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FORT MONMOUTH PROCUREMENT OFFICE
FORT MONMOUTH, NEW JERSEY

MICROMINIATURIZED PACKAGING OF
2N384 and 2N697

Final Report
1 October 1960 - 1 February 1962

Contract No. DA-36-039-sc-85377
Req. No. 40704-PM-60-93-93

SYLVANIA SEMICONDUCTOR DIVISION
WOBURN, MASSACHUSETTS

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ABSTRACT

The purpose of this contract was to mount existing germanium drift field and silicon mesa transistor junction structures in an existing welded hermetically sealed miniature "pancake" package by making necessary part modifications and developing required assembly procedures. During the period of the contract the package diameter was reduced from 0.265" max. to 0.250" max. Package height is 0.072" max. The objective electrical specifications are MIL-S-19500/27A (2N384) and MIL-S-19500/99A (2N696-697)

Design changes were made in the drift field transistor junction - base tab assembly and in the transistor header. A welded connection between base tab and base header lead was required to meet objective shock test requirements. Samples meeting the objective specifications were made, evaluated, and delivered.

The silicon mesa transistor junction structure required no modification. A molybdenum pedestal was added to the header for this device and associated material, brazing, and plating problems were solved. Samples meeting the objective specification were made, evaluated, and delivered.

The final packaged devices demonstrated excellent hermetic sealing by readily passing Radiflo leak test with 98% having leak rates less than $- 1 \times 10^{-11}$ std. cc/second.

PUBLICATIONS, LECTURES, REPORTS AND CONFERENCES

- A. A meeting was held at Fort Monmouth on October 17, 1960 between representatives of Sylvania, RCA, and the Signal Corps for the purpose of discussing package dimensions. Sylvania agreed to investigate the feasibility of reducing the maximum package diameter from 0.265" to 0.250". Experimental parts to the smaller dimension were not available during this quarter.
- B. A meeting was held at USASRDL on 21 February 1961 attended by representatives of USASRDL, USASSA, and Sylvania. A modification to the contract was agreed to in which the maximum O. D. of the transistor to be developed as a result of this contract was reduced from 0.265" to 0.250". The first devices to the new dimension were scheduled for delivery to the Signal Corps 1 June 1961.
- C. Meetings were held with Mr. Milton Tobman of USASRDL at Woburn on May 24, 1961 and on June 20, 1961 for the purpose of reviewing progress.

TASK I

PURPOSE

- A. The purpose of this Task is to modify an existing pancake package and an existing internal device structure to develop a transistor 0.072" maximum height and 0.265" maximum diameter having as the objective specification the military 2N384 specification MIL-S-19500/27A. Maximum diameter was reduced during the course of the contract to 0.250".
- B. To establish assembly techniques.
- C. To fabricate and submit samples of these devices for approval and standardization.

I. 1 Analysis of Task

Figures A-1 and A-2 (Appendix A) show package and alloy assembly status at initiation of contract. Figure A-1 is the package (header) drawing. Figure A-2 is the drawing of the alloy assembly which was being manufactured, having the electrical characteristics of MIL-S-19500/27A. The dimensions of the assembly obviously far exceeded the maximum space available in the package, therefore the principal task was to reduce the geometric outline of this device without impairing its electrical characteristics.

I. 2 Dimensional Design (Alloy Assembly Only)

This was undertaken in two stages; redesign of a base tab to fit the package and redesign of the alloyed pellet to fit these new base tabs.

I. 2. 1 Base Tab (Geometrical Reduction of)

The Figures A-3 and A-4, Appendix A, are given to illustrate the various designs considered for the base tab. Figure A-4 was selected as the most practical of the group to manufacture and jig; the latter being necessary for subsequent operations. A radius which is equal to the radius of the lead wires of the package header was put on one side of the base tab to make the accomplishment of lead positioning easier. The base metal, nickel, was not changed from what was already in use. Figure A-5, Appendix A, is a manufacturing drawing of Figure A-4, the base tab selected to begin the development program.

Figure A-6, Appendix A, is the final version of the base tab used in the actual production of the 275 development models which were assembled during the third quarter, and used as the official sample group. These devices were submitted for evaluation to the objective specification MIL-S-19500/27A. Contract Item 1(e), 150 development models, were shipped 31 May 1961 from this group.

The basic difference between figures A-5 and A-6 is that the "bullet nose", of Figure A-5 is removed. The reason is discussed in Section 3. 0.

I. 2. 2 Germanium Pellet

The germanium pellet to be used could have taken any number of different geometries such as square, rectangular, or round. The round pellet was chosen initially but was not absolutely necessary. The most influential guide in this decision was the belief that round cavities in alloying fixtures could be made more accurately with ease than any other shape.

The diameter of the round pellet was, when completely processed, equal to approximately fifty-four mils -- the maximum diameter of the base tab. These round pellets were used through the first and second quarter, but at the beginning of the third quarter were changed to a thirty-eight mil by thirty-eight mil square. This change came about as a result of the production facilities capability of reproducing more accurately the square pellet as opposed to the development facilities capability to reproduce round pellets. The round cavities of the alloying fixtures were not affected by this change since the diagonal of the square is slightly less than fifty-four mils.

I. 3 Development of Assembly Procedures

I. 3. 1 Foreword:

The purpose of this task was to take an existing alloyed assembly, the 2N384, and an existing package design, the pancake package Figure A-1, Appendix A, and develop techniques which would enable the manufacturer to produce the 2N384 device in the pancake package. These two parts, package and subassembly, were not developed as a part of this contract and their development prior to the contract is therefore not reported herein.

I. 3. 2 Internal Assembly: Lead Attachment to Alloyed Subassemblies

The arrangement of the alloyed subassembly in the package header during the first two (2) quarters made necessary the attaching of a collector connecting wire before mounting the unit on the header. Figure A-7, Appendix A, illustrates this point and the general internal construction for this period. A sample lot of devices manufactured as described above was submitted for evaluation. The results of testing to MIL-S-19500/27A Groups A and B are tabulated in Table I. All tests were passed except for the shock test. The nine (9) units which failed Group B, Subgroup 3 (500 G, one millisecond shock) were opened and examined. It was determined from this examination that all of these units had been torn loose at the point where the base tab and internal base lead were connected by solder. To eliminate this mode of failure, an alternate method using welded construction was investigated.

Along with the advent of this new assembly approach, an agreement had been reached which brought about a change in the maximum package diameter from .265" to .250". A summation of the task ahead at this particular point is as follows:

1. Solve the shock problem.
2. Modify tools, jigs, fixtures, process to accomodate the new 0.250" diameter package.

Table 1 GROUP A INSPECTION

Examination or Test	Conditions	Symbol	Limits Min Max	Unit	Sample Size	Number Failures	Number Pass	Notes
SUBGROUP 1 Visual and mechanical examination					100	Zero	All	
SUBGROUP 2 Collector cutoff current (dc), open emitter	$V_{CB} = -12 \text{ Vdc}$ $I_E = 0$	I_{CBO}	-12	$\mu\text{A dc}$	100	Zero	All	
Collector cutoff current (dc), open base	$V_{CE} = -20 \text{ Vdc}$ $I_B = 0$	I_{CEO}	-1	mA dc				
Collector saturation current	$V_{CB} = -1.5 \text{ Vdc}$ $I_E = 0$	I_s	-8	$\mu\text{A dc}$				
Small-signal Short- circuit forward- current transfer ratio.	$f = 1 \text{ kc}$	h_{fe}	20 175					
SUBGROUP 3 Collector cutoff current (dc), open emitter	$V_{CB} = -10 \text{ Vdc}$ $I_E = 0$	I_{CBO}	-50	$\mu\text{A dc}$	100	Zero	All	
Emitter cutoff current (dc), open collector	$V_{EB} = -0.5 \text{ Vdc}$ $I_C = 0$	I_{EBO}	-12	$\mu\text{A dc}$				
SUBGROUP 4 Noise figure	$f = 50 \text{ mc}$ $R_G = 30 \Omega$ $R_L = 2000 \Omega$	NF	10	db	100	Zero	All	No. 1
Output capacitance	$V_{CB} = -12 \text{ Vdc}$ $I_E = 0$	C_{ob}	3	μuf				
Transducer Gain	$f = 50 \text{ mc}$ $R_G = 30 \Omega$ $R_L = 2000 \Omega$		15	db				

Table 1 (cont'd) GROUP A INSPECTION

Examination or Test	Conditions	Symbol	Limits Min	Limits Max	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>SUBGROUP 5</u> Transducer gain	f = 50 mc R _G = 30 Ω R _L = 2000 Ω V _{CB} = -4 Vdc I _E = +1.5 mAdc		13		db	100	Zero	All	
<u>SUBGROUP 6</u> Thermal Resistance		θ_{JA}			$^{\circ}\text{C}/\text{mW}$	15	Zero	All	

Note No. 1 - The noise figure measurements were made at 12.5 mc.

GROUP B INSPECTION

<u>SUBGROUP 1</u> Physical dimensions						15	1	14	No. 2
<u>SUBGROUP 2</u> Soldering	5 cycles; T = +95 $^{\circ}$ +50C -00C								
Temperature cycling	T = +95 $^{\circ}$ +50C -00C and 0 $^{\circ}$ $\pm$ 20C					15	Zero	All	
Thermal shock (glass strain)									
Moisture resistance									
End points:									
Collector cutoff current (dc), open emitter	V _{CB} = -40 Vdc I _E = 0 f = 1kc	I _{CBO}	-75		μAdc				
Small-signal short circuit forward-current transfer ratio		h_{fe}	15						

Table 1 (Cont'd) GROUP B INSPECTION

Examination or Test	Conditions	Symbol	Limits Min Max	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>SUBGROUP 3</u> Shock	500 G t = 1 msec; 5 blows each in orientations X ₁ , Y ₁ , Y ₂ , and Z ₁ (total of 20 blows)				15	9	6	
Constant acceleration Vibration fatigue Vibration, variable frequency End points: (Same as for Sub- group 2)	5000 G 10 G 100 to 1000 cps 10 G							
<u>SUBGROUP 4</u> Lead fatigue					15	Zero	All	
<u>SUBGROUP 5</u> Barometric pressure, reduced (altitude operation).	Pressure = 15 mm mercury V _{CEO} = -40 Vdc I _E = 0 I _{CEO} = -75 7uadc, max t = 60 seconds				15	Zero	All	
Salt atmosphere (cor- rosion) End points: (Same as for Sub- group 2).								

Table 1 (Cont'd) GROUP B INSPECTION

Examination or Test	Conditions	Symbol	Limits Min Max	Unit	Sample Size	Number Failures	Number Pass	Notes
<u>SUBGROUP 6</u> <u>Storage life</u> End points: Collector cutoff current (dc), open Small - signal short-circuit forward-current transfer ratio	$T_{stg} = +100^{\circ} \pm 0^{\circ} \text{ } ^{\circ}\text{C}$ $V_{CBO} = -40 \text{ Vdc}$ $I_E = 0$	I_{CBO} h_{fe}	 15 -100	 udc	15	Zero	All	
	$T_A = +25^{\circ} \pm 3^{\circ}\text{C}$ $P_C = 100 \text{ } ^{+0}_{-12} \text{ mW}$				15	Zero	All	
<u>SUBGROUP 7</u> <u>Operation life</u> End points: (Same as for Subgroup 6)								

Note No. 2 - One lead diameter too thick.

3. Prepare, evaluate and submit 150 development models in the 0.250" diameter package.

I. 3. 2. 1 Base Tab Welding

The shock problem was solved by substituting base tab welding for soldering. The header design was modified to produce a longer header base lead for lap welding and to reduce the final package diameter to 0.250" maximum. Drawings of the modified header and the tools developed to flatten, weld and bend the base header lead are given in Appendix B.

The steps followed in shaping the base header lead, welding, and bending are illustrated in Figures B-1, B-2, B-3, and B-4 of Appendix B.

Samples were made using both the welded and soldered construction during the same period. These samples were subjected to the shock, constant acceleration and vibration fatigue tests. The results of this experiment are given in Table II, which follows, and clearly demonstrates the efficacy of the weld construction. In this experiment, the twenty (20) soldered units had fewer failures (3) than the original test sample of fifteen (15) which had nine (9) failures as previously shown in Table I. The conclusions drawn are that the soldering technique is very operator dependent and that welding is definitely superior.

I. 3. 2. 2 Assembly Process Specifications

Process specifications describing the assembly method developed are given in Appendix C.

Two possible techniques for attaching leads to the alloyed dots were investigated. The first required the use of a soldering iron, organic flux, and solder. The second approach involved the use of a hydrogen atmosphere conveyor type furnace and graphite jigs to hold alloyed assemblies and lead wires. The latter approach was considered possible because of good emitter and collector dot concentricity.

Attempts to use the furnace technique were discontinued after a mechanical yield of thirty percent was achieved. The reason for abandoning this method was because of the

TABLE II

COMPARISON OF SOLDERED VS WELDED CONSTRUCTION

Construc- tion	Shock			Constant Acceleration			Vibration Fatigue			Notes
	No. Tstd.	Pass	Fail	No. Tstd.	Pass	Fail	No. Tstd.	Pass	Fail	
Soldered (controls)	23	20	3	20	17	3	17	14	3	Note #1
Welded	8	8	0	8	8	0	8	8	0	Note #2
Welded	12	11	1	11	11	0	11	11	0	Note #3

Note #1 The 3 shock failures were opened and examined. This examination revealed that the base tab was torn loose from the internal base lead connection.

Note #2 These units have SR-98 in place of Ecco Bond as the adhesive for attaching the free end of the base tab to the header.

Note #3 The one shock failure was opened and examined, No physical defect could be observed.

very close tolerances required of carbon jigs (boats) to accomplish accurate positioning of the .005" diameter lead wire in the center of the .006" diameter emitter dot. The soldering iron method was therefore used. A description of the internal assembly of the transistor for the first two quarters follows:

1. Connect a .005" diameter, .125" long tin-plated copper wire to the collector dot with the aid of a soldering iron and 63/37 tin/lead solder.
2. Connect "bullet nose" end of tab to the base header lead using a soldering iron, and 63/37 tin/lead solder.
3. Connect a .005" diameter, .100" long tin-plated copper wire to the emitter header lead using a soldering iron and 63/37 tin/lead solder.
4. Connect opposite end of wire used in step 2 to the emitter dot using a soldering iron and 63/37 tin/lead solder.
5. Solder the opposite end of lead attached to the collector dot to the collector header lead.

It is necessary to perform step 2 before step 3. If the order were reversed the wire would detach from the emitter dot. This and keeping the collector wire from contacting the metal portion of the header were considered to be the most difficult operations of the assembly procedure. All other operations were readily accomplished with experienced factory personnel.

T A B L E III

GROUP A TEST RESULTS

Parameter- Condition-	ICBO VCBO= -12V IE = 0	ICEO VCEO= -20V IB = 0	IS VCB= -1.5V IE = 0	hfe VCB = -12V IE = 1.5mA f = 1 KC	ICBO VCBO= -40V IE = 0	IEBO VEBO= -0.5V IC = 0	N. F. (1) VCB = -12V IE = 1.5 mA f = 12.5 mc RG = 100Ω RL = 2000Ω	N. F. (2) VCB = -12V IE = 1.5mA f = 50mc RG = 30Ω RL = 2000Ω	COB VCB= -12V IE = 0 f = 140KC	T. G. VCB= - 12V IE = 1.5mA f = 50mc RG = 30Ω RL = 2000Ω	T. G. VCB = - 4V IE = 1.5mA f = 50mc RG = 30Ω RL = 2000Ω > 13db
Limit -	<12μa	<1000μa	<8μa	>20 <175	<50μa	<12μa		<10db	<3pf	>15db	
MAXIMUM 90%	7.6 5.1	660.0 280.0	5.8 3.5	155.0 135.0	12.0 7.0	6.8 1.2	5.6 4.2	12.5 11.2	2.8 2.4	21.2 20.1	21.0 19.7
MEDIAN 10%	2.8 1.5	115.0 29.0	2.1 1.2	82.0 43.0	4.2 2.2	0.3 0.2	3.4 2.6	9.5 7.8	2.1 1.8	19.3 18.0	18.4 15.1
MINIMUM	0.7	12.0	0.5	28.0	1.1	0.1	2.0	6.2	1.7	15.5	13.7

- (1) Measured on the kit used for Device #5; Correlated with the Signal Corps.
(2) Measured on a kit that is in the development stage and which has not been correlated.

I. 4 Fabrication and Testing Development Models for Delivery

I. 4. 1 Fabrication:

Sub assemblies and Parts - Appendix C

Drawing No.

Header	B31-33127-P119
Alloyed Dice & Base Tab Assembly	TF50-6
Lead Wire	A31-7371-P85
Cap	A31X-33124-P74

Assembly Process Specifications - Appendix C

Tab Welding	TF50-1
Header Adjust	TF50-2
Tab Bend	TF50-3
Pre-Test	TF50-4
Ecco Bond	TF50-5

Using parts and specifications listed above, 275 development models were built in 0.250" diameter packages using welded base tab attachment.

I. 4. 2 Test and Evaluation

The 275 devices were evaluated to the objective specification MIL-S-19500/27A.

I. 4. 2. 1 Group A Tests

Group A test results are tabulated in Table III.

I. 4. 2. 2 Group B Tests

Group B test results are presented in Table IV.

I. 4. 2. 3 Power Dissipation Capability

Dissipation in free 25°C air is approximately 100 mw and in an infinite 25°C heat sink is approximately 300 mw.

I. 4. 2. 4 Summary and Conclusions

Summary: The devices fabricated and submitted met all of the Group A requirements of the objective specification for this task, MIL-S-19500/27A.

The devices were successfully built in a smaller package than the 0.265" maximum diameter required by the original contract: 0.250" maximum diameter.

The final development models passed all Group B requirements of objective specification MIL-S-19500/27A except for Subgroup 3. Four out of a sample of 20 failed Subgroup 3, 2 on 5000 g Constant Acceleration, 1 on 10 g Vibration Fatigue, and 1 on 10 g Variable Frequency Vibration Fatigue. Subsequent investigation revealed improper loading technique and marginal design of the Constant Acceleration test fixture had caused marked deformation of the header-flange area of the failed devices and was the direct cause of their failure. Properly loaded devices did not fail Group B tests.

Conclusion: The Sylvania drift field PNIP junction assembly was successfully modified and mounted in the Sylvania "pancake" package less than 0.072" high and less than 0.250" diameter. The final development models delivered met or exceeded all of the requirements of the objective specification MIL-S-19500/27A.

Test results of Group B, Subgroup 3 were adversely affected by defective jigging.

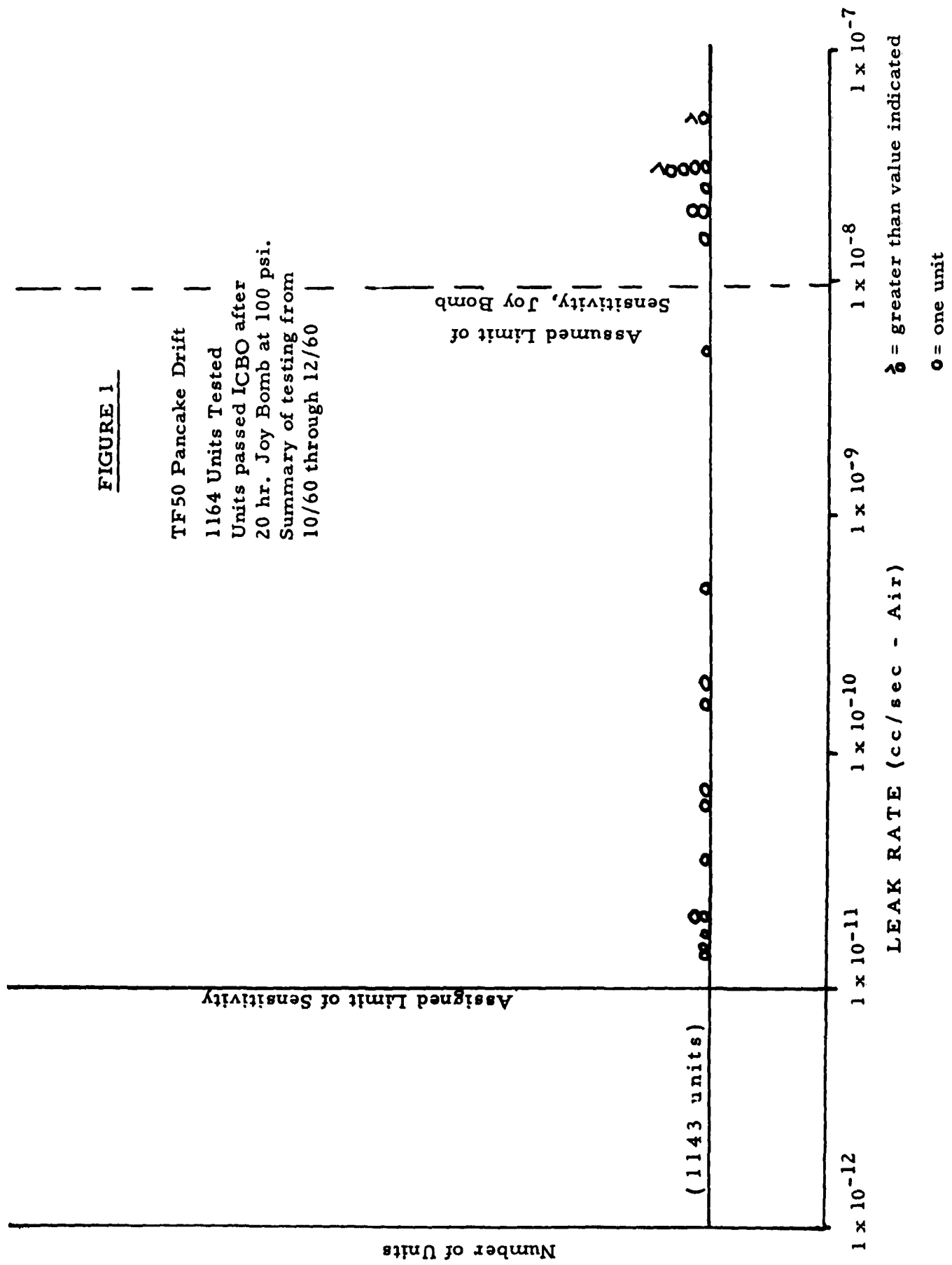
Leak testing of the final package by Radiflo showed 1143 units of a test lot of 1164 with leak rates less than 1×10^{-11} std. c. c. /min. None had leak rates greater than 5×10^{-7} std. c. c. /min. Figure 1 is a graph of these results.

TABLE IV
GROUP B INSPECTION

EXAMINATION OR TEST	CONDITIONS	Symbol	Limits		Unit	Sample Size	Number Failures	Number Pass	Notes	
			Min	Max						
<u>SUBGROUP 1</u> Physical dimensions					}	15	1	14	Note 1	
<u>SUBGROUP 2</u> Soldering	5 cycles; $T = +95^{\circ} + 5^{\circ}C$ $-0^{\circ}C$					}				
Temperature cycling	$T = +95^{\circ} + 5^{\circ}C$ $-0^{\circ}C$ & $0^{\circ} \pm 2^{\circ}C$									
Thermal shock (glass strain)							20	1	19	Note 2
Moisture resistance					}					
End points:										
Collector cutoff current (dc), open emitter	$V_{CBO} = -40Vdc$ $I_E = 0$ $f = 1kc$	ICBO	-75			}				
Small-signal short circuit forward-current transfer ratio		h_{fe}	15		20		0	20		
<u>SUBGROUP 3</u> Shock										
Constant acceleration	500 G $t = 1 \text{ msec};$ 5 blows each in orientations X ₁ , Y ₁ , Y ₂ , and Z ₁ (total of 20 blows)				}					
Vibration fatigue	5000 G									
Vibration, variable frequency	10 G 100 to 1000 cps 10 G									
End points: (Same as for Sub- group 2)						20	4	16	Note 3	

TABLE IV (Cont'd)
GROUP B INSPECTION

EXAMINATION OR TEST	CONDITIONS	Symbol	Limits		Unit	Sample Size	Number Failures	Number Pass	Notes
			Min	Max					
<u>SUBGROUP 4</u> Lead fatigue	Pressure = 15mm mercury VCBO = -40 Vdc I _E = 0 ICBO = -75 7uAdc max. t = 60 seconds					20	0	All	
<u>SUBGROUP 5</u> Barometric pressure, reduced (altitude operation).									
Salt atmosphere (corrosion) End Points: (Same as for Subgroup 2).						20	0	All	
<u>SUBGROUP 6</u> Storage life End points: Collector cutoff current (dc), open Small - signal short-circuit forward-current transfer ratio	Tstg = +100° -3° C VCBO = -40 Vdc I _E = 0	ICBO h _{fe}			-100 uAdc 15 -100	20	0	All	
<u>SUBGROUP 7</u> Operation life End points: (Same as for Subgroup 6)	T _A = +25° ± 3°C P _C = 120 ⁺⁰ / ₋₁₂ mW					19	0	All	
	Note 1: One flange diameter .001" over .450" maximum. Note 2: One ICBO failure on Temperature Cycling. Note 3: Test fixture caused failure recorded. See Section I.4.2.4								



TASK II

PURPOSE

- A. The purpose of this Task is to modify an existing pancake package and an existing internal device structure to develop a transistor 0.072" maximum height and 0.265" maximum diameter having as the objective specification the military 2N696-697 specification MIL-s-19500/99A. Maximum diameter was reduced during the course of the contract to 0.250".
- B. To establish assembly techniques.
- C. To fabricate and submit samples of these devices for approval and standardization.

II. 1 Analysis of Task

Figure 1(a) (Section III) and Drawing TD43-2 (Appendix D) show package and pellet status at initiation of contract. Figure 8 (Section III) is the initial header drawing. Drawing TD43-2 (Appendix D) shows the completed pellet which was being manufactured, having the electrical characteristics of MIL-S-19500/99A. The dimensions and geometries were quite compatible and the principal task was to refine both so that highest reliability and greatest ease of fabrication were obtained.

II. 2 Dimensional Design

No dimensional design change was considered or made on the original silicon mesa pellet. The standard 2N696-697 pellet was adequate for the package. There were two approaches to combining the package with the pellet, one involved using the header as is (Figure 9, Section III) the other consisted of using a molybdenum pedestal upon which the pellet is mounted (Figure 10, Section III). It was found that the latter approach was the most practical based on both, ease of mounting to the header, and ease of thermo compressive bonding.

A major change in package dimensions was agreed upon, during the contract, which changed the package flange diameter from .265" to .250" (Figure 4(a), Section III).

II. 3 Development of Assembly Procedures

II. 3. 1 Foreword: The purpose of this contract simply stated was to take an existing device pellet, the 2N696-697 and an existing package design, the pancake package Figure 1(a) (Section III), and develop techniques which would enable the manufacturer to produce the 2N696-697 device in the pancake package. These two parts, package and device pellet, were not developed as a part of this contract and their development prior to the contract is therefore not reported herein.

II. 3. 2 Internal Assembly and Lead Attachment

Figure 10 (Section III) illustrates the position of the pellet upon the pedestal and the arrangement of the bonding wires. The pellet was mounted on the gold plated moly pedestal in a K & S Model 601 header mounting machine. A 0.5 mil gold-antimony preform was used between pellet and pedestal in order to accomplish this. Gold wires, 1 mil thick, were thermocompressively bonded to the aluminum stripes and to the posts of the package using a K & S thermocompressive bonder (Model #400). These two operations required slight modifications of the above mentioned equipment in order to handle the pancake package.

II. 3. 3 Major Problem Areas

The attachment to the header and subsequent gold plating of the molybdenum pedestal was the major problem; however, a satisfactory technique using brazing and double gold plating was developed as described in this report Section III. 3. Other problems, such as vendor ability to meet specified tolerances, welding procedures and gold plating were encountered and are also described in Section III of this report.

Although an existing epitaxial pellet structure was considered, it was decided that a non-epitaxial device would best meet the objective requirements of MIL-S-19500/99A, and the needs of the Signal Corps. All samples delivered were fabricated with standard pellet structure.

II. 4 Fabrication of Models for Delivery

II. 4. 1 Subassembly and Parts

		<u>Drawing No.</u>
Header	(Figure 10, Section III)	B31-S-1411-P2
Cap	(Figure 6, Section III)	X-33124-P74
Silicon Mesa Pellet	(Appendix D)	TD 43-2
Lead Wire	(Appendix D)	PR-142

II. 4. 2 Assembly Process Specifications

Header Mounting	(Appendix D)	TD 43-2-P26
Bonding	(Appendix D)	TD 43-2-P27

Using parts and specifications listed above, 100 development models were built in 0.250" diameter packages, evaluated, and delivered.

II. 5 Test and Evaluation

II. 5. 1 One hundred development models were submitted to the Signal Corps on August 4, 1961. A summary of the results evaluated against MIL-S-19500/99A is given in Table I.

II. 5. 2 Conclusions

The Sylvania NPN silicon mesa, 2N696-697 junction, was successfully mounted in a modified Sylvania "pancake" package less than 0.072" high and less than 0.250" diameter. The final development models delivered, met or exceeded all of the requirements of the objective specification MIL-S-19500/99A.

TABLE I

SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP A - Test Results

Parameter - Conditions -	LV _{CER} R _{BE} =10 P _W ±167 u sec ≤1% duty cycle I _C = 100 ma	BV _{CBO} I _E = 0 I _C = 100 ma	IC _{BO} I _E = 0 V _{CB} = +30	h _{FE} I _C = 150 ma V _{CE} = 10V P _W ≤12 msec ≤ 2% duty cy.	V _{BE} (sat) I _C = 150 ma I _B = 15 ma	V _{CE} (sat) I _C = 150 ma I _B = 15 ma	h _{fe} I _C = 50ma V _{CE} = 10V f = 20 mc	COB I _E = 0 V _{CB} = 10V	BV _{EBO} I _C = 0 I _E = 1 ma
<u>SUBGROUP 1</u>	Visual and Mechanical								
<u>SUBGROUP 2</u>	ZERO FAILURES (°/100)								
Test Equip.	Al-1	T-742	T-742	T-728	T-422	T-422			
Limits	(>+40V DC)	(>+60V DC)	(<1.0 µa)	(>20 <60 and >40<120) (Note 5)	(1.3V DC)	(<1.5V DC)			
Maximum	72	108.0	0.807	115.0	1.30	1.48			
90%	58	96.5	0.197	107.0	1.22	0.95			
Median	52	88.7	0.011	71.3	1.06	0.72			
10%	42	77.4	0.003	48.0	0.98	0.45			
Minimum	40	66.0	0.001	26.8	0.95	0.22			
	ZERO UNITS FAILED SUBGROUP 2: (°/100)								
<u>SUBGROUP 3</u>									
Test Equip.							JB-1	TO-21	AL-2
Limits							(>2.0, >2.5) (Note 5)	(<35 µµf)	(>5V DC)
Maximum							9.5	17.4	8.6
90%							9.2	16.1	8.2
Median							8.2	14.3	8.0
10%							7.3	13.1	7.9
Minimum							6.7	7.8	7.8
	ZERO UNITS FAILED SUBGROUP 3: (°/100)								

TABLE I (Continued)

SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP A Test Results

Parameter Condition	- -	ICBO $T_A = 150^\circ\text{C} \pm 3^\circ$ $V_{CB} = 30\text{ V}$ $I_E = 0$	h_{FE} $I_C = 500\text{ ma}$ $V_{CE} = 10\text{ V}$ $P_W \leq 10$ usec $\leq 5\%$ duty cycle	h_{FE} $I_C = 10\text{ ma}$ $V_{CE} = 10\text{ V}$	RTH ⊙ J-C
Test Equipment		T-569	AL-2	T-166	T-309
Limits		(<100ua)	(>12.5, >20) (Note 5)	(>15, >30) (Note 5)	(<75° c/w)
<u>SUBGROUP 4</u>					
Maximum		80.0			
90%		6.4			
Median		1.0			
10%		0.2			
Minimum		0.1			
ZERO UNITS FAILED SUBGROUP 4; °/100					
<u>SUBGROUP 5</u>					
Maximum			83.3	154.0	
90%			65.0	118.0	
Median			43.4	67.3	
10%			27.7	50.0	
Minimum			20.0	38.0	
ZERO UNITS FAILED SUBGROUP 5; °/100					
<u>SUBGROUP 6</u>					
Number of units tested	-	10			
Maximum					41.2
90%					35.0
Median					32.8
10%					31.4
Minimum					29.6
ZERO UNITS FAILED SUBGROUP 6; °/100					

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP B Test Results

Subgroups 2, 3 and 4 were evaluated for I_{CBO} at $V_{CB} = +30 V_{DC}$ (limit $\leq 2\mu a$), V_{CE} (sat) at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$ (limit $\leq 1.65 V_{DC}$), and V_{BE} (sat) at $I_C = 150 \text{ mA}$, $I_B = 15 \text{ mA}$ (limit $\leq 1.45 V_{DC}$).

Subgroups 6-7, the life tests, were evaluated for I_{CBO} at $V_{CB} = +30 V_{DC}$ (limit $\leq 2\mu a$) and h_{FE} at $I_C = 150 \text{ mA}$, $V_{CE} = 10 V_{DC}$, $P_W \leq 12 \text{ m sec}$, and duty cycle 2% (limit > 15 and > 30).

SUBGROUP 1

Physical Dimensions 12 Failures, Lead Diameter; 12 Failures
15 Tested , Note 1.

SUBGROUP 2

	Initial Reading	After Temp. Cycling, 5 cycles, T max = 200°C	After Moisture Resistance Test
	<u> </u>	<u> </u>	<u> </u>
	$I_{CO} (\mu a)$	limit $\leq 2.0 \mu a$ $I_{CO} (\mu a)$	limit $\leq 2.0 \mu a$ $I_{CO} (\mu a)$
Maximum	0.190	0.360	0.350
Median	0.010	0.010	0.040
Minimum	0.005	0.005	0.005
		limit $\leq 1.65 V$	limit $\leq 1.65 V$
	$V_{CE} (\text{volts})$	$V_{CE} (\text{volts})$	$V_{CE} (\text{volts})$
Maximum	0.876	0.898	1.070
Median	0.432	0.580	0.520
Minimum	0.214	0.217	0.219
		limit $\leq 1.45 V$	limit $\leq 1.45 V$
	$V_{BE} (\text{volts})$	$V_{BE} (\text{volts})$	$V_{BE} (\text{volts})$
Maximum	1.200	1.270	1.250
Median	1.010	0.100	1.010
Minimum	0.945	0.944	0.941

ZERO UNITS FAILED OF 15 UNITS TESTED; 0/15

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP B Test Results

SUBGROUP 3

	Initial Reading	Constant Accelera- tion 20,000G	Shock 500G	Vibration Fatigue 20G	Vibration Variable Freq. 20G
	$I_{CO}(\mu a)$	$I_{CO}(\mu a)$	$I_{CO}(\mu a)$	$I_{CO}(\mu a)$	$I_{CO}(\mu a)$
Maximum	0.192	0.187	D.S. * (0.277)	D.S. * (1.17)	D.S. * (0.592)
Median	0.012	0.024	0.037	0.063	0.104
Minimum	0.002	0.003	0.003	0.006	0.003
	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)	V_{CE} (volts)
Maximum	1.090	C.S. * (1.10)	C.S. * (1.11)	C.S. * (1.12)	C.S. * (1.12)
Median	0.681	0.684	0.710	0.702	0.697
Minimum	0.417	0.341	0.419	0.425	0.415

*1 UNIT FAILED, EMITTER OPEN AFTER CONSTANT
ACCELERATION; ¹/15, NOTE 2

SUBGROUP 4

	Initial Reading	Salt Atmosphere
	$I_{CO}(\mu a)$	$I_{CO}(\mu a)$
Maximum	0.216	29.800 *
Median	0.019	0.022
Minimum	0.004	0.002
	V_{CE} (volts)	V_{CE} (volts)
Maximum	1.200	1.200
Median	1.090	1.090
Minimum	0.986	0.976

*1 UNIT FAILED, I_{CO} LIMIT; ¹/15, NOTE 3

SUBGROUP 5

Lead Fatigue
ZERO LEADS BROKE; 0/15

TABLE I (Continued)
SILICON MESA PANCAKE TRANSISTOR EVALUATION
RESULTS PER MIL-S-19500/99A

GROUP B Test Results

	<u>Initial Reading</u>	<u>After 250 hrs.</u>	<u>After 500 hrs.</u>	<u>After 750 hrs.</u>	<u>After 1000 hrs.</u>
--	----------------------------	---------------------------	---------------------------	---------------------------	----------------------------

SUBGROUP 6

Operating Life TA = + 25°C, V_{CB} = 30V, PC = 400 mw

I_{CO} at V_{CB} = 30 V (<2μa)

Maximum	0.680	0.290	0.370	0.986	1.350
Median	0.150	0.045	0.035	0.074	0.065
Minimum	0.005	0.005	0.001	0.002	0.0026

h_{FE} at I_C = 150 mA, V_{CE} = 10 V, P_W ≤ m sec, Duty Cycle 2% (>15>30)
(Note 5)

Maximum	74.6	87.7	79.4	79.8	79.4
Median	54.1	59.8	57.5	55.3	53.9
Minimum	43.1	43.1	41.9	43.1	43.0

ZERO UNITS FAILED. 0/15

SUBGROUP 7

+ 300°C Storage Life

I_{CO} at V_{CB} = 30 V (<20 μa)

Maximum	0.400	0.158	0.514	1.180	0.549
Median	0.090	0.055	0.085	0.084	0.049
Minimum	0.005	0.002	0.002	0.003	0.003

h_{FE} at I_C = 150 mA, V_{CE} = 10 V, P_W ≤ 12 m sec, Duty Cycle 2% (>15 and >30)
(Note 5)

Maximum	59.8	74.2	64.9	64.9	72.2
Median	51.9	60.2	53.2	53.6	56.0
Minimum	45.2	45.2	37.6	36.5	37.8

ZERO UNITS FAILED - 2 UNITS DEVELOPED BROKEN LEADS AND
WERE NOT EVALUATED. 0/13 NOTE 4

Note 1.

Samples passed all dimensional requirements except 12 units out of 15 had leads 0.001 inch greater than the required diameter. Header plating is corrected to eliminate this oversize condition.

Note 2.

Group B, Subgroup number 3 had one failure after Constant Acceleration at 20,000 G. This unit failed because the emitter lead connection came loose internally at the post. Bonding procedure corrected.

Note 3.

Radiflo test showed unit to be hermetically tight.

Note 4.

Group B, Subgroup number 7, + 300°C storage life, had zero failures. Two units were not evaluated during life due to broken external package leads. The broken leads were due to use of incorrect test jigs for the electrical measurements. After 1000 hours storage I_{CBO} was measured and both units were good for that parameter (number 11 - 0.002 μ a and number 13 - 0.001 μ a).

Note 5.

All testing was done as per MIL-S-19500/99A (Sig C). Two limits are given for h_{FE} and h_{fe} measurements because units were to be classified as SYL 2099 (2N696) and SYL 2445 (2N679); the last specified limit is for the SYL 2445.

SECTION III

PURPOSE

- A. The purpose of this work was to modify the existing Sylvania pancake package to accomodate a drift field germanium transistor and a silicon mesa switching transistor. The work was carried out in support of Tasks I and II.
- B. To establish manufacturing capabilities for the modified package design and to fabricate a sufficient number of parts to demonstrate capability and provide parts for fabrication of samples required in Tasks I and II.

SECTION III PACKAGE EVOLUTION

III. 1 General

III. 1. 1 Design

The package was designed by Sylvania prior to the contract as a resistance-welded hermetic enclosure consisting of a kovar stamping with kovar terminals sealed in with 7052 (hard) glass in a stress-free oxide seal. The outline is illustrated in Figure 1(a) and 1(b). (The outline later became EIA TO-47.) Lead wires were .014" in diameter in order to provide enough current-carrying capacity and sufficient stiffness to allow direct insertion into printed-circuit boards. The entire package was tin plated for corrosion resistance and solderability. The pin circle diameter was at .141", the smallest allowing insertion into a standard .100" grid circuit board. Experimental units with seal lengths of .040" and .030" were fabricated and tested hermetically. It was found that a seal length of .030" allowed some leaks after the thermo-mechanical shock of welding a SAE 1010 steel cap to the header in a resistance welder. A .035" seal length was decided upon. For the given diameter, it was calculated (Figure 2) that a stock thickness of .009" was necessary to allow hydrostatic pressure testing at 200 psig with less than a .001" deflection. Steel caps were stamped from copper-coated steel to inhibit rusting of the cap, to allow closer tolerances, and to provide longer tool life by action of the copper as a die lubricant.

An indexing tab was provided for easy lead orientation and automatic insertion. The flange diameter of the cap (Figure 3) was made smaller than the flange diameter of the header in order to protect against weld flash, and the flange of the cap was angled to provide a projection for current-concentration in welding.

After the .265" diameter package was tooled and considerable experience was gained in welding the package, it was found that thinning of stock during drawing, use of overlapping tolerances and close control of welding electrodes would enable reduction of the diameter of the package to .250" (Figure 4(a) and 4(b)). With retooling for .250" maximum diameter package, defects in the original stampings were corrected thus providing a reliable, manufacturable package suitable for high-volume production.

III. 1. 2 Capacitance

Lead-to-case capacitance of the package was measured with a Boonton Q-meter and compared with the TO-5 and TO-18.

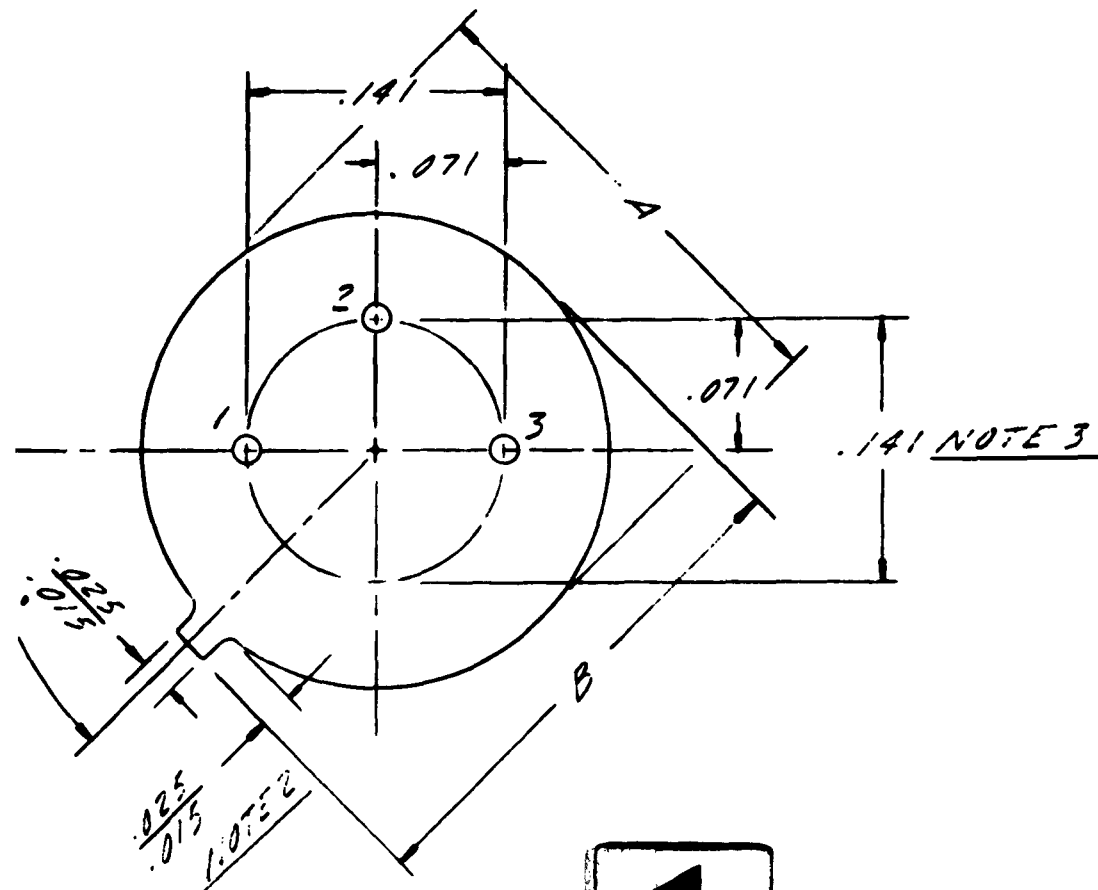
TO-5	0.65 pf
TO-18	1.45 pf
TO-47 (Pancake)	0.95 pf

Hand-drawn technical drawing of a mechanical part, likely a base seat, with dimensions and notes.

Dimensions and features:

- Top width: $.265 \text{ D.}$
- Inner width: $.240 \text{ D.}$
- Bottom width: $.255$ (outer) and $.220$ (inner)
- Height: $.070$ and $.060$
- Base: BASE SEAT
- Height from base: 1.500 MIN.
- Note: $.25$ (pointing to a vertical feature)
- Note: NOTE 1

1. THIS DEVICE
CIRCUIT BOARD
APPLICATION
SIZED OR
SIMILAR AP
BRIDGING A
WASHER OR
MAY BE NE
2. SPECIFIED
BETWEEN .0
OUTSIDE TA
UNCONTROL
3. TABLE LENGTH
DIMENSION
4. MAX. DIA. LL
PLANE .025
BE WITHIN
IN RESPECT



1

- CN60-1933

MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^{\circ}-15'$

REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

TES: -

THIS DEVICE IS FOR SOCKETED, SINGLE-SIDED
CIRCUIT BOARD, WIRE-IN & SIMILAR
APPLICATIONS. WHERE USED IN DOUBLE-
SIDED OR EYELETTED CIRCUIT BOARD, OR
SIMILAR APPLICATIONS WHERE SOLDER
BRIDGING MAY OCCUR, A DIELECTRIC
SPACER OR OTHER STAND-OFF DEVICE
MAY BE NECESSARY.

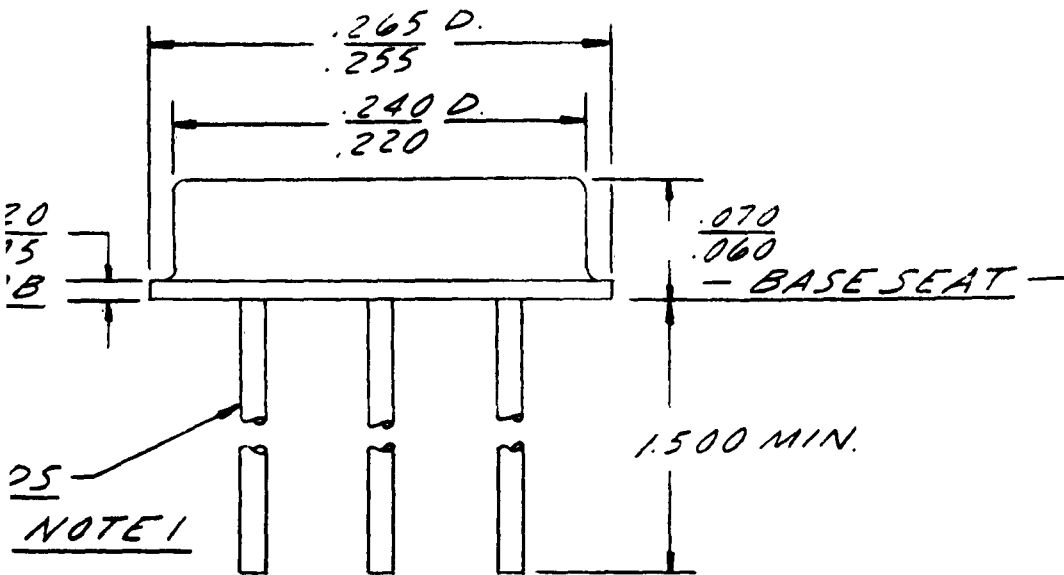
SPECIFIED LEAD DIA. APPLIES IN THE ZONE
BETWEEN .025 & 1.500 FROM BASE SEAT.
OUTSIDE THIS ZONE THE LEAD DIA IS
UNCONTROLLED.

LEAD LENGTH DETERMINED BY SUBTRACTING
DIMENSION "A" FROM DIMENSION "B".
MAX. DIA. LEAD MEASURED AT A GAUGING
PLANE .025 $\pm$.001 BELOW BASE SEAT SHALL
BE WITHIN .007 OF THEIR TRUE POSITION
WITH RESPECT TO THE MAX. WIDTH TAB.

2

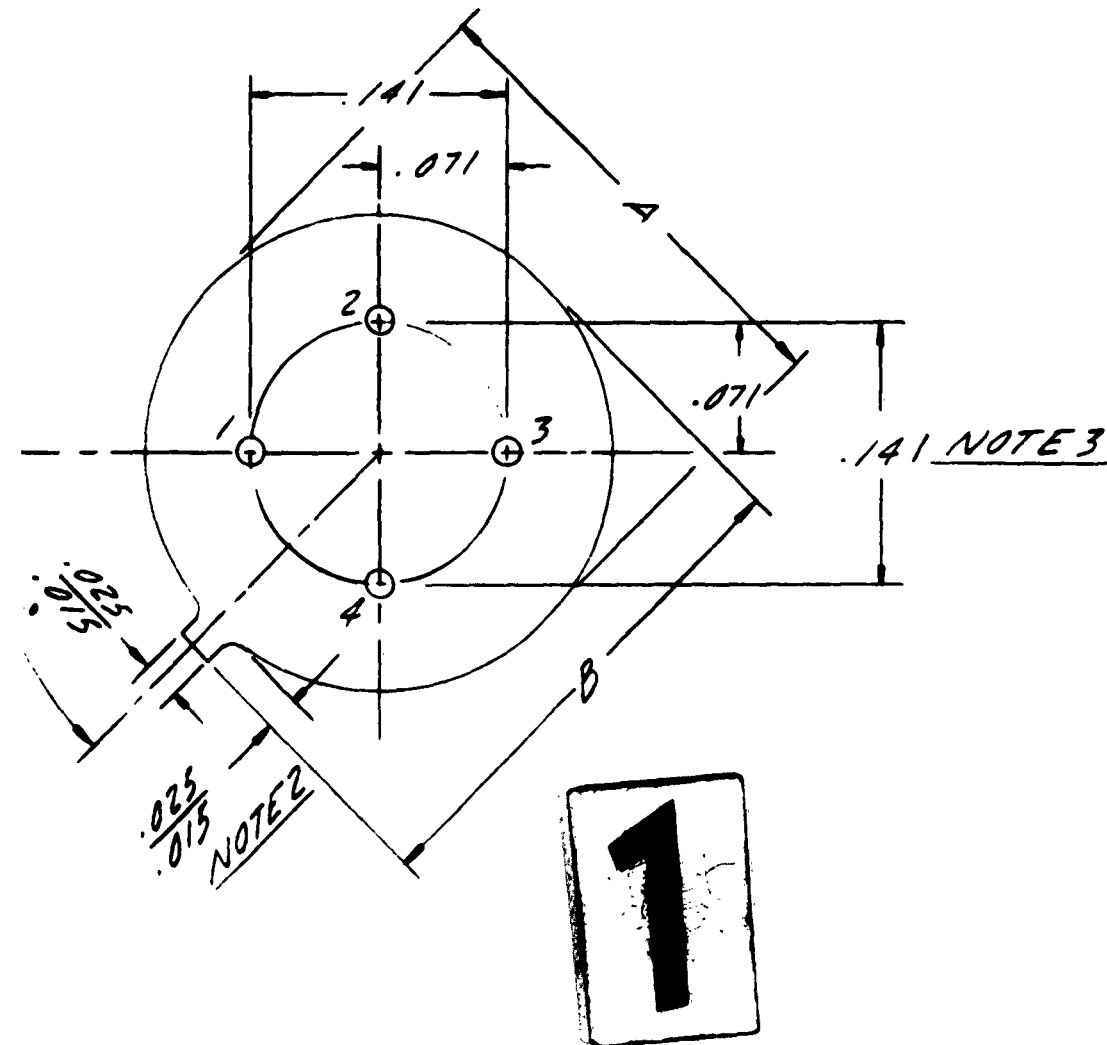
REV.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED ST. McMANUS	12 MAY 1968	PART — OUTLINE —		
	DRAWN W. Stanley	12 MAY 1968			
	SCALE		SYLVANIA	ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33426P54

CN60-1933 -



— NOTES —

1. THIS DEVICE IS FOR USE ON A CIRCUIT BOARD IN APPLICATIONS WHERE A SINGLE-SIDED OR DOUBLE-SIDED SIMILAR APPLICATION BRIDGING A HOLE IN THE BOARD MAY BE NECESSARY.
2. SPECIFIED DIMENSIONS ARE BETWEEN DIMENSIONS OUTSIDE THE HOLES UNLESS OTHERWISE SPECIFIED.
3. TAB LENGTHS ARE DIMENSIONS FROM THE CENTER OF THE HOLES TO THE END OF THE TABS.
4. MAX. DIA. OF HOLES IN PLANE .025 IN. BE WITHIN .005 IN. RESPECT TO THE CENTER OF THE HOLES.



6)

MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^{\circ}-15'$

REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

NOTES —

THIS DEVICE IS FOR SOCKETED, SINGLE-SIDED
CIRCUIT BOARD, WIRE-IN & SIMILAR
APPLICATIONS. WHERE USED IN DOUBLE-
SIDED OR EYELETTED CIRCUIT BOARD, OR
SIMILAR APPLICATIONS WHERE SOLDER
BRIDGING MAY OCCUR, A DIELECTRIC
SPACER OR OTHER STAND-OFF DEVICE
MAY BE NECESSARY.

SPECIFIED LEAD DIA. APPLIES IN THE ZONE
BETWEEN .025 & 1.500 FROM BASE SEAT.
OUTSIDE THIS ZONE, THE LEAD DIA. IS
CONTROLLED.

LEAD LENGTH DETERMINED BY SUBTRACTING
DIMENSION "A" FROM DIMENSION "B"
MAX. DIA. LEAD MEASURED AT A GAUGING
PLANE .025 $\pm .001$ BELOW BASE SEAT SHALL
BE WITHIN .007 OF THEIR TRUE POSITION
WITH RESPECT TO THE MAX. WIDTH TAB.

2

REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED	13 MAY 1966	PART		
	DRAWN	W. Stanley	— OUTLINE —		
	SCALE		SYLVANIA ELEC. PROD., INC. SEMICONDUCTOR DIVISION		

CN60-1934 —

B31-33406P53

29-

Figure 2

CALCULATION OF CAP AND HEADER DEFLECTION

The following four pages of Figure 2 describe the design calculations used in determining cap dimensions and stock thickness.

CALCULATION OF CAP AND HEADER DEFLECTION

- I. Bending of a uniformly loaded circular plate:
(from Timoshenko, Strength of Materials, Part II, 3rd Edition,
Van Nostrand, 1956)

For simply supported edges,

$$\delta_{\max.} = \frac{(5 + \mu) q a^4}{64 (1 + \mu) D}$$

For clamped edges,

$$\delta_{\max.} = \frac{q a^4}{64 D}$$

$$D = \frac{E h^3}{12 (1 - \mu^2)}$$

E = Modulus of elasticity (Young's), psi.

μ = Poisson's ratio

q = uniformly distributed load, psi.

a = radius of plate, in.

$\delta_{\max.}$ = maximum deflection (at center), in.

It is desired to have a total deflection (cap deflection plus header deflection) not greater than .002".

Figure 2 (Cont'd)

II. Considering simply supported edges,

$$\delta_{\max.} = \frac{(5+\mu) q a^4}{64 (1+\mu) D}$$

$$D = \frac{(5+\mu) q a^4}{64 (1+\mu) \delta_{\max.}} = \frac{E h^3}{12 (1-\mu^2)}$$

$$h^3 = \frac{12 (5+\mu) q a^4 (1-\mu^2)}{64 (1+\mu) E \delta_{\max.}}$$

$$h = \left(\frac{12 (5+\mu) (1-\mu^2) q a^4}{64 (1+\mu) E \delta_{\max.}} \right)^{1/3}$$

For steel,

$$\mu = 0.3$$

$$E = 30 \times 10^6 \text{ psi.}$$

For the cap,

$$a = .102 \text{ in.}$$

$$\delta_{\max.} = 1 \times 10^{-3} \text{ in.}$$

$$h = \left[\frac{12 (5.3) (.91) (200) (1.02)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) 10^{-3}} \right]^{1/3}$$

$$h = 5.66 \times 10^{-3} \text{ in.}$$

For the header,

$$a = .124 \text{ in.}$$

$$h = \left[\frac{12 (5.3) (.91) (200) (1.24)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) 10^{-3}} \right]^{1/3}$$

$$h = 13.76 \times 10^{-3} \text{ in.}$$

Figure 2 (Cont'd)

III. Considering clamped edges,

$$\delta_{\max} = \frac{q a^4}{64 D}$$

$$D = \frac{q a^4}{64 \delta_{\max}} = \frac{E h^3}{12 (1-\mu^2)}$$

$$h^3 = \frac{12 q a^4 (1-\mu^2)}{64 E \delta_{\max}}$$

$$h = \left(\frac{12 (1-\mu^2) q a^4}{64 E \delta_{\max}} \right)^{1/3}$$

For the cap,

$$h = \left[\frac{12 (.91) (200) (1.02)^4 \times 10^{-4}}{64 \times 30 \times 10^6 \times 10^{-3}} \right]^{1/3}$$

$$h = 3.54 \times 10^{-3} \text{ in.}$$

For the header,

$$h = \left[\frac{12 (1.09) (200) (1.24)^4 \times 10^{-4}}{64 \times 30 \times 10^6 \times 10^{-3}} \right]^{1/3}$$

$$h = 8.60 \times 10^{-3} \text{ in.}$$

IV. Header deflection:

Since we want to keep the cap stock and the header stock as close to the same thickness as possible for good welding, let us first find the header deflection for a simply-supported plate of the thickness calculated for a clamped plate. If the simply-supported plate deflection is less than .002", we can then calculate the stock thickness required for the cap to deflect no more than the difference between the header deflection and .002"

Figure 2 (Cont'd)

For simply-supported edges,

$$D = \frac{30 \times 10^6 (9)^3 \times 10^{-9}}{12 (.91)} = 2.47$$

$$\delta_{\max.} = \frac{5.3 \times 200 (1.24)^4 \times 10^{-4}}{64 (1.3) 2.47} = .0012''$$

V. Allowable cap deflection:

$$\begin{array}{rcl} \text{Max. allowable total deflection} & = & .002'' \\ - \text{Calculated header deflection} & = & .0012'' \\ \hline \text{Allowable cap deflection} & = & .0008'' \end{array}$$

VI. Required cap stock thickness:

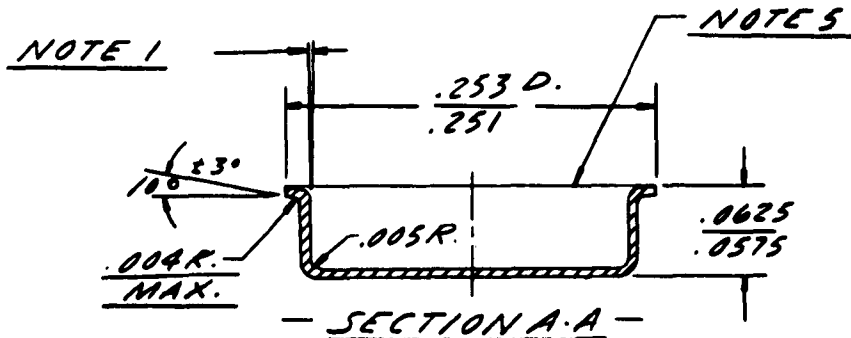
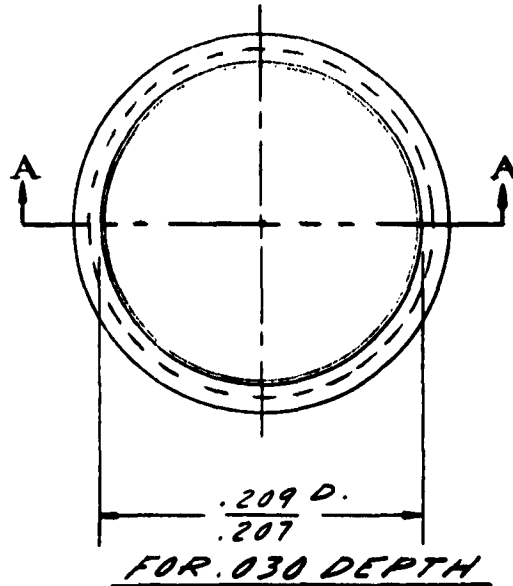
$$h = \left[\frac{12 (5.3) (.91) (200) (1.02)^4 \times 10^{-4}}{64 (1.3) (30 \times 10^6) (8 \times 10^{-4})} \right]^{1/3}$$

$$h = .0086''$$

Since kovar has a higher electrical resistivity than steel, and since the kovar header must be welded to the steel cap, metal thickness must be factored into welding. Since the steel resistivity is lower, and $R < L$, where L is path length, and since the heat generated at welding is proportional to R , it seems advisable to make cap stock thickness greater than header stock thickness in order to balance resistances in the welder circuit. The cap stock will therefore be made .001" thicker than header stock, or .010".

FIGURE 3

THIS PRINT TO BE REPLACED BY
A31-33124P74 ON 1 MAY 1961



— NOTES: —

1. 1° MAX. TAPER INSIDE OF SHELL
2. BODY TO FLANGE ECCENTRICITY .002 MAX. T.I.R.
3. THICKNESS OF FLANGE MUST NOT VARY MORE THAN ±.0005.
4. PART TO BE CLEANED BY FIRING IN A HYDROGEN ATMOSPHERE FURNACE AT 900°C FOR 20 MIN. KEEP ENTIRELY SURROUNDED BY GAS TO 200°C, PACK IN AIR-TIGHT CONTAINERS WHILE STILL AS HOT AS PRACTICABLE.
5. FLANGE TO BE FLAT WITHIN .001 WITH FACE FREE OF BURRS.

SAW 23 JAN 1961	REPLACEMENT NOTE ADDED CNG-250 1/16/61	B
STM 2 MAY 1960	REVISED PER CNG-1751 2 MAY 1960	A
APPR'D	REVISIONS	LTR.

ALL DIMENSIONS UNLESS OTHER-
WISE SPECIFIED ARE IN INCHES
WITH TOLERANCES OF:

FRACTIONAL ± 1/64
DECIMAL ± .005
ANGULAR ± 1/2°



CNG-1126 MATERIAL: .010 1010 CRS, COPPER PLATED

SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT - WILMINGTON

TITLE:

— CAP —

SIZE CODE

A31

DRAWN DATE SCALE
WILMINGTON, DE 1/1/60 1:1X
APP'D DESIGN DATE APP'D PROD. DATE
2 MAY 1960 66

REV. LTR.

B

+



+

This device is for socketed, single-sided circuit board, wire-in and similar applications. Where used in double-sided or eyeleted circuit board, or similar applications where solder bridging may occur, a dielectric washer or other standoff device may be necessary.

SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT -

SIZE CODE

A31

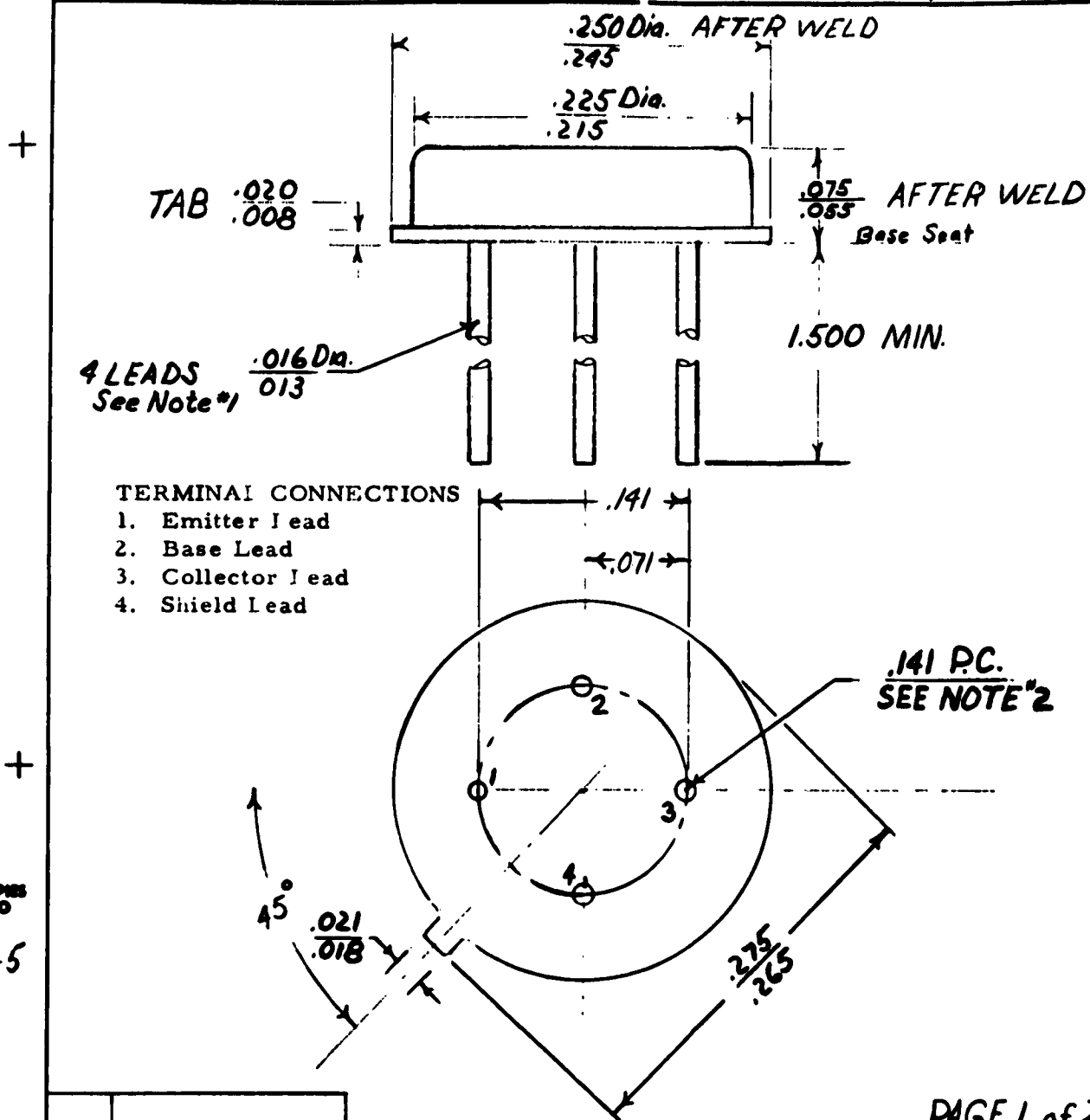
DEFIANCE NO. 1000N 21100

NOTES

1. Specified lead diameter applies in the zone between .025 and 1.500 from base seat. Outside of this zone the lead diameter is uncontrolled.
2. Maximum diameter lead measured at a gauging plane .025 .001 below base seat shall be within .007 of their true position .000 in respect to the maximum width tab.

PAGE 2 of 2

APPR'D	REVISIONS	LTR.	MATERIAL:				
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$			SYLVANIA ELECTRIC PRODUCTS, INC.		DRAWN <i>SAJ</i>	DATE <i>3/6</i>	SCALE ---
			SEMICONDUCTOR DIVISION PLANT-		APP'D DESIGN DATE <i>3/11 2 Nov 62</i>		
TITLE: <i>OUTLINE</i>			SIZE CODE		REV. LTR		
			<i>A31</i>		<i>33426P72 C</i>		



COPIES TO

A-5

PAGE 1 of 2

C	Revised Print
B	CN61-2622 4/19/61 CC
A	CN61-2274 4/3/61 4 Lead Note 1
APPROVED	REVISIONS
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:	
FRACTIONAL $\pm 1/64$	
DECIMAL $\pm .005$	
ANGULAR $\pm .001$	

DIMENSIONS IN INCHES

This device is for socketed, single-sided circuit board, wire-in and similar applications. Where used in double-sided or eyeleted circuit board, or similar applications where solder bridging may occur, a dielectric washer or other standoff device may be necessary.

(Notes continued next page)

SYLVANIA ELECTRIC PRODUCTS, INC.

SEMICONDUCTOR DIVISION PLANT -

TITLE:

OUTLINE

SIZE CODE

A31

DRAWN

RAY

DATE

3/61

SCALE

10:1

APP'D DESIGN DATE

CN61-90

APP'D PROD. DATE

REV. LTY

C

NOTES

1. Specified lead diameter applies in the zone between .025 and 1.500 from base seat. Outside of this zone the lead diameter is uncontrolled.
2. Maximum diameter lead measured at a gauging plane .025 .001 below base seat shall be within .007 of their true position .000 in respect to the maximum width tab.

PAGE 2 of 2

APPR'D	REVISIONS	LTR.	MATERIAL:				
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$			SYLVANIA ELECTRIC PRODUCTS, INC.		DRAWN	DATE	SCALE
			SEMICONDUCTOR DIVISION PLANT -		RAJ	3/62	
			TITLE:		APP'D DESIGN DATE		APP'D PROD. DATE
			OUTLINE		CN 61-926		
			SIZE CODE	REV. LTR.			
			A31	33926P77		C	

III. 1. 3 Lead Fatigue

Lead fatigue testing of finished transistors was done by holding the package in a fixture with the leads hanging vertically, attaching a one-pound, one-ounce weight to the end of a lead and cycling at a constant speed (ten bends per minute). One bend is defined as rotation of the body of the device through a 90° arc (lead held down by one pound weight) and back to 0°. All bends are in the same direction. Results obtained show an average number of bends per lead of 4.5, maximum of 14, minimum of 3.5. Data is shown below:

PACKAGE LEAD FATIGUE TEST RESULTS

(Sample 100)

<u>Number of 90° Bends</u>	<u>Incoming Part</u>	<u>Completed Transistor</u>
less than 3	0 failures	0 failures
3.5	0	9
4	3	10
4.5	14	32
5	10	8
5.5	37	5
6	3	4
6.5	7	3
7 14	4	4
14	22	25
	100	100

III.2 Task I Package - Germanium Drift Field Transistor (2N384)

III.2. 1 Design Considerations

The 2N384 "drift-field" transistor required all elements electrically insulated from case and a fourth lead to the case. The header therefore has three glassed-in leads and the fourth lead butt-welded to the outside of the case.

III. 2. 2 Package Development

III. 2. 2. 1 Headers

The header originally used was part number B31-33127-P114 shown in Figure 5. Because of thinning of the stock in the drawing of the embosses, there was more space than anticipated across the eyelets and the eyelet walls were slanted. Also, the placement of the eyelets and emboss was off-center in respect to the outside diameter of the package. As a result, cap-to-header centering was difficult, and considerable trouble was encountered initially at welding. The situation was improved by reducing the inside diameter of the cap, but it was not until the part was retooled to reduce the diameter of the package to .250" (Figures 6 and 7) that the welding of the package became routine.

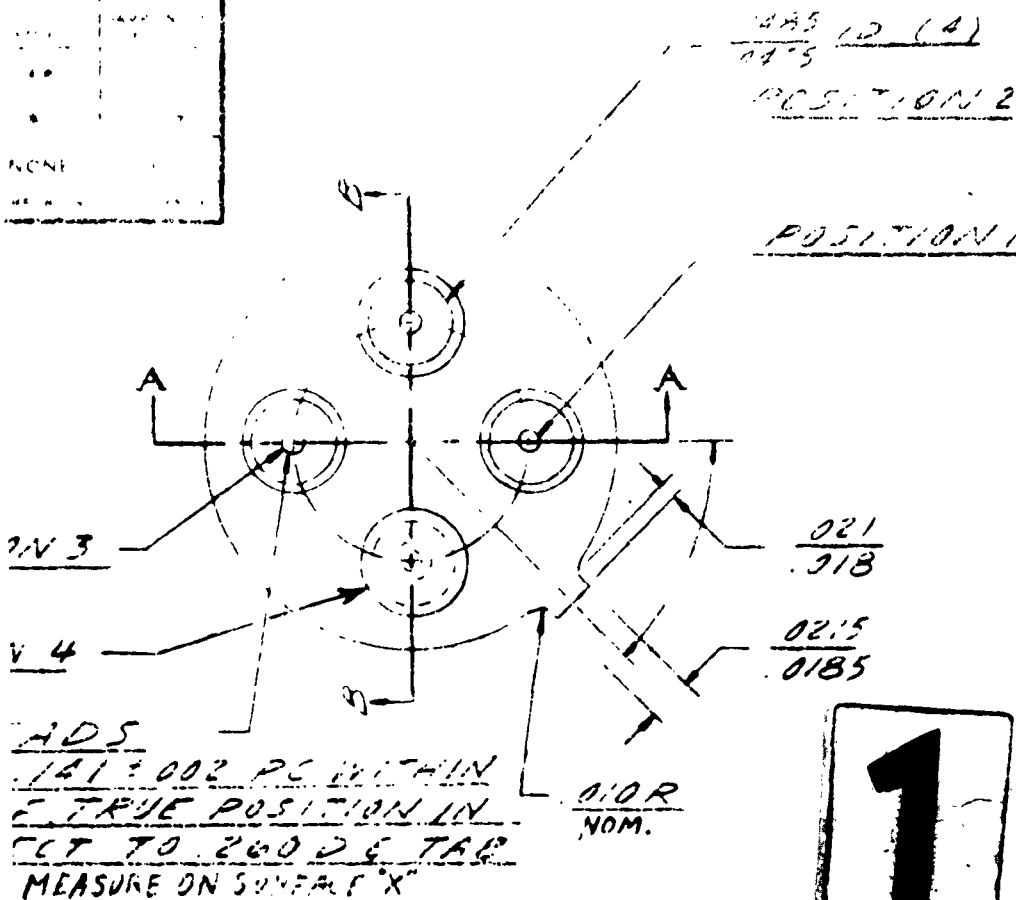
III. 2. 2. 2 Welding

Initially, a Raytheon "L" head condenser discharge welder with a Model 1101 power supply was used for seal welding. Results were satisfactory, but a change was later made to an "M" head welder to minimize electrode alignment error and forging of the base metal during welding. The improved alignment allowed changes in weld pressure and heat settings to obtain excellent hermetic seals without excessive forging. Maximum diameters achieved are between .248" and .250".

III. 2. 2. 3 Tab Attachment

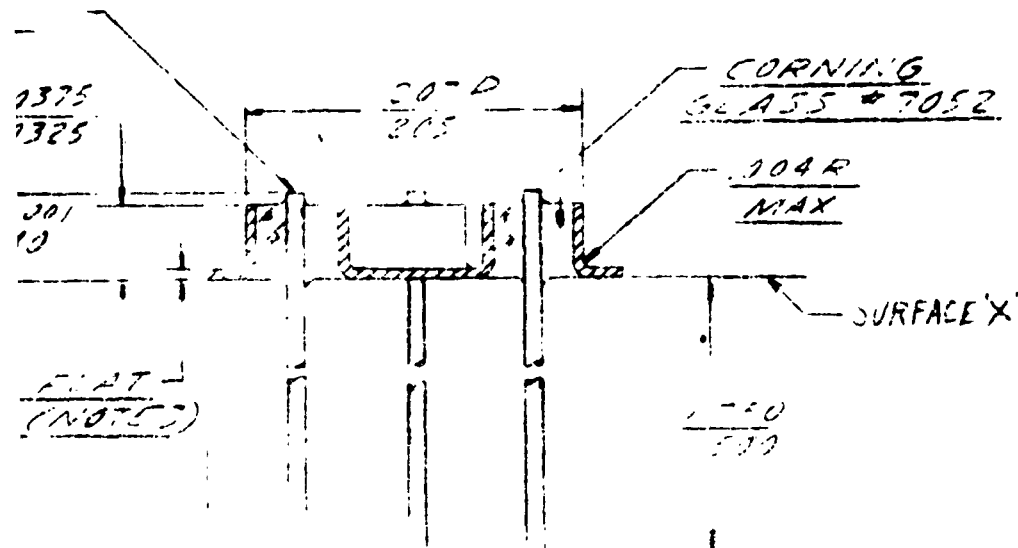
It was proposed at the beginning of the contract to attach one end of the base tab to the base lead by soldering and the other end to the emboss in position four by means of an insulating adhesive. The tab, adhesive, emboss combination made a parallel plate capacitor, and, since the "drift-field" transistor was a high-frequency device, it was sensitive to extra capacitances. A test was undertaken to determine the average capacitance between base tab and case, and at the same time, to determine the resistance to thermal shock of any adhesive used. Four epoxies were evaluated for the necessary properties: SR98, a silicon resin; Laminac, a polyester resin; Eccobond 26, an epoxy adhesive made by Emerson and Cummings, Inc.; and Eastman 910 adhesive. The different materials were applied to sample units which were then baked for sixty hours to harden the epoxy. Capacitance and temperature cycle tests were made. With

TOLERANCE LEGEND	
1	1.0000
2	0.0005
3	0.0002
4	0.0001
5	0.00005
6	0.00002
7	0.00001
8	0.000005
9	0.000002
10	0.000001
11	0.0000005
12	0.0000002
13	0.0000001
14	0.00000005
15	0.00000002
16	0.00000001
17	0.000000005
18	0.000000002
19	0.000000001
20	0.0000000005
21	0.0000000002
22	0.0000000001
23	0.00000000005
24	0.00000000002
25	0.00000000001
26	0.000000000005
27	0.000000000002
28	0.000000000001
29	0.0000000000005
30	0.0000000000002
31	0.0000000000001
32	0.00000000000005
33	0.00000000000002
34	0.00000000000001
35	0.000000000000005
36	0.000000000000002
37	0.000000000000001
38	0.0000000000000005
39	0.0000000000000002
40	0.0000000000000001
41	0.00000000000000005
42	0.00000000000000002
43	0.00000000000000001
44	0.000000000000000005
45	0.000000000000000002
46	0.000000000000000001
47	0.0000000000000000005
48	0.0000000000000000002
49	0.0000000000000000001
50	0.00000000000000000005
51	0.00000000000000000002
52	0.00000000000000000001
53	0.000000000000000000005
54	0.000000000000000000002
55	0.000000000000000000001
56	0.0000000000000000000005
57	0.0000000000000000000002
58	0.0000000000000000000001
59	0.00000000000000000000005
60	0.00000000000000000000002
61	0.00000000000000000000001
62	0.000000000000000000000005
63	0.000000000000000000000002
64	0.000000000000000000000001
65	0.0000000000000000000000005
66	0.0000000000000000000000002
67	0.0000000000000000000000001
68	0.00000000000000000000000005
69	0.00000000000000000000000002
70	0.00000000000000000000000001
71	0.000000000000000000000000005
72	0.000000000000000000000000002
73	0.000000000000000000000000001
74	0.0000000000000000000000000005
75	0.0000000000000000000000000002
76	0.0000000000000000000000000001
77	0.00000000000000000000000000005
78	0.00000000000000000000000000002
79	0.00000000000000000000000000001
80	0.000000000000000000000000000005
81	0.000000000000000000000000000002
82	0.000000000000000000000000000001
83	0.0000000000000000000000000000005
84	0.0000000000000000000000000000002
85	0.0000000000000000000000000000001
86	0.00000000000000000000000000000005
87	0.00000000000000000000000000000002
88	0.00000000000000000000000000000001
89	0.000000000000000000000000000000005
90	0.000000000000000000000000000000002
91	0.000000000000000000000000000000001
92	0.0000000000000000000000000000000005
93	0.0000000000000000000000000000000002
94	0.0000000000000000000000000000000001
95	0.00000000000000000000000000000000005
96	0.00000000000000000000000000000000002
97	0.00000000000000000000000000000000001
98	0.000000000000000000000000000000000005
99	0.000000000000000000000000000000000002
100	0.000000000000000000000000000000000001



6) NO GLA
WELD
SURFA

- NOTES:
1. FINISH: BA
 2. AFTER WEL
 3. FLANGE TH
 4. CONCENTRIC
 5. INNER LEAD



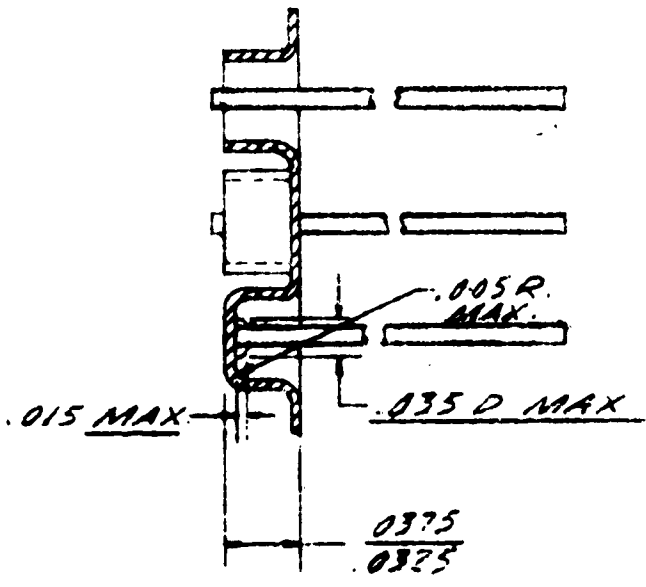
THIS PART TO BE REPLACED
BY B31-33127 P119 ON IM

CNGO-1834

MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL ± 1/64	DECIMAL ± .005	ANGULAR ± 0°-15'

NUMBERS IN SQUARE AND SHARP EDGES

6) NO GLASS LEATHER OR PARTICLES SHALL BE IN THE WELD AREA INCLUDING TOP & BOTTOM FLANGE SURFACES.



- REVISIONS
- A) .004 R MAX. WAS .003 R. NOM. 5.015 R. MAX WAS .003 R. NOM. PER ENG-1753 2 MAR 60
 - B) ADD "CLIP" TO GLASS ENG-2309 21 MAY 60
 - C) REMOVED "CLIP" FROM PEEK ENG-3671 21 SEP 60
 - D) NOTE ADDED (6) ENG-5220 1/24/61
 - E) REPLACEMENT No. ADDED ENG-253 1-19-61
 - F) FROM LEADS TO LEAD ENG-627 2-9-61
 - G) ADDED MEASURE ON SURFACE X ENG-1149 2-28-61

FINISH: BRIGHT DIP
 AFTER WELDING STEM TO CAP SEALS TO PASS
 X100 STD CC/SEC LEAK RATE
 LARGE THICKNESS OF ANY ONE PIECE MUST
 ALL WITHIN 3.0005 INCLUDING TAB
 CONCENTRICITY OF .207/.205 D F.260 D
 MUST BE .002 MAX. T.I.R.
 INNER LEADS TO BE SURFACE GROUND TO LENGTH

2

BE REPLACED
 P19 ON 1 MAY 61

0-1234

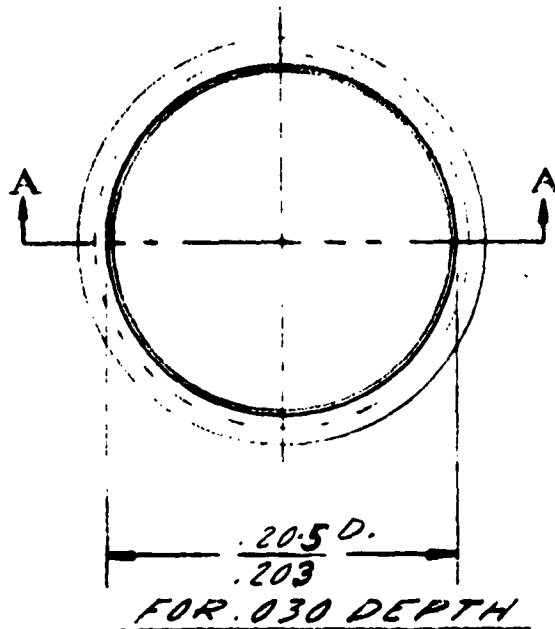
REV	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED	DATE	PART		
	DRAWN				
	SCALE				
SYLVANIA			ELEC. PROD., INC. SEMICONDUCTOR DIVISION	B31-33127-P11	

CLEAR

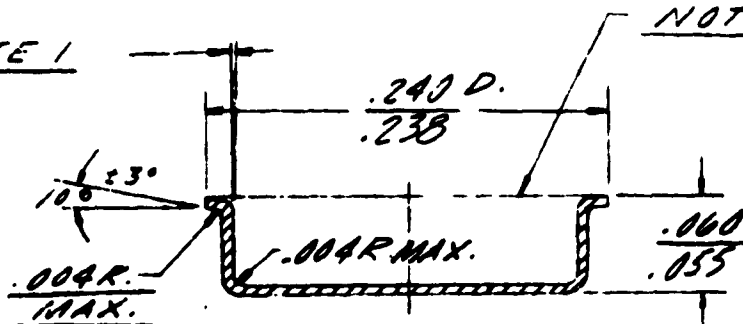
SYLVANIA

ELEC. PROD., INC.
SEMICONDUCTOR
DIVISION

B31-33127-P11



NOTE 1



NOTES

SECTION A-A

NOTES

1. 1° MAX TAPER INSIDE OF SHELL
2. BODY TO FLANGE ECCENTRICITY .002 MAX. T.I.R.
3. THICKNESS OF FLANGE MUST NOT VARY MORE THAN ±.0005
4. PART TO BE CLEANED BY FIRING IN A HYDROGEN ATMOSPHERE FURNACE AT 900°C FOR 20 MIN. KEEP ENTIRELY SURROUNDED BY GAS TO 200°C. PACK IN AIR-TIGHT CONTAINERS WHILE STILL AS HOT AS PRACTICABLE.
5. FLANGE TO BE FLAT WITHIN .001 WITH FACE FREE OF BURRS.

STW	205	202
18 APR 1961	203 WAS 202	
	CN61-2519	B
	4-10-61	
STW	205/203 WAS 205/203	A
	205-2200	
APPR'D	REVISIONS	STR

CN60-4304 MATERIAL: .008 1010 CRS, COPPER PLATED

ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF:

FRACTIONAL ± 1/64

DECIMAL ± .005

ANGULAR ± 1/2°

SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT - WOBURN

DRAWN DATE SCALE
WIT 11/10/60 10X

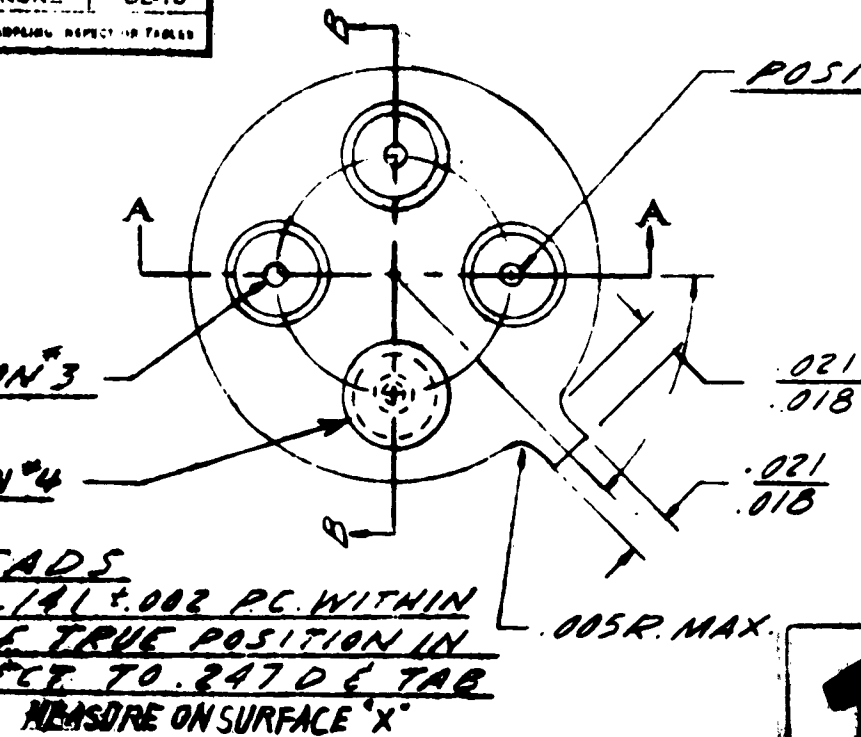
APP'D DESIGN DATE APP'D PROD. DATE

TITLE: - CAP -

SIZE CODE **A31** X33/24-P74 B

FIGURE 7

TOLERANCE LEGEND	
SYMBOL	SAMPLING PLAN
♦♦	DL-5
*	DL-7
NONE	DL-10
SAMPLING DEFECT OR FAILURE	

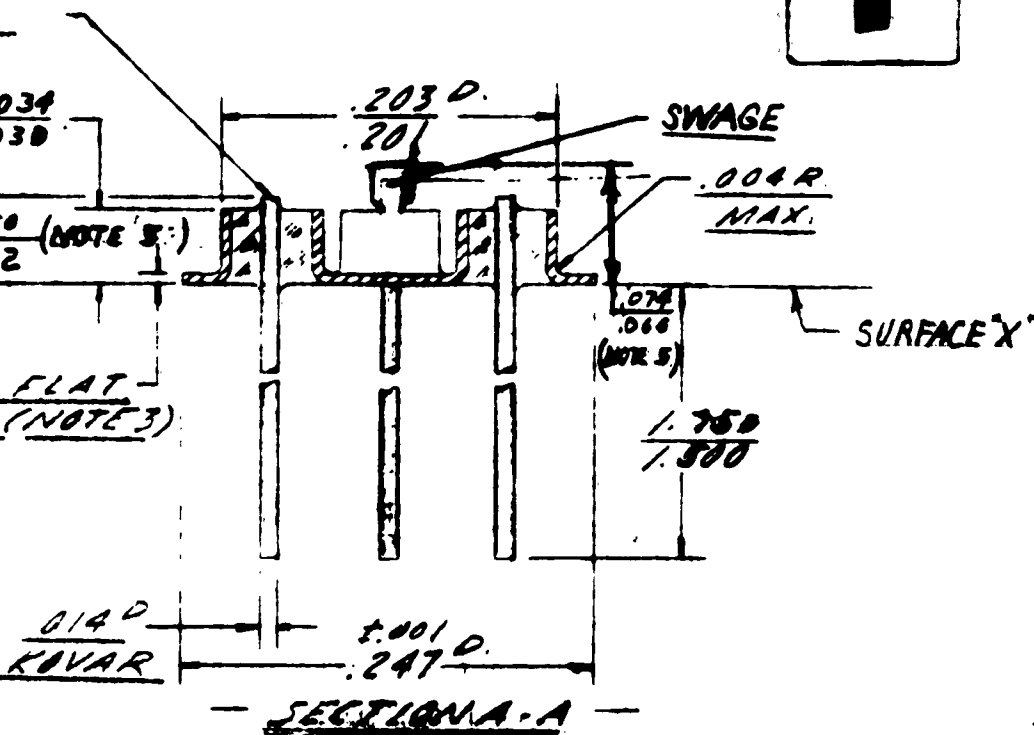


8. NO GLASS SP
WELD AREA

SURFACES

9. SURFACE 'X' TO BE
WITHIN .002

10. LEADS MUST MEET BEND TO
PER SYLVANIA SPEC: CON-108



NOTES:

- *1. FINISH: BR
- *2. AFTER WELD
1X10 TO STD
3. FLANGE THK
FALL WITHIN
- *4. CONCENTRIC
MUST BE .00
5. THE .050/.042 DIM. AN
6. WELDED LE
HEADED WIR
LEAD WELD
THAN .001, OR
7. MAX. TAPER
SIDES OF EYE
& EMBOSSES
BE 2°

CN60-4300

MACHINING TOLERANCE UNLESS OTHERWISE NOTED

FRACTIONAL $\pm 1/64$

DECIMAL $\pm .005$

ANGULAR $\pm 0^{\circ}15'$

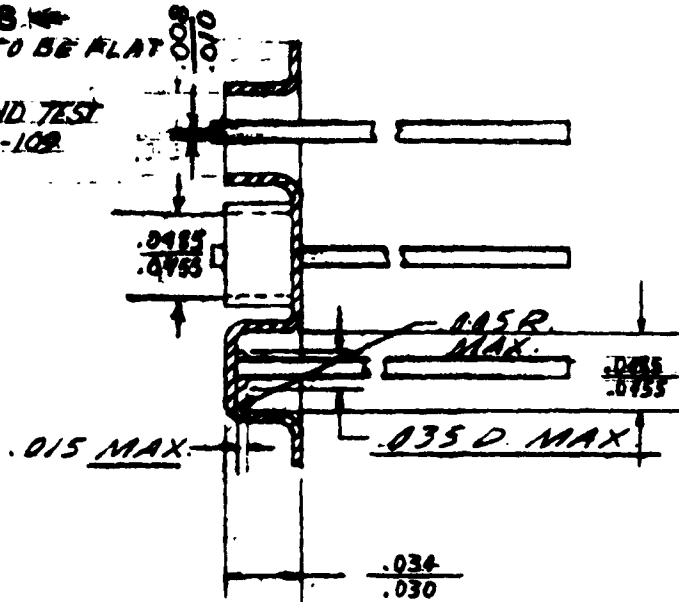
REMOVE ALL BURRS
AND SHARP EDGES

REVISIONS

- A) NO GLASS SPATTER ADDED
CNGO-5820 1/13-61
- B) ADDED MEASUREMENT SURFACE X
CNGI-1152 2-17-61
- C) REVISED PER CNGI-4414 7-19-61
- D) ADDED NOTE 58 DIM.
CNGI-4990 3-AUG-61
- E) ADDED NOTE 10
CNGI-5753 12 SEPT-61

NO GLASS SPATTER OR PARTICLES SHALL BE IN THE WELD AREA INCLUDING BOTH TOP & BOTTOM FLANGE SURFACES.

REFACE X TO BE FLAT
THIN .002
MEET BEND TEST
SPEC: CON-108



SECTION D-D

5. -
BRIGHT DIP
TER WELDING STEM TO CAP SEALS TO PASS
STD CC/SEC. OF AIR LEAK RATE.
THICKNESS OF ANY ONE PIECE MUST
BE WITHIN .0005 INCLUDING TAB.
CENTRICITY OF .203/.201 D. E.247 D.
BY .002 MAX. T.I.R.
EQ/042 DIM. APPLIES TO BONDLEADS 1 AND 3. THE .074/.066 DIM. APPLIES ONLY TO LEAD
ADDED LEAD MUST BE SPOT WELDED USING
WELD WIRE & THE SURFACE OPPOSITE THE
WELD SHOULD NOT BE DEFORMED MORE
1.001, OR VISIBLY DISFIGURED

2

DRAWING NO.	DATE	DESCRIPTION	NEXT ASSEMBLY
DESIGN		FINISH	
DESIGNED		HEAT TREAT	
APPROVAL	DATE	MATERIAL	COVAR OR EQUIV CORNING 7052 GLASS
DESIGN		EQUIV.	
DESIGNED		PART	HEADER (MM 2N309)
DESIGNED			
SCALE	10X	SYLVANIA	ELEC. PROD. INC. SEMICONDUCTOR DIVISION
			B31-331274119

4300 -

-42-

Eccobond 26 the parts adhered more quickly, and there was little difficulty in applying it only where needed. Mean value of capacitance using Eccobond was 1.8 pf; mean value using Laminac was 1.5 pf. SR 98 gave poor results in the first run and Eastman 910 cannot withstand temperatures greater than 83°C. Temperature cycle was performed on the first run by immersing units in boiling water, then in liquid nitrogen. After two cycles the units with SR 98 came apart. Of the units using Laminac, 25% remained intact; of the units using Eccobond 26, 50% remained intact; of the units using Eastman 910, 16% remained intact. In the second test, three of fifteen units with Laminac remained intact after two cycles. Twenty units out of twenty with Eccobond remained intact after two cycles and showed no defects under the microscope. Eccobond 26 was chosen. In devices, it readily passed thermal shock and cycle per MIL-S-19500.

For the first two quarters of the contract, attachment of the base tab to the base header lead was made by lead-tin soldering as had been originally planned. During the second quarter, it was found that this soldered connection failed in the 500 g. 1 msec shock test. A change was made to welded construction. The new process consisted of flattening the end of the base terminal with the terminal still vertical, and then bending the terminal and base tab down to allow the base tab to rest horizontally across the emboss in position four. Hermeticity tests showed that no damage had been done to the seals in the process of forming the base lead. The change from soldered to welded construction successfully eliminated shock and centrifuge failures.

III. 2. 2. 4 Hermeticity

Except for early difficulty in welding, no trouble was encountered with hermeticity during the entire contract period. Frequent samples were tested to a sensitivity of 1×10^{-11} std cc/sec. leak rate by the "Radiflo" method of leak detection. Of 1040 units tested between May and August 1961, 98.4% had leak rates less than 1×10^{-11} . Several JAN moisture tests were run with no failures.

III. 3 Task II Package - Silicon Mesa Transistor (2N696)

III. 3. 1 Design Considerations

In the "mesa" type of diffused transistor structure, the collector portion of the semiconductor die is usually bonded to a flat surface on the header, making the package electrically common with the collector. For this reason, a three-lead design was used, with emitter and base leads insulated from the case and the collector lead butt-welded to the outside of the case (See Figure 8).

III. 3. 2 Mounting Scheme

III. 3. 2. 1 Design

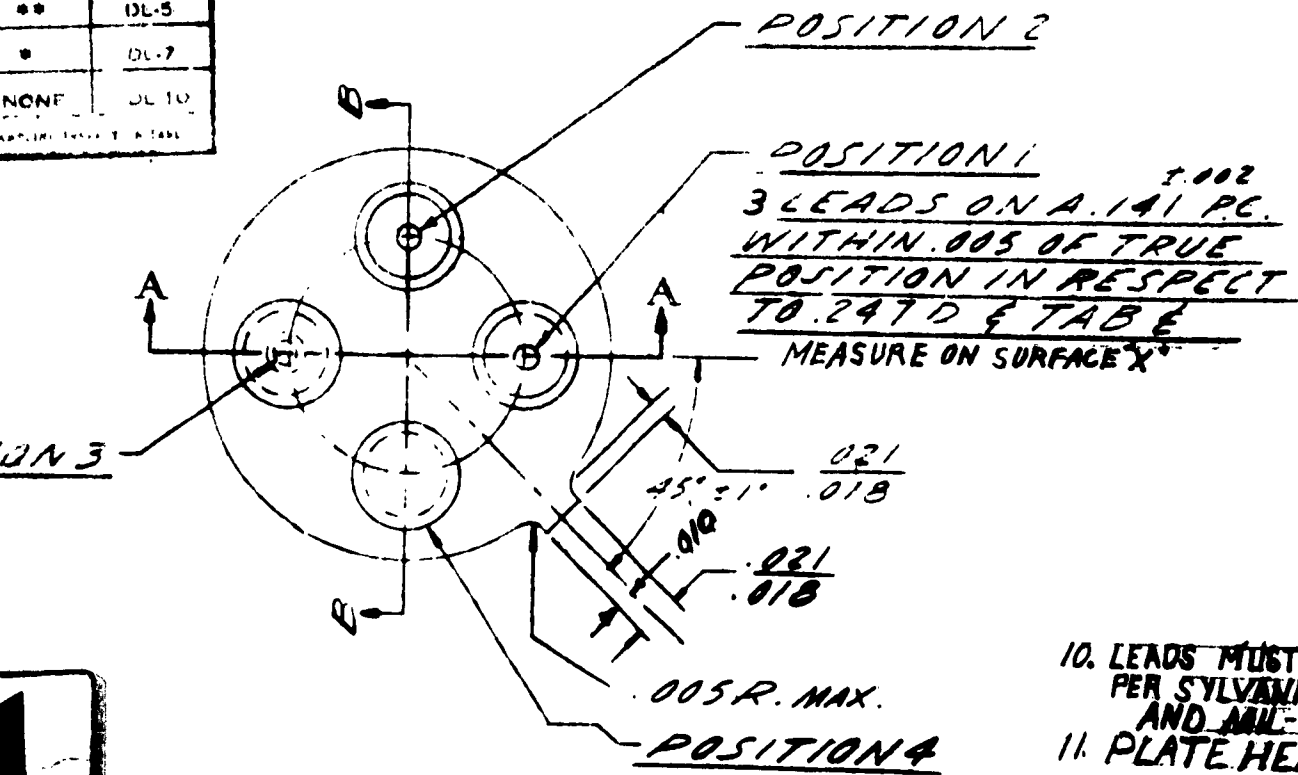
Initially, it was felt that the most straight-forward method of mounting the die in the package would be to bond or braze it directly to the stem assembly, either in the center (Figure 9) or between the emitter and base terminals. Because the die was to be mounted directly on the package, it was felt that the thermal impedance (junction to case) would be very low. However, mechanical problems were anticipated due to shorting of the bonding wires to the sides of the eyelets because the die would be so deep in the package. The length of the lead wires was also considered a possible trouble area because of the centrifuge requirement; and finally the restricted space was considered a detriment to lead bonding, since the bonding tool required maneuvering space.

For these reasons, another approach was considered. A solid disc or slug of metal was to be brazed, welded or soldered to the stem assembly between the eyelets as in Figure 10. The mesa die was then to be mounted on this "pedestal". Lead length and danger of shorting would be significantly reduced and bonding would be made easier, but it was feared that the thermal impedance would suffer. An approximate calculation of thermal impedance predicted $40^{\circ}\text{C}/\text{w}$ to $70^{\circ}\text{C}/\text{w}$ for the silicon mesa device in this package.

III. 3. 2. 2 Development

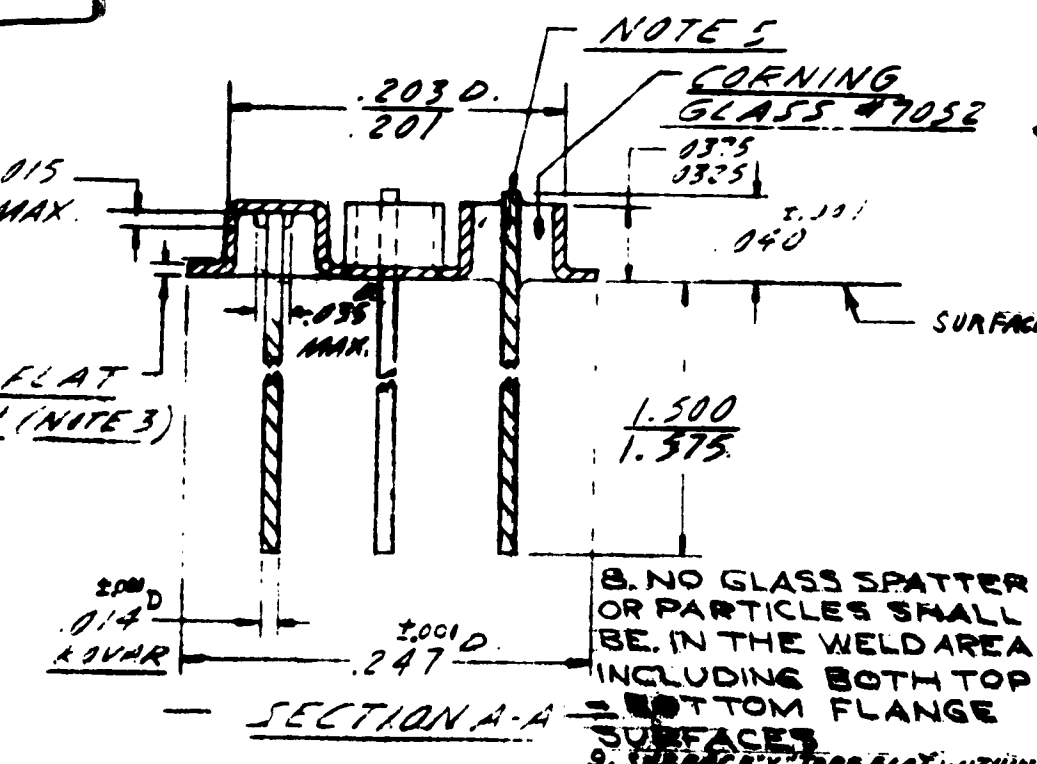
The first devices were made with no "pedestals", the die being mounted to the gold plating directly on the header. The anticipated difficulties were encountered. The space in the center was so small that thermocompression bonding to the emitter and base stripes was very difficult. The bonding wire was long and free to swing under mild shock.

ION LEGEND	
SYMBOL	SAMPLE # PLAN
••	DL-5
•	DL-7
NONE	DL-10



10. LEADS MUST MEET PER SYLVANIA SPEC. AND MIL-S-195
11. PLATE HEADER

- NOTES —
- *1. FINISH: A
 - **2. AFTER W PASS 1X10
 3. FLANGE TH FALL WITH
 - **4. CONCENTR MUST BE V
 5. INNER LEAD LENGTH.
 6. WELDED LE HEADED L
 - LEAD WELL THAN .001, OR VISIBLY DISF
 7. MAX. TAPER SIDES OF EYE
 - EMBOSSES BE 2°



SECTION A-A

9. SURFACE X TO BE FLAT WITHIN .002.
(SEE NOTE 10 ABOVE)

— CN 60-4307 —

MACHINING TOLERANCE UNLESS OTHERWISE NOTED

FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 0^\circ.15'$ REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

A) 500/575 WAF
500/530 PER
CN60-4553
17 NOV. 1960

B) REVISED PER
CN60-4685
18 NOV. 1960

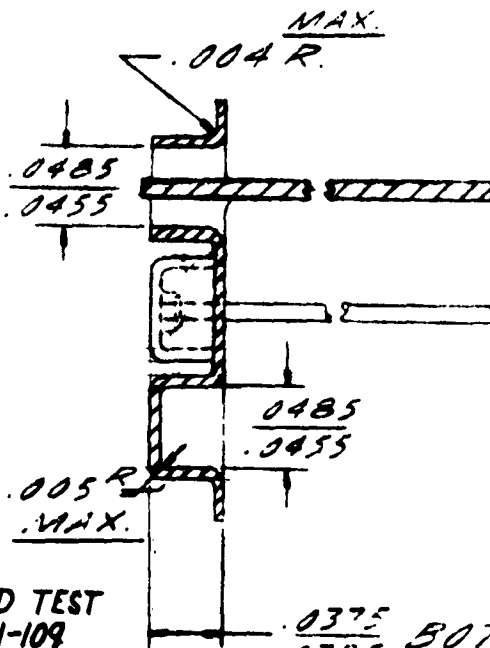
C) REVISED PER
CN60-5299
27 DEC 1960

D) NO GLASS
SPATTER ADD.
CN60-5280 1/24

E) ADDED MEASURE ON
SURFACE X
CN61-1154 2-27-61

F) REVISED PER CN61-
4417 7-19-61

G) CN61-5593 3/10/61
ADDED NOTE 10.



SECTION 9.5

MUST MEET BEND TEST
PENNSYLVANIA SPEC: CON-109
AUG-5-19500

HEADER PER CN61-33127P180

BOTH EMBOSSES MUST
BE WITHIN .002 IN
HEIGHT ON ANY
ONE PART

FINISH: BRIGHT DIP
AFTER WELDING STEM TO CAP SEALS TO
PASS 1X10 STD. CC/SEC. LEAK RATE.
MAXIMUM THICKNESS OF ANY ONE PIECE MUST
BE WITHIN $\pm .0005$ INCLUDING TAB.
ECCENTRICITY OF 203/201 D & 247 D
MUST BE WITHIN .002 T/R.
LEADERS TO BE SURFACE GROUND TO
LENGTH.

ADDED LEAD MUST BE SPOT WELDED USING
ADDED WIRE & THE SURFACE OPPOSITE THE
WELD SHOULD NOT BE DEFORMED MORE

.001, OR
ANY DISFIGURED.

TAPER OF
OF EYELETS
PASSES TO

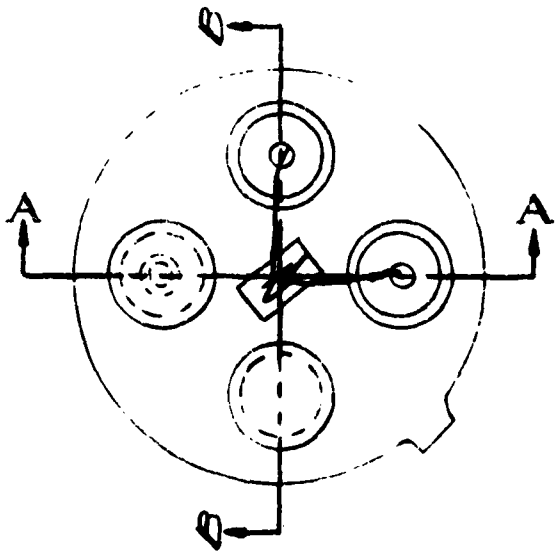
4307 -

NO.	DRAWING NO.	REV.	DESCRIPTION	REV.	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVAL	DATE	MATERIAL		(GLASS)
	DESIGN		EQUIP.		
	ENGINEER		PART		HEADER (MM 2N697) -
	STANDARD				
	SCALE	10x			

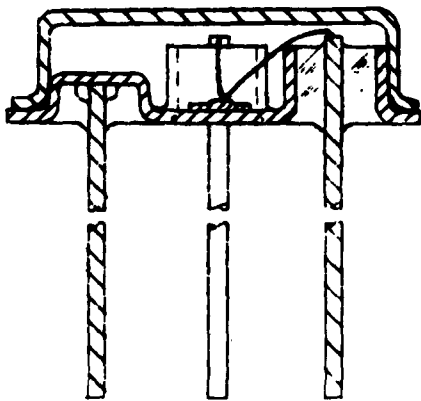
SYLVANIA

ELEC. PROD., INC.
SEMICONDUCTOR
DIVISION

B31- 33127P180



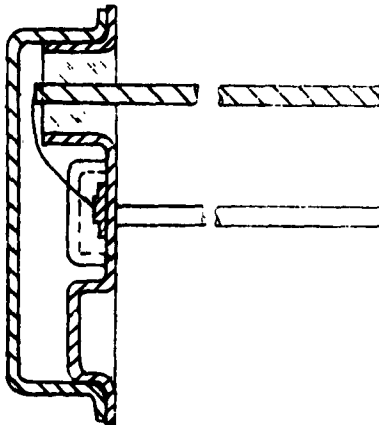
CAP REMOVED



1

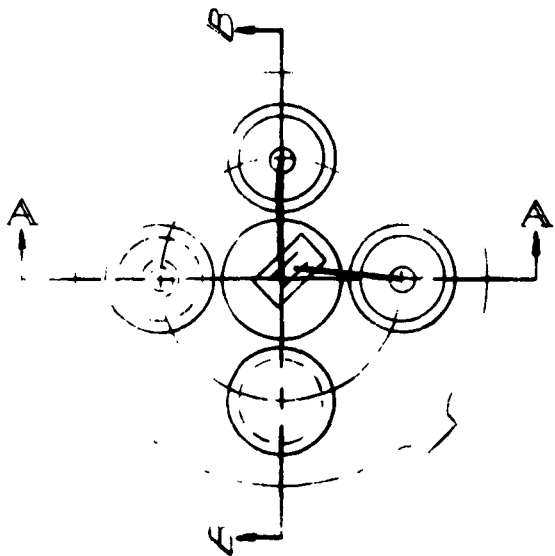
SECTION A-A

CN60-1935

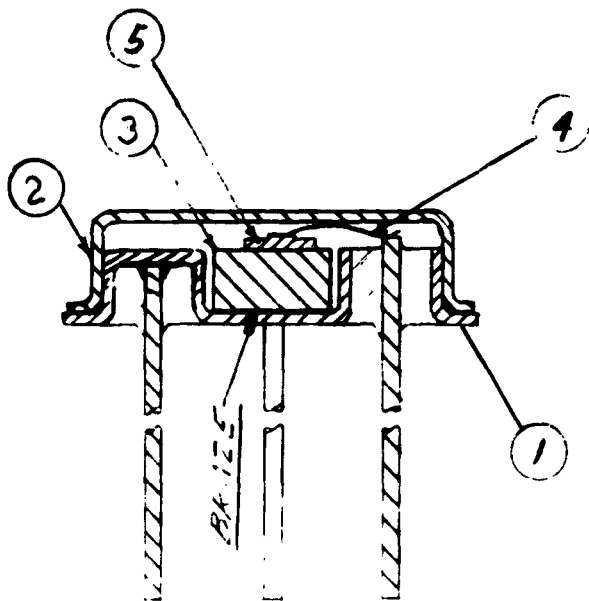
MACHINING TOLERANCE UNLESS OTHERWISE NOTED				REMOVE ALL BURRS AND SHARP EDGES.	
FRACTIONAL $\pm 1/64$		DECIMAL $\pm .005$		ANGULAR $\pm 0^{\circ}-15'$	
 SECTION B-B				REVISIONS	
REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED		PART	— ASSEMBLY —	
	DRAWN		SYLVANIA ELEC. PROD., INC. SEMICONDUCTOR DIVISION B31-S-1411P1		
	SCALE				

2

1935 —



LA - REMOVED



— NOTES —

1. PROCESS SPECIFIC

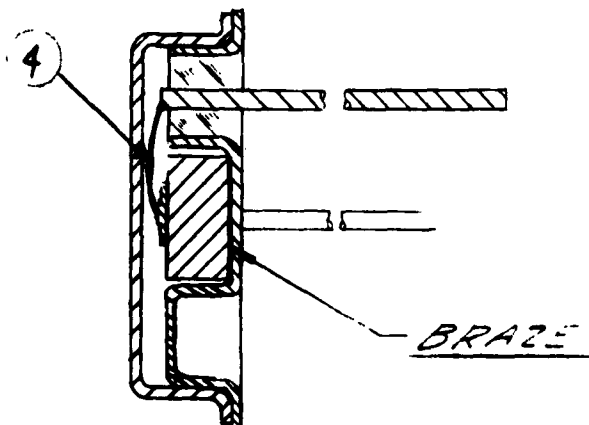
— SECTION A-A —

— CN60-1936 —

**REMOVE ALL BURRS
AND SHARP EDGES.**

ANGULAR $\pm 0^{\circ}-15'$

REVISIONS



SECTION 5

	TD43-2-P26	1	THERM COMP BOND		
	TD43-2-P26	1	HEADER MOUNTING		
	F-30	1	BRAZING OPERATION		
1	A31-4253P140		SILICON MESA PELLET		5
2	PR 142		WIRE		4
1	A31-6105 P3B		PEDESTAL		3
1	A31-X33124P74		CAP		2
1	B31-33127P180		PLATE/HEADER		1

2

SPECIFICATION

REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
MODEL NO.	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED	12 MAY 1962	PART — ASSEMBLY —		
	DRAWN	13 MAY 1962			
	W. Stacey				
	SCALE				
		SYLVANIA ELEC. PROD., INC. SEMICONDUCTOR DIVISION		B31-S-14, 1P2	

2-1936 —

Also, because of the roughness of the header due to draw marks in the metal, the yield was very low. It was therefore decided that a mounting platform ("pedestal") of a high thermal conductivity material would be used.

Copper Pedestal

The first, natural choice of materials was OFHC copper, to be used for its high thermal conductivity and brazability. The copper pedestals were brazed to the headers in a "pusher" type furnace, a CI Hayes Electric Furnace Type BA 43, using Handy and Harman Easy-Flo #45 silver solder as a braze material. This material contains copper, silver, zinc and cadmium in the proportions 14, 45, 16, 24. The brazing specification is outlined in Figure 11, and the brazing fixtures are shown in Figure 12 and 13. Copper pedestals were unsatisfactory due to dissimilar expansion causing the dice to crack and a tendency to increase leakage currents in silicon devices.

Molybdenum Pedestals

Molybdenum pedestals were procured and tried. The parts were brazed in the same manner as with the copper. Molybdenum pedestals with a flash plate of copper (for good braze wetting) were first used, but even this small amount of copper under the die affected electrical characteristics enough to make it undesirable. Next, copper flashed pedestals from which the copper on the top side (the side on which the unit was mounted) was sanded off were tried, but the gold plate (plated after brazing) blistered and bubbled upon subsequent heating because of poor adhesion to the molybdenum. At this time, it was found that the braze material would wet the molybdenum even if it were not plated with copper and a sample of unplated molybdenum pedestals was brazed to unplated headers. Braze flow and wetting were excellent, but the gold plate applied after brazing blistered because of the difficulty of depositing an adherent plate of molybdenum.

Gold Plating

Two methods of surface preparation are commonly used for gold plating of molybdenum: Copper flash preplate and vapor blasting. The first is unusable in this situation. The second presents a difficulty. Vapor blasting of a part containing a glass-to-metal seal, especially a short seal length tends to weaken or destroy the hermetic seal. Therefore, it was necessary to vapor blast the moly pedestal, gold plate it, and then mount it on the header. The whole assembly was then gold plated. This approach worked with reasonable success but a less expensive procedure was desired.

FIGURE 11

SYLVANIA ELECTRIC PRODUCTS INC. SEMICONDUCTOR DIVISION PLANT <u>WOBURN</u>		TITLE BRAZING OPERATION PANCAKE SILICON MESA	NO. <u>F-30</u> SHEET <u>1</u> OF <u>1</u> WRITER <u>L. H. Epstein</u> DATE ISSUED: <u>12 Oct. 60</u>	REV.
---	--	--	--	------

REVISION & CN CN61-148 STM 12 Oct. 60	IN FURNACE #2 IN THE FURNACE ROOM, USING A DRY HYDROGEN ATMOSPHERE, SUBJECT THE LOADED STAINLESS MESH BASKETS FROM PRE-BRAZING ASSEMBLY TO THE FOLLOWING HEATING CYCLE: PREHEAT: 5 MIN. AT APPROXIMATELY 300°C HEAT: 8 MIN. AT 800°C. FOR SILICON MESA (MOLYBDENUM SLUGS) COOL: 15 MIN. IN EACH COOLING ZONE
---	---

COPIES TO <u>BB</u>	
---------------------	--

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.
FRACTIONAL ± 1/64	DECIMAL ± .005	ANGULAR ± 0°-15'	
ENTIRE LENGTH OF PIECE 0.23 ± .001 X 3/16 DR. MILL SLOTS 100 HOLES 1750. DRILL THRU C. BORE 264 D. ± .001 X 3/16 DR.			
REVISIONS MATERIAL OXIDIZED STAINLESS STEEL PER CND - 4439			REQ'D EQUIPMENT PART PAIRCE MESH PACKAGE BOIT
DES. APPR'D PROD. APPR'D DRAWN W. HARRY CHECKED			REMARKS
MODEL No. REFERENCE			MAT'L LIST ITEM
DATE: 10/1/51 SIZE			ITEM
PER CND - 4439			ITEM
OXIDIZED STAINLESS STEEL			ITEM
DES. APPR'D			ITEM
PROD. APPR'D			ITEM
REFERENCE			ITEM
MODEL No.			ITEM

FIGURE 13

MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.	
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^{\circ}-15'$		
REVISIONS MATERIAL OXIDIZED STAINLESS STEEL PER CNGO-4439		MODEL No. REFERENCE DES. APPR'D PROD. APPR'D DRAWN W. J. H. <i>W. J. H.</i> CHECKED		
EQUIPMENT PANCAKE MESA PACKAGE		REQ'D LIST DWG. NO. ITEM MAT'L LIST REMARKS		
PART --- WEIGHT ---		DATE 11.10.63 SIZE 10X SYLVANIA ELEC. PROD. INC. SEMICONDUCTOR DIVISION		
A31-41468-1				

Powder Metal Molybdenum Pedestals

During the second quarter, the possibility of making the pedestals by powder metallurgy, rather than the then current method of stamping them out of sheet was investigated. It was felt that the powder metal pedestals would have several advantages. Since the surface was rougher, plating might be more adherent and elimination of the two-step plating process seemed a distinct possibility. Also, because of the rough surface, it was felt that the pedestals might be welded rather than brazed to the headers. Finally, it was expected that powder metal pedestals would be less expensive.

In practice, plating did show a definite improvement and the pedestals proved to be weldable to the header. Moly has too high a melting point to make a true weld; the joint produced is a very good nickel braze, the nickel being supplied by the nickel-rich, bright-dipped kovar surface. The powder-metal pedestals brought on three new problems. When the pedestals were welded to the headers after glass sealing, the welding shock cracked the glass. When the pedestals were welded to the stampings before glass sealing, they would turn black in the bright-dip that took place after sealing. Finally, the pedestals were only 96% dense, and their porosity allowed undesirable entrapments to be sealed within the transistor package.

Final Choice Pedestal

The final process consisted of B-T brazing of stamped molybdenum pedestals and two-shot gold plating.

Thermal Impedance

Measurement of thermal impedance on finished devices showed that, contrary to expectations, the units made with molybdenum pedestals had lower thermal impedance than those made without pedestals. The heat-spreading effect of the molybdenum pedestal had been greater than anticipated.

III. 3. 3 Seals and Welding

In the early part of the development, package parts received from the vendor did not conform to the print as described in Section III. 2. 2. 1.

An attempt was then made to remedy the defects in the stampings, and the changes, while solving the original problems, caused weak seals which leaked after the thermal shock of header mounting. The seals

were strengthened and the die mounting temperature curve was modified. The result of these changes was a drop in shrinkage due to leaks from 50-75% to 10-15%. An attempt to reduce this shrinkage by welding the moly pedestal into the package rather than brazing it in (brazing was done in hydrogen, and the oxide seal was reduced) failed for the reasons described in paragraph III. 3. 2. 2. Closer control of the brazing process and gradual improvements in seal quality and header mounting technique brought about a seal shrinkage rate of less than three percent.

III. 3. 4 Hermeticity

Radiflo and JAN moisture testing on 55 samples of finished devices showed one unit in 55 with a leak rate greater than 1×10^{-11} std cc/sec. This leak was 5×10^{-7} , less than that detectable by JAN moisture test. No failures occurred on JAN moisture test.

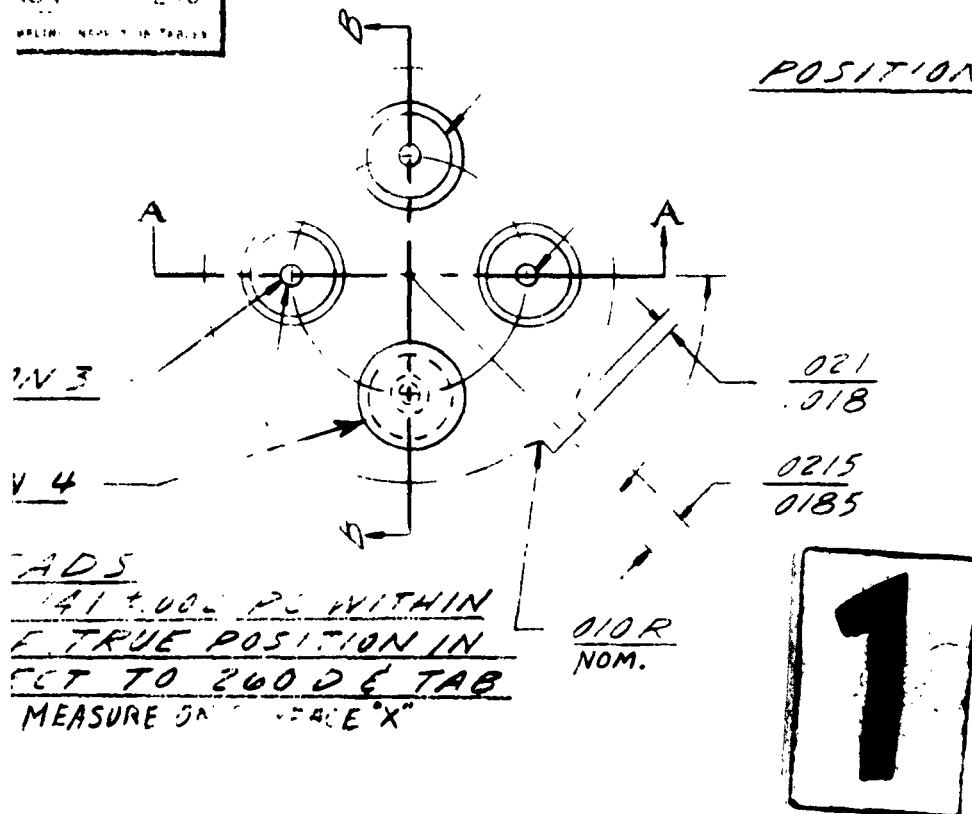
III. 4. Conclusion:

The Sylvania "Pancake" package was adapted to contain both Drift Field Germanium transistors and Silicon Mesa transistors. Leak rate of packaged devices is less than 1×10^{-11} std cc/sec. by Radiflo test on better than 98% of the completed devices. Packages readily meet the requirement of the contract to "equal or exceed" hermeticity requirements of MIL-S-19500/A. Both packages are within the limits of .070" high and .250" diameter.

APPENDIX A

6) SURFACES

POSITION,



0375
0325

207 D
205

BURNING
GLASS #7052

.004 R
MAX.

— SURFACE 'X'

FLAT -
(NOTE 3)

1.750
1.500

— NOTES: —

- *1. FINISH: BRIG
- **2. AFTER WELD
1X10-10 STD
3. FLANGE THICK
FALL WITHIN
- **4. CONCENTRICIT
MUST BE .002
5. INNER LEADS

THIS PART TO BE REPLACE
BY B31-33127 P119 ON 1MA

— CN'60 - 1234 —

— SECTION A-A —

MACHINING TOLERANCE UNLESS OTHERWISE NOTED

FRACTIONAL $\pm 1/64$

DECIMAL $\pm .005$

ANGULAR $\pm 0^\circ-15'$

REMOVE ALL BURRS
AND SHARP EDGES.

REVISIONS

A) .004R MAX.
WAS .003R.
NOM F.005R
MAX WAS .003R
NOM PER
CN60-1753
2 MAY 60

B) R13 "CLEAR" TO GLASS
CN60-2500 21 MAY 60

C) REMOVED X ROOM PART #
CN60-3691 21 SEP 1960

D) NOTE ADDED (6)
CN60-5220
1/12/61

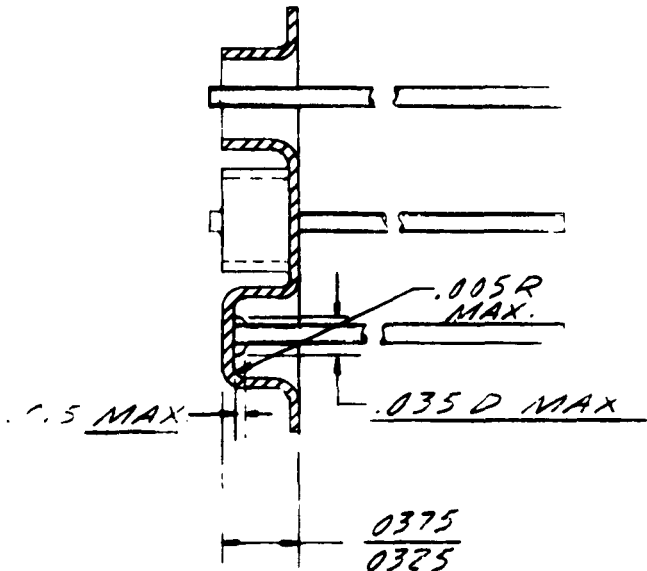
E) REPLACEMENT
NO. ADDED
CN61-253 1-19-61

F) FROM 2 LEADS TO 4 LEADS
CN61-6-7 2-29-61

G) ADDED MEASUREMENT ON
SURFACE X
CN61-1149 2-29-61

FLAT PART OF C A BE IN THE
BOTTOM FLANGE

SURFACES.



CS: —
FINISH: BRIGHT DIP
TER WELDING STEM TO CAP SEALS TO PASS
10-10 STD CC/SEC. LEAK RATE
THICKNESS OF ANY ONE PIECE MUST
BE WITHIN $\pm .0005$ INCLUDING TAB
CENTRICITY OF .207/.205 D F.260 D
ST BE .002 MAX. T.I.R.
VER LEADS TO BE SURFACE GROUND TO LENGTH

2

REQ.	DRAWING NO.	NOTE	DESCRIPTION	ITEM	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVALS	DATE	MATERIAL		(CLEAR)
	DESIGN		EQUIP.		
	CHECKED	DATE	PART		
	DRAWN				
	SCALE				

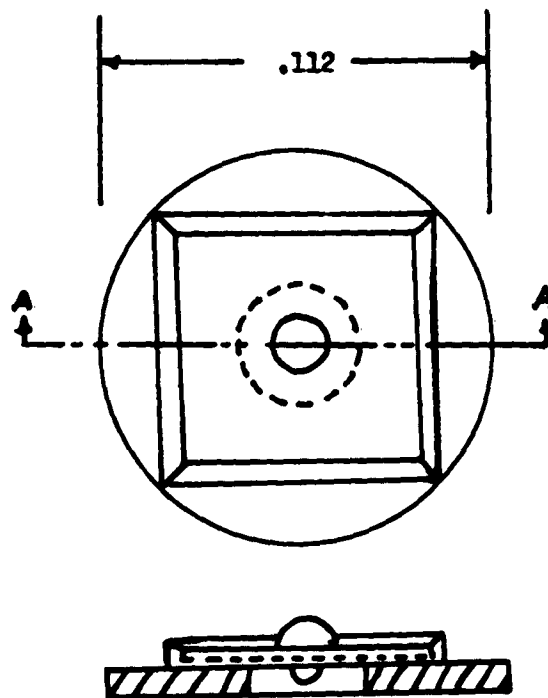
REPLACED
19 ON 1 MAY 61

1234

SYLVANIA ELEC. PROD., INC.
SEMICONDUCTOR
DIVISION

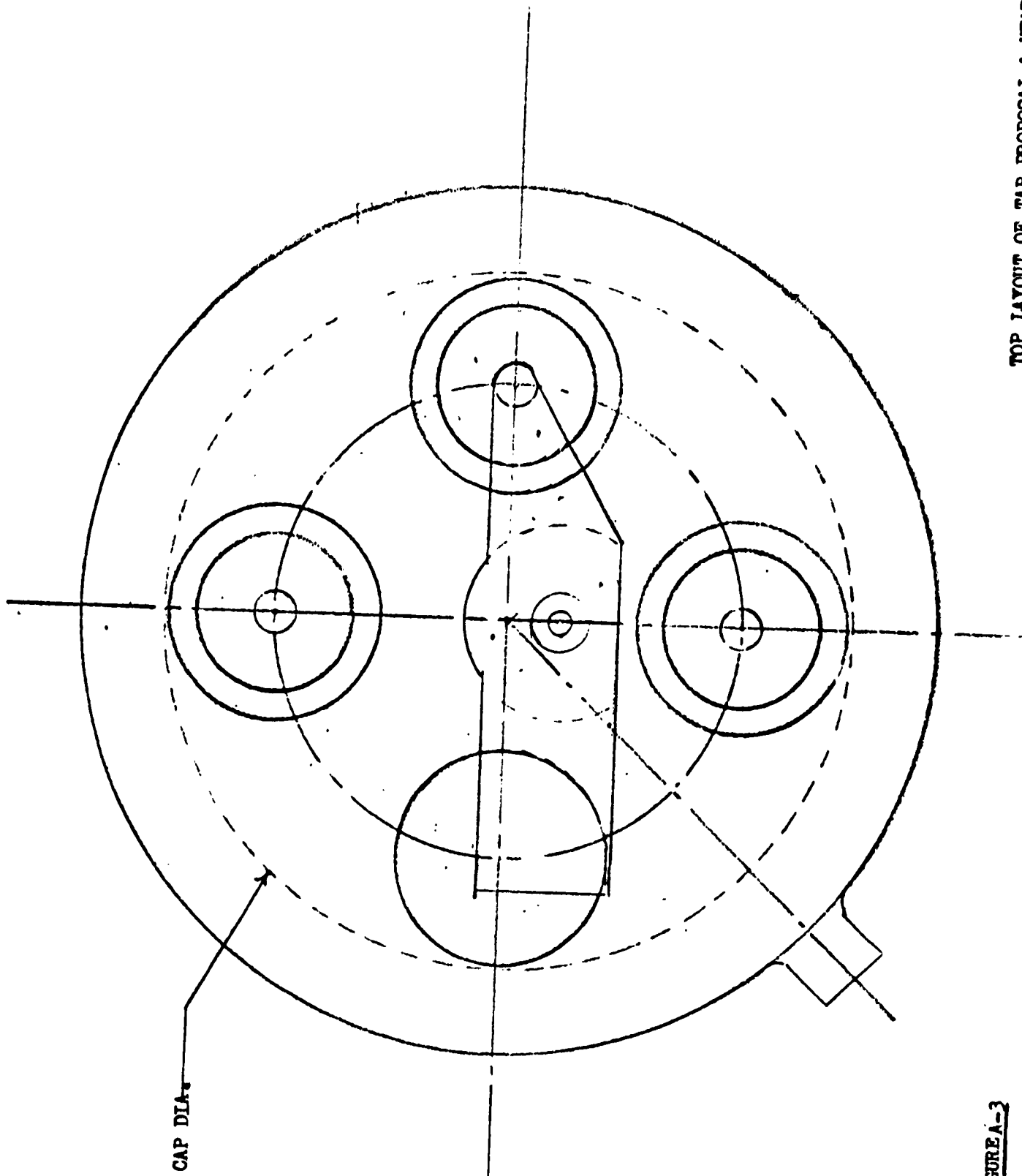
B31-114

FIGURE A-2



Section AA

ALLOY SUBASSEMBLY



CAP DIA.

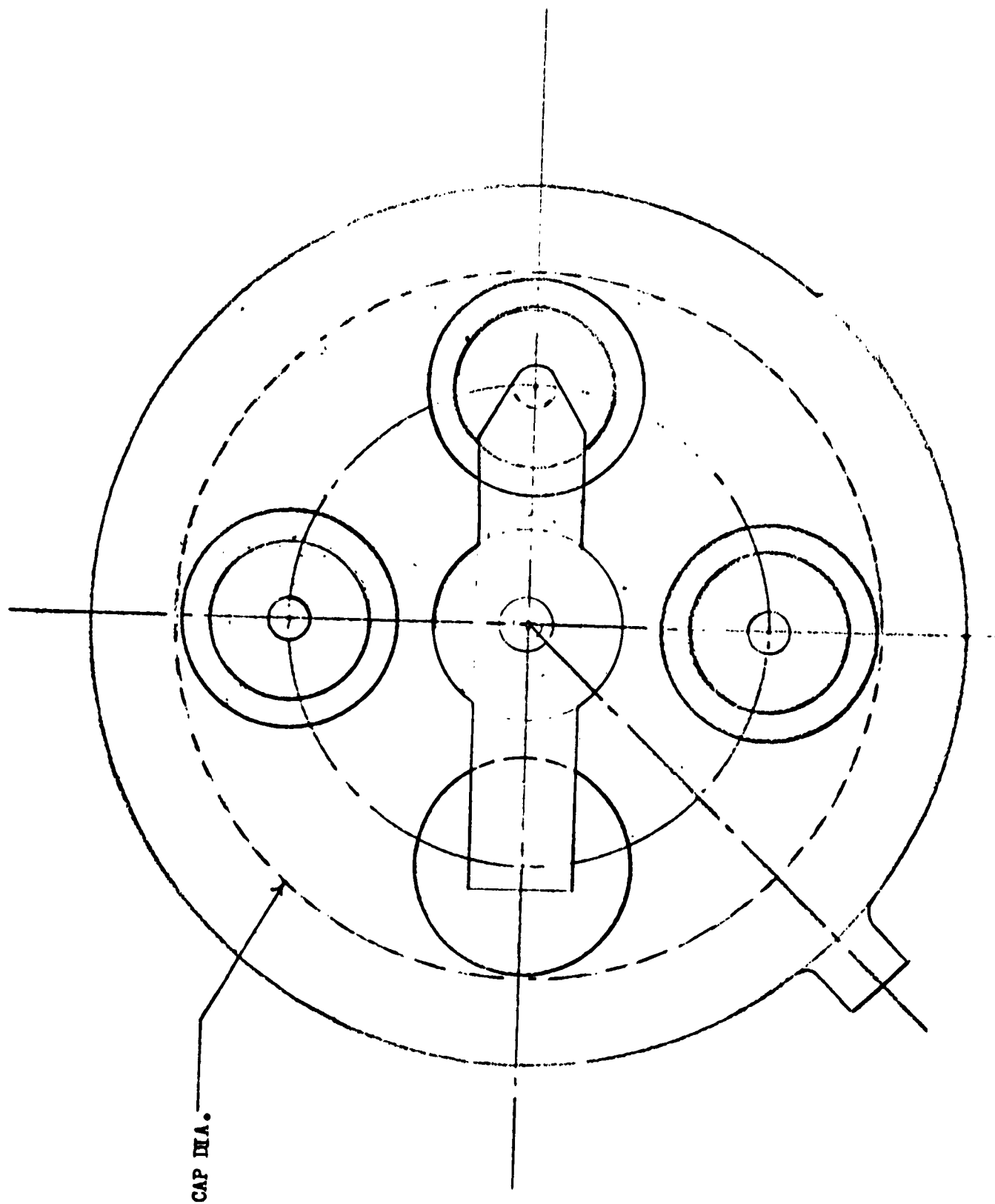
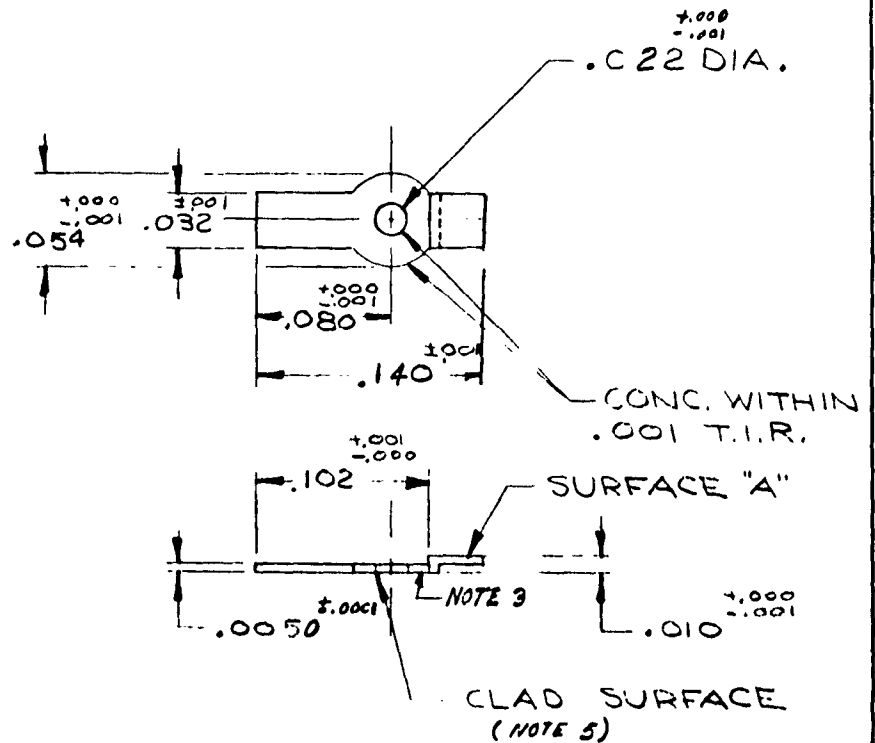


FIGURE A-4

TOP LAYOUT OF TAB PROPOSAL & HEADDEF "D"

FIGURE 26



NOTES:

1. SURFACE "A" TO BE FLAT WITHIN .0005
2. MAX BURR IN HOLE TO BE .001 MAX.
3. THIS SURFACE TO BE FREE FROM BURRS.
4. TAB TO BE FREE OF WRINKLES AND TOOL MARKS
5. 60/40 TIN-LEAD CLAD, .0005^{+.0002}/_{-.0003} THICK ON ONE SIDE.

COPIES
TO

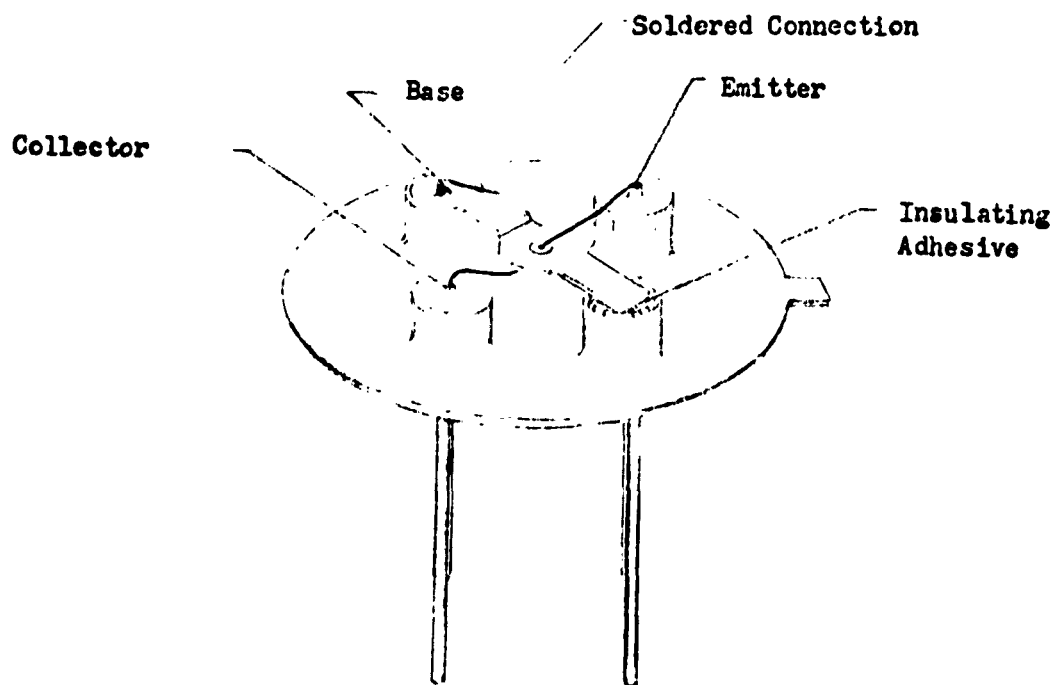
D-1

60	CN 61-5878	B
18547	26 SLP 7 6'	
61	CN 61-5878	A
20	110 WNS .160 LEO.	
APPR'D	REVISIONS	LTR.
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$		

MATERIAL: GRADE A NICKEL .0050^{+.0001}/_{-.0001} THK.

SYLVANIA ELECTRIC PRODUCTS, INC.		DRAWN	DATE	SCALE
SEMICONDUCTOR DIVISION		BEAYMAN	1/13/64	10:1
PLANT-WOBURN		APP'D DESIGN	DATE	APP'D PROD. DATE
TITLE:		SIZE CODE	REV. LTR.	
TAB		A31	33514P68	B

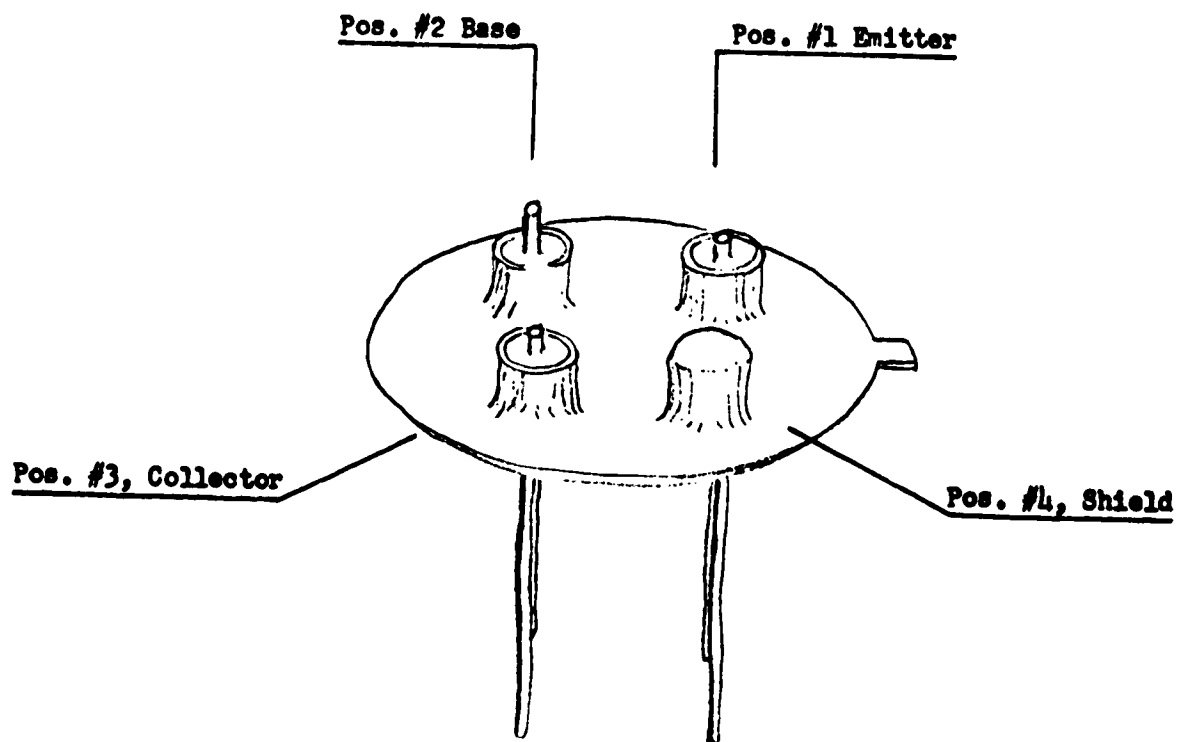
FIGURE A-7



GENERAL INTERNAL CONSTRUCTION OF
MICROMINIATURE DRIFT FIELD DEVICE

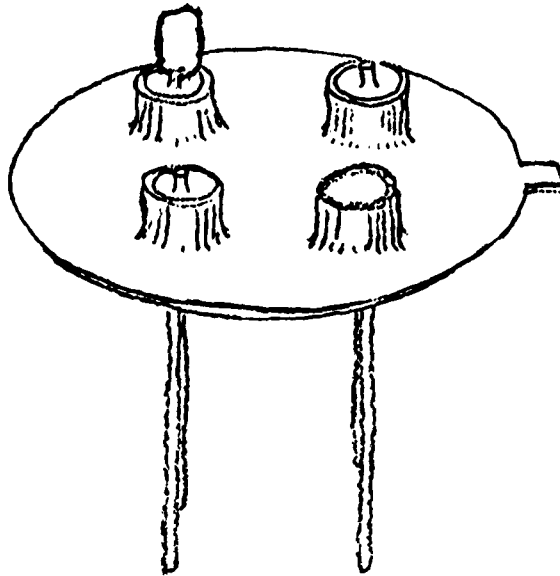
APPENDIX B

HEADER AS SUPPLIED BY VENDOR



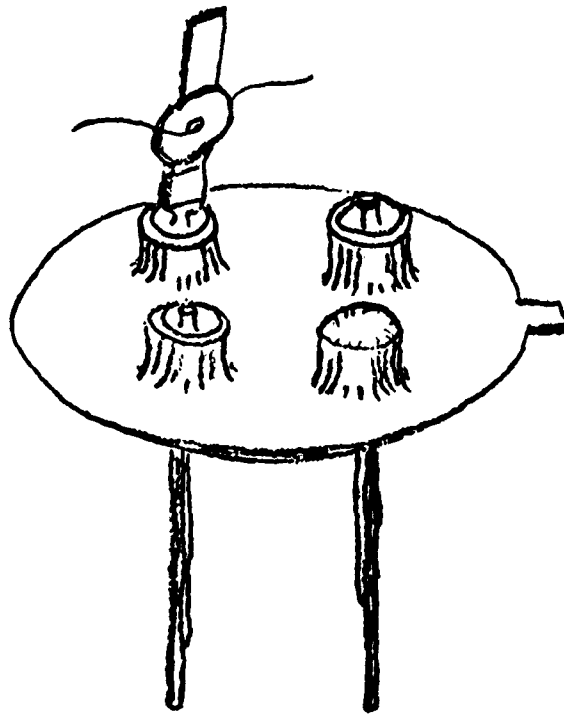
MICROMINIATURE DRIFT FIELD, FIGURE # B-1

HEADER WITH SECONDARY OPERATION
OF LEAD CUTTING & FLATTENING



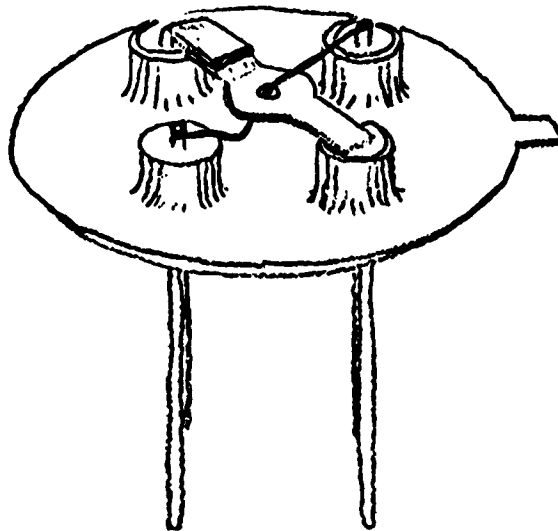
MICROMINIATURE DRIFT FIELD, FIGURE # B-2

ALLOYED SUBASSEMBLY WELDED TO HEADER



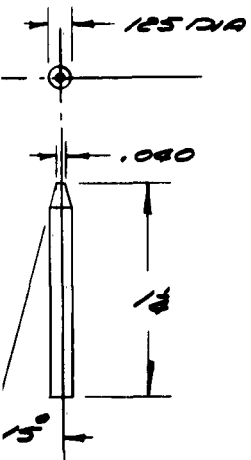
MICROMINIATURE DRIFT FIELD, FIGURE # B-3

WELDED AND ADJUSTED DEVICE & HEADER ASSEMBLY

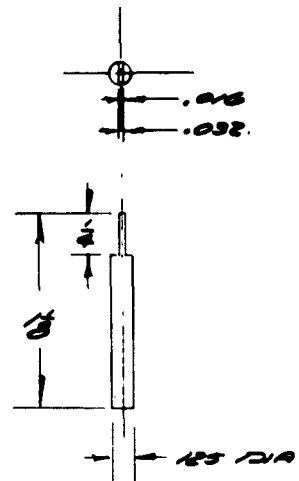


MICROMINIATURE DRIFT FIELD, FIGURE # B-4

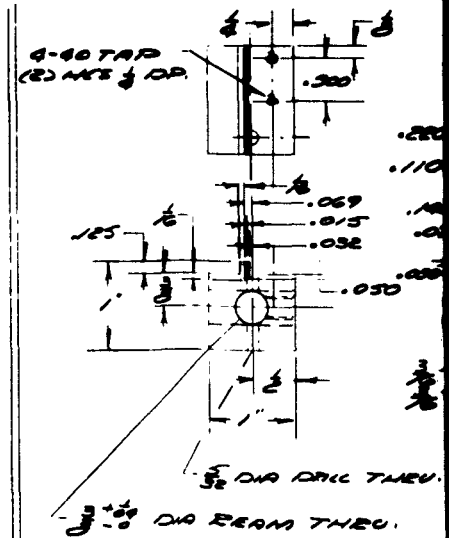
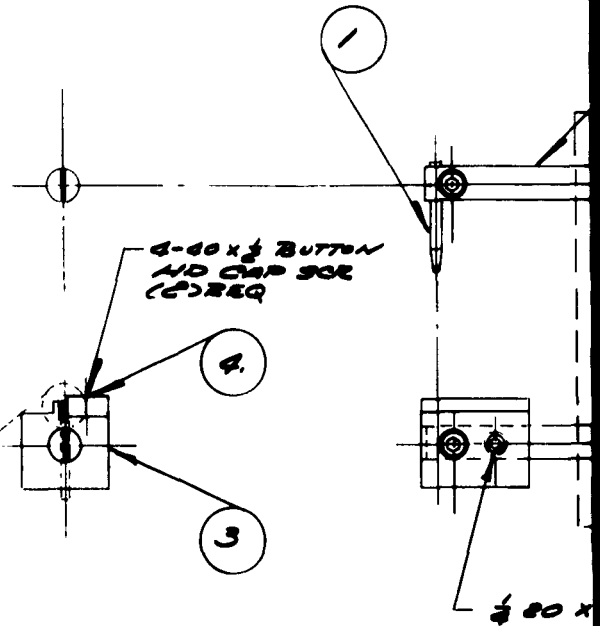
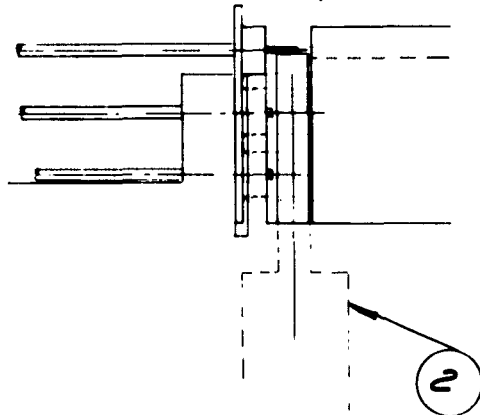
MAT ZIRTUNG
(1) REQ.



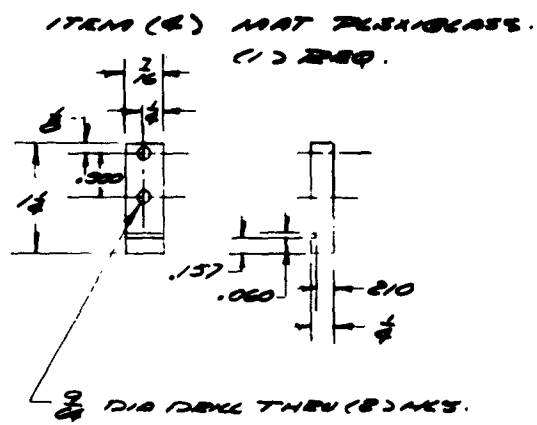
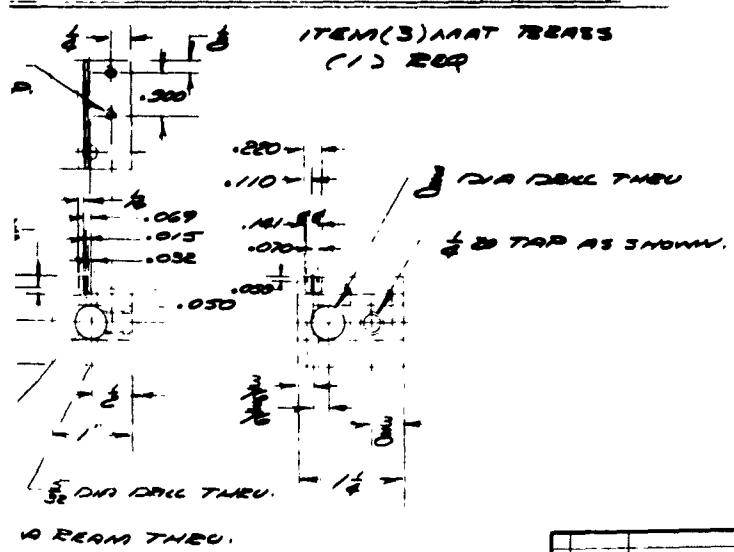
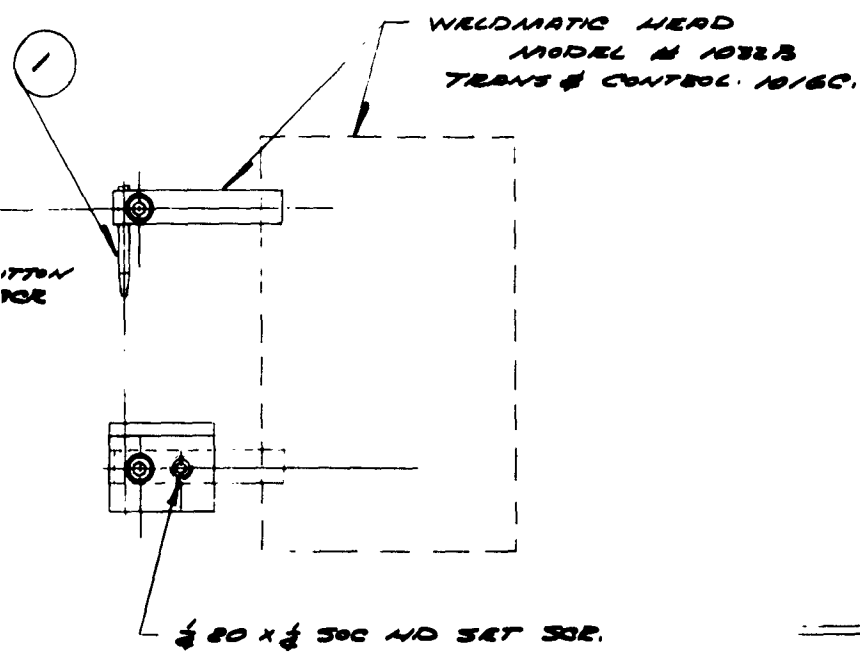
MAT ZIRTUNG
(1) REQ.



SIZE 10X.



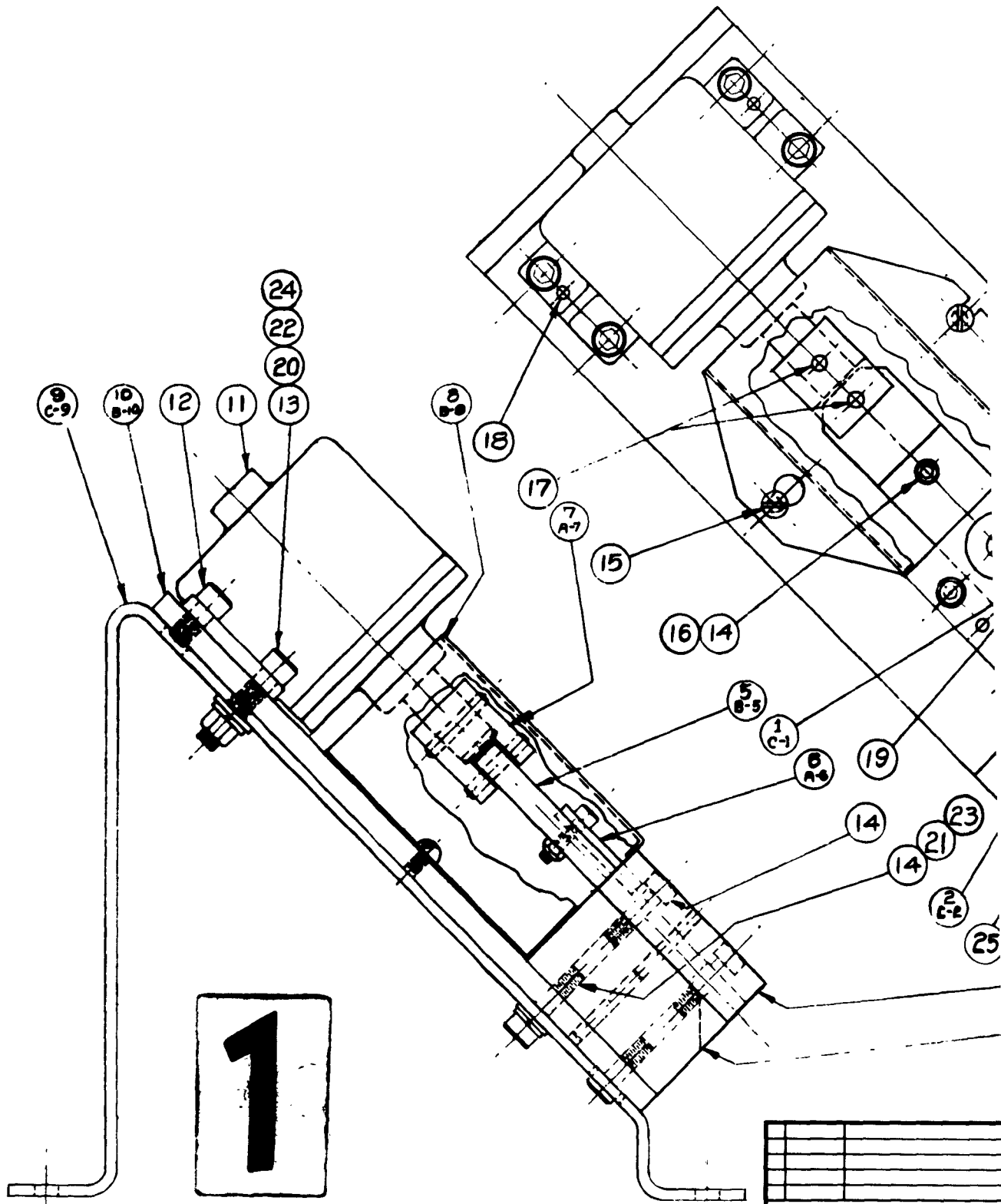
MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.
FRACTIONAL ± 1/64	DECIMAL ± .005	ANGULAR ± 0°-15'	



MODEL NO		REFERENCE		DES APP'D		REQ'D		LIST DWS NO		ITEM		MAY'L LIST		REMARKS	
REVISED		MATERIAL		PROD APP'D		EQUIPMENT		PART		DATE		SIZE		SYLVANIA	
DRAWN		BY		CHECKED		DATE		ELEC. PROD. INC.		SEMICONDUCTOR		DIVISION		D 3141695-A1	

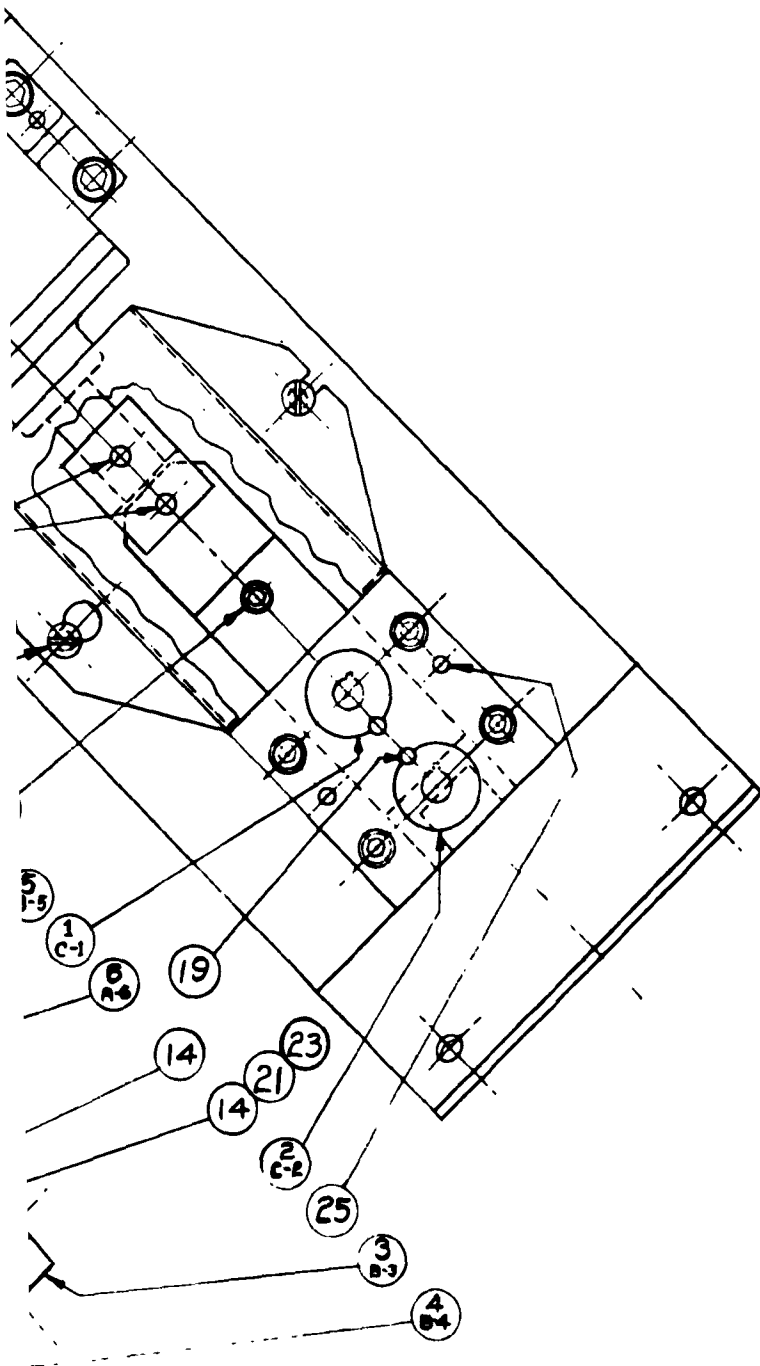
FIGURE B-6

MARK DRAWING NO
ON PART



REVISIONS	
MATERIAL	

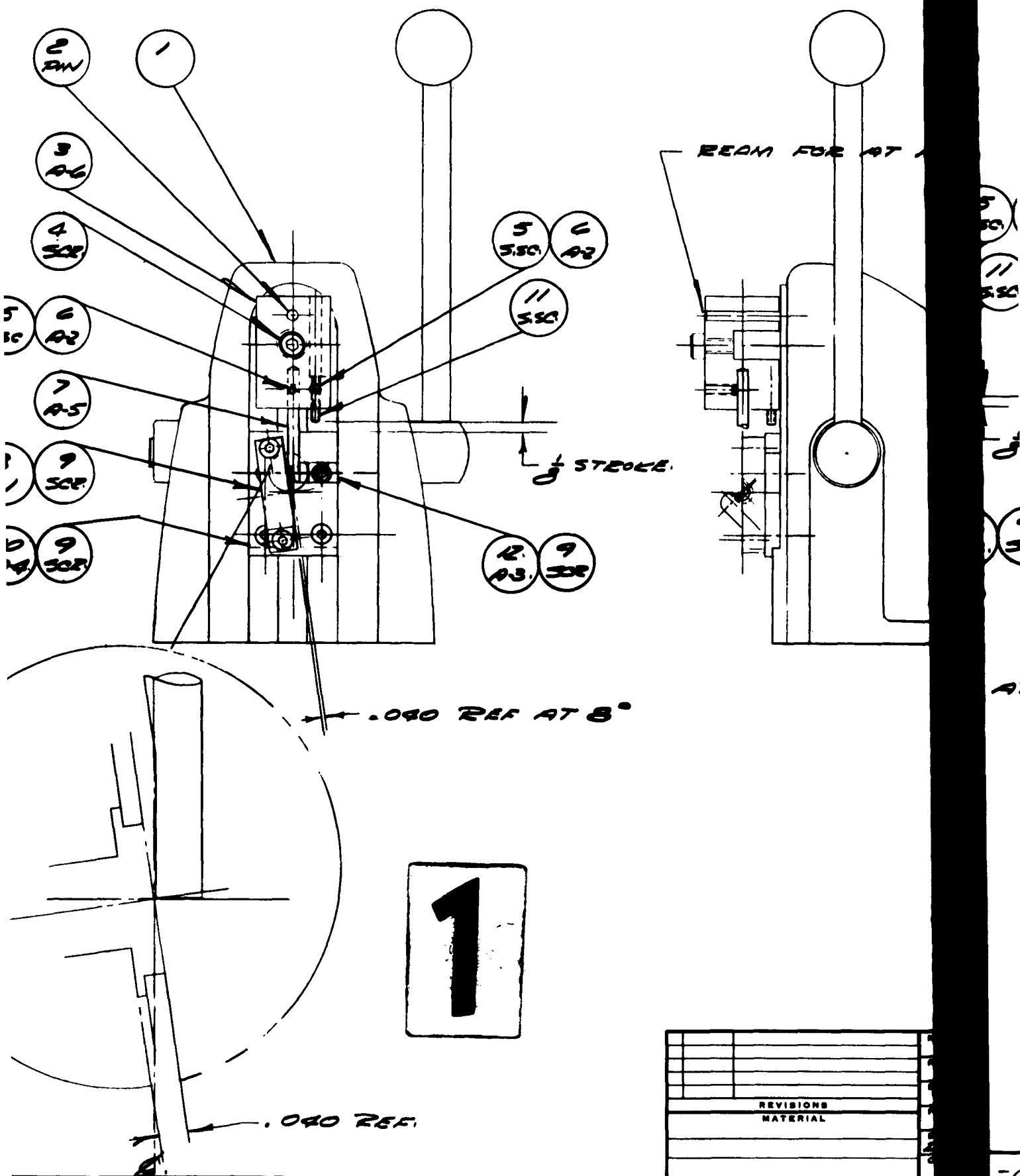
MACHINING TOLERANCE UNLESS OTHERWISE NOTED			REMOVE ALL BURRS AND SHARP EDGES.
FRACTIONAL $\pm 1/64$	DECIMAL $\pm .005$	ANGULAR $\pm 0^{\circ}-15'$	



MODEL No.							
REFERENCE							
DES. APPR'D				YI			
PROD. APPR'D		REQ'D	LIST DWG. NO.	ITEM	NAT'L LIST	REMARKS	
REVISIONS		EQUIPMENT DRIFT FIELD PANCAKE PK'G.					
MATERIAL		PART CUT-OFF & SWAGE TOOL ASSEMB.					
DRAWN		FULL SIZE		SYLVANIA		ELEC. PROD. INC. SEMICONDUCTOR DIVISION	
CHECKED		DATE:		C31-43505-A1			

2

FIGURE B-7

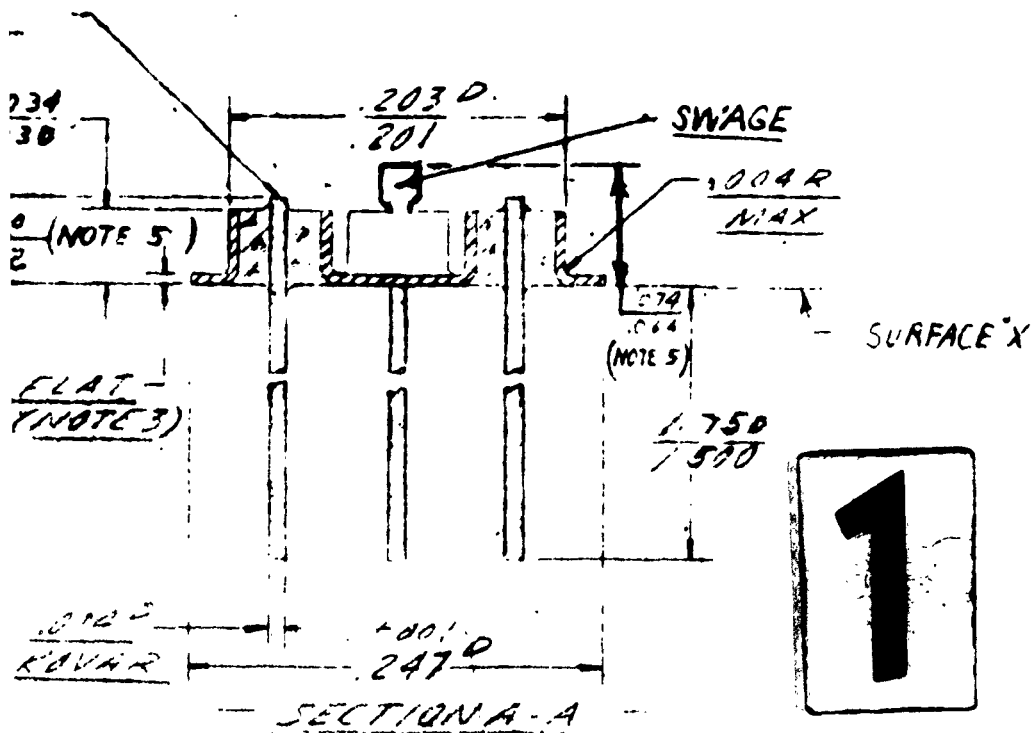
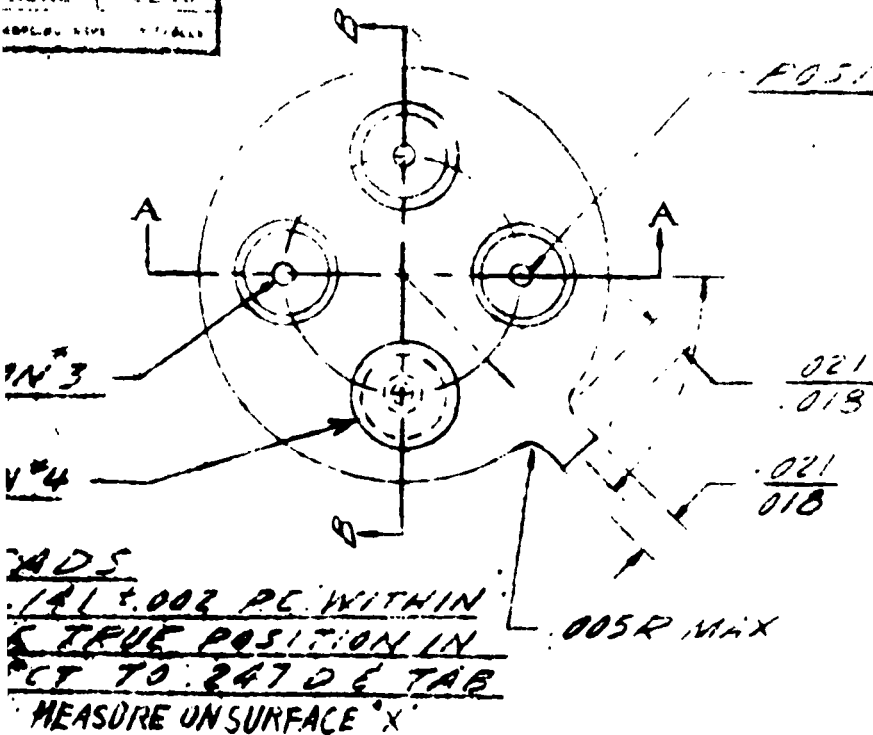


APPENDIX C

PART I

Subassembly and Part Drawings

TOLERANCE LEGEND	
SYMBOL	DIMENSION
±	0L-8
±	0L-7
NONE	0L-10
EXPLICIT	0L-11



8. NO GLASS
WELD AREA

SURFACES

9. SURFACE X TO B
WITHIN .002

10. LEADS MUST MEET END T
PER PENNSYLVANIA SPEC: CON-109

NOTES:

1. FINISH: BR
2. AFTER WELD
3. FLANGE TH
4. CONCENTRIC
5. THE .050/.042 DIM. AP
6. WELDED LE
7. MAX. TAPER

MACHINING TOLERANCE UNLESS OTHERWISE NOTED		
FRACTIONAL ± 1/64	DECIMAL ± .005	ANGULAR ± 0°-10'

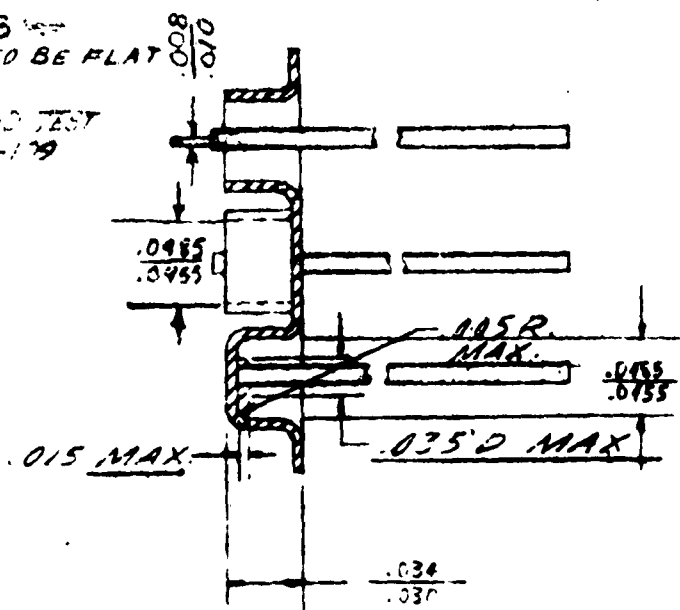
REMOVE ALL BURRS
AND SHARP EDGES

REVISIONS

- A) NEW GLASS SPATTER ADDED
CNGO-5229 1/13-61
- B) ADDED MEASURED SURFACE X
CNGI-1152 2-27-61
- C) REVISED PER CNGI-4414 7-19-61
- D) ADDED NOTE 58 DIM.
CNGI-4990 3-16-61
- E) ADDED NOTE 10
CNGI-5753 12 SEPT 61

NO GLASS PARTICLES SHALL BE IN THE
WELD AREA INCLUDING BOTH TOP & BOTTOM FLANGE

SURFACES
SURFACE X TO BE FLAT
WITHIN .002
MEET END TEST
SPEC: CON-179



ES: —
INSIDE BRIGHT DIP
TER WELDING STEM TO CAP SEALS TO PASS
10.0 ± .002 CC/SEC. OF AIR LEAK RATE.
ANGE THICKNESS OF ANY ONE PIECE MUST
4 WITHIN ± .0005 INCLD. NG TAB
V CENTRICITY OF .203/.2010 F.2430
ST BE .002 MAX T.I.R
050/.042 DIM. APPLIES TO BOTH LEADS 1 AND 3. THE .074/.066 DIM. APPLIES ONLY TO LEAD
LODD LEAD MUST BE TIT WELDED USING
DED WIRE & THE SURFACE OPPOSITE THE
D WELD SHOULD NOT BE DEFORMED MORE
N .001 OR VISIBLY DISFIGURED

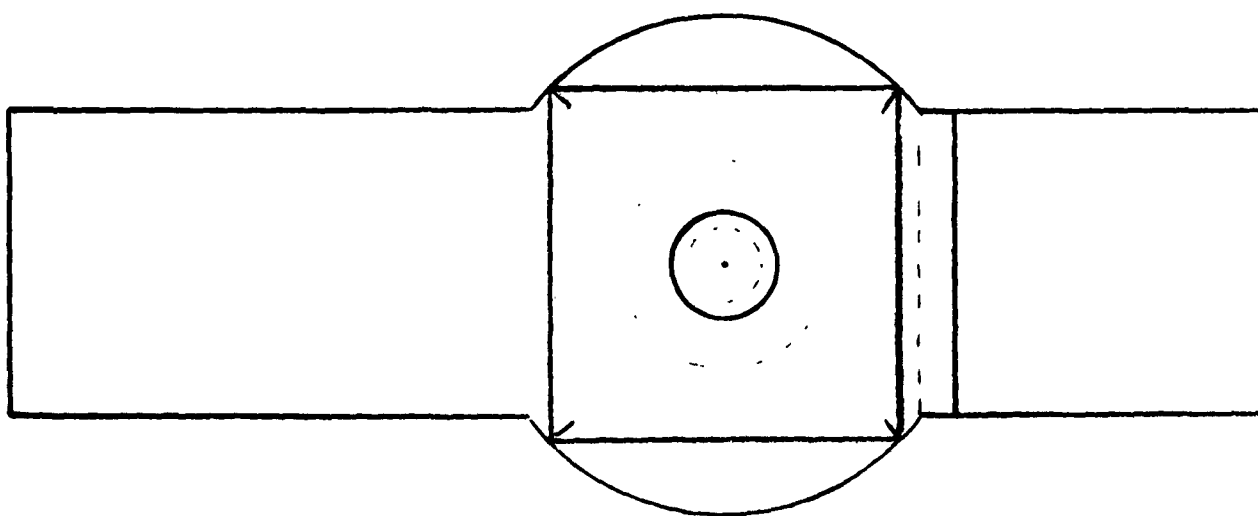
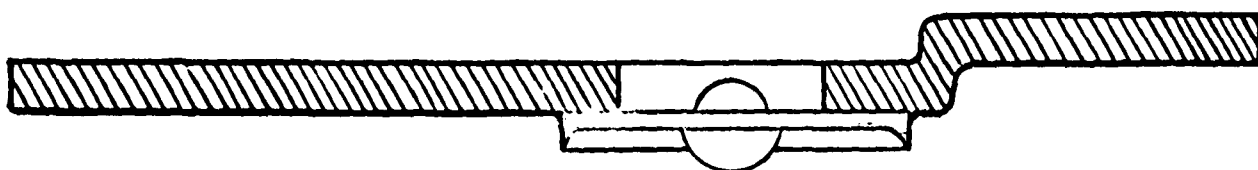
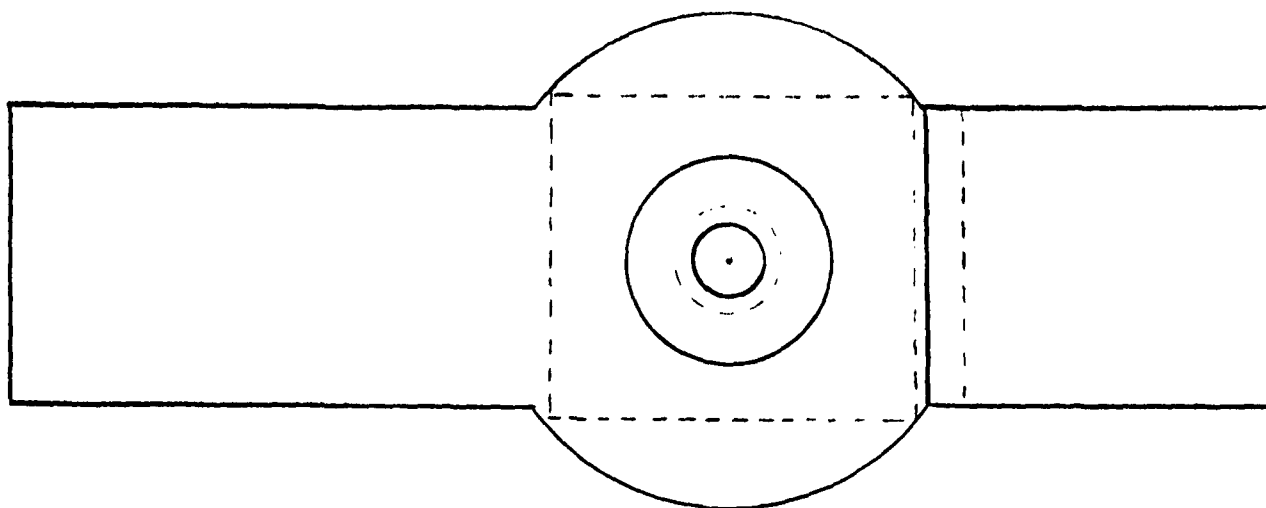
2

X. TAPER OF
1 OF EYELET
1801-EE TO

REV.	DRAWING NO.	NOTE	DESCRIPTION	ITER	NEXT ASSEMBLY
	DRAWN		FINISH		
	DESIGNED		HEAT TREAT		
	APPROVAL	DATE	MATERIAL		
	DESIGN		EQUIP.		
	CHECKED		PART		
	DRAWN				
	SCALE				

4700 —

SYLVANIA ELEC. PROD., INC. SEMICONDUCTOR DIVISION B31-3312TP



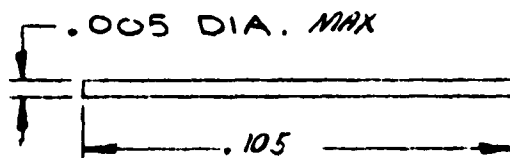
ALLOYED DICE & BASE TAB ASSEMBLY

+

+

COPIES
TO

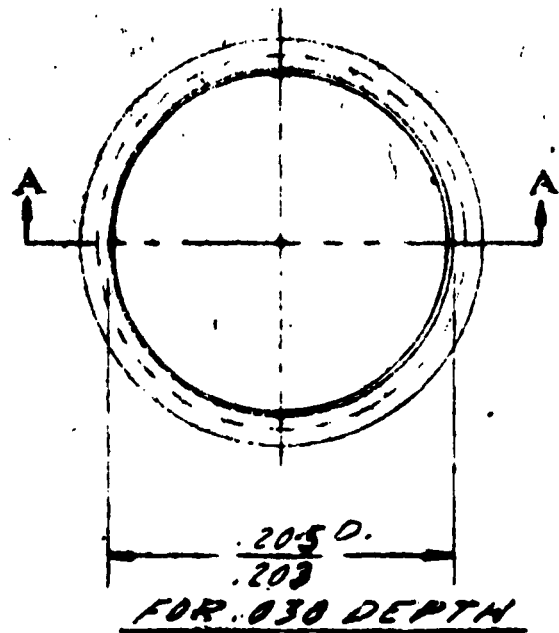
D-1



* MAT'L. $\pm .0001$
 DEAD SOFT .0040 DIA. COPPER,
 TIN PLATED TO .005 DIA. MAX

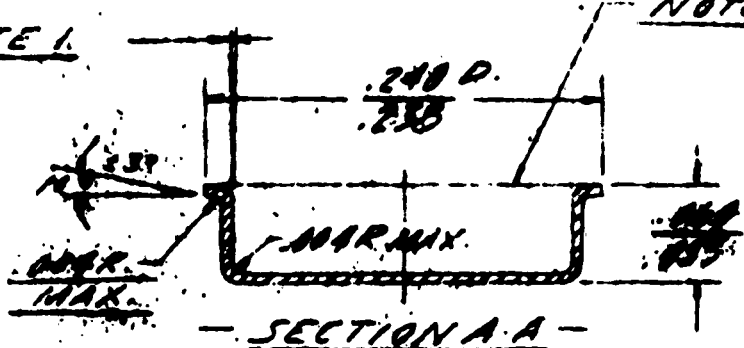
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APPR'D	REVISIONS	LTR.	CN51-5876	MATERIAL: *
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$			SYLVANIA ELECTRIC PRODUCTS, INC. SEMICONDUCTOR DIVISION PLANT-WOBURN	DRAWN DATE SCALE 20:1 APP'D DESIGN DATE APP'D PROD DATE REV. LTR
TITLE: LEAD			SIZE CODE A31	7371P85



NOTE 1.

NOTES



SECTION A-A

NOTES:

1. MAX. TAPER INSIDE OF HOLE
2. BODY TO REMAIN RECENTLY MAX. T.L.R.
3. THICKNESS OF FLANGE MAY VARY MORE THAN .005
4. PART TO BE CLEANED BY FINE HYDROGEN ATMOSPHERE FOR AT 900°C FOR 30 MIN. KEEP SURROUNDED BY GAS TO 200°C IN AIR-TIGHT CONTAINERS STILL AS HOT AS PRACTICABLE
5. FLANGE TO BE FLAT WITHIN .004 FACE FREE OF BURRS.

STW 18 APR 1961	.205 203 WAS .202 CNC-1-2519 4-18-61	B
STW	204/203 WAS 205/203 CNC-1-2519	A
APP'D	REVISIONS	LT
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$		

CNC-1-4304 MATERIAL: 100 1010 CRS, C

SYLVANIA ELECTRIC PRODUCTS, INC.
SEMICONDUCTOR DIVISION PLANT - HEBURN

TITLE: CAP SEE CODE A31

PART II

Process Specifications

TAB WELDING (TF50-1)

1.0 Equipment

- 1.1 Locating jig - Dwg. #D31-41495-A1
- 1.2 Weldmatic Power unit #1016C
- 1.3 Weldmatic Weldinghead #1032
- 1.4 Magnifying Glass and Lamp (Fisher Scientific Cat. #12-0710)
- 1.5 Tweezers (Genuine Hub #5)
- 1.6 Holding trays

2.0 Materials

- 2.1 Tabbed alloyed subassembly
- 2.2 Base header assembly (Dwg. # B31-33129P119)
- 2.3 Bibulous paper (Central Scientific #66200)

3.0 Procedure

- 3.1 Pre-set power unit to deliver four (4) watt seconds.
- 3.2 Position tabbed alloy assembly on locating jig.
- 3.3 Insert header assembly into locating jig.
- 3.4 Depress foot pedal attached to welding head.
- 3.5 Remove welded subassembly from fixture and place in holding tray.
Hold for subsequent operations in suitable storage area.

4.0 Quality

- 4.1 Weld pressure setting to be determined by line Engineer and/or Technician. Welding operation must not be performed without the daily consent of either of the above (Engr. and/or Tech.).
- 4.2 Samples are to be taken at regular intervals during operation and examined by Line Engineer and/or Technician for mechanical strength.

HEADER ADJUST (TF50-2)

1.0 Equipment

- 1.1 Microscope (American Optical Cycloptic 10x Paired Eye Piece plus F3 objective lens) Model #359.
- 1.2 Soldering Iron (Unger Electric Tool Inc.) with soldering head part #1235
- 1.3 Stainless steel tweezers (Genuine Hub #5)
- 1.4 Filament cutters (Genuine Dumont #15A)
- 1.5 Stainless steel wire basket, 3" wide x 7" long x 1" high (#30 Mesh)
- 1.6 Pyrex dish (#213B20, 1 1/2 quarts)
- 1.7 Tooth picks
- 1.8 Adjust jig
- 1.9 Dry Box (-20°F Dewpoint, max.)
- 1.10 Drying oven with dry N₂ feed
- 1.11 Bending fixture- Dwg. #C31-43517-A1

2.0 Materials

- 2.1 Alloyed subassembly welded in accordance with TF50-1 to header - Dwg. # B31-33127P)
- 2.2 Emitter connecting wire
- 2.3 Collector connecting wire
- 2.4 Neutro #14 flux
- 2.5 Hot running demineralized water supply

3.0 Procedure

- 3.1 Preheat soldering iron.
- 3.2 Preheat drying oven to 100°C ± 5°C.
- 3.3 Fill pyrex dish with running demineralized water - keep a continuous flow into dish which is approximately equal to or greater than one liter/minute.
- 3.4 Insert header assembly in adjust jig.
- 3.5 Flux collector dot and lead wire with the aid of a toothpick, connect lead to dot by soldering.
- 3.6 Remove assembly from jig.

Header Adjust (TF50-2) continued

3. 7 Insert assembly into bending jig and bend in accordance with TF50-3.
3. 8 Remove assembly from bending jig and insert in adjust jig.
3. 9 Preflux emitter dot and header pin designated as the emitter lead.
3. 10 Solder an emitter connecting wire to the emitter lead.
3. 11 Connect the opposite end of this emitter connecting wire to the emitter dot. Clip off any excess wire with the aid of supplied filament cutters.
3. 12 Preflux the header pin designated as the collector lead.
3. 13 Connect the loose end of the collector lead wire to the collect lead of header.
3. 14 Remove assembly from adjust fixture and immerse in pyrex dish containing running demineralized water.
3. 15 Allow unit to rinse for a minimum of 15 minutes.
3. 16 Transfer rinsed units into preheated oven and allow to dry for 30 minutes minimum.

4. 0 Quality

4. 1 The purity of the rinse water is to be greater than two (2) megohms. All units washed in any rinse water with a purity less than designated are to be Sparkleen cleaned and rewashed in accordance with item 3. 15.
4. 2 The temperature of the rinse water is to be a minimum of 60°C, and a maximum of 90°C. Water temperatures which differ from that designated are not to be used. Units inadvertently washed with water which does not meet specified requirements are to be reworked in accordance with item 4. 1.

TAB BEND (TF50-3)

1.0 Equipment

- 1.1 Bending jig - Dwg. # C31-43517-A1
- 1.2 Storage trays

2.0 Materials

- 2.1 Header with attached subassembly
- 2.2 Finger cots

3.0 Procedure

- 3.1 Insert assembly into bending jig.
- 3.2 Pull lever down to "Stop" and release.
- 3.3 Remove subassembly from jig and place in tray.

4.0 Quality

- 4.1 Finger cots are to be worn while handling units. Rewash all units handled otherwise for a period not less than 15 minutes in deionized water (purity > 2 megohms).
- 4.2 "Stop and Release" setting to be set by Line Engineer or Technician only.

PRE-TEST (TF50-4)

1.0 Equipment

- 1.1 Tektronix transistor curve tracer #575.
- 1.2 Class 40 base test socket.
- 1.3 Dry box (-20°F Max. Dewpoint).

2.0 Materials

- 2.1 Etched, washed and dried SYL-993.

3.0 Procedure

- 3.1 Turn power switch of curve tracer on.
- 3.2 Set peak volt range switch to 0 - 200 V position.
- 3.3 Set polarity switch to PNP position.
- 3.4 Set vertical current select dial to 0.1 MA position.
- 3.5 Set horizontal voltage select dial to "Collector Volts" 10 position.
- 3.6 Set base step generator to plus (+) position.
- 3.7 Plug in test socket collector and base leads to appropriate binding posts of scope. (For simplicity, use transistor B side and set transistor selector to Transistor B).
- 3.8 Turn intensity knob full right until desired intensity is obtained.
- 3.9 Set peak volt dial to approx. 6 (this should produce a green trace (Horiz) six div. long).
- 3.10 Set circuit selector to base grounded position.
- 3.11 Position trace in extreme right center portion of screen.
- 3.12 Plug unit into test socket located inside of dry box.
- 3.13 Accept all units which do not cause the green Hor. trace to drop more than one division.

4.0 Quality

- 4.1 Equipment must be calibrated daily by Electronics Equipment Maintenance Group. (See Phil Campbell or Ashley Thomas).
- 4.2 All units which do not meet and requirements of step 3. 13 and have been re-etched for a maximum of two times are to be rejected. These units are to be scrapped.

ECCO BOND (TF50-5)

1.0 Equipment

- 1.1 Suitable stainless steel or aluminum storage trays
- 1.2 Dry box (-20°F Max.)
- 1.3 Tweezers Dumont 3C
- 1.4 Finger cots
- 1.5 Aluminum cup
- 1.6 Magnifying glass with attached light (Fisher Scientific Co. #12-07101)
- 1.7 Toothpicks

2.0 Material

- 2.1 All units which have met the pretest requirements of TF50-4.
- 2.2 Ecco Bond 26 (Emerson & Cuming Inc., Canton, Mass.)
- 2.3 Bibulous Paper (Central Scientific Co. Boston, Mass. Cat. #66200)

3.0 Procedure

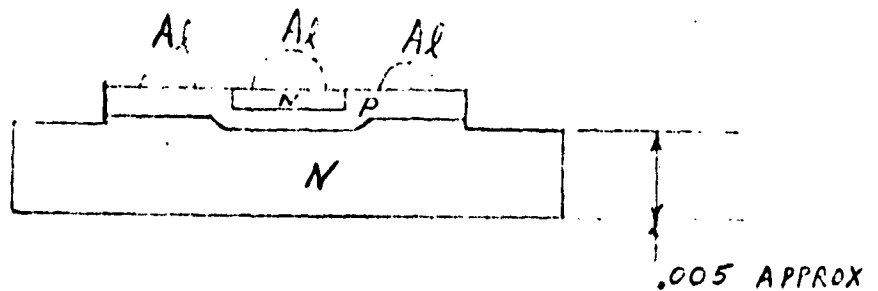
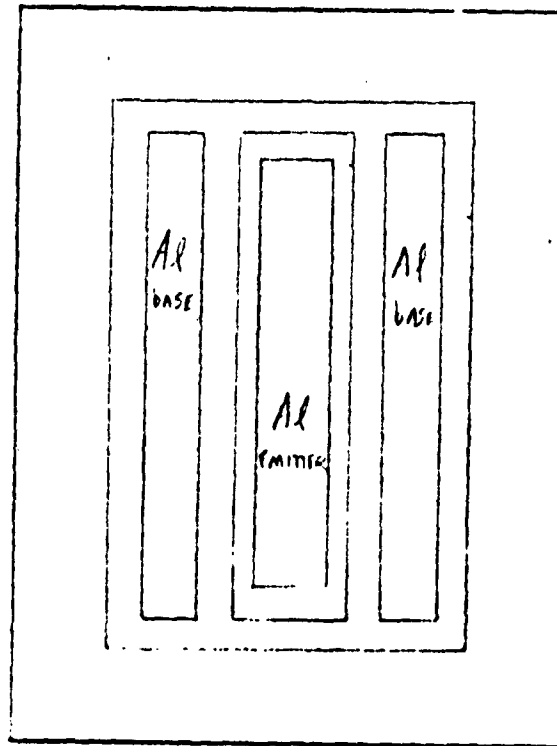
- 3.1 Mix Ecco Bond in accordance with manufacturer's specifications.
- 3.2 Apply a portion of this mixture between the header and base tab.
- 3.3 Allow applied mixture to cure in a dry atmosphere for a minimum of eight (8) hours.

3.4

4.0 Quality

- 4.1 Reject all units that have excess Ecco Bond near or around the weld area (flange) of the header.
- 4.2 Discard all adhesive that has not been used one-half (1/2) hour after being mixed.
- 4.3 Operators must wear finger cots.
- 4.4 Use only clean aluminum cups when mixing adhesive.

APPENDIX D



DIMS: .025 X .035 X .005

APPR'D	REVISIONS	LTR.	CN61-7132		TYPE: 2N696-2N697		
ALL DIMENSIONS UNLESS OTHERWISE SPECIFIED ARE IN INCHES WITH TOLERANCES OF: FRACTIONAL $\pm 1/64$ DECIMAL $\pm .005$ ANGULAR $\pm 1/2^\circ$			SYLVANIA ELECTRIC PRODUCTS, INC.		DRAWN	DATE	SCALE
			SEMICONDUCTOR DIVISION PLANT - WOBURN		APP'D. DESIGN DATE	APP'D. PROD. DATE	
TITLE: SILICON MESA PELLET			SIZE CODE	A314253P140			REV. LTR.

(PURCHASE SPECIFICATION (PR-142))

Material: Gold Wire
Diameter: 0.0010" $\pm$.0001 Note 1
Purity: 99.99% - 99.995% Note 2
Weight per units length of wire: 1.956 MGM per 20 CM $\pm$ 5%
Minimum Break Load: 4 GMS. Note 3
Elongation Range: 3% - 8%
Spooling: Wind 200' ($\pm$ 25') on each of No. 5 spools.
The wire should be clean, free of grease,
dust or foreign particles.
Source of Supply: Sigmund Cohn Corporation
Either 121 So. Columbus Avenue
Mt. Vernon, New York
Or Secon Metals

For MID Purposes:

Note 1: Measured optically.

Note 2: A certificate of analysis should accompany lots on
a twice a year basis.

Note 3: MID to submit to the line a sample spool for a pull
test to determine the minimum break load. (And elongation
range).

HEADER MOUNTING (TD 43-2-P26)

1.0 Equipment

- 1.2 K and S Wafer bonder, Model 601
- 1.3 Special tweezers for mounting (Supplied with header mounter).
- 1.4 Tweezers
- 1.5 Clean 250 ML beaker

2.0 Material

- 2.1 Si pelleter TD43-2
- 2.2 Forming gas
- 2.3 Header per parts list
- 2.4 Preforms for TD (46-2) as per parts list. .5 mil thick, 35 mil dia., AuSb.

3.0 Safety

- 3.1 Refer to TST 31-19 for safety precautions.

4.0 Procedure

- 4.1 To turn equipment on:
 - 4.1.1 Turn power supply switch to "ON" position
 - 4.1.2 Turn control cabinet switch to "LIMIT" position.
 - 4.1.3 Plug in power-strip for accessory equipment (microscope lights, and vacuum pick-up pump with the 4-way electric valve system).
- 4.2 Adjust the forming gas flow rate
- 4.3 Turn slider rotation knob to the right and lock.
- 4.4 Sprinkle a small number (20-30) of gold preforms on the cap of the locating sliding stage. Replenish as necessary.
- 4.5 Sprinkle a small number of dice (20-30) on the cap of the locating sliding stage. Replenish as necessary.
- 4.6 Turn slider rotation knob to the left and lock.
- 4.7 Model 601-Depress Front tab. Insert header (emitter tab to right). Release tab and close cover.
- 4.8 Looking through the stereo microscope locate a gold preform on the cap of the locating gliding stage. Glide stage and bring the wafer directly below the tip of the needle of the vacuum pick-up.

HEADER MOUNTING (TD 43-2-P26) (Continued)

- 4.9 Lower the Z action slider arm and bring the needle of the vacuum pick-up directly onto the center of the preform. Depress the "pick-up foot -switch" (left switch of double foot-switch)
- 4.10 Raise the pick-up arm and transfer the preform onto the header by turning the slider rotation knob to the right and locking it in place.
- 4.11 Lower the pick-up arm and center the preform onto moly pedestal on the header by adjusting the tubular micrometers on the back and the right side of the machine. (Once this adjustment is made no further adjustments are required for subsequent cycles).
- 4.12 Release the "pick-up foot-switch" and depress the "release foot-switch" (right switch of double foot-switch).
- 4.13 Raise the pick-up arm making certain that the preform is not displaced from its original position.
- 4.14 Turn positioning knob to the left and lock.
- 4.15 Looking through the stereomicroscope, locate a die (stripes facing up) on the cap of the locating gliding stage. Glide the stage and bring the die directly below the tip of the needle of the vacuum pick-up.
- 4.16 Rotate the gliding stage and align the stripes along the vertical axis of the field of view.
- 4.17 Bring the needle of the vacuum pick-up directly onto the center of the silicon die. Depress the "pick-up foot-switch."
- 4.18 Raise the pick-up needle and transfer the silicon die onto the header by turning the slider rotation knob to the right and locking it in place.
- 4.19 Lower the pick-up needle and place the die squarely over the gold preform.
- 4.20 Holding the pick-up needle down, apply pressure on the die.
- 4.21 Release the "pick-up foot switch".
- 4.22 Keeping one finger over the "press to stop bonding" button (red button) and looking through the microscope, observe carefully the die and wafer assembly.
- 4.23 Within the next 3-5 sec. the bottom of the Si die starts to melt and goes into solution with the gold. A dark shiny area forms around the die and spreads radially away from the silicon.
- 4.24 Model 601 - As soon as a fillet is found around the die, step on the cooling pedal. Do not release cooling pedal until package is removed from machine. Continue holding vacuum pick-up needle down until fillet freezes. (Time should not exceed 4 seconds).

HEADER MOUNTING (TD 43-2-P26) (Continued)

- 4.25 Wait until fillet freezes, then lift pick-up needle and inspect die for cracks and alloying through.
- 4.26 Turn the slider rotation knob to the left and lock in place.
- 4.27 Model 601 - Depress tab and take header from heater column.
- 4.28 Model 601 - Release cooling pedal
- 4.29 Place units in beakers and record number on counter.
- 4.30 Repeat steps 4.7 through 4.30 until all the units are mounted on headers.
- 4.31 To turn dice upside down -- pick up dice with vacuum pick-up needle. Lift needle slightly and release abruptly. Repeat until dice turn over. Use of tweezers is also permissible.
- 4.32 To turn equipment off:
 - 4.32.1 Turn power supply switch to "off" position.
 - 4.32.2 Turn control cabinet switch to "off" position.
 - 4.32.3 Unplug power strip for accessory equipment.
 - 4.32.4 Close the forming gas supply.

5.0 Quality

- 5.1 Each die should be placed symmetrically and squarely on pedestal of the header.
- 5.2 There should be a continuous fillet surrounding each die, covering a minimum of 75% of the dies periphery.
- 5.3 All four corners of each die should be touching the header.
- 5.4 Visible cracks on dice (under 50X magnification) are not acceptable.
- 5.5 Any units with gold alloyed through the surface of the mesa, or touching the mesa in any way should be rejected.
- 5.6 Do not touch the tops of the headers before or after mounting the dice.
- 5.7 Pressure on pickup needle to be 8 gm.
- 5.8 Refer to the flow chart for the appropriate process quality control specification.

THERMO-COMPRESSION BONDING OF LEADS (TD 43-2-P27)

1.0 Equipment

- 1.1 K and S Thermocompression Bonder (Model 400) with controls and accessories.

2.0 Material

- 2.1 Units per flow chart
- 2.2 Forming gas
- 2.3 Wire per parts list
- 2.4 Methyl Alcohol, C. P. or Electronic Grade.
- 2.5 Pipe cleaners

3.0 Safety

- 3.1 Refer to TST 31-19 for safety precautions.

4.0 Procedure

4A. Procedure for Setting up Equipment

- 4A.1 Turn temperature control to "Auto".
- 4A.2 Adjust gas flow. Gas to be 95.5 N₂ -H₂. Gas to be passed through dryer (Hayes Molecular Sieve) and dew point to be -50^o F or better
- 4A.3 Temperature to be calibrated each day. Bonders for pancake package to be set to 310^o C.
- 4A.4 Bonding point to fix securely in vertical position in "V" groove of bonding tool holder. It must be free of "play". Point must not be chipped or damaged.
- 4A.5 Check the wire feeder for position (it must be capable of feeding wire to the unit within the limit of the joystick). Check the wire feeder by depressing the foot pedal and note the ability of it to feed.
- 4A.6 Adjust the position of the bonding lead so that each stripe can be bonded without Losing Focus. Set screws may be employed to secure motion. Magnification is to be between 2.5 and 3.0 on the zoomar microscope.
- 4A.7 All glare because of light source is to be removed by re-positioning the light source. Glare caused by reflection of light in the bonding wedge is not possible if wedge is positioned correctly.
- 4A.8 Bonding wedge is to be positioned so that the long axis of the wedge is parallel to the stripe. Wedge height and entire assembly height is to be adjusted so that application of pressure to a die will not result in a scrubbing motion.
- 4A.9 Machine is to be left on at all times.

THERMO COMPRESSION BONDING OF LEADS (TD43-2-P27) (Continued)

4B. Procedure for Bonding

- 4B.1 Check to see that forming gas is flowing.
- 4B.2 Turn light on
- 4B.3 Adjust microscope to suitable setting with magnification between 7.5 and 3.0. Test the alignment by inserting a scrap unit and rotating the bonding head.
- 4B.4 Use the special tweezers and load a transistor with the emitter tab to the left.
- 4B.5 TF43-2 Rotate the bonding head to a position where the base post is to the right. Feed out wire across the base post to the left base stripe. Bond the left base stripe then the right base stripe and then the post. Break wire, rotate the bonding head and repeat the operation to bond the emitter stripe and emitter post. Again stagger the bonding to avoid shorting.
- 4B.6 Remove unit from bonder and insert in a clean tray.
- 4B.7 Repeat all operations until all the units are bonded.

5.0 Quality

- 5.1 Units are not to be handled except with tweezers.
- 5.2 Degrease tweezers four times per day.
- 5.3 Use a small pipe cleaner and alcohol (methyl) to clean the bonding wedge four times per day
- 5.4 Inspect the gas flow once per hour minimum.
- 5.5 Store completed units in dry box.

AD _____ Accession No. _____ Sylvania Semiconductor Div., Woburn, Mass. "MICROMINIATURIZED PACKAGING OF 2N384 and 2N697" Final Rpt, 1 February 1962. Period 1 October 1960 to 1 February 1962 Contract DA-36-039-sc-85377 (Unclassified) 90 p.p., including 40 illus., tables, charts. Prepared by: L. Epstein, C. Lawrenson, I. Feinberg, F. Bower. The purpose of this contract is to adapt germanium drift field and silicon mesa transistor junction structures and a micro miniature package such that hermetically (over)	Unclassified 1. "Microminiaturized Packaging of 2N384 and 2N697", Final Report 2. Contract DA36-039-sc-85377	AD _____ Accession No. _____ Sylvania Semiconductor Div., Woburn, Mass. "MICROMINIATURIZED PACKAGING OF 2N384 and 2N697" Final Rpt, 1 February 1962. Period 1 October 1960 to 1 February 1962 Contract DA-36-039-sc-85377 (Unclassified) 90 p.p., including 40 illus., tables, charts. Prepared by: L. Epstein, C. Lawrenson, I. Feinberg, F. Bower. The purpose of this contract is to adapt germanium drift field and silicon mesa transistor junction structures and a micro miniature package such that hermetically (over)	Unclassified 1. "Microminiaturized Packaging of 2N384 and 2N697", Final Report 2. Contract DA36-039-sc-85377	Unclassified 1. "Microminiaturized Packaging of 2N384 and 2N697", Final Report 2. Contract DA36-039-sc-85377
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AD _____ Accession No. _____ sealed microminiature transistors having maximum dimension of .250" diameter and .072" height are produced. Modification and design changes, were made and processes developed to assemble such devices. Samples meeting the objective electrical and environmental specifications MIL-S-19500/27A (2N384) and MIL-S-19500/99A (2N696) were built and delivered. Design considerations, parts, and processes are described.	Unclassified	AD _____ Accession No. _____ sealed microminiature transistors having maximum dimension of .250" diameter and .072" height are produced. Modification and design changes, were made and processes developed to assemble such devices. Samples meeting the objective electrical and environmental specifications MIL-S-19500/27A (2N384) and MIL-S-19500/99A (2N696) were built and delivered. Design considerations, parts, and processes are described.	Unclassified
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