VALVE ELECTRONIC

ADMIRALTY SURFACE WEAPONS ESTABLISHMENT

CV2487

Specification AD/CV 2487 incorporating MIL-E-1/889A
Issue 2 Dated 15.10.63
To be read in conjunction with K1006.

SECURITY

Specification	Valve
Unclassified	Unclassified

TYPE OF VALVE Tetrode with external anode.
CATHODE Indirectly heated
ENVELOPE Glass and metal
PROTOTYPE 4X250B

MARKING

See K1001/4

BASE

9-pin Special

CONNECTIONS

Pin	Electrode
1	g2
2	k
3	h
4	k
5	int. con.
6	k
7	h
8	k
Centre Pin	g1

RATING
(All limiting values are absolute)

			Note
Heater Voltage	(V)	6.0	
Heater Current	(A)	2.6	
Max. Grid Voltage	(V)	-250	
Max. Control Grid Dissipation	(W)	2	
Max. Screen Dissipation	(W)	12	
Max. Anode Temperature	(°C)	250	
Max. Base Seal Temperature	(°C)	175	
Max. Frequency	(Mc/s)	500	
Min. Cathode Heating Period	(Secs)	30	
Class AB Audio			
Max. Anode Voltage	(V)	2000	
Max. Anode Dissipation	(W)	250	
Max. Anode Input	(W)	500	
Max. Anode Current	(mA)	250	
Max. Screen Grid Voltage	(V)	400	
Class C Telephony			
Max. Anode Voltage	(V)	1500	
Max. Anode Dissipation	(W)	165	
Max. Anode Input	(W)	300	
Max. Anode Current	(mA)	200	
Max. Screen Grid Voltage	(V)	300	
Class C Telegraphy			
Max. Anode Voltage	(V)	2000	
Max. Anode Dissipation	(W)	250	
Max. Anode Input	(W)	500	
Max. Anode Current	(mA)	250	
Max. Screen Grid Voltage	(V)	300	

DIMENSIONS

See drawing on page 7

CAPACITANCES (pF)

C in (nom)	15.7
C out (nom)	4.5
Ca-g1 (max)	0.06

TESTS

The tests for Valve Type 4X250B in specification MIL-E-1/889A shall apply with the addition of the following test which is to be regarded as part of Acceptance Inspection Part 2 (design) on Page 3:-

SWEPT FREQUENCY SHORT CIRCUIT TEST

The valve shall be vibrated over the range 20 c/s to 1000 c/s, using the equipment described in S.V.T.L. Technical Report No. 124/61 to detect short circuits. With screen grid connected to cathode, there shall be no shorts between these electrodes and the grid of duration greater than the limits stated in paragraph 5 of the Report.

The rate of change of frequency shall be not more than 25 c/s per minute from 20 c/s to 75 c/s, and not more than 50 c/s per minute from 75 c/s to 1000 c/s.

The acceleration shall be not less than 2g from 20 c/s to 75 c/s, and not less than 1g from 75 c/s to 1000 c/s, and shall be applied in any two mutually perpendicular directions normal to the major axis of the valve.

CV2487

MIL-E-1/889A
14 October 1960
SUPERSEDING
MIL-E-1/889
28 June 1957

MILITARY SPECIFICATION SHEET

ELECTRON TUBE, TETRODE, EXTERNAL ANODE, INTEGRAL-FINNED

JAN-4X250B, 4X250F, 4CX250B, 4CX250F

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

DESCRIPTION: RF power amplifier, oscillator or frequency multiplier

F_1 = 500 Mc

ABSOLUTE-MAXIMUM RATINGS:

Parameter: / Unit:		Ef Vac (see note 1)	Eb Vdc	Ec1 Vdc	Ec2 Vdc	Ehk Vdc	Ib mAdc	Pg1 W
	Code							
C Tel :	a, c	6.0±10%	1,500	-250	300	±150	200	2
C Tlg :	a, c	6.0±10%	2,000	-250	300	±150	250	2
AB :	a, c	6.0±10%	2,000	-250	400	±150	250	2
C Tel. :	b, d	26.5±10%	1,500	-250	300	±150	200	2
C Tlg :	b, d	26.5±10%	2,000	-250	300	±150	250	2
AB :	b, d	26.5±10%	2,000	-250	400	±150	250	2
TEST COND:	a, c	6.0	1,000	adj	300	0	150	---
	b, d	26.5	1,000	adj	300	0	150	---

ABSOLUTE-MAXIMUM RATINGS:

Parameter: / Unit:		Pg2 W	Pp W	Pi W	T (base seal) °C	T (anode seal) °C	T (anode core) °C	tk sec (min)	Cooling (see note 3)	Alt ft
	Code									
C Tel :	a, c	12	165	300	(See note 2)	250	250	30	---	10,000
C Tlg :	a, c	12	250	500		250	250	30	---	10,000
AB :	a, c	12	250	500		250	250	30	---	10,000
C Tel :	b, d	12	165	300		250	250	30	---	10,000
C Tlg :	b, d	12	250	500		250	250	30	---	10,000
AB :	b, d	12	250	500		250	250	30	---	10,000
TEST COND:	a, c	---	---	---	---	---	---	120	(See note 4)	---
	b, d	---	---	---	---	---	---	120	(See note 4)	---

PIN NO. : 1 2 3 4 5 6 7 8 Center pin — BASE: B8-236

ELEMENTS: g2 k h k int con k h k g1 — DIMENSIONS: See figure 1 and note 5

JAN-4X250B, 4X250F,
a b
4CX250B, 4CX250F
c d

FSC 5960

CV2487

PAR. NO.	CODE	TEST	CONDITIONS	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL OR CODE	SYMBOL	LIMITS Min	LIMITS Max	UNIT
		General							
3.1	All	Qualification	Required for JAN marking	---	---	---	---	---	---
3.6	All	Performance	(See note 6)	---	---	---	---	---	---
4.5	All	Holding period		---	---	t	72	---	hr
---	All	Cathode	Coated unipotential	---	---	---	---	---	---
		Qualification inspection (see note 7)							
3.4.3	All	Base connections	9-pin special (see note 5)	---	---	---	---	---	---
---	a, b	Cooling	Eb = 1,000 Vdc; Ec2 = 300 Vdc;	---	---	T (anode core)	---	250	°C
			Ec1/Ib = 250 mAdc (see note 8)	---	---	T (base seal)	---	175	°C
	c, d		Eb = 1,000 Vdc; Ec2 = 300 Vdc; Ec1/Ib = 250 mAdc (see note 8)	---	---	T (anode core)	---	225	°C
---	All	Pressure drop	No voltages (see note 9)	---	---	---	---	0.35	In. H_2O
---	c, d	Life test (3)	Power output, except air flow = 1.5 cfm	---	---	t	100	---	hr
---	c, d	Life-test (3) end point	Power output	---	---	Po	200	---	W (useful)
		Acceptance inspection, part 1 (production) (see note 10)							
4.9.1	All	Mechanical-production tests		---	---	---	---	---	---
4.10.4.3	All	Screen-grid current		0.65	II	Ic2	-7.0	+3.0	mAdc
4.10.5.2	All	Grid voltage		0.65	II	Ec1	-32.0	-45.0	Vdc
4.10.6.1	All	†Total grid current	Eb = 2,000 Vdc; Ib = 125 mAdc	0.65	II	Ic1	---	-15	uAdc
4.10.6.6	a, b	Primary (control)-grid emission	Ic1 = 70 mAdc; t = 15; plate and screen grid floating	0.65	II	Isg1	---	-25	uAdc
	c, d		Ic1 = 70 mAdc; t = 120; plate and screen grid floating			Isg1	---	-250	uAdc
4.10.6.6	a, b	Primary (screen)-grid emission	Ec1 = 0 Vdc; Ic2 = 100 mAdc; t = 15; plate floating	0.65	II	Isg2	---	-250	uAdc
	c, d		Ec1 = 0 Vdc; Ic2 = 100 mAdc; t = 120; plate floating			Isg2	---	-250	uAdc

PAR. NO.	CODE	TEST	CONDITIONS	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL OR CODE	SYMBOL	LIMITS Min	LIMITS Max	UNIT
		Acceptance inspection, part 1 (production) (see note 10) - Contd							
4.10.8	a, c	Heater current		0.65	II	If	2.30	2.90	Aac
	b, d			0.65	II	If	0.50	0.62	Aac
---	All	Pulse emission (1)	Eb = Ec2 = 250 Vdc; Ec1 = -100 Vdc; ec1/ik = 1.5 a; prr = 11.0±1.0; tp = 4,500 us min (see note 11)	0.65	II	Δik	---	200	ma
	a, c		Ef = 5.4 Vac						
	b, d		Ef = 23.8 Vac						
---	All	Positive grid-current division	Eb = Ec2 = 250 Vdc; Ec1 = -100 Vdc; ec1/ib = 1.0 a; prr = 11.0±1.0; tp = 4,500 us min (see note 12)	0.65	II	ec1	8	18	v
						ic1	---	200	ma
						ic2	---	260	ma
		Acceptance inspection, part 2 (design)							
4.9.19.1	All	Low-frequency vibration	No voltages	6.5	L6	---	---	---	---
4.9.19.3	All	Bump	Angle = 20°	6.5	L6	---	---	---	---
---	All	Control-grid lug bending test	(See note 13)	6.5	L6	---	---	---	---
4.10.1.5	All	Pulse emission (2)	eb = ec1 = ec2 = 850 v (see note 14)	6.5	L6	is	40	---	a
4.10.14	All	Direct-interelectrode capacitance	EIA standard shields No. 320 and 321, or equivalent	6.5	L6	Cgp	---	0.06	uuf
						Cin	14.2	17.2	uuf
						Cout	4.0	5.0	uuf
4.10.15	All	Heater-cathode leakage	Ehk = ±150 Vdc	6.5	L6	Ihk	---	150	uAdc
			Ehk = -150 Vdc			Ihk	---	150	uAdc
---	All	Power output	Class C amplifier; F = 470 to 500 Mc; Eb = 2,000 Vdc; Ec1 = -90 Vdc; Ec2 = 250 to 300 Vdc; Ic1 = 25 mAdc max; Eg1/Ib = 250 mAdc (see note 15)	6.5	L6	Po	225	---	W (useful)
	a, c		Ef = 5.5 Vac						
	b, d		Ef = 24.3 Vac						
---	a, b	Humidity test	(See note 16)	6.5	L6	---	---	---	---
---	a, b	Post humidity test end point		---	---	Ic1	---	-15	uAdc

PAR. NO.	CODE	TEST	CONDITIONS	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL OR CODE	SYMBOL	LIMITS Min	LIMITS Max	UNIT
		Acceptance inspection, part 3 (life)							
4.11	All	Life test (1)	Group C; power output	---	---	t	500	---	hr
4.11.4	All	Life-test (1) end points	Pulse emission (2)	---	---	is	30	---	a
			Primary screen-grid emission	---	---	Isg2	---	-250	uAdc
			Heater-cathode leakage						
			Ehk = ±150 Vdc	---	---	Ihk	---	150	uAdc
			Ehk = -150 Vdc	---	---	Ihk	---	150	uAdc
	a, b		Primary control-grid emission	---	---	Isg1	---	-100	uAdc
	c, d		Primary control-grid emission	---	---	Isg1	---	-250	uAdc
4.11	All	Life test (2)	Group C; Ec1 = Ec2 = Eb = 0 Vdc	---	---	t	500	---	hr
	a, c		Ef = 6.60 Vac						
	b, d		Ef = 29.1 Vac						
---	All	Life-test (2) end points	(See notes 17 and 18)	---	---	Rg1g2	10	---	Meg
						Rg2k	10	---	Meg
						Rg1k	10	---	Meg
4.9.18 and 4.9.18.1.7	All	Container drop	Required						
5.	All	Preparation for delivery	(See notes 19 and 20)						

NOTES:

1. To obtain maximum life, it is necessary to adjust heater voltage to values indicated below at the indicated frequencies of operation. These figures are for straight-through amplifier operation.

Frequency (Mc), All	Ef (Vac), a, c	Ef (Vac), b, d
300 or lower	6.00	26.5
301 to 400	5.75	25.3
401 to 500	5.50	24.3

It is recommended that the heater voltage be maintained within ±5 percent when consistent operation and extended tube life are factors. This applies to both nominal and derated voltages.

2. Ratings for base seal temperature are as follows:

Code	C Tel	C Tlg	AB
a, b	175	175	175
c, d	250	250	250

3. At a plate dissipation of 250 watts and an incoming air temperature of 25° C maximum.a minimum air flow of 3.8 cubic feet per minute (cfm) at sea level must pass through the anode cooler. At this flow of 3.8 cfm, the static pressure drop across the tube and socket shown on Drawing 246-JAN, is approximately 0.30 inch of water. The pressure drop varies with the amount of escaping air and with the shape and construction of the air director. This rating applies at bias voltages less than 100 volts and frequencies less than 500 Mc. Air cooling on the tube base must be increased with increasing negative grid bias or with increasing frequency, or a combination of both. In all cases of operation, a socket which provides forced-air cooling of the base must be used and maximum seal temperature ratings must not be exceeded. The air flow shall be applied before or simultaneously with electrode voltages, and may be removed simultaneously with them.

4. In all electrical tests involving heater voltage, the socket shown on Drawing 246-JAN, or equivalent, shall be used. Forced-air cooling is permitted at the rate of 4.0 cfm maximum for the base and anode, unless otherwise specified in the specific test conditions. A separate source may be used for the base and anode, but neither shall exceed 4.0 cfm.

5. See Drawing 168-JAN for the contact surface alinement gage and Drawing 246-JAN for the grid pin gage.

6. 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.

NOTES:

7. All tests listed hereon shall be performed during qualification inspection; however, these tests are normally performed during qualification inspection only. ←

8. The cooling test shall be made as follows: At an ambient temperature of 25° C, both base and anode shall be cooled by applying an air flow of 3.8 cfm maximum at sea level from a single source using the infinite baffle system as shown on figure 7, or equivalent. At the specified test conditions, the anode core temperature, and the base seal temperature (types 4X250B and 4X250F) shall not exceed the specified limits. Temperatures shall be measured by means of thermocouples, located as follows: ←

   Anode core: (all) — This thermocouple shall be embedded in the top of the core, adjacent to the cooler 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.

   Base seal: (4X250B and 4X250F) — 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.

   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 thermocouples, their installation, and the measuring instrument used to determine temperature shall all be in accordance with good engineering practice.

9. An infinite baffle system as shown on figure 7, or equivalent, with an air flow of 3.8 cfm at sea level shall be used. The static pressure drop is measured across the tube and socket. ←

10. The AQL for the combined defectives for attributes in acceptance inspection, part 1 (production), excluding inoperatives and mechanical, shall be 1 percent. A tube having one or more defects shall be counted as one defective. Standard MIL-STD-105, inspection level II, shall apply.

11. Pulse emission (1) is taken on the voltage conditions specified. The grid voltage pulse is essentially a square wave, and the magnitude is adjusted to produce a total cathode current of 1.5 amperes at the leading edge of the pulse. (See fig. 2.) The difference in cathode current (Δik) from the leading edge to the falling edge of the pulse (see fig. 2) shall not exceed the specified limit. The input wave shape shall have a tr and a tf of 25 us maximum each, and the slope of the top of the pulse may be not greater than 0.5 percent with a ripple not to exceed 0.1 percent. For basic test circuit, see figure 6. ←

12. Positive current division is taken with the voltage conditions as specified. The grid voltage 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 magnitude of ec1, ic1, ic2 is recorded and shall be within the specified limits. The input wave shape shall have a tr and tf of 25 us maximum each, and the slope of the top of the pulse may be not greater than 0.5 percent with a ripple not to exceed 0.1 percent. For basic test circuit see figure 6. ←

13. The control-grid bending test should be made as follows:

   (a) Tube shall be mounted in a horizontal position.
   (b) A bending moment of 5.25 in./lb shall be applied to the control-grid lug by means of the fixtures shown on figure 4.
   (c) After this test the tube shall pass all the electrical measurements of acceptance inspection, part 2 (design).

14. 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 (us). At 50-percent amplitude, the duration shall be less than 2 us. 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: ←

Conditions		Minimum	Maximum	
is = 40 a, eb = ec1 = ec2	etd:	---	850	v

   For life-test end points, is = 30 a.

15. Circuit and cavity in accordance with Drawing 223-JAN, or equivalent.

16. The tube 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 tube in close proximity to a water bath heated to 95° to 100° C.

17. This is a destructive test.

18. This test shall be made 30 minutes after Ef is turned off. Rated air flow shall still be maintained during the 30-minute interval. Use circuit shown on figure 5, or equivalent.

19. Tubes shall be prepared for domestic or overseas shipment, as specified in the contract or order, in accordance with Specification MIL-E-75/1. Rough handling (container drop) test (d) and container size L shall apply. When specified in the contract or order, rough handling (container drop) test (i) shall be performed on the individual container utilized.

20. Pack in water-vaporproof bag sealed at 20° C and relative humidity of 50 percent maximum. If opaque bag is used, the tube-type number shall be stamped thereon.

CV2487

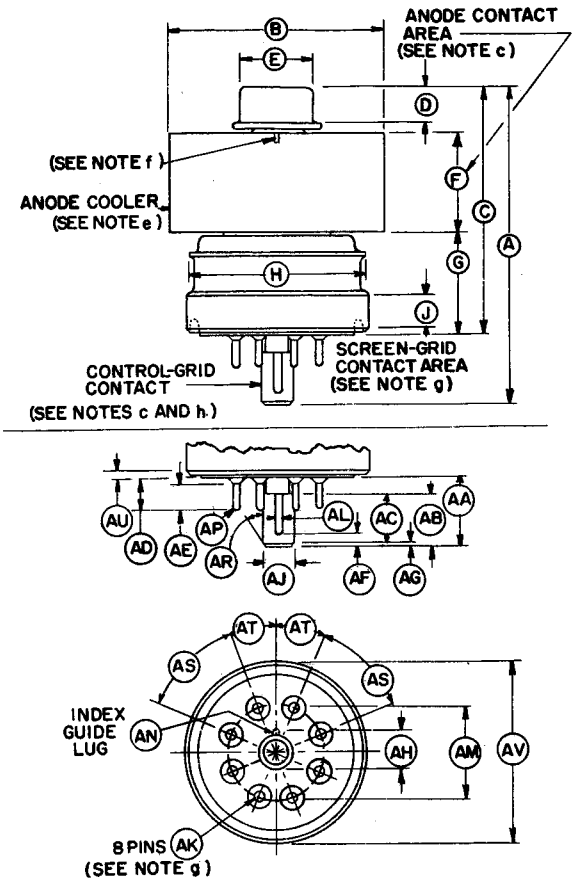
NOTES:

21. Production lots shall be suitably identified.

22. Referenced documents shall be of the issue in effect on the date of invitation for bids.

Custodians:
Army - Signal Corps
Navy - Bureau of Ships
Air Force

Preparing activity:
Navy - Bureau of Ships
(Project 5960-0946)



BASE B8-236

DIM.	AQL (PERCENT DEFECTIVE)	INSPECTION LEVEL	LIMITS Min	LIMITS Max
QUALIFICATION INSPECTION				
B	—	—	1.610 dia	1.640 dia
D	—	—	0.240	0.280
E	—	—	0.559 dia	0.573 dia
F	—	—	0.710	0.790
G	—	—	0.750	0.810
H	—	—	—	1.406 dia
J	—	—	0.187	—
AC	—	—	0.360	—
AE	—	—	0.187	—
AF	—	—	0.068	0.108
AH	—	—	0.298	0.308
AP	—	—	0.005 R min or 0.035 X 22.5°	
ACCEPTANCE INSPECTION, PART 2 (DESIGN)				
A	6.5	L6	2.324	2.464
C	6.5	L6	1.810	1.910
AA	6.5	L6	0.514	0.554
AB	6.5	L6	—	0.456
AD	6.5	L6	—	0.250
AJ	6.5	L6	0.255 dia	0.265 dia
AK	6.5	L6	0.045 dia	0.053 dia
AL	6.5	L6	0.078	0.086
AM	6.5	L6	0.680 dia	0.694 dia
AN	6.5	L6	—	0.043 R
AV	6.5	L6	1.417 dia	1.433 dia
NOMINAL DIMENSIONS (SEE NOTE b)				
AG	0.031			
AR	30°			
AS	45°			
AT	22.5°			
AU	0.080			

NOTES:
a. All dimensions in inches, unless otherwise specified.
b. Dimensions without tolerances are for information and are not required for inspection purposes.
c. Alinement of anode, screen-grid, and control-grid contact surfaces shall be determined by alinement gage specified on Drawing 168-JAN.
d. Air-system socket shall be as specified on Drawing 246-JAN.
e. Anode clamping shall be confined to anode cooler.
f. Location of control-grid contact (index guide) lug may be referenced by a notch in the top of the anode cooler or by an arrow depressed into the surface of the anode cooler.
g. Base pins shall enter full length into pin alinement gage specified on Drawing 246-JAN.
h. Dimensions of control-grid contact (index guide) shall be determined by control-grid contact gages II-1, II-2, and II-3 as specified on Drawing 246-JAN.

Figure 1. Outline drawing.

JAN-4X250B, 4X250F,
a b
4CX250B, 4CX250F
c d

CV2487

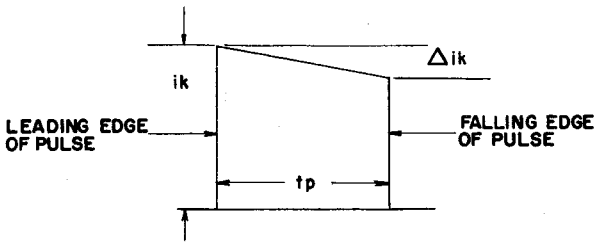


Figure 2. Pulse emission.

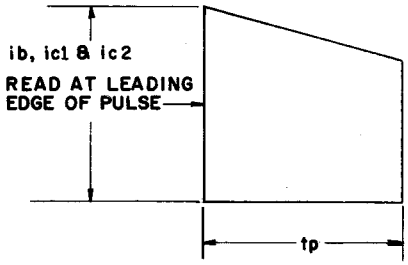


Figure 3. Grid-voltage pulse.

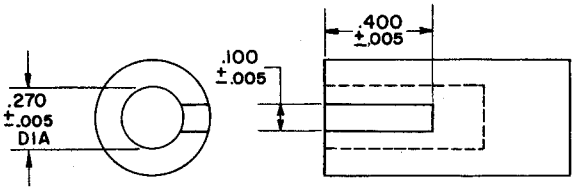


Figure 4. Control-grid lug fixture.

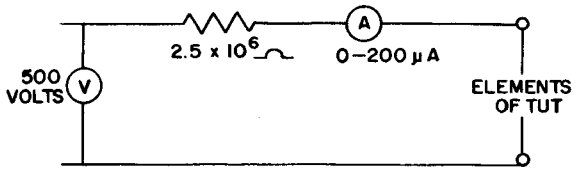


Figure 5. Interelectrode leakage test circuit.

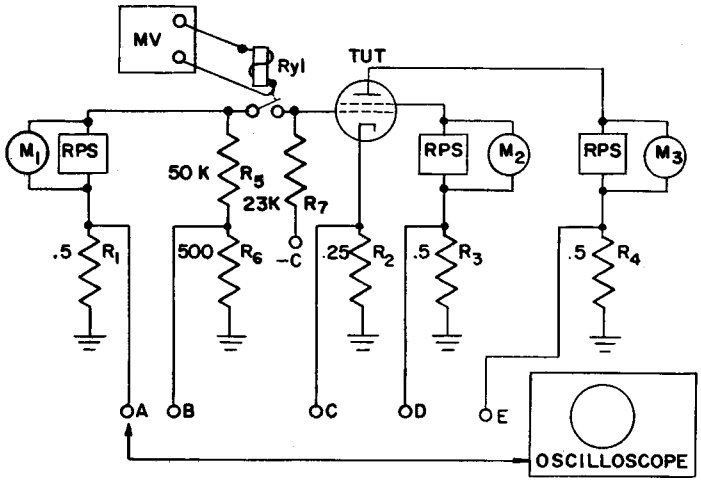


Figure 6. Basic test circuit.

NOTES:
a. Regulated power supplies are capable of maintaining the voltage steady over the duration of the pulse.
b. Meters are accurate to within 1 percent.
c. Ryl mercury wetted contact type, or equivalent.
d. Unused metering resistors may be shorted out.
e. Peak reading devices which measure pulse amplitude may be used in place of oscilloscope. Amplitude of leading edge shall be measured within 30 microseconds.

CV2487

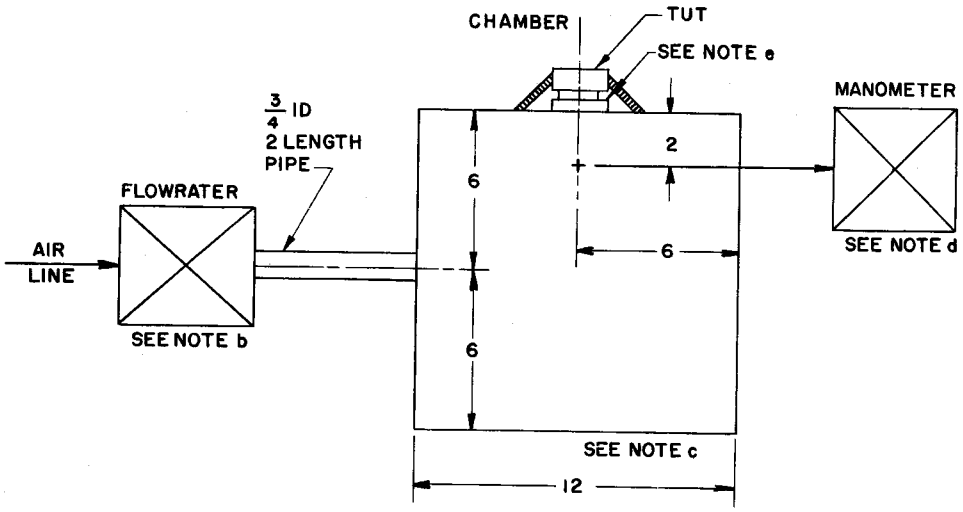


Figure 7. Block diagram.

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