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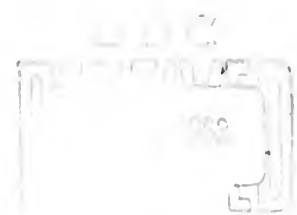
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THE VICTOREEN INSTRUMENT CO. / 5806 HOUGH AVE. CLEVELAND 3, OHIO

N-63-4-3

STANDARDIZATION OF COMPONENTS
FOR
CD V-700, CD V-715, CD V-727



BY
THE VICTOREEN INSTRUMENT COMPANY
CLEVELAND, OHIO

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

ABSTRACT

Results of development work aimed at reducing maintenance and spare parts requirements for the CD V-700 and CD V-715, and specific recommendations regarding both mechanical and circuit designs for the CD V-700, CD V-715 and CD V-727 are presented. Designs for components -- such as the CD V-715 and CD V-727 ion chambers, the CD V-700 probe assembly, and interchangeable one and two "D" cell battery holders for the CD V-700, CD V-715 and CD V-727 -- are also presented. Specific recommendations are also made on interchangeable case tops and bottoms for all three instruments. Recent, and present redesigns, for all three instruments are evaluated with respect to reducing the number of different components necessary for maintenance without sacrificing performance characteristics. Detailed mechanical drawings illustrating the specific recommendations for all three instruments, and graphs illustrating both the energy and the directional dependence for the CD V-715 are included as part of the overall report. All work was conducted under contract OCD-OS-62-276 for the Office of Civil Defense, Department of Defense.

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APPENDIX I - PROJECT PLAN

1. Purpose.

This report presents the results of a developmental investigation aimed at reducing the maintenance and spare parts requirements for standard OCD instruments CD V-700 and CD V-715, and developing final designs for certain key components used in these instruments. More specifically, this work has included, but has not been limited to the following items listed in the Scope of the Work Section of Contract OCD-OS-62-276:

1. Develop final engineering designs for the CD V-715 and CD V-727 ion chambers, and for the CD V-700 probe assemblies.
2. Develop final designs for interchangeable one and two "D" cell battery holders for universal use in CD V-700, CD V-715 and CD V-727.
3. Develop case tops and bottoms fully interchangeable for CD V-700, CD V-715 and CD V-727 application.
4. Develop standard size and mounting means for circuit board sub-assemblies and specify a common stud arrangement which can be used for all three instruments.
5. Evaluate recent circuit designs for CD V-700, CD V-715 and CD V-727 and present redesigns which reduce the number of different components needed for maintenance without sacrificing operational characteristics.
6. Produce alternate designs in each category above with Contractor's recommended preference. Six preproduction instruments shall be furnished to demonstrate the recommended designs along with detailed engineering drawings and specifications, and laboratory test data.

A still more detailed listing of specific items covered in this standardization program may be found in the Project Plan submitted near the beginning of the project, which is reproduced in Appendix I.

II. Conclusions and Summary.

The actual conclusions and results of this standardization project are many and varied and are detailed in the following section "Recommended Specification Changes". They may be summarized into the three main categories below, however.

- A. In the standardization of mechanical parts, the major items accomplished are the specification of common case tops and bottoms for all three instruments, the standardization of enclosed battery boxes, and the standardization of geiger tube probes for the CD V-700.
- B. The standardization of electrical parts encompasses mainly semiconductors, high-impedance switching performance for the CD V-715, and High-meg resistors for this instrument. Some recommendations on readout meters are also made.
- C. The standardization of the radiation detectors includes complete component and assembly specifications for the ion chamber of the CD V-715 and CD V-727. Response and energy dependence results from all directions with both steel and aluminum case bottoms are presented. More detailed mechanical specifications of the

6993 geiger tube have been prepared as well as energy dependence data for this detector in its probe.

A specification of each component of the preproduction instruments was prepared and submitted with the instruments themselves.

III. Recommended Specification Changes

The following three lists are recommended changes in the CD V-700, CD V-715, and CD V-727 specifications. Practically all of the recommendations are allied directly with standardization, but a few are items which merely require updating because they have escaped notice. This section only lists the actual changes. Discussion of the reasons for these recommendations is given in later sections of this report:

A. Changes in CD V-700 Specification dated November 1, 1959.

1. Paragraph 4.3, Accuracy. Add the sentence, "Additional capacitance having a negligibly high leakage resistance associated with it may be added to the metering circuit to permit adequate testing on the X1 and X10 ranges".
2. Paragraph 4.4.4, Fluctuations. Change the 2% in this section to 4%.
3. Paragraph 6, Components. Add 6.9 Semiconductor. The power supply oscillator transistor or transistors shall be germanium PNP devices housed in a TO-5 package with the following ratings:

V_{CB}	-40V
V_{CE}	-39V
V_{BE}	+1V
I_C	100 ma
Dissipation	100 mw
h_{fe}	20-300
I_{CBO}	-1 ma

Transistors such as Motorola 2N1925 or Raytheon 2N1956 are suitable.

The metering circuit transistor or transistors shall be germanium PNP devices housed in a TO-5 package with the following ratings.

V_{CB}	-20V
V_{CE}	-18V
V_{BE}	+5V
I_C	200 ma
Dissipation	150 mw
f_{ab}	800 KC
I_{CBO}	20 μ a
I_{EBO}	20 μ a
h_{fe}	20-300

Transistors such as Motorola 2N1193 or Raytheon 2N1017 will meet these requirements.

Diodes, with the exception of the high voltage rectifier, shall be silicon, have a

75V PIV rating, a maximum leakage of $2\mu\text{a}$ at 25 volts, and forward current of 80 ma at 0.8 volts. Types such as Motorola IN4002 or Raytheon IN3728 may be used.

4. Paragraph 7.6, Grounding of Shielding. Change next-to-last sentence to: "The probe cable shield shall be grounded to the chassis by a solder lug fastened to a case top support post with a screw".

5. Paragraph 7, Wiring and Cabling. Add new sub-paragraph. "7.8 Circuit Board. As far as practicable, all components shall be mounted on a printed circuit board. Copper-clad fiberglass reinforced epoxy boards, NEMA grade G-10, 1/16" thick shall be used. At least one ounce copper shall be used and protected with "seal bright" or tin or solder plating".

6. Paragraph 8.1, Type. Change "5" to "4" in last sentence..

7. Paragraph 8.5, Connections. Change the last sentence to: "Battery boxes shall meet the requirements of Attachment D-3".

8. Paragraph 10.4.1, Material. Eliminate "alloyed zinc" from the first sentence. Add the following sentence: The case shall be as specified in Attachment D-6.

9. Paragraph 11.9.2, replace the present wording with the following: "The check source shall consist of $0.026 \pm .0013$ square inches of .005" thick of depleted uranium foil under an aluminum foil or metal cal, .003 inches thick. This will give a reading of 2 ± 0.5 mR/hr with an instrument meeting all specification requirements".

10. Paragraph A1.2, Insulation. Delete this paragraph from the specification.

11. Page A-6. Revise drawing dimensions as follows: Change the $\pm 1/4$ tolerance on the $1-5/8$ dimension to $\pm 1/16$. Change the tube diameter dimension to $5/8 \pm 1/32$.

12. Attachment B. Replace drawing of page B-1 with drawing 700-205 of probe assembly and details 700-202, 700-203, 700-204 and 700-206 (Figures 9 thru 13 of this report).

13. Attachment D. Replace page D-2 with drawing 815-103 (Figure 1 of this report). Replace page D-3 with drawing 700-214, battery box assembly, and details 700-209 and 700-210 (Figures 3, 4 and 5 of this report). Add as page D-6 the drawing 815-106, case bottom (Figure 2 of this report).

B. Changes in CD V-715 Specification dated July 1, 1960.

1. Paragraph 5.3, Humidity. Add a sub-paragraph 5.3.1 stating: "The following test to test the high impedance circuit gasketing shall be performed at room temperature. One cubic centimeter of water shall be placed in the case bottom and the instrument closed with the pull catches snapped shut. After one hour with this moisture inside the case, the requirements of paragraph 4.6.3 shall be met.

2. Paragraph 6, Components. Add a new sub-paragraph: 6.9, High-Meg Resistors. Only hermetically sealed, glass encapsulated high-meg resistors with an accuracy of $\pm 5\%$ of nominal value shall be used as ion current signal resistors. Victoreen Instrument Company type RX-1 or equal will meet these requirements.

Add a second new sub-paragraph: 6.10, Electrometer Tube. The electrometer tube shall meet the following requirements:

Package: T2 x 3
 Filament Voltage: 1.25 nominal
 Filament Current: 10 ma nominal
 Plate Current: 50 μ a min. - 165 μ a max. ($E_b = 8V$)
 Transconductance: 85 μ mho min. - 150 μ mho max. ($E_g = -3V$)
 Grid Current: 1×10^{-13} amperes max.
 Surface Coating: Baked on silicone or dry film coating type Dow Corning #993 to prevent surface leakage due to moisture adsorption shall be applied to glass surface around leads.

Tubes such as Victoreen VX-86 or Raytheon selected 5886 may be used.

Add a third new paragraph 6.11, Semiconductors. The power supply oscillator transistor or transistors shall be germanium PNP devices in a TO-5 package with the following ratings:

V_{CE}	6V
V_{CB}	6V
h_{fe}	100 - 300 at $I_b = .1$ ma
f_{ab}	200 KC
I_{CER}	600 μ a max. at $V_{CE} = -6V$

Transistors such as type Motorola 2N1193 or Raytheon 2N1018 will meet these requirements.

All diodes or rectifiers shall be silicon with a PIV rating of 75 volts. Types such as Motorola IN4002 or Raytheon IN3728 may be used.

3. Paragraph 7, Wiring and Cabling. Add a new sub-paragraph, "7.8 Circuit Board. As far as practicable all components shall be mounted on a printed circuit board. Copper-clad fiberglass reinforced epoxy boards, NEMA grade G-10, 1/16" thick shall be used. At least one ounce copper shall be used and protected with "seal bright" or tin or solder plating".

4. Paragraph 8.1, Type. Change the "3" in the last sentence to "2".

5. Paragraph 8.3, Operational Life. Delete the last sentence in the parentheses.

6. Paragraph 8.5, Connections. Add the following sentence: "Battery cases shall meet the requirements of Attachment D-2".

7. Paragraph 9.5, Tube Sockets. Delete the paragraph.

8. Paragraph 10.4.1, Material. Delete "Alloyed zinc" from the first sentence. Add the following sentence: "The case shall be as specified in Attachment C-3".

9. Attachment A. Add the drawings of the ion chamber parts submitted with the prototype instruments. As an alternate add drawing 815-12 of the feed-thru terminal (Figure 14 of this report) and a word description of the chamber parts as in the CD V-727 or CD V-717 specifications.

10. Attachment C. Substitute drawing 815-103 (Figure 1 of this report) for page

C-2. Add drawing 815-106, case bottom (Figure 2 of this report) as page C-3.

11. Attachment D. Add a new page D-2 showing drawing 815-100, battery box assembly and detail drawings 815-101 and 102 (Figures 6, 7 and 8 of this report).

C. Changes in CD V-727 Specification dated November 1, 1961.

1. Paragraph 6, Components. Add a new sub-paragraph "6.9, Electrometer Tube. The electrometer tube shall be E. I. A. type 5886".

2. Paragraph 6, Components. Add a new sub-paragraph, "6.10, High-Meg Resistors. A single, hermetically sealed, glass encapsulated high-meg resistor with an accuracy of $\pm 5\%$ of nominal value shall be used as ion current signal resistor".

3. Paragraph 7.1.2, Circuit Board. Change the second sentence to read "Copper-clad fiberglass reinforced epoxy boards, NEMA grade G-10, 1/16" thick shall be used".

4. Paragraph 10.4.1, Material. Delete "alloyed zinc" from the first sentence. Also add the sentence: "The case shall be as specified in Attachment C-3".

5. Attachment A-3. Add the dimensions of 3-1/2 inches and 3-7/16 inches to define the centerline hole location of the mounting holes for the chamber lid.

6. Attachment C-2. Replace with drawing 815-103 (Figure 1 of this report).

7. Attachment C. Add drawing 815-106 (Figure 2) as Attachment C-4.

8. Attachment D-2. Replace battery box drawing with drawings 700-214, 700-209, 700-210, 815-100, 815-101, and 815-102 (Figures 3 thru 8 of this report).

IV. Standardization of Common Mechanical Parts

A. Case Tops and Bottoms.

The mechanical parts common to the three subject instruments, the CD V-700, CDV-715 and CD V-727, are the case top, case bottom and the battery boxes. A study of all prototype instruments supplied or made available soon forced the conclusion that no single instrument (or even single manufacturer) had a mounting boss location system on the case top that could serve all the others. When a wide boss spacing was considered, the circuit boards of some existing types could not be redrilled for new boss mounting holes without breaking through the edge. A narrower boss spacing resulted in interference with components on the boards of instruments having wider spacing. Furthermore, due to instruments with either three or four bosses per side, no single arrangement was satisfactory for a standard boss location which would not interfere with components on some existing circuit board.

Therefore, the mounting boss location chosen revolved around the already-standardized mounting holes for the ionization chamber of the CD V-727. This results in a mounting boss spacing across the width of the instruments of 3-1/2" which is the widest used on any existing instruments. The selection of this width was also desirable since it allows the maximum sized circuit board and hence the maximum number of parts to be placed on such board. The number of bosses chosen was eight rather than six or four. This decision was based

on two reasons; the need for two double battery boxes in some versions of the CD V-700 and the requirement for four bosses for the already-standardized ionization chamber. The rear four bosses are slightly shorter than the front four to allow the circuit board to overlap the ionization chamber on the CD V-715 and CD V-727, a design feature common to practically all OCD ion chamber instruments.

Because of the above, the standardized case top may not be used as a replacement part for all existing instrument models. However, the case bottom shown in Figure 2 may be so used. This figure calls for an aluminum bottom, but a drawn steel version with a slight flange is entirely adequate from the gamma-ray absorption consideration discussed later, as long as the dimensions of Figure 2 are not violated. The use of steel has therefore not been eliminated from the proposed specification.

It is felt important to point out that the dimensioning of the case top gasket groove has been changed. The location of the groove itself is the same, but decimal dimensions have been so placed that accumulative tolerances will not result to permit the position of this groove to wander excessively. These new decimal dimensions and the case bottom dimensions will allow any case bottom and top to be used interchangeably.

B. Calibration Potentiometer Locations.

The standardization of the boss location and length then led to the standardization of the position of the calibration potentiometers. These positions are shown on the case top assembly drawing 815-105 supplied with the prototype instruments. The dimensions are given with respect to the bottom surface of the case top and centered between the first and second board mounting post. These dimensions are $47/64$ " to potentiometer center line from bottom surface of case top and a spacing of $33/64$ " is called for between individual potentiometer shafts. This is the spacing presently used on all prototype instruments.

C. Battery Boxes.

The designs for the enclosed single and double battery boxes are shown in Figures 3 thru 8. Additional detail drawings of hinges and snaps which are referred to in these figures are provided in the drawings which cover the specification of the individual instrument parts. The battery boxes have mounting holes not only for the new standardized boss location, but also for the bosses of existing instrument types. In other words, these battery boxes may be used as spare parts or replacement parts for existing instrument models.

V. CD V-700 Component Parts Standardization.

The major items standardized in the CD V-700 are geiger tube probe and geiger tube, operational check source and the semiconductors.

A. Geiger Tube and Probe Assembly.

The geiger tube probe drawings, Figures 9 thru 13, along with the changes of tolerance on the window location of the geiger tube makes for a uniform assembly in which the geiger tube window and the probe window will always line up properly. Figures 16 thru 21 show the complete developmental story. Figure 16 is the present specified geiger tube. Figure 17 shows the variations in window position possible. Figure 18 shows the result on the combination of probe and tube as presently specified and found in the prototypes. Figures

19, 20 and 21 show the same items with the new proposed dimensions and tolerances.

One additional specification modification on the geiger tube, which perhaps should be included but is not really mandatory, is a revision of the geiger tube test procedure. The circuit of Figure 22, is a suggested test circuit which can evaluate the geiger tube performance as related to the modern semiconductor circuits in which it is now used. The input impedance of these circuits is materially different from that of the older tube circuits for which the present tests were set up. With this test circuit the pulse output with a high voltage of 860 volts should not be less than 0.25 volts and the pulse width should not exceed 150 microseconds at 63% down from the pulse peak. These pulse heights and widths refer to the geiger tube only and have no bearing on the signal at the headphone connector. It is not recommended that the signal output for the headphone be changed.

B. Calibration Check Source.

An investigation of the calibration check sources used on the CD V-700 case bottoms showed considerable variation not only in intensity but also in radioactive material. Radium seems to be the material used in some. In order to permit interchangeability, this source has been standardized as a certain cross sectional area of U²³⁸ foil under a specified aluminum cover. The thickness of the uranium, .005" is essentially that of the maximum range of the uranium betas in the material. Therefore, $\pm 20\%$ changes in foil thickness will have negligible effect on beta output. Only the cutting or stamping dimensions need be held to assure source uniformity. All Victoreen-made CD V-700's have used this identical source.

C. Semiconductors.

The semiconductors specified in the proposed changes involve primarily the transistors of the CD V-700 instruments. Emphasis has been placed on the specification of parameters rather than the specification of type numbers. This has been done for two reasons. First, the relatively wide range of parameters did not conveniently fit any one type and second, parameter specification allows new manufacturers or new transistors to be easily considered. Both low and high limit devices for both the counting circuit and power supply transistors were installed in all versions of the CD V-700 available and were found to result in calibratable in-specification instruments.

VI. CD V-715 Component Parts Standardization.

The parts standardization for CD V-715 encompasses the ionization chamber, electrometer tube, high impedance insulators, high-meg resistors, and semiconductors.

A. Ionization Chamber.

The ionization chamber results are best shown on Figures 23, 24, and 25. Basically the data show that the chamber presently used in the Victoreen CD V-715 is the best compromise for either an aluminum or steel case bottom. Figure 23 shows that the energy dependence of this chamber is least when used with a steel case bottom, but is still less than the $\pm 20\%$ permitted even when used with an aluminum bottom.

The following additional observations on these last three figures may be of value. The

difference in response from the same direction in Lionel chambers may indicate a poorly controlled amount of high atomic number material in their liner. Additional absorption in the chamber bottom of Lionel units would greatly help the low energy front-to-bottom ratio in these chambers, and consequently the overall energy dependence. These chambers cannot be used with a steel case bottom with their present response. When a steel case bottom is used, the response at low energies from the bottom is excessively low, and not within specification.

Further data taken on a CDV-715 are presented in Figures 26, 27 and 28. These plots show the relative response and the energy dependence in the three major mutually perpendicular planes. These figures indicate no unexpected "blind" spots or directions of high peak response.

B. Electrometer Tube.

The recommended specification of the electrometer tube is given by specifying operating and min. - max. parameters rather than by specifying a tube type. It is not recommended that a straight 5886 type be specified for several reasons. First of all, the plate current limits for the 5886 are given with a 60,000 Ω plate load resistor. The presence of this plate resistor swamps the actual variations of plate current by permitting the plate voltage to change. Hence, the range of plate current variation in a 5886 is larger than that specified. It is so large that performance is affected in all present circuits at especially the high current end. The second reason for not specifying the 5886 is that test parameters for this tube are not close to actual operating conditions. Plate voltage used on all versions of the CDV-715's is about 8 volts, for instance. The 5886 test point calls for 22.5 volts. Finally, the maximum grid current, triode operated, for the 5886 is specified as 2.5×10^{-13} amperes (again at a test point far removed from actual operating conditions in the CDV-715's). This grid current will produce approximately 5% full scale deflection on the X0.1 range. Since this is excessively high, a lower maximum grid current than that specified for the 5886 has been recommended.

C. High Impedance Insulators.

The high impedance insulators, consisting of the ion chamber feed-thru seal, the high impedance section of the range switch, and the glass envelope of the electrometer tube, were thoroughly investigated for electrical leakage effects, especially those due to humidity. Various switch insulator and feed-thru materials such as glass, ceramic, Kel-F, teflon, epoxy and micalex were tried in models of the CDV-715. A small amount of water was put in the case bottom and the instrument was closed to create a 100% relative humidity inside the instrument. Even with the best of these insulating materials (teflon or Kel-F) excessive leakage was observed in less than 1/2 hour. This proved to be due to moisture films on the base of the electrometer tube itself. The tubes were checked for silicone dry-film treatment and some were again dry-filmed with the same results. It was thereupon decided that the gasketing requirements for the high impedance circuitry already in the specification must be enforced. A test similar to that described above is therefore recommended for the humidity portion of the performance specification. The submitted prototypes of the CDV-715 present one method of adequate gasketing of this section of the circuitry. This method also creates a convenient package for the high impedance circuitry which can be stocked assembled in a dry plastic bag as a replaceable part.

D. High-Meg Resistors.

For a comparative evaluation of hermetically sealed, glass encapsulated and composition encapsulated high-megs, four groups of each type, five resistors per group, were run under the following conditions:

- Group 1: Continuous 160°F operation
- Group 2: 100% relative humidity at 160°F, continuous
- Group 3: 100% relative humidity at 160°F plus 2 hours per day at -50°F
- Group 4: Room ambient conditions

All of the above was set up for each of the ranges of the CDV-715 resistors. Typical results are shown for resistors of both types in the $2 \times 10^{10}\Omega$ range (the X1 range of the CDV-715).

RESISTANCE - MEGOHMS

	IRC BT 1/2				Victoreen RX1			
	Start	30 days	60 days	90 days	Start	30 days	60 days	90 days
Group 1	24,470	23,280	22,170	22,100	21,700	22,070	21,630	21,760
	23,600	22,850	21,830	21,800	26,200	26,250	26,250	26,070
	26,000	24,770	23,610	23,600	20,100	20,200	20,300	19,950
	21,260	20,700	19,870	19,840	26,300	26,660	26,350	26,330
	22,390	21,500	20,480	20,420	26,390	27,100	26,710	26,850
Group 2	27,060	15,340	5,600	10,250	24,050	24,100	24,200	23,910
	22,620	13,110	4,400	8,000	24,530	24,450	24,450	24,400
	21,300	14,400	2,360	6,650	23,600	25,200	30,150	30,300
	22,950	13,950	7,350	12,800	24,370	24,450	24,500	24,430
	24,780	17,610	5,500	8,750	24,150	24,130	24,130	24,030
Group 3	25,170	15,000	5,370	10,700	25,360	25,350	25,370	25,350
	24,530	12,570	2,240	4,850	26,950	26,950	26,950	26,870
	20,270	14,500	3,480	6,150	24,220	24,200	24,200	24,100
	22,650	17,500	3,750	6,110	24,750	24,730	24,630	24,500
	26,280	13,600	2,350	3,750	23,400	23,450	23,520	23,580
Group 4	21,680			21,700	19,360			19,370
	21,760			21,780	23,810			23,810
	24,950			24,970	23,950			23,950
	23,450			23,480	19,050			19,070
	22,850			22,910	19,560			19,640

It is estimated that the environment of Group 3 may be equivalent to 10 or 15 years of storage. The deterioration of the composition encapsulated type under these conditions were repeated for all the other three resistance values. On the basis of these data, the hermetically

sealed, glass encapsulated type is recommended in the specification.

The specification of the actual values of the high-meg resistors in addition to the tolerances was seriously considered. It is true that all present models of the CD V-715's have the same values of high-megs. These are 2.0×10^{11} , 2.0×10^{10} , 2.0×10^9 and 2.0×10^8 ohms for the X100, X10, X1 and X0.1 ranges, respectively. It is also likely that the first production contract of the CD V-717 will have the same value of high-meg resistors. If these are the major considerations, then the values given above should be specified.

There is, however, real reason not to limit the value of these signal resistors. The time constant of instrument response with these high-megs is marginally high in practically every case. If the values above are specified, then all future instruments will have this same time constant since the circuit designers ingenuity will be stifled in this direction. For this reason, the actual high-meg resistance values have not been recommended in the specification section.

E. Semiconductors.

The oscillator transistor parameters have been specified so that this semiconductor may be used both in the low frequency oscillator circuit with the iron cored transformer utilized by the Landers and Lionel versions and in the more efficient high frequency oscillator with the ferrite cored transformer used in the Victoreen version. All diodes have been specified at the same PIV rating, even though some do not require this rating. The price differential for lower voltage diodes is between \$.01 and \$.02 each, and it is felt that the necessity of stocking a single diode is well worth the difference.

F. Meter Linearity.

An evaluation of the circuit response non-linearity of the CD V-715's showed that approximately $\pm 4\%$ non-linearity exists in all versions. This non-linearity is due to the operating characteristics of the electrometer tube. In the case of the Landers and Lionel circuits with a negative-going grid signal, the response drops off at the high end of the range. In the Victoreen circuit, the grid signal is positive-going and the upper end of the scale is more sensitive than the lower. Since the directions of this non-linearity are opposite, and since it is only a small fraction of overall instrument accuracy, no changes in the meter scale have been recommended. However, if a change to two batteries (or a shorter battery life) can be utilized to provide higher operating plate currents, the response of both circuits will be more linear.

VII. CD V-727 Component Parts Standardization.

Aside from the common mechanical parts standardized, the only major components considered were the oscillator transistor, the high-meg resistor, and the electrometer tube. The preceding discussion holds for the oscillator transistor and high-meg resistor recommendations. The electrometer tube in the CD V-727 does not have nearly as severe requirements as in the CD V-715. First of all, two batteries are used and the battery life requirement is shorter. This allows a higher plate current to be applied (there is even enough energy left to operate a zener regulator). Hence wider plate current variations can be tolerated from tube to tube. Also, much higher grid currents can be tolerated; full scale ion current on the

X0.1 range of the CD V-715 is barely observable on the CD V-727. Therefore, the 5886 is quite adequate and has been recommended. Actually the VX-86 will work also, and can be put into the specification.

VIII. Miscellaneous Considerations.

A. Indicating Meter.

The taut band suspension meter was considered as a possible alternative to the jewel pivoted movement. This type of suspension shows excellent performance in the current region below 50 microamperes due primarily to the reduction of friction in the suspension. However, in the region above 50 microamperes the jewel suspension has comparable electrical performance. The jewel pivoted suspension has the added feature of being rigidly restricted in its motion when subjected to shock and/or vibration.

The present meter specification is considered adequate for the CD V-700, CD V-715 and CD V-727 insofar as performance is concerned. A possible upgrading of the meter could be achieved by specifying a steel housing for the entire meter. This would result in:

1. A more rigid mounting of the internal assembly.
2. Reduction in case distortion should the meter be inadvertently subjected to excessive temperature.
3. Reduced interference from strong magnetic and/or electrical fields.

B. Battery Complement.

The battery complement for the CD V-700, CD V-715 and CD V-727 can be restricted to the use of "D" cells, NEDA type 13, without resorting to the use of other types of batteries.

The actual quantity per instrument will be determined by the desired battery life. In any case, it would seem desirable to limit battery life to not less than 100 continuous hours of operation and still maintain specified accuracy.

1. CD V-700.

Battery life is limited principally by the high voltage oscillator which supplies voltage for the GM tube. Using two batteries to supply the oscillator voltage, the minimum battery life expectancy of 100 hours can be achieved. Additional loading of these batteries by other circuits makes the battery life marginal. Additional batteries are required for the count rate circuit.

Battery life tests performed on the CD V-700-6B indicate that at least three batteries are required to meet the minimum battery life requirement of 100 hours.

2. CD V-727.

Battery life tests performed on the CD V-727 indicate that two batteries are adequate to meet the existing battery life specification.

3. CD V-715.

Battery life to achieve 150 hours of operation as required in the existing specification produces marginal operation at the battery end point with one "D" cell. The use of two "D"

cells in parallel will provide more than adequate battery life.

From a practical standpoint, it would be desirable to restrict the battery complement to one "D" cell. Operation beyond the 150 hours produces moderate errors but does not make the instrument completely inoperative. This approach reduces the possibility of having an inoperative instrument due to a lack of batteries in emergency conditions.

If longer battery life is a "must", then two "D" cells should be used with the provision that the batteries be operated in parallel. This connection will permit operation with one battery under emergency conditions.

C. CD V-717.

In general, the recommended standardizations as applied to the CD V-715 may also be applied to the CD V-717.

Possible exceptions would be the chamber construction and the battery complement.

Since a cable must be attached to the chamber, the high impedance terminal on the chamber must be modified from the CD V-715 to accommodate a tri-axial connector.

The dual case bottom construction in the CD V-717 restricts the available space in the top compartment and hence precludes the use of two batteries. However, as indicated in paragraph VIII. B., the use of one "D" cell has the specific advantage of reducing the required battery spares.

Due to the limited number of CD V-717's that have been constructed to date, it would be desirable to hold the standardization of components in abeyance until production experience is obtained.

D. CD V-750/CD V-715, Common Transistor For:

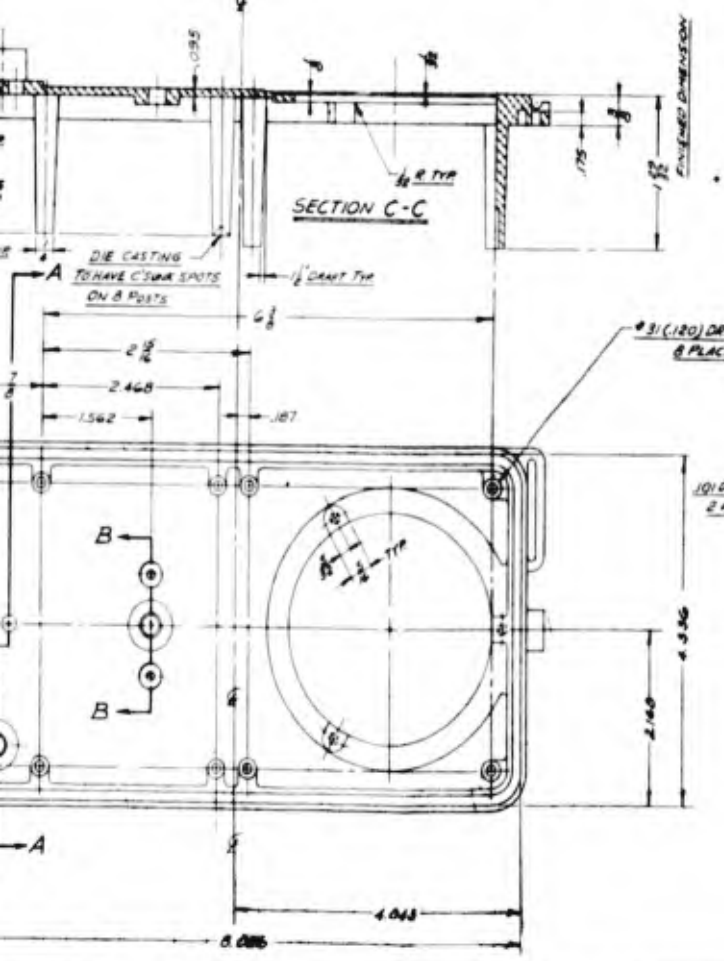
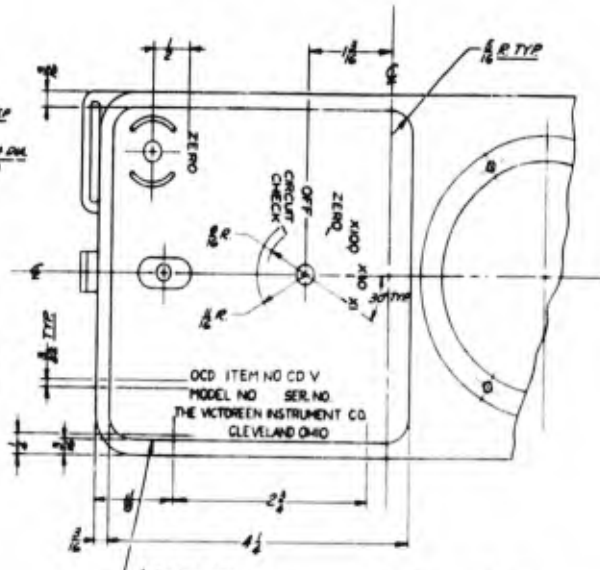
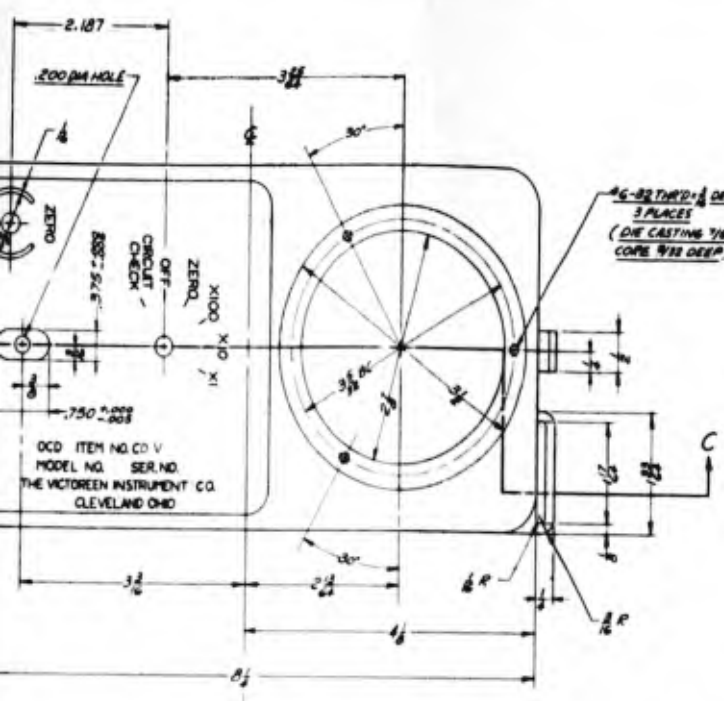
Results show that it would be more advantageous not to specify an oscillator transistor common to both the CD V-750 and CD V-715. Transistors with certain parameters, e. g., beta spread and collector break-down voltage, are more apropos for one or the other, but not necessarily for both. Optimization could result in something short of ideal performance for either, and could conceivably present some undesirable maintenance considerations.

E. CD V-717/CD V-715; Effect of Extra-Cameral Volume.

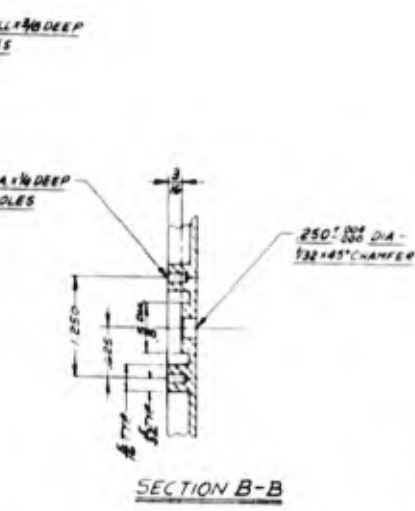
Experimental results, and close order verified calculations, forego and verify that the overall extra-cameral volume should not effect energy dependence and exposure dose rate determinations to any more than $\pm 5\%$. Its effect is of some consequence, but not necessarily of any great significance. Therefore, we recommend that the specifications for both instruments specify that the effect of extra-cameral volume be equal to, or less than, $\pm 5\%$ of the true exposure dose rate for photons whose energies range between 80 Kev to 1.25 mev.

REV. NO.	DATE	DESCRIPTION	BY	CHKD

USE 3-55071



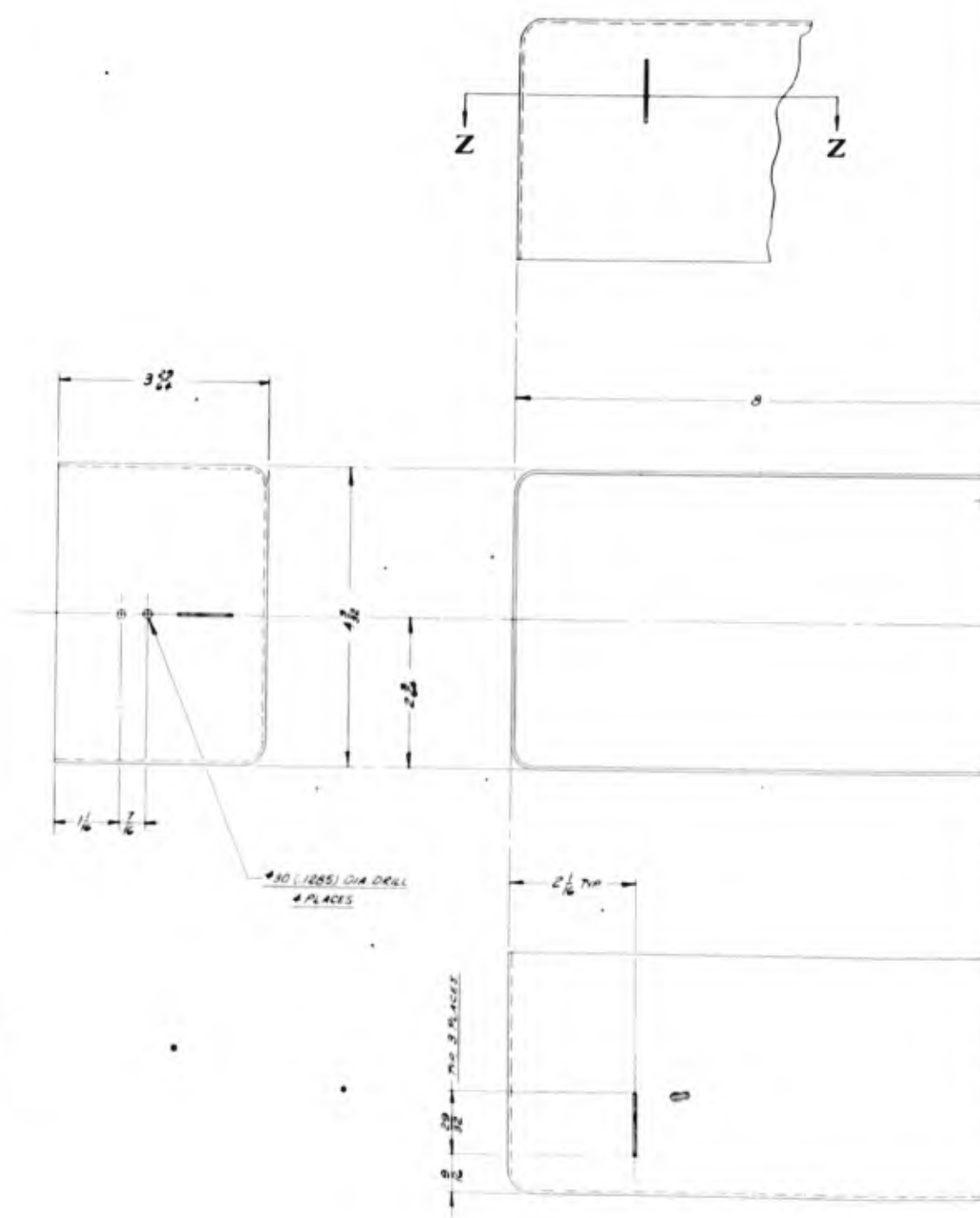
ENGRAVING DETAILS
ALL ENGRAVING TO BE 1/16 HIGH
ALL ENGRAVING TO BE 0.10 - 0.15 DEEP, CENTER AS SHOWN



2

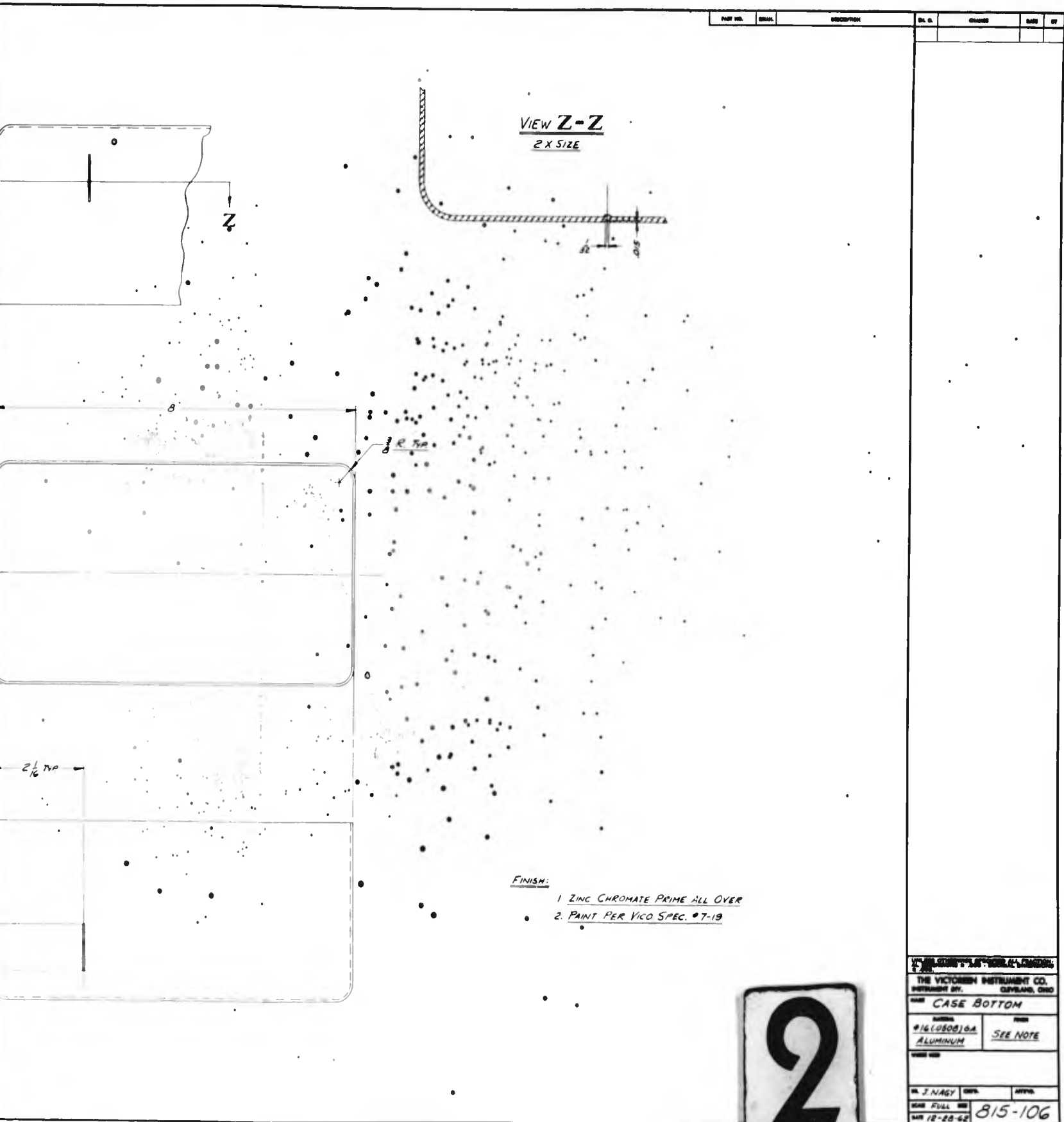
THE VICTOREEN INSTRUMENT CO. INSTRUMENT DIV. CLEVELAND, OHIO	
CASE TOP	
MATERIAL DIE-CAST ALUM.	FINISH PAINT PER VICO SPEC. 7-12
DATE FULL MAR 12-27-62	815-103

815-106



1

FIGURE 2

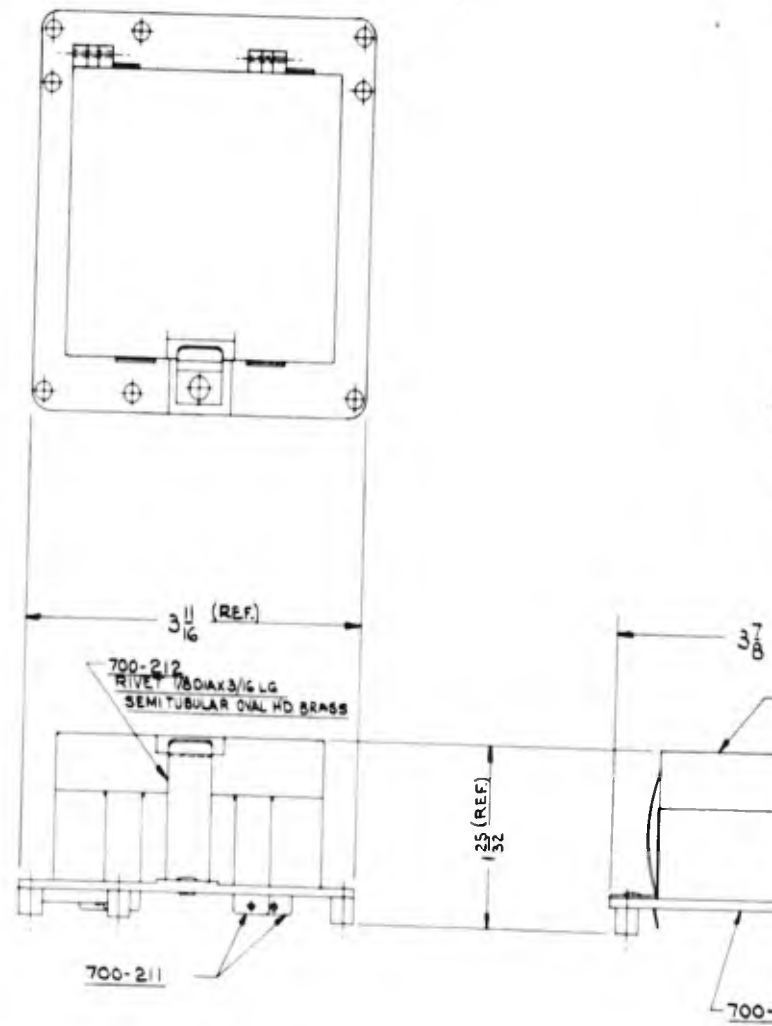


PART NO.	QTY.	DESCRIPTION	DR. G.	DATE	BY
----------	------	-------------	--------	------	----

2

THE VICTORIN INSTRUMENT CO. CLEVELAND, OHIO	
PART NO. CASE BOTTOM	
QTY. #16 (0500) 6A	SEE NOTE
MATERIAL ALUMINUM	
DR. J. NAGY	DATE
DATE FULL 12-28-62	815-106

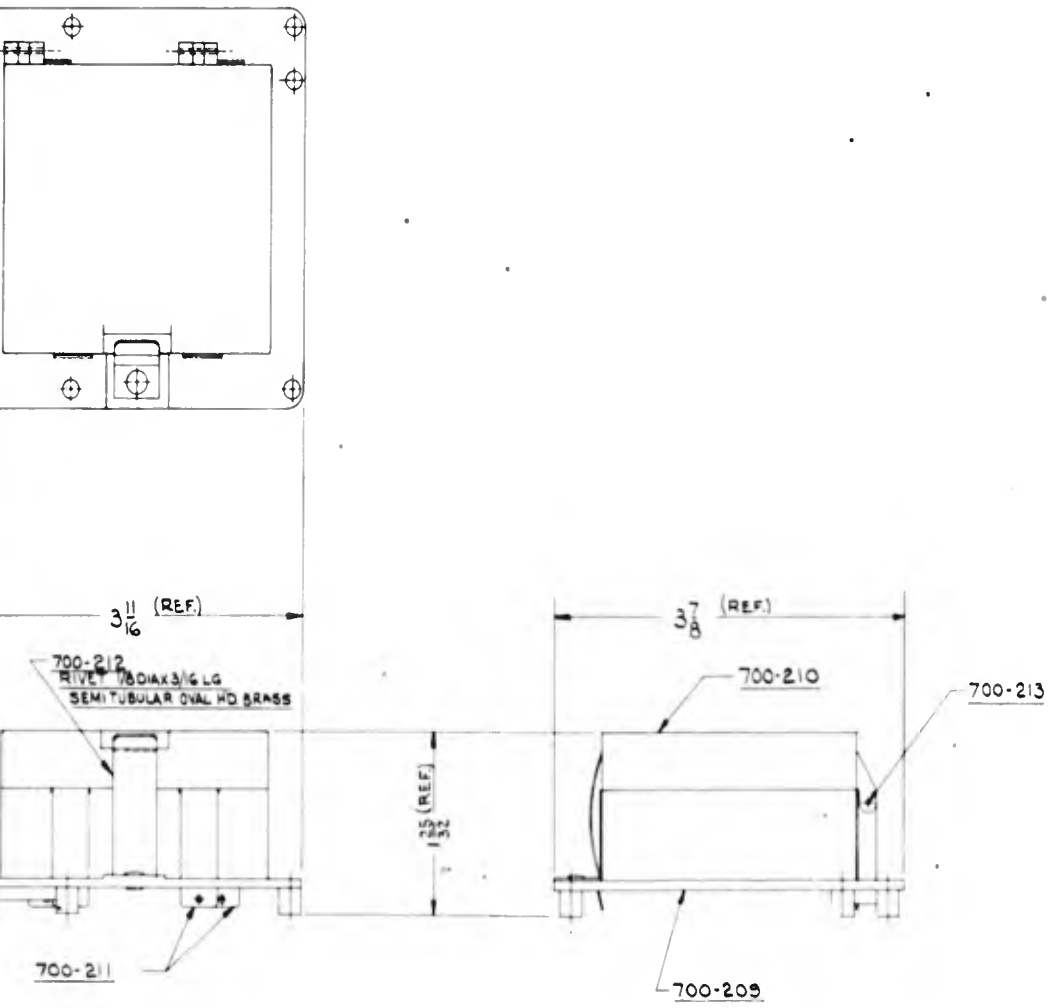
700-214



1

FIGURE 3

PART NO.	QTY.	DESCRIPTION	BL. G.	CHG.	DATE	BY
700-209	1	BATTERY BOX		USE 3-55871		
700-210	1	BATTERY BOX LID				
700-211	4	BATTERY CONTACT				
700-212	1	CLIP				
700-213	2	HINGE PIN				
	1	RIVET 1/8 DIA X 3/16 LG SEMI-TUBULAR OVAL HEAD BRASS				



UNLESS OTHERWISE SPECIFIED ALL FRACTIONAL DIMENSIONS ± .005 - DECIMAL DIMENSIONS ± .001

THE VICTOREEN INSTRUMENT CO.
INSTRUMENT DIV. CLEVELAND, OHIO

NAME BATTERY BOX ASSY

MATERIAL	FINISH
∞	∞

WHERE USED

DR. O. C. R. J. S. E.	CHK'D.	APP'VD.
SCALE FULL	SIZE	700-214
DATE 2-20-60		

2

700-209

DRAFT ANGLE
TYPICAL ON
OUTSIDE WALL

SECTION - A-A

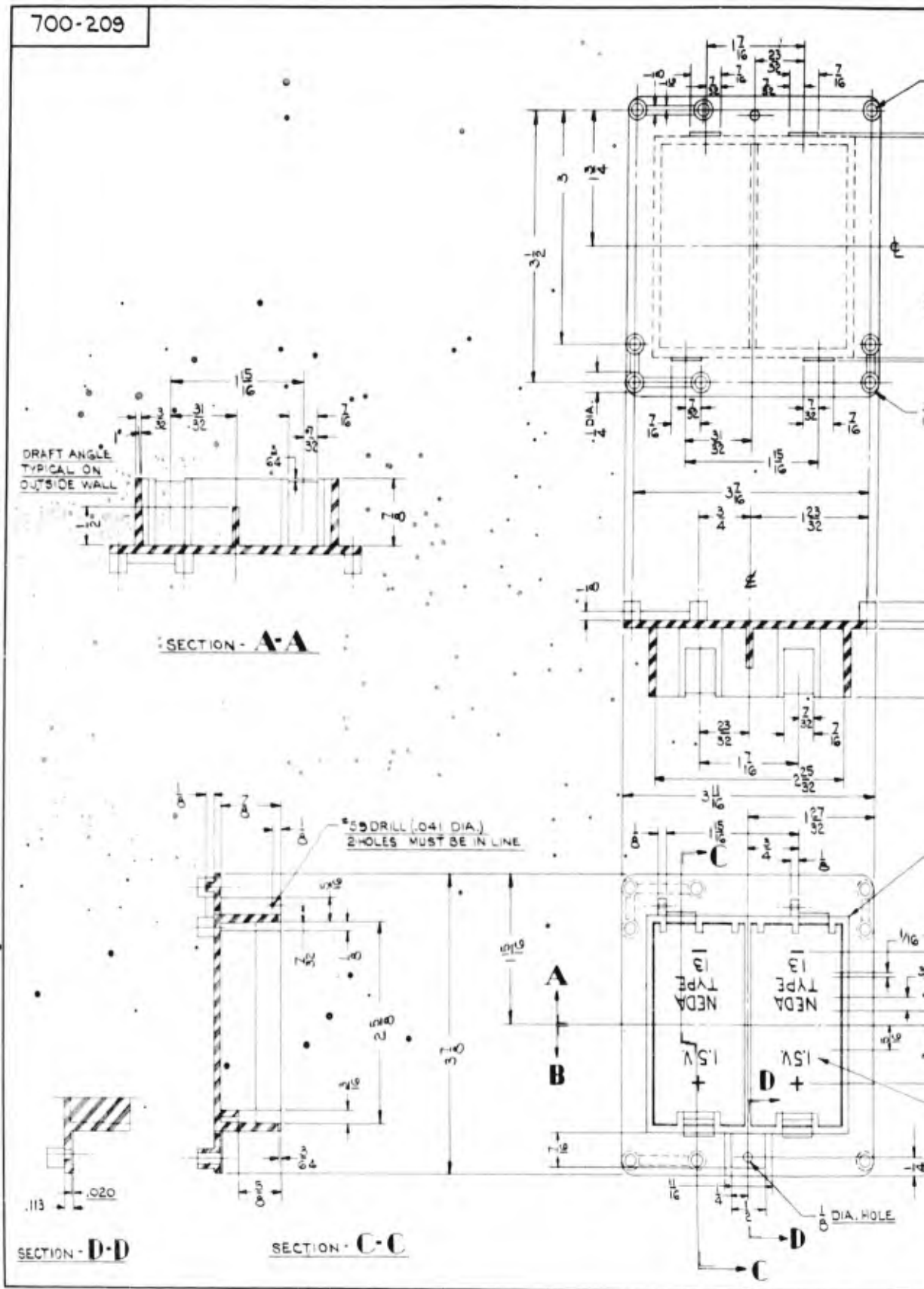
55 DRILL (.041 DIA.)
2 HOLES MUST BE IN LINE

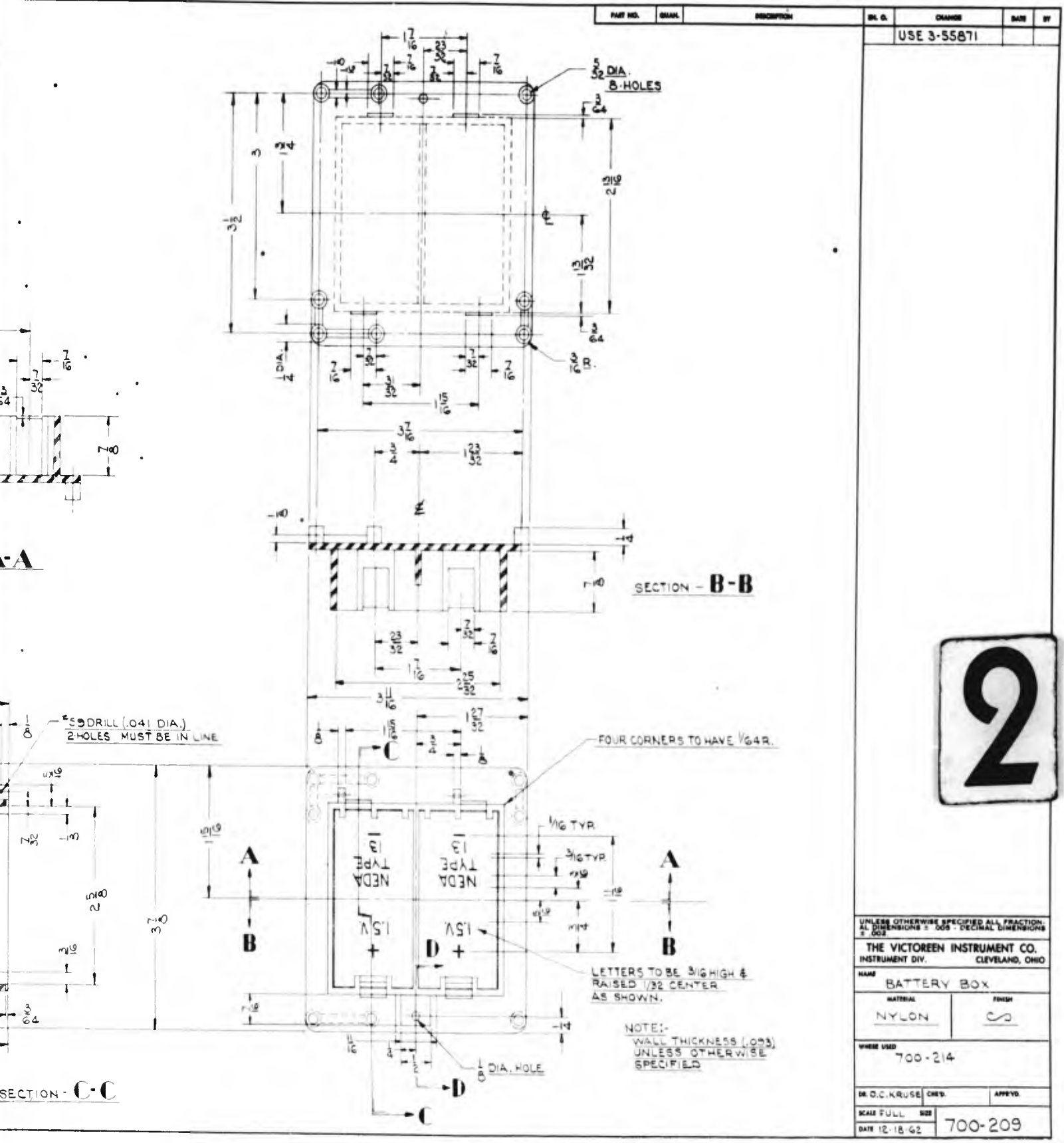
SECTION - D-D

SECTION - C-C

1

FIGURE 4





2

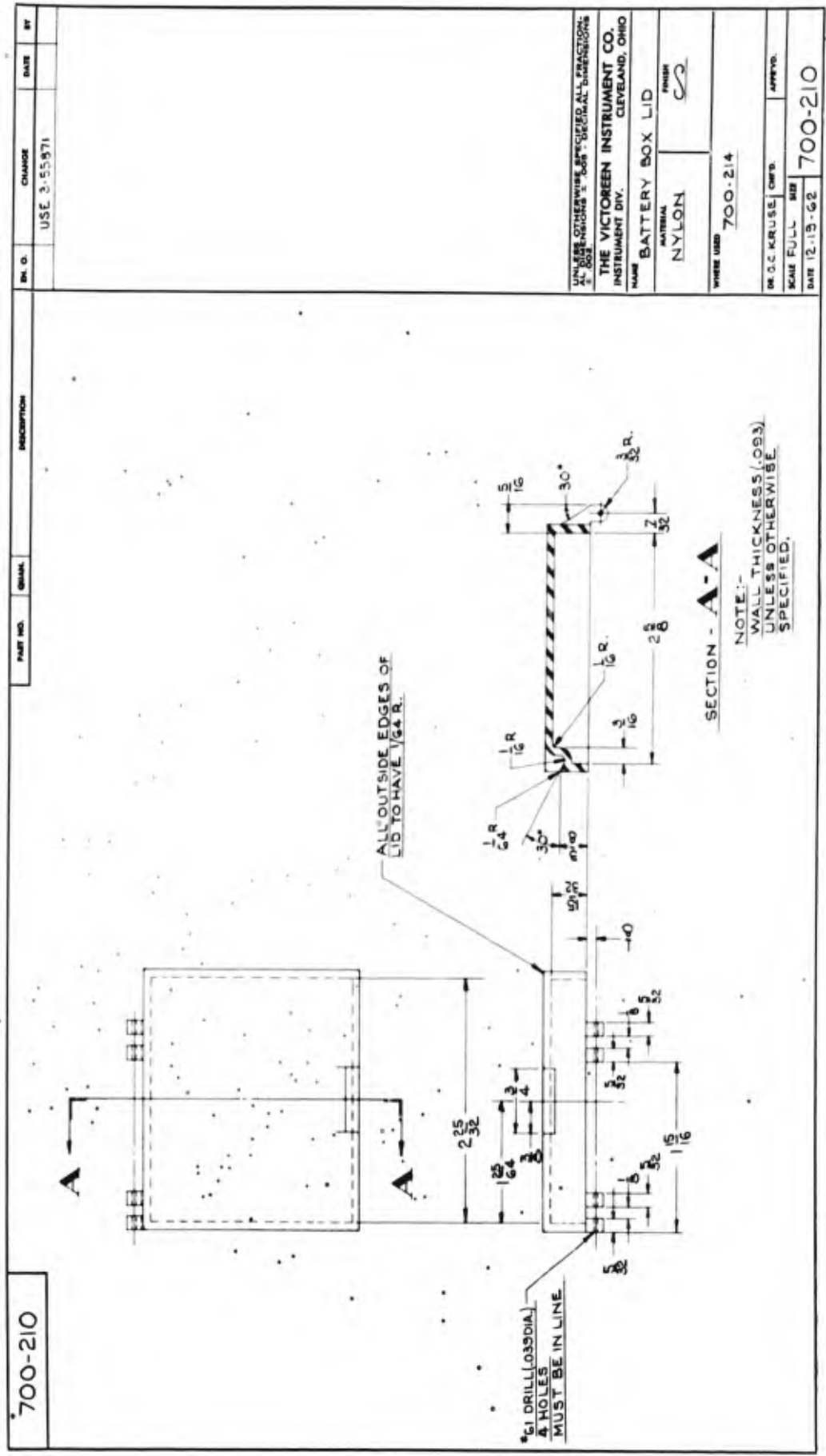
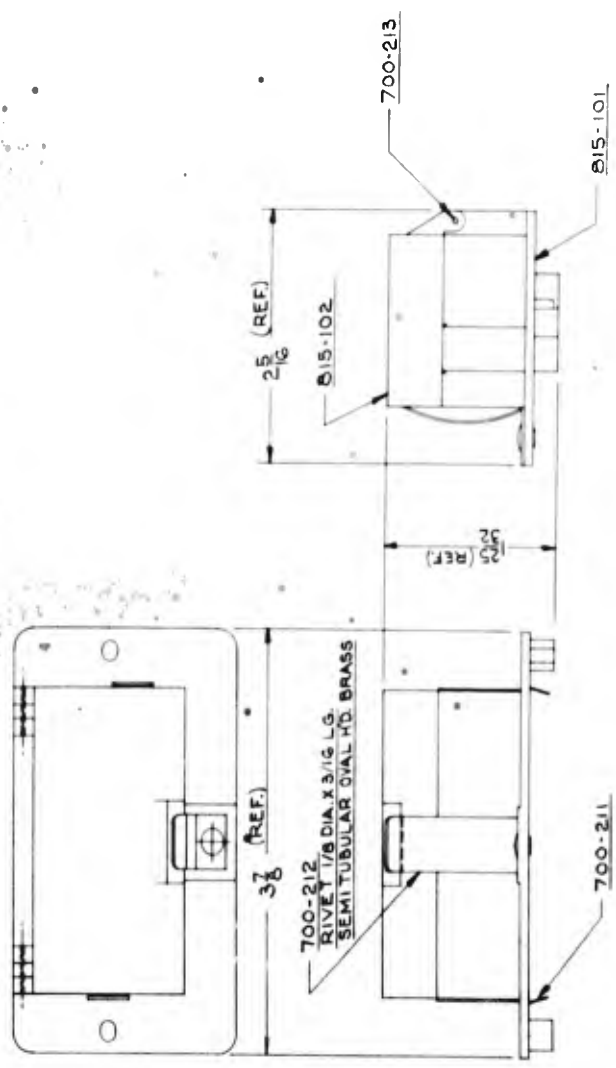


FIGURE 5

815-100

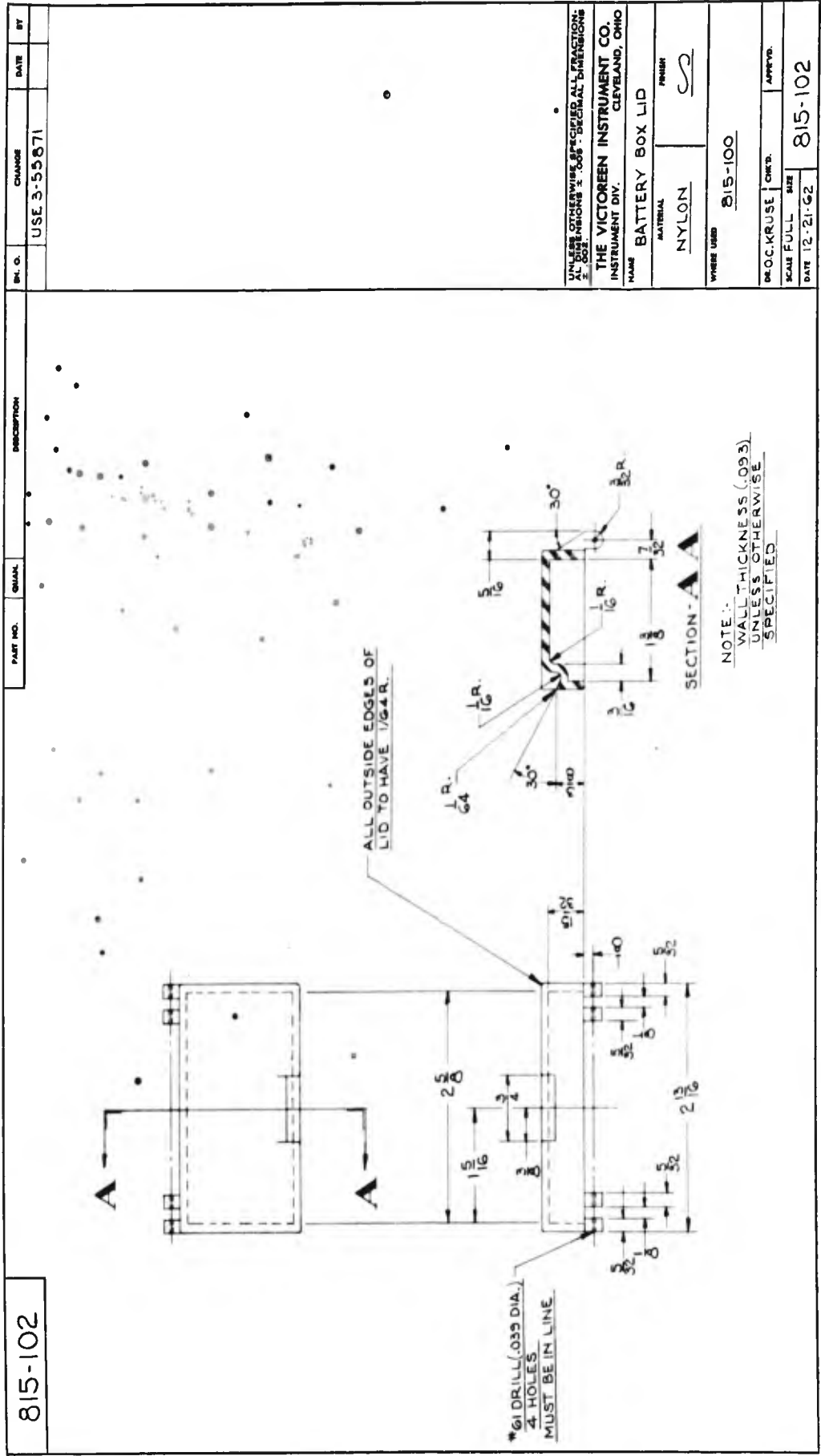
PART NO.	QUAN.	DESCRIPTION
815-101	1	BATTERY BOX
815-102	1	BATTERY BOX LID
700-211	2	BATTERY CONTACT
700-212	1	CLIP
700-213	2	HINGE PIN
	1	RIVET 1/8 DIA. X 3/16 LG. SEMI-TUBULAR-OVAL HEAD - BRASS

PK. Q.	CHANGE	DATE	BY
	USE 3-55871		



UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES AND DECIMAL FRACTIONS. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE SPECIFIED.		
THE VICTOREEN INSTRUMENT CO. INSTRUMENT DIV. CLEVELAND, OHIO		
NAME BATTERY BOX ASSY.		
MATERIAL S		
FINISH S		
WHERE USED		
DR. C. C. KRUSE	CHKD.	APPRVD.
SCALE FULL	SIZE	815-100
DATE 12-21-62		

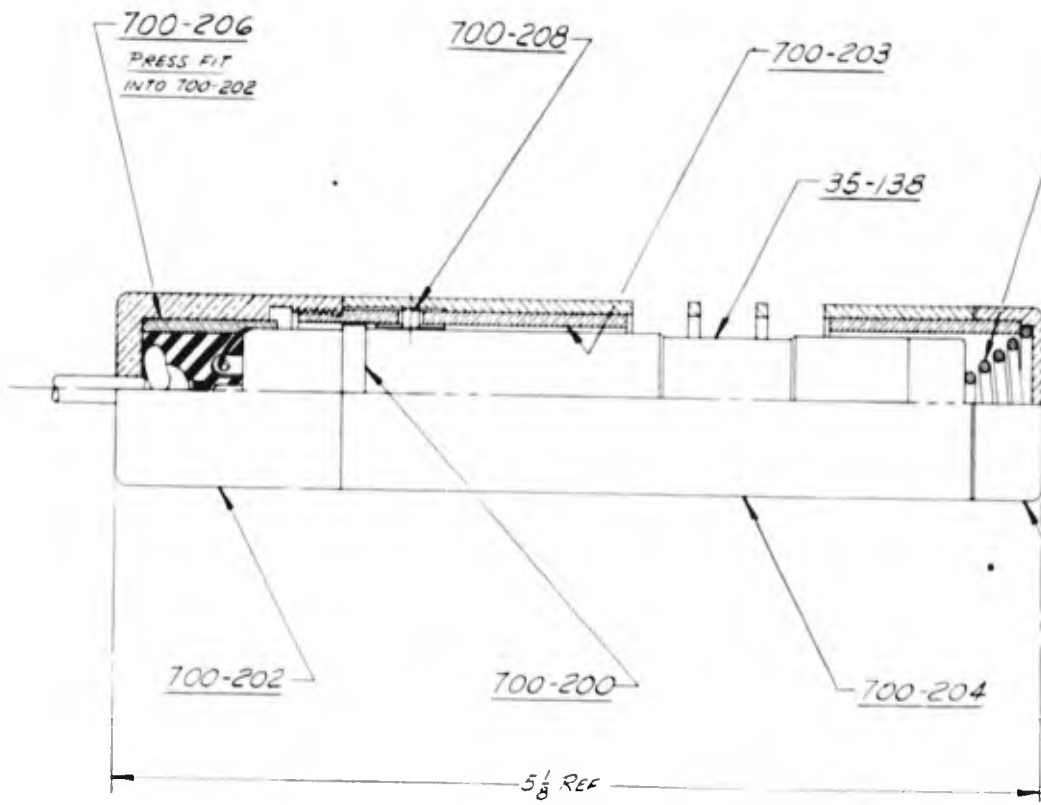
FIGURE 6



UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE TO BE IN INCHES AND DECIMAL FRACTIONS.	
THE VICTOREEN INSTRUMENT CO.	
INSTRUMENT DIV. CLEVELAND, OHIO	
NAME BATTERY BOX LID	
MATERIAL	NYLON
FINISH	S
WHERE USED	815-100
DROC. KRUSE	CHKD.
SCALE FULL SIZE	APPRV.
DATE 12-21-62	815-102

FIGURE 8

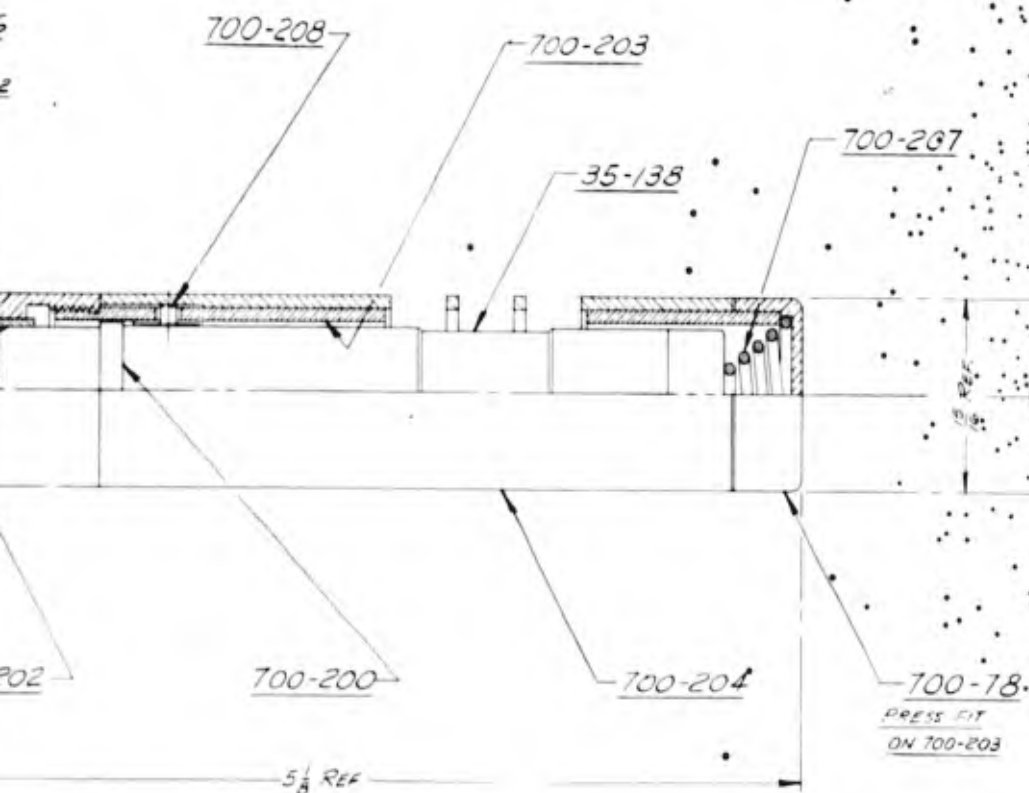
700-205



1

FIGURE 9

PART NO.	QTY.	DESCRIPTION	DL. G.	CHANGE	DATE	BY
35-138	1	GEIGER TUBE		USE 3-55871		
700-78	1	END CUP				
700-200	1	GASKET				
700-208	1	TUBE SOCKET ASS'Y				
700-202	1	SOCKET HOUSING				
700-203	1	TUBE HOUSING				
700-204	1	SHIELD				
700-206	1	TUBE SOCKET ASS'Y				
700-207	1	TUBE SPRING				



UNLESS OTHERWISE SPECIFIED ALL FRACTIONS ARE IN THIRDS OF AN INCH DECIMAL DIMENSIONS TO .005

THE VICTOREEN INSTRUMENT CO.
INSTRUMENT DIV. CLEVELAND, OHIO

NAME *PROBE ASSEMBLY*

MATERIAL	FINISH
<i>∞</i>	<i>∞</i>

WHERE USED

DR. *J. NAGY* CHG. APP'VD.

SCALE *2X* SIZE DATE *12-8-62* *700-205*

2

FIGURE 9

700-206		DESCRIPTION		CHANGE		DATE		BY	
PART NO.	QUAN.			IN. O.	USE 3-55871				
33-43	1	TUBE SOCKET							
700-17	1	CABLE							
700-201	1	POTTING SHELL							
	-	EPOXY MS#J4316							
	-	SOLDER 60:40							

33-43

700-201

700-17

EPOXY MS#J4316

7/16

PIN #3

PIN #1

UNLESS OTHERWISE SPECIFIED ALL FRACTIONS AND DIMENSIONS ± .005 - DECIMAL DIMENSIONS ± .002.

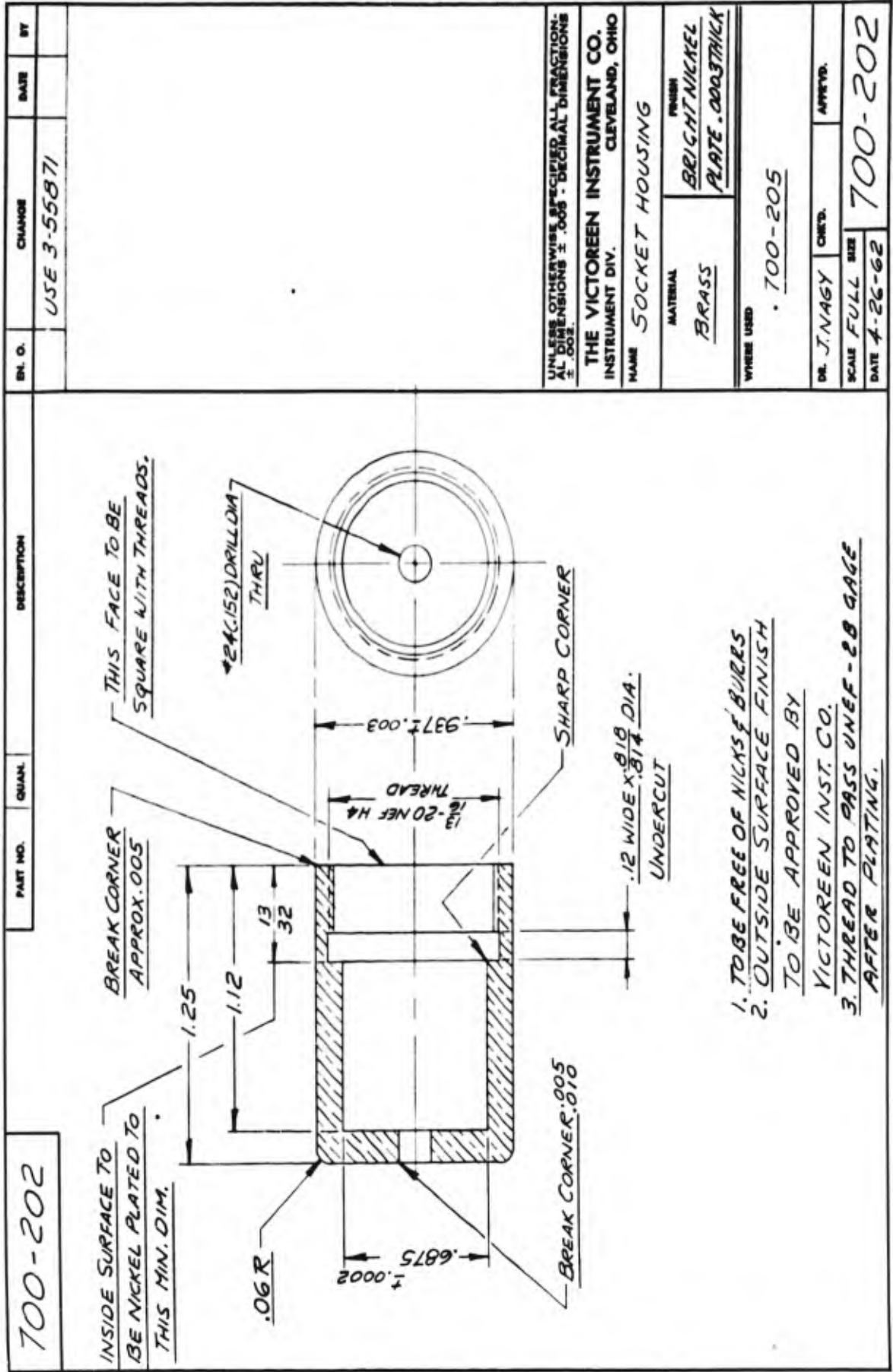
THE VICTOREEN INSTRUMENT CO.
INSTRUMENT DIV. CLEVELAND, OHIO

NAME **TUBE SOCKET ASSY**

MATERIAL ∞	FINISH ∞
WHERE USED 700-205	

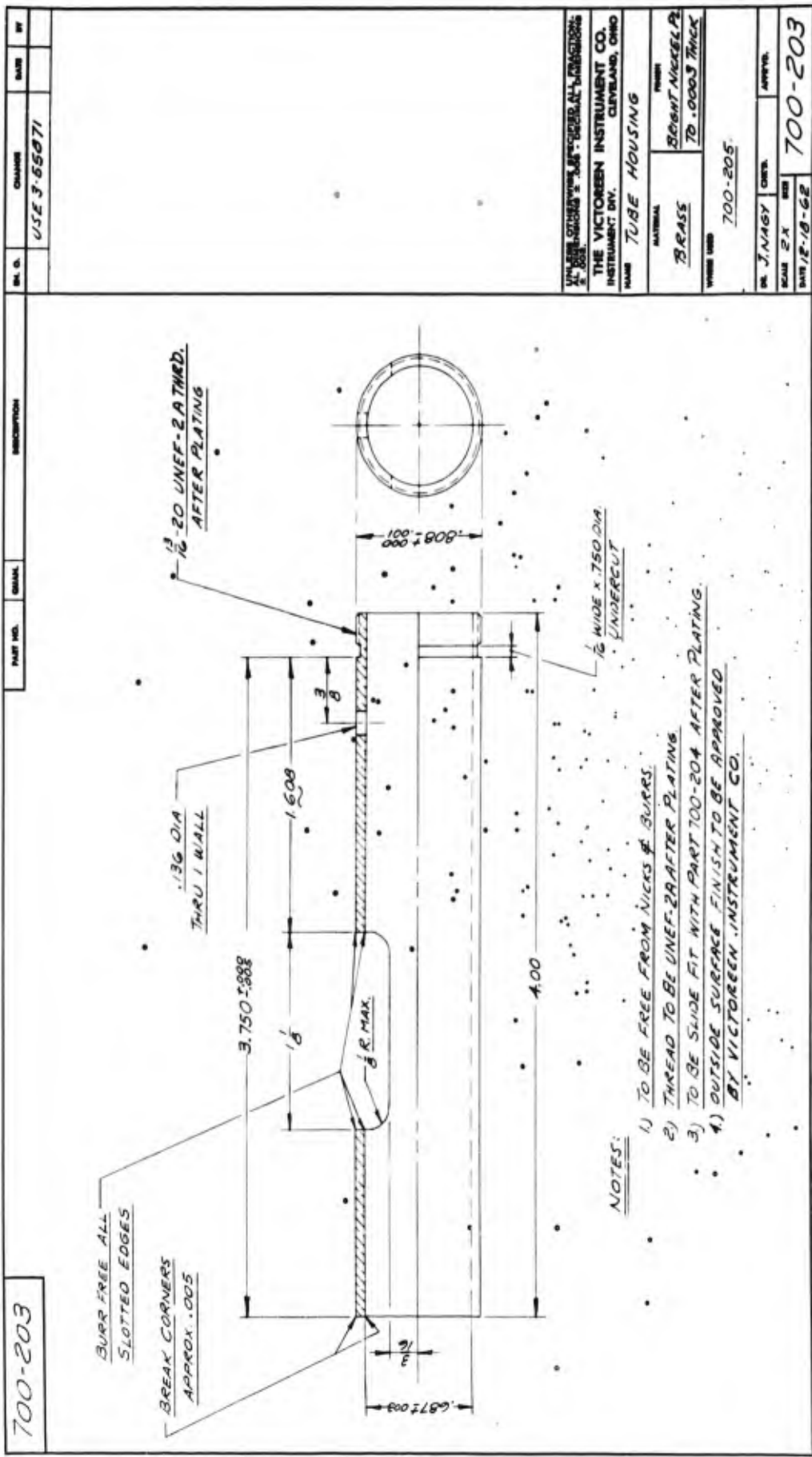
DR. J. NAGY	CHKD.	APPRD.
SCALE 2X	REV	
DATE 12-18-62		700-206

FIGURE 10



1. TO BE FREE OF NICKS & BURS
2. OUTSIDE SURFACE FINISH TO BE APPROVED BY VICTOREEN INST. CO.
3. THREAD TO PASS UNEF-2B GAGE AFTER PLATING.

FIGURE 11



UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE TO BE HOLDING DIMENSIONS.

THE VICTOREEN INSTRUMENT CO.
INSTRUMENT DIV.
CLEVELAND, OHIO

NAME TUBE HOUSING

MATERIAL BRASS

FINISH 80/90 Nickel P

THICKNESS TO .0003 THICK

WORK ORDER 700-205

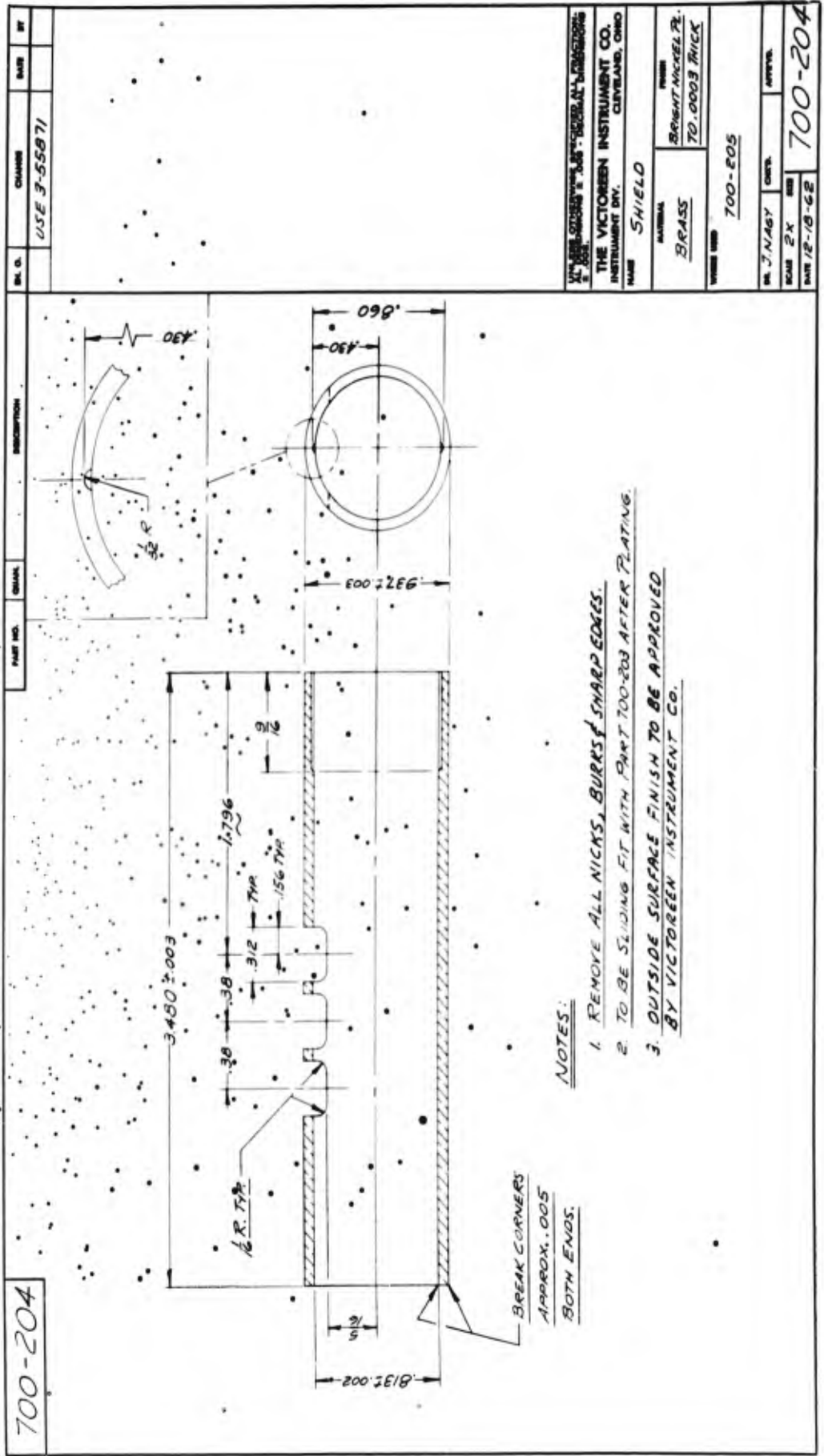
DR. J. NAGY CHECKED _____ APPROVED _____

SCALE 2 X

DATE 12-18-62

700-203

FIGURE 12



UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE TO BE HOLD TO TOLERANCES AS SHOWN.

THE VICTOREEN INSTRUMENT CO.
INSTRUMENT DIV.
CLEVELAND, OHIO

NAME *SHIELD*

MATERIAL *BRASS*

FINISH *BRIGHT NICKEL PL.*

QUANTITY *70,000*

TRUCK *TRUCK*

WORK ORDER *700-205*

DR. *J. NAGY*

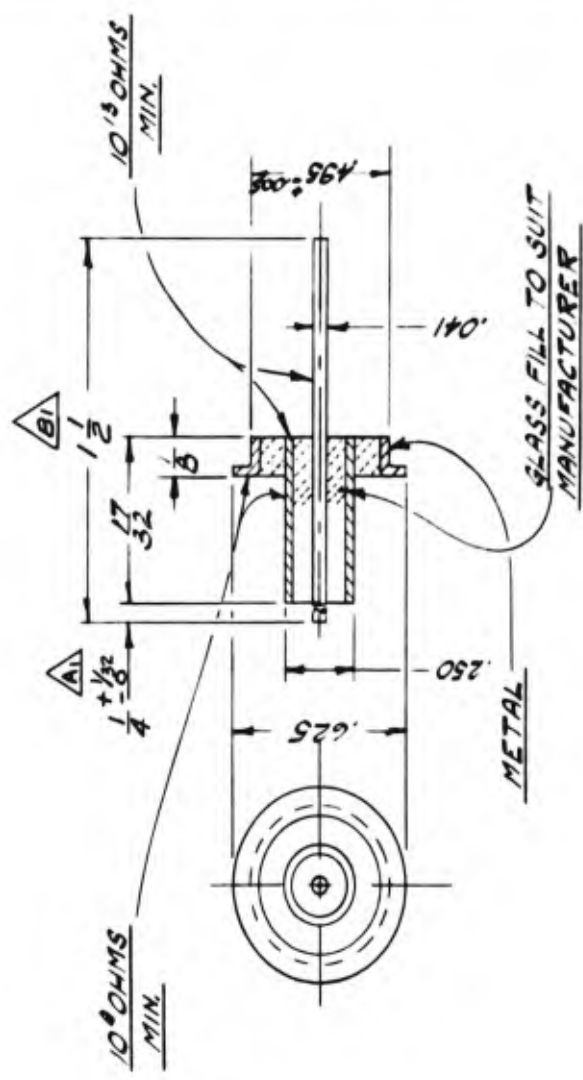
SCALE *2X*

DATE *12-18-62*

APPROV. *700-204*

FIGURE 13

815-12		DESCRIPTION	
PART NO.	QUAN.		
BL. O.	CHANGE	DATE	BY
11407	USE 55590		
11410	A1 - ADD TOLERANCE	6-28-62	FLECK
11412	B1 - WAS 1/16	8-15-62	J.N.
11436	C - ADD VENDOR NAME & NO	11-21-62	J.N.
<p>UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS AND TOLERANCES ARE IN DECIMAL DIMENSIONS ±.001.</p> <p>THE VICTOREEN INSTRUMENT CO. INSTRUMENT DIV. CLEVELAND, OHIO</p> <p>NAME <u>TERMINAL</u></p> <p>MATERIAL <u>FRIB</u></p> <p>FINISH <u>CS</u></p> <p>WHERE USED <u>815-32</u></p> <p>DR. <input checked="" type="checkbox"/> CHKD. <input type="checkbox"/> APPVD. <input type="checkbox"/></p> <p>SCALE <u>2 X</u> SIZE <u>815-12</u></p> <p>DATE <u>2/1/62</u></p>			



SEALTRON CORP.
#17074-35 OR EQUIV.

FIGURE 14

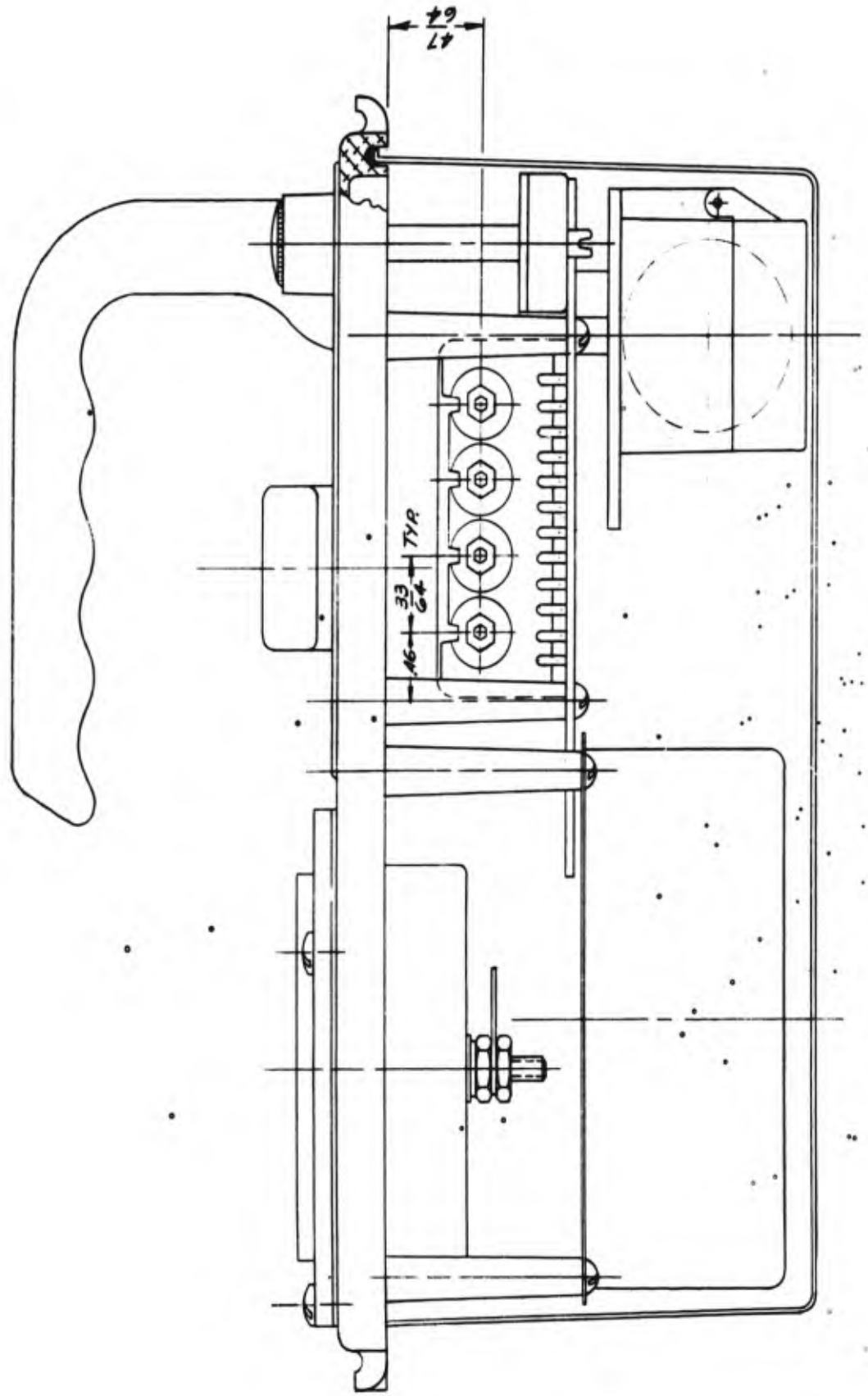


Figure 15. Calibration Potentiometer Location (815-105)

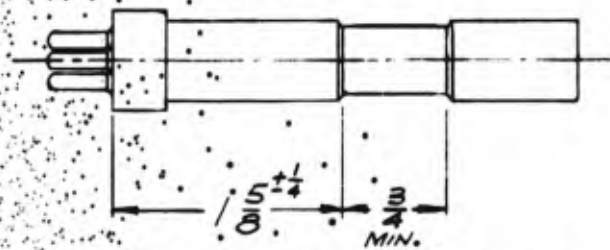


Figure 16

DIMENSIONS PER ATTACHMENT A
OF OCD SPECIFICATION FOR CD V-700

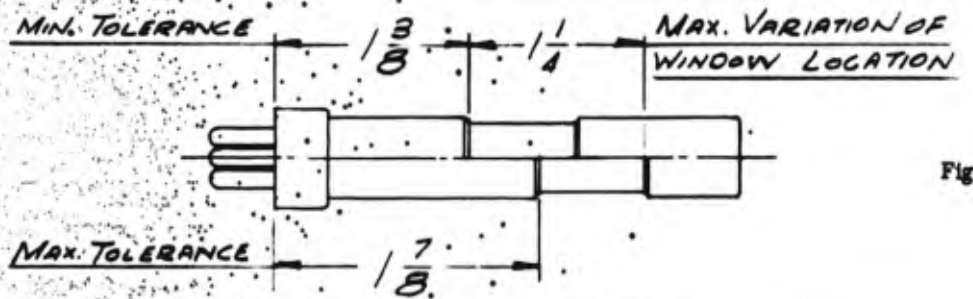


Figure 17

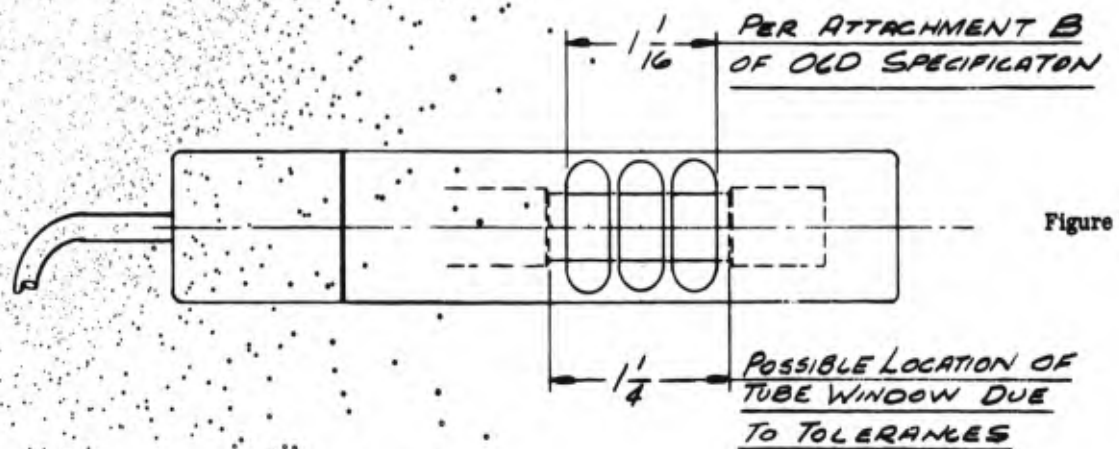


Figure 18

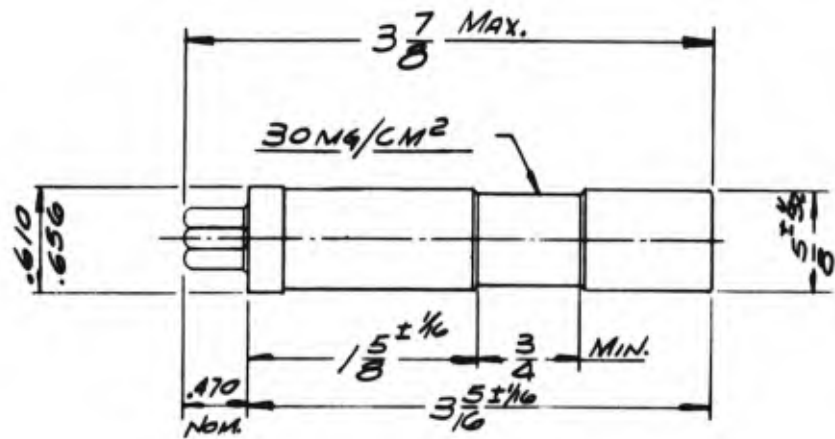


Figure 19

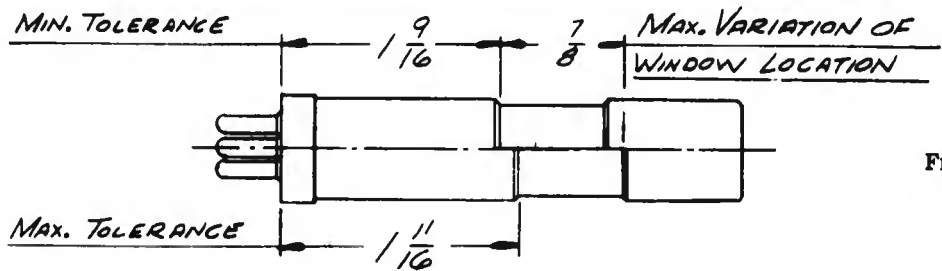


Figure 20

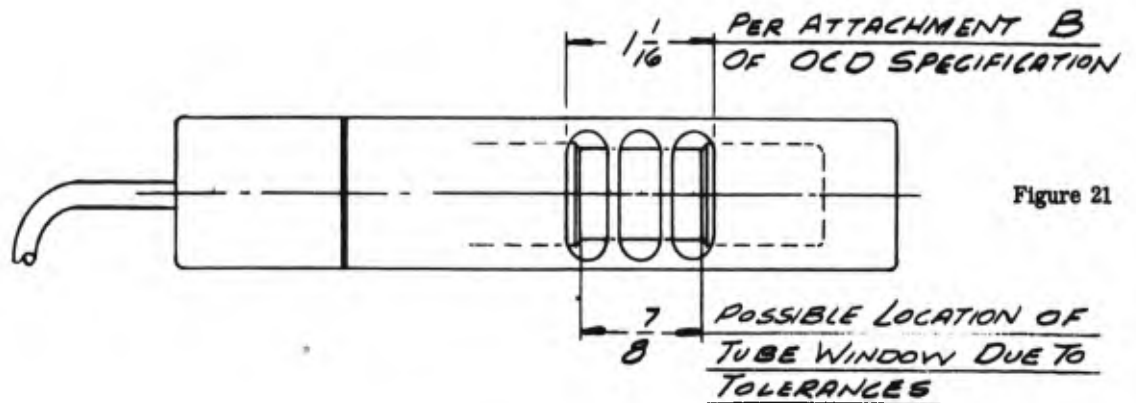


Figure 21

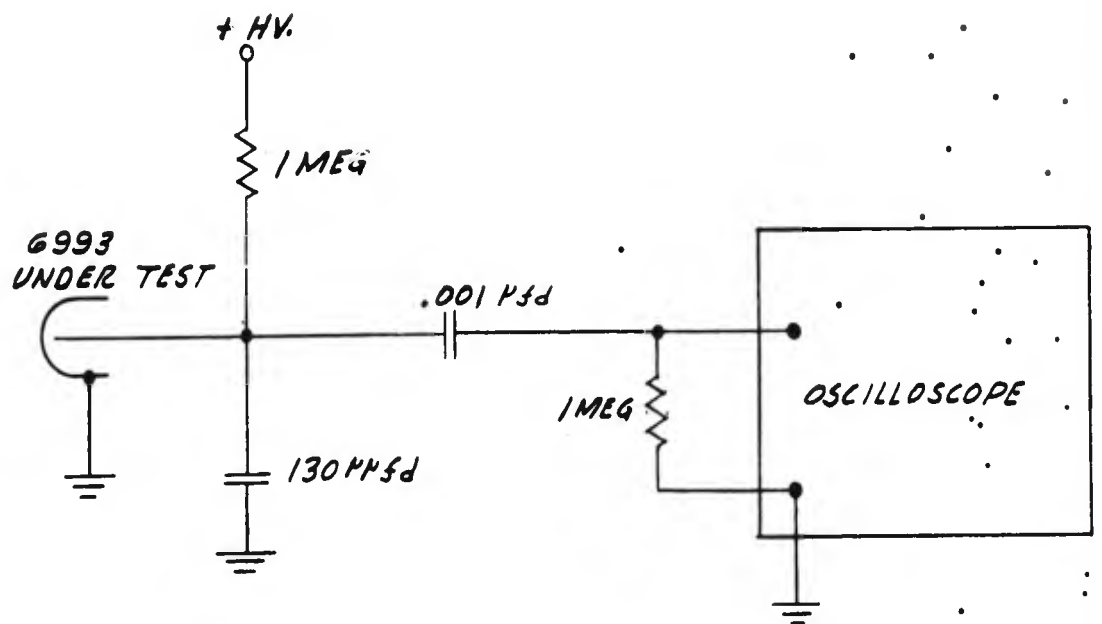
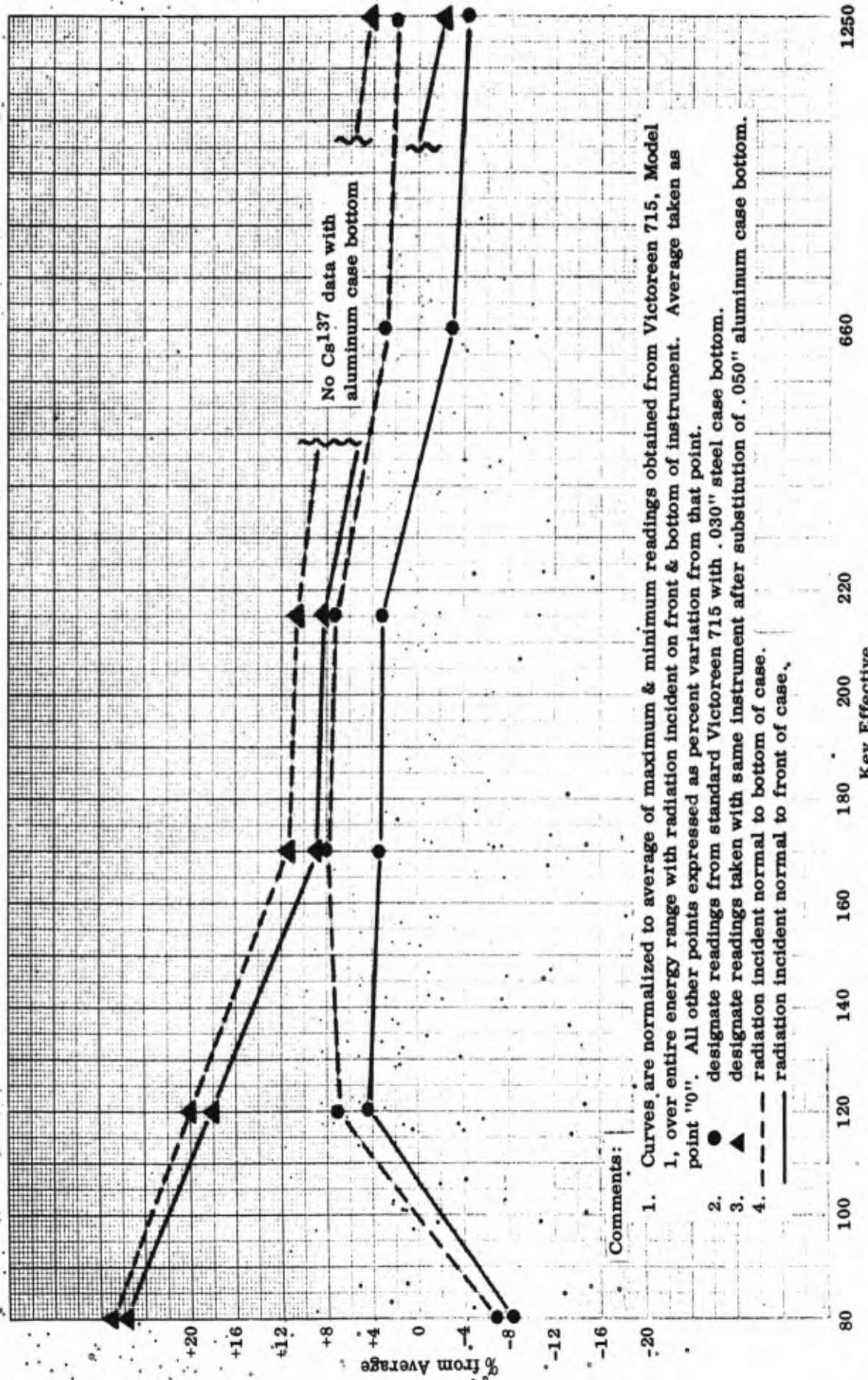


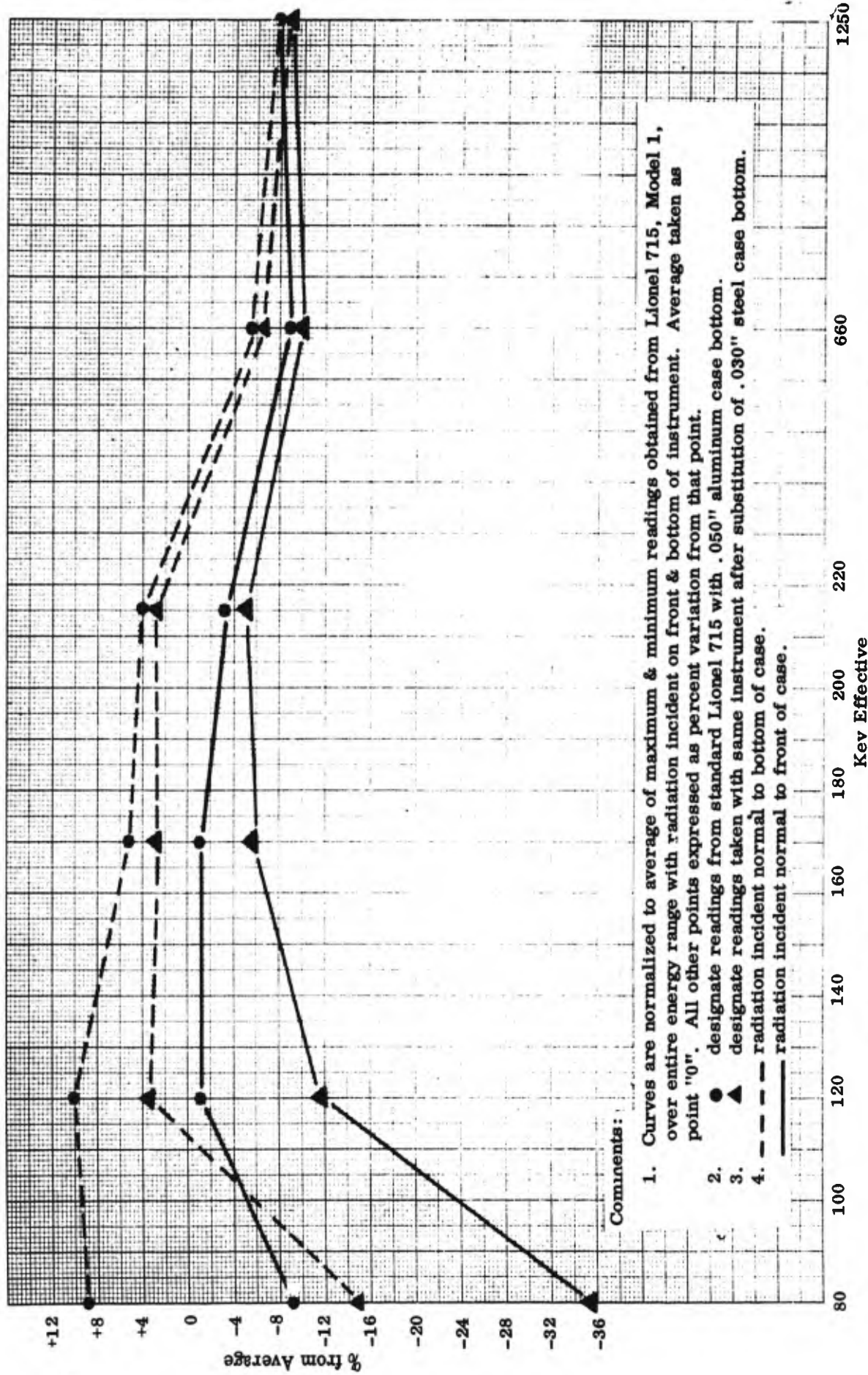
Figure 22. Type 6993 Revised Test Procedure



Comments:

1. Curves are normalized to average of maximum & minimum readings obtained from Victoreen 715, Model 1, over entire energy range with radiation incident on front & bottom of instrument. Average taken as point "0". All other points expressed as percent variation from that point.
2. ● designate readings from standard Victoreen 715 with .030" steel case bottom.
3. ▲ designate readings taken with same instrument after substitution of .050" aluminum case bottom.
4. --- radiation incident normal to bottom of case.
 — radiation incident normal to front of case.

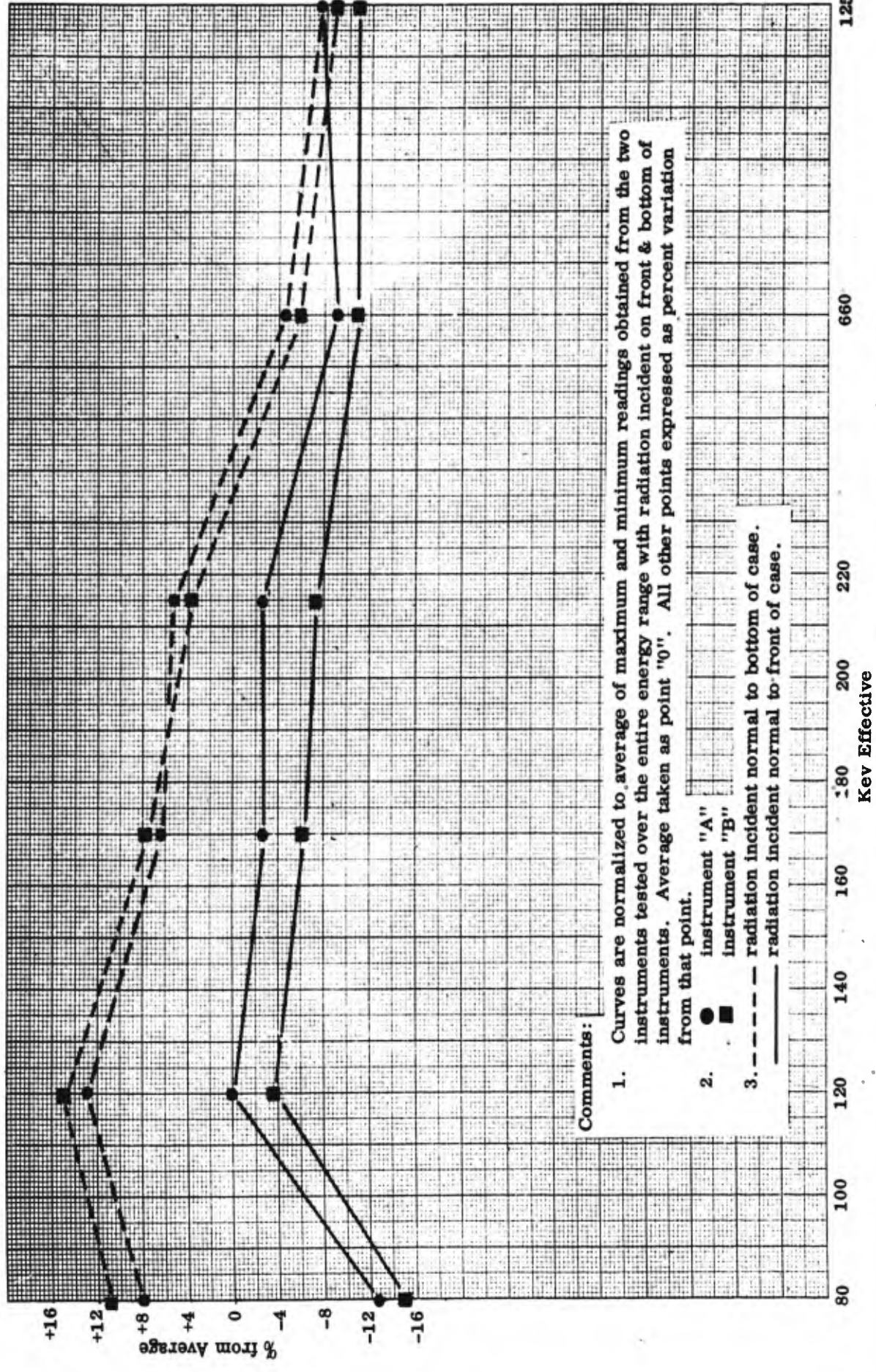
Figure 23. Energy Dependence of Victoreen CD V-715, Model 1, Survey Meter



Comments:

1. Curves are normalized to average of maximum & minimum readings obtained from Lionel 715, Model 1, over entire energy range with radiation incident on front & bottom of instrument. Average taken as point "0". All other points expressed as percent variation from that point.
2. ● designate readings from standard Lionel 715 with .050" aluminum case bottom.
3. ▲ designate readings taken with same instrument after substitution of .030" steel case bottom.
4. - - - radiation incident normal to bottom of case.
 — radiation incident normal to front of case.

Figure 24. Energy Dependence of Lionel CD V-715, Model 1, Survey Meter



Comments:

1. Curves are normalized to average of maximum and minimum readings obtained from the two instruments tested over the entire energy range with radiation incident on front & bottom of instruments. Average taken as point "0". All other points expressed as percent variation from that point.
2. ● instrument "A"
■ instrument "B"
3. - - - radiation incident normal to bottom of case.
— radiation incident normal to front of case.

Figure 25. Energy Dependence of Lionel CD V-715, Model 1A, Survey Meter

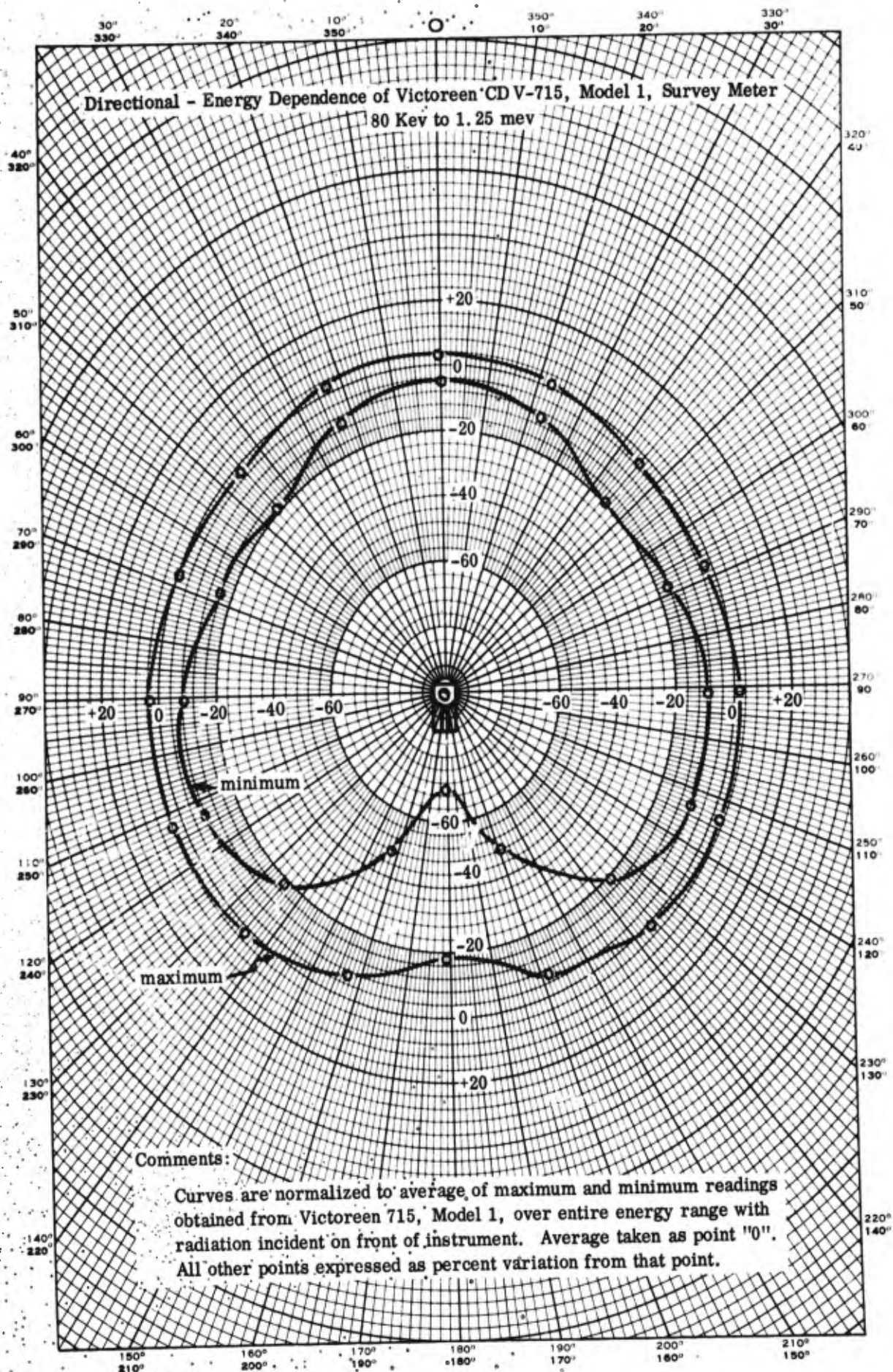


Figure 26

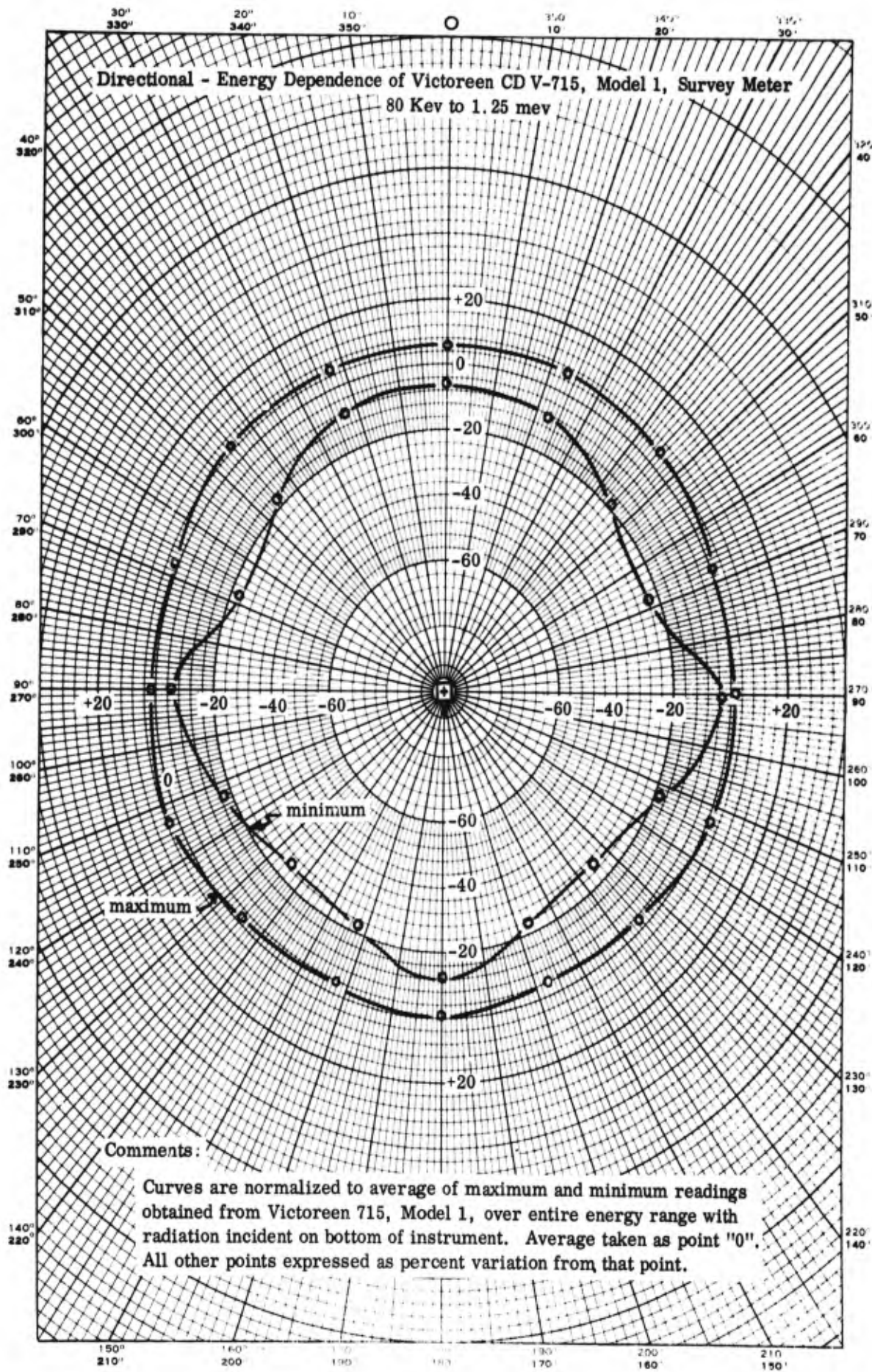


Figure 27

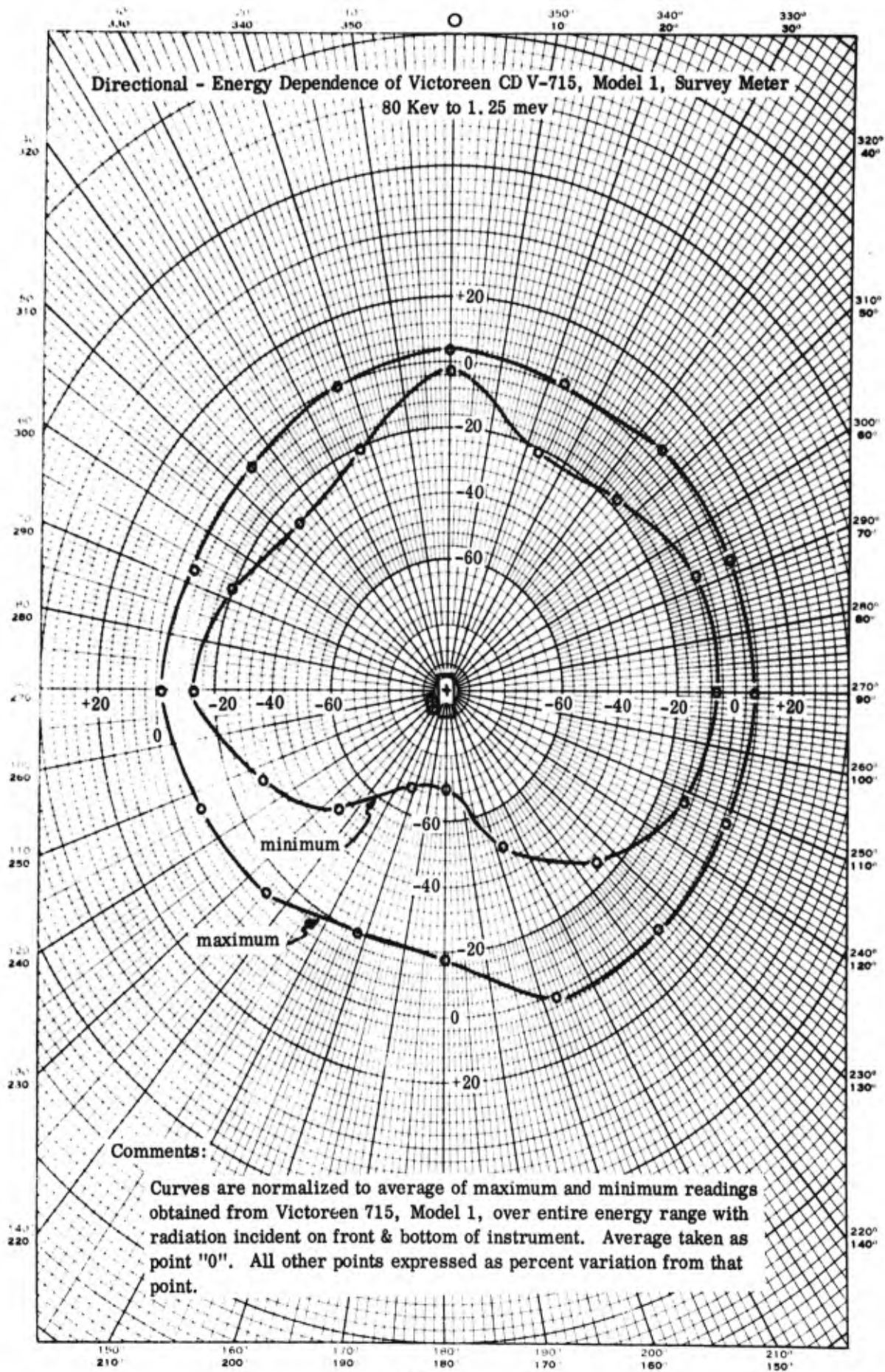


Figure 28

APPENDIX I

PROJECT PLAN
OCD SURVEY INSTRUMENT COMPONENT STANDARDIZATION
CONTRACT #OCD-OS-62-276

The following items and the discussions pertaining thereto comprise the planned specific work under this OCD standardization project. The specific items to be considered for standardization were obtained from two sources. Preliminary investigative work during July and August by the assigned Victoreen developmental people brought to light a number of the topics to be considered, and Mr. Robert Martin of OCD suggested the inclusion of a number of others at a Project Planning Meeting held in Washington, D. C. The discussions during this Planning Meeting served to finalize the items which are to be considered for standardization and are listed and discussed below.

CD V-715 ELECTRICAL PARTS.

1. Perhaps the most important item to be standardized on the CD V-715 instrument is the ion chamber detector itself. Not only the details of material and thickness of the various chamber component parts will be selected but attention will be given to the ionization chamber feed-thru insulator or seal. The material, construction, and dimensions of this seal are very important to the appropriate operation of the chamber and will be considered for specification. The leakage resistance of the ionization chamber itself as well as its individual high impedance insulators such as the seal will be specified. The question of a teflon, Kel-F, or glass seal will be decided upon and the appropriate material specified if necessary. Specification of the ion chamber construction, materials, and their thicknesses will entail a consideration of the actual instrument case bottom and its material, configuration and thickness. As a part of this work, detailed energy dependence data will be taken from all directions, not only from the front and bottom of the instrument. For instance, the energy dependence at 45° and other skew directions will be checked and will be considered in chamber specifications.
2. Perhaps the second most important element in the CD V-715 are the signal resistors used to generate a voltage drop measured by the electronics of the instrument. A detailed set of accelerated humidity, shelf life, and temperature cycling tests will be conducted on all varieties of presently used signal resistors to obtain data necessary for the appropriate specification of these resistors. Questions which are to be resolved are those of kind and degree of encapsulation necessary and/or type of humidity and shelf life testing. In conjunction with the ion chamber and electronic parts specification the actual value of the signal resistors will also be fixed so that only one type need be stocked by OCD in the future.
3. Another of the high impedance components which will be evaluated for detailed specification purpose is the portion of the selector switch used for the signal circuits. Again, material specification and possibly surface treatment to reduce moisture effects will be evaluated and recommendations made for appropriate specification.
4. The electrometer tube used to date in all OCD instruments has always been essentially the same. Experimental data and calculations will be combined to specify the maximum and minimum parameters of a tube suitable for the CD V-715 and CD V-727 instruments.

Among these parameters are maximum grid current, maximum and minimum transconductance, and maximum and minimum plate currents at appropriate operating voltages.

5. Consideration will be given to the possibility of standardization of the transistor utilized in the power supply of the CD V-715. Attempts will be made to specify parameters rather than transistor types so that new transistors as well as maximum number of presently available types can be used in this application. Under this portion of the project an investigation will be initiated to determine the possibility of utilizing and specifying the same transistor in the Model CD V-750 Charger as will be called for in the CD V-715.

6. Preliminary investigation of some CD V-715 models has indicated that battery life, especially with certain manufacturers' batteries, is marginal. A much more detailed investigation of the battery life problem will be made. First consideration will be the possibility of increasing power supply efficiency to increase the battery life. The second consideration would be the actual recommendation to lower the presently specified 150 hours of operation. The third consideration would be the advisability of increasing the battery complement to two "D" cells. It is suggested at this writing that the third alternative be recommended only as a very last resort.

7. No specification exists at present for the drift in instrument zero with varying temperature. Experimental information will be accumulated to intelligently specify this operating parameter.

8. It has already been established in the preliminary investigation that all 715 circuitries are somewhat non-linear. The amount and direction of this non-linearity depends on circuit design. A more detailed investigation of these non-linearities will be made with the possibility in mind of permitting a certain deliberate non-linearity in the meter scale to be specified.

CD V-715 MECHANICAL PARTS.

1. The extra-cameral effect is presently not specified on the CD V-715. Since this effect or its energy dependence may appreciably influence operation at different altitudes, its maximum magnitude should and will be specified.

2. Evaluation of various circuit board materials will be performed in order to specify a material with suitable mechanical and electrical properties. Appropriate mechanical strength and appropriate low moisture absorption will be important considerations.

CD V-700 ELECTRICAL PARTS.

1. The type 6993 geiger tube appears to require certain additions to its specifications in order to make certain that it can be applied appropriately to the present-day solid-state counting circuits. The charge per pulse from this geiger tube should be specified in a more direct and exact manner than is presently done. An investigation into the manner of such specification and its magnitude will be conducted. The cold leakage resistance across the terminals of this geiger tube, it is felt, should also be specified.

2. Again, as in the CD V-715 above, an evaluation program of the transistors and diodes will be conducted with the aim of specifying the parameters appropriately so that true semiconductor interchangeability will result. The preliminary investigation has already indicated that this is quite feasible with the transistor in the high voltage power supply circuit.

Secondary work will be undertaken to specify maximum operating currents, peak inverse voltage, leakage resistance and diode type.

3. Detailed consideration will be given to the high voltage power supply itself with a view to specifying its components to ensure sufficiently high efficiency so that battery life does not become marginal. There is a slight possibility that transformer improvements may somewhat increase present efficiency. If so, this particular item will be appropriately specified.

CDV-700 MECHANICAL PARTS.

1. The location and detailed size and geometry of the beta window of the geiger tube probe will be specified. At present, there is still excessive latitude in the specifications on this item. Briefly, it was decided at the Planning Meeting to specify the beta window openings so that they would be just as wide as the geiger tube itself and so that the beta window of the tube would not be too likely to be damaged. Consideration will also be given to appropriately dimensioning the tube socket sealing gasket in order to always have the center of the beta window of the geiger tube coincide with the center of the window in the probe shield.

2. Investigative work will be done in an attempt to improve the probe cable junctions especially at the probe end where a relatively loosely specified potting material is called for.

3. The geiger tube presently requires an insulating wrap of mylar tape in order to isolate the shell from ground. A final check will be made into any problems connected with removing this requirement which is now considered obsolete.

MECHANICS OF THE COMBINED CD V-700, CD V-715 and CD V-727.

1. One of the major results of this standardization program will be the finalized design of a single case top including all major holes and bosses suitable for any of the above three instruments. The mechanical design requirements of circuit boards, ionization chamber, switches, and battery boxes will be co-ordinated into a design allowing OCD to stock a single case top which will be suitable for all of the instruments. As much consideration as possible will be given to making this case top fit the more peculiar and somewhat contradictory requirements of the remote reading shelter meter.

2. A single, common case bottom design will also be worked out and specified. Important considerations in specifying this item are material and thickness required to permit the ion chamber instruments to function appropriately as far as gamma energy dependence from various directions is concerned. Consideration will also be given to standardizing the hold-down latches of the case bottom. A small portion of the case bottom evaluation will be devoted to appropriately specifying the dimensions of a uranium foil calibration source on the case bottom for the CDV-700. This will permit true inter-changeability of one CD V-700 case with another.

3. The standardization of appropriate battery boxes or holders and their mounting holes will be carried out. Specification of a single battery and a two-battery holder are anticipated with dove-tailing or interlocking features so that up to four batteries may be utilized on one instrument case top. Positive battery retainers will be specified for all boxes so that batteries cannot drop out on opening an instrument. In the battery box standardization appropriate attention will be given to contact format and its relationship to contact resistance

and ease of replacement in the event of corrosion.

In general, the previous described specification of the mechanical parts requires a high degree of integration of case top, case bottom, ion chambers, meters, circuit boards, switches, and battery boxes. This integration will have to be carried out jointly by frequent meetings of the various individuals and groups assigned to partial tasks at Victoreen and by appropriate contacts with OCD research personnel.

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