

Note to the user.

This Military Specification MIL-E-1D contains 190 pages.

For your convenience, a number of "navigation links" have been made.

Go to the Contents, page ii of this document.

A mouse-click on the Section or Appendix of interest, presents the top page of the selection.

Amendment 5 was released on 24 April 1961.

This resulted in a large number of handwritten changes throughout the specification.

The amendment is retained and filed at the end of the document, page 191 - 228.

Please consult these pages for changes hard to read.

Specific UK amendments of MIL-E-1D are listed in specification K1006.

Please consult this document for details.

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MILITARY SPECIFICATION

ELECTRON TUBES AND CRYSTAL RECTIFIERS

This specification has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

1. SCOPE

1.1 Scope. This specification covers electron tubes and crystal rectifiers for use in the equipment of the Armed Services. For the purpose of this specification, the term "tube(s)" shall be construed to include electron tubes and crystal rectifiers.

1.2 Classification. This specification covers general classes of tubes such as:

ATR tubes
Beam-switching tubes
Cathode-ray tubes
Cold cathode discharge tubes
Counter tubes
Crystal rectifiers
Electrometer tubes
Gas-filled rectifiers
Glow tubes
High-vacuum rectifiers
Iconoscopes
Klystrons
Magnetrons
Noise generator tubes
Pencil tubes
Phototubes
Planar tubes
Pre-TR tubes
Pulse modulators
Radiac tubes
Receiving tubes
Reference cavities

Spark-gap modulators
Thyratrons
Transmitting tubes
TR tubes
Traveling wave tubes
Tuning-eye tubes
Voltage regulator tubes

The class into which each tube falls is indicated on the tube specification sheet. (See 3.9.)

2. APPLICABLE DOCUMENTS

2.1 The following specifications, standards, specification sheets, drawings, and publications, of the issue in effect on date of invitation for bids, form a part of this specification:

SPECIFICATIONS

FEDERAL

L-P-406 — Plastics, Organic:
General Specifications, Test Methods.

Amals
PI MILITARY MIL-I-10 - Insulating Materials
Electrical, Ceramic, Class L

Amals
PI JAN-L-10 — Insulating Materials,
Ceramic Radio, Class L.

MIL-M-14 — Molding Plastics and
Molded Plastic Parts, Thermosetting.

Amals
PI MIL-P-75 — Packaging, Packing,
and Container-Marking of Electron
Tubes.

Amals
PI MIL-E-75. Electron Tubes, Packaging, Packing and
Container-Marking of. General Specification for
MIL-M-14540 - Marking of Commodities
and Containers to Indicate
Radioactive Material

STANDARDS

MILITARY

u.k. Amult 2 DEF-131
MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes.

Amult 5 MIL-STD-200 — ~~Military Standard for~~ Electron Tubes; ~~and Semiconductor Devices, Diodes,~~

pl MIL-STD-202 — Test Methods for Electronic and Electrical Component Parts.

DRAWINGS

ARMED SERVICES ELECTRO-STANDARDS AGENCY

123-JAN — Bump Test Equipment Assembly and Details.

180-JAN — High Impact (Fly-weight) Shock Machine for Electronic Devices.

182-JAN — Hum & Microphonics Test Set.

184-JAN — End-Grip Retainer for Impact Testing of Miniature and Sub-miniature Electron Tubes.

194-JAN — Noise and Microphonics Test Set.

195-JAN — Converter Test Oscillator Assembly and Schematic Diagram.

200-JAN — Deflection Cone for Miniature Tube Base Strain Test.

216-JAN — Tube Clamps and Adapter Rings (for Impact Tests).

217-JAN — Capacitance Adapter (for Subminiature Flat Press Tubes).

245-JAN — Holder for Glass Strain Testing of Miniature and Subminiature Tubes.

248-JAN — Cathode Interface Resistance Electron Tube Test Circuit.

249-JAN — Missing RF Pulse Detector Schematic Diagram.

262-JAN — Electron Tube Bulb Temperature Oven.

PUBLICATIONS

NAVY DEPARTMENT

NAVSHIPS 900,152 — Manufacturers' Designating Symbols.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring agency or as directed by the contracting officer.)

Obtainable from T.V.C. office

2.2 Other publications. The following documents form a part of this specification.

AMERICAN STANDARDS ASSOCIATION

ASA C16.5-1954 — Volume Measurements of Electrical Speech and Program Waves.

Amult 5
pl (Application for copies should be addressed to the American Standards Association, Inc., 48 East Forty-Fifth Street, New York 17, N. Y.) or British Standards Institute, 2 Park Street, London W.1.

ELECTRONIC INDUSTRIES ASSOCIATION
NATIONAL ELECTRICAL
MANUFACTURERS' ASSOCIATION

JO-G2-2 — Dimensional Characteristics of Electron Tubes.

JO-G3-1 — Electron Tube Bases, Caps, and Terminals.

JO-G3-5 — Registered Bases, Caps, and Terminals.

JO-G5-1 — Gauges for Electron Tube Bases.

(Application for copies should be addressed to the Electronic Industries Association, 11 West 42nd Street, New York 36, N. Y.)

3. REQUIREMENTS

3.1 Qualification. Tubes furnished under this specification shall be a product which has passed the qualification tests specified in section 4. (See 6.2.)

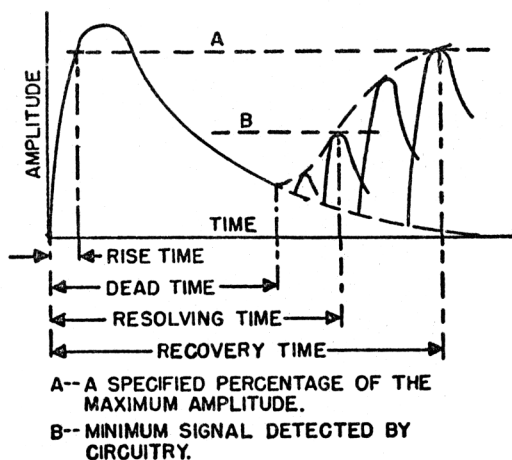
3.2 Definitions. The definitions of terms used in this specification and on the tube specification sheets are, in general, those used by the electronic and electrical industries.

3.2.1 Background counts. Background counts are counts caused by radiation coming from sources other than measured.

3.2.2 Count (in a radiation counter). A count in a radiation counter is a single response of the counting system. (See also 3.2.33.)

3.2.3 Counting-rate-versus-voltage characteristic. The counting-rate-versus-voltage characteristic is a graph of the counting rate as a function of applied voltage for a given constant average intensity of radiation.

3.2.4 Dead time. Dead time is the time from the start of a counted pulse until an observable succeeding pulse can occur (See graph 1.)



GRAPH 1. Graphical representation of terms.

3.2.5 Defect. A defect is any deviation of the unit of product from requirements of this specification, drawings, purchase descriptions, and any changes thereto in the contract or order.

3.2.5.1 Major defect. A major defect is a defect which could result in failure, or materially reduce the usability of the tube for its intended purpose.

3.2.5.2 Minor defect. A minor defect is one which does not materially reduce the usability of the tube for its intended purpose, or is a departure from established standards having no significant bearing on the effective use or operation of the tube.

3.2.5.3 Control defect. A control defect is a defect which constitutes deviation from good workmanship or applicable specifications, but which has no effect on the functioning, assembly, maintenance, and life of the unit in service.

3.2.6 Defective. A defective is a tube having one or more defects.

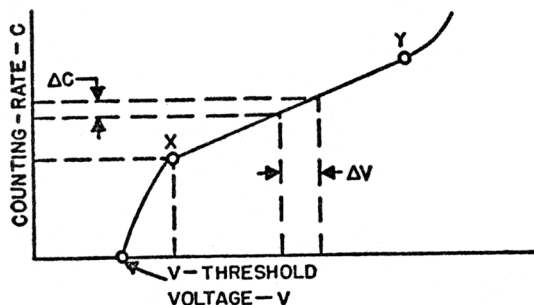
3.2.7 Efficiency (of a radiation counter tube). The efficiency of a radiation counter tube is the probability that a tube count will take place with a specified particle or quantum incident in a specified manner.

3.2.8 Electron tube. An electron tube is a device consisting of an evacuated enclosure containing a number of electrodes between two or more of which conduction of electricity may take place through the vacuum or contained gas.

3.2.9 Gas amplification (of a radiation counter tube). The gas amplification of a radiation counter tube is the ratio of the charge collected to the charge liberated by the initial ionizing event.

3.2.10 Geiger-Mueller region (of a radiation counter tube). The Geiger-Mueller region of a radiation counter tube is the range of applied voltage in which the charge collected per isolated tube count is independent of the charge liberated by the initial ionizing event.

3.2.11 Geiger-Mueller threshold. The Geiger-Mueller threshold is the lowest applied voltage at which the charge collected per isolated tube count is substantially independent of the nature of the initial ionizing event. (See graph 2.)



GRAPH 2. Counting-rate-voltage characteristic.

3.2.12 Initial ionizing event. The initial ionizing event is an ionizing event that initiates a tube count.

3.2.13 Inoperatives. Inoperatives are shorts, discontinuities, and air leaks as defined in 3.2.13.1 to 3.2.13.3, inclusive.

3.2.13.1 Shorts. The following are short-circuit classes:

3.2.13.1.1 Permanent short. A permanent short is a short circuit which exists for an appreciable time when there is no accelerating force applied to the tube. This class includes sustained short circuits which may be cleared by subsequent acceleration.

3.2.13.1.2 Temporary short. A temporary short is a short circuit resulting from and lasting during the application of an accelerating force. When it is necessary to classify temporary shorts as to their degree or the method of testing, the following terms are preferred:

- (a) A tap short is a temporary short as determined with the relatively low accelerating force as in the tap-shorts test specified in 4.7.3.
- (b) A transient short is a temporary short of relatively short duration occurring during a high-level shock impact, such as that specified in 4.9.20.5.

3.2.13.2 Discontinuities. A discontinuity is a lack of continuity in any circuit. (See 4.7.1.)

3.2.13.3 Air leaks. An air leak defective is to be considered an inoperative if it has been determined to be an air leak by the generally accepted methods of air leak detection. (See 4.7.6.)

3.2.14 Limits. The term "within the limits specified" includes the limit values shown on the tube specification sheet.

3.2.14.1 Bogey value. The bogey value is a design center value or objective. For asymmetrically distributed characteristics, the bogey value is not the center value of the limits.

3.2.15 Lot. The term "lot" shall mean "inspection lot", i.e., a collection of units of product submitted by a supplier for Government inspection. Only one lot of tubes of a given type shall be presented for Government inspection during one 24-hour period. No lot shall be larger than the sum of the preceding five lots.

3.2.16 Major cross section. The major cross section of a tube is the first of the following which is applicable:

- (a) As defined on the tube specification sheet.
- (b) The plane of the deflecting electrodes farther from the base of electrostatic cathode-ray tubes.
- (c) The plane of the heater pins of metal tubes or shielded glass tubes and symmetrically constructed tubes.
- (d) The plane of the number 1 grid side rods of tubes with cylindrical or concentric elements.
- (e) Any plane through the axis of the tube of perfectly symmetrically constructed tubes.

Where the above criteria are not applicable, the major cross section will be defined on the tube specification sheet.

3.2.17 Multiple tube counts (in a radiation counter tube). Multiple tube counts in a radiation counter tube are spurious counts induced by previous tube counts.

3.2.18 Overvoltage. Overvoltage is the amount by which the applied voltage exceeds the Geiger-Mueller threshold.

3.2.19 Plateau. The plateau is the portion of the counting-rate-versus-voltage characteristic curve in which the counting rate is substantially independent of the applied voltage. (See XY, graph 2.)

3.2.20 Plateau length. The plateau length is the range of applied voltage over which the plateau of a radiation counter tube extends.

3.2.21 Process average. The process average is the average percentage of defective items in the first samples from submitted inspection lots. Usually the number of lots or a time period is specified. In production-acceptance sampling, the process average, unless otherwise specified, is established by computing the arithmetic mean of the percent defectives in the last 10 consecutive lots, from a minimum of 5 days' production.

3.2.22 Proportional region. The proportional region is the range of applied voltage in which the gas amplification is greater than unity and is independent of the charge liberated by the initial ionizing event.

3.2.23 Quenching (in a radiation counter tube). Quenching in a radiation counter tube is the process of terminating a discharge by inhibiting reignition.

3.2.24 Radiation counter. A radiation counter is an instrument used for detecting or measuring radiation by counting action.

3.2.25 Recovery time (of a radiation counter). The recovery time of a radiation counter is the minimum time from the start of a counter pulse to the instant a succeeding pulse can attain a specific percentage of the maximum amplitude of the counter pulse. (See graph 1.)

3.2.26 Reference point and potentials.

3.2.26.1 Reference point. The reference point for the electrode potential is: the cathode terminal, if present; the negative terminal of a filament operated on direct current; or the electrical center of the filament circuit operated on alternating current. When tests are to be made with cathode-resistor bias, the reference point for all potentials, except heater-cathode and suppressor-grid, shall be the negative terminal of the cathode resistor. The reference point for heater-cathode and suppressor-grid potentials shall be the positive terminal of the cathode resistor.

3.2.26.2 Applied potential. The applied potential on an electrode is the potential between the electrode and the reference point.

3.2.26.3 Supply potential. The supply potential is the potential furnished to a circuit containing an electron tube.

3.2.26.4 Polarity. All potentials are designated by polarity with respect to the reference point. Positive electrode current is defined as a current flow equivalent to a flow of electrons from the primary cathode to the electrode.

3.2.26.5 Pulse. A pulse is a recurrent momentary flow of energy of short time duration.

3.2.26.6 Spike. A spike is a transient of very short duration, during which the amplitude appreciably exceeds the average amplitude of the pulse.

3.2.27 Relative plateau slope. The relative plateau slope is the average percentage change in the counting rate over a specified range of the plateau per unit increment of applied voltage.

3.2.28 Reliable tubes. For the purpose of this specification, reliable tubes are those tubes so designated on the tube specification sheet.

3.2.29 Resolving time (of a radiation counter). The resolving time of a radiation counter is the minimum time from the start of a counted pulse to the instant a succeeding

pulse can be detected by the counting circuit. (This quantity pertains to the combination of tube and recording circuit.)

3.2.30 Response (of a radiation counter tube). The response of a radiation counter tube is the response when operated under specified circuit conditions and in a standard radiation field.

3.2.31 Spurious tube counts (in a radiation counter tube). Spurious tube counts are counts in a radiation counter tube other than background counts and those caused by the source measured.

3.2.32 Starting voltage (of a radiation counter tube). The starting voltage of a radiation counter tube is the voltage at which uniform pulses with specified average amplitude appear across a specified resistor and in a specified radiation field.

3.2.33 Tube count (in a radiation counter tube). A tube count is a count resulting from a terminated discharge produced by an ionizing event in a radiation counter tube.

3.3 Material. The material for each part shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the tubes to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.

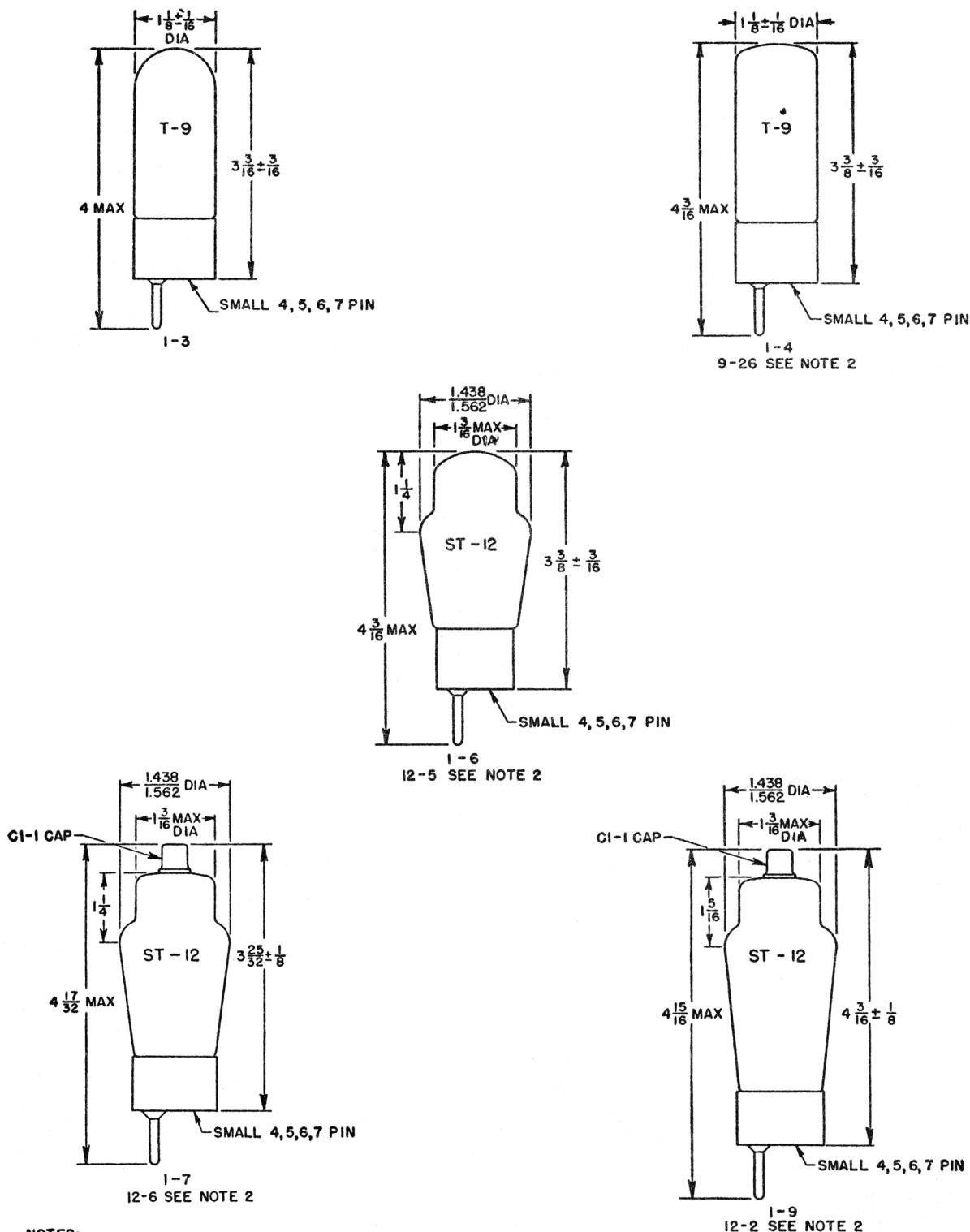
3.3.1 Insulating materials. Insulating materials used externally or internally shall not soften, flow, or be otherwise affected electrically or mechanically, at temperatures caused by continuous operation at maximum tube ratings.

3.4 Design and construction. When referenced on the tube specification sheet by identifying number, the design and construction of the bulb outlines, caps, capacitance shields, bases, pole tips and gaps for magnetrons, locking jacks and plugs for magnetrons, and gas-kets shall be in accordance with figures 1 to 24, inclusive.

3.4.1 Conductors. The size of conducting wires and other parts shall be ample to preclude overheating under maximum operating conditions.

3.4.2 Seal-off tip. Except when shown on the outline drawings or specifically permitted on the tube specification sheet, the glass envelope shall not have an exposed seal-off tip.

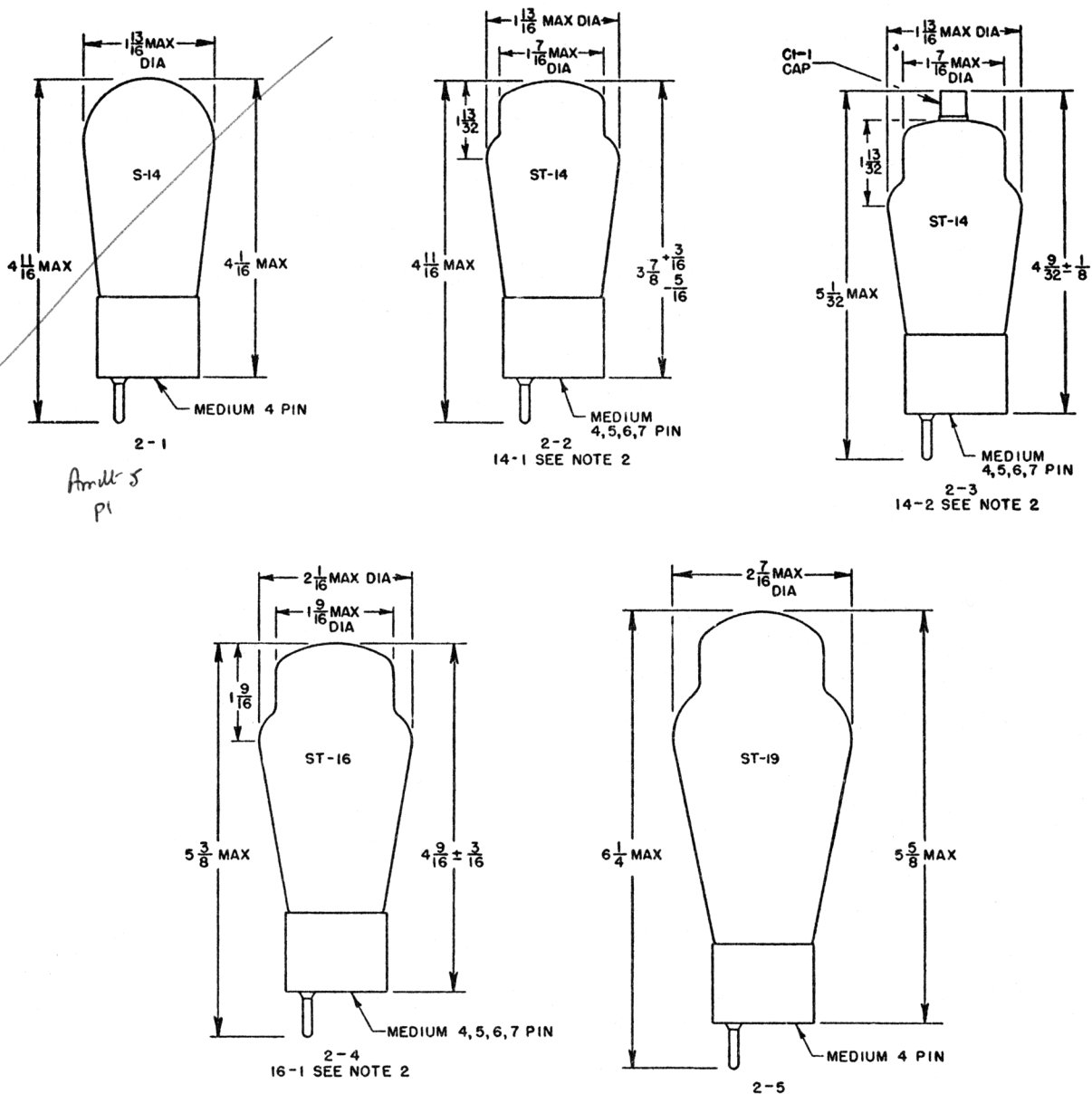
3.4.3 Base connections. Electrode connections to the pins shall be as specified on the tube specification sheet. The pin numbers shall correspond to those appearing on the applicable base diagram. (See fig. 12 to 21, incl.) Pins marked internal connection are reserved for manufacturing purposes and are not suitable for connections in external circuits. Pins marked no connection shall have no internal connections.



NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955
3. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES

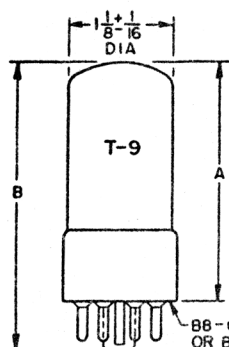
FIGURE 1. Bulb outlines.



NOTES:

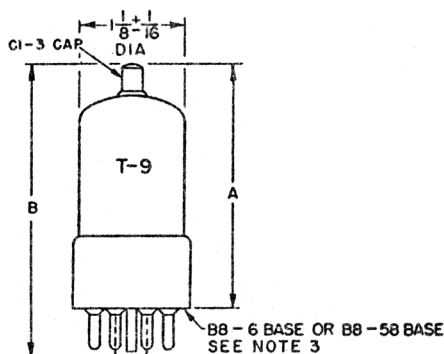
1. ALL DIMENSIONS IN INCHES.
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955
3. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES

FIGURE 2. Bulb outlines.

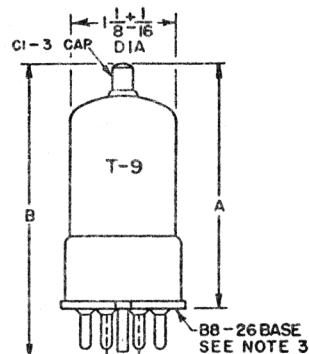


INTERMEDIATE SHELL OCTAL SEE NOTE 2	SHORT INTERMEDIATE SHELL OCTAL SEE NOTE 2	DIMENSION	
		A	B
		MAX	MAX
3-1 (9-1)	3-12 (9-36)	$1\frac{3}{4}$	$2\frac{5}{16}$
3-4 (9-7)	3-13 (9-39)	$2\frac{1}{2}$	$3\frac{1}{16}$
3-6 (9-11)	3-14 (9-41)	$2\frac{3}{4}$	$3\frac{5}{16}$
3-9 (9-13)	3-15 (9-42)	$2\frac{13}{16}$	$3\frac{3}{8}$
3-10 (9-15)	3-16 (9-43)	$2\frac{7}{8}$	$3\frac{7}{16}$

OUTLINE FOR 3-1, 3-4, 3-6, 3-9, 3-10, 3-12, 3-13, 3-14, 3-15, 3-16

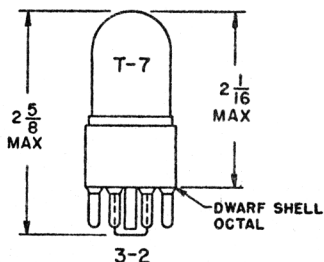


OUTLINE FOR 3-5, 3-11, 3-17, 3-18



OUTLINE FOR 3-7, 3-19

INTERMEDIATE SHELL OCTAL SEE NOTE 2	SHORT INTERMEDIATE SHELL OCTAL SEE NOTE 2	DIMENSION			SMALL WAFER OCTAL WITH SLEEVE SEE NOTE 2
		A		B	
		MIN	MAX	MAX	
3-5 (9-17)	3-17 (9-45)	$2\frac{5}{16}$	$2\frac{3}{4}$	$3\frac{5}{16}$	3-7 (9-18)
3-11 (9-21)	3-18 (9-47)	$2\frac{5}{16}$	$2\frac{15}{16}$	$3\frac{1}{2}$	3-19 (9-22)



NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955
3. OR ANY DERIVED PIN COMBINATIONS

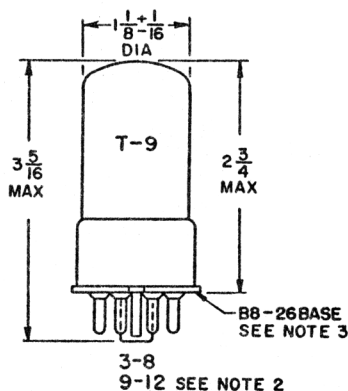
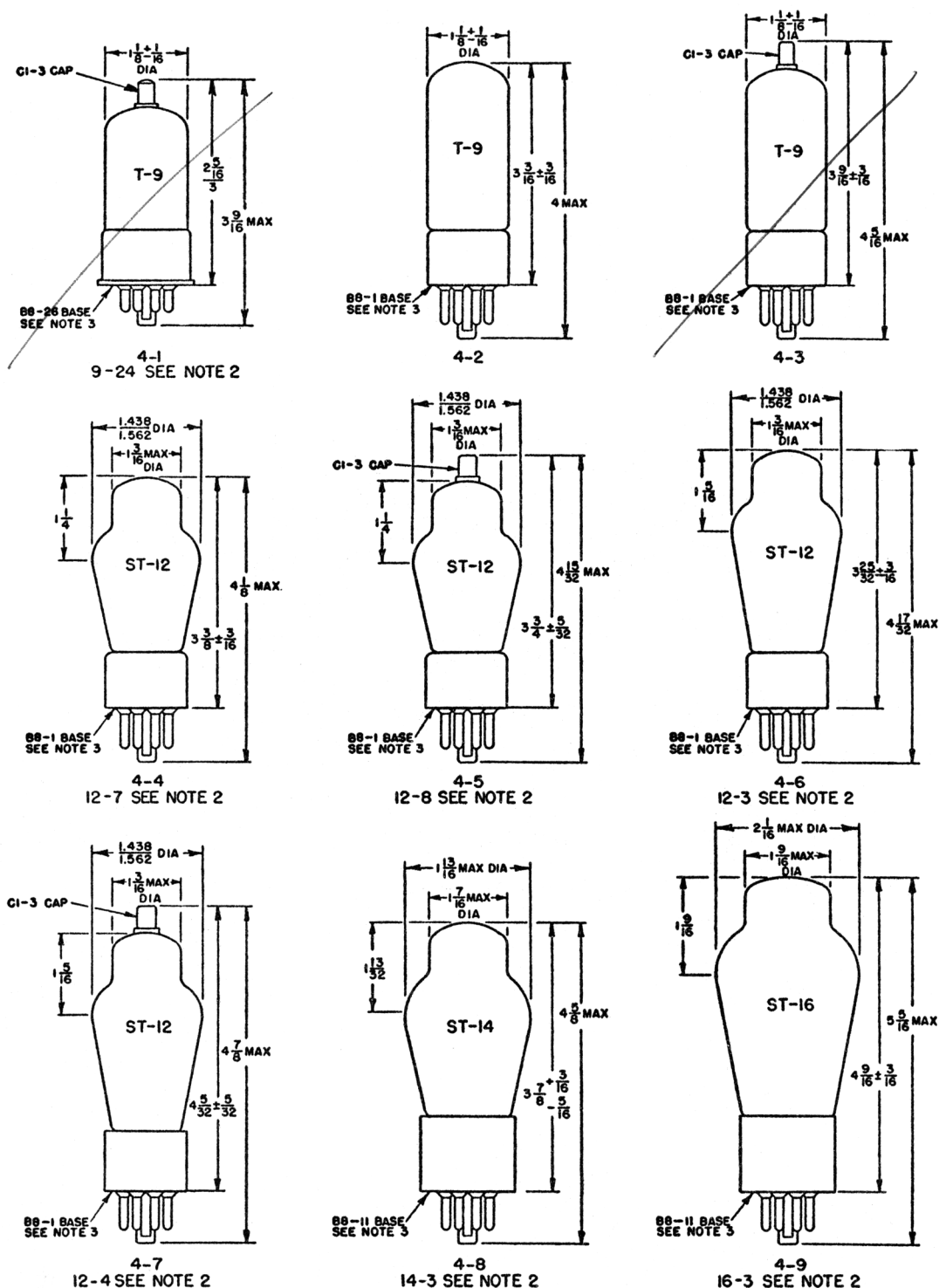


FIGURE 3. Bulb outlines.

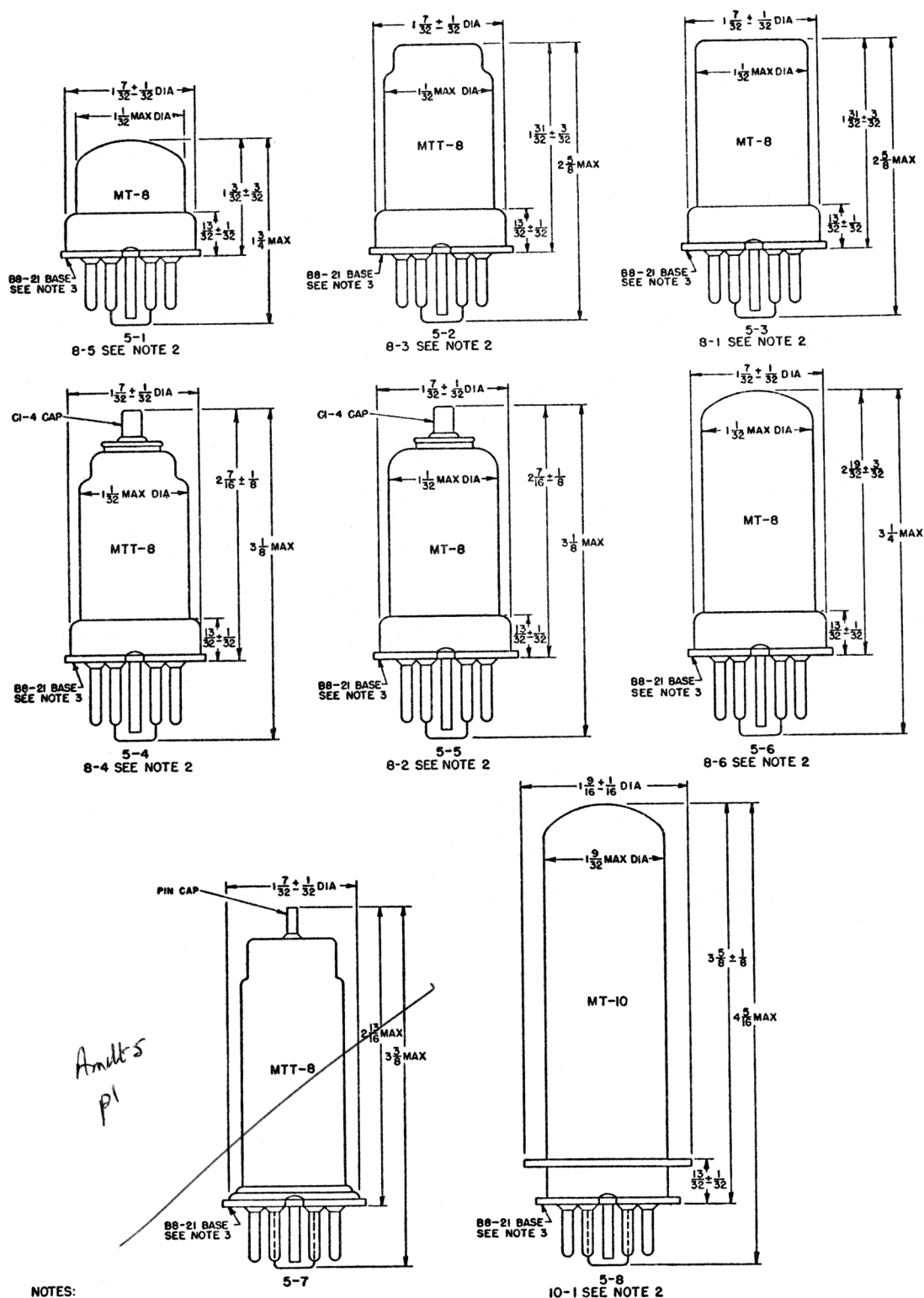
Amc's
pl



NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955
3. OR ANY DERIVED PIN COMBINATIONS
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES

FIGURE 4. Bulb outlines.



NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955
3. OR ANY DERIVED PIN COMBINATIONS

FIGURE 5. Bulb outlines.

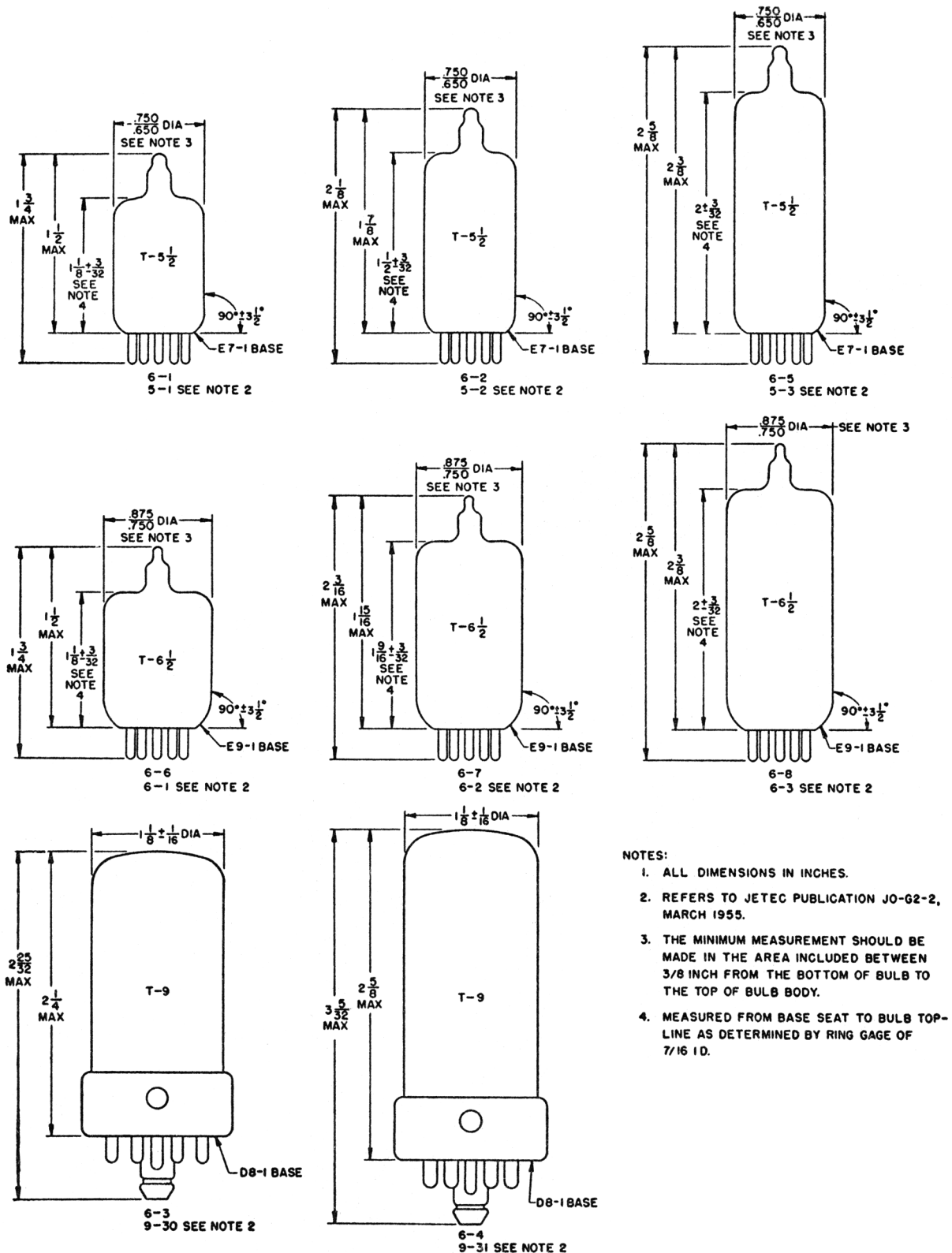
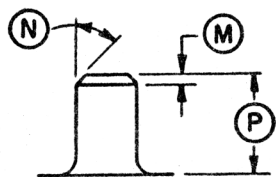
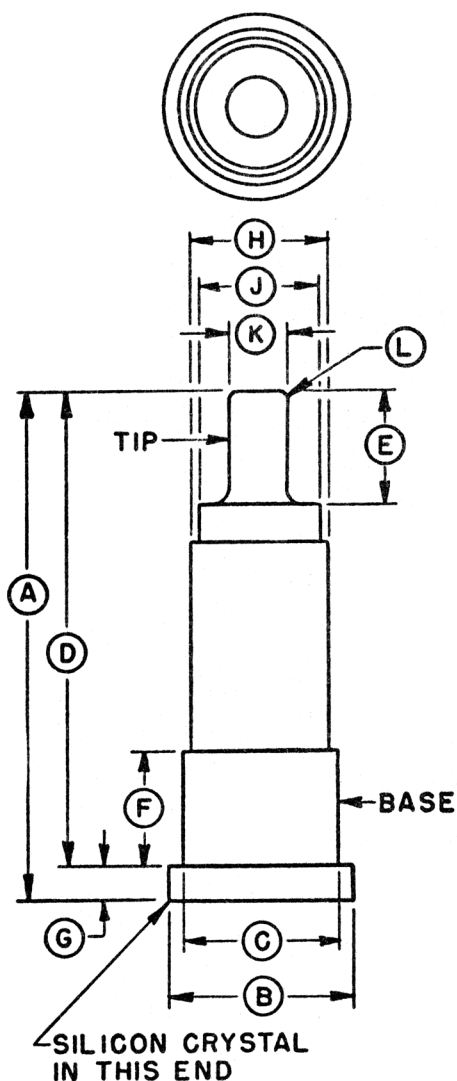


FIGURE 6. Bulb outlines.



ALTERNATE CONSTRUCTION
OF PIN



REF	DIMENSIONS	
	MIN	MAX
A	.800	.840
B	.292	.296
C	.246	.250
D	.753	.783
E	.180	.190
F	.193	.199
G	.047	.057
H		.240 DIA
J	.195 DIA	.225 DIA
K	.092 DIA	.094 DIA
L	.030R	.046R
M	.010	.030
N	10°	45°
P	.180	.190

NOTES:

1. ALL DIMENSIONS IN INCHES.
2. ECCENTRICITY BETWEEN TIP AND BASE SHALL NOT EXCEED .0075.
3. METAL PARTS SHALL BE SILVER PLATED MIN 20 MSI OR GOLD PLATED MIN 10 MSI.
4. THE POLARITY SHALL BE SUCH THAT THE BASE IS POSITIVE WHEN CURRENT FLOWS IN THE FORWARD (PASS) DIRECTION.

PRODUCTION TEST MEASUREMENTS:

C, K, NOTE 2.

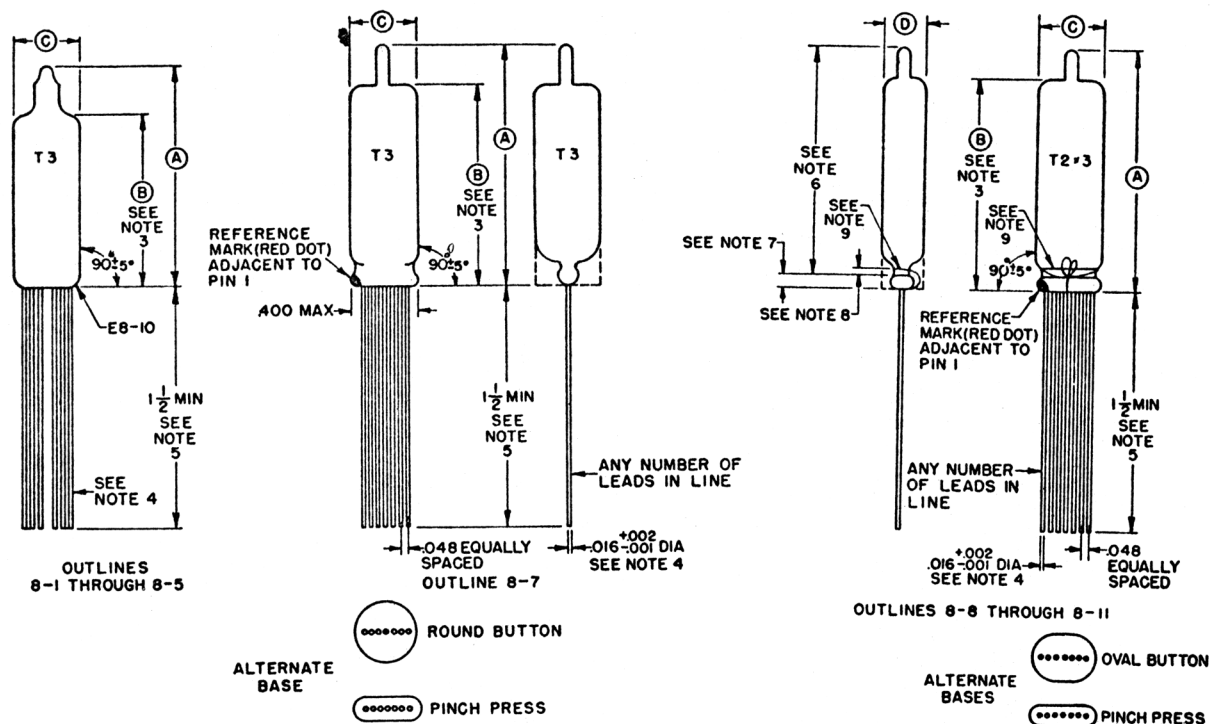
DESIGN TEST MEASUREMENTS:

B, D, E, F, G, H, J, L, M, N, P.

QUALIFICATION TEST:

MEASUREMENTS: A, NOTE 3.

FIGURE 7. Semiconductor diode outline.

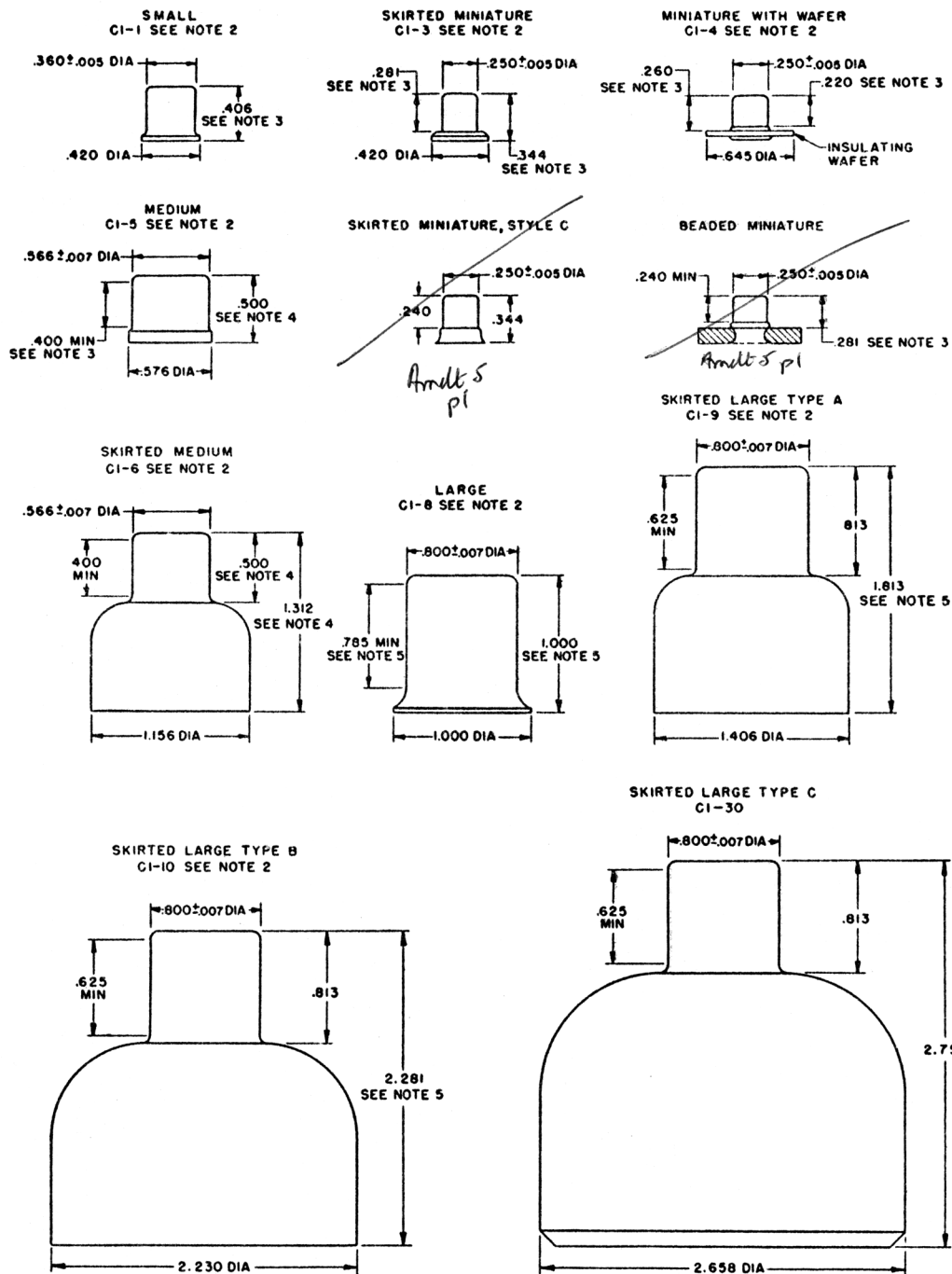


OUTLINE	DIMENSIONS						SEE NOTE 2	
	A MAX	B		C		SEE NOTE 10		
		DIM	TOL ±	MAX	MIN			
8-1	1.375	1.075	.060	.400	.366	3-1		
8-2	1.500	1.200	.060	.400	.366	3-2		
8-3	1.625	1.325	.060	.400	.366	3-8		
8-4	1.750	1.450	.060	.400	.366	3-3		
8-5	2.000	1.700	.060	.400	.366	3-4		
8-6	DELETED							
8-7	1.500	1.250	.100	.400	.366	3-6		
				C MAX	C MIN	D MAX	D MIN	
8-8	1.500	1.300	.100	.385	.350	.285	.245	2-1
8-9	1.250	1.070	.100	.385	.350	.285	.245	2-2
8-10	1.500	1.300	.100	.400	.350	.285	.245	2-5
8-11	1.250	1.070	.100	.400	.350	.285	.245	2-6

NOTES:

1. ALL DIMENSIONS IN INCHES.
2. REFERS TO JETEC PUBLICATION JO-G2-2, MARCH 1955.
3. MEASURE FROM BASE SEAT TO BULB-TOP LINE AS DETERMINED BY RING GAGE OF .210±.001.
4. LEAD DIAMETER TOLERANCE SHALL GOVERN BETWEEN .050 TO .250 FROM THE GLASS, TINNED WITHIN .050 OR LESS OF GLASS PRESS.
5. ALTERNATIVE LEAD LENGTH SHALL BE .200±.015 WHEN CUT LEADS ARE REQUIRED BY PROCUREMENT CONTRACT OR TSS. CUT LEADS SHALL BE ESSENTIALLY SQUARE CUT AND THE MAXIMUM BURR SHALL BE .003 INCREASE OVER THE ACTUAL LEAD DIAMETER.
6. METALLIC COATED WHEN SPECIFIED ON THE TSS.
7. APPLIES TO PINCH PRESS TYPES ONLY (.12 MAX-.02 MIN).
8. GROUND LEAD OVERLAPPED BY SHIELD BY A MINIMUM OF .04.
9. SHIELD TO GROUND WIRE MAY BE FROM EITHER SIDE OF THE MAJOR DIMENSION. ALTERNATE CONSTRUCTION: UNUSED OR EXTRA RANDOM LEAD IN PRESS OR BUTTON MAY BE FOLDED BACK AND WRAPPED AROUND BULB TO MAKE CONTACT WITH SHIELD.
10. THE MINIMUM MEASUREMENT SHOULD BE MADE IN AREA INCLUDED BETWEEN 1/2 INCH FROM THE BOTTOM OF BULB AND APPROXIMATELY 1/4 INCH FROM TOP OF BULB BODY.

FIGURE 8. *Bulb outlines.*

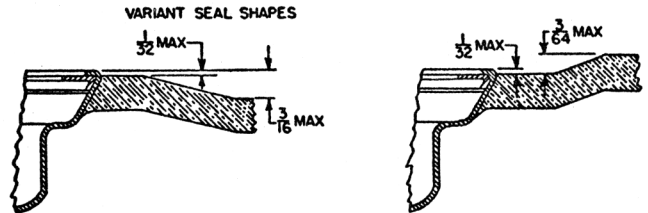
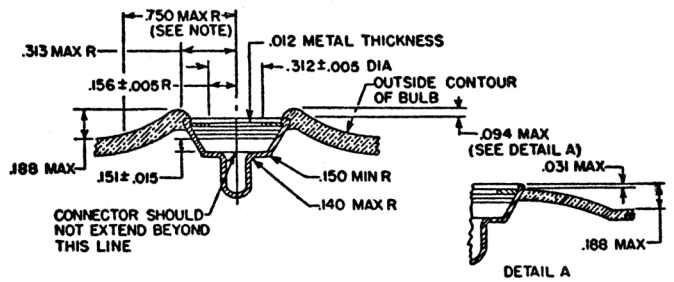
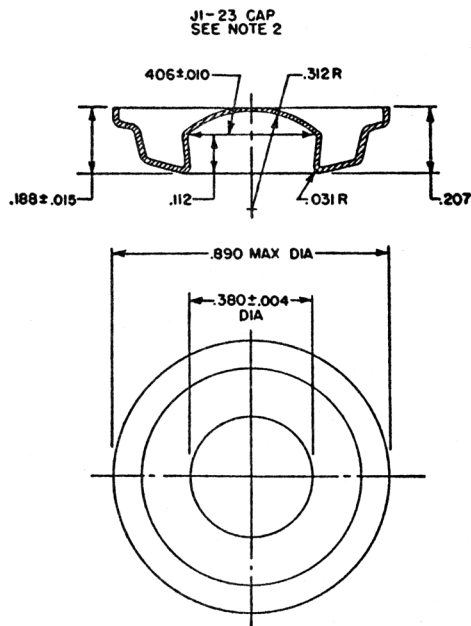


NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-63-1, MARCH 1955
3. ON FINISHED TUBE ADD .020 FOR SOLDER
4. ON FINISHED TUBE ADD .040 FOR SOLDER
5. ON FINISHED TUBE ADD .060 FOR SOLDER
6. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES

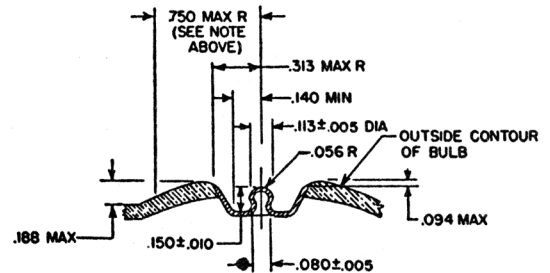
FIGURE 9. Caps.

RECESSED SMALL CAVITY CAP JI-21 SEE NOTE 2



NOTE:
PROTRUSION OF GLASS AROUND CAP ABOVE BULB CONTOUR IS LIMITED TO AREA BOUNDED BY CIRCLE CONCENTRIC WITH CAP AXIS AND HAVING RADIUS OF $.750 \text{ MAX}$. FOR ATTACHING OR DETACHING, THE CONNECTOR SHOULD REQUIRE NOT MORE THAN 8 POUNDS TOTAL FORCE PERPENDICULAR TO THE PLANE OF THE RIM OF THE CAP

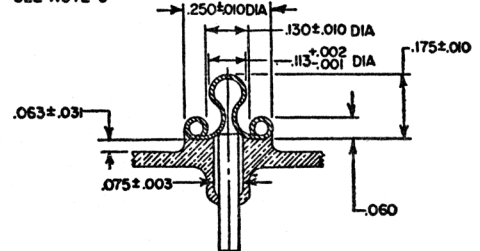
RECESSED SMALL BALL CAP JI-22
SEE NOTE 2



VARIANT SEAL SHAPES



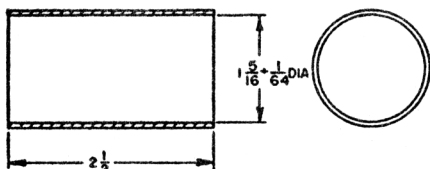
SMALL BALL CONTACT CAP JI-25
SEE NOTE 3



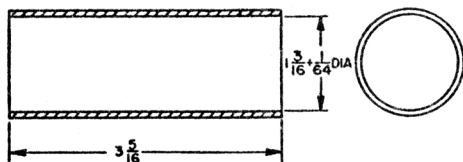
NOTES

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G3-1 MARCH 1955
3. REFERS TO JETEC PUBLICATION JO-G3-5 JUNE 1950
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES

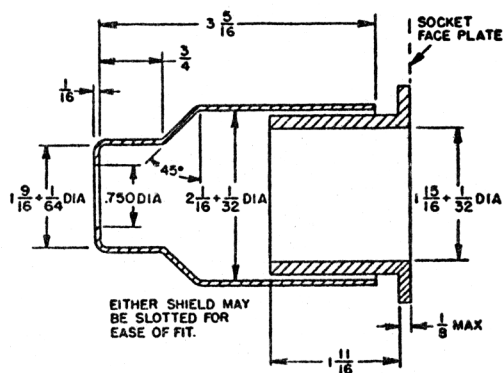
FIGURE 10. Caps.



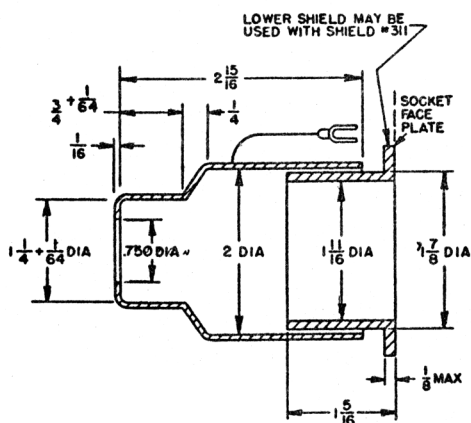
308. FOR USE WITH LOCKAL QT OR SIMILAR TYPE TUBES EMPLOYING T-9 BULBS AND HAVING rf APPLICATIONS.



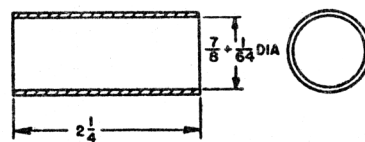
309. FOR USE WITH THE 1.4-VOLT LINE OF TUBES OR SIMILAR TYPES EMPLOYING T-9 BULBS AND HAVING rf APPLICATIONS.



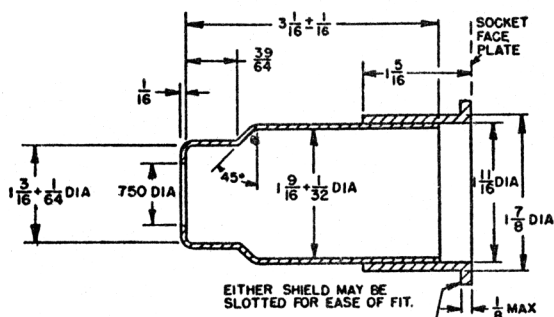
312. FOR USE WITH TUBES EMPLOYING ST-16 BULBS AND HAVING rf APPLICATIONS.



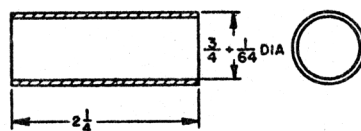
310. FOR USE WITH TUBES EMPLOYING ST-12 BULBS.



315. FOR USE WITH TUBES EMPLOYING T-6 1/2 BULBS (6-4 TO 6-6 INCL) AND HAVING rf APPLICATIONS.



311. FOR USE WITH G TYPE TUBES EMPLOYING ST-12 BULBS AND HAVING rf APPLICATIONS.



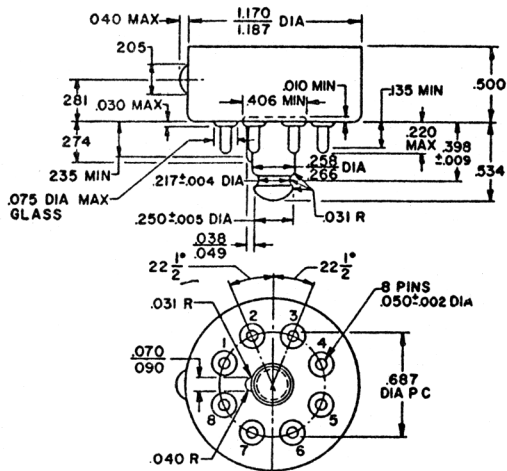
316. FOR USE WITH TUBES EMPLOYING T-5 1/2 BULBS (6-1 TO 6-3 INCL) AND HAVING rf APPLICATIONS.

NOTES:

1. ALL DIMENSIONS IN INCHES.
2. $\frac{3}{32}$ MAX RADIUS ALLOWABLE ON ALL INTERNAL EDGES
3. UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE $\pm \frac{1}{64}$ ON FRACTIONS, $\pm .005$ ON DECIMALS AND $\pm \frac{1}{2}^\circ$ ON ANGLES.

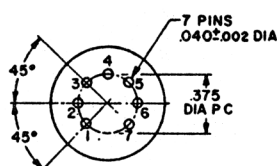
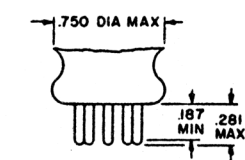
FIGURE 11. Capacitance shields.

LOCK-IN TYPE BASE
D8-1 SEE NOTE 2



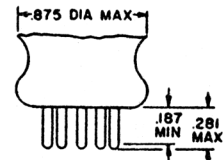
FOR PIN ALINEMENT USE
GAGE NO. GD8-1
(SEE APPENDIX D)

MINIATURE 7-PIN BUTTON
E7-1 SEE NOTE 2



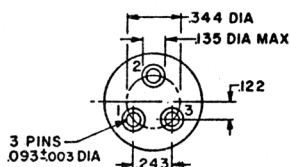
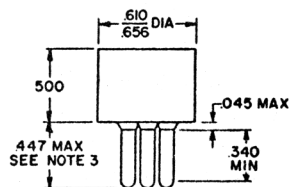
FOR PIN ALINEMENT USE
GAGE NO. GE7-1
(SEE APPENDIX D)

MINIATURE 9-PIN BUTTON
E9-1 SEE NOTE 2



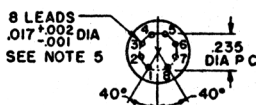
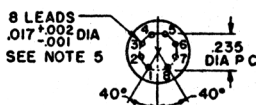
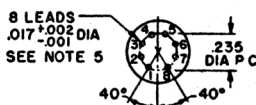
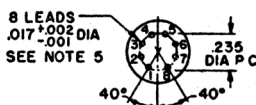
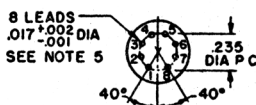
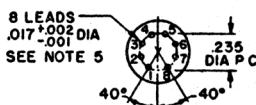
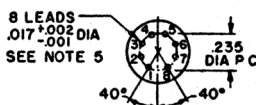
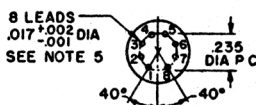
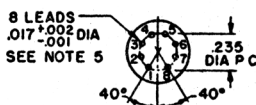
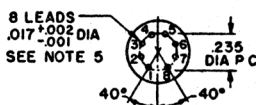
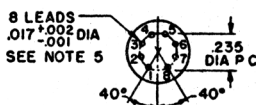
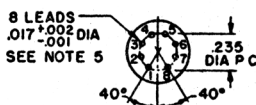
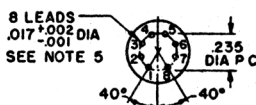
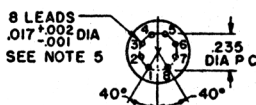
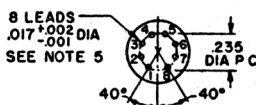
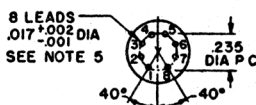
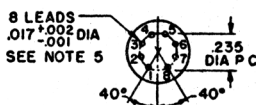
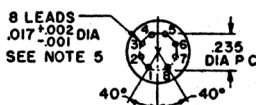
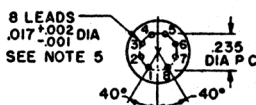
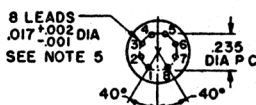
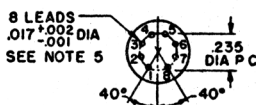
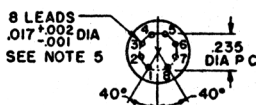
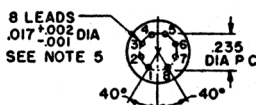
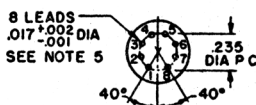
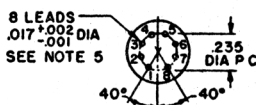
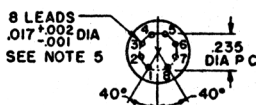
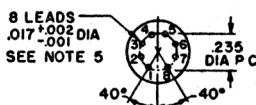
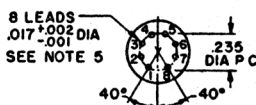
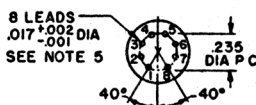
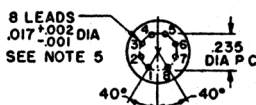
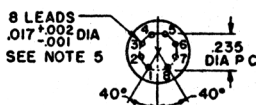
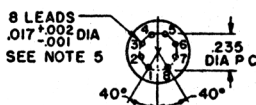
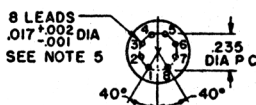
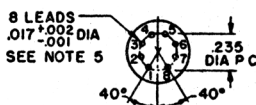
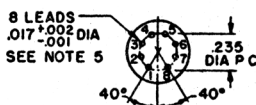
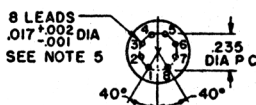
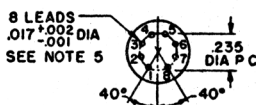
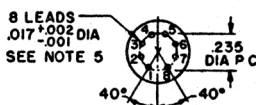
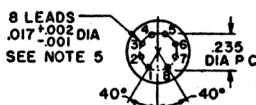
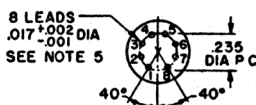
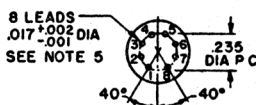
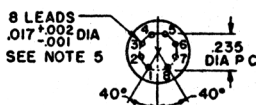
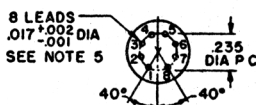
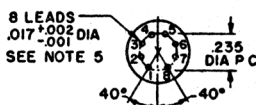
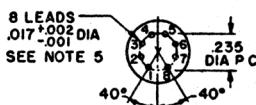
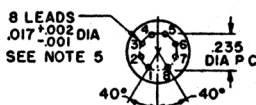
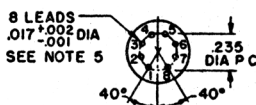
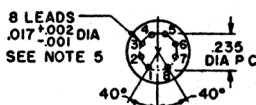
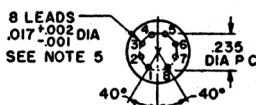
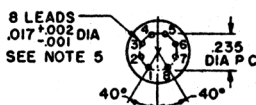
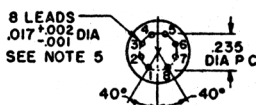
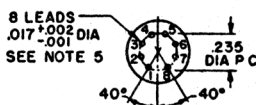
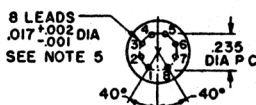
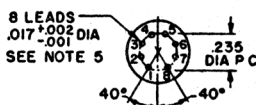
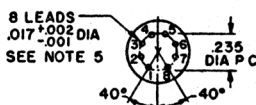
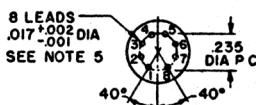
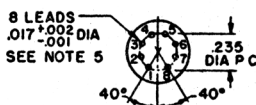
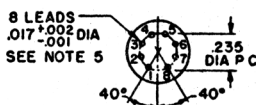
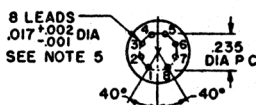
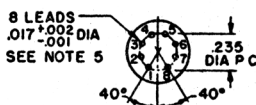
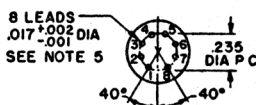
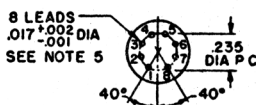
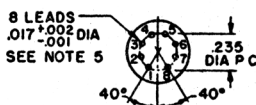
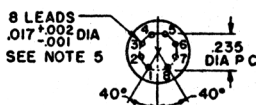
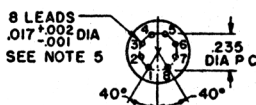
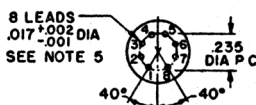
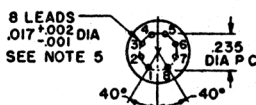
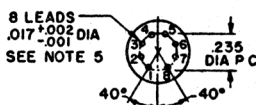
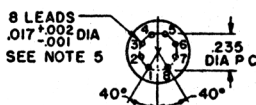
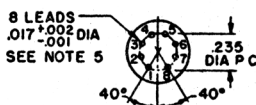
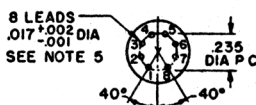
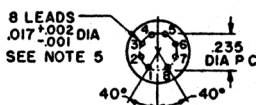
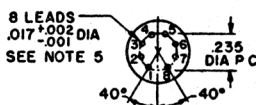
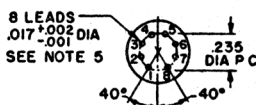
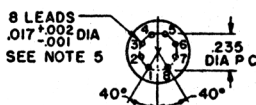
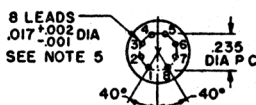
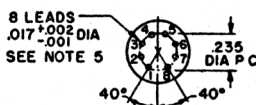
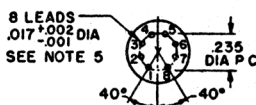
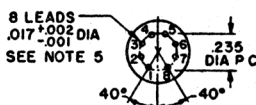
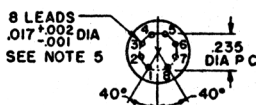
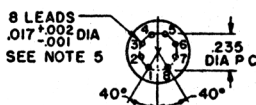
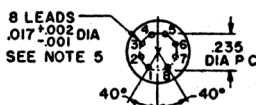
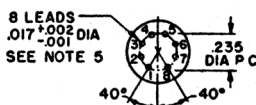
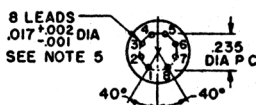
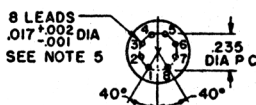
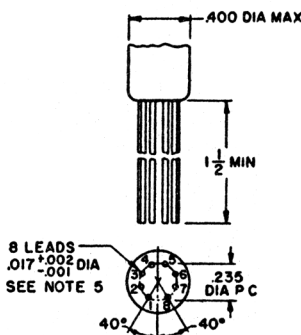
FOR PIN ALINEMENT USE
GAGE NO. GE9-1
(SEE APPENDIX D)

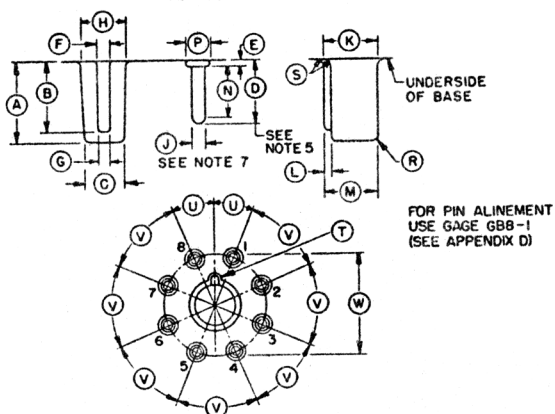
PEEWEE 3-PIN
A3-1 SEE NOTE 2



FOR PIN ALINEMENT USE
GAGE NO. GA3-1
(SEE APPENDIX D)

SUBMINIATURE 8-PIN LONG LEADS
E8-10 SEE NOTE 2

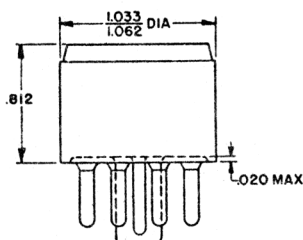


PIN AND INDEX GUIDE DIMENSIONS
FOR OCTAL BASES

REF	MIN	REF CENTER	MAX
A	.550	.560	.570
B	.490	.500	.510
C	.300	.308	.315
D	.427	.437	.447
E			.050
F	.085	.090	.095
G	.075	.080	.085
H	.305	.312	.317
J	.090	.093	.096
K	.352	.362	.372
L	.040	.047	.055
M	.343	.353	.363
N	.340		
P			.135
R		.031R	
S			.050R
T		.040R	
U		22.5°	
V		45°	
W		.687	

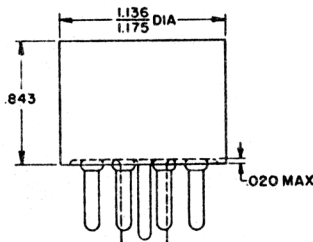
320 (And 5 p 2)

DWARF SHELL OCTAL



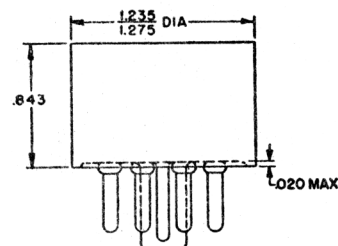
BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B5-45	5	2-4-6

SMALL SHELL OCTAL



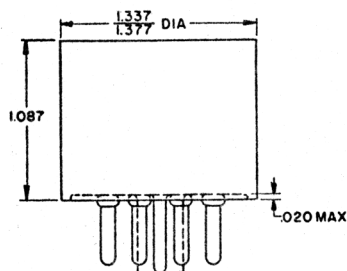
BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-1	8	
B7-2	7	6
B6-3	6	4-6
B5-5	5	3-5-7

INTERMEDIATE SHELL OCTAL



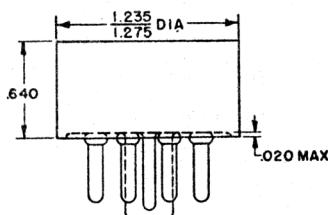
BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-6	8	
B7-7	7	6
B6-8	6	1-6
B6-8	6	4-6
B5-82	5	1-4-6
B5-10	5	3-5-7

MEDIUM SHELL OCTAL

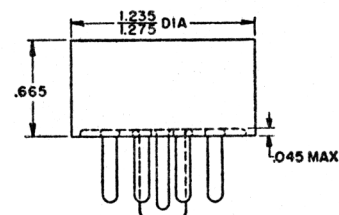


BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-11	8	
B8-69 SEE NOTE 6	8	
B7-12	7	6
B6-13	6	4-6
B5-15	5	3-5-7

SHORT INTERMEDIATE SHELL OCTAL



BASE SEE NOTE 3	NO. OF PINS	OMIT PINS
B8-46	8	
B7-47	7	6
B6-48	6	4-6
B5-49	5	3-5-7

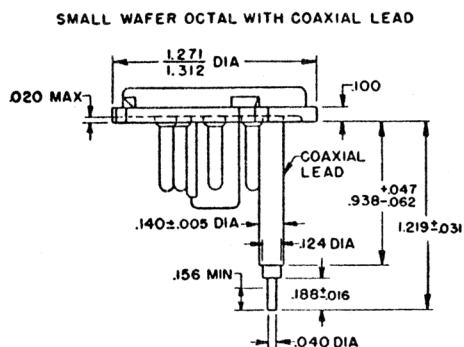
SHORT INTERMEDIATE-SHELL OCTAL
WITH EXTERNAL BARRIERS

BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-58	8	
B7-59	7	6
B6-84	6	1-6
B6-60	6	4-6
B5-85	5	1-4-6
B5-62	5	3-5-7

NOTES:

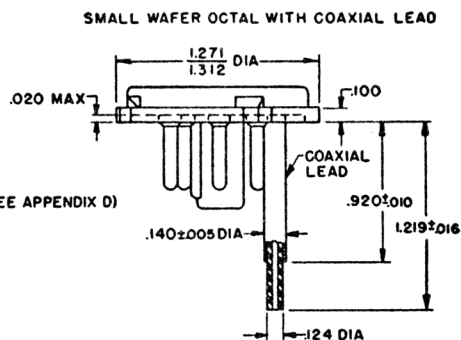
- ALL DIMENSIONS IN INCHES.
- REFERS TO JETEC PUBLICATION JO-G3-1, MARCH 1955
- REFERS TO JETEC PUBLICATION JO-G3-5, APRIL 1956
- DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES
- ON FINISHED TUBE, ADD .030 FOR SOLDER
- SAME AS B8-11 EXCEPT SEATED HEIGHT 1.375
- DOES NOT INCLUDE INCREASED DIAMETER DUE TO SOLDER

FIGURE 13. Bases.



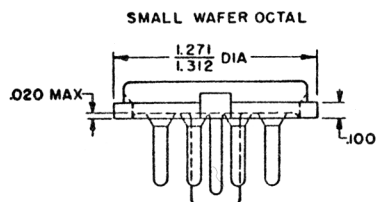
BASE SEE NOTE 2	NO. OF PINS	OMIT PINS	COAXIAL LEAD
B7-91	5	3-6	4
B6-90	4	3-5-6	4

PIN AND COAXIAL LEAD POSITIONS MAY BE CHECKED ONLY BY MEANS OF ALINEMENT GAGE AND GAGING PROCEDURE SAME AS G88-1, (SEE APPENDIX D) EXCEPT THAT NO. 4 PIN HOLE SHALL BE .1600 ± .0005 DIA TO A DEPTH OF $\frac{1}{4}$ MIN

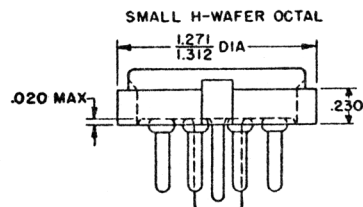


BASE SEE NOTE 2	NO. OF PINS	OMIT PINS	COAXIAL LEAD
B6-92	4	3-5-6	4
B7-93	7		4

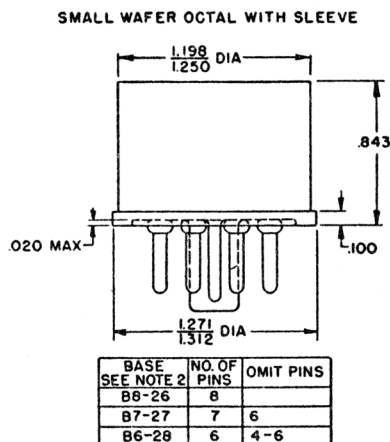
Amkr-5
p2



BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-21	8	
B7-22	7	6
B6-23	6	4-6
B5-25	5	3-5-7
B5-25(MOD)	5	3-5-6



BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-106	8	
B6-108	6	4-6



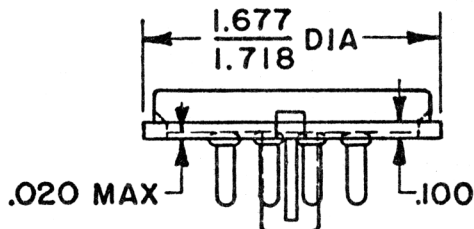
BASE SEE NOTE 2	NO. OF PINS	OMIT PINS
B8-26	8	
B7-27	7	6
B6-28	6	4-6

NOTES:

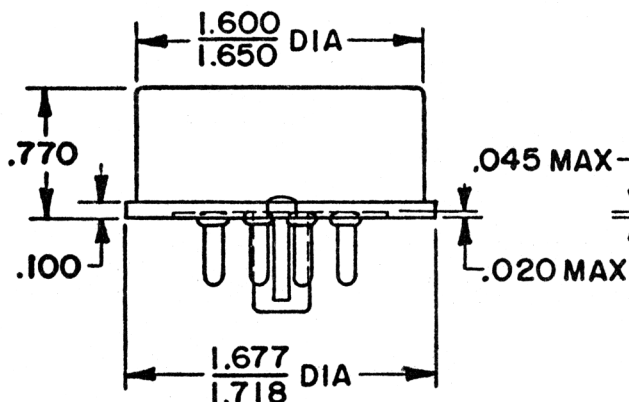
1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G3-1, MARCH 1955
3. ON FINISHED TUBE, ADD .030 FOR SOLDER.
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.

FIGURE 14. Bases.

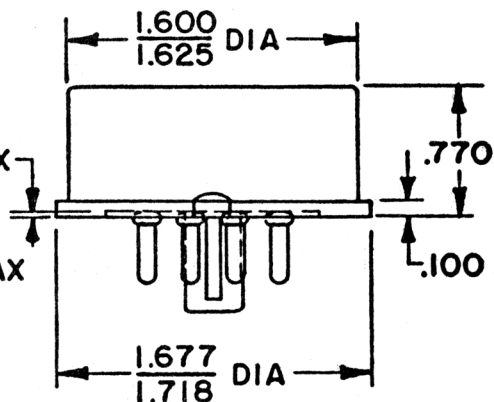
LARGE WAFER OCTAL 8-PIN
B8-32 SEE NOTE 2



LARGE WAFER OCTAL WITH
SLEEVE 8-PIN
B8-86 SEE NOTE 3



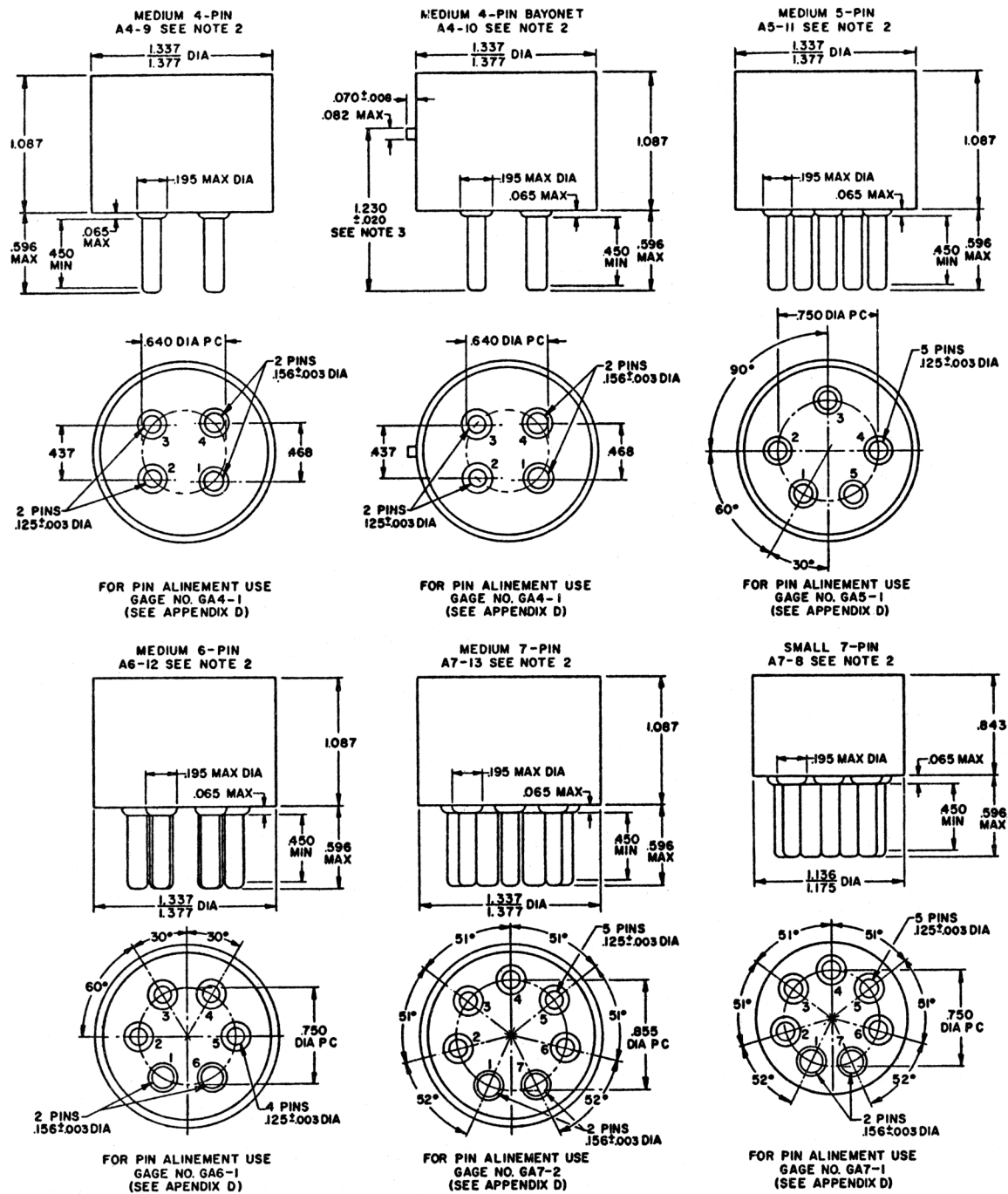
LARGE WAFER OCTAL WITH
EXTERNAL BARRIERS AND
SLEEVE 8-PIN
B8-98 SEE NOTE 2



NOTES:

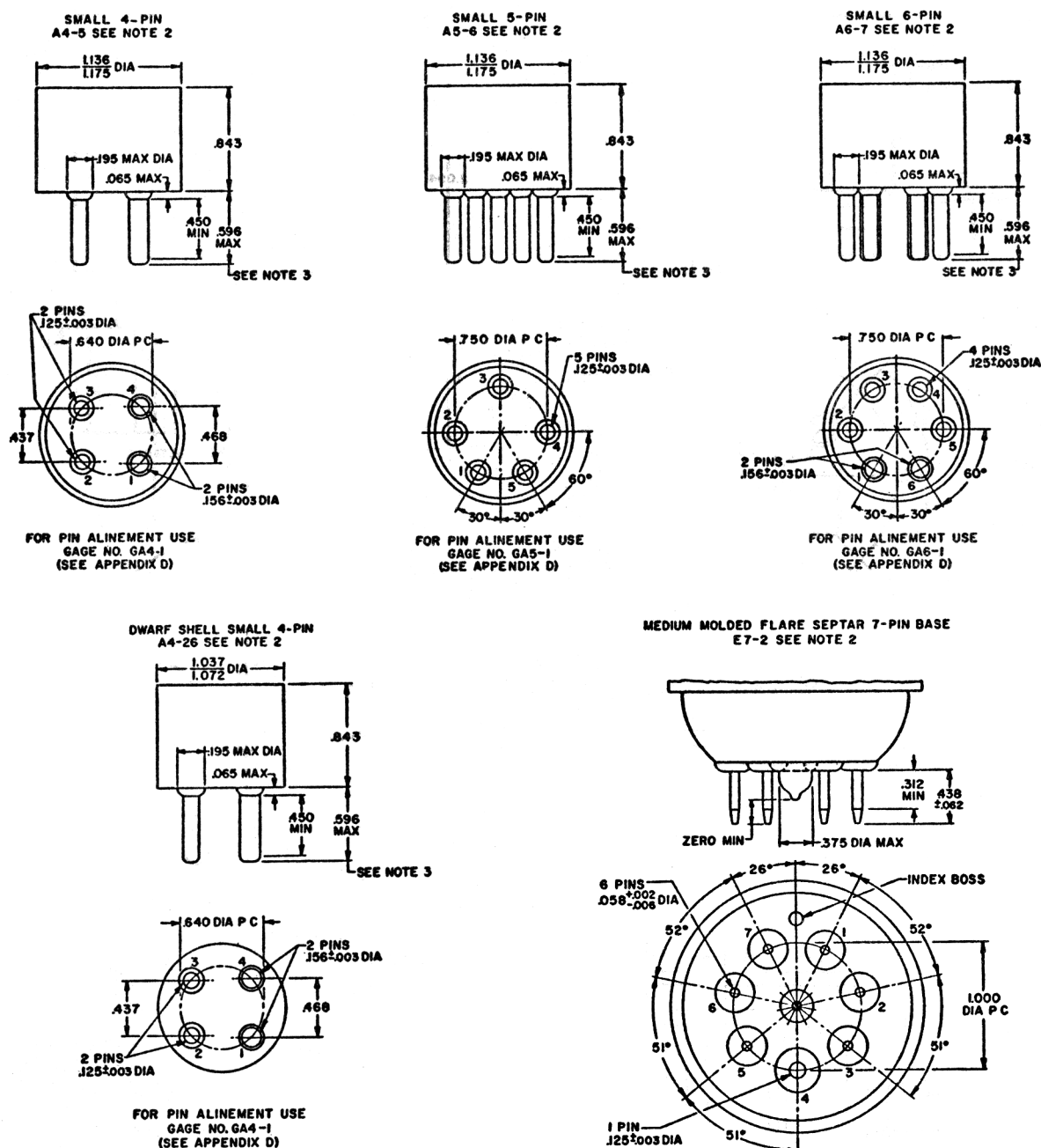
1. ALL DIMENSIONS IN INCHES.
2. REFERS TO JETEC PUBLICATION JO-G3-1, MARCH 1955.
3. REFERS TO JETEC PUBLICATION JO-G3-5, APRIL 1956.
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES;
5. ON FINISHED TUBE, ADD .030 FOR SOLDER.

FIGURE 15. Bases.



- NOTES:
- 1. ALL DIMENSIONS IN INCHES
 - 2. REFERS TO JETEC PUBLICATION JO-63-1, MARCH 1955
 - 3. ON FINISHED TUBE, ADD .030 FOR SOLDER
 - 4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES
 - 5. PIN DIAMETERS DO NOT INCLUDE INCREASE IN DIAMETER DUE TO SOLDER

FIGURE 16. Bases.



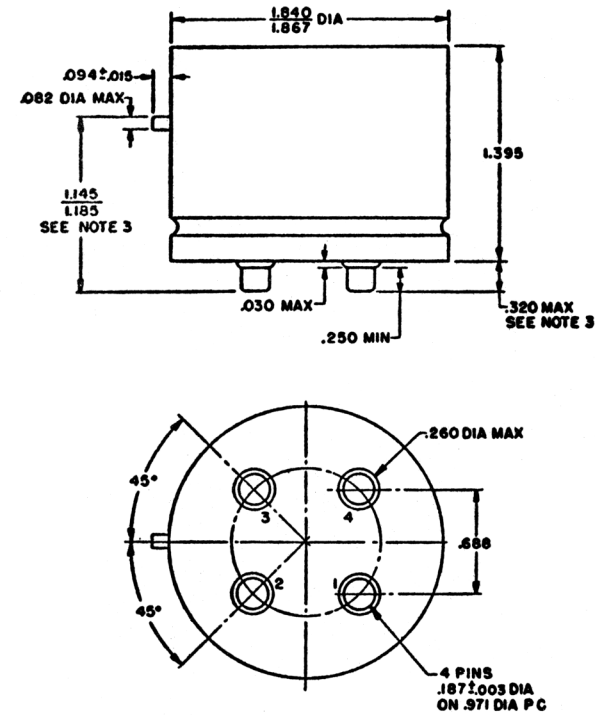
NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G3-1, MARCH 1955
3. ON FINISHED TUBE, ADD .030 MAX FOR SOLDER
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES
5. PIN DIAMETERS DO NOT INCLUDE INCREASE IN DIAMETER DUE TO SOLDER

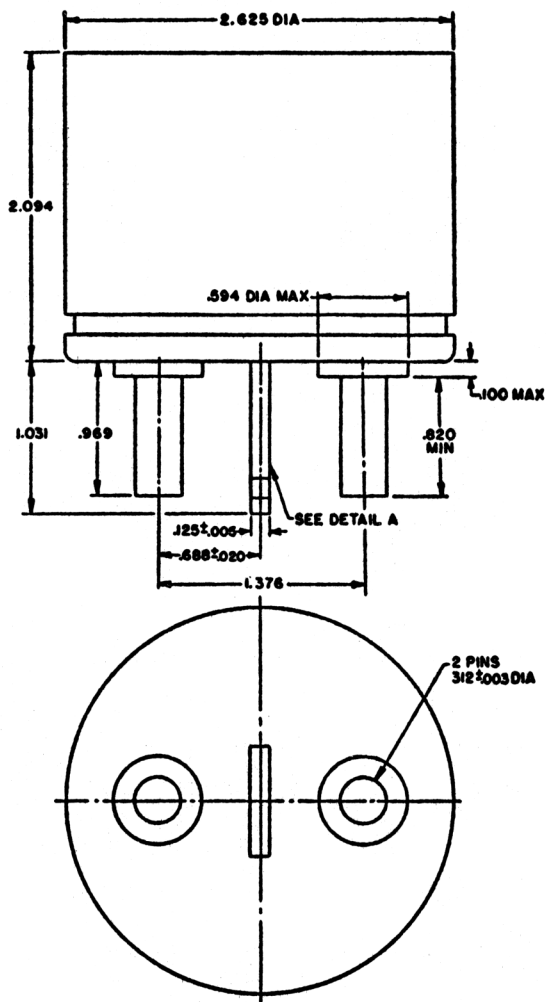
BASE PIN POSITIONS SHALL BE HELD TO TOLERANCES SUCH THAT THE BASE WILL FIT A FLAT PLATE GAGE HAVING A THICKNESS OF $\frac{3}{8}$ AND SIX $.080 \pm .0005$ HOLES AND ONE $.145 \pm .0005$ HOLE LOCATED ON A $1.000 \pm .0005$ DIA CIRCLE AT SPECIFIED CENTERS. THE COMPLETE LENGTH OF PINS SHALL, WITHOUT UNDUE FORCE, PASS INTO AND DISENGAGE FROM THE GAGE. THERE SHALL BE AN EXHAUST CLEARANCE HOLE OF .490 MINIMUM IN THE GAGE.

FIGURE 17. Bases.

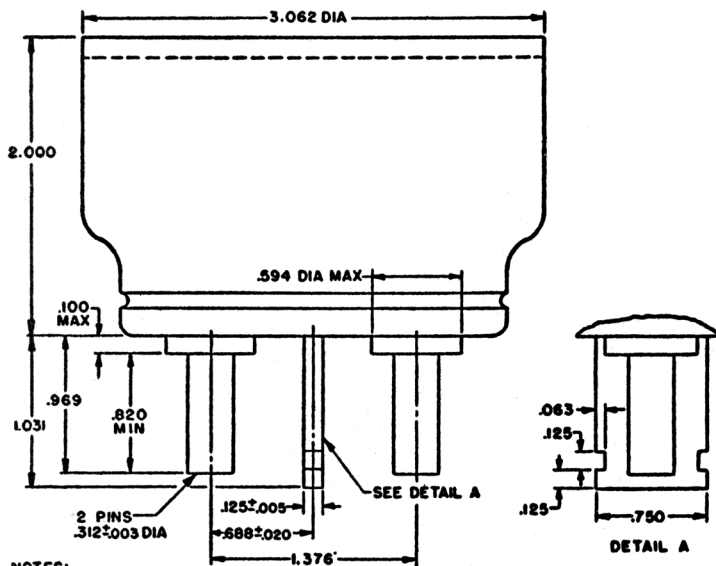
4-PIN JUMBO BASE
A4-29 SEE NOTE-2



3-PIN JUMBO BASE
A3-20 SEE NOTE 2



3-PIN SKIRTED JUMBO BASE
A3-21 SEE NOTE 2

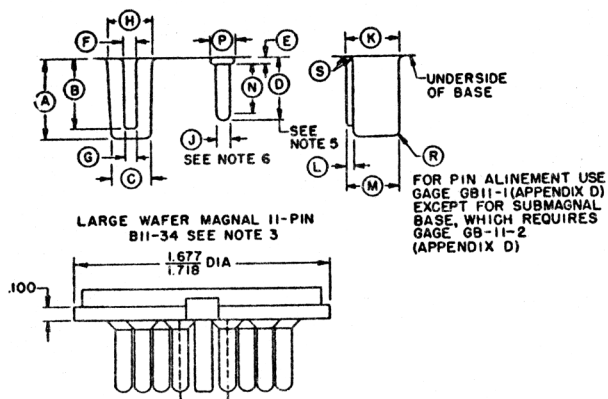


NOTES:

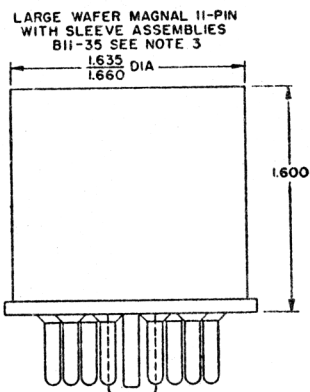
1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-63-1, MARCH 1955
3. ON FINISHED TUBE, ADD .060 MAX FOR SOLDER
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES
5. PIN DIAMETERS DO NOT INCLUDE INCREASE IN DIAMETER DUE TO SOLDER

FIGURE 18. Bases.

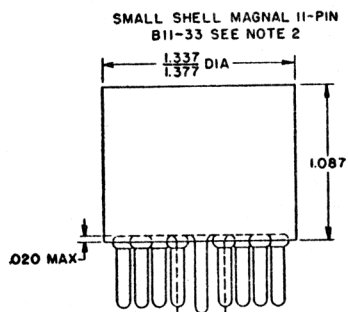
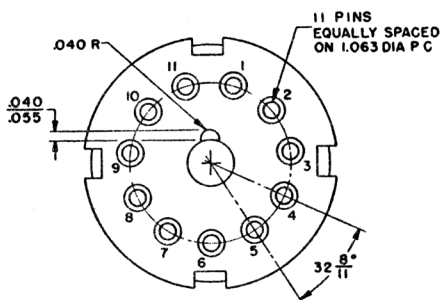
PIN AND INDEX GUIDE DIMENSIONS FOR MAGNAL AND SUBMAGNAL BASES



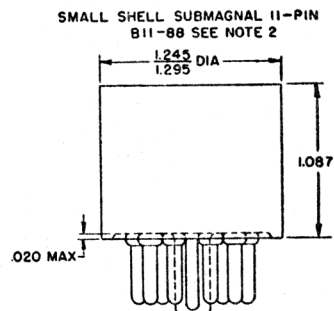
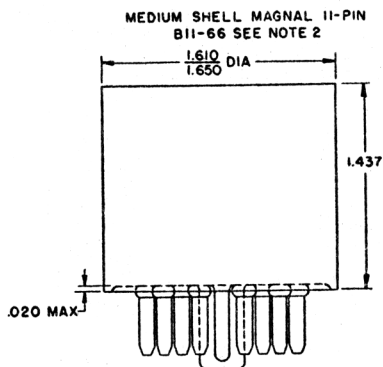
REF	MIN	REF CENTER	MAX
A	.550	.560	.570
B	.490	.500	.510
C	.300	.308	.315
D	.427	.437	.447
E			.050
F	.085	.090	.095
G	.075	.080	.085
H	.305	.312	.317
J	.090	.093	.096
K	.352	.362	.372
L	.040	.047	.055
M	.343	.353	.363
N	.340		
P			.135
R		.031 R	
S			.050 R



OTHER DIMENSIONS ARE SAME AS
FOR LARGE WAFER MAGNAL II-PIN



OTHER DIMENSIONS ARE SAME AS
FOR MEDIUM SHELL MAGNAL II-PIN



40 R

.040
±.005

11 PINS
EQUALLY SPACED
ON .750 DIA P.C.

1 2 3 4 5 6 7 8 9 10 11

32 8/11

FOR PIN AND INDEX GUIDE DIMENSIONS
SEE DETAIL

FOR PIN AND INDEX GUIDE DIMENSIONS
SEE DETAIL

NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G3-1, MARCH 1955
3. REFERS TO JETEC PUBLICATION JO-G3-5, APRIL 1956
4. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
5. ON FINISHED TUBE, ADD .030 FOR SOLDER.
6. DOES NOT INCLUDE INCREASED DIAMETER DUE TO SOLDER

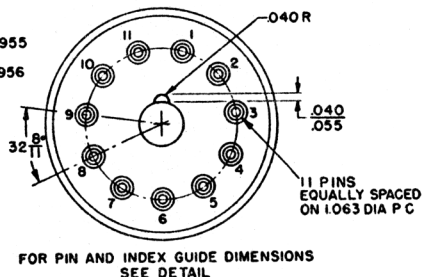
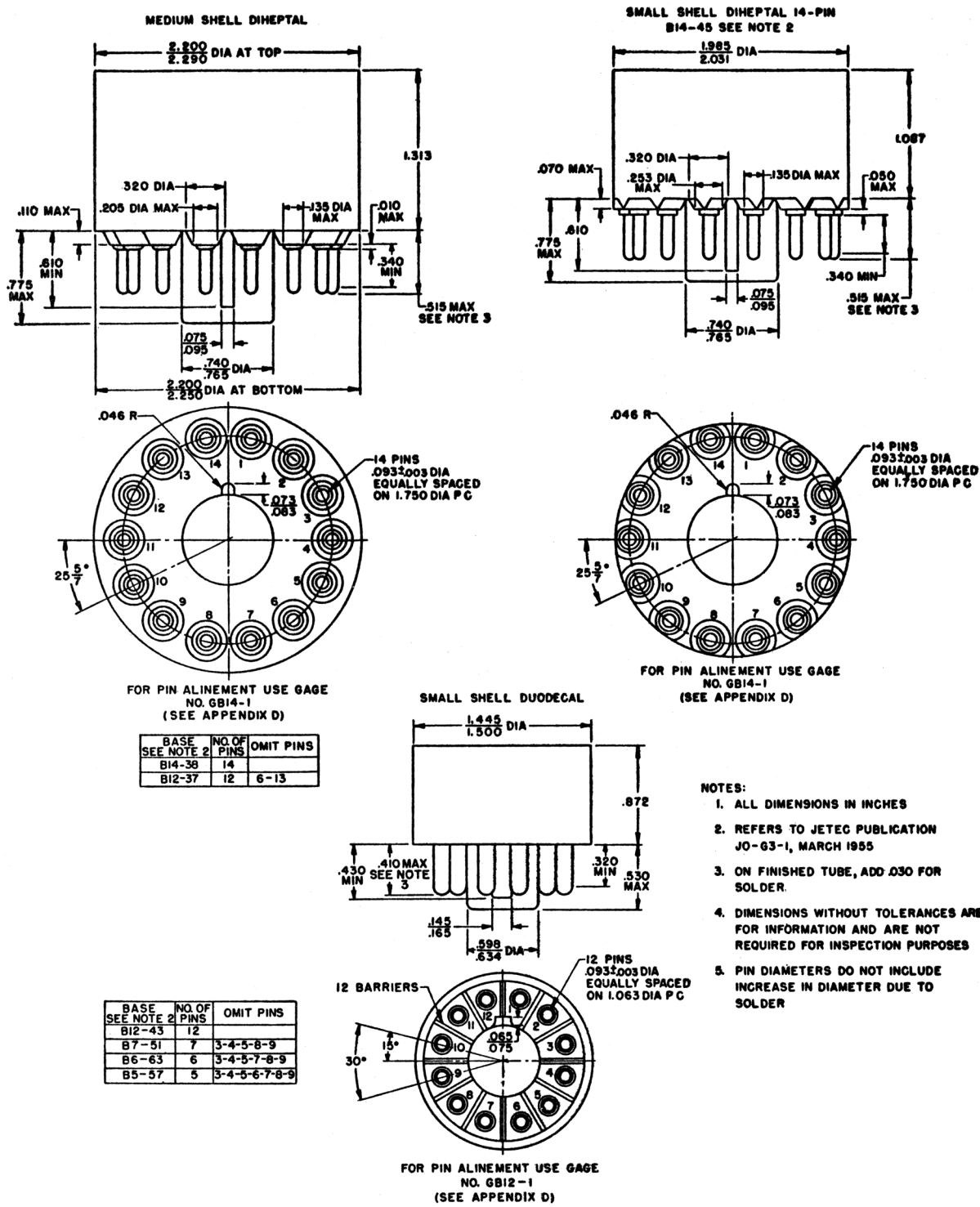


FIGURE 19. Bases.



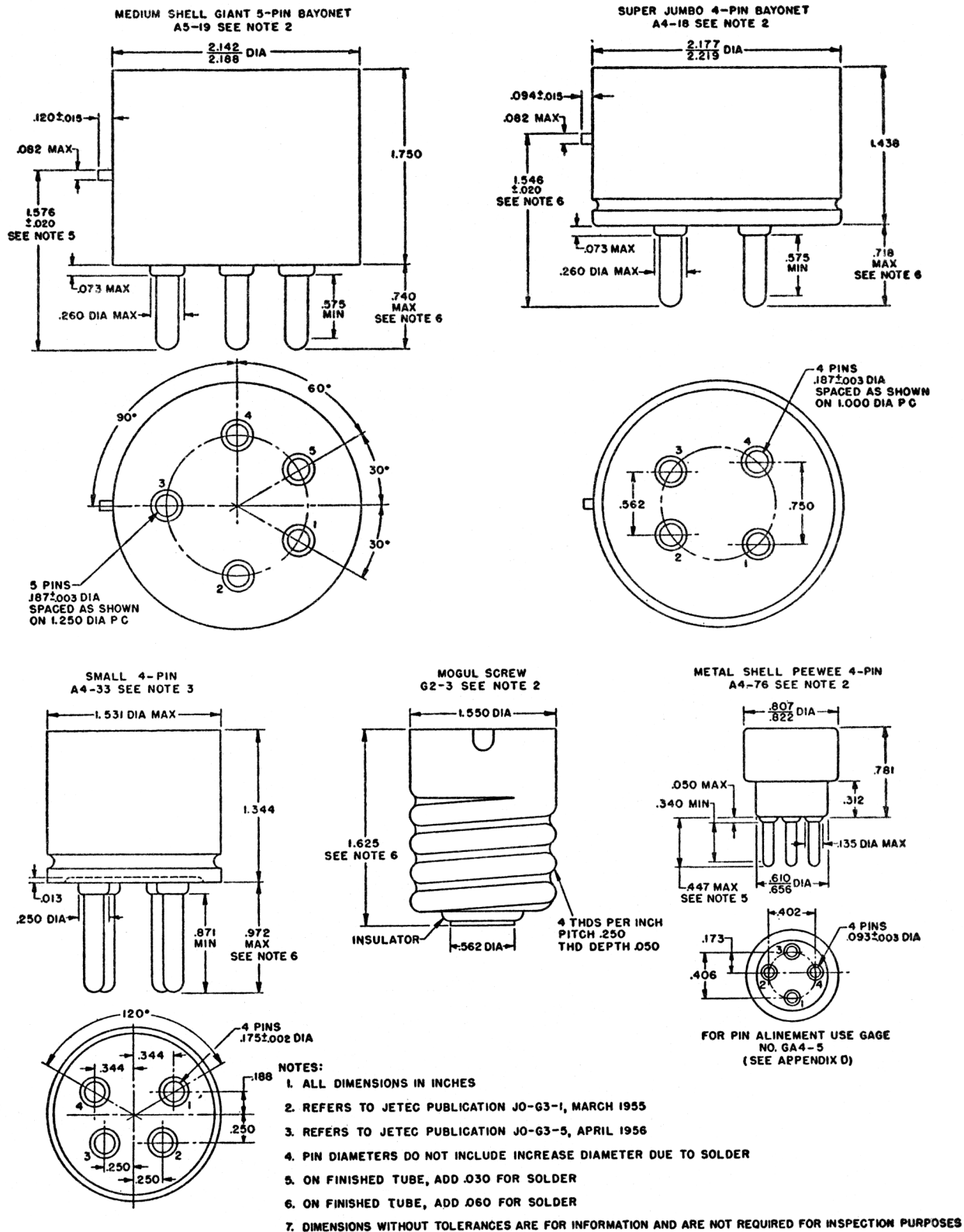
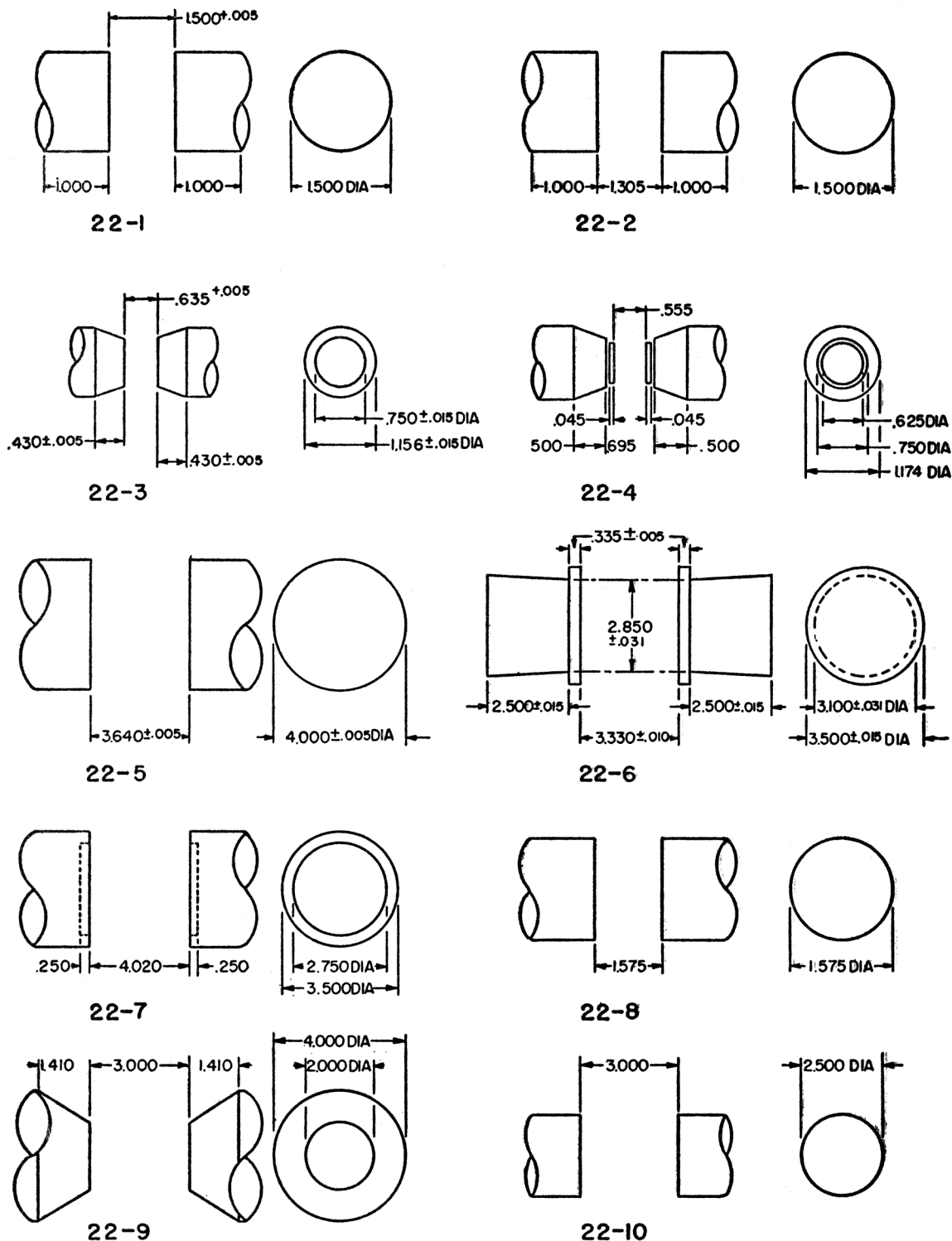


FIGURE 21. Bases.

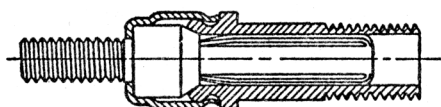


NOTES:

1. ALL DIMENSIONS IN INCHES. DIMENSIONS WITHOUT TOLERANCES ARE FOR INFORMATION ONLY
2. MATERIAL SHALL BE SOFT IRON OR COLD ROLLED STEEL
3. SIDE AND END VIEWS OF POLE FACES ARE SHOWN

FIGURE 22. Pole tips and gaps for magnetrons.

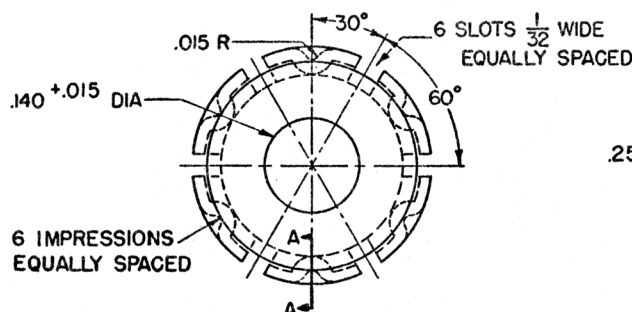
ASSEMBLY



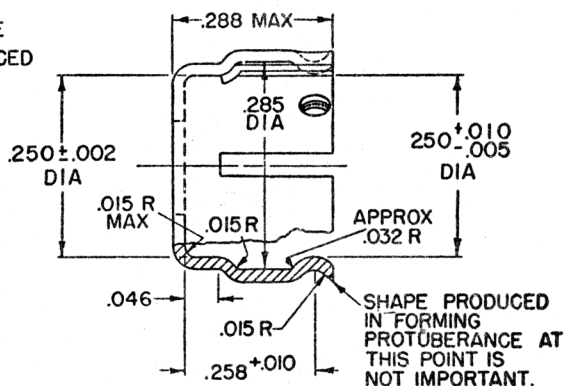
SPRING CLIP



DETAIL OF ALTERNATE METHOD OF MAKING GROOVE. SPUN IN AROUND SKIRT, TAKING PLACE OF IMPRESSIONS.

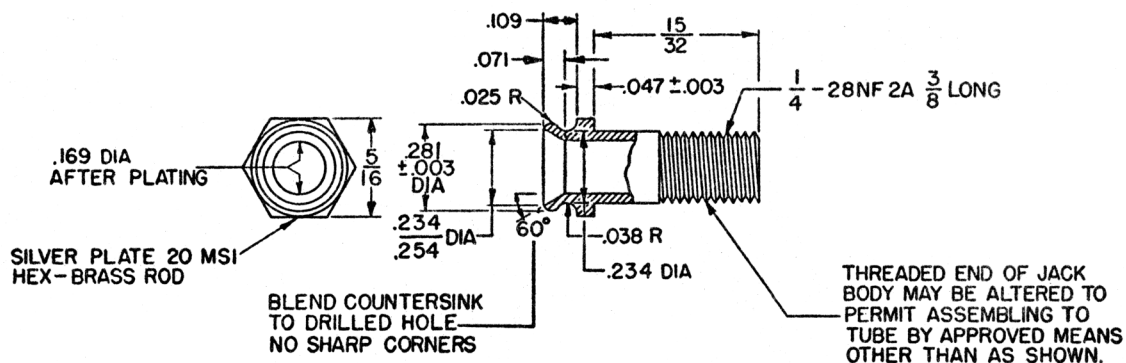


#26 (.016) B. & S. GAGE BERYLLIUM COPPER SHEET. HEAT TREAT AFTER DRAWING TO SPRING TEMPER. SILVER PLATE 20 MSI.



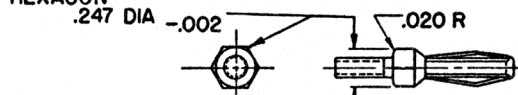
SECTION A - A

JACK BODY



PLUG BODY

MODIFY BY REMOVING HEXAGON



ALL DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE $\pm 1/64$ ON FRACTIONS, $\pm .005$ ON DECIMALS, $\pm 1/2^\circ$ ON ANGLES

MAKE FROM COMMERCIAL 274 GENERAL RADIO PLUG OR EQUIVALENT SILVER PLATE 20 MSI

FIGURE 23. Locking jack and plug for magnetrons.

GASKET DESIGNATION	OUTSIDE DIAMETER (A)	INSIDE DIAMETER (B)	THICKNESS (C)
JTC-1	2.000±.020	1.625±.025	.063±.010
JTC-2	1.890±.020	1.500±.015	.063±.010
JTC-3	2.187±.010	1.531±.015	.094±.010
JTC-4	2.875±.010	2.468±.015	.063±.010
JTC-5	2.425±.025	2.040±.015	.063±.010
JTC-6	2.406±.010	2.032±.015	.094±.010
JTC-7	2.812±.010	2.593±.015	.063±.010
JTC-8	4.625±.020	3.300±.030	.063±.010
JTC-9	2.688±.020	2.063±.020	.063±.010
JTC-10	2.344±.020	2.000±.020	.125±.015
JTC-11	5.625±.030	4.313±.030	.093±.015
JTC-12	5.063±.035	4.000±.035	.125±.035
	14 HOLES .196±.005 DIA EQUALLY SPACED ON 4.750±.010 DIA CIRCLE		
JTC-13	1.562±.010	.947±.015	.125±.015
JTC-14	2.110±.010	1.453±.015	.093±.010
JTC-15	1.500±.020	1.141±.020	.063±.010
JTC-16	5.400±.035	4.555±.035	.069±.015
JTC-17	5.188±.020	4.437±.015	.125±.015
	12 HOLES .063±.010 DIA EQUALLY SPACED ON 4.970±.010 DIA CIRCLE		
JTC-18	5.625±.030	4.313±.030	.093±.015
	6 HOLES .344±.020 DIA EQUALLY SPACED ON 5.125±.020 DIA CIRCLE		

NOTES:

1. ALL DIMENSIONS IN INCHES
2. REFERS TO JETEC PUBLICATION JO-G3-2, FEBRUARY 1948

GASKET SHALL BE A RUBBER-LEAD-RUBBER COMBINATION OR EQUIVALENT

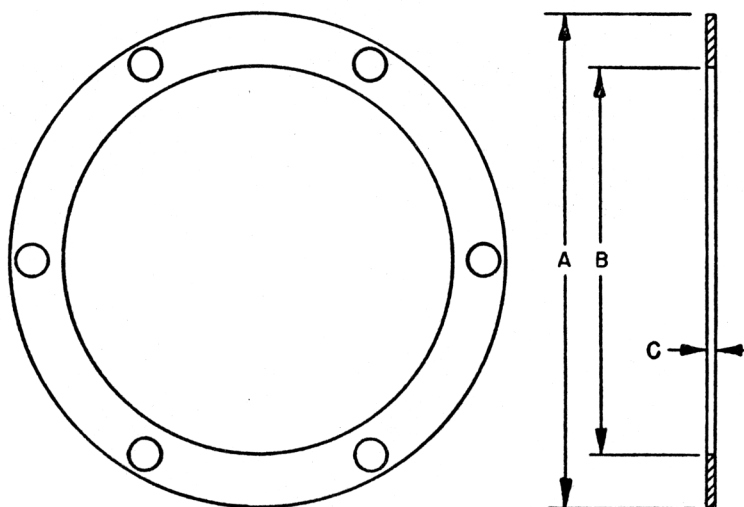


FIGURE 24. Gaskets.

3.5 Maximum ratings. (See 6.5.)

3.6 Performance. The performance requirements of each type of tube covered by this specification and the applicable tests to determine these requirements shall be as specified on the tube specification sheet (See 4.7 to 4.19.2.4, incl.) The following requirements and tests may not be listed on the tube specification sheet but the requirements and tests apply to all types except where the design and construction of the tube make the requirement or test meaningless:

Requirement or test	Paragraph
Material	3.3 and 3.3.1
Conductors	3.4.1
Seal-off tip	3.4.2
Base connections	3.4.3
Marking	3.7
Manufacturer's source code	3.7.7
Workmanship	3.8
General procedures for acceptance (determine that tube design and material employed comply with qualification inspection photographs and bill of materials)	4.1
Test conditions	4.3
Order of tests	4.4
Holding period	4.5
Preheating	4.6
Preheating cathode-ray tubes	4.6.1
Continuity and short tests.	4.7
Insulation of electrodes...	4.8
Mechanical tests	4.9
Mechanical-production tests	4.9.1
Mechanical-production tests (for reliable subminiature tubes)	4.9.1.1
Dimensions	4.9.2
Dimensions (for cathode-ray tubes) .	4.9.2.1
Brass or bronze sleeve base test . Base sleeve	4.9.3
Insulating quality of base material	4.9.4
Base, cap, and insert secureness	4.9.5

Requirement or test	Paragraph
Base pin solder depth (rigid leads)	4.9.5.1
Salt spray (corrosion) ...	4.9.8
Order for all tests (for ruggedized tubes) ..	4.9.20.1
Electrical characteristics measured before and after shock or fatigue (for ruggedized tubes) ..	4.9.20.2
Permanence of marking ...	4.9.21
Loose particles in magnets	60.1
	(Appendix B.)

3.7 Marking. Each tube shall be marked in accordance with 4.9.21. The information specified in 3.7.1 to 3.7.7, inclusive, is required as applicable. 3-7.6 inclusive, 3-7.8 and 3-7.9

3.7.1 Tube designation. The tube designation shall be made up as specified in 3.7.1.1 to 3.7.1.3, inclusive, as applicable. The designation as marked on the tube shall be used in all correspondence, markings, etc., with reference to tubes.

3.7.1.1 "JAN" prefix. The designation of all tubes procured under this specification shall bear the prefix "JAN", except that in the case of small tubes (T-6½ bulb outline or smaller) the prefix "J" shall be used. Tubes procured under a contract which either permits or requires any changes in any of the conditions or requirements of this specification shall not bear the prefix "JAN" nor any abbreviation thereof. The "JAN" brand is registered under number 504860 by the United States Patent Office and shall be used only on tubes which have passed Government inspection.

3.7.1.2 Qualification code. The qualification-code marking follows the "JAN" prefix. This designation is assigned to the manufacturer for use on all tube types of his manufacture which have passed the qualification tests and have been approved for inclusion on the Qualified Products List. The code-designating letters shall be as listed in Publication NAVSHIPS 900,152. The code-designation shall be used

only by the manufacturer to whom it has been assigned and only as a part of the designation on tubes manufactured at the plant to which the qualification approval was granted. In the case of small tubes (see 3.7.1.1), the manufacturer's code designation may be abbreviated by deleting "C" (the indication that the code has been assigned to a commercial organization in the United States or Canada).

3.7.1.2.1 Tubes not having qualification.

Tubes procured under this specification from a source of supply for which no qualification approval has been granted, shall be marked "JAN" followed by the type on the side wall of the base, or on the envelope of metal, lock-in tubes, or other glass tubes, or on the bulb of tubes without bases. The prefix "J", abbreviation for "JAN", shall be used only as specified in 3.7.1.1. The manufacturer's code name which signifies qualification shall not be used on any part of the tube.

3.7.1.3 Tube type number. The number identifying each tube type follows the "JAN" or qualification-code marking, or both, as applicable. For magnetrons, when the tube specification sheet covers a series of tubes, the tube type number shall be that of the type covering the frequency band determined by the test specified in 4.10.7.3.

3.7.2 Manufacturer's identification. The tube shall be marked with the name, initials, or trade-mark, of only the bona fide tube manufacturer who has contracted under this specification to supply directly either the Government agencies or their equipment manufacturers with tubes, and at whose plants or establishments the specification tests have been performed and Government inspection made upon such tubes contracted to be supplied. The marking shall be placed on the base, bulb, or shell, and shall not detract from the tube designation. The equipment manufacturer's name or trade-mark shall not appear on the tube unless the tube manufacturer supplying the tube for the contract is also the equipment manufacturer.

3.7.3 Country of origin. The phrase "Made in U.S.A." shall be marked in small characters below or adjacent to the tube designation, except that for tubes made in a foreign country the phrase shall be changed accordingly. Tubes not having space for "Made in U.S.A." shall have this marking placed on the unit package as specified in Specification MIL-P-75. Tubes (semiconductor devices or smaller) not having space for this marking shall have the individual carton marked as specified in Specification MIL-P-75. MIL-E-75

3.7.4 Acceptance date. Where practicable, each tube shall be marked with its acceptance date by a code number placed directly below or to the right or left of the phrase "Made in U.S.A." When impracticable to place this information on a tube because of size, the date-packaged information as specified for the unit-package marking in Specification MIL-P-75 shall be used in lieu of the acceptance date. The characters shall be smaller than those in the tube designation but not smaller than those in "Made in U.S.A.". The first two numbers in the code shall be the last two digits of the number of the year. The second two numbers shall be two digits indicating the calendar week of the year; when the number of the week is a single digit, it shall be preceded by a zero. Reading from left to right or top to bottom the code number shall designate the year and week of acceptance, in that order. Space between numbers shall not exceed $\frac{1}{16}$ inch. If the branding process is such that the bulbs are branded prior to assembly of the tubes, the acceptance-date marking may be performed on a quarterly basis, provided the date used is in advance of the acceptance time.

3.7.5 Service-life guarantee. Tubes sold under service-life guarantee shall be marked with the manufacturer's serial number, contract number, and the number of hours guaranteed.

3.7.6 Additional markings. When markings additional to those specified in 3.7.1 to 3.7.5, inclusive, are required on the tube specification sheet, they shall be marked in the manner specified thereon. Tubes not having space for

unless otherwise stated the Marking of values shall be in accordance with K100114 and, in addition, the tubes shall be marked with the American tube type number.
[U.K. Amelt-3]

these additional markings shall have the individual carton marked as specified in Specification MIL-P-75.

3.7.7 Manufacturer's source code. If the manufacturer desires to include a source code in the tube marking, this code may be marked on the tube, provided such a source code appears in only one place on the tube and the size of the characters of the source code is not larger than the size of those in the date code. The source code shall be restricted to the use of the Electronic Industries Association assigned numerical system. When the date code is directly below "Made in U.S.A.", the source code shall be located to the left or right of "Made in U.S.A.". When the date code is either to the left or right of "Made in U.S.A.", the source code shall be located on the opposite side of "Made in U.S.A." or directly below it. The inclusion of a source code shall not be construed as permission to omit any of the markings specified in 3.7.1 to 3.7.6, inclusive. Any additional hidden source or date code shall not conflict with nor impair the legibility of the specified markings.

3.8 Workmanship. Tubes shall be manufactured and processed in a careful and workmanlike manner, in accordance with good design and sound practice. See Appendix B for guidance.

3.9 Military specification sheets (tube specification sheets) for individual tube types. The detail requirements and tests for each tube type covered by this specification are specified on the military specification sheets and the tube shall be tested in accordance with the referenced test procedures specified in section 4. The military specification sheets dated prior to 2 May 1952 as part of Specification JAN-1A and referencing paragraphs in Specification JAN-1A are a part of this specification and shall be used with this specification until superseded by military specification sheets issued under this specification. (See 6.6) In the event of any conflict between other requirements of this specification and the individual military specification sheets, the latter shall govern, except as specified in 4.3. (See 6.1.)

3.9.1 Abbreviations and symbols. For the purpose of simplification, the following abbreviations and symbols are used herein and on the tube specification sheets wherever practicable:

A	Angstrom unit
A	Amperes (may be either ac rms or dc)
a	Amperes (peak value) or anode
Aac	ac amperes (rms)
α (alpha)	Attenuation constant
ac	Alternating current
Adc	dc amperes
ALD	Acceptance limit for sample dispersion
ATR tube	Anti-transmit-receive tube
AQL	Acceptable quality level
β (beta)	Phase constant
B/Yo	Tuning susceptibility
c	Velocity of light
C	Capacitance
$^{\circ}\text{C}$	Degrees centigrade
cb	Centibels
Cgk, Cgp, Cpk, etc.	Tube capacitance between the electrodes indicated
Cin	Input capacitance
Ck	Capacitor between cathode and ground
CL	Load capacitance
cm	Centimeter
Cout	Output capacitance
cps	Cycles per second
CRO	Cathode ray oscilloscope
ct	Center tap
CW	Continuous wave
Δ (delta)	A change in the value of the indicated variable. When expressed in percent the difference in readings is divided by the initial reading and multiplied by 100
db	Decibels
D1, 2, 3, 4	Deflection plates
dc	Direct current
DF	Deflection factor in volts per inch
dik	Rate of rise of cathode current pulse
dt	
Du	The product of time of pulse and pulse repetition rate (duty cycle)
dy	Dynode
EB	Ballistic deflection
Eb, Eb1, 2, 3	dc voltage on respective anodes or plates. In the case of multiplex tubes containing more than one operating unit, the number of the unit concerned is inserted between the voltage symbol and the element symbol. For example, E2b, E1b, E1c2, etc. The number of the unit is the number of the plate in that unit.

The applicable specification sheets are those CV specifications which are to be read in conjunction with K1006

eb	Peak dc anode or plate voltage
Ebb	dc anode or plate supply voltage
Eb/Ib	Adjust plate voltage to produce the specified plate current
Ec, Ec1	dc voltage on respective grids
2,3 Ec2 Ec3	Calibrating voltage
Ecc, Ecc1	dc supply voltage to respective grids
Ec/Ib	Adjust grid voltage for the specified plate current
Eco	dc cutoff grid voltage
ed	Voltage peak between anode No. 2 and any deflection plate in cathode ray tubes
Edy	dc voltage of anode producing secondary emission
Ee	End-of-plateau voltage
Ef	Filament or heater voltage
Ef/Po	Adjust filament potential (with other potentials held constant) to reduce the power output obtained on oscillation by the amount specified.
Eg1,2,3	rms value of ac component of input voltage for respective grids
egk	Peak voltage drop between grid and cathode
egy, egy1	Peak forward grid voltage
2,3	
egx	Peak inverse grid voltage
Ehk	Heater-cathode voltage (sign to indicate polarity of heater with respect to cathode)
Eid	Ignitor voltage drop
Eo	dc component of output voltage of rectifiers
EO	Overvoltage for radiation counter tubes
eo	Pulse amplitude
Ep	rms value of the ac component of plate voltage with respect to cathode
Epp	ac anode or plate supply voltage
epx	Peak plate inverse voltage
epy	Peak forward anode or plate forward voltage
Er	Reflector voltage
Eres	Reservoir voltage
Ers	Resonator voltage
Es	dc emission voltage
Es	Starting voltages for radiation counter tubes
Esd	External shield voltage
Esh	Shell voltage
Esig	Applied signal voltage
Eta	Target voltage
Etd	Average voltage drop between anode and cathode
etd	Peak voltage drop between anode and cathode

Ez	Ionization, breakdown, or striking voltage
f	Filament
F	Frequency (in cps)
FA	Maximum frequency above which receiving tube performance deteriorates seriously and sharply
F1	Maximum frequency at which maximum ratings apply
F2	Frequency at which maximum plate voltages and plate input are limited to 50 percent of the ratings for F1. For frequencies between F1 and F2 the maximum plate voltage and plate input will be reduced in the correct proportion so that at the frequency F2 these factors will not exceed 50 percent of their maximum ratings
fct	Filament center tap
fk	Filament-cathode return
Fsg	Frequency of signal generator
ftL	Foot lamberts
G	Acceleration of gravity
G/Yo	Equivalent conductance
γ (gamma)	Propagation constant
g, g1,2,3	Grid (number to identify grids, starting from cathode)
g2+4	Grids having common pin connection
GA	Gas amplification
Gr	Gas ratio
H	Field strength in gauss
hct	Heater center tap
ht	Heater tap
Ia	Anode current
Ib, Ib1	dc current of respective anodes or plates
2,3	
ib	Peak value of dc anode or plate current. When used in reference to pulses, the maximum peak current excluding spike
Ic, Ic1	dc current of respective grid
2,3	
ic	Peak grid current
Idy	Current of anode producing secondary emission
If	Filament or heater current
if	Intermediate frequency
Ig	rms value of ac component of grid current
Ihk	Heater-cathode leakage current
Ii	Ignitor current
Ik	dc cathode current
ik	Peak cathode current
iL	Peak load current
int con	Internal connection
Io	dc component of output current of rectifiers per tube

Ip	rms value of ac component of plate current	mVac	ac millivolts (rms)
Ir	Reflector current	mVdc	dc millivolts
Ires	Reservoir current	MW	Megawatts
Irs	Resonator current	Mw	Peak megawatts
Is	dc emission current	mW	Milliwatts
is	Peak emission current	mw	Peak milliwatts
Isg	dc component of primary emission from grid indicated	N	Counts for radiation counter tubes
Ita	dc target current	nc	No connection
Iz	Ionization current	NF	Noise figure
°K	Degrees Kelvin	Npm	Counts per minute
k	Cathode	Nps	Counts per second
kc	Kilocycles	Nr	Output noise ratio (ratio of noise power output to resistance noise power)
kMc	Kilomegacycles	p	Plate
KTb	Theoretical resistance noise power	/p	Per plate
kv	Peak kilovolts	Pb	Plate breakdown factor (epy x prr x ib)
kVA	Kilovolt-amperes	Pd	Average drive power
kva	Peak kilovolt-amperes	pd	Peak drive power
kVac	ac kilovolts (rms)	Pg1,2,3	Power dissipation of respective grids
kVdc	dc kilovolts	Pi	Power input (plate)
kW	Kilowatts	pi	Peak power input
kw	Peak kilowatts	Pj	Reactive power in watts
L	Lamberts	Pl	Plateau length
LAL	Lower acceptance limit for sample average or sample median	Pn	Noise output
λ (lambda)	Wavelength	P'o	Intrinsic P
λo	Resonant wavelength	Po	Average power output
Lc	Conversion loss or gain (ratio of available signal power to the available intermediate frequency power)	Po	Peak leakage power
Lib	Leakage current	ΔPo, etc.	Change in Po, etc., of an individual tube, caused by the specified change in Ef
Li	Insertion loss	ΔPo, etc.	Change in Po, etc., caused by a test (life, shock, fatigue, etc)
lm	Lumens	po	Peak power output
LRLM	Lower reject limit median for a sample of tubes	Pp	Plate or anode power dissipation
LS1	Standardized light source supplied by a coiled tungsten lamp with a lead or lime glass envelope operated at a color temperature of 2,870° K	pr	Pulse recurrence rate in pulses per second
LSLA	Lower specification limit for average of acceptable lots	Pr-TR Tube	Pre-Transmit-receive tube
M	Figure of merit, or one million	Ps	Relative plateau slope
m	Meter, or one-thousandth	Q	Quality of a circuit
mA	ac (rms) or dc milliamperes	QL	Loaded Q
ma	Peak milliamperes	Qo	Intrinsic Q or quality of a circuit without external loading
mAac	ac milliamperes (rms)	r	Reflector
MAdc	dc milliamperes	r	Roentgen
Mc	Megacycles	R	Resistance
Meg	Megohms	Rb	dc resistance of external plate circuit (bypassed)
mftL	Millifoot lamberts	Rc	dc resistance of external grid circuit (bypassed)
mH	Millihenry	Rc	Reference resistor for noise-ratio measurements (for crystal rectifiers)
mL	Millilamberts	rf	Radio frequency
mr	Milliroentgen	Rf	Resistance in series with filament or heater
MRSD	Maximum rated standard deviation	Rg	Resistance in series with grid
ms	Milliseconds	rg	Dynamic internal grid resistance
ms	Missing r.f. pulses		
ms	milligrams per square inch (plating)		
Mu or u	Amplification factor		
mv	Peak millivolts		

Rk	Resistance in series with cathode		
Rka1, Rka2,	Tube resistance between the elec-		
Rkrs, Rfrs, etc.	trodes indicated		
RL	Load resistance (Unity power fac-		
	tor. Negligible dc resistance)		
rms	Root mean square		
Rp	Resistance in series with plate or		
	anode		
rp	Dynamic internal plate resistance		
	of tube		
rs	Resonator		
Rv	Video impedance		
S	Static sensitivity (phototubes)		
s	Dynamic sensitivity (phototubes)		
Sc	Conversion transconductance		
Sd	Spectral distribution		
sd	Shield		
se	Starter electrode		
Sg1, g2, etc.	Transconductance between the ele-		
	ments indicated		
sh	Shell		
σ (sigma)	"Input" standing-wave ratio in		
	voltage		
σ' (sigma prime)	"Output" standing-wave ratio in		
	voltage		
Sm	Transconductance (control grid-		
	plate)		
Δ Sm, etc.	Change in Sm, etc., of an individual		
Ef	tube, caused by the specified		
	change in Ef		
Δ Sm, etc.	Change in Sm, etc., caused by a		
t	test (life, shock, fatigue, etc)		
Sr	Sensitivity ratio (max Ib to min Ib)		
T	Temperature (degrees centigrade)		
t	Test duration (seconds, unless		
	otherwise specified)		
TA	Ambient temperature		
ta	Target		
tad	Anode delay time. A time interval		
	between the point on the rising		
	portion of the grid pulse which		
	is 26 percent of the maximum		
	unloaded pulse amplitude and the		
	point where anode conduction		
	takes place		
Δ tad	Anode delay time drift		
TE	Envelope temperature		
tf	Time of fall. The time duration of		
	pulse to fall from 70.7 percent		
	of the maximum pulse amplitude		
	to 26 percent of the maximum		
	pulse amplitude, excluding spike,		
	in microseconds		
THg	Temperature of condensed mercury		
TIR	in °C Total indicator reading		
tj	Variation in firing time		
tk	Cathode-conditioning time (in sec-		
	onds) necessary before the ap-		
	plication of high voltage. In TR		
	tubes, time delay between ap-		
	plication of ignitor voltage and		
	rf power		
tp	Pulse duration (excluding magne-		
	trons). The time interval be-		
	tween the points on the trace		
	envelope at which the instantan-		
	eous amplitudes are equal to		
	70.7 percent of the maximum		
	amplitude, excluding spike. For		
	magnetrons, see 4.16.3.3		
tr	Time constant of rise (excluding		
	magnetrons). The time duration		
	of a pulse to rise from 26 per-		
	cent of the maximum pulse am-		
	plitude to 70.7 percent of the		
	maximum pulse amplitude ex-		
	cluding spike, in microseconds.		
trc	Time of rise of current pulse in		
	microseconds (for magnetrons,		
	see 4.16.3.3)		
TR tube	Transmit-receive tube		
trv	Time of rise of voltage pulse in		
	microseconds (for magnetrons,		
	see 4.16.3.3)		
TUT	Tube under test		
u	Amplification factor		
ua	Microamperes, peak value		
uAac	ac microamperes (rms)		
uAdc	dc microamperes		
UAL	Upper acceptance limit for sample		
	average or sample median		
umhos	Micromhos		
uf	Microfarads		
uh	Microhenries		
URLM	Upper reject limit median of a		
	sample of tubes		
us	Microseconds		
USLA	Upper specification limit for aver-		
	ages of acceptable lots		
uuf	Micromicrofarads		
uVac	ac microvolts (rms)		
uVdc	dc microvolts		
uW	Microwatts		
V	Volts (may be either ac rms or dc)		
v	Volts, peak value		
VA	Volt-amperes		
va	Peak volt-amperes		
Vac	ac volts (rms)		
Vdc	dc volts		
v/in	Volts, peak value, per inch of		
	deflection		
Vj	Amplitude jitter		
VSWR	Voltage standing wave ratio		
VU	Volume units		
Vx	Extinguishing voltage		
W	Watts		
w	Peak watts		
Ws	Spike leakage energy		
X1	The orientation of a tube rigidly		
	mounted for mechanical tests		
	with the main axis of the tube		
	and the major cross section of		

the tube elements normal to the direction of the accelerating force

- X2** The orientation of a tube rigidly mounted for mechanical tests with the main axis of the tube normal and the major cross section parallel to the accelerating force
- x** Denoting peak inverse value
- Y1** The orientation of a tube rigidly mounted for mechanical tests with the main axis of the tube parallel to the direction of the accelerating force. (When Y1 is referred to for shock tests, the principal base of the tube is toward the hammer)
- Y2** The orientation of a tube (for shock test only) which is the same as Y1 except that the principal base of the tube is away from the hammer
- y** Denoting peak forward value
- Z** Impedance
- Zd** Impedance to anode of deflection plate circuit at power-supply frequency
- Zg** Impedance of the grid circuit
- Zgg** Impedance between grids of push-pull circuit
- Zgk** Impedance between grid and cathode
- Zi** Input impedance
- ZL** Load reactance (with negligible dc resistance)
- Zm** Modulator frequency load impedance
- Zo** Output impedance and characteristic impedance
- Zp** Impedance in plate circuit
- Zpp** Impedance between plates in push-pull circuit
- 1D2** Deflection produced by the deflection plates nearer the screen (for cathode-ray tubes)
- 3D4** Deflection produced by the deflection plates nearer the base (for cathode-ray tubes)
- **** Qualification test
- *** Standard-design test
- #** Special-design test
- ##** Periodic-check test
- †** Test to be performed at the conclusion of the holding period (see 4.5)
- ←** Indicates change on tube specification sheet
- ←o** Indicates deletion from the tube specification sheet

4. QUALITY ASSURANCE PROVISIONS

See Amdl 5 P3

4.1 General procedures for acceptance.

Acceptance-sampling procedures shall be performed in accordance with Standard MIL-STD-105 and the applicable special procedures of Appendix C. The Government will ascertain that the tubes, when submitted for inspection, meet all the requirements of this specification and of the tube specification sheet. The manufacturer shall furnish all necessary facilities and equipment for making the tests (except qualification tests) and inspection required by this specification, and shall carry out all tests under the supervision of the Government. The test equipment shall be adequate in quantity to avoid delay during inspection. The Government reserves the right to make other tests, not specifically required, when such tests are deemed necessary to determine full compliance with the requirements of this specification. The manufacturer may also make such additional tests as he may deem necessary to insure proper quality control of his product. Other test methods may be submitted for those specified herein provided it is demonstrated to the Government that there is adequate correlation between the results of the manufacturer's test methods and those specified in this specification, and provided that such substitution in no manner relaxes the requirements of this specification. The schematic wiring diagram of the test equipment to be used shall be made available for checking by the Government. The Government reserves the right to check the calibration and accuracy of the test equipment at any time. The manufacturer shall make available for Government use a statement describing the materials and pertinent design features of the tube, such as anode, grid, base, filament, material, construction, etc. The Government shall be supplied with one set of photographs of each tube for which the manufacturer has been granted qualification approval. These photographs and statement of materials and construction shall be the same as those submitted with the request for authorization to submit samples for qualification tests, and shall be used by the Government for the periodic spot checking of the tubes to determine whether

the design and construction of the tubes conforms to that for which qualification was granted. Unless otherwise specified in 4.9.1, any tube which fails any test shall be rejected unless the manufacturer has corrected the cause of failure.

4.1.1 Classification of tests. Each test specified on the tube specification sheet will fall into one of the following groups. A test may include several measurements.

4.1.1.1 Qualification tests. All tests listed on the tube specification sheet shall be conducted as qualification tests. The tests marked on the tube specification sheet with two asterisks shall be conducted as qualification tests only, and shall not be conducted as acceptance inspection. The use of the two asterisks in this sense shall not be construed as limiting qualification tests to those items so marked.

4.1.1.1.1 Periodic-check tests. The tests marked on the tube specification sheet with two number symbols (##) shall be conducted as periodic-check tests and as qualification tests. The tubes for periodic-check tests shall be selected at random at intervals so that, at the time any lot is offered for acceptance, not less than three tubes shall have been tested during the last 12 calendar months. Should the tube or tubes fail such a test, the matter shall be reported to the Armed Services Electro-Standards Agency, (ASESA) as a matter affecting qualification. The failure of one or more samples for periodic-check test shall not be cause for rejection of tubes until such time as the effect of the failure on qualification has been determined.

4.1.1.2 Standard-design tests. The tests marked on the tube specification sheet with one asterisk shall be conducted as standard-design tests at inspection level L6 of Standard MIL-STD-105 and an AQL of 6.5 percent for each individual test, and as qualification tests.

4.1.1.3 Special-design tests. The tests marked on the tube specification sheet with one number symbol shall be conducted as special-

design tests at inspection level L6 of Standard MIL-STD-105 and an AQL of 4.0 percent for each individual test, and as qualification tests.

4.1.1.4 Tests with special AQLs. All test items specified on the tube specification sheet with an AQL value shall be tested in accordance with the acceptance-sampling procedure of Standard MIL-STD-105, and the applicable special provisions of Appendix C. Where inspection level IA is specified, inspection level L6 shall be used. These tests shall also be performed as qualification inspection.

4.1.1.5 Life tests. Life tests shall be performed as specified on the tube specification sheet or as specified in 4.11 to 4.11.8, inclusive, as applicable.

4.1.1.6 Production tests. All tests not included in 4.1.1.1 to 4.1.1.5, inclusive, are production tests. Except for tests marked with a dagger sign, production tests have no symbol marking. Production tests are divided into three major groupings:

Group A: Mechanical inspection. All mechanical, visual-mechanical, and dimensional characteristics designated as production tests. See 4.9 for classification of defects and inspection-acceptance criteria.

Group B: Electrical tests. All electrical characteristics designated as production tests. All electrical defects are major 1 defects, 1 percent AQL.

Group C: Inoperatives. All inoperatives (shorts, discontinuities, and air leaks) are major 1 defects, 4.0 percent AQL.

4.1.1.7 Variable sampling. When specified on the tube specification sheet, the measurements of certain electrical tests for the lot shall be controlled for central tendencies, deviations of lot average from bogey, and for dispersion about the average. The sample size shall be as

See Andlt 5 p7 for sections 4.1.2 Resubmitted lots 4.1.4 Testing & bonding at remote locations
4.1.3 Irregular Production 4.1.5 Delayed shipment of inspected tubes

unless the Approving Authority requests otherwise for any particular value type
this paragraph 4.2 shall be superseded by section 15 of specification K1001

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See Andt 5 p 7

specified on the tube specification sheet. For inspection procedures, see Appendix C.

4.2 Qualification. Qualification of individual tube types will be obtained in accordance with the instructions of Appendix A.

4.2.1 Qualification tests. Qualification tests shall include tests of all classifications from 4.1.1 to 4.1.1.6, inclusive, and as specified on the tube specification sheet. The Government reserves the right to conduct any tests or inspection within the ratings of the tube which they may deem necessary to determine compliance with the requirements of the specification.

4.3 Test conditions. All test conditions in this specification shall be determined by the following order of precedence:

- The particular test conditions specified on the tube specification sheet.
- The test paragraph of this specification referred to on the tube specification sheet.
- The general test conditions specified on the tube specification sheet.
- The general definition and test requirement paragraph of this specification.

In multiunit tubes, the unit or units not under test shall be connected to the reference point or biased to cutoff. Tapped filaments designed for either series or parallel operation shall be tested in a manner which will insure proper internal and external connections. Any shields and metal-tube envelopes, except those of external anode tubes and metal cathode-ray tubes, shall be connected to the reference point. When tests are to be made with cathode resistor bias, the resistor shall be bypassed with a capacitor of 3 ohms maximum reactance at the test frequency. Tubes shall be tested at an ambient temperature of not less than 20° C under free convection conditions or equivalent, except where other cooling means are specified under test conditions on the tube specification sheet. Wiring or bus bar connections of ample size

to carry necessary currents are permitted; however, electrode connectors designed expressly for cooling purposes shall not be used unless specified under test conditions on the tube specification sheet.

4.3.1 Test conditions for qualification tests.

When conditions for a test specify only a single limiting condition (for example, a minimum value for a test voltage with no maximum specified), the Government Laboratory will use the specified value when performing qualification tests.

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4.4 Order of tests. Tests may be conducted in any order, except that after the mechanical tests specified in 4.9.19 the tubes shall meet all performance requirements on the tube specification sheet, and that grid-current and emission tests shall be conducted in the order listed on the tube specification sheet. For qualification tests, the container drop, low-frequency vibration, emission, and bump tests specified in 4.9.18, 4.9.19.1, 4.10.1, and 4.9.19.3, respectively, if required, shall be performed last. The order of tests for ruggedized tubes shall be as specified in 4.9.20.1.

4.5 Holding period. Tubes shall be held nonoperating for a minimum period of 24 hours (48 hours minimum for cathode-ray tubes). This holding period shall be initiated after the completion of all manufacturing processes. Tests designated by a dagger sign (†) on the tube specification sheet may be made before and shall be made at the conclusion of the holding period; tests not designated by a dagger sign shall be made before or after the holding period, provided the order of tests specified in 4.4 is maintained.

4.5.1. See below

4.6 Preheating. Prior to testing, all tubes shall be preheated under conditions not exceeding the maximum ratings for sufficient time to obtain stabilized values of electrical characteristics. Preheating may be done in the test set if desired by the manufacturer.

4.6.1 Cathode-ray tubes. Cathode-ray tubes shall be preheated for not less than 60 seconds

All values shall be subjected to the holding period specified in K1001 Section 16

[u.k. Andt 12] 39

under conditions of maximum rated filament voltage (no other voltages necessary).

4.6.2 Stabilization. When stabilization is specified on the tube specification sheet, all tubes shall be stabilized prior to characteristic tests for not less than the period specified. Voltages as specified on the tube specification sheet shall be applied continuously during stabilization. After all of the tubes in any lot have been stabilized once and have met the requirements of this specification, no further stabilization on these tubes will be required.

4.7 Continuity and short tests.

4.7.1 Continuity. All tubes shall be tested for continuity of all circuits including shell, base, base sleeve, shield, and duplicate-pin connections to the same electrode. The tubes shall also be tested for continuity during and after the tap-shorts test specified in 4.7.3. Tubes failing to show continuity in any of these tests shall be rejected as inoperable.

4.7.2 Permanent shorts. All tubes shall be tested for shorts between any of the elements without tapping the tube. Tubes showing shorts in this test shall be rejected as inoperable.

4.7.3 Tap shorts. Unless specifically excepted by the tube specification sheet, tubes shall be tested for tap shorts as follows: The tube shall be mounted in the socket of the short-testing equipment and tapped three times on each of two sides 90° apart. Sharp blows shall be delivered with an approved mallet or an approved mechanical device. When any tap-short indication is obtained, the test shall be repeated. When any short indication is again obtained, the tube shall be rejected as inoperable.

4.7.4 Shorts in filamentary-type tubes. Filament suspension of filamentary-type tubes which are intended for operation from dry batteries shall be of such design that when the filament opens, a short circuit between the filament and any element carrying "B" voltage shall not result. The following test will be con-

ducted as a qualification test on all such tubes: Raise Ef until the filament opens. Test for shorts from the filament to elements carrying B+ voltage. If a short circuit is indicated and passes in excess of five times the rated filament current without burning out the short circuit, the tube will be deemed a failure. This test will be performed at a Government laboratory on three tubes which shall be in addition to the number required for qualification-test samples. Manufacturer's data are not required for this test.

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4.7.5 Continuity and short tests (for reliable tubes). All reliable tubes shall be tested for continuity of all the circuits, including duplicate-pin connections to the same electrode, for shorts between any of the tube elements or between the elements and the no-connection base pins; and for air leaks. The mallet used for tapping during this test shall be a 1/8-inch diameter fiber rod inserted and glued into the small end of a No. 8 high-quality cork 1 1/16 inches long and having a large diameter of 7/8 inch and a small diameter of 1 1/16 inch. The overall length of rod and cork shall be 6 inches. Other approved equivalent devices may be used. The tubes to be tested for continuity and shorts shall be preheated for 5 minutes with operation voltages or rated heater voltage only applied. The tubes shall be tapped with a stroke of approximately 2 inches at least three times in each of two planes 90° apart. An indicating device with a minimum peak sensitivity of 50,000 ohms shall be used. Tubes which give indication of one or more of the following shall be rejected:

- (a) Either a permanent or a tap short at any time during the tapping procedure.
- (b) Any open circuit.
- (c) Air leaks.

Any tube which shows a grid current of 1.0 uAdc or twice the maximum limit for grid current, whichever is greater, shall be considered as inoperable.

4.7.6 Air leaks. Tubes shall be tested for air leaks by the generally accepted methods of

air-leak detection. In those cases where such methods cannot be applied, either of the following criteria shall be applied:

- (a) Grid current is 1 microampere or is twice the maximum limit, whichever is greater. In those cases in which there is a different maximum limit after life tests, ^{Amult's PQ} that limit shall be used in judging ^(during the life test) an air-leak defect that occurs during life tests.

- (b) In the case of vacuum diodes, ionized gas appears in space outside the anode (not to be confused with bulb fluorescence).

See
Amult's → 4-77, 4-78
PQ, 10-11

4.8 Insulation of electrodes. This test shall be conducted as a special-design test. Test each control grid to all other elements tied and test each plate to all other elements tied. The value of the insulation resistance, measured with the applied potential specified in 4.8.1, 4.8.2, and 4.8.3, as applicable, shall be not less than 10 megohms. This test shall be performed, with the filament energized, immediately after the other specified electrical tests are concluded. This test shall not be made, however, on tubes such as gas-filled tubes, cathode-ray tubes, and magnetrons, which by their nature render the test impractical. The test shall not be made on tubes whose rated anode potential exceeds 750 Vdc, nor on rectifier tubes whose maximum rms test voltage per plate exceeds 750 Vac.

4.8.1 *Receiving tubes with maximum plate potential rating greater than 300 Vdc.* Receiving tubes with maximum plate potential rating greater than 300 Vdc or rectifiers whose maximum rms test voltage per plate exceeds 300 Vac shall be tested with a negative potential of at least 500 Vdc, when measuring insulation resistance from plate to all other elements tied. The applied potential shall be not less than — 300 Vdc when measuring insulation resistance from each control grid to all other elements tied.

4.8.2 *Receiving tubes with maximum plate potential rating of 300 Vdc or less.* Receiving tubes with a maximum plate potential rating

less than 300 Vdc, except those intended for dry-battery operation, or rectifiers whose maximum rms test voltage per plate is less than 300 Vac, shall be tested with a negative potential of at least 300 Vdc when measuring insulation resistance from plate to all other elements tied. However, the applied potential shall be a negative voltage of at least 100 Vdc when measuring insulation resistance from each control grid to all other elements tied.

4.8.3 *Receiving tubes intended for dry-battery operation.* Receiving tubes intended for dry-battery operation shall be tested with a negative potential of 100 Vdc.

4.9 Mechanical tests. The following tests are not listed on the tube specification sheets, but they shall be performed on all tube types unless the design and construction of the tube makes the test inapplicable:

Test	Paragraph
Mechanical-production tests	4.9.1
Mechanical-production tests (for reliable subminiature tubes) . .	4.9.1.1
Dimensions	4.9.2
Brass or bronze sleeve base	4.9.3
Insulating quality of base material	4.9.4
Base, cap, and insert secureness . .	4.9.5
Salt spray (corrosion)	4.9.8
Permanence of marking	4.9.21

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P II

The manufacturer shall correct all deviations from this specification pointed out by the Government. The tests, other than those listed above, in 4.9.1 to 4.9.21, inclusive, shall be performed when so indicated on the tube specification sheet.

4.9.1 *Mechanical-production tests.* Tubes shall be subjected to visual and mechanical inspection for appearance, workmanship, and production dimension tests. These tests shall be classified as production tests, and shall be conducted at inspection level I of Standard MIL-STD-105 with the following AQL values:

Type of defect	AQL
Major 1	1. percent (combined defectives)

Type of defect	AQL
Major 2	1 percent (each defect)
Minor	2.5 percent (combined defectives)
Control	6.5 percent (each defect)

Production-dimension test defects shall be classified as major 1 defects. The degree of defects for mechanical-production tests (i.e., major 1, major 2, minor, or control) is indicated in the classification of defects in Appendix B. Individual tubes shall not be rejected for control defects; however, if an AQL of 6.5 percent for such defects in any lot is exceeded, the lot shall be rejected.

4.9.1.1 *Mechanical-production tests (for reliable subminiature tubes)*. Tubes shall be subjected to visual and mechanical inspection for appearance, workmanship, and dimensions. These tests shall be classified as production tests and shall be conducted at inspection level I of Standard MIL-STD-105 with the following AQL values:

Type of defect	AQL
Major 1	0.4 percent (combined defectives)
Major 2	0.4 percent (each defect)
Minor	2.5 percent (combined defectives)
Control	6.5 percent (each defect)

Inspection shall be made using 10-power magnification for the defects as specified in Appendix B.

4.9.2 *Dimensions*. Each tube shall be inspected for conformance as to size, shape, and finish according to the applicable drawing specified on the tube specification sheet. The dimensions, except those for cathode-ray tubes, shall be checked on a qualification-, design-, or production-test basis, as specified on the tube specification sheet or on the outline drawing.

4.9.2.1 *Dimensions (for cathode-ray tubes)*.

All dimensions with tolerances, maximums, and minimums shall be standard design-test measurements. All dimensions without tolerances are nominal, and shall be qualification measurements.

4.9.3 *Base sleeves*. Three samples from each lot or shipment of brass, bronze or stainless steel base sleeves used in fabricating tubes shall be tested. The degreased, unplated brass or bronze base sleeve shall be crimped to a base wafer (insert) and immersed in a 1-percent aqueous solution of mercurous nitrate to which has been added 3 milli-liters of nitric acid (sp gr 1.42) per liter. After 15 minutes immersion, the samples shall be removed from the solution, washed, wiped dry, and inspected for cracks in the brass or bronze sleeve. Any evidence of cracking shall be considered a failure and the lot of brass or bronze base sleeves shall be rejected. Plated brass or bronze base sleeves shall be tested in the same manner after first removing the plating with acid. If stainless steel is used, the salt-spray (corrosion) test specified in 4.9.8 shall be substituted for the acid test.

4.9.4 *Insulating quality of base material*. This test shall be a qualification test and shall be performed on 8-pin intermediate-shell octal bases submitted by the base molder. The test shall be made at a frequency of 100 Mc. The equivalent parallel resistance of the base coupled to the adapter shown on figure 25 shall be measured and assigned zones, as follows:

Zone number	Resistance range (ohms)
1	0 to 5,500
2	5,500 to 8,500
3	8,500 to 10,000
4	10,000 to 12,500
5	12,500 to 15,000
6	15,000 to 20,000
7	20,000 to 25,000
8	25,000 to 32,500
9	32,500 to 40,000
10	40,000 to 50,000
11	50,000 to 75,000
12	75,000 to 100,000

Zone number	Resistance range (ohms)
13	100,000 to 150,000
14	150,000 to 250,000
15	250,000 to ∞

The measurement shall be taken on each base after 48 hours immersion in distilled water at 50° C, followed by 2 to 5 minutes drying in an air blast. The base material shall have a zone equal to or greater than that specified on the tube specification sheet. If no zone is indicated, the following is required for the material specified:

Material	Zone number
Ceramic	13 or higher
Low-loss phenolic....	11 or higher
Other phenolics	5 or higher

For tube types, other than receiving tubes, requiring ceramic bases or inserts, grade ~~I-4~~^{L-41} insulating material as specified in Specification ~~JAN-I-10~~^{JAN-I-10} shall be used.

4.9.4.1 Arc resistance. Tube bases fabricated from plastic material with noncarbonizing properties shall be molded from plastic conforming to type MAG of Specification MIL-M-14 furnished by qualified suppliers. The base material shall have an insulating quality of zone 5 or higher when measured as specified in 4.9.4. The arc-resistance test specified in method 4011.2 of Specification L-P-406 shall be used in testing the plastic material for noncarbonizing qualities.

4.9.5 Base, cap, and insert secureness. Assembled tubes with bases or caps shall be tested for secureness of bases, caps, and in-

serts by gradually applying torque or pull of the amount specified in table I and between the elements specified in table II. When immersion is required in table II (except for receiving tube bases), the tubes shall be immersed in water at a temperature of 50° C for 18 hours, and then removed and cooled for 1 hour at room temperature. For receiving tubes when base immersion is required in table II, the tubes shall be immersed in water at a temperature of 50° C for 42 hours or in boiling water for 6 hours and then removed and cooled for 1 hour at room temperature. After the immersion test there shall be no loosening of cemented joints and no loosening by more than $\frac{1}{32}$ -inch movement of non-cemented mechanical joints. This test shall be conducted as a standard-design test.

4.9.5.1 Base pin solder depth (rigid leads).

Receiving-type tubes constructed with a wafer header and rigid leads shall be submitted to a test to determine depth of solder contact within the base pins. This test shall be made by sectioning soldered joints of scrap tubes or by use of x-ray techniques. Tubes shall be rejected if the depth of soldered contacts within the base pins is less than $\frac{1}{16}$ inch. On these tubes it shall be determined that the bulb has been cemented to the base. This test shall be conducted as a standard-design test.

4.9.5.2 Wafer-base pull. Fabricated tubes shall have a total force of 60 pounds applied to all pins simultaneously in a direction away from the tube and parallel to the axis. The wafer shall not be loosened from the metal shell.

TABLE I. Torque or pull to be applied to bases and caps.

Base or cap size	Torque	Pull
	<i>Inch-pounds</i>	<i>Pounds</i>
Bases 0.65 inch or less	12	_____
Bases having a maximum overall diameter of 0.65 to 1.5 inches	20	_____
Bases larger than 1.5 inches	40	_____
Locktal or lock-in bases	_____	35
Medium, small, or miniature caps	1.5	_____
Large caps (including caps of cathode-ray tubes)	3	_____

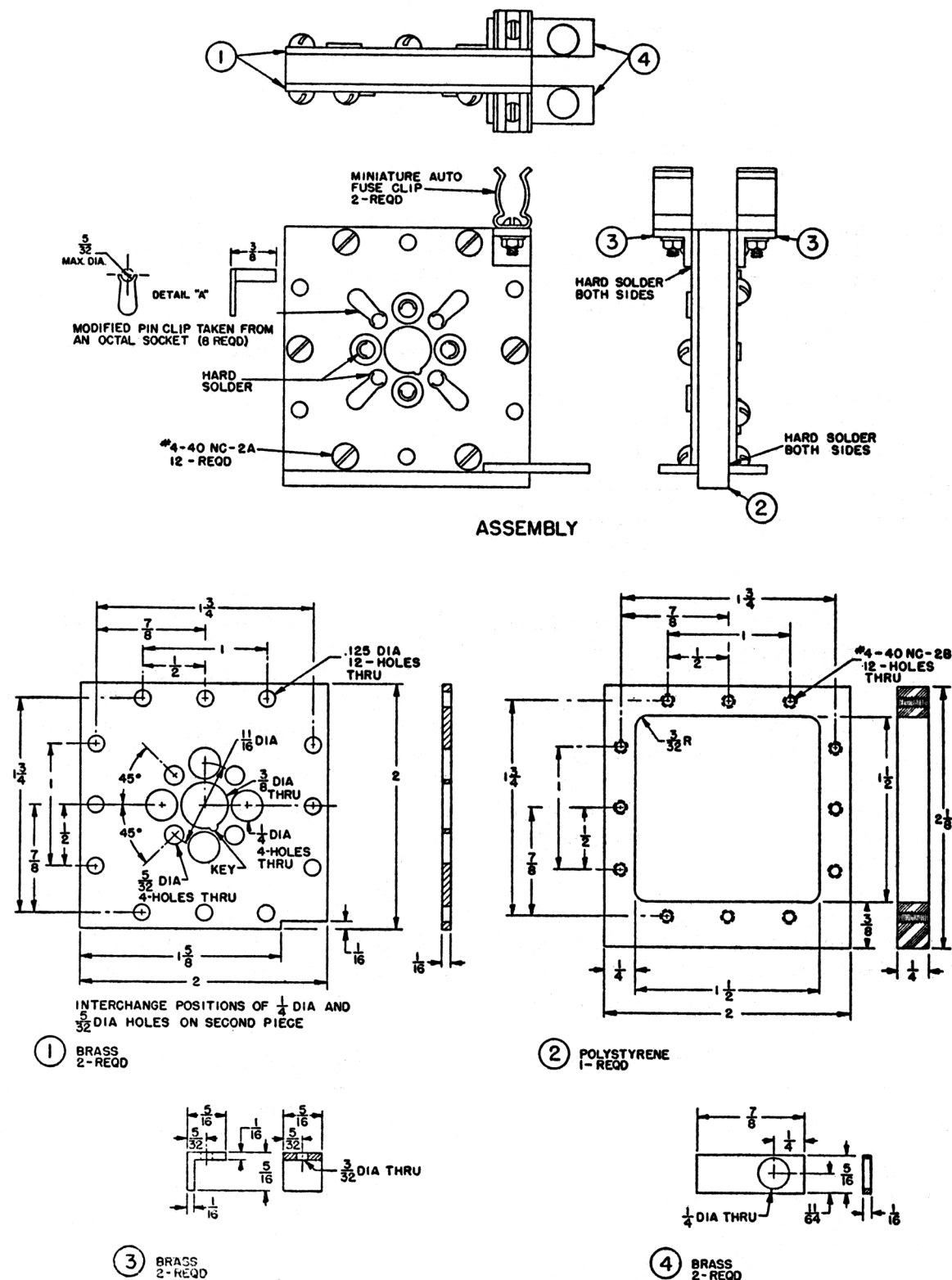


FIGURE 25. Adapter for octal tube bases.

TABLE II. *Immersion requirements and torque elements.*

Design	Immersion	Torque elements
Base, pin mount, and shell integral	Required	Base and bulb, or pins (and guide lug) and bulb
Base, wafer insert	Required	Pins (and guide lug) and bulb, or insert and bulb
Base, phenolic wafer insert metal tubes	Not required	Pins (and guide lug) and shell
Base, ceramic insert metal tubes	Not required	Pins (and guide lug) and shell
Base, wafer only	Not required	As specified on the tube specification sheet
Locktal or lock-in bases	Required	Pull between bulb and base
Cap, cemented	Required	Cap and bulb
Caps, metal tube ¹	Not required	Cap and shell

¹ Total movement of 22½° permitted.

4.9.5.3 Subminiature lead fatigue. This test shall be conducted as a special-design test. Two leads per tube shall be tested. The leads shall be selected in a cyclical manner (regular recurring), for example, leads No. 1 and 2 on the first tube, leads No. 2 and 3 on the second tube, etc. The lead-fatigue test shall be made by subjecting each lead under test to a pull of 16 ± 1 ounces. Each lead shall withstand the minimum number, as specified on the tube specification sheet, of 90° arcs at the glass header. An arc is defined as the movement of the lead away from the tube through 90° from normal and back to normal. A lead shall be considered to have failed at the time it breaks off from the tube. Acceptance or rejection of the lot shall be based on the number of tubes defective. A tube having one or more defective leads shall be considered a defective tube. This test is a destructive test. Electrical rejects may be used in the performance of this test.

4.9.6 Glass strain.

4.9.6.1 Miniature-tube base-strain. The miniature-tube base-strain test shall be performed on a sampling basis. See Appendix C for acceptance sampling procedure. ~~The test shall be performed within approximately 1 hour after the exhaust operation during manufacture.~~ The container for the boiling water

shall be sufficiently large so that, while the test is being made, no tube is closer than ¾ inch to the retaining wall of the vessel. The container shall have a minimum capacity of 2 liters per 15 tubes, and shall be at least three-quarters full for every strain test. This is to insure an approximately uniform temperature gradient for all tubes in the test. The holders, for the simultaneous testing of at least one-half of the tubes in the sample at one time, shall have sufficient spacing between the pins of adjacent tubes so that the tubes do not come in contact with each other. A minimum of six holes ⅜ inch in diameter shall be drilled in the plate of each holder. Prior to testing, all tubes shall be submitted to pin-straightening procedure. Align the axis of the tube with the axis of the deflection cone in accordance with Drawing 200-JAN, and carefully push the small end of the cone into the circle formed by the pins until the cone lies firmly against the tube bottom. Place the holder of tubes into boiling water at 97° to 100° C so that the tubes attached to cones are completely submerged in the water for a period of 10 seconds. After the 10-second submerging period, remove from the water, place on a wooden support, and allow to cool at room temperature. Tubes shall then be examined for class of strain-test defects. If observation, after removal of the cones, shows some pins bent more than others, the test is being made improperly.

Defects are:

Group	Defect
A	Bulb or tip cracks, or both
B	Button cracks
C	Seal cracks

A tube which shows one or more of these defects shall be a defective tube for this test.

4.9.6.2 Glass envelope strain. The glass bulb, but not the base, of the tube shall be immersed in water at not less than 97° C for 15 seconds, and immediately thereafter immersed in water at not more than 5° C for 5 seconds. The volume of water shall be large enough to be appreciably unaffected in temperature by this test. The glass bulb shall not crack or break. For all-glass type tubes, the entire tube shall be immersed.

4.9.6.3 Glass strain (for ^{miniature and subminiature} receiving tubes). All tubes submitted to this test shall have been sealed a minimum of 48 hours prior to conducting this test. All tubes shall be at room temperature. The entire tube shall be immersed in water at not less than 97° C for 15 seconds, and immediately thereafter immersed in water at not more than 5° C for 5 seconds. The volume of water shall be large enough so that the water temperature will not be appreciably affected by the test. The method of submersion for miniature and subminiature tubes shall be in accordance with Drawing 245-JAN and such that the minimum of heat is conducted away by the holder used. The tubes shall be placed in the water so that no contact is made with the containing vessel, nor shall the tubes contact each other. After the 5-second submersion period, the tubes shall be removed and allowed to cool at room temperature on a wooden surface. After drying at room temperature for a period of 48 hours, the tubes shall be inspected for evidence of air leaks. (See 4.7.6.) Electrical rejects other than inoperatives may be used in the performance of this test.

4.9.7 Moisture-vaporproof barrier pack. When a moisture-vaporproof barrier pack is specified in the appendix (tube-type-number list) of Specification MIL-P-75, the tubes

shall be packed in a moisture-vaporproof barrier as specified in Specification MIL-P-75, and shall then be subjected to the salt-spray (corrosion) and humidity tests as specified in 4.9.8 and 4.9.9, respectively, in lieu of those tests on the tube alone.

4.9.8 Salt spray (corrosion). The tubes shall be tested in accordance with method 101, test condition A, of Standard MIL-STD-202. After the test the tubes shall be examined to determine whether the corrosion-resistance is equal to that of similar type tubes. This is a qualification test.

4.9.9 Humidity. The tubes shall be subjected to an atmosphere of 95 to 100 percent relative humidity at a temperature of 95° to 100° C for a period of 96 hours. These conditions may be met by exposing the tubes in close proximity to a water bath heated to 95° to 100° C. The tubes shall not show mechanical failures, harmful corrosion, loss of plating, paint, etc., or any other defect or deterioration which may interfere with their operation. When called for on the tube specification sheet this test shall be conducted as a periodic-check test.

4.9.9.1 Moisture resistance. The tubes shall be tested in accordance with method 106 of Standard MIL-STD-202. After the holding period of 24 hours at room ambient conditions, electrical measurements as specified on the tube specification sheet shall be made.

4.9.10 Temperature cycling. The tubes shall be subjected to the number of temperature cycles specified on the tube specification sheet. Low temperature shall be -65° C or lower; high temperature shall be 85° C or higher. Tubes shall be maintained at each end temperature for sufficient time to reach equilibrium, but for not less than 5 minutes. Changes in temperature from end point to end point shall be gradual, but the cycle shall not exceed 30 minutes in time. At the manufacturer's option, the tubes may be taken immediately from an oven to cold box or vice versa. The test may be started at any point in the cycle.

A cycle is defined as a series including both end-point temperatures and return. For example, room temperature to -65°C to 85°C to room temperature.

4.9.11 Pressure. The completed tubes shall withstand 45 pounds per square inch absolute pressure for a period of at least 60 seconds. This pressure shall be attained within 60 seconds.

4.9.12 Low pressure. The tubes shall be tested under the conditions specified in a chamber evacuated to a pressure not exceeding 70 mm Hg absolute. The tubes shall operate satisfactorily, shall not change in frequency, and shall not exceed the limits specified. In addition, there shall be no arc-overs or harmful coronas exhibited, nor shall there be any other defect or deterioration which may interfere with the operation of the tubes.

4.9.12.1 Low-pressure voltage breakdown. The tubes shall be tested in a chamber under the conditions of pressure specified on the tube specification sheet. The specified voltage shall be applied between the base pins (or leads) of the elements carrying B+ voltage and their adjacent pins (or leads). Voltage shall be of sinusoidal waveform with $F = 60$ cycles. Tubes showing evidence of corona or arcing shall be considered defective.

*See
Amlic 3 → 4.9.12-2
P12*
4.9.13 Pressurizing. The tubes shall be hermetically tight after the parts noted in the outline drawing on the tube specification sheet have been gasketed as specified to a pressure chamber for 1 minute at the specified air pressure. This test may be eliminated if the particular design renders it meaningless, and it is so recorded on the qualification report.

4.9.14 Temperature coefficient. The temperature coefficient, $\Delta F/^{\circ}\text{C}$, shall be determined from the average of three tests over any 30°C temperature range. Conditions shall be as specified on the tube specification sheet. The temperature shall be that of the frequency-determining element.

4.9.15 Temperature operation.¹

4.9.15.1 Low-temperature operation.¹ The tubes shall operate under the conditions specified on the tube specification sheet, following the specified warmup time at an initial ambient temperature of -65°C .

4.9.15.2 High-temperature operation.¹ The tubes shall operate at the ambient temperature and under the conditions specified on the tube specification sheet.

4.9.16 Bulb temperature.¹ When a measurement of bulb temperature is required, the hot spot shall be located as specified in 4.9.16.1 and the temperature measured as specified in either 4.9.16.2 or 4.9.16.3. The method to be used shall be specified on the tube specification sheet. Where the use of thermocouples may not be practical because of high voltage or stray rf power, a temperature-sensitive paint or lacquer may be used.

4.9.16.1 Hot-spot location. For each tube type the hottest point on the tube envelope shall be determined using a temperature lacquer (Tempilaq or equivalent) with melting point not more than 5°C less than the maximum permissible bulb temperature for the type. The tube shall be placed in an oven, as described on Drawing 262-JAN, and, with the specified test conditions applied, the oven temperature shall be raised until the lacquer just begins to melt locally. The central point of the melted area shall be taken as the location of the hottest point.

4.9.16.2 Temperature by loop-thermocouple measurement. A loop-thermocouple device of the following specifications shall be used for measuring bulb temperature: A length of wire of type 304 or 302, spring temper, stainless steel, diameter 0.004 inch, roughly equal to the perimeter of the tube envelope in the cross-sectional zone containing the hottest

¹ References to 4.9.15 and 4.9.16 on tube specification sheets dated prior to the approval date of this specification shall refer to 4.9.15.1 and 4.9.15.2, respectively, of this specification.

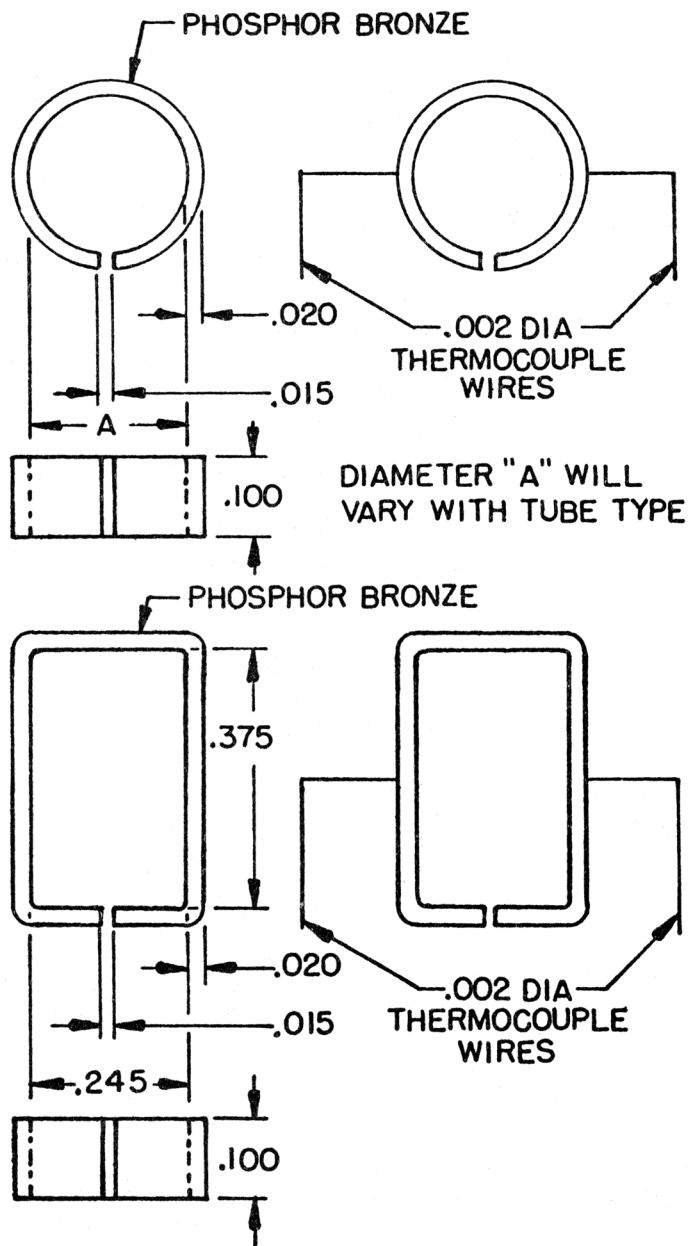


FIGURE 26. Typical conduction band temperature measurement rings.

point, shall be formed into a loop by spot welding the ends together; at approximately one-fourth the length of the loop from the weld, a V-shaped kink shall be made at right angles to the plane of the loop to insure spring-tightness of the loop on the envelope; at approximately one-half the length of the loop from the kink, the junction of a No. 40 Brown and Sharp, or equal, gage thermocouple of chromel and alumel shall be spot-welded to the inside of the loop. The junction of the thermocouple shall be calibrated to within $\pm 0.5^\circ \text{C}$. The loop-thermocouple shall be placed on the tube envelope so that the junction is in direct contact with the hottest point. (See 4.9.16.1.) The tube, with the thermocouple in position, shall be placed in the oven described on Drawing 262-JAN. The cold junctions of the oven thermocouple and the loop-thermocouple shall be immersed in a melting ice bath, or a cold junction compensated potentiometer may be used provided the necessary accuracy is obtained. All voltages shall be read with a potentiometer with a sensitivity of at least 0.02 millivolt (or 0.5°C , if direct reading). With the oven at the specified temperature and with the specified conditions applied to the tube, the bulb temperature shall be read.

4.9.16.3 Temperature by conduction-band measurements. Envelope temperature measurements shall be made by use of thermocouple wires welded to opposite sides of a split phosphor bronze ring in good thermal contact with the envelope. The dimensions of the ring shall be as shown on figure 26 or such that equivalent envelope contact is made. Unless otherwise specified, the ring shall be located at the hottest spot on the envelope. (See 4.9.16.1.) At the temperature specified on the tube specification sheet and with the specified conditions applied to the tube, the bulb temperature shall be read.

4.9.17 Mechanical fatigue. The tube shall withstand the specified number of coarse or vernier tuning cycles, or both, without failure, undue wear, or any other deterioration which might render the tube unsuitable for use by

the Armed Services. The movement of the mechanism shall be over a range corresponding to the frequency range specified. This test may be made on a non-operating tube.

4.9.18 Container drop. The tube shall be packaged and packed in the type of container and in the manner specified in Specification MIL-P-75. The packaged tube shall then be dropped onto a rigid horizontal surface four times; once each on the top and bottom and once on each of two adjacent sides of the container. The height of the drop test shall be 3 feet unless otherwise specified in Specification MIL-P-75. Tubes used for this test shall have met all the requirements of this specification prior to this test. Following this test the tubes shall comply with the applicable portion of 4.9.18.1 and shall pass those tests required on the tube specification sheet to be performed after the drop test. This test shall be performed three times a year in accordance with table III. (Container-Drop Sampling Plan.)

4.9.18.1 Container-drop compliance. The acceptance criteria shall be in accordance with table III. For all tube types, inoperable tubes are defined as those tubes that will not function because of shorts without tapping, open connections, no electron emission in tubes requiring electron emission, broken envelopes, loose metallic components, bases or caps that are loose without application of torque, and pins or caps so distorted that the base or cap will not function with complementary circuit components or will not pass applicable gages. For receiving-type tubes and for other types which require a tap-shorts test, tubes that show short indication on every tap of the tap-shorts test are also inoperable tubes.

4.9.18.1.1 Receiving tubes. Receiving tubes which have been subjected to the container-drop test shall be within the limits of the tests for heater-cathode insulation, plate current, cutoff, and the following when specified as production tests: Power output, transconductance, plate resistance, ac amplification, and conversion transconductance.

TABLE III. Container drop sampling plan.

Domestic container tube content	Number of containers dropped	Number of tubes dropped	Acceptance number (Inoperatives only)	Acceptance number (Inoperatives plus electrical defects)
200	1	200	5	19
100	1	100	3	11
50	2	100	3	11
48	2	96	3	11
36	3	108	3	11
32	3	96	3	11
25	¹ 4 (1)	¹ 100 (25)	¹ 3 (1)	¹ 11 (3)
18	1	18	1	2
16	1	16	1	2
8	1	8	0	1
6	1	6	0	1
4	2	8	0	1
1	5	5	0	1

¹ Figures in parentheses represent all alternate plans to be used for other than receiving tubes.

4.9.18.1.2 *Cathode-ray tubes.* After the container-drop test, cathode-ray tubes shall be subjected to the following tests and shall meet the requirements specified.

- (a) The change in position of the undeflected focused spot from its position noted before the test shall not exceed the following values:

Tube face diameter (inches)	Change (mm)
1	1.5
2	3
3	3
4	4
5	4
7	5
9	6
10	6
12 and over	8

- (b) The change in deflection factor for electrostatic tube types shall not exceed 5 percent.
- (c) Starting with a tube with no loose particles, the maximum number of loose particles as a result of dropping shall be no more than a total of five loose particles greater than $\frac{1}{64}$ inch in any one cathode-ray tube. Tubes having any loose particles greater than $\frac{1}{64}$ inch shall be

vibrated with the face down in a horizontal plane at 5 G for 1 minute. If the screen shows damage from such vibration, the tubes shall be rejected.

- (d) The change in grid cutoff voltage shall not exceed 10 percent.
- (e) There shall be no damage to the external parts of the tube.

4.9.18.1.3 *Rectifiers.* Rectifiers which have been subjected to the container-drop test shall be within the limits of the operation and heater-cathode insulation tests. Gas rectifiers shall be subjected to these tests 24 hours after the container-drop test has been performed.

4.9.18.1.4 *Voltage regulators.* Voltage regulators which have been subjected to the container-drop test shall be within the limits of the ionization-voltage test. Only those ionization tests which are production tests shall be made.

4.9.18.1.5 *Klystrons.* Klystrons which have been subjected to the container-drop test shall be tested for controlling-electrode voltage, power output, and tuning range. After the container-drop test, the controlling-electrode voltage and power output shall not have

changed from their initial values by more than the amount specified. The tubes shall pass the frequency-range test specified on the tube specification sheet. Tubes using an external cavity shall operate within the frequency specified.

4.9.18.1.6 *Thyratrons.*

4.9.18.1.6.1 *Thyratrons (excluding hydrogen thyratrons).* Thyratrons, after the container-drop test, shall pass the anode-voltage, grid-voltage and operation tests when these tests are specified on the tube specification sheet. These tests shall be made 24 hours after the container-drop test has been made.

4.9.18.1.6.2 *Hydrogen thyratrons.* Hydrogen thyratrons, after the container-drop test, shall pass the time jitter and operation (1) tests when these tests are specified on the tube specification sheet. These tests shall be made 24 hours after the container-drop test has been made.

4.9.18.1.7 *Transmitting tubes.* After the container-drop test, transmitting tubes shall pass the plate-current, cutoff, and operation tests when these tests are specified on the tube specification sheet.

4.9.18.1.8 *Magnetrons.*¹ After the container-drop test, magnetrons shall pass the initial test requirements for pulse voltage, stability, frequency, and bandwidth. These tests shall be performed under the oscillation conditions for these parameters specified in life-test end points.

4.9.18.1.9 *Gas switching tubes.*¹ After the container-drop test, TR tubes shall pass the initial acceptance limits for the ignitor voltage test specified. After the container-drop test, pre-TR and ATR tubes shall pass the initial acceptance limits for the firing time test specified.

4.9.18.1.10 *Other classes of tubes.*¹ All other classes of tubes which have been sub-

¹References to 4.9.18.1.8 on tube specification sheets dated prior to the approval date of this specification shall refer to 4.9.18.1.8, 4.9.18.1.9, or 4.9.18.1.10 (as applicable) in this specification.

jected to the container-drop test shall meet the initial acceptance limits of the production tests as specified on the tube specification sheet.

4.9.19 *Vibration and bump tests.*

4.9.19.1 *Low-frequency vibration.* The tube shall be rigidly mounted on a table vibrating with simple harmonic motion at a frequency of 25 ± 2 cps with a fixed amplitude of 0.040 ± 0.0025 inch (total excursion of 0.080 ± 0.005 inch). Each tube shall be vibrated in positions X1 and X2, except that if the cumulative result of tests on 50 or more tubes of a construction shows that more than 75 percent of the tubes have higher output voltages in one position, subsequent measurements shall be taken only in the position giving the higher readings. The voltages specified on the tube specification sheet shall be applied to the tube during vibration. The value E_b under test conditions shall be regarded as E_{bb} and shall be applied to the tube through the specified resistor (R_p). The impedances of plate and screen voltage supplies shall not exceed that of a 40 uf capacitor at 10 cps. (Preheating of the tube at these voltages is permissible.) The value of the alternating voltage (E_p) produced across the resistor (R_p) as a result of vibration shall be measured with a suitable device. This device shall have an appropriate voltage range and shall have the ability to measure, with an error of less than 10 percent, the rms value of a sine wave of voltage at all frequencies from 20 to 5,000 cps. Thermal or VU meters may be used provided the shunting effect on the plate load does not result in error greater than the 10 percent allowed above. Unless otherwise specified, each tube shall be vibrated for a time necessary to obtain a stable reading of output voltage or for a maximum period of 30 seconds in any one position. The stable reading shall not exceed that specified on the tube specification sheet. However, if at the end of 30 seconds, the average value of the meter reading exceeds 50 percent of the maximum specified voltage and is increasing, the tube shall be vibrated for a total time of 3

minutes, and the tube rejected if the average value of the meter reading at the end of this period exceeds the maximum specified voltage. When this test is conducted and no measurement is made of output voltage, each tube shall be vibrated for 60 seconds each in positions X1 and X2. This test shall not result in tap or permanent shorts or defects which will cause the tube to be inoperable.

4.9.19.2 High-frequency vibration. This test shall be conducted as specified in 4.9.19.1, except that the frequency of the vibrating table shall be 50 ± 2 cps.

4.9.19.3 Bump. Each tube shall be mounted in a vertical position in the standard bump-test equipment shown on Drawing 123-JAN. No electrical potentials shall be applied to the tube during this test. The hammer arm shall be released from the specified angle and allowed to strike the glass envelope one blow at an angle of 45° to the plane of the press seal. The hammer shall strike the tube in such position that free pendulum motion is obtained without excessive wobble. This test shall be performed three times. Subsequent to this test, the tube shall comply with all applicable mechanical requirements and meet the limits of all tests specified on the tube specification sheet.

4.9.19.4 Bump and short. Each tube shall be tested as specified in 4.9.19.3, and, in addition, suitable indicating potentials shall be applied to the various electrode combinations through a short-indicating device. There shall be no shorts, momentary or permanent, between the elements during this test.

4.9.19.5 Operation bump. The tube shall be mounted as shown on the tube specification sheet, under specified test conditions. This test shall be made with a pendulum consisting of a steel ball $\frac{5}{8}$ inch in diameter suspended by a wire 0.02 inch in diameter, with the distance between the point of suspension and the center of the ball $4\frac{1}{4}$ inches, or with an equivalent pendulum. The ball shall be suspended so that when at rest it touches the

tube at approximately one-half the distance between the extreme limits of the tube projecting above the socket. In this position, the point of suspension of the ball shall be directly above the center of the ball. The ball shall be permitted to swing freely through an arc of 60° in a plane through the axis of the tube and from such an angle that the ball strikes only the tube envelope. After striking the tube with the ball in accordance with the test, the power output or the frequency, or both if specified, shall not change by more than the amounts indicated. The tube shall be considered to have met the test satisfactorily if, after testing in this manner three times, the tube does not fail on any test and if, during this test, the quantity measured does not at any time show a nontransient change of more than the specified amount from the original value.

4.9.19.6 Operation vibration. The tube shall be vibrated in accordance with 4.9.19.1, with the specified operating conditions applied. A test load shall be arranged to pick up some power output from the tube. If the load is not vibrated with the tube, it shall be arranged so that the frequency pulling of the tube is negligible compared to the variation in frequency due to the vibration of the tube. The total radio-frequency spectrum, including any permanent change in frequency, shall not exceed the limit specified on the tube specification sheet. For klystrons, the test load, as seen by the tube, shall be as specified on the tube specification sheet. Spectrum bandwidth determination shall be made during the test, with the operating conditions held unchanged.

4.9.19.7 Nonoperation vibration. The tube shall be vibrated at the specified frequency and acceleration in accordance with 4.9.19.2. The conditions of operation before and after vibration, including the adjustment of the tuner mechanism and reflector voltage, shall remain unchanged. The difference between the oscillation frequencies before and after vibration shall not exceed the limit specified.

4.9.19.8 Cathode-ray vibration. Electrostatic deflection types shall be vibrated in posi-

tions X1 and X2. Magnetic-deflection types shall be vibrated in planes normal to their axes successively in two directions mutually at right angles. Each tube shall withstand, without damage; simple harmonic vibration, at an amplitude of $0.040 \pm .0025$ inch (0.080 ± 0.005 inch total excursion), at a frequency of 25 ± 2 cps for 60 seconds and at a frequency of 50 ± 2 cps for 300 seconds, in each direction. A circular trace shall be presented on the screen and the increase in line width due to relative motion of tube parts when vibrated at 25 ± 2 cps and 50 ± 2 cps shall be measured.

4.9.19.9 etc

4.9.20 Mechanical tests (for ruggedized tubes).

4.9.20.1 Order of all tests. Tests may be conducted in any order except that vibration and shock tests shall be conducted after electrical characteristics are measured, and that grid-current and emission tests shall be conducted in the order listed on the tube specification sheet. The tests in 4.9.19.1 to 4.9.19.7, inclusive, when specified on the tube specification sheet, shall be conducted in the order listed. Shock, fatigue, drop, and life tests shall be conducted on different tubes.

4.9.20.2 Electrical characteristics measured before and after shock or fatigue. Tubes subjected to shock or fatigue testing shall conform to the initial limits specified for all characteristics which are required as criteria for post-shock or post-fatigue acceptability. After the shock or fatigue test specified in 4.9.20.5 and 4.9.20.6, respectively, the tubes shall comply with the post-shock or post-fatigue limits specified.

4.9.20.3 Variable frequency vibration. This test shall be a qualification test. The tubes shall be vibrated under the conditions specified in 4.9.19.1 and position Y1 shall be added. The tubes shall be vibrated in each of the three positions through the frequency range from 10 to 50 cps and back to 10 cps. The time for gradually covering the range from 10 to 50 cps shall be 3 to 15 minutes. Each

and back to 10 cps

tube shall be vibrated for 60 seconds at the frequency which gives the maximum vibrations output voltage in each of the three positions. If at the end of the 60 seconds the vibrations output is increasing, the vibration shall be continued until there is no further increase. The tubes shall not show vibrational output in excess of the maximum limit specified. This test shall not result in tap or permanent interelectrode shorts or defects which cause the tube to be inoperable.

4.9.20.4 Low-frequency vibration (see 4.9.19.1).

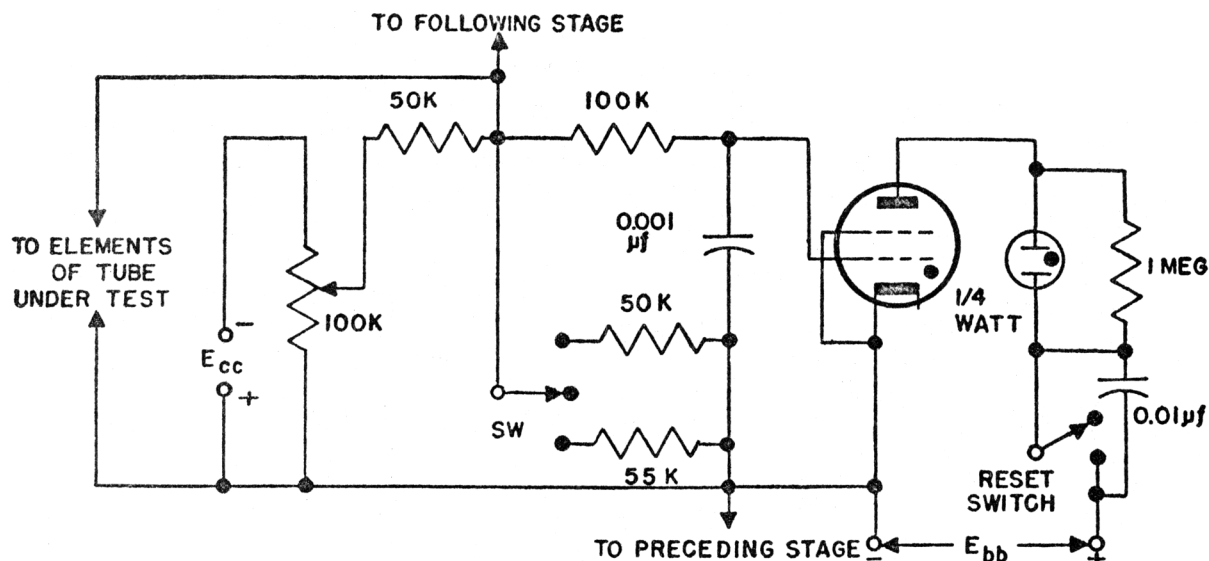
4.9.20.5 Shock test. The shock test shall be conducted on the Navy type, high-impact (flyweight) shock machine for electronic devices, or its equivalent. (See Drawing 180-JAN.) The standard steel hammer shall be used. The shock machine shall be so adjusted that the hammer at rest just contacts the anvil of the shock table. Each tube shall be subjected to a total of 20 hammer blows of the specified angular displacement; that is, five blows in each of the positions X1, X2, Y1, and Y2, in any sequence. The tube shall be mounted in the clamp, as specified:

Size of tube	Drawing No.
Miniatures	184-JAN
Subminiatures	184-JAN
T-9 and larger	216-JAN

On subminiature tubes the leads may be clipped. The tubes shall be tested under one of the following conditions:

- With the voltages which are specified on the tube specification sheet applied to the tube.
- With a thyatron-controlled, short-circuit indicator with the circuit constants as shown on figure 27, or its equivalent, connected to indicate interelectrode shorts. Tubes shall have rated filament or heater voltage applied.

When the shock test is specified as a basis for lot acceptance, lots shall be acceptable if sample tubes comply with the shock-test samp-



E_{cc} SHOULD BE ADJUSTED TO INDICATE A SHORT WITH A 50000 OHM RESISTOR AND TO GIVE NO INDICATION WITH 55000 OHMS. THE FIRING VOLTAGE E_c SHOULD NOT BE OUTSIDE THE RANGE OF 1.0 TO 3.0 VOLTS.

FIGURE 27. Short-circuit indicator.

ling procedure specified in Appendix C. Tubes which show one or more of the following defects shall be considered failures:

- Tubes which show permanent shorts during the shock tests.
- Tubes which show tap or permanent shorts or open circuits following shock tests, when tested as specified in 4.7.2 and 4.7.3 respectively.
- Tubes which do not comply with post-shock limits.

This is a destructive test.

4.9.20.6 Fatigue test. The tubes shall be rigidly mounted on a table vibrating with simple harmonic motion at a frequency of 25 ± 2 cps with an amplitude of 0.040 ± 0.005 inch (total excursion 0.080 ± 0.005 inch) or any equivalent combination of frequency and excursion resulting in 2.5 G applied to the tube under test. The tubes shall be vibrated for a total of 96 hours, 32 hours in each of the three positions, X1, X2, and Y1. Only rated filament or heater voltage shall be applied. Tubes which show one or more of the following defects shall be considered failures:

- Tubes which show permanent or tap shorts or open circuits following fatigue test, when tested as specified in 4.7.2 and 4.7.3, respectively.
- Tubes which do not comply with post-fatigue limits.

This is a destructive test.

4.9.21 Permanence of marking. All tubes shall be marked in a legible and permanent manner on the base, bulb, or shell with the information as specified in 3.7.1 to 3.7.7, inclusive, as applicable. The time for submission of samples for permanence of marking shall be set by the manufacturer. The marking shall be rubbed with a soft chamois held firmly in the hand. Exerting as much pressure as possible, the marking shall be rubbed 12 times. After this test, the marking shall not have worn thin, changed color, become ragged, or lost appreciable gloss. This test shall be conducted as a standard-design test. (See 3.7.)

4.10 General electrical tests. For procedures peculiar to hydrogen thyratron tests see Appendix E.

4.10.1 Emission current.

4.10.1.1 Emission. To avoid damaging the tube under test, the emission voltage shall be applied only for sufficient time to permit the emission to reach the specified minimum value. The duration of the test shall not exceed 5 seconds. When only a minimum current limit is specified, a voltage less than the value specified may be applied provided the required minimum emission current is thus obtained. In qualification testing of receiving tubes, when only a minimum current limit is specified, the test shall be performed by increasing the applied voltage until the specified minimum emission current is obtained and reading the voltage drop across the tube under test.

4.10.1.1.1 Emission at reduced filament voltage. If an emission-current test is specified at reduced filament voltage, this test shall be performed prior to the emission-current test at rated filament voltage. Operate the tube with 90 percent of rated filament voltage only applied. After allowing the cathode temperature to stabilize, apply the emission voltage in the manner specified in 4.10.1.1.

4.10.1.1.2 Emission at rated filament voltage. Operate the tube with rated filament voltage only applied. After allowing the cathode temperature to stabilize, apply the emission voltage in the manner specified in 4.10.1.1.

4.10.1.2 Peak emission by voltage drop. The tube shall be tested with the specified voltage applied to the filament or heater, with a 60-cycle plate supply sufficient to start the tube and sufficient series resistance to limit the anode current to the specified maximum current (ib) value per anode. A suitable circuit designed to permit the conduction of the specified peak current for one or two approximate half-cycles per second shall be provided. The peak voltage drop, exclusive of the starting voltage, measured from an anode to the reference point as shown on a cathode-ray oscilloscope, or by other suitable means, shall be within the limits specified.

4.10.1.3 Peak emission. The filament or heater potential shall be supplied and the grid or grids, if present, shall be connected to the plate. A suitable condenser shall be discharged through the tube and a load resistor. The peak current shall be measured by an oscilloscope suitably calibrated. An equivalent method may be used. Pulses shall be applied in such a manner that the tube will not be damaged. The peak current shall be within the limits specified and there shall be no evidence of sparking during the test.

4.10.1.4 Emission by oscillation. At the end of the power-oscillation test specified in 4.10.2.2, the filament potential shall be reduced until the rf power output has been reduced 10 percent, at which point the filament potential shall not exceed the value specified; or the filament potential shall be adjusted to the limit value specified, at which point the power output shall be not less than 90 percent of the initial value.

4.10.1.5 Pulsing emission. The tube shall be operated at the electrode potentials specified. Where pulse voltages are indicated, the pulse duration shall be not less than 2 nor greater than 10 us. Time of rise shall be not greater than 10 percent of the pulse duration and time constant of fall not greater than 20 percent of the pulse duration. The duty shall be not less than 0.001. Variations in 80 percent of the top portion of the pulse shall not exceed ± 5 percent of the maximum amplitude and no portion shall fall below the maximum amplitude by more than 10 percent. There shall be no sign of arcing during the latter half of the test and the average peak plate current shall be within the limits specified.

4.10.1.6 Pulsing emission sinusoid. The tube shall be operated at the electrode potentials specified on the tube specification sheet. Where pulse voltages are indicated, the pulse duration shall be not less than 2 us and the pulse recurrence rate not less than 50 pulses per second. A sinusoid or partial sinusoid pulse may be used. There shall be no sign of arcing

during the latter half of the test and the average peak plate current shall be within the limits specified.

4.10.1.7 *Thyratron or gas-rectifier emission.*

The tube shall conduct pulses at a recurrence rate of not less than 1 nor more than 60 pulses per second. The duration of the pulses shall be such that the current flows not less than 0.5 nor more than 2.0 percent of the time. The pulse width in no case shall be less than 150 us. The shape of these pulses shall be such that the current rises smoothly and continuously to its peak value near the middle of the pulse. The grid or grids, if any, shall be connected as specified. With the filamentary types, connection to the filament circuit shall be made to the midpoint of the filament transformer. Variations in the tube voltage drop at current values below the peak current specified shall be ignored. There shall be no evidence of sparking of the filament (or cathode) or of flashover during the test, and the peak voltage drop shall be within the limits specified.

4.10.1.8 *Emission oscillation.* This test shall be made with the tube operating under the oscillation-test conditions after the power-oscillation test. (See 4.10.2.2.) The filament potential shall be changed as specified and the change in power output or cathode current shall be within the limits specified.

4.10.2 *Oscillator tests.*

4.10.2.1 *Oscillator grid current.* Oscillator performance shall be measured according to the circuit shown on Drawing 195-JAN. The specified voltages shall be applied to all elements through the specified circuit impedances. Oscillator performance is determined by the value of grid current for the specified resonant tuned impedance as obtained by the adjustment of R1.

4.10.2.2 *Power oscillation.* When the frequency of operation is not specified, each tube shall be operated as a self-excited oscillator or as a separately excited amplifier, at any fre-

quency. If a frequency is specified, the test frequency shall be not lower than that value but may be higher if the manufacturer so desires. Each tube shall be so tested that the load circuit is adjusted for not more than the specified plate current and the grid excitation is adjusted until the dc grid current is within 20 percent of the value specified. A resistor of the specified value (± 10 percent) shall be connected in the dc grid circuit. Useful power output, when specified, shall be interpreted to be the power delivered to the load. When tested as a self-excited oscillator, the total rf power output of the tube shall be within the limits specified. When tested as a separately excited amplifier, the total rf power output of the tube minus the power furnished by the driver to the control grid and the bias source shall be within the limits specified.

4.10.2.3 *Internal insulation.* At the conclusion of the power-oscillation test of the highest frequency specified on the tube specification sheet (including qualification test) and with operation at approximately the same frequency, the anode voltage shall be increased by 10 percent and the circuit readjusted to obtain the same plate input. The grid drive may be reduced but the power output shall be not less than that specified for the referenced oscillation test. The tube shall then be operated for 1 hour under the above conditions. During this period, the insulating material used within the tube should not become overheated, as indicated by reddening, nor should any electrical breakdown occur within or upon the surface of such insulation. At the end of this test, the emission and power output shall be within the limits specified for the referenced oscillation test.

4.10.3 *Noise tests.* When tapping of a tube is specified, each tube shall be tapped at least three times in each of two directions which are at right angles to each other. Sharp blows shall be delivered with an approved mallet or an approved mechanical device.

4.10.3.1 *Radio-frequency noise (other than shot-effect noise).* The plate of the tube under

test shall be coupled to the input of an rf amplifier at a frequency within the range of 50 to 1,600 kc per second. The minimum bandwidth (including all tuned circuits) at 10 times the input signal specified for the gain adjustment shall be 5 kc per second. The audio responses shall be within ± 5 db of the response at 400 cps over the frequency range of 100 to 2,000 cps. A commercial dynamic loudspeaker with a rating of at least 2.5 watts, properly coupled and excited, shall be used. The gain of the amplifier (see fig. 28) shall be adjusted by removing the tube from the socket and introducing the specified calibrating signal voltage (measured at the terminals of the signal generator) modulated 30 percent at 400 cycles into the plate circuit at the tube socket through a series combination of capacitance (reactance 100 ohms max) and a minimum resistive rf impedance (Z_1) of 100,000 ohms ± 20 percent at the operating frequency. The transformer shall have a primary resonant impedance of 50,000 ohms ± 20 percent and shall be tuned to resonance. The amplifier gain shall be adjusted for 50 mW output. The calibrating network shall be removed and the tube under test inserted, the

transformer retuned to resonance, and the signal removed. Tubes of the same type may be tested without further tuning. The heater and external shield shall be at rf ground potential. The external grid circuit resistance for the tube under test shall be from 5,000 to 25,000 ohms and shall not be bypassed. When operating under the above conditions, the tube shall be tapped. If any objectionable noise is heard in the loudspeaker, the tube shall be rejected. Noise indicating devices other than the loudspeaker are acceptable, provided they give comparable results. The value of E_b given under test conditions shall be regarded as E_{bb} for this test. Self-bias may be used for this test provided the cathode resistor is bypassed.

4.10.3.2 Audio-frequency noise. The plate of the tube under test shall be coupled to the input of a power amplifier, the response of which shall be within ± 5 db of the response at 400 cps over the frequency range of 60 to 5,000 cps. This power amplifier shall have an overload voltage characteristic of at least 10 to 1 with the specified calibrating signal used as the reference. The value of E_b under test

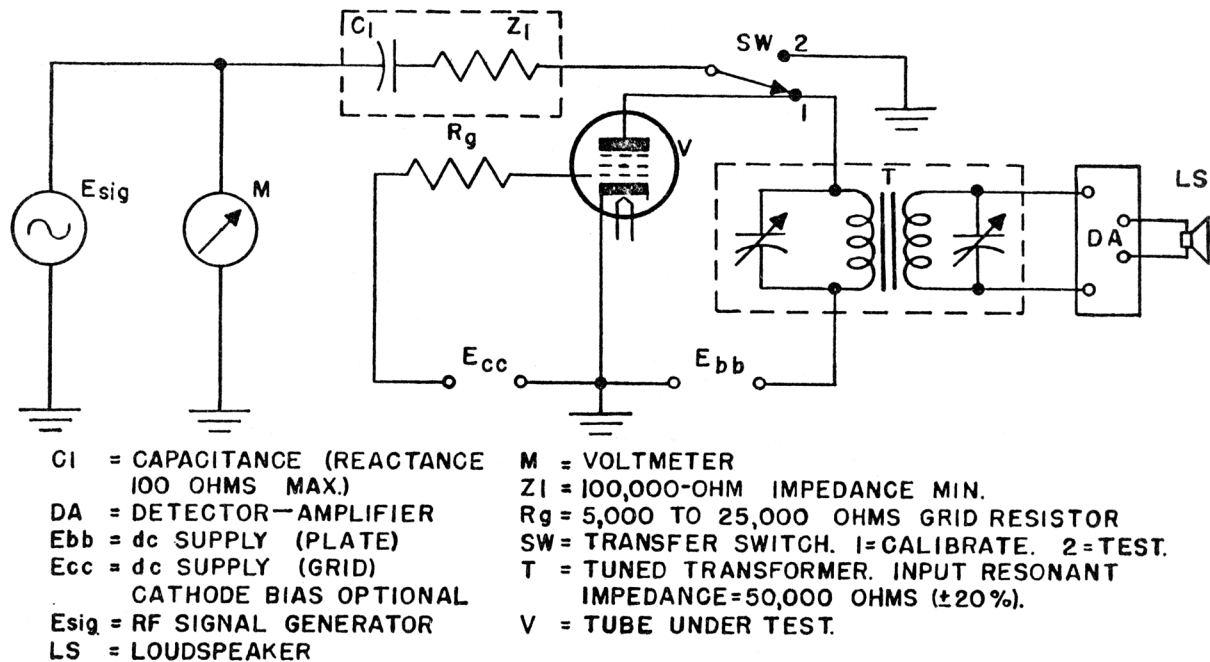


FIGURE 28. Radio-frequency noise test.

conditions shall be regarded as Ebb for this test. A commercial dynamic loudspeaker (4 inch min) with a rating of at least 2.5 watts, properly coupled and excited, shall be used. The gain of the power amplifier (see fig. 29) shall be adjusted by removing the tube from the socket and introducing the specified calibrating voltage at 400 cycles into the plate circuit at the tube socket through a capacitor having an impedance of not more than 100 ohms at the calibrating frequency. The power amplifier gain shall be adjusted for 50 mW output, unless otherwise specified. The signal and calibrating network shall be removed and the tube under test inserted. The minimum external grid-circuit resistance for the tube under test shall be 100,000 ohms and shall not be bypassed. The minimum external plate-circuit impedance shall be as specified. When operating under the above conditions, the tube shall be tapped. If any objectionable noise is heard in the loudspeaker, the tube shall be rejected. Any electrical disturbance sufficiently large to interfere with proper operation of equipment is considered objectionable. Noise-indicating devices other than the loudspeaker and neon indicator are acceptable provided

they give comparable results. When a meter deflection is specified, this reading shall be obtained by using a VU meter, operated in accordance with Standard ASA No. C16.5-1954. Both the meter and speaker shall be connected to the amplifier in such a manner that the meter indicates 50 mW when the speaker is receiving 50 mW of power from the amplifier.

4.10.3.3 Audio-frequency noise and microphonics. The tube under test shall have the specified operating potentials applied to all elements and shall be tested in an acoustic chamber constructed in accordance with Drawing 182-JAN, with ~~an RCA Victor dynamic speaker MI 6234, or equivalent,~~ mounted on the 11- by 18-inch closed end and facing inward, and the tube test socket mounted approximately 3 inches from the opposite open end. The top and sides of the acoustic chamber shall be free and clear of all material that might affect the acoustic characteristics. The plate of the tube under test shall be coupled through a 0.1-uf capacitor to an audio amplifier having an input resistance of approximately 100,000 ohms and a response char-

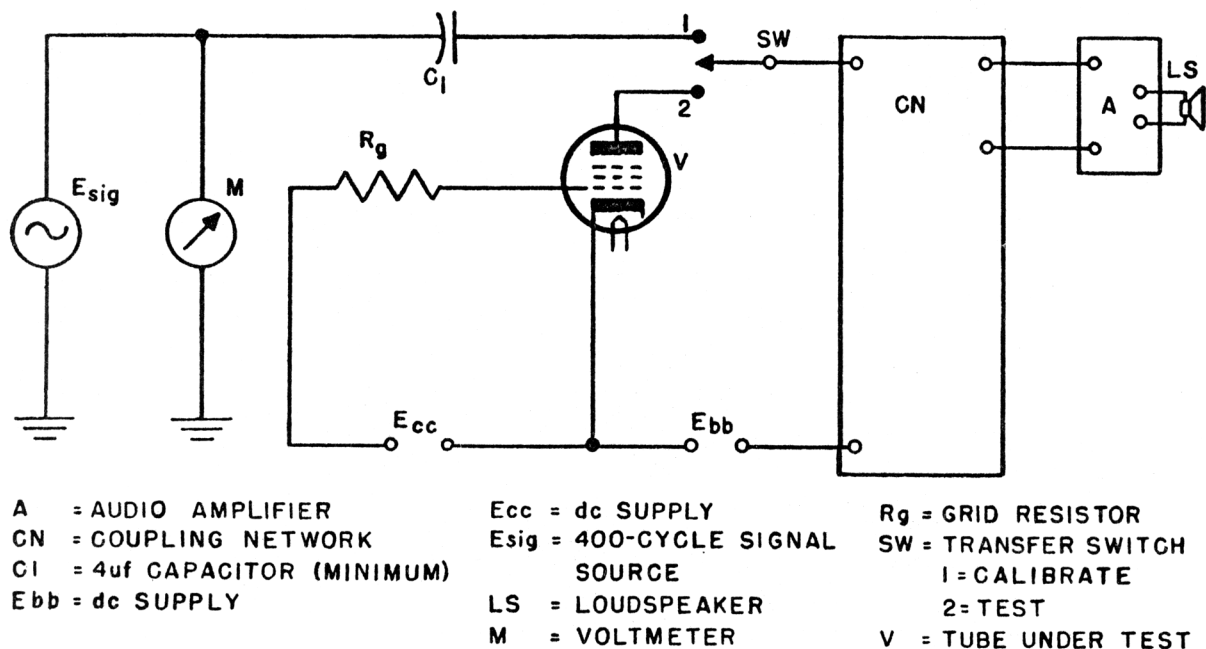


FIGURE 29. Audio-frequency noise test.

acteristic between ⁵⁰⁰60 and 5,000 cps, flat within ± 2.0 db of the 400 cycle response, with a resistor load substituted for the speaker. The power amplifier shall be capable of delivering 5 watts with less than 10 percent distortion. The speaker shall be coupled to the output of the amplifier so as to present rated load to the amplifier. The output indicator shall be a VU meter operated in accordance with Standard ASA No. C16.5-1954. The VU type meter with its attenuator shall be bridged across a suitable tap on the output of the amplifier. The VU meter may have the dial calibrated in electrical or arbitrary units, but the attenuator shall be designed to retain the ballistic characteristics specified for the VU meter. The calibrated points used for setting the amplifier gain shall be the rejection points and shall be determined for each test set on the basis of the power in the resistor load only. At 400 cycles and 50 mW, the resistor shall have been adjusted to the same impedance as the voice coil for which it is substituted. The amplifier gain shall be adjusted (without the tube in the test socket) to give the specified output with the specified calibration voltage at 400 cycles applied to the plate terminal of the tube-test socket. The calibrating voltage

shall be removed and the tube under test inserted. (See fig. 30.) When operating under the above conditions, no objectionable noise or microphonism shall be evident either with the tube at rest or when it is tapped. Objectionable noise or microphonism shall be defined as:

(a) Background noise ^{or} sustained microphonics ^{or oscillation} over 2 seconds in duration having greater than $\frac{1}{2}$ mW output power level.

(b) Clicks or scratchy noises of any sort.

The ballistic deflection as indicated by the output meter shall not exceed the maximum output specified.

4.10.3.4 Noise and microphonics (for reliable receiving tubes).¹ The basic circuit for the noise and microphonics test is shown on figure 1 of Drawing 194-JAN. In this circuit, the tube under test is connected in a resistance coupled amplifier circuit. The circuit constants R_k , R_{g1} , R_{g2} , and R_p , and applied electrode voltages shall be those values as specified by tube type on the tube specification sheet. The value of E_b under test conditions shall be regarded as E_{bb} for this test. The principal

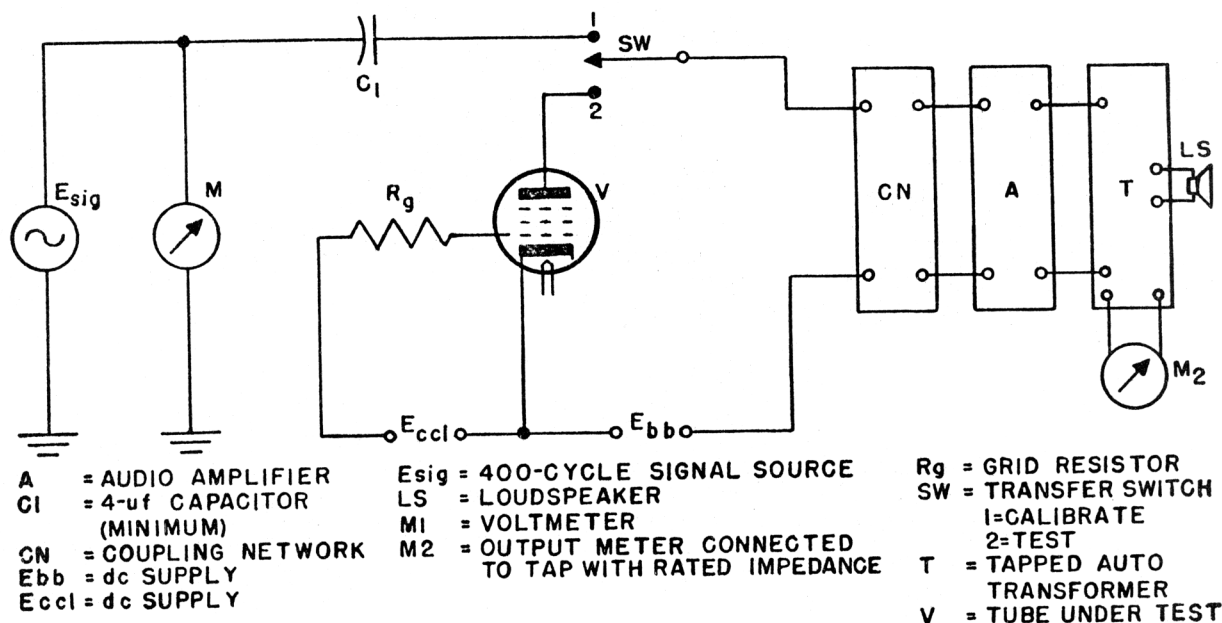


FIGURE 30. Audio-frequency noise and microphonics test.

components of this equipment, as shown on Drawing 194-JAN, are described as follows:

- (a) *Calibration circuit.* The calibration circuit (Ecal) is provided for selecting the specified signal voltages on each tube specification sheet. The calibration circuit used for this purpose shall have a range of 0 to 1,000 mV and shall be capable of supplying any calibrating voltage in this range with an accuracy of ± 2 percent.
- (b) *Cathode follower and noise and microphonics amplifier.* The plate of the tube under test shall be coupled to the input of the cathode follower which may be located either in the test chassis as shown on the drawings or in the noise and microphonics amplifier. The response of the cathode follower and amplifier shall be within ± 0.5 db of the response at 400 cps over the frequency range of 50 to 5,000 cps and have a 6 db per octave maximum cutoff rate in the ranges 20 to 50 cps and 5 to 20 kc. The response shall be measured at the plate terminal of the test socket with a generator having an output impedance of 10,000 ohms, or less. The actual input resistance of the cathode follower shall be 1 Meg in parallel with a distributed circuit capacity of 80 ± 10 uuf. The power amplifier shall have a power capability of 3 watts minimum at a point of 3 percent harmonic distortion. The hum and noise level shall be at least 30 db below rejection level. Below the 3 watt level the output voltage shall not fall more than 3 db when going from no load to full load over the frequency range of 50 to 5,000 cps. The output to input voltage

ratio of the cathode follower and amplifier shall be linear within ± 5 percent over the output power range of 0 to 3 watts.

- (c) *Speaker.* The speaker shall be an 8-inch commercial dynamic type with a rating of at least 2.5 watts. The speaker shall be coupled to the output of the amplifier so as to present rated load to the amplifier. The speaker may be mounted in accordance with figure 2 of Drawing 194-JAN and shall be positioned in such a manner that acoustic and mechanical feedback to the tube under test is at a minimum.
- (d) *Output meter.* The output indicator shall be a VU meter (operated in accordance with Standard ASA No. C16.5-1954) with the rejection level set at the meter reading obtained during calibration.
- (e) *Mechanical tapping device.* A mechanical tapping device shall be used for mechanically exciting the tube under test during noise and microphonics testing. This tapper consists of a motor driven cam actuating an overbalanced lever which delivers an impact to a suspended platform upon which an adapter and the tube under test are mounted. The platform shall be tapped at the rate of 120 taps per minute. The details of the mechanical parts of the tapper and the adapter box for mounting the tube under test are as shown on figure 3 of Drawing 194-JAN and must be standardized so that good correlation will exist between data taken on different equipments.
- (f) *Mallet.* The mallet used for manual tapping shall consist of a $\frac{1}{8}$ -inch diameter fiber rod, fully inserted and glued into the small end of a No. 8 cork. The overall length

¹ References to 4.10.3.5 on tube specification sheets dated prior to the approval date of this specification shall refer to 4.10.3.4 in this specification.

of rod and cork shall be 6 inches. The mallet may be equipped with a conductive coating.

The operation of the equipment shall be as follows:

- (a) *Calibration.* The gain shall be adjusted for 50 mW output by removing the tube from the socket and introducing the specified calibrating voltage, at a frequency between 50 and 5,000 cps, into the plate circuit at the tube socket. During calibration, the output of the amplifier shall be terminated in a load resistor having the same impedance as, the speaker. The signal and calibrating network shall be removed.
- (b) *Test procedure.* The tube under test shall be inserted. The tube shall be operated under conditions as specified on the tube specification sheet in an adapter in accordance with figure 4 of Drawing 194-JAN. When operating under the above conditions, the automatic tapper shall be energized and the average maximum output as observed during approximately 6 taps noted. If the output reading is rising, continue only until the reading is stabilized. Then, the tube shall be tapped sharply two times with a mallet, using a 2-inch stroke, and the output re-read under automatic-tapping conditions.

Tubes shall be rejected for microphonics if the average maximum VU meter reading exceeds the specified limits either before or after the manual tapping when the output load switch is in the microphonics position. Tubes shall be rejected for noise if any objectionable noise is heard in the speaker such as that caused by leakage, intermittent shorts, etc, when the output-load switch is in noise position. Objectionable noise shall be defined as clicks or scratchy noises of any kind.

4.10.4 Electrode currents. When electrode-current tests are made on converter-type receiving tubes, no signal shall be applied to the signal grid.

4.10.4.1 Plate current. With the specified potentials applied to the electrodes, the plate current shall be within the limits specified.

4.10.4.2 Positive-grid current. With the specified potentials applied to the electrodes, the positive-grid current shall be within the limits specified.

4.10.4.3 Screen-grid current. With the specified potentials applied to the electrodes, the screen-grid current shall be within the limits specified.

4.10.4.4 Suppressor-grid current. With the specified potentials applied to the electrodes, the suppressor-grid current shall be within the limits specified.

4.10.4.5 Target current. With the specified potentials applied to the electrodes, the target current shall be within the limits specified.

4.10.4.6 Cathode current. With the specified potentials applied to the electrodes, the cathode current shall be within the limits specified.

4.10.4.7 Dynode current. With the specified potentials applied to the electrodes, the dynode current shall be within the limits specified.

4.10.4.8 Resonator current. When the specified potentials are applied to the electrodes, the resonator current shall be within the limits specified. This test is used on klystrons when a common cathode-heater pin prevents the cathode-current test specified in 4.10.4.6.

4.10.4.9 Tube operation time. Tube operation time is the time (t_1) required for the plate current to reach a specified percentage of the plate current measured at the conclusion of a specified period of time (t_2). The tube filament shall be energized instantaneously from a substantially zero impedance source. The tube shall have had no potentials

applied for a period of at least 1 hour prior to the performance of this test. Tubes intended principally for use with zero bias or fixed bias shall be tested under plate current test conditions with zero or fixed bias. Tubes intended for use with self bias or those intended for use with either self bias or fixed bias shall be tested under self bias plate current conditions. The time (t_1) for the plate current to reach the specified percentage of the plate current measured at the conclusion of the time (t_2) specified shall not exceed the maximum specified for the individual tube type.

4.10.5 Electrode voltages. When electrode-voltage tests are performed on converter-type receiving tubes, no signal shall be applied to the signal grid.

4.10.5.1 Filament voltage. With the filament conducting the specified current, the filament voltage shall be within the limits specified. During this test no other elements shall be conducting.

4.10.5.2 Grid voltage. With the specified potentials applied to the electrodes, the grid voltage necessary for the conduction of the specified current shall be within the limits specified.

4.10.5.3 Plate voltage. With the specified potentials applied, the plate voltage necessary for the conduction of the specified current shall be within the limits specified.

4.10.5.4 Reflector voltage. With the specified potentials applied and the tube adjusted for the frequency specified, the reflector voltage necessary for maximum obtainable power output shall be within the limits specified.

4.10.6 Grid currents.

4.10.6.1 Total grid current. With the specified voltages applied to the tube, the total grid current read with a series microammeter shall be within the limits specified. The total external circuit resistance shall not exceed 100,000 ohms, except that when the maximum current limit is $-0.5 \mu\text{Adc}$ or less, the resist-

ance may be increased to 1.0 Meg maximum. The duration of this test (including preheating time at specified test conditions, if continuous with the test) shall be 2 minutes unless a greater duration is specified, or, in the case of tubes having a specified maximum grid current of 5 μA or less, it shall be only long enough to establish a steady value. When a greater duration is required, a test period of 3 minutes shall be permitted if the grid current at the end of this time is stable or is no longer rising, and does not exceed the limits specified.

4.10.6.2 Grid emission. This test applies to tubes where grid emission is high compared to grid leakage. At the conclusion of the test specified in 4.10.6.1, the tube shall be biased to cutoff and the grid current measured immediately. This current shall be considered to be due to leakage and primary emission and shall be within the limits specified.

4.10.6.3 Grid leakage. This test applies to tubes where grid leakage is high compared to grid emission. At the conclusion of the test specified in 4.10.6.1, the filament or heater voltage shall be cut off and the grid current measured when the parts have cooled down. This current shall be considered to be due to leakage and shall not exceed the limit specified.

4.10.6.4 Grid current (cold). The filament switch shall be opened until the elements have cooled below a visible color. The filament switch shall then be closed and the value of the grid current at the first pause in its rising value shall not exceed the value specified.

4.10.6.5 Gas current. When specified on the tube specification sheet, the value of the current determined as specified in 4.10.6.2 shall be subtracted from the value of the current determined as specified in 4.10.6.1. This difference shall be considered the gas current and shall be within the limits specified.

4.10.6.6 Primary grid emission. By means of suitable rectifiers and a 60-cycle ac source, the grid shall be heated during the positive

half cycles, and the primary emission measured during the negative half cycles. The voltage shall be adjusted for the average grid current specified. The primary emission current shall be not greater than the limit specified.

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4.10.6.7 Reflector current.

4.10.6.7.1 *Total reflector current.* When the specified voltages are applied to the tube, the total reflector current shall be within the limits specified. The duration of this test, including preheating time at specified test conditions if continuous with the test, shall be as specified. The tube may or may not be oscillating during this test.

4.10.6.7.2 *Reflector-leakage current.* At the conclusion of the test specified in 4.10.6.7.1, the cathode connection shall be opened and the reflector current shall be measured. This current shall be considered to be due to leakage and shall be within the limits specified.

4.10.6.7.3 *Reflector-gas current.* When specified on the tube specification sheet, the value of current determined as specified in 4.10.6.7.2 shall be subtracted from the value of current determined as specified in 4.10.6.7.1. This difference shall be considered reflector-gas current and shall be within the limits specified.

4.10.7 High-frequency tests.

4.10.7.1 *HF oscillator grid current.* When the tube is oscillating within 5 percent of the specified frequency and under the specified conditions, the grid current shall be within the limits specified.

4.10.7.2 *Cold-loading resistance.* The specified coil (Q1 not less than 175, C approximately 20 uuf) shall be inserted in terminals marked "coil" on a Boonton Radio Corporation Q meter, Model 170A, or equivalent. The frequency dial shall be set to specified frequency on the Q meter. The tube elements shall be connected to terminals marked "condenser" as specified on the tube specification

sheet. Those elements not indicated shall be left floating. The Q2 of the tube-coil combination shall be determined, and the resistance (R) computed as follows:

$$R = \frac{1.59 \times 10^5 (Q1Q2)}{FC (Q1-Q2)}$$

Where:

Q1 = Q of coil.

Q2 = Q of tube-coil combination.

F = frequency in megacycles.

C = standard condenser capacity in uuf.

The resistance computed shall be not less than the minimum value specified.

4.10.7.3 *Frequency (or wavelength).* Frequency (or wavelength) shall be measured after the conditions of the applicable test have been fulfilled. The value $c = 2.998 \times 10^{10}$ cm/sec shall be used if frequencies are converted to wavelength for convenience of testing.

4.10.7.3.1 *Fixed tuned frequency.* Fixed tuned frequency shall be measured by a meter which is calibrated to an accuracy of 0.05 percent. The frequency shall be within the limits specified.

4.10.7.3.2 *Tunable frequency.* The tube shall be capable of being tuned smoothly and without discontinuities over a frequency range including the limits specified. In the case of klystrons, the number of turns of the tuner required to tune the tube over the frequency range shall be as specified.

4.10.7.4 *Resonant frequency.* The cold tube shall be attached to the open end of a parallel-line Lecher frame having a movable shorting bar. The pins specified on the tube specification sheet shall be attached to the lines. The diameters and spacing of the lines shall be as specified on the tube specification sheet for the tube being tested. An oscillator or signal generator tuned to the frequency specified on the tube specification sheet shall be loosely coupled to the Lecher frame. The oscillator or signal generator shall be provided with some

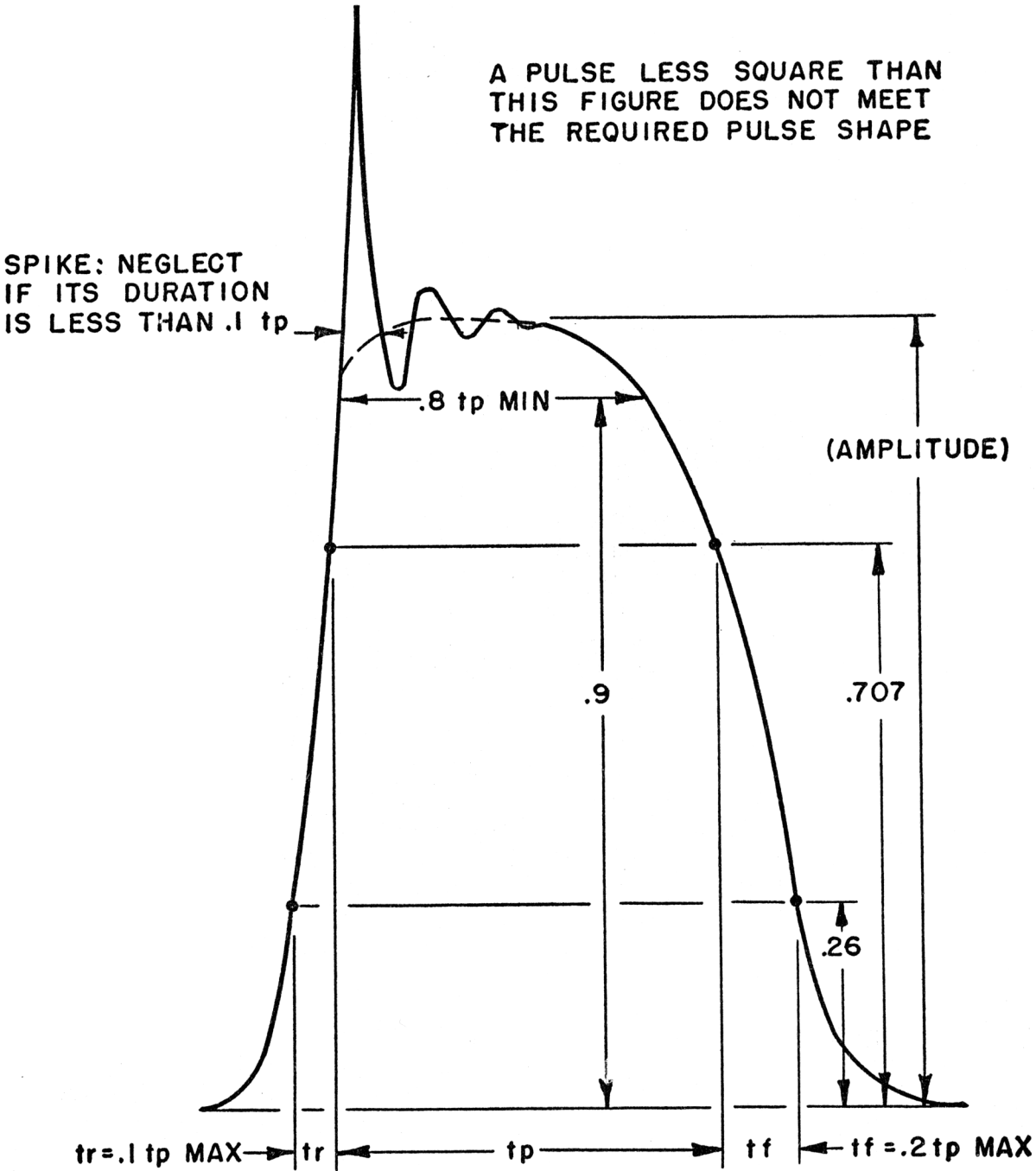


FIGURE 31. Pulse voltage or current characteristics.

device indicating energy absorption when the Lecher frame with the tube attached is tuned to resonance. This device may be a grid-current meter for an oscillator, or an auxiliary tuned line with voltage detector (crystal or vacuum tube) for a signal generator. When tuned to resonance, as shown by the indicator, the length of the Lecher frame from shorting bar to the base of the tube shall be not less than the length specified on the tube specification sheet.

4.10.7.5 Pulse voltages or currents. When pulse voltages or currents are specified on the tube specification sheet, the values of time of pulse, repetition rate, and pulse amplitude shall be specified. The pulse amplitude shall be defined as the maximum value (excluding spike) of a smooth curve through the average of the fluctuation over the top portion of the pulse. (See fig. 31.) The allowable spike width measured at the base of the spike shall not exceed 10 percent of the pulse duration (t_p). The width of the pulse, at an amplitude 0.9 of the pulse amplitude, shall be not less than 80 percent of the pulse duration (t_p). The time of rise (t_r) shall not exceed 0.1 of the pulse duration (t_p), and time of fall (t_f) shall not exceed 0.2 of the pulse duration (t_p). Pulse requirements for magnetrons shall be as specified in 4.16.3.3.

4.10.8 Heater or filament current. When the voltage specified on the tube specification sheet is applied to the heater or filament, the current shall be within the limits specified. During this test no other elements shall be conducting.

4.10.9 Transconductance. The grid-plate transconductance shall be determined graphically from the slope of the grid-plate transfer characteristic, calculated from measurements of the amplification factor and the plate conductance, or measured directly by the method shown on figure 32, or by an equivalent method. When balance has been attained, $S_m = \frac{R_2}{R_1 R_3}$, providing R_1 and R_3 are negligible in comparison with grid and plate resistance, respectively. The grid-plate transconductance shall be within the limits specified. For a change in value of transconductance with reduced filament or heater voltage, the reading at the reduced voltage shall be taken when the value of transconductance is rising or stable.

4.10.10 Plate resistance. The plate resistance shall be determined graphically from the reciprocal of the slope of the graph of plate currents as ordinates against plate voltages as abscissas (other electrode voltages being

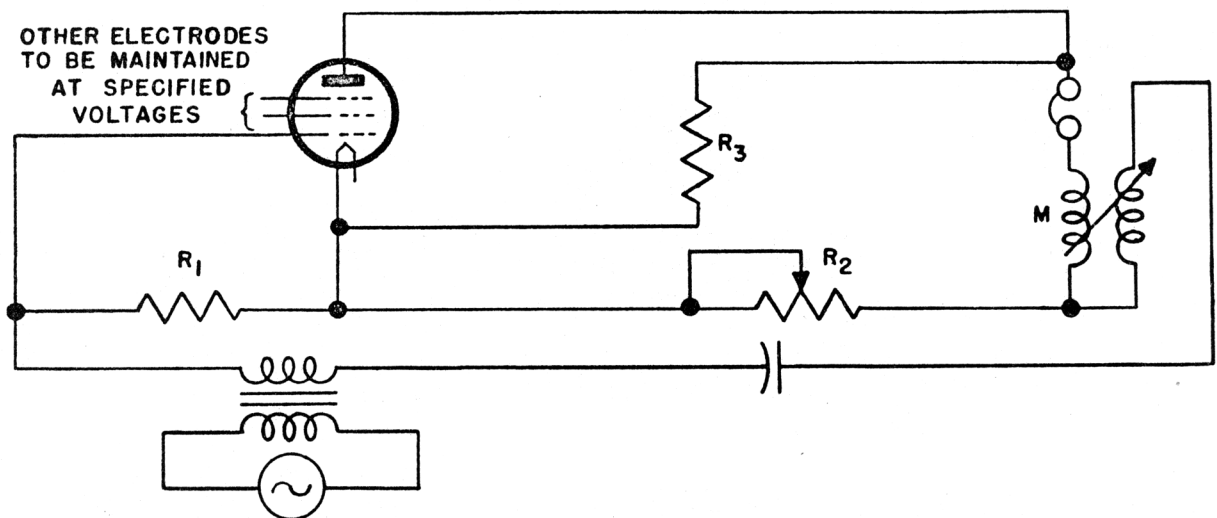


FIGURE 32. Circuit arrangement for measuring transconductance.

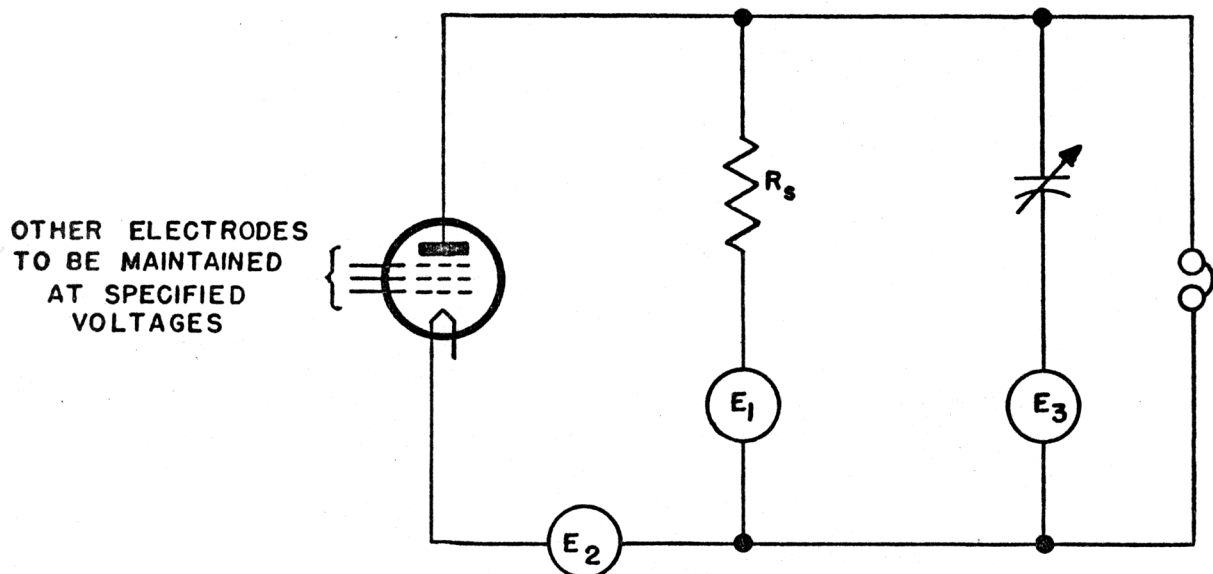


FIGURE 33. Circuit arrangement for measuring plate resistance.

maintained constant), or measured by means of the voltage-ratio method shown on figure 33, or an equivalent method. The dc drop in the bridge should be corrected by additional supply voltage. The voltage-ratio method utilizes a system of transformers, capacitors, and attenuators to supply three independent, properly phased and adjusted voltages from a common source. The voltages E_1 , E_2 , and E_3 must be in phase. When balance has been ob-

tained, $R_p = \frac{E_2}{E_1} R_s$, where R_s is a fixed resistor of approximately 100,000 ohms. The plate resistance shall be within the limits specified.

4.10.11 Amplification tests.

4.10.11.1 Amplification factor. The amplification factor shall be measured statically by

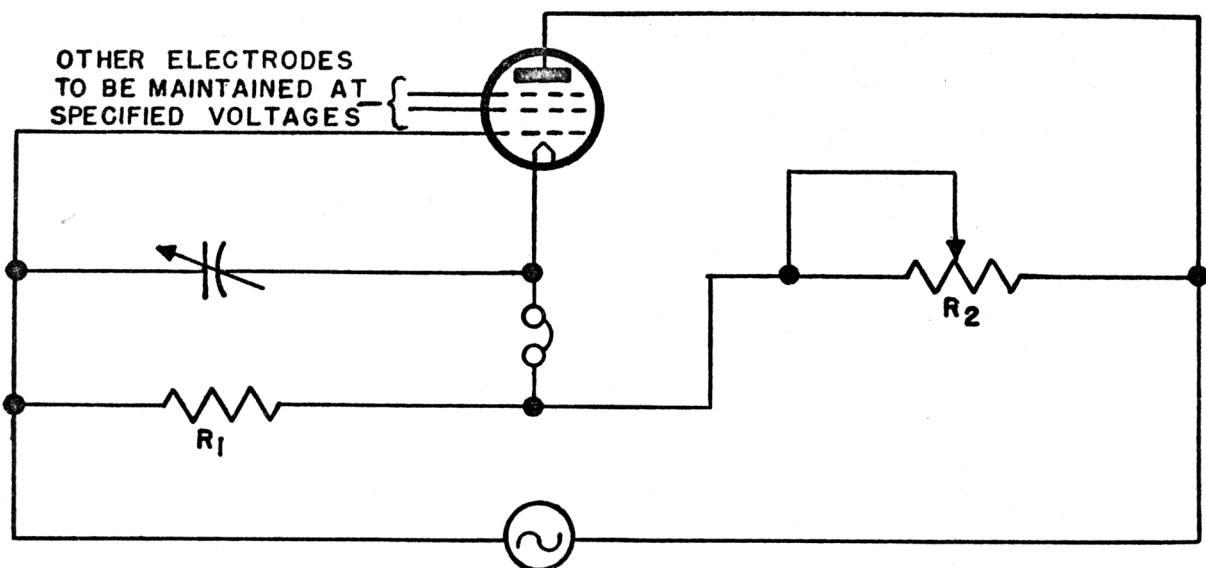


FIGURE 34. Circuit arrangement for measuring amplification factor.

computing the ratio of the increments of change in plate voltage and control electrode voltage at a fixed plate current, or dynamically by a balance method as shown on figure 34, or by an equivalent method. When balance is

obtained, $u = \frac{R_2}{R_1}$. The dc drop in the bridge

should be corrected by additional supply voltage. The limitations of no grid current imposed on the use of the circuit shown on figure 34 demand that gas current as well as electron current be negligible. The amplification factor shall be within the limits specified.

4.10.11.2 *ac amplification*. The test shall be made with the specified input signal (E_{sig}) at a frequency of 60 to 2,000 cycles. The signal shall be coupled to the grid of the tube with no bias supply, through a 0.1- μ f capacitor. A 10-Meg resistor shall be connected from the grid to ground. The internal impedance of the signal source shall not exceed 2,500 ohms. The resistance (R_p) in series with the plate shall be 0.5 Meg, unity power factor. The circuit capacitance (including the vacuum-tube voltmeter) shall have a reactance of not less than 5 Meg at the test frequency. Qualification testing shall be made with E_{sig} at a frequency of 400 cycles and with the output voltage measured by the Hewlett-Packard 400C vacuum-tube voltmeter, or equivalent.

4.10.12 *Conversion transconductance*. Conversion transconductance shall be determined from measurements of the magnitude of a single-beat frequency component ($F' - F''$ or $F' + F''$), of the output current, and of the magnitude of the input voltage of frequency F' , and shall be within the limits specified. The standard method of measurement of conversion transconductance shall be by application of 60-cycle voltages of identical phase and frequency from a source of less than 100 ohms impedance, to the specified electrodes, such as the signal and oscillator grids, with provisions for a phase reversal of 180° of one with respect to the other. (See fig. 35.) The time constant of the grid-coupling capacitor (C_1) and grid-resistor (R_1) at the oscillator grid-signal frequency (F_o)

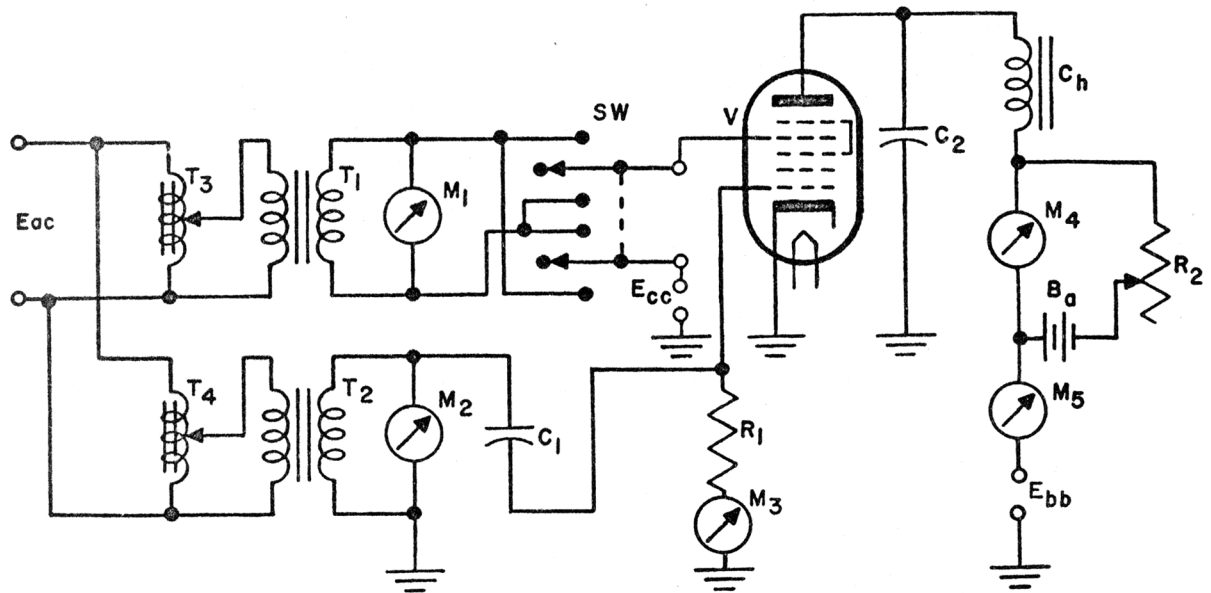
shall satisfy the equation $\frac{1}{F_o R_1 C_1} = 0.16$.

The change in dc plate current due to the phase reversal represents the difference frequency plate current component. The value of the signal frequency voltage shall be 0.354 volt. The quotient of the change in plate current and twice the peak value of the sinusoidal voltage applied to the signal input electrode shall be the conversion transconductance. Specified operating potentials shall be applied to the tube, and the oscillator injection voltage shall be adjusted to the specified oscillator grid current.

4.10.13 *Operation of rectifiers*. Each tube shall operate satisfactorily and without sign of arc-backs or sparking in a rectifier circuit under the conditions specified. In a circuit for gas or mercury-vapor tubes, the source impedance shall be such that at least 10 times the average plate current will be obtained on an arc-back. A rejectable arc is a current in the reverse direction equal to or greater than the rated value of surge current in the forward direction. When the test conditions specify circuit constants, the dc current in the load resistor shall be within the limits specified. The duration of this test shall be sufficient to obtain indications of satisfactory operation. Qualification samples, except samples of receiving tubes, shall be operated for 1 hour. For mercury-vapor rectifier tubes, the cathode shall be allowed to heat for a period of time sufficient to distribute the mercury properly in the bulb. Heater types having the cathode brought out to a separate terminal shall have the highest-numbered heater pin connected to the negative side of the load, unless the load voltage exceeds the maximum heater-cathode voltage rating, in which case the maximum rated voltage difference shall be maintained. When an ac heater-cathode potential is specified, the heater voltage shall be phased to subtract from this heater-cathode potential. Inductive loading shall not be used.

→ 4-10.13.1 = 17 See Amdt 5 p 15

4.10.14 *Direct interelectrode capacitance*. The capacitance between the designated combination of elements shall be within the limits



Ba = BUCKING BATTERY
 Ch = CHOKE (FILTER)
 C1 = COUPLING CAPACITOR
 C2 = CAPACITOR (FILTER)
 Eac = 60-CYCLE SUPPLY (SINUSOIDAL)
 Ebb = dc SUPPLY
 Ecc = dc SUPPLY
 M1 = VOLTMETER (SIGNAL)
 M2 = VOLTMETER (OSCILLATOR INJECTION)
 M3 = dc MICROAMMETER (OSCILLATOR GRID CURRENT)

M4 = dc MICROAMMETER (LOW RESISTANCE) INCREMENTAL PLATE CURRENT
 M5 = dc MILLIAMMETER (PLATE CURRENT)
 R1 = OSCILLATOR GRID RESISTOR
 R2 = RHEOSTAT (BUCKING CURRENT)
 SW = REVERSING SWITCH
 T1, T2 = ISOLATION TRANSFORMERS
 T3, T4 = VARIABLE AUTO TRANSFORMERS
 V = TUBE UNDER TEST

FIGURE 35. Conversion transconductance test.

specified on the tube specification sheet. All metal parts except the input and output electrodes shall be connected to the cathode unless otherwise specified. These parts include internal and external shields, base sleeves, and unused pins, but do not include the electrodes of inactive sections of multiplex tubes. The electrodes of the sections of multiplex tubes which are not common to the section under test shall be connected to ground. The applications of these principles to the capacitances normally measured in various types are shown in table IV. For cathode ray tubes the capacitance shall be measured between elements as specified on the tube specification sheet ("all" signifies all other elements within the tube envelope); elements not specified for the individual test on the tube specification sheet shall be grounded. For transmitting tubes employing metal-sleeve type bases with the

sleeve not connected internally to any base pin or electrode, the capacitance measurements shall be made without grounding that sleeve or connecting it to any electrode, and capacitance to other objects shall be kept at a minimum. The tube pins and leads shall be shielded from each other and from elements of the tube so that they and their connections will not form part of the capacitance being measured.

4.10.14.1 Conditions of test. Interelectrode capacitance shall be measured with the cathode cold and with no direct voltages present unless otherwise specified, using standard capacitance sockets and standard cap connectors; standard shields shall be used when specified on the tube specification sheet. When used, cylindrical shields shall set squarely on and

See Amdt 5 pp 16-19 inclusive

TABLE IV. Connections of electrodes of tubes or sections for measuring direct interelectrode capacitances.

Type of tube or section	Capacitance	Measure between	Ground
Indirectly heated cathode type	Heater-Cathode	Heater and cathode	All other electrodes
	Input	Plate and (cathode + filament + shields, etc)	Other sections
	Coupling	Diode-plate and plate of other section(s)	All other electrodes
	Coupling	Diode-plate and grid of other section(s)	All other electrodes
Triode, tetrode, and pentode	Grid-plate	Grid and plate	All other electrodes
	Input	Grid and cathode + filament + screen + shields, etc)	Plates, diodes, and inactive section(s)
	Output	Plate and (cathode + filament + screen + shields, etc)	Grid, diode, and inactive section(s)
	Coupling	Grid and plate of other section	All other electrodes
	Coupling	Plate and plate of other section	All other electrodes
	Input (grounded grid)	Cathode and (grid + filament + screen + shields, etc)	Plate, diode, and inactive section(s)
	Output (grounded grid)	Plate and (grid + filament + screen + shields, etc)	Cathode, diode, and inactive section(s)
	Grid-plate (1)	Signal grid (1) and plate	All other electrodes
	Grid-plate (2)	Signal grid (2) and plate	All other electrodes
Mixer	Input (1)	Signal grid (1) and all other electrodes	None
	Input (2)	Signal grid (2) and all other electrodes	None
	Output	Plate and all other electrodes	None
Converter	Coupling	Signal grid (1) and signal grid (2)	All other electrodes
	Mixer grid-plate	Signal grid and plate	All other electrodes
	RF input	Signal grid and all other electrodes	None
	Mixer output	Mixer plate and all other electrodes	None
	Osc grid-plate	Osc grid and osc plate	All other electrodes
	Osc input	Osc grid and cathode + filament + shields, etc)	Osc plate and other section(s)
	Osc output	Osc plate and (cathode + filament + shields, etc)	Osc grid and other section(s)
	Osc output ¹	Cathode and (heater + screen + shields, etc)	Osc grid
	Osc input ¹	Osc grid and all other electrodes	None
	Osc grid-cathode ¹	Osc grid and cathode	All other electrodes
	Coupling	Osc grid and signal grid	All other electrodes
	Coupling	Osc plate and signal grid	All other electrodes

¹ Applies to converters normally operated with rf voltage between cathode and ground.

be concentric with the capacitance socket. When both shield and a cap are used, the cap connector shall be concentric with the opening of the shield. When measuring capacitance not requiring shields, the lower member of standard two-part shields shall be removed

if this part significantly affects the measured capacitance.

4.10.14.2 Test circuits. An rf bridge, or equivalent method, shall be used to measure direct interelectrode capacitances, throughout

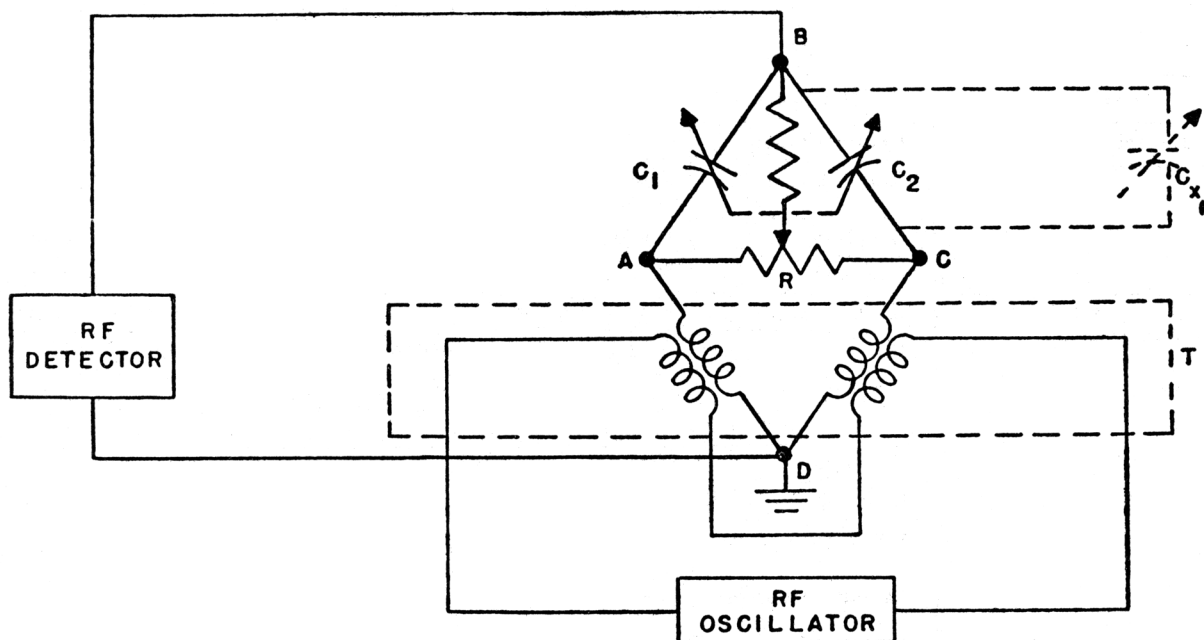


FIGURE 36. Circuit arrangement for measuring direct-interelectrode capacitances.

the usual range of tube capacitance, ie, 0.0001 to 100 uuf. A bridge circuit for the measurement of direct interelectrode capacitances of a tube is shown on figure 36. A stable oscillator, such as a crystal-controlled oscillator, supplies rf power through a closely coupled balanced transformer (T). Balance is indicated by a null-indicating vacuum-tube voltmeter which is made up of a tuned amplifier, diode rectifier, and dc meter indicator. For convenience, the capacitors are ganged differentially so that increase of one capacitance is accompanied by an equal decrease of the other. Balance may then be effected by varying the two capacitance branches of the bridge until they are equal (when $C_x = C_1 - C_2$). Then the balance, $C_x = |2\Delta C_1| = |2\Delta C_2|$.

4.10.14.3 Capacitance sockets and cap connectors.

4.10.14.3.1 Capacitance sockets. The following requirements shall be standard for capacitance sockets for tubes having bases indicated in table V. The construction and shielding of capacitance sockets and leads shall be such that when the holes for the insertion of base

pins are covered with a grounded, flat metal plate, the capacitance between any one socket terminal and all other socket terminals tied together shall not exceed 0.00010 uuf for receiving tubes. The hole for the accommodation of the locating lug of octal and locking-in bases shall be less than 0.500 inch in diameter. The diameter of the holes for the insertion of the base pins (see fig. 37) shall be limited to the values specified in table V. The socket face plate shall be flat and shall have a minimum diameter as specified in table

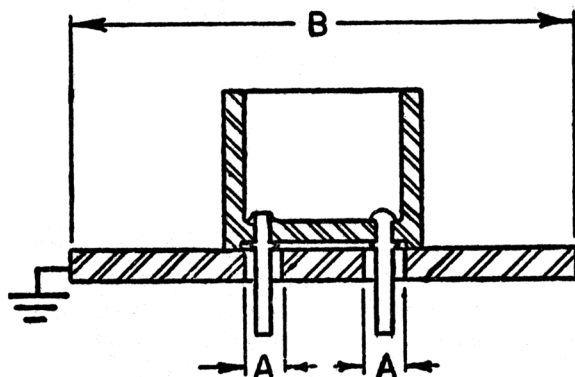
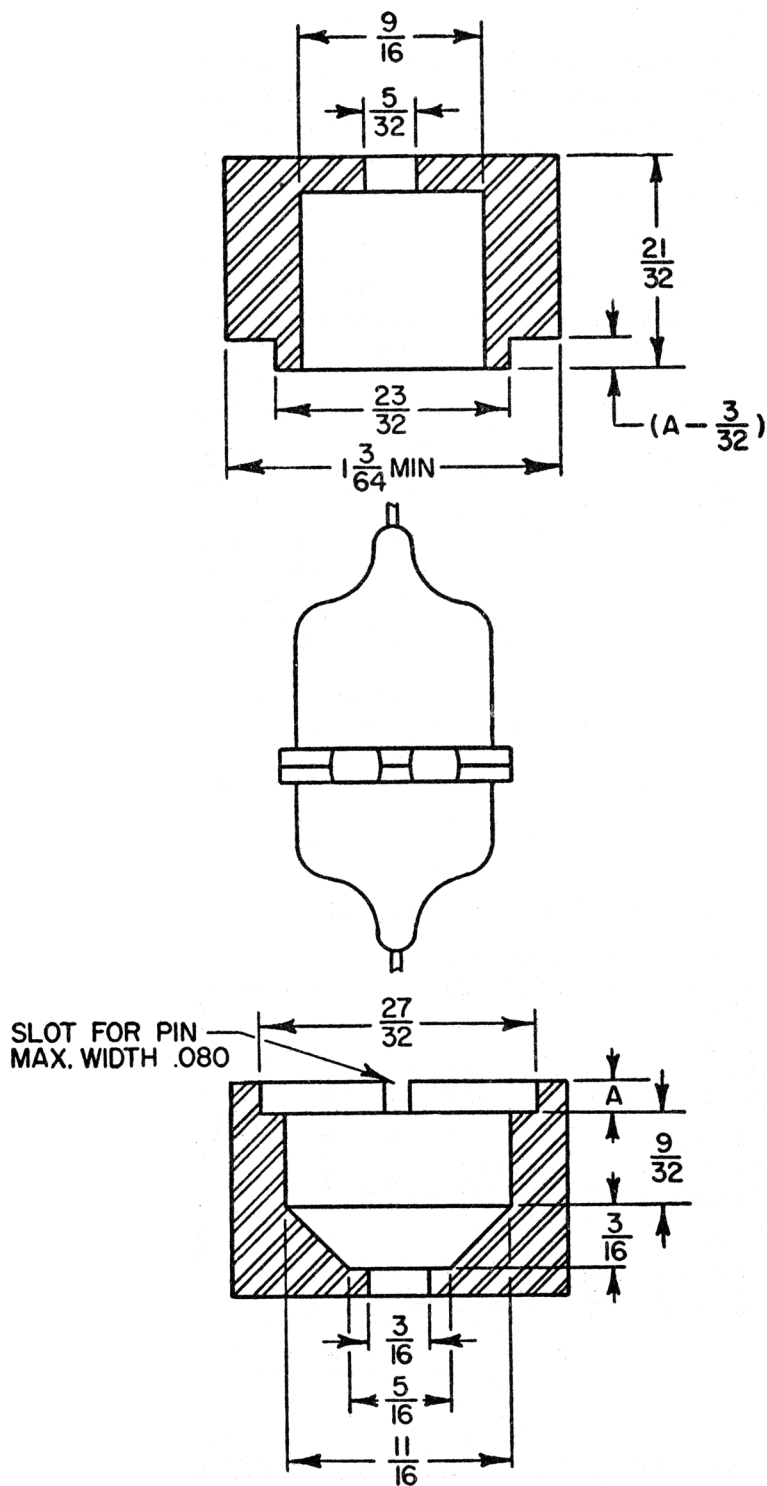


FIGURE 37. Capacitance-test socket.



ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED
TOLERANCES ON FRACTIONS $\pm \frac{1}{64}$ INCHES.

FIGURE 38. Capacitance test socket for acorn tubes.

V. Any structure above the face plate shall have negligible effect on the capacitance being measured. A thin insulating film may be per-

manently attached to the face plate of capacitance sockets to provide insulation for ungrounded shielding members. The socket shall be so constructed that the base of the tube under test will seat on the face plate.

TABLE V. Dimensions for capacitance sockets.

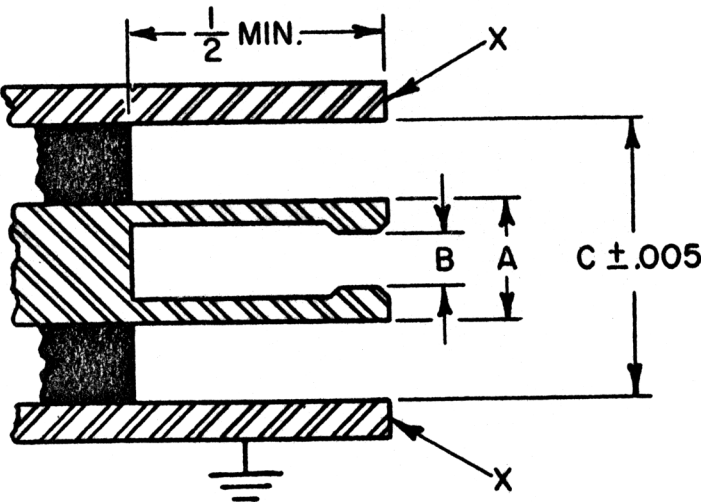
Base designation	Diameter	
	A (max)	B (min)
	<i>Inch</i>	<i>Inches</i>
Standard 4-pin.....	0.250	3
Standard 5-pin.....	.250	3
Standard 6-pin.....	.250	3
Standard 7-pin.....	.250	3
Octal.....	.175	3
Locking-in.....	.093	3
Miniature 7-pin.....	.075	2½
Miniature 9-pin.....	.075	2¾
4-pin jumbo.....	.375	3
Super jumbo 4-pin.....	.375	3
Giant 5-pin.....	.325	3
Giant 7-pin.....	.325	3
Subminiature outlines 8-1 to 8-5, incl.	.065	2
Subminiature outlines 8-7 to 8-11, incl.	(See Drawing 217-JAN)	

4.10.14.3.1.1 *Acorn tubes.* It shall be standard to measure acorn tubes in the capacitance-test sockets shown on figure 38. (See table V also.)

4.10.14.3.2 *Standard cap connectors.* Standard cap connectors shall be as specified in table VI and on figure 39.

TABLE VI. Dimensions for standard cap connectors.

Cap designation	Diameter		
	A±1/64	B	C±0.005
	<i>Inch</i>	<i>Inch</i>	<i>Inch</i>
Medium.....	21/32	0.556	0.850
Small.....	29/64	.352	.750
Miniature.....	21/64	.242	.750



NOTES:

- 1. A THIN INSULATING FILM MAY BE PLACED ON SURFACE "X".
- 2. TO ACCOMODATE INSERTION AND WITHDRAWAL OF TOP CAP, SLOTS SHOULD BE USED IN A-B SO THAT THAT PORTION WILL HAVE THE REQUIRED RESILIENCY.

FIGURE 39. Standard cap connectors for capacitance tests.

4.10.15 Heater-cathode leakage. The rated heater voltage shall be applied. For heaters having a rating of less than 35 volts, either ac or dc voltage shall be used; for heaters having a rating of 35 volts or greater, only ac heater voltage shall be used. One hundred volts dc in series with a microammeter shall be applied between the highest numbered heater pin and the cathode. If ac heater-cathode potential is specified, the heater voltage shall be phased to subtract from this heater-cathode potential. The current shall be determined for both negative and positive polarities between heater and cathode, except for rectifiers or rectifier sections of multiunit tubes, in which the measurements shall be made with the heater at a negative potential with respect to the cathode. The absolute value(s) of the leakage current measured shall not exceed the limit specified. All other tube elements, except those internally connected, shall be electrically isolated from the heater during this test. A resistor, in series with the current meter, of not more than 1,000 ohms per volt of heater-cathode potential, shall be used in this measurement.

4.10.16 Power output. The power output shall be measured in accordance with the ap-

plicable method specified in 4.10.16.1 and 4.10.16.2.

4.10.16.1 Class A amplifier. Power output shall be measured with specified potentials applied to the tube. The specified signal shall be applied to the control grid and measurement made of the total ^{power} output delivered from the plate of the tube into the specified resistive load. Unless otherwise specified, the impedance of the signal source shall be very low as compared with the minimum peak grid impedance. For a change in power output with reduced filament or heater voltage, the reading at the reduced voltage shall be taken when the value of the power output is rising or stable.

PRECAUTION: The impedance of all voltage supplies shall be limited to 1 percent of the load resistance. Where a plate coupling transformer or choke is employed the loss should be added to the power measured in the load resistance.

The following standard method will be used by Government laboratories for qualification tests: This test shall be made with the circuit shown on figure 40. The specified load shall be inserted in the plate circuit, the specified

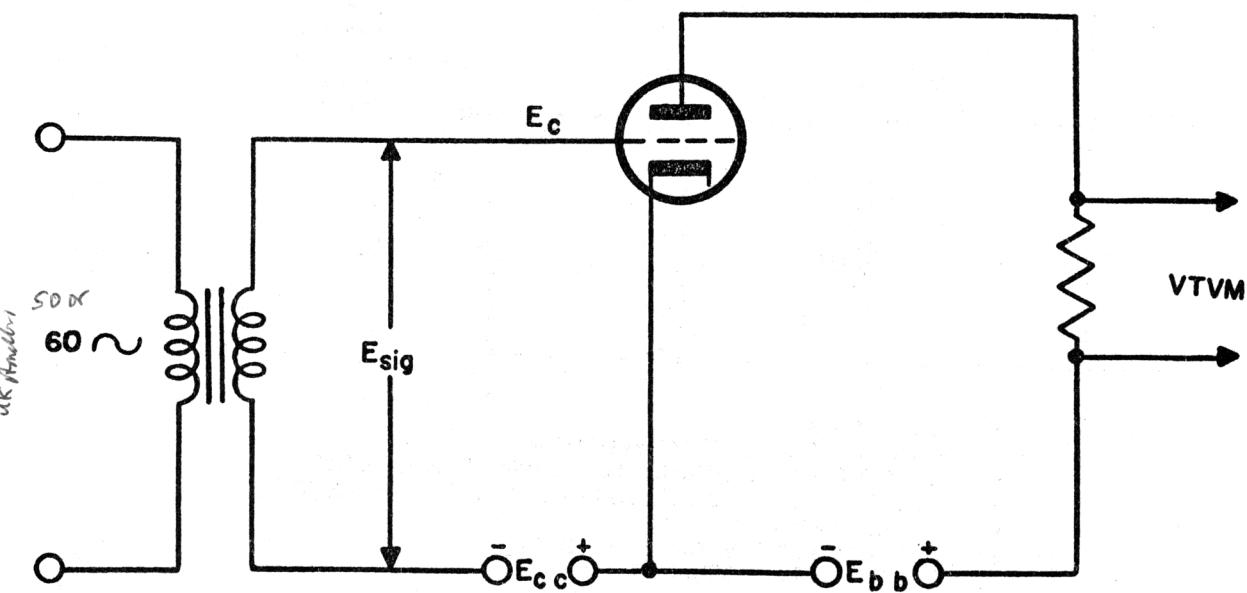


FIGURE 40. Circuit for measuring class A power output.

potentials shall be applied to the tube elements, and a 60-cycle sinusoidal voltage of specified value shall be applied directly to the control grid. The internal impedance of the signal source shall not exceed 2,500 ohms. The rms alternating voltage across the load shall be measured with an rms measuring vacuum-tube voltmeter whose input impedance is at least 1 Meg, and the ac power in the load calculated.

4.10.16.2 Class B amplifier. This test shall be made on a tube or on each separate unit of multiunit tubes, in the circuit shown on figure 41. The grid circuit shall have the specified impedance at the signal frequency and negligible dc resistance. The grid signal shall be adjusted to the specified voltage without a tube in the socket. The impedance of the signal source shall be adjusted without a tube in the socket so that a resistor load of the same value as the specified impedance decreases the signal voltage 50 percent when connected across the grid circuit. The total harmonic distortion of the signal must not exceed 5 percent excluding distortion introduced by the source impedance. A noninduc-

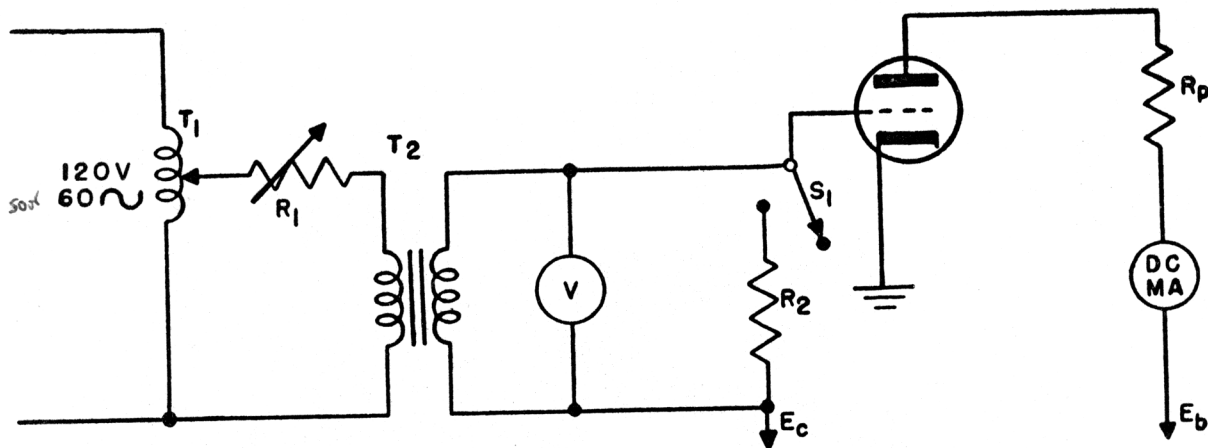
tive resistance load (R_p) shall be inserted in the plate circuit of the tube without the use of shunting choke or transformer. The specified plate voltage (E_b) shall be regarded as supply voltage (E_{bb}) for this test. The dc plate current shall be measured with no signal (I_{bo}) and with the specified signal (I_{bs}) and the power output calculated as follows:

$$P_o = \frac{\pi^2}{4} \left(I_{bs} - \frac{I_{bo}}{4} \right)^2 R_p$$

For production purposes, the manufacturer may use a fixed value of I_{bo} provided the value chosen is representative of the current product. For a change in power output with reduced filament or heater voltage, the reading at the reduced voltage shall be taken when the value of the power output is rising or stable.

4.10.17 Thyatron grid characteristics.

Limits specified for grid voltages shall apply when the common point of the plate and grid circuits is the cathode, or, in filamentary types, is the midtap of the filament transformer or the midpoint of the filament, if present.



- T1 = 5-A VARIAC
 T2 = LOW-IMPEDANCE TRANSFORMER
 R1 = 10,000-OHM NONINDUCTIVE 8-WATT RHEOSTAT
 R2 = 500-OHM $\pm 5\%$ NONINDUCTIVE 4-WATT RESISTOR
 V = ac VOLTMETER
 S1 = MICROSWITCH NORMALLY OPEN
 Rp = PLATE LOAD RESISTOR

FIGURE 41. Circuit for measuring class B power output.

4.10.17.1 Critical grid voltage for conduction. Under the conditions specified, the control-grid voltage shall be changed in a positive direction until the tube starts to conduct current. The grid voltage measured at the grid-voltage supply required to cause conduction shall be within the limits specified.

4.10.17.2 Critical anode voltage for conduction. Under the conditions specified, the anode voltage shall be increased until the tube starts to conduct current. The anode voltage required to cause conduction shall be within the limits specified.

4.10.18 Tube voltage drop. This test shall be performed under the conditions specified. The anode voltage shall be applied for a minimum of 1.0 second. The potential drop between anode and cathode shall be within the limits specified. For filamentary types, the measurement shall be made between the anode and electrical center of the filament circuit.

4.10.19 Thyatron high-voltage operation. Under the conditions specified, the control-grid supply voltage shall be changed in a negative direction. The tube shall be in a state of conduction at the specified minimum grid supply voltage and conduction shall cease before the specified maximum grid supply voltage is reached.

4.10.20 Thyatron cold-gas conduction. The anode voltage shall be applied between anode and grid with the grid approximately at ground potential. The plate resistor shall be adjacent to the anode and no connection shall be made to the filament (or cathode). The temperature of all parts of the tube shall be between 15° and 50° C. The frequency of the plate-supply voltage shall not exceed 150 cps. At the minimum limit specified for the anode-supply voltage, or less, not more than two flash discharges of any nature shall occur. Between the minimum and maximum limits specified for the anode-supply voltage, the tube shall conduct the specified current for at least 1 second, or shall conduct three or more flashes of current.

4.10.21 Thyatron grid current. With the tube operating under the specified conditions, the grid bias shall be increased in a negative direction to a value, Ecco(1), at which the tube just cuts off. The negative grid bias shall then be made zero, and the specified grid resistance shall be reduced to 10,000 ohms, and the plate current readjusted to the value specified. The grid bias shall again be increased in a negative direction to cutoff, Ecco(2). The grid current shall be computed from the following formula:

$$I_c \text{ (in } \mu\text{A)} = \frac{\text{Ecco(1)} - \text{Ecco(2) (in volts)}}{\Delta R_g \text{ (in Meg)}}$$

The grid current as determined in accordance with the above method shall not exceed the maximum limit specified.

4.10.22 Starting voltage. After the tube has conducted the specified anode current (I_o) for 1 minute, the starting voltage shall be measured immediately and shall be within the limits specified.

4.10.23 Grid-pulse operation. The electrical potentials specified on the tube specification sheet shall be applied to the tube. Sufficient negative grid voltage shall be applied to cut off the plate current. The cathode shall be preheated for a minimum of 30 seconds before grid pulse is applied. The duration of the test, excluding preheating, shall be as specified. The grid pulse (in time duration, excluding time of rise and time of fall) shall be as specified. Instantaneous plate, screen, and negative grid voltages shall not exceed 1.5 times their specified dc values due to transients. There shall be no evidence of arcing during the last half of this test.

4.10.24 Pulse emission. The tube shall be tested for pulse emission in the circuit shown on figure 42. A resistor shall be substituted for the tube under test for calibration purposes. R_a , R_p , and the calibrating resistor (as shown on figure 42) shall be within + 5 percent of that specified on the tube specification sheet and shall be noninductive. The control grid, and the shield grid when present,

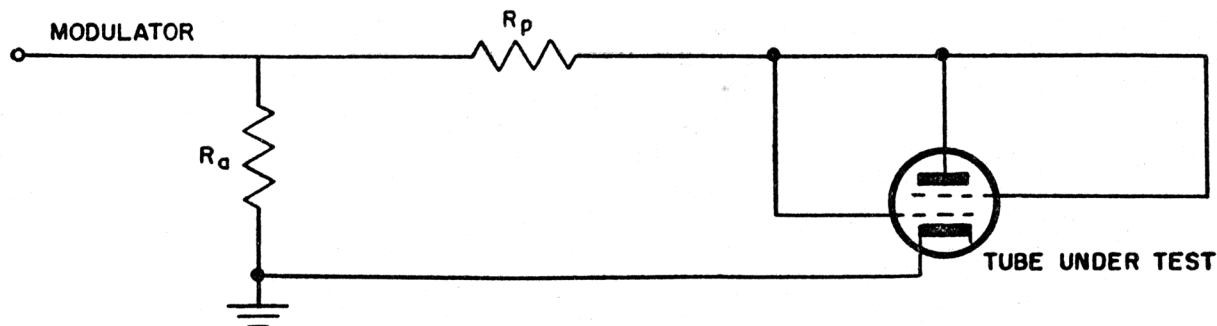


FIGURE 42. Circuit for testing pulse emission.

shall be tied directly to the anode. The calibrated pulse voltage amplitude shall be within the value specified over 80 percent of the top portion of the pulse and shall not vary from this value by more than 5 percent. The modulator impedance shall be as specified on the tube specification sheet. The pulse voltage characteristics shall be $t_p = 5.0 \pm 0.25$ us; $t_r = 0.5$ us maximum; $t_f = 1.0$ us maximum. The pulse emission shall be within the limits specified on the tube specification sheet.

4.11 Life tests. When specified on the tube specification sheet, sample tubes shall be subjected to life tests throughout production. When the tube specification sheet requires tubes to be furnished with a service-life guarantee, only 4.11.6 shall apply. *Except for stability and survival-rate tests, life tests are considered destructive.*

4.11.1 Conditions. The following conditions, when applicable to the type of tube under test, supplement the conditions on the tube specification sheet:

- (a) The manufacturer may choose intermittent or continuous operation, unless the former is specified. (See 4.11.5.)
- (b) The mean electrode potentials (except heater or filament) may deviate from the specified values by not more than -10% percent, *or + infinity*, provided the average electrode dissipations are equal to those obtained under the specified conditions.
- (c) The mean value of the filament or heater voltage shall be maintained at the specified value.

(d) If a heater-cathode potential is required during the life test, the resistance applied in series with this potential shall not exceed 5,000 ohms except for rectifier types, in which case the series resistance shall be approximately zero.

(e) When either ac or dc filament voltage is permitted, the grid bias shall be adjusted so that the average electrode dissipations are equivalent to those obtained under the specified conditions.

(f) See Amdt 5 p 19

4.11.1.1 Phototubes. These tubes shall be tested in a lightproof box containing the specified light source. The entire cathode of the tube shall be exposed to the light.

4.11.1.2 Cathode-ray tubes.¹ In addition to the requirements of 4.11 and 4.11.1, cathode-ray tubes shall be tested with a raster covering not less than 25 percent nor more than 75 percent of the tube-screen area. The light output or beam current shall be initially adjusted to the specified value measured in accordance with the pertinent portions of 4.12.5.2. Life tests shall be interrupted at approximately 10 and 50 percent of the specified life-test duration for measurement of the pertinent characteristics and any necessary readjustment of the test conditions.

¹ References to 4.11.2 on cathode-ray tube specification sheets dated prior to the approval date of this specification shall refer to 4.11.1.2 in this specification.

4.11.1.3 *TR, ATR, and pre-TR tubes.* These tubes shall have the rf line power measured immediately before the last tube preceding the load. Periodically during the life test, the tubes under test may be interchanged in their positions on the life-test rack. When an ignitor structure is used, the ignitor current shall not be adjusted during the life test. Life-test end points shall be measured using the voltage and resistor specified on the tube specification sheet.

4.11.2 *Tubes for life tests.*¹ The tubes shall be taken at random by the Government throughout the production. If the tubes selected are outside the initial specification limits for those characteristics designated as life-test end points or if the tubes have mechanical defects, they may be replaced by randomly selected good tubes. When tube types submitted under this specification are part of the manufacturer's regular production and are life-tested by him regularly under the specified conditions and in at least the required quantities, the results of these tests may be accepted in lieu of the results of the tests specified herein, at the option of the Government.

4.11.3 *Determination of life-test plan.* Except where the life-test sampling plan is specified, the required life-test plan shall be determined as follows:

4.11.3.1 *Reliable tubes.* When the tube specification sheet designates the tube as "Reliable", the following life-tests, as required by the tube specification sheet, shall be performed. In the absence of specific provisions on the tube specification sheet, the sampling and testing procedures applicable to life-tests specified for reliable receiving tubes in Appendix C shall apply.

(a) *Stability life test.* This is a test of 1 to 1 1/2 hour duration, under specified conditions, preceded and followed by measurements of one or

or more specified characteristics, and with specified maximum percentage characteristic changes for individual tubes. The AQL will be stated on the tube specification sheet.

(b) *Survival-rate life test.* This is a test of 100 hours duration, under specified conditions, followed by a continuity and shorts test as specified in 4.7.5, with a specified maximum number of resulting failures. This test is designed to maintain quality level in terms of early life survival.

(c) *1,000-hour and 500-hour intermittent life test.* This is a test of 1,000 hours duration, under specified electrical conditions, and with switching as described in 4.11.5, unless otherwise specified. For each of certain specified characteristics, end-points (see 4.11.4) and a maximum number of defectives are specified for both 500- and 1,000-hour checks. When the required 1,000-hour quality history has been built up, the tests may be terminated at the end of 500 hours in accordance with the applicable procedures and sampling plans specified in Appendix C.

4.11.3.1.1 *Equivalent conditions.* For survival-rate life test, the equivalent stability-life-test conditions shall be interpreted as having the same heater voltage (E_f) and heater-cathode voltage (E_{hk}) as the stability life test; and the same interruptions as specified in 4.11.5. The electrode voltages shall be such that the element dissipations are not less than 80 percent, nor more than 100 percent of stability-life-test plate dissipation. These voltages shall be chosen within the limits of 200 percent and 50 percent of the stability-life-test voltages.

4.11.3.1.2 *Order for evaluation of life test.* If a tube is defective for more than one char-

¹ References to 4.11.2 on cathode-ray tube specification sheets dated prior to the approval date of this specification shall refer to 4.11.1.2 in this specification.

acteristic, the characteristic appearing first in the life-test end points shall constitute the failure.

4.11.3.2 Life test groups A, B, C, and D.

When the tube specification sheet refers to one of these group letters, the duration of the test and life test end points (see 4.11.4) will also be specified. The number of tubes to be life tested shall be determined by the group in the following listing to which the tube type is assigned on the tube specification sheet or 1 percent of each month's production, whichever is less. In no event shall the number be less than one tube per month.

Group A—Not less than 5, nor more than 10 tubes per week.

Group B — Not less than three, nor more than five tubes per week.

Group C — Not less than one, nor more than three tubes per week.

Group D — Not less than one, nor more than three tubes per month.

At the option of the manufacturer, additional tubes in any quantity considered necessary to represent more accurate statistical sampling of the lot may initially be subjected to all tests required, and failure data shall be based on the total number of tubes placed on test. After the life test has started, the manufacturer may add an additional quantity of tubes to the initial life-test sample, but this may be done only once for any life-test lot. The tubes shall be checked (by applying the specified end-point tests) at intervals during the test. The length of these intervals shall be decided by the manufacturer. The average life of the sample shall be calculated as follows:

- (a) If the tube successfully completes the number of hours specified on the tube specification sheet, the number of credit hours shall be considered equal to the specified duration of the test.
- (b) If the time of failure of a tube was determined exactly, the number of

credit hours shall be equal to the number of hours on life completed before failure.

- (c) If the time of failure of a tube cannot be determined exactly, the number of credit hours shall be computed by one of the following methods, whichever yields the lesser results:

1. The sum of the hours earned up to the time of the last successful reading plus 10 percent of the life-test duration specified on the tube specification sheet.
2. The number of hours midway between the time of the last successful reading to the time of the first unsuccessful reading.

The average life of the sample shall be the average of the hours credited to the individual tubes in that sample. The total number of tubes placed on life test from the lot shall be considered the life-test sample but, at the discretion of the Government, any tube whose failure is due to test equipment failure or operator error shall not be considered. Unless otherwise specified on the tube specification sheet, at the conclusion of the time specified for the life test, the average life of the sample shall be not less than 80 percent of the duration of the test. This is a destructive test.

4.11.3.3 Release prior to completion of life test. The Government may release lots of tubes for shipment prior to completion of life test if, firstly, the completed life test samples immediately preceding the current samples meet the requirements given in the table below and, secondly, the current uncompleted life test samples shall not have failed at this time. An uncompleted life test sample shall be considered unsatisfactory for early release purposes if it is mathematically impossible for it to qualify under 4.11.3.2 when considering only those tubes which were initially subjected to life test.

Minimum completed average credit hours	Requirements for completed samples immediately preceding present sample
(a) 80 percent of specified life, unless qualified in b, c, d, or e for earlier release.	None
(b) 60 percent of specified life, unless qualified in c, d, or e for earlier release.	either (1) If the last three completed samples passed. or (2) If not more than 1 of the last 10 completed samples failed.
(c) 30 percent of specified life, unless qualified in d or e for earlier release.	either (1) If the last five completed samples passed. or (2) If not more than 1 of the last 14 completed samples failed.
(d) 10 percent of specified life, unless qualified in e for earlier release.	either (1) If the last seven completed samples passed. or (2) If not more than 1 of the last 17 completed samples failed.
(e) 0 percent of specified life.	If the last 10 completed samples passed.

4.11.3.4 Life-test failure after shipment. In the event a life-test group fails and the lot of tubes represented has been shipped prior to the completion of life test, the manufacturer shall immediately inform the responsible contracting officer of the orders filled by such a lot or lots and the matter shall be subject to renegotiation. The manufacturer shall notify the Government immediately of the failure and of the action taken.

4.11.4 Life-test end point. The criterion for life-test end point shall be either that provided by the relevant general paragraph in this specification or the characteristic(s) specified on the tube specification sheet. A tube shall be considered to have reached the end of its life, ie, shall be considered a defective, when it fails the specified life-test end point limit(s), measured under the specified test conditions, or exhibits one or more of the following defects: discontinuity (see 4.7.1), permanent shorts (see 4.7.2), air leaks (see 4.7.6). When two or more tests are specified for the life-test end points, failure on any

one of these tests shall constitute failure of the tube. When optional tests are specified on the tube specification sheet, the one selected by the manufacturer at the start of the test shall govern.

4.11.4.1 Life-test end points for cathode-ray tubes. In addition to the requirements of 4.11.4, cathode-ray tubes shall not exceed the following limits at the end of the specified life test:

Heater-cathode leakage 30 uAdc
Grid No. 1 leakage 5 uAdc
Grid No. 2 leakage 15 uAdc
Anode No. 1 leakage 15 uAdc
Anode No. 2 leakage 15 uAdc
Stray emission As specified in 4.12.4.2

4.11.5 Intermittent life-test operation. When intermittent life-test operation is performed, the tubes shall be operated under the specified test conditions with the filament or heater supply interrupted periodically. There shall be 12 to 25 uniform cycles, totalling approximately 20 hours of "on" operation per 24 hours. The filament or heater supply shall be applied and removed instantaneously. Other potentials may be applied continuously, at the option of the manufacturer. The accumulation of the "on" time shall be the time considered in determining compliance with the minimum specified time value. The filament or heater-supply impedance shall not exceed 10 percent of the hot filament-load impedance. Warmup time, tk, when specified on the tube specification sheet as a test condition for intermittent life test, shall be adhered to at the beginning of each "on" period. This is a destructive test.

4.11.6 Service-life guarantee. When service-life guarantee is specified on the tube specification sheet, the tube shall not be subjected to the life test but shall have a service-life guarantee. The period of this service-life guarantee shall be as specified on the tube specification sheet, subject to modification in the contract or order.

The maximum frequency of interruption shall be one interruption per hour

Not less than 1 minute on and
not less than 1 minute off

4.11.7 *Heater-cycling life test.* A complete cycle is made in a 2-minute period as follows: 1 minute "on", 1 minute "off". Duration of the cycling test shall be 2,000 cycles. The heater-voltage supply shall have a regulation of not more than 4 percent (no-load to steady-state load). Heater-cathode voltage shall remain on continuously. Any tube which shows an open heater, open cathode circuit, heater-cathode short, or fails to meet any specified life-test-end-point limit for this test prior to the completion of the cycling test shall be considered a defective tube. The AQL for this test shall be 1.0 percent. A leakage current in excess of 7.5 mA_{dc} between the heater and cathode shall be considered a heater-cathode short. Acceptance-sampling procedures applicable to the heater-cycling life test shall be as specified in Appendix C. This is a destructive test.

4.11.8 *Cathode interface life test.* The tubes shall be operated for 500 hours with 110 percent normal heater voltage applied and with the other electrodes disconnected. The tubes shall be preheated for approximately 5 minutes, after the conclusion of the 500 hours of operation, with 90 percent of normal heater voltage applied and with the other electrodes disconnected. The tubes shall then be tested in the circuit shown on Drawing 248-JAN, with 90 percent of normal heater voltage applied and with the cathode current adjusted to the minimum value necessary to provide sufficient transconductance to permit a stable measurement of cathode interface resistance. The readings of cathode interface resistance shall be within the limits specified. As an alternative, a test method known to correlate with the method of Drawing 248-JAN and with the conditions specified may be utilized.

4.12 *Cathode-ray tube tests.* The tests specified in 4.12.1 to 4.12.14, inclusive, are applicable only to cathode-ray tubes. The tubes shall be subjected to such of these tests as are specified on the tube specification sheet.

4.12.1 *Electrode tests.*

4.12.1.1 *Electrode currents.* Under the specified test conditions, the electrode current

shall be within the limits specified. The light output shall be measured as specified in 4.12.5.2.

4.12.1.2 *Voltage breakdown.* The maximum rated heater (or filament) voltage shall be applied with the potential of the control grid at maximum rating with respect to the cathode, and with the instantaneous potential of any part of the heater at its maximum rating with respect to the cathode (when unipotential cathode not internally connected to the heater is employed) and with all other voltages equal to zero. Maximum rated heater or filament voltage shall be 7.0 volts for tubes with heater or filament voltage rating of 6.3 ± 10 percent and 2.75 volts for tubes with maximum heater or filament voltage of 2.5 ± 10 percent. There shall be no recurrent breakdown between elements.

4.12.1.3 *Voltage breakdown (electrostatic types).* The control grid shall be adjusted for cutoff, and the first and second anodes (and the third anode, when present) set at their maximum rated voltages. There shall be no breakdown between elements.

4.12.1.4 *Voltage breakdown (magnetic types).* The control grid shall be adjusted for cutoff, and grid No. 2 and anode set at their maximum rated voltages. There shall be no breakdown between elements.

4.12.2 *Gas tests.*

4.12.2.1 *Gas "cross".* Test voltage as specified shall be applied and the trace adjusted to focus. The screen of the tube shall be scanned to yield a square pattern having an area equal to approximately 2 by 2 inches. Linear saw-tooth scanning as follows shall be used:

Horizontal 2,100 to 6,300 cps
Vertical 50 to 60 cps

When the light output or screen current is set at the value specified on the tube specification sheet, the appearance on the screen of a "cross" is indicative of excessive gas. All tubes upon which crosses appear shall be rejected.

4.12.2.2 *Gas ratio.* With voltages as specified in conditions A and B and with focus, scanners, and ion trap magnets off, I_k (mA_{dc}) and I_b (uA_{dc}) shall be determined.

Condition A	Condition B
$E_b = -25$ V	$E_b = -25$ V
$E_{c2} = +300$ V	$E_{c2} = +300$ V
$E_{c1}/I_k = 500$ uA	$E_{c1} = -90$ V

For types with cutoff voltages greater than 90, use sufficient bias to insure cutoff. The value of gas ratio (Gr) shall be computed from the following equation and shall not exceed the limit specified on the tube specification sheet.

$$Gr = \frac{I_b \text{ (condition A)} - I_b \text{ (condition B)}}{.500}$$

4.12.3 Alinement tests.

4.12.3.1 *Base (electrostatic types).* The angle between the trace produced by the designated deflecting plates and the plane passing through both the center of the designated base pin and the axis of the tube shall not exceed 10°. With a positive potential applied on the plate specified on the tube specification sheet, the spot shall be deflected in the direction of the designated pin.

4.12.3.2 *Side terminal (electrostatic types).* The angle between a designated trace and a plane through the center of the side terminal and the axis of the tube shall not exceed 10°.

4.12.3.3 *Side terminal and base.* The angle between the plane passing through both the center of the designated base pin and the axis of the tube, and the plane passing through the center of the side terminal and the axis of the tube shall not exceed 10°. The designated base pin shall be on the same side of the tube as the side terminal.

4.12.3.4 *Neck and bulb (electrostatic types).* The alinement of the neck with the body of the tube shall be measured by rotating the tube about an axis through the center of the pin circle (in the plane of the bottom of the base) and the center of the face of the bulb. The diameter of the circular area swept

through by transverse section of the neck at a point $\frac{1}{4}$ inch nearer the base than the CD line (the horizontal line at the junction of the bulb body and neck) shall not exceed the value specified.

4.12.3.5 *Neck and base (electrostatic types).* The angle between the longitudinal axis of the base and the longitudinal axis of the neck shall not exceed 2°.

4.12.3.6 *Neck and bulb (magnetic types).* The tube shall be rotated about the axis of the neck, and measurement shall be made of the variation in distance from the axis of rotation to the periphery of the bulb in a plane normal to the axis of rotation and nearer the base than the point where the axis of rotation intersects the face of the tube by the following schedule of distances: 0.3125 inch for 5-inch tubes, 0.75 inch for 7-inch tubes, 1.25 inches for 9-inch tubes, 1.5 inches for 10-inch tubes, and 1.75 inches for 12-inch tubes. The axis of the neck is defined as the axis of rotation when the neck is supported on two sets of "V" wheels, 3-wheel chucks or equivalent, placed 0.75 inch and 4.25 inches below the reference plane. The variation shall be not more than 0.125 inch for 3- and 5-inch tubes, 0.225 inch for 7-inch tubes, and 0.400 inch for 9-, 10-, and 12-inch tubes.

4.12.3.7 *Angle between traces.* When measured with a device having an accuracy of at least $\pm 0.2^\circ$, the angle between horizontal and vertical traces shall be $90^\circ \pm 3^\circ$. The angle shall be measured counterclockwise from the horizontal traces. The angle between corresponding traces of multigun tubes shall be not greater than 1°.

4.12.3.8 *Face tilt.* When the tube is rotated about the axis of the neck, as defined in 4.12.3.6, the total variation in the distance from the face plate to a plane perpendicular to the axis of rotation shall be not greater than 0.080 inch for 3- and 5-inch tubes, 0.150 inch for 7-inch tubes, and 0.225 inch for 9-, 10-, and 12-inch tubes. This variation shall be measured on the face at a distance from

the axis of rotation equal to the minimum useful screen radius for the tube.

4.12.3.9 Neck straightness. The neck and base straightness shall be determined by the insertion of the tube neck in a cylinder 5 inches long and 1.4375 inches maximum inside diameter. This cylinder shall move freely between the reference line and the base of the assembled tube.

4.12.4 Spurious illumination tests.

4.12.4.1 Cathode illumination. With the tube enclosed in a lightproof container and with the specified heater potential applied for a minimum of 60 seconds, the light output at the face of the tube shall be not more than 0.154 mftL in any 2-inch diameter area.

4.12.4.2 Stray emission (conventional types). With the tube enclosed in a lightproof container, with the specified potentials applied, and with no deflecting fields applied, the tube shall be biased to cutoff. Under these conditions the entire face of the tube shall be examined for stray emission by an observer who has accommodated his eyes to viewing the face of the cathode ray tube for at least 2 minutes through an aperture in the lightproof container. If stray emission occurs, scanning fields such as would be required to produce a 1 by 1 inch raster shall be applied, under which condition the stray emission shall disappear completely. This test shall be a design test.

4.12.4.3 Stray emission (daylight viewing types). This test shall be performed in the same manner as specified in 4.12.4.2 except that stray emission should disappear completely when scanning fields, as would be required to produce a 2 by 2 inch raster, are applied. This test shall be a design test.

4.12.5 Screen and glass-face quality. The tube shall be viewed while operating at the normal test voltage conditions specified on the tube specification sheet with the screen fluorescing uniformly under a defocused scan. Long

persistence screens shall also be viewed under phosphorescence. In either case the ambient illumination shall be well below the luminescent level.

4.12.5.1 Blemishes. Inspection shall be made for spots, holes, and blemishes on the screen and face of the tube. The number and sizes of, and the intensity variation due to, spots, holes, and blemishes shall not exceed those specified in Appendix B.

4.12.5.2 Light output. The light output of the screen shall be measured under the specified conditions and the following general conditions: A 35- to 105-line pattern shall be provided on the cathode-ray tube screen, using 60-cycle saw-tooth scanning on one axis and 2,100- to 6,300-cycle saw-tooth scanning on the other axis. In the case of electrostatic deflection types, the mean potential of free deflecting plates shall be that of anode No. 2. The pattern size shall be adjusted to 2 by 2 inches, and the light output shall be read. A foot-candle meter, corrected for the spectral response of the eye, shall be used to measure the light output. The light output so determined shall be not less than the value specified on the tube specification sheet. When these conditions are satisfied, and the foot-candle meter is placed so that the sensitized surface of the photocell is against the tube face, the meter may be used to read foot-lamberts directly.

4.12.5.3 Modulation. The grid drive (grid voltage above spot-cutoff) required for the specified minimum light output or screen current shall be not greater than the value specified on the tube specification sheet.

4.12.5.4 Screen (P7 types). The phosphorescent light intensity observed 1 second after completion of the application of a single standard raster to the tube is cb1; the intensity observed 1 second after the fifth raster is cb5. The buildup factor is described as G5:1 and is defined as the ratio of the light intensity obtained 1 second after the fifth raster to the light intensity obtained 1 second after the first raster, when these are expressed on a linear

light scale instead of the centibel scale. In practice, it turns out to be rather easier to calculate if the antilogarithm of the difference between cb5 and cb1 is used to calculate the factor G5:1. Unless otherwise specified, the screen characteristics shall be measured under the following conditions:

- (a) Anode voltage (relative to cathode) = 4,000 volts.
- (b) Grid voltage (g2 for magnetically focused tubes) = 250 volts.
- (c) Raster size (focused beam) = 7.1 by 7.1 cm, giving a total area of 50 cm². (Beam is defocused for measurement.)
- (d) Duration of raster = $\frac{1}{60}$ sec. The raster is formed by means of linear scanning with the horizontal scanning frequency 12 kc and the vertical scanning frequency 60 cycles. The raster is repeated at 1-second intervals.
- (e) Distance of raster from axis of calibrated 931VA multiplier tube = 30 cm.
- (f) Beam current = 60 ua defocused to a spot approximately 0.25 cm in diameter.
- (g) Red light: Sufficient to de-excite the phosphor before buildup measurements so that the results are within 3 cb of those that would have been obtained after total de-excitation.
- (h) Filter: Wratten No. 15, or equivalent.

Deviations from the conditions listed above in regard to test voltages, currents, pattern size, etc, required to test a number of different tube types, may be tolerated if such deviations are referred to the ~~Armed Services Electro-Standards Agency (ASESA)~~. A description of the P7 screen primary standard replica lamp will be found in the Material Laboratory, New York Naval Shipyard Report NE 091105, dated 26 June 1952.¹ Centibels may

¹ Copies of this report may be obtained from the Bureau of Ships, Code 816, Navy Department, Washington 25, D. C.

be converted to millifoot-lamberts by the use of the following equation:

$$\text{mftL} = 2 \times 10^{-3} \times 10^{\frac{\text{cb}}{100}}$$

The minimum acceptable screen characteristics shall be:

Property	Limits	Property	Limits
cb5	400 cb or B5	20 mftL	
G5:1	4	BR	4

The two sets of test limits are equivalent.

4.12.5.4.1 Screen brightness I. Screen brightness I shall be measured under the same conditions as those specified in 4.12.5.4, except that no pulsing shall be used on the grid, and the screen current shall be 60 uA. The steady-state light output shall be 640 cb minimum.

4.12.6 Line width tests. Two line width determinations shall be made; one determination at the center of the screen (position A in both electrostatic- and magnetic-deflection types) and another determination at a point along the direction of high-frequency scanning, distant from the center of the screen by $\frac{3}{8}$ of the maximum bulb diameter. In the case of electrostatic types, this second position is referred to as position B; in the case of magnetic types, as position C.

4.12.6.1 Line width (electrostatic deflection). The scanning pattern specified in 4.12.5.2 shall be set at the light output or screen current specified. The high-frequency scanning shall be applied to the deflecting plates nearest the screen and the amplitude shall be adjusted to give a line length of approximately 90 percent of the maximum tube diameter. The low-frequency scanning amplitude shall be expanded to make the line structure clearly visible and adjustment shall be made for best focus in the center of the pattern. The pattern shall be compressed until the line structure first disappears or begins to overlap or shows reverse line structure at the center of the screen. The line width at position A is then given by the quotient of the width of the compressed-pattern trans-

verse to the line structure divided by the number of lines which are being scanned, and shall be within the values specified. The connection of deflection elements to the low- and high-frequency scanning supplies shall then be interchanged and line-width determination repeated without adjustment of focus. In this case, however, the line-structure disappearance or overlapping shall be determined at the less favorable of the two alternate B positions. Again, the line width is given by the transverse width of the pattern divided by the number of lines. The line width so determined shall be within the values specified.

4.12.6.2 Line width (magnetic-deflection). The procedure specified in 4.12.6.1 for electrostatic types shall be followed in the case of line width determination at position A. Without interchange of connections to the deflecting elements, line-width determination shall then be made at the less favorable of the two alternate C positions. (Request for approval to use focusing and deflection coils required for line-width tests shall be referred to the Armed Services Electro-Standards Agency (ASESA).) The line width so determined shall be within the values specified.

4.12.7 Spot position. The tube shall be operated at the test conditions specified. The tube shall be shielded against external magnetic and electrical influences and the control-grid voltage shall be set at a value which will avoid damage to the screen.

4.12.7.1 Spot position (magnetic deflection). With the tube operated as specified in 4.12.7, the distance between the center of the undeflected spot and the center of the screen shall be within the limits specified. In the case of magnetic-focus types, the focusing current shall be zero. In the case of electrostatic-focus types, the spot shall be adjusted for focus.

4.12.7.2 Spot position (electrostatic deflection). The tube shall be operated as specified in 4.12.7 and adjusted for focus with each of the free deflecting electrodes connected to

anode No. 2. The spot shall be within a square, the dimensions of which are within the limits specified on the tube specification sheet, the center of which coincides with the geometric center of the tube face, and one side of which is parallel to a trace produced by one set of deflecting electrodes.

4.12.7.3 Spot displacement (leakage). The tube shall be operated as specified in 4.12.7 and adjusted for focus with each of the free deflecting electrodes connected to anode No. 2 through a 10 Meg resistor. The spot displacement produced by the shorting of each resistor in turn shall not exceed the value specified. An equivalent combination of resistance and displacement limit may be used.

4.12.8 Zero-bias anode current (magnetic focus). At the electrode voltages specified, the zero-bias anode current shall be measured, and shall be not less than the values specified in table VII for tubes having the corresponding values of cutoff.

TABLE VII. Grid No. 1 cutoff voltage versus minimum zero-bias current.

Grid No. 1 cutoff voltage	Minimum zero-bias current	Grid No. 1 cutoff voltage	Minimum zero-bias current
25	350	48	692
26	350	49	713
27	350	50	735
28	350	51	758
29	350	52	780
30	350	53	802
31	360	54	825
32	377	55	850
33	394	56	872
34	419	57	895
35	431	58	918
36	449	59	943
37	468	60	966
38	487	61	991
39	507	62	1,015
40	527	63	1,040
41	547	64	1,065
42	567	65	1,090
43	587	66	1,115
44	607	67	1,142
45	628	68	1,165
46	650	69	1,192
47	670	70	1,217

4.12.9 Grid cutoff voltage. The grid voltage shall be adjusted for visual extinction of the undeflected focused spot. The cutoff voltage shall be within the limits specified.

4.12.10 Focusing tests. The beam shall be focused under the test conditions specified.

→ See Amdt 5 p29

4.12.10.1 Focusing voltage at cutoff. With the control-grid voltage adjusted so that the pattern is barely visible, the voltage necessary to bring the beam to focus shall be within the limits specified.

4.12.10.2 Focusing voltage, zero-bias. With the control-grid voltage varied through the range of zero volts to cutoff, the voltage necessary to bring the beam to focus shall be within the limits specified.

Standard focusing coil TEDEC No 106

mult 5
729

4.12.10.3 Focusing ampere turns. } JAN standard coil No. 20, or equivalent, shall be used. The number of ampere turns required for focus, as determined by multiplying the current in milliamperes by 4.5, shall be within the limits specified. The distance D from the center of the focus-coil air gap to the reference line shall be as specified.

See Amdt 5 p 29

4.12.11 Deflection factor. With the test conditions specified, the deflection factor (the ratio of the instantaneous voltage to the corresponding deflection in inches) on each axis shall be within the limits specified.

See Amdt 5 p 30

4.12.12 Deflection-factor uniformity. The deflection-factor uniformity on each deflection axis shall be determined. For any axis, the deflection factors corresponding to symmetrical deflections of 25 percent and 75 percent of the minimum useful screen diameter shall be measured along the tube-face contour. The factor at 25-percent deflection shall not differ from the factor at 75-percent deflection by more than 5 percent.

4.12.13 Electrode-leakage tests. The leakage shall be measured under the test conditions specified.

4.12.13.1 Heater-cathode leakage. In testing tubes having unipotential cathodes not con-

nected to the heater within the tube, rated heater voltage shall be applied to the heater terminals and the instantaneous potential of any part of the heater shall be maintained at at least —125 volts with respect to the cathode. The heater-cathode leakage current shall not exceed 10 uAdc.

4.12.13.2 Grid No. 1 leakage. With the control grid biased to cutoff, the leakage between grid No. 1 and all other electrodes shall not exceed 3 uAdc.

4.12.13.3 Grid No. 2 leakage. With the control grid biased to cutoff, the leakage between grid No. 2 and all other electrodes shall not exceed 5 uAdc.

4.12.13.4 Anode No. 1 leakage. With the control grid biased to cutoff, the leakage between anode No. 1 and all other electrodes shall not exceed 5 uAdc.

4.12.13.5 Anode No. 2 leakage. With the control grid biased to cutoff, the leakage between anode No. 2 and all other electrodes shall not exceed 5 uAdc.

4.12.14 Magnetization. The tube shall be demagnetized and shall then immediately be scanned with a raster as specified in 4.12.6.1 or 4.12.6.2, as applicable. The change in line width following demagnetization shall not exceed 20 percent of the line width measured in accordance with 4.12.6.1 or 4.12.6.2, as applicable. The change of position of the undeflected spot shall not exceed 40 percent of the maximum allowable spot-to-center distance. The entire tube shall then be exposed to a magnetic field of 500 gauss $\pm$ 10 percent, after which the tube shall not exceed the maximum limits for the line width or spot-to-center distance specified.

→ 4.12.15 See Amdt 5 p30

4.13 Cold-cathode discharge tube tests. The tests specified in 4.13.1 to 4.13.6, inclusive, are applicable only to voltage regulators, cold-cathode tubes, and other similar types. The tubes shall be subjected to such of these tests as are specified on the tube specification sheet.

4.13.1 Ionization voltage. When a holding period is specified for the test specified in 4.13.1.1 or 4.13.1.2, each test shall be immediately preceded by its own holding period. A test shall not be repeated until this holding period has again elapsed.

4.13.1.1 Ionization voltage (1) (with illumination). Under the conditions specified on the tube specification sheet, the voltage required to start conduction shall be within the limits specified. The tube shall be subjected to normal room illumination, either natural or artificial, unless some specific value of illumination is given. When a conditioning current is specified, this current shall be conducted between the elements to be tested not more than 30 seconds prior to making this test. This conditioning current shall be conducted for a period of not less than 0.1 second nor greater than 5 seconds.

4.13.1.2 Ionization voltage (2) (total darkness). The tube shall be held inoperative in total darkness for a holding period of not less than 24 hours prior to performance of the test and until completion of the test. Under the conditions specified on the tube specification sheet, the voltage required to start conduction in total darkness shall be within the limits specified.

4.13.2 Tube voltage drop. Under the specified conditions and with the tube conducting current for at least 0.1 second, the tube voltage drop shall be within the limits specified.

4.13.2.1 Regulation. The voltage drop across the tube shall be measured under two different conditions: First, while conducting a specified minimum current; and second, while conducting a specified maximum current. The difference between the two voltages shall be within the limits specified for regulation.

4.13.3 Leakage current. Voltage-regulator tubes shall be tested for leakage current by applying the specified anode potential. The total external circuit resistance shall not exceed 100,000 ohms. The anode current shall be within the limits specified.

4.13.4 Noise and oscillation test.

4.13.4.1 Test equipment. The tube shall be operated from a well filtered variable dc supply, the output capacitance of which shall be at least 16 uf. The voltage from the filter output shall be supplied to the tube through a series resistance of 500 ohms. The internal connection between the base pins shall be connected in series with the tube electrode. The tube shall be coupled through a series capacitance of 0.1 uf to the amplifier specified in the audio-frequency noise test. (See 4.10.3.2) If a meter other than a standard VU meter is used, calibration may be performed with a keyed signal and all meter readings shall be taken on the peak swing of the pointer.

4.13.4.2 Oscillation test. The current through the tube shall be varied in each direction between the minimum and the maximum specified values, employing either voltage or load variation, and taking not less than 2 seconds to traverse the range. No oscillation persisting over a current range of more than 2 mAdc shall be generated as evidenced by aural observations.

4.13.4.3 Noise test. With the conduction current reduced to the value specified, the tube shall be tapped as specified for the noise tests. (See 4.10.3.) The amplifier gain shall be adjusted for 50 mW output when the maximum voltage limit specified is applied at 400 cycles to the amplifier input. Tubes producing a voltage disturbance to the amplifier which exceeds the specified limit shall be rejected.

4.13.5 Uniformity of cathode glow. Under the conditions specified on the tube specification sheet, the cathode glow shall be substantially uniform over the cathode surface.

4.13.6 Transfer current. Under the conditions specified, the current to the control anode (grid) required to cause the tube to conduct current to the main anode shall be within the limits specified.

4.14 Crystal-rectifier tests. The tests specified in 4.14.1 to 4.14.4.5, inclusive, are ap-

plicable only to crystal rectifiers. The crystal rectifiers shall be subjected to such of these tests as are specified on the tube specification sheet. Production tests may be performed in any sequence, except that the burnout test shall precede all others and shall be made only once on each crystal rectifier. Design tests shall be performed in the order specified on the tube specification sheet. All tests shall be performed after a 24-hour holding period following completion of all manufacturing processes.

4.14.1 Handling precautions. After production tests have been completed, the following handling precautions shall be observed:

- (a) Ground all equipment.
- (b) Handle the unit by the base only. Make contact to the equipment through this end before touching the top, and maintain hand contact with the equipment until the unit is in place.
- (c) Keep units in metal shields until they are inserted in the equipment or until necessary to remove for test.
- (d) Do not tamper with the set screws.

4.14.2 Burnout test.

4.14.2.1 Burnout by dropping. Each crystal rectifier shall be subjected to a dc pulse from the coaxial line shown on the drawing specified on the tube specification sheet. The line shall be charged with the specified voltage and the contact shall be made by dropping the center conductor vertically from a height of 2 ± 0.05 inches above the contact position. The electrical and mechanical connection shall be such as to have minimum effect on the free fall of the conductor. The inner conductor shall be negative with respect to the outer conductor. After completion of this test, the crystal rectifier shall meet all other requirements of the tube specification sheet.

4.14.2.2 Burnout by pulsing. Each crystal rectifier shall be subjected to a pulse or pulses of the length and voltages specified. After

completion of this test, the crystal rectifier shall meet all other requirements of the tube specification sheet.

To the satisfaction of the Qualification Approval Authority

4.14.3 Electrical tests. The following tests shall be conducted in the mixer shown on the drawing specified. All fixed adjustments of the mixer shall be made in a Government laboratory designated by the bureau or service concerned. In the test equipment, the impedance presented to the mixer by the local oscillator (and the signal generator, if used) shall be the impedance(s) to which the mixer is tuned. The frequency and the available power of the local oscillator (and the signal generator, if used) shall be as specified on the tube specification sheet.

To the satisfaction of the Qualification Approval Authority

4.14.3.1 Conversion loss. The testing apparatus shall be calibrated by means of a group of 10 crystal rectifiers which have been selected and measured as standards at a Government laboratory designated by the bureau or service concerned. The entire standard group of 10 shall be discarded as standards whenever more than 2 in that group have changed relative to the others by 0.5 db or more. However, those crystal rectifiers which have changed less may be resubmitted for calibration as a part of new groups of 10. Secondary standards may be established by the manufacturer by comparison tests with a standard group. Conversion loss shall be measured in accordance with method A or B, as specified on the tube specification sheet.

4.14.3.1.1 Method A. The conversion loss of the unit under test shall be determined by comparing its if output power with that of standard crystal rectifiers when the available rf signal input power is kept constant. The mixer shall be connected to an if amplifier whose input impedance as seen at the crystal terminals matches R_c and which provides the given dc load resistance (R_L). The conversion loss shall not exceed the limit specified.

4.14.3.1.2 Method B. The oscillator amplitude shall be modulated at the specified frequency and the mixer connected to a load having an impedance (Z_m) at modulation fre-

quency and a dc resistance (RL). The conversion loss of the unit under test shall be determined by comparing its power output at modulation frequency to that obtained from standard crystal rectifiers when the available power from the local oscillator and its percentage modulation are kept constant. The conversion loss shall not exceed the limit specified.

4.14.3.2 Output noise ratio. As a check on the test equipment, the indicated noise ratios of resistances of $2R_c$ and $0.5R_c$ shall be not less than 0.8 times. Output noise ratio shall be measured in accordance with method A or B, as specified on the tube specification sheet.

4.14.3.2.1 Method A. The ratio of the available noise output power from the unit under test to that from R_c , at room temperature, shall not exceed the limit specified. The mixer shall be connected to an if amplifier whose input impedance as seen at the crystal terminals matches R_c and which provides the given dc load resistance (RL).

4.14.3.2.2 Method B. The ratio of the noise output power from the unit under test to that from R_c , at room temperature, shall not exceed the limit specified. The mixer shall be connected to an if amplifier whose input impedance as seen at the crystal terminals matches R_c and which provides the given dc load resistance (RL). The local oscillator shall be coupled to the mixer through a filter, as specified, and an attenuator matched to the impedance of the coupling to the mixer and having at least a 5 db attenuation.

4.14.3.3 if impedance. The impedance measured at the if terminal of the mixer at the specified frequency shall be within the limits specified on the tube specification sheet.

4.14.3.4 Video impedance. The impedance measured at the video terminal of the crystal mount at the specified frequency shall be within the limits specified.

4.14.3.5 Figure of merit. The figure of merit (M) shall be calculated by the following equation:

$$M = \frac{aR_v}{\sqrt{R_v + R_a}}$$

Where R_a is a specified constant, a is the current sensitivity in amperes of rectified current-per-watt available rf power, and R_v is the video impedance. The value of the rectified current used in calculating a shall be the rectified current into zero-load impedance. The holder shall be tuned for maximum rectified current for each unit tested. A minimum of 10 db of attenuation shall be inserted between the rf oscillator and holder. The figure of merit shall be not less than the limit specified.

4.14.3.6 Rectified crystal current. The rectified crystal current determined under the conditions for conversion loss (see 4.14.3.1) shall be not less than the limit specified.

4.14.4 Mechanical tests. The mechanical tests specified in 4.14.4.1 to 4.14.4.5, inclusive, shall be conducted when specified on the tube specification sheet. At the completion of each test, the electrical tests (see 4.14.3) specified on the tube specification sheet shall be conducted and the performance shall be within the limits specified.

4.14.4.1 Temperature. The crystal rectifiers shall be subjected to five consecutive temperature cycles beginning at a temperature of -40°C as follows: The units shall be heated from a temperature of -40°C to a temperature of $+70^\circ\text{C}$ in a 15- to 20-minute period, and cooled again to a temperature of -40°C in a 15- to 20-minute period. When the temperature test is conducted as a production test, the time periods of heating and cooling shall be sufficient to bring the lot to the specified temperature. The time necessary to attain the initial -40°C temperature and to return from the final -40°C temperature to ambient temperature is optional with the manufacturer. The crystal rectifiers shall meet the requirements specified for this test on the tube specification sheet.

4.14.4.2 Drop. The crystal rectifier shall be dropped three times from a horizontal position to a maple-wood block 1 inch thick and not

less than 6 by 6 inches. The height from which the crystal rectifier is dropped shall be as specified on the tube specification sheet. The crystal rectifier shall meet the requirements specified for this test on the tube specification sheet.

4.14.4.3 Torque. A torque of 1.5 inch-pounds about the crystal-rectifier axis shall be applied without shock between the end contacts and in a direction which tends to cause loosening of the end contacts. The manufacturer's recommendation shall be followed in the method of clamping the crystal rectifier. The crystal rectifier shall meet the requirements specified for this test on the tube specification sheet.

4.14.4.4 Axial strain. With the base of the crystal rectifier clamped, a force of 1 pound shall be applied without shock at right angles to the axis of the crystal rectifier as near the tip of the small contact as is practicable. The crystal rectifier shall meet the requirements specified for this test on the tube specification sheet.

4.14.4.5 Immersion. The crystal rectifier shall be immersed in a water bath at a temperature of 40° C for 15 minutes. At the conclusion of this period, it shall be transferred immediately to a water bath at a temperature of 25° C and immersed for 15 minutes. The surface of the crystal rectifier shall then be wiped dry and the required electrical tests shall be conducted within 1 hour. The crystal rectifier shall meet the requirements specified for this test on the tube specification sheet.

4.15 Klystron tests. The tests specified in 4.15.1 to 4.15.7.2, inclusive, are applicable only to klystrons. The tubes shall be subjected to such of these tests as are specified on the tube specification sheet. See Appendix C for special inspection provisions for klystrons.

4.15.1 Power output. Measurements on tubes in an oscillating state shall be made with the proper voltages applied and the tubes coupled to the specified load as specified. The standing wave ratio in voltage shall be less

than the value specified. The power output shall be continuous throughout the frequency range for the voltage ranges specified and, if specified on the tube specification sheet, the power shall be above the minimum value specified at all frequencies within the range. When the power output is to be measured at a specified frequency, the voltages shall be adjusted within the ranges specified to obtain maximum power output. Tubes furnished with two or more rf output terminals shall produce the specified minimum power from each of the terminals separately.

4.15.1.1 Broad-band testing. The assembly of the broad-band testing circuit, the details of the components of the load, and the testing procedures shall be as specified on the tube specification sheet.

4.15.2 Emission oscillation. This test shall be made with the tube oscillating under the oscillation test conditions after the oscillation test. The filament potential shall be changed as specified, and the change in power output or cathode current shall be within the limits specified. This measurement shall be made after the specified time interval.

4.15.3 Electronic tuning range. The mechanical-tuning and controlling voltage within the range specified shall be adjusted mutually for a maximum power output at the frequency specified. The controlling voltage shall then be adjusted above and below the value for maximum power so that the power is reduced to the value specified on the tube specification sheet. The frequency change between these specified values shall be defined as the electronic-tuning range. This test shall be made in the equipment specified, adjusted to the conditions specified on the tube specification sheet. If specified, the electronic-tuning range shall be free from hysteresis.

4.15.4 Frequency drift. The total frequency change measured under the conditions specified shall be within the limits specified.

4.15.5 Temperature coefficient. The temperature coefficient, when tested under the condi-

tions specified, shall be computed in frequency units per degree centigrade over the range specified.

4.15.6 Warmup time. The warmup time measured under the conditions specified shall not exceed the value specified.

4.15.7 Hysteresis. The measurement of electrical-tuning hysteresis shall be made with the frequency of oscillation adjusted to the value specified. In addition to the direct voltage required for the mode specified, a 60-cycle or other low-frequency sweep voltage of essentially sinusoidal shape, sufficiently large to suppress oscillations on the two ends of the sweep, shall be applied between the controlling electrode and the cathode. The crystal-rectifier current shall be examined as a function of the sweep voltage with a cathode-ray oscilloscope, and any interval over which oscillation is observed for one direction of sweep only is said to exhibit hysteresis.

4.15.7.1 Hysteresis (1). The ratio of the voltage interval or intervals in which hysteresis is present to the voltage interval in which oscillation is observed shall not exceed the amount specified.

4.15.7.2 Hysteresis (2). The ratio of the highest power level at which hysteresis occurs

to the maximum power level shall be within the limits specified. Suitable methods shall be used to calibrate the crystal response in terms of relative power level.

4.16 Magnetron tests. The tests specified in 4.16.1 to 4.16.8, inclusive, are applicable only to magnetrons. The tubes shall be subjected to such of these tests as are specified on the tube specification sheet. See Appendix C for special inspection provisions for magnetrons.

4.16.1 Air cooling. The cooling arrangement and velocity of air flow shall be as specified on the tube specification sheet. The temperature at the point specified shall not exceed the temperature of the incoming air by more than 50° C or the value specified.

4.16.2 Cathode. The electron source shall be as specified.

4.16.3 Oscillation. Each magnetron shall be tested for oscillation according to the conditions specified on the tube specification sheet.

4.16.3.1 Magnetic field. The oscillation test shall be conducted with the north-seeking pole adjacent to the magnetron face nearer the cathode lead, and with the required field produced between the specified pole tips. The field

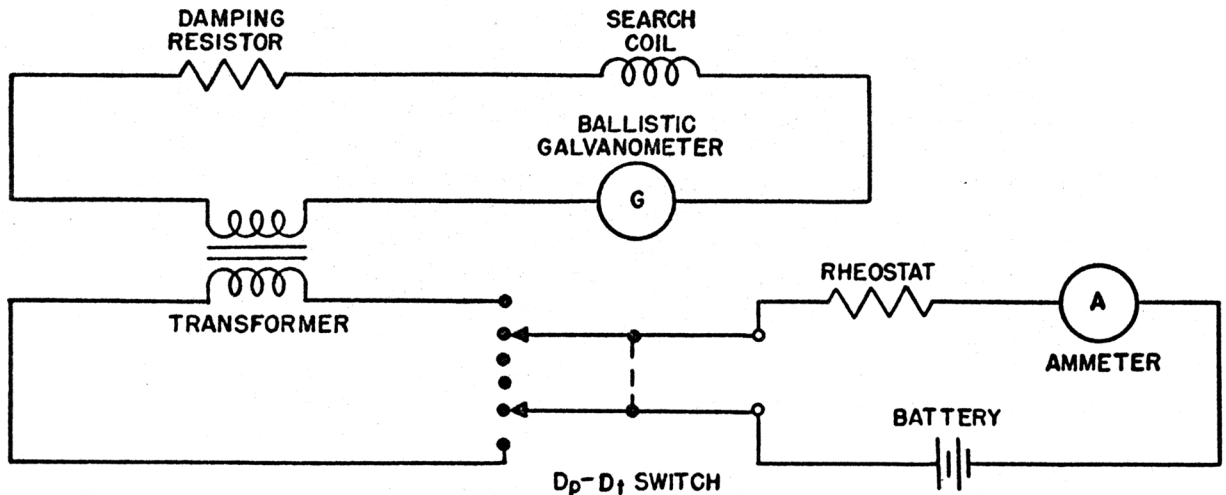


FIGURE 43. Magnetic-field test circuit.

strength shall be measured centrally between the poles, at the axis of the poles, by means of the specified standard search coil in conjunction with a ballistic galvanometer. The galvanometer shall have a period of at least 15 seconds and shall be used with the circuit shown on figure 43.

Magnetic-field strength (H) shall be measured by rotation of the search coil through 180° or by removal of the coil from the magnetic field and noting the galvanometer deflection (d). H is obtained from d by means of the following equation:

$$H = \frac{m}{NA} \frac{(I)}{dl} d \times 10^8$$

(when coil is rotated), OR

$$H = \frac{2m}{NA} \frac{(I)}{dl} d \times 10^8$$

(when coil is removed from field)

Where:

m = mutual inductance of coil in henries.

NA = number of turns x means area of one turn (CGS units).

I = dc primary current in amperes.

dl = deflection produced by sudden reversal in direction of I.

An equivalent test method may be used, provided it is correlated with the above. The four standard search coils are closely wound with a single layer of No. 40 enamel wire on brass cylinders. The NA of the coils shall be calculated from measured values. Further requirements for standard and substitute coils are specified in tables VIII and VIIa. Coil No. 160A may be substituted for coil No. 160, and coil No. 200A for coil No. 200, provided they are satisfactorily correlated.

TABLE VIII. *Standard coils.*

Coil number	Cylinder diameter	Number of turns	Nominal length of winding	Nominal NA (in CGS units)
	<i>Inch</i>		<i>Inch</i>	
160.....	0.160	34	0.135	4.6
200.....	.200	75	.300	15
400.....	.409	150	.600	129
600.....	.600	150	.600	280

TABLE VIIa. *Substitute coils.*

Coil number	Cylinder diameter	Cylinder material	Outside diameter of wound coil	Nominal length of winding	Number of turns	Nominal NA (in CGS units)
	<i>Inch</i>		<i>Inch</i>	<i>Inch</i>		
160A.....	0.063	Brass	0.187	0.094	408	34
200A.....	.170	Brass	.200	.300	300	45

4.16.3.2 Heater-cathode warmup time. The heater-cathode warmup time shall not exceed the value specified on the tube specification sheet at the applied heater voltage specified. Upon application of the anode voltage, the applied heater voltage shall be maintained or reduced as specified.

4.16.3.3 Pulse characteristics. The smooth peak is the maximum value of a smooth curve

through the average of the fluctuation over the top portion of the pulse as shown on figure 44. The pulse duration shall be at the time interval between the two points on the current pulse at which the instantaneous current is 50 percent of the smooth-peak current. Pulse-current ripple, the maximum deviation from the smooth-peak current over the top portion of the pulse, shall be as specified on the tube specification sheet. The time of rise

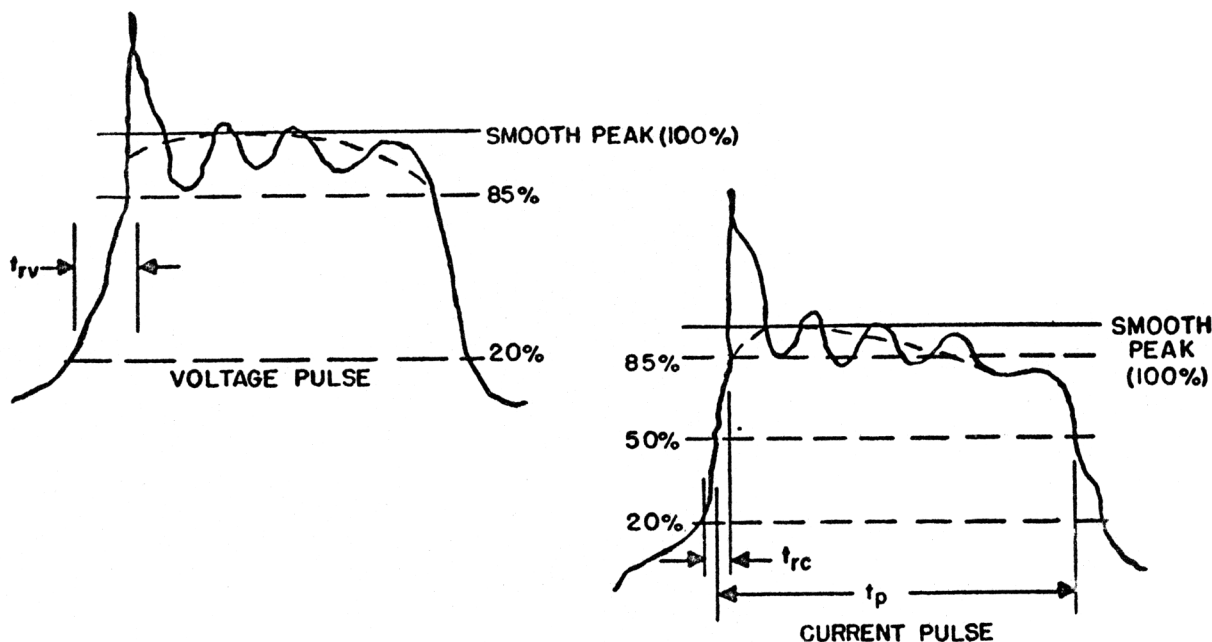


FIGURE 44. Pulse characteristics for magnetrons.

of a pulse, defined as the time interval between points of 20 and 85 percent of the smooth-peak value measured on the current pulse, shall be as specified. The duty cycle shall be as specified ± 10 percent.

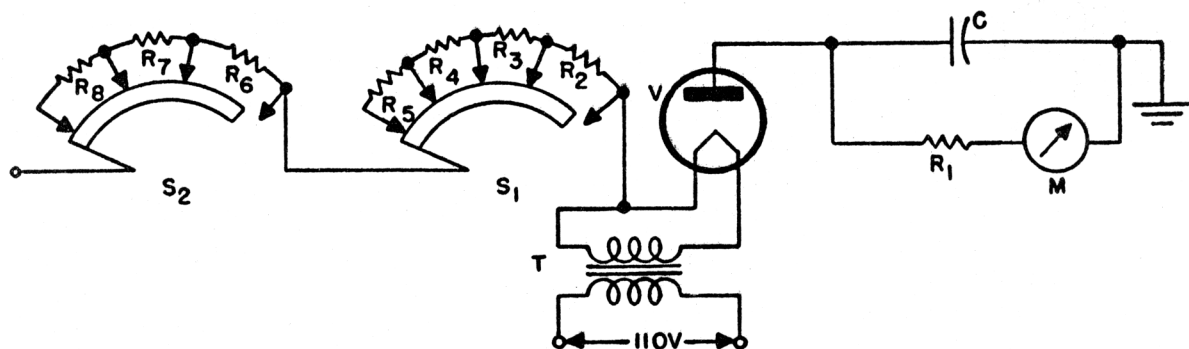
4.16.3.4 Average anode current. The average anode current shall be adjusted to the value specified.

4.16.3.5 Pulse voltage. The pulse voltage during test shall be within the limits specified on the tube specification sheet. Pulse-voltage measuring equipment shall be the standard peak voltmeter circuit as shown on figure 45 calibrated by means of dc potentials, or an equipment calibrated against that circuit on flat-topped pulses. The accuracy may be affected by changes in R_1 due to changes in ambient temperature, therefore R_1 and V should be mounted so as to minimize this effect. For pulse conditions and voltages outside the above limits, a suitable measuring device should be employed. This unit should be calibrated with the peak voltmeter within its range. If a spike occurs on the voltage pulse, as shown on figure 44, resistance shall be added in series with the peak voltmeter at

S1 and S2. The correct value of resistance (R_c) can best be determined by observing the change in meter reading (M) with addition of resistance at S1 and S2 in increments of 100 ohms. This value shall not exceed 1,500 ohms. (See fig. 46.)

4.16.3.6 Power output. The tube shall be connected to the transmission line and terminating load by means of the specified coupling. The line shall be so terminated that the VSWR will be less than 1.1 to 1. For tubes in which the specified coupling includes an impedance transformation section, the VSWR measured shall not include the VSWR of this section. For tubes in which the specified coupling does not impose any such section, the VSWR shall be measured adjacent to the output coupling of the tube. The power-absorption circuit shall be arranged to permit calorimetric measurement of average power.

4.16.3.7 rf bandwidth. The rf bandwidth measured at one-quarter power by means of an rf spectrometer shall be within the limits specified on the tube specification sheet.



V = 836 DIODE FOR VOLTAGES OF 0-3 kv OR kvdc, 719A DIODE FOR VOLTAGES OF 3-10 kv OR kvdc, 705A OR 8020 DIODE FOR VOLTAGES OF 10-30 kv OR kvdc.
 C = 0.002-uf CAPACITOR, 25-kv RATING.
 M = MICROAMMETER (SUITABLE RANGE).
 T = FILAMENT TRANSFORMER, 20-uuf CAPACITY (MAX.), 35-kv INSULATION.

S1, S2 = SWITCHES SUITABLE FOR MOUNTING RESISTORS R2 TO R8 AND FOR PULSE OPERATION.
 R1 = 200-MEGOHM, NONINDUCTIVE RESISTOR, 50-WATT RATING.
 R2,3,4,5 = 100-OHM NONINDUCTIVE RESISTORS, 2-WATT RATING.
 R6,7,8 = 500-OHM NONINDUCTIVE RESISTORS, 2-WATT RATING.

FIGURE 45. Pulse-voltage measuring circuit.

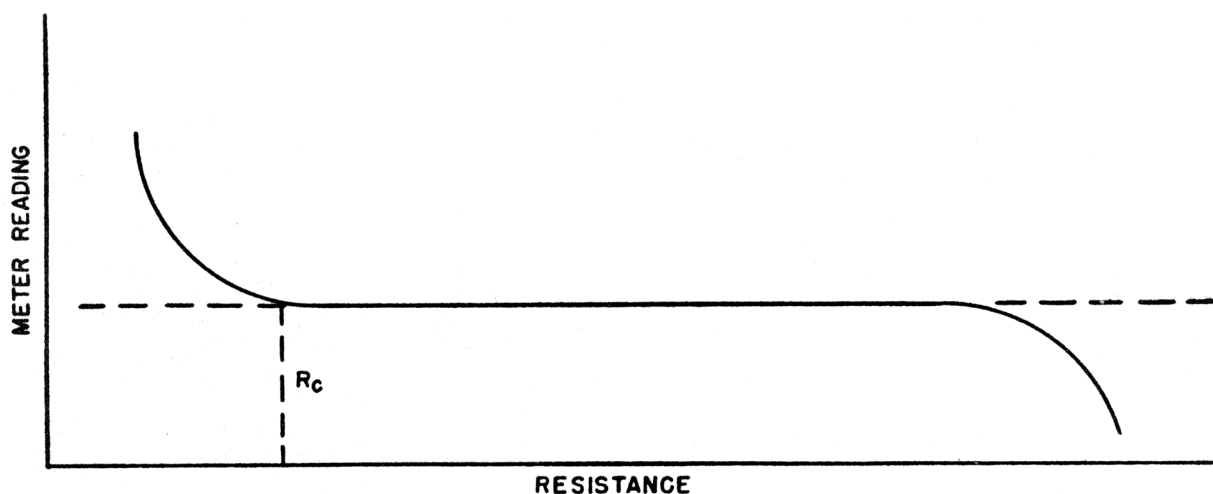


FIGURE 46. Correct value for removal of voltage spike.

4.16.4 Nonoscillating characteristics. A CW oscillator, tuned to the measured frequency of the tube under test, shall be loosely coupled into a system terminated by the magnetron with its specified coupling. Between the standing-wave indicator and the magnetron coupling, the line shall be uniform. The VSWR shall be within the limits specified and the position of the standing wave maximum from

the reference point specified on the outline drawing shall be within the limits specified.

4.16.5 Pulling factor. The pulling factor is the difference between the maximum and minimum frequencies reached when 1.5 VSWR is varied through all phase angles. The pulling factor shall be within the limits specified on the tube specification sheet. The test condi-

tions shall be those of the specified oscillation test. The entire plumbing (including the standing wave introducer) normally connected to the tube for test shall have a VSWR of not less than 1.5 in any phase position measured on an additional standing-wave detector which connects the calibrating tube to the plumbing. On retest of the tube, at other than the manufacturing location, the VSWR shall be not more than 1.5 in any phase position. The VSWR shall be within the limits specified over the frequency ranges, pulse durations, and repetition rates at which the plumbing will be used. A suggested method of calibrating the standing-wave detector, particularly applicable to waveguide-test plumbing, is shown on figure 47. The system is calibrated by measuring the response as a function of the position of the detector carriage with a short-circuit element connected to one side of the standing-wave detector as indicated. The response at the distance X from the position of maximum response shall be

$$1 + \cos \frac{2\pi X}{D}$$

taken as $\frac{D}{2}$ of the maximum response. D is the measured distance between successive minima. The standing-wave detector shall have a sensitivity constant within 2 percent over the length used and shall be designed and adjusted so that it is not over-coupled to the line.

4.16.6 Pushing factor. The pushing factor, the difference between the frequencies measured at the average anode current specified, shall be within the limits specified. The pushing factor excludes frequency changes caused

by thermal effects. The test conditions shall be those of the specified oscillation test.

4.16.7 Stability. Stable operation of a magnetron shall be determined by such of the following requirements as are specified. The magnetron shall be operated under the specified conditions of oscillation into a transmission line having a VSWR of specified magnitude, the phase of which is adjusted at the start of each measurement interval to produce maximum instability.

4.16.7.1 General energy stability of the rf pulse (missing rf pulses). General stability of a magnetron shall be measured in terms of the percentage of output pulses which are wholly or partially deficient in rf energy in the desired frequency band. A deficient pulse is defined as one whose energy content is less than the average content of a group of whole and complete pulses by a percentage specified. A whole and complete pulse is one produced by a magnetron whose rf output per pulse is affected only by random variations in line voltage, modulator characteristics, and load match, while it is operating at a specified power output and at the desired frequency. Missing rf pulses shall be recorded during the specified time interval by an electronic counter activated by a missing rf pulse detector circuit such as that shown on Drawing 249-JAN, or an equivalent. The rectified rf pulse input to the circuit shall be sampled from the magnetron load through a frequency selective device of specified band-pass. The reference input to the circuit shall be sampled from the voltage pulse applied to the magnet-

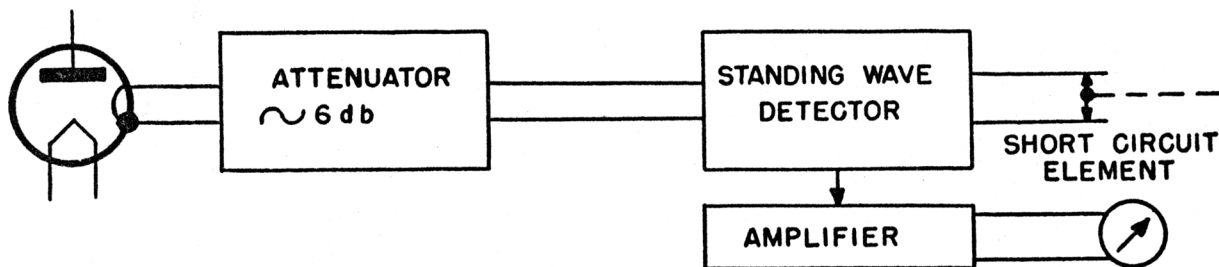


FIGURE 47. Calibration of standing-wave detector.

ron. The missing pulse detector employed shall be capable of recording random and occasional deficient pulses like those resulting from misfiring or moding, as well as consecutive clusters of deficient pulses which are usually caused by arcing.

4.16.7.2 Arcing. Arcs shall be recorded by an electronic counter which is activated by an arc detector circuit as shown on figure 48, or equivalent. The arc detector shall be adjusted to respond to peak currents which rise to 10 percent or greater above normal operating peak current. The tube shall be considered stable if the counter records less than the maximum allowable percentage of arcs during the specified test period.

4.16.7.3 Starting stability. This measurement shall be performed as the first test following the holding period. At the beginning of the test interval, pulse power shall be applied, and the observations of 4.16.7.1 or 4.16.7.2 shall be made as specified.

4.16.8 Permanent-magnet test. Permanent-magnet stability shall be demonstrated by the demagnetizing apparatus and test shown on the drawing specified on the tube specification

sheet. The operating pulse voltage shall not be reduced by more than the specified amount at the oscillation test specified.

4.17 Phototube tests. The tests specified in 4.17.1 to 4.17.5, inclusive, are applicable only to phototubes. The tubes shall be subjected to such of these tests as are specified on the tube specification sheet.

4.17.1 Test conditions.

4.17.1.1 Enclosures. Phototubes shall be tested while enclosed within a suitable light-proof box. Suitable light baffles shall be provided to insure that only direct radiation from the light source impinges on the phototube cathode. The beam of light striking the cathode shall have approximately parallel rays which are formed by the screen apertures. An adjustable aperture shall determine the area of the cathode subjected to light bombardment. The usable areas of phototube cathodes shall exclude support wires or parts falling behind the tube structure such as the stem, but shall not exclude that part of the cathode behind the anode, anode support wire, or activator support wire. Dimensions shall be relative to the bottom of the base shell or end cap. Cathode location shall be by pro-

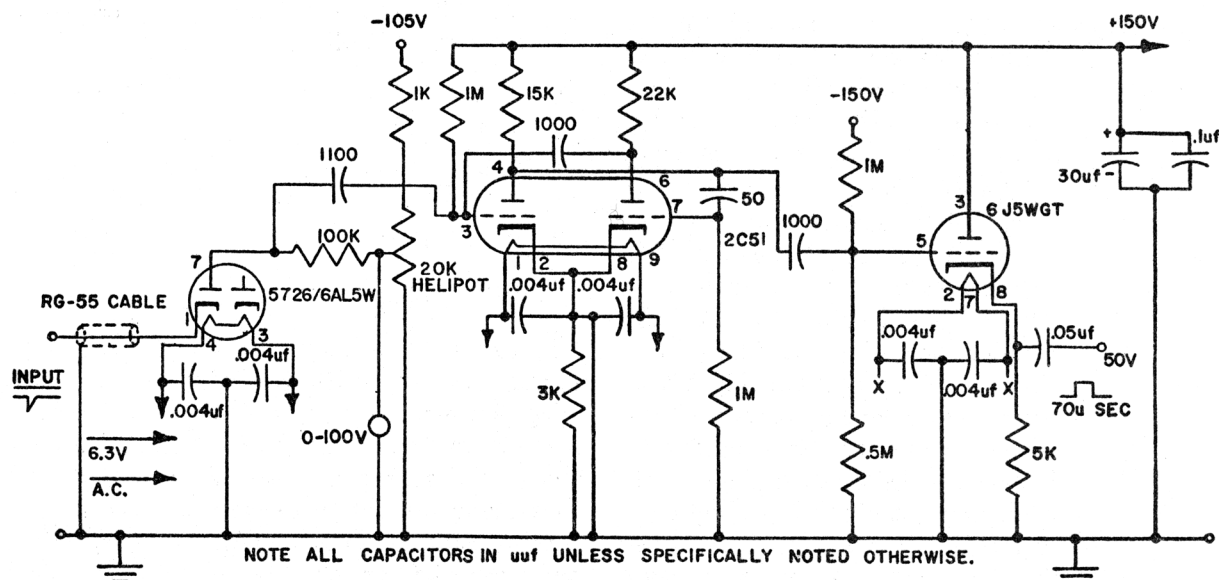


FIGURE 48. Arc detector.

jection to a plane normal to the direction of illumination.

4.17.1.2 Temperatures. The tube shall be placed in an enclosure and a thermometer used to measure the ambient temperature. The temperature of the enclosure shall be controlled by means of a rheostat and adjusted to the specified ambient value. Infrared radiation from the heating element shall not strike the cathode of the phototube being tested.

4.17.1.3 Standardized light sources (LS1). A coiled tungsten lamp with a lead- or lime-glass envelope operated at a color temperature of 2,870° K shall be used. Nonfiltered light flux on the phototube shall never exceed 0.1 lumen.

4.17.1.4 Measurement of light intensity. The distance from the light source to the phototube shall be varied to obtain the desired intensity of illumination measured in lumens. The following method shall be used to calibrate the phototube-test set:

- (a) A standard lamp shall be certified periodically at a recognized certification laboratory for candle-power and current requirements at a color temperature of 2,870°K.
- (b) The phototube-test lamp shall be adjusted to operate at a color temperature of 2,870° K by means of comparison with the standard lamp through the use of an optical pyrometer.
- (c) A suitable light-sensitive device shall be calibrated against the standard lamp by calculation. A phototube-test lamp shall be substituted for the standard lamp and with the calibrated light-sensitive device in the position which the test phototube will occupy in the enclosure, the test lamp shall be moved until the proper light intensity from this lamp falls upon the light-sensitive device through the aperture.

4.17.2 Current tests.

4.17.2.1 Anode current. With the specified luminous flux incident on the photocathode, and with the specified anode voltages applied, the anode current shall be within the specified limits. For gas phototubes, this measurement shall be made at 30 seconds after the application of the anode voltages.

4.17.2.2 Dynamic anode current. A toothed wheel (calibrated with a stroboscope against a beat-frequency oscillator) shall be used to modulate a light beam from a specified source incident on the phototube cathode. The speed of the toothed wheel shall be varied and the phototube output shall be fed into an amplifier which has been previously calibrated to insure its relative flatness of response over the desired frequency range. The dynamic sensitivity at each specified frequency shall be within the limits specified. This test may be replaced by any suitable test demonstrated to be equivalent.

4.17.2.3 Spectral - response identification. Identification of the type of phototube spectral response shall be made by using a series of light filters and standardized light sources. The following standard filters, manufactured by Corning Glass Works, of the melt indicated, or filters having equivalent transmission characteristics, shall be used.

Filter number	Melt number (1943)
2540	439
3384	422
3482	521
5113	491
5850	219
9780	8 of 10-20-43

The test shall be made using a 25-volt anode supply. Series resistance shall not exceed 1 Meg. Transmission tests shall be made by inserting the standard filters successfully between the source and the photo-cathode and measuring the relative response to the transmitted radiation. (See table IX.) Position of the inserted filters shall be normal to the light beam and such as to minimize the effect of

TABLE IX. Percent response using filter or filter combination.

Spectral-response symbol	Light source	Filter number							
		5113		3384 and 9780		3482 and 5850		2540	
		Min	Max	Min	Max	Min	Max	Min	Max
S1	LS1	0.05	2.5	1.5	8.0	40.0	75.0	2.0	40.0
S3	LS1	1.0	4.0	9.0	35.0	3.0	32.0	0	1.0
S7	LS1	0.2	1.0	8.0	15.0	32.0	55.0	0.5	10.0
S8	LS1	1.5	6.0	15.0	45.0	1.0	6.0	0	0.1

TABLE IXa. Bandwidth limits (angstroms).

Spectral-response symbol	Spectral response					
	100%		10% short wave		10% long wave	
	Min	Max	Min	Max	Min	Max
S4	3,500	4,500	2,700	3,300	5,800	6,400
S11	3,900	4,900	3,000	3,500	5,850	6,400

reflection. All currents recorded shall be the difference of currents measured with light on and off to eliminate dark-current error. The transmission (percent of no-filter current reading) for each filter or filter combination shall be within the limits for the spectral-response symbol specified. For phototubes of spectral responses ^{S11}S4 and ^{S10}S11, the spectral response shall be measured with a monochromator. The response shall be within the limits shown in table IXa for the spectral-response symbol specified on the tube specification sheet.

4.17.3 Gas-amplification factor. The anode current of gas phototubes shall be measured at 90 and at 25 volts, and the ratio between the two shall be within the limits specified on the tube specification sheet. The series resistance shall be as specified.

4.17.4 Dark current. Dark current is the current which flows between any two or more electrodes of a photoelectric device in the absence of such radiant energy as is normally used to excite the device during the test. The dark current, at the voltage specified, shall not exceed the limit specified.

4.17.5 Signal-to-noise ratio. Prior to testing, the tubes shall be kept in the dark at an

ambient temperature of $75^{\circ} \pm 5^{\circ} \text{F}$ for not less than 1 hour. The specified light source shall be modulated at 90 cps, using a square-wave, or equivalent. The light spot on the cathode shall be as specified on the tube specification sheet. The tube output shall be fed into a low-pass amplifier calibrated in db, the bandwidth of which is 1,000 cps. Read the amplifier output with a VU meter calibrated in db. The signal-to-noise ratio shall be determined as follows:

- Signal — With light on, adjust attenuator so that the VU meter is at zero. Read attenuator setting.
- Noise — With light off, read as for signal.
- S/N ratio (in db) = Signal minus noise.

4.18 TR, ATR, and pre-TR tubes.

4.18.1 Ignitor ignition time (TR tubes). The tube shall be placed in the circuit as shown on figure 49, or equivalent circuit. With the specified dc voltage applied to the ignitor electrode through the specified series resistor, the time of fire shall be measured. This test shall be performed not less than 24 hours after any previous discharge. The tube shall fire within the time specified.

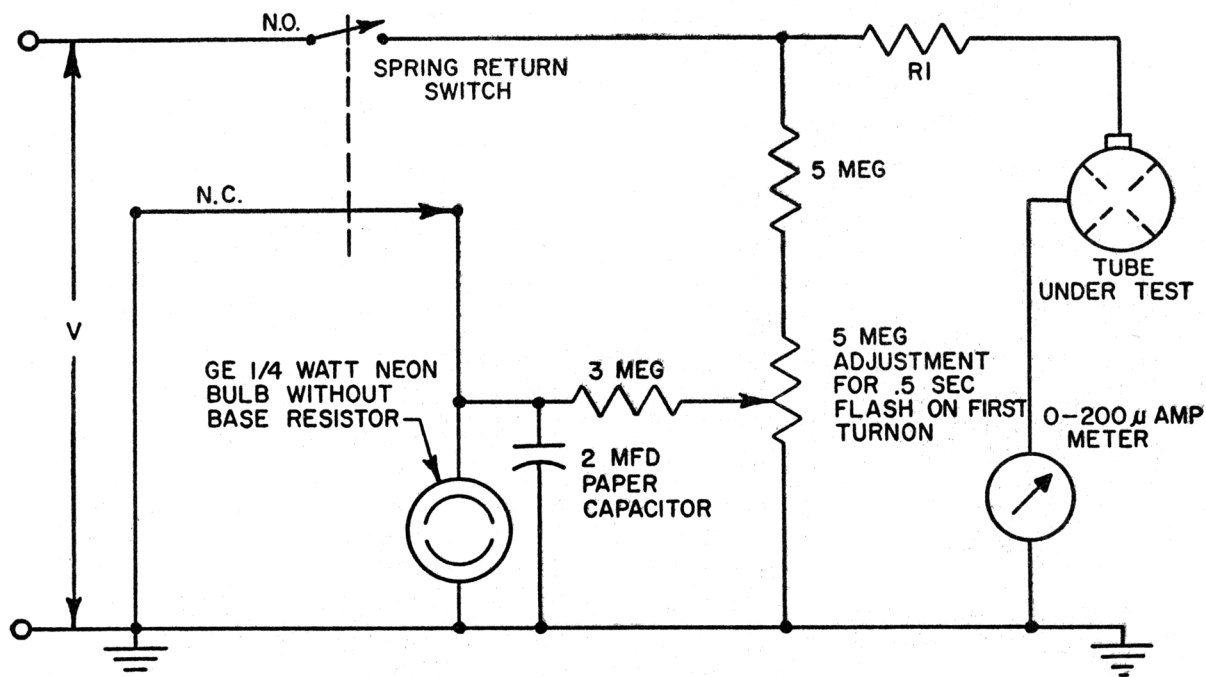


FIGURE 49. Ignitor firing-time circuit.

4.18.2 Ignitor voltage drop (TR tubes). With the ignitor current adjusted to the value specified, the voltage drop across the tube shall be measured. The voltage drop shall be within the limits specified.

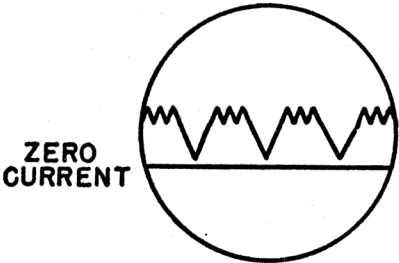
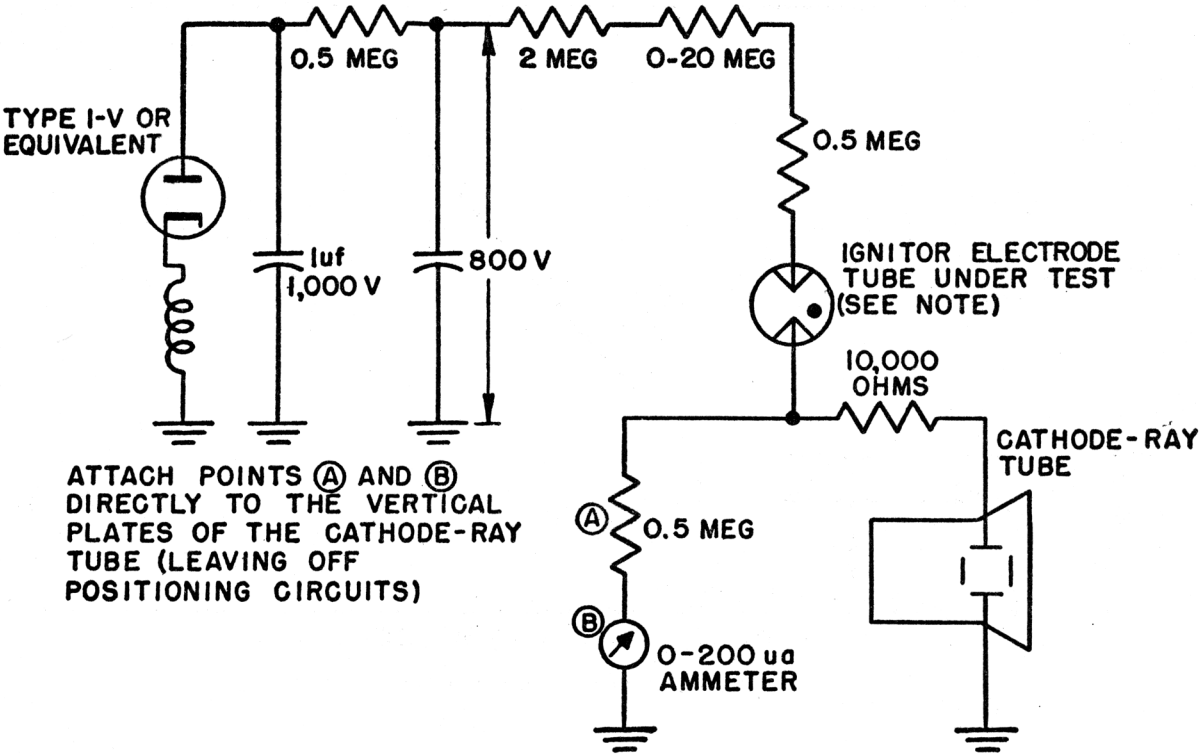
4.18.3 Ignitor oscillation (TR tubes). The tube shall be placed in the circuit as shown on figure 50, or equivalent circuit. With the supply voltage adjusted to 800 Vdc, the ignitor current shall be set by means of the variable resistor in series with the ignitor electrode. The minimum current that will prevent low-frequency relaxation oscillations shall be within the limits specified on the tube specification sheet. The high-frequency oscillations cause no difficulties. Relaxation oscillations are indicated on the oscilloscope trace when the current drops below the level of the high-frequency relaxation oscillations.

4.18.4 Insertion loss.

4.18.4.1 Insertion loss (integral cavity). The insertion loss of a tube is the db loss of power incurred in a transmission line due

to the insertion of the tube between a matched generator and load. The insertion loss shall be measured by a transmission method, shown on figure 51, in which the tube is placed between a matched generator and detector. With the signal generator set at the reference frequency, the tube shall be tuned to resonance as evidenced by a pronounced peak of the output indicator. The db loss of power at the detector, due to insertion of the tube in the transmission line, shall be within the limits specified. Moreover, as the tuning screw is turned through its complete range, the tube shall be rejected if, in addition to the main peak, one or more peaks of the output indicator are present for which A is greater than a 20° movement of the tuning knob or B is greater than 10 percent of the amplitude of the main peak. (See fig. 52.)

4.18.4.2 Insertion loss (fixed tuned). The tube shall be placed in the circuit specified in 4.18.4.1. With the signal generator set at the reference frequency, the db loss of power at the detector, due to the insertion of the tube in the transmission line, shall be within the limits specified.



RELAXATION OSCILLATIONS ARE
INDICATED ON THE OSCILLOSCOPE
TRACE WHEN THE CURRENT DROPS
BELOW THE LEVEL OF THE HIGH-
FREQUENCY RELAXATION OSCILLATIONS

NOTE:
THE 0.5 MEG. RESISTOR SHALL BE PLACED AS CLOSE AS
POSSIBLE TO THE IGNITOR TERMINAL OF THE TUBE

FIGURE 50. Ignitor oscillation circuit.

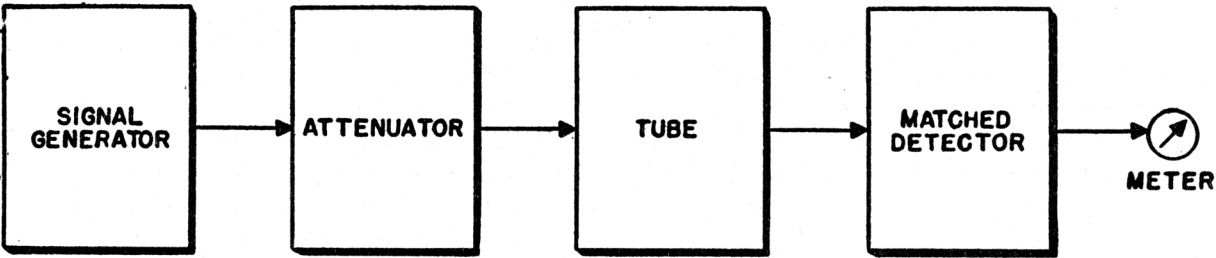
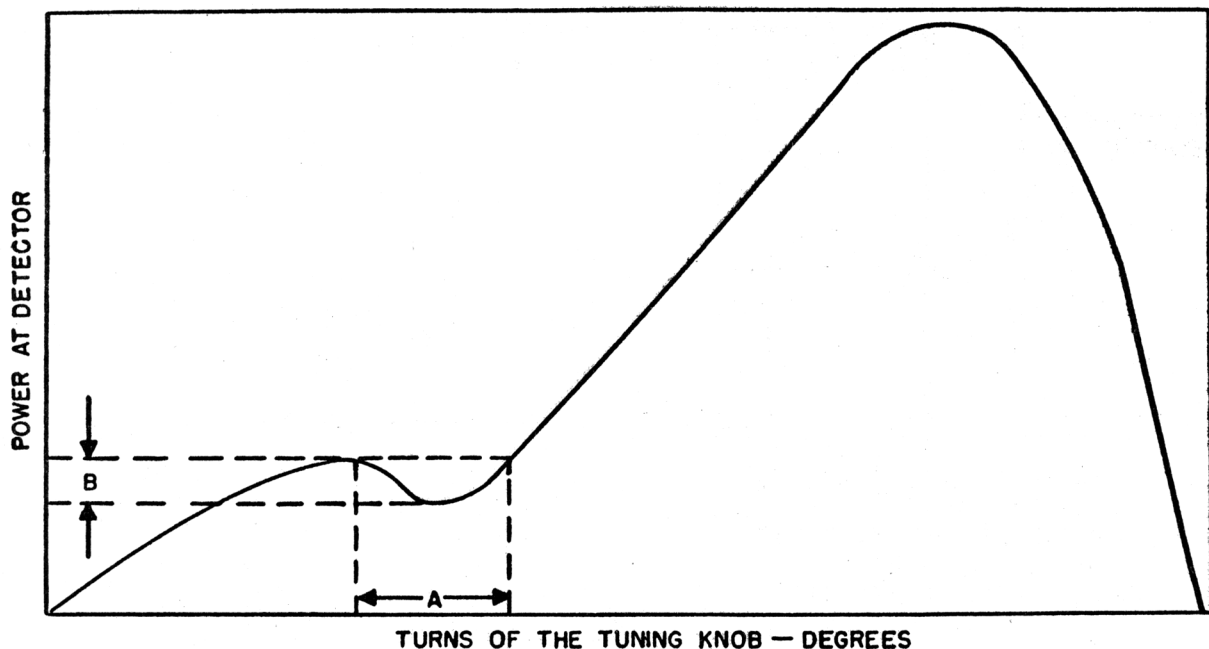


FIGURE 51. Equipment layout for insertion-loss measurements.

FIGURE 52. *Tuning characteristics.*

4.18.4.3 Insertion loss (external cavity). The tube shall be mounted in the specified cavity and placed in the circuit specified in 4.18.4.1. With the signal generator set at the reference frequency, a relative power reading at the output detector shall be noted. The tube shall then be replaced by the specified cavity calibrator (dummy tube), and the new output reading recorded. The db ratio of power at the detector with the calibrator in the cavity, to power at the detector with the tube in place, shall be within the limits specified.

4.18.5 Ignitor interaction (TR tubes).

4.18.5.1 Ignitor interaction (insertion loss). Ignitor interaction is defined as the additional insertion loss a TR tube incurs due to the ignitor electrode discharge. The tube shall be placed in the circuit specified in 4.18.4.1. With the ignitor current set to the value specified, the increase in insertion loss over the quiescent insertion loss shall be not more than the amount specified.

4.18.5.2 Ignitor interaction (ΔQ). The discharge of the ignitor electrode causes an in-

crease in the effective shunt conductance across a TR cavity. Since intrinsic Q is a function of the power loss in the cavity, ignitor interaction can be interpreted as the change in intrinsic Q incurred due to the ignitor discharge. With the ignitor current adjusted to the given value, the change in intrinsic Q as measured in 4.18.20.2 shall be within the limits specified.

4.18.6 Tuning range (TR tubes). When tested as shown on figure 51, the tube shall cover the minimum tuning range specified. No tube shall require less than the specified number of complete turns of the tuning screw to cover this range. The tuning screw shall be cycled from stop to stop before electrical tests are performed. The cones of the tubes shall not touch, as shown by an electrical-continuity test, when the tuning control is cycled through its entire range.

4.18.7 Tuning (TR tubes). The tube shall be mounted in the specified external cavity and placed between a matched signal generator and detector. The signal-generator frequency shall be varied to obtain the resonant frequency of the tube and cavity as evidenced

by a pronounced peak at the output indicator. The value of this resonant frequency shall be within the limits specified.

4.18.8 Ignitor - current - temperature drift (TR tubes). Using a constant voltage source, the ignitor current shall be adjusted to the specified value at 25° C. The ambient temperature shall be raised gradually to 100° C, and the change in ignitor current shall be within the limits specified.

4.18.9 Leakage power (TR tubes). The leakage power shall be measured after a shelf life of 7 days. The tube shall be mounted as a series tee with the rf power in the main line set for the conditions specified on the tube specification sheet. The tube shall be tuned to the reference frequency, and the ignitor current set to the given value. The peak leakage power can be obtained from the following equation:

$$\text{Peak leakage power} = \frac{\text{average power}}{\text{pr} \times \text{width of leakage pulse}}$$

A functional block diagram of the system is shown on figure 53.

4.18.10 Spike-leakage energy. The leakage energy shall be measured after a shelf life of 7 days. The tube shall be mounted as a

series tee with the rf power in the main line set for the conditions specified. With the ignitor current adjusted to the given value, the average leakage power through the tube shall be measured at each of the two designated pulse durations tp1 and tp2. The spike-leakage energy (Ws) shall be within the limits specified when determined as follows:

$$W_s = \frac{10^7}{\text{pr}} \left[P_1 - \frac{(P_1 - P_2) \text{tp}_1}{(\text{tp}_1 - \text{tp}_2)} \right]$$

Where:

P1 = average leakage power at tp1, in watts.

P2 = average leakage power at tp2, in watts.

4.18.11 Flat leakage power. The flat leakage power shall be within the limits specified when calculated as follows:

$$\text{pf} = \frac{(P_1 - P_2)}{\text{pr} (\text{tp}_1 - \text{tp}_2)}$$

4.18.12 Ignitor - leakage resistance (TR tubes). Ignitor-leakage resistance is the dc resistance between the ignitor electrode and tube body when the tube is in the de-ionized state. This resistance shall be within the limits specified. The measurement shall be made after the completion of the leakage power and ignitor tests.

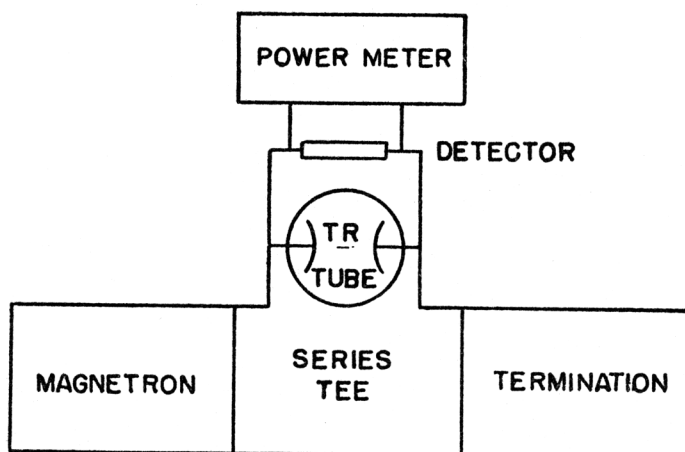


FIGURE 53. Equipment layout for leakage-power measurements.

4.18.13 Loaded Q .

4.18.13.1 *Loaded Q (TR tubes).* The tube shall be placed in a transmission circuit between a matched signal generator and a matched detector, with sufficient attenuation between the generator and tube to prevent frequency or power changes in the signal source due to tuning of the tube. With the signal source at the reference frequency (F_o), the tube shall be tuned to resonance, as indicated by a pronounced peak of the output indicator, and the output power shall be noted. The frequency of the signal generator shall then be increased until the power at the termination falls to one-half of the value at resonance. The frequency at this point shall be recorded as F_1 . The procedure shall then be repeated in the direction of decreasing frequency, the resulting half-power point being noted as F_2 . The loaded Q shall be within the limits specified when determined as follows:

$$QL = \frac{F_o}{F_1 - F_2}$$

As the signal generator is tuned from F_1 to F_2 , its output power must be stable in amplitude to better than 1 percent to insure accurate determination of the half-power frequencies. If this condition cannot be satisfied, the frequency versus power-output characteristic of the signal generator must be determined and taken into account in locating F_1 and F_2 .

4.18.13.2 *Loaded Q (ATR tubes).* The tube shall be inserted as a series tee in the specified mount between a matched generator and termination. The loaded Q is then defined in terms of the rate of change of susceptance with frequency, and may be expressed as:

$$QL = \frac{F_o \frac{dB/Y_o}{df}}{2(1 + G/Y_o)} = \frac{F_o \frac{db}{df}}{2(1 + g)}$$

Where:

F_o = resonant frequency.

df = $F_1 - F_2$.

$B/Y_o = b$ = normalized susceptance of the tube.

$G/Y_o = g$ = normalized conductance of the tube.

Since F_o is always within F_r , the reference frequency for the tube, this latter quantity shall always be employed in place of F_o in the above equation. The quantity $\frac{db}{df}$, which is the rate of change of susceptance with frequency, in the vicinity of F_o , can be determined by the measurement of b at two frequencies near F_o and assuming a linear relationship between b and f . The linear relationship may be assumed for any frequencies within 1 percent of F_o . An alternative technique for the determination of $\frac{db}{df}$ involves the measurement in front of the tube of the rate of change of the phase of the standing wave minimum with frequency; then:

$$\frac{db}{df} = \frac{2\pi}{\lambda g} \times (1 + 2g) \times \frac{dl}{df}$$

Where:

λg = guide wavelength at the reference frequency.

g = normalized conductance of the tube.

$\frac{dl}{df}$ = rate of change of the phase of the voltage standing wave before the tube with frequency. $\frac{dl}{df}$ must be determined at the voltage maximum close to the plane of symmetry of the tube. Since it is not usually possible to take measurements at this position, a correction for the length of line must be made.

This is:

$$\frac{dl}{df} = \frac{dl'}{df} - \frac{m}{4} \frac{d\lambda g}{df}$$

Where:

$\frac{dl'}{df}$ = measured slope of the line obtained by plotting the observed position of a voltage minimum as a function of frequency.

m = odd number of quarter wavelengths measured, at resonance, from the reference minimum to the plane of symmetry of the tube.

Frequencies within 1 percent of F_0 should be employed in the measurement of $\frac{dl}{df}$

4.18.14 Frequency-temperature effect. The frequency drift of the tube over the temperature range shall be determined in accordance with method A or B.

4.18.14.1 Method A. The tube shall be placed in a temperature-controlled chamber at room temperature and connected in a transmission circuit between a matched signal generator and detector. With the generator set at the reference frequency, the tube shall be tuned to resonance as indicated by a pronounced peak of the output indicator. The temperature in the chamber shall then be reduced to 0° C and the tube body allowed to come to thermal equilibrium. The resonant frequency of the tube at 0° C shall be determined by retuning the signal generator for a peak of the output; the procedure shall then be repeated at + 100° C. The frequency drift of the tube over the temperature range shall be within the limits specified.

4.18.14.2 Method B. The tube shall be mounted in the specified external cavity and placed in a circuit as specified in method A. The signal generator shall be tuned to the resonant frequency of the tube and cavity as indicated by a pronounced peak of the output indicator. The frequency shall be recorded and the procedure of method A shall then be followed. The frequency drift over the temperature range shall be within the limits specified.

4.18.15 Recovery time.

4.18.15.1 Recovery time (constant attenuation) (TR tubes). The recovery time is the time after rf ionization of a TR tube at which the low-level rf attenuation of the tube is 3 db above its attenuation in the unexcited state. The following method of determining this parameter, or an equivalent method, shall be used: The tube shall be mounted as a series tee with the rf power in the main line set for the specified conditions. The tube shall be

caused to resonate at the reference frequency and the ignitor current set to the specified value. A low-level pulse modulated signal (simulated received echo) at the reference rf frequency, which is synchronized with the high-powered transmitter rf pulse through a trigger variable delay unit, shall be introduced into the main line through a coupling device. The power transmitted through the TR tube shall be amplified and impressed upon the vertical deflection plates of a synchroscope whose horizontal sweep is synchronized with the transmitting modulator. As the low-level signal is varied in time with respect to the transmitter pulse, its amplitude variation, due to the attenuation characteristic of the TR tube, shall be viewed on the synchroscope. Attenuation measurements are made with respect to the amplitude of signal received when the delay is made a large percent of the time between high-power pulses, at which point the TR tube has completely recovered. This reference can be obtained by employing the internal-trigger generator of the synchroscope as the synchronizing source, and delaying the trigger to the transmitter modulator by 10 to 20 us. Thus, the received signal can be displayed immediately preceding and immediately following the transmitted pulse. The recovery time, measured from the trailing edge of the transmitted pulse to the leading edge of the received signal, shall be within the limits specified. This measurement can conveniently be made by using the leading edge of the transmitted pulse as a reference and subtracting the pulse duration from the time readings. A functional block diagram of the system is shown on figure 54.

4.18.15.2 Recovery time (constant delay) (TR tubes). When tested as specified in 4.18.15.1, the low-level attenuation of the TR tube at the specified time after transmission shall be within the limits specified.

4.18.15.3 Recovery time (pre-TR tubes). The measurement of recovery time for the pre-TR tube shall be accomplished in the same manner as for the TR tube specified in 4.18.15.1. If a TR tube is used following the

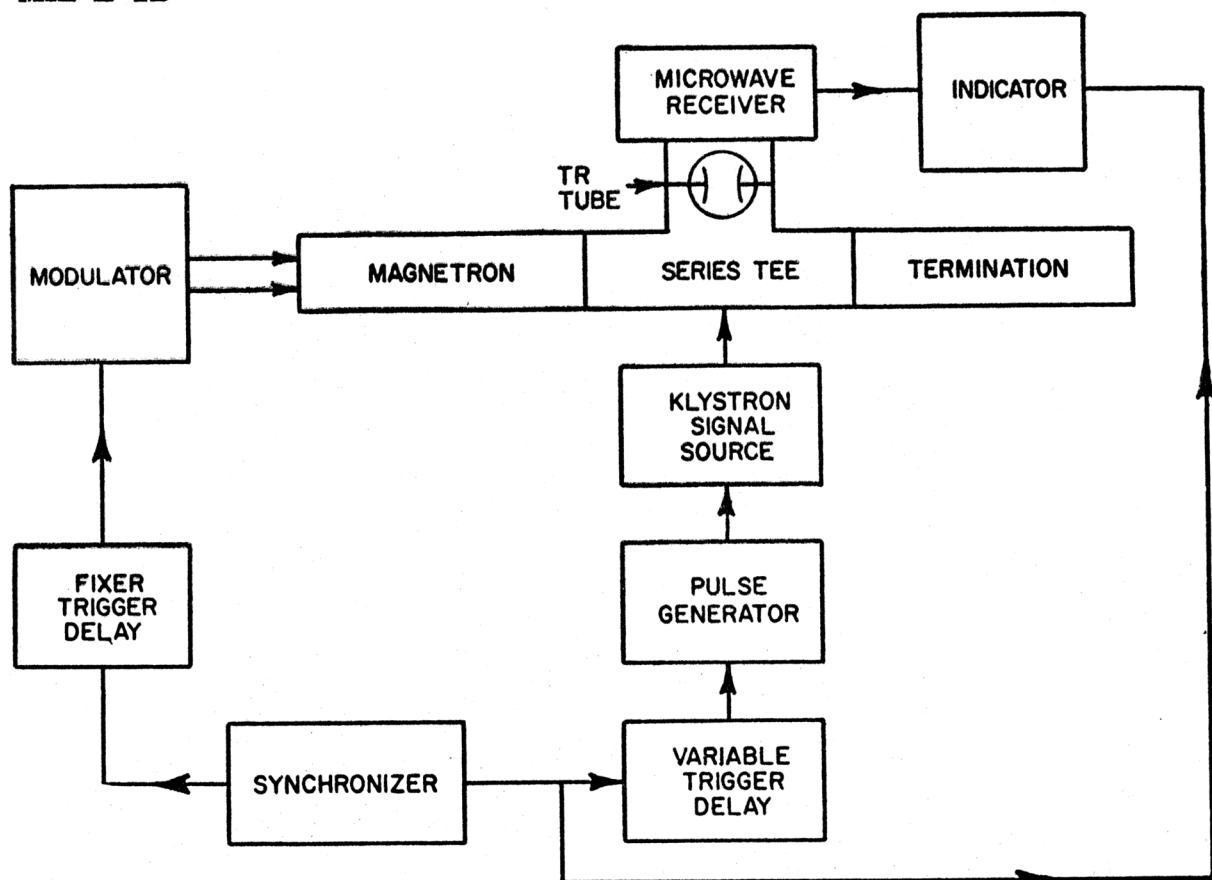


FIGURE 54. Equipment layout for recovery-time measurements.

pre-TR tube, the received signal must see a match looking into the TR cavity, ie, tuned to resonance and properly loaded. If loading cannot be adjusted, resistive padding can be employed between the pre-TR and the TR tube. Precautions shall also be taken to insure that the recovery characteristic of the TR tube will not affect the measurement of the recovery time of the pre-TR tube.

4.18.16 Pressure operation. The air pressure specified on the tube specification sheet shall be applied to both windows of the tube for a period of $\frac{1}{2}$ hour, after which the pressure shall be reduced to atmospheric pressure. After five such cycles the tube shall pass the ignitor ignition-time test specified in 4.18.1.

4.18.17 Temperature cycling.

4.18.17.1 Temperature cycling (TR, ATR, and pre-TR tubes). The tube shall be exposed

to one cycle of gradual temperature variation, from room temperature to -40° to $+100^{\circ}$ C to room temperature. The temperature may be allowed to come to equilibrium at room temperature in going from -40° to $+100^{\circ}$ C. At the conclusion of the cycle, the tube shall pass the ignitor ignition-time test specified in 4.18.1. This test may be performed before the final finishing operation.

4.18.17.2 Temperature cycling life test end point (TR tubes). At the conclusion of the cycling (see 4.18.17.1), the tube shall pass the ignitor ignition-time test specified in 4.18.1. Not less than 24 hours after the temperature-cycling-life test, the tube shall again pass the ignitor ignition-time test.

4.18.17.3 Temperature cycling life test end point (ATR tubes). At the conclusion of the cycling (see 4.18.17.1), the tube shall pass the firing-time test specified in 4.18.27. Not less

than 24 hours after the temperature-cycling-life test, the tube shall again pass the firing-time-test.

4.18.18 VSWR. The tube shall be mounted in a low-level transmission circuit between a matched generator and termination. With the signal generator at the reference frequency, the VSWR measured immediately before the tube shall be within the limits specified.

4.18.19 High-level VSWR. The tube shall be mounted as a series tee with the rf power in the main line set for the specified conditions. With a termination whose VSWR is less than the allowable value, the VSWR in the line immediately preceding the tube shall be within the limits specified. This test may be made at lower power by simulating the arc by a metallic short in intimate contact with the inside of the window.

4.18.20 Intrinsic Q.

4.18.20.1 Intrinsic Q (high-Q external cavity). The tube shall be mounted in the specified cavity and placed in a circuit between a matched generator and detector. The signal generator shall be tuned to resonance, as indicated by a pronounced peak of the output indicator, and the resonant wavelength (λ_0) and relative value of the power transmitted to the detector (P_d) shall be recorded. The frequency of the signal generator shall then be decreased from resonance until the transmitted power falls to one-half its original value, and the corresponding wavelength shall be measured and recorded as λ_1 . The frequency shall then be increased above the resonant value to the half-power point and this wavelength recorded as λ_2 . The power available at the detector (P_a) is determined by removing the tube and associated cavity from the circuit. The intrinsic Q of the tube and cavity shall be computed from the following equation:

$$Q_0 = \frac{\lambda_0}{(\lambda_1 - \lambda_2)(1 - \sqrt{T})}$$

Where:

$$T = \frac{P_d}{P_a}$$

λ_0 = wavelength at resonance.

λ_1 = wavelength at lower half-power point.

λ_2 = wavelength at upper half-power point.

This equation assumes that the input- and output-coupling devices are identical. The coupling devices may be checked for equality by measuring the VSWR with the cavity reversed so that the former output coupling device is used as the input. If the VSWR measured with the cavity in its initial position is denoted as r_1 , and the VSWR with the cavity reversed is r_2 , r_1 and r_2 will be equal if the coupling devices are identical. If r_1 and r_2 are not equal, the expression for Q_0 becomes:

$$Q_0 = \frac{\lambda_0}{\lambda_1 - \lambda_2} \frac{1 + r_1 r_2 + r_1 + r_2}{r_1 r_2 - 1}$$

4.18.20.2 Intrinsic Q (relative). The tube shall be tested on a relative basis under the conditions specified in 4.18.20.1 by comparing the reading of the output indicator at resonance with the reading for a tube whose intrinsic Q is known. The test cavity shall be isolated from the oscillator by at least 10-db attenuation. The test equipment shall be calibrated at intervals, not to exceed 30 days, by means of tubes that have passed the intrinsic Q measurement specified in 4.18.20.1.

4.18.21 Intrinsic P.

4.18.21.1 Intrinsic P (P'). The tube shall be mounted in the specified cavity and placed in a circuit between a matched generator and detector. The resonant cavity and its associated tube shall be excited from the signal generator through a matched attenuator and standing wave detector, and the input power adjusted to a level that is insufficient to fire the tube. The frequency of the signal generator shall be tuned to the resonant wavelength of the cavity as indicated by a pronounced peak in the power observed in the output circuit. The output and input coupling mechanisms (either loops or irises) shall be adjusted until the input to the cavity is matched to the transmission line as measured by the standing

Am 4.5 p 30

wave detector, and until the low-level transmission T is between 0.1 and 0.01. The transmission T is defined as the ratio of the power transmitted through the cavity at resonance, to the power available at the input to the cavity when measured by removing the cavity and connecting the power-measuring device to the input transmission line. With each change in the coupling, the signal generator shall be retuned to resonance. After final adjustment, the resonant wavelength λ_0 and the low-level transmission T shall be measured and recorded. The frequency of the signal generator shall then be decreased until the power transmitted through the cavity has dropped to one-half its value at resonance. The wavelength corresponding to this point shall be measured and recorded as λ_1 . The frequency shall then be increased above resonance to the half-power point and this wavelength measured and recorded as λ_2 . The signal generator shall be ^{retuned} returned to resonance and the input power level increased to the amount stated on the tube specification sheet, which should be sufficient to fire the tube gap. No change should be made in the adjustments of the coupling mechanisms. The power in watts measured in the output circuit under these conditions shall be recorded as P_r . The value of P_o shall be computed from the following equation:

$$P_o = \frac{2 P_r \lambda_0}{T (\lambda_1 - \lambda_2)} \text{ volt-amperes}$$

It should be noted that λ_0 , λ_1 , λ_2 , and T are all measured at low levels with the tube unfired, and that P_r is the only quantity measured when the tube is fired. When the required input power is specified in terms of the power into the gas discharge, this is computed from the following equation:

$$P_g = \left[\frac{P P_o (\lambda_1 - \lambda_2)}{2 \lambda_0} \right]^{1/2} - \frac{P_o (\lambda_1 - \lambda_2)}{2 \lambda_0}$$

Where P_g is the power in the gas discharge, P is the available power at the input to the cavity, and the other symbols are already defined. In the event that it is impossible or inconvenient to adjust the coupling mechanisms to the cavity to the matched input conditions, the intrinsic P can be expressed as

$$P_o = \frac{4 P_r \lambda_0}{T (\lambda_1 - \lambda_2)} \cdot \frac{1}{(1 + g)}$$

Where:

g = normalized input admittance to the cavity.

$$P_g = \left[\frac{P P_o (\lambda_1 - \lambda_2)}{\lambda_0} \cdot \frac{1}{(1 + g)} \right]^{1/2} - \left[\frac{P_o (\lambda_1 - \lambda_2)}{\lambda_0} \cdot \frac{g}{(1 + g)} \right]$$

Defining the VSWR before the tube as r , where $r > 1$, g is equal to r or $\frac{1}{r}$ depending upon whether g is greater or less than unity. The ambiguity can be resolved, as follows: The position of a minimum in the standing wave pattern is measured along the standing wave detector from an arbitrary origin. If $g < 1$, there will be a quarter-wavelength shift from the position of the minimum at resonance to the position of the minimum at frequencies far off resonance. If $g > 1$, the position of the minimum will be the same at resonance as for frequencies far off resonance.

4.8.21.2 Intrinsic P (relative). The tube shall be tested on a relative basis, under the conditions specified in 4.18.21.1, by comparing the reading of the output indicator when the tube gap is fired with tubes having known intrinsic P values within the specified limits. The readings of the output indicator are assumed to be proportional to the value of intrinsic P . The cavity temperature shall be $47^\circ \pm 3^\circ \text{C}$ and the tube temperature shall be 45°C or higher, when inserted into the cavity.

4.18.22 Water-vapor content. The tube shall be operated in the circuit specified in 4.18.21.1. A small portion of the tube envelope shall be cooled by the application of solid CO_2 . The intrinsic P , measured by the relative method specified in 4.18.21.2, shall then fall to a value within the limits specified on the tube specification sheet. In determining these limits, percentages are to be taken with respect to the initial intrinsic P value of each individual tube.

4.18.23 High-level protection. The tube shall be mounted in the cavity specified on the tube

specification sheet and placed in a transmission circuit between a matched generator and detector. The power level at the input shall be sufficient to fire the rf gap of the tube, and to insure that the measurement is being made on the flat part of the power in the gap versus leakage-power curve. If the main discharge gap does not fire, it shall be caused to fire by a short application of the ignitor voltage. The tube shall be tested on a relative basis by comparing the reading of the output meter when the gap is fired, to the reading of a ^{standard} standing tube when its gap is fired. The output indication of the tube shall be less than that of a standard tube.

4.18.24 Attenuation. The attenuation characteristic is defined as the interaction of the attenuator electrode. With the specified electrode current, the attenuation shall be measured as specified in 4.18.15.1. Due to the high level of this attenuation, it may be necessary to employ a heterodyning technique for the amplification and final detection of the power at the termination. A suggested procedure is as follows: The tube shall be inserted in a transmission circuit between a matched CW signal generator and a matched crystal mixer supplied with a local oscillator for heterodyning. The output of the mixer shall be amplified by a high-gain if receiver and passed through a calibrated attenuator to an input indicator. With the signal generator at the reference frequency, the tube shall be tuned to resonance as evidenced by a pronounced peak of the output indicator, and the output reading noted. The attenuator electrode current shall be adjusted to the specified value and the calibrated attenuator setting varied until the output indication returns to the original reading. The db change in the attenuator setting, which is equal to the signal attenuation introduced by the attenuator electrode current, shall be within the limits specified.

4.18.25 Tuning susceptance. The tube shall be inserted as a series tee in the specified mount between a matched generator and termination. Either method A or B, specified in 4.18.25.1 and 4.18.25.2, respectively, shall be used to compute susceptance.

4.18.25.1 Method A. The susceptance shall be measured by comparing the phase of the standing wave before the tube with that of a tube that is known to be resonant at the reference frequency. The susceptance shall be computed as follows:

$$b = \frac{(1 + 2g)}{2} \tan \frac{4\pi\Delta l}{\lambda_{go}}$$

Where:

$b = B/Y_o$ = normalized susceptance of the tube.

$g = G/Y_o$ = normalized conductance of the tube.

Δl = phase shift of voltage standing wave from sample to standard.

λ_{go} = guide wavelength (same units as for l at reference frequency).

This can be expressed approximately as:

$$b = (1 + 2g) \frac{2\pi\Delta l}{\lambda_{go}} \text{ for small } \Delta l$$

4.18.25.2 Method B. An alternative technique involves the determination of the ratio of P_i , the power incident upon the tube, and P_1 , the power transmitted to the matched termination, with the signal source set at the reference frequency F_r . The susceptance of the tube is then computed as follows:

$$b^2 = \frac{K(1 + 2g)^2 - 4g^2}{(4 - 4K)}$$

Where:

g = normalized conductance of the tube.

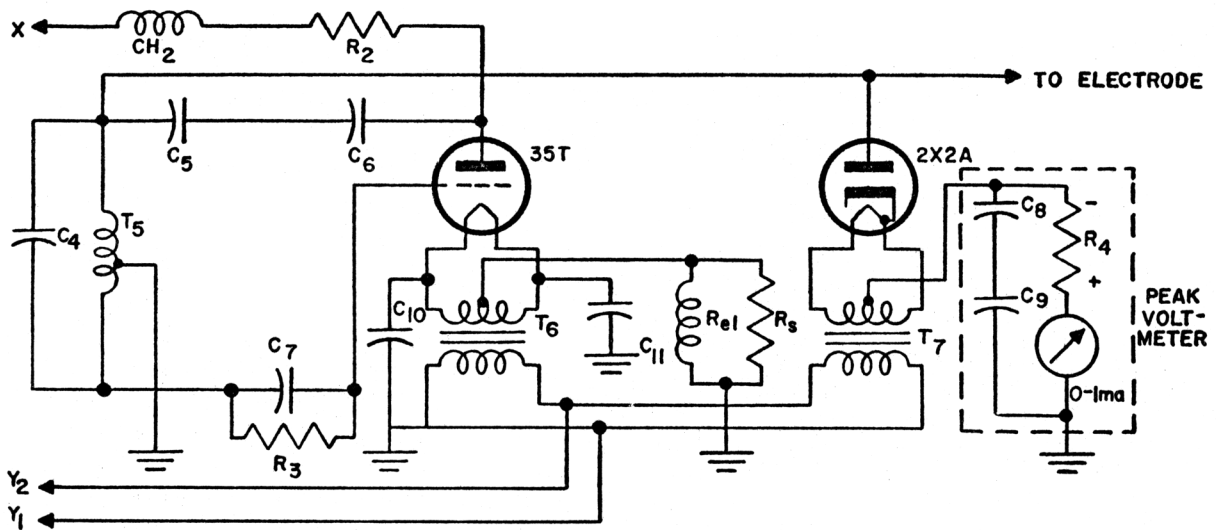
P_i = the power incident upon the tube.

P_1 = the power transmitted to the matched termination.

and

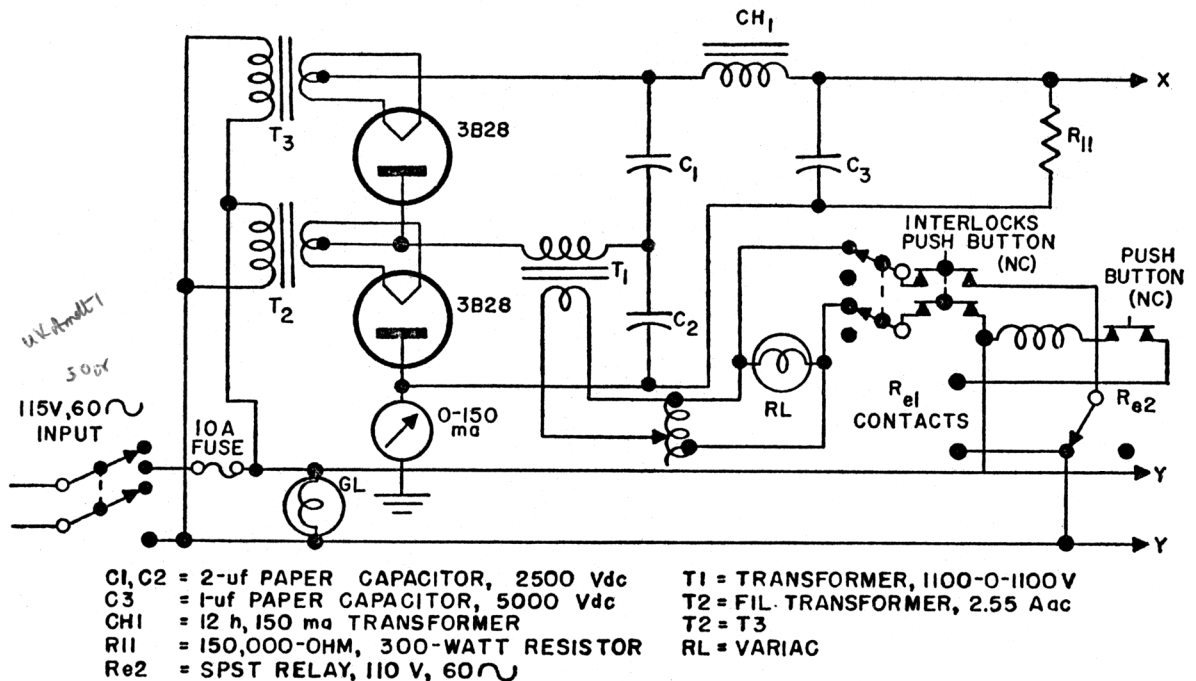
$$K = \frac{P_1}{P_i}$$

Care must be exercised if a directional coupler is employed for a measurement of P_i . The power reflected by the tube is comparable in magnitude to the incident power, and the directivity of the coupler may not be great enough to prevent this reflected power from affecting the measurement of P_i . A calibrated attenuator between the coupler and the tube under test may be used to eliminate this problem.



- C4 = 75-uf, AIR CAPACITOR (.05 BETWEEN PLATES)
 C5,C6 = .0018-uf, MICA CAPACITOR, 2500 Vdc
 C7 = .0009-uf, MICA CAPACITOR, 2500 Vdc
 C8,C9 = .0047-uf, MICA CAPACITOR, 2500 Vdc
 C10,C11 = .001-uf, MICA CAPACITOR, 2500 Vdc
 CH2 = rf-CHOKE, 12 SECTIONS, EACH 75 TURNS 30 WIRE
 R2 = 300-OHM NONINDUCTIVE RESISTOR
 R3 = 1500-OHM, 20-WATT RESISTOR

- R4 = 5 I-MEG, 2-WATT RESISTOR (SERIES)
 R5 = 400-OHM, 10-WATT RESISTOR
 Rel = OVERLOAD RELAY, SPST 24 Vdc COIL (65 ma 300 OHMS)
 T5 = TANK COIL, 8.5 uh, 15 TURNS, 2.5 DIA, 3 LONG
 T6 = fil TRANSFORMER, 5 Vac, 3 Aac
 T7 = fil TRANSFORMER, 2 Vac, 2.5 Aac 7500 V INSUL.



- C1,C2 = 2-uf PAPER CAPACITOR, 2500 Vdc
 C3 = 1-uf PAPER CAPACITOR, 5000 Vdc
 CH1 = 12 h, 150 ma TRANSFORMER
 R11 = 150,000-OHM, 300-WATT RESISTOR
 Re2 = SPST RELAY, 110 V, 60~

- T1 = TRANSFORMER, 1100-0-1100 V
 T2 = FIL. TRANSFORMER, 2.55 Aac
 T2 = T3
 RL = VARIAC

FIGURE 55. Oscillator, peak voltmeter, and power supply for rf pressure gage.

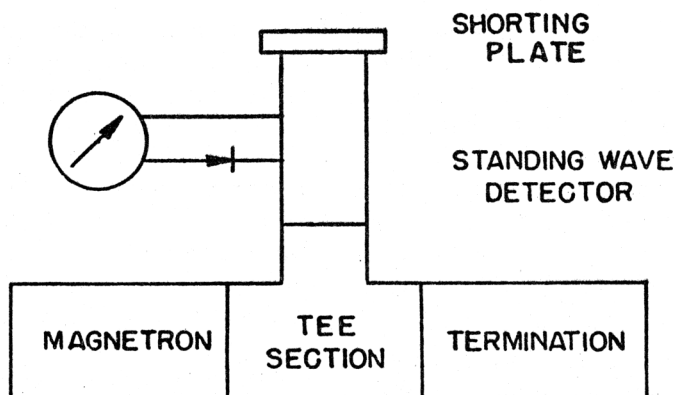


FIGURE 56. Equipment layout for position-of-short measurements.

4.18.26 Equivalent conductance. The equivalent conductance shall be computed as specified in either method A or B.

4.18.26.1 Method A. The tube shall be inserted as a series tee in the specified mount between a matched generator and a matched termination. A curve of VSWR (r) may be plotted around the reference frequency. The maximum value of the VSWR (r_o) occurs at the resonant frequency of the tube, at which the susceptance (b) is equal to zero. The equivalent conductance is then computed as follows:

$$g = \frac{1}{r_o - 1}$$

4.18.26.2 Method B. An alternative method for determining the equivalent conductance consists of measuring the power incident upon the tube and the power transmitted to the termination with the signal source set at the resonant frequency F_o . The equivalent conductance is then computed as follows:

$$g = \frac{1}{2(K-1)}$$

Where:

P_i = the power incident upon the tube.

P_1 = the power transmitted to the termination.

$$K = \sqrt{\frac{P_i}{P_1}}$$

The precautions in 4.18.25.2 regarding the measurement of P_i are equally applicable to this measurement.

4.18.27 Firing time. The tube shall be inserted as a series tee in the specified mount and followed by a matched termination. With the rf power in the main line set at the specified conditions, the time after application of power for the tube to fire shall be within the limits specified. This test shall be made after a holding period of at least 168 hours.

4.18.28 Arc loss. With the tube operating as specified in 4.18.27, the power loss in the arc shall be within the limits specified. This loss shall be taken as the db change in power at the termination when the tube is replaced by a metallic short circuit.

4.18.29 Gas content. The tube shall be measured for gas content by the rf pressure tester shown on figure 55, or equivalent. With the specified electrode in place on the tube window, the voltage shall be raised until a discharge is initiated, and then lowered to the extinguishing point. The extinguishing voltage (V_x) shall be within the limits specified.

4.18.30 Mode purity. The tube shall be inserted as a series tee in the mount specified, and placed in a circuit between a matched generator and termination. No appreciable energy shall be excited in the tube mount in other than the desired mode. The VSWR before the tube shall be greater, over the given frequency range, than the value specified.

4.18.31 Position of short. With the equipment shown on figure 56, the rf power in the

main line shall be set for the conditions specified, and the position of the voltage standing wave minimum before the shorting plate shall be determined. The metal shorting plate shall then be replaced by the tube, and the shift in the position of the voltage standing wave minimum shall be within the limits specified.

4.18.32 Frequency-vibration effect. The tube shall be tuned to resonance at the frequency specified and then vibrated in the direction of the tuner axis as specified in 4.9.19.2. After vibration, the tuning shall not have changed by more than the allowable amount and the tube shall pass all applicable electrical tests.

4.18.33 Vibration. The tube shall be vibrated in a plane perpendicular to the ignitor axis under the conditions specified. During this interval there shall be no evidence of shorting between the ignitor electrode and the adjacent cone.

4.19 Radiation counter tubes.

4.19.1 General tests.

4.19.1.1 Background, contamination, and photosensitivity.

4.19.1.1.1 Background and contamination. The tube response (count rate) determined using the circuit specified shall be not more than the limit specified. The tube shall be mounted in a horizontal position and may be shielded from extraneous radiation fields by lead of a maximum thickness of 2 inches, with aluminum of a maximum thickness of $\frac{1}{8}$ inch interposed between it and the tube. The counting time and the tube operating voltage for this test shall be as specified.

4.19.1.1.2 Photosensitivity. The photosensitivity shall be measured after a period of not less than 60 minutes during which time the tube has not been exposed to ultraviolet light. The tube response (count rate) shall be determined, using the circuit specified. The source

of light radiation, the position and orientation of the tube with respect to the light source, the voltage at which the tube is operated, and the duration of the count shall be as specified. The testing procedure shall be as follows: Determine count rate with light off, then determine count rate with light on. The difference between the two count rates is the count rate due to photosensitivity. This difference shall be not more than the limit specified.

4.19.1.1.3 Background, contamination, and photosensitivity. The photosensitivity shall be measured after a period of not less than 60 minutes during which time the tube has not been exposed to ultraviolet light. The tube response (count rate), due to the combined effects of background, contamination, and photosensitivity determined using the circuit specified, shall be not more than the limit specified. The source of light radiation, the position and orientation of the tube with respect to the light source, the voltage at which the tube is operated, and the duration of the count shall be as specified. The tube may be shielded from extraneous radiation fields by lead with aluminum interposed between it and the tube, with maximum thickness as specified in 4.19.1.1.1.

4.19.1.2 Leakage current. The leakage current between anode and cathode, determined at the applied voltage specified, shall be not more than the limit specified. The reading shall be taken 30 minutes after the humidity chamber has reached equilibrium at $50^{\circ} \pm 5^{\circ}$ C and 90 ± 5 percent relative humidity.

4.19.1.3 Mechanical tests. Subsequent to each mechanical test, the tube shall comply with all applicable structural requirements and meet any electrical tests specified to be performed under the mechanical tests. No voltage shall be applied during these tests.

4.19.1.3.1 Variable frequency vibration. The variable frequency vibration test shall be performed as specified in 4.9.20.3. The method of mounting shall be as specified on the tube specification sheet.

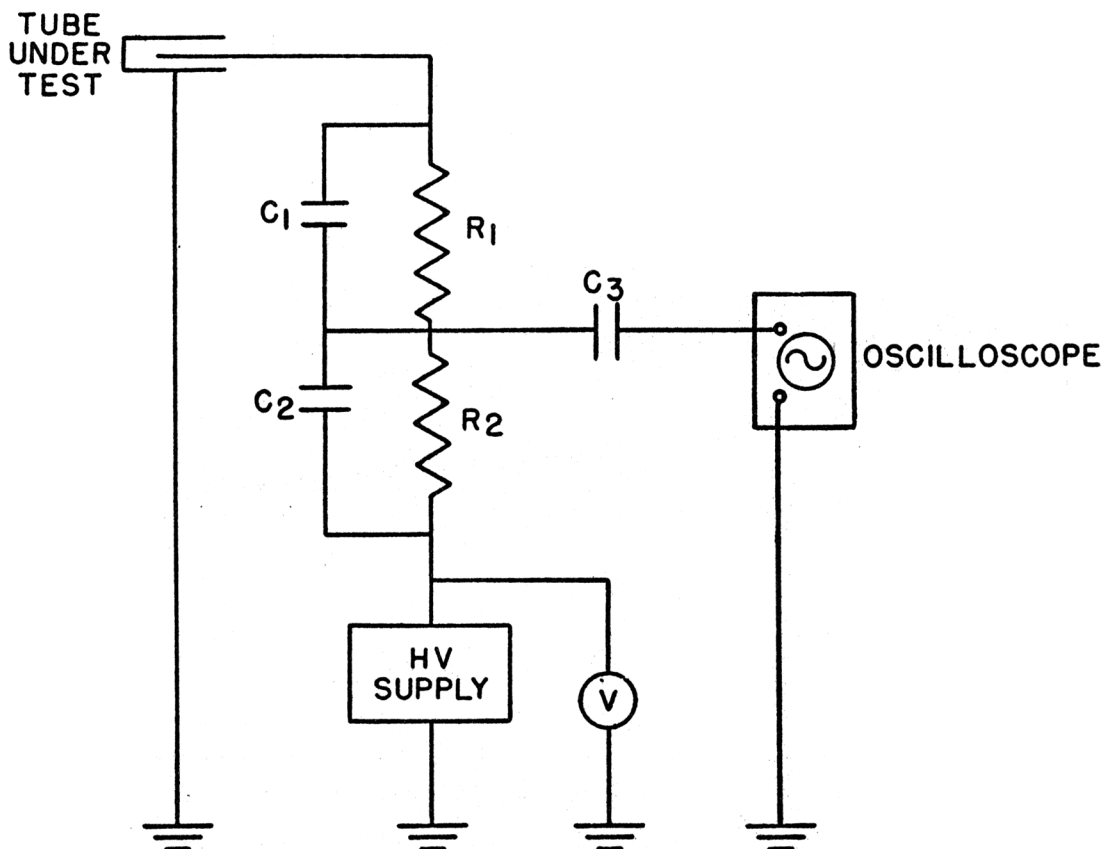


FIGURE 57. Circuit used for measuring pulse amplitude and starting voltage.

4.19.1.3.2 Shock test. The shock test shall be performed as specified in 4.9.20.5. Directions X1 and X2 shall be chosen at random unless otherwise specified.

4.19.2 Geiger-Mueller types.

4.19.2.1 Starting voltage. The starting voltage is defined as the applied counter tube voltage at which uniform pulses of a specified average amplitude appear across the total resistance in the circuit shown on figure 57. The test shall be performed using a calibrated high-impedance oscilloscope, a low-impedance power supply, and a high-impedance voltmeter (V). The count rate shall be less than 200 counts per second. The starting voltage shall be not greater than the limit specified.

4.19.2.2 Plateau characteristics. Plateau characteristics shall be obtained by method A or B.

4.19.2.2.1 Plateau tracing (method A). When the plateau tracing (count rate versus applied tube voltage) of a radiation counter tube is made at the recommended operating voltage, at a counting rate of 100 Nps, and using a recording-rate meter having the following characteristics, the relative plateau slope, end-of-plateau voltage, and plateau length shall be within the limits specified. (See 4.19.2.2.1.1, 4.19.2.2.1.2, and 4.19.2.2.1.3, respectively.)

- (a) *Resolving time.* The resolving time shall be 50 ± 5 us.
- (b) *Discrimination level.* The discrimination level shall be 1 ± 0.1 volts.
- (c) *Accuracy.* The recording-rate meter shall be capable of measuring uniform recurrence rates ranging from 10 to 200 Nps, with an accuracy of 5 percent.

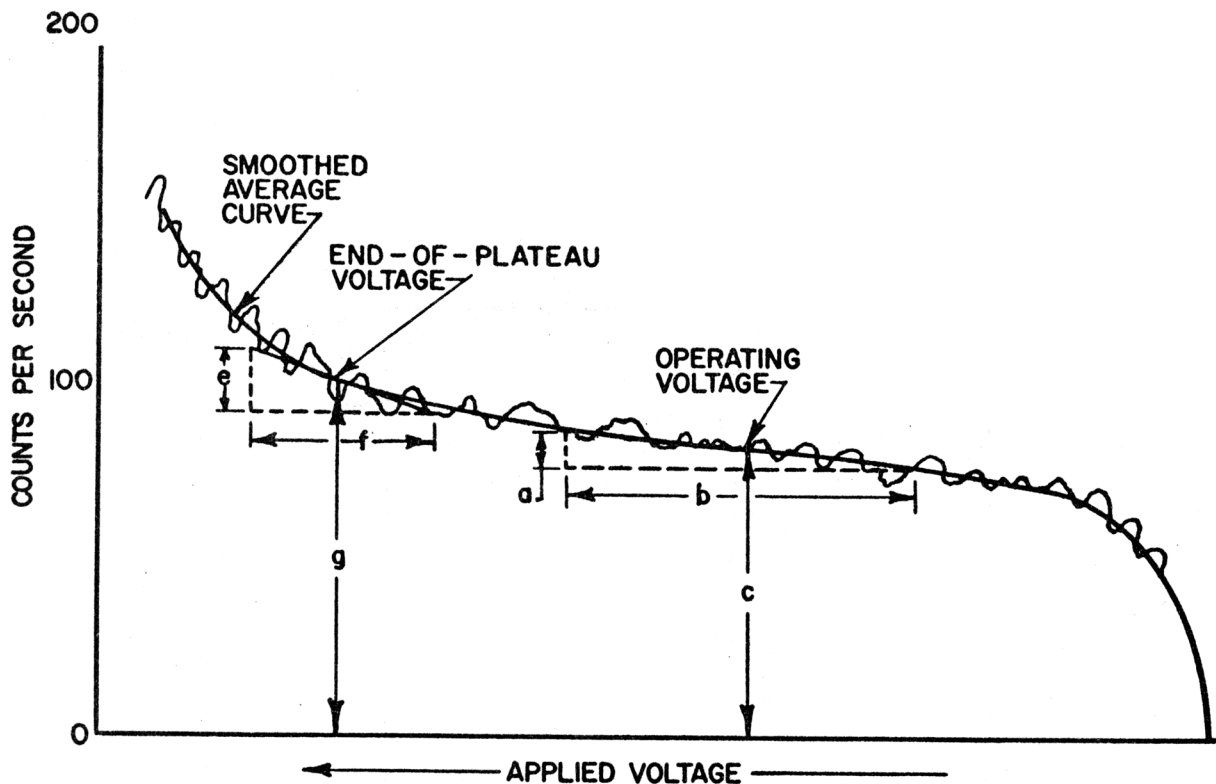


FIGURE 58. Typical plateau tracing showing smoothed average curve.

- (d) *Deflection sensitivity.* The deflection sensitivity of the recorder shall be not less than 1 inch per 50 Nps.
- (e) *Full-scale deflection.* The full-scale deflection of the recorder shall indicate not less than 200 Nps.
- (f) *Voltage drive.* The potential across the tube shall be applied at a uniform rate of increase not greater than 100 volts per minute.
- (g) *Time constant.* The time constant shall be not greater than 2.5 seconds.

4.19.2.2.1.1 Relative plateau slope. The relative plateau slope shall be determined from the average curve drawn through the plateau tracing obtained as specified in 4.19.2.2.1. A typical plateau tracing with an average curve drawn through it is shown on figure 58. The relative plateau slope shall be determined over a voltage range specified. Referring to figure

58, the relative plateau slope in percent per volt shall be given by $100 a/bc$, where:

- a = change in count rate (Nps) over specified voltage range.
- b = specified voltage range (volts).
- c = count rate (Nps) measured at the specified operating voltage.

4.19.2.2.1.2 End-of-plateau voltage. The end-of-plateau voltage is the lowest applied counter tube voltage at which the relative slope of a line drawn tangent to the smoothed average curve (see fig. 58), obtained as specified in 4.19.2.2.1, exceeds a value given on the tube specification sheet. Referring to figure 58, the end-of-plateau voltage is the lowest voltage at which the relative slope, $100 e/fg$, is equal to the value given on the tube specification sheet, where:

- e/f = slope of line drawn tangent to average curve (Nps).

g = absolute count rate measured at the point of tangency (Nps).

4.19.2.2.1.3 Plateau length. The plateau length of a counter tube shall be the difference between the end-of-plateau voltage and the starting voltage.

4.19.2.2.2 Scaler (method B). When plateau characteristics are to be determined by use of a scaler, details will be given on the tube specification sheet.

4.19.2.3 Response. The tube response count rate and response current (see 4.19.2.3.1 and 4.19.2.3.2, respectively), determined using a standard excitation unit or a specific radiation field and circuit as specified, shall be within the limits specified.

4.19.2.3.1 Response count rate. The tube response count rate shall be measured using a scaler having a resolving time of 5 μ s or less, and a discrimination level of 0.25 volt. The counting time and the tube operating voltage for the test shall be as specified.

4.19.2.3.2 Response current. The response current shall be determined as specified in 4.19.2.3.

4.19.2.4 Pulse amplitude. The pulse amplitude is defined as the peak pulse voltage developed across the total resistance shown on figure 57. The test shall be performed using a calibrated high-impedance oscilloscope, a low-impedance power supply, and a high-impedance voltmeter (V). The pulse amplitude shall be within the limits specified.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing. Unless otherwise specified (see 6.1), tubes shall be prepared for shipment in accordance with Specification MIL-P-75.

5.2 Marking. In addition to any special marking required by the contract or order, unit package and exterior shipping containers

Valves shall be packaged in accordance with K1005

shall be marked in accordance with Specification MIL-P-75.

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Title, number and date of the applicable military specification sheet (tube specification sheet), and the complete type designation. (See 3.9.)
- (c) Whether packing and marking are for domestic or overseas shipment. (See sect. 5.)

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(d) $\rightarrow$ See Amult-5 p 30

6.2 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in Qualified Products List QPL-1 whether or not such products have actually been so listed by that date.

6.2.1 The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products covered by this specification may be obtained from the Armed Services Electro-Standards Agency (ASESA), Fort Monmouth, N. J.

6.3 Service uses. Equipment using the tubes covered by this specification should be designed so that all tubes meeting this specification perform satisfactorily in the normal service for which the equipment is designed. The use of characteristics not controlled by this specification is not permitted unless the bureau or service concerned has specifically approved such use.

6.4 Use of tubes in design of new equipment. The inclusion in this specification of a tube specification sheet for a particular tube type shall in no manner be interpreted as authority to use that tube in the design of new equipment. ~~Standard MIL-STD-200~~ is mandatory for the choice of tubes for use in new electrical and electronic equipments.

6.5 Absolute maximum ratings. The values specified on the tube specification sheet under "maximum" are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values above which the serviceability of any individual tube may be impaired. In order not to exceed absolute ratings, the designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be approached or exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variations in the equipment itself.

Caution: It does not necessarily follow that combination of absolute maximum ratings can be attained simultaneously. In the event that the specified altitude rating is exceeded, reduction of instantaneous voltages (excluding filament or heater voltage) may be required.

6.5.1 Receiving-tube ratings. Receiving-tube ratings specified on the tube specification sheet are absolute maximum values for an average tube, and equipment should be designed with this fact in mind. However, these ratings may be exceeded as indicated in 6.5.1.1 and 6.5.1.2 without serious deterioration in tube life.

6.5.1.1 Plate voltage. Unless otherwise specified on the tube specification sheet, when the load impedance is of such type that the instantaneous voltage at the plate never exceeds the supply voltage, the supply voltage may be twice the maximum rated dc plate voltage, provided the maximum rated average dissipation is never exceeded on any electrode.

6.5.1.2 Screen voltage. The maximum screen voltage may be exceeded when all of the following conditions are met:

- (a) The screen voltage does not exceed the dc plate voltage rating under any operating conditions.
- (b) The average screen dissipation does not exceed the maximum rating under the operating conditions specified on the tube specification sheet.
- (c) The screen voltage, at the operating condition which results in maximum screen current, does not exceed the maximum rating.

6.6 Cross index. The cross index Specification JAN-1A to Specification MIL-E-1D, ASES 52-8, facilitates the conversion to Specification MIL-E-1 of tube specification sheets dated prior to 2 May 1952. Copies of the cross index may be obtained, upon request, from the Armed Services Electro-Standards Agency (ASESA), Fort Monmouth, N. J.

→ 6.7. See Amdt 5 p31

Notice. When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

Custodians:

Army—Signal Corps
Navy—Bureau of Ships
Air Force

Other interests:

Army—CMOT
Navy—AMCMdOrS

Preparing activity:

Navy—Bureau of Ships

APPENDIX A

[Amend-5 p32]

QUALIFICATION INSPECTION AND CORRELATION

10. SCOPE

10.1 This appendix details the procedure for submission of samples, with related data, for qualification inspection of tubes covered by this specification.

20. REQUEST FOR QUALIFICATION

20.1 A manufacturer desiring to submit samples for qualification inspection shall address his request to:

Director
Armed Services Electro-Standards
Agency (ASESA)
Fort Monmouth, New Jersey

20.2 Information to be submitted to the ASESA.

20.2.1 *Information to be submitted with each request.* Each letter of request shall refer to only one type of tube, be in quadruplicate, and contain the following:

- (a) The location of the plant wherein the tube for which qualification is sought will be, or is, manufactured.
- (b) The manufacturer's type designation of the tube for which qualification is sought, as well as any other designation by which the tube may now be, or has been, known.
- (c) A statement of the manufacturer's ability to make the tubes and the availability of all necessary equipment to perform the specified (design and production) tests. (See 3.9.)
- (d) The number of copies of the information specified in 20.3, 20.4, and 20.5 of this appendix.

20.2.1.1 *Additional information to be submitted only with first request.* The following information shall be submitted only once, with the first request by the manufacturer for qualification:

- (a) Four copies of a statement of the extent of the manufacturer's engineering organization.
- (b) Four copies of a statement of the manufacturer's production capacity and facilities, including a list of the types of tubes produced, production capacity and normal production of each type of tube for the past 2 years, and description of the manufacturing facilities and equipment.
- (c) If the manufacturer has Government contracts for the tube type being submitted, four copies of information regarding the contract number, number of types involved in each contract, and delivery date shall be furnished.
- (d) One copy of a statement certifying the following:

The manufacturer:

1. Is the actual manufacturer of the samples submitted for qualification inspection.
2. Will not use the results of such inspection, or information that inspection was conducted, for advertising, sales promotion, or publicity purposes.
3. Will not apply for reinspection of the tubes until satisfactory evidence is furnished to the ASESA that all the defects which were disclosed by the original inspection have been corrected.

4. Will furnish under all subsequent Army, Navy, or Air Force contracts or orders, tubes equal in every respect to those qualified.
5. Will notify the ASESA of any changes or improvements in design of a tube which has already received qualification, and will provide a complete statement describing the changes, the reason(s) therefor, and the improvements expected to be accomplished thereby.

Forms for the certification specified in (d) above are available, on request, from the ASESA.

20.2.2 Change in design of tube types having qualification. If resubmission is requested because of changes or improvements in design of a tube which has already received qualification, the manufacturer shall submit four copies of a complete statement describing the changes, the reason(s) therefor, and the improvements expected to be accomplished thereby.

20.3 Information on tubes. The information shall include four copies of a statement(s) describing the materials and pertinent design features of the tube, such as anode, grid, base, filament material, construction, etc. This need not be detailed to the extent of manufacturing data but shall be sufficiently complete to definitely define the particular construction. A fifth copy of this statement shall be retained by the manufacturer and be available to the Government at the plant. Copies of description forms are available, on request, from the ASESA.

20.4 Manufacturer's test data. Five copies of a complete report of the manufacturer's tests, including test conditions, on the tubes shall be submitted. Four copies shall be submitted to the ASESA with the request for qualification inspection, and one copy shall be submitted to the designated laboratory with the samples. This report shall include all spe-

cified production and design tests (see 3.9) except dimensions. Tests which by their nature tend to destroy or deteriorate the tube, such as life or base, cap, and insert secureness, shall be performed on samples other than those submitted for qualification inspection. Five copies of complete data on life tests, either performed under the cognizance of the Government, or certified by the manufacturer as having been performed on production tubes of the same design as the specimens submitted for qualification inspection, shall be submitted to the ASESA with the request for qualification or within 60 days thereafter. Inaccurate or inadequate test data may be the cause for refusal of authorization of tests. The test report shall refer to each specimen by a serial number, which shall be marked on the specimen and on the report in such a manner as to be clearly defined. Duplicate serial numbers shall never be used for the same tube type. The number of samples for which life-test data are required shall be determined by the group to which the particular tube is assigned (see 3.9), as follows:

	Reliable	Number of specimens
Group A		20
Group B		10
Group C		5
Group D		3

When the heater-cycling life test is specified (see 3.9), heater-cycling data on 50 samples shall be submitted. When the stability life test and survival-rate life test are specified (see 3.9), stability-life data on 50 samples and survival-rate-life data on 100 samples shall be submitted as part of the life-test data. The specified AQL shall apply.

20.5 Photographs. Six copies of at least one photograph of the completely assembled tube and of the tube either without envelope but with the assembly cut open (showing internal construction) or with the parts unassembled (exploded assembly) shall be submitted. Four sets of photographs shall be submitted to the ASESA, one set shall be available to the Government at the plant, and one

set shall be submitted with the samples to the test laboratory. The photographs shall be 8 by 10 inches in size, depict the tube on as large a scale as practicable (for T-6 $\frac{1}{2}$ or smaller bulbs, a minimum magnification of 3:1 is required), and include the type number, manufacturer, plant of manufacturer, place of manufacture, appropriate reference scale (scale placed in the plane of, and parallel to, the centerline of the tube and the tube parts photographed, and perpendicular to the optical axis of the camera), and approximate date of letter forwarding the samples to the test laboratory. Radiographs may be employed if contributory to the description.

30. SAMPLE

30.1 The sample submitted for qualification shall be representative of the manufacturer's normal production, shall be produced by and at the plant where manufacture is, or is to be, accomplished, and shall be selected from current completely processed production.

30.2 Number of samples. Unless otherwise specified herein, there shall be submitted 4 samples each of tubes having a unit list price in excess of ten dollars, or 6 samples each of tubes having a unit list price of ten dollars or less. A bogey tube, if specified (see 3.9), shall be in addition to the samples specified herein and may be a tube that has been stabilized by life-test operation.

30.2.1 *Ruggedized and reliable tubes.* The following tabulation shows the number of samples to be submitted for the various tests:

Test	Number of samples
(a) Electrical	6
(b) Shock	10
(c) Fatigue	6
(d) Variable-frequency vibration.	6
(e) Low-frequency vibration.	Use (a) samples
(f) Mechanical resonance.	Use (d) samples
(g) Torque	Use (a) samples
(h) Dimensions	Use (a) samples

(The manufacturer shall submit readings for all tests.)

30.2.2 *Semiconductor diodes.* Twenty-four samples shall be submitted.

30.2.3 *Subminiature-lead-fatigue test.* Five additional samples shall be submitted. These may be electrical rejects.

30.2.4 *Test for shorts in filamentary-type tubes.* Three additional samples shall be submitted. These may be electrical rejects.

40. MARKING OF SAMPLES

3-7-6 inclusive, 3-7-8 and 3-7-9

40.1 The marking specified in 3.7.2 to 3-7-7, inclusive, for tubes submitted for qualification shall be marked on the samples by the process and in the manner which the manufacturer plans to use in production. The commercial designation may be used. The marking will be checked only for legibility and durability.

50. SHIPMENT OF SAMPLES

50.1 When the information specified herein has been submitted, authorization will be given by the ASESA to ship the samples to a designated laboratory. The samples shall be carefully packed, and the package marked and addressed as indicated in the letter of authorization and shipped at the manufacturer's expense to the laboratory designated in the authorization. Submission shall be made at the manufacturer's expense and the samples shall in no way be made the basis for any claim against the Government. No shipment of samples shall be made until specific authorization is received. This shipment shall be accompanied by one copy of the test data as specified in 20.4; one set of the photographs(s) as specified in 20.5; and one copy of the defining features as specified in 20.3. When it is specified that a bogey tube (a selected tube having certain specified characteristics) be used in setting or adjusting the test equipment, the manufacturer shall include in the shipment a stabilized bogey tube, except

TABLE X. *Correlation tolerances (receiving tubes).*

Parameter	Allowable correlation tolerance
Filament current	$\pm 2\%$
Emission	$\pm 20\%$
Heater-cathode leakage.	$\pm 25\%$ of specified limit (see 3.9)
AF noise (4.10.3.2) (4.10.3.3) (4.10.3.4)	$\pm 25\%$ of specified limit (see 3.9) in power
Transconductance	$\pm 7\%$ ($\pm 10\%$ above 20,000)
Transconductance at reduced Ef.	$\pm 15\%$
Cutoff Sm	$\pm 20\%$ of specified limit (see 3.9)
Plate resistance	$\pm 7\%$ to 150 K ohms $\pm 10\%$ < 20 K ohms or > 150 K ohms $\pm 25\%$ > 1 Meg
Mu	$\pm 3\%$ 10 to 100 $\pm 6\%$ < 10 and > 100
Plate current	$\pm 4\%$ or engineering judgment, depending on tube stability
Plate current cutoff	$\pm 20\%$ of specified limit (see 3.9)
Grid current Ic1	± 0.3 uAdc or $\pm 25\%$ of specified limit (see 3.9), whichever is greater
Screen current Ic2	$\pm 10\%$
Capacitance	$\pm 20\%$ < 0.01 uuf $\pm 15\%$.01 to .1 uuf $\pm 10\%$.11 to 1.0 uuf $\pm 3\%$ > 1.0 uuf
Power output (audio)	$\pm 10\%$ (watts)
Power output (rf)	$\pm 10\%$ < 50 Mc (total power, and when circuit is uniquely specified); $\pm 15\%$ for others
Rectifier (operation current.)	$\pm 2\%$ if bogey tube is specified (see 3.9); otherwise $\pm 5\%$
ac amplification	-5% (mfr low) +10% (mrf high)

when it is specified that the Services will furnish standard tubes. (See 3.9.) These tubes may be obtained on a loan basis from the Services by applying to the ASESA. As soon as the samples have been shipped to the designated laboratory, the ASESA shall be notified of the date of shipment.

60. CRITERIA FOR EVALUATION OF TEST RESULTS

60.1 The criteria specified in 60.1.1 to 60.1.2.2, inclusive, of this appendix will be used in the evaluation of the results of the examination of the samples.

60.1.1 *Criteria for electrical tests.* No electrical failures will be permitted on samples submitted for qualification.

60.1.1.1 *Correlation tolerances.* Tables X to XVIII, inclusive, specify the allowable deviations of manufacturer's test data from Service-laboratory test data. All tolerances are on individual readings. The Service-laboratory readings will be used as standards except for power and gas tubes. For power and gas tubes, tolerances are based on the specified limits. The allowable correlation tolerances for power and gas tubes will be 5 percent of the range when minimum and maximum limits are specified, and 10 percent of the limit when a minimum or maximum limit is specified. (See 3.9.)

TABLE XI. *Correlation tolerances (magnetrons).*

Parameter	Allowable correlation tolerance		
	L band	S band	X band
rf power:			
< 1 megawatt	$\pm 20\%$	$\pm 20\%$	$\pm 20\%$
> 1 megawatt	$\pm 25\%$	$\pm 25\%$	$\pm 25\%$
Pulse voltage	$\pm 5\%$	$\pm 5\%$	$\pm 5\%$
Filament current	$\pm 2\%$	$\pm 2\%$	$\pm 2\%$
Anode current	$\pm 10\%$	$\pm 10\%$	$\pm 10\%$
Rate of rise of voltage	$\pm 10\%$	$\pm 10\%$	$\pm 10\%$
rf frequency	± 5 Mc	± 5 Mc	$\pm 10\%$
rf bandwidth	± 1 Mc	± 1 Mc	± 1 Mc
Pulling	± 2 Mc	± 2 Mc	± 2 Mc
Stability	(Engineering judgment)		

TABLE XII. Correlation tolerances
(gas-switching tubes).

TR TUBES		
Parameter	Allowable correlation tolerance (percent)	
	S band	X band
Low-level VSWR	± 5	± 5
Spike leakage	± 20	± 20
Recovery time	± 8	± 8
Flat leakage	± 15	± 15
Arc loss	± 15	± 15
Insertion loss	± 20	± 20
Ignitor voltage	± 2 (all bands)	
Ignitor currents	± 2 (all bands)	
rf frequency limits	± 0.1	± 0.1
ATR TUBES		
Loaded Q	± 25	± 10
Recovery time	± 15	± 15
Tuning susceptance	± 20	± 20
Equivalent conductance	± 20	± 20
Arc loss	± 15	± 15
HIGH Q TR TUBES		
Loaded Q	± 10	± 10
Intrinsic Q	± 10	± 10

TABLE XIII. Correlation tolerances (klystrons).

Parameter	Allowable correlation tolerance (percent)
Heater current	± 2
Repeller voltage	± 10
Grid current	± 5
Resonator current (non-oscillating).	± 5
Heater-cathode leakage	± 25
Electrode insulation	± 25
Bump (ΔP_o)	± 20
Total reflector current:	
Gas current	± 25
Leakage current	
Grid current (cutoff)	± 25 of specified limit (see 3.9)
Low pressure	± 25
Emission ΔI_k	± 20
Electronic tuning range (ΔF)	± 20
ΔE_r (between $\frac{1}{2}$ power points)	± 5
Hysteresis	± 25
Power output (L, S, X bands)	± 40
	± 20
Frequency (measured in standard cavity).	± 10 of specified range (see 3.9)
Mechanical tuning range (frequency at end points).	± 0.3
Temperature coefficient	± 25
Pressure coefficient	± 25
Thermal tuning time	(Engineering judgment)

TABLE XIV. Correlation tolerances (planar tubes).

Parameter ¹	Allowable correlation tolerance
Heater current	$\pm 2\%$
Heater-cathode leakage	$\pm 25\%$ of specified max limit (see 3.9)
Grid (gas) current	± 0.3 uAdc or $\pm 25\%$ of specified limit (see 3.9), whichever is greater
Plate current	$\pm 4\%$
Plate current (cutoff)	$\pm 20\%$
Amplification factor	$\pm 5\%$
Transconductance	$\pm 10\%$
Emission (pulsed or cw)	$\pm 20\%$
Interelectrode capacitance	$\pm 2.5\%$ for C _{gp} ; $\pm 2.5\%$ for C _{gk} ; $\pm 5\%$ for C _{pk}
Power oscillation:	
Different cavities	$\pm 15\%$
Mfr's cavity built onto tube	$\pm 5\%$
Noise figure	± 1 db
Cavity bandpass	$\pm 15\%$
Frequency drift (ΔE_f)	$\pm 20\%$
Frequency test in standard cavity.	$\pm 0.25\%$

¹ Forced cooling for thermal stability shall be used on all static measurements.

TABLE XV. Correlation tolerances
(semiconductor diodes).

Parameter	Allowable correlation tolerance
Forward current	$\pm 15\%$
Reverse current:	
at 10 V or less:	
When current ≤ 10 uA	± 5 uA
When current > 10 uA	± 10 uA
At more than 10 V	$\pm 25\%$
Rectification efficiency (100 Mc).	$\pm 20\%$
Rectified current or voltage (60).	$\pm 10\%$

TABLE XVI. Correlation tolerances
(microwave crystal rectifiers).

Parameter	Allowable correlation tolerance
Conversion loss	± 0.5 db
Output noise ratio if impedance	$\pm .4$
VSWR	$\pm 20\%$
Rectified crystal current	± 0.3
Figure of merit	$\pm 20\%$
Video impedance	$\pm 20\%$
	$\pm 30\%$

TABLE XVII. Correlation tolerances
(cathode-ray tubes).

Parameter	Allowable correlation tolerance (percent)
Heater current	±3
Anode No. 1 current	±5
Cathode current	±5
Light output	±5
Modulation	±10
Line width "A"	±15
Line width "B"	±15
Line width "C"	±15
Spot position	±10
Spot displacement	±10
Grid cutoff	±10
Focusing voltages (cutoff)	±5
Focusing voltages (75% cutoff)	±5
Deflection factors (all)	±5
Deflection uniformity	±5
Heater to cathode leakage	±3
Grid No. 1 leakage	±3
Grid No. 2 leakage	±3
Anode No. 2 leakage	±3
Screen cb5:1	(Ratio of buildup ±1)
Screen cb5	(±10 cb)
Focusing ampere turns	±5
Aperture alinement	±10
Capacitance	±3

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POWER AND GAS TUBES
(See 60.1.1.1 of this appendix)

60.1.2 Criteria for mechanical tests. The criteria for mechanical tests will be as specified in table XIX, 60.1.2.1, and 60.1.2.2.

TABLE XIX. Criteria for mechanical tests.

Test	Number of specimens	Number of defectives allowed
Shock	10	2
Fatigue	6	1
Lead fatigue	5	0
Vibration: ¹		
Low frequency	6 (use specimens used in electrical tests)	0
Variable frequency	6	0

¹ In the event the manufacturer's readings are consistently higher than those of the test laboratory, comparison of ranking will be made.

60.1.2.1 Physical condition of samples after mechanical tests. After the mechanical tests, the samples shall meet all of the initial visual mechanical requirements unless otherwise specified.

60.1.2.2 Mechanical tests for semiconductor diodes and microwave crystal rectifiers. No failures are allowed on mechanical tests performed on samples of semiconductor diodes and microwave crystal rectifiers.

70. ACTION ON TEST RESULTS

70.1 If the samples submitted fail the qualification tests, the manufacturer will be so advised and will be furnished with a report covering the test results.

70.2 If the samples pass the qualification tests, the manufacturer will be notified that the product is being included on the Qualified Products List and will be furnished a report covering the test results. Approval will apply only to the plant specified in the letter of notification and will be effective as of the date of the letter.

TABLE XVIII. Correlation tolerances (phototubes).

Parameter	Type of phototube	Allowable correlation tolerance (percent)
Dark current	Gas	±15
	Vacuum	±15
	Photomultiplier L1k	±15
	(1) L1b	±25
	(2) L1b	±30
Anode current	(3) L1b	±20
	(4) L1b	±35
	Gas (1) Ib	±10
	Vacuum (1) Ib	±10
	Photomultiplier 1k	±10
	Gas (2) Ib	±10
	Vacuum (2) Ib	±10
Gas amplification	Photomultiplier Ib	±20
	Gas	±12
	Vacuum	±4
Gas ratio	All	±25
Spectral response		
Capacitance		±5

80. REMOVAL OF QUALIFICATION APPROVAL

80.1 A product may be removed from the Qualified Products List for violation of any of the provisions upon which approval was granted, among which are the following:

- (a) The product offered does not meet the requirements of the specification.
- (b) The manufacturer is delivering a different product from the one originally qualified.
- (c) The manufacturer has discontinued manufacture of the product. Except where the manufacturer has requested removal of his product, he will be notified of the proposed removal of the product from the list and the reason therefor. The manufacturer will be invited to furnish comment.

- (d) Changes in design, construction or place of manufacture shall be reported to ASES for determination of the need for resubmission.

90. DISPOSITION OF SAMPLES

90.1 Samples having a unit list price of less than ten dollars will be retained by the test laboratory or will be returned to the manufacturer, at the option of the laboratory. Other samples may be returned to the manufacturer, at the manufacturer's expense, if return is requested not later than 30 days after the test report is mailed to the manufacturer. The laboratory will exercise the utmost care in testing the samples, but assumes no responsibility for their condition when returned. The laboratory may cut the leads of subminiature tubes to 0.200 ± 0.015 inch when performing destructive tests. The laboratory reserves the right, on qualified tubes, to retain one sample of each qualified type.

The criteria shall serve as a guide to take quality in case of dispute between the acceptance inspector and the contractor on matters of Visual and Mechanical inspection. It is not intended to be a list of mandatory tests

APPENDIX B

VISUAL AND MECHANICAL INSPECTION

10. SCOPE

10.1 This appendix establishes uniform criteria for defects for an individual tube. The criteria shall apply whether a 100-percent inspection procedure or a sampling inspection procedure is used. In order to establish the AQL basis for each defect discussed in this appendix, the degree of defect (major 1, major 2, minor, or control) is indicated in a column to the right of the defect.

20. GENERAL INSTRUCTIONS

20.1 Inspection shall be made with the unaided eye unless magnification is specified.

30. GENERAL DEFECTS

30.1 Glass envelopes.

30.1.1 Terminology.

Blister. A bubble in the glass due to the inclusion of air or other gas, having a maximum dimension in excess of that specified in particular definitions paragraph in 30.1.5 of this appendix.

Checks and cracks. Fissures extending into or through the wall of the glass envelope.

Cluster. Two or more stones or knots when the minimum separation is not more than $\frac{1}{16}$ inch.

Cord. An attenuated transparent inclusion possessing optical or other properties differing from the parent glass.

Glass adhered. A foreign piece of glass attached to the outside surface of the tube.

Glass knot. A small transparent area of incompletely assimilated glass having an irregular, knotty, or tangled appearance; a transparent stone. The "size" of a knot refers to the maximum linear dimension of its most distinct contour. A "cluster" of knots is a

group of two or more knots that are spaced not more than $\frac{1}{16}$ inch apart. A cluster is considered as one knot. The size of a cluster shall be considered as the maximum overall dimension of the group.

Hard glass. General term covering glasses with a low coefficient of expansion (usually below 50×10^{-7}).

Scale. A small piece of metallic oxide or carbon embedded in the glass. Not to be confused with allowable slight blackening of seal area caused by reduced lead in the glass.

Scuff. Small scratches or abrasions in the surface of the glass.

Side mold marked. Side of bulb has a "pinched" appearance.

Side or top mold ringed. Surface of bulb contains circumferential undulations.

Soft glass. General term covering glasses having a high coefficient of expansion (usually above 50×10^{-7}).

Stone. A piece of clay or other unmelted glass batch material embedded in the glass, usually evidenced as a white opaque spot. The dimension of a stone refers to the maximum linear dimension of the undigested or opaque portion. A "cluster" of stones is a group of two or more stones which are spaced not more than $\frac{1}{16}$ inch apart. A cluster is considered as one stone. The dimension of a cluster shall be considered as the maximum overall dimension of the group.

Wavy. Containing a number of fine cords.

30.1.2 Instructions. The glass inspection criteria in 30.1.4 to 30.1.11.2, inclusive, of this appendix shall apply to tubes with soft-glass envelopes up to and including $2\frac{1}{2}$ inch envelope design (largest diameter), hard-glass envelopes, and miniature and subminiature tubes. These criteria shall not apply to cathode-ray tubes or other optically employed

devices. Debatable tubes (tubes which cannot be determined to conform to the criteria of any of the paragraphs on glass defects, 30.1.4 to 30.1.11.2, incl, of this appendix) shall be subjected to the glass-strain test as specified in 4.9.6.3. A tube passing the glass-strain test shall be considered acceptable under the visual-inspection paragraph for which the tube was originally questioned. A tube failing the glass-strain test shall be classified a defective under the visual-inspection paragraph for which the tube was originally questioned.

30.1.3 Soft and hard glass. The criteria in 30.1.4 to 30.1.11.2, inclusive, of this appendix are established for glasses known to the industry as codes 001, 008, 012, 014, and 816 or equivalents (soft glass); and codes 7720, 7740, 7760, 7040, 7050, 7060, 7052, 9741, 1720, 7070, and 7750 (hard glass). Special hard-glass classifications are as follows:

Class A — 7720, 7740, 7760 or equivalents.

Class B — 7040, 7050, 7060, 7052, 9741 or equivalents.

Class C — 7070, 7750, 1720 or equivalents.

30.1.4 Stones.

30.1.4.1 Soft-glass stones.

30.1.4.1.1 Size and number.

Up to 0.010 inch — Acceptable.

0.011 to 0.020 inch — If in quantity of four or moreMinor

0.021 inch and more — Size and number more than the values specified in Table XX.Minor

30.1.4.2 Hard-glass stones.

TABLE XX. *Acceptable soft-glass stones.*

Bulb size glass-envelope diameter	Max acceptable stone size ¹		Max number of stones acceptable in one bulb
	Max, if 1 stone	Max for each, if 2 stones	
<i>Inches</i>	<i>Inch</i>	<i>Inch</i>	
Up to $\frac{3}{8}$	0.025	-----	1
$1\frac{1}{32}$ to $\frac{5}{8}$	.035	-----	1
$2\frac{1}{32}$ to 1.....	.050	0.040	2
$1\frac{1}{32}$ to $1\frac{1}{2}$	.063	.045	2
$1\frac{9}{16}$ to $2\frac{1}{2}$	.085	.063	2

¹ The maximum dimension of the undigested portion (usually white in appearance and presenting a distinct contour) of a stone shall be the determining stone size.

TABLE XXI. *Acceptable hard-glass stones.*

Bulb size ¹ (length x dia)	Max acceptable stone size ²			Max number of stones acceptable in one bulb
	Max, if 1 stone	Max for each, if		
		2 stones	3 stones	
<i>Inches</i>	<i>Inch</i>	<i>Inch</i>	<i>Inch</i>	
Up to 3.....	$\frac{1}{32}$	$\frac{1}{32}$	-----	2
3 to 32.....	$\frac{1}{16}$	$\frac{3}{64}$	-----	2
Over 32.....	$\frac{3}{32}$	$\frac{1}{16}$	$\frac{3}{64}$	3

¹ Bulb-size classification is obtained by multiplying the bulb diameter in inches by the finished-bulb length in inches.

² The maximum dimension of the undigested portion (usually white in appearance and presenting a distinct contour) shall be the determining stone size.

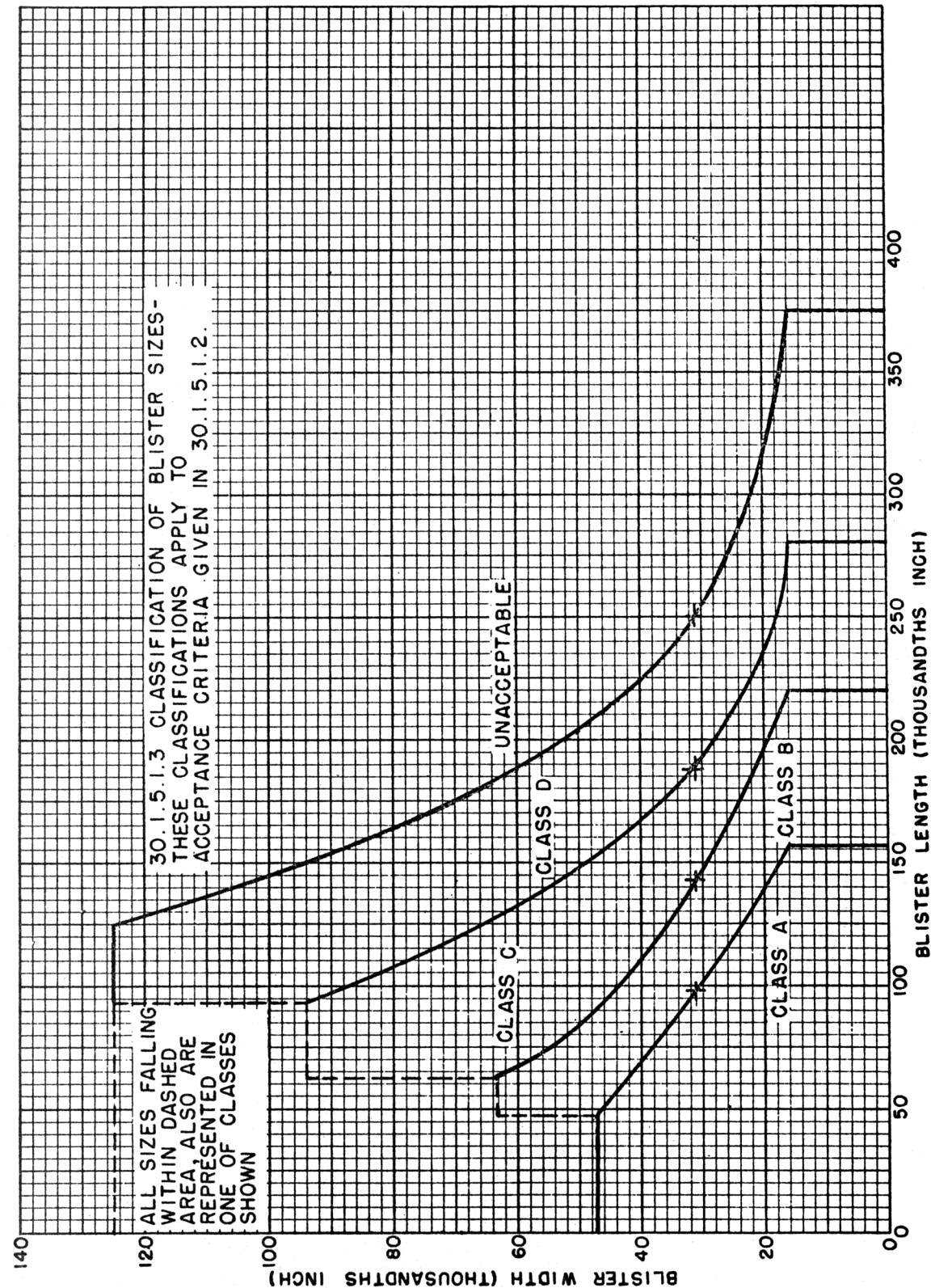


FIGURE 59. Classification of soft-glass-unbroken-blister sizes.

TABLE XXII. *Acceptable soft-glass unbroken blisters.*

Glass-envelope max dia	Acceptable number of blisters				Max total
	Class ¹				
	A	B	C	D	
<i>Inches</i>					
Up to $\frac{3}{8}$	2	0	0	0	2
$\frac{13}{32}$ to $\frac{3}{8}$	3	0	0	0	3
$\frac{21}{32}$ to 1.....	5	2	0	0	5
$\frac{11}{32}$ to $1\frac{1}{2}$	8	4	2	0	9
$\frac{18}{16}$ to $2\frac{1}{2}$	14	7	3	2	17

¹ Class of blister is determined from figure 59.**30.1.4.2.1 Size and number.**

- up to 0.020 inch — Acceptable.
 0.021 to $\frac{1}{32}$ inch — If in quantity of four or more. Minor
 Over $\frac{1}{32}$ inch — Size and number more than the values specified in table XXI. Minor

30.1.4.2.2 Overglazing. Stones more than $\frac{1}{32}$ inch not overglazed. Minor

30.1.5 Blisters.**30.1.5.1 Soft-glass blisters.**

30.1.5.1.1 Open blisters. Open-surface blisters 0.025 inch or more. Minor

30.1.5.1.2 Buried or unbroken-surface blisters. No attempt shall be made to break unbroken blisters.

Total number and class of blisters 0.025 inch and more, more than the values specified in table XXII. Minor

30.1.5.1.3 Classification of soft-glass unbroken-blisters sizes. (See fig. 59.)

30.1.5.1.4 Blister-measuring scale. The scale shown on figure 60 shall be transferred to a flexible transparent scale for use.

30.1.5.2 Hard-glass blisters.

30.1.5.2.1 Open blisters. Open-surface blisters $\frac{1}{32}$ inch or more. Accept if raw edges of the open-surface blisters are finished off. Minor

30.1.5.2.2 Buried or unbroken-surface blisters (class A or B glass). No attempt shall be made to break unbroken blisters. Minor

Reject if:

- 4 or more blisters with a maximum dimension more than $\frac{3}{16}$ inch occur in any area bounded by a 1-inch circle, or
- 13 or more blisters with a maximum dimension between $\frac{1}{32}$ and $\frac{3}{64}$ inch occur in any area bounded by a 1-inch circle, or
- Size of any blister is more than the value specified in table XXIII.

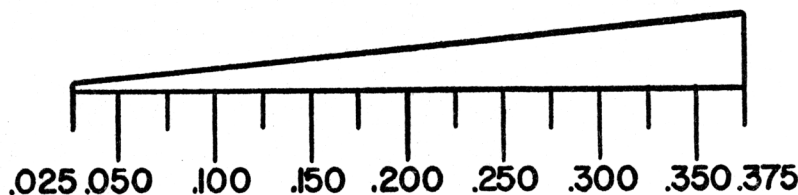
FIGURE 60. *Blister-measuring scale.*

TABLE XXIII. *Acceptable hard-glass unbroken blisters.*

Bulb size ¹ (length x dia)	Blister size			
	Max dia (if round)	Max area	Equivalent elliptic dimensions	Max length
<i>Inches</i> Up to 5	<i>Inch</i> $\frac{3}{32}$	<i>Square Inch</i> 0.0087	<i>Inches</i> (nearest $\frac{1}{64}$) $\frac{1}{16} \times \frac{1}{8}$ or $\frac{1}{32} \times \frac{3}{16}$ or $\frac{1}{64} \times \frac{9}{32}$	<i>Inches</i> $\frac{9}{32}$
Over 5 to 25	$\frac{3}{16}$	0.0352	$\frac{5}{32} \times \frac{7}{32}$ or $\frac{1}{8} \times \frac{9}{32}$ or $\frac{3}{32} \times \frac{11}{32}$ or $\frac{1}{16} \times \frac{1}{2}$ or $\frac{1}{32} \times \frac{3}{4}$ or $\frac{1}{64} \times 1$	1
Over 25 to 45	$\frac{1}{4}$	0.063	$\frac{3}{16} \times \frac{5}{16}$ or $\frac{1}{8} \times \frac{3}{8}$ or $\frac{3}{32} \times \frac{15}{32}$ or $\frac{1}{16} \times \frac{9}{16}$ or $\frac{1}{32} \times 1\frac{1}{4}$	1 $\frac{1}{4}$
Over 45 to 70	$\frac{5}{16}$	0.076	$\frac{1}{4} \times \frac{1}{2}$ or $\frac{1}{8} \times 1$ or $\frac{1}{16} \times 1\frac{1}{2}$	1 $\frac{1}{2}$
Over 70	$\frac{3}{8}$	0.141	$\frac{1}{4} \times \frac{3}{4}$ or $\frac{1}{8} \times 1\frac{1}{4}$ or $\frac{1}{16} \times 2$	2

¹ Bulb-size classification is obtained by multiplying the bulb diameter in inches by the finished-bulb length in inches.

TABLE XXIV. *Acceptable hard-glass knots (class A glass).*

Envelope size (length x dia)	Max dimension			Max number of knots
	1 knot	2 knots	3 knots	
Up to 32	<i>Inch</i> $\frac{3}{64}$	<i>Inch</i> $\frac{1}{16}$	<i>Inch</i> —	3
Over 32	$\frac{1}{64}$	$\frac{5}{64}$	$\frac{1}{16}$	4

30.1.6 Scratched bulb. Scratches on surface of bulb more than $\frac{3}{4}$ inch in length, having sufficient depth to definitely catch the fingernail. Scratches which do not catch the fingernail shall be accepted.Minor

30.1.7 Glass adhered. Maximum dimension of adhered glass more than $\frac{3}{32}$ inch.Minor

30.1.8 Checks and cracks. Crack extending into or through the wall of the glass envelope.Major 1

→ See Amdt 5 p 32

30.1.9 Scale. Scale more than $\frac{1}{32}$ inch in maximum dimension.Minor

30.1.10 Glass knot (hard glass).

30.1.10.1 For envelopes made with class A glass:

Knots up to a maximum dimension of $\frac{1}{64}$ inch, except when in clusters, shall be accepted.

Maximum dimension and number of knots more than the value specified in table XXIV.Minor

30.1.10.2 For envelopes made with class B or C glass:

Knots shall be separated, in all cases, by a distance equal to one-third the maximum circumference of the envelope. Knots up to $\frac{1}{16}$ inch, except when in strings, shall be accepted.

Number of knots more than the value specified in table XXV.Minor

TABLE XXV. *Acceptable hard-glass knots (class B or C glass).*

Knot size	Max number of knots in one envelope ¹
<i>Inch</i>	
$\frac{1}{4}$	1
$\frac{1}{8}$ to $\frac{1}{4}$	3
$\frac{1}{16}$ to $\frac{1}{8}$	6

¹ Maximum total length of string of knots: 6 inches in one envelope.

30.1.11 Tip defects.

30.1.11.1 Sharp tips. Sharp, chipped, or stringy.Minor

30.1.11.2 Re-entrant (sucked-in) exhaust tip. Re-entrant depth more than one-third of tip diameter.Control

30.2 Metal envelopes.

30.2.1 Dents.

30.2.1.1 Number. More than two dents in a tube.Minor

30.2.1.2 Depth. Any dent more than $\frac{1}{32}$ inch in depth.Minor

30.2.2 Paint.

30.2.2.1 Crimping. The base-wafer crimping process causes exposed body metal to a distance more than $\frac{3}{32}$ inch above top edge of base wafer.Minor

30.2.2.2 Mars, peeling blemishes. Combined total area of exposed metal more than $\frac{1}{4}$ by $\frac{1}{8}$ inch, or equivalent area.Minor

30.2.2.3 Scratches. A scratch on the painted surface exposing body metal more than $\frac{1}{2}$ inch in length for metal receiving tube types or 2 inches in length for other types.Minor

30.3 Bases, base pins and inserts, and top caps.

30.3.1 Thermosetting plastic bases.

30.3.1.1 Blisters on side of base.

30.3.1.1.1 Buried or unbroken-surface blisters. Outside diameter of base more than maximum. (Unbroken blisters shall be subjected only to pressure of a fingernail.)Major 1

30.3.1.1.2 Open blisters.

30.3.1.1.2.1 *Size.* Any single open-surface blister more than $\frac{1}{8}$ by $\frac{1}{8}$ inch, or equivalent area.Minor

30.3.1.1.2.2 *Number.* More than five open-surface blisters more than 0.030 inch in maximum dimension.Minor

30.3.1.2 *Blisters on bottom of base.*

30.3.1.2.1 *Position.* Blister(s) connecting any two base pins.Major 1

30.3.1.2.2 *Height.* Blister more than 0.010 inch in height.Major 1

30.3.1.2.3 *Open.* Open-surface blisters more than 0.030 inch in maximum dimension. (Unbroken blisters shall be subjected only to pressure of a fingernail.)Minor

30.3.1.3 *Blisters on guide lug.* Outside diameter of lug more than maximum...Major 1

30.3.1.4 *Chips.*

30.3.1.4.1 *Size.* Chips less than 0.030 inch in maximum dimension shall be accepted.

30.3.1.4.2 *Depth.* Individual chips more than $\frac{1}{32}$ inch in depth.Minor

30.3.1.4.3 *Area.* Chips more than $\frac{1}{8}$ by $\frac{1}{8}$ inch, or equivalent area.Minor

30.3.1.4.4 *Corner chips.* Corner chips extending more than $\frac{1}{8}$ inch along any of the intersecting surfaces.Control

30.3.1.4.5 *Key chips.* Guide-lug-key chips more than 0.030 inch in longest dimension.Minor

30.3.1.4.6 *Number.* More than five open-surface blisters or five chipped places.Minor

30.3.1.5 *Cracks.*

30.3.1.5.1 *Number.* Any cracks. ...Major 1

30.3.1.6 *Scratches.* Base scratched...Control

30.3.2 *Ceramic bases.*

30.3.2.1 *Chips.*

30.3.2.1.1 *Depth.* Individual chips more than $\frac{1}{32}$ inch in depth.Minor

30.3.2.1.2 *Area.* Chips more than $\frac{1}{8}$ by $\frac{1}{8}$ inch, or equivalent area.Minor

30.3.2.1.3 *Corner chips.* Corner chips extending more than $\frac{1}{8}$ inch along any of the intersecting surfaces.Minor

30.3.2.1.4 *Key chips.* Guide-lug key chipped.Major 1

30.3.2.1.5 *Number.* More than five open-surface blisters or five chipped places.Minor

30.3.2.2 *Cracks.*

30.3.2.2.1 *Deep cracks.* Any body cracks.Major 1

30.3.2.2.2 *Glaze cracks.*

Any glaze cracks extending from one pin to another.Minor
Any other glaze cracks.Control

30.3.2.2.3 *Scratches.* Base scratched.Control

30.3.3 *Metal bases.*

30.3.3.1 *Dents.*

30.3.3.1.1 *Number.* More than two dents in a tube.Minor

30.3.3.1.2 *Depth.* Any dent more than $\frac{1}{32}$ inch in depth.Minor

30.3.3.2 *Plating.*

A scratch exposing base metal more than $\frac{1}{2}$ inch in length.Minor
Scratches not exposing base metal.Control

30.3.3.2.1 Peeling and blisters.

Any peeling of plating where plating is required for electrical reasons.Major 1

Peeling of plating where appearance is seriously affected.Minor

Peeling of plating, or blisters, where appearance only is involved, provided the appearance of the tube is not seriously affected.Control

30.3.4 Base pins.**30.3.4.1 Bayonet pins.**

30.3.4.1.1 Lateral motion. Total lateral motion more than $\frac{1}{64}$ inch.Minor

30.3.4.1.2 Rotation.

The stake bayonet pin rotates, but cannot be pushed into base wall.Control

Unstaked pin rotates.Minor

30.3.4.2 Contact pins.**30.3.4.2.1 Lateral motion.**

Total lateral motion of contact pins, other than pins sealed directly in glass, more than $\frac{1}{32}$ inch at pin tip when moved with the fingers.Minor

Pins sealed directly in glass shall have no motion.

30.3.4.2.2 Rotation. Any contact-pin rotation.Minor

30.3.4.2.3 Alinement. Pin alinement not conforming to pin-alinement gage when gage is specified.Minor

TABLE XXVI. Increased diameter of contact pin.

Bogey-pin diameter (base drawing)	Max diameter
<i>Inch</i>	<i>Inch</i>
0.093	0.098
.125	.131
.156	.162
.187	.195
.312	.320

30.3.4.2.4 Increased diameter by solder.

Maximum diameter by presence of solder is more than that specified in table XXVI.Minor

30.3.5 Base inserts.**30.3.5.1 Ceramic wafer.**

Deep cracks.Major 1

Glaze cracks extending from any pin to another pin or to the sleeve...Minor

30.3.5.2 Glass. All cracks and chips on candelabra or other lamp bases with glass insulation, unless otherwise specified (see 3.9), shall be accepted.

30.3.6 Soft-solder defects.**30.3.6.1 Loose or unsoldered wires.**

Loose or unsoldered wire or wires in pins or caps.Major 1

30.3.6.2 Exposed wire. More than $\frac{1}{32}$ inch of wire length exposed beyond end of pin or cap; or $\frac{1}{32}$ inch of wire length exposed ^{beyond} solder when end of pin or cap is concealed by solder.Minor

30.3.6.3 Excess solder on pin. See 30.3.4.2.4 of this appendix.

30.3.6.4 Soldering of wire to base pins. Depth of solder contact less than $\frac{1}{16}$ inch. (Applies only to pins with 0.156 inch or more design center.)Minor

30.3.7 Envelope and base.

30.3.7.1 Envelope and base alinement. Maximum distance to the outermost point of the bulb more than 60 percent of the specified maximum bulb diameter (see 3.9), using the centerline of the base as a reference.Minor

30.3.7.2 Cementing.

30.3.7.2.1 Looseness. Any immediately apparent looseness of cemented junction of base.Major 1

30.3.7.2.2 *Excess cement.*

Cement protruding more than $\frac{1}{16}$ inch on bases less than $1\frac{1}{2}$ inches in diameter.Minor

Cement protruding more than $\frac{3}{16}$ inch on bases $1\frac{1}{2}$ inches or more in diameter.Minor

30.3.7.2.3 *Voids.*

Bases used for tube support failing base, cap, and insert secureness test.Major 1

Bases not used for tube support and voids not totalling more than one-eighth of tube circumference...Control

30.3.8 *Wafers and base or envelope.*

30.3.8.1 *Rotational movement.* Total rotational movement of wafer with respect to crimped metal more than $\frac{1}{32}$ inch when tried with the fingers.Minor

30.3.8.2 *Separating movement.* Any movement separating any part of the wafer away from the crimped metal more than $\frac{1}{64}$ inch when tried with the fingers.Minor

30.3.8.3 *Base-wafer crimping removes paint.* The base-wafer crimping process causes exposed body metal to a distance more than $\frac{3}{32}$ inch above top edge of base.Minor

30.3.9 *Top cap and envelope.*

30.3.9.1 *Alinement.* Centerline of top cap departing from centerline of bulb by more than 10 percent of diameter of dome.Minor

30.3.9.2 *Cementing.*

Excess cement protruding more than $\frac{1}{32}$ inch from edge of cap with contact diameter of $\frac{3}{8}$ inch or less, or more than $\frac{1}{16}$ inch from edge of cap with contact diameter more than $\frac{3}{8}$ inch.Minor

Any looseness of cemented junction of top cap.Major 1

30.3.9.3 *Crimping.* Total rotational movement from top cap to envelope of metal tubes more than $22\frac{1}{2}^\circ$ when tried with the fingers.Minor

30.3.9.4 *Dents.*

Any dent more than $\frac{1}{32}$ inch in depth.Minor

More than two dents more than 0.010 inch in depth.Minor

30.3.9.5 *Welds.* Any missing welds...Minor

30.4 *Leads.*

30.4.1 *Unconnected.* Except where intended.Major 1

30.4.2 *Condition of leads.* Leads are knotted, or severely kinked.Control

30.4.3 *Frayed leads (stranded lead cables).* More than 10 percent of the strands are broken.Major 1

NOTE: The free ends of broken strands shall be removed.

30.5 *Internal mechanical structure.*

30.5.1 *Spot welding.* Broken, open or not welded.Major 1

30.5.2 *Cracked micas.* Cracked through except for bumper point.Control

30.5.3 *Plates fused.* In the active area of the plate, fused or incipient melting (holes, blisters, etc) due to bombardment.Control

30.5.4 *Getter ^{area} flash.* Getter not flashed, getter missing, or detached.Major 1

30.5.5 *Getter peel.* Peeled or blistered more than $\frac{1}{32}$ inch in longest dimension for subminiature tubes, and $\frac{1}{16}$ inch in longest dimension for all other tubes....Minor

30.5.6 *Loose particles.* In receiving tubes and allied types (in any part of finished tube). For reliable subminiature receiving tubes, see 40.4.2 of this appendix. For reliable miniature receiving tubes, see 70.4.4 of this appendix.

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30.5.6.1 Instructions. Debatable tubes (tubes which cannot be determined to conform to the criteria of 30.5.6.3 of this appendix) shall be subjected to the following short-circuit test: Conventional short-circuit test equipment shall be used. The tube shall be tapped with an approved mallet, using a stroke of approximately 2 inches. The tube shall be tapped three times in each of the following positions:

- (a) tube inverted;
- (b) tube horizontal;
- (c) tube horizontal but rotated 180° from position (b).

Any tap-short indication shall be considered a major 2 defect. *particles-indicator test specified in 30.5.6.5 of this appendix*

30.5.6.2 Loose particles that by visual inspection can be determined to be of a nonconducting nature.

30.5.6.2.1 Micas.

Any single particle more than $\frac{3}{8}$ inch in longest dimension. Minor

More than 5 of the mica particles more than $\frac{1}{32}$ inch in longest dimension. Minor

30.5.6.2.2 Other nonconducting material.

Any single particle more than $\frac{1}{8}$ inch in longest dimension. Minor

More than 3 of the particles more than $\frac{1}{64}$ inch in longest dimension. Minor

30.5.6.3 Loose particles that by visual inspection can be determined to be of a conducting nature. Any particle whose largest dimension is more than three-fourths of the nominal minimum interelement spacing (except heater-cathode) or $\frac{1}{64}$ inch, whichever is greater, but, in any case, not more than $\frac{1}{16}$ inch. Major 2

30.5.6.4 Loose particles in tubes where particles cannot be determined by other means to be of a conducting or nonconducting nature. In the event a decision on acceptance or rejection cannot be made on the basis of 30.5.6.2 or the first part

of 30.5.6.3 of this appendix, the individual tube in question shall be subjected to the ~~short circuit test specified in 30.5.6.1 of this appendix~~. Major 2
particles-indicator test specified in 30.5.6.5 of this appendix

30.6 Branding or etching.

To 5.6.5 Seal App 5 p 32
30.6.1 Missing or wrong etch or brand. Etch or brand is incorrect, or etch or brand is not legible. Major 1

30.7 Vacuum seals (metal to glass).

30.7.1 Copper-to-glass feather-edge seals.

30.7.1.1 Color.

Black seals and seal colors outside range of light straw to deep red, inclusive (and brownish green for code 7052 glass). Major 1
 Nonacceptable color more than 25 percent of the seal width, or $\frac{1}{16}$ inch, whichever is less. Minor

30.7.1.2 Shale. A shale is herein defined as parting of the glass from the copper.

Width of shale more than 25 percent of the seal width. Major 1

30.7.1.3 Cracks. Spent external circumferential or moon cracks more than 25 percent of the seal width from the glass edge, or more than $\frac{3}{32}$ inch, whichever is less. Major 1

30.7.1.4 Bubbles.

Loss of seal width due to bubbles is more than one-third. Minor
 Any single bubble more than one-sixth of the seal circumference. Minor
 Combined length of all bubbles more than one-third of the seal circumference. Minor

30.7.1.5 Combination of shales, bubbles, cracks, and rejectable color. A combination of these items is more than 33 percent of the seal width. Major 1

30.7.1.6 Splits in feather edge. Any split more than 25 percent of the seal width.Minor

30.7.2 Fernico-, kovar-, or rodar-to-glass seals.

30.7.2.1 Cylindrical-edge-type seals.

30.7.2.1.1 Color. Less than $\frac{1}{16}$ inch of the seal width has a color ranging between metallic gray and dark gray....Minor

NOTE: This criterion does not apply to seals which are plated prior to glassing; for example, chrome-, gold-, or silver-plated seals.

30.7.2.1.2 Bubbles.

Loss of seal width due to bubbles is more than one-third.Minor

Any single bubble more than one-sixth of the seal circumference.Minor

Combined length of all bubbles more than one-third of the seal circumferenceMinor

30.7.2.1.3 Shale. Width of shale more than 25 percent of the seal width....Major 1

30.7.2.1.4 Cracks. Spent external circumferential or moon cracks more than 25 percent of the seal width from the glass edge, or more than $\frac{3}{32}$ inch, whichever is less.Major 1

30.7.2.1.5 Splits in metal edge. Any split more than 25 percent of the seal width.Minor

30.7.2.2 Disc- and window-type seals.

30.7.2.2.1 Shale. Width of shale more than 25 percent of the seal width, on seals $\frac{1}{8}$ inch or more in width.Minor

30.7.2.2.2 Cracks.

Spent external circumferential or moon cracks within 25 percent of the seal width from the glass edge, or $\frac{1}{16}$ inch, whichever is less, on

seals $\frac{1}{8}$ inch or more in width, shall be accepted.

All other cracks on seals $\frac{1}{8}$ inch or more in width.Major 1

Any degree of cracks on seals less than $\frac{1}{8}$ inch in width.Major 1

30.7.2.2.3 Bubbles.

Any bubble more than $\frac{1}{32}$ inch in maximum dimension, on seals less than $\frac{1}{8}$ inch in width.Minor

Any bubble more than $\frac{1}{16}$ inch in maximum dimension, on seals $\frac{1}{8}$ inch or more in width.Minor

Distance between bubbles of $\frac{1}{64}$ to $\frac{1}{32}$ inch in maximum dimension is less than $\frac{1}{16}$ inch, on seals less than $\frac{1}{8}$ inch in width.Minor

Distance between bubbles of $\frac{1}{32}$ to $\frac{1}{16}$ inch in maximum dimension is less than $\frac{1}{16}$ inch, on seals $\frac{1}{8}$ inch or more in width.Minor

Cluster of bubbles of any size causes loss of seal width of 33 percent or moreMajor 1

30.7.2.2.4 Color. Less than one-third of the seal width has a color ranging between metallic gray and dark gray....Minor

NOTE: This criterion does not apply to seals which are plated prior to glassing; for example, chrome-, gold-, or silver-plated seals.

30.7.2.3 Fernico-, kovar-, or rodar-eyelet-to-glass-to-lead seal.

30.7.2.3.1 Cracks (see fig. 61).

Annular cracks which surround the leads (sketch 1) and radial cracks not more than two in number, not extending more than halfway between the lead and inside edge of eyelet, and not deeper than height of glass above eyelet (sketch 2), shall be accepted.

Cracks extending across eyelet seal as in sketch 3 of figure 61....Major 1
Shaled seals or seals with cracks which fall outside above limits.Major 1

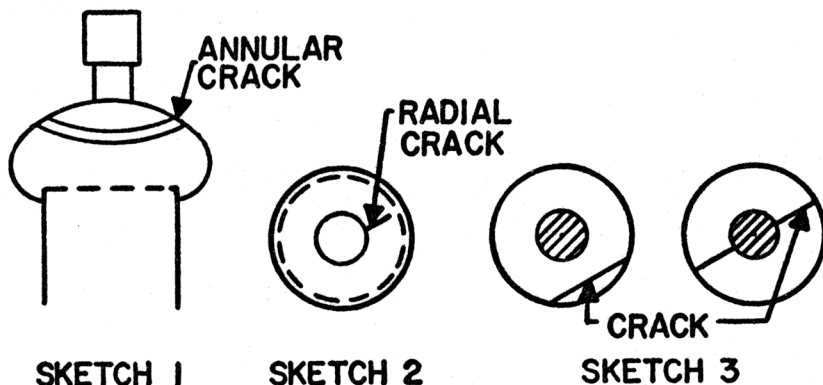


FIGURE 61. Cracks.

30.7.3 Tungsten-rod-to-glass seals.

30.7.3.1 Envelope seals with external bosses.

30.7.3.1.1 Checks.

- Axial check exceeding in depth one-third of length of glass-to-tungsten seal. Major 1
- Radial checks extending more than $\frac{1}{8}$ inch from the pin. Major 1

30.8 Air-cooled fin-type radiators.

30.8.1 Solder obstruction.

Solder between the fins all the way around the edge of the envelope and inside circumference of the outer shell up to $\frac{1}{32}$ inch or 5 percent of the fin width, whichever is greater. In addition, 10 percent of the spaces between fins may be filled with solder up to 25 percent of the radial-fin width. Control

NOTE: Fillets shall be accepted at all corners.

40. ADDITIONAL CRITERIA FOR INSPECTION OF RELIABLE SUBMINIATURE TUBES

40.1 Instructions. Internal and external defects shall be combined. Ten-power magnification shall be used for the defects described in the following paragraphs of this appendix:

30.1.8	40.3.1.5	40.4.3
30.5.1	40.3.2	40.4.5.1
30.5.2	40.3.3	
40.2.1	40.4.1	
40.3.1.2	40.4.2	

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40.4.1.1

The requirements of 30 to 30.6.1, inclusive, of this appendix shall be supplemented or amended by the requirements of 40.2 to 40.4.5.2, inclusive, of this appendix. Debatable tubes (tubes which cannot be determined to conform to any criteria of 30.1.4 to 30.1.11.2, inclusive, 40.2.1, or 40.4.3 of this appendix) shall be subjected to the glass-strain test specified in 30.1.2 of this appendix. A tube passing the glass-strain test shall be considered acceptable under the visual-inspection paragraph for which the tube was originally questioned. A tube failing the glass-strain test shall be classified a defective under the visual-inspection paragraph for which the tube was originally questioned.

40.2 Glass envelopes.

40.2.1 Chipped-out section on external surface of glass. Any chips deeper than 0.010 inch or more than $1\frac{1}{2}$ mm in maximum dimension on the straight portion of the bulb, or on the header. Minor

40.2.2 Re-entrant (sucked-in) exhaust tip. Re-entrant depth more than one-third of the tip diameter. Minor

40.2.3 Seals of envelopes. Tube does not fit applicable outline gage. Control

40.3 Leads.

40.3.1 Tinning defects.

40.3.1.1 *Tinning splashes.* Foreign material adhering to the outside surface, or globules of tin adhering to the header or the untinned portion of the leads. Minor

40.3.1.2 *Poor tinning.* Bare spot encircling lead, or any spot 0.04 inch long or more, except within 0.05 inch or more than 1½ inches from glass. Control

40.3.1.3 *Excessive tinning.* Maximum lead diameter is more or less than that specified on the outline drawing from 0.05 to 0.25 inch from the base of the tube; or the lead diameter from 0.25 inch to 1.5 inches from the base of the tube is more than the maximum diameter by 0.021 inch. A micrometer shall be used for measurement. Minor

40.3.1.4 *Lumpy tinning.* Lumpy tinning shall be accepted if the lead diameter in individual spots is not more than one and one-half times the bogey lead diameter. Control

40.3.1.5 *Incomplete tinning.* Tinned portion of the lead does not extend to within 0.05 inch of the header. Minor

40.3.2 *Burned dumet leads.* Copper sheath has been burned through outside the envelope. Minor

40.3.3 *Corrosion (header and leads).* Any corrosion of material causing a leakage path on the header, or any corrosion in the lead recesses of the header or on the leads. Minor

40.4 Internal mechanical structure.

40.4.1 *Welds (other defects).* Either element of a weldment reduced by more than one-half its formed cross-sectional area, or splash from weld present on any

element other than in original weld area. Control
40.4.1.1 See Amdt 5 p 33

40.4.2 Loose particles.

40.4.2.1 *Instructions.* The requirements of 40.4.2.1 to 40.4.2.4, inclusive, of this appendix supersede those of 30.5.6 to 30.5.6.3, inclusive, of this appendix. All tubes shall be tapped in an upright position by a standard tube tapper. Immediately after tapping, the tube shall be visually inspected for loose particles. The tube shall be rotated about its main axis in a horizontal position while the tube is under visual observation. Debatable tubes (tubes which cannot be determined to conform to any criteria of 40.4.2.1 to 40.4.2.4, inclusive, of this appendix) shall be subjected to the ~~short-circuit~~ ^{particle indicator} test specified in 30.5.6.1 of this appendix.
30.5.6.5

40.4.2.2 *Loose particles that by visual inspection can be determined to be of a nonconducting nature.* Particles with a maximum dimension more than 1/16 inch. Minor

40.4.2.3 *Loose particles that by visual inspection can be determined to be of a conducting nature.* Loose (nonadhering, free to roll or tumble) conducting particles, the largest dimension of which is more than three-fourths of the nominal minimum interelement spacing (except heater-cathode) or 0.003 inch, whichever is greater. Major 2

40.4.2.4 *Loose particles that cannot be seen or that by visual means alone cannot be determined to be of a conducting or nonconducting nature.* In the event a decision on acceptance or rejection cannot be made on the basis of 40.4.2.2 or the first part of 40.4.2.3 of this appendix, the individual tube in question shall be subjected to the ~~short-circuit~~ ^{particle indicator} test specified in 30.5.6.1 of this appendix. Major 2
30.5.6.5

40.4.2.5 *Dangling particles.* Dangling particles or slivers which are firmly at-

tached shall be accepted. A questionable tube shall be subjected to the fixed-frequency-vibration test specified. (See 3.9.) The tube shall be considered acceptable if the particle is still attached at the conclusion of the vibration test.Major 2

40.4.3 Metal touching bulb. All cases of metal parts or particles touching the bulb as identified by a white spot or check appearing in the glass (unless specifically intended by design).Major 1

40.4.4 Missing points on mica. More than 25 percent of mica points missing on any mica that supports the tube structure.Control

40.4.5 Heater-coating defects.

40.4.5.1 Chipped or cracked coating. Heater coating on heater or heater legs missing or damaged so as to expose bare heater wire within 0.020 inch of entrance to cathode sleeve.Minor

40.4.5.2 Uncoated heater wire. More than $\frac{1}{16}$ inch of uncoated heater wire, measured from perimeter of weld.Minor

50. CRITERIA FOR INSPECTION OF CATHODE-RAY TUBES

50.1 Application. In 50-2 of this appendix are specified the criteria for the determination of the screen and face-plate quality while 50.3 specifies the criteria for the determination of the glass quality of all parts of the bulb other than the face plate; these criteria apply to tubes of questionable quality only.

50.2 Screen and face-plate defects.

50.2.1 Definitions.

Bright spot. A small area or point source of light on the tube screen with an intensity (fluorescent or phosphorescent) at least twice the brightness of the surrounding area. (Its colour need not be the same as the surrounding area.)

Bruise or bruise check. Fissures caused by impact carbonized mold (or plunger)
chill wrinkle
Cold glass

See Amdt 5 p 34

Bulls-eye top. A lens effect occurring on the closed end of the bulb.

Color. In these criteria "color", unless otherwise stated, refers to the color observed with the screen activated as specified in 4.12.5.

Color spot. A small area which is noticeably discolored and which has fluorescent or phosphorescent intensity less than one-half or more than one and one-half times that of the surrounding area.

Combination spots. Spots which appear to have combinations of the characteristics of dead, bright, and color spots shall be classified as the type they resemble most.

Dead spot. A small area which emits practically no light; for example, holes and nonfluorescent or nonphosphorescent spots in the screen, and opaque particles, open blisters, and bruise checks in the face-plate glass.

Face-contour variation. Variation in the inside or outside face surface contour, such as "bulls-eye top" or "suck-up".

Quality area. That area specified (see 3.9) as the minimum useful screen area.

Shaded or mottled area. Minor gradation in color or luminous intensity with respect to overall screen background, such as may be caused by uneven screen distribution, water marks, mold or loading marks, and scum or spew.

Surface blemish. Inside or outside surface defect such as spot, chill wrinkle, and cord.

50.2.2 Classification of glass defects. All face-plate glass defects shall be classified into one of the following groups:

- Group 1Dead spot
- Group 2Shaded or mottled area
- Group 3Face-contour variation
- Group 4Surface blemish
- Group 5Color spot

Examples of the classification of common glass defects are shown in table XXVII.

50.2.3 Evaluation of defects. All defects shall be classified as major 1.

Impact mark
Lap
Loading mark
Mold mark
Oil spot
Rust, rouge or scale

See Amdt 5
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Spew
Suck-up

See Amdt 5
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TABLE XXVII. *Classification of glass defects.*

Defect	Group
Blister (except that clear buried or unbroken-surface blisters which meet the requirements of 50.2.3.4 of this appendix shall not be considered as defects).	1
Bruise or bruise check	1
Bull's-eye top	3
Carbonized mold (or plunger)	4
Chill wrinkle	4
Cold glass	4
Color spot	5
Color streak	2
Cord	4
Dirt on mold (or plunger)	1
Impact mark (outside surface)	4
Lap (inside surface)	4
Loading mark	2
Mold mark	2
Oil spot	4
Rust, rouge, or scale	1
Scum or spew	2
Shear mark	2
Stone or embedded dirt	1
Suck-up or rundown	3

50.2.3.1 *Spot defects.*

50.2.3.1.1 *Minimum sizes of nonelongated spots.* Spots which are not elongated and are less than those specified in the following listing shall be accepted:

Type of spot	Inch
Dead	0.015
Bright	0.015
Color	0.040

50.2.3.1.2 *Elongated spots.*

(a) Elongated spots of any length whose maximum width is 0.010 inch shall be accepted.

(b) Elongated spots between 0.010 and 0.020 inch in width whose length is $\frac{1}{2}$ inch or less shall be included in the assessment of the total number of spots in accordance with tables XXVIII, XXIX, and XXX. A tube shall be considered defective if it has elongated spots between 0.010 and 0.020 inch in width and more than $\frac{1}{2}$ inch in length.

TABLE XXVIII. *Acceptable spots (bulbs up to $7\frac{1}{2}$ inches in diameter or diagonal).*

Type of spot	Max dia	Number in one tube	Of which not more than	Are more than	Minimum separation
	Inch			Inch	Inch
Dead (blown bulbs)	0.060	15	7	0.030	$\frac{1}{4}$
Dead (pressed-face bulbs)	.040	15	5	.030	$\frac{1}{4}$
Bright	.040	6	2	.030	$\frac{1}{4}$
Color	.060	10	2	.050	$\frac{1}{4}$

TABLE XXIX. *Acceptable spots (bulbs $7\frac{1}{2}$ to $16\frac{1}{2}$ inches in diameter or diagonal).*

Type of spot	Max dia	Number in one tube	Of which not more than	Are more than	Minimum separation
	Inch			Inch	Inch
Dead	0.080	25	12	0.040	$\frac{1}{2}$
Bright	.060	9	2	.050	$\frac{1}{2}$
Color	.080	16	2	.060	$\frac{1}{2}$

TABLE XXX. Acceptable spots (rectangular bulbs more than 16½ inches in diagonal).

Type of spot	Zone A		Zone B		Zone C		Total No. in one tube	Minimum separation ¹
	Max dia	No.	Max dia	No.	Max dia	No.		
	<i>Inch</i>		<i>Inch</i>		<i>Inch</i>			<i>Inch</i>
Dead	0.040	5	0.060	7	0.080	10	18	1
Bright	.040	2	.060	5	.070	6	12	1
Color	.060	6	.070	9	.080	12	20	1

¹ Any spot 0.030 inch or less in diameter may be as close as ½ inch to any other spot.

(c) The diameter of elongated spots whose width is more than 0.020 inch shall be taken as half the sum of the length and width. The resultant diameter shall be assessed in accordance with tables XXVIII, XXIX, and XXX.

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of spot defects

50.2.3.1.3 Size, number, and separation. A tube shall be considered defective if the size and number of spots is more than, or the separation of spots is less than, the values specified in tables XXVIII, XXIX, and XXX.

50.2.3.1.3.1 Rectangular bulbs more than 16½ inches in diagonal. Faces of rectangular bulbs whose diagonal is more than 16½ inches are divided into three zones, all centered on and aligned with the tube face plate. Zone A is the central rectangle, zone B is a larger rectangle excluding zone A, and zone C is the area between zone B and the edge of the minimum useful screen area (ie, quality area). Sizes of zones are as follows:

Bulb diagonal (inches)	Zone A (inches)	Zone B (inches)
17	5 x 7	10¼ x 11¼
20	6 x 8	11½ x 13¼
21	6 x 8	11½ x 14
24	7 x 9	13 x 15½
27	10 x 12	15 x 18½

50.2.3.2 Shaded or mottled areas. All degrees shall be accepted in which the fluorescent and, when applicable, phosphorescent characteristics are as specified (see 3.9), and in which there is not more than a two-to-one

variation in any of these characteristics between the mottled or shaded areas and the surrounding unaffected area. A tube shall be considered defective if scum or spew is present whose length is more than 20 percent of the screen diameter or diagonal.

50.2.3.3 Face-contour variations. A tube shall be considered defective if face-contour variations are present which cause total internal reflection of light (ie, area looks black) when viewed at an angle of 30° to the normal of the face surfaces at the point where the face-contour variation occurs.

50.2.3.4 Inside and outside surface blemishes. All degrees shall be accepted which are not visible to the unaided eye when viewed along the axis of the tube from a distance of three times the screen diameter or diagonal, or 12 inches, whichever is greater. Visible blemishes shall be classified as dead spots and shall conform with the requirements specified in tables XXVIII, XXIX, and XXX.

50.2.3.5 Scratches.

(a) Scratches of any length whose width is less than 0.002 inch shall be accepted.

(b) A tube having scratches of 0.002 to 0.005 inch in width whose combined total length is more than 2 inches shall be considered defective.

(c) A tube having scratches of 0.005 to 0.010 inch in width whose combined total length is more than ½ inch shall be considered defective.

TABLE XXXI. *Acceptable unbroken blisters.*

Tube diameter	Blister size		Max number of blisters in any 2-inch circle	Of which not more than	Have a length more than
	Max dia	Elliptical limits			
<i>Inches</i> 1 to 3, incl.....	<i>Inch</i> 0.095	<i>Inches</i> 0.030 x 0.187 or .062 x .125 or .016 x .281	11	3	<i>Inch</i> 0.062
Over 3 to 5½, incl.....	0.187	0.125 x 0.281 or .062 x .500 or .031 x .750 or .016 x 1	11	3..... 0.062 and 2..... .500	
Over 5½ to 7, incl.....	0.312	0.250 x 0.500 or .125 x 1	11	3..... 0.250 and 2..... .500	
Over 7	0.375	0.250 x 0.750 or .125 x 1.250	11	3..... 0.312 and 2..... .750	

(d) A tube having any scratches whose width is more than 0.010 inch shall be considered defective.

surface blisters are present which are more than 0.095 inch in diameter. This shall apply to bulbs of all sizes.

50.2.3.6 *Shear mark.* A tube shall be considered defective if any outside shear marks are present in the ^{useful}screen area.

50.3.2.2 *Buried or unbroken-surface blisters.* A bulb shall be considered defective if the size and number of unbroken blisters are more than the values specified in table XXXI.

50.3 Bulb defects.

50.3.1 *Evaluation of defects.* All defects which fail to meet the criteria of 50.3.2 to 50.3.12, inclusive, of this appendix shall be classified as major 1 defects. All blisters, stones, glass knots, bruises, and scale less than 0.030 inch in diameter shall be accepted. For elliptical defects such as stones, glass knots, bruises, and scale, the following equivalent-diameter formula shall be used:

$$\text{Equivalent diameter} = \frac{\text{length} + \text{width}}{2}$$

50.3.2 Blisters.

50.3.2.1 *Open blisters.* A bulb shall be considered defective if more than three open-

50.3.3 *Stones.* A bulb shall be considered defective if stones exceed the following dimensions:

- More than 0.078 inch in diameter in bulbs up to and including 7 inches in diameter.
- More than 0.130 inch in diameter in bulbs more than 7 inches in diameter.
- Exposed (not glazed over) stones more than 0.030 inch in diameter on the outside glass surface.

50.3.4 *Glass knots.* A bulb shall be considered defective if glass knots are more than

0.187 inch in diameter, and if glass knots of any size protrude more than 0.030 inch.

50.3.5 Bruises. A bulb shall be considered defective if bruises are more than 0.050 inch in diameter.

50.3.6 Scale. A bulb shall be considered defective if scale exceeds the following dimensions:

- (a) More than 0.030 inch in diameter in bulbs up to and including 7 inches in diameter.
- (b) More than 0.062 inch in diameter in bulbs more than 7 inches in diameter.

50.3.7 Cracks and checks. A bulb shall be considered defective if any cracks or checks are present.

50.3.8 Chips. A bulb shall be considered defective if any unglazed chips are present.

50.3.9 Scuff. A bulb shall be considered acceptable if scuff is present.

50.3.10 Scratches. A bulb shall be considered defective if scratches exceed the following dimensions:

- (a) Between 0.002 and 0.004 inch in width which are more than 2 inches in length.
- (b) Between 0.004 and 0.006 inch in width which are more than 0.500 inch in length.
- (c) More than 0.006 inch in width.

50.3.11 Radius lap and outside shear marks. Radius lap and outside shear marks shall be accepted.

50.3.12 Finish. Splice contours shall be as smooth and as free from sharp re-entrant angles as good commercial practice permits.

60. ADDITIONAL CRITERIA FOR INSPECTION OF MAGNETRONS

60.1 Loose particles in magnetrons. Small particles in a tube which would not interfere with the operation of the tube shall be accepted. Indication of excessive loose cathode coating or the presence of flakes more than $\frac{1}{16}$ by $\frac{1}{16}$ inch shall be cause for rejection. Evidence of metallic particles shall normally be considered as cause for rejection. In the event of question of acceptability, before rejection, the tube shall be vibrated in such a manner as to place the metallic particle in the most unfavorable position, normally in the anode space; if the performance of the tube is then satisfactory, the tube shall be accepted. Upon evidence of particles which are indicative of a latent defect, the tube shall be rejected unless it has been determined by life and vibration tests to be a harmless condition.

60.2 Surface conditions of die-cast aluminum magnet sheathing for magnetrons.

60.2.1 General instructions. Sizes and filling of flaws, such as cracks, chipout, unfilled areas, etc., shall conform to the same limits as specified herein for blow holes. Filling material used shall be approved by the magnet user.

60.2.2 Definitions.

Blow holes. Any holes in the sheathing or a hole exposed by any mechanical operation performed on the sheathing. The dimension of such holes shall be determined by use of plug gages of the diameters specified in 60.2.3 of this appendix.

60.2.3 Requirements.

- (a) Blow holes less than 0.30 inch in diameter shall be accepted.
- (b) The maximum acceptable dimension (except as indicated for periphery of a cast or machined hole) of any defect, regardless of plug size specified, shall be 0.375 inch. In areas other than the periphery of cast or machined holes provided for assembly or mounting purposes, blow holes shall not accept

a gage of the maximum size indicated or appear with greater frequency than is indicated in the following:

0.045 inch to 0.094 inch, not more than 5 in a $\frac{1}{2}$ -inch-diameter circle.

Above 0.030 inch to, but not including, 0.045 inch, not more than 10 in a $\frac{1}{2}$ -inch-diameter circle.

Combination of above blow holes, not more than 10 in a $\frac{1}{2}$ -inch-diameter circle.

- (c) The maximum acceptable dimension of any defect occurring in the periphery of a cast or machined hole provided for assembly or

mounting use, regardless of plug size specified, shall be 0.187 inch. No more than two defects shall appear in any periphery of a cast or machined hole.

- (d) Any defect capable of accepting the maximum plug gage listed shall be filled, and the filler surface shall be made to conform to the shape of the adjacent surfaces.
- (e) Die-casting-holding-pin depressions, approximately $\frac{1}{4}$ inch in diameter, uniform in size and location, shall be accepted.
- (f) Separation of aluminum cover and magnet shall not exceed $\frac{1}{32}$ inch where visible or exposed.

70. Criteria for Inspection of Reliable
Immature Receiving Tubes

See Appd 5 pp 35-37

APPENDIX C

SPECIAL ACCEPTANCE-INSPECTION PROVISIONS

10. SCOPE

10.1 This appendix covers special procedures and criteria, not included in Standard MIL-STD-105 and appendix thereto, for acceptance inspection of specific classes of tubes.

20. PROCEDURE AND CRITERIA PECULIAR TO SPECIFIC CLASSES OF TUBES

20.1 Shock test for receiving tubes (special acceptance sampling procedures).

20.1.1 Lot. For the purpose of the shock test a lot shall be as specified in Standard MIL-STD-105, and shall consist of tubes of one type manufactured during the period of not longer than 1 week. No lot shall be larger than the sum of the preceding five lots.

20.1.2 Normal inspection. Normal inspection shall be used when:

- (a) *Process average not established.* The process average has not been established in accordance with 20.1.5.1 of this appendix.
- (b) *Process average more than AQL.* The process average as determined by the provisions of 20.1.5.1 of this appendix is more than 20 percent defective.

The sampling plan shall be in accordance with table XXXII.

TABLE XXXII. Normal-inspection sampling plan.

Sample size (n)	Acceptance number (c)	Rejection number (r)
48	14	15

20.1.3 *Reduced inspection.* Reduced inspection shall be used when the process average as determined in accordance with 20.1.5.1 of this appendix is less than 20 percent defective. The number of samples to be used and the acceptance criteria to be used shall be determined by use of the reduced-inspection sampling plan in table XXXIII in conjunction with the process average.

20.1.4 *Special inspection.* Special inspection shall be used under the following circumstances:

- (a) *Small lots.* When lots consist of less than 1,000 tubes, special inspection may be used.
- (b) *Mixed lots.* When lots cannot be considered to be homogenous due to the inability to meet the requirement of 20.1.1 of this appendix, special inspection shall be used.

TABLE XXXIII. Reduced-inspection sampling plan.

Process average	First sample			Second sample	Cumulative sample		
	Size (n ₁)	Acceptance number (c ₁)	Rejection number (r ₁)	Size (n ₂)	Size (n _c)	Acceptance number (c _c)	Rejection number (r _c)
Percent							
0 to 5.00	4	0	1	16	20	7	8
5.01 to 15.00	12	1	8	20	32	11	12
15.01 to 20.00	20	2	11	20	40	13	14

TABLE XXXIV. *Special-inspection sampling plan.*

Lot size (N)	First sample			Second sample	Cumulative sample		
	Size (n ₁)	Acceptance number (c ₁)	Rejection number (r ₁)	Size (n ₂)	Size (n _c)	Acceptance number (c _c)	Rejection number (r _c)
1 to 399	4	0	4	8	12	4	5
400 to 599	8	1	7	12	20	7	8
600 to 799	12	1	8	20	32	11	12
800 to 999	20	2	11	20	40	13	14

20.1.4.1 Small lots. The special-inspection procedure for small lots may be used for small lots in place of the normal- or reduced-inspection procedure specified in 20.1.2 and 20.1.3, respectively, of this appendix. The inspection of small lots may be performed in accordance with the provisions of table XXXIV.

20.1.4.2 Mixed lots. The inspection of mixed lots shall be performed in accordance with the special-inspection sampling plan in table XXXIV.

20.1.5 Process average.

20.1.5.1 Establishment of process average. A total of 192 tubes taken from a minimum of 4 lots shall be used to compute the process average. In this computation, not more than 48 tubes shall be considered from any one lot. The process average shall be recomputed after each lot has been inspected in order to determine the applicability of reduced or normal inspection to the succeeding lot. Only initial-sample results shall be used in computing the process average. The process average shall be recomputed through the use of the initial-sample results of the requisite number of preceding lots to have a total sample of at least 192 tubes.

20.1.5.2 Reestablishment of process average. Upon the rejection of a lot while using normal or reduced inspection, it shall be necessary to reestablish the process average before proceeding to the use of reduced inspection. The reestablishment shall be accomplished by inspecting the next four lots in accordance with table XXXII. The new process average shall

be based upon the data obtained on 192 tubes, samples being obtained by selecting 48 tubes from each of 4 lots.

20.1.5.3 Lack of knowledge of process average. When insufficient data are available for the establishment of the process average as specified in 20.1.5.1 of this appendix, normal or special inspection shall be used as specified in 20.1.2 and 20.1.4, respectively, of this appendix.

20.2 Reliable receiving tubes.

20.2.1 Applicability. The sampling procedures outlined in 20.2.2 to 20.2.7.1.3, inclusive, of this appendix shall be used in the acceptance inspection of reliable receiving tubes.

20.2.2 Reliable tubes. For the purpose of this appendix, reliable tubes shall be those tubes so specified. (See 3.9.)

20.2.3 Lot. A lot shall be as specified in ~~Standard MIL-STD-105~~, and shall consist of tubes of one type manufactured during the period of not longer than 1 week. Lots consisting of less than 301 tubes shall be considered as consisting of 301 tubes for sampling purposes.

20.2.4 Acceptance sampling procedure by variables.

20.2.4.1 Applicability. When a variables sampling procedure is specified (see 3.9), either the procedure of method A, using the mean and average range, or the procedure of method B, using the median and quasirange, shall be used.

20.2.4.2 Test for lot-average acceptance.

20.2.4.2.1 Method A (using the mean).

- (a) Select a 35-tube sample at random from the lot. Number these tubes consecutively.
- (b) Determine the average value of the specified characteristic (see 3.9) of the 35-tube sample. If this value is on or above the LAL and on or below the UAL, accept for lot average.
- (c) Numerical limits specified (see 3.9) are determined in part by the sample size.

20.2.4.2.2 Method B (using the median).

- (a) Select a 35-tube sample at random from the lot. Test for the electrical characteristic for which variables acceptance limits are specified. (See 3.9.)
- (b) Arrange the 35 measurements in order of magnitude. Find the value of the 18th measurement on the sample so arranged. This is the median ($\tilde{x}$) of the sample of 35. If the $\tilde{x}$ is on or above the LAL and on or below the UAL, accept for lot average.

20.2.4.3 Test for lot-dispersion acceptance.

20.2.4.3.1 Method A (using the average range).

- (a) Divide the 35-tube sample into 7 groups of 5 tubes each. Determine the range, R , of each group for the measured characteristic specified. (See 3.9.)
- (b) Compute the $\bar{R}$ which is the average of the R values. If $\bar{R}$ is equal to or less than the ALD, accept for lot dispersion.
- (c) Numerical limits specified (see 3.9) are determined in part by the sample size.

20.2.4.3.2 Method B (using the quasirange).

- (a) Arrange the 35 measurements in order of magnitude. Find the difference between the 3rd and 33rd measurements on the sample so arranged. This is the quasirange (QR_3) of the sample of 35.
- (b) Multiply this quasirange by 0.80. If QR_3 multiplied by 0.80 is equal to or less than the ALD, accept the characteristic for lot dispersion.

20.2.4.4 Procedure for resubmitted lots. Before resubmission to the acceptance sampling test by variables, a nonconforming lot shall be reworked or retested 100 percent, or both, by the manufacturer. If the nonconforming test item is of such nature that 100-percent retesting without rework is sufficient, the lot may be resubmitted to test by variables for the nonconforming test item only. If the nonconforming test item is of such nature as to require rework and retest, all the lot shall be reinspected for all characteristics which are specified for variables testing. (See 3.9.)

NOTE: If the product is considerably off-center, it may be necessary to test to limits tighter than the specified minimum or maximum (see 3.9) in order to move the average (or median) within the limits for acceptance.

20.2.5 Life-test sampling procedure.

20.2.5.1 Stability life test.

- (a) Life-test samples shall be selected from the lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing tubes which are outside the specified initial limits for the specified life-test-end-point characteristics, such tubes shall be replaced by randomly selected acceptable tubes. (See 3.9.)
- (b) Serially mark all tubes of the sample.

(c) Record the specified characteristic measurements on the entire sample after a maximum operation of 15 minutes under specified voltage and current conditions. (See 3.9.)

(d) Operate at specified test conditions for 1 hour + 30 minutes. The life

— 0

test shall be conducted as specified in 4.11 and 4.11.5, except that the following shall be substituted for 4.11.1(b): The mean electrode potentials, except heater or filament, may be established at values differing by not more than 5 percent from the specified values provided the same average electrode dissipations are obtained that occur with the specified voltages. (See 3.9.) Fluctuations of all voltages, including heater or filament voltage, shall be as small as practicable.

(e) Record the specified characteristic measurements at the end of this test period. The specified characteristic measurements shall be taken immediately following the test, or the tubes shall be preheated for 15 minutes under specified test voltage and current conditions, and the characteristic immediately measured. (See 3.9.) The 15-minute preheat shall be considered as part of the test time.

(f) A defective shall be defined as a tube having a change in the specified characteristic greater than that specified. (See 3.9.)

(g) A resubmitted lot shall be subjected to all measurements-acceptance tests except mechanical inspection, vibration, and low-pressure-voltage-breakdown tests.

consists of a series of normal-, reduced-, and tightened-inspection sampling plans for use at 100 hours. The sample size is dependent on lot size, and the transfer between normal, reduced, and tightened inspection is dependent upon quality history.

20.2.5.2.1 Selection of inspection procedure.

(a) *Normal inspection.* Normal inspection shall be used initially and shall be continued until the conditions for reduced or tightened inspection are satisfied.

(b) *Reduced inspection.* Reduced inspection may be used if the conditions for reduced inspection specified in ~~DEF-131~~ Standard MIL-STD-105 are met, ^[U.K. Amdt 39] or if no lot in the last 10 lots inspected shall have been declared nonconforming for survival-rate-life-test qualities. A tube type that has qualified for reduced inspection shall revert to normal inspection under either of the following conditions:

1. If a lot is indicated to be nonconforming by the reduced-inspection plan.
2. If the percent defective, as computed from the defects found from the total first samples of the last 10 lots, is greater than the specified AQL.

The conditions for requalification for reduced inspection shall be the same as for initial qualification for reduced inspection.

(c) *Tightened inspection.* Tightened inspection shall be used when specified in ~~DEF-131~~ Standard MIL-STD-105 or when 2 or more lots in the last ^[U.K. Amdt 39] 10 lots inspected are declared nonconforming for survival-rate-life-test qualities. Tightened inspection shall be used to reevaluate the quality of any lot previously declared nonconforming. Normal inspection may replace tightened in-

20.2.5.2 *Survival-rate life test.* The procedure for assuring the maintenance of a desirable quality level in terms of early life survival

spection in accordance with the provisions of Standard MIL-STD-

U.K. Amdt-30 105. DEF-131

20.2.5.2.2 Selection of sampling plans. The requisite rates of failure (AQL) shall be designated as the specified acceptance-inspection conditions. (See 3.9.)

(a) *Normal-inspection sampling plan.*

This sampling plan shall be selected by using inspection level II of Standard MIL-STD-105 to determine the sample-size code letter. The use of single sampling or double sampling determines the actual sampling plan. When obtaining sample-size code letters, any lot containing between 301 and 800 tubes shall be considered to consist of 800 tubes, and any lot containing more than 8,000 tubes shall be considered to consist of 8,001 tubes.

(b) *Reduced-inspection sampling plan.*

This sampling plan shall be selected by using inspection level II of Standard MIL-STD-105 to determine the sample-size code letter and the actual sampling plan. If the indicated sample is less than 22 tubes, the actual sampling plan shall be that called for by use of the specified AQL (see 3.9) and sample-size code letter "K". This will provide a sample size of at least 22 tubes except for an AQL of 0.15 percent. In this particular case, sample-size code letter "L" shall be used. When obtaining sample-size code letters, any lot containing between 301 and 800 tubes shall be considered to consist of 800 tubes, and any lot containing more than 8,000 tubes shall be considered to consist of 8,001 tubes.

(c) *Tightened-inspection sampling plan.*

This sampling plan shall be selected by using inspection level II

U.K. Amdt-30 DEF-131 of Standard MIL-STD-105 to determine the sample-size code letter. The use of tightened sampling, single sampling, or double sampling determines the actual sampling plan. When obtaining sample-size code letters, any lot containing between 301 and 800 tubes shall be considered to consist of 800 tubes, and any lot containing more than 8,000 tubes shall be considered to consist of 8,001 tubes.

20.2.5.2.3 Survival - rate - life - test sample. The survival-rate-life-test sample shall be selected from the lot at random in such a manner as to be representative of the lot. If such selection results in a sample containing one or more tubes which are defective as specified in 4.7.5, such tubes shall be replaced by randomly selected good tubes.

20.2.5.2.4 Inspection procedures.

- (a) Select sample in accordance with 20.2.5.1 (a) of this appendix.
- (b) Test tubes at 100 hours as specified in 4.7.5. When any tap-short indication is obtained, the test shall be repeated. When any short indication is again obtained, the tube shall be rejected as inoperable.
- (c) Determine the number of defectives at the 100-hour period.
- (d) If more than the allowable number of defectives occur, declare the lot nonconforming.
- (e) A resubmitted lot shall be subjected to all measurements-acceptance tests except mechanical inspection, capacitance, vibration, and low-pressure-voltage-breakdown tests.

20.2.5.2.5 Equivalent conditions. For survival-rate life test, the equivalent stability-life-test conditions shall be interpreted as having the same heater voltage (Ef) and heater-cathode voltage (Ehk) as the stability life

test; and the same interruptions as the intermittent life test specified in 4.11.5. The electrode voltages shall be such that the element dissipations are not less than 80 percent nor more than 100 percent of stability-life-test plate dissipation. These voltages shall be maintained within the limits of 50 percent minimum and 200 percent maximum.

20.2.5.3 Intermittent life test.

- (a) The first 20 tubes of the stability-life-test sample which meet the measurements-acceptance-test limits for those characteristics specified as intermittent-life-test and points shall be used for the intermittent-life-test sample. (See 3.9.) In the event that a second stability-life-test sample is used, the first 20 tubes from that sample which meet these limits shall be used.
- (b) In the event of failure of the first sample on intermittent life test, select a completely new sample ~~(DEF-131) (Standard MIL-STD-105, sample-size code letter I)~~ and stabilize it in accordance with the conditions of the stability life test. Then select from it the first 40 tubes which meet the measurements-acceptance-test limits for those characteristics specified as intermittent-life-test end points. (See 3.9.) Subject these 40 tubes to the intermittent life tests. Acceptance shall then be based on combined results from the first and second samples.
- (c) As an alternate method, the manufacturer may select his life-test samples as specified in 20.2.5.1 (a) of this appendix.
- (d) *Regular life test.*
 1. Regular life test shall be conducted for 1,000 hours.
 2. Regular - life - test acceptance shall be on the basis of the specified 500- and 1,000-hour-life-test-end-point limits. (See 3.9.)

3. Regular life test shall be in effect initially and shall continue in effect until the eligibility criteria for the reduced-hours life test have been met.

(e) *Reduced-hours life test.*

1. Eligibility for reduced-hours life tests shall be as follows: No lot failure due to the regular 1,000-hour life test has occurred in the preceding 3 consecutive lots.
 2. Reduced-hours life test shall be conducted for 500 hours and acceptance shall be based on the 500-hour-life-test-end-point limits. Two 500-hour-life-test lot failures occurring in the last 3 consecutive lots shall result in loss of eligibility for reduced-hours life testing.
 3. The life-test sample from the first lot accepted each month shall continue on life test for an additional 500 hours (1,000 hours total life-test time). Failure of this sample to meet the 1,000-hour-life - test - end - point limits shall result in loss of eligibility for reduced-hours testing.
- (f) The life-test sample shall be read at the following times:
- | |
|----------------------------------|
| 0 hours |
| 500 + 48 hours |
| — 24 |
| 1,000 + 48 hours (when in force) |
| — 24 |
- Additional reading periods may be used at the discretion of the tube manufacturer.
- (g) *Acceptance criteria.* The lot shall be considered satisfactory for acceptance if: The specified allowable defects are not exceeded and the change of the average of any characteristic in the life-test sample

specified for life-test control of averages is not exceeded. (See 3.9.) The average percentage change shall be obtained from the determination of the individual changes for each tube in the life-test sample from the zero-hour value for the specified characteristic or characteristics. (See 3.9.) For purposes of computation of this average percentage change, the absolute values of the individual changes for each tube in the life-test sample shall be used. Any tube found inoperable during life testing shall not be considered in the calculation of this average.

- (h) A resubmitted lot shall be subjected to all measurements-acceptance tests except mechanical inspection, vibration, and low-pressure-voltage-breakdown tests.
- (i) Not more than one accidental breakage shall be allowed in the life-test sample. In the event that one life-test tube is accidentally broken, acceptability of the life-test sample shall be based upon the remaining tubes in the sample provided the broken tube was not known to be a defective.

20.2.6 Acceptance-inspection procedure for miniature-tube-base-strain test.

20.2.6.1 Sampling procedure. The sample shall consist of 30 tubes taken at random from the production of each sealing-and-exhaust unit. This sample size, $n=30$, shall be used for both tightened and normal inspection. For normal inspection, the sample shall be taken twice during each regular work shift. For tightened inspection, the sample shall be taken every hour. In either case, the first sample shall be taken at the start of each work shift. Tightened inspection shall be in effect initially and shall continue in effect until the criteria for normal inspection have been met.

20.2.6.2 Qualification for normal inspection. A unit shall qualify for normal inspection only when all of the following requirements have been met:

- (a) There has been no change of tube type on the unit during the testing of the last five samples required for qualifying.
- (b) Not more than a total of eight defects has been found in the last five samples.
- (c) No rejection has occurred in the last five samples.

20.2.6.3 Acceptance and rejection criteria. The production lot represented by the sample shall be:

- (a) *Accepted* if not more than three defectives for "A", "B", or "C" defects, respectively (see 4.9.6.1), or if not more than a total of four defectives, are found in the sample.
- (b) *Rejected* if four or more defectives for "A", "B", or "C" defects, respectively, or if a total of five or more defectives, are found in the sample.

20.2.6.4 Records. A record of all defectives shall be maintained for each sealing-and-exhaust unit. This record shall show the exhaust-unit number, the date and time of sample, the number of defectives in each group, the total defectives, and the rejections occurring in the last five samples.

20.2.6.5 Action to be taken on rejected lots. If a lot is rejected on this test, all production from this exhaust unit during the period between the present and previous samples shall be 100 percent strain-tested for that class of defect which caused rejection.

NOTE: The results of the retest shall be submitted to quality control, and these data shall be used as a basis for acceptance of the rejected lot. These results shall not be used in the cumulative record.

TABLE XXXV. *Tightened-inspection sampling plan.*

Lot size (N)	Sample size			Acceptance number	
	First sample (n ₁)	Second sample (n ₂)	Cumulative sample (n ₁ + n ₂)	In first sample (Ac ₁)	In cumulative sample (Ac ₂)
Less than 801.....	25	50	75	0	1
801 to 3,200.....	50	100	150	0	2
3,201 and over.....	50	100	150	0	2

20.2.7 Acceptance-inspection procedure for heater-cycling life test.

20.2.7.1 Sampling procedure. Sampling plans are provided for tightened, normal, and reduced inspection. The conditions under which tightened-, normal-, or reduced-inspection sampling plans are to be used are specified in 20.2.7.1.1, 20.2.7.1.2, and 20.2.7.1.3, respectively, of this appendix. A lot-by-lot and summary record shall be kept to show the results of the acceptance inspection for the last 10 successive lots in order that the moving average percentage of defective tubes may be determined. This percentage of defective tubes, computed from the results of the first samples for the last 10 successive lots, and rounded off to the nearest 0.1 percent, is defined as the process average.

20.2.7.1.1 Tightened inspection. Tightened inspection is a double-sampling procedure conducted according to table XXXV. Tightened inspection shall be in effect initially and shall continue until the eligibility criteria for normal inspection or reduced inspection have been met.

20.2.7.1.2 Normal inspection. Normal inspection shall be conducted according to the

double-sampling procedure outlined in table XXXVI. Eligibility for normal inspection is: The process average is greater than 0.7 percent but does not exceed 1.9 percent. Loss of eligibility: When the process average exceeds 1.9 percent, normal inspection shall be discontinued and tightened inspection resumed.

20.2.7.1.3 Reduced inspection. Reduced inspection shall be conducted according to the double-sampling procedure outlined in table XXXVII. Eligibility for reduced inspection is: The process average is 0.7 percent or less. Loss of eligibility: (a) Reduced inspection shall be discontinued and normal inspection resumed when the process average is greater than 0.7 percent but does not exceed 1.9 percent, and at the same time no lot has been rejected; (b) reduced inspection shall be discontinued and stricter inspection used for subsequent lots whenever a lot is rejected, or the process average is greater than 1.9 percent.

20.3 Acceptance inspection provisions for klystrons and magnetrons.

20.3.1 Design-test procedure.

20.3.1.1 Lot. The lot size for regular sampling inspection shall normally be 1 week's

TABLE XXXVI. *Normal-inspection sampling plan.*

Lot size (N)	Sample Size			Acceptance number	
	First sample (n ₁)	Second sample (n ₂)	Cumulative sample (n ₁ + n ₂)	In first sample (Ac ₁)	In cumulative sample (Ac ₂)
Less than 801.....	15	30	45	0	1
801 to 3,200.....	35	70	105	0	2
3,201 and over.....	50	100	150	1	3

TABLE XXXVII. *Reduced-inspection sampling plan.*

Lot size (N)	Sample Size			Acceptance number	
	First sample (n ₁)	Second sample (n ₂)	Cumulative sample (n ₁ + n ₂)	In first sample (Ac ₁)	In cumulative sample (Ac ₂)
Less than 801.....	15	30	45	0	1
801 to 3,200.....	15	30	45	0	1
3,201 and over.....	25	50	75	0	2

production. A lot may be more than 1 week's production but not more than 1 month's production if submitted as a single lot.

20.3.1.2 Early-release procedure. Eligibility: The early-release inspection procedure outlined below may be used only while reduced inspection is in effect on the specific tube type. When eligibility for reduced inspection has been established, the following procedures may be put into effect:

- (a) For design-check sampling purposes, a lot may consist of the monthly production of the specific tube type.
- (b) While reduced inspection is in effect, tubes may be released on a current basis, ie, shipment need not be withheld pending the test results of the design sample.
- (c) The samples representing the monthly lot may be selected at random

either in weekly subsamples, which will accumulate to the required number, or from the production of any single week during the corresponding month, at the option of the Government.

NOTE: When samples are selected entirely from production of a single week, a "skip" method of selection shall be utilized, ie, the choice of "sample" weeks shall be staggered in such a manner as to assure a random selection when considered over a period of several months.

- (d) The test required for acceptance shall be started no later than 1 week after the complete sample has been selected.

In the event that eligibility for reduced inspection is lost, the early-release procedure shall immediately be discontinued and normal-inspection procedure instituted.

20.3.1.3 Reduced Inspection *Reduced inspection*

OK Amend 30 DEF-131 procedure R-1 and inspection level L-4 of standard MIL-STD-105 shall apply. (This sampling provides inspection procedures equivalent to those formerly contained in the Inspection Instructions for Electron Tubes for lot sizes up to and including 500 units.)

APPENDIX D

GAGES FOR TUBES

10. SCOPE

10.1 This appendix covers procedures for gaging tubes. The general information in this appendix applies to alinement or ring gages, as applicable.

20. ALIGNMENT GAGES FOR BASE TERMINAL SPACINGS

20.1 Use. Standard alinement gages shall be used when specified on individual base drawings, or for a number of similar base drawings, to govern the spacing and alinement of base contacts and such other factors as may be important to interchangeability. Pin-alinement gages are intended to be used for attachable bases before assembly on tubes and for integral-type bases. They may be used for attachable bases assembled on tubes, provided all solder is removed from the sides of the contact pins. When the base is an integral part of the tube, gaging shall be performed without any alteration to the leads (such as removal of tinning).

20.2 Designation. It shall be standard to identify gages for tube bases, caps, and such other parts as mate with sockets or connector attachments, by a designation consisting of, in the order of appearance in the designation:

- (a) A constant letter symbol, "G", indicating gage.

- (b) A letter symbol indicating the generic group to which the accessory belongs.

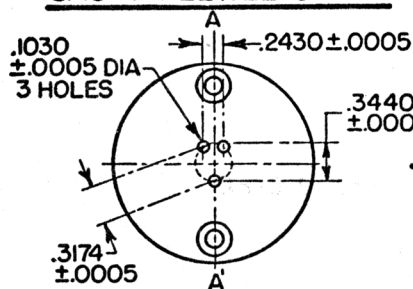
- (c) A first number symbol indicating the maximum number of terminals or contact members possible in the base for which the gage is designed.

- (d) A dash (—).

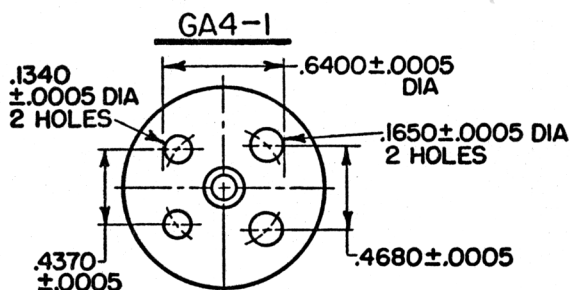
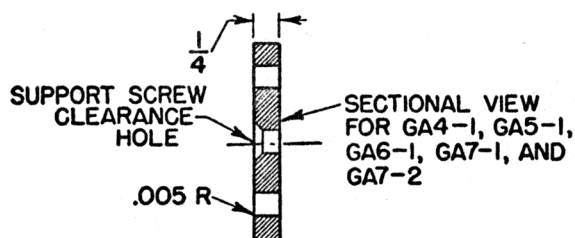
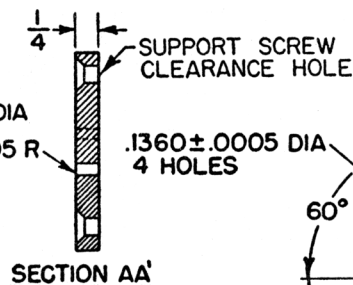
- (e) A second number symbol indicating the serial order of assignment of the designation.

EXAMPLE: GB8-1 designates a gage for generic-group "B" bases with eight pin holes, and is the first serially assigned gage for such measurement.

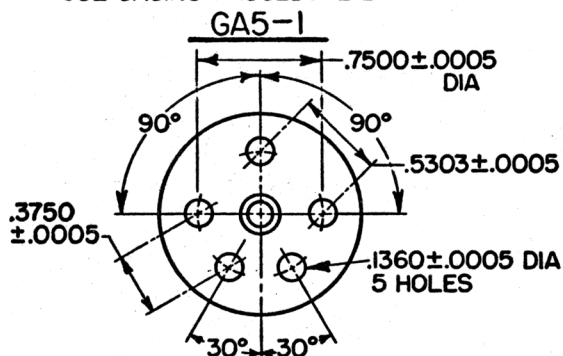
20.3 Design. Standard base-pin alinement gages shall conform to the drawings on figure 62. The total weight specified on each gage drawing is the required total weight of gage and accessory. The procedure indicated on each drawing refers to the procedures specified in 20.4 of this appendix.

GA3-1 PEEWEE 3-PIN

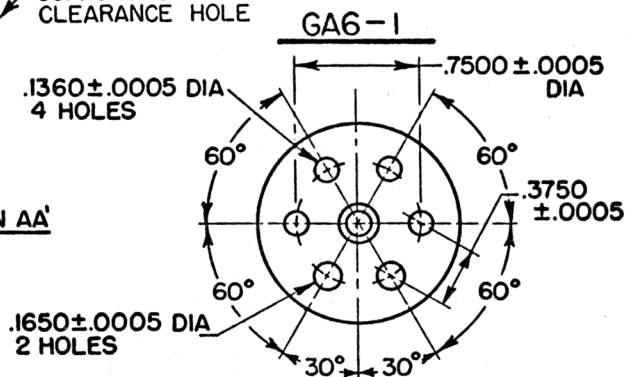
TOTAL WGT. - 2 LBS.
USE GAGING PROCEDURE 2



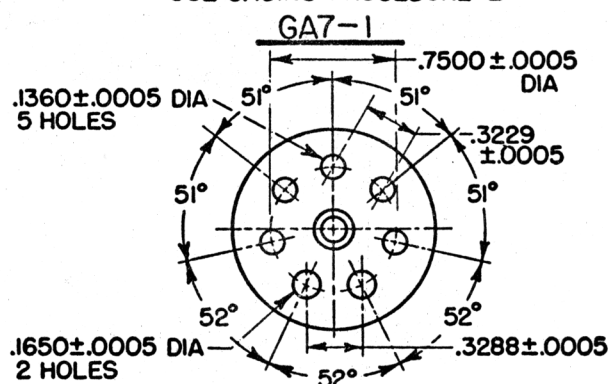
TOTAL WGT. - 4 LBS.
USE GAGING PROCEDURE 2



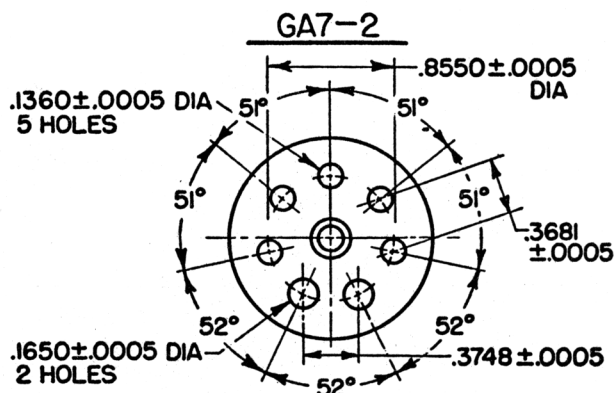
TOTAL WGT. - 4 LBS.
USE GAGING PROCEDURE 2



TOTAL WGT. - 4 LBS.
USE GAGING PROCEDURE 2



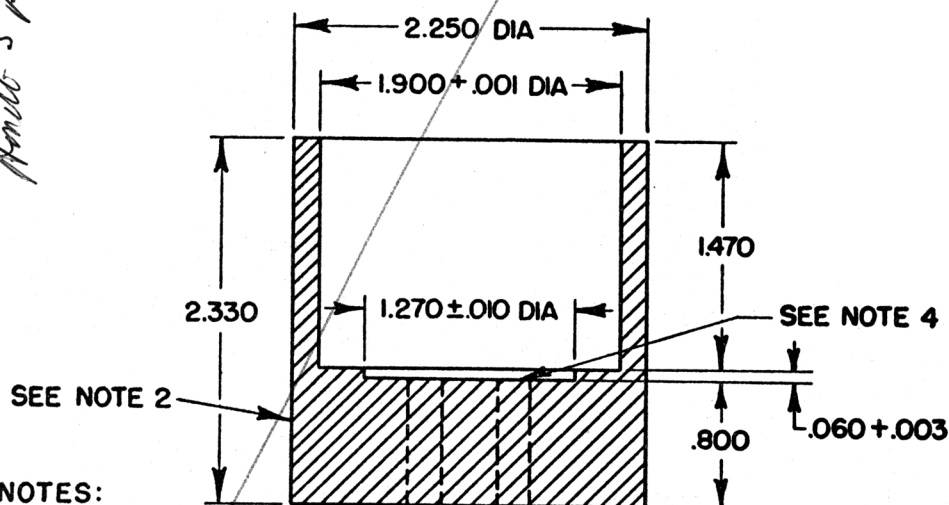
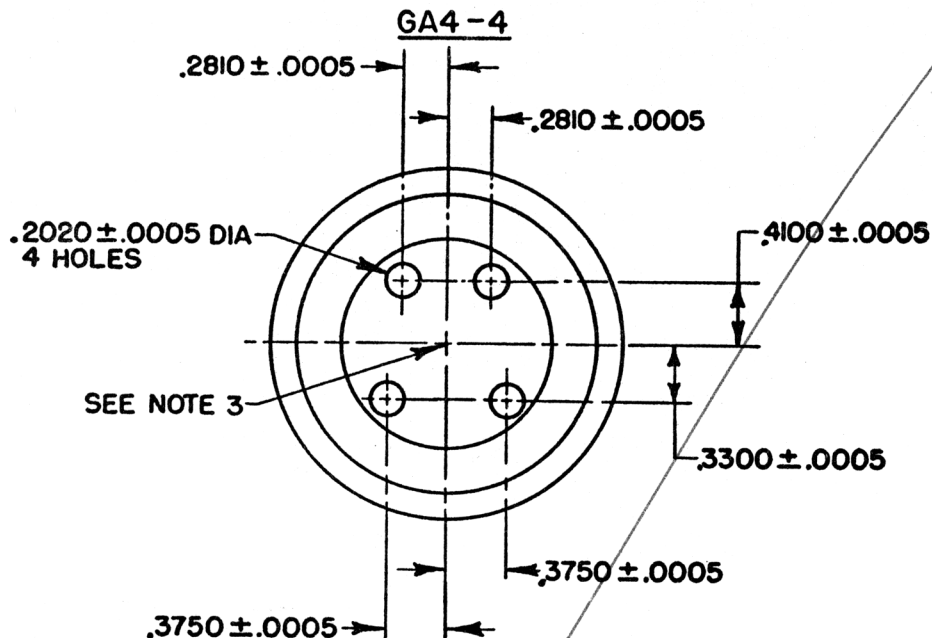
TOTAL WGT. - 4 LBS.
USE GAGING PROCEDURE 2



TOTAL WGT. - 4 LBS.
USE GAGING PROCEDURE 2

TOLERANCE ON CHORD DIMENSIONS BETWEEN PIN HOLES NOT CUMULATIVE.
ALL DIMENSIONS IN INCHES.

FIGURE 62. *Standard base-pin-alinement gages.*

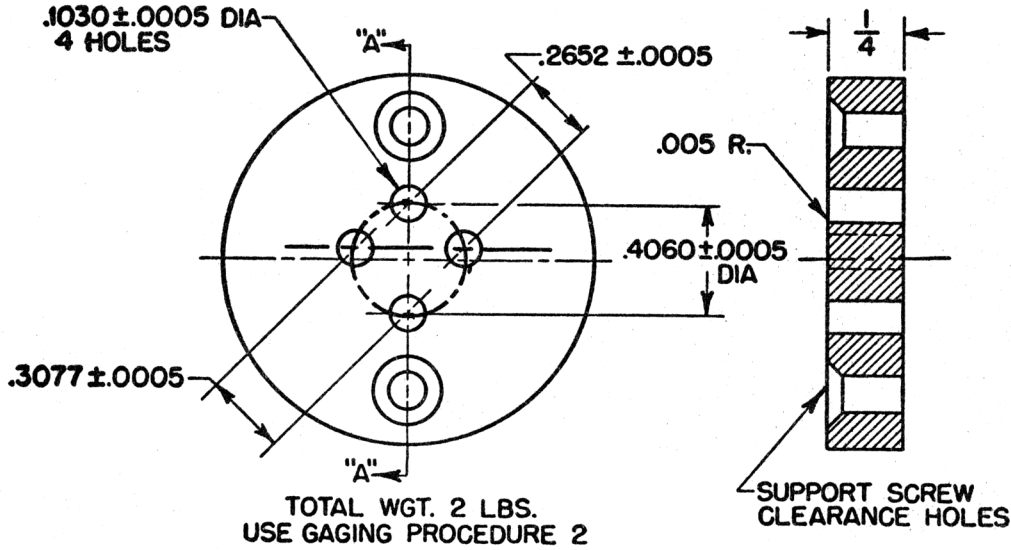


NOTES:

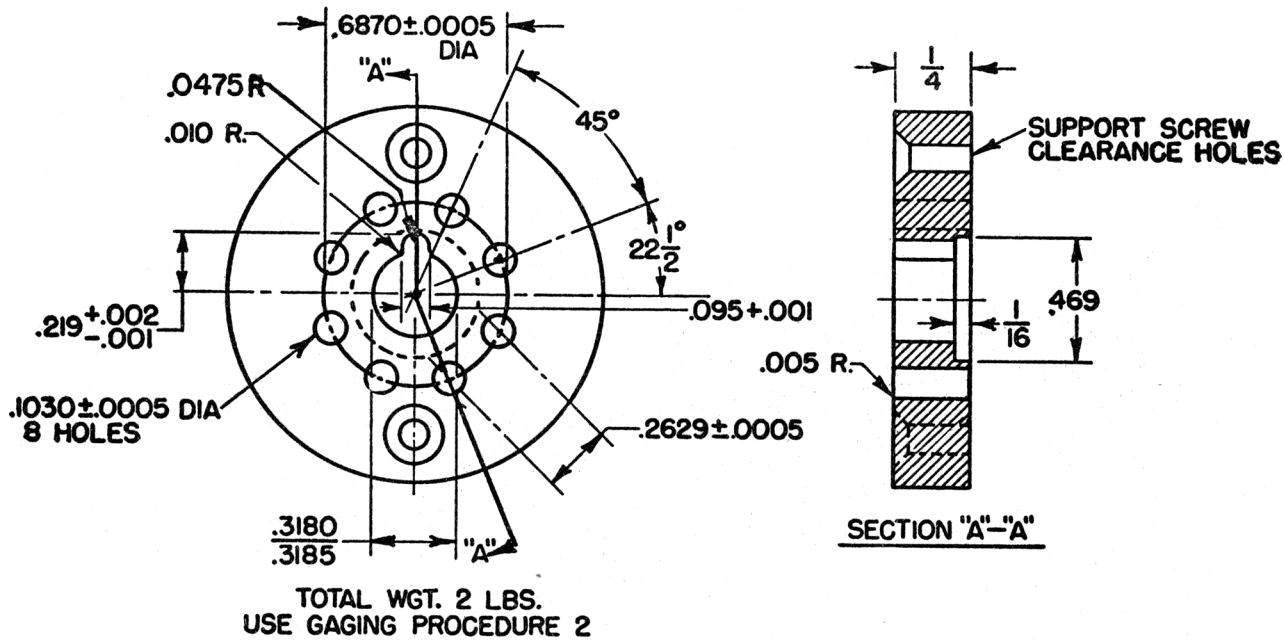
1. ALL DIMENSIONS IN INCHES.
2. MOUNTING METHOD IS OPTIONAL.
3. ECCENTRICITY OF PIN CIRCLE WITH RESPECT TO BARRIER I. D. MUST NOT EXCEED $.0025$.
4. PIN CIRCLE DIAMETER, PIN SPACING, PIN HOLE DIAMETER AND TOLERANCES APPLY TO SURFACE INDICATED.
5. TOTAL WEIGHT 5 POUNDS. USE GAGING PROCEDURE 2.

FIGURE 62. Standard base-pin-alinement gages.—Continued

GA4-5
PEEWEE 4-PIN



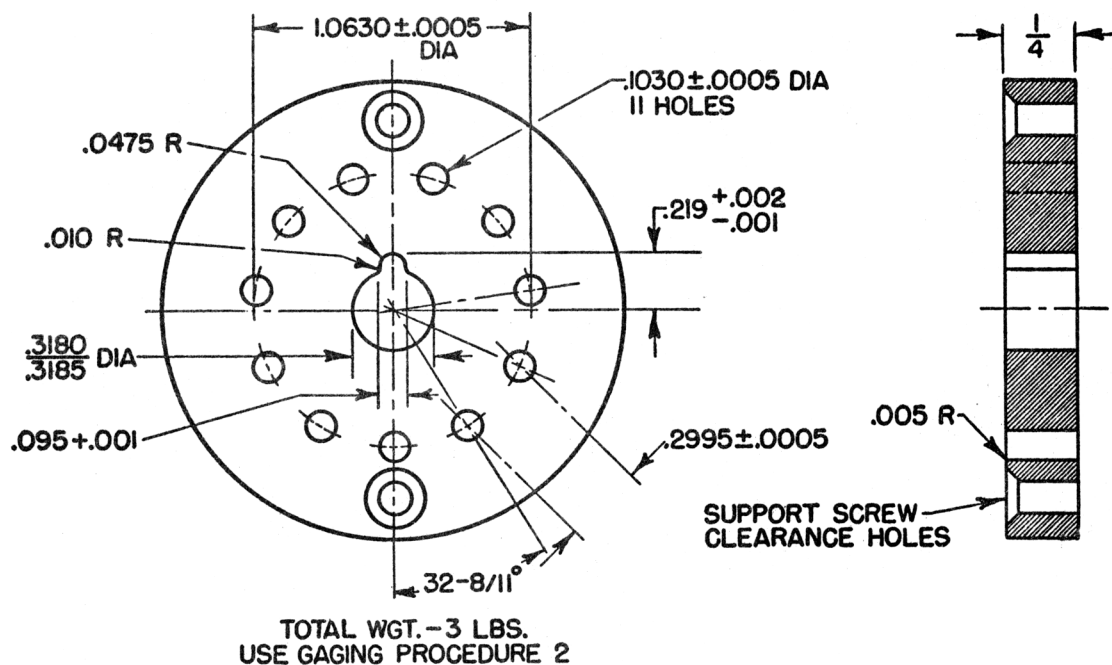
GB8-1
OCTAL



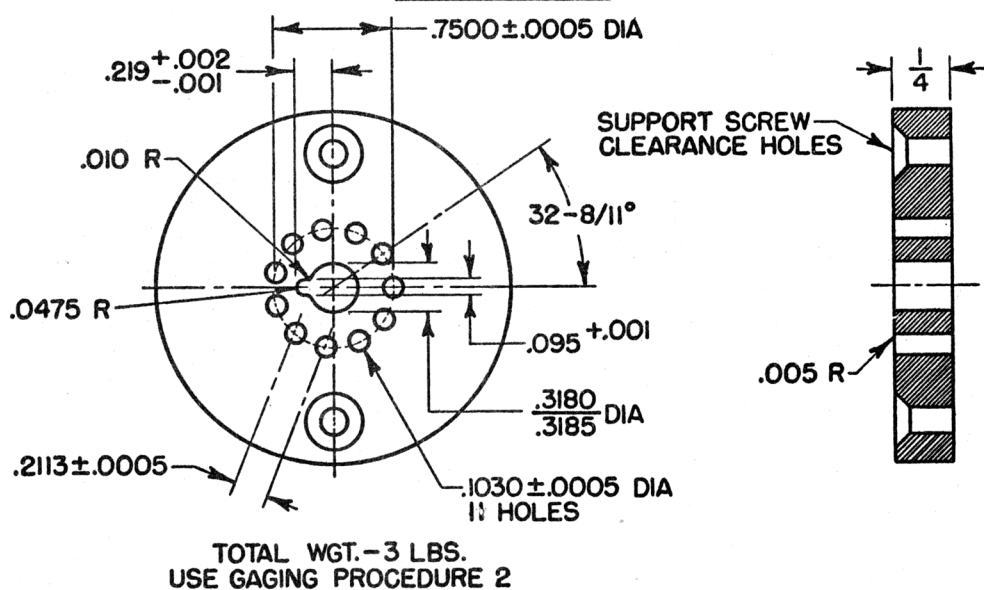
TOLERANCE ON CHORD DIMENSIONS BETWEEN PIN HOLES NOT CUMULATIVE
ALL DIMENSIONS IN INCHES.

FIGURE 62. Standard base-pin-alignment gages.—Continued

GBII-1
MAGNAL



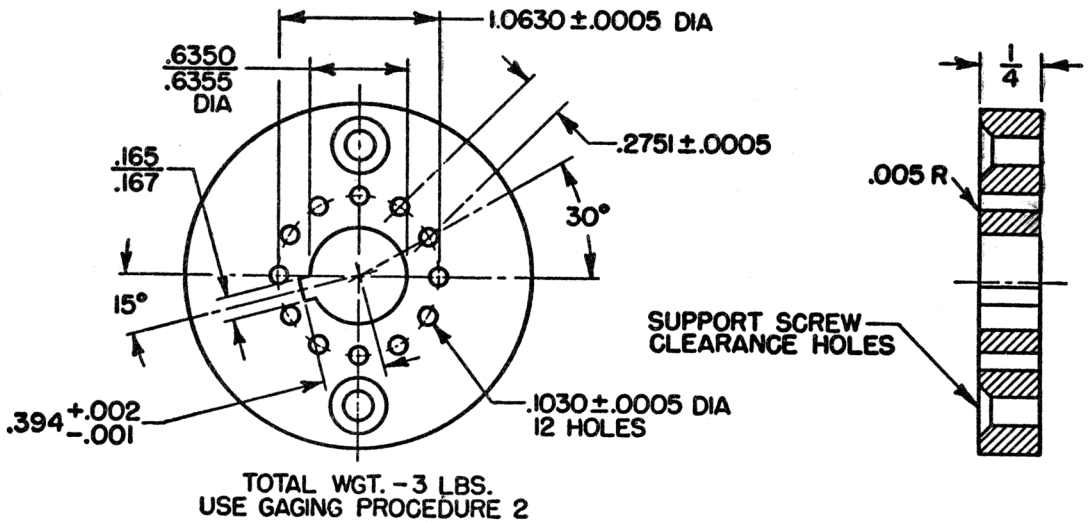
GBII-2
SUBMAGNAL



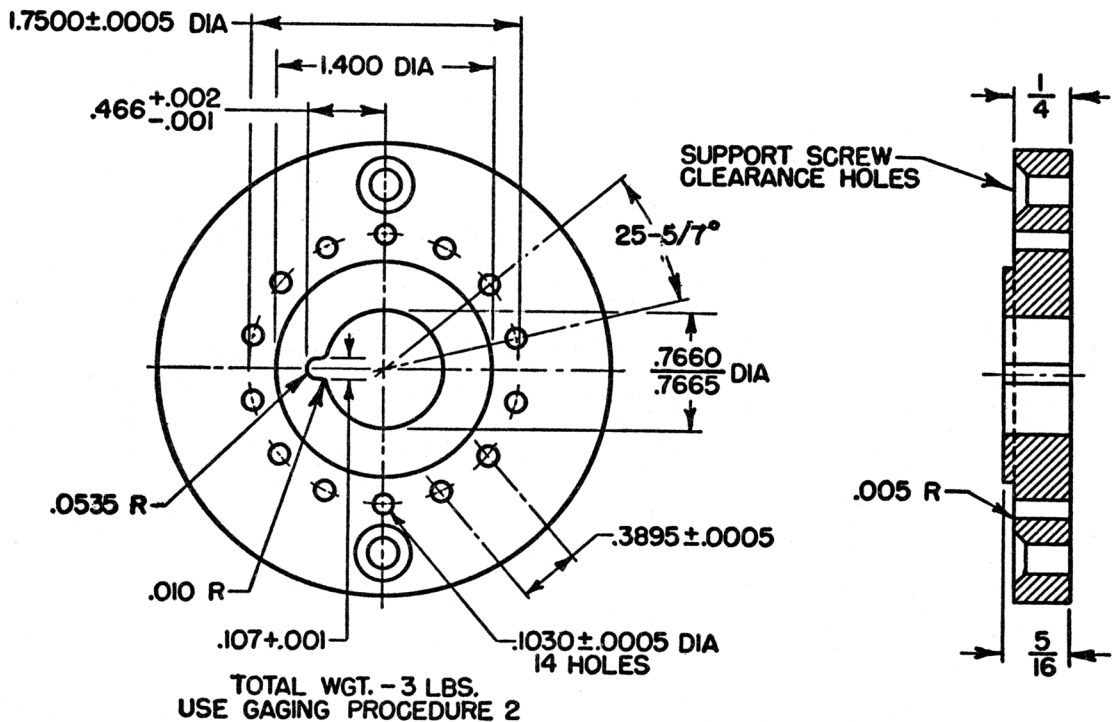
TOLERANCES ON CHORD DIMENSIONS BETWEEN PIN HOLES NOT CUMULATIVE.
ALL DIMENSION IN INCHES.

FIGURE 62. Standard base-pin-alinement gages.—Continued

GBI2-1
DUODECAL



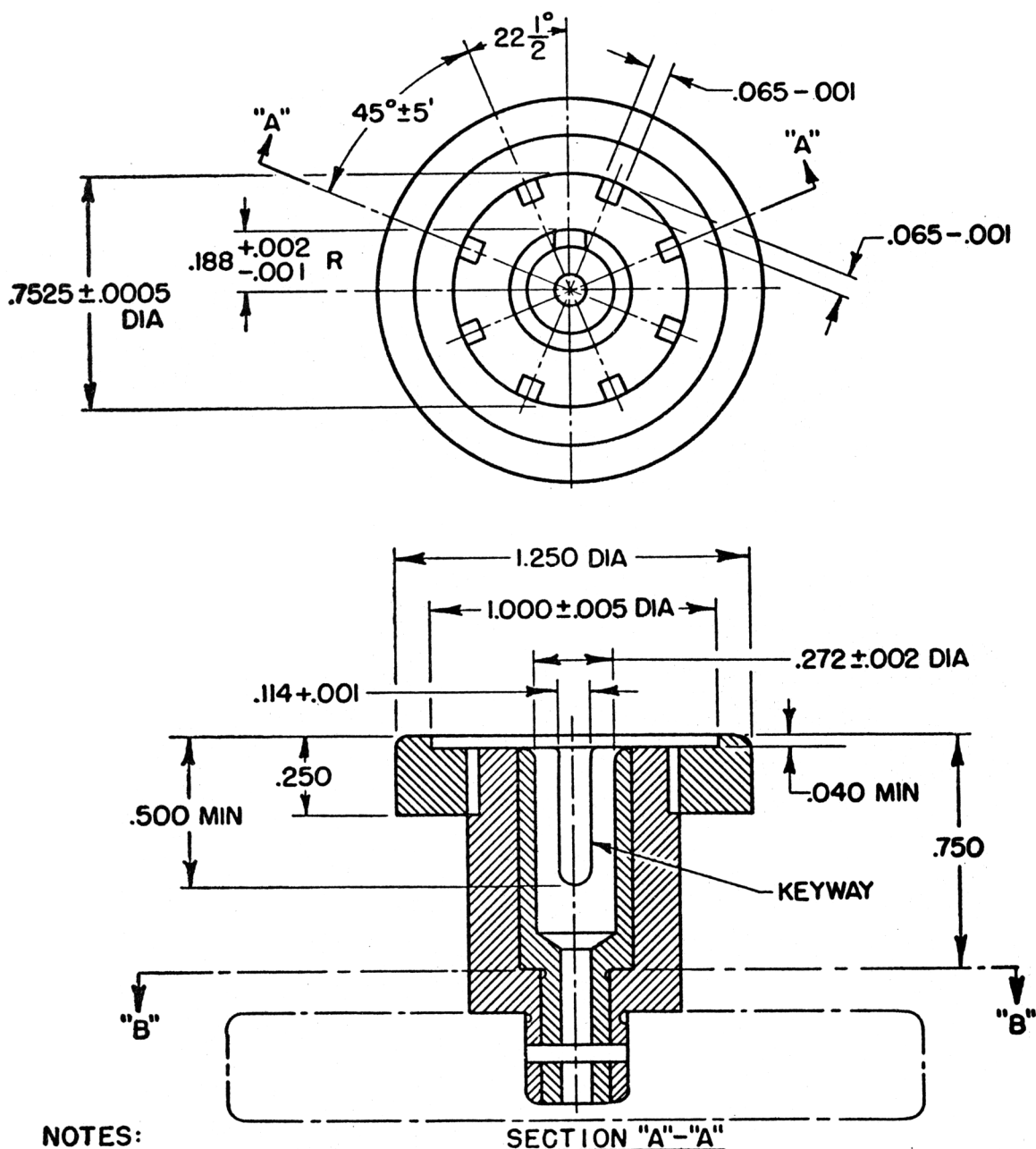
GBI4-1
DIHEPTAL



TOLERANCES ON CHORD DIMENSIONS BETWEEN PIN HOLES NOT CUMULATIVE.
ALL DIMENSIONS IN INCHES.

FIGURE 62. Standard base-pin-alinement gages.—Continued

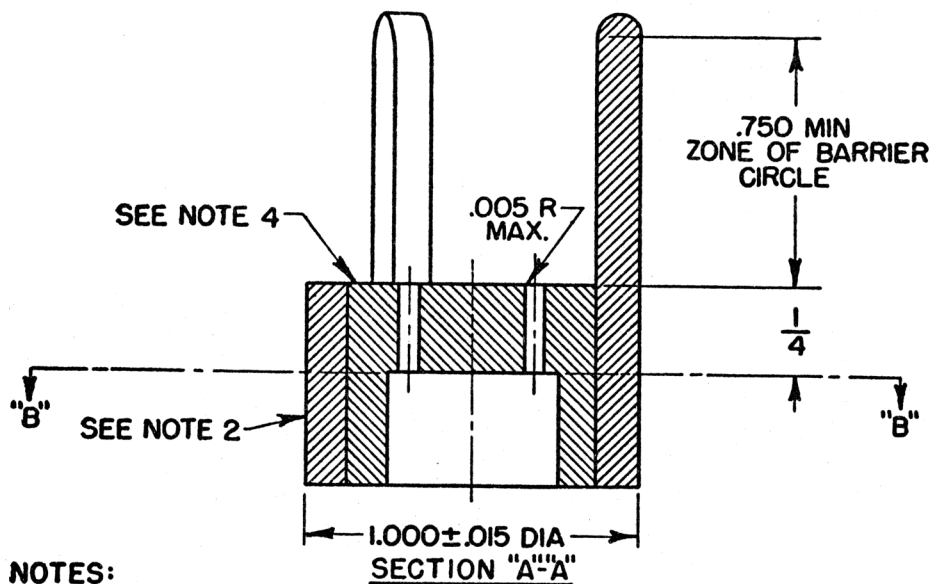
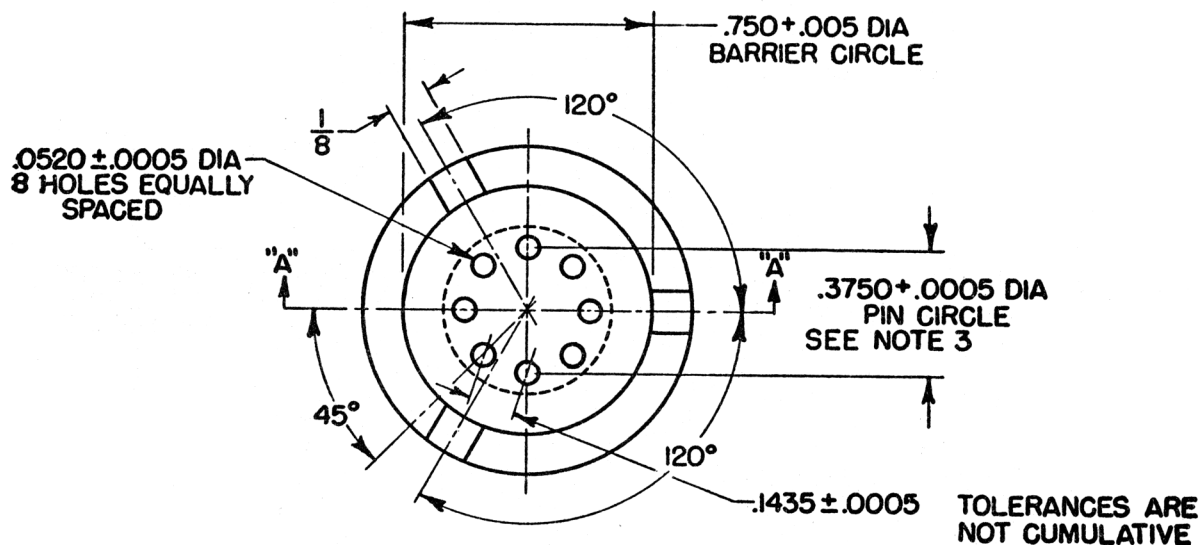
GD8-1
LOCKING-IN



NOTES:

1. ALL DIMENSIONS IN INCHES.
2. DIMENSIONS, MOUNTING METHOD, ETC. BELOW PLANE "B"-"B" ARE OPTIONAL.
3. DIMENSIONS AND TOLERANCES FOR PIN HOLE CIRCLE AND PIN HOLE SIZE AND SPACING, APPLY TO UPPER SURFACE.
4. USE GAGING PROCEDURE 1.

FIGURE 62. *Standard base-pin-alignment gages.—Continued*

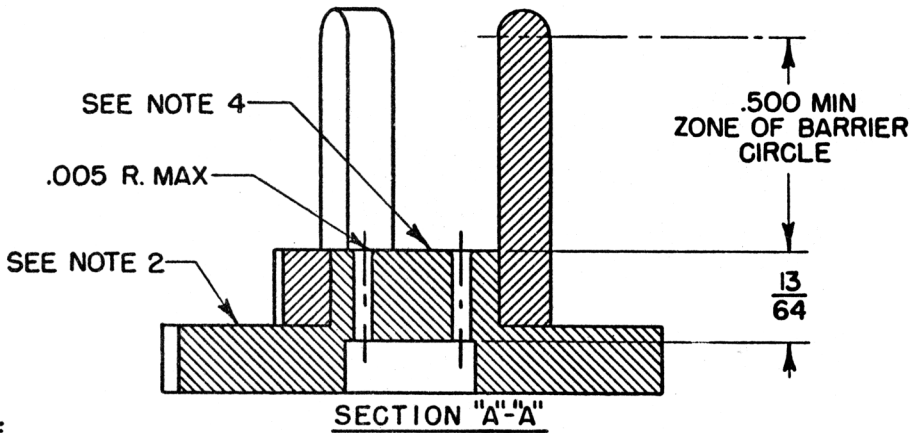
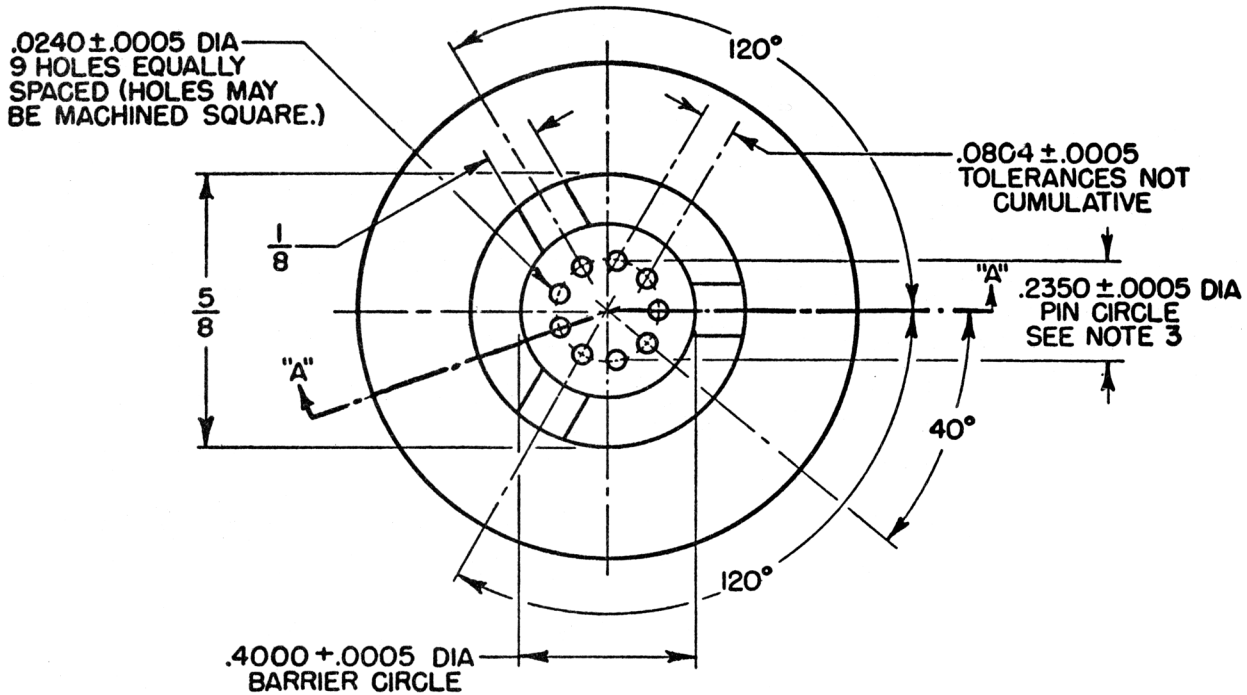


NOTES:

1. ALL DIMENSIONS IN INCHES.
2. DIMENSIONS, MOUNTING METHOD, MOUNTING FLANGE, ETC. BELOW PLANE "B"—"B" ARE OPTIONAL.
3. ECCENTRICITY OF PIN CIRCLE WITH RESPECT TO BARRIER CIRCLE MUST NOT EXCEED .0025 .
4. PIN CIRCLE DIAMETER, PIN SPACING AND PIN HOLE DIAMETER DIMENSIONS AND TOLERANCES APPLY TO UPPER SURFACE.
5. USE GAGING PROCEDURE 1.

FIGURE 62. *Standard base-pin-alinement gages.—Continued*

GE8-1
SUBMINIATURE

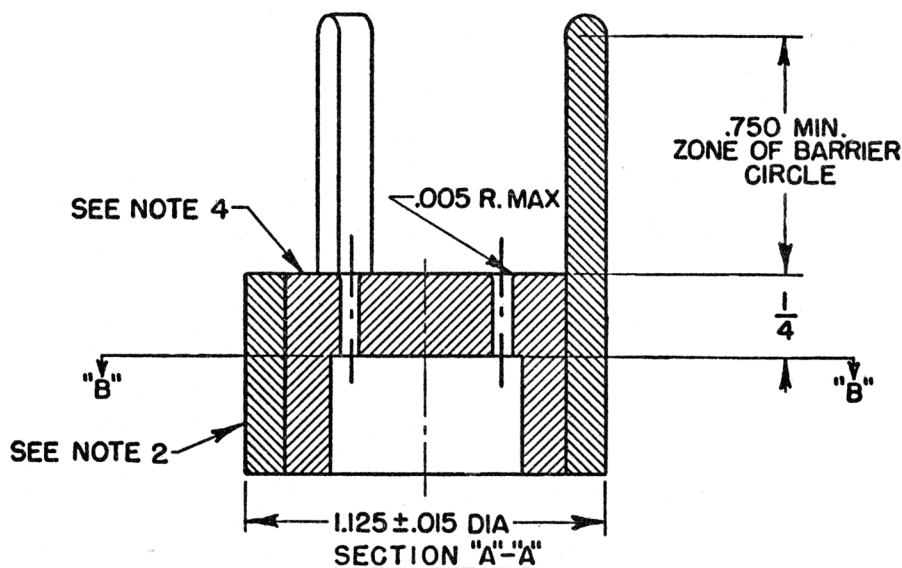
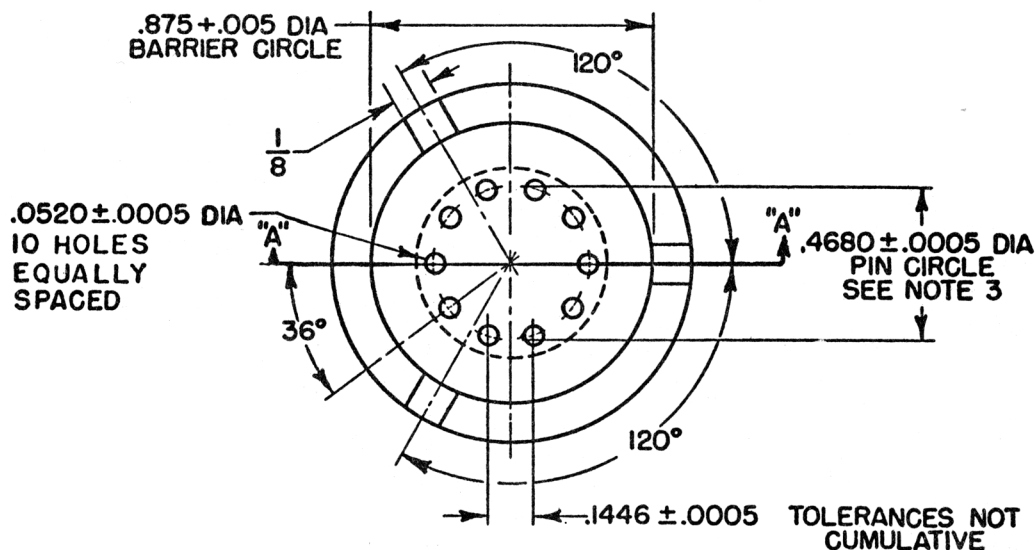


NOTES:

1. ALL DIMENSIONS IN INCHES.
2. MOUNTING METHOD IS OPTIONAL.
3. ECCENTRICITY OF PIN CIRCLE WITH RESPECT TO BARRIER I.D. MUST NOT EXCEED $.0025$.
4. PIN CIRCLE DIAMETER, PIN SPACING, PIN HOLE DIAMETER AND TOLERANCES APPLY TO UPPER SURFACE.
5. USE GAGING PROCEDURE 1.

FIGURE 62. Standard base-pin-alinement gages.—Continued

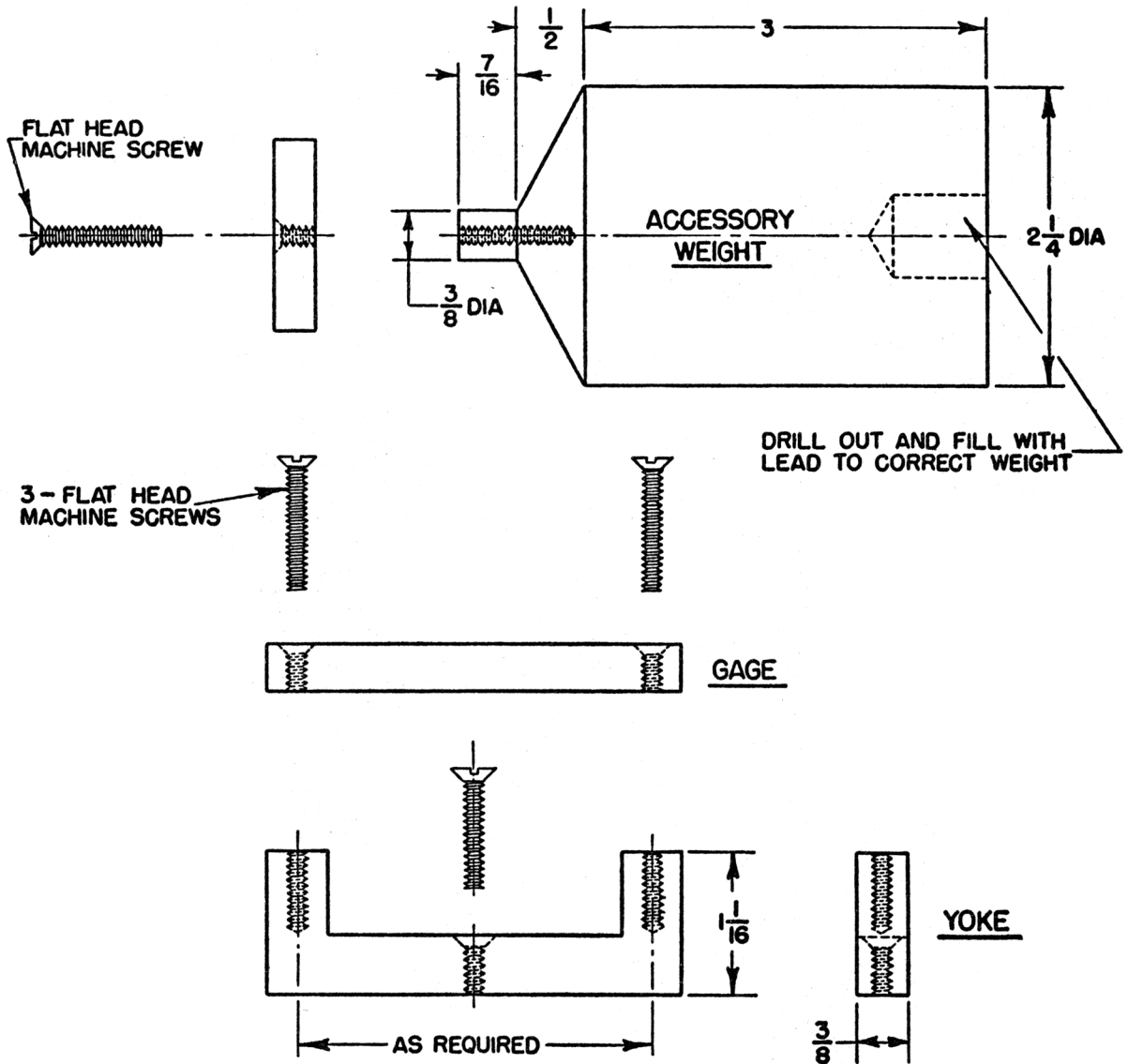
GE9-1
MINIATURE BUTTON 9-PIN



NOTES:

1. ALL DIMENSIONS IN INCHES.
2. DIMENSIONS, MOUNTING METHOD, MOUNTING FLANGE, ETC., BELOW PLANE "B"-"B" ARE OPTIONAL.
3. ECCENTRICITY OF PIN CIRCLE WITH RESPECT TO BARRIER CIRCLE MUST NOT EXCEED $.0025$.
4. PIN CIRCLE DIAMETER, PIN SPACING AND PIN HOLE DIAMETER DIMENSIONS AND TOLERANCES APPLY TO UPPER SURFACE.
5. USE GAGING PROCEDURE 1.

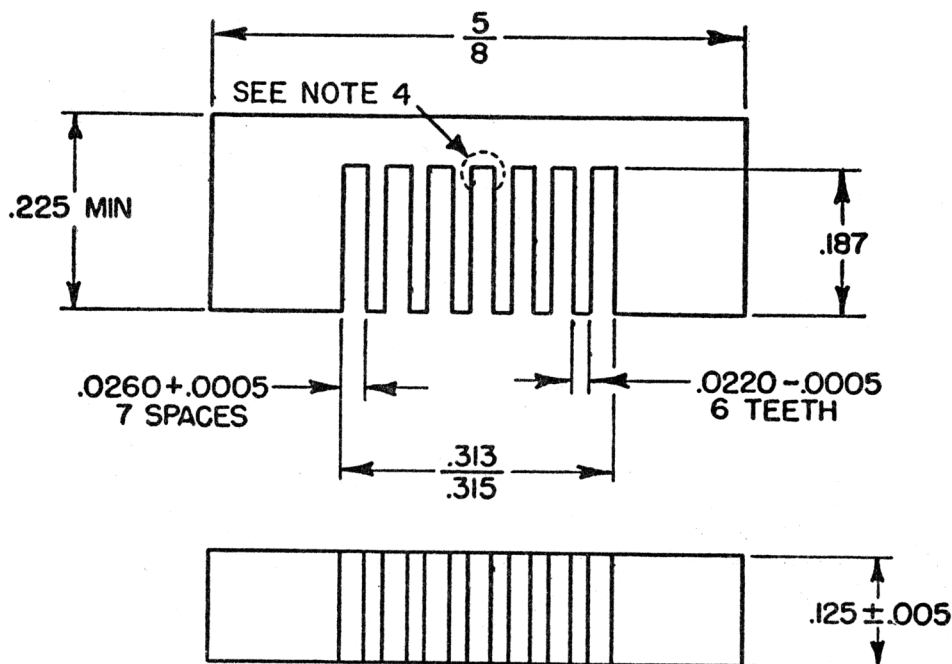
FIGURE 62. Standard base-pin-alinement gages.—Continued



ALL DIMENSIONS IN INCHES.

FIGURE 63. Typical accessory weight for base-pin-alignment gages.

GE7-3
INLINE-LEAD SUBMINIATURE



NOTES:

1. ALL DIMENSIONS IN INCHES.
2. ALL SURFACES OF TEETH RELIEVED WITH .005-.010 RADIUS.
3. MOUNTING ON STRAIGHT EXTENSION BLOCK OR 90° BLOCK OPTIONAL.
4. A SINGLE APPROPRIATE SLOT MAY BE ENLARGED TO A LEAD LENGTH NOT OVER .050 TO PROVIDE CLEARANCE FOR A SHIELD GROUND-LEAD.
5. GAGING PROCEDURE: WITH TUBE HELD WITH ITS AXIS AT RIGHT ANGLES TO FACE PLANE OF TEETH AND THE PLANE OF THE LEADS TRANSVERSE TO TEETH THE LEADS SHALL PRESS INTO SLOTS AND SOME PORTION OF BASE SURFACE SHALL BOTTOM AGAINST GAGE WHEN A FORCE NOT EXCEEDING TWENTY OUNCES IS APPLIED.
6. THIS GAGE IS TO CHECK THE LEAD SPACING ON A SAMPLING BASIS. IT IS NOT TO BE USED FOR 100 PERCENT GAGING AS IT MAY DAMAGE THE TINNED SURFACES.

FIGURE 64. *Lead-spacing gage for inline-lead subminiature tubes.*

20.4 Standard procedures.

20.4.1 *Gaging procedure 1.* The entire length of the pins shall, without undue force, pass into and disengage from the specified gage.

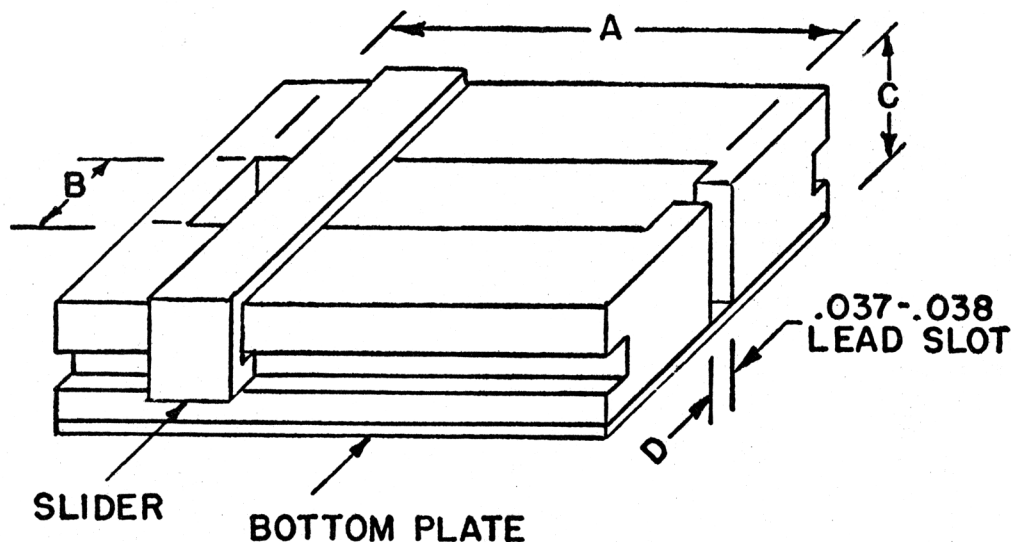
20.4.2 *Gaging procedure 2.* The gage shall be attached to such an accessory weight as will give the total weight specified on the gage drawing. The entire length of the pins shall pass into the gage and, on withdrawal, shall become disengaged without lifting the total weight of assembled gage and accessory weight. A typical accessory weight is shown on figure 63.

30. RING GAGES FOR BASE AND SLEEVE DIAMETERS

30.1 Standard ring gages for checking maximum and minimum base and sleeve diameters shall have:

- (a) A hole-diameter tolerance of $\begin{smallmatrix} +0.0005 \\ -0.0000 \end{smallmatrix}$ inch for maximum base and sleeve diameters.
- (b) A tolerance of $\begin{smallmatrix} +0.0000 \\ -0.0005 \end{smallmatrix}$ inch for minimum base and sleeve diameters.
- (c) A minimum thickness of $\frac{3}{8}$ inch.

Standard ring gages for checking bases with bayonet pins shall have a suitable clearance slot for the bayonet pin.



Outline	Dimensions		
	A +.001	Gage minor B +.001	Gage major C +.001
	Inches	Inch	Inch
8-8	1.500	.285	.385
8-9	1.250	.285	.385
8-10	1.500	.285	.400
8-11	1.250	.285	.400

Standard procedure for gaging T2x3 outline dimensions: The tube shall fit in the gage with-

out undue force. The bulb shall lie completely within the enclosure as determined with slider.

FIGURE 65. T2x3 outline gage.

APPENDIX E

INSPECTION PROCEDURES FOR ELECTRICAL TESTS
ON HYDROGEN THYRATRONS

10. SCOPE

10.1 This appendix covers the fundamental processes involved in the performance of electrical tests on hydrogen thyratrons.

10.2 This appendix is intended to serve as a supplement to the tube specification sheets and does not relieve the inspector of any testing responsibilities designated thereon. The information herein is presented to familiarize the inspector with those test conditions most difficult to evaluate.

20. ELECTRICAL TESTING OF HYDROGEN THYRATRONS

20.1 Test equipment. The synchroscope and the test set proper, consisting of the filament, reservoir (for tubes with reservoirs), and grid and anode circuits, constitute the inspector's tools for the electrical testing of hydrogen thyratrons. An inspector shall ascertain that all static-type meters are accurately calibrated. In addition, he shall assure himself by a periodic check that all the grid and plate pulse characteristics of the tubes are as specified. (See 3.9.) Since many of the test conditions and test results must be measured with the synchroscope, it is essential that the inspector be familiar with the calibration and use of this instrument. The following is the basic scheme for calibrating the axes of the synchroscope:

- (a) *Vertical-axis calibration.* The unit of vertical deflection is the dc volt. The vertical-deflection scale is calibrated with a standard 1/2-percent dc voltmeter. Associated calibration charts or meters should be periodically recalibrated.
- (b) *Horizontal-axis (sweep) calibration.* The unit of horizontal deflection is

the microsecond. The horizontal sweep calibration is obtained with a standard, triggered, shock-excited oscillator. The standard sweep calibrator is calibrated as follows: A stable CW oscillator is calibrated against a crystal-controlled frequency standard, using standard calibration procedures. The output of the CW oscillator is then coupled to an LC circuit which is tuned to resonance at the desired frequency. The output of the shock-excited oscillator is then tuned to the resonant LC circuit.

20.2 Grid pulse characteristics. Grid pulse characteristics are properties of the output pulse of the trigger circuit, measured at the grid-input point of the tube with the grid disconnected. The scope input is secured from a capacitance or compensated resistance voltage divider tap, and this voltage is connected to the vertical plates through a matching coaxial cable. The voltage ratio of dividers plus associated cables should be checked either against a direct measurement on a synchroscope or an electrostatic peak-reading voltmeter. The test circuit shall be arranged to compensate for the removal of measuring equipment when the tube is operated. The grid pulse characteristics shall be measured as follows:

- egy: Measured with an electrostatic peak-reading voltmeter (a peak-reading dc voltmeter calibrated for the operating repetition rate may be substituted) or by examining the scope presentation as shown on figure 66.
- tr: Measured by examining the scope presentation as shown on figure 66.

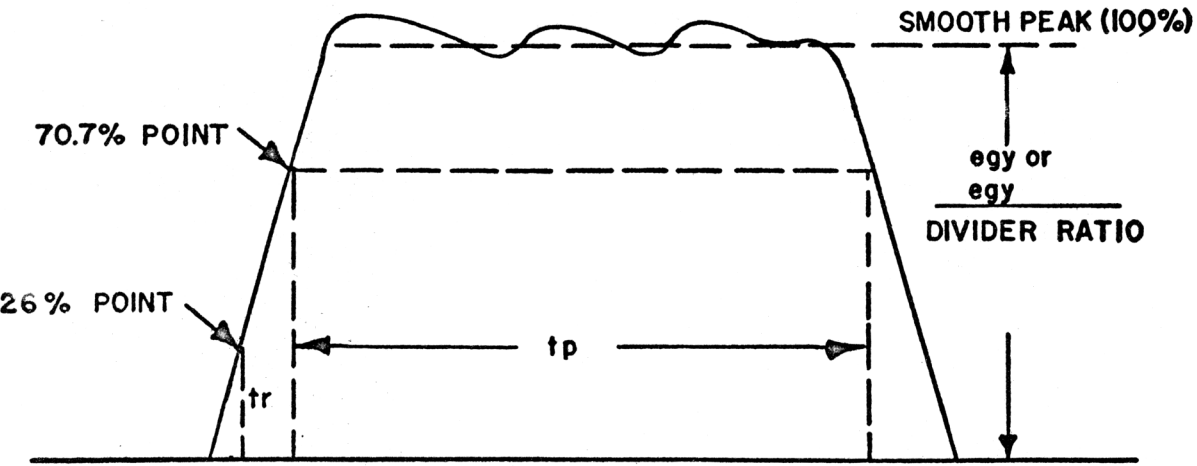


FIGURE 66. Grid pulse.

tp: Measured by examining the scope presentation as shown on figure 66.

20.3 Trigger-source impedance. The impedance of trigger sources employing a line-type modulator (gas tube circuit) shall be measured by the short-circuit current method or the matching-resistor method. The impedance of trigger sources employing a high vacuum tube, cathode follower (or similar circuit) shall be measured by the short-circuit current method only.

20.3.1 Short-circuit current method. The

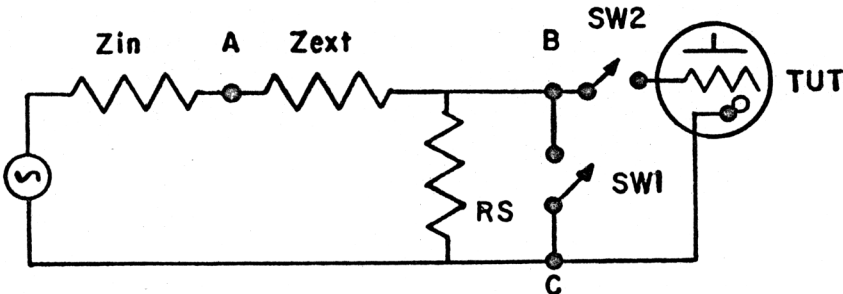
equivalent trigger circuit shown on figure 67 shall be used.

The voltage from B to C (eBC) shall be measured with the switches open. Switch SW1 shall then be closed and the voltage from A to C (eAC) shall be measured. The short-circuit current (is) shall then be determined from:

$$is = \frac{eAC}{Z_{ext}}$$

The trigger-source impedance (Z_s) is then:

$$Z_s = \frac{eBC}{is} = \frac{eBC}{eAC} Z_{ext}$$



- Z_{in} = INTERNAL IMPEDANCE OF TRIGGER CIRCUIT
- Z_{ext} = EXTERNAL RESISTANCE ADDED SO THAT $Z_{in} + Z_{ext}$ = DESIRED SOURCE IMPEDANCE (Z_s)
- R_S = THYRATRON GRID RETURN RESISTOR
- SW = SWITCH

FIGURE 67. Trigger circuit.

20.3.2 Matching-resistor method. The equivalent trigger circuit shown on figure 67 shall be used. The open-circuit voltage from B to C (eBC) shall be measured. A noninductive resistor shall be inserted between B and C, and the value of resistance shall be adjusted until the voltage across the resistance is equal to one-half the open-circuit voltage. The trigger-source impedance is then equal to the value of the resistance inserted.

20.4 Plate (current) pulse characteristics. With the exception of epy, the plate pulse characteristics shall be measured by examining the scope presentation of the voltage across a cathode current viewing resistor. The plate pulse characteristics shall be measured as follows:

epy: Measured with an electrostatic peak-reading voltmeter (a peak-reading dc voltmeter calibrated for the operating repetition rate may be substituted). The dc plate voltmeter reading for each epy level specified (see 3.9) shall be noted for subsequent use. epy versus Ebb settings shall be rechecked after each change of any plate circuit component.

ib: Measured by examining the scope presentation as shown on figure 68.

$\frac{dik}{dt}$

This value is defined as the rate of rise of the current pulse. It is the ratio of the current change between the 26-percent and 70.7-percent points of the leading edge to the rise time for that portion of the pulse. It shall be computed from measurements taken from the scope presentation as shown on figure 68.

tp: Measured by examining the scope presentation as shown on figure 68.

20.4.1 Resonant prr. Resonant prr is essentially a function of the charging-choke inductance and the pulse-forming network capacitance. It shall be measured by examining the charging-current waveforms on an oscilloscope with a reasonably good amplifier. The waveforms are developed by examining the voltage across a noninductive resistor inserted in series between the normally connected power supply return and the ground with several cycles of the half-sine waves presented. By varying the pulse recurrence rate (adjusting the audio-oscillator frequency) the resonant pulse recurrence rate is determined as the repetition frequency at which the falling edge of one charging cycle and the leading edge of the next charging cycle just meet, forming a sharp cusp. The conditions of the charging circuit for pulse recurrence rates less than,

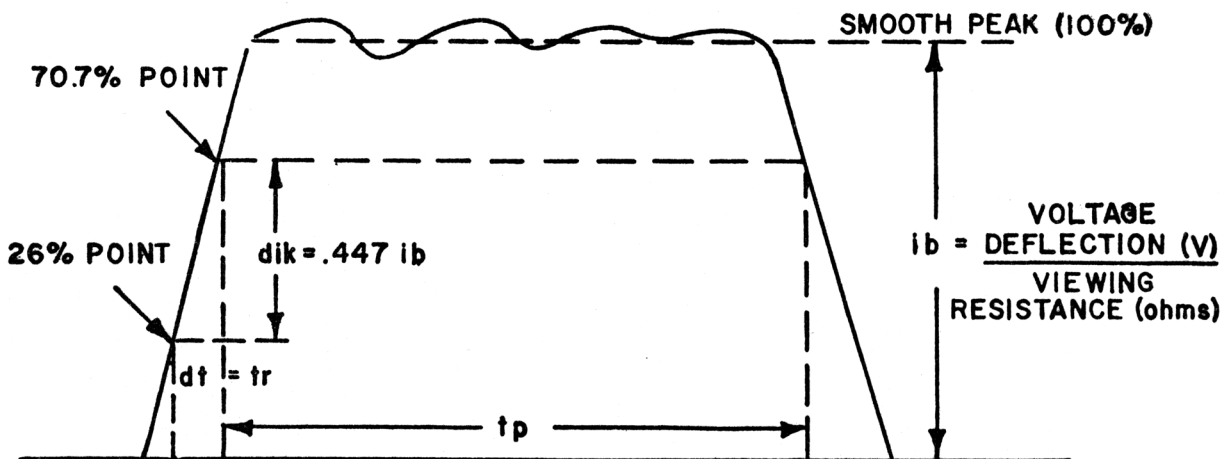
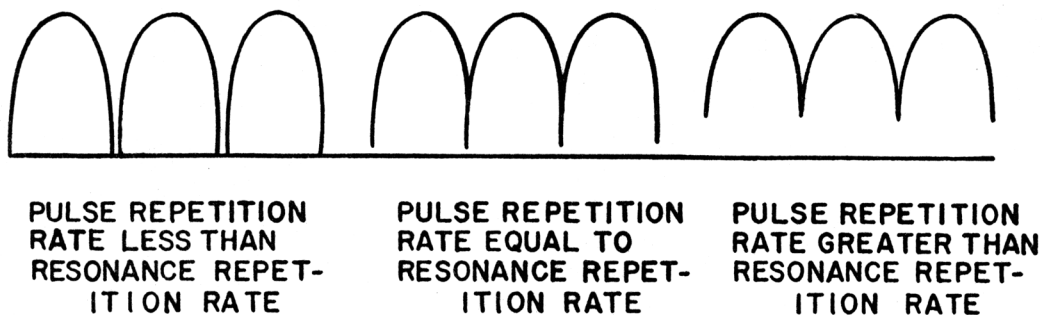


FIGURE 68. Plate current pulse.

FIGURE 69. *Pulse-recurrence rates.*

equal to, and greater than, the resonant pulse recurrence rate are shown on figure 69.

20.5 Procedures for electrical (group B) production tests.

20.5.1 Cathode-heater current (see 4.10.8). On tubes with reservoirs this test shall be performed with the reservoir voltage set at the base value.

20.5.2 Reservoir - heater current (see 4.10.8). This test shall be performed with the cathode-heater voltage set at the specified value. (See 3.9.)

20.5.3 Instantaneous start. This shall be the first operational test after the 96-hour holding period. The procedure for the test shall be as follows:

- (a) Turn on the cathode-heater voltage (and reservoir voltage when applicable) and allow the specified warmup period. (See 3.9.)
- (b) Set up the driver and plate circuits for operation under the specified conditions. (See 3.9.) The rate of rise of the peak forward anode voltage shall be checked periodically.
- (c) Adjust the anode supply voltage control to the open-circuit setting required for the specified epy. (See 3.9.)
- (d) Turn on the trigger high voltage and apply the specified trigger voltage to the grid of the tube. (See 3.9.)

- (e) Snap-start the tube by pushbutton application of the anode voltage determined in step c above. The tube shall start and operate satisfactorily within the specified number of attempts. (See 3.9.)

20.5.4 Operation 1. The procedure for this test shall be as follows. Items (b), (e), and (f) are applicable only to tubes with reservoirs.

- (a) Set up the anode circuit for operation under the specified conditions. Adjust the open-circuit trigger voltage to the maximum limit specified (or lower, at the option of the manufacturer). (See 3.9.)
- (b) Readjust the reservoir voltage to the base value minus 5 percent and allow 5 minutes for the pressure to stabilize. The base value shall be within the limits specified for the reservoir-voltage (1) test. (See 3.9.)
- (c) Apply the trigger voltage. Start the plate at the minimum position of the voltage control and raise the voltage until the specified epy has been reached. (See 3.9.)
- (d) The tube shall operate as specified for the specified period. (See 3.9.)
- (e) After 15 minutes of operation under the above conditions, and while the tube continues in operation, raise the reservoir voltage to the base value plus 5 percent.

- (f) The tube shall operate as specified for an additional 10 minutes. At the end of this 10-minute period and with the tube still operating, the reservoir voltage shall be reduced to the base value. The tube shall then operate as specified for an additional 5 minutes.
- (g) Snap off the plate voltage and perform the dc anode voltage test specified in 20.5.5 of this appendix.

20.5.5 dc anode voltage. The procedure for this test shall be as follows:

- (a) The test shall be performed within 60 seconds after the termination of the operation 1 test and under the same circuit conditions.
- (b) Start the plate at the minimum position of the voltage control and raise the voltage until the tube starts to conduct.
- (c) The dc anode voltage at this point shall not exceed the specified maximum value (See 3.9.)

20.5.6 Operation 2. When this test is specified as a production test for tubes without reservoirs, the tubes shall be tested under the specified conditions (see 3.9), and in accordance with the applicable procedures specified in 20.5.4 of this appendix. Tube types with reservoirs shall be tested as follows:

- (a) Set up the anode circuit for operation under the specified conditions. Adjust the open-circuit trigger voltage to the maximum limit specified (or lower, at the option of the manufacturer). (See 3.9.)
- (b) Set the reservoir voltage at 5 percent less than the optimum value for operation 2 as determined by the manufacturer. The manufacturer's optimum value shall be within the limits specified in the reservoir-voltage (2) test. (See 3.9.)

- (c) After the specified warmup period, apply the trigger voltage to the grid of the tube. Start the plate at the minimum position of the voltage control and raise the voltage until the specified epy has been reached. (See 3.9.)
- (d) The tube shall operate as specified for 10 minutes.
- (e) After 10 minutes of operation and while the tube continues in operation, raise the reservoir voltage to the optimum value for operation 2 plus 5 percent.
- (f) The tube shall operate as specified for an additional 10 minutes.

20.5.7 Emission. This test requires a special testing circuit which is normally not a part of standard hydrogen-thyratron test equipment. Figure 70 shows a recommended circuit for use in performing this test. The procedure for the test shall be as follows:

- (a) Set up the pulsing circuit for operation under the specified conditions. (See 3.9.)
- (b) Turn on the cathode-heater voltage (and reservoir voltage when applicable) and allow the specified warmup period. (See 3.9.)
- (c) Apply the positive pulse to the grid of the tube under test (TUT) and adjust the pulse voltage for the specified ik. (See 3.9.) This value shall be measured by examining the scope presentation of the current pulse appearing across a viewing resistor (R_v) as shown on figure 70 (scope connected to J_2).
- (d) Determine the point of start of the current pulse by examining the same scope presentation referenced in step c above.
- (e) Connect the scope to view the positive pulse voltage at the grid of the TUT, as shown on figure 70 (scope connected to J_1).

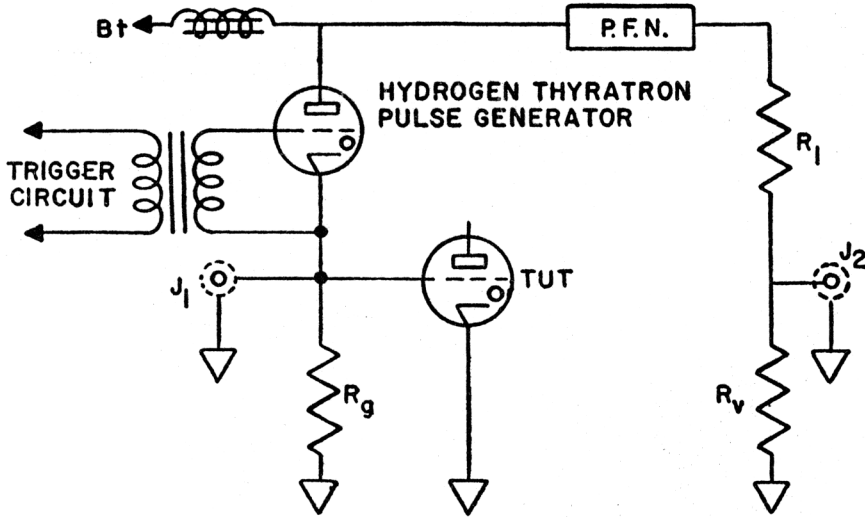


FIGURE 70. Emission test circuit.

- (f) Measure the voltage between the grid and the cathode (egk) of the TWT at the specified time interval (see 3.9) after the start of the current pulse. This measurement shall be accomplished by examining the scope presentation referenced in step e above and the scope presentation as shown on figure 71.
- (g) This measured value of egk shall not exceed the specified maximum

value, and the average voltage shall not rise beyond the voltage-measuring point. (See 3.9.)

20.6 Procedures for electrical design tests.

20.6.1 Anode delay time (t_{ad}). This test is a measurement of the time interval between the 26-percent point on the rising position of the unloaded grid pulse and the point where anode conduction takes place. This time interval shall be measured by examining the scope

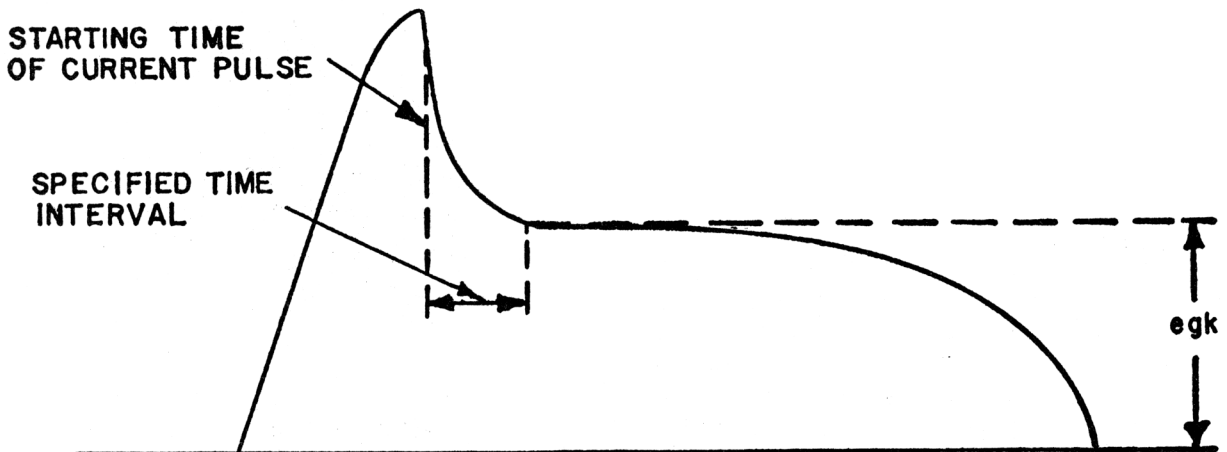


FIGURE 71. Positive grid pulse (emission test).

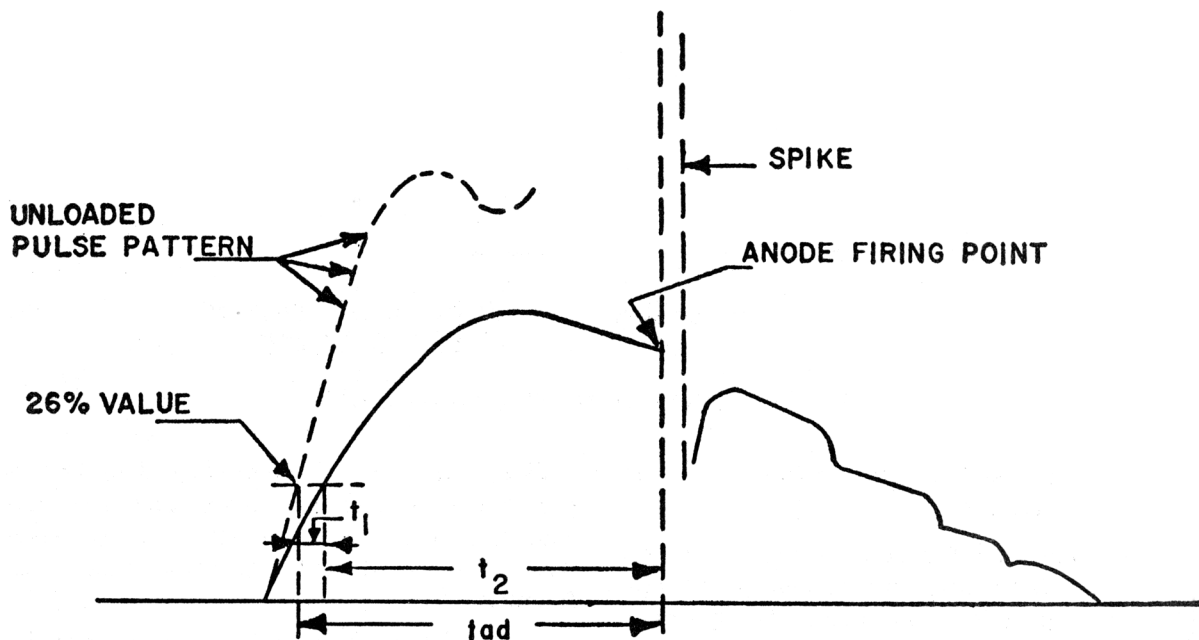


FIGURE 72. Grid pulse (anode conducting).

presentation as shown on figure 72. The procedure for the test shall be as follows:

- (a) Turn on the cathode-heater voltage (and reservoir voltage when applicable) and allow the specified warmup period. (See 3.9.)
- (b) Connect the scope to the grid divider terminal.
- (c) Set up the driver and plate circuits for operation under the specified conditions. (See 3.9.)
- (d) View the unloaded grid pulse and determine the 26-percent value.
- (e) Close the grid disconnect switch, choose the reference point on the loaded grid pulse, and measure t_1 as shown on figure 72.
- (f) Operate the tube as specified.
- (g) After 2 minutes (minimum) of operation, measure t_2 by examining the grid pulse (with tube operating) as shown on figure 72.
- (h) The anode delay time (t_{ad}), $t_1 + t_2$, shall not exceed the specified maximum value. (See 3.9.)

20.6.2 Anode-delay-time drift (Δt_{ad}).

This test is a measurement of the change in anode delay time caused by continued operation of the tube. The procedure for the test shall be as follows:

- (a) After completion of the initial t_{ad} reading, continue the tube in operation under the same conditions.
- (b) After a 5-minute interval (total of 7 minutes operation), make another measurement of the t_{ad} .
- (c) Determine the increment between the initial and second readings. This value is the Δt_{ad} and shall not exceed the specified maximum value. (See 3.9.)

20.6.3 Time jitter (t_j). This test is a measurement of the variation in anode firing time. Time jitter shall be determined by examining the scope presentation of the cathode current pulse. The procedure for the test shall be as follows:

- (a) Set up the tube for operation under the specified conditions. (See 3.9.)
- (b) Connect the scope to view the voltage

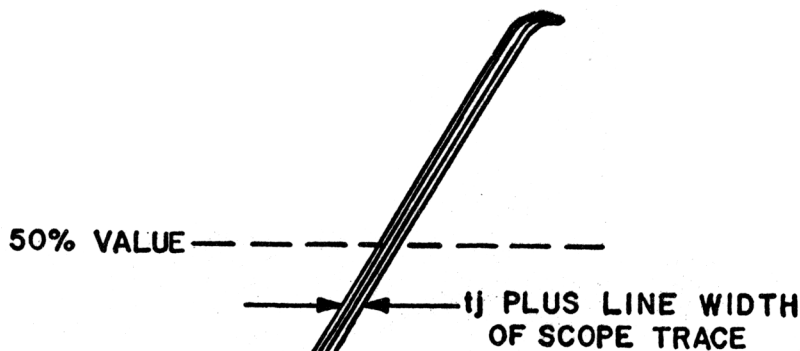


FIGURE 73. Cathode current pulse (leading edge).

across the jitter cathode viewing resistor.

- (c) Turn on the cathode-heater voltage (and reservoir voltage when applicable) and allow the specified warmup period. (See 3.9.)
- (d) Operate the tube, and determine the point on the rising portion of the pulse which is 50 percent of the maximum pulse amplitude.
- (e) At this point, measure the width of the trace as shown on figure 73.
- (f) This value, less line width, is the time jitter of the tube and shall not exceed the specified maximum value. (See 3.9.)

20.6.4 Heater-cathode leakage. Not applicable to all tubes. (See 3.9.)

20.6.5 Reservoir (1) stability. This test is performed to determine compliance with the reservoir voltage (1), when specified. (See 3.9.) The procedure for the test shall be as follows:

- (a) Set up the trigger and anode circuits for operation under operation 1 test conditions.
- (b) Set the reservoir voltage at the base value plus 5 percent.
- (c) After the specified warmup period, apply the trigger voltage to the grid of the tube. Start the plate at the minimum position of the voltage control and raise the voltage until the specified epy has been reached. (See 3.9.)
- (d) The tube shall operate continuously for 30 minutes without evidence of arc-back or anode heating.

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MILITARY SPECIFICATION

ELECTRON TUBES AND CRYSTAL RECTIFIERS

This amendment forms a part of Military Specification MIL-E-1D, 31 March 1958, and has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force.

Page 1, paragraph 2.1, list of military specifications: Delete "JAN-I-10" and "MIL-P-75", with corresponding titles.

Page 1, paragraph 2.1, list of military specifications: Add:

"MIL-I-10 - Insulating Materials, Electrical, Ceramic, Class L.
MIL-E-75 - Electron Tubes, Packaging, Packing, and Container-
Marking of, General Specification for.
MIL-M-19590-Marking of Commodities and Containers to Indicate
Radioactive Material."

Page 2, paragraph 2.1, list of military standards: Delete "MIL-STD-200" with corresponding title and substitute:

"MIL-STD-200 - Electron Tubes; and Semiconductor Devices, Diode."

Page 2, paragraph 2.2, list of other publications: Delete parenthetical statement under "ASA C16.5-1954" and substitute:

"(Application for copies should be addressed to the American Standards Association, Inc., 10 East 40th Street, New York 16, N. Y.)"

Page 2, paragraph 3.1: Delete and substitute:

"3.1 Qualification. Tubes furnished under this specification shall be a product which has been tested, and has passed the qualification tests specified in 4.1.1.1.1 and 4.2.1, and has been listed on or approved for listing on the applicable Qualified Products List. (See 6.2.)"

Page 3, paragraph 3.2.1, line 3: Following "than", insert "that".

Page 8, figure 2: Delete outline 2-1.

Page 10, figure 4: Delete outlines 4-1 and 4-3.

Page 11, figure 5: Delete outline 5-7.

Page 15, figure 9: Delete outline for "SKIRTED MINIATURE, STYLE C" cap.

Page 15, figure 9: Delete outline for "BEADED MINIATURE" cap.

Page 19, figure 13, pin and index guide dimension tabulation, reference "N":

MIL-E-1D
AMENDMENT 5

Delete minimum dimension ".340" and substitute ".320".

Page 20, figure 14: In the tabulation, delete "B7-93" and substitute "B9-93".

Page 31, paragraph 3.6, listing under requirement or test: Delete "Brass or bronze sleeve base test" and substitute "Base sleeves".

Page 31, paragraph 3.7, line 3: Delete "3.7.7, inclusive, "and substitute "3.7.6, inclusive, 3.7.8, and 3.7.9".

Page 32, paragraph 3.7.3: Delete "MIL-P-75" wherever it appears in the specification and substitute "MIL-E-75".

Page 32, paragraph 3.7.6, lines 2 and 3: Delete "3.7.5, inclusive, " and substitute "3.7.6, inclusive, 3.7.8, and 3.7.9".

Page 33, paragraph 3.7.7, fourth line from bottom: After "inclusive" add "3.7.8, and 3.7.9."

Page 33: Following paragraph 3.7.7, add new paragraphs:

"3.7.8 Special marking. Tubes with intentionally added radioactive isotopes shall be marked in accordance with Specification MIL-M-19590, except tubes in type I classification, as defined in Specification MIL-M-19590, shall be marked in accordance with 3.7.8.1.

"3.7.8.1 Type I class tubes. When the level of activity for a radioactive isotope included in an individual tube is less than the value shown in table I of Specification MIL-M-19590, the tube shall be marked with the identification symbol "  " immediately following the tube type number itself in the same manner and color as used in the tube brand marking, eg, " **JAN-XYZ-000**  ". This identification symbol is intended only to indicate the presence of a radioactive material, and is not to be construed to indicate a hazard.

"3.7.9 Lot identification. Each nonserial numbered tube listed in the preferred and guidance lists of Standard MIL-STD-200 shall be marked with a lot-identification marking so that tubes of a given lot (see "Submittal of Product" section of Standard MIL-STD-105) may be identified. Lot-identification markings

Unless otherwise stated the Marking of valves shall be in accordance with K1001/4 and, in addition, the valves shall be marked with the American Tube Type number [U.K. Amdl- 3]

See previous page
shall be limited to the use of Arabic numerals and English letters, or combinations of both. The size of the characters of the lot identification shall be not larger than the size of these in the date code."

Page 33, paragraph 3.9.1: Add the following abbreviations:

"ATR tube	Anti-transmit-receive tube
Ecal	Calibrating voltage
mm	Millimeter
MP	Missing rf pulses
msi	Milligrams per square inch (plating)
Pre-TR tube	Pre-transmit-receive tube
QPL	Qualified Products List
TIR	Total indicator reading
TR tube	Transmit-receive tube
TUT	Tube under test"

Page 34, paragraph 3.9.1, symbol Ec/Ib: In line 2 of definition, delete "late" and substitute "plate"

Page 37, paragraph 3.9.1, symbol Zg: In definition, delete "Imedance" and substitute "Impedance".

Pages 37 and 38, paragraph 4.1: Delete and substitute:

"4.1 Responsibility for inspection and general procedures for acceptance.

(a) Responsibility for inspection. The supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements. Test equipment and inspection facilities shall be of sufficient accuracy, quality, and quantity to permit performance of the required inspection. The supplier shall establish calibration of test equipment to the satisfaction of the Government.

(b) General procedures for acceptance. Acceptance-sampling procedures shall be performed in accordance with Standard DEF-13/ MIL-STD-105 and the applicable special procedures of appendix C to this specification. The manufacturer may make such additional tests as he may deem necessary to insure proper quality control of his product. Other test methods may be substituted for those specified herein provided it is demonstrated to the Government that there is adequate correlation between the results of the manufacturer's test methods and those

*unless the Approving or the Inspection Authority
request otherwise on any particular value type,
these sentences are deleted.*
EWK: Amndt 6

specified in this specification, and provided that such substitution in no manner relaxes the requirements of this specification. The schematic wiring diagram of the test equipment to be used shall be made available for review by the Government. The manufacturer shall make available for Government use a statement describing the materials and pertinent design features of the tube, such as anode, grid, base, filament, material, construction, etc. The Government shall be supplied with one set of photographs of each tube for which the manufacturer has been granted qualification approval. These photographs and statement of materials and construction shall be the same as those submitted with the request for authorization to submit samples for qualification test, and shall be used by the Government for the periodic review of the tubes to determine whether the design and construction of the tubes conform to that for which qualification was granted. Unless otherwise specified in 4.9.1, any tube which fails any test shall be rejected unless the manufacturer has corrected the cause of failure."

Pages 38 and 39, paragraphs 4.1.1 to 4.1.1.7, inclusive: Delete and substitute:

"4.1.1 Classification of tests. Tests specified on tube specification sheets will be indicated by one of the methods specified in 4.1.1.1 and will fall into one of the groups specified in 4.1.1.2.

"4.1.1.1 Methods of indicating tests.

"4.1.1.1.1 Method A (preferred). Test classifications will be indicated on tube specification sheet by grouping tests in blocks by inspection criteria as indicated below:

<u>BLOCK TITLE</u>	<u>DESCRIPTION</u>
<u>General</u>	Covers general performance requirements applicable to the whole specification, and are not assigned an inspection level or AQL.
<u>Qualification inspection</u> (Previously "Qualification approval")	Constitutes only the tests normally performed at qualification inspection. (See 4.1.1.2.1)
<u>Acceptance inspection, part 1</u> (<u>Production</u>) (Previously "Measurement acceptance")	Normally performed on a lot-sampling basis with a combined AQL. Covers critical

parameters likely to be affected by daily variations in assembly and processing (see 4.1.1.2.6).

Acceptance inspection, part 2

(Design) Normally performed on a lot-sampling basis and specifies AQL and inspection level. Covers parameters that normally will not be affected by daily variations in assembly and processing (see 4.1.1.2.3 and 4.1.1.2.4).
(Previously "Measurement acceptance")

Acceptance inspection, part 3

(Life or periodic-check) Tests performed at stated conditions for a specified period of time (see 4.1.1.2.5); or
(Previously "Acceptance life")

Tests performed on a nonstatistical periodic basis on key design characteristics to assure against unacceptable degrees of deterioration for those characteristics.

"4.1.1.1.2 Method B. Test classifications are indicated on the tube specification sheet by utilizing the symbols indicated below. This method shall not be used in formulating new tube specification sheets under this specification.

<u>Test</u>	<u>Symbol</u>
Qualification (only)	**
Standard design	*
Special design	#
Periodic-check	##
Production	Except for tests marked with a dagger sign "†" (see 3.9.1), production tests have no symbol marking. Life tests and tests with special AQL are not conducted as production tests.

"4.1.1.2 Inspection groups.

"4.1.1.2.1 Qualification tests. All tests listed on the tube specification sheets shall be conducted as qualification tests. Tests indicated on the

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tube specification sheet as qualification tests shall normally be conducted as qualification tests only.

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"4.1.1.2.2 Periodic-check tests. The tubes for periodic-check tests shall be selected at random intervals so that, at the time any lot is offered for acceptance, not less than three tubes shall have been tested during the last 12 calendar months. Should the tube or tubes fail such a test, the matter shall be reported to the ~~Armed Services Electro-Standards Agency (ASESA)~~ as a matter affecting qualification. The failure of one or more samples in a periodic-check test shall be no cause for rejection of tubes until such time as the effect of the failure on qualification has been determined.

"4.1.1.2.3 Design tests. Inspection level ~~L6 of Standard MIL-STD-105~~ shall be used for standard-and special-design tests. Unless otherwise specified (see 3.9), AQL for each individual test shall be as follows:

<u>Design test</u>	<u>AQL (percent defective)</u>
Standard	6.5
Special	4.0

"4.1.1.2.4 Tests with special AQL. All test items specified on the tube specification sheet with an AQL value shall be sampled and inspected in accordance with ~~Standard MIL-STD-105~~ and the applicable special provisions of appendix C. Where inspection level 1A is specified, inspection level L6 shall be used.

"4.1.1.2.5 Life tests. Life tests shall be performed as specified on the tube specification sheet or as specified in 4.11 to 4.11.8, inclusive, as applicable.

"4.1.1.2.6 Production tests. Production tests are divided into the three major groupings listed below and shall be conducted as follows:

- Group A: Mechanical inspection. All mechanical, visual-mechanical, and dimensional characteristics designated as production tests. For classification of defects and acceptance-inspection criteria, see 4.9.
- Group B: Electrical tests. All electrical characteristics designated as production tests. All electrical defects are major 1 defects, 1 percent AQL (combined defectives).
- Group C: Inoperatives. All inoperatives (shorts, discontinuities, and air leaks) are major 1 defects, 0.4 percent AQL (combined defectives).

"4.1.1.2.7 Variable sampling. The measurements of certain electrical tests for the lot shall be controlled for central tendencies, deviations of lot average from bogey, and for dispersion above the average. The sample size shall be as specified on the tube specification sheet. For acceptance-inspection procedures, see appendix C.

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"4.1.2. Resubmitted lots. In the event additional electrical processing is performed on tubes in order to repair a defect, an additional life-test sample shall be chosen from the resubmitted lot. Resubmitted lots shall be as defined in Standard MIL-STD-105. DEF-131

"4.1.3 Irregular production. When production is intermittent or irregular (ie, characterized by lapses of 1-month duration or longer), either normal or tightened inspection shall be used, depending on the eligibility of the manufacturer. The government may authorize reduced inspection for design tests after the first lot, if all of the following conditions are met:

- (a) The lapse of time is less than 3 months;
- (b) The manufacturer was eligible for reduced inspection at the end of previous production run; and
- (c) Eligibility for reduced inspection is maintained.

"4.1.4 Testing and branding at remote locations. The following criteria shall govern production-test acceptance and branding of tubes at locations other than at the point of manufacture:

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- not under the inspection control of the manufacturer*
- (a) When tubes are manufactured and tested at one plant and branded at another location, group C (inoperatives) tests shall be performed at the branding location, in accordance with the applicable acceptance-inspection procedure, immediately prior to branding.
 - (b) When tubes are manufactured at one plant but transported to another location for production testing and branding all production tests (groups A, B, and C) shall be performed at the branding point, in accordance with the applicable acceptance-inspection procedure, prior to branding.

"4.1.5 Delayed shipment of inspected tubes. The following criteria shall govern the acceptance of inspected tubes which have been held in storage:

See UK Amnt 10. See also new paragraph 4.5.1

- (a) Tubes which have passed Government inspection and have subsequently been held in storage for a period of 30 days or longer shall be retested for group C (inoperatives) defects, in accordance with the applicable acceptance-inspection procedure, prior to branding and shipping.
- (b) Tubes which have passed Government inspection and have subsequently been held in storage for a period of ~~12~~ months or longer shall be retested for ~~all production tests (groups A, B, and C),~~ Group C (inoperatives)

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in accordance with the applicable acceptance-inspection procedure, prior to branding and shipping. In addition, ~~the air-leak test specified in 4.7.6 shall be performed as part of group C tests.~~"

Page 39 paragraph 4.3.1 line 5: Following "Government", insert "-approved".

Page 40, paragraphs 4.7.1 to 4.7.3, inclusive: Delete and substitute:

"4.7.1 Continuity. Tubes shall be tested for continuity of all possible circuits, including shell, base, base sleeve, shield, and duplicate-pin connections to the same electrode, as applicable. During the continuity tests, the tube shall be tapped (except life-test samples) as specified in 4.7.7 for receiving tubes and as specified in 4.7.8 for all other tubes. Tubes which give an indication of a permanent or intermittent open circuit during this test shall be rejected as inoperable.

"4.7.2 Permanent shorts. Tubes shall be tested, as specified in 4.7.7 for receiving tubes and as specified in 4.7.8 for all other tubes, for shorts between any of the elements, no-connection base pins, and internal shields, without mechanical excitation of the tube. Tubes showing permanent shorts during this test shall be rejected as inoperable.

"4.7.3 Tap shorts. Unless otherwise specified (see 3.9), tubes shall be subjected to the shorts test and tapping procedure as specified in 4.7.7 for receiving tubes, and the tapping procedure as specified in 4.7.8 for all other tubes.

"4.7.3.1 Regular-tube types. If a short indication is obtained, the tapping cycle shall be repeated two more times. If a short indication is again obtained, the tubes shall be rejected as inoperable.

"4.7.3.2 Reliable-tube types. If a short indication is obtained at any time during the tapping procedure, the tube shall be rejected as inoperable."

Page 40, paragraph 4.7.4, next to last sentence: Following "Government", insert "-approved".

Page 40, paragraph 4.7.5: Delete and substitute:

"4.7.5 Continuity and shorts tests (for reliable tubes). Tubes shall be subjected to the shorts test and tapping procedure as specified in 4.7.7 for receiving tubes, and the tapping procedure as specified in 4.7.8 for all other tubes. Tubes which give an indication of one or more of the following shall be rejected as inoperable:

- (a) Open circuits. (See 4.7.1)
- (b) Permanent shorts. (See 4.7.2)

- (c) Tap shorts. (See 4.7.3.2.)
- (d) Air leaks. (See 4.7.6.)"

Page 41, paragraph 4.7.6, item a, line 5: Delete "that" and substitute "twice the life-test".

Page 41: Following paragraph 4.7.6, add new paragraphs:

"4.7.7 Shorts test (for receiving tubes). The tube shall be connected to the shorts test equipment in such a manner that the minimum specified sensitivity is maintained between all elements in a single section of a tube, but like elements in the sections of a multisection tube may be paralleled provided that the mechanical assembly of the tube structure is such that the possibility of shorts between sections is proven to be remote in that the cumulative result of tests on 1,000 or more tubes of a given construction shows that no more than 0.4 percent of the tubes show any indication of tap shorts between like elements in the sections of a multielement tube. The shorts simulator used for calibration shall be of the passive type (time-controlled-switch closure) and shall add a minimum of capacitance to the circuit under test consistent with good low-capacitance wiring technique. Except for heater-cathode, a short circuit shall be defined as an equivalent resistance between adjacent elements which persists for a period of time in excess of that determined by a limiting curve of resistance versus time duration passing through the following points:

<u>Resistance,</u> <u>ohms</u>	<u>Time duration</u>
600,000	Constant value (permanent short)
500,000	500 us
100,000	100 us
1,000	60 us

For heater-cathode, the sensitivity need not exceed 10 percent of the above resistance value. Figure 74 illustrates this curve and is marked to show the area of rejection and acceptance, ie, a short circuit of 100,000 ohms equivalent resistance shall be accepted if it persists for less than 100 us, etc. The voltage applied between adjacent elements of the tube shall have a value between 20 and 70 volts dc or peak ac. When tapping is specified for shorts testing, it shall be performed in accordance with the following provisions:

- (a) The tube shall be mounted in the test socket of the shorts test equipment and tapped three times on each of two planes 90° to 120° apart. During tapping, the tube shall be supported only by a socket and a light-finger pressure or soft-cushioned mechanical pressure on the dome of the bulb. The finger or mechanical pressure on the dome of the bulb shall be used

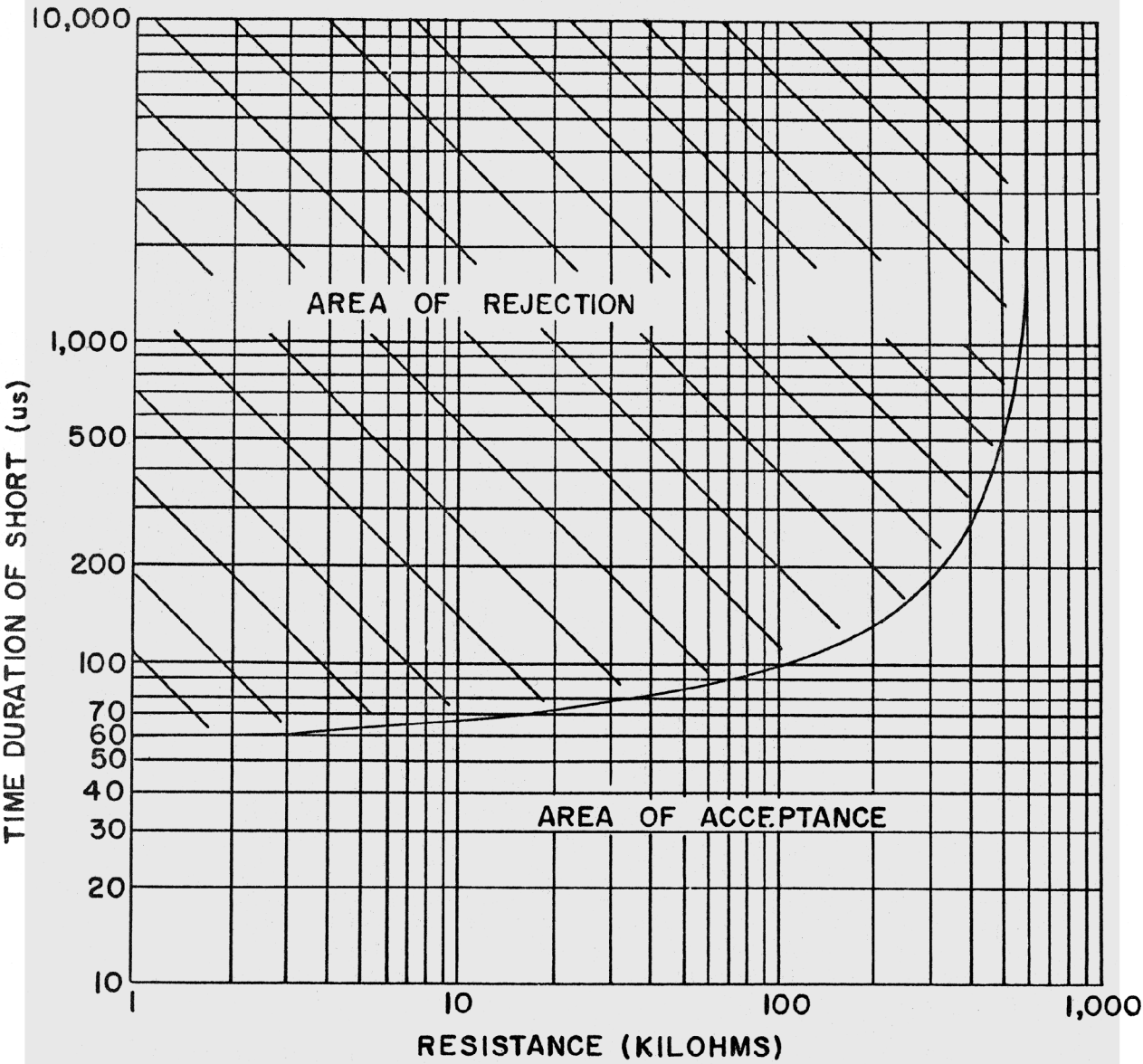


Figure 74 - Resistance versus time duration.

- only to prevent the tube from coming out of the socket. This pressure shall be so applied that it offers negligible restraint to lateral motion at the top of the bulb.
- (b) The tap blows shall be delivered to the tube approximately two-thirds up on the holddown height.
 - (c) The tapping device shall be so designed and adjusted that it will deliver an impulse of approximately one-half sine wave of 300 ± 50 us duration, as measured at 10 percent of the amplitude of the half wave, and have a minimum average amplitude equivalent to 80 G peak acceleration for T-5-1/2 and larger tubes, and 40 G peak acceleration for tubes smaller than the T-5-1/2 bulb size.
 - (d) The tapper impulse shall be measured with a Gulton model A-305 accelerometer, or equivalent, mounted in a standard production type (replaceable cap and clips) T-5-1/2 socket and having no other support. The tap blow shall be delivered to the accelerometer at the approximate midpoint and in a direction parallel to the plane of maximum sensitivity of the accelerometer. The output of the accelerometer shall be coupled through a cathode follower and low-pass filter-amplifier combination to a suitable calibrated oscilloscope. The low-pass filter shall have a minimum high-frequency cutoff at 5,000 cps. (The Gulton KA-1 test set on 5-kc filter position possesses appropriate characteristics.

"4.7.8 Tapping procedure (for other than receiving tubes). The tube shall be mounted in the socket of the short test equipment and tapped three times on each of two planes 90° apart. Sharp blows shall be delivered with a mallet consisting of a $1/8$ inch-diameter fiber rod inserted and glued into the small end of a No. 8 high quality cork $1-1/16$ inches long and having a large diameter of $7/8$ inch and a small diameter of $11/16$ inch. The overall length of rod and cork shall be 6 inches."

Page 41, paragraph 4.9: In the list of tests, delete "Brass or bronze sleeve base" and substitute "Base sleeves".

Page 42, paragraph 4.9.1: At end of paragraph, add "The decision to accept or reject the lot shall be made independently for each degree (major 1, major 2, minor, or control) for which an AQL is designated."

Page 43, paragraph 4.9.4, last sentence: Delete "L-4" and substitute "L-411"; delete "JAN-1-10" and substitute "MIL-I-10".

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Page 43, paragraph 4.9.5.1, third sentence: Delete and substitute "The minimum depth of soldered contacts within the base pins shall be as follows:

<u>Pin size,</u> <u>inch</u>	<u>Minimum penetration,</u> <u>inch</u>
0.093	1/32
0.125	1/32
0.156	1/16
0.187	1/16
Larger than 0.187	3/32"

Page 46, paragraph 4.9.6.3: In heading, delete "for" and substitute "miniature and subminiature"; following second sentence, insert "The tube holder shall be in accordance with Drawing 245-JAN. "; delete fifth sentence; in seventh sentence, delete "cool at" and substitute "return to".

Page 46, paragraph 4.9.7: Delete.

Page 46, paragraph 4.9.8, second sentence: Delete and substitute "After this test, the tubes shall be examined and shall show no mechanical failures, harmful corrosion, loss of plating or paint, or any other defect or deterioration which may interfere with operation."

Page 47: Following paragraph 4.9.12.1, add new paragraph:

"4.9.12.2 Low-pressure voltage breakdown (for cathode-ray tubes). Unless otherwise specified (see 3.9), this test shall be made with the following voltages applied to all base pins, as applicable:

Heater voltage	Nominal rated values
Ehk	Maximum negative
Ecl	Maximum negative
Deflection plate voltages	Maximum Eb2 plus maximum ed
All other voltages	Maximum rated values

NOTE: During the test, each deflection plate individually and one at a time shall be switched from +ed to -ed (maximum) to +ed (maximum). Coronaproof base connectors that do not degrade the tube-voltage-breakdown characteristics shall be employed. With voltages applied, the pressure shall be reduced to specified value and maintained for 60 seconds. Neon light indicators having an approximate 1,000 uAdc sensitivity shall be connected in series with each base electrode for detecting corona or voltage

breakdown. The tube shall be considered satisfactory if no neon indicator light glows during the 60-second period."

Page 49, paragraph 4.9.18, line 4: Following "packaged tube", insert "or packed tubes".

Page 49, paragraph 4.9.18.1.1, lines 4 to 8 inclusive: Delete and substitute "following when specified as production tests (see 3.9): Heater-cathode leakage, plate current, cutoff, power output, transconductance, plate resistance, ac amplification, and conversion transconductance."

Page 52, paragraph 4.9.19.3, next to last line: Following "all", insert "production".

Pages 52 and 53, paragraph 4.9.19.8: Delete and substitute:

"4.9.19.8 Vibration (cathode-ray tubes). Each tube shall be vibrated in positions X_1 and X_2 , and shall withstand, without damage, simple harmonic vibration, at an amplitude of 0.040 ± 0.0025 inch (0.080 ± 0.005 inch total excursion), at a frequency of 25 ± 2 cps for 60 seconds and at a frequency of 50 ± 2 cps for 300 seconds, in each direction. The increase in line width or displacement of the spot due to the relative motion of the tube parts shall not exceed the limit specified. Electrostatic-deflection tubes shall be vibrated with a circular trace adjusted for optimum focus. Magnetic deflection, electrostatic-focus tubes shall be vibrated with a low-intensity optimum-focus spot. Magnetic deflection, magnetic-focus tubes shall be vibrated with a low-intensity spot corresponding to the image of the final aperture.

"4.9.19.9 Sweep-frequency vibration. The tubes shall be fastened rigidly to the vibration platform and vibrated with simple harmonic motion over a frequency range of 50 to 2,000 cps at an acceleration value of 10 G peak. The acceleration over the frequency range shall be within ± 20 percent of the reference acceleration at 100 cps. The frequency shall increase from 50 to 2,000 cps with approximately logarithmic progression and shall require 4 minutes minimum, 5 minutes maximum, to traverse the range. Each tube shall be vibrated in positions X_1 and X_2 , except that if the cumulative result of tests on 50 or more tubes of a given construction shows that more than 75 percent of the tubes have higher output voltages in one position, subsequent measurements need only be taken in the position showing the higher readings.

"4.9.19.9.1 Receiving tubes. Receiving tubes shall be tested as specified in 4.9.19.9 with the specified voltages (see 3.9) applied to the tubes during vibration. The value of Ebb shall be the same as the value of Eb under the test conditions and shall be applied to the tube through the specified resistor, Rp. The value of the alternating voltage, Ep, produced across

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the resistor, R_p , as a result of vibration, shall be measured with a suitable device. This device shall have an appropriate voltage range and shall have the ability to measure, with an error of less than 10 percent, the rms value of a sine wave of voltage at all frequencies from 20 to 20,000 cps, and shall have dynamic response characteristics equivalent to or faster than a VU meter (as described in American Standard C16.5-1954). The value of E_p shall not exceed the limit specified (see 3.9) at any point in the swept frequency range, nor shall this test result in open circuits, permanent shorts, or tap shorts as specified in 4.7.1, 4.7.2, and 4.7.3. For special construction tubes, vibration positions shall be specified on tube specification sheets."

Page 53, paragraph 4.9.20.3, third and fourth sentences: Delete and substitute "The tubes shall be vibrated at a constant amplitude in each of three positions through the frequency range from 10 to 50 cps and back to 10 cps. The time for gradually covering the range from 10 to 50 cps and back to 10 cps shall be 3 to 15 minutes."

Page 54, paragraph 4.9.20.5, item b, line 4: Delete "and 4.7.3, respectively" and substitute "to 4.7.3.2, inclusive."

Page 54, paragraph 4.9.20.6, item a, lines 4 and 5: Delete "and 4.7.3, respectively" and substitute "to 4.7.3.2, inclusive."

Page 54, paragraph 4.9.21: In line 4, delete "3.7.7" and substitute "3.7.9"; delete third and fourth sentences and substitute "While holding the tube in the chamois-covered palm of one hand, and exerting as much pressure as possible with the other hand, the marking shall be rubbed 12 times with a soft chamois."

Page 58, paragraph 4.10.3.3, lines 6 and 7: Delete "an RCA Victor dynamic speaker MI-6234, or equivalent," and substitute "a 7-inch- or 8-inch-diameter speaker having a nominal free-air cone-resonance of 70 cps or lower, and a power rating of 5 watts minimum."

Page 61, paragraph 4.10.4.9, line 2: Delete "(t1)" and substitute "(t1)".

Page 63, paragraph 4.10.6.6, fourth line from bottom: Following "for the", insert "input power or".

Page 63, paragraph 4.10.7.2, equation: Delete " Q^1 " and " Q^2 " and substitute " Q_1 " and " Q_2 ", respectively.

Page 67, paragraph 4.10.13: Delete and substitute:

"4.10.13 Operation of rectifiers. Each tube shall operate satisfactorily and without rejectable arc-backs in a rectifier circuit under the conditions specified. The criteria for rejectable arc-back and their detection shall be as specified in 4.10.13.1 to 4.10.13.3, inclusive, as applicable, or as specified.

When the test conditions specify circuit constants, the dc current in the load resistor shall be within the limits specified. The duration of test shall be sufficient to obtain indication of satisfactory operation. For mercury-vapor rectifiers, the cathode shall be allowed to heat for a period of time sufficient to distribute the mercury properly in the bulb. Inductive loading shall not be used.

"4.10.13.1 Operation of receiving-type rectifiers. In the operation of receiving-type rectifiers, a rejectable arc-back is defined as one which has a peak reverse current which is at least 3.5 times the rated peak steady-state plate current per plate and which occurs after a delay of at least 5 input frequency cycles from the time of application of plate voltage. This delay distinguishes arcs attributable to the tube from those which result from transient instability of the test equipment. The arc-back detector shall have a maximum charging time constant of 0.5 ms, and shall be capable of detecting a single rectangular peak of 0.5 ms duration with an amplitude of 3.5 times the rated peak steady-state plate current per plate. This is not a destructive test.

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"4.10.13.2 Operation of gas rectifiers. In the operation of gas rectifiers, a rejectable arc-back is defined as one which has a current in the reverse direction whose peak value is not less than five times the peak forward anode current obtained during this test. In the test circuit, the source impedance shall be such that the peak value of the steady-state current in the shorting circuit, when all tubes are short circuited, shall be not less than 7.5 times the peak forward anode current obtained during this test. The arc-back detector shall be capable of detecting a rejectable arc current whose duration is 1/4 cycle to 1/2 cycle of the frequency of the applied voltage. Unless otherwise specified (see 3.9), the frequency of operation shall be 60 cps. Qualification samples shall be operated for 1 hour. Unless otherwise specified (see 3.9), rejectable arc-backs do not apply to life tests.

"4.10.13.3 Operation of high-power vacuum rectifiers. In the operation of high-power vacuum rectifiers, a rejectable arc-back is defined as one which has a current in the reverse direction whose peak value is not less than the value specified. In the test circuit, the source impedance shall be such that the peak value of the steady-state current in the shorting circuit, when all tubes are short circuited, shall be not less than the value specified. The arc-back detector shall be capable of detecting a rejectable arc current whose duration is equal to or greater than 1/4 cycle of the frequency of the applied voltage. The frequency of the applied voltage shall be as specified. Qualification samples shall be operated for 1 hour. Unless otherwise specified (see 3.9), rejectable arc-backs do not apply to life tests".

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Page 69, table IV: Delete and substitute:

"Table IV. Connections of electrodes of tubes or sections for measuring direct interelectrode capacitances.

Type of tube unit or section	Capacitance	Measure between	Ground
Indirectly-heated cathode types	Heater-cathode	Heater and cathode	All other elements, shields, metal parts, etc.
Diode	Plate-all	Plate and (cathode + heater + shields + metal parts, etc)	Other units
	Cathode-diode plate	Cathode and (diode plate + heater + shields + metal parts, etc)	Other units
	Coupling (between units).	Diode plate and plate of other unit(s)	All other elements, shields, metal parts, etc
	Coupling (between units)	Diode plate and grid of other unit(s)	All other elements, shields, metal parts, etc
Triode, tetrode, and pentode	Interelectrode (general)	Specified two electrodes of same unit	All other elements, shields metal parts, etc
	Grid-plate	Grid and plate	All other elements, shields, metal parts, etc
	Input	Grid and (cathode + heater + screen + suppressor + shields + metal parts, etc)	Plate, diodes, inactive unit(s)
	Output	Plate and (cathode + heater + screen + suppressor + shields + metal parts, etc)	Grid, diodes, inactive unit(s)
	Coupling (between units)	Grid of one unit and plate of other	All other elements, shields, metal parts, etc

"Table IV. Connections of electrodes of tubes or sections for measuring direct interelectrode capacitances. (Cont'd)

Type of tube unit or section	Capacitance	Measure between	Ground
	Coupling (between units)	Plate of one unit and plate of other	All other elements, shields, metal parts, etc
	Coupling (general)	Electrode of one unit and electrode of other	All other elements, shields, metal parts, etc
	Cathode-plate (grounded grid)	Cathode and plate	All other elements, shields, metal parts, etc
	Input (grounded grid)	Cathode and (grid + heater + screen + suppressor + shields + metal parts, etc)	Plate, diodes, inactive unit(s)
	Output (grounded grid)	Plate and (grid + heater + screen + suppressor + shields + metal parts, etc)	Cathode, diodes, inactive unit(s)
Mixer	Signal grid (1)-plate	Signal grid (1) and plate	All other elements, shields, metal parts, etc
	Signal grid (2)-plate	Signal grid (2) and plate	All other elements, shields, metal parts, etc
	Input (1)	Signal grid (1) and (all other elements, shields, metal parts, etc)	---
	Input (2)	Signal grid (2) and (all other elements, shield, metal parts, etc)	---
	Output	Plate and (all other elements, shields, metal parts, etc)	---

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Table IV. Connections of electrodes of tubes or sections for measuring direct interelectrode capacitance. (Cont'd)

Type of tube unit or section	Capacitance	Measure between	Ground
	Coupling	Signal grid (1) and signal grid (2)	All other elements, shields, metal parts, etc
Converter	Signal grid-mixer plate	Signal grid and mixer plate	All other elements, shields, metal parts, etc
	rf input	Signal grid and (all other elements, shields, metal parts, etc)	---
	Mixer output	Mixer plate and (all other elements, shields, metal parts, etc)	---
	Osc grid-osc plate	Osc grid and osc plate	All other elements, shields, metal parts, etc
	Osc input	Osc grid and (cathode + heater + mixer plate + signal grid + shields + metal parts, etc)	Osc plate
	Osc output	Osc plate and (cathode + heater + mixer plate + signal grid + shields + metal parts, etc)	Osc grid
	Osc input ^{1/}	Osc grid and (all other elements, shields, metal parts, etc)	---
	Osc output ^{1/}	Cathode and (heater + mixer plate + signal grid + osc plate + shields + metal parts, etc)	Osc grid

^{1/}Applies to converters normally operated with rf voltage between cathode and ground.

Table IV. Connections of electrodes of tubes or sections for measuring direct interelectrode capacitance. (Cont'd)

Type of tube unit or section	Capacitance	Measure between	Ground
	Osc grid cathode ^{1/}	Osc grid and cathode	All other elements, shields, metal parts, etc
	Osc grid-mixer plate ^{1/}	Osc grid and mixer plate	All other elements, shields, metal parts, etc
	Osc grid-all except cathode ^{1/}	Osc grid and (mixer plate + signal grid + osc plate + heater + shields + metal parts, etc)	Cathode
	Coupling	Osc grid and signal grid	All other elements, shields, metal parts, etc
	Coupling	Osc plate and signal grid	All other elements, shields, metal parts, etc

^{1/}Applies to converters normally operated with rf voltage between cathode and ground.

Page 73, paragraph 4.10.16.1, line 5: Following "total", insert "power".

Page 76, paragraph 4.11: At end of paragraph, add "Except for stability and survival-rate tests, life tests are considered destructive."

Page 76, paragraph 4.11.1: Add:

"(f) If a minimum envelope temperature is specified, the requirement will be satisfied if a tube having a bogey plate-current value $\pm$ 5 percent under normal test conditions is determined to operate at the minimum specified temperature at any position on a life-test rack. (See 3.9.)"

Page 77, paragraph 4.11.2: Delete and substitute:

"4.11.2 Tubes for life tests^{1/}(see 6.1). The tubes comprising the sample shall be selected at random by the Government throughout the production.

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In the case of expensive devices, by agreement with the Inspectorate, tubes which are rejected for non-relevant parameters e.g. defective plating, mechanical dimensions, face and screen defects etc., can be selected for the sample.

Tubes selected may, at the discretion of the manufacturer, be subjected to any tests on the tube specification sheet. If the tubes are outside the initial specification limits for the chosen tests or if they have mechanical defects, they may, at the discretion of the manufacturer, be replaced by randomly selected good tubes. When tube types submitted under this specification are part of the manufacturer's commercial production and are life-tested by him under the specified conditions and in at least the required quantities, the Government may accept the results of these tests in lieu of the results of the tests specified herein."

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Page 77, paragraph 4.11.3.1, item a, lines 1 and 2: Delete "1 to 1-1/2 hour" and substitute "2 to 20 hours".

Pages 78 and 79, paragraphs 4.11.3.2 to 4.11.3.4, inclusive: Delete and substitute:

"4.11.3.2 Life-test groups A, B, C, and D. The procedures for applicable life-test groups shall be as specified in 4.11.3.2.1 and in the paragraphs listed below:

<u>Group</u>	<u>Paragraphs</u>
A	4.11.3.3 to 4.11.3.3.3, incl
B	4.11.3.4 to 4.11.3.4.2, incl
C	4.11.3.5 to 4.11.3.5.2, incl
D	4.11.3.6 and 4.11.3.6.1

When the tube specification sheet refers to one of the above group letters, the duration of the test and life-test end points (see 4.11.4) will also be specified. The tubes shall be checked (by applying the specified end-point tests) at intervals during the test. The length of these intervals shall be decided by the manufacturer. The total number of tubes placed on life test from the lot shall be considered the life-test sample but, at the discretion of the Government, any tube whose failure is due to test-equipment failure or operator error shall not be considered a failure. Such tubes may be replaced by tubes randomly selected from the same lot. The Government may release tube lots for shipment prior to completion of life test if eligibility for prerelease has been established. When establishing eligibility for prerelease, in those cases where there has been a production discontinuity of both military and commercial production for a period in excess of 12 months, eligibility for prerelease shall be reestablished. When tube types submitted under this specification are part of the manufacturer's commercial production and are tested by him under the life-test conditions specified herein, and in at least the required quantities, the results of these tests may be used to establish eligibility for prerelease of such types.

"4.11.3.2.1 Life-test failure after shipment (groups A, B, C, and D). In the event a life-test sample fails and the lot of tubes represented has been shipped prior to completion of life test, the manufacturer shall

immediately notify the cognizant Government inspector and the contracting officer of the failure and of action taken.

"4.11.3.3 Life-test group A. The number of tubes to be life tested per life-test lot shall be in accordance with the following double-sampling plan (a life-test lot shall be a maximum of 1-week's production):

DOUBLE-SAMPLING PLAN ^{1/}				
	Sample size	Cumulative sample size	Acceptance number	Rejection number
First sample . . .	5	5	1	4 (or 3 inoperatives)
Second sample . .	10	15	3 (2 or less inoperatives)	4 (or 3 inoperatives)

^{1/} The plan applies at the end of the specified life-test period.

"4.11.3.3.1 Establishment of eligibility for prerelease (group A). A minimum number of tubes (excluding second samples) shall have completed the specified life-test duration before the prerelease plan can be used. In order to more rapidly establish eligibility for prereleasing, larger life-test samples may be selected from initial life-test lots in accordance with the following:

- (a) The number of tubes from any lot shall not exceed 10.
- (b) In those cases where more than five tubes are selected, the tubes shall be sequentially numbered and the first five tubes shall be considered the first sample for evaluation of the lot they represent.

"4.11.3.3.2 Release prior to completion of life test (group A). A lot is eligible for shipment prior to completion of life test if the sampling test results meet the requirements in the following prerelease tabulation:

CRITERIA FOR PRERELEASE AT:	ALLOWABLE NUMBER DEFECTIVES AT: ^{1/}				
	TUBE SAMPLE	10% of specified life	30% of specified life	60% of specified life	100% of specified life
10% of specified life	Current 5	0	---	---	---
	Last 30	1	2	3	5
30% of specified life	Current 5	---	0	---	---
	Last 30	---	3	4	5
60% of specified life	Current 5	---	---	1	---
	Last 30	---	---	4	5

^{1/} The requirements of this tabulation are applicable to first sample only.

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The above tabulation is to be interpreted as follows:

<u>Prerelease period</u>	<u>Criteria for prerelease</u>
10 percent of specified life.	1. The five-tube sample from the lot being evaluated shall contain 0 defectives at 10 percent of the specified life-test duration; and 2. The last 30 tubes which have completed 10 percent of the specified life-test duration shall contain not more than 1 defective; and 3. The last 30 tubes which have completed 30 percent of the specified life-test duration shall contain not more than 2 defectives (cumulatively), and 4. The last 30 tubes which have completed 60 percent of the specified life-test duration shall contain not more than 3 defectives (cumulatively), and 5. The last 30 tubes which have completed 100 percent of the specified life-test duration shall contain not more than 5 defectives (cumulatively).
30 percent of specified life.	1. The five-tube sample from the lot being evaluated shall contain 0 defectives at 30 percent of the specified life-test duration; and 2. The last 30 tubes which have completed 30 percent of the specified life-test duration shall contain not more than 3 defectives (cumulatively); and

<u>Prerelease period</u>	<u>Criteria for prerelease</u>
30 percent of specified life. . . .	3. The last 30 tubes which have completed 60 percent of the specified life-test duration shall contain not more than 4 defectives (cumulatively); and 4. The last 30 tubes which have completed 100 percent of the specified life-test duration shall contain not more than 5 defectives (cumulatively).
60 percent of specified life. . . .	1. The five-tube sample from the lot being evaluated shall contain not more than 1 defective (cumulatively) at 60 percent of the specified life-test duration; and 2. The last 30 tubes which have completed 60 percent of the specified life-test duration shall contain not more than 4 defectives (cumulatively); and 3. The last 30 tubes which have completed 100 percent of the specified life-test duration shall contain not more than 5 defectives (cumulatively).

For purposes of prerelease only, the manufacturer shall take readings at the prerelease periods shown in the above tabulation. Readings may be taken on sample tubes 24 hours prior to or 72 hours subsequent to the prerelease period and may be considered as having been read at the prerelease period; however, the full 10 percent of the specified life-test duration shall be completed prior to release at the 10-percent prerelease period.

"4.11.3.3.3 Exceptional life history (group A). In those cases where a tube type shows exceptionally good life history, as determined by compliance with conditions (a) and (b) below, interim readings at 30 percent and 60 percent of specified life may be discontinued, at the option of the manufacturer, and the lot may be released at 10 percent of specified life:

- (a) The five-tube sample from the lot being evaluated shall contain 0 defectives at 10 percent of specified life.

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- (b) The last 30 tubes which have completed 100 percent of the specified life-test duration shall contain not more than 1 defective.

When defectives occur at 10 percent of specified life which make it mathematically impossible for the tube type to meet the 100-percent-of-specified-life criterion in (b) above, prerelease procedures shall revert to those specified in 4.11.3.3.2.

"4.11.3.4 Life-test group B. The number of tubes to be life tested per life-test lot shall be in accordance with the following sampling plan (a life-test lot shall be a maximum of 1-week's production):

$$n_1 = 3 \qquad c_1 = 0$$

$$n_2 = 3 \qquad c_2 = 1$$

except that $c_1 = 1$ if the first sample from the preceding lot contained 0 defectives.

The above plan applies at the end of the specified life-test period.

"4.11.3.4.1 Establishment of eligibility for prerelease (group B). A minimum of 12 tubes shall have completed the specified life-test duration before the prerelease plan can be used. At the option of the manufacturer, in order to more rapidly establish eligibility for prereleasing, larger life-test samples may be selected from life-test lots in accordance with the following:

- (a) The number of tubes from any one lot shall not exceed six.
- (b) In those cases where more than three tubes are selected, the tubes shall be sequentially numbered and the first three tubes shall be considered the first sample for evaluation of the lot they represent; the second three tubes shall be considered as the second sample, when required.

"4.11.3.4.2 Release prior to completion of life test (group B). A lot is eligible for shipment prior to completion of life test if the sampling test results meet the requirements in the following prerelease tabulation:

CRITERIA FOR PRERELEASE AT:	TUBE SAMPLE	ALLOWABLE NUMBER OF DEFECTIVES ^{1/}
10% of specified life	Current 3	0
	Last 18	0
30% of specified life	Current 3	0
	Last 18	2
60% of specified life	Current 3	0
	Last 18	3

^{1/}The requirements of this tabulation are applicable to first sample only.

The above tabulation is to be interpreted as follows:

<u>Prerelease period</u>	<u>Criteria for prerelease</u>
10 percent of specified life.	1. The three-tube sample from the lot being evaluated shall contain 0 defectives at 10 percent of the specified life-test duration; and 2. The last 18 tubes which have started life test shall contain 0 defectives at their present life-test status at the time of prerelease of the current lot.
30 percent of specified life.	1. The three-tube sample from the lot being evaluated shall contain 0 defectives at 30 percent of the specified life-test duration; and 2. The last 18 tubes which have started life test shall contain not more than 2 defectives at their present life-test status at the time of prerelease of the current lot; and 3. That portion of the last 18 tubes which have started but have not completed life test shall contain not more than 1 defective at the time of prerelease of the current lot.
60 percent of specified life.	1. The three-tube sample from the lot being evaluated shall contain 0 defectives at 60 percent of the specified life-test duration; and 2. The last 18 tubes which have started life test shall contain not more than 3 defectives at their present life-test status at the time of prerelease of the current lot; and

Prerelease period

Criteria for prerelease

- 60 percent of specified life. 3. That portion of the last 18 tubes which have started but have not completed life test shall contain not more than 1 defective at the time of prerelease of the current lot.

"4.11.3.5 Life-test group C. The number of tubes to be life tested per life-test lot shall be in accordance with the following sampling plan (a life-test lot shall be a maximum of 1-month's production):

$$n_1 = 4$$

$$c_1 = 1$$

$$n_2 = 4$$

$$c_2 = 2$$

except that $c_1 = 2$ if the first sample from the preceding lot contained 0 defectives.

The above plan applies at the end of the specified life-test period.

"4.11.3.5.1 Establishment of eligibility for prerelease (group C). A minimum of 16 tubes shall have completed the specified life-test duration before the prerelease plan can be used. At the option of the manufacturer, in order to more rapidly establish eligibility for prereleasing, larger life-test samples may be selected from life-test lots in accordance with the following:

- (a) The number of tubes from any one lot shall not exceed 8.
- (b) In those cases where more than four tubes are selected, the tubes shall be sequentially numbered and the first four tubes shall be considered the first sample for evaluation of the lot they represent; the second four tubes shall be considered as the second sample, when required.

"4.11.3.5.2 Release prior to completion of life test (group C). A lot is eligible for shipment prior to completion of life test if the sampling test results meet the requirements in the following prerelease tabulation:

CRITERIA FOR PRERELEASE AT:	TUBE SAMPLE	ALLOWABLE NUMBER OF DEFECTIVES ^{1/}
10% of specified life	Current 4	0
	Last 16	1
30% of specified life	Current 4	0
	Last 16	2
60% of specified life	Current 4	1
	Last 16	3

^{1/} The requirements of this tabulation are applicable to first sample only.

The above tabulation is to be interpreted as follows:

<u>Prerelease period</u>	<u>Criteria for prerelease</u>
10 percent of specified life.	1. The four-tube sample from the lot being evaluated shall contain 0 defectives at 10 percent of the specified life-test duration; and 2. The last 16 tubes which have started life test shall contain not more than 1 defective at their present life-test status at the time of prerelease of the current lot; and 3. That portion of the last 16 tubes which have started but have not completed life test shall contain 0 defectives at the time of prerelease of the current lot.
30 percent of specified life.	1. The four-tube sample from the lot being evaluated shall contain 0 defectives at 30 percent of the specified life-test duration; and 2. The last 16 tubes which have started life test shall contain not more than 2 defectives at their present life-test status at the time of prerelease of the current lot; and 3. That portion of the last 16 tubes which have started but have not completed life test shall contain not more than 1 defective at the time of prerelease of the current lot.
60 percent of specified life.	1. The four-tube sample from the lot being evaluated shall contain not more than 1 defective at 60 percent of the specified life-test duration; and

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2. The last 16 tubes which have started life test shall contain not more than 3 defectives at their present life-test status at the time of prerelease of the current lot; and
3. That portion of the last 16 tubes which have started but have not completed life test shall contain not more than 1 defective at the time of prerelease of the current lot.

"4.11.3.6 Life-test group D. The number of tubes to be life tested shall be not less than one or more than three tubes per month or 1 percent of each month's production, whichever is less. The average life of the sample shall be calculated as follows:

- (a) If the tube successfully completes the number of hours specified (see 3.9), the number of credit hours shall be considered equal to the specified duration of the test.
- (b) If the time of failure of a tube was determined exactly, the number of credit hours shall be equal to the number of hours on life completed before failure.
- (c) If the time of failure of a tube cannot be determined exactly, the number of credit hours shall be computed by one of the following methods, whichever yields the lesser results:
 1. The sum of the hours earned up to the time of the last successful reading plus 10 percent of the life-test duration specified (see 3.9.)
 2. The number of hours midway between the time of the last successful reading to the time of the first unsuccessful reading.

The average life of the sample shall be the average of the hours credited to the individual tubes in that sample. Unless otherwise specified (see 3.9), at the conclusion of the time specified for the life test, the average life of the sample shall be not less than 80 percent of the duration of the test.

"4.11.3.6.1 Release prior to completion of life test (group D). A lot is eligible for shipment prior to completion of life test if the completed life-test samples immediately preceding the current samples meet the requirements listed below, and the current uncompleted life-test samples shall not have failed at this time. An uncompleted life-test sample shall be considered unsatisfactory for prerelease if it is mathematically impossible for it to qualify in accordance with 4.11.3.6 when considering only those tubes which are initially subjected to life test.

<u>Prerelease period</u>	<u>Criteria for prerelease</u>
10 percent of specified life	1. If the last seven completed samples passed; or 2. If not more than 1 of the last 17 completed samples failed.
30 percent of specified life	1. If the last five completed samples passed; or 2. If not more than 1 of the last 14 completed samples failed.
60 percent of specified life	1. If the last three completed samples passed; or 2. If not more than 1 of the last 10 completed samples failed.
80 percent of specified life	None

Page 80, paragraph 4.12, line 2: Delete "4.12.14" and substitute "4.12.15".

Page 81, paragraph 4.12.2.2 equation: Delete "(condition A" and substitute "(condition A)".

Page 82, paragraph 4.12.4.3: Delete.

Page 84, paragraph 4.12.6.2, third sentence: Delete and substitute "Unless otherwise specified (see 3.9), standard focusing coil JEDEC No. 106 and deflection yoke JEDEC No. 120, or equivalent, shall be used. The distance (D) from center of focus coil air gap to reference line shall be as specified."

Page 85, paragraph 4.12.10: At end of paragraph, add: "Unless otherwise specified (see 3.9), for magnetic deflection types, deflection yoke JEDEC No. 120, or equivalent, shall be used."

Page 85, paragraph 4.12.10.3, lines 1 and 2: Delete "JAN standard coil No. 20" and substitute "Standard focusing coil JEDEC No. 106,"

Page 85, paragraphs 4.12.11 and 4.12.12: Delete and substitute:

"4.12.11 Deflection factor. With the test conditions specified, the deflection factor (the ratio of the deflecting voltage to the corresponding deflection in inches as determined on each axis by deflecting the beam from a position $\frac{3}{4}$ useful scan radius, left or up from center, to a position $\frac{3}{4}$ useful scan radius, right or down from center, shall be within the limits specified.

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"4.12.12 Deflection-factor uniformity. The deflection-factor uniformity on each deflection axis shall be determined. For any axis, the deflection factors corresponding to 25 percent and 75 percent of the minimum useful scan radius shall be measured from center of useful scan along the tube-face contour. Measurements on each axis shall be made on both sides from the center. The factor at 25-percent deflection shall not differ from the factor at 75-percent deflection, on the same side of the center of the useful scan, by more than 5 percent."

Page 85: Following paragraph 4.12.14, add new paragraph:

"4.12.15 Interaction factor (for multigun cathode-ray tubes). The deflection per unit volt of the beam generated by an electron gun at any position of that beam within its useful scan, when a balanced voltage of at least 300 vdc is applied to the 1D2 deflection electrodes of all of the other electron guns, shall be not greater than the value specified. Each electron gun shall be subjected to this test."

Page 97, paragraph 4.17.2.3, table IXa: Delete and substitute:

"Table IXa. Bandwidth limits (angstroms).

Spectral response symbol	Spectral response					
	100%		10% short wave		10% long wave	
	Min	Max	Min	Max	Min	Max
S1	6,500	8,500	2,700	3,300	9,000	12,400
S4	3,500	4,500	2,700	3,300	5,800	6,400
S10	4,200	4,800	3,050	3,350	6,600	7,300
S11	3,900	4,900	3,000	3,500	5,850	6,400

Page 97, paragraph 4.17.2.3, sixth line from bottom: Delete "S4 and S11" and substitute "S1, S4, S10, and S11,".

Page 105 and 106, paragraph 4.18.21.1, line 38: Delete "returned" and substitute "retuned".

Page 107, paragraph 4.18.23, third line from bottom: Delete "standing" and substitute "standard".

Page 113, paragraph 6.1: Add:

"(d) Tubes used for life tests shall be in addition to the quantity to be delivered (see 4.11.2.)".

Page 113, paragraphs 6.2 and 6.2.1: Delete and substitute:

"6.2 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Bureau of Ships; however, information pertaining to qualification of products may be obtained from the Armed Services Electro-Standards Agency (ASESA), Fort Monmouth, N. J."

Page 114, paragraph 6.5.1.1: Delete and substitute:

"6.5.1.1 Plate voltage. Unless otherwise specified, the average plate voltage (averaging from 0.1 second) should not exceed the maximum rated dc plate voltage; and the peak positive plate voltage should not exceed twice the maximum rated dc plate voltage (see 3.9.)"

Page 114, paragraph 6.5.1.2, items b and c: Delete and substitute:

- "(b) The plate voltage rating is greater than the screen voltage rating.
- "(c) The average screen dissipation does not exceed values given by the following formula:

$$Pg2 = Pg2 \text{ (max rating)} \left[1 - \left(\frac{Ec2 - Ec2 \text{ (max rating)}}{Eb \text{ (max rating)} - Ec2 \text{ (max rating)}} \right)^2 \right]$$

This formula applies when the average screen voltage is between the maximum rated dc screen voltage and the maximum rated dc plate voltage."

Page 114: Following paragraph 6.6, add new paragraph:

"6.7 International standardization agreements. Certain provisions of this specification are the subject of international standardization agreement. When amendment, revision, or cancellation of this specification is proposed, the departmental custodians will inform their respective Departmental Standardization Offices so that appropriate action may be taken respecting the international agreement concerned."

Page 114, other interests, including listing: Delete in its entirety and substitute "International interest (see section 6)".

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Page 115, appendix A: In the title, delete "and correlation".

Page 116, appendix A, paragraph 20.4: Insert "Reliable20" as the first item of the group listing for number of specimens required.

Page 117, appendix A, paragraph 30.2.1, last sentence: Following "all", insert "electrical".

Page 117, appendix A, paragraph 40.1, lines 1 and 2: Delete "3.7.7, inclusive," and substitute "3.7.6, inclusive, 3.7.8 and 3.7.9".

Page 118, appendix A, paragraph 60.1.1.1: Delete.

Pages 118 to 120, inclusive, appendix A: Delete tables X to XVIII, inclusive; following table XVIII, delete "POWER AND GAS TUBES (see 60.1.1.1 of this appendix)".

Page 122, appendix B, paragraph 30.1.1: In line 2 of definition for "cord", delete "other"; in line 2 of definition for "glass adhered", delete "outside".

Page 127, appendix B, paragraph 30.1.8: At the end of paragraph, add "This does not include surface checks or cracks, due to impact, that are less than 0.04 inch in the largest surface dimension."

Page 129, appendix B, paragraph 30.3.6.2, line 4: Following "posed", insert "beyond".

Page 129, appendix B, paragraph 30.3.6.4: Delete.

Page 130, appendix B, paragraph 30.5.4: In heading, delete "flash" and substitute "area"; following "flashed", add ", getter missing or detached".

Page 130, appendix B, paragraph 30.5.6: At end of paragraph, add "For reliable subminiature receiving tubes, see 40.4.2 of this appendix. For reliable miniature receiving tubes, see 70.4.4 of this appendix."

Page 131, appendix B, paragraph 30.5.6.1, lines 4 and 5: Beginning with "following", delete remainder of paragraph and substitute "particles-indicator test specified in 30.5.6.5 of this appendix."

Page 131, appendix B, paragraph 30.5.6.4, lines 9 and 10: Beginning with "short-", delete remainder of paragraph and substitute "particles-indicator test specified in 30.5.6.5 of this appendix Major 2".

Page 131, appendix B: Following paragraph 30.5.6.4, add new paragraph:

"30.5.6.5 Particles-indicator test. After preheating at rated Ef, tubes shall be tested with the heater energized in a particles tester. The indicator

shall have sensitivity as defined in 4.7.7. The tube shall be tapped 12 times with an average blow of 25 G, measured with a Gulton model A-303 accelerometer, or equivalent, 300 us minimum time duration, throughout the following movements:

- (a) With the tube in a vertical position, rotate the main axis through a vertical plane to the inverted position and return.
- (b) Rotate the tube about its main axis for a minimum of 180° and return. (If not simultaneous with motion (a), the main axis shall be horizontal.)

Each tube in the sample shall be subjected to one test cycle as specified. Any short indication shall be considered a major 2 defect."

Page 133, appendix B, paragraph 40.1: Add "40.4.1.1" to a listing of paragraphs requiring ten-power magnification.

Page 134, appendix B: Following paragraph 40.4.1, add new paragraph:

"40.4.1.1 Weldments (detached). Weldments that become detached Major 1"

Page 134, appendix B, paragraph 40.4.2.1: In line 2, delete "40.4.2.4" and substitute "40.4.2.5"; in third line from bottom, delete "40.4.2.4" and substitute "40.4.2.5".

Page 134, appendix B, paragraph 40.4.2.1, lines 15 and 16: Beginning with "short-", delete remainder of paragraph and substitute "particles-indicator test specified in 30.5.6.5 of this appendix."

Page 134, appendix B, paragraph 40.4.2.4, lines 9 and 10: Beginning with "short-", delete remainder of paragraph and substitute "particles-indicator test specified in 30.5.6.5 of this appendix Major 2".

Page 135, appendix B, paragraph 50.2.1, definition for bright spot: In line 1, delete "or point source"; at end of paragraph, add "Its color need not be the same as that of the surrounding area."

Page 135, appendix B, paragraph 50.2.1, definition for color spot: Delete and substitute:

"Color spot. A small area which is noticeably discolored and which has a fluorescent or phosphorescent intensity substantially different from the surrounding area but not within the limits of dead or bright spots."

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Page 135, appendix B, paragraph 50.2.1: Add following definitions:

"Bruise or bruise check. Fissures caused by impact.

"Bulls-eye top. A lens effect occurring on the closed end of the bulb.

"Carbonized mold (or plunger). Minute irregular depressions disturbing the intended surface.

"Chill wrinkle. Fine ripples or waves on the surface of the glass.

"Cold glass. Small particles of glass which cling loosely to the main surface of the glass by electrostatic charge or moisture.

"Impact mark (outside surface). A hazy area resulting from the molten glass contacting the mold parts.

"Lap. A fold in the surface.

"Loading mark. Minute variable indentations on the surface of the glass normally caused by air.

"Mold mark. A mark on the surface of the glass resulting from imperfections on the surface of the molding equipment.

"Oil spot. A spot usually circular and hazy with a mottled surface caused by the reduction of oil to carbon on the molding equipment.

"Rust, rouge, or scale. Small particles of contamination adhered to or embedded in the surface of the glass.

"Spew. A streak of finely divided foreign material or small seeds in the glass or on the surface.

"Suck-up. A departure from the intended shape resulting from a change in glass distribution when the plunger is removed."

Page 136, appendix B, table XXVII, third and fourth lines from the bottom: Delete "Shear mark 2" and "Scum or".

Page 136, appendix B, paragraph 50.2.3.1.2, item a: After "inch", insert "or less".

Page 137, appendix B, paragraph 50.2.3.1.3: Add at the end of heading, "of spot defects."

Page 138, appendix B, paragraph 50.2.3.6, line 3: Following "in the", insert "useful".

Page 140, appendix B: Following paragraph 60.2.3, add new paragraphs:

"70. CRITERIA FOR INSPECTION OF RELIABLE MINIATURE RECEIVING TUBES

"70.1 Instructions. The criteria of 10 to 30.8.1, inclusive, of this appendix shall be applicable, except as modified herein. Inspection shall be in accordance with inspection level I of Standard MIL-STD-105. Internal and external defects shall be combined. Ten-power magnification shall be used in examining tubes for the defects described in the following paragraphs of this appendix:

30.5.1	70.2.3	70.4.3	70.4.5
30.5.2	70.4.1	70.4.4.2	70.4.7
70.2.1	70.4.1.1	70.4.4.3	70.4.8.1
70.2.2	70.4.2	70.4.4.4	70.4.8.2

Debatable tubes (tubes which cannot be determined to conform to any criteria of 30.1.4 to 30.1.11.2, inclusive, 70.2.1, and 70.4.5 of this appendix) shall be subjected to the glass-strain test specified in 4.9.6.3. A tube passing the glass-strain test shall be considered acceptable under the visual-inspection paragraph for which the tube was originally questioned. A tube failing the glass-strain test shall be classified a defect under the visual-inspection paragraph for which the tube was originally questioned.

"70.2 Glass envelopes.

"70.2.1 Chipped-out section on external surface of glass. Any chips deeper than 0.010 inch or greater than 1-1/2 mm in maximum dimension on the straight portion of the bulb, or on the header Minor

"70.2.2 Re-entrant (sucked-in) exhaust tip. Re-entrant depth greater than one-third of the tip diameter Minor

"70.2.3 Blisters in dumet seal. Total length of blister-free seal less than twice the dumet-wire diameter Minor

"70.3 Leads.

"70.3.1 Missing pins. Any missing pins Major 1

"70.4 Internal mechanical structure.

"70.4.1 Welds. Either element of a weldment reduced by more than one-half its formed cross-sectional area, or splash from weld present on any element other than in original weld area Control

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"70.4.1.1 Weldments (detached). Weldments that become detached Major 1

"70.4.2 Spacing. Spacing less than 0.010 inch between elements, supports, etc. outside of the mica spacers, except where specifically intended by design Minor

"70.4.3 Cathode tabs. Any evidence of tear or crack in cathode tab occurring below the cathode weld Minor

"70.4.4 Loose particles.

"70.4.4.1 Instructions. The requirements of 70.4.4.1 to 70.4.4.4, inclusive, of this appendix supersede those of 30.5.6 to 30.5.6.3, inclusive, of this appendix. All tubes shall be tapped in an upright position by a standard tube tapper. Immediately after tapping, the tube shall be visually inspected for loose particles as specified in 70.4.4.2 to 70.4.4.4, inclusive, of this appendix. The tube shall be rotated about its main axis in a horizontal position while the tube is under visual observation. Following the visual inspection, all tubes in the sample shall be subjected to the particles-indicator test specified in 30.5.6.5 of this appendix.

"70.4.4.2 Loose particles that by visual inspection can be determined to be of a nonconducting nature. Particles with a maximum dimension greater than 1/16 inch. Debatable tubes shall remain in the sample and shall be subjected to the remaining test Minor

"70.4.4.3 Loose particles that by visual inspection can be determined to be of a conducting nature. Loose (non-adhering, free to roll or tumble) conducting particles, the largest dimension of which is greater than 1/64 inch. Debatable tubes shall remain in the sample and shall be subjected to the remaining tests Major 2

"70.4.4.4 Dangling particles or slivers. Dangling particles or slivers which are firmly attached shall be accepted. Debatable tubes shall be subjected to the particles-indicator test specified in 30.5.6.5 of this appendix. The tube shall be considered acceptable if the particle is still attached at the conclusion of the particles-indicator test Major 2

"70.4.5 Metal touching bulb. All instances of metal parts or particles touching the bulb, as identified by a white spot or check appearing in the glass (unless specifically intended by design) Major 1

"70.4.6 Missing point on mica. More than 25 percent of mica points missing on any mica that supports the tube structure Control

"70.4.7 Mica coating. Clear mica path connecting any two adjacent elements exceeding in width the dimension of the smaller element (where coating is intended) Minor

"70.4.8 Heater-coating defects.

"70.4.8.1 Chipped or cracked coating. Heater coating on heater or on heater legs, missing or damaged so as to expose bare heater wire within 0.020 inch of entrance to cathode sleeve Minor

"70.4.8.2 Uncoated heater wire.

- (a) Uncoated heater wire exceeding 1/16 inch, measured from perimeter of weld toward the cathode Minor
- (b) Uncoated heater wire exceeding coated-heater-wire diameter beyond 0.020 inch from ends of cathode sleeve... Control

"70.4.9 Getter defects.

"70.4.9.1 Getter peel. Peeled or blistered larger than 1/32 inch in longest dimensions Minor

"70.4.9.2 Getter area. Getter flash covers an area less than 1/16 square inch Minor

"70.4.9.3 Burned getter. Getter burned through Major 2."

Pages 141 and 142, appendix C, tables XXXIII and XXXIV: Delete rejection number "0" and substitute "---".

Page 144, appendix C, paragraph 20.2.5.1, items d to g, inclusive. Delete and substitute:

"(d) The regular stability-life-test sample shall be operated at the specified stability-life-test conditions (see 3.9), or equivalent, for 20 ± 4 hours with an intermediate down-period reading point at 2 hours $\pm$ 30 minutes. (Intermittent or continuous operation may be employed.) The regular stability-life test shall be in effect initially and shall continue in effect until the eligibility criteria for the reduced-hours stability-life test have been met.

"(e) Reduced-hours stability-life test.

1. Eligibility for reduced-hours stability-life test shall be as follows: No lot failure due to the regular stability-life test has occurred in the preceding five consecutive lots.
2. Reduced-hours stability-life test shall be conducted for 2 hours $\pm$ 30 minutes. Acceptance shall be based on the stability-life-test end-point limit. One lot failing the reduced-hours stability-life test shall result in loss of eligibility for the reduced-hours stability-life test.
3. The stability-life-test sample from the first lot accepted each month shall continue on stability-life test to the 20 ± 4

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hours duration. Failure of this sample to meet the regular stability-life-test end-point limit shall result in loss of eligibility for the reduced-hours stability-life test.

- "(f) Life test shall be conducted as specified in 4.11.1, except that the mean electrode potentials (except heater or filament) may be established at values differing by not more than 5 percent from the specified values, provided the same average electrode dissipations are obtained that occur with the specified voltages. (See 3.9.) Fluctuations of all voltages, including heater or filament voltage, shall be as small as practicable.
- "(g) Record measurements of the specified characteristics at the specified reading periods. The measurements shall be taken immediately following the specified reading periods, or the tubes shall be preheated a maximum of 15 minutes under specified voltage and current conditions, and the characteristics immediately measured following the specified reading periods. (See 3.9.)
- "(h) A defective shall be defined as a tube having a change in the specified characteristic greater than that specified (see 3.9.).
- "(i) A resubmitted lot shall be subjected to all measurements-acceptance tests except mechanical inspection, capacitance, vibration, and low-pressure voltage-breakdown tests."

Page 149, appendix C: Following paragraph 20.3.1.2, add new paragraph:

"20.3.1.3 Reduced inspection. Reduced inspection procedure R-1 and inspection level L4 of Standard MIL-STD-105 shall apply. (This sampling provides inspection procedures equivalent to those formerly contained in the Inspection Instructions for Electron Tubes for lot sizes up to and including 500 units.)"

Page 152, appendix D, figure 62: Delete standard base-pin-alinement gage GA4-4.

Page 184, index, line 2: Delete "and correlation Appendix A".

Custodians:

Army - Signal Corps
Navy - Bureau of Ships
Air Force

Preparing activity:

Navy - Ships
(Project 5960-0993)

International interest (see section 6)