

MINISTRY OF AVIATION D.L.R.D./R.A.E.

SPECIFICATION M.O.A./CV.2519 Incorporating MIL-E-1/160 H. ISSUE 4A Dated 1.2.63 To be read in conjunction with K.1006	<u>SECURITY</u>	
	<u>SPECIFICATION</u>	<u>VALVE</u>
	Unclassified	Unclassified

TYPE OF VALVE: Power Tetrode - External Anode CATHODE: Indirectly Heated ENVELOPE: Glass Metal Construction PROTOTYPE: 4X150A	<u>MARKING</u>	
	See K1001/4	
	<u>BASE</u>	
	See Drawing on Page 7 BS.448/B&F	
<u>RATINGS AND CHARACTERISTICS</u> (All limiting values are absolute)		
	<u>CONNECTIONS</u>	
	<u>PIN</u>	<u>ELECTRODE</u>
	1	Screen g2
	2	Cathode k
	3	Heater h
	4	Cathode k
	5	Int. Con. IC
	6	Cathode k
	7	Heater h
	8	Cathode k
	Centre Pin	Con. Grid g1
	Cooling Fin	Anode a
<u>NOTES</u>		
Heater Voltage (V)	6.0	
Heater Current (A)	2.6	
Max. Negative Control Grid Volts (V)	250	
Max. Input Control Grid (W)	2	
Max. Heater Cath. Voltage (V)	+150	
Max. Anode Core Temp. (°C)	250	A
Max. Anode Seal Temp. (°C)	200	A
Max. Base Seal Temp. (°C)	175	A
Max. Altitude (ft)	10,000	
Min. Cathode Heating Period (Secs)	30	
<u>Class A B Audio</u>		
Max. Anode Voltage (kV)	2	
Max. Anode Dissipation (W)	250	
Max. Anode Input (W)	500	
Max. Anode Current (mA)	250	
Max. Voltage Screen Grid (V)	400	
Max. Screen Dissipation (W)	12	
<u>Class C Telephony</u>		
Max. Anode Voltage (Up to 150 Mc/s) (kV)	1.6	
Max. Anode Input (Up to 150 Mc/s) (W)	320	
Max. Anode Volts (Between 150 and 500 Mc/s) (kV)	1	
Max. Anode Input (Between 150 and 500 Mc/s) (W)	200	
Max. Anode Dissipation (W)	165	
Max. Voltage Screen Grid (V)	300	
Max. Screen Dissipation (W)	10	
Max. Anode Current (mA)	200	
<u>DIMENSIONS</u>		
See Drawing on Page 7		

(163726)

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RATINGS AND CHARACTERISTICS (Contd.)

<u>Class C Telegraphy</u>		
Max. Anode Voltage (Up to 150 Mc/s)	(kV)	2
Max. Anode Input (Up to 150 Mc/s)	(W)	500
Max. Anode Volts (Between 150 and 500 Mc/s)	(kV)	1.25
Max. Anode Input (Between 150 and 500 Mc/s)	(W)	312
Max. Anode Dissipation	(W)	250
Max. Voltage Screen	(V)	300
Max. Screen Dissipation	(W)	12
Max. Anode Current	(mA)	250
<u>CAPACITANCES (pf)</u>		
C in (Nom.)		15.25
C out (Nom.)		4.4
Cagl (Max.)		0.05
<u>NOTES</u>		
A. See Note 1 on Page 4		
B. <u>For Information.</u> This specification contains the requirements of Military Specification MIL-E-1/160H plus some agreed United Kingdom modifications shown arrowed.		
C. The Joint Services Catalogue Number is 5960-99-000-2519.		
<u>TESTS</u>		
The Data and Tests for Valve Type CV.2519 Pages 1 to 9) shall apply.		

CV2519 CV3991

MILITARY SPECIFICATION SHEET

ELECTRON TUBE, TRANSMITTING TETRODE, EXTERNAL ANODE
CV2519 (JAN 4X150A) CV3991 (JAN 4X150D)

Specification M.O.A./CV.2519
ISSUE 4A dated 1.2.63
and Specification M.O.A./CV.3991
ISSUE 2A dated 1.2.63
Incorporating Military
Specification MIL-E-1/160H
dated 8.9.60
Prepared by:
Ministry of Aviation
Royal Aircraft Establishment.

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

DESCRIPTION: Radial-Beam power amplifier or oscillator
F₁ = 150 Mc

ABSOLUTE MAXIMUM RATINGS

Parameter:	Ef	Eb	Ec1	Ec2	Ehk	Ib	Pg1	Pg2	Pp	Pi	(Base Seal)	(Anode Seal)	(Anode Core)	tk	Alt
Unit:	Vac	Vdc	Vdc	Vdc	Vdc	mA	W	W	W	W	°C	°C	°C	sec	ft
AB Audio	Note 2	2000	-250	400	+150	250	2	12	250	500	Note 1	Note 1	Note 1	min	
C Tel. (Up to 150 Mc)	Note 2	1600	-250	300	+150	200	2	10	165	320	175	200	250	30	10000
C Tel. (150 to 500 Mc)	Note 2	1000	-250	300	+150	200	2	10	165	200	175	200	250	30	10000
C Flg. (Up to 150 Mc)	Note 2	2000	-250	300	+150	250	2	12	250	500	175	200	250	30	10000
C Flg. (150 to 500 Mc)	Note 2	1250	-250	300	+150	250	2	12	250	312	175	200	250	30	10000

TEST CONDITIONS:

CV2519(4X150A)	6.0	2000	Ajust	300	0	150	-	-	-	-	Note 3	-	-	120	-
CV3991(4X150D)	26.5	2000	Ajust	300	0	150	-	-	-	-	Note 3	-	-	120	-

BASE: See Fig. 1

DIMENSIONS: See Fig. 1

PIN NUMBER: 1 2 3 4 5 6 7 8 Centrepin Radiator Ring terminal
ELEMENT: g2 k h k k Int Con. k h k g1 p g2

Para. No.			AQL(Percent Defective)	Insp. Level or Code	SYMBOL	LIMIT		Units
						Min.	Max.	
3.1	GENERAL qualification	Required for JAN marking	-	-	-	-	-	-
3.6	Performance Cathode	See Note 4 Coated unipotential	-	-	-	-	-	-
3.4.3	Qualification inspection (See Note 5) Base connections Pressure Drop	No voltages (see Note 6)	-	-	-	-	0.60	ins. of water
4.10.2.2	Power oscillation(1)	F = 150 Mc.min. Ec1 = -90 Vdc. Ic1 = 25 mA d.c. max. Eg1/Ib = 250 mA dc Note 28	-	-	Po	225	-	W (Useful)
-	Cooling	Eb = 1000 Vdc Ec1/Ib = 250 mA d.c. Note 7	-	-	T(anode core)	-	175	°C
-			-	-	T(anode seal)	-	150	°C
-			-	-	T(base seal)	-	125	°C
-	Overload	Eb = 1000 Vdc Note 8	-	-	-	-	-	-

CV.2519/4A/1
CV.3991/2A/1

CV2519
CV3991

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Para. No.	Test	Conditions	AQL(Percent Defective)	Insp.Level or Code	Symbol	LIMITS		Units
						Min.	Max.	
-	Overload End Point Resonance Search	Total grid current E _f = 6.3V E _{c1} = -90 Vdc E _{c2} + k = 0 = E. Peak Acc. = 1.1g + 0.1g Freq. Range = 100 ⁺ c/s to 1kc/s Notes 18, 19, 20, 22	-	-	Ic1	-	-25 Note 23	μAdc
<u>Acceptance Inspection part 1 (production) (See Notes 9 & 24)</u>								
4.10.1.5	Pulsing emission	eb = ec1 = ec2 = 850V Note 10	0.65	II	1S	30	-	a
4.10.4.3	Screen-grid current	Eb = 1000 Vdc	0.65	II	Ic2	-5	+3	mAdc
4.10.5.2	Grid Voltage	Eb = 1000 Vdc	0.65	II	Ec1	-32	-45	Vdc
4.10.6.1	Total grid current	Ib = 125 mAdc.	0.65	II	Ic1	-	-15	μAdc
-	Positive grid-current division	Eb = Ec2 = 250 Vdc Ec1 = -100 Vdc, ec1/ib = 1.0 a pr = 11.0 + 1.0, tp = 4500 μSec. min. Note 11	0.65	II	ec1 ic1 ic2	8 - -	18 250 260	v ma ma
4.10.6.6	Primary grid emission (control)	Ic1 = 70mAdc, t = 15 plate and screen grid floating.	0.65	II	Isg1	-	-25	μAdc
4.10.6.6	Primary grid emission (screen)	Ec1 = 0 Vdc, IC2 = 100 mA d.c. t = 15, plate floating	0.65	II	Isg2	-	-250	μAdc
4.10.8	Heater Current	CV2519 CV3991	0.65 0.65	II II	If If	2.30 0.50	2.90 0.62	Ao.c Ao.c
	Shorts Test (warm-up)	The valves shall be tested for short-circuits between control grid, cathode and screen grid during the warm-up period of 120 secs. after application of heater voltage. Note 22		100%			Note 23	
<u>Acceptance Inspection part 2(design)</u>								
4.9.19.1	Low-frequency vibration	No voltages	6.5	L6	-	-	-	-
-	Resonance Search	No voltages Min. Peak Acc. = 1g. Freq. Range = 500 c/s to 1kc/s Notes 18, 20, 21, 22	6.5	II	-	-	Note 23	-
4.9.19.3	Bump	Angle = 20°	6.5	L6	-	-	-	-
4.10.15	Heater-cathode Leakage	Ehk = +150 Vdc Ehk = -150 Vdc.	6.5	L6	Ihk Ihk	- -	150 150	μAdc μAdc

Para. No.	Test	Conditions	AQL (Percent Defective)	Insp. Level or Code	Symbol	LIMITS		Units
						Min.	Max.	
-	Control Grid lug bending test	Note 12	6.5	L6	-	-	-	-
4.10.2.2	Power Oscillation Test	Class C amplifier F = 460 - 490 Mc/s Eb = 1250 Vdc Ec1 = -90 Vdc Ec2 = 250 to 300 Vdc Max. Ic1 = 20 mA d.c. Eg1/IB = 250mA d.c. Ef = (CV2519 = 5.5 Va.c. (CV3991 = 24.3 Va.c. Note 13	6.5	L6	Po	14.5	-	W (useful)
4.10.14	Direct-interelectrode capacitance	EIA standard shield Nos. 320 and 321, or equivalent.	6.5	L6	(Cgp (Cin (Cout	- 14.5 4.0	0.05 17.0 4.8	μ F μ F μ F
<u>Acceptance Inspection Part 3 (life)</u>								
4.11	Life test (1)	Group C: power oscillation (2)	-	-	t	500	-	hr
4.11.4	Life test 1 end points	Pulse emission Primary grid emission Primary screen grid emission Heater cathode leakage Ehk = +150 Vdc Ehk = -150 Vdc	- - - - -	- - - - -	is Isg1 Isg2 Ihk Ihk	21 - - - -	- -100 -250 150 150	μ Adc μ Adc μ Adc μ Adc μ Adc
4.11	Life test (2)	Group C Ec1 = Ec2 = Eb = 0 Vdc Ef = (CV2519 = 6.6 Vac (CV3991 = 29.1 Vac	-	-	t t	500 500	- -	hr hr
4.11.4	Life Test (2) end point	Note 14	-	-	Rglg2 Rg2k Rglk	10 10 10	- - -	Meg Meg Meg
4.11	Life test (3)	Group D: power oscillation (1)	-	-	t	500	-	hr.
4.11.4	Life test (3) end points	Pulse emission Primary grid emission Primary screen grid emission Heater-cathode leakage Ehk = +150 Vdc Ehk = -150 Vdc	- - - - -	- - - - -	is Isg1 Isg2 Ihk Ihk	21 - - - -	-100 -250 150 150	μ Adc μ Adc μ Adc μ Adc μ Adc
-	Shelf life	No voltages applied Note 24	-	100%	t	12 (Note 25)	-	weeks
-	Shelf life test end points.	Pulse emission	-	-	is	30 (Note 26)	-	a
4.10.6.1	Total grid current	Required	-	-	Ic1	-	5.0 (Note 27)	μ Adc
4.9.18	Container drop	Required	-	-	-	-	-	-
4.9.18.1.7	Preparation for-delivery	Note 15	-	-	-	-	-	-

NOTES:

- When the tube is operated at 100 percent of maximum rated plate dissipation at an incoming air temperature of 25°C maximum, a minimum air flow of 5.6 cubic feet per minute (cfm) at sea level shall pass through the anode cooler. The static pressure drop across the anode cooler at this flow is approximately 0.26 inch of water. If the socket on Drawing 246-JAN is used, an incoming air flow of 5.6 cfm to the grid of the socket is required. At this flow of 5.6 cfm, the static pressure drop directly across the tube and socket is approximately 0.60 inch of water. This pressure drop varies with the amount of escaping air and with the shape and construction of the air director. The air flow rating applies at bias voltages less than 100 volts and frequencies less than 500 mc. Air cooling of the tube shall be increased with increased negative grid bias, increased incoming air temperatures, or increased frequency of operation, or a combination. In all cases of operation, a socket which provides forced air cooling of the base shall be used and maximum seal and radiator temperature ratings shall not be exceeded. The air flow shall be applied before or simultaneously with electrode voltages, and may be removed simultaneously with them.
- The filament voltage for CV2519 is 6.3Vac^{+10%} & 26.5V^{+10%} for CV3991. Maximum life may be obtained by adjusting the heater voltage in accordance with the application. A table of heater voltage versus frequency is presented as a guide.

Frequency (Mc)	Ef(Vac)	
	CV.2519	CV.3991
Up to 300	6.00	26.5
301 to 400	5.75	25.5
401 to 500	5.50	24.3

- In all cases of electrical tests involving application of heater voltage, the socket on Drawing 246-JAN, or equivalent, shall be used. An incoming air flow of 6.0 cfm maximum to the grid end of the socket is permitted.
- All tests listed in 3.6 are applicable, except 4.6.1, 4.8, 4.9.1.1, 4.9.2.1, 4.9.3, 4.9.8, 4.9.20.1, 4.9.20.2 and 60.1 of Appendix B.
- All tests listed hereon shall be performed during qualification inspection; however, these tests are normally performed during qualification inspection only.
- An infinite baffle system as shown in figure 2, or equivalent, with an air flow of 5.6 cfm at sea level shall be used. The static pressure drop is measured across the tube and socket.
- The cooling test shall be made as follows:

At an ambient temperature of 25°C, both the base and the anode shall be cooled by applying an air flow of 5.6 cfm maximum, at sea level from a single source using the infinite baffle system as shown on figure 2, or equivalent.

At the specified conditions, the anode core temperature, anode seal temperature, and the base seal temperature shall not exceed the specified limits.

All temperatures shall be measured by means of thermocouples located as follows:

Anode core: This thermocouple shall be embedded in the top of the cooler, with the anode dome removed if necessary, by means of drilling a small hole, shallow enough so that the tube vacuum shall not be lost, placing the welded thermocouple junction therein, and then peening the edges of the hole so as to hold the thermocouple firmly in place.

Anode seal: This thermocouple shall be attached, using any appropriate material, to the surface of the metal immediately above metal-to-dielectric seal.

Base seal: This thermocouple shall be attached, using any appropriate material, to the surface of the metal immediately adjacent to the base dielectric material and at the immediate periphery of the dielectric material.

NOTES (Cont'd.)

In all cases, good electrical continuity between the thermocouple and the metal area in close proximity must be demonstrated before the cooling test can be performed. The size and material of the thermocouple, their installation, and the measuring instrument used to determine temperature shall all be in accordance with good engineering practice.

8. This is a destructive test. Operate the tube in an upright position. Preheat the tube at specified test conditions for 1 minute. Remove air flow for 100 seconds. Restore air flow and after 1 minute perform the total grid current test. Any tube which evidences a short or open circuit during this test will be considered a failure.
9. The AQL for the combined defectives for attributes in acceptance inspection, part 1 (production), excluding inoperatives and mechanical, shall be 1 percent. Standard MIL-STD-105, inspection level II, shall apply.
10. The maximum value of the voltage applied to the plate and grids shall not exceed 900 volts. The pulse duration measured at 5 percent of the maximum value shall be not less than 3 microseconds (μs). At 50-per-cent amplitude the duration shall be less than 2 μs. The applied voltage shall have a maximum repetition rate such that the duty cycle, based on the pulse length measured at 50-percent amplitude, shall not exceed 0.0002 (0.02 percent). An alternate pulse emission test may be used with the following conditions and limits:

<u>Conditions</u>	<u>Minimum</u>	<u>Maximum</u>
is = 30a, eb = ecl = ec2 etc:	---	850 v

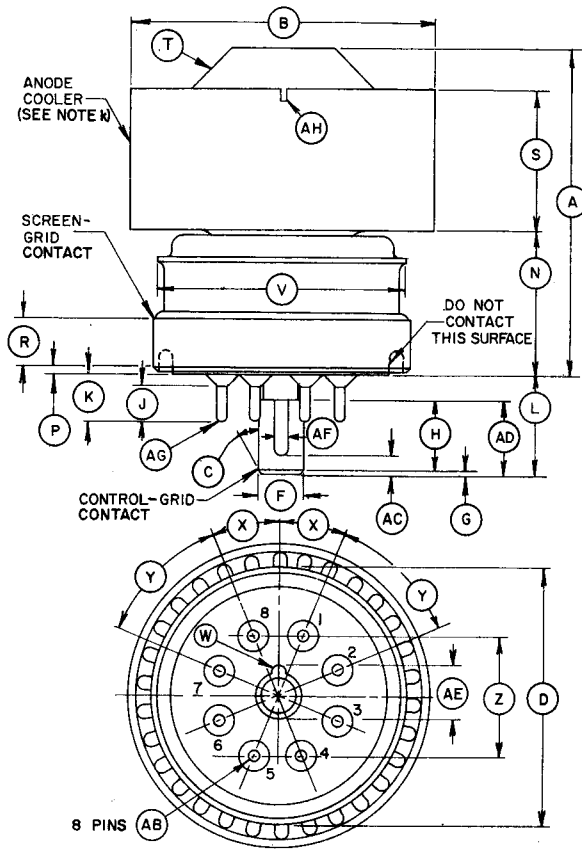
For life-test end points, is = 21a.

11. Positive current division is taken with the voltage conditions as specified. The grid voltage pulse is essentially a square wave and its magnitude is adjusted to produce a plate current of 1.0 ampere at the leading edge of the pulse. (See fig. 3). The magnitudes of ecl, and ic2 are recorded and shall be within the specified limits. The input wave shape shall have a tr and tf of 25 μs, maximum each, and the slope of the top of the pulse may not exceed 0.5 percent, with a ripple of less than 0.1 percent. For basic test circuit see figure 4.
12. The control grid lug bending test should be made as follows:-
 - (a) The tube shall be mounted in a horizontal position.
 - (b) A bending moment of 5.25 pound-inches shall be applied to the control-grid lug by means of the fixture shown on figure 5.
 - (c) After this test the tube shall pass all the electrical tests in acceptance inspection, part 2 (design), and fit the pin alignment gage as indicated on Drawing 246-JAN.
13. Circuit and cavity shall be in accordance with Drawing 223-JAN, or equivalent.
14. This test shall be made a minimum of 30 minutes after Ef is turned off. Rated air flow shall be maintained during the 30-minute interval. For test circuit see figure 6, or equivalent.
15. Tubes shall be prepared for domestic or overseas shipment, as specified in the contract or order, in accordance with Specification MIL-E-75 and appendix thereto. When specified in the contract or order, rough handling (container drop) test (i) shall be performed on the individual container utilized.
16. Production lots shall be suitably identified.
17. Referenced documents shall be of the issue in effect on the date of invitation for bids.
18. The valve shall be vibrated with a force producing the specified peak acceleration and shall be applied perpendicular to its axis in a line through the heater pins 3 and 7.
19. The frequency of vibration shall be increased from 100 c/s to 1000 c/s at the rate specified in Note 20.

NOTES (Cont'd.)

20. The rate of change of frequency shall be:-
- (i) Not exceeding one octave per minute from 25 c/s to 200 c/s
 - (ii) Not exceeding 100 c/s per minute between 200 c/s and 500 c/s
 - (iii) Not exceeding 250 c/s per minute between 500 c/s and 1000 c/s.
- Where approved high sensitivity recording equipment is used the rate of sweep shall not be greater than 15 seconds per octave. Up to 200 c/s and not greater than 45 seconds per octave above 200 c/s.
21. The frequency of vibration shall be increased from 500 c/s to 1000 c/s at the rate specified in Note 20.
22. Detection of short-circuits shall be carried out using the Valve Inter-Electrode Short-Circuit Detector detailed in S.V.T.L. Technical Report No. 124/61 (Circuit Diag. Fig. 6).
23. The limits specified in S.V.T.L. Technical Report No. 124/61 Paragraph 5 shall apply.
24. All valves submitted for acceptance shall initially undergo the specified shelf life test. The criteria for acceptance shall be based on the results of the Shelf Life End Points, which shall be performed immediately prior to and then repeated after the Shelf Life period. The results obtained in each case shall be recorded. After completion of the Shelf Life Test End Points the remaining specified tests shall be performed.
25. When the combined rejection rate for the Shelf Life Test End Points does not exceed 5% on each of three consecutive lots the duration of the Shelf Life may be reduced to 4 weeks until such time as the combined rejection rate exceeds 7 $\frac{1}{2}$ %. The 12 week period shall then be reinstated until the failure rate again merits reduced duration.
26. Valves are acceptable providing the "Post-Shelf Life" value of "is" is not less than half the "Pre-Shelf" value. An over-riding minimum limit of 30 amps shall apply.
27. A valve is acceptable providing the 'Post Shelf Life' value of I_{C1} is
- (i) not greater than 5.0 μ A d.c. or
 - (ii) not greater than twice the 'Pre Shelf Life' value. An over-riding maximum limit of 15 μ A d.c. shall apply.
28. A suitable cavity for the power oscillation test is given in S.V.T.L. Drawing S.V.T.L.0197.

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DIM.	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL	LIMITS	
			Min	Max
QUALIFICATION INSPECTION				
B	---	---	1.610 dia	1.640 dia
H	---	---	0.380	---
I	---	---	0.187	---
N	---	---	0.750	0.810
R	---	---	0.187	---
S	---	---	0.710	0.790
T	---	---	(see note n)	
V	---	---	---	1.406 dia
AC	---	---	0.088	0.108
AG	---	---	0.005 R	---
AH	---	---	(see note m)	
ACCEPTANCE INSPECTION, PART 2 (DESIGN)				
A			1.710	1.860
D			1.417 dia	1.433 dia
F			(see note d)	(see notes c and h)
K			---	0.250
L	6.5	L6	0.514	0.554
AB			0.045 dia (see note f)	0.053 dia (see notes f and i)
AD			---	0.456
AE			0.298 (see note e)	0.308 (see note c)
NOMINAL DIMENSIONS (SEE NOTE b)				
C	30°			
G	1/32			
P	0.080			
W	0.043 R (see notes c and f)			
X	22-1/2° (see note f)			
Y	45° (see note f)			
Z	0.687 dia (see note f)			
AF	(see notes c and f)			

- NOTES:
- All dimensions in inches, unless otherwise specified.
 - Dimensions without tolerances are for information and are not required for inspection purposes.
 - Maximum dimensions shall be such that the grid pin will enter to a distance of 0.1875 into grid-pin gage as specified on Drawing 246-JAN.
 - Minimum dimensions shall be determined by grid-pin gage II-1 as specified on Drawing 246-JAN.
 - Dimensions shall be determined by grid-pin gages II-2 and II-3 as specified on Drawing 246-JAN.
 - Dimensions and angular positions shall be determined by pin-alignment gage as specified on Drawing 246-JAN.
 - Alignment of contact surfaces shall be determined by alignment gage as specified on Drawing 168-JAN.
 - Maximum allowable control-grid contact torque shall be 5 inch-pounds.
 - Maximum allowable bending moment shall be 0.25 inch-pound.
 - Anode clamping shall be confined to anode cooler.
 - Location of grid-pin key shall be referenced by a notch in the top of the anode cooler or an arrow depressed into the surface of the anode cooler.
 - Dome contour shall be such that it will be contained within crosshatched area of template shown on figure 7. Optical comparator techniques are normally used for this purpose.
 - Air-system socket for tube types 4X150A and 4X150D shall be as specified on Drawing 246-JAN.

Figure 1. Outline drawing.

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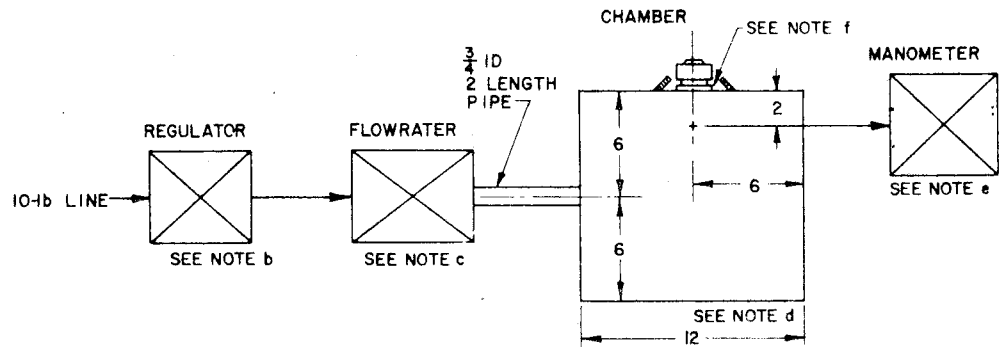


Figure 2. Block diagram

NOTES:

- a. All dimensions in inches.
- b. Fisher-Governor, pressure regulator model 67, or equivalent.
- c. Fischer Porter Flowrater Model B4-27-10/77, or equivalent.
- d. 12-inch cube inside dimensions, compound sealed.
- e. F. W. Dwyer Manometer, 0 to 1 inch of water (Fisher Scientific Company 11-295-5 draft gage), or equivalent.
- f. Socket specified on Drawing 246-JAN, or equivalent.

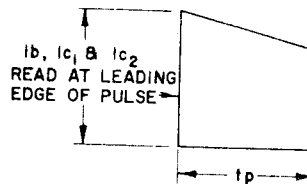


Figure 3. Pulse

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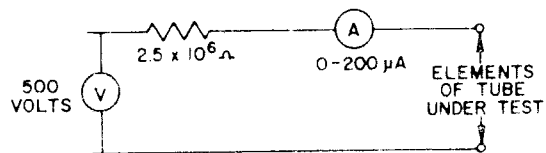


Figure 6. Interelectrode leakage test circuit.

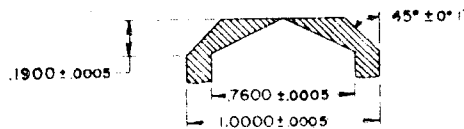


Figure 7. Contour limits of dome shape.