonuniform appearance because dirty parts are likely to blister when heated later.

PROCEDURE (CONT'D)

3. Parts are poured gently from cleaning basket to the barrel.
4. Parts to be struck as specified in striking table, are immersed in barrel in striking tank. For all the other parts, omit Steps 4, 5, and 6.
5. Strike parts according to time and current specified in table. Make sure the barrel is rotating and the filter pump is operating during striking.
6. Barrel is lifted out of strike solution while still rotating and allowed to rotate with one end resting on the drain board for four revolutions to drain strike solution out of the parts.
7. Barrel is transferred to plating tank.
8. Plate according to the number of parts per barrel, current and time specified in the table. Make sure the barrel is rotating and the filter is operating during plating.
9. Barrel is lifted out of plating solution while still rotating and allowed to rotate with one end resting on drain board for four revolutions to drain plating solution out of parts.
10. Barrel with parts still rotating, is placed into cold water rinse and barrel is allowed to rotate for one minute. Barrel is lifted out of cold water rinse while still rotating and allowed to rotate with one end resting on drain board for four revolutions to drain cold water out of parts. (See note.)
11. Barrel, with parts still rotating is placed into hot water rinse and barrel is allowed to rotate for one minute. Barrel is lifted out of hot water rinse while rotating and allowed to rotate with one end resting on drain board for four revolutions to drain hot water out of parts. Electric plug is pulled out to stop barrel rotating.
12. Barrel is carried to hot water rinse next to Kreider dryer. Barrel of parts is dumped through funnel cover into drying basket submerged in running hot water.
13. Drying basket, with parts is lifted out of hot water and into Kreider spin dryer. Parts are spun until dry which usually takes about two minutes with steam heated hot air.

Rinsing and drying must be done carefully and equipment kept in top condition or stains will appear on plated parts causing rejection of tubes composed of stained parts.

Note: If subsequent operation is *C6-3D, it must start immediately after this rinse. Parts must not be permitted to dry or partially dry between these operations.

COPPER BARREL PLATING

PURPOSE

1. To provide an adherent copper plating to assemblies and tube parts.
2. Plate is to be uniform unstained, unblistered, and of specified thickness.

SAFETY

Plating Bath - observe safe handling procedures required in working with hot strongly alkaline cyanide solutions. Do not mix with acid or expose to acid fumes.
Venting - Vent bath vapors into vapor exhaust system.
Acetone - Observe safe handling procedure required for volatile and flammable solvent.

EQUIPMENT

1. Plating Tank - Plastisol or Koroseal lined steel 24" x 24" x 72" working volume 164 gallons equipped with steam heating coil and indicating automatic temperature control.
2. Plating Barrels - Daniels' 8H Plastic.
3. Barrel Rotating Drive - Motor/reduction gear driving common shaft providing rotating drive for four barrel positions.
4. Rectfiers - separate unit for each of four positions 50 amp., 10V.
5. Stainless steel anodes - size and number as required.
6. Contact medium - metal pins or copper-clad plastic balls.
7. Rinse Tanks - stainless steel
8. Baskets - stainless, approximately 8" x 8" dia.
9. Filter - immersion type with impeller pump.
10. Vapor Exhaust Venting System.

MATERIALS

Copper cyanide, 70 - 71% copper	KR02075
Sodium cyanide, 96%	KR0107
Sodium carbonate	KR01429
Sodium hydroxide	KR01432
"Rocheltex" (brightener)	KR01414
Copper anodes, OFHC	KR03372
Acetone	KR04358

BATH COMPOSITION

Material	New Bath Content	Control Limits
Copper cyanide	902 oz.	5-6 oz/gal
Sodium cyanide	1320 oz.	1.5-2.[illegible] oz/gal (Free)
Sodium carbonate	328 oz.	2.0-6.0 oz/gal
Sodium hydroxide	246 oz.	pH 12-13
"Rocheltex"		6-10% (volume)
Deionized water to make up to 164 gallons		500,000 ohms or greater

Operating temperature 140-160 F.

Anode to cathode area = 1:1
(adjust as required to maintain copper cyanide content)

Current density - see Plating Process Cards

MAINTENANCE

1. Solution level - maintain level 2 - 2 1/2 inches below top of plating tank by addition of deionized water as required.
2. Bath composition control - The maintenance of proper balance between area of copper and stainless anodes will assist in holding copper cyanide bath content within limits.

PROCEDURE

1. The specified number of precleaned parts are placed into the plating barrel, containing the specified type and quanity of contact medium.
2. The loaded plating barrel is inserted into one of the four plating positions provided at the plating tank - insert with barrel rotating drive running.
3. Immediately turn switch of rectifier serving the position being loaded to "ON". Adjust rectifier control to specified plating current.
4. Plate as specified - time and current.
5. Turn rectifier switch to "OFF".
6. Immediately raise plating barrel to position above solution level. Drain excess solution from parts.
7. Transfer loaded barrel to cold running rinse water tank. Immerse barrel until water covers plated parts. Tumble rinse by rotating barrel 10 - 15 seconds.
8. Drain to remove excess rinse water. Transfer plated parts to stainless steel basket. Rinse in cold running water with agitation 10 - 15 seconds.

PROCEDURE (CONT'D)

9. Rinse in cold flowing deionized water 10 - 15 seconds.
10. Rinse in hot flowing deionized water 10 - 15 seconds.
11. Rinse in hot flowing deionized water 10 - 15 seconds. (Repeat Step 10 but in second tank or tank section).
12. Rinse in cold flowing deionized water 10 - 15 seconds.
13. Parts that are to receive further plating application are carried into the next plating procedure or pretreatment without drying.
14. Parts not to be immediately transferred to another plating operation are rinsed in acetone 10 - 15 seconds, dried, and placed in storage or transport containers, omitting cold deionized rinse of Step #12.

PROCESS SCHEDULES AND INSTRUCTIONS

1. See Parts Process Cards for specified precleaning and preprocessing schedule.
2. See Plating Process Cards for specified number of parts per barrel load, type and quantity of plating contact medium, plating current, plating time, and plating thickness.
3. See Tumbling Process Card for specified tumbling procedure where tumbling is called for by Parts Process Card.

S-RLE/3

COPPER, BARREL PLATING

PURPOSE

1. To provide an adherent copper plating to tube assemblies.
2. Plating is to be semibright, unstained, free of blisters and of specified thickness.

SAFETY

Plating Bath - Observe safe handling procedures required in working with hot strongly alkaline cyanide solutions. Do not mix with acid or expose to acid fumes.
Venting - Vent bath vapors into Vapor Exhaust System

EQUIPMENT

1. Plating Tank - Plastisol or Koroseal lined steel, 24" x 24" x 16", working volume 36 gallons, equipped with steam heating coil and automatic temperature control.
2. Plating Barrel - Daniels 8H Plastic
3. Rectifier - 50 amp. 12V
4. Baskets - stainless, approximately 8" x 8" dia.
5. Rinse Tanks - stainless
6. Filter - immersion type with impeller pump.
7. Contact Medium - metal pins.
8. Stainless steel Anodes - 1/8" x 2" x 11 1/2"
9. Vapor Exhaust Venting System

MATERIALS

Copper Cyanide, 70 - 71% copper	KR02075
Potassium cyanide, 98%	KR0479
Potassium carbonate, Reagent, Anhydrous	KR0478
Potassium hydroxide, Reagent	KR0480
"Rocheltex" (brightener)	KR01414
Copper Anodes, OFHC, 1 1/2" x 5" x 9"	KR03372

BATH COMPOSITION

Material	New Bath Content	Control Limits
Copper cyanide	286 oz.	7.2-8.8 oz/gal
Potassium cyanide	464 oz.	0.8-1.2 oz/gal (Free)
Potassium carbonate	72 oz.	6 oz/gal max.
Potassium hydroxide	200 oz.	Ph 13 or greater
"Rochseltex"		8-10% (volume)
Deionized water to make up to 34 gal.		500,000 ohms or greater

Operating Temperature 160-170 F.

Anode to cathode area = 2:1

Current density - See Plating Process Card

MAINTENANCE

1. Maintain solution at working volume - at determined point approximately 2 - 2 1/2" inches below top of tank by addition of deionized water as required.
2. Anode Maintenance - proper copper ion content of plating bath will be maintained by use of one copper anode and two stainless anodes on each of two anode bars. Adjustment in anodes will be required as copper anodes errode and are reduced in area. Adjust to maintain approximately the initial balance between area of copper and stainless anodes.

PROCEDURE

1. The specified number of precleaned tube assemblies or parts are transferred into the plating barrel.
2. Plating barrel is inserted into plating tank with barrel rotating drive on and the bath at operating temperature.
3. Rectifier is immediately turned on and set to specified plating current. After initial adjustment duplicate barrel loads may be inserted with the current on followed by slight current adjustment as required. Hold immersion time with current off to a minimum.
4. Plate as specified - current and time.
5. Raise plating barrel to position above solution level. Drain excess solution from parts.
6. Transfer barrel to cold running water rinse tank. Immerse barrel until rinse water covers plated parts. Tumble rinse by rotating barrel 10 - 15 sec.
7. Drain to remove excess rinse water. Transfer parts to stainless basket. Rinse in cold running water with agitation.

PROCEDURE (CONT'D)

8. Rinse parts in cold flowing deionized water 10-15 sec. with agitation.
9. Rinse in hot flowing deionized water 10 sec.
10. Repeat Step 9 in a second hot rinse tank section.
11. Rinse in cold flowing deionized water 10 sec.
12. Tubes to be nickel plated are transferred to that operation without drying.
13. Parts not to be immediately transferred to another plating operation are dried and placed in storage or transport containers, omitting the cold deionized rinse of Step #11.

PROCESS SCHEDULES AND INSTRUCTIONS

1. See Parts Process Cards for specified precleaning and preprocessing schedule.
2. See Plating Process Cards for specified number of parts per barrel load, plating current, plating time and plating thickness.
3. See Tumbling Process Cards for specified tumbling procedure where tumbling is called for by Parts Processing Card.

LIMITATION

The time of rinsing in hot water in Steps 9 and 10 is reduced to 10 seconds to prevent oxidization of copper plating prior to nickel plating.

R1P

GOLD, BARREL PLATING

PURPOSE

1. To provide an adherent gold plate to tube assemblies and parts.
2. Plating is to be yellow in color, unblistered and of specified thickness.

SAFETY

Plating Bath - Observe safe handling procedure required in working with hot alkaline cyanide solutions. Do not mix with acid or expose to acid fumes. Keep ammonium hydroxide and ammonium salts away from gold drag-out rinses, gold plating and deplating solutions to insure against the formation of EXPLOSIVE gold fulminate.
Acetone - Observe safe handling procedure required for volatile and flammable solvent.
Venting - vent bath vapor into Vapor Exhaust System.

EQUIPMENT

1. Plating Tank, stainless steel - type 304, 40 gallon capacity, 24" x 18" x 24" deep set in water bath tank 31" x 24" x 30" equipped with an 8 pass 3/4" steam coil - bottom mounted, automatic indicating thermostatic temperature control.
2. Power Supply: Rectifier - stepless voltage control, 50 amp. 9V. capacity, equipped with an amperehour meter of 100 amp. capacity, 1/4 scale with totalizing dial.
3. Plating Barrel - Daniels' 8H Plastic - entire bottom fitted with 2 nickel plate as cathode.
4. Drag-out Tank - Plastisol or Koroseal lined steel.
5. Rinse tanks - stainless steel
6. Rinse baskets - stainless steel
7. Anodes - stainless, 18 - 8 grade.
8. Filter - immersion type with impeller pump.
9. Warm Air Drying Unit - Open rectangular tank, approximately 24" x 48" x 24" deep, air input into end supplied with steam heat coil, air filter and fan for clean flowing warm air drying.

MATERIALS

Gold Potassium Cyanide Solution	
Technic Trushade, 24 kt. (50ml = 1 dwt)	KR0410
Potassium Cyanide, 98%	KR0479

MATERIALS (CONT'D)

Potassium phosphate, dibasic, Reagent (Dipotassium phosphate)	KR01181
Potassium carbonate, Reagent	KR0478
Acetone	KR04358

BATH COMPOSITION

Material	New Bath Content	Control Limits
Gold cyanide solution	17,000 ml	8-9 dwt/gal
Potassium cyanide	160 oz	3- [illegible] oz/gal (free)
Potassium phosphate (Dibasic)	160 oz	3-[illegible] oz/gal
Potassium carbonate	160 oz	4-15 oz/gal
Deionized water to make up to 40 gallons		500,000 ohms or greater

Operating temperature 145- 155 F.

Anode to cathode area = 1:1

MAINTENANCE

1. Solution level - maintain working of the plating bath 3 1/2 inches below top of plating tank by transferring solution from the drag-out rinse tank as required. Use deionized water for make up of drag-out rinse volume. Maintain fluid level in water bath plating tank jacket as required.
2. Maintain plating bath gold content by additions of Trushade gold concentrate solution based on ampere hours indicated on meter, confirming gold content by gravimetric analysis performed at intervals of one week. At the lower current densities with cathode efficiency at 70%, the replenishment would be 17 dwt. (850 ml Trushade gold concentrate solution) for each 5 ampere hours (20 meter untis) of plating. Five ampere hours of plating will reduce the gold content of a 40 gallon bath from 8.5 dwt/gal. (midpoint of operating range) to 8.07 dwt/gal.

PROCEDURE

1. Place specified number of precleaned parts into plating barrel - barrel will have been preloaded where gold strike procedure SI 13700 R1P/1 is specified to precede this plating operation.
2. Turn rectifier switch to "on" position and set voltage control to approximate first step position. Turn barrel rotating drive on.
3. Insert loaded plating barrel into plating tank, contacting (with current on) the cathode contact in a minimum time.

PROCEDURE (CONT'D)

4. Immediately adjust voltage control for specified plating current.
5. Plate as specified - time and current schedule.
6. Turn rectifier switch to "off" position.
7. Raise plating barrel to drain position and drain of excess solution.
8. Transfer loaded plating barrel to drag-out rinse tank and tumble rinse for 10 - 15 sec. Drain excess solution into drag-out rinse tank.
9. Transfer parts to stainless steel basket.
10. Rinse in cold deionized water for 15 - 30 sec.
11. Rinse in hot deionized water for 15 - 30 sec.
12. Rinse in hot deionized water for 15 - 30 sec.
13. Rinse in acetone for 10 - 15 sec.
14. Drain thoroughly and dry in warm air.
15. Remove from basket to storage and transport containers or to next process.

PROCESS SCHEDULES AND INSTRUCTIONS

See Parts Process Cards for precleaning and preprocessing schedules for additional processing.

See Plating Process Cards for specified number of parts per barrel load, plating current, plating time, and plating thickness.

See Tumbling Process Cards where tumbling procedures are called for in Parts Processing Cards.

LIMITATIONS

This gold plating bath is not designed to produce a bright plate deposit. Burnishing may follow plating where a bright finish is required as an external final finish on completed tube assemblies.

All rinsing is in flowing deionized water with agitation, except for drag-out and final acetone rinse.

RlP/1

GOLD STRIKE BARREL PLATING

PURPOSE

To provide an adherent gold strike plate on a nickel plated substrate upon which a heavier deposit of gold may be plated in a convential gold plating bath.

SAFETY

Plating Bath - observe safe handling procedures required in working with hot strongly alkaline cyanide solutions. Do not mix with acid or expose to acid fumes.

Vent vapors into vapor exhaust system. Large volumes of hydrogen are liberated at the cathode during plating with this bath; therefore, the vapor and spray produced must be vented into an exhaust system.

EQUIPMENT

1. Plating tank - Plastisol or Koroseal lined steel 24" x 24" x 16" having a working volume of 36 gallons, equipped with a stainless steel heating coil and automatic temperature control.
2. Plating barrel - Daniels' 8H Plastic equipped with a solid nickel plate covering entire bottom as cathode.
3. Anodes - stainless steel, size and number as required to provide an anode equal to the cathode area. Equal anode area provided for each of 2 anode bars.
4. Rinse tanks - stainless steel
5. Rectifier - 50 amp., 12v
6. Filter - immersion type with impeller pump.
7. Vapor Exhaust Venting System.

MATERIALS

1. Gold concentrate solution, technic 24 kt. industrial (20 ml = 1 dwt)	KR01177
2. Potassium cyanide, 98%	KR0479
3. Potassium phosphate dibasic, Reagent (Dipotassium phosphate)	KR01181

BATH COMPOSITION

Material	New Bath Content	Control Limits
Gold Concentrate Solution	720 ml	0.85-1.15 dwt/gal.
Potassium cyanide	234 oz.	4.3-6.5 oz/gal. (Free)
Potassium Phosphate (Dibasic)	112 oz.	2.1-3.1 oz/gal
Potassium Carbonate	None	15oz/gal. max.
Deionized water to make up to 36 gal.		500,000 ohms resistance or greater

Operating Temperature 112-118 F.

Anode to Cathode area = 1:1

Current density - See Plating Process Card

MAINTENANCE

1. Maintain solution at working volume - at determined point approximately 2-2 1/2" below top of tank by addition of deionized water as required.

PROCEDURE

1. The specified number of parts to be plated are placed into the plastic plating barrel. Parts shall have been pretreated to insure that they are clean and free of any acid residues.
2. The loaded plating barrel is inserted into the plating tank with the barrel rotating drive running and the bath at operating temperature.
3. The rectifier is immediately turned on and set to the specified plating current.
4. Plate as specified - current and time.
5. At the end of the plating cycle lift the plating barrel to the drain position and drain excess solution from parts.
6. Immediately transfer loaded plating barrel to cyanide gold plating bath (R1P) without intermediate rinse.

PROCESS SCHEDULES AND INSTRUCTIONS

1. See Parts Process Card for specified precleaning, plating and rinsing schedules.
2. See Plating Process Card for specified number of parts per barrel load, current density and time schedule.

LIMITATION

This Gold Strike Bath MIP/1 composition is compatible with the bath composition of Cyanide Gold Plating Bath MIP; therefore, the small amount of chemicals carried over, as drag-out, into Gold Plating Bath MIP will do no harm. However, this strike bath shall not be used, without intermediate rinsing, in combination [illegible]

The plating bath control limit of 15 oz/gal. maximum set for potassium carbonate is an estimated value. The actual concentration limit must be determined through additional operating experience.

BARREL FINISHING

PURPOSE

This method is used for deburring, cleaning, descaling and for surface refinement of most metals.

EQUIPMENT

Closed polygonal (vertical) barrels lined with neoprene, or its equivalent
Bins for storing tumbling media.
Stainless steel graduated scoop (4 cup).
Glass bottle, graduated in ounces (4 oz.)
Suitable loading and unloading equipment.
Stainless steel mesh screens and vibrating equipment.

MATERIALS

Alumina chips, (Lord Chemical Company), sizes #1, 3, 4, 8, 12 and special sizes. (#1 is the largest)

Compound	Use	Cutting Life Of Compound (Hrs.)
4X	Fine abrasive for light burrs and low micro-inch finishing	2-4
3A	Fast cutting during life, then a gradual breakdown to polishing action.	3-6
6A	Same as 3A, but a coarser abrasive	3-6
HS-9	Same coarseness as 6A but used especially for hard metals. Will breakdown to fine polishing action in 20-24 hours.	6-10
24-48	Alumina - used for cleaning ceramics (Norton Company)	

Cleaning compounds (Lord Chemcial Company).
- a. GW (neutral)
- b. MC-3 (alkaline)

Finishing and burnishing compound (Lord Chemical Company)
- a. Cap (for copper and lead)
- b. Hi-Brite (other metals - except nickel)
- c. DL (for nickel)
- d. AP2X (Copper and lead)

Descaling compound (Lord Chemical Company)
DL (for oxide removal)

Steel burnishing pins (Hartford Steel Ball Company)
1/16" diameter x 1/4" long tapered on ends.

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MATERIALS (CONT'D)

Steel burnishing cones (Hartford Steel Ball Company)
1/8" double cones
Rust preventatives
a. Mineral oil (Esso-Fractol A)
b. Watershed (Heatbath Corporation)
Acetone

PROCEDURE

1. Alumina chip-media are washed by tumbling with hot water and 1 to 4 oz. GW for 5 minutes. (if necessary)
2. Media is rinsed well with warm water.
3. Parts to be tumbled are added so that the total load of parts and media will settle to 50-60% of the barrel volume during tumbling.

Note: a. Fragile parts must be handled with care to prevent distortion during loading and unloading - may require alternate loading of parts and chips in layers.
b. Geometry of the parts will determine the initial height of load.
c. To prevent damage to heavy parts during tumbling, select or add a larger size of chips.

4. The amount and type of abrasive compound to be used is added based on experience.
5. Tap water is added to desired level - usually 1 to 6 inches below load level. Abrasive action increases as water decreases.
6. Barrel is closed and rotated at desired rpm. Decrease the speed of rotation as mass and/or fragility of individual parts increases. Time and rpm. must be based on experience - normally 8-25 rpm. for 5 cu. ft. barrel and 20-60 rpm. for 1 cu. ft. barrel.
7. Barrel contents are rinsed well with water.
8. For copper and lead: CAP is added for cleaning and finishing.

a. Tap water is added to load level.
b. Barrel is closed and rotated at desired rpm. for 1 hour.
c. Barrel contents are rinsed well with water, the load is dumped with care, and parts spearated from chips by screening or vibrating equipment.
d. Parts are rinsed in acetone and blown dry.

9. For all other metals: Add MC-3 for cleaning.

a. Hot tap water is added to load level.
b. Barrel is closed and rotated at desired rpm. for 10-30 min.
c. Barrel contents are rinsed well with water.

PROCEDURE (CONT'D)

10. Operation 9 is followed with a brightening or burnishing process: Add Hi-Brite compound.

   a. Tap water is added to cover the load with 1 to 2" of water.
   b. Barrel is closed and rotated at desired rpm. for about 1 hour.
   c. Barrel contents are rinsed well with water, the load is dumped with care and parts separated from chips by screening or vibrating equipment (except steel and nickel).
   d. Parts are dried in Kreider Dryer.

11. For steep parts:

   a. Operations 10, 10a, 10b are performed.
   b. Barrel contents are rinsed well with water.
   c. Water is added to load level.
   d. Watershed is added.
   e. Barrel is closed and rotated at desired rpm. for 10 min.
   f. Water is drained from barrel.
   g. The load is dumped with care and parts separated from chips by screening or vibrating equipment.
   h. Parts are dried thoroughly in Kreider Dryer.
   i. Parts are dipped with agitation, in rust preventing mineral oil and drained.

12. For nickel parts:

   a. Operations 10, 10a, 10b are performed.
   b. Barrel contents are rinsed well with water.
   c. Water is added to cover load.
   d. DL is add.
   e. Barrel is closed and rotated at desired rpm. for 1/2 to 2 hours.
   f. Barrel contents are rinsed well with water.
   g. The load is covered with clean water, the barrel is closed and tumble rinsed for 5 minutes.
   h. Step 12f is repeated, then load is dumped with care and parts separated from chips by screening or vibrating equipment.
   i. Parts are rinsed well with clean acetone and blown dry.

PROCEDURE (CONT'D)

Lord Chem. Compound	Bbl. #1 3/4 ft.^{3} Amount-(cups)	Bbl. [illegible] 5 1/2 ft.^{3} Amount-(cups)	Bbl. 3· 7 1/2 ft.^{3} Amount-(cups)
4X	4	15	1[illegible]
3A	1	4 1/2	6
6A	1	4	5
HS-9	1	5	[illegible]
[illegible]-3	1/4	1 1/2	[illegible]
Hi-Brite	1/2	3 1/2	[illegible]
CAP	1/2	1 1/2	2
AP2X	3 oz	22 oz	3[illegible] oz
GW (liq.)	1 oz	4 oz	6 oz
DL (liq.)	5 oz	24 oz	32 oz
Watershed (liq. Heatbath Corp.	1 1/2 oz	[illegible] oz	[illegible]

PROCESS CONTROL

Barrels and chip-media should be kept clean and sharp by periodic 10-min. runs with hot water and GW. Intervals will vary with the application.
Chips should be screened to insure proper size, especially if wedges of chips are likely to occur.
Mixing of compounds in a water slurry may be necessary with tubing or shells up to 3/8" inside diameter, to prevent packing of compound in the inside diameters.
Use hot water with IC-3 and GW.
Do not use GW as a final rinse on steels, since it is a wetting agent
Never leave a DL charge in the barrel when the barrel and parts are stopped; it may spot soft steels when not in motion.

SAFETY

Loosen door clamps slowly with care to "bleed" pressure which has built up during tumbling.
DL solution is phosphoric acid, essentially; handle with care and avoid contact between it and cyanide.

A P P E N D I X   J

Serial Number ____

MANUAL OF INSPECTION AND QUALITY CONTROL PROCEDURES COVERING ELECTRON TUBE TYPE 6299

Order Number 6008-PP-61-81-81

Contract Number DA-36-039-SC-85953

General Electric Company
Electronic Components Division
Tube Department
Owensboro, Kentucky

E. L. Davis

E. L. Davis, Superintendent- Planar & Thyratron Production

J. L. Finney

J. L. Finney, Supervisor-Test & Quality Control

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J. E. Martin, Supervisor-Process Engineering - Planar & Thyratron Production

QUALITY CONTROL MANUAL

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CONTROL:

This manual is unclassified with respect to military security, but is considered to be Company and Army confidential in accordance with SIG 434 SIP 3016 (SPL), Exhibit II, Paragraph 2b.

Obsolete or revised material should be destroyed by the holder.

For additional copies of this manual, contact: Manager, Engineering Administration and Application Engineering, General Electric Company, Tube Department, Owensboro, Kentucky.

QUALITY CONTROL MANUAL

QUALITY CONTROL MANUAL

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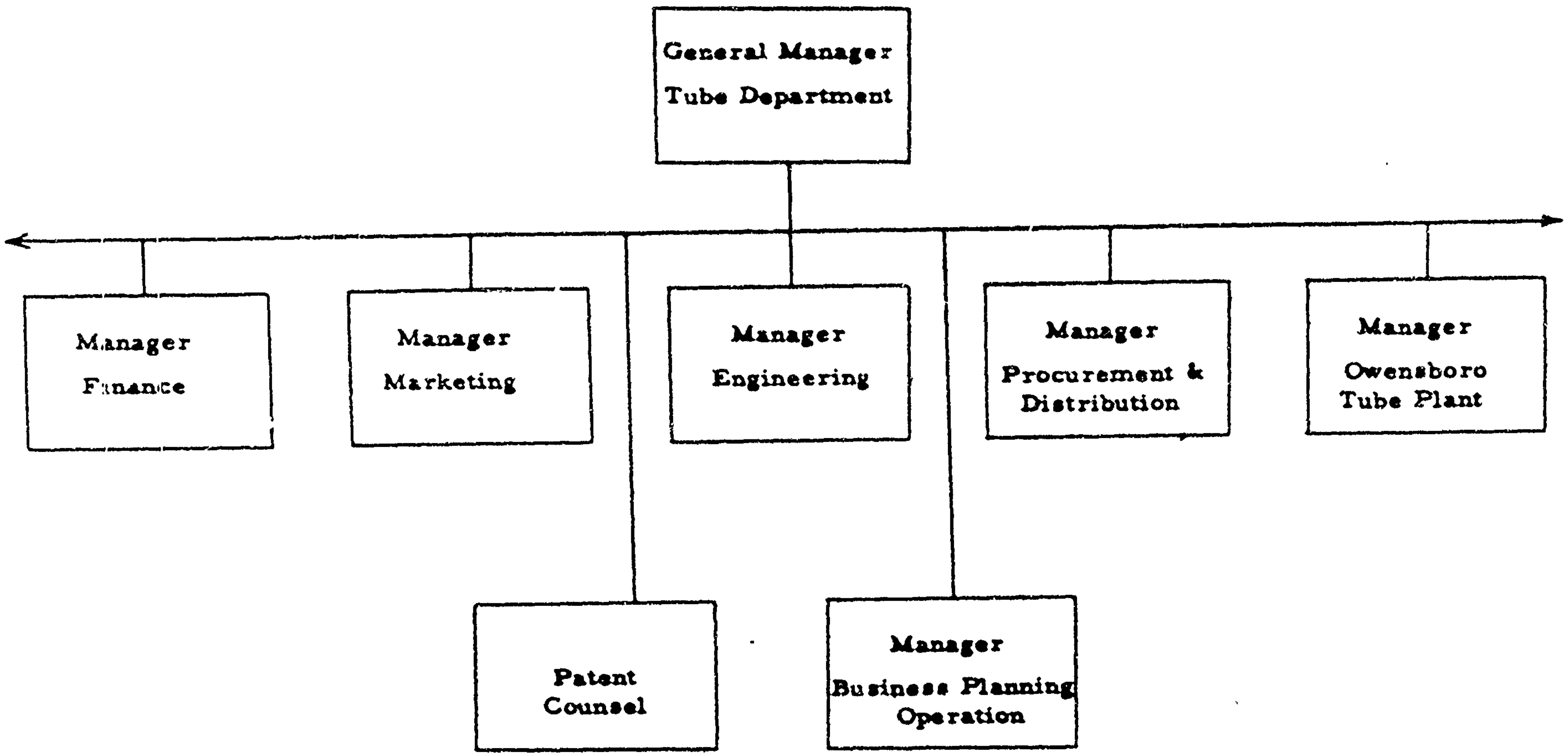
INTRODUCTION

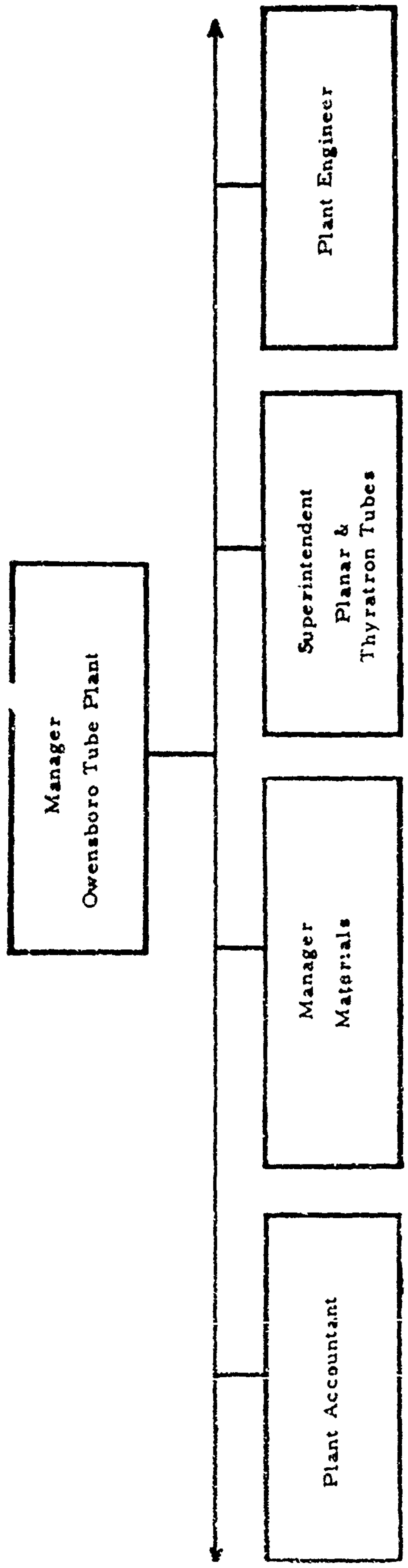
The electron tube type 6299 is a high-mu metal and ceramic triode intended for operation as a grounded-grid class A radio-frequency amplifier at frequencies as high as 3,000 megacycles. Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

The purpose of the contract was to evaluate certain areas of advanced tube manufacturing techniques and to apply them where feasible to JAN 6299, resulting in a more reliable and better performing tube. The objective requirements for the improved tube are Signal Corps Technical Requirement SCS-90 (Improved JAN 6299) and operation at a tube temperature rating of 225°C. The areas investigated were:

1. Improved alignment, concentricity and ceramic strength.
2. Improved anode to ceramic seal.
3. Temperature control at exhaust.
4. Improved application of cathode coating.
5. Improved cathode mounting.
6. Improved processing for higher temperature operation.
7. Improvement in humidity testing.
8. Improved exhaust fixturing.
9. Extended life test and tube failure analysis.

GENERAL ORGANIZATION

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Owensboro Tube Plant
Plant Engineer
Superintendent
Planar &
Thyratron Tubes
Manager
Materials
Plant Accountant

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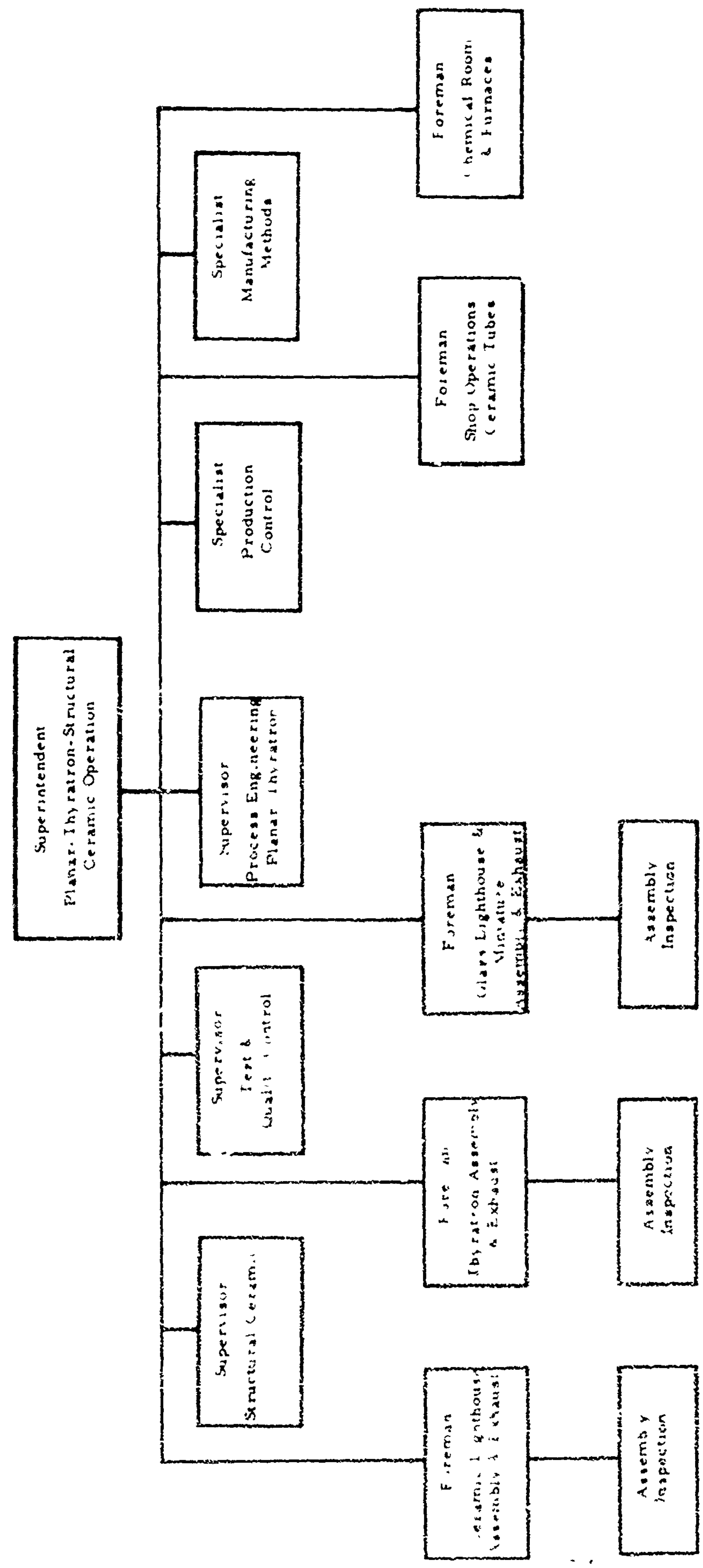

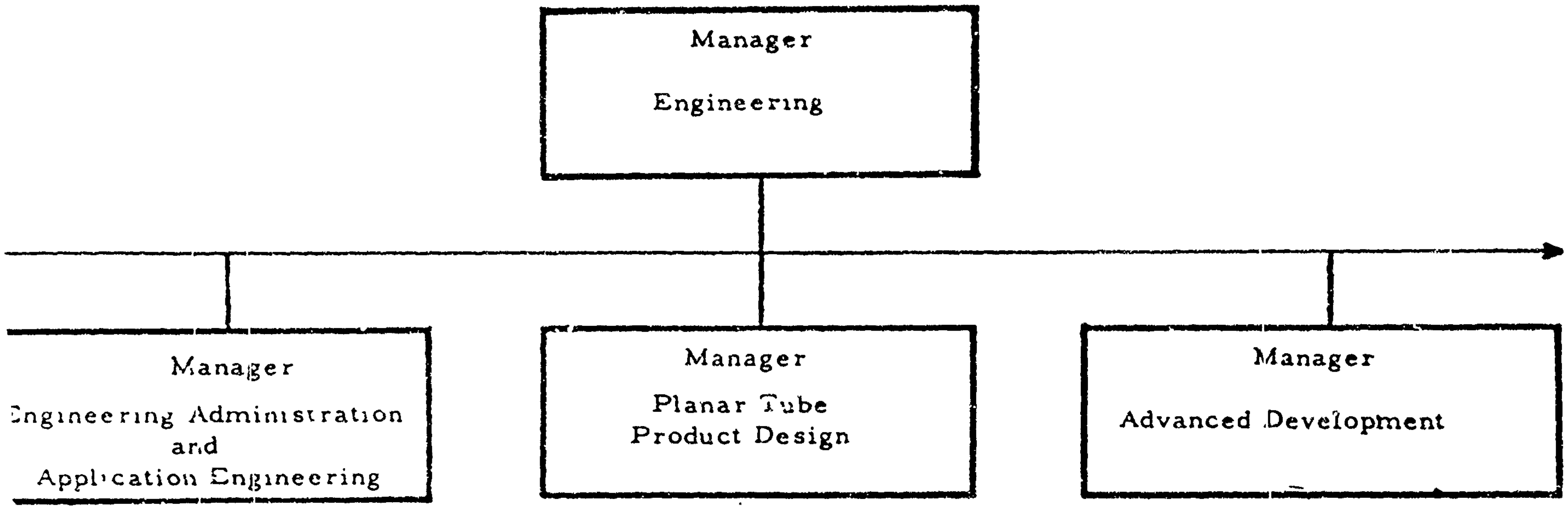
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Planar Tube
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Advanced Development

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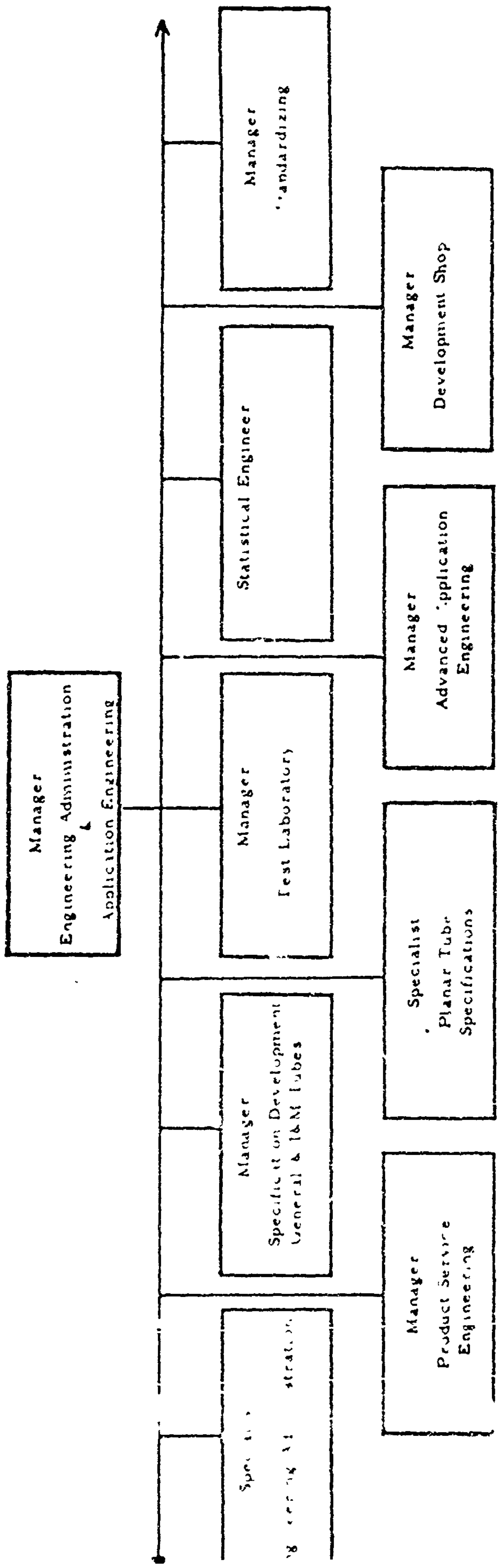

TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

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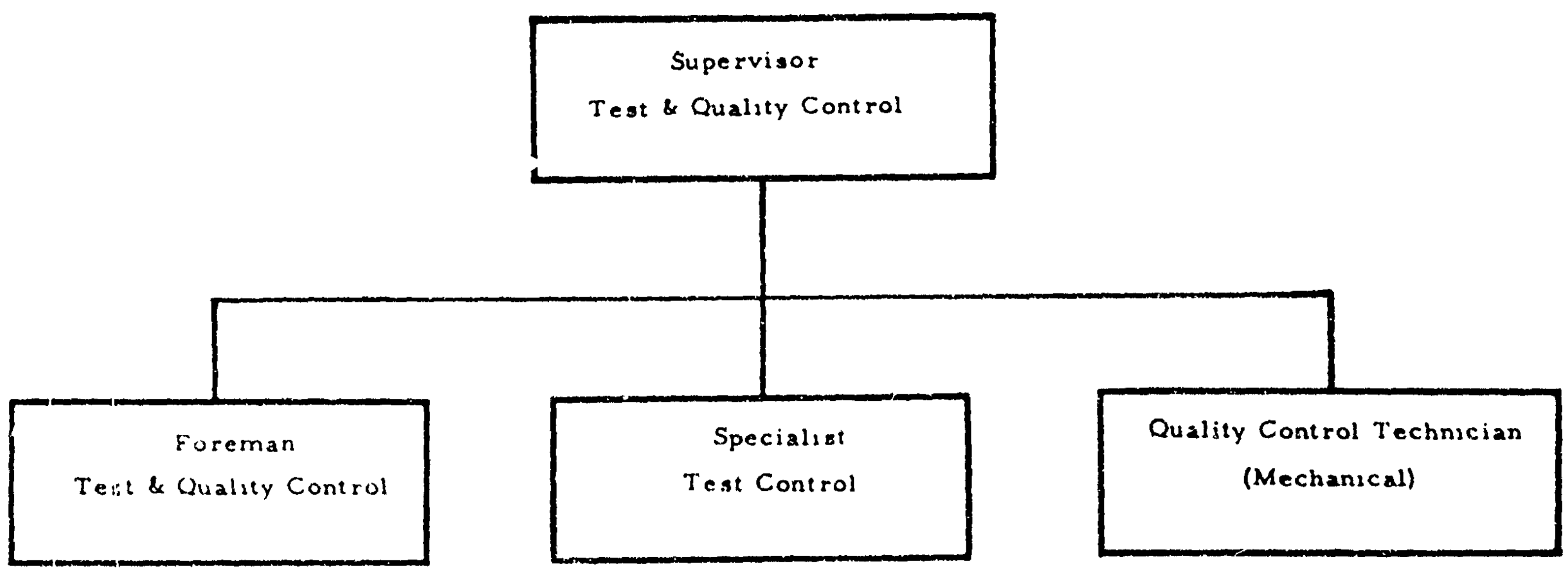

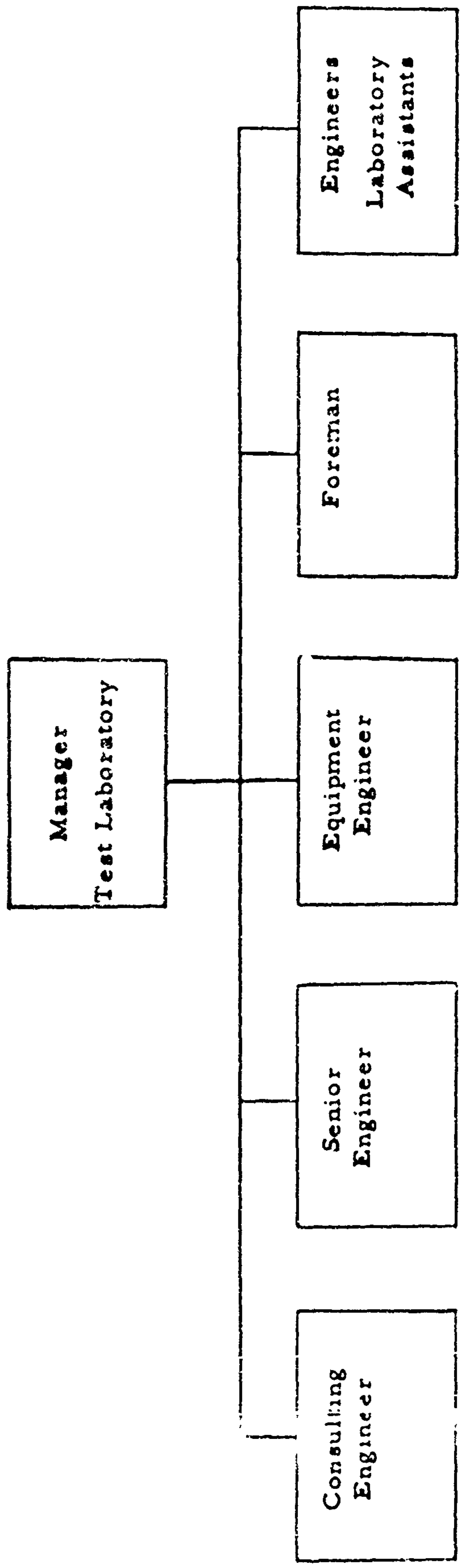
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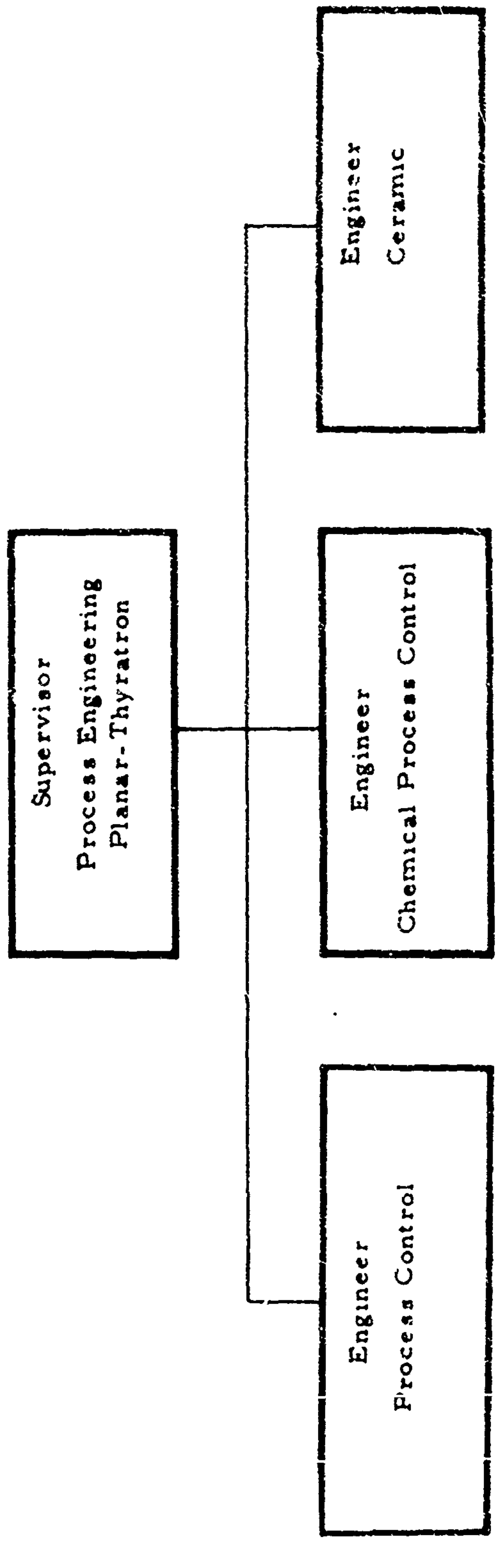
Engineer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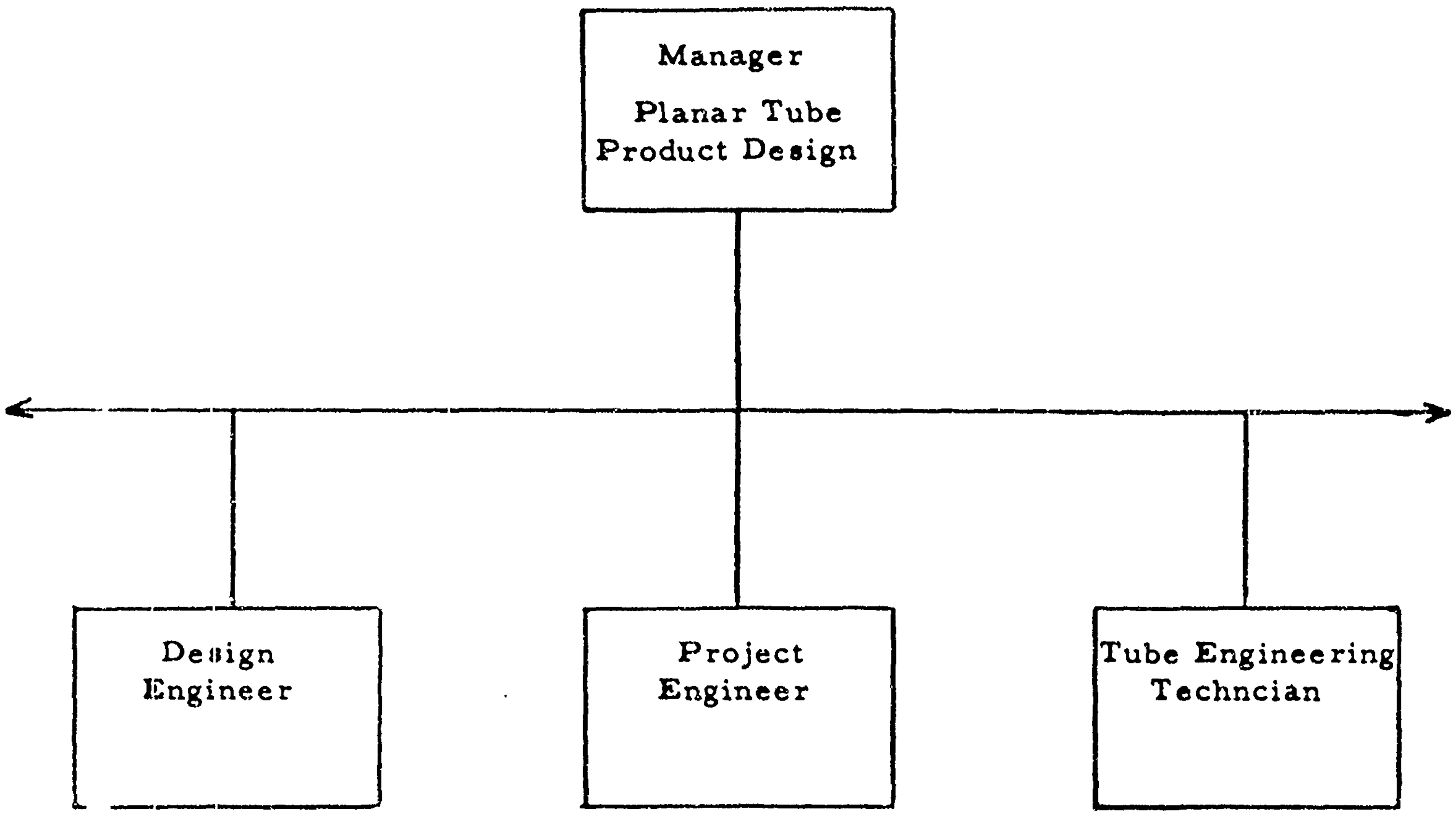
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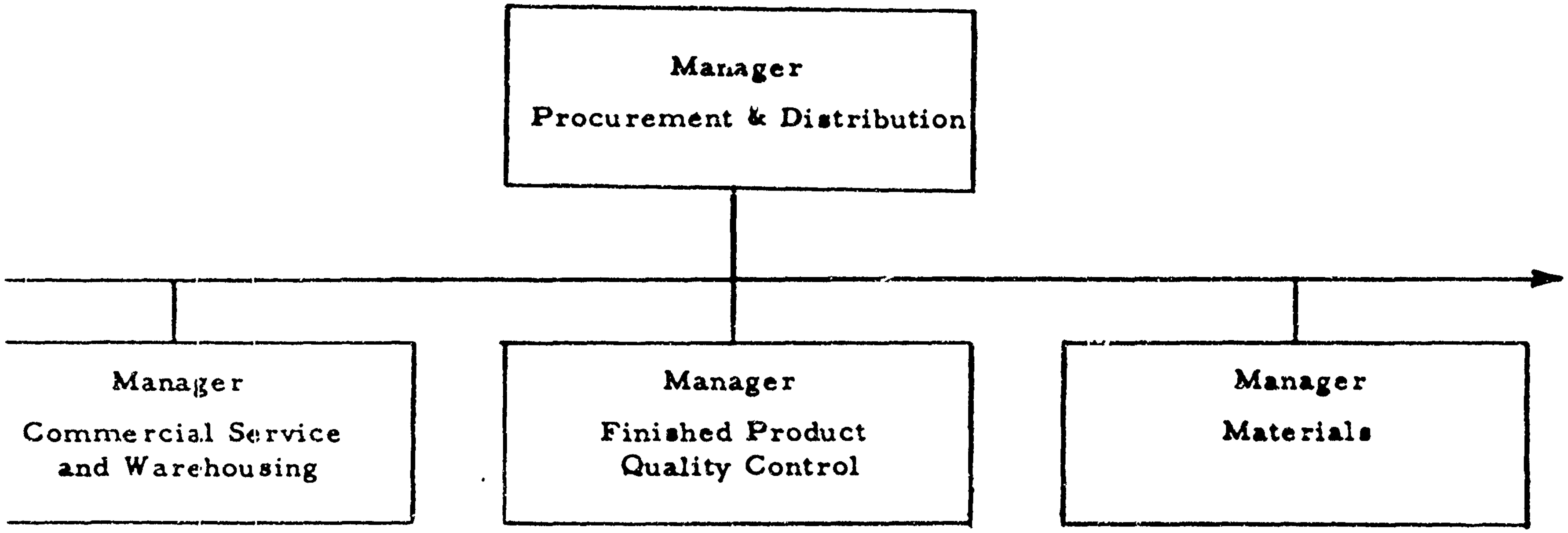

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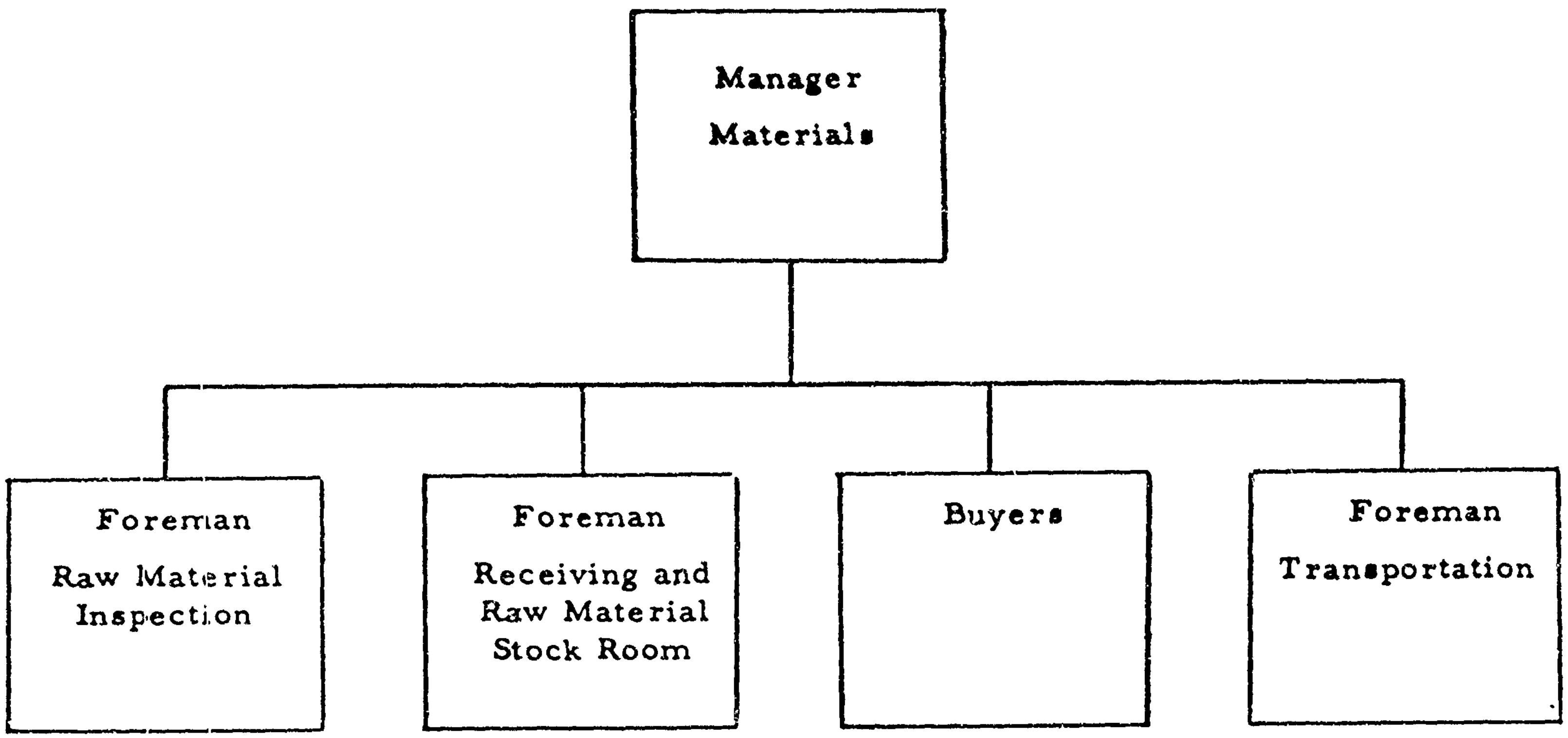
Owensboro, Kentucky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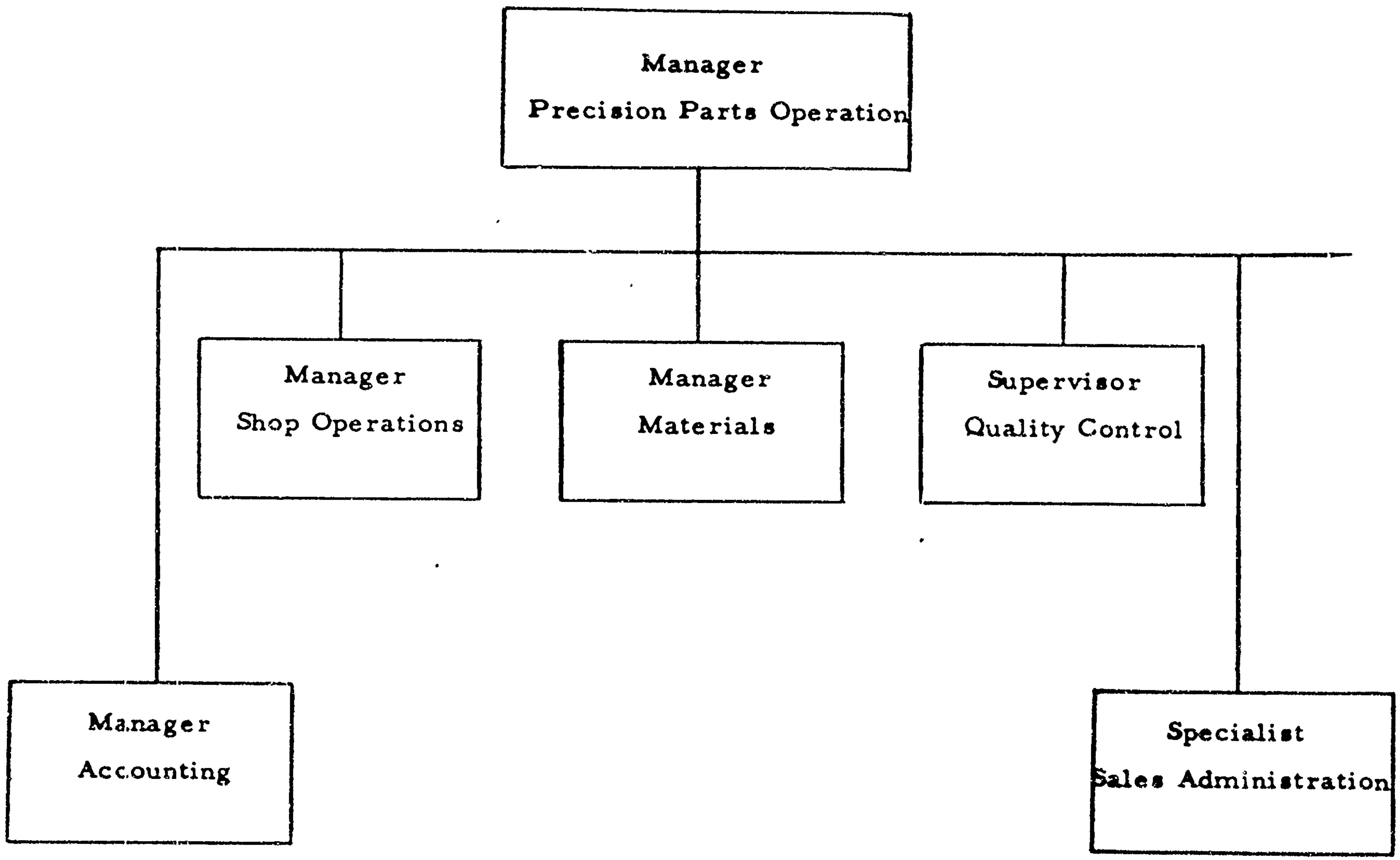
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Shop Operations
Manager
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Quality Control
Manager
Accounting
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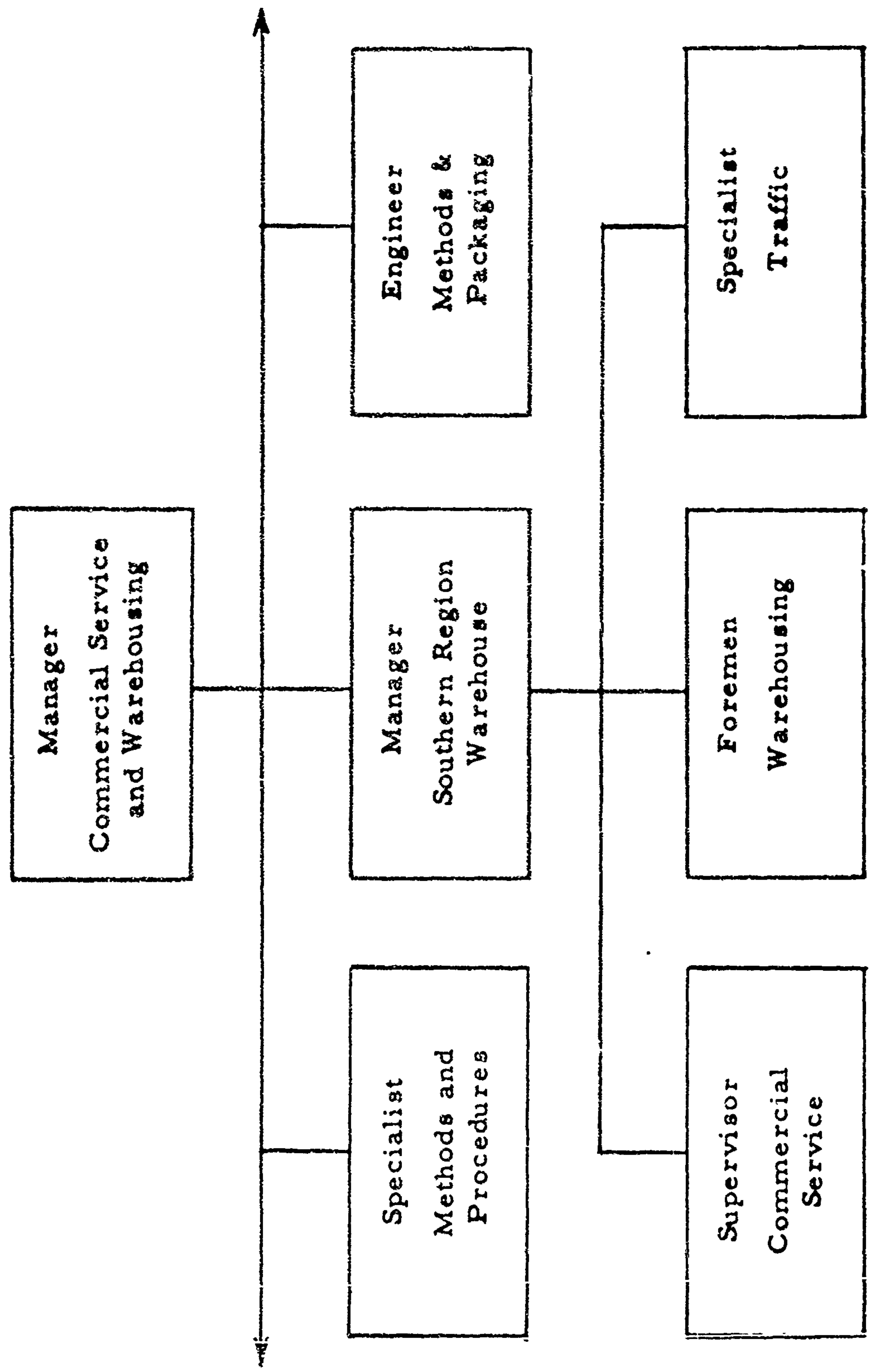
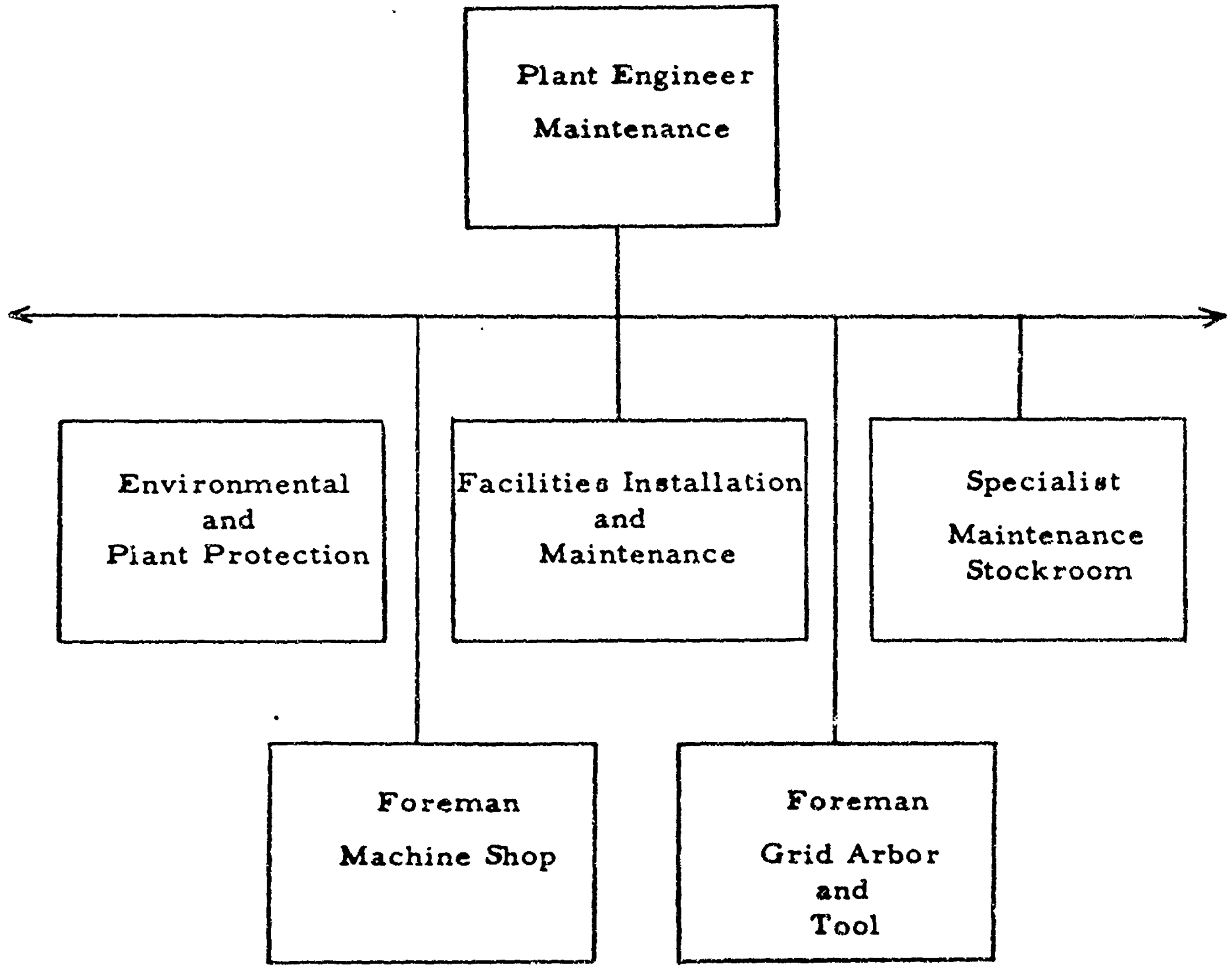
Sales Administration

QUALITY CONTROL MANUAL





GENERAL ELECTRIC
TUBE DEPARTMENT
Owensboro, Kentucky

QUALITY CONTROL MANUAL

GENERAL NOTES

I. QUALITY CONTROL DATA FEEDBACK AND ANALYSIS

A. Test records from the Engineering Test Laboratory and Test and Quality Control are fed back to process engineering and management for product control.

II. TEST EQUIPMENT

A. Each section is responsible for the maintenance and calibration of its test equipment.

III. TOOLS AND GAGES

A. Each section is responsible for the maintenance and calibration of the tools and gages used within the section.

IV. ENGINEERING CONSTRUCTION AND TEST SPECIFICATION CHANGES

A. Alteration Notices (AN's) and Temporary Alteration Notices (TAN's) on construction and test specifications are issued, and controlled by a positive integrated system as covered in Department Instruction #7.1-8 (Classification Engineering).

V. TUBES REQUIRING MILITARY QUALIFICATION INSPECTION

A. When it is necessary to have samples available for "In-plant" qualification testing the Engineering Administration Section is responsible for:

1. Securing the necessary data;
2. Testing tubes in the Engineering Test Laboratory and Finished Product Quality Control;
3. Writing design - and - construction information;

4. Obtaining construction photographs;
5. Informing the Quality Assurance Representative in Charge when "In-plant" qualification testing is requested;
6. Making arrangements with the Quality Assurance Representative in Charge to witness "In-plant" tests when such tests have been authorized by proper authority;
7. Preparing the qualification test report.

B. The Project Engineer is responsible for supplying Engineering Administration with photographic samples and up to date construction details.

VI. INDUSTRIAL SECURITY

A. The plant Security Officer is responsible for maintenance of industrial security and, where required, military security.

VII. MILITARY COGNIZANCE

A. Quality assurance cognizance: (U. S. Army), Cincinnati Procurement District, U. S. Army, 550 Main Street, Federal Office Building, Cincinnati 2, Ohio.

B. Security cognizance: (U. S. Navy), Inspector of Naval Material, 4300 Goodfellow Blvd., Building 101, St. Louis 20, Missouri.

C. Contract auditing cognizance: (U. S. Air Force), Cincinnati Air Procurement District, 3rd Floor, Swift Building, 9th and Sycamore Streets, Cincinnati 2, Ohio.

VIII. RESPONSIBILITIES OF ENGINEER - PROCESS CONTROL

1. Analyze shrinkage, cost and quality information and determine objectives which are consistent with the broad function of supplying engineering direction.

2. Formulate short and long range plans for improvements in product performance and quality and manufacturing processes.
3. Revise plans and goals in a timely fashion as indicated by changes in engineering requirements so as to meet objectives.
4. Organize own work and time in the most efficient and effective manner.
5. Organize the available resources of equipment, personnel, and other factors at his disposal to efficiently obtain his objectives.
6. Direct efforts toward the manufacture of products that meet engineering specifications and which are competitive in quality and costs.
7. Provide manufacturing with timely, accurate and effective instructions for reducing costs and improving product quality.
8. Pursue a program of self-development and contribute to the technical education of others within the department.
9. Provide engineering leadership within the plant by contributing new and/or original ideas for solving problems associated with manufacturing.
10. Implement plans for and continuously maintain an aggressive shrinkage and over-all manufacturing loss reduction program and institute corrective measures as deemed necessary.
11. Responsible for working with Design Engineering regarding process, specification and production problems. Recommend manufacturing processes and contribute whenever possible to the design of new tubes.
12. Set up techniques for following product quality and initiate corrective measures as deemed necessary.

13. Initiate inspection standards for incoming parts and in-process production and evaluate sample parts from vendors; and is responsible for determining the necessity for and the extent of process controls and inspections.
14. Analyze, appraise and interpret the measured results of work done and make known and readjust work of measuring as necessary.
15. Maintain records and reports to indicate the effectiveness of his work.
16. Consult the Supervisor - Manufacturing Engineering regarding matters of importance in his area of responsibility or of any matter that affects the relationships with others.
17. Confer with other Engineers, and Specialists in his subsection regarding related problems.
18. Consult with other subsection personnel as required to fulfill his duties and responsibilities.
19. Consult with other engineering and manufacturing components as needed regarding problems in his area.

IX. IDENTIFICATION OF REJECTED MATERIAL

A. Rejected material, in Shop Operations, Ceramic Tubes, is tagged, analyzed and scrapped.

X. STANDARDS CALIBRATION PROCEDURE AND SCHEDULE

A. Primary standards are in general checked once a year by a laboratory traceable to the Bureau of Standards.

B. The primary standard for measuring voltages and currents is a standard cell and is calibrated as per "A" above.

QUALITY CONTROL MANUAL

C. The secondary standards are meters calibrated by using the standard cell. This is done approximately every 3 months.

D. Meters are calibrated periodically against the secondary standards. Meters are tagged with their date of calibration. All removable meters are calibrated monthly. The permanently located meters are calibrated every 90 days with an additional calibration at seasonal changes, such as summer to winter, and in the event of any question on results.

XI. INSPECTION NOTES

The first phase of this contract specifies a production rate of 1000 tubes per month. In-process inspection is accomplished by trained operators in a bench inspection set-up under the Foreman-Glass Lighthouse & Miniature Assembly and Exhaust, under the surveillance of the process engineer.

The following additional information is presented:

I. Reference Documents are:

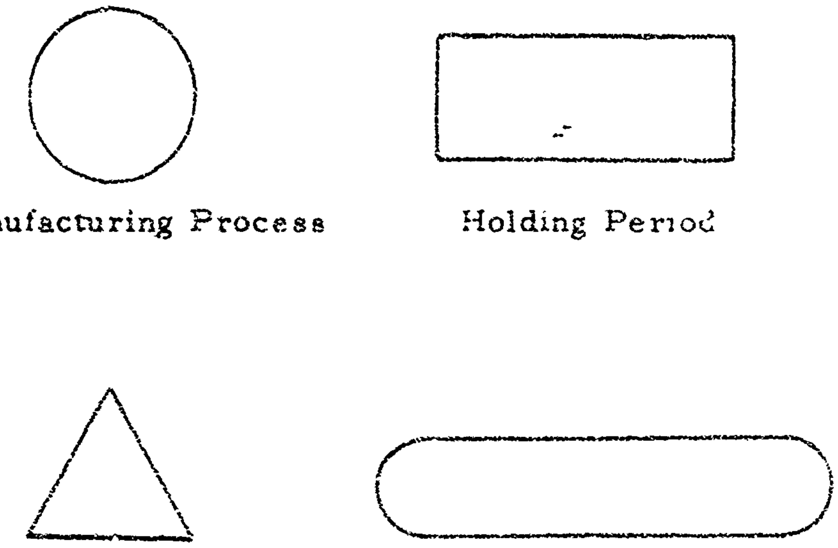
A. Standardized construction drawings for type 6299.

B. Standardized process specifications for type 6299.

II. Changes in parts, tolerances, limits, processing instructions, and inspection procedures are authorized by Engineering TAN's or AN's.

QUALITY CONTROL MANUAL

XII. FLOW CHART LEGEND (Per SIC 434 SIP 3016 SPL)



Manufacturing Process

Holding Period

*Product Inspection

*Quality Check

V - Visual

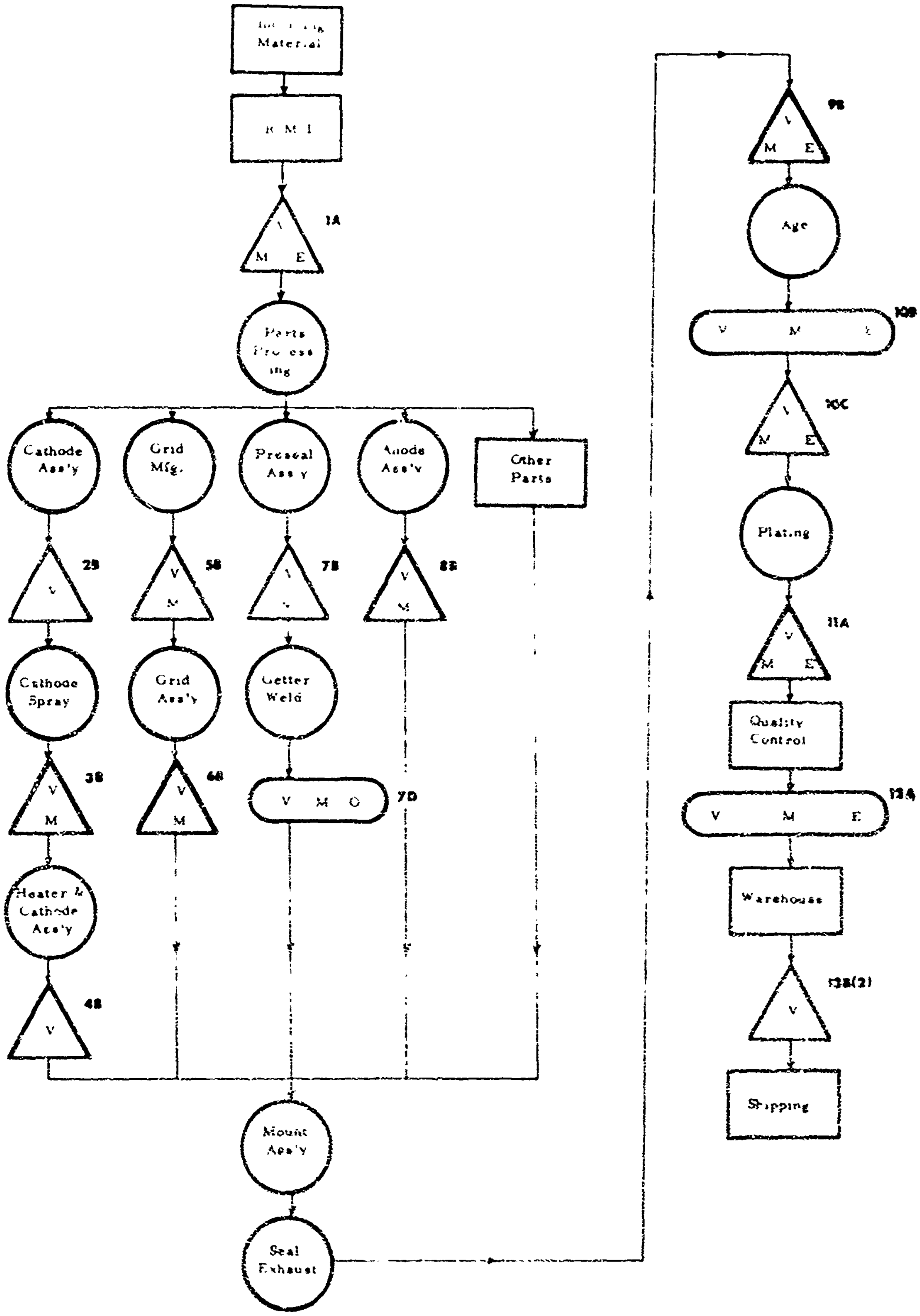
M - Mechanical

E - Electrical

O - Operator

*Letters and numbers refer to Inspection Stations in Section II.

QUALITY CONTROL MANUAL


Material
1A
Cathode Ass'y
Grid Mfg.
Preseal Ass'y
Anode Ass'v
Other Parts
2B
5B
7B
8B
Cathode Spray
Grid Ass'y
Getter Weld
3B
6B
V M O
7D
Heater & Cathode Ass'y
4B
Mount Ass'y
Seal Exhaust
9B
Age
10B
10C
Plating
11A
Quality Control
12A
Warehouse
13B(2)
Shipping

INSPECTION STATIONS

1. RECEIVING MATERIALS INSPECTION

   A. Process: Collect, inspect, and distribute incoming parts and raw materials.

      (1) Inspection Procedure: Incoming stock is identified according to purchase order or contract. Material is sampled in accordance with internal inspection specification, (see index). Visual and mechanical inspection is performed in accordance with this specification. Material is either accepted to stock or returned to supplier.

      (2) AQL's and sample sizes: Inspection specification, (see index).

      (3) Classification of defects: Inspection specification, (see index).

      (4) Calibration of test equipment Calibration is conducted in accordance with TM-100.

      (5) Reference document: Inspection specification index, and TM-100.

      (6) Changes in parts, tolerances, limits, etc., are authorized by: Alteration Notices or Temporary Alteration Notices originated by the Process Control Engineer.

      (7) Changes in inspection procedures are authorized by: Process Control Engineer.

   B. Exhibits: Section III, exhibits 1 through 9.

QUALITY CONTROL MANUAL

2. CATHODE ASSEMBLY

A. Cathode Assembly Process

B. Inspection Procedure

(1) After cathode assembly, cathodes are inspected under a 10X microscope.

(2) AQL's and sample sizes: 100% inspection.

(3) Classification of defects: Burrs, torn, malformed foil.

(4) Inspection instruments: 10X microscope.

(5) Forms used: Miniature Ceramic Shrinkage Report, Exhibit #10; Route Process card, Exhibit #11 is a sample of this type of card.

QUALITY CONTROL MANUAL

3. COATED CATHODE AND INSULATOR ASSEMBLY

A. Cathode Spray Process

B. Inspection Procedure

(1) a. Cathode density is checked each run;

b. Cathode height is checked after milling cathode;

c. Each cathode is inspected under a microscope for visual defects.

(2) AQL's and sample sizes:

a. Two control cathodes are checked for density;

b. 100% inspection;

c. 100% inspection.

(3) Classification of defects:

a. Density, high or low,

b. Cathode height, high or low;

c. Tilted cathode; chipped or insufficient coating.

(4) Inspection instruments: 10X microscope, dial gauge, balance scales, cathode dummies (control cathodes).

(5) Forms used: Exhibit #10; Exhibit #11; Cathode Assembly Shrinkage Report, Exhibit #12.

QUALITY CONTROL MANUAL

4. HEATER AND CATHODE ASSEMBLY

A. Assembly Process

B. Inspection Procedure

(1) After heater is welded into coated cathode and insulator assembly, a 10X microscope is used to inspect heater coating, weld and cathode face.

(2) AQL's and sample sizes: 100% inspection.

(3) Classification of defects: Open or weak welds, chipped heater coating, cathode coating chipped or dirty.

(4) Inspection instruments: 10X microscope.

(5) Forms used: Exhibits #10 and #11.

5. GRID MAKING

A. Grid Manufacturing Process

B. Inspection Procedure

(1) After winding, grids are placed under a 10X microscope, inspected and trimmed.

(2) AQL's and sample sizes: 100% inspection.

(3) Classification of defects: Windows, copper balls, poor spacing, overlapped wires.

(4) Inspection instruments: 10X Binocular microscope.

(5) Forms used: Exhibits #10 and #11.

QUALITY CONTROL MANUAL

6. GRID ASSEMBLY

A. Assembly Process

B. Inspection Procedure

(1) All grids are inspected with a 10X microscope for visual defects. Grids are then checked for vibration.

(2) AQL's and sample size: Visual inspection - 100% inspection. For vibration, lots sizes to 300 are sampled using MIL-STD-105, Level II, 2.5% AQL; for lot sizes over 300, 1.0% AQL.

(3) Classification of defects: Windiws, copper balls, poor brazing, poor spacing, overlapped wires, lint and dirt, poor tension on wires.

(4) Inspection instruments: 10X microscope, vibration equipment.

(5) Forms used: Exhibits #10 and #11.

7. PRESEAL ASSEMBLY

A. Preseal Assembly Procedure

B. Inspection Procedure

(1) a. Assemblies are inspected under a 10X microscope.

b. After preseal assembly and braze, assemblies are tested for leakers with helium leak detector.

(2) AQL's and sample sizes:

a. 100% inspection.

b. 100% inspection.

(3) Classification of Defects

a. Improper assembly, poor solder flow.

b. Leakers.

(4) Inspection instruments: Helium leak detector, 10X microscope.

(5) Forms used: Exhibits #10 and #11.

C. Getter welding process

D. After the getter has been welded, the operator makes a check for proper weld.

QUALITY CONTROL MANUAL

8. ANODE ASSEMBLY

A. Anode Assembly Process

B. Inspection Procedure

(1) a. After anode assembly and braze, assemblies are tested for leakers with helium leak detector.

b. Assemblies are inspected under a 10X microscope for visual defects.

(2) AQL's and sample sizes:

a. 100% inspection.

b. 100% inspection.

(3) Classification of defects:

a. Leakers.

b. Anode not seated; burred, defaced anode.

(4) Inspection instruments: Helium leak detector, 10X microscope.

(5) Forms used: Exhibits #10 and #11.

QUALITY CONTROL MANUAL

QUALITY CONTROL MANUAL

9. EXHAUST AND SEALING

A. Exhaust and Sealing Process

B. Inspection Procedure

(1) After exhaust and sealing, the tubes are checked for inoperatives.

(2) AQL's and sample sizes: 100% inspection.

(3) Classification of defects: Open and shorted heaters, air-leakers, grid-anode shorts.

(4) Inspection instruments: Heater voltage power supply.

(5) Forms used: Exhibit #10; Manufacturing Record, Exhibit #13.

QUALITY CONTROL MANUAL

10. AGING

A. Aging Process

B. Daily Quality Control Check

(1) After exhaust, sealing and aging, tubes are tested as specified by Process Engineering.

(2) AQL's and sample sizes: 100% inspection or 56 tubes per day.

(3) Classification of defects: As specified by Process Engineering.

(4) Inspection instruments: Various electrical test sets.

(5) Forms used: Daily Quality Control Check, Exhibit #14.

C. Initial Test

(1) a. All tubes are tested for inoperative defects after aging.

b. All tubes are tested for characteristics assigned by the Process Engineer after aging.

(2) AQL's and sample sizes:

a. 100% inspection.

b. 100% inspection.

(3) Classification of defects:

a. Shorts, opens, leakers.

b. Specified electrical characteristics.

(4) Inspection instruments:

a. Inoperatives test set.

b. Applicable electrical test sets for specified characteristics.

(5) Forms used: Exhibits #10 and #13.

11. PLATING

A. Plating Process

B. Final Test and Inspection

(1) Inspection Procedure

a. All tubes are tested for inoperatives.

b. All tubes are tested for characteristics assigned by the Process Engineer.

c. All tubes are inspected for visual defects and for concentricity.

(2) AQL's and sample sizes:

a. 100% inspection.

b. 100% inspection.

c. 100% inspection.

(3) Classification of defects:

a. Shorts, opens, leakers.

b. Specified electrical characteristics.

c. Mechanical defects and concentricity.

(4) Inspection instruments:

a. Inoperatives test set.

b. Applicable electrical test sets for specified characteristics.

c. Concentricity gauge.

(5) Forms used: Exhibit #10.

QUALITY CONTROL MANUAL

12. ACCEPTANCE TESTS

A. Process: Finished Tube Acceptance Test

(1) Inspection procedure:

a. After factory tests, tubes shall be submitted to Test and Quality Control for complete electrical and mechanical tests in accordance with the applicable MIL-E-1 test specification, MIL-STD-105, and other referenced documents.

(2) AQL's and sample sizes: AQL's and sample sizes shall be in accordance with the applicable test specification.

(3) Classification of defects: Defects are defined by limits on the applicable test specification sheet.

(4) Inspection equipment used: The conventional equipment used for testing tube type 6299 has received approval and is listed in the List of Miniature Ceramic List of Production Test Facilities dated 18 June 1962. The equipment used for the improved version of the 6299 has received approval and is listed in the Improved Miniature Ceramic List of Test Facilities dated 15 October 1963.

(5) Forms used:

a. Product Acceptance Sampling Record, Exhibit #15.

b. Median Control Data, Exhibit #16.

c. Life Test Tube Location Card, Exhibit #17.

d. Life Test Data, Exhibit #18.

e. Life Test Status Report, Exhibit #19.

f. Master Shrinkage Symbol List, Exhibit #20.

13. COMMERCIAL SERVICE AND WAREHOUSE

A. Commercial Service

(1) Order Service: Orders requiring government inspection are received from customers or via other sales offices and edited by Commercial Service Clerks.

(2) Order Service clerks release material for inspection and shipment as required by purchase orders. Copies of this release authorize inspection of material, as indicated, and packaging/packing and shipment of material.

a. Instructions for tube branding are furnished the Branding Department and Warehouse by Commercial Service.

b. Instructions for packaging and unit packaging marking, when required, are furnished the Packaging Department and Warehouse by Commercial Service.

c. Container marking labels are prepared by Commercial Service and furnished to the Shipping Department.

d. Packing lists, invoices, shipping documents, etc., are prepared for each shipment by commercial Service.

(3) Reference documents. Commercial Service and Warehouse Procedures 2.7, 2.12-1, 2.15, 2.15-1, 2.13-1, 3.1-1, SI 13700K.

B. Warehouse

(1) Tubes that require completion of life test prior to shipment, are transferred to Warehouse after all other tests have been completed. These lots are placed in "life-held" status until a notice of satisfactory completion of life test is received.

(2) Prior to branding, tubes are inspected 100% by branding operator for type. Each set-up is checked for accuracy and legibility by the set-up operator. After branding, spot checks are made for proper brand. Marking permanency tests are

Date Issue
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QUALITY CONTROL MANUAL

made on tubes branded for government use, in accordance with method 1105, MIL-E-1.

(3) Tubes are either bulk packaged or unit packaged as required by purchase order.

(4) Shipping Department places labels on shipping containers, places invoices, packing lists, etc., inside the containers, seals containers and releases material to carriers for shipment.

(5) Reference documents: Commercial Service and Warehouse Procedures (see paragraph 12. A. 3).

C. Exhibits: Section III, Exhibits 21 through 23.

Reference Documents not attached:

Drawing List N-11606, drawings of type 6299.

Acceptance Specifications for type 6299.

Military Specifications:

Basic Section, MIL-E-1;

MIL-E-1/48413;

SCL 7001/91;

MIL-STD-105;

MIL-E-75.

Commercial Service & Warehouse Procedures.

RTD-164 U-5

- 1

INCOMING MATERIAL INSPECTION RECORD

USE IN CONJUNCTION WITH DRWG. NO. ____

PART NAME ____

AREA ____

MANUFACTURE ____

1.
2.
3.
4.
5.
6.

PREPARED BY: ____ DATE ____

INSPECTED BY ____

INSPECTION APPROVAL ____

USAF COORDINATION ____

DIVISION

INSPECTION RECORD — LOT DATA: NUMBER, SIZE — FIRST SAMPLES — DISP

DATE ACCEPTED

A.I.R.T. NO.

INSPECTOR

EXHIBIT 1

GENERAL ELECTRIC
OWENSBORO TUBE PLANT
MATERIALS SECTION
OWENSBORO, KY.

RAW MATERIAL INSPECTION REPORT

SERIAL NO.

DATE

Material Inspected For:	Date Rec'd / Part No.
Approval of Regular Shipment ☐	Amt. Rec'd / Order No.
Approval of Test Lot ☐	Vendor / Mfg. Dates
Approval of Die Samples ☐	Tube Type / Melt No. / Die No. / Lot No.
Engineering Complaint ☐	
Factory Complaint ☐	Description / Location
Inspection Time	Sample Size / Sampled By / Inspected By

Summary of Inspection Results

EXHIBIT 2

Disposition of Material

Rejected ☐ Criticised ☐ Disapproved ☐ Approved ☐ Waive ☐

Amount Rejected	Number Spools	Spool Size	Requisition Number
Rejection Waived By:	Returned to Stock	Report Approved by:	

ies Ky. Elec.

RAW MATERIAL INSPECTION SECT.
8-4060 Rev. 3-52

MATERIAL INSPECTION SUMMARY

Date________________

PART NUMBER	CODE NUMBER	SUPPLIER	AMOUNT	ORDER NUMBER ETC-	NOTES

EXHIBIT 3

lvania							Industrial					
							Micacraft					
n. Pl							Reliance					
C. A.							Sylvania					

TUBE VENDOR RATING

SS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.
CENTERS						
ter Elec.						
et						
.A						
GLASS BULBS						
ney						
ve. Bulb						
ning						
LASS TUBING						
dgeville						
an						
OLY W. BARE						
er						
OLY W.PLTD						
mund Cohn						
er						
vania						
NI. W BARE						
ver-Harris						
. Driver						
Elec.						
et						
vania						
ies						

CLASS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.
7. NI.WIRE PLTD						
W.B. Driver						
Ky. Electronic						
Driver-Harris						
Sylvania						
8. T.GRID WIRE						
Dover						
Sigmund Cohn						
Cleve. Wire						
Kassel						
Rembar						
Luma						
9. SUPP.W.NI.						
W.B. Driver						
Techaloy						
. SUPP.W.NPS						
Cleve. Welds						
Carolina Welds						
R.C.A						
Ky. Elec.						
Sylvania						
# 510						
11. SUPP. W. CU.CLAD STEEL						
Sylvania						
Ky. Elec.						

EXHIBIT 4[1]

TUES P. VENDOR RATING .T IOD

EXHIBIT 4[2]

CLASS VENDOR	CURRENT MONTH Amount Rec'd	CURRENT MONTH Amount Def.	CURRENT MONTH % Def.	YEAR-TO-DATE Amount Rec'd	YEAR-TO-DATE Amount Def.	YEAR-TO-DATE % Def.	CLASS VENDOR	CURRENT MONTH Amount Rec'd	CURRENT MONTH Amount Def.	CURRENT MONTH % Def.	YEAR-TO-DATE Amount Rec'd	YEAR-TO-DATE Amount Def.	YEAR-TO-DATE % Def.
2.SUPP.W.CU.							17. STRIP(Cont						
ltd Steel S67							Kassel						
ylvania S-68													
y.Electronic													
510							18. RIBBON						
							W. B. Driver						
3.SUPP.W.CU.							Driver-Harris						
ubo Clad C-37							Sylvania						
y.Electronic							Dover						
ylvania							Chi. Dev. Corp						
510							A.V. Doran Co.						
4.SUPP.W.R. CU.							19.MOLY FRAME						
. B. Driver							GRID, RIBBON &						
510							SHEET						
							Elmet						
							Dover						
5.SUPP.W.MISC							Cleveland Wire						
levelan Weld													
. B. Driver													
rolina Weld							20.CUT WIRE-						
ystone							RIBB						
							#510						
							Dover						
.FRAME GRID													
LY - S							21.FIL. RIBBON						
D. 114							Sigmund Cohn						
ver - Cut Rod													
ver - Coils							22.MICA SPACER						
							American						
. STRI							Asheville						
B. Driver							Ford						
iver-Harris							Huse						
lvania							Industrial						
[illegible]							Micacraft						
n. Pl.							Reliance						

TUBES VENDOR RATING ...RT ...IOD

CLASS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.
22. MICA SPACER CON'T						
United Mineral						
Victory						
23. INSULATORS						
American Lava						
Coors Porc.						
Mansol						
Diamonite						
G. E.						
Corborundum						
24. HEATER WIRE						
Cleveland Wire						
Sylvania						
Elec. D. Corp.						
25. CATHODES						
Precision						
Superior						
Sylvania						
26. STEM LEADS						
Carolina Weld						
Cleveland W.						
American Elec.						
Elec. Bases						
GE Elec.						
E. Co.						

EXHIBIT 43

CLASS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.
27. COILS						
Precision Fil.						
Sylvania						
R. C. A.						
Elec. D. Corp.						
Union City						
28. PLATES, RAD SHIELDS & ETC.						
Precision						
Truelove						
#510						
Micro Stamping						
Sylvania						
R. C. A.						
J. & H.						
Art Wire						
Dover						
Haydu						
Qual. Tool &Die						
Sunair						
Ramco						
Romac						
Superior						
Western Gold						
Engelhard						
Fansteel						
Handy & Harmon						
Hunter Springs						
Cleveland Tung.						
S & F. Metals						
Cleveland Weld						
Amer. Panicor						
Fab. Metal						

TUBE

VENDOR RATING

TOD____

CLASS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.	CLASS VENDOR	CURRENT MONTH Amount Rec'd	Amount Def.	% Def.	YEAR-TO-DATE Amount Rec'd	Amount Def.	% Def.
29. BASE PINS													
Bead Chain													
30. BASES													
Loranger													
#510													
National ̣lec.													
Pioneer Elec.													
Mech. Ins'tron													
31. SOLDER													
Handy & Harmon													
Western ̣oll													
32. WIRE MESH													
Newark Wi̇e ft													
Newark ̣̣es													

EXHIBIT 44

RAW MATERIAL PARTS SUMMARY SHEET MONTH ____________________

TTERS	Getter Elec.	Kemet	King	R.C.A.		
-05000 -10000						
ieces						
GLASS BULBS	Pitney	Cleveland Bulb	Corning			
-11000 -14900						
.eces						
ASS BING	Bridgeville	Logan				
-15000 -20000						
Pounds						
LY WIRE ARE	Dover					
20000 21000 A-B ors						

5.
AR-
N13
N13
N13
N13
N13
N13
ete

6. N
N11
N17A
N21A
N25A
N27A
ete

7. N
P
N11E
N21E
N25E
eter

TU
GR

EXHIBIT 5 1

2

RAW MATERIAL PARTS SUMMARY SHEET

MONTH ________________

5. ..LY WIRE ..LATED	Sigmund Cohn	..over	Sylvania			
..-20000 AR-21000 M13C M13J M13O M13E M13L M13D M13P M13R ..3K ..eters						

6. NI. WIRE BARE	Driver-Harris	W.B. Driver	Kentucky Electronics	Kemet	Sylvania	Hayn.. Stell..
N11A-H N17A N21A-B-H N25A N27A ..eters						

EXHIBIT 5[2]

7. NI. WIRE PLATED	W.B. Driver	Kentucky Electronics	Driver-Harris	Sylvania		
N11E-F-L-N N21E N25E ..eters						

.. TUNGSTEN GRID WIRE	Dover	Sigmund Cohn	Cleveland Wire	Kassel	Rembar	Luma..

SU..

P..

S..
N..

-2..
-6..

P..

S..
.U.

-3..

P..

S..
.U.

-67
-68

P

SUPP.WIRE NI.	W.B. Driver	Techaloy					13. SUP TUB
Pounds							-3 In

SUPP.W. NPS	Cleveland Welds	Carolina Welds	Sylvania	Kentucky Electronics	#510	R.C.A.	14. SU CR.
-23 -65 Pounds							C-9 In P

EXHIBIT 53

SUPP.W. CU.C.STEEL	Sylvania	Kentucky Electronics					15. SUP MIS
-38 Pounds							I-27 S-63 In Pc

SUPP.W. CU.PLTD.S	Kentucky Electronics	#510					FRA SUPP
-67 -68 Pounds							M14.

.AW MATERIAL PARTS SUMMARY SHEET MONTH ____________

13. SUPP.W.CU. TUBE CLAD	Kentucky Electronics	Sylvania	#510			
[redacted]-37 In Pounds						
14. SUPP.W. CR. CU.	W.B. Driver	#510				
C-92 In Pounds						
15. SUPP.W. MISC.	W.B. Driver	Carolina Welds	Keystone			
I-27 S-63 In Pounds						
FRAME G. SUPP.ROD	Dover (Pieces)	Dover (Coils)				
M14.						

EXHIBIT 54

RAW MATERIAL PARTS SUMMARY SHEET MONTH ____________ RAW

STRIP	Driver-Harris	Sylvania	Thomas	General Plate	R.C.A.	Bembar
-27000 -27300 Pounds						

STRIP CON'TD	Kassel					
-27000 -27200 Pounds						

EXHIBIT 5[5]

RIBBON	W.B. Driver	Driver-Harris	Sylvania	Dover	Chi.Dev.Corp.	A.V. Do
-27000 -27200 Feet						

MOLY F.C. RIBBON & SHEET	Elmet	Dover	Cleveland Wire			
1 1						

20. CUT W RIBBO

KR-2600
KR-2620

KR-2800
KR-2820

Pieces

21. FIL. RIBB

KR-4400
KR-4400

MICA SPAC

KR-3000
KR-3700

MSI

Pieces

MICA CON

RAW MATERIAL PARTS SUMMARY SHEET MONTH ____________

CUT WIRE-RIBBON	#510	Dover				
KR-26000 KR-26200 KR-28000 KR-28200 Pieces						

FIL. RIBBON	Sigmund Cohn					
KR-41000 KR-44000						

EXHIBIT 56

MICA SPACERS	American	Ashville	Ford	Kuse-Liberty	Industrial	Mic...
KR-30000 KR-37000 M51 Pieces						

MICA CON'TD	Reliance	Sylvania	United Mineral	Victory		

W MAT

ULATO

000
000

es

TER
E

4000
6000

rs

THODE

18000
50000

STEM
LEADS

51000
56000

ces

W MATERIAL PARTS SUMMARY SHEET   MONTH ____________   RAW

JLATORS	American Lava	Coors Porcelain	Mansol	Diamonite	G.E.	Corburundu
`000						
>000						
es .						

TER E	Cleveland Wire	Sylvania	Elec.Dev.Corp.			
1000						
6000						
rs						

EXHIBIT 57

THODES	Precision		Superior	Sylvania		
18000						
50000						

STEM LEADS	Carolina Welds	Cleveland Welds	American Electric	Elec. Bases Inc.	DKE Electric	G.E.
51000						
56000						
ces						

28. Engi

28. Fab Me

29. BA PI

KR-870
KR-870
KR-870
KR-870

Pieces

30. BASI

KR-800(
KR-830(

Pieces

RAW MATERIAL PARTS SUMMARY SHEET MONTH ______________

Engelhard	Handy & Harmon	Hunter Spring	Cleveland Tungsten	S & F Metals	Cleveland Welds	Amer Panic
28. Fabricated Metal						
29. BASE PINS	Bead Chain					
KR-87013 KR-87014 KR-87015 KR-87017 Pieces						
30. BASES	Loranger	#510	National Elec.	Pioneer Elec.	Mechanical Instron	
KR-80000 KR-83000 Pieces						

EXHIBIT 58

RAW M…

SOLDE…

…oy Oz.

WIRE MESH

RAW MATERIAL PARTS SUMMARY SHEET MONTH ____________

SOLDER	Handy & Harmon	Western Gold				
oy Oz.						
WIRE MESH	Neward Wire (Pounds)	Newark Wire (Pieces)				

EXHIBIT 59

Materia

Distribu

NOTICE:

PART NU

VENDOR

MANUFAC

DESCRIP

AMOUNT

REASON

DISPOS

aterials Section

Report No.

RESTRICTED MATERIAL REPORT

Date

Distribution:

NOTICE: The Materials Section is holding in Restricted Stock the following material which cannot be used in regular production and is not returnable to vendor. Unless material can be disposed of in some other way, please initiate a Scrap Order so we may clear our records.

PART NUMBER | REVISION | MATERIAL

VENDOR | DATES RECEIVED

MANUFACTURING DATES | TUBE TYPES

DESCRIPTION

AMOUNT RESTRICTED | DATE RESTRICTED | REQ. NO.

EXHIBIT 6

REASON FOR RESTRICTION:

DISPOSITION OF MATERIAL:	S.O. Number	By

MATERIAL MOVE SHEET

DATE ____________

-143 FROM ____________ SECTION TO ____________ SECTION ____________ PLANT

PART#	DESCRIPTION	TYPE										TOTAL

EXHIBIT 7

EXHIBIT 8

DEFECTIVE MATERIAL SUMMARY

Year 19______

[illegible]	Req. No.	Date Ref.	Supplier	Part No.	Amount Rejected	Defect	No. Sp.	Disposition	Date	Shipping Memo No.

Reject 2 or more

G[illegible]HIC P[illegible]TS V[illegible]ICATION

Date	Lot #	XR -	O.D.			Thickness			Recess			Visual	Action
			# OK	# Large	# Small	OK	Large	Small	OK	Under	Over		

EXHIBIT 9

MINIATURE CERAMIC SHRINKAGE REPORT
for W/E ________

TUBE TYPE ____________ Page ___ of ___

	RWKS		4000	4001	4002	4003	4004	6501	5102	6404	6405	6406	5200	6201	6204	6601	7600	7602	4602	5100	6411	7700	7801	7900			TOT PROD	TOT REJ	% SKGE
HEATER AND CATHODE ASSEMBLY																													
COATED CATHODE AND INSULATOR ASSEMBLY																													
CATHODE AND INSULATOR ASSEMBLY																													
CATHODE ASSEMBLY																													
SEAL ASSEMBLY (LESS GETTER)																													
GRID ASSEMBLY																													
ANODE ASSEMBLY																													
GETTER AND SEAL ASSEMBLY																													

EXHIBIT 101

EXHIBIT 10 2

MINIATURE CERAMIC SHRINKAGE REPORT

TUBE TYPE ______ For W/E ______ Page ___ of ___

RWK			5100		7200	5300	4000	4200	4300	4001	4002					5300		2000	1000	1110	9720	2207		TOT PROD	TOT REJ	% SKGE
	EXHAUST REJECTS																									
	FRESHIP TEST REJECT, VISUAL - MECHANICAL																									

RWK	9720	2204	2205	2207	9041	9042 9043	2000	9011	9000	9022	9051	9052	9053	9003	9252	9211	9212	9741	9742		9032	9100	9090	TOT PROD	TOT REJ	% SKGE
	GETTER FLASH AND AGING																									
	INITIAL TEST REJECTS, ELECTRICAL																									
	LEAK CHECK																									
	PRESHIP TEST REJECTS, ELECTRICAL																									

S-4191

PLANAR SHRINKAGE REPORT

Date W/E ____________

Tube Type	LEAK CHECK Total Input	Total Rej.	% Rej.	EXHAUST Total Input	Total Rej.	% Rej.	AGING Total Input	Total Rej.	% Rej.	INITIAL TEST Total Input	Total Rej.	% Rej.	PRESHIP TEST Total Input	Inoperatives	Mech.	Elec.	Total Rej.	% Rej.
2B22																		
2C40																		
2C40A																		
2C42																		
2C43																		
2C46																		
5450																		
6299																		
7391																		
7644																		
7784																		
6442																		
6771																		
5099A																		
5420																		
6897/2C39B																		
5288																		
7289																		

EXHIBIT 103

Dwg. No. N-11606-AN — Pt. No.

Description Coated Cath & Insul Asm — Tube 6299, 7644

Material (N11606-AP) — No. Pts.

1.	1. Clean Cl-2C/SCR-1	MT
2.	2. Spray J1-1P (30 asm/load) & check	
3.	2/30 for coating thickness	MT
4.	3. Mill coating to size & check coating	
5.	thickness on dial indicator	MT
6.	4. 100% inspection	INSP
7.	5. Coat I.D. & O.D. J5E	MT
8.	6. 100% inspection	INSP
9.		
10.		
11.		
12.		

KEEP TICKET WITH JOB — STD-396-8 (4-58)

EXHIBIT 11

CATHODE ASSEMBLY SHRINKAGE REPORT

S-4140 DATE

Symbol	Rej.	Received	% Shrg.
5002			
5103			
5203			
6201			
6202			
6203			
6204			
6205			
6206			
7002			
7003			
7004			
7600			
7900			
TOTAL			

EXHIBIT 12

EXHIBIT 13

MANUFACTURING RECORD

OPERATION	DATE	OPR.	# REJECTS/DEFECT	GOOD
Exhaust Assy. Weld Ni Ribbon				
Exhaust (H2)				
Remove Lead and Clean Ceramics				
Flash Getter				
Activate and Age				
Pulse Age				
D C Age				
A C Age				
R F Age				
LF Test				
Noise and Gain Test				
Power Out Test				
Htk Leakage Test				
R F Test				

MANUFACTURING RECORD No.

TUBE TYPE	S. O. #	
ITEM	LOT #	PROCESS DATE
CATHODE BASE MATERIAL		
CATHODE COATING MIX		
HEATERS		

REMARKS:

EXHAUST DATA

Item No.	Set #	Pump Down	RF (1)	IBH	RF (2)	T_2H_2	RF (3)	Tip Off	Leak Rate	Good	No. Rej./Def.

EXB-200-B

DATE | ACC ☐ REJ ☐ | DATE | ACC ☐ REJ. ☐ | DATE

Miniature Ceram

REMARKS

EXHIBIT 14

CAPACITANCE TEST

Cap 13 14 15 16 17 18 19 20 21 22

Cap

S-1803

EXHAUST DATA

RUN NO	SET #	PUMP DOWN	RF1	TEM	RF2	TIM2	RF3	TIP OFF	GOOD	NO. REJECT/ DEFECT

QUALITY CONTROL SECTION
PLANAR THYRATRON — OWENSBORO
PRODUCT ACCEPTANCE SAMPLING RECORD

ROUP	MECHANICAL			ELECTRICAL				INOPERATIVE			
SIZE	FIRST SECOND			FIRST SECOND				FIRST SECOND			
AQL	10	2.5	6.5	AQL	.65	1.0		AQL	4		
DEFECTS ALLOWED				DEFECTS ALLOWED				DEFECTS ALLOWED			
DEFECTS FOUND				DEFECTS FOUND				DEFECTS FOUND			
DEFECTS	1	2	T	DEFECTS	1	2	T	DEFECTS			
				If				Shorts			
				Ihk				Opens			
				Ib				Air Leaks			
				Sm				Rksh			
				Ic				Rhsh			
				Etd				Rgsh			
				etd				Rgp			
				C W P.O.				T-Short			
				Pulse P.O							
				Cgp							
				Cgk							
				Pwr Gain							
				Noise							
				TOTAL							

TESTED BY ______ A ☐ REJ ☐ ______ DATE

TESTED BY ______ ACC ☐ REJ ☐ ______ DATE

TESTED BY ______ ACC ☐ REJ. ☐ ______ DATE

LOT No. ______ TUBE TYPE ______

LOT SIZE ______ DATE ______

REMARKS

This material has been inspected for all attributes listed on the Government Classification of Defects for the Applicable Inspection Position.

Having been found acceptable, the material is submitted for Government Acceptance.

______ Q C
(Signature for Contractor)

LOT DISPOSITION ______

QUANTITY ACCEPTED ______

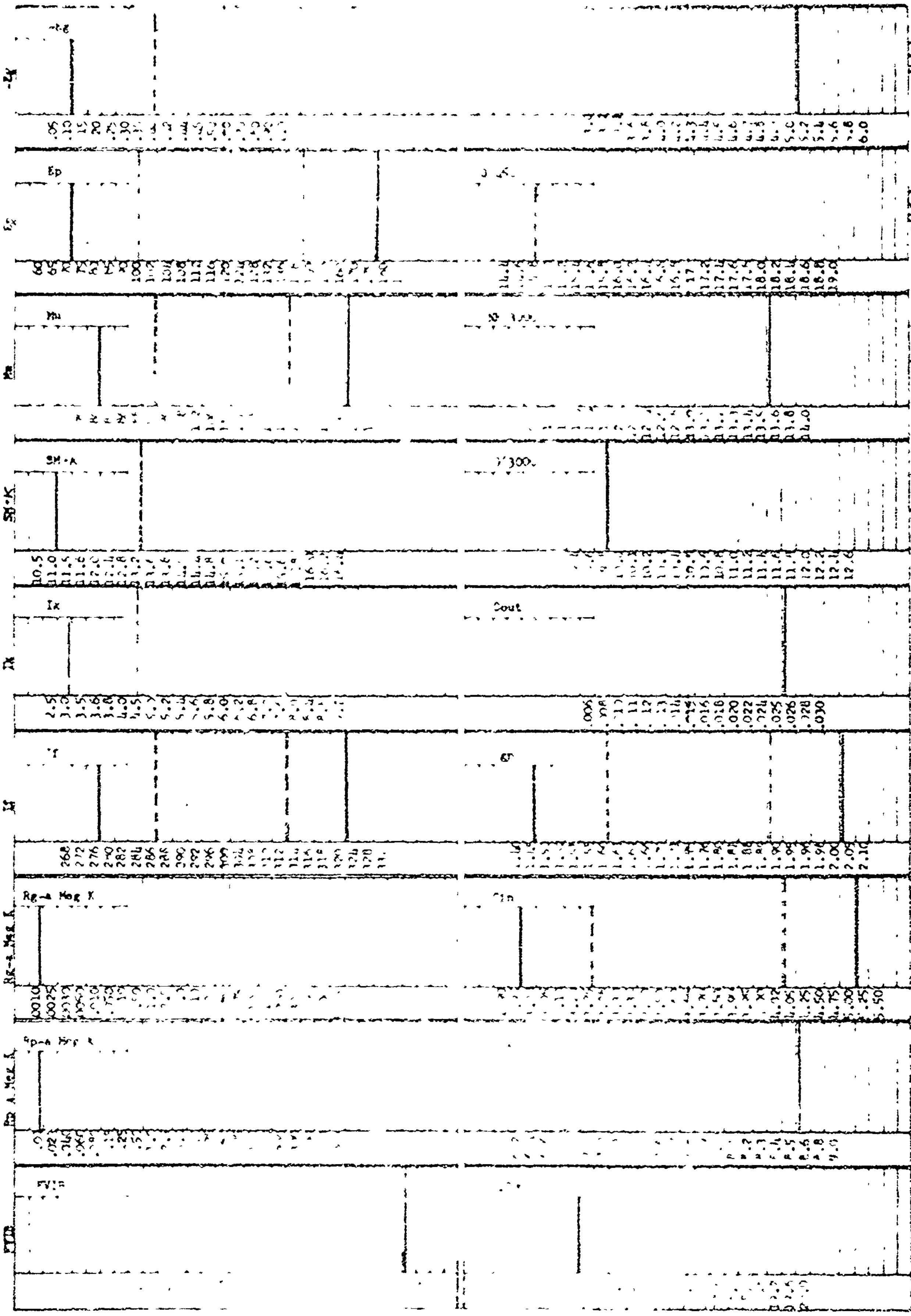
______ (Signature for Government) ______ Date

EXHIBIT 15

DATE
TESTED
LOT #
LOT SIZE

GENERAL ELECTRIC COMPANY

TYPE 6299
7784



S-2525

S-2257-C PLANAR-THYRATRON LIFE TEST TUBE LOCATION CARD

Tube Type Sample Size Kind of L.T.

Lot #	Rack #	Shelf #	Socket #	Comp.	Rest.

Reading Periods	On Life	Off Life	Int. Hrs.	Acc. Hrs.	Date
1					
100					
200					
250					
300					
400					
500					
750					
1000					

EXHIBIT 17

RECEI[illegible] [illegible] [illegible]RD

OWEN [illegible]ORC[illegible] T[illegible] [illegible]LANT

PLANAR AND [illegible]TRATRON

E[illegible] CTRON[illegible] TUBE [illegible] TEST [illegible]ATA

TUBE TYPE

PRODUCTION REP.

NO. OF TUBES -

Life Test Conditions:

Test Intervals

Off Life

On Life

Interval Hours

Ac[illegible] Hours

Date

Test [illegible]/[illegible] No.

END POINT LI[illegible]

LIFE TEST NO.

Extended Life

Disc. After ____ Hours

EXHIBI[illegible] [illegible]8

PLANAR-THYRATRON LIFE TEST STATUS REPORT

S-2546

[illegible] TYPE

Lot No.	Date LT Started	Date LT Ends	Quantity Prod.	Kind of L.T.	Reading		Disposition		Remarks
					500	1000	Life	Design	

EXHIBIT 19

[illegible]

[illegible]

[illegible] Tube defectives due to exhaust machine
1100 Failed to tip off
[illegible] Tipoff length incorrect
[illegible] Tipoff defective
[illegible] Button pin out
[illegible] Punctured on exhaust
[illegible] Anode deformed on exhaust
[illegible] Hole burned in aperture on exhaust
[illegible] Bulb discolored on exhaust
[illegible] Pins not spread
[illegible] Pellet not exploded
[illegible] Pellet exploded, traces on bulb
[illegible] Pellet exploded, cracking glass
[illegible] Stem, welded missing
[illegible] Exhaust tube cracked - temperature
[illegible] Tube not centered on all positions
[illegible] Unlisted defect

Open and Shorted Elements

[illegible] Heater element open
[illegible] Heater element shorted
[illegible] Heater burned out
[illegible] Getter element open
[illegible] Getter element shorted
[illegible] Undetermined short
[illegible] Anode-grid short
[illegible] Anode-cathode short
[illegible] Anode-cathode short
[illegible] Anode-cathode short
[illegible] Grid-cathode short
[illegible] Grid-cathode short (?)
[illegible] Grid-anode short
[illegible] Anode-shell short
[illegible] Cathode-shell short
[illegible] Grid-shell short
[illegible] Cathode-anode short

Leads and Bases

[illegible] Lead wire defective
[illegible] Lead wire missing
[illegible] Lead wire broken
[illegible] Lead wire too short
[illegible] Lead wires shorted
[illegible] Lead wires too close internally
[illegible] Lead wires poorly brazed or welded
[illegible] Tab/terminals not properly aligned
[illegible] Base defective
[illegible] Base dimensions incorrect
[illegible] Case threaded wrong
[illegible] Base marking defective
[illegible] Radiator defective
[illegible] Radiator dimensions incorrect
[illegible] Unlisted defect

[illegible]

[illegible] Insulator chipped or cracked
[illegible] Heater insulator chipped or cracked
[illegible] Getter insulator chipped or cracked
[illegible] Cathode insulator chipped or cracked
[illegible] Anode insulator chipped or cracked
[illegible] Envelope insulator chipped or cracked
[illegible] Leaky insulator
[illegible] Foreign substance on insulator
[illegible] Metallizing defective before firing
[illegible] Metallizing defective after firing
[illegible] Metallizing defective
[illegible] Defective insulator-metal seal
[illegible] Defective seal, broken pin
[illegible] Defective seal, cathode cup/shell
[illegible] Defective seal, grid cup/shell/anode
[illegible] Defective seal, anode/shell
[illegible] Thermal shock failure

Parts and Assemblies

[illegible] Post/tab incorrectly mounted
[illegible] Grid/tab incorrectly mounted
[illegible] Cathode/tab incorrectly mounted
[illegible] Anode/tab incorrectly mounted
[illegible] Anode/tab incorrectly mounted
[illegible] Getter/tab incorrectly mounted
[illegible] Post/tab out of concentricity
[illegible] Grid/tab out of concentricity
[illegible] Anode/tab out of concentricity
[illegible] Cathode tab out of concentricity
[illegible] Cathode shell out of concentricity
[illegible] Post/tab out of flat or tilted
[illegible] Grid/tab out of flat or tilted
[illegible] Anode/tab out of flat or tilted
[illegible] Cathode/tab out of flat or tilted
[illegible] Heater/tab out of flat or tilted
[illegible] Post/tab out of spec dimensionally
[illegible] Anode-grid dim. out of spec
[illegible] Grid mesh hi
[illegible] Grid mesh lo
[illegible] Unlisted defect
[illegible] Post cap defective
[illegible] Post not centered
[illegible] Cathode defective
[illegible] Cathode loose or off
[illegible] Anode on cathode
[illegible] Cathode face defective
[illegible] Anode dim. on cathode
[illegible] Cathode spiral defective
[illegible] Cathode shell cap defective
[illegible] Grid defective
[illegible] Grid bowed
[illegible] Holes in grid mesh
[illegible] Loose grid mesh
[illegible] Broken grid mesh
[illegible] Uneven grid mesh
[illegible] Grid mesh and tab bonded together
[illegible] Burns on grid
[illegible] Grid mesh not properly seated
[illegible] Grid mesh (?)
[illegible] Grid flange defective
[illegible] Anode defective
[illegible] Anode off or loose
[illegible] Anode cap loose
[illegible] Defective heater
[illegible] Heater cap defective or missing
[illegible] Heater support defective or missing
[illegible] Impurities getter
[illegible] Getter cup/shell defective
[illegible] Spring post defective
[illegible] Unlisted defect

Coatings, Finishes, Welds, Brazes

[illegible] Coating defective
[illegible] Filament or tip defective
[illegible] Cathode coating defective
[illegible] Cathode coating (?)
[illegible] Cathode coating (?)
[illegible] Cathode oxide on cathode (?)
[illegible] Plating defective
[illegible] Bare spots on plating
[illegible] Plating blistered
[illegible] Plating stained or discolored
[illegible] Plating hi
[illegible] Plating lo
[illegible] Plating outside beyond limits
[illegible] Corrosion through gold plating
[illegible] Finish defective
[illegible] Internal parts oxidized
[illegible] Finish defective due to wrong processing
[illegible] Finish poorly etched or polished
[illegible] Defective weld
[illegible] Excessive weld splatter
[illegible] Cap weld on cathode defective
[illegible] Defective braze
[illegible] Defective soldering
[illegible] Solder beads (?)
[illegible] Unlisted defect

Glass

[illegible] Bulb cracked other than at seal
[illegible] Bulb cracked at cathode seal
[illegible] Bulb cracked at anode seal
[illegible] Bulb cracked at grid seal
[illegible] Bulb cracked by cullet (?)
[illegible] Bulb defective, rater (?) damaged
[illegible] Defective glass
[illegible] Air bubbles in glass
[illegible] Air lines in glass
[illegible] Excessive stones in glass
[illegible] Stem press cracked/chipped
[illegible] Stem shoulder cracked/chipped
[illegible] Stem cracked under collar
[illegible] Leads exposed in press
[illegible] Leads too close in press
[illegible] Metal-to-glass seal defective
[illegible] Metal-to-glass seal defective, anode
[illegible] Metal-to-glass seal defective, cathode
[illegible] Metal-to-glass seal defective, grid
[illegible] Metal-to-glass seal defective, cap
[illegible] Metal-to-glass seal defective, anode
[illegible] Post cap chipped/cracked
[illegible] Flare chipped/cracked
[illegible] Tubulation chipped/cracked
[illegible] Glass-to-glass seal defective
[illegible] Defective due to machine
[illegible] Loose particles in assembly
[illegible] Loose particles in bulb
[illegible] Loose particles in anode
[illegible] Vacuum leakage
[illegible] Unlisted defect

Electrical Defects

[illegible] No emission
[illegible] [illegible] emission low
[illegible] [illegible] emission high
[illegible] Short pulse, low emission (Lp)
[illegible] Long pulse, low emission (Lp)
[illegible] Short pulse, low emission (Lp)
[illegible] Long pulse, low emission (Lp)
[illegible] [illegible] emission
[illegible] Filament current high
[illegible] Filament current low
[illegible] Anode current high
[illegible] Anode current low
[illegible] Low power output
[illegible] Pulsed power low
[illegible] CW power low
[illegible] Low grid current
[illegible] Heater-cathode leakage high
[illegible] Grid-anode leakage high
[illegible] Grid-cathode leakage high
[illegible] Grid/shell leakage high
[illegible] Filament/shell leakage high
[illegible] Anode (?) voltage high
[illegible] Anode (?) grid voltage low
[illegible] Anode (?) grid voltage high (cutoff)
[illegible] Anode (?) grid voltage low (cutoff)
[illegible] Anode (?) grid voltage high
[illegible] [illegible] grid current high
[illegible] [illegible] grid current low
[illegible] [illegible] grid voltage high
[illegible] [illegible] grid voltage low
[illegible] Gassy
[illegible] Gas loading pressure high
[illegible] Gas loading pressure low
[illegible] Grid emission
[illegible] Grid distortion
[illegible] Black out
[illegible] Contact potential
[illegible] Dust emission
[illegible] Noise figure high
[illegible] Low amplification factor
[illegible] High amplification factor
[illegible] Mutual conductance high
[illegible] Mutual conductance low
[illegible] Mutual conductance low at reduced Ef
[illegible] Rejected based on engineering, control and test analysis
[illegible] Operation failure (defect unknown)
[illegible] No oscillation
[illegible] Oscillation unstable or intermittent
[illegible] Oscillation unstable at (?) rating
[illegible] Leakage (?)
[illegible] Excessive (?)
[illegible] (?) in rating or oscillation
[illegible] High internal (?), voltage low
[illegible] High potential (?), voltage high
[illegible] Leakage, [illegible]
[illegible] - [illegible] Leakage, suffix indicating location
[illegible] Anode voltage high
[illegible] Anode voltage low
[illegible] Anode-grid capacity high
[illegible] Anode-grid capacity low
[illegible] Cathode-grid capacity high
[illegible] Cathode-grid capacity low
[illegible] Cathode-anode capacity high
[illegible] Cathode-anode capacity low
[illegible] Output capacity high
[illegible] Output capacity low
[illegible] Heater-cathode capacity high
[illegible] Heater-cathode capacity low
[illegible] Tunable vibration
[illegible] Fixed vibration
[illegible] Noise and microphonics

Symbol

[illegible]

AND RECEIVING REPORT

...FFICE ADMINISTERING CONTRACT	8. INSPECTION OFFICE
9. AGENCY PLACING ORDER ON SUPPLIER—CITY—STATE	
10. NAME OF PRIME CONTRACTOR—CITY—STATE	
12. MANUFACTURING OR WAREHOUSE SHIPPED FROM—CITY—STATE	
14. SHIPPED TO—MARK FOR	

(Remittance Address if Different)

7. CREDIT VOUCHER OR FILE NO.	
... PRIME CONTRACT OR P. O. NO.	
11. SUPPLEMENTS AND CHANGE ORDERS	
13. ORDER NO. OF SUPPLIER	
15. PROC. DIR. OR REQUISITION NO.	
16. SHIPMENT ORDER NO.	
17. SHIPMENT NUMBER ON CONTRACT	
a. PARTIAL	b. FINAL
18. GROSS WEIGHT	19. NET WEIGHT

.0. DATE SHIPPED	21. SEAL NUMBERS	22. B/L OR REGISTRATION NO	23. CAR NO.	24. ROUTING

CONTRACT ITEM NUMBER 25	STOCK AND/OR PART NUMBER AND DESCRIPTION OF ARTICLES (Indicate no. of shipping containers—Type of container—Container no.) 26	UNIT OF MEAS. 27	QUANTITY SHIPPED 28	QUANTITY RECEIVED 29	UNIT COST 30	TOTAL COST 31

EXHIBIT 21

32. APPROPRIATION	C. ARTICLES SHOWN IN COLUMN ... HAVE BEEN RECEIVED IN APPARENT GOOD CONDITION EXCEPT AS NOTED DATE INCHECKER
33. INVOICE ROUTING	34. CLASS—CODE | 35. ACCOUNT ... | 36. DEBIT VOUCHER OR ... NO.
... I CERTIFY THAT THE ITEMS LISTED HEREIN HAVE BEEN INSPECTED BY ME OR UNDER MY SUPERVISION, THEY CONFORM TO CONTRACT, AND HAVE BEEN ACCEPTED, EXCEPT AS NOTED. DATE SIGNATURE OF AUTHORIZED GOVERNMENT REPRESENTATIVE (Typed name of Inspector)	B. I CERTIFY THAT I HAVE RECEIVED AND/OR ACCEPTED THE ARTICLES SHOWN HEREIN (Use are as Contract ...) EXCEPT AS NOTED. DATE

DD FORM 1 OCT. 63 250

PREVIOUS EDITIONS MAY BE USED

CONTROL NO. | SHIP TO | SOLD TO | CUST. NO.

CONTRACT NO.

SHIPPED FROM OWENSBORO, KENTUCKY

P - PREPAID
C - COLLECT
1 - FOB DESTINATION
2 - FOB PT. OF SHIPMENT

MKT. DIST. NO.

BRAND | PACKING | INSPECTION

CUSTOMER ORDER NO.

CARRIER

TUBE TYPE	DEL. WK.	REQ. YR.	EST. DELIVERY	QUANTITY ORDERED	QUANTITY SHIPPED	UNIT PRICE

EXHIBIT 2

CONTRACT OR
ORDER NO.

FROM: GENERAL ELECTRIC COMPANY
OWENSBORO, KENTUCKY

TO:

FSN

ELECTRON TUBES

QUANTITY

TYPE NO.

PKG./PK. LEVEL

DATE PKD.

GROSS WT. CF.

CONTAINER NO. OF

CONTRACT OR
ORDER NO.

FROM: GENERAL ELECTRIC COMPANY
OWENSBORO, KENTUCKY

TO:

EXHIBIT 23

FSN

ELECTRON TUBES

QUANTITY

TYPE NO.

PKG./PK. LEVEL

DATE PKD.

GROSS WT. CF.

CONTAINER NO. OF

CONTRACT OR
ORDER NO.

FROM: GENERAL ELECTRIC COMPANY
OWENSBORO, KENTUCKY

TO:

FSN

ELECTRON TUBES

QUANTITY

TYPE NO.

PKG./PK. LEVEL

DATE PKD.

GROSS WT. CF.

CONTAINER NO. OF

SRW-161