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FINAL REPORT

ON

DESIGN AND MANUFACTURE OF SEALED
NICKEL-CADMIUM CELLS OF CYLINDRICAL
DESIGN TO SIGNAL CORPS TECHNICAL
REQUIREMENT SCL-7504 A

DECEMBER 1, 1959 TO MARCH 31, 1963

REPORT NO. 4

CONTRACT NO. DA-36-039 SC-84496

FILE NO. 40541-PM-60-93-93

DA TASK NO. 3G18 03 001 02

PLACED BY U.S. ARMY ELECTRONICS
RESEARCH AND DEVELOPMENT LABORATORY
FORT MONMOUTH, NEW JERSEY

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SONOTONE CORPORATION
ELMSFORD, NEW YORK

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JUN 1963

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FINAL REPORT

on

Design and Manufacture of Sealed
Nickel-Cadmium Cells of Cylindrical
Design to Signal Corps Technical
Requirement SCL-7504A, June 28, 1961

December 1, 1959 to March 31, 1963

Report No. 4

Contract No. DA-36-039 SC-84496
File No. 40541-PM-60-93-93
DA Task No. 3G 1803 001 02

Object: The Design and Manufacture of
60 Engineering Test Models of Each
of 3 Sizes of Sealed, Cylindrical
Nickel-Cadmium Cells, viz.
10 A.H., 50 A.H. and 100 A.H. Capacity

Prepared by:

Francis Alliegro
Francis Alliegro
Supervisor
Battery Improvement Laboratory

Reviewed by:

Winslow E. Ryan
Winslow E. Ryan
Administrative Executive
Battery Improvement Laboratory

Approved by:

George A. Baumstark
Dr. George A. Baumstark
Director
Battery Improvement Laboratory

COL 23

August B. Mundel
August B. Mundel
Director of Engineering

SONOTONE CORPORATION
Elmsford, New York

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I. PURPOSE

The purpose of this contract is the design and manufacture of 60 engineering test models of each of three sizes of sealed nickel-cadmium cells, viz. 10 A.H., 50 A.H. and 100 A.H. capacity, measured at the five hour rate, meeting the requirements of SCL-7504A. These requirements are as follows:

The cells shall be cylindrical and have a re-useable pressure relief valve.

The cells shall yield 50% of their nominal capacity when discharged at the 5 hour rate at minus 40°F to 1.0 volt, and shall yield 75% when discharged to 1.0 volt at the 3C₅ rate at room temperature.

Although no definite requirement is specified for life test or for storage, design objectives are for 5000 continuous cycles of 20% depth of discharge and for storage in a discharged state for 5 years from minus 80°F to 165°F without any degradation of performance.

The batteries shall be capable of passing the following environmental tests after which they shall meet full specification requirements: temperature shock, high and low frequency vibration, mechanical shock, acceleration and elevation. All of these environmental tests are described fully in the appropriate section of this report.

II. ABSTRACT

The sixty cells of each of three sizes (10 A.H., 50 A.H. and 100 A.H.) have been manufactured. The qualification tests of SCL-7504A have been successfully passed and all cells have been delivered. All 10 A.H. and 50 A.H. cells had teflon sealed terminals. In the 100 A.H. size, 40 cells had teflon seals and 20 cells had ceramic seals. Fifty each of the 50 A.H. and 100 A.H. cells have been partially scored to immobilize the core assembly in order to withstand the severe vibration and shock requirements of SCL-7504A. Parts lists and pertinent drawings of all types of cells have been included in this report.

III. REFERENCES AND CONFERENCES

A. References

1. Final Report - "Study of Sealed Nickel-Cadmium Batteries", (1960) Sonotone Corporation
DA 36-039 SC-78249.
2. Final Report - "Investigation Leading to the Development of a Nickel-Cadmium Battery Having a Hermetically Sealed Construction", (1957) Sonotone Corporation
DA 36-039 SC-73009
3. "The Hermetically Sealed Sintered Plate Nickel-Cadmium Cell", L. Belove and I. Schulman, Proceedings of the Thirteenth Annual Battery Research and Development Conference, April 30, 1959.
4. First, Second and Third Quarterly Reports - "Design and Manufacture of Sealed Nickel-Cadmium Cell of Cylindrical Design to Signal Corps Technical Requirement SCL-7504".
5. Technical Program Letter Report - "Design and Manufacture of Sealed Cylindrical Nickel-Cadmium Cells", (1961) Sonotone Corporation - DA 36-039 SC-84496.

III. REFERENCES AND CONFERENCES (continued)

B. Conferences

<u>Date</u>	<u>Location</u>	<u>USAERDL Representatives Present</u>	<u>Sonotone Representatives Present</u>
12-15-59	Ft.Monmouth, N.J.	H. Mandel A. Frink D. Clark	Dr.G.A.Baumstark H. Bilsky F. Alliegro
3-15-60	Elmsford, N.Y.	R. Lunz	Dr.G.A.Baumstark L. Belove W. Ryan H. Bilsky A. Mundel F. Alliegro
5-13-60	Ft.Monmouth, N.J.	H. Mandel R. Lunz A. Frink	H. Bilsky F. Alliegro
7-6-60	Elmsford, N.Y.	Dr. E. Baars R. Lunz	W. Ryan H. Bilsky F. Alliegro
8-31-60	Ft.Monmouth, N.J.	P. Rappaport H. Mandel R. Lunz	H. Bilsky F. Alliegro
9-14-60	Ft.Monmouth, N.J.	Dr. A.Fishbach H. Mandel R. Lunz	D. Goldstein F. Alliegro
11-2-60	Elmsford, N.Y.	R. Lunz	Dr.G.A.Baumstark W. Ryan F. Alliegro
1-13-61	Ft.Monmouth, N.J.	H. Mandel P. Rappaport R. Lunz	Dr.G.A.Baumstark S. Richman F. Alliegro
4-7-61	Elmsford, N.Y.	R. Lunz	F. Alliegro

III. REFERENCES AND CONFERENCES (continued)

B. Conferences (continued)

<u>Date</u>	<u>Location</u>	<u>USAERDL Representatives Present</u>	<u>Sonotone Representatives Present</u>
4-26-61	Ft. Monmouth, N.J.	Mrs. S. Duze H. Mandel P. Rappaport	F. Alliegro
8-30-61 thru 9-1-61	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro
1-11-62	Ft. Monmouth, N.J.	Mrs. S. Duze P. Rappaport	A. Mundel F. Alliegro
7-20-62	Ft. Monmouth, N.J.	Mrs. S. Duze P. Rappaport H. Getzlaff S. Del Vecchio	Dr. G. A. Baumstark W. Vignini F. Alliegro
10-16-62 thru 10-18-62	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro
2-12-63 and 2-13-63	Elmsford, N.Y.	Mrs. S. Duze	F. Alliegro

The conferences up to and including that of 4-26-61 have been described in the first three Quarterly Reports of this contract and in the one Technical Program Letter Report.

The conferences of 8-30-61, 10-16-62 and 2-12-63 were held to enable Mrs. Duze to witness qualification testing (especially the environmental tests) of the cells produced under this contract.

On 1-11-62 the difficulties encountered in the ceramic sealing of large terminals were discussed, and a new mechanical design

III. REFERENCES AND CONFERENCES

B. Conferences (continued)

of these seals was presented.

At the conference of 7-20-62, Messrs. Del Vecchio and Getzlaff presented suggestions pertaining to the various elements of ceramic sealing, especially brazing alloys, metallizing materials and ceramic composition. Also, at this meeting, Sonotone agreed to supply intercell connectors and related hardware for the cells previously shipped under the contract.

IV. DATA AND DISCUSSION

A. Difficulties Encountered

Several extensions of this contract have been required.

The first of these, extending the time of the contract from November 30, 1960 to May 29, 1961, was requested to enable Sonotone to evaluate and select a separator superior to the then standard cellulosic material. Another reason for this extension was the need for unusual support and immobilization of the cores of the cells, especially in view of the heavy stack-ups and the severe vibration and shock requirements of SCL-7504.

A second extension to November 20, 1961 was requested and granted, mainly to incorporate our improved method of terminal sealing (ceramic to metal bonding). This new type of seal was to apply to 50 each of the 100 A.H. and 50 A.H. cells. All of the 10 A.H. cells (60) and 10 each of the two larger sizes were made with Teflon seals. The 10 A.H. cells were shipped on 10-17-61, while ten 100 A.H. and ten 50 A.H. cells (Teflon seals) were shipped on 11-28-61.

A third extension to 3-31-62 was requested when it was discovered that ceramic seals identical to those to be supplied on this contract developed leaks after several months of use by other customers.

IV. DATA AND DISCUSSION

A. Difficulties Encountered (continued)

Difficulties with the delivery of ceramic sealed covers from a vendor made it necessary to procure a further extension to 6-30-62.

Further difficulties with the low percentage of acceptable covers from the supplier, plus defective bar stock (from which the cover blanks had been made) caused more delays, with the result that the contract time was extended to 3-31-63.

The above difficulties and the manner in which they have been resolved are described in detail in the following section of this report, which summarizes the project under the various elements of the designs such as plates, separator, etc.

B. Summary

1. Plates

To meet the high rate ($3C_5$) and the low temperature ($-40^{\circ}F$) requirements of SCL-7504A, thin plates were used (approx. 0.023") along with a theoretical N/P ratio of 2. The loading of the plates with active material was 1.35g/cc for the positive and 2.2g/cc for the negative, both being approximately 30% over the normal loading. In the positive plates, 5% of the active material is Cobaltous Hydroxide.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

1. Plates (continued)

Stacked rectangular plates were used instead of spirally wound plates even though the latter gives a much greater cross-section efficiency. However, the rectangular core design made possible lighter and less bulky current carrying hardware inside the cells. In addition, the stacked rectangular plates afford maximum reliability and less difficult manufacturing procedures.

On all cells, approximately 9 square inches of positive plate was used per ampere hour of nominal capacity, with an equal area of negative plate. In the 10 A.H. cells, two plate widths were used, while in the 50 A.H. and 100 A.H. cells, three plate widths were used to afford maximum utilization of the cross-section area (Figure 1).

2. Separator

Due to the high temperature storage requirement and the requirement for efficient operation at temperatures as high as 125°F, several materials were investigated to either replace or complement the cellulosic separator which was standard at the time of the placement of the

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

2. Separator (continued)

contract. The following materials were checked:

Woven Teflon #T-10-42

Calendered Woven Nylon

Pellon #920 and #T-1800

Webril #430

Paper and Teflon #T-10-42

Polyvinyl Alcohol

Woven nylon Impregnated with PVA

Woven nylon coated with PVC and PVA

Paper coated with polyethylene

Non-woven polypropylene #305 POE

Based on the results of the testing described in the previous reports and on extensive tests conducted by Sonotone's Space Laboratory, the non-woven polypropylene #305POE was selected.

In addition to withstanding the environmental and other requirements of SCL-7504A, this separator has withstood 4990 cycles of charge and discharge in sealed "D" cells. The cycling was performed as in paragraph 4.4.5 of SCL-7504A as regards depth of discharge, amount of over-charge and time of both charge and discharge. Failure

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

2. Separator (continued)

was attributed to the combination of coiled core design plus the deep scoring of the cell case, causing an area of pressure at which the failure occurred.

One problem was encountered due to the selection of polypropylene. In spite of its stability at elevated temperature in cell operation, this material exhibited a marked tendency to vaporize during the welding of the collector bars to the groups of plate contact tabs.

The problem was overcome by the use of metal combs which served as heat sinks for individual tabs during welding.

3. Cell Case

Stainless steel was selected as the case material due to its inertness in this type of application, eliminating the need for protective plating. Stainless steel also gives excellent non-porous welds with the heli-arc method.

The mathematical analysis described in the First Quarterly Report gave the dimensions for minimum cell weight shown in Table I.

IV. DATA AND DISCUSSION

B. Summary (continued)

3. Cell Case (continued)Table I

<u>Cell Type</u>	<u>O.D. Inches</u>	<u>Cylinder Ht. Inches</u>	<u>Overall Ht. Inches</u>	<u>Tube Wall Thickness</u>	<u>End Plate Thickness</u>
BB440/U 10 A.H.	1.8	6.0	6.5	0.020	0.067
BB441/U 50 A.H.	3.0	8.9	9.4	0.025	0.116
BB441/U 100 A.H.	4.0	9.3	9.8	0.025	0.155

The following considerations were included in the calculations: Cross-sectional area efficiency, minimum usable tube wall thickness, head space losses, end plate thickness and maximum practical plate length.

4. Electrolyte

The electrolyte in the first prototype cells made under this contract was 1.3 sp.gr. KOH to which was added 18g./L. of LiOH. This electrolyte was added to the extent of 18% of the core weight. This has been standard electrolyte loading for sealed nickel-cadmium cells where repeated cycling is involved, but it was found to give poor results during discharge at

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

4. Electrolyte (continued)

minus 40°F. By changing to electrolyte of 1.40 sp.gr. the minus 40°F performance was improved to the extent that the low temperature requirements of SCL-7504A are easily met. (This electrolyte contains 9g./l. of LiOH)

Improvement in low temperature performance was also sought by adding CsOH and/or RbOH to KOH and LiOH, but with negative results.

5. Terminals

Early in the development of the cell design, it was decided to locate both the positive and negative terminal on the same end. Also, to increase reliability and to decrease the possibility of accidental shorting, both terminals were insulated from the cover. To accomplish the sealing of these terminals in the cover, our standard Teflon design was planned for all 180 cells. Details of this design are shown in Figures 2 and 3. Helium leak testing of this type of seal showed a leakage rate on the order of 1 cc of gas per cell per year.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

In the Spring of 1961, Sonotone was engaged in developing a very promising method for sealing large metal terminals in a metal cell case, using metal to ceramic bonding. Since this design had been proven capable of withstanding severe vibration and shock, the contract was amended so that fifty cells each of the 50 A.H. and 100 A.H. sizes would be supplied with ceramic seals, while ten each of these two sizes along with all sixty of the 10 A.H. cells would contain the Teflon seals.

All materials for the manufacture of the ceramic sealed cells were procured and the necessary sub-assemblies were manufactured. On or about the 1st of October 1961, when the final assembly of these cells was about to take place, we were notified by one of our customers that ceramic seals identical to those planned for this contract were developing leaks after 3-4 months of use.

This design is shown in detail in Figure 4. Mechanically, this design keeps the entire assembly in compression when the proper torque is applied to the hex nut, preventing tensile and shear forces from acting on the ceramic and metal to ceramic braze joint. The actual materials used

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

in the initial seals were as described below.

The brazing alloy was Ni-Oro, a nickel-gold, selected for its resistance to KOH. The retainers were Cerami-seal, a nickel steel selected because its thermal expansion characteristics closely matched the ceramic material. The ceramic body was 94-96% alumina, and the surfaces of the ceramic to be bonded were metallized with molybdenum-manganese. This molybdenum-manganese surface was then nickel plated for bonding (actual alloying) with the Ni-Oro during the brazing operation.

Initial investigation of the failure of this seal pointed to the metallizing as the weak point, since the molybdenum-manganese proved to be the least inert of the materials involved in the presence of voltage and KOH. Therefore, most of the early efforts to correct the difficulty were directed toward using other metallizing materials, such as molybdenum-titanium, titanium, and tungsten. Also, gold plating was used to try to protect the molybdenum-manganese.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

Since none of the above attempts solved the problem, we investigated other brazing alloys with lower melting points, because the high melting point of the Ni-Oro resulted in some mismatch in thermal expansion even with the special nickel-steels such as Cerami-seal and Fernico V.

Other brazing materials included Copper, Copper-Silver, Silver, Nickel-Antimony, Gold-Antimony, Indium solders, Gold-germanium and Indium-gold.

Concurrently, we were investigating the mechanical design as a possible source of trouble. Since all the failures were observed to occur at the braze joining the inner surface of the ceramic seal to the inner retainer, it was felt that the inner brazed joint was subjected to tensile stress during the cooling following the brazing operation due to thermal expansion mismatch between the ceramic body and the nickel-steel retainer. This could cause a porous braze, an increased proclivity to corrosion or both.

The mechanical design was changed to that shown in Figure 5, which used a double tapered ceramic seal element. This retains the advantages of the previous design by preventing

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

shear and tensile forces during vibration and shock, while eliminating most of the tensile stress which could occur during the cooling after brazing.

This change did not give the desired improvement. Further investigation indicated the possibility of a porous condition in the braze. This porous condition was actually observed on samples made with Ni-Oro, which up to this point was still regarded as the most likely material due to its inertness in KOH. This porosity was observed on pieces which never had contact with KOH. A similar observation was described by Mr. Del Vecchio of the Signal Corps at the Conference of 20th July 1962.

Simultaneous efforts on ceramic seal improvements were under investigation in the Sonotone Space Laboratory where smaller cells were manufactured for a large number of satellites. Here both glass and ceramic seals had been used. Due to these efforts the final choice of braze metal was made based on what had been effective on "D" and "F" size cells. This was high grade silver, which was then incorporated in the double taper design. Six such seals were assembled in cells which have been subjected to continuous overcharge

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

5. Terminals (continued)

since December 13, 1962, with no indication of failure.

Continuous overcharging has proved to be an excellent accelerated test method for this application.

6. Vents

The resealable vents used on all the cells made under this contract are designed to release at 200 psi. The details of this vent are shown in Figure 6. Helium leak tests on these vents showed a loss of 1 cc of gas per year, and release-seal cycling shows an accuracy of $\pm 10\%$. Recently USAERDL personnel have reported slight deterioration of the neoprene "O" rings. Initial attempts to correct this condition involved the use of Teflon "O" rings, but they were unsuccessful due to the flow characteristics of the Teflon and to the seat design. However, two promising investigations are presently under way, one in which a Teflon coated neoprene "O" ring, and the other in which Teflon compositions of different flow characteristics are being checked for use in our present design. All cells shipped contain the neoprene "O" rings in the vents.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

7. Environmental Testing

During the environmental testing required by SCL-7504A, the only problem encountered occurred during the vibration testing of the 100 A.H. cells. While performing the qualification test in October 1962, all 8 cells under test failed to survive the vibration.

Failure was caused by the breaking of approximately 50% of the individual plate contact tabs - the result of motion of the heavy cores during vibration in the longitudinal axis. To further immobilize the core, the walls of the cylinders were partially scored. The scoring tool was designed to indent the cell container only at points where the effect would be to exert pressure perpendicular to the face of the plates and stack-ups. Care was taken to avoid damage to the plate and stack-up edges. The scoring was done on fifty each of the 100 A.H. and 50 A.H. cells, and not on the cells delivered on October 17, 1961 or November 28, 1961.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests

All the qualification tests performed on the BB440, BB441 and BB442 "teflon and ceramic" cells were performed in accordance with SCL-7504A. In a few instances, it was necessary to change the test procedures in order to meet the time allowed for the use of the environmental test equipment. USAERDL approval was obtained before any of these changes were made.

The sixteen (16) cells of each size, designated by SCL-7504A to receive the qualification tests, were numbered 1 to 16. These qualification numbers correspond to the serial numbers of each type in the following manner:

Serial Number					Serial Number				
Qual. No.	BB440 (10 AH)	BB441 (50 AH)	BB442 (100 AH)		Qual. No.	BB440 (10 AH)	BB441 (50 AH)	BB442 (100 AH)	
			Teflon	Ceramic				Teflon	Ceramic
1	00058	38	11	45	9	00052	18	27	53
2	00047	53	13	46	10	00056	58	29	54
3	00023	34	15	47	11	00021	21	31	55
4	00035	47	17	48	12	00020	43	33	56
5	00055	11	19	49	13	00014	17	35	57
6	00039	50	21	50	14	00038	31	37	58
7	00015	28	23	51	15	00048	13	39	59
8	00016	45	25	52	16	00044	35	41	60

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)Test Procedure as Per SCL-7504A:1) Inspection as per Paragraph 4.3

Cells #1-16 of each size were inspected for evidence of electrolyte leakage on the external surfaces. The weight of each cell was also recorded.

Comment:

There were no indications of electrolyte leakage on any of the external surfaces.

2) Full Capacity Discharge as per Paragraph 4.4.2.1

Cells #1-16 were charged in accordance with paragraph 4.4.1 (.2C₅ rate - 8 hours). After a minimum stand of 30 minutes between charge and discharge all the cells were discharged at the .2C₅ rate. The minimum specified discharge time to the 1.0 volt end point is 300 minutes.

Comment:

All test cells met the capacity requirements of the specification. Refer to Tables II, III, IV and V for individual cell performance.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)3) High Rate Discharge as per Paragraph 4.4.4

Cells #1-16 were charged as per paragraph 4.4.1. Cells 1-8 were discharged at the $3C_5$ rate and cells 9-16 were discharged at the $.2C_5$ rate. The discharge time and voltage requirements are as follows:

<u>Disch. Rate</u>	<u>Minimum Time to 1.0V</u>	<u>Minimum 5 Sec. Disch. Volt</u>
$3C_5$	15 min.	1.15 volt
$.2C_5$	300 min.	No requirement

Comment:

All test cells met the requirements of the specification.

Refer to Tables II, III, IV and V for discharge performance of the individual cells.

4) Low Temperature Test as per Paragraph 4.4.3

Cells #1-16 were charged as per paragraph 4.4.1. Cells #1-4 and #9-12 were placed in a cold chamber at -40°F and allowed to stabilize for at least 24 hours at this temperature. A discharge was then performed at the $.2C_5$ rate. The minimum specified time to the 1.0 volt end point is 150 minutes. Cells #5-8 and #13-16 were discharged at room temperature at the $.2C_5$ rate. The minimum specified time to the 1.0 volt end point is 300 minutes.

Comment:

All cells met capacity requirements during this test.

Refer to Tables II, III, IV and V for individual cell performance.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

- 5) Temperature Shock as per Paragraph 4.5.1 (In accordance with MIL-STD-202 Method 102A, Condition D)

Cells #1,2, 5,6, 9,10, 13, and 14 were used for the temperature shock requirements. The cells were in a discharged condition during the test. The temperature cycle was repeated five (5) times and is as follows:

30 minute stand at -44°C ; 10-15 minute stand at room temp.

30 minute stand at $+85^{\circ}\text{C}$; 10-15 minute stand at room temp.

Comment:

All cells met the specification requirements during and after the completion of the test.

- 6) Vibration (low and high frequency) as per Paragraph 4.5.5 and 4.5.6

Cells #1-16 were charged as per Paragraph 4.4.1. Cells 1,2, 5,6, 9,10, 13,14 were used for the vibration test.

The remaining cells were used as controls and discharged at the $.2\text{C}_5$ rate at room temperature.

The following vibration cycle was performed in each of three planes, one plane being perpendicular to the cell cover, and the other two planes being parallel to the cell cover and perpendicular to each other. Also, one of these latter planes was perpendicular to the plates.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

<u>Vibration Cycle:</u>	<u>Low Frequency</u>	<u>High Frequency In Accordance with (MIL-STD-202A Sec.C Part 2)</u>
Freq. Range	10-55-10 cps	55 - 2000 cps
Excursion	.06" double amplitude	-
Acceleration	-	10g
Scanning Rate	1 cycle/sec./minute	3 degrees/min.
Total Scanning Time	90-100 minutes	35 $\pm$ 5 minutes
Tests Performed*	O.C.V. monitored	.2C ₅ discharge

Comment:

There were no voltage interruptions or capacity failures on any of the three types of cells. The .2C₅ discharge rate was continued at the completion of the vibration tests and the total discharge time to the 1.0V end point is taken as the accumulated time during and after vibration. The minimum specified time to 1.0 volt is 300 minutes. Refer to Tables II, III, IV and V for the individual cell performance of the vibrated and non-vibrated cells.

* In order to complete the tests in the time allotted for the vibration, it was necessary, in some instances, to perform the .2C₅ discharge during the low frequency vibration. USAERDL approval was obtained for this additional discharge.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

Shock, Acceleration and Altitude as per Paragraph 4.5.2,
4.5.3, 4.5.4

Cells #1-16 were charged at the $.2C_5$ rate. The odd numbered cells (1, 3, 5, 7, 9, 11, 13, 15) were used for the Shock, Acceleration and Altitude tests. The even numbered cells (2, 4, 6, 8, 10, 12, 14, 16) performed as controls and were discharged at room temperature at the $.2C_5$ rate to the specified end point.

Shock:

Each cell was subjected to three mutually perpendicular shocks of equal magnitude. For each shock the cell was accelerated in such a manner that during the first 3 milliseconds the minimum average acceleration was 75 g's. The open circuit voltage of each cell was monitored during each shock plane.

Comment:

There were no voltage interruptions observed in any of the cells during any part of the shock test.

Acceleration:

The cells were subjected to an acceleration of 60 g's in both directions along an axis perpendicular to the top and bottom of the cell, and in one direction along each of the other two mutually perpendicular axes. Each period of the acceleration was for a duration of 5 minutes. The total acceleration time was 20 minutes.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

7) (continued)

Comment:

During the testing of the BB442 (100 A.H. "teflon" cells) the acceleration fixture failed and four (4) of the cells were damaged. Although the damage will prevent the final acceptance of these particular cells, they continued along in the remaining phases of the test program meeting capacity requirements. (Refer to section discussing extent of cell damage).

The $.2C_5$ rate discharge was performed on the BB440 (10 A.H.) cells during each of the 5 minute acceleration periods. The discharge was then continued in the altitude test. This extra test was performed with USAERDL approval.

Elevation:

On completion of the acceleration tests the eight (8) cells were placed in an altitude chamber in an upright position. The barometric pressure was reduced to simulate an altitude of 120,000 feet above sea level (3.5 mm Hg) and a discharge at the $.2C_5$ rate was performed. The altitude conditions were maintained until the specified cutoff voltage was reached. The minimum specified time to 1.0 volt is 300 minutes.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

7) (continued)

Comment:

All the cells met the capacity requirements during the altitude test. Refer to Tables II, III, IV, and V for the individual cell performance.

8) Full Capacity Discharge as per Paragraph 4.4.2.1

On the completion of all the environmental and temperature tests, the sixteen (16) cells were charged at the $.2C_5$ rate and discharged at the $.2C_5$ rate at room temperature. The minimum specified time to the 1.0 volt end point is 300 minutes.

Comment:

All cells met capacity requirements during this final test. Refer to Tables II, III, IV and V for individual cell performance.

9) Inspection as per Paragraph 4.3

Each of the sixteen (16) qualification cells was inspected for indications of electrolyte leakage around the seals, vents and heliarc welds, and the weight of each cell was compared with the weight taken prior to the start of the qualification test. Average performance during the qualification tests is summarized in the discharge curves, figures 7, 8 and 9.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

9) (continued)

Comment:

Except for the four (4) BB442 "teflon" cells damaged during acceleration by failure of the fixture, there were no indications of external damage or electrolyte leakage around the terminal seals or heliarc welds, nor any loss in weight on any of the sixteen (16) cells of each type tested.

Two of the four cells damaged by the acceleration fixture failure appear to be perfectly functional. Due to the extent of the denting and gouging of the cell case material (Figure 10), there is possibility of core damage. The other two damaged cells are no longer sealed, since the terminals were driven into the cover, destroying the teflon seal (Figure 11). All four cells have been replaced with new cells containing ceramic seals, using the original serial numbers (11, 27, 35, 39).

Test Locations and Witnesses:BB440/U Cells (10 A.H.)

All electrical and temperature tests were performed at Sonotone. All environmental tests were performed at York Research, Stamford, Conn., witnessed by Mrs. Sylvia Duzé of USAERDL.

IV. DATA AND DISCUSSION (continued)

B. Summary (continued)

8. Qualification Tests (continued)

9) (continued)

BB441/U Cells (50 A.H.)

All electrical, temperature and vibration tests were performed at Sonotone. (Vibration witnessed by Mrs. Sylvia Duze). All remaining environmental tests performed at York Research, Stamford, Conn. (Witnessed by Mrs. Sylvia Duze).

BB442/U Cells (100 A.H. Teflon and Ceramic)

All electrical and temperature tests performed at Sonotone. All environmental tests performed at General Precision Labs., Pleasantville, N. Y. There was no USAERDL witness present. We are attaching an affidavit from General Precision Labs covering the environmental testing. (See Exhibit I).

V. OVERALL CONCLUSIONS

1. Large sealed nickel-cadmium cells can be manufactured incorporating all of the advantages of the more conventional sizes.
2. Based on the minus 40°F data, these large cells have superior low temperature discharge characteristics to the usual size cells.
3. Since no abnormal behavior was exhibited by the 100 A.H. capacity cell, this does not appear to be the maximum in size and capacity for this design.
4. The requirements of SCL-7504A are realistic.

VI. RECOMMENDATIONS

1. The cells delivered under this contract should be checked for conformance to the design objectives of SCL-7504A regarding life cycling and storage.
2. The excellent low temperature performance of these cells should be further explored.
3. When these cells are connected in series, the metal cell cases should be electrically insulated from each other, and the hardware shown in Figure 12 should be used. When fastening the intercell connectors, torque should not exceed 50 inch pounds on the teflon sealed terminals, and 30 inch pounds on the ceramic sealed terminals.
4. Work should be done on improving the overcharge and heat dissipation characteristics of these cells, the aim being ultimate use of this type of cell in vehicles or other applications where the charging is done by constant potential devices.
5. Adapt recent developments in Sonotone satellite cells for use in these large cells, e.g.

New separators

New Plaque loading techniques

New ceramic sealing techniques.

VII. PERSONNEL

Listed below are the personnel who worked on the contract for a total of over 200 hours, together with the total number of hours spent by the Design Engineering Group and by the Battery Improvement Laboratory.

Design Engineering

<u>Name</u>	<u>Title</u>	<u>Hours</u>
J. Herrmann	Environmental Test Engineer	200
H. Bilsky	Supervisory Engineer	520
I. Michalko	Des. Engineer	2100
I. Goldstein	Des. Engineer	850
G. Lanni	Machinist	530
M. Legman	Machinist	230
Others		<u>870</u>
	Design Engineering Total	5300

Battery Improvement Laboratory

F. Alliegro	Supervisory Engineer	860
W. Ryan	Administration	205
R. McCormick	Assoc. Engineer	2100
J. Perez	Engineer	310
D. Volpe	Technician	300
J. Spiteri	Technician	260
Others		<u>1165</u>
	Battery Improvement Lab. Total	5200
Combined Total		10,500

The above does not include production personnel.

CROSS SECTION DIMENSIONS OF CYLINDRICAL CELLS
AND LOCATION OF NYLON SPACERS

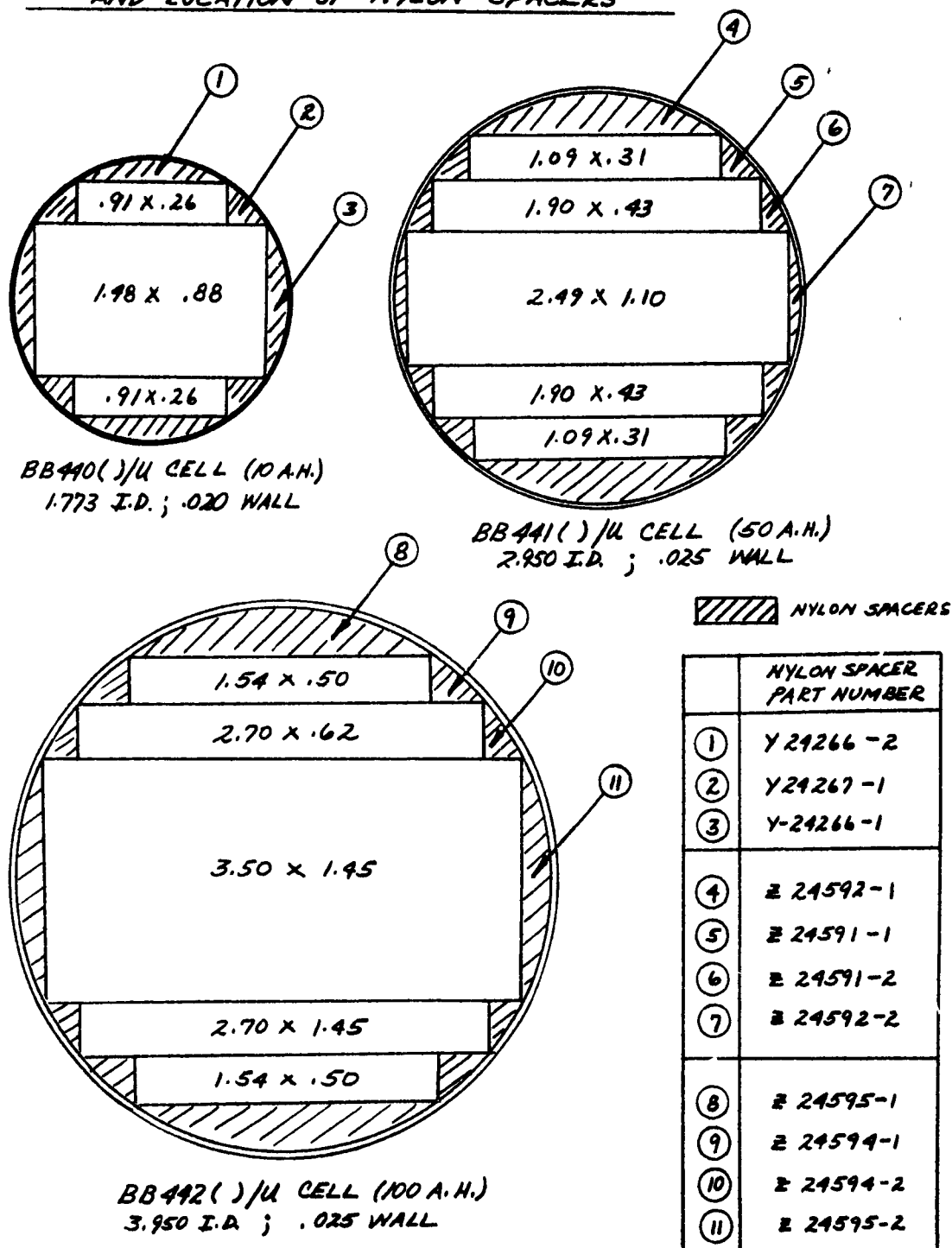
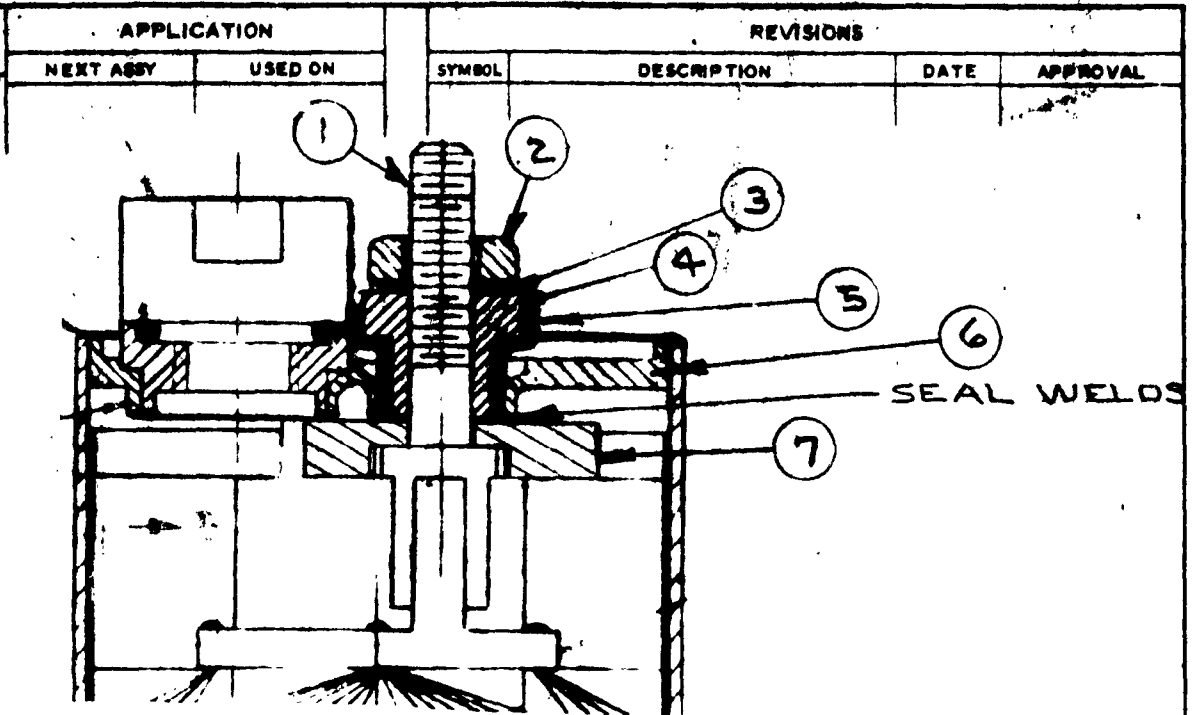


FIG. 1

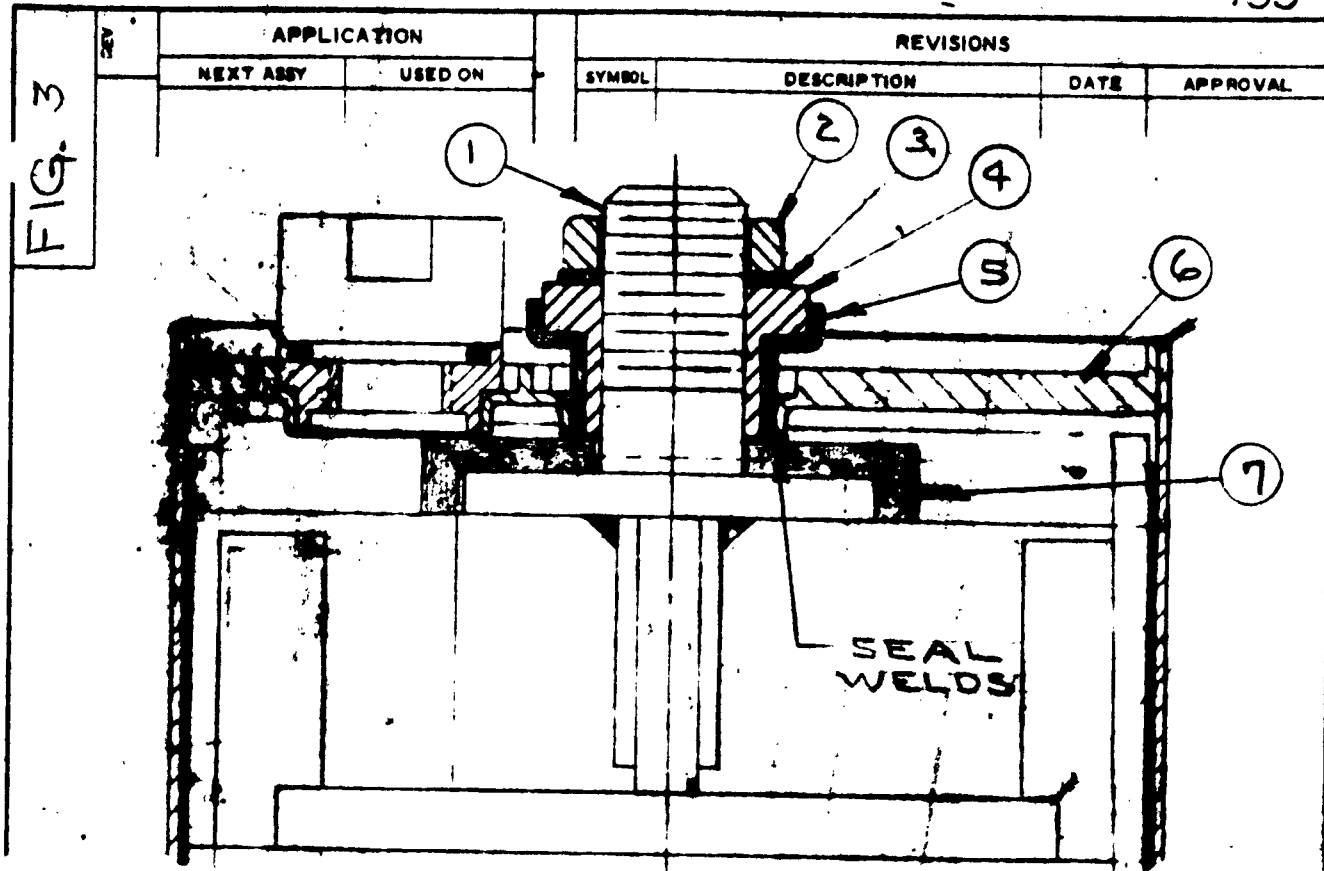
FIG. 2



- 1- TERMINAL
- 2- NUT
- 3- FLAT WASHER - STAINLESS STEEL
- 4- TEFLON SEAL
- 5- RETAINER - STAINLESS STEEL
- 6- COVER - STAINLESS STEEL
- 7- INTERIOR TERMINAL WASHER - TEFLON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON FRACTIONS DECIMALS ANGLES $\pm 1/64$ ± 0.10 ± 0.20 APPLICABLE SPEC. SPEC. PM. SPEC. P.C. SPEC. ENCL. SPEC.	SIGNATURES	DATE	TITLE	SONOTONE CORP. ELMSFORD, N. Y.
	DESIGNER		TEFLON SEAL 10 A.H.	
	DRAWNMAN			
	CHECKER			
	APPROVED			
	APPROVED			
	APPROVED			
	APPROVED			
	APPROVED			

SCALE	DWG SIZE	FIG. 2	REV.
DO NOT SCALE DRAWING	A	SHEET	97



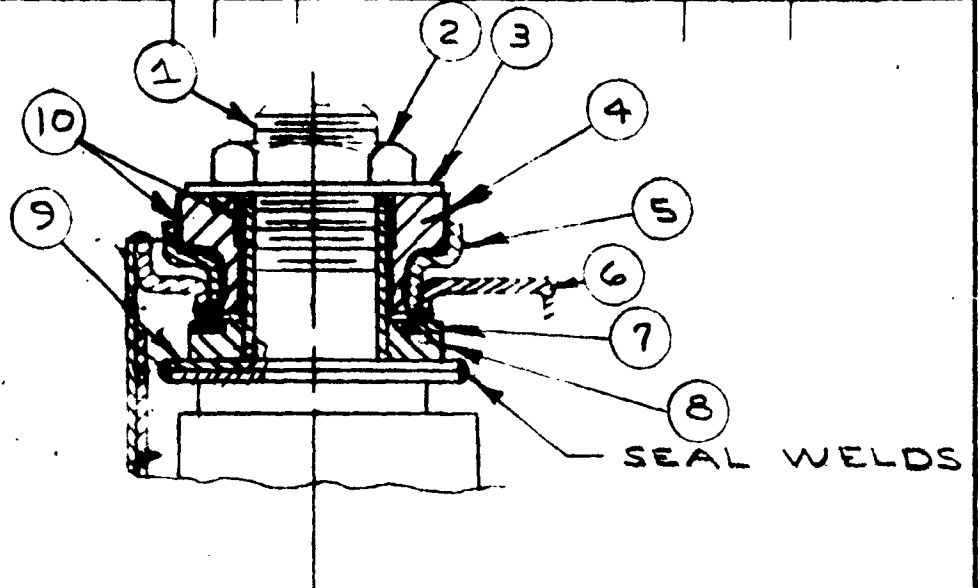
- 1- TERMINAL
- 2- NUT
- 3- FLAT WASHER - STAINLESS STEEL
- 4- TEFLON SEAL
- 5- RETAINER - STAINLESS STEEL
- 6- COVER - STAINLESS STEEL
- 7- INTERIOR TERMINAL WASHER - TEFLON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>FRACTIONS</th> <th>DECIMALS</th> <th>ANGLES</th> </tr> <tr> <td>$\pm 1/64$</td> <td>± 0.10</td> <td>$\pm 0^{\circ}30'$</td> </tr> </table> APPLICABLE SPEC. 1. SPEC.	FRACTIONS	DECIMALS	ANGLES	$\pm 1/64$	± 0.10	$\pm 0^{\circ}30'$	SIGNATURES	DATE	TITLE	SONOTONE CORP. ELMSFORD, N. Y.
	FRACTIONS	DECIMALS	ANGLES							
	$\pm 1/64$	± 0.10	$\pm 0^{\circ}30'$							
	DESIGNER		TEFLON SEAL 50 A.H.	FIG. 3						
	DRAFTSMAN									
CHECKER										
APPROVED										
APPROVED										
APPROVED										
APPROVED										
APPROVED										

SCALE DO NOT SCALE DRAWING	DWG SIZE A	SHEET OF
-------------------------------	--	-------------

FIG. 4

APPLICATION		REVISIONS			
NEXT ASSY	USED ON	SYMBOL	DESCRIPTION	DATE	APPROVAL



- 1- TERMINAL
- 2- NUT
- 3- BELLEVILLE SPRING WASHER
- 4- CERAMIC SEAL
- 5- CERAMIC SEAL RETAINER-OUTER
- 6- COVER - STAINLESS STEEL
- 7- BALL BEARING WASHER
- 8- CERAMIC SPACER
- 9- CERAMIC SEAL RETAINER - INNER
- 10- BRAZE MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
AND AFTER PLAYING
TOLERANCES ON

FRACTIONS	DECIMALS	ANGLES
$\pm 1/64$	± 0.010	$\pm 30' 30''$

UNLESS OTHERWISE SPECIFIED

MA. SPEC.

FIN. SPEC.

PROD. SPEC.

QUAL. SPEC.

SIGNATURES

DESIGNER
DRAWN BY
CHECKER
APPROVED
APPROVED
APPROVED
APPROVED
APPROVED

DATE

TITLE

CERAMIC
SEAL
I.D. & O.D.

SONOTONE
CORP.
ELMSFORD,
N. Y.

SCALE

DO NOT SCALE DRAWING

DWG
SIZE

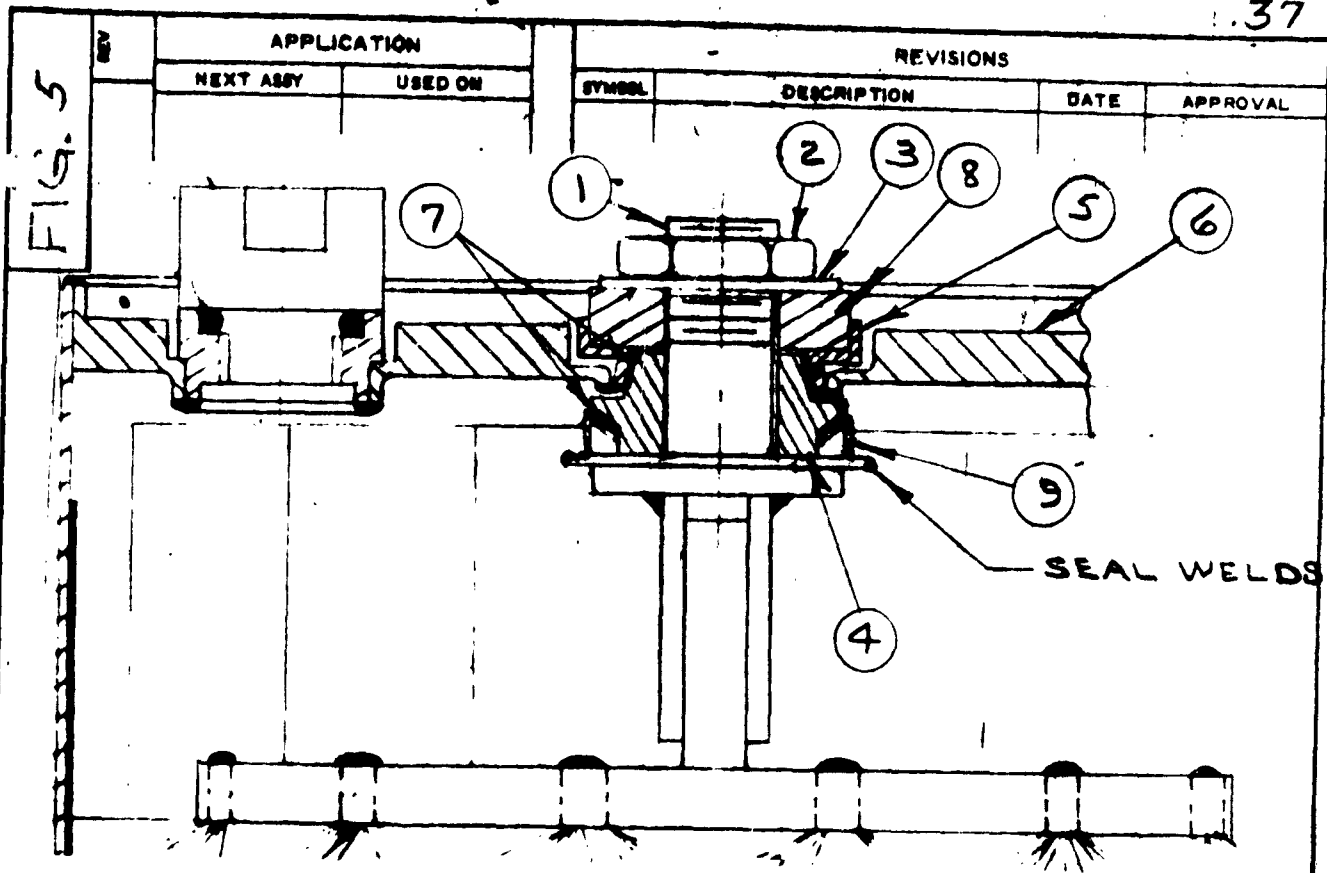
A

FIG. 4

SHEET

REV.

FIG. 5



- 1- FLANGE NUT
- 2- NUT
- 3- SPRING WASHER
- 4- CERAMIC SEAL - DOUBLE TAPER
- 5- CERAMIC SEAL - DOUBLE TAPER
- 6- TOWER - STAINLESS STEEL
- 7- CERAMIC SEAL
- 8- CERAMIC SPACER
- 9- CERAMIC SEAL

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND AFTER PLATING TOLERANCES ON FRACTIONS DECIMALS ANGLES ±1/64 ±0.010 ±0.30 APPLICABLE SPEC. . SPEC. FIN. SPEC. PROC. SPEC. QUAL. SPEC.	SIGNATURES		DATE	TITLE		SONOTONE CORP. ELMSFORD, N. Y.	
	DESIGNER			CERAMIC			
	DRAFTSMAN			SEAL			
	CHECKER			DOUBLE TAPER			
	APPROVED						
	APPROVED			SCALE	DWG SIZE	FIG. 5	REV.
	APPROVED			DO NOT SCALE DRAWING	A	OF	

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.
Z-22355

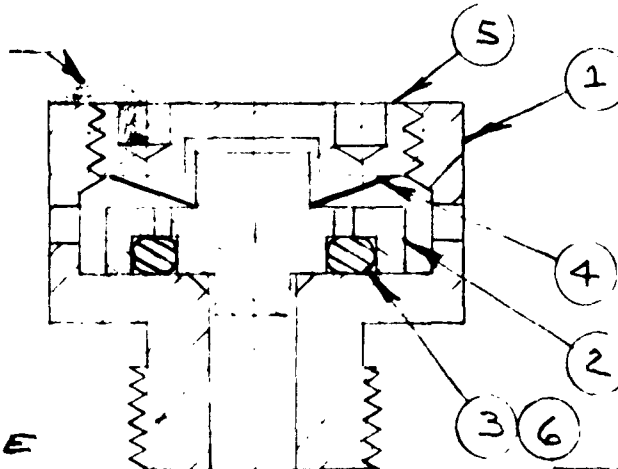
DESCRIPTION VALVE ASSY - VENT

SCALE 4X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	VALVE BODY	T22356					1
2	"O" RING RETAINER	Y22357					1
3	"O" RING	Y10343					1
4	BELLEVILLE SPRING	IT.16 Y16128 IT.20					1
5	VALVE SCREW	Z22358					1
6	SILICONE GREASE- HIGH VACUUM		MS20019 IT.16 MS20007 IT.14				AS REQ. AS REQ.
7	CEMENT						1

SEE NOTE 3



1-COAT IT.3 WITH
IT.6. USE GREASE
SPARINGLY.

2-CALIBRATE TO
RELEASE PRESSURE
OF 200 ± 10 PSIG.

3-AFTER CALIBRATING
PLACE CEMENT IT.7
AS SHOWN.

ASSY	RELEASE PRESSURE
1	200 ± 10
2	100 ± 10

R-1386	R-1384
R-1385	W-24240

IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z22355	DRAWN BY S. J. 12/19/57	CHECKED BY:	ENG. APPROVAL	RES. APPROVAL	CHANGES	ADD AS 22355 4/17/62
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W-24250
X-24260
PL 1279
X-22340
ASSEMBLIES USED ON

FIG. 6

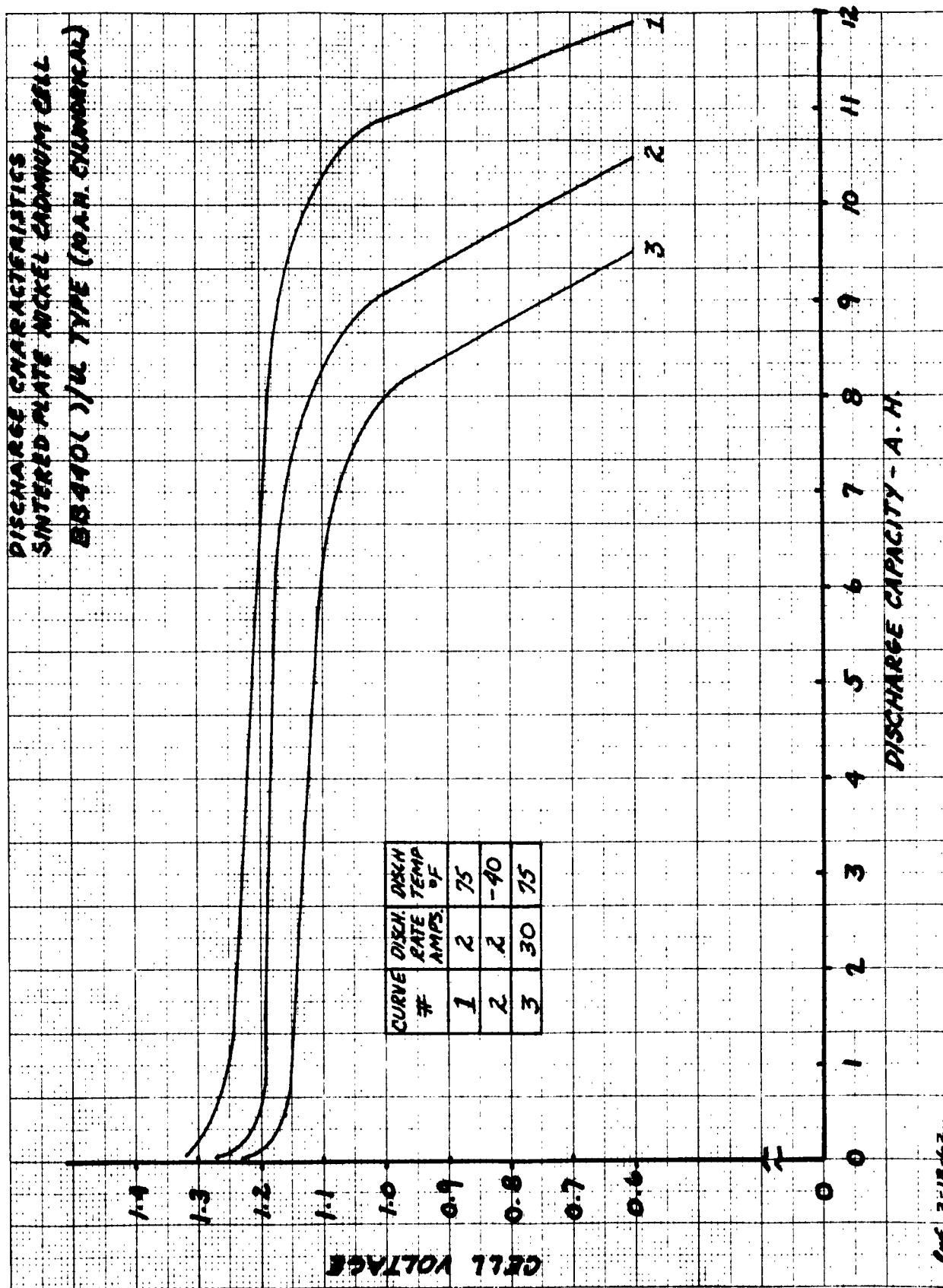


FIG. 7

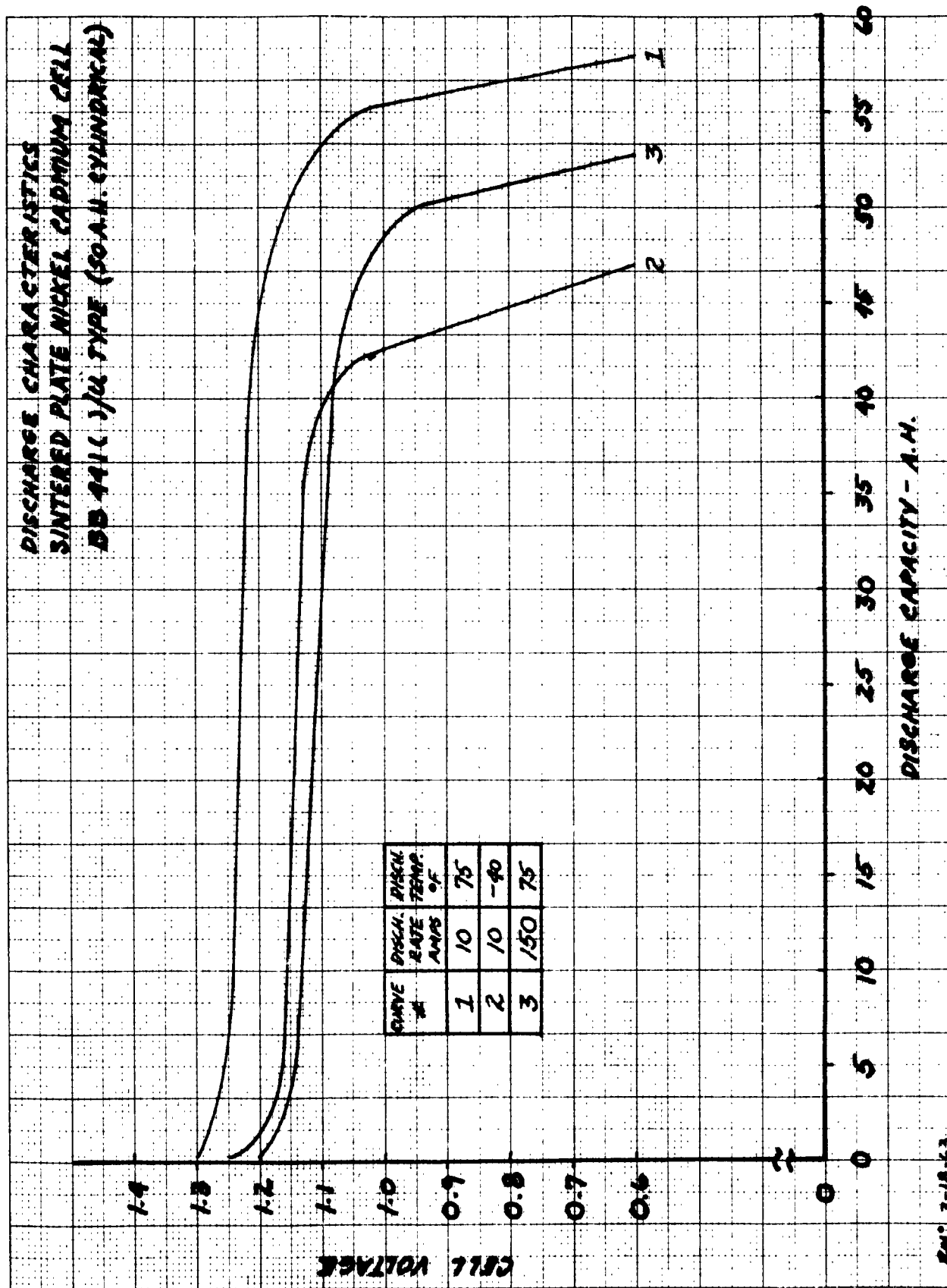
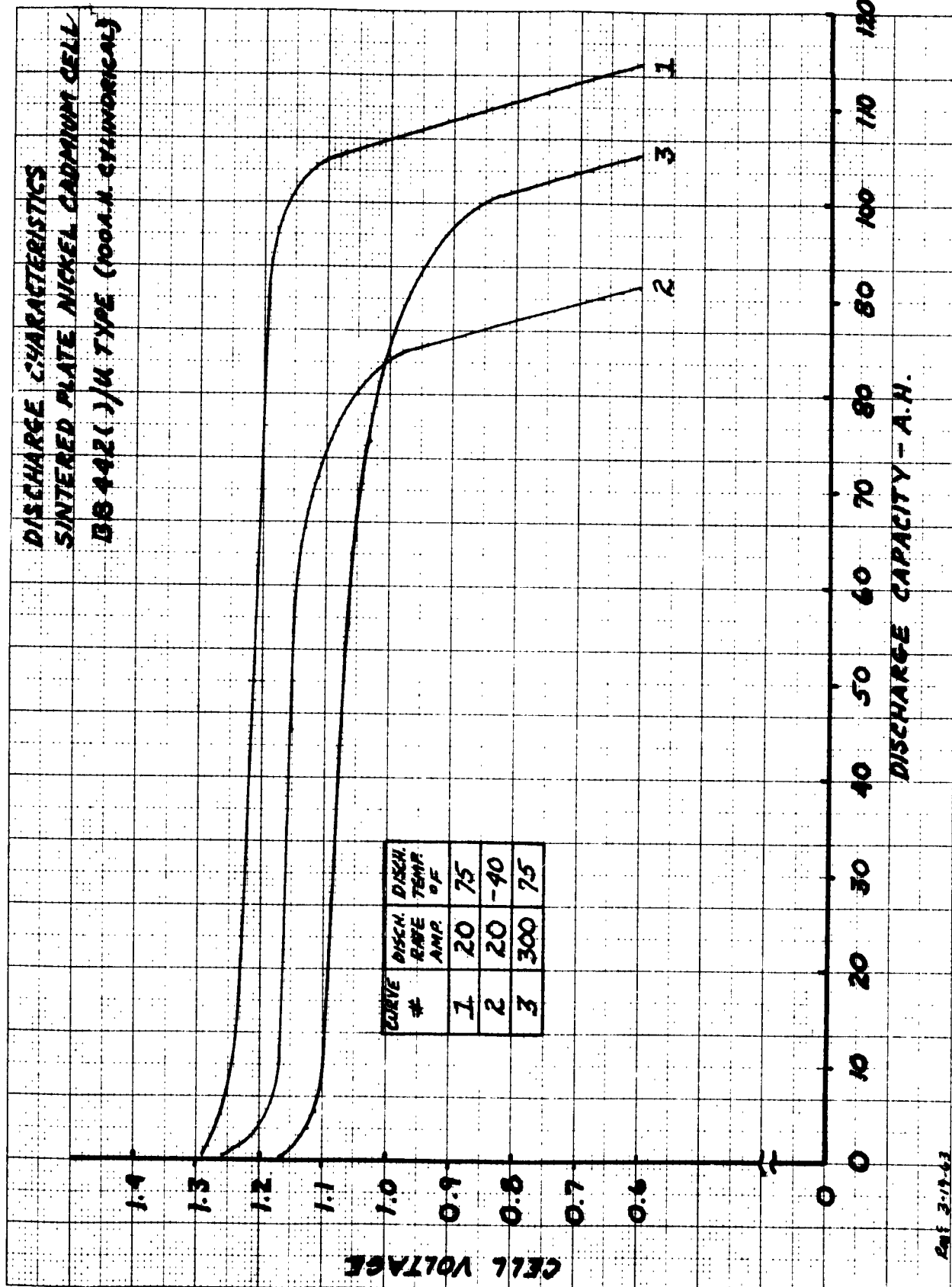


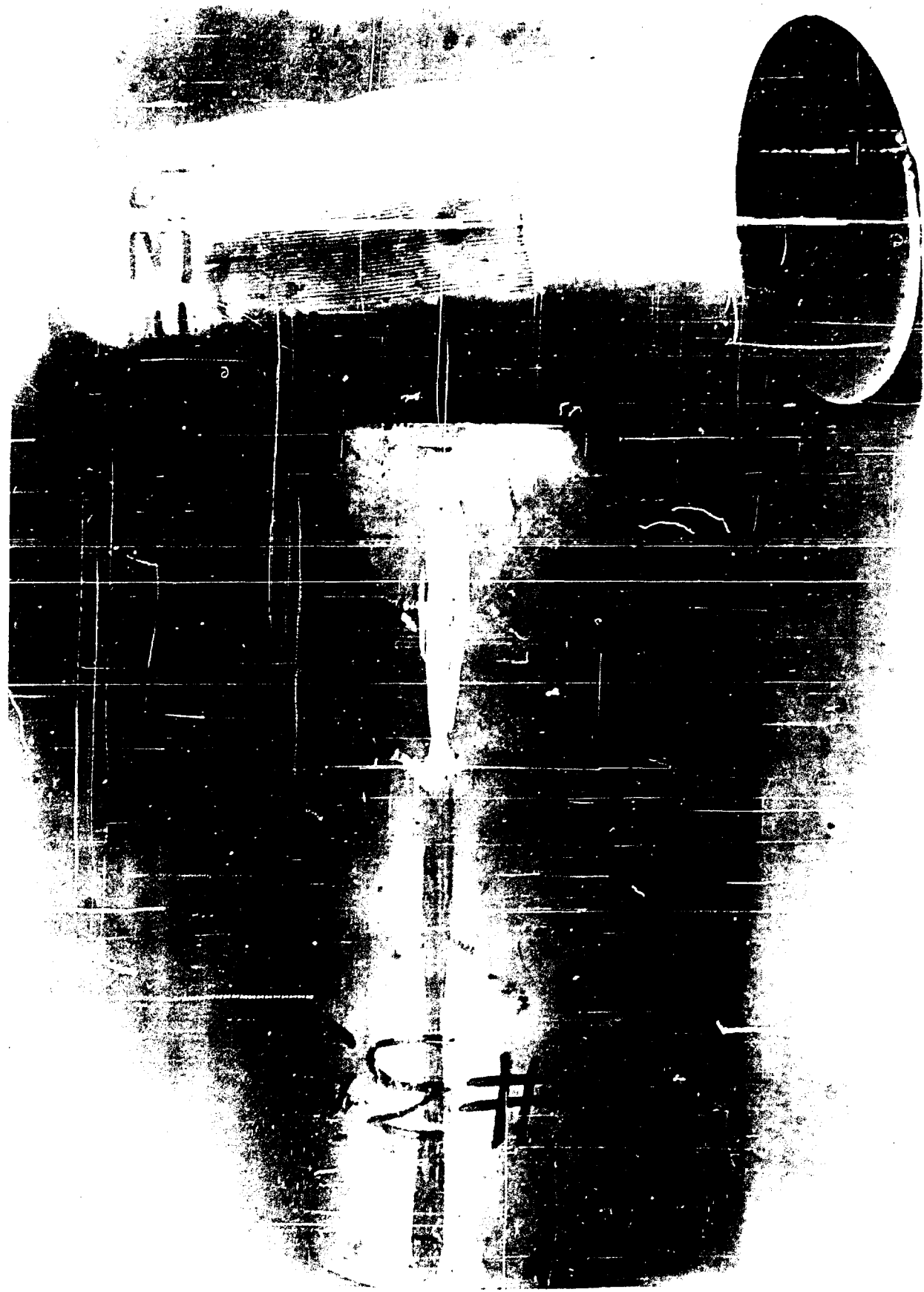
FIG. 8



Ref 3-19-63

FIG. 9

P. 91





QUALIFICATION TEST 88410(1)UL CELL AS PER SCL 75041
(10 A.H. CYLINDRICAL CELL)

TABLE II

P. 44

SERIAL NUMBER	00058	00047	00023	00035	00035	00039	00015	00016	00052	00056	00027	00021	00014	00038	00098	00044
QUAL. TEST NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TEST DESCRIPTION																
1. INSPECTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. 2G RATE (2 AMPERES)	400.2 406.3	400.4 412.4	404.7 413.6	395.3 410.5	391.7 408.3	399.7 409.9	408.2 417.3	403.4 410.6	408.4 414.7	401.2 407.4	385.1 401.4	376.9 383.2	390.4 401.6	413.6 422.7	391.3 408.4	402.3 407.7
DISCH. 2G RATE	389.1	391	386.7	384.6	379	386.1	390.3	387								
DISCH. 3G RATE (30 AMPERES)	396.2	400.2	393.7	390.1	388	394.5	400.4	394.6								
5 SEC. VOLT.																
1.0V									1.22	1.22	1.23	1.22	1.21	1.22	1.22	1.21
0.6V									15.8	17.2	16.5	16.1	15.9	17.2	15.7	16
									17.6	20.6	19.4	19.7	19.1	20.6	18.3	19.2
DISCH. 2G RATE																
DISCH. 2G RATE (-40°F)	285.5	252.1	214.6	297					2678	3114	270.1	2644				
NO DISCH.	311.1	285.6	292.2	320					321	326	311.4	312				
TEMP SHOCK	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. 2G RATE			327	329			338.5	343.7			328	330.8			325	322.5
			349	357			375.1	384.9			366.7	353.4			355.6	356.6
DISCH. 2G RATE (VIBRATION)	308.6	304.6				307.7			322.6	327.3			321.6	306.8		
	322.7	313.5				320.9			339.7	327.6			331.5	313.4		
DISCH. 2G RATE		307.2		340.1		310.5		338.6		327.6		321.5		317.6		328.3
		343.5		368.7		341.4		371.1		357.3		360.1		348.1		368.8
DISCH. 2G RATE (SHOCKS, ACCEL., & ALTITUDE)	343.4		334.7				325.5		353.9		345.6		343.9		356.9	
	351		353.4				346.5		363.3		363.8		354		366.3	
DISCH. 2G RATE	321.4	322.3	302.6	334.3	301.9	319.7	321.1	333.5	324.1	344.3	310.7	324.5	323.2	331.8	319.8	324.9
	344.6	345.6	344.3	361.8	340.2	357.1	359.3	363.4	354.3	356.5	350.7	358.3	351	354.7	345.1	361.1
INSPECTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

* NO DISCH. DURING SHOCK; 88 HR. STAND AT 0°F BETWEEN ACCEL. & ALTITUDE TESTS.

QUALIFICATION TEST BB441(1)/U CELL AS PER SEC 7504A
(50 A.H. CYLINDRICAL CELL)

TABLE III

P. 45

SERIAL NUMBER	38	53	34	47	11	50	28	45	18	58	21	43	17	31	13	35
QUAL. TEST NUMBER	1	2	3	4	5	6	7	8	9	10	11	2	13	14	15	16
TEST DESCRIPTION																
1. INSPECTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. .2G RATE (10 AMPERES)	317.1	32.3	317.8	315.8	315.8	310	318	311.8	316	313.5	314.4	32.8	311.8	321.5	319.5	319
DISCH. .2G RATE	339.5	343.4	343	337.8	333	334.5	338.4	330.5	333.7	330.7	334	32.9	322.2	340	338	340.5
DISCH. .2G RATE									350.7	338.5	348.3	352.9	355.8	345.2	350.5	344.1
DISCH. .2G RATE (150 AMPERES)	1.22	1.20	1.20*	1.20	1.20	1.19-	1.20	1.185	365.2	357.4	367	361.7	372.2	373.4	365	368.8
DISCH. .2G RATE	1.0V	1.0V	1.0V	1.0V	1.0V	1.0V	1.0V	1.0V								
DISCH. .2G RATE (-40°F)	236.7	251.7	259.7	253.9	357.5	356.2	361.5	360	254	254.5	265.7	261.6	356	356	359	352
TEMP. SHOCK	256.6	273.1	281.6	277.3	371.9	377.2	371.1	371.7	285	287.4	298.1	294.6	376	383	374	383
DISCH. .2G RATE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. .2G RATE			345.5	338.5			357	350.5			330	335			353.4	356.8
DISCH. .2G RATE (VIBRATION)		331	360	358.5		337	369.5	360.2	314	302.4	350	351.4	333	344.5	364	376
DISCH. .2G RATE	316.5	337			333.8	345			318	307			342	331		
SHOCK & ACCEL.		334.6		333		316.1		321.3		332.5		332.7		320		336.6
DISCH. .2G RATE	✓	345.6	✓	340.7	✓	327.4		329	✓	349	✓	331.9	✓	329.8	✓	339.5
DISCH. .2G RATE (ALTITUDE)	313.4		321.6		303.8		318.6		308		328.1		301.5		312.5	
DISCH. .2G RATE	323.3		336.8		312.4		334.1		319.1		339.3		304.1		327.4	
DISCH. .2G RATE	314	328	320.2	319.6	305	315.8	305	304.7	315.9	331	316	325.5	314	320	306	323.5
INSPECTION	337	353	341.6	337.1	322	337.3	313	321.4	332.1	343.2	330.1	340.6	329.1	331.6	319	341.4

QUALIFICATION TEST BB442(1) 1/4 CELL AS PER SCL 2509A
(100 A.H. CYLINDRICAL CELL WITH THERON SENS)

TABLE IV

P. 46

SERIAL NUMBER	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41
QUAL. TEST NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
TEST DESCRIPTION	*								*				*		*	
1. INSPECTION	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. .2G RATE (20 AMPERES)	341.7	343.4	344.1	355	333.8	337.4	353.3	332.6	335.5	342	339.4	342.4	339.6	338.9	339.6	333.4
DISCH. .2G RATE	358.9	360.8	361.1	369.3	355.1	357.2	368.1	355.6	359.2	355.7	356	356.3	356.3	356	353.8	349.1
DISCH. .2G RATE									328.5	336	326.9	329.2	329.1	329.5	332	325
DISCH. .2G RATE (300 AMPERES)	1.16	1.16	1.155	1.155	1.16	1.16	1.155	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16	1.16
DISCH. .2G RATE	17.5	17.7	17	18.3	15.7	15.4	17	16.3								
DISCH. .2G RATE	22.4	22.4	21.3	21.4	21	20.4	21	20.6								
DISCH. .2G RATE					312.4	318	322.5	322.5	248.7	245	246.5	244	308	306.1	308	307.5
DISCH. .2G RATE (-40°F)	252.3	249.2	252	289.5					269.5	267	268	267.5				
TEMP. SHOCK	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DISCH. .2G RATE			312	341			336	330			306	310			321	321
DISCH. .2G RATE (VIBRATION)	344.1	311.3	316	344			339	333			312	315		310.2	326	327
DISCH. .2G RATE	320.2	315.9		334.3	315.6	325		306.8	303.3	308.7			310.2	319.9		
DISCH. .2G RATE		304.6		338	305.6	308.3		311.8	317	324		305.3	315.6	307		310.2
SHOCK & ACCEL.	✓	313.7	✓		✓	308.3	✓		✓	317.7	✓	308	✓	314	✓	313
DISCH. .2G RATE (ALTITUDE)	307.2	310.1			315		304.6		304.8		310.6		332		321.7	
DISCH. .2G RATE	313	313			324		312.7		311.1		313		340		345	
DISCH. .2G RATE	352	316	307	348	311.5	311	322	321	345	323	308.4	306.1	314	306	306.8	308.4
DISCH. .2G RATE	360	322	315	351	322	317	329	326	352	329	315	313	321	308.1	310	317
INSPECTION.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NOTE: * CELLS DAMAGED DURING ACCELERATION TEST

[illegible]

TABLE V



GPL Division
GENERAL PRECISION, Inc.
PLEASANTVILLE, NEW YORK

ENVIRONMENTAL TEST REPORT

NO. D-120

ITEM DESCRIPTION

100 Ampere Hour Cells

Teflon Seals

MANUFACTURED BY Sonotone, Elmstedt, N.Y.

MFRS PART NO. _____ GPL PART NO. _____

QUANTITY Sixteen (16) CHARGE NO. 101-1000

TEST REQUESTEE J. Herman, Sonotone

TEST CONDUCTED BY A. Lanzetta Wm. Greubel
A. Lanzetta W. Greubel

TEST REPORT BY Wm. Greubel
W. Greubel

APPROVED BY R. Baran DATE 3/26/63
R. Baran
Dynamic Test Section

EXHIBIT 2

GPL DYNAMIC TEST SECTION

TEST REPORT NO. D-120

page 2 of 5

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BEST
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GRL DYNAMIC TEST SECTION

TEST REPORT NO. D-179

Page 3 of 5

I PURPOSE

- 1.1 To determine the ability of the 100 ampere hour battery cells to withstand the vibration, shock, acceleration, and altitude tests described below without mechanical or electrical failure.

II TEST SPECIFICATIONS AND INSTRUCTIONS

- 2.1 Specification 300-7504A, Paragraphs 4.4.2 thru 4.5.3.
- 2.2 Environmental test request dated 2-25-63.

III TEST EQUIPMENT

- 3.1 20 Vibration Exciter, Model 5-55
- 3.2 20 Control Console, Model 7-60
- 3.3 20 Endevco Accelerometer, Model 221
- 3.4 20 Endevco Accelerometer, Model 221B
- 3.5 20 Vibration Exciter, Model 1-100
- 3.6 20 Vibration Meter, Model 43
- 3.7 20 Vibration Pickup, Vertical - Type 124
- 3.8 20 Vibration Pickup, Vertical, Type 124
- 3.9 20 Vibration Pickup, Horizontal - Type 124
- 3.10 Ballantine VIV, Model 601
- 3.11 Hewlett - Packard Audio Oscillator, Model 2010
- 3.12 Dumont Cathode Ray Oscillograph, Type 300A
- 3.13 Barry 150 VU Medium Impact Shock Machine
- 3.14 Brown-Mite Band Pass Filter
- 3.15 Endevco Accelerometer, Model 221B

OPT-DYNAMIC TEST SECTION

TEST REPORT NO. D-120

Page 4 of 5

III TEST EQUIPMENT (cont'd)

3.16 Rotary Accelerator

3.17 Rotary Accelerator Console

3.18 Test fixtures - supplied by Sonotone Corp.

IV TEST PROCEDURE4.1 Vibration test

4.1.1 The test specimens were subjected to sinusoidal vibration in each of the 3 mutually perpendicular axes per specification MIL-STD-883C, paragraphs 4.5.5 and 4.5.6.

"4.5.5 Low Frequency Vibration - 10:55:10 cps @ 1 cps/min sweep, 0.5 in/axis
0.001" rms Amplitude

4.5.6 High Frequency Vibration - 55:2000 cps in 30 min
0.1 g ± 10%

4.2 Shock test

4.2.1 The test specimens were subjected to a mechanical impact shock test as follows: 3 shocks per specimen, one shock in each of 3 mutually perpendicular axes, with the shock level of $\frac{1}{2}$ g reached in $\frac{1}{2}$ milliseconds.

4.3 Acceleration test

4.3.1 The test specimens were subjected to an acceleration test as follows: Acceleration level 60 g's for a duration of five (5) minutes in each of the four (4) directions outlined below;

1. perpendicular to the specimens terminals
2. Perpendicular to the specimens terminals (rotated 90°)
3. parallel to the thrust axis
4. parallel to the thrust axis inverted 180°

4.4 Altitude Test

- 4.4.1 The test specimens in an upright position, were subjected to a simulated altitude of 120,000 feet while a five (5) hour discharge test was conducted by Sonotone personnel.

V TEST RESULTS

5.1 Vibration Test

- 5.1.1 The test specimens were monitored during vibration testing and showed no electrical or mechanical damage.

5.2 Shock Test

- 5.2.1 The test specimens were monitored during mechanical impact shock testing and showed no electrical or mechanical damage.

5.3 Acceleration Test

- 5.3.1 The test specimens were monitored during acceleration testing and showed no electrical damage in the following two (2) axis:

- 1) perpendicular to specimens terminals
- 2) **perpendicular to specimens terminals (rotated 90°)**

- 5.3.2 Upon raising rotary accelerator up to desired speed with specimens parallel to thrust axis (inverted 180°), a tightening bolt sheared allowing four (4) test specimens to be dislodged from original position resulting in mechanical and electrical damage to the four specimens. Test was stopped to allow Sonotone to redesign test fixture.

- 5.3.3 The test specimens mounted on redesigned test fixture were subjected to the remaining two (2) axes of acceleration testing and showed no further electrical or mechanical damage.

5.4 Altitude Test

- 5.4.1 The test specimens were monitored during altitude testing and showed no further electrical or mechanical damage.

48a



GPI Division
GENERAL PRECISION, Inc.
PLEASANTVILLE, NEW YORK

ENVIRONMENTAL TEST REPORT

NO. D-124

ITEM DESCRIPTION

100 Ampere Hour Cells
Ceramic Seals

MANUFACTURED BY Sonotone, Elmford, N.Y.

MFRS PART NO. _____ GPI PART NO. _____

QUANTITY Sixteen (16) CHARGE NO. 101-17960

TEST REQUESTEE J. Herman, Sonotone

TEST CONDUCTED BY W. Grubel

TEST REPORT BY W. Grubel

APPROVED BY R. Brown DATE 3 26-63

W. Grubel
Dynamatic Test Division

EXHIBIT 2

OPL DYNAMIC TEST SECTION

48 F
TEST REPORT NO. D-124

Page 2 of 5

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V	TEST RESULTS	5

JPL DYNAMIC TEST SECTION

TEST REPORT NO. D-124

Page 3 of 5

I. PURPOSE

- 1.1 To determine the ability of the 100 Ampere Hour Battery Cells to withstand the vibration, shock, acceleration, and altitude tests described below without mechanical or electrical failure.

II. TEST SPECIFICATIONS AND INSTRUCTIONS

- 2.1 Specification 001-7504A, paragraphs 4.3.2 thru 4.3.6.
- 2.2 Environmental Test request dated 2-25-63.

III. TEST EQUIPMENT

- 3.1 MB Vibration Exciter, Model C-50
- 3.2 MB Control Console, Model 1-60
- 3.3 Endevco Accelerometer, Model 2211
- 3.4 Endevco Accelerometer, Model 2215
- 3.5 LAB Vibration Exciter, RVN-1000
- 3.6 MB Vibration Meter, Model M3
- 3.7 MB Vibration Pickup, Vertical - Type 124
- 3.8 MB Vibration Pickup, Vibromate, Type 11
- 3.9 MB Vibration Pickup, Horizontal - Type 111
- 3.10 Ballantine RVN, Model 601
- 3.11 Hewlett-Packard Audio Oscillator, Model 2010
- 3.12 Dumont Cathode Ray Oscillograph, Type 304A
- 3.13 Barry 450 VD medium impact Shock machine
- 3.14 Kronn-Hite Band Pass Filter
- 3.15 Endevco Accelerometer, Model 2215

III TEST EQUIPMENT (cont'd)

3.16 Rotary Accelerator

3.17 Rotary Accelerator Console

3.18 Test Fixtures - supplied by Sonotone Corp.

IV TEST PROCEDURES4.1 Vibration Test

4.1.1 The test specimens were subjected to sinusoidal vibration in each of the 3 mutually perpendicular axis per specification OGI-7502A, paragraph 4.2.2 and 4.2.3.

"4.2.2. Low Frequency Vibration - 1000:10 c/s @ 1 cps/min sweep, 0.1 in/axis
0.001" DBI Amplitude

"4.2.3. High Frequency Vibration - 50:2000 c/s in 35 min
0.1 in/axis

4.2 Shock Test

4.2.1 The test specimens were subjected to a mechanical impact shock test as follows: 3 shocks per specimen, one shock in each of 3 mutually perpendicular axes, with the shock level of $\pm 10g$ reached in 3 ± 1 milliseconds.

4.3 Acceleration Test

4.3.1 The test specimens were subjected to an acceleration test as follows: acceleration level 60g's for a duration of five (5) minutes in each of the four (4) directions outlined below:

- 1) Perpendicular to the specimens longitudinal axis rotated 90°
- 2) ~~Perpendicular to the specimens longitudinal axis~~
- 3) Parallel to the thrust axis
- 4) Parallel to the thrust axis inverted 180°

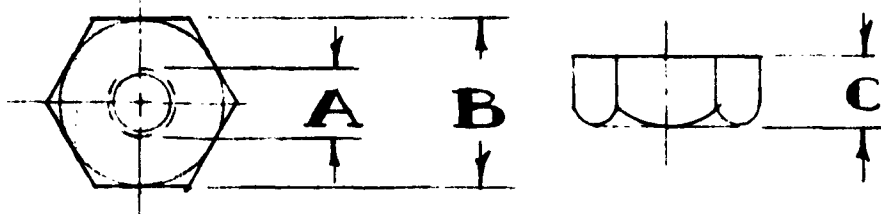
4.4 Altitude Test

4.4.1 The test specimens in an upright position, were subjected to a simulated altitude of 120,000 feet while a five (5) hour discharge test was conducted by ponotone personnel.

V Test Data

5.1 Electrical performance of specimens was monitored by the customer and no apparent electrical or visual mechanical damage was found upon completion of testing.

HEX. NUT



SOM

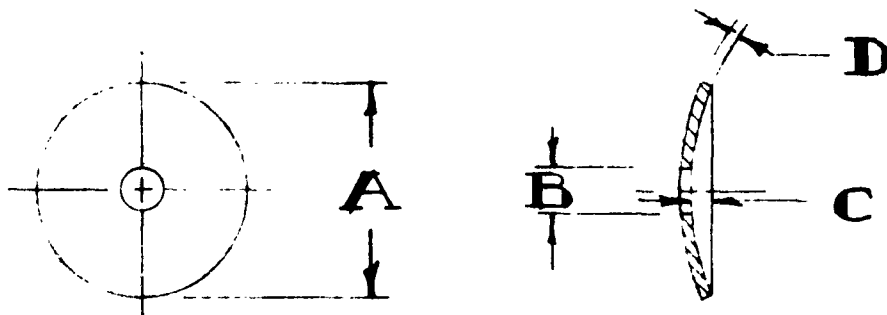
DESCRIPTION

SCALE

ITEM	DE

CELL	ITEM	DIMENSIONS				MATERIAL	FINISH
		A	B	C	P.D.		
BB 440/U	1	10-32	3/8	.125	.1737 .1764	STEEL	COMM. NI.PL.

BELLEVILLE SPRING



CELL	ITEM	A	B	C	D	MATERIAL	FORCE TO FLATTEN
BB440/U	1	.375	.195	.012	.0157	SP. ST.	57 ±15%
BB441/U	2	.561	.204	.025	.0276	302 S.S.	300 ±15%

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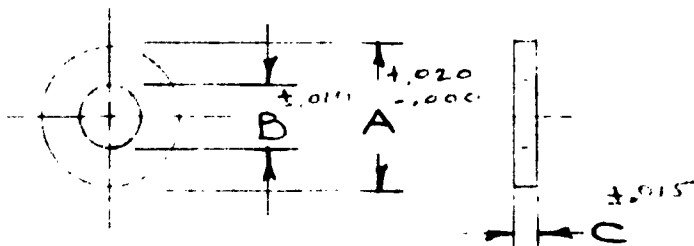
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Y- P. 4

DESCRIPTION CONNECTING HARDWARE

SCALE BILL OF MATERIAL

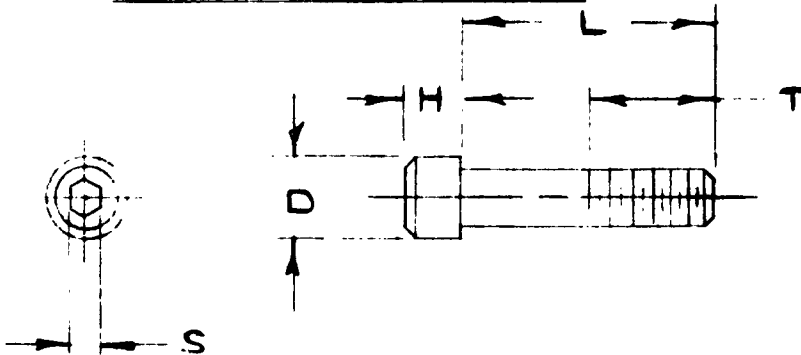
ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.

FLAT WASHER



CELL	ITEM	SCREW SIZE	A	B	C
BB441/U BB442/U	1	#10	.750	.203	.062

CAP SCREW



CELL	ITEM	SIZE	L	T	H	D	S	REMARKS
BB441/U BB442/U	1	10-32	.500	Std.	.190	.312	.156	Ni.PL.

MATERIAL	FORCE TO FLATTEN
ST.	57 $\pm 15\%$
S.S.	300 $\pm 15\%$

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FIG. 12

ASSEMBLIES USED ON

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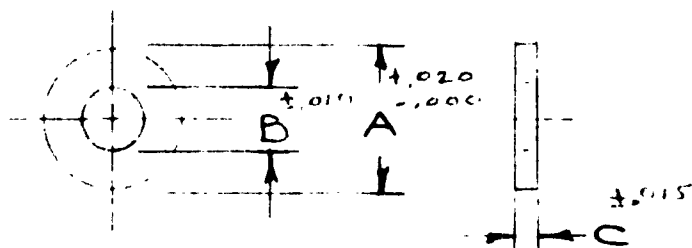
Y-

P. 4

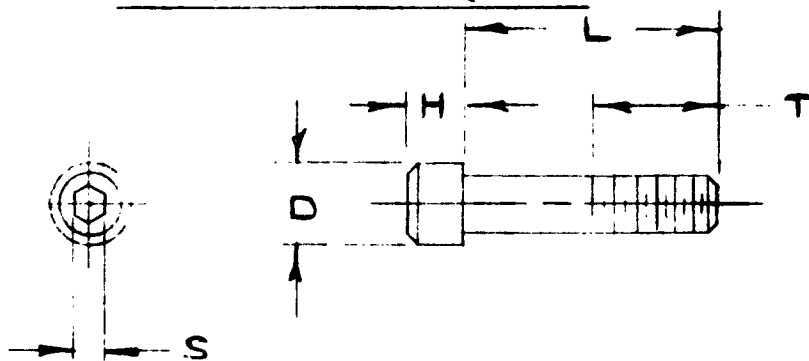
DESCRIPTION CONNECTING HARDWARE

SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.

FLAT WASHER

CELL	ITEM	SCREW SIZE	A	B	C
BB441/U BB442/U	1	#10	.750	.203	.062

CAP SCREW

CELL	ITEM	SIZE	L	T	H	D	S	REMARKS
BB441/U BB442/U	1	10-32	.500	STD.	.190	.312	.156	Ni.PL.

RIAL	FORCE TO FLATTEN
ST.	57 ±15%
S.S.	300 ±15%

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FIG. 12

ASSEMBLIES
USED ONIN REFERRING TO THIS
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NUMBER AND ISSUE NUMBER

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DRAWING & ISSUE NO.

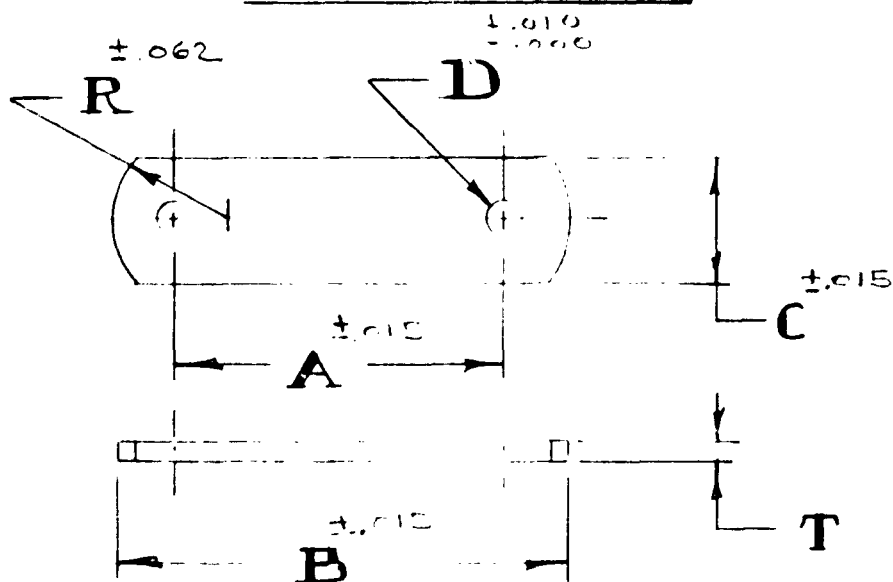
Z- P.49A

DESCRIPTION CONNECTING HARDWARE

SCALE BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.

CONNECTOR



CELL	ITEM	A	B	C	D	R	T
BB440/U	1	1.093	1.468	.375	.218	.375	.025
BB442/U	2	1.604	2.345	.750	.218	.500	.125
BB441/U	3	1.435	2.185	.750	.218	.500	.125

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FIG. 12

ASSEMBLIES
USED ON

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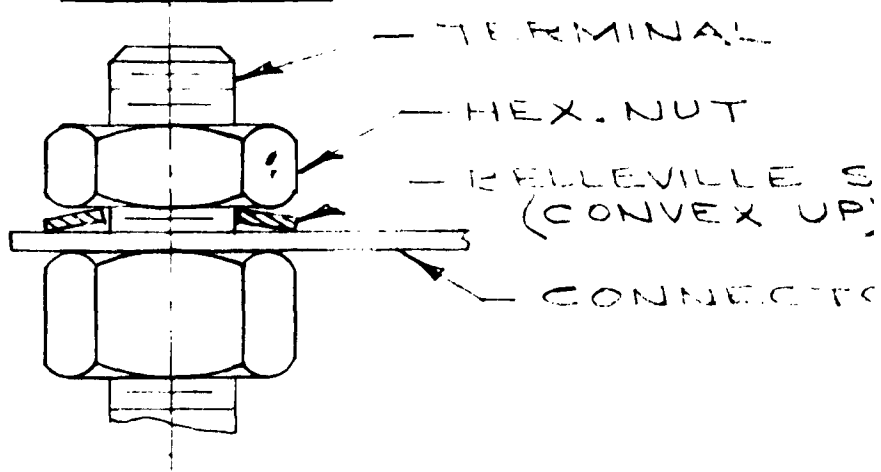
DRAWING
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DESCRIPTION ASSEMBLY OF CONNECTING HARDWARE

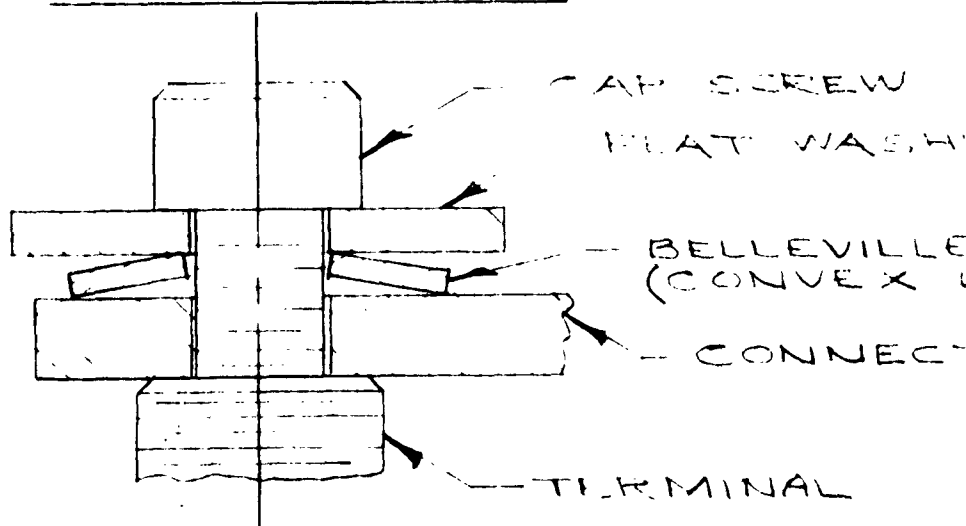
SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN.

10 A.H.



50 & 100 A.H.



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VIII. APPENDIX

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Parts List 10 A.H. Cell	-	54
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Tab Dimensions	13	56
Separator (MS20412)	-	57
Collector Bar (Z23827)	14	58
Terminal (Y23832)	15	59
Insulator (Z24217)	16	60
Insulator (Z24218)	17	61
Spacer (Y24266)	18	62
Spacer (Y24267)	19	63
Spacer (Y24268)	20	64
Parts List 50 A.H. Cell	-	65
Collector Bar (Y23856)	21	66
Terminal (Y23854)	22	67
Insulator (Z24219)	23	68
Spacer (Z24593)	24	69
Spacer (Z24592)	25	70
Spacer (Z-24591)	26	71

VIII. APPENDIX

<u>Description</u>	<u>Figure No.</u>	<u>Page</u>
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Collector Bar (Y23859)	27	73
Insulator (Z-24220)	28	74
Spacer (Z-24596)	29	75
Spacer (Z-24595)	30	76
Spacer (Z-24594)	31	77
100 A.H. (ceramic) outline Drawing (Y25191)	32	78
Cell Weights	(Table VII)	79

Method of Assembly

Raw plaques are manufactured by sintering nickel powder, using as support a nickel wire screen. On each plaque, the individual plates are then delineated by a coining operation. The coining operation also compresses an area at the top of each plate to allow the spot welding of a contact tab at a later stage in the manufacturing procedure.

The plaques are then loaded with the active materials by impregnating with nitrate solution (nickel nitrate for positive and cadmium nitrate for negative), and electrolyzing in sodium hydroxide solution.

The processed plaques are made into individual plates by cutting through the coined areas. The coined area around the edge of the plate reduces the possibility of loosening of sintered metal or screen wires.

A nickel contact tab is spot welded to each plate. The individual core assemblies (e.g. line 4 of PL 1384) are made by stacking the required number of plates, interleaving them with a continuous layer of separator, which is 1/4 inch wider than the plate height. These core assemblies are kept intact by a thin strip of polyethylene tape.

Method of Assembly (continued)

The tabs are grouped and heli-arc welded in the slots of the collector bars, and the collector bars heli-arc welded to the terminals. In the teflon sealed cells, the terminals are sealed into the covers after the cover is heli-arc welded to the can. In the ceramic sealed cells the terminals are brazed into the covers, then the terminal is welded to the collector bar after which the cover is welded to the can.

In all types of cells, the metal retainers are heli-arc welded to the cover. In the ceramic sealed cells, the brazing is accomplished by firing the cover assembly in a reducing atmosphere furnace at 1800° - 1850° F. Prior to the firing, the silver braze metal, in the form of rings, is positioned (one ring at the upper seal and one ring at the lower seal). The silver flows between the double taper ceramic seal and the cerami-seal metal parts (items 5 and 9 of Figure 5) effecting the seal. The silver wire is 0.031" in diameter.

Prior to welding the cover to can, insulators are placed on the bottom and around the periphery of the core and collector bar assembly, and spacers inserted at the ends and edges of the individual cores. A spacer is also inserted between the collector bars and the top edge of the core assembly. Placement of spacers is detailed in Figure 1, p. 33.

PARTS LIST

SUBJECT *Cylinder All Assy - 10 R. H. 1. 7731.D.*

LI. NO.	DESCRIPTION										DRAWING NO.	R
	1	2	3	4	5	6	7	8	9	10		
1	<i>Cylinder All Assy</i>										X24250	
2	<i>Core, Collector Bar & Terminal Assy</i>										Y24227	
3	<i>Core and Collector Bar Assy</i>										Y24230	
4	<i>Core Assy - Center</i>										Y24236	
5	<i>Positive plate & tab Assy</i>										Y24237 Assy 2	
6	<i>Tab -</i>										X16143/T. 5	1
7	<i>Nickel Strips</i>										MS20207/T. 5	2
8	<i>Positive plate Assy</i>										Y24238 Assy 2	1
9	<i>Cement</i>										MS20007/T. 47	2
10	<i>Processed Pos. Plaque</i>										X24214/T. 2	4
11	<i>Processed Pos. Plaque</i>										X24215/T. 2	4
12	<i>Processed Pos. Plaque</i>										X24216/T. 2	4
13	<i>Coinc. Plaque</i>										X24211/T. 2	4
14	<i>Coinc. Plaque</i>										X24212/T. 2	4
15	<i>Coinc. Plaque</i>										X24213/T. 2	4
16	<i>Raw Plaque</i>										X10481/T. 20	1
17	<i>Screw</i>										X10480/T. 1	1
18	<i>Wire Cloth</i>										MS20201/T. 1	2
19	<i>Nickel powder</i>										MS20215	2
20	<i>Neg. plate & tab Assy</i>										Y24237 Assy 1	1
21	<i>Tab</i>										X16143/T. 5	1
22	<i>Nickel Strips</i>										MS20207/T. 5	2
23	<i>Neg. plate Assy</i>										Y24238 Assy 1	1
24	<i>Cement</i>										MS20007/T. 47	2
25	<i>Processed Neg. Plaque</i>										X24214/T. 1	4
26	<i>Processed Neg. Plaque</i>										X24215/T. 1	4
27	<i>Processed Neg. Plaque</i>										X24216/T. 1	4
28	<i>Coinc. Plaque</i>										X24211/T. 1	4
29	<i>Coinc. Plaque</i>										X24212/T. 1	4
30	<i>Coinc. Plaque</i>										X24213/T. 1	4

ISSUE 1

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CHANGES

PAGE
1
OF
4
PAGE

LII NO.	DESCRIPTION										DR
	1	2	3	4	5	6	7	8	9	10	
1										Raw Plaque	X10
2										Screen	X10
3										White Cloth	M52
4										Nickel Powder	M52
5										Propylene Separator	M52
6										Polyethylene Tapes	M52
7										Form Assy - End	X24
8										Pos plate & tab Assy	X24
9										Tab	X16
10										Nickel Strips	M52
11										Positive plate Assy	X24
12										Cement	M52
13										Processed plaque	X24
14										Coined Plaque	X24
15										Raw Plaque	X10
16										Screen	X10
17										White Cloth	M52
18										Nickel powder	M52
19										Neg. Plate & tab Assy	X24
20										Tab	X16
21										Nickel Strips	M52
22										Neg. plate Assy	X24
23										Cement	M52
24										Processed Neg. Plaque	X24
25										Coined Plaque	X24
26										Raw Plaque	X10
27										Screen	X10

PL-1380
ISSUE 1

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PARTS LIST

SUBJECT Cylinder Cell Assy - 10 P.H. - 1.7.

LIN. NO.	DESCRIPTION									
	1	2	3	4	5	6	7	8	9	10
1										Wire Cloth
2										Nickel Powder
3										Polyethylene Separator
4										Polyethylene tape
5										Collector Bar
6										Terminal
7										Cyl. and Bottom Assy
8										Bottom Cover
9										Cylinder Case
10										Insulator - Bottom
11										Insulator - Side
12										Interior Terminal Assembly
13										Cover and Vent Bushing Assy
14										Cover
15										Retainer-metal
16										Vent Bushing
17										Seal-terminal
18										Washer
19										Nut-terminal
20										"O" Ring
21										Valve Assy - Vent
22										Valve Body
23										"O" Ring Retainer

P.L.-138A
ISSUE 11
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CHANGES

Table VI

Plate Dimensions

<u>Cell</u>	<u>Plate No.</u>	<u>Width</u>	<u>Height</u>	<u>Thickness</u>
BB440/U	Y24238-1 & 2	1.46"	4.015"	0.023"
"	Y24243-1 & 2	0.89"	4.015"	0.023"
BB441/U	Y24251-1 & 2	2.472"	6.373"	0.023"
"	Y24252-1 & 2	1.883"	6.373"	0.023"
"	Y24253-1 & 2	1.078"	6.373"	0.023"
BB442/U	Y24261-1 & 2	3.390"	6.683"	0.023"
"	Y24262-1 & 2	2.591"	6.683"	0.023"
"	Y24263-1 & 2	1.450"	6.683"	0.023"

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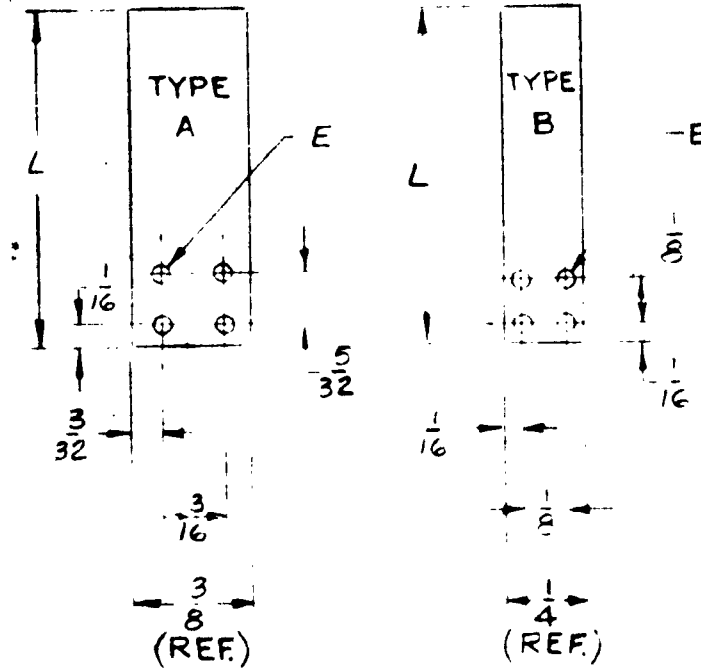
DRAWING & ISSUE NO.

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DESCRIPTION CONTACT TAB

SCALE _____ BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.	RE



TYPE NO.	QTY.	MATERIAL THICKNESS	L ± 1/32	E	CONDITION	#/MATERIAL	PUNCH PER SET	LAST REV.
10143	89	.007"	1 1/2	.047	50 I.P. & 100 A.B.	.67	B	
10145	57	.007"	1.375	.047	10 A.B.	1.43	A	

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FIG. 13

ASSEMBLY
USED ON

SONOTONE CORP. ELMSFORD, N. Y.

MATERIAL SPECIFICATION

MS-20,412

ISSUE

SUBJECT POLY-PROPYLENE

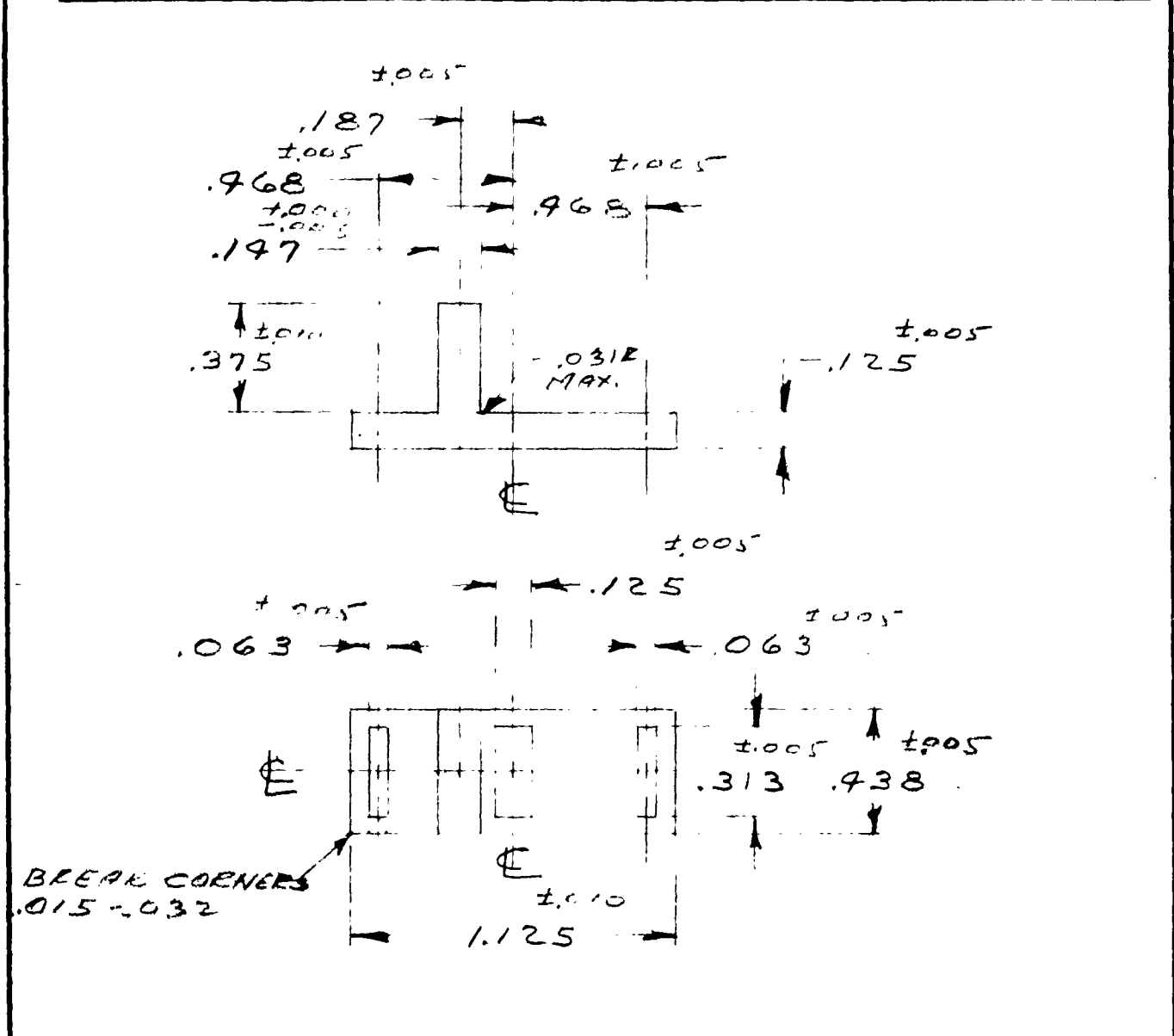
ITEM	DESCRIPTION	THICKNESS	SIZE	SOURCE
1	EXP. 306 POE 20 - 40 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 3.5 OZ. PER SQ. YARD.	.008 - .010		AMERICAN FELT Co.
2	305 PO av. permeability 31 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 2.5 OZ. PER SQ. YARD.	.010 ± .0015		SAME AS IT 1
3	305 POE av. permeability 22 CFM PER SQUARE FOOT AT 0.5 INCHES OF WATER. WEIGHT 2.5 OZ. PER SQ. YD.	.008 .0065 - .0085		SAME AS IT 1

THIS MATERIAL NOT APPROVED FOR TRANSMISSION
6605
2244
2074

NOTE 1: CUT TEN 2 INCH TEST SQUARES AT RANDOM FROM THE FIRST YARD OF POLYPROPYLENE SEPARATOR MATERIAL. PLACE TEST SQUARES IN BOILING 1.4KOH FOR 30 MINUTES. ANY EVIDENCE OF BROWN DISCOLORATION IS CAUSE FOR REJECTION. ANY REJECTED MATERIAL IS TO BE REPORTED TO THE MATERIALS LAB ALONG WITH THE TEST SAMPLE FOR FINAL DESPOSITION.

MS 20,412	PREPARED BY I. MICHALKO	CHECKED <i>[Signature]</i>	APPROVED <i>[Signature]</i>	CHANGES	ADDED IT. 2 1/3 CN-1506 11/1/60 JN	ADDED IT. 3 11/1/60 JN	ADDED Note 1 CN-1512 (11-1-60) JN	REVISED THICKNESS NEW IT. 2-3 (4-4-60) CN 4532	SHEET 1 OF 1 SHEET
-----------	----------------------------	-------------------------------	--------------------------------	---------	--	---------------------------	---	--	--------------------------------

SONOTONE CORP. ELMSFORD, N. Y.					DRAWING & ISSUE NO.			
DESCRIPTION <u>COLLECTOR BAR</u>					<u>Z-23827</u>			
SCALE <u>2X</u> BILL OF MATERIAL					1.773 I.D. 1.745 I.D.			
ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.	
1	C.R.S.				NICKEL PLATE		1	

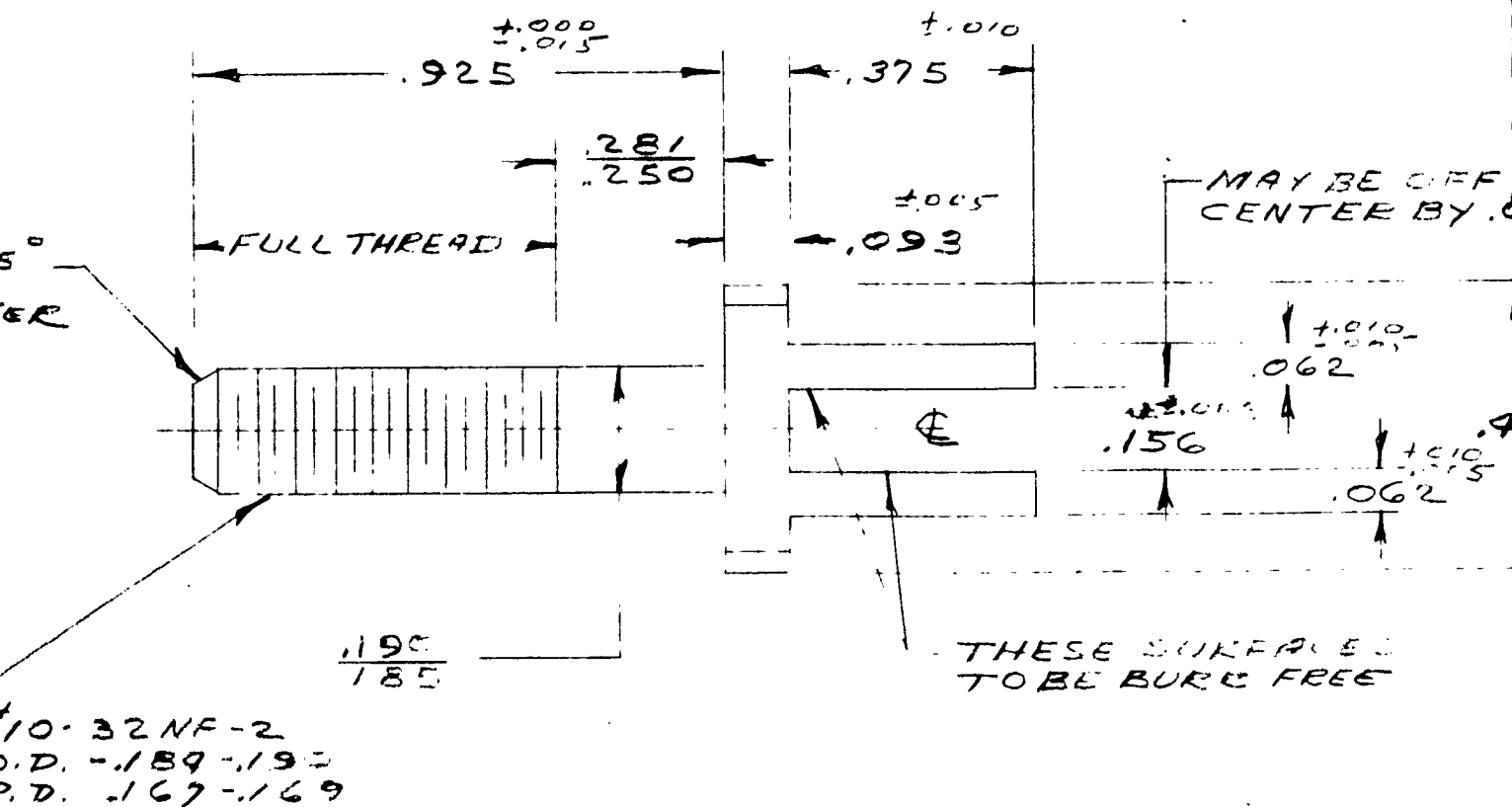


IN REFERRING TO THIS DRAWING STATE DRAWING NO. AND ISSUE NO.				DO NOT SCALE DRAWING				P. L. 1384	
238 71 DRAWN BY: <u>2-13-1-1-1-1-1-1</u> CHECKED BY: ENG. APPROVAL RES. APPROVAL CHANGES				Y-24230					
				ASSEMBLIES USED ON					

SCALE 4x

ITEM	DESCRIPTION
1	C.P. STE 1019 1019

NICK
MINIM



ENG. APPROVAL

RES. APPROVAL

CHANGES

1

PAGE 27

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-2383

DESCRIPTION TERMINAL

1.2451.0

SCALE 4X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	C.P. STEEL-SAE 1008 1014 1015 OR 1016					

NICKEL PLATE .0005 HEAT TREAT
MINIMUM 3 MIN. @ 1400-1700 F

MAY BE OFF
CENTER BY .010

±.004

.437

±.005

1/32 X 45 CHAMF

±.010

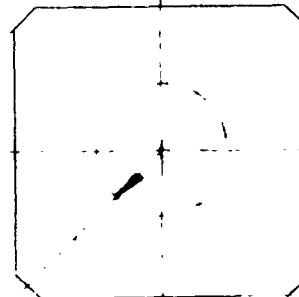
.062

±.004

.437

±.010

.062



2

THESE SURFACES
SHOULD BE BURE FREE

- MUST BE CONCENTRIC
WITHIN .004 FULL
INDICATOR READING.

B-384

Y-24227

ASSEMBLIES
USED ON

DO NOT SCALE DRAWING

IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

FIG - 15

SONOTONE CORP. ELMSFORD, N. Y.

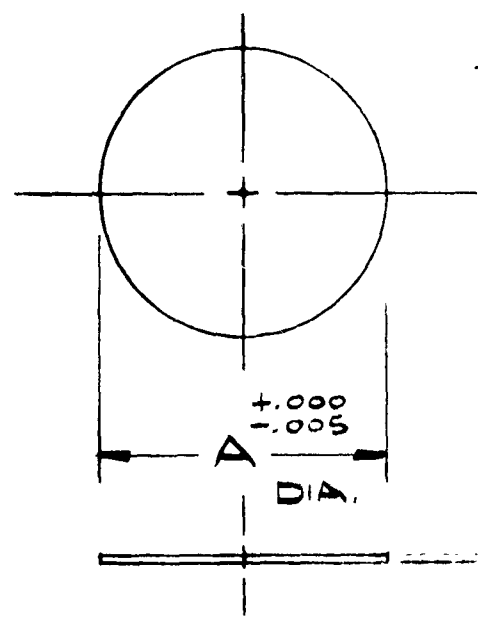
DRAWING & ISSUE NO.
Z-24217

DESCRIPTION **BOTTOM INSULATOR**

SCALE **—** BILL OF MATERIAL

A DIA. MAT. SPEC.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	NYLON-BYTEL #101		1.773	MS-20087 IT. 7		
2	NYLON-BYTEL #101		2.950	MS-20087 IT. 7		
3	NYLON-BYTEL #101		3.950	MS-20087 IT. 7		



$\frac{1}{32}$ STOCK (REF.)

X-24250 W-24240

IN REFERRING TO THIS DRAWING
STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

W-24260

Z-242 1
DRAWN BY: WFE 1-25-61
CHECKED BY:
ENG. APPROVAL
RES. APPROVAL
CHANGES

Ø-1384
Ø-1385
Ø-1386
ASSEMBLIES
USED ON

PAGE 61

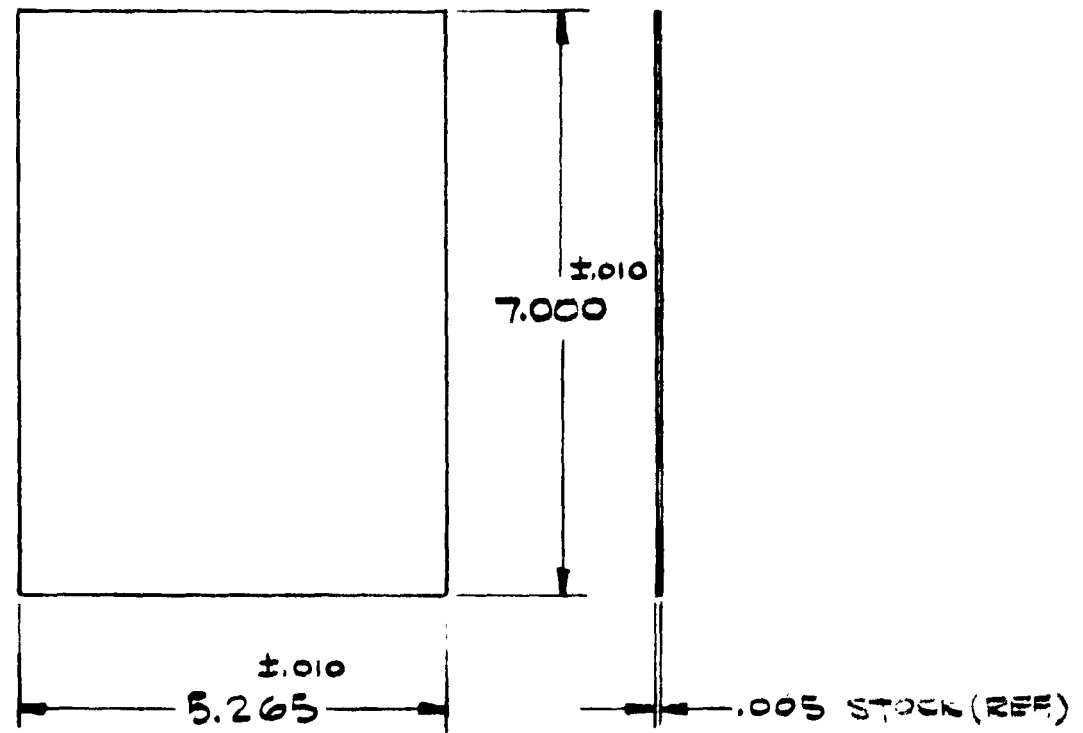
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.
Z-24218

DESCRIPTION **SIDE INSULATOR**

SCALE **1/2 SIZE** BILL OF MATERIAL **1.773 I.D.**

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.	RES.
1	NYLON - ZYTEL #101		MS-20087 IT.23				1



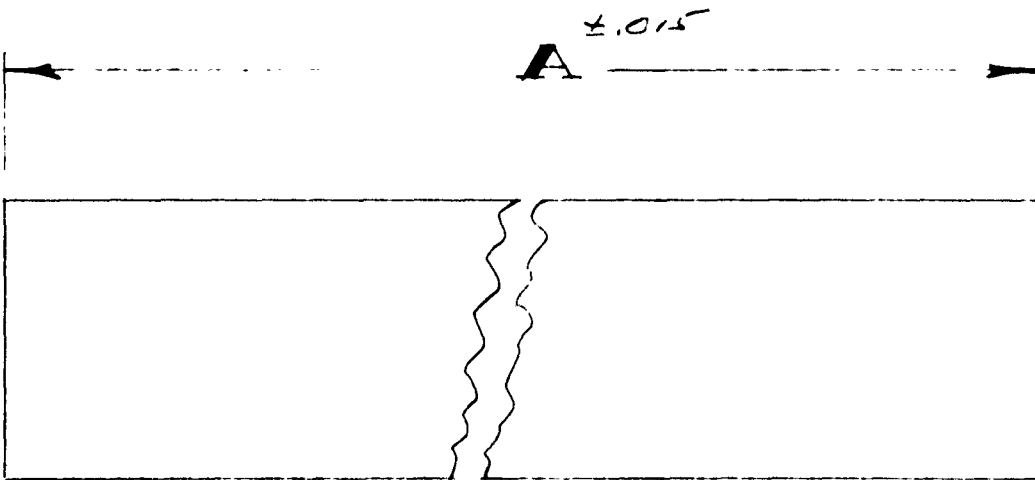
IN REFERRING TO THIS DRAWING STATE DRAWING No. AND ISSUE No.					DO NOT SCALE DRAWING							
Z-242.1	DRAWN BY.	1-25-61	CHECKED BY.	ENG. APPROVAL	RES. APPROVAL	CHANGES						R-1384
												X-24250
	ASSEMBLIES USED ON											

SONOTC

DESCRIPTION SP

SCALE 2X

ITEM	DESCRIPTION
1	NYLON #101
2	NYLON #101



1

ENG. APPROVAL	
RES. APPROVAL	
CHANGES	5.100 (2) was 5.000 9.260 was 9.125 Don't 12.61

PAGE 62

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-24266

DESCRIPTION SPACER -

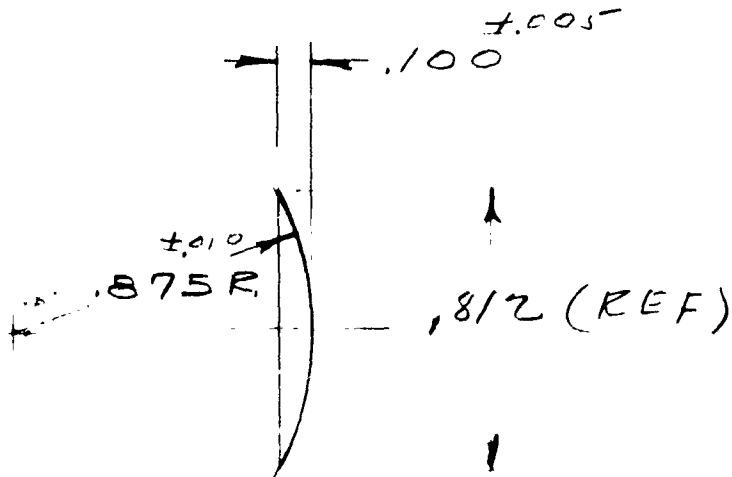
1.773 I.D.

SCALE 2X

BILL OF MATERIAL

A

ITEM	DESCRIPTION & MATERIAL	DWG. NO	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-ZYTEL #101			5.100			1
2	NYLON-ZYTEL #101			4.260			1



2

P.L. 13x4

DO NOT SCALE DRAWING

ASSEMBLIES
USED ON

IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

SONO

DESCRIPTION SF

SCALE 2X

ITEM	DESCR
1	NYLO #101
2	NYLO #101

$\pm .015$

A

1

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

5.1.00 L2
WAS Q.00
ADD IT. 2
on 5/9/61

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

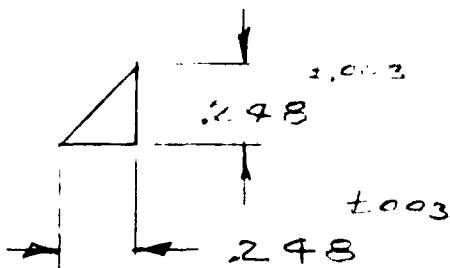
Y-24267

DESCRIPTION SPACER - CORNER - 1.773 I.D.SCALE 2X

BILL OF MATERIAL

A

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-ZYTEL H101			5,100			1
2	NYLON-ZYTEL H101			5,550			1



2

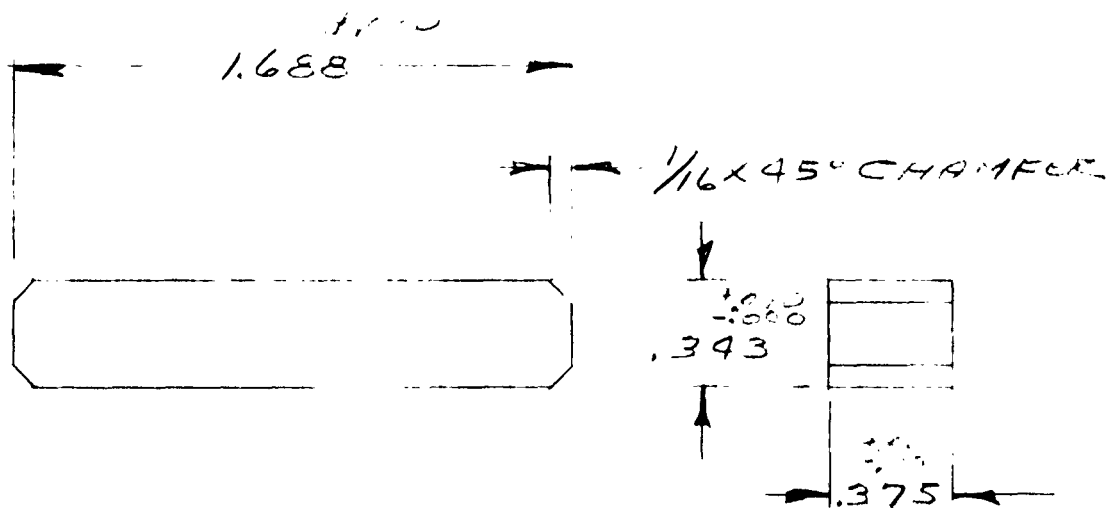
PL 13 & 4

DO NOT SCALE DRAWING

ASSEMBLIES
USED ONIN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

FIG-19

DES
SC/



1

Y242691

DRAWN BY.

20.2/17/61

CHECKED BY.

ENG. APPROVAL

RES. APPROVAL

CHANGES

213.12

213.12

PAGE 64

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-24268

DESCRIPTION SPACE BAR - 1.773

SCALE

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON 277EL. #101						1

2

PL 13 x 4

DO NOT SCALE DRAWING

ASSEMBLIES
USED ON

IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

FIG-20

SONOTONE CORP. ELMSFORD, N. Y.

Page 65 A

PARTS LIST

SUBJECT *Cylinder Cell Assy - 50 A.H. - 2.9501.D.*

IE NO.	DESCRIPTION										DRAWING NO.	REC
	1	2	3	4	5	6	7	8	9	10		
1	<i>Cylinder Cell Assy</i>										W24240	1
2	<i>Core, Collector Bar & Terminal Assy</i>										X24228	1
3	<i>Core and Collector Bar Assy</i>										X24231	1
4	<i>Core Assy - Center</i>										Y24249	2
5	<i>Positive plate & tab Assy</i>										Y24247 Assy 2	18
6	<i>Tab</i>										X16143/T.89	18
7	<i>Nickel Strip</i>										MS20207/T.5	
8	<i>Positive plate Assy</i>										Y24251 Assy 2	18
9	<i>Cement</i>										MS20007/T.47	
10	<i>Processed Pos. Plaque</i>										X24216/T.2	9
11	<i>Coured Plaque</i>										X24213/T.2	9
12	<i>Raw Plaque</i>										X10481/T.20	9
13	<i>Screen</i>										X10480/T.1	9
14	<i>Nickel Cloth</i>										MS20201/T.1	9
15	<i>Nickel Powder</i>										MS20215	9
16	<i>Neg. plate & tab Assy</i>										Y24247 Assy 1	18
17	<i>Tab</i>										X16143/T.89	18
18	<i>Nickel Strip</i>										MS20207/T.5	
19	<i>Neg. plate Assy</i>										Y24251 Assy 1	18
20	<i>Cement</i>										MS20007/T.47	
21	<i>Processed Neg. plaque</i>										X24216/T.1	9
22	<i>Coured Plaque</i>										X24213/T.1	9
23	<i>Raw Plaque</i>										X10481/T.4	9
24	<i>Screen</i>										X10480/T.1	9
25	<i>Nickel Cloth</i>										MS20201/T.1	9
26	<i>Nickel powder</i>										MS20215	9
27	<i>Propylene Separator</i>										MS20412/T.3	AS
28	<i>Polyethylene tape</i>										MS20313/T.6	EEI

P.L.-138

ISSUE

DRAWN BY

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

PAGE

OF

PAGES

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

PAGE 65 B

SUBJECT Cylinder Cell Room - 50 P.H. - 2,950 I.D.

P.L.-1385

LI NO.	DESCRIPTION										DRAWING NO.	REQD.
	1	2	3	4	5	6	7	8	9	10		
1											Y24245	2
2											Y24248 Assy 2	14
3											X16143/T.5	14
4											MS20207/T.5	REQ
5											Y24252 Assy 2	14
6											MS20007/T.4	REQ
7											X24215/T.2	4 2/3
8											X24212/T.2	4 2/3
9											X10481/T.20	4 2/3
10											X10480/T.1	4 2/3
11											MS20201/T.1	REQ
12											MS20215	REQ
13											Y24248 Assy 1	14
14											X16143/T.5	14
15											MS20207/T.5	
16											Y24252 Assy 1	14
17											MS20007/T.4	
18											X24215/T.1	4 2/3
19											X24212/T.1	4 2/3
20											X10481/T.4	4 2/3
21											X10480/T.1	4 2/3
22											MS20201/T.1	REQ
23											MS20215	REQ
24											MS20412/T.3	AS
25											MS20313/T.4	REQ
26											Y24246	2
27											Y24249 Assy 2	10

P.L.-1385
ISSUE

DRAWN BY
Jm/1/26/64

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ENG. APPROVAL

RES. APPROVAL

CHANGES

PAGE
2
OF
4
PAGES

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

PAGE 150

SUBJECT *Cylinder Cell Assy - 50 R.H. - 2.950 I.D.*

P.L.-1385

QTY.	DESCRIPTION										DRAWING NO.	REQD
	1	2	3	4	5	6	7	8	9	10		
1											X16143/T.89	10
2											MS20207/T.5	
3											Y24253A55Y2	10
4											MS20007/T.47	
5											X24216/T.2	10
6											X24213/T.2	10
7											X10481/T.20	10
8											X10480/T.1	10
9											MS20201/T.1	AS REQ
10											MS20215	AS REQ
11											Y24249A65Y1	10.
12											X16143/T.89	10
13											MS20207/T.5	AS REQ
14											Y24253A55Y1	10
15											MS20007/T.97	AS REQ
16											X24216/T.1	10
17											X24213/T.1	10
18											X10481/T.4	10
19											X10480/T.1	10
20											MS20201/T.1	AS REQ
21											MS20215	AS REQ
22											MS20412/T.3	AS REQ
23											MS20313/T.6	AS REQ
24											Y23856	2
25											X18176/T.88	2
											Y23854	2
											Z15110/T.14	4

P.L.-1385
ISSUE 1DRAWN BY
1/26/61

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

PAGE
3
OF
4
PAGES

SONOTONE CORP. ELMSFORD, N. Y.

PARTS LIST

Page 651

SUBJECT Cylinolac Cell Assy-50 RH.-2,950 I.D.

P.L.-/385

LIN NO.	DESCRIPTION	DRAWING NO.	REQD.
1	Cylinder Bottom Assy	Y24234	1
2	Cover - Bottom	X23998	1
3	Cylinders	Y24225	1
4	Inlet Valve - Bottom	Z24217/T.2	1
5	Inlet Valve - Seal	Z24219	1
6	Inlet Valve - Gasket / Packing	Z22551/T.1	2
7	Gasket and Vent Bushing Assy	X24220	1
8	Cover	X23997	1
9	Piston - Outlet	Z23855	2
10	Vent Bushing	Z22350	1
11	Seal - Gasket	Z23857	2
12	Rush	Z19654	2
13	Spot - Term.	X15111/T.3	2
14	O' Ring	Y10343/T.19	1
15	V-Valve Ring & T	Z22355	1
16	Valve Body	Y22356	1
17	O' Ring Piston	Y22357	1
18	O' Ring	Y10393/T.16	1
19	Bellville Spring	Y16128/T.20	1
20	Valve Screen	Z22358	1
21	Silicon Grease - High Vacuum	M320019/T.16	AS REQ
22	Gasket	M320007/T.14	AS REQ
23	Electrolyte		
24	Spacer Bar	Z24593	1
25	Spacer	Z24592/T.1	2
26	Spacer	Z24592/T.2	2
27	Spacer - normal	Z24591/T.1	4
28	Spacer - corrosion	Z24591/T.2	4
	Gasoline drawing	Y24264	1

PL-1385
ISSUE 1

DRAWN BY
1736/61

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

27 0505

224592/1

26/26597/12

4/16505

11

7/9/01/54

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P
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PAGE 4 OF 4

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PAGE
4
OF
4
PAGES

SONOT

DESCRIPTION CO

SCALE 2X

ITEM	DESCRIPTION
1	C.R.S.

+0.000
-0.010

177

€

+0.010
.750

.063 R
174X.

+0.005
.187

+0.005
.093

.093

+0.005
.063

+0.005
+0.005
.438
.625

+0.005 €
.287

+0.005
.530

+0.005
.276

+0.005
2.375

- BREAK CORNERS
.015 - .032

ENG. APPROVAL
RES. APPROVAL
CHANGES

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-23856

DESCRIPTION COLLECTOR BAR

SCALE 2X

BILL OF MATERIAL 2.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	C.R.S.				NICKEL PLATE	

±.010

0.05

0.05

0.05 ±.005

8 .025

1

BREAK CORNERS
C15 .032

2

X-24231

1305

ASSEMBLIES
USED ON

DO NOT SCALE DRAWING

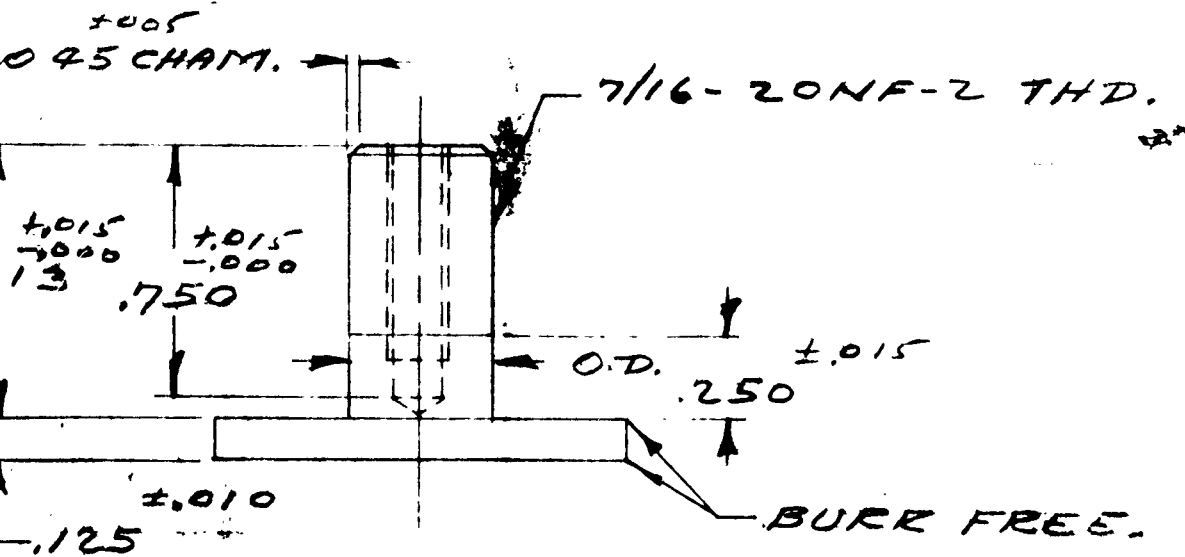
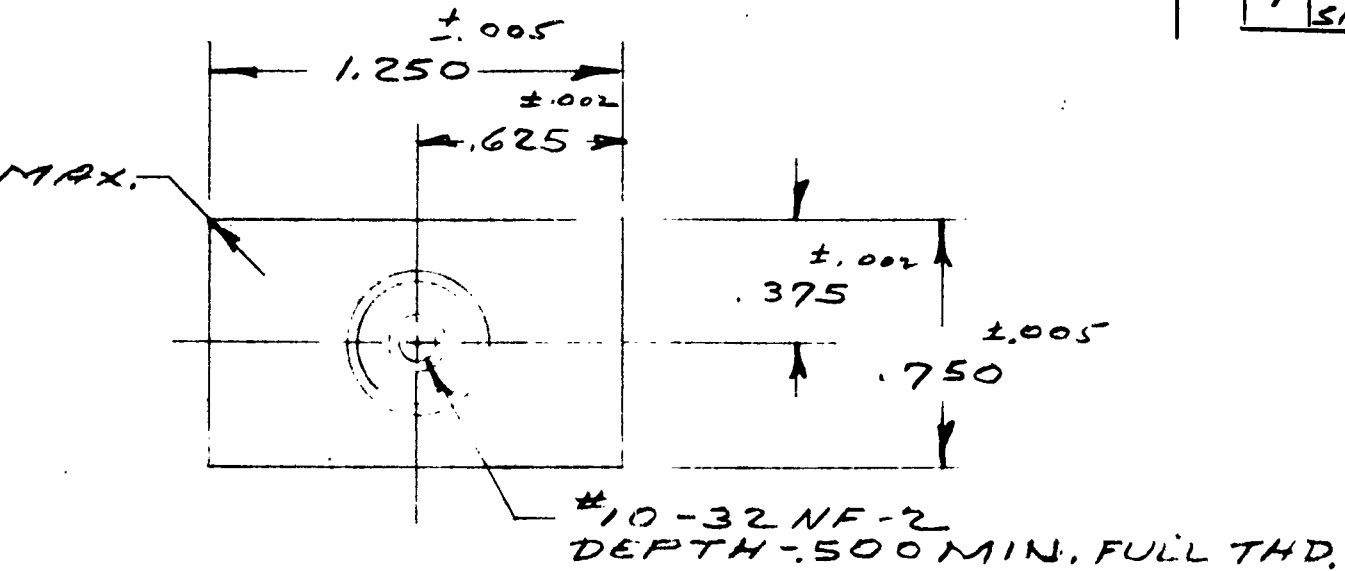
IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

F19-21

SONOT

DESCRIPTION: FESCALE: 2X

ITEM	DESCRIPTION
1	COLD R SAE 1006



DESIGN APPROVAL	1
REV. APPROVAL	
CHANGES	

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-2385

DESCRIPTION: TERMINAL STUD 50#100RH

SCALE 2X BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	COLD ROLLED STEEL SAE 1006-1010-1018				NICKEL PLATE	

205

J, FULL THD.

THD.

EE.

2

X-18176

R-1385

R-1386

ASSEMBLIES
USED ON

DO NOT SCALE DRAWING

IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

F19-22

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

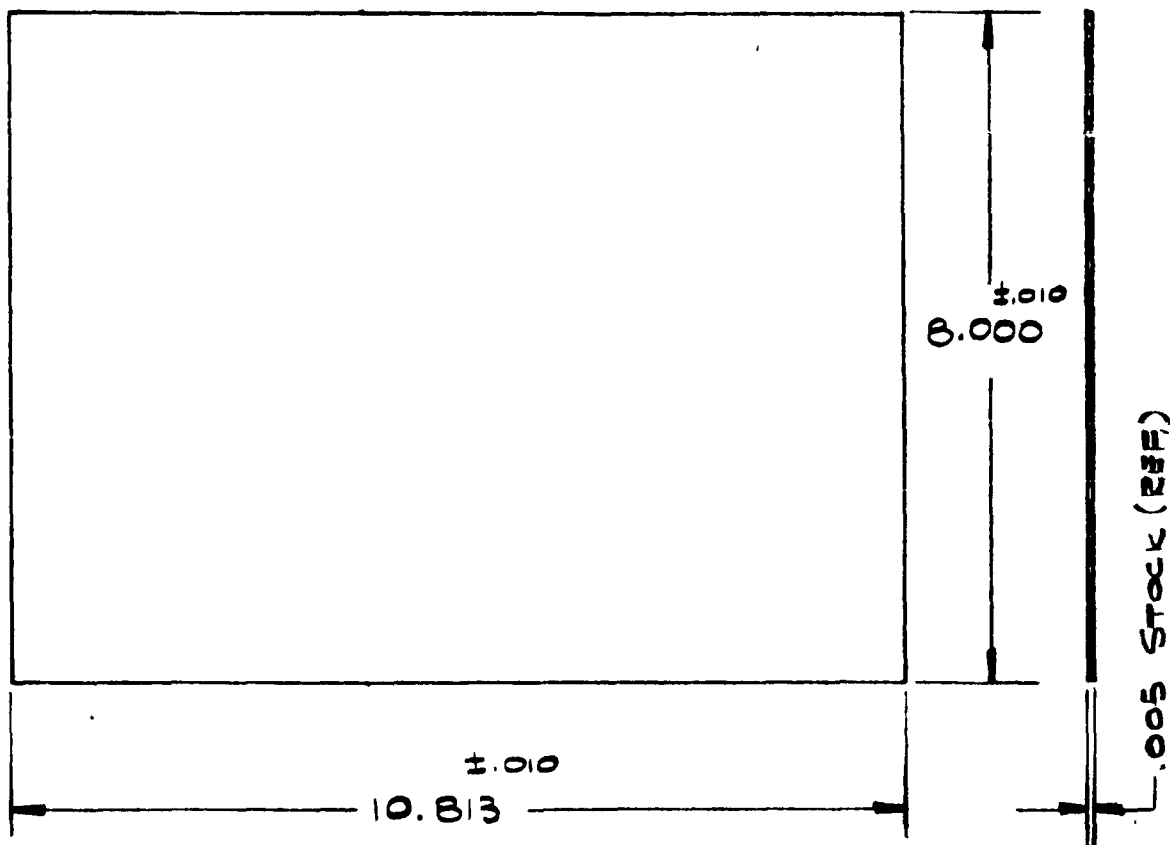
Z-24219

DESCRIPTION SIDE INSULATOR

SCALE 1/2 SIZE

BILL OF MATERIAL 2.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	RE
1	NYLON - ZYTEL #101		MS-20087 IT. 23				1



IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z-24219 11

DRAWN BY:
LJB 1-25-61

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

R-1385

W-24240

ASSEMBLIES
USED ON

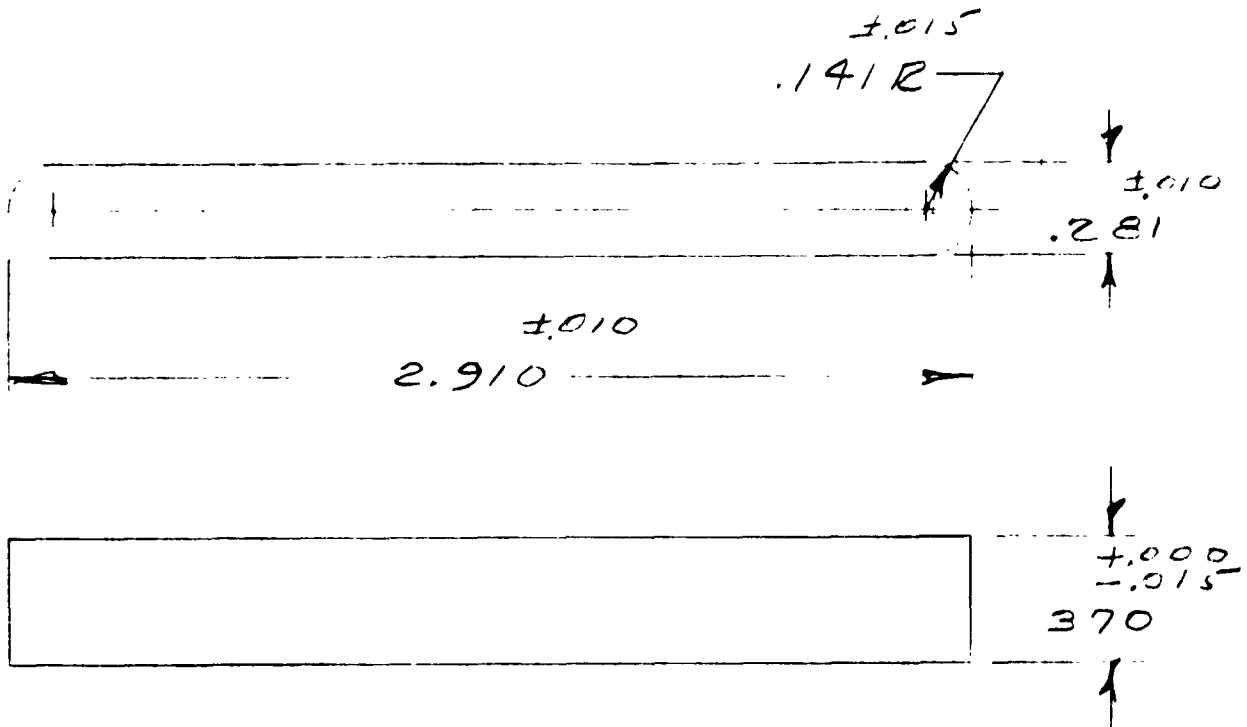
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Z-24593

DESCRIPTION SPACER BAR 2.950 I.D.SCALE 2x BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.
1	NYLON-27TEL #101					

IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z-245931

DRAWN BY:

JAN 5/10/61

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLY
USED ON

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Z-24592

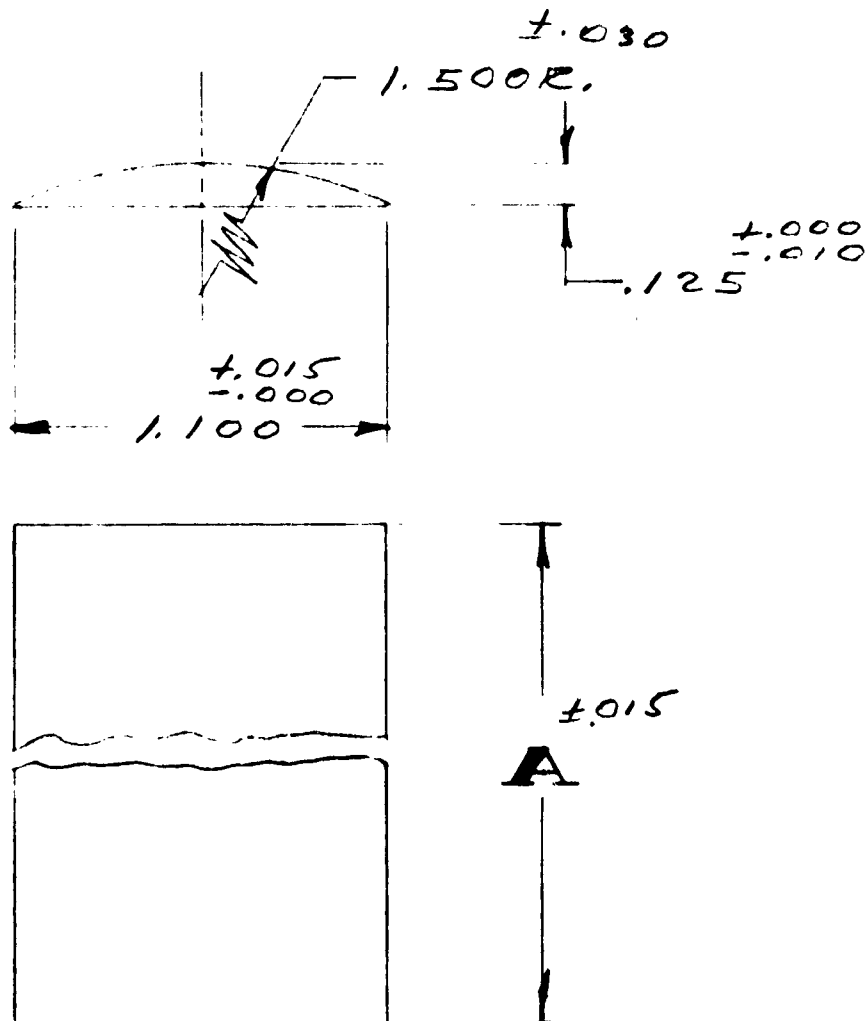
DESCRIPTION SPACER

2.950 I.D.

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-2YTEL #101			6.600			1
2	NYLON-2YTEL #101			8.380			1



IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z-245, d1

DRAWN BY:
S. 5/10/61

CHECKED BY:

ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES
USED ON

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Z-24591

DESCRIPTION SPACER - CORNER 2.95017SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-2YTEL #101			7.000			1
2	NYLON-2YTEL #101			8.380			1

$\begin{matrix} +0.000 \\ -0.015 \end{matrix}$
 $\rightarrow .390 \leftarrow$

$\begin{matrix} +0.000 \\ -0.010 \end{matrix}$
 $\downarrow .435 \uparrow$

$\pm .015$
A

IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z24591

DRAWN BY

CHECKED BY

ENG. APPROVAL

RES. APPROVAL

CHANGES

7.000 4.000 12

7.350

2.12.1

ASSEMBLIES
USED ON

PARTS LIST

SUBJECT *Cylinder Cell Assy - 100 P.H. - 3.9501, D.*

PL-1384

NO.	DESCRIPTION										DRAWING NO.	REQD
	1	2	3	4	5	6	7	8	9	10		
1	Cylinder Cell Assy										W24260	
2	Core, Collector Bar & Terminal Assy										X24229	
3	Core and Collector Bar Assy										X24232	
4	Core Assy - Center										Y24254	2
5	Positive plate & tab Assy										Y24257 Assy 2	24
6	Tab										X16143/T.89	24
7	Nickel Strips										MS20207/T.5	REQ
8	Positive plate Assy										Y24261 Assy 2	24
9	Cement										MS20007/T.97	REQ
10	Processed Pos. Plaque										X24214/T.2	8
11	Coined Plaque										X24211/T.2	8
12	Raw Plaque										X10481/T.20	8
13	Screen										X10480/T.1	8
14	Wine Cloth										MS20201/T.1	REQ
15	Nickel Powder										MS20215	REQ
16	Neg. Plate & tab Assy										Y24257 Assy 1	24
17	Tab										X16143/T.89	24
18	Nickel Strips										MS20207/T.5	REQ
19	Negative plate Assy										Y24261 Assy 1	24
20	Cement										MS20007/T.47	REQ
21	Processed Neg Plaque										X24214/T.1	8
22	Coined Plaque										X24211/T.1	8
23	Raw Plaque										X10481/T.4	8
24	Screen										X10480/T.1	8
25	Wine Cloth										MS20201/T.1	REQ
26	Nickel Powder										MS20215	REQ
27	Propylene Separator										MS20412/T.3	AS
28	Polyethylene tape										MS20313/T.6	REQ

PL-1384	ISSUE 1	DRAWN BY	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES	PAGE 1 OF 4 PAGES
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P.L.-/386

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OF
4
PAGE

78E-1386

SUBJECT Cylinder Cell Assy - 100 P.H. - 3.950 I.D.

LI. NO.	DESCRIPTION										DRAWING NO.	REQD.
	1	2	3	4	5	6	7	8	9	10		
1											X16143/T.89	14
2											MS20207/T.5	AS REQ
3											Y24263 Assy 2	14
4											MS20007/T.47	AS REQ
5											X24215/T.2	4 3/4
6											X24212/T.2	4 3/4
7											X10481/T.20	4 3/4
8											X10480/T.1	4 3/4
9											MS20201/T.1	AS REQ
10											MS20215	REQ
11											Y24259 Assy 1	14
12											X16143/T.89	14
13											MS20207/T.5	AS REQ
14											Y24263 Assy 1	14
15											MS20007/T.47	AS REQ
16											X24215/T.7	4 3/4
17											X24212/T.1	4 3/4
18											X10481/T.4	4 3/4
19											X10480/T.1	4 3/4
20											MS20201/T.1	AS REQ
21											MS20215	REQ
22											MS20412/T.3	AS REQ
23											MS20313/T.6	AS REQ
24											Y23859	2
25											X18176/T.88	2
26											Y23854	2
27											Z15110/T.14	4

P.L.-1386

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CHANGES

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3
OF
4
PAGES

Feb 7 '11

P.L. 1386

Cylinder Cell Assy - 100 P.H. - 3.950 I.D.

[illegible]

P.L.-1381	ISSUE	DRAWN BY S. J. 26/6	CHECKED BY	ENG. APPROVAL	RES. APPROVAL	CHANGES ADD 12 224576 224592/1 224592/2 224592 224592/1	224594-1 224574 4 RES 245 224594 224592 224592/1	LINE 5 WAS 2-24229 CN 17692 F.A.G PAGE 61562	PAGE 4 OF 4 PAGES
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SONOTO

DESCRIPTION COLLE

SCALE

ITEM	DESCRIPTION
1	C.R. S.

.063 R. MAX.

.177 $\pm .005$
 $\pm .010$.750 $\pm .005$.187 $\pm .005$.125 $\pm .005$.093 $\pm .005$.063 $\pm .005$.438 $\pm .005$
.688 $\pm .005$.372 $\pm .005$.682 $\pm .005$.415 $\pm .005$ BREAK CORNE
.015-.0323.187 $\pm .015$
 $\pm .000$

RES. APPROVAL

CHANGES

1

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y-23859

DESCRIPTION COLLECTOR BAR

SCALE _____

BILL OF MATERIAL

3.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	C.R.S.				NICKEL PLATE		1

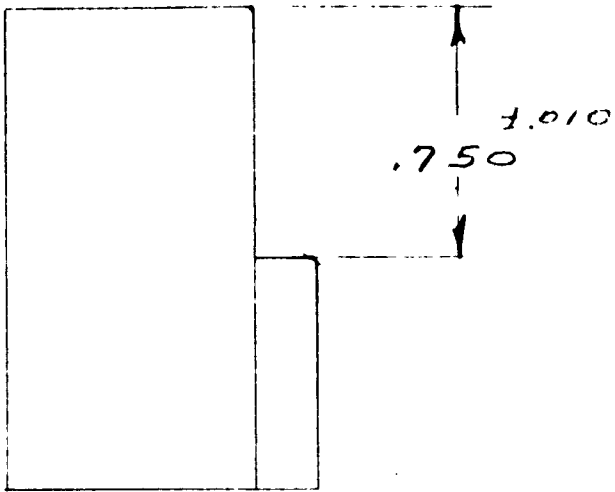
750

.005
.187

.005

±.005
.063

±.005
±.005
.438 .688



BREAK CORNERS
.015-.032

2

X- 24232

R-1386

ASSEMBLIES
USED ON

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DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

FIG-27

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

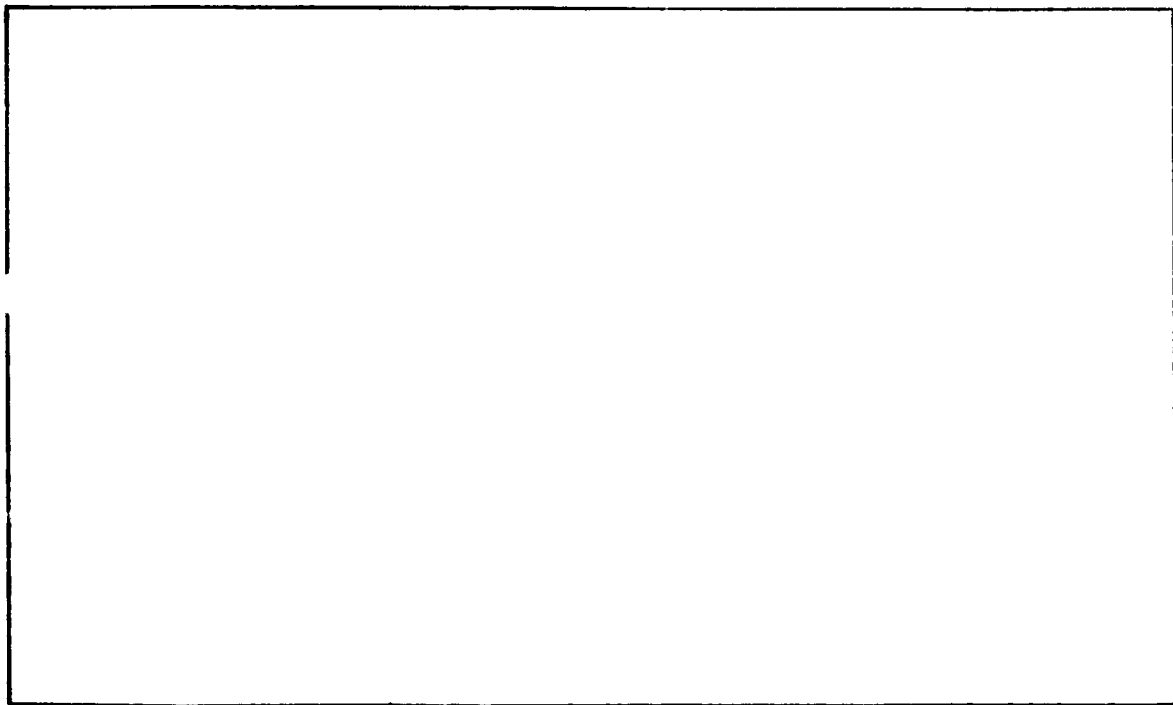
Z-24220

DESCRIPTION SIDE INSULATOR

SCALE 1/2 SIZE BILL OF MATERIAL 3.950 I.D.

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-ZYTEL #101		MS-20087 1723				1

.005 SDC <(REF.)



±.010
8.313

±.010
14.070

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W.24260

ASSEMBLIES
USED ON

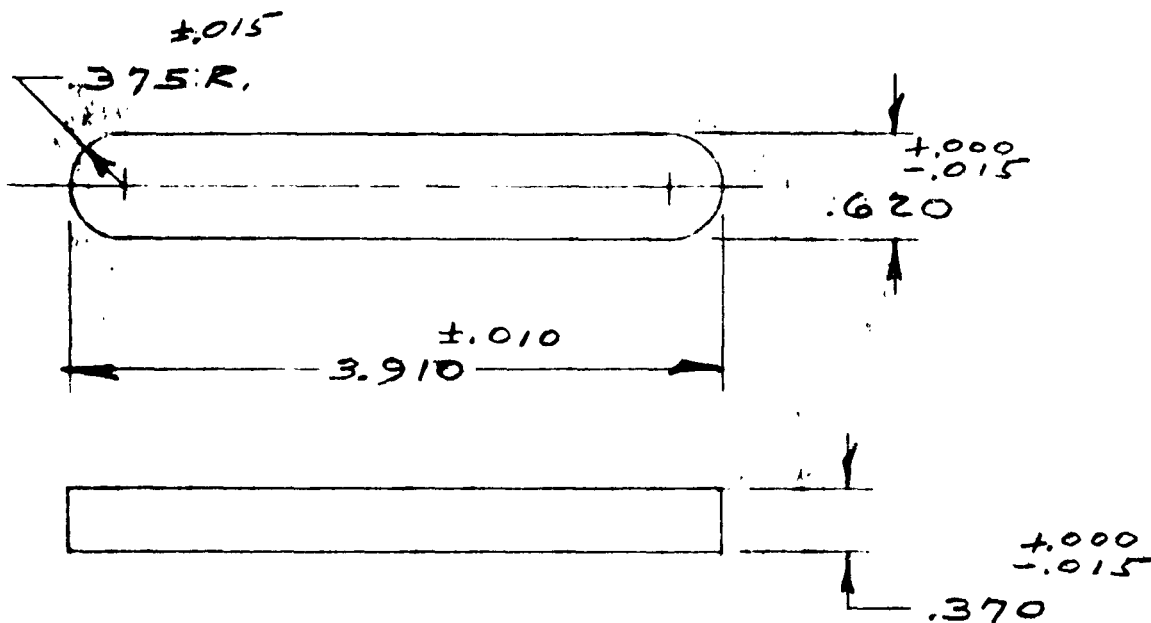
SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Z-24596

DESCRIPTION SPACER-BAR 3.950 I.D.TALE FULL BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROD. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-2YTEL #101						1

IN REFERRING TO THIS DRAWING
STATE DRAWING No. AND ISSUE No.

DO NOT SCALE DRAWING

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S. J. G. 61

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ASSEMBLIES
USED ON

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

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DESCRIPTION SPACER

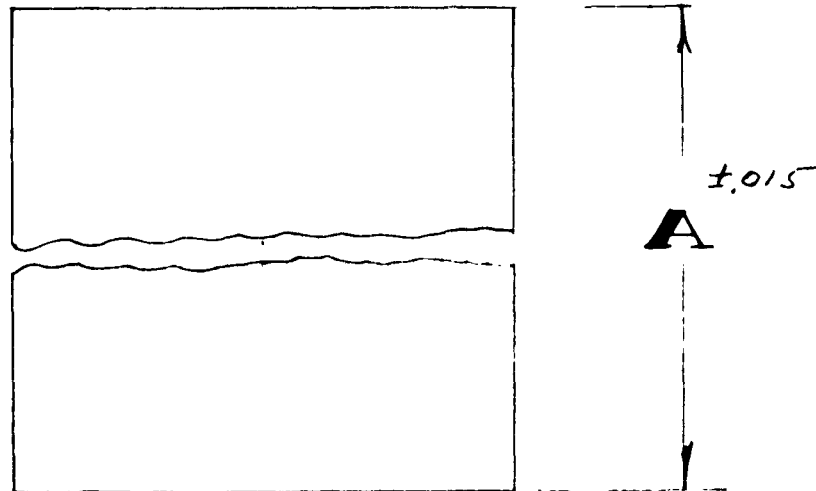
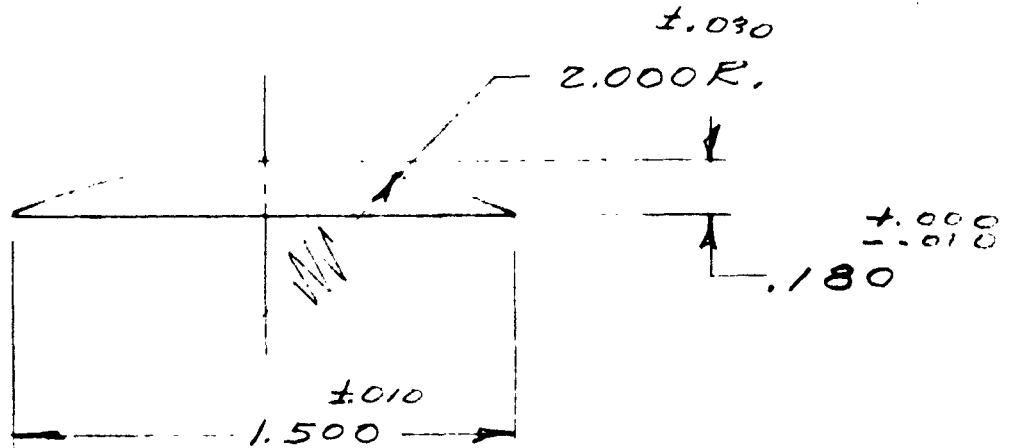
3.950 I.D.

SCALE 2X

BILL OF MATERIAL

A

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROG. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON-ETTEL #101			6.900			1
2	NYLON-ETTEL #101			8.690			1



IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

Z-24595-1

DRAWN BY

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ENG. APPROVAL

RES. APPROVAL

CHANGES

ASSEMBLIES
USED ON

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Z-24594

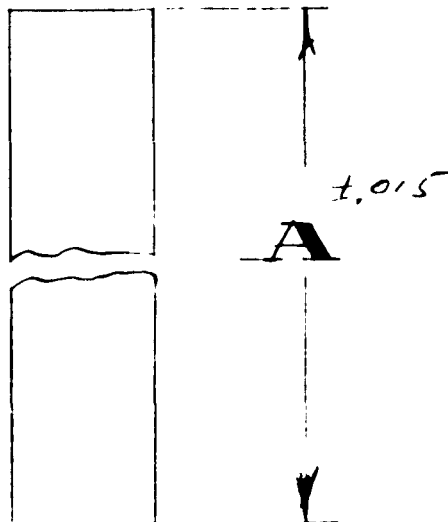
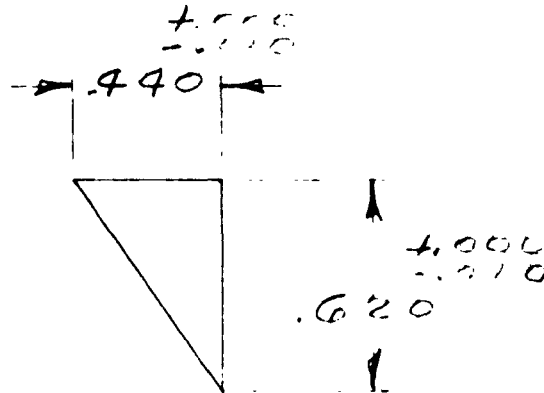
DESCRIPTION SPACER - CORNER

3.950 I.D.

SCALE 2X

BILL OF MATERIAL

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROD. SPEC.	FIN. SPEC.	QUAL. SPEC.	REQ.
1	NYLON ZYTEL #101			8.690			1
2	NYLON - ZYTEL #101			7.250			1

IN REFERRING TO THIS DRAWING
STATE DRAWING NO. AND ISSUE NO.

DO NOT SCALE DRAWING

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	ENG. APPROVAL		
	RES. APPROVAL		

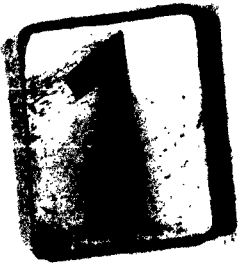
ASSEMBLIES
USED ON

SONOY

DESCRIPTION QU
SCALE FULL

ITEM	DESCRIP

t.060
.300



t.060
9.320

NG. APPROVAL
ES. APPROVAL
CHANGES

SONOTONE CORP. ELMSFORD, N. Y.

DRAWING & ISSUE NO.

Y.25191

DESCRIPTION OUTLINE DWG. 100AH. - 3.9501.D.

SCALE FULL BILL OF MATERIAL CERAMIC

ITEM	DESCRIPTION & MATERIAL	DWG. NO.	MAT. SPEC.	PROC. SPEC.	FIN. SPEC.	QUAL. SPEC.

2

$\pm .06$
.300

10-32 TAP THD.

$\pm .06$

.300

$\pm .010$
2.560

$\pm .031$

7.000

PL 146.9

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USED ON

IN REFERRING TO THIS
DRAWING STATE DRAWING
NUMBER AND ISSUE NUMBER

Table VII

Cell Weights

<u>Cell Type</u>	<u>Core</u>	<u>Electrolyte</u>	<u>Case, Cover Terminals, etc.</u>	<u>Total</u>
BB440/U	Av. 0.68# Range 0.02#	0.13#	Av. 0.57# Range -	Av. 1.38# Range 0.05#
BB441/U	Av. 3.33# Range 0.18#	0.64#	Av. 1.94# Range -	Av. 5.91# Range 0.17#
BB442/U	Av. 6.43# Range 0.28#	1.23#	Av. 3.24# Range -	Av. 10.90# Range 0.27#

AD _____ Accession No. _____
Sonotone Corp., Elmsford, N.Y.
UNCLASSIFIED
1. Batteries - sealed
2. Batteries - Nickel-Cadmium
Contract DA-36-009 SC-84496

DESIGN AND MANUFACTURE OF SEALED
NICKEL-CADMIUM CYLINDRICAL CELLS
F. Alliegro, W. Ryan, G. Baumstark, A.B. Mendel
Final Report, 1 December 1959 to 31 March 1963
79 pp 32 illus., 7 Tables
Signal Corps Contract DA-36-009 SC-84496
DA Task No. 3318 03 011 02, Unclassified Report
The sixty cells of each of three sizes (10 A.H.,
50 A.H. and 100 A.H.) have been manufactured.
The qualification tests of SZL-7504A have been
successfully passed and all cells have been delivered.
All 10 A.H. and 50 A.H. cells had teflon sealed terminals.
In the 100 A.H. size, 40 cells had teflon seals and 20
cells had ceramic seals.

Fifty each of the 50 A.H. and 100 A.H. cells have been
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Parts lists and pertinent drawings of all types of cells
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UNCLASSIFIED

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Contract DA-36-099 SC-84496

AD
Sonsone Corp., Elmsford, N.Y.

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