Type 1B24

TR Tube

GENERAL CHARACTERISTICS

Electrical

Max. Ignitor Ignition Time	5 Seconds
Max. Insertion Loss	1.5 Decibels
Frequency Tuning Range	8490 - 9600 Megacycles
Ignitor Voltage Drop for 100 Microamperes	325 - 450 Volts
Max. Peak Leakage Power	30 Milliwatts
Max. Loaded Q	350
Recovery Time - Loss of signal in the tube four microseconds following the pulse shall not be more than 3 db in excess of the loss, 100 microseconds following the pulse.	
Ignitor Interaction, Max.	0.2 Decibel

Mechanical

Ionizable Medium	Gas
Number of Electrodes	*2
Dimensions	See Outline
Mounting Position	Any

MAXIMUM RATINGS

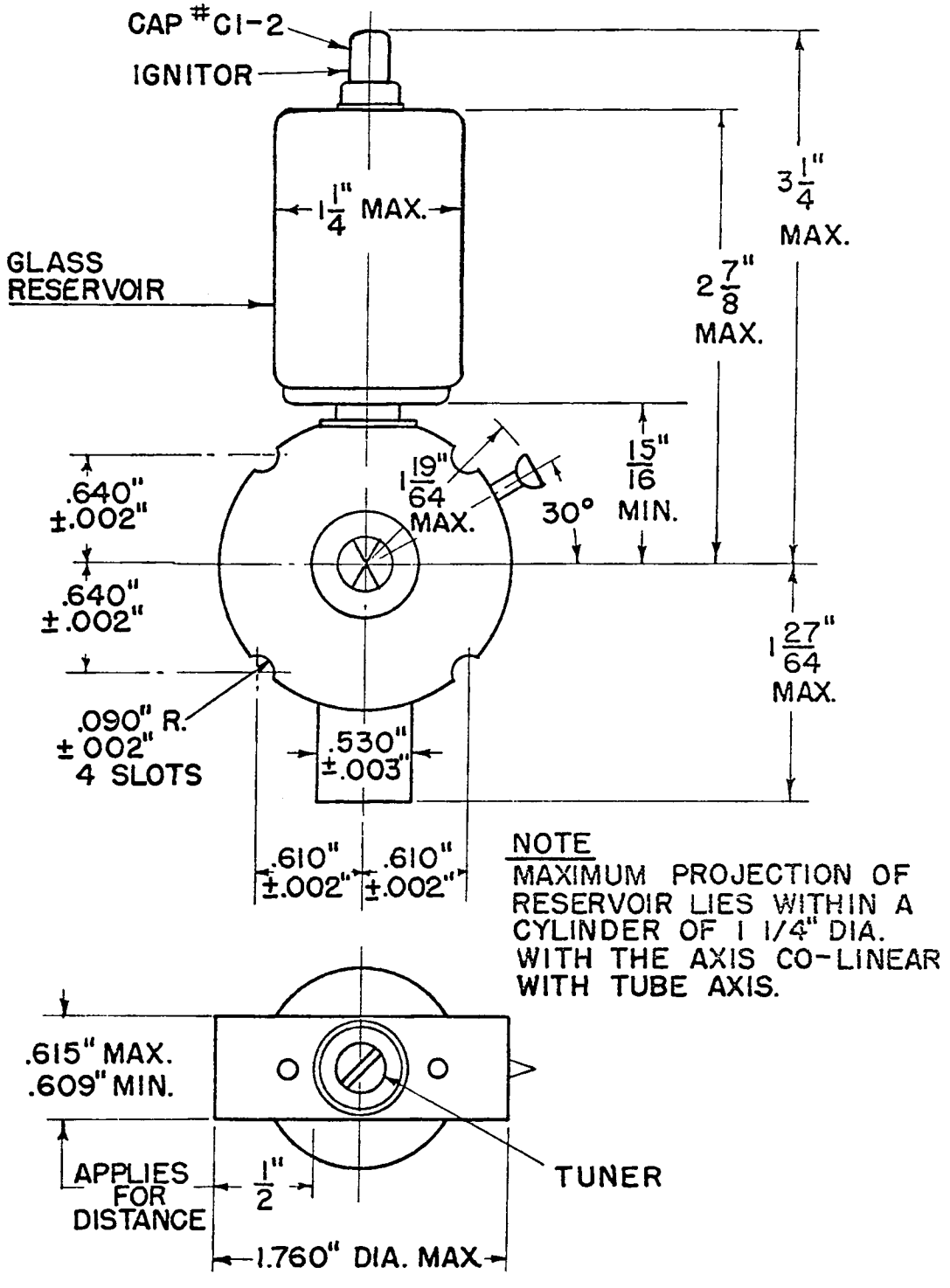
Ignitor Open Circuit Voltage, DC	-750 to -1000 Volts
Ignitor Current	100 to 200 Microamps.
Ambient Temperature Range	-50 to +100°C

* The two points at the center of the tube constitute an rf gap, while the ignitor (at extreme end of reservoir and negative) and body constitute a dc gap used to produce ionization to help trigger the rf gap.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B24


CAP #C1-2
IGNITOR
GLASS RESERVOIR
1 1/4" MAX.
3 1/4" MAX.
2 7/8" MAX.
15/16" MIN.
30°
1 19/64" MAX.
.640" ±.002"
.640" ±.002"
.090" R. ±.002" 4 SLOTS
.530" ±.003"
1 27/64" MAX.
.610" ±.002"
.610" ±.002"
NOTE
MAXIMUM PROJECTION OF RESERVOIR LIES WITHIN A CYLINDER OF 1 1/4" DIA. WITH THE AXIS CO-LINEAR WITH TUBE AXIS.
.615" MAX.
.609" MIN.
APPLIES FOR DISTANCE
1/2"
TUNER
1.760" DIA. MAX.

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 1B26

Tunable TR Tube

GENERAL CHARACTERISTICS

Electrical

Max. Ignitor Ignition Time	5 Seconds
Max. Insertion Loss	1.75 Decibels
Frequency Tuning Range	23630 - 24580 MC
Ignitor Voltage Drop for 100 Microamperes	235 - 450 Volts
Max. Peak Leakage Power	25 Milliwatts
Recovery Time - Loss of signal in the tube 4 microseconds following the pulse shall be not more than 3 db in excess of the loss 100 microseconds following the pulse.	
Ignitor Interaction, Max.	0.2 db

Mechanical

Ionizatable Medium	Gas
Number of Electrodes	*2
Dimensions	See Outline
Mounting Position	Any

MAXIMUM RATINGS

Ignitor Open Circuit Voltage, DC	-750 to -1000 Volts
Ignitor Current	100 to 200 Microamps.
Ambient Temperature Range	-50°C to +100°C

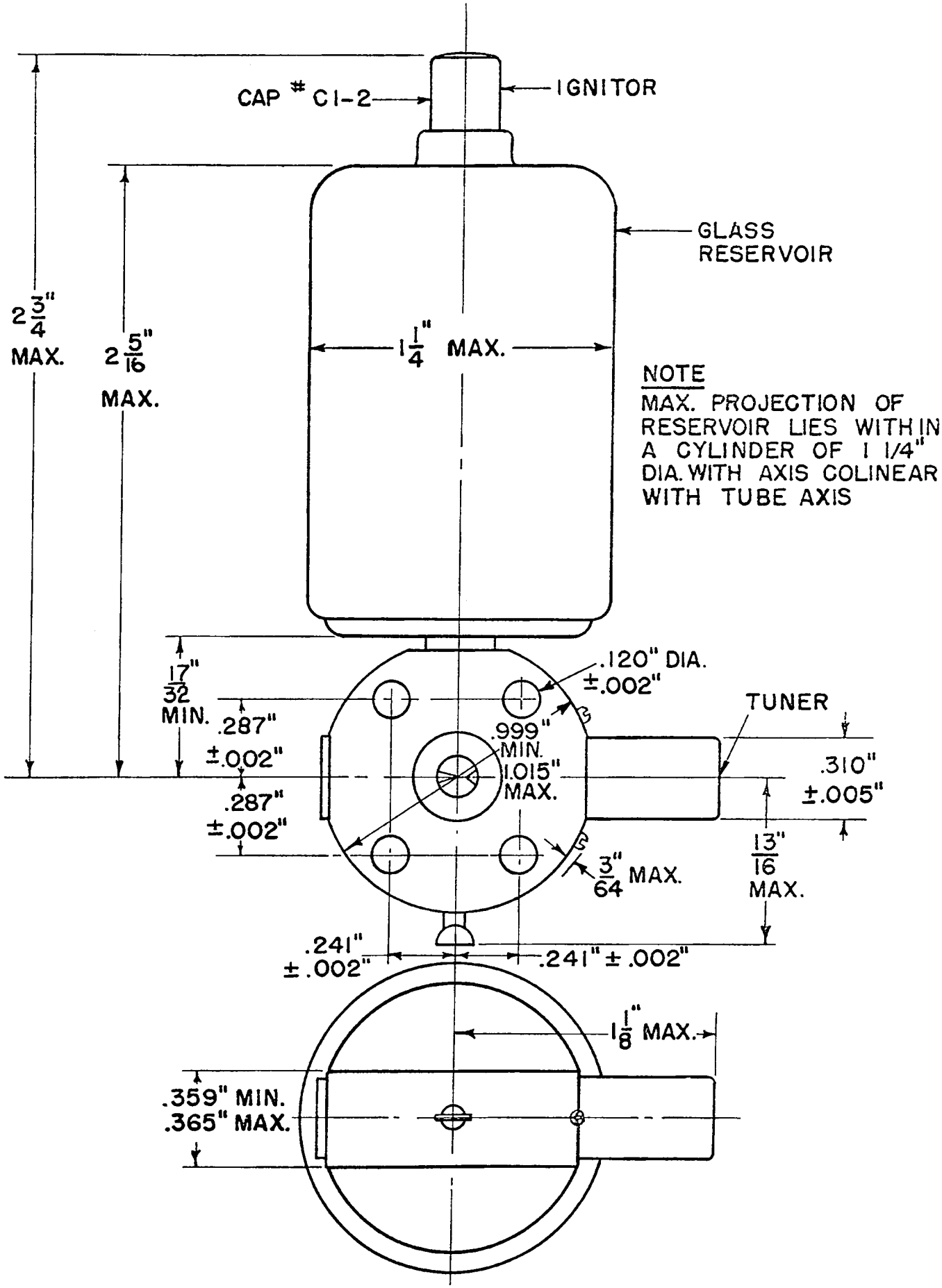
* The two points at the center of the tube constitute an r-f gap, while the ignitor (at extreme end of reservoir and negative) and body constitute a dc gap used to produce ionization to help trigger the r-f gap.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B26

SECURITY CLASSIFICATION – CONFIDENTIAL



12-5-45

WESTINGHOUSE ELECTRONIC TUBES

Type 1B32/532A

Spark Gap

GENERAL CHARACTERISTICS

Electrical

Instantaneous Breakdown Voltage	
Initial Peak	1000 Volts
Recurrent Peak	875 Volts
Voltage Drop	150 to 350 Volts
Inter Electrode Capacitance	1 to 1.6 Micro-Microfarads

Mechanical

Ionizable Medium	Gas
Number of Electrodes	2
Dimensions	See Outline
Mounting Position	Any

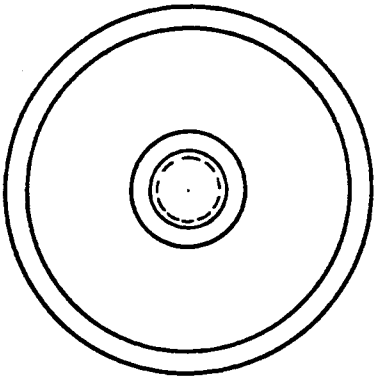
MAXIMUM RATINGS

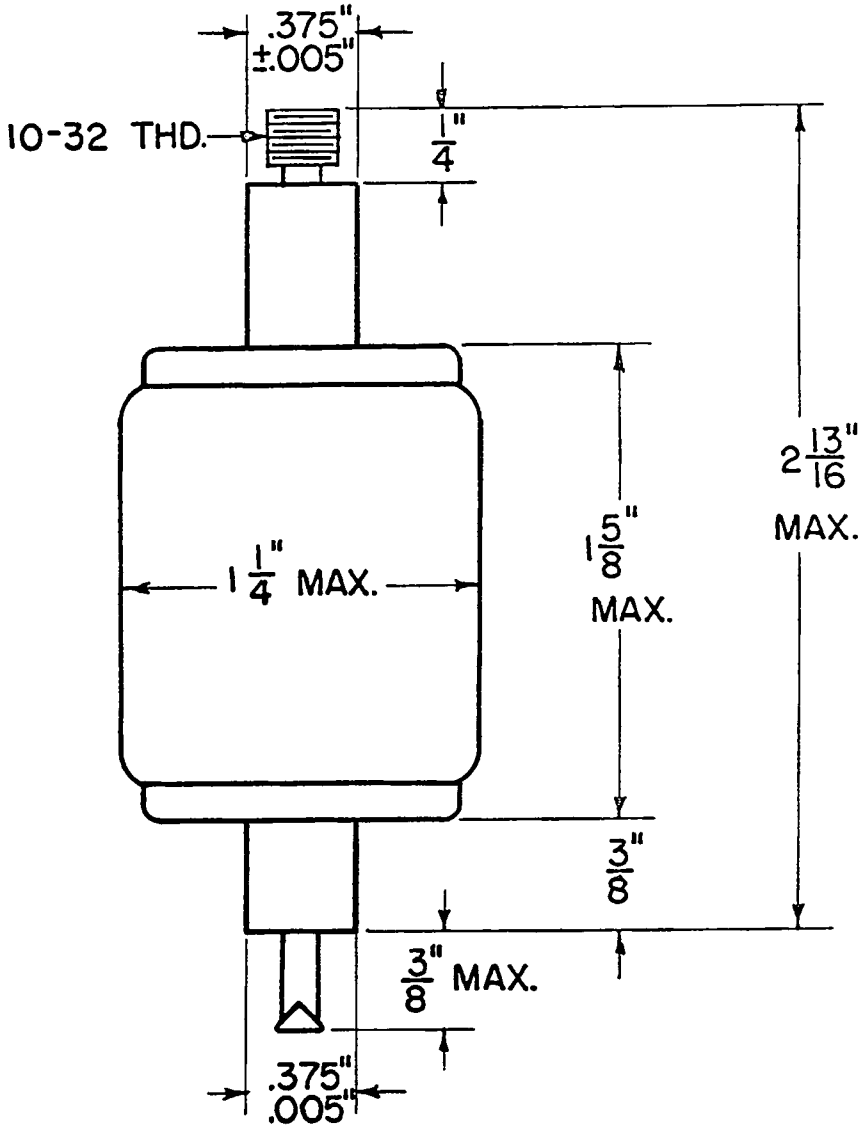
Ambient Temperature	-50 to +100°C.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B32 / 532A





12-5-45

WESTINGHOUSE ELECTRONIC TUBES

Type 1B34

Series Spark Gap

GENERAL CHARACTERISTICS

Electrical

Frequency Range	120 - 2000 Cycles/Sec.
Instantaneous Breakdown Voltage	
Initial Peak	6.5 Kilovolts
Recurrent Peak	6.0 Kilovolts
Voltage Drop, Measured after .5 Microseconds	80 Volts
Interelectrode Capacitance	6 Micro Microfarads

Mechanical

Ionizable Medium	Gas
Number of Electrodes	2
Mounting Position	Cathode End Up and Within 60° of Vertical
Dimensions	See Outline

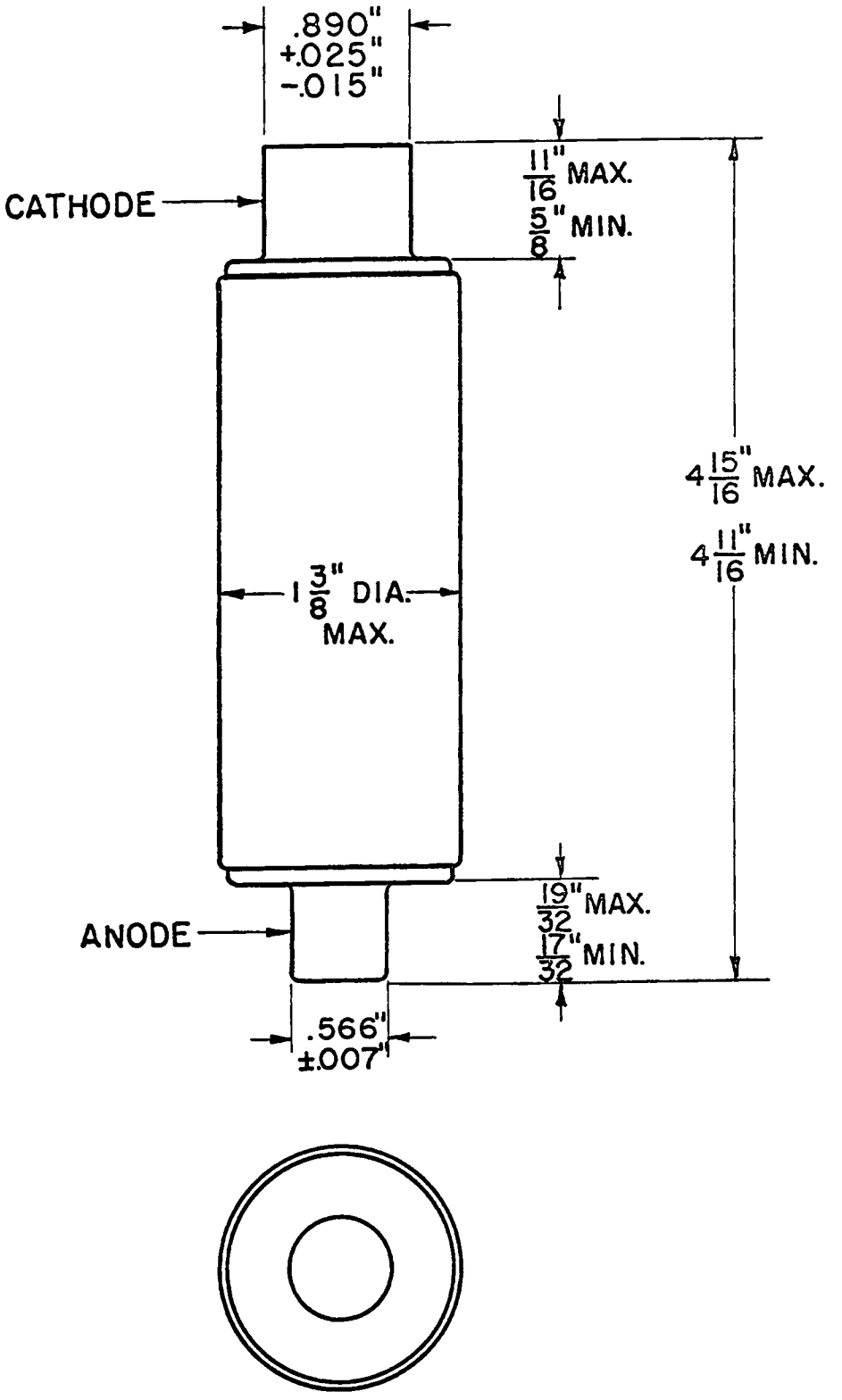
MAXIMUM RATINGS

Peak Power Dissipation	25 Kilowatts
Peak Current	120 Amperes
Average Power Dissipation	25 Watts
Average Current	120 Milliamperes
Frequency	2000 Cycles/Second
Ambient Temperature	-50 to +100°C.
Duty Cycle	.001

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B34


.890"
+.025"
-.015"
CATHODE
11/16" MAX.
5/8" MIN.
4 15/16" MAX.
4 11/16" MIN.
1 3/8" DIA.
MAX.
ANODE
19/32" MAX.
17/32" MIN.
.566"
±.007"

12-5-45

Series Spark Gaps
Types 1B41, 1B45, 1B49

Types 1B41, 1B45, 1B49 are gas-filled, cold-cathode diodes. Two or more tubes are used in series as the switching device in line-type pulsers.

GENERAL DATA

Electrical:

Frequency Range	120 to 2000 cps
Interelectrode Capacitance	7 uuf
Instantaneous Breakdown Voltage (Nominal):	
1B41	9.5 kv
1B45	14 kv
1B49	12 kv

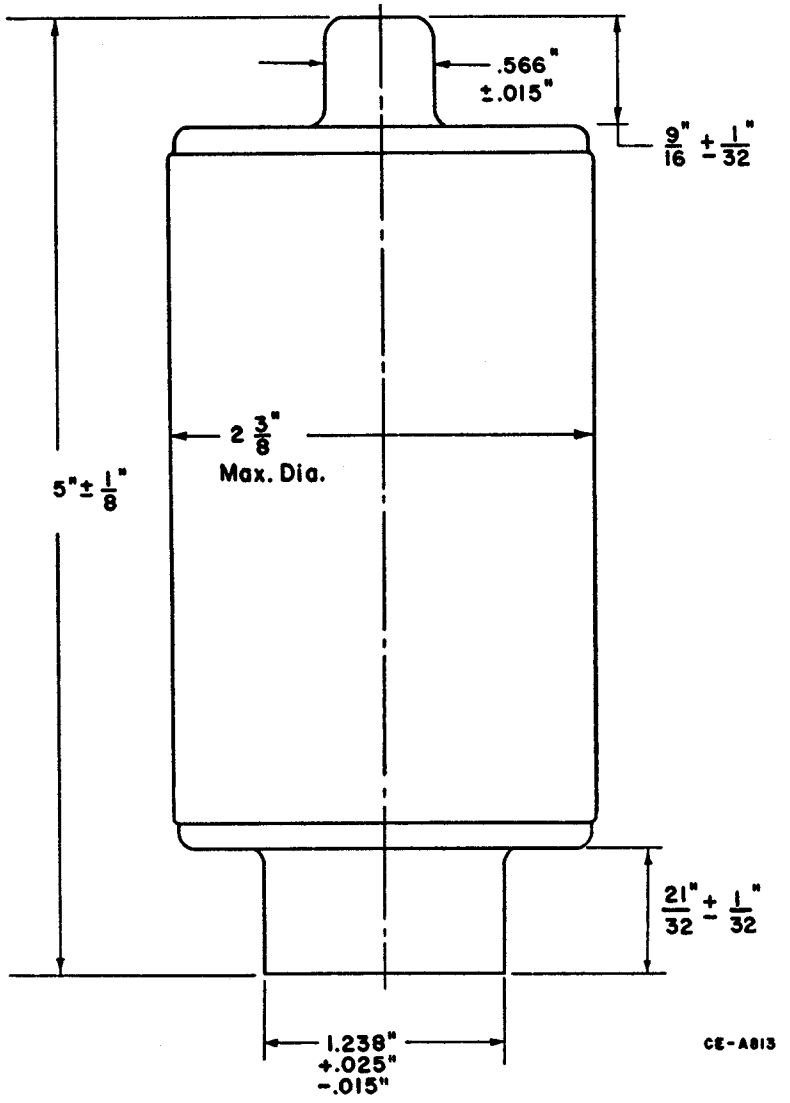
Mechanical:

Ionized Medium	Gas
Number of Electrodes	Two
Mounting Position	Cathode End Up; Within 60° of Vertical

MAXIMUM RATINGS

Peak Current	450 max.	Amperes
Average Power Dissipation	25 max.	Watts
Average Current	210 max.	Ma.
Frequency	2000 max.	cps
Ambient Temperature	−50 to 100 max.	°C
Duty Cycle	0.001 max.	

YOU CAN BE SURE ... IF IT'S Westinghouse



WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 1B45

Series Spark Gap

GENERAL CHARACTERISTICS

Electrical

Frequency Range	120 - 2000 Cycles/Sec.
Instantaneous Breakdown Voltage	
Initial Peak	15.5 Kilovolts
Recurrent Peak	15.0 Kilovolts
Voltage Drop, Measured after .5 Microseconds	100 Volts
Interelectrode Capacitance	7 Micro Microfarads

Mechanical

Ionizable Medium	Gas
Number of Electrodes	2
Mounting Position	Cathode End Up and Within 60° of Vertical
Dimensions	See Outline

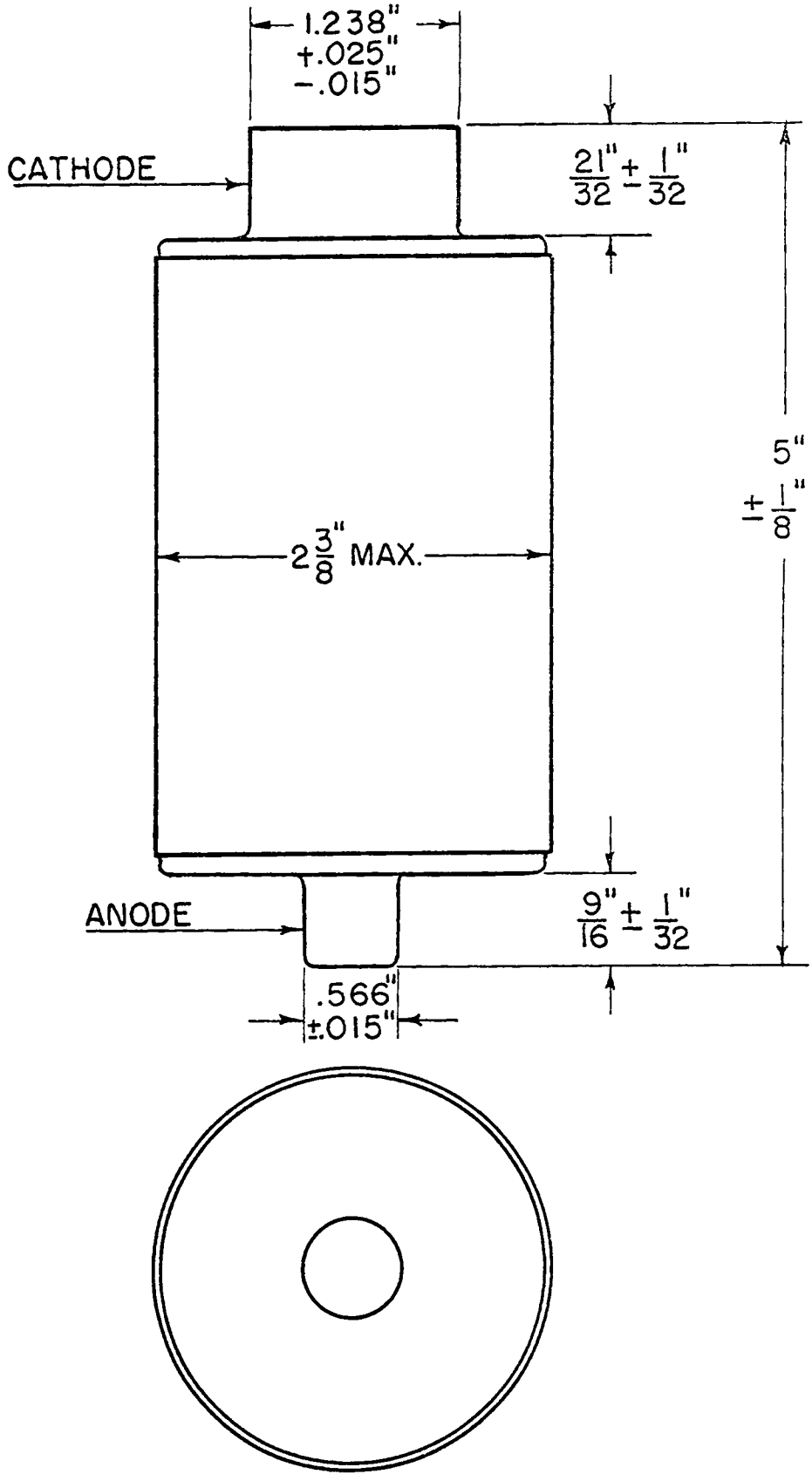
MAXIMUM RATINGS

Peak Power Dissipation	45 Kilowatts
Peak Current	450 Amperes
Average Power Dissipation	25 Watts
Average Current	210 Milliamps.
Frequency	2000 Cycles/Sec.
Ambient Temperature	-50 to +100°C.
Duty Cycle	.001

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B41, 1B45, 1B49



12-5-45

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 1B49

Series Spark Gap

GENERAL CHARACTERISTICS

Electrical

Frequency Range	120 - 2000 Cycles/Sec.
Instantaneous Breakdown Voltage	
Initial Peak	12.0 Kilovolts
Recurrent Peak	11.5 Kilovolts
Voltage Drop, Measured after .5 Microseconds	100 Volts
Interelectrode Capacitance	7 Micro Microfarads

Mechanical

Ionizable Medium	Gas
Number of Electrodes	2
Mounting Position	Cathode End Up and Within 60° of Vertical
Dimensions	See Outline

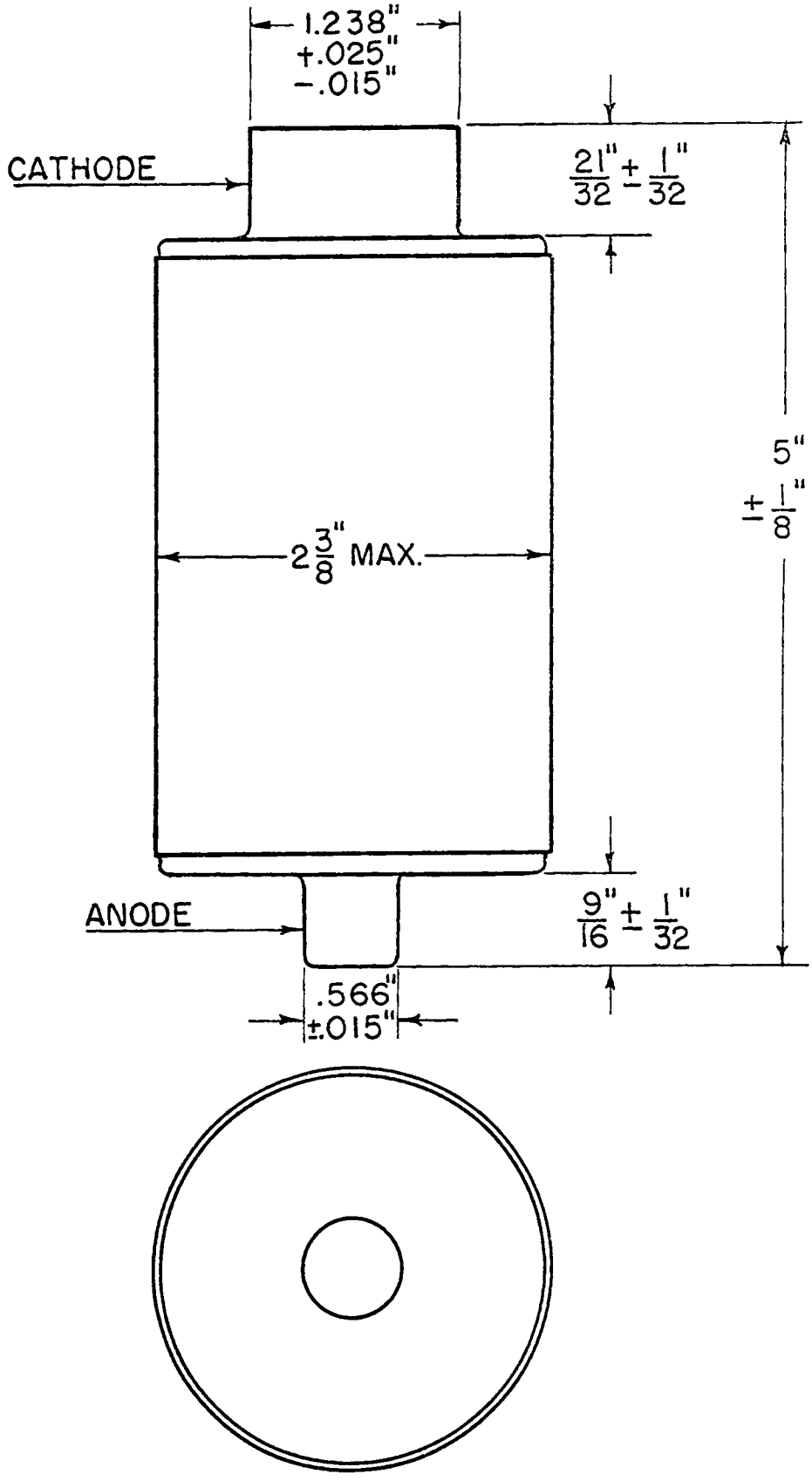
MAXIMUM RATINGS

Peak Power Dissipation	45 Kilowatts
Peak Current	450 Amperes
Average Power Dissipation	25 Watts
Average Current	210 Milliamps.
Frequency	2000 Cycles/Sec.
Ambient Temperature	-50 to +100°C.
Duty Cycle	.001

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1B41, 1B45, 1B49



12-5-45

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 1Q21

Tunable Reference Cavity

GENERAL CHARACTERISTICS

Electrical

Maximum Insertion Loss	10.5 Decibels
Frequency Tuning Range	9200 - 9300 Megacycles
Minimum Loaded Q	2000

Note:- Above ratings (other than tuning range) are at 9250 Megacycles.

Mechanical

Internal Atmosphere	Same as External
Dimensions	See Outline
Mounting Position	Any

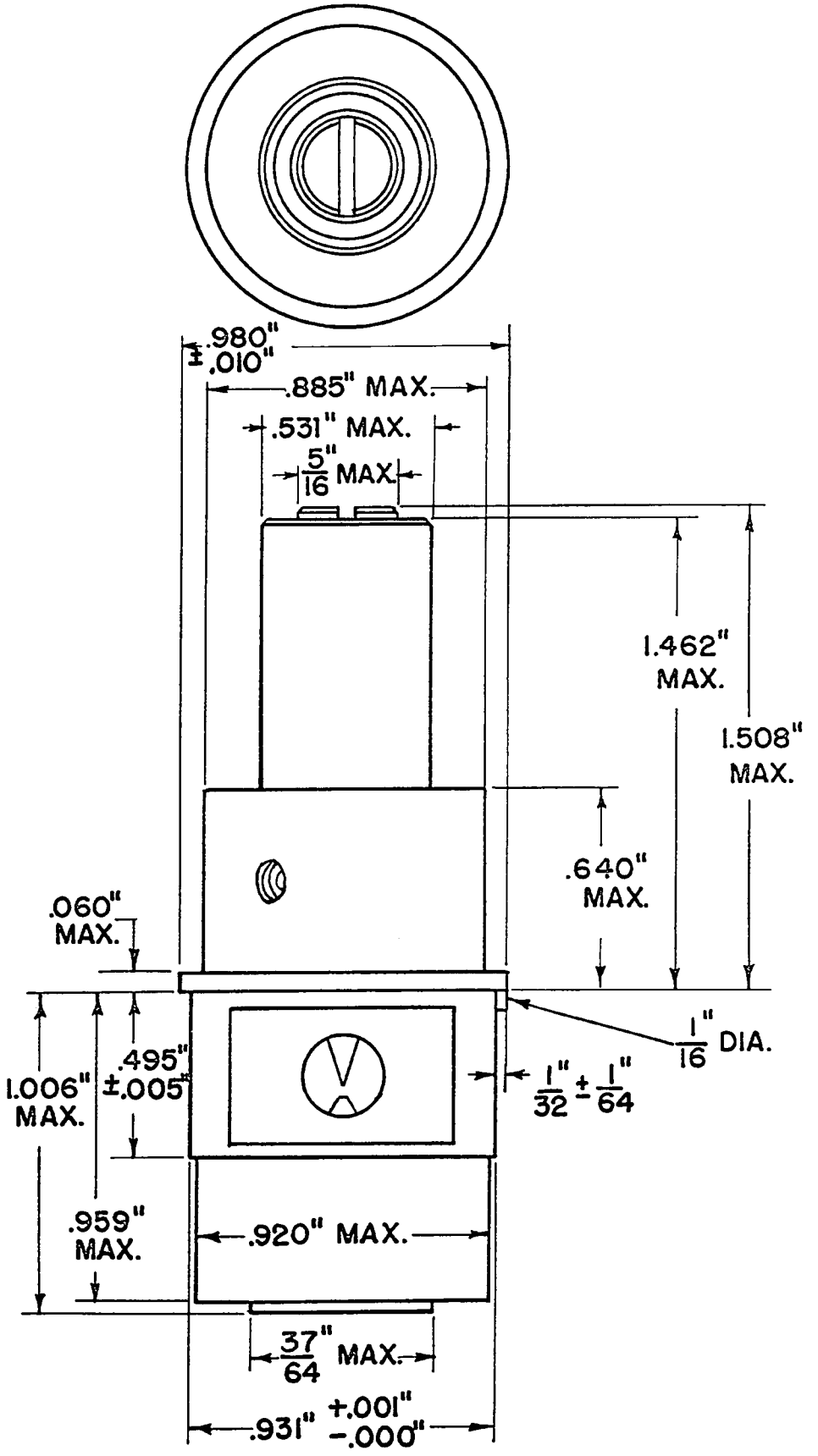
MAXIMUM RATINGS

Frequency Shift with Temp. Change from 25°C to 100°C.	± 0.6 Megacycles
Ambient Temperature Range	-50°C to +100°C

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1Q21


.980" ±.010"
.885" MAX.
.531" MAX.
5/16" MAX.
1.462" MAX.
1.508" MAX.
.640" MAX.
.060" MAX.
1/16" DIA.
1.006" MAX.
.495" ±.005"
1/32" ± 1/64"
.959" MAX.
.920" MAX.
37/64" MAX.
.931" +.001" -.000"

12-5-45

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Types 1Q22, 1Q23, 1Q24 and 1Q25

Reference Cavities

GENERAL CHARACTERISTICS

Electrical

Frequency	
1Q22	9250 ± 0.3 Megacycles
1Q23	9280 ± 0.3 Megacycles
1Q24	9310 ± 0.3 Megacycles
1Q25	9375 ± 0.6 Megacycles
Insertion Loss	4 - 6 Decibels
Loaded Q	1900 - 2400
Input Standing Wave Ratio in Voltage	2.3

Mechanical

Internal Atmosphere	Vacuum
Dimensions	Outline
Mounting Position	Any

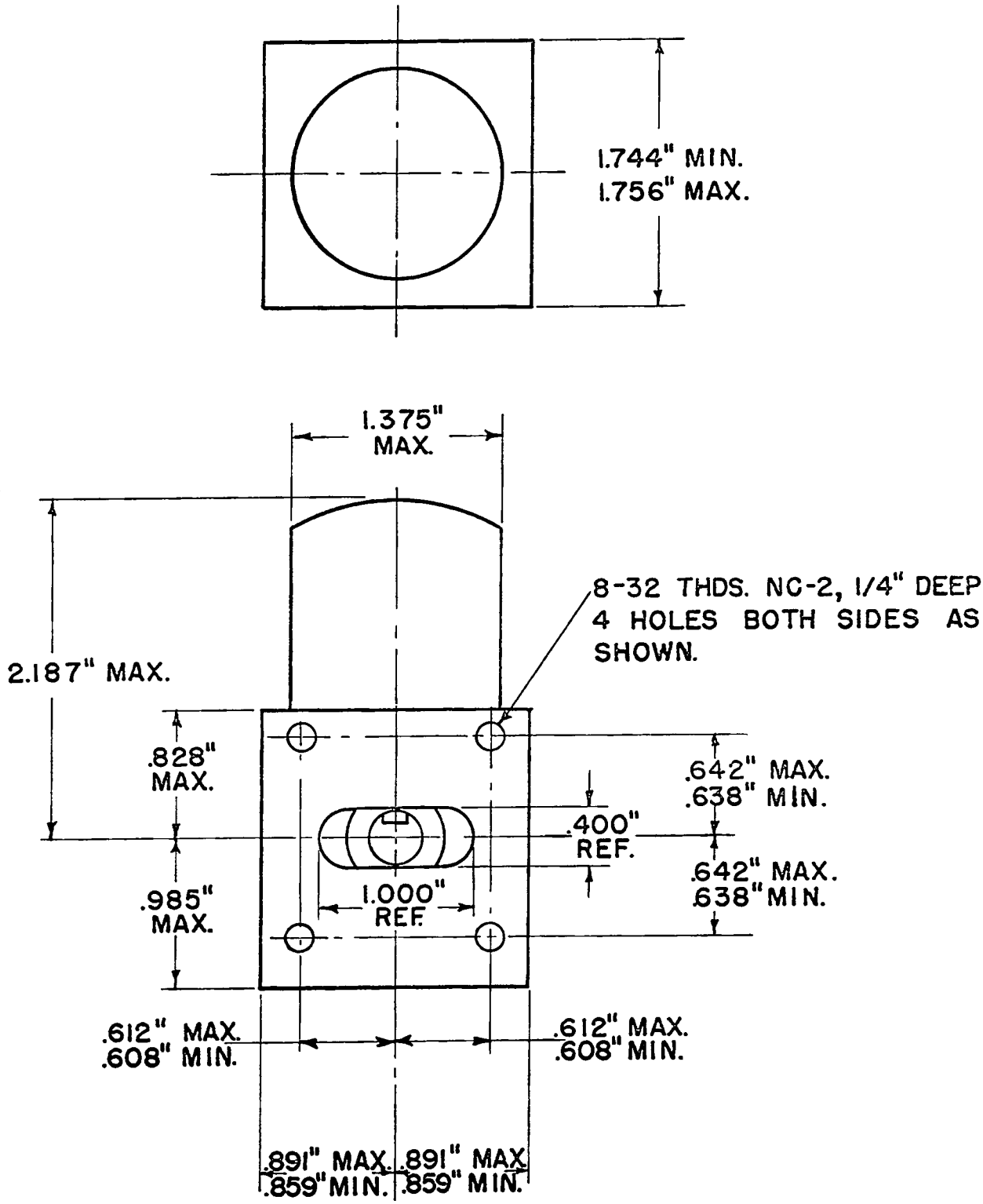
MAXIMUM RATINGS

Frequency Shift with Temperature from 25°C to 100°C	± 0.5 Megacycles
Frequency Shift with Barometric Pressure from Atmospheric to Vacuum	± 0.15 Megacycles
Frequency Shift Due to 10 g. Shock or Vibration	± 0.1 Megacycles
Ambient Temperature Range	-50 to +100°C

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

IQ 22, 23, 24 & 25


1.744" MIN.
1.756" MAX.
1.375" MAX.
2.187" MAX.
8-32 THDS. NC-2, 1/4" DEEP
4 HOLES BOTH SIDES AS
SHOWN.
.828" MAX.
.985" MAX.
.642" MAX.
.638" MIN.
.400" REF.
1.000" REF.
.642" MAX.
.638" MIN.
.612" MAX.
.608" MIN.
.612" MAX.
.608" MIN.
.891" MAX.
.859" MIN.
.891" MAX.
.859" MIN.

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 1R21

Ignitron Type for Radar Pulsing Service

GENERAL CHARACTERISTICS

Electrical

Ignitor Voltage	900 Volts
Ignitor Current	200 Amperes
Pulse Rate	135 Pulses/Second

Mechanical

Metal Envelope

Dimensions	See Outline
Mounting Position	Vertical, Anode Up
Cooling	Forced Air

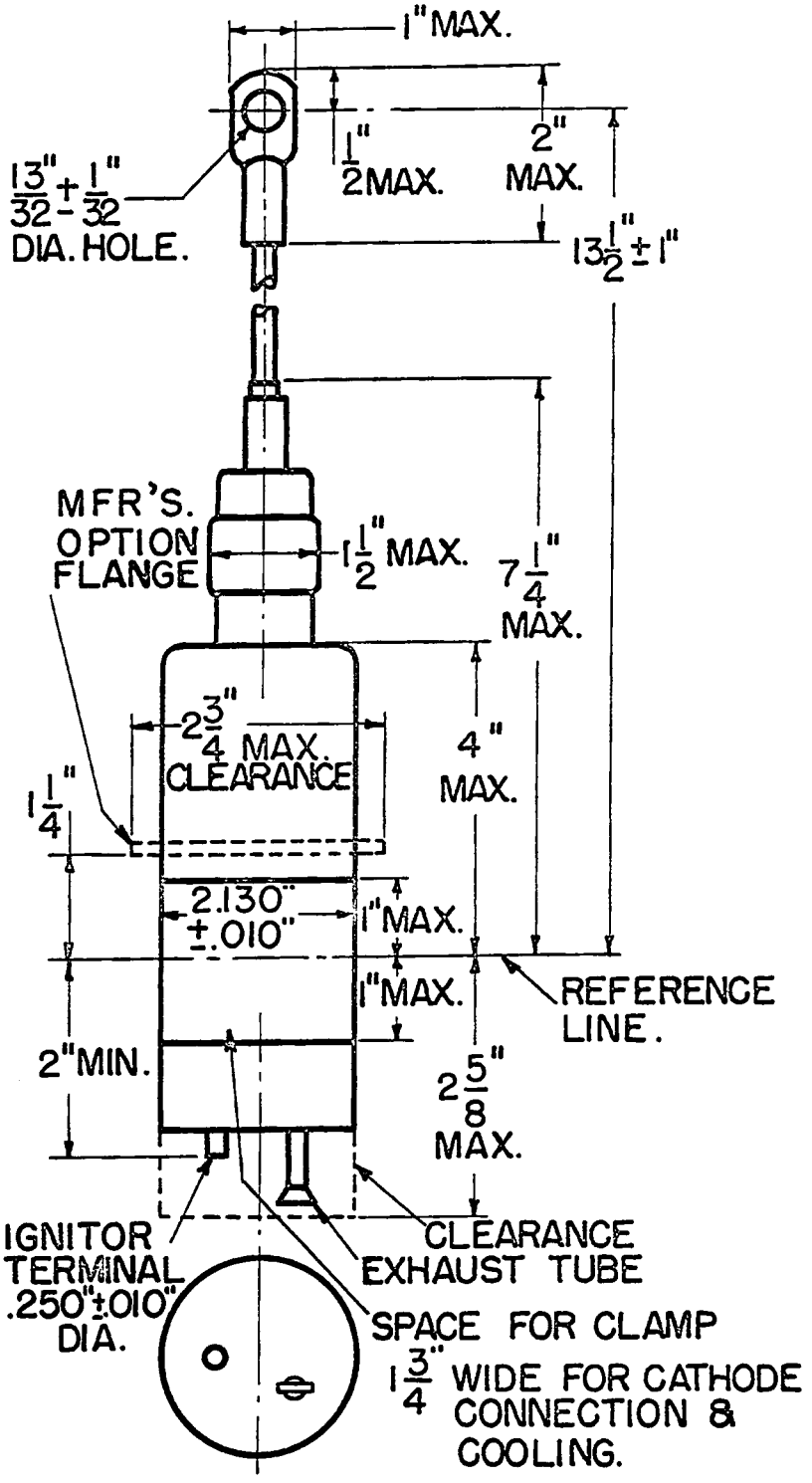
MAXIMUM RATINGS

Maximum Peak Forward Voltage	9 Kilovolts
Maximum Inverse Voltage	2.0 Kilovolts
Maximum Peak Current	400 Amperes
Maximum Average Current	.5 Ampere
Ambient Temperature Range	-20 to +55°C

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

1R21


1" MAX.
1" 2 MAX.
2" MAX.
13/32" + 1/32" - 1/32" DIA. HOLE.
13 1/2" ± 1"
MFR'S. OPTION FLANGE
1 1/2" MAX.
7 1/4" MAX.
2 3/4" MAX. CLEARANCE
4" MAX.
1 1/4"
2.130" ± .010"
1" MAX.
1" MAX.
REFERENCE LINE.
2" MIN.
2 5/8" MAX.
IGNITOR TERMINAL .250" ± .010" DIA.
CLEARANCE EXHAUST TUBE
SPACE FOR CLAMP
1 3/4" WIDE FOR CATHODE CONNECTION & COOLING.

12-5-45

Westinghouse

2DX4
3DX4
6DX4

January 1, 1963

UHF TRIODE TYPES 2DX4, 3DX4 AND 6DX4

The 2DX4, 3DX4 and 6DX4 are miniature 7-pin triodes designed for local oscillator service in television receivers which operate in the ultra-high-frequency region. Internal lead inductance is reduced by employing double connections to the plate and grid.

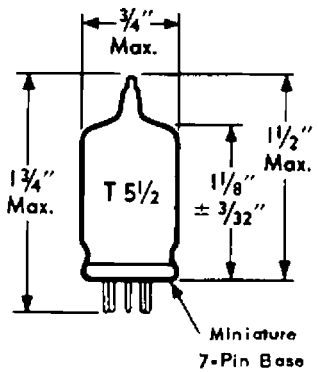
The 2DX4 and 3DX4 have been designed for use in receivers which employ series connected heaters, especially in television receivers where the picture-tube heater is in series with other heaters. When each is employed in this type of circuit with other tubes similarly designed having the same heater current rating, heater voltage surges across individual tubes are minimized inasmuch as heater warm-up characteristic is controlled.

ELECTRICAL

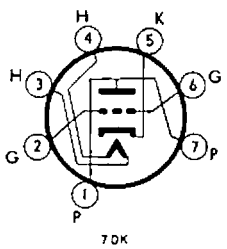
Cathode	Coated Unipotential			
Heater:	2DX4	3DX4	6DX4	
Voltage (ac or dc)	2.4	3.0	6.3 ± 0.6	Volts
Current	0.6 ± 0.040	0.45 ± 0.030	0.20	Ampere
Warm-Up Time (Note 1)	11	11	–	Seconds
Direct Interelectrode Capacitances:		Shielded	Unshielded	
Grid to Plate		1.6	1.6	μμf
Input		3.9	3.7	μμf
Output		1.5	0.38	μμf
Plate to Cathode		0.18	0.20	μμf
Grid to Cathode		3.6	3.6	μμf
Heater to Cathode		3.4	3.4	μμf

MECHANICAL

Bulb	T-5-1/2
Base	Miniature 7-Pin (JEDEC E7-1)
Basing	7DK
Mounting Position	Any
Outline	5-1



CE-A551



UHF OSCILLATOR SERVICE

MAXIMUM RATINGS

Design Maximum Values

DC Plate Voltage	150	max.	Volts
DC Grid Voltage	–50	max.	Volts
DC Grid Current	2	max.	Ma.
Plate Dissipation	2.2	max.	Watts
DC Cathode Current	20	max.	Ma.
Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode:			
Total DC + Peak	100	max.	Volts
Heater Positive with Respect to Cathode:			
DC Component	50	max.	Volts
Total DC + Peak	100	max.	Volts

TYPICAL OPERATION at 1000 Mc: (Note 2)

Plate Supply Voltage	100	Volts
Plate Resistor	220	Ohms
Grid Resistor	10000	Ohms
Plate Current	14	Ma.
Grid Current	250	μamp

CHARACTERISTICS

Plate Voltage	85	Volts
Cathode Bias Resistor	150	Ohms
Amplification Factor	30	–
Plate Resistance	2700	Ohms
Transconductance	11000	μmhos
Plate Current	10	Ma.

NOTES

1. Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying four times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to three times rated heater voltage divided by rated heater current.
2. Measured in JEDEC standard UHF oscillator No. 400.

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Receiving Tube Section

WESTINGHOUSE ELECTRIC CORPORATION ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #4105, Jan. 28, 1963

Westinghouse

6HM5
4HM5
3HM5
2HM5

August 20, 1963

SHARP-CUTOFF TRIODE 2HM5, 3HM5, 4HM5 AND 6HM5

The 2HM5, 3HM5, 4HM5 and 6HM5 are sharp-cutoff, seven-pin miniature triode types designed particularly for service in V.H.F. television tuners as grounded cathode r-f amplifiers. These types are electrically and mechanically similar to the 2HA5, 3HA5, 4HA5 and 6HA5 except for bulb length.

The 2HM5, 3HM5 and 4HM5 have been designed for use in receivers which employ series connected heaters, especially in television receivers where the picture-tube heater is in series with other heaters. When each is employed in this type of circuit with other tubes similarly designed having the same heater current rating, heater voltage surges across individual tubes are minimized inasmuch as heater warm-up characteristic is controlled.

ELECTRICAL:

Heater Characteristics:	2HM5	3HM5	4HM5	6HM5	
Voltage (ac or dc)	2.4	2.9	4.0	6.3	Volts
Current	0.60	0.45	0.30	0.185	Ampere
Warm-up Time (Note 1)	11	11	11	–	Seconds
Direct Interelectrode Capacitances: (Shielded) (Note 2)					
Grid to Plate			0.34 max.		μμf
Input			4.5		μμf
Output			3.0		μμf
Heater to Cathode			2.5		μμf

MECHANICAL:

Cathode	Coated Unipotential
Bulb	T-5-½
Base	Miniature 7-Pin (JEDEC E7-1)
Outline	5-2
Basing	7GM
Mounting Position	Any

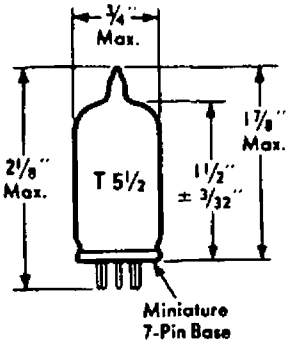
RATINGS:

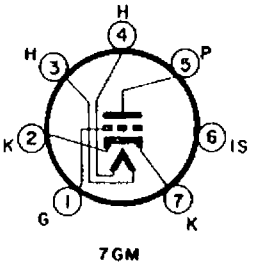
Design Maximum Values

Plate Voltage				200 max.	Volts
Plate Dissipation				2.2 max.	Watts
Grid Voltage:					
Negative Value				50 max.	Volts
Cathode Current				20 max.	Ma.
Grid Circuit Resistance (Self Bias)				1.0 max.	Megohm
Heater Ratings:					
Allowable Heater Voltage	2HM5	3HM5	4HM5	6HM5	
Maximum	–	–	–	6.9 max.	Volts
Minimum	–	–	–	5.7 min.	Volts
Allowable Heater Current:					
Maximum	640	480	320	– max.	Ma.
Minimum	560	420	280	– min.	Ma.
Heater-Cathode Voltage:					
Heater Negative with Respect to Cathode DC	100	100	100	max.	Volts
Heater Positive with Respect to Cathode DC	100	100	100	max.	Volts

CHARACTERISTICS & TYPICAL OPERATION:

Plate Voltage	120	135	Volts
Grid Voltage	0	–1	Volts
Grid Resistance	0.1	0	Megohm
Transconductance	18,000	14,500	μmhos
Grid Cutoff Bias	See Note 6	See Note 3	
Plate Current	15.0	12.5	Ma.
Amplification Factor	82	78	–
Hot Input Resistance (Note 4)	–	1000	Ohms
Hot Input Capacitance (Note 4)	–	8.5	μμf
Noise Figure (Note 5)	4.0	4.2	db





7GM

NOTES

1. Heater Warm-up Time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying four times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to three times rated heater voltage divided by rated heater current.
2. With JEDEC shield No. 316 connected to ~~Pin 1~~ cathode.
3. Grid Volts for gm = 150 μmhos: –5.7
   Grid Volts for gm = 1500 μmhos: –2.7
4. Measured at 200 Mc. with plate at signal ground. Ect = –1.5 Volt.
5. In a 200 Mc. noise-matched, optimized, neutralized, grounded-cathode triode amplifier stage.
6. Grid volts for gm = 150 μmhos: –5.1

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #4413, Sept. 16, 1963

WESTINGHOUSE ELECTRONIC TUBES

Type 2J21

Magnetron

GENERAL CHARACTERISTICS

Electrical

Cathode	Unipotential, Coated
Filament Voltage	6.3 Volts
Filament Current	1.2 - 1.4 Amperes
Frequency	9345 - 9405 Megacycles
Magnetic Field Strength	2400 Gauss
Pulse Duration	1 Microsecond
Repetition Rate	1000 Cycles/Sec.
Anode Voltage	10.5 - 12.5 Kilovolts
Anode Current, Peak	10 Amperes
Peak Power Output	10 Kilowatts

Mechanical

Dimensions	See Outline
Mounting Position	Any
Cooling	Forced Air

MAXIMUM RATINGS

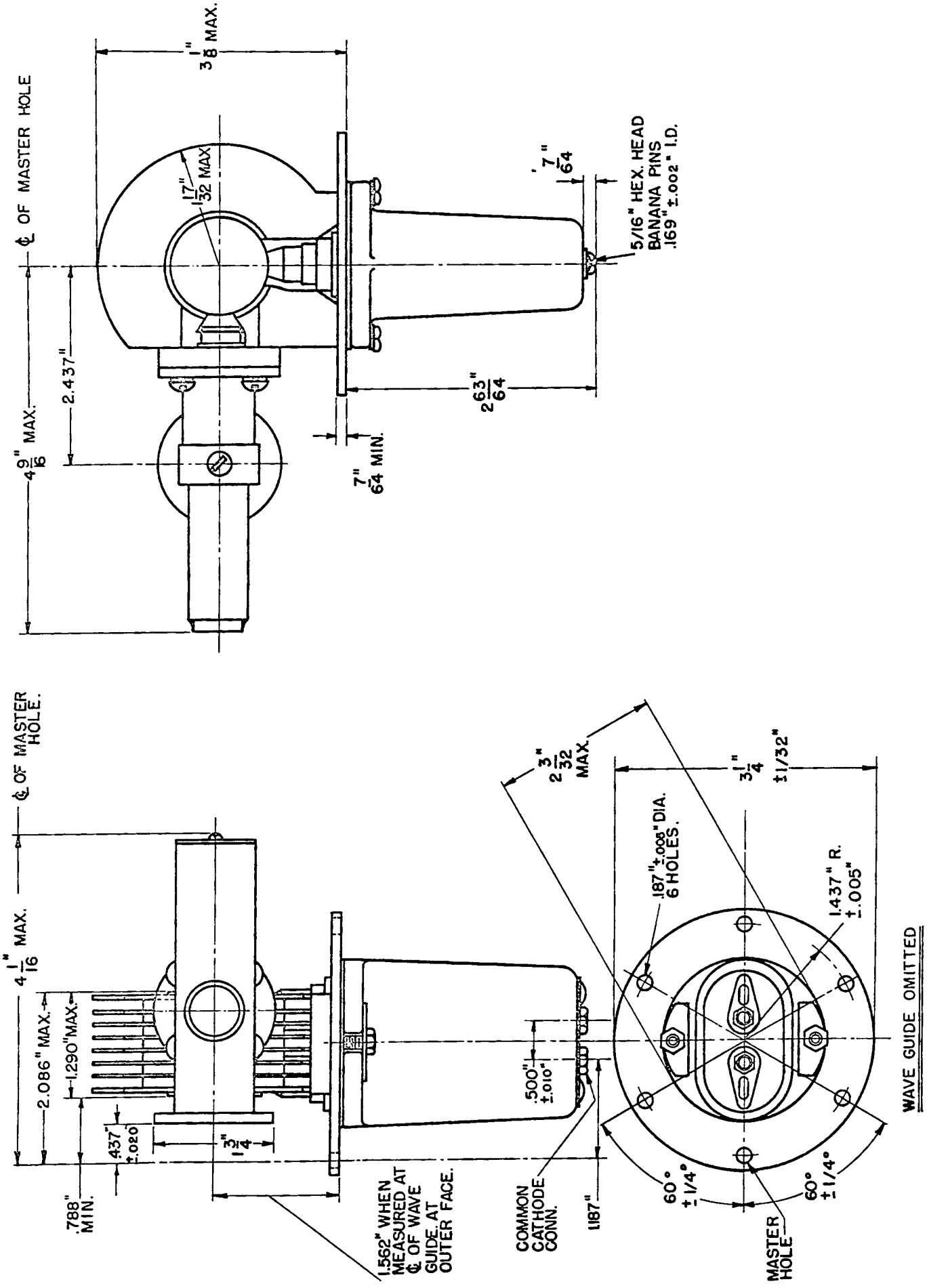
Peak Anode Voltage	13.5 Kilovolts
Peak Anode Current	10 Amperes
Anode Dissipation	180 Watts
Duty Cycle	.002
Anode Temperature	100° C

Tube shall not be operated longer than 5 microseconds in any 100 microsecond interval.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

2J21


℄ OF MASTER HOLE
1" 3/8 MAX.
17" 1/32 MAX
7" 1/64
5/16" HEX. HEAD BANANA PINS .169" ±.002" I.D.
4 9/16" MAX.
2.437"
2 63/64"
7" 64 MIN.
℄ OF MASTER HOLE.
4 1/16" MAX.
2.086" MAX.
1.290" MAX.
.437" ±.020
1 3/4"
.788" MIN.
1.562" WHEN MEASURED AT ℄ OF WAVE GUIDE AT OUTER FACE.
COMMON CATHODE CONN.
.500" ±.010"
1.187"
2 3/32" MAX.
3 1/4" ±1/32"
.187" ±.008" DIA. 6 HOLES.
1.437" R. ±.005"
60° ±1/4°
60° ±1/4°
MASTER HOLE
WAVE GUIDE OMITTED

12-5-45

WESTINGHOUSE ELECTRONIC TUBES

Type 2K40

Velocity Modulation Amplifier/Oscillator (Klystron)

GENERAL CHARACTERISTICS

Electrical

Cathode	Unipotential Coated
Heater Voltage	6.3 Volts
Heater Current	0.33 - 0.39 Amperes
Frequency Range	5000-10,000 Megacycles
Accelerator Potential	250 Volts
Disk Potential	1200 Volts
Collector Potential	1200 Volts
Power Output	30 Milliwatts

Mechanical

Dimensions	See Outline
Mounting Position	Any
Mechanical Tuning	Yes

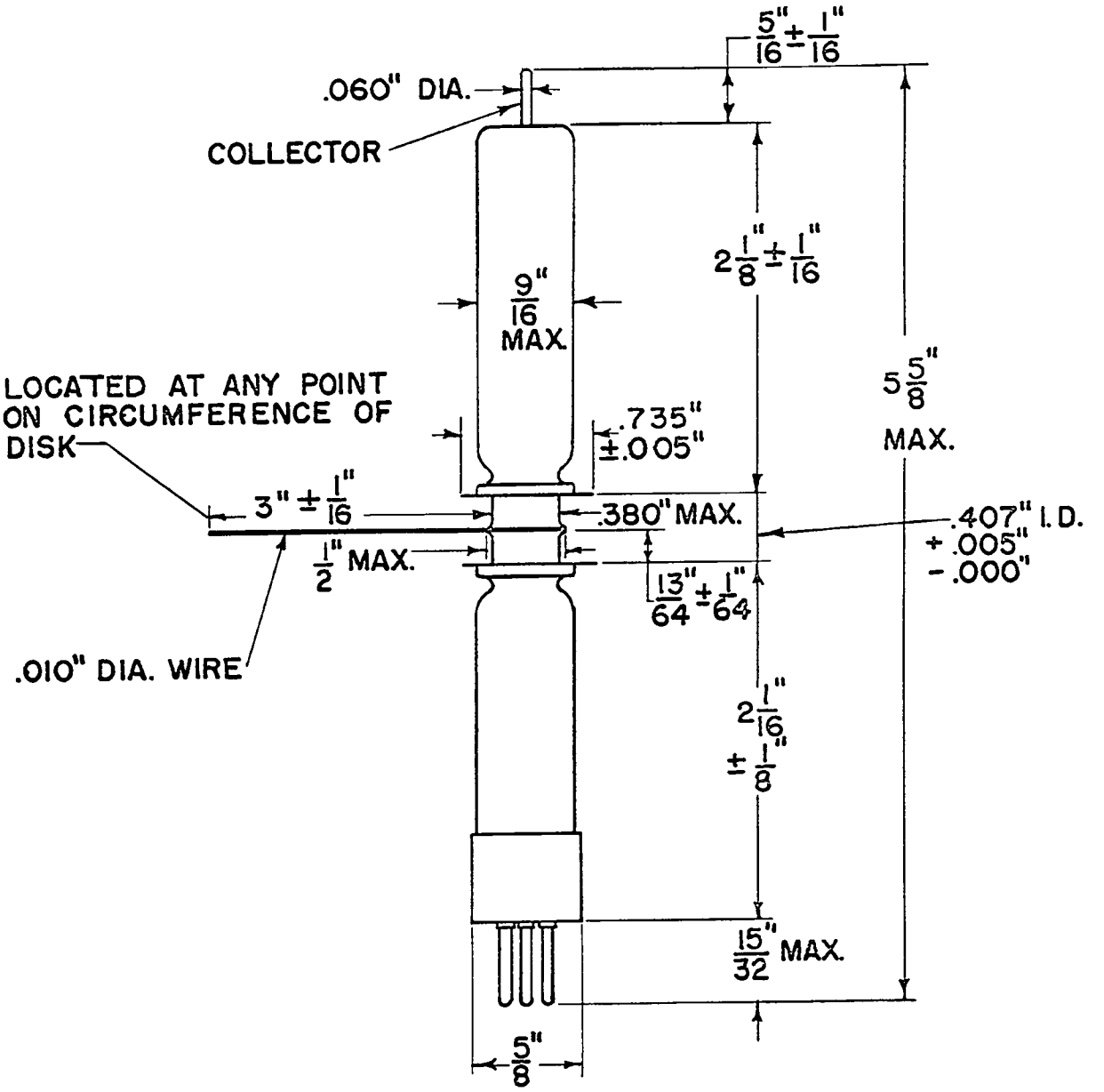
MAXIMUM RATINGS

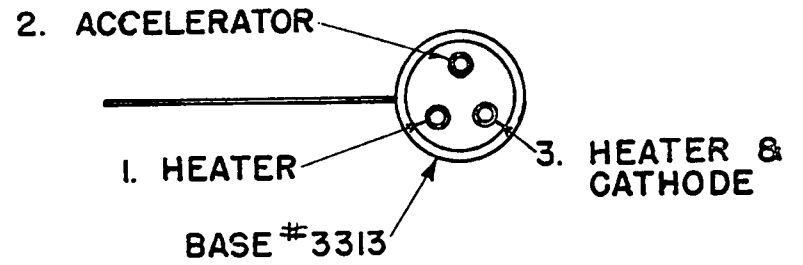
Power Input	18 Watts
Dissipation	18 Watts
Resonator Voltage	1200 Volts
Resonator Current	4 Milliamps.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

2K40


5/16" ± 1/16"
.060" DIA.
COLLECTOR
2 1/8" ± 1/16"
9/16" MAX.
5 5/8" MAX.
LOCATED AT ANY POINT ON CIRCUMFERENCE OF DISK
.735" ±.005"
3" ± 1/16"
.380" MAX.
.407" I.D. +.005" -.000"
1/2" MAX.
13/64" ± 1/64"
.010" DIA. WIRE
2 1/16" ± 1/8"
15/32" MAX.
5/8"


2. ACCELERATOR
1. HEATER
3. HEATER & CATHODE
BASE #3313

12-5-45

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Type 2K51, 2K52, 2K53

Secondary Emission Klystron

GENERAL CHARACTERISTICS

Electrical

Cathode	Unipotential Coated
Heater Voltage	6.3 Volts
Heater Current	1.4 Amperes
Mechanical Tuning Range	
2K51	2700 - 3300 Megacycles
2K52	2900 - 3700 Megacycles
2K53	3200 - 4000 Megacycles
Electronic Tuning Range	40 Megacycles
Resonator Voltage Range	1500 - 3000 Volts
Secondary Cathode Voltage Range Positive with Respect to Cathode	0 - 500 Volts
Grid Voltage Range	0 - 150 Volts
Power Output	5 - 30 Watts

Mechanical

Dimensions	See Outline
Mounting Position	Any
Mechanical Tuning	Yes

MAXIMUM RATINGS

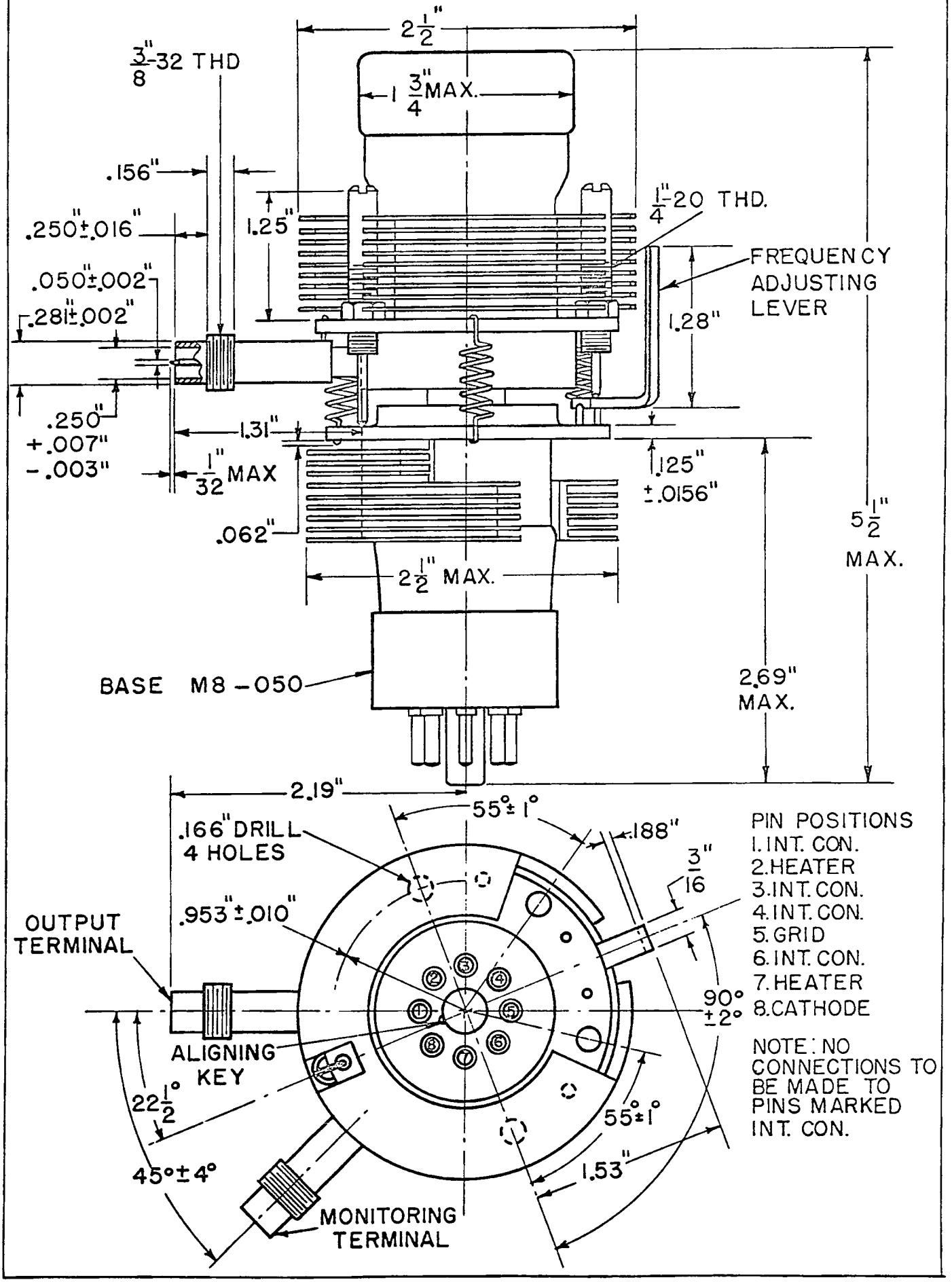
Power Input	700 Watts
Dissipation *	700 Watts
Resonator Voltage	3000 Volts
Resonator Current	300 Milliamps.

* Forced air cooling must be used if power input exceeds 50 watts.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

2K51,52,53


2 1/2"
3/8"-32 THD
1 3/4" MAX.
.156"
.250"±.016"
1.25"
1/4"-20 THD.
FREQUENCY ADJUSTING LEVER
.050"±.002"
.281"±.002"
1.28"
.250" +.007" -.003"
1.31"
1/32" MAX
.125" ±.0156"
5 1/2" MAX.
.062"
2 1/2" MAX.
BASE M8-050
2.69" MAX.
2.19"
55°±1°
.188"
.166" DRILL 4 HOLES
3/16"
.953"±.010"
OUTPUT TERMINAL
90° ±2°
ALIGNING KEY
22 1/2°
55°±1°
45°±4°
1.53"
MONITORING TERMINAL
PIN POSITIONS
1. INT. CON.
2. HEATER
3. INT. CON.
4. INT. CON.
5. GRID
6. INT. CON.
7. HEATER
8. CATHODE
NOTE: NO CONNECTIONS TO BE MADE TO PINS MARKED INT. CON.

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Types 4J70, 4J71, 4J72 and 4J73

Magnetrons

GENERAL CHARACTERISTICS

Electrical

Cathode	Unipotential, Coated
Heater Voltage	16.0 Volts
Heater Current	2.8 - 3.4 Amperes
Mechanical Tuning Range	
4J70	3710 - 3540 Megacycles
4J71	3560 - 3390 Megacycles
4J72	3410 - 3240 Megacycles
4J73	3260 - 3090 Megacycles
Magnetic Field Strength	2500 Gauss
Power Output at .0006 Duty Cycle and 70 Amperes	350 Watts

Mechanical

Dimensions	See Outline
Mounting Position	Any
Cooling	Forced Air

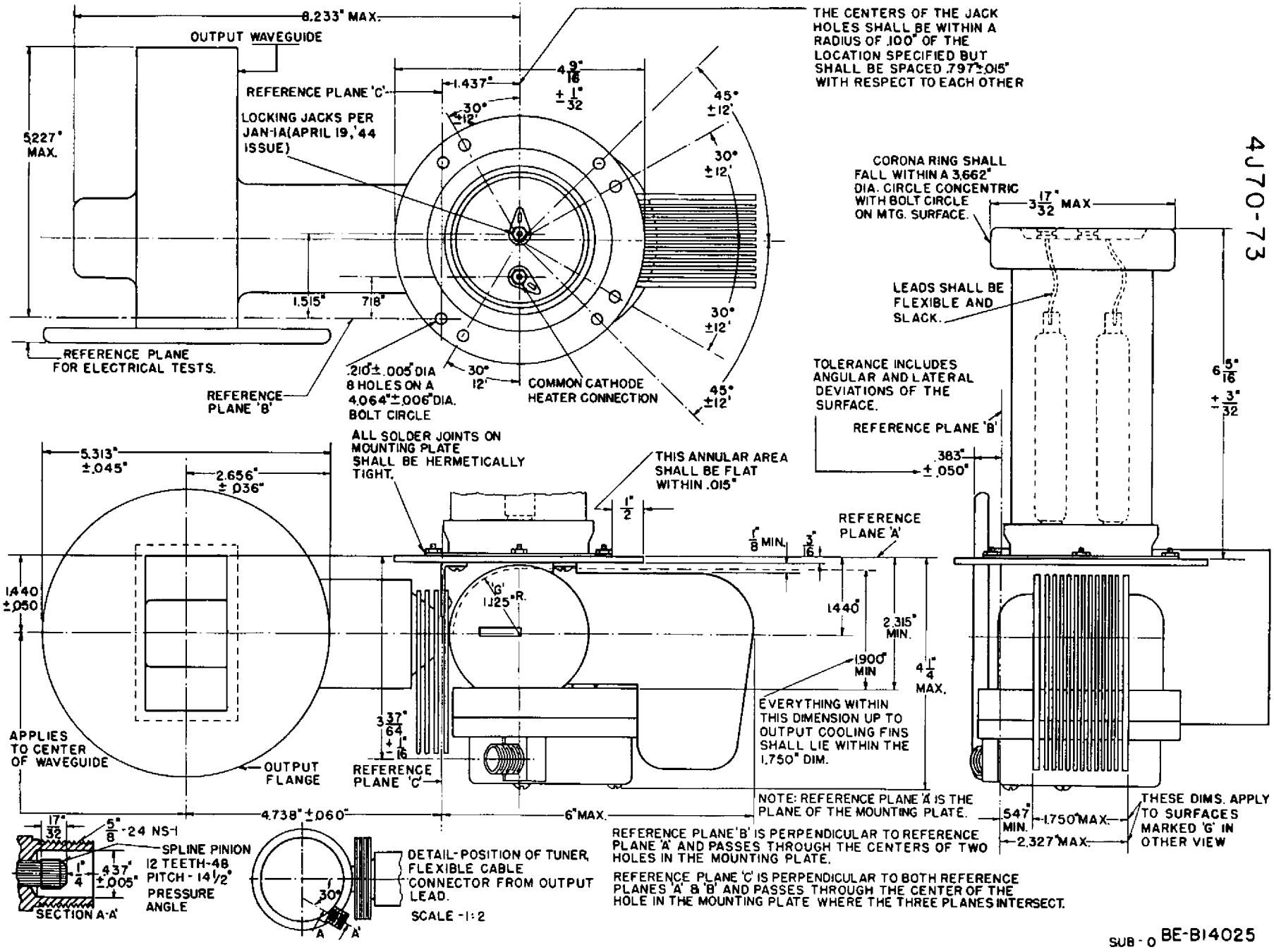
MAXIMUM RATINGS

Peak Anode Voltage	30 Kilovolts
Peak Anode Current	70 Amperes
Anode Dissipation	700 Watts
Duty Cycle *	.001
Anode Temperature	125° C
Pulse Duration	2.5 Microseconds

* The tube shall not be operated longer than 5 microseconds in any 100 microsecond interval.

Bloomfield, New Jersey December 5, 1945

from RMA release # 568, Feb. 27, 1947



4J70-73

SUB - 0 BE-B14025

WESTINGHOUSE ELECTRONIC TUBES

SECURITY CLASSIFICATION Confidential

Types 4J74, 4J75, 4J76 and 4J77

Tunable Magnetrons

GENERAL CHARACTERISTICS

Electrical

Cathode	Unipotential, Coated
Heater Voltage	16.0 Volts
Heater Current	2.8 - 3.4 Amperes
Mechanical Tuning Range	
4J74	3110 - 2990 Megacycles
4J75	3010 - 2890 Megacycles
4J76	2910 - 2790 Megacycles
4J77	2810 - 2690 Megacycles
Magnetic Field Strength	2700 Gauss
Power Output at .0006 Duty Cycle and 70 Amperes	450 Watts

Mechanical

Dimensions	See Outline
Mounting Position	Any
Cooling	Forced Air

MAXIMUM RATINGS

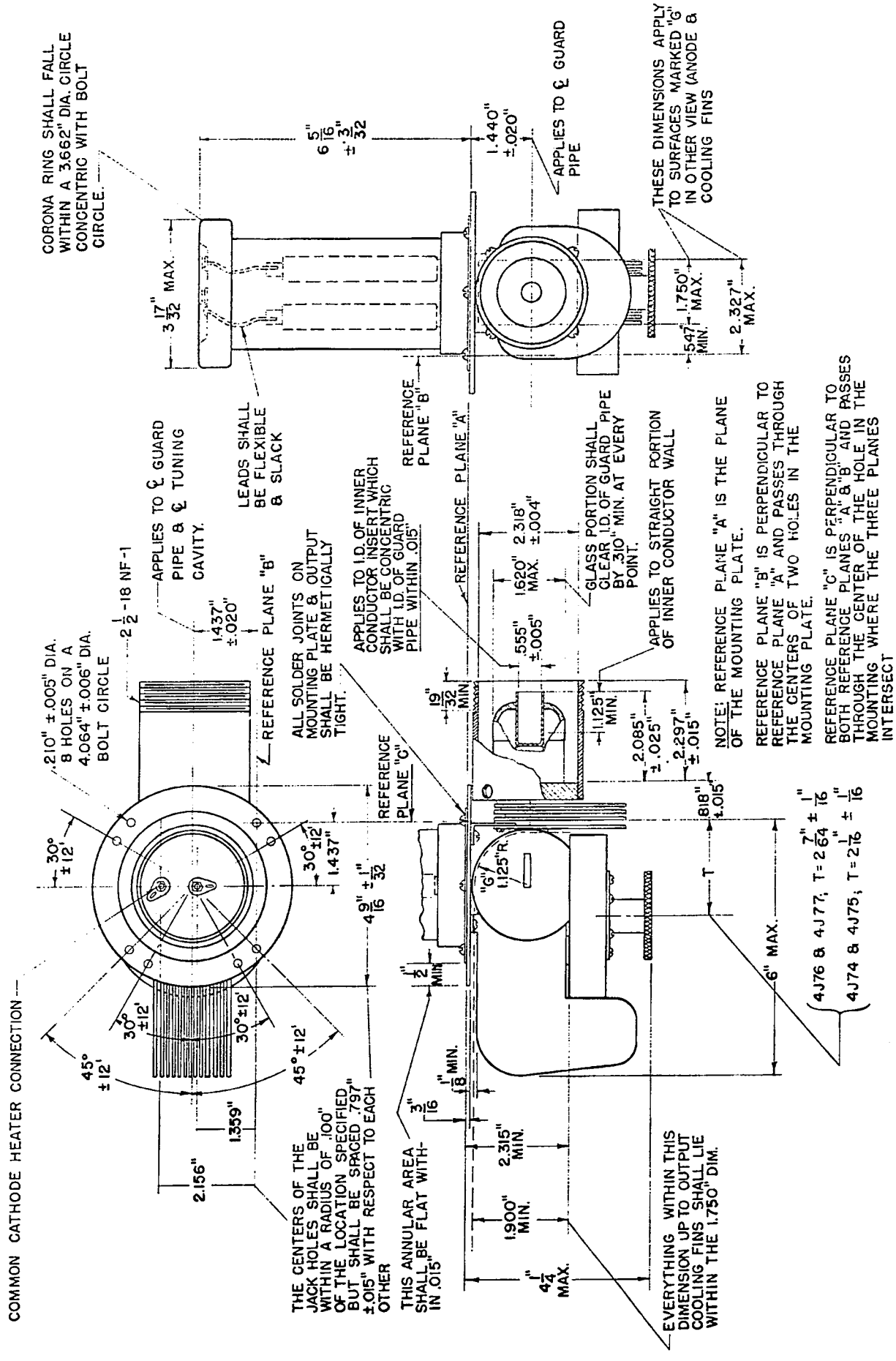
Peak Anode Voltage	30 Kilovolts
Peak Anode Current	70 Amperes
Anode Dissipation	700 Watts
Duty Cycle *	.001
Anode Temperature	125° C
Pulse Duration	2.5 Microseconds

* The tube shall not be operated longer than 5 microseconds in any 100 microsecond interval.

Bloomfield, New Jersey December 5, 1945

from RMA release # 470, Feb. 11, 1946

4J74-77



12-5-45

RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 436

September 20, 1945

sponsor:
Westinghouse Electric Corp.

RMA TYPE

5B21

Gas-Filled Rectifier

GENERAL CHARACTERISTICS

Electrical

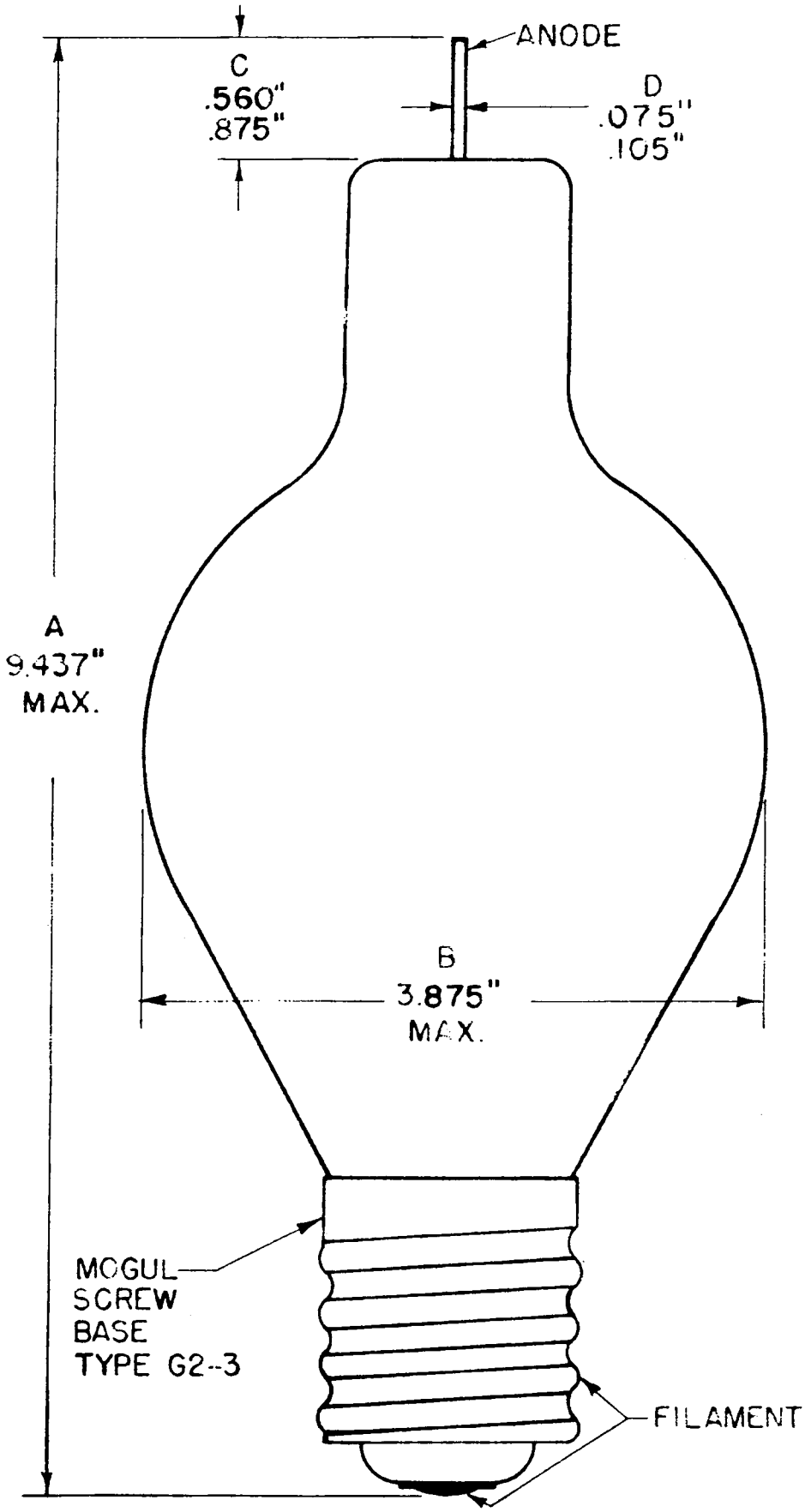
Filament:	Thoriated Tungsten
Voltage	2.5 Volts
Current	25 Amps.
Pickup Voltage (d.c.)	
Average	12.0 Volts
Range	8 - 16 Volts
Arc Voltage	
Average	7.5 Volts
Range	5 - 9 Volts

Mechanical

Type of Cooling	Convection
Base	Mogul Screw Type G2-3
Maximum Overall Dimension	
Length	9-7/16 Inches
Diameter	3-7/8 Inches

Maximum Ratings

Current	
Average	15.0 Amperes
Peak	90.0 Amperes
Output Voltage	60 Volts d.c.
Peak Inverse Voltage (Half-Wave Circuit)	225 Volts
Temperature (Ambient)	-50 to + 65


ANODE
C
.560"
.875"
D
.075"
.105"
A
9.437"
MAX.
B
3.875"
MAX.
MOGUL
SCREW
BASE
TYPE G2-3
FILAMENT

Low Drive
Type 10AMP7
July 6, 1960

HIGH TRANSCONDUCTANCE RADAR DISPLAY TUBE TYPE 10AMP7

The 10AMP7 is a low drive cathode ray tube with low-voltage-electrostatic focus and magnetic deflection designed for service in radar display applications. An input signal of 3.5 to 5.5 volts having a bandwidth of 13 megacycles will drive the tube to full brightness (400 to 750 microamperes peak anode current). Other characteristics include round glass construction, relatively flat, neutral gray glass faceplate and a long-persistence P 7 screen.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.6 ± 10%	Ampere
Direct Interelectrode Capacitances:		
Triode Unit:		
Grid to Cathode	4.5	μμf
Grid to Plate (Note 1)	2.3	μμf
Grid to CRT Gun Grid 1	1.0	μμf
CRT Gun Unit:		
Grid 2 (Note 1) to Grid 1	5.7	μμf
Grid 2 (Note 1) to all electrodes except Grid 1	6.0	μμf
Grid 1 to all electrodes except Grid 2 (Note 1)	3.9	μμf
Input:		
Cathode Drive (Note 2)	45	μμf
Grid Drive (Note 2)	50	μμf
Output	8	μμf
Screen:		
Phosphor	P7	
Fluorescence	Blue	
Phosphorescence	Greenish-Yellow	
Persistence	Long	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angle	53°	

MECHANICAL:

Mounting Position	Any
Minimum Screen Diameter	9"
Faceplate:	
Configuration	Spherical
Glass	Neutral Gray
Transmittance	76%
Bulb Diameter	10-1/2" ± 1/16"
Overall Length	16-9/16" ± 3/8"
Anode Terminal	Recessed Small Cavity Cap (JEDEC J1-21)
Base	Small Shell Duodecal 7-Pin (JEDEC B7-223)
Net Weight	10 Pounds

from JEDEC release #2939, Aug. 22, 1960
sponsor: Westinghouse Electric Corp.

MAXIMUM RATINGS:

Absolute Maximum Values			
CRT Gun Unit:			
Anode Voltage	12000	max.	Volts
Grid 4 (Focus) Voltage	1000	max.	Volts
Grid 2 & Triode Plate Voltage	350	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	150	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater-Positive with respect to Cathode	180	max.	Volts
Heater Negative with respect to Cathode (Note 3)	180	max.	Volts
Triode Unit:			
Grid Negative Bias	50	max.	Volts
Plate Dissipation (Note 1)	3.5	max.	Watts
Average Cathode Current	25	max.	Ma.

LIMITING CIRCUIT VALUES:

CRT Gun Grid 1 Circuit Resistance	0.5	max.	Megohm
Triode Grid Circuit Resistance	50000	max.	Ohms

TYPICAL OPERATING CONDITIONS:

0 to 13 Mc. Bandpass (Note 4)

CRT Gun Unit:		
Anode Voltage	10000	Volts
Grid 4 (Focus) Voltage (Notes 5 & 6)	0 to 600	Volts
Grid 2 & Triode Plate Supply Voltage, Ebb (Note 1)	300	Volts
Grid 2 & Triode Plate Voltage, Ebo (Notes 6 & 7)	160	Volts
Grid 1 Supply Voltage, Eccl (Note 2)	-200 to -250	Volts
Grid 1 Voltage for Spot Cut-off, Eco (Note 8)	-25 to -40	Volts
Triode Unit:		
Grid Bias Voltage (Notes 6 & 9)	-6.5	Volts
Amplification Factor	20	
Plate Resistance (Note 10)	1540	Ohms
Transconductance (Note 10)	13000	μmhos
Plate Current (Note 10)	20	Ma.
Plate Load Resistor	6800	Ohms
Gain (Approx.)	15	
Spot Position (Note 11)	18	mm

1. Triode plate and CRT Gun Grid 2 are connected internally.

2. Obtained for a value of voltage coupling coefficient k_c between triode plate and control grid equal to 0.5.

3. A peak value of 410 volts design center maximum may be applied for not more than 15 seconds during equipment warm-up periods.

4. A typical line width of .015" may be expected with an anode current of 100 microamperes.

5. Measured at 100 microamperes anode current.

6. Voltage measured with respect to cathode.

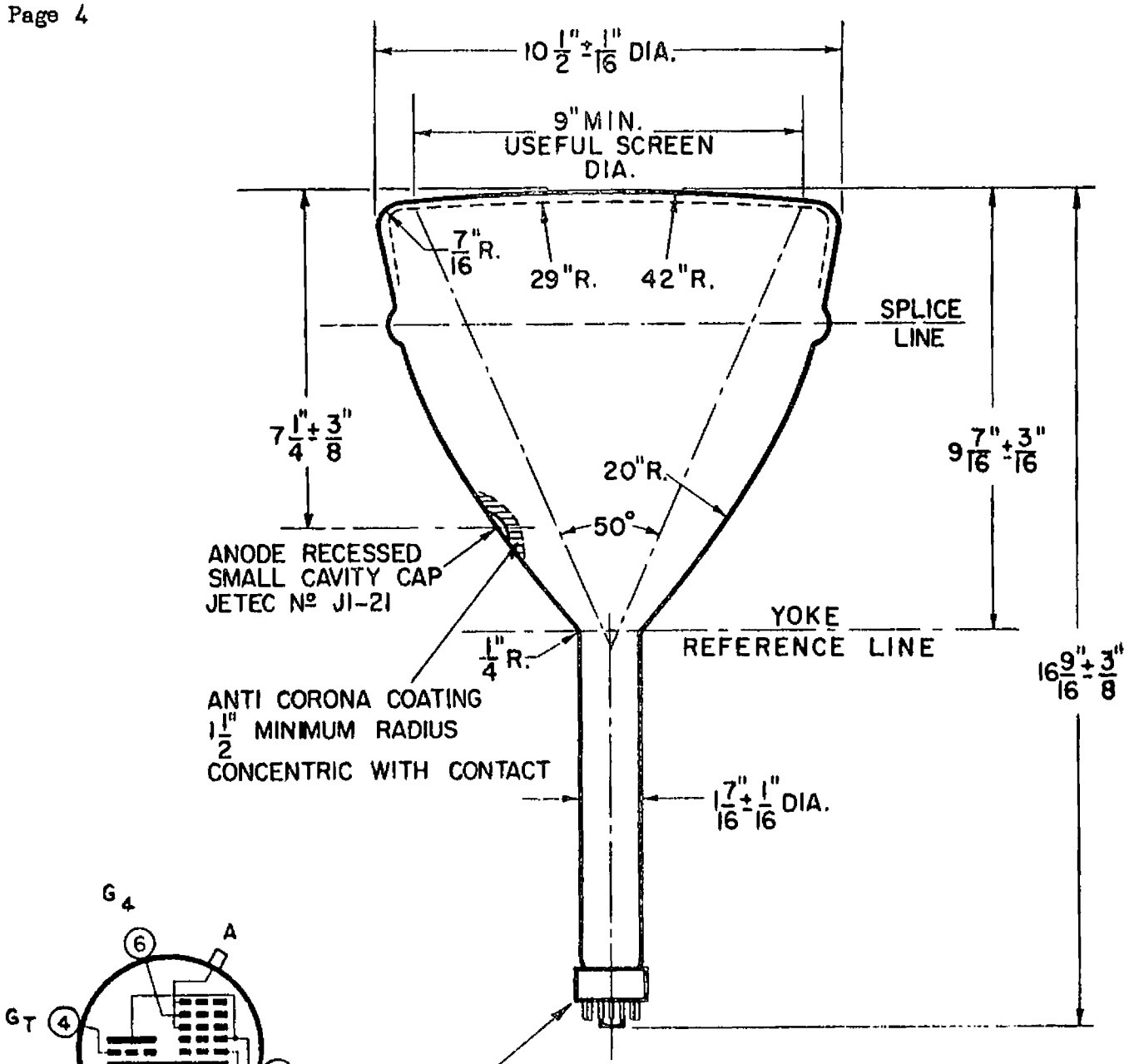
7. E_{bo} is the quiescent plate voltage at zero signal input (20 mA plate current).

8. Voltage difference between cathode and control grid pins required to cut off the cathode ray beam when the gun is operating at the quiescent plate voltage level E_{bo}.

9. For best performance adjust the triode grid bias for 20 mA plate current at zero signal input.

10. At indicated quiescent plate voltage E_{bo} operating point.

11. The center of the undeflected, unfocused spot will fall within a circle having an 18 mm radius concentric with the center of the tube face.



12BC

NOTES:

1. Reference line is determined by upper edge of RETMA Gage No. 112 when resting on cone of tube.

2. Radial tolerance of alignment of anode terminal with 3 is ± 10 degrees.

Caution: Do not handle tube by part of bulb having anti-corona coating.

October 29, 1956

RF and IF Pentode Type 12DK5

The 12DK5 is a 9-pin miniature pentode designed for service as an intermediate frequency amplifier in automobile receivers with a transistor output stage whose driving power is taken from the diode detector. The 12DK5 may also be used as a radio frequency amplifier since it features high transconductance at low plate and grid 2 voltages and low grid 1-plate capacity. The cutoff characteristics of the 12DK5 are especially suitable for avc operation.

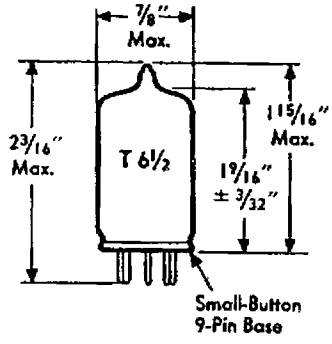
GENERAL DATA

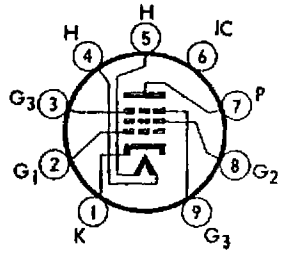
Electrical:

Cathode	Coated Unipotential	
Heater:		
Voltage	12.6	Volts
Current	0.3	Ampere
Direct Interelectrode Capacitances (shielded):#		
Grid to Plate	0.045	uuf
Input	9.5	uuf
Output	2.65	uuf

Mechanical:

Bulb	T-6-1/2
Base	Miniature 9-pin (JETEC E9-1)
Basing	9GT
Mounting Position	Any





from JETEC release #1776, Nov. 12, 1956

MAXIMUM RATINGS

Design-Maximum Values○

Plate	16 max.	Volts
Screen Voltage	16 max.	Volts
Heater-Cathode Voltage	16 max.	Volts
Grid 1 Voltage		
Positive	0 max.	Megohm

AMPLIFIER - CLASS A_1

Characteristics and Typical Operation

Plate Voltage	12.6	Volts
Grid 3 (suppressor) Voltage	0	Volts
Grid 2 (Screen) Voltage	12.6	Volts
Plate Current	2.0	Ma
Grid 2 Current	0.65	Ma
Transconductance	3300	umhos
Plate Resistance	100,000	Ohms
Grid Leak Resistor (Bypassed)	2.2	Megohms
Grid Voltage for I_b 10 ua.	2.5	Volts

With JETEC Shield #315 connected to ground

○ Design-Maximum Ratings are the limiting values expressed with respect to bogie tubes at which satisfactory tube life can be expected to occur in the types of service for which the tube is rated. Therefore, the equipment designer must establish the circuit design so that initially and throughout equipment life no design-maximum value is exceeded with a bogie tube under the worst probable operating conditions with respect to supply-voltage variation, equipment control adjustment, load variation and environmental conditions.

□ When used in automative service from a 12 volt source under no circumstances should the heater voltage be less than 10.0 volts or more than 15.9 volts. These extreme variations in heater voltage may be tolerated for short periods; however operation at or near these absolute limits in heater voltage necessarily involves sacrifice in performance at low heater voltage and in life expectancy at high heater voltage. Equipment reliability can be significantly increased with improved supply voltage regulation.

TELEVISION PICTURE TUBE TYPE 14AEP4

February 20, 1957

90° Deflection
Rectangular Glass
Magnetic Deflection

Low G2 Voltage
Cathode Drive Design
Aluminized
No Ion Trap

External Conductive Coating
Spherical Face Plate
12 1/16" x 9 1/2" Picture

The 14AEP4 is an electrostatic-focus picture tube of rectangular glass construction with a spherical face plate of neutral gray glass. Its features include an electron gun designed specifically for cathode drive operation. Fuller advantage is taken of the potentialities of cathode drive, with the result that this tube gives increased highlight contrast, as compared with conventional tubes, with equal or slightly less drive required. It operates at a low G2 voltage. The allowable cutoff range has been reduced to assure greater uniformity of product. The 14AEP4 has an external conductive coating, and it has a metalbacked screen for increased picture brightness. A new design no-ion-trap gun allows a reduction in overall length from previous 90° tubes.

ELECTRICAL:		
Cathode	Coated Unipotential	
Heater:		
Voltage	6.3 ac or dc	Volts
Current	0.6	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other electrodes	6	uuf
Cathode to all other electrodes	5	uuf
External Conductive Coating to Anode		
Maximum	1200	uuf
Minimum	800	uuf
Screen		
Phosphor	No. 4 Sulfide Type	
Fluorescence	White	
Persistence	Short	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle (Approx.)	80°	
Vertical Angle (Approx.)	65°	
Diagonal Angle (Approx.)	90°	
No Ion Trap	No. Magnet Required	

MECHANICAL:	
Mounting Position	Any
Screen Dimensions	
Height	9-1/2" min.
Width	12-1/16" min.
Diagonal	13" min.
Faceplate	Spherical
Glass	Neutral Filter
Transmission (Approx.)	78 per cent
Bulb Dimensions	
Height	10-9/16" ± 1/8"
Width	13-1/16" ± 1/8"
Diagonal	14" ± 1/8"
Overall Length	13-3/16" ± 3/8"
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)

MAXIMUM RATINGS, Cathode Drive Service:	
Design Center Values	
Anode Voltage*	14,000 max. Volts
Grid 4 to Grid 1 Voltage	
Positive Value	1000 max. Volts
Negative Value	500 max. Volts
Grid 2 to Grid 1 Voltage	200 max. Volts
Cathode to Grid 1 Voltage	
Positive Bias Value	125 max. Volts
Negative Bias Value	0 max. Volts
Negative Peak Value	0 max. Volts
Peak Heater-Cathode Voltage	
Heater Negative with respect to Cathode	
During warm-up period of 15 sec. max.	410 max. Volts
After equipment warm-up period	180 max. Volts
Heater Positive with respect to Cathode	180 max. Volts

TYPICAL OPERATING CONDITIONS

Cathode Drive ♦			
Anode to Grid 1 Voltage	10000	12000	Volts
Grid 4 to Grid 1 Voltage	-50 to +350	-50 +350	Volts
Grid 2 to Grid 1 Voltage	110	110	Volts
Cathode to Grid 1 for Raster Cutoff ♦ §	32 to 50	32 to 50	Volts

LIMITING CIRCUIT VALUES:	
Grid 1 Circuit Resistance	1.5 max. Megohms
Grid 2 Circuit Resistance ⊕	0.1 min. Megohm
Focus Electrode Circuit Resistance ⊕	0.1 min. Megohm

NOTES:

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 9000 volts..

♦ This tube may be operated in grid drive if desired, with some loss in efficiency. Average raster cutoff, using grid drive, may be calculated:

$$E_{G1_{CO}} = .502\, E_{G2} + 5.8$$

⊕ Protective resistance in the G2 and focus electrode circuits is advisable to prevent damage to the tube.

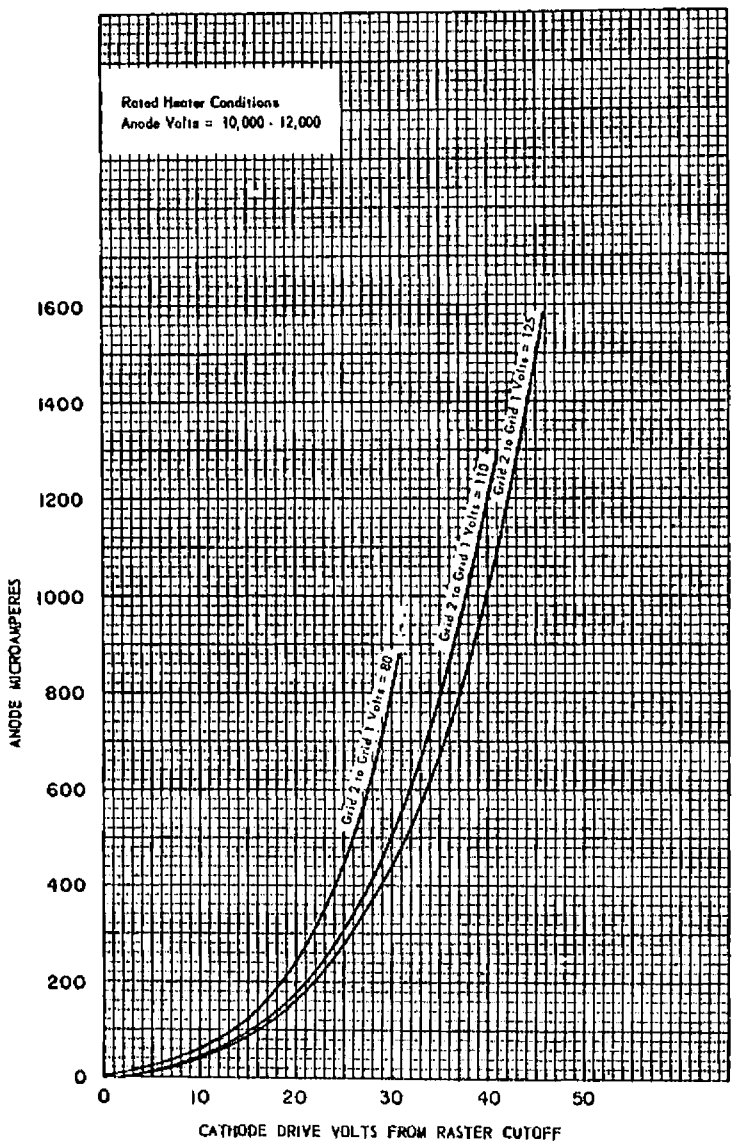
♦ Raster size 12 1/16" by 9 1/2".

§ For values of cutoff other than recommended operating voltages, see Cutoff Design Chart.

from JETEC release #1863, March 11, 1957

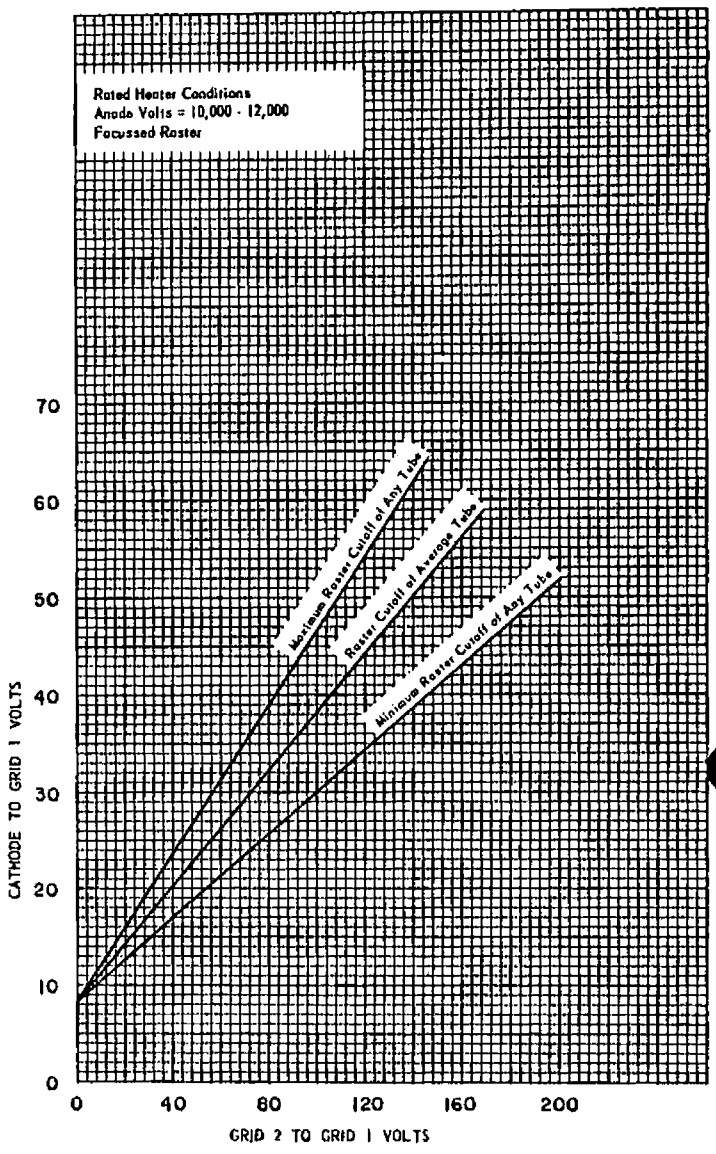
Westinghouse

AVERAGE CATHODE DRIVE CHARACTERISTICS

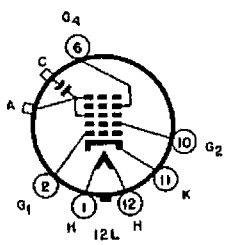


CE-A1262

CATHODE DRIVE CUTOFF DESIGN CHART



CE-A1263

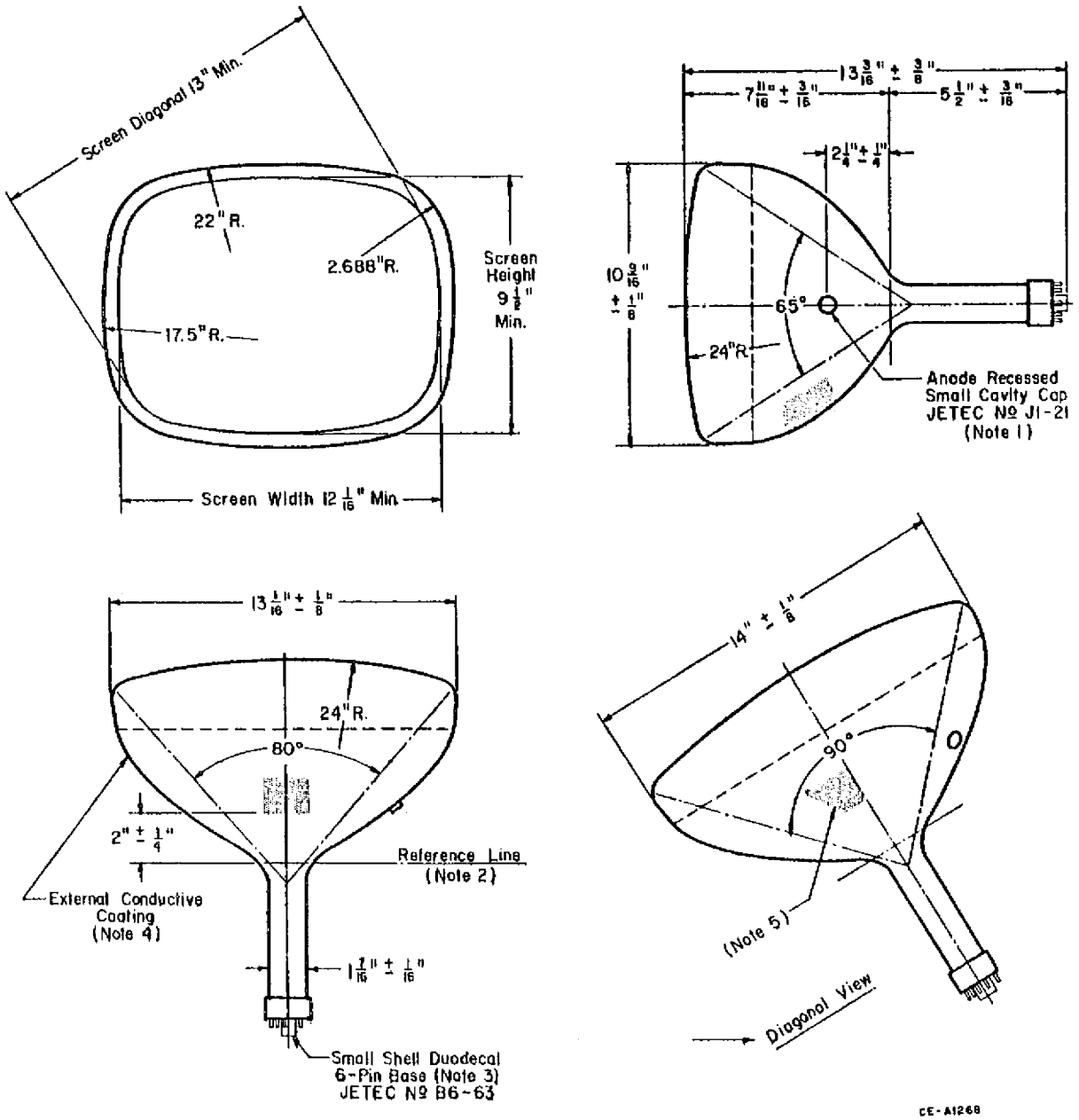


Bottom View

A—Grids 3 & 5, Collector.

C—External Conductive Coating.

OUTLINE DRAWING



NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2¾".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ±¼" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

February 25, 1958

TELEVISION PICTURE TUBE TYPE 14AWP4

90° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Low G_2 Voltage (50 Volts)
6.3 Volts, 0.45 Amp. Heater
Cathode Drive Design
Electrostatic Focus

External Conductive Coating
Spherical Faceplate
No Ion Trap
12-1/16" x 9-1/2" Picture

ELECTRICAL:

Cathode	Coated Unipotential
Heater:	
Voltage (ac or dc)	6.3 Volts
Current	0.45 Ampere
Direct Interelectrode Capacitances:	
Grid 1 to all other Electrodes	6 uuf
Cathode to all other Electrodes	5 uuf
External Conductive Coating:	
Maximum	1200 uuf
Minimum	800 uuf
Screen:	
Phosphor	Aluminized P4
Fluorescence	White
Persistence	Short
Focusing Method	Electrostatic
Deflection Method	Magnetic
Horizontal Angle, approx.	85°
Vertical Angle, approx.	68°
Diagonal Angle, approx.	90°
No Ion Trap Gun	No Magnet Required

MECHANICAL:

Mounting Position	Any
Screen Dimensions:	
Height	9-1/2" Min.
Width	12-1/16" Min.
Diagonal	13" Min.
Face Plate	Spherical Outer and Inner Surfaces
Glass	Neutral Filter
Transmission	74 per cent
Bulb Dimensions:	
Height	10-9/16" ± 1/8"
Width	13-1/16" ± 1/8"
Diagonal	14" ± 1/8"
Overall Length	13-3/16" ± 3/8"
Net Weight, approx.	8 Pounds
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)

MAXIMUM RATINGS, Cathode Drive Service:

Design Center Values

Anode Voltage*	14000 max.	Volts
Grid 4 to Grid 1 Voltage:		
Positive Value	1000 max.	Volts
Negative Value	500 max.	Volts
Grid 2 to Grid 1 Voltage	68 max.	Volts
Cathode to Grid 1 Voltage:		
Positive Bias Value	140 max.	Volts
Negative Peak Value	0 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Negative with Respect to Cathode:		
During Warmup Period of 15 sec. max.	410 max.	Volts
After Equipment Warmup Period	180 max.	Volts
Heater Positive with Respect to Cathode	180 max.	Volts

TYPICAL OPERATING CONDITIONS, Cathode Drive Service:

Anode Voltage	12000	14000	Volts
Grid 4 to Grid 1 Voltage	-50 to +350	0 to +400	Volts
Grid 2 to Grid 1 Voltage	50	50	Volts
Cathode to Grid 1 Voltage for Raster Cutoff▲	32 to 47	32 to 47	Volts

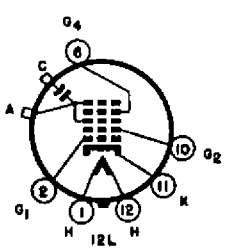
LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5 max.	Megohms
Grid 2 Circuit Resistance**	0.1 min.	Megohms
Grid 4 Circuit Resistance**	0.1 min.	Megohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12000 volts.

**Protective resistance in the G_2 and G_4 circuits is advisable to prevent damage to the tube.

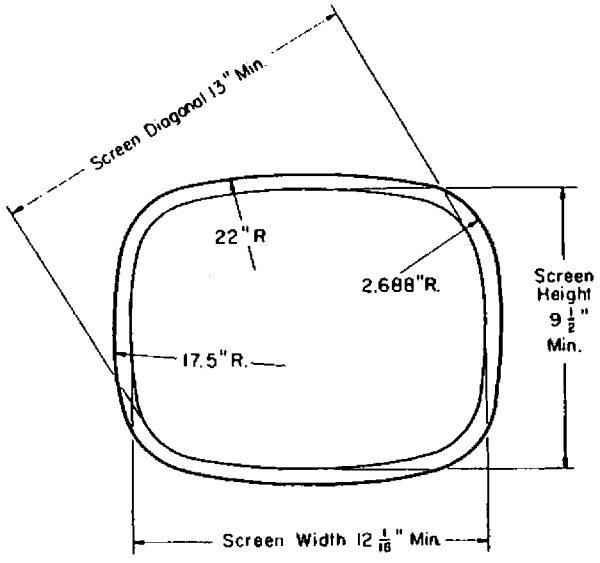
▲ Raster size 9-1/2" x 12-1/16"

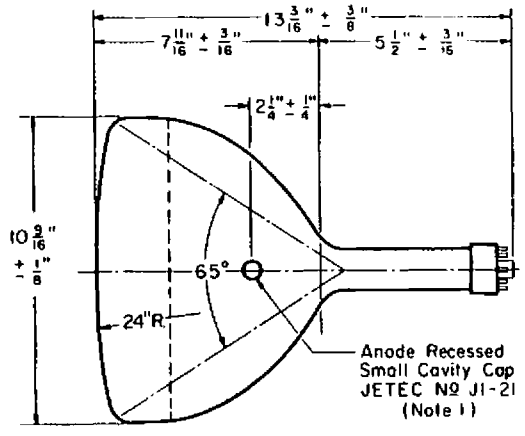


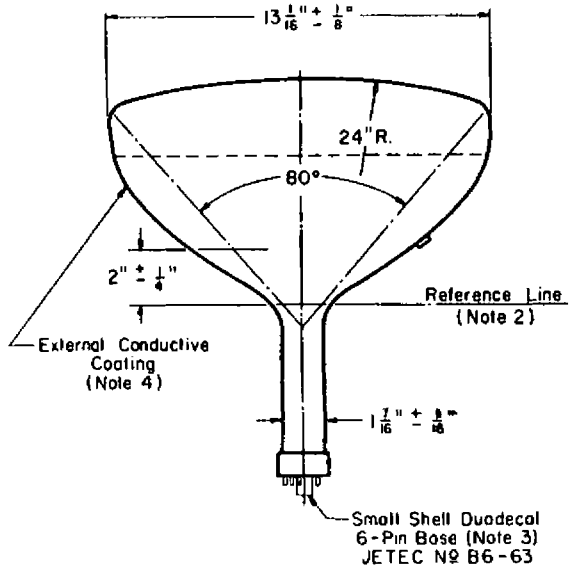
Bottom View
A - Grids 3 & 5, Collector.
C - External Conductive Coating

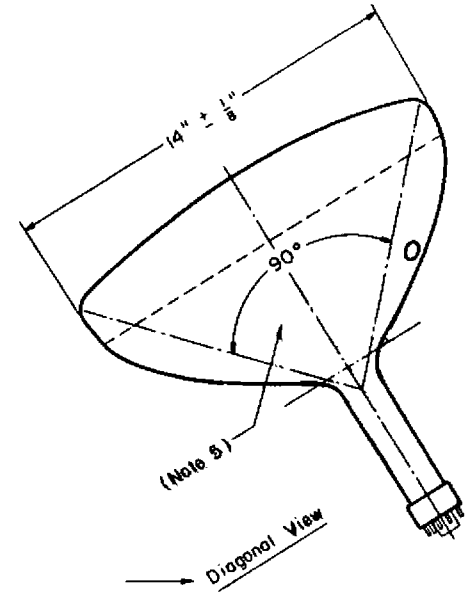
from JETEC release #2127, March 10, 1958

Cathode Ray Tube Section









CE-A1268

NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2 3/4".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

RADAR DISPLAY TUBE TYPE 14AZP4

The 14AZP4 is a magnetically focused, magnetically deflected cathode ray display tube. Its high resolution gun coupled with high brightness capabilities make it especially suited for high resolution monitor applications.

The face is gray-glass for improved contrast and the screen is aluminized for increased brightness.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.6	Volts
Direct Interelectrode Capacitances:		
Grid 1 to All Other Electrodes	6	μμf
Cathode to All Other Electrodes	5	μμf
Screen:		
Phosphor	Aluminized P4	
Fluorescence	White	
Persistence	Short	
Focusing Method	Magnetic	
Deflection Method	Magnetic	
Horizontal Angle, (approx.)	65°	
Vertical Angle, (approx.)	50°	
Diagonal Angle, (approx.)	70°	
No Ion Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any
Useful Screen Dimensions:	
Screen Area, Min.	96 Sq. Inches
Height	8-5/8" Min.
Width	11-1/2" Min.
Diagonal	12-3/4" Min.
Faceplate	Spherical
Glass	Neutral Filter
Transmission	76%
Bulb Dimensions:	
Height	9-23/32" ± 1/8"
Width	12-17/32" ± 1/8"
Diagonal	13-11/16" ± 1/8"
Neck Length	7-1/2"
Overall Length	16-25/36" ± 3/8"
Anode Terminal	Recessed Small Cavity Cap (JEDEC J1-21)
Base	Small Shell Duodecal 5-Pin (JEDEC B5-57)
Basing	12D

MAXIMUM RATINGS

Design Center Values

Anode Voltage*	20000	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Positive Bias Value	2	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode:			
During warmup period of 15 sec. max.	410	max.	Volts
After Equipment Warmup Period	180	max.	Volts
Heater Positive with Respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage	16000	18000	Volts
Grid 2 Voltage	300	300	Volts
Grid 1 Voltage for Spot Cutoff	-35 to -75	-35 to -75	Volts
Focusing Coil Current■	110 ±20%	110 ± 20%	Ma.
Line Width▲	.013	.013	Inch

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5	max.	Megohms
Grid 2 Circuit Resistance	10000	min.	Ohms
Grid 4 Circuit Resistance	10000	min.	Ohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12 000 volts.

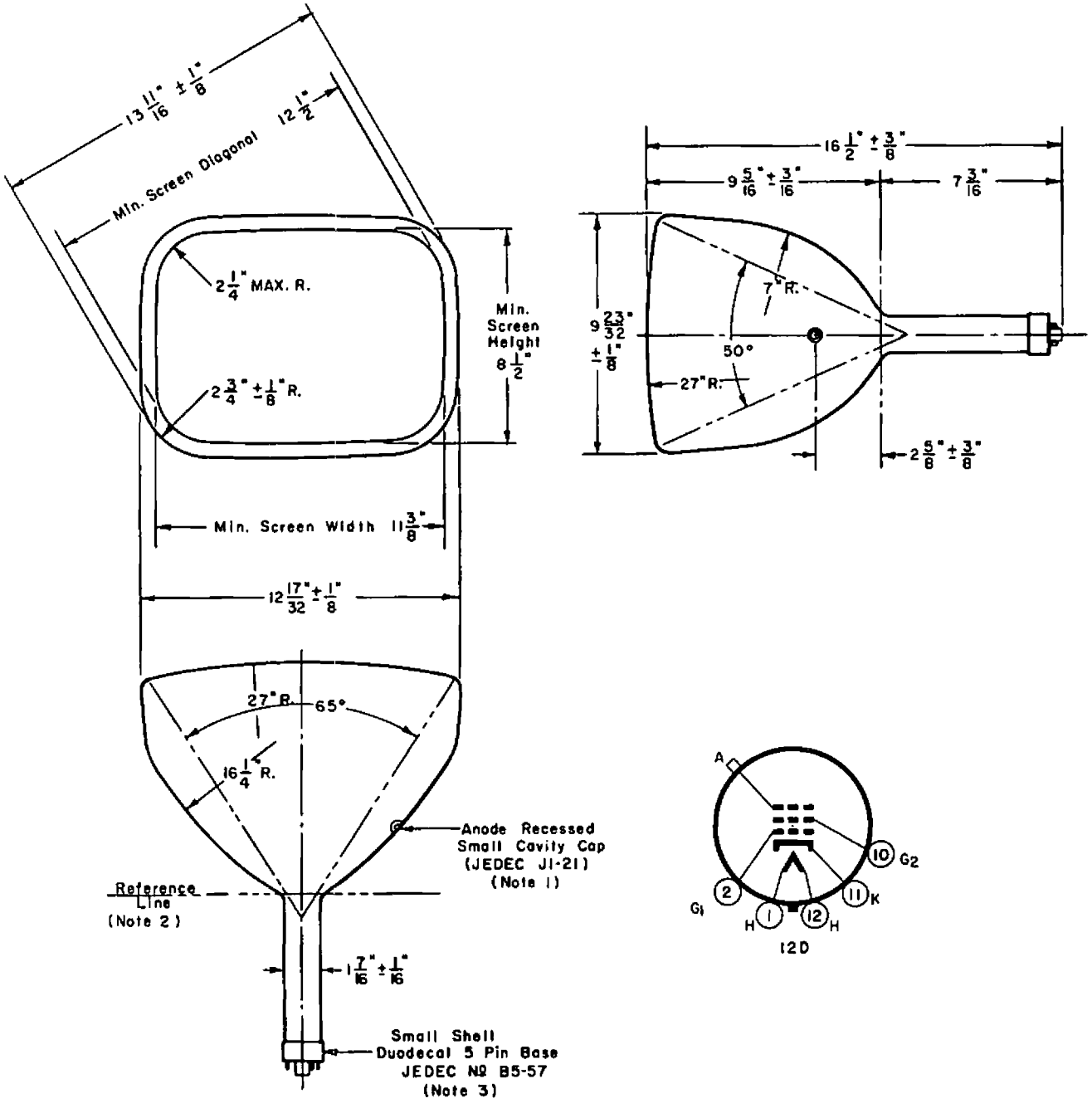
♦ Protective resistance in the Grid 2 and Grid 4 circuits is advisable to prevent damage to the tube.

■ For RMA standard focus coil, JEDEC #109, or equivalent to produce best focus at an anode current of 100 μa.

▲ With an anode current of 100 microamperes, typical line width at center of faceplate, using half-amplitude points of light energy distribution of a single line, is 0.013".

X-Ray Warning: Inasmuch as the tube rating permits operation at voltages as high as 22 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.

from JEDEC release #2493, June 15, 1959



NOTE 1: Anode terminal alignment with vacant base-pin position 3 has angular tolerance about tube axis of ± 30°.

NOTE 2: Yoke Reference Line is determined by plane of flared end of JEDEC Reference-Line Gauge No. 110 when seated on funnel of tube.

NOTE 3: The socket should not be mounted rigidly but should be allowed to move freely and have flexible leads.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

Television Picture Tube Types 14NP4 & 14NP4-A

Rectangular Glass Construction — Electrostatic Focus — 90° Deflection
External Conductive Coating — Spherical Faceplate
Magnetic Deflection — 12-1/8" 9-5/8" Picture Size

The 14NP4 and 14NP4A are electrostatic-focus, directly-viewed picture tubes of rectangular glass construction. A new bulb design permits 90° deflection with a resulting reduction of the overall length of approximately two inches as compared with previously available 14-inch tubes. The faceplates are spherical and they are made of neutral gray glass. Both types have an external conductive coating; the 14NP4A has a metal-backed screen for increased picture brightness.

GENERAL DATA

Electrical:

Cathode	Coated Unipotential	
Heater:		
Voltage	6.3	ac or dc Volts
Current	0.6	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other electrodes	6	µµf
Cathode to all other electrodes	5	µµf
External Conductive Coating to Anode		
Maximum	750	µµf
Minimum	500	µµf
Screen:		
Phosphor	No. 4 Sulfide Type	
Fluorescence	White	
Persistence	Short	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle (Approx.)	80°	
Vertical Angle (Approx.)	65°	
Diagonal Angle (Approx.)	90°	
Ion-Trap Gun	External Single-Field Magnet	

Mechanical:

Mounting Position	Any
Screen Dimensions (Tentative)	
Height	9-5/8" min.
Width	12-1/8" min.
Diagonal	13-1/16" min.
Projected Area	106 sq. in. min. (tentative)
Faceplate:	Spherical
Glass	Netural Filter
Transmission (Approx.)	78 per cent
Bulb Dimensions	
Height	10-9/16"±1/8"
Width	13-1/16"±1/8"
Diagonal	14" ±1/8"
Overall Length	14-1/4"±3/8"
Neck Length	6-9/16"±3/16"

Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)
Bulb Number	J112A1

MAXIMUM RATINGS

Design Center Values

Anode Voltage #	14000 max. Volts
Grid 4 Voltage:	
Positive Value	1000 max. Volts
Negative Value	500 max. Volts
Grid 2 Voltage	500 max. Volts
Grid 1 Voltage:	
Negative Bias Value	180 max. Volts
Positive Bias Value	0 max. Volts
Positive Peak Value	0 max. Volts
Peak Heater-Cathode Voltage:	
Heater Negative with Respect to Cathode	
During Warm-up Period of 15 sec. max.	410 max. Volts
After Equipment Warm-up Period	180 max. Volts
Heater Positive with respect to Cathode	180 max. Volts

TYPICAL OPERATING CONDITIONS

For Anode Voltage #	10,000	12,000 Volts
For Grid 2 Voltage	250	300 Volts
Grid 4 Voltage for Focus with Anode Current of 100 μampere	-50 to +350	-50 to+350 Volts
Grid 1 Voltage for Visual Extinction of Focused Raster	-24 to -64	-28 to -72 Volts
Ion-Trap Magnet (Rated Strength)†	.28	30 Gausses

LIMITING CIRCUIT VALUES

Grid 1 Circuit Resistance*	1.5 max. Megohms
Grid 2 Circuit Resistance*	0.1 min. Megohms
Focus Electrode Circuit Resistance	0.1 min. Megohms

*Protective resistance in the G2 and Focus Electrode circuits is advisable to prevent damage to the tube.

#Brilliance and definition decrease with decreasing anode voltage. In general, the anode voltage should not be less than 9,000 volts.

†It is recommended that the magnet slug be located on the same side of the tube neck as pin 6.

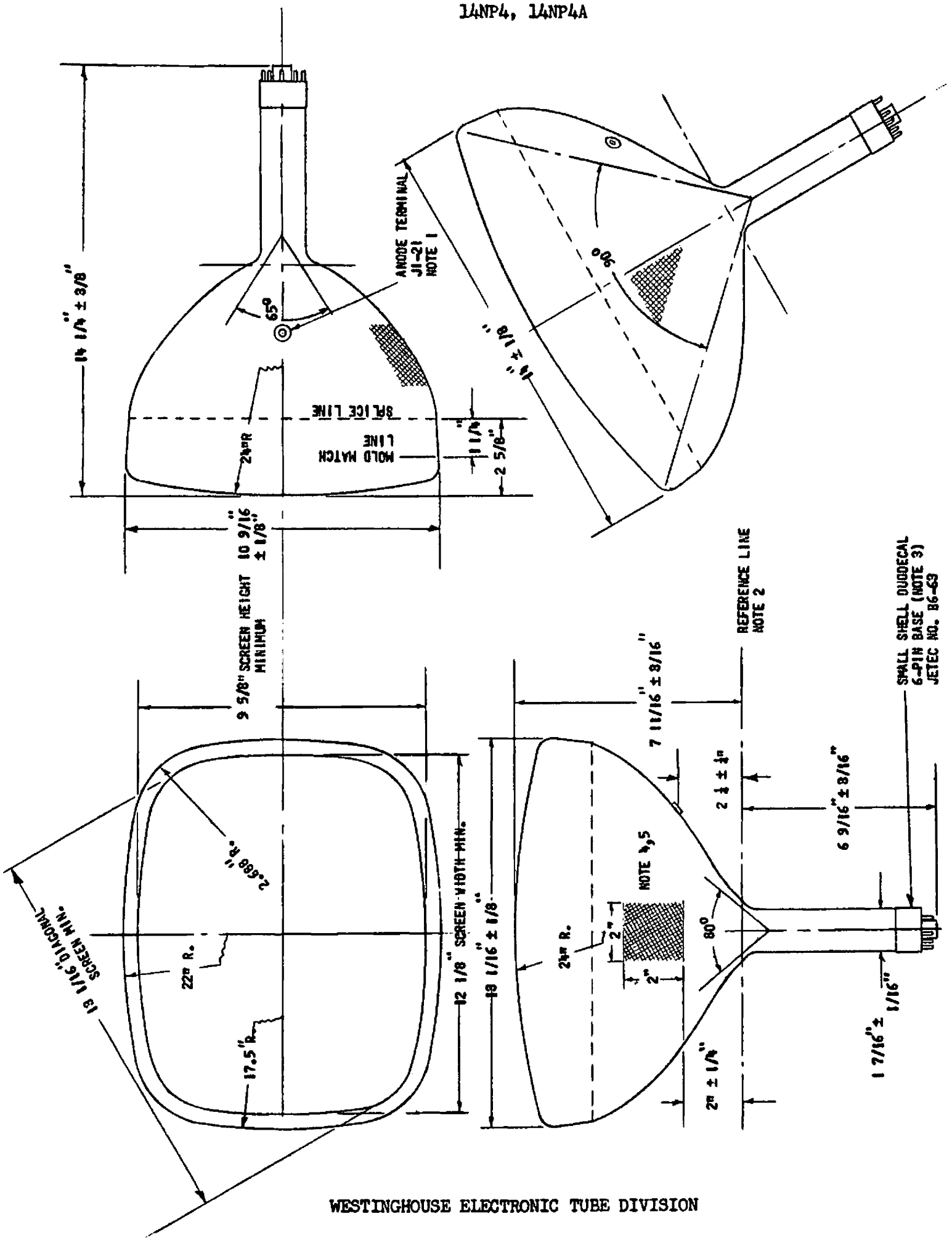
NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of $\pm 30^{\circ}$ measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diamter of 2 3/4".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located $2" \pm 1/4"$ from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.


14 1/4" ± 3/8"
ANODE TERMINAL J1-21 NOTE 1
65°
SPLICE LINE
24" R
MOLD MATCH LINE
1 1/4"
2 5/8"
10 9/16" ± 1/8"
14 1/16" ± 1/8"
90°
9 5/8" SCREEN HEIGHT MINIMUM
2.689"
13 1/16" DIAGONAL SCREEN MIN.
22" R.
17.5" R.
12 1/8" SCREEN WIDTH MIN.
18 1/16" ± 1/8"
24" R.
NOTE 4,5
2"
2"
80°
7 11/16" ± 8/16"
REFERENCE LINE NOTE 2
2 1/4" ± 1/4"
6 9/16" ± 8/16"
2" ± 1/8"
1 7/16" ± 1/16"
SMALL SHELL DUODECAL 6-PIN BASE (NOTE 3) JETEC NO. B6-63

September 2, 1957

from JETEC release #2011, Sept. 16, 1957

RADAR DISPLAY TUBE TYPE 16AKP7

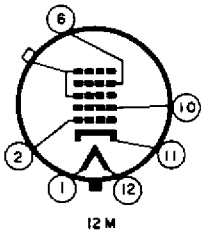
The 16AKP7 is an electrostatic focus, magnetic deflection round glass radar display tube. The screen is aluminized to increase brightness and uses a P7 phosphor for improved viewing characteristics. The 16AKP7 features a straight no-ion-trap gun which produces a very narrow line which gives the tube high resolution capabilities.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage	6.3	Volts
Current	0.60	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	9.0	uuf
Grid 2 to all other Electrodes	7.0	uuf
Cathode to all other Electrodes	7.0	uuf
Screen:		
Phosphor	P7	
Fluorescence	Blue	
Phosphorescence	Yellow	
Persistence	Long	
Focusing Method	Electrostatic	
Deflection Method	Magnetic	
Deflection Angle	53%	
No-Ion-Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any
Minimum Screen Diameter	14-1/2"
Faceplate Configuration	Spherical
Glass	Filter
Transmission	76%
Bulb Diameter	15-7/8" ± 1/8"
Overall Length	22-1/16" ± 3/8"
Neck Length	7-3/16"
Anode Terminal	J1-21
Base	B7-51



12M

PIN 1: HEATER
PIN 2: GRID 1
PIN 6: GRID 4(FOCUS)
PIN 7: NO CONNECTION
PIN 10: GRID 2
PIN 11: CATHODE
PIN 12: HEATER
CAP : ANODE

MAXIMUM RATINGS:

Design Center Values

Anode Voltage	14000 max.	Volts
Grid 4 (Focusing Electrode) Voltage	1000 max.	Volts
Grid 2 Voltage	450 max.	Volts
Grid 1 Volts:		
Negative Bias Value	140 max.	Volts
Positive Bias Value	0 max.	Volts
Positive Peak Value	0 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Negative with Respect to Cathode During Warm-up Period not to exceed 15 Seconds	410 max.	Volts
After Equipment Warm-up	180 max.	Volts
Heater Positive with Respect to Cathode	180 max.	Volts

LIMITING CIRCUIT VALUES ⊕

Grid 1 Circuit Resistance	1.5 max.	Megohms
Grid 2 Circuit Resistance	0.1 min.	Megohms
Grid 4 Circuit Resistance	0.1 min.	Megohms

TYPICAL OPERATING CONDITIONS ▲

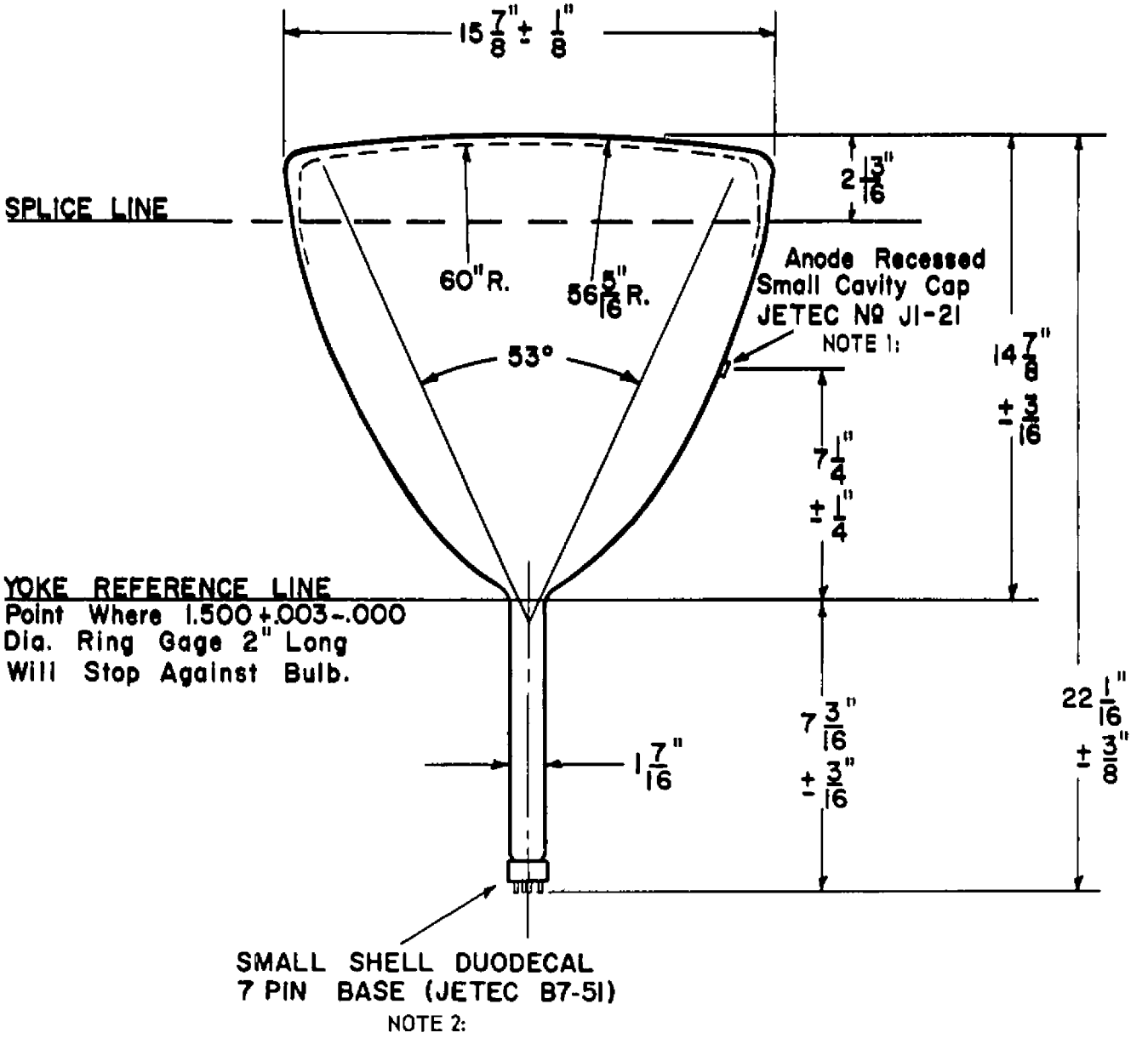
Anode Voltage	12000	Volts
Grid 4 Voltage♦	-300 to +250	Volts
Grid 2 Voltage	300	Volts
Grid 1 Voltage■	-35 to -75	Volts

♦ With the combined grid 1 bias voltage and video-signal voltage adjusted to give an anode current of 100 microamperes on a 13-1/4" by 13-1/4" raster.

■ For visual extinction of focused spot.

▲ A typical line width of 0.025" may be expected with an anode current of 100 microamperes.

⊕ Protective resistance in the G2 and focus electrode circuits is advisable to prevent damage to the tube.



NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2 3/4".

February 17, 1958

TELEVISION PICTURE TUBE TYPE 17CXP4

90° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Low G_2 Voltage (50 Volts)
6.3 Volt, 0.45 Amp. Heater
Cathode Drive Design
Electrostatic Focus

External Conductive Coating
Spherical Faceplate
No Ion Trap
14-5/16" x 11-1/8" Picture

ELECTRICAL:

Cathode	Coated Unipotential
Heater:	
Voltage (ac or dc)	6.3 Volts
Current	0.45 Ampere
Direct Interelectrode Capacitances:	
Grid 1 to all other Electrodes	6 uuf
Cathode to all other Electrodes	5 uuf
External Conductive Coating to Anode:	
Maximum	1500 uuf
Minimum	1000 uuf
Screen:	
Phosphor	Aluminized P4
Fluorescence	White
Persistence	Short
Focusing Method	Electrostatic
Deflection Method	Magnetic
Horizontal Angle (Approx.)	85°
Vertical Angle (Approx.)	68°
Diagonal Angle (Approx.)	90°
No-Ion Trap Gun	No Magnet Required

MECHANICAL:

Mounting Position	Any
Screen Dimensions:	
Height	11-1/8" Min.
Width	14-5/16" Min.
Diagonal	15-9/16" Min.
Face Plate	Spherical Outer and Inner Surfaces
Glass	Neutral Filter
Transmission	74 per cent
Bulb Dimensions:	
Height	12-1/4" ± 1/8"
Width	15-3/8" ± 1/8"
Diagonal	16-5/8" ± 1/8"
Overall Length	14-5/8" ± 3/8"
Net Weight (Approx.)	13 Pounds
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)

MAXIMUM RATINGS, Cathode Drive Service:

Design Center Values

Anode Voltage*	16000 max.	Volts
Grid 4 to Grid 1 Voltage:		
Positive Value	1000 max.	Volts
Negative Value	500 max.	Volts
Grid 2 to Grid 1 Voltage	68 max.	Volts
Cathode to Grid 1 Voltage:		
Positive Bias Value	140 max.	Volts
Negative Peak Value	0 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Negative with Respect to Cathode:		
During Warmup Period of 15 sec. max.	410 max.	Volts
After Equipment Warmup Period	180 max.	Volts
Heater Positive with Respect to Cathode	180 max.	Volts

TYPICAL OPERATING CONDITIONS, Cathode Drive Service:

Anode Voltage	12000	14000	Volts
Grid 4 to Grid 1 Voltage	-75 to +325	-50 to +350	Volts
Grid 2 to Grid 1 Voltage	50	50	Volts
Cathode to Grid 1 Voltage for Raster Cutoff▲	32 to 47	32 to 47	Volts

LIMITING CIRCUIT VALUES:

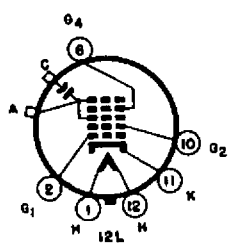
Grid 1 Circuit Resistance	1.5 max. Megohms
Grid 2 Circuit Resistance**	0.1 min. Megohms
Grid 4 Circuit Resistance**	0.1 min. Megohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12000 volts.

**Protective resistance in the G_2 and G_4 circuits is advisable to prevent damage to the tube.

▲ Raster size 11-1/8" x 14-5/16"

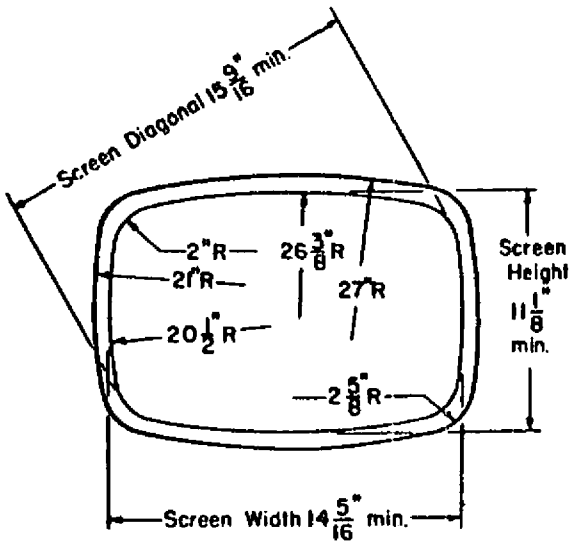
Inasmuch as the tube rating permits operation at voltages as high as 17.6 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.

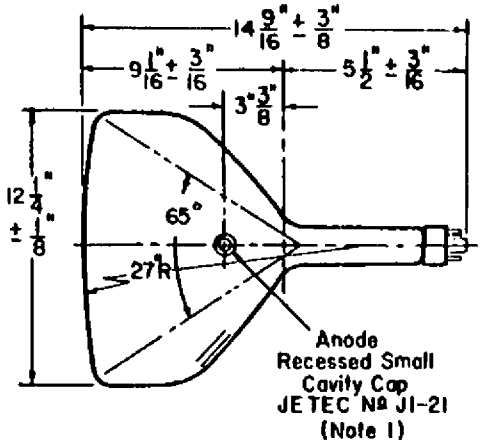


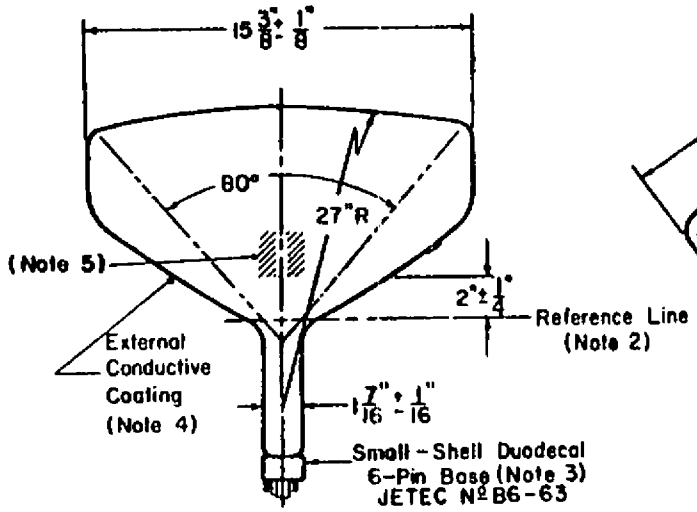
Bottom View
A - Grids 3 & 5, Collector.
C - External Conductive Coating

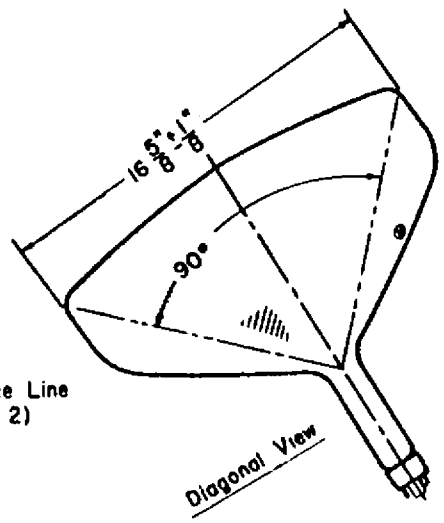
Cathode Ray Tube Section

from JETEC release #2117, March 3, 1958









CE-C1266

NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2¾".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ±¼" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

August 4, 1958

TELEVISION PICTURE TUBE TYPE 17CYP4

90° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Electrostatic Focus
Lightweight Tube
4-1/2" Neck Length

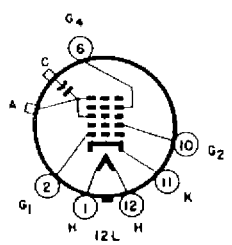
External Conductive Coating
Spherical Faceplate
14-3/4" x 11-11/16" Picture
No Ion Trap

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.6	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating:		
Maximum	1500	uuf
Minimum	1000	uuf
Screen:		
Phosphor	Aluminized P4	
Fluorescence	White	
Persistence	Short	
Focusing Method	Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle, approx.	85°	
Vertical Angle, approx.	68°	
Diagonal Angle, approx.	90°	
No Ion Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any	
Screen Dimensions:		
Screen Area, Min.	155	Sq. Inches
Height	11-11/16"	Min.
Width	14-3/4"	Min.
Diagonal	15-5/8"	Min.
Faceplate	Spherical Inner & Outer Surfaces	
Glass	Neutral Filter	
Transmission	77%	
Bulb	J132½C	
Bulb Dimensions:		
Height	12-3/4" ± 1/8"	
Width	15-5/8" ± 1/8"	
Diagonal	16-9/16" ± 1/8"	
Overall Length	14" ± 3/8"	
Net Weight, approx.	10	Pounds
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)	
Base	Small Shell Duodecal 6-Pin (JETEC B6-203)	



MAXIMUM RATINGS:

Design Center Values

Anode Voltage*	16000	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	140	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode:			
During warmup period of 15 sec. max..	410	max.	Volts
After Equipment Warmup Period	180	max.	Volts
Heater Positive with Respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage	14000	Volts
Grid 4 Voltage	-50 to +350	Volts
Grid 2 Voltage▲	450	Volts
Grid 1 Voltage for Raster Cutoff■	39 to 105	Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5	max. Megohms
Grid 2 Circuit Resistance♦	10000	ohms
Grid 4 Circuit Resistance♦	10000	ohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12000 volts.

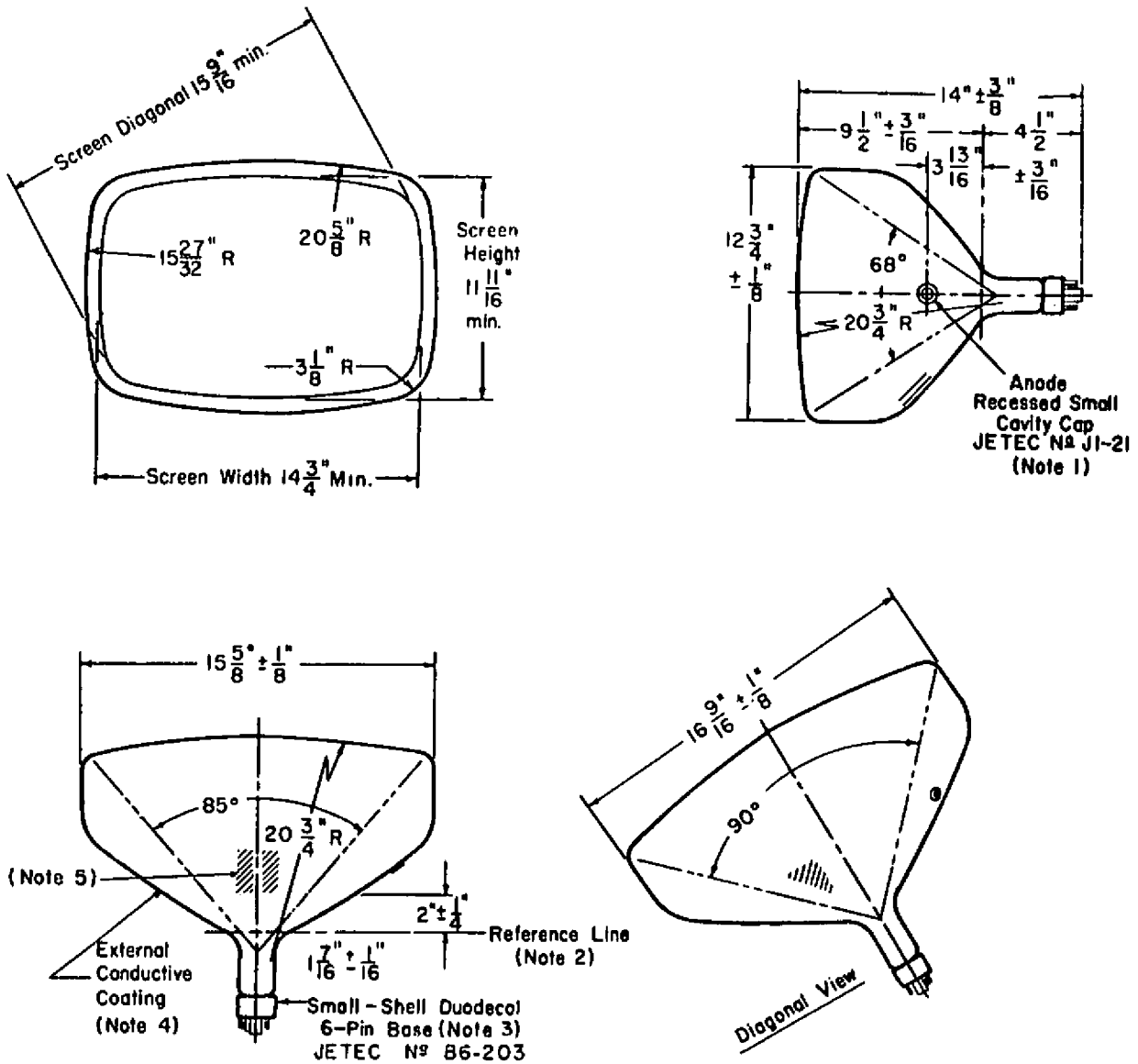
♦ Protective resistance in the Grid 2 and Grid 4 circuits is advisable to prevent damage to the tube.

▲ It is recommended that Grid 2 be operated at a voltage greater than 300 volts since resolution is affected below this level.

■ Raster size is 11-11/16" x 14-3/4".

Inasmuch as the tube rating permits operation at voltages as high as 17.6 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK
from JETEC release #2264, Aug. 25, 1958



CE-C1371

NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2¾".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ±¼" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

May 29, 1958

TELEVISION PICTURE TUBE TYPE 17CZP4

90° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Electrostatic Focus
4-1/2" Neck Length

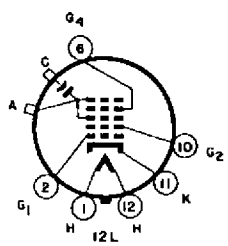
External Conductive Coating
Spherical Faceplate
No Ion Trap
14-5/16" x 11-1/8" Picture

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.6	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating:		
Maximum	1500	uuf
Minimum	1000	uuf
Screen:		
Phosphor	Aluminized P4	
Fluorescence	White	
Persistence	Short	
Focusing Method	Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle, approx.	85°	
Vertical Angle, approx.	68°	
Diagonal Angle, approx.	90°	
No Ion Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any	
Screen Dimensions:		
Screen Area, Min.	149	Sq. Inches
Height	11-1/8"	Min.
Width	14-5/16"	Min.
Diagonal	15-9/16"	Min.
Faceplate	Spherical Outer & Inner Surfaces	
Glass	Neutral Filter	
Transmission	74	Per Cent
Bulb	J133G1	
Bulb Dimensions:		
Height	12-1/4" ± 1/8"	
Width	15-3/8" ± 1/8"	
Diagonal	16-5/8" ± 1/8"	
Overall Length	13-5/8" ± 3/8"	
Net Weight, approx.	13	Pounds
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)	
Base	Small Shell Duodecal 6-Pin (JETEC B6-203)	
Basing	12L	



MAXIMUM RATINGS:

Design Center Values

Anode Voltage*	16000	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	140	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode:			
During warmup period of 15 sec. max.	410	max.	Volts
After equipment warmup period	180	max.	Volts
Heater Positive with Respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage	14000	Volts
Grid 4 Voltage	-50 to +350	Volts
Grid 2 Voltage▲	450	Volts
Grid 1 Voltage for Raster Cutoff■	39 to 105	Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5	max. Megohms
Grid 2 Circuit Resistance♦	10000	ohms
Grid 4 Circuit Resistance♦	10000	ohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 10000 volts.

♦ Protective resistance in the Grid 2 and Grid 4 circuits is advisable to prevent damage.

▲ It is recommended that Grid 2 be operated at a voltage greater than 300 volts since resolution is affected below this level.

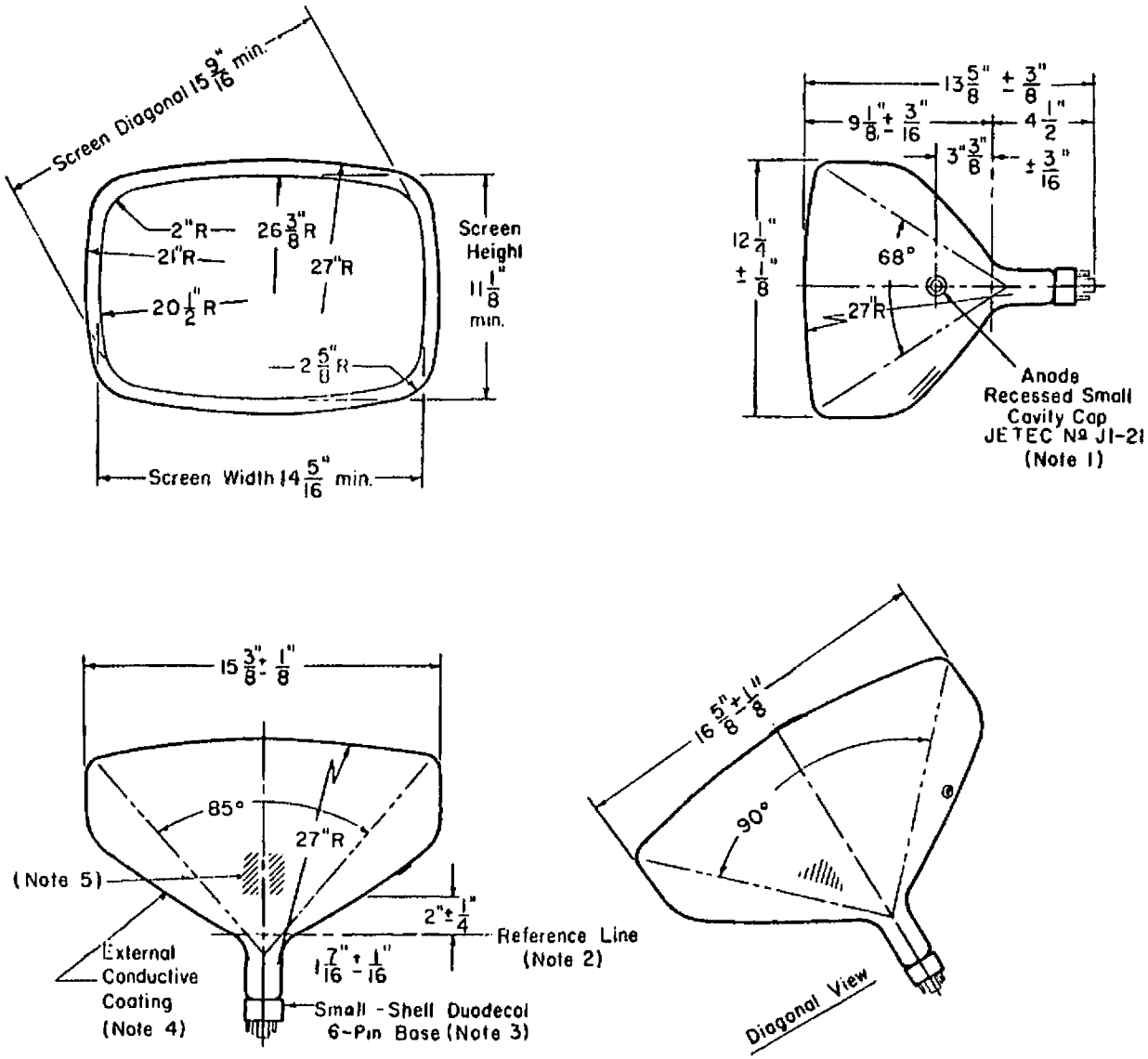
■ Raster size is 11-1/8" x 14-5/16"

Inasmuch as the tube rating permits operation at voltages as high as 17.6 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.

NOTE: It is recommended that centering magnets be within 2-11/16" of yoke reference line.

Cathode Ray Tube Section

from JETEC release #2219, June 16, 1958



NOTE 1. The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of Reference-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 3".

NOTE 4. External conductive coating must be grounded.

NOTE 5. Contact area of external conductive coating 2" min. x 2" min. located 2" ± 1/4" from reference line 90° counterclockwise from anode button as viewed from base end of tube.

TELEVISION PICTURE TUBE TYPE 17DHP4

110° Magnetic Deflection
Rectangular Glass Construction
Low-Voltage Electrostatic Focus
Straight Gun, No Ion Trap Required
450 Ma Controlled Warm-Up Heater

4-1/8" Neck Length

Aluminized Screen
14-3/4" x 11-11/16" Screen Size
Spherical Faceplate
External Conductive Coating
11-7/16" Max. Overall Length

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.45	Ampere
Warm-Up Time (approx.)♦	11	Seconds
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	μμf
Cathode to all other Electrodes	5	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Screen:		
Fluorescence	White	
Phosphor	Aluminized P4	
Persistance	Short	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angle:		
Horizontal	105°	
Vertical	87°	
Diagonal	110°	
No-Ion-Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any
Screen Dimensions (min. at greatest part):	
Width	14-3/4"
Height	11-11/16"
Diagonal	15-3/4"
Area	155 Sq. Inches
Faceplate	Spherical
Glass	Neutral Gray
Transmission (approx.)	78%
Bulb Dimensions (at greatest part):	
Width	15-5/8" ± 1/8"
Height	12-3/4" ± 1/8"
Diagonal	16-9/16" ± 1/8"
Bulb Number	J132½A1 or equiv.
Neck Length	4-1/8" ± 1/8"
Overall Length	11-1/4" ± 3/16"
Anode Terminal	Recessed Small Cavity Cap JEDEC No. J1-21
Base	Small Button, 7-Pin Style B JEDEC No. B7-208
Basing	8HR
Net Weight (approx.)	10 lbs.

♦ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

MAXIMUM RATINGS:

Design Center Values

Anode Voltage †	16000	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	2	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode §	180	max.	Volts
Heater Positive with Respect to Cathode	180	max.	Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5	max.	Megohms
Grid 2 Circuit Resistance■	10000	min.	Ohms
Grid 4 Circuit Resistance■	10000	min.	Ohms

GRID DRIVE OPERATION

(Video Signal Applied to Grid 1)

TYPICAL OPERATING CONDITIONS:

Anode Voltage	14000 Volts
Grid 2 Voltage	500 Volts
Grid 4 Voltage for Focus	0 to +400 Volts
Grid 1 Cutoff Voltage▲	-43 to -72 Volts

CATHODE DRIVE OPERATION

(Video Signal Applied to Cathode)

TYPICAL OPERATING CONDITIONS:

Anode to Grid 1 Voltage	14000 Volts
Grid 2 to Grid 1 Voltage	500 Volts
Grid 4 to Grid 1 Voltage for Focus	0 to 400 Volts
Cathode to Grid 1 Cutoff Voltage▲	40 to 63 Volts

† Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts is not recommended.

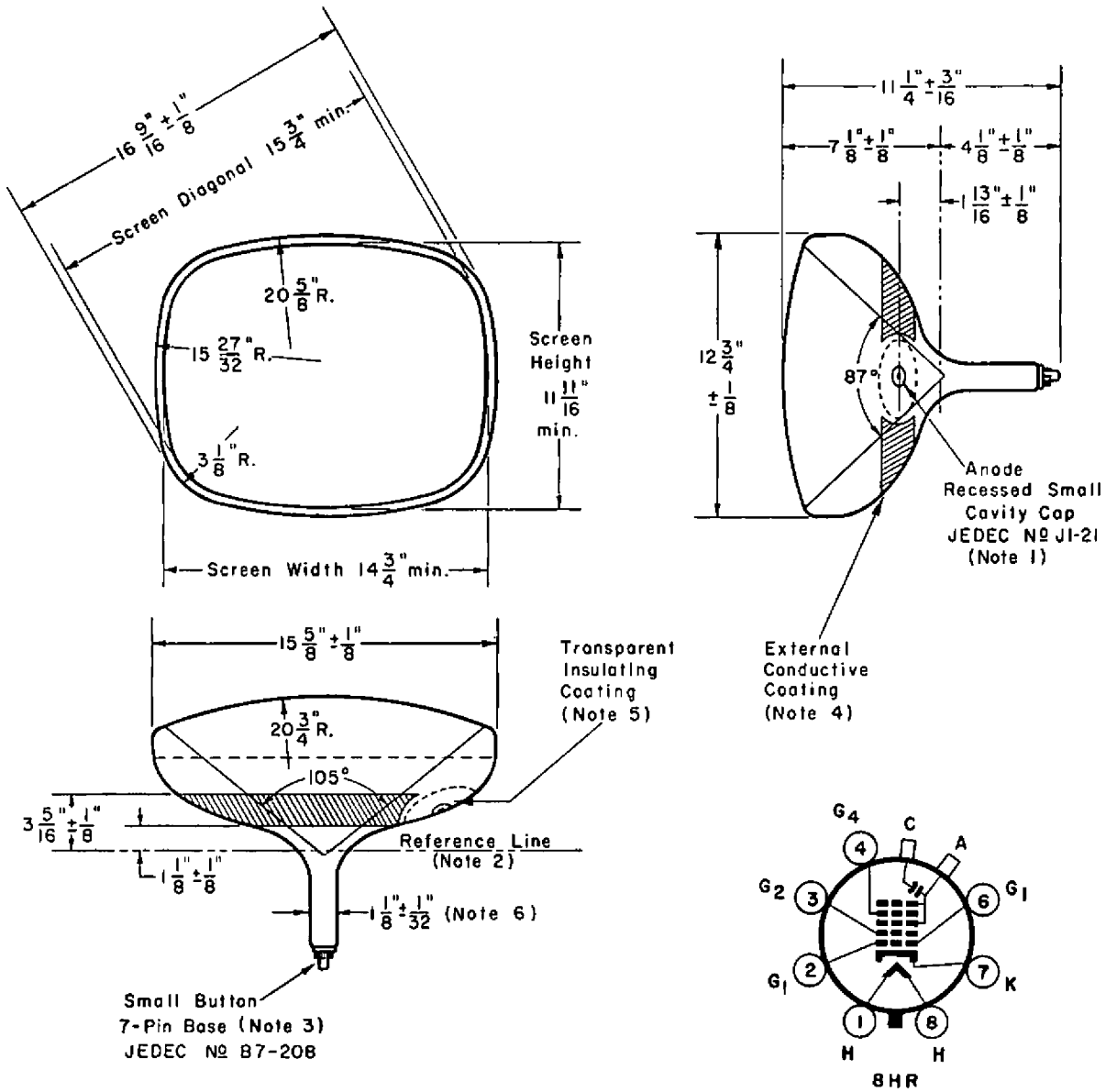
▲ For visual extinction of focused raster.

■ Protective resistance in the grid 2 and grid 4 (focus electrode) circuit is advisable to prevent damage to the tube.

X-RAY WARNING: Inasmuch as the tube rating permits operation at voltages as high as 17.6 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltages in excess of 16 kilovolts.

§ A peak value of 410 volts design center maximum may be applied for not more than 15 seconds during equipment warm-up periods.

from JEDEC release #2396A, June 15, 1959



CE-C1369

NOTE 1: The plane through the tube axis and base pin 4 may vary from the plane through the tube axis and the anode terminal by an angular tolerance of ± 30°. The anode terminal is on the same side of the tube as pin 4.

NOTE 2: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel. With a minimum neck length tube, the PM centering magnet (0 to 8 gaus) should extend no more than 2-1/8" from the yoke reference line.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: To clean this area, wipe only with a soft, dry, lintless cloth. The transparent insulating coating is approx. 6" in diameter.

NOTE 6: Neck diameter may be a maximum of 1.168" at the splice.

TELEVISION PICTURE TUBE TYPE 17EBP4

The 17EBP4 is a 110° picture tube with a spherical grey glass faceplate, short neck length and an aluminized screen. This type has an external conductive coating with a special configuration such that it may be grounded by the tube mounting system.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.45	Ampere
Warm-Up Time (Approx.)♦	11	Seconds
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	μμf
Cathode to all other Electrodes	5	μμf
External Conductive Coating to Anode:		
Maximum	1700	μμf
Minimum	1100	μμf
Screen:		
Fluorescence	White	
Phosphor	Aluminized P4	
Persistence	Short	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angle:		
Horizontal	105°	
Vertical	87°	
Diagonal	110°	
No-Ion-Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any
Screen Dimensions (min. at greatest part):	
Width	14-3/4"
Height	11-11/16"
Diagonal	15-3/4"
Area	155 Sq. Inches
Faceplate	Spherical
Glass	Neutral Gray
Transmission (Approx.)	78%
Bulb Dimensions (at greatest part):	
Width	15-5/8" ± 1/8"
Height	12-3/4" ± 1/8"
Diagonal	16-9/16" ± 1/8"
Bulb Number	J132½ A1 or equiv.
Neck Length	4-1/8" ± 1/8"
Overall Length	11-1/4" ± 3/16"
Anode Terminal	Recessed Small Cavity Cap JEDEC No. J1-21
Base	Small Button, 7-Pin Style B JEDEC No. B7-208
Basing	8HR
Net Weight (Approx.)	10 lbs.

♦ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

MAXIMUM RATINGS:

Design Maximum Values

Anode Voltage†	20000	max.	Volts
Grid 4 Voltage:			
Positive Value	1100	max.	Volts
Negative Value	550	max.	Volts
Grid 2 Voltage	700	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	154	max.	Volts
Negative Peak Value	220	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	2	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode §	200	max.	Volts
Heater Positive with Respect to Cathode	200	max.	Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5	max.	Megohms
Grid 2 Circuit Resistance■	10000	min.	Ohms
Grid 4 Circuit Resistance■	10000	min.	Ohms

GRID DRIVE OPERATION
(Video Signal Applied to Grid 1)

TYPICAL OPERATING CONDITIONS:

Anode Voltage	14000	Volts
Grid 2 Voltage	500	Volts
Grid 4 Voltage for Focus	0 to +400	Volts
Grid 1 Cutoff Voltage▲	−43 to −72	Volts

CATHODE DRIVE OPERATION
(Video Signal Applied to Cathode)

TYPICAL OPERATING CONDITIONS:

Anode to Grid 1 Voltage	14000	Volts
Grid 2 to Grid 1 Voltage	500	Volts
Grid 4 to Grid 1 Voltage for Focus	0 to 400	Volts
Cathode to Grid 1 Cutoff Voltage▲	40 to 63	Volts

§ Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts is not recommended.

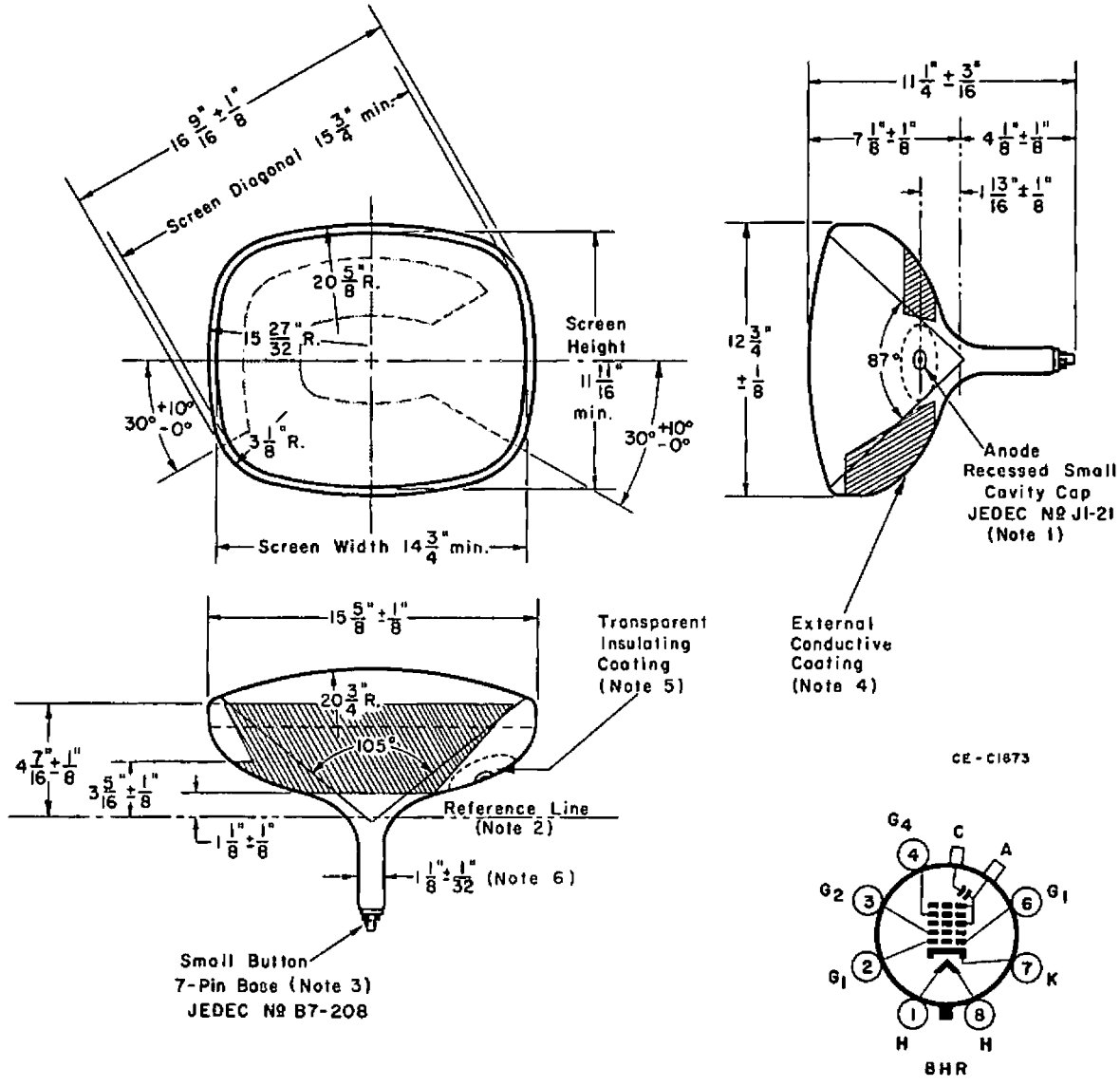
▲ For visual extinction of focused raster.

■ Protective resistance in the grid 2 and grid 4 (focus electrode) circuit is advisable to prevent damage to the tube.

X-RAY WARNING: Inasmuch as the tube rating permits operation at voltages as high as 22.0 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltages in excess of 16 kilovolts.

§ A peak value of 450 volts design center maximum may be applied for not more than 15 seconds during equipment warm-up periods.

from JEDEC release #3246, April 24, 1961



NOTE 1: The plane through the tube axis and base pin 4 may vary from the plane through the tube axis and the anode terminal by an angular tolerance of ± 30°. The anode terminal is on the same side of the tube as pin 4.

NOTE 2: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel. With a minimum neck length tube, the PM centering magnet (0 to 8 gaus) should extend no more than 2-1/8" from the yoke reference line.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: To clean this area, wipe only with a soft, dry, lintless cloth. The transparent insulating coating is approx. 6" in diameter.

NOTE 6: Neck diameter may be a maximum of 1.168" at the splice.

TELEVISION PICTURE TUBE TYPE 19ACP4

114° Magnetic Deflection		External Conductive Coating
Rectangular Glass	Electrostatic Focus	Spherical Faceplate
Aluminized Screen	5-1/8" Neck Length	No Ion Trap
Gray Filter Glass	Low G_2 Voltage (50 Volts)	12" × 15-1/8" Screen Size

ELECTRICAL:

Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	103	Degrees
Vertical	86	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Heater Current at 6.3 volts	600 ± 30	Ma.
Heater Warm-up Time⊕	11	Seconds

OPTICAL:

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78 Percent	

MECHANICAL:

Overall Length	12-3/8 ± 1/4	Inches
Greatest Dimensions of Tube:		
Diagonal	18-5/8 ± 1/8	Inches
Width	16-13/32 ± 1/8	Inches
Height	13-11/32 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	17-9/16	Inches
Horizontal	15-1/8	Inches
Vertical	12	Inches
Area	172	Sq. Inches
Neck Length	5-1/8 ± 1/8	Inches
Bulb	J149	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight	13-1/2 Lbs.	

RATINGS:

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	20000	Volts
Minimum Anode Voltage▲	12000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, −550	Volts
Maximum Grid 2 Voltage	70	Volts
Cathode Voltage:		
Maximum Negative Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 15 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS:

CATHODE DRIVE SERVICE:

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)	0 to 400	Volts DC
Grid 2 Voltage	50	Volts DC
Cathode Voltage for raster cutoff	35 to 50	Volts DC

LIMITING CIRCUIT VALUES:

Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance†	10000	Ohms

⊕ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

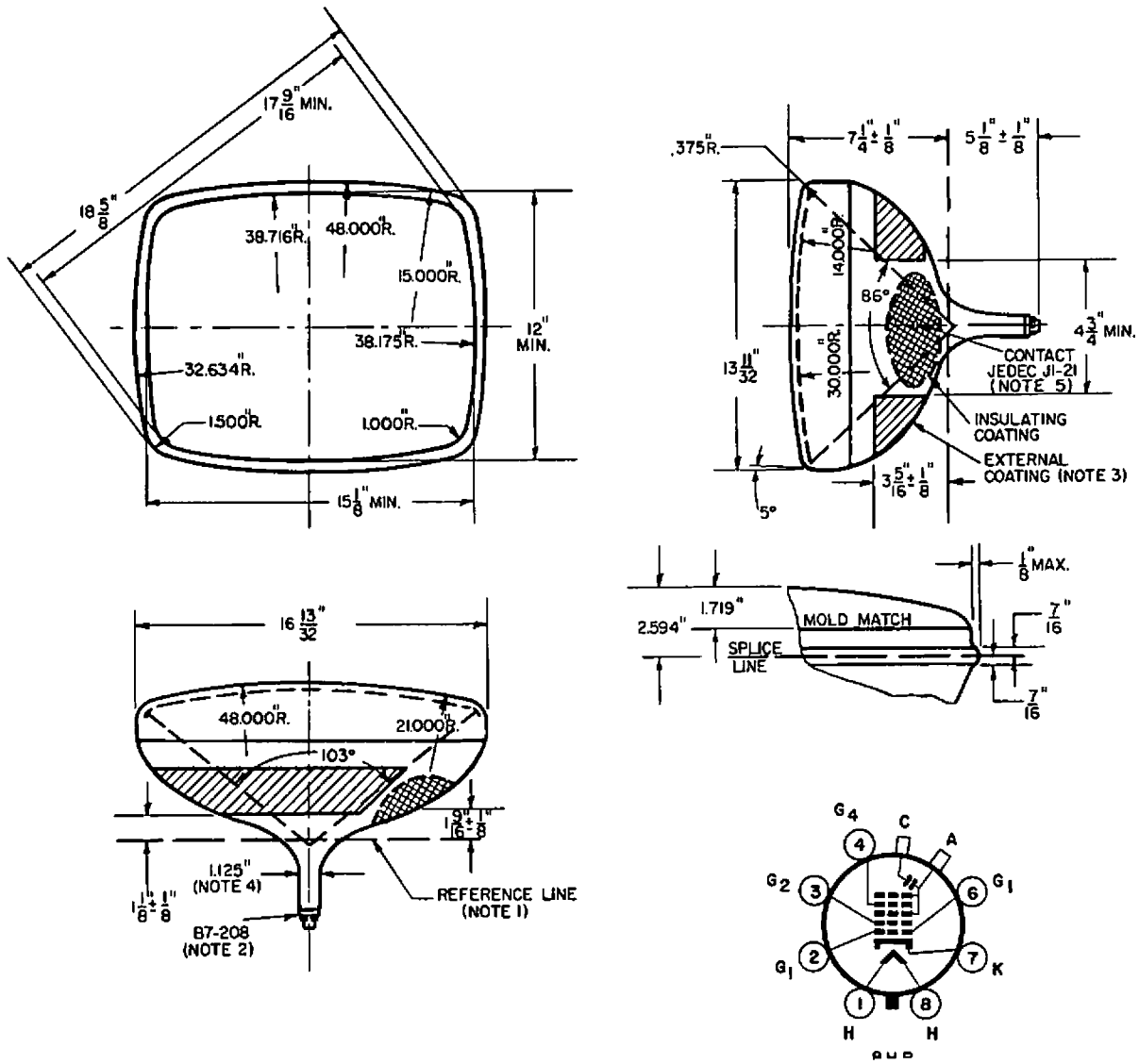
▲ Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts in not recommended.

† Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #3046, Nov. 28, 1960

Westinghouse



NOTE 1: Yoke Reference Line is determined by plane surface of flared end of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: Anode terminal alignment with pin 4 has angular tolerance about tube axis of ± 30°.

Westinghouse

19AHP4

October 1, 1960

TELEVISION PICTURE TUBE TYPE 19AHP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

6.3 Volt, 450 Ma. Heater
Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
12" × 15-1/8" Screen Size

ELECTRICAL:

Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	103	Degrees
Vertical	86	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Heater Current at 6.3 volts	450 ± 5%	Ma.
Heater Warm-up Time⊕	11	Seconds

OPTICAL:

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78	Percent

MECHANICAL:

Overall Length	11-3/8 ± 1/4	Inches
Greatest Dimensions of Tube:		
Diagonal	18-5/8 ± 1/8	Inches
Width	16-13/32 ± 1/8	Inches
Height	13-11/32 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	17-9/16	Inches
Horizontal	15-1/8	Inches
Vertical	12	Inches
Area	172	Sq. Inches
Neck Length	4-1/8 ± 1/8	Inches
Bulb	J149	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight	13-1/2 Lbs.	

RATINGS:

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	17600	Volts
Minimum Anode Voltage▲	12000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, −550	Volts
Maximum Grid 2 Voltage	650	Volts
Cathode Voltage:		
Maximum Negative Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 15 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS:

CATHODE DRIVE SERVICE:

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)	0 to 400	Volts DC
Grid 2 Voltage	500	Volts DC
Cathode Voltage for raster cutoff	40 to 63	Volts DC

LIMITING CIRCUIT VALUES:

Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance†	10000	Ohms

⊕ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

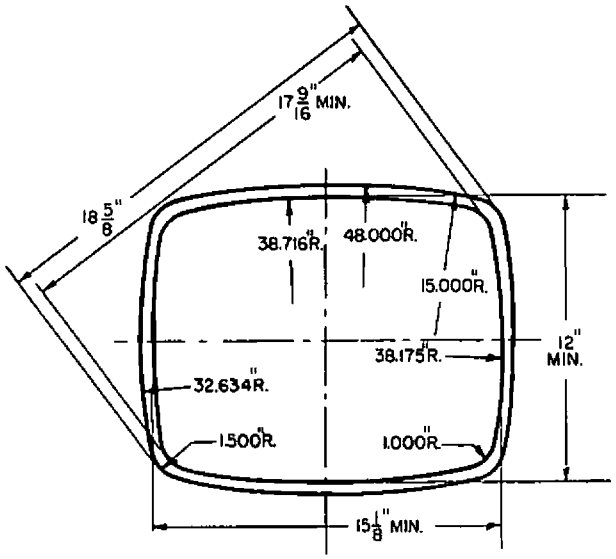
▲ Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts in not recommended.

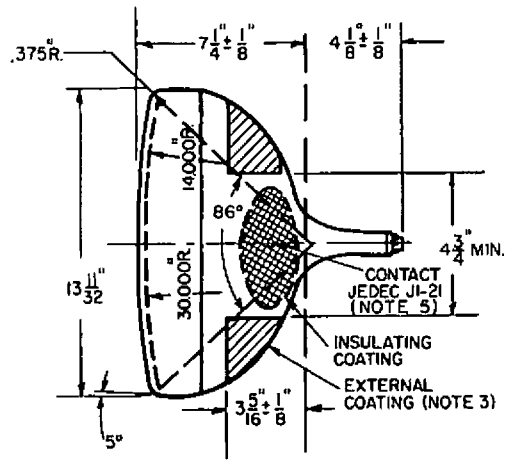
† Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

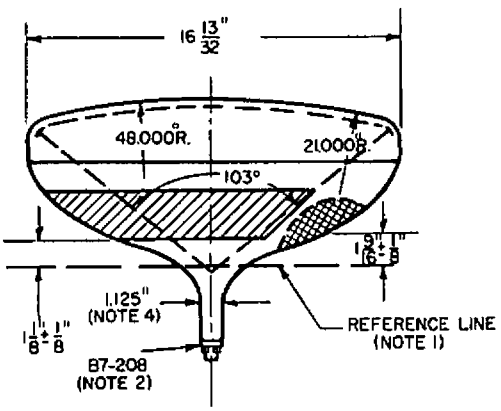
X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

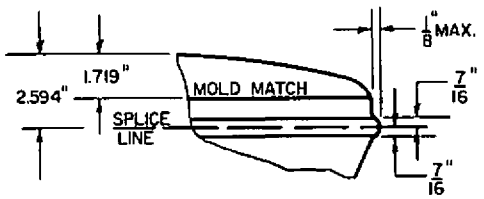
from JEDEC release #3046, Nov. 28, 1960

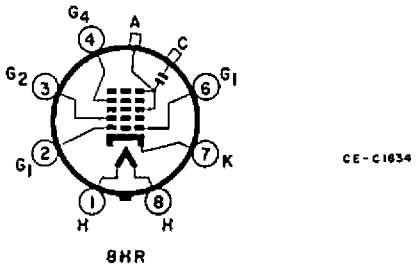
Westinghouse











8HR

NOTE 1: Yoke Reference Line is determined by plane surface of flared end of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: Anode terminal alignment with pin 4 has angular tolerance about tube axis of ± 30°.

TELEVISION PICTURE TUBE TYPE 19ALP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

6.3 Volt, 300 Ma. Heater
Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
12" × 15-1/8" Screen Size

ELECTRICAL:

Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	103	Degrees
Vertical	86	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Heater Current at 6.3 volts	300 ± 5%	Ma.
Heater Warm-up Time⊕	18	Seconds

OPTICAL:

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78	Percent

MECHANICAL:

Overall Length	11-3/8 ± 1/4	Inches
Greatest Dimensions of Tube:		
Diagonal	18-5/8 ± 1/8	Inches
Width	16-13/32 ± 1/8	Inches
Height	13-11/32 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	17-9/16	Inches
Horizontal	15-1/8	Inches
Vertical	12	Inches
Area	172	Sq. Inches
Neck Length	4-1/8 ± 1/8	Inches
Bulb	J149	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight	13-1/2 Lbs.	

RATINGS:

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	22000	Volts
Minimum Anode Voltage▲	12000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, −550	Volts
Maximum Grid 2 Voltage	700	Volts
Cathode Voltage:		
Maximum Negative Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 45 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS:

CATHODE DRIVE SERVICE:

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)	0 to 400	Volts DC
Grid 2 Voltage	500	Volts DC
Cathode Voltage for raster cutoff	45 to 95	Volts DC

LIMITING CIRCUIT VALUES:

Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance†	10000	Ohms

⊕ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

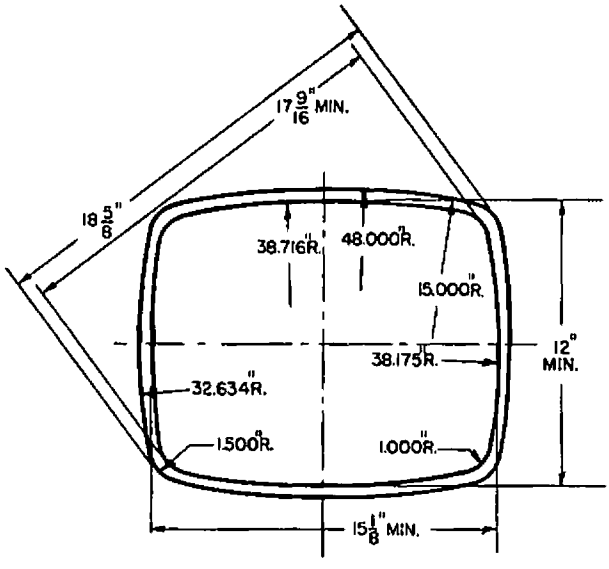
▲ Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts in not recommended.

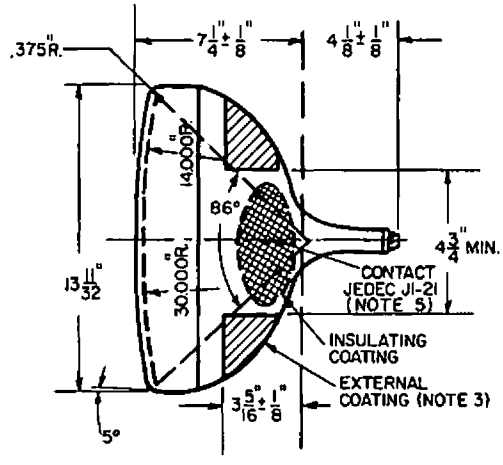
† Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

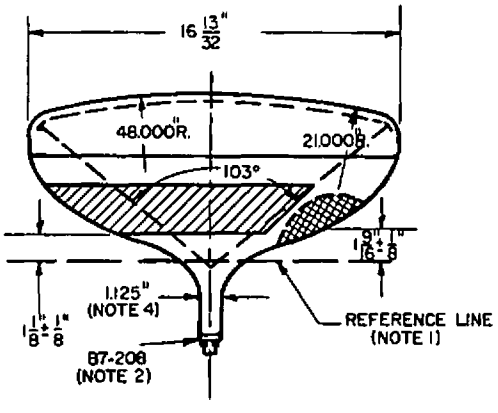
X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

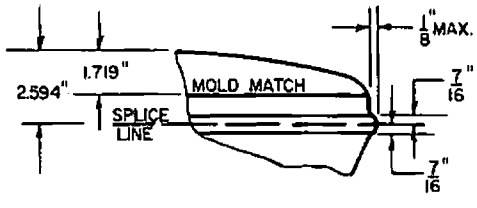
from JEDEC release #3046, Nov. 28, 1960

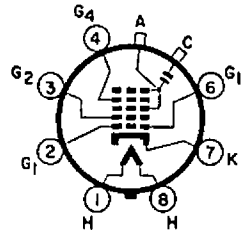
Westinghouse











8HR

NOTE 1: Yoke Reference Line is determined by plane surface of flared end of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: Anode terminal alignment with pin 4 has angular tolerance about tube axis of ± 30°.

Westinghouse

19BVP4

October 1, 1961

TELEVISION PICTURE TUBE TYPE 19BVP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

6.3 Volt, 600 Ma. Heater
Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
12" x 15-1/8" Screen Size

ELECTRICAL:

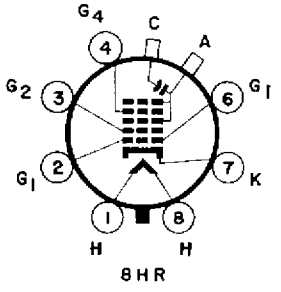
Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	103	Degrees
Vertical	86	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Heater Current at 6.3 volts	600 ± 5%	Ma.
Heater warm-up Time (Note 1)	11	Seconds

OPTICAL:

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78	Percent

MECHANICAL:

Overall Length	11-3/4 ± 1/4	Inches
Greatest Dimensions of Tube:		
Diagonal	18-5/8 ± 1/8	Inches
Width	16-13/32 ± 1/8	Inches
Height	13-11/32 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	17-9/16	Inches
Horizontal	15-1/8	Inches
Vertical	12	Inches
Area	172	Sq. Inches
Neck Length	4-1/2 ± 1/8	Inches
Bulb	J149A1	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight	13-1/2 Pounds	



8HR

RATINGS:

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	23500	Volts
Minimum Anode Voltage (Note 2)	12000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, -550	Volts
Maximum Grid 2 Voltage	700	Volts
Cathode Voltage:		
Maximum Negative Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 15 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS:

CATHODE DRIVE SERVICE:

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	20000	Volts DC
Grid 4 Voltage (Focusing Electrode)	250	Volts DC
Grid 2 Voltage (Note 3)	500	Volts DC
Cathode Voltage for raster cutoff	45 to 95	Volts DC

LIMITING CIRCUIT VALUES:

Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance (Note 4)	10000	Ohms

1. Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

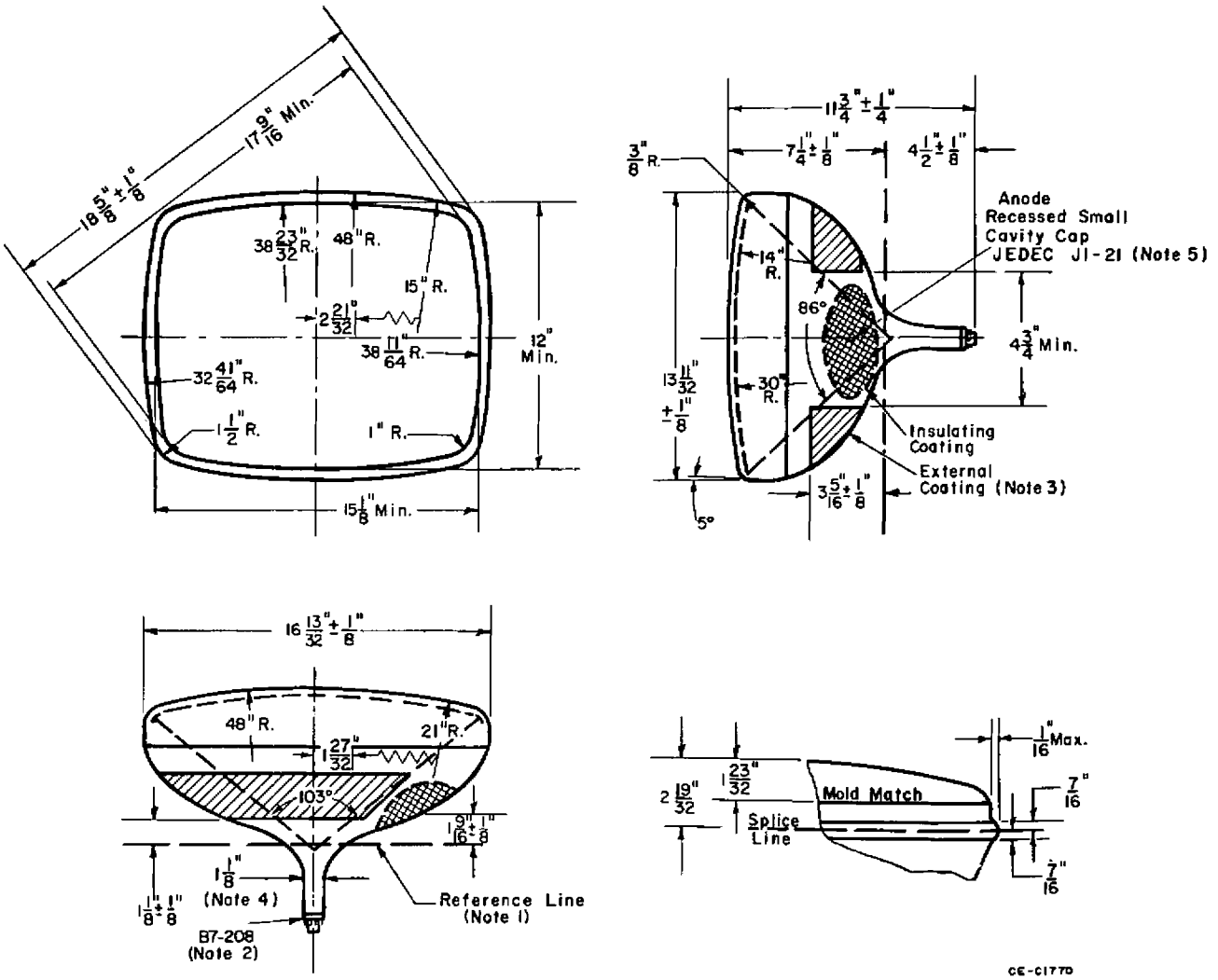
2. Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts in not recommended.

3. It is recommended that not less than 300 volts on Grid 2 be used, as resolution is affected at lower voltages.

4. Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #3450, Oct. 16, 1961



NOTE 1: Yoke Reference Line is determined by plane C-C' of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: Anode terminal alignment with pin 4 has angular tolerance about tube axis of ±30°.

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TELEVISION PICTURE TUBE TYPE 19BWP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

6.3 Volt, 450 Ma. Heater
Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
12" x 15-1/8" Screen Size

ELECTRICAL:

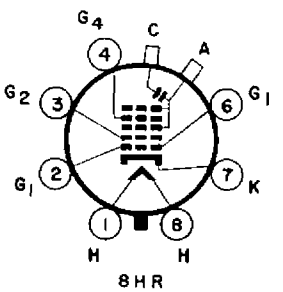
Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	103	Degrees
Vertical	86	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	1500	μμf
Minimum	1000	μμf
Heater Current at 6.3 volts	450 ± 5%	Ma.
Heater Warm-up Time (Note 1)	11	Seconds

OPTICAL:

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78	Percent

MECHANICAL:

Overall Length	11-3/4 ± 1/4	Inches
Greatest Dimensions of Tube:		
Diagonal	18-5/8 ± 1/8	Inches
Width	16-13/32 ± 1/8	Inches
Height	13-11/32 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	17-9/16	Inches
Horizontal	15-1/8	Inches
Vertical	12	Inches
Area	172	Sq. Inches
Neck Length	4-1/2 ± 1/8	Inches
Bulb	J149A1	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight	13-1/2	Pounds



8HR

RATINGS:

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	23500	Volts
Minimum Anode Voltage (Note 2)	12000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, -550	Volts
Maximum Grid 2 Voltage	700	Volts
Cathode Voltage:		
Maximum Negative Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 15 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS:

CATHODE DRIVE SERVICE:

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	20000	Volts DC
Grid 4 Voltage (Focusing Electrode)	250	Volts DC
Grid 2 Voltage (Note 3)	500	Volts DC
Cathode Voltage for raster cutoff	45 to 95	Volts DC

LIMITING CIRCUIT VALUES:

Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance (Note 4)	10000	Ohms

1. Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

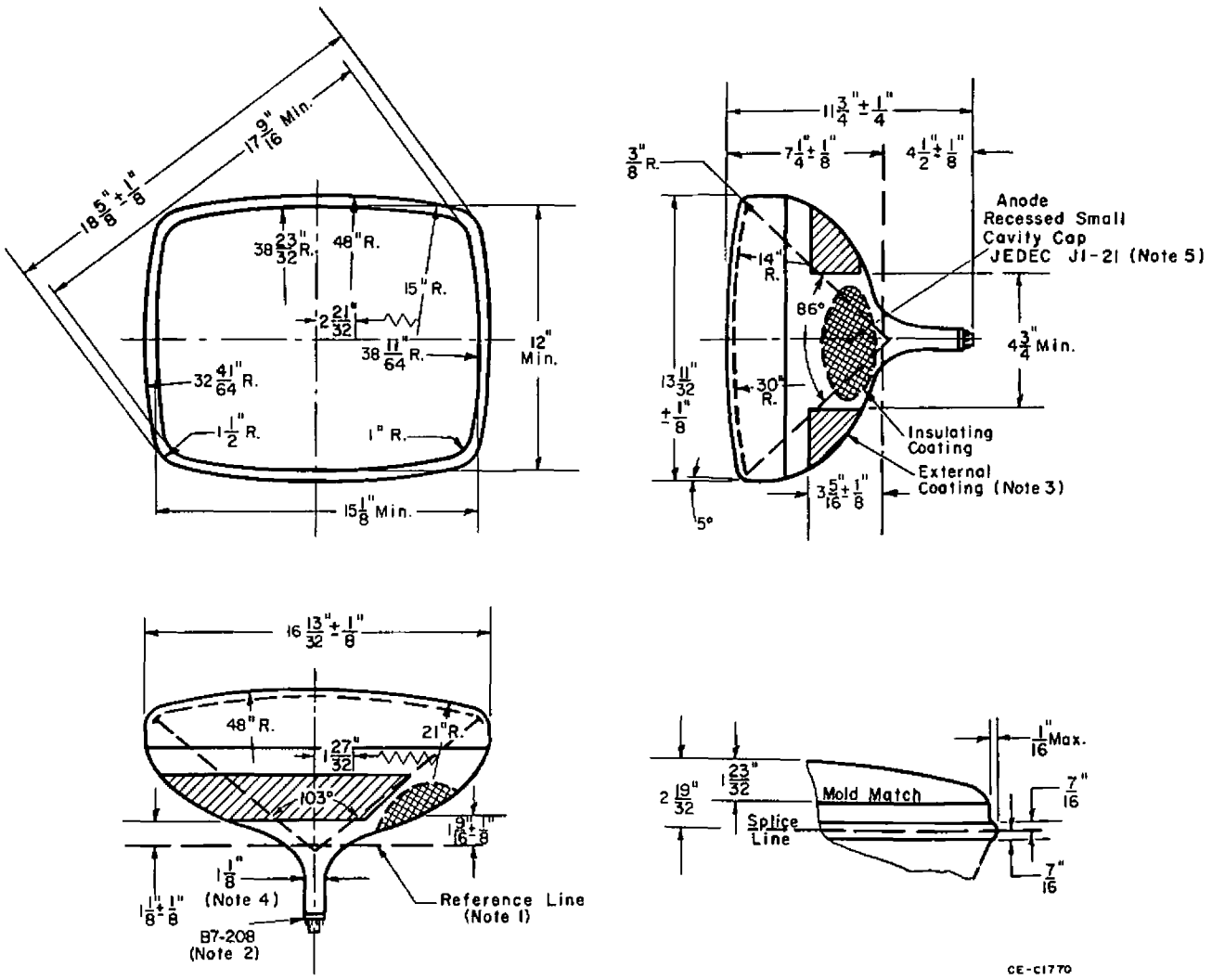
2. Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 12000 volts in not recommended.

3. It is recommended that not less than 300 volts on Grid 2 be used, as resolution is affected at lower voltages.

4. Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #3450, Oct. 16, 1961



NOTE 1: Yoke Reference Line is determined by plane C-C' of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (2 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: Anode terminal alignment with pin 4 has angular tolerance about tube axis of ±30°.

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WESTINGHOUSE

ELECTRON TUBE TYPE 195

AMPLIFIER AND OSCILLATOR

GENERAL CHARACTERISTICS

Air-Cooled Triode

Filament Voltage	10 Volts
Filament Current	3.25 Amperes
Amplification Factor	12
Transconductance, Grid-Plate	1200 umhos
Capacitance, Grid-Plate	2.8 uuf
Capacitance, Grid-Filament	2.2 uuf
Capacitance, Plate-Filament	1.2 uuf
Approximate Resonant Frequency, Grid-Plate	200 MC
Net Weight	8 oz.
Shipping Weight	4 lbs.

MAXIMUM RATINGS AND TYPICAL OPERATION CONDITIONS

R-F Power Amplifier and Oscillator, Class C

Telegraph and Therapy Service
Key-down Conditions Without Modulation*

Maximum Ratings

Plate Volts, A-C, RMS	3000
Plate Volts, D-C, Unfiltered	3000
Plate Current, D-C, Ma	150
Plate Input, Watts	450
Plate Dissipation, Watts	125
Plate Volts and Input for 15 MC	100%
Plate Volts and Input for 30 MC	80%
Plate Volts and Input for 60 MC	60%
Grid Volts, D-C	-500
Grid Volts, R-F	750
Grid Current, D-C, Ma	40

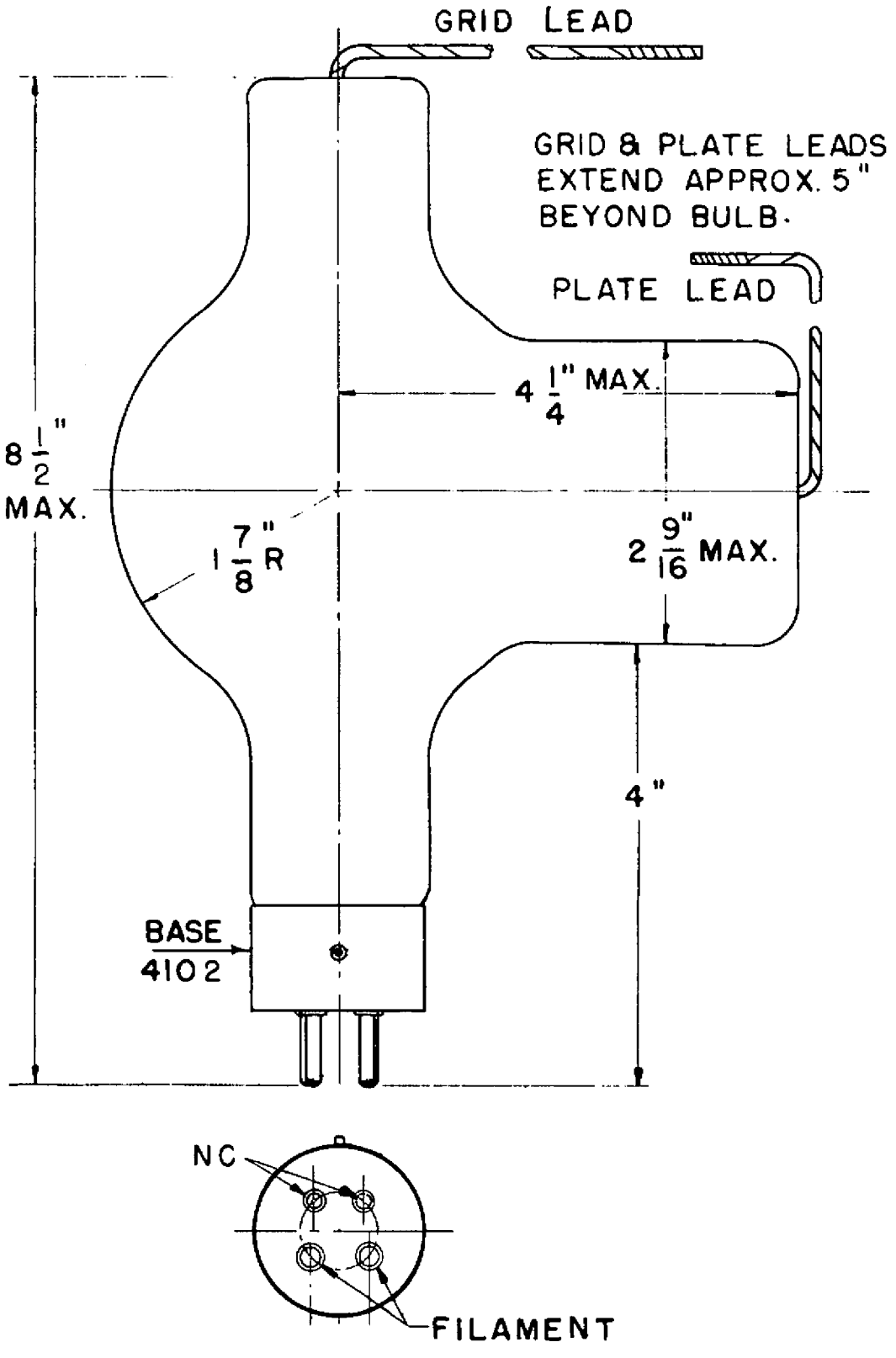
Typical Operation, Class C

Plate Volts, A-C, RMS	2000	2500	3000
Plate Volts, D-C, Unfiltered	1800	2250	2700
Plate Current, D-C, Ma	150	132	116
Plate Input, Watts	335	365	385
Plate Dissipation, Watts	110	110	110
Grid Volts, D-C	-200	-350	-500
Grid Volts, R-F, Peak	450	600	750
Grid Current, Ma	20	15	15

*Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

from RMA release # 553, Jan. 10, 1947

195 - 196


GRID LEAD
GRID & PLATE LEADS EXTEND APPROX. 5" BEYOND BULB.
PLATE LEAD
4 1/4" MAX.
8 1/2" MAX.
1 7/8" R
2 9/16" MAX.
4"
BASE 4102
NC
FILAMENT

WESTINGHOUSE

ELECTRON TUBE TYPE 196

AMPLIFIER AND OSCILLATOR

GENERAL CHARACTERISTICS

Air-Cooled Triode	
Filament Voltage	10 Volts
Filament Current	3.25 Amperes
Amplification Factor	35
Transconductance, Grid-Plate	1600 umhos
Capacitance, Grid-Plate	3 uuf
Capacitance, Grid-Filament	2.4 uuf
Capacitance, Plate-Filament	1.4 uuf
Resonant Frequency, Grid-Plate	200 MC
Net Weight	8 oz.
Shipping Weight	4 lbs.

MAXIMUM RATINGS AND TYPICAL OPERATION CONDITIONS

R-F Power Amplifier and Oscillator, Class C

Telegraph and Therapy Service
Key-down Conditions Without Modulation°

Maximum Ratings

Plate Volts, A-C, RMS	3000
Plate Volts, D-C, Unfiltered	3000
Plate Current, D-C, Ma	150
Plate Input, Watts	450
Plate Dissipation, Watts	125
Plate Volts and Input for 15 MC	100%
Plate Volts and Input for 30 MC	80%
Plate Volts and Input for 60 MC	60%
Grid Volts, D-C	-500
Grid Volts, R-F	750
Grid Current, D-C, Ma	40

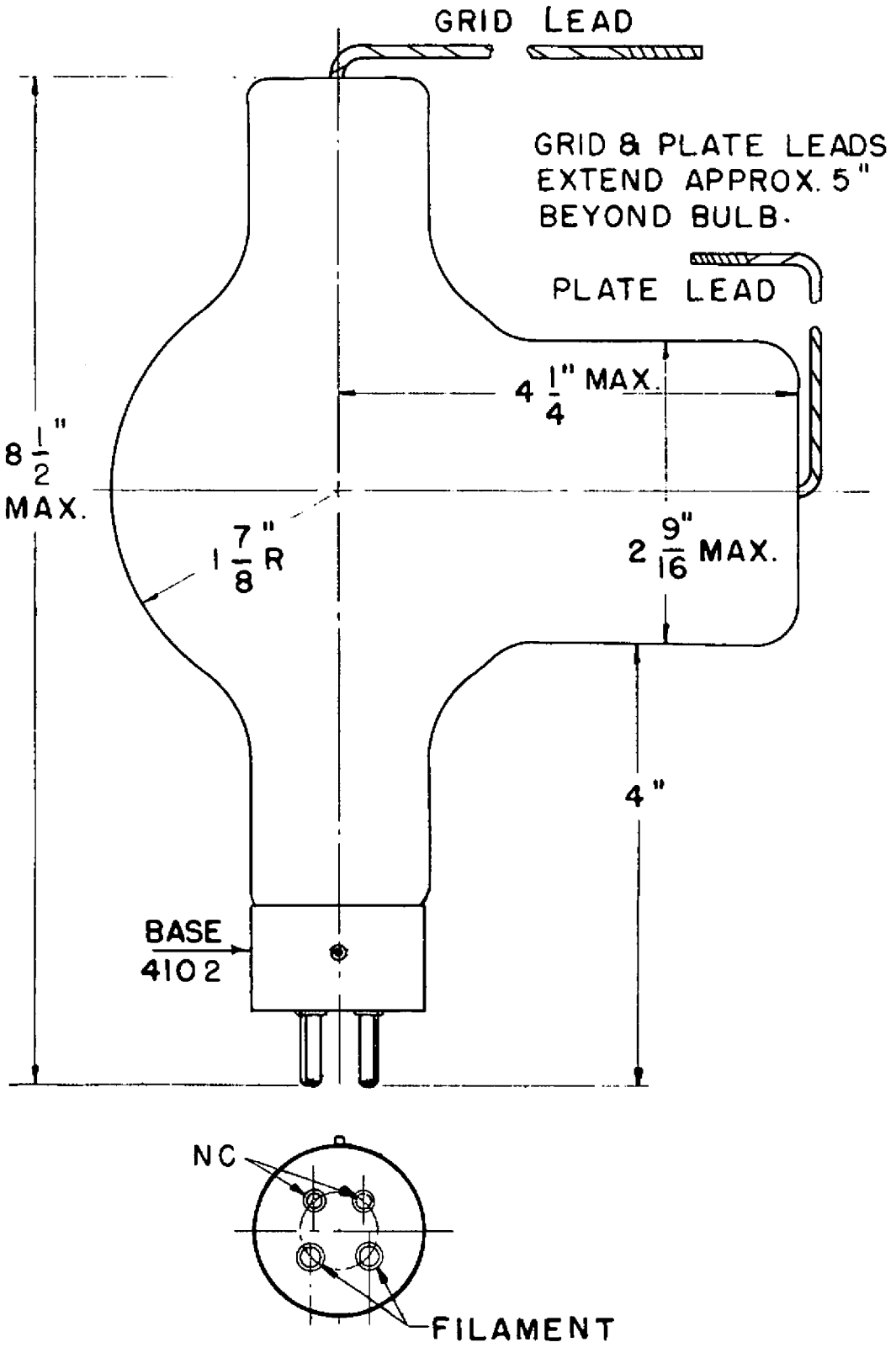
Typical Operation, Class C

Plate Volts, A-C, RMS	2000	2500	3000
Plate Volts, D-C, Unfiltered	1800	2250	2700
Plate Current, D-C, Ma	150	132	116
Plate Input, Watts	335	365	385
Plate Dissipation Watts	110	110	110
Grid Volts, D-C	-75	-100	-125
Grid Volts, R-F, Peak	250	250	300
Grid Current, Ma	20	15	15

°Modulation, essentially negative, may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

from RMA release # 553, Jan. 10, 1947

195 - 196


GRID LEAD
GRID & PLATE LEADS EXTEND APPROX. 5" BEYOND BULB.
PLATE LEAD
4 1/4" MAX.
8 1/2" MAX.
1 7/8" R
2 9/16" MAX.
4"
BASE 4102
NC
FILAMENT

TELEVISION PICTURE TUBE TYPE 21DKP4A

110° Magnetic Deflection
Rectangular Glass
Aluminized
Neutral Gray Glass

Light Weight Bulb
300 Ma. Controlled Warm-up Heater

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-1/16" x 15-1/16" Picture

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.30 ± 5%	Ampere
Heater Warm-up Time⊕	18	Seconds
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	μμf
Cathode to all other Electrodes	5	μμf
External Conductive Coating to Anode:		
Maximum	2500	μμf
Minimum	1700	μμf
Screen:		
Phosphor	Aluminized P4	
Fluorescence	White	
Persistence	Short	
Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle	105°	
Vertical Angle	87°	
Diagonal Angle	110°	
No Ion Trap	No Magnet Required	

MECHANICAL:

Mounting Position	Any	
Screen Dimensions: Minimum		
Height	15-1/16"	
Width	19-1/16"	
Diagonal	20-1/4"	
Area	262 sq. Inches	
Faceplate	Spherical	
Glass	Neutral Gray	
Transmission	76%	
Bulb Dimensions: Bulb No.	J171G1 or Equiv.	
Height	16-3/8" ± 1/8"	
Width	20-1/4" ± 1/8"	
Diagonal	21-3/8" ± 1/8"	
Overall Length	14-11/16" ± 5/16"	
Neck Length	5-7/16" ± 1/8"	
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)	
Base	Small Button 7-Pin (JETEC B7-183)	
Basing	8HR	
Weight (approx.)	20 Pounds	

⊕ Heater Warm-up Time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

MAXIMUM RATINGS:

Design Center Values

Anode Voltage	18000▲	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Positive Bias Value	0	max.	Volts
Positive Peak Value	2	max.	Volts
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with respect to Cathode #	180	max.	Volts
Heater Positive with respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage♦	16000	Volts
Grid 4 Voltage	0 to 400	Volts
Grid 2 Voltage	300	Volts
Grid 1 Voltage for Raster Cutoff	-35 to -72	Volts

LIMITING CIRCUIT VALUES:

Grid 4 Resistance to Voltage Source■	10000	min.	Ohms
Grid 2 Resistance to Voltage Source■	10000	min.	Ohms
Grid 1 Circuit Resistance	1.5	max.	Megohms

♦ Operation with anode voltage or anode to grid 1 voltage less than 12000 volts is not recommended.

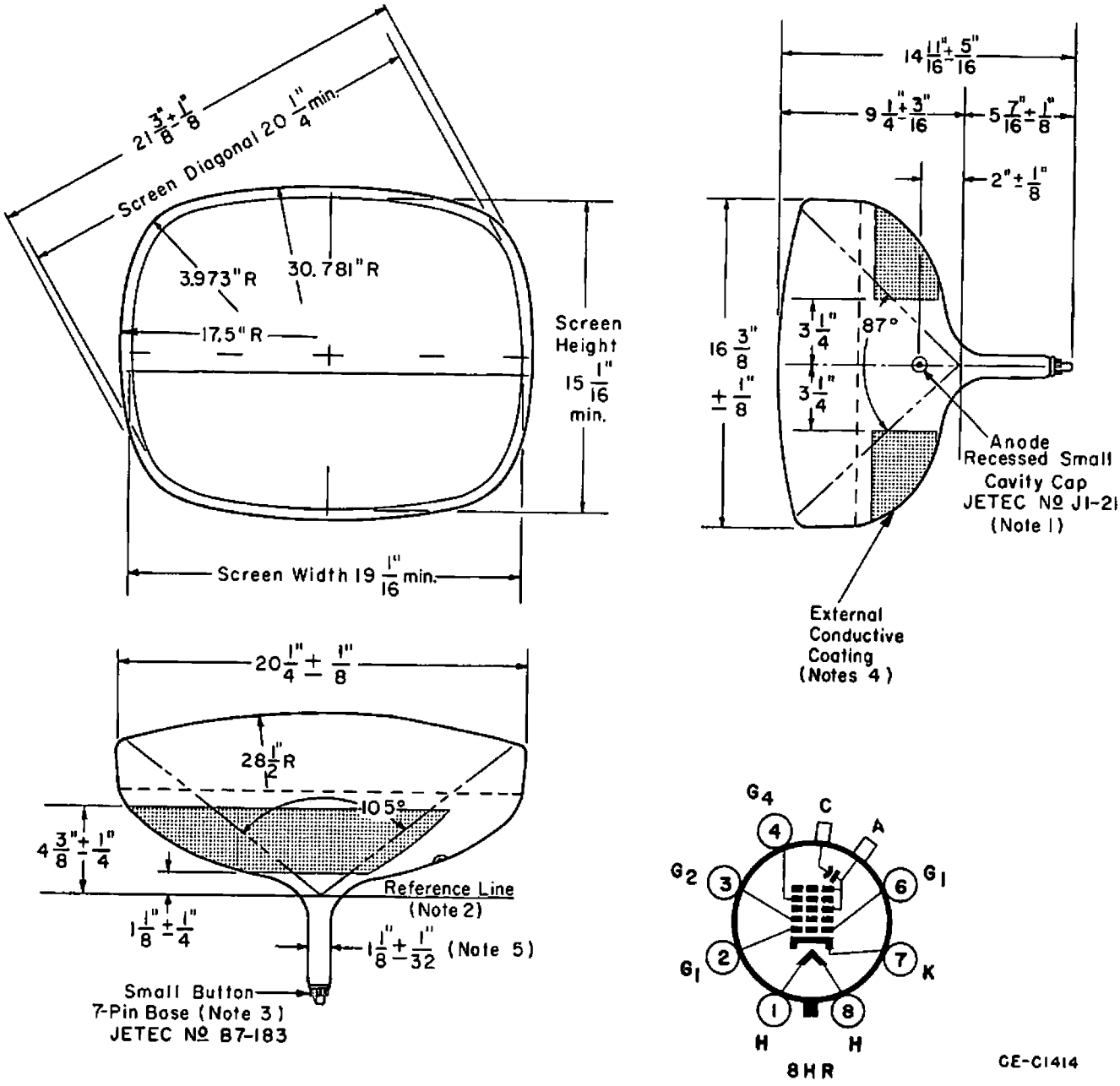
■ Protective resistance in the grid 4 and grid 2 circuits is advisable to prevent damage to the tube. If applicable, one resistor common to both circuits may be used.

▲ Inasmuch as the tube rating permits operation at voltages as high as 19.8 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed when operating conditions involve voltages in excess of 16 kilovolts.

During 45 second warmup period this value may be 410 max. volts.

Note: With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from the yoke reference line.

from JEDEC release #2624, Nov. 9, 1959



CE-C1414

NOTE 1: The plane through the tube axis and base pin 4 may vary from the plane through the tube axis and the anode terminal by an angular tolerance of ±30°. The anode terminal is on the same side of the tube as pin 4.

NOTE 2: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: Neck diameter may be a maximum of 1.168" at the splice.

May 23, 1958

TELEVISION PICTURE TUBE TYPE 21DVP4

90° Deflection
Rectangular Glass Construction
Magnetic Deflection

Electrostatic Focus
Low Heater Power

External Conductive Coating
Spherical Face Plate
15" x 19-1/8" Picture Size

The 21DVP4 is a low-voltage electrostatic focus, rectangular glass picture tube. It's characteristics include an aluminized screen, a spherical neutral gray faceplate and an external conductive coating.

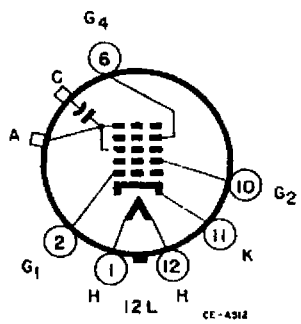
The 21DVP4 features a heater requiring 6.3 volts at only 300 milliamperes. The heater also has a controlled warm-up time for service in series-heater string television receivers.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.30	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating to Anode:		
Maximum	750	uuf
Minimum	500	uuf
Screen:		
Phosphor	No. 4 Sulfide Type	
Fluorescence	White	
Persistence	Short	
Focusing Method	Low-Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle, approx.	85°	
Vertical Angle, approx.	68°	
Diagonal Angle, approx.	90°	
Ion Trap Gun	External Single-Field Magnet	

MECHANICAL:

Mounting Position	Any
Screen Dimensions:	
Height	15-1/16" Min.
Width	19-1/16" Min.
Diagonal	20-1/4" Min.
Area	262 Sq. Inches
Face Plate	Spherical Outer and Inner Surfaces
Glass	Neutral Gray
Transmission	74 Per Cent
Bulb Dimensions:	
Height	16-3/8" ± 1/8"
Width	20-1/4" ± 1/8"
Diagonal	21-3/8" ± 1/8"
Overall Length	20" ± 3/8"
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)
Basing	12L
Net Weight, approx.	25 Lbs.



Bottom View
C—External Conductive Coating
A—Grids 3 & 5, Collector

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK
from JETEC release #2219, June 16, 1958

MAXIMUM RATINGS:

Design Center Values			
Anode Voltage†	20000	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Positive with Respect to Cathode	180	max.	Volts
Heater Negative with Respect to Cathode	180	max.	Volts

TYPICAL USE OF DESIGN RANGES:

For Anode Voltage†	14000	18000	Volts
For Grid 2 Voltage	300	300	Volts
Grid 4 Voltage for Focus with Anode Current of 100 uampere	-50 to 300	0 to 400	Volts
Grid 1 Voltage for Visual Extinction of Focused Raster**	-28 to -72	-28 to -72	Volts
Ion-Trap Magnet:			
Rated Strength	40	46	Gausses

MAXIMUM CIRCUIT VALUE:

Grid 1 Circuit Resistance	1.5	max.	Megohms
Grid 2 Circuit Resistance■	0.10	min.	Megohms
Grid 4 Circuit Resistance■	0.10	min.	Megohms

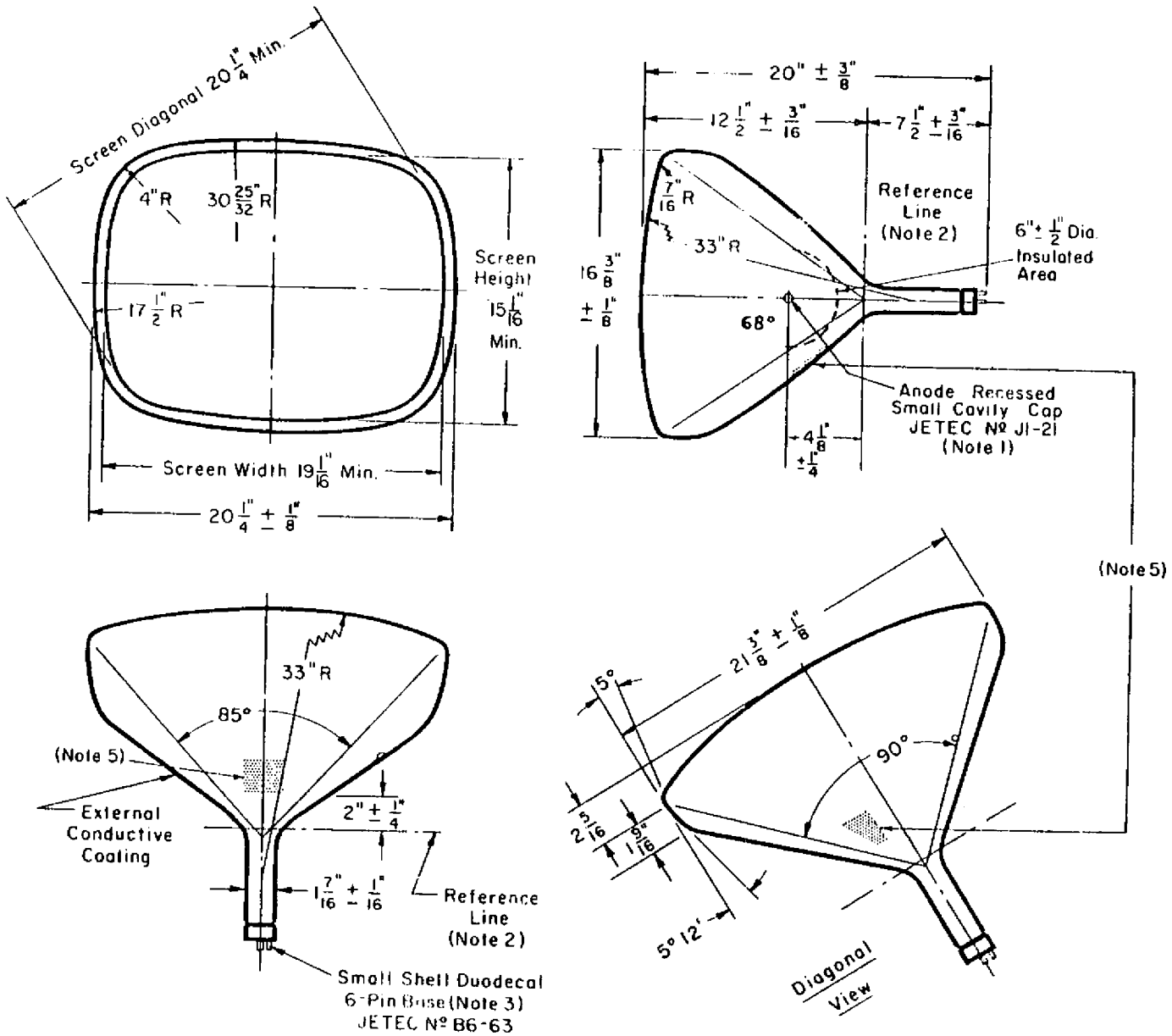
**Raster size 19-1/16 x 15-1/16

A peak value of 410 volts design center maximum may be applied for not more than 15 seconds during equipment warm-up periods.

† Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 14000 volts.

NOTE: Inasmuch as the tube rating permits operation at voltages as high as 22 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions

■ Protective resistance in the Grid 2 and Grid 4 circuits is advisable to prevent tube damage.



CE-C675

NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2 3/4".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

September 26, 1958

TELEVISION PICTURE TUBE TYPE 21DWP4

110° Magnetic Deflection — 6.3 Volt, 300 Ma. Heater — External Conductive Coating
Rectangular Glass — Spherical Faceplate
Aluminized — No Ion Trap
Neutral Gray Glass — 19-1/16" x 15-1/16" Picture

The 21DWP4 is a low-voltage-electrostatic focus, rectangular glass picture tube. It has a spherical neutral gray glass faceplate, an aluminized screen and an external conductive coating.

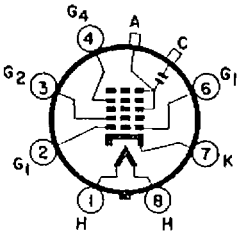
The 21DWP4 features wide angle (110°) deflection and an improved, short, electron gun. As a result of these features, the overall length is greatly reduced. Television receiver designers using this tube can employ more compact cabinets than were previously required for 21" tubes. The 21DWP4 also has a smaller diameter neck permitting more efficient deflection. By this means the power necessary to fully scan the picture area is little more than that required for a 90° Tube. The 21DWP4 has a low power heater.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	~~0.60~~ 0.30	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating to Anode:		
Maximum	2500	uuf
Minimum	2000	uuf
Screen:		
Phosphor	No. 4 Sulfide Type	
Fluorescence	White	
Persistance	Short	
Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle	105°	
Vertical Angle	87°	
Diagonal Angle	110°	
No Ion Trap	No Magnet Required	

MECHANICAL:

Mounting Position	Any
Screen Dimensions: Minimum	
Height	15-1/16"
Width	19-1/16"
Diagonal	20-1/4"
Area	262 sq. Inches
Faceplate	Spherical
Glass	Neutral Gray
Transmission	74%
Bulb Dimensions: Bulb No.	J171H1 or Equiv.
Height	16-3/8" ± 1/8"
Width	20-1/4" ± 1/8"
Diagonal	21-3/8" ± 1/8"
Overall Length	14-7/16" + 5/16"
Neck Length	5-7/16"
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Button 7-Pin ((JETEC B7-183)
Basing	8HR
Net Weight	23 Pounds



8HR

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JETEC release #2289, Oct. 13, 1958

MAXIMUM RATINGS:

Design Center Values			
Anode Voltage	18000▲	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Positive Bias Value	0	max.	Volts
Positive Peak Value	0	max.	Volts
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with respect to Cathode #	180	max.	Volts
Heater Positive with respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage♦		14000	Volts
Grid 4 Voltage		-50 to +350	Volts
Grid 2 Voltage		450	Volts
Grid 1 Voltage for Raster Cutoff	-28 to -72	-45 to -105	Volts

LIMITING CIRCUIT VALUES:

Grid 4 Resistance to Voltage Source■	0.01	min.	Megohms
Grid 2 Resistance to Voltage Source■	0.01	min.	Megohms
Grid 1 Circuit Resistance	1.5	max.	Megohms

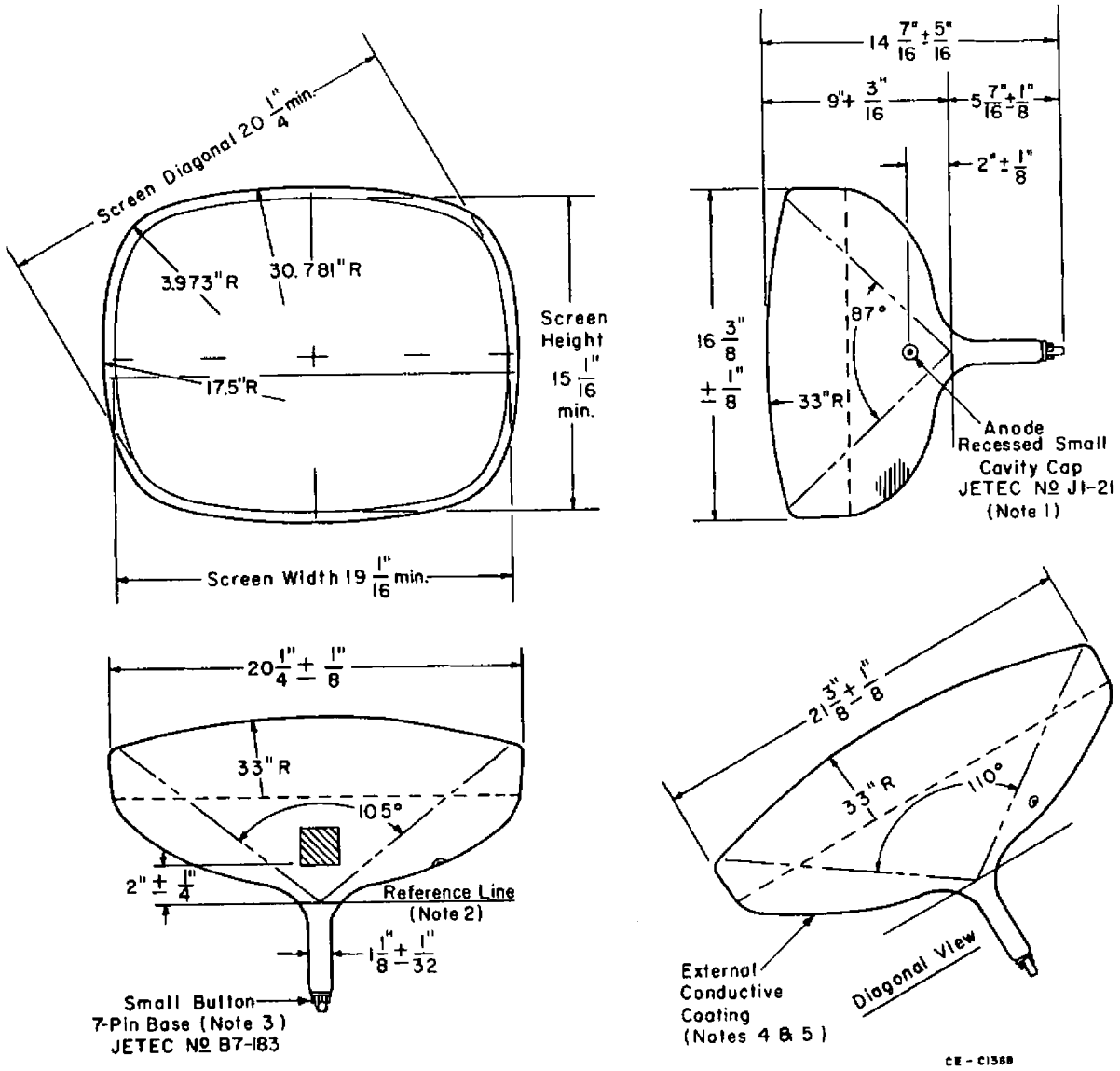
♦ Operation with anode voltage or anode to grid 1 voltage less than 12000 volts is not recommended.

■ Protective resistance in the grid 4 and grid 2 circuits is advisable to prevent damage to the tube. If applicable, one resistor common to both circuits may be used.

▲ Inasmuch as the tube rating permits operation at voltages as high as 19.8 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed when operating conditions involve voltages in excess of 16 kilovolts.

During 15 second warmup period this value may be 410 max. volts.

Note: With a minimum neck length tube, the PM centering magnet (0 to 8 gaus) should extend no more than 2-1/8" from the yoke reference line.



NOTE 1: The plane through the tube axis and base pin 4 may vary from the plane through the tube axis and the anode terminal by an angular tolerance of ±30°. The anode terminal is on the same side of the tube as pin 4.

NOTE 2: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress latual strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

November 7, 1958

TELEVISION PICTURE TUBE TYPE 21ELP4

90° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Electrostatic Focus
6-1/2" Neck Length
6.3 Volt, 300 Ma. Heater

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-1/16" x 15-1/16" Picture

ELECTRICAL:

Cathode	Coated Unipotential
Heater:	
Voltage (ac or dc)	6.3 Volts
Current	0.3 Ampere
Direct Interelectrode Capacitances:	
Grid 1 to all other Electrodes	
Cathode to all other Electrodes	5 uuf
External Conductive Coating:	
Maximum	2500 uuf
Minimum	2000 uuf
Screen:	
Phosphor	Aluminized P4
Fluorescence	White
Persistence	Short
Focusing Method	Electrostatic
Deflection Method	Magnetic
Horizontal Angle (Approx.)	85°
Vertical Angle (Approx.)	68°
Diagonal Angle (Approx.)	90°
No Ion Trap Gun	No Magnet Required

MECHANICAL:

Mounting Position	Any
Screen Dimensions:	
Minimum Screen Area	262 Sq. In.
Height	15-1/16" Min.
Width	19-1/16" Min.
Diagonal	20-1/4" Min.
Face Plate	Spherical Outer and Inner Surfaces
Glass	Neutral Filter
Transmission	74 per cent
Bulb Number	J171E1 or Equiv.
Bulb Dimensions:	
Height	16-3/8" ± 1/8"
Width	20-1/4" ± 1/8"
Diagonal	21-3/8" ± 1/8"
Neck Length	6-1/2"
Overall Length	19" ± 3/8"
Net Weight (Approx.)	23 Pounds
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)
or	Short Small Shell Duodecal 6-Pin (JETEC B6-203)

MAXIMUM RATINGS, Grid Drive Service:

Design Center Values

Anode Voltage■	20000 max.	Volts
Grid 4 Voltage:		
Positive Value	1000 max.	Volts
Negative Value	500 max.	Volts
Grid 2 Voltage	500 max.	Volts
Grid 1 Voltage:		
Negative Bias Value	140 max.	Volts
Negative Peak Value	200 max.	Volts
Positive Bias Value	0 max.	Volts
Positive Peak Value	0 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Negative with Respect to Cathode:		
During Warmup Period of 15 sec. max.	410 max.	Volts
After Equipment Warmup Period	180 max.	Volts
Heater Positive with Respect to to Cathode	180 max.	Volts

TYPICAL OPERATING CONDITIONS, Grid Drive Service:

Anode Voltage*	14000	16000 Volts
Grid 4 Voltage	-50 to +350	0 to 400 Volts
Grid 2 Voltage♦	450	450 Volts
Grid 1 Voltage for Raster Cutoff▲	-45 to -105	-45 to -105 Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5 max.	Megohms
Grid 2 Circuit Resistance**	10000 min.	Ohms
Grid 4 Circuit Resistance**	10000 min.	Ohms

* Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 11000 volts.

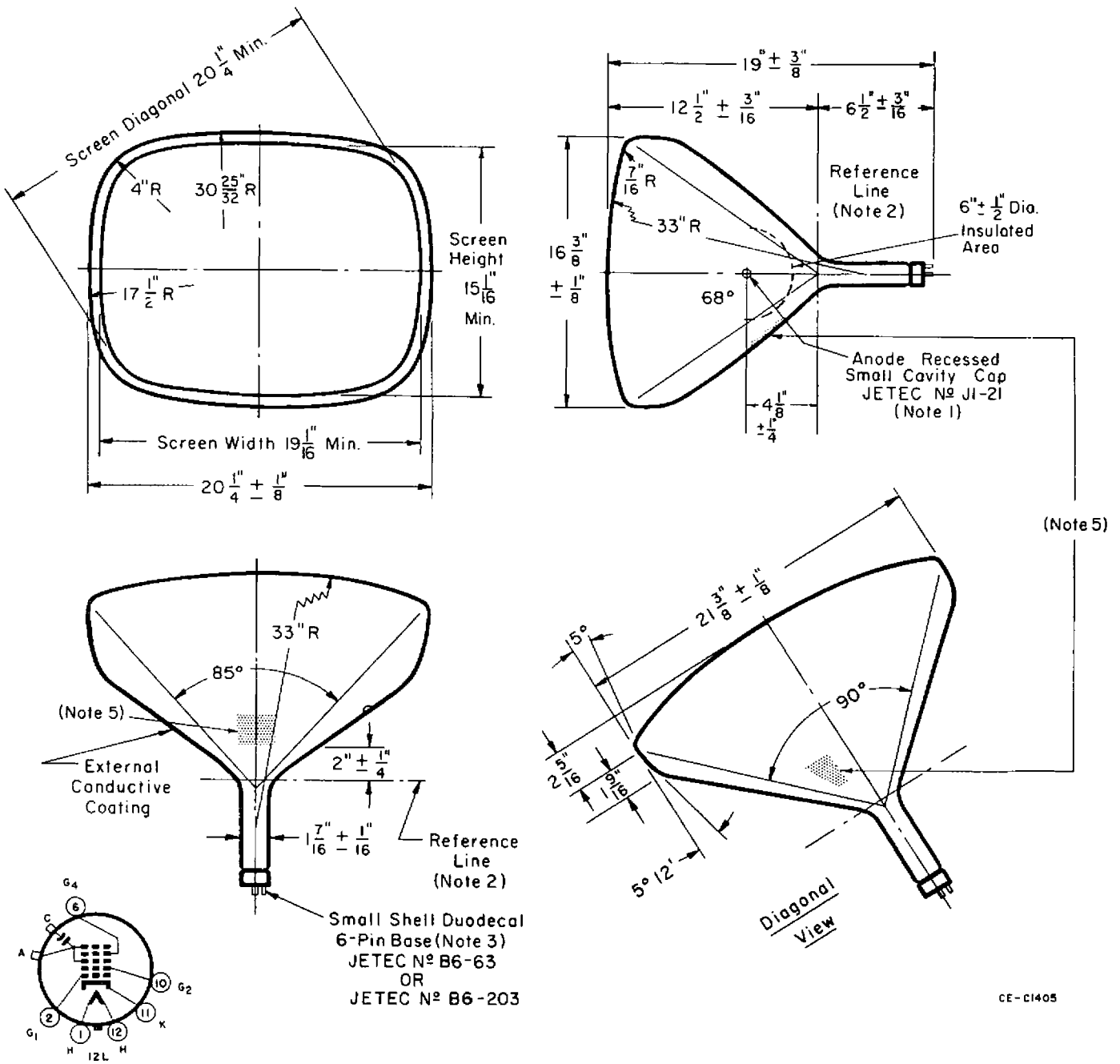
**Protective resistance in the G_2 and G_4 circuits is advisable to prevent damage to the tube.

▲ Raster size 19-1/16" x 15-1/16"

■ Inasmuch as the tube rating permits operation at voltages as high as 22 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.

♦ It is recommended that Grid 2 be operated at a voltage greater than 300 volts since resolution is affected at lower voltages.

from JETEC release #2347, Dec. 29, 1958



NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2-3/4".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. × 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

December 8, 1958

TELEVISION PICTURE TUBE TYPE 21EMP4

110° Magnetic Deflection
Rectangular Glass
Aluminized
Neutral Gray Glass

4-3/16" Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-1/16" x 15-1/16" Picture

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.60	Ampere
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating to Anode:		
Maximum	2500	uuf
Minimum	2000	uuf
Screen:		
Phosphor	Aluminized P-4	
Fluorescence	White	
Persistance	Short	
Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle	105°	
Vertical Angle	87°	
Diagonal Angle	110°	
No Ion Trap	No Magnet Required	

MECHANICAL:

Mounting Position	Any	
Screen Dimensions: Minimum		
Height	15-1/16"	
Width	19-1/16"	
Diagonal	20-1/4"	
Area	262 sq. Inches	
Faceplate	Spherical	
Glass	Neutral Gray	
Transmission	74%	
Bulb Dimensions: Bulb No.	J171H1 or Equiv.	
Height	16-3/8" ± 1/8"	
Width	20-1/4" ± 1/8"	
Diagonal	21-3/8" ± 1/8"	
Overall Length	13-3/16" ± 5/16"	
Neck Length	4-3/16" ± 1/8"	
Anode Terminal	JETEC J1-21	
Base	JETEC B7-208	
Basing	8HR	
Net Weight	23 Pounds	

MAXIMUM RATINGS:

Design Center Values

Anode Voltage	18000▲	max.	Volts
Grid 4 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 Voltage	500	max.	Volts
Grid 1 Voltage:			
Positive Bias Value	0	max.	Volts
Positive Peak Value	0	max.	Volts
Negative Bias Value	140	max.	Volts
Negative Peak Value	200	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with respect to Cathode #	180	max.	Volts
Heater Positive with respect to Cathode	180	max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage♦	16000	Volts
Grid 4 Voltage	0 to + 400	Volts
Grid 2 Voltage■	450	Volts
Grid 1 Voltage for Raster Cutoff	-45 to -105	Volts

LIMITING CIRCUIT VALUES:

Grid 4 Resistance to Voltage Source■	10000	min.	Ohms
Grid 2 Resistance to Voltage Source■	10000	min.	Ohms
Grid 1 Circuit Resistance	1.5	max.	Megohms

♦ Operation with anode voltage or anode to grid 1 voltage less than 11000 volts is not recommended.

■ It is recommended that Grid 2 be operated at a voltage greater than 300 volts since resolution is affected at lower voltages.

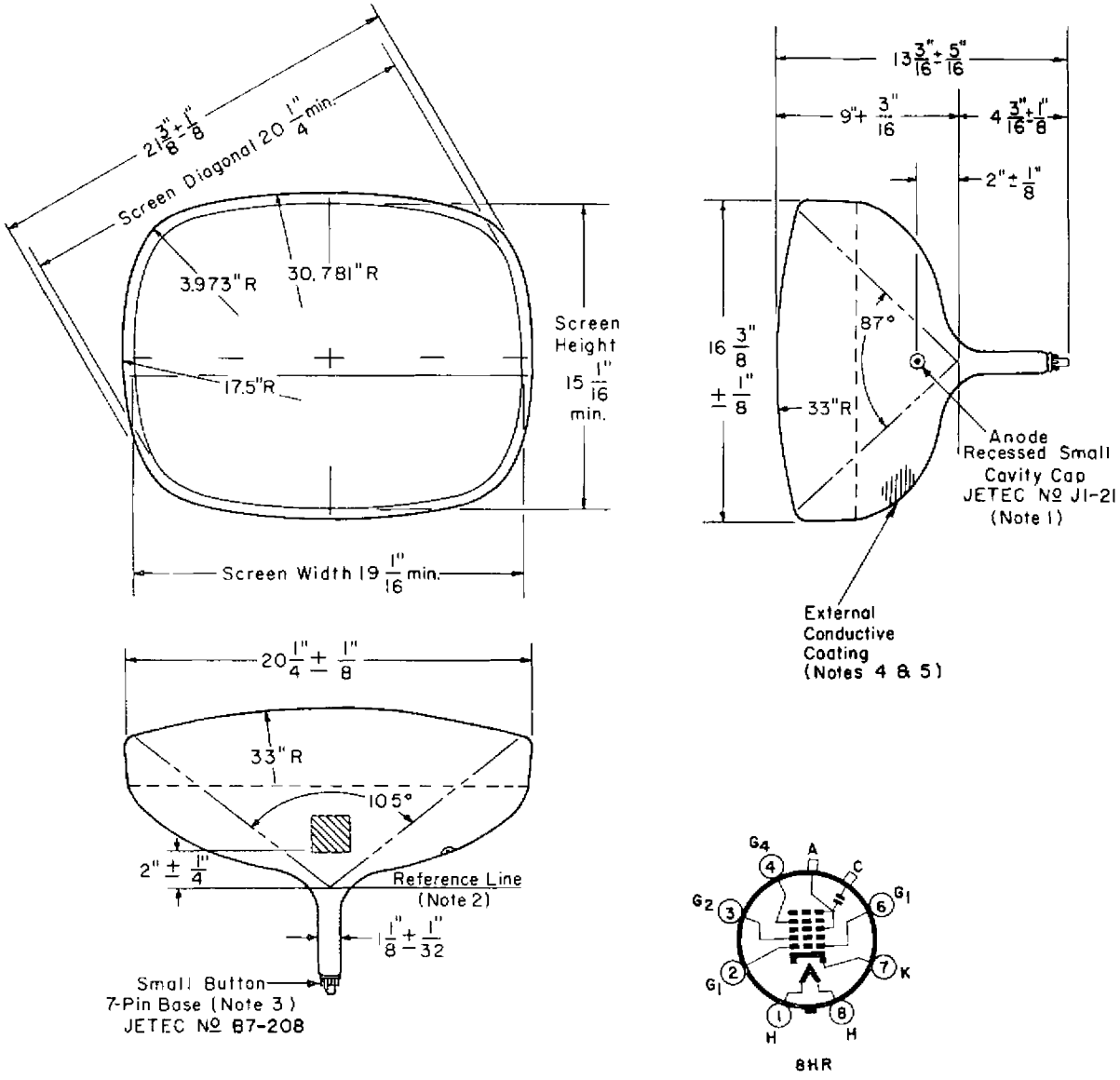
■ Protective resistance in the grid 4 and grid 2 circuits is advisable to prevent damage to the tube. If applicable, one resistor common to both circuits may be used.

▲ Inasmuch as the tube rating permits operation at voltages as high as 19.8 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed when operating conditions involve voltages in excess of 16 kilovolts.

During 15 second warmup period this value may be 410 max. volts.

Note: With a minimum neck length tube, the PM centering magnet (0 to 8 gaus) should extend no more than 2-1/8" from the yoke reference line.

from JETEC release $2347, Dec. 29, 1958



NOTE 1: The plane through the tube axis and base pin 4 may vary from the plane through the tube axis and the anode terminal by an angular tolerance of ±30°. The anode terminal is on the same side of the tube as pin 4.

NOTE 2: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. × 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

April 24, 1959

CATHODE RAY DISPLAY TUBE TYPE 21EWP4

The 21EWP4 is a magnetically focused, magnetically deflected cathode ray display tube featuring a high resolution gun. The 21EWP4 is primarily useful for high resolution, high brightness monitor display where a large screen is required.

The screen is aluminized for increased brightness and the tube has a gray-glass face for improved contrast.

ELECTRICAL:

Cathode	Coated Unipotential
Heater:	
Voltage	6.3 Volts
Current	0.6 Ampere
Direct Interelectrode Capacitance:	
Grid 1 to All Other Electrodes	6 μμf
Cathode to All Other Electrodes	5 μμf
Screen:	
Phosphor	Aluminized P-4
Fluorescence	White
Persistence	Short
Focusing Method	Magnetic
Deflection Method	Magnetic
Horizontal Angle (approx.)	67°
Vertical Angle (approx.)	53°
Diagonal Angle (approx.)	72°
No Ion Trap	No magnet required

MECHANICAL:

Mounting Position	Any
Useful Screen Dimensions:	
Height	15-1/16" Min.
Width	19-1/16" Min.
Diagonal	20-1/4" Min.
Faceplate	Spherical
Glass	Neutral Gray
Transmission	74% Approx.
Bulb Dimensions:	
Height	16-3/8" ± 1/8"
Width	20-1/4" ± 1/8"
Diagonal	21-3/8" ± 1/8"
Overall Length	23-1/32" ± 3/8"
Neck Length	7-1/2" ± 3/16"
Anode Terminal	J1-21
Base	B5-57
Basing	12D

MAXIMUM RATINGS

Design Center Values

Anode Voltage	20,000 max.	Volts
Grid 2 Voltage	1,000 max.	Volts
Grid 1 Voltage:		
Positive Peak Value	0 max.	Volts
Positive Bias Value	0 max.	Volts
Negative Peak Value	200 max.	Volts
Negative Bias Value	140 max.	Volts
Peak Heater Cathode Voltage:		
Heater Negative with respect to cathode		
During warmup not to exceed 15 sec.	410 max.	Volts
After equipment warmup	180 max.	Volts
Heater positive with respect to cathode	180 max.	Volts

TYPICAL OPERATING CONDITIONS:

Anode Voltage	18,000	16,000	Volts
Grid 2 Voltage	300	300	Volts
Grid 1 Voltage for Spot Cutoff	-33 to -75	-33 to -75	Volts
Focus Coil Current (approx.) ♦	115 ± 20%	108 ± 20%	Ma.
Line Width ▲	.018	.018	Inch

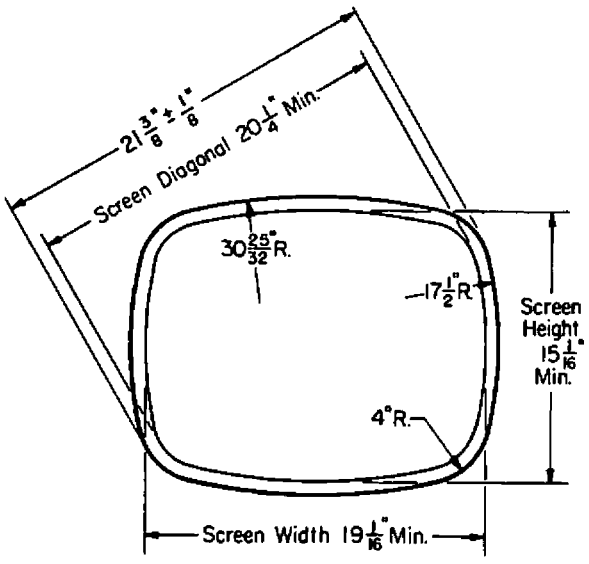
LIMITING CIRCUIT VALUES:

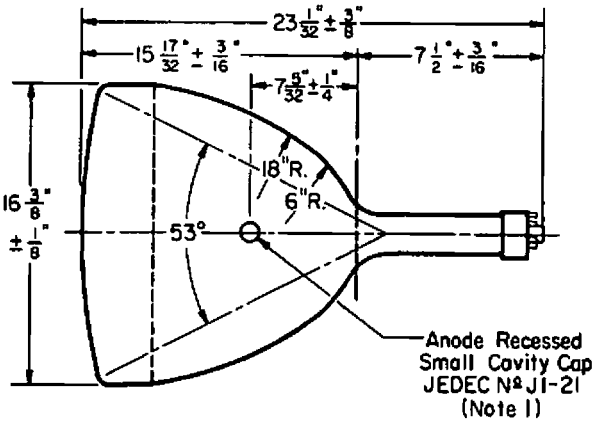
Grid 1 Circuit Resistance	1.5	max.	Megohms
Grid 2 Circuit Resistance	10,000	min.	Ohms

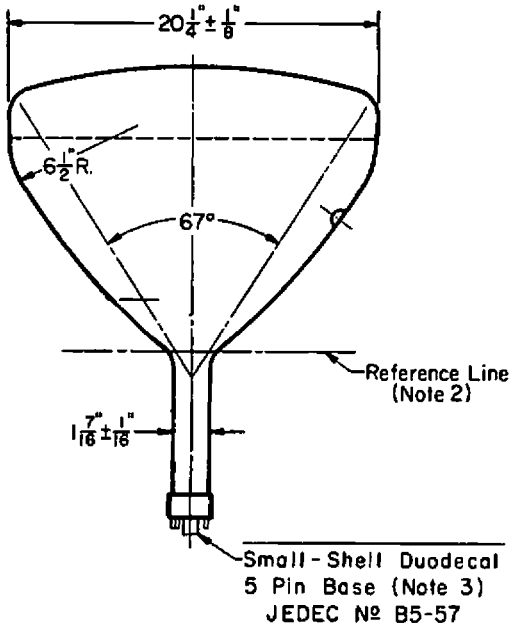
▲ Using an eye-corrected photocell, the light output level is set to 40 foot-lamberts. Typical line width at center of faceplate, using half-amplitude points of the light energy distribution of a single line, is 0.018".

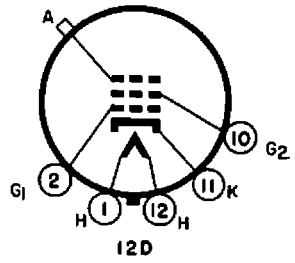
♦ For JEDEC focusing coil #109 or equivalent located 3-1/4" from reference line.

from JEDEC release #2473, June 1, 1959









CS-C1469

NOTE 1: Anode terminal alignment with vacant base-pin position 3 has angular tolerance about tube axis of ± 30°.

NOTE 2: Yoke Reference Line is determined by plane of flared end of JEDEC Reference-Line Gauge No. 110 when seated on funnel of tube.

NOTE 3: The socket should not be mounted rigidly but should be allowed to move freely and have flexible leads.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

June 28, 1956

22EP22

DIRECT VIEW, THREE GUN, SHADOW MASK COLOR PICTURE TUBE

Magnetic Deflection
Magnetic Convergence
Aluminized Tricolor Phosphor Dot Screen

Rectangular Glass	Spherical Face Panel
No Metal Flanges	19-3/8" x 15-1/16" Minimum Picture Size
Electrostatic Focus	External Conductive Coating

The 22EP22 is a 22" rectangular all glass three gun shadow mask type color picture tube. It features a true all glass envelope to completely eliminate the need for high voltage insulation in the tube support means used in the television receiver.

The 262 square inch rectangular screen, minimum dimensions 15-1/16" high by 19-3/8" wide with rounded corners, is deposited on the inner surface of the gray glass face panel for improved contrast and viewing comfort. The 22EP22 uses three electrostatic focus guns spaced 120° apart with axes tilted toward the the tube axis to facilitate convergence of the three beams on the screen. Individual convergence control of each beam is provided by three pairs of pole pieces to be used with external magnets for radial adjustment and an additional pair of pole pieces for tangential adjustment of the blue beam.

GENERAL DATA

ELECTRICAL DATA

Focusing Method	Electrostatic
Convergence Method	Individual Beam Magnetic
Deflection Method	Magnetic
Deflection Angles, approximate	
Horizontal	70°
Vertical	55°
Diagonal	72°
Direct Interelectrode Capacitances, Approximate	
Cathodes to All Other Electrodes	16 uuf
Grid #1 (one gun) to All Other Electrodes*	7 uuf
Grid #3 (All #3 Grids tied together internally) to All Other Electrodes	9 uuf
External Conductive Coating to Anode (Note 1)	1500 to 2800 uuf

*(except No. 1 grids of other two guns)

from JETEC release #1684, July 9, 1956

OPTICAL DATA

Phosphor Number (of the three separate phosphors collectively)	P22
Fluorescence and phosphorescence of separate phosphors, respectively	Red, green, blue
Persistence (of the separate phosphors collectively)	Medium
Screen	
Type	Aluminized, tricolor, phosphor dot
Minimum useful size	W=19-3/8" X H=15-1/16" D=20-1/8"
Area	262 sq. in.
Arrangement of Phosphor Array	Triangular group consisting of blue dot, green dot, and red dot.
Number of Groups	Approx. 365,000
Separation of Groups	.029" approx.
Facepanel	
Type	Neutral density grey glass
Light Transmission	73%

MECHANICAL DATA

Overall Length	25-3/8"
Greatest Dimensions of Bulb	
Diagonal	22 1/4"±1/8"
Width	21 21/32" ±1/8"
Height, not including blue gun reference guide	17 9/16" ±1/8"
Neck Length	9 11/16"
Anode Contact	Recessed small cavity cap (JETEC J1-21)
Base	Small Neodiheptal 12-Pin (JETEC B12-131)
Mounting Position	Neck Horizontal, Blue Gun Up
Weight (Approx.)	31 Pounds

MAXIMUM RATINGS
(Design Center Values) (Note 2)

Heater Voltage (ac or dc)	6.3	Volts
Heater Current at 6.3 Volts	1.8 ±10%	Amperes
Anode Voltage	25000 Max.	Volts
Anode Current (Average, each gun) (Note 3)	500 Max.	uampere
Grid No.3 Voltage	6000 Max.	Volts
Grid #2 Voltage (Each Gun)	800 Max.	Volts

Maximum Ratings (continued):

Grid #1 Voltage (Each Gun)	
Negative Bias Value	400 Max. Volts
Positive Bias Value	0 Max. Volts
Positive Peak Value	2 Max. Volts
Peak Heater-Cathode Voltage (Each Gun)	
Heater Negative with respect to cathode	
During Equipment Warm-Up not to exceed 15 sec.	410 Max. Volts
After Equipment Warmup	180 Max. Volts
Heater Positive with respect to cathode	180 Max. Volts

RANGE VALUES FOR EQUIPMENT DESIGN
(For anode voltage, Eb, of 25000 volts)

Grid #3 (Focusing Electrode) Voltage	16.0 to 20.4% of Eb Volts
Grid #2 Voltage for Visual Extinction of Focused Raster with Grid#1 Voltage at a Fixed Value (Each Gun)	See Cutoff Design Chart
Grid #1 Voltage for Visual Extinction of Focused Raster with Grid #2 Voltage at a Fixed Value (Each Gun)	See Cutoff Design Chart
Variation in Raster Cutoff between Guns in any Tube	±21% of average of highest and lowest cutoff values
Grid #3 Current (Total) (Note 4)	-45 to +75 uampere
Grid #2 Current (Each Gun)	-15 to +15 uampere
Percentage of Anode Current Supplied by Each Gun for Illuminant C white (ICI coordinates X= .0310, Y= 0.316)	
Red Gun	47 to 67 Percent
Green Gun	15 to 30 Percent
Blue Gun	13 to 27 Percent
Maximum Raster Shift in Any Direction from Screen Center (Note 5)	1-1/4" in any direction
Maximum Raster or Beam Shift to be Provided for Purity and Convergence:	
Purity Device	1-1/4" in any direction
Converging Devices (Note 6)	
Radial Static Convergence Shift (each Beam)	±5/8"
Radial Dynamic Convergence Shift (Horizontal)	
Red Beam	1/4"
Green Beam	1/4"
Blue Beam	1/2"
Radial Dynamic Convergence Shift(Vertical)	
Red Beam	3/8"
Green Beam	3/8"
Blue Beam	1/8"
Lateral Static Convergence Shift(Blue Beam)	±1/2"

EXAMPLE OF USE OF DESIGN RANGES
(For anode voltage = 25000 volts)

Grid #3 (Focusing Electrode) Voltage	4000 to 5100 Volts
Grid #2 Voltage for Visual Extinction of Focused Raster with Grid #1 Voltage of -60 Volts (Each Gun)	50 to 225 Volts
Grid #1 Voltage for Visual Extinction of Focused Raster with Grid #2 Voltage of 200 Volts (Each Gun)	-55 to -105 Volts

CIRCUIT VALUES

Grid #1 Circuit Resistance (Each Gun)	1.5 Max. Megohms
Effective Resistance of the Several Electrode-Heater Circuits should be Sufficient to Limit Instantaneous Short Circuit Current to	300 Max. Ma. (total)
Suggested Resistance between Anode and Grid #3 Supply Output Capacitor and Tube to Limit Instantaneous Short Circuit Current	50000 Min. Ohms

NOTES

1. External conductive coating must be grounded.

2. The maximum ratings provide a ten percent safety factor in accordance with the standard Design-Center System of rating cathode-ray tubes; i.e., the tube will withstand the combined effects of variations in line voltage and components provided the maximum Design-Center values are not exceeded by more than ten percent.

3. A value of average anode current per gun higher than 500 ua will increase picture brightness but may impair resolution and shorten cathode life.

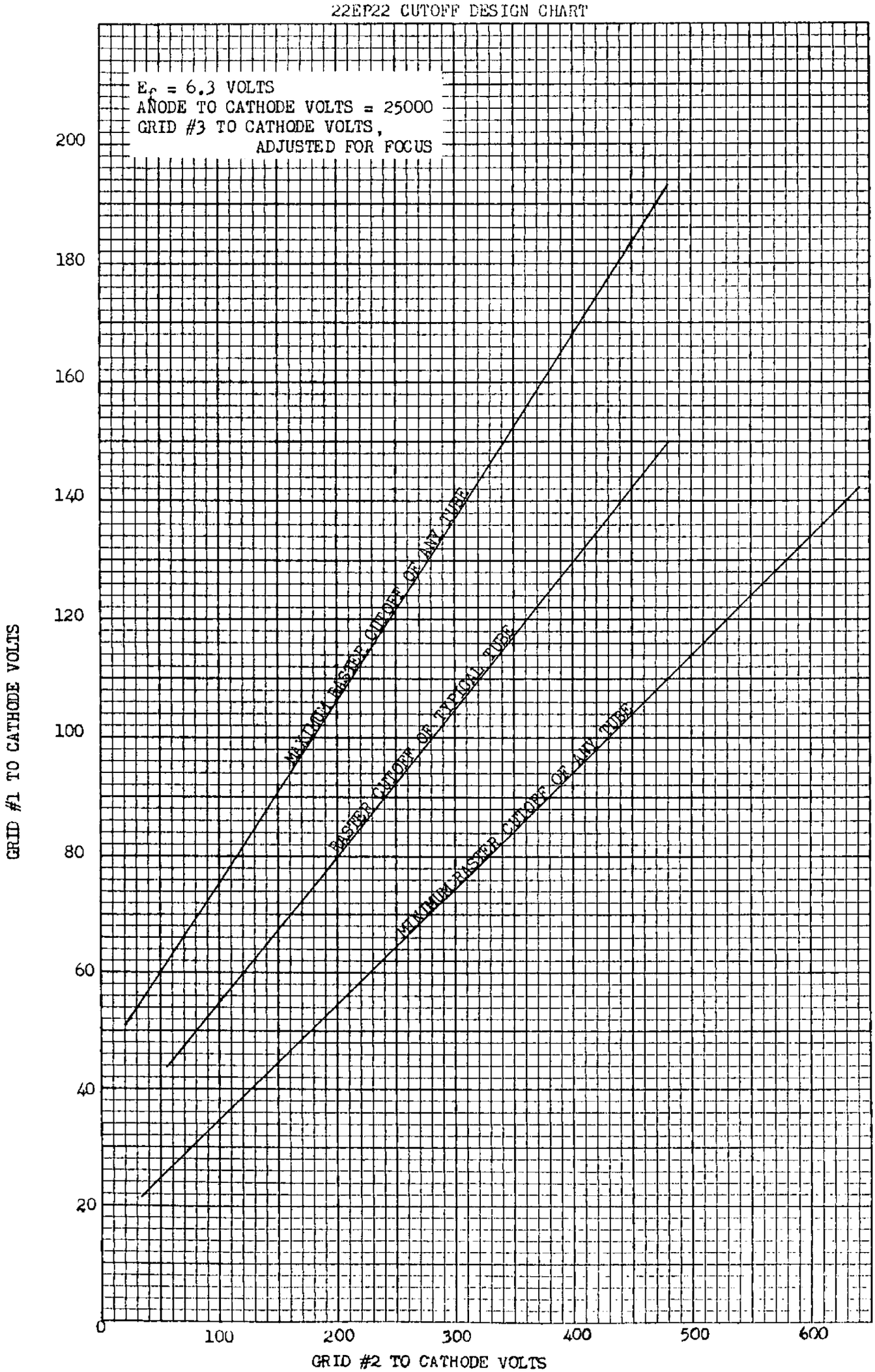
4. For an anode current of 800 ua drawn from any one gun.

5. Centering of the raster on the screen is accomplished by passing direct current of the required value through each pair of deflecting coils to compensate for the raster shift resulting from optimum adjustments of convergence, color purity, and concentricity.

6. Convergence shifts are produced by external permanent magnetic and/or electromagnetic devices adjacent to each gun. The static shifts are controlled by dc currents through appropriate coils or static magnetic fields produced by adjustable permanent magnets. Dynamic convergence shifts are produced by ac currents, having essentially parabolic waveforms, which are synchronized with the scanning.

X-Ray Warning - Since this tube is operated at voltages as high as 25000 volts, x-ray radiation shielding may be necessary to avert possible danger of personal injury from prolonged exposure at close range. The protective window provided in the equipment using this tube may provide such a safeguard.

Field Neutralizing Device - This tube is designed to be used without a magnetic shield. Varying effects of earth's magnetic field in various locations and for various receiver orientations require a neutralizing coil and trimming magnets around the periphery of the tube face for optimum color purity.


22EP22 CUTOFF DESIGN CHART
E_f = 6.3 VOLTS
ANODE TO CATHODE VOLTS = 25000
GRID #3 TO CATHODE VOLTS,
ADJUSTED FOR FOCUS
MAXIMUM RASTER CUTOFF OF ANY TUBE
RASTER CUTOFF OF TYPICAL TUBE
MINIMUM RASTER CUTOFF OF ANY TUBE
GRID #1 TO CATHODE VOLTS
0
20
40
60
80
100
120
140
160
180
200
100
200
300
400
500
600
GRID #2 TO CATHODE VOLTS

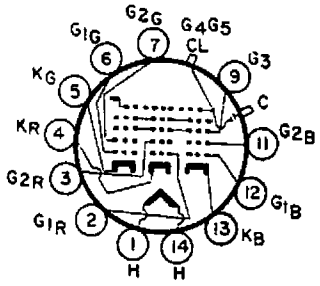
WESTINGHOUSE ELECTRIC CORP.
ELECTRONIC TUBE DIVISION
ELMIRA, N.Y.

22" COLOR TUBE

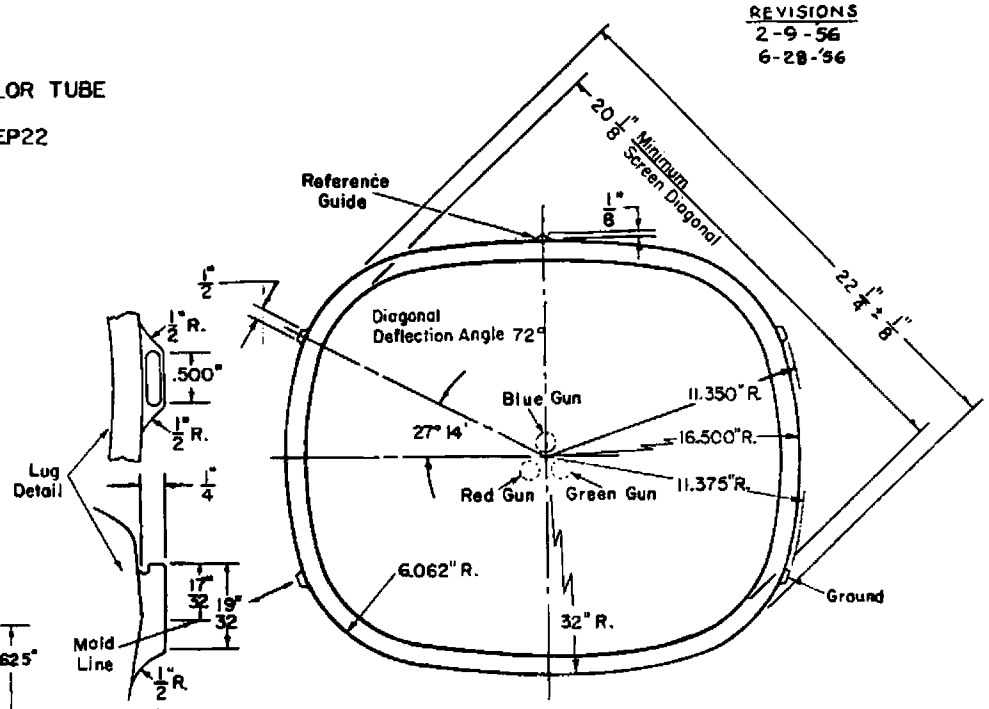
22EP22

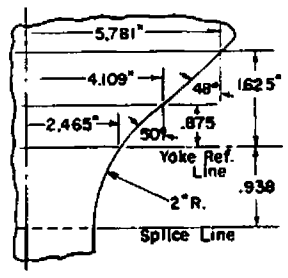
REVISIONS
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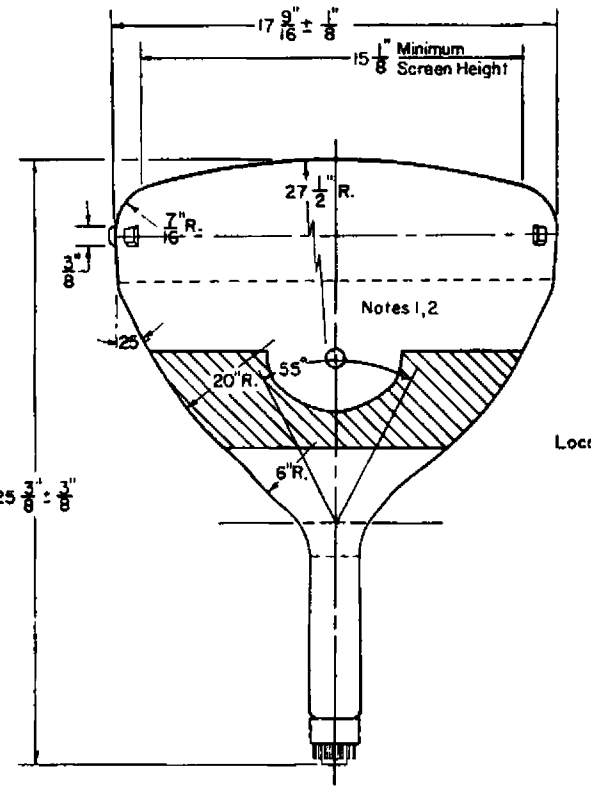
1: Heater
2: Grid No. 1 Of Red Gun
3: Grid No. 2 Of Red Gun
4: Cathode Of Red Gun
5: Cathode Of Green Gun
6: Grid No. 1 Of Green Gun
7: Grid No. 2 Of Green Gun



9: Grids No. 3
11: Grid No. 2 Of Blue Gun
12: Grid No. 1 Of Blue Gun
13: Cathode Of Blue Gun
14: Heater
CL: Contact Button Anode (Grid No. 4 Collector)
C: External Conductive Coating

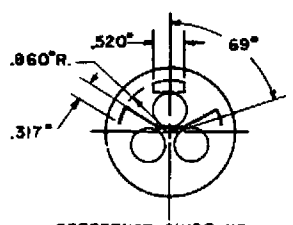




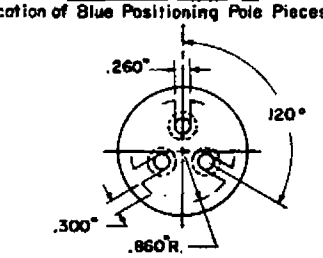


Note 1: Anode Terminal Aligns ± 30° With A Plane Through The Tube Axis Passing Between Pin #1 And #2.

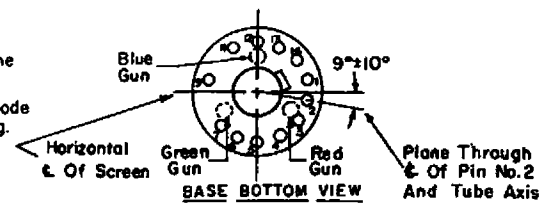
Note 2: An Area Approximately 8" In Dia. Centered On The Anode Terminal Is Left Free Of External Conductive Coating.



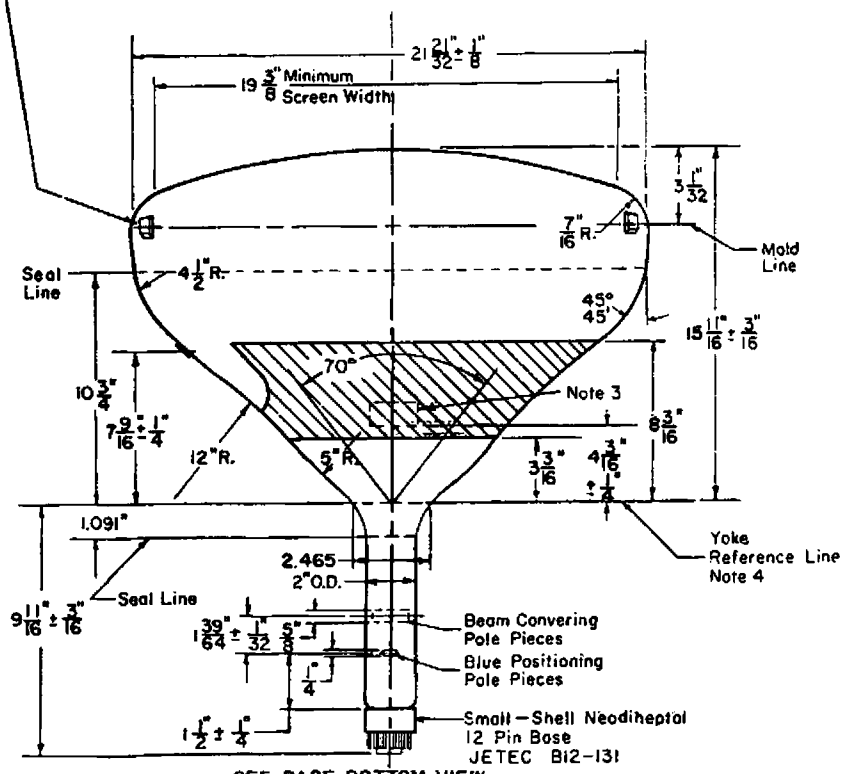
REFERENCE GUIDE UP
Location of Blue Positioning Pole Pieces



Location Of Beam Converging Pole Pieces



BASE BOTTOM VIEW



SEE BASE BOTTOM VIEW

Note 3: The Shaded Area Indicates The Approximate Shape And Location Of The External Conductive Coating, In All Cases The Coating Will Contain The 2" X 2" JETEC Contact Area (Dotted) As Shown On The Same Side As The Blue Gun.

Note 4: Yoke Reference Line Is Determined By The Plane Of The Upper Edge Of A Reference Line Gage (2.465 I.D. Cylinder) When The Gage Is Resting On The Cone

TWIN PANEL TELEVISION PICTURE TUBE TYPE 23BP4

110° Magnetic Deflection
Rectangular Glass
Aluminized
Gray Filter Glass

Twin Face Panel, Integral Safety Glass
Electrostatic Focus
Extremely Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-5/16" × 15-1/4" Screen Size

GENERAL:

Deflection Method	Magnetic
Focusing Method	Electrostatic
Deflection Angles (approx.)	
Diagonal	110°
Horizontal	99°
Vertical	82°
Screen	
Phosphor	Aluminized P4
Fluorescence	White
Persistence	Short
Faceplate	Spherical Gray Filter Glass
Laminated Panel	FP198A1
Light Transmission (approx.)	40%
Weight	31 Pounds

ELECTRICAL:

Heater	
Voltage	6.3 Volts
Current	0.6 Ampere
Warm-up Time□	11 Seconds
Direct Interelectrode Capacitances:	
Grid 1 to all other electrodes	6 μμf
Cathode to all other electrodes	5 μμf
External Conductive Coating	
Maximum	2500 μμf
Minimum	2000 μμf

MECHANICAL:

Mounting Position	Any
Screen Dimensions	
Screen Area	282 sq. in. Min.
Height	15-1/4" Min.
Width	19-5/16" Min.
Diagonal	22-5/16" Min.
Bulb Dimensions	
Bulb	J187A1
Height	17-5/16" + 1/8" -1/16"
Width	21-5/16" + 1/8" -1/16"
Diagonal	24-45/64" + 3/32" -1/16"
Overall Length	14-7/16" ± 3/8"
Neck Length	4-3/8" ± 1/8"
Anode Terminal	Recessed Small Cavity Cap (JEDEC J1-21)
Base	Small Button 7-Pin (JEDEC B7-208)
Basing	8HR

MAXIMUM RATINGS:

Design Center Values

Anode Voltage♦	20000 max.	Volts
Grid 4 Voltage		
Positive Value	1000 max.	Volts
Negative Value	500 max.	Volts
Grid 2 Voltage	500 max.	Volts
Grid 1 Voltage		
Negative Peak Value	200 max.	Volts
Negative Bias Value	140 max.	Volts
Positive Bias Value	0 max.	Volts
Positive Peak Value	0 max.	Volts
Peak Heater-Cathode Voltage		
Heater Negative with Respect to Cathode		
During Warm-up Period of 15 Sec. Max.	410 max.	Volts
After Equipment Warm-up Period	180 max.	Volts
Heater Positive with Respect to Cathode	180 max.	Volts

TYPICAL GRID DRIVE OPERATING CONDITIONS:

Anode Voltage	14000 Volts
Grid 4 Voltage	0 to + 400 Volts
Grid 2 Voltage⊕	450 Volts
Grid 1 Voltage for Raster Cutoff	-45 to -105 Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5 max.	Megohms
Grid 2 Circuit Resistance▲	10000 min.	Ohms
Grid 4 Circuit Resistance▲	10000 min.	Ohms

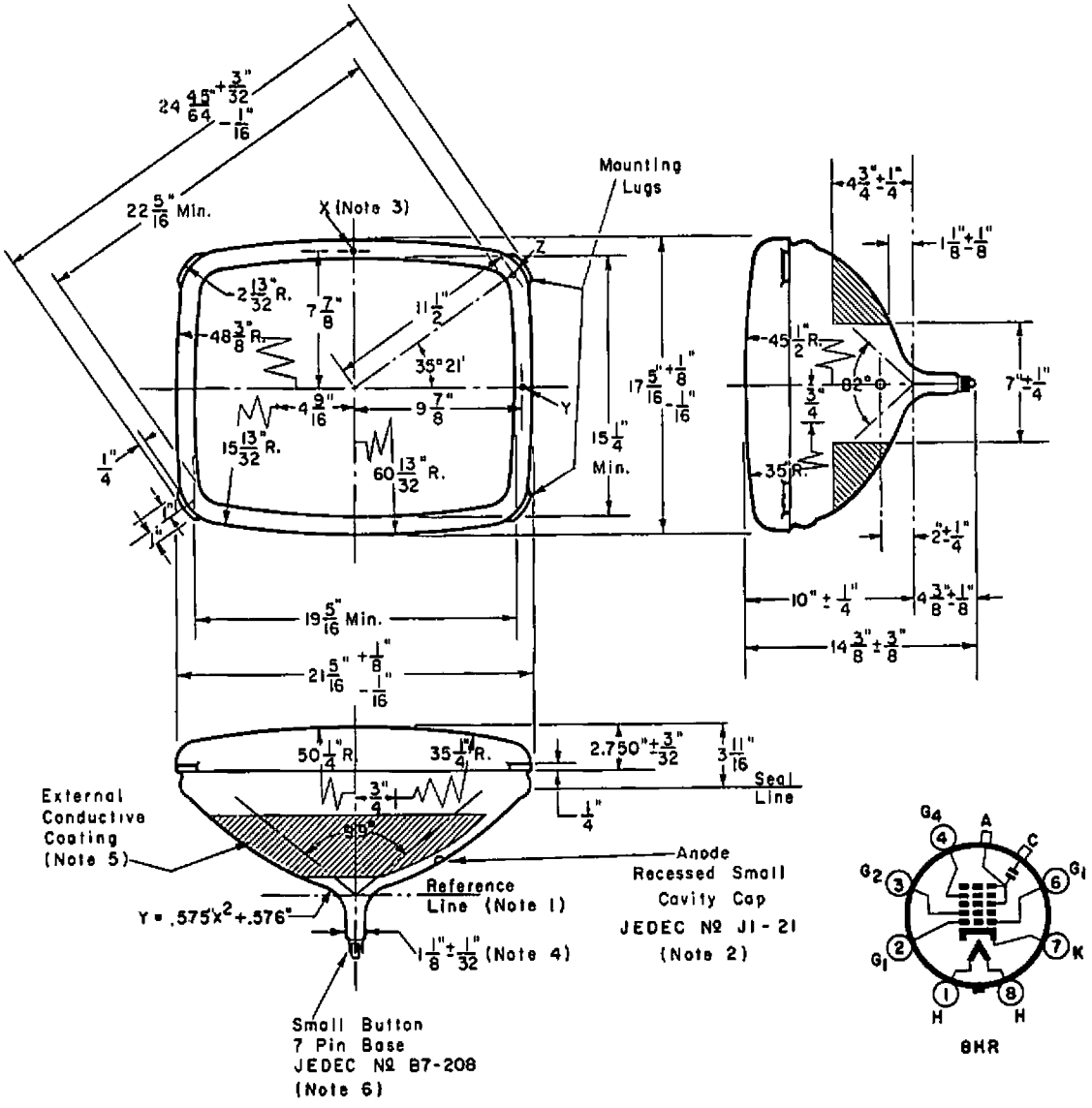
♦ Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12,000 volts.

▲ Protective resistance in the G2 and G4 circuits is advisable to prevent damage to the tube.

⊕ It is recommended that not less than 300 volts on Grid 2 be used, as resolution is affected at lower voltages.

□ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

from JEDEC release #2624, Nov. 9, 1959



NOTE 1: With the tube neck inserted through the flared end of Reference Line Gauge JETEC No. 126 and with the tube seated in the gauge, the reference line is determined by the intersection of the plane face of the flared end of the gauge with the tube funnel. With a minimum neck length tube, the PM centering magnet (0 to 8 gaus) should extend no more than 2-1/8" from the yoke reference line.

NOTE 2: Base pin 4 aligns with major axis within 30° and is on same side as anode terminal.

NOTE 3: Planes perpendicular to the axis and passing through points X, Y and Z are determined as follows:
Plane tangent to crown of face, to plane of X = 0.758" nom.
Plane of X to plane of Y = 0.463 ± 0.030".
Plane of X to plane of Z = 0.970 ± 0.030".

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

NOTE 5: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 6: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the bulb axis and having a diameter of 1-3/4".

TELEVISION PICTURE TUBE TYPE 23DCP4

94° Magnetic Deflection	6.3 Volt, 450 Ma. Heater	External Conductive Coating
Rectangular Glass	Electrostatic Focus	Spherical Faceplate
Aluminized Screen	5" Neck Length	No Ion Trap
Gray Filter Glass	Low G_2 Voltage (30 Volts)	15-1/16" × 19-1/8" Screen Size

ELECTRICAL

Focusing Method	Low Voltage Electrostatic	
Deflection Method	Magnetic	
Deflection Angles (Approx.):		
Horizontal	83	Degrees
Vertical	68	Degrees
Diagonal	94	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, (Approx.)	5	μμf
Grid 1 to all other electrodes, (Approx.)	6	μμf
External Conductive Coating to Anode:		
Maximum	2500	μμf
Minimum	1700	μμf
Heater Current at 6.3 Volts	450 ± 5%	Ma.
Heater warm-up Time (Note 1)	11	Seconds

OPTICAL

Phosphor Number	Aluminized P4	
Light Transmittance at Center, Approximate	78	Percent

MECHANICAL

Overall Length	17-5/64 ± 5/16	Inches
Greatest Dimensions of Tube:		
Diagonal	23-3/8 ± 1/8	Inches
Width	20-1/2 ± 1/8	Inches
Height	16-1/2 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	22-1/4	Inches
Horizontal	19-1/8	Inches
Vertical	15-1/16	Inches
Area	282	Sq. Inches
Neck Length	5 ± 1/8	Inches
Bulb	J187H1	
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Weight (Approx.)	27-1/2	Pounds

RATINGS

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive with Respect to Grid 1.

Maximum Anode Voltage	23500	Volts
Minimum Anode Voltage (Note 2)	11000	Volts
Maximum Grid 4 Voltage (Focusing Electrode)	+1100, −400	Volts
Maximum Grid 2 Voltage	70	Volts
Minimum Grid 2 Voltage	20	Volts
Cathode Voltage:		
Maximum Negative Bias Value	0	Volts DC
Maximum Negative Peak Value	2	Volts
Maximum Positive Bias Value	154	Volts DC
Maximum Positive Peak Value	220	Volts
Maximum Heater-Cathode Voltage		
Heater Negative with Respect to Cathode		
During Warm-Up Period not to Exceed 15 Seconds	450	Volts
After Equipment Warm-Up Period	200	Volts
Heater Positive with Respect to Cathode	200	Volts

TYPICAL OPERATING CONDITIONS

CATHODE DRIVE SERVICE

Unless Otherwise Specified, All Voltage Values are Positive with Respect to Grid 1.

Anode Voltage	18000	Volts DC
Grid 4 Voltage (Focusing Electrode)	0 to 400	Volts DC
Grid 2 Voltage	50	Volts DC
Cathode Voltage for Raster Cutoff	35 to 55	Volts DC

LIMITING CIRCUIT VALUES

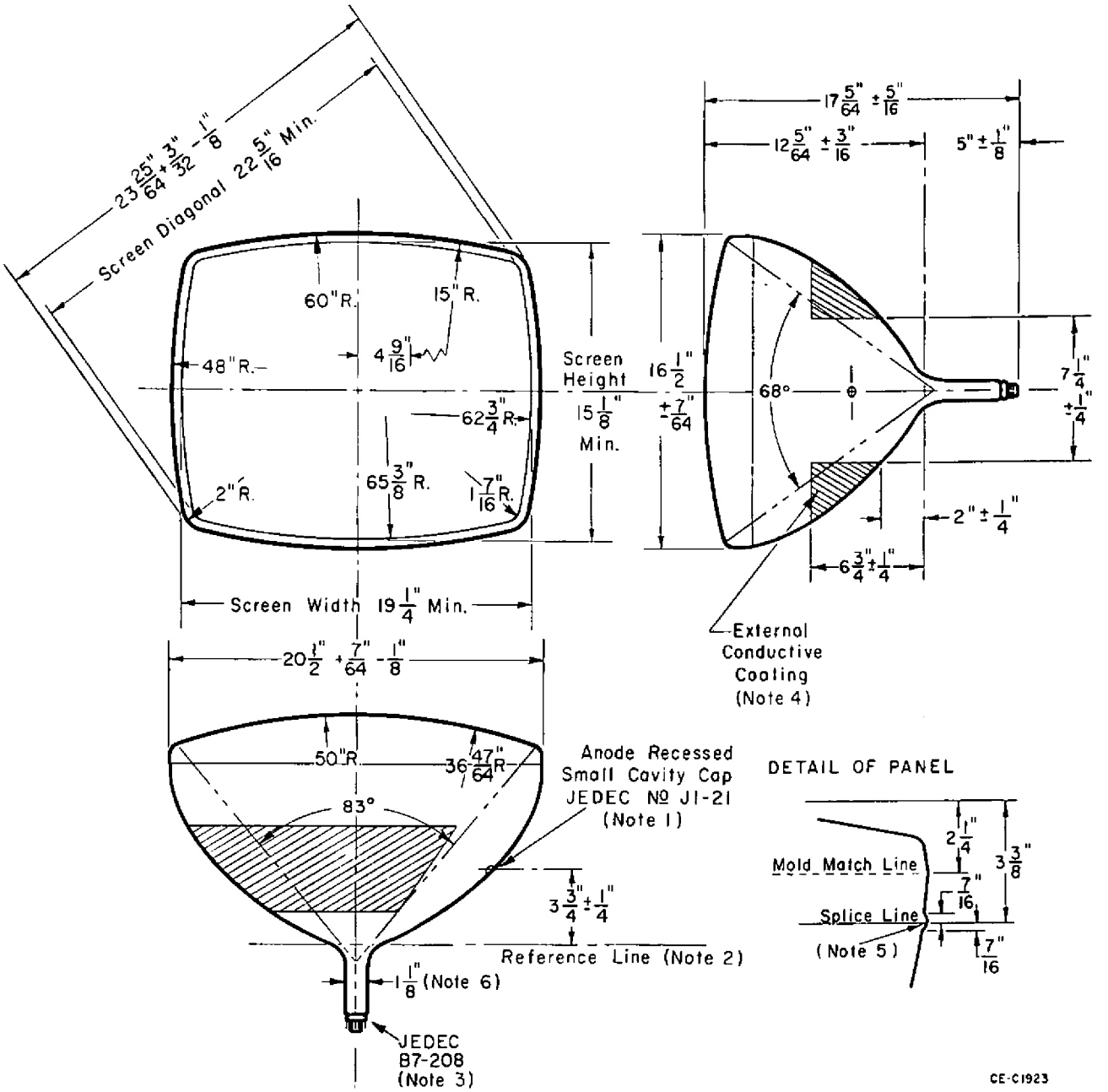
Maximum Grid 1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance (Note 3)	10000	Ohms

NOTES

1. Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.
2. Brilliance and definition decrease with decreasing anode voltage. Operation with anode voltage less than 11000 volts is not recommended.
3. Protective resistance in the grid 2 and grid 4 (focus electrode) circuits is advisable to prevent damage to the tube.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #4120, Feb. 4, 1963



NOTE 1: Base pin 4 aligns with major axis and anode terminal within 30° and is on same side as anode terminal.

NOTE 2: Yoke Reference Line is determined by plane G-C^1 of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 3: The socket should not be mounted rigidly, but should be allowed to move freely and have flexible leads. The associated wiring should not impress lateral strains on the base pins. The bottom circumference of the base wafer will lie within a circle concentric with the tube axis and having diameter of 1-3/4".

NOTE 4: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 5: Splice-line seal bulge may protrude a maximum of 1/16" from dimension surface at any around the seal.

NOTE 6: Neck diameter may be a maximum of 1.168" at the splice.

The information contained herein is supplied without assuming responsibility for infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Westinghouse Electric Corporation.

TELEVISION PICTURE TUBE TYPE 23FP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-1/4" × 15-3/16" Screen Size

ELECTRICAL:

Focusing Method	Electrostatic	
Deflection Angles (Approx.):		
Horizontal	102	Degrees
Vertical	84	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, approximate	5	μμf
Grid #1 to all other electrodes, approximate	6	μμf
External Conductive Coating to Anode	2500 max.	μμf
	2000 min.	μμf
Heater Current at 6.3 volts	600 ± 60	Ma.
Heater Warm-up Time⊕	11	Seconds

OPTICAL

Phosphor Number	Aluminized P4	
Light Transmittance at Center, (Approx.)	78	Percent

MECHANICAL:

Overall Length	13-3/4 ± 5/16	Inches
Greatest Dimensions of Tube:		
Diagonal	23-25/64 + 3/32 − 1/8	Inches
Width	20-1/2 + 1/16 − 1/8	Inches
Height	16-1/2 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	22-5/16	Inches
Horizontal axis	19-1/4	Inches
Vertical axis	15-3/16	Inches
Area	278	Sq. Inches
Neck Length	4-1/2 ± 1/8	Inches
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Bulb Contact Alignment:		
J1-21 contact aligns with pin position #4,	±30	Degrees
Base Alignment:		
Pin #4 aligns with horizontal picture axis	±30	Degrees

⊕ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

RATINGS

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive and Measured with Respect to Cathode

Maximum Anode Voltage	22000	Volts
Minimum Anode Voltage	11000	Volts
Maximum Grid 4 Voltage	+1100 −550	Volts
Maximum Grid 2 Voltage	550	Volts
Minimum Grid 2 Voltage	200	Volts
Grid 1 Voltage:		
Maximum Negative Bias Value	154	Volts
Maximum Negative Peak Value	220	Volts
Maximum Positive Bias Value	0	Volts
Maximum Positive Peak Value	2	Volts
Maximum Heater Voltage	6.93	Volts
Minimum Heater Voltage	5.67	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 15 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS

Grid Drive Service

Unless otherwise specified, all voltage values are positive with respect to cathode.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)□	200	Volts DC
Grid 2 Voltage	450	Volts DC
Grid 1 Voltage for raster cutoff.	−45 to −105	Volts DC

Cathode Drive Service:

Unless otherwise specified, all voltage values are positive with respect to Grid 1.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)□	250	Volts DC
Grid 2 Voltage	500	Volts DC
Cathode Voltage for raster cutoff.	45 to 95	Volts DC

LIMITING CIRCUIT VALUES

Maximum Grid #1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance■	10000	Ohms

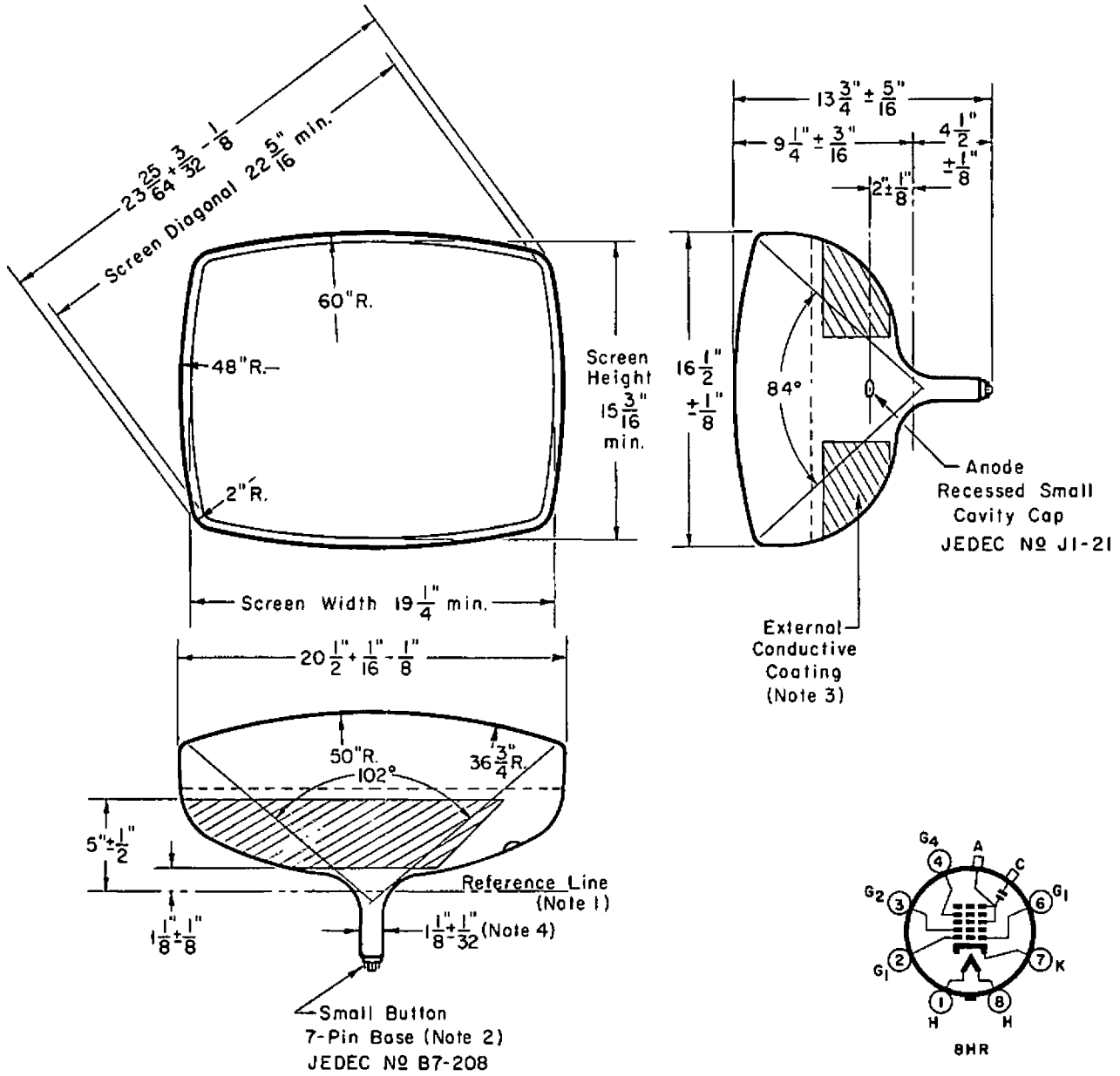
□ With the combined grid 1 bias voltage and video-signal voltage adjusted to give an anode current of 150 microamperes on a 15-3/16" × 19-1/4" pattern from type 2F21 Monoscope or equivalent. Individual tubes will have satisfactory focus at some value between 0 and 400 volts.

■ Protective resistance in the grid 2 and grid 4 (focus electrode) circuit is advisable to prevent damage.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #2697, Jan. 18, 1960

Westinghouse



NOTE 1: Yoke Reference Line is determined by plane surface of flared end of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

TELEVISION PICTURE TUBE TYPE 23VP4

114° Magnetic Deflection
Rectangular Glass
Aluminized Screen
Gray Filter Glass

6.3 Volt, 300 Ma. Heater
Electrostatic Focus
Short Neck Length

External Conductive Coating
Spherical Faceplate
No Ion Trap
19-1/4" × 15-3/16" Screen Size

ELECTRICAL:

Focusing Method	Electrostatic	
Deflection Angles (Approx.):		
Horizontal	102	Degrees
Vertical	84	Degrees
Diagonal	114	Degrees
Direct Interelectrode Capacitances:		
Cathode to all other electrodes, approximate	5	μμf
Grid #1 to all other electrodes, approximate	6	μμf
External Conductive Coating to Anode	2500 max.	μμf
	2000 min.	μμf
Heater Current at 6.3 volts	300 ± 30	Ma.
Heater Warm-up Time⊕	18	Seconds

OPTICAL

Phosphor Number	Aluminized P4	
Light Transmittance at Center, (Approx.)	78	Percent

MECHANICAL:

Overall Length	13-3/4 ± 5/16	Inches
Greatest Dimensions of Tube:		
Diagonal	23-25/64 + 3/32 − 1/8	Inches
Width	20-1/2 + 1/16 − 1/8	Inches
Height	16-1/2 ± 1/8	Inches
Minimum Useful Screen Dimensions (Projected):		
Diagonal	22-5/16	Inches
Horizontal axis	19-1/4	Inches
Vertical axis	15-3/16	Inches
Area	278	Sq. Inches
Neck Length	4-1/2 ± 1/8	Inches
Bulb Contact	J1-21	
Base	B7-208	
Basing	8HR	
Bulb Contact Alignment:		
J1-21 contact aligns with pin position #4,	±30	Degrees
Base Alignment:		
Pin #4 aligns with horizontal picture axis	±30	Degrees

⊕ Heater warm-up time is defined as the time required for the voltage across the heater to reach 80% of its rated value after applying 4 times rated heater voltage to a circuit consisting of the tube heater in series with a resistance equal to 3 times rated heater voltage divided by rated heater current.

RATINGS

Design Maximum System

Unless Otherwise Specified, Voltage Values are Positive and Measured with Respect to Cathode

Maximum Anode Voltage	22000	Volts
Minimum Anode Voltage	11000	Volts
Maximum Grid 4 Voltage	+1100 −550	Volts
Maximum Grid 2 Voltage	550	Volts
Minimum Grid 2 Voltage	200	Volts
Grid 1 Voltage:		
Maximum Negative Bias Value	154	Volts
Maximum Negative Peak Value	220	Volts
Maximum Positive Bias Value	0	Volts
Maximum Positive Peak Value	2	Volts
Maximum Heater Voltage	6.93	Volts
Minimum Heater Voltage	5.67	Volts
Maximum Heater-Cathode Voltage		
Heater negative with respect to cathode		
During warm-up period not to exceed 45 seconds	450	Volts
After equipment warm-up period	200	Volts
Heater positive with respect to cathode	200	Volts

TYPICAL OPERATING CONDITIONS

Grid Drive Service

Unless otherwise specified, all voltage values are positive with respect to cathode.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)□	200	Volts DC
Grid 2 Voltage	450	Volts DC
Grid 1 Voltage for raster cutoff	−45 to −105	Volts DC

Cathode Drive Service:

Unless otherwise specified, all voltage values are positive with respect to Grid 1.

Anode Voltage	14000	Volts DC
Grid 4 Voltage (Focusing Electrode)□	250	Volts DC
Grid 2 Voltage	500	Volts DC
Cathode Voltage for raster cutoff	45 to 95	Volts DC

LIMITING CIRCUIT VALUES

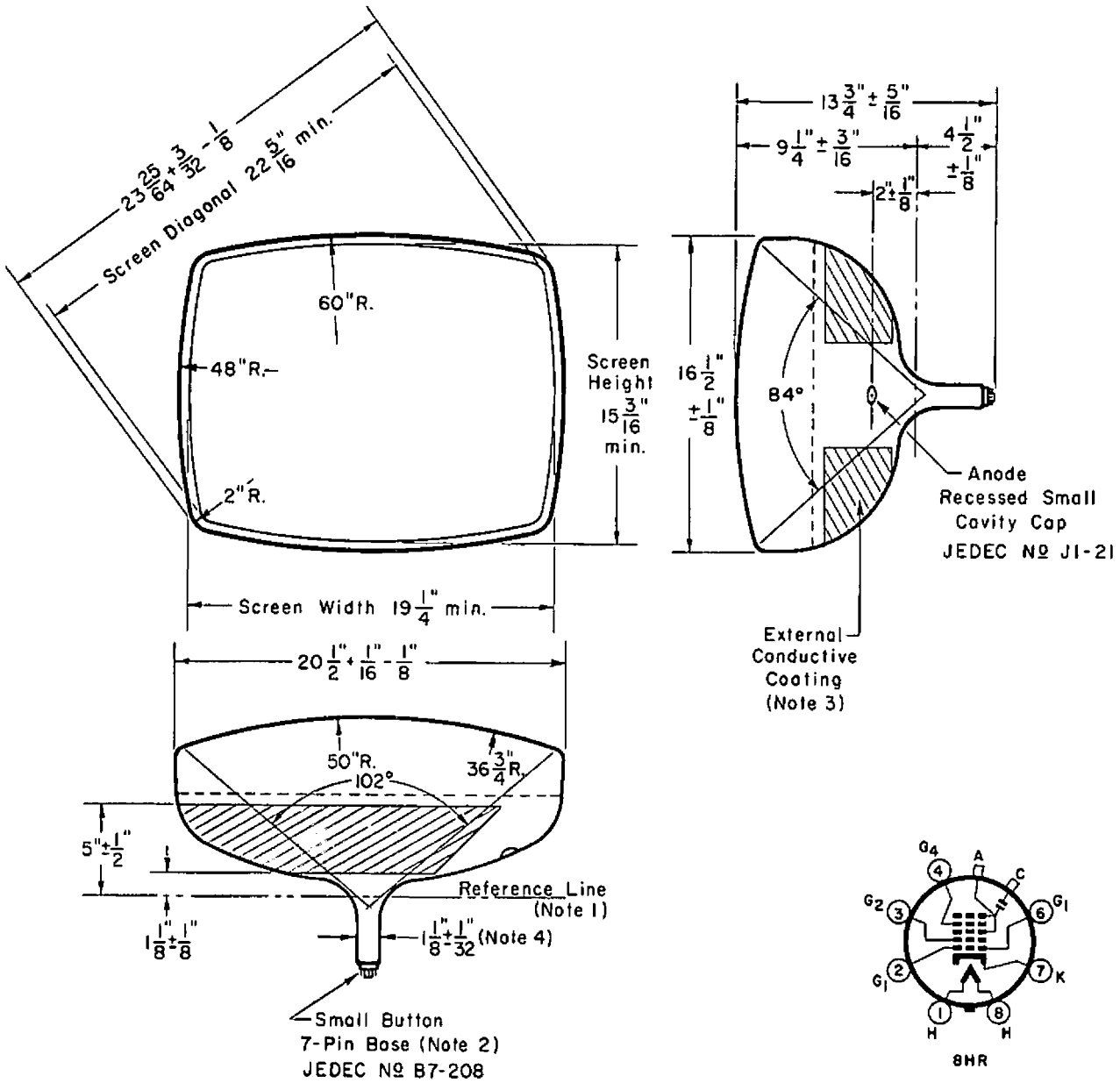
Maximum Grid #1 Circuit Resistance	1.5	Megohms
Minimum Grids 2 & 4 Circuit Resistance■	10000	Ohms

□ With the combined grid 1 bias voltage and video-signal voltage adjusted to give an anode current of 150 microamperes on a 15-3/16" × 19-1/4" pattern from type 2F21 Monoscope or equivalent. Individual tubes will have satisfactory focus at some value between 0 and 400 volts.

■ Protective resistance in the grid 2 and grid 4 (focus electrode) circuit is advisable to prevent damage.

X-RAY WARNING: Operation with voltages in excess of 16KV may require shielding to limit radiation of very soft x-rays.

from JEDEC release #2697, Jan. 18, 1960



NOTE 1: Yoke Reference Line is determined by plane surface of flared end of JEDEC Reference-Line Gauge No. 126 when seated on funnel of tube. With a minimum neck length tube, the PM centering magnet (0 to 8 gauss) should extend no more than 2-1/8" from Yoke Reference Line.

NOTE 2: Lateral strains on the base pins must be avoided. The socket should have flexible leads permitting free movement. The perimeter of the base wafer will be inside a 1-3/4" diameter circle concentric with tube axis.

NOTE 3: External conductive coating forms supplementary filter capacitor and must be grounded.

NOTE 4: Neck diameter may be a maximum of 1.168" at the splice.

February 25, 1958

TELEVISION PICTURE TUBE TYPE 24ATP4

90° Deflection
Rectangular Glass
Magnetic Deflection
Cathode Drive Design

Electrostatic Focus
No Ion Trap
Aluminized

21-1/2" x 16-31/32" Picture
Spherical Faceplate
External Conductive Coating
Low G_2 (50 Volts)

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage(ac or dc)	6.3	Volts
Current	0.6	Ampere
Warm-up Time	11.0	Seconds
Direct Interelectrode Capacitances:		
Grid 1 to all other Electrodes	6	uuf
Cathode to all other Electrodes	5	uuf
External Conductive Coating to Anode:		
Maximum	2500	uuf
Minimum	2000	uuf
Screen:		
Phosphor	Aluminized P4	
Fluorescence	White	
Persistence	Short	
Focusing Method	Electrostatic	
Deflection Method	Magnetic	
Horizontal Angle, approx.	85°	
Vertical Angle, approx.	68°	
Diagonal Angle, approx.	90°	
No Ion Trap Gun	No Magnet Required	

MECHANICAL:

Mounting Position	Any	
Screen Dimensions:		
Height	16-31/32"	Min.
Width	21-1/2"	Min.
Diagonal	22-13/16"	Min.
Faceplate	Spherical Outer and Inner Surfaces	
Glass	Neutral Filter	
Transmission	73 per cent	
Bulb Dimensions:		
Height	18-7/16" ± 3/16"	
Width	22-11/16" ± 3/16"	
Diagonal	24" ± 3/16"	
Overall Length	19-1/8" ± 3/8"	
Anode Terminal	Recessed Small Cavity Cap (JETEC J1-21)	
Base	Small Shell Duodecal 6-Pin (JETEC B6-63)	
Bulb Number	J192A2	

MAXIMUM RATINGS, Cathode Drive Service:

Design Center Values

Anode Voltage †	20000	max.	Volts
Grid 4 to Grid 1 Voltage:			
Positive Value	1000	max.	Volts
Negative Value	500	max.	Volts
Grid 2 to Grid 1 Voltage	68	max.	Volts
Cathode to Grid 1:			
Negative Bias Value	140	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Positive with Respect to Cathode	180	max.	Volts
Heater Negative with Respect to Cathode#	180	max.	Volts

TYPICAL OPERATING CONDITIONS, Cathode Drive Service:

Anode Voltage	14000	18000	Volts
Grid 2 to Grid 1 Voltage	50	50	Volts
Grid 4 to Grid 1 Voltage for Focus with anode Current of 200 uampere	-50 to 350	0 to 400	Volts
Cathode to Grid 1 Voltage for Visual Extinction of Focused Raster*	+32 to +47	+34 to +49	Volts

LIMITING CIRCUIT VALUES:

Grid 1 Circuit Resistance	1.5 max.	Megohms
Grid 2 Circuit Resistance**	0.1 min.	Megohms
Grid 4 Circuit Resistance**	0.1 min.	Megohms

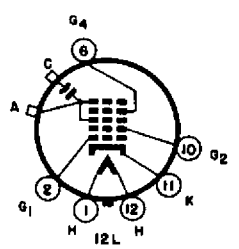
A peak value of 410 volts design center maximum may be applied for not more than 15 seconds during equipment warm-up periods.

† Brilliance and definition decrease with decreasing anode voltage. In general, anode voltage should not be less than 12000 volts.

* Raster size is 21-1/2" x 16-31/32".

**Protective resistance in the G_2 and G_4 circuits is advisable to prevent damage to the tube.

Inasmuch as the tube rating permits operation at voltages as high as 22 kilovolts (absolute value), shielding of the tube for x-ray radiation may be needed whenever the operating conditions involve voltage in excess of 16 kilovolts.



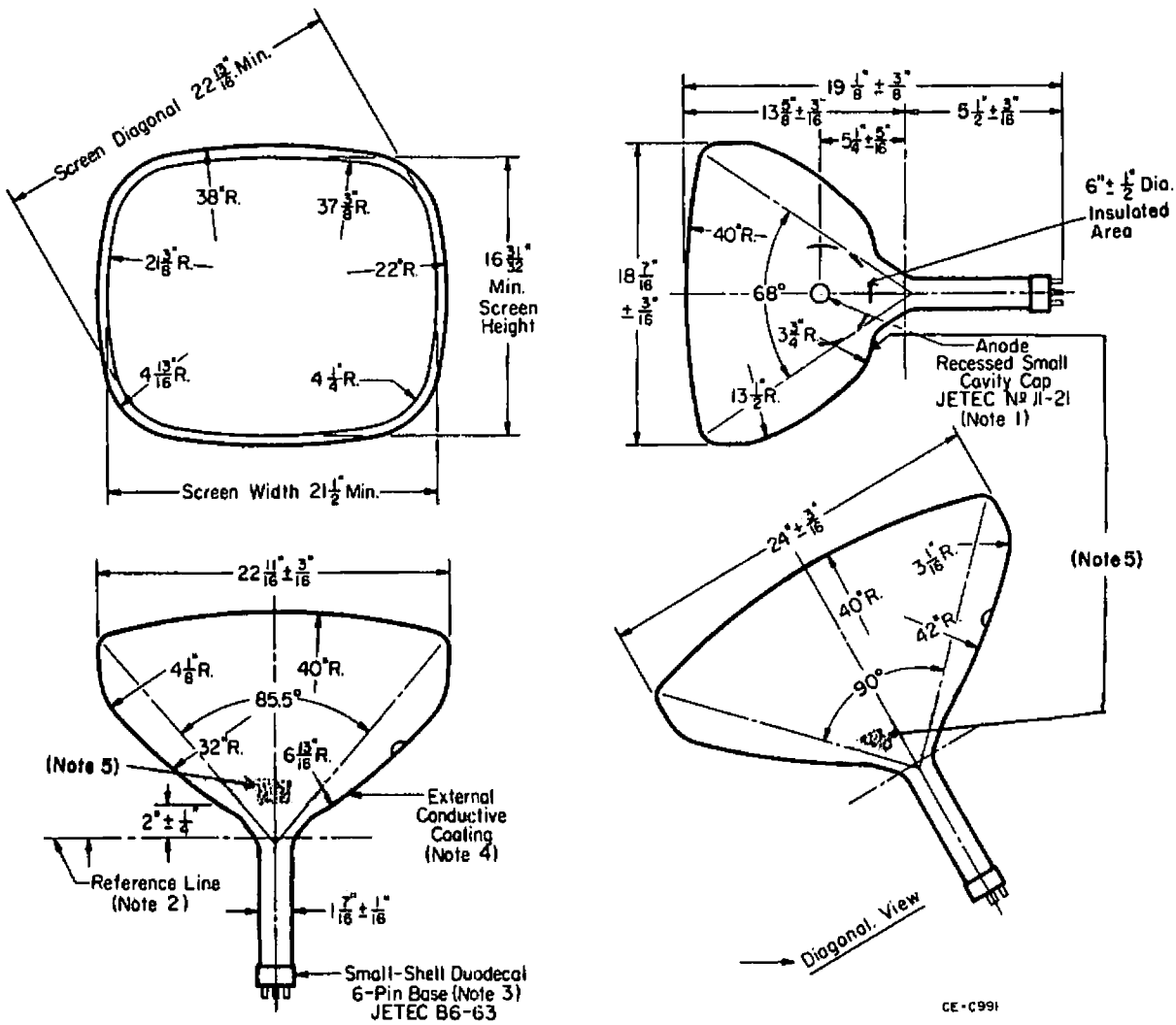
Bottom View

A - Grids 3 & 5, Collector.
C - External Conductive Coating

Cathode Ray Tube Section

from JETEC release #2127, March 10, 1958

OUTLINE DRAWING



NOTE 1: The plane through the tube axis and the base pin No. 6 may vary from the plane through the tube axis and the bulb terminal by an angular tolerance of ±30° measured about the tube axis. The bulb terminal is on the same side of the tube as pin No. 6.

NOTE 2: With the tube neck inserted through the flared end of REFERENCE-Line Gauge (JETEC No. 116) and with the tube seated in the gauge, the reference line is determined by the intersection of the plane cc' (face of the flared end) of the gauge with the glass funnel.

NOTE 3: The socket should not be mounted rigidly but it should be allowed to move freely and it should have flexible leads. The bottom circumference of the base shell will lie within a circle concentric with the bulb axis and having a diameter of 2 3/4".

NOTE 4: External conductive coating must be grounded.

NOTE 5: Contact area of external conductive coating 2" min. x 2" min. located 2" ± 1/4" from Reference Line 90° counterclockwise from anode button as viewed from base end of tube.

WL-530

Water Cooled Triode

GENERAL CHARACTERISTICS

Electrical

Cathode	Thoriated Tungsten
Filament Voltage	7 to 8 Volts
Filament Current	85 Amperes
Nominal Peak Emission	80 Amperes
Min. Power Output During Pulse	75 Kilowatts
Amplification Factor	21 to 26
Interelectrode Capacitance	
Grid to Plate, Max.	27 Micro Microfarads
Grid to Cathode, Max.	23 Micro Microfarads
Plate to Cathode, Max.	4 Micro Microfarads

Mechanical

Type of Cooling (Anode)	Distilled Water
Type of Cooling (Grid)	Forced Air
Dimensions	See Outline
Operating Position	Anode End Down

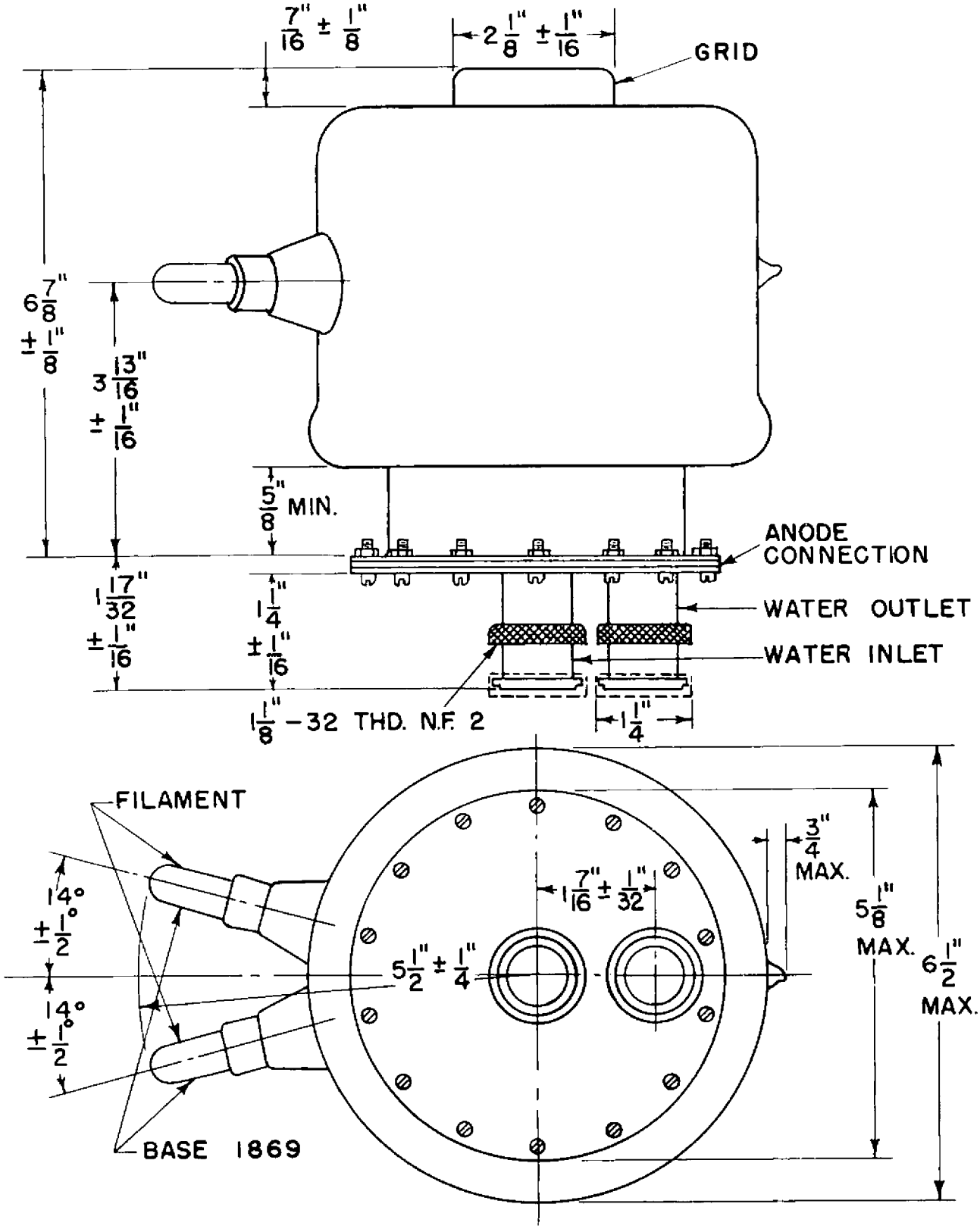
MAXIMUM RATINGS

Plate Potential	15,000 Volts
Grid Potential	4000 Volts
Plate Dissipation	8000 Watts
Operating Frequency	120 Megacycles

Bloomfield, New Jersey December 5, 1945

from RMA release # 612, Oct. 20, 1947
sponsor: Westinghouse Electric Co.

WL-530


7/16" ± 1/8"
2 1/8" ± 1/16"
GRID
6 7/8" ± 1/8"
3 13/16" ± 1/16"
5/8" MIN.
ANODE CONNECTION
WATER OUTLET
WATER INLET
1 17/32" ± 1/16"
1 1/4" ± 1/16"
1 1/8" -32 THD. N.F. 2
1 1/4"
FILAMENT
14° ± 1/2°
14° ± 1/2°
BASE 1869
1 7/16" ± 1/32"
5 1/2" ± 1/4"
3/4" MAX.
5 1/8" MAX.
6 1/2" MAX.

12-5-45

WL Form SP-8

Jan. 27, 1943

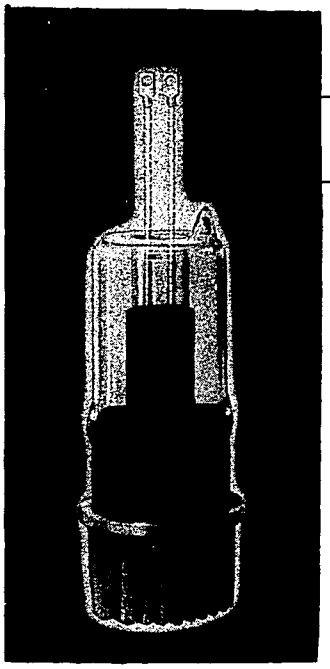
WL-531

New Information

RMA Release # 321

Westinghouse

RADIO TRANSMITTING TUBE



VACUUM RECTIFIER

GENERAL CHARACTERISTICS

Forced-Air-Cooled Diode*

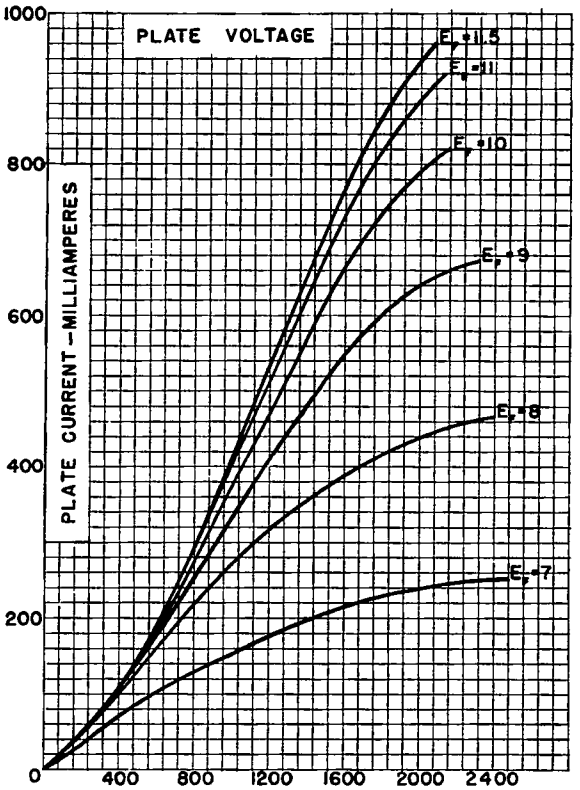
Filament Potential	11.5 volts
Filament Current	20 amperes
Filament Connections	Flexible Leads and Lugs
Maximum Over-all Length (Leads add 3" Approx.)	9¾ inches
Maximum Diameter (over radiator)	3¾ inches
Mounting Position	Radiator Down

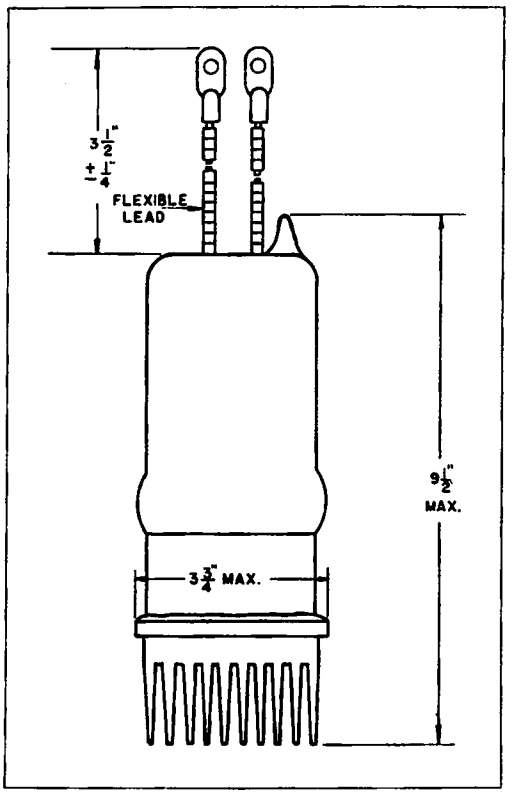
MAXIMUM RATINGS

Peak Inverse Anode Potential	50,000 volts
Peak Plate Current	750 milliamperes
Average or D-c Plate Current	290 milliamperes

Notes

* A forced air flow of approximately 50 cubic feet per minute should start with application of the filament voltage.





For installation and operation refer to TD-93-A. For application information refer to TD-94.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
Special Products Department
BLOOMFIELD, NEW JERSEY

E6-41, C18-2
Effective 6-41

RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 516

September 5, 1946

sponsor:
Westinghouse Electric Corp.

RMA TYPE 579-B

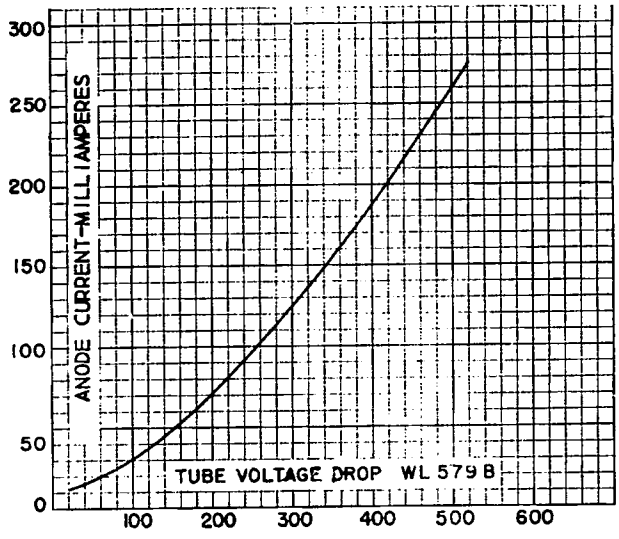
HIGH VOLTAGE VACUUM RECTIFIER

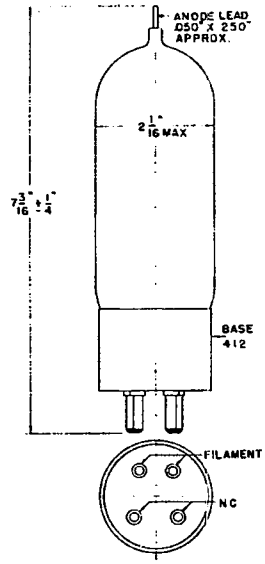
GENERAL CHARACTERISTICS

Air Cooled Diode
Filament Voltage..... 2.5 Volts
Filament Current..... 6 Amperes

MAXIMUM RATINGS

Anode Voltage, Peak Inverse..... 20,000 Volts
Anode Current, Peak..... 270 Milliamperes
Anode Current, Ave..... 25 Milliamperes
Temperature, Ambient Air..... .. 50° C.
Temperature, Bulb..... 75° C.





RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 416

September 5, 1946

RMA TYPE **627**

GRID CONTROLLED MERCURY VAPOR RECTIFIER

sponsor:
Westinghouse Electric Corp.

GENERAL CHARACTERISTICS

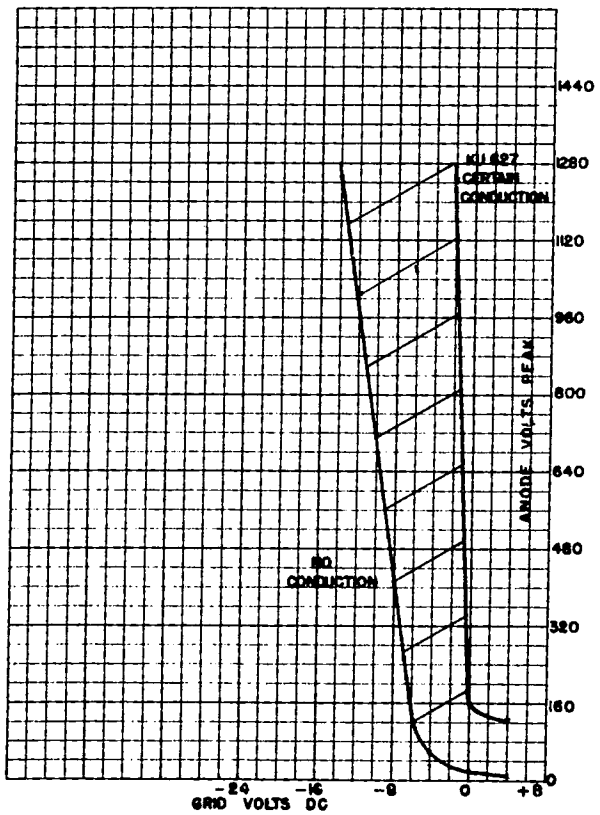
Air Cooled Triode
Filament Voltage.....2.5 Volts
Filament Current.....6 Amperes
Filament Heating Time.....10 Seconds
Grid Current, Max., just before Conduction, Grid Negative.....4 Microamperes
Ionization Time, Max.....10 Microseconds
Deionization Time, Max.....1000 Microseconds
Tube Voltage Drop, Average.....12 Volts
Capacitance, Anode-Grid.....2.5 uuf
Control Characteristic.....Negative
Mounting Position.....Pin Base Down
Temperature, Optimum, Condensed Mercury.....*40° to 45° C

*Measured at top edge of base.

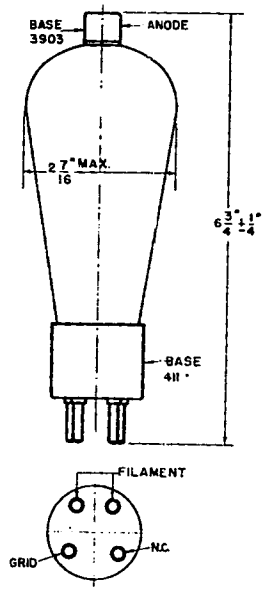
MAXIMUM RATINGS

Up to 150 Cycles

Anode Voltage, Peak Forward.....1250 Volts
Anode Voltage, Peak Inverse.....2500 Volts
Anode Current, Average.....0.64 Ampere
Anode Current, Peak.....2.5 Amperes
Anode Current, Surge, for design only.....25 Amperes
Grid Voltage, Peak Negative, before Conduction.....500 Volts
Grid Current, Average Positive, Anode Positive...0.06 Ampere
Grid Current, Peak Positive, Anode Positive.....0.25 Ampere
Averaging Time, Anode and Grid Currents.....30 Seconds
Temperature Range, Condensed Mercury.....*25° to 70° C



Space between limiting curves indicates variations which may be expected in individual tubes initially and throughout life when operated within the specified temperature range.



RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 516

September 5,1946

RMA TYPE **629**

sponsor:
Westinghouse Electric Corp.

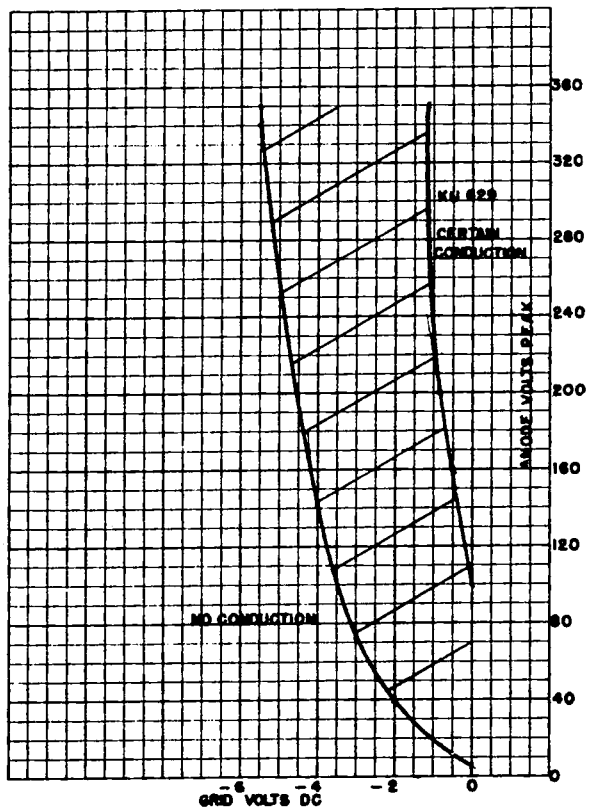
GRID CONTROLLED GAS RECTIFIER

GENERAL CHARACTERISTICS

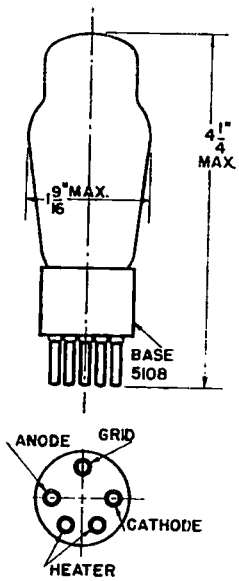
Air Cooled Triode	
Heater Voltage	2.5 Volts
Heater Current	2.6 Amperes
Cathode Heating Time	30 Seconds
Grid Current, Max., just before Conduction	2.5 Microamperes
Ionization Time	10 Microseconds
Deionization Time, Max	1000 Microseconds
Tube Voltage Drop, Average	15 Volts
Capacitance, Grid-Plate	3.3 uuf
Capacitance, Grid-Cathode	3.3 uuf
Capacitance, Plate-Cathode	1.8 uuf
Control Characteristic	Negative
Mounting Position	Any

MAXIMUM RATINGS

Anode Voltage, Peak Forward	350 Volts
Anode Voltage, Peak Inverse	350 Volts
Anode Current, Average	0.04 Ampere
Anode Current, Peak	0.2 Ampere
Anode Current, Surge, for design only	2.0 Amperes
Grid Voltage, Peak Negative	90 Volts
Grid Current, Average, Anode Positive	0.4 Milliampere
Grid Current, Peak Anode Positive	20 Milliamperes
Heater to Cathode Voltage Range	—45 to + 5 Volts
Averaging Time, Anode and Grid Currents	10 Seconds
Temperature Range	—40° to + 70° C



Space between limiting curves indicates variations which may be expected in individual tubes initially and throughout life when operated within the specified temperature range.



RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

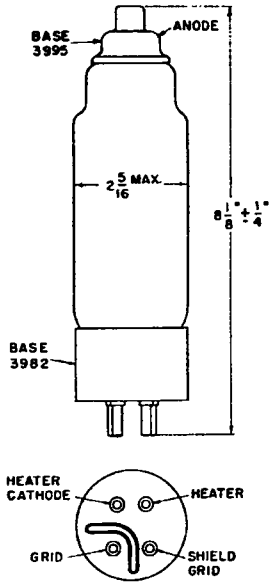
Release No. 516

September 5, 1946

RMA TYPE 672

GRID CONTROLLED MERCURY VAPOR RECTIFIER

sponsor:
Westinghouse Electric Corp.



GENERAL CHARACTERISTICS

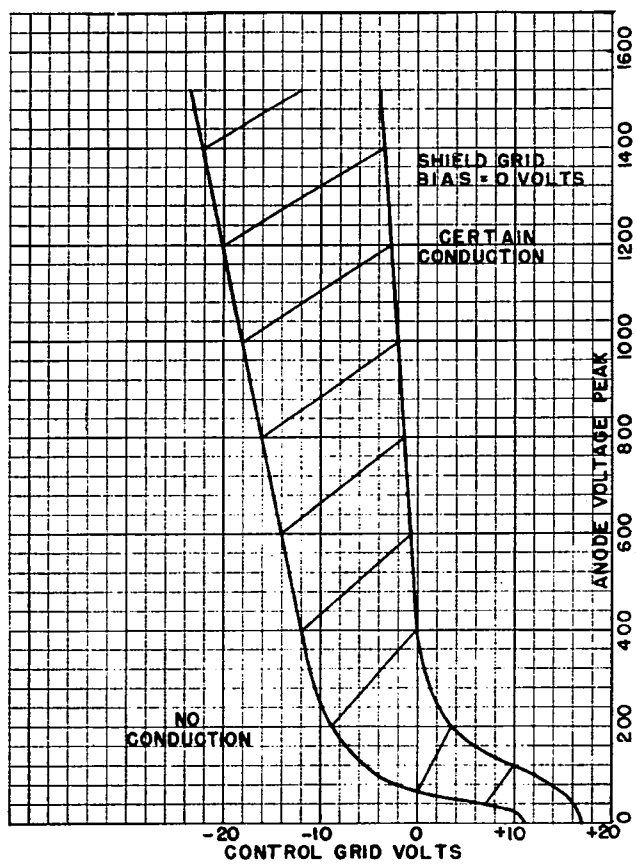
Air Cooled Tetrode	
Heater Voltage	5 Volts
Heater Current	6 Amperes
Cathode Heating Time	5 Minutes
Grid Current, Max., just before Conduction, Grid Negative	2 Microamperes
Ionization Time	10 Microseconds
Deionization Time	1000 Microseconds
Tube Voltage Drop	12 Volts
Capacitance, Anode-Grid	0.04 uuf
Capacitance, Anode-Shield Grid	3 uuf
Control Characteristic	Negative
Mounting Position	Pin Base Down
Temperature, Optimum, Condensed Mercury	*45° to 50° C

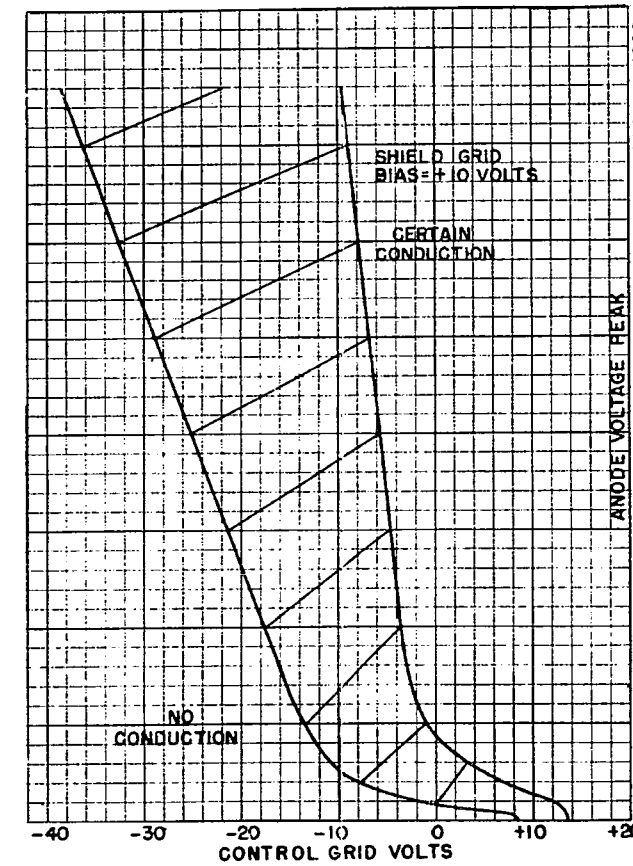
MAXIMUM RATINGS

Up to 150 Cycles

Anode Voltage, Peak Forward	1500 Volts
Anode Voltage, Peak Inverse	1500 Volts
Anode Current, Average	2.5 Amperes
Anode Current, Peak	30 Amperes
Anode Current, Surge, for design only	150 Amperes
Grid Voltage, Peak Negative, before Conduction	1000 Volts
Grid Current, Average Positive, Anode Pos.	0.25 Ampere
Grid Current, Peak Positive, Anode Positive	1.0 Ampere
Shield Grid Voltage, Peak Neg., before Conduction	300 Volts
Shield Grid Current, Positive, Ave. Anode Pos.	0.25 Ampere
Shield Grid Current, Peak Positive, Anode Pos.	1.0 Ampere
Averaging Time, Anode and Grid Currents	15 Seconds
Temperature Range, Condensed Mercury	*40° to 80° C

*Measured at top edge of base.





Space between limiting curves indicates variations which may be expected in individual tubes initially and throughout life when operated within the specified temperature limits.

RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 516

September 5, 1946

RMA TYPE 676

GRID CONTROLLED MERCURY VAPOR RECTIFIER

GENERAL CHARACTERISTICS

sponsor:
Westinghouse Electric Corp.

Air-Cooled Triode

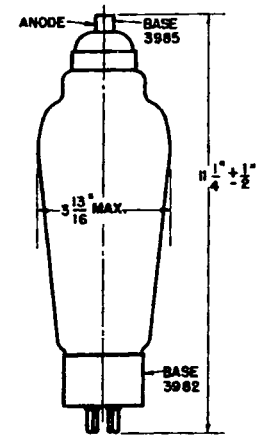
Heater Voltage	5 Volts
Heater Current	10.0 Amperes
Cathode Heating Time	5 Minutes
Grid Current, Max., just before Conduction, Grid Negative	5 Microamperes
Ionization Time, Max	10 Microseconds
Deionization Time, Max	1000 Microseconds
Tube Voltage Drop	12 Volts
Capacitance, Anode—Grid	5 uuf
Control Characteristic	Negative
Mounting Position	Pin Base Down
Temperature, Range, Optimum, Condensed Mercury	*45° to 55° C

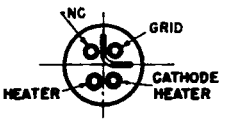
MAXIMUM RATINGS

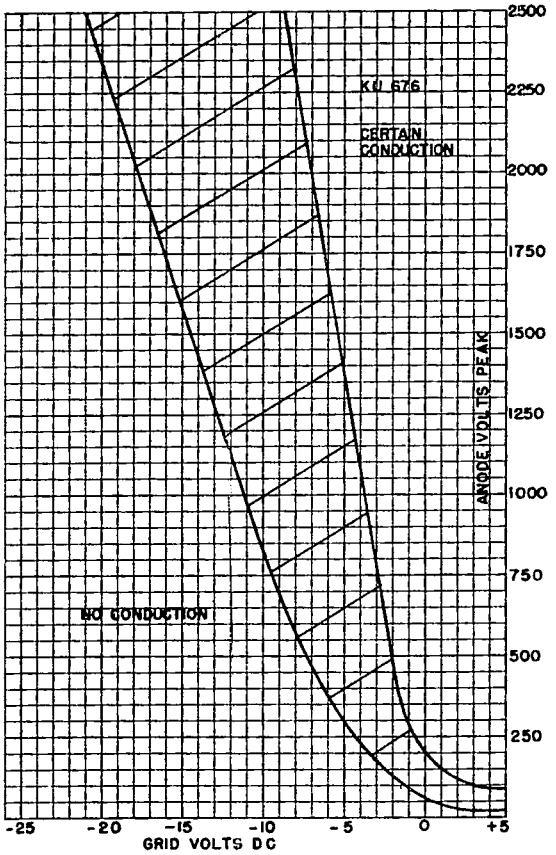
Up to 150 Cycles

	Continuous Service	Welder Control Service
Anode Voltage, Peak Forward	2500 Volts	750 Volts
Anode Voltage, Peak Inverse	2500 Volts	750 Volts
Anode Current, Average	6.4 Amps.	2.5 Amps.
Anode Current, Peak	40 Amps.	77 Amps.
Anode Current, Surge, for design only	200 Amps.	200 Amps.
Grid Voltage, Peak Negative, before Conduction	500 Volts	500 Volts
Grid Current, Average Positive, Anode Positive	0.25 Amp.	0.25 Amp.
Grid Current, Peak Positive, Anode Positive	1 Amp.	1 Amp.
Averaging Time, Anode and Grid Currents	15 Sec.	5 Sec.
Temperature Range, Condensed Mercury	*40 to 80°C	*40° to 90° C

*Measured at top edge of base.







Space between the limiting curves indicates variations which may be expected in individual tubes initially and throughout life when operated within the specified temperature range.

RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 516

September 5, 1946

RMA TYPE 677

GRID CONTROLLED MERCURY VAPOR RECTIFIER

GENERAL CHARACTERISTICS

Air Cooled Triode	
Heater Voltage	5 Volts
Heater Current	10 Amperes
Cathode Heating Time	5 Minutes
Grid Current, Max., just before Conduction, Grid Negative	5 Microamperes
Ionization Time, Max.	10 Microseconds
Deionization Time, Max.	1000 Microseconds
Tube Voltage Drop	12 Volts
Capacitance, Anode—Grid	5 uuf
Control Characteristic	Negative
Mounting Position	Pin Base Down
Temperature, Optimum, Condensed Mercury	**35° to 45° C

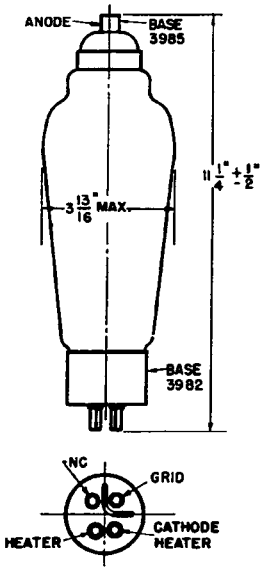
MAXIMUM RATINGS

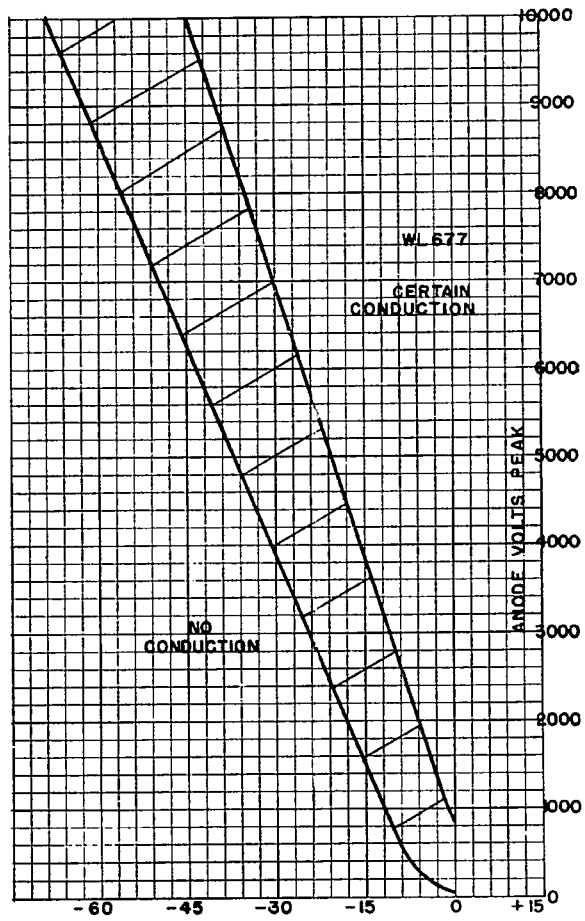
Up to 150 Cycles

Anode Voltage, Peak Forward	10,000 Volts
Anode Voltage, Peak Inverse	10,000 Volts
Anode Current, Average	*4 Amperes
Anode Current, Peak	*15 Amperes
Anode Current, Surge, for design only	*16 Amperes
Grid Voltage, Peak Positive, Anode Negative	10 Volts
Grid Voltage, Peak Negative, before Conduction	500 Volts
Grid Current, Average Positive, Anode Pos.	0.25 Ampere
Grid Current, Peak Positive, Anode Positive	1 Ampere
Averaging Time, Anode and Grid Currents	15 Seconds
Temperature Range, Condensed Mercury	**30° to 50° C

*These ratings apply only when the tube is used in circuits which limit the short circuit current to the values given.

**Measured at top edge of base.





Space between the limiting curves indicates variations which may be expected in individual tubes initially and throughout life when operated within the specified temperature range.

sponsor:
Westinghouse Electric Corp.

RADIO MANUFACTURERS ASSOCIATION
ENGINEERING DEPARTMENT

Release No. 516

September 5, 1946

RMA TYPE **678**

GRID-CONTROLLED MERCURY VAPOR RECTIFIER

sponsor:
Westinghouse Electric Corp.

GENERAL CHARACTERISTICS

Air-Cooled Triode

Filament Voltage	5.0 Volts
Filament Current	7.5 Amperes
Filament Heating Time*	1 Minute
Tube Voltage Drop	15 Volts
Typical Control Bias at 10,000 Volts**	−50 Volts
Typical Control Bias at 15,000 Volts**	−75 Volts
Capacitance, Anode Grid	10 uuf
Mounting Position	Pin Base Down
Temperature Range, Optimum, Condensed Mercury, for 10,000 Volts	35-50°C
Temperature Range, Optimum, Condensed Mercury, for 15,000 Volts	35-45°C

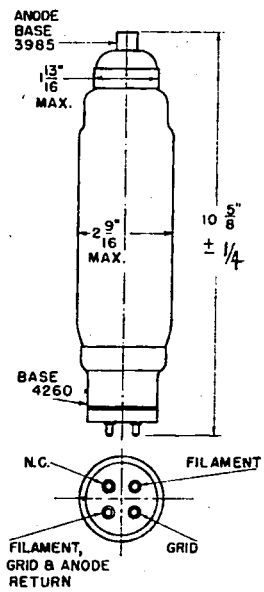
MAXIMUM RATINGS

25 to 150 Cycles

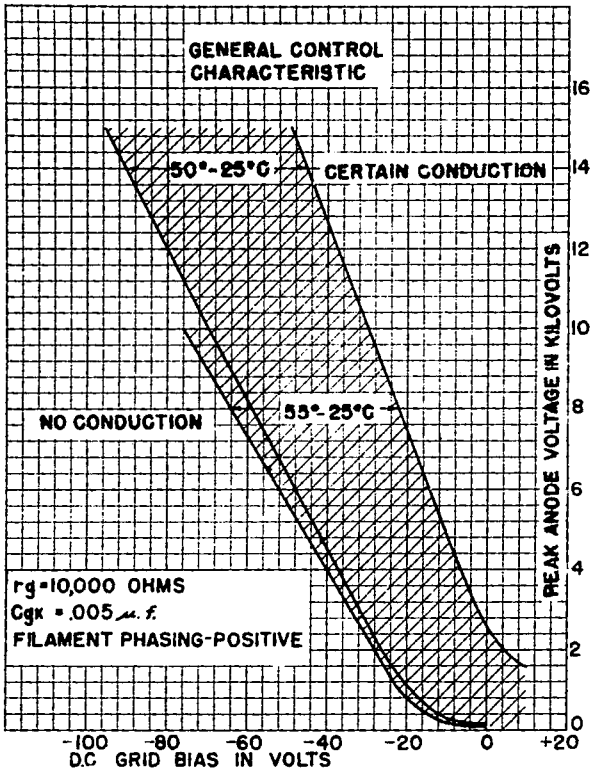
Anode Voltage, Peak Forward	10,000 Volts	15,000 Volts
Anode Voltage, Peak Inverse	10,000 Volts	15,000 Volts
Anode Current, Average	1.6 Amperes	1.6 Amperes
Anode Current, Peak	6 Amperes	6 Amperes
Anode Current, Surge, Design Only	50 Amperes	50 Amperes
Grid Voltage, Peak Negative, before Conduction	500 Volts	500 Volts
Grid Voltage, Peak Positive, Anode Negative	10 Volts	10 Volts
Grid Current, Average Positive, Anode Positive	0.1 Ampere	0.1 Ampere
Grid Current, Peak Positive, Anode Positive	1 Ampere	1 Ampere
Averaging Time, Anode and Grid Currents	One period of the supply frequency.	1 Cycle	1 Cycle
Temperature Range, Condensed Mercury	25 to 55°C	25 to 50°C
Frequency Range	25 to 150 cps	25 to 150 cps

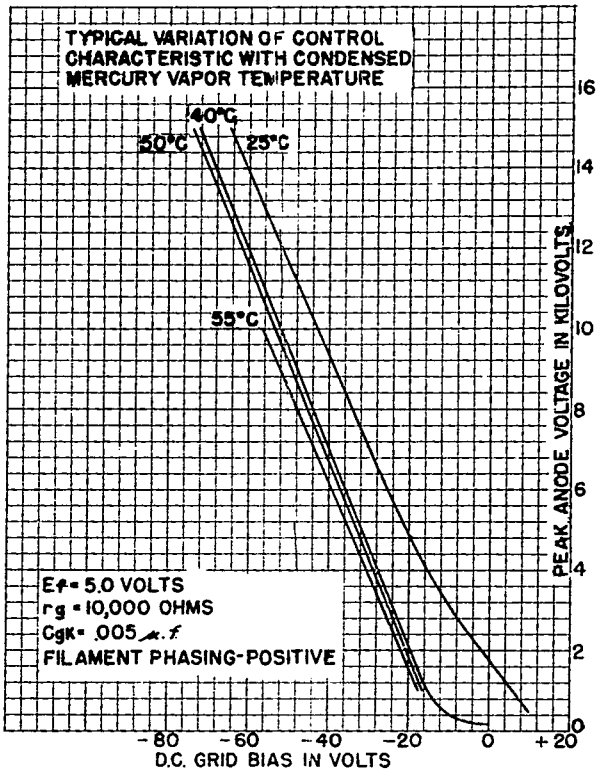
*The minimum heating time refers only to the filament. Sufficient additional time must be allowed, during cold weather periods, to permit the condensed mercury temperature to rise to the minimum condensed mercury temperature limit.

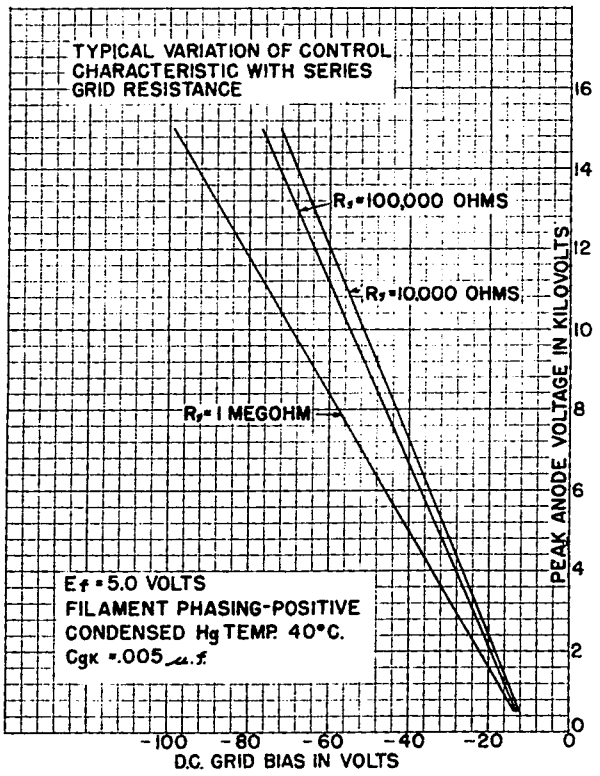
**This typical bias value is valid when using a 100,000-ohm resistor and a 0.01 microfarad grid to cathode by-pass condenser.

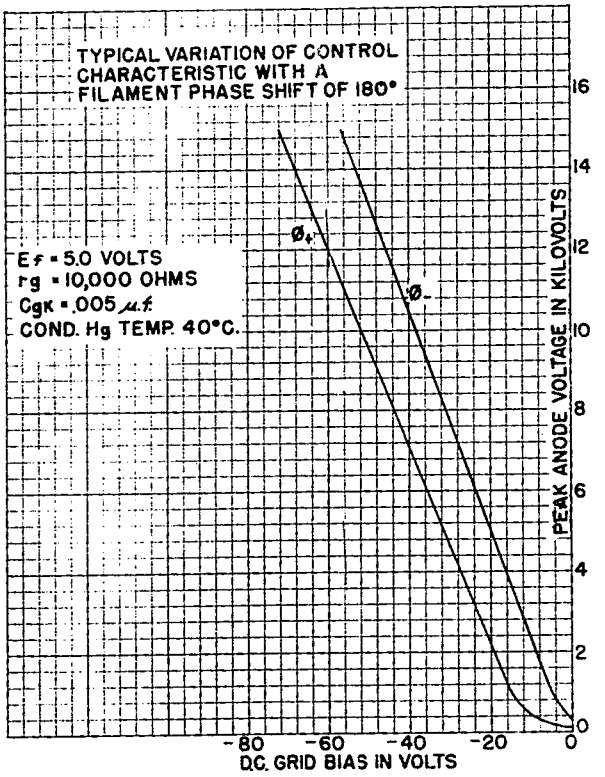


RMA TYPE 678









General Control Characteristic Curve.

The Control Characteristic shown is intended only to indicate the range of control necessary.

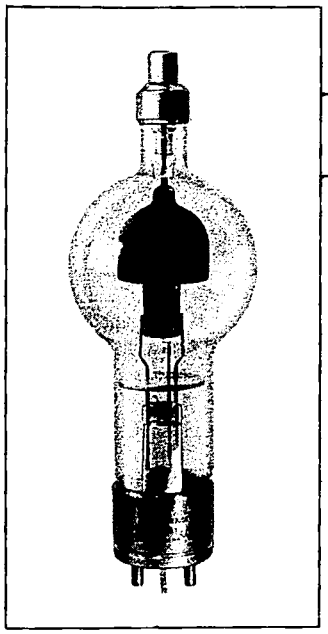
It should be noted that any individual tube will have a characteristic spread much narrower than the composite curve shown. If temperature control is used, the characteristic spread is still further reduced.

Jan. 27, 1943

WL Form SP-21
New Information

RMA Release #: 321

WL-881



Westinghouse

RADIO TRANSMITTING TUBE

MERCURY VAPOR RECTIFIER

GENERAL CHARACTERISTICS

No. of Electrodes	2
Cathode*** Indirectly Heated Type	
Voltage (a-c.)	5 volts
Current (approx.)	9.5 amps
Heating Time** (Typical)	60 secs.
Tube Drop	
Maximum	20 volts
Minimum	5 volts
Net Weight (approx.)	24 oz.
Shipping Weight (approx.)	6 lbs.
Installation and Operation	TD-93-A
Application	TD-94

MAXIMUM RATINGS

Peak Inv. Anode Voltage (150 cycles and below)	10,000 volts	15,000 volts
Condensed Mercury Temp. Range	30°—60° C.	30°—40° C.
Type of Cooling	Natural	Forced Air*
Instantaneous Anode Current (25–150 cycles)	15 amps.	15 amps.
Average (or D-c.) Anode Current	5 amps.	5 amps.
Maximum Average Time	30 secs.	30 secs.
Surge Anode Current	100 amps.	100 amps.
Maximum Time of Surge	0.1 second	0.1 second

Notes

* Approximately 50—150 C.F.M.

** Minimum before applying anode volts. Sufficient preheating time to bring the tube within the required operating temperature range is always necessary.

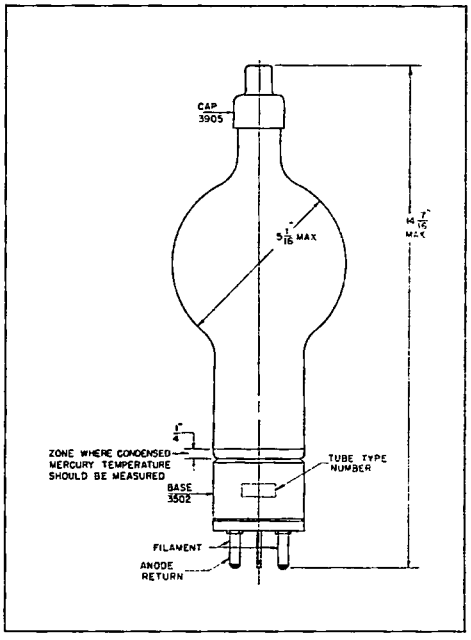
*** The anode return should be made to the cathode pin adjacent to the letter "C" stamped on the edge of the base.

For Typical Operating Conditions, etc., see reverse side.

GENERAL INFORMATION

The WL-881 incorporates several features of advanced design. Its extremely moderate cathode power of 47.5 watts is utilized so economically that two tubes in single phase full wave can deliver almost 50 Kw. of DC. It uses a uni-potential cathode of new design that gives current ratings ordinarily obtained only with quadrature operation. No additional quadrature rating is shown for the WL-881.

The WL-881 should not be subjected to shock either in handling, transporting or mounting. The condensed mercury temperature should be in the stated range before high voltage is applied. When the tube has been in transportation, or out of service for a long period the usual time delay should be increased and the plate voltage applied in steps should arc back be evident. A thermometer attached with a small dab of putty to the glass at the point indicated on the Outline diagram is satisfactory. Where the tubes are not forced—air cooled, they should be mounted in free air; and in any case the tubes should not be subjected to strong R-F or electrostatic fields. The typical operating conditions shown on the reverse side are maximum, and current and/or voltage rating may be used at a value less than maximum.

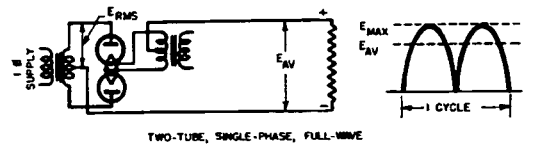


WL-881

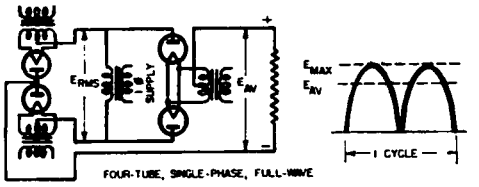
Westinghouse

RADIO TRANSMITTING TUBE

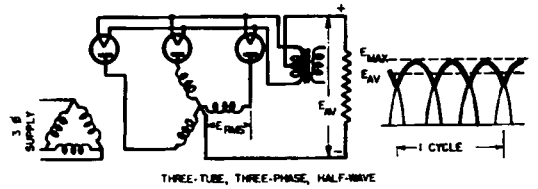
TYPICAL RECTIFIERS



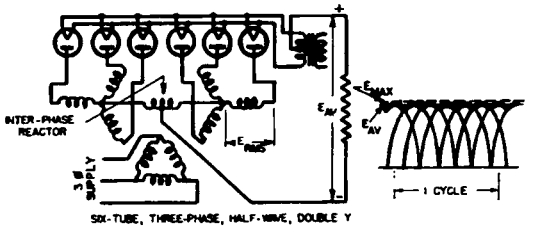
TWO-TUBE, SINGLE-PHASE, FULL-WAVE



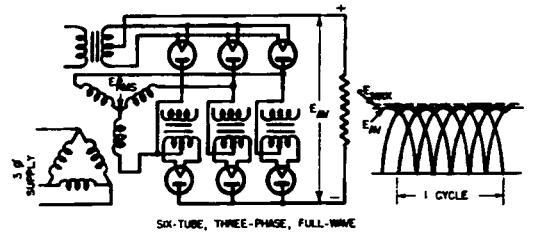
FOUR-TUBE, SINGLE-PHASE, FULL-WAVE



THREE-TUBE, THREE-PHASE, HALF-WAVE



SIX-TUBE, THREE-PHASE, HALF-WAVE, DOUBLE Y



SIX-TUBE, THREE-PHASE, FULL-WAVE

MERCURY VAPOR RECTIFIER
Current & Voltage Relations

Typical Operating Conditions

E_{AV}	E_{INV}	I_{AV}	TEMP. RANGE	E R.M.S.	D.C. TO FILTER	MAX. D.C. AMPS. OUTPUT
.636 E_{max} .900 E_{rms}	3.14 E_{av}	.636 I_{max}	30-60	3540	3180	10
			30-40	5300	4770	10
.636 E_{max} .90 E_{rms}	1.57 E_{av}	.636 I_{max}	30-60	7070	6360	10
			30-40	10,600	9540	10
.827 E_{max} 1.17 E_{rms}	2.09 E_{av}	.827 I_{max}	30-60	4180	4780	15
			30-40	6120	7170	15
.827 E_{max} 1.17 E_{rms}	2.09 E_{av}	1.91 I_{max}	30-60	4080	4780	30
			30-40	6120	7170	30
1.65 E_{max} 2.34 E_{rms}	1.05 E_{av}	.955 I_{max}	30-60	4080	9560	15
			30-40	6120	14,340	15

NOTES

The typical operating conditions above are based on the maximum ratings as shown on the first page. They also assume ideal conditions, which include: D-c, voltage is output of tubes—no filter considered; no tube voltage drop; pure resistance load; balanced phase voltages (for 3 phase); and Sine Wave a-c. supply. In the case of the 6 tube, 3 phase, half-wave double Y circuit, the wave-form and typical voltages apply only at full rated load. When lower load conditions prevail, the voltage must be reduced, reaching a maximum reduction of 15% at no load.

In the above tables and circuits, E_{av} refers to d-c. output volts, E_{inv} is the peak inverse voltage on each tube, I_{av} the d-c. output current. E_{rms} is transformer secondary voltage as shown on circuit. E_{max} should not be confused with E_{inv}; E_{max} is the peak of the output wave as shown. I_{max} is the peak current per tube.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
Special Products Department
BLOOMFIELD, NEW JERSEY

Effective 7-42

from RMA release #553, Jan. 10, 1947

WESTINGHOUSE

ELECTRON TUBE TYPE 899-A

MODULATOR, AMPLIFIER AND OSCILLATOR

GENERAL CHARACTERISTICS

Water-Cooled Triode #	
Filament Voltage ≠	14.5 Volts
Filament Current	180 Amperes
Amplification Factor	27
Capacitance, Grid-Plate	23 uuf
Capacitance, Grid-Filament	10 uuf
Capacitance, Plate-Filament	5 uuf
Net Weight	25 lbs.
Shipping Weight	125 lbs.

MAXIMUM RATINGS AND TYPICAL OPERATION CONDITIONS

R-F Power Amplifier, Class B

Carrier conditions per tube for use with a maximum modulation factor of 1.0.

Maximum Ratings

Plate Volts, D-C	18000
Plate Current, D-C, Ampere	2.5
Plate Input, Watts	30000
Plate Dissipation, Watts	20000
Plate Volts and Input for 5 MC	100%
Plate Volts and Input for 15 MC	75%
Plate Volts and Input for 60 MC	50%

Typical Operation

Plate Volts, D-C	10000	15000
Plate Current, D-C, Amperes	1.65	1.70
Grid Volts, D-C*	-200	-400
Grid Volts, Peak R-F	800	900
Grid Current, D-C, Ampere	0.10	0.07
Driving Power, Watts **	540	660
Power Output, Watts	5000	8000

Plate-Modulated R-F Power Amplifier, Class C

Carrier conditions per tube for use with a maximum modulation factor of 1.0.

Maximum Ratings

Plate Volts, D-C	10000
Plate Current, D-C, Amperes	2.5
Plate Input, Watts	15000
Plate Dissipation, Watts	15000
Plate Volts and Input for 5 MC	100%
Plate Volts and Input for 15 MC	75%
Plate Volts and Input for 60 MC	50%
Grid Volts, D-C	-3000
Grid Current, D-C, Amperes	0.5

ELECTRON TUBE TYPE 899-A (Continued)

Typical Operation

Plate Volts, D-C	8000	10000
Plate Current, D-C, Amperes	1.35	1.25
Grid Volts, D-C	-1500	-1600
Grid Volts, Peak R-F	2600	2700
Grid Current, D-C, Ampere	0.28	0.33
Driving Power, Watts	730	850
Power Output, Watts	8000	10000

R-F Power Amplifier and Oscillator, Class C

Key-down conditions per tube without modulation ##

Maximum Ratings

Plate Volts, D-C	18000
Plate Current, D-C, Ampere	5.0
Plate Input, Watts	60000
Plate Dissipation, Watts	30000
Plate Volts and Input for 5 MC	100%
Plate Volts and Input for 15 MC	75%
Plate Volts and Input for 60 MC	50%
Grid Volts, D-C	-3000
Grid Current, D-C, Ampere	0.6

Typical Operation

Plate Volts, D-C	10000	15000	18000
Plate Current, D-C, Amperes	2.0	2.8	2.8
Grid Volts, D-C	-1400	-1800	-2000
Grid Volts, Peak R-F	2700	3200	3600
Grid Current, D-C Amp	0.30	0.25	0.15
Driving Power, Watts	800	800	450
Power Output, Watts	15000	25000	35000

NOTES:

Water flow of 8 to 16 gallons per minute must be provided for cooling of the anode. Water termperatures must not exceed 70° C under any conditions of operation. The filament and the grid stem can be properly cooled by supplying five cubic feet of air per minute to each. Both the water and air cooling must be applied before application of any voltages and continue for at least 10 minutes after they are removed.

♯ This tube can often be operated with reduced filament voltage when the load conditions are lower than maximum. When the filament voltage is to be removed, it should be reduced gradually in six equal steps over a period of three minutes.

° With A-C filament supply. When D-C is used, the grid voltage value should be reduced by 10 volts.

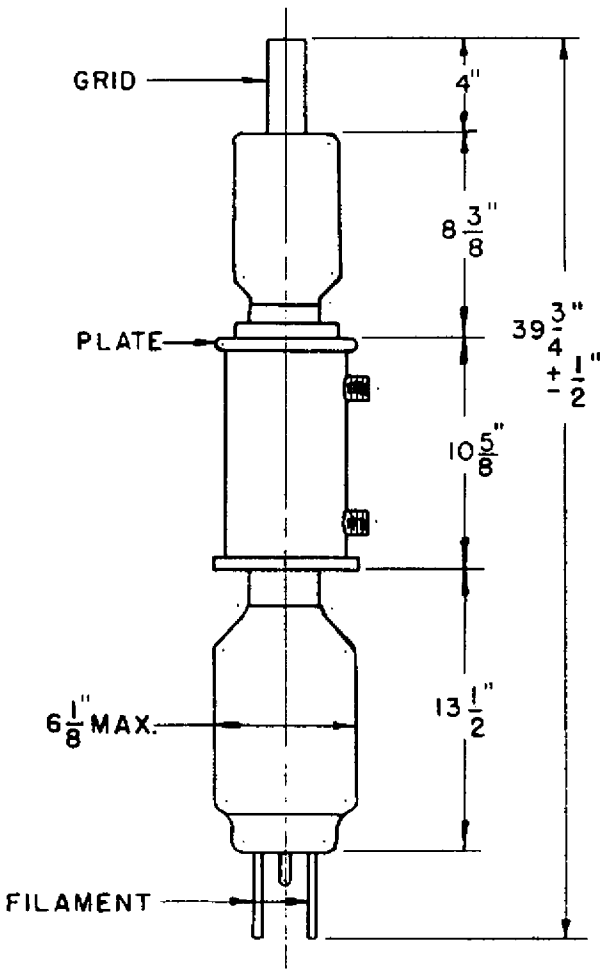
°° At crest of audio-frequency cycle with modulation factor of 1.0.

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

WESTINGHOUSE LAMP DIVISION
WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY
BLOOMFIELD, N. J.

SPECIFICATION NO.
DATE 1-22-41
SUPERSEDES
DATED

899A



PRINTED ON
"IMPERIAL" TRACING CLOTH
K & E CO., N. Y.

BE-5140 SUB 0 J.J.T. 1-22-41

from RMA release # 683, Aug. 2, 1948

6/23/48

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5519

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Oil	
Focal Spot Size (Double Focus)		
Projected Length	2.1 and 4.2	mm
Width	2.1 and 4.2	mm
Base Description	None	
Maximum Overall Dimensions	8-3/16 x 2-7/16	Inches
Outline Drawing Number	60011	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	100,000	*Heat Units
Continuous Rating	30,000	Heat Units Per Minute

Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)** — Continuous to Heat Capacity of Head

	Spot Size	Full Wave	Half Wave	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	Both	110	100	100	90	Kilovolts
Value of d.c. Avg. Current at Maximum Voltage Rating	2.1	50	44	-	34	Milliamps.
	4.2	169	139	-	103	Milliamps.
Allowable Time of Operation Under Above Conditions	Both	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak KV useful times D-C average milliamperes.

Time	2.1 mm. Spot Size #Full Wave	Half Wave	Self-Rectified	4.2 mm. Spot Size #Full Wave	Half Wave	Self-Rectified
0.1 Sec.	6100	4200	2950	18250	13000	8700
1 "	4800	3375	2560	11800	9600	6900
5 "	3900	2880	2300	8100	7300	5650
30 "	2800	2150	1900	3400	3400	3400

*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times D-C average MA and is proportiona to power.

Ratings are for 100 KV peak plate voltage.

2-2

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT.

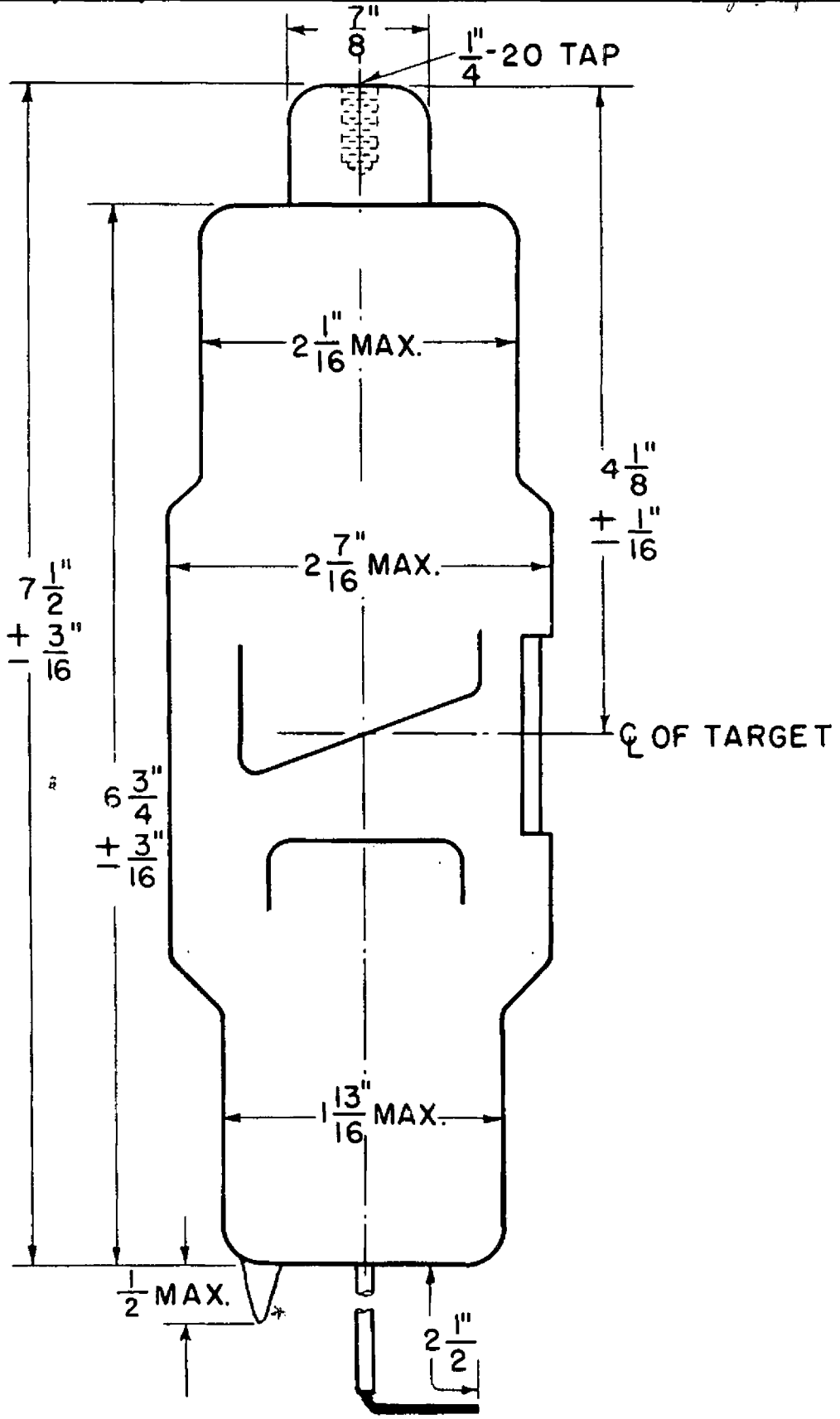
11

60011 C

COMMERCIAL OUTLINE

A | S. TAYLOR | 5/15/41

5519, 5521, 5522, 5523,



11009

from RMA release # 683, Aug. 2, 1948
& release # 683A, Dec. 14, 1948

6/23/48

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5520

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	~~Air~~ Oil	
Focal Spot Size		
Projected Length	1.5	mm.
Width	1.5	mm.
Base Description	None	
Maximum Overall Dimensions	8-3/16 x 2-7/16	Inches
Outline Drawing Number	60011	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	100,000	* Heat Units
Continuous Rating	30,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	Continuous to Heat Capacity of Head	

	Full Wave	Half Wave	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	110	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	29	24	-	19	Milliamps
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak KV useful times D-C average milliamperes.

Time	***Full Wave	Half Wave	Self-Rectified
0.1 Sec.	3450	2350	1700
1 "	2750	2000	1520
5 "	2250	1800	1400
30 "	1700	1500	1250

*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times D-C average MA and is proportional to power.

***Ratings are for 100 KV peak plate voltage.

2-2

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT.

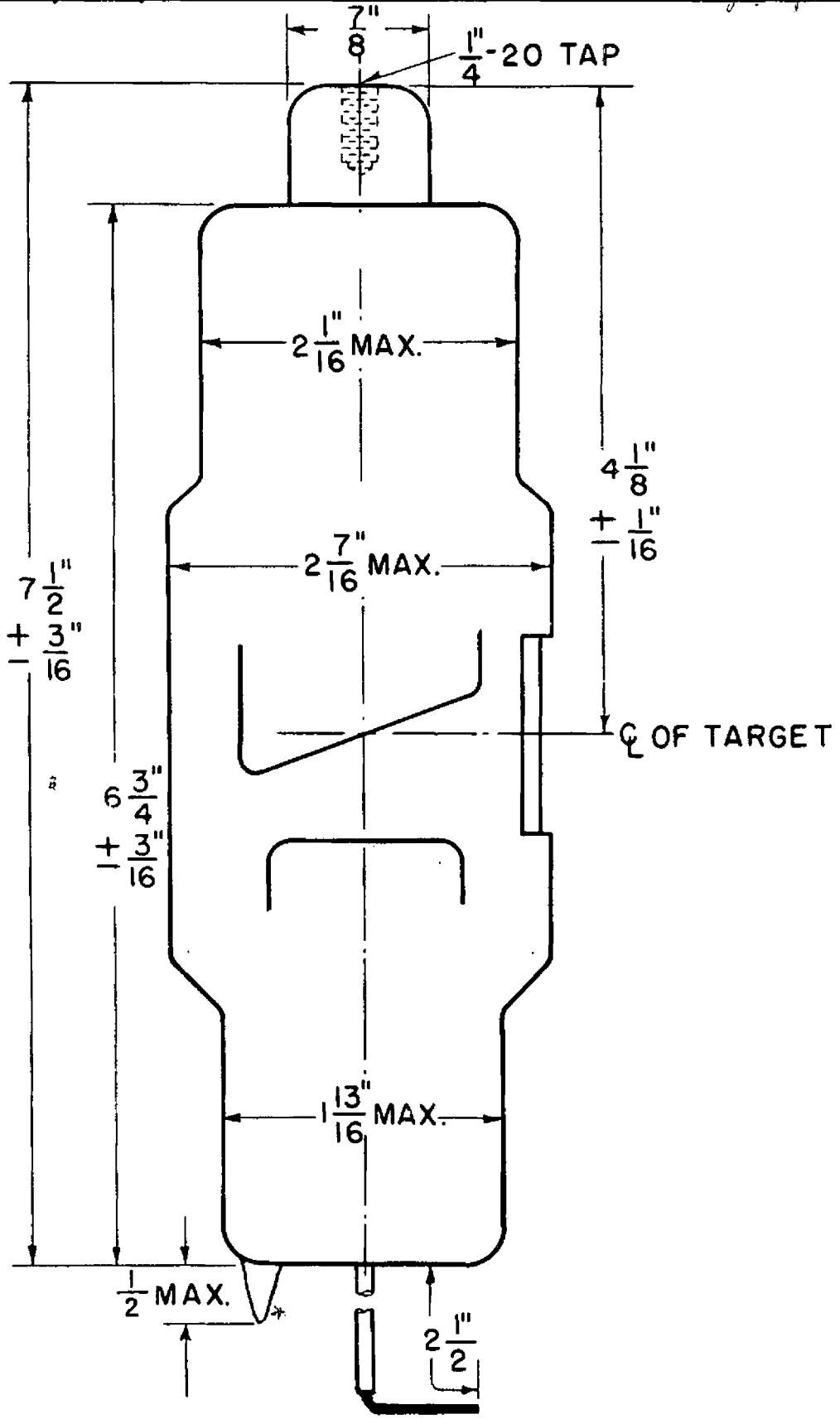
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60011 C

COMMERCIAL OUTLINE

A | S. TAYLOR | 5/15/41

5519, 5521, 5522, 5523,



11009

from RMA release # 683, Aug. 2, 1948
& release # 683A, Dec. 14, 1948

6/23/48

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5521

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	~~Air~~ Oil	
Focal Spot Size		
Projected Length	2.1	mm.
Width	2.1	mm.
Base Description	None	
Maximum Overall Dimensions	8-3/16 x 2-7/16	Inches
Outline Drawing Number	60011	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	100,000	*Heat Units
Continuous Rating	30,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	Continuous to Heat Capacity of Head	

	Full Wave	Half Wave	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	110	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	50	44	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak KV useful times D-C average milliamperes.

Time	***Full Wave	Half Wave	Self-Rectified
0.1 Sec.	6100	4200	2950
1 "	4800	3375	2560
5 "	3900	2880	2300
30 "	2800	2150	1900

*Heat untis are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times D-C average MA and is proportional to power.

***Ratings are for 100 KV peak plate.

2-2

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT.

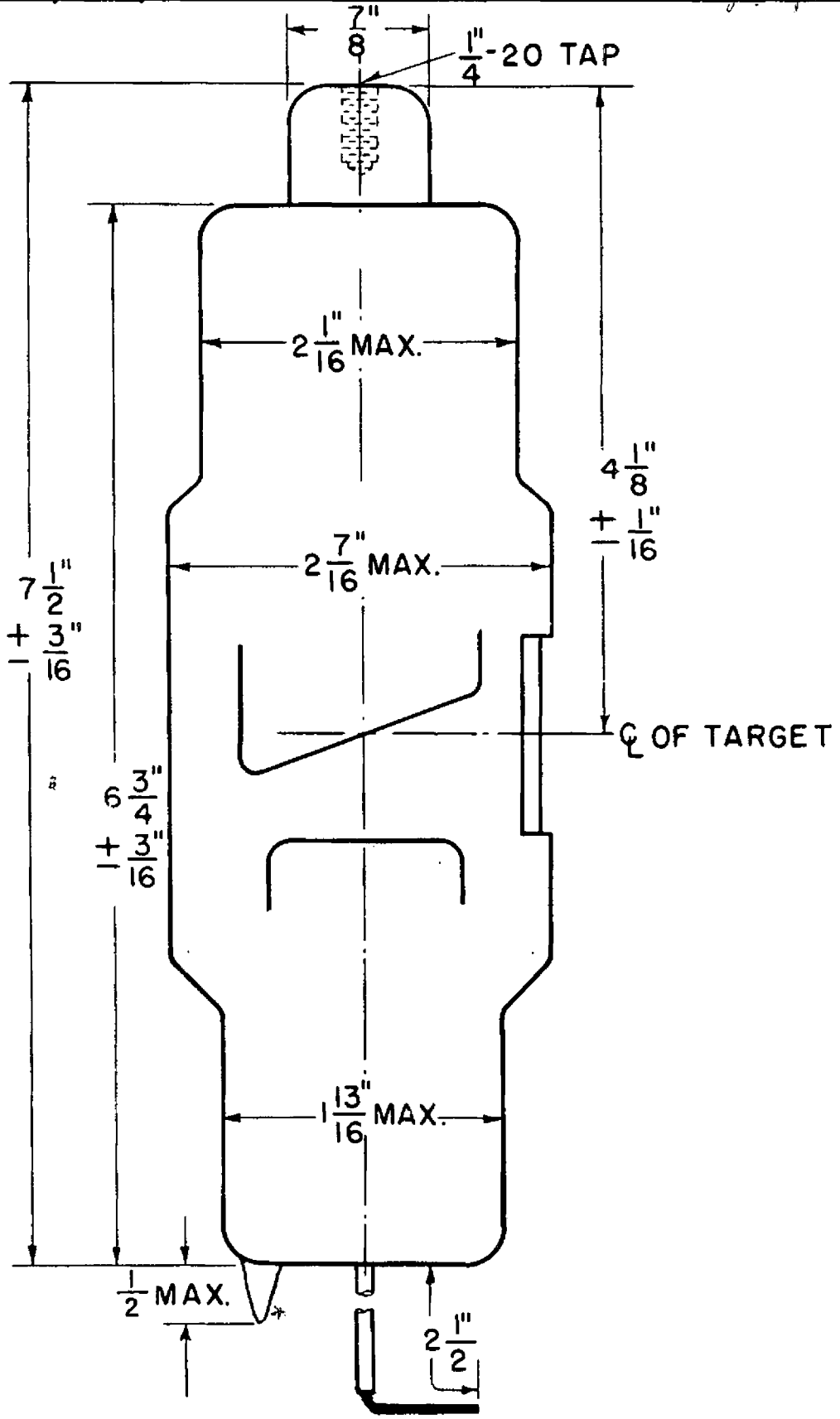
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60011 C

COMMERCIAL OUTLINE

A | S. TAYLOR | 5/15/41

5519, 5521, 5522, 5523,



11009

from RMA release # 683, Aug. 2, 1948
& release # 683A, Dec. 14, 1948

6/23/48

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5522

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	~~Air~~ Oil	
Focal Spot Size		
Projected Length	3.0	mm.
Width	3.0	mm.
Base Description	None	
Maximum Overall Dimensions	8-3/16 x 2-7/16	Inches
Outline Drawing Number	60011	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	100,000	*Heat Units
Continuous Rating	30,000	Heat Units Per Minute

Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)** — Continuous to Heat Capacity of Head

	Full Wave	Half Wave	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	110	100	100	90	Kilovolts
Value of D-C average current at Maximum Voltage Rating	98	79	-	19	Milliamps
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak KV useful times D-C average milliamperes.

Time	***Full Wave	Half Wave	Self-Rectified
0.1 Sec.	10800	7400	4950
1 "	7600	5900	4160
5 "	5900	4800	3600
30 "	3400	3300	2740

*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times D-C average MA and is proportional to power.

***Ratings are for 100 KV peak plate voltage.

2-2

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
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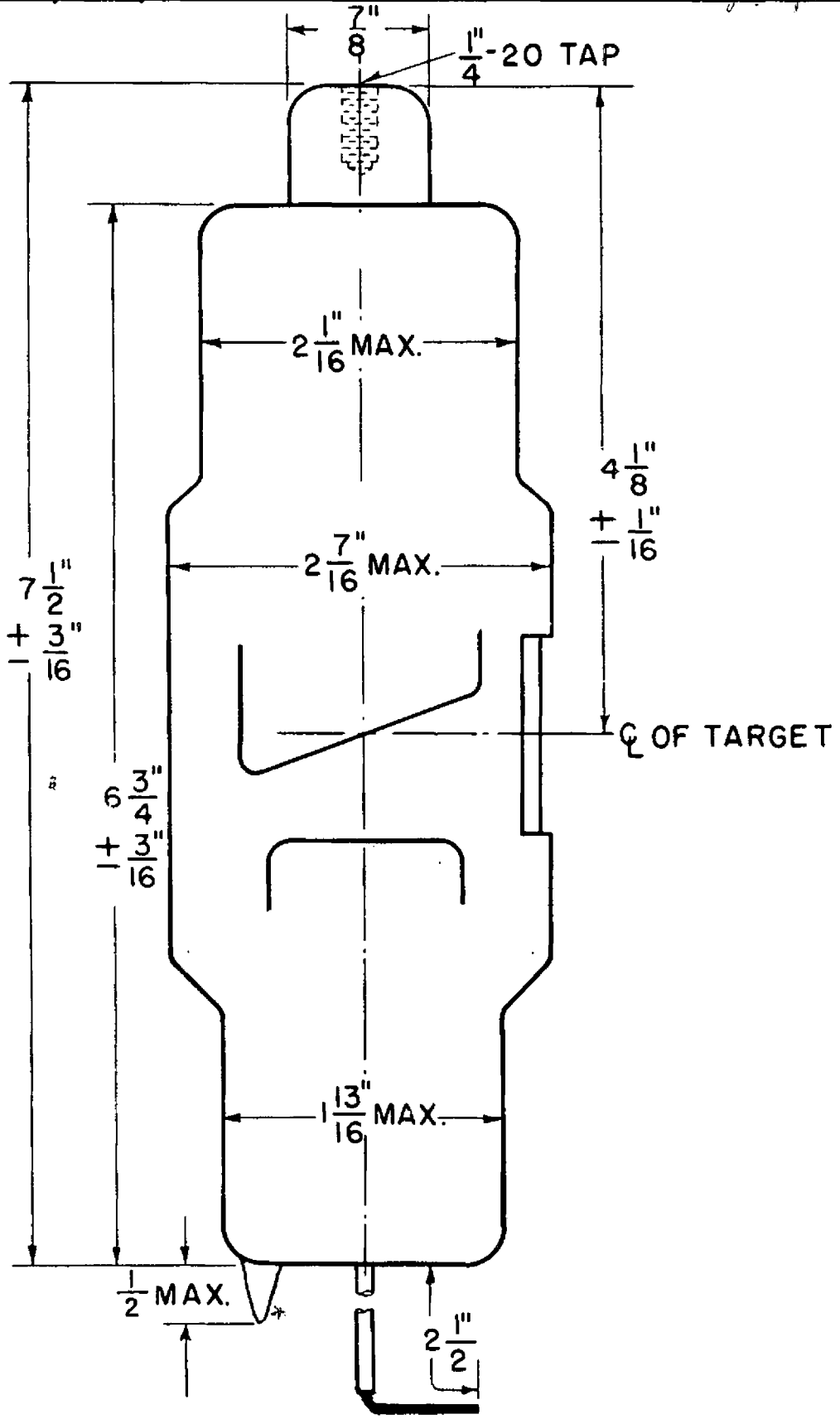
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60011 C

COMMERCIAL OUTLINE

A | S. TAYLOR | 5/15/41

5519, 5521, 5522, 5523,



11009

from RMA release # 683, Aug. 2, 1948
& release # 683A, Dec. 14, 1948

6/23/48

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5523

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	~~Air~~ Oil	
Focal Spot Size		
Projected Length	4.2	mm.
Width	4.2	mm.
Base Description	None	
Maximum Overall Dimensions	8-3/16 x 2-7/16	Inches
Outline Drawing Number	60011	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	100,000	*Heat Units
Continuous Rating	30,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	Continuous to Heat Capacity of Head	

	Full Wave	Half Wave	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	100	100	100	90	Kilovolts
Value of D-C Average Current at Maximum Voltage Rating	169	139	-	103	Milliamps
Allowable Time of Operating Under Above Conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak KV useful times D-C average milliamperes.

Time	***Full Wave	Half Wave	Self-Rectified
0.1 Sec.	18250	13000	8700
1 "	11800	9600	6900
5 "	8100	7300	5650
30 "	3400	3400	3400

*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times D-C average MA and is proportional to power.

***Ratings are for 100 KV peak plate voltage.

2-2

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT.

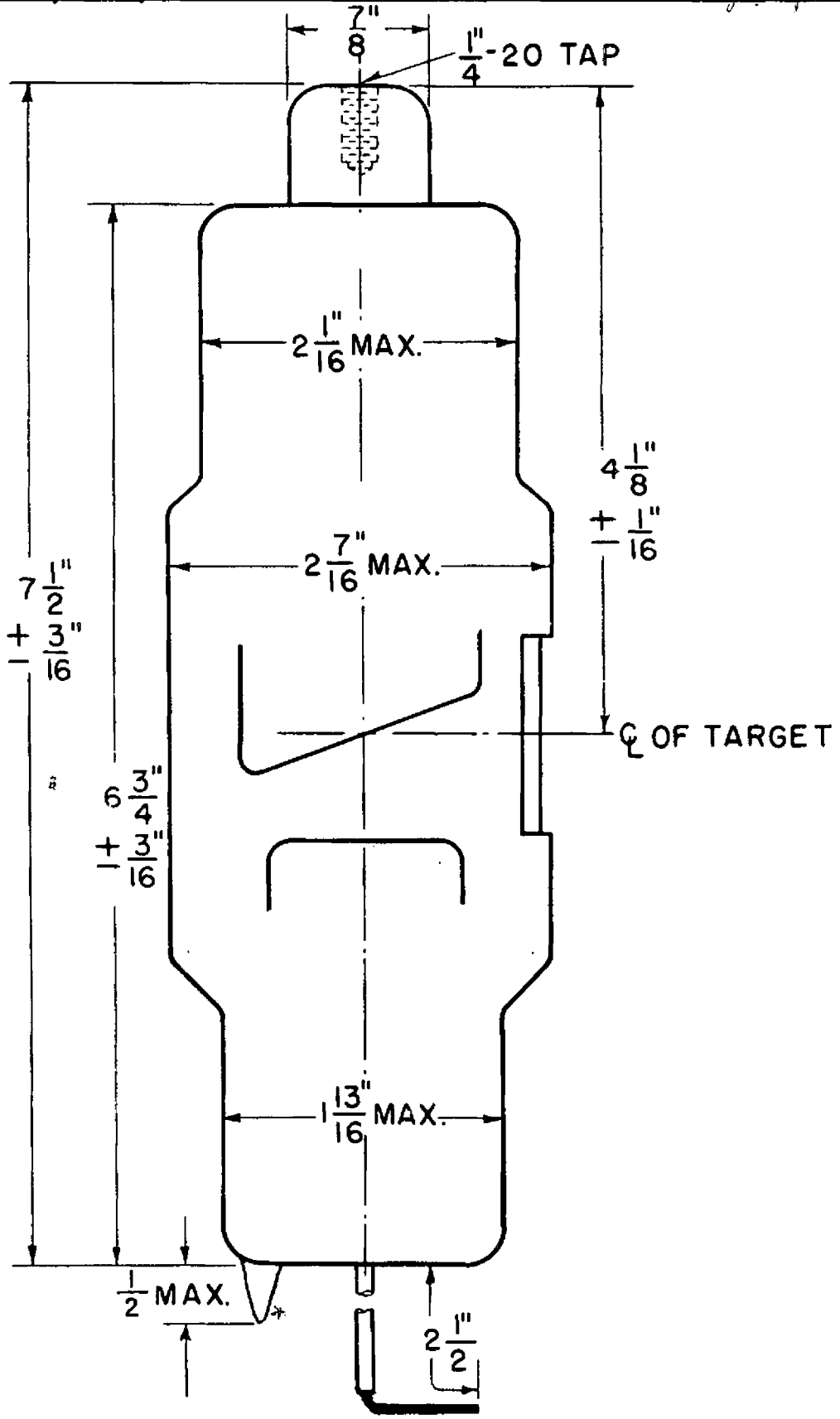
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60011 C

COMMERCIAL OUTLINE

A | S. TAYLOR | 5/15/41

5519, 5521, 5522, 5523,



11009

RMA Release No. 640

February 25, 1948

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5532

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	2.1	mm
Width	2.1	mm
Base Description	G2-2	
Maximum Overall Dimensions	15-1/4 x 3-13/16	Inches
Outline Drawing Number	5532	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	150,000	*Heat units
Continuous Rating	12,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	10	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamperes
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-Rectified
0.1 Sec.	6200	4225	2940
1 "	4800	3400	2575
5 "	3920	2675	2310
30 "	2800	2190	1910

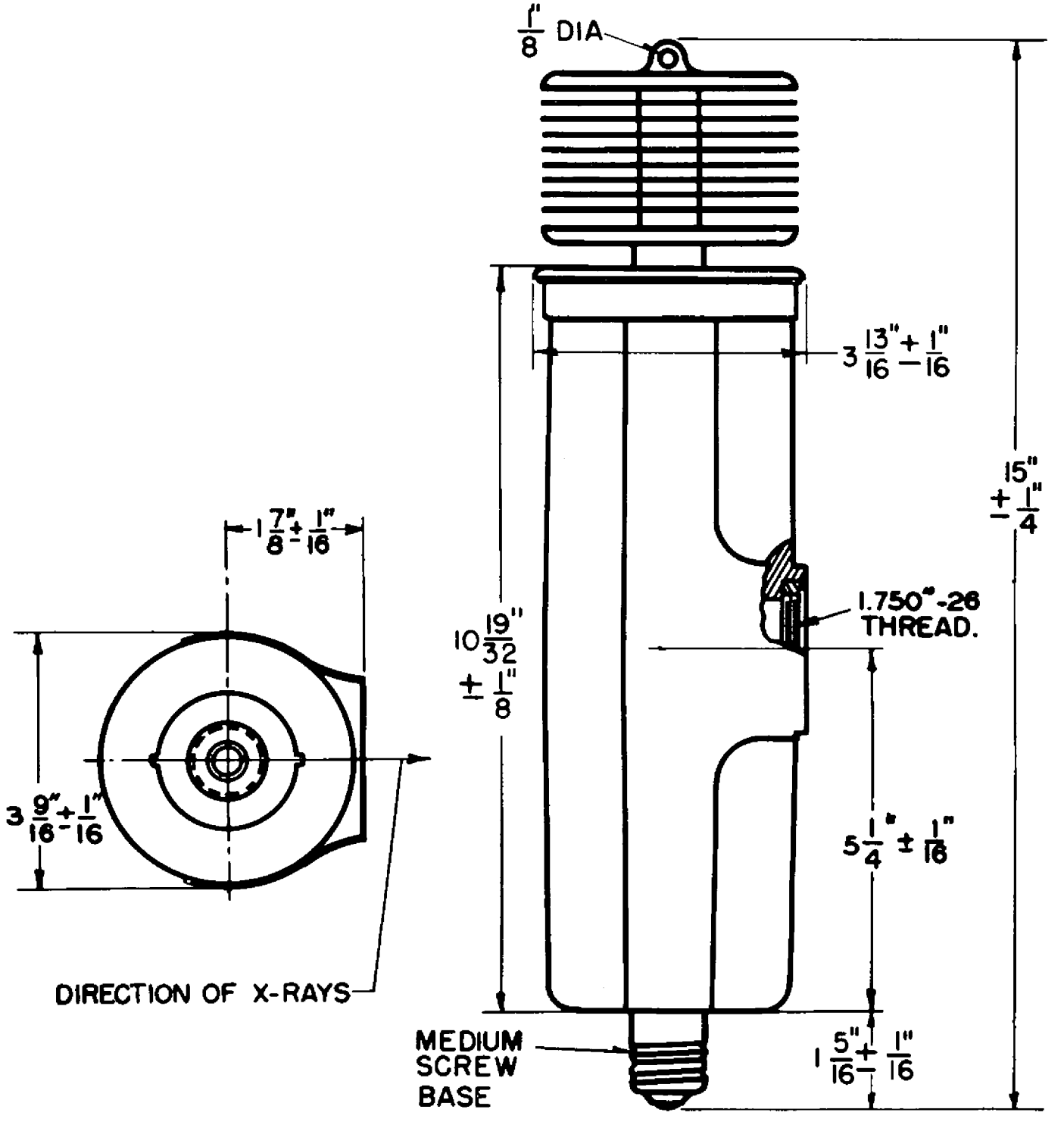
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release 640

February 25, 1948

RMA TYPES 5532, 5533, 5534



RMA Release No. 640

February 25, 1948

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5533

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	3.0	mm
Width	3.0	mm
Base Description	G2-2	
Maximum Overall Dimensions	15-1/4 x 3-13/16	Inches
Outline Drawing Number	5533	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	150,000	*Heat units
Continuous Rating	12,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	10	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-Rectified
0.1 Sec.	10800	7400	4950
1 "	7600	5900	4150
5 "	5900	4800	3600
30 "	3400	3300	2740

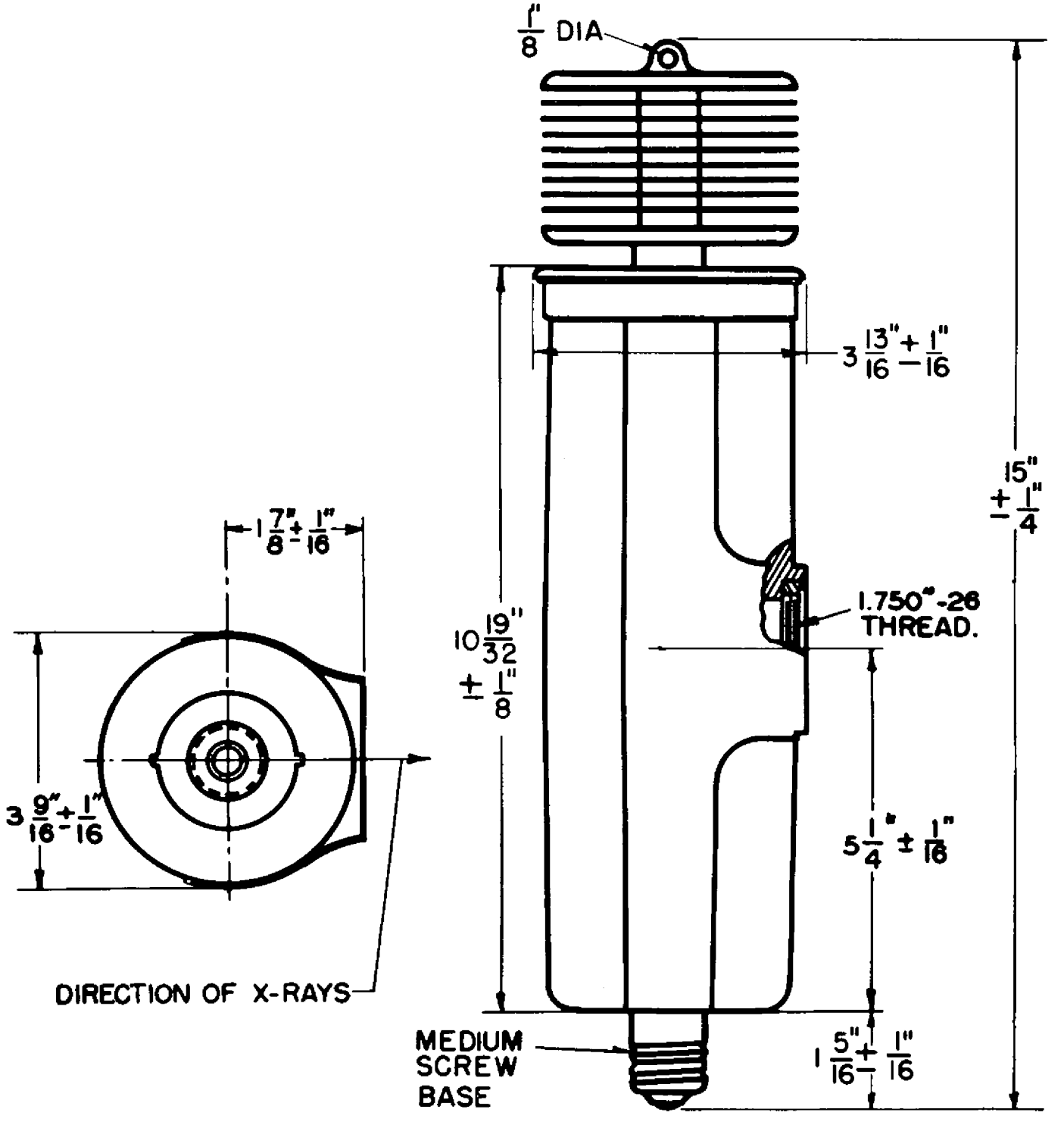
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release 640

February 25, 1948

RMA TYPES 5532, 5533, 5534



RMA Release No. 640

WESTINGHOUSE February 25, 1948

X-RAY TUBE DATA SHEET

Electron Tube Type 5534

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	4.2	mm
Width	4.2	mm
Base Description	G2-2	
Maximum Overall Dimensions	15-1/4 x 3-13/16	Inches
Outline Drawing Number	5534	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	150,000	*Heat units
Continuous Rating	12,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	10	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	18250	13000	8700
1 "	11800	9600	6900
5 "	8100	7300	5650
30 "	3400	3400	3400

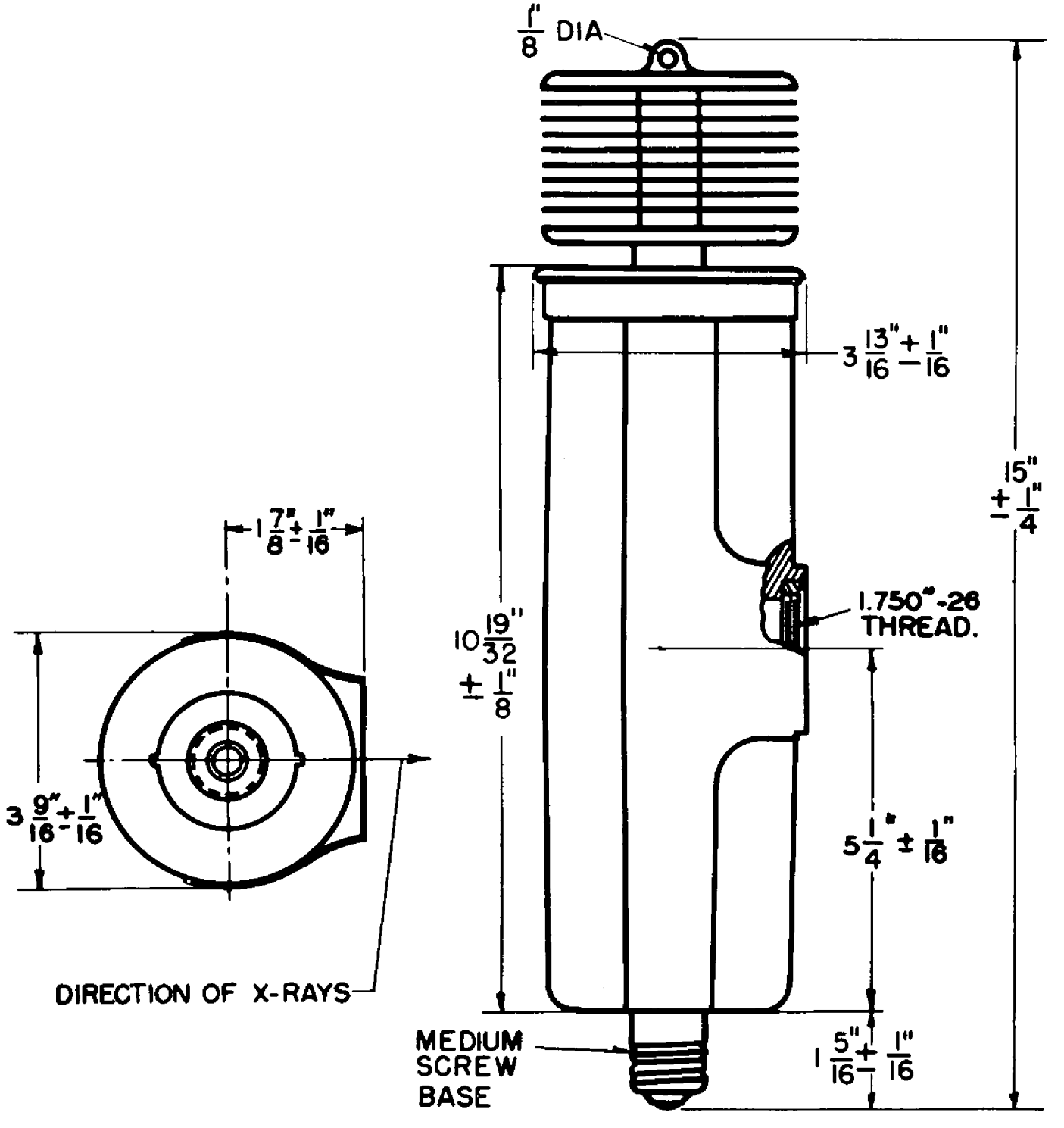
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release 640

February 25, 1948

RMA TYPES 5532, 5533, 5534



RMA RELEASE No. 640

WESTINGHOUSE February 25, 1948

X-RAY TUBE DATA SHEET

Electron Tube Type 5535

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	2.1 and 4.2	mm
Width	2.1 and 4.2	mm
Base Description	Special 3-pin	
Maximum Overall Dimensions	14-19/32 x 3-13/16	Inches
Outline Drawing Number	5535	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	150,000	*Heat units
Continuous Rating	12,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	10	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	2.1 mm spot size			4.2 mm spot size		
	Full Wave	Half Wave	Self-rectified	Full Wave	Half Wave	Self-rectified
0.1 Sec.	6200	4225	2940	18250	13000	8700
1 "	4800	3400	2575	11800	9600	6900
5 "	3920	2875	2310	8100	7300	5650
30 "	2800	2190	1910	3400	3400	3400

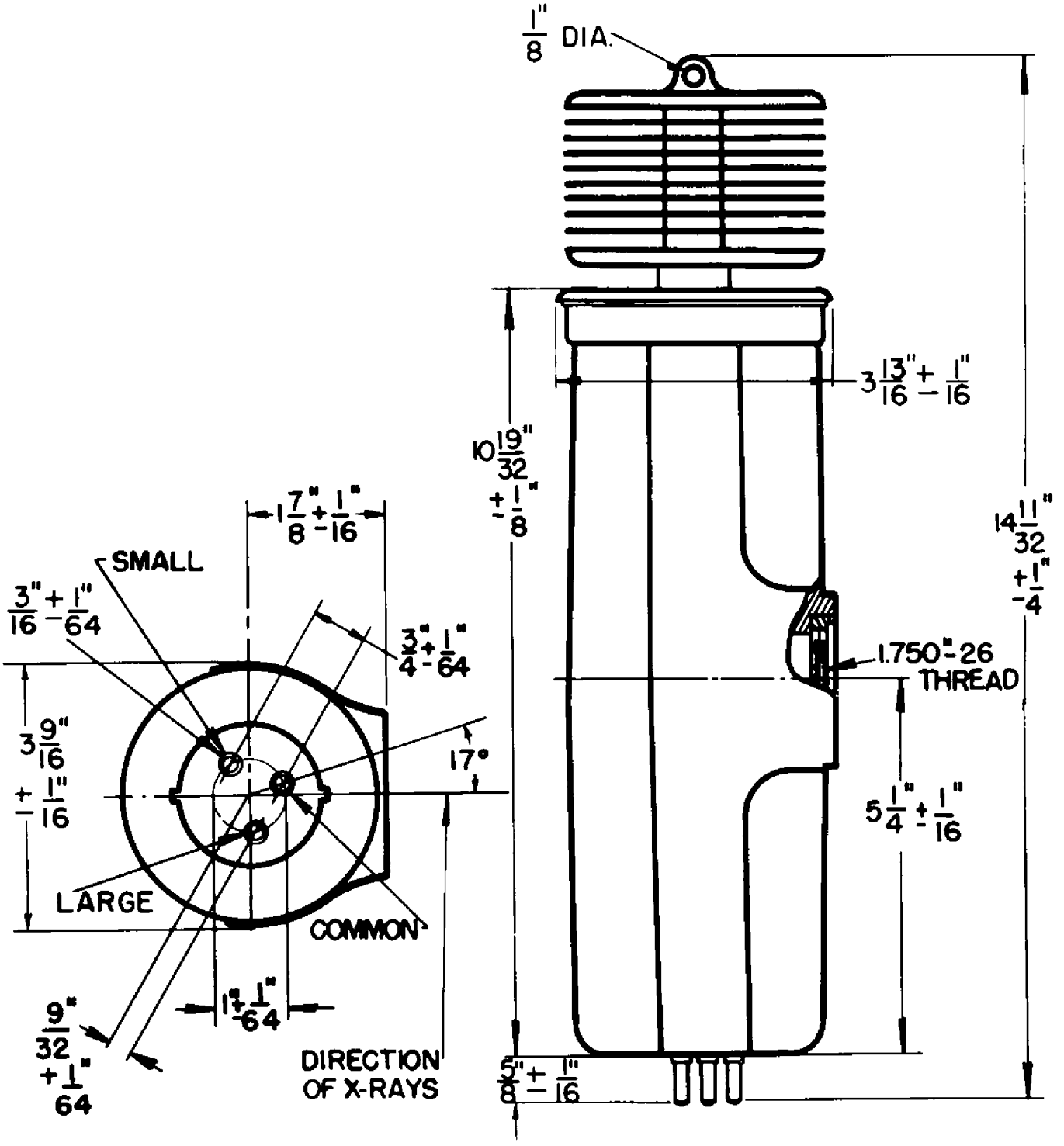
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

** KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPE 5535



WESTINGHOUSE RMA Release 640

X-RAY TUBE DATA SHEET February 25, 1948

Electron Tube Type 5536

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	2.1	mm
Width	2.1	mm
Base Description	G2-2	
Maximum Overall Dimensions	16-3/8 x 3-13/16	Inches
Outline Drawing Number	5536	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	270,000	*Heat units
Continuous Rating	15,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	6200	4225	2940
1 "	4800	3400	2575
5 "	3920	2875	2310
30 "	3020	2250	1970

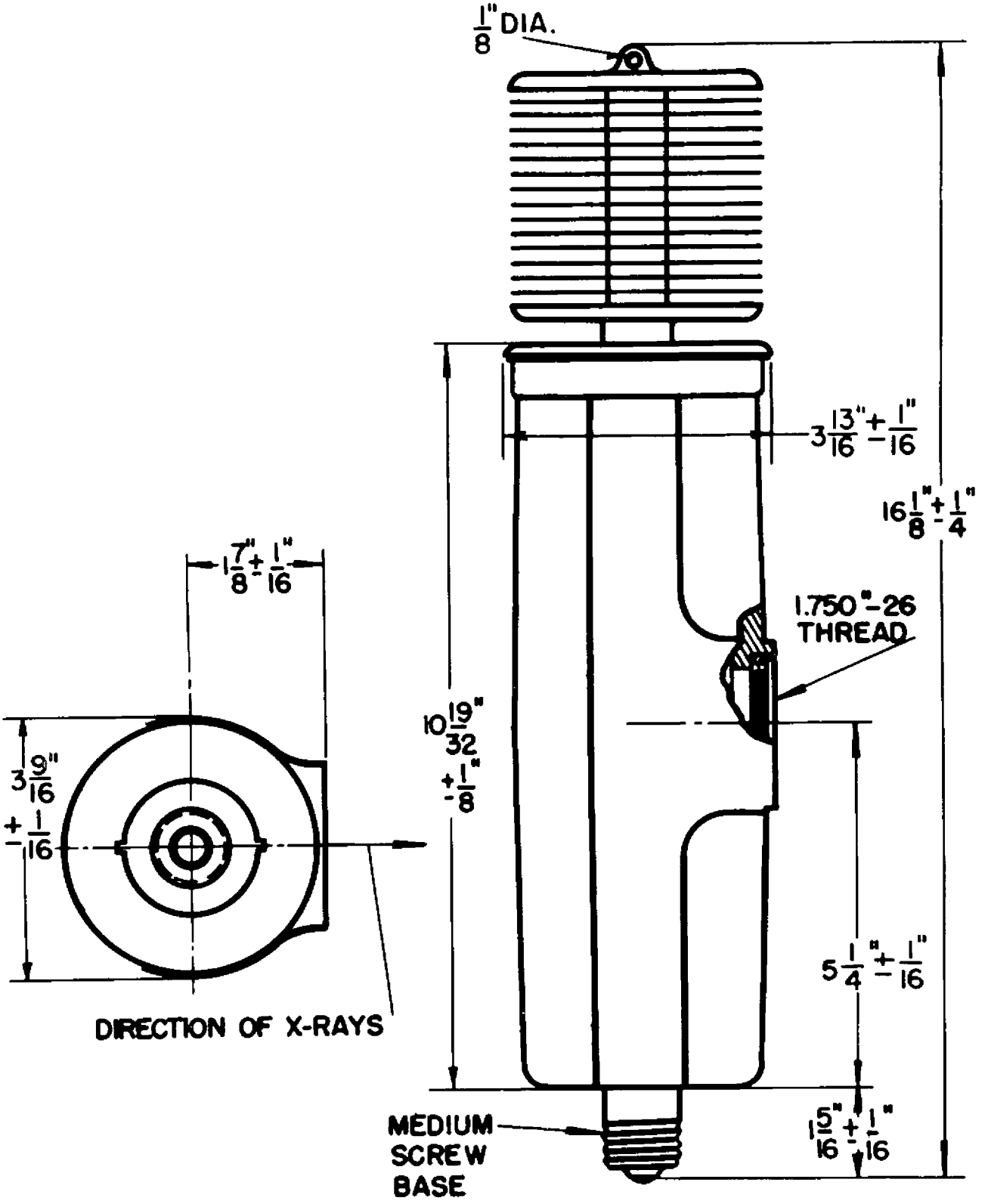
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

** KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPES 5536, 5537, 5538



RMA Release 640

February 25, 1948

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5537

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	3.0	mm
Width	3.0	mm
Base Description	G2-2	
Maximum Overall Dimensions	16-3/8 x 3-13/16	Inches
Outline Drawing Number	5537	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	270,000	*Heat units
Continuous Rating	15,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	10800	7400	4950
1 "	7600	5900	4150
5 "	5900	4800	3600
30 "	4450	3640	2950

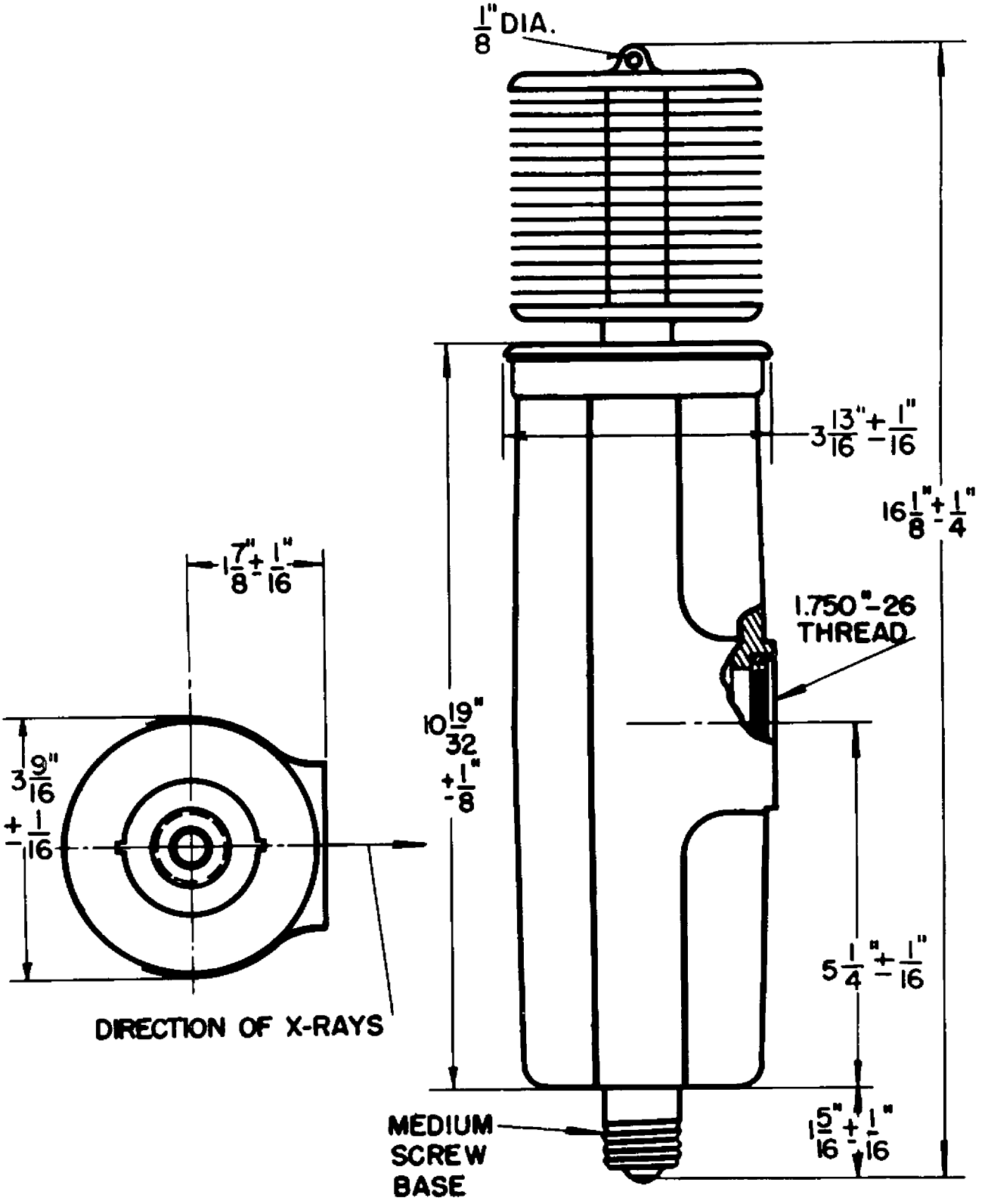
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPES 5536, 5537, 5538



RMA RELEASE No. 640

WESTINGHOUSE February 25, 1948

X-RAY TUBE DATA SHEET

Electron Tube Type 5538

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	4.2	mm
Width	4.2	mm
Base Description	G2-2	
Maximum Overall Dimensions	16-3/8 x 3-13/16	Inches
Outline Drawing Number	5538	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	270,000	*Heat units
Continuous Rating	15,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	18250	13000	8700
1 "	11800	9600	6900
5 "	8400	7300	5650
30 "	6000	4600	4000

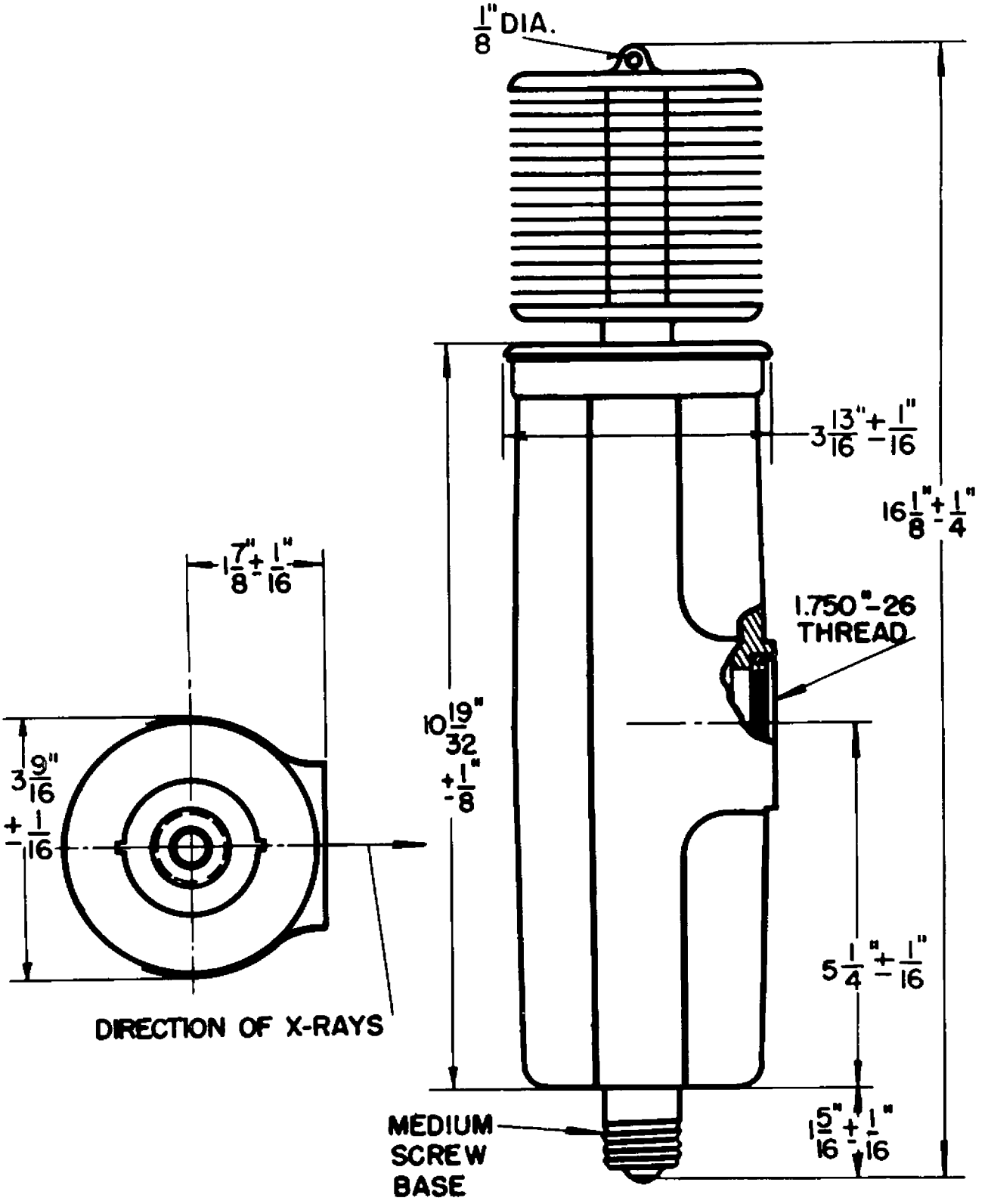
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPES 5536, 5537, 5538



RMA Release No. 640

February 25, 1948

WESTINGHOUSE

X-RAY TUBE DATA SHEET

Electron Tube Type 5539

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	2.1 and 4.2	mm
Width	2.1 and 4.2	mm
Base Description	Special 3-pin	
Maximum Overall Dimensions	15-23/32 x 3-13/16	Inches
Outline Drawing Number	5539	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	270,000	*Heat units
Continuous Rating	15,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

	2.1 mm spot sizes			4.2 mm spot sizes		
Time	Full Wave	Half Wave	Self-rectified	Full Wave	Half Wave	Self-rectified
0.1 Sec.	6200	4225	2940	18250	13000	8700
1 "	4800	3400	2575	11800	9600	6900
5 "	3920	2875	2310	8400	7300	5650
30 "	3020	2250	1970	6000	4600	4000

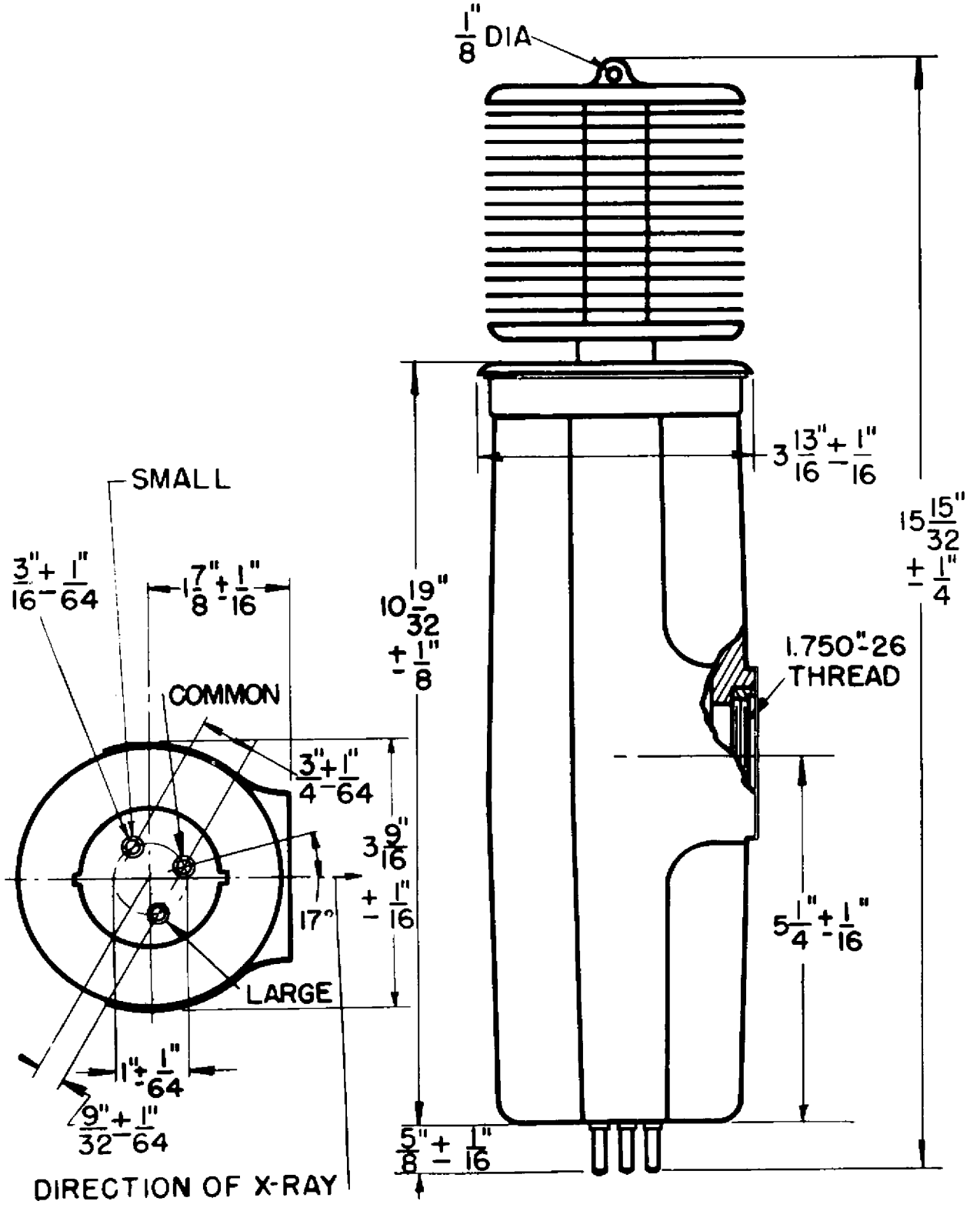
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPES 5539, 5540



RMA Release No. 640

WESTINGHOUSE February 25, 1948

X-RAY TUBE DATA SHEET

Electron Tube Type 5540

GENERAL

Electrical Data		
Filament Current Range	3.5 to 5.5	Amperes
Filament Voltage Range	3.5 to 10	Volts
Mechanical Data		
Type of Cooling	Air	
Focal Spot Size		
Projected length	1.5 and 3.0	mm
Width	1.5 and 3.0	mm
Base Description	Special 3-pin	
Maximum Overall Dimensions	15-23/32 x 3-13/16	Inches
Outline Drawing Number	5540	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	270,000	*Heat units
Continuous Rating	15,000	Heat units per minute
Maximum Fluoroscopic Rating at a Loading of 425 (KV x MA)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of D-C average current at maximum voltage rating	68	45	-	34	Milliamps.
Allowable time of operation under above conditions	1/20	1/20	-	1/20	Second

Table of short-time ratings which are given as the product of peak kv useful times D-C average milliamperes.

	1.5 mm spot size			3.0 mm spot size		
Time	Full Wave	Half Wave	Self-rectified	Full Wave	Half Wave	Self-rectified
0.1 Sec.	3500	2600	1700	10800	7400	4950
1 Sec.	2800	2000	1520	7600	5900	4150
5 Sec.	2300	1800	1400	5900	4800	3600
30 Sec.	1700	1500	1250	4450	3640	2950

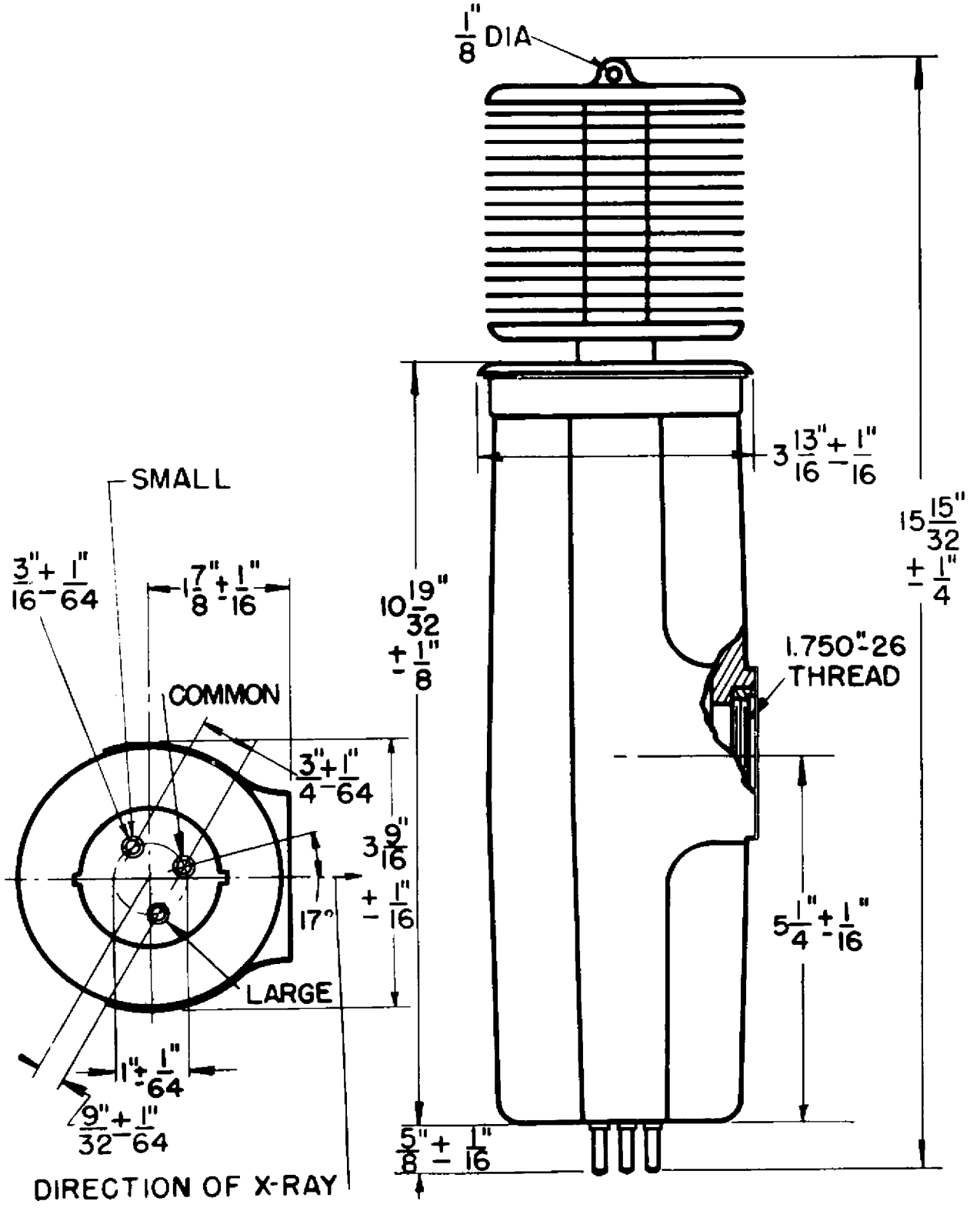
*Heat units are defined as the product of the peak voltage in kilovolts, D-C average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of Peak KV times D-C average MA and is proportional to power.

RMA Release No. 640

February 25, 1948

RMA TYPES 5539, 5540



IGNITRON TYPE WL-5555A

The WL-5555A is a sealed, stainless-steel jacketed, water-cooled, mercury-pool tube designed primarily for power rectification. In this service six tubes will rectify 600 kilowatts at 300 volts dc and 500 kilowatts at 600 and 900 volts dc. The WL-5555A is also used for alternating current control at 2400 volts, rms. The WL-5555A features an intergral thermostat bracket to permit installation of tube temperature-operated safety control circuitry.

GENERAL DATA

Electrical

Type of Cathode Excitation		Cyclic
Type of Cathode Spot Starting		Ignitor
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Auxiliary Anodes	1	
Ignitors	2	
Arc Drop at 600 Peak Amperes (See Figure 13)	16.2	volts
Ignitor Excitation Requirements (See page 2 for ignitor ratings)		
Separate-Excitation Source (See Figures 2 and 11)		
Open-Circuit Voltage Range	450 – 750	volts
Short-Circuit Current Range	45 – 75	amp
Anode Firing (2400 Volts, Welding Service),		
50 ohms in series with ignitor	Anode	volts

Mechanical

Mounting Position	Vertical, cathode down	
Envelope Material	Stainless steel	
Length, maximum	29-3/4	in
Width, not including water connections	5-3/4	in
Type of Cooling		water
Characteristics for Water Cooling, at continuous average		
current and rated minimum water flow of	3	gpm
Water Temperature Rise, maximum	5	°C
Maximum Pressure Drop, at 3 gallons per minute	7	lbs/sq in
Net Weight	25	lbs
Shipping Weight	33	lbs

from JEDEC release #4234, April 22, 1963

MAXIMUM RATINGS

AS A POWER RECTIFIER (6-phase double-wye or 3-phase rectifier) See Note 1.

DC Output Voltage, maximum	300	600	volts
Maximum Voltage Reduction by Phase Retard	0	0	percent
Maximum Average Current Per Tube			
Continuous	200	150	amp
Two-Hour Overload	300	225	amp
One-Minute Overload	400	300	amp
Outlet Water Temperature, maximum	50	40	°C
Inlet Water Temperature, minimum	3	3	°C
Minimum Water Flow Ratings			
For Recirculating Cooling	3	3	gpm
For Direct Raw Water Cooling (See Note 2)	1	1	gpm
Frequency Range	25-60	25-60	cps

AS AN AC CONTROL (Two tubes in inverse parallel) See Note 3 and Figure 15.

Maximum Voltage, rms	2400	volts
Maximum Demand (See Note 4)	2400	kva
Average Current at Maximum Demand	135	amp
Maximum Average Current	207	amp
Demand at Maximum Average Current	1105	kva
Maximum Averaging Time at 2400 Volts, rms	1.66	sec
Maximum Surge Current, Peak	6000	amp
Maximum Duration of Surge Current	0.15	sec
Outlet Water Temperature, maximum	30	°C
Inlet Water Temperature, minimum	10	°C
Minimum Water Flow	3	gpm

IGNITOR RATINGS

For power rectifier or ac control service

See page 1 for ignitor excitation requirements

Maximum Voltage		
Positive	Anode	volts
Negative	5	volts

Maximum Current		
Peak	100	amp
Root Mean Square	15	amp
Average	2	amp
Maximum Averaging Time	10	sec

Note 1.

These ratings are in accordance with American Standards Association Report C34.1-1949 "Pool Cathode Mercury Arc Power Converters for Railway Substations or Mining Service". For ratings apply to other voltages, voltage reduction by phase retard, or various outlet water temperatures See Figure 14.

Note 2.

For water flow controlled by a thermostatic valve. At highest ambient water temperature and minimum water pressure, water flow must be enough to insure outlet water below maximum rated temperature.

Note 3.

Rms demand voltage, current, and kva are all on the basis of full-cycle conduction (no phase delay) regardless of whether or not phase control is used.

Note 4.

With the use of log-log paper, straight-line interpolation between tabulated points may be used for other tabulated ratings of demand kva versus average anode current.

MAXIMUM FAULT CURRENT RATINGS

The ratio of rated maximum fault current to rated zero–phase–retard continuous average tube current, occurring during the following intervals after fault initiation, shall not exceed the values tabulated below:

Interval	Peak Forward	Peak Reverse
0 to .016 second	80	185
.016 to .05 second	80	130
.05 to .15 second	80	92
.15 to .20 second	55	–

These fault–current ratios are based on field experience and measurements on commercial rectifiers and are to be construed as a basis for circuit design. The fault current has transient components which account for the higher values for the shorter times. The current corresponding to the last interval is the sustained dc short–circuit tube current. It may be used to calculate the minimum transformer commutating impedance (Z_c), referred to the secondary, required to insure proper protection of the tubes. Z_c is determined by the following formula:

$$Z_c = \frac{\sqrt{2}\, E_s}{I_{ss}}$$

E_s = line to neutral rms voltage of the dc winding in volts
I_{ss} = sustained dc short–circuit current in amperes
Z_c = commutating impedance in ohms

SELF OR ANODE IGNITOR EXCITATION

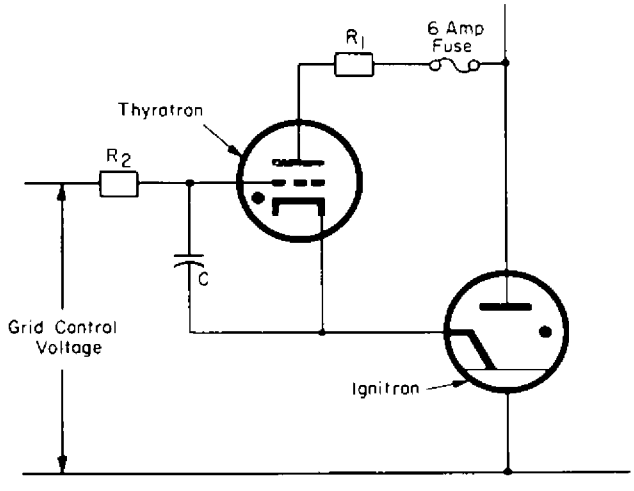


FIGURE 1

SATURATING REACTOR-CAPACITOR SEPARATE EXCITATION IGNITOR CIRCUIT

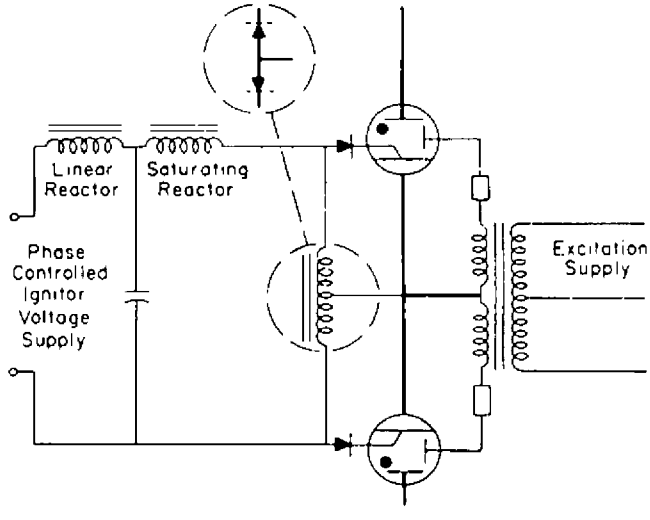


FIGURE 2

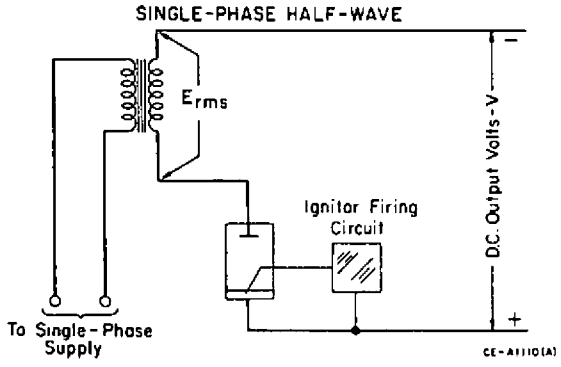


FIGURE 3

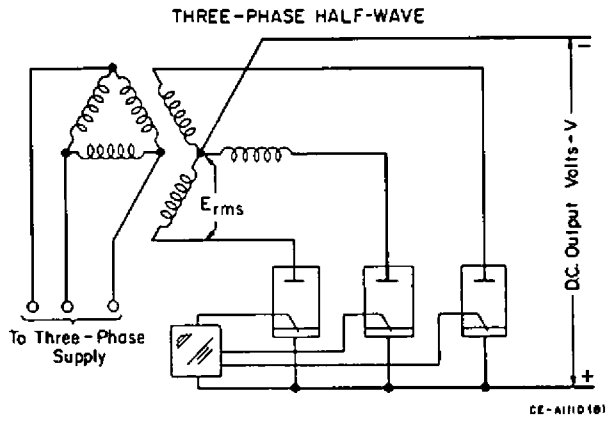


FIGURE 4

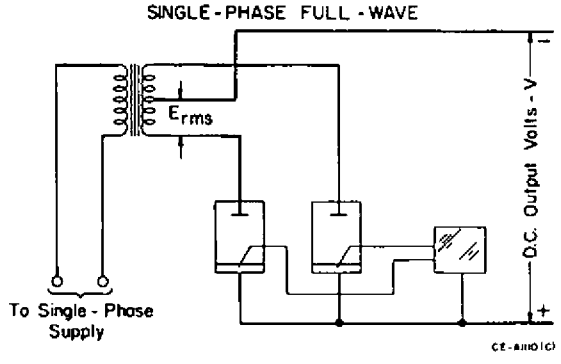


FIGURE 5

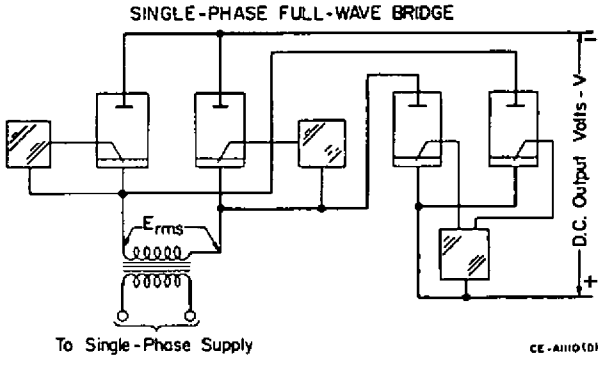


FIGURE 6

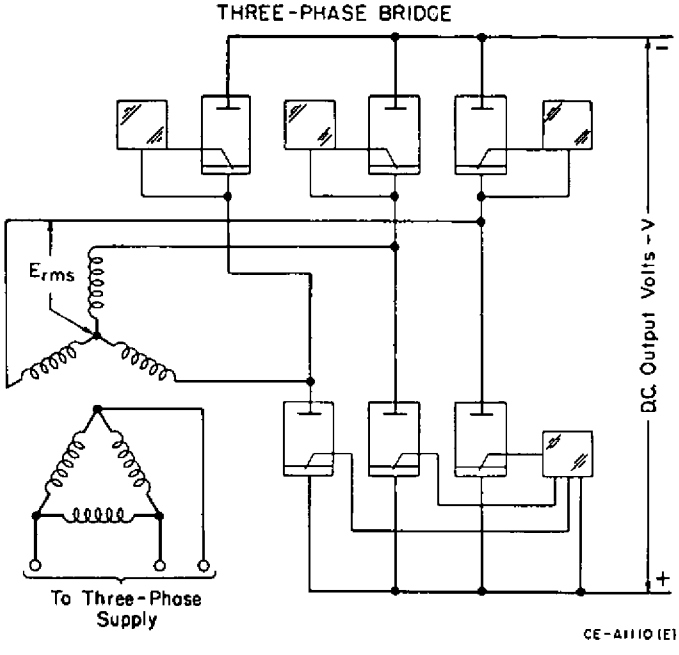


FIGURE 7

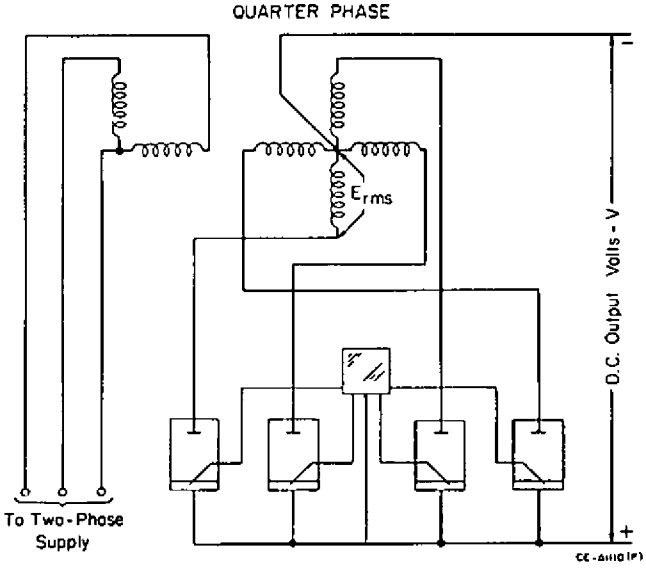


FIGURE 8

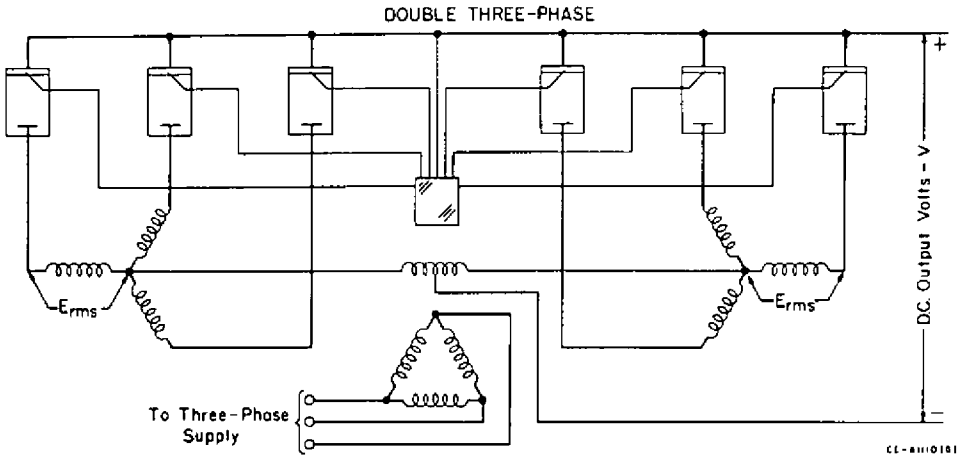


FIGURE 9

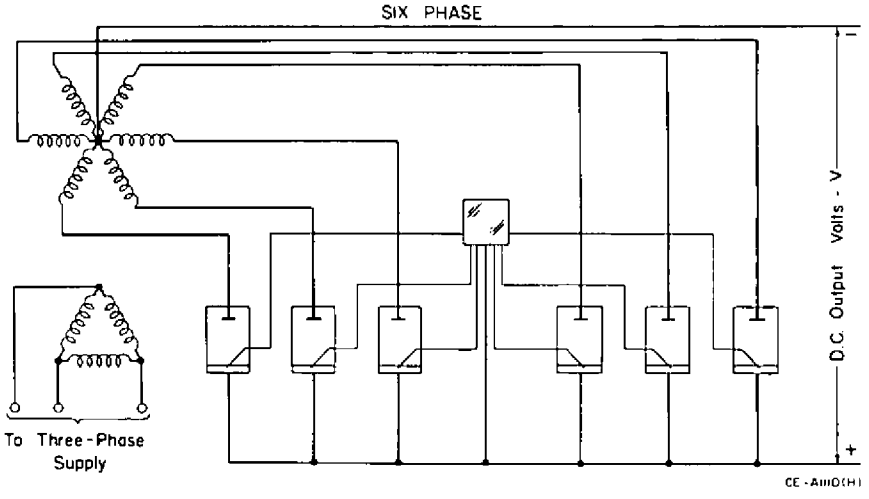


FIGURE 10

The information contained herein is furnished without assuming any obligations. The description and illustration of circuits herein does not convey to the purchaser of tubes any license for circuits under the patent claims of Westinghouse Electric Corporation or others.

	Symbol	Fig. 3	Fig. 4	Fig. 5	Fig. 6	Fig. 7	Fig. 8	Fig. 9	Fig. 10
Transformer Secondary Voltage, rms	E	2.22V	.854V	1.11V	1.11V	.427V	.785V	.854V	.740V
Peak Inverse Voltage	E_1	1.41E	2.45E	2.83E	1.41E	2.45	2.83E	2.45E	2.83E
Peak Inverse Voltage	E_1	3.14V	2.09V	3.14V	1.57V	1.05V	2.22V	2.09V	2.09V
Anode Current, rms	I	1.57A	0.578A	0.785A	0.785A	0.578A	0.500A	0.289A	0.408A
DC Output Voltage, average	V	–	–	–	–	–	–	–	–
DC Output Voltage, peak	V_1	3.14V	1.21V	1.57V	1.57V	1.05V	1.11V	1.05V	1.05V
Major Ripple Voltage, rms	V_2	1.11V	0.177V	0.472V	0.472V	0.04V	0.106V	0.04V	0.04V
Major Ripple Frequency	f	f	3f	2f	2f	6f	4f	6f	6f
DC Output Current, average	A	–	–	–	–	–	–	–	–
Anode Current, peak (resistive load)	A_1	3.14A	1.21A	1.57A	1.57A	1.05A	1.11A	0.52A	1.05A
Anode Current, peak (resistive load)	A_1	$3.14A_3$	$3.63A_3$	$3.14A_3$	$3.14A_3$	$3.15A_3$	$4.5A_3$	$3.15A_3$	$6.3A_3$
Anode Current, peak (inductive load)	A_2	–	A	A	A	A	A	0.5A	A
Anode Current, average	A_3	A	0.33A	0.5A	0.5A	0.33A	0.25A	0.167A	0.167A
Transformer Primary Volt-Amperes	–	3.49VA	1.21VA	1.11VA	1.11VA	1.05VA	1.11VA	1.05VA	1.29VA
Transformer Secondary Volt-Amperes	–	3.49VA	1.71VA	1.57VA	1.11VA	1.05VA	1.57VA	1.48VA	1.81VA
Line Volt-Amperes	–	3.49VA	1.21VA	1.11VA	1.11VA	1.05VA	1.11VA	1.05VA	1.05VA

NOTES

Symbols E and V are shown on circuit diagrams. Allowance must be made for voltage drop in tubes, transformer and circuit.

Circuit, Figure 3 results in considerable transformer unbalancing with consequent reduction of kva output.

Peak inverse voltage 2.45E, Figure 9, becomes 2.83E for light loading.

Ratios given are on the assumption that there is no back emf in the load circuit and no phase-back.

Primary volt-amperes required do not include transformer losses which must be considered.

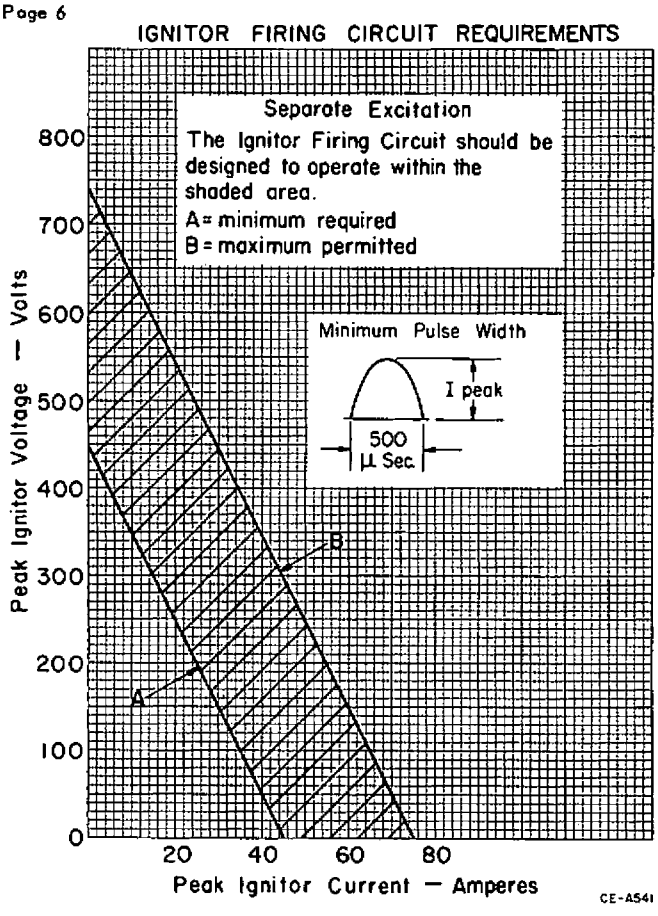


FIGURE 11

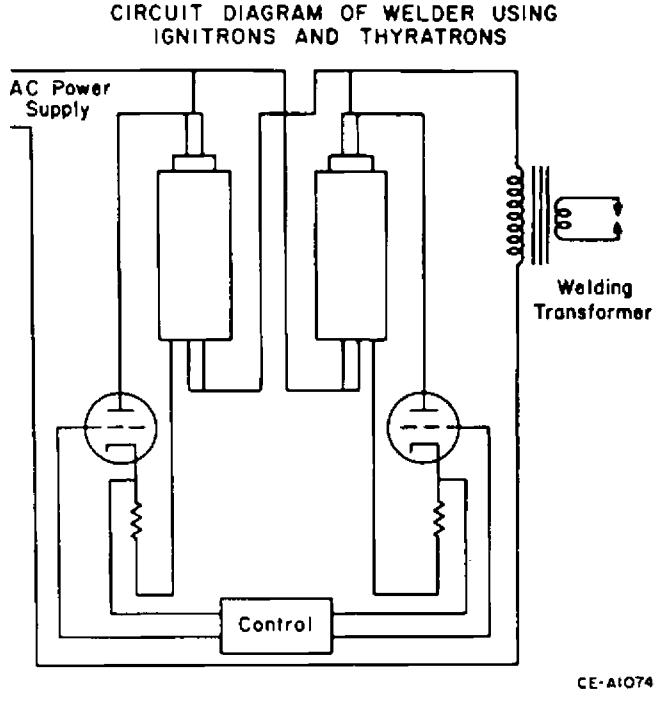


FIGURE 12

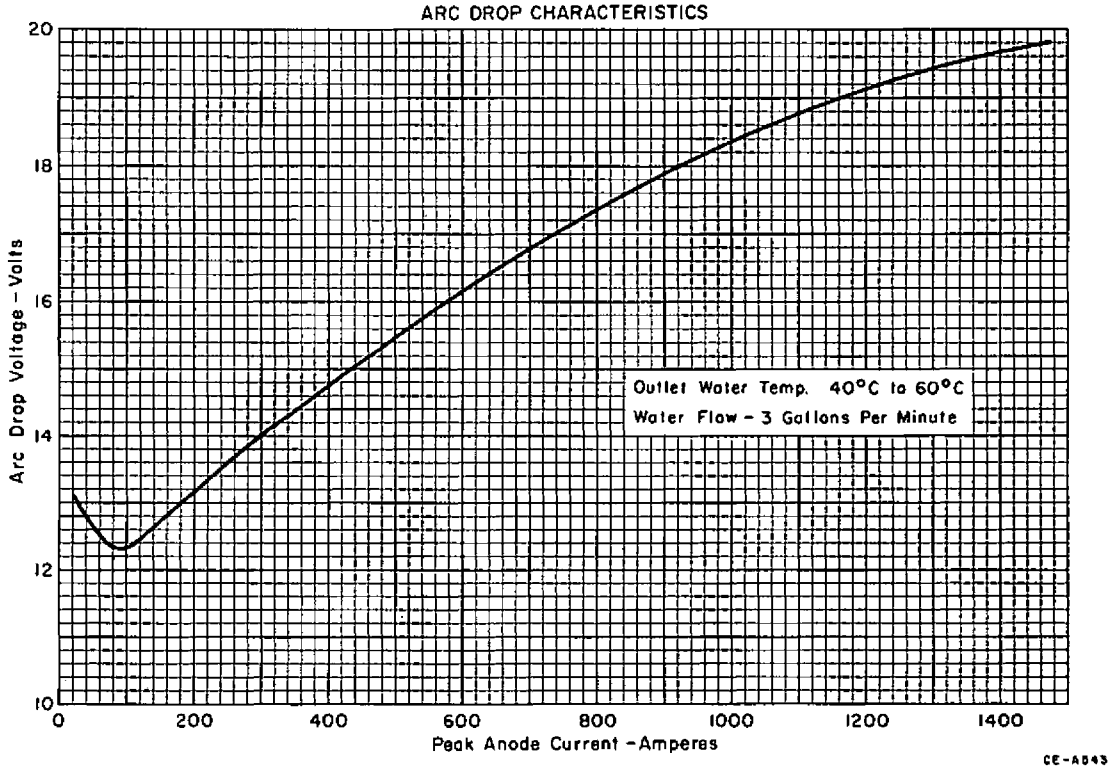
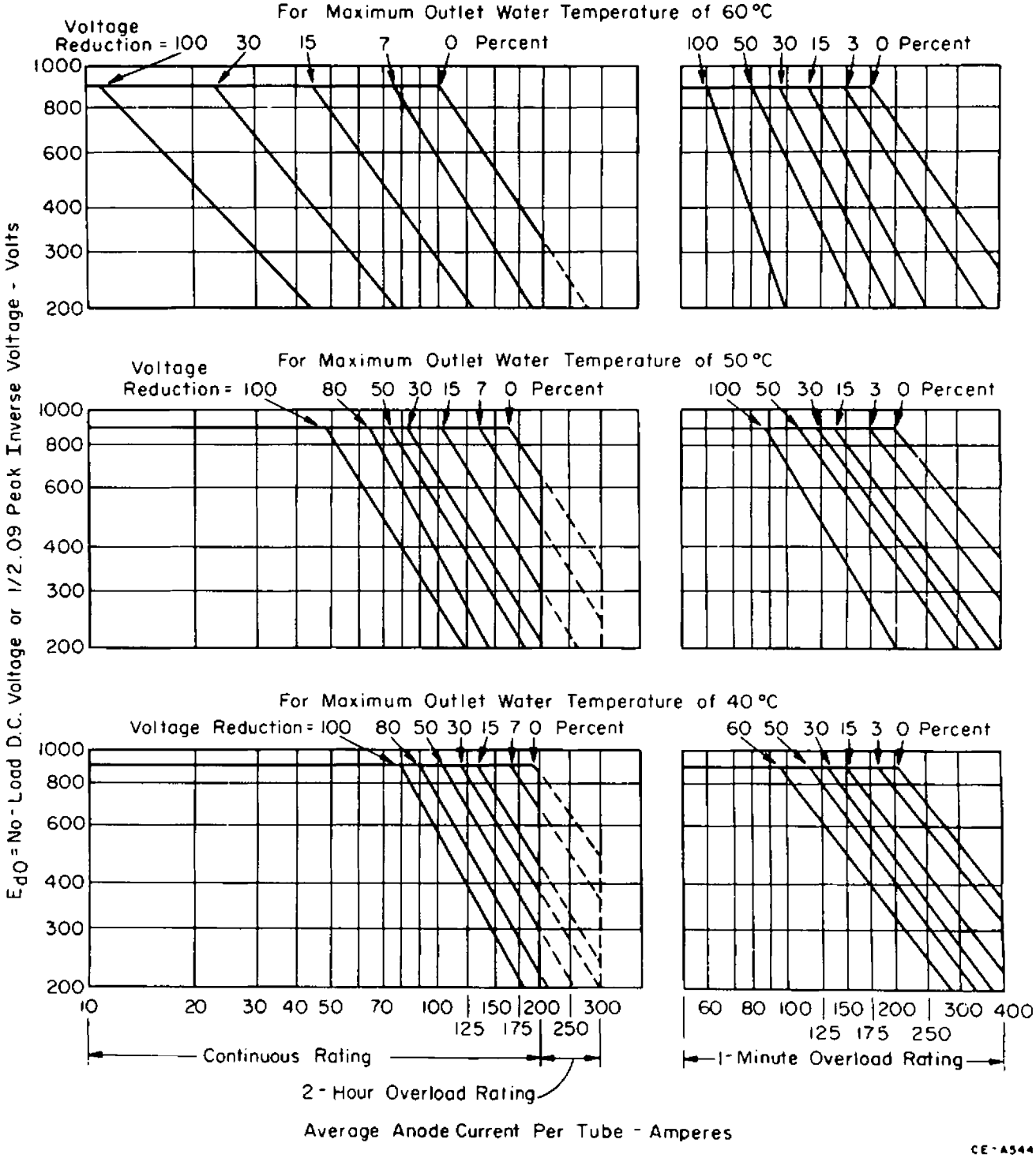


FIGURE 13

RATING CHART FOR SIX-PHASE DOUBLE-WYE
OR THREE-PHASE RECTIFICATION SERVICE
Showing
D.C. Output Voltage and Current
Percent Voltage Reduction by Phase Retard



CE-A544

FIGURE 14

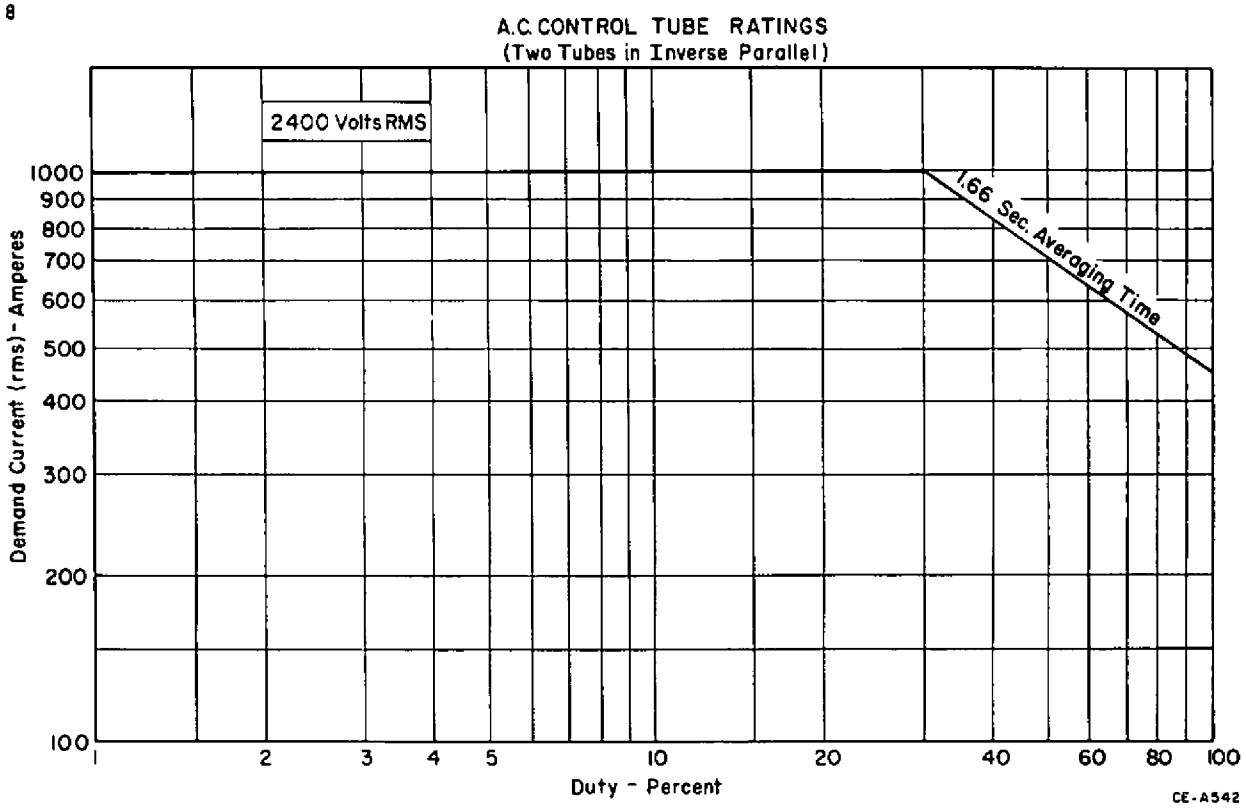
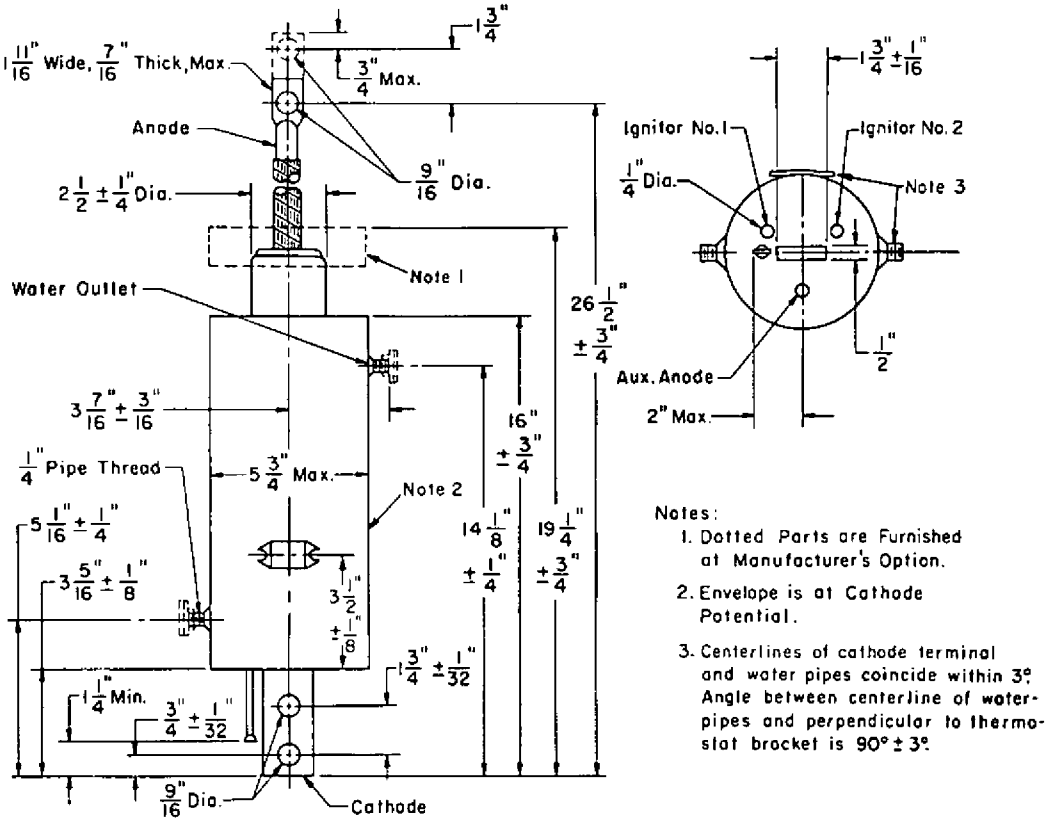


FIGURE 15



Notes:

1. Dotted Parts are Furnished at Manufacturer's Option.
2. Envelope is at Cathode Potential.
3. Centerlines of cathode terminal and water pipes coincide within 3°. Angle between centerline of water-pipes and perpendicular to thermostat bracket is 90° ± 3°.

FIGURE 16

The information contained herein is supplied without assuming responsibility for infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of Westinghouse Electric Corporation.

July 15, 1950

WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5599

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Oil	
Maximum oil temperature	200	°F
Focal Spot Size		
Projected length	2.1	mm
Width	2.1	mm
Outline drawing number	5599	
Mounting position	Any	

MAXIMUM RATINGS

Heat capacity	150,000	*Heat units
Continuous rating	25,000	Heat units per minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)**	continuous	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	125	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second	39	44	-	34	Milliamps

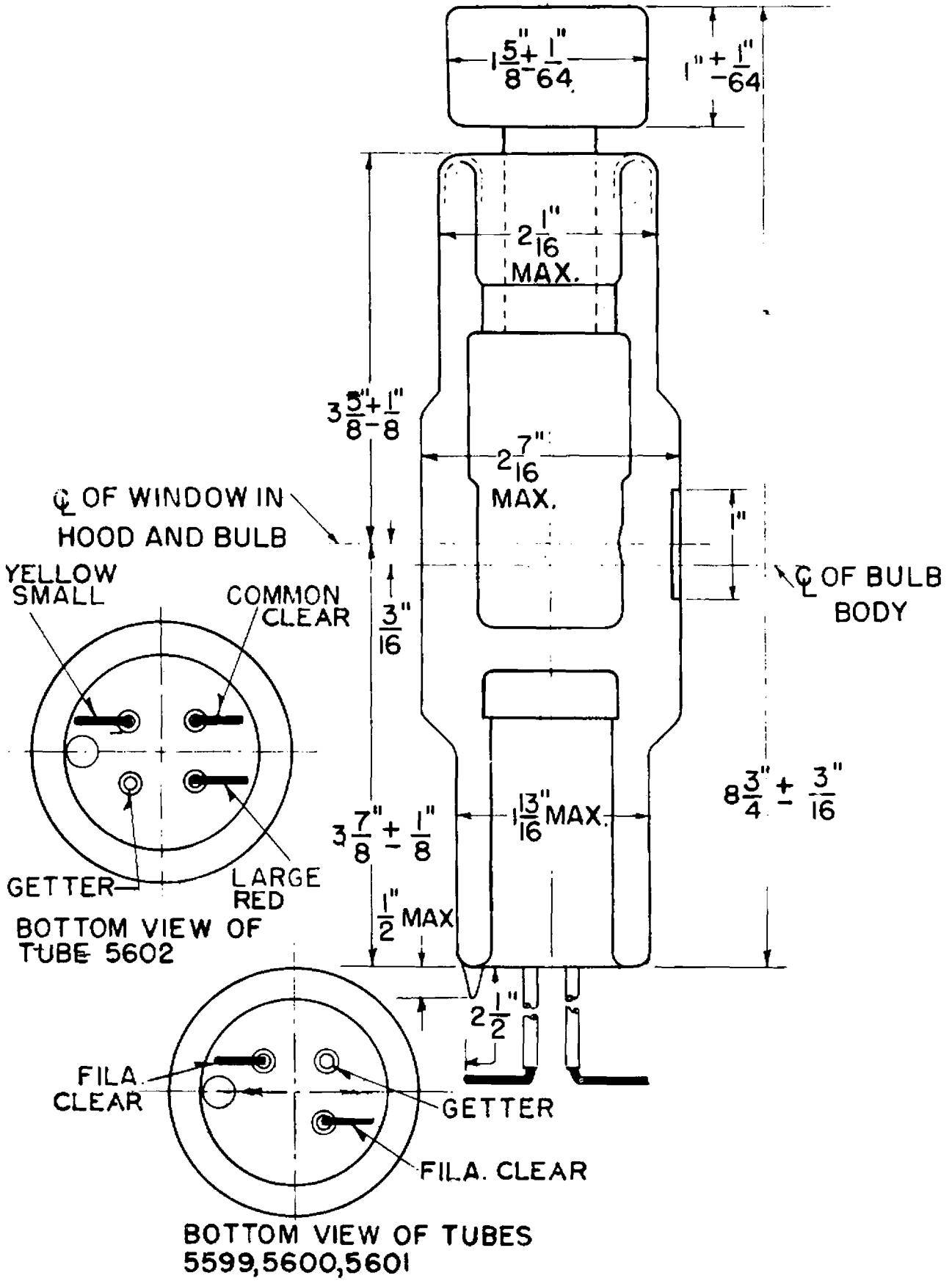
Table of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

Time	125 KV Peak Full Wave	100 KV Peak Half Wave	90 KVP Useful Self-rectified
0.1 Sec.	4580	4170	2940
1 "	3620	3410	2570
5 "	2950	2875	2310
30 "	2140	2200	1925

*Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE OUTLINES
TYPES 5599, 5600, 5601, & 5602



WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5600

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Oil	
Maximum oil temperature	200	°F
Focal spot size		
Projected length	3.0	mm
Width	3.0	mm
Outline drawing number	5600	
Mounting position	Any	

MAXIMUM RATINGS

Heat capacity	150,000	*Heat units
Continuous rating	25,000	Heat units per minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)**	continuous	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	125	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second	72	79	-	58	Milliamps.

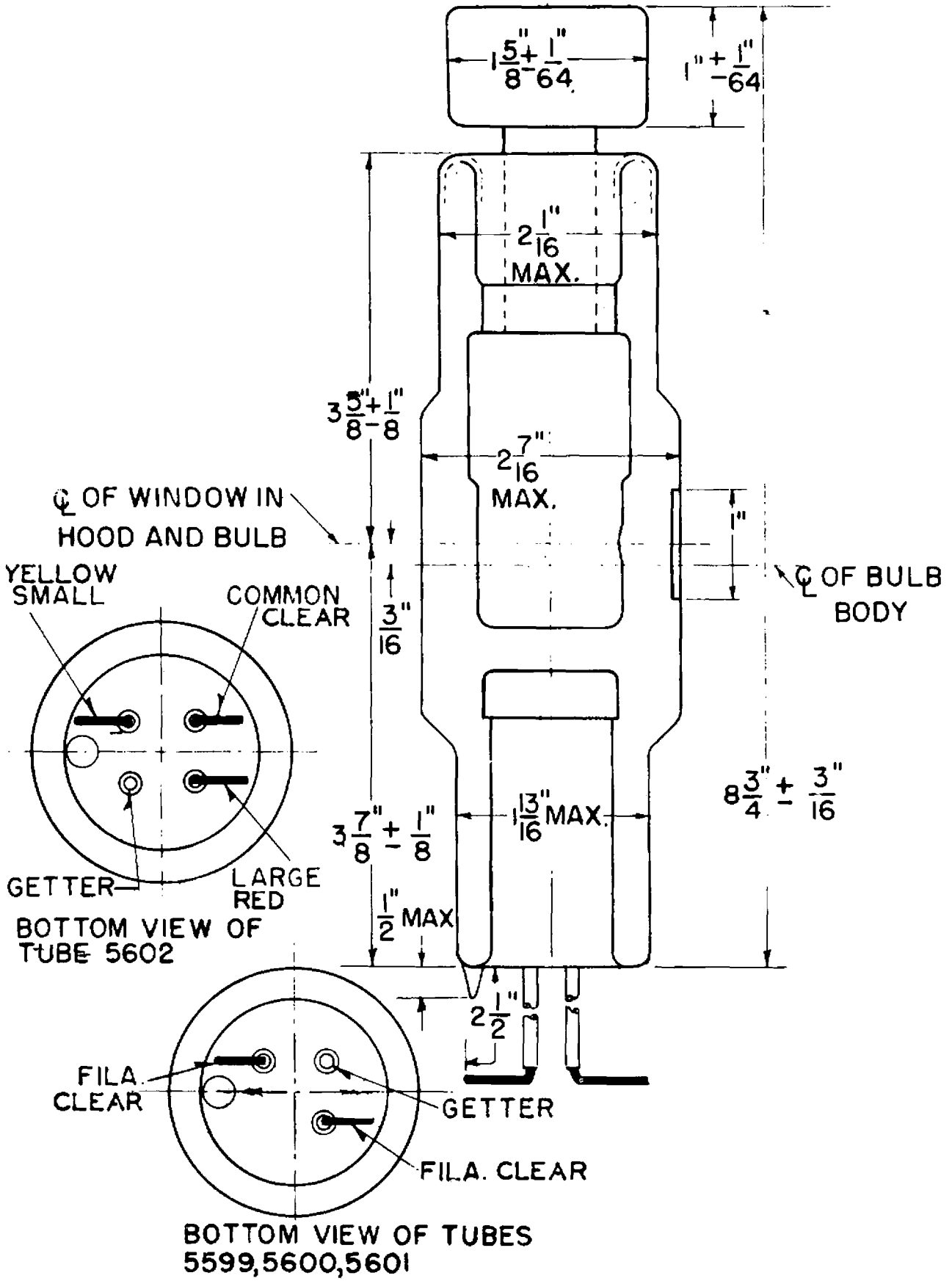
Table of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

Time	125 KV Peak Full Wave	100 KV Peak Half Wave	90 KVP Useful Self-rectified
0.1 Sec.	7970	7440	4960
1 "	5750	5915	4150
5 "	4460	4850	3590
30 "	2550	3330	2760

*Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE OUTLINES
TYPES 5599, 5600, 5601, & 5602



WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5601

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Oil	
Maximum oil temperature	200	°F
Focal spot size		
Projected length	4.2	mm
Width	4.2	mm
Outline drawing number	5601	
Mounting position	Any	

MAXIMUM RATINGS

Heat capacity	150,000	*Heat units
Continuous rating	25,000	Heat units per minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)**	Continuous	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	125	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second	125	140	-	103	Milliamps.

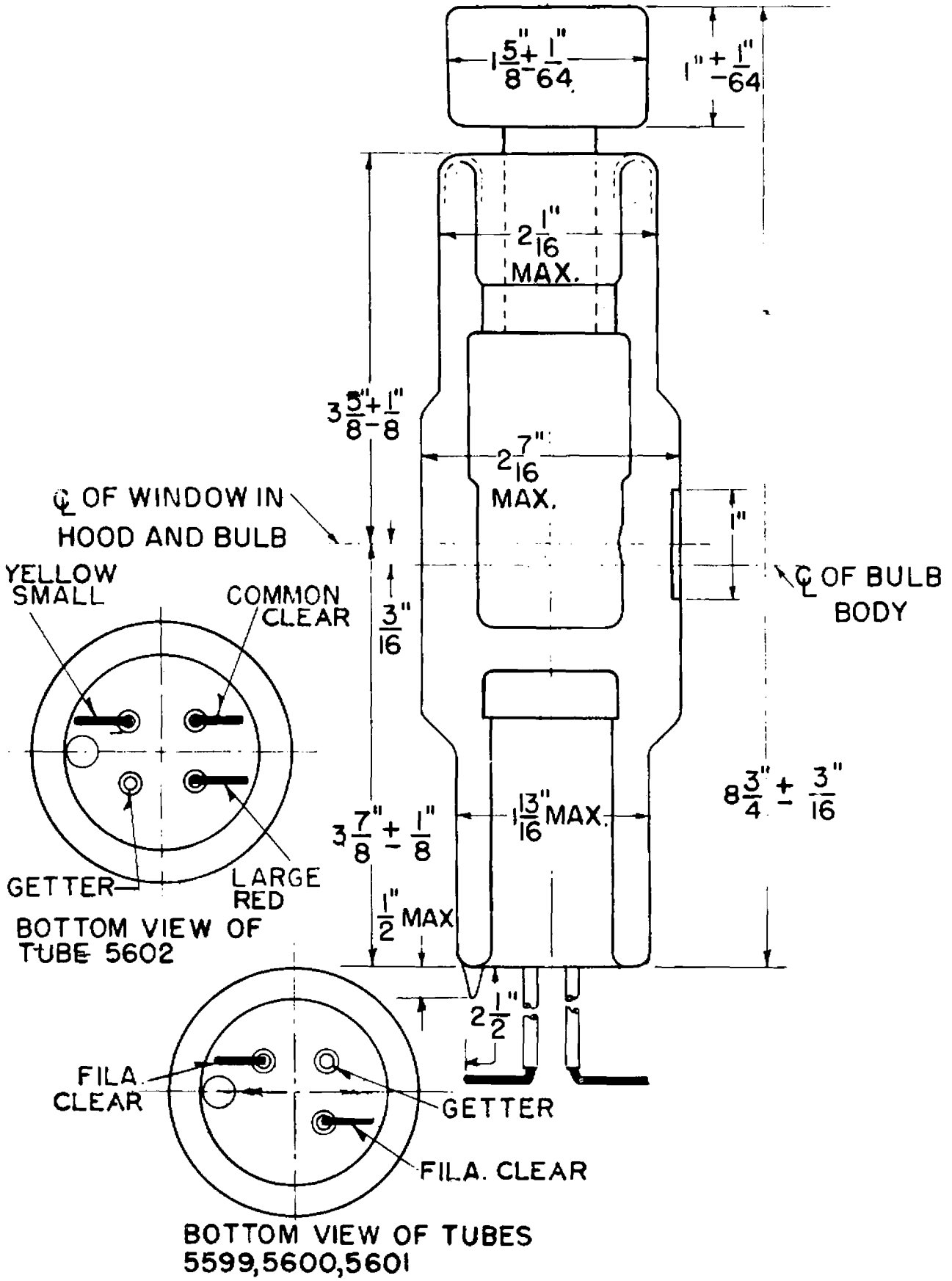
Table of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

Time	125 KV Peak Full Wave	100 KV Peak Half Wave	90 KVP Useful Self-rectified
0.1 Sec.	13700	13000	8740
1 Sec.	8900	9650	6870
5 Sec.	6090	7300	5560
30 Sec.	2550	3400	3400

*Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE OUTLINES
TYPES 5599, 5600, 5601, & 5602



WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5602

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Oil	
Maximum oil temperature	200	°F
Focal Spot Sizes (Superimposed)		
Projected length	2.1 and 4.2	mm
Width	2.1 and 4.2	mm
Outline drawing number	5602	
Mounting position	Any	

MAXIMUM RATINGS

Heat capacity	150,000	*Heat units
Continuous rating	25,000	Heat units/minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)	Continuous	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	125	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second for 2.1 mm spot	39	44	-	34	Milliamps
Value of dc average current at maximum voltage rating for 1/20 second for 4.2 mm spot	125	139	-	103	Milliamps.

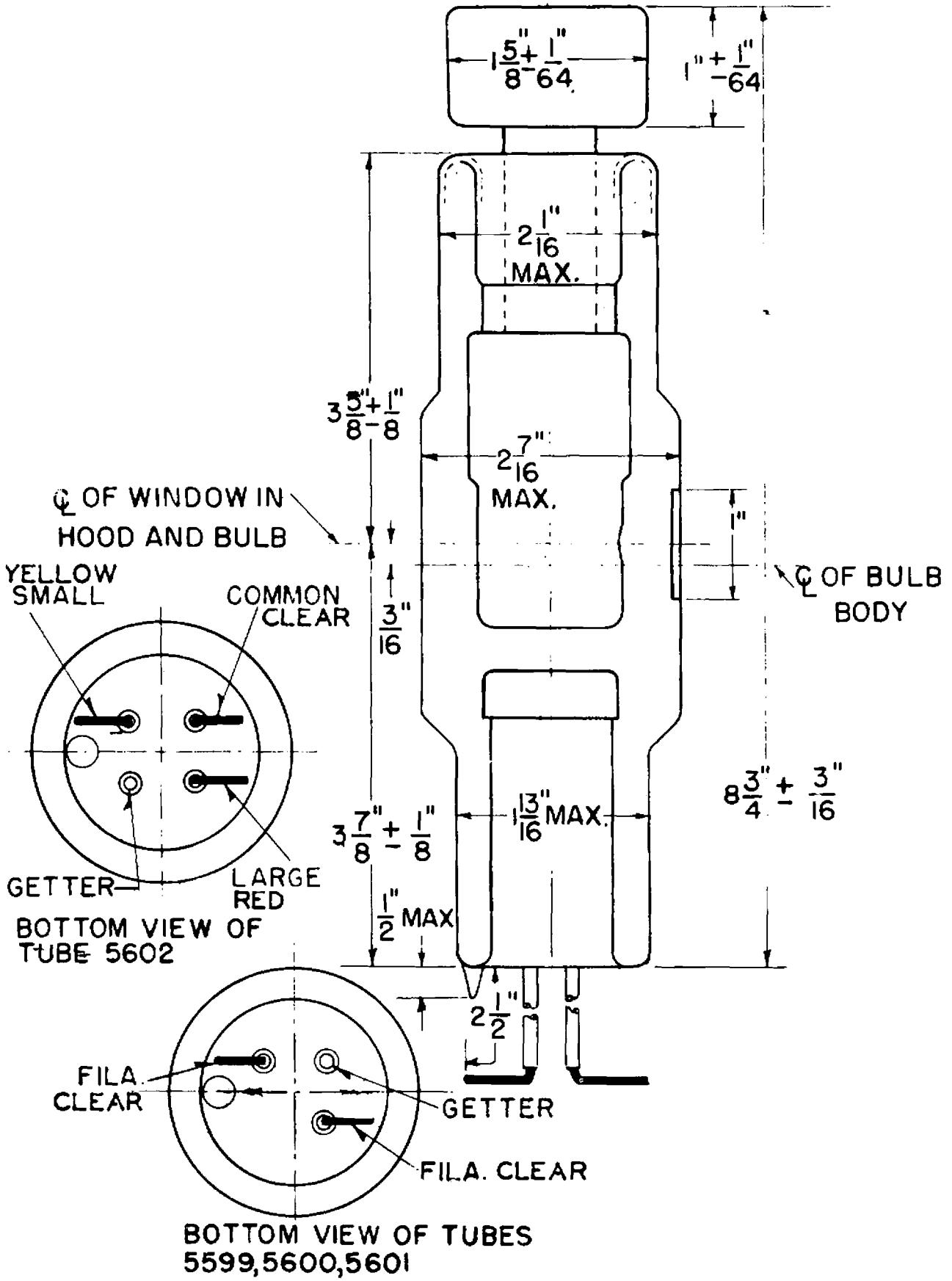
Table of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

	2.1 mm spot size			4.2 mm spot size		
Time	125 KVP Full Wave	100 KVP Half Wave	90 KVP Useful Self-rectified	125 KVP Full Wave	100 KVP Half Wave	90 KVP Useful Self-rectified
0.1 Sec.	4580	4170	2940	13700	13000	8740
1 Sec.	3620	3410	2570	8900	9650	6870
5 Sec.	2950	2875	2310	6090	7300	5560
30 Sec.	2140	2200	1925	2550	3400	3400

*Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

** Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE OUTLINES
TYPES 5599, 5600, 5601, & 5602



From RMA release #672, June 28, 1948

May 4, 1948

WESTINGHOUSE ELECTRIC CORPORATION

[redacted]-5705

The [redacted]-5705 is a three-electrode tube designed for use as a modulator, amplifier and oscillator. The anode is water-cooled and capable of dissipating 10 kilowatts. The cathode is a pure tungsten filament. Maximum ratings apply up to 30 megacycles.

GENERAL

Electrical Data	Minimum	Bogey	Maximum	
Filament Voltage	-	22	23	Volts
Filament Current at Bogey Voltage	57	60	62	Amps.
Filament Starting Current	-	-	120	Amps.
Filament Cold Resistance	-	0.031	-	Ohms
Amplification Factor:				
E_c = -50 Volts, I_b = 0.75 Amps.	42.5	50.0	57.5	
Interelectrode Capacitances:				
Grid-Plate	27	30	33	uuf
Grid-Filament	15	20	24	uuf
Plate-Filament	0.5	1.5	2.5	uuf

Mechanical Data

Mounting Position - Vertical, Anode Down				
Type of Cooling - Water				
Water Flow on Anode		-	8	GPM
Maximum Outgoing Water Temperature	-	-	70	°C
Maximum Glass Temperature	-	-	150	°C
Net Weight, Approximate			3-1/2	Pounds

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR - CLASS B

Maximum Ratings, Absolute Values	CCS°	
D-C Plate Voltage	15,000	Volts Max.
Maximum Signal D-C Plate Current ♯	2.0	Amps. Max.
Maximum Signal Plate Input ♯	20,000	Watts Max.
Plate Dissipation ♯	7,500	Watts Max.

Typical Operation (Unless Otherwise Specified, Values are For Two Tubes)	CCS°	CCS°	CCS°	
D-C Plate Voltage	6,000	10,000	12,500	Volts
D-C Grid Voltage	0.0	-90	-170	Volts
Peak A-F Grid-to-Grid Voltage	1,000	1,380	1,370	Volts
Zero Signal D-C Plate Current	0.5	0.5	0.4	Amps.
Maximum Signal D-C Plate Current	2.6	3.3	2.8	Amps.
Effective Load Resistance, Plate-to-Plate	4,200	6,400	10,000	Ohms
Maximum Signal Driving Power, Approximate	135	240	160	Watts
Maximum Signal Power Output, Approximate	6,000	20,000	22,000	Watts

°Continuous Commercial Service.
♯Averaged over any audio-frequency cycle of sine-wave form.

RADIO-FREQUENCY POWER AMPLIFIER - CLASS B
(Carrier Conditions For Tube For Use With A Maximum Modulation Factor of 1.0)

Maximum Ratings, Absolute Values	CCS°	
D-C Plate Voltage	15,000	Volts Max.
D-C Plate Current	1.0	Amps. Max.
Plate Input	15,000	Watts Max.
Plate Dissipation	10,000	Watts Max.

Typical Operation	CCS°	CCS°	CCS°	
D-C Plate Voltage	6,000	10,000	14,000	Volts
D-C Grid Voltage	-	-100	-190	Volts
Peak R-F Grid Voltage	230	370	440	Volts
D-C Plate Current	0.640	0.77	0.82	Amps.
D-C Grid Current, Approximate	0.030	0.060	0.03	Amps.
Driving Power, Approximate //	77	133	106	Watts
Power Output, Approximate	1,000	2,500	4,000	Watts

°Continuous Commercial Service.
//At crest of audio-frequency cycle with modulation factor of 1.0

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER - CLASS C TELEPHONY
(Carrier Conditions Per Tube For Use With A Maximum Modulation Factor of 1.0)

Maximum Ratings, Absolute Values	CCS°	
D-C Plate Voltage	10,000	Volts Max.
D-C Grid Voltage	-2,000	Volts Max.
D-C Plate Current	1.0	Amps. Max.
D-C Grid Current	0.3	Amps. Max.
Plate Input	10,000	Watts Max.
Plate Dissipation	~~6,000~~ 6600	Watts Max.

Typical Operation	CCS°	CCS°	CCS°	
D-C Plate Voltage	6,000	8,000	10,000	Volts
D-C Grid Voltage	-1,000	-1,300	-1,600	Volts
Peak R-F Grid Voltage	1,650	1,950	2,250	Volts
D-C Plate Current	0.83	0.82	0.78	Amps.
D-C Grid Current, Approximate	0.28	0.24	0.23	Amps.
Driving Power, Approximate	420	430	460	Watts
Power Output, Approximate	3,500	5,000	6,000	Watts

°Continuous Commercial Service.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY
(Key-Down Conditions Per Tube Without Amplitude Modulation) //

Maximum Ratings, Absolute Values	CCS°	
D-C Plate Voltage	15,000	Volts Max.
D-C Grid Voltage	-2,000	Volts Max.
D-C Plate Current	2.0	Amps. Max.
D-C Grid Current	0.4	Amps. Max.
Plate Input	30,000	Watts Max.
Plate Dissipation	10,000	Watts Max.

Typical Operation	CCS°	CCS°	CCS°	
D-C Plate Voltage	8,000	10,000	12,000	Volts
D-C Grid Voltage	-1,000	-1,300	-1,600	Volts
Peak R-F Grid Voltage	1,700	2,150	2,550	Volts
D-C Plate Current	1.17	1.4	1.55	Amps.
D-C Grid Current, Approximate	0.22	0.24	0.23	Amps.
Driving Power, Approximate	330	495	565	Watts
Power Output, Approximate	6,500	10,000	14,000	Watts

°Continuous Commercial Service.
//Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

Maximum ratings apply up to 30 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

Frequency	30	55	110	Mcs.
Percentage of Maximum Rated Plate Voltage and Plate Input:				
Class B	100	85	75	%
Class C Plate Modulated	100	85	75	%
Class C Unmodulated	100	75	50	%

ELECTRICAL DATA

Characteristics:	Conditions:		Equipment Design Limits: Min.	Bogey	Max.
Grid Voltage	E_b = 1.5 KV, I_b = 6.0 Amps.	e_c:	-	-	925 Volts
Grid Current	E_b = 1500 Volts, I_b = 6.0 Amps.	i_c:	-	-	1.75 Amps.
Plate Voltage	E_c = 0, E_b set so that I_b = 0.75 Amps. D-C	E_b:	7.5	9.25	11.0 KV DC
Plate Voltage	E_c = -100, E_b set so that I_b = 0.75 Amps. D-C	E_b:	12.0	14.25	16.5 KV DC
Grid Voltage	E_b = 15 KV D-C, E_c set so that I_b = 20 Ma. D-C	E_c:	-240	-320	-400 V D-C
Peak Cathode Current: Represents maximum useable cathode current for tube as plate current plus grid current for any condition of operation.		$i_{k(p)}$:	9.0	-	- Amps.
Power Output:	E_b = 15 KV D-C, I_b = 2.0 Amps D-C I_c = .250 Amps. D-C, R_g = 5,000 Ohms	P_o:	20	-	- KW

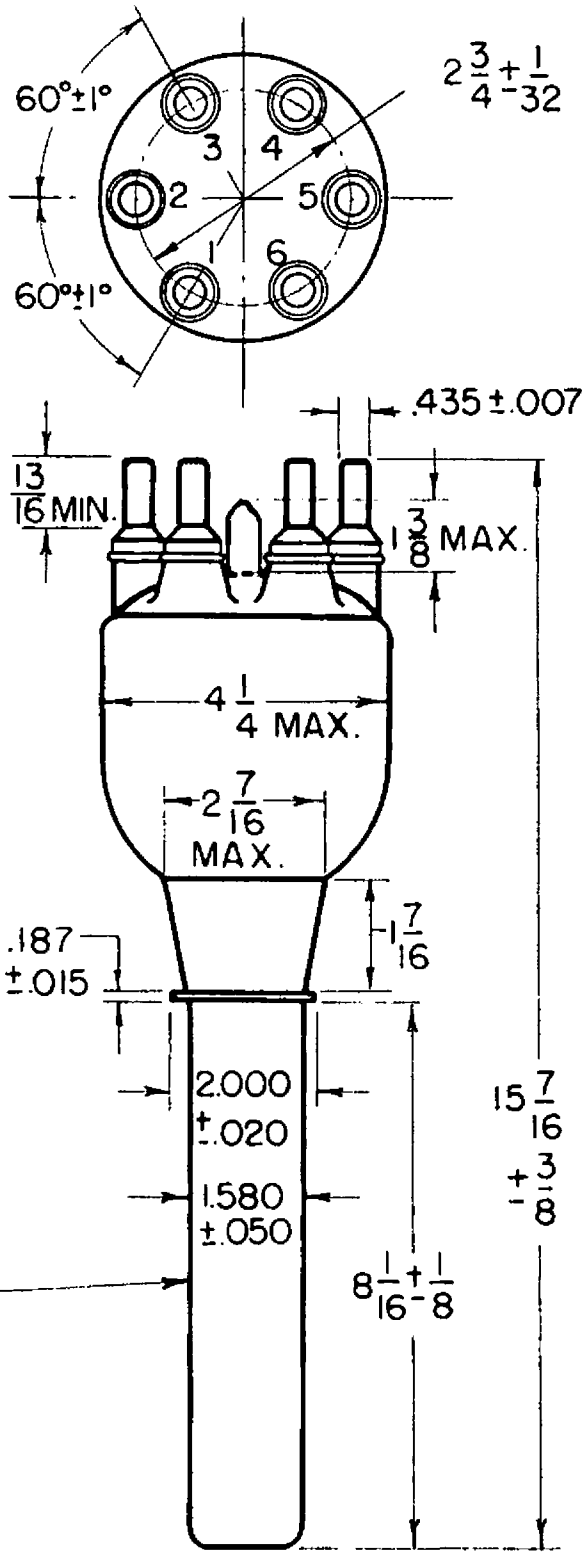
WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT.

COMMERCIAL OUTLINE

60046 A

A | DRN. J.L. | CHKD.

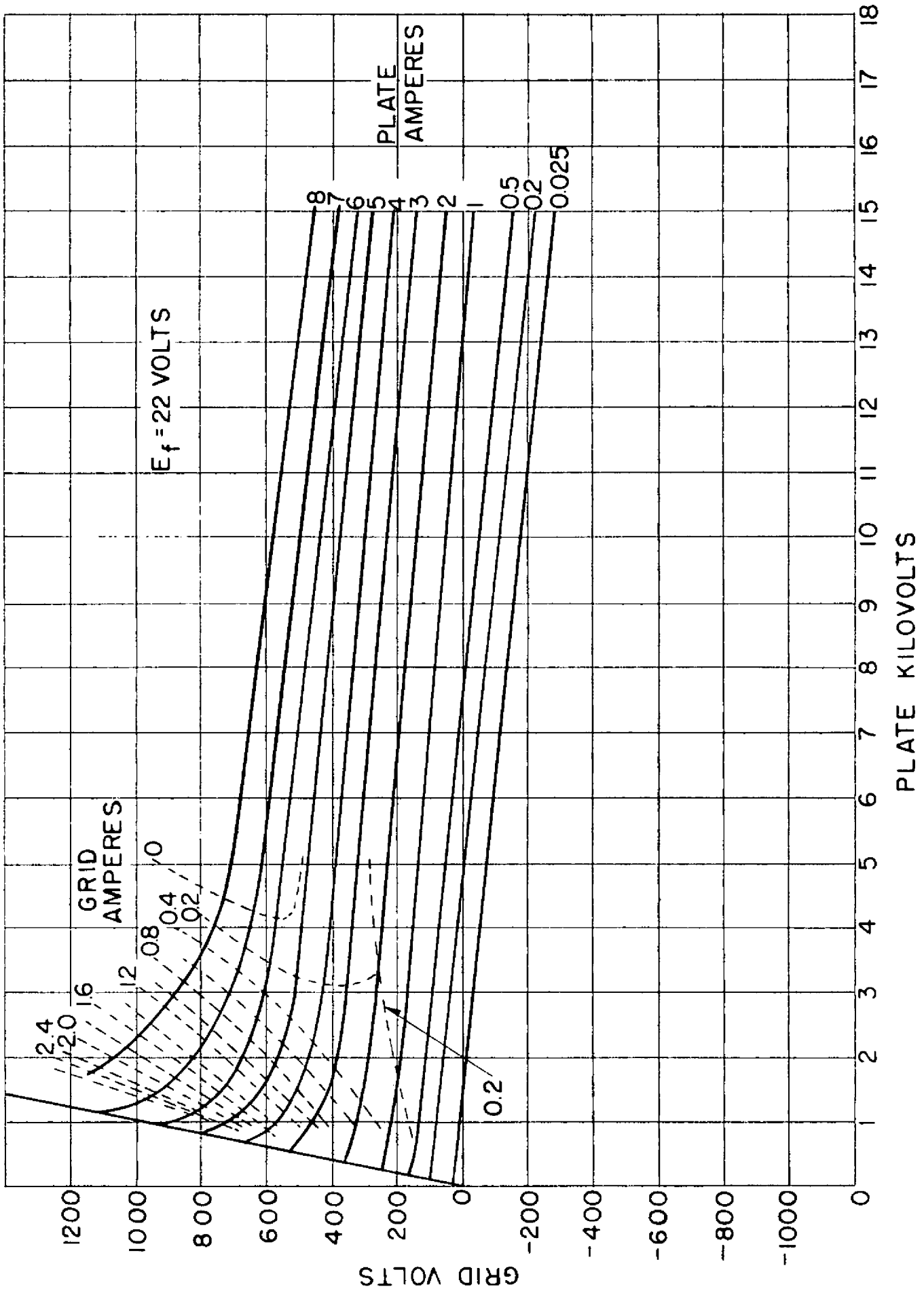
5705.



ALL DIMS. IN INCHES
FRACTIONS ±
DECIMALS ±
} UNLESS OTHERWISE SPECIFIED

* INDICATES A CHANGE

SCALE


PLATE AMPERES
8
7
6
5
4
3
2
1
0.5
0.2
0.025
E_f = 22 VOLTS
GRID AMPERES
2.4
2.0
1.6
1.2
0.8
0.4
0.2
0
0.2
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
GRID VOLTS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
PLATE KILOVOLTS

WESTINGHOUSE ELECTRIC CORPORATION

Superficial Therapy X-Ray Tube Data

Electron Tube Type 5711

The 5711 tube is an oil-cooled x-ray tube designed for superficial therapy service.

GENERAL

Electrical Data		
Filament current range	3.5 to 4.7	Amperes
Filament voltage range	3.0 to 6.0	Volts
Mechanical Data		
Type of cooling	Forced oil	
Focal spot size		
Target angle	45	Degrees
Projected length	9.5	mm
Width	3.5	mm
Outline drawing number	5711	
Operating position	Any	

MAXIMUM RATINGS

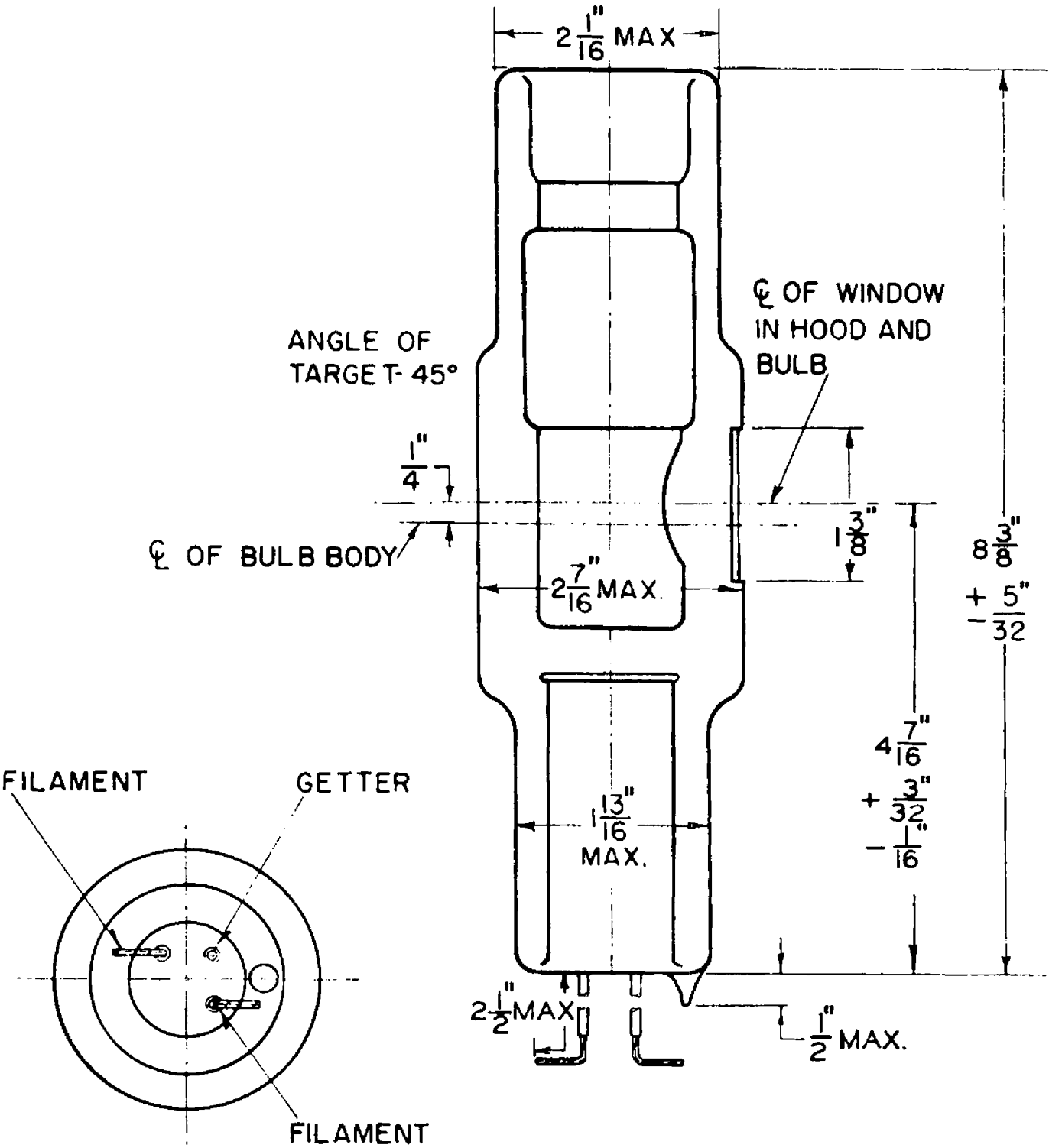
Maximum filament current for continuous operation	4.5	Amperes
Minimum flow of cooling oil	1-1/2	gpm
Maximum cooling oil temperature	122	°F
Maximum voltage on full wave and two valve half wave generators	120	KVP

Maximum voltage on self-rectified generator, 100 KVP Useful, 110 KVP Inverse

Continuous ratings in dc average milliamperes:

Maximum Voltage	Ambient Temp. to 80°F	Ambient Temp. to 90°F	Ambient Temp. to 100°F
120 KVP	15.0 ma	12.5 ma	10 ma
110 KVP	16.4 ma	13.5 ma	11 ma
100 KVP	18.0 ma	15.0 ma	12 ma

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE
TUBE TYPE 5711



WESTINGHOUSE ELECTRIC CORPORATION

Superficial Therapy X-Ray Tube Data

Electron Tube Type 5712

The 5712 tube is a therapy tubehead designed for superficial therapy service. The tubehead contains an oil-cooled insert tube type 5711.

GENERAL

Electrical Data		
Filament current range	3.5 to 4.7	Amperes
Filament voltage range	3.0 to 6.0	Volts
Mechanical Data		
Type of cooling	Forced oil	
Focal spot size		
Target angle	45	Degrees
Projected length	9.5	mm
Width	3.5	mm
Outline drawing number	5712	
Operating position	Any	

MAXIMUM RATINGS

Maximum filament current for continuous operation	4.5	Amperes
Minimum flow of cooling oil	1-1/2	gpm
Maximum cooling oil temperature	122	°F
Oil pressure drop across tubehead, approx.	28	psi
Maximum voltage on full wave and two valve half wave generators	120	KVP
Maximum voltage on self-rectified generator	100	(KVP Useful
	110	(KVP Inverse

Continuous ratings in dc average milliamperes:

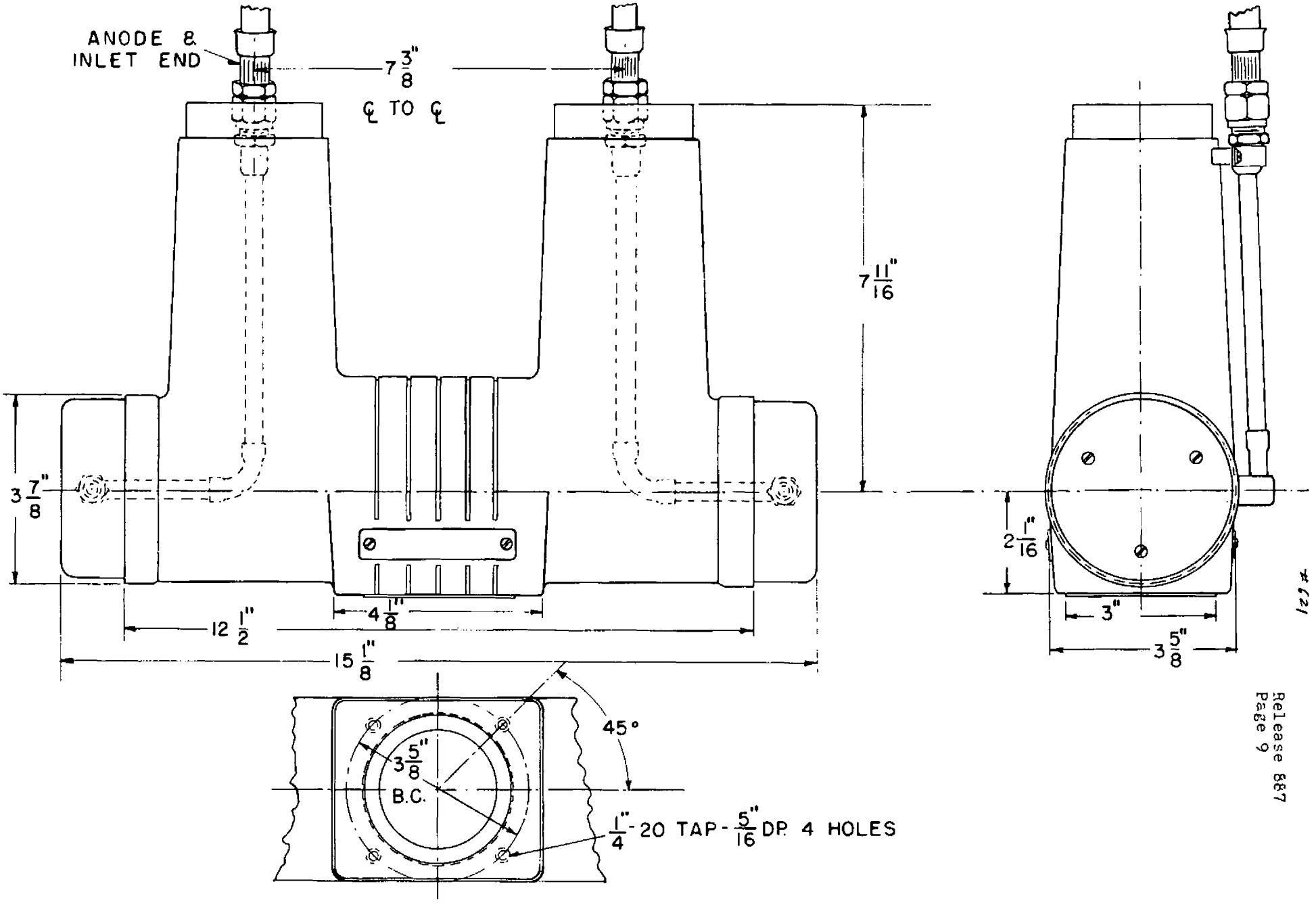
Maximum Voltage	Ambient Temp. to 80°F	Ambient Temp. to 90°F	Ambient Temp. to 100°F
120 KVP	15.0 ma	12.5 ma	10 ma
110 KVP	16.4 ma	13.5 ma	11 ma
100 KVP	18.0 ma	15.0 ma	12 ma

WESTINGHOUSE ELECTRIC CORPORATION

6-28-50

X-RAY TUBE

TUBE TYPE 5712



#121

Release 887
Page 9

4/20/49

WESTINGHOUSE
X-RAY TUBE DATA SHEET
ELECTRON TUBE TYPE 5745.

Westinghouse Developmental Number 594.

GENERAL

Electrical Data		
Filament Current Range	1.6 - 2.5	Amps.
Filament Voltage Range	2.4 - 3.5	Volts
Mechanical Data		
Type of Cooling	Oil	
Focal Spot Size		
Projected Length	1.5	mm.
Width	1.5	mm.
Maximum Overall Length	5	Inches
Outline Drawing Number	600598	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	20,000	*Heat Units
Continuous Rating	15,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 550 (KV x MA)**	1,000	Seconds

	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	75	70	Kilovolts
Value of DC Average Current of Maximum Voltage Rating	-	15	Milliamperes
Allowable Time of Operation Under Above Conditions	-	18	Seconds

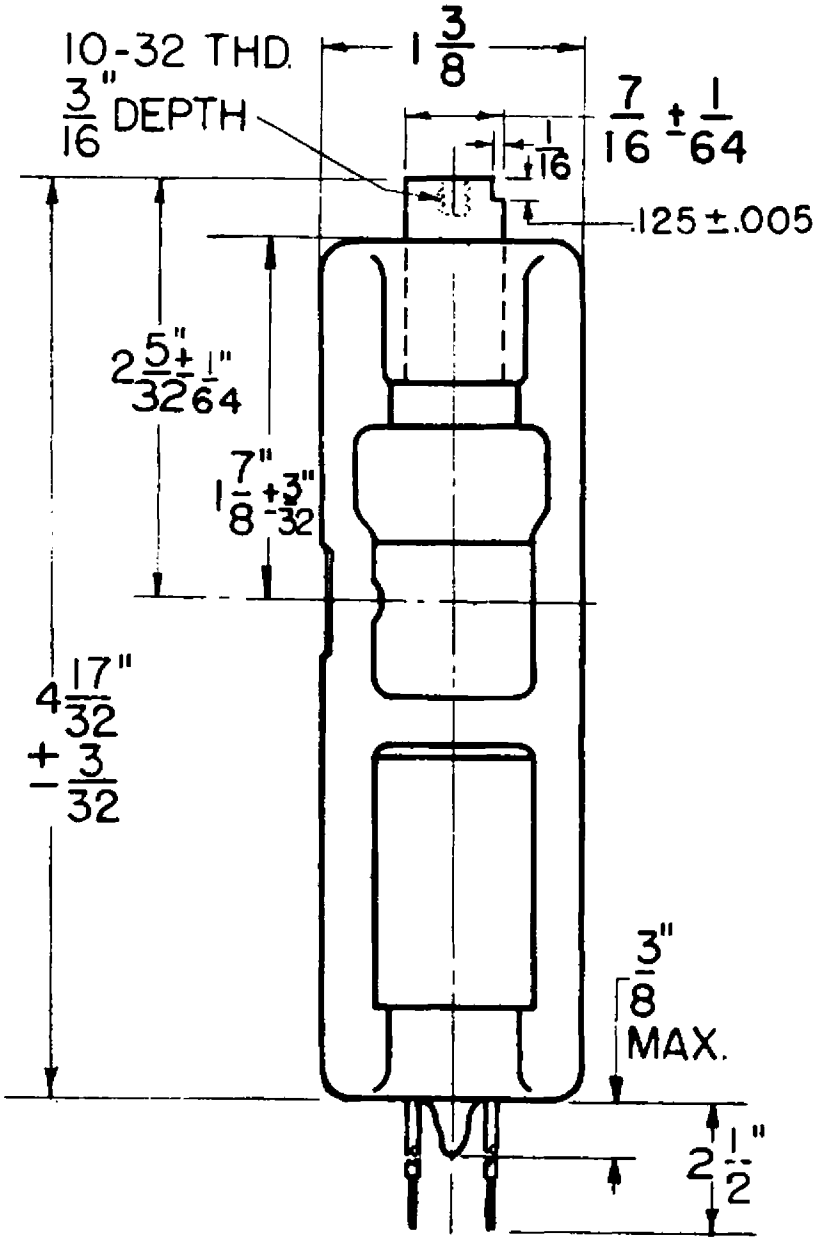
Table of short-time ratings which are given as the product of peak useful KV times DC average milliamperes.

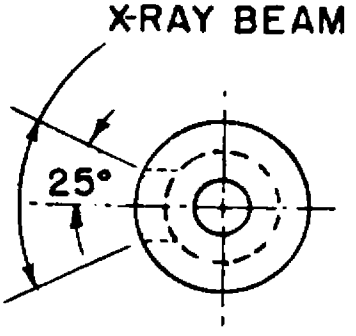
Time	Self-Rectified
20 Seconds	990
50 Seconds	720
100 Seconds	520

* Heat units are defined as the product of the peak voltage in kilovolts, DC average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times DC average MA and is proportional to power.

RMA TYPE 5745, 5746





ANGLE OF TARGET - 20°

4/29/49

WESTINGHOUSE
X-RAY TUBE DATA SHEET
ELECTRON TUBE TYPE 5746.

GENERAL

Electrical Data		
Filament Current Range	1.6 - 2.5	Amps.
Filament Voltage Range	2.4 - 3.5	Volts
Mechanical Data		
Type of Cooling	Oil	
Focal Spot Size		
Projected Length	1.0	mm.
Width	1.0	mm.
Maximum Overall Length	5	Inches
Outline Drawing Number	600688D	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	20,000	*Heat Units
Continuous Rating	15,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 550 (KV x MA)**	1.000	Seconds

	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	75	70	Kilovolts
Value of DC Average Current of Maximum Voltage Rating	-	15	Milliamperes
Allowable Time of Operation Under Above Conditions	-	1	Second

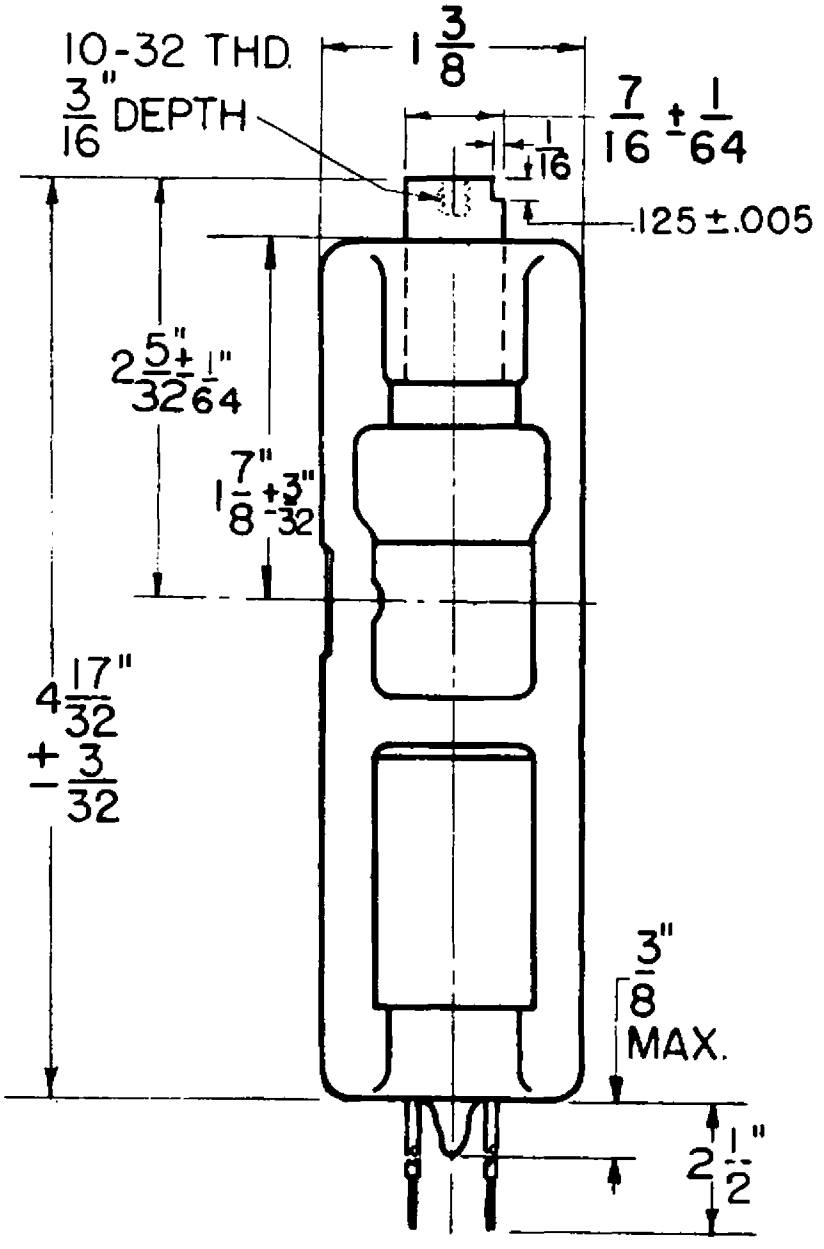
Table of short-time ratings which are given as the product of peak useful KV times DC average milliamperes.

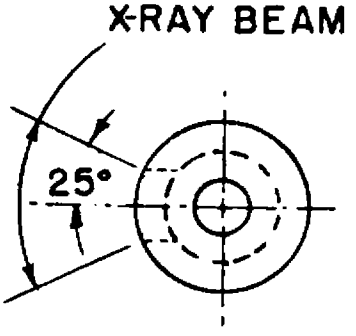
Time	Self-Rectified
1 Second	1050
5 Seconds	970
10 "	870
50 "	710
100 "	525

* Heat units are defined as the product of the peak voltage in kilovolts, DC average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times DC average MA and is proportional to power.

RMA TYPE 5745, 5746





ANGLE OF TARGET - 20°

4/29/49

WESTINGHOUSE
X-RAY TUBE DATA SHEET
ELECTRON TUBE TYPE 5747.

Westinghouse Developmental Number 393.

GENERAL

Electrical Data		
Filament Current Range	1.8 - 2.5	Amps.
Filament Voltage Range	4.2 - 6.5	Volts
Mechanical Data		
Type of Cooling	Oil	
Focal Spot Size		
Projected Length	1.5	mm.
Width	1.5	mm.
Maximum Overall Length	5-21/32	Inches
Outline Drawing Number	600579	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	25,000	*Heat Units
Continuous Rating	21,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 550 (KV x MA)**	Continuous to Heat Capacity of Head	

	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	85	80	Kilovolts
Value of DC Average Current of Maximum Voltage Rating	-	10	Milliamperes
Allowable Time of Operation Under Above Conditions	-	1	Second

Table of short-time ratings which are given as the product of peak useful KV times DC average milliamperes.

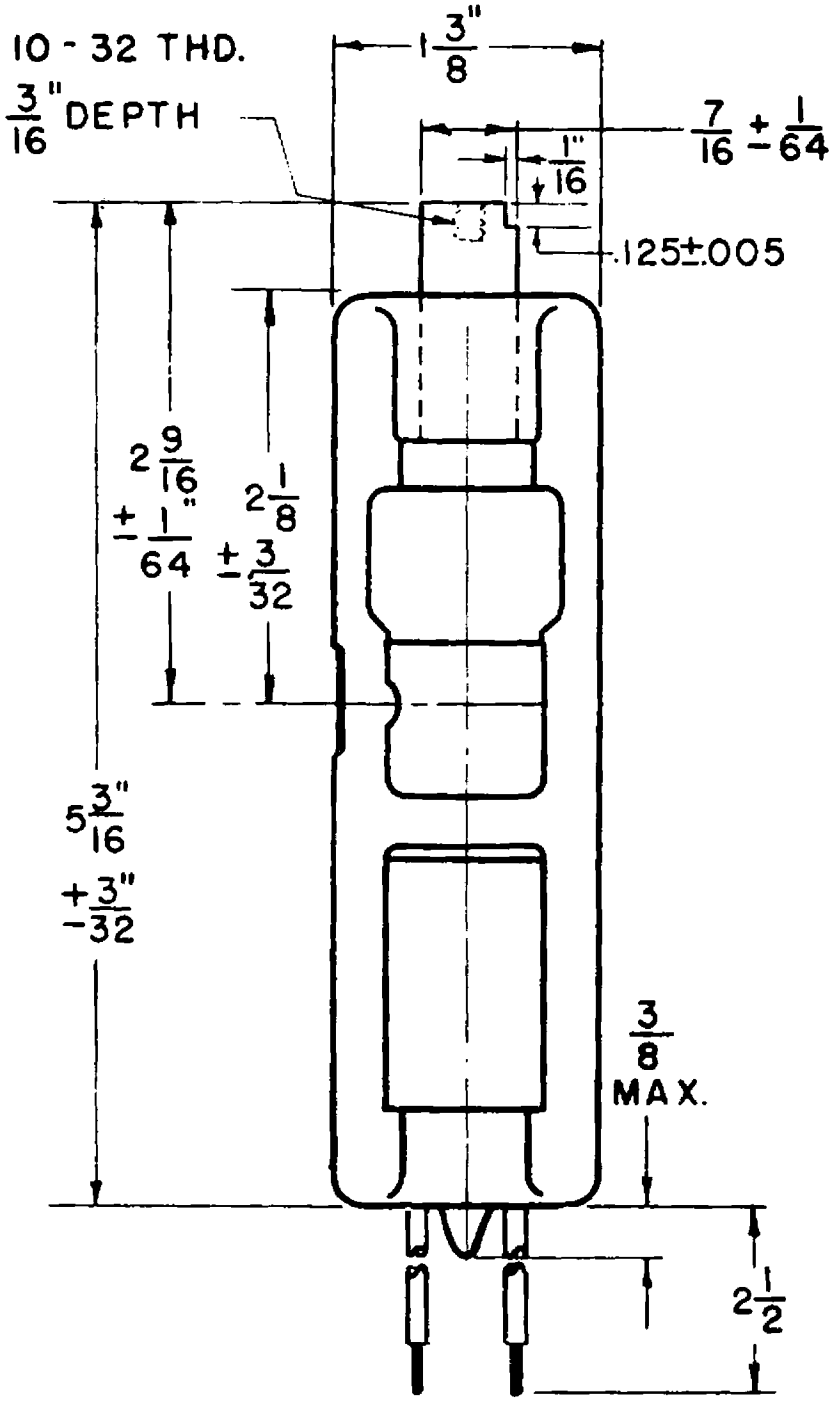
Time	Self-Rectified
1 Second	1520
3 Seconds	1440
10 "	1350
30 "	950
100 "	415

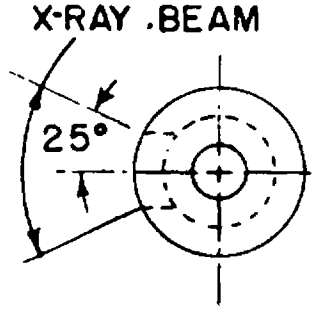
* Heat units are defined as the product of the peak voltage in kilovolts, DC average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times DC average MA and is proportional to power.

from RMA release #755, May 5, 1949

RMA TYPE 5747,5748





ANGLE OF TARGET-20°

4/20/49

WESTINGHOUSE
X-RAY TUBE DATA SHEET
ELECTRON TUBE TYPE 5748.

GENERAL

Electrical Data		
Filament Current Range	1.8 - 2.5	Amps.
Filament Voltage Range	4.2 - 6.5	Volts
Mechanical Data		
Type of Cooling	Oil	
Focal Spot Size		
Projected Length	1.0	mm.
Width	1.0	mm.
Maximum Overall Length	5-21/32	Inches
Outline Drawing Number	600870	
Mounting Position	Any	

MAXIMUM RATINGS

Heat Capacity	25,000	*Heat Units
Continuous Rating	21,000	Heat Units Per Minute
Maximum Fluoroscopic Rating at a Loading of 350 (KV x MA)**	Continuous to Heat Capacity of Head	

	Self-Rectified Inverse	Self-Rectified Useful	Units
Peak Plate Voltage	85	80	Kilovolts
Value of DC Average Current of Maximum Voltage Rating	-	19	Milliamperes
Allowable Time of Operation Under Above Conditions	-	1	Second

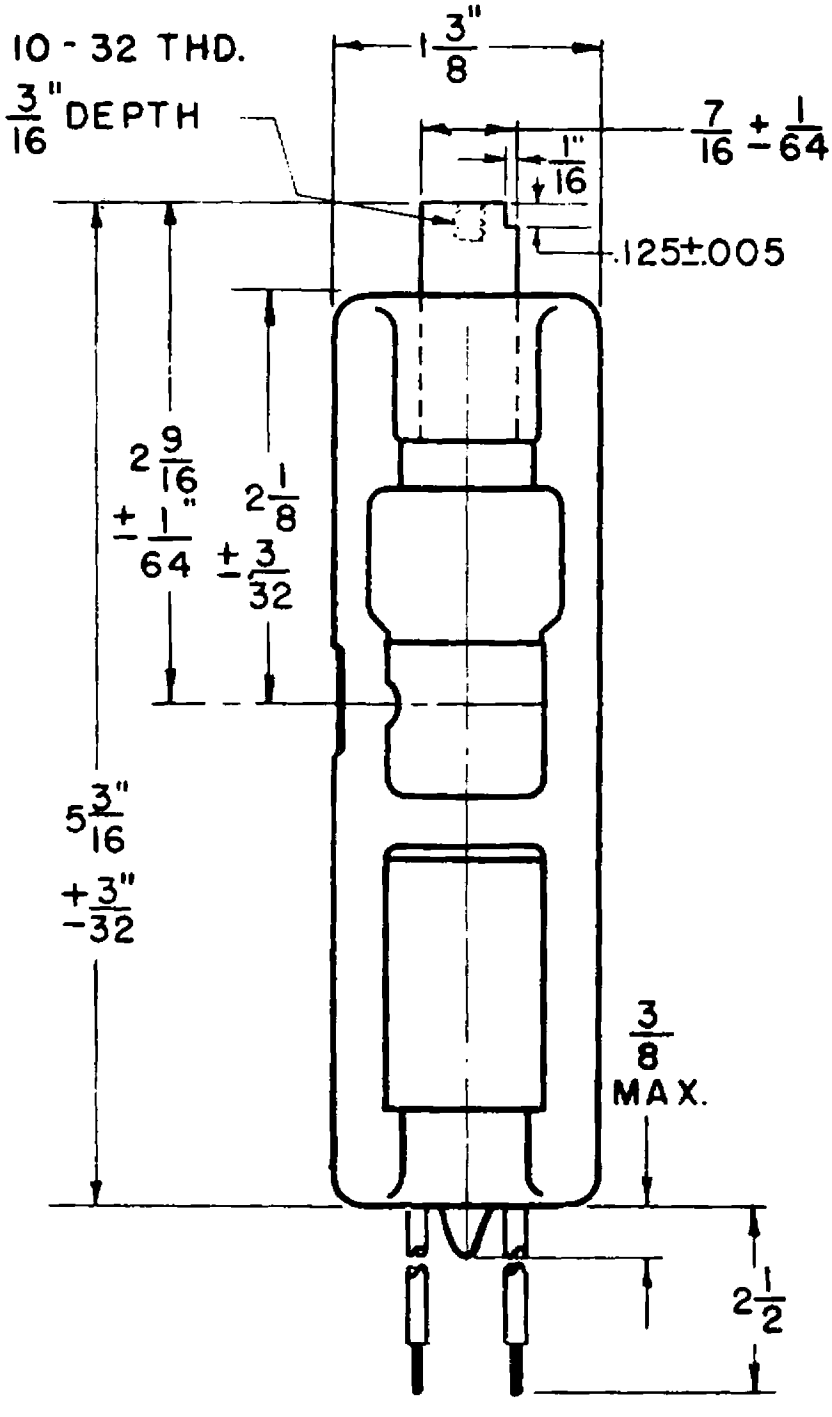
Table of short-time ratings which are given as the product of peak useful KV times DC average milliamperes.

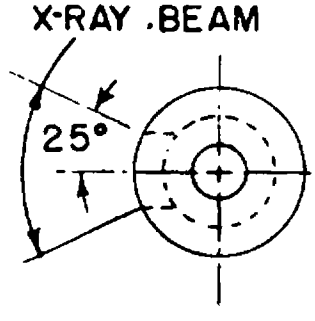
Time	Self-Rectified
1 Second	1050
3 Seconds	970
10 "	870
30 "	780
100 "	415

* Heat units are defined as the product of the peak voltage in kilovolts, DC average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**KV x MA is defined as the product of peak KV times DC average MA. and is proportional to power.

RMA TYPE 5747,5748





ANGLE OF TARGET-20°

WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5781

The 5781 tube is a removable insert x-ray tube designed for regular duty service.

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Air	
Focal spot size		
Projected length	1.5	mm
Width	1.5	mm
Outline drawing number	5781	
Mounting position	Any	

MAXIMUM RATINGS

Heat Capacity	150,000	*Heat units
Continuous rating	12,000	Heat units per minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)**	10	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second	37	24.5	-	19.5	Milliamps.

Table of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	3480	2350	1700
1 "	2770	2025	1520
5 "	2270	1800	1400
30 "	1690	1500	1250

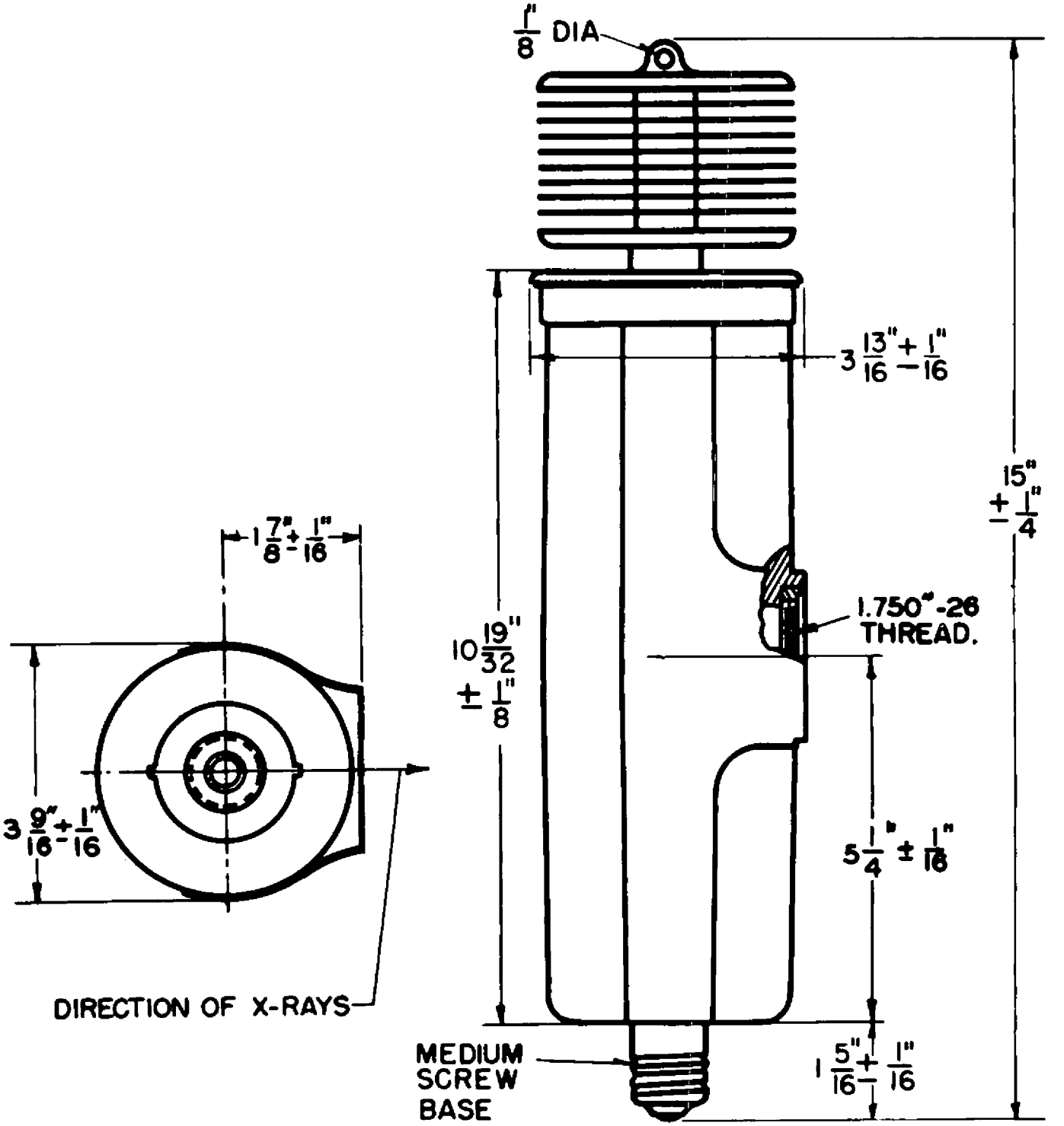
*Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE

TUBE TYPE 5781



WESTINGHOUSE ELECTRIC CORPORATION

X-RAY TUBE DATA SHEET

Electron Tube Type 5782

The 5782 tube is a removable insert x-ray tube designed for heavy duty service.

GENERAL

Electrical Data		
Filament current range	3.5 to 5.5	Amperes
Filament voltage range	3.5 to 10	Volts
Mechanical Data		
Type of cooling	Air	
Focal spot size		
Projected length	1.5	mm
Width	1.5	mm
Outline drawing number	5782	
Mounting position	Any	

MAXIMUM RATINGS

Heat capacity	270,000	*Heat units
Continuous rating	15,000	Heat units per minute
Maximum fluoroscopic rating at a loading of 425 (kv x ma)**	20	Minutes

	Full Wave	Half Wave	Self-rectified Inverse	Self-rectified Useful	Units
Peak plate voltage	100	100	100	90	Kilovolts
Value of dc average current at maximum voltage rating for 1/20 second	37	24.5		19.5	Milliamps.

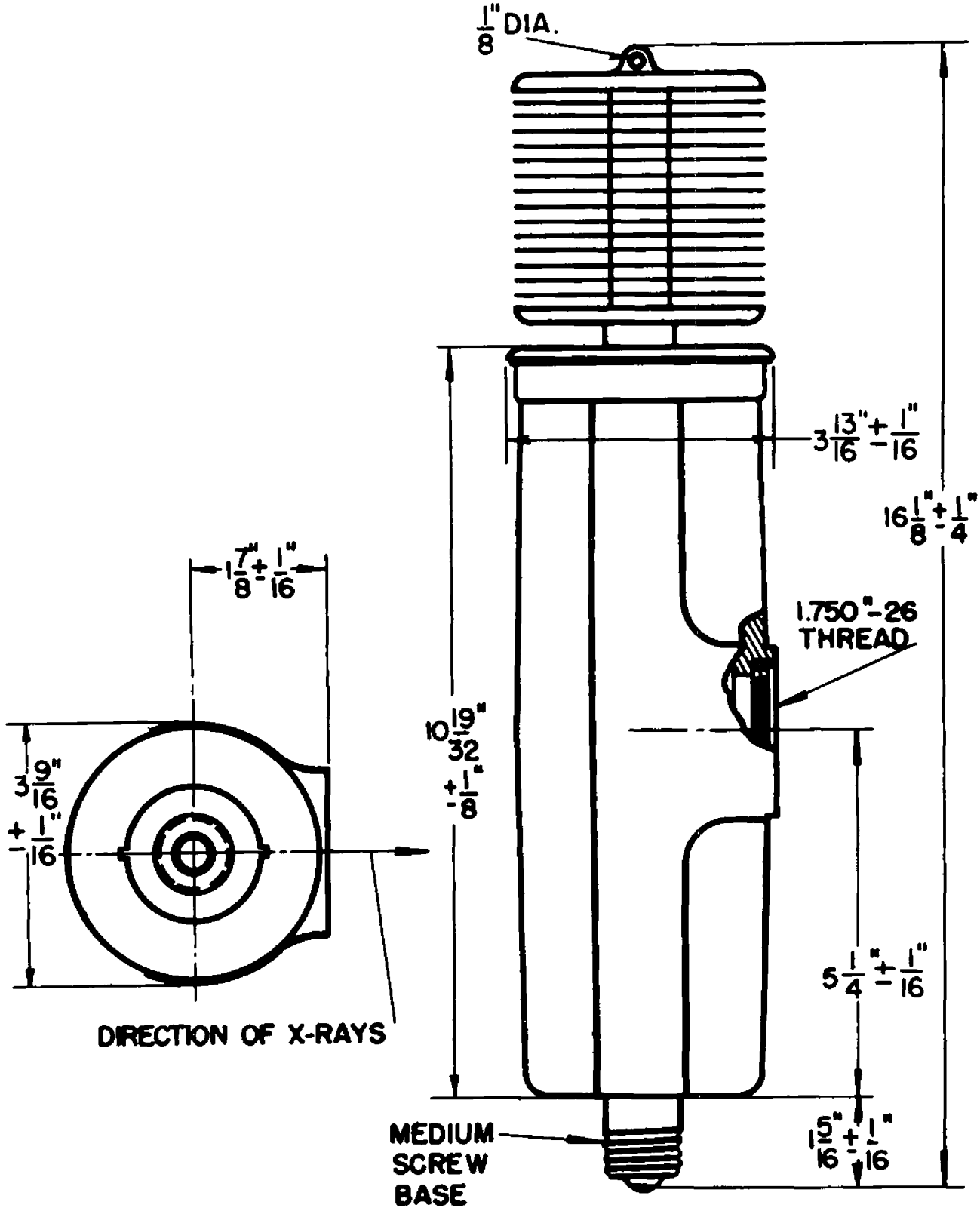
Teble of short-time ratings which are given as the product of peak kv useful times dc average milliamperes.

Time	Full Wave	Half Wave	Self-rectified
0.1 Sec.	3480	2350	1700
1 "	2770	2025	1520
5 "	2270	1800	1400
30 "	1700	1520	1250

* Heat units are defined as the product of the peak voltage in kilovolts, dc average current in milliamperes, and the exposure time in seconds, and is proportional to energy.

**Kv x ma is defined as the product of peak kv times dc average ma and is proportional to power.

WESTINGHOUSE ELECTRIC CORPORATION
X-RAY TUBE
TUBE TYPE 5782



Sponsor:
Westinghouse Electric Corp.

Release No. 787
September 28, 1949

POOL TUBE DATA SHEET

TYPE NO. 5821

Type of Pool Tube Ignitron

Principle Use Frequency Changer Resistance Welding Control

Description: The 5821 ignitron is a sealed, stainless steel jacketed, water-cooled, mercury pool tube designed primarily for control of frequency changer resistance welders. The tube contains baffles needed for good performance in this application. The ignitor is adapted to intermittent service.

ELECTRICAL DATA GENERAL

Type Cathode Excitation	Cyclic	
Type Cathode Spot Starting	Ignitor	
Number of Electrodes		
Main Anodes	1	
Main Cathodes	1	
Ignitors	1	
Arc Drop at 900 Peak Amperes	25	Volts
Cathode Excitation Requirements:		
Ignitor Voltage Required to Fire	200	Volts
Ignitor Current Required to Fire	30	Amps.
Starting Time at Required Voltage or Current	100	Microseconds

MECHANICAL DATA GENERAL

Envelope Material	Metal	
Overall Length	23-3/4	Max. Inches
Overall Width exclusive of water connections	2-3/4	Max. Inches
Net Weight (See outline drawing for details)	3.6	Lbs.
Type Cooling	Water	
Water Temperature Rise	4	°C Max.
Pressure Drop	1.8	Lbs./Sq.In. Max.

MAXIMUM RATINGS

Maximum Peak Anode Voltage			
Inverse	1200	1500	Volts
Forward	1200	1500	Volts
Maximum Peak Anode Current (1)	900	720	Amps.
Corresponding Average Anode Current (1)	9.0	7.2	Amps.

MAXIMUM RATINGS (Continued)

Maximum Average Anode Current (1)	37.5	30	Amps.
Corresponding Peak Anode Current (1)	225	180	Amps.
Maximum Averaging Time	8.3	8.3	Seconds
I_{av}/I_{peak} (Max. Averaging time 0.2 sec.)	.166	.166	Max.
I_{fault}/I_{peak}	12.5	12.5	Max.
Maximum Duration of Fault Current	0.15	0.15	Sec.
Frequency	60	60	Cps

Note 1 - Straight line interpolation on log-log paper is allowed between corresponding points. These ratings are on the basis of operation at no phase retard. At any value of phase retard all current ratings are reduced in direct proportion to the average output voltage.

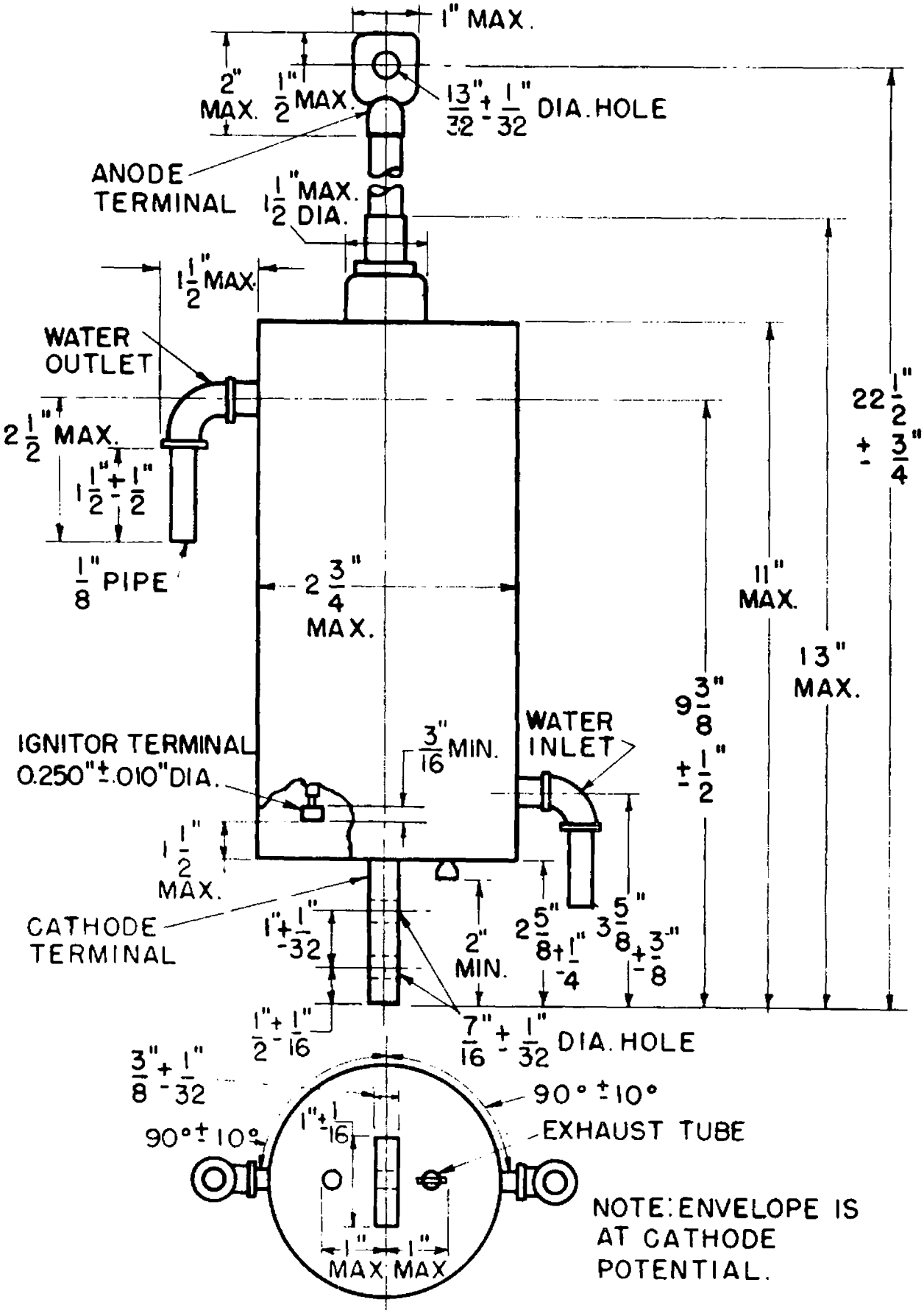
Ignitor

Maximum Voltage		
Positive	Anode	Volts
Negative	5	Volts
Maximum Current		
Peak	100	Amps.
Root Mean Square	10	Amps.
Average	1	Amp.
Maximum Averaging Time	5	Sec.

Thermal

Maximum Outlet Water Temperature	35	°C
Minimum Inlet Water Temperature	10	°C
Minimum Water Flow	1.0	Gpm

5821



NOTE: ENVELOPE IS AT CATHODE POTENTIAL.

from RMA release #890A, April 20, 1951

WL-5833

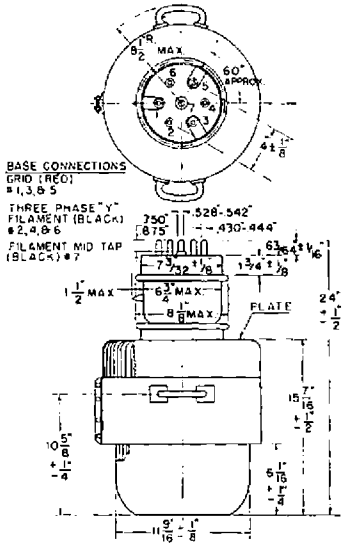
New Information
December 15, 1950

Data Sheet 86-270

WESTINGHOUSE ELECTRONIC TUBES

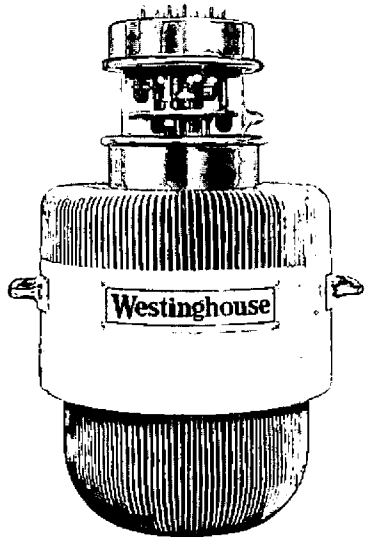
PLIOTRON WL-5833

MODULATOR AND AMPLIFIER



DESCRIPTION

The WL-5833 is a three-electrode vacuum tube designed for use as a modulator and amplifier. The anode is capable of dissipating 35 kilowatts during Continuous Commercial Service. Cooling is accomplished by forced air. The cathode is a pure tungsten three-phase filament. Maximum ratings apply up to 6 megacycles.



GENERAL CHARACTERISTICS

ELECTRICAL DATA:

	Min	Bogey	Max	
Filament voltage (per phase to neutral)		20	21	volts
Filament current (per phase)		143		amps
Filament starting current (per phase)			215	amps
Filament heating time(before applying plate voltage)	10			sec
Filament cold resistance per phase to wye center		0.013		ohms
Amplification factor		37		
Peak cathode emission current#			60	amps
Direct interelectrode capacitances:				
Grid-plate		40		uuf
Grid-filament		80		uuf
Plate-filament		6		uuf

Represents maximum usable cathode emission current (plate current plus grid current) for any condition of operation.

MECHANICAL DATA:

Mounting position	Vertical - Anode down
Type of cooling	Forced-air
Ratings based on maximum incoming air temperature of	45 °C

Required vertical air flow through radiator‡			
Plate dissipation-kW	35	28	21
% of rating	100	80	60
Air flow - cubic ft. per min.	1800	1400	1100
Static pressure - inches of water	2.5	1.2	0.6

Required air flow to filament and grid seals‡	30 cfm min
Bulb temperature	180 °C max
Seal temperature	180 °C max
Radiator temperature	220 °C max
Net weight, approx	225 pounds
Shipping weight, approx	455 pounds

‡Air flow must be started with application of any voltages and may be discontinued after removal of all voltages.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Af Power Amplifier and Modulator, Class B

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	14	kV max
Maximum signal dc plate current*	6.5	amps max
Maximum signal plate input*	80	kW max
Plate dissipation*	35	kW max

* Averaged over any af cycle of sine-wave form.

Typical Operation (Unless otherwise specified, values are for two tubes)	CCS	
Dc plate voltage	14.0	kV
Peak af grid to grid voltage	1560	volts
Dc grid voltage	-320	volts
Zero signal dc plate current	0.5	amps
Maximum signal dc plate current	10.3	amps
Effective load resistance, plate to plate	3380	ohms
Maximum signal driving power, approx	740	watts
Maximum signal power output, approx	100	kW

WL-5833

Pliotron
86-270 Data Sheet

WESTINGHOUSE ELECTRONIC TUBES

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd)

Plate-Modulated rf Power Amplifier, Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	14	kV max
Dc grid voltage	-2000	volts max
Dc plate current	5	amps max
Dc grid current	2	amps max
Plate input	70	kW max
Plate dissipation	23	kW max

Typical Operation	CCS	
Dc plate voltage	12.5	kV
Peak rf plate voltage	11.5	kV
Dc grid voltage	-1500	volts
Peak rf grid voltage	2200	volts
Dc plate current	4.8	amps
Dc grid current, approx	0.9	amps
Driving power, approx	2000	watts
Power output, approx	50	kW

Rf Power Amplifier, Class C Telegraphy

Key-down conditions per tube without amplitude modulation§

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	18	kV max
Dc grid voltage	-2000	volts max
Dc plate current	10	amps max
Dc grid current	2	amps max
Plate input	180	kW max
Plate dissipation	35	kW max

Typical Operation	CCS	
Dc plate voltage	17	kV
Dc grid voltage	-1400	volts
Peak rf grid voltage	2500	volts
Dc plate current	10	amps
Dc grid current, approx	1.7	amps
Driving power, approx℄	4500	watts
Power output, approx ℄	136	kW

§ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

℄ With essentially sine wave excitation.

RATINGS VS. FREQUENCY

Maximum ratings apply up to 6 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

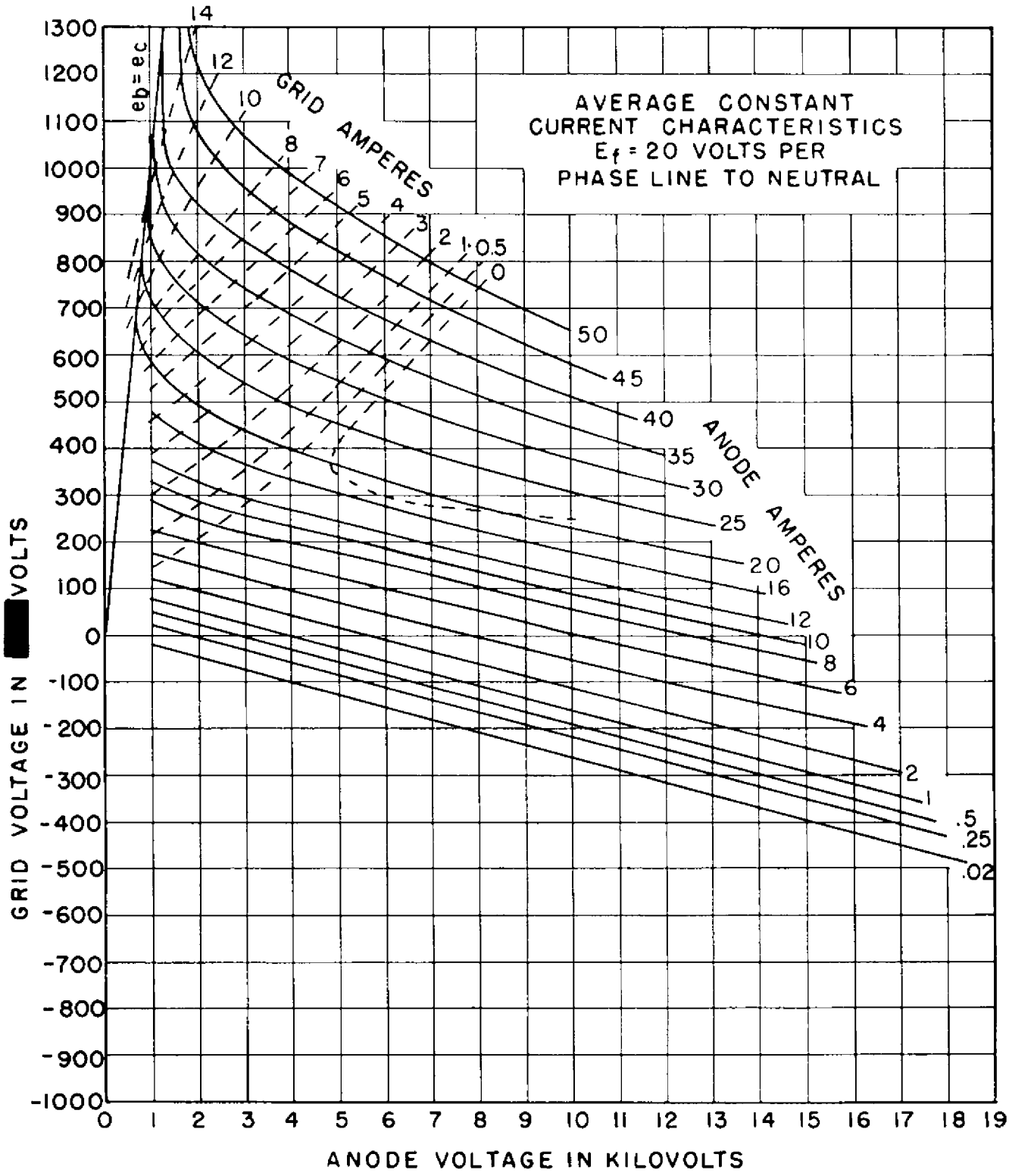
Frequency	6	12	25	mc
Percentage of maximum rated plate voltage and plate input				
Class C telephony	100	90	81	%
Class C telegraphy	100	71	58	%

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

Characteristics:	Conditions:		Limits Min	Bogey	Max	
Grid voltage	e_b= 2 kV; i_b = 40 a	$e_{c:}$			1100	v
Grid current	e_b= 2 kV; i_b = 40 a	$i_{c:}$			11.5	a
Plate voltage	E_c= 0 Vdc; I_b= 1.0 Adc	$E_{b:}$	3.1	3.8	4.5	kVdc
Plate voltage	E_c= -200 Vdc; I_b= 1.0 Adc	$E_{b:}$	10.1	11.5	12.9	kVdc
Grid voltage	E_b= 10 kVdc; I_b= .020 Adc	$E_{c:}$	-180	-250	-320	Vdc
Plate power output	Class C telegraphy, amplifier service only, for F less than 6 megacycles.	$P_{o:}$	135			kW*

* With sine-wave excitation.

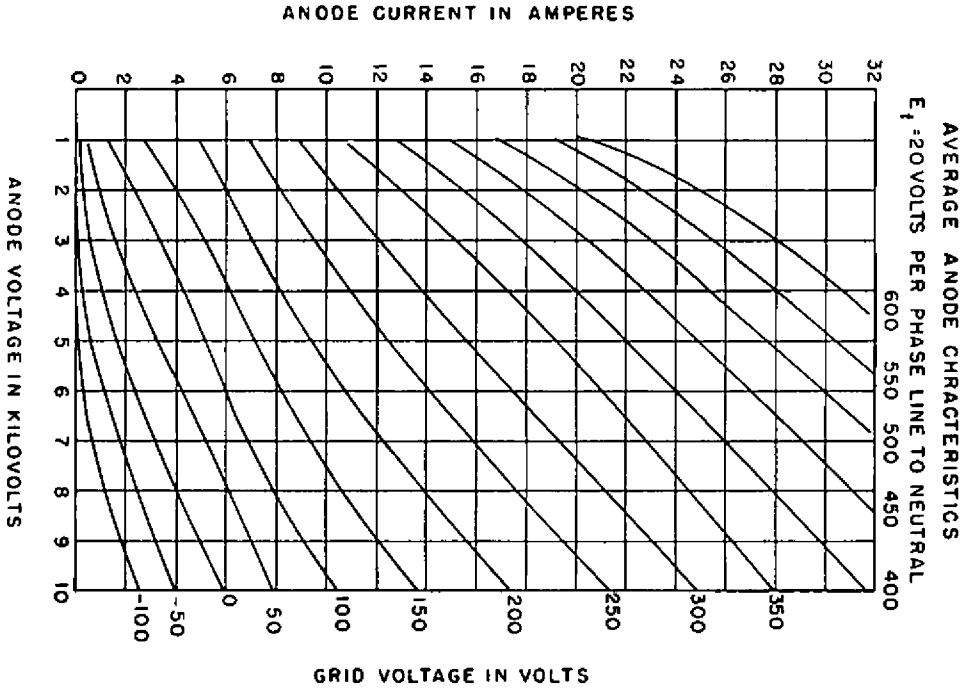
WESTINGHOUSE **ELECTRONIC TUBES**

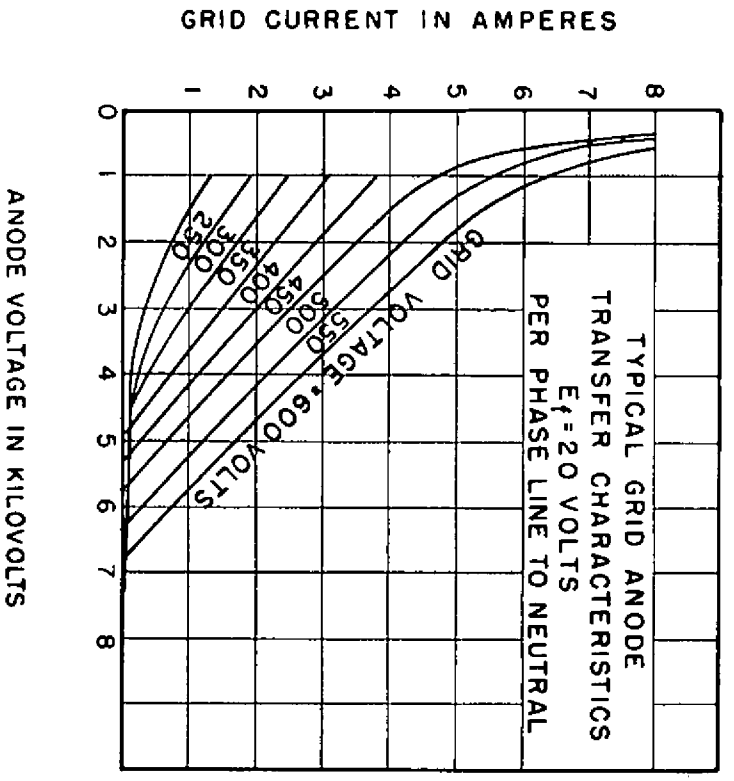


WL-5833

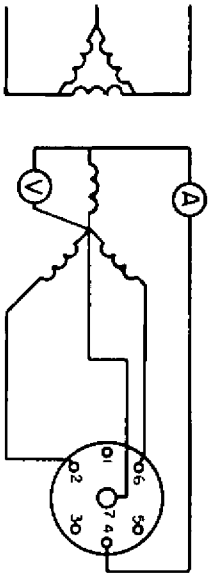
Pliotron
86-270 Data Sheet

WESTINGHOUSE **ELECTRONIC TUBES**





FILAMENT TERMINALS 2,4,6 & 7 PAINTED BLACK
GRID TERMINALS 1,3,& 5 PAINTED RED



FILAMENT CONNECTIONS
THREE PHASE AC SUPPLY

WESTINGHOUSE ELECTRIC CORPORATION
Electronic Tube Division
BLOOMFIELD, NEW JERSEY

Printed in U. S. A.

June 22, 1949

Westinghouse Electric Corporation
Bloomfield, New Jersey

Type 5846
Reference Cavity

The 5846 is a fixed frequency, transmission type, vacuum sealed, reference cavity for use at 9280 megacycles as a frequency determining reference.

Electrical Data - General

Resonant Frequency			9280	Mc
Loaded Q (Circuit Q for absorption types)			2100	
Insertion Loss at Resonant Frequency			5	db

Mechanical Data - General

Cannot be Pressurized				
Ambient Temperature Range	-40	to	+100	°C
Net Weight (approximately)			3/4	lb.
Mounting Position			Any	
Outline Drawing Number			60130	

Maximum Ratings

Incident Peak Power	5	Kw

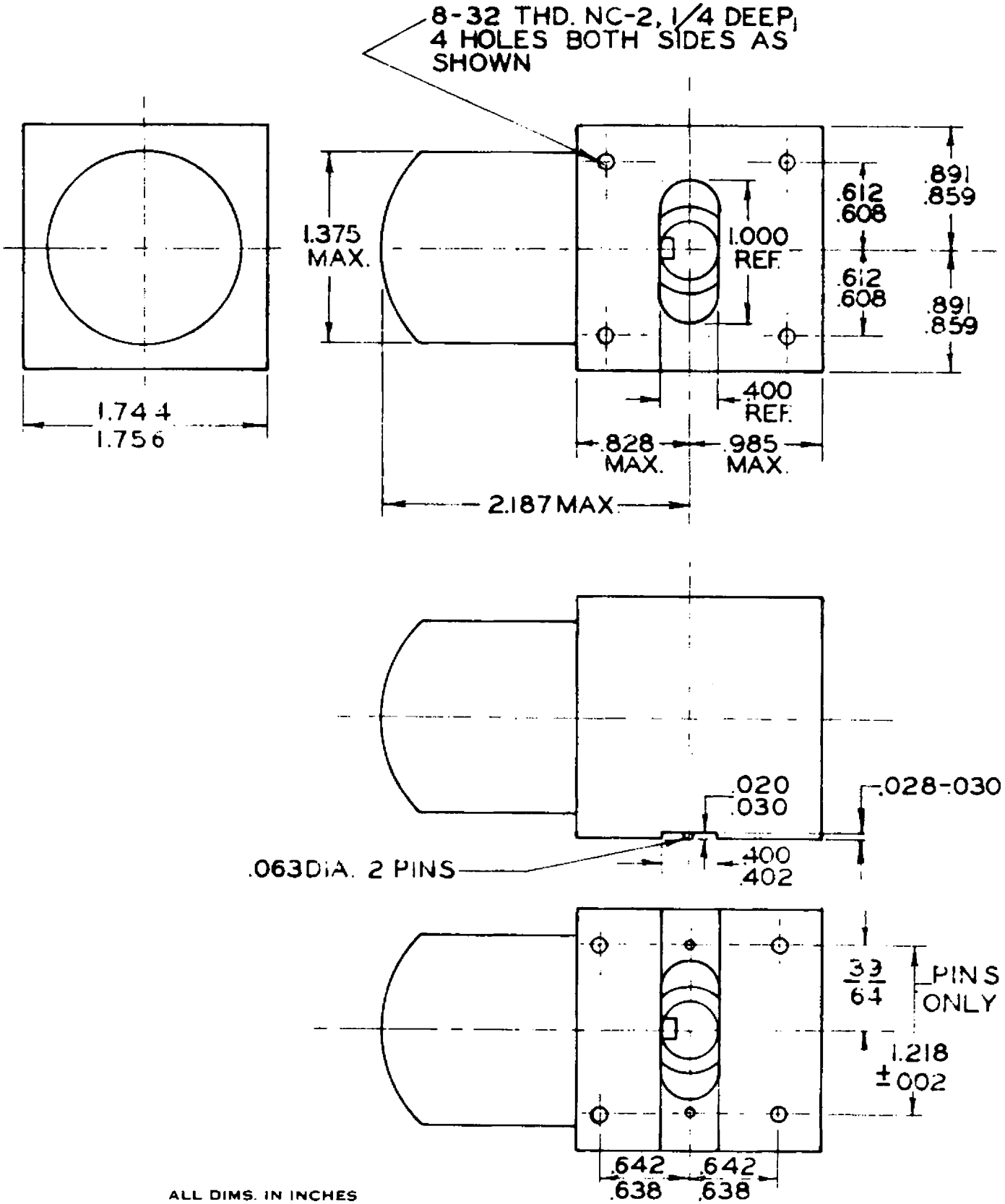
Electrical and Mechanical Data with Limits

Change in Resonant Frequency with Vibration 10 g	± .1	Mc max.
Change in Resonant Frequency with Pressure 100 mm to 2 Atmospheres	± .1	Mc max.
Change in Resonant Frequency with Temperature -40 to + 100°C	± .3	Mc max.
Change in Resonant Frequency due to *Creep	± .3	Mc max.

*Creep is the small hysteresis change in the length of a metal due to it being taken through heating and cooling cycles.

WESTINGHOUSE ELECTRIC CORPORATION
LAMP DIVISION
SPECIFICATIONS AND STANDARDS DEPT

TYPE 5846



ALL DIMS. IN INCHES

Westinghouse Electric Corporation January 6, 1950

RMA Release 822

Type 5859
X-Ray Rectifier Tube

GENERAL CHARACTERISTICS

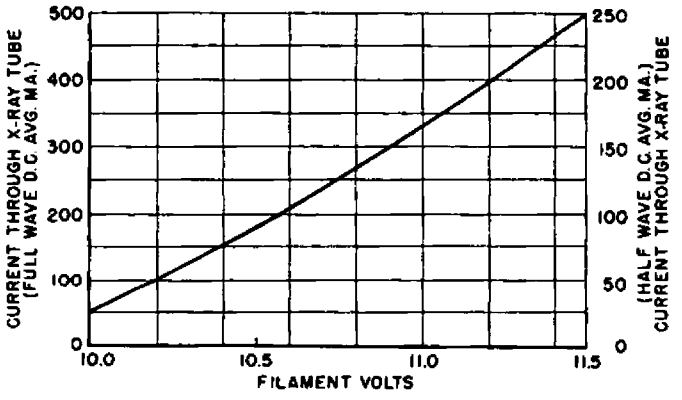
Electrical		
Filament Potential	10.0 to 11.5	Volts
Filament Current	11.3 to 12.8	Amperes
Mechanical		
Outline Drawing Number	60132	
Type of Cooling	Oil immersed	
Mounting Position	Any	

MAXIMUM RATINGS*

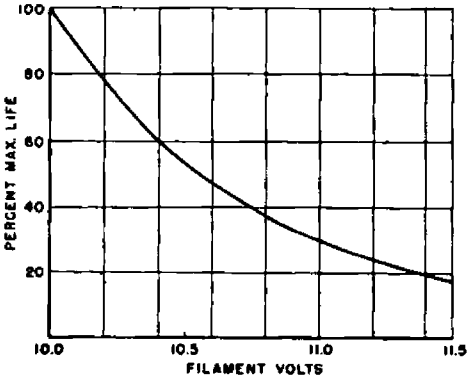
Continuous Duty		
Maximum Continuous Rating	100	Ma
Maximum Inverse Voltage Across Tube	140	KVP
Intermittent Rating with Automatic Filament Boost		
Maximum Intermittent Rating	500	Ma
Maximum Intermittent Inverse Voltage Across Tube	125	KVP

*These ratings apply to full-wave circuits only and refer to the milliamperes as read on a d.c. average milliammeter in series with the x-ray tubes.

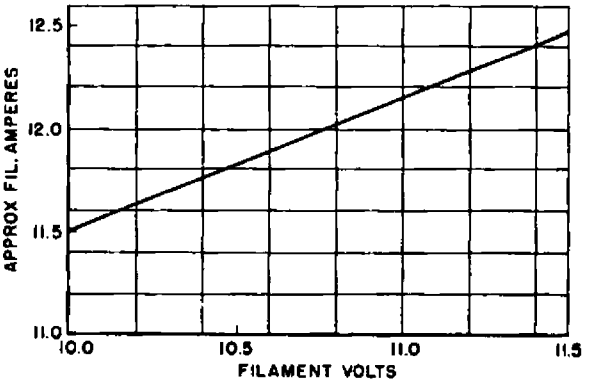
Filament Voltage Adjustment Chart



Relative Filament Life as Function of Filament Volts

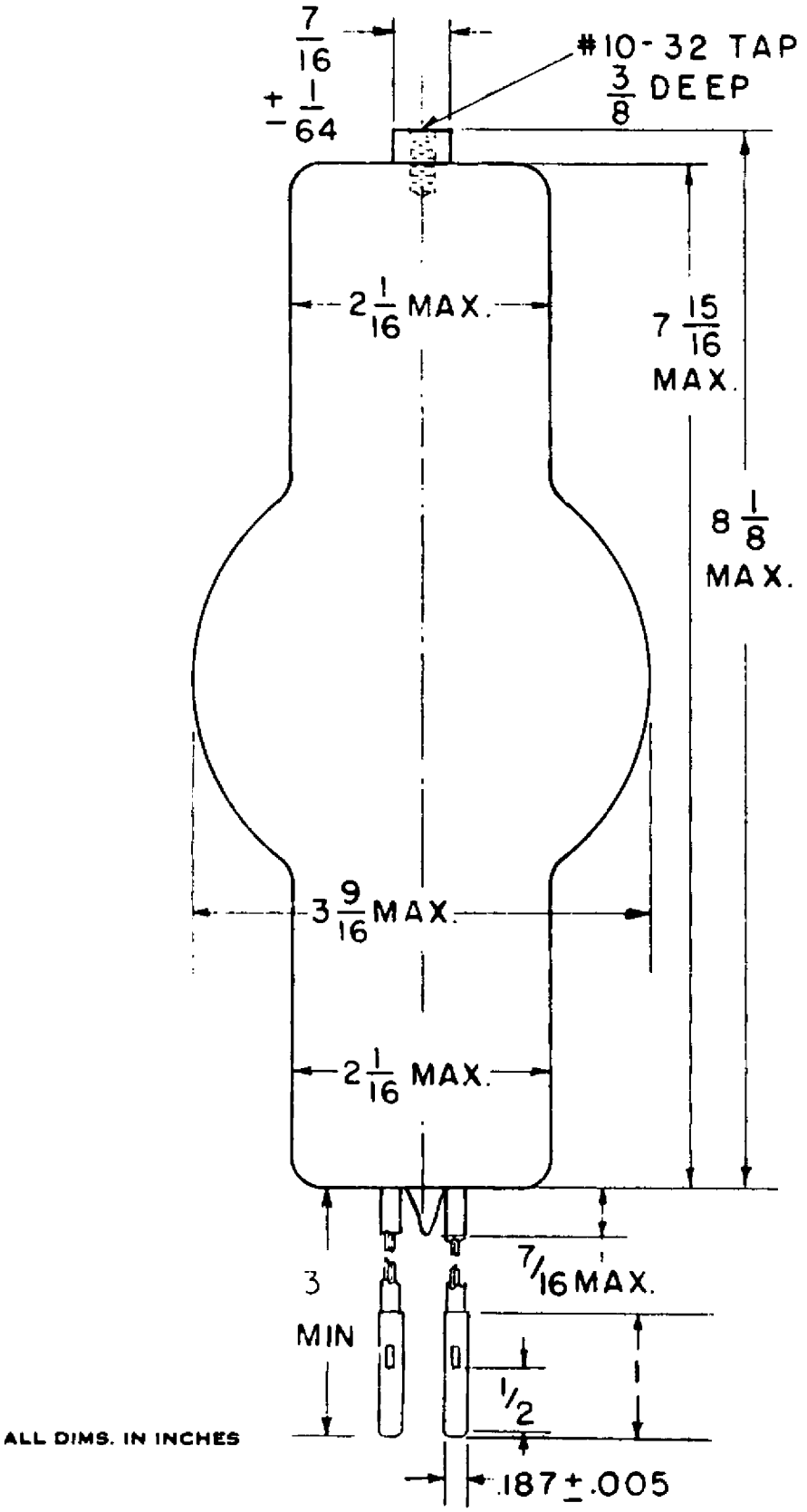


Filament Characteristics



January 6, 1950

Type 5859
X-Ray Rectifier Tube



Westinghouse Electric Corporation January 6, 1950

RMA Release 822

Type 5860
X-Ray Rectifier Tube

GENERAL CHARACTERISTICS

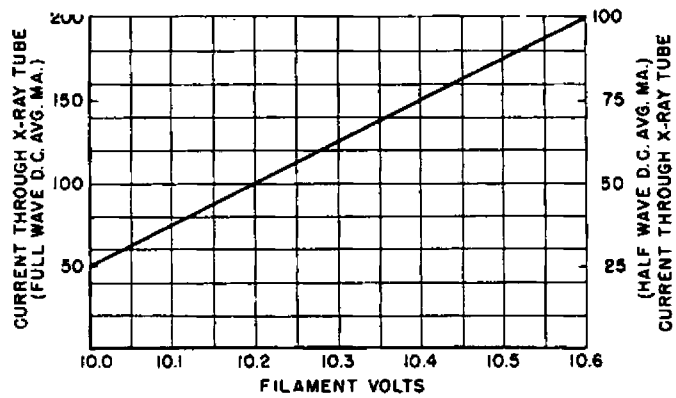
Electrical		
Filament Potential	10.0 to 10.6	Volts
Filament Current	11.3 to 12.3	Amperes
Mechanical		
Outline Drawing Number	60131	
Type of Cooling	Oil immersed	
Mounting Position	Any	

MAXIMUM RATINGS*

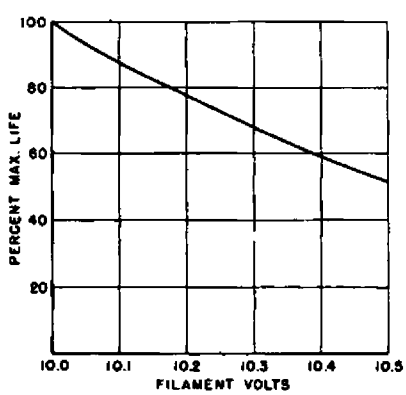
Continuous Duty		
Maximum Continuous Rating	50	Ma
Maximum Inverse Voltage Across Tube	125	KVP
Intermittent Rating		
Maximum Intermittent Rating	200	Ma
Maximum Intermittent Inverse Voltage Across Tube	125	KVP

*These ratings apply to full-wave circuits only and refer to the milliamperes as read on a d.c. average milliammeter in series with the x-ray tubes.

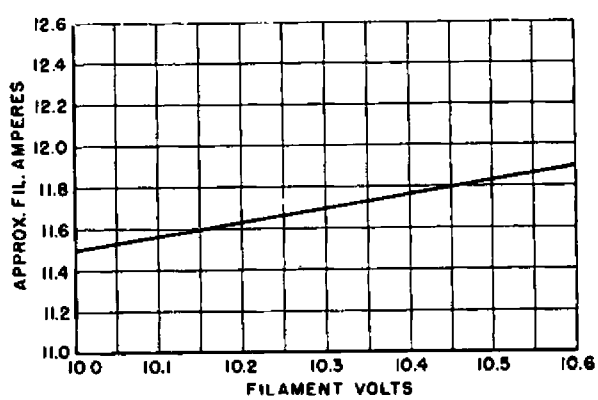
Filament Voltage Adjustment Chart



Relative Filament Life as Function of Filament Volts

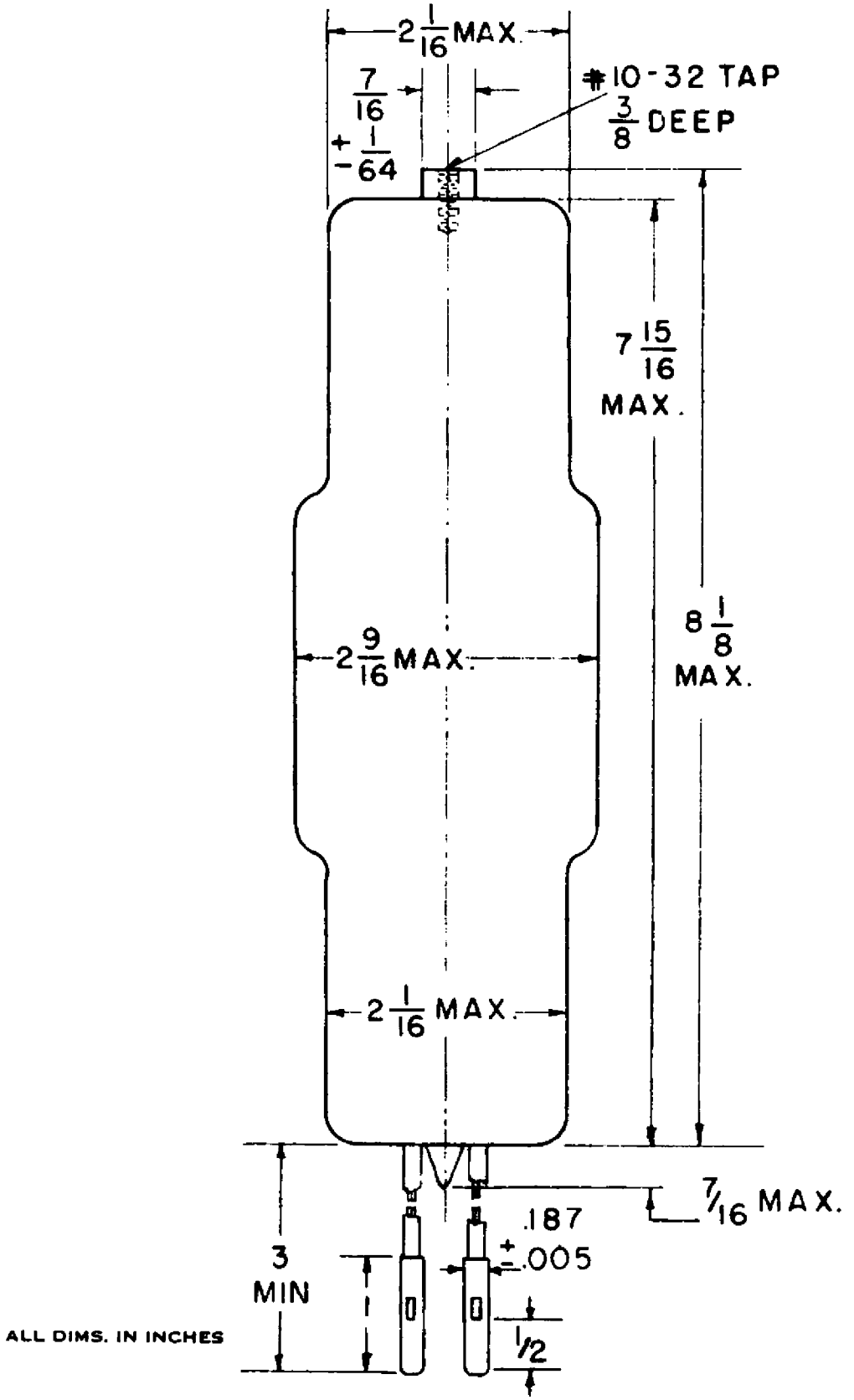


Filament Characteristics



January 6, 1950

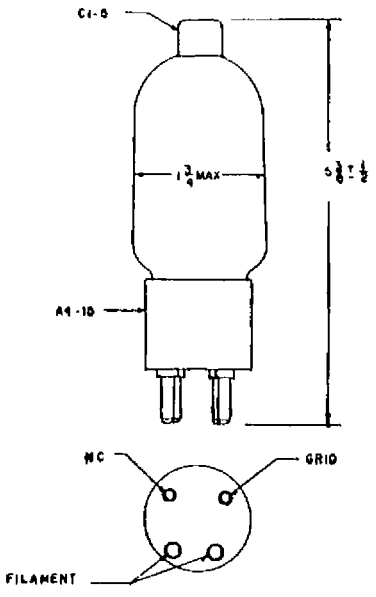
Type 5860
X-Ray Rectifier Tube



THYRATRON TYPE WL-5877

February 20, 1957

The WL-5877 is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged on a wide range of ambient temperatures. The WL-5877 is designed for operation in industrial control and ignitor firing service.



GENERAL DATA

	Min.	Bogey	Max.	
ELECTRICAL:				
Cathode		Directly Heated Coated Filament		
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts = 2.5.	9.8	10.8	11.8	Amperes
Heating Time	30	--	--	Seconds
Deionization Time		See Figure 2		
Ionization Time		10		μsec
Critical Anode Voltage at Grid Voltage of +6 Volts	--	--	100	Volts
Critical Grid Voltage at Anode Voltage of 1500 Volts-See Fig. 1	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.)				
Anode to Grid		0.51		μμf
Grid to Filament		15.6		μμf
Anode to Filament		3.4		μμf
Typical Arc Drop		16		Volts
Control Characteristic				Negative
MECHANICAL:				
Mounting Position				Any
Overall Height (Approx.)				5 3/8"
Overall Diameter (Maximum)				1 3/4"
Type of Cooling				Air, Unrestricted Convection
Temperature Range				-55 to + 70 C
Bulb				T-13
Anode Cap				JETEC C1-5
Base				JETEC A4-15
Net Weight (Approx.)				5 oz.
Shipping Weight (Approx.)				2 lb.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:		
Peak Anode Voltage		
Forward	1500 max.	Volts
Inverse	1500 max.	Volts
Anode Current		
Peak	40 max.	Amperes
Average	3.2 max.	Amperes
Surge (Duration 0.10 second or less)	560 max.	Amperes
Commutation Factor ♦	200 max.	va/μsec
Current Rate of Change	0.25 max.	a/μsec
Voltage Rate of Change	800 max.	v/μsec
Negative Control Grid Voltage		
Before Conduction	250 max.	Volts
During Conduction §	10 max.	Volts
Average Positive Control Grid Current		
Averaging Time = 1 cycle ♦	0.20 max.	Ampere
Operating Frequency ⊕	60 max.	cps

from JETEC release #1899, April 15, 1957

NOTES

General — These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

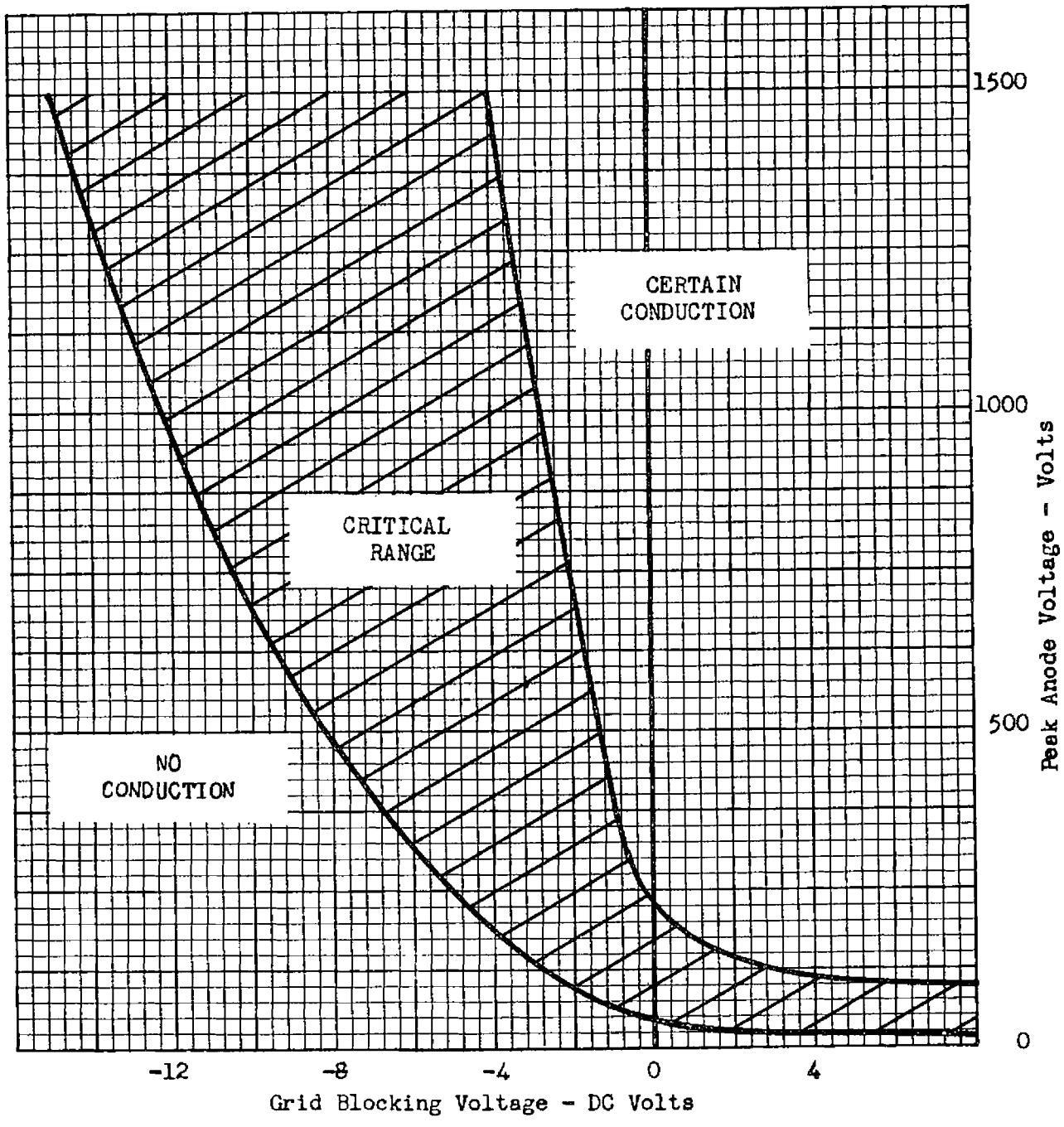
♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit.

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

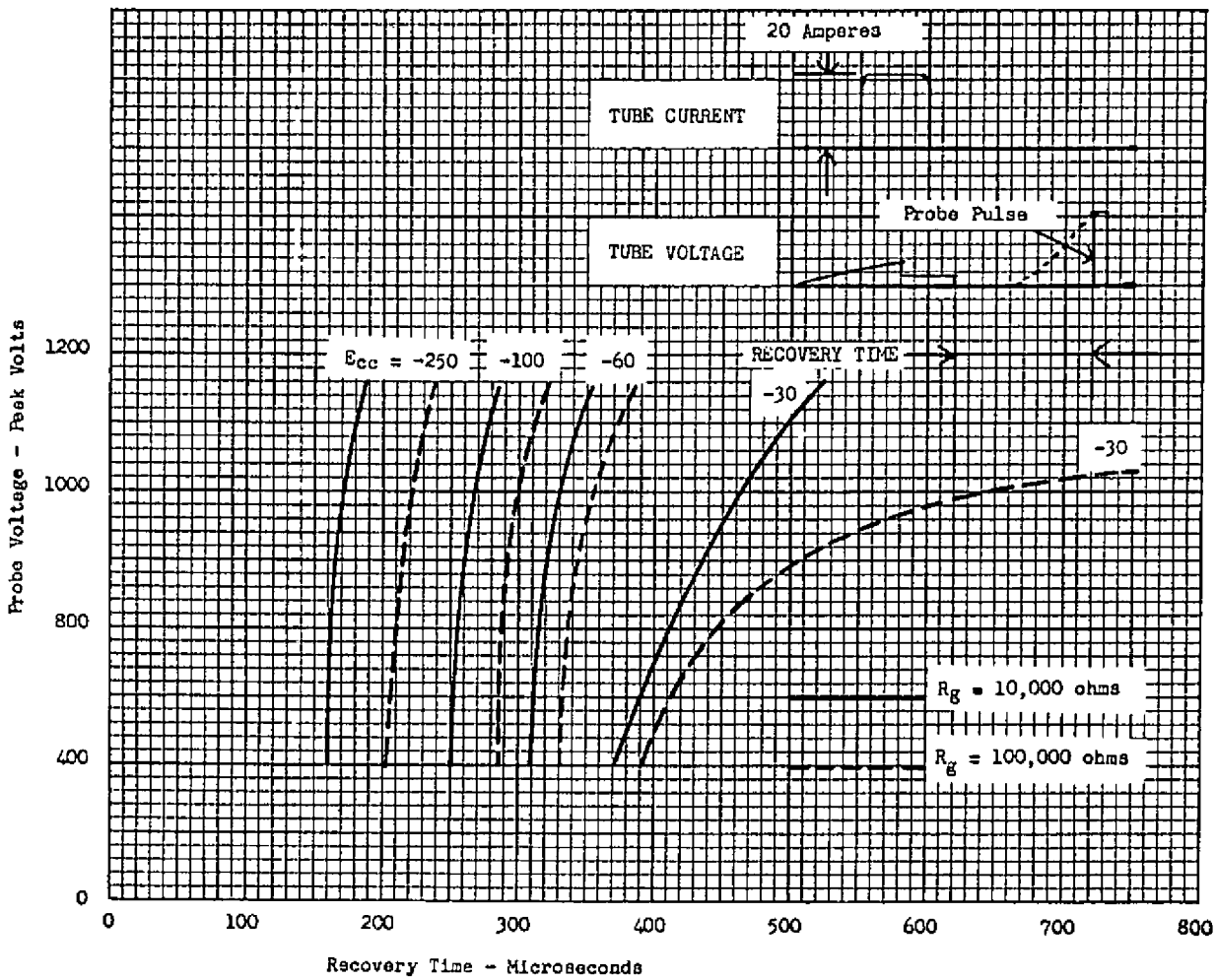
♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturer.

CRITICAL GRID VOLTAGE



WL-5877 RECOVERY TIME (TYPICAL)



December 23, 1957

THYRATRON TYPE WL-5878

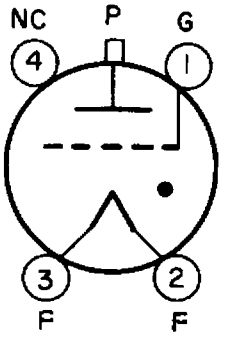
The WL-5878 is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged over a wide range of ambient temperatures. The WL-5878 is designed for application in industrial control circuits requiring a quick heating cathode.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts = 2.5	19.0	21.0	23.0	Amperes
Heating Time	60	-	-	Seconds
Ionization Time		10		usec
Critical Anode Voltage at Grid Voltage of +6 Volts	-	-	100	Volts
Critical Grid Voltage at Anode Voltage of 1500 Volts-See Fig. 1	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.)				
Anode to Grid		1.0		uuf
Grid to Cathode		28.0		uuf
Typical Arc Drop		16		Volts
Control Characteristic				Negative

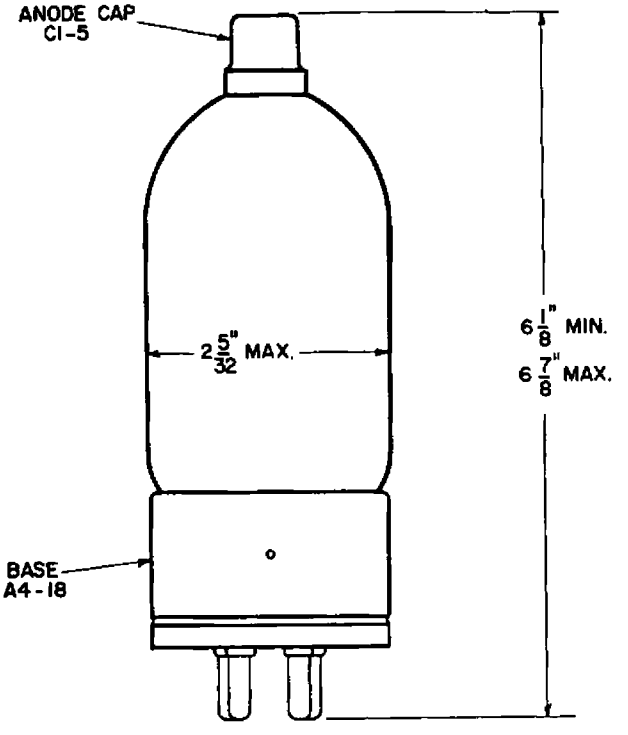
MECHANICAL:

Mounting Position	Any
Overall Height (Approx.)	6-1/2"
Overall Diameter (Maximum)	2-5/32"
Type of Cooling	Air, Unrestricted Convection
Temperature Range	-55 to +70° C
Bulb	T-18
Anode Cap	JETEC C1-5
Base	JETEC A4-18
Net Weight (Approx.)	8 oz.
Shipping Weight (Approx.)	2 lb.



BASE CONNECTIONS

G - Control Grid
F - Filament
P - Anode
NC - No Connection



CE-A1137

CE-A1321

Thyratron Section

from JETEC release #2073, Jan. 6, 1958

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:

Peak Anode Voltage			
Forward	1500	max.	Volts
Inverse	1500	max.	Volts
Anode Current			
Peak	80	max.	Amperes
Average (Averaging Time 15 Seconds)	6.4	max.	Amperes
Surge (Duration 0.10 Second or Less)	1120	max.	Amperes
Commutation Factor♦	200	max.	va/usec
Current Rate of Change	0.25	max.	a/usec
Voltage Rate of Change	800	max.	v/usec
Negative Control Grid Voltage			
Before Conduction	250	max.	Volts
During Conduction §	10	max.	Volts
Average Positive Control Grid Current			
Averaging Time = 1 cycle▲	0.20	max.	Ampere
Operating Frequency⊕	60	max.	cps

NOTES

General These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

All anode and grid returns should be made to the center of the filament transformer.

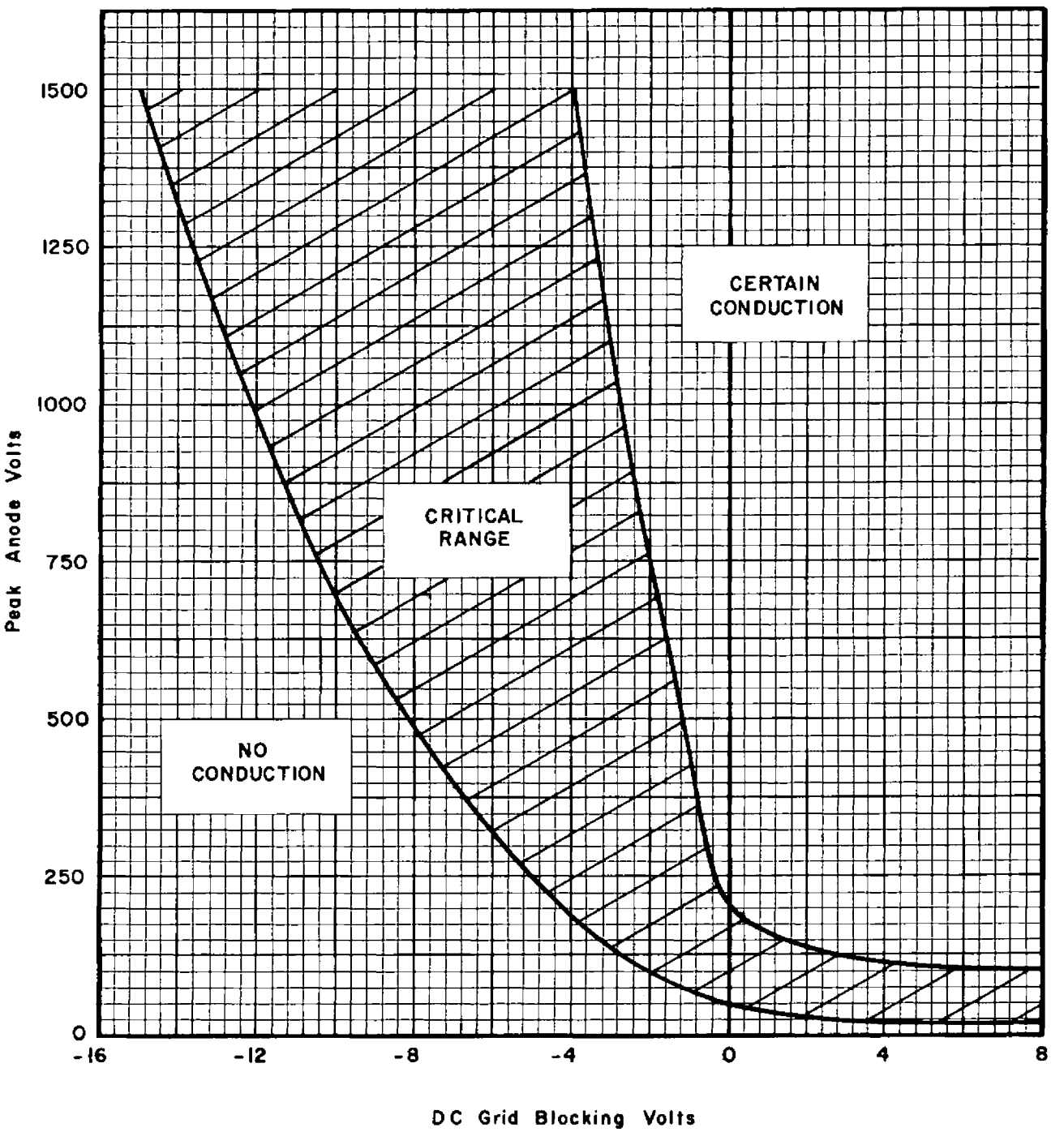
♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

▲ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturers.

CRITICAL GRID VOLTAGE



CE-A1349

RTMA sponsor:
Westinghouse Electric Corp.

Release No. 926

October 30, 1950

ELECTRON TUBE TYPE 5891

The 5891 is a three-electrode tube designated for use as an oscillator, modulator, or amplifier. The anode is capable of dissipating 25 kilowatts during Continuous Commercial Service. Cooling is accomplished by forced air. The cathode is a thoriated tungsten filament which may be operated either three-phase wye or single-phase. Maximum ratings apply up to 10 megacycles.

GENERAL

Electrical Data:	Min:	Bogey:	Max:	
Filament Voltage (three-phase) line to neutral	10	11	11.6	Volts
*Filament Current per phase at Bogey Voltage	89	95	101	Amperes
Filament Voltage, (single-phase)	10	11	11.6	Volts
*Filament Current single-phase at Bogey Voltage	267	285	303	Amperes
*No limiting of filament starting current is necessary on either single or three-phase excitation.				
Filament Heating Time	10	-	-	Seconds
Amplification Factor: E_c= -200V; I_b=1.0 A.	-	36	-	
Peak Cathode Current, Note 1	-	-	50	Amperes
Direct Interelectrode Capacitances:				
Grid-Plate	32	40	48	uuf
Grid-Filament	64	80	96	uuf
Plate-Filament	3	6	9	uuf

NOTE 1: Represents maximum usable cathode current, (plate current plus grid current), for any condition of operation.

Mechanical Data:				
Mounting Position	Vertical - Anode Down			
Type of Cooling	Forced Air			
Ratings based on maximum incoming air temperature of			45°C	
Required Vertical Air Flow Through Radiator: (Note 2)				
Plate Dissipation - Per cent of Rating	100%	80%	60%	
Required Air Flow cubic feet per minute	1800	1450	1100	
Pressure, inches of water	2.2	1.5	0.85	
Required Air Flow to Filament and Grid Seals (Note 2):			10 CFM	Min.
Maximum Bulb Temperature			180°C	
Maximum Seal Temperature			180°C	
Maximum Radiator Temperature			180°C	
Net Weight, approximate			130	Pounds

NOTE 2: Cooling air may be applied and removed simultaneously with all voltages.

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR - CLASS B

Maximum Ratings, Absolute Values	CCS	
D.C. Plate Voltage	15.0	KV Max.
Maximum Signal D.C. Plate Current f	6.0	Amps. Max.
Maximum Signal Plate Input f	90.0	KW Max.
Plate Dissipation f	25.0	KW Max.

f Averaged over any audio-frequency cycle of sine-wave form.

Typical Operation: (Unless Other Specified, Values Are For Two Tubes)	CCS		
D.C. Plate Voltage	10	15	KV
Peak A-F Grid-to-Grid Voltage	960	1540	Volts
D.C. Grid Voltage	-210	-340	Volts
Zero Signal D.C. Plate Current	0.5	0.5	Amps.
Maximum Signal D.C. Plate Current	6.4	10.0	Amps.
Effective Load Resistance Plate-to-Plate	3200	3560	Ohms
Maximum Signal Driving Power, Approximate	195	970	Watts
Maximum Signal Power Output, Approximate	35	100	KW

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER - CLASS C TELEPHONY
(Carrier Conditions Per Tube For Use With A Maximum Modulation Factor of 1.0)

Maximum Ratings, Absolute Values	CCS	
D.C. Plate Voltage	12,500	Volts Max.
D.C. Grid Voltage	-2000	Volts Max.
D.C. Plate Current	5	Amps. Max.
D.C. Grid Current	1.0	Amps. Max.
Plate Input	62.5	KW Max.
Plate Dissipation	17	KW Max.

Typical Operation:	CCS	CCS	
D.C. Plate Voltage	10,000	12,500	Volts
Peak R-F Plate Voltage	9000	10,800	Volts
D.C. Grid Voltage	-800	-1500	Volts
Peak R-F Grid Voltage	1300	2090	Volts
D.C. Plate Current	3.4	4	Amps.
D.C. Grid Current, Approximate	0.74	0.77	Amps.
Driving Power, Approximate	915	1550	Watts
Power, Output, Approximate	28	40	KW

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR - CLASS C TELEGRAPHY
(Key-Down Conditions Per Tube Without Amplitude Modulation):

Maximum Ratings, Absolute Values	CCS	
D.C. Plate Voltage	15,000	Volts Max.
D.C. Grid Voltage	-2000	Volts Max.
D.C. Plate Current	8	Amps. Max.
D.C. Grid Current	1	Amp. Max.
Plate Input	100	KW Max.
Plate Dissipation	25	KW Max.

Typical Operation:	CCS		
D.C. Plate Voltage	12,500	15,000	Volts
Peak R.F Plate Voltage	10,500	12,400	Volts
D.C. Grid Voltage	-1250	-1500	Volts
Peak R.F Grid Voltage	1845	2220	Volts
D.C. Plate Current	5.2	6	Amps.
D.C. GridCurrent, Approximate	0.95	1	Amps.
Driving Power, Approximate *	1700	2160	Watts
Power Output, Approximate *	50	70	KW

With essentially sine wave excitation.

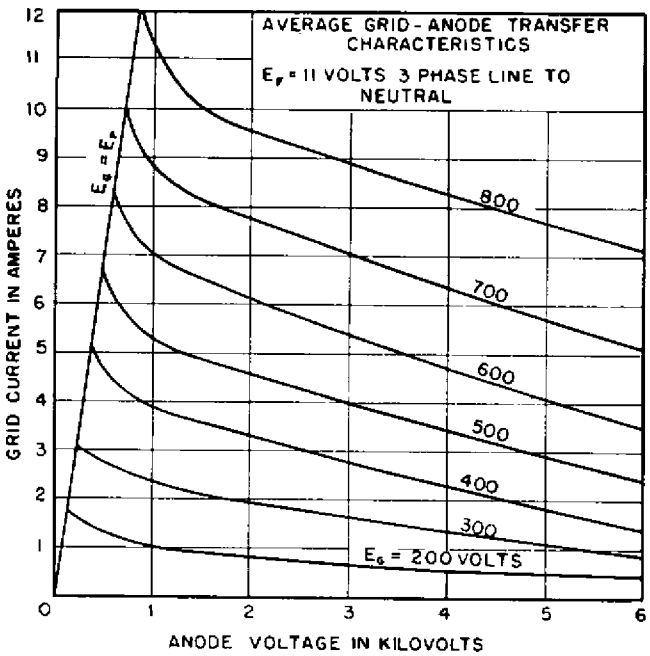
RATINGS VS. FREQUENCY

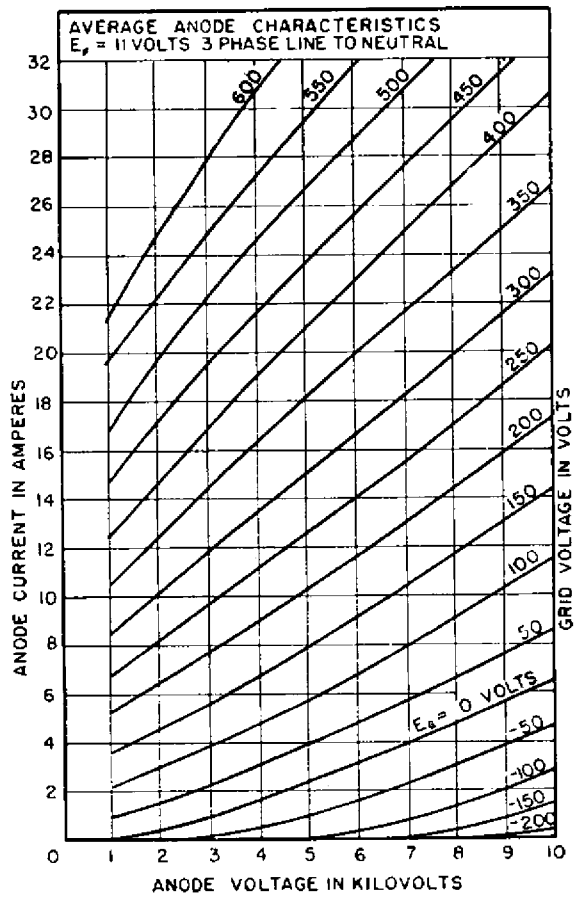
Maximum ratings apply up to 10 megacycles. The tube may be operated at higher frequencies provided the maximum values of the plate voltage and power input are reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

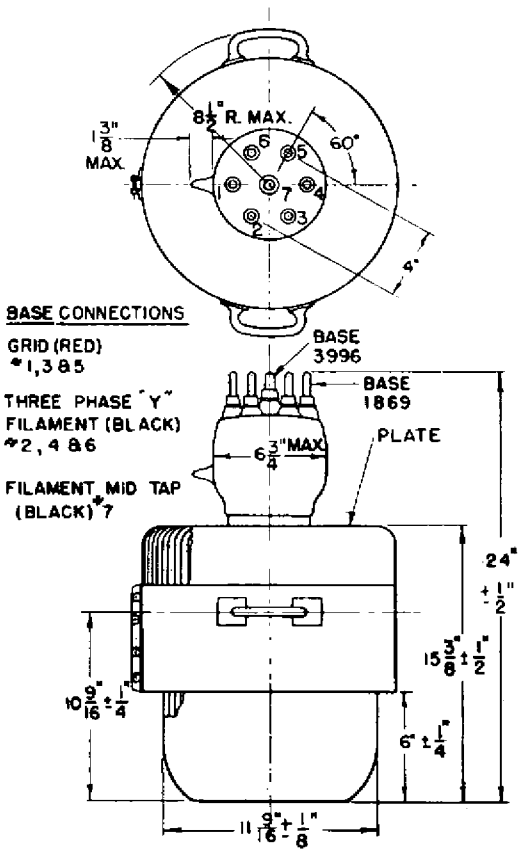
Frequency	10	18	25	Mcs.
Percentage of Maximum Rated Plate Voltage and Plate Input:				
Class C Telegraphy	100	88	80	%
Class C Plate Telephony	100	88	80	%

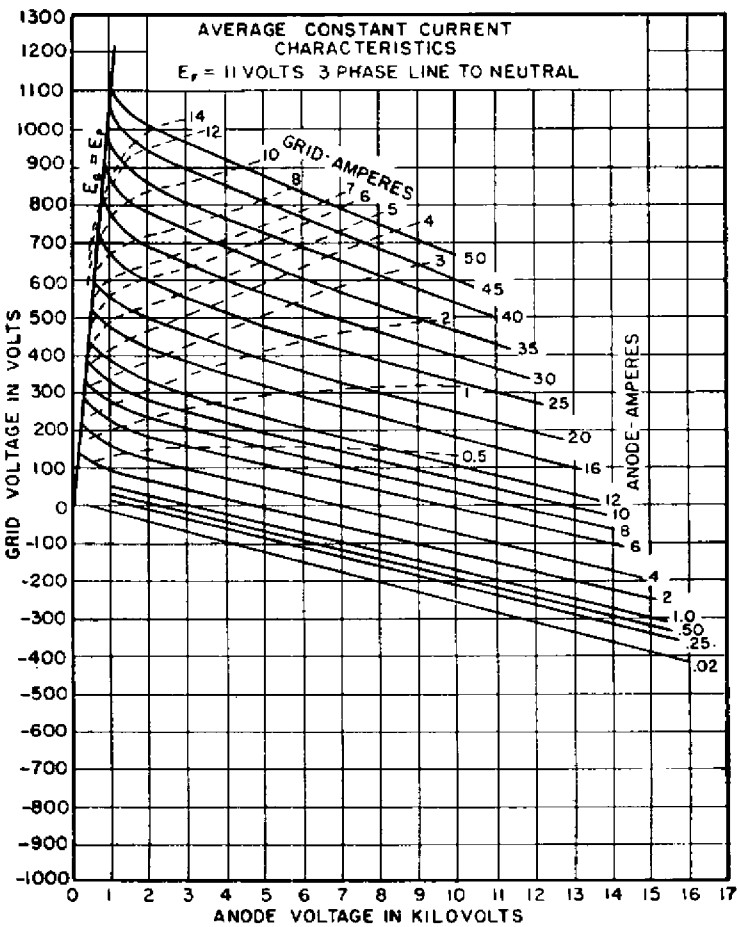
CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

Characteristic:	Conditions:		Limits: Min:	Bogey:	Max:	
Grid Voltage:	E_f=11Vac; E_b=2.6KV; i_b=35A.	e_c:	-	-	900	Volts
Grid Current:	E_f=11Vac; E_b=2.6KV; i_b=35A.	i_c:	-	-	10	Amps.
Plate Voltage:	E_f=11Vac; E_c=0; I_b=1.0Adc	E_b:	2.6	3.3	4.0	KVdc
Plate Voltage:	E_f=11Vac; E_c= -200Vdc; I_b=1.0Adc	E_b:	9.7	11.3	12.9	KVdc
Grid Voltage:	E_b=10KVdc; I_b=0.020Adc	E_c:	-180	-250	-320	Vdc
Plate Power Output:	Class C Telegraphy E_f=11Vac; E_b=15KV I_b= 6Adc; E_c= -1500 Vdc	P_o:	65	-	-	KW


AVERAGE GRID-ANODE TRANSFER CHARACTERISTICS
E_f = 11 VOLTS 3 PHASE LINE TO NEUTRAL
$E_g = E_p$
800
700
600
500
400
300
E_g = 200 VOLTS
GRID CURRENT IN AMPERES
ANODE VOLTAGE IN KILOVOLTS


AVERAGE ANODE CHARACTERISTICS
E_f = 11 VOLTS 3 PHASE LINE TO NEUTRAL
600
550
500
450
400
350
300
250
200
150
100
50
E_g = 0 VOLTS
-50
-100
-150
-200
ANODE CURRENT IN AMPERES
GRID VOLTAGE IN VOLTS
ANODE VOLTAGE IN KILOVOLTS


8½" R. MAX.
13/8" MAX.
60°
4"
BASE CONNECTIONS
GRID (RED) *1,3&5
THREE PHASE "Y" FILAMENT (BLACK) *2,4&6
FILAMENT MID TAP (BLACK) *7
BASE 3996
BASE 1869
PLATE
6¾" MAX.
24" ± ½"
15 3/8" ± ½"
10 9/16" ± ¼"
6" ± ¼"
11 9/16" ± ⅛"


AVERAGE CONSTANT CURRENT CHARACTERISTICS
E_f = 11 VOLTS 3 PHASE LINE TO NEUTRAL
$E_g = E_p$
GRID-AMPERES
ANODE-AMPERES
.02
.25
.50
1.0
0.5
GRID VOLTAGE IN VOLTS
ANODE VOLTAGE IN KILOVOLTS

Release No. 846
March 24, 1950

Type 5934

The WL-5934 is a high vacuum diode for rectifier service. The cathode is a thoriated tungsten filament.

ELECTRICAL DATA

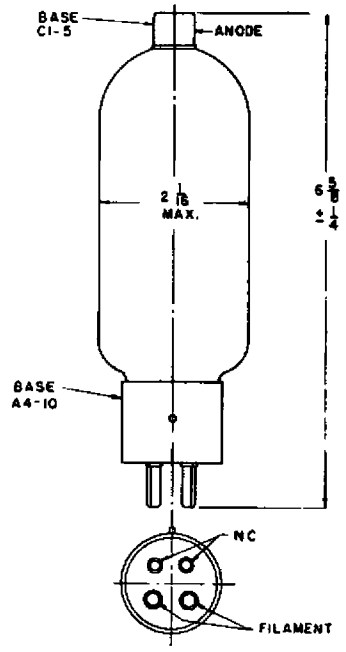
Filament Voltage	2.5	Volts
Filament Current	6	Amperes
Filament Heating Time - Filament and Plate voltage may be applied simultaneously.		
Tube Voltage Drop, at I_b of 270 milli-amperes, Approx.	520	Volts

MECHANICAL DATA

Overall Dimensions, Drawing	60146	
Mounting Position, Vertical with Filament Base Either Up or Down.		

MAXIMUM RATINGS

Maximum Peak Inverse Anode	20,000	Volts
Maximum Peak Plate Current	270	Milliamperes
Average Plate Current	25	Milliamperes
Average Plate Current for a Maximum Time of 5 Minutes	100	Milliamperes
Average Plate Dissipation	75	Watts

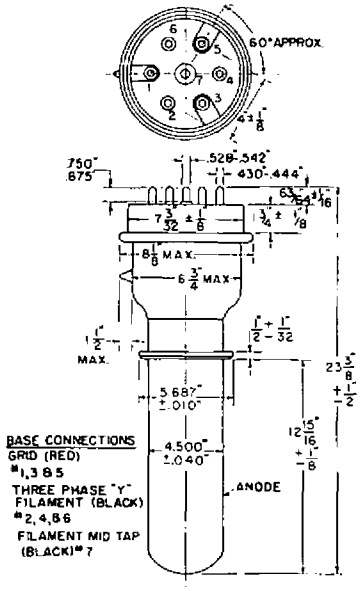


WL-5936

New Information
December 15, 1950

Data Sheet 86-273

WESTINGHOUSE ELECTRONIC TUBES

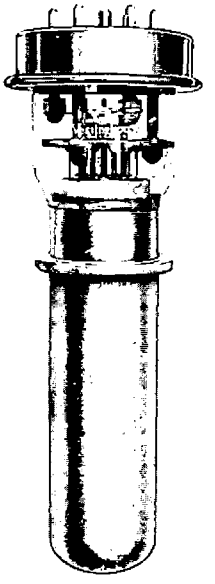


PLIOTRON WL-5936

MODULATOR, AMPLIFIER AND OSCILLATOR

DESCRIPTION

The WL-5936 is a three-electrode vacuum tube designed for use as a modulator, amplifier, or oscillator. The anode is capable of dissipating 70 kilowatts during Continuous Commercial Service. Cooling is accomplished by water and forced air. The cathode is a pure tungsten three-phase filament. Maximum ratings apply up to 15 megacycles.



GENERAL CHARACTERISTICS

ELECTRICAL DATA:

	Min	Bogey	Max	
Filament voltage (per phase to neutral)		20	21	volts
Filament current (per phase)		143		amps
Filament starting current (per phase)			215	amps
Filament heating time (before applying plate voltage)	10			sec
Filament cold resistance per phase to wye center		0.013		ohms
Amplification factor		37		
Peak cathode emission current#			60	amps
Direct interelectrode capacitances:				
Grid-plate		38		uuf
Grid-filament		80		uuf
Plate-filament		5		uuf

Represents maximum usable cathode emission current (plate current plus grid current) for any condition of operation.

MECHANICAL DATA:

Mounting position	Vertical–Anode down	
Type of cooling	Water & forced-air	
Ratings based on maximum incoming air temperature of	45	°C max
Required air flow to filament and grid seals ‡	30	cfm min
Glass temperature (at grid and filament seals)	180	°C max
Water flow required: ‡		
Anode	30	GPM
Water pressure	100	psi
Outlet water temperature	70	°C
Net weight, approx	26	pounds
Shipping weight, approx	85	pounds

‡ Air and water flow must be started with application of any voltages and may be discontinued after removal of all voltages.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

Af Power Amplifier and Modulator, Class B

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	18	kV max
Maximum signal dc plate current *	10	amps max
Maximum signal plate input *	180	kW max
Plate dissipation *	70	kW max

* Averaged over any af cycle of sine-wave form.

Typical Operation (Unless otherwise specified, values are for two tubes)

	CCS	CCS	CCS	
Dc plate voltage	12.0	14.0	18.0	kV
Peak af grid to grid voltage	1520	1560	2340	volts
Dc grid voltage	-260	-320	-440	volts
Zero signal dc plate current	0.5	0.5	0.5	amps
Maximum signal dc plate current	11.6	10.3	15.6	amps
Effective load resistance plate to plate	2432	3380	2880	ohms
Maximum signal driving power, approx	856	740	1930	watts
Maximum signal power output, approx	100	100	200	kW

WL-5936

Pliotron
86-273 Data Sheet

WESTINGHOUSE ELECTRONIC TUBES

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS (Cont'd)

Plate-Modulated rf Power Amplifier, Class C Telephony

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	14	kV max
Dc grid voltage	-2000	volts max
Dc plate current	5.0	amps max
Dc grid current	2.0	amps max
Plate input	70	kW max
Plate dissipation	46	kW max

Typical Operation	CCS	CCS	
Dc plate voltage	12.5	12.5	kV
Peak rf plate voltage	11.5	11.5	kV
Dc grid voltage	-1500	-1500	volts
Peak rf grid voltage	1975	2200	volts
Dc plate current	2.45	4.8	amps
Dc grid current, approx	0.43	0.9	amps
Driving power, approx	820	2000	watts
Power output, approx	27	50	kW

Rf Power Amplifier and Oscillator, Class C Telegraphy

Key-down conditions per tube without amplitude modulation§

Maximum Ratings, Absolute Values	CCS	
Dc plate voltage	18.0.	kV max
Dc grid voltage	-2000	volts max
Dc plate current	10.0	amps max
Dc grid current	2.0	amps max
Plate input	180	kW max
Plate dissipation	70	kW max

Typical Operation	CCS	CCS	
Dc plate voltage	17.0	17.0	kV
Dc grid voltage	-800	-1400	volts
Peak rf grid voltage	1700	2500	volts
Dc plate current	9.6	10.0	amps
Dc grid current, approx	1.55	1.7	amps
Driving power, approx℄	2500	4500	watts
Power output, approx ℄	125	136	kW

§ Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

℄With essentially sine-wave excitation.

RATINGS VS. FREQUENCY

Maximum ratings apply up to 15 megacycles. The tube may be operated at higher frequencies provided the maximum values of plate voltage and power input are reduced according to the tabulation (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at these frequencies.

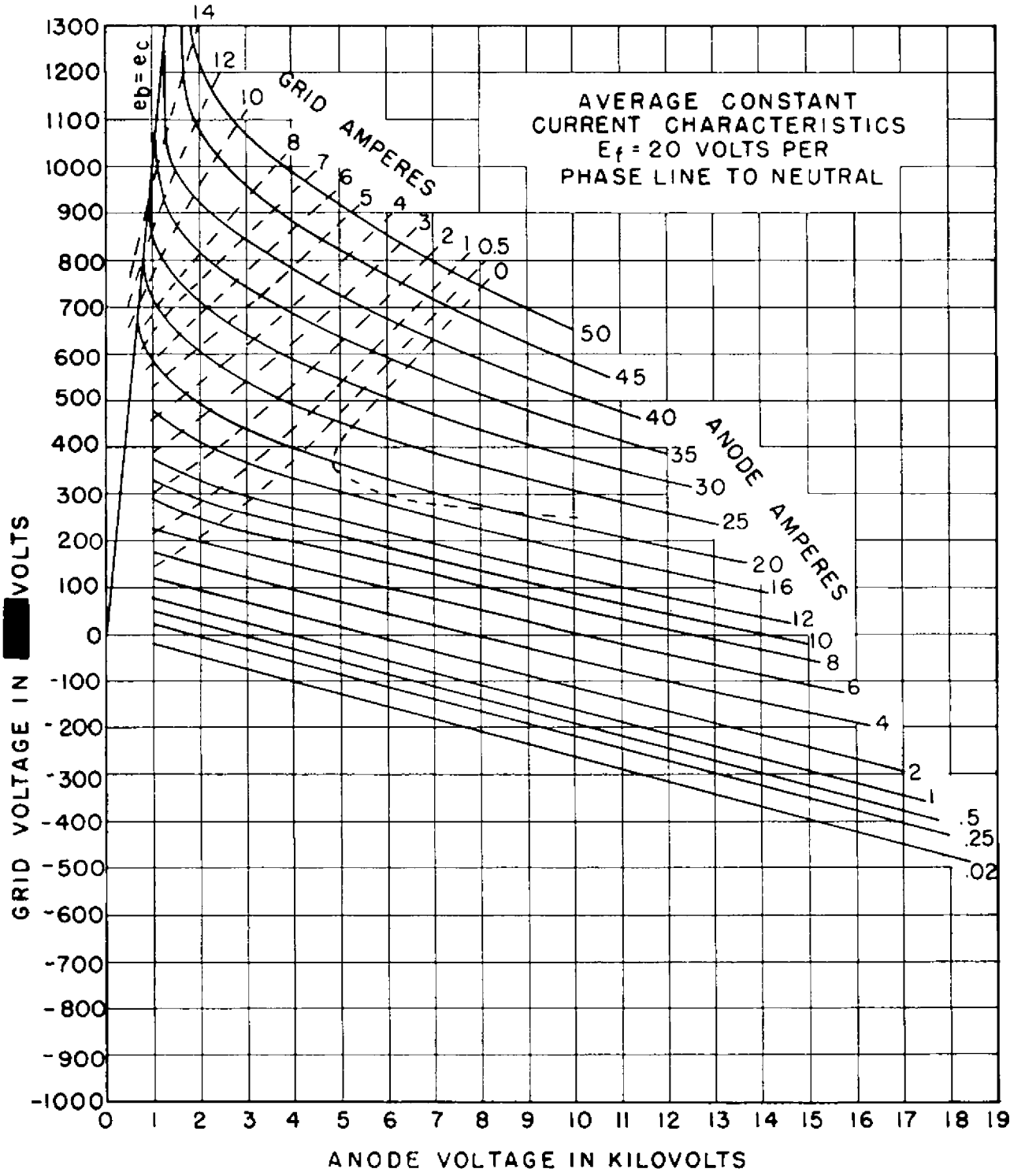
Frequency	15	20	25	mc
Percentage of maximum rated plate voltage and plate input				
Class C telephony	100	88	81	%
Class C telegraphy	100	82	70	%

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

Characteristics:	Conditions:		Limits Min	Bogey	Max	
Grid voltage	e_b= 2 kV; i_b= 40 a	e_c:			1100	v
Grid current	e_b= 2 kV; i_b= 40 a	i_c:			11.5	a
Plate voltage	E_c= 0 Vdc; I_b= 1.0 Adc	E_b:	3.1	3.8	4.5	kVdc
Plate voltage	E_c= -200 Vdc; I_b= 1.0 Adc	E_b:	10.1	11.5	12.9	kVdc
Grid voltage	E_b= 10 kVdc; I_b= .020 Adc	E_c:	-180	-250	-320	Vdc
Plate power output	Class C telegraphy, for F less than 15 megacycles.	P_o:	120			kW*

* With sine-wave excitation.

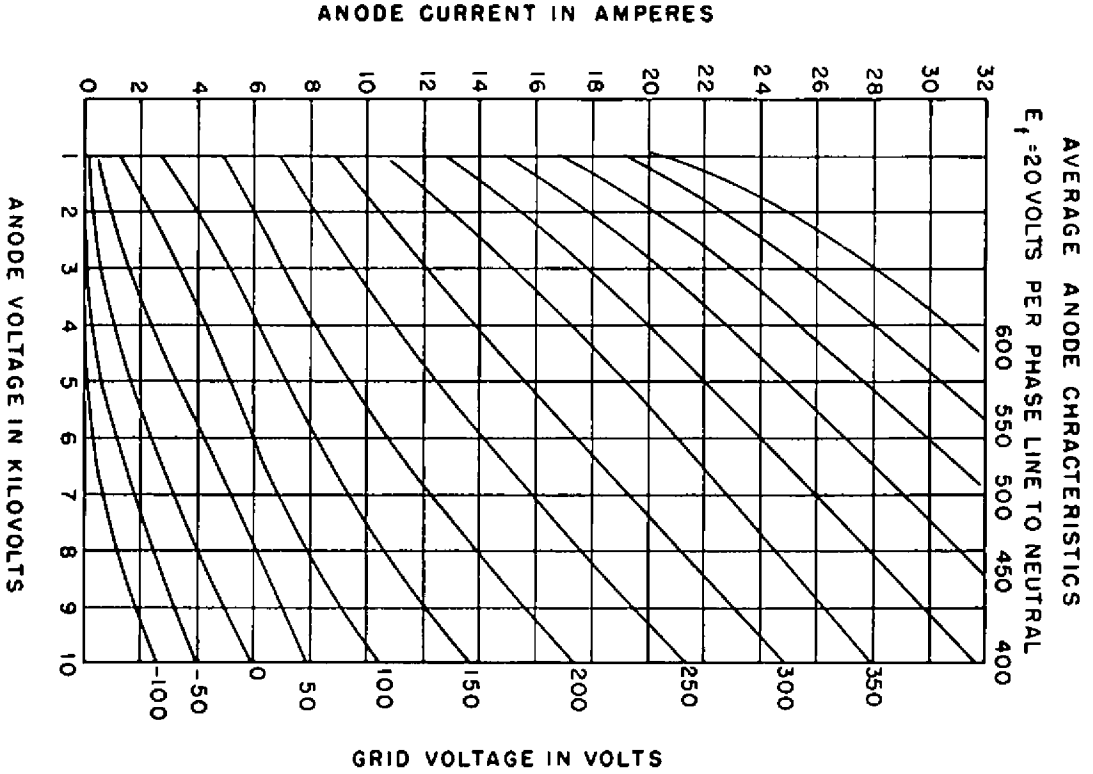
WESTINGHOUSE ELECTRONIC TUBES

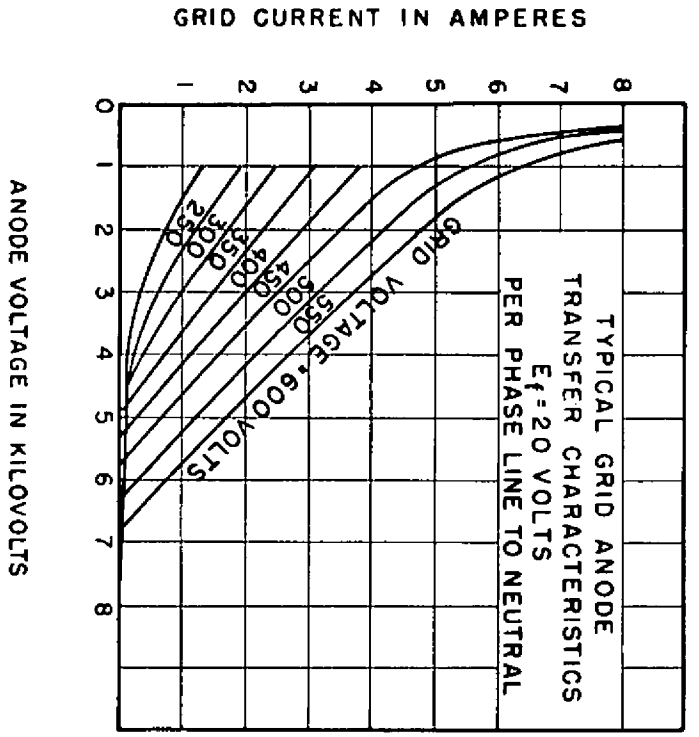


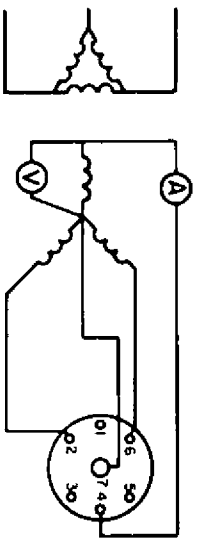
WL-5936

Pliotron
86-273 Data Sheet

WESTINGHOUSE ELECTRONIC TUBES







FILAMENT CONNECTIONS

THREE PHASE AC SUPPLY

FILAMENT TERMINALS 2,4,6 & 7 PAINTED BLACK
GRID TERMINALS 1,3,& 5 PAINTED RED

WESTINGHOUSE ELECTRIC CORPORATION
Electronic Tube Division
BLOOMFIELD, NEW JERSEY

Printed in U. S. A.

WESTINGHOUSE ELECTRIC CORPORATION

BLOOMFIELD, NEW JERSEY

12-17-51

DATA SHEET

Type 5939

Gas Switching Window Tube

Description

The 5939 tube is a fixed tuned gas switching window for use in pulsed systems operating at frequencies in the 1300 megacycle region. A pair of these tubes, spaced as specified below, constitutes a broad-band pre-TR device.

Mechanical Data

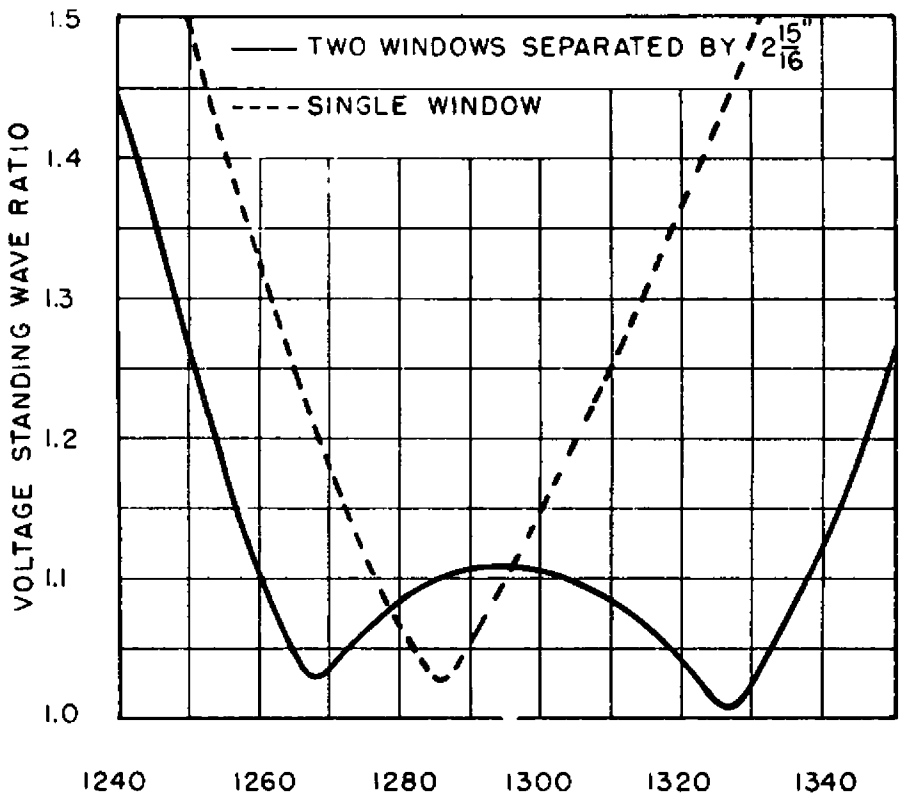
Outline Dimensions, Drawing No. 60158-B
Window consists of a metal plate and gas-filled glass bulb.

Mounting

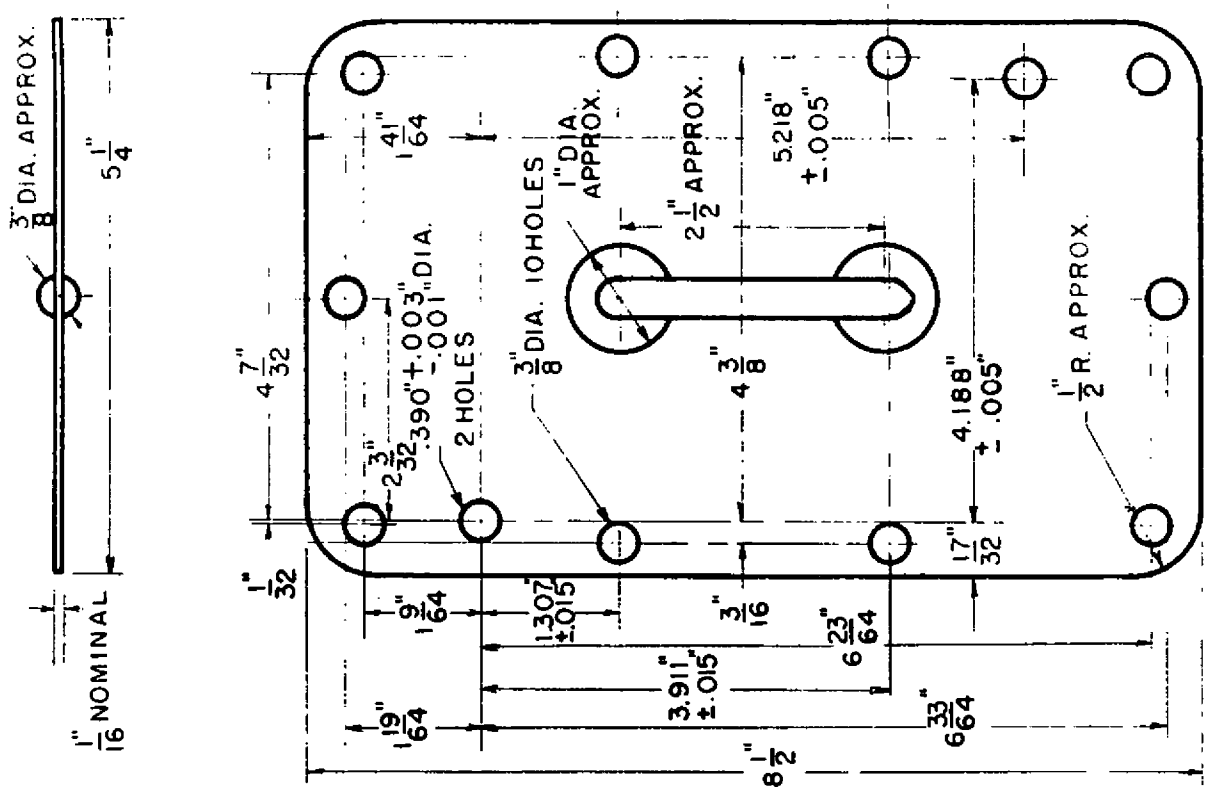
The tube may be mounted in any position. It should be clamped between suitable gaskets to flanges UG-368/U (female) and UG-369/U (male) soldered to RG-69/U waveguide.

Ratings	Maximum	Nominal	Minimum	Units
Peak Power	800	500		KW
Average power	500			W
Pulse Duration	4			µs
Duty Cycle	.001	.0006		
Ambient Temperature	60		-20	°C
Life(at 500 KW, 4 µs, 150 pps)		2000	500	hrs.
Electrical Data - Single Window				
Resonant Frequency	1292		1280	Mc/sec.
Low Level Input V.S.W.R.		See Graph		
Loaded Q	3.4			
Insertion Loss at Resonance	0.3			db
Leakage Power, Average over Pulse at 500 KW, 4 µs, 150 pps	6.0	4.5		KW
Leakage Power, Average over Pulse at 500 KW, 1 µs, 600 pps	6.5	5.0		KW
Recovery Time at 500 KW, 3 db down	36	<12		µs
Arc Loss at 500 KW	0.08			db
Minimum Firing Power at 4 µs, 150 pps	8	3(approx.)		KW
Minimum Firing Power at 1 µs, 600 pps	6	2(approx.)		KW
Electrical Data - Two Windows, Separation 2-15/16" Between Centerlines				
Operational Band	1350		1250	Mc/sec.
Low Level Input VSWR over the Band	1.4(See Graph)			
Insertion Loss	0.6			db
Leakage Power, Recovery Time, Arc Loss, Minimum Firing Power	Same as for single window above.			

Type 5939



CURVES OF VOLTAGE STANDING WAVE RATIO VS FREQUENCY FOR A SINGLE WINDOW AND FOR A COMBINATION OF TWO WINDOWS RESONANT AT 1286 MC/SEC.



WESTINGHOUSE ELECTRIC CORPORATION

ELECTRON TUBE

TUBE TYPE 5966

The type 5966 tube is a special triode designed for ionization vacuum gauge service. It can be used to measure pressures as low as 10^{-10} mm Hg. The cathode is a pure tungsten filament.

ELECTRICAL DATA (Approximate)

Filament and Voltage*	6 ac or dc volts
Filament and current	2.5 amperes

MECHANICAL DATA

Outline Drawing Number	60150
Type of Cooling	Air
Maximum overall length (Including tubulation)	11-1/2 inches
Maximum Tube Radius	2-3/4 inches
Maximum Bulb Diameter	2-1/16inches
Bulb Glass Nonex	Code 772
Tubulation diameter, (Approx.)	1/2 inch
Operating Position	Vertical

MAXIMUM RATINGS

Ion Collector Voltage	-100 Volts
Grid Voltage	+500 Volts
Ambient Temperature	100° Centigrade
Maximum Gas Pressure	10^{-3} mm Hg.

TYPICAL OPERATION

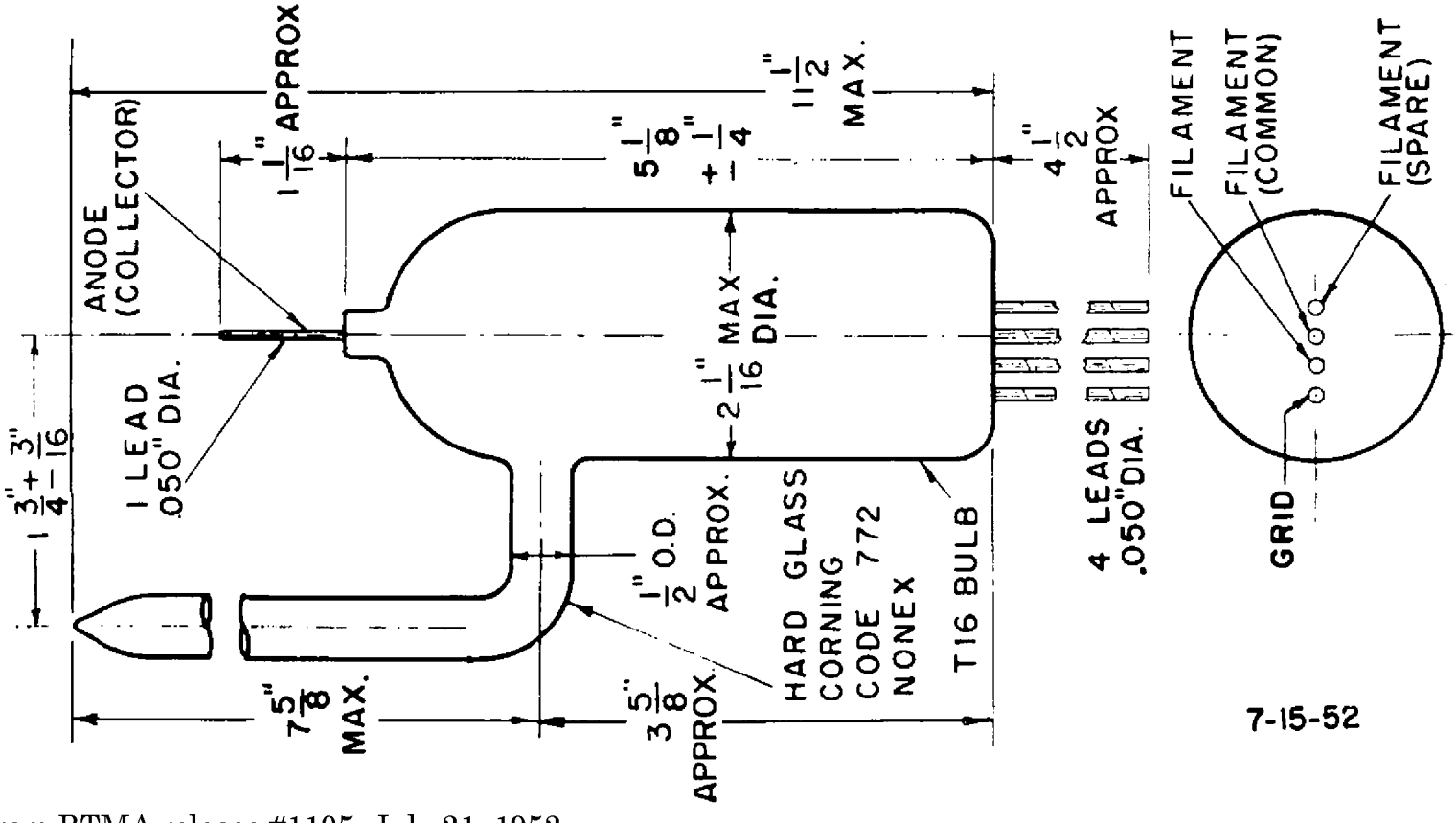
Ion Collector Voltage	-30 Volts
Grid Voltage	+150 Volts
Grid Current	10 Milliamperes
Sensitivity	1 μ amp/10^{-5} mm Hg.

CONDITIONS FOR OUTGASSING ELEMENTS

Grid Voltage	+500 Volts Max.
Ion Collector	Tied To Grid
Filament**	
Series Connection	15 Volts Max.
Parallel Connection	7.5 Volts Max.
Outgas Power on Grid & Ion Collector	100 Watts Max.

* Two Filaments are supplied, one of which is a spare.

** To outgas the ionization gauge, the two filaments may be connected either in series or parallel. Connect ion collector to grid and attach to +500 volts dc. Adjust emission current by raising filament voltage to give the desired operating condition to outgas the elements.



from RTMA release #1105, July 21, 1952

Westinghouse

WL-5973A

April 15, 1963

HIGH-VACUUM RECTIFIER TYPE WL-5973A

The WL-5973A is a two-electrode high-vacuum tube designed for service as a rectifier or surge-limiting diode. Design features include ruggedized anode and filament support structures, an efficient thoriated-tungsten filament, and a low tube-voltage-drop which allows the tube to carry high-average currents without exceeding rated plate dissipation.

In rectifier service, the tube will operate at average currents as high as 1.25 amperes at 40,000 volts and one ampere at higher voltages. In limiter service, ratings as high as 20 amperes at 75,000 volts apply. These ratings make the tube particularly suitable for use in radar as a charging diode to supply d.c. power to magnetrons or as a limiter to restrict fault currents. Other applications include high-voltage power supplies in cable-testing service and smoke precipitators.

ELECTRICAL

	Min.	Bogey	Max.	
Cathode	Thoriated-Tungsten Filament			
Filament:				
Voltage	15.2	16	16.8	Volts
Current at 16 Volts	18.0	19.1	20.2	Amperes
Starting Current	–	–	30	Amperes
Cold Resistance	–	0.1	–	Ohms
Heating Time	30	–	–	Seconds
Tube Voltage Drop at 5 Amperes:				
Plate Current	850	950	1050	Volts
Interelectrode Capacitance	–	14	–	$\mu\mu f$

RECTIFIER SERVICE

MAXIMUM RATINGS

Absolute Maximum Values

	40 KV or Less	more than 40 KV	
Peak Inverse Anode Voltage	75 max.		Kilovolts
Anode Current:			
Peak	5	5	max. Amperes
Average	1.25	1.00	max. Amperes
Plate Dissipation	850 (Note 2)	800 (Note 3)	max. Watts

LIMITER SERVICE

MAXIMUM RATINGS

Absolute Maximum Values

Peak Inverse Anode Voltage	75 max.	Kilovolts
Peak Anode Current	20 max.	Amperes
Plate Dissipation	800 max.	Watts

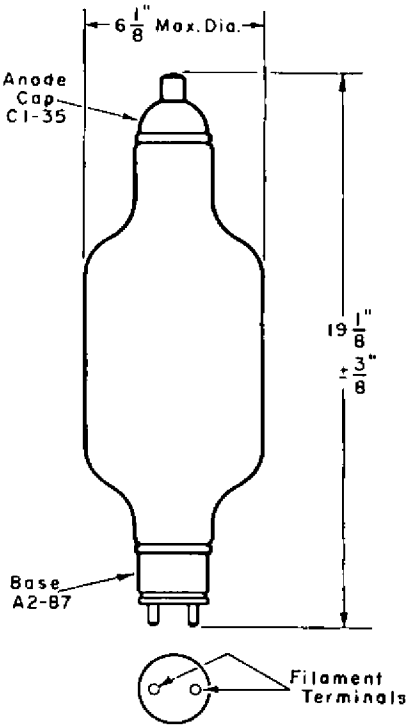
NOTES

1. Tubes enclosed or near other tubes may require forced-air cooling to limit bulb and base temperatures to rated values.
2. Observed temperature of 1010° C max. at any point on the anode.
3. Observed temperature of 985° C max. at any point on the anode.

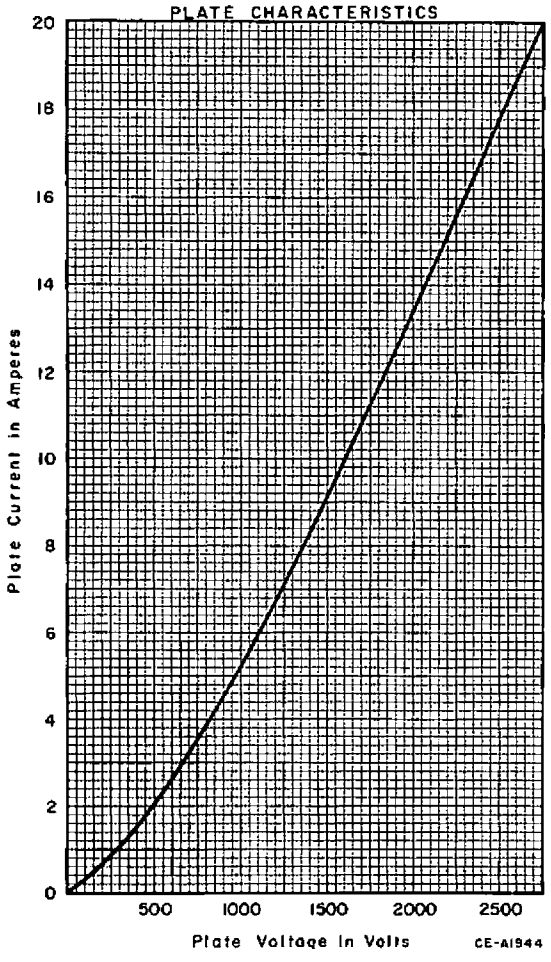
X-Ray Warning: Operation of the WL-5973A at voltages in excess of 16 kilovolts may necessitate x-ray radiation shielding to protect the user from possible danger of personal injury due to prolonged exposure at close range.

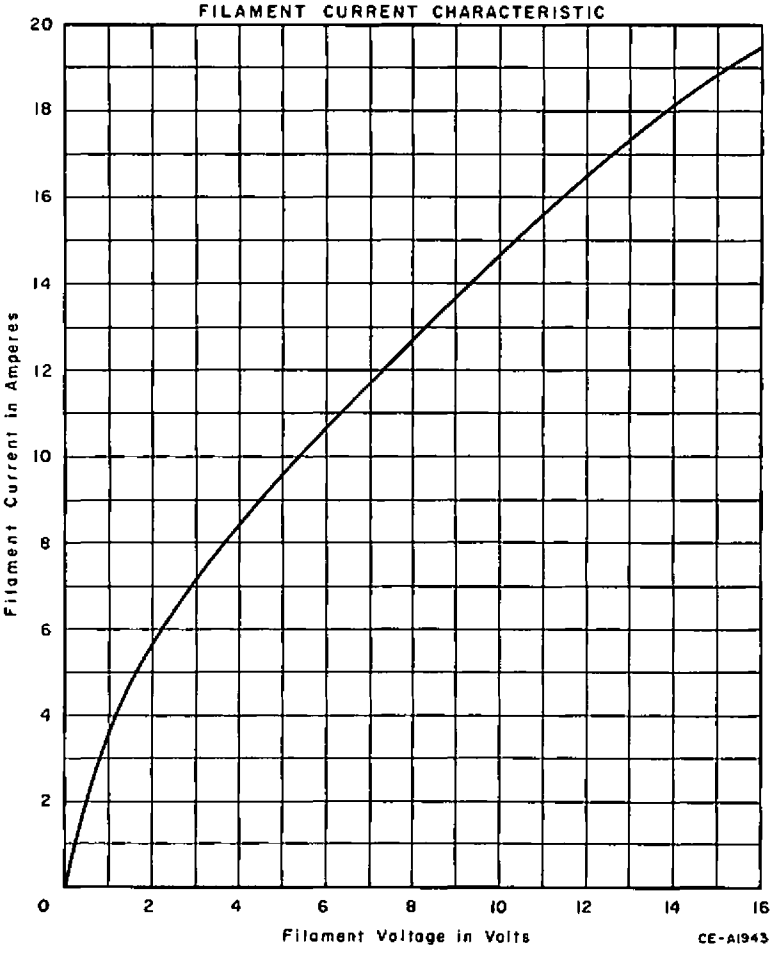
MECHANICAL

Type of Cooling (Note 1)	Radiation
Maximum Glass Temperature	300° C
Maximum Base Temperature	150° C
Mounting Position	Vertical, Base Down
Net Weight (Approx.)	3 Pounds



from JEDEC release #4244, April 29, 1963





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from RTMA release #935A, March 20, 1951

WESTINGHOUSE ELECTRIC CORPORATION

ELECTRON TUBE TYPE 5974

Release No. 935

December 5, 1950

The WL-3318 is a two-electrode high vacuum tube designed for use as an oil immersed rectifier. The cathode is a pure tungsten filament.

Mechanical Data

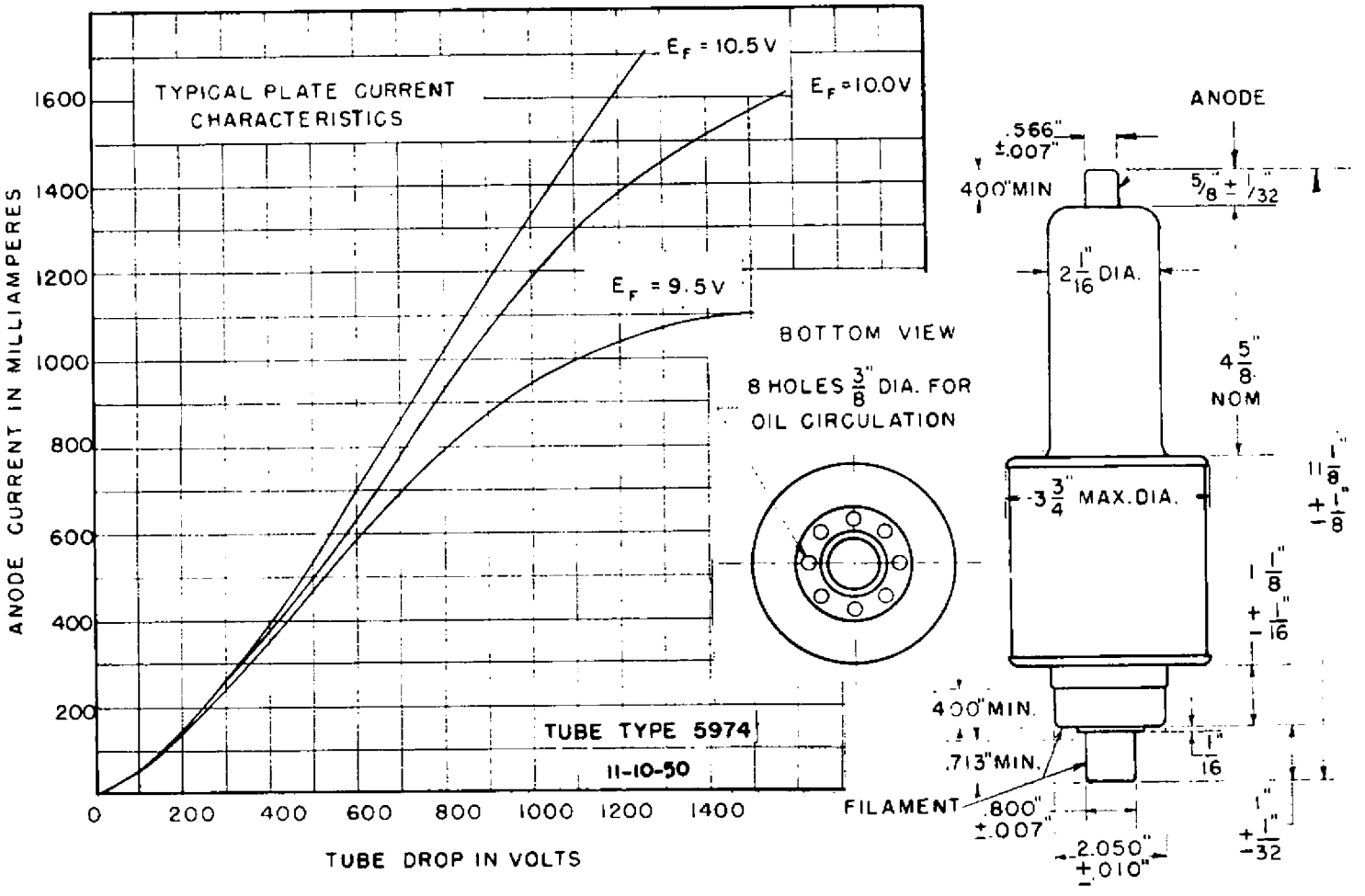
Outline Drawing Number	60151
Type of Cooling	Oil immersed
Mounting Position	Any

Electrical Data

Filament Voltage	10	Volts
Filament Current	50	Amperes
Filament Heating Time	10	Seconds
Tube Voltage Drop at I_b = 1.00 ampere	860	Volts

Maximum Ratings

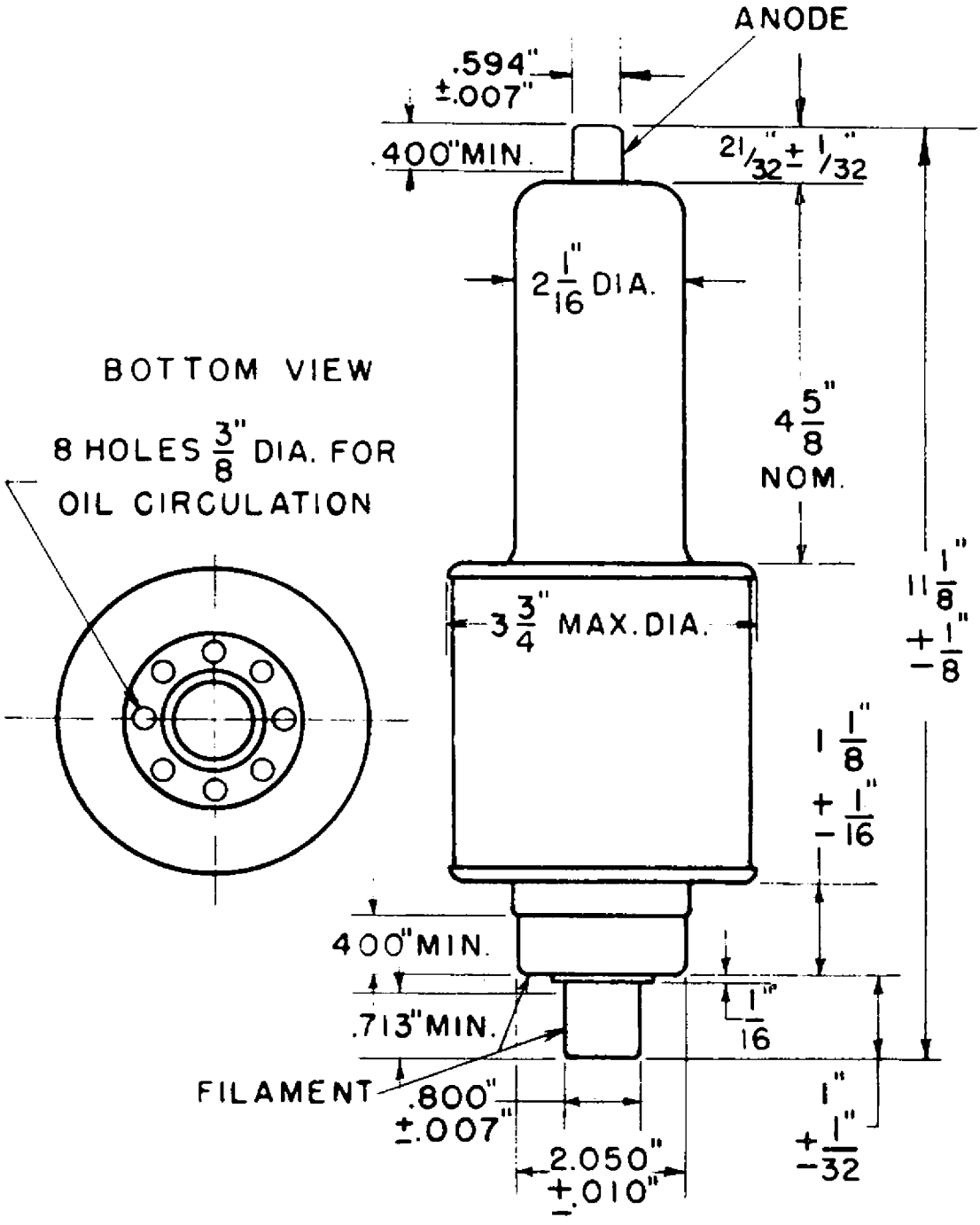
Maximum Peak Inverse Voltage	125	Kilovolts
Peak Plate Current	1.00	Ampere
Average Plate Current	0.30	Ampere
Average Plate Dissipation	750	Watts



Release No. 935A

March 20, 1951

WESTINGHOUSE ELECTRIC CORPORATION
ELECTRON TUBE
TUBE TYPE 5974



POWER AMPLIFIER TRIODE TYPE WL-5986

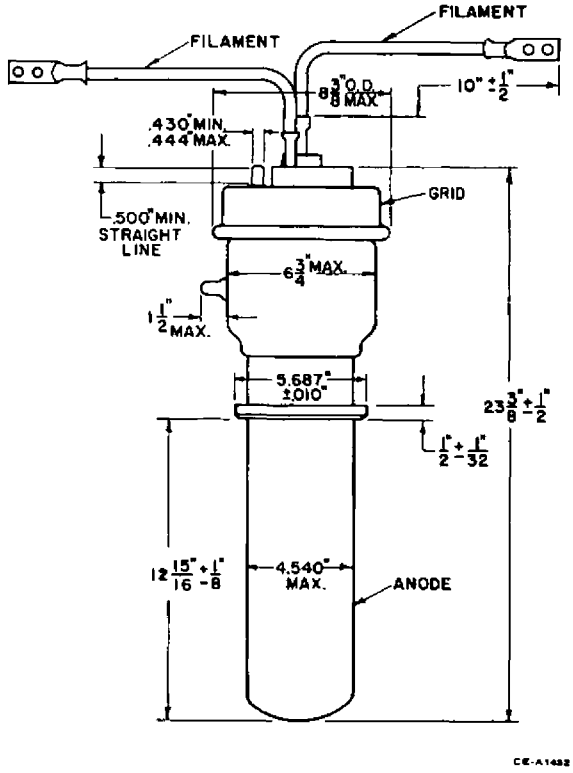
The WL-5986 is a three-electrode tube designed for use as an oscillator or amplifier. The anode is water cooled and is capable of dissipating 70 kilowatts. The cathode is a thoriated tungsten filament. Maximum ratings apply upto 15 megacycles.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament			
Filament:	Min.	Bogey	Max.	
Voltage	11.5	12.0	12.5	Volts
Current at Bogey Voltage	275	300	315	Amperes
Heating Time	15	--	--	Seconds
Amplification Factor with Plate Amps=1.0 & Grid Volts= -200			37	
Direct Interelectrode Capacitances (approx.):				
Grid to Plate			37	μμf
Grid to Filament			90	μμf
Plate to Filament			6	μμf

MECHANICAL:

Mounting Position	Vertical, Anode Down
Type of Cooling	Water
Minimum Water Flow	30 GPM
Maximum Outlet Water Temperature	70 °C
Air Flow to Filament and Grid Seals	30 CFM
Maximum Bulb Temperature	180 °C
Maximum Seal Temperature	165 °C
Net Weight (approx.)	28 Pounds



Radio Frequency Power Amplifier and Oscillator Class C Telegraphy (Key down conditions pertube without modulation)

MAXIMUM RATINGS♦

Absolute Maximum Values:			
DC Plate Voltage	17500	max.	Volts
DC Grid Voltage	-2400	max.	Volts
DC Plate Current	15.0	max.	Amperes
DC Grid Current	2.0	max.	Amperes
Plate Power Input	200	max.	Kilowatts
Plate Dissipation	70	max.	Kilowatts
Typical Operating Characteristics:			
DC Plate Voltage	1700		Volts
DC Grid Voltage	-1500		Volts
Peak RF Grid Voltage	2290		Volts
DC Plate Current	10.6		Amperes
DC Grid Current (approx.)	1.95		Amperes
Driving Power (approx.)	4.25		Kilowatts
Power Output (approx.)	136		Kilowatts

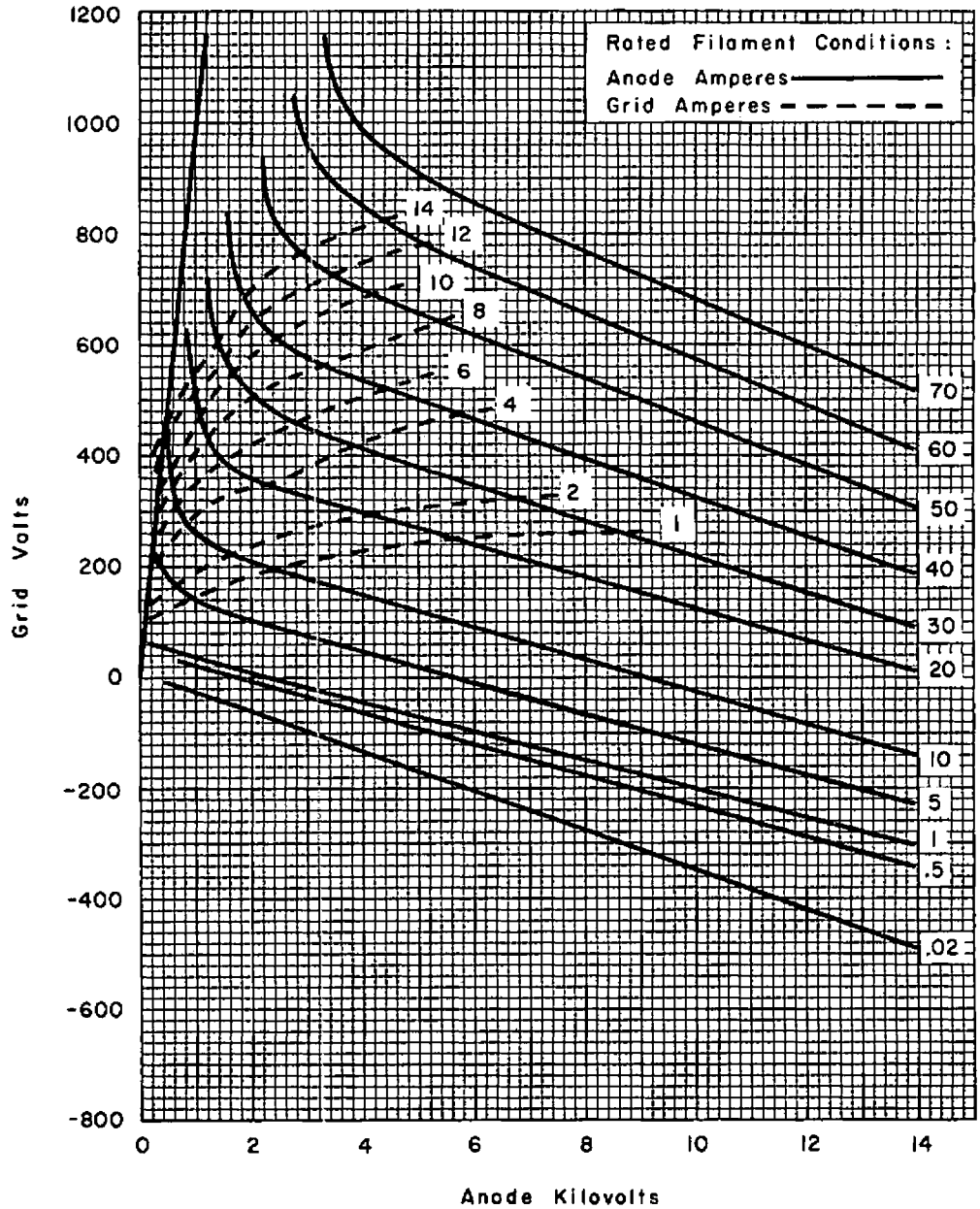
♦ Maximum ratings apply up to 15 megacycles. The tube may be operated at higher frequencies with reduced maximum plate voltage and plate power input as shown below. At the higher frequencies, special attention must be given to cooling. Increased air flow as high as 250 CFM may be required to maintain bulb and seal temperatures.

Frequency Derating Chart

Frequency	15	20	30	Megacycles
Maximum Permissable:				
DC Plate Voltage	100	90	78	Percent
Plate Power Input	100	90	78	Percent

from JEDEC release #2465, May 18, 1959

AVERAGE CONSTANT CURRENT CHARACTERISTICS



August 11, 1955

WL-5997
Image Intensifier

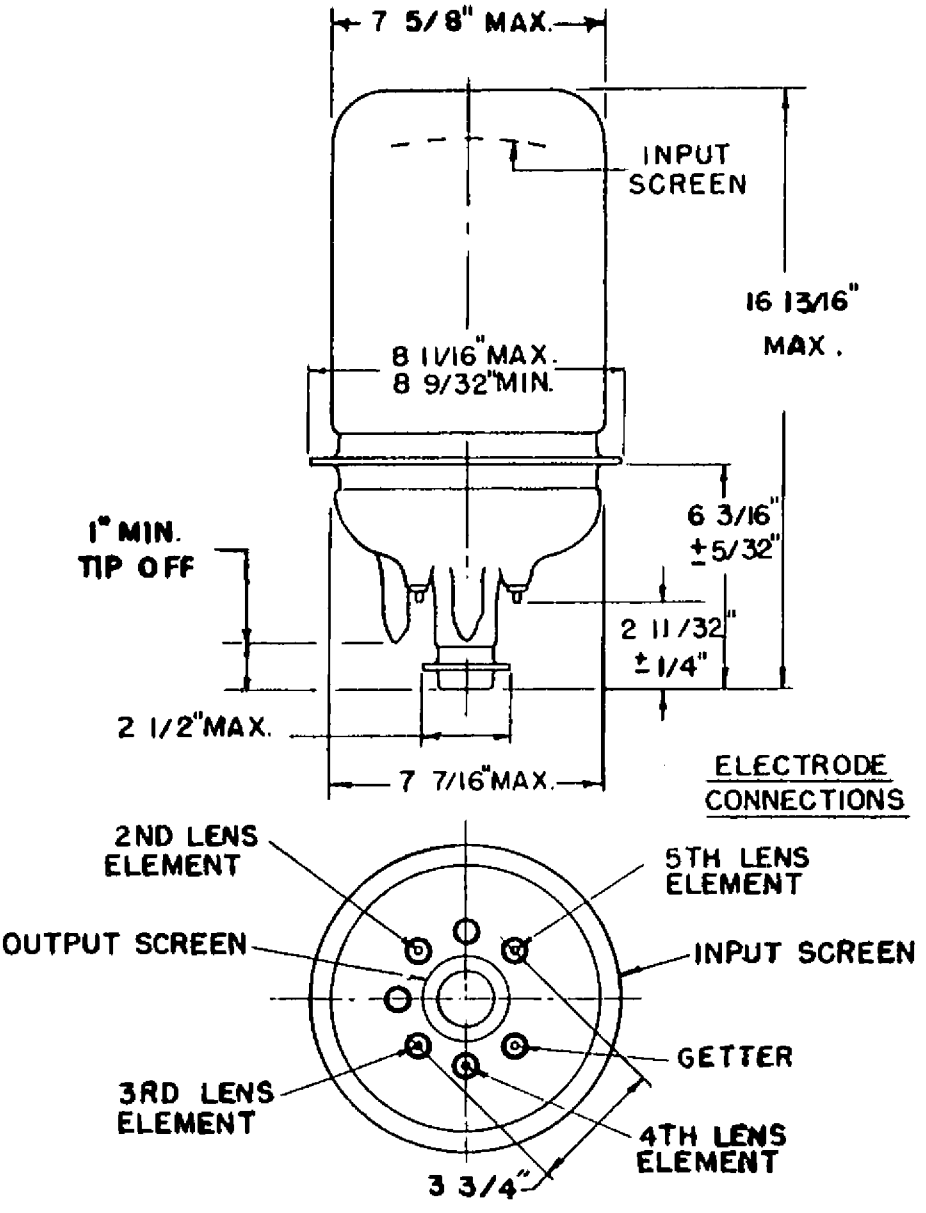
The WL-5997 is a high vacuum tube designed to transduce x-radiation to visible radiation by electronic means. This tube produces an image of reduced size having a brightness increase of at least 200 times. X-radiation passing through the subject impinges on an input fluorescent screen 5 inches in diameter; a photoelectric surface in intimate contact with the input fluorescent screen converts the x-ray image to an electron image. The electron image is focused and accelerated toward a metal-backed phosphor screen one inch in diameter. The resulting fluorescent image is viewed in true orientation to the subject, by a suitable optical system, and nearly in original size. Fluoroscopy can be performed in a lighted room without dark adaptation of the observer's eyes.

GENERAL DATA

Brightness Intensification	200 x	min.
Minification Ratio (Approx.)	5:1	
Definition of unfiltered tube		
45-mesh over 50% (min.) of screen area		
35-mesh over 95% (min.) of screen area		

Operating Voltages:		
Output Screen Voltage	30 max.	kv.
No. 5 Lens	4.8	kv.
No. 4 Lens	1.8	kv.
No. 3 Lens	0.68	kv.
No. 2 Lens	0.2	kv.
No. 1 Lens		ground
Cathode		ground
Operating Current	250	μa

from JETEC release #1510, Aug, 29, 1955


7 5/8" MAX.
INPUT SCREEN
16 13/16" MAX.
8 1/16" MAX.
8 9/32" MIN.
1" MIN. TIP OFF
6 3/16" ±5/32"
2 11/32" ±1/4"
2 1/2" MAX.
7 7/16" MAX.
ELECTRODE CONNECTIONS
2ND LENS ELEMENT
5TH LENS ELEMENT
OUTPUT SCREEN
INPUT SCREEN
GETTER
3RD LENS ELEMENT
4TH LENS ELEMENT
3 3/4"

Release No. 992
July 6, 1951

WESTINGHOUSE ELECTRIC CORPORATION
Bloomfield, New Jersey

Type 6040
Reference Cavity

The 6040 is a fixed frequency, transmission type, vacuum sealed, reference cavity for use at 9308 megacycles as a frequency determining reference.

Electrical Data - General

Resonant Frequency	9308	Mc
Loaded Q	2100	
Insertion Loss at Resonant Frequency	5	db

Mechanical Data - General

Can be Pressurized		
Ambient Temperature Range	-40 to +100	°C
Net Weight (approximately)	3/4	lb
Mounting Position	Any	
Outline Drawing Number	60136	

Maximum Ratings

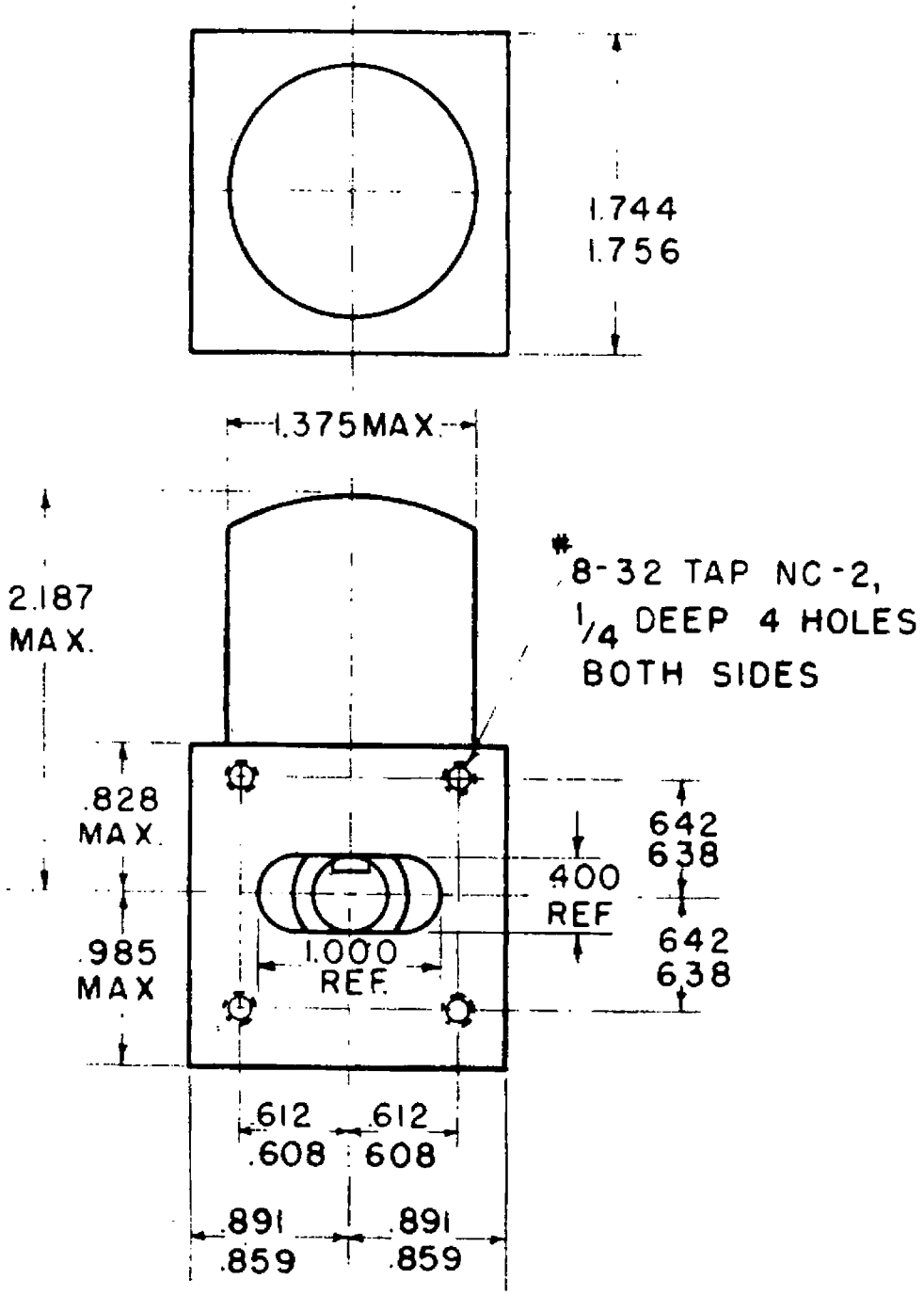
Incident Peak Power	5	Kw

Electrical and Mechanical Data with Limits

Change in Resonant Frequency with Vibration 10 g.	± .1	Mc max.
Change in Resonant Frequency with Pressure from atmospheric to 125 mm of mercury or to 3 atmospheres.	± .15	Mc max.
Change in Resonant Frequency with Temperature from Room Temperature to -40°C or +100°C.	± .3	Mc max.
Change in Resonant Frequency due to mechanical creep.	± .3	Mc max.

Release No. 992
July 6, 1951

WESTINGHOUSE ELECTRIC CORPORATION
ELECTRON TUBE
TUBE TYPES 6040 & 6041



Release No. 992
July 6, 1951

WESTINGHOUSE ELECTRIC CORPORATION
Bloomfield, New Jersey

Type 6041
Reference Cavity

The 6041 is a fixed frequency, transmission type, vacuum sealed, reference cavity for use at 9312 megacycles as a frequency determining reference.

Electrical Data - General

Resonant Frequency	9312	Mc
Loaded Q	2100	
Insertion Loss at Resonant Frequency	5	db

Mechanical Data - General

Can be Pressurized		
Ambient Temperature Range	-40 to +100	°C
Net Weight (approximately)	3/4	lb
Mounting Position	Any	
Outline Drawing Number	60136	

Maximum Ratings

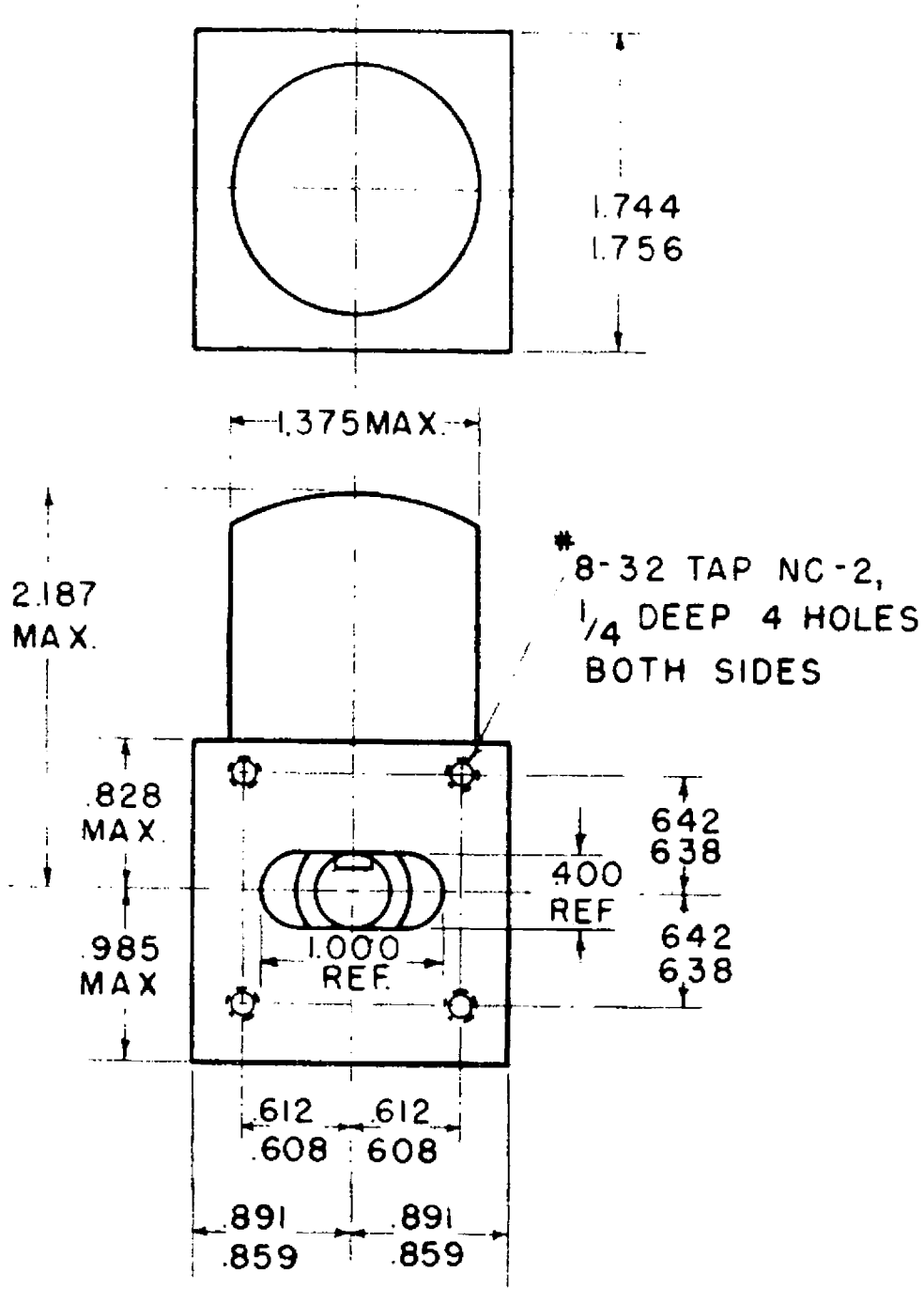
Incident Peak Power	5	Kw

Electrical and Mechanical Data with Limits

Change in Resonant Frequency with Vibration 10 g.	± .1	Mc max.
Change in Resonant Frequency with Pressure from Atmospheric to 125 mm of Mercury or to 3 Atmospheres.	± .15	Mc max.
Change in Resonant Frequency with Temperature from Room Temperature to -40°C or to +100°C	± .3	Mc max.
Change in Resonant Frequency due to Mechanical Creep	± .3	Mc max.

Release No. 992
July 6, 1951

WESTINGHOUSE ELECTRIC CORPORATION
ELECTRON TUBE
TUBE TYPES 6040 & 6041



Release No. 976

May 25, 1951

Type 6089
Reference Cavity

The 6089 is a fixed frequency, transmission type, vacuum sealed, reference cavity for use at 9280 megacycles as a frequency determining reference.

Electrical Data - General

Resonant Frequency	9280	Mc
Loaded Q	2100	
Insertion Loss at Resonant Frequency	5	db

Mechanical Data - General

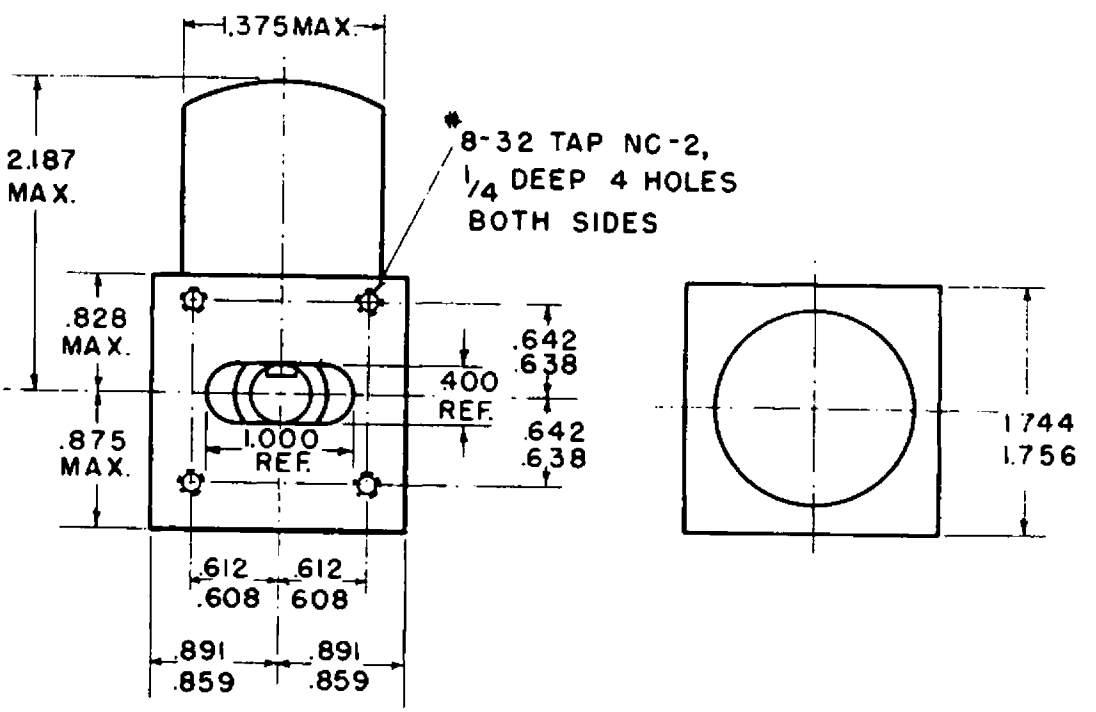
Can be Pressurized		
Ambient Temperature Range	-40 to +100	°C
Net Weight (approximately)	3/4	lb.
Mounting Position	Any	
Outline Drawing Number	60159	

Maximum Ratings

Incident Peak Power	5	Kw

Electrical and Mechanical Data with Limits

Change in Resonant Frequency with Vibration 10 g.	+ or - .1	Mc max.
Change in Resonant Frequency with Pressure from atmospheric to 125 mm of mercury or to 3 atmospheres.	+ or - .15	Mc max.
Change in Resonant Frequency with Temperature from Room Temperature to -40°C or + 100°C.	+ or - .3	Mc max.
Change in Resonant Frequency due to mechanical creep.	+ or - .3	Mc max.



WESTINGHOUSE ELECTRIC CORPORATION
Bloomfield, New Jersey

HIGH-VACUUM DIODE 6102

Oil-Immersion Type
Small Size

40 Kv. Peak Inverse Voltage
Light Weight

The high-vacuum diode type 6102 is designed for use in rectifier applications involving peak inverse voltages up to 40 kv. The maximum average current is 150 ma. and the peak current is 900 ma. The 6102 has a thoriated tungsten filament and is intended for oil-immersed installation.

GENERAL DATA

Electrical:

	Min.	Center	Max.	
Filament Type (See Note II)		Thoriated Tungsten		
Filament Voltage	4.75	5.0	5.25	Volts
Filament Current at center volts	6.8	7.2	7.6	Ampere
Filament Heating Time	3	---	---	Seconds
Tube Voltage Drop (Ib = 150 ma)		300		Volts

Mechanical:

Mounting (See Note I)	Special	
Mounting Position	Vertical, plate up or down	
Cooling	Oil Immersion	
Glass Bulb Temperature	180 max.	°C
Seal Temperature	180 max.	°C
Oil Temperature (See Note III)	80 max.	°C
Net Weight	3.5	ounces

MAXIMUM RATINGS
Absolute Values

Rectifier Service:

Peak Inverse Voltage	40	max.	Kv.
Peak Plate Current	.900	max.	Ampere
Average Plate Current	.150	max.	Ampere
Average Plate Dissipation	140	max.	Watts

TYPICAL OPERATION

Single-Phase, Full-Wave:

Full Transformer Secondary Voltage (Erms)	28300	Volts
D-C Output Voltage to Filter	12700	Volts
D-C Output Current	.300	Ampere

Single-Phase, Full-Wave Bridge:

Transformer Secondary Voltage (Erms)	28300	Volts
D-C Output Voltage to Filter	25400	Volts
D-C Output Current	.300	Ampere

Three-Phase, Half-Wave:

Transformer Secondary Voltage (Erms) Line to Neutral	16400	Volts
D-C Output Voltage to Filter	19100	Volts
D-C Output Current	.450	Ampere

Three-Phase, Double-Y Parallel (See Note V):

Transformer Secondary Voltage (Erms) Line to Neutral	14100	Volts
D-C Output Voltage to Filter	16500	Volts
D-C Output Current	.900	Ampere

Three-Phase, Full-Wave Bridge:

Transformer Secondary Voltage (Erms) Line to Neutral	16400	Volts
D-C Output Voltage to Filter	38000	Volts
D-C Output Current	.450	Ampere

NOTES

I. Mounting
The 6102 should be supported by the plate terminal so that the axis of the tube is vertical with the plate terminal either up or down. Flexible leads should be provided for the filament connections to prevent strain on the tube seals.

II. Filament
The filament of the 6102 is designed for a-c operation from a transformer secondary winding. The filament voltage measured at the tube terminals should not vary more than 5% from the rated value, including the effects of power-supply regulation. The filament voltage should be applied at least 3 seconds before plate voltage is applied. Safety precautions should be observed when the filament voltage is measured in cases where the filament is at a high potential.

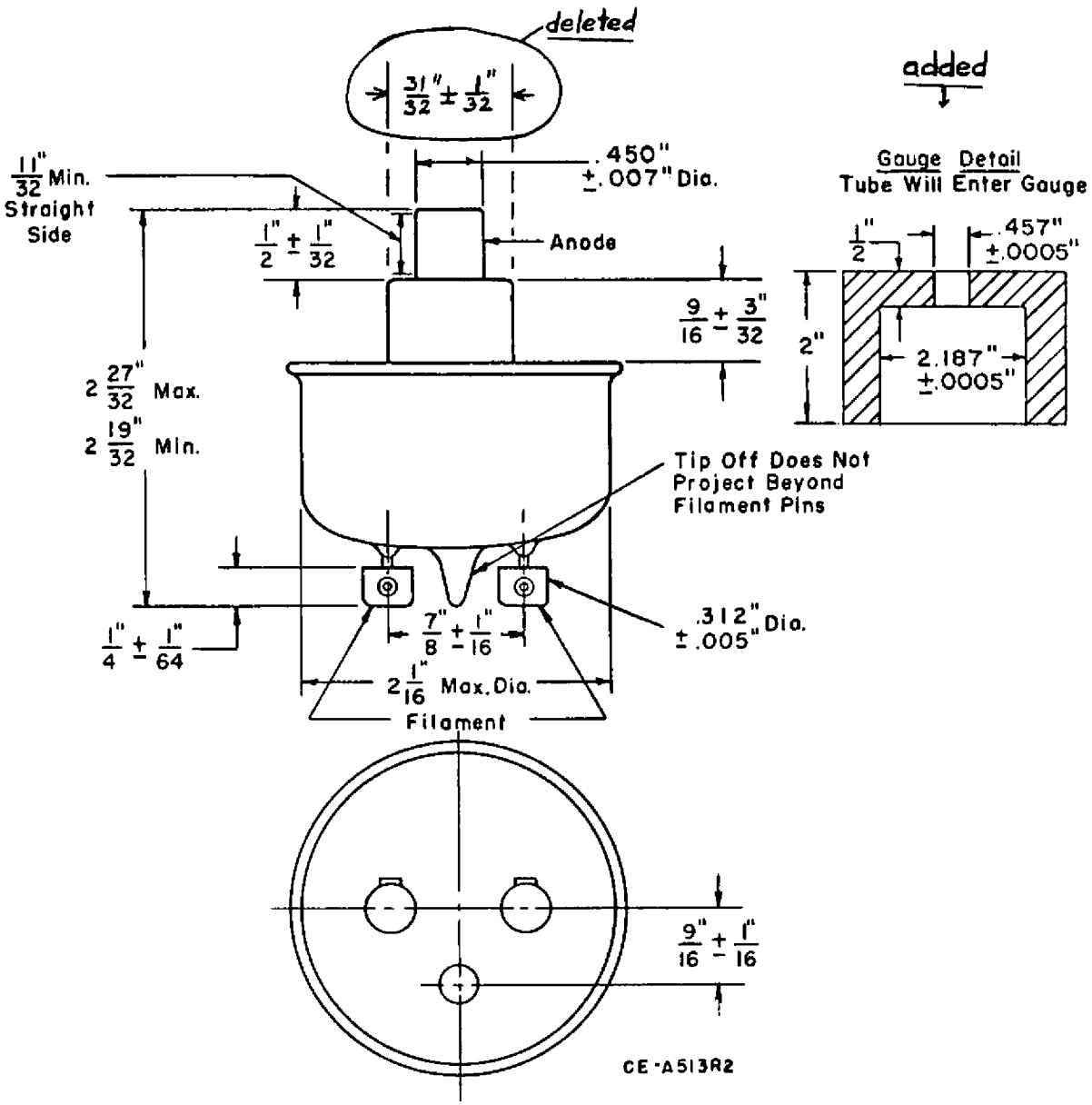
III. Oil Temperature
The local oil temperature is to be measured 1/8" radially outward from the outside of the anode in the plane of the anode seal. This temperature should not exceed 80°C max. as measured with a thermocouple.

IV. Filter Input
Filter circuits of the condenser-input type may be employed; the capacity of the condenser must be such that the peak plate current rating will not be exceeded. Choke-input filters may be preferred in order to obtain the largest average d-c output current under the most favorable conditions.

V. No Load
Under no load conditions, the peak inverse voltage across the tube will rise 15%.

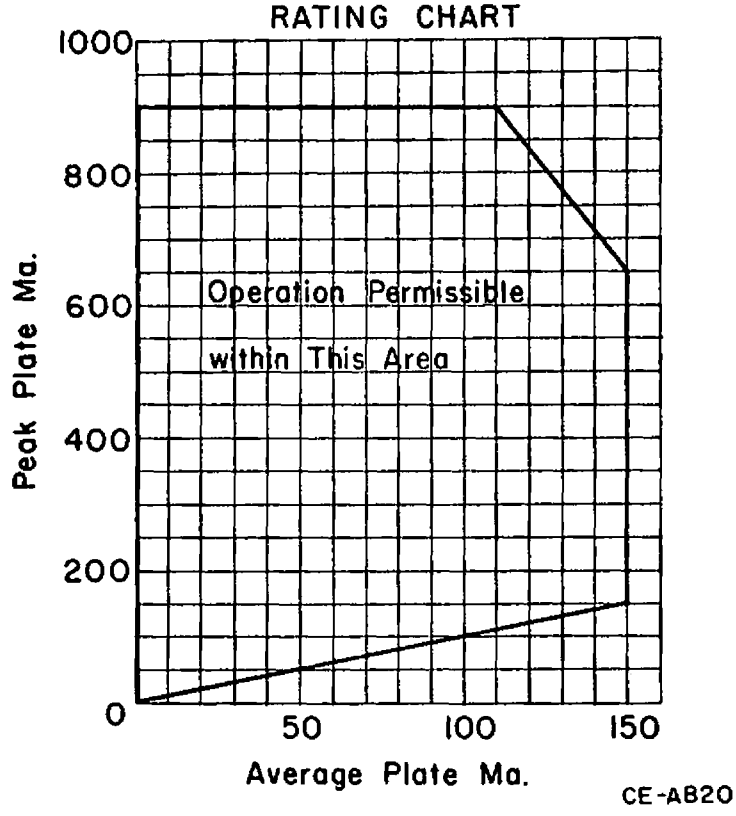
VI. General
The allowable load currents shown under "Typical Operation" are for ideal conditions; circuit regulation and other factors will reduce these currents in practical installations.

6102 OUTLINE



July 15, 1954

Type 6102


RATING CHART
1000
800
600
400
200
0
Peak Plate Ma.
Operation Permissible
within This Area
50
100
150
Average Plate Ma.
CE-A820

HIGH-VACUUM DIODE 6103

Forced-Air Cooled Type
Small Size

20 Kv. Peak Inverse Voltage
Light Weight

The high-vacuum diode type 6103 is designed for use in rectifier applications involving peak inverse voltages up to 20 kv. The maximum average current is 150 ma. and the peak current is 900 ma. The 6103 has a thoriated tungsten filament and is intended for forced-air cooling installation.

GENERAL DATA

Electrical:

	Min.	Center	Max.	
Filament Type (See Note II)		Thoriated Tungsten		
Filament Voltage	4.75	5.0	5.25	Volts
Filament Current at center volts	6.8	7.2	7.6	Ampere
Filament Heating Time	3	---	---	Seconds
Tube Voltage Drop (Ib = 150 ma)		300		Volts

Mechanical:

Mounting (See Note I)	Special
Mounting Position	Vertical, plate up or down
Cooling (See Note III)	Forced Air
	Air flow of 50 cu. ft. per min. is required to be directed into the open side of the radiator.
Static Back Pressure	less than 0.1 inches water
Temperature of Input Air	45 max. °C
Radiator Temperature	200 max. °C
Seal Temperature	180 max. °C
Net Weight	8-1/2 ounces

MAXIMUM RATINGS
Absolute Values

Rectifier Service:

Peak Inverse Voltage	20	max.	Kv.
Peak Plate Current	.900	max.	Ampere
Average Plate Current	.150	max.	Ampere
Average Plate Dissipation	140	max.	Watts

TYPICAL OPERATION

Single-Phase, Full Wave:

Full Transformer Secondary Voltage (Erms)	14100	Volts
D-C Output Voltage to Filter	6300	Volts
D-C Output Current	.300	Ampere

Single-Phase, Full-Wave Bridge:

Transformer Secondary Voltage (Erms)	14100	Volts
D-C Output Voltage to Filter	12700	Volts
D-C Output Current	.300	Ampere

Three-Phase, Half-Wave:		
Transformer Secondary Voltage (Erms) Line to Neutral	8200	Volts
D-C Output Voltage to Filter	9500	Volts
D-C Output Current	.450	Ampere
Three-Phase, Double-Y Parallel (See Note V):		
Transformer Secondary Voltage (Erms) Line to Neutral	7000	Volts
D-C Output Voltage to Filter	8300	Volts
D-C Output Current	.900	Ampere
Three-Phase, Full-Wave Bridge:		
Transformer Secondary Voltage (Erms) Line to Neutral	8200	Volts
D-C Output Voltage to Filter	19000	Volts
D-C Output Current	.450	Ampere

NOTES

I. Mounting
The 6103 should be supported by the plate terminal so that the axis of the tube is vertical with the plate terminal either up or down. Flexible leads should be provided for the filament connections to prevent strain on the tube seals.

II. Filament
The filament of the 6103 is designed for a-c operation from a transformer secondary winding. The filament voltage measured at the tube terminals should not vary more than 5% from the rated value, including the effects of power-supply regulation. The filament voltage should be applied at least 3 seconds before plate voltage is applied. Safety precautions should be observed when the filament voltage is measured in cases where the filament is at a high potential.

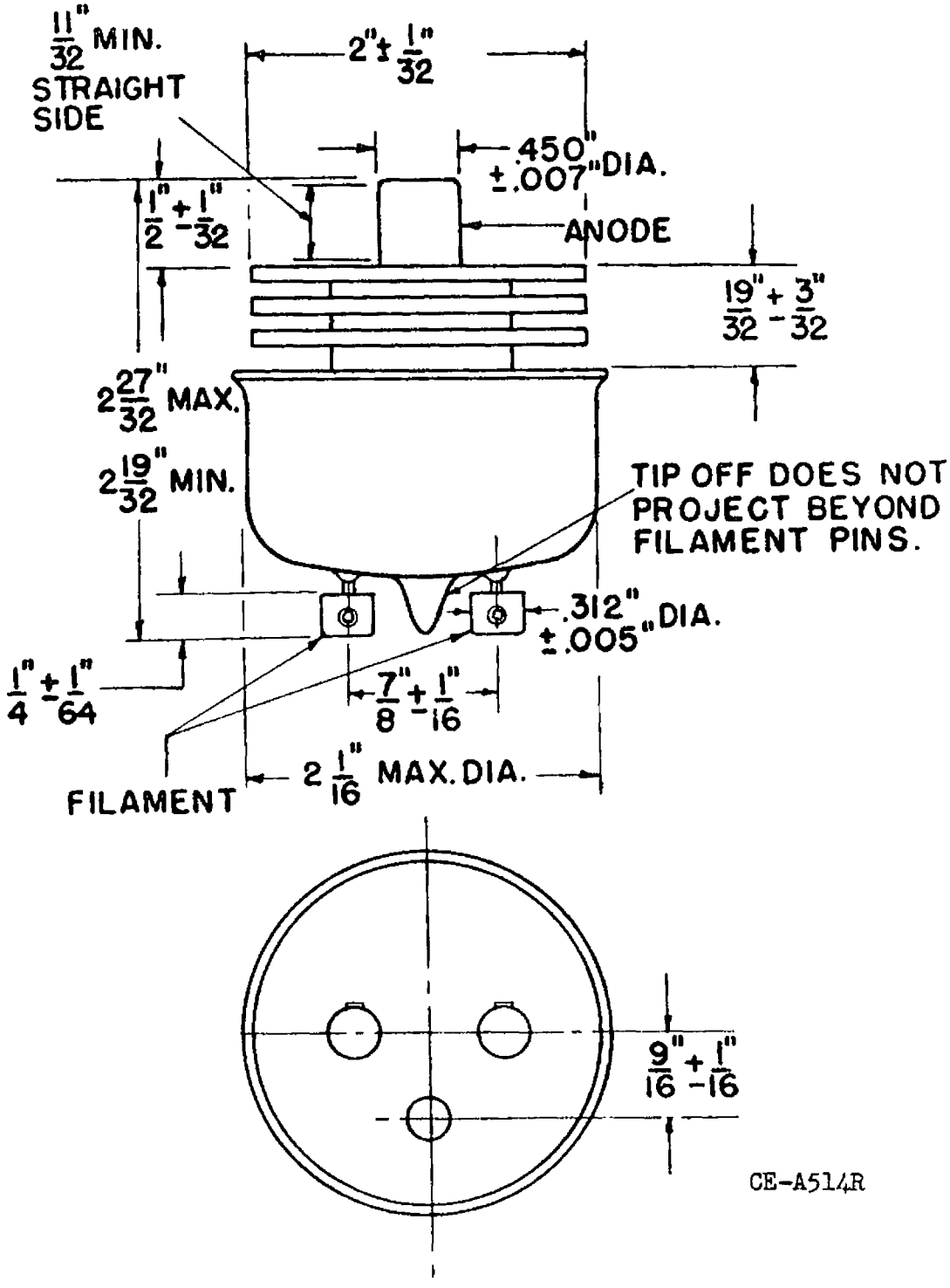
III. Cooling
Cooling air flow should start with the application of any voltages and should continue until all voltages are removed.

IV. Filter Input
Filter circuits of the condenser-input type may be employed; the capacity of the condenser must be such that the peak plate current rating will not be exceeded. Choke-input filters may be preferred in order to obtain the largest average d-c output current under the most favorable conditions.

V. No Load
Under no-load conditions, the peak inverse voltage across the tube will rise 15%.

VI. General
The allowable load currents shown under "Typical Operation" are for ideal conditions; circuit regulation and other factors will reduce these currents in practical installations.

6103 OUTLINE



September 15, 1955

Gas Switching Window Tube WL-6260

The WL-6260 is a fixed-tuned gas switching window designed for use in high power pulsed systems operating at frequencies in the 1300 megacycle region. Used in pairs, spaced approximately a quarter-wave apart, it constitutes a broad-band pre-TR device.

GENERAL DATA

Electrical:

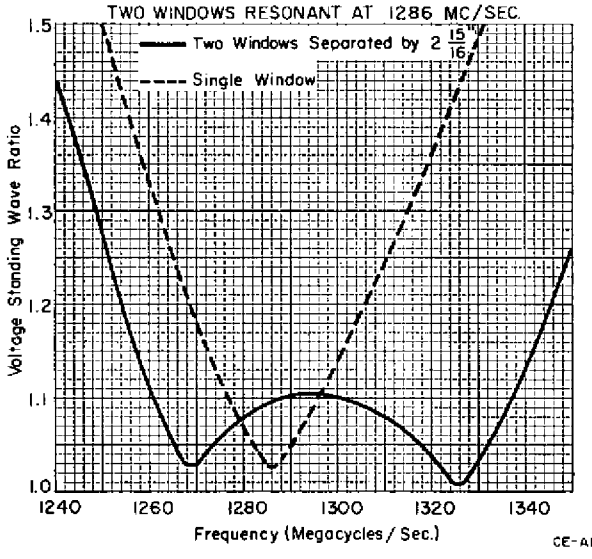
Peak Power	3 max.	Mw
Average Power	4	Kw
Pulse Duration	5 max.	μsec
Duty Cycle	.0015	
Ambient Temperature	+100 to −55	°C
Transmitter Peak Power Output (Min.)*	10	Kw

Mechanical:

Mounting Position	Any
Outline Dimensions	See Page 2
Mounting Flange	
Female	UG-417/U or UG-368/U
Male	UG-369/U
Wave Guide	RG-69/U

*4 μsecond pulse. Minimum power for tube breakdown.

VOLTAGE STANDING WAVE RATIO VS. FREQUENCY FOR A SINGLE WINDOW AND FOR A COMBINATION OF TWO WINDOWS RESONANT AT 1286 MC/SEC.



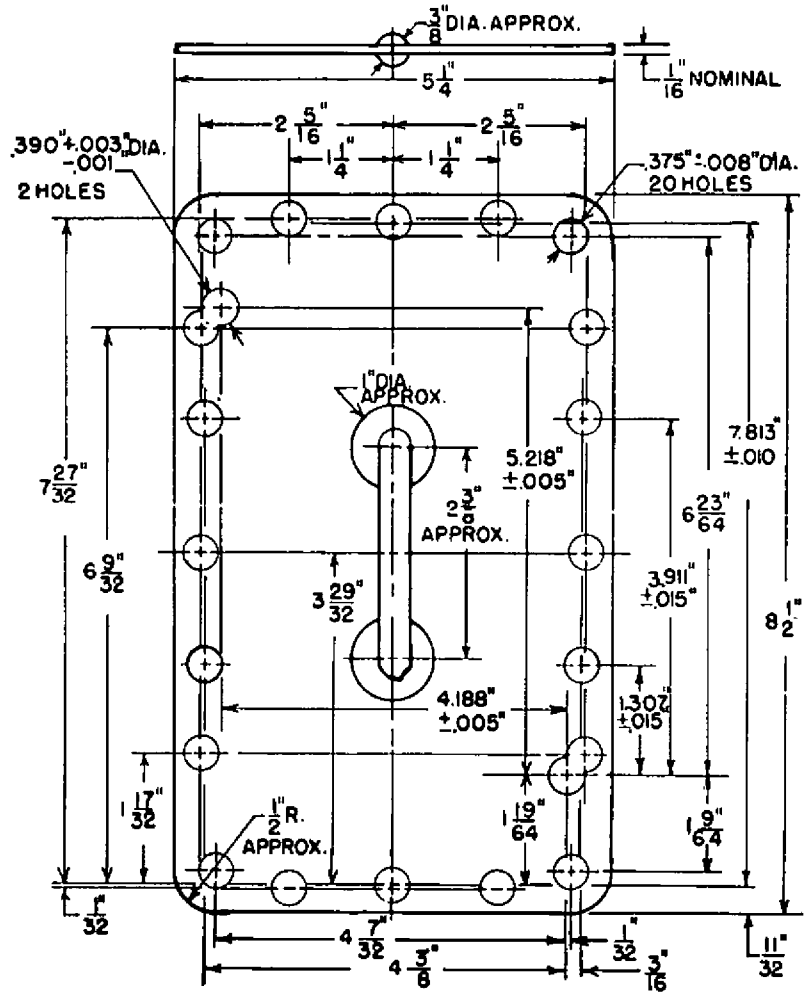
Electrical Data, Single Window:

	Max.	Typical	Min.	
Resonant Frequency	1290	—	1280	Mcs
Low Level Input V.S.W.R.		See Graph		
Loaded Q	3.5	—	—	
Insertion Loss at Resonance	0.25	—	—	db
Leakage Power, Average Over Pulse at 2 Mw, 4 μsec, 150 pps	17	13	—	Kw
Recovery Time at 2 Mw, 3 db down	—	20	—	μsec
Arc Loss at 2 Mw	0.08	—	—	db

Electrical Data, Two Windows, Separation 2-15/16" between Centerlines:

	Max.	Typical	Min.	
Operational Band	1350	—	1250	Mcs
Low Level Input V.S.W.R. Over Operational Band	1.4	See Graph		
Insertion Loss	0.5	—	—	db
Leakage Power, Average Over Pulse at 2 Mw, 4 μsec	0.7	—	—	Kw
Recovery Time at 2 Mw, 3 db down	—	20	—	μsec
Arc Loss at 2 Mw	0.08	—	—	db

from JETEC release #1535, Oct. 31, 1955


3/8" DIA. APPROX.
1/16" NOMINAL
5 1/4"
2 5/16"
2 5/16"
1 1/4"
1 1/4"
.390" +.003" -.001" DIA.
2 HOLES
.375" ±.008" DIA.
20 HOLES
1" DIA. APPROX.
7 27/32"
6 9/32"
5.218" ±.005"
2 3/8" APPROX.
3 29/32"
7.813" ±.010
6 23/64"
3.911" ±.015"
8 1/2"
4.188" ±.005"
1.302" ±.015"
1 17/32"
1" R. APPROX.
1 19/64"
1 9/64"
1/32"
4 7/32"
4 3/8"
1/32"
3/16"
11/32"

CE-A1011

WL-6285
L-BAND MAGNETRON

September 12, 1956

The WL-6285 is a very high power magnetron designed for pulse operation at 1310 mc. It is capable of peak power outputs up to 10 megawatts. It has been tested at pulse widths up to 10 microseconds at .0018 duty. This represents the highest obtainable power-duty product for magnetrons.

This magnetron is a fixed frequency tube employing a hole and slot anode with 10 resonators, doubly strapped. It is designed to operate with voltages up to 70kv and with peak anode currents of 350 amperes. The magnetic field required at maximum voltage is approximately 1600 gauss with a proportionally lower field required at lower voltage. Because of the size and weight of the magnet, it is not "packaged" with the tubes. The weight of the magnetron is approximately 60 pounds.

The magnetron operates into 6-1/2" diameter circular waveguide with no pressurizing or gas insulation required. The anode and end covers are water cooled. Forced air cooling is required for the output window.

The cathode is an indirectly heated cermet composed of pressed and sintered thoria and tungsten powder. The cathode heating power required for starting is 4kw. This heater power is reduced during oscillation to 1-3kw depending upon the average anode input power.

The cathode-heater assembly in this magnetron is designed to permit operation of the tube in any mounting position.

The efficiency varies from 40-50% depending upon the particular operating point chosen.

A set of typical operating values are:

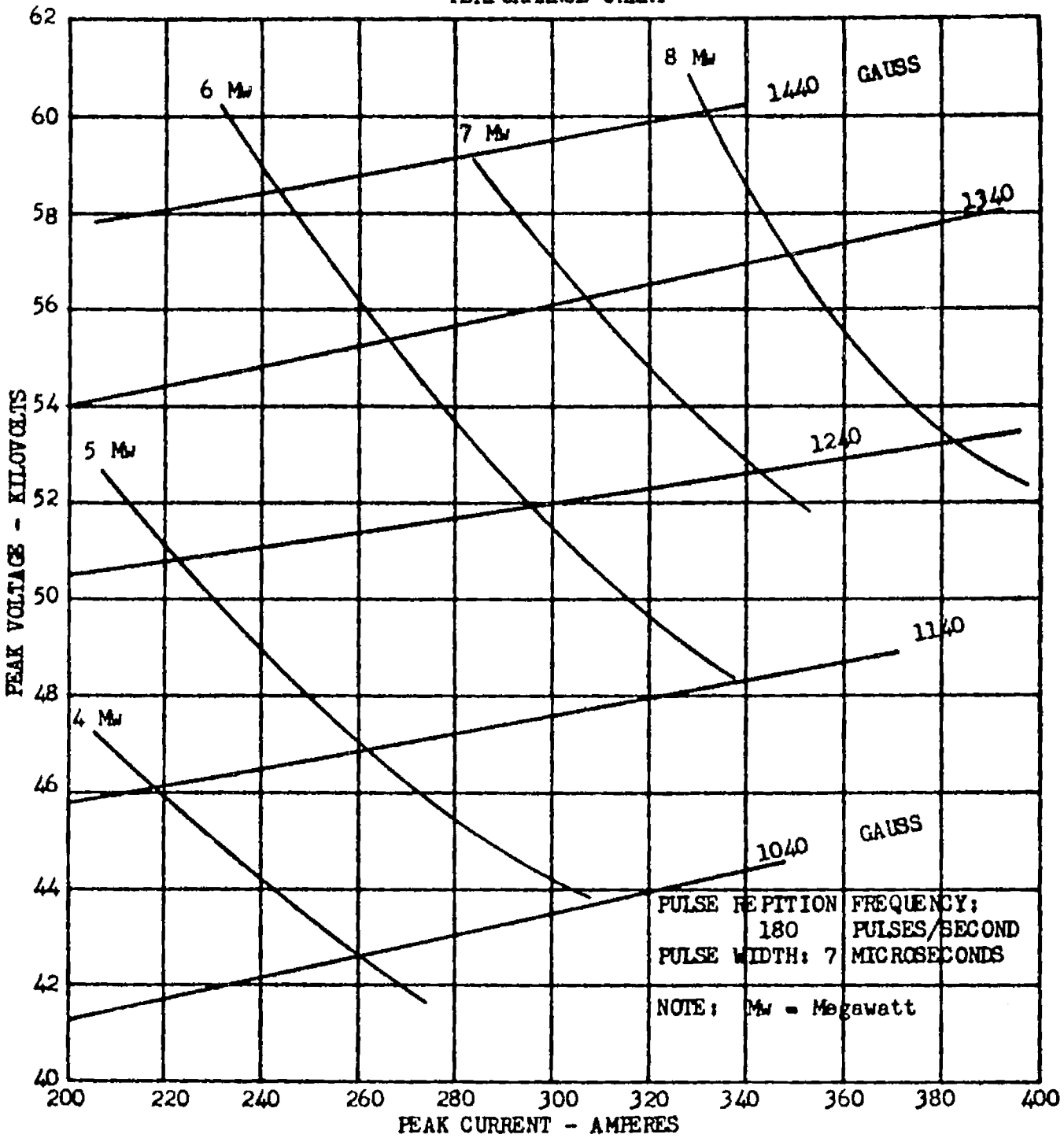
pulse width	7 u sec
repetition rate	180 pulses per second
peak current	280 amperes
peak voltage	56 kilovolts
peak power out	6.5 megawatts
efficiency	43%
magnetic field	1300 gauss
cathode power (oscillating condition)	2.3 kilowatts

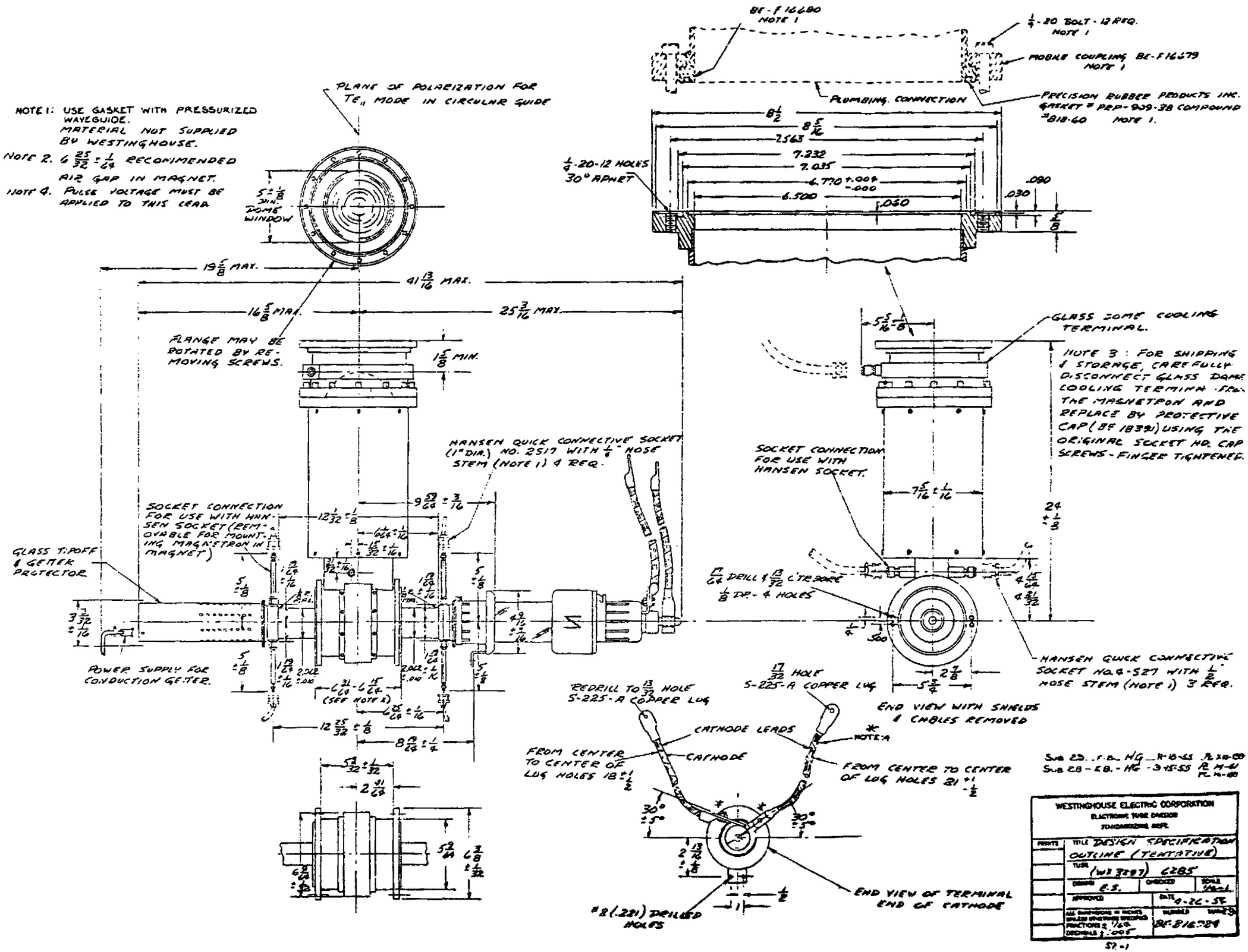
A performance chart is shown on the next page for a typical tube.

from JEDEC release #3798, Aug. 13, 1962

WL-6285

PERFORMANCE CHART




NOTE 1: USE GASKET WITH PRESSURIZED WAVEGUIDE. MATERIAL NOT SUPPLIED BY WESTINGHOUSE.
Note 2. 6 25/32 ± 1/64 RECOMMENDED AIR GAP IN MAGNET.
NOTE 4. PULSE VOLTAGE MUST BE APPLIED TO THIS LEAD.
PLANE OF POLARIZATION FOR TE11 MODE IN CIRCULAR GUIDE
5 ± 1/8 DIA DOME WINDOW
19 5/8 MAX.
41 13/16 MAX.
16 5/8 MAX.
25 3/16 MAX.
FLANGE MAY BE ROTATED BY REMOVING SCREWS.
1 5/8 MIN.
HANSEN QUICK CONNECTIVE SOCKET (1" DIA.) NO. 2517 WITH 1/4" NOSE STEM (NOTE 1) 4 REQ.
SOCKET CONNECTION FOR USE WITH HANSEN SOCKET (REMOVABLE FOR MOUNTING MAGNETRON IN MAGNET)
GLASS TIPOFF & GETTER PROTECTOR
POWER SUPPLY FOR CONDUCTION GETTER.
BF-F 16680 NOTE 1
1/4-20 BOLT - 12 REQ. NOTE 1
MODULE COUPLING BF-F16679 NOTE 1
PLUMBING CONNECTION
PRECISION RUBBER PRODUCTS INC. GASKET # PRP-939-38 COMPOUND #818-60 NOTE 1.
1/4-20-12 HOLES 30° APART
8 1/2
8 5/16
7.563
7.232
7.035
6.710 +.004 -.000
6.500
.080
.030
.050
5/8
GLASS DOME COOLING TERMINAL.
NOTE 3: FOR SHIPPING & STORAGE, CAREFULLY DISCONNECT GLASS DOME COOLING TERMINAL FROM THE MAGNETRON AND REPLACE BY PROTECTIVE CAP (BF 18391) USING THE ORIGINAL SOCKET HD. CAP SCREWS - FINGER TIGHTENED.
SOCKET CONNECTION FOR USE WITH HANSEN SOCKET.
7 5/16 ± 1/16
24 ± 1/8
17/64 DRILL & 13/32 C'TERBORE 1/8 DP. - 4 HOLES
HANSEN QUICK CONNECTIVE SOCKET NO. 4-527 WITH 1/2" NOSE STEM (NOTE 1) 3 REQ.
17/32 HOLE S-225-A COPPER LUG
END VIEW WITH SHIELDS & CABLES REMOVED
REDRILL TO 13/32 HOLE S-225-A COPPER LUG
CATHODE LEADS
CATHODE
NOTE A
FROM CENTER TO CENTER OF LUG HOLES 18 ± 1/2
FROM CENTER TO CENTER OF LUG HOLES 21 +1 -1/2
30° ± 5°
END VIEW OF TERMINAL END OF CATHODE
#8 (.221) DRILLED HOLES
Sub 29 - F.B. HG - 8-16-55 JL 10-55
Sub 28 - F.B. - HG - 3-15-55 JL 4-41
WESTINGHOUSE ELECTRIC CORPORATION
ELECTRONIC TUBE DIVISION
TITLE DESIGN SPECIFICATION OUTLINE (TENTATIVE)
TUBE (WL 7297) C28S
DRAWN E.S. CHECKED
APPROVED
DATE 9-26-58
NUMBER BF-816284
52-1

from JETEC release #1506, Aug. 22, 1955

Westinghouse RELIATRON® Tube
WL-6307
BF_3 Proportional Counter

The WL-6307 is a boron trifluoride proportional counter for the detection of thermal neutrons. The counter has an all-aluminum body one inch in diameter and 12 inches long; it is provided with a connector for "HN" cable fittings. The WL-6307 is extremely rugged and will operate at temperatures up to 80°C. It is filled to a pressure of 55 cm. Hg with BF_3 enriched to 96% with Boron-10 isotope. The sensitivity of the counter is approximately 4.5 counts per second for a unit thermal neutron flux and it operates in the vicinity of 2000 volts.

GENERAL DATA

Mechanical:

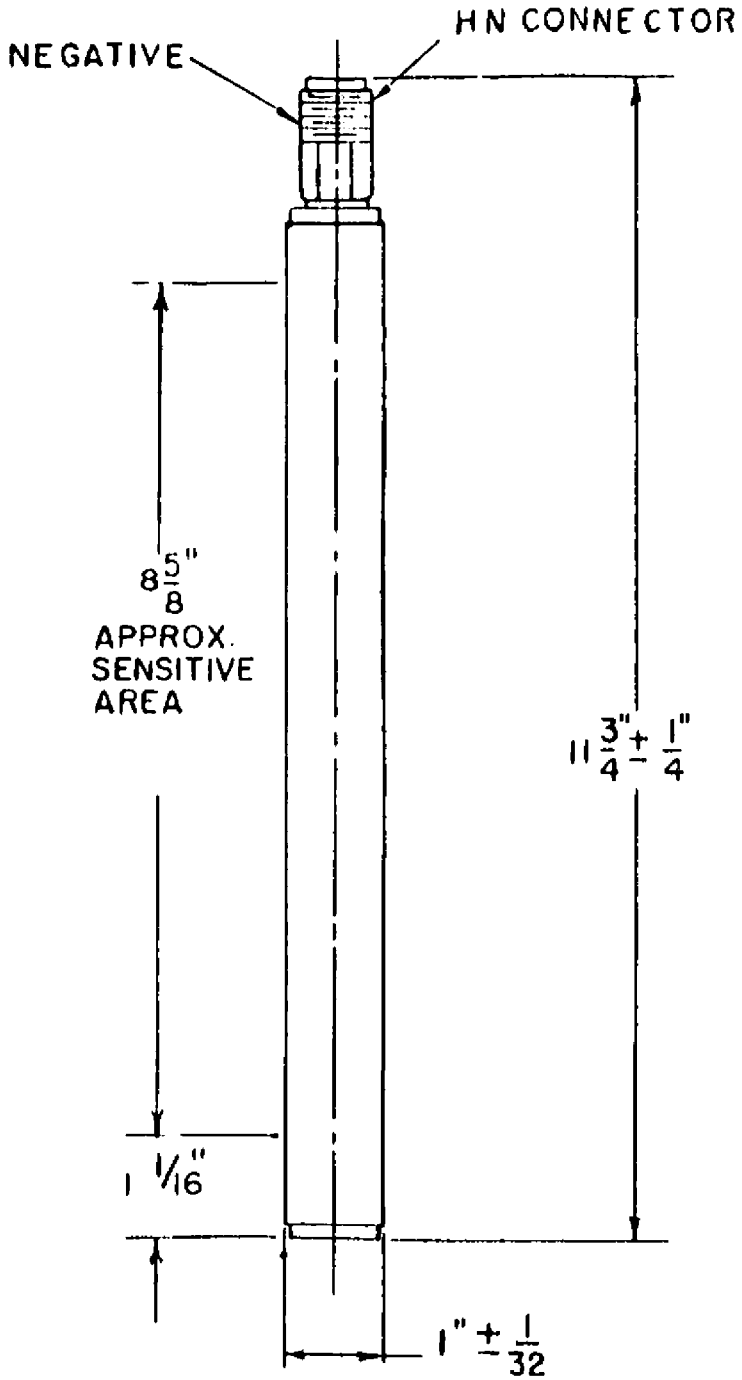
Overall Length	12"
Diameter	1"
Sensitive Length	8.5"
Center Conductor	0.001" Diameter Tungsten Wire
Body Material	Aluminum
Filling: BF_3 enriched to 96% in B^{10} at pressure of 55 cm Hg.	

Operational:

Operating Voltage, approx.	2000	Volts
Operating Temperature, maximum for extended periods of time	80	°C
Sensitivity, counts per second#	4.5	
Multiplication Factor, at 2000 volts	500	

Plateau: Operating plateaus 200 volts or greater in length and with an average slope of 2.0% per 100 volts or less obtainable with 5 millicurie radium-beryllium neutron source.

For an isotropic thermal neutron flux of one neutron per cm^2 - sec.


NEGATIVE
HN CONNECTOR
8 5/8" APPROX. SENSITIVE AREA
11 3/4" ± 1/4"
1 1/16"
1" ± 1/32

from JETEC release #1506, Aug. 22, 1955

WESTINGHOUSE ELECTRONIC TUBE DIVISION

Sales Department: Elmira, New York

August 1, 1955

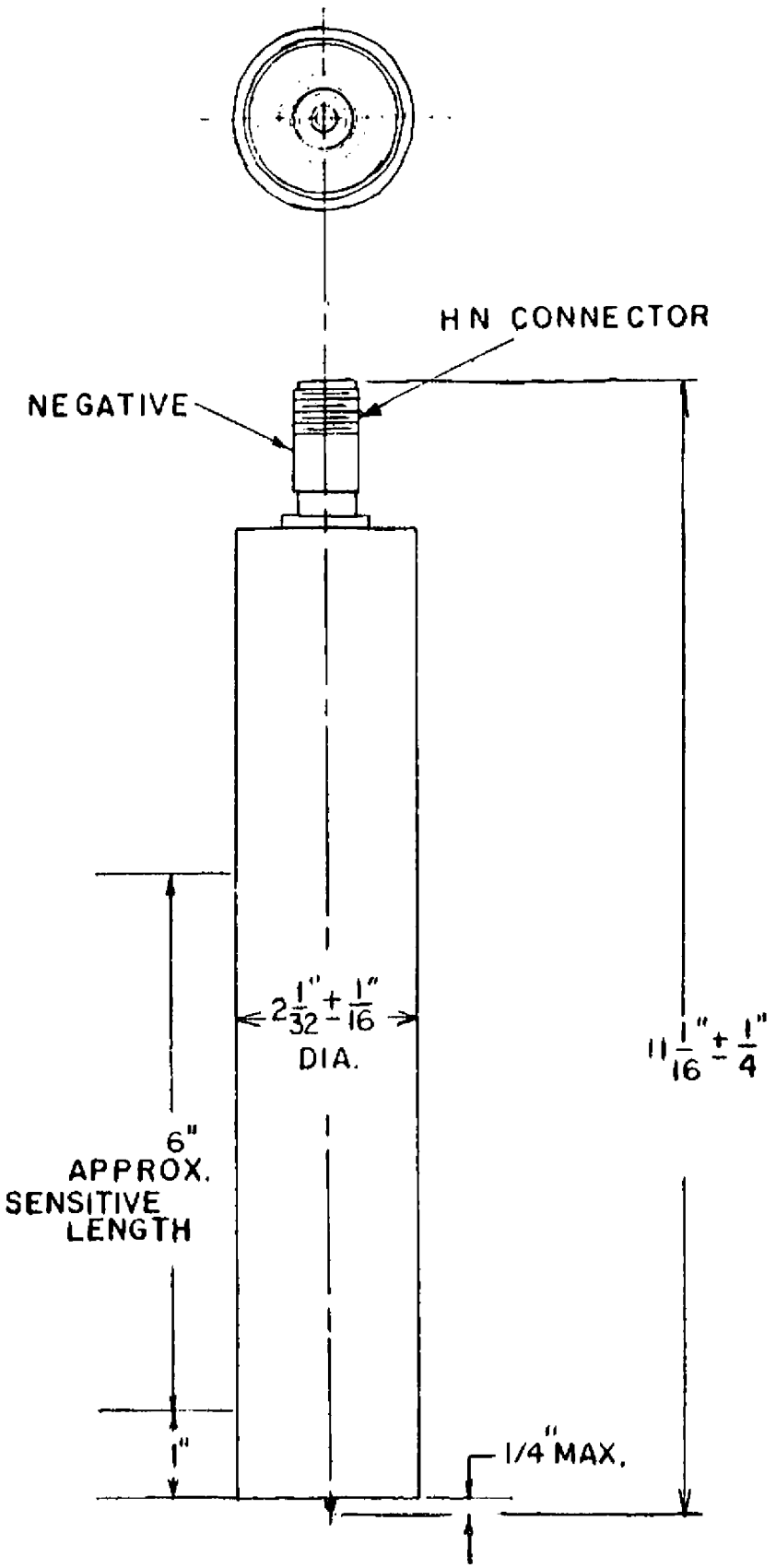
Westinghouse RELIATRON® Tube
WL-6376
Fission Counter Tube

The WL-6376 is a pulse ionization chamber for the detection of thermal neutrons by means of the ionization pulses produced in the gas atmosphere of the counter by fission fragments.

The detecting material is uranium exides enriched in U-235 isotope coated on aluminum electrodes. The counter tube has an all-aluminum body two inches in diameter and it is 11-7/8 inches long; it is provided with a connector for "HN" cable fittings. The WL-6376 is extremely rugged and will operate at temperatures up to 80° C. It is filled to a pressure of one atmosphere with a nitrogen-argon mixture. The sensitivity is approximately 0.7 count per neutron/cm^2 when the background counting rate for the naturally radioactive uranium is 5.0 counts per second. The counter operates up to 10^5 counts per second, and it will operate with no sensitivity loss up to this rate in the presence of 10^{10} X-rays/cm^2-sec.

GENERAL DATA

Mechanical:		
Overall Length	11-7/8" max.	
Diameter	2-1/32" max.	
Sensitive Length	6"	
Insulating Materials	Polystyrene & Alumina	
Body Material	Aluminum	
Operational:		
Operating Voltage, approx.	300	Volts
Operating Temperature	80	°C
Operating Voltage Plateau	200 - 800	Volts


HN CONNECTOR
NEGATIVE
$2\frac{1}{32}" \pm \frac{1}{16}"$
DIA.
$11\frac{1}{16}" \pm \frac{1}{4}"$
6"
APPROX.
SENSITIVE
LENGTH
1"
1/4" MAX.

The 6376 and 6377 detectors have been qualified as meeting requirements of MIL-STD-167, Mechanical Vibrations of Shipboard Equipment. As defined in Section 1.3 of the specification, all detectors are classified as Type 1, equipment intended for shipboard use which may be capable of withstanding the environmental conditions which may be encountered aboard Naval vessels. The equipment to be used is optional with the manufacturer, providing it meets the conditional requirements for amplitude and frequency defined in the specification. The test procedure calls for an Exploratory Test to determine resonance frequencies, if any; a variable frequency test; and an endurance test. In each of the tests, the detectors must be vibrated in each of the three principal directions of vibration.

Exploratory vibration is conducted at an amplitude of 0.010 inches from 5 to 33 cps in 1 cps steps, remaining 15 seconds at each step.

The variable frequency test is conducted from 5 to 33 cps in 1 cps steps of 5 min. duration. The amplitude shall be 0.030 inches in the 5 - 15 cps range, 0.020 in the 16 - 25 range, and 0.010 in the 26 - 33 range.

The endurance test is run at the resonant frequencies determined in the exploratory test, or if none, at 33 cps for two hours in each position. The amplitude will be determined by the frequency of vibration as in the variable frequency test.

Acceptance is based upon satisfactory electrical and nuclear operation upon completion of the endurance test and ability to perform as indicated by noise generation measurement during the variable frequency and endurance tests.

The 6376 and 6377 detectors have been qualified as meeting the requirements of MIL-S-901, Shockproof Equipment, class HI (High Impact), shipboard application, tests for. As defined in Section 3.1.2 of the specification, all detectors are tested as type C which means that they are considered individual devices. For the purpose of test, the detectors are classified by weight and all detectors fall into the light category (250 pounds and below) per Section 1.2.1 Tests on equipment falling into the above-defined classes are tested on a lightweight shock-testing machine (BUSHIPS Drawing 10-T-2145-L) utilizing a 400 pound hammer. In the tests the detectors are subjected to three blows parallel to each of the three principal axes, the three blows for each direction to be with heights of hammer drop of one foot, three feet, and five feet. This gives a total of nine blows of the hammer. The degree of acceleration is determined by the characteristics of the equipment.

The prime criteria for acceptance is the ability to perform during or after the test; however, none of the parts shall become detached from the apparatus.

April 10, 1958

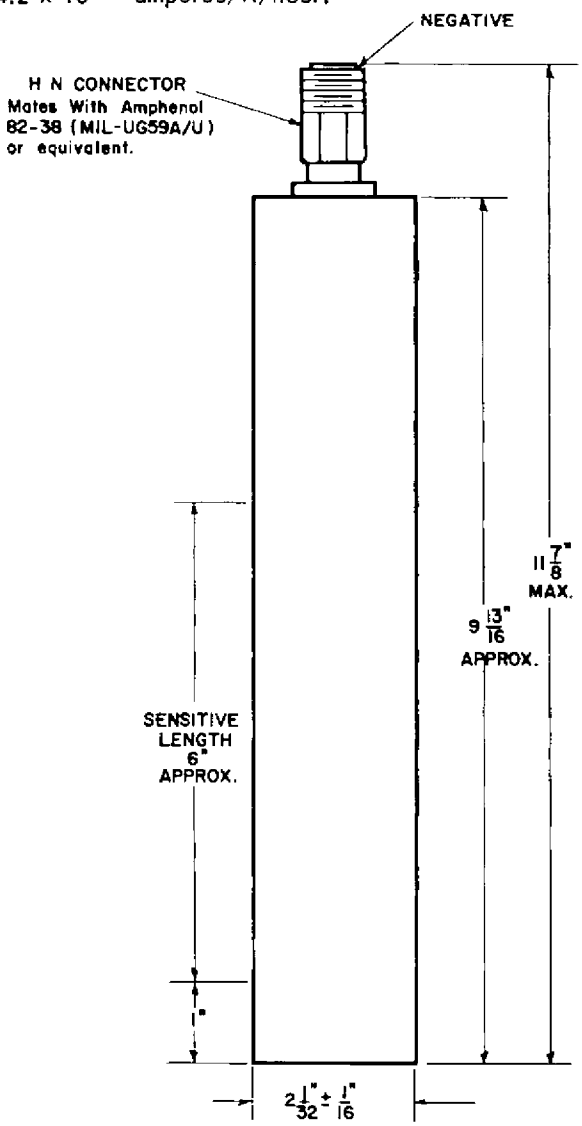
DUAL RANGE FISSION CHAMBER TYPES WL-6376 AND WL-6376A

The WL-6376 and WL-6376A are aluminum-cased dual-range thermal neutron detectors. Ionization pulses are produced in the nitrogen-argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating. The sensitive coating consists of uranium oxide highly enriched in U-235 isotope. These types are extremely rugged ♦ and will operate in any position.

The WL-6376 may be operated or stored in ambient temperatures not exceeding 175°F similarly, the maximum ambient temperature for the WL-6376A is 300°F.

The WL-6376 and WL-6376A may be operated either as fission counters in a flux range of 2.5 to 2.5 x 10^5 neutrons/cm^2/second or as ionization chambers in a flux range of 5 x 10^5 to 1 x 10^{10} neutrons/cm^2/second.

In a typical operation as fission counters, they have a neutron sensitivity of approximately 0.7 counts/neutron/cm^2 with an operating voltage of 300 volts. An incident gamma flux of 10^{10} photons/cm^2/second (3.8 x 10^4 R/hour) results in a maximum loss in sensitivity of 1%. When connected for service as an ionization chamber, the neutron sensitivity is approximately 1.4 x 10^{-13} amperes/neutron/cm^2/second and the gamma sensitivity is approximately 4.2 x 10^{-11} amperes/R/hour.



CE-A1253

MECHANICAL:		
Maximum Diameter	2-3/32	Inches
Maximum Overall Length	11-7/8	Inches
Approx. Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds
MATERIALS:		
Body and Electrodes		Aluminum
Insulation		Polystyrene & Alumina
Neutron Sensitive Coating:		
Content	U_3O_8 enriched to more than 90% in U-235	
Thickness	2	mg/cm^2
Total Amount of U-235	1.72	gm
Gas Filling	Nitrogen and Argon at 76 cm Hg	
Output Impedance:		
Resistance (greater than)	10^9	ohms
Capacity	190	uuf
MAXIMUM RATINGS:		
Absolute Maximum Values		
Voltage Between Electrodes	800	Volts
Thermal Neutron Flux	2.5 x 10^{10}	$n/cm^2/sec$
Total Integrated Neutron Flux	2 x 10^{17}	n/cm^2 (nvt)
Temperature:		
WL-6376	175	°F
WL-6376A	300	°F
TYPICAL OPERATION AS A FISSION COUNTER:		
Operating Voltage	300	Volts
Operating Voltage Plateau ⊕	200 to 800	Volts
Neutron Flux Range	2.5 to 2.5 x 10^5	$n/cm^2/sec$
Sensitivity □	0.7	$count/n/cm^2$
Output Pulse Characteristics:		
Magnitude	2 x 10^{-4}	Volts
Inherent Rise Time	2 x 10^{-7}	Seconds
TYPICAL OPERATION AS AN IONIZATION CHAMBER:		
Operating Voltage	300 to 800 *	Volts
Neutron Flux Range	5 x 10^5 to 1 x 10^{10} †	$n/cm^2/sec$
Neutron Sensitivity	1.4 x 10^{-13}	$amp/n/cm^2/sec$
Gamma Sensitivity	4.2 x 10^{-11}	amp/R/hr

Neutron & Radiation Detector Section

from JETEC release #2175, May 5, 1958

♦ The WL-6376 and WL-6376A have passed Military Specifications MIL-S-901 for shock and MIL-Std-167 (Type1) for vibration.

⊕ Counting Rate at different operating voltages is shown in CE-A1362.

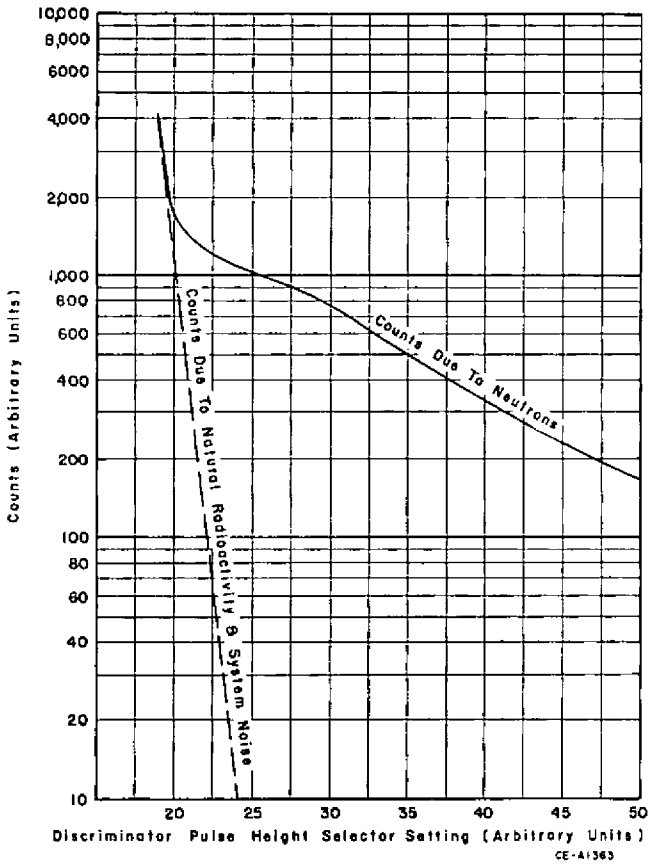
□ The sensitivity is 0.7 count/m/cm^2 for an alpha background counting rate of 5 counts/sec. By varying the pulse-height selector setting, other counter sensitivities are obtainable for different background counting rates as shown in CE-A1363.

* Depending on incident neutron flux level.

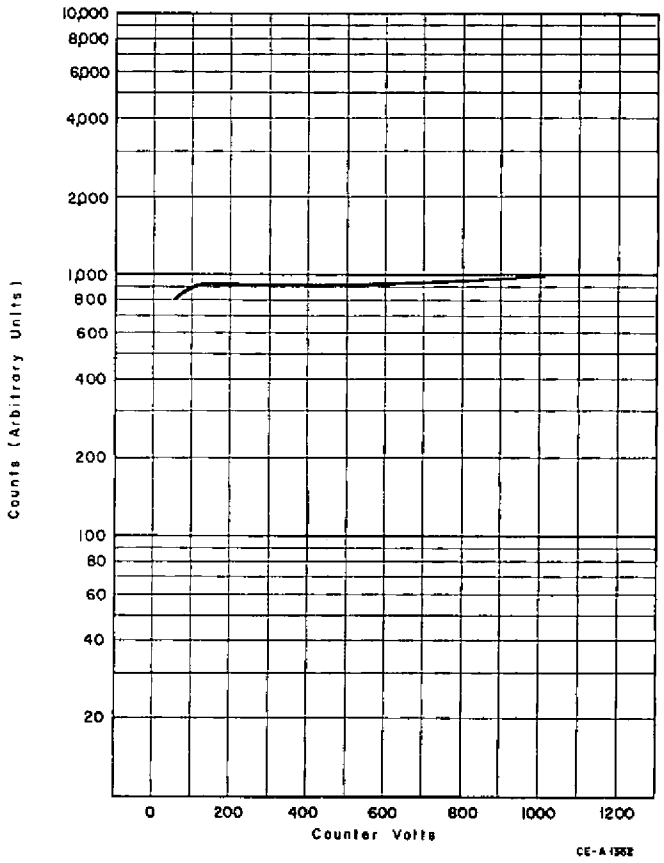
† Lower limit of range is determined by alpha background current of approximately 1.6 x 10^{-8} amperes.

NOTE: These tubes may not be immersed in water and high humidity environments should be avoided since they may impair performance.

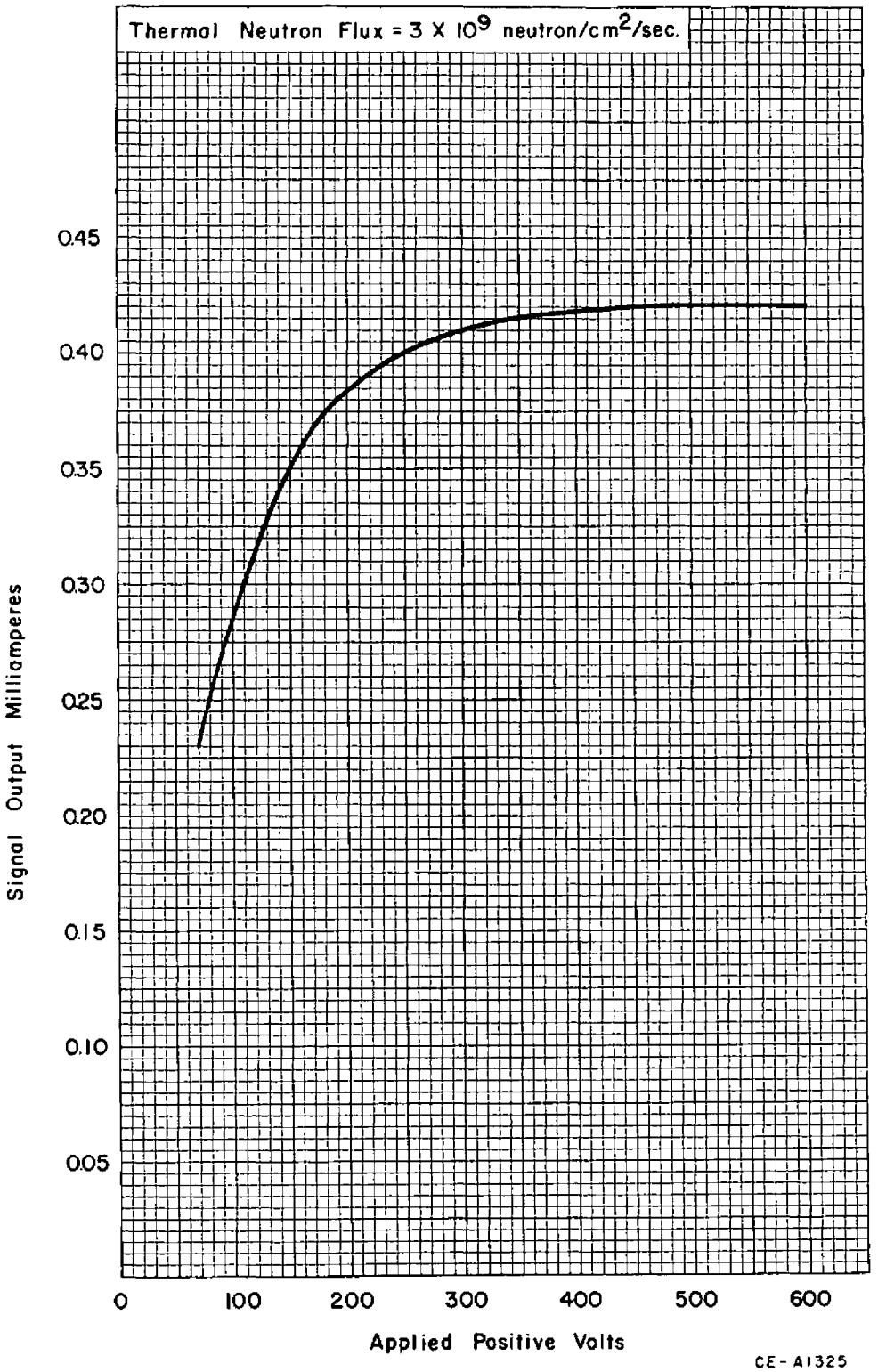
COUNTER SENSITIVITY AS FUNCTION OF PULSE HEIGHT SETTING



COUNTING RATE CHARACTERISTIC



TYPICAL SATURATION CHARACTERISTICS
Ion Chamber Operation



from JETEC release #1506, Aug. 22, 1955

WESTINGHOUSE ELECTRONIC TUBE DIVISION

Sales Department: Elmira, New York

August 1, 1955

Westinghouse RELIATRON® Tube
WL-6377
Compensated Ionization Chamber

The WL-6377 is a boron-lined ionization chamber for the detection of thermal neutrons. Gamma ray compensation provides an extended range of operation. It is filled to atmospheric pressure with nitrogen. The sensitivity of the chamber is approximately 4×10^{-14} amperes per unit neutron flux.ϕ The sensitivity to gamma rays when operated uncompensated is approximately 4×10^{-11} amperes per R per hour; when compensated, the gamma ray sensitivity is easily reduced by a factor of 100.

The WL-6377 is approximately 24 inches long overall and 3-1/8 inches in diameter; and it is constructed of a special high-purity magnesium alloy. Connections are provided by "HN" cable fittings. The tube is both shock-proof and non-microphonic, and it will operate continuously at a temperature of 80°C.

GENERAL DATA

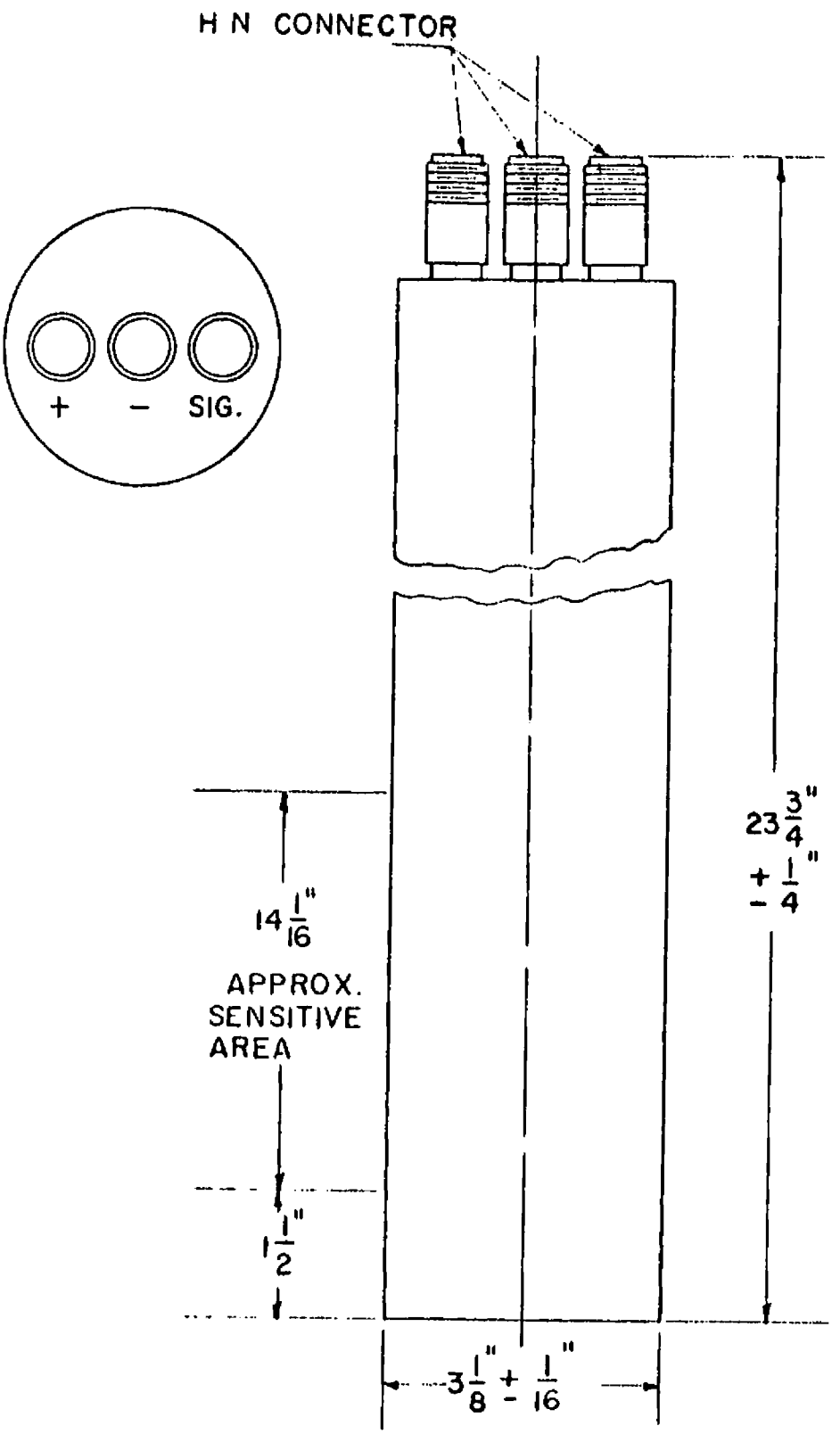
Mechanical	
Overall Length	24" max.
Diameter	3-1/8"
Sensitive Length	14-1/16"
Body Material	3% Al, 97% Mg.
Insulator Material	Polystyrene
Neutron Sensitive Lining	Approx. 1 mg/cm^2 of boron enriched to 96% B^{10}
Filling	1 Atmosphere of N_2

Operational:			
Operating Voltage (Note 1)	+800	+300	volts
Maximum Saturated Output	1×10^{-3}	2×10^{-4}	amperes
Typical Compensating Voltage (Note 2)	-25	-25	volts

ϕ Unit neutron flux equals one neutron per cm^2 per second.

Note 1: The operating voltage should be applied between the positive electrode and the signal electrode.

Note 2: The compensating voltage should be connected between the signal electrode and the negative electrode.


H N CONNECTOR
+
−
SIG.
$14\frac{1}{16}$"
APPROX.
SENSITIVE
AREA
$1\frac{1}{2}$"
$23\frac{3}{4}$" $+\frac{1}{4}$" $-$
$3\frac{1}{8}$" $+\frac{1}{16}$" $-$

The 6376 and 6377 detectors have been qualified as meeting requirements of MIL-STD-167, Mechanical Vibrations of Shipboard Equipment. As defined in Section 1.3 of the specification, all detectors are classified as Type 1, equipment intended for shipboard use which may be capable of withstanding the environmental conditions which may be encountered aboard Naval vessels. The equipment to be used is optional with the manufacturer, providing it meets the conditional requirements for amplitude and frequency defined in the specification. The test procedure calls for an Exploratory Test to determine resonance frequencies, if any; a variable frequency test; and an endurance test. In each of the tests, the detectors must be vibrated in each of the three principal directions of vibration.

Exploratory vibration is conducted at an amplitude of 0.010 inches from 5 to 33 cps in 1 cps steps, remaining 15 seconds at each step.

The variable frequency test is conducted from 5 to 33 cps in 1 cps steps of 5 min. duration. The amplitude shall be 0.030 inches in the 5 - 15 cps range, 0.020 in the 16 - 25 range, and 0.010 in the 26 - 33 range.

The endurance test is run at the resonant frequencies determined in the exploratory test, or if none, at 33 cps for two hours in each position. The amplitude will be determined by the frequency of vibration as in the variable frequency test.

Acceptance is based upon satisfactory electrical and nuclear operation upon completion of the endurance test and ability to perform as indicated by noise generation measurement during the variable frequency and endurance tests.

The 6376 and 6377 detectors have been qualified as meeting the requirements of MIL-S-901, Shockproof Equipment, class HI (High Impact), shipboard application, tests for. As defined in Section 3.1.2 of the specification, all detectors are tested as type C which means that they are considered individual devices. For the purpose of test, the detectors are classified by weight and all detectors fall into the light category (250 pounds and below) per Section 1.2.1 Tests on equipment falling into the above-defined classes are tested on a lightweight shock-testing machine (BUSHIPS Drawing 10-T-2145-L) utilizing a 400 pound hammer. In the tests the detectors are subjected to three blows parallel to each of the three principal axes, the three blows for each direction to be with heights of hammer drop of one foot, three feet, and five feet. This gives a total of nine blows of the hammer. The degree of acceleration is determined by the characteristics of the equipment.

The prime criteria for acceptance is the ability to perform during or after the test; however, none of the parts shall become detached from the apparatus.

Westinghouse®

WL-6567

March 17, 1959

HIGH VACUUM AMPLIFIER TYPE WL-6567

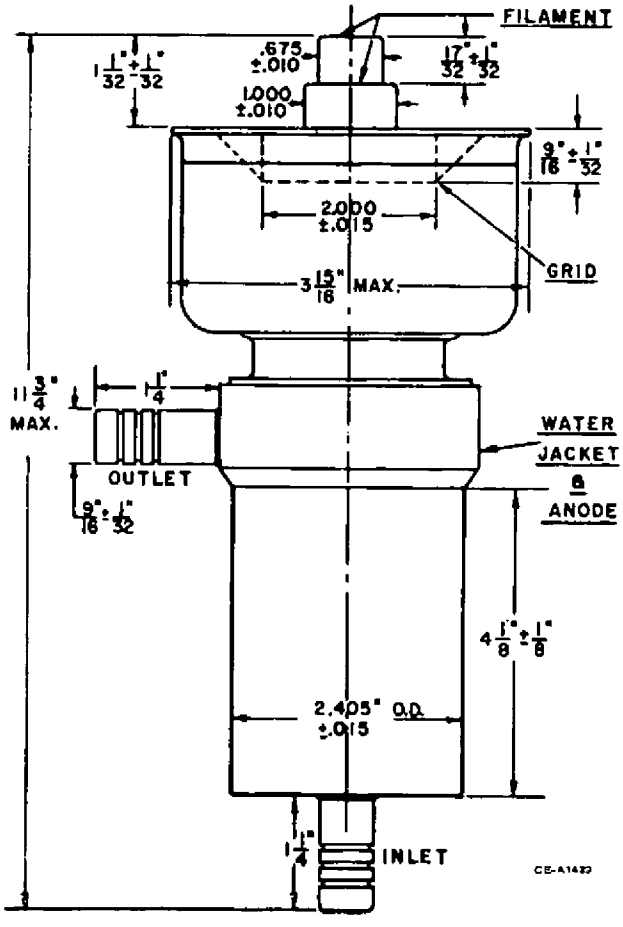
The WL-6567 is a three-electrode tube designed for use as an oscillator or amplifier. The anode is water-cooled and is capable of dissipating 15 kilowatts. The cathode is a single phase thoriated tungsten filament. Maximum ratings apply up to 50 megacycles.

Electrical:

Filament	6.0	Volts
Filament Current	70	Amperes
Amplification Factor	33	
Direct Interelectrode Capacitances:		
Grid to Plate	14	μμf
Grid to Filament	30	μμf
Plate to Filament	.5	μμf

Mechanical:

Mounting Position▲	Vertical, Anode Down
Anode	External with Integral Water Jacket
Type of Cooling	Water
Minimum Water Flow■	7 GPM
Air Flow to Filament and Grid Seals	30 CFM
Maximum Temperature:	
Outlet Water	70° C
Bulb	180° C



CLASS C TELEGRAPHY
(Key down without modulation)

Maximum Ratings:

Absolute Maximum Values

DC Plate Voltage	12,000 max.		Volts
DC Plate Current	2.5 max.		Amperes
DC Grid Voltage	-1200 max.		Volts
DC Grid Current	.75 max.		Amperes
Plate Input	24 max.		Kilowatts
Plate Dissipation	15 max.		Kilowatts

Typical Operating Characteristics:

DC Plate Voltage	9000	10,000	12,000	Volts
DC Grid Voltage	-600	-700	-800	Volts
Peak R.F. Grid Voltage	960	1,100	1,200	Volts
DC Plate Current	1.97	1.96	1.94	Amp
DC Grid Current	0.45	0.42	0.39	Amp
Peak R.F. Plate Voltage	8000	9,000	11,000	Volts
Driving Power♦	414	441	445	Watts
Power Output	14.1	15.9	19.3	Kilowatts
Power Input	17.8	19.6	23.3	Kilowatts

CLASS B AUDIO FREQUENCY AMPLIFIER OR MODULATOR

Maximum Ratings (Per Tube)

Absolute Maximum Values

DC Plate Voltage	12,000 max.		volts
DC Plate Current (max. signal)	2.50 max.		amperes
DC Grid Current (max. signal)	0.50 max.		amperes
Plate Input	26.0 max.		kilowatts
Plate Dissipation	15.0 max.		kilowatts

Typical Operating Characteristics:

(Values are for two tubes)

DC Plate Voltage	5500	10,500	volts
DC Plate Current (max. signal)	3.95	4.0	amperes
Plate Current, Zero-Signal	.80	0.200	amperes
Grid to Grid Peak A.F.	680	1030	volts
DC Grid Voltage	-100	-300	volts
Driving Power (max. signal)	185	150	watts
Power Output	13.2	27.0	kilowatts
Power Input	21.7	42.0	kilowatts
Plate Load (plate to plate)	2780	5600	ohms
Distortion-Harmonic (Approx.)	4.8	3	percent
Peak R.F. Plate Voltage	4300	8820	volts

♦ Allowance must be made for grid circuit losses which are not included.

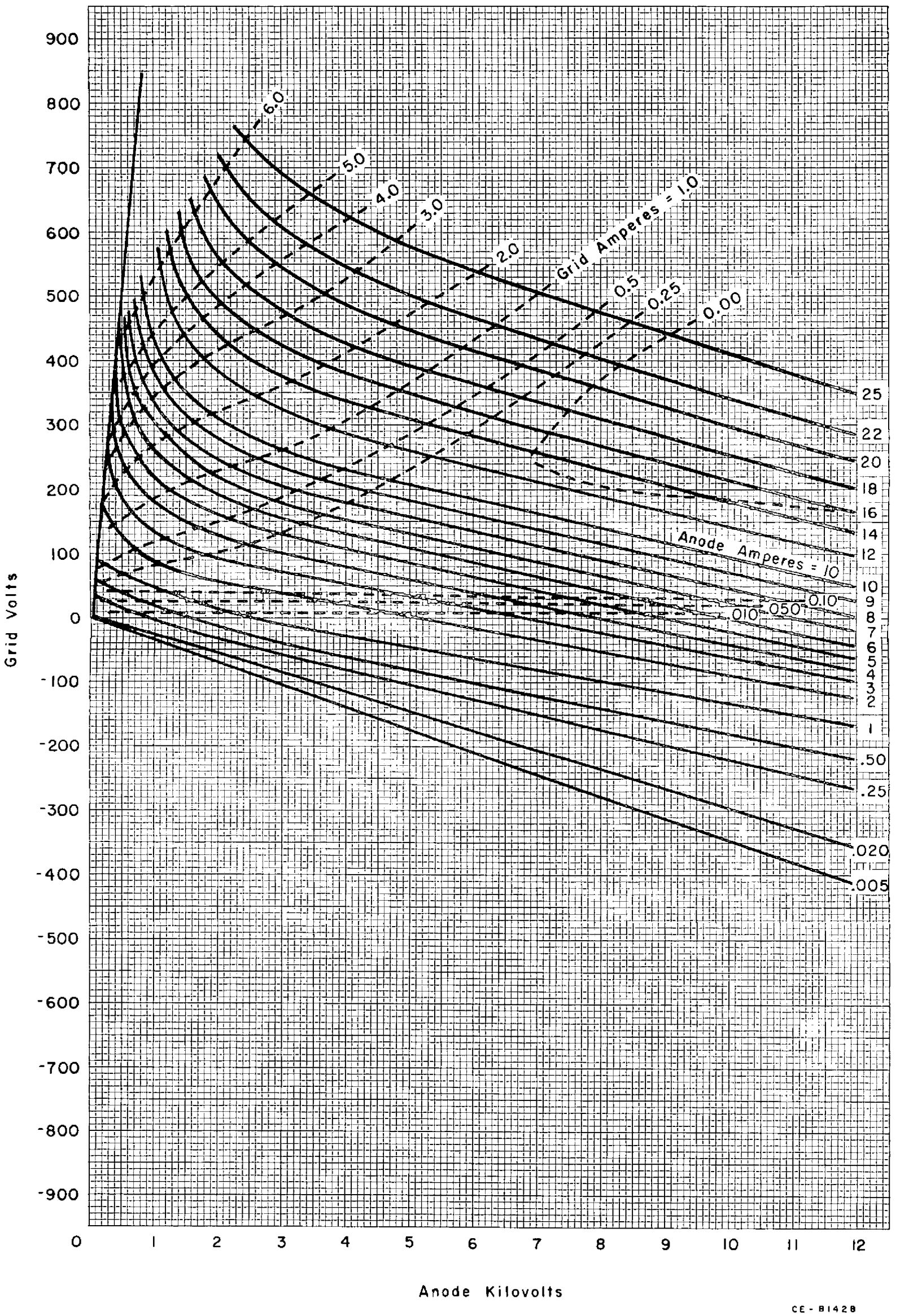
▲ Connectors for WL-6567 are available from Westinghouse.

■ Pressure drop at 7 GPM is 16 lb/in².

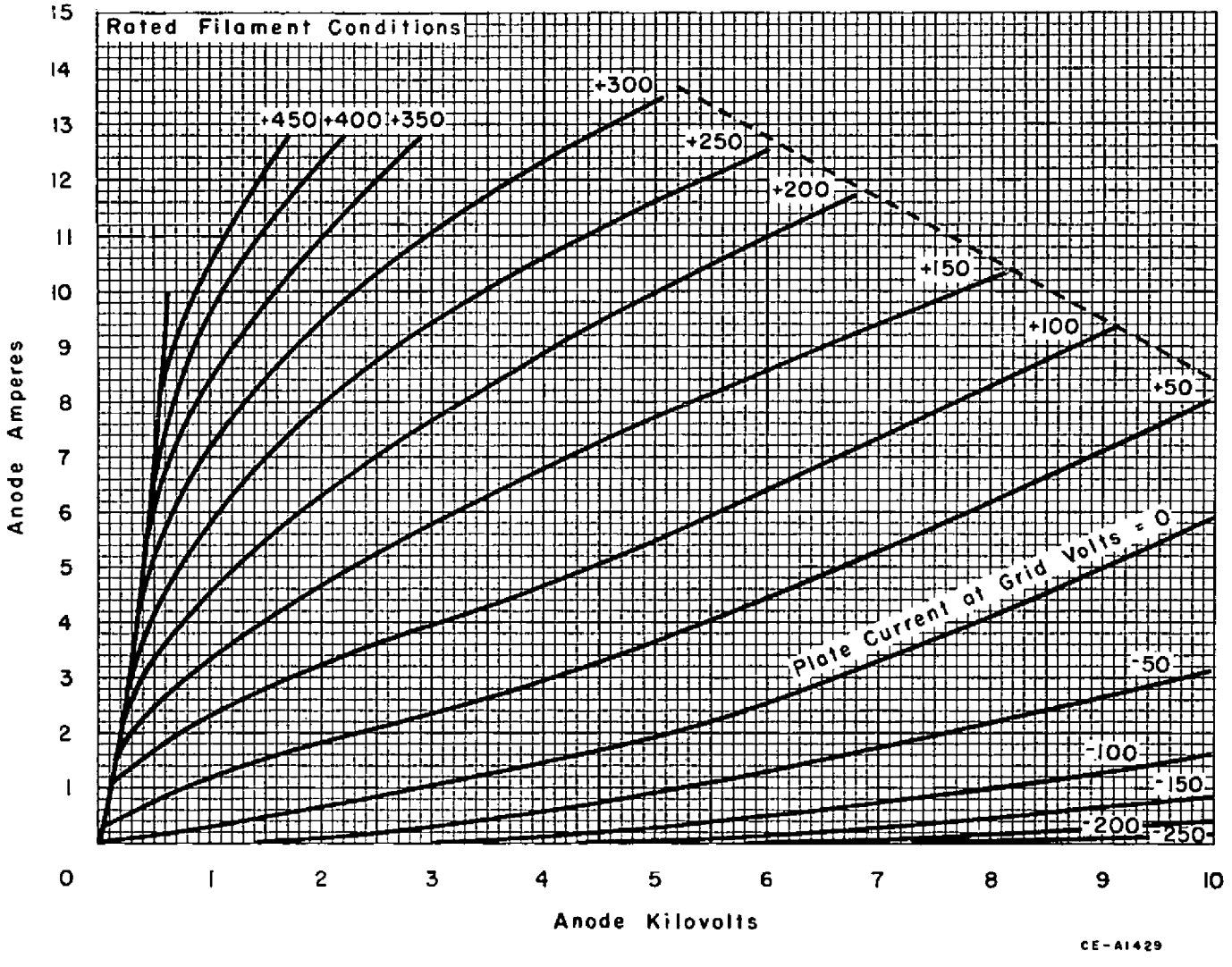
WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #2471, May 25, 1959

AVERAGE CONSTANT CURRENT CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



April 1, 1957

INERT-GAS MERCURY-VAPOR THYRATRON TYPE WL-6783

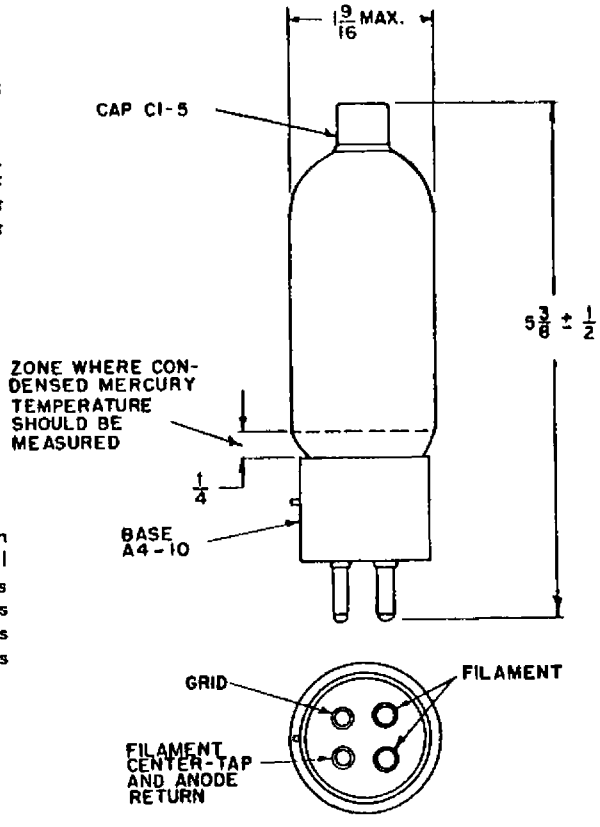
The WL-6783 is a three electrode thyratron with negative control characteristic. It is filled with a combination of an inert gas and mercury vapor. As a result of this admixture, the WL-6783 combines the long life characteristic of a mercury vapor thyratron with the fast starting and wide ambient temperature operating range typical of an inert gas thyratron. In addition, the WL-6783 operates dependably with a higher condensed mercury temperature than other inert gas and mercury vapor filled types.

The higher ambient and condensed mercury temperatures allowed permit the WL-6783 to be used in compact, enclosed equipment with less stringent cooling requirements than formerly needed.

ELECTRICAL:

Filament	Minimum	Bogey	Maximum	
Voltage	2.37	2.5	2.63	Volts
Current at 2.5 Volts	7.0	8.5	10.0	Amperes
Heating Time	10	--	--	Seconds

Critical Grid Voltage	See Control Characteristic of WL-6783	
Deionization Time, Approx.	1000	usec.
Ionization Time, Approx.	10	usec.
Anode Voltage Drop, Typical	16	Volts
Anode-Grid Capacitance	0.35	uuf
Grid-Cathode Capacitance	11.5	uuf
Anode-Cathode Capacitance	5.1	uuf



MECHANICAL:

Type of Cooling	Air, Unrestricted Convection	
Mounting Position	Vertical Base Down, to Horizontal	
Overall Length, Approx.	5-1/2	Inches
Maximum Diameter	1-9/16	Inches
Net Weight, Approx.	3	Ounces
Shipping Weight, Approx.	2	Pounds

from JETEC release #1901, April 15, 1957

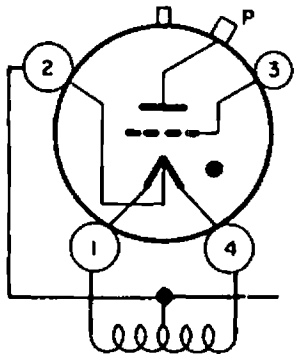
MAXIMUM RATINGS:

Absolute Values	General Control Service		Ignitor Firing Service	
Peak Anode Voltage	2500	1500	1500	max. Volts
Inverse	2500	1500	1500	max. Volts
Forward	2500	1500	1500	max. Volts
Cathode Current				
Peak	20	20	30 ~~20~~	max. Amp.
Average	1.6	1.6	- -	max. Amp.
Fault (Surge), max. Duration 0.1 sec.½ = ■				
Connection (a)	240	240		max. Amp.
Connection(b)	120	120		max. Amp.
Connection (c)	120	120		max. Amp.
Averaging Time	15	15		max. Sec.
Frequency	60 ~~150~~	60 ~~150~~	60 ~~150~~	max. Cps.
Negative Control Grid Voltage				
Before Conduction	250	250	250	max. Volts
During Conduction	10	10	10	max. Volts
Positive Control Grid Current, Average (Averaging Time, 1 Cycle)	10	10	10	max. Amp.
Temperature Range, Condensed Mercury*.	20 to 90	20 to 100	20 to 100	°C
Approx. Condensed Mercury Temperature Rise, ⊕				
For Ambient Temperature of 20°C	44 ~~50~~			°C
For Ambient Temperature of 70°C	32.5 ~~30~~			°C

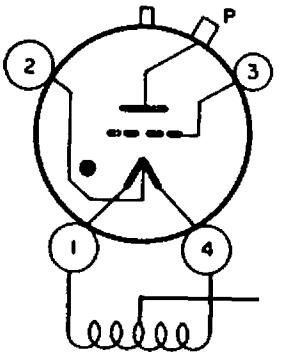
NOTES:

■ These ratings are effective only when the anode return connections are made according to the following diagrams:

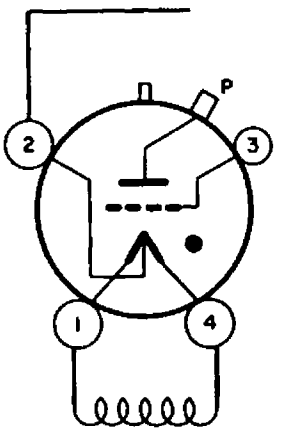
Connection a



Connection b



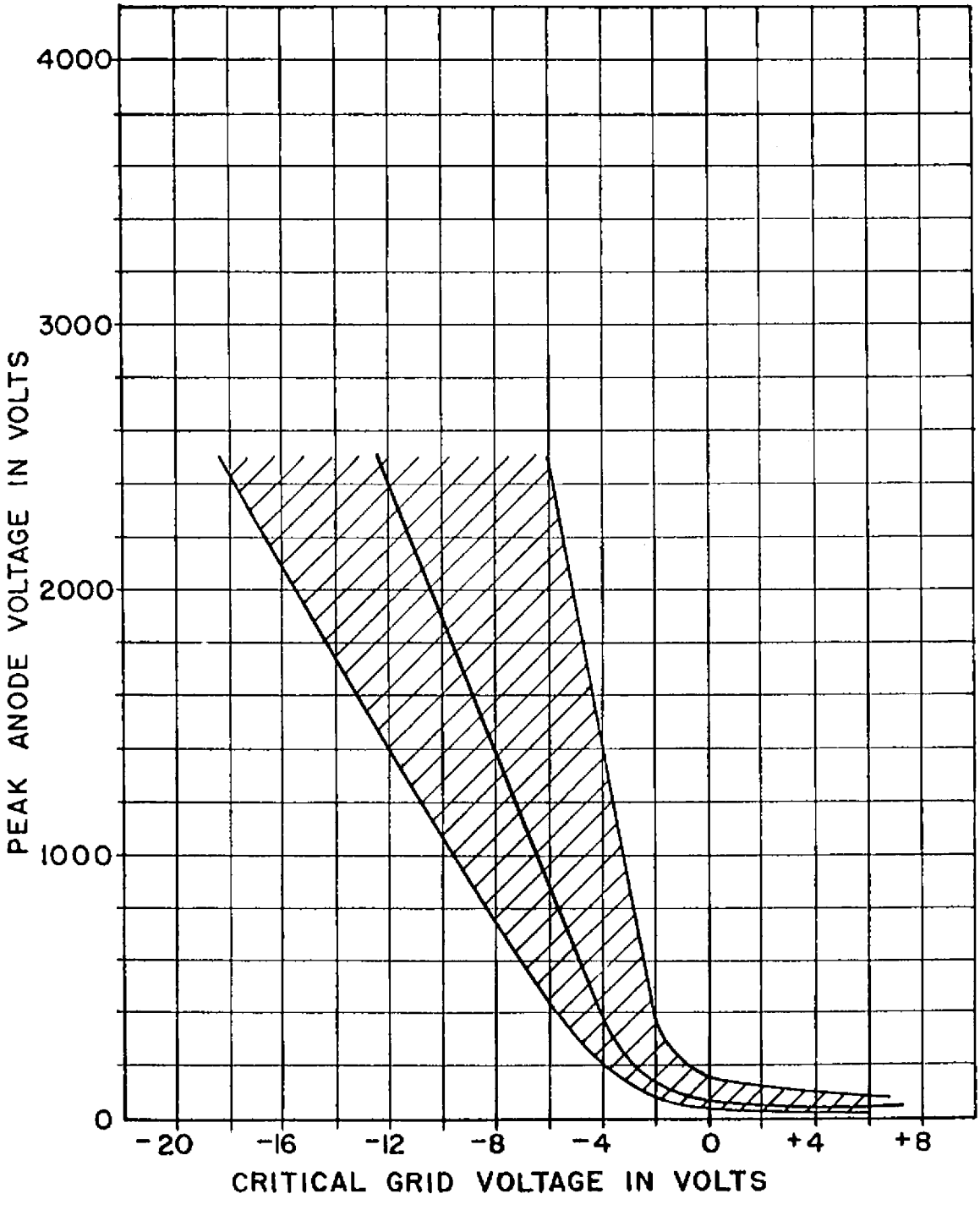
Connection c



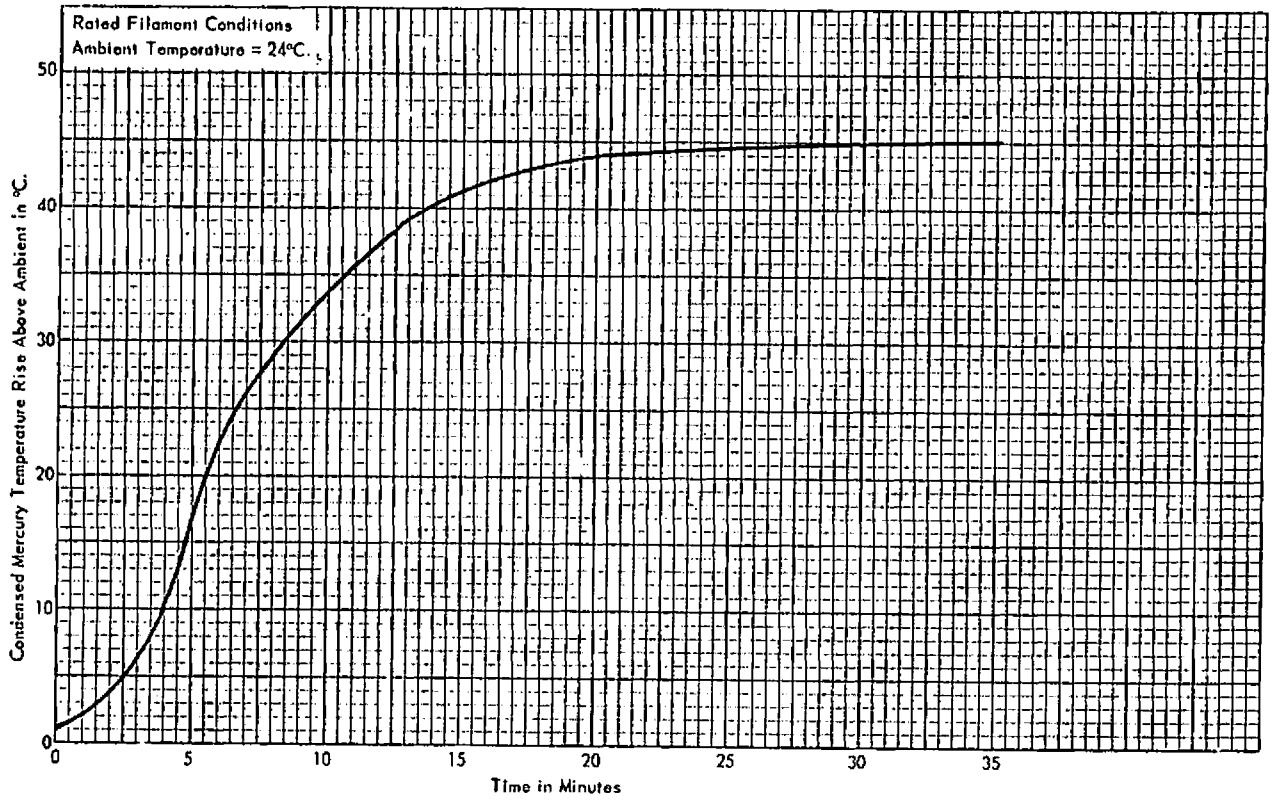
* The condensed mercury temperature is measured in the zone indicated on the outline drawing. It is necessary that the condensed mercury temperature be 20°C in order to operate the tube on mercury. If the tube is operated below a condensed mercury temperature of 20°C for extended periods, the usual circuit precautions for inert gas tube operation should be followed.

⊕ The temperature rise above ambient for intermediate ambient temperatures may be determined by linear interpolation.

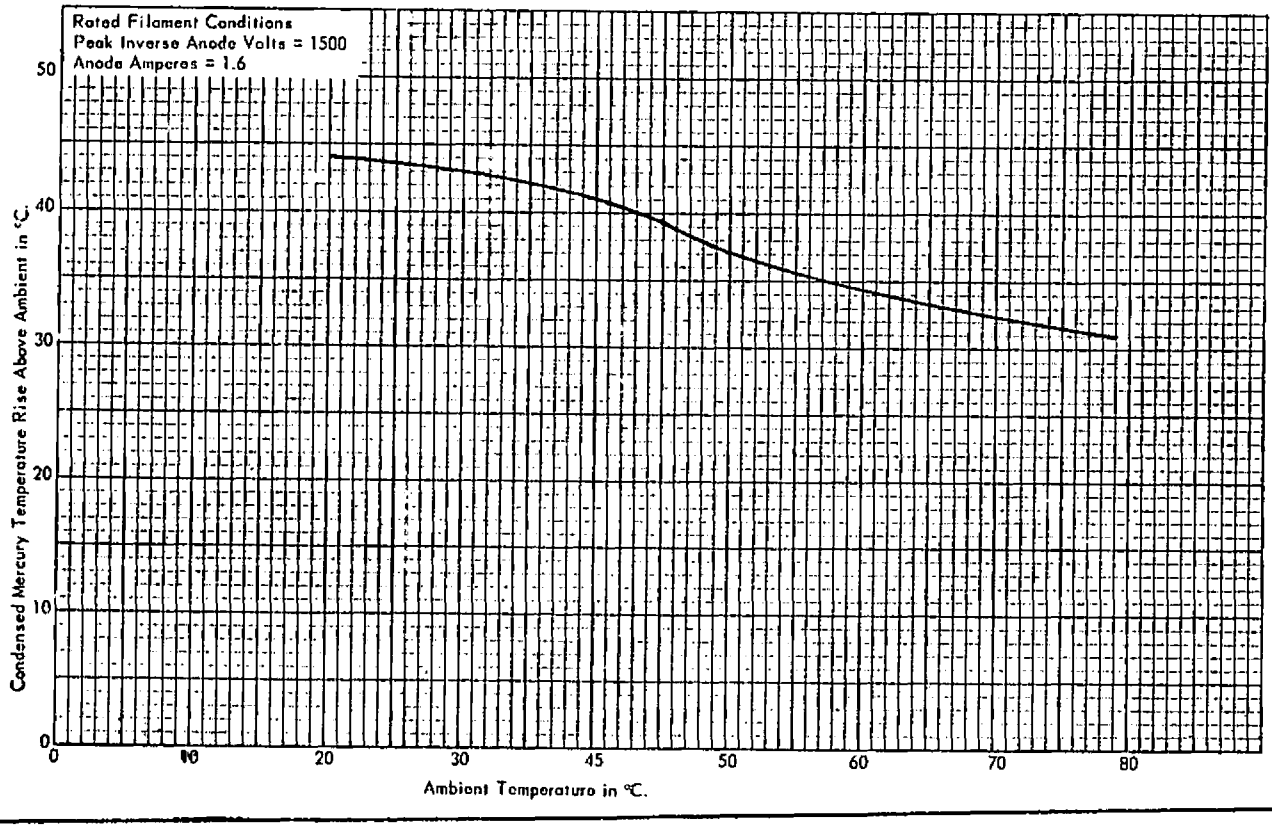
CONTROL CHARACTERISTIC OF WL-6783



RATE OF CONDENSED MERCURY TEMPERATURE RISE ABOVE AMBIENT



CONDENSED MERCURY TEMPERATURE RISE ABOVE AMBIENT AS A FUNCTION OF AMBIENT TEMPERATURE



from JETEC release #1512, Aug. 29, 1955

August 19, 1955
Revised
September 9, 1955

WL-6794

The WL-6794 is a special triode designed for ionization gauge service. It can be used to measure pressures in the range from 10^{-3}mm Hg to 10^{-10}mm Hg. The cathode is a pure tungsten filament. This type is electrically interchangeable with electron tube type 5966.

GENERAL DATA

Electrical:		
Filament Voltage*	6	vac or vdc
Filament Current	2.5	amps
Ion Collector Voltage	-100 max.	volts
Grid Voltage	+500 max.	volts
Mechanical:		
Type of Cooling	Air	
Max. Operating Temperature	100°	centigrade
Bulb Glass	Nonex-code 7720	
Tubulation Glass	Pyrex-code 7740	
Operating Position	Vertical	

TYPICAL OPERATION

Ion Collector Voltage	-30	volts
Grid Voltage	+150	volts
Grid Current	10	ma.
Sensitivity	1 μamp/10^{-5}mm Hg	

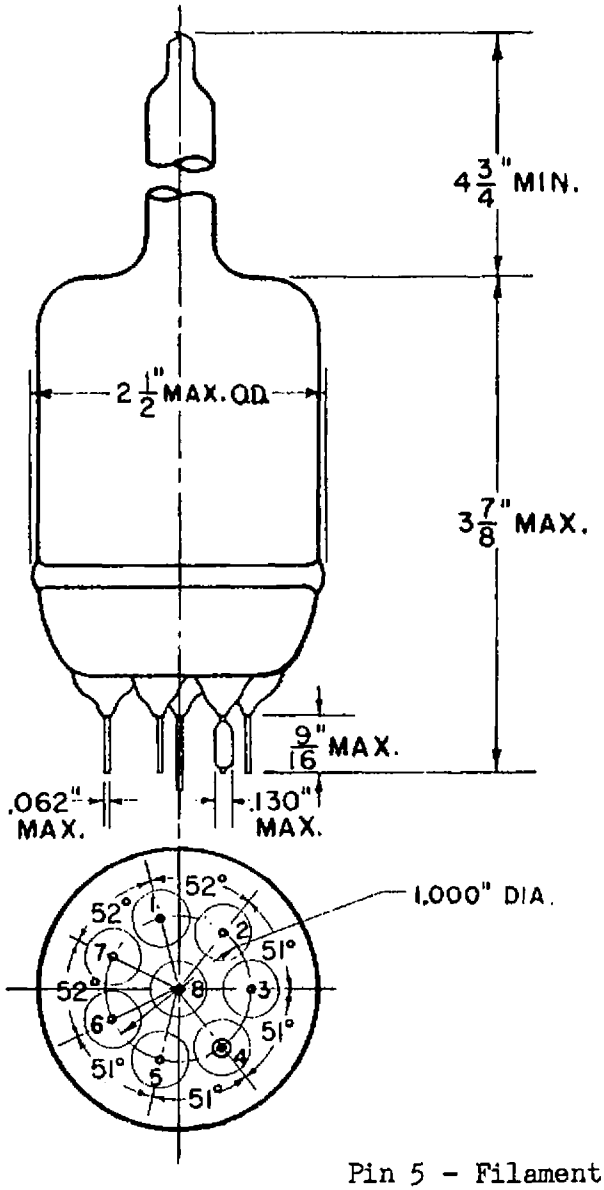
CONDITIONS FOR OUTGASSING

Grid Voltage	+500 max.	volts
Ion Collector	Tied to Grid	
Filament**		
Series Connection	15 max.	volts
Parallel Connection	7.5 max.	volts
Outgas Power	100 max.	watts

NOTES

* Two filaments are supplied, one of which is a spare.

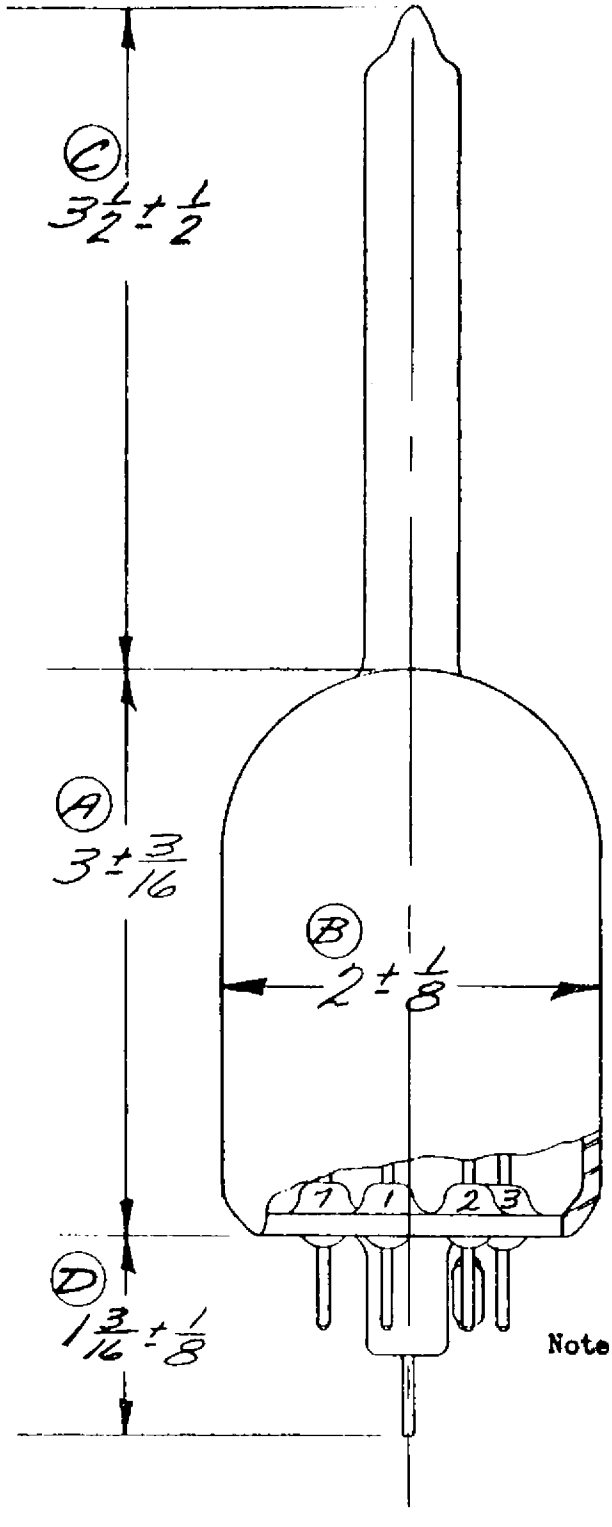
** To outgas the gauge, the two filaments may be connected either in series or parallel. Connect the ion collector to grid and attach to +500 volts dc. Adjust emission current by raising filament voltage to give the desired operating condition to outgas the elements.

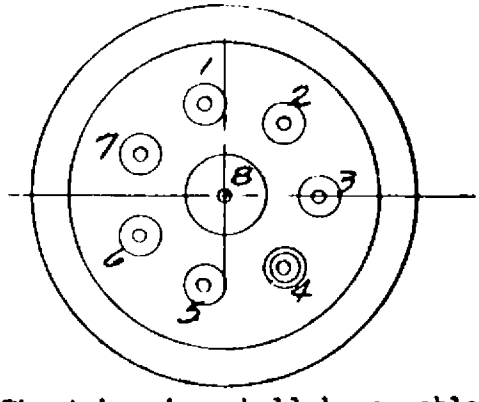


Pin 1 - Filament No. 1
Pin 2 - Filament No. 1
Pin 3 - Grid
Pin 4 - No Connection

Pin 5 - Filament No. 2
Pin 6 - Filament No. 2
Pin 7 - Grid
Pin 8 - Anode

Release No. 1512A
Nov. 6, 1961





Note 1: The tube pins shall be capable of entering gage A3-1P-6794-T1B for a distance of 3/8 min.

2: Grid pins must not exceed more than 3° out of parallel with bulb sides.

March 18, 1957

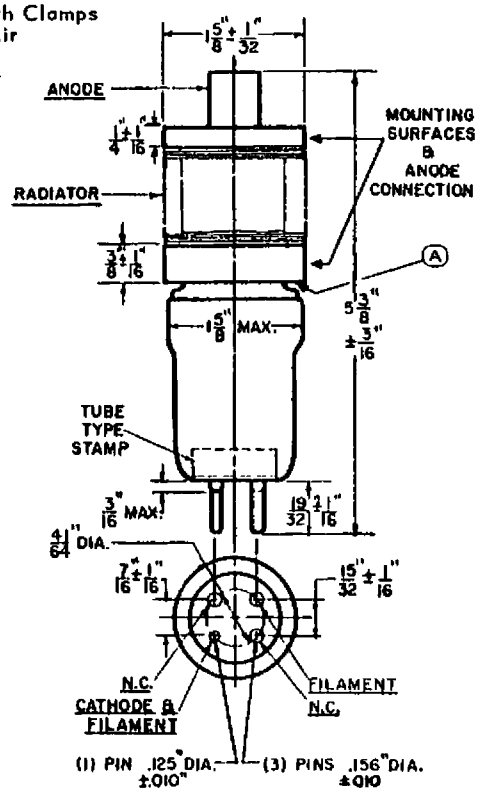
High-Vacuum Rectifier Type WL-6898

The WL-6898 is a forced-air cooled diode designed for service in air-borne radar equipment. This tube performs three distinct functions in radar modulators: a power rectifier to obtain the necessary high DC voltage; a charging-diode to couple the DC power to the pulse-forming network; and a clipper diode to absorb the reflected wave from the output magnetron.

The WL-6898 combines low heater power in a unipotential cathode, small size and light weight with higher maximum ratings than previous designs. This tube also incorporates structural and process features resulting in reliable performance in the adverse environment encountered in air-borne operation.

GENERAL DATA

ELECTRICAL:		
Cathode		Coated Unipotential
Voltage	5.0	Volts
Current	8.0	Amperes
Number of Electrodes	2	
MECHANICAL:		
Outline Dimensions		See Drawing
Mounting		Tube supported by Radiator
Pin Connections		Flexible Leads with Clamps
Cooling ♦		Forced Air
Rate	5	CFM
Static Pressure	0.16	Inch Water
Ambient Temperature	-55 to 100	°C
Altitude		Sea Level
Cathode Heating Time	120	Seconds
Net Weight	7.5	Ounces
Maximum Radiator Temperature ★	160	°C



CE-A1287

MAXIMUM RATINGS
Absolute Maximum Values

As CLIPPER DIODE:			
Peak Inverse Voltage	16000	max.	Volts
Peak Current (Continual) ♟	20	max.	Amperes
Average Current (Continual)	20	max.	Ma.
Peak Current (Intermittent) ⊕	30	max.	Ma.
Average Current (Intermittent) □	80	max.	Amperes
As CHARGING DIODE:			
Peak Inverse Voltage	16000	max.	Volts
Peak Current	600	max.	Ma.
Average Current	200	max.	Ma.
As HALF-WAVE RECTIFIER:			
Peak Inverse Voltage	16000	max.	Volts
Peak Current	630	max.	Ma.
Average Current	200	max.	Ma.

NOTES

♦ An air flow of 5 CFM through the radiator must precede the application of any voltages and must continue until all voltages are removed. The direction of flow must be parallel to the radiator fins.

□ For maximum of 5 seconds

♟ For maximum pulse duration of 5 microseconds.

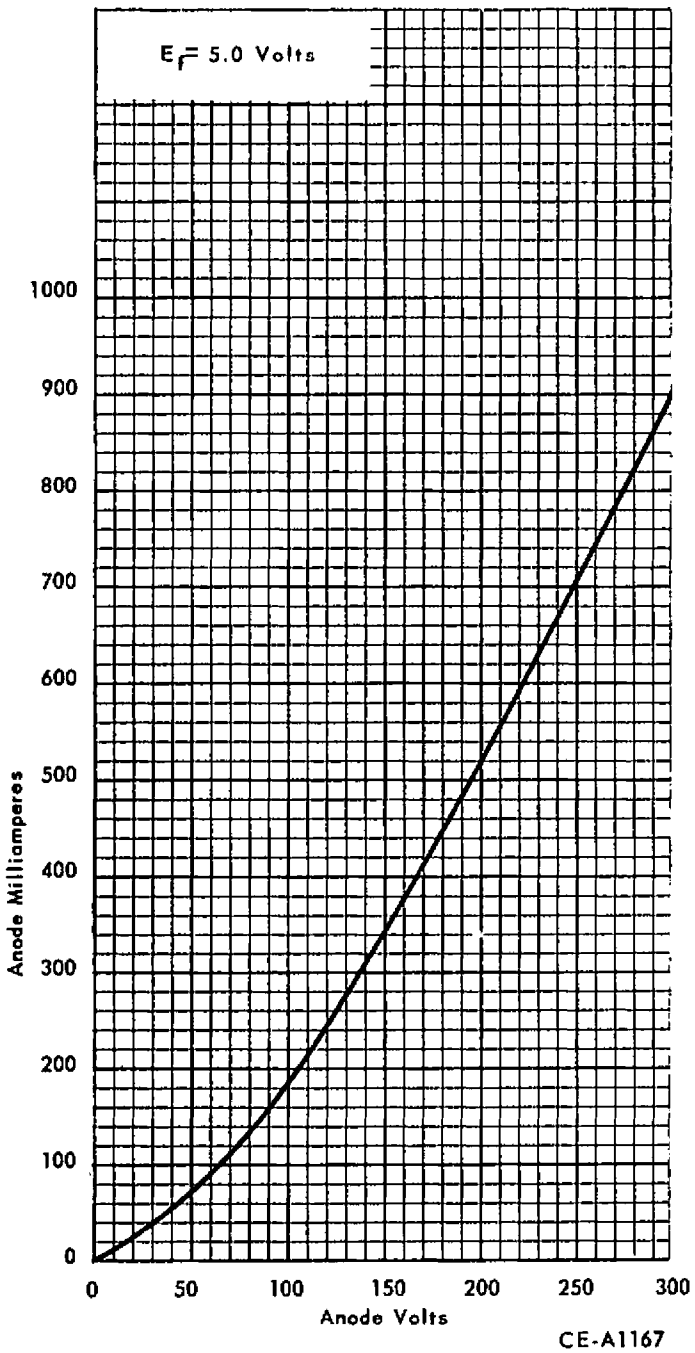
⊕ For maximum pulse duration of 5 microseconds repeatable during total time interval not to exceed 5 seconds.

★ Measured at point A, on outline drawing, with temperature sensitive paint.

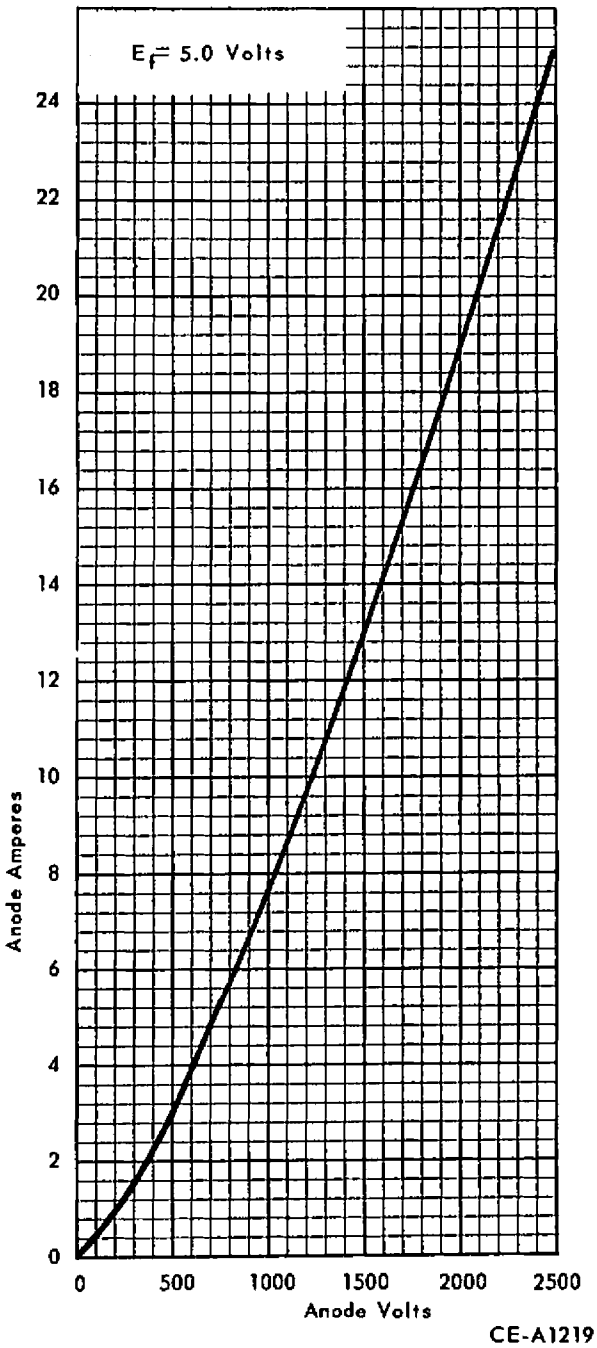
WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JETEC release #1880, March 25, 1957

AVERAGE PLATE CHARACTERISTIC



PULSE DIODE CHARACTERISTIC



December 26, 1956

WL-6937
UNCOMPENSATED IONIZATION CHAMBER

The WL-6937 is a BF_3 filled uncompensated ionization chamber of guard ring construction for the detection of thermal neutrons in the power range of reactor operation. It is filled to 250 mm-Hg with BF_3 enriched to 96% with the Boron-10 isotope. The sensitivity of the chamber is approximately 4×10^{-14} amperes per unit neutron flux.* It is extremely rugged and may be operated at temperatures up to 80°C.

The tube has an all-aluminum body three inches in diameter, an overall length of fourteen inches, and is provided with type "HN" connectors for cable fittings.

GENERAL DATA

MECHANICAL:

Overall Length	14"
Diameter	3"
Weight (approx.)	2½ pounds
Sensitive Length (approx.)	7"
Insulating Materials	Polystyrene & Alumina
Body Material	Aluminum

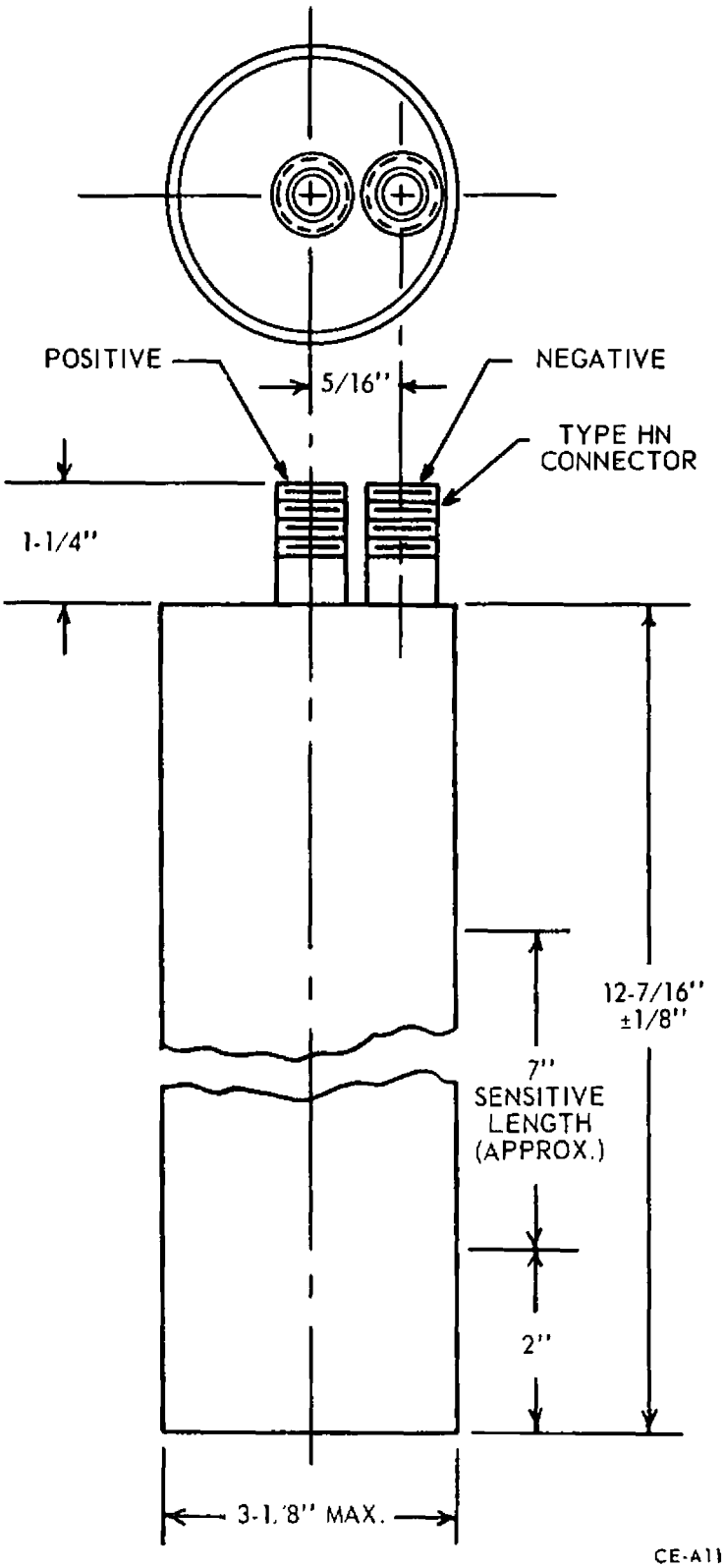
OPERATIONAL:

1. Neutron Flux	2.5×10^9 n/cm²/sec
Saturated Output	10^{-4} amperes
Operating Voltage for Saturation	200 volts (min.)
2. Neutron Flux	1.5×10^{10} n/cm²/sec
Saturated Output	6×10^{-4} amperes
Operating Voltage for Saturation	600 volts (min.)

* Unit neutron flux equals one neutron per cm^2 per second.

from JETEC release #1827, Jan. 14, 1957

Westinghouse



Release No. 1827A
May 8, 1961

The 6937 detector has been qualified as meeting requirements of MIL-STD-167, Mechanical Vibrations of Shipboard Equipment. As defined in Section 1.3 of the specification, all detectors are classified as Type 1, equipment intended for shipboard use which must be capable of withstanding the environmental conditions which may be encountered aboard Naval vessels. The equipment to be used is optional with the manufacturer, providing it meets the conditional requirements for amplitude and frequency defined in the specification. The test procedure calls for an Exploratory Test to determine resonance frequencies, if any; a variable frequency test; and an endurance test. In each of the tests, the detectors must be vibrated in each of the three principal directions of vibration.

Exploratory vibration is conducted at an amplitude of 0.010 inches from 5 to 33 cps in 1 cps steps, remaining 15 seconds at each step.

The variable frequency test is conducted from 5 to 33 cps in 1 cps steps of 5 min. duration. The amplitude shall be 0.030 inches in the 5 - 15 cps range, 0.020 in the 16 - 25 range, and 0.010 in the 26 - 33 range.

The endurance test is run at the resonant frequencies determined in the exploratory test, or if none, at 33 cps for two hours in each position. The amplitude will be determined by the frequency of vibration as in the variable frequency test.

Acceptance is based upon satisfactory electrical and nuclear operation upon the completion of the endurance test and ability to perform as indicated by noise generation measurements during the variable frequency and endurance tests.

The 6937 detector has been qualified as meeting the requirements of MIL-S-901, Shockproof Equipment, class HI (High Impact), shipboard application, tests for. As defined in Section 3.1.2 of the specification, all detectors are tested as type C which means that they are considered individual devices. For the purpose of test, the detectors are classified by weight and all detectors fall into the light category (250 pounds and below) per Section 1.2.1. Tests on equipment falling into the above-defined classes are tested on a lightweight shock-testing machine (BUSHIPS Drawing 10-T-2145-L) utilizing a 400 pound hammer. In the tests the detectors are subjected to three blows parallel to each of the three principal axes, the three blows for each direction to be with heights of hammer drop of one foot, three feet and five feet. This gives a total of nine blows of the hammer. The degree of acceleration is determined by the characteristics of the equipment.

The prime criteria for acceptance is the ability to perform during or after the test; however, none of the parts shall become detached from the apparatus.

December 26, 1956

WL-6938
HIGH SENSITIVITY BF_3 PROPORTIONAL COUNTER

The WL-6938 is a multi-element proportional counter for the detection of thermal and high-speed neutrons. It is intended for use in the range from 0.025 neutrons per cm^2 per second to 2.5×10^3 neutrons per cm^2 per second. The detector consists of a heavy walled all-aluminum case, enclosing a polyethylene moderator block which surrounds a group of individual proportional counters. The case is provided with type "HN" cable fitting and four tapped holes on the top for mounting or support. Each counter is filled to a pressure of 55 cm Hg with BF_3 enriched to 96% with the Boron-10 isotope. The counter is extremely rugged and it will operate continuously in any position, and at temperatures up to 80°C. The sensitivity is approximately 55 counts per second for a unit neutron flux, and it operates in the vicinity of 2200 volts.

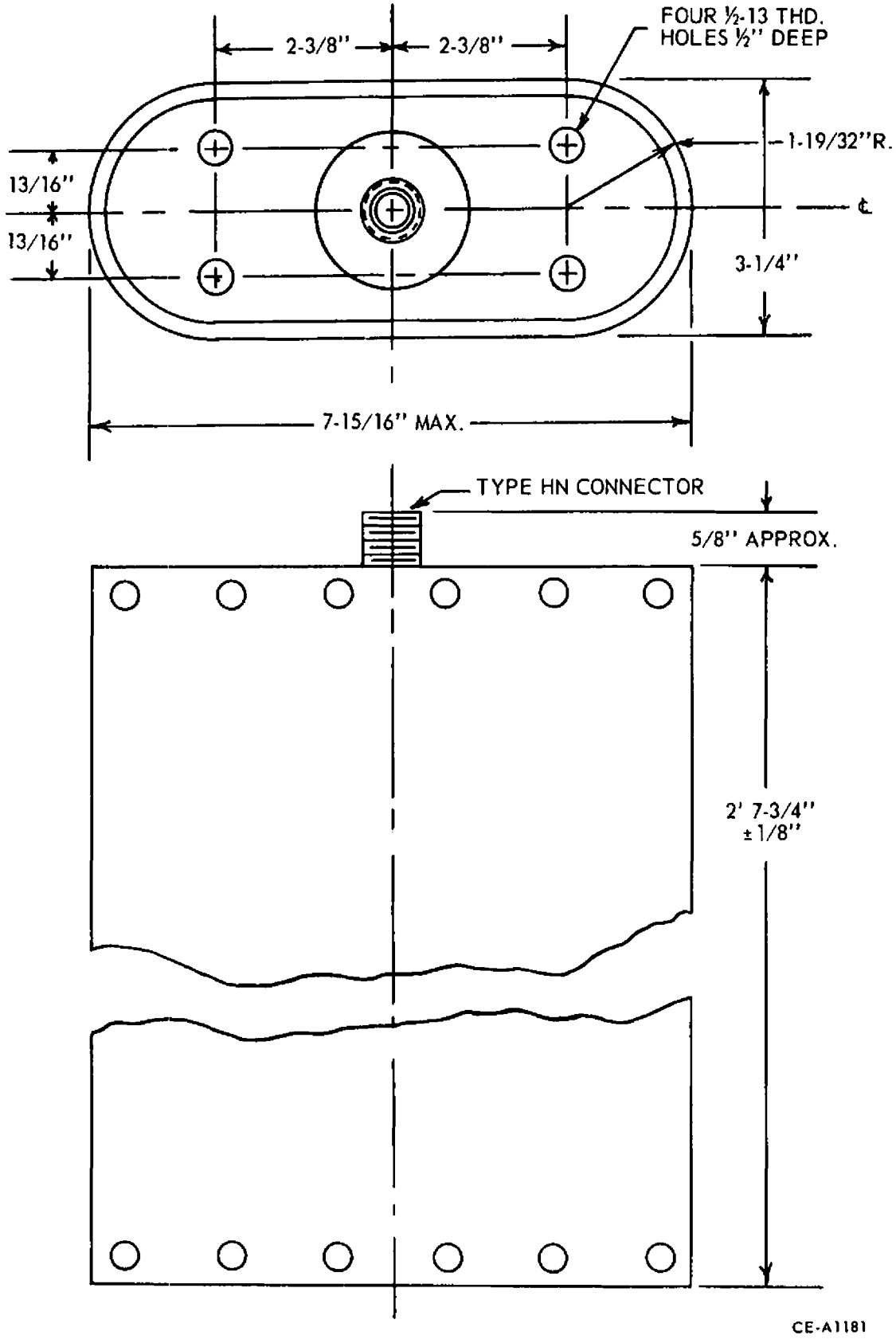
GENERAL DATA

MECHANICAL:	
Overall Length	2' 8-3/8"
Overall Width	8"
Weight (approx.)	30 lbs.
Sensitive Length	26"
Insulating Materials	Polystyrene & Alumina
Body Material	Aluminum
OPERATIONAL:	
Operating Voltage (approx.)	2200 Volts
Operating Temperature	80° C. max.
Sensitivity (approx.), Note 1	55 Counts per Second
Multiplication Factor, at 2000 Volts	500
Plateau Length	200 Volts min.

NOTE 1: For an isotropic thermal neutron flux of one neutron per cm^2 per second.

from JETEC release #1827, Jan. 14, 1957

Westinghouse



CE-A1181

November 26,1956

WL-6941
UNCOMPENSATED IONIZATION CHAMBER

The WL-6941 is an uncompensated ionization chamber for the detection of thermal neutrons in the power range of reactor operation. The detecting material is uranium oxide enriched in U-235 isotope coated on aluminum electrodes. The sensitivity of the chamber is approximately 4×10^{-14} amperes per unit neutron flux. It is extremely rugged and may be operated up to 80°C. The tube has an all-aluminum body two inches in diameter and 11-7/8" long, provided with a connector for "HN" cable fittings. It is filled to a pressure of one atmosphere with a nitrogen-argon mixture.

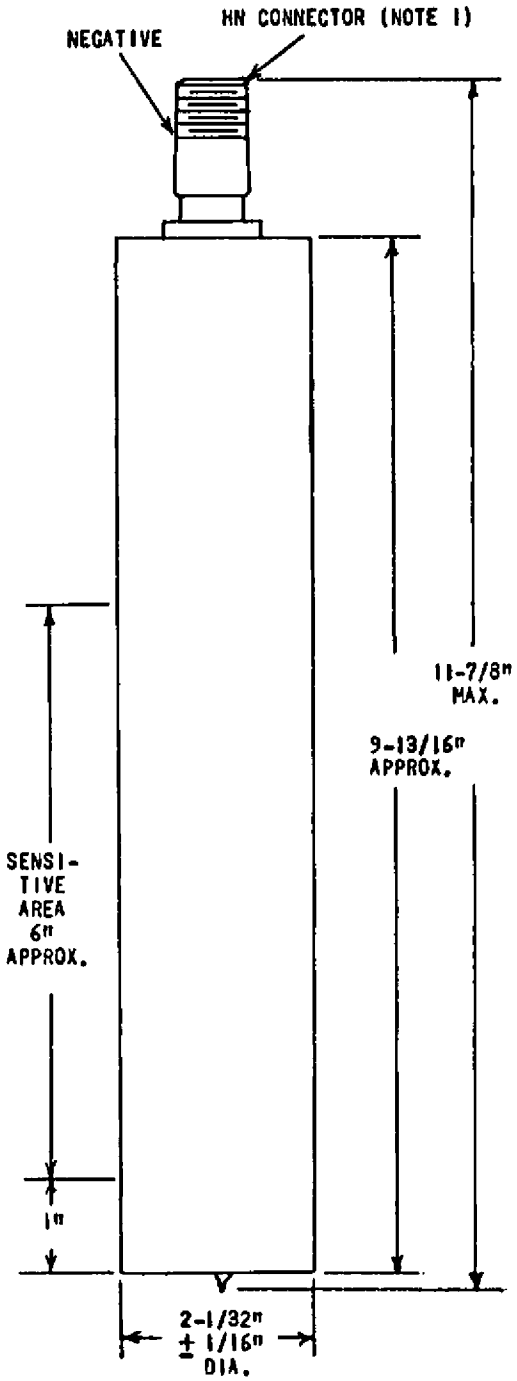
GENERAL DATA

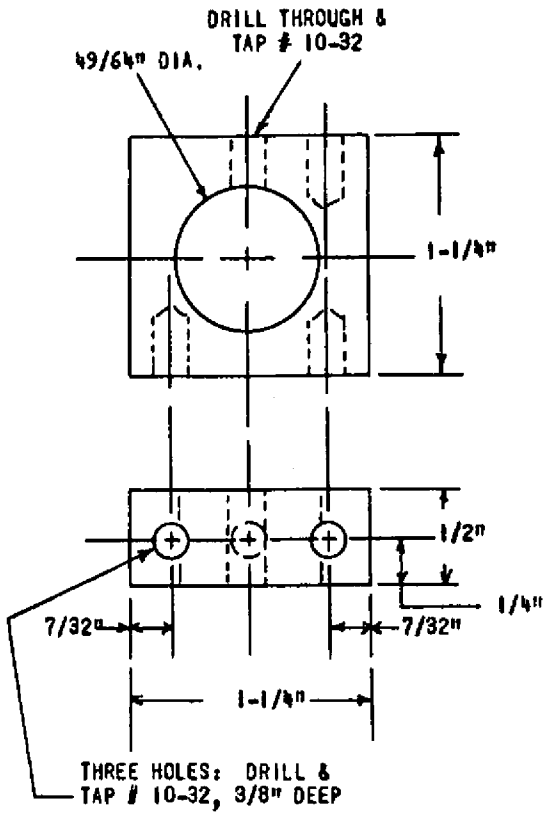
Mechanical:		
Overall Length	11-7/8"	
Diameter, Max.	2-3/32"	
Net Weight	1-3/4 lb	
Shipping Weight, approx.	12 lb	
Insulating Materials	Polystyrene and Alumina	
Sensitive Length, approx.	6"	
Body Material	Aluminum	
Neutron Sensitive Material	U_3O_8 fully enriched in U-235	
Filling	$A\text{-}N_2$ at one atmosphere	
Maximum Ratings:		
Operating Voltage	1000	Volts
Unit Neutron Flux	2.5×10^{10}	nv
Total Integrated Flux	1×10^{17}	nvt
Operating Temperature	80	°C
Operational:		
Operating Voltage	+300 to +800	Volts
Neutron Sensitivity	4×10^{-14}	amp./neutron/cm^2/sec.
Neutron Flux Range (Note 1)	5×10^5 to 2.5×10^{10}	neutrons/cm^2/sec.
Typical Saturated Output:		
1. Neutron Flux	2×10^9	n/cm^2/sec.
Saturated Output	10^{-4}	amperes
Operating Voltage for Saturation	200	volts (min.)
2. Neutron Flux	3×10^{10}	n/cm^2/sec.
Saturated Output	2×10^{-3}	amperes
Operating Voltage for Saturation	800	volts(min.)

Note 1: Lower level limited by alpha background current of about 3×10^{-9} amperes.

from JETEC release #1802, Dec. 10, 1956

Westinghouse





MICARTA MOUNT: MAY BE USED TO SUPPORT THE WL-6376 FROM CABLES, ETC. SUPPLIED WITH TUBE. FITS OVER THE HN CONNECTOR AND SECURED BY MALE HN CONNECTOR (PART NO. 43-73-1)

NOTE 1: THIS CONNECTOR WILL MATE WITH AMPHENOL PLUG 82-38 (MIL-UG59A/U) OR EQIVALENT.

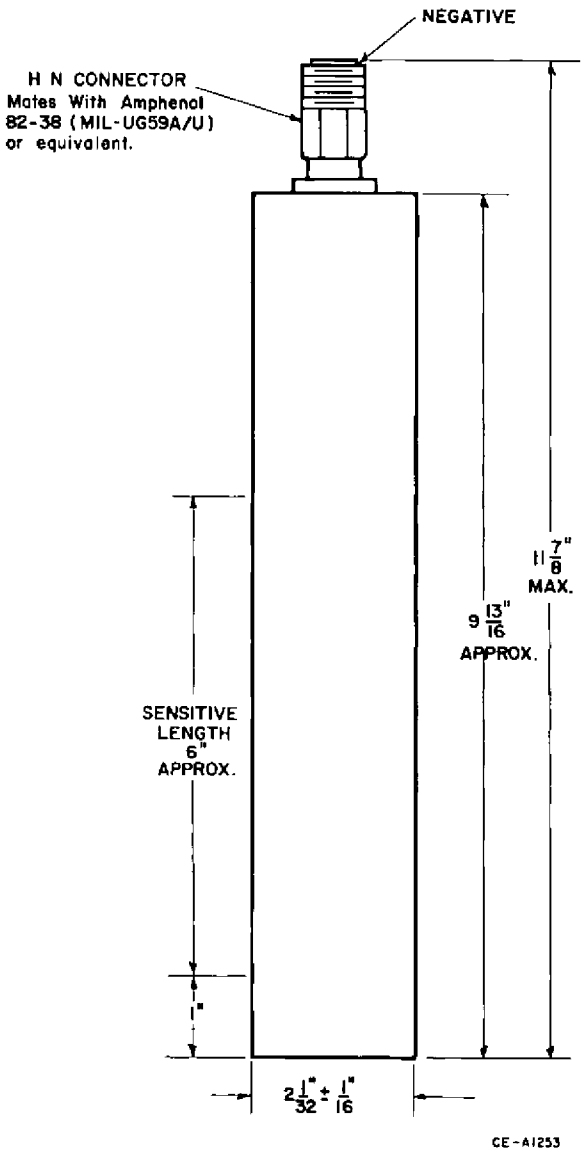
CE-A1253

April 10, 1958

UNCOMPENSATED IONIZATION CHAMBER TYPES WL-6941 AND WL-6941A

The WL-6941 and WL-6941A are aluminum cased ionization chambers designed to detect thermal neutrons in the flux range from 5×10^5 to 5×10^{10} neutrons/cm^2/second. Ionization currents are produced in the nitrogen-argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating, consisting of uranium oxide highly enriched in U-235 isotope. The neutron sensitivity of these types is 2.6×10^{-14} amperes/neutron/cm^2/second and the gamma sensitivity is 3×10^{-11} ampere/Roentgen/hour. These tubes are provided with a type "HN" connector and are extremely rugged♦ being operable in any position.

The WL-6941 may be operated or stored in ambient temperatures not exceeding 175°F; similarly, the maximum ambient temperature for the WL-6941A is 300°F.



MECHANICAL:		
Maximum Diameter	2-3/32	Inches
Maximum Overall Length	11-7/8	Inches
Approx. Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds
MATERIALS:		
Body		Aluminum
Insulation		Polystyrene & Alumina
Gas Filling		Argon-Nitrogen Mixture at 76 cm Hg
Neutron Sensitive Coating:		
Content	U_3O_8 enriched to more than 90% in U-235	
Thickness	2.0	mg/cm^2
Total Amount of U-235	0.4	gm
MAXIMUM RATINGS:		
Absolute Maximum Values		
Interelectrode Voltage (dc)	1000 max.	Volts
Thermal Neutron Flux	5×10^{10} max.	n/cm^2/sec
Total Integrated Flux	1×10^{17} max.	n/cm^2(nvt)
Ambient Temperature:		
WL-6941	175 max.	°F
WL-6941A	300 max.	°F
TYPICAL OPERATING CHARACTERISTICS:		
Voltage Between Electrodes□	300 to 800	Volts
Neutron Flux Range⊕	5×10^5 to 5×10^{10}	n/cm^2/sec
Neutron Sensitivity	2.6×10^{-14}	amp/n/cm^2/sec
Gamma Sensitivity	3×10^{-11}	amp/R/hr
Leakage Resistance	10^9 min.	ohms
Capacitance Signal Electrode to Case	180	uuf
TYPICAL SATURATION CHARACTERISTICS:		
For Thermal Neutron Flux of 3×10^9 n/cm^2/sec		
Operating Voltage	200 min.	Volts
Output Current	8×10^{-5}	Amperes
For Thermal Neutron Flux of 2.5×10^{10} n/cm^2/sec		
Operating Voltage	800 min.	Volts
Output Current	6.5×10^{-4}	Amperes

□ Saturation voltage varies with neutron flux.

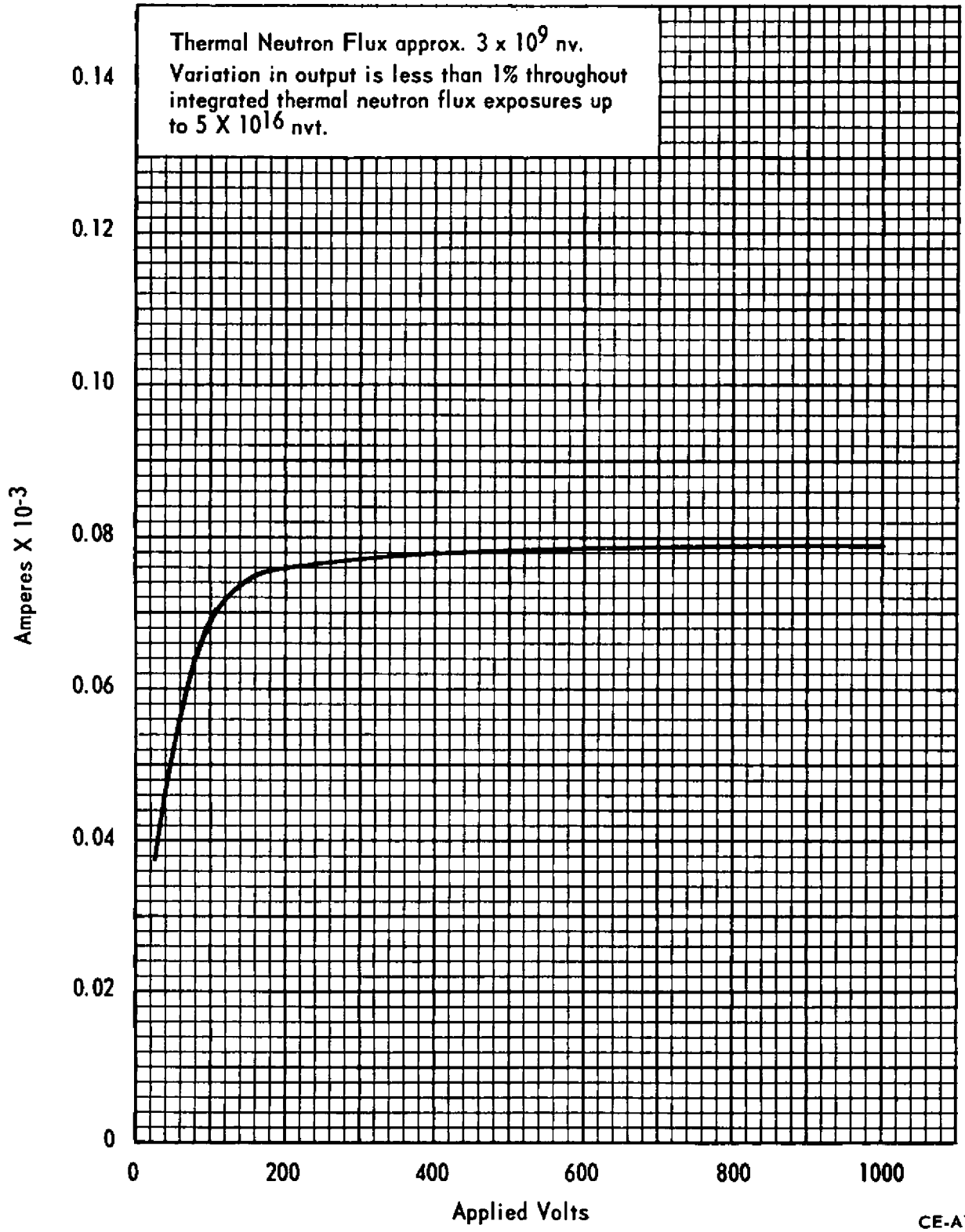
⊕ Lower level limited by alpha background current of approximately 3×10^{-9} amperes.

♦ The WL-6941 and WL-6941A have passed Military Specifications MIL-S-901 for shock and MIL-Std-167 (Type 1) for vibration.

NOTE: These tubes may not be immersed in water and high humidity environments should be avoided since they may impair performance.

from JETEC release #2175, May 5, 1958

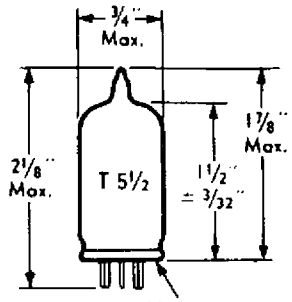
TYPICAL SATURATION CHARACTERISTIC



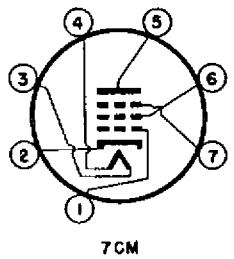
February 1, 1957

Dual-Control Pentode Type WL-6954

The WL-6954 is a sharp-cutoff dual-control pentode of 7-pin miniature construction designed for service in industrial and military equipment as a gating, mixing or delay tube.



OUTLINE DRAWING



7CM

SOCKET CONNECTIONS

BOTTOM VIEW

PIN 1 - GRID 1
PIN 2 - CATHODE AND INTERNAL SHIELD
PIN 3 - HEATER
PIN 4 - HEATER
PIN 5 - PLATE
PIN 6 - GRID 2
PIN 7 - GRID 3

GENERAL DATA

ELECTRICAL:		
Cathode		Coated Unipotential
Heater		
Voltage (ac or dc)	6.3	Volts
Current	0.3	Ampere
Direct Interelectrode Capacitances (Unshielded)		
Grid 1 to Plate	0.0035 max.	*uuf*
Grid 3 to Plate	1.5 max.	*uuf*
Grid 1 Input	6.0	*uuf*
Output	5.0	*uuf*
Grid 3 to All Other Elements	3.0	*uuf*
Coupling (Grid 1 to Grid 3)	0.09 max.	*uuf*
MECHANICAL:		
Bulb		T-5½
Base		Miniature 7-Pin (JETEC E7-1)
Outline		5-2
Basing		7CM
Mounting Position		Any

CHARACTERISTICS

Plate Voltage	150	Volts
Grid 2 (Screen) Voltage	150	Volts
Grid 3 Voltage	-3.0	Volts
Grid 1 Voltage	-1.0	Volts
Plate Resistance	50,000	Ohms
Transconductance		
Grid 1 to Plate	2050	*umhos*
Grid 3 to Plate	1000	*umhos*
Plate Current	5.8	Ma.
Grid 2 Current	6.6	Ma.
Grid 1 Cutoff □	-6.5	Volts
Grid 3 Cutoff ♦	-9.5	Volts

MAXIMUM RATINGS

(DESIGN CENTER VALUES)

Plate Voltage	300 max.	Volts
Grid 2 Supply Voltage	300 max.	Volts
Grid 2 Voltage		See Grid 2 Input Rating Chart
Positive Grid 1 Voltage	0 max.	Volts
Plate Dissipation	3.0 max.	Watts
Grid 2 Dissipation	1.0 max.	Watt
Heater-Cathode Voltage:		
Heater Positive with Respect to Cathode:		
DC Component	100 max.	Volts
Total DC and Peak	200 max.	Volts
Heater Negative with Respect to Cathode:		
Total DC and Peak	200 max.	Volts

from JETEC release #1854, Feb. 25, 1957

TEST LIMITS

	Min.	Max.	
HEATER CURRENT	0.275	0.325	Ampere
Heater Volts = 6.3			
PLATE CURRENT			
Heater Volts = 6.3			
Plate Volts = 250			
Grid 2 Volts = 150			
(1) Cathode Bias Resistor§ = 68 Ohms	5.5	12.5	Ma.
(2) Grid 1 Volts = -8.0	0	35	μamp
(3) Grid 3 Volts = -15.0 & Grid 1 Volts = -2.0	0	100	μamp
GRID 2 CURRENT			
Heater Volts = 6.3			
Plate Volts = 250			
Grid 2 Volts = 150			
Cathode Bias Resistor § = 68 Ohms	3.3	5.9	Ma.
GRID 1 TRANSCONDUCTANCE			
Heater Volts = 6.3 Grid 2 Volts = 150			
Plate Volts = 250 Cathode Bias Resistor § = 68 Ohms			
Initial	3500	5600	μmhos
After 500 hrs. Life Test	3000		μmhos
INTERELECTRODE CAPACITANCES (Shielded) ▲			
Grid 1 to Plate		0.0035	μμf
Input	4.4	6.6	μμf
Output	3.5	6.5	μμf
HEATER-CATHODE LEAKAGE			
Heater 100 Volts Positive With Respect to Cathode	0	20	μamp
Heater 100 Volts Negative With Respect to Cathode	0	20	μamp
TOTAL GRID CURRENT	0	-1.0	μamp
Heater Volts = 6.3 Grid 2 Volts = 150			
Plate Volts = 250 Grid 1 Volts = -1.5			
EMISSION	60		Ma.
Heater Volts = 6.3 Grid 2 Volts = 20			
Plate Volts = 20 Grid 1 Volts = 20‡			
LIFE TEST (Group A)	500		Hours
Heater Volts = 6.3 Grid 3 Volts = 0			
Plate Volts = 250 Grid 1 Volts = -4.0			
Grid 2 Volts = 150 Load Resistance = 250,000 Ohms			
RADIO FREQUENCY NOISE (Calibrating R.F. Signal is 30 Millivolts)			
Heater Volts = 6.3 Grid 2 Volts = 150			
Plate Volts = 250 Cathode Resistor = 68 Ohms			
VIBRATION SIGNAL OUTPUT (at 25 cycles with 2.5G accelerations -		100	millivolts
Heater Volts = 6.3 Plate Resistor = 2000 Ohms			
Plate Volts = 250 Grid 1 Resistor = 1.0 Megohm			
Grid 2 Volts = 150 Grid 3 Resistor = 1.0 Megohm			
Cathode Bias Resistor = 68 Ohms			

NOTES

□ For Plate Current of 10 μamp.

♦ For Plate Current of 100 μamp.

§ Bypassed by Capacitor whose impedance is 5 ohms or less at frequency used.

▲ JETEC Shield No. 316 connected to cathode.

‡ Cathode-Bias Resistor equals 0.

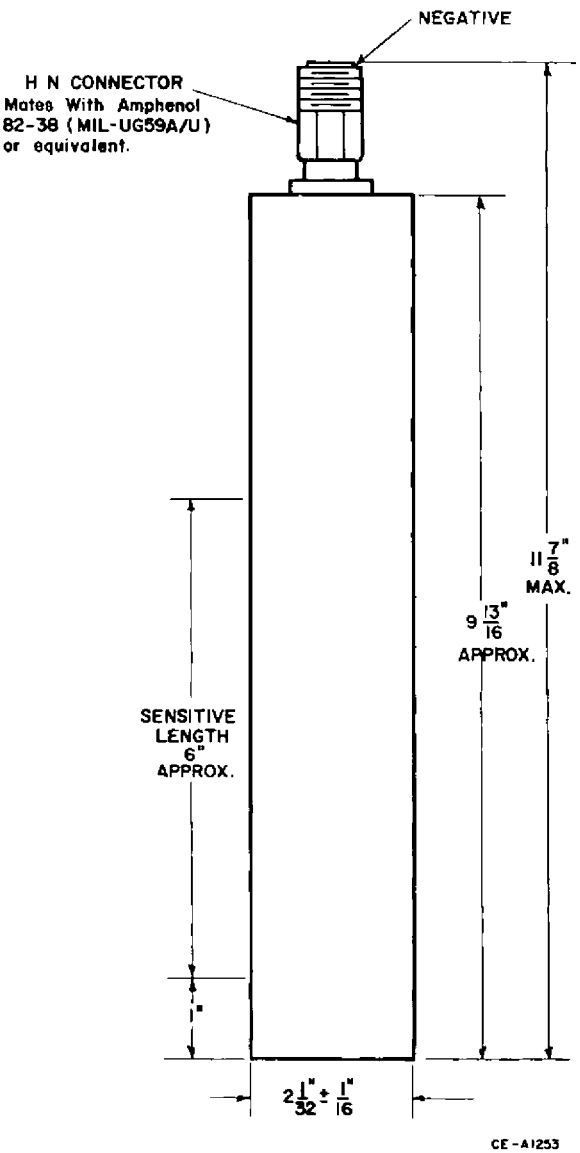
April 10, 1958

FISSION COUNTER TYPES WL-6971 AND WL-6971A

The WL-6971 and WL-6971A are fission counters designed to detect thermal neutrons in the flux range from 1.25 x 10 to 1.25 x 10^6 neutrons/cm^2/second. Ionization pulses are produced in the nitrogen-argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating. The sensitive coating consists of uranium oxide enriched to 20% in U-235 isotope. These types are extremely rugged ♦ and will operate in any position.

The WL-6971 may be operated or stored in ambient temperatures not exceeding 175°F; similarly, the maximum ambient temperature for the WL-6971A is 300°F.

The sensitivity of the WL-6971 and WL-6971A is 1.4 x 10^{-1} counts/neutrons/cm^2 when the pulse amplifier discriminator is adjusted for a background counting rate of 1 count/second for the naturally radioactive uranium. An incident gamma flux of 10^{10} photons/cm^2/second results in a maximum decrease in sensitivity of 1% up to 10^5 counts/second.



MECHANICAL:		
Maximum Diameter	2-3/32	Inches
Maximum Overall Length	11-7/8	Inches
Approx. Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds
MATERIALS:		
Body and Electrodes		Aluminum
Insulation		Polystyrene & Alumina
Neutron Sensitive Coating:		
Content	U_3O_8 enriched 20% in U-235	
Thickness	2.0	mg/cm^2
Total Amount of U-235	0.37	gm
Gas Filling		Argon-Nitrogen Mixture at 76 cm Hg
MAXIMUM RATINGS:		
Absolute Maximum Values		
Voltage Between Electrodes	800 max.	Volts
Thermal Neutron Flux	2.5 x 10^{10} max.	n/cm^2/sec
Total Integrated Neutron Flux	1 x 10^{17} max.	n/cm^2
Temperature:		
WL-6971	175 max.	°F
WL-6971A	300 max.	°F
TYPICAL OPERATING CHARACTERISTICS:		
Operating Voltage	300	Volts
Operating Voltage Plateau ⊕	200 to 800	Volts
Neutron Flux Range	1.25 x 10 to 1.25 x 10^6	n/cm^2/sec
Sensitivity □	1.4 x 10^{-1}	count/n/cm^2
Output Pulse Characteristics:		
Magnitude	2 x 10^{-4}	Volts
Inherent Rise Time	2 x 10^{-7} max.	Seconds
Leakage Resistance	10^9 min.	ohms
Capacitance-Signal Electrode to Case	190	uuf

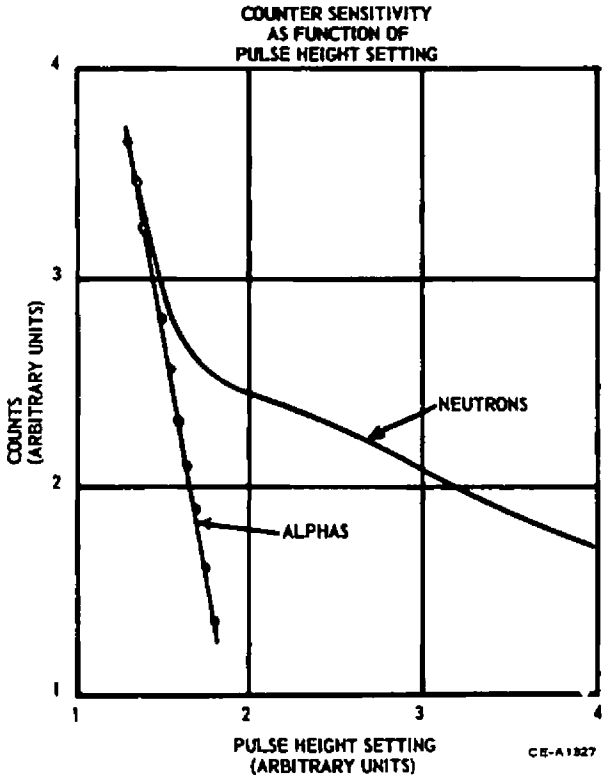
♦ The WL-6971 and WL-6971A have passed Military Specifications MIL-S-901 for shock and MIL-Std-167 (Type 1) for vibration.

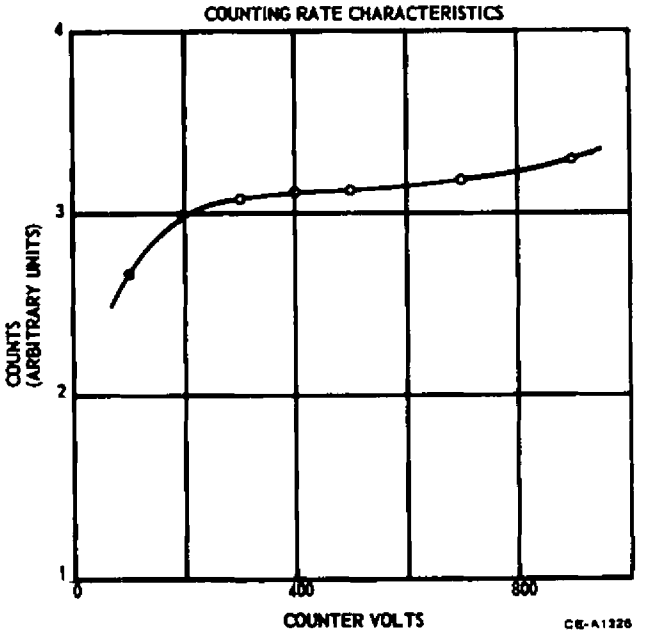
⊕ Counting Rate at different operating voltages is shown in CE-A1326.

□ The sensitivity is 1.4 x 10^{-1} counts/n/cm^2 for an alpha background counting rate of 1 count/sec. By varying the pulse-height selector setting, other counter sensitivities are obtainable for different background counting rates as shown in CE-A1327.

NOTE: These tubes may not be immersed in water and high humidity environments should be avoided since they may impair performance.

from JETEC release #2175, May 5, 1958


COUNTER SENSITIVITY
AS FUNCTION OF
PULSE HEIGHT SETTING
COUNTS
(ARBITRARY UNITS)
4
3
2
1
NEUTRONS
ALPHAS
1
2
3
4
PULSE HEIGHT SETTING
(ARBITRARY UNITS)
CE-A1327


COUNTING RATE CHARACTERISTICS
COUNTS
(ARBITRARY UNITS)
4
3
2
1
0
400
800
COUNTER VOLTS
CE-A1326

WL-6998

BF_3 PROPORTIONAL COUNTER

The WL-6998 is a proportional counter for the detection of thermal neutrons. It is intended for use in neutron fluxes in the range of 0.07 neutron/cm^2/sec to 7×10^3 neutron/cm^2/sec. The counter has an all-aluminum body one inch in diameter and 30-3/8 inches long; it is provided with a connector for "HN" cable fittings. The WL-6998 is extremely rugged and will operate in any position and at temperatures up to 80°C. It is filled to a pressure of 55 cm Hg with BF_3 enriched to 96% with Boron-10 isotope. The sensitivity of the counter is approximately 15 counts per second for unit thermal neutron flux and it operates in the vicinity of 2100 volts. Although the counter is sensitive to gamma radiation, the pulses arising from incident photons are sufficiently small that they normally can be biased out by the amplifier discriminating circuits.

MECHANICAL:

Overall Length	30-3/8" ± 1/8"
Diameter, Max.	1-1/32"
Net Weight	10 oz.
Shipping Weight, Approx.	5 lb.
Sensitive Length, Approx.	26"
Center Conductor	0.001" Diameter Tungsten Wire
Body	Aluminum
Insulating Material	Polystyrene and Alumina
Filling	BF_3 enriched to 96% is B-10 at pressure of 55 cm Hg

MAXIMUM RATINGS:

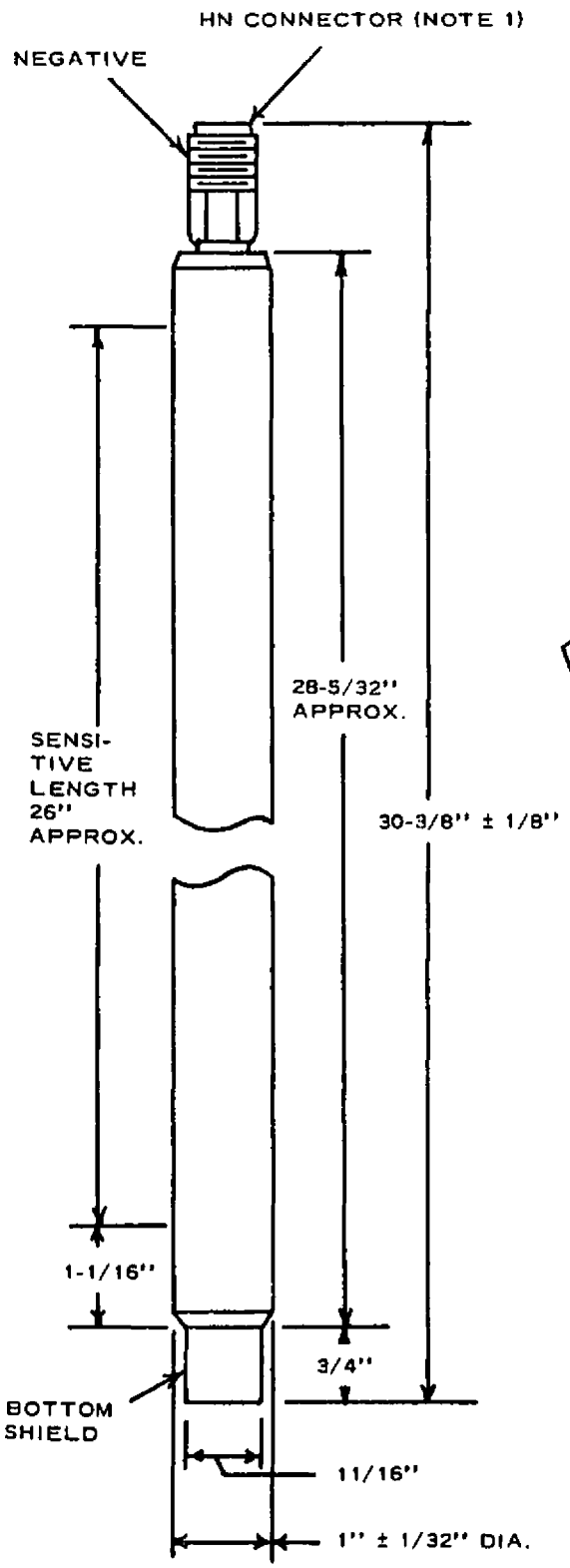
Thermal Neutron Flux	7×10^3 nv
Total Life	10^9 counts
Operating Temperature	80°C

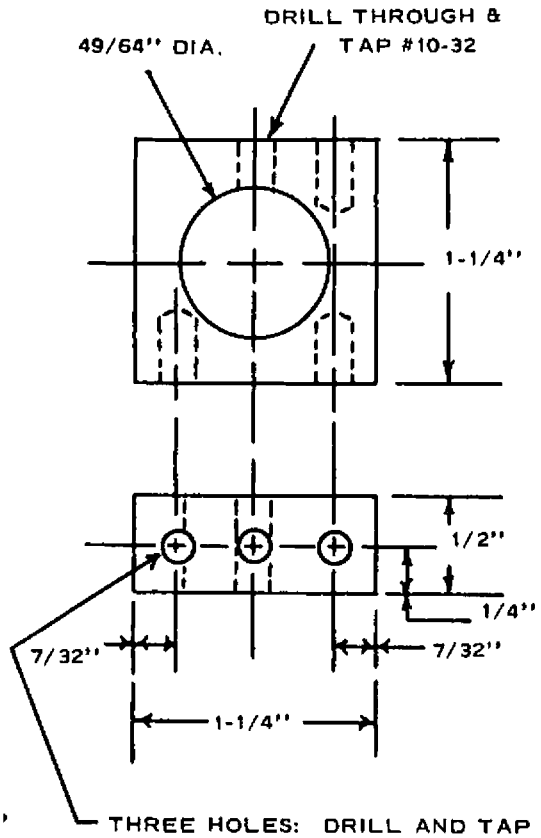
OPERATIONAL:

Operating Voltage, Approx.	2100 Volts
Sensitivity	15 counts/neutron/cm^2
Neutron Flux Range	7×10^{-2} to 7×10^3 neutron/cm^2/sec
Multiplication Factor, at 2100 Volts	500
Plateau	Operating plateau 200 volts or greater in length and width an average slope of 0.02% per volt or less obtainable with 5 millicurie radiumberyllium neutron source.
Output	Under typical operating conditions, output pulse is a few millivolts with inherent rise time of about 1 us.

from JETEC release #1880, March 25, 1957

Westinghouse®





MICARTA MOUNT MAY BE USED TO SUPPORT THE WL-6998 FROM CABLES, ETC. SUPPLIED WITH THE TUBE. FITS OVER THE HN CONNECTOR AND SECURED BY MALE HN CONNECTOR.
(PART NO. 43-73-1)

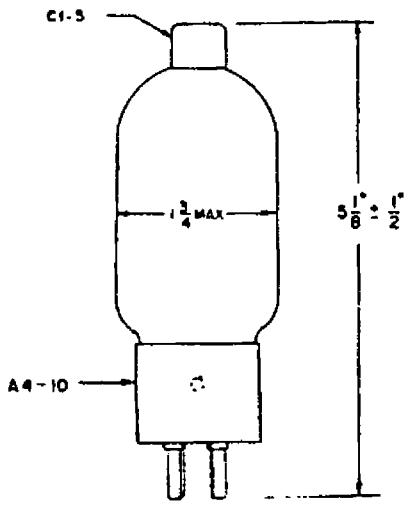
NOTE 1: THIS CONNECTOR WILL MATE WITH AMPHENOL PLUG 82-38 (MIL-UG59A/U) OR EQUIVALENT.

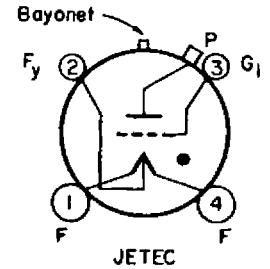
from JETEC release #1944, June 10, 1957

June 3, 1957

THYRATRON TYPE WL-7031

The WL-7031 is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged over a wide range of ambient temperatures. The WL-7031 is designed for operation in industrial control and ignitor firing service. This tube is electrically similar to the WL-5877.





JETEC 4CF

BASE CONNECTIONS

F - Filament
G_1 - Control Grid
P - Plate & Anode
F_y - Filament Center Tap & Anode Return

GENERAL DATA

	Min.	Bogey	Max.	
ELECTRICAL:				
Cathode		Directly Heated Coated Filament		
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts = 2.5	9.8	10.8	11.8	Amperes
Heating Time	30	- -	- -	Seconds
Deionization Time		See Figure 2		
Ionization Time		10		usec
Critical Anode Voltage at Grid Voltage at +6 Volts	- -	- -	100	Volts
Critical Grid Voltage at Anode Voltage of 1500 Volts-See Figure 1	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.)				
Anode to Grid		0.51		uuf
Grid to Filament		15.6		uuf
Anode to Filament		3.4		uuf
Typical Arc Drop		16		Volts
Control Characteristic				Negative
MECHANICAL:				
Mounting Position				Any
Overall Height (Approx.)				5-3/8"
Overall Diameter (Maximum)				1-3/4"
Type of Cooling				Air, Unrestricted Convection
Temperature Range				-55 to +70°C
Bulb				T-13
Anode Cap				JETEC C1-5
Base				JETEC A410
Net Weight (Approx.)				5 oz.
Shipping Weight (Approx.)				2 lb.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:		
Peak Anode Voltage		
Forward	1500 max.	Volts
Inverse	1500 max.	Volts
Anode		
Peak	40 max.	Amperes
Average	3.2 max.	Amperes
Surge, max. Duration 0.1 sec.■		
Connection (a)	560 max.	Amperes
Connection (b)	280 max.	Amperes
Connection (c)	280 max.	Amperes
Commutation Factor ♦	200 max.	va/usec
Current Rate of Change	0.25 max.	a/usec
Voltage Rate of Change	800 max.	v/usec
Negative Control Grid Voltage		
Before Conduction	250 max.	Volts
During Conduction §	10 max.	Volts
Average Positive Control Grid Current		
Averaging Time = 1 cycle♦	0.20 max.	Ampere
Operating Frequency⊕	60 max.	cps

NOTES

General — These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit.

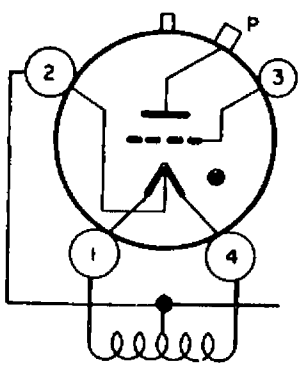
§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturer.

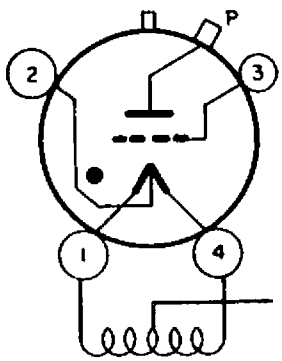
■ These ratings are effective only when the anode return connections are made according to the following diagrams:

Connection a



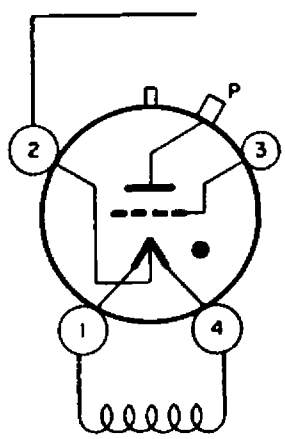
(a)

Connection b



(b)

Connection c



(c)

Figure 1
CRITICAL GRID VOLTAGE OF WL-7031

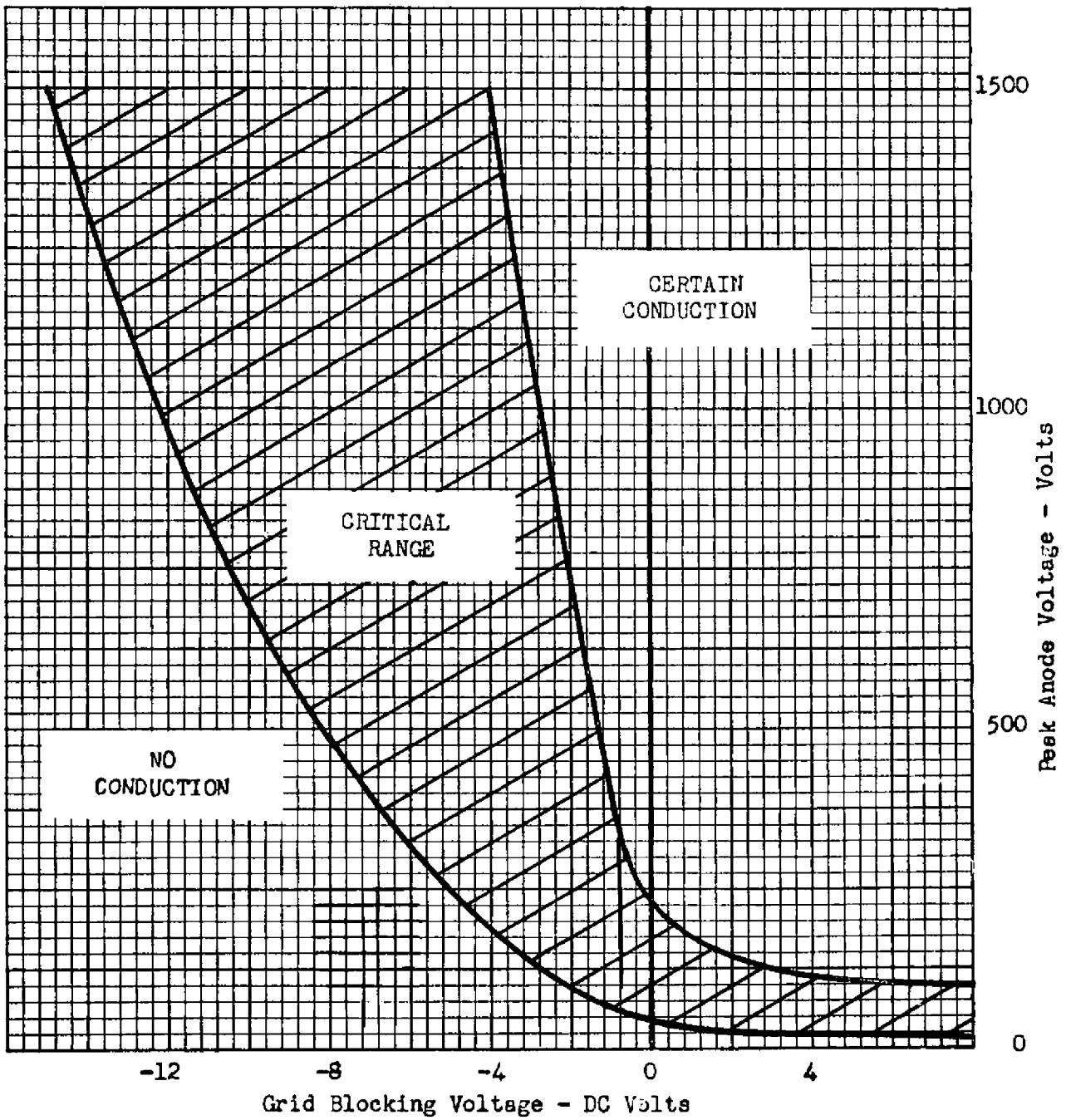
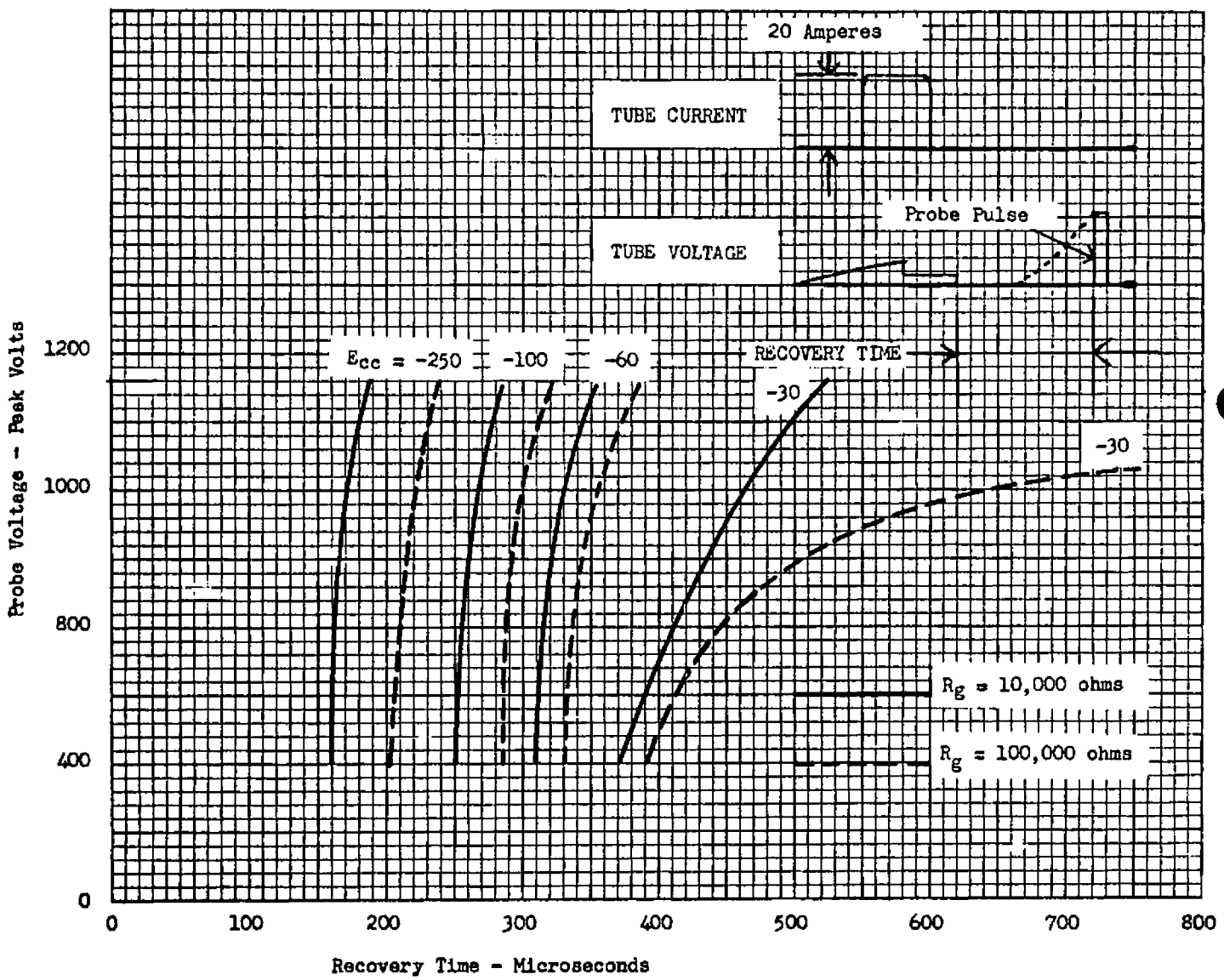


Figure 2
WL-7031 RECOVERY TIME (TYPICAL)

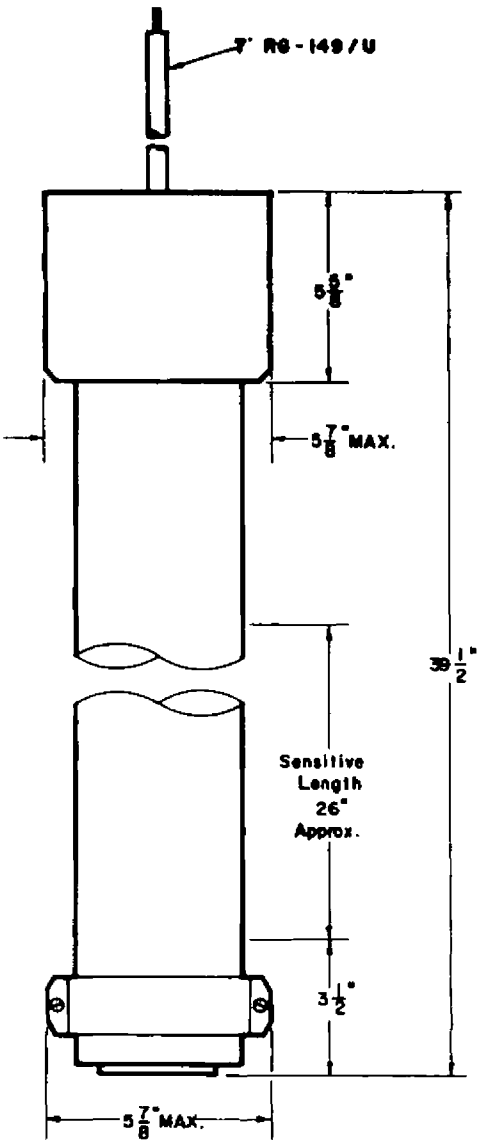


October 1, 1957

HIGH SENSITIVITY BF_3 PROPORTIONAL COUNTER TYPE WL-7087

The WL-7087 is a high sensitivity, multielement, proportional counter designed to detect thermal and intermediate speed neutrons in the flux range from 2.5×10^{-2} to 2.5×10^{3} neutrons/cm²/second.⊕ The tube is provided with a 7 foot length of RG-149/U cable sealed into the case for electrical connections. The WL-7087 is hermetically sealed although it is not designed to withstand the galvanic erosion caused by water immersion. The WL-7087 is extremely rugged and will operate in any position and at temperatures not exceeding 175°F.

The WL-7087 consists of four proportional counter units surrounded by a polyethylene moderator block and enclosed by a heavy-walled aluminum cylinder. The elements are one inch in diameter and twenty-eight inches long and are located symetrically in the case. Each counter employs BF_3 enriched to 96% in Boron-10 isotope as the neutron sensitive material resulting in an overall sensitivity for the WL-7087 of approximately 40 counts/neutron/cm² with an operating voltage of 2000 volts.



MECHANICAL:		
Maximum Diameter	5-7/8	Inches
Approx. Overall Length	39-1/2	Inches
Approx. Sensitive Length	26	Inches
Net Weight	36-3/4	Pounds
Approx. Shipping Weight	100	Pounds
MATERIALS:		
Body		Aluminum
Center Electrodes of each Unit	0.001" Diameter	Tungsten
Insulation		Polyethylene & Alumina
Gas Filling	BF_3 Enriched 96%	B-10
MAXIMUM RATINGS:		
Absolute Maximum Values		
Voltage Between Electrodes	2500	Volts
Operating:		
Thermal Neutron Flux	2.5×10^{3}	n/cm²/sec
Temperature	175	°F
Non-Operating:⊕		
Thermal Neutron Flux	4×10^{9}	n/cm²/sec
Gamma Flux	10^{4}	R/hr
Temperature	175	°F
TYPICAL OPERATING CHARACTERISTICS:†		
Voltage Between Electrodes	2000	Volts
Neutron Flux Range	2.5×10^{-2} to 2.5×10^{3}	n/cm²/sec
Multiplication Factor	500	
Sensitivity	40	counts/n/cm²
Plateau Characteristics:		
Length (Minimum)	200	Volts
Overall Slope ..... (less than)	4	Per Cent
Output Pulse Characteristics:		
Magnitude ..... (more than)	10^{-3}	Volts
Inherent Rise Time .. (less than)	5×10^{-8}	Seconds

⊕ When in flux levels exceeding the recommended operating range, the tube should be shunted with a maximum resistance of 1.5 megohms, and the operating voltage removed.

† These characteristics will vary depending on associated circuitry. For application details, see page 3.

from JETEC release #2028, Oct. 28, 1957

TYPICAL OPERATING CHARACTERISTICS

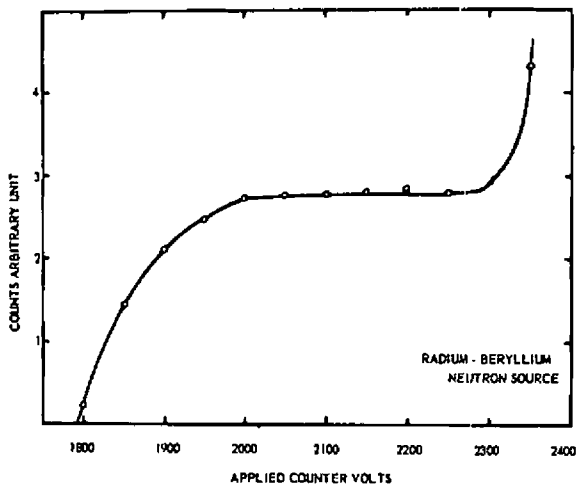


Figure 1
VOLTAGE CURVE FOR BF_3 COUNTER

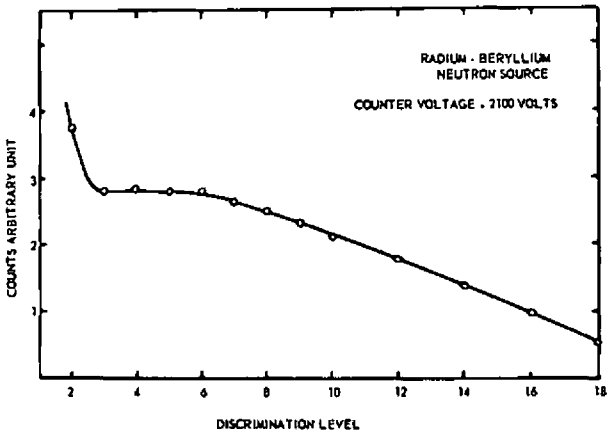


Figure 2
INTEGRAL BIAS CURVE FOR BF_3 COUNTER

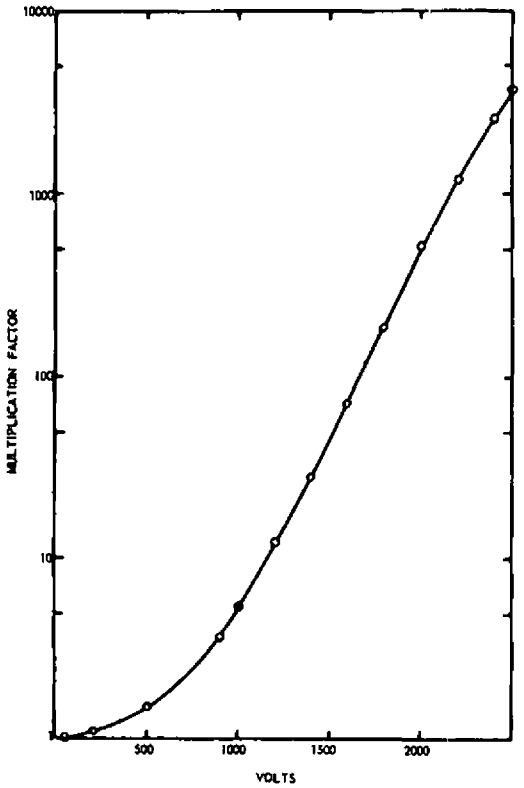


Figure 3
MULTIPLICATION CURVE FOR BF_3 COUNTER

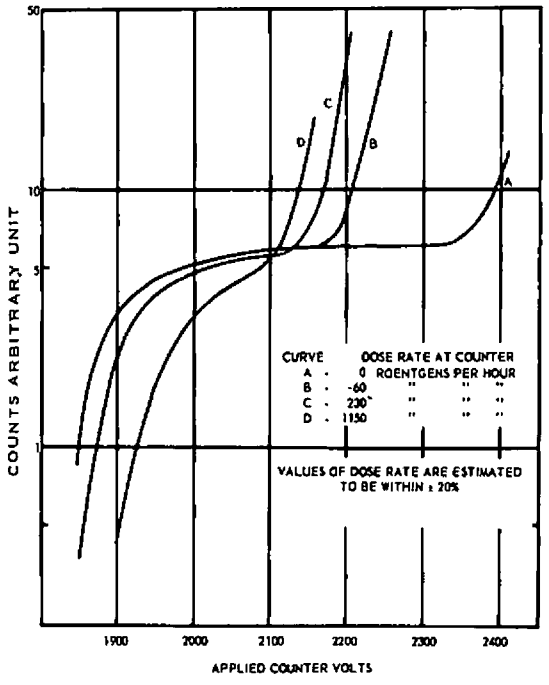


Figure 4
NEUTRON RESPONSE OF BF_3 COUNTER UNDER CO^{60} GAMMA IRRADIATION

BF_3 PROPORTIONAL COUNTER-INSTRUMENTATION

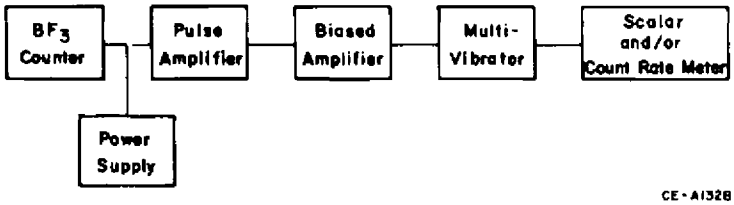
This section describes instrumentation associated with the proportional counter, which must provide -

1. A method of applying the operating voltage
2. A method of removing the pulse and amplifying it to a useable level.

The output pulse from a proportional counter tube is of negative polarity and is formed by the external circuitry.

As the tube is normally located at a distance from the instrumentation, coaxial cable must be employed to transmit the pulse from the tube to the amplifier. For lengths of cable less than 25 feet cable effects may be neglected. However, for lengths greater than 25 feet capacitive effects become significant and must be cancelled. This will be discussed in detail later.

A block diagram indicating the general requirements of the BF_3 proportional counter is shown in CE-A1328.



The BF_3 proportional counter is operated with the center wire positive and the outer cylinder negative. As the outer cylinder is electrically part of the tube, it should be operated at ground potential.

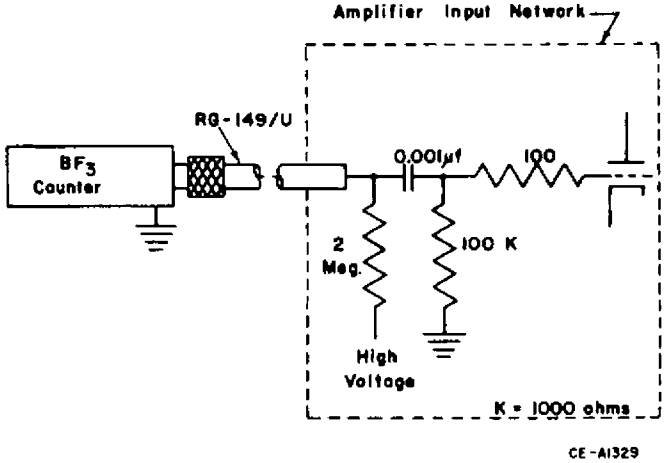
Amplifier input circuitry will vary according to the application.

EFFECT OF AMPLIFIER INPUT CHARACTERISTICS ON PULSE SIZE AND SHAPE

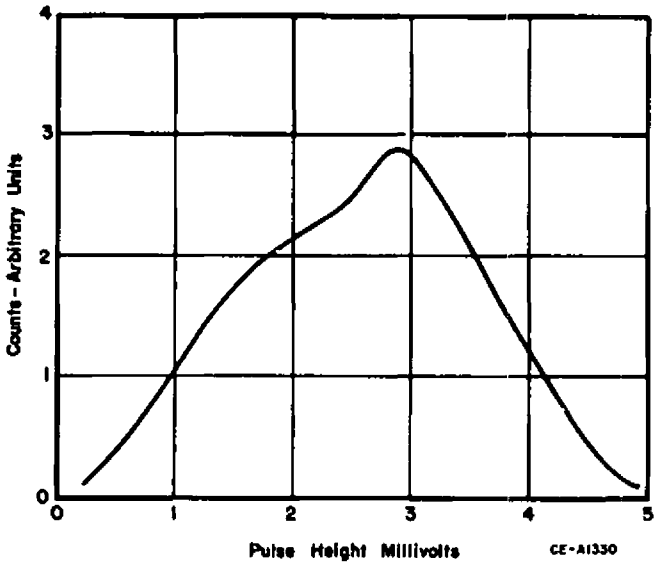
The output of the BF_3 counter, is essentially a sharply rising waveform with rise time less than 5×10^{-8} seconds. The extremely high resistance of the counter tube permits the accumulated charge to remain, thus presenting to the external circuitry the appearance of a step. In a proportional counter the charge formation is local in nature, i.e., the discharge takes place in a limited area within the tube and, hence, a relatively small charge is formed. This can be contrasted with a Geiger counter where the discharge for a single particle is distributed along the length of the center wire and the output pulse may have heights as great as 200 volts. The height of this step voltage change in the BF_3 counter may be as low as 10^{-4} volts. Voltage steps will vary as a function of applied voltage even when the tube is operated on the plateau. The external circuit converts these step functions into pulses.

Gamma radiation causes secondary emission from the gas and metal parts of the tube. Pulses of a lower magnitude are formed and these must be considered in amplifier designs.

Under the following circuit conditions employing a length less than 25 feet of RG 149/U (C = 22 uuf/ft) pulse heights vary from one to six millivolts as the voltage applied to the tube is varied from 1950 to 2250 volts. Note that the high voltage is fed through a high impedance in CE-A1329.



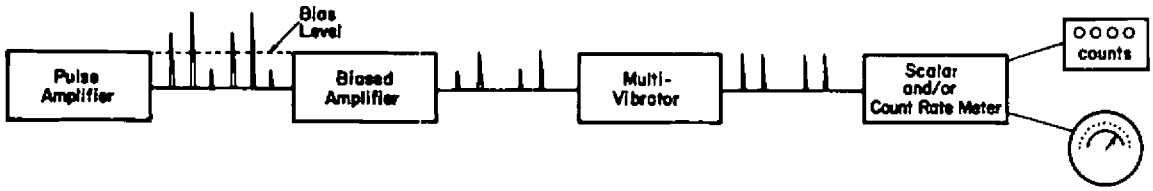
PULSE HEIGHT DISTRIBUTION



The pulse height will not only vary as the applied voltage, but while operating at a specific voltage, say 2000 volts, the pulse height will be distributed over a range. At 2000 volts the pulse height distribution will vary from approximately .5 mv to 3.5 mv as shown in CE-A1330.

Pulses due to gamma radiation will increase in approximately the same fashion, but are about 1/20 the size of the average pulses due to neutron events.

In typical circuitry, gamma pulses are discriminated in a biased amplifier stage which will amplify only pulses greater than the selected bias value. This discriminator circuit drives a one shot multivibrator whose output is a pulse of constant magnitude. The bias of the discriminator circuit is adjusted so that only the high magnitude pulses are selected to drive the multivibrator. The multivibrator output pulses drive a scalar and/or count rate meter as shown in CE-A1331.



CE A1331

SPECIAL CONSIDERATIONS

If cable lengths greater than 25 feet are required, cable capacity undesirably influences the pulse formation and transmission. Termination in a high impedance to obtain high magnitude pulses becomes difficult as the cable appears as a capacitive element across the tube. To minimize long cable effects, it is desirable to terminate the cable in its characteristic impedance to make the cable appear as a purely resistive element. Since the characteristic impedance is usually low, it becomes obvious that the pulse height is greatly reduced since it is now developed across a lower value of resistance. Additional amplifier gain is required to compensate for this reduced pulse amplitude which is on the order of 20:1. Gamma pulses will correspondingly decrease.

GENERAL AMPLIFIER REQUIREMENTS

The maximum count rate at which the tube will satisfactorily operate is about 3×10^5 counts per second. This is a mean frequency. The separation of pulses varies statistically, and generally speaking, an amplifier of 2 megacycle bandwidth will suffice for normal application of the BF_3 proportional counter.

In order to distinguish between neutron events, it is necessary to decay the pulse rapidly to prevent overlap. A .8 microsecond decay time is satisfactory for most applications and this decay is usually accomplished at the input of the linear amplifier. When high impedance terminations are employed (with short cables), it is customary to provide either a cathode follower or a preamplifier with a high impedance input and perform the differentiation at the output of the preamplifier or the input of the main amplifier. As differentiation is substantial when a low impedance termination is used, the wisdom of additional pulse shaping will depend upon the particular circuit employed.

JOINT ELECTRON DEVICE ENGINEERING COUNCIL

11 West Forty-Second Street
New York 36, N.Y.

E. I. A.
REGISTRATION
FILE

Announcement

of

Electron Device Type Registration

Release No. 2436

April 6, 1959

The Joint Electron Device Engineering Council announces the registration of the following electron device designation

7087A*

on the application of

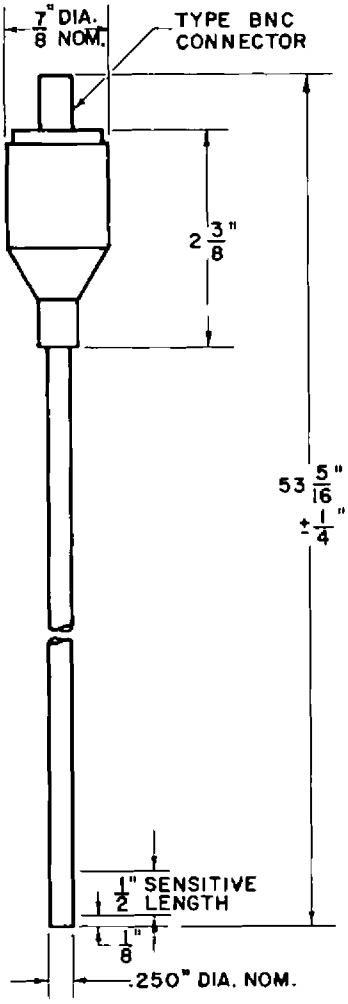
Westinghouse Electric Corporation
Elmira, New York

*The type 7087A is identical to the 7087 as registered in Release No. 2028, dated October 28, 1957, except for utilizing a cable length of 25 feet.

December 29, 1958

FLUX MAPPING FISSION CHAMBER TYPE WL-7186

The WL-7186 is a miniature fission chamber 0.5 inch long and 0.25 inch in diameter, with an integral rigid coaxial cable four feet in length. Ionization pulses are produced in the nitrogen-argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating, which consists of uranium oxide highly enriched in the U-235 isotope. The WL-7186 is rugged in construction and will operate in any position and at temperatures up to 125°C. The exposed portions of the chamber and integral cable are of stainless steel, thereby permitting operation of the sensitive volume under water. §



MECHANICAL:

Body Diameter (Max.)	1/4	Inches
Head Diameter (Max.)	7/8	Inches
Overall Length (Max.)	53-9/16	Inches
Weight	1/2	Pound

MATERIALS:

Body	Stainless Steel
Center Electrode	Steel
Head	Brass
Insulation	Teflon and Alumina
Gas Filling	Argon-Nitrogen
Neutron Sensitive Coating	U_3O_8 Enriched to More Than 90% in U-235

MAXIMUM RATINGS:

Voltage Between Electrodes	500	Volts
Temperature	125	°C

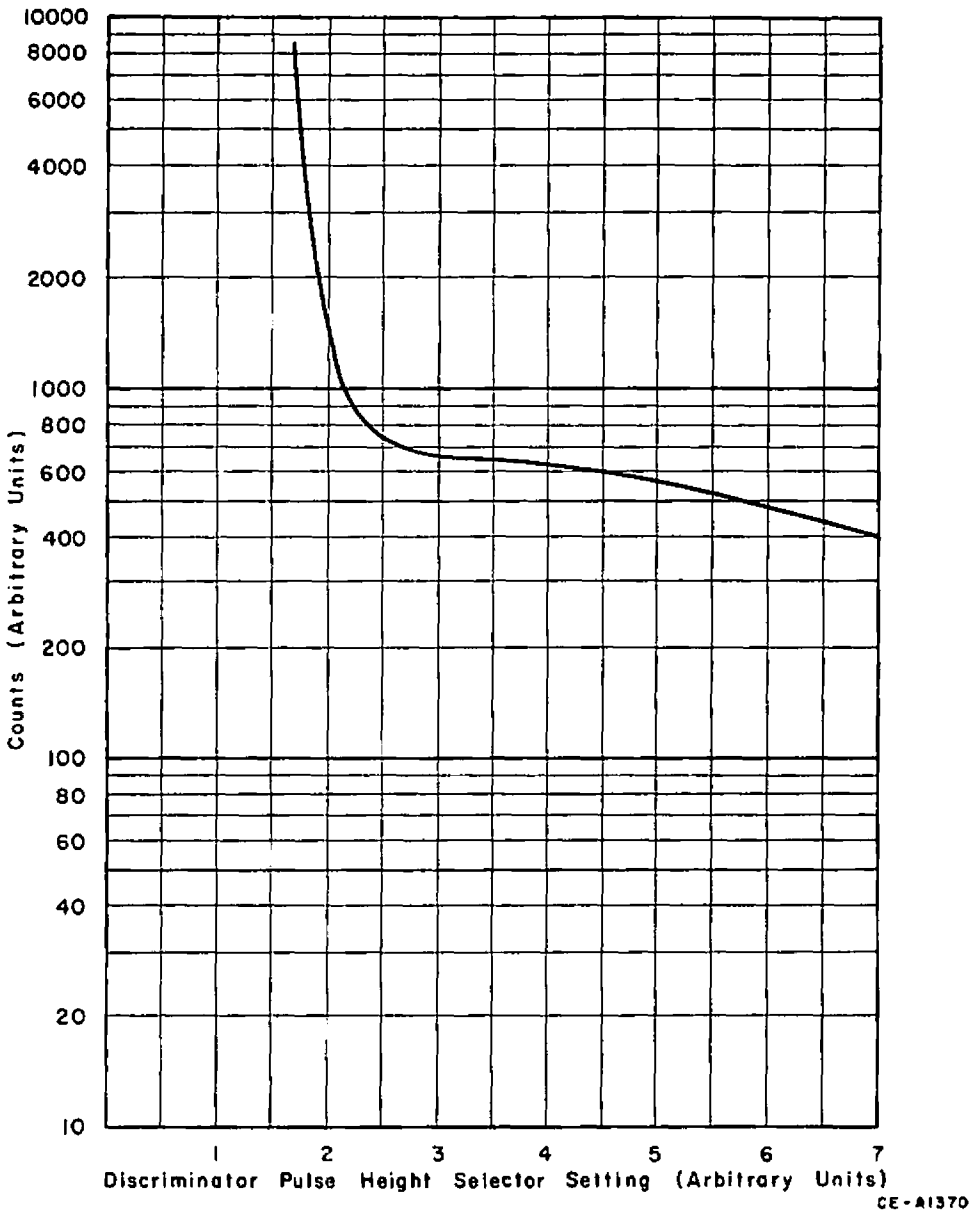
OPERATIONAL:

Output Impedance	10^9 ohms, 55 uuf	
Thermal Neutron Sensitivity (Approx.)	0.001	cps/nv
Operating Voltage Range	250 to 400	Vdc
Output Pulse Characteristics:		
Magnitude	10^{-4}	Volts
Inherent Rise Time	2×10^{-7}	Seconds
Overall Gain of Amplifiers	50000	

§ In operating the unit partly immersed, care must be taken to keep the connector free of water.

from JEDEC release #2118A, April 6, 1959

COUNTER SENSITIVITY AS A FUNCTION OF PULSE HEIGHT SELECTOR SETTING



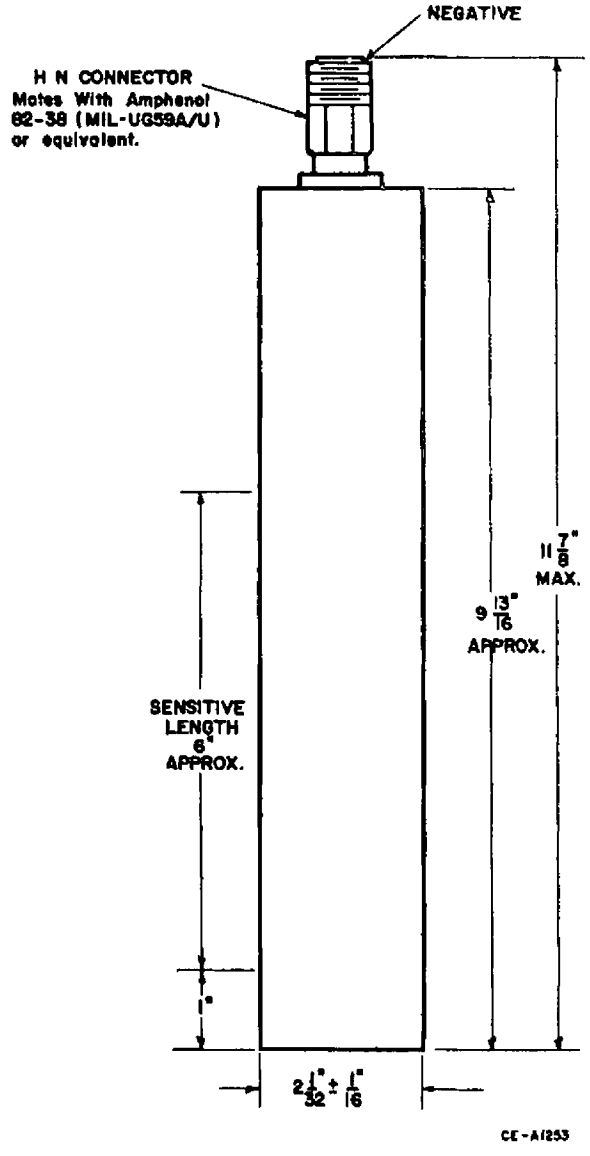
February 24, 1958

FISSION COUNTER TYPE WL-7187

The WL-7187 is a fission counter designed to detect thermal neutrons in the flux range from 1.25 x 10 to 1.25 x 10^6 neutrons/cm^2/second. Ionization pulses are produced in the nitrogen-argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating. The sensitive coating consists of uranium oxide highly enriched in U-235 isotope. The WL-7187 is extremely rugged.♦

The characteristics of the WL-7187 are such that sensitivity to changes in the setting of the discriminator pulse height selector is minimized. This attribute makes the tube desirable in critical facilities where its high gamma sensitivity will not impair accuracy of readings. In this application, the WL-7187 permits good day-to-day reproducibility of readings.

The sensitivity of the WL-7187 is 5.2 x 10^{-1} counts/neutron/cm^2 when the pulse amplifier discriminator is adjusted for a background counting rate of 5 counts/second for the naturally radioactive uranium. An incident gamma flux of 10^{10} photons/cm^2/second results in a maximum decrease in sensitivity of 3% up to 10^5 counts/second.



MECHANICAL:

Maximum Diameter	2-3/32	Inches
Maximum Overall Length	1'-7/8	Inches
Approx. Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds

MATERIALS:

Body and Electrodes		Aluminum
Insulation		Polystyrene & Alumina
Neutron Sensitive Coating:		
Content	U_3O_8 enriched to more than 90% in U-235	
Thickness	1.0	mg/cm^2
Total Amount of U-235	0.86	gm
Gas Filling	Argon-Nitrogen Mixture at 220 cm Hg	

MAXIMUM RATINGS:

Absolute Maximum Values

Voltage Between Electrodes	800 max.	Volts
Thermal Neutron Flux	2.5×10^{10} max.	$n/cm^2/sec$
Total Integrated Neutron Flux	1×10^{17} max.	n/cm^2
Temperature	300 max.	°F

TYPICAL OPERATING AS A FISSION COUNTER:

Operating Voltage	300	Volts
Operating Voltage Plateau⊕	200 to 800	Volts
Neutron Flux Range	1.25 x 10 to 1.25 x 10^6	$n/cm^2/sec$
Sensitivity□	5.2 x 0^{-1}	$count/n/cm^2$
Output Pulse Characteristics:		
Magnitude	2 x 10^{-4}	Volts
Inherent Rise Time	2 x 10^{-7} max.	Seconds
Leakage Resistance	10^9 min.	ohms
Capacitance-Signal Electrode to Case	190	uuf

♦ The WL-7187 has passed Military Specification MIL-S-901 for shock and MIL-Std-167 (Type1) for vibration.

⊕ Counting Rate at different operating voltages is shown in CE-A1358.

□ The sensitivity is 5.2 x 10^{-1} counts/n/cm^2 for an alpha background counting rate of 5 count/sec. By varying the pulse-height selector setting, other counter sensitivities are obtainable for different background counting rates as shown in CE-A1359.

NOTE: This tube may not be immersed in water and high humidity environments should be avoided since they may impair performance.

from JETEC release #2118, March 3, 1958

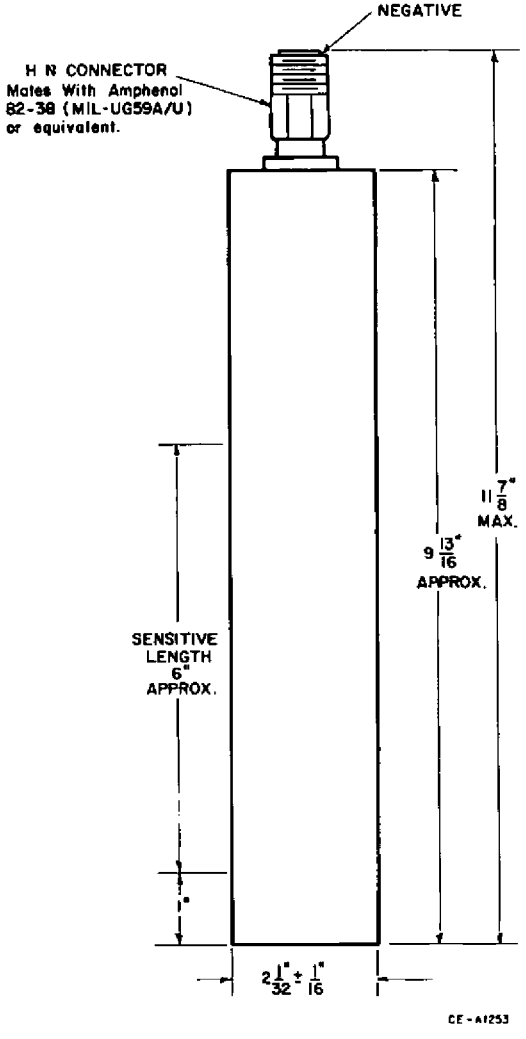
June 12, 1958

FISSION COUNTER TYPE WL-7188

The WL-7188 is a fission counter designed to detect thermal neutrons in the flux range from 2.5 x 10 to 2.5 x 10^6 neutrons/cm^2/second. Ionization pulses are produced in the nitrogen argon atmosphere by fission fragments resulting from thermal neutrons incident on the sensitive coating. The sensitive coating consists of uranium oxide highly enriched in U-235 isotope. The WL-7188 is extremely rugged ♦ and can be stored or operated in any position at temperatures up to 300° F.

The characteristics of the WL-7188 are such that sensitivity to changes in the setting of the pulse height selector is minimized. This attribute makes the tube desirable in critical facilities. In this application, the WL-7188 permits good day-to-day reproduceability of readings.

The sensitivity of the WL-7188 is 7 x 10^{-2} counts/neutron/cm^2 when the pulse amplifier discriminator is adjusted for a background counting rate of 1 count/second for the naturally radioactive uranium. An incident gamma flux of 10^{10} photons/cm^2/second results in a maximum decrease in sensitivity of 1% up to 10^5 counts/second.



MECHANICAL:

Maximum Diameter	2-3/32	Inches
Maximum Overall Length	11-7/8	Inches
Approx. Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds

MATERIALS:

Body and Electrodes		Aluminum
Insulation		Polystyrene & Alumina
Neutron Sensitive Coating:		
Content	U_3O_8 enriched to more than 90% in U-235	
Thickness	0.2	mg/cm^2
Total Amount of U-235	.086	gm
Gas Filling	Argon-Nitrogen Mixture at 76 cm Hg	

MAXIMUM RATINGS:

Absolute Maximum Values

Voltage Between Electrodes	800 max.	Volts
Thermal Neutron Flux	2.5×10^{10} max.	$n/cm^2/sec$
Total Integrated Neutron Flux	1×10^{17} max.	n/cm^2
Temperature	300 max.	° F

TYPICAL OPERATION AS A FISSION COUNTER:

Operating Voltage	300	Volts
Operating Voltage Plateau ⊖	200 to 800	Volts
Neutron Flux Range	2.5 x 10 to 2.5 x 10^6	$n/cm^2/sec$
Sensitivity □	.07	count/n/cm^2
Output Pulse Characteristics:		
Magnitude	2×10^{-4}	Volts
Inherent Rise Time	2×10^{-7} max.	Seconds
Leakage Resistance	10^9 min.	ohms
Capacitance-Signal Electrode to Case	190	uuf

♦ The WL-7188 has passed Military Specification MIL-S-901 for shock and MIL-Std-167 (Type 1) for vibration.

⊕ Counting Rate at different operating voltages is shown in CE-A1326.

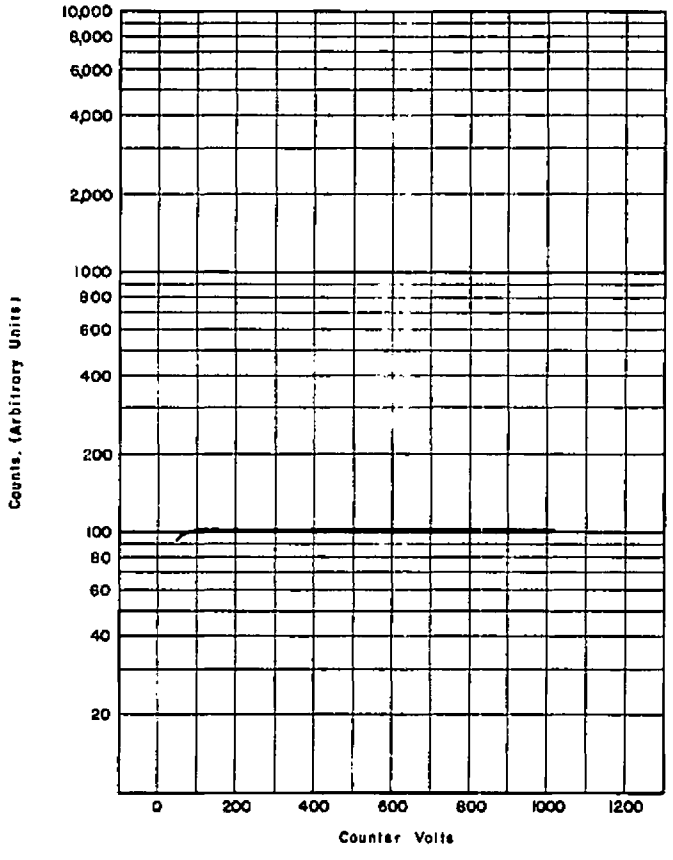
□ The sensitivity is .07 counts/n/cm^2 for an alpha background counting rate of 1 count/sec. By varying the pulse-height selector setting, other counter sensitivities are obtainable for different background counting rates as shown in CE-A1327.

NOTE: This tube may not be immersed in water and high humidity environments should be avoided since they may impair performance.

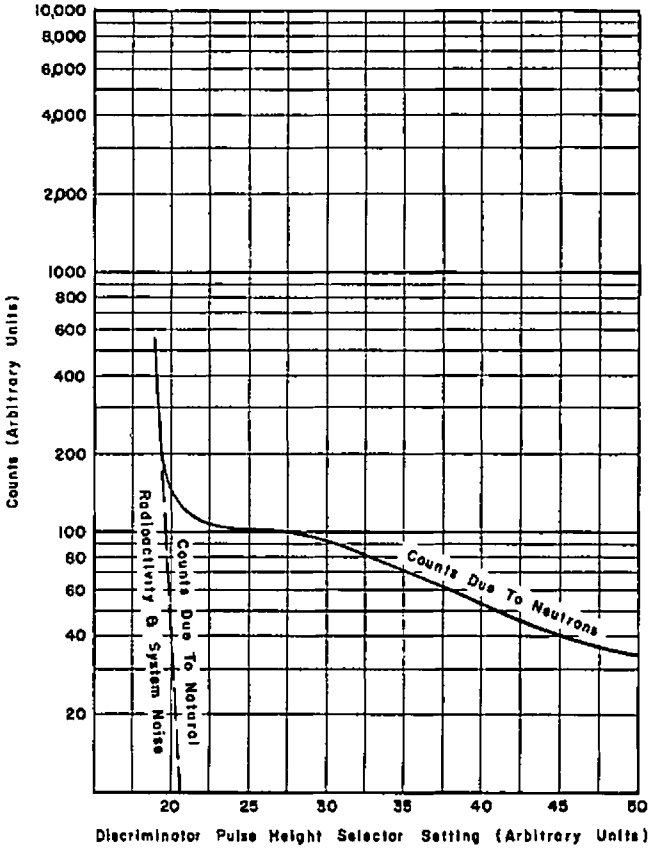
Neutron & Radiation Detector Section

from JETEC release #2241, July 7, 1958

COUNTING RATE CHARACTERISTIC



COUNTER SENSITIVITY AS FUNCTION OF PULSE HEIGHT SETTING



Westinghouse

WL-7198A

July 15, 1963

EXTREME ENVIRONMENT NON-BURN IMAGE ORTHICON TYPE WL-7198A

The WL-7198A image orthicon is a non-burn image orthicon, that is completely environmentally adapted to military applications, having high sensitivity and resolution. The WL-7198A is both mechanically and electrically interchangeable with the WL-7198 and will operate in any commercially available image orthicon camera.

The WL-7198A ruggedized design will permit operation in airborne equipment and other applications where a reliable and environmentally adapted tube is required. This tube will pass MIL-E-5272 vibration, shock, temperature and humidity specifications as detailed in data. The WL-7198A has an S-10 photosurface and the proven long-life target of the WL-7611.

This special target, developed by Westinghouse, is essentially free of after-image or picture-sticking and raster-burn throughout life when operating in the temperature range of 40 to 55°C. Resolution and gray-scale are equal to or better than the WL-7198.

In the first 50 hours of use, the WL-7198A can be cleared of target burns created by exposure of 3×10^{-3} foot candles maximum photocathode illumination for periods up to 1 hour duration.

The WL-7198A has a spectral response comparable to that of the human eye. Good grey-scale rendition of colors is possible inasmuch as it is insensitive to infrared rays which would otherwise cause color masking.

ELECTRICAL:		
Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3 ± 10%	Volts
Current	0.6	Ampere
Direct Interelectrode Capacitance:		
Anode to all other Electrodes	12	uuf
Photocathode	Semitransparent	
Response (See Spectral Response Compared With Human Eye).		
Rectangular Image (4x3 aspect ratio):		
Useful Size of	1.6" max. Diagonal	
Focusing Method	Magnetic	
Deflection Method	Magnetic	

MECHANICAL:	
Overall Length	15-3/16" ± 1/4"
Greatest Diameter of Bulb	3" ± 1/16"
Shoulder Base	Keyed Jumbo Annular 7-Pin
End Base	Small Shell Diheptal 14-Pin (JETEC B14-45)
Operating Position Recommended	Tube axis not less than 20° from the vertical with faceplate down
Weight (approx.)	1 lb., 6 oz.
Min. Deflecting-Coil Inside Diameter	2-3/8"
Deflecting-Coil Length	5"
Focusing-Coil Length	10"
Alignment-Coil Length	15/16"
Photocathode Distance:	
Inside End of Focusing Coil	1/2"

MAXIMUM RATINGS:			
Absolute Maximum Values:			
Photocathode:			
Voltage	-650	max.	Volts
Illumination	50	max.	ft-c
Grid 6 Voltage	-650	max.	Volts
Target Voltage:			
Positive Value	10	max.	Volts
Negative Value	10	max.	Volts
Grid 5 Voltage	150	max.	Volts
Grid 4 Voltage	300	max.	Volts
Grid 3 Voltage	400	max.	Volts
Grid 2 and Dynode 1 Voltage	400	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	125	max.	Volts
Positive Bias Value	0	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode	125	max.	Volts
Heater Positive with Respect to Cathode	10	max.	Volts
Anode-Supply Voltage (Note 1)	1850	max.	Volts
Voltage per Multiplier Stage	400	max.	Volts
Environmental Conditions:			
Operating Temperature:			
Of any part of bulb	71	max.	°C
Of bulb at large end of tube - Target Section	20	min.	°C
Temperature Difference:			
Between target section and any part of bulb hotter than target section	7-1/2	max.	°C
Shock (Note 2)	30	max.	G's
Vibration (Note 3)	10	max.	G's
Humidity			Note 4.

PRINTED IN U.S.A.

Camera & Storage Tube Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #4356, July 22, 1963

TYPICAL OPERATING CONDITIONS

Photocathode Voltage (Image Focus)	−400 to −600	Volts
Grid 6 Voltage (Accelerator):		
75% of Photocathode Voltage	−300 to −450	Volts
Target Voltage (Note 5)	+1 to −3	Volts
Grid 5 Voltage (Decelerator)	0 to 125	Volts
Grid 4 Voltage (Beam Focus)	130 to 180	Volts
Grid 3 Voltage (Note 6)	225 to 330	Volts
Grid 2 and Dynode 1 Voltage	300	Volts
Grid 1 Voltage for Picture Cutoff	−45 to −115	Volts
Dynode 2 Voltage	600	Volts
Dynode 3 Voltage	910	Volts
Dynode 4 Voltage	1200	Volts
Dynode 5 Voltage	1490	Volts
Anode Voltage	1550	Volts
Anode Current (dc)	30	μamp
Signal-Output Current (Peak to Peak)	2 to 15	μamp
Target Temperature Range (See Text)	40 ± 2	°C
Ratio of Peak-to-Peak Highlight: Video-Signal Current to RMS Noise Current (Approx.)	25	–
Min. Peak-to-Peak Blanking Voltage	10	Volts
Field Strength at Center of Focusing Coil (Note 7)	75	Gausses
Field Strength of Alignment Coil (Approx.)	0 to 3	Gausses

TYPICAL PERFORMANCE

Sensitivity:

at foot-candles

Photocathode Illumination (Note 8)	Lines Horizontal Resolution (Note 9)
3×10^{-2}	625 center min.
3×10^{-3}	525 center min.
3×10^{-3}	350 corner min.
3×10^{-4}	275 center min.

Image Retention:

At 0 Hours (New Tube) (Note 10)	0 Sec.
At 750 Hours (Note 11)	30 Sec.

REMOVAL OF PERMANENT BURN

0 to 50 Hours of Tube Life

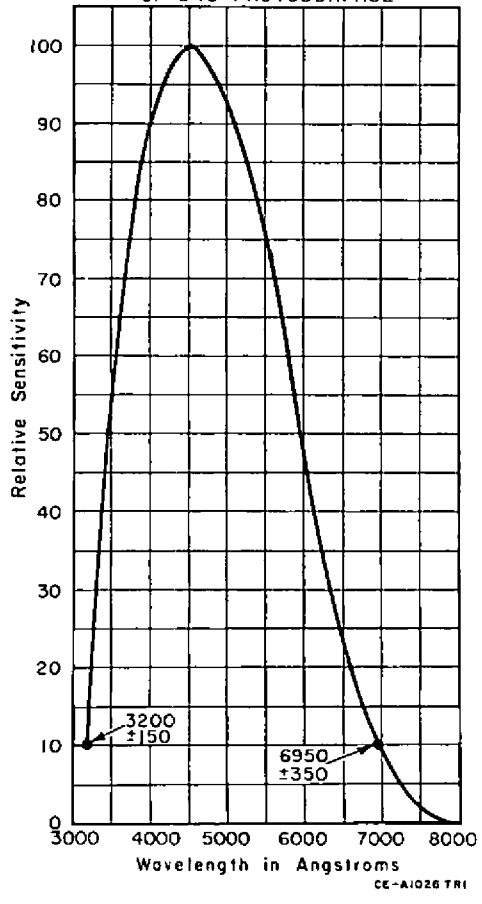
Procedure ..... See Note 12

Burn-in Time (Minutes)	Recovery Time (Minutes)
10	20
20	40
30	60
40	180
50	180
60	180

NOTES

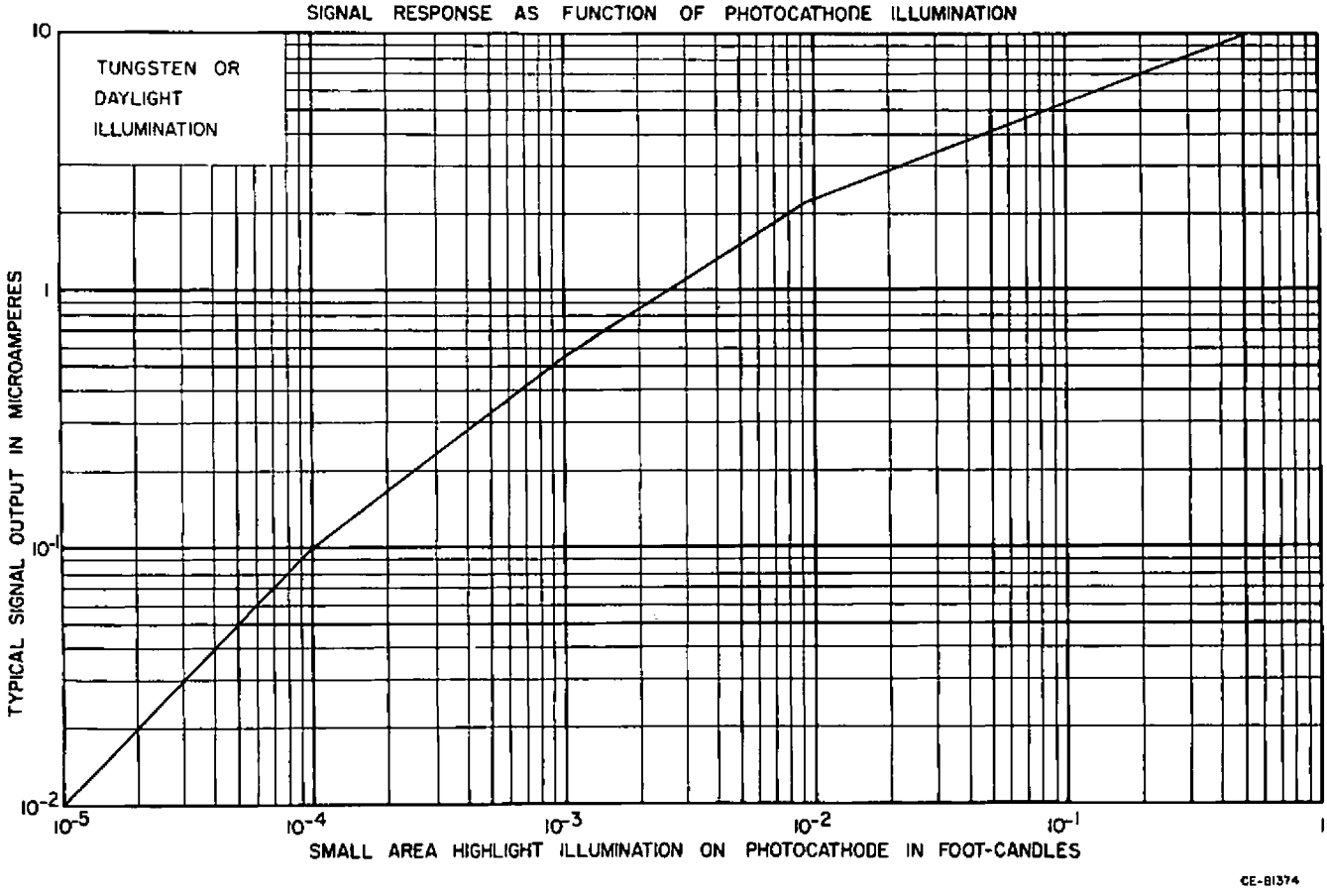
1. Ratio of dynode voltages is shown under Typical Operation.
2. Under conditions specified in MIL-E-5272A Par. 4.15.2.1.
3. Under conditions specified in MIL-E-5272A Par. 4.7.1. Procedure I except at operating temperature only. Center horizontal resolution at 3×10^{-2} foot-candles photocathode illumination will be at least 350 lines with 5G applied acceleration in the frequency range of 50 to 500 cycles per second.
4. Under conditions specified in MIL-E-5272A Par. 4.4.1. and Par. 4.4.3. The resistance between pins is at least 100 megohms following this test.
5. Adjustable from −3 to −5 volts with blanking voltage off.
6. Adjust to give the most uniformly shaded picture near maximum signal.
7. Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.
8. With 2870° K illumination.
9. In properly adjusted TK31A image orthicon camera chain, or equivalent, with EIA (formerly RETMA) 1956 Resolution Chart.
10. After 5 minutes exposure focused on RETMA chart with tube operating 1 f stop above Knee.
11. After 30 seconds exposure focused on RETMA chart with tube operating 1 f stop above Knee.
12. Tube having burn-in of specified time is recovered by exposure to uniform white surface, under standard operating conditions, except overscan, for the specified recovery time. This procedure also removes darkened raster area due to change in scan sweeps.

SPECTRAL RESPONSE CHARACTERISTIC OF S-10 PHOTOSURFACE



CE-A1026 TRI

SIGNAL RESPONSE AS FUNCTION OF PHOTOCATHODE ILLUMINATION



CE-81374

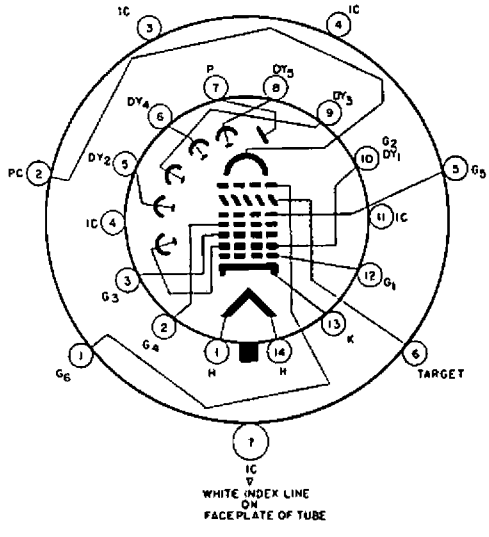
SMALL SHELL DIHEPTAL 14-PIN BASE

Pin 1: Heater
Pin 2: Grid 4
Pin 3: Grid 3
Pin 4: Internal Connection (Do NOT Use)
Pin 5: Dynode 2
Pin 6: Dynode 4
Pin 7: Anode
Pin 8: Dynode 5
Pin 9: Dynode 3
Pin 10: Dynode 1 & Grid 2
Pin 11: Internal Connection (Do NOT Use)
Pin 12: Grid 1
Pin 13: Cathode
Pin 14: Heater

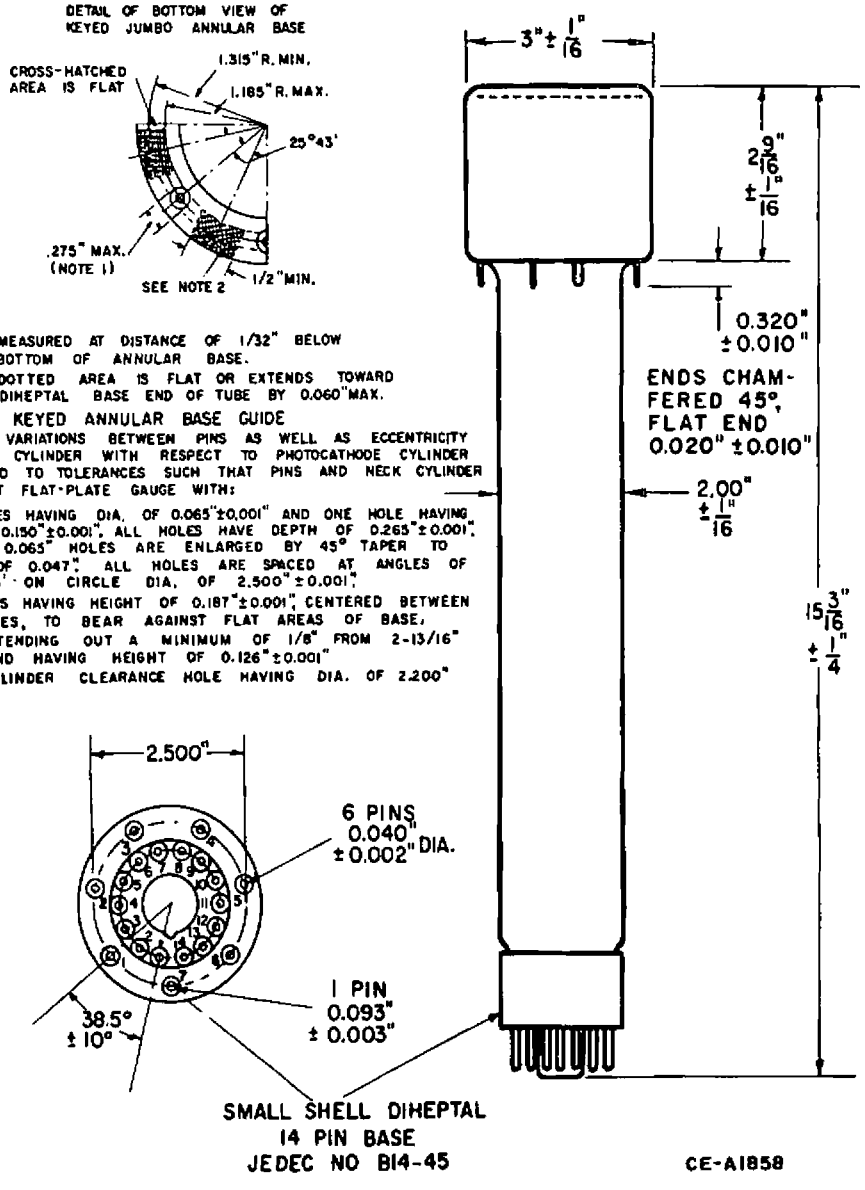
KEYED JUMBO ANNULAR 7-PIN BASE

Pin 1: Grid 6
Pin 2: Photocathode
Pin 3: Internal Connection (Do NOT Use)
Pin 4: Internal Connection (Do NOT Use)
Pin 5: Grid 5
Pin 6: Target
Pin 7: Internal Connection (Do NOT Use)

Direction of Incident Light should be approximately Parallel to Tube Axis toward the Large End (Faceplate)



CE-81030



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April 11, 1958

POWER AMPLIFIER TRIODE TYPE WL-7215

The WL-7215 is a three element power amplifier and oscillator tube especially designed for operation with lower voltage power supplies. Its high perveance structure permits the generation of 6 kilowatts at a plate voltage of only 5 kilovolts at excellent efficiency. Outputs of 13-1/2 kilowatts are obtainable at 9 kilovolts.

The anode design features an integral water jacket with an internal spiral water diverter which maintains turbulence of cooling water. This prevents the occurrence of anode hot spots and accounts for high power density capability of the tube. The WL-7215 will dissipate 9 kilowatts with only 3-3/4 gallons per minute and still provides ample safety margin for instantaneous overloads.

The filament structure incorporates a unique spring loaded high efficiency design. The high efficiency thoriated tungsten filament provides 50 amperes peak emission at only 350 watts of filament power. The rugged spring loaded structure inhibits sagging and breaking of filament strands thus insuring long life and uniformity of characteristics with life.

These features make the WL-7215 a particularly attractive design for induction and dielectric heating applications. The internal structure is very precisely designed and production controls assure uniformity from tube to tube. These design features are reflected in a high degree of uniformity of performance in class B and class C RF power amplifier and oscillator operation. Ratings apply to 30 megacycles.

GENERAL DATA

ELECTRICAL:

	min.	bogey	max.	
Filament Voltage	5.7	6.0	6.3	Volts
Filament Current	57	60	63	Amp.
Filament Starting Current	-	-	300	Amp.
Filament Cold Resistance	-	0.016	-	Ohms
Amplification Factor	18	22	26	
Interelectrode Capacitances:				
Grid to Plate	12	16	21	uuf
Grid to Filament	15	19	22	uuf
Plate to Filament	0.2	0.80	1.0	uuf

MECHANICAL:

Mounting Position	Vertical, Anode Up or Down			
Type of Cooling	Water and Forced Air			
Min. Required Water Flow:				
Plate Dissipation	3	6	9	KW
Water Flow in Gallons per Minute	1	2	3.75	gpm
Pressure Drop	0.85	1.9	7	psi
Required Air Flow on Filament and Grid Seals			30	CFM
Max. Glass Temperature			180	°C
Net Weight, approx.			1-3/4	lbs.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, CLASS C TELEGRAPHY

(Key-down conditions per tube without amplitude modulation)

MAXIMUM RATINGS:

Absolute Maximum Values

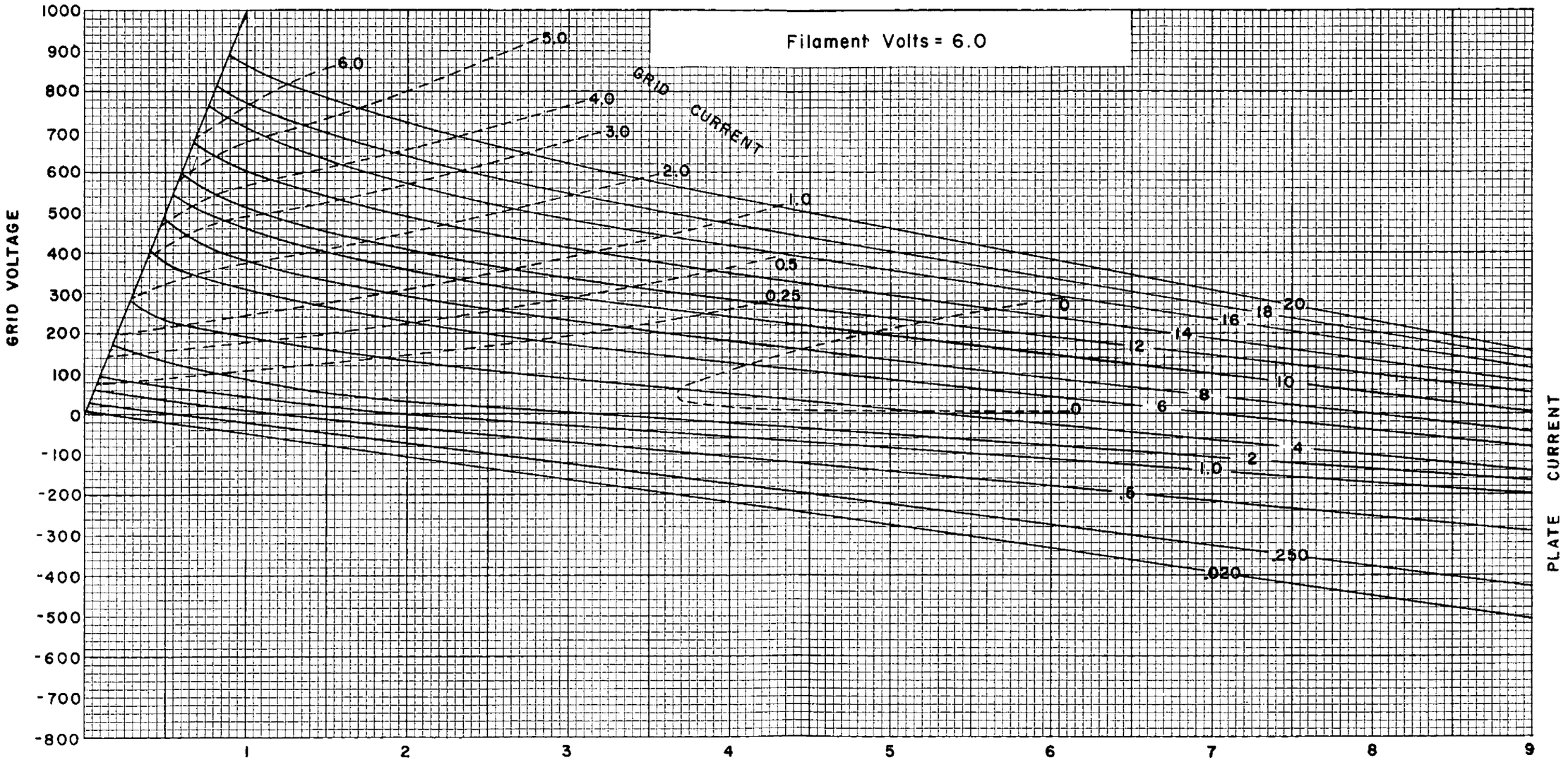
DC Plate Voltage	9200	max.	Volts
DC Plate Current	2.0	max.	Amp.
Plate Input	18000	max.	Watts
Plate Dissipation	9000	max.	Watts
DC Grid Voltage	-1500	max.	Volts
DC Grid Current	0.5	max.	Amp.

TYPICAL OPERATION:

DC Plate Voltage	5000	9000	Volts
DC Grid Voltage	-800	-1400	Volts
Peak Radio-Frequency Grid Voltage	1240	1850	Volts
DC Plate Current	1.61	2.0	Amp.
DC Grid Current	0.40	0.18	Amp.
Driving Power, approx.	480	337	Watts
Power Output, approx.	6430	13600	Watts

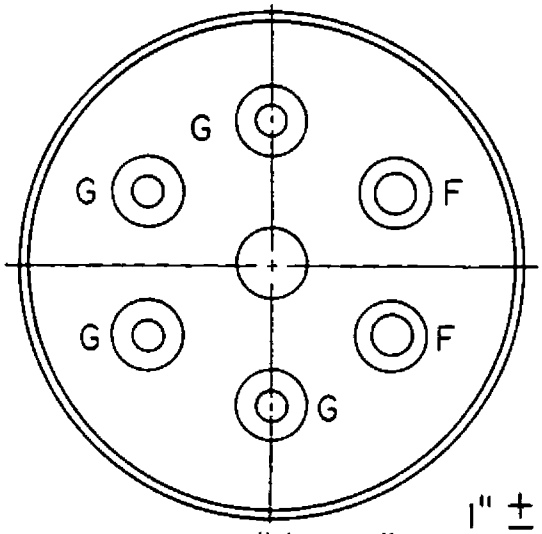
from JETEC release #2169, April 28, 1958

AVERAGE CONSTANT-CURRENT-CHARACTERISTICS



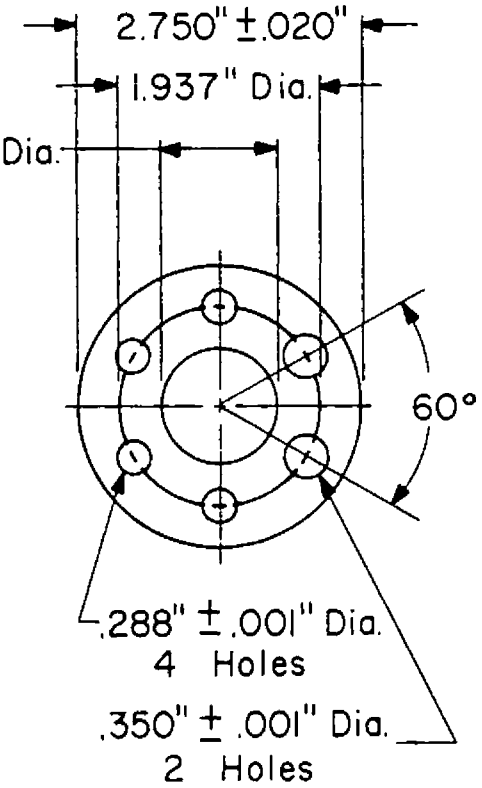
CE-C1366

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

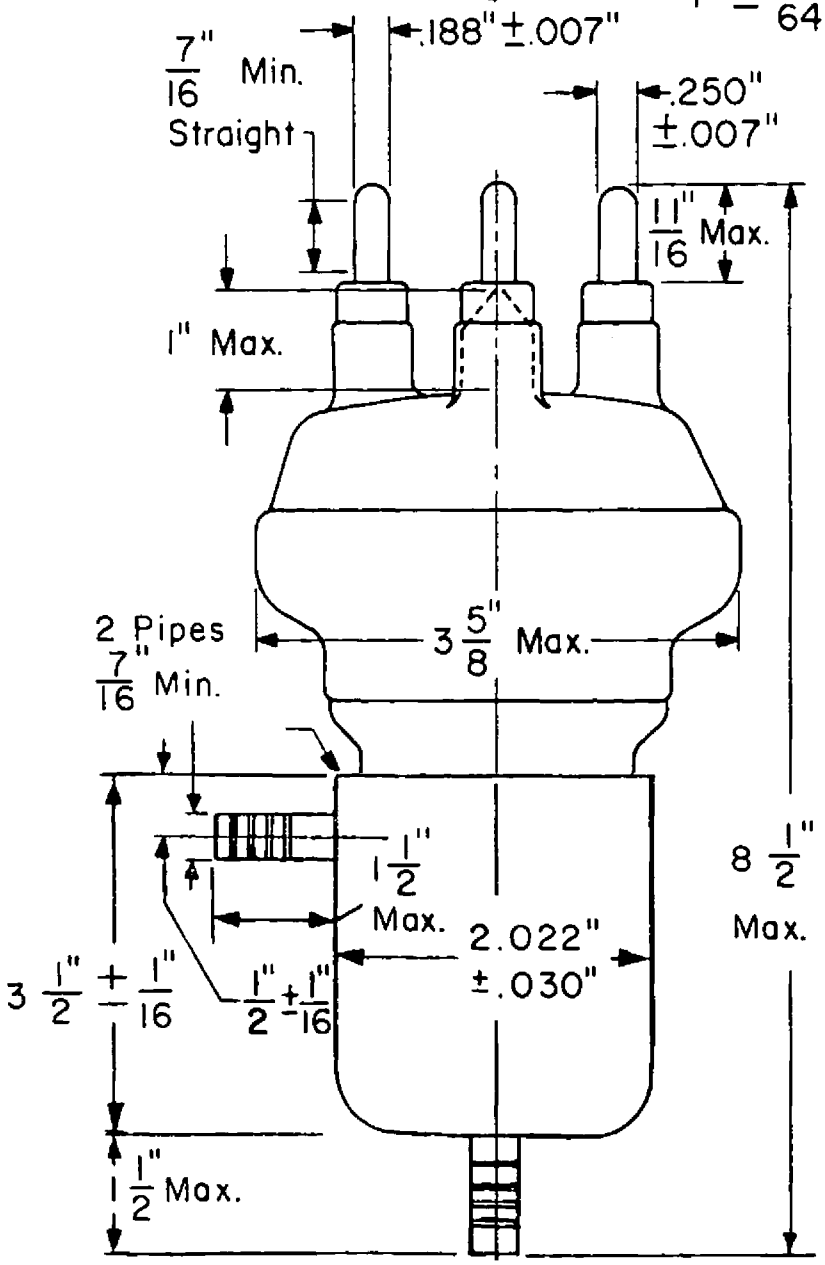


PIN ALIGNMENT GAGE

Metal, .500" ± .010" Thick



Note: Pins Must Enter Full Depth of Gage.



BASE CONNECTIONS

F - Filament
G - Grids

CE-A1367

RADECHON 5/27/58

WL-7225

TENTATIVE DATA

This tube is a 3" storage tube of the barrier grid, electrical in, electrical out type. Electrostatic focus and deflection are employed.

It is of particular use in computer applications or for signal conversion systems. Special features which commend its use in preference to earlier types are:

1. Extreme ruggedness of construction.
2. 2.6" diameter of useful target.
3. A target composed of a material having a higher secondary emission ratio than mica, enabling the tube to be operated at higher ultor voltages.
4. A barrier grid of unique construction and very fine mesh, thus increasing the resolution of the device.
5. An improved electron gun offering a beam focussing to a fine spot.
6. A convenient and rugged coaxial connector for the output terminations making possible a compact mounting not previously attainable.

Constructional features include an electron gun mounted on four multiform glass beads to which are also attached the deflection plates. This technique makes for great rigidity and good alignment of the components.

While the gun is mounted conventionally at the cathode end, the robust G5 disc is directly secured to the collector ring by four stout support columns, thus forming a particularly rugged assembly.

from JETEC release #2240, July 7, 1958

The mesh - target assembly is strongly constructed in a special manner which insures that the backplate is in continuous and positive contact with the target and the assembly is made integral with the Kovar wall and end-plate of the tube.

GENERAL DATA

Cathode Heater

Voltage	6.3 volts
Current	0.6 amp.

Inter-electrode capacities:

Cathode to all electrodes	15 uuf
G1 to all electrodes	9 uuf
DJ_1 to all electrodes	13 uuf
DJ_2 to all electrodes	13 uuf
DJ_3 to all electrodes	13 uuf
DJ_4 to all electrodes	13 uuf
DJ_1 to DJ_2	5 uuf
DJ_3 to DJ_4	7 uuf
Barrier grid to target backing plate	1600 uuf ± 20%
Note. An alternative type offers	1000 uuf ± 20%
Barrier grid mesh to collector	18 uuf
Collector to all other electrodes	22 uuf
Focussing Method	Electrostatic
Deflection Method	Electrostatic
Overall Length	11.75"
Greatest diameter of tube:	3.1"
Maximum useful target diameter	2.6"

Base: JETEC B14-45

Mounting Position: Any, except with base up and tube at an angle of less than 45° to the vertical.

Weight: 1 lb., 1 oz.

OPERATING DATA

1. Uniformity

The ratio of the maximum to minimum signal obtained from the target at V_K = -1500 volts does not exceed 2:1.

2. Resolution

A square wave of 10 volts amplitude is applied to one deflection plate. At each stationary spot location the information is regenerated 2700 times. Initially a "one" is stored at one location and a "zero" at the other. The pulse amplitude is slowly decreased until one spot fails. The "read around" is then quoted as 2700 at the measured number of spots per target diameter.

The WL7225 under these conditions resolves approximately 130 spots per target diameter.

MAXIMUM RATINGS

Expressed with respect to the cathode:

Ultor	3000 Max. volts
G1	- 300 Max. volts
G3 - with respect to ultor	1000 Max. volts
Positive bias value	3 volts
Backing electrode to barrier grid	200 Max. volts

MAXIMUM RATINGS (Continued)

Collector with respect to barrier grid	200 Max. volts
Peak Heater to cathode voltage:	
Heater negative with respect to cathode	125 Max. volts
Heater positive with respect to cathode	10 Max. volts

TYPICAL OPERATING CONDITIONS

Ef = 6.3 volts

EK = -1500 volts

EG1 = variable

EG1 cutoff = -1540 volts

EG2 cutoff = + 150 volts

EG3 cutoff = - 1000 $\pm$ 10% volts

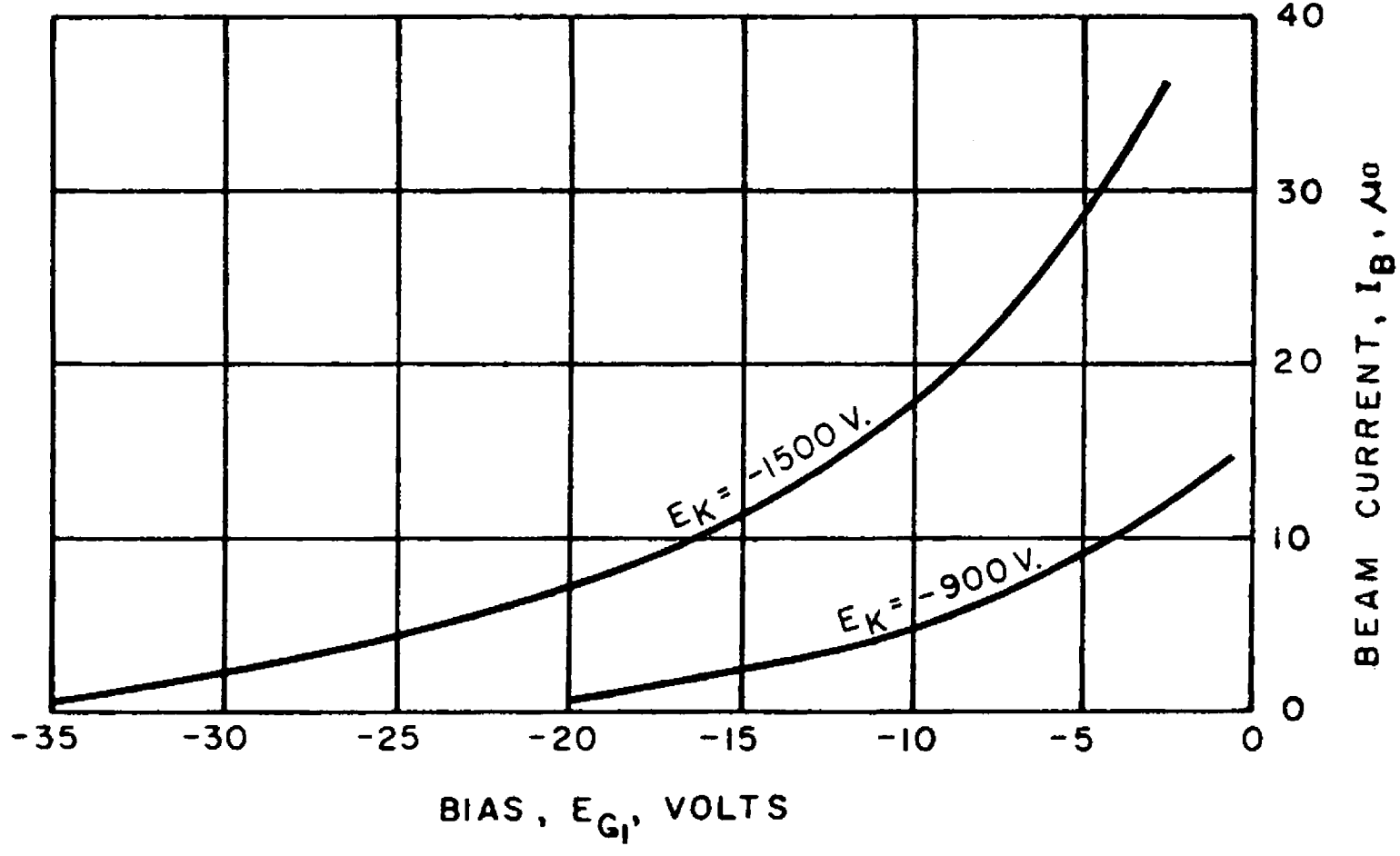
EG4 cutoff = + 150 volts

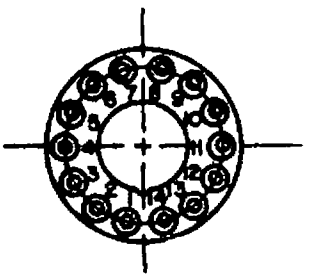
EG5 (collector) = + 150 volts

MAXIMUM VALUES OF ELECTRICAL LEAKAGE

Backplate to mesh	10000 Megohms Min.
G3 to all other electrodes in operating condition above	10 uA Max.
G5 to all other electrodes	1500 Megohms
Any one deflection plate to all other electrodes	2000 Megohms

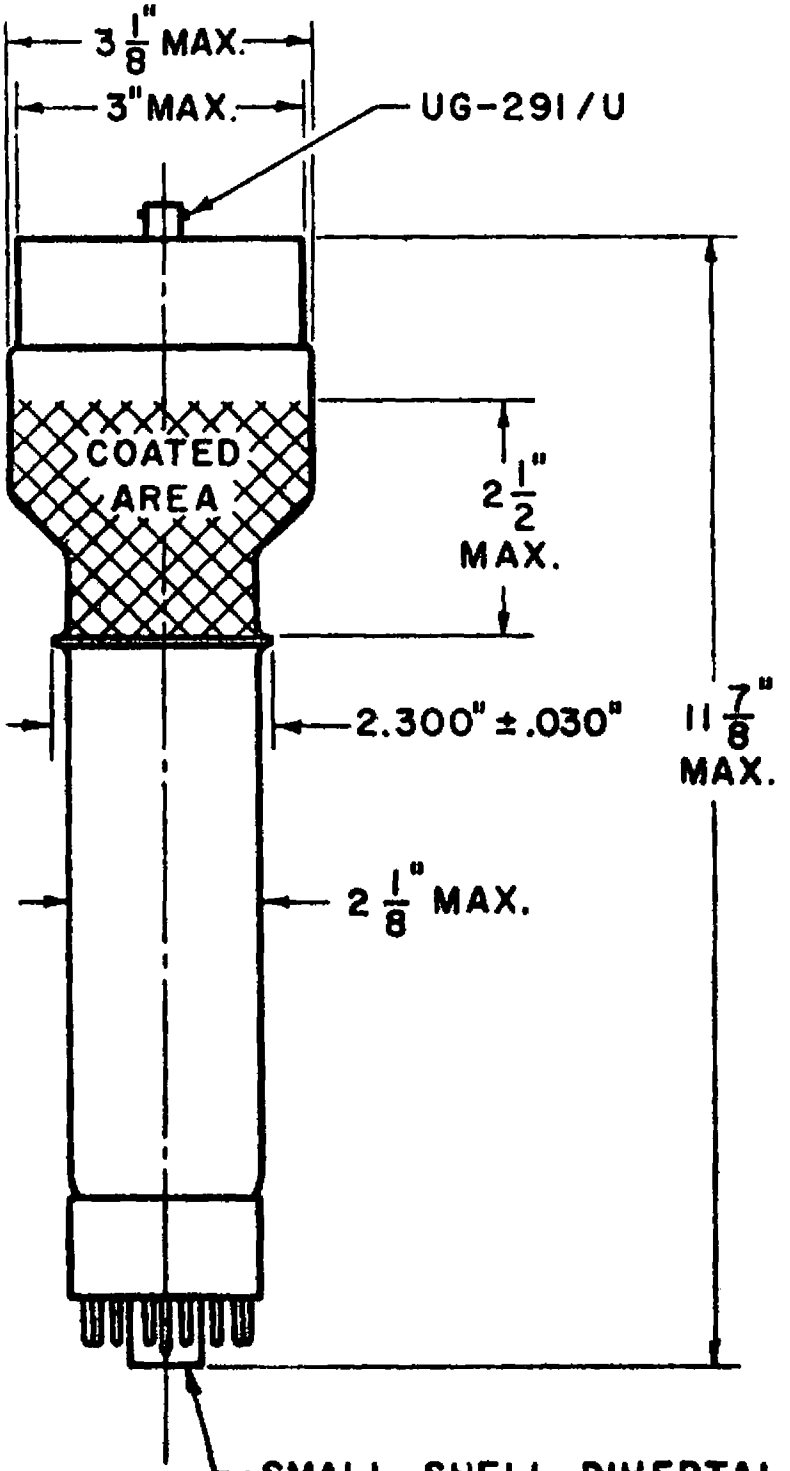
TRANSFER CURVES
BEAM CURRENT VS BIAS VOLTS
WL-7225 RADECHON
5-7-58





BASE PIN CONNECTIONS

PIN NO. 1	HEATER
2	CATHODE
3	GRID NO.1
4	INTERNAL CONNECTION
5	GRID NO.3 , FOCUSING ELECTRODE
6	NO CONNECTION
7	DEFLECTING ELECTRODE DJ4
8	DEFLECTING ELECTRODE DJ3
9	GRID NO.2 & GRID NO. 4
10	DEFLECTING ELECTRODE DJ2
11	DEFLECTING ELECTRODE DJ1
12	NO CONNECTION
13	INTERNAL CONNECTION
14	HEATER



July 1, 1958

WL-7228 FIVE INCH DIRECT VIEW STORAGE TUBE

The WL-7228 is a five-inch storage tube with selective erasure, developed by Westinghouse, for applications which require a bright display free of scintillations. The WL-7228 can be used in fire control radar, weather radar, transient studies, data transmission, half-tone storage, and visual displays requiring steady, narrow bandwidth transmission capable of being carried by telephone lines.

Performance characteristics of the tube include brightnesses of up to 2000 foot-lamberts with 10,000 volts applied to the phosphor, good resolution of half-tone displays. The writing speed of from 10^4 to 10^5 cm/sec is capable of freezing high frequency transients and, consequently, it provides sufficient time to adequately examine and record them.

The tube contains electrostatically focused and deflected writing guns and a flood gun. The writing guns can be used either for writing or selective erasure. In writing the beam lands at such a velocity that the secondary emission ratio is greater than unity and the storage grid is charged positively. If the velocity of the beam is further increased, the secondary emission ratio goes below unity and the storage grid is charged negatively, thereby erasing the written charge pattern. The writing and erasing operations are described in detail in the "Principles of Operation."

The viewing or reading is accomplished by a wide-angle beam of electrons which floods the electrodes controlling the storage and brightness of the display.

The WL-7228 is designed to be operated unpressurized in airborne applications. The pin connections have been grouped to separate high potential gradients over long external paths to eliminate electrical leakage at high altitudes. The grouping of the pin connections also incorporates improved deflection characteristics by eliminating long inductive leads from the base to the deflecting electrodes. The deflection leads are brought out radially through the neck to minimize lead length and cross coupling.

PRINCIPLES OF OPERATION

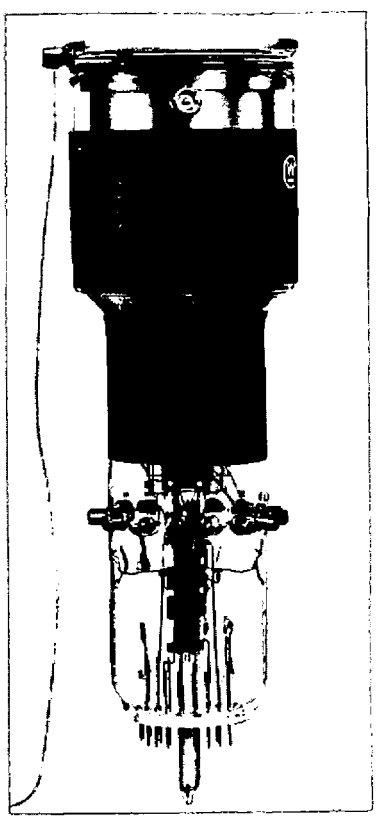
The Viewing Operation

The flood gun, in conjunction with its grids – the control grid no. 1, the accelerating grid no. 2, the collimating grids no. 3 and no. 4, a storage grid capacitively coupled to a backing electrode, a collector grid, and a highly-efficient phosphor screen – comprise the viewing section.

The flood gun provides a low-energy, high-density, highly-divergent beam which continuously floods the electrodes of the viewing section. Grids no. 2, no. 3, and no. 4 act as the collimating elements of the viewing section. These grids consist in general of conductive coatings on the bulb wall. The collimation is necessary in order that the low-velocity electrons will approach the storage grid in paths normal to the plane of the storage grid. This requirement causes all of the electrons of the viewing beam to arrive at the storage grid with equal energy components in the direction normal to the storage grid, thus causing any potential pattern existing on the storage grid to affect all of the electrons equally.

Electrically connected to the grid no. 4 is the collector mesh. This mesh not only serves to collect the secondary electrons from the storage grid and to uniformly accelerate the flood electron, but it also repels any positive ions produced by collisions of electrons with residual gas in the region between the collector and the flood gun cathode. This action prevents the ions from landing on the storage grid with resultant neutralization of the written charge pattern and destruction of the signal.

The storage grid consists of a fine metal mesh, one side of which is covered by a thin layer of insulating material. The insulator acts as a large number of individual storage elements capacitively coupled to the mesh. The charge established on the insulator by the writing beam modulates the viewing beam



Approx. one-fifth actual size

Special Devices Section

from JETEC release #2273, Sept. 8, 1958

In much the same way as modulation is provided by the control grid of a triode. The more positively charged regions of the storage mesh allow higher currents to reach the phosphor, corresponding to a highlight signal. The less positively charged elements allow proportionately smaller amounts of current to reach the phosphor, corresponding to half-tones. Thus, the WL-7228 is able to display visual output complete with half-tones.

The Writing Operation

The writing gun is similar to that used in electrostatically focused and deflected oscillograph tubes. This gun is capable of a high-density beam with very high resolution. The writing gun is generally operated between 1000-2000 volts. At this potential the electrons from the writing beam have sufficient energy to cause a secondary emission ratio greater than unity. Thus, since more electrons are leaving the storage grid than are arriving, a net positive charge results. The control grid of the writing gun regulates the amount of current falling on the storage grid at any particular instant. Therefore, the amount of positive charge developed on a particular element of the storage grid is proportional to the magnitude of the writing beam at the instant at which it is discharging that element. If it were not for the viewing electrons, the storage grid would charge to a potential near that of the collector. However, when the storage grid becomes more positive than the flood gun cathode, the landing of the viewing beam will limit any further charging. It is possible, then, to establish on the storage grid a charge corresponding to any potential intermediate between the storage grid cutoff voltage and the viewing gun cathode surface potential.

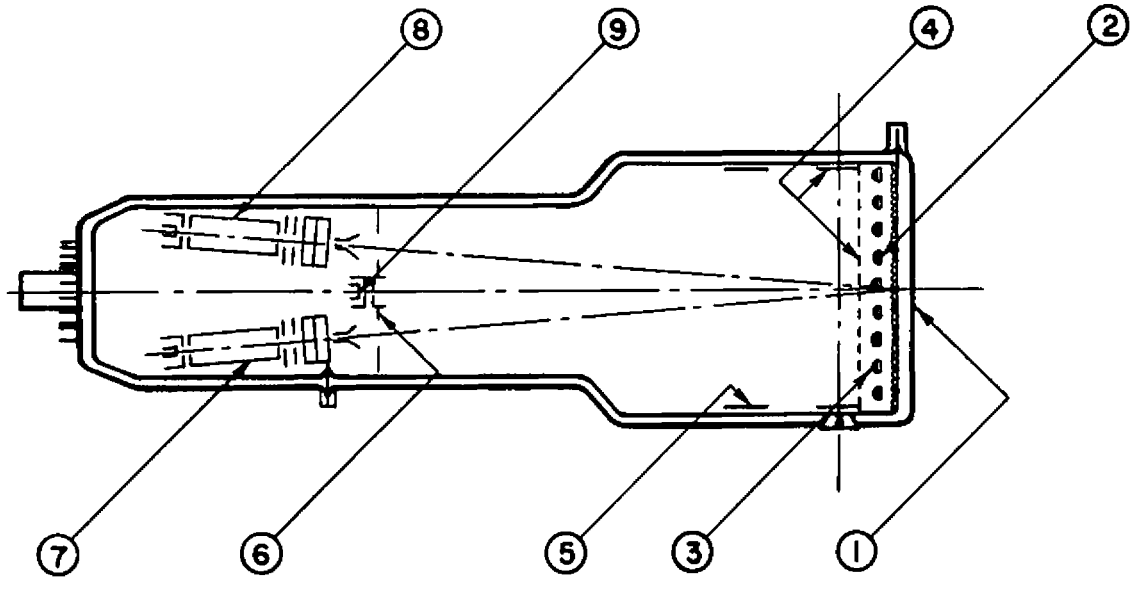
The potential of any particular element regulates the amount of viewing beam current reaching the phosphor. The visual output brightness of any element on the phosphor is proportional to the density and velocity of the electrons landing on the element. Because the potential is constant, the brightness is therefore directly proportional to the density of the viewing current which is in turn regulated by the potential on the storage grid.

Erasing Operation – Flood Gun Erasure

The stored pattern is erased by applying positive pulses to the backing electrode. Since the storage grid is capacitively coupled to the backing electrode, its potential tends to follow that of the backing electrode. Therefore, the positive pulses applied to the backing electrode cause the storage grid to shift in the positive direction and allow the flood electrons to land until the storage grid is charged to cathode potential. Then, with the pulse removed, the storage grid potential falls to a value which is at or beyond cutoff. The magnitude and duration of the pulse applied to the backing electrode determines the amount which the storage grid becomes negative with respect to the flood gun cathode with the pulse removed.

Erasing Operation – Selective Erasure

It is often advantageous to erase a specific part of the stored signal without erasing other parts. As the total electron-

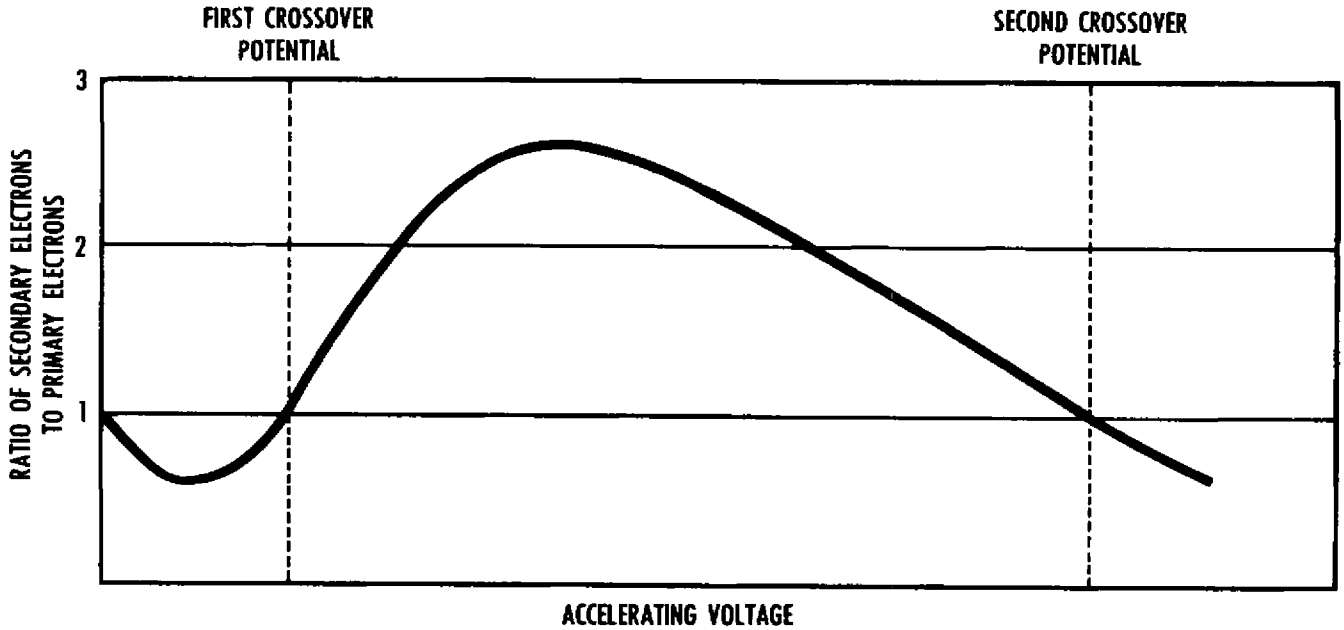


CE-A1384

1 - VIEWING SCREEN
2 - BACKING ELECTRODE
3 - STORAGE GRID
4 - COLLECTOR GRID - GRID NO. 4
5 - GRID NO. 3
6 - GRID NO. 2
7 - WRITING GUN
8 - ERASE GUN
9 - FLOOD GUN

Figure No. 1

SECONDARY EMISSION CHARACTERISTIC



CE-A1385

SECONDARY EMISSION RATIO δ_c = $\frac{\text{CURRENT AT COLLECTOR}}{\text{PRIMARY BEAM CURRENT}}$

The secondary emission curve shows the various modes of operation in a direct view storage tube. When the electrons land between the first crossover and the second crossover, the secondary emission ratio is greater than unity and the insulator is charged positively, producing a written signal. If the primary energy is increased above the second crossover, the insulator is charged negatively, erasing the written pattern.

The viewing is accomplished with electron potentials from zero volts to some slight negative voltage. Therefore, the viewing electrons do not land and do not affect the stored signal.

Figure No. 2

volt energy of the beam increases from zero volts, the secondary emission ratio first decreases then increases to a maximum value, substantially greater than unity. This maximum usually occurs between 500 and 1000 volts for the WL-7228. In the interest of better resolution, operation of the writing gun at 1500 volts is recommended. As the voltage of the electron beam increases further, the secondary emission ratio goes below unity, and it becomes possible to use the beam for selective erasure. With the WL-7228, selective erasure of reasonable speed usually occurs at a voltage of the order of 3000 volts. This high velocity erase mode has many advantages. The erase beam has high resolution resulting in much greater selectivity. The erase beam is also capable of much greater density. The greater beam density not only results in a faster erasing speed, but also results in substantially less interaction between guns used simultaneously in the write or erase modes.

A serious drawback of a low velocity erase system is the effect of the collimating optics of the flood gun on the erase beam. Since the erase beam is of the same order of velocity as the flood beam in this system, the collimating optics of the flood gun converge not only the flood beam, but also the erase beam. The erase beam tends to be deflected toward the center of the tube by the collimating lenses. Consequently, a low velocity erase beam is very difficult to control and has serious non-uniformities in deflection linearity.

Since the WL-7228 utilizes a selective erase system with a high velocity beam, it is essentially free from distortions of the type described above. Therefore, the WL-7228 is a completely flexible direct view storage tube. The WL-7228 may be employed as a direct view storage tube with two separately focused and deflected writing guns. Simply by raising the potential of one of the writing guns, the tube becomes a direct view storage tube with very high selectivity and speed of erasure.

Write Through

It is often desirable to display non-stored information simultaneously with stored information. This mode of operation or WRITE THROUGH is practical only if the non-stored information does not seriously disturb the charge pattern established on the storage grid. In order not to deteriorate the charge pattern, a secondary emission ratio of unity is necessary. The secondary emission curve in Figure No. 2, indicates that unity secondary emission occurs at three primary electron beam energy levels. Two of these – the zero energy potential and the first crossover potential – occur at energy levels too low for a well defined beam necessary for detailed information. The third unity secondary emission energy level occurs at the second crossover potential which is at sufficiently high beam energy (approx. 2500 to 3000 electron volts in the WL-7228) to be suitable for displaying detailed information without seriously affecting the stored signal. By adjusting either the erase gun or the write gun to the second crossover potential, WRITE THROUGH – simultaneous display of stored and non-stored information – is possible for limited periods with minimum impairment of the stored signal.

GENERAL

	Writing Section	*Selective Erase Section*	*Viewing Section*	
Heater for Unipotential Cathode:				
Voltage (ac or dc)	6.3 ± 5%	6.3 ± 5%	6.3 ± 5%	Volts
Current	0.6	0.6	0.6	Ampere
Cathode Heating Time (min): Before other electrode voltages are applied	--	--	30	Seconds
Focusing	Electrostatic	Electrostatic	None	
Deflection	Electrostatic	Electrostatic	None	
Phosphor	High Visual Efficiency Type, Aluminized			
Fluorescence	Yellow			
Phosphorescence	Yellow-Green			
Min. Useful Display Diameter	4"			
Max. Overall Length	16-1/2"			
Seated Length	15"			
Greatest Bulb Diameter	5 ± 1/16"			
Base	Small Button Thirtyfivar (JETEC E35-28)			
Bulb Terminals (Four)	Recessed Small Ball Cap (JETEC J1-22)			

MAXIMUM RATINGS
Absolute Values

	Writing Section	*Selective Erase Section*	*Viewing Section♦*	
Screen Voltage	--	--	11000 max.	Volts
Backing Electrode Voltage	--	--	35 max.	Volts
Equivalent Voltages				
Grid No. 4 Voltage	3000 max.§ 150 max.♦	3500 max.▲ 150 max.♦	300 max.	Volts
Grid No. 3 Voltage	1000 max.§	1250 max.▲	300 max.	Volts
Grid No. 2 Voltage	3000 max.§	-3500 max.▲	150 max.	Volts
Cathode Voltage	-3000 max.♦			Volts
Grid No. 1 Voltage:				
Negative Bias Value	200 max.§	200 max.	200 max.	Volts
Positive Bias Value	0 max.§	0 max.	0 max.	Volts
Positive Peak Value	0 max.	0 max.	0 max.	Volts
Peak Deflection Voltage: Between G4 and any Deflection Electrode	500 max.	600 max.	--	Volts
Heater-Cathode Voltage:				
Negative Heater Voltage	125 max.§	125 max.	125 max.	Volts
Positive Heater Voltage	125 max.§	125 max.	125 max.	Volts

TYPICAL OPERATING VALUES

	Viewing Section♦			
Screen Voltage	10000	10000	5000	Volts
Backing Electrode	5 to 20	5 to 20	5 to 20	Volts
Grid No. 4 Volts	200 to 250	150 to 200	150 to 200	Volts
Grid No. 3 Volts	50 to 150	25 to 125	25 to 125	Volts
Grid No. 2 Volts□	70 to 105	50 to 80	50 to 80	Volts
Grid No. 1 Volts	0 to -70	0 to -50	0 to -50	Volts
Max. Screen Current	700	400	400	uamps
Max. Grid No. 2 Current	3	2	2	Ma.
Max. Grid No. 3 Current	2	1.5	1.5	Ma.
Max. Grid No. 4 Current	3	2	2	Ma.
Max. Backing Electrode Current	2	1.5	1.5	Ma.
Max. Cathode Current	5	3.5	3.5	Ma.
Resolution●	250	250	250	lines/dia.
Number of Half-Tones★	4-5	4-5	4-5	
Viewing Duration⊕	20	40	40	Sec.
Brightness♦	2800	1500	300	ft-l.
Erasing Speed†	10000	10000	10000	cm/sec.

Ranges for Electrode Supplies:§	*Writing Section*	*Selective Erase Section*	
Grid No. 4 Voltage	500 to 3000§	500 to 3500▲	Volts
Grid No. 3 Voltage	12 to 30% of E_{c2}	12 to 30% of E_{c2}	Volts
Grid No. 2 Voltage	500 to 3000	500 to 3500	Volts
Deflection Factors:			
$D_{j1} + D_{j2}$	28-38 Vdc/in/KV of E_{c4}	28-38 Vdc/in/KV of E_{c4}	
$D_{j3} + D_{j4}$	28-38 Vdc/in/KV of E_{c4}	28-38 Vdc/in/KV of E_{c4}	
Writing Speed■	100000		cm/sec.

● RESOLUTION: Number of total lines resolved by shrinking raster method with Grids No. 2 and 4 at 1000 volts with respect to the writing gun cathode.

★ NUMBER OF HALF-TONES: Observed with video signal from EIA test pattern as signal.

⊕ VIEWING DURATION: Measured as the time required for the background brightness to increase from zero brightness and with screen at indicated voltage.

♦ BRIGHTNESS: Measured as the maximum average brightness with the entire storage grid written to maximum brightness and with screen at indicated voltage.

† ERASING SPEED: Measured as the time to selectively erase from saturated brightness to black level with zero bias on erase gun and grids No. 2 and 4 of the erase fun at 3000 volts with respect to the erase gun cathode.

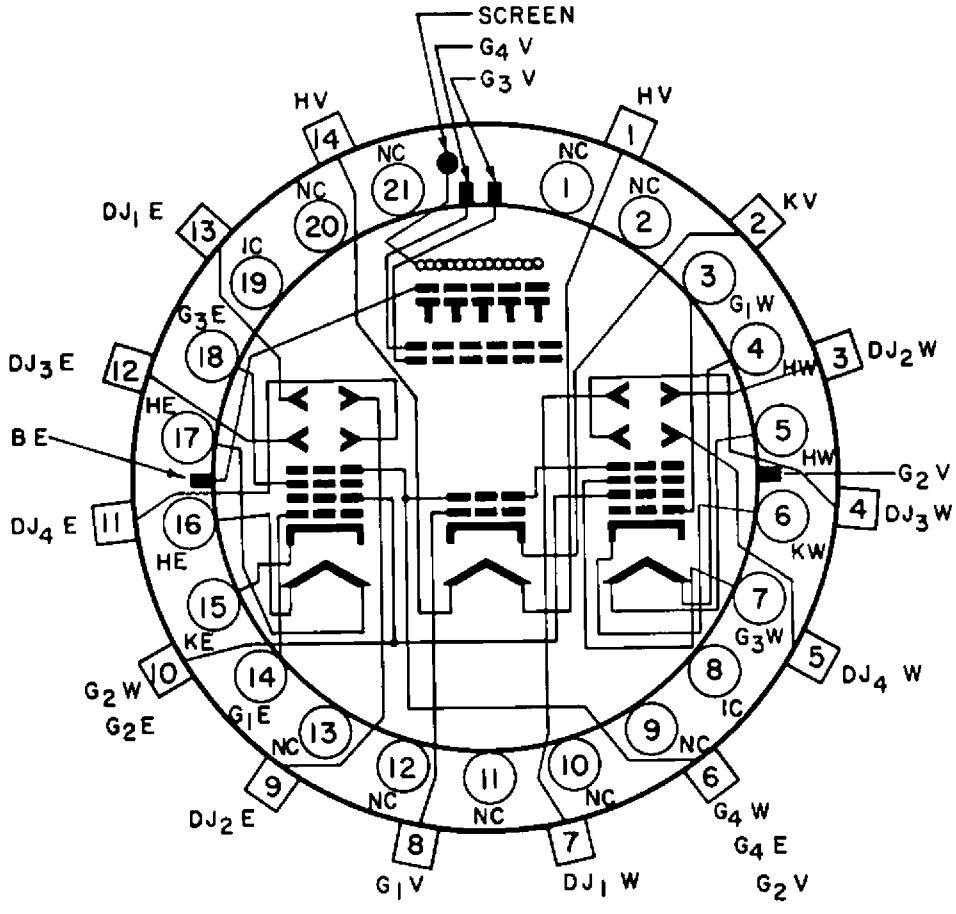
§ Voltages are shown with respect to the cathode of the writing gun.

♦ Voltages are shown with respect to the cathode of the viewing gun.

▲ Voltages are shown with respect to the cathode of the erase gun.

□ Grid No. 2 of viewing gun connected internally to Grid No. 4 of writing gun. (Grid No. 2 of writing guns usually connected externally to Grid No. 4 of writing guns.)

■ WRITING SPEED: Measured as the time required to write from zero to 90% of maximum brightness with zero grid bias on the writing gun and Grids No. 2 and 4 of writing gun at 1000 volts with respect to the writing gun cathode.



BOTTOM VIEW

CE-A1383

SOCKETS

1 - No connection
2 - No connection
3 - Grid No. 1 of writing gun
4 - Heater of writing gun
5 - Heater of writing gun
6 - Cathode of writing gun
7 - Grid No. 3 of writing gun
8 - Internal connections. Do not use.
9 - No connection. Do not use.
10 - No connection. Do not use.
11 - No connection. Do not use.
12 - No connection. Do not use.
13 - No connection. Do not use.
14 - Grid No. 1 of erase gun
15 - Cathode of erase gun
16 - Heater of erase gun
17 - Heater of erase gun
18 - Grid No. 3 of erase gun
19 - Internal connection. Do not use.
20 - No connection.
21 - No connection.
22 to 35 - No connection.

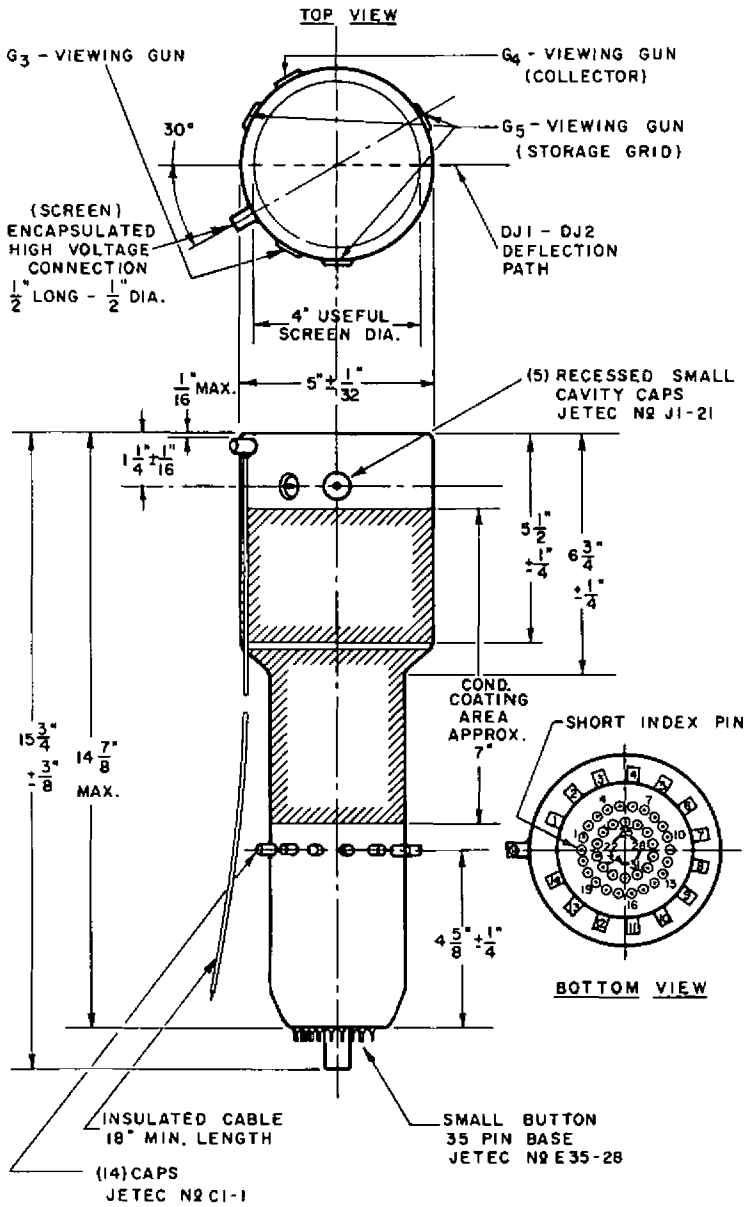
DJ - Deflecting Electrode
W - Writing Gun
V - Viewing Gun
E - Erasing Gun

NECK CONNECTIONS

1 - Heater of viewing gun
2 - Cathode of viewing gun
3 - DJ_2 of writing gun
4 - DJ_2 of writing gun
5 - DJ_2 of writing gun
6 - Grid No. 4 of writing gun, Grid No. 4 of erase gun and Grid No. 2 of viewing gun
7 - DJ_1 of writing gun
8 - Grid No. 1 of viewing gun
9 - DJ_2 of erase gun
10 - Grid No. 2 of writing gun, and Grid No. 2 of erase gun
11 - DJ_2 of erase gun
12 - DJ_2 of erase gun
13 - DJ_2 of erase gun
14 - Heater of viewing gun

FLEXIBLE LEAD - Screen Connection

RECESSED CAVITY CAPS - See Outline Drawing



CE-B-1382

Center line of bulb will not deviate more than 3° in any direction from perpendicular erected at center of face plate.

The plane through the tube axis and each of the following items may vary from the DJ1 – DJ2 deflection paths by these angular tolerances (measured about the tube axis): encapsulated connection (screen), 30° ± 5°; index pin of base, ±10°; fifteenth (vacant) position of C1-1 caps on tube neck, ± 10°; DJ3 - DJ4 deflection paths, 90° ± 3°. Index pin of base and fifteenth cap position are on same side of tube as encapsulated connection.

Westinghouse®



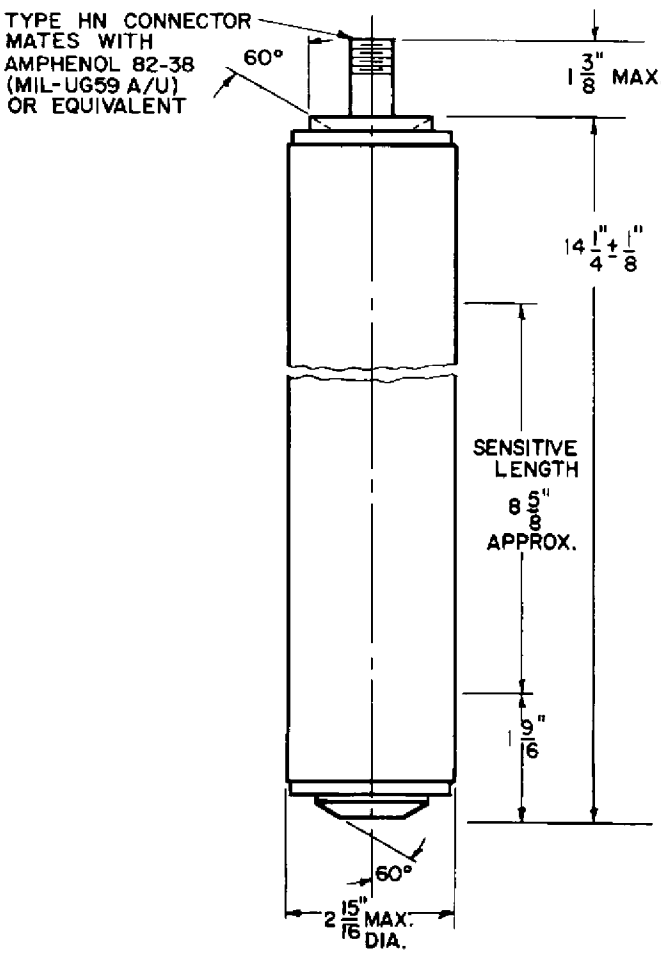
WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

August 4, 1958

BF_3 PROPORTIONAL COUNTER TYPE WL-7243

The WL-7243 is an aluminum body proportional counter designed to detect thermal neutrons in the flux range from 8×10^{-2} to 8×10^{3} neutrons/cm²/second.⊕ This counter is extremely rugged♦ and will operate in any position and at ambient temperatures up to 175° F.

The WL-7243 is fitted with an "HN" type connector and consists of three individual proportional counters, each 1" in diameter and 10-5/8" long and filled with BF_3 enriched to 96% with Boron-10 isotope. The sensitivity of the WL-7243 is approximately 13 counts/neutron/cm² at an operating voltage of 2000 volts. The pulses arising from incident gamma photons are sufficiently small that they normally can be biased out by the amplifier.



MECHANICAL:

Maximum Diameter	2-15/16	Inches
Maximum Overall Length	15-3/4	Inches
Approx. Sensitive Length	8-5/8	Inches
Net Weight	3-1/8	Pounds
Shipping Weight, approx.	8	Pounds

MATERIALS:

Body	Aluminum
Center Electrodes	Tungsten
Insulation	Polystyrene & Alumina
Gas Filling	BF_3 enriched 96% B-10

MAXIMUM RATINGS:

Absolute Maximum Values

Voltage Between Electrodes	2500	max. Volts
Operating:		
Thermal Neutron Flux□	8×10^{3}	max. nv
Temperature	175	max. °F
Non-Operating:		
Thermal Neutron Flux	4.0×10^{9}	max. nv
Gamma Flux	10^{4}	max. R/hr
Temperature	175	max. °F

TYPICAL OPERATING CHARACTERISTICS:

Voltage Between Electrodes, approx.	2000 Volts
Neutron Flux Range	8×10^{-2} to 8×10^{3} nv
Multiplication Factor	500
Sensitivity	13 counts/n/cm²
Plateau Length	Minimum of 200 volts with overall slope of 4% or less.
Output Pulse	Minimum of 10^{-3} volts with inherent rise time of less than 5×10^{-8} seconds.

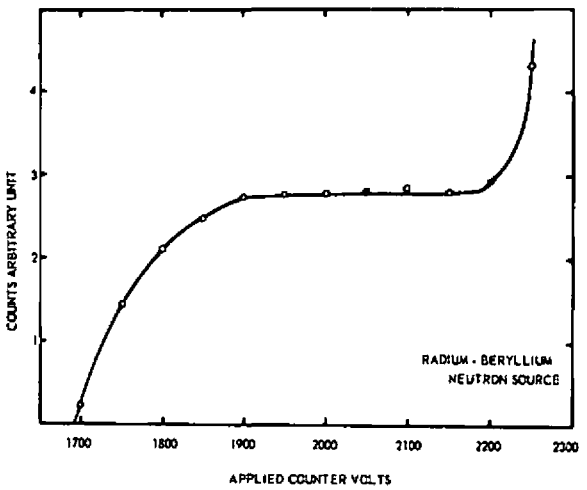
⊕ When in flux levels exceeding the recommended operating range, the tube should be shunted with a maximum resistance of 1.5 megohms and the operating voltage removed.

♦ The WL-7243 has passed military specification MIL-S-901 for shock and MIL-Std-167 (Type 1) for vibration.

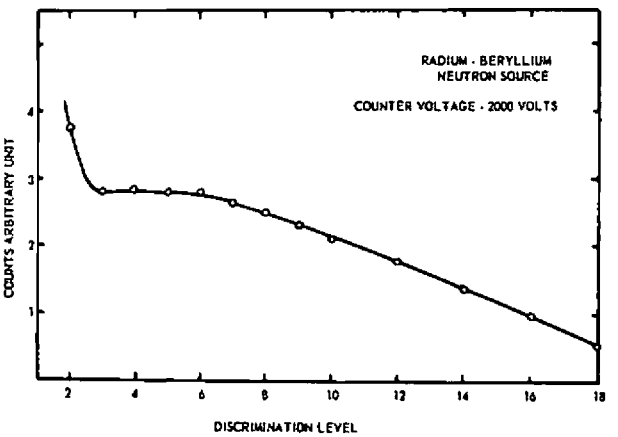
□ With high speed circuitry, the counter may be operated to 8×10^{4} nv.

NOTE: This tube may not be immersed in water and high humidity environments should be avoided since they may impair performance.

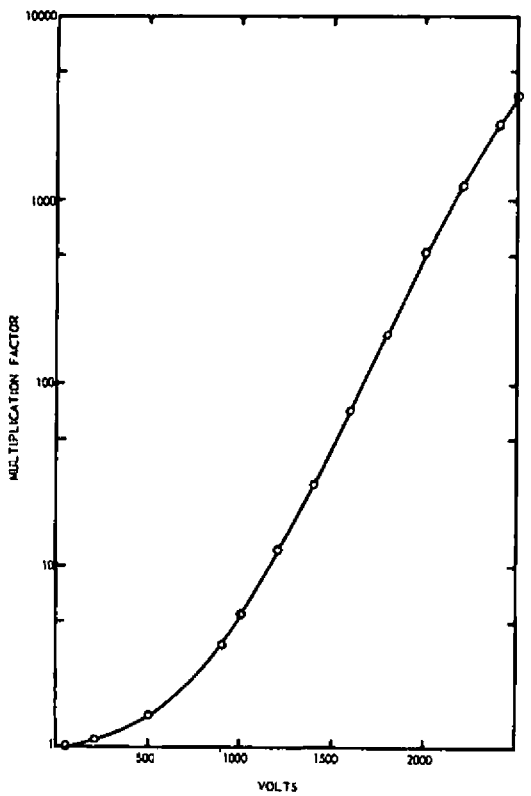
from JETEC release #2263, Aug. 25, 1958



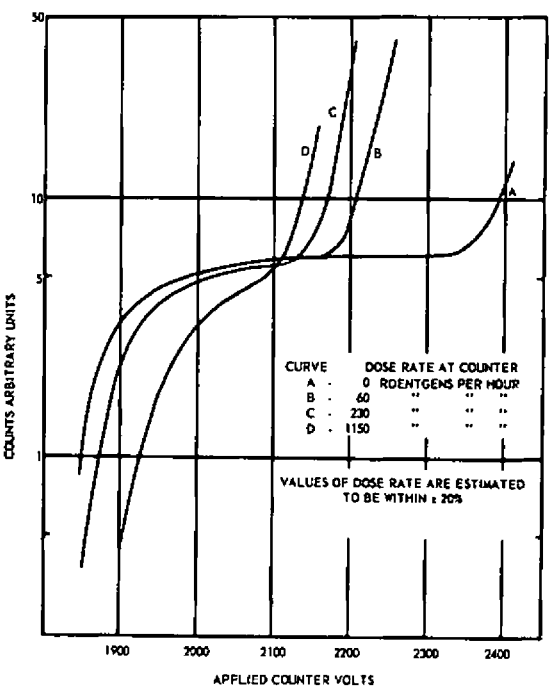
VOLTAGE CURVE FOR BF_3 COUNTER



INTEGRAL BIAS CURVE FOR BF_3 COUNTER



MULTIPLICATION CURVE FOR BF_3 COUNTER



NEUTRON RESPONSE OF BF_3 COUNTER

POWER AMPLIFIER TRIODE TYPE 7255

The 7255 is a three element power amplifier and oscillator tube especially designed for operation with lower voltage power supplies. Its high perveance structure permits the generation of 6 kilowatts at a plate voltage of only 5 kilovolts at excellent efficiency. Outputs of 13-1/2 kilowatts are obtainable at 9 kilovolts.

The anode design features an integral water jacket with an internal spiral water diverter which maintains turbulence of cooling water. This prevents the occurrence of anode hot spots and accounts for high power density capability of the tube. The 7255 will dissipate 9 kilowatts with only 3-3/4 gallons per minute and still provides ample safety margin for instantaneous overloads.

The filament structure incorporates a unique spring loaded high efficiency design. The high efficiency thoriated tungsten filament provides 50 amperes peak emission at only 350 watts of filament power. The rugged spring loaded structure inhibits sagging and breaking of filament strands thus insuring long life and uniformity of characteristics with life.

These features make the 7255 a particularly attractive design for induction and dielectric heating applications. The internal structure is very precisely designed and production controls assure uniformity from tube to tube. These design features are reflected in a high degree of uniformity of performance in class B and class C RF power amplifier and oscillator operation. Ratings apply to 30 megacycles.

GENERAL DATA

ELECTRICAL:

	min.	bogey	max.	
Filament Voltage	5.7	6.0	6.3	Volts
Filament Current	57	60	63	Amp.
Filament Starting Current	-	-	300	Amp.
Filament Cold Resistance	-	0.016	-	Ohms
Amplification Factor	18	22	26	
Interelectrode Capacitances:				
Grid to Plate	12	16	21	$\mu\mu f$
Grid to Filament	15	19	22	$\mu\mu f$
Plate to Filament	0.2	0.80	1.0	$\mu\mu f$

MECHANICAL:

Mounting Position		Vertical, Anode Down		
Type of Cooling		Water and Forced Air		
Min. Required Water Flow:				
Plate Dissipation	3	6	9	KW
Water Flow in Gallons per Minute	1	2	3.75	gpm
Pressure Drop	0.85	1.9	7	in. psi
Required Air Flow on Filament and Grid Seals			30	CFM
Max. Glass Temperature			180	°C
Net Weight, approx.			1-3/4	lbs.

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, CLASS C TELEGRAPHY

(Key-down conditions per tube without amplitude modulation)

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	9200	max.	Volts
DC Plate Current	2.0	max.	Amp.
Plate Input	18000	max.	Watts
Plate Dissipation	9000	max.	Watts
DC Grid Voltage	-1500	max.	Volts
DC Grid Current	0.5	max.	Amp.

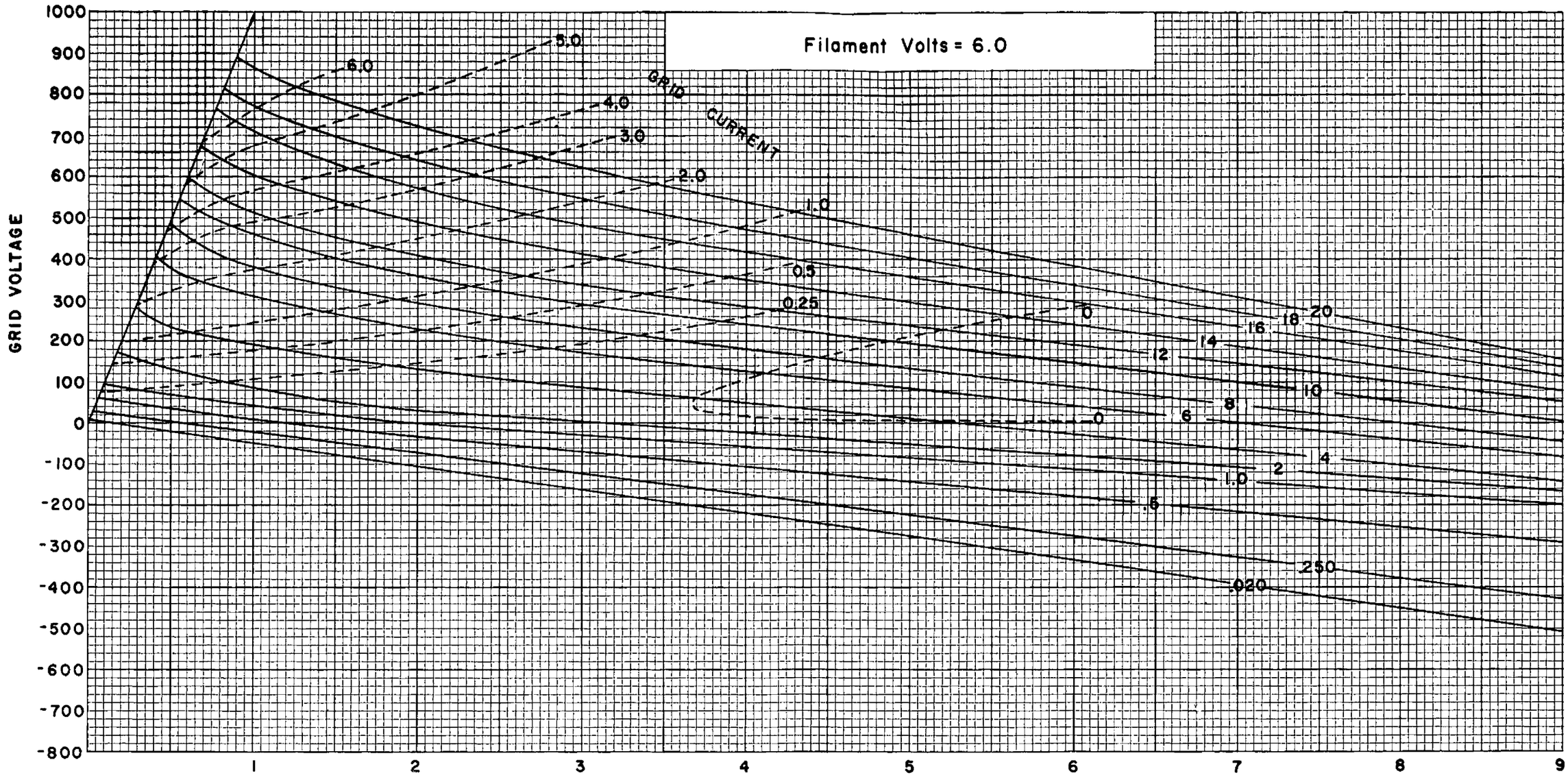
TYPICAL OPERATION:

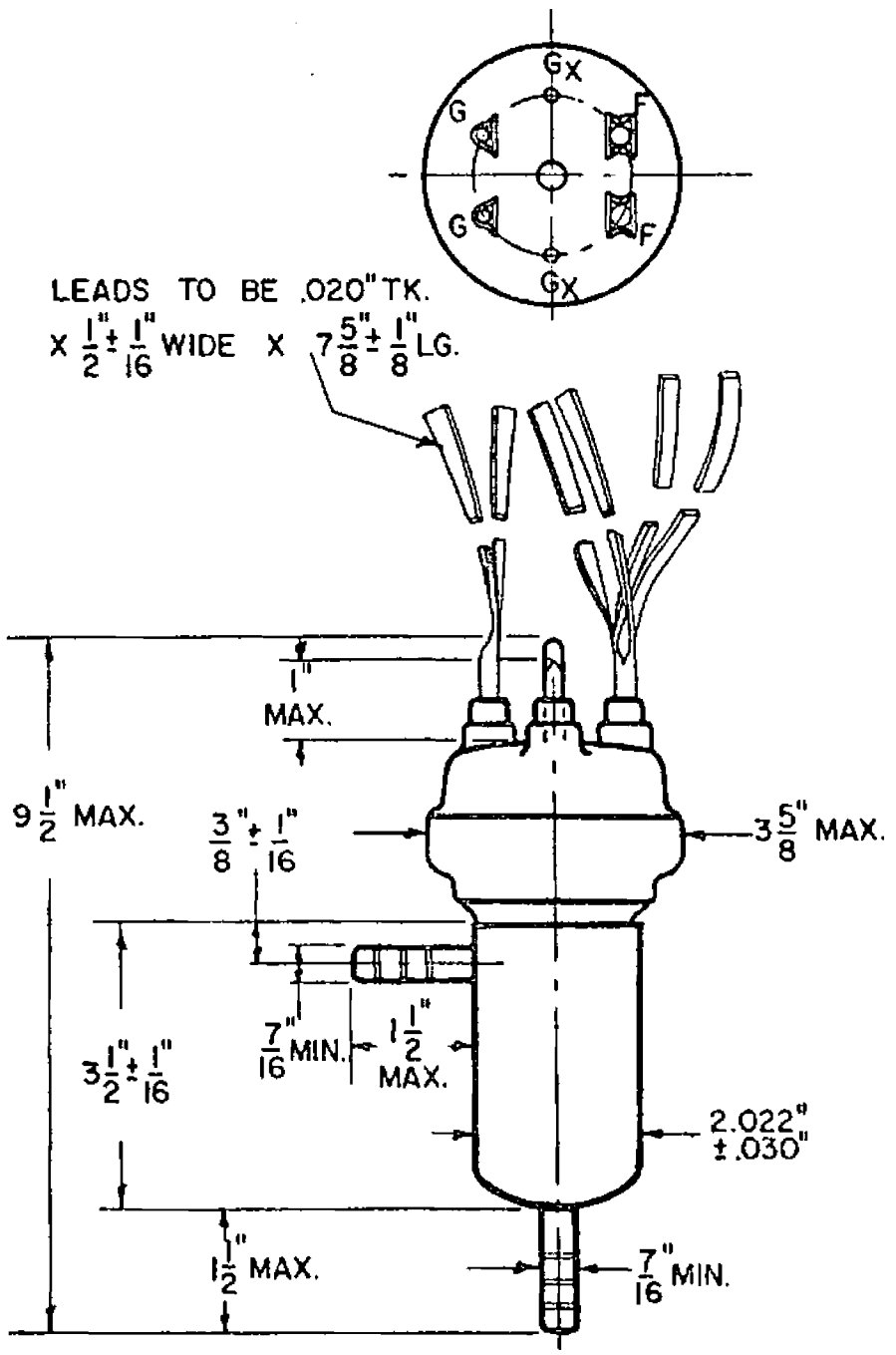
DC Plate Voltage	5000	9000	Volts
DC Grid Voltage	-800	-1400	Volts
Peak Radio-Frequency Grid Voltage	1240	1850	Volts
DC Plate Current	1.61	2.0	Amp.
DC Grid Current	0.40	0.18	Amp.
Driving Power, approx.	480	337	Watts
Power Output, approx.	6430	13600	Watts

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #2850, June 20, 1960

AVERAGE CONSTANT-CURRENT CHARACTERISTICS




GX
G
F
G
F
GX
LEADS TO BE .020" TK.
X 1/2" ± 1/16" WIDE X 7 5/8" ± 1/8" LG.
1" MAX.
9 1/2" MAX.
3/8" ± 1/16"
3 5/8" MAX.
3 1/2" ± 1/16"
7/16" MIN.
1 1/2" MAX.
2.022" ± .030"
1 1/2" MAX.
7/16" MIN.

February 14, 1959

LIGHT IMAGE INTENSIFIER TYPE WL-7257

The WL-7257 is a high vacuum tube designed to intensify light radiation by electronic means. This tube produces an image of reduced size having a brightness increase of 1000 times minimum for input color temperature of 2870°K, and 2500 times minimum for actinic blue input. Incoming radiation impinges on an input photosurface five inches in diameter, converting the light image to an electron image. The photocathode is deposited directly on the inner side of the polished bulb face and is capable of becoming an integral part of an external optical system. The electron image is focused and accelerated toward an aluminum backed P11 phosphor screen with a useful output diameter of one inch.

Electrical:

Gain with 30KV on Anode Screen: ▲	
Approximate Image Minification Gain	25
Light Quantum Gain:	
With 2870°K Tungsten Input	50
With Actinic Blue Input	100
Optical Minification Ratio	5:1
Input Resolution ■	75 line pairs/inch
Photocathode Illumination:	
Threshold for Imaging (approx)	10^{-7} ft-C
Photocathode Spectral Response	See Page 2
Output Phosphor Spectral Response	See Page 3
Outer Phosphor Persistance	See Page 3

Mechanical:

Maximum Diameter	8-11/16"
Maximum Length	15-3/4"
Maximum Usable Photocathode Diameter	5"
Radius of Curvature of Input Screen ♦	10-1/4"
Maximum Usable Output Screen Diameter	1"
Net Weight (approx)	6-1/8 Pounds
Shipping Weight (approx)	21 Pounds
Operating Position	Any

Maximum Ratings:

Absolute Maximum Values

Anode Screen to Photocathode Voltage	30 max.	Kilovolts
Peak Pulse Anode Screen Current	1 max.	Milliampere

Typical Operating Conditions:

Photocathode and First Lens Element	Grounded
Anode Screen Voltage	20 to 30 Kilovolts
Fifth Lens Element	13.9% to 16.4% of Anode Voltage
Fourth Lens Element	40% of Fifth Lens Element Voltage
Third Lens Element	8% of Fifth Lens Element Voltage
Second Lens Element	3% of Fifth Lens Element Voltage
Approximate Anode Screen Current with 10^{-3} foot candle input to tube	1 to 2 Microamperes

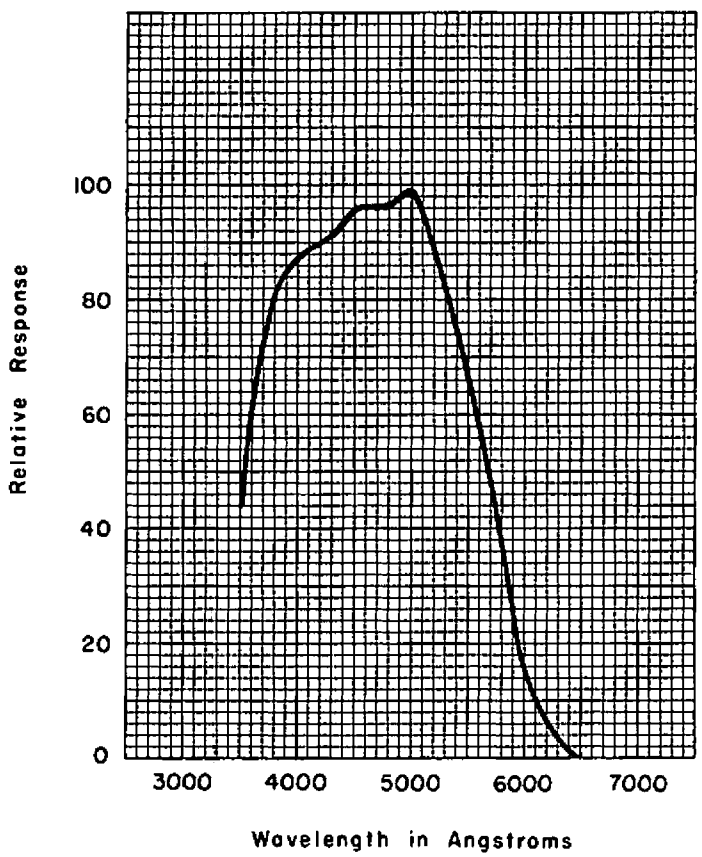
▲ With a fixed light-intensity input, the light-intensity output varies linearly with anode screen voltage from 0 to 30 kilovolts.

■ The resolution measurements are made over the central area of the photocathode.

♦ Thickness tolerance of faceplate is ±0.025" over entire surface.

from JEDEC release #2293A, March 23, 1959

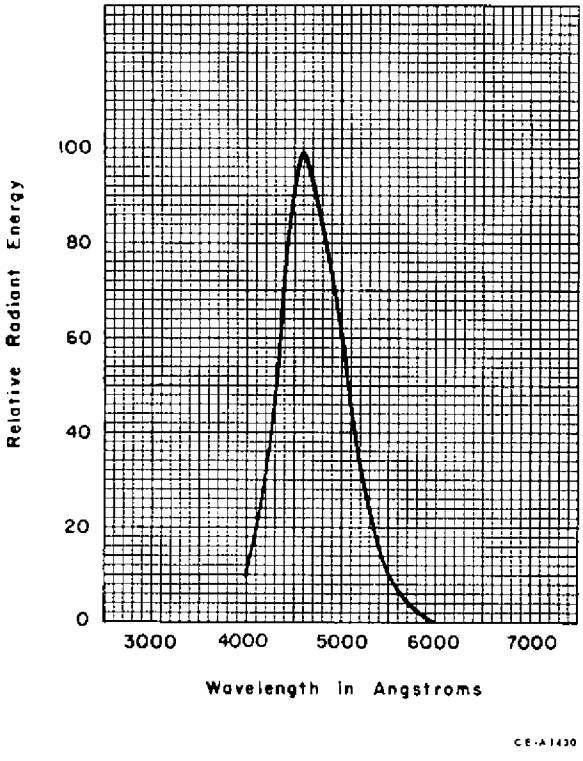
OXIDIZED CESIUM ANTIMONY PHOTOCATHODE
SPECTRAL SENSITIVITY CHARACTERISTIC



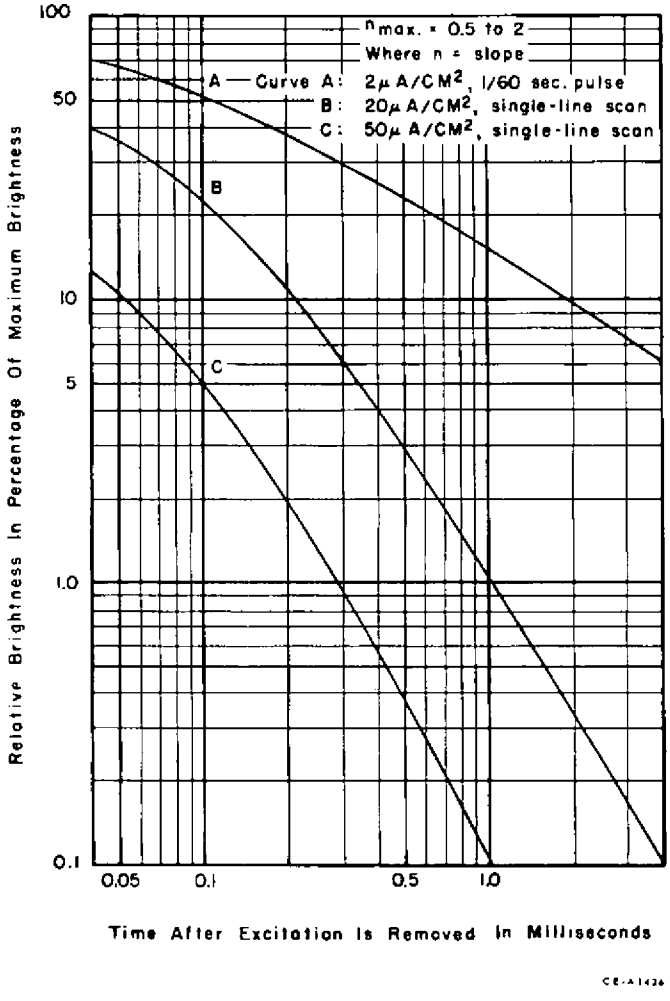
CE-A1431

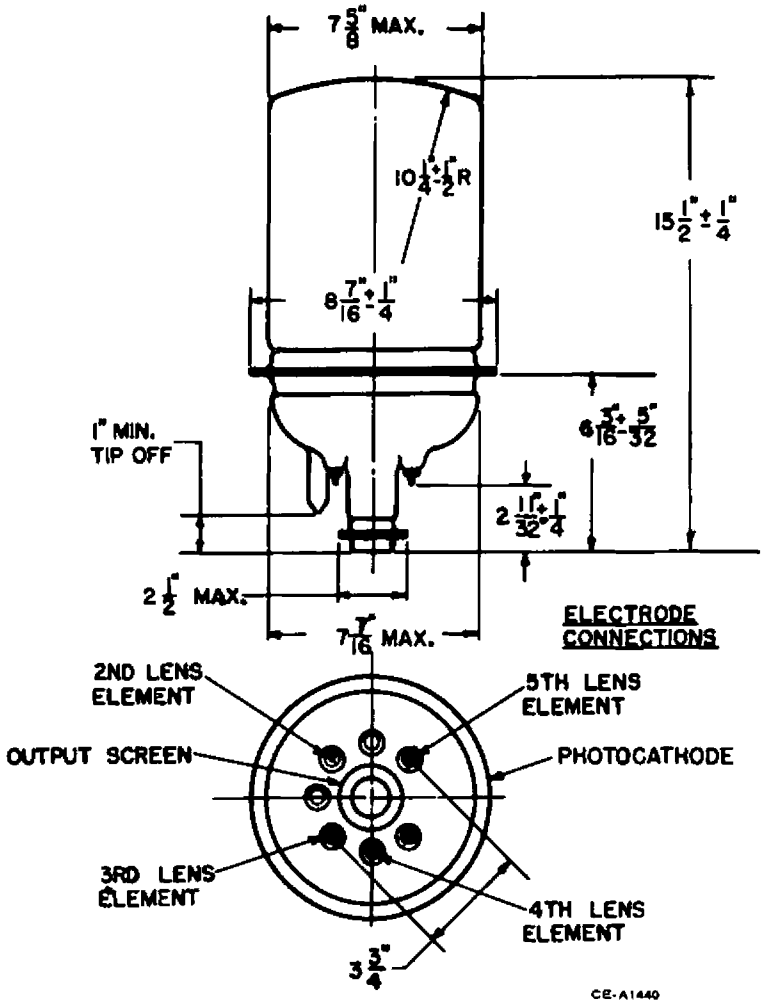
P11 PHOSPHOR

SPECTRAL ENERGY EMISSION CHARACTERISTIC



P11 PHOSPHOR PERSISTENCE CHARACTERISTIC




7 5/8" MAX.
10 1/4" ± 1/2" R
15 1/2" ± 1"
8 7/16" ± 1"
1" MIN.
TIP OFF
6 3/16" ± 5/32"
2 11/32" ± 1"
2 1/2" MAX.
7 7/16" MAX.
ELECTRODE CONNECTIONS
2ND LENS ELEMENT
5TH LENS ELEMENT
OUTPUT SCREEN
PHOTOCATHODE
3RD LENS ELEMENT
4TH LENS ELEMENT
3 3/4"
CE-A1440

September 1, 1960

DIRECT VIEW STORAGE TUBE TYPE 7268

Two Writing Guns
Viewing Gun
Integral Tube and Shield Assembly

4" Display Diameter

5-1/4" Overall Diameter Including Shield
15-3/4" Overall Length
25 Pin Two-Tier Base

The 7268 is a direct-view storage tube incorporating two writing guns and a viewing gun system capable of producing a bright, non-flickering, uniform display over a four inch diameter viewing area. The two electrostatically focused and deflected writing guns permit independent and simultaneous writing of two signals.

Performance characteristics of the tube include a brightness of up to 2500 foot-lamberts with 10,000 volts applied to the phosphor, good resolution of half-tone displays, and excellent display uniformity. The writing speed of 36,000 inches per second is sufficient to "freeze" high frequency transients, and storage time is long enough to allow adequate examination and recording of the display.

The 7268 is particularly useful for such applications as airborne fire control radar, weather radar, transient studies, data transmission including half-tone storage, telemetering, facsimile, and visual displays requiring steady, narrow-bandwidth transmission over telephone lines.

The 7268 is designed to operate under military environmental conditions. It may be operated unpressurized at high altitudes. The pin connections have been grouped according to operating potentials within a Westinghouse designed Two-Tier 25 Pin Base (JEDEC B25-216) which features unusually long external leakage paths between pin circles. In addition, the base is potted to eliminate internal leakage.

The entire tube is potted within its magnetic shield with a synthetic silicone-rubber material providing protection against mechanical shock, vibration, humidity, and leakage between bulb terminals. The magnetic shield is resistant to salt spray.

The integral tube-and-shield assembly together with the improved base design greatly simplify tube installation procedure.



ELECTRICAL:

Storage:

Type	Half-Tone or Line
Mode	Control of Transmission
Type of Erasure	Overall

Writing Guns: (Each Gun)

Cathode			Coated Unipotential	
Heater:	Min.	Bogey	Max.	
Voltage (ac or dc)	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Amperes
Focusing Method				Electrostatic
Deflection Method				Electrostatic
Number of Writing Guns				Two

Viewing Gun:

Cathode			Coated Unipotential	
Heater:	Min.	Bogey	Max.	
Voltage	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Ampere
Warm-up Time before Applying High Voltages	30	--	--	Seconds
Focus and Deflection	Undeflected, Collimated "Flood" Gun			

Direct Interelectrode Capacitances:

External Integral Shield Grounded

Writing Gun Cathode to All Internal Elements	7 max.	μμf
Viewing Gun Cathode to All Internal Elements	10 max.	μμf
Writing Gun Grid 1 to All Internal Elements	10 max.	μμf
Viewing Gun Grid 1 to All Internal Elements	18 max.	μμf
Deflection Electrode 1 to Deflection Electrode 2	3 max.	μμf
Deflection Electrode 3 to Deflection Electrode 4	2 max.	μμf
Deflection Electrode 1 to All Internal Elements	8 max.	μμf
Deflection Electrode 2 to All Internal Elements	8 max.	μμf
Deflection Electrode 3 to All Internal Elements	8 max.	μμf
Deflection Electrode 4 to All Internal Elements	8 max.	μμf
Backing Electrode to All Internal Elements	110 max.	μμf

OPTICAL:

Phosphor:

Type	High Visual Efficiency, Aluminized P20
Fluorescence	Yellow-Green
Phosphorescence	Yellow-Green
Persistence	Short
Faceplate	Optical Glass, Ground and Polished Flat

MECHANICAL:

Minimum Useful Viewing Diameter	4"
Maximum Overall Length	16"
Maximum Seated Length	14-1/4"
Greatest Shield Diameter	5-1/4" ± 1/16"
Viewing Screen Terminal	Flexible Cable

Caps on Large End of Bulb

Backing Electrode	Recessed Small Ball (JEDEC J1-22)
Collecting Electrode	Recessed Small Ball (JEDEC J1-22)
Collimating Electrode	Recessed Small Ball (JEDEC J1-22)

Base ..... 25 pin Two Tier Deci-Quindecimal (JEDEC B25-216)

Mounting Position	Any

MAXIMUM RATINGS:

Absolute Maximum Values

Writing Gun:

(Reference Voltage is Writing Gun Cathode)

Grids 2 & 4 Voltage♦	3000 max.	Volts
With Respect to Viewing Gun Cathode	200 max.	Volts
Grid 3 Voltage (Focus)	2000 max.	Volts
Negative with Respect to Viewing Gun Cathode	2600 max.	Volts
Grid 1 Voltage:		
Negative Bias Value	200 max.	Volts
Positive Bias Value	0 max.	Volts
Positive Peak Value	2 max.	Volts
Cathode Voltage Negative with Respect to Viewing Gun Cathode	2800 max.	Volts
Voltage Between any Deflection Electrode and Grids 2 & 4:♦		
Positive or Negative Peak Value	500 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Positive or Negative with Respect to Cathode	125 max.	Volts

Viewing Gun:

(Reference Voltage is Viewing Gun Cathode)

Viewing Screen Voltage	11000 max.	Volts
Grid 5 Voltage (Backing Electrode)	35 max.	Volts
Grid 4 Voltage (Collecting Electrode)	300 max.	Volts
Grid 3 Voltage (Collimating Electrode)	300 max.	Volts
Grid 2 Voltage (Accelerating Electrode)♦	200 max.	Volts
Grid 1 Voltage:		
Negative Bias Value	150 max.	Volts
Positive Bias Value	0 max.	Volts
Peak Heater-Cathode Voltage Heater Positive or Negative with Respect to Cathode	125 max.	Volts

LIMITING CIRCUIT VALUES

Viewing Screen Series Current-Limiting Resistance	1.0 min.	Megohm
Backing Electrode Circuit Resistance	5000 max.	Ohms
Collecting Electrode Unbypassed Series Current-Limiting Resistance	22000 min.	Ohms
Grid 1 Circuit Resistance	1.0 max.	Megohm
Resistance in Any Deflecting Electrode Circuit⊕	0.1 max.	Megohm

ENVIRONMENTAL LIMITS

Atmospheric Pressure	60 max.	P.S.I.
Altitude (Non-pressurized)	60,000 max.	Feet
Temperature:		
Operating	0 to 50	°C
Non-Operating	-60 to 80	°C
Relative Humidity (Non-Operating)	95	Percent

Vibration .... Sinusoidal Vibration from 10 to 50 cycles per second with a total excursion of 0.015 inches and from 50 to 500 cycles per second with 2 g acceleration will not damage the tube.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Note: Damage to the 7268 may occur if the Writing-Gun beam is turned on before the Viewing-Gun-beam current has reached normal operating value or if the Viewing-Gun beam is turned off before the Writing-Gun beam.

Reference Point for DC Voltages is Ground

Writing Guns:			
Grids 2 & 4 Voltage♦		50 to 125	Volts
Grid 3 Voltage (Focus)		-1975 to -2150	Volts
Grid 1 Voltage to Writing Gun Cathode		0 to -100	Volts
Cathode Voltage		-2400	Volts
Grids 2 & 4 Current♦		100	μampere
Grid 3 Current (per gun)		-10 to 5	μampere
Cathode Current		See CE-A 1472	
Deflection Factors			
Deflecting Electrodes 1 and 2♦		80 to 100	V dc/In.
Deflecting Electrodes 3 and 4♦		80 to 100	V dc/In.
Focused Beam Position †			0.5 Inch
Viewing Gun:	Range	Typical	
Viewing Screen Voltage	8000 to 11000	10000	Volts
Grid 5 Voltage (Backing Electrode)	0 to 10	2	Volts
Grid 4 Voltage (Collecting Electrode)	175 to 300	265	Volts
Grid 3 Voltage (Collimating Electrode)	5 to 150	75	Volts
Grid 2 Voltage♦	50 to 125	90	Volts
Grid 1 Voltage	0 to -50	0	Volts
Cathode			Grounded
Viewing Screen Current		250	μamperes
Grid 5 Current (Backing Electrode)		2	μamperes
Grid 4 Current (Collecting Electrode)		1.5	Ma.
Grid 3 Current (Collimating Electrode)		200	μamperes
Cathode Current		2	Ma.

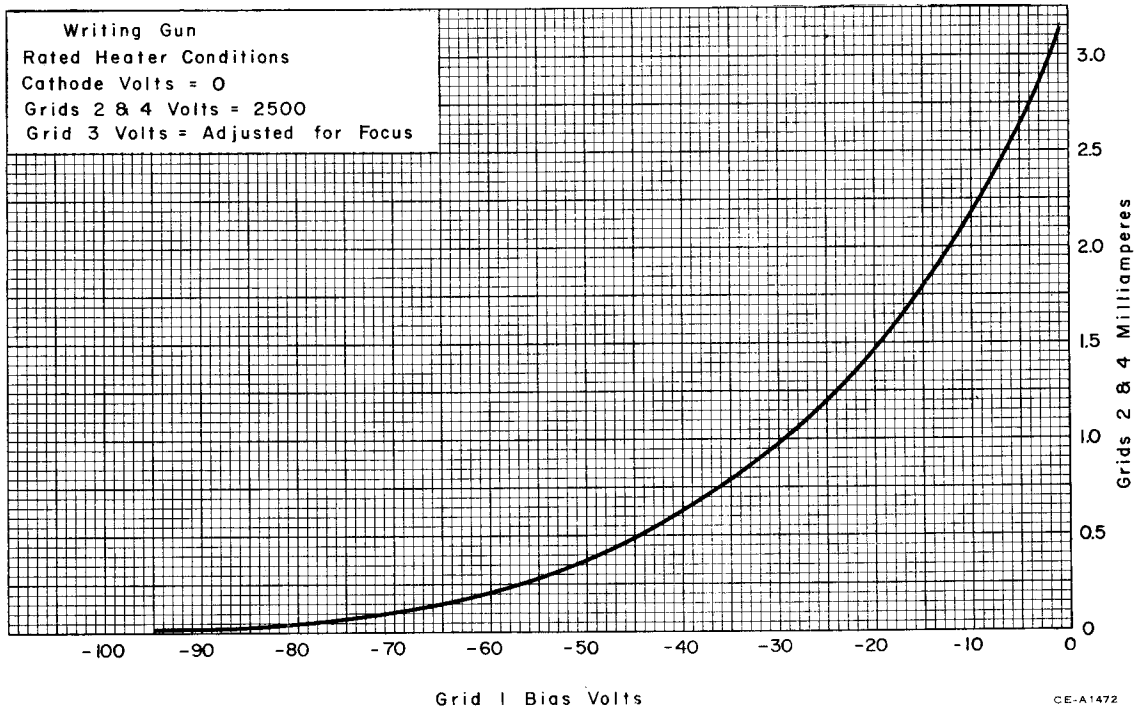
♦ Grids 2 & 4 of both Writing Guns are internally connected together and to Grid 2 of the Viewing Gun.

♦ For other values of cathode to Grids 2 & 4 Voltages, the deflection factor is approximately 32 to 40 V dc/In./KV of cathode to Grids 2 & 4 Voltage.

† With all deflecting electrodes tied to Grids 2 & 4, and erasure at a convenient value the undeflected, focused spots will fall within a circle of 0.5 inch radius, centered on the tube faceplate.

⊕ Approximately equal resistances should be used in each deflecting-electrode circuit.

AVERAGE WRITING GUN ANODE TRANSFER CHARACTERISTIC



PERFORMANCE DATA

Viewing Time	5	Seconds
Erasing Time	50	Milliseconds
Display Uniformity (Δep min.)	1	Volt
Writing Speed	36,000	Inches/Second
Half Tones	5	
Brightness (Screen Voltage = 10 KV)	2500	Ft-Lamberts
Contrast Ratio	5	
Resolution	50	Lines/Inch
Grid Drive	20	Volts

Methods of Measuring Tube Performance

Viewing Time: A standard raster is written to saturated brightness with overlapping lines. The brightness level near the center of the viewing screen is then measured with a spot photometer. For this measurement, the color response of the measuring device is unimportant, as only relative brightness readings are required. The complete raster is then erased to visual extinction and the erase pulse removed. The screen is allowed to increase in brightness, and the time interval required for the brightness level at the center of the screen to increase to 10% of the initial brightness level is taken as the viewing time.

Erasing Time: Erasure is produced by positive rectangular pulses applied to the backing electrode. With an erase pulse amplitude adjustable from 2 to 10 volts peak-to-peak, complete erasure may be accomplished in 50 milliseconds from the start of the pulse, or when the sum of the duration of the pulses is 50 milliseconds. Note that by adjustment of pulse amplitude, shape, duration, and pulse repetition frequency it is possible to adjust total time for erasure as desired.

The erasing time under stated erasing conditions is taken as the time required for the flood beam to reduce the output luminence from 90% of its saturated value to 10% of that value. A rectangular raster covering the entire viewing area is written to 90% of saturated brightness and the raster is erased by pulsing the backing electrode for a known length of time. The process is repeated and the length of the erase pulse is changed until the desired degree of erasure is obtained.

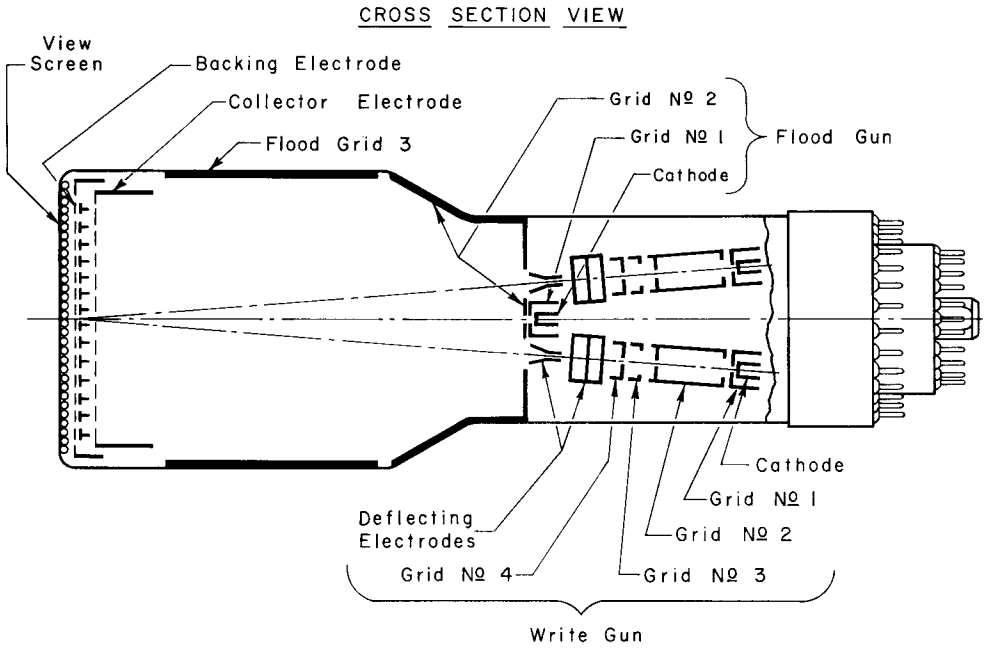
Display Uniformity (Δ ep min.): The difference between the amplitude of an erase pulse required to brighten any area of an unwritten screen, and the amplitude of an erase pulse required to completely illuminate the screen is described as the display uniformity, (Δ ep-min.). The erase pulses used for this measurement are positive rectangular pulses adjusted from 2 to 10 volts peak to peak to produce complete erasure in 50 milliseconds.

Writing Speed: This is the maximum scanning speed at which a raster can be written to a specified brightness in one frame time at a writing gun cathode current below a specified value. A raster is applied having frequencies and trace length necessary to produce the specified scanning speed. The focus electrode is adjusted for best focus at the center of the raster. The tube is erased to cutoff and with a rectangular drive pulse of adjustable amplitude a single raster is written. This step is repeated, moving the lines progressively closer together until the individual lines in the raster cannot be discerned visually. As the lines approach the merging condition, the control grid pulse ampitude is adjusted to give a written raster with brightness of 2500 foot lamberts. When this brightness is achieved and the lines cannot be discerned visually, the condition of visually limited contrast ratio exists and it is under this condition that the cathode current is to be read. The cathode current measured with an oscilloscope is less than one milliampere.

Contrast Ratio: A trace is written to saturation brightness while continuously writing and erasing. Using positive rectangular erase pulses variable from 2 to 10 volts peak-to-peak, the persistence (time required for a written area to be reduced to 10% of saturated brightness) is adjusted to 2 seconds. The ratio of brightnesses in the written and unwritten areas is defined as the contrast ratio. This measurement is made with a maximum ambient brightness of 10 foot-lamberts.

Resolution: Erasure is adjusted to a convenient value. A 60 cps sawtooth voltage is applied to the horizontal deflection electrodes and 2100 to 6300 cps sawtooth voltage to the vertical deflection electrodes. The light level is set at 1000 ± 5% foot-lamberts with a vertical trace length of 3-1/2 inches. The raster is expanded horizontally so that the number of lines can be counted. Adjustment is made for best focus at center of raster. The raster is compressed horizontally until lines merge or just overlap at center of screen. The width of this compressed pattern perpendicular to the line structure is measured. Resolution is the number of lines in the compressed pattern divided by its width. The scanning voltages are interchanged and the resolution is measured as before at points on the center vertical axis 1½ inches above and below the center of the tube face.

Grid Drive: This is the drive required for writing to 90% of saturated brightness with a writing speed of 36,000 inches per second in 1 scan. Note the writing gun drive characteristic. In the useful region, writing speed is proportional to writing current.



Principles of Operation

The WL-7268 contains, in addition to a phosphor screen and writing guns similar to those of conventional cathode-ray tubes, a storage surface, a secondary-electron collimating system, all of which can be seen in Cross Section View.

The storage surface is a dielectric material deposited on a fine metallic mesh called the backing electrode. Initially this surface is charged to a uniform potential near the viewing gun cathode voltage. Either or both of the writing guns scan the storage surface and create a charge pattern by secondary emission from the dielectric material. Because this dielectric material is an excellent insulator, the charge pattern does not leak away, but remains for a period of time, as long as a week under non-operating conditions. The secondary electrons liberated from the storage surface are attracted to a collecting mesh.

The reading or viewing gun does not scan the screen, but produces a wide-angle beam of electrons which "floods" the entire storage mesh and penetrates through its holes to bombard the phosphor screen. The charge pattern written upon the storage surface controls the viewing gun beam in a manner similar to the control of plate current by the signal applied to the control grid of a triode. In this way the signals applied to the two writing guns are converted to patterns on the storage surface, and these produce corresponding patterns on the phosphor screen. The penetration of electrons through the storage mesh is proportional to the charge written upon it, hence, intermediate shades of gray or half-tones may be reproduced. Because of the high current density of the viewing beam, the high accelerating potential on the screen, and simultaneous bombardment of all portions of the viewing screen, the display is extremely bright.

The Viewing Section

The viewing section consists of the following elements: a cathode, control grid, accelerating grid, collimating electrode, collecting electrode, backing electrode, and viewing screen.

The cathode is oxide coated and indirectly heated. Grids 1 and 2 are conventional aperture grids and the collimating electrode grid 3 is a conductive coating applied to the bulb wall. The collecting electrode is a fine metallic mesh mounted slightly toward the cathode from the backing electrode.

The backing electrode is an extremely fine metallic mesh upon which the dielectric or storage material is

deposited. This material is on the cathode side of the mesh as shown in Cross Section View.

The viewing screen is an aluminized P20 phosphor having short persistence and high visual efficiency. The Spectral Response Curves show that the peak radiation from this phosphor coincides with the peak sensitivity of the human eye.

The Viewing Operation

The viewing gun produces a wide angle, low energy, high density electron stream which continuously floods the storage surface. The electrons are highly divergent as they emerge from the aperture of the accelerating grid no. 2, but by proper adjustment of grids no. 2, 3, and 4, the electron stream is collimated to provide uniform, normal flooding of the backing electrode. It is necessary that all of the electrons of the viewing beam approach the storage surface in paths normal to the backing electrode in order that they will have equal energy components in this direction. Only under this operating condition will equal charges at various points on the storage surface have equal control of the flood beam. Thus, collimation is necessary for uniformity of display.

The functions of the collecting electrode are several. In addition to its effect upon collimation, it serves to accelerate electrons in the beam; it repels positive ions produced by collisions of electrons with gas molecules in the region between cathode and collector, thus preventing destruction of the stored pattern by ions; it collects secondary electrons produced when the writing beams impinge upon the storage surface; and it collects viewing beam electrons turned back near the storage surface when its potential is negative.

When the viewing section voltages are applied, some of the viewing beam electrons are intercepted by the collector mesh, and others are decelerated to near zero velocity at the storage grid. Their velocity is so low at this point that fewer secondary electrons are emitted than strike the storage surface. Thus electrons accumulate until the potential is approximately the same as the viewing gun cathode, or zero potential.

At this time when the collimated viewing beam approaches the storage mesh, electrons cannot land upon the storage mesh, but will either return to the more positive collecting electrode or penetrate through the holes of the backing electrode to be accelerated to the phosphor viewing screen producing a bright display. The brightness of the screen under this condition is designated as "saturated brightness". A condition of equilibrium exists, and the storage surface remains charged to approximately zero potential. If the storage surface is made positive by a writing gun or other means, the surface will be immediately restored to zero potential by the viewing gun beam. If, now the backing electrode is suddenly made more positive by several volts, the storage surface will also become positive momentarily because of the very close capacitive coupling between the backing electrode and storage surface, but again the viewing beam will restore the storage surface to zero potential. If next the backing electrode is returned to its original value, the storage surface potential will drop by an equal amount to a negative potential and will retain this charge since viewing beam electrons cannot land. If this negative voltage is great enough, it will cut off the viewing beam electrons preventing them from reaching the phosphor and resulting in a dark screen.

The writing guns are used to produce a charge pattern upon the storage surface varying in potential from the storage surface cutoff value to zero potential. Since these potentials are at or below viewing gun cathode potential, no viewing beam electrons may land upon the storage surface to destroy the written pattern and it will remain until erased or degraded by positive ions produced by collision of electrons in the viewing beam with residual traces of gas between the viewing screen and collecting electrode.

Without altering its own form the stored charge pattern in thus able to control the electrons impinging upon the screen, producing a bright stored image with full tone range from visual extinction to saturated brightness.

The Writing Guns

The two writing guns are of identical design and are similar to those found in electrostatically focused and deflected oscilloscope tubes. They are capable of forming a well defined beam having high current-density resulting in excellent resolution and high writing speed.

Both guns are shown in Cross Section View and each consists of an oxide coated, indirectly heated cathode, a control grid 1, first and second anodes (grids 2 & 4) which are internally connected, a focusing grid 3, and horizontal and vertical deflection plates.

The Writing Operation

The writing guns are generally operated with the cathode at -2400 volts with respect to the viewing-gun cathode. At this potential the electrons from the

writing beam have sufficient energy to cause the secondary emission ratio at the storage surface to be greater than unity. Thus, since more electrons are leaving the storage surface than are arriving. the surface assumes a less-negative potential whenever the beam strikes, Since the secondaries are attracted to the positive collecting electrode it would appear that the writing beam could charge the storage surface to collecting electrode potential, but in practice the viewing beam lands upon the surface whenever it tends to become positive and returns it to approximately viewing-gun cathode potential.

The writing beam electrons striking the storage surface can then result in potentials varying from storage-grid-cutoff voltage to approximately zero potential. The storage surface potential is controlled over this range by the amplitude and duration of the writing beam current which is determined by the signal applied to the control grid.

As was described previously, the potential at any point on the storage surface determines the number of viewing beam electrons passing through the storage mesh holes in that immediate vicinity. When any point is sufficiently positive to allow passage of electrons, they will be accelerated by the high viewing screen potential and strike the phosphor directly opposite that point. The result is a bright spot on the viewing screen having a size only slightly larger than that of the corresponding point where the writing gun beam struck the storage surface. The brightness of this spot is directly proportional to the density and velocity of the electrons landing on the element, the density being determined by the elemental charges of the storage surface, and the velocity by the potential of the viewing screen.

The image brightness may be varied by adjusting the screen potential, but because the screen is aluminized, the light output decreases rapidly below 5000 volts. Operation below this value is not recommended.

The Erasing Operation

A method of preparing the storage surface for the writing operation has already been described under The Viewing Operation. This technique, which involves charging the storage surface to a negative value by the momentary application of a positive potential to the backing electrode, is actually an erasing method known as static erasure.

During the application of the positive potential to the backing electrode, viewing-beam electrons land on the storage surface and drive it uniformly to cathode potential thus erasing any stored information.

A disadvantage of this method is that during erasure and subsequent re-writing no information or only incomplete information is displayed. Also the entire screen is illuminated to the saturation brightness level or higher during erasure.

In most applications it is desirable to present a display which gradually decays after a given interval of time. This type of operation may be obtained by applying a continuous series of positive pulses to the backing electrode at a rate sufficiently fast to prevent visible phosphor flicker. The technique of applying a series of pulses to the backing electrode is known as dynamic erasure.

The amount of charge erased during each erase pulse depends upon pulse duration, shape and amplitude. These factors together with erasing-pulse repetition frequency determine the rate at which the observed display decays.

If the erasing pulses are smaller in amplitude than the viewing-beam cutoff voltage, erasure will not be complete, whereas if the pulses are greater than cutoff they will eventually drive the storage surface below cutoff or "blacker than black". Therefore it is not advisable to use erase pulse amplitude as a means of adjusting erasing time.

When a rectangular erasing pulse is used, all portions of the storage surface will simultaneously become positive with respect to the viewing-gun cathode and viewing-beam electrons will be deposited at nearly the same rate over the entire surface regardless of initial charge. Thus charges representing the brighter elements will remain after other elements have been erased and the brighter areas will be visible for a longer period than the darker areas.

If a positive-going sawtooth erasing pulse is used, the least-negative storage elements will reach cathode potential before the remaining elements, thus allowing viewing-beam electrons to land on elements representing brighter areas for a longer period than on those representing darker areas. With this type of proportional erasure, half-tones will persist as long as bright areas.

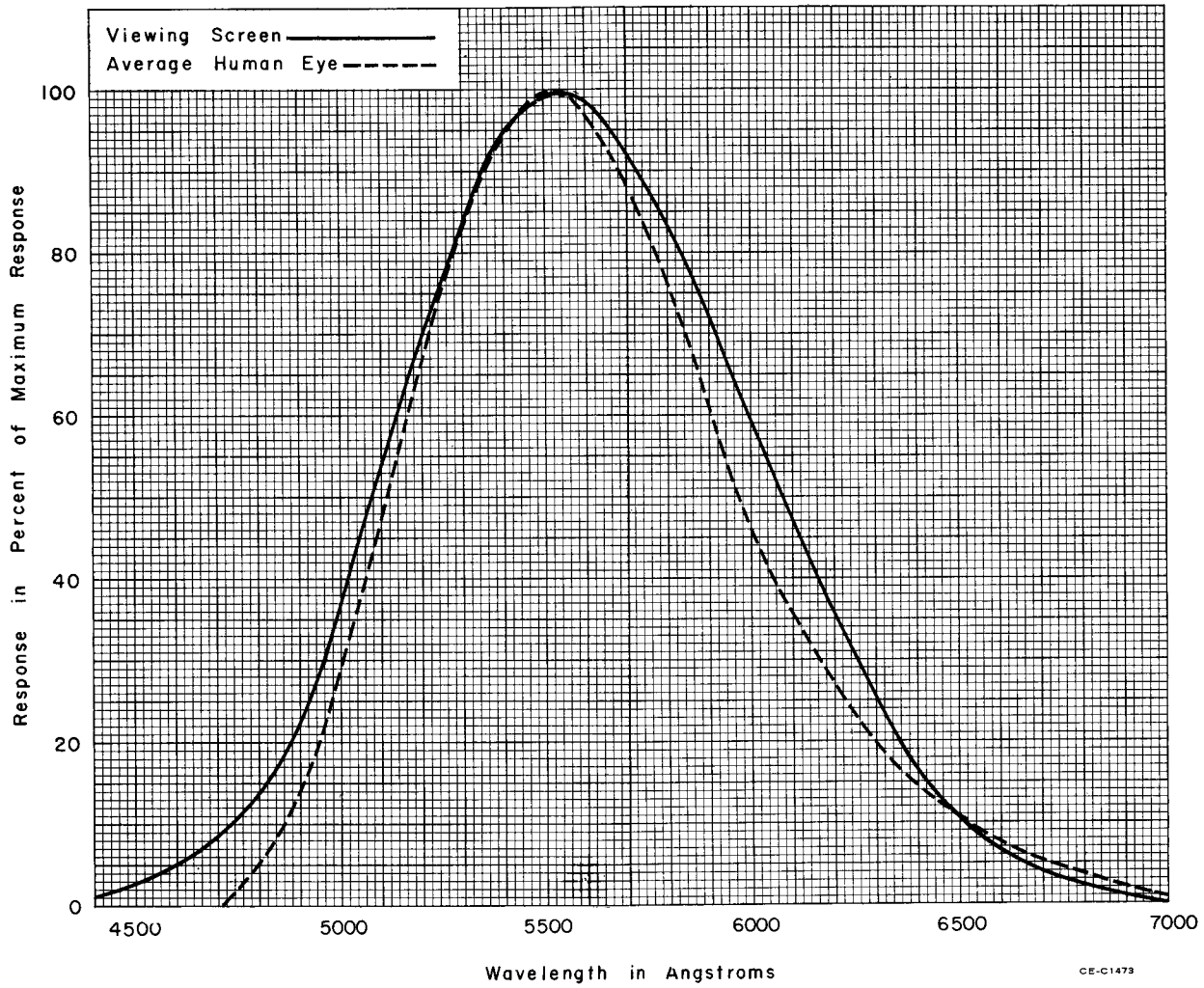
For applications involving half-tone display, the rectangular erase pulses should be adjusted in amplitude so that the storage surface is charged to exactly cutoff potential by the erasing operation.

For applications such as radar, where noise must be

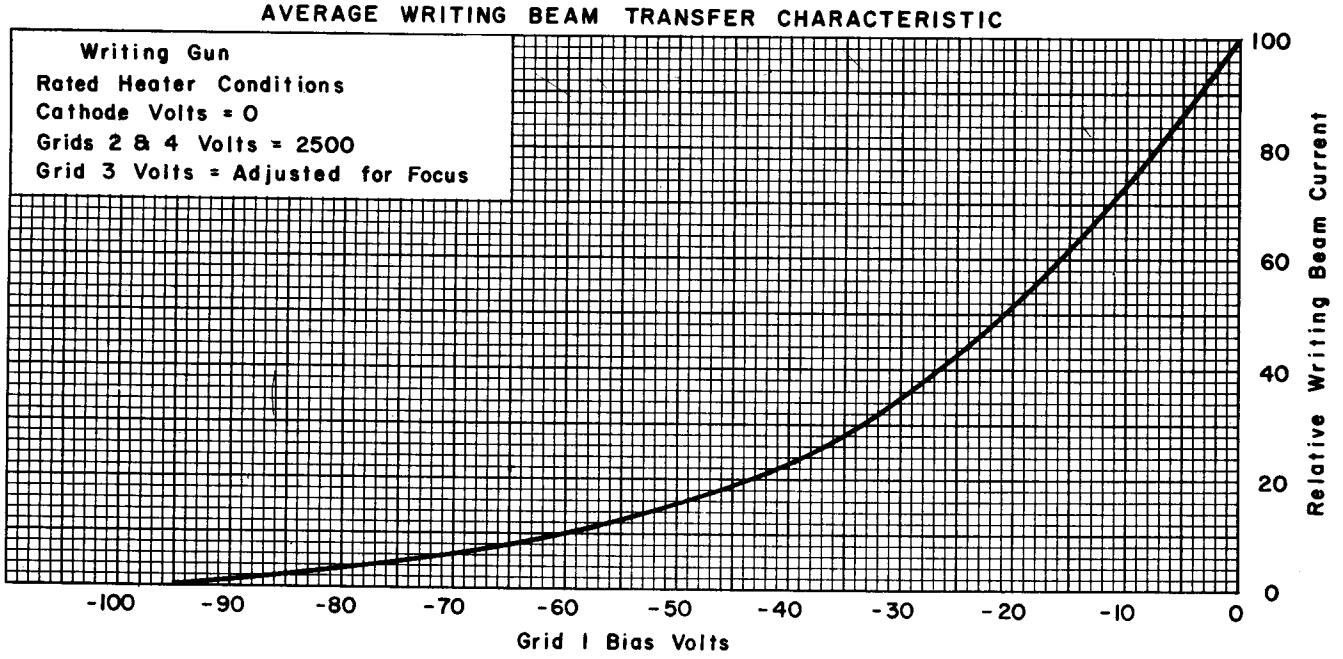
suppressed, a more positive erase pulse may be used to drive the storage surface several volts below cutoff. The writing beam must then scan the surface several times to bring the written elements above cutoff.

If possible the erase-pulse amplitude should be adjusted so that the noise component of the writing gun signal is just sufficient to bring the storage surface to cutoff. The signal above this level will then allow viewing-beam electrons to produce a display representing that signal without any noise background.

SPECTRAL RESPONSE CHARACTERISTICS

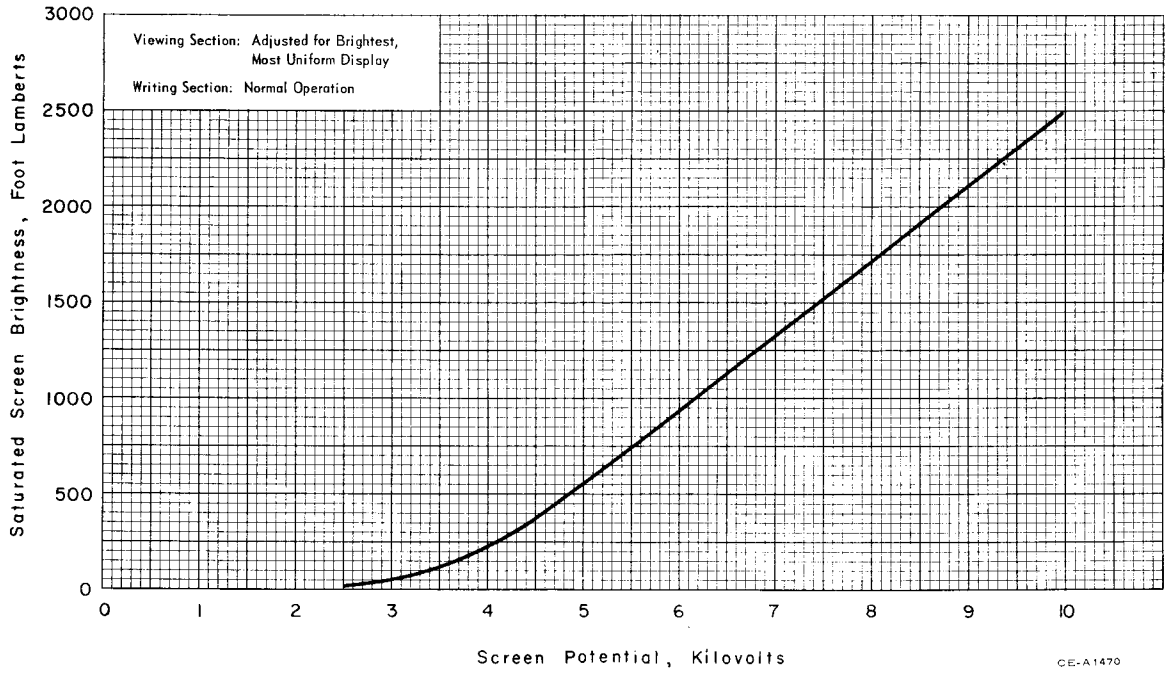


AVERAGE WRITING BEAM TRANSFER CHARACTERISTIC



CE-A1471 R1

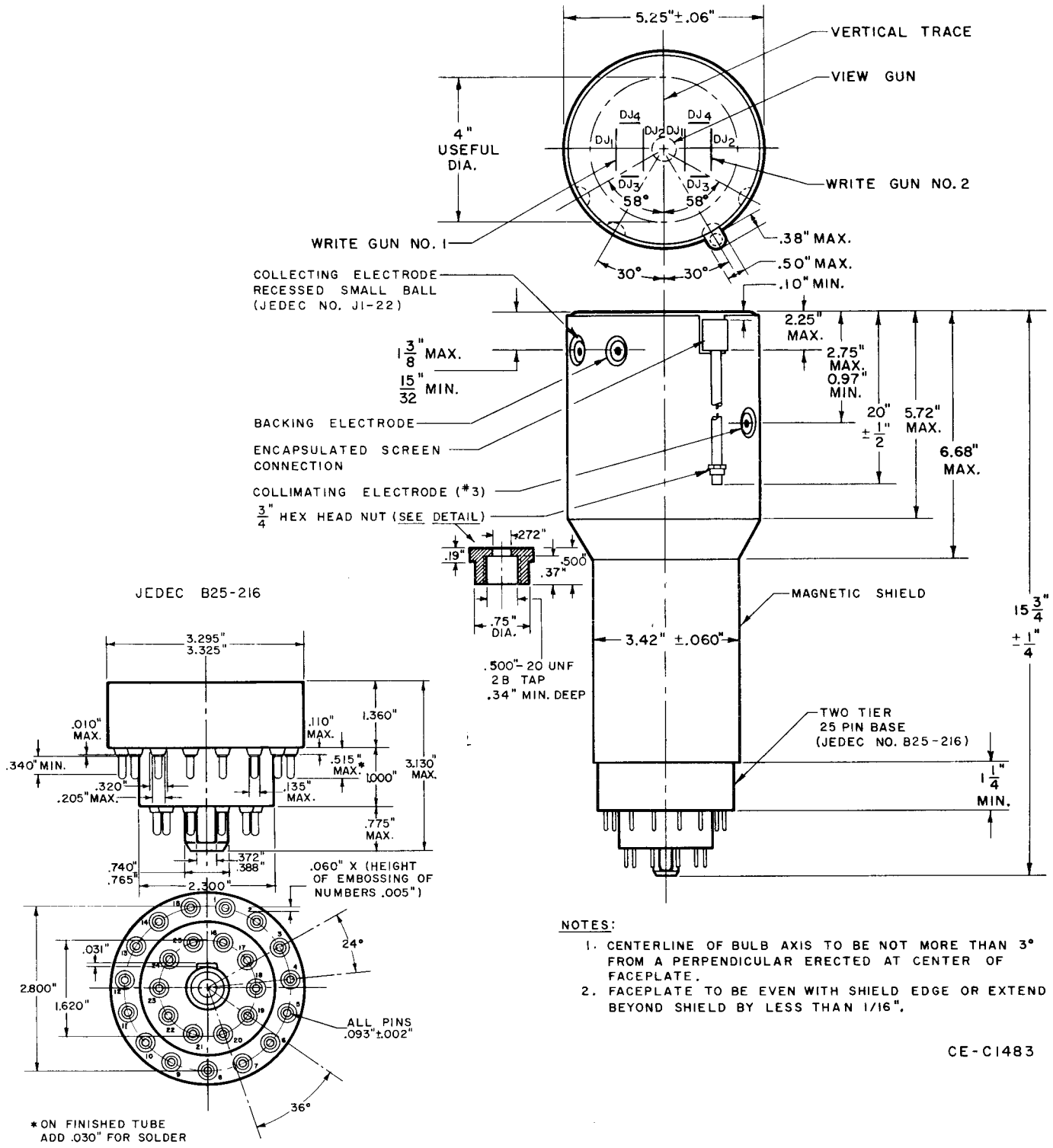
SCREEN BRIGHTNESS AS A FUNCTION OF SCREEN POTENTIAL



CE-A1470

Westinghouse

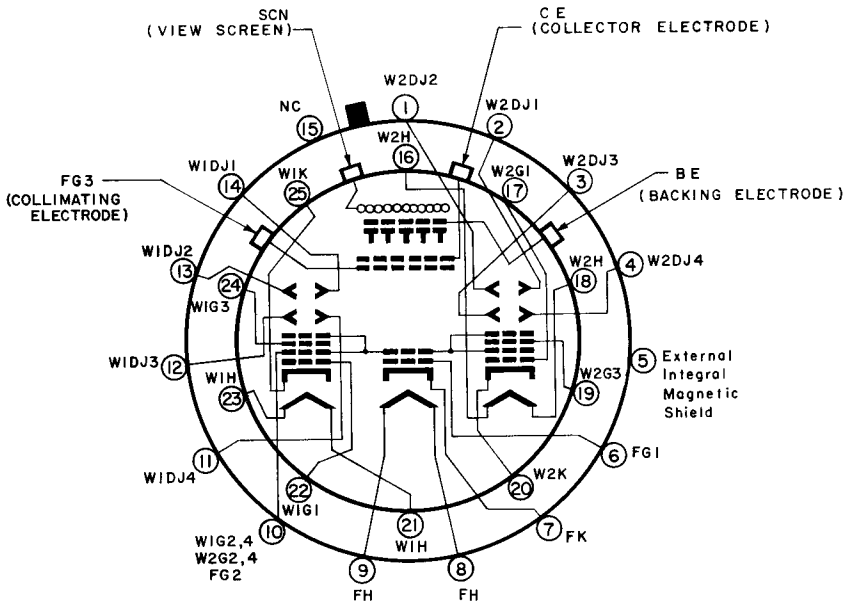
COMMERCIAL OUTLINE



NOTES:

1. CENTERLINE OF BULB AXIS TO BE NOT MORE THAN 3° FROM A PERPENDICULAR ERECTED AT CENTER OF FACEPLATE.
2. FACEPLATE TO BE EVEN WITH SHIELD EDGE OR EXTEND BEYOND SHIELD BY LESS THAN 1/16".

CE-C1483



BOTTOM VIEW

CE-A1399 R2

INDEX OF TERMINALS

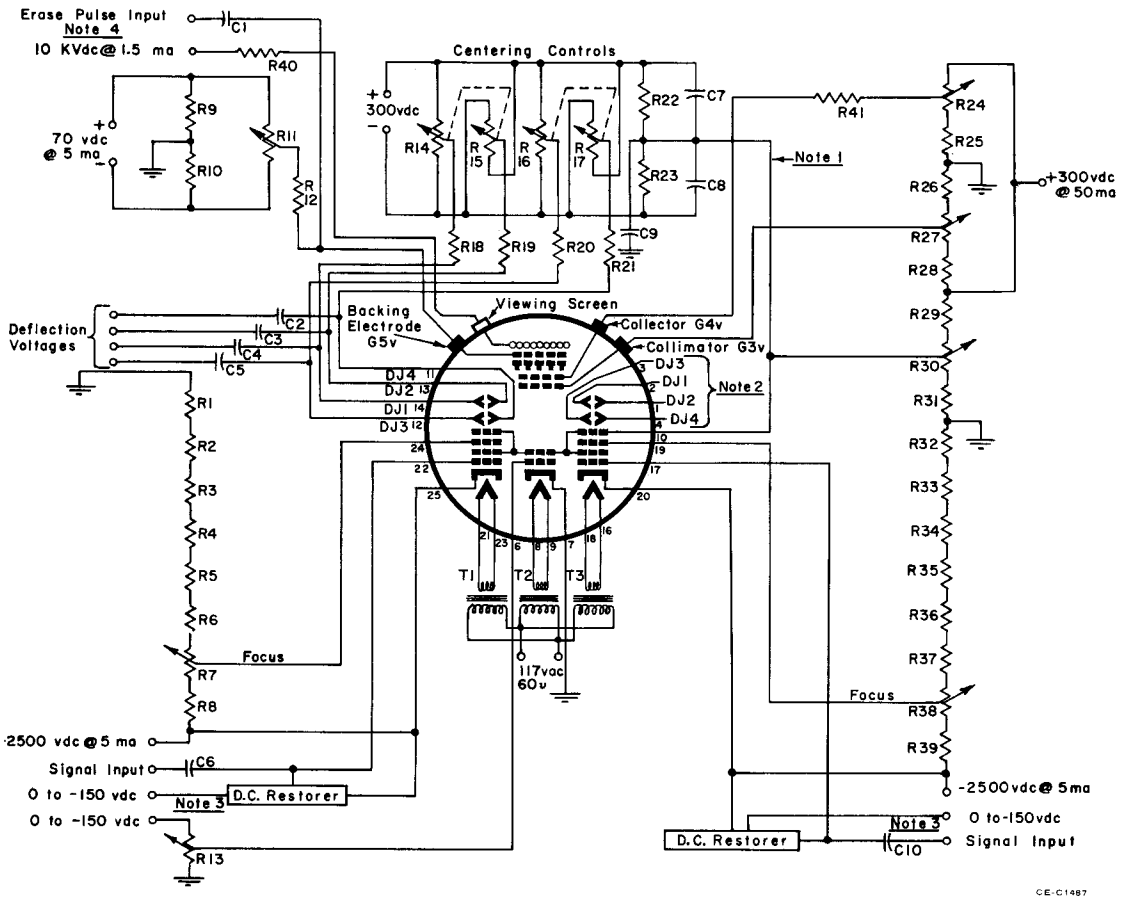
BASE PINS

Pin No.	Gun	Element
1	Write (2)	Deflection Electrode 2
2	Write (2)	Deflection Electrode 1
3	Write (2)	Deflection Electrode 3
4	Write (2)	Deflection Electrode 4
5	External Integral Magnetic Shield	
6	Flood	Grid 1
7	Flood	Cathode
8	Flood	Heater
9	Flood	Heater
10	Write (1)	Grids 2 & 4
	Write (2)	Grids 2 & 4
	Flood	Grid 2
11	Write (1)	Deflection Electrode 4
12	Write (1)	Deflection Electrode 3
13	Write (1)	Deflection Electrode 2
14	Write (1)	Deflection Electrode 1
15	NO CONNECTION (DO NOT USE)	
16	Write (2)	Heater
17	Write (2)	Grid 1
18	Write (2)	Heater
19	Write (2)	Grid 3
20	Write (2)	Cathode
21	Write (1)	Heater
22	Write (1)	Grid 1
23	Write (1)	Heater
24	Write (1)	Grid 3
25	Write (1)	Cathode

CAPS ON LARGE END OF BULB

Gun	Element
Flood	Collimating Electrode
Flood	View Screen
Flood	Collect or Electrode
Flood	Backing Electrode

TYPICAL POWER SUPPLY REQUIREMENTS



Note 1: The mean deflection potential is referred to the writing gun final anode potential to prevent astigmatism.
Note 2: Centering and deflection circuitry for Writing Gun 2 is similar to that shown for Writing Gun 1.
Note 3: Voltages are with respect to each writing gun cathode. Entire supply must be insulated from ground for 4000 volts.
Note 4: Erase Pulse Characteristics, Amplitude: 0 to 10 volts peak-to-peak, Width: 2 to 10 microseconds, Frequency: 0 to 1000 pulses per second

C_1: 0.1 μf, 200 volts
C_2, C_3, C_4, C_5: Value depends on deflection-voltage frequency and waveform
C_6, C_{10}: Value depends on signal-voltage frequency and waveform, 4000 volts
C_7, C_8: 0.05 μf, 600 volts
C_9: 0.5 μf, 600 volts
R_1, R_{32}: 91,000 ohms, 1 watt
R_2, R_{25}, R_{29}, R_{33}: 100,000 ohms, 1 watt
R_3, R_4, R_5, R_6, R_{34}, R_{35}, R_{36}, R_{37}: 470,000 ohms, 2 watts
R_7: Write Gun 1 Focus Control, 250,000-ohm potentiometer, 2 watts
R_8, R_{39}: 180,000 ohm, 1 watt
R_9, R_{10}, R_{22}, R_{23}: 1 megohm, 0.5 watt
R_{11}: Backing Electrode Control 100,000-ohm potentiometer, 2 watts
R_{12}: 5,000 ohm, 1 watt
R_{13}: View Gun Grid 1 Control, 250,000-ohm potentiometer 2 watts
R_{14}, R_{15}: Write Gun 1 DJ_1 & DJ_2 Centering Controls Dual 1 megohm potentiometers, 2 watts
R_{16}, R_{17}: Write Gun 1 DJ_3 & DJ_4 Centering Controls Dual 1 megohm potentiometers, 2 watts
R_{18}, R_{19}, R_{20}, R_{21}: 100,000 ohm, 0.5 watt
R_{24}: Collector Control, 200,000-ohm potentiometer, 2 watts
R_{26}, R_{28}, R_{31}: 51,000 ohm, 1 watt
R_{27}: Collimator Control, 200,000-ohm potentiometer, 2 watts
R_{30}: Accelerating Anode Control, 150,000 ohm potenti- 2 watts
R_{38}: Write Gun 2 Focus Control, 250,000-ohm potentiometer, 2 watts
R_{40}: 1 megohm, 5 watts
R_{41}: 22,000 ohm, 1 watt
T_1, T_3: Filament Transformer Primary 117 volts, Secondary 6.3 volts @ 1 ampere Insulated for 4000 volts
T_2: Filament Transformer Primary 117 volts, Secondary 6.3 volts @ 1 ampere.

The information contained herein is furnished without assuming any obligations. The description and illustration of circuits herein does not convey to the purchaser of tubes any license for circuits under the patent claims of Westinghouse Electric Corporation or others.

THYRATRON TYPE WL-7269

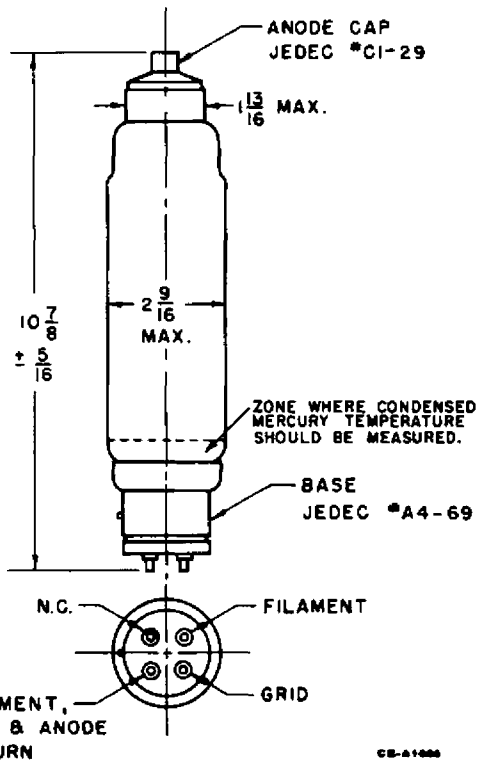
The WL-7269 is a three-electrode mercury-vapor thyratron with negative control characteristics. The tube is designed for rectifier and industrial control service.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament Voltage	4.75	5.00	5.25	Volts
Filament Current at Bogey Voltage	4.50	5.00	5.50	Amp.
Cathode Heating Time*	300	-	-	Sec.
Interelectrode Capacitance:				
Anode to Grid	-	10	-	uuf
Deionization Time, approx.	-	1000	-	usec
Ionization Time, approx.	-	10	-	usec
Anode Voltage Drop	-	15	-	Volts

MECHANICAL:

Type of Cooling.▲	Air Convection
Mounting Position	Vertical, Base Down
Net Weight, approx.	11 Ounces
Shipping Weight, approx.	2 Pounds



MAXIMUM RATINGS:

Absolute Values

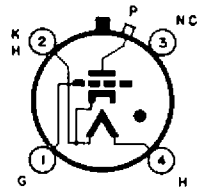
Maximum Peak Anode Voltage:			
Forward (see temperature range)	15000	21000	Volts
Inverse (see temperature range)	15000	21000	Volts
Maximum Cathode Current:			
Peak	12.0	12.0	Amp.
Average	3.2	3.2	Amp.
Surge (max. duration 0.1 second)	50	50	Amp.
Max. Average Time §	1.0	1.0	Cycle
Maximum Negative Control Grid Voltage:			
Before Conduction	-500	-500	Volts
During Conduction	-10	-10	Volts
Maximum Positive Control Grid Voltage:			
Anode Negative	10	10	Volts
Maximum Positive Control Grid Current:			
Peak	1.0	1.0	Amp.
Average	0.1	0.1	Amp.
Maximum Average Time §	1.0	1.0	Cycle
Condensed-Mercury Temperature Limits■	25-55	25-50	°C
Frequency Range	25-150	25-150	cps
Equilibrium Condensed-Mercury Temperature Rise Above Ambient:			
No Load, approx.	9		°C

* The minimum heating time refers only to the cathode. Sufficient additional time must be allowed, during cold-weather periods, to permit the condensed-mercury temperature to rise to the minimum condensed-mercury temperature limit.

▲ Forced-air cooling will be required in many applications to maintain the condensed-mercury temperature within the specified condensed-mercury temperature limits.

■ The optium condensed-mercury temperature limits for 20000-volt operation are 35-45° C. For 15000-volt operation the optimum limits are 35-50° C.

§ One period of the supply frequency.



BASE CONNECTIONS

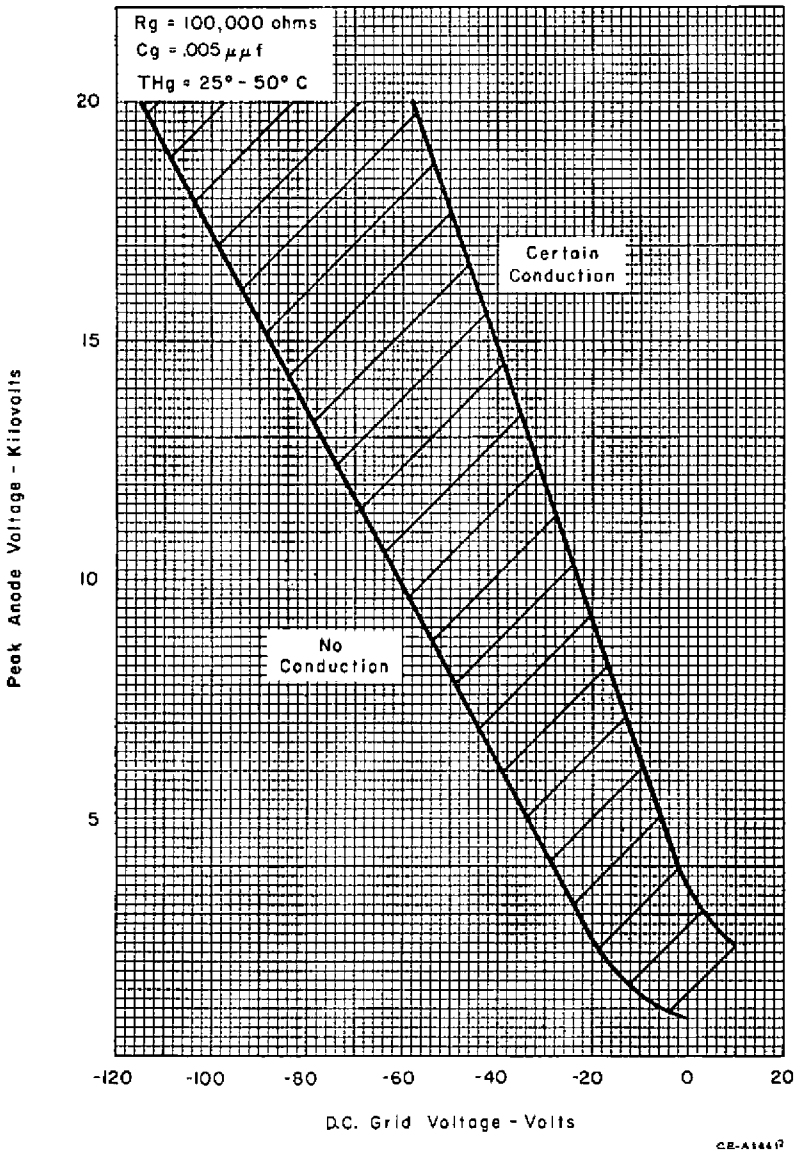
H - Heater
K - Cathode
G - Grid
NC - No Connection
P - Anode

EE-A1403

Thyratron Section

from JEDEC release #2432, April 6, 1959

CONTROL CHARACTERISTICS



August 25, 1958

SLOW SCAN VIDICON TYPE WL-7290

The WL-7290 is a small size vidicon type camera tube designed for slow speed scanning applications. The extremely low dark current of the WL-7290 permits high-resolution, long-storage-time with higher sensitivity, higher output signal and better signal-to-noise ratio.

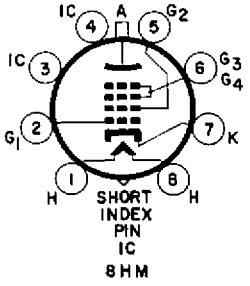
The WL-7290 with slow scan is also useful for transmitting high resolution information over conventional audio circuits as the system bandwidth requirements are sharply reduced with slow scan.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3 ± 10%	Volts
Current	0.6	Ampere
Direct Interelectrode Capacitance:		
Signal Electrode to all other Electrodes	4.5	uuf
Spectral Response	from 3000 to 6000 Angstroms	
Photoconductive Layer:		
Orientation of Tube to Scan	Proper orientation is obtained when the horizontal scan is essentially parallel to the plane passing through the tube axis and short index pin.	
Focusing Method	Magnetic	
Deflection Method	Magnetic	

MECHANICAL:

Overall Length	6-1/4" ± 1/4"
Greatest Diameter	1.125" ± 0.010"
Bulb	T-8
Base	Small-Button, 8-Pin (JETEC E8-11)
Operating Position	Any
Basing	8HM



MAXIMUM RATINGS:

Absolute Maximum System			
Signal-Electrode Voltage	25	max.	Volts
Grid 4 & Grid 3 Voltage	350	max.	Volts
Grid 2 Voltage	350	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	125	max.	Volts
Positive Bias Value	0	max.	Volts
Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode	125	max.	Volts
Heater Positive with Respect to Cathode	10	max.	Volts
Faceplate Temperature	45	max.	°C

TYPICAL OPERATION AND CHARACTERISTICS:

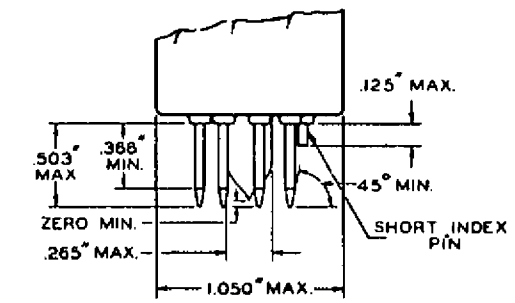
For Scanned Area of 1/2" x 3/8"♦		
Signal-Electrode Voltage	10 to 25	Volts
Grid 4 (Decelerator) & Grid 3 (Beam Focus) Voltage	250	Volts
Grid 2 (Accelerator) Voltage	300	Volts
Grid 1 Voltage:		
(For Picture Cutoff ▲)	-45 to -100	Volts
Dark Current	0.0002	uamp
Average "Gamma" of Transfer Characteristic for Signal Output Current Between 0.0002 and 0.2 uamp	0.95	
Min. Peak-to-Peak Blanking Voltage:		
When Applied to Grid 1	40	Volts
When Applied to Cathode	10	Volts
Field Strength at Center of Focusing Device	40	Gausses
Field Strength of Adjustable Alignment Coil	0 to 4	Gausses
Approx. Storage Time:		
450 Line Resolution	40	Seconds
350 Line Resolution	120	Seconds

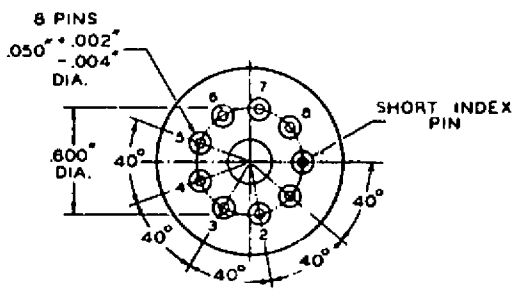
♦ The quality area of the target extends to the edges of the target. The entire target may therefore be scanned with no degradation of picture quality.

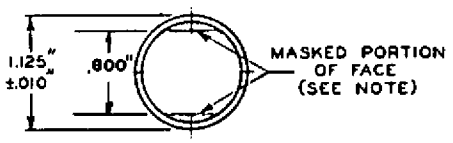
▲ With no blanking voltage on Grid 1.

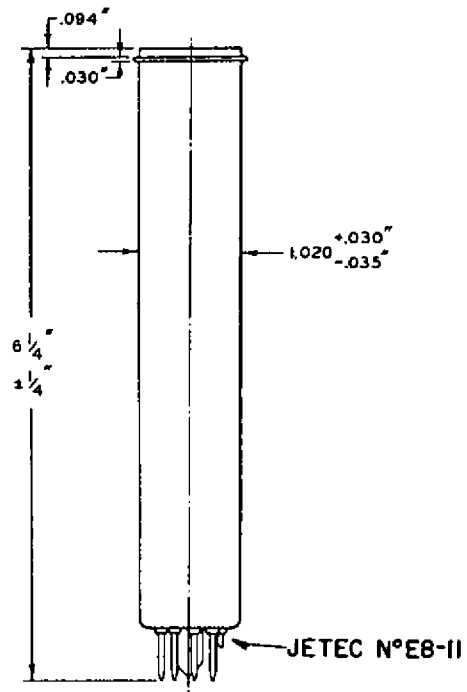
from JETEC release #2273, Sept. 8, 1958

8 PIN BASE
JETEC Nº E8-11









BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT PINS WILL FIT A FLAT PLATE GAUGE HAVING THICKNESS OF 1/4" AND 9 HOLES 0.0700" ± 0.0005" SO LOCATED ON A 0.6000" ± 0.0005" DIA. CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.2052" ± 0.0005". GAUGE IS PROVIDED WITH CENTER HOLE HAVING DIAMETER OF 0.300" ± 0.001" AND SAME CENTER AS THE PIN CIRCLE.

STRAIGHT SIDES OF MASKED PORTIONS ARE PARALLEL TO PLANE PASSING THROUGH TUBE AXIS AND SHORT INDEX PIN

CE-A1350

THYRATRON TYPE WL-7297

The WL-7297 is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged on a wide range of ambient temperatures. The WL-7297 is designed for operation in industrial control and ignitor firing service. The WL-7297 is electrically similar to the WL-5877 and the WL-7031.

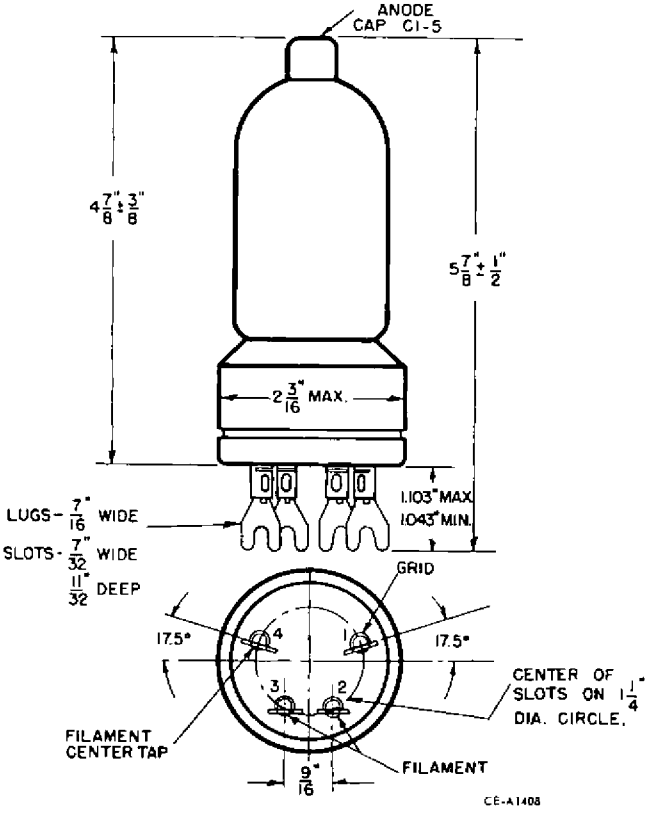
GENERAL DATA

ELECTRICAL:

	Min.	Bogey	Min.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts=2.5	9.8	10.8	11.8	Amperes
Heating Time	30	--	--	Seconds
Deionization Time	See CE-A1347			
Ionization Time		10		usec
Critical Anode Voltage at Grid:				
Voltage of +6 Volts	--	--	100	Volts
Critical Grid Voltage at Anode:				
Voltage of 1500 Volts-See CE-A1348	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.):				
Anode to Grid		0.51		uuf
Grid to Filament		15.6		uuf
Anode to Filament		3.4		uuf
Typical Arc Drop		16		Volts
Control Characteristic				Negative

MECHANICAL:

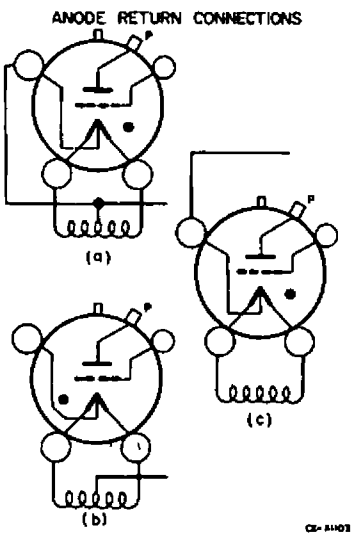
Mounting Position	Any
Overall Height (Approx.)	5-7/8"
Overall Diameter (Maximum)	2-3/16"
Type of Cooling	Air, Unrestricted Convection
Temperature Range	-55 to +70° C
Bulb	T-13
Anode Cap	JETEC C1-5
Base	Lug Size and Location per JETEC A4-90
Net Weight (Approx.)	5 oz.
Shipping Weight (Approx.)	2 lb.



from JEDEC release #2354A, March 23, 1959

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:			
Peak Anode Voltage:			
Forward	1500	max.	Volts
Inverse	1500	max.	Volts
Anode Current:			
Peak	40	max.	Amperes
Average (Averaging Time 15 Seconds)	3.2	max.	Amperes
Surge■ (Duration 0.10 Second, Max.)			
Connection A	560	max.	Amperes
Connection B	280	max.	Amperes
Connection C	280	max.	Amperes
Commutation Factor♦	200	max.	va/usec
Current Rate of Change	0.25	max.	a/usec
Voltage Rate of Change	800	max.	v/usec
Negative Control Grid Voltage:			
Before Conduction	250	max.	Volts
During Conduction§	10	max.	Volts
Average Positive Control Grid Current:			
Averaging Time = 1 cycle♦	0.20	max.	Ampere
Operating Frequency⊖	60	max.	cps



NOTES

General These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit.

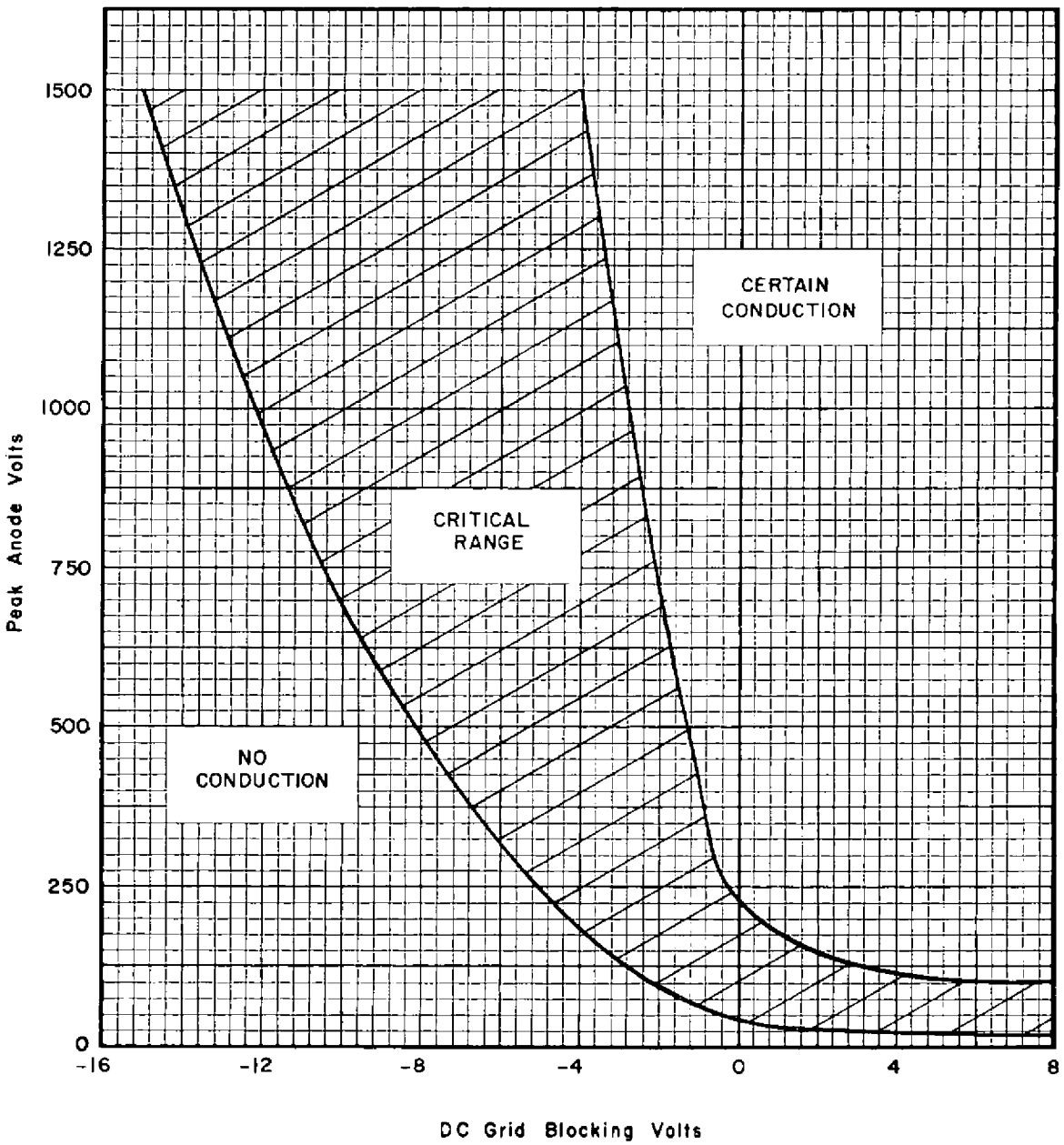
§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

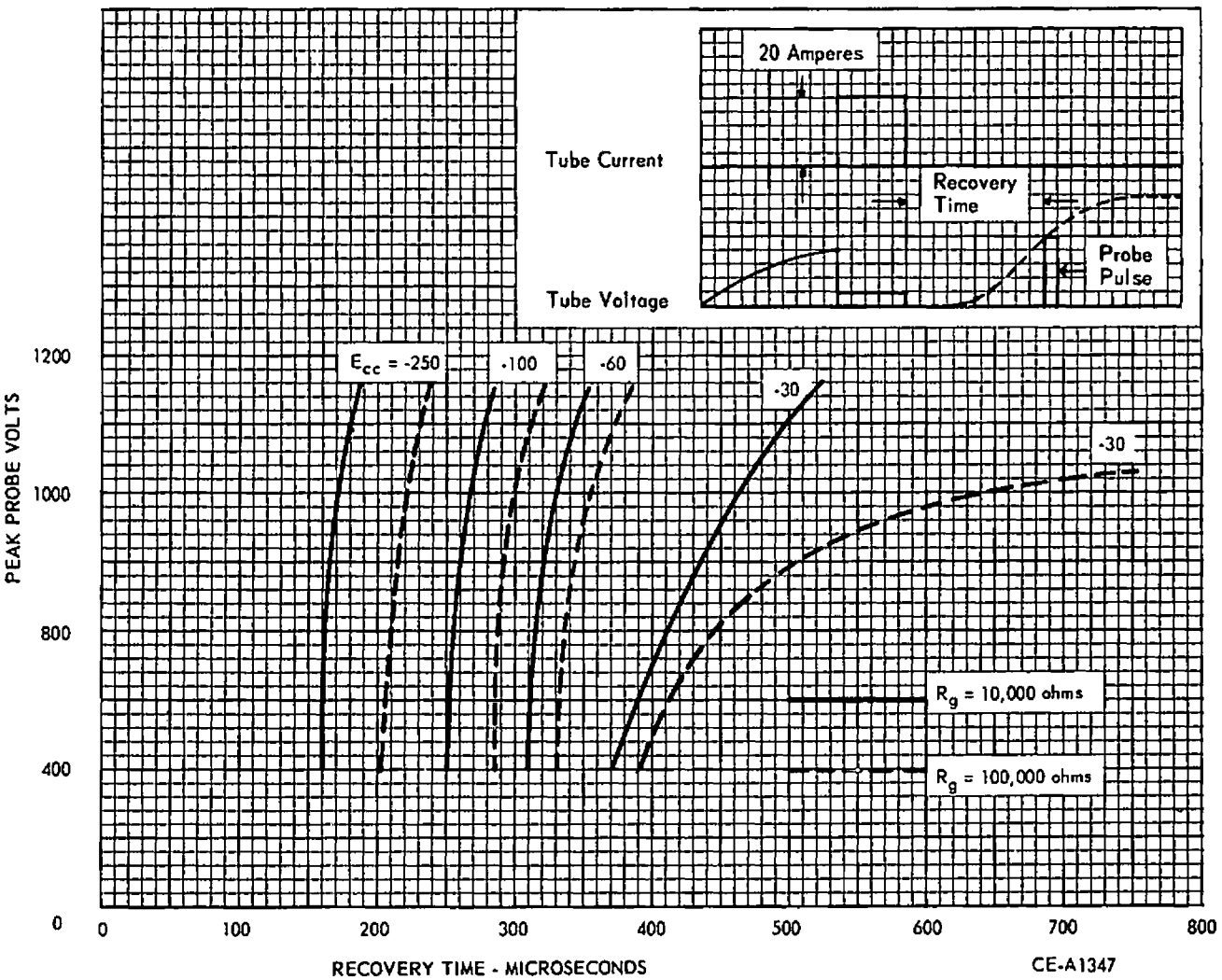
⊖ For higher frequency ratings, consult the tube manufacturer.

■ These ratings are effective when the anode return connections are made as shown in CE-A1103.

CRITICAL GRID VOLTAGE



TYPICAL RECOVERY TIME



December 11, 1958

THYRATRON TYPE WL-7298

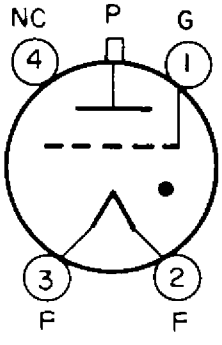
The WL-7298 is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged over a wide range of ambient temperatures. The WL-7298 is designed for application in industrial control circuits requiring a quick heating cathode. The WL-7298 is electrically similar to the WL-5878 and WL-7299.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts = 2.5	19.0	21.0	23.0	Amperes
Heating Time	60	-	-	Seconds
Ionization Time		10		usec
Critical Anode Voltage at Grid Voltage of +6 Volts	-	-	100	Volts
Critical Grid Voltage at Anode Voltage of 1500 Volts-See Fig. 1	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.)				
Anode to Grid		1.0		uuf
Grid to Cathode		28.0		uuf
Typical Arc Drop		16		Volts
Control Characteristic				Negative

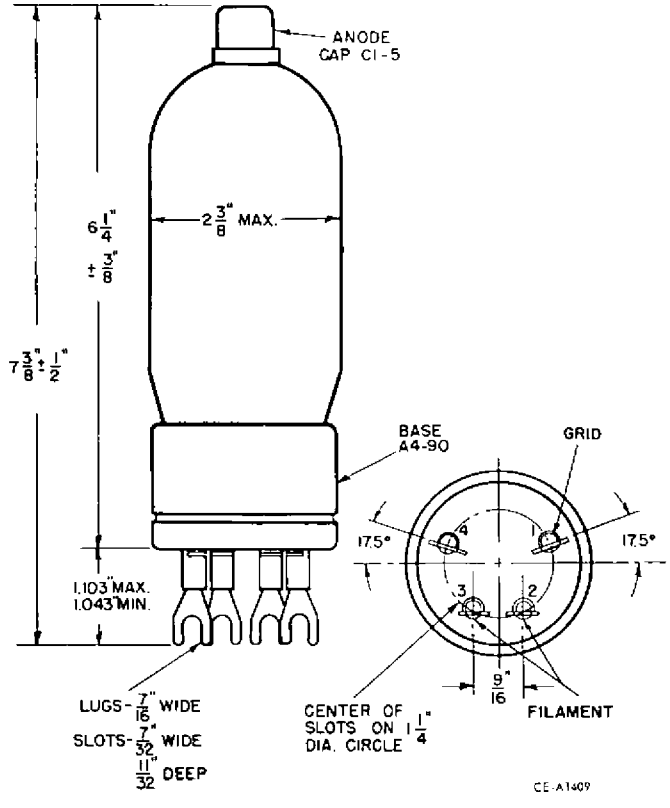
MECHANICAL:

Mounting Position	Any
Overall Height (Approx.)	7-3/8"
Overall Diameter (Maximum)	2-3/8"
Type of Cooling	Air, Unrestricted Convection
Temperature Range	-55 to +70° C
Bulb	T-18
Anode Cap	JETEC C1-5
Base	JETEC A4-90
Net Weight (Approx.)	8 oz.
Shipping Weight (Approx.)	2 lb.



BASE CONNECTIONS

G - Control Grid
F - Filament
P - Anode
NC - No Connection



CE-A1137

Thyratron Section

from JETEC release #2354, Jan. 5, 1959

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:			
Peak Anode Voltage			
Forward	1500	max.	Volts
Inverse	1500	max.	Volts
Anode Current			
Peak	80	max.	Amperes
Average (Averaging Time 15 Seconds)	6.4	max.	Amperes
Surge (Duration 0.10 Second or Less)	1120	max.	Amperes
Commutation Factor♦	200	max.	va/usec
Current Rate of Change	0.25	max.	a/usec
Voltage Rate of Change	800	max.	v/usec
Negative Control Grid Voltage			
Before Conduction	250	max.	Volts
During Conduction §	10	max.	Volts
Average Positive Control Grid Current			
Averaging Time = 1 cycle▲	0.20	max.	Ampere
Operating Frequency⊕	60	max.	cps

NOTES

General These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

All anode and grid returns should be made to the center of the filament transformer.

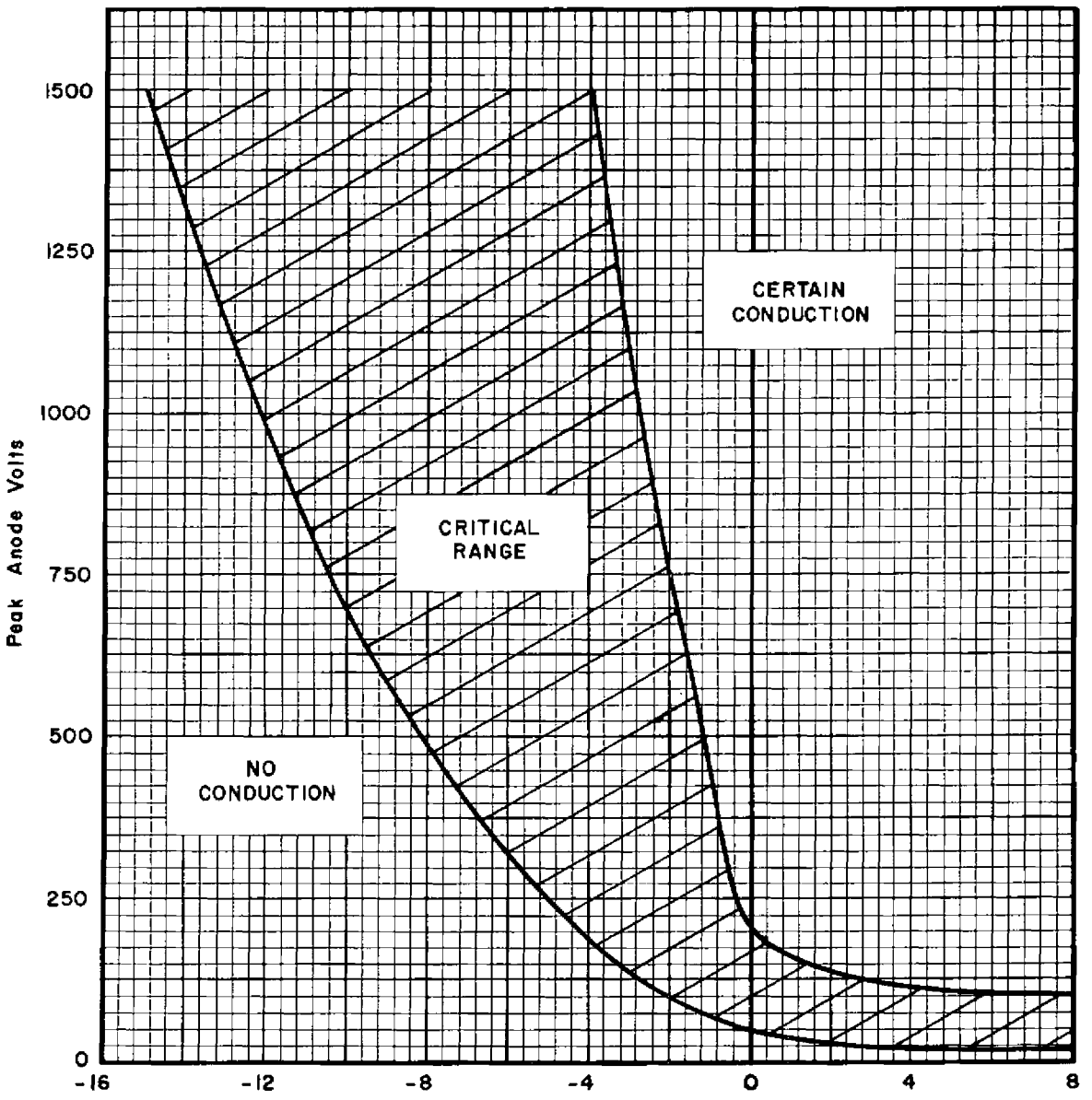
♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

▲ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturers.

CRITICAL GRID VOLTAGE



CE-A1349

February 12, 1959

THYRATRON TYPE WL-7299

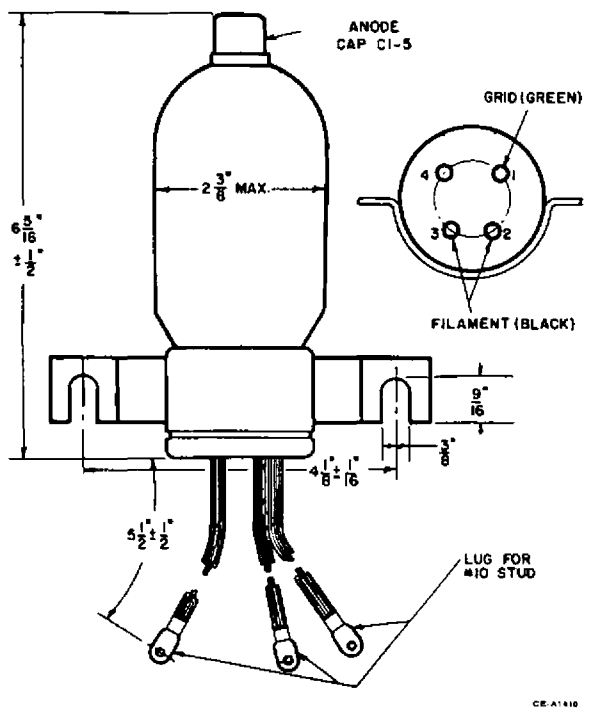
The **WL-7299** is a three-electrode, inert-gas-filled, grid-controlled thyratron with negative control characteristics. Cooling is by unrestricted air convection and characteristics remain essentially unchanged over a wide range of ambient temperatures. The **WL-7299** is designed for application in industrial control circuits requiring a quick heating cathode. The WL-7299 is electrically similar to the WL-5878 and WL-7298.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts=2.5	19.0	21.0	23.0	Amperes
Heating Time	60	-	-	Seconds
Ionization Time		10		usec
Critical Anode Voltage at Grid Voltage of +6 Volts	-	-	100	Volts
Critical Grid Voltage at Anode Voltage of 1500 Volts	-4.0	-9.5	-15.0	Volts
Interelectrode Capacitances (Approx.)				
Anode to Grid		1.0		uuf
Grid to Cathode		28.0		uuf
Typical Arc Drop		16		Volts
Control Characteristic				Negative

MECHANICAL:

Mounting Position	Any
Overall Height (Approx.)	6-5/16"
Overall Diameter (Maximum)	2-3/8"
Type of Cooling	Air, Unrestricted Convection
Temperature Range	-55 to +70° C
Bulb	T-18
Anode Cap	JETEC C1-5
Base	See Outline
Net Weight (Approx.)	8 oz.
Shipping Weight (Approx.)	2 lb.



Thyratron Section

from JEDEC release #2432, April 6, 1959

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES:			
Peak Anode Voltage			
Forward	1500	max.	Volts
Inverse	1500	max.	Volts
Anode Current			
Peak	80	max.	Amperes
Average (Averaging Time 15 Seconds)	6.4	max.	Amperes
Surge (Duration 0.10 Second or Less)	1120	max.	Amperes
Commutation Factor♦	200	max.	va/usec
Current Rate of Change	0.25	max.	a/usec
Voltage Rate of Change	800	max.	v/usec
Negative Control Grid Voltage			
Before Conduction	250	max.	Volts
During Conduction§	10	max.	Volts
Average Positive Control Grid Current			
Averaging Time= 1 cycle▲	0.20	max.	Ampere
Operating Frequency⊕	60	max.	cps

NOTES

General These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

All anode and grid returns should be made to the center of the filament transformer.

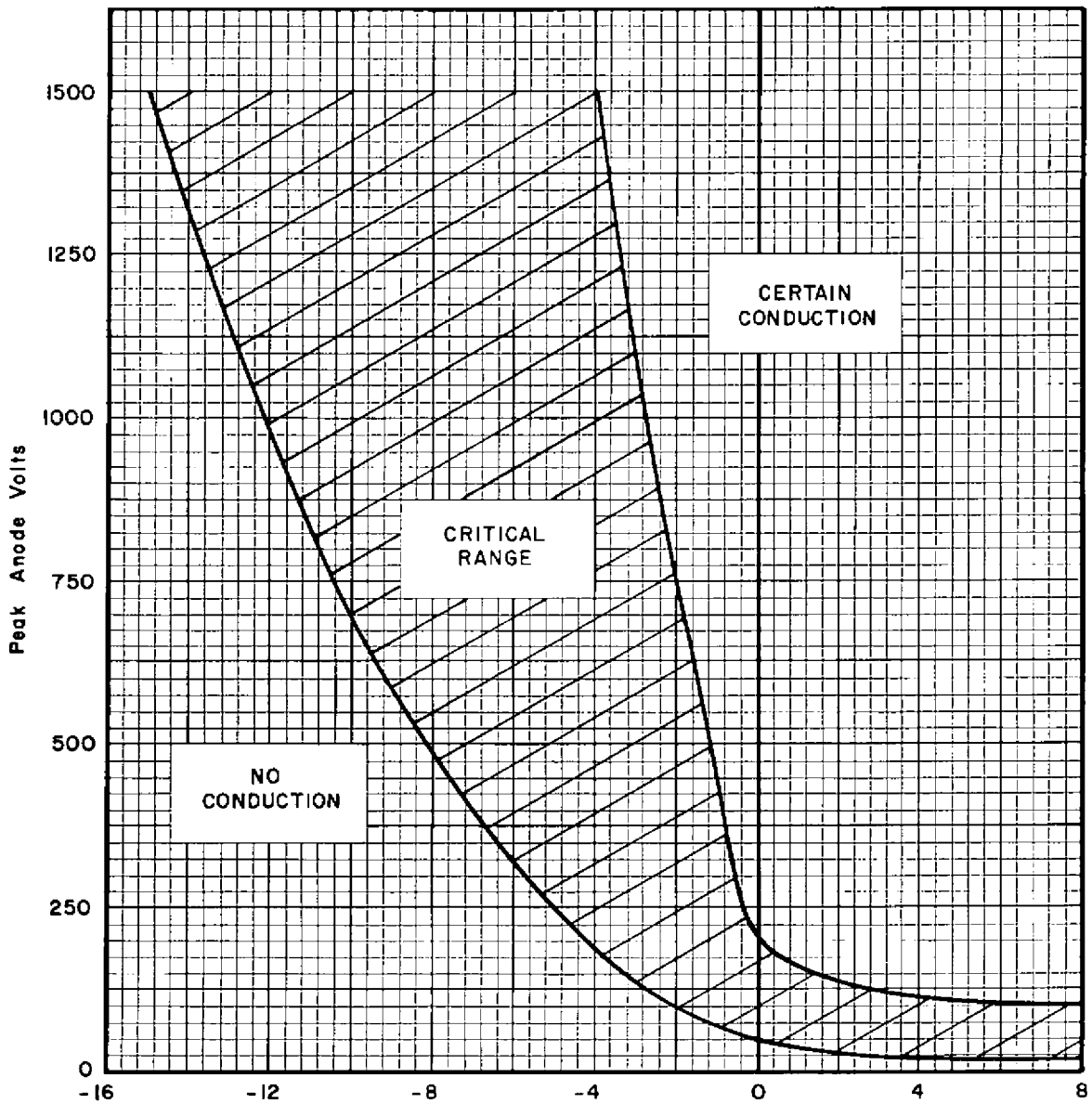
♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

▲ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturer.

CRITICAL GRID VOLTAGE



CE-A1349

April 23, 1959

THYRATRON TYPE WL-7306

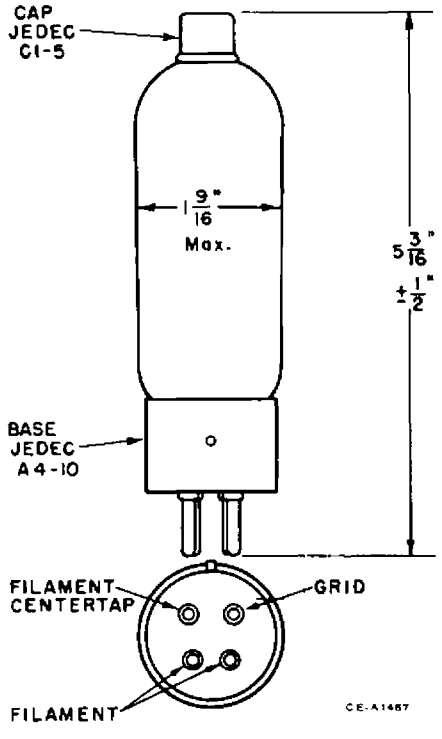
The WL-7306 is a three-electrode, inert gas filled thyratron with a negative control characteristic. This tube is designed primarily for industrial control applications.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts=2.5	--	9.0	11	Amperes
Heating Time	30	--	--	Seconds
Deionization Time	less than 1000			μsec
Ionization Time (approx.)		10		μsec
Critical Grid Voltage		See CE-A1451		
Maximum Critical Grid Current		10		μamp
Interelectrode Capacitances (approx.):				
Anode to Grid		2		μμf
Grid to Cathode		10		μμf
Typical Arc Drop		10		Volts
Control Characteristic				Negative

MECHANICAL:

Mounting Position	Any
Overall Height (approx.)	5-3/16"
Overall Diameter (Maximum)	1-9/16"
Type of Cooling	Air, Unrestricted Convection
Temperature Range	-55 to +70 °C
Bulb	T-12
Anode Cap	JEDEC C1-5
Base	JEDEC A4-10
Net Weight	3 oz
Shipping Weight (approx.)	24 oz



ABSOLUTE MAXIMUM VALUES

Peak Anode Voltage:			
Forward	1000	max.	Volts
Inverse	1250	max.	Volts
Anode Current:			
Peak	30	max.	Amperes
Average	2.5	max.	Amperes
Averaging Time	4.5	max.	Sec.
Surge, max. Duration 0.1 sec. ■ :			
Connection (a)	240	max.	Amperes
Connection (b)	120	max.	Amperes
Connection (c)	120	max.	Amperes
Commutation Factor ♦	0.66	max.	va/μsec²
Negative Control Grid Voltage:			
Before Conduction	100	max.	Volts
During Conduction §	10	max.	Volts
Average Positive Control Grid Current:			
Averaging Time=1 cycle ♦	0.10	max.	Ampere
Operating Frequency ⊕	150	max.	cps

General These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Value given is for a maximum initial inverse voltage of 350 volts.

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing throught the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

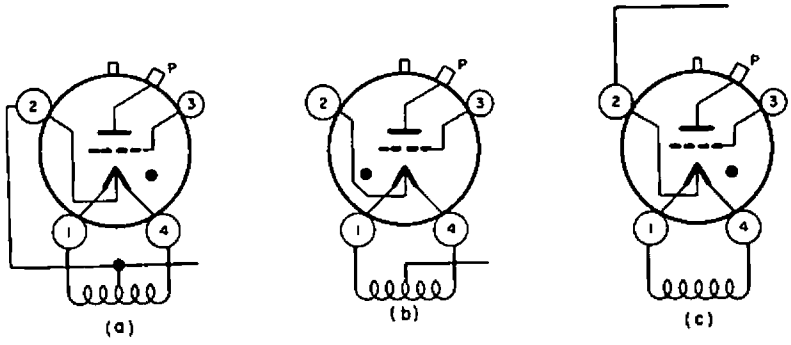
♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

⊕ For higher frequency ratings, consult the tube manufacturer.

■ These ratings are effective only when the anode return connections are made according to the diagrams shown in CE-A1468.

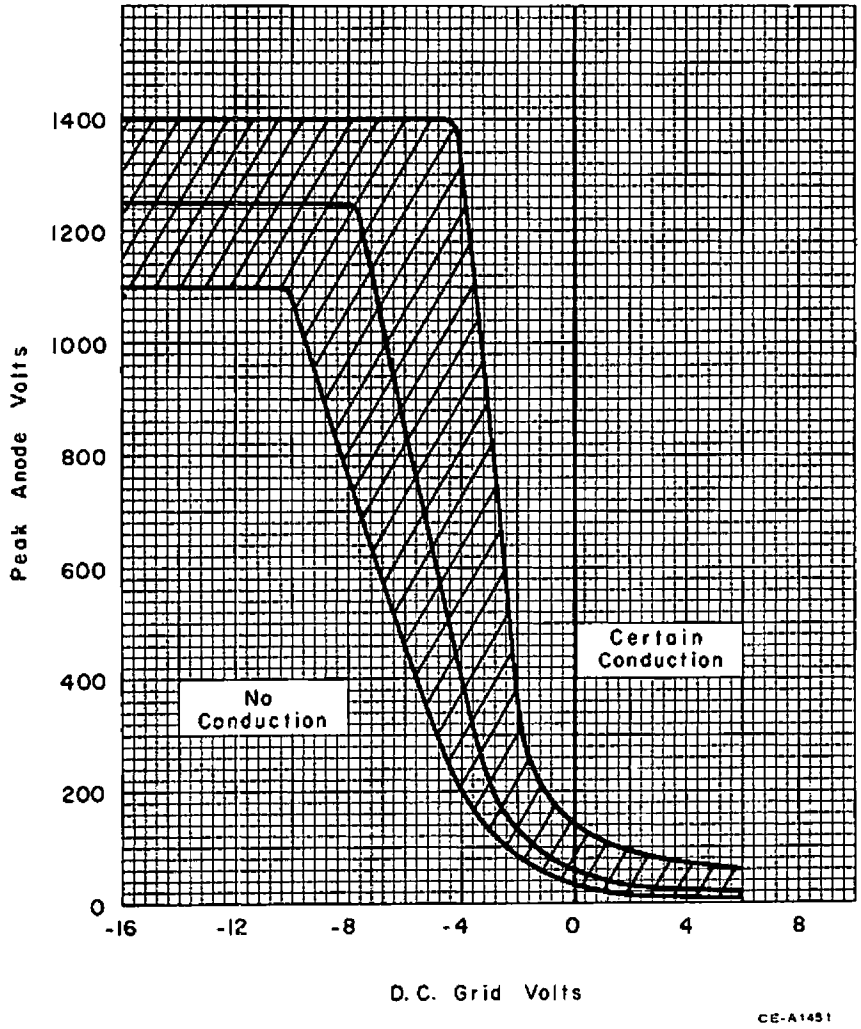
from JEDEC release #2485, June 8, 1959

ANODE RETURN CONNECTIONS



CE-A1468

CRITICAL GRID VOLTAGE



CE-A1451

THYRATRON TYPE WL-7307

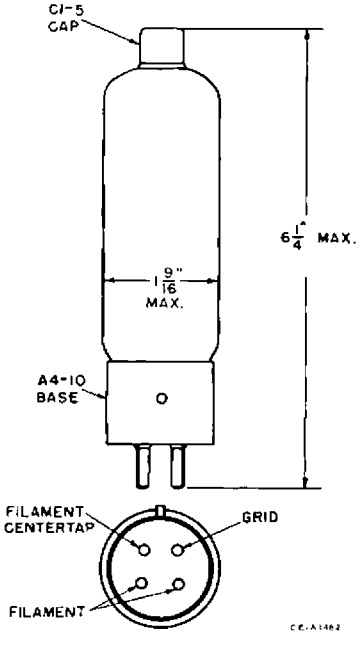
The WL-7307 is a three-electrode thyratron with negative control characteristic and an inert gas-mercury vapor filling. The WL-7307 has the long life characteristic of mercury vapor tubes and the fast starting and wide ambient temperature range associated with inert gas tubes. It is designed for ignitor firing and industrial control applications.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current	--	9.0	11.0	Amperes
Heating Time	20	--	--	Seconds
Direct Interelectrode Capacitances:				
Anode to Grid			2	μμf
Grid to Filament			12	μμf
Critical Grid Voltage		See Curve		
Deionization Time (Typical)			1000	μseconds
Ionization Time (approx.)			10	μsecond
Anode Voltage Drop (Typical with 8 Amperes Peak)			10	Volts

MECHANICAL:

Type of Cooling	Air Unrestricted Convection
Mounting Position	Vertical, Base Down
Net Weight	3 Ounces
Shipping Weight (approx)	24 Ounces



MAXIMUM RATINGS

Absolute Maximum Values

Peak Anode Voltage:		
Forward	1500 max.	Volts
Inverse	1500 max.	Volts
Cathode Current:		
Peak	30 max.	Amperes
Average	2.5 max.	Amperes
Averaging Time	5 max.	Seconds
Fault (Surge, Max. Duration 0.1 Sec.): ▲		
Connection (a) See CE-A1103	240 max.	Amperes
Connection (b) See CE-A1103	120 max.	Amperes
Connection (c) See CE-A1103	120 max.	Amperes
Negative Grid Voltage:		
Before Conduction	250 max.	Volts
During Conduction	10 max.	Volts
Positive Grid Current (Average): ♦		
Averaging Time = 1 Cycle	0.10 max.	Ampere
Maximum Frequency ■	150 max.	CPS
Condensed Mercury Temperature Range ♦	-40 + 80 max.	°C

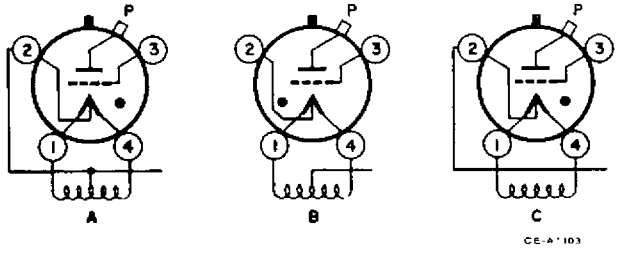
▲ These ratings are effective only anode return connections are made as shown in CE-A1103.

♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

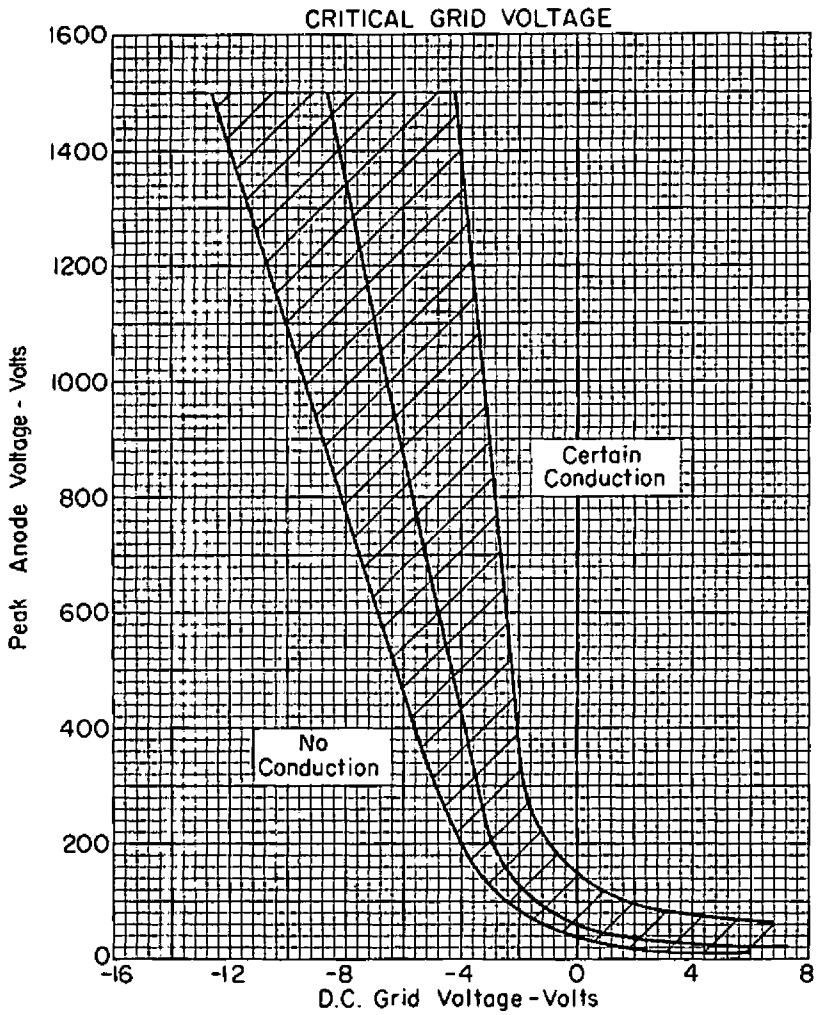
♦ Satisfactory starting and operation will result at the condensed-mercury temperature indicated. For optimum life, the condensed-mercury temperature after warm-up should be 40 to 80 °C. If the tube is operated at condensed-mercury below 20 °C for extended periods, the usual circuit precautions for inert gas tubes should be taken.

■ For higher frequency ratings, consult the tube manufacturer.

ANODE RETURN CONNECTIONS



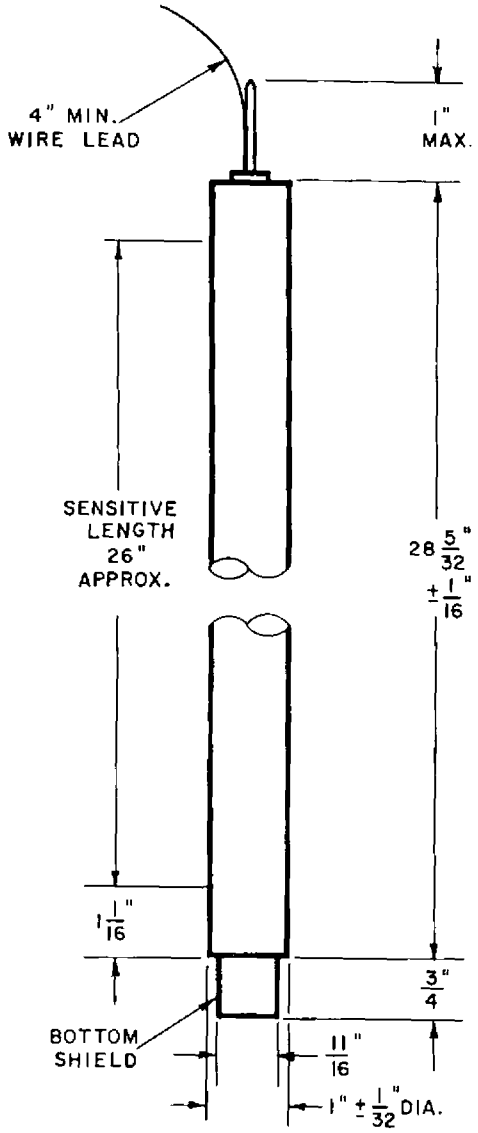
from JEDEC release #2495, June 15, 1959


CRITICAL GRID VOLTAGE
1600
1400
1200
1000
800
600
400
200
0
Peak Anode Voltage - Volts
Certain Conduction
No Conduction
-16
-12
-8
-4
0
4
8
D.C. Grid Voltage - Volts
CE-A1088

July 14, 1959

BF_3 PROPORTIONAL COUNTER TYPE- WL-7317

The WL-7317 is electrically identical with the WL-6998. Its mechanical differences include all alumina insulation and flying lead for center electrode terminal as shown in Commercial Outline below. See WL-6998 data sheet for electrical data.



from JEDEC release #2597, Oct. 5, 1959

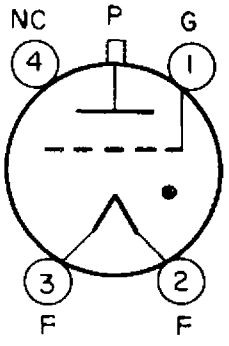
November 14, 1958

THYRATRON TYPE WL-7321/C6J/L

The WL-7321/C6J/L thyratron is a three-electrode, grid-controlled, Xenon-gas-filled rectifier with negative control characteristics. Cooling is obtained by unrestricted air convection, and the tube operates over a wide temperature range from -55 to +75 degrees Centigrade. The filamentary-type coated cathode is heated directly from a 2.5-Volt a-c supply. The WL-7321/C6J/L is designed for power-control applications where stable characteristics are necessary over a wide temperature range. The WL-7321/C6J/L is electrically similar to the WL-5685/C6JA and WL-6860/C6J/F.

ELECTRICAL:	Min.	Bogey	Max.	
Filament, cathode directly heated				
Voltage▲	2.38	2.5	2.63	Volts
Current	19	21	23	Amp
Heating Time, approx.	60	–	–	Sec
Deionization Time, approx.	–	–	1000	u sec
Critical Grid Current	–	–	10	u amp
Critical Anode Voltage at Grid Voltage of +4 Volts	–	–	75	Volts
Negative Grid Voltage	–	–	100	Volts
Interelectrode Capacitance, approx.				
Grid to Anode	–	4	–	uuf
Grid to Filament	–	21	–	uuf
Typical Arc Voltage Drop	–	9	–	Volts
Critical Grid Voltage at Anode Voltage of 1000 Volts (See CE-A1138)	-3	-4.6	-6.2	Volts
Control Characteristics				Negative

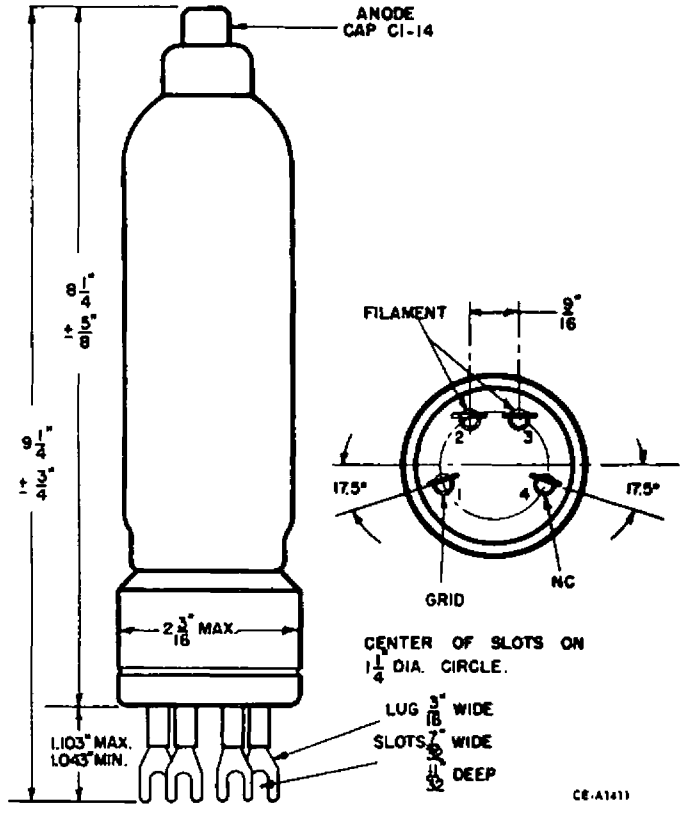
MECHANICAL:	
Mounting Position	Vertical, base down
Overall Height, approx.	9-1/4"
Overall Diameter, approx.	2"
Type of Cooling	Air, unrestricted convection
Temperature Range	-55 to +75 °C
Bulb	T-16
Anode Cap	Medium Skirted JETEC C1-14
Base	Lug Size and Location per JETEC A4-90
Net Weight, approx.	7 oz
Shipping Weight, approx.	2 lb



BASE CONNECTIONS

G - Control Grid
F - Filament
P - Anode
NC - No Connection

CE-A1137



Thyratron Section

from JETEC release #2349, Dec. 29, 1958

MAXIMUM RATINGS:

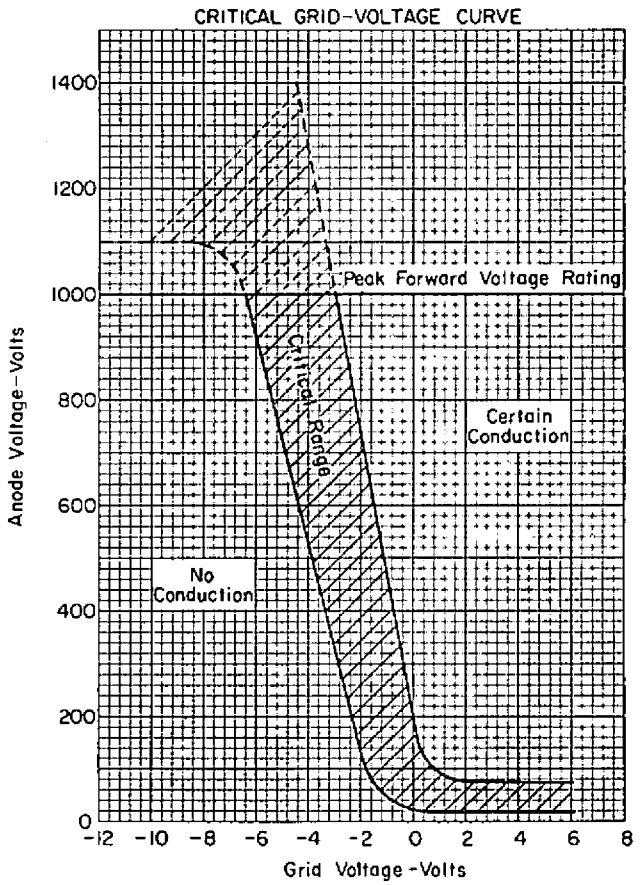
Absolute Values■

Peak Anode Voltage, max.		
Forward	1000	Volts
Inverse	1250	Volts
Anode Current, max.		
Peak	77	Amp
Average, continuous	6.4	Amp
Average Overload (3 seconds), max.	12.8	Amp
Surge Current, maximum duration 0.1 second	770	Amp
Temperature Range	-55 to +75	°C
Commutation Factor, max.♦	0.66	

▲ Filament, pin No. 2 should be negative with respect to pin No. 3 during the anode conduction period.

■ All of the ratings are for return connections to the center tap of the filament transformer secondary.

♦ The commutation factor is defined as the product of the rate of current decay, immediately preceding the end of the commutation period, in amperes per microsecond and the rate of rise of the initial inverse voltage in volts per microsecond, or CF = amp/u sec × volts/u sec.



CE-A1138

Shaded space between limiting curves represents the area of conduction and indicates variations which may be expected initially and throughout the life of the tube when operated within the specified temperature range.

LOW MU POWER TRIODE TYPE 7328A

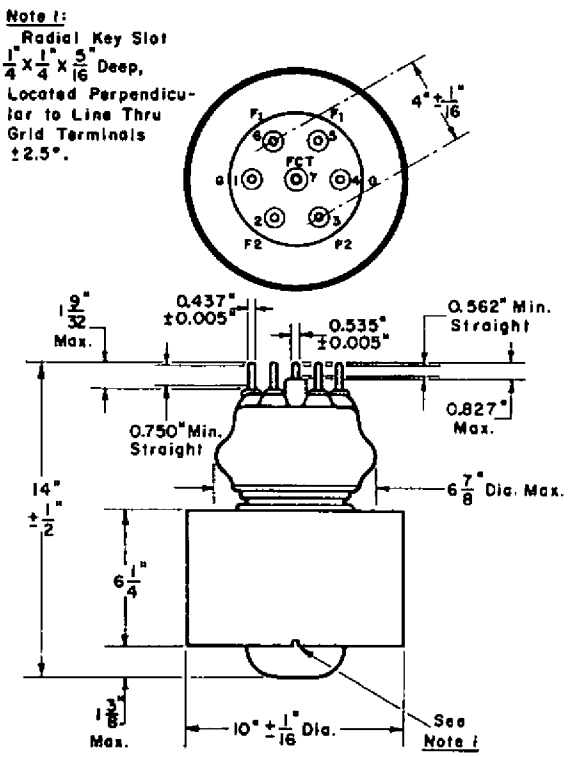
The 7328A is a three element tube designed for service as a modulator or AF amplifier. Electrical characteristics make it particularly suitable for Class AB_1 or AB_2 circuits. The anode is capable of dissipating 20 KW CCS with forced air cooling. The cathode is a single phase, thoriated tungsten filament.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament		
Filament:			
Voltage	7.0		Volts
Current	245		Amperes
Starting Current (max.)	1000		Amperes
Amplification Factor: Grid Volts = −450, Plate Amperes = 5.0	6		
Maximum Usable Cathode Current	60		Amperes
Direct Interelectrode Capacitances:			
Grid to Plate	78		$\mu\mu f$
Grid to Filament	68		$\mu\mu f$
Plate to Filament	7		$\mu\mu f$

MECHANICAL:

Mounting Position	Vertical, Anode Down			
Cooling:				
Type	Forced Air			
Amount Required:				
Plate Dissipation	10	15	20	Kilowatts
Air Flow	800	1250	1700	CFM
Static Pressure	2.0	3.5	6.0	In. H_2O
Maximum Incoming Air Temperature	45 °C			
Maximum Seal Temperature	180 °C			
Net Weight	72 Pounds			



MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	10 max.		Kilovolts
DC Plate Current	10 max.		Amperes
Plate Power Input (Note 1)	50 max.		Kilowatts
Plate Dissipation (Note 1)	20 max.		Kilowatts
Grid Dissipation	~~300~~ 800 Max.		Watts

TYPICAL OPERATING CHARACTERISTICS:
(Values for Two Tubes)

AF Power Amplifier & Modulator Service

Class AB_1 Operation				
DC Plate Voltage	8	9	10	Kilovolts
DC Grid Voltage	−1700	−1900	−2200	Volts
Peak AF Grid-to-Grid Voltage	3350	3750	4350	Volts
Zero Signal DC Plate Current	0.5	0.5	0.5	Amperes
Maximum Signal DC Plate Current	6.4	7.4	8.2	Amperes
Effective Plate-to-Plate Load Impedance	2400	2400	2400	Ohms
Driving Power	0	0	0	Watts
Maximum Signal Power Output	30	39.5	49.5	Kilowatts
Class AB_2 Operation				
DC Plate Voltage	8	9	10	Kilovolts
DC Grid Voltage	−1700	−1900	−2200	Volts
Peak AF Grid-to-Grid Voltage	3700	4100	4700	Volts
Zero Signal DC Plate Current	0.5	0.5	0.5	Amperes
Maximum Signal DC Plate Current	7.4	8.4	9.3	Amperes
Effective Plate-to-Plate Load Impedance	2400	2400	2400	Ohms
Driving Power	50	55	61	Watts
Maximum Signal Power Output	40	51	65	Kilowatts

from JEDEC release #3263, May 8, 1961

PULSE SERVICE

MAXIMUM RATINGS:

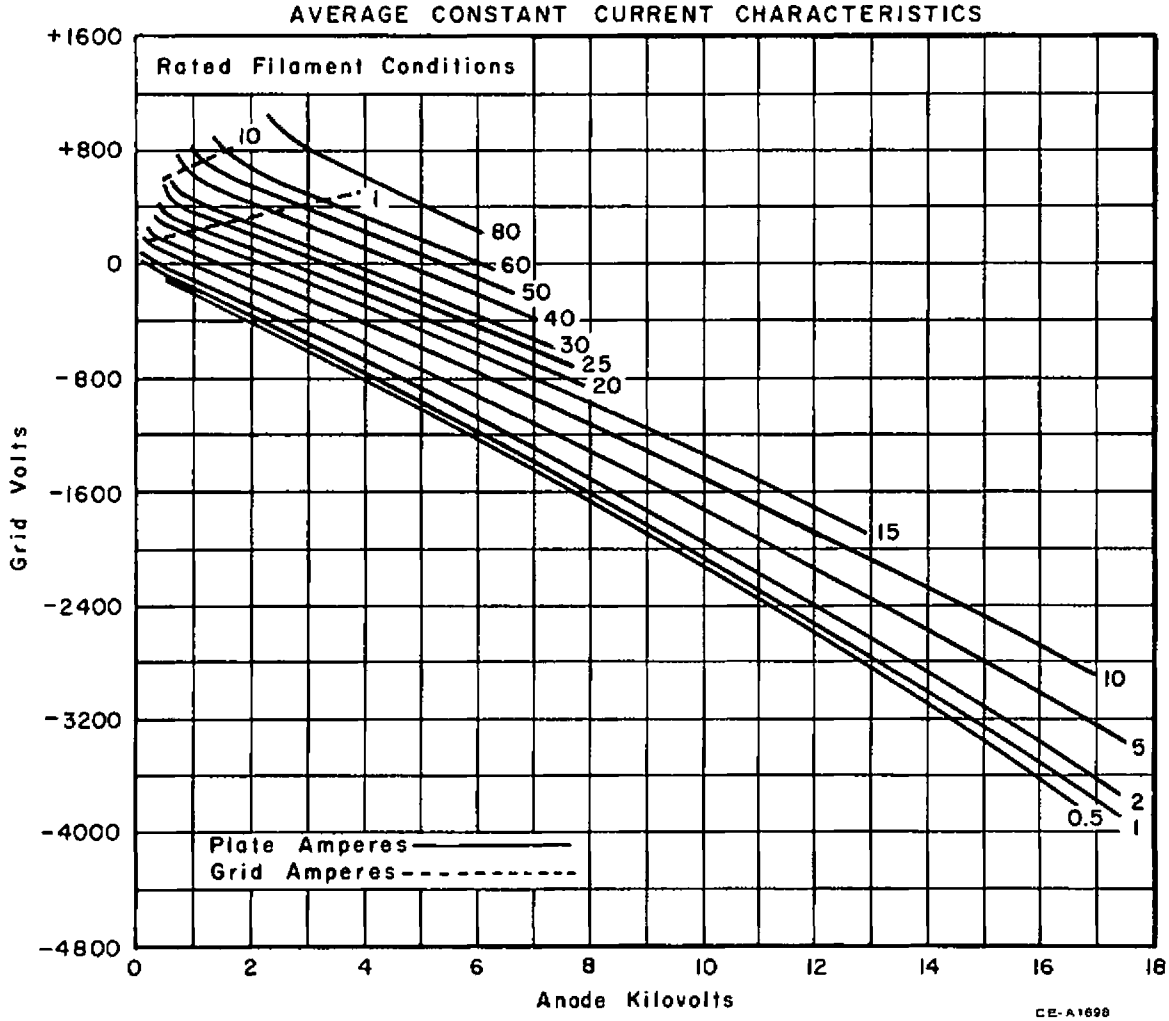
Absolute Maximum Values

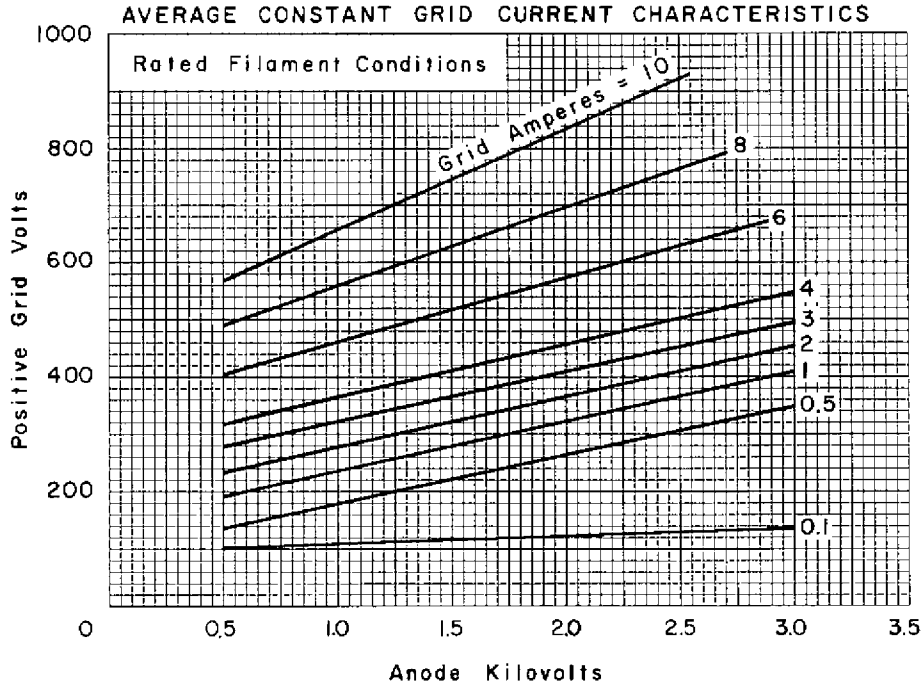
DC Plate Voltage	20	max.	Kilovolts
DC Grid Voltage	-6000	max.	Volts
Peak Positive Grid Voltage	2500	max.	Volts
Peak Pulse Plate Current	88	max.	Amperes
Peak Pulse Grid Current	12	max.	Amperes
Plate Dissipation	800 20	max.	Kilowatts
Grid Dissipation	~~300~~	max.	Watts
Pulse Length	2000	max.	μseconds
Duty Factor	0.01	max.	
Peak Pulse Cathode Current (Note 2)	100	max.	Amperes

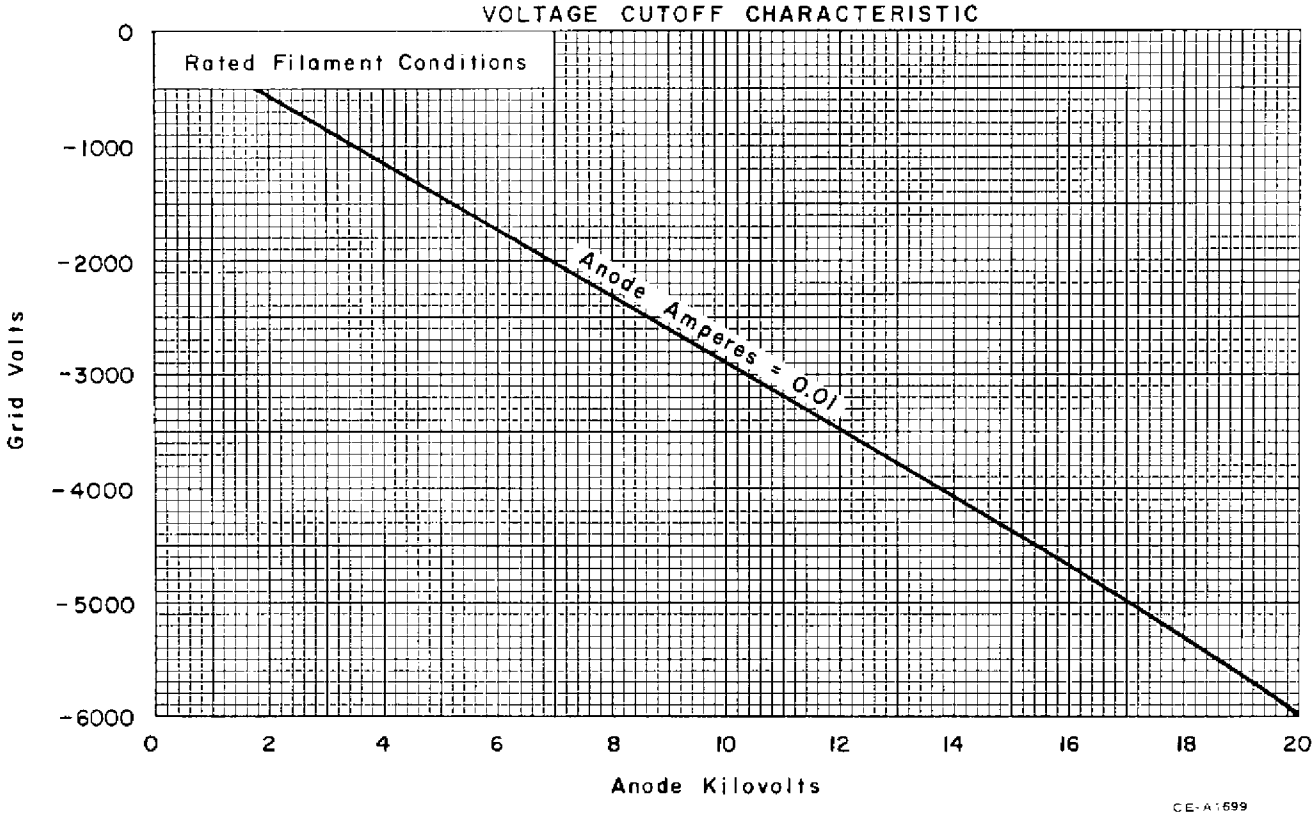
X-Ray Warning: The Maximum Ratings of the 7328A permit operation at voltages in excess of 16 KV. Therefore equipment design considerations should include the possible generation of soft x-rays.

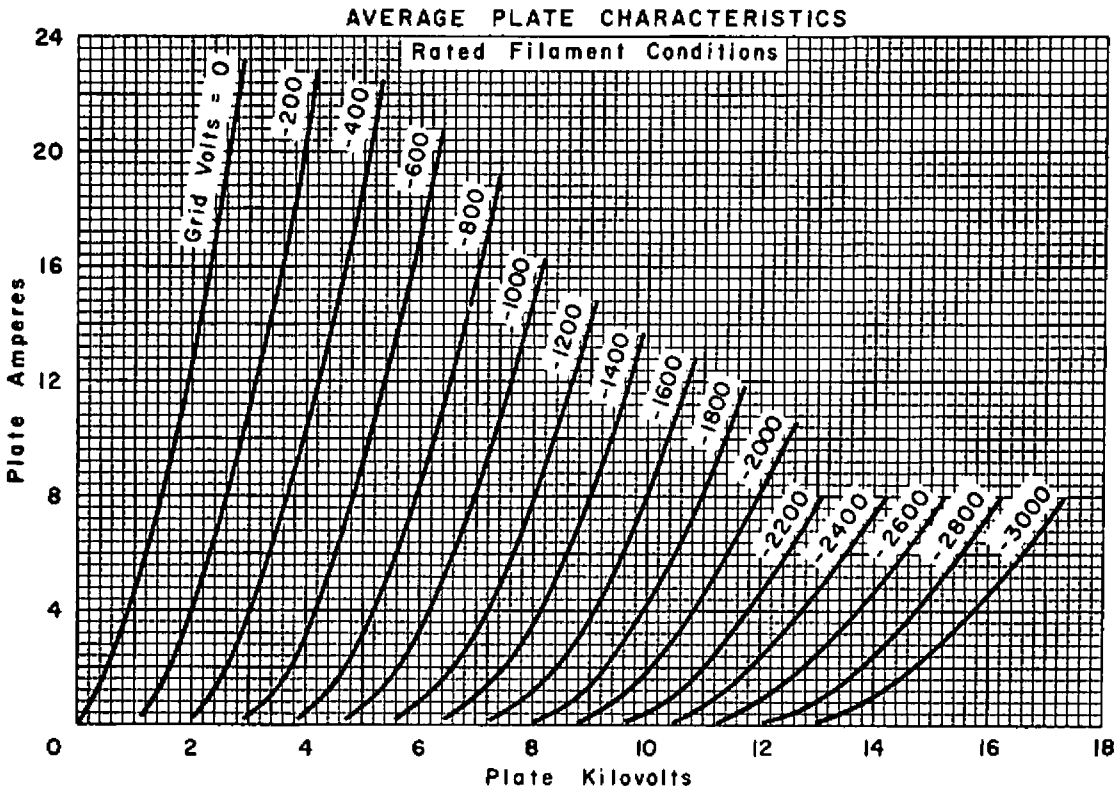
1. Averaged over any AF cycle of sine wave form.
2. A maximum of 160 amperes is permitted with 7.6 volts applied to filament. Continuous operation at elevated filament temperature will reduce length of service received.

AVERAGE CONSTANT CURRENT CHARACTERISTICS




AVERAGE CONSTANT GRID CURRENT CHARACTERISTICS
Rated Filament Conditions
Grid Amperes = 10
8
6
4
3
2
1
0.5
0.1
Positive Grid Volts
1000
800
600
400
200
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Anode Kilovolts
CE-A1697


VOLTAGE CUTOFF CHARACTERISTIC
Rated Filament Conditions
Anode Amperes = 0.01
Grid Volts
0
-1000
-2000
-3000
-4000
-5000
-6000
0
2
4
6
8
10
12
14
16
18
20
Anode Kilovolts
CE-A1699

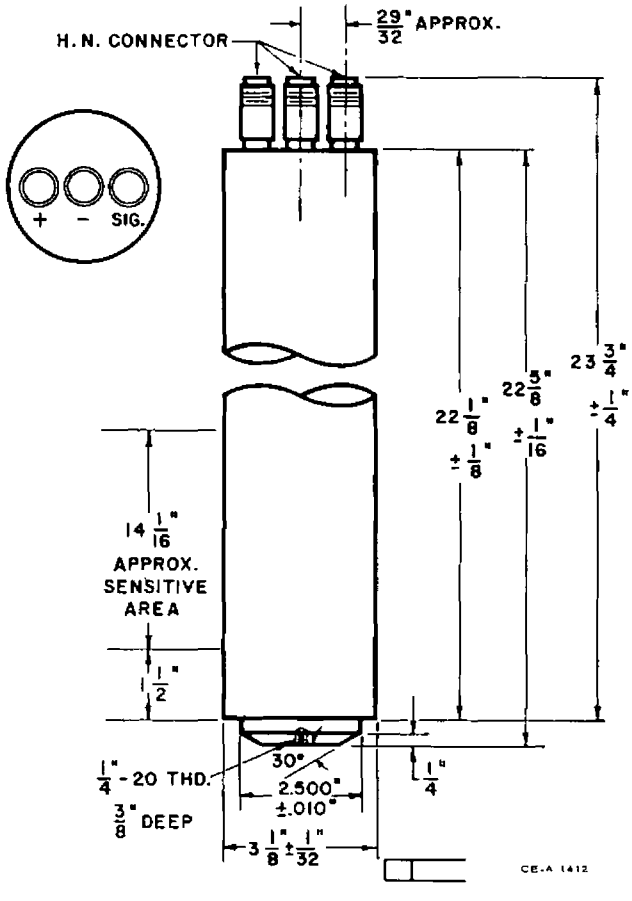

AVERAGE PLATE CHARACTERISTICS
Rated Filament Conditions
Grid Volts = 0
-200
-400
-600
-800
-1000
-1200
-1400
-1600
-1800
-2000
-2200
-2400
-2600
-2800
-3000
Plate Amperes
0
4
8
12
16
20
24
2
4
6
8
10
12
14
16
18
Plate Kilovolts
CE-A1646

December 5, 1958

ELECTRICALLY COMPENSATED IONIZATION CHAMBER TYPE WL-7353

The WL-7353 is a high purity magnesium alloy, boron lined ionization chamber designed to detect thermal neutrons in the flux range from 2.5×10^2 to 2.5×10^{10} neutrons/cm²/second. This type is extremely rugged♦ and will operate in any position at temperatures not exceeding 175°F. Connections are made through "HN" type cable fittings. The gas filling is nitrogen at a pressure of 76 cm Hg.

The WL-7353 incorporates two outstanding features. The first is the use of a "guard ring" type of construction to minimize the reduction in signal currents due to leakage through the insulators. The second is the provision for adjustable gamma compensation.⊕ The neutron sensitivity of the chamber is approximately 4×10^{-14} amperes/neutron/cm²/second. Gamma sensitivity is approximately 3×10^{-11} amperes/R/hr when operated uncompensated but is reduced to approximately 3×10^{-13} amperes/R/hr in compensated operation thus extending the operating range two decades lower.



The WL-7353 is electrically similar to the WL-6377. The significant mechanical difference is that the WL-7353 has an extended portion with a tapped hole to facilitate mounting.

MECHANICAL:

Maximum Diameter	3-5/32	Inches
Maximum Overall Length	24-1/2	Inches
Approx. Sensitive Length	14-1/16	Inches
Net Weight	5-3/8	Pounds
Shipping Weight	19	Pounds

MATERIALS:

Body	Alloy 3% Al, 97% Mg
Insulation	Polystyrene & Alumina
Gas Filling	Nitrogen
Neutron Sensitive Material	Boron enriched to 92% with B-10 1 mg/cm² thick

MAXIMUM RATINGS:

Absolute Maximum Values

Thermal Neutron Flux	10^{11} max.	n/cm²/sec
Temperature	175 max.	°F
Interelectrode Voltage (dc)	1500 max.	Volts

TYPICAL OPERATING CHARACTERISTICS:

Approx. Operating Voltage□	300 to 800	Volts
Compensating Voltage■	-10 to -80	Volts
Neutron Sensitivity	4×10^{-14}	Amp/n/cm²/sec
Thermal Neutron Flux Range	2.5×10^2 to 2.5×10^{10}	n/cm²/sec
Approx. Signal Electrode Output Impedance:		
Capacity	160	uuf
Leakage Resistance	10^{14} min.	ohms

TYPICAL SATURATION CHARACTERISTICS:

For Neutron Flux of 2.5×10^{10} neutrons/cm²/second		
Operating Voltage	800	Volts
Output Current	10^{-3}	Amperes
For Neutron Flux of 2.5×10^9 neutrons/cm²/second		
Operating Voltage	300	Volts
Output Current	2×10^{-4}	Amperes

♦ The WL-7353 has passed military specifications MIL-S-901 for shock and BuShips 40T9 for vibration.

□ Guide to connections is shown on page 2. Saturation voltage varies with neutron flux as shown on page 3.

■ Value of compensating voltage is dependent on the gamma flux gradient on the tube.

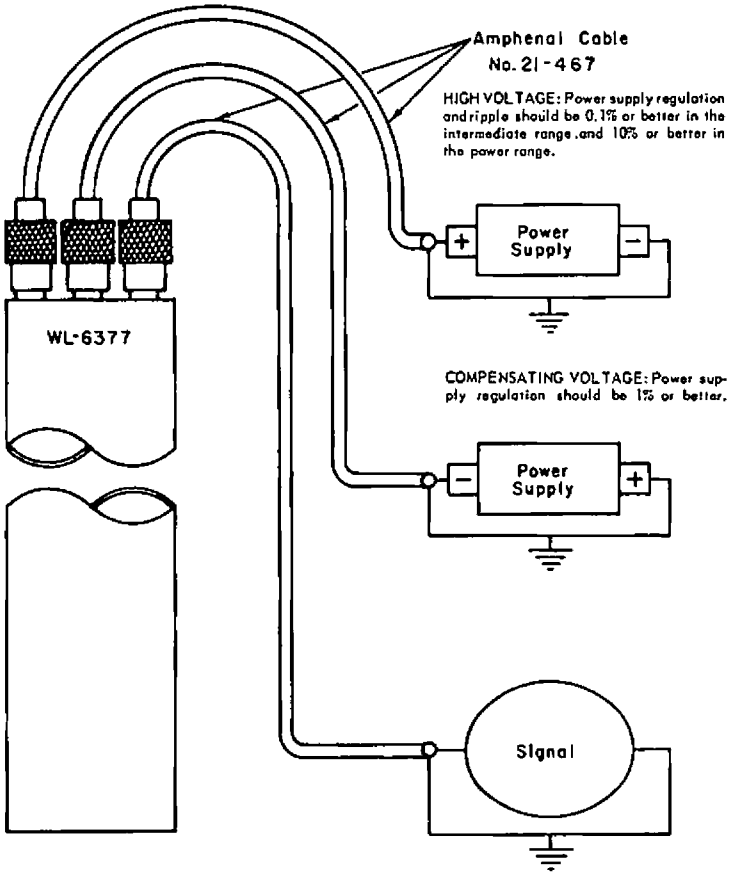
⊕ By varying the voltage on an electrode.

NOTE: This tube may not be immersed in water and high humidity environments should be avoided since they may impair performance.

Neutron & Radiation Detector Section

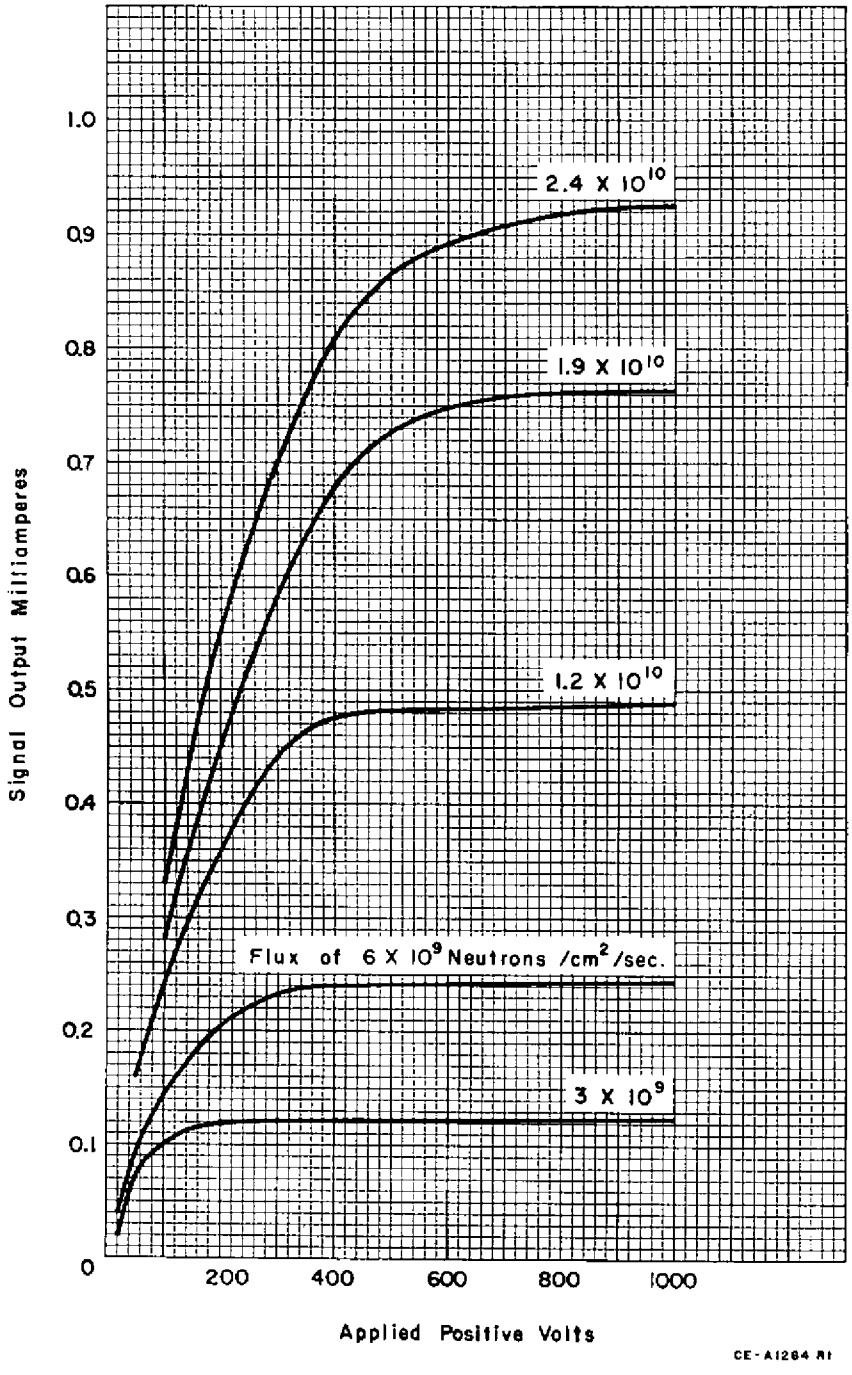
from JETEC release #2360, Jan. 19, 1959

TYPICAL CONNECTION DIAGRAM



CE-A1324

TYPICAL SATURATION CHARACTERISTICS



Westinghouse

7356

October 1, 1960

DIRECT VIEW STORAGE TUBE TYPE 7356

Two Identical Write-Erase Guns
Flood Gun
Integral Tube and Shield Assembly
High Speed Selective Erasure

5-1/4" Overall Diameter Including Shield
15-3/4" Overall Length
25 Pin Two-Tier Base
4" Display Diameter

The 7356 is a direct-view storage tube incorporating two identical Write-Erase guns and a Viewing gun system capable of producing a bright, non-flickering, uniform display over a full four inch diameter viewing area. The two electrostatically focused and deflected Write-Erase guns permit independent and simultaneous writing of two signals, or writing with one gun and high speed selective erasure with the other.

Performance characteristics of the tube include a brightness of 2500 foot-lamberts with 10,000 volts applied to the phosphor, good resolution of half-tone displays, and excellent display uniformity. The writing speed of 36,000 inches per second is sufficient to "freeze" high frequency transients, and storage time is long enough to allow adequate examination and recording of the display.

The 7356 is particularly useful for such applications as airborne fire control radar, weather radar, navigational radar, transient studies, data transmission including half-tone storage, telemetering, facsimile, and visual displays requiring steady, narrow-bandwidth transmission over telephone lines.

The 7356 is designed to operate under military environmental conditions. It may be operated unpressurized at high altitudes. The pin connections have been grouped according to operating potentials within a Westinghouse designed Two-Tier 25 Pin Base (JEDEC B25-216) which features unusually long external leakage paths between pin circles. In addition, the base is potted to eliminate internal leakage.

The entire tube is potted within its magnetic shield with a synthetic silicone-rubber material providing protection against mechanical shock, vibration, humidity, and leakage between bulb terminals. The magnetic shield is resistant to salt spray.

The integral tube-and-shield assembly together with the improved base design greatly simplify tube installation procedure.



from JEDEC release #3248, April 24, 1961

ELECTRICAL:

Storage:
- Type . . . . . Half-Tone or Line
- Mode . . . . . Control of Transmission
- Types of Erasure . . . . . High Speed Selective or Overall

Write-Erase Guns: (Each Gun)
- Cathode . . . . . Coated Unipotential
- Heater:

	Min.	Bogey	Max.	
Voltage (ac or dc)	5.67	6.3	6.93	Volts
Current at Bogey Voltage	0.50	0.60	0.70	Amperes

- Focusing Method . . . . . Electrostatic
- Deflection Method . . . . . Electrostatic
- Number of Write-Erase Guns . . . . . Two

Flood Gun:
- Cathode . . . . . Coated Unipotential
- Heater:

	Min.	Bogey	Max.	
Voltage	5.67	6.3	6.93	Volts
Current at Bogey Voltage	0.50	0.60	0.70	Ampere

- Warm-up Time before Applying High Voltages . . . . . 30 -- -- Seconds
- Focus and Deflection. . .Undeflected, Collimated "Flood" Gun

Direct Interelectrode Capacitances:
External Integral Shield Grounded

Write-Erase Gun Cathode to All	7 max.	μμf
Flood Gun Cathode to All	10 max.	μμf
Write-Erase Gun Grid 1 to All	10 max.	μμf
Flood Gun Grid 1 to All	18 max.	μμf
Deflecting Electrode 1 to Deflecting Electrode 2.	3 max.	μμf
Deflecting Electrode 3 to Deflecting Electrode 4.	2 max.	μμf
Deflecting Electrode 1 to All	8 max.	μμf
Deflecting Electrode 2 to All	8 max.	μμf
Deflecting Electrode 3 to All	8 max.	μμf
Deflecting Electrode 4 to All	8 max.	μμf
Backing Electrode to All	110 max.	μμf

OPTICAL:

Phosphor:
- Type . . . . . High Visual Efficiency, Aluminized P20
- Fluorescence . . . . . Yellow-Green
- Phosphorescence . . . . . Yellow-Green
- Persistence . . . . . Short

Faceplate . . . . . Optical Glass, Ground and Polished Flat

MECHANICAL:

- Minimum Useful Viewing Diameter . . . . . 4.0"
- Maximum Overall Length . . . . . 16"
- Maximum Seated Length . . . . . 14-1/4"
- Greatest Shield Diameter . . . . . 5-1/4" ± 1/16"
- Viewing Screen Terminal . . . . . Flexible Cable
- Cap on Large End of Bulb
  - Backing Electrode . . . . . Recessed Small Ball (JEDEC J1-22)
  - Collecting Electrode. . . . . Recessed Small Ball (JEDEC J1-22)
  - Collimating Electrode Recessed Small Ball (JEDEC J1-22)
- Base . . . . . 25 pin Two-Tier Deci-Quindecimal (JEDEC B25-216)
- Mounting Position . . . . . Any

MAXIMUM RATINGS:

Absolute Maximum Values

WRITE-ERASE GUNS:

(Reference Voltage is Write-Erase Gun Cathode)

Grid 2 & 4 Voltage♦	3700 max.	Volts
With Respect to Flood Gun Cathode	200 max.	Volts
Grid 3 Voltage (Focus)	3000 max.	Volts
Negative with Respect to Flood Gun Cathode	2600 max.	Volts
Grid 1 Voltage:		
Negative Bias Value.	150 max.	Volts
Positive Bias Value.	0 max.	Volts
Positive Peak Value.	2 max.	Volts
Cathode Voltage Negative with Respect to Flood Gun Cathode	3500 max.	Volts
Voltage Between any Deflection Electrode and Grids 2 & 4:♦		
Positive or Negative Peak Value.	500 max.	Volts
Peak Heater-Cathode Voltage:		
Heater Positive or Negative with Respect to Cathode	125 max.	Volts

FLOOD GUN:

(Reference Voltage is View Gun Cathode)

Viewing Screen Voltage	11000 max.	Volts
Grid 5 Voltage (Backing Electrode)	35 max.	Volts
Grid 4 Voltage (Collecting Electrode). . . .	300 max.	Volts
Grid 3 Voltage (Collimating Electrode) . . .	300 max.	Volts
Grid 2 Voltage (Accelerating Electrode)♦ .	200 max.	Volts
Grid 1 Voltage:		
Negative Bias Value.	150 max.	Volts
Positive Bias Value.	0 max.	Volts
Peak Heater-Cathode Voltage		
Heater Positive or Negative with Respect to Cathode	125 max.	Volts

LIMITING CIRCUIT VALUES

Viewing Screen Series Current-Limiting Resistance	1.0 min.	Megohm
Backing Electrode Circuit Resistance . . .	5000 max.	Ohms
Collecting Electrode Unbypassed Series Current-Limiting Resistance	22000 min.	Ohms
Grid 1 Circuit Resistance	1.0 max.	Megohm
Resistance in Any Deflecting Electrode Circuit⊕	0.2 max.	Megohm

ENVIRONMENTAL LIMITS

Atmospheric Pressure	60 max.	P.S.I.
Altitude (Non-pressurized)	60,000 max.	Feet

- Temperature:
  - Operating . . . . . 0 to 50 °C
  - Non-Operating . . . . . -55 to 100 °C
- Relative Humidity (Non-Operating) . . . . . 95 Percent
- Vibration . . . . Sinusoidal Vibration from 10 to 50 cycles per second with a total excursion of 0.015 inches and from 50 to 500 cycles per second with 2 g acceleration will not damage the tube.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Note: Damage to the 7356 may occur if the Write-Erase-Gun beam is turned on before the Flood-Gun-beam current has reached normal operating value or if the Flood-Gun beam is turned off before the Write-Erase-Gun-beam.

Reference Point for DC Voltages is Ground

WRITE-ERASE-GUNS:

Grids 2 & 4 Voltage♦	50 to 125	Volts
Grid 3 Voltage (Focus):★		
During Writing Operation	-1435 to -1375	Volts
During Selective Erasure	-3150 to -3050	Volts
Grid 1 Voltage to Write-Erase Gun Cathode	0 to -100	Volts
Cathode Voltage:★		
During Writing Operation	-1600	Volts
During Selective Erasure	-3500	Volts
Grids 2 & 4 Current♦	100	μampere
Grid 3 Current (per gun)	-10 to 5	μampere
Cathode Current	See Gun Transfer Characteristic	
Deflection Sensitivity:♦		
Deflecting Electrodes 1 and 2	32 to 40 V dc/In./KV	
Deflecting Electrodes 3 and 4	32 to 40 V dc/In./KV	
Focused Beam Position†	0.5 Inch	

FLOOD GUN:	Range	Typical	
Viewing Screen Voltage	8000 to 11000	10000	Volts
Grid 5 Voltage (Backing Electrode)	-35 to +35	10	Volts
Grid 4 Voltage (Collecting Electrode)	175 to 300	200	Volts
Grid 3 Voltage (Collimating Electrode)	5 to 150	75	Volts
Grid 2 Voltage♦	50 to 125	100	Volts
Grid 1 Voltage	0 to -50	0	Volts
Cathode			Grounded
Viewing Screen Current		250	μamperes
Grid 5 Current (Backing Electrode)		2	μamperes
Grid 4 Current (Collecting Electrode)		1.5	Ma.
Grid 3 Current (Collimating Electrode)		200	μamperes
Cathode Current		2	Ma.

♦ Grids 2 & 4 of both Write-Erase Guns are internally connected together and to Grid 2 of the View Gun.

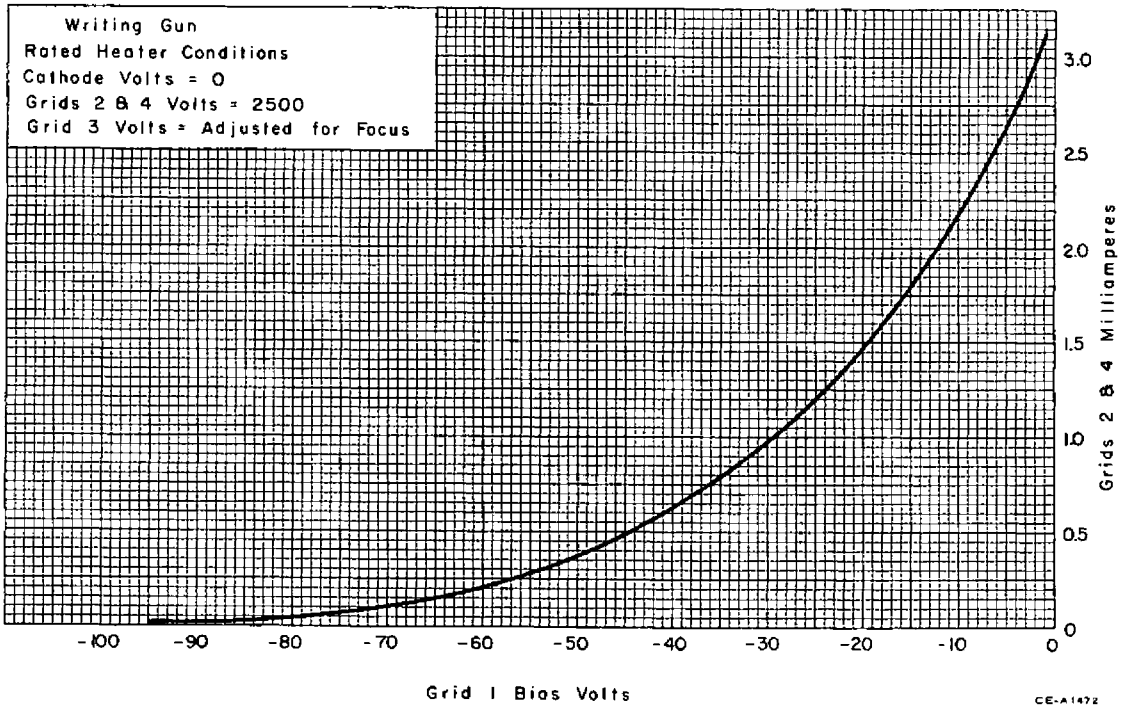
♦ Deflection Sensitivity is in Volts dc/In./KV of Accelerating Potential.

† With all deflecting electrodes tied to Grids 2 & 4, and erasure at a convenient value the undeflected, focused spots will fall within a circle of 0.5 inch radius, centered on the tube faceplate.

⊕ Approximately equal resistances should be used in each deflecting electrode circuit.

★ The accelerating voltage of the Write-Erase Guns determines their mode of operation. The second crossover potential of a typical tube is in the range from 2000 to 3000 volts. Accelerating voltages exceeding this point result in selective erasure. Writing occurs with voltages lower than second crossover. Optimum-focus voltage will change with changes in the accelerating voltage.

AVERAGE WRITING GUN ANODE TRANSFER CHARACTERISTIC



PERFORMANCE DATA

Viewing Time	5	Seconds
Erasing Time (View Gun Erasure)	50	Milliseconds
Erasing Speed (Selective Erasure)	20,000	Inches/Second
Display Uniformity (Δe_p min.)	1	Volt
Writing Speed	36,000	Inches/Second
Half Tones	3	
Brightness (Screen Voltage = 10 KV)	2500	Ft-Lamberts
Contrast Ratio	5	
Resolution	50	Lines/Inch
Grid Drive	30	Volts

Methods of Measuring Tube Performance

Viewing Time: Viewing duration is the time during which the visual output of a storage tube increases from exactly visual extinction to 10% of saturated brightness without the application of a writing signal or erase pulses. The tube shall be primed and then erased to exactly visual extinction. The erase pulses are removed and the screen allowed to increase in brightness. The time interval required for the brightness level at the center of the screen to increase to 10% of saturated brightness is the viewing duration.

Erasing Time: The storage surface is primed. Erasure is produced by a positive rectangular pulse applied to the backing electrode. The amplitude of this pulse is set to one volt above backing electrode cutoff and the pulse width necessary to erase from saturated brightness to 10% of saturation brightness is the erasing time.

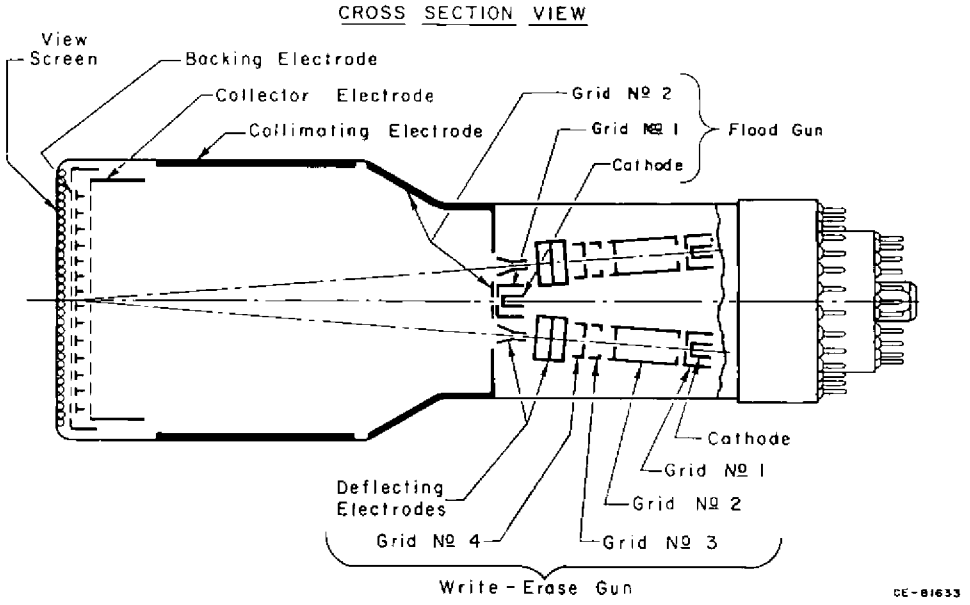
Display Uniformity (Δe_p min.): The difference between the amplitude of an erase pulse required to brighten any area of an unwritten screen, and the amplitude of an erase pulse required to evenly illuminate the screen is described as the display uniformity, (Δe_p min.). The erase pulses used for this measurement are positive rectangular pulses adjusted from 2 to 10 volts peak to peak to produce complete erasure in 50 milliseconds.

Writing Speed (Cathode Current): A raster is applied having frequencies and trace length necessary to produce a scanning speed of 36,000 inches per second. The focus electrode is adjusted for best focus at the center of the raster. The tube is erased to cutoff and a single raster is written by applying a rectangular pulse of adjustable amplitude to Grid 1 of the writing gun. The last step is repeated moving the lines of the raster progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the control grid pulse amplitude is adjusted to give a written raster of 2000 ft-L. When this brightness is achieved and the lines cannot be discerned visually, the condition of the visually limited contrast ratio exists and it is under this condition that the cathode current is measured.

Contrast Ratio: A trace is written to saturation brightness while continuously writing and erasing. Using positive rectangular erase pulses variable from 2 to 10 volts peak-to-peak, the persistence (time required for a written area to be reduced to 10% of saturated brightness) is adjusted to 2 seconds. The ratio of brightnesses in the written and unwritten areas is defined as the contrast ratio. This measurement is made with a maximum ambient brightness of 10 foot-lamberts.

Resolution: A 60 cps sawtooth voltage is applied between deflecting electrodes D_3D_4 and a 2100 to 6300 cps sawtooth voltage is applied between deflecting electrodes D_1 and D_2 giving a raster of approximately 40 lines. Blanking is used to eliminate trace return lines. Trace length shall be adjusted to 3.5 inches. Raster is expanded and number of lines determined. Focus electrode is adjusted for best focus at the center of the raster. Backing electrode is erased to cutoff and G_1, writing gun, is pulsed to write as single raster. Last step is repeated moving the lines progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the grid pulse amplitude shall be adjusted to give brightness of 1000 ft-L. When the specified brightness is achieved and the lines cannot be discerned visually, the condition for visually limited contrast ratio exists, and the resolution measured at this condition is the limiting resolution. The resolution in lines per inch is the number of horizontal lines counted when the raster was expanded divided by the height of the compressed raster.

Grid Drive: This is the drive required for writing to 90% of saturated brightness with a writing speed of 36,000 inches per second in 1 scan. Note the writing gun drive characteristic. In the useful region, writing speed is proportional to writing current.



Principles of Operation

The WL-7356 contains, in addition to a phosphor screen and Write-Erase Guns similar to those of conventional cathode-ray tubes, a storage surface, a secondary-electron collector and a Flood Gun with an electron collimating system, all of which can be seen in Cross Section View.

The storage surface is a dielectric material deposited on a fine metallic mesh called the backing electrode. Initially this surface is charged to a uniform potential near the viewing gun cathode voltage. Either or both of the writing guns scan the storage surface and create a charge pattern by secondary emission from the dielectric material. Because this dielectric material is an excellent insulator, the charge pattern does not leak away, but remains for a period of time, as long as a week under non-operating conditions. The secondary electrons liberated from the storage surface are attracted to a collecting mesh.

The reading or flood gun does not scan the screen, but produces a wide-angle beam of electrons which "floods" the entire storage mesh and penetrates through its holes to bombard the phosphor screen. The charge pattern written upon the storage surface controls the viewing gun beam in a manner similar to the control of plate current by the signal applied to the control grid of a triode. In this way the signals applied to the Write-Erase Guns are converted to patterns on the storage surface, and these produce corresponding patterns on the phosphor screen. The penetration of electrons through the storage mesh is proportional to the charge written upon it, hence, intermediate shades of gray or half-tones may be reproduced. Because of the high current density of the flood beam, the high accelerating potential on the screen, and simultaneous bombardment of all portions of the viewing screen, the display is extremely bright.

The Flood Section

The flood section consists of the following elements: a cathode, control grid, accelerating grid, collimating electrode, collecting electrode, backing electrode, and viewing screen.

The cathode is oxide coated and indirectly heated. Grids 1 & 2 are conventional aperture grids and the collimating electrode (Grid 3) is a conductive coating applied to the bulb wall. The collecting electrode (Grid 4) is a fine metallic mesh mounted slightly toward the cathode from the backing electrode.

The backing electrode (Grid 5) is an extremely fine metallic mesh upon which the dielectric or storage material is deposited. This material is on the cathode side of the mesh as shown in Cross Section View.

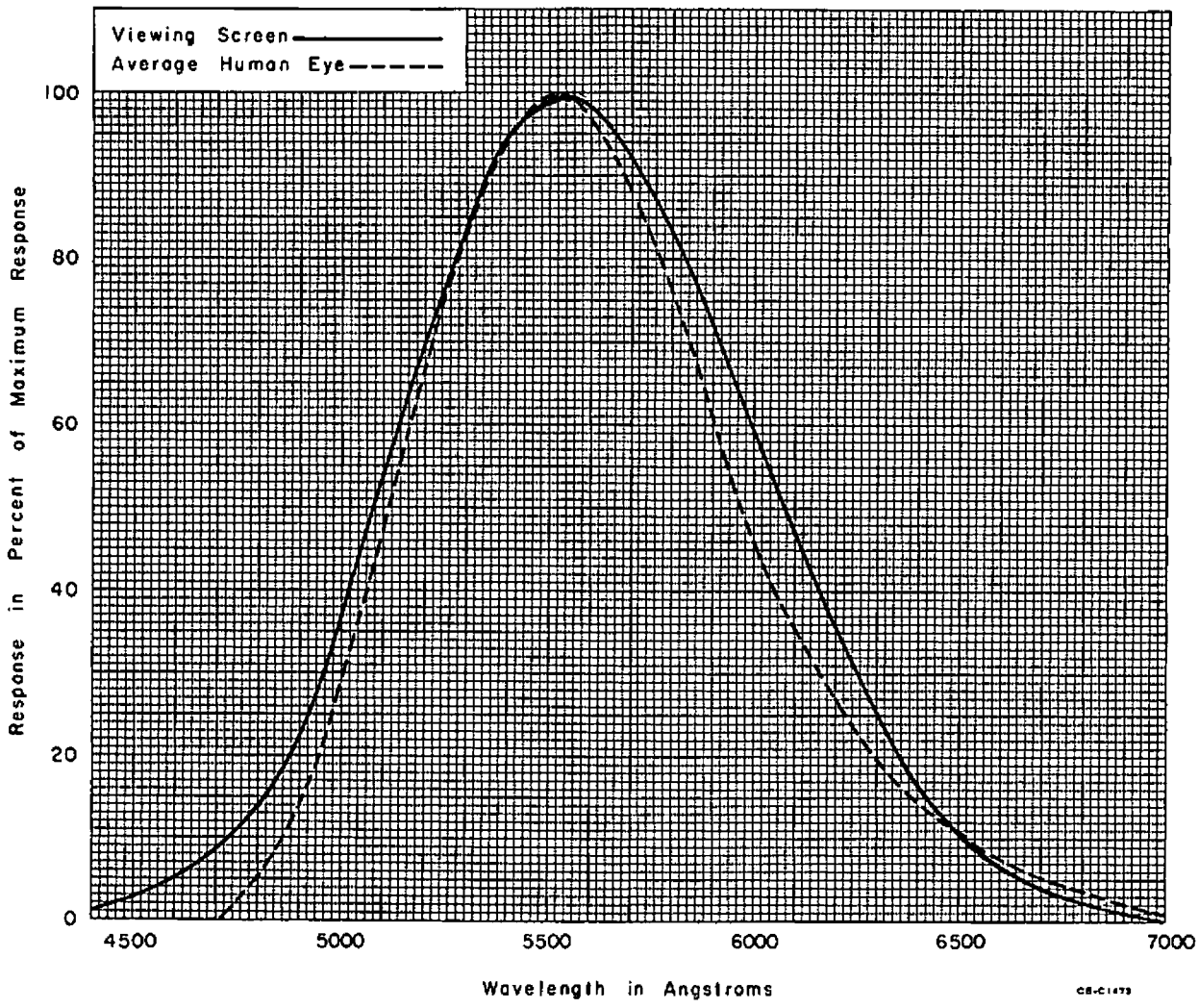
The viewing screen is an aluminized P20 phosphor having short persistence and high visual efficiency. The Spectral Response Curves show that the peak radiation from this phosphor coincides with the peak sensitivity of the human eye.

The Viewing Operation

The Flood Gun produces a wide angle, low energy, high density electron stream which continuously floods the storage surface. The electrons are highly divergent as they emerge from the aperture of the accelerating electrode (Grid 2), but by proper adjustment of Grids 2, 3, and 4, the electron stream is collimated to provide uniform, normal flooding of the backing electrode. It is necessary that all of the electrons of the viewing beam approach the storage surface in paths normal to the backing electrode in order that they will have equal energy components in this direction. Only under this operating condition will equal charges at various points on the storage surface have equal control of the flood beam. Thus, collimation is necessary for uniformity of display.

The functions of the collecting electrode are several. In addition to its effect upon collimation, it serves to accelerate electrons in the beam; it repels positive ions produced by collisions of electrons with gas

SPECTRAL RESPONSE CHARACTERISTICS



molecules in the region between cathode and collector, thus preventing destruction of the stored pattern by ions; it collects secondary electrons produced when the writing beams impinge upon the storage surface; and it collects viewing beam electrons turned back near the storage surface when its potential is negative.

When the viewing section voltages are applied, some of the flood beam electrons are intercepted by the collector mesh, and others are decelerated to near zero velocity at the storage grid. Their velocity is so low at this point that fewer secondary electrons are emitted than strike the storage surface. Thus electrons accumulate until the potential is approximately the same as the Flood Gun cathode, or zero potential.

At this time when the collimated viewing beam approaches the storage mesh, electrons cannot land upon the storage mesh, but will either return to the more positive collecting electrode or penetrate through the holes of the backing electrode to be accelerated to the phosphor viewing screen producing a bright display. The brightness of the screen under this condition is designated as "saturated brightness". A condition of equilibrium exists, and the storage surface remains charged to approximately zero potential. If the storage surface is made positive by a writing gun or other means, the surface will be immediately restored to zero potential by the viewing gun beam. If, now the backing electrode is suddenly made more positive by several volts, the storage surface will also become positive momentarily because of the very close capacitive coupling between the backing electrode and storage surface, but again the viewing beam will restore the storage surface to zero potential. If next the backing electrode is returned to its original value, the storage surface potential will drop by an equal amount to a negative potential and will retain this charge since viewing beam electrons cannot land. If this negative voltage is great enough, it will cut the viewing beam electrons preventing them from reaching the phosphor and resulting in a dark screen.

The Write-Erase Guns are used to produce a charge pattern upon the storage surface varying in potential from the storage surface cutoff value to zero potential. Since these potentials are at or below viewing gun cathode potential, no viewing beam electrons may land upon the storage surface to destroy the written pattern and it will remain until erased or degraded by positive ions produced by collision of electrons in the viewing beam with residual traces of gas between the viewing screen and collecting electrode.

Without altering its own form the stored charge pattern in thus able to control the electrons impinging upon the screen, producing a bright stored image with full tone range from visual extinction to saturated brightness.

The Write-Erase Guns

The two Write-Erase Guns are of identical design and are similar to those found in electrostatically focused and deflected oscilloscope tubes. They are capable of forming a well defined beam having high current-density resulting in excellent resolution and high writing speed.

Both guns are shown in Cross Section View and each consists of an oxide coated, indirectly heated cathode, a control electrode (Grid 1), two accelerating electrodes (Grids 2 & 4) which are internally connected, a focusing electrode (Grid 3); and horizontal and vertical deflection plates.

The Writing Operation

The Write-Erase Guns are generally operated with the cathode at -2400 volts with respect to the Flood Gun cathode. At this potential the electrons from the writing beam have sufficient energy to cause the secondary-emission ratio at the storage surface to be greater than unity. Thus, since more electrons are leaving the storage surface than are arriving, the surface assumes a less-negative potential whenever the beam strikes. Since the secondaries are attracted to the positive collecting electrode it would appear that the writing beam could charge the storage surface to collecting-electrode potential, but in practice the viewing beam lands upon the surface whenever it tends to become positive and returns it to approximately viewing-gun cathode potential.

The writing-beam electrons striking the storage surface can then result in potentials varying from storage-grid-cutoff voltage to approximately zero potential. The storage-surface potential is controlled over this range by the amplitude and duration of the writing-beam current which is determined by the signal applied to the control grid.

As was described previously, the potential at any point on the storage surface determines the number of viewing-beam electrons passing through the storage-mesh holes in that immediate vicinity. When any point is sufficiently positive to allow passage of electrons, they will be accelerated by the high viewing- screen potential and strike the phosphor directly opposite that point. The result is a bright spot on the viewing screen having a size only slightly larger than that of the corresponding point where the writing beam struck the storage surface. The brightness of this spot is directly proportional to the density and velocity of the electrons landing on the element, the density being determined by the elemental changes of the storage surface, and the velocity by the potential of the viewing screen.

The image brightness may be varied by adjusting the screen potential, but because the screen is aluminized, the light output decreases rapidly below 5000 volts. Operation below this value is not recommended.

The Erasing Operations

Flood Gun Erasure (Overall)

A method of preparing the storage surface for the writing operation has already been described under The Viewing Operation. This technique, which involves charging the storage surface to a negative value by the momentary application of a positive potential to the backing electrode, is actually an erasing method known as static erasure.

Static Erasure

During the application of the positive potential to the backing electrode, viewing-beam electrons land on the storage surface and drive it uniformly to cathode potential thus erasing any stored information.

A disadvantage of this method is that during erasure and subsequent re-writing no information or only incomplete information is displayed. Also the entire screen is illuminated to the saturation-brightness level or higher during erasure.

Dynamic Erasure

In most applications it is desirable to present a display which gradually decays after a given interval of time. This type of operation may be obtained by applying a continuous series of positive pulses to the backing electrode at a rate sufficiently fast to prevent visible phosphor flicker. The technique of applying a series of pulses to the backing electrode is known as dynamic erasure.

The amount of charge erased during each erase pulse depends upon pulse duration, shape and amplitude. These factors together with erasing-pulse repetition frequency determine the rate at which the observed display decays.

If the erasing pulses are smaller in amplitude than the viewing-beam cutoff voltage, erasure will not be complete, whereas if the pulses are greater than cutoff they will eventually drive the storage surface below cutoff or "blacker than black". Therefore it is not advisable to use erase pulse amplitude as a means of adjusting erasing time.

When a rectangular erasing pulse is used, all portions of the storage surface will simultaneously become positive with respect to the viewing-gun cathode and viewing-beam electrons will be deposited at nearly the same rate over the entire surface regardless of initial charge. Thus charges representing the brighter elements will remain after other elements have been erased and the brighter areas will be visible for a longer period than the darker areas.

If a positive-going sawtooth erasing pulse is used, the least-negative storage elements will reach cathode potential before the remaining elements, thus allowing viewing-beam electrons to land on elements representing brighter areas for a longer period than on those representing darker areas. With this type of proportional erasure, half-tones will persist as long as bright areas.

For applications involving half-tone display, the rectangular erase pulses should be adjusted in amplitude so that the storage surface is charged to exactly cutoff potential by the erasing operation.

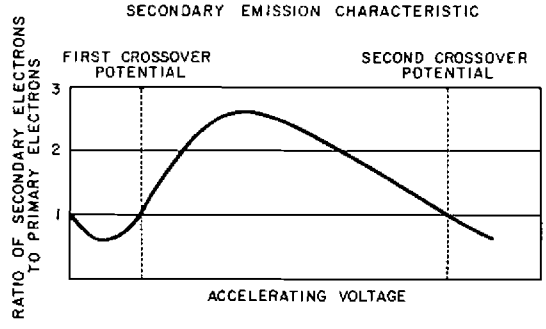
For applications such as radar, where noise must be suppressed, a more positive erase pulse may be used to drive the storage surface several volts below cutoff. The writing beam must then scan the surface several times to bring the written elements above cutoff.

If possible the erase-pulse amplitude should be adjusted so that the noise component of the writing gun signal is just sufficient to bring the storage surface to cutoff. The signal above this level will than allow

viewing-beam electrons to produce a display representing that signal without any noise background.

Write-Erase Gun-Erasure (High Speed Selective)

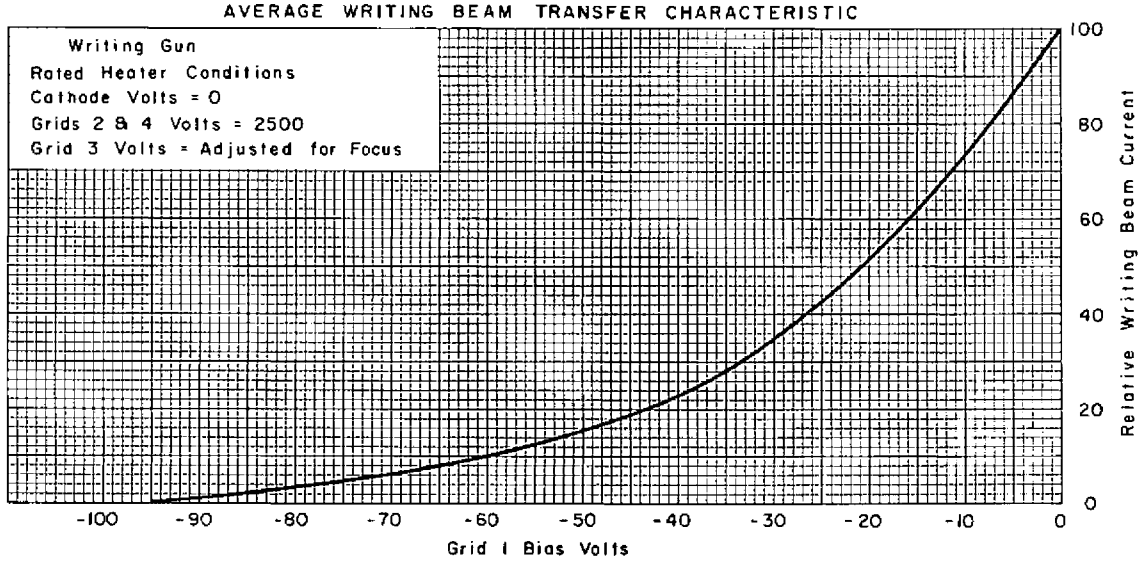
It is often advantageous to erase a specific part of the stored signal without erasing other parts. As the total electron-volt energy of the beam increases from zero volts, the secondary-emission ratio first decreases then increases to a maximum value, substantially greater than unity. This maximum usually



occurs at 1200 volts for the 7356. In the interest of better resolution, operation of the writing gun at 1600 volts is recommended. As the voltage of the electron beam increases further, the secondary emission ratio goes below unity, and it becomes possible to use the beam for selective erasure. With the 7356 selective erasure of reasonable speed usually occurs at a voltage of the order of 2400 volts. This high velocity erase mode has many advantages. The erase beam has high resolution resulting in much greater selectivity. The erase beam is also capable of much greater density. The greater beam density results in a faster erasing speed, and also results in substantially less interaction between guns used simultaneously in the write or erase modes.

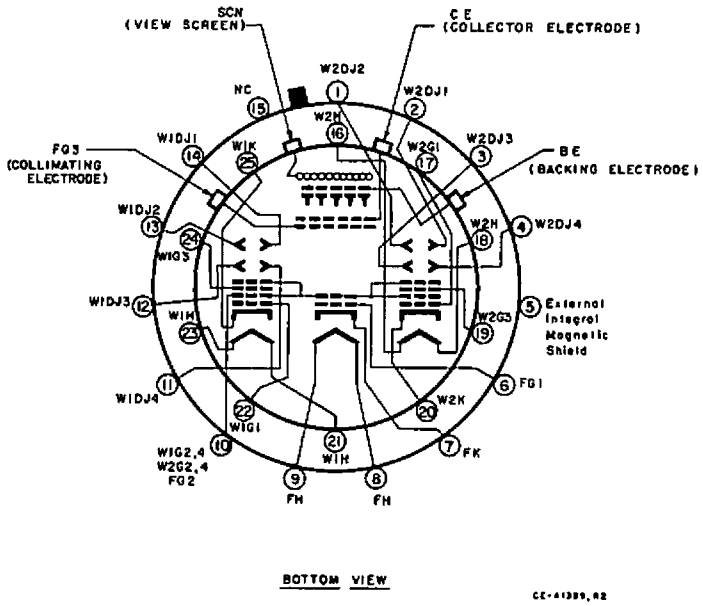
A serious drawback of a low-velocity-erase system is the effect of the collimating optics of the flood gun on the erase beam. Since the erase beam is of the same order of velocity as the flood beam in this system, the collimating optics of the flood gun converge not only the flood beam, but also the erase beam. The erase beam tends to be deflected toward the center of the tube by the collimating lenses. Consequently, a low velocity erase beam is very difficult to control and has serious non-uniformities in deflection linearity.

Since the 7356 utilizes a selective erase system with a high-velocity beam, it is essentially free from distortions of the type described above. The 7356 maybe employed as a direct view storage tube with two separately focused and deflected writing guns. Simply by rasing the potential of one of the writing guns, the tube becomes a direct view storage tube with high selectivity and speed of erasure.



INDEX of TERMINALS

Pin No.	Gun	Element
1	Write-Erase (2)	Deflection Electrode 2
2	Write-Erase (2)	Deflection Electrode 1
3	Write-Erase (2)	Deflection Electrode 3
4	Write-Erase (2)	Deflection Electrode 4
5	External Integral Magnetic Shield	
6	Flood	Grid 1
7	Flood	Cathode
8	Flood	Heater
9	Flood	Heater
10	Write-Erase (1 & 2)	Grids 2 & 4
	Flood	Grid 2
11	Write-Erase (1)	Deflection Electrode 4
12	Write-Erase (1)	Deflection Electrode 3
13	Write-Erase (1)	Deflection Electrode 2
14	Write-Erase (1)	Deflection Electrode 1
15	No Connection (Do NOT Use)	
16	Write-Erase (2)	Heater
17	Write-Erase (2)	Grid 1
18	Write-Erase (2)	Heater
19	Write-Erase (2)	Grid 3
20	Write-Erase (2)	Cathode
21	Write-Erase (1)	Heater
22	Write-Erase (1)	Grid 1
23	Write-Erase (1)	Heater
24	Write-Erase (1)	Grid 3
25	Write-Erase (1)	Cathode

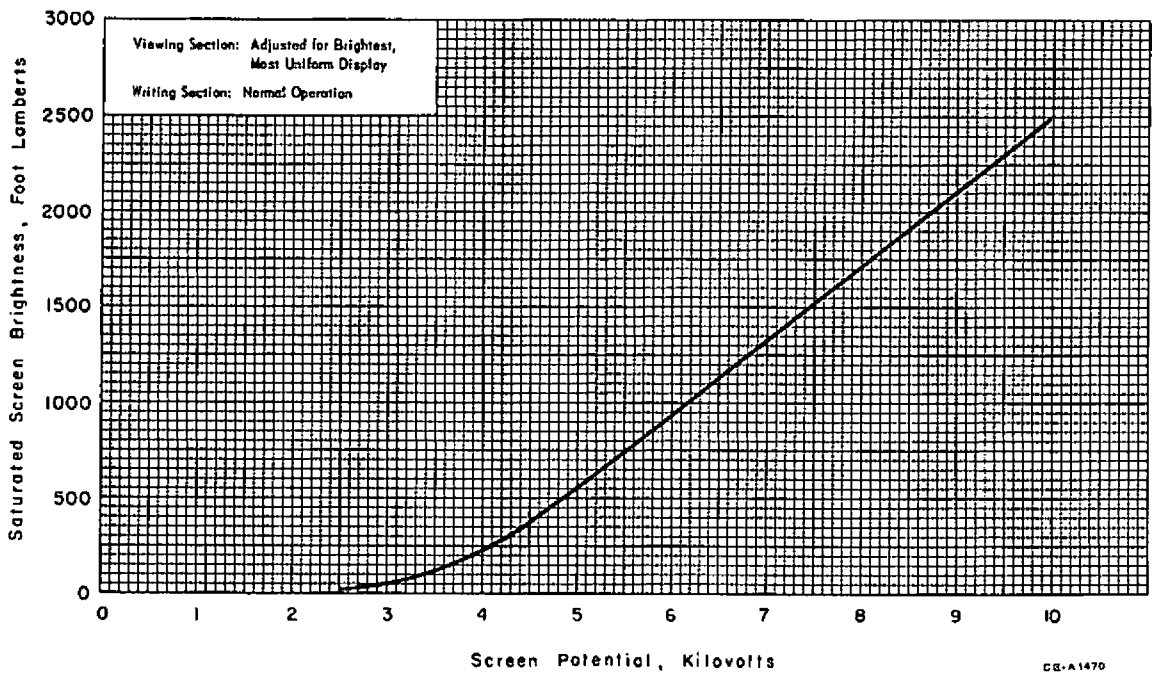


BULB CAPS

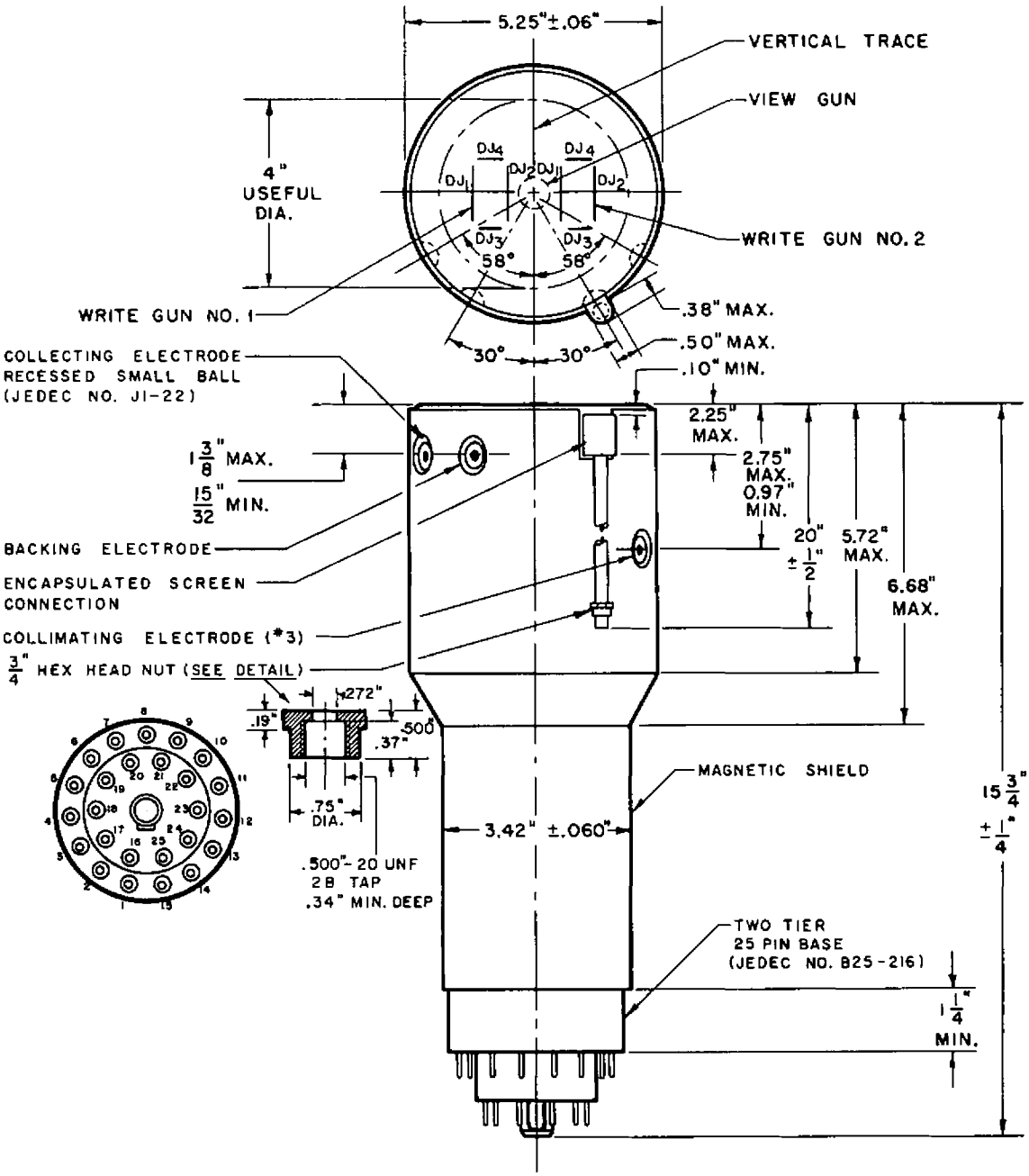
Flood Grid 3 (Collimating Electrode)
Collection Electrode
Backing Electrode
View Screen

Note: Write-Erase guns 1 & 2 are identical. Either may be used for writing or selective erasure.

SCREEN BRIGHTNESS AS A FUNCTION OF SCREEN POTENTIAL



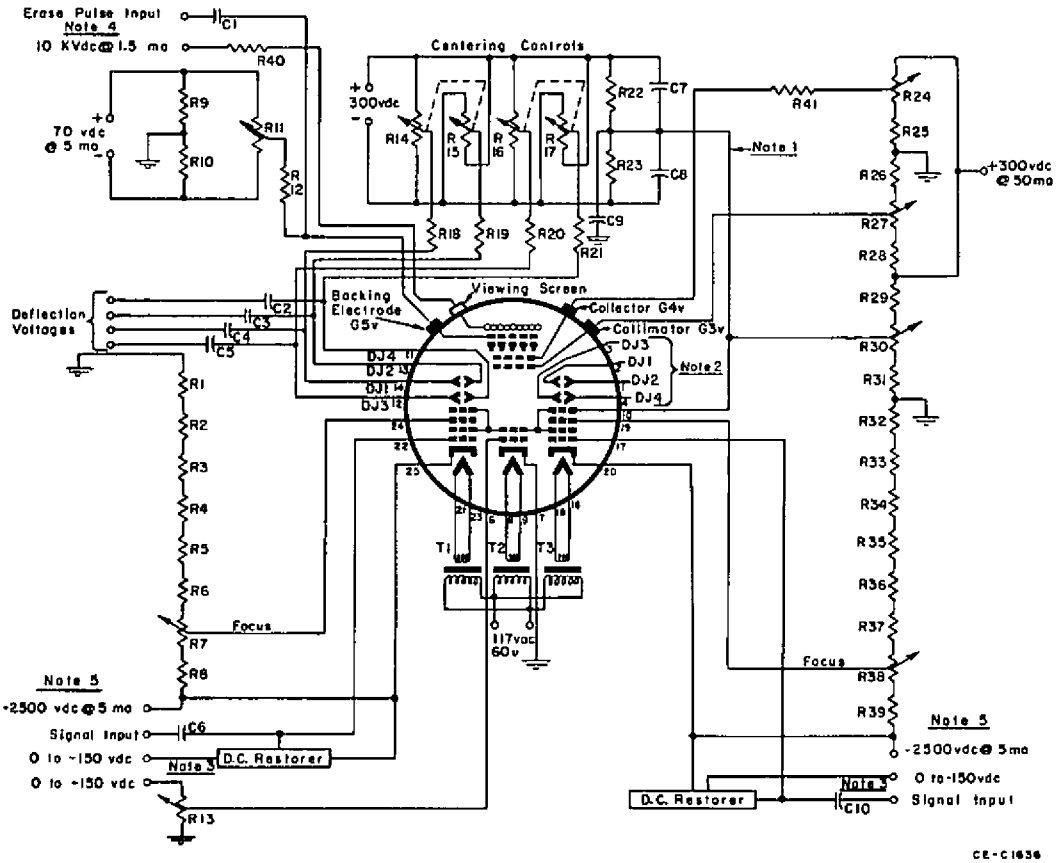
OUTLINE DRAWING



NOTES:

1. CENTERLINE OF BULB AXIS TO BE NOT MORE THAN 3° FROM A PERPENDICULAR ERECTED AT CENTER OF FACEPLATE.
2. FACEPLATE TO BE EVEN WITH SHIELD EDGE OR EXTEND BEYOND SHIELD BY LESS THAN 1/16".

CE-C1483



Note 1: The mean deflection potential is referred to the writing gun final anode potential to prevent astigmatism.
Note 2: Centering and deflection circuitry for Writing Gun 2 is similar to that shown for Writing Gun 1.
Note 3: Voltages are with respect to each writing gun cathode. Entire supply must be insulated from ground for 4000 volts.
Note 4: Erase Pulse Characteristics, Amplitude: 0 to 10 volts peak-to-peak, Width: 2 to 10 microseconds, Frequency: 0 to 1000 pulses per second
Note 5: Power supply requirement for gun to be used for selective erasure is −3000 volts.

C_1: 0.1 μf, 200 volts

C_2, C_3, C_4, C_5: Value depends on deflection-voltage frequency and waveform

C_6, C_{10}: Value depends on signal-voltage frequency and waveform, 4000 volts

C_7, C_8: 0.05 μf, 600 volts

C_9: 0.5 μf, 600 volts

R_1, R_{32}: 91,000 ohms, 1 watt

R_2, R_{25}, R_{29}, R_{33}: 100,000 ohms, 1 watt

R_3, R_4, R_5, R_6, R_{34}, R_{35}, R_{36}, R_{37}: 470,000 ohms, 2 watts

R_7: Write Gun 1 Focus Control, 250,000-ohm potentiometer, 2 watts

R_8, R_{39}: 180,000 ohm, 1 watt

R_9, R_{10}, R_{22}, R_{23}: 1 megohm, 0.5 watt

R_{11}: Backing Electrode Control 100,000-ohm potentiometer, 2 watts

R_{12}: 5,000 ohm, 1 watt

R_{13}: View Gun Grid 1 Control, 250,000-ohm potentiometer 2 watts

R_{14}, R_{15}: Write Gun 1 DJ_1 & DJ_2 Centering Controls Dual 1 megohm potentiometers, 2 watts

R_{16}, R_{17}: Write Gun 1 DJ_3 & DJ_4 Centering Controls Dual 1 megohm potentiometers, 2 watts

R_{18}, R_{19}, R_{20}, R_{21}: 100,000 ohm, 0.5 watt

R_{24}: Collector Control, 200,000-ohm potentiometer, 2 watts

R_{26}, R_{28}, R_{31}: 51,000 ohm, 1 watt

R_{27}: Collimator Control, 200,000-ohm potentiometer, 2 watts

R_{30}: Accelerating Anode Control, 150,000 ohm potenti- 2 watts

R_{38}: Write Gun 2 Focus Control, 250,000-ohm potentiometer, 2 watts

R_{40}: 1 megohm, 5 watts

R_{41}: 22,000 ohm, 1 watt

T_1, T_3: Filament Transformer Primary 117 volts, Secondary 6.3 volts @ 1 ampere Insulated for 4000 volts

T_2: Filament Transformer Primary 117 volts, Secondary 6.3 volts @ 1 ampere.

The information contained herein is furnished without assuming any obligations. The description and illustration of circuits herein does not convey to the purchaser of tubes any license for circuits under the patent claims of Westinghouse Electric Corporation or others.

Westinghouse®

WL-7363

March 13, 1959

THYRATRON TYPE WL-7363

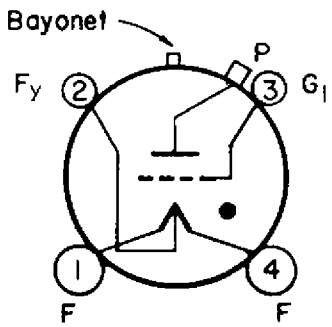
The WL-7363 tube is a three-electrode, inert gas-filled thyratron with a negative control characteristic. This tube is designed primarily for inverter and industrial control applications.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Filament Current at Bogey Voltage	--	8.5	10	Amperes
Filament Heating Time	10	--	--	Seconds
Critical Grid Voltage			See CE-A1088	
Grid Current Before Conduction				
Zero Anode Current			See CE-A1089	
Rated Anode Current			See CE-A1090	
Grid Current During Conduction.			See CE-A1091	
Typical Deionization Time			See CE-A1442	
Ionization Time (approx)		10		μsecond
Typical Anode Voltage Drop		16		Volts
Direct Interelectrode Capacitances:				
Anode-Grid Capacitance		0.35		$\mu\mu$f
Grid-Cathode Capacitance		11.5		$\mu\mu$f
Anode-Cathode Capacitance		5.1		$\mu\mu$f

MECHANICAL:

Type of Cooling	Air, convection
Mounting Position	Any
Cap, medium, ceramic insert	JEDEC C1-5
Base . . . . . Medium 4-Pin Bayonet, Metal Shell	JEDEC A4-10
Basing	4CF
Bulb	T-12
Net Weight (approx.)	3 oz
Shipping Weight (approx.)	24 oz

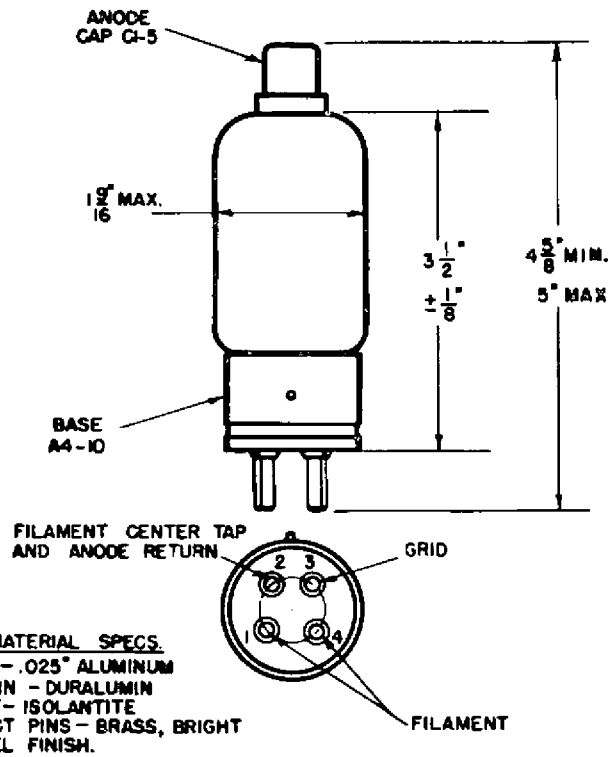


JETEC
4CF

BASE CONNECTIONS

F – Filament
G_1 – Control Grid
P – Plate & Anode
F_y – Filament Center Tap & Anode Return

CE-A1102



BASE MATERIAL SPECS.
1. SHELL – .025" ALUMINUM
2. SIDE PIN – DURALUMIN
3. INSERT – ISOLANTITE
4. CONTACT PINS – BRASS, BRIGHT NICKEL FINISH.

Thyratron Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #2432, April 6, 1959

MAXIMUM RATINGS■

Absolute Maximum Values:

Peak Anode Voltage			
Forward	1500	max.	volts
Inverse	1500	max.	volts
Cathode Current:			
Peak	20	max.	amp
Average	1.6	max.	amp
Fault (surge) maximum duration 0.1 sec:♦			
Connection (a)	240	max.	amp
Connection (b)	120	max.	amp
Connection (c)	120	max.	amp
Maximum Average Time	15	max.	sec
Commutation Factor▲	10	max.	va/μsec
Current Rate of Change	0.07	max.	amp/μsec
Voltage Rate of Change	150	max.	v/μsec
Negative Control Grid Voltage:			
Before Conduction	-250	max.	volts
During Conduction:♦	-10	max.	volts
Average Positive Control Grid Current:			
Averaging Time=1 cycle:§	0.10	max.	amp
Ambient Temperature Limits	-55 to +70	max.	°C
Maximum Frequency			See CE-A1442

♦ These ratings are effective only when connections are made as shown in CE-A1103.

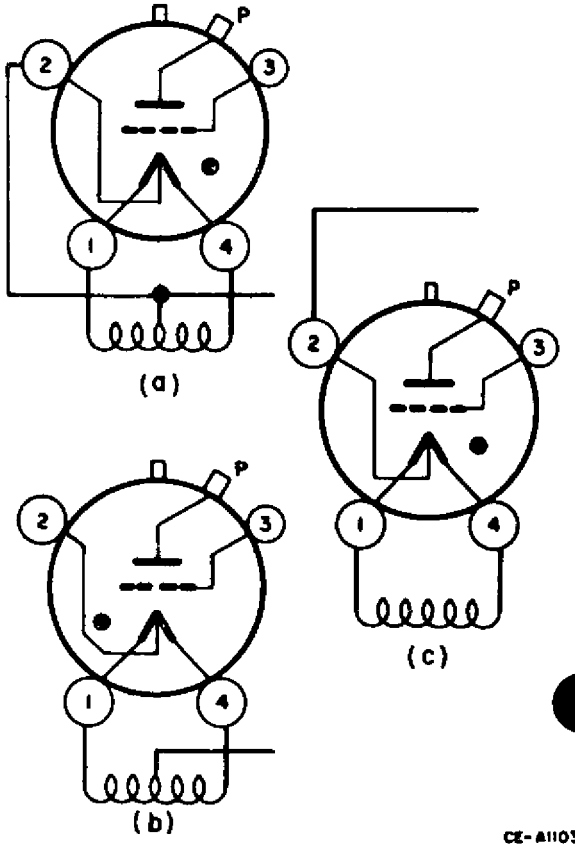
■ These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

▲ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Limits are given on both components of this factor to correspond to factory test data limits. The limit on current rate of change is about at the highest value which is allowable under the fault current limit.

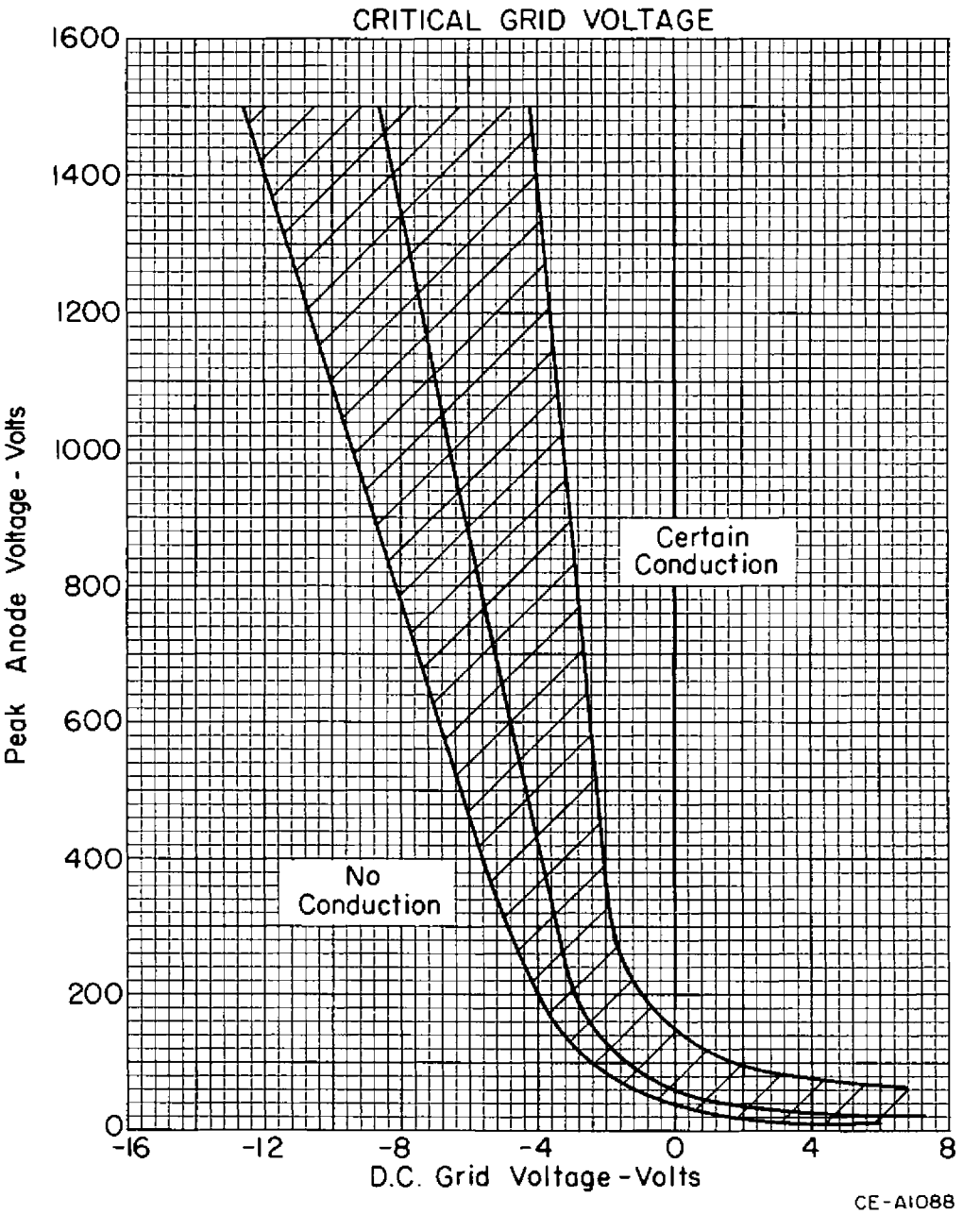
♦ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings. The magnitude of the grid current during conduction is shown by the curves of CE-A1091.

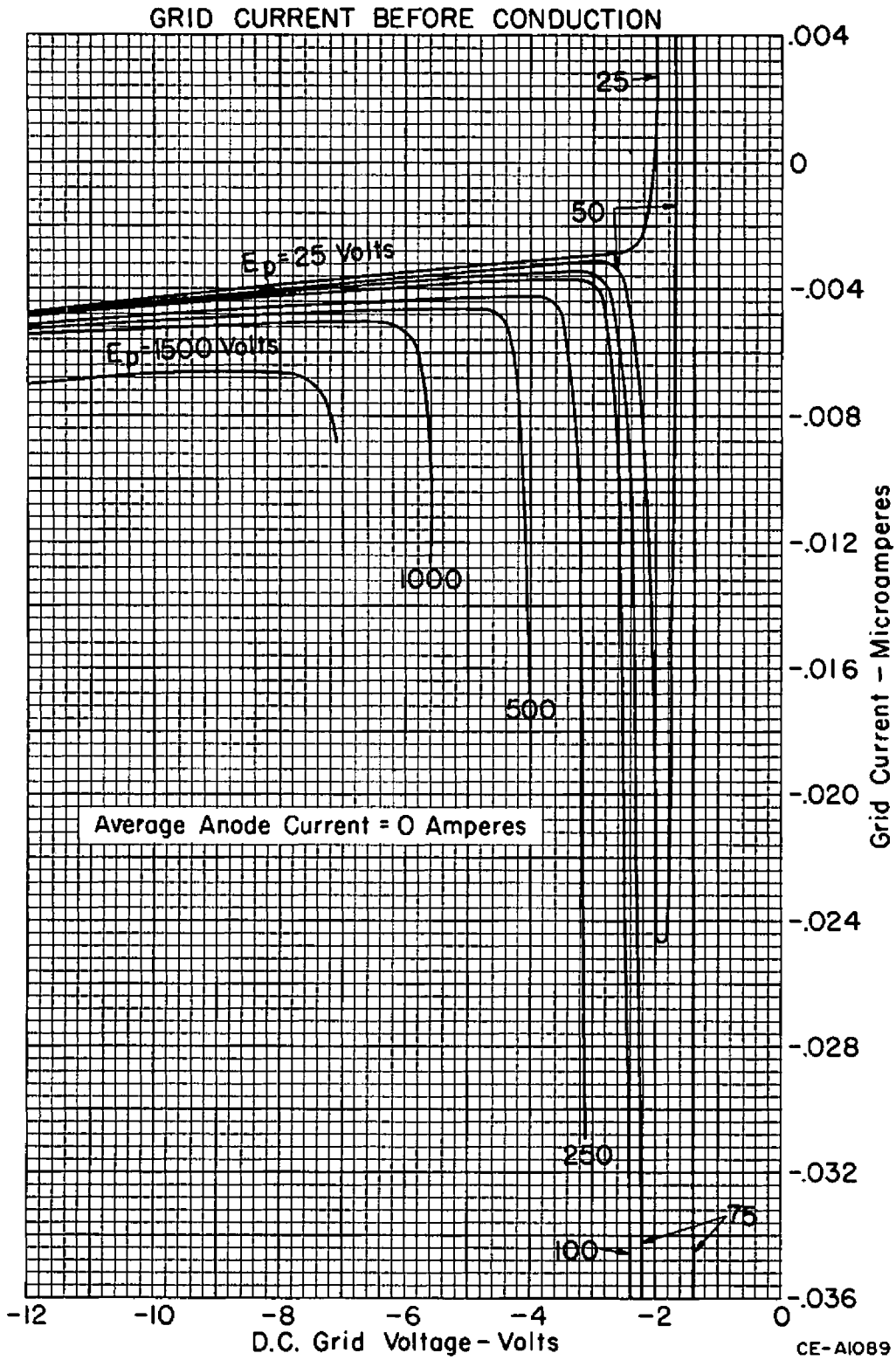
§ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

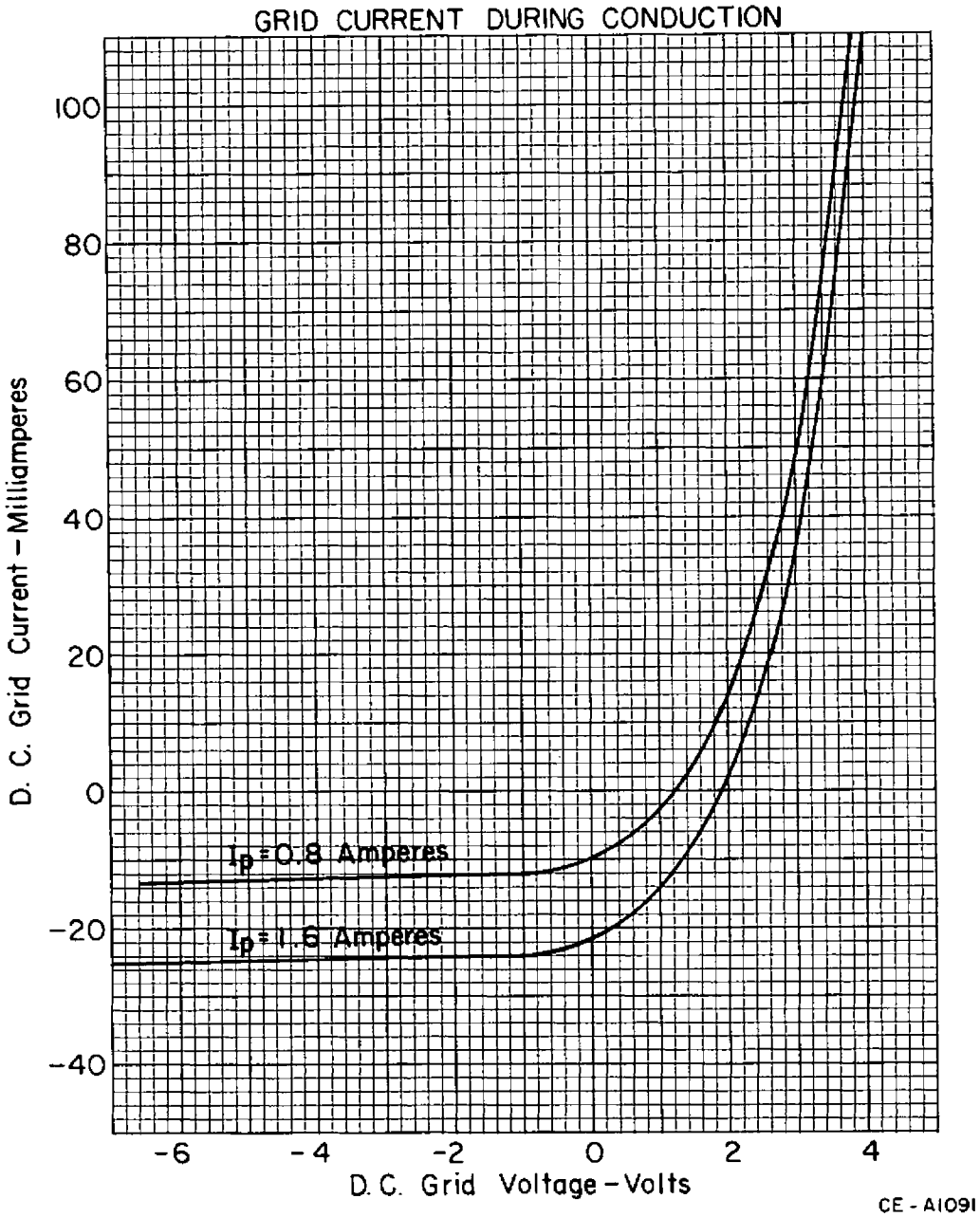
ANODE RETURN CONNECTIONS



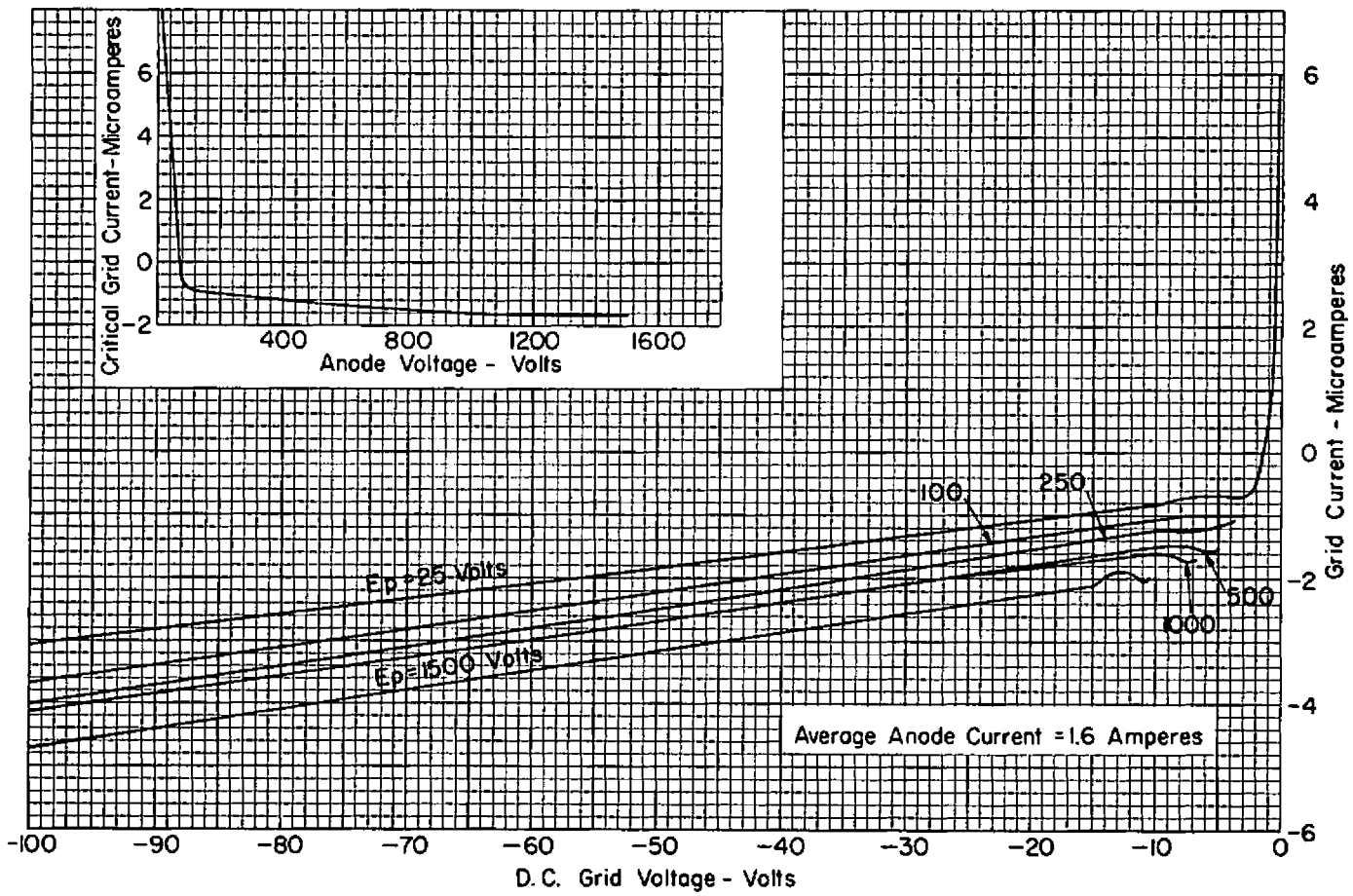
CE-A1103


CRITICAL GRID VOLTAGE
1600
1400
1200
1000
800
600
400
200
0
Peak Anode Voltage - Volts
Certain Conduction
No Conduction
-16
-12
-8
-4
0
4
8
D.C. Grid Voltage - Volts
CE-A1088


GRID CURRENT BEFORE CONDUCTION
.004
0
-.004
-.008
-.012
-.016
-.020
-.024
-.028
-.032
-.036
Grid Current - Microamperes
25
50
Ep=25 Volts
Ep=1500 Volts
1000
500
Average Anode Current = 0 Amperes
250
75
100
-12
-10
-8
-6
-4
-2
0
D.C. Grid Voltage - Volts
CE-A1089

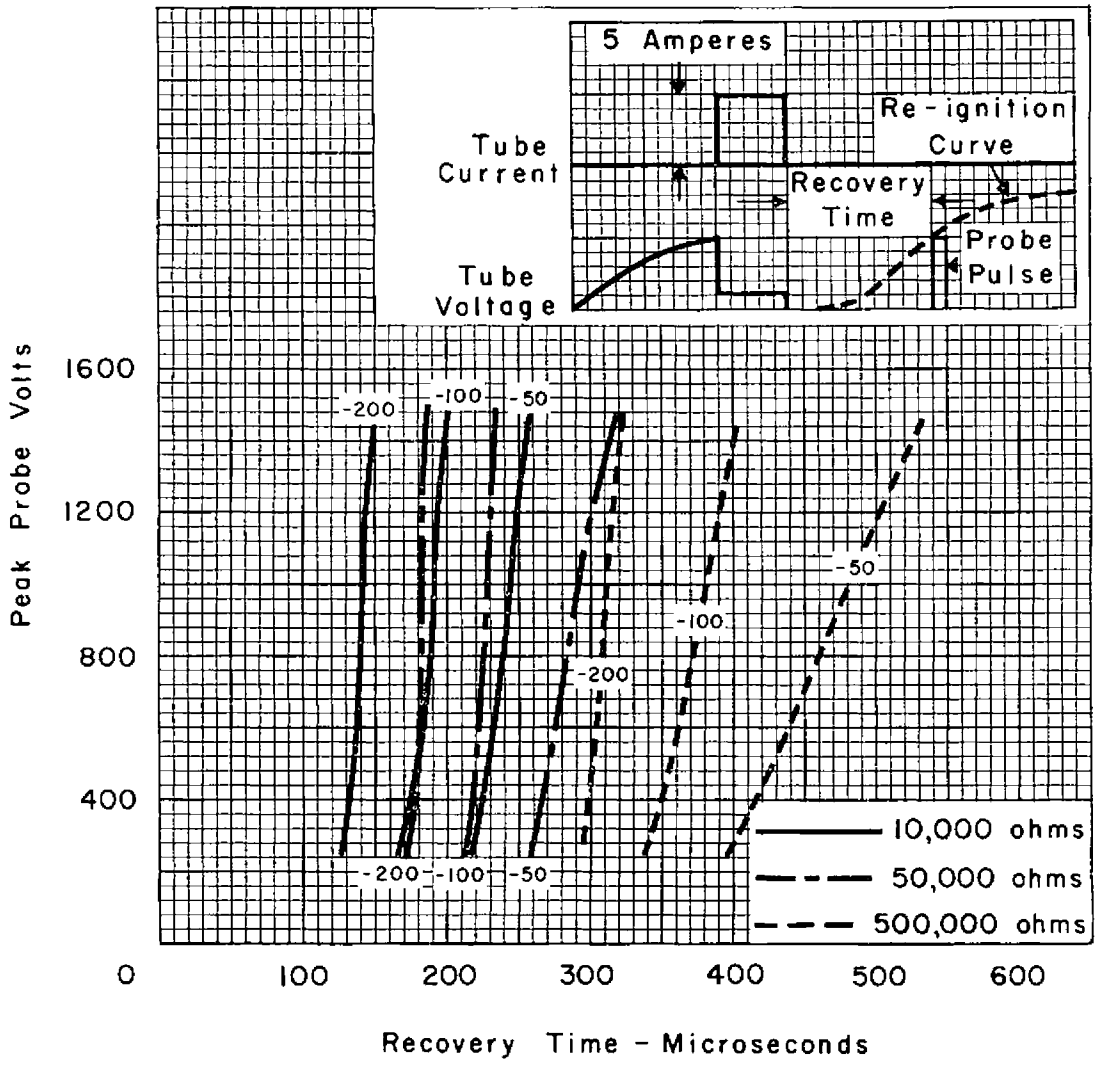

GRID CURRENT DURING CONDUCTION
100
80
60
40
20
0
-20
-40
D. C. Grid Current – Milliamperes
I_p = 0.8 Amperes
I_p = 1.6 Amperes
-6
-4
-2
0
2
4
D. C. Grid Voltage – Volts
CE - A1091

GRID CURRENT BEFORE CONDUCTION



CE-A1090

TYPICAL RECOVERY TIME



CE-A1442

LINEAR BEAM-POWER PENTODE TYPE WL-7371

The WL-7371 is a beam-power pentode designed for service in the linear amplifier stages of Single-Sideband-Suppressed-Carrier transmitters. The radiation cooled anode can dissipate 75 watts. The cathode is a thoriated tungsten filament. Maximum ratings apply up to 175 megacycles.

The WL-7371 incorporates a vane-type suppressor grid which permits high-efficiency linear-radio-frequency-amplifier performance with zero suppressor-grid voltage. Its high-perveance design and high power sensitivity enable the WL-7371 to deliver high power output with low power-supply voltage and driving power requirements.

ELECTRICAL:

Cathode		Thoriated Tungsten Filament		
Filament:	Min.	Bogey	Max.	
Voltage	--	6.3	--	Volts
Current	3.0	3.2	3.6	Amperes
Grid 1 to Grid 2 Amplification Factor		5		
Direct Interelectrode Capacitances:	Min.	Bogey	Max.	
Grid 1 to Plate	--	0.06	0.1	μμf
Input	5.4	7.5	7.6	μμf
Output	3.5	4.2	4.9	μμf
Transconductance:				
Plate Volts = 500, Grid 2 Volts = 400, Plate Milliamperes = 150			4500	μmhos

MECHANICAL:

Mounting Position	Vertical
Cooling:	
Below 160 Mc.	Unrestricted Convection
Above 160 Mc.	15 CFM Air Flow on Anode Seal
Maximum Bulb Temperature	180°C
Base♦	7-Pin Septar (JEDEC E7-2)
Top Cap	Skirted Small
Net Weight	3.6 Ounces
Shipping Weight	3 Pounds

MAXIMUM RATINGS

Continuous Commercial Service

	Class AB_1	Class C		
DC plate Voltage	2000	2000	max.	Volts
DC Grid 2 Voltage	600	600	max.	Volts
DC Grid 3 Voltage (Suppressor)	100	100	max.	Volts
DC Plate Current	175	175	max.	Ma.
Grid 2 Power Input	10	10	max.	Watts
Plate Dissipation	75	75	max.	Watts

CLASS AB_1 LINEAR AMPLIFIER

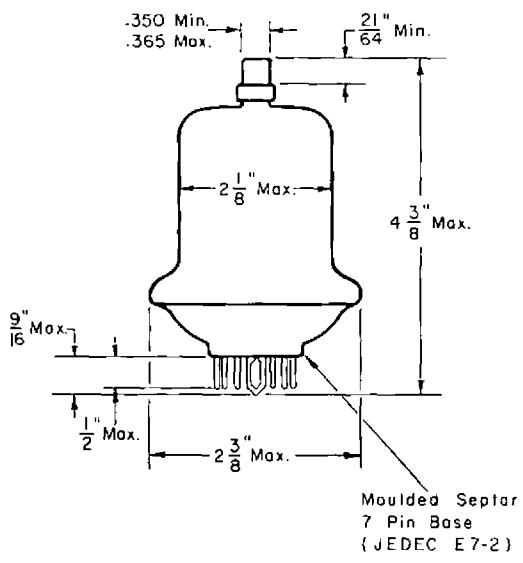
TYPICAL OPERATING CHARACTERISTICS

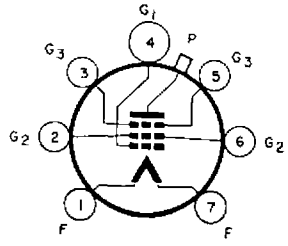
Single-Sideband-Suppressed-Carrier (Intermittent Modulation)*

DC Plate Voltage	1000	1500	2000	Volts
DC Grid 3 Voltage (Suppressor)	0	0	0	Volts
DC Grid 2 Voltage	600	600	600	Volts
DC Grid 1 Voltage (Control)	-100	-110	-115	Volts
Plate Current:				
Zero Signal	38	30	25	Ma.
Maximum Signal	175	175	175	Ma.
Grid 2 Current: (Screen)				
Zero Signal	0	0	0	Ma.
Maximum Signal	10	8	7	Ma.
Peak RF Grid Voltage	100	110	115	Volts
Maximum Signal Plate Power Input	175	260	350	Watts
Maximum Signal Plate Dissipation	70	110*	125*	Watts
Maximum Signal Power Output to Load	96	140	210	Watts

♦ Base fits Johnson No.122-101 or 122-247 or National No.HX-29 socket.

* During normal voice modulation, average plate dissipation will not exceed 75 watts.





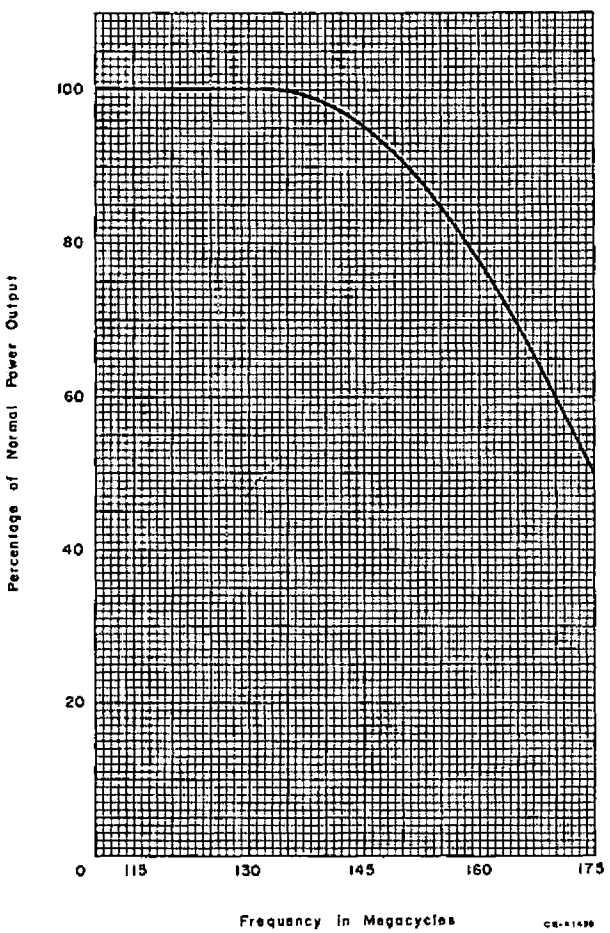
from JEDEC release #2656, Dec. 7, 1959

CLASS C AMPLIFIER
CW. or FM

TYPICAL OPERATING CHARACTERISTICS
For Frequencies up to 175 Mc.

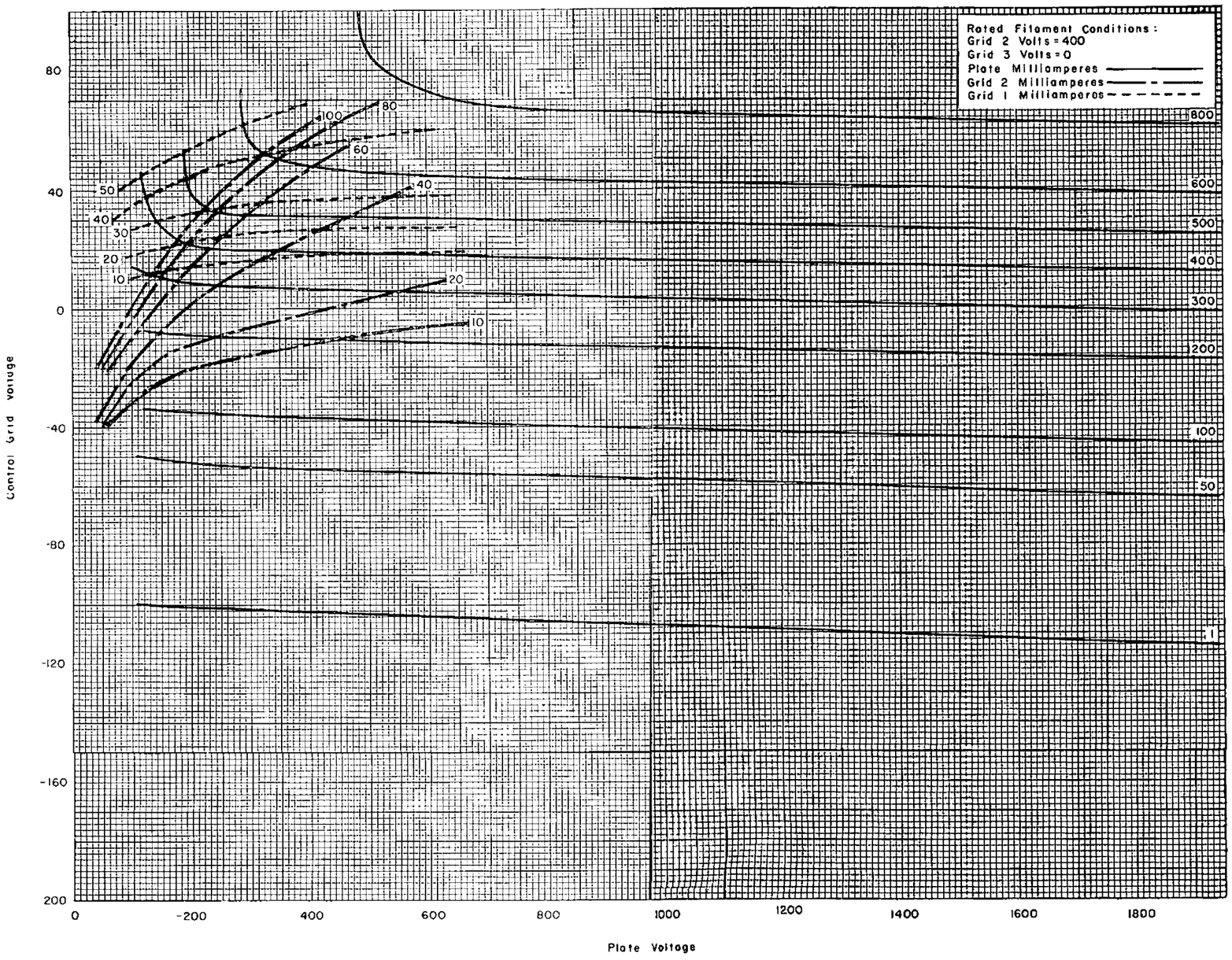
DC Plate Voltage	1000	1000	1500	1500	2000	2000	Volts
DC Grid 3 Voltage (Suppressor)	0	+50	0	+50	0	+50	Volts
DC Grid 2 Voltage	400	400	400	400	600	400	Volts
DC Grid 1 Voltage (Control)	-140	-150	-160	-170	-200	-200	Volts
DC Plate Current	127	166	140	146	144	140	Ma.
DC Grid 2 Current	19	10	18	8	9	6	Ma.
DC Grid 1 Current (Control)	5	5	3	3	2.5	2.5	Ma.
Peak RF Grid 1 Voltage	190	215	218	220	238	250	Volts
Driving Power	1.2	1.2	1.0	1.0	0.5	0.5	Watts
Plate Power Input	127	166	210	219	288	280	Watts
Grid 2 Power Input	7.5	4	7.2	3.2	5.4	2.4	Watts
Plate Dissipation	47	52	60	58	69	61	Watts
Power Output	80	114	150	161	219	219	Watts

FREQUENCY OPERATING CURVE



Westinghouse®

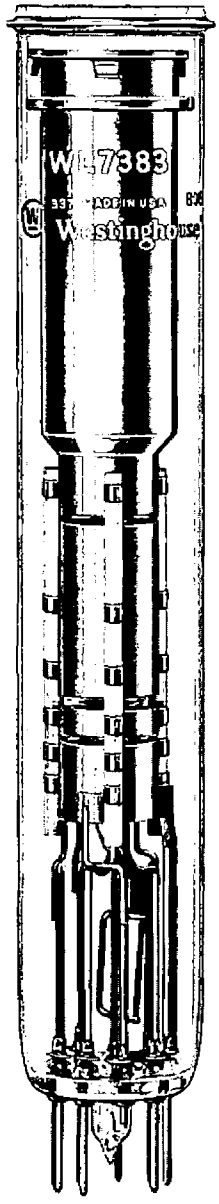
AVERAGE CONSTANT CURRENT CHARACTERISTICS



PICKUP-STORAGE TUBE TYPE-7383
(PERMACHON)

The WL-7383 is a 1" pickup-storage tube designed for high resolution, long storage continuous readout applications. Storage is excellent both in terms of resolution and duration of the stored image. The WL-7383 can be operated in a standard vidicon camera (with modifications) and offers a gray scale rendition comparable to conventional pickup tubes. The tube possesses signal integrating properties. It is convenient for many practical purposes to regard the tube as a sensitive photographic film in determining the exposure time of the scene whose image is to be stored. The tube when allowed to view at very low light levels offers a noticeable improvement on the performance of the human eye.

The Permachon may also be used in reduced-bandwidth-transmission applications not requiring storage by employing scan frame times of approximately 25 seconds. Slow scan operation can only be achieved by maintaining continuous, stationary, light-information on the input during readout. No integration of information occurs during this mode of operation.



ELECTRICAL:

Cathode	Coated Unipotential
Heater:	
Voltage (ac or dc)	6.3 ± 10% Volts
Current	0.6 Ampere
Direct Interelectrode Capacitance:	
Signal Electrode to all other Electrodes	4.5 $\mu\mu f$
Spectral Response	from 3000 to 7000 Angstroms
Photoconductive Layer:	
Orientation of Tube to Scan	Proper orientation is obtained when the horizontal scan is essentially parallel to the plane passing through the tube axis and short index pin.
Focus Method	Magnetic
Deflection Method	Magnetic

MECHANICAL:

Overall Length	6-1/4" ± 1/4"
Greatest Diameter	1.125" ± 0.010"
Bulb	T-8
Base	Small-Button, 8-Pin (JETEC E8-11)
Operating Position	Any

MAXIMUM RATINGS:

Absolute Maximum System

Signal-Electrode Voltage	15 max. Volts
Grids 4 & 5 Voltage	350 max. Volts
Grid 3 Voltage	350 max. Volts
Grid 2 Voltage	350 max. Volts
Grid 1 Voltage:	
Negative Bias Value	125 max. Volts
Positive Bias Value	0 max. Volts
Heater-Cathode Voltage:	
Heater Negative with Respect to Cathode	125 max. Volts
Heater Positive with Respect to Cathode	10 max. Volts
Ambient Temperature	45 max. °C

from JEDEC release #2597, Oct. 5, 1959

TYPICAL OPERATION AND CHARACTERISTICS:

For Scanned Area of 1/2" × 3/8"

Signal-Electrode Voltage▲	6 to 14	Volts
Grid No.4 (Decelerator) & Grid No.3 & Grid 5 (Beam Focus) Voltage	250	Volts
Grid 2 (Accelerator) Voltage	300	Volts
Grid 1 Voltage: (For Picture Cutoff)□	-45 to -100	Volts
Dark Current†	0.1 - 0.7	μampere
Initial Signal Current♦	0.3 - 1.0	μampere
Holding Signal Current♦	0.2 - 0.9	μampere
Min. Peak-to-Peak Blanking Voltage: §		
When Applied to Grid 1	40	Volts
When Applied to Cathode	10	Volts
Field Strength at Center of Focusing Device	40	Gausses
Field Strength of Adjustable Alignment Coil	0 to 4	Gausses
Approx. Storage Time:▲		
600 TV Line Resolution⊕	5	Minutes
450 TV Line Resolution⊕	10	Minutes
Sensitivity■		

▲ Optimum storage is achieved by operating about 12 volts. Storage time is decreased as signal electrode voltage is decreased.

□ With no blanking voltage on Grid 1.

† For signal electrode voltages from 6 to 14 volts, and after integration.

♦ Holding signal current, obtained during read-out, will normally be less than initial signal current, obtained during write (optical input). For 0.6 foot-candle faceplate illumination during write initial signal current varies from 0.3 to 1.0 μa and holding signal current from 0.2 to 0.9 μa as target voltage is varied from 6 to 14 volts. However, after integration holding signal current approaches initial signal current.

§ The target voltage, measured with respect to ground, will vary with type of blanking used. If cathode blanking is used in the camera, the higher DC cathode impedance will provide a lower cathode to target potential or effective target potential. Dark current and signal current are high in the permachon compared to a vidicon. With cathode blanking used in a standard camera it is often possible to cut off the Permachon when grid bias is set too low. Under these conditions, no picture would be obtained regardless of target voltage setting.

For this reason, grid blanking is recommended. It is possible to operate with cathode blanking but then grid bias and target voltage settings are more critical.

⊕ Number of lines just resolvable, in vertical wedge of EIA chart imaged on 1/2" × 3/8" scanned area, while displayed on a monitor which does not limit resolution.

■ The sensitivity of the Permachon is such that with 19 foot-candles illumination on the faceplate, saturation is reached in less than 10 milliseconds exposure time. With 1.9 foot-candles the necessary exposure time is 0.5 seconds and with 0.19 foot-candles, it is 2.6 seconds.

With exposure times of approximately 10 milliseconds, the contrast of the stored image is somewhat less than normal. Shorter exposure times will result in saturation using higher light intensities with significant loss of contrast of the stored image.

EQUIPMENT DESIGN NOTES

The camera housing should incorporate features not usually found in TV cameras. The camera housing should be light tight. The most convenient place to install the erasing light source may be within the camera housing. Considering the Permachon as photographic film, provision must be made for intermittant exposure during writing times and complete light cutoff during readout.

If the apparent storage of the Permachon is shorter than normal, this may be due to either equipment limitations, which may be corrected, or, to improper mode of operation.

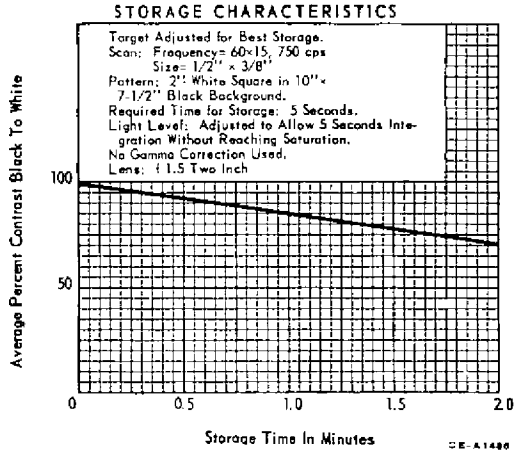
Equipment design factors which can result in apparent low storage include target voltage supply impedance and excessive temperature. Any high impedance in series with the target load (usually 50K approx.) should be removed from the circuit. Such an impedance will result in undesirable target voltage limiting. Automatic target voltage adjustment circuits should also be removed or disabled. Overheating of the Permachon can result in loss of storage. The associated circuitry should be heat shielded such that the ambient temperature around the Permachon does not exceed 45 °C.

The high output signal from the Permachon can result in amplifier overload in commercial vidicon cameras. Reduction of target load impedance is one possible way of preventing amplifier overload but results in a degradation of signal-to-noise ratio. A more satisfactory solution is to reduce the gain of the system or inject the signal after the very-low-level preamplifier stage. The method used will depend on where, in the amplifier, the overload is taking place.

PERFORMANCE NOTES

Storage Time: Operating conditions may be selected to vary the storage time from less than one second to more than 10 minutes with continuous electrical readout. Using standard television scan rates, 4×10^4 electrical images may be taken from a single exposure. Toward the end of the longer storage times, a slight decrease in contrast and apparent resolution is noticeable. Resolution of 600 TV lines with 8 shades of gray can be maintained for approximately 5 minutes.

The degradation of stored display which initially occurs appears as a loss of contrast, with black areas turning to white rather than a worsening of resolution.



Resolution: As was stated under Storage Time, a usable resolution of 600 TV lines is obtainable. Significantly higher resolution can be obtained by increasing accelerator potential and focus field. The operating conditions required will vary with the application. Modification of associated equipment will usually be required. For further data, write to Westinghouse Electronic Tube Division, Sales Dept., Elmira, N.Y. outlining your specific requirements.

SET UP INSTRUCTIONS

The following notes are given to aid in the setting up of the tube and to advise of some unusual precautions which must be taken.

1. With shutter open, adjust deflection to obtain proper scan size.
   A standard 6198A or 6326A may be used for this adjustment.
2. Adjust target to 6 volts.
3. A f 1.5 - 2 inch lens is satisfactory.
4. Close shutter.
5. Adjust grid one control in a more positive direction until target is charged. A wiping effect is noted when charged condition is reached.
6. Adjust alignment to obtain best uniformity of landing.
7. Scene brightness need not exceed 5 foot candles.
8. Stop lens to approximately f 8 and open shutter.
9. If highlights go negative as observed on a monitor, adjust grid one for increase in beam current.
   The scene illumination and exposure time will determine the lens stop.
10. Focus optically and electrically, erasing as often as necessary.
11. To erase:
    (a) Shut off beam and remove lens.
    (b) Flash target with light of at least 20 foot candles.
12. Replace lens and turn up beam.
13. Open diaphragm until desired contrast is obtained on monitor.
14. Close shutter - - picture should be stored.

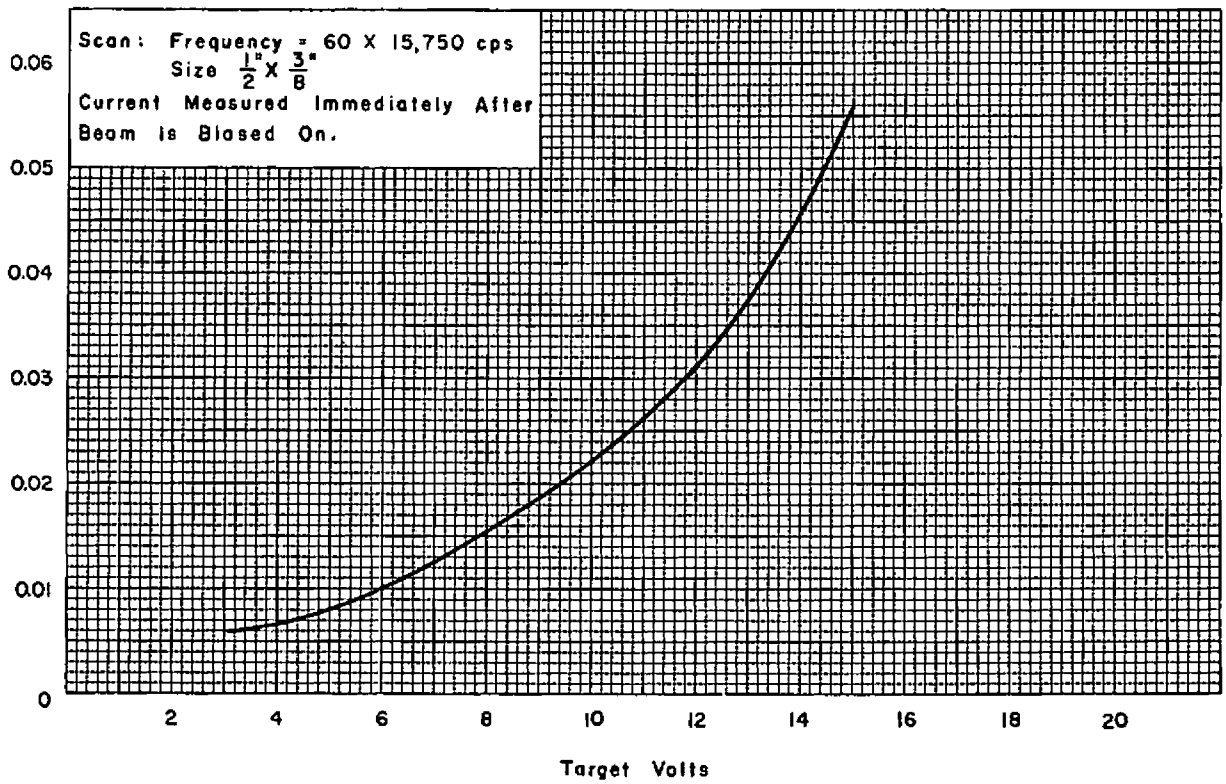
    The optimum target voltage will vary from tube to tube. If not adjusted properly a short storage or poor contrast picture is possible. If storage is short, increase target voltage to a maximum of 15 volts.

Erasure: There are two ways in which erasure can be accomplished:

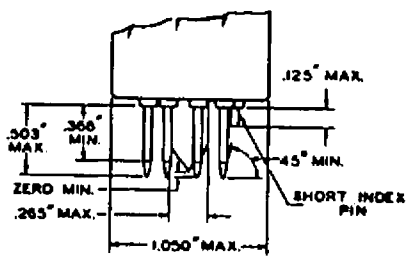
1. The face of the tube is flooded uniformly with light. This process may be carried out in less then a second with about 20 foot candles or with a single intense flash of approximately 5×10^{-4} seconds duration. Associated with this method, which finds the most general application, is the need to allow time for priming the storage layer after erasure and before the next exposure to visual information. Five frames of normal television scanning are sufficient for this priming action. Thus, the process of erasure and priming together need not occupy more than about 1/5 of a second. Complete erasure is obtained if the electron beam is blanked off during the light pulse.

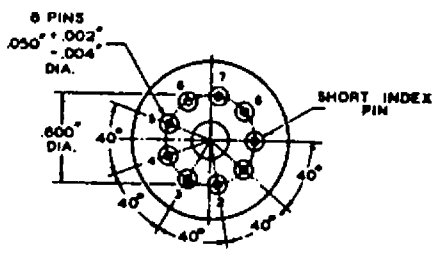
2. The information may be erased by switching off the beam. This method may, however, occupy 5 to 10 seconds.

AVERAGE DARK CURRENT CHARACTERISTIC

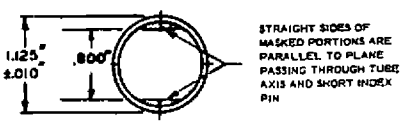


8 PIN BASE
JETEC Nº E8-11

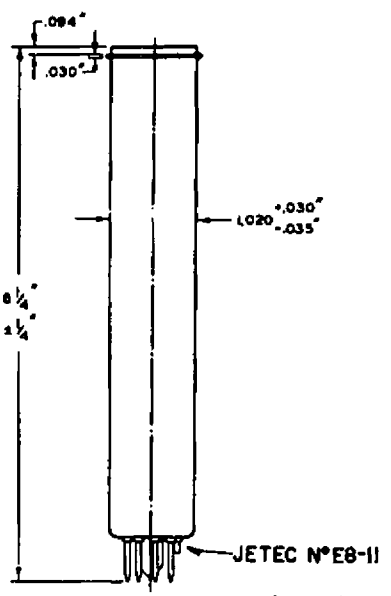




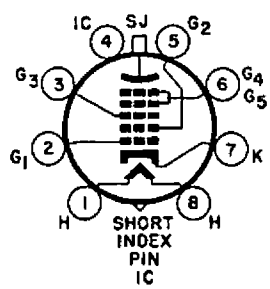
BASE-PIN POSITIONS ARE HELD TO TOLERANCES SUCH THAT PINS WILL FIT A FLAT PLATE GAUGE HAVING THICKNESS OF 1/4" AND 8 HOLES 0.0700" ± 0.0005" SO LOCATED ON A 0.6000" ± 0.0025" DIA. CIRCLE THAT THE DISTANCE ALONG THE CHORD BETWEEN ANY TWO ADJACENT HOLE CENTERS IS 0.2050" ± 0.0005". GAUGE IS PROVIDED WITH CENTER HOLE HAVING DIAMETER OF 0.200" ± 0.001" AND SAME CENTER AS THE PIN CIRCLE.



STRAIGHT SIDES OF MASKED PORTIONS ARE PARALLEL TO PLANE PASSING THROUGH TUBE AXIS AND SHORT INDEX PIN



CE-A1350



HARD TUBE PULSE MODULATOR TYPE WL-7413

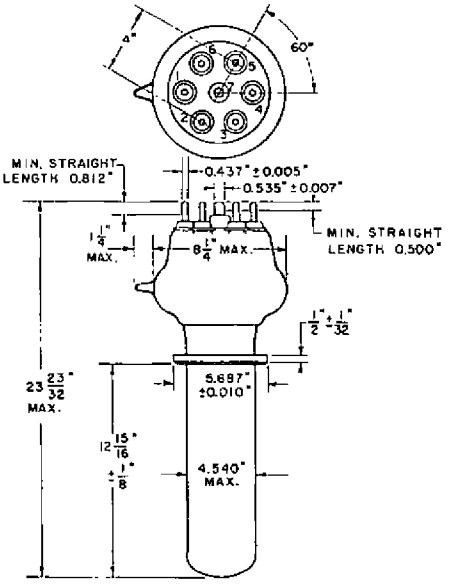
The WL-7413 is a large three-electrode, immersion cooled tube designed to deliver 9 megawatts peak pulse power as a hard-tube modulator. The anode is capable of dissipating 14 kilowatts, exclusive of filament heating power, when oil cooled or 50 kilowatts when water cooled. The cathode is a multiple-strand, thoriated-tungsten filament which may be operated either single phase or 3 phase.

ELECTRICAL:

Cathode	Multiple-Strand, Thoriated-Tungsten Filament	
Filament:		
Voltage:		
Single Phase Connection	12	Volts
3 Phase Connection (to neutral)	12	Volts
Current:		
Single Phase Connection	309	Amperes
3 Phase Connection (per phase)	103	Amperes
Minimum Filament Heating Time	15	Seconds
Amplification Factor	21	
Direct Interelectrode Capacitances: (approx.)		
Grid to Plate	42	$\mu\mu f$
Grid to Filament	95	$\mu\mu f$
Plate to Filament	6	$\mu\mu f$

MECHANICAL:

Mounting Position	Vertical, Anode Down		
Net Weight (approx.)	25 Pounds		
Shipping Weight (approx.)	90 Pounds		
Cooling:			
Type	Oil	Water	
Maximum Fluid Temperature	80	45	°C
Maximum Bulb & Seal Temperature	180	180	°C
Minimum Water Flow	--	30	G.P.M.



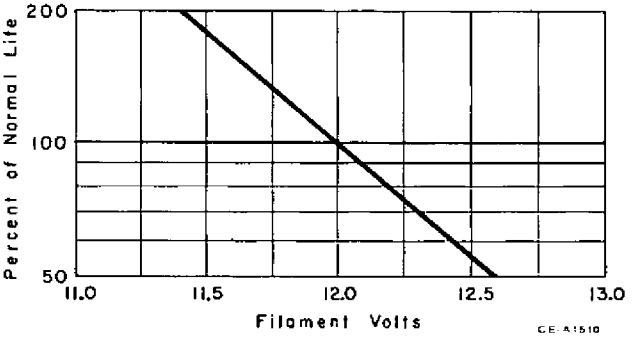
MAXIMUM RATINGS

Absolute Maximum Values

DC Plate Voltage	60	max.	Kilovolts
DC Grid Voltage	-3500	max.	Volts
Peak Positive Grid Voltage	2500	max.	Volts
Peak Pulse Plate Current	150	max.	Amperes
Peak Pulse Grid Current	50	max.	Amperes
Plate Dissipation:			
Oil Cooled	14	max.	Kilowatts
Water Cooled	50	max.	Kilowatts
Grid Dissipation	1.0	max.	Kilowatts
Pulse Length	1000	max.	μseconds
Duty Factor	0.01	max.	
Peak Pulse Cathode Current	200	max.	Amperes

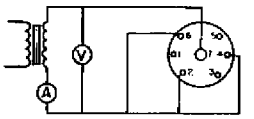
X-Ray Warning: The Maximum Ratings of the WL-7413 permit operation at voltages in excess of 16 KV. Therefore equipment design considerations should include the possible generation of soft x-rays.

FILAMENT EMISSION LIFE CHARACTERISTIC



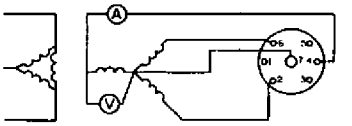
FILAMENT CONNECTIONS

SINGLE PHASE AC SUPPLY



V=12 VOLTS
A=309 AMPERES

THREE PHASE AC SUPPLY

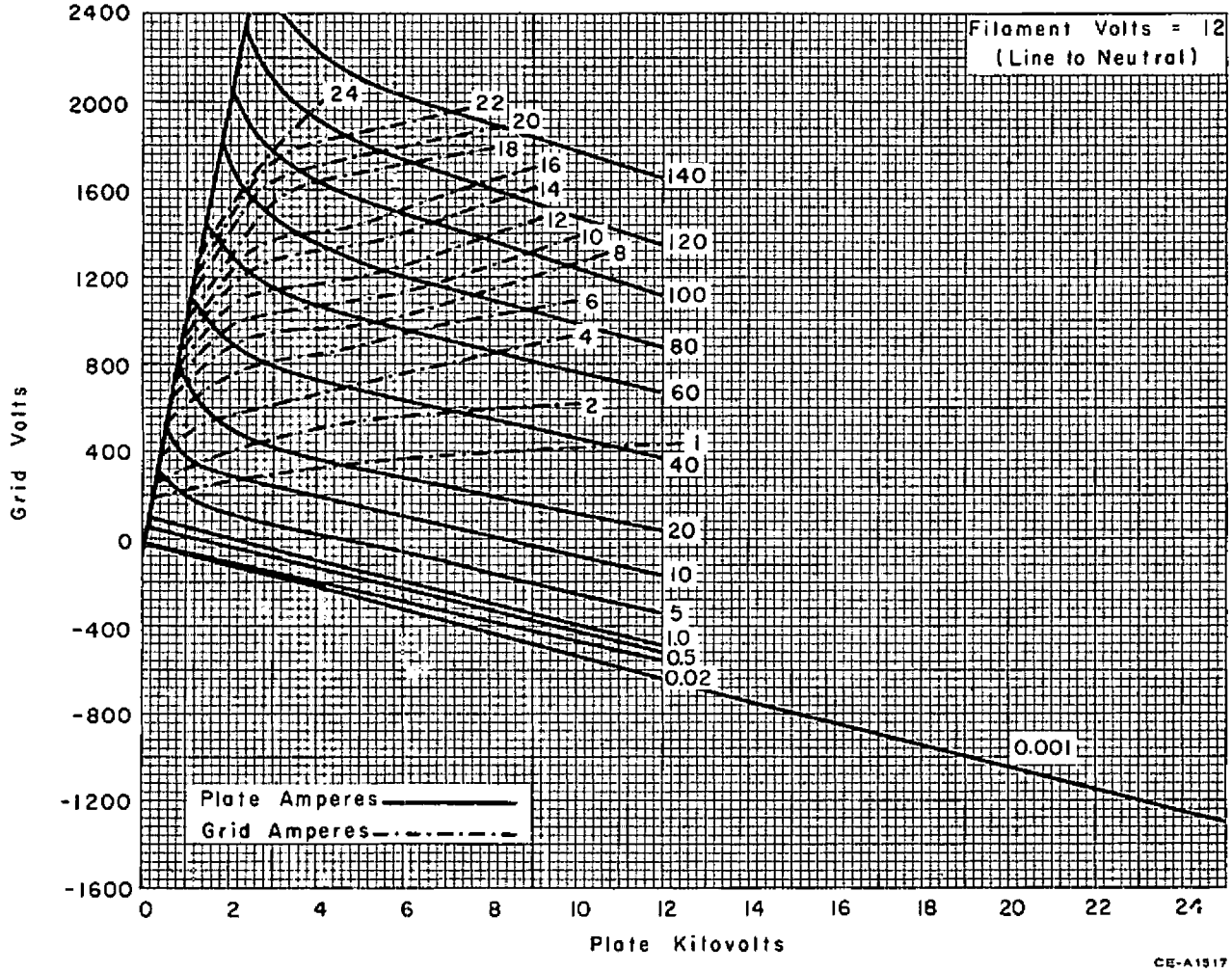


V=12 VOLTS TO NEUTRAL
A=103 AMPERES PER PHASE

FILAMENT TERMINALS 2, 4, 6 & 7 PAINTED BLACK
GRID TERMINALS 1, 3, 8 5 PAINTED RED

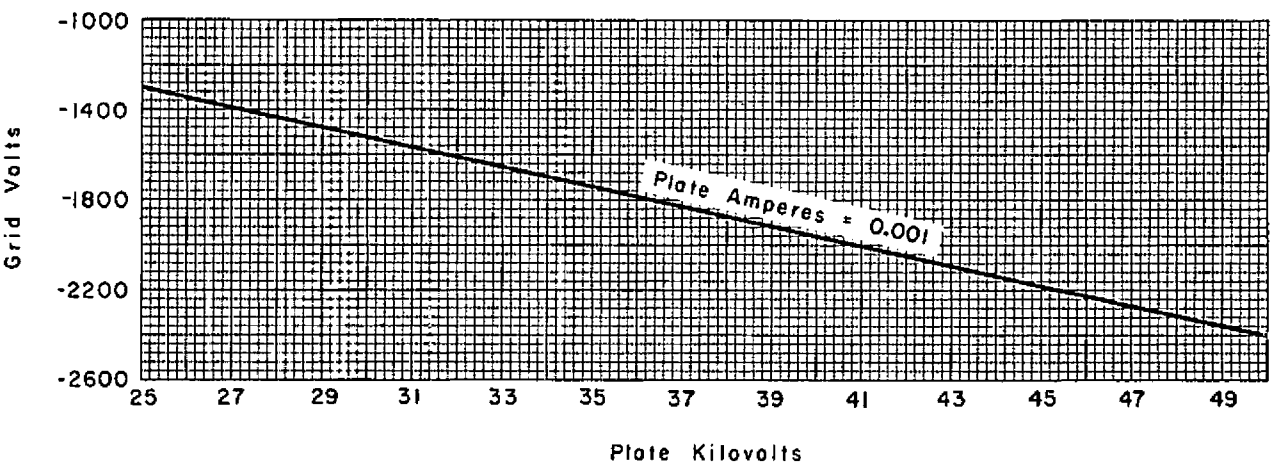
from JEDEC release #2656, Dec. 7, 1959

AVERAGE CONSTANT CURRENT CHARACTERISTICS



CE-A1517

HIGH VOLTAGE CUT-OFF CHARACTERISTIC



CE-A1518

WESTINGHOUSE PRINTED CIRCUIT TUBE TYPE WL-7430

The WL-7430 is a sharp-cutoff pentode designed for service as a wide-band, high-frequency amplifier. This tube has characteristics similar to the type 6AK5.

The WL-7430 features a new envelope design which makes the tube extremely rugged. This new envelope also permits better lead isolation and uses flying leads designed to be soldered into the circuit. The arrangement of the leads in the WL-7430 reduces lead inductance and facilitates design of a multitube distributed amplifier circuit which takes the form of a transmission line.

The WL-7430 also finds applications in critical circuits requiring a high degree of physical and electrical stability.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	0.2	Amperes

MAXIMUM RATINGS:

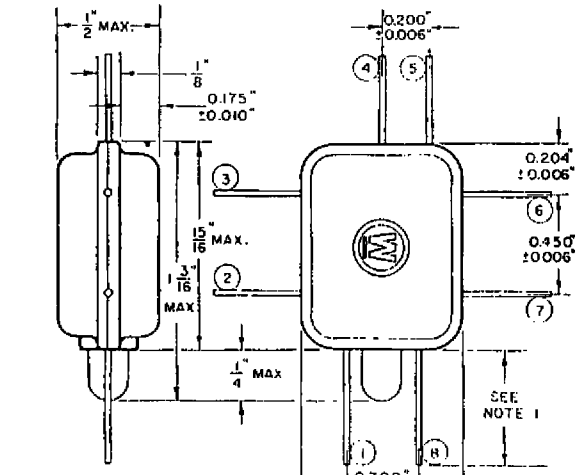
Design Center Values

Plate Voltage	180	max.	Volts
Grid 2 Voltage	140	max.	Volts
Positive Grid 1 Voltage	0	max.	Volts
Plate Dissipation	1.7	max.	Watts
Grid 2 Dissipation	0.5	max.	Watts
Cathode Current	18	max.	Ma.

TYPICAL OPERATING CHARACTERISTICS

Plate Voltage	120	180	Volts
Grid 2 Voltage	120	120	Volts
Grid 1 Voltage	-2	-2	Volts
Plate Resistance	0.3	0.5	Megohm
Transconductance	5000	5100	μmhos
Plate Current	7.5	7.7	Ma.
Grid 2 Current	2.5	2.4	Ma.
Grid 1 Cutoff Voltage⊕	-8.5	-8.5	Volts

⊕ For plate current of 20 microamperes.



NOTES:
1. LEAD LENGTHS 2,3,4,5, 6 & 7 ARE 3/8" LONG. LEADS 1 & 8 ARE 1/2" LONG.
2. LEAD CENTER DIAMENSIONS APPLY WHERE THE LEAD INTERSECTS THE ENVELOPE.
3. ALL LEADS TO HAVE A TINNED DIA OF .020 ±.0015.

LEAD CONNECTIONS

Lead No.	Element
1	Heater & Cathode
2	Plate
3	Grid 1
4	Cathode & Grid 3
5	Grid 2
6	Grid 1
7	Plate
8	Heater

Westinghouse®

WL-7463

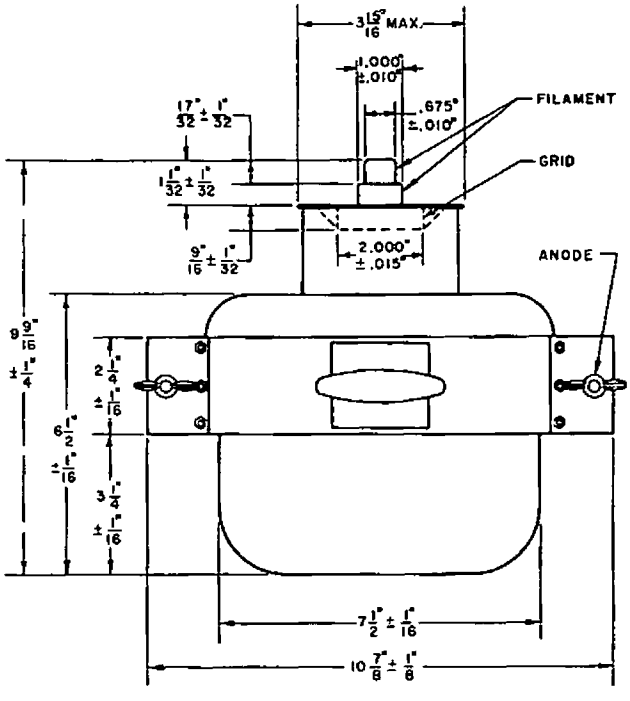
December 15, 1959

HIGH VACUUM AMPLIFIER TYPE WL-7463

The WL-7463 is a three-electrode tube designed for use as an oscillator or amplifier. The anode is forced air and is capable of dissipating 12 kilowatts. The cathode is a single phase thoriated tungsten filament. Maximum ratings apply up to 60 megacycles.

Electrical:		
Filament	6.0	Volts
Filament Current	70	Amperes
Amplification Factor	33	
Direct Interelectrode Capacitances:		
Grid to Plate	14	μμf
Grid to Filament	30	μμf
Plate to Filament	.5	μμf

Mechanical:				
Mounting Position▲	Vertical, Anode Down			
Type of Cooling	Forced Air			
Required Air Flow Through Radiator:				
Plate Dissipation	8	10	12	KW
Air Flow	550	850	1100	CFM
Static Back Pressure	0.4	0.9	1.4	In. Water
Required Air Flow to Filament and Grid Seals⊕	30			CFM
Maximum Bulb Temperature	180			°C
Net Weight (Approx.)	36			Lbs.



CLASS C TELEGRAPHY
(Key down without modulation)

Maximum Ratings:			
Absolute Maximum Values			
DC Plate Voltage	12,000 max.		Volts
DC Plate Current	2.5 max.		Amperes
DC Grid Voltage	-1200 max.		Volts
DC Grid Current	.75 max.		Amperes
Plate Input	24 max.		Kilowatts
Plate Dissipation	12 max.		Kilowatts

Typical Operating Characteristics:				
DC Plate Voltage	9000	10,000	12,000	Volts
DC Grid Voltage	-600	-700	-800	Volts
Peak R.F. Grid Voltage	960	1,100	1,200	Volts
DC Plate Current	1.97	1.96	1.94	Amp
DC Grid Current	0.45	0.42	0.39	Amp
Peak R.F. Plate Voltage	8000	9,000	11,000	Volts
Driving Power♦	414	441	445	Watts
Power Output	14.1	15.9	19.3	Kilowatts
Power Input	17.8	19.6	23.3	Kilowatts

CLASS B AUDIO FREQUENCY AMPLIFIER OR MODULATOR

Maximum Ratings (Per Tube)			
Absolute Maximum Values			
DC Plate Voltage	12,000 max.		volts
DC Plate Current (max. signal)	2.50 max.		amperes
DC Grid Current (max. signal)	0.50 max.		amperes
Plate Input	26.0 max.		kilowatts
Plate Dissipation	12.0 max.		kilowatts

Typical Operating Characteristics:			
(Values are for two tubes)			
DC Plate Voltage	5500	10,500	volts
DC Plate Current (max. signal)	3.95	4.0	amperes
Plate Current, Zero-Signal	.80	0.200	amperes
Grid to Grid Peak A.F.	680	1030	volts
DC Grid Voltage	-100	-300	volts
Driving Power (max. signal)	185	150	watts
Power Output	13.2	27.0	kilowatts
Power Input	21.7	42.0	kilowatts
Plate Load (plate to plate)	2780	5600	ohms
Distortion-Harmonic (Approx.)	4.8	3	percent
Peak R.F. Plate Voltage	4300	8820	volts

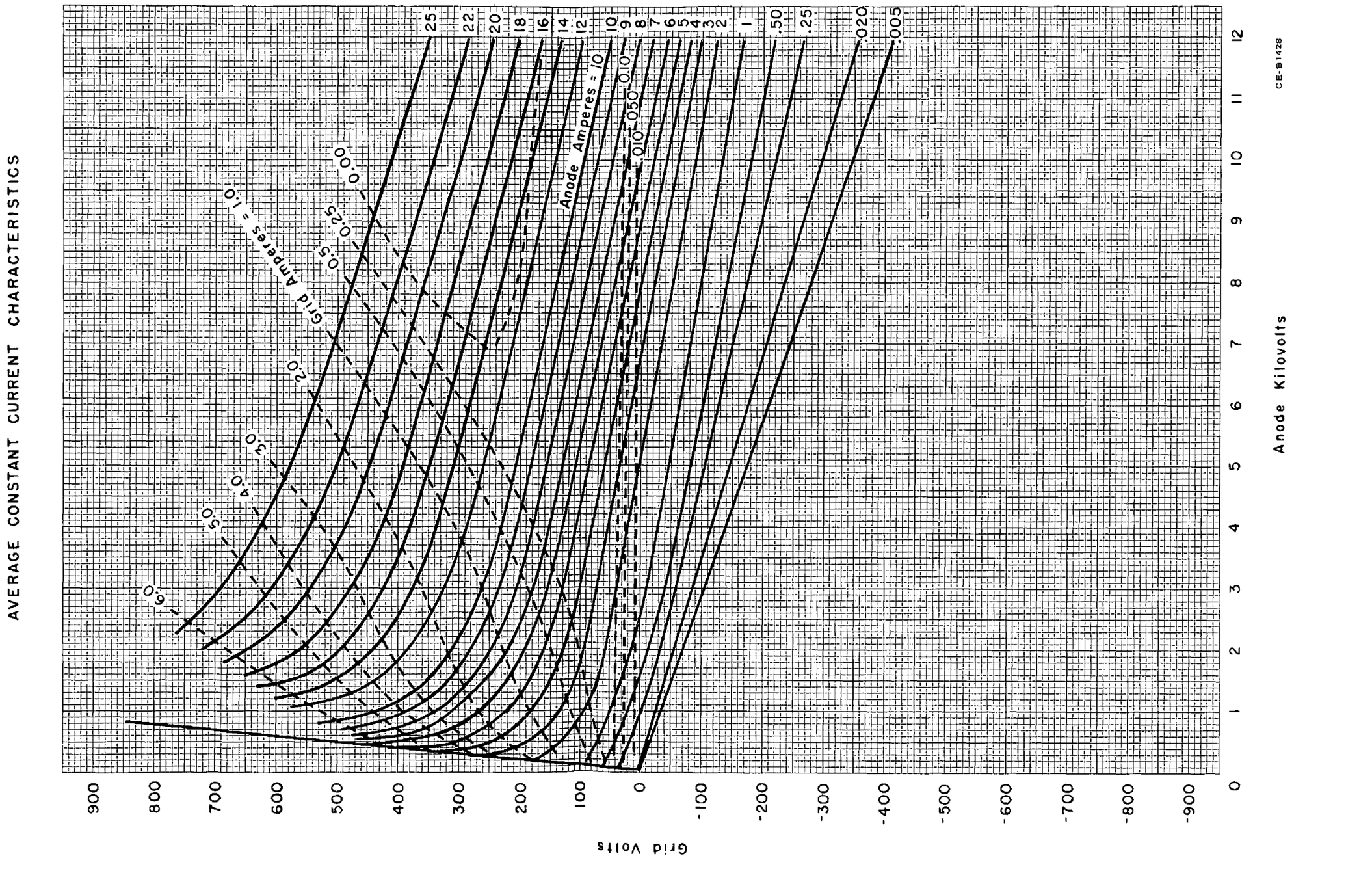
♦ Allowance must be made for grid circuit losses which are not included.

▲ Connectors for WL-7463 are available from Westinghouse.

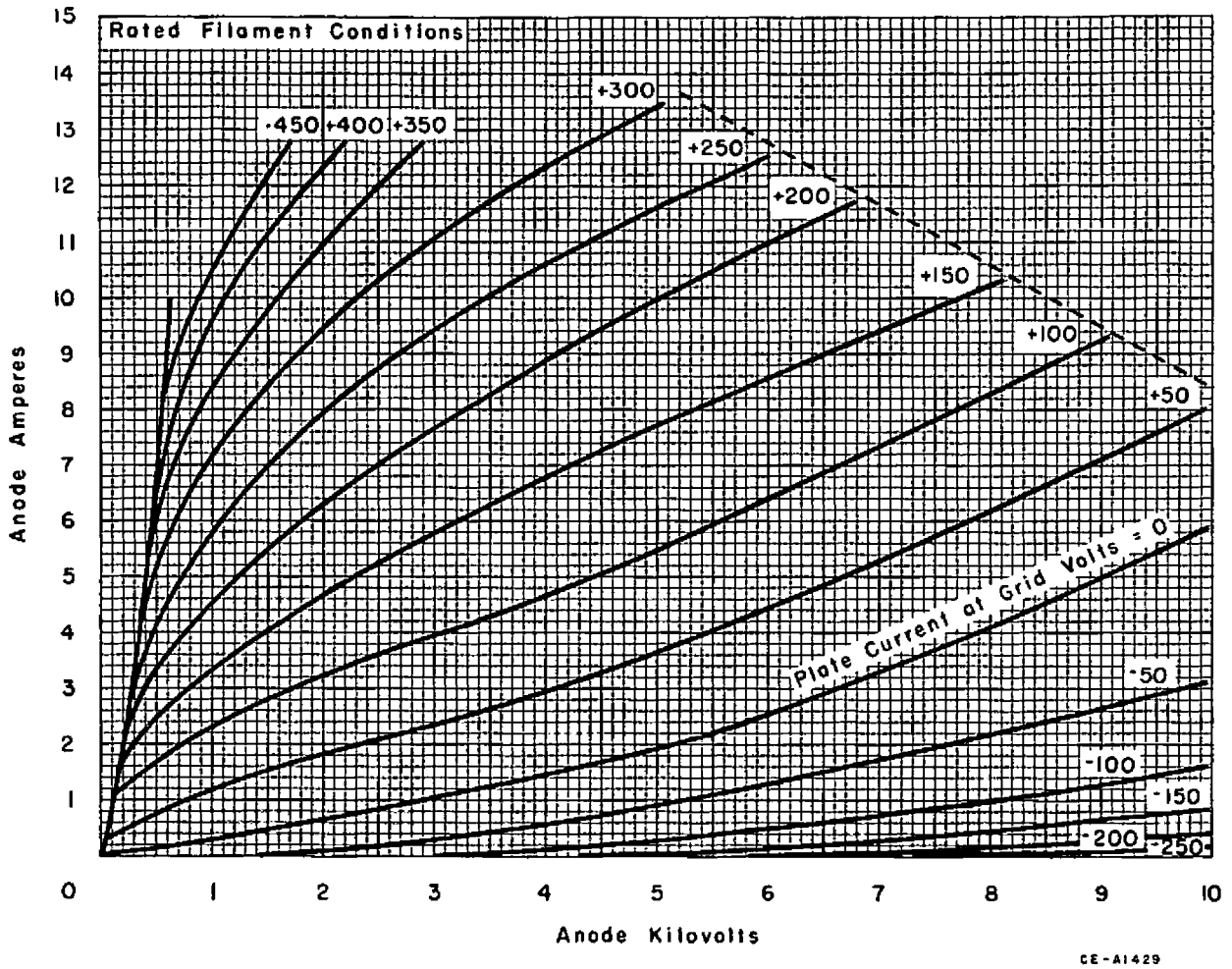
⊕ A portion of the air flowing through the radiator may be deflected to provide cooling of the filament and grid seals.

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #2668, Dec. 21, 1959


AVERAGE CONSTANT CURRENT CHARACTERISTICS
Anode Amperes = 10
25
22
20
18
16
14
12
10
9
8
7
6
5
4
3
2
1
.50
.25
.020
.005
.10
.050
.010
Grid Amperes = 1.0
0.0
0.25
0.5
2.0
3.0
4.0
5.0
6.0
Grid Volts
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
Anode Kilovolts
0
1
2
3
4
5
6
7
8
9
10
11
12
CE-B1428

AVERAGE PLATE CHARACTERISTICS



POWER AMPLIFIER TRIODE TYPE WL-7464

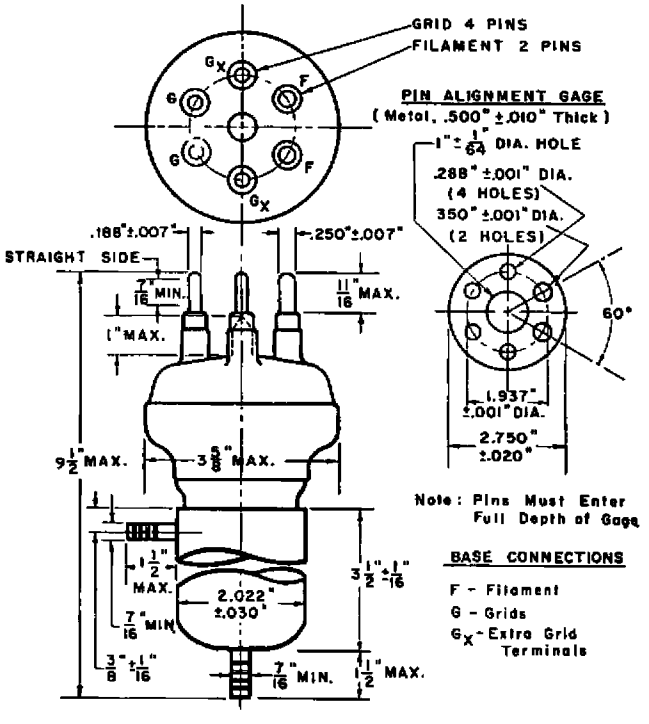
The WL-7464 is a three electrode tube designed for use as a modulator or amplifier. The anode is capable of dissipating 8.0 kilowatts of power in Continuous Commercial Service. Cooling is accomplished by water flow through an integral water jacket. The cathode is a thoriated tungsten filament. Maximum ratings apply for audio frequencies.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament Voltage	5.7	6.0	6.3	Volts
Filament Current	57	60	63	Amperes
Filament Starting Current	--	--	300	Amperes
Filament Resistance, (cold)	--	.016	--	Ohms
Amplification Factor	--	6.0	--	
Direct Interelectrode Capacitance (Avg.):				
Grid-Plate		14		μμf
Grid-Filament		15		μμf
Plate-Filament		1.5		μμf

MECHANICAL:

Mounting Position	Vertical, Anode Down
Type of Cooling	Water
Water Flow Required	3.75 GPM
Water Pressure	7.0 PSI
Maximum Outlet Water Temperature	70°C
Airflow on Filament & Grid Seals	30 CFM
Maximum Glass Temperature	180° C
Net Weight	1.75 Pounds



AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR-CLASS A

MAXIMUM RATINGS

Absolute Maximum Values

DC Plate Voltage	8.0	max.	Kilovolts
Negative DC Grid Voltage	1500	max.	Volts
Plate Input	8.0	max.	Kilowatts
Plate Dissipation	8.0	max.	Kilowatts

TYPICAL OPERATING CHARACTERISTICS

DC Plate Voltage	5250	Volts
DC Grid Voltage	-625	Volts
Peak AF Grid Voltage	625	Volts
Peak AF Plate Voltage	2850	Volts
DC Plate Current	1.5	Amperes
Load Resistance	2060	Ohms
2nd Harmonic Distortion (approx.)	5	Per Cent
Power Output	2.0	Kilowatts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR CLASS AB_1

MAXIMUM RATINGS (PER TUBE)

Absolute Maximum Values	CCS	
DC Plate Voltage	8.0 max.	Kilovolts
DC Plate Current	2.5 max.	Amperes
Negative DC Grid Voltage	2000 max.	Volts
Plate Input	18.0 max.	Kilowatts
Plate Dissipation	8.0 max.	Kilowatts

TYPICAL OPERATING CHARACTERISTICS

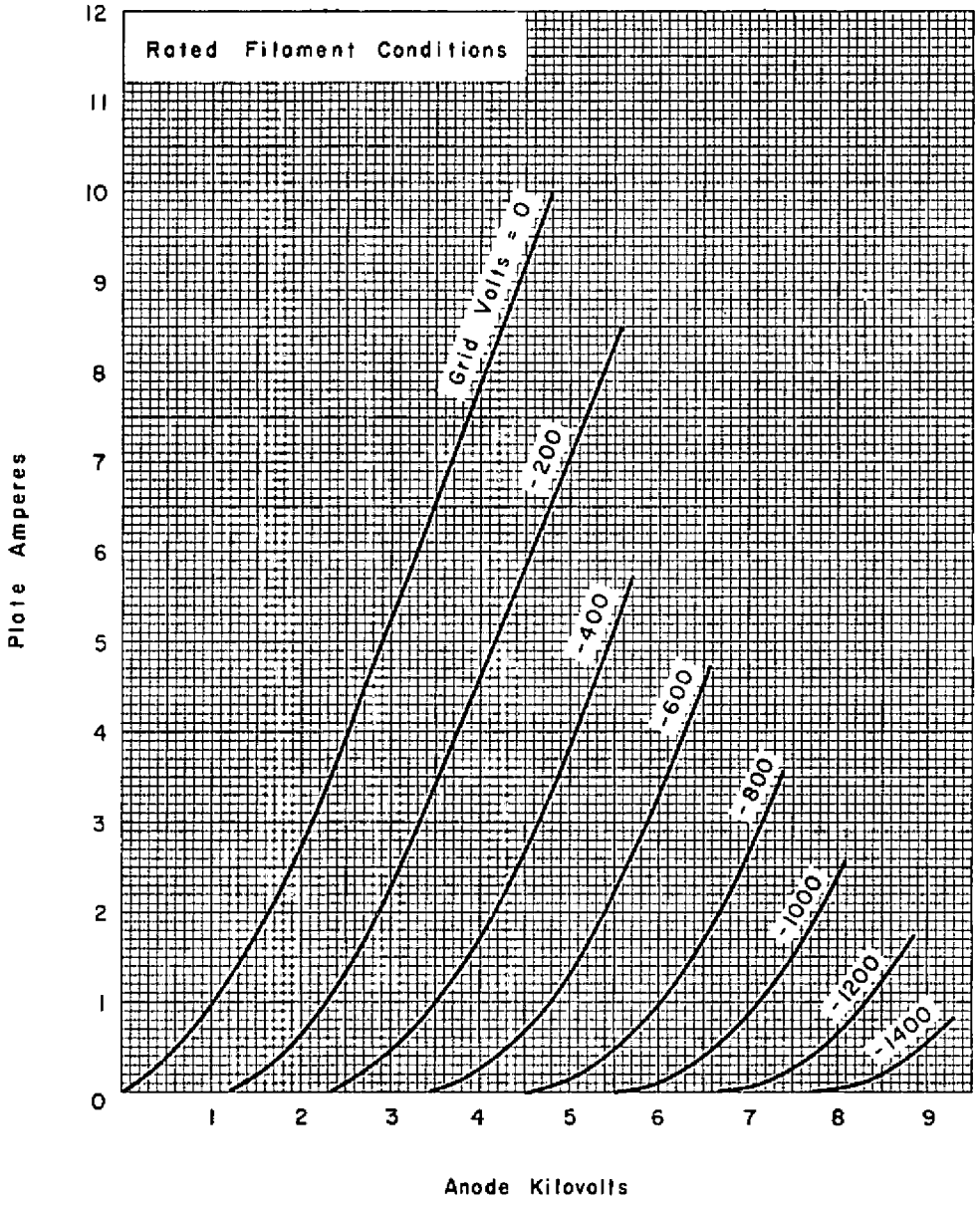
(Unless Otherwise Specified, Values are for Two Tubes)

DC Plate Voltage	7.5	Kilovolts
DC Grid Voltage	1200	Volts
Peak AF Grid to Grid Voltage	2340	Volts
Zero Signal Plate Current	.30	Amperes
Maximum Signal DC Plate Current	2.68	Amperes
Peak AF Plate to Plate Voltage	9.4	Kilovolts
Effective Load Resistance (Plate to Plate)	4820	Ohms
Maximum Signal Driving Power	0	Watts
Maximum Signal Power Output	10.8	Kilowatts
Total Harmonic Distortion (approx.)	2.3	Per Cent

from JEDEC release #2665, Dec. 14, 1959

Westinghouse®

AVERAGE PLATE CHARACTERISTICS



THYRATRON TYPE WL-7509

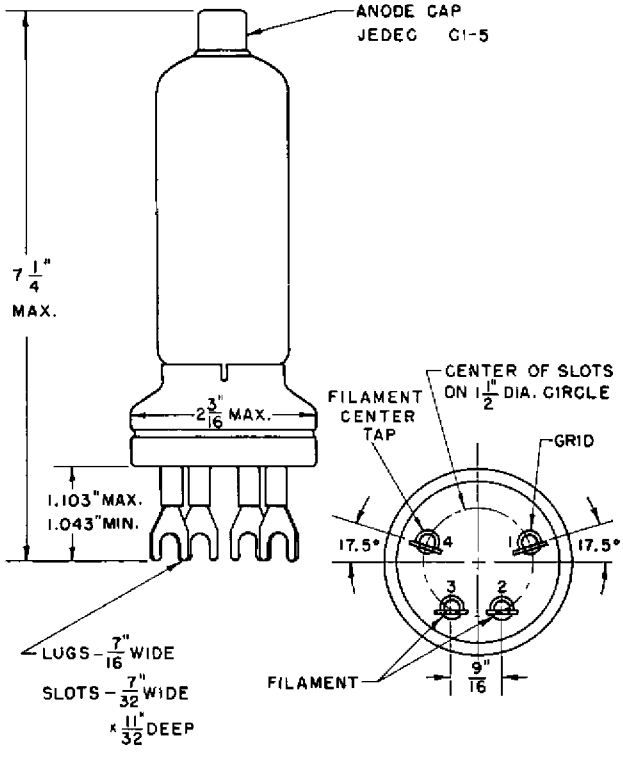
The WL-7509 is a three-electrode thyratron with negative control characteristic and an inert gas-mercury vapor filling. The WL-7509 has the long life characteristic of mercury vapor tubes and the fast starting and wide ambient temperature range associated with inert gas tubes. It is designed for ignitor firing and industrial control applications. The WL-7509 is electrically similar to the WL-7307.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current	--	9.0	11.0	Amperes
Heating Time	20	--	--	Seconds
Direct Interelectrode Capacitances:				
Anode to Grid			2	μμf
Grid to Filament			12	μμf
Critical Grid Voltage	See Critical Grid Voltage			
Deionization Time (Typical)			1000	μseconds
Ionization Time (Approx.)			10	μsecond
Anode Voltage Drop (Typical with 8 Amperes Peak)			10	Volts

MECHANICAL:

Type of Cooling	Air, Unrestricted Convection
Mounting Position	Vertical, Base Down
Bulb	T-12
Base	Lug Location and Size per JEDEC A4-90
Net Weight	4 Ounces
Shipping Weight (Approx.)	24 Ounces



MAXIMUM RATINGS

Absolute Maximum Values

Peak Anode Voltage:			
Forward	1500	max.	Volts
Inverse	1500	max.	Volts
Cathode Current:			
Peak	30	max.	Amperes
Average	2.5	max.	Amperes
Averaging Time	5	max.	Seconds
Fault (Surge, Max. Duration 0.1 Sec.): ▲			
Connection (a) See CE-A1103	240	max.	Amperes
Connection (b) See CE-A1103	120	max.	Amperes
Connection (c) See CE-A1103	120	max.	Amperes
Negative Grid Voltage:			
Before Conduction	250	max.	Volts
During Conduction	10	max.	Volts
Positive Grid Current (Average): ♦			
Averaging Time = 1 Cycle	0.10	max.	Ampere
Maximum Frequency ■	150	max.	CPS
Condensed Mercury Temperature Range ♦	-40 to + 80	max.	°C

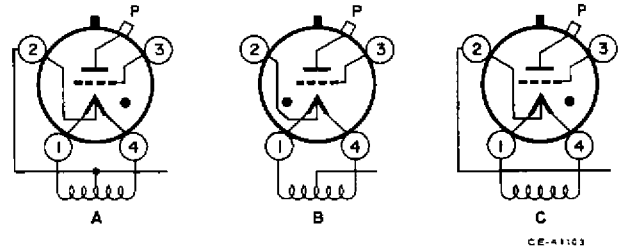
▲ These ratings are effective only anode return connections are made as shown in CE-A1103.

♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

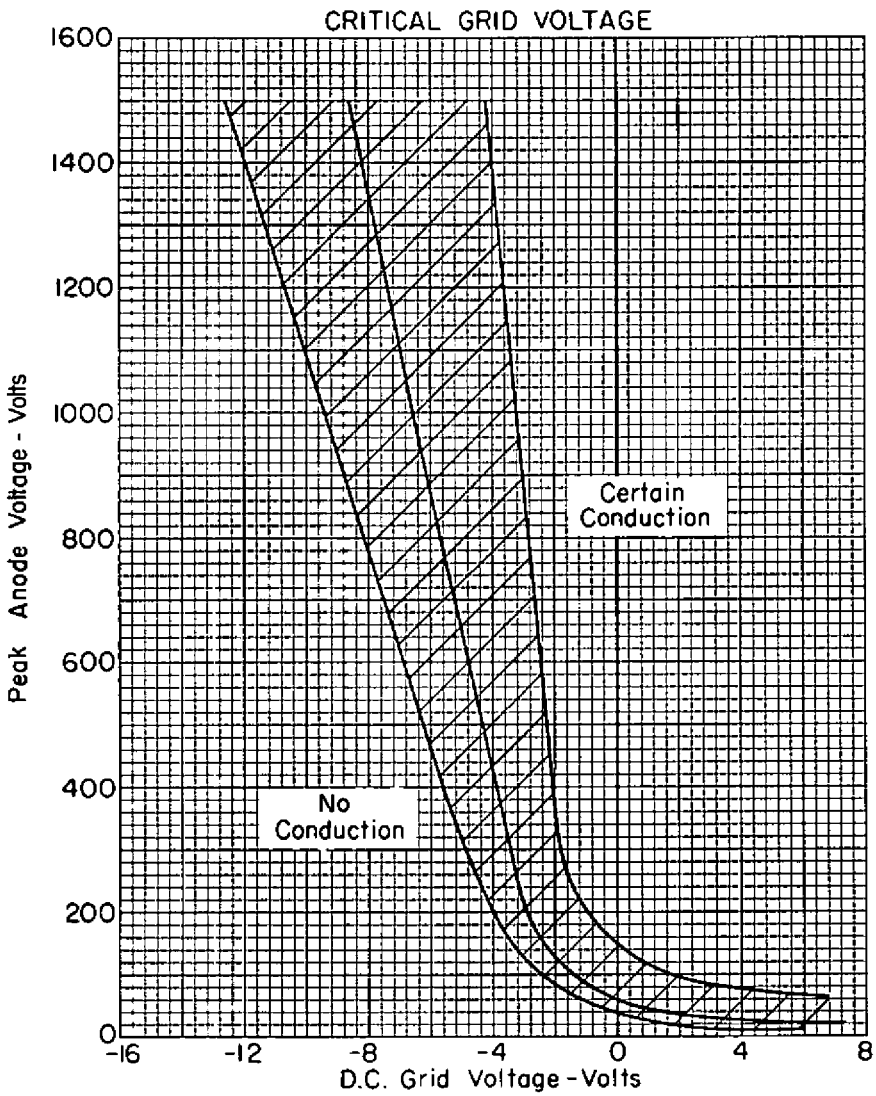
♦ Satisfactory starting and operation will result at the condensed-mercury temperature indicated. For optimum life, the condensed-mercury temperature after warm-up should be 40 to 80 °C. If the tube is operated at condensed-mercury below 20 °C for extended periods, the usual circuit precautions for inert gas tubes should

■ For higher frequency ratings, consult the tube manufacturer.

ANODE RETURN CONNECTIONS



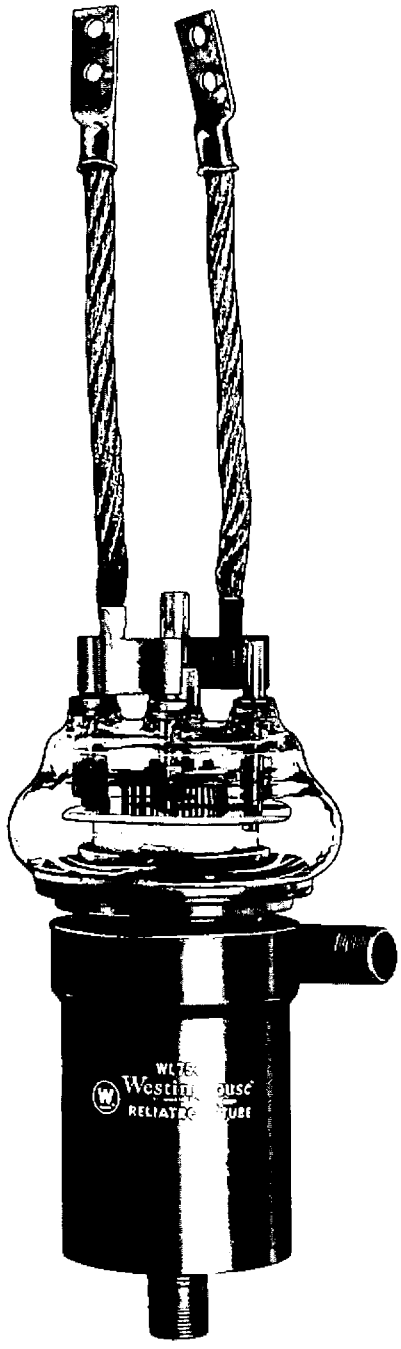
from JEDEC release #2665, Dec. 14, 1959


CRITICAL GRID VOLTAGE
1600
1400
1200
1000
800
600
400
200
0
Peak Anode Voltage - Volts
Certain Conduction
No Conduction
-16
-12
-8
-4
0
4
8
D.C. Grid Voltage - Volts

CE-A1088

LO MU POWER TRIODE TYPE 7540

The 7540 is a three electrode tube designed for zero drive modulator service. The anode is rated for 35KW dissipation during Continuous Commercial Service. An accuratly aligned integral water jacket assures steam free operation even under most severe beaming conditions. The cathode is thoriated tungsten. Ratings are for audio frequency only.



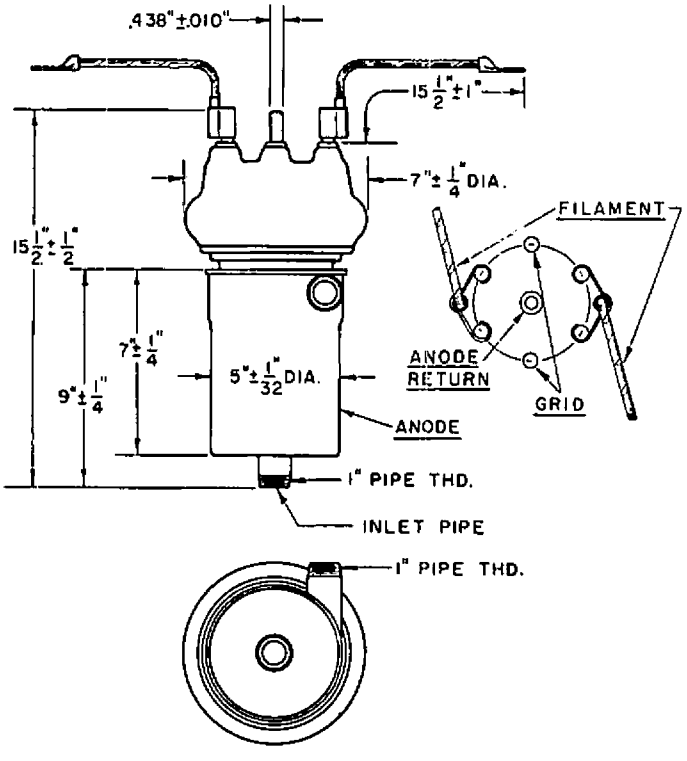
from JEDEC release #2793, April 25, 1960

ELECTRICAL:

Filament Voltage	5.0	
Filament Amperes	250	
Amplification Factor	5	
Interelectrode Capacities: (approx.)		
Grid to Plate	50	μμf
Grid to Filament	65	μμf
Plate to Filament	8	μμf

MECHANICAL:

Mounting Position	Vertical anode down
Anode Cooling	water - 30gpm
Max. water outlet Temperature	70°C
Water Pressure drop	8psi/30gpm
Max. Glass Temperature	180°C
Glass Seal Cooling	50 CFM
Net Weight	18 Pounds
Shipping Weight	



MAXIMUM RATINGS

Absolute Maximum Values	CCS		
DC Plate Voltage	15	max.	Kilovolts
DC Plate Current*	10	max.	Amperes
Plate Power Input*	70	max.	Kilowatts
Plate Dissipation*	35	max.	Kilowatts
Grid Dissipation	0	max.	Watts

* Averaged over AF cycle of sine wave.

TYPICAL OPERATING CHARACTERISTICS
(Two Tubes in Push-Pull)

DC Plate Voltage	10	12.5	Kilovolts
DC Grid Voltage	-2000	-2800	Volts
Peak AF Grid to Grid Voltage	3950	5500	Volts
Zero Signal DC Plate Current	2	1	Amperes
Max. Signal DC Plate Current	9.5	8	Amperes
Effective Plate-to-Plate Load Resistance	1880	3000	Ohms
Driving power	0	0	Watts
Max. Signal Power Output	52.5	59	Kilowatts

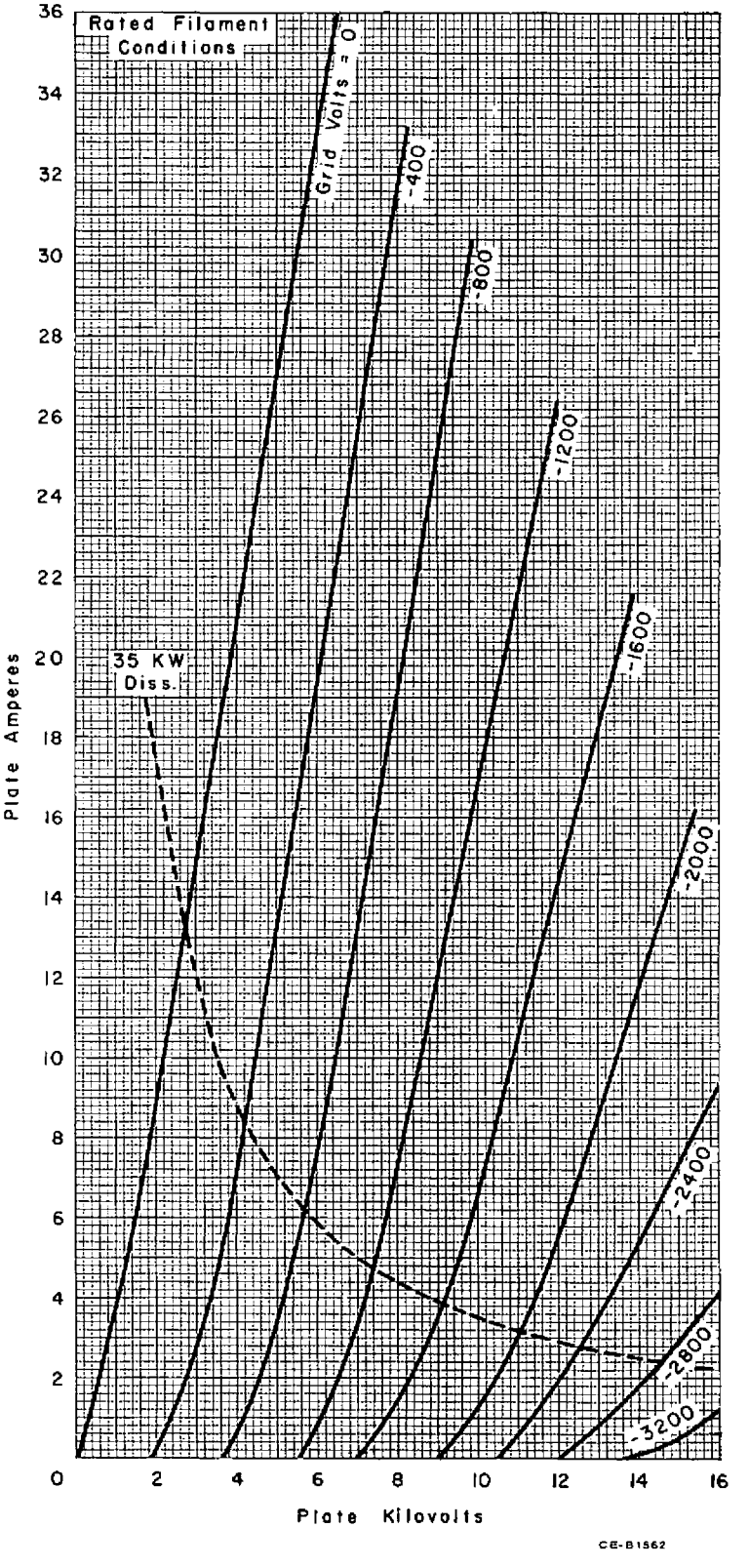
TYPICAL OPERATING CHARACTERISTICS
(Two Tubes in Push-Pull)
(Reactive Load)

DC Plate Voltage	12.5	Kilovolts
DC Grid Voltage	-2800	Volts
Peak AF Grid to Grid Voltage	5500	Volts
Zero Signal DC Plate Current	1.0	Amperes
Max. Signal DC Plate Current	3.1	Amperes
Effective Plate-to-Plate Load Resistance	9400	Ohms
Driving Power	0	Watts
Instantaneous Peak Power Output	37.5	K.V.A.
Load power Factor	0.2	

COOLING WATER REQUIREMENTS

Anode Dissipation Kilowatts	Water Flow Gallons/Minute
17	15
23	20
29	25
35	30

AVERAGE PLATE CHARACTERISTICS



MAGNETRON TYPE 7541

Hand Tunable with Lock | Forced Air Cooled | 250 KW Peak
8500-9600 M.C. | Integral Magnet | Power Output

The 7541 is a tunable X-band magnetron. It is designed to serve as a pulse oscillator at frequencies between 8500 and 9600 megacycles per second. Its tuner design allows frequency to be set at any desired frequency and locked in place.

The 7541 has a typical power output of approximately 250 kilowatts over its entire frequency range. Pulse widths up to 1.1 microseconds may be used. Thermal drift is typically 10 megacycles, even at the extremes of the frequency range. The 7541 provides excellent spectrum shape and excellent stability of operation.

Structurally, the 7541 employs a double strapped, vane type anode. Tuning is accomplished by contacting plungers in four tuner cavities which are tightly coupled to the main resonator system. Tuning is therefore accomplished remote from the interaction space and in low field areas of the tube, greatly improving both electrical and thermal stability. An impregnated cathode is used which is arc resistant and has excellent life properties. Mechanical gearing is provided to "gang" the tuners and permit tuning from a single shaft. The 7541 has a waveguide type output which is designed to couple to a modified UG-52A/U choke flange. The output may be pressurized, although no breakdown will occur if pressure is maintained at 1 atmosphere.

The 7541 tuner is designed for hand tuning. A lock nut is provided which may be tightened after the desired frequency is reached. A calibrated dial provides an indication of tube frequency.

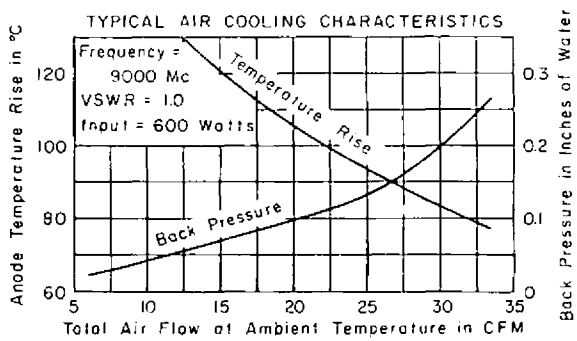
The 7541 is designed for transmitter service in airborne fire control systems and in missile seeker systems. The tube is useful in ground as well as airborne installations where a high performance X-band power source is required. While the tube is designed for a 0.001 duty cycle, higher duties may be used with reduced peak power output. The 7541 is designed to replace the fixed-tuned 4J50 series magnetrons.

MECHANICAL:

Mounting Position	Any
Dimensions	See Outline Drawing
Air Flow:	
To Fins	An air stream should be directed along the cooling fins toward the body of the tube. Adequate flow should be provided so that the temperature of the anode block does not exceed 150°C.
Cathode Bushing	Oil Immersed or Pressurized ⊕
Waveguide Output Flange	Mates with modified JAN UG-52/U
Cathode Connector	The cathode connector should contain a built-in capacitor such as the Jettron No. 9000-C manufactured by Jettron Products, Hanover, New Jersey.
Tuner	Calibrated with Lock Nut
Tuning Torque:	
Tube:	
Room Temperature	150 in. oz. Max.
Extreme Temperature (125°C to −55°C)	200 in. oz. Max.
Equipment (applied to stops)	200 in. oz. Max.
Tuner Backlash ■	20 Megacycles Max.
Lubrication †	
Pressurization of Output	15 psia (Min.) 45 psia (Max.)
Vibration §	
Shock	30 g's, 11 Milliseconds
Net Weight (Approx.)	12 Pounds
Shipping Weight	25 Pounds

ELECTRICAL:

Heater, for Unipotential Cathode:		
Voltage (ac)	13.75	Volts
Current at 13.75 Volts	Min.: 2.8 Max.: 3.5	Amperes
Starting Current	Maximum instantaneous starting current must never exceed 12 amperes.	
Minimum Cathode Heating Time	150	Seconds
Frequency	8500-9600	Megacycles
Maximum Frequency Pulling at VSWR of 1.5	15	Megacycles



from JEDEC release #3416, Sept. 11, 1961

PULSED OSCILLATOR SERVICE

MAXIMUM AND MINIMUM RATINGS:	Min.	Max.	
Peak Anode Voltage	--	23	Kilovolts
Peak Anode Current	--	27.5	Amperes
Peak Power Input	--	630	Kilowatts
Duty	--	0.0011	--
Pulse Duration	--	1.1	Microseconds
Rate of Rise of Voltage Pulse	70	140	kv/μsecond
Anode Block Temperature	--	150	°C
Cathode Bushing Temperature	--	165	°C
Load Voltage Standing Wave Ratio	--	1.2	

TYPICAL OPERATION WITH LOAD
VOLTAGE STANDING WAVE RATIO
EQUAL TO OR LESS THAN 1.05 EXCEPT AS NOTED

OSCILLATION WITH DUTY CYCLE OF 0.001:		
Heater Voltage ●	0	Volts
Peak Anode Voltage	22	Kilovolts
Peak Anode Current	27.5	Amperes
Pulse Repetition Rate	1000	cps
Pulse Duration	1.0	μseconds
RF Bandwidth with worst phasing of 1.2 VSWR	1	Megacycle
Side Lobes	10	dB
Pulling Figure at VSWR of 1.5	12	Megacycles
Pushing Figure	0.2	Mc/amp
Peak Power Output	250	Kilowatts

NOTES

⊕ No breakdown will occur if pressure is maintained above 600 mm of Hg. Air flow must be sufficient to keep bushing below 165°C.

■ Backlash is defined as the difference in frequency when a given dial setting is approached in either direction of rotation.

† The 7541 is factory lubricated and should not require further lubrication. Care should be exercised to keep foreign particles out of the exposed portions of the turner mechanism. Should Further lubrication be desired, Dow Corning Silicone No. 33 Grease should be used on the gears.

● Heater voltage should be 0 volts for maximum life at 27.5 ma. and 0.001 duty. Higher voltages are permissible but may result in short life. Heater voltage for power input less than 450 watts = $13.75\left(1-\frac{\text{Power Input}}{450}\right)$.

§ Special vibration problems encountered with the 7541 should be referred to the Microwave Engineering Dept. Westinghouse Electric Corporation, Elmira, New York.

NOTES FOR OUTLINE DRAWING

1: Reference plane A is defined as the plane through that portion of the mounting flange designated as annular surface D. Reference plane B is defined as the plane which is perpendicular to plane A and passes thru the exact centers of mounting flange holes number 2 and number 3. Reference plane C is defined as the plane which is perpendicular to plane A and plane B and passes thru the exact center of mounting flange holes number 3 and number 4.

2: Surfaces D and E of the waveguide output flange and the mounting flange are made so that they may be used to provide a hermetic seal. This surface shall be flat within 0.015 TIR with a surface roughness of 32 per MIL-STD-10.

3: The axis of the heater-cathode terminal will be within the confines of a cylinder whose radius is 3/64 inch and whose axis is perpendicular to reference plane A at the specified location.

4: All points on mounting flange other than specified in Note 1 must lie within 0.015 inch above or below reference plane A.

5: The limits include angular as well as lateral deviations.

6: These dimensions define extremities of the 0.169 inch internal diameter of the cylindrical heater-terminal.

7: These dimensions define extremities of the 0.540 inch internal diameter of the cylindrical heater-cathode terminal.

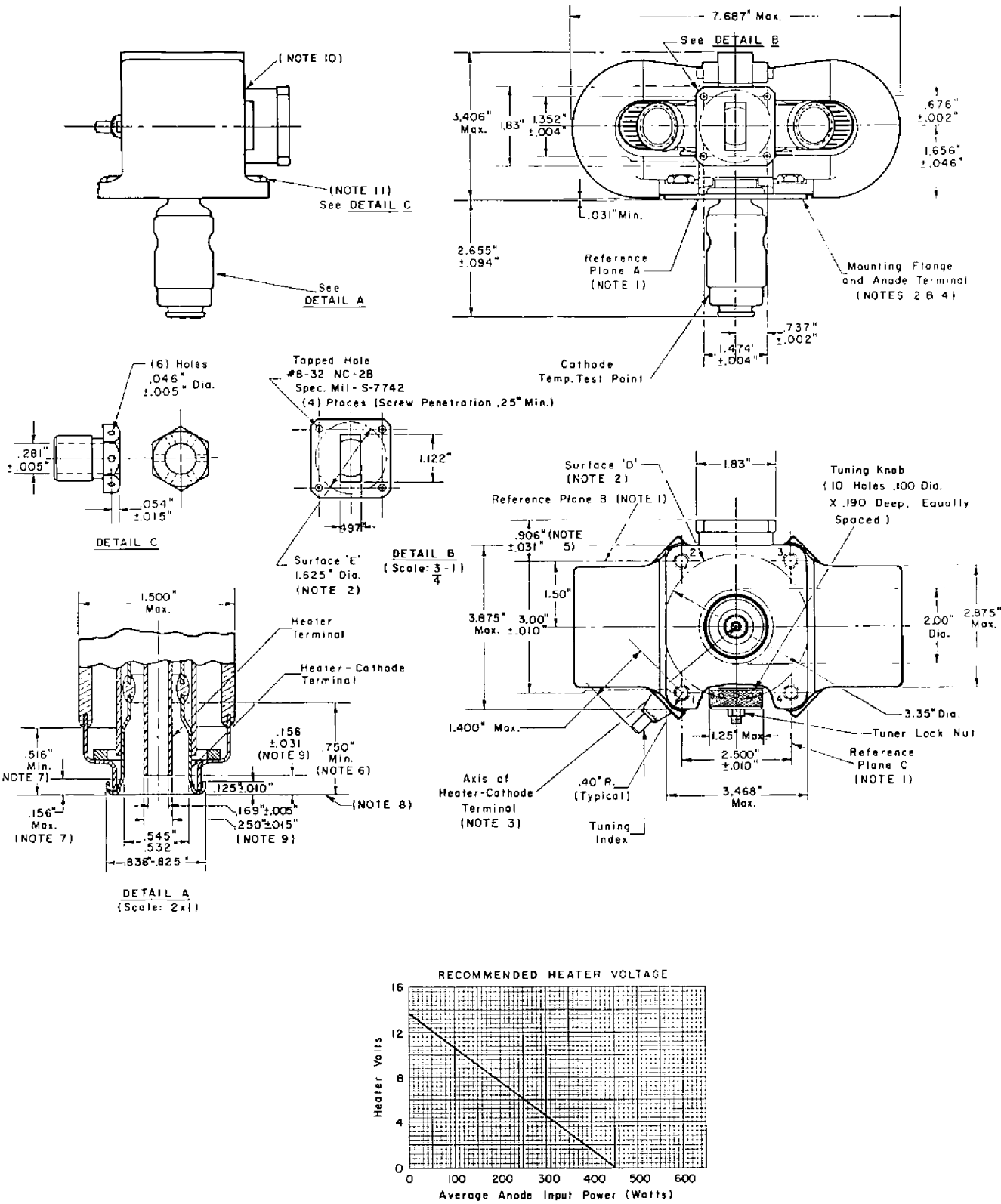
8: No part of the connector device for the heater and heater-cathode terminals should bear against the underside of this lip.

9: The heater terminal and the heater-cathode terminal are concentric within 0.010 inch.

10: Anode temperature shall be measured at junction of waveguide and anode back.

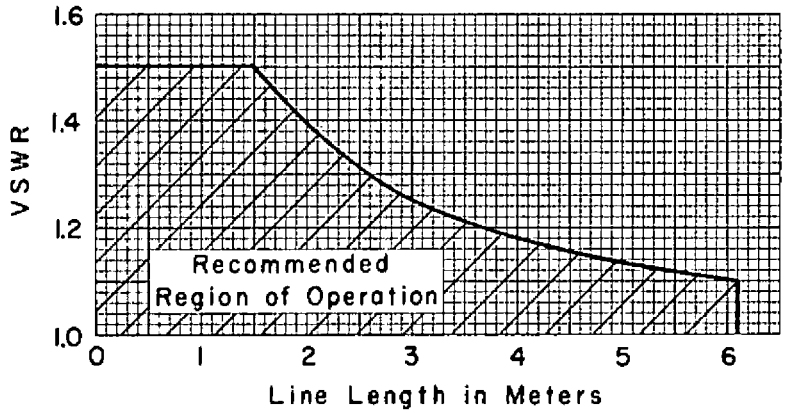
11: A 1-3/32" minimum long stud thru the mounting holes shall not interfere with any part of the tube.

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(NOTE 10)
(NOTE 11)
See DETAIL C
See DETAIL A
7.687" Max.
See DETAIL B
3.406" Max.
1.83"
1.352" ±.004"
.676" ±.002"
1.656" ±.046"
.031" Min.
2.655" ±.094"
Reference Plane A (NOTE 1)
Mounting Flange and Anode Terminal (NOTES 2 & 4)
.737" ±.002"
1.474" ±.004"
Cathode Temp. Test Point
(6) Holes .046" ±.005" Dia.
.281" ±.005"
.054" ±.015"
DETAIL C
Tapped Hole #8-32 NC-2B Spec. Mil-S-7742 (4) Places (Screw Penetration .25" Min.)
1.122"
.437"
Surface 'E' 1.625" Dia. (NOTE 2)
DETAIL B (Scale: 3-1/4)
Surface 'D' (NOTE 2)
Reference Plane B (NOTE 1)
1.83"
Tuning Knob (10 Holes .100 Dia. X .190 Deep, Equally Spaced)
.906" (NOTE 5) ±.031"
1.50"
3.875" Max.
3.00" ±.010"
2.00" Dia.
2.875" Max.
3.35" Dia.
1.400" Max.
1.25" Max.
Tuner Lock Nut
2.500" ±.010"
Reference Plane C (NOTE 1)
Axis of Heater-Cathode Terminal (NOTE 3)
.40" R. (Typical)
3.468" Max.
Tuning Index
1.500" Max.
Heater Terminal
Heater-Cathode Terminal
.516" Min. (NOTE 7)
.156 ±.031 (NOTE 9)
.750" Min. (NOTE 6)
.125±.010"
(NOTE 8)
.156" Max. (NOTE 7)
.545" .532"
.169"±.005"
.250"±.015" (NOTE 9)
.838"-.825"
DETAIL A (Scale: 2x1)

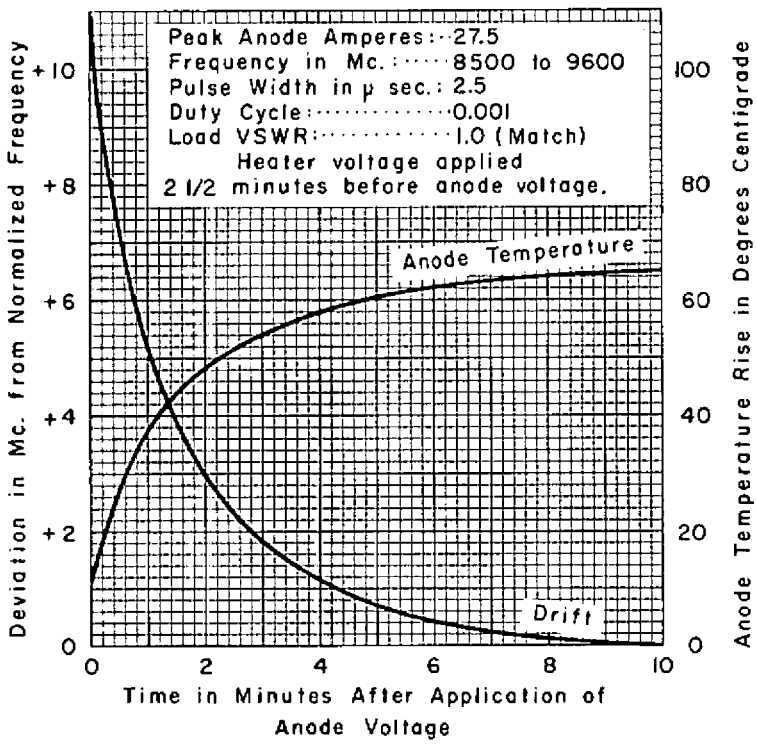
RECOMMENDED HEATER VOLTAGE
Heater Volts
16
12
8
4
0
0
100
200
300
400
500
600
Average Anode Input Power (Watts)
CE-A1815

RECOMMENDED OPERATING REGION
IN
RG-51/U WAVEGUIDE



CE-A1610

TYPICAL FREQUENCY DRIFT CHARACTERISTICS



CE-A1607

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THYRATRON TYPE WL-7556

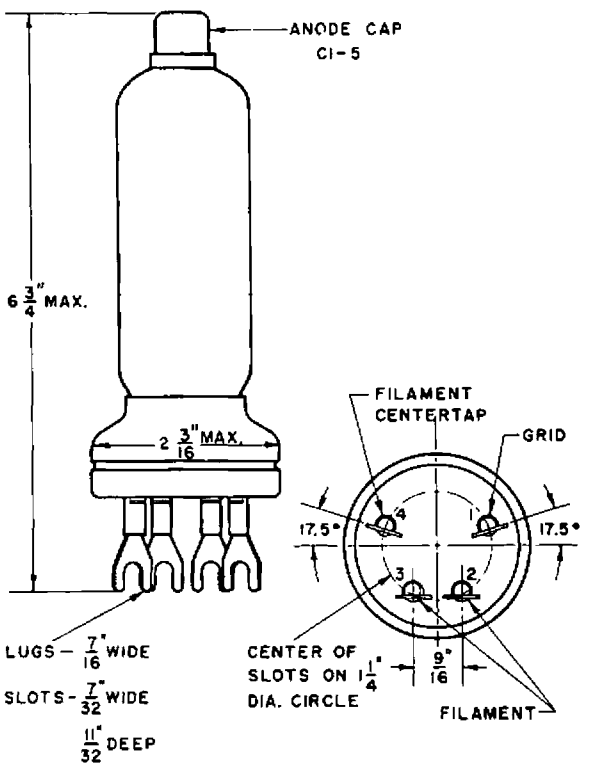
The WL-7556 is a three-electrode, inert gas filled thyratron with a negative control characteristic. This tube is designed for industrial control applications. The WL-7556 is electrically similar to the WL-7306.

ELECTRICAL:

	Min.	Bogey	Max.	
Cathode	Directly Heated Coated Filament			
Filament:				
Voltage	2.37	2.50	2.63	Volts
Current at Filament Volts = 2.5	--	9.0	11	Amperes
Heating Time	30	--	--	Seconds
Deionization Time	less than 1000			μsec
Ionization Time (Approx.)			10	μsec
Critical Grid Voltage	See Critical Grid Voltage Curve			
Maximum Critical Grid Current			10	μamp
Interelectrode Capacitances (Approx.):				
Anode to Grid			2	μμf
Grid to Cathode			10	μμf
Typical Arc Drop			10	Volts
Control Characteristic				Negative

MECHANICAL:

Mounting Position	Any
Type of Cooling	Air, Unrestricted Convection
Bulb	T-12
Base	Lug Size and Location per JEDEC A4-90
Net Weight	3 oz
Shipping Weight (Approx.)	24 oz



ABSOLUTE MAXIMUM VALUES

Peak Anode Voltage:			
Forward	1000	max.	Volts
Inverse	1250	max.	Volts
Anode Current:			
Peak	30	max.	Amperes
Average	2.5	max.	Amperes
Averaging Time	4.5	max.	Sec.
Surge, max. Duration 0.1 sec.■:			
Connection (a)	240	max.	Amperes
Connection (b)	120	max.	Amperes
Connection (c)	120	max.	Amperes
Commutation Factor ♦	0.66	max.	$va/\mu sec^2$
Negative Control Grid Voltage:			
Before Conduction	100	max.	Volts
During Conduction §	10	max.	Volts
Average Positive Control Grid Current:			
Averaging Time = 1 cycle ♦	0.10	max.	Ampere
Operating Frequency ⊕	150	max.	cps
Ambient Temperature Range	-55 to +70	max.	°C

General: These ratings are important in the prevention of "clean-up" or loss of the inert gas filling. Their observance will reduce the bombardment of anode or grid by positive ions of the gas filling, which may cause the gas ions to be absorbed in the tube element concerned.

♦ Commutation factor is the product of the rate of current decay in amperes per microsecond just prior to the end of commutation and the rate of inverse voltage rise in volts per microsecond just after the end of commutation. Its value should not exceed the value given in order to reduce ion bombardment of the anode during the deionization period. Value given is for a maximum initial inverse voltage of 350 volts.

§ When the tube conducts, positive ions are attracted to a grid at negative potential. This positive ion current flowing through the grid resistor will reduce the negative voltage at the grid from the higher negative grid supply voltage. To reduce ion grid bombardment, sufficient resistance must be provided to drop the negative grid supply voltage to a value not more negative than -10 volts as shown in the ratings.

♦ This rating indicates the heat emission properties of the grid. This value of current may be safely drawn to the grid if conduction occurs only while the anode is positive. However, during the period of negative anode potential, the grid potential must also be negative to prevent electrons being drawn to the grid and generating positive ions which would bombard the anode.

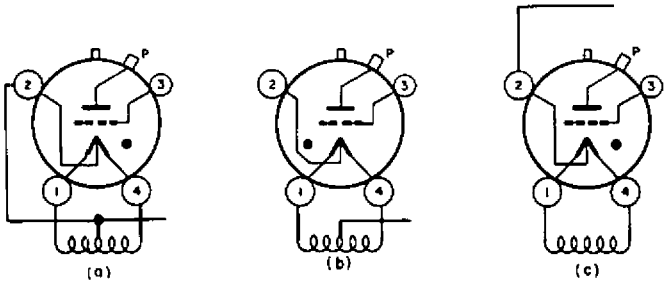
⊕ For higher frequency ratings, consult the tube manufacturer.

■ These ratings are effective only when the anode return connections are made according to the diagrams shown in CE-A1468.

from JEDEC release #2717, Feb. 7, 1960

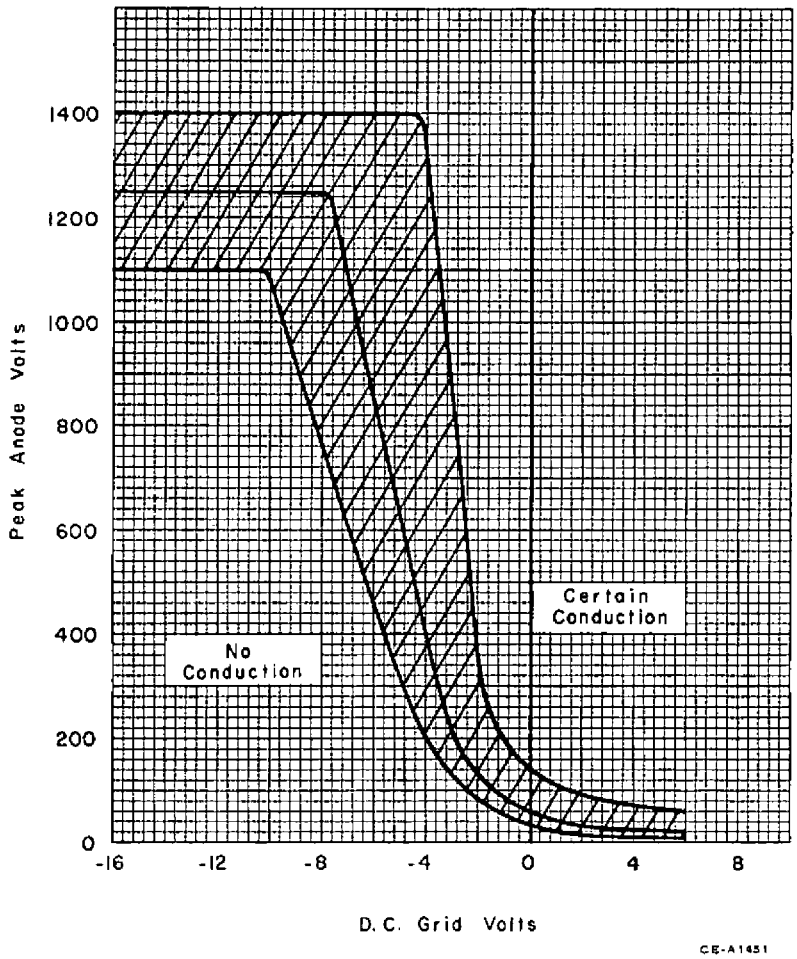
Westinghouse®

ANODE RETURN CONNECTIONS



CE-A1468

CRITICAL GRID VOLTAGE



CE-A1451

POWER AMPLIFIER TRIODE TYPE 7565

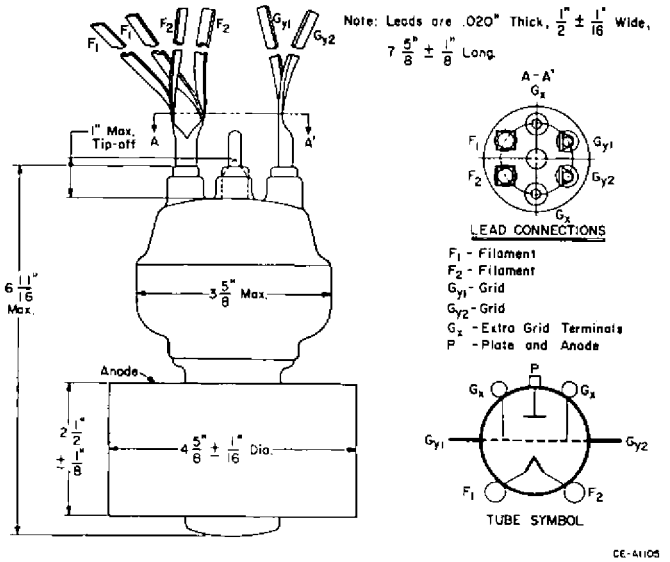
The 7565 is a three electrode tube designed for use as a modulator or amplifier. The anode is capable of dissipating 4 kilowatts of power in Continuous Commercial Service. Cooling is accomplished by forced air. The cathode is a thoriated tungsten filament. Maximum ratings apply for audio frequencies.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament Voltage	5.7	6.0	6.3	Volts
Filament Current	57	60	63	Amperes
Filament Starting Current	--	--	300	Amperes
Filament Resistance, (cold)	--	.016	--	Ohms
Amplification Factor	--	6.0	--	
Direct Interelectrode Capacitances (Avg.):				
Grid-Plate			14	μμf
Grid-Filament			15	μμf
Plate-Filament			1.5	μμf

MECHANICAL:

Mounting Position	Vertical, Anode Up or Down		
Type of Cooling	Forced Air		
Maximum Incoming Air Temperature	45 °C		
Required Air Flow on Anode:			
Per Cent Plate Dissipation Rating	100	75	50
Air Flow-Cubic Feet per Minute	300	200	125
Static Pressure-Inches of Water	2.5	1.25	0.7
Required Air Flow on Filament	Air flow through radiator is normally sufficient		
Maximum Glass Temperature	160 °C		
Net Weight, approximate	4-7/8 lbs.		
Shipping Weight, approximate	10 lbs.		



AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR-CLASS A

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	8.0	max.	Kilovolts
Negative DC Grid Voltage	1000	max.	Volts
Plate Input	4.0	max.	Kilowatts
Plate Dissipation	4.0	max.	Kilowatts

TYPICAL OPERATING CHARACTERISTICS:

DC Plate Voltage	4500	Volts
DC Grid Voltage	-570	Volts
Peak AF Grid Voltage	570	Volts
Peak AF Plate Voltage	2700	Volts
DC Plate Current	0.88	Amperes
Load Resistance	4500	Ohms
2nd Harmonic Distortion (approx.)	3.8	Per Cent
Power Output	950	Watts

AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR CLASS AB

MAXIMUM RATINGS (PER TUBE):

Absolute Maximum Values	CCS		
DC Plate Voltage	8.0	max.	Kilovolts
DC Plate Current	2.5	max.	Amperes
Negative DC Grid Voltage	1500	max.	Volts
Plate Input	8.0	max.	Kilowatts
Plate Dissipation	4.0	max.	Kilowatts

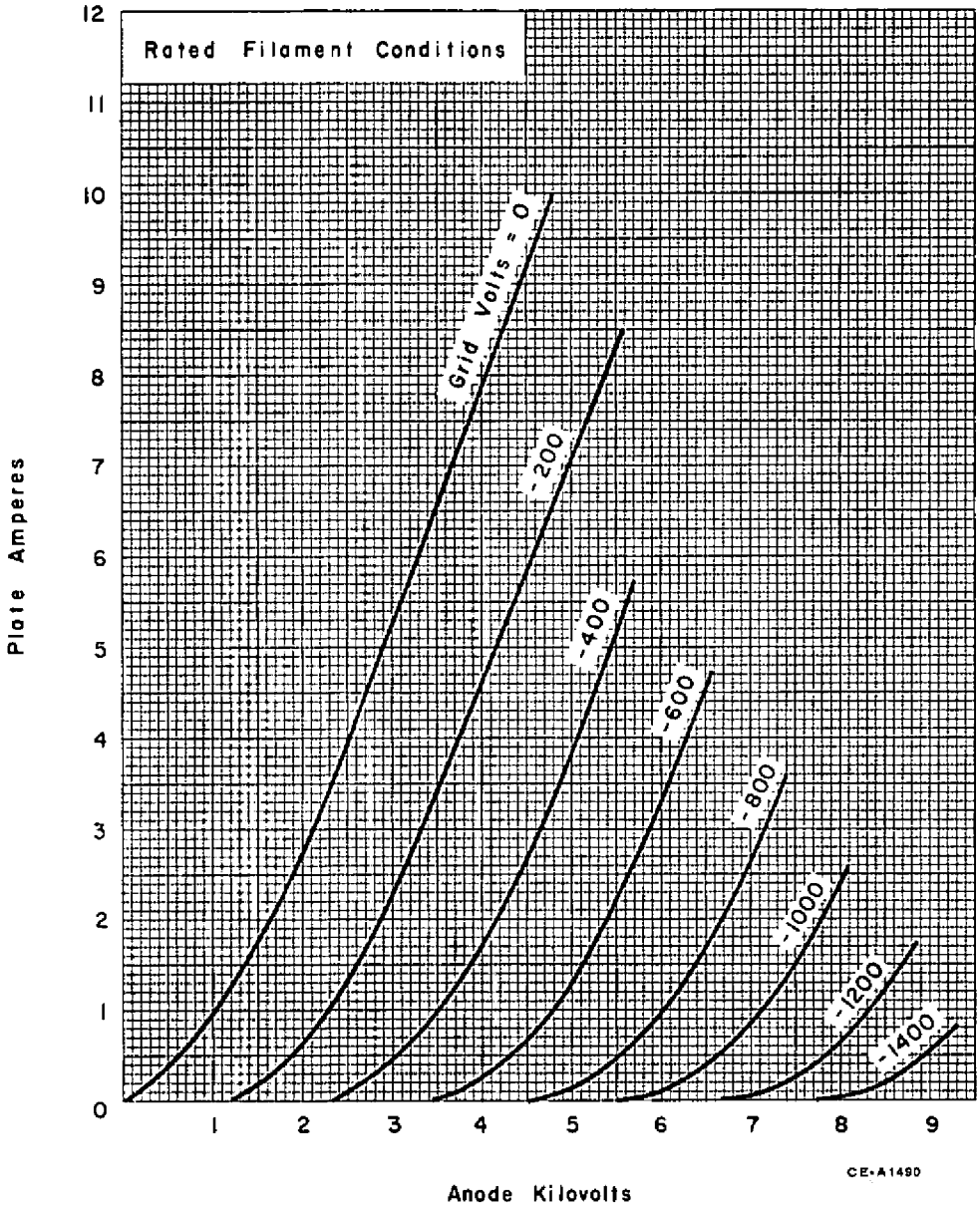
TYPICAL OPERATING CHARACTERISTICS:

(Unless Otherwise Specified, Values are for Two Tubes)

DC Plate Voltage	7.0	Kilovolts
DC Grid Voltage	-1140	Volts
Peak AF Grid to Grid Voltage	2280	Volts
Zero Signal Plate Current	0.5	Amperes
Maximum Signal DC Plate Current	2.2	Amperes
Peak AF Plate to Plate Voltage	9.2	Kilovolts
Effective Load Resistance (Plate to Plate)	5100	Ohms
Maximum Signal Driving Power	0	Watts
Maximum Signal Power Output	7.7	Kilowatts
Total Harmonic Distortion (Approx.)	4.5	Per Cent

from JEDEC release #3394, Aug. 28, 1961

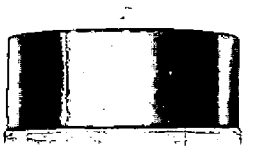
AVERAGE PLATE CHARACTERISTICS



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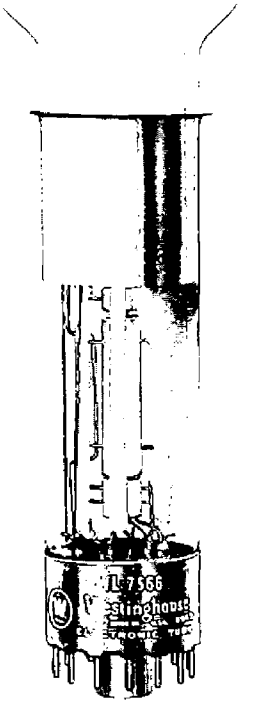
BARRIER GRID STORAGE TUBE TYPE WL-7566
(RADECHON)

Rugged Construction — High Resolution — 2.6" Useful Diameter Target
Shielded Target Assembly — Coaxial Connection for Signal Output



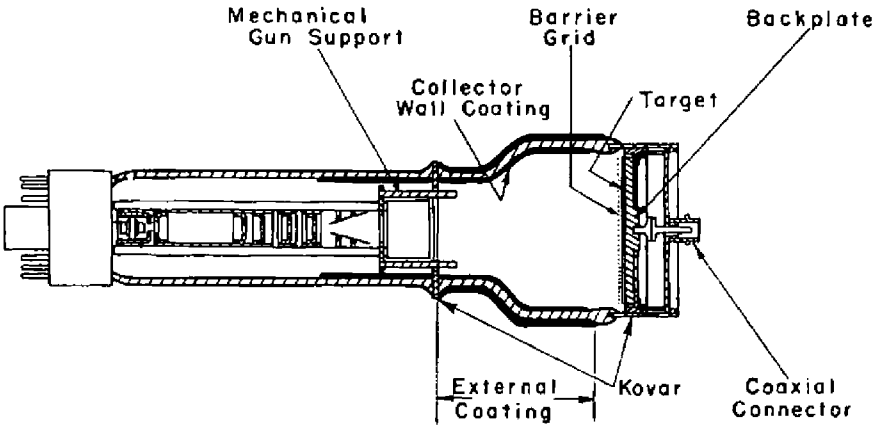
The WL-7566 is a 3" electrical write, electrical read, barrier-grid type storage tube. It is designed for service in digital or analog computer systems and pulse height analyzers.

The WL-7566 uses a single gun with electrostatic focus and deflection. The electron-optical design of this gun makes unnecessary any astigmatic correction in order to achieve a fine electron beam of high current density at all deflections. A high degree of mechanical strength is imparted to the 4-bead gun structure by making the collector terminal an integral part of the gun. The collector terminal is a thick Kovar ring sealed into the envelope of the tube and electrically connected to the collector wall coating and external conductive coating. Permanent axial alignment of the gun is thus ensured by mechanically securing both ends of the gun.



The mesh-target storage assembly of the WL-7566 is extremely rugged. The barrier-grid is a fine, woven stainless-steel mesh, treated to control secondary emission ratio to unity, stretched drum tight on a ring which is welded to the outer Kovar cylinder. The mica target is between, and in continuous contact with the barrier grid and back plate. The back plate is retained firmly against the target and a single heavy lead is brought out through a glass bead seal in the center of the Kovar end cup and terminated in the center conductor of a hermetically sealed BNC connector. Since the entire target assembly is surrounded by a Kovar cylinder, a high degree of shielding is obtained reducing the generation of spurious signals due to external fields.

The WL-7566 is designed to operate in existing systems. The use of a coaxial connector provides a quick and positive means of electrical connection with a shielded output. The increased resolution capability, uniformity of output and rugged construction results in an all round improvement in system performance.



from JEDEC release #2668, Dec. 21, 1959

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage	6.3	Volts
Current♦	0.6	Ampere
Interelectrode Capacities:		
Cathode to all Other Electrodes	15	μμf
Grid 1 to all Other Electrodes	10	μμf
Grids 2 & 4 to all Other Electrodes	10	μμf
DJ1 to all Other Electrodes	8	μμf
DJ2 to all Other Electrodes	8	μμf
DJ3 to all Other Electrodes	7.5	μμf
DJ4 to all Other Electrodes	7.5	μμf
DJ1 to DJ2	1.5	μμf
DJ3 to DJ4	2	μμf
Barrier Grid to Backplate	1600 ± 20%	μμf
Collector to Backplate	0.2	μμf
Barrier Grid to Collector	18	μμf
Collector to All Other Electrodes	22	μμf
Interelectrode Insulation:		
Cathode to all Other Electrodes	500 min.	Megohms
Heater to Cathode	50 min.	Megohms
Any one Deflection Plate to all Other Deflection Plates	500 min.	Megohms
Backplate to Barrier Grid	100 min.	Megohms
Grid 3 to all Other Electrodes	500 min.	Megohms
Grid 1 to all Other Electrodes	500 min.	Megohms
Focusing Method		Electrostatic
Deflecting Method		Electrostatic
Deflection Sensitivity:		
DJ1 and DJ2	110 ± 7%	Volts/Inch/KV
DJ3 and DJ4	125 ± 7%	Volts/Inch/KV
Spot Position⊕	0.065	Inch

♦ Reasonable performance is obtained with a minimum of 0.45 amperes of heater current. The decrease in relative signal output and beam current resulting from a decrease in heater current is shown in CE-A1421.

⊕ Undeflected focused spot falls within 0.065" of the geometric center of the target.

MECHANICAL:

Mounting Position	Any
Maximum Diameter	3-1/8"
Maximum Overall Length	11-7/8"
Maximum Usable Target Diameter	2.6"
Base	Small Shell 14 Pin Base (JEDEC B14-45)
Signal Connector	Hermetically Sealed BNC Panel Jack JAN No. UG-657/U
Net Weight (approx.)	1 Pound
Shipping Weight (approx.)	4 Pounds

MAXIMUM RATINGS:

Absolute Maximum Values

Cathode to Barrier Grid Voltage	-3300	max.	Volts
Grid 1 to Barrier Grid Voltage	-3000	max.	Volts
Grid 1 to Cathode Voltage	+3	max.	Volts
Grid 3 to Grids 2 & 4 Voltage	-3000	max.	Volts
Back Plate to Barrier Grid Voltage	+200	max.	Volts
Heater-Cathode Voltage	±100	max.	Volts

TYPICAL OPERATING CONDITIONS:

(With Barrier Grid Grounded)

Cathode Voltage	-1100	Volts
Grid 1 Cutoff Voltage	-1140	Volts
Grids 2 & 4 Voltage	+150	Volts
Grid 3 Voltage	-770 ± 5%	Volts
Collector Voltage	+150	Volts
Back Plate Voltage:		
Reading Conditions	0	Volts
Writing Conditions	+40	Volts

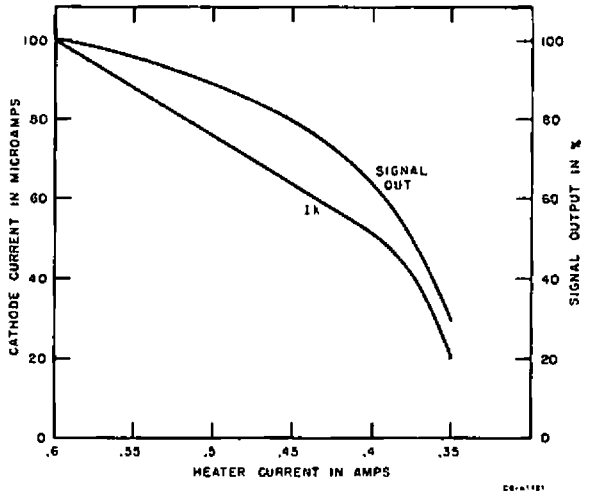
MERIT FACTOR:

	Min.	Bogey
Read Around Ratio using 70% of usable target diameter	800	3000

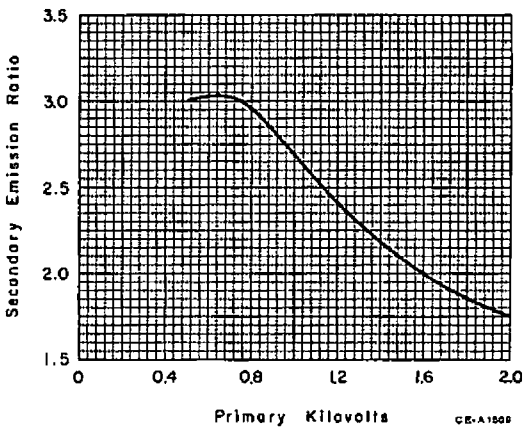
PRINCIPLES OF OPERATION

When an electron beam bombards an insulator, secondary electrons are emitted in proportion to the secondary emission ratio of the target material at the operating voltage. For the WL-7566 target, this ratio follows the general pattern in curve CE-A1509.

VARIATION OF SIGNAL OUTPUT WITH HEATER CURRENT

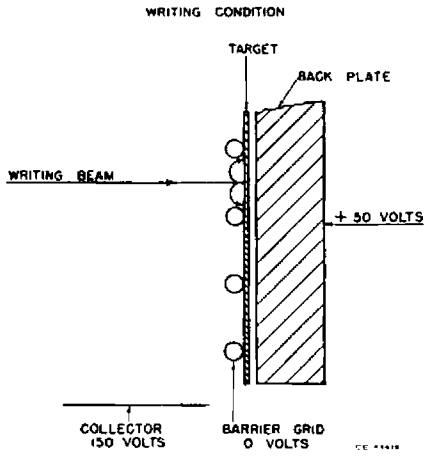


SECONDARY EMISSION CHARACTERISTIC

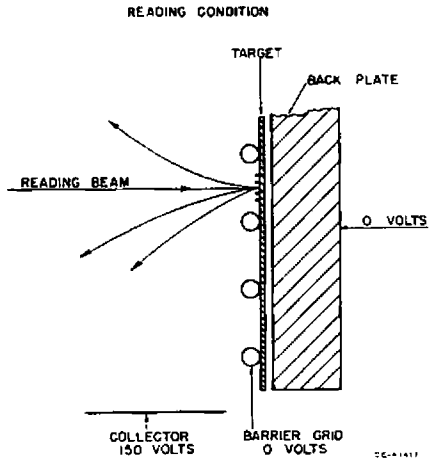


If a grounded grid is placed touching the target, and a positive potential applied to the backplate, a retarding electric field is formed which acts like a barrier to prevent the secondary electrons from escaping from the small areas formed by the spaces of the grid. If the back plate is returned to the potential of the barrier grid during scan, secondary electrons will be released. These secondary electrons are attracted to the collector maintained at a positive potential.

In the writing operation of the WL-7566 the backplate is pulsed 20 to 50 volts positive with respect to the barrier grid. A similar positive potential is initially induced on the target surface. The modulated electron beam is scanned across the target. The barrier grid prevents the escape or redistribution of secondary electrons and the information is stored on the target in the form of a pattern of negativly charged areas. This operation is illustrated in CE-A1418.



During the reading operation, the back plate is returned to the same potential as the barrier grid. The written areas of the target surface assume a negative potential with respect to the barrier grid. An unmodulated electron beam is scanned across the target. A burst of secondary electrons leaves the target as the reading beam enters each aperture in the barrier grid which contains a charged area. These electrons are attracted to the collector held at a potential of +150 volts with respect to the barrier grid. This operation is illustrated in CE-A1417.



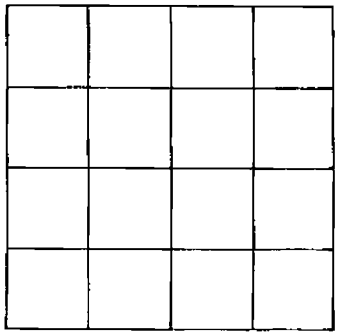
This current, or the displacement current flowing in the back plate, constitutes the output signal. This reading process discharges the target toward an equilibrium potential which is close to that of the barrier grid. A negligible disturbance signal is produced when the scanning beam strikes the mesh which is treated in such a manner that the secondary emission ratio is approximately unity. This close control of the secondary emission ratio of the barrier grid results in a very favorable signal to noise ratio.

PERFORMANCE

The WL-7566 is primarily designed for use in digital computers. In this application, a significant performance indicator is the Readaround Ratio capability. The Readaround Ratio Test is performed in the following manner:

Raster: A pattern of 4096 dots is made by arranging 16 square blocks of 16 × 16 each in the form shown in CE-A1508. An identical pattern interlaced results in a 8192 dot raster.

READAROUND TEST RASTER

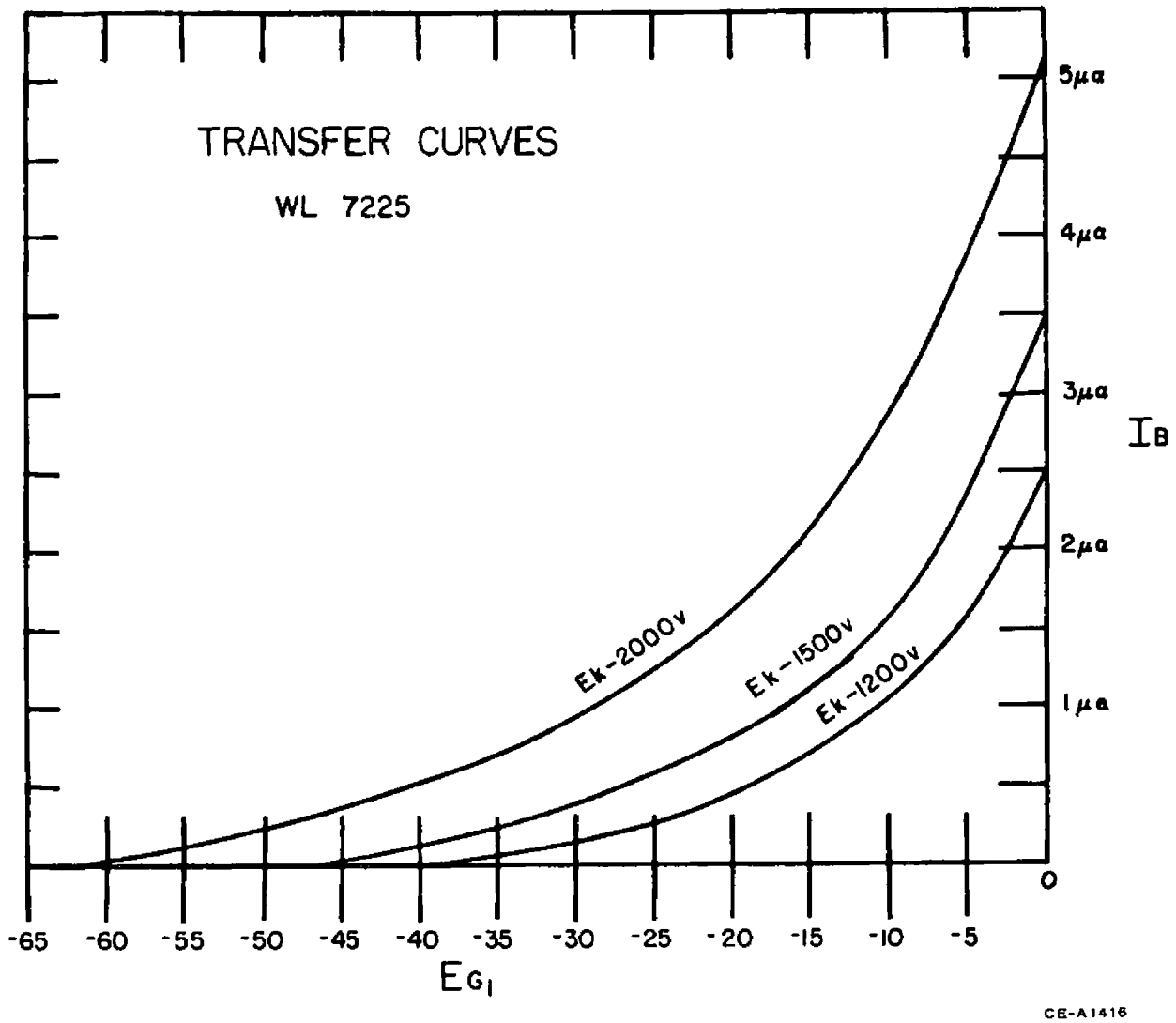


CE-A1508

Writing: Writing is achieved by switching the backplate to either +15 volts to write a "1" or -15 volts to write a "0". In each case the beam duration is sufficient to bring the spot to equilibrium. The Radechon grid drive is adjusted to provide a "1" read signal of a predetermined size at the output of the gain stabilized read amplifier; this is arranged to correspond to a beam current of approximately 1 μa.

Reading: The output from the read amplifier drives a discriminator having a triggering threshold of one quarter of the nominal "1" signal amplitude. Any signal triggering the discriminator is interpreted as a "1", all others as "0" 's. The test is performed with an ultor voltage of 1100 volts and a well focused spot.

The Readaround Ratio Test: An interlaced pattern of 8192 "0" 's or "1" 's is stored on the target. The regeneration cycle is set at 1 microsecond "read", 3 microsecond "rewrite" and 6 microsecond "deflect". Next, an equally spaced pattern of one-eighth of the total dot pattern (1024) is written to the opposite polarity of the previously written pattern. In turn, each of the 1024 locations is addressed N consecutive times. (An address is a read followed by a rewrite). The addressing of a spot in this manner, degrades the charge stored at adjacent spots. When the degradation of charge at any spot is such that its "readout" signal crosses the discriminator threshold, a "readaround failure" is said to have occurred. This procedure is then repeated for a pattern of dots written to the oppo-



site polarity. The entire pattern is examined in this way such that every nearest neighbor of every spot is consulted N consecutive times, and the smallest value N for which a readaround failure occurs is called the readaround ratio of the tube.

Results: When the WL-7566 is tested this way, the readaround ratio is approximately 3000 with a minimum of 800. This test, however, only uses approximately 70% of the usable target area. If the full usable target diameter is used, a much higher readaround ratio will be obtained. For high resolution applications, up to 40,000 dots can be stored with corresponding lower readaround ratios.

Information may be written and stored for many hours, if desired, before being read out. The uniformity of output is such that for a constant signal applied the ratio of the maximum to minimum signal obtained from the target does not exceed 2 to 1 with a cathode voltage of -1100 volts. The signal output actually is much more uniform than this ratio indicates. The wide latitude given includes highly localized disturbances on the target surface.

For further information on the use of Radechons in a digital storage application see:

Greenwood and Staehler
Bell System Technical Journal
September 1958 Page 1195
and
C.F. Ault
Bell System Technical Journal
March 1959 Page 445

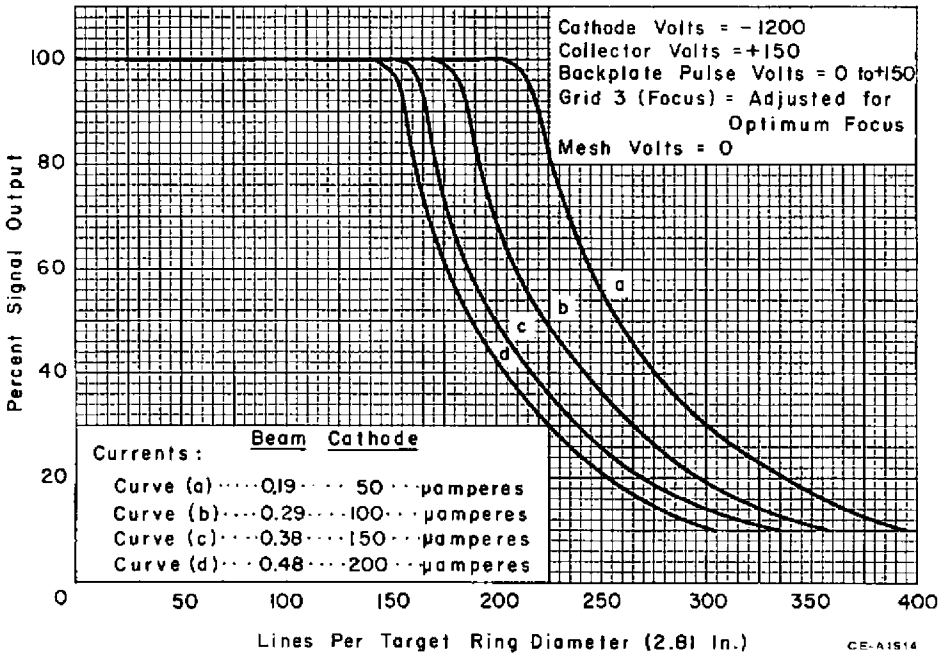
Target Life: Under conditions of intensive bombardment of one spot, the signal output will fall, approaching a final value of 70% of its original value.

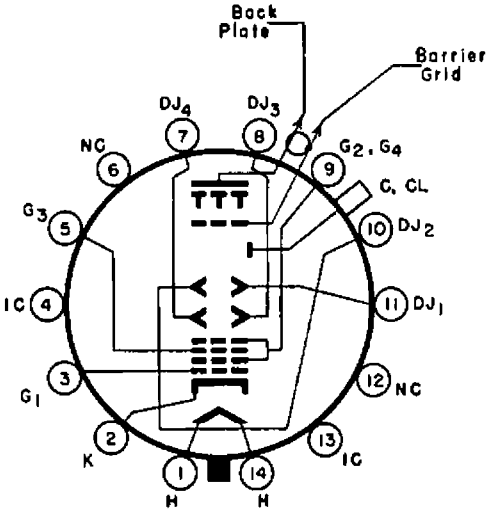
When a 50% duty cycle is used, this decrease in signal will not occur within the first four hours.

The normal operating conditions of digital computers are such that noticeable signal decrease is unlikely to occur for at least 1000 hours.

Resolution: The WL-7566 may also be used in applications employing a conventional raster. The tube characteristic of value in this application is its resolution. The resolution of the WL-7566 may be expressed in lines per target diameter when the target is scanned with a conventional raster. The difference in resolution with four values of beam current is shown in CE-A1514.

RESOLUTION CHARACTERISTICS





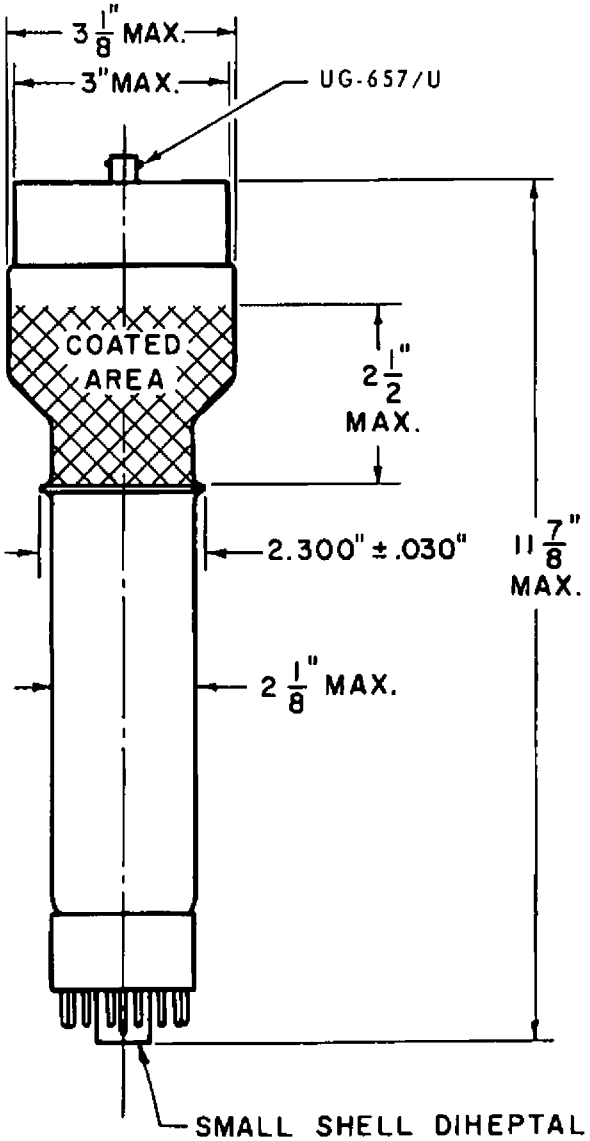
Socket Connections
(Bottom View)

Pin No.	Element
1	Heater
2	Cathode
3	Grid 1
4	Internal Connection (Do Not Use)
5	Grid 3
6	No Connection
7	Deflecting Electrode 4
8	Deflecting Electrode 3
9	Grids 2 & 4
10	Deflecting Electrode 2
11	Deflecting Electrode 1
12	No Connection
13	Internal Connection (Do Not Use)
14	Heater

Bulb Terminals

Neck Flange: External Conductive Coating (C), Internal Shield, Collector (CL)

Coaxial Connector
Center Electrode: Back Plate
Outside Electrode: Barrier Grid, End Cylinder



BEAM POWER AMPLIFIER TYPE 7591A

The 7591A is a glass octal beam power pentode designed for use as an audio frequency power output tube. The tube has high power sensitivity and high efficiency and is especially designed for applications where high power output is required. Plate construction with special heavy material of high heat conductivity will allow the use of the tube at a higher plate dissipation than is possible with conventional plates. A power output as high as 45 watts with 1.5% total harmonic distortion is available in push-pull Class AB1 application with 450 volt plate voltage and 400 screen voltage.

The 7591A is a direct replacement for type 7591 and has controlled zero-bias plate and screen currents. It also features a special low-loss base.

MECHANICAL:

Bulb	T-9 Glass
Base	Plaskon, Octal 7 Pin B7-238
Cathode	Coated Unipotential
Mounting Position	Any

ELECTRICAL:

Heater Characteristics:		
Heater Voltage, AC or DC	6.3	Volts
Heater Current	0.80	Amperes
Heater-Cathode Voltage (Design Maximum Values):		
Heater Negative with Respect to Cathode		
Total DC and Peak	200	Volts
Heater Positive with Respect to Cathode		
D.C.	100	Volts
Total D.C. and Peak	200	Volts
Direct Interelectrode Capacitances:		
Grid-to-Plate	.25	$\mu\mu f$
Input	10.0	$\mu\mu f$
Output	5.0	$\mu\mu f$

RATINGS

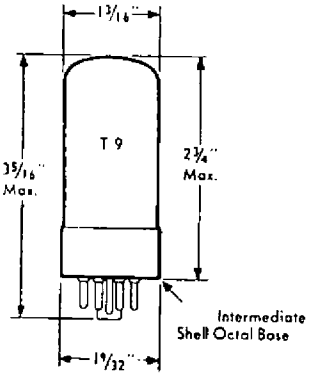
Design-Maximum Values:		
Plate Voltage	550	Volts
Screen Voltage	440	Volts
Plate Dissipation	19.0	Watts
Screen Dissipation (Note 1)	3.3	Watts
Cathode Current	90	Ma.
Grid No. 1 Circuit Resistance:		
With Fixed Bias	0.3	Megohms
With Cathode Bias	1.0	Megohms

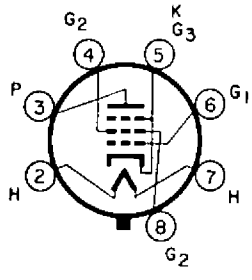
CHARACTERISTICS & TYPICAL OPERATION

Plate Voltage	60 (Note 2)	300	Volts
Screen Voltage	250 (Note 2)	300	Volts
Grid No. 1 Voltage	0	−10	Volts
Peak A.F. Grid Voltage	--	10.0	Volts
Plate Current (Zero Signal)	140 (Note 3)	60	Ma.
Plate Current (Max. Signal)	--	75	Ma.
Screen Current (Zero Signal)	30 (Note 3)	8.0	Ma.
Screen Current (Max. Signal)	--	15.0	Ma.
Transconductance	--	10,200	Micromhos
Plate Resistance	--	29,000	Ohms
Triode Amplification Factor	--	16.8	--
Load Resistance	--	3000	Ohms
Power Output	--	11	Watts
Total Harmonic Distortion	--	13	Percent

Push-Pull Class AB1 - Ultra-Linear (Note 4)
Operation (Values for Two Tubes)

	Fixed Bias	Cathode Bias	
Plate Supply Voltage	400	425	Volts
Grid 1 Voltage	−20.5	--	Volts
Cathode Resistor (Common to Two Tubes)	--	185	Ohms
Peak A.F. Grid-to-Grid Voltage	41	42	Volts
Zero Signal Plate Current	80	88	Ma.
Maximum Signal Plate Current	138	104	Ma.
Zero Signal Screen Current	11.5	13.0	Ma.
Maximum Signal Screen Current	26.4	17.5	Ma.
Effective Load, Plate-to-Plate	6600	6600	Ohms
Total Harmonic Distortion	1.0	2.0	Percent
Maximum Signal Power Output	32	26	Watts





8K Q

from JEDEC release #4250, May 6, 1963

Push-Pull Class AB1 - Pentode Connection (Values for Two Tubes)

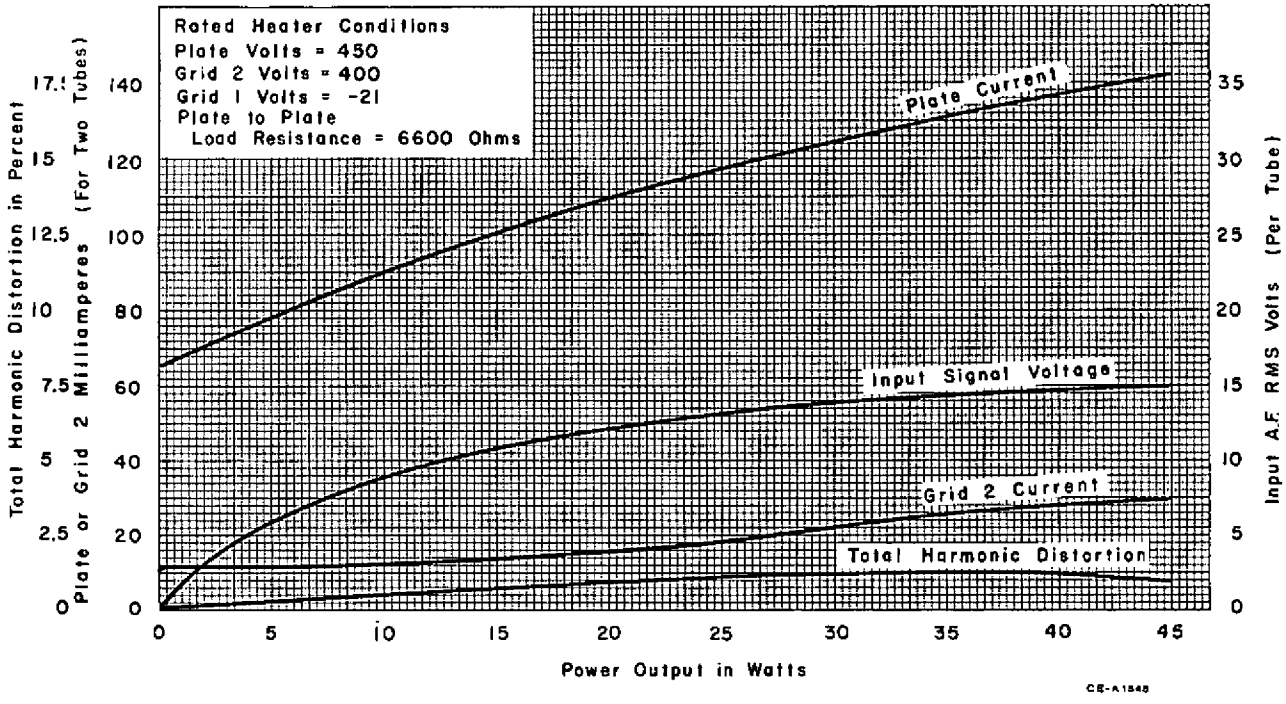
	Fixed Bias					Cathode Bias	
Plate Supply Voltage	300	350	400	450	450	450	Volts
Screen Supply Voltage	300	350	350	350	400	400	Volts
Grid 1 Voltage	-12.5	-15.5	-16.0	-16.5	-21	--	Volts
Common Cathode Resistor	--	--	--	--	--	200	Ohms
Peak AF Grid-to-Grid Voltage	25	31	32	33	42	28	Volts
Zero Signal Plate Current	86	92	85	77	66	82	Ma.
Max. Signal Plate Current	116	130	143	153	144	94	Ma.
Zero Signal Screen Current	12.6	13.0	11.0	9.6	9.4	11.5	Ma.
Max. Signal Screen Current	26.0	28.6	27.0	27.0	30.0	22	Ma.
Effective Load, Plate-to-Plate	6600	6600	6600	6600	6600	9000	Ohms
Total Harmonic Distortion	2.5	2.0	1.5	1.5	1.5	2.0	Percent
Maximum Signal Power Output	23	30	37	43	45	28	Watts

NOTES

1. Screen dissipation may be permitted to reach 6 watts during the periods of maximum input of speech and music signals. For efficient operation of the screen, the two screen connections, pins 4 and 8, should be externally tied together.
2. Applied for short interval (2 seconds maximum) so as not to damage tube.
3. These values can be measured by a method involving a recurrent waveform such that the plate and grid 2 dissipation will be kept within ratings to prevent damage to the tube.
4. Screen tapped at 40% of primary turns.

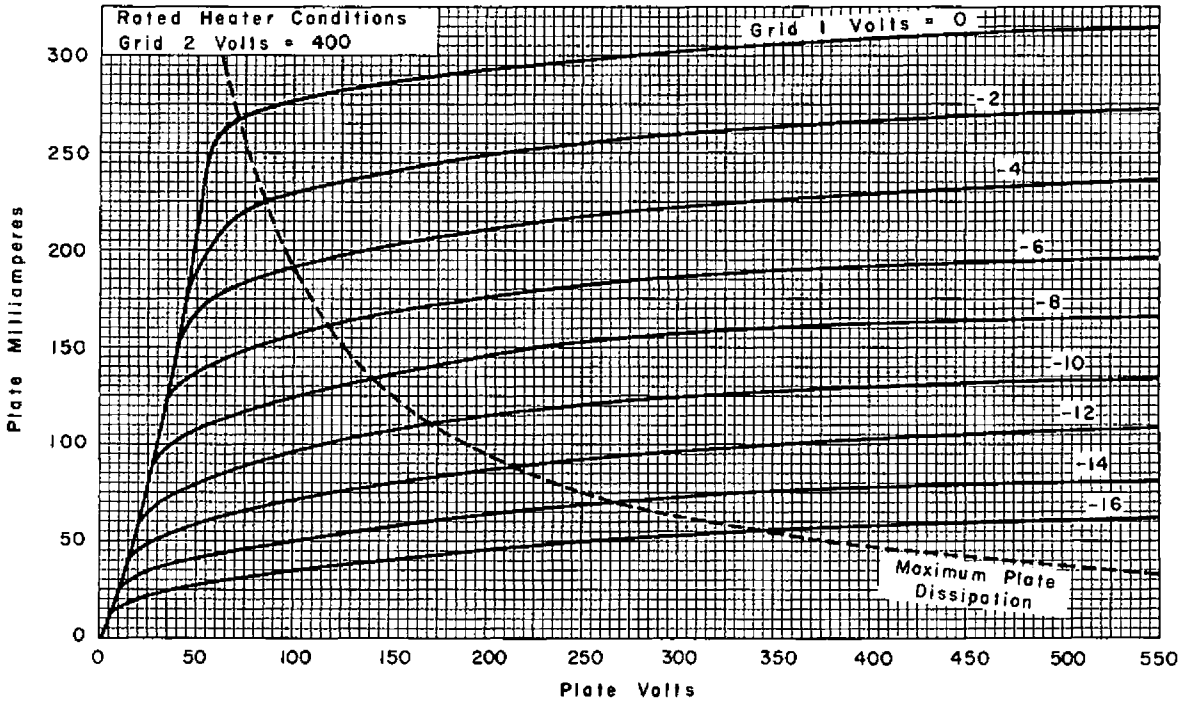
AVERAGE, OPERATING CHARACTERISTICS

Class AB_1 Push-Pull



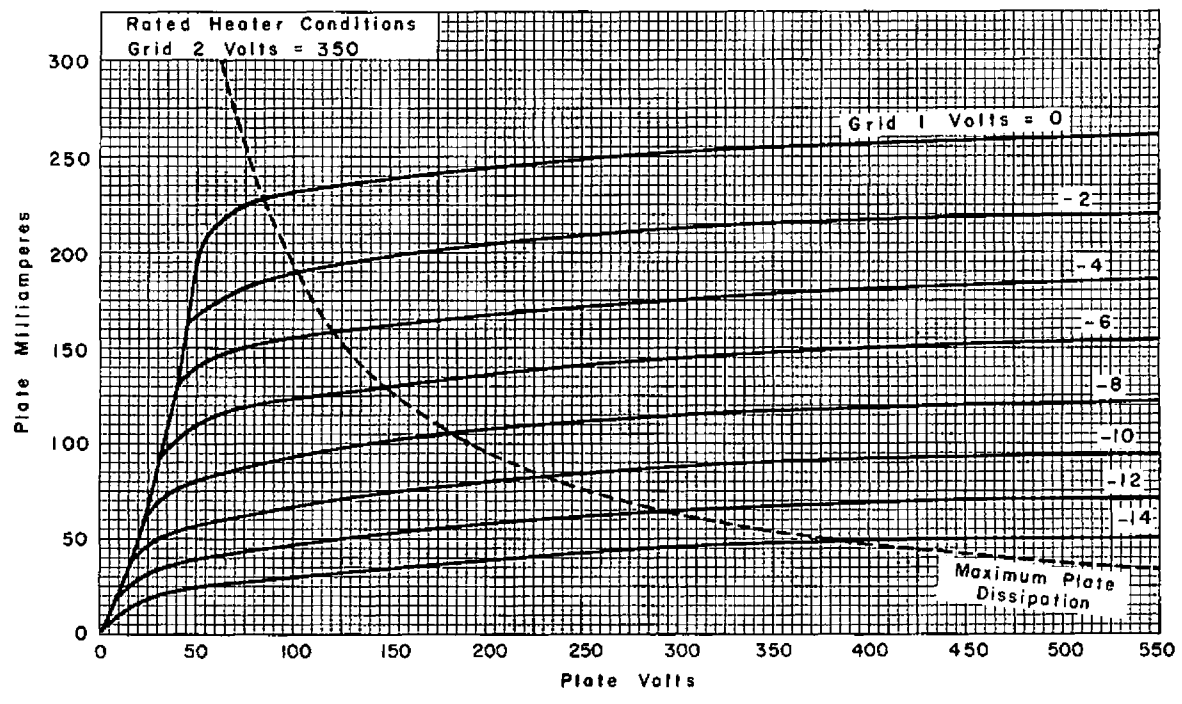
CS-A1548

AVERAGE PLATE CHARACTERISTICS



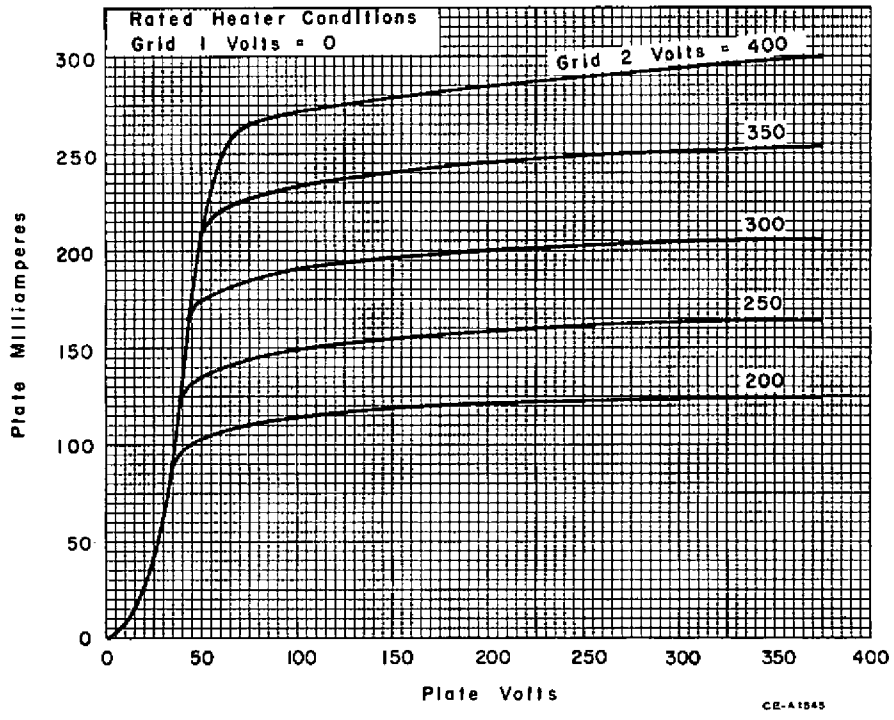
CE-A1543

AVERAGE PLATE CHARACTERISTICS

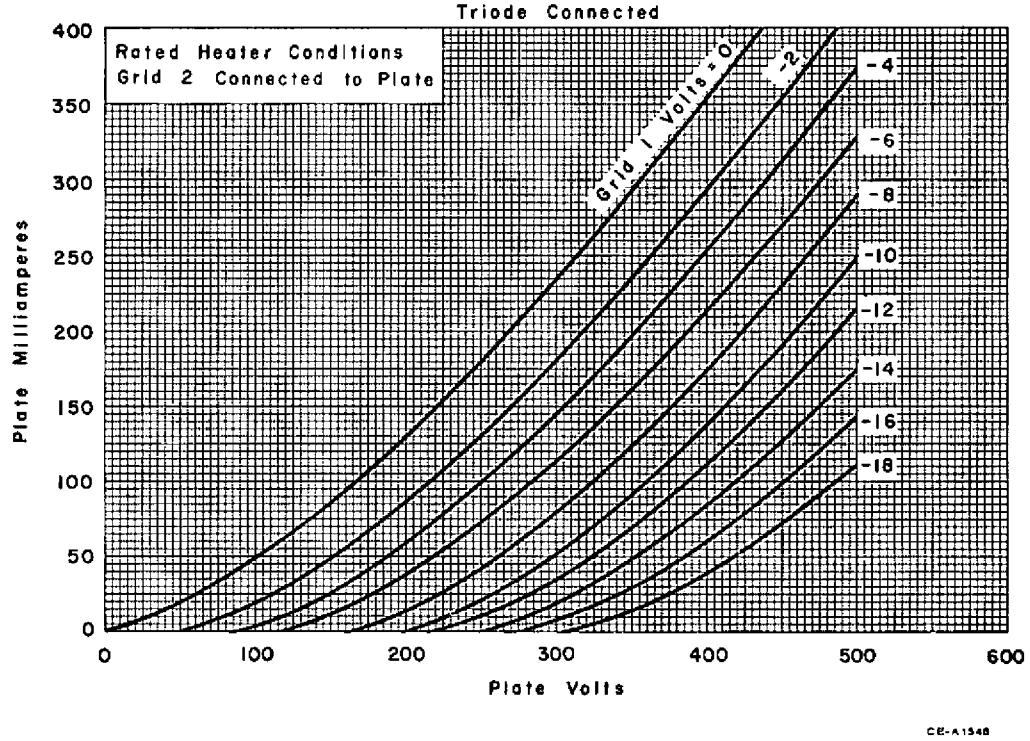


CE-A1544

AVERAGE PLATE CHARACTERISTICS

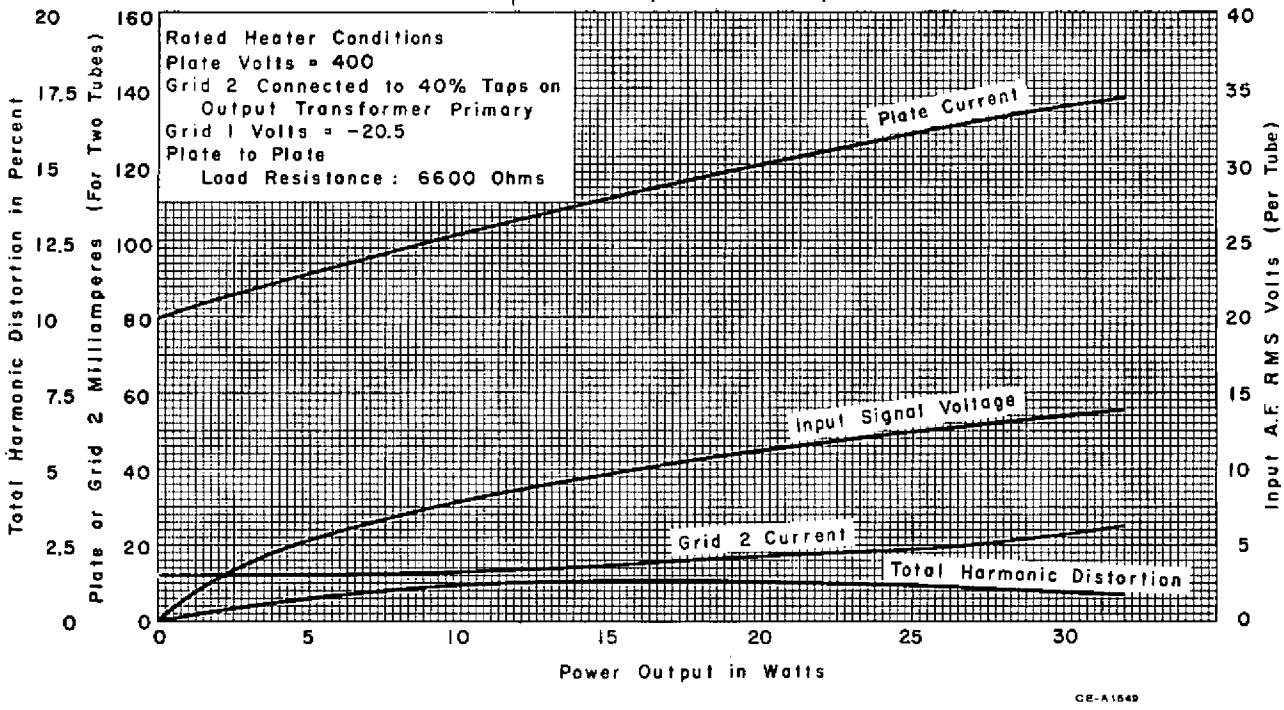


AVERAGE PLATE CHARACTERISTICS
Triode Connected



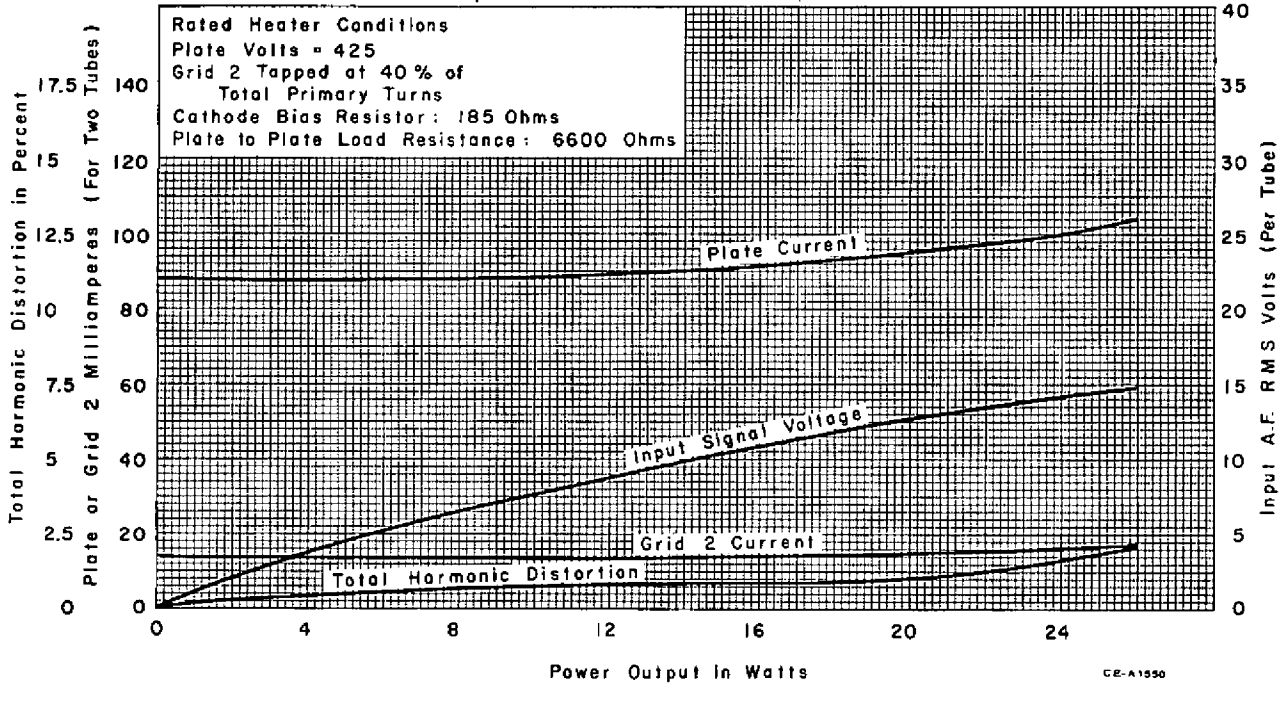
AVERAGE OPERATING CHARACTERISTICS

Class AB_1 Push-Pull, Ultra-Linear, Fixed Bias

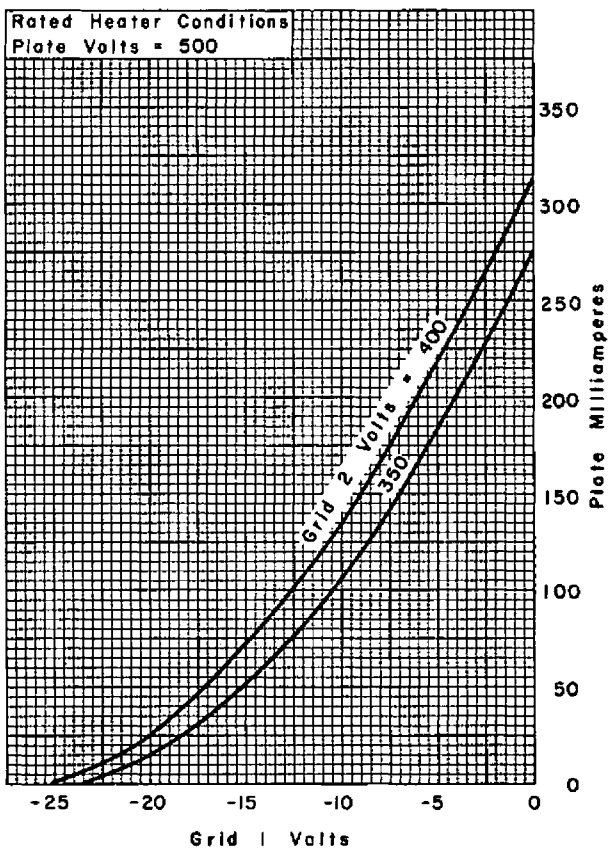


AVERAGE OPERATING CHARACTERISTICS

Class AB_1 Push-Pull Ultra-Linear Operation Self Bias



AVERAGE TRANSFER CHARACTERISTICS



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VHF POWER TRIODE TYPE 7604

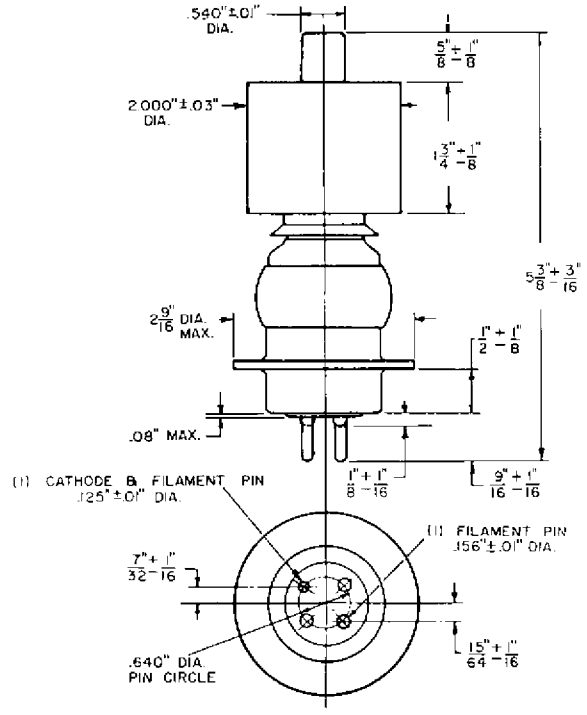
The 7604 is a three electrode tube designed for use as an oscillator, amplifier or modulator. The forced-air-cooled external radiator is capable of dissipating 600 watts. An efficient oxide coated cathode is employed. Maximum ratings apply to 60 megacycles and operation with reduced input is permissable to 350 megacycles.

ELECTRICAL:

Cathode	Oxide Coated Unipotential	
Heater:		
Voltage	5.0	Volts
Current	8.0	Amperes
Amplification Factor	20	
Interelectrode Capacitances:		
Grid to Plate	11.8	μμf
Grid to Cathode	26	μμf
Plate to Cathode	0.25	μμf
Interelectrode Capacitances with Socket in Place:□		
Grid to Plate	12	μμf
Grid to Cathode	35	μμf
Plate to Cathode	0.24	μμf

MECHANICAL:

Mounting Position□	Vertical - anode up or down	
Type of Cooling	Forced Air	
Maximum Incoming Air Temperature	45	°C
Minimum Required Air Flow on Radiator:		
Plate Dissipation	600	Watts
Air Flow Cubic Feet per Min.	30	CFM
Pressure in Inches	0.9	Inches
Maximum Glass Temperature	160	°C
Net Weight	14	Ounces
Shipping Weight	3	Pounds



MAXIMUM RATINGS - CLASS C TELEGRAPHY

(Key down conditions per tube without modulation)

D.C. Plate Voltage	4000	Volts
D.C. Plate Current	0.50	Amperes
D.C. Grid Voltage	−500	Volts
D.C. Grid Current	0.075	Amperes
Plate Input	1.8	Kilowatt
Plate Dissipation	600	Watts
Grid Dissipation	15	Watts

TYPICAL OPERATION - CLASS C TELEGRAPHY

(Key down without A.M.)

D.C. Plate Voltage	2500	3500	Volts
D.C. Grid Voltage	−275	−400	Volts
Peak R.F. Grid Voltage	370	525	Volts
D.C. Plate Current	0.272	0.400	Amperes
D.C. Grid Current	0.046	0.069	Amperes
Peak R.F. Plate Voltage	2100	2950	Volts
Driving Power (Approx.)⊕	17	35	Watts
Power Output	530	1100	Watts

R.F. POWER AMPLIFIER - CLASS AB

Maximum Ratings:

D.C. Plate Voltage	4000	Volts
Max. Signal D.C. Plate Current	0.600	Amperes
Max. Signal Plate Input	1.5	Kilowatts
Plate Dissipation	600	Watts
Grid Dissipation	15	Watts

TYPICAL OPERATION

Class AB_2 R-F Linear Amplifier (One Tube)

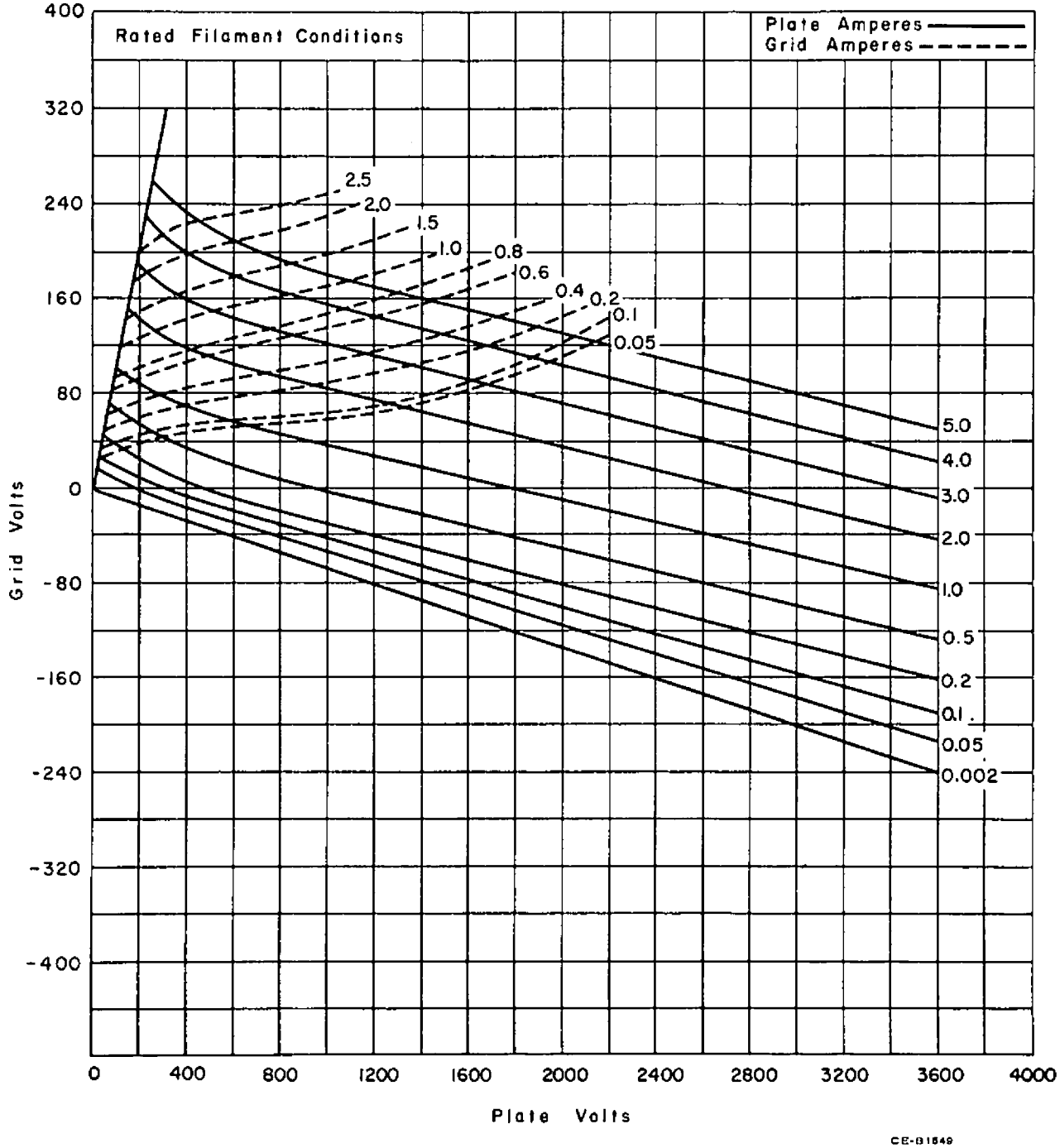
Grounded Grid Operation - Frequencies Below 60 mc.:

D.C. Plate Voltage	3500	Volts
D.C. Grid Voltage	−210	Volts
D.C. Plate Current	.285	Amperes
Zero Signal Plate Current	0.045	Amperes
D.C. Grid Current	0.008	Amperes
Peak R.F. Grid Voltage	270	Volts
Plate Dissipation	245	Watts
Driving Power (Approx.)	65	Watts
Power Output (Approx.)	755	Watts

□ The tube may be supported either by the anode or by use of a socket, Westinghouse Part No. 3-2H-4290. This socket is designed to provide a low inductance contact to the grid. Anode support of the tube may be done with a Lapp No. 43751 Insulating Support, sold by Lapp Insulator Co., Leroy, N.Y. or equivalent. When tube is operated anode down, cooling of the base end of the tube is necessary. Free air convection will suffice for most applications.

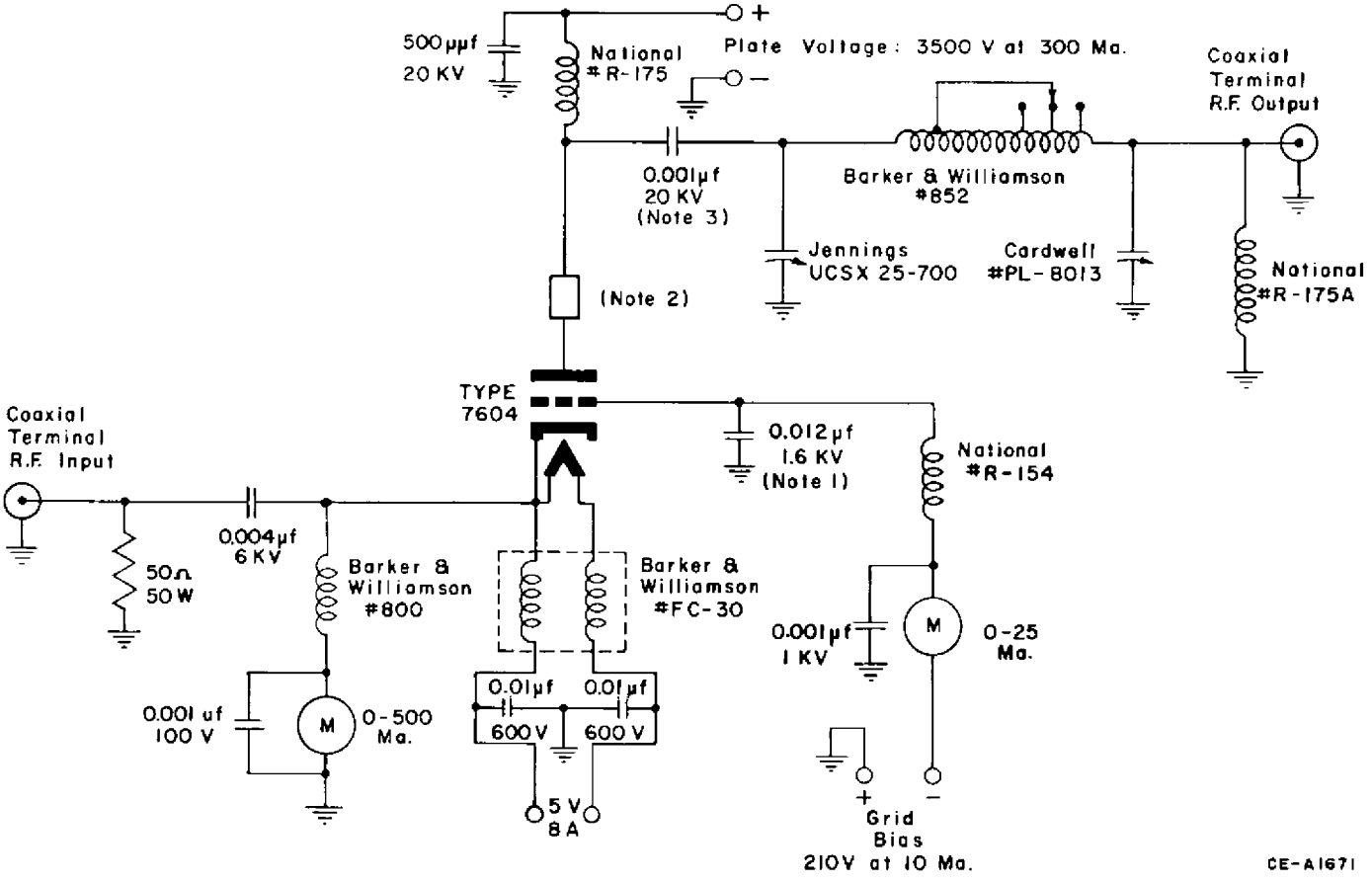
from JEDEC release #3184, March 13, 1961

AVERAGE CONSTANT CURRENT CHARACTERISTICS



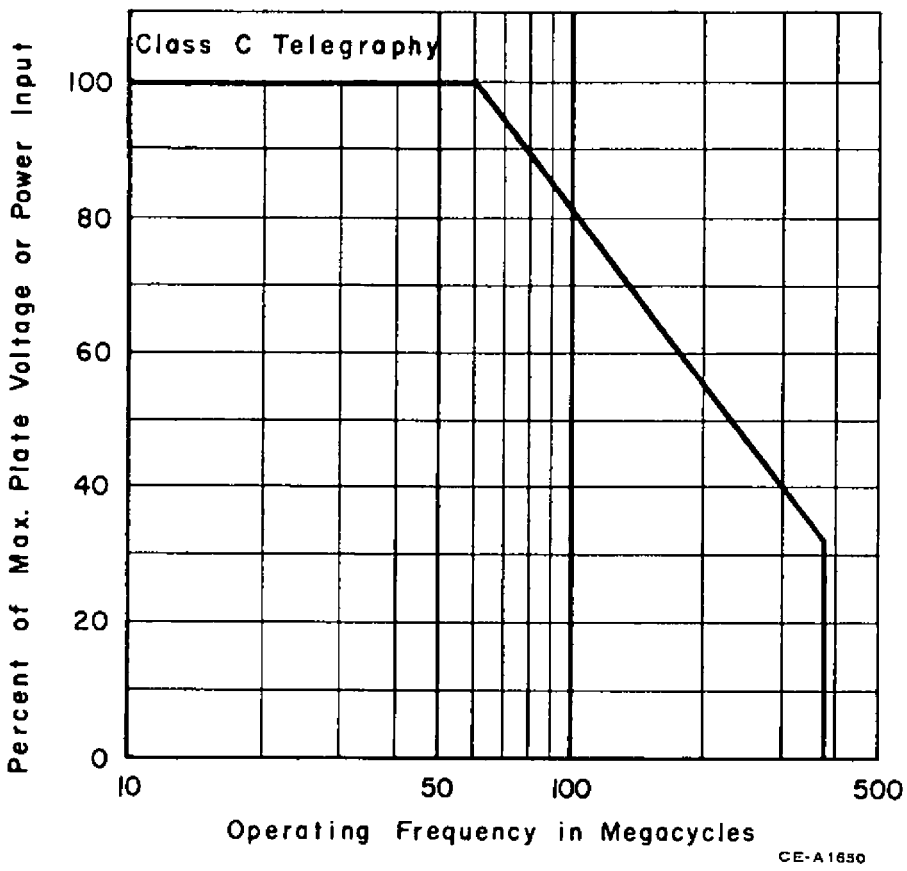
CE-B1549

KILOWATT LINEAR AMPLIFIER FOR 80 THROUGH 10 METERS



Note 1: Four 0.003 μf, 1.6 KV disc-caps attached at 90° intervals around grid ring.
Note 2: Parasitic suppressor consists of 7 turns of #12 wire on 47 Ω, 2 watt resistor.
Note 3: Two TV high voltage filter capacitors in parallel.

FREQUENCY DERATING CURVE



Westinghouse®

WL-7606

December 1, 1959

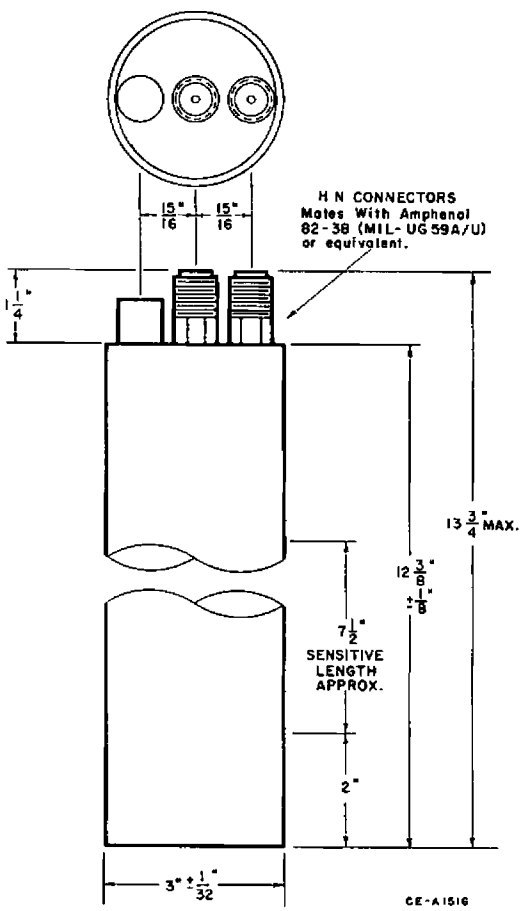
HIGH TEMPERATURE
UNCOMPENSATED IONIZATION CHAMBER TYPE WL-7606

The WL-7606 is an aluminum cased ionization chamber designed to detect thermal neutrons in the flux range from 2.5×10^4 to 2.5×10^{10} neutrons/cm^2/second. Ionization currents are produced by thermal neutrons incident on the sensitive coating, which consists of Boron enriched to 96% in B-10 isotope. The neutron sensitivity of the WL-7606 is 4.4×10^{-14} amperes/neutron/cm^2/second and the gamma sensitivity is 5×10^{-11} amperes/Roentgen/hour. The tube is provided with type "HN" connectors and is extremely rugged, being operable in any position and at temperatures up to 500 °F.

The WL-7606 employs a guard ring type of construction. This features minimizes reduction in signal current due to leakage through the insulators.

MECHANICAL:

Maximum Diameter	3	Inches
Maximum Overall Length	13-3/4	Inches
Approx. Sensitive Length	7-1/2	Inches
Connectors §	Hermetically Sealed HN Type	
Net Weight	2-1/2	Pounds
Shipping Weight	10	Pounds



ELECTRICAL:

Interelectrode Capacitances:		
Signal Electrode to Case♦	250	μμf
High Voltage Electrode to Case⊕	170	μμf
Interelectrode Resistance:		
At 500° F		
Signal Electrode to Case	10^9 min.	Ohms
High Voltage Electrode to Case	10^9 min.	ohms

MATERIALS:

Body	Aluminum
Insulation	Alumino
Gas Filling	Argon-Nitrogen Mixture at 76 cm Hg
Neutron Sensitive Material	Boron enriched to 96% in B-10

MAXIMUM RATINGS:

Absolute Maximum Values

Interelectrode Voltage	1500 max.	Volts
Thermal Neutron Flux	1.0×10^{11} max.	n/cm^2/sec
Ambient Temperature	500 max.	°F

TYPICAL OPERATING CHARACTERISTICS:

Operating Voltage□	200 to 800	Volts
Thermal Neutron Flux	2.5×10^4 to 2.5×10^{10}	n/cm^2/sec
Neutron Sensitivity	4.4×10^{-14}	amp/n/cm^2/sec
Gamma Sensitivity	5×10^{-11}	amp/R/hr

TYPICAL SATURATION CHARACTERISTICS:

For Neutron Flux of 3×10^9 n/cm^2/sec		
Operating Voltage	250 min.	Volts
Output Current	1.3×10^{-4}	Amperes
For Neutron Flux of 1.5×10^{10} n/cm^2/sec		
Operating Voltage	600 min.	Volts
Output Current	6.6×10^{-4}	Amperes

□ Saturation voltage varies with neutron flux. Either positive or negative voltage can be used.

♦ High voltage electrode connected to case.

⊕ Signal electrode connected to case.

Note: The WL-7606 may not be immersed in water. If the WL-7606 is to be used in a high humidity environment, the connectors joining the cable to the tube must be vapor proof.

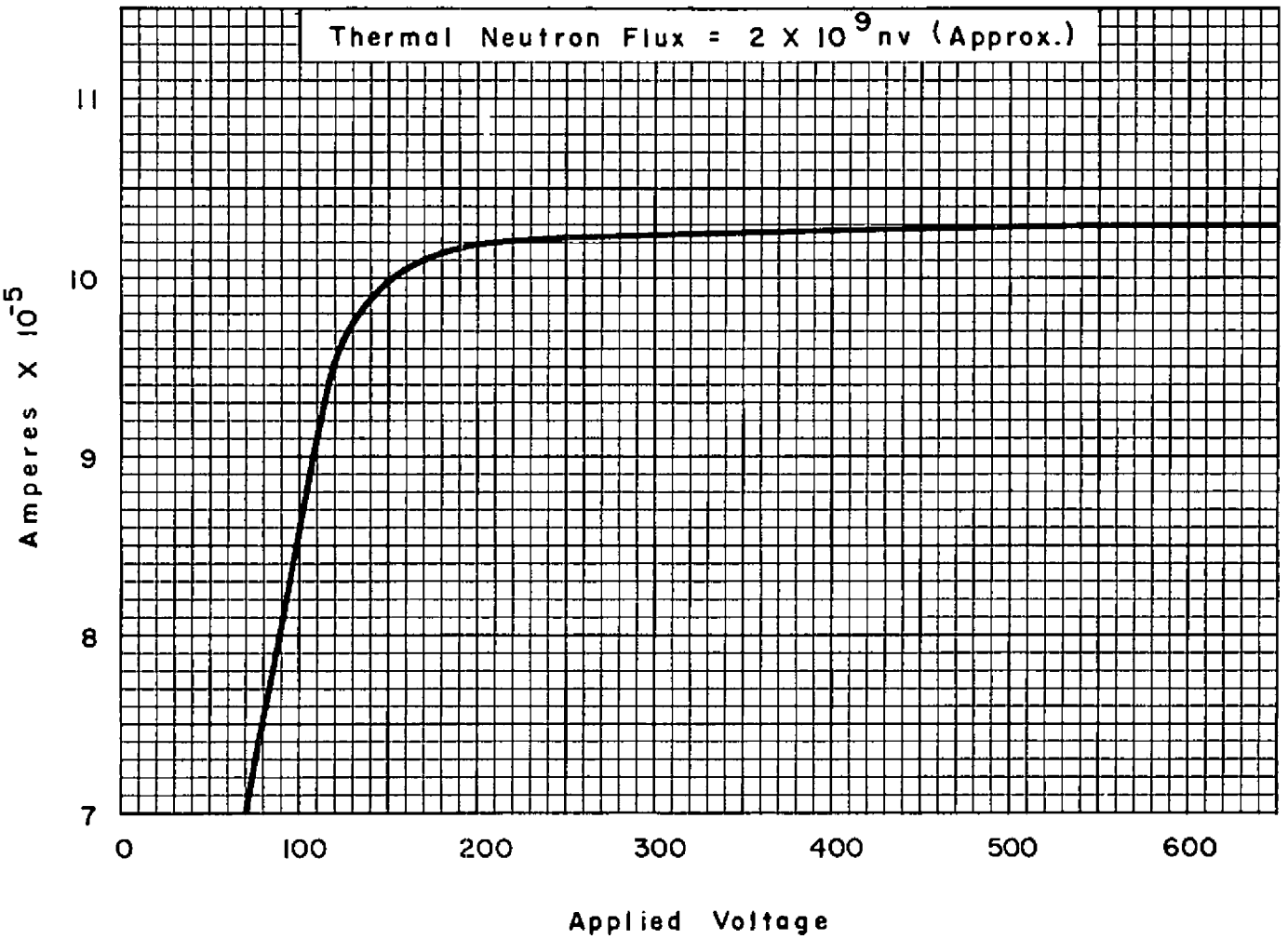
§ The connectors may be tightened with the fingers with no precautions. If a tool is used, the connector body must be wrench held to prevent fracturing the vacuum seal between connector body and detector case.

Neutron & Radiation Detector Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #2656, Dec. 7, 1959

TYPICAL SATURATION CHARACTERISTIC



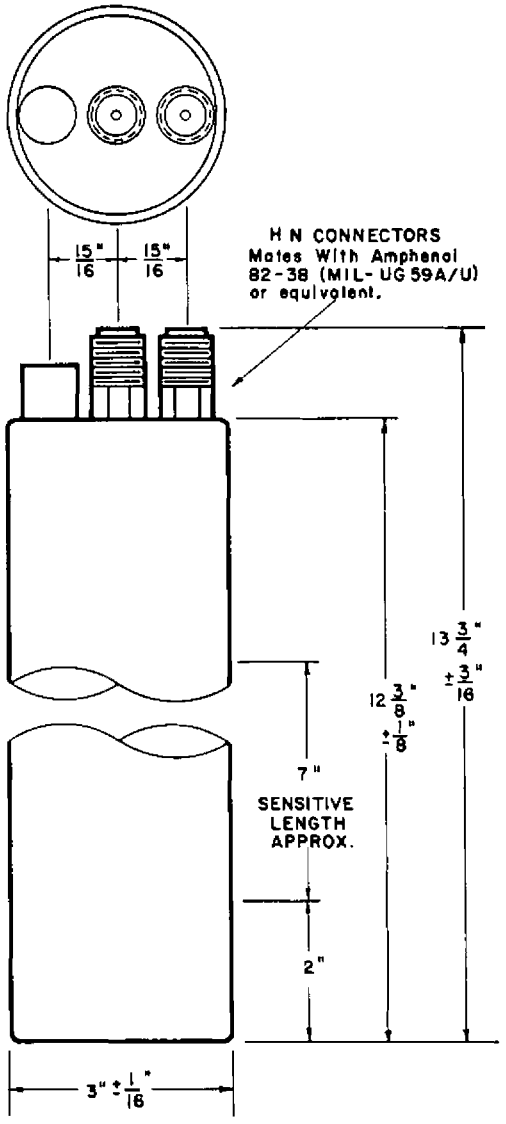
CE-A1515

April 1, 1960

HIGH TEMPERATURE GUARD RING FISSION CHAMBER 7657

The 7657 fission chamber is designed to detect thermal neutrons in the range of 1.4 to 1.4 x 10^5 neutrons/cm^2/second. The detector is extremely rugged in construction designed to pass MIL-S-901 for shock and MIL-Std-167 (Type 1) for vibration. The 7657 is of guard ring construction, a feature which minimizes electrical leakage across the internal insulators, and it may be operated in any position at temperatures up to 500°F.

The 7657 is constructed of aluminum, with high purity alumina ceramic insulators throughout, including those used in the type HN coaxial connectors. In typical operation, the counter has a thermal neutron sensitivity of 0.7 counts/neutron/cm^2 throughout a wide range of applied voltage.



MECHANICAL:		
Maximum Diameter	3-1/32	Inches
Maximum Overall Length	13-3/4	Inches
Approximate Sensitive Length	7-1/2	Inches
Net Weight	2-1/2	Pounds
Shipping Weight	10	Pounds
MATERIALS:		
Element Body		Aluminum
Electrodes		Aluminum
Insulation		Hi-purity Alumina Ceramic
Neutron Sensitive Material:		
Content	U_3O_8 Enriched to more than 90% in U-235	
Thickness		2 mg/cm^2
Total Quantity		1.72 grams
Gas Filling		Argon-Nitrogen Mixture
Gas Pressure		76 Cm of Hg
IMPEDANCE:		
Resistance at 500°F (minimum)	10^9	Ohms
Capacitance:		
Signal Electrode to Case (approx.)	225	$\mu\mu f$
High Voltage Electrode to Case (approx.)	160	$\mu\mu f$
MAXIMUM RATINGS:		
Voltage Between Electrodes	1000	Volts
Temperature	500	°F
External Pressure (Note 2)	180	Pounds/$inch^2$
Thermal Neutron Flux	10^{11}	nv
TYPICAL OPERATION: (Note 1)		
Operating Voltage	300	Volts
Operating Voltage Plateau (See Figure 2)	200 to 800	Volts
Thermal Neutron Flux Range	1.4 to 1.4 x 10^5	nv
Sensitivity (Note 1)	0.7	cps/nv
Output Pulse Characteristics:		
Amplitude (Unloaded)	2 x 10^{-4}	Volts
Inherent Rise Time (Average)	2 x 10^{-7}	Seconds

1. The sensitivity is 0.7 counts/neutron/cm^2 when the alpha background counting rate of the naturally radioactive uranium is adjusted to 5 counts/second. By varying the pulse height selector on the associated circuitry other sensitivities are available. See Figure 1, also the section entitled "Fission Counter Operation".
2. The pressurizing atmosphere must be dry and non-corrosive.

from JEDEC release #2793, April 25, 1960

COUNTER SENSITIVITY AS FUNCTION OF PULSE HEIGHT SETTING

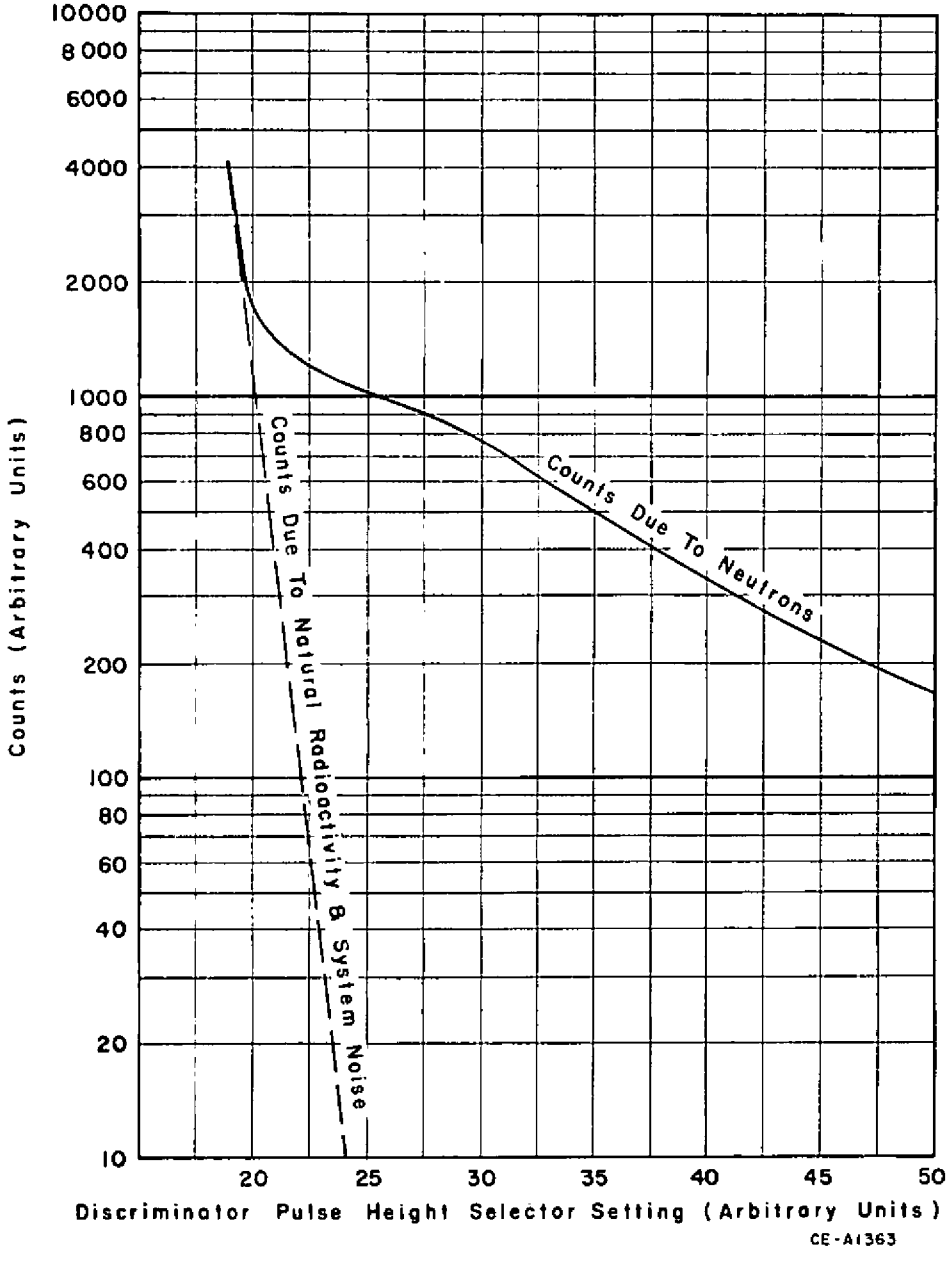


FIGURE 1

COUNTING RATE CHARACTERISTIC

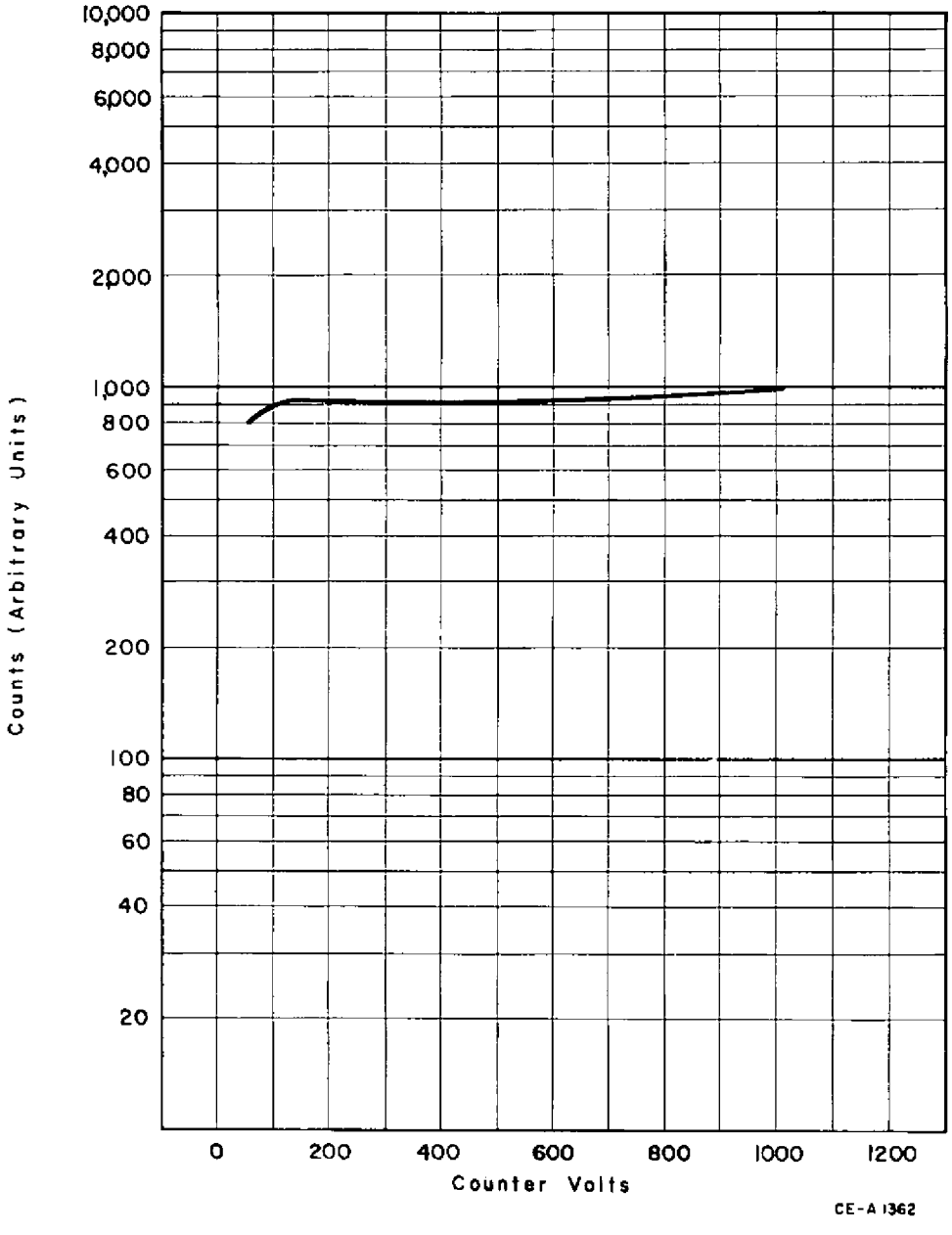


FIGURE 2

Westinghouse

7658

September 15, 1960

HIGH VACUUM RECTIFIER TYPE 7658

The type 7658 is a high-voltage, vacuum rectifier designed for service in oil-immersed applications. It features a thoriated-tungsten filament in a helical design, to minimize risk of breakage, withstand electric field forces better, reduce anode-to-filament spacing for higher efficency and permit more tolerance in permissable filament voltage variations.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament			
Filament:	Min.	Bogey	Max.	
Voltage	3.6	4.0	4.4	Volts
Current	--	6.8	--	Amperes
Heating Time	2	--	--	Seconds

MECHANICAL:

Type of Cooling (Note 1)	Oil Immersion
Mounting Position	Any
Net Weight	8 Ounces
Shipping Weight	4 Pounds

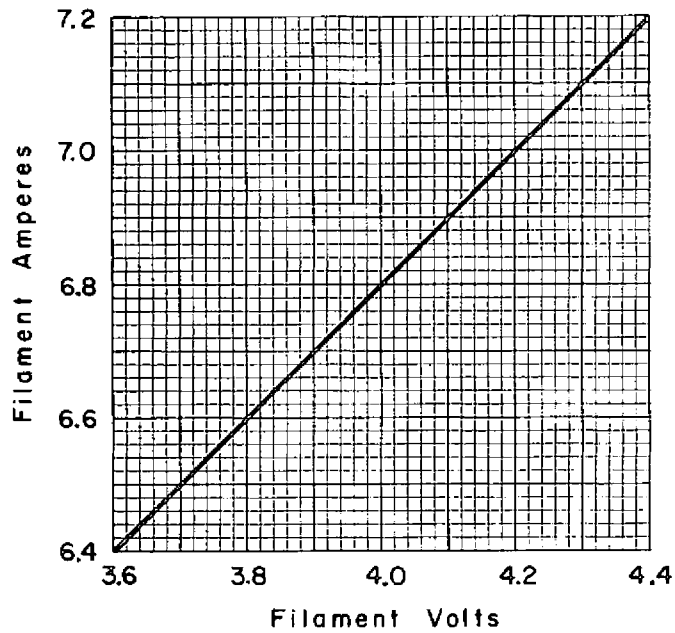
MAXIMUM RATINGS:

Absolute Maximum Values

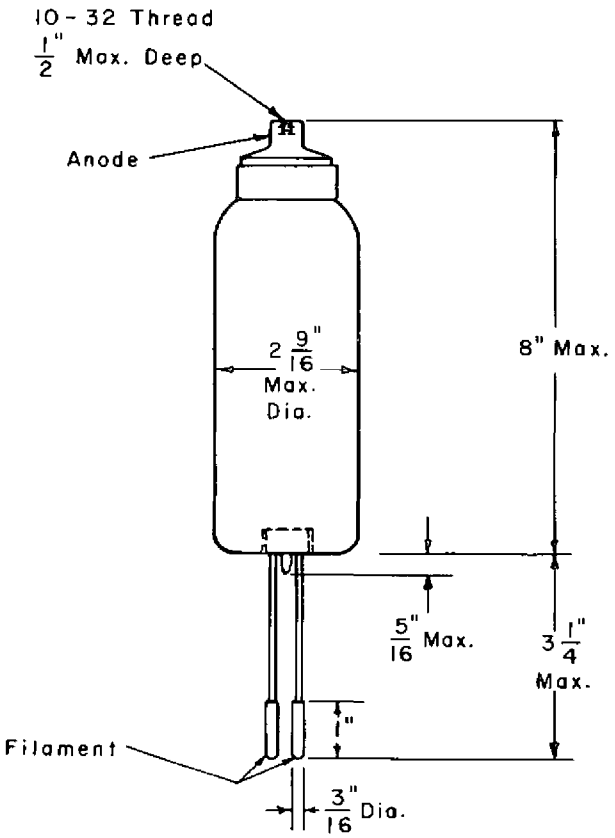
Peak Inverse Anode Voltage	125 max.	Kilovolts
Anode Current:		
Peak	750 max.	Ma.
Average	150 max.	Ma.

1. The dielectric value of the cooling oil must not be less than 250 KV peak per inch.

AVERAGE FILAMENT-CURRENT CHARACTERISTIC



CE-A1580

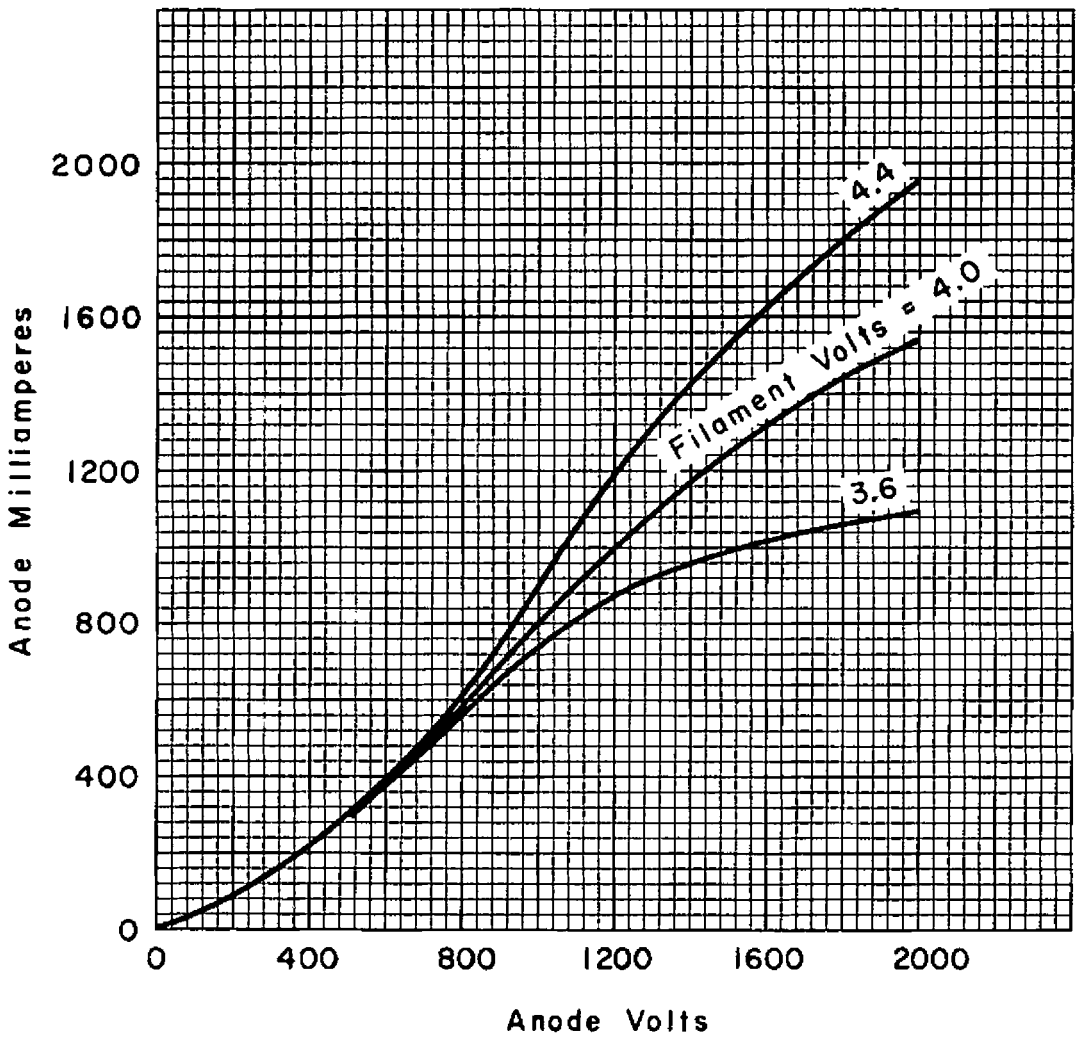


High Vacuum Rectifier Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #3080, Dec. 18, 1960

AVERAGE ANODE CURRENT CHARACTERISTICS

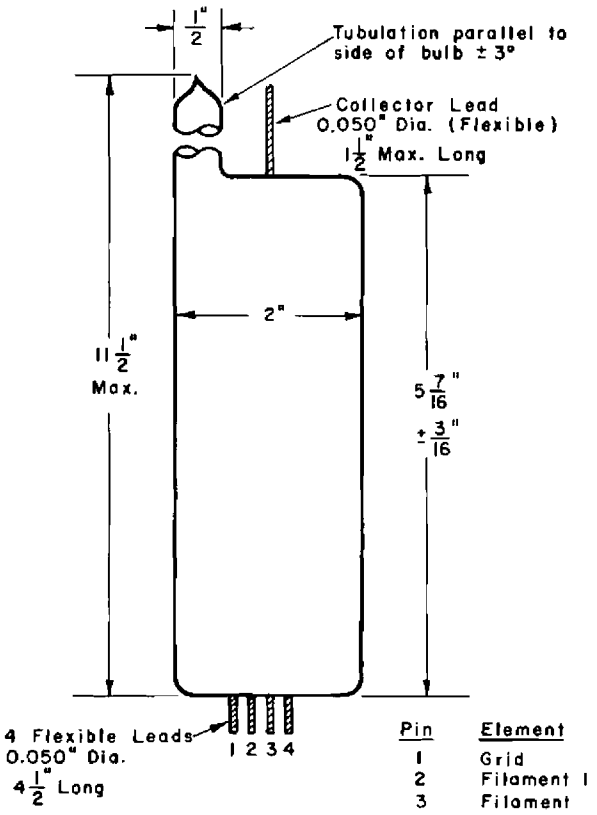


CE-A1579

LOW PRESSURE ION GAUGE TUBE TYPE 7675

The 7675 is an ionization type of vacuum-gauge tube for measurement of gas pressures as low as 10^{-10} mm of mercury. The tube has a hard glass bulb with a one-half inch diameter tubulation. The 7675 employs an electrode structure having a minimum of metal surface with the result that the tube is easily out-gassed.

The 7675 is a triode of the Bayard-Alpert inverted geometry design having two tungsten filaments, one of which is a spare. The grid structure is operated at a positive potential with respect to the filament while the ion collector is at a negative potential. Electrons are accelerated from the filament to the grid; they bombard and ionize gas molecules, and the resultant positive ions are attracted to the collector. The ratio of the collector current (positive ion current) to the grid current is proportional to the gas pressure.



Pin	Element
1	Grid
2	Filament 1
3	Filament Common
4	Filament 2

ELECTRICAL:

Filament Type (Note 1)	Tungsten
Operating Filament Voltage (Approx.)	7 ac or dc Volts
Operating Filament Current	2.5 ± 8% Amperes

MECHANICAL:

Maximum Tube Length (including tubulation)	11-1/2"
Maximum Bulb Length	5-5/8"
Maximum Bulb Diameter	2-1/16"
Tubulation (Note 3)	1/2" (Approx.) Diameter Hard Glass Coming Code 7720
Mounting Position	Vertical

MAXIMUM RATINGS:

Absolute Maximum Values

Ion Collector Voltage	−100	max.	Volts
Grid Voltage	+500	max.	Volts
Ambient Temperature	100	max.	°C
Gas Pressure	0.001	max.	mm Hg
Filament Voltage (Note 2)	10	max.	Volts
Emission Current	200	max.	Ma.

TYPICAL OPERATION:

Ion Collector Voltage	−30	Volts
Grid Voltage	+150	Volts
Grid Current	10	Ma.
Sensitivity	1 μa./10^{-5}	mm Hg

CONDITIONS FOR OUTGASSING ELEMENTS:

Ion Collector	Connected to Grid		
Grid Voltage	+500	max.	Volts
Filament (Note 2), Series	20	max.	Volts
Parallel	10	max.	Volts
Grid & Collector Power	100	max.	Watts

NOTES

1. The 7675 has two filaments, both of which should be used during outgassing cycles. During pressure measuring operation only one filament need be used. The voltage and current values are for either filament operated alone.
2. If it is necessary to outgas the tube using one filament only, the voltage must not exceed 11V. Shorter life must be expected under these conditions.
3. Other ion gauges, similar to type 7675 but having different materials of tubulation, are available under different numbers.

from JEDEC release #3395, Aug. 28, 1961

APPLICATION

The basic principle of the ionization gauge is described briefly in the introduction, where mention was made of the ratio of collector current to grid current as a measure of gas pressure. In order to measure gas pressure with an ionization gauge tube, the current ratio or some proportional quantity must be observed. If the grid current is held constant, then gas pressure will be proportional to collector current. The accuracy of pressure values is, then, dependent on the stability of grid current. The grid current is reasonably independent of grid voltage for grid voltages above that corresponding to the maximum probability of ionization of any gas which may be present. A grid voltage of 150 volts is sufficient, and stability is increased by the use of a voltage regulator tube (0D3).

The collector voltage must be sufficiently negative to attract all positive ions. This value is not critical; in practice, a voltage of −22.5 or greater will be satisfactory.

Ionization gauge tubes are commonly operated temperature limited. Consequently, the grid current at a fixed grid voltage is a first order function of filament temperature. This effect provides a convenient means of controlling grid current, i.e., by control of filament voltage.

Outgassing of metal and glass parts can be accomplished conveniently by connecting grid and collector together and passing a high current through the tube. The voltage applied to the grid and collector should not exceed +500 volts and maximum outgas power is 100 watts. DC supply is recommended for outgassing, although line-frequency supply has been used successfully. The two units of the filament may be operated either in series or parallel. Emission current is adjusted by increasing the filament voltage until the desired outgassing condition is reached. Although the elements may be outgassed using only one filament, due to the higher operating temperature required to produce the necessary outgassing current, tungsten evaporation is rapid and seriously impairs the life of the tube. Consequently outgassing using both filaments is strongly recommended.

To facilitate outgassing, the following schedule should be followed, especially during the first outgassing of a new tube or after a tube has been exposed to air.

Starting at 25 mA raise the bombarding current in 25 mA steps to maximum desired current. Each step should be 5 minutes minimum and the tube should be switched off for 1 minute between steps. At no time should the filament voltage exceed the maximum allowed.

The filament should never be heated in air; therefore, it is desirable to employ a thermo-couple or Pirani gauge coupled to a relay system to prevent excitation of the tube until the gas pressure has been reduced to 0.001 mm of mercury. The power-supply control circuit shown in Figure 1 incorporates such protection. The thermocouple tube closes the sensitive relay when the gas pressure has been reduced to the operating range of the 7675. Next, an auxiliary relay closes the power contactor. In the event a leak develops, the circuit removes power from the 7675.

Two power supply circuit diagrams are given: Figure 2 is relatively simple. It does not provide automatic regulation of filament temperature. The operator is required to set a reference level of grid (electron) current each time a reading is taken. The reference is set by the variable transformer in the primary of the filament transformer. The accuracy is dependent upon steadiness of electron current in the time interval between setting the electron current and reading the ion current.

The second supply circuit, Figure 3 provides continuous regulation of electron current; therefore, the gas pressure can be continuously read without resetting the reference grid current. The filament temperature is regulated by a varying impedance in series with the primary of the filament transformer. This series impedance is the plate resistance of the 6AS7-G tube. The impedance is determined by the 6AS7-G grid potential which, in turn, is provided by the voltage potential drop across the plate load resistance of the 6AU6. The grid bias of the 6AU6 is derived from the electron (grid) current of the 7675 flowing through resistor R1. Thus, if the grid current of the 7675 tends to rise, the temperature of the 7675 filament is reduced and the electron current is maintained substantially constant.

The gas (ion) current can be measured by any commercial microammeter having a range of 0.01 microampere to 1.0 milliampere. The Beta Electronics microammeter is an example of a suitable meter. Precision meters of the D'Arsonval type may be used to measure gas currents in the higher pressure ranges.

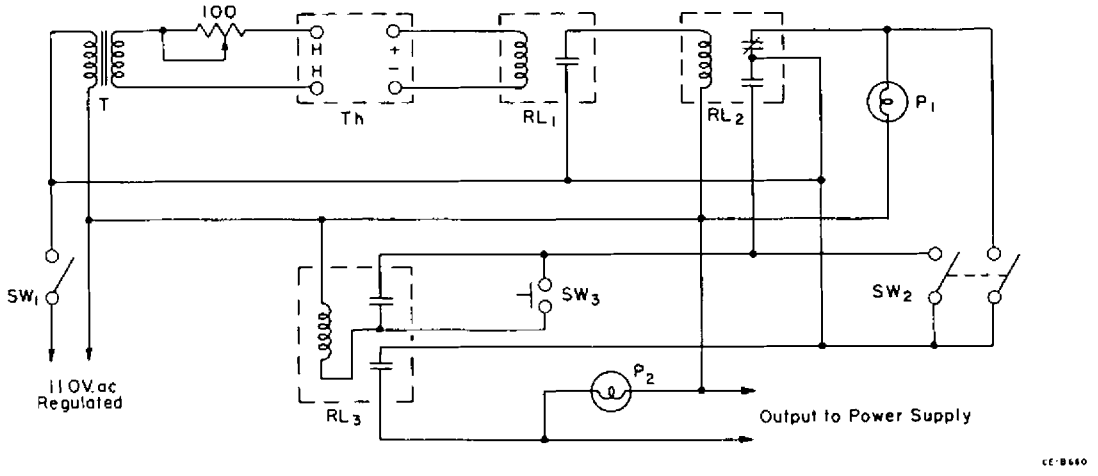


FIGURE 1

Resistor value in ohms

Th – Thermocouple: Type 7677 or equivalent
RL_1 – Sensitrol or equivalent
RL_2 – Weston 712 relay or equivalent
RL_3 – 115-volt relay
P_1 – 115-volt pilot lamp, red
P_2 – 115-volt pilot lamp, green
SW_1 – Switch
SW_2 – DPST switch
SW_3 – Manual start-reset (normally open push button)
T – Transformer: 110v primary; 6.3v, 1a. secondary

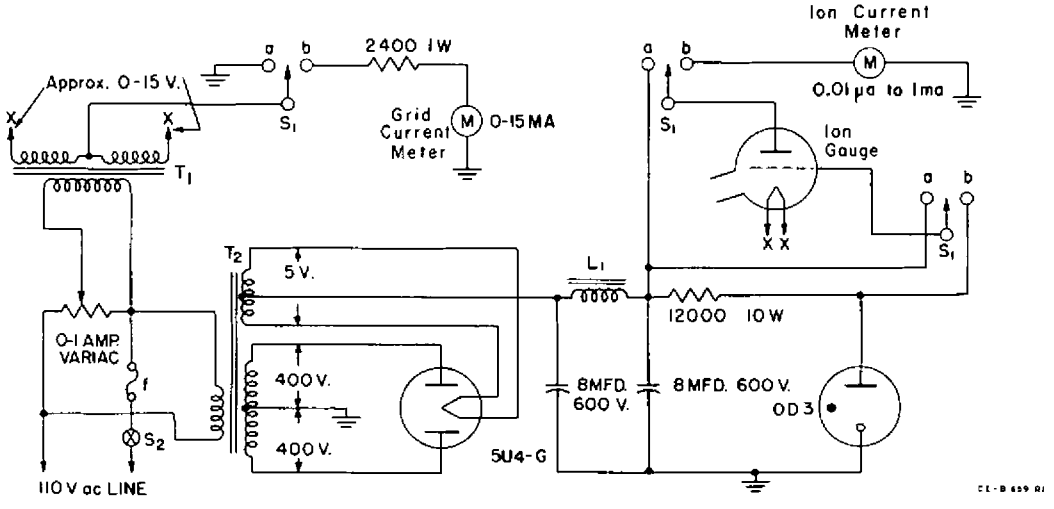
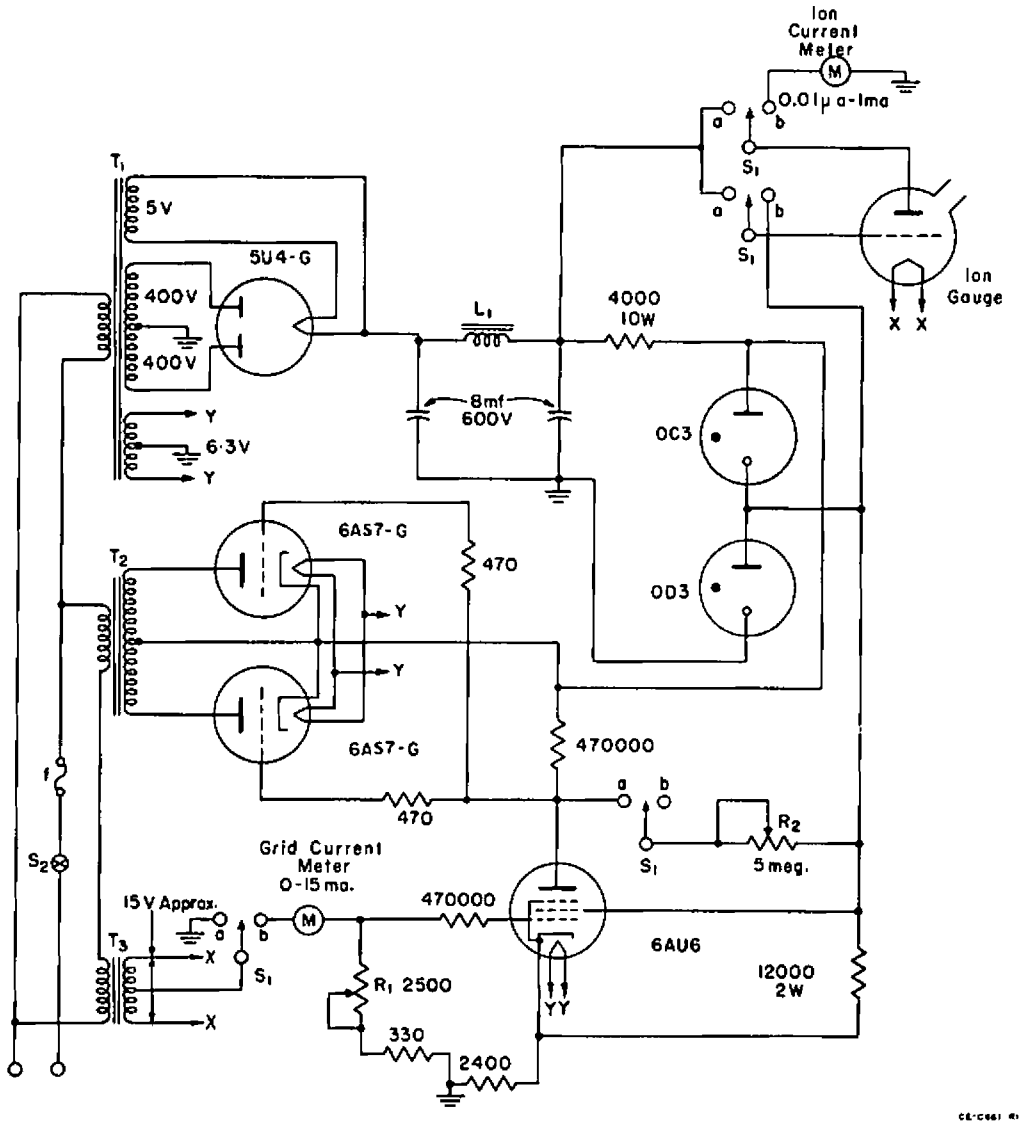


FIGURE 2

Resistor value in ohms

L_1 – Stancor C-1721 or equivalent
T_1 – UTC S70 or equivalent
T_2 – Stancor PM8412 or equivalent
S_1 – 3PDT switch (position a to outgas, position b to operate)



Resistor value in ohms
Resistors are 1/2 watt except as specified.

S_1 – 4PDT switch (position a to outgas, position b to operate)

R_1 – Grid current adjustment

R_2 – Outgas adjustment

T_1 – Stancor PM-8412 or equivalent

T_2 – Stancor PM-8410 or equivalent

T_3 – UTC S70 or equivalent

L_3 – Stancor C-1721 or equivalent

May 15, 1960

HIGH PRESSURE ION GAUGE TYPE 7676

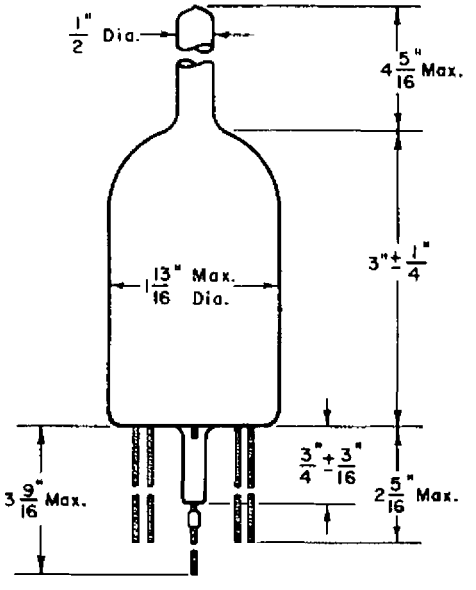
The 7676 is a three electrode ionization type vacuum gauge designed to measure gas pressures in the range of 1×10^{-5} to 5×10^{-1} mm Hg. The operating filament is a thoria coated iridium wire. Filament burnout will not occur if the tube is accidentally let down to air during operation. The ion collector is a flat plate parallel to the operating filament. The other electrode, which is used as an electron emitter during outgassing and as an electron collector during operation, is a tungsten ribbon parallel to the ion collector on the opposite side of the operating filament.

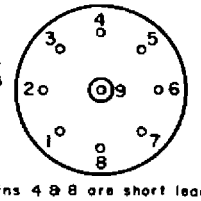
ELECTRICAL:

Outgassing:		
Cathode	Tungsten Ribbon Filament	
Filament:		
Voltage (ac or dc) approx.	5	Volts
Current	13	Amperes
Operating:		
Cathode	Thoria Coated Iridium Filament	
Filament:		
Voltage	2.0	Volts
Current at 1×10^{-5} mm Hg.	2.25	Amperes

MECHANICAL:

Type of Cooling	Air
Tubulation:	
Glass	Nonex, Code 7720
Size	½" Diameter
Mounting Position	Any





OUTGASSING (See Note)

Electrode	Lead
Outgas Filament (+)	1 & 3
Outgas Filament (−)	5 & 7
Collector	9

Tie Lead 2 or 6 to one side of outgas Filament.

OPERATING

Electrode	Lead
Operate Filament (+)	2
Operate Filament (−)	6
Ion Collector	9

Electron Collector 1, 3, 5 or 7

(Pins 4 & 8 are short leads.)

Note: Both leads of each terminal of outgas filament must be used during outgassing to prevent damage to the tube.

MAXIMUM RATINGS:

Absolute Maximum Values

Outgassing: (DC voltages are with respect to Outgas-Filament-Electron-Collector Electrode)		
Ion collector Voltage	500 max.	Volts
Ion Collector DC Power Input	15 max.	Watts
Filament Voltage (ac or dc)	5.5 max.	Volts
Ambient Temperature	100 max.	°C
Operating: (DC voltages are with respect to Operate Filament)		
Ion Collector Voltage	+65 max.	Volts
Outgas-Filament-Electron-Collector Electrode Voltage	−65 max.	Volts
Filament Voltage (ac or dc)	2.0 max.	Volts
Ambient Temperature	100 max.	°C
Gas Pressure	1 max.	mm Hg

OUTGASSING CONDITIONS

Ion Collector Voltage with respect to Outgas-Filament-Electron-Collector Electrode	+300	Volts
Operate-Filament*	Connected to Outgas-Filament-Electron-Collector-Electrode	
Outgas-Filament:		
Voltage (ac or dc)	5.0	Volts
Current	13	Amperes

OPERATING CONDITIONS

Ion Collector Voltage with respect to Operate-Filament	−60	Volts
Outgas-Filament-Electron-Collector Electrode Voltage with respect to Operate Filament	+60	Volts
Operate-Filament Conditions for 50 Microamperes Electron Current:		
Voltage (ac or dc)		
At 1×10^{-4} mm Hg.	1.1	Volts
At 5×10^{-1} mm Hg.	1.8	Volts
Electron Current:		
From 1×10^{-4} to 1×10^{-2} mm Hg.	1	Ma.
From 1×10^{-3} to 1×10^{-1} mm Hg.	50	μA.
From 1×10^{-2} to Saturation	10	μA.
Sensitivity with Nitrogen $S = (i+ / i-) \times (1/P)$	0.4	$(\text{mm Hg})^{-1}$
Pressure Measuring Range with Nitrogen (See Figure 1)	1×10^{-4} to 6×10^{-1}	mm Hg

* Voltage must not be applied across operate filament during outgassing.

Special Devices Section

from JEDEC release #2885, July 18, 1960

AVERAGE ION CURRENT TRANSFER CHARACTERISTICS

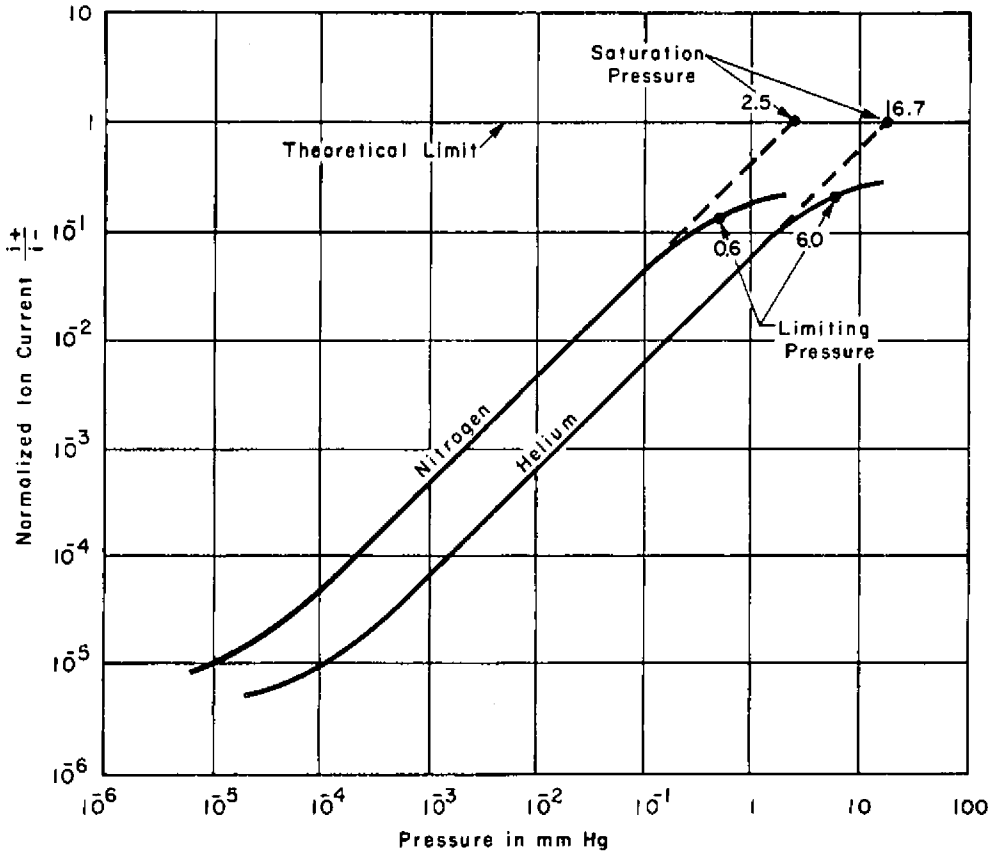


FIGURE 1 CE-A1572

GAUGE CHARACTERISTICS FOR DIFFERENT GASSES

	N_2	CO	He	H_2
Sensitivity in $(mmHg)^{-1}$	0.4	0.42	0.06	0.21
Saturation Pressure in mmHg	2.5	2.6	16.7	4.8
Limiting Pressure in mmHg	0.6	0.6	6.0	0.6

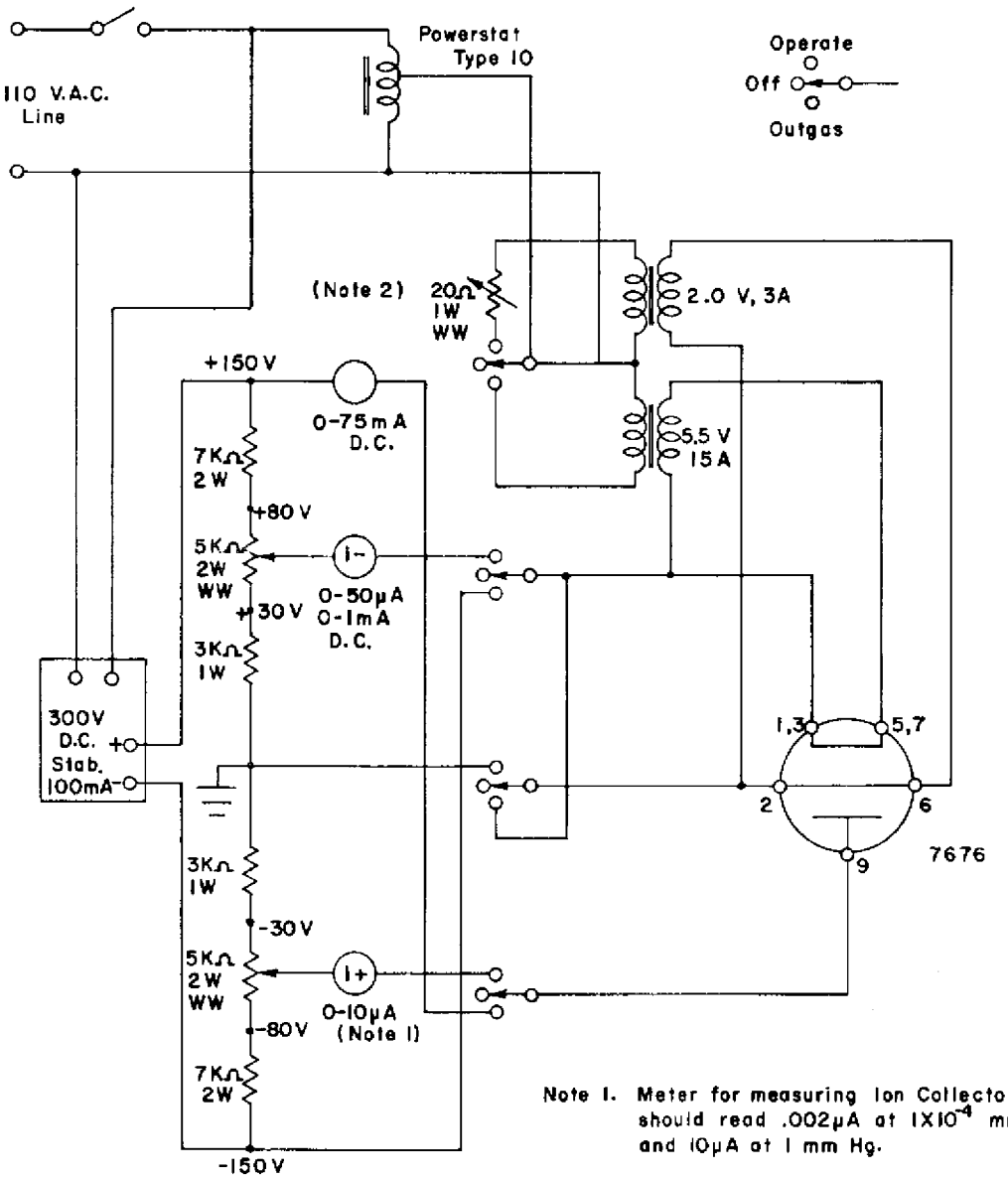
APPLICATION DATA

The circuitry for operation of the tube consists of suitable 60 V DC. power supplies for each collecting electrode and a variable voltage filament supply. A meter with ranges from 10^{-5} to 10^{-3} ampere is required for measuring electron current and a sensitive microammeter with ranges from 10^{-8} to 10^{-5} amperes is required in the ion collector circuit. The filament power required is 2 volts at 2.5 amperes for operation and 5.5 volts at 13 amperes for outgassing. A circuit incorporating these features is shown in Figure 2. In this circuit, a 300 volt, 100 milliampere stabilized power supply is used.

For outgassing the full 300 V is used, the outgassing current being set by the outgassing filament temperature. The outgas filament voltage is adjusted by a variable auto-transformer.

During operation, the operating filament is connected to the center of a resistance chain across the power supply. The electron collector and ion collector are connected to potentiometers in the resistance chain, so that the ion collector is approximately 60 volts negative, and the electron collector approximately 60 volts positive with respect to the operate filament. The operate filament supply is controlled by a variable auto-transformer, with a series variable resistance which acts as a fine control.

7676 GAUGE POWER SUPPLY



Note 1. Meter for measuring Ion Collector should read .002μA at $1X10^{-4}$ mm Hg. and 10μA at 1 mm Hg.

Note 2. Fine control for filament voltage will give 2% variation.

FIGURE 2

CE - 81577

Since pressures over a wide range are to be covered, the cooling effect by the residual gas on the filament can be considerable, resulting in changes in electron current. An operate circuit with an automatic filament control, in which a change in electron current will be compensated by a change in filament voltage, is shown in Figure 3.

AUTOMATIC CONTROL CIRCUIT

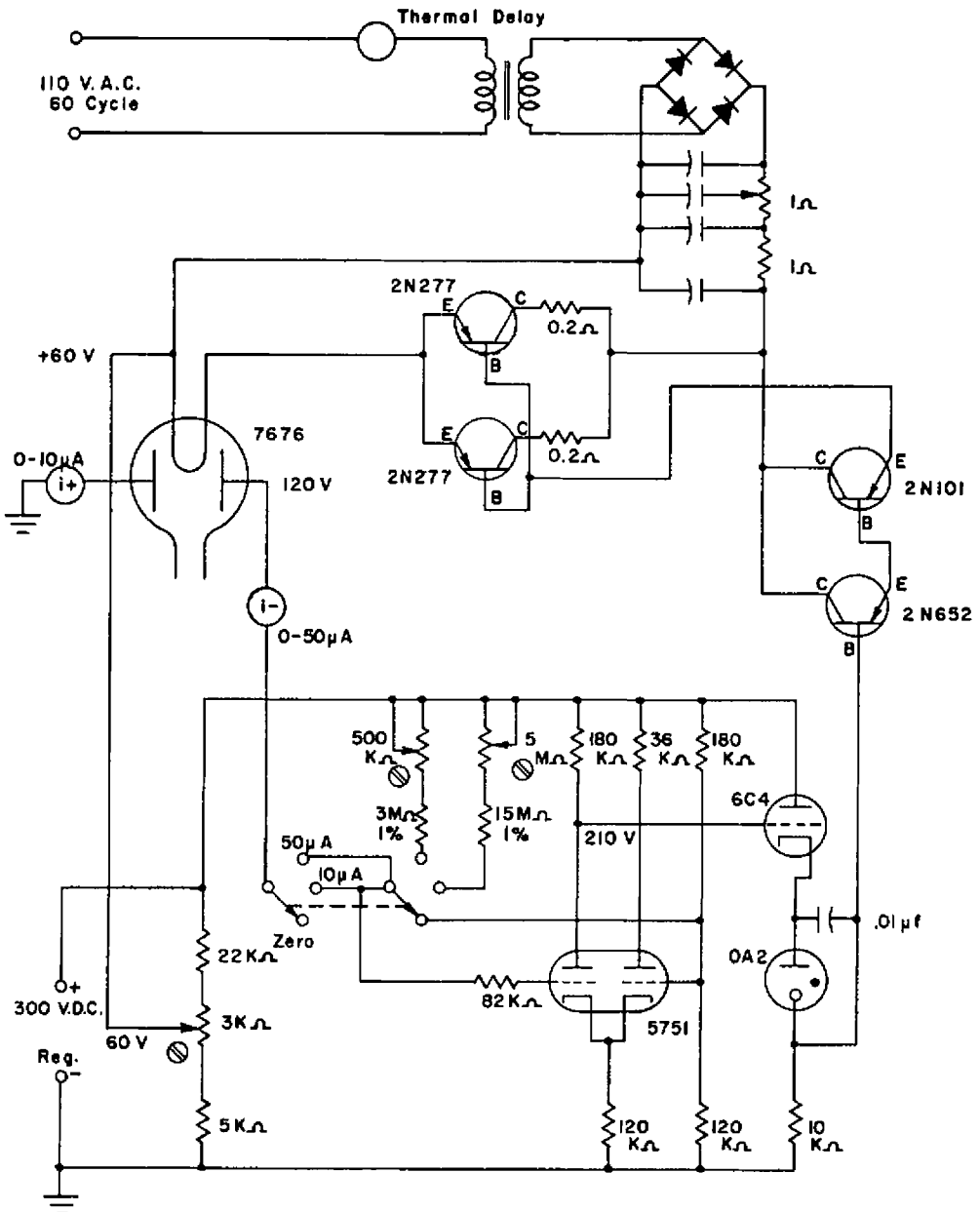
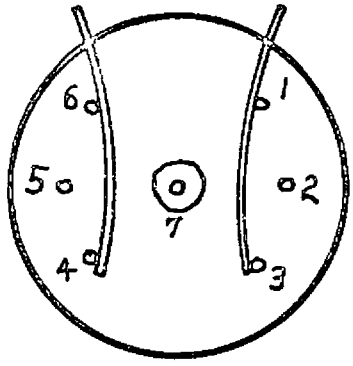


FIGURE 3 CE-B1578

Release No. 2885A
December 7, 1964

NEW TYPE 7676 CONNECTIONS



CONNECTIONS

OUTGASSING	Pin
Outgas Filament +(Note 1)	1&3 (Tied Together)
Outgas Filament -(Note 1)	4&6 (Tied Together)
Collector	7
Operate Filament	Tie Pin 2 or 5 to Pin 1&3 or 4&6

OPERATING	
Operate Filament +	2
Operate Filament -	5
Ion Collector	7
Electron Collector	1&3 or 4&6

NOTE

1. Filament tie straps have a 1/8' hole drilled at one end to receive connector screws.

THERMOCOUPLE VACUUM GAUGE TYPE 7677

The 7677 features a thermocouple heated by a filament. The internal gas pressure determines the heat transfer characteristics and thereby the output of the thermocouple. The type 7677 is useful for pressure measurements in the range from 1 to 10^{-3} millimeters of mercury.

ELECTRICAL:

Thermocouple Materials	Nichrome & Advance
Heater Resistance at 25 °C	65 Ohms
Thermocouple Resistance at 25 °C	10 Ohms

MECHANICAL:

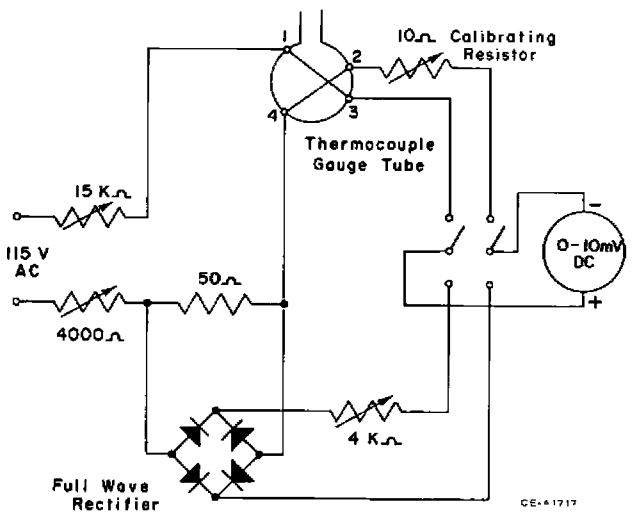
Mounting Position	Vertical
Base	JEDEC A4-9
Tubulation:	
Diameter	3/8"
Material	Nonex, Corning Code 7720
Net Weight (Approx.)	2 Ounces

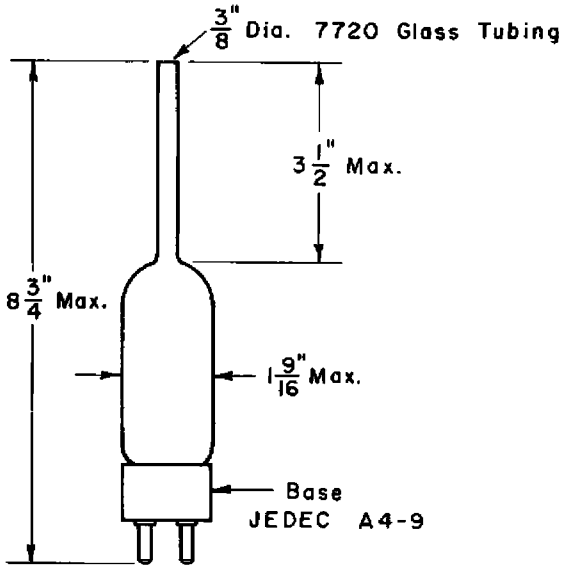
OPERATIONAL:

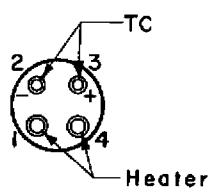
Heater Current	25 Ma.
Thermocouple Output:	
At 10^{-3} mm Hg Pressure	10 mV.

Note: Other thermocouple gauge tubes, similar to type 7677 but having different sizes and materials of tubulation, are available under different numbers.

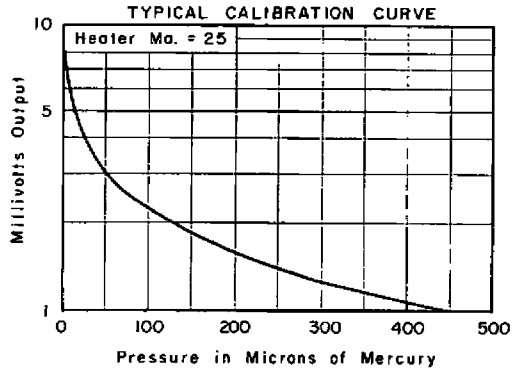
TYPICAL THERMOCOUPLE OPERATION







TYPICAL CALIBRATION CURVE



from JEDEC release #3247, April 24, 1961

Westinghouse

7682

January 15, 1961

DIRECT VIEW STORAGE TUBE TYPE 7682

One Writing Gun
Viewing Gun
Integral Tube and Shield Assembly

4" Display Diameter
5-1/4" Overall Diameter
14-7/8" Overall Length

The 7682 is a display storage tube with high writing speed and moderate brightness. It is capable of electrically writing and storing a bright, flicker-free display on a 4 inch diameter fluorescent screen.

The viewing screen requires 5 kilovolts and the brightness exceeds 200 foot-lamberts with a writing speed of 400,000 inches per second. The 7682 has a storage time of 30 seconds which permits storage and display of very high speed transients for liesurely examination. In applications of this type and others having written information of a repetitive character, the ability of the tube to integrate successive weak signals is of great utility.

Longer storage periods may be obtained by pulsing the flood gun. If the pulse rate is high enough, no flicker will be observed. In this manner, storage times up to 30 minutes may be achieved with some loss of brightness. The display would still be clearly legible in a lighted room.

The 7682 is suitable for applications such as airborne fire-control and navigational radar, weather radar, airport surveillance, transient studies and visual-display element in narrow-band-width data transmission systems.

The 7682 is designed for military use and is therefore capable of meeting appropriate military specifications. The entire tube is potted within a salt spray resistant magnetic shield with a synthetic silicone rubber material. Protection against mechanical shock, vibration, humidity and leakage between bulb terminals is thereby achieved.

One writing gun and a flood gun are mounted in the 7682. The writing gun has electrostatic focus and deflection.



Camera & Storage Tube Section
WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #3208, April 3, 1961

ELECTRICAL:

Storage:
- Type . . . . . Half-Tone or Line
- Mode . . . . . Control of Transmission
- Type of Erasure . . . . . Overall

Write Gun:
- Cathode . . . . . Coated Unipotential
- Heater:

	Min.	Bogey	Max.	
Voltage (ac or dc)	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Amperes

- Focusing Method . . . . . Electrostatic
- Deflection Method . . . . . Electrostatic

Flood Gun:
- Cathode . . . . . Coated Unipotential
- Heater:

	Min.	Bogey	Max.	
Voltage	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Ampere

- Warm-up Time before Applying High Voltages . . . . . 30 -- -- Seconds
- Focus and Deflection . . . Undeflected, Collimated "Flood" Gun

Direct Interelectrode Capacitances:
External Integral Shield Grounded

Writing Gun Grid 1 to All Internal Elements	8 max.	μμf
Deflection Electrode 1 to All Internal Elements	8 max.	μμf
Deflection Electrode 2 to All Internal Elements	8 max.	μμf
Deflection Electrode 3 to All Internal Elements	8 max.	μμf
Deflection Electrode 4 to All Internal Elements	8 max.	μμf

OPTICAL:

Phosphor:
- Type . . . . . High Visual Efficiency, Aluminized P20
- Fluorescence . . . . . Yellow-Green
- Phosphorescence . . . . . Yellow-Green
- Persistence . . . . . Short

Faceplate . . . . . Optical Gloss, Ground and Polished Flat

MECHANICAL:

- Minimum Useful Viewing Diameter . . . . . 3-15/16"
- Maximum Overall Length . . . . . 14-7/8"
- Maximum Seated Length . . . . . 14-1/4"
- Greatest Shield Diameter . . . . . 5-1/4" ± 1/16"
- Viewing Screen Terminal . . . . . Flexible Cable
- Caps on Large End of Bulb
  - Backing Electrode . . . . . Recessed Small Ball (JEDEC J1-22)
  - Collector Electrode . . . . . Recessed Small Ball (JEDEC J1-22)
  - Collimating Electrode . . . . Recessed Small Ball (JEDEC J1-22)
- Base . . . . . 14 Pin Small Diheptal (JEDEC B14-45)
- Mounting Position . . . . . Any

MAXIMUM RATINGS:

Absolute Maximum Values

Write Gun:

(Reference Voltage is Write Gun Cathode)

Grids 2 & 4 Voltage♦	3000	max.	Volts
With Respect to Flood Gun Cathode	200	max.	Volts
Grid 3 Voltage (Focus)	2000	max.	Volts
Negative with Respect to Flood Gun Cathode	2600	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	200	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	2	max.	Volts
Cathode Voltage Negative with Respect to Flood Gun Cathode	2800	max.	Volts
Voltage Between any Deflection Electrode and Grids 2 & 4: ♦			
Positive or Negative Peak Value	500	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Positive or Negative with Respect to Cathode	125	max.	Volts

Flood Gun:

(Reference Voltage is Flood Gun Cathode)

View Screen Voltage	5000	max.	Volts
Grid 5 Voltage (Backing Electrode)	35	max.	Volts
Grid 4 Voltage (Collector Electrode)	300	max.	Volts
Grid 3 Voltage (Collimating Electrode)	200	max.	Volts
Grid 2 Voltage (Accelerating Electrode)♦	200	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	150	max.	Volts
Positive Bias Value	0	max.	Volts
Peak Heater-Cathode Voltage			
Heater Positive or Negative with Respect to Cathode	125	max.	Volts

LIMITING CIRCUIT VALUES:

View Screen Series Current-Limiting Resistance	1.0	min.	Megohm
Backing Electrode Circuit Resistance	5000	max.	Ohms
Collector Electrode Unbypassed Series Current-Limiting Resistance	22000	min.	Ohms
Grid 1 Circuit Resistance	1.0	max.	Megohm
Resistance in Any Deflecting Electrode Circuit⊕	0.1	max.	Megohm

ENVIRONMENTAL LIMITS:

Atmospheric Pressure	60	max.	P.S.I.
Altitude (Non-pressurized)	60,000	max.	Feet
Temperature:			
Operating	-35 to +71		°C
Non-Operating	-62 to +85		°C
Relative Humidity (Non-Operating)	95		Percent

Vibration . . . . . Sinusoidal Vibration from 5 to 18 cycles per second with a total excursion of 0.30 inches and from 18 to 500 cycles per second with 3 g acceleration will not damage the tube.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Note: Damage to the 7682 may occur if the Write-Gun beam is turned on before the Flood-Gun-beam current has reached normal operating value or if the Flood-Gun beam is turned off before the Write-Gun beam.

Reference Point for DC Voltages is Ground

Write Guns:			
Grids 2 & 4 Voltage♦		90 to 110	Volts
Grid 3 Voltage (Focus)		−2000 to −2300	Volts
Grid 1 Voltage to Writing Gun Cathode		0 to −70	Volts
Cathode Voltage		−2400	Volts
Grids 2 & 4 Current♦		100	μampere
Grid 3 Current (per gun)		−10 to 5	μampere
Cathode Current		See Gun Transfer Characteristic	
Deflection Factors			
Deflection Electrodes 1 and 2♦		72 to 88	V dc/In.
Deflection Electrodes 3 and 4♦		72 to 88	V dc/In.
Focused Beam Position†		0.5	Inch
Flood Gun:	Range	Typical	
View Screen Voltage	3000 to 5000	5000	Volts
Grid 5 Voltage (Backing Electrode)	2 to 15	10	Volts
Grid 4 Voltage (Collecting Electrode)	150 to 300	200	Volts
Grid 3 Voltage (Collimating Electrode)	5 to 150	60	Volts
Grid 2 Voltage♦	90 to 110	100	Volts
Grid 1 Voltage	0 to −50	0	Volts
Cathode			Grounded
View Screen Current		250	μamperes
Grid 5 Current (Backing Electrode)		2	μamperes
Grid 4 Current (Collector Electrode)		1.5	Ma.
Grid 3 Current (Collimating Electrode)		200	μamperes
Cathode Current		2	Ma.

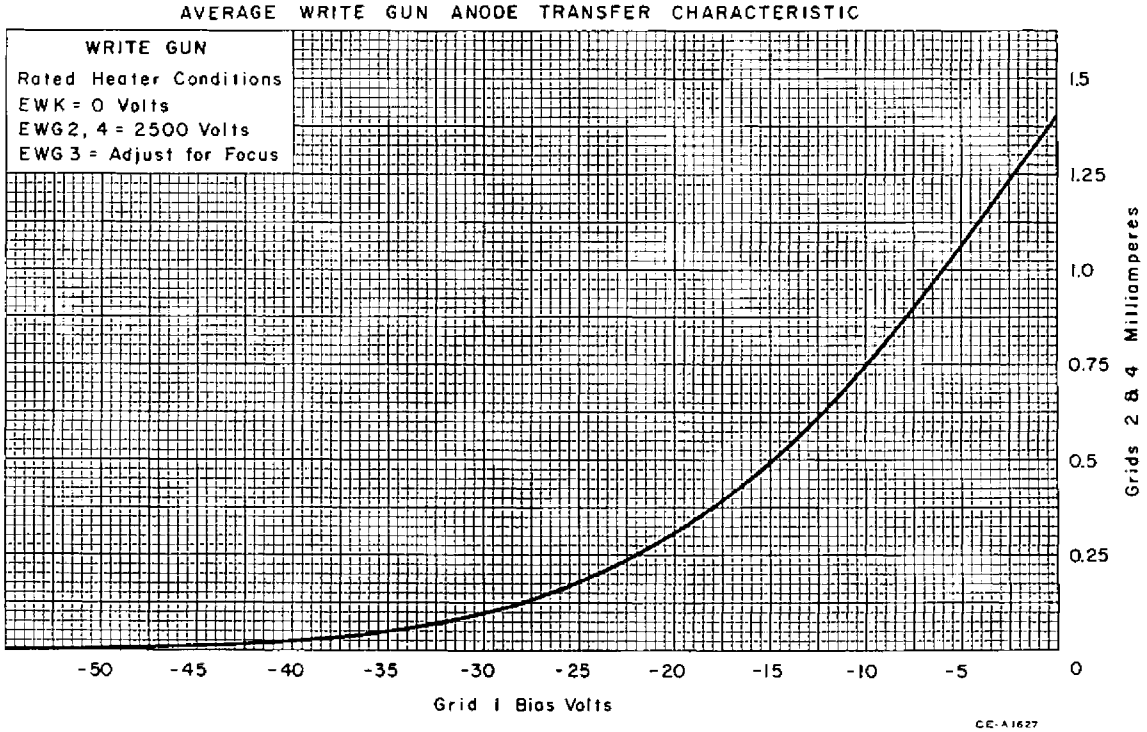
♦ Grids 2 & 4 of the Write Gun are internally connected together and to Grid 2 of the Flood Gun.

♦ For other values of cathode to Grids 2 & 4 Voltages, the deflection factor is approximately 32 ± 10% V dc/In./KV of cathode to Grids 2 & 4 Voltage.

† With all deflection electrodes tied to Grids 2 & 4, and erasure at a convenient value the undeflected, focused spots will fall within a circle of 0.5 inch radius, centered on the tube faceplate.

⊕ Approximately equal resistances should be used in each deflection electrode circuit

AVERAGE WRITE GUN ANODE TRANSFER CHARACTERISTIC



PERFORMANCE DATA

Viewing Time	30	Seconds
Erasing Time (Flood Gun Erasure)	50	Milliseconds
Display Uniformity (Δe_p min.)	2	Volt
Writing Speed	400,000	Inches/Second
Half Tones	4	
Brightness (Screen Voltage = 5 KV)	200	Ft-Lamberts
Contrast Ratio	10	
Resolution	50	Lines/Inch
Grid Drive	30	Volts

Methods of Measuring Tube Performance

Viewing Time: Viewing duration is the time during which the visual output of a storage tube increases from exactly visual extinction to 10% of saturated brightness without the application of a writing signal or erase pulses. The tube shall be primed and then erased to exactly visual extinction. The erase pulses are removed and the screen allowed to increase in brightness. The time interval required for the brightness level at the center of the screen to increase to 10% of saturated brightness is the viewing duration.

Erasing Time: The storage surface is primed. Erasure is produced by a positive rectangular pulse applied to the backing electrode. The amplitude of this pulse is set to one volt above backing electrode cutoff and the pulse width necessary to erase from saturated brightness to 10% of saturation brightness is the erasing time.

Display Uniformity (Δe_p min.): The difference between the amplitude of an erase pulse required to brighten any area of an unwritten screen, and the amplitude of an erase pulse required to evenly illuminate the screen is described as the display uniformity, (Δe_p min.). The erase pulses used for this measurement are positive rectangular pulses adjusted from 2 to 10 volts peak to peak to produce complete erasure in 50 milliseconds.

Writing Speed (Cathode Current): A raster is applied having frequencies and trace length necessary to produce a scanning speed of 400,000 inches per second. The focus electrode is adjusted for best focus at the center of the raster. The tube is erased to cutoff and a single raster is written by applying a rectangular pulse of adjustable amplitude to Grid 1 of the writing gun. The last step is repeated moving the lines of the raster progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the control grid pulse amplitude is adjusted to give a written raster of 200 ft-L. When this brightness is achieved and the lines cannot be discerned visually, the condition of visually limited contrast ratio exists and it is under this condition that the cathode current is measured.

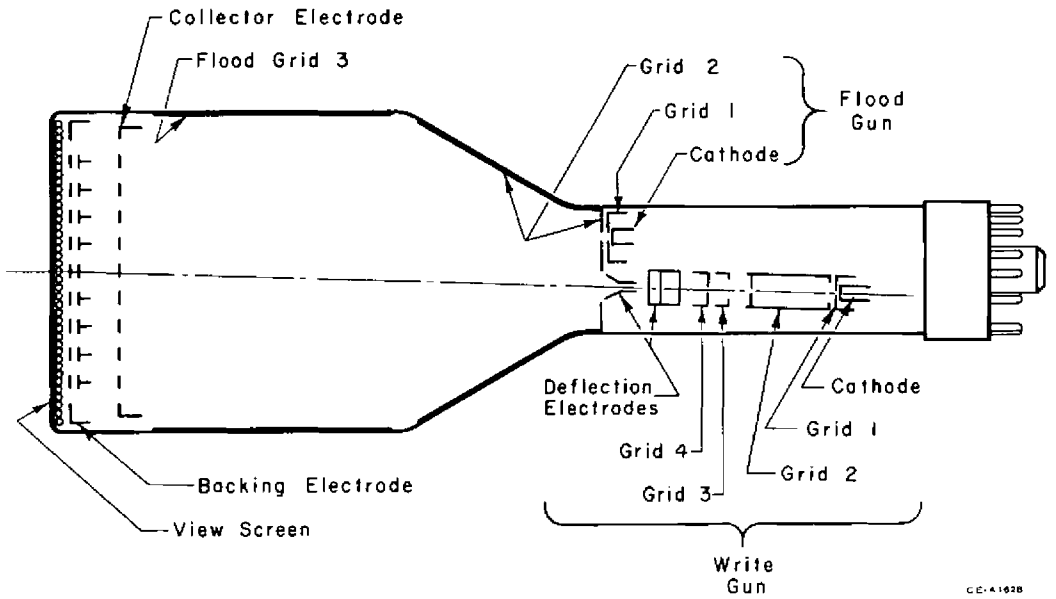
Contrast Ratio: A trace is written to saturation brightness while continuously writing and erasing. Using positive rectangular erase pulses variable from 2 to 10 volts peak-to-peak, the persistence (time required for a written area to be reduced to 10% of saturated brightness) is adjusted to 2 seconds. The ratio of brightnesses in the written and unwritten areas is defined as the contrast ratio. This measurement is made with a maximum ambient brightness of 10 foot-lamberts.

Resolution: A 60 cps sawtooth voltage is applied between deflecting electrodes D_3D_4 and a 2100 to 6300 cps sawtooth voltage is applied between deflecting electrodes D_1 and D_2 giving a raster of approximately 40 lines. Blanking is used to eliminate trace return lines. Trace length shall be adjusted to 3.5 inches. Raster is expanded and number of lines determined. Focus electrode is adjusted for best focus at the center of the raster. Backing electrode is erased to cutoff and G_1, writing gun, is pulsed to write a single raster. Last step is repeated moving the lines progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the grid pulse amplitude shall be adjusted to give brightness of 100 ft-L. When the specified brightness is achieved and the lines cannot be discerned visually, the condition for visually limited contrast ratio exists, and the resolution measured at this condition is the limiting resolution.

The resolution in lines per inch is the number of horizontal lines counted when the raster was expanded divided by the height of the compressed raster.

Grid Drive: This is the drive required for writing to 90% of saturated brightness with a writing speed of 400,000 inches per second in 1 scan. Note the writing gun drive characteristic. In the useful region, writing speed is proportional to writing current.

CROSS SECTION VIEW



Principles of Operation

The 7682 contains, in addition to a phosphor screen and a write gun similar to that of a conventional cathode-ray tube, a storage surface, a secondary-electron collimating system, all of which can be seen in Cross Section View.

The storage surface is a dielectric material deposited on a fine metallic mesh called the backing electrode. Initially this surface is charged to a uniform potential near the flood gun cathode voltage. The write gun scans the storage surface and creates a charge pattern by secondary emission from the dielectric material. Because this dielectric material is an excellent insulator, the charge pattern does not leak away, but remains for a period of time, as long as a week under non-operating conditions. The secondary electrons liberated from the storage surface are attracted to a collecting mesh.

The reading or flood gun does not scan the screen, but produces a wide-angle beam of electrons which "floods" the entire storage mesh and penetrates through its holes to bombard the phosphor screen. The charge pattern written upon the storage surface controls the flood gun beam in a manner similar to the control of plate current by the signal applied to the control grid of a triode. In this way the signals applied to the write gun are converted to patterns on the storage surface, and these produce corresponding patterns on the phosphor screen. The penetration of electrons through the storage mesh is proportional to the charge written upon it, hence, intermediate shades of gray or half-tones may be reproduced. Because of the high current density of the flood beam, the high accelerating potential on the screen, and simultaneous bombardment of all portions of the view screen, the display is extremely bright.

The Viewing Section

The viewing section consists of the following elements: a cathode, control grid, accelerating grid, collimating electrode, collector electrode, backing electrode, and viewing screen.

The cathode is oxide coated and indirectly heated. Grids 1 and 2 are conventional aperture grids and the collimating electrode grid 3 is a conductive coating applied to the bulb wall. The collector electrode is a fine metallic mesh mounted slightly toward the cathode from the backing electrode.

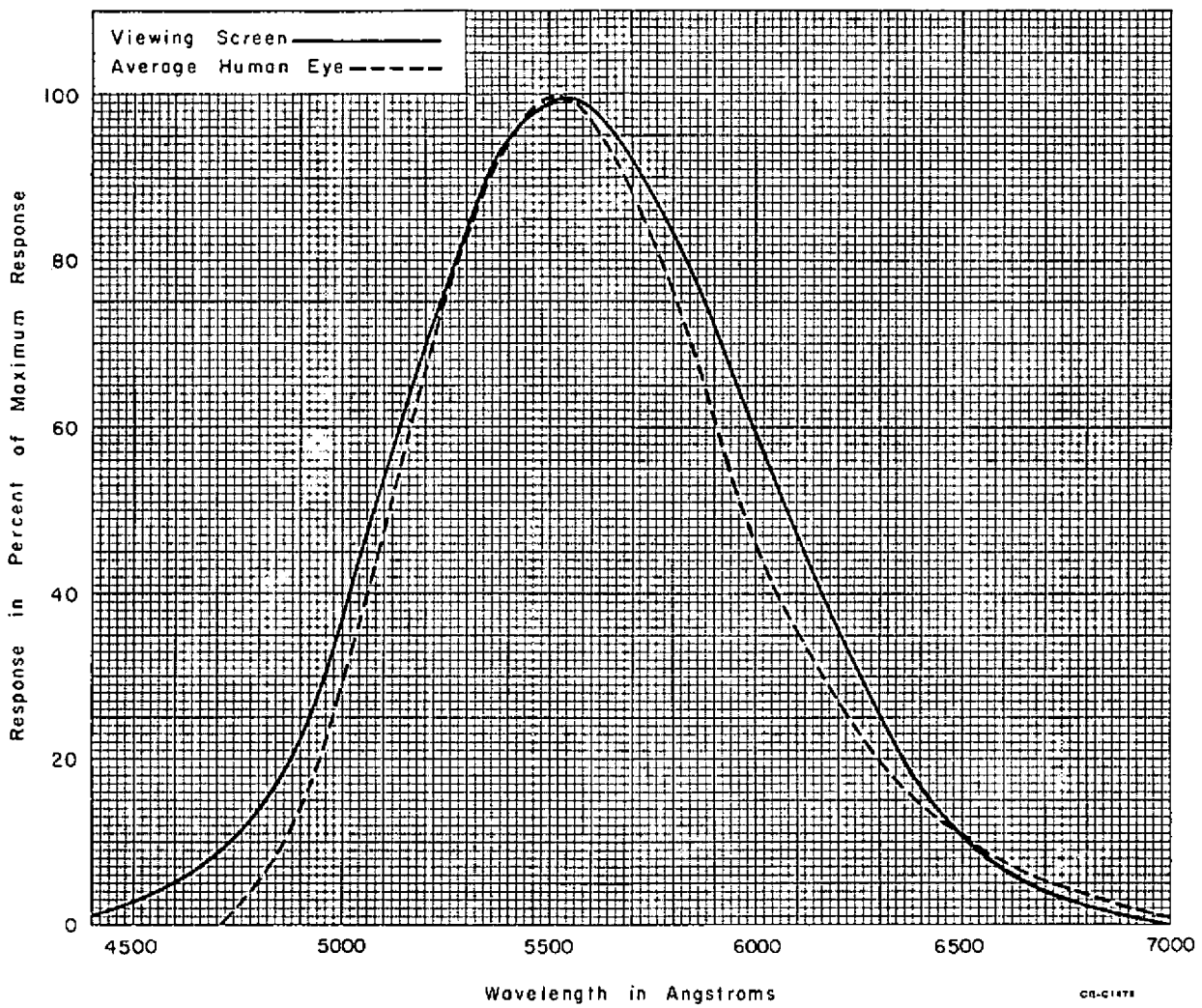
The backing electrode is an extremely fine metallic mesh upon which the dielectric or storage material is deposited. This material is on the cathode side of the mesh as shown in Cross Section View.

The view screen is an aluminized P20 phosphor having short persistence and high visual efficiency. The Spectral Response Curves show that the peak radiation from this phosphor coincides with the peak sensitivity of the human eye.

The Viewing Operation

The flood gun produces a wide angle, low energy, high density electron stream which continuously floods the storage surface. The electrons are highly divergent as they emerge from the aperture of the accelerating grid no. 2, but by proper adjustment of grids no. 2, 3, and 4, the electron stream is collimated to provide uniform, normal flooding of the backing electrode. It is necessary that all of the electrons of the viewing beam approach the storage surface in paths normal to the backing electrode in order that they will have equal energy components in this direction. Only under this operating condition will equal charges at various points on the storage surface have equal control of the flood beam. Thus, collimation is necessary for uniformity of display.

SPECTRAL RESPONSE CHARACTERISTICS



The functions of the collector electrode are several. In addition to its effect upon collimation, it serves to accelerate electrons in the beam; it repels positive ions produced by collisions of electrons with gas molecules in the region between cathode and collector, thus preventing destruction of the stored pattern by ions; it collects secondary electrons produced when the writing beams impinge upon the storage surface; and it collects viewing beam electrons turned back near the storage surface when its potential is negative.

When the flood section voltages are applied, some of the flood beam electrons are intercepted by the collector mesh, and others are decelerated to near zero velocity at the storage grid. Their velocity is so low at this point that fewer secondary electrons are emitted than strike the storage surface. Thus electrons accumulate until the potential is approximately the same as the flood gun cathode, or zero potential.

At this time when the collimated flood beam approaches the storage mesh, electrons cannot land upon the storage mesh, but will either return to the more positive collector electrode or penetrate through the holes of the backing electrode to be accelerated to the phosphor view screen producing a bright display. The brightness of the screen under this condition is designated as "saturated brightness" A condition of equilibrium exists, and the storage surface remains charged to approximately zero potential. It the storage surface is made positive by a write gun or other means, the surface will be immediately restored to zero potential by the flood gun beam. If, now the backing electrode is suddenly made more positive by several volts, the storage surface will also become positive momentarily because of the very close capacitive coupling between the backing electrode and storage surface, but again the viewing beam will restore the storage surface to zero potential. It next the backing electrode is returned to its original value, the storage surface potential will drop by an equal amount to a negative potential and will retain this charge since viewing beam electrons cannot land. If this negative voltage is great enough, it will cut off the viewing beam electrons preventing them from reaching the phosphor and resulting in a dark screen.

The write gun is used to produce a charge pattern upon the storage surface varying in potential from the storage surface cutoff value to zero potential. Since these potentials are at or below flood gun cathode potential, no flood beam electrons may land upon the storage surface to destroy the written pattern and it will remain until erased or degraded by positive ions produced by collision of electrons in the flood beam with residual traces of gas between the view screen and collector electrode.

Without altering its own form the stored charge pattern in thus able to control the electrons impinging upon the screen, producing a bright stored image with full tone range from visual extinction to saturated brightness.

The Write Gun

The write gun is similar to those found in electrostatically focused and deflected oscilloscope tubes. It is capable of forming a well defined beam having high current-density resulting in excellent resolution and high writing speed.

The gun is shown in Cross Section View and consists of an oxide coated, indirectly heated cathode, a control grid 1, first and second anodes (grids 2 & 4) which are internally connected, a focusing grid 3, and horizontal and vertical deflection plates.

The Writing Operation

The write gun is generally operated with the cathode at −2400 volts with respect to the flood-gun cathode. At this potential the electrons from the write beam have sufficient energy to cause the secondary emission ratio at the storage surface to be greater than unity. Thus, since more electrons are leaving the storage surface than are arriving, the surface assumes a less-negative potential whenever the beam strikes, since the secondaries are attracted to the positive collector electrode it would appear that the write beam could charge the storage surface to collector electrode potential, but in practice the flood beam lands upon the surface whenever it tends to become positive and returns it to approximately flood-gun cathode potential.

The write-beam electrons striking the storage surface can then result in potentials varying from storage-grid-cutoff voltage to approximately zero potential. The storage surface potential is controlled over this range by the amplitude and duration of the write beam current which is determined by the signal applied to the control grid.

As was described previously, the potential at any point on the storage surface determines the number of flood beam electrons passing through the storage mesh holes in that immediate vicinity. When any point is sufficiently positive to allow passage of electrons, they will be accelerated by the high viewing screen potential and strike the phosphor directly opposite that point. The result is a bright spot on the viewing screen having a size only slightly larger than that of the corresponding point where the write gun beam struck the storage surface. The brightness of this spot is directly proportional to the density and velocity of the electrons landing on the element, the density being determined by the elemental charges of the storage surface, and the velocity by the potential of the view screen.

The image brightness may be varied by adjusting the screen potential, but because the screen is aluminized, the light output decreases rapidly below 5000 volts. Operation below this value is not recommended.

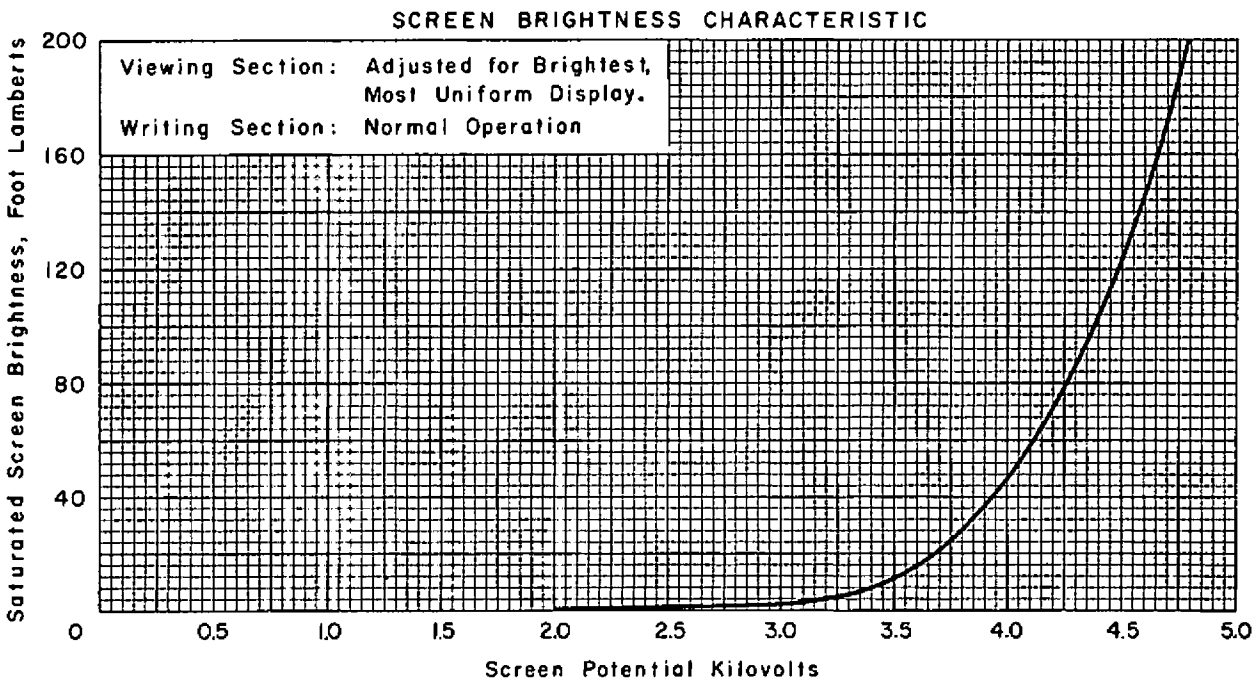
The Erasing Operation

A method of preparing the storage surface for the writing operation has already been described under The Viewing Operation. This technique, which involves charging the storage surface to a negative value by the momentary application of a positive potential to the backing electrode, is actually an erasing method known as static erasure.

During the application of the positive potential to the backing electrode, flood-beam electrons land on the storage surface and drive it uniformly to cathode potential thus erasing any stored information.

A disadvantage of this method is that during erasure and subsequent re-writing no information or only incomplete information is displayed. Also the entire screen is illuminated to the saturation brightness level or higher during erasure.

In most applications it is desirable to present a display which gradually decays after a given interval of time. This type of operation may be obtained by applying a continuous series of positive pulses to the backing electrode at a rate sufficiently fast to prevent visible phosphor flicker. The technique of applying a series of pulses to the backing electrode is known as dynamic erasure.



The amount of charge erased during each erase pulse depends upon pulse duration, shape and amplitude. These factors together with erasing-pulse repetition frequency determine the rate at which the observed display decays.

If the erasing pulses are smaller in amplitude than the viewing-beam cutoff voltage, erasure will not be complete, whereas if the pulses are greater than cutoff they will eventually drive the storage surface below cutoff or "blacker than black." Therefore it is not advisable to use erase pulse amplitude as a means of adjusting erasing time.

When a rectangular erasing pulse is used, all portions of the storage surface will simultaneously become positive with respect to the flood-gun cathode and flood-beam electrons will be deposited at nearly the same rate over the entire surface regardless of initial charge. Thus charges representing the brighter elements will remain after other elements have been erased and the brighter areas will be visible for a longer period than the darker areas.

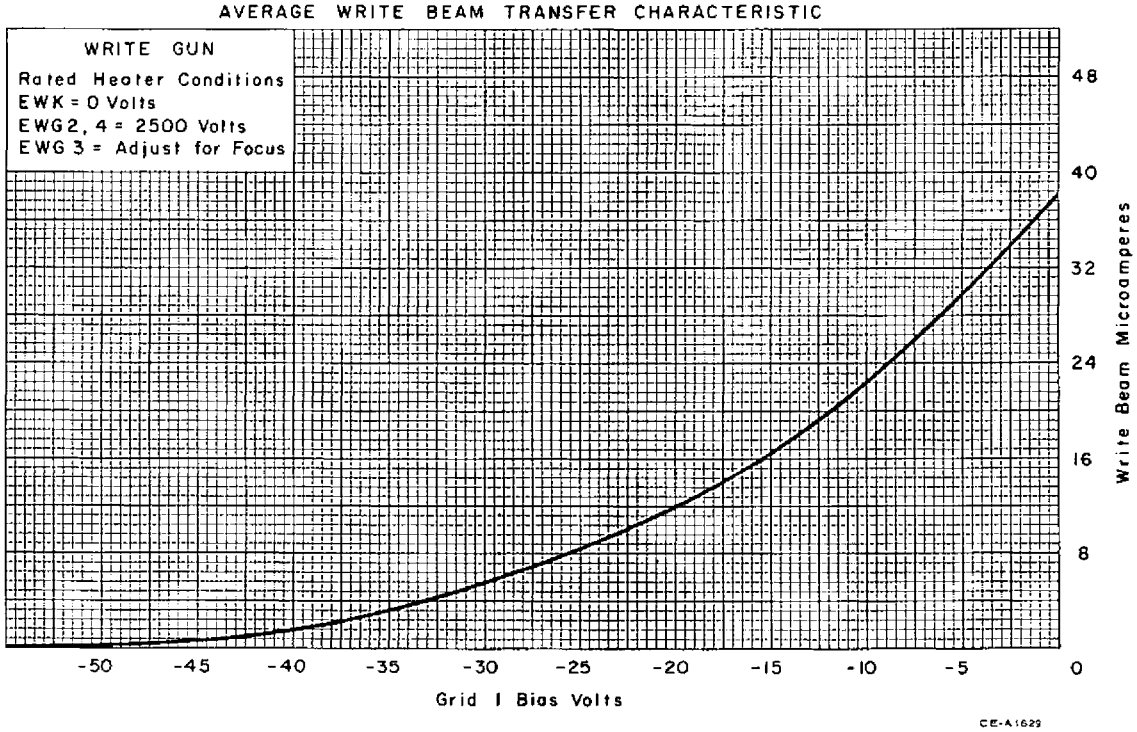
If a positive-going sawtooth erasing pulse is used, the least-negative storage elements will reach cathode potential before the remaining elements, thus allowing flood-beam electrons to land on elements representing brighter areas for a longer period than on those representing darker areas. With this type of proportional erasure, half-tones will persist as long as bright areas.

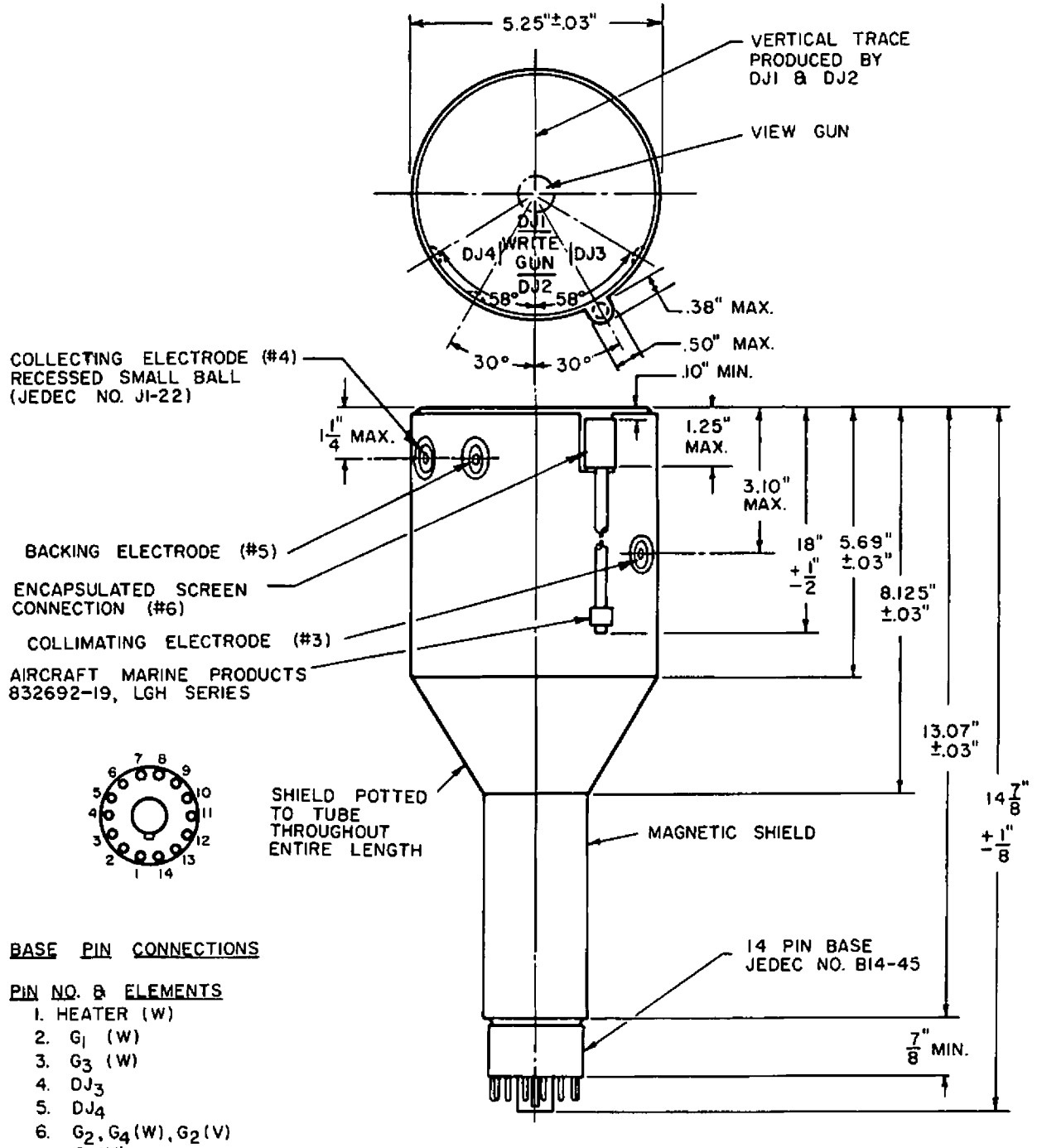
For applications involving half-tone display, the rectangular erase pulses should be adjusted in amplitude so that the storage surface is charged to exactly cutoff potential by the erasing operation.

For applications such as radar, where noise must be suppressed, a more positive erase pulse may be used to drive the storage surface several volts below cutoff. The write beam must then scan the surface several times to bring the written elements above cutoff.

If possible the erase-pulse amplitude should be adjusted so that the noise component of the writing gun signal is just sufficient to bring the storage surface to cutoff. The signal above this level will then allow flood-beam electrons to produce a display representing that signal without any noise background.

AVERAGE WRITE BEAM TRANSFER CHARACTERISTIC





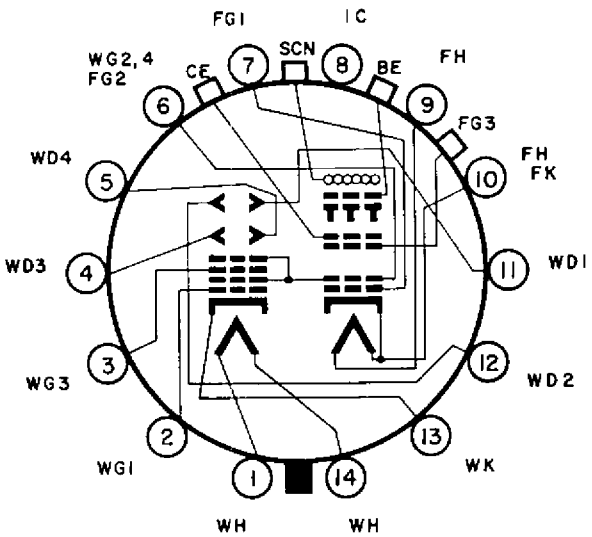
BASE PIN CONNECTIONS

PIN NO. & ELEMENTS

1. HEATER (W)
2. G_1 (W)
3. G_3 (W)
4. DJ_3
5. DJ_4
6. G_2, G_4 (W), G_2 (V)
7. G_1 (V).
8. N. C.
9. HEATER (V)
10. HEATER (V), CATHODE (V)
11. DJ_1
12. DJ_2
13. CATHODE (W)
14. HEATER (W)

(W) = WRITE

(V) = VIEW



CE-A1691

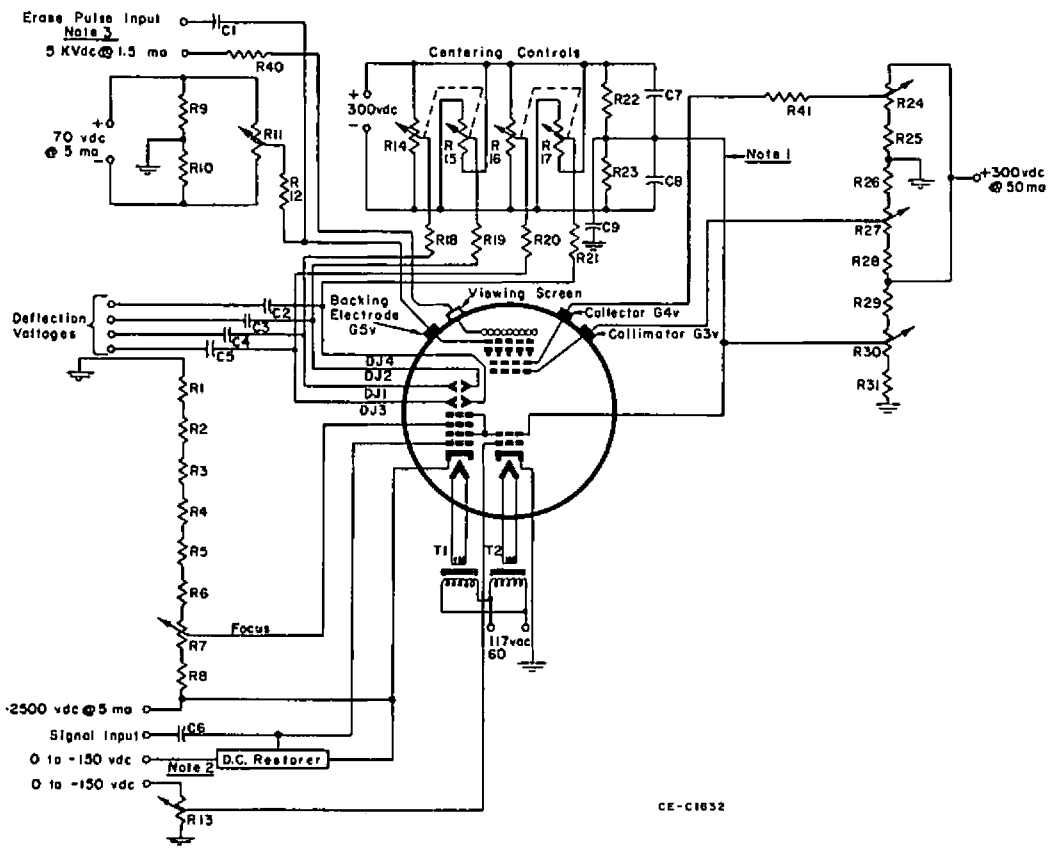
INDEX OF TERMINALS

BASE PINS

Pin No.	Gun	Element
1	Write	Heater
2	Write	Grid 1
3	Write	Grid 3 (Focus)
4	Write	Deflection Electrode 3
5	Write	Deflection Electrode 4
6	Write	Grids 2 & 4
	Flood	Grid 2
7	Flood	Grid 1
8	Internal Connection (Do NOT Use)	
9	Flood	Heater
10	Flood	Heater & Cathode
11	Write	Deflection Electrode 1
12	Write	Deflection Electrode 2
13	Write	Cathode
14	Write	Heater

CAPS ON LARGE END OF BULB

Gun	Element
Flood	Grid 3 (Collimating Electrode)
Flood	Collecting Electrode
Flood	Backing Electrode
Flood	View Screen



Note 1: The mean deflection potential is referred to the writing gun final anode potential to prevent astigmatism.
Note 2: Voltages are with respect to writing gun cathode. Entire supply must be insulated from ground for 4000 volts.
Note 3: Erase Pulse Characteristics, Amplitude: 0 to 10 volts peak-to-peak, Width: 2 to 10 microseconds, Frequency: 0 to 1000 pulses per second.

C_1: 0.1 μf, 200 volts
C_2, C_3, C_4, C_5: Value depends on deflection-voltage frequency and waveform
C_6: Value depends on signal-voltage frequency and waveform, 4000 volts
C_7, C_8: 0.05 μf, 600 volts
C_9: 0.5 μf, 600 volts
R_1: 91,000 ohms, 1 watt
R_2, R_{25}, R_{29}: 100,000 ohms, 1 watt
R_3, R_4, R_5, R_6: 470,000 ohms, 2 watts
R_7: Write Gun Focus Control: 250,000-ohm potentiometer, 2 watts
R_8: 180,000 ohm, 1 watt
R_9, R_{10}, R_{22}, R_{23}: 1 megohm, 0.5 watt
R : Backing Electrode Control: 100,000-ohm potentiometer, 2 watts
R_{12}: 5,000 ohm, 1 watt
R_{13}: Flood Gun Grid 1 Control: 250,000-ohm potentiometer 2 watts
R_{14}, R_{15}: Write Gun D_1 & D_2 Centering Controls: Dual 1 megohm potentiometers, 2 watts
R_{16}, R_{17}: Write Gun D_3 & D_4 Centering Controls: Dual 1 megohm potentiometers, 2 watts
R_{18}, R_{19}, R_{20}, R_{21}: 100,000 ohm, 0.5 watt
R_{24}: Collector Electrode Control: 200,000-ohm potentiometer, 2 watts
R_{26}, R_{28}, R_{31}: 51,000 ohm 1 watt
R_{27}: Collimating Electrode Control: 200,000-ohm potentiometer, 2 watts
R_{30}: Accelerating Anode Control: 150,000 ohm potentiometer, 2 watts
R_{40}: 1 megohm, 5 watts
R_{41}: 22,000 ohm, 1 watt
T_1: Filament Transformer: Primary 117 volts, Secondary 6.3 volts @ 1 ampere, Insulated for 4000 volts
T_2: Filament Transformer: Primary 117 volts, Secondary 6.3 volts @ 1 ampere

The information contained herein is furnished without assuming any obligations. The description and illustration of circuits herein does not convey to the purchaser of tubes any license for circuits under the patent claims of Westinghouse Electric Corporation or others.

LINEAR LOW-MU TRIODE TYPE 7685

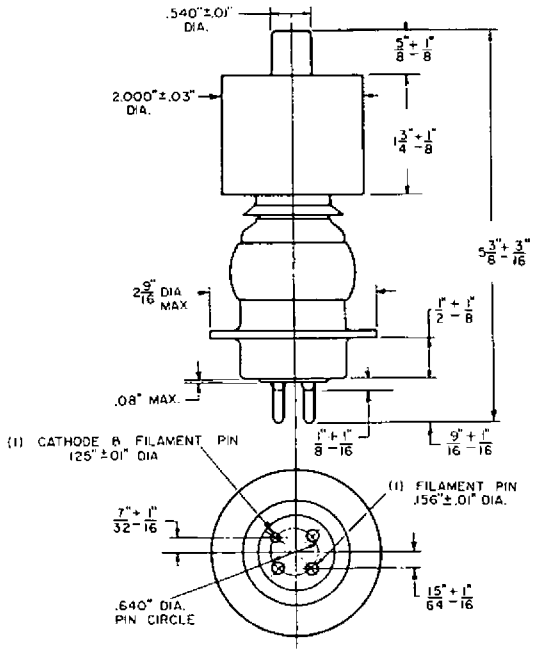
The 7685 is a low-mu triode designed for service as a class AB_1 or class B linear amplifier in audio or r-f service. The 7685 is well suited for application in broadcast and single-sideband transmitters, ultrasonic generators, and sonar pulse amplifiers. The forced air cooled anode is capable of dissipating 600 watts. The cathode is of indirectly-heated, oxide-coated, unipotential design. Maximum ratings apply to 60 megacycles.

ELECTRICAL:

Cathode	Oxide-Coated Unipotential		
Heater:			
Voltage	5.0		Volts
Current	8.0		Amperes
Starting Current (Max.)	24		Amperes
Resistance (Cold)	0.1		Ohm
Minimum Filament Heating Time	120		Seconds
Amplification Factor	6.5		
Direct Interelectrode Capacitances:	Tube Only	Tube in Socket	
Grid to Plate	11.8	11.9	μμf
Grid to Cathode	26.0	35.0	μμf
Cathode to Plate	0.6	0.6	μμf

MECHANICAL:

Mounting Position□	Vertical, Anode Up or Down			
Cooling:				
Method	Forced Air			
Maximum Incoming Air Temperature	45 °C			
Required Air Flow on Anode:				
Plate Dissipation	200	400	600	Watts
Air Flow Required	15	20	30	CFM
Static Pressure	0.3	0.5	0.9	In. H_2O
Maximum Glass Temperature	180			°C
Net Weight	14			Ounces
Shipping Weight	3			Pounds



CLASS AB POWER AMPLIFIER †

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	4.0 max.		Kilovolts
DC Grid Voltage⊕	−800 max.		Volts
DC Plate Current	600 max.		Ma.
DC Plate Power Input★	1.5 max.		Kilowatts
Plate Dissipation★	600 max.		Watts
Grid Dissipation	3 max.		Watts

TYPICAL OPERATING CHARACTERISTICS - Class AB_1

(Values for two tubes)

DC Plate Voltage	4000	Volts
DC Grid Voltage	−550	Volts
Peak A-F Grid-to-Grid Voltage	1100	Volts
Zero Signal Plate Current	0.120	Amperes
Maximum Signal Plate Current	0.635	Amperes
Effective Plate-to-Plate Load Resistance	12300	Ohms
Maximum Signal Driving Power	0	
Maximum Signal Power Output	1550	Watts

⊕ Grid circuit resistance should not exceed 100000 ohms.

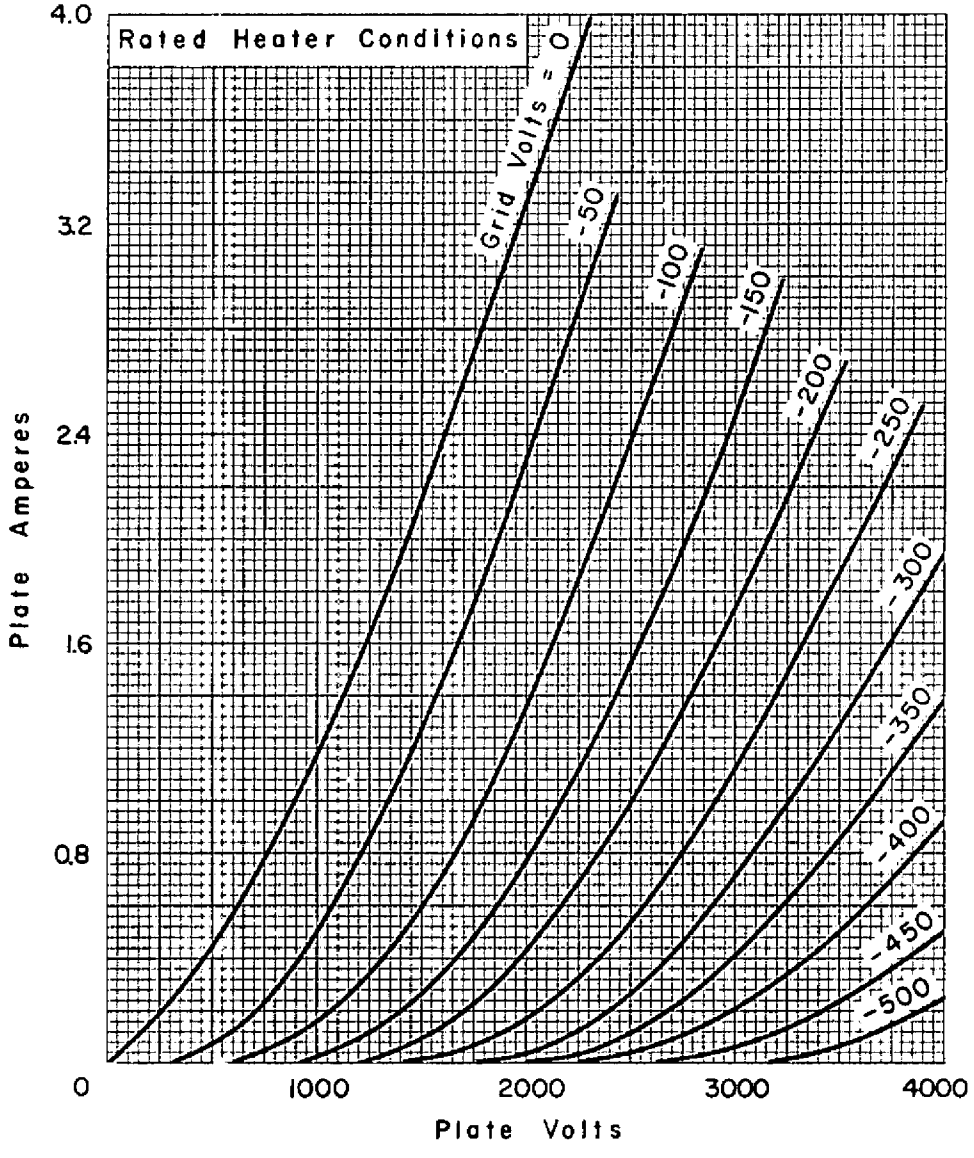
★ Averaged over any cycle of sine wave form.

□ The tube may be supported either by the anode or by use of a socket, Westinghouse Part No. 3-2H-4290. This socket is designed to provide a low inductance contact to the grid. Anode support of the tube may be done with a Lapp No. 43751 Insulating Support, sold by Lapp Insulator Co., Leroy, N.Y. or equivalent. When tube is operated anode down, cooling of the base end of the tube is necessary. Free air convection will suffice for most applications.

† Operation in other classes of service is possible. For information on specific applications, contact Westinghouse Electronic Tube Division Sales Department outlining your design requirements.

from JEDEC release #3045, Nov. 28, 1960

AVERAGE PLATE CHARACTERISTICS



CE-A1587

September 15, 1960

HARD TUBE PULSE MODULATOR TYPE 7691

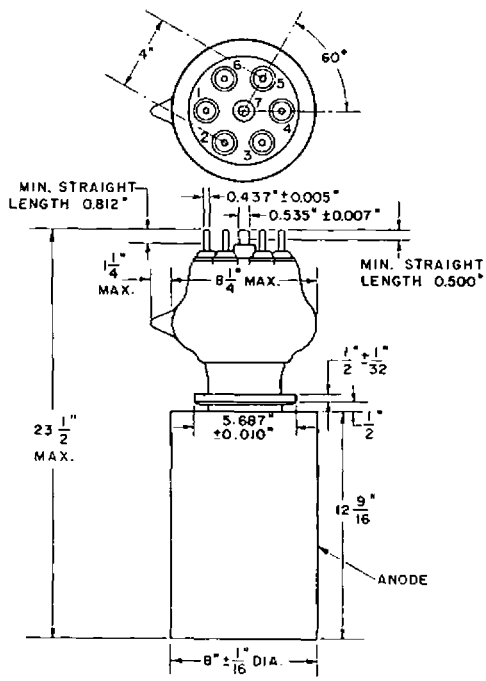
The 7691 is a large three-electrode, forced air cooled tube designed for pulse applications as a hard-tube modulator. The anode is capable of dissipating 10 kilowatts, exclusive of filament heating power. The cathode is a multiple-strand, thoriated-tungsten filament which may be operated either single phase or 3 phase.

ELECTRICAL

Cathode	Multiple-Strand, Thoriated-Tungsten Filament	
Filament:		
Voltage:		
Single Phase Connection	12	Volts
3 Phase Connection (to neutral)	12	Volts
Current:		
Single Phase Connection	309	Amperes
3 Phase Connection (per phase)	103	Amperes
Minimum Filament Heating Time	15	Seconds
Amplification Factor	21	
Direct Interelectrode Capacitances: (approx.)		
Grid to Plate	42	$\mu\mu f$
Grid to Filament	95	$\mu\mu f$
Plate to Filament	8	$\mu\mu f$

MECHANICAL:

Mounting	Vertical, Anode Down			
Net Weight	60 Pounds			
Shipping Weight	125 Pounds			
Cooling:				
Method	Forced Air Flow			
Maximum Ambient Air Temperature	50 °C			
Maximum Bulb and Seal Temperature	180 °C			
Required Air Flow Through Radiator:				
Plate Dissipation	10	8	5	Kilowatts
Air Flow	800	700	500	CFM
Static Pressure	2.75	2	1	In. H_2O



LONG PULSE OPERATION

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	60 max.		Kilovolts
DC Grid Voltage	−3500 max.		Volts
Peak Positive Grid Voltage	2500 max.		Volts
Peak Pulse Plate Current	150 max.		Amperes
Peak Pulse Grid Current	50 max.		Amperes
Plate Dissipation	10 max.		Kilowatts
Grid Dissipation	1.0 max.		Kilowatt
Pulse Length	1000 max.		μseconds
Duty Factor	0.01 max.		
Peak Pulse Cathode Current	200 max.		Amperes

SHORT PULSE OPERATION

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	60 max.		Kilovolts
DC Grid Voltage	−3500 max.		Volts
Peak Positive Grid Voltage	3500 max.		Volts
Peak Pulse Plate Current (Note 1)	400 max.		Amperes
Peak Pulse Grid Current (Note 1)	100 max.		Amperes
Peak Pulse Cathode Current (Note 1)	500 max.		Amperes
Plate Dissipation	10 max.		Kilowatts
Grid Dissipation	1.0 max.		Kilowatt
Pulse Length	0.5 max.		μseconds
Duty Factor	0.0012		

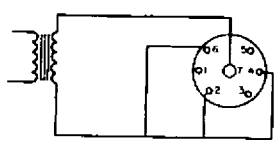
1. These values are attainable only under the following filament conditions.

Filament Voltage:		
Single Phase	13	Volts
Three Phase (to neutral)	13	Volts
Filament Current:		
Single Phase	318	Amperes
Three Phase (per phase)	106	Amperes

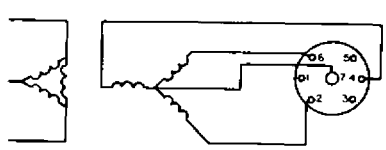
X-Ray Warning: The Maximum Ratings of the 7691 permit operation at voltages in excess of 16 KV. Therefore equipment design considerations should include the possible generation of soft x-rays.

FILAMENT CONNECTIONS

SINGLE PHASE AC SUPPLY



THREE PHASE AC SUPPLY

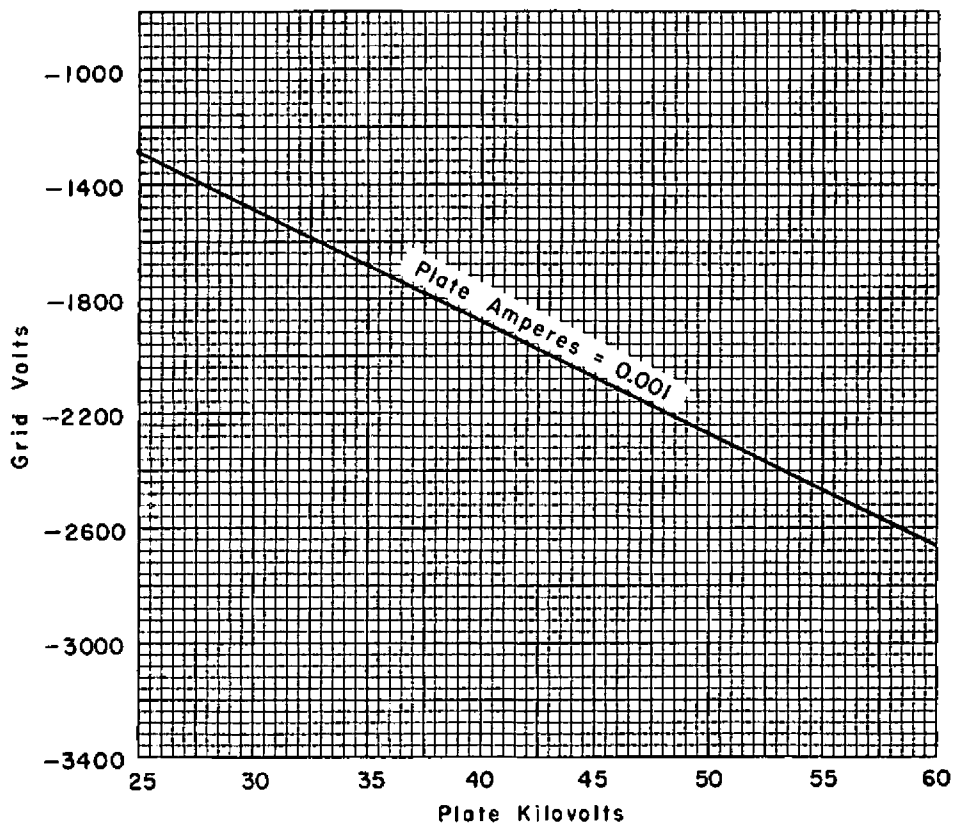


FILAMENT TERMINALS 2, 4, 6 & 7 PAINTED BLACK
GRID TERMINALS 1, 3, 8 5 PAINTED RED

GE-A1523

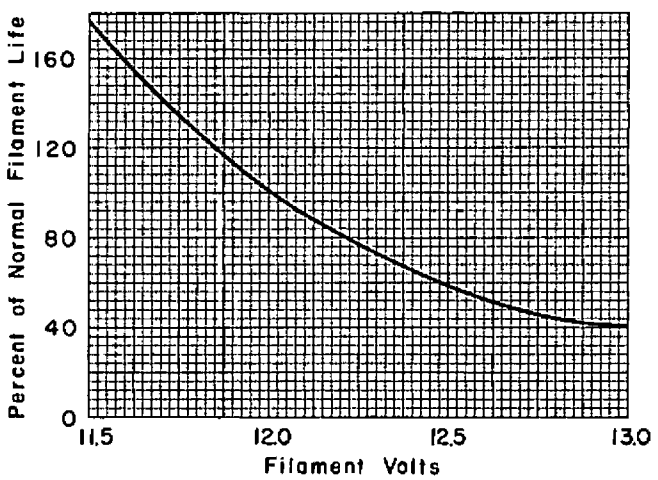
from JEDEC release #3080, Dec. 18, 1960

HIGH VOLTAGE CUT-OFF CHARACTERISTICS



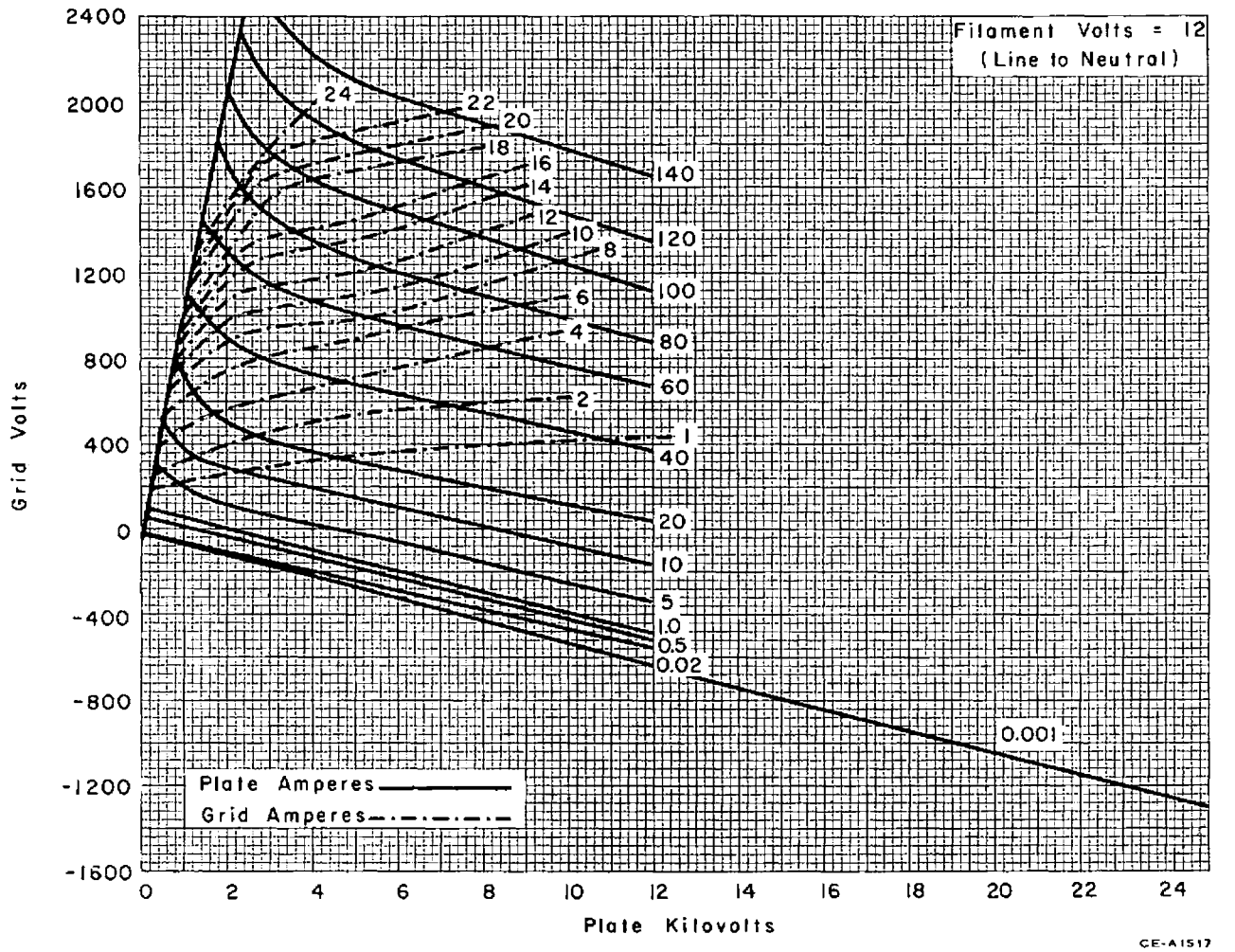
CE-A1518 R1

AVERAGE FILAMENT LIFE EXPECTANCY



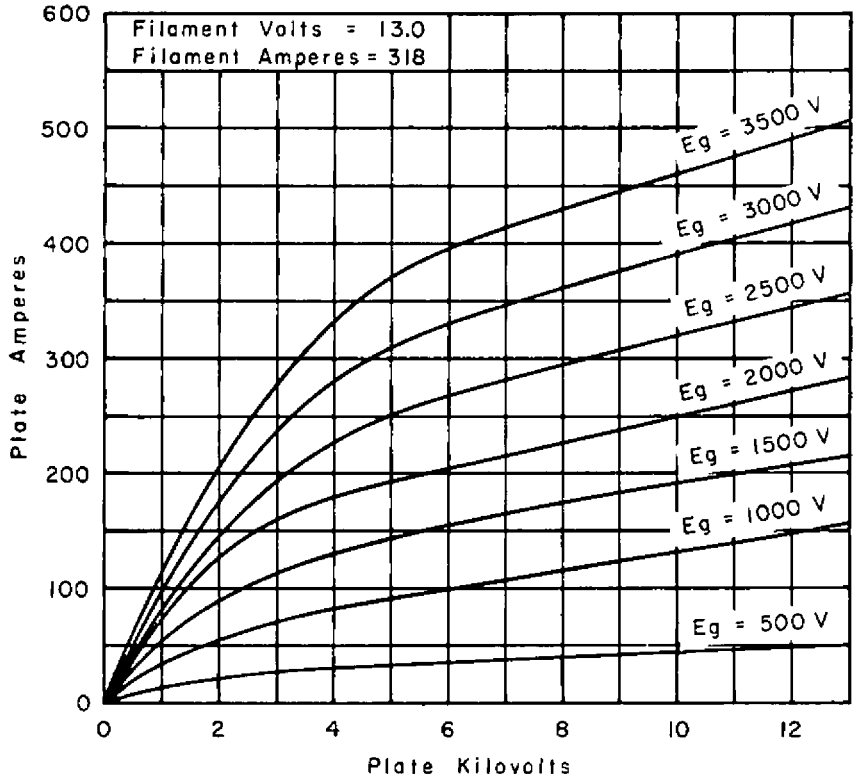
CE-A1510 R1

AVERAGE CONSTANT CURRENT CHARACTERISTICS



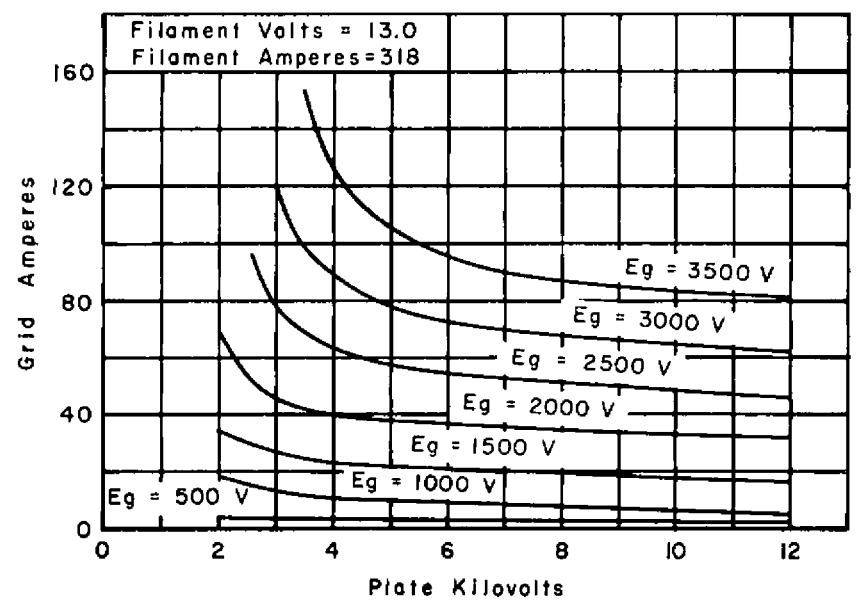
CE-A1517

AVERAGE PLATE CHARACTERISTICS
(0.5 Microsecond Pulse Service)



CE-A1584

AVERAGE GRID CHARACTERISTICS
(0.5 Microsecond Pulse Service)



CE-A1585

IGNITRON FOR CAPACITOR DISCHARGE SERVICE TYPE 7740

The 7740 is a sealed, steel envelope tube with Shoop sprayed area where contact is made to the cathode. The anode connection is a threaded stud. The combination is suitable for connection in low inductance, high current circuits as used in high current capacitor discharge circuits operating up to 20000 volts. In this service the tube will discharge up to 35000 amperes.

GENERAL

Number of Electrodes

Anodes	1
Cathodes	1
Ignitors	1

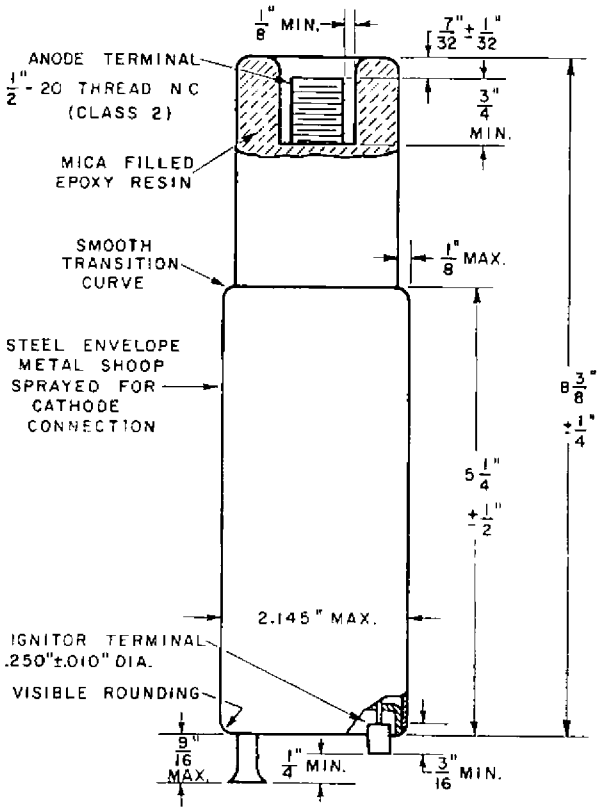
Ignitor Firing Circuit

Capacitor	0.5	μf
Capacitor Voltage	2.5	Kilovolts
Series Resistor	10	Ohms
Pulse Transformer Ratio (Note 1)	1/1	
Firing Thyratron	Type 4C35	

Mechanical

Mounting Position – Axis Vertical, Anode Lead up

Net Weight	3.7	lbs.
Shipping Weight	4.6	lbs.
Maximum Tube Temperature (measured on cathode header)	60	°C



MAXIMUM RATINGS FOR CAPACITOR DISCHARGE

Peak Anode Voltage (Note 2)

Inverse	20000	max.	Volts
Forward (Note 3)	20000	max.	Volts

Anode Current

Peak	35000	max.	Ampere
Coulombs Per Discharge	18.6	max.	Amp. Sec.
Repitition Rate	2	max.	Per Minute
Rise Time	5000	max.	Amps/μsec
Average Current	0.6	max.	Ampere

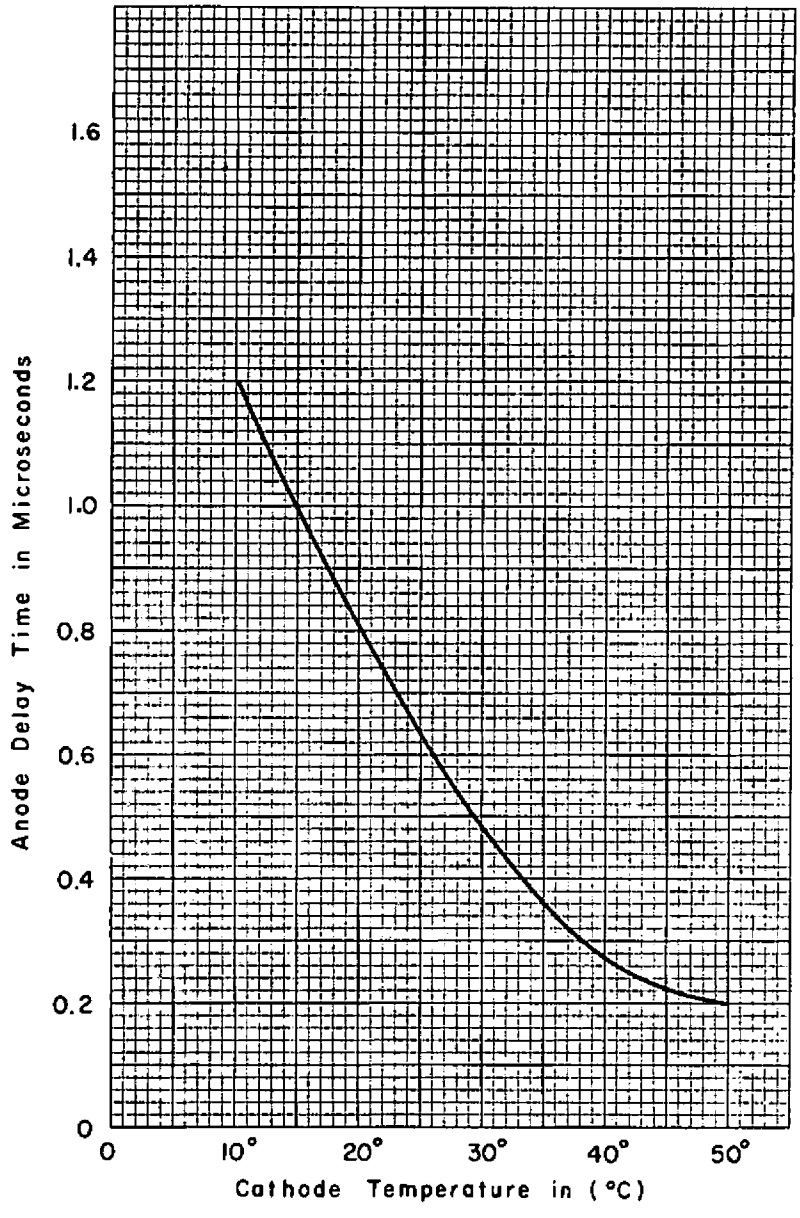
Note 1: The use of a pulse transformer in the ignitor circuit is optional. It may be used for isolation where desired. The capacitor size and voltage and other constants should be adjusted according to the transformer turns ratio. Values shown are for 1/1 ratio.

Note 2: Before installing, mercury must be evaporated from the anode. During operation the anode must always be at higher temperature than the tube envelope. After operation the anode must cool more slowly than the envelope to insure that no mercury condenses on the anode. Initial anode heating may be done by screwing anode threaded connection into metal block heated to 140°C for six to eight hours. Lower portion of envelope must be cooled by water or other method to 25°C or less.

Note 3: Forward voltage (Hold-off voltage) is the voltage to which the capacitors, being switched by the ignitron, are charged.

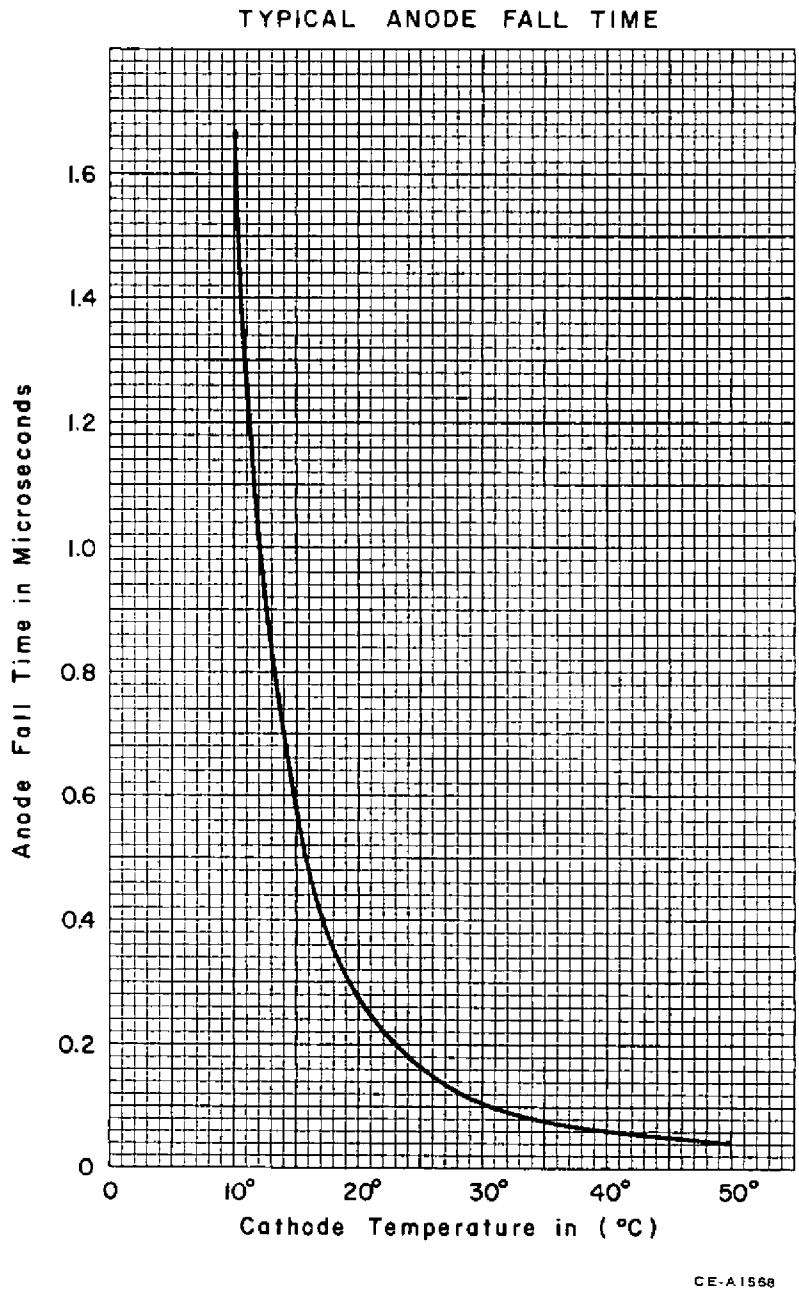
from JEDEC release #3782, June 25, 1962

TYPICAL ANODE DELAY TIME



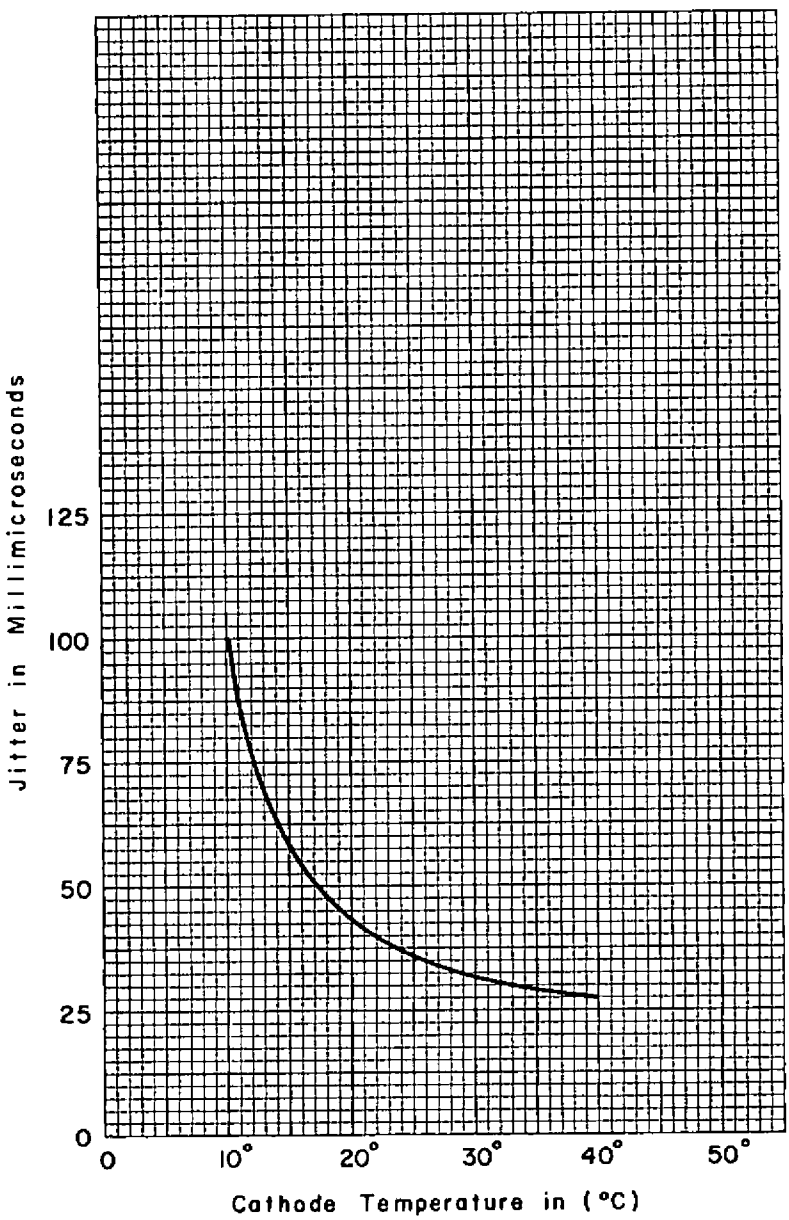
CE-A1570

Anode Delay Time is the time from start of rise of ignitor signal voltage to reduction of anode voltage to 90% of the forward voltage.



Anode Fall Time is the time for anode voltage to fall from 90% to 10% of the forward voltage.

TYPICAL JITTER



CE-A1569

Jitter is the variation in time for anode voltage to fall to 50% of the forward voltage, stated as a plus-minus value from the average.

Westinghouse

Feb. 10, 1961

COMPENSATED IONIZATION CHAMBER TYPE 7741

The 7741 compensated ionization chamber is designed to detect thermal neutrons in the range from 2.5×10^{2} to 2.5×10^{10} neutrons/cm^2/second, in the presence of very high gamma radiation fields. The detector is of rugged construction, incorporating a design which allows operation at temperatures up to 500°F.

The 7741 incorporates two outstanding design features. The first is the use of a "guard ring" type of construction to minimize reduction in signal currents due to leakage through the insulators. The second is the provision for continuously variable, electrical compensation. The neutron sensitivity of the chamber is approximately 4×10^{-14} amperes/neutron/cm^2/second. Gamma sensitivity is approximately 3×10^{-11} amperes/R/hr when operated uncompensated, but it is reduced to approximately 3×10^{-13} amperes/R/hr in compensated operation, thus extending the operating range two decades.

The 7741 is constructed of high purity materials to reduce the effect of induced radioactivity. The case is 1100 aluminum; the electrode of 3% aluminum, 97% magnesium alloy. Insulation is high purity alumina.

The 7741 is similar to the 6377 and 7353 in performance characteristics, differing primarily in outline dimensions and operating temperature.

MECHANICAL:

Maximum Diameter	3-3/16	Inches
Maximum Overall Length	24	Inches
Approximate Sensitive Length . . .	14	Inches
Net Weight	6-1/2	Pounds
Shipping Weight	20	Pounds

from JEDEC release #3180, March 6, 1961

MATERIALS:

Outer Case	1100 Aluminum	
Electrodes	3% Al, 97% Mg Alloy	
Insulation	Alumina	
Neutron Sensitive Material:		
Content	Boron enriched in B-10	
Thickness	1 mg/cm^2	
Gas Filling	Nitrogen	

IMPEDANCE:

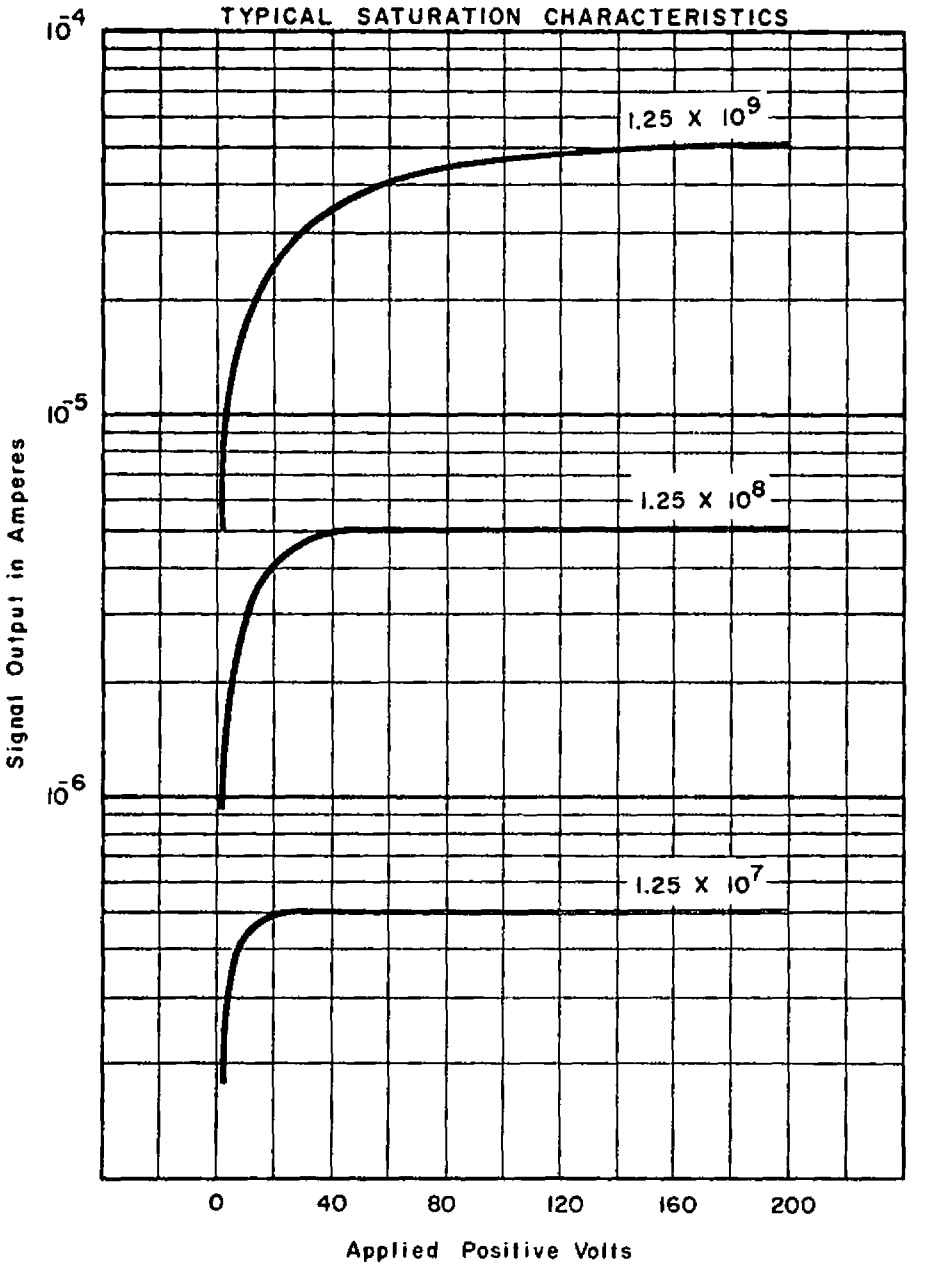
Resistance (500°F):		
Signal to Case (Minimum)	10^{12}	Ohms
H.V. to Case (Minimum)	10^{10}	Ohms
Compensating to Case (Minimum)	10^{10}	Ohms
Resistance (68°F):		
Signal to Case (Minimum)	10^{14}	Ohms
H.V. to Case (Minimum)	10^{12}	Ohms
Compensating to Case (Minimum)	10^{12}	Ohms
Capacitance: (Remaining electrodes tied to case)		
Signal to Case (Approx.)	315	uuf
H.V. to Case (Approx.)	420	uuf
Compensating to Case (Approx.)	200	uuf

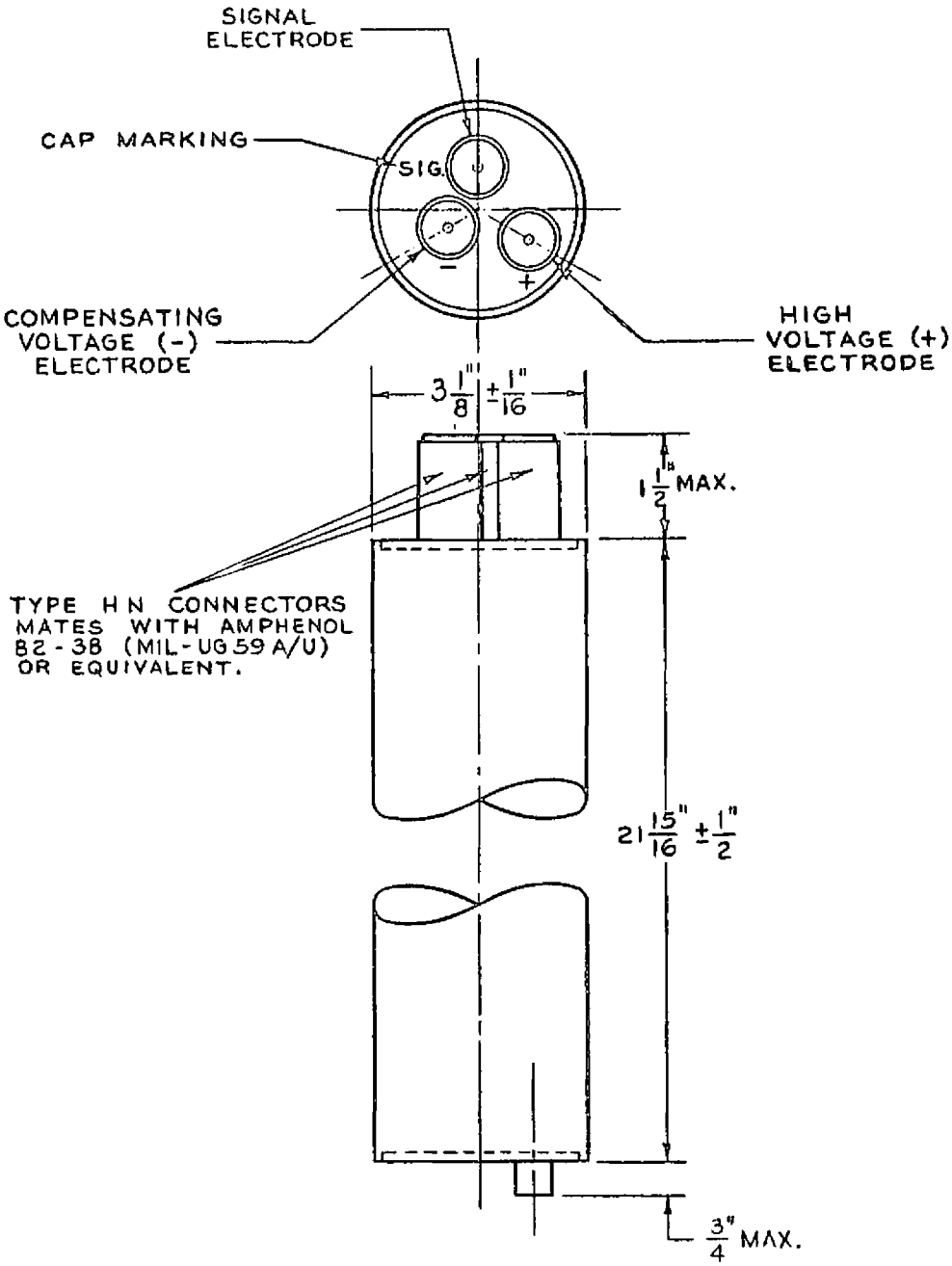
MAXIMUM RATINGS:

Voltage:		
H.V. to Case	1500	Vdc
L.V. to Case	500	Vdc
Signal to Case (for test)	500	Vdc
Temperature:		
Operating (Max.)	500	°F
Storage (Max.)	550	°F
External Pressure:		
(Dry and Non-corrosive atmosphere)	180	psia
Thermal Neutron Flux	5 x 10^{11}	nv

TYPICAL OPERATION:

Operating Voltage	300 to 800	Vdc
Compensating Voltage	-10 to -80	Vdc
Thermal Neutron Flux Range	2.5 x 10^2 to 2.5 x 10^{10}	n/cm^2/sec
Thermal Neutron Sensitivity	4 x 10^{-14}	amperes/nv
Gamma Sensitivity Uncompensated	3 x 10^{-11}	amperes/R/hr
Saturation Characteristics	See Figure	


TYPICAL SATURATION CHARACTERISTICS
10^{-4}
10^{-5}
10^{-6}
Signal Output in Amperes
1.25 X 10^{9}
1.25 X 10^{8}
1.25 X 10^{7}
0
40
80
120
160
200
Applied Positive Volts


SIGNAL ELECTRODE
CAP MARKING
SIG.
COMPENSATING VOLTAGE (-) ELECTRODE
HIGH VOLTAGE (+) ELECTRODE
3 1/8" ± 1/16"
1 1/2" MAX.
TYPE H N CONNECTORS MATES WITH AMPHENOL 82-38 (MIL-UG 59 A/U) OR EQUIVALENT.
21 15/16" ± 1/2"
3/4" MAX.

Westinghouse

7748

February 15, 1961

POWER AMPLIFIER TRIODE TYPE 7748

The type 7748 is a three electrode tube designed for service as an oscillator, amplifier or modulator in Class B & C operation. The anode is water cooled with an integral water jacket and is capable of dissipating 35 kilowatts during C.C.S. The cathode is a thoriated tungsten filament which may be operated either with d-c or single-phase a-c. Maximum ratings apply to 30 megacycles.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament	
Filament:		
Voltage	8.0	Volts
Current	150	Amperes
Minimum Heating Time	15	Seconds
Amplification Factor	20	
Direct Interelectrode Capacitances:		
Grid to Plate	79	μμf
Grid to Filament	71	μμf
Plate to Filament	4	μμf

MECHANICAL:

Mounting Position	Vertical, Anode Down
Type of Cooling	Water
Water Flow Required	30 GPM
Static Pressure (at 30 GPM)	8 PSI
Maximum Outlet-Water Temperature	70 °C
Maximum Grid and Filament Seal Temperature	180 °C
Net Weight	18 Pounds

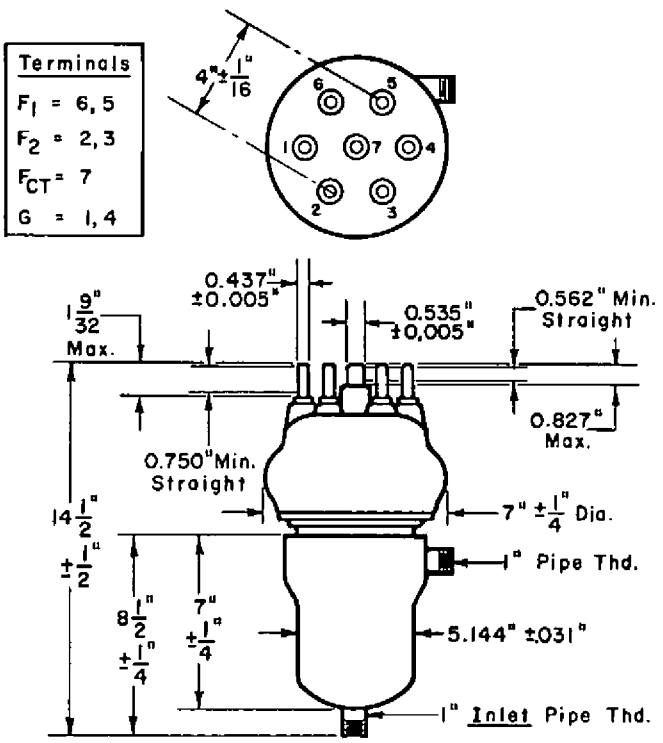
MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	12.5	max.	Kilovolts
DC Plate Current	10	max.	Amperes
DC Grid Voltage	−3000	max.	Volts
DC Grid Current	1.25	max.	Amperes
Plate Power Input	80	max.	Kilowatts
Plate Dissipation	35	max.	Kilowatts

TYPICAL OPERATING CHARACTERISTICS:

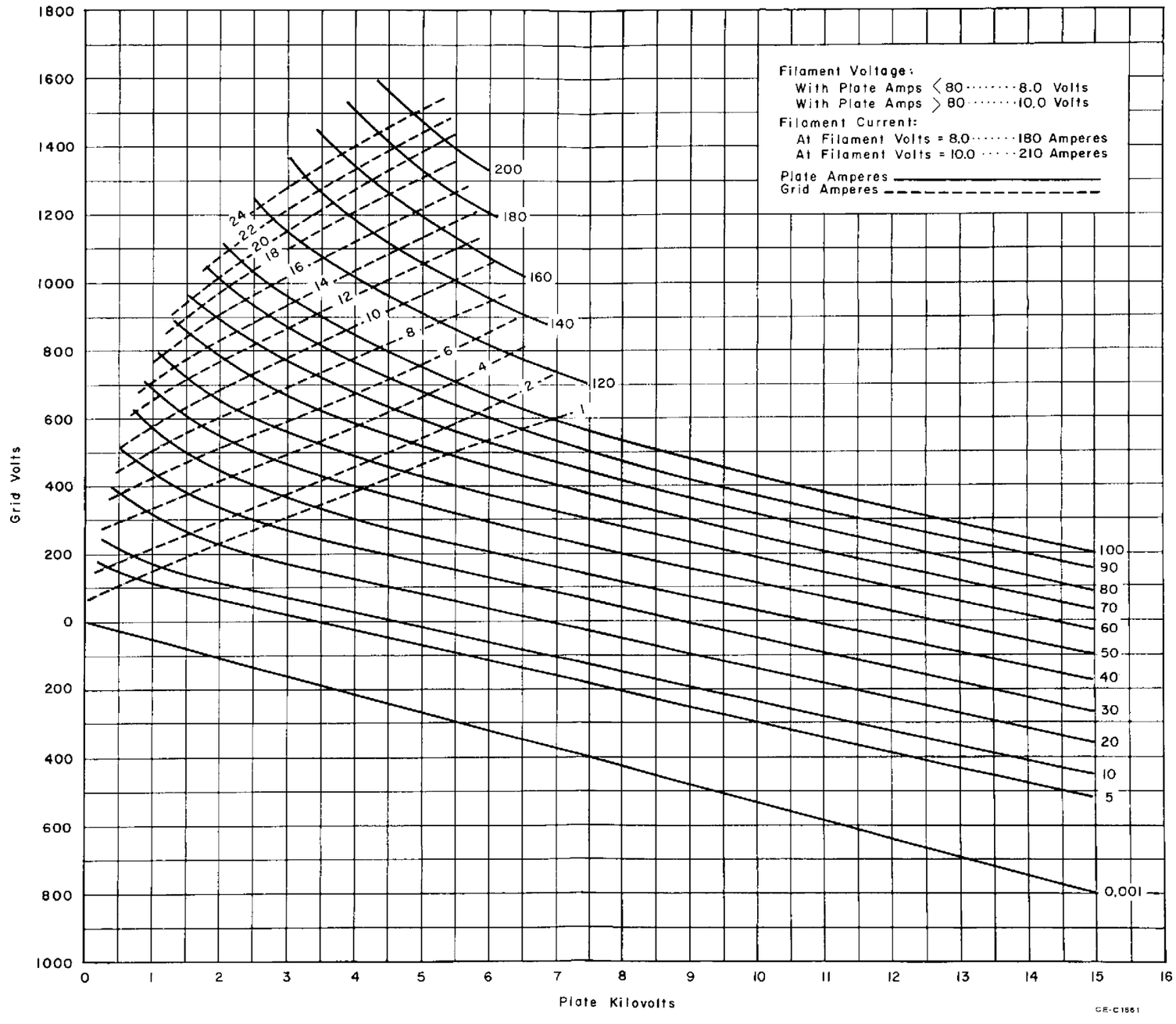
DC Plate Voltage	7500	10000	12500	Volts
DC Grid Voltage	−800	−1100	−1300	Volts
Peak R.F. Grid Voltage	1250	1500	1700	Volts
DC Plate Current	5.5	4.7	4.25	Amperes
DC Grid Current	0.875	0.58	0.59	Amperes
Driving Power	1050	850	970	Watts
Power Output	33.5	40	46.5	Kilowatts

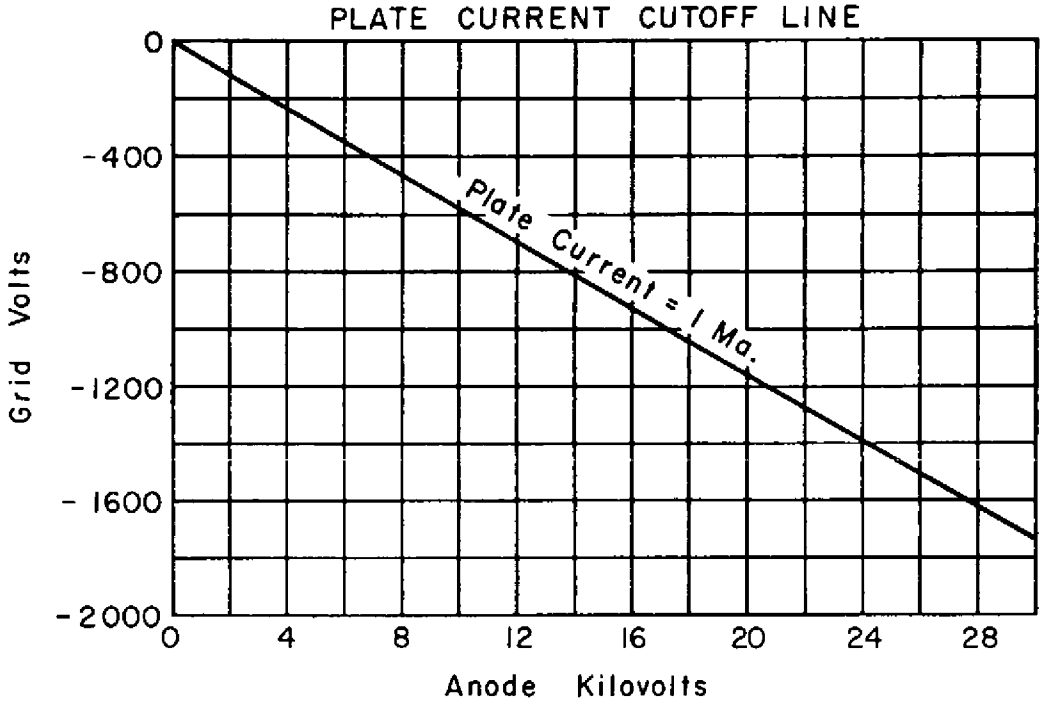


High Vacuum Amplifier Section

from JEDEC release #3207, April 3, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS




PLATE CURRENT CUTOFF LINE
0
-400
-800
-1200
-1600
-2000
Grid Volts
Plate Current = 1 Ma.
0
4
8
12
16
20
24
28
Anode Kilovolts
CE-A1675

HARD TUBE PULSE MODULATOR TYPE 7750

The 7750 is a three-electrode tube designed for service as a hard tube modulator. The forced-air cooled anode is capable of dissipating 8 kilowatts. The cathode is a thoriated tungsten filament which may be operated with either d-c or single-phase a-c.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament		
Filament:			
Voltage (d-c or single phase a-c)	8		Volts
Current	180		Amperes
Heating Time (minimum)	15		Seconds
Amplification Factor	20		

MECHANICAL:

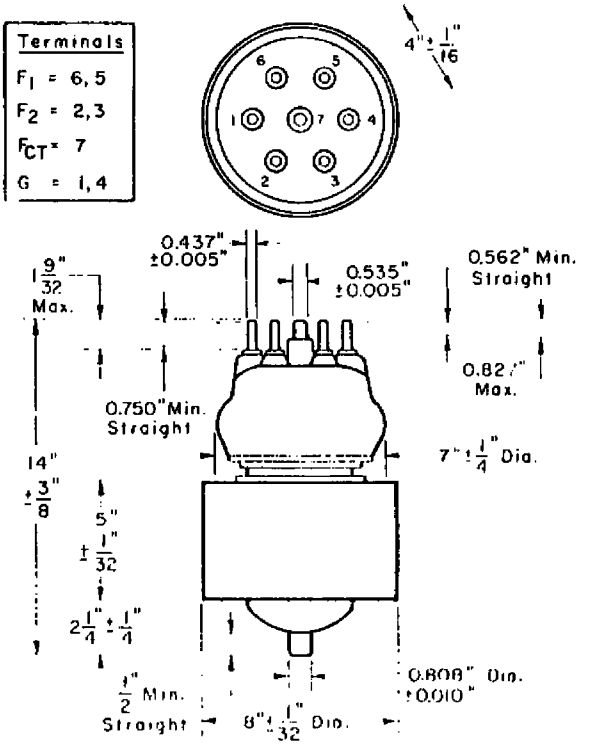
Mounting Position	Vertical, Anode Down		
Type of Cooling	Forced Air		
Required Air Flow Through Radiator:			
Plate Dissipation	6	8	Kilowatts
Air Flow	400	600	CFM
Static Back Pressure	0.6	1.0	In. H_2O
Maximum Bulb Temperature	180 °C		
Net Weight	30 Pounds		

MAXIMUM RATINGS:

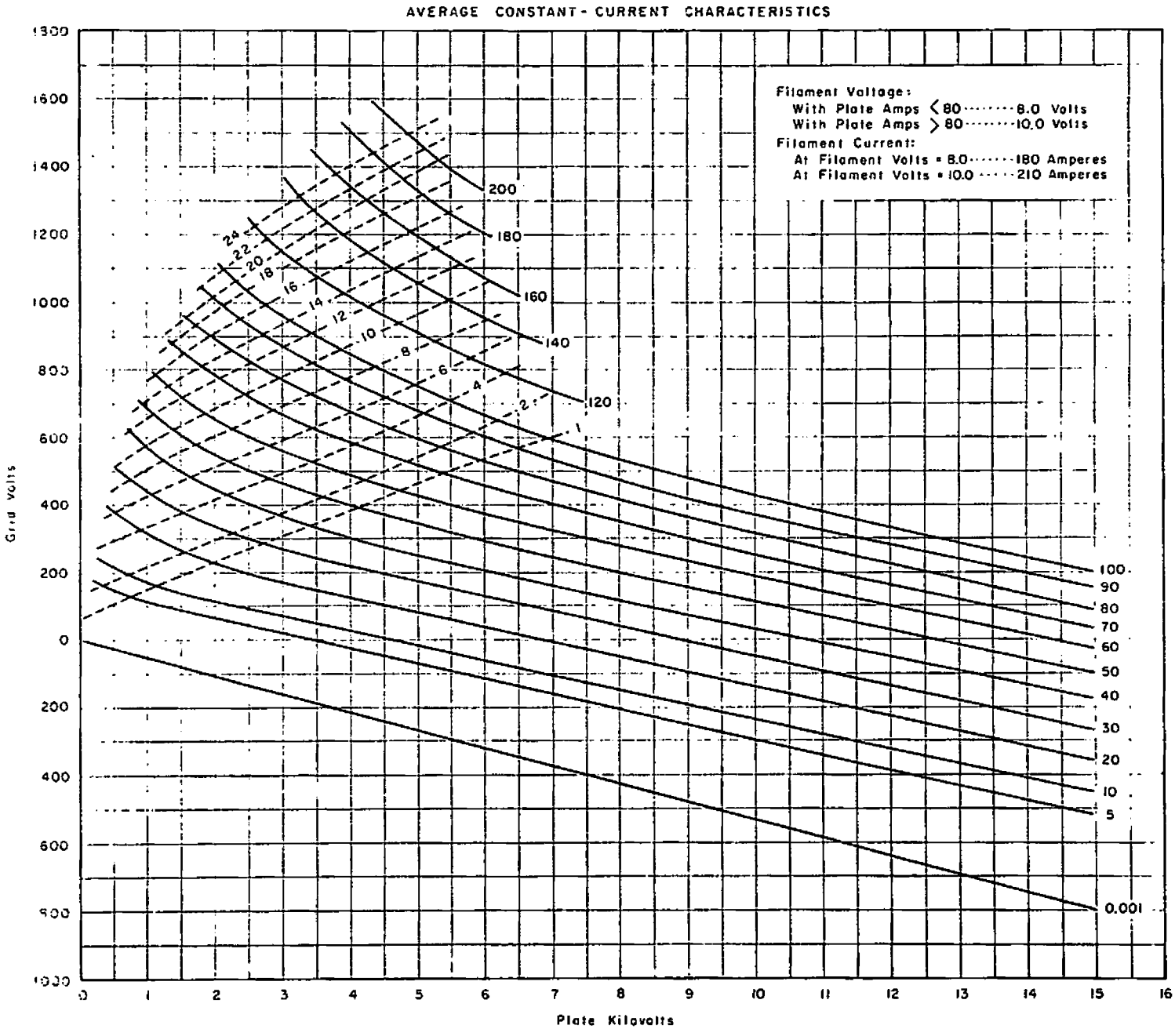
Absolute Maximum Values

DC Plate Voltage	30	max.	Kilovolts
DC Grid Voltage	−2500	max.	Volts
Peak Positive Grid Voltage	2000	max.	Volts
Peak Pulse Plate Current	80	max.	Amperes
Peak Pulse Grid Current	20	max.	Amperes
Plate Dissipation	8	max.	Kilowatts
Grid Dissipation	800	max.	Watts
Pulse Length	1000	max.	Microseconds
Duty Factor	0.02	max.	
Peak Pulse Cathode Current	100*	max.	Amperes

* Peak pulse cathode current of 200 amperes is allowable on pulses of 10 microseconds or less duration if filament is elevated to 10.0 volts.



from JEDEC release #3080, Dec. 18, 1960


AVERAGE CONSTANT-CURRENT CHARACTERISTICS
Filament Voltage:
With Plate Amps < 80 ····· 8.0 Volts
With Plate Amps > 80 ····· 10.0 Volts
Filament Current:
At Filament Volts = 8.0 ····· 180 Amperes
At Filament Volts = 10.0 ····· 210 Amperes
Grid Volts
Plate Kilovolts
1800
1600
1400
1200
1000
800
600
400
200
0
200
400
600
800
1000
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
200
180
160
140
120
24
22
20
18
16
14
12
10
8
6
4
2
1
100
90
80
70
60
50
40
30
20
10
5
0.001

Westinghouse

7794

January 1, 1961

TUNABLE MAGNETRON TYPE 7794

The 7794 is a C band 5 watt CW magnetron. It is designed for AM modulated communications, telemetering and relay systems requiring high average power with good bandwidth. In pulse code modulation systems peak powers up to 10 watts are available. In amplitude modulated systems one hundred percent modulation of a five watt carrier is permitted. With 100% modulation incidental FM is less than 10 megacycles. The rugged light weight design permits use on airborne systems where shock and vibration are severe.

The 7794 uses a multivaned anode structure and an oxide coated unipotential cathode. It contains a capacitive tuning element which can be adjusted by means of a differential screw to a desired frequency in the range 4200-4400 Mc. The integral magnets are enclosed in steel shells which serve to shield the magnetron from stray magnetic field effects.

The 7794 is also most satisfactory for laboratory use as its tuning system permits precise and repeatable frequencies settings any where in the range. Its signal is readily sensed when tube is amplitude modulated. The power output is high enough for standing wave measurements or research into off-resonance spurious behavior.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (Note 1)	6.3	Volts
Current	0.6 ± 10%	Ampere
Warm-Up Time (Note 2)	40	Seconds

MECHANICAL:

Max. Overall Length	3.750	Inches
Max. Diameter (Excluding Turminals)	1.656	Inches
Connectors:		
Output	BNC Connector Jack JAN UG-89/U	
Operating Voltages	Special 8-Pin In-Line Plug	
Cooling	Unrestricted Air Convection	
Ambient Temperature	−55°C to +70°C	
Shell Temperature	35°C max. above ambient	
Vibration and Shock (Note 3)	Ruggedized	
Operating Position (Note 4)	Any	
Net Weight	0.9 Pounds	

Life: 500 hours of C.W. operation at maximum power with correspondingly longer usefulness at lower duty cycle or power.



from JEDEC release #3219, April 10, 1961

TYPICAL OPERATION: Continuous Wave Oscillator

(Load VSWR 2.0 Max.)	Min.	Typical	Max.	
Heater Voltage (Note 1)	5.7	6.3	7.0	Volts
Heater Current	0.54	0.60	0.66	Amperes
Cathode Voltage	−250	−425	−450	Volts
Cathode Current	10	30	60	Ma.
Power Output	0.5	4.5	5	Watts
Frequency	4200	--	4400	Megacycles
Pulling Figure for VSWR of 1.5	--	--	4.0	Megacycles

TYPICAL OPERATION: Pulsed Applications

(Load VSWR 2.0 Max.)				
Heater Voltage (Note 1)	5.7	6.3	7.0	Volts
Heater Current	0.54	0.60	0.66	Amperes
Peak Cathode Voltage	−250	−450	−500	Volts
Peak Current	10	60	100	Ma.
Peak Power	0.5	5.0	10.0	Watts
Duty Cycle (Note 5)	0.001	0.5	1.0	

TYPICAL OPERATION: Amplitude Modulation

(Load VSWR 2.0 Max.)				
Heater Voltage (Note 1)	5.7	6.3	7.0	Volts
Heater Current	0.54	0.60	0.66	Amperes
Cathode Center Voltage	−300	−350	−400	Volts
Cathode Current (average)	15	30	60	Ma.
Modulation Frequency	--	10^3	10^6	Cycles/Sec.
Modulation Amplitude (Note 6)	--	--	100%	

1: Operation of heater with direct current will be necessary in most cases to minimize frequency modulation at alternating current supply frequencies. A.C. operation is permissible in some applications. The heater should be connected to the cathode through 1 megohm of resistance.

2: Cathode voltage and heater voltage can be applied simultaneously, but power will not be available at full rating in less than 40 seconds.

3: The tube has been tested to the limit of hammer tests. Special vibration problems encountered should be referred to the nearest Westinghouse Electronic Tube salesman or Westinghouse Electronic Tube Division, Elmira, N.Y.

4: The tube connectors do not provide mechanical support. Non-magnetic clamps should be used to support the shell. Typical application supports the tube with its principle axis horizontal.

5: A typical application uses square wave modulation, but pulse widths less than 1.0 microseconds have been demonstrated to be useful.

6: The amplitude of modulation voltage is related to cathode center voltage. In general, the difference between 230 volts and the operating center voltage is the amplitude needed for 100% sine wave modulation.

Operating Recommendations

Maximum Ratings:

The maximum ratings must not be exceeded if performance characteristics are to be maintained. It does not necessarily follow that all maximum ratings can be applied simultaneously.

Magnetic Field Precautions:

While the steel shell enclosing the integral permanent magnets serves as an effective magnetic shield, it still is possible to affect the operating point of the tube if brought within strong A.C. field regions. Ferromagnetic materials should not be used for mounting brackets. Magnets should be kept at least one inch from the tube. Turning the screws in either end cover can affect the magnetic field and make the tube inoperative.

Handling Precautions:

This tube is exceptionally rugged and can take extreme shock conditions and any normal handling without special precaution except that the output section can be bent by strong pressure. It is advised that the tube be cradled in the inner part of its shipping container when on the bench, because this is designed to keep the tube away from ferromagnetic surfaces or contact with other tubes.

Tuning:

The tube is delivered with frequency set and locked at the center of its tuning range. Loosening the locking nut permits rotation of the tuning screw in either direction. An approximate tuning curve is shown in Figure 1. Tuning is achieved by motion of

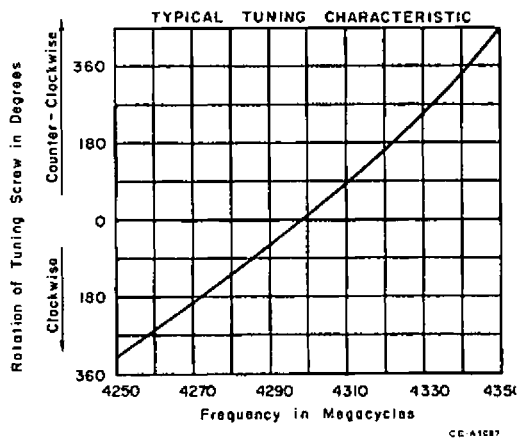


FIGURE 1

a capacitive element inside the vacuum enclosure. The differential screw system permits precise and repeatable settings. The locking nut permits close settings to be maintained in systems where vibration is extreme. The thermal stability variation of frequency with change in ambient temperature is shown in Figure 2. The reference value is the frequency

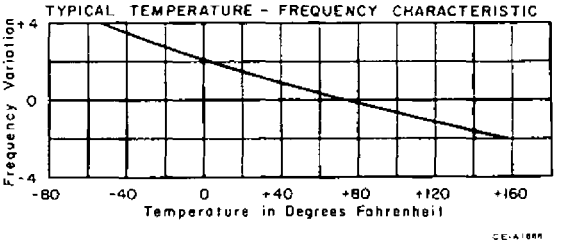


FIGURE 2

after 20 minutes stabilization at room temperature. During this interval, frequency may show a drift of about −5 Mc.

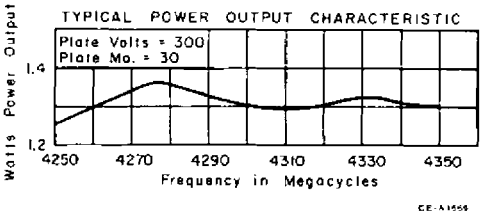


FIGURE 3

Power Uniformity:

When operated as a C.W. oscillator at a current of 30 ma., the power output remains constant within ± 0.1 watt, as shown in Figure 3.

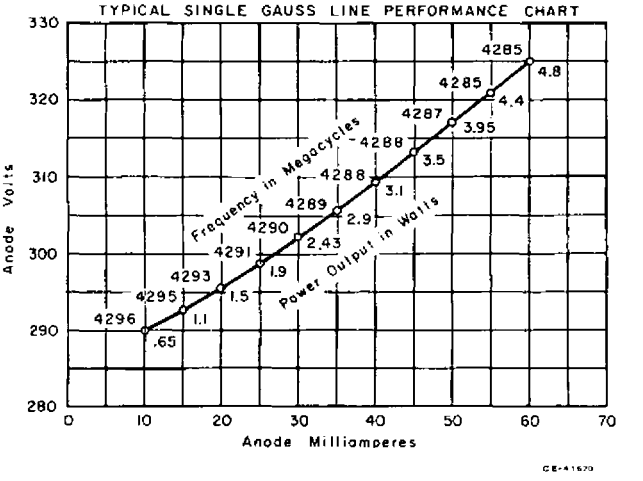
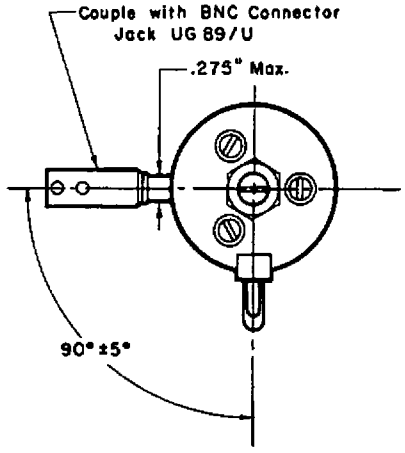


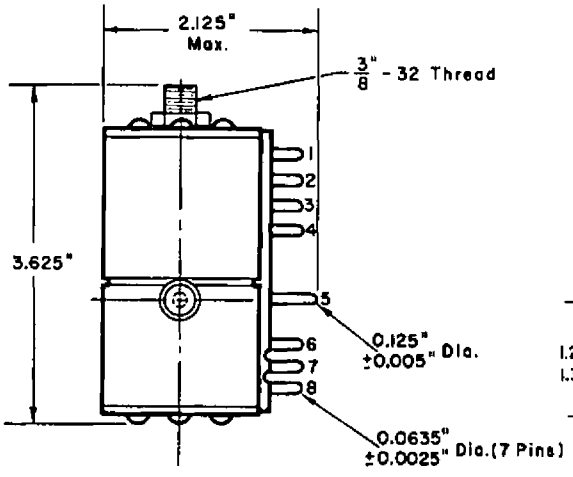
FIGURE 4

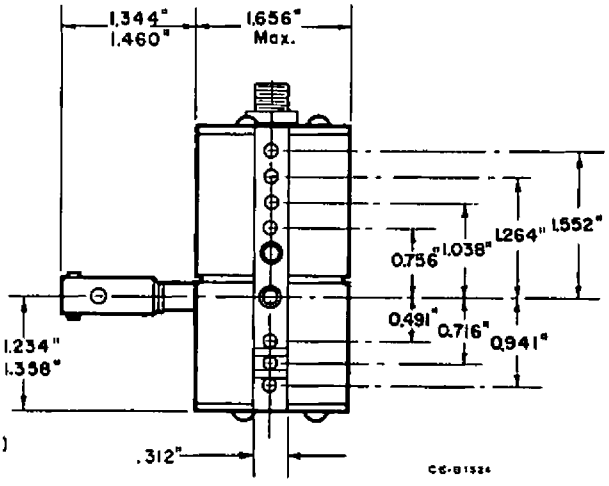
Performance:

A single gauss-line performance chart for a typical tube is shown in Figure 4 for a locked frequency setting of the tube. This shows the FM tuning probable with amplitude modulation. Higher or lower magnetic field settings are possible to meet specific requirements. Application problems should be referred to the nearest Westinghouse Electronic Tube salesman or Westinghouse Electronic Tube Division, Elmira, N.Y.

PIN#	CONNECTION
1	NO CONNECTION
2	NO CONNECTION
3	NO CONNECTION
4	NO CONNECTION
5	ANODE (GROUND)
6	HEATER
7	CATHODE
8	HEATER







MAGNETRON TYPE 7795

Fixed Frequency	5 Watt Output	Integral Magnets
4300 ± 10 Megacycles	100% Amplitude Modulated	10 Watts with Duty Cycles

The 7795 is a C band 5 watt CW magnetron. It is designed for amplitude modulated communications, telemetering and relay systems requiring high average power with good bandwidth. In pulse code modulation systems peak powers up to 10 watts are available with duty cycles ranging to five watts average power. In amplitude modulated systems one hundred percent modulation of a five watt carrier is permitted. With 100% modulation incidental FM is less than 8 megacycles. The rugged, light weight design of the 7795 permits use on airborne systems where shock and vibration are severe.

The 7795 uses a multivaned anode structure and an oxide coated unipotential cathode. It contains a capacitive tuning element preset in the factory to 4300 ± 10 megacycles. The integral magnets are enclosed in steel shells to shield the magnetron from stray magnetic field effects.

ELECTRICAL:

Cathode	Coated Unipotential	
Heater:		
Voltage (Note 1)	6.3	Volts
Current	0.6 ± 10%	Amperes
Heating Time (minimum)	40	Seconds

MECHANICAL:

Operating Position (Note 4)	Any	
Connectors:		
Output	Couples with BNC Jack (JAN UG-89/U)	
Operating Voltages	Special 8-Pin In-Line Socket	
Cooling	Unrestricted Air Convection	
Ambient Temperature	−55 to +70 °C	
Shell Temperature (maximum)	40 °C Above Ambient	
Vibration: (Note 2)		
Frequency	25	CPS
Amplitude	0.080	Inches
Net Weight	1	Pound
Shipping Weight	2	Pounds

MAXIMUM RATINGS:

Absolute Maximum Values

Heater Voltage	7.0	max.	Volts
Anode Voltage	425	max.	Volts
Modulation Frequency	1	max.	Mc.
Average Power Input	30	max.	Watts
Heater-Cathode Voltage	± 45	max.	Volts

TYPICAL OPERATING CHARACTERISTICS:

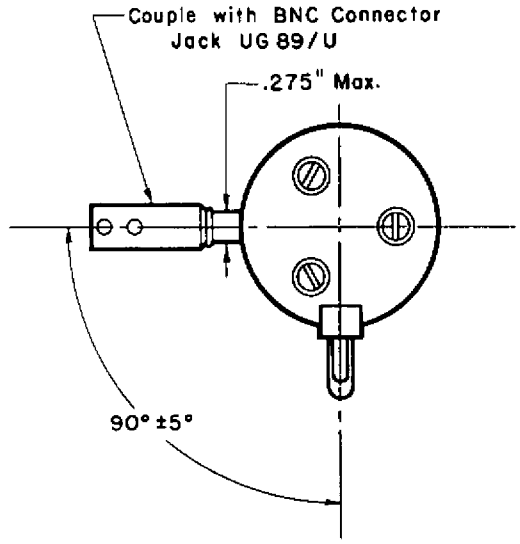
Voltages are with respect to Ground

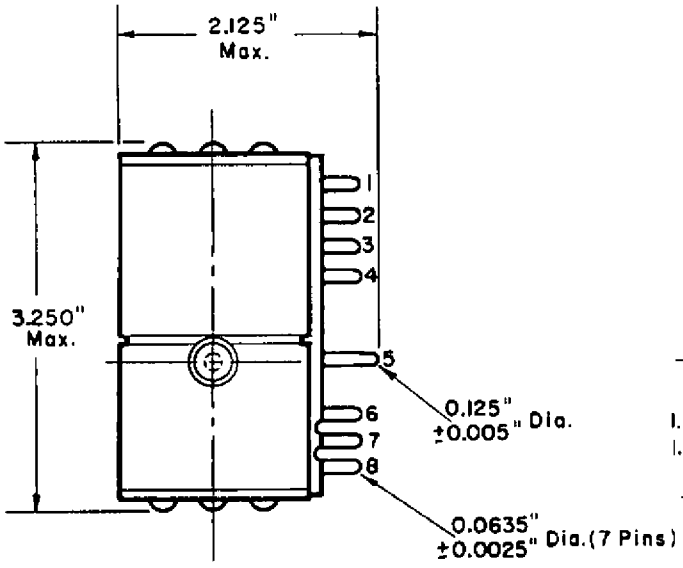
Anode	Grounded	
Cathode Voltage	−425	Volts
Anode Current	30	Ma.
Power Output:		
Peak Power at 0.5 Min. Duty	10	Watts
Average Continuous Power (Note 3)	5	Watts
Frequency (Note 5)	4300	Mc.
Frequency Tolerance	± 10	Mc.

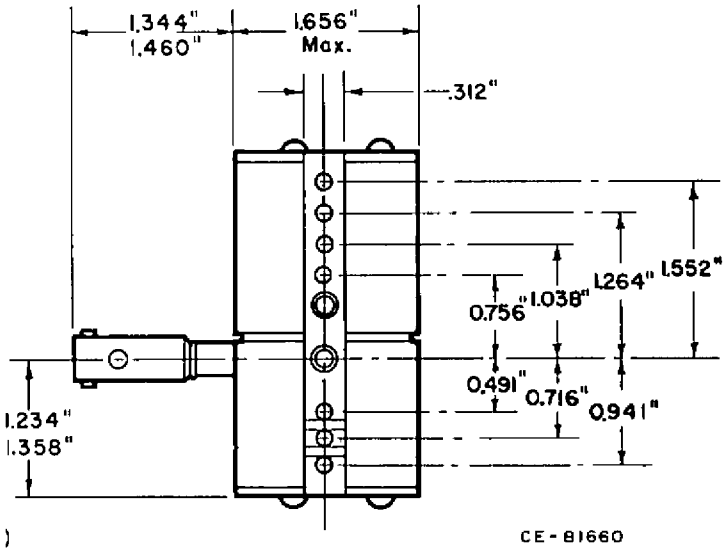
1. Heater should be connected to cathode through 100 K resistor.
2. Special vibration problems should be referred to Westinghouse Electronic Tube Division, Elmira, N.Y.
3. 100% amplitude modulation with 5 watts carrier is permitted.
4. The connectors do not provide mechanical support. Non-magnetic clamps should be used to support the shell.
5. Other versions of this tube are available to operate on different frequencies. The tube may be set, at the factory, to any frequency between 4200 and 4400 megacycles with a tolerance of ± 10 megacycles.

from JEDEC release #3184, March 13, 1961

PIN#	CONNECTION
1	NO CONNECTION
2	NO CONNECTION
3	NO CONNECTION
4	NO CONNECTION
5	ANODE (GROUND)
6	HEATER
7	CATHODE
8	HEATER







MAGNETRON TYPE 7796

Band Sweep Operation	1-1/2 Watts	Electro-Mechanical
Amplitude Modulation	Power Output	Frequency Sweep

The 7796 is a C band CW magnetron intended for use in applications requiring swept frequency operation over the band from 4200 to 4400 megacycles. Over this band, the power output is 1.5 watts minimum. Frequency is changed by varying the strap-to-strap capacity of the doubly-strapped vane resonator. This is accomplished by an electrically-driven reed inside the vacuum envelope. This member can be driven at any frequency from 0 to 300 cycles per second. Reed resonance occurs at approximately 300 cycles per second.

The 7796 can be frequency modulated at frequencies up to 300 cycles per second at a deviation from 0 to 100 megacycles. The AM modulation resulting from this deviation is very small. The center frequency can be varied from 4200 to 4400 by passing dc current through the drive coils.

The 7796 has a very low pushing figure, permitting it to be amplitude modulated with small amounts of incidental FM. Amplitude modulation is accomplished by varying the anode voltage. Modulation at frequencies up to 1 megacycle is possible.

The 7796 is small, light weight and resistant to shock and vibration. Integral magnets are contained within an external steel shell. Output is from a BNC connector.

ELECTRICAL:		
Cathode	Coated Unipotential	
Heater:		
Voltage	6.3	Volts
Current	0.6 ± 10%	Ampere
Heating Time	40	Seconds
Reed Drive Coil Resistance at 25°C	0.3 to 0.4	Ohms

MECHANICAL:	
Operating Position (Note 1)	Any
Connectors:	
Output	Couples with BNC Jack (JAN UG-89/U)
Operating Voltages	Special 8-Pin In-Line Socket
Cooling	Unrestricted Air Convection
Ambient Temperature	−55 to +70 °C
Shell Temperature (Max.)	40 °C Above Ambient
Magnet Isolation	Shell must be at least 1" from Magnets
Vibration: (Note 2)	
Frequency	25 CPS
Amplitude	0.080 Inches
Net Weight	1 Pound
Shipping Weight	2 Pounds

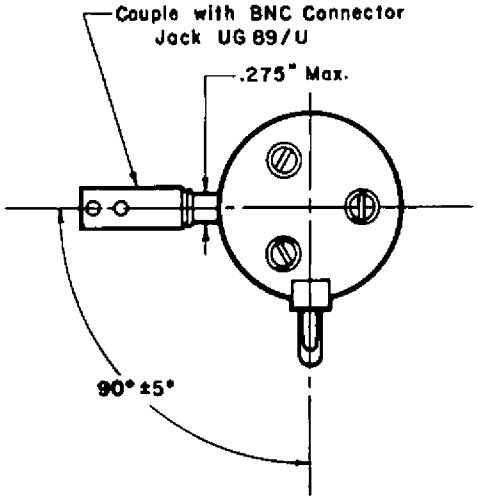
MAXIMUM RATINGS:		
Absolute Maximum Values:		
Heater Voltage	7.0 max.	Volts
Anode Voltage	350 max.	Volts
Anode Modulating Voltage for Pulse or Amplitude Modulation for 100% Modulation	100 max.	Volts
Heater-Cathode Voltage	± 45 max.	Volts

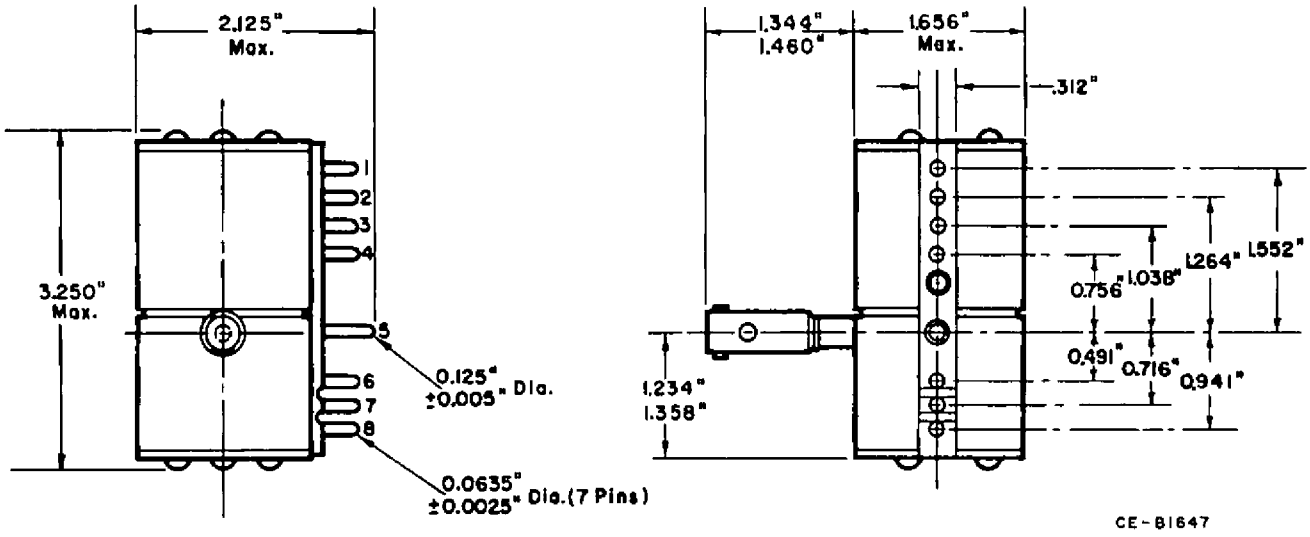
TYPICAL OPERATING CHARACTERISTICS:		
Anode Voltage	350	Volts
Anode Current	30	Ma.
Reed Resonant Frequency	300 ± 30	CPS
Reed Drive Peak-to-Peak Voltage at Resonance for ± 100 Mc. Shift	0.1	Volts
Reed Drive Direct Current for ± 100 Mc Shift	± 0.5	Ampere
Audio Power for 100% Amplitude Modulation	2.5	Watts
Average RF Power Output over Band	1.5	Watts

1. The connectors do not provide mechanical support. Non-magnetic clamps should be used to support the shell.
2. Special vibration problems should be referred to Westinghouse Electronic Tube Division, Elmira, New York.

from JEDEC release #3184, March 13, 1961

PIN#	CONNECTION
1	DRIVE (+)
2	NO CONNECTION
3	NO CONNECTION
4	DRIVE (GROUND)
5	ANODE (GROUND)
6	HEATER
7	CATHODE
8	HEATER





HIGH PRESSURE ION GAUGE TYPE 7903

The 7903 is a small, three-electrode ionization type vacuum gauge designed to measure gas pressures in the range of 1×10^{-5} to 5×10^{-1} mm Hg. The operating filament is a thoria coated iridium wire. Filament burnout will not occur if the tube is accidentally let down to air during operation. The ion collector is a flat plate parallel to the operating filament. The other electrode, which is used as an electron emitter during outgassing and as an electron collector during operation, is a tungsten ribbon parallel to the ion collector on the opposite side of the operating filament.

ELECTRICAL:

Outgassing:		
Cathode	Tungsten Ribbon Filament	
Filament:		
Voltage (ac or dc) Approx.	3.6	Volts
Current	13	Amperes
Operating:		
Cathode	Thoria Coated Iridium Filament	
Filament:		
Voltage	1.3	Volts
Current at 1×10^{-5} mm Hg	2.4	Amperes

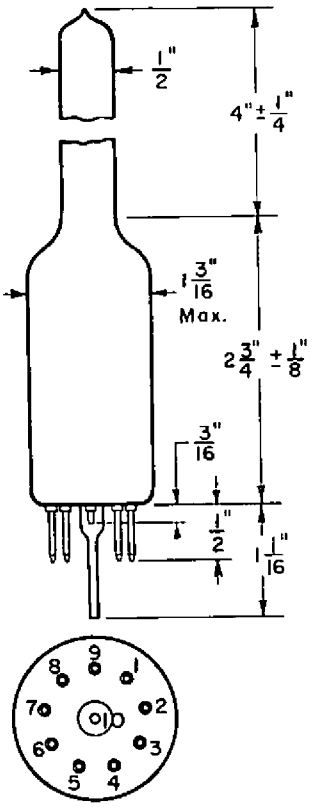
MECHANICAL:

Type of Cooling	Air
Tubulation: (Note 1)	
Glass	Pyrex, Corning Code 7740
Size	½" Diameter
Mounting Position	Any

MAXIMUM RATINGS:

Absolute Maximum Values

Outgassing: (DC Voltages are with Respect to Outgas-Filament-Electron-Collector Electrode).			
Ion Collector Voltage	400	max.	Volts
Ion Collector DC Power Input	12	max.	Watts
Filament Voltage (ac or dc)	4	max.	Volts
Ambient Temperature	100	max.	°C
Operating: (DC Voltages are with Respect to Operate Filament)			
Ion Collector Voltage	+65	max.	Volts
Outgas-Filament-Electron-Collector Electrode Voltage	−65	max.	Volts
Filament Voltage (ac or dc)	1.5	max.	Volts
Ambient Temperature	100	max.	°C
Gas Pressure	1	max.	mm Hg



INDEX OF TERMINALS

1. Electron Collector & Outgas Filament #1
2. Operate Filament #1
3. Electron Collector & Outgas Filament #1
4. No Connection.
5. Electron Collector & Outgas Filament #2
6. No Connection.
7. Operate Filament #2
8. Electron Collector & Outgas Filament #2
9. Short Index Pin
10. Ion Collector

Note: Both leads of each terminal of Outgas Filament should be used during outgassing to prevent damage to the tube.

from JEDEC release #3207, April 3, 1961

OPERATING CONDITIONS

Ion Collector Voltage with Respect to Operate-Filament	−60	Volts
Outgas-Filament-Electron-Collector Electrode Voltage with Respect to Operate Filament	+60	Volts
Operate-Filament Conditions for 50 Microamperes Electron Current: Voltage (ac or dc) At 1×10^{-4} mm Hg	1.3	Volts
Electron Current:		
From 1×10^{-4} to 1×10^{-2} mm Hg	1	Ma.
From 1×10^{-3} to 1×10^{-1} mm Hg	50	μA.
From 1×10^{-2} to Saturation	10	μA.
Sensitivity with Nitrogen $S = (i+ / i-) \times (1/P)$	0.4	$(\text{mm Hg})^{-1}$
Pressure Measuring Range with Nitrogen (See Figure 1)	1×10^{-4} to 6×10^{-1}	mm Hg

OUTGASSING CONDITIONS

Ion Collector Voltage with Respect to Outgas-Filament-Electron Collector Electrode	+300	Volts
Operate-Filament (Note 2)	Connected to Outgas-Filament-Electron-Collector-Electrode	
Outgas-Filament: Voltage (ac or dc)	3.6	Volts
Current	13	Amperes

NOTES

1. Other ion gauges, similar to type 7903 but having different sizes and materials of tubulation, are available under different numbers.
2. Voltage must not be applied across operate filament during outgassing.

AVERAGE ION CURRENT TRANSFER CHARACTERISTICS

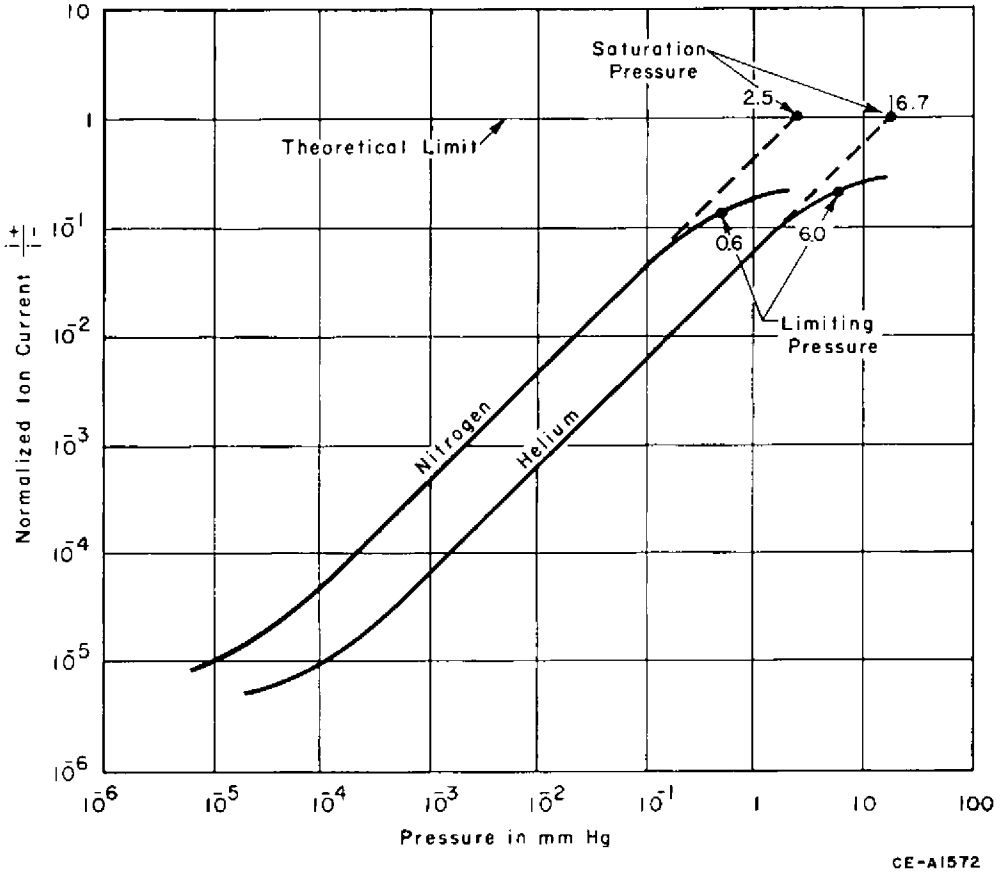


FIGURE 1

GAUGE CHARACTERISTICS FOR DIFFERENT GASSES

	N_2	CO	He	H_2
Sensitivity in $(mmHg)^{-1}$	0.4	0.42	0.06	0.21
Saturation Pressure in mmHg	2.5	2.6	16.7	4.8
Limiting Pressure in mmHg	0.6	0.6	6.0	0.6

APPLICATION DATA

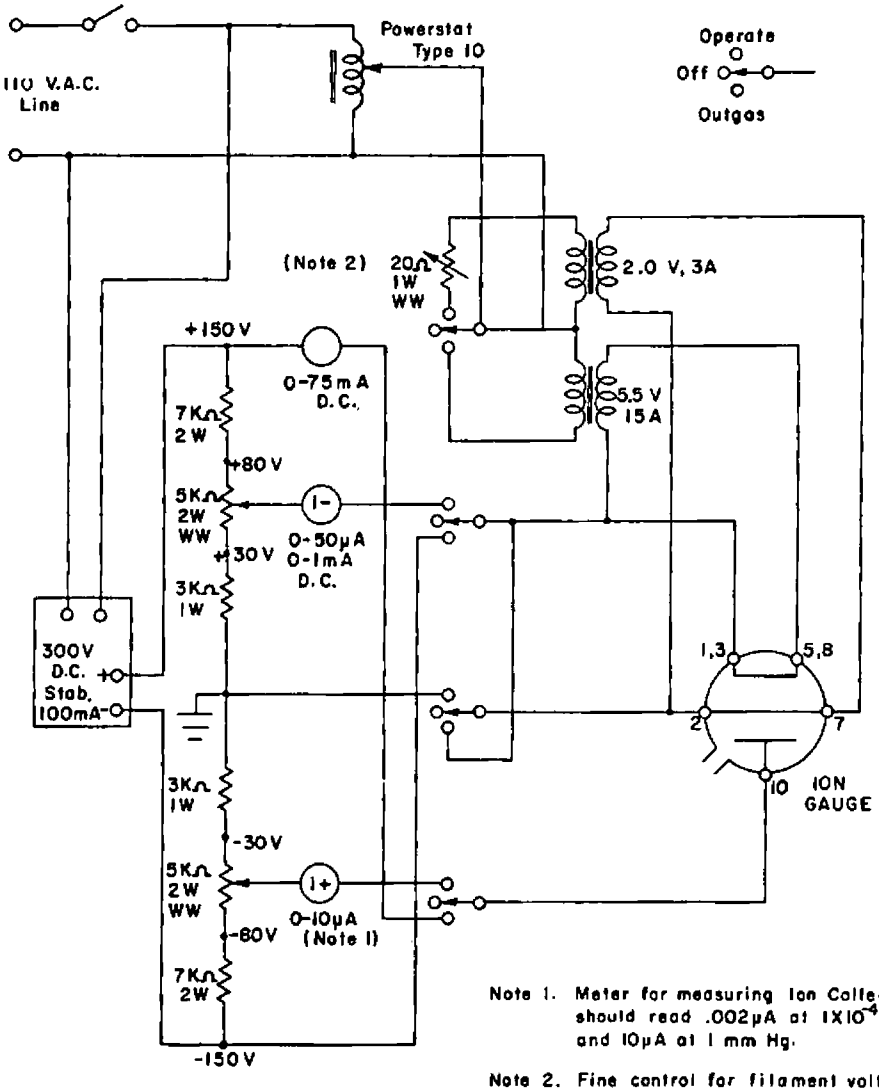
The circuitry for operation of the tube consists of suitable 60 V DC power supplies for each collecting electrode and a variable voltage filament supply. A meter with ranges from 10^{-5} to 10^{-3} ampere is required for measuring electron current and a sensitive microammeter with ranges from 10^{-8} to 10^{-5} amperes is required in the ion collector circuit. The filament power required is 2 volts at 2.5 amperes for operation and 5.5 volts at 13 amperes for outgassing. A circuit incorporating these features is shown in Figure 2. In this circuit, a 300 volt, 100 milliampere stabilized power supply is used.

For outgassing the full 300 V is used, the outgassing current being set by the outgassing filament temperature. The outgas filament voltage is adjusted by a variable auto-transformer.

During operation, the operating filament is connected to the center of a resistance chain across the power supply. The electron collector and ion collector are connected to potentiometers in the resistance chain, so that the ion collector is approximately 60 volts negative, and the electron collector approximately 60 volts positive with respect to the operate filament. The operate filament supply is controlled by a variable auto-transformer, with a series variable resistance which acts as a fine control.

Pressures over a wide range are covered. The cooling effect by the residual gas on the filament is considerable, resulting in changes in electron current. An operate circuit with an automatic filament control, in which a change in electron current is compensated by a change in filament voltage, is desirable as it permits continuous monitoring of pressure.

ION GAUGE POWER SUPPLY



Note 1. Meter for measuring Ion Collector should read .002μA at $1X10^{-4}$ mm Hg. and 10μA at 1 mm Hg.

Note 2. Fine control for filament voltage will give 2% variation.

CE-B1719

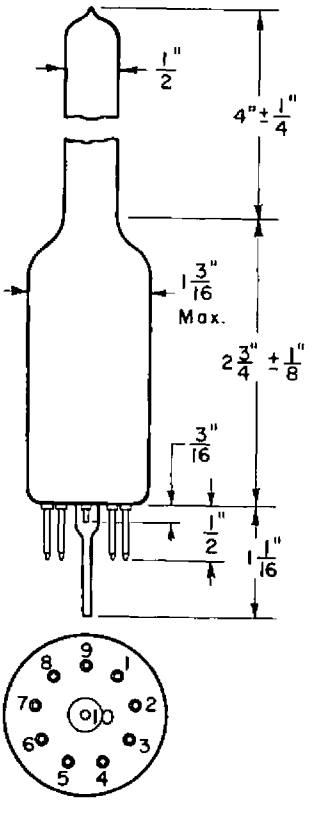
FIGURE 2

IONIZATION GAUGE TUBE TYPE 7904

The 7904 is an ionization type vacuum gauge for measurement of gas pressure in the range from 1×10^{-3} to 1×10^{-9} mm of mercury. The tube has a hard glass bulb with a one-half inch diameter pyrex tubulation.

The 7904 is a triode of the Bayard-Alpert inverted geometry design with three tungsten filaments. The filaments may be operated one at a time with two spares, two filaments in series or parallel with one spare, or three filaments in parallel. The grid structure is operated at a positive potential with respect to the filament while the ion collector is at a negative potential. As electrons are accelerated from the filament to the grid, they bombard and ionize gas molecules, and the resultant positive ions are attracted to the collector. The ratio of the collector current to the grid current is proportional to the gas pressure.

Outgassing of metal and glass parts is accomplished by connecting grid and collector together and passing a high current through the tube. Sufficient emission current for outgassing is obtained by adjusting filament voltage.



INDEX TO TERMINALS

1. Filament 1
2. Filament Common
3. Grid
4. Filament 2
5. Filament Common
6. Grid
7. Filament 3
8. Filament Common
9. Short Index Pin (NC)
10. Collector

ELECTRICAL:

Filament Material	Tungsten	
Filament:		
Voltage (ac or dc) (Approx.)	4	Volts
Current	1.5	Amperes

MECHANICAL:

Cooling Method	Free Air Convection
Bulb Diameter	1-3/16 Max.
Tubulation: (Note 1)	
Glass	Pyrex Corning Code 7740
Size	1/2" Diameter
Mounting Position	Vertical

MAXIMUM RATINGS:

Absolute Maximum Values

Ion Collector Voltage	−100	max.	Volts
Grid Voltage	+500	max.	Volts
Ambient Temperature	100	max.	°C
Gas Pressure (Power Applied)	1×10^{-3}	max.	mm Hg.

TYPICAL OPERATION: (Note 2)

Ion Collector Voltage	−30	Volts
Grid Voltage	+150	Volts
Grid Current	10	Ma.
Sensitivity	$1\ \mu a/10^{-5}$	mm Hg.

CONDITIONS FOR OUTGASSING ELEMENTS:

Ion Collector	Connected to Grid		
Grid Voltage	+500	max.	Volts
Filament:			
Series (Two Filaments)	10	max.	Volts
Parallel	5	max.	Volts
Grid and Collector Power	30	max.	Watts

1. Other ion gauges, similar to type 7904 but having different sizes and materials of tubulation, are available under different numbers.

2. The type 7904 is similar in construction to the type 5966. For a detailed description of the operation and application of Bayard-Alpert ion gauges, refer to 5966 data sheet.

Figure 1 is an example of a control circuit, using a thermocouple gauge, which prevents application of power to ion gauge when pressure is too high. Figure 2 is a simple ion gauge power supply which requires an adjustment every time a pressure reading is taken.

from JEDEC relese #3219, April 10, 1961

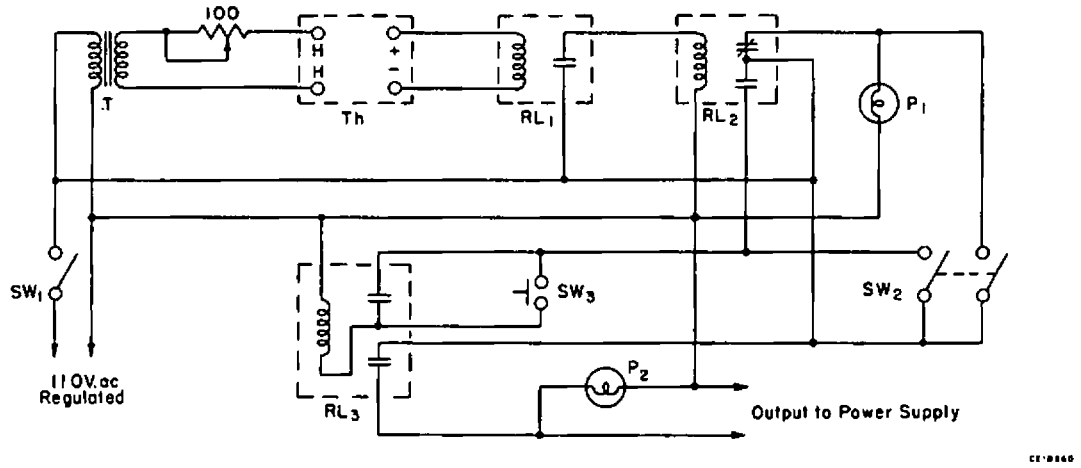


FIGURE 1

Resistor value in ohms

Th – Thermocouple: Type 7677 or equivalent
RL_1 – Sensitrol or equivalent
RL_2 – Weston 712 relay or equivalent
RL_3 – 115-volt relay
P_1 – 115-volt pilot lamp, red
P_2 – 115-volt pilot lamp, green
SW_1 – Switch
SW_2 – DPST switch
SW_3 – Manual start-reset (normally open push button)
T – Transformer: 110v primary; 6.3v, 1a. secondary

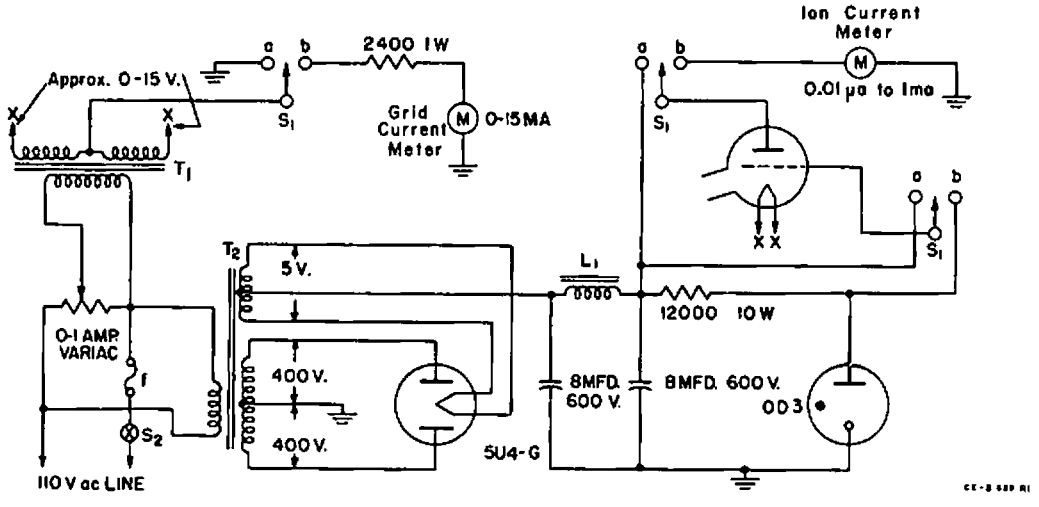


FIGURE 2

Resistor value in ohms

L_1 – Stancor C-1721 or equivalent
T_1 – UTC S70 or equivalent
T_2 – Stancor PM8412 or equivalent
S_1 – 3PDT switch (position a to outgas, position b to operate)

MULTIPLIER PHOTOTUBE TYPE 7908
FOR EXTREME ENVIRONMENTS

The type 7908 is a 10-stage 3/4" diameter multiplier phototube having a flat end-window photocathode with an S-11 spectral response. The 7908 is designed to render reliable service when subjected to the environmental extremes of temperature shock, temperature extremes, humidity, mechanical shock and vibration, altitude and elevated-temperature altitude tests contained in Military Specification MIL-E-5272. The 7908 further incorporates an integral, potted voltage-divider resistor network to achieve maximum compactness and reliability of associated equipment.

ELECTRICAL:	Min.	Avg.	Max.	
Spectral Response	--	S11	--	
Cathode Luminous Sensitivity with 200 Volts, d-c Between Cathode and All Other Electrodes	30	--	--	μA/Lumen
Anode Luminous Sensitivity with 105 Volts d-c/Stage	3	--	--	A/Lumen
Cathode Radiant Sensitivity at 0.44 Microns with 200 Volts Between Cathode and All Other Electrodes	--	0.045	--	μA/μWatt
Anode Dark Current with 105 Volts/Stage (25° C)	--	--	0.05	μAmpere
Current Amplification with 105 Volts/Stage	--	150,000	--	
Wavelength at Maximum Response	3900	4400	4900	Angstroms
Wavelength at 10% of Maximum Response on long Wavelength Side	5850	6125	6400	Angstroms
Wavelength at 10% of Maximum Response on short Wavelength Side	3000	3250	3500	Angstroms

MECHANICAL:

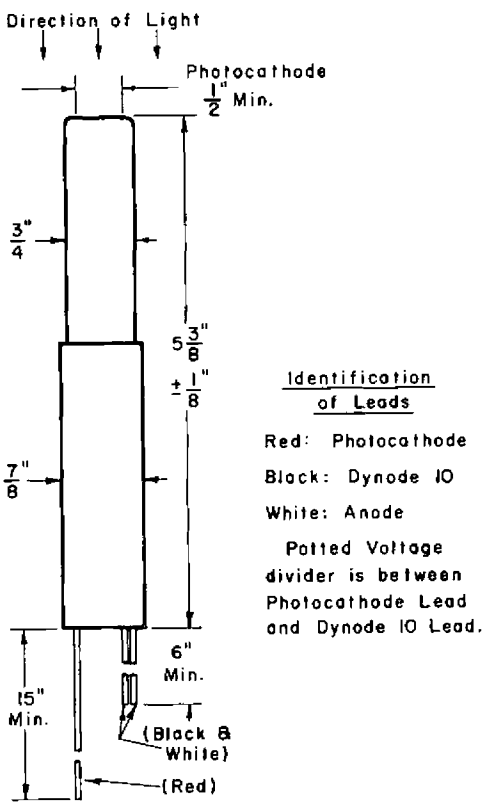
Window Diameter (Min.)	1/2"
Tube Diameter	7/8"
Overall Length (Excluding Leads)	5-3/8" ± 1/8"
Base	Potted Flexible Leads
Mounting Position	Any
Window Index of Refraction	1.5

MAXIMUM RATINGS:

Absolute Maximum Values

Peak Cathode Current (Note 1)	10	max.	μAmpere
Average Anode Current (Note 2)	1	max.	Ma.
Peak Anode Current	5	max.	Ma.
Average Anode Dissipation (Note 2)	0.5	max.	Watt
Peak Anode Dissipation	2.0	max.	Watt
Ambient Temperature	75	max.	°C

1. The cathode current given here is that current at which the response of the cathode current ceases to be a linear function of the light intensity because of cathode resistance. In general, the cathode current must be kept well below this value in order to satisfy the maximum ratings on the anode current.
2. Averaged over a 30 second interval maximum.



Identification of Leads

Red: Photocathode

Black: Dynode 10

White: Anode

Potted Voltage divider is between Photocathode Lead and Dynode 10 Lead.

from JEDEC release #3142, Feb. 13, 1961

MULTIPLIER PHOTOTUBE TYPE 7909

The type 7909 is a 3/4" diameter 10-stage multiplier phototube having a flat end-window photocathode with an S-11 spectral response. This type incorporates an integral, potted voltage-divider resistor network to achieve maximum compactness of associated equipment.

ELECTRICAL:	Min.	Avg.	Max.	
Spectral Response	--	S11	--	
Cathode Luminous Sensitivity with 200 Volts, d-c Between Cathode and All Other Electrodes	30	--	--	μA/Lumen
Anode Luminous Sensitivity with 105 Volts d-c/Stage	3	--	--	A/Lumen
Cathode Radiant Sensitivity at 0.44 Microns with 200 Volts Between Cathode and All Other Electrodes	--	0.045	--	μA/μWatt
Anode Dark Current with 105 Volts/Stage (25° C)	--	--	0.05	μAmpere
Current Amplification with 105 Volts/Stage	--	150,000	--	
Wavelength at Maximum Response	3900	4400	4900	Angstroms
Wavelength at 10% of Maximum Response on long Wavelength Side	5850	6125	6400	Angstroms
Wavelength at 10% of Maximum Response on short Wavelength Side	3000	3250	3500	Angstroms

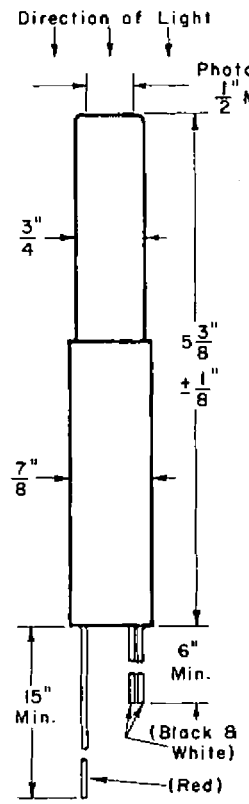
MECHANICAL:	
Window Diameter (Min.)	1/2"
Tube Diameter	7/8"
Overall Length (Excluding Leads)	5-3/8" ± 1/8"
Base	Potted Flexible Leads
Mounting Position	Any
Window Index of Refraction	1.5

MAXIMUM RATINGS:

Absolute Maximum Values

Peak Cathode Current (Note 1)	10	max.	μAmpere
Average Anode Current (Note 2)	1	max.	Ma.
Peak Anode Current	5	max.	Ma.
Average Anode Dissipation (Note 2)	0.5	max.	Watt
Peak Anode Dissipation	2.0	max.	Watt
Ambient Temperature	75	max.	°C

1. The cathode current given here is that current at which the response of the cathode current ceases to be a linear function of the light intensity because of cathode resistance. In general, the cathode current must be kept well below this value in order to satisfy the maximum ratings on the anode current.
2. Averaged over a 30 second interval maximum.



Identification of Leads

Red: Photocathode

Black: Dynode 10

White: Anode

Potted Voltage divider is between Photocathode Lead and Dynode 10 Lead.

from JEDEC release #3142, Feb. 13, 1961

Westinghouse

7982

May 8, 1961

LOW MU POWER TRIODE TYPE 7982

The 7982 is a three element tube designed for service as a modulator or AF amplifier. Electrical characteristics make it particularly suitable for Class AB_1 or AB_2 circuits. The anode is capable of dissipating 35 KW CCS with water cooling. The cathode is a single phase, thoriated tungsten filament.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament	
Filament:		
Voltage	7.0	Volts
Current	265	Amperes
Starting Current (max.)	1000	Amperes
Amplification Factor: Grid Volts = –450, Plate Amperes = 5.0	5.5	
Maximum Usable Cathode Current	60	Amperes
Direct Interelectrode Capacitances:		
Grid to Plate	78	μμf
Grid to Filament	68	μμf
Plate to Filament	7	μμf

MECHANICAL:

Mounting Position	Vertical, Anode Down
Type of Cooling (Note 3)	Water
Water Flow Required	30 GPM
Static Pressure (at 30 GPM)	8 PSI
Maximum Outlet-Water Temperature	70 °C
Maximum Grid and Filament Seal Temperature	180 °C
Net Weight	18 Pounds

MAXIMUM RATINGS:

Absolute Maximum Values

DC Plate Voltage	10	max.	Kilovolts
DC Plate Current	10	max.	Amperes
Plate Power Input (Note 1)	75	max.	Kilowatts
Plate Dissipation (Note 1)	35	max.	Kilowatts
Grid Dissipation	800	Max.	Watts

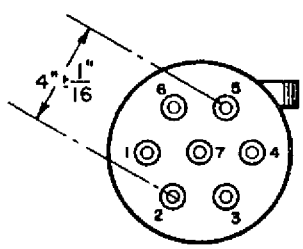
TYPICAL OPERATING CHARACTERISTICS:

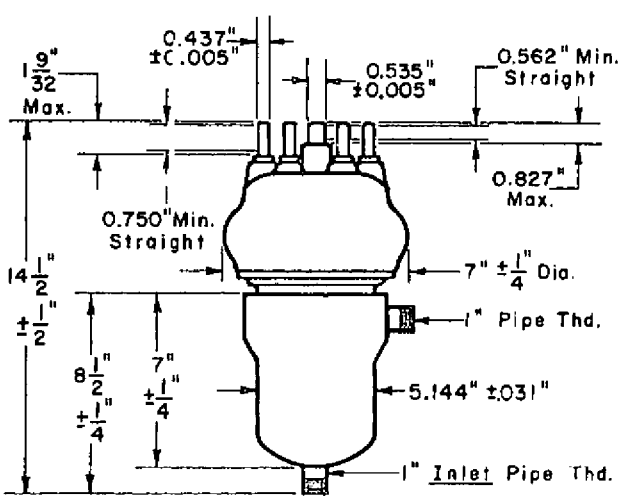
(Values for Two Tubes)

AF Power Amplifier & Modulator Service

Class AB_1 Operation				
DC Plate Voltage	8	9	10	Kilovolts
DC Grid Voltage	–1700	–1900	–2200	Volts
Peak AF Grid-to-Grid Voltage	3350	3750	4350	Volts
Zero Signal DC Plate Current	0.5	0.5	0.5	Amperes
Maximum Signal DC Plate Current	6.4	7.4	8.2	Amperes
Effective Plate-to-Plate Load Impedance	2400	2400	2400	Ohms
Driving Power	0	0	0	Watts
Maximum Signal Power Output	30	39.5	49.5	Kilowatts
Class AB_2 Operation				
DC Plate Voltage	8	9	10	Kilovolts
DC Grid Voltage	–1700	–1900	–2200	Volts
Peak AF Grid-to-Grid Voltage	3700	4100	4700	Volts
Zero Signal DC Plate Current	0.5	0.5	0.5	Amperes
Maximum Signal DC Plate Current	7.4	8.4	9.3	Amperes
Effective Plate-to-Plate Load Impedance	2400	2400	2400	Ohms
Driving Power	50	55	61	Watts
Maximum Signal Power Output	40	51	65	Kilowatts

Terminals	
F_1	6, 5
F_2	2, 3
F_{CT}	7
G	1, 4





High Vacuum Amplifier Section

from JEDEC release #3310, June 19, 1961

PULSE SERVICE

MAXIMUM RATINGS:

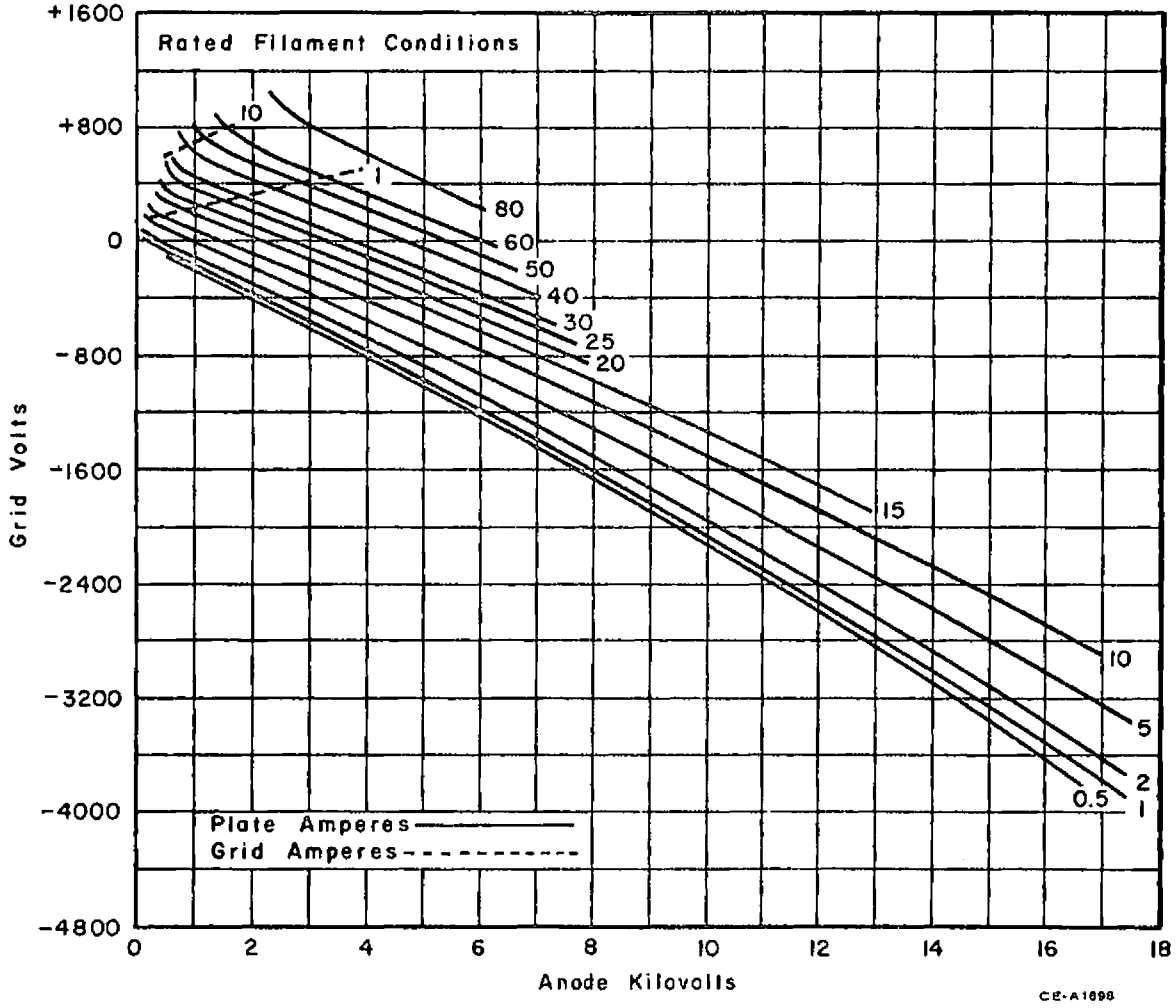
Absolute Maximum Values

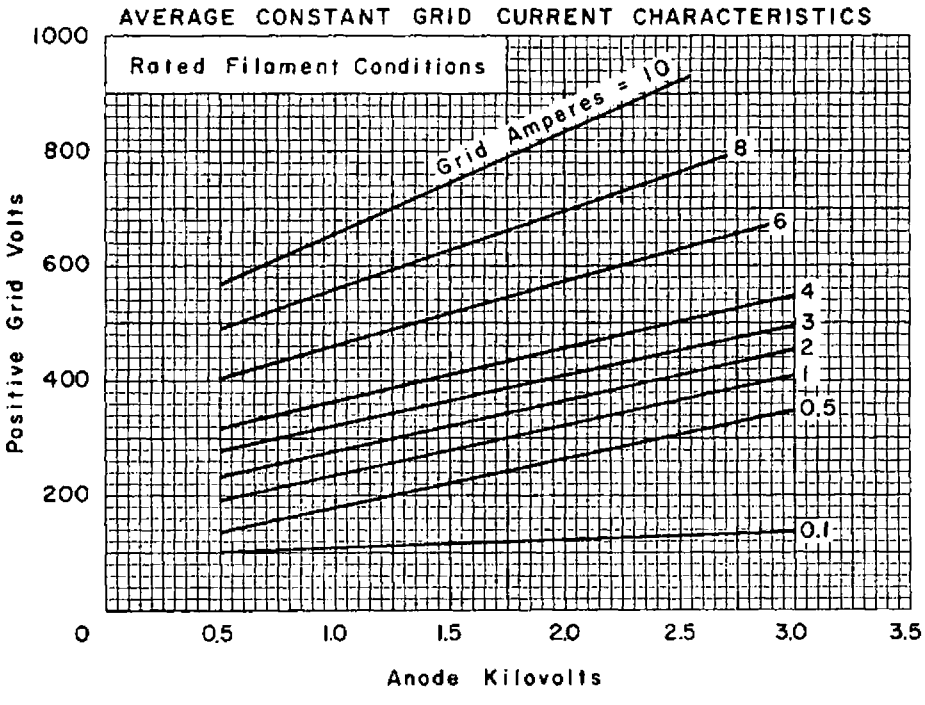
DC Plate Voltage	20	max.	Kilovolts
DC Grid Voltage	-6000	max.	Volts
Peak Positive Grid Voltage	2500	max.	Volts
Peak Pulse Plate Current	88	max.	Amperes
Peak Pulse Grid Current	12	max.	Amperes
Plate Dissipation	35	max.	Kilowatts
Grid Dissipation	800	max.	Watts
Pulse Length	1000	max.	μseconds
Duty Factor	0.01	max.	
Peak Pulse Cathode Current (Note 2)	100	max.	Amperes

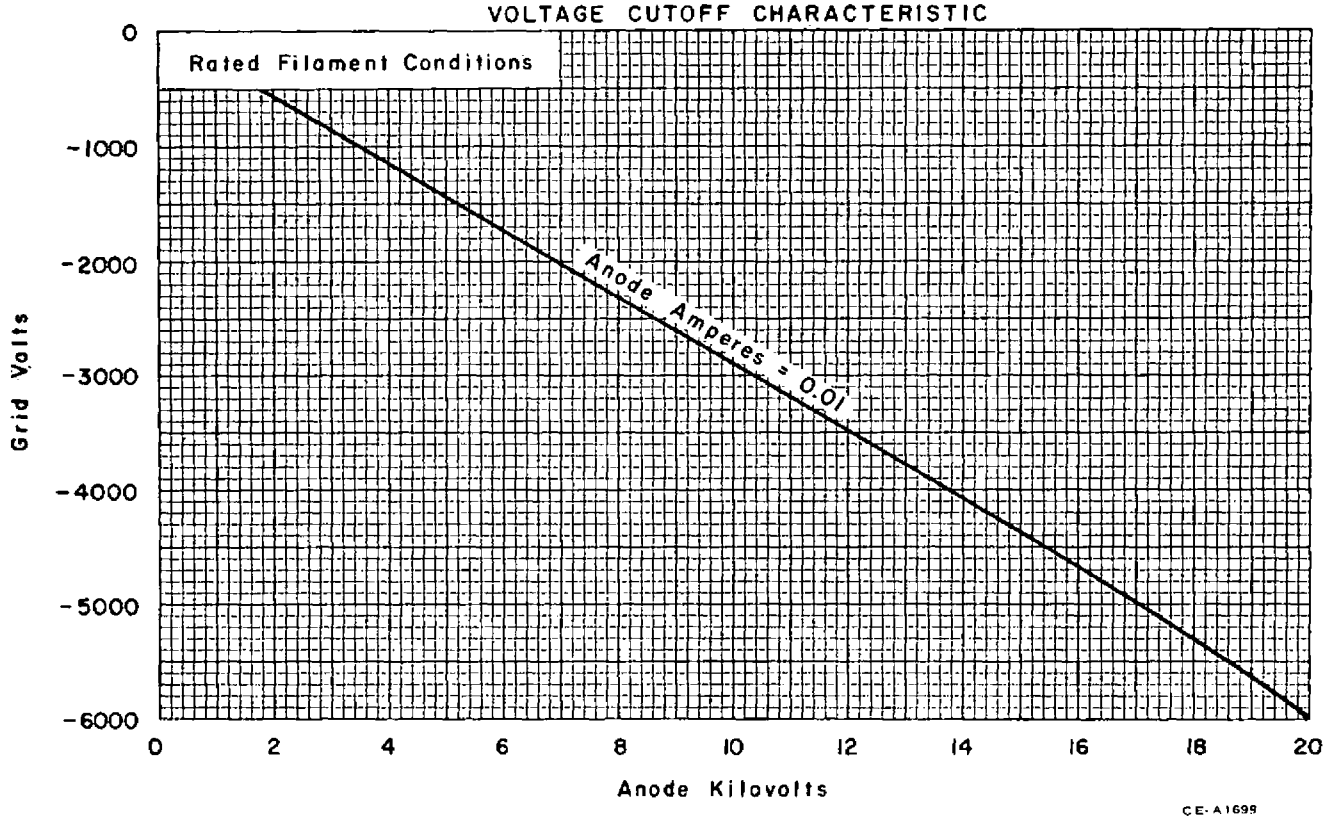
X-Ray Warning: The Maximum Ratings of the 7982 permit operation at voltages in excess of 16 KV. Therefore equipment design considerations should include the possible generation of soft x-rays.

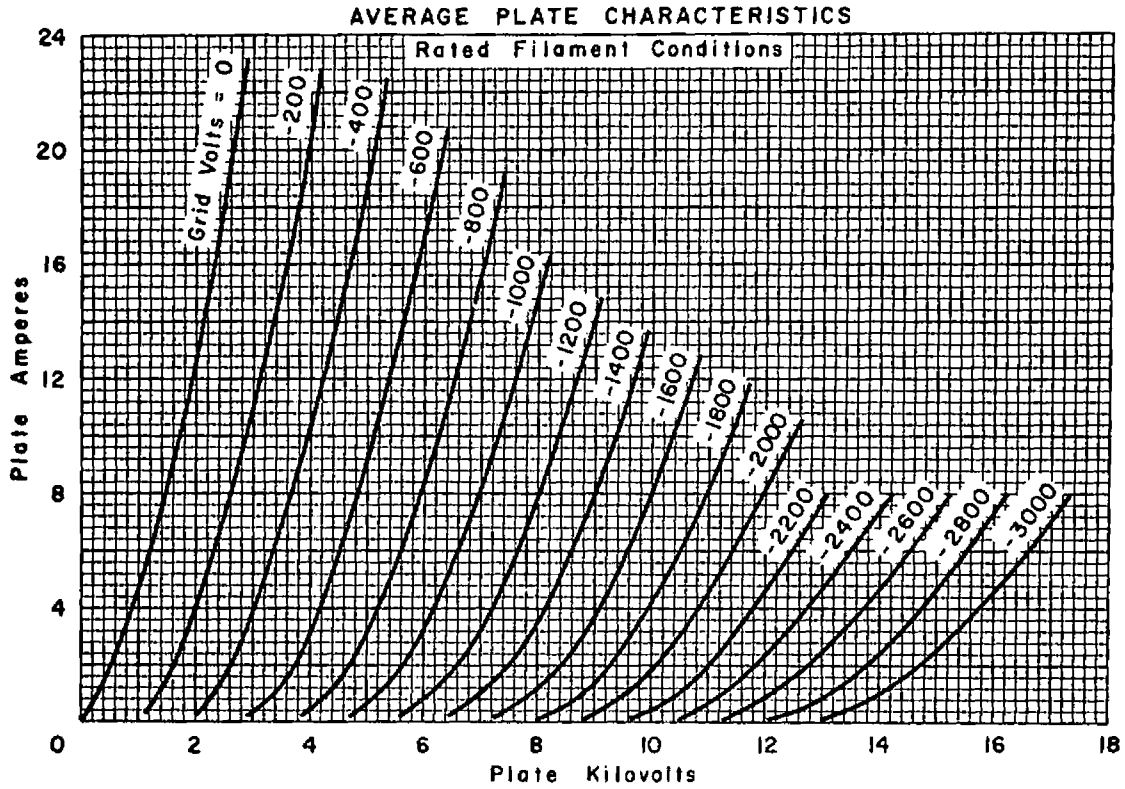
1. Averaged over any AF cycle of sine wave form.
2. A maximum of 160 amperes is permitted with 7.6 volts applied to filament. Continuous operation at elevated filament temperature will reduce length of service received.
3. 50 CFM air shall be directed on filament and grid seals.

AVERAGE CONSTANT CURRENT CHARACTERISTICS




AVERAGE CONSTANT GRID CURRENT CHARACTERISTICS
Rated Filament Conditions
Grid Amperes = 10
8
6
4
3
2
1
0.5
0.1
Positive Grid Volts
1000
800
600
400
200
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Anode Kilovolts
CE-A1697


VOLTAGE CUTOFF CHARACTERISTIC
Rated Filament Conditions
Anode Amperes = 0.01
Grid Volts
0
-1000
-2000
-3000
-4000
-5000
-6000
0
2
4
6
8
10
12
14
16
18
20
Anode Kilovolts
CE-A1698



CE-A1546

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THYRATRON TYPE 8043

The 8043 is a three-electrode mercury-vapor thyratron with negative control characteristics. The tube is designed for rectifier and industrial control service, especially in induction heating power supplies.

ELECTRICAL:

	Min.	Bogey	Max.	
Filament Voltage	4.75	5.00	5.25	Volts
Filament Current at Bogey Voltage	5.7	-	6.2	Amp.
Cathode Heating Time*	300	-	-	Sec.
Interelectrode Capacitance:				
Anode to Grid	-	10	-	uuf
Deionization Time, approx.	-	1000	-	usec
Ionization Time, approx.	-	10	-	usec
Anode Voltage Drop	-	15	-	Volts

MECHANICAL:

Type of Cooling▲	Air Convection
Mounting Position	Vertical, Base Down
Net Weight, approx.	11 Ounces
Shipping Weight, approx.	2 Pounds

MAXIMUM RATINGS:

Absolute Values

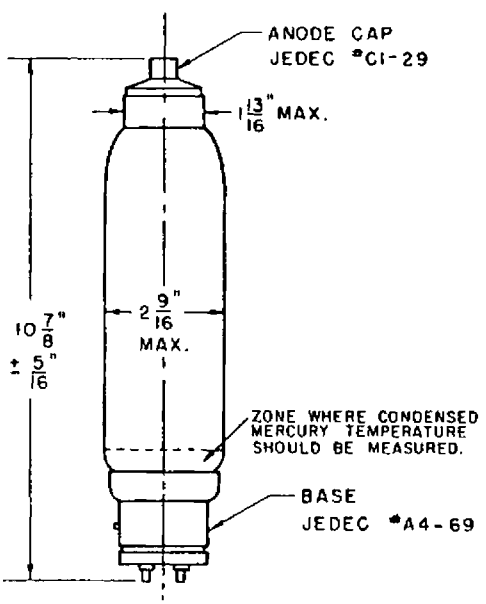
Maximum Peak Anode Voltage:			
Forward (see temperature range)	15000	21000	Volts
Inverse (see temperature range)	15000	21000	Volts
Maximum Cathode Current:			
Peak	7.5	7.5	Amp.
Average	2.0	2.0	Amp.
Surge (max. duration 0.1 second)	50	50	Amp.
Max. Average Time§	1.0	1.0	Cycle
Maximum Negative Control Grid Voltage:			
Before Conduction	-500	-500	Volts
During Conduction	-10	-10	Volts
Maximum Positive Control Grid Voltage:			
Anode Negative	10	10	Volts
Maximum Positive Control Grid Current:			
Peak	1.0	1.0	Amp.
Average	0.1	0.1	Amp.
Maximum Average Time§	1.0	1.0	Cycle
Condensed-Mercury Temperature Limits■	25-55	25-50	°C
Frequency Range	25-150	25-150	cps
Equilibrium Condensed-Mercury Temperature Rise Above Ambient:			
No Load, approx.	9		°C

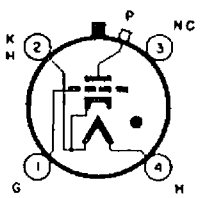
* The minimum heating time refers only to the cathode. Sufficient additional time must be allowed, during cold-weather periods, to permit the condensed-mercury temperature to rise to the minimum condensed-mercury temperature limit.

▲ Forced-air cooling will be required in many applications to maintain the condensed-mercury temperature within the specified condensed-mercury temperature limits.

■ The optium condensed-mercury temperature limits for 21000-volt operation are 35-45° C. For 15000-volt operation the optimum limits are 35-50° C.

§ One period of the supply frequency.





BASE CONNECTIONS

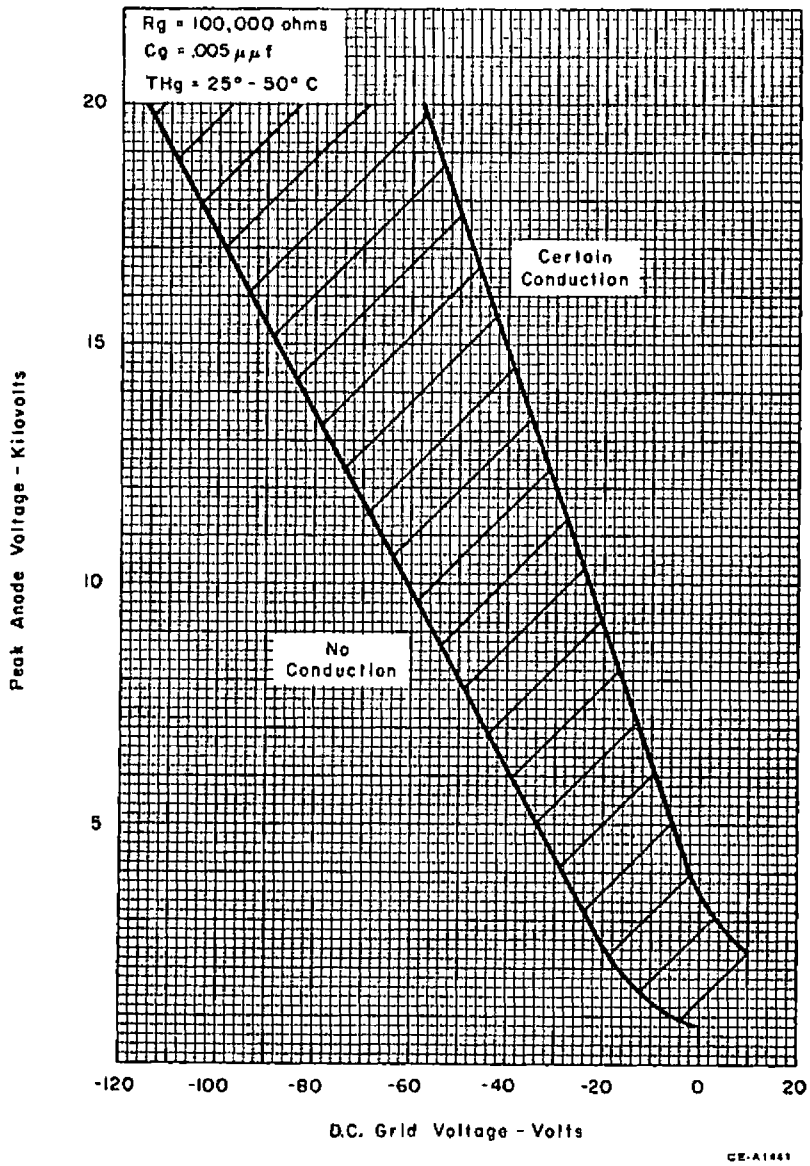
H - Heater
K - Cathode
G - Grid
NC - No Connection
P - Anode

CE-A1403

Thyratron Section

from JEDEC release #3247, April 24, 1961

CONTROL CHARACTERISTICS



Westinghouse

8044

June 15, 1961

HARD TUBE PULSE MODULATOR TYPE 8044

The 8044 is a three electrode tube designed for service as a hard tube modulator. The forced air cooled anode is capable of dissipating 20 kilowatts. The cathode is a single phase thoriated tungsten filament.

ELECTRICAL:

Cathode	Thoriated Tungsten Filament	
Filament:		
Voltage (d-c single phase a-c)	8	Volts
Current	185	Amperes
Heating Time (minimum)	15	Seconds
Amplification Factor	20	
Direct Interelectrode Capacitances:		
Grid to Plate	79	$\mu\mu f$
Grid to Filament	71	$\mu\mu f$
Plate to Filament	4	$\mu\mu f$

MECHANICAL:

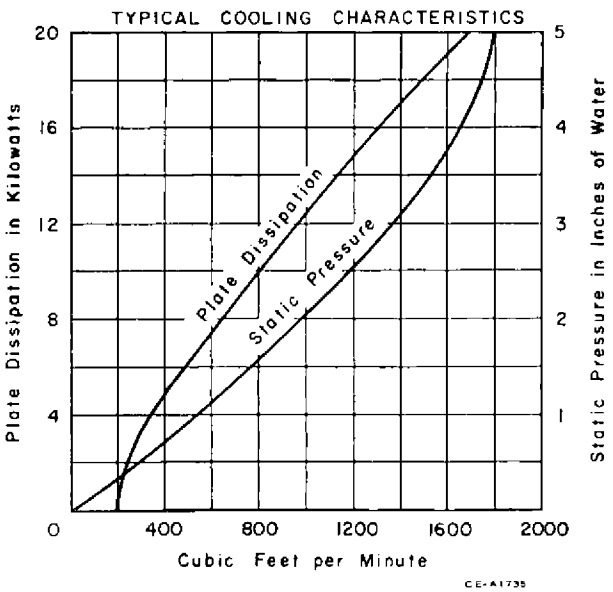
Mounting Position	Vertical, Anode Down		
Type of Cooling	Forced Air		
Required Air Flow Through Radiator:			
Plate Dissipation	10	20	Kilowatts
Air Flow	800	1700	CFM
Static Back Pressure (Max.)	2.0	4.5	In. H_2O
Maximum Bulb Temperature	180 °C		
Net Weight	72 Pounds		

MAXIMUM RATINGS:

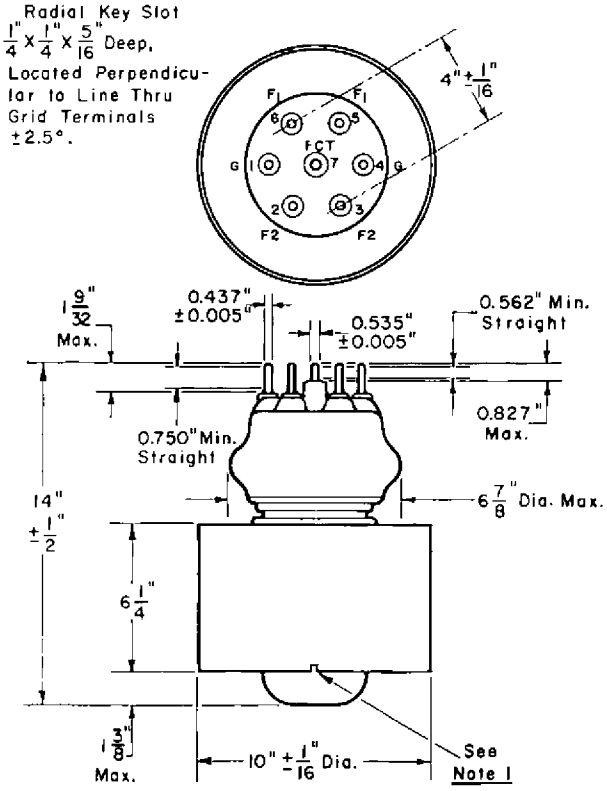
Absolute Maximum Values

DC Plate Voltage	30	max.	Kilovolts
DC Grid Voltage	−2500	max.	Volts
Peak Positive Grid Voltage	2000	max.	Volts
Peak Pulse Plate Current	80	max.	Amperes
Peak Pulse Grid Current	25	max.	Amperes
Plate Dissipation	20	max.	Kilowatts
Grid Dissipation	800	max.	Watts
Pulse Length	1000	max.	Microseconds
Duty Factor	0.02	max.	
Peak Pulse Cathode Current (Note 1)	105	max.	Amperes

1. Peak pulse cathode current of 200 amperes is allowable on pulses of 10 microseconds or less duration if filament is elevated to 10.0 volts.



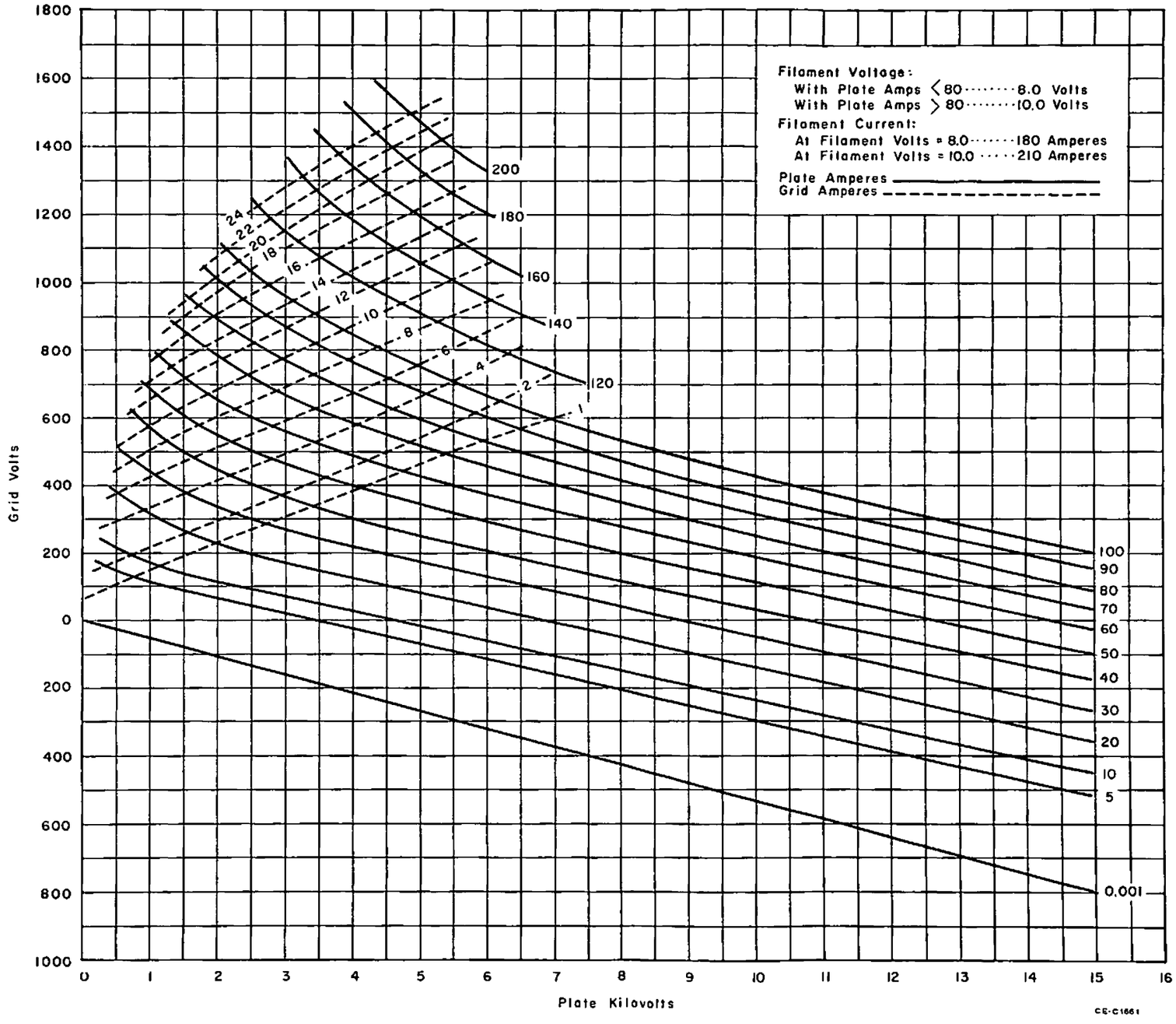
Note 1:
Radial Key Slot
$\frac{1}{4}$" X $\frac{1}{4}$" X $\frac{5}{16}$" Deep,
Located Perpendicular to Line Thru Grid Terminals ±2.5°.

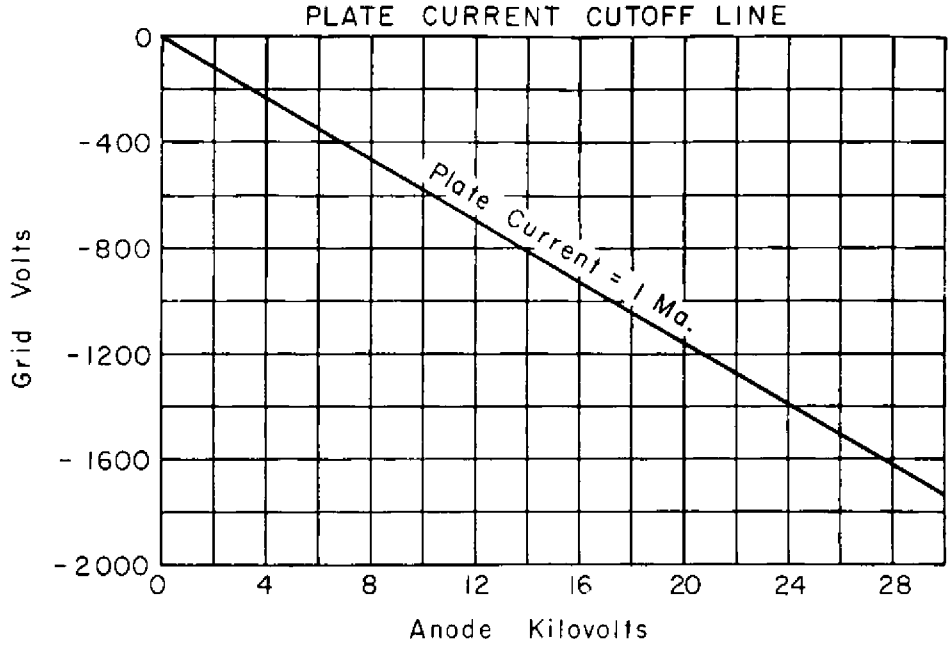


High Vacuum Amplifier Section

from JEDEC release #3342, July 17, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS





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LOW PRESSURE ION GAUGE TUBE TYPE 8057

The 8057 is an ionization type of vacuum-gauge tube for measurement of gas pressure as low as 10^{-9} mm of mercury. The tube has a hard glass bulb with a 3/4 inch diameter tubulation. The 8057 employs a Bayard-Alpert electrode structure having a minimum of metal surface for ease of out-gassing.

The 8057 is a triode having two tungsten filaments which may be operated singly, in series, or in parallel. The helical grid structure is made of non-sag tungsten and is easily outgassed by connecting it directly to a suitable A-C or D-C supply.

The grid structure is operated at a positive potential with respect to the filament while the ion collector is at a negative potential. Electrons are accelerated from the filament to the grid; they bombard and ionize gas molecules, and the resultant positive ions are attracted to the collector. The ratio of the collector current (positive ion current) to the grid current is proportional to the gas pressure.

ELECTRICAL:

Filament Type	Tungsten
Filament Voltage (1 Filament)	Approx. 7 AC or DC Volts
Filament Current (1 Filament)	2.5 ± 8% Amperes

MECHANICAL:

Maximum Tube Length	5-1/4"
Maximum Bulb Diameter	2-1/16
Tubulation:	
Size	3/4 Inch
Material	Nonex (Corning Code 7720)
Mounting Position	Vertical

MAXIMUM RATINGS:

Absolute Maximum Values

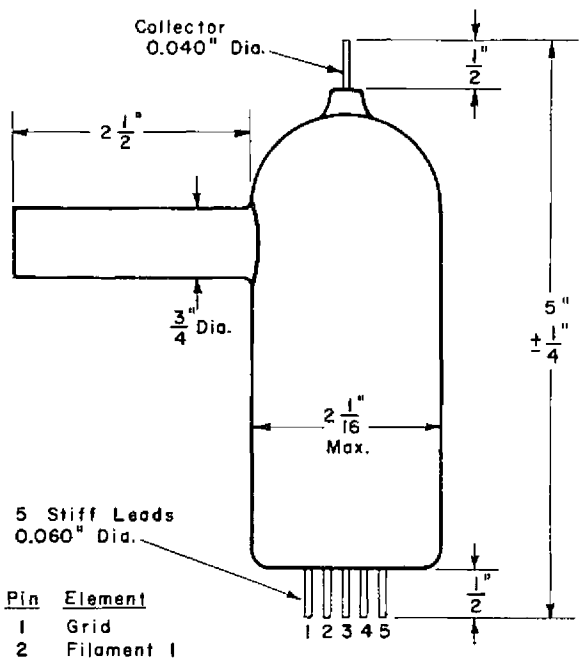
Ion Collector Voltage	−100	max.	Volts
Grid Voltage	+500	max.	Volts
Ambient Temperature	100	max.	°C
Gas Pressure	0.001	max.	mm Hg.

Typical Operation:

Ion Collector Voltage	−30	Volts
Grid Voltage	+150	Volts
Grid Current	10	Ma.
Sensitivity	1μa/10^{-9}	mm Hg.

Conditions For Outgassing Grid:

Grid Voltage	Approx.	6 to 7	Volts
Grid Current	Approx.	9 to 10	Amperes



Pin	Element
1	Grid
2	Filament 1
3	Filament Common
4	Filament 2
5	Grid

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from JEDEC release #3378, Aug. 21, 1961

DIRECT VIEW STORAGE TUBE TYPE WL-8067

One Writing Gun
Viewing Gun
Integral Tube and Shield Assembly

4" Display Diameter
5-1/4" Overall Diameter
14-7/8" Overall Length

The WL-8067 is a display storage tube with high writing speed and moderate brightness. It is capable of electrically writing and storing a bright, flicker-free display on a 4 inch diameter fluorescent screen.

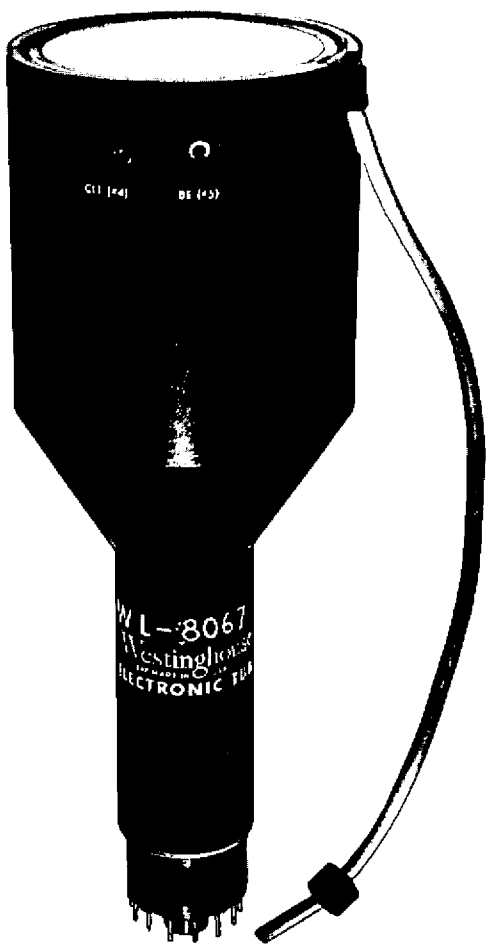
The viewing screen requires 10 kilovolts and the brightness exceeds 2000 foot-lamberts with a writing speed of 100,000 inches per second. The WL-8067 has a storage time of 30 seconds which permits storage and display of very high speed transients for liesurely examination. In applications of this type and others having written information of a repetitive character, the ability of the tube to integrate successive weak signals is of great utility.

Longer storage periods may be obtained by pulsing the flood gun. If the pulse rate is high enough, no flicker will be observed. In this manner, storage times up to 30 minutes may be achieved with some loss of brightness. The display would still be clearly legible in a lighted room.

The WL-8067 is suitable for applications such as airborne fire-control and navigational radar, weather radar, airport surveillance, transient studies and visual-display element in narrow-band-width data transmission systems.

The WL-8067 is designed for military use and is therefore capable of meeting appropriate military specifications. The entire tube is potted within a salt spray resistant magnetic shield with a synthetic silicone rubber material. Protection against mechanical shock, vibration, humidity and leakage between bulb terminals is thereby achieved.

One writing gun and a flood gun are mounted in the WL-8067. The writing gun has electrostatic focus and deflection.



OPTICAL:

Phosphor:	
Type	High Visual Efficiency, Aluminized P20
Fluorescence	Yellow-Green
Phosphorescence	Yellow-Green
Persistence	Short
Faceplate	Optical Glass, Ground and Polished Flat

MECHANICAL:

Minimum Useful Viewing Diameter	4"
Maximum Overall Length	14-7/8"
Maximum Seated Length	14-1/4"
Greatest Shield Diameter	5-1/4" ± 1/16"
Viewing Screen Terminal	AMP #832692-19
Caps on Large End of Bulb	
Backing Electrode	Recessed Small Ball (JEDEC J1-22)
Collector Electrode	Recessed Small Ball (JEDEC J1-22)
Collimating Electrode	Recessed Small Ball (JEDEC J1-22)
Base	14 Pin Small Diheptal (JEDEC B14-45)
Mounting Position	Any

from JEDEC release #4122, Feb. 4, 1963

ELECTRICAL:

Storage:

Type	Half-Tone or Line
Mode	Control of Transmission
Type of Erasure	Overall

Write Gun:

Cathode			Coated Unipotential	
Heater:	Min.	Bogey	Max.	
Voltage (ac or dc)	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Amperes
Focusing Method			Electrostatic	
Deflection Method			Electrostatic	

Flood Gun:

Cathode			Coated Unipotential	
Heater:	Min.	Bogey	Max.	
Voltage	5.67	6.3	6.93	Volts
Current	0.50	0.60	0.70	Ampere
Warm-up Time before Applying High Voltages	30	--	--	Seconds
Focus and Deflection	Undeflected, Collimated "Flood" Gun			

Direct Interelectrode Capacitances:

External Integral Shield Grounded

Writing Gun Grid 1 to All Internal Elements	8 max.	$\mu\mu f$
Deflection Electrode 1 to All Internal Elements	8 max.	$\mu\mu f$
Deflection Electrode 2 to All Internal Elements	8 max.	$\mu\mu f$
Deflection Electrode 3 to All Internal Elements	8 max.	$\mu\mu f$
Deflection Electrode 4 to All Internal Elements	8 max.	$\mu\mu f$

MAXIMUM RATINGS:

Absolute Maximum Values

Write Gun:

(Reference Voltage is Write Gun Cathode)

Grids 2 & 4 Voltage♦	3000	max.	Volts
With Respect to Flood Gun Cathode	200	max.	Volts
Grid 3 Voltage (Focus)	2000	max.	Volts
Negative with Respect to Flood Gun Cathode	2600	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	200	max.	Volts
Positive Bias Value	0	max.	Volts
Positive Peak Value	2	max.	Volts
Cathode Voltage Negative with Respect to Flood Gun Cathode	2800	max.	Volts
Voltage Between any Deflection Electrode and Grids 2 & 4: ♦			
Positive or Negative Peak Value	500	max.	Volts
Peak Heater-Cathode Voltage:			
Heater Positive or Negative with Respect to Cathode	125	max.	Volts

Flood Gun:

(Reference Voltage is Flood Gun Cathode)

View Screen Voltage	11,000	max.	Volts
Grid 5 Voltage (Backing Electrode)	35	max.	Volts
Grid 4 Voltage (Collector Electrode)	300	max.	Volts
Grid 3 Voltage (Collimating Electrode)	200	max.	Volts
Grid 2 Voltage (Accelerating Electrode)♦	200	max.	Volts
Grid 1 Voltage:			
Negative Bias Value	200	max.	Volts
Positive Bias Value	0	max.	Volts
Peak Heater-Cathode Voltage			
Heater Positive or Negative with Respect to Cathode	125	max.	Volts

LIMITING CIRCUIT VALUES:

View Screen Series Current-Limiting Resistance	1.0	min.	Megohm
Backing Electrode Circuit Resistance	5000	max.	Ohms
Collector Electrode Unbypassed Series Current-Limiting Resistance	22000	min.	Ohms
Grid 1 Circuit Resistance	1.0	max.	Megohm
Resistance in Any Deflecting Electrode Circuit⊕	0.1	max.	Megohm

ENVIRONMENTAL LIMITS:

Atmospheric Pressure	45	max.	P.S.I.
Altitude (Non-pressurized)	60,000	max.	Feet
Temperature:			
Operating	−35 to +71		°C
Non-Operating	−62 to +85		°C
Relative Humidity (Non-Operating)	95		Percent

Vibration . . . . . Sinusoidal Vibration from 5 to 18 cycles per second with a total excursion of 0.30 inches and from 18 to 500 cycles per second with 3 g acceleration will not damage the tube.

TYPICAL OPERATING CONDITIONS AND CHARACTERISTICS

Note: Damage to the tube may occur if the Write-Gun beam is turned on before the Flood-Gun-beam current has reached normal operating value or if the Flood-Gun beam is turned off before the Write-Gun beam.

Reference Point for DC Voltages is Ground

Write Guns:

Grids 2 & 4 Voltage♦	0 to 200	Volts
Grid 3 Voltage (Focus)	−2000 to −2300	Volts
Grid 1 Voltage to Writing Gun Cathode	0 to −70	Volts
Cathode Voltage	−2400	Volts
Grids 2 & 4 Current	100	μampere
Grid 3 Current (per gun)	−10 to 5	μampere
Cathode Current	See Gun Transfer Characteristic	
Deflection Factors		
Deflection Electrodes 1 and 2♦	72 to 88	V dc/In.
Deflection Electrodes 3 and 4♦	72 to 88	V dc/In.
Focused Beam Position†	0.5	Inch

Flood Gun:	Range	Typical	
View Screen Voltage	8000 to 10,000	10,000	Volts
Grid 5 Voltage (Backing Electrode)	−	2	Volts
Grid 4 Voltage (Collecting Electrode)	150 to 300	250	Volts
Grid 3 Voltage (Collimating Electrode)	5 to 150	80	Volts
Grid 2 Voltage♦	90 to 110	100	Volts
Grid 1 Voltage	0 to −50	0	Volts
Cathode		Grounded	
View Screen Current		250	μamperes
Grid 5 Current (Backing Electrode)		2	μamperes
Grid 4 Current (Collector Electrode)		1.5	Ma.
Grid 3 Current (Collimating Electrode)		200	μamperes
Cathode Current		2	Ma.

NOTES

♦ Adjust for astigmatism control.

♦ For other values of cathode to Grids 2 & 4 Voltages, the deflection factor is approximately 32 ± 10% V dc/In./KV of cathode to Grids 2 & 4 Voltage.

† With all deflection electrodes tied to Grids 2 & 4, and erasure at a convenient value the undeflected, focused spots will fall within a circle of 0.5 inch radius, centered on the tube faceplate.

⊕ Approximately equal resistances should be used in each deflection electrode circuit

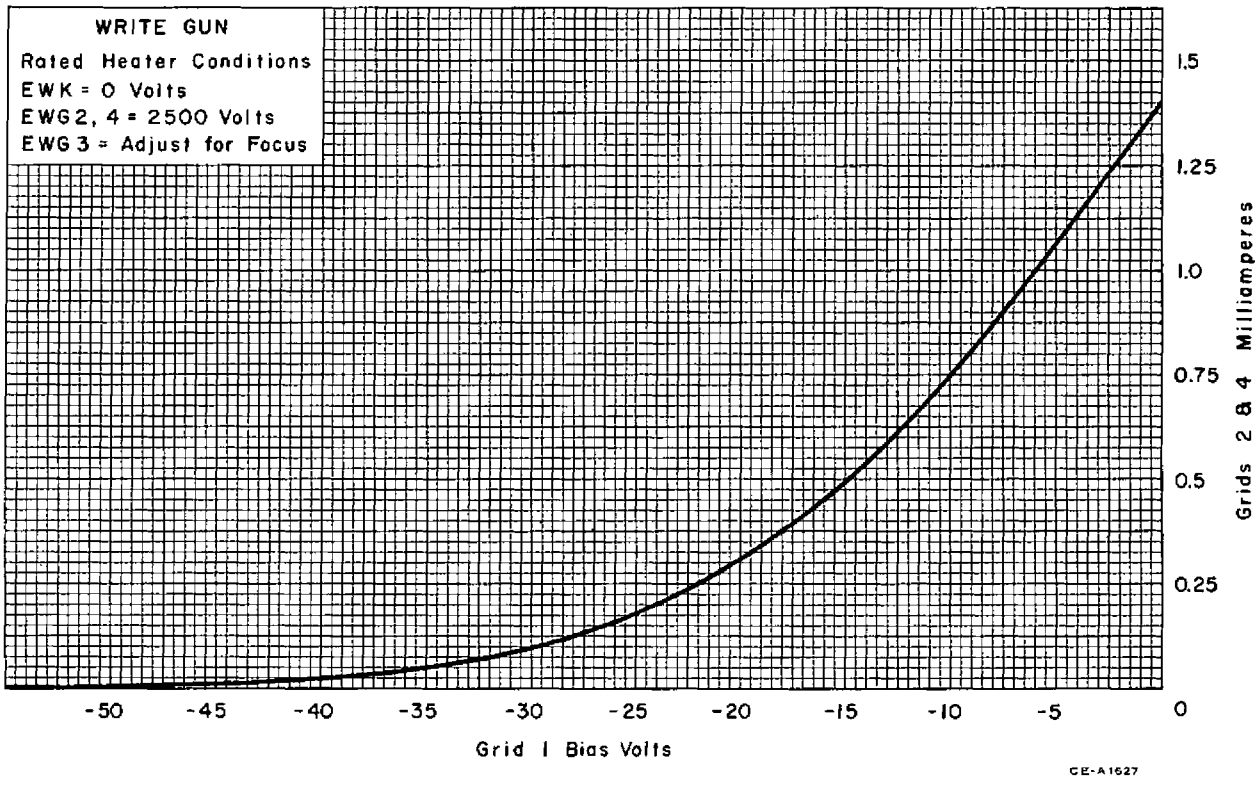
THE PRIME OPERATION

The tube is said to be primed when the entire surface of the storage dielectric is charged uniformly to flood-gun-cathode potential. The backing electrode/storage grid then has minimum cutoff effect on the flood beam electrons and the entire viewing screen is uniformly illuminated to saturation brightness. If the storage surface is then erased to cutoff by applying a positive pulse train to the backing electrode, the flood beam electrons will just be prevented from passing through to the viewing screen. The surface, then, will be completely free of past history. This is the starting point for all accurate measurements on the tube.

The fastest and most effective method of priming the surface is by momentarily increasing the backing electrode potential by about 200 volts. This can most conveniently be done by switching the backing electrode lead to collector potential, leaving it there one or two seconds then switching it back to its own potential of 10 volts.

One note of caution; because the flood gun beam current reaches a maximum value during the time when the two electrodes are connected together, they should not be allowed to remain so connected for long periods (over 10 or 15 seconds). Leaving the tube in the prime condition for extended periods will result in a loss of light output due to viewing screen damage and in temporary reduction in viewing duration due to evolution of excessive amounts of gas from the viewing screen. Viewing duration can be restored by leaving the tube in the erase mode for 15 or 20 minutes - allowing the getters to absorb the excess gas, but any damage to the viewing screen cannot be repaired.

AVERAGE WRITE GUN ANODE TRANSFER CHARACTERISTIC



PERFORMANCE DATA

Viewing Time	30	Seconds
Erasing Time (Flood Gun Erasure)	50	Milliseconds
Display Uniformity (Δe_p min.)	2	Volt
Writing Speed	100,000	Inches/Second
Half Tones	4	
Brightness (Screen Voltage = 5 KV)	2000	Ft-Lamberts
Contrast Ratio	10	
Resolution	50	Lines/Inch
Grid Drive	30	Volts

Methods of Measuring Tube Performance

Viewing Time: Viewing duration is the time during which the visual output of a storage tube increases from exactly visual extinction to 10% of saturated brightness without the application of a writing signal or erase pulses. The tube shall be primed and then erased to exactly visual extinction. The erase pulses are removed and the screen allowed to increase in brightness. The time interval required for the brightness level at the center of the screen to increase to 10% of saturated brightness is the viewing duration.

Erasing Time: The storage surface is primed. Erasure is produced by a positive rectangular pulse applied to the backing electrode. The amplitude of this pulse is set to one volt above backing electrode cutoff and the pulse width necessary to erase from saturated brightness to 10% of saturation brightness is the erasing time.

Display Uniformity (Δe_p min.): The difference between the amplitude of an erase pulse required to brighten any area of an unwritten screen, and the amplitude of an erase pulse required to evenly illuminate the screen is described as the display uniformity, (Δe_p min.). The erase pulses used for this measurement are positive rectangular pulses adjusted from 2 to 10 volts peak to peak to produce complete erasure in 50 milliseconds.

Writing Speed (Cathode Current): A raster is applied having frequencies and trace length necessary to produce a scanning speed of 100,000 inches per second. The focus electrode is adjusted for best focus at the center of the raster. The tube is erased to cutoff and a single raster is written by applying a rectangular pulse of adjustable amplitude to Grid 1 of the writing gun. The last step is repeated moving the lines of the raster progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the control grid pulse amplitude is adjusted to give a written raster of 2000 ft-L. When this brightness is achieved and the lines cannot be discerned visually, the condition of visually limited contrast ratio exists and it is under this condition that the cathode current is measured.

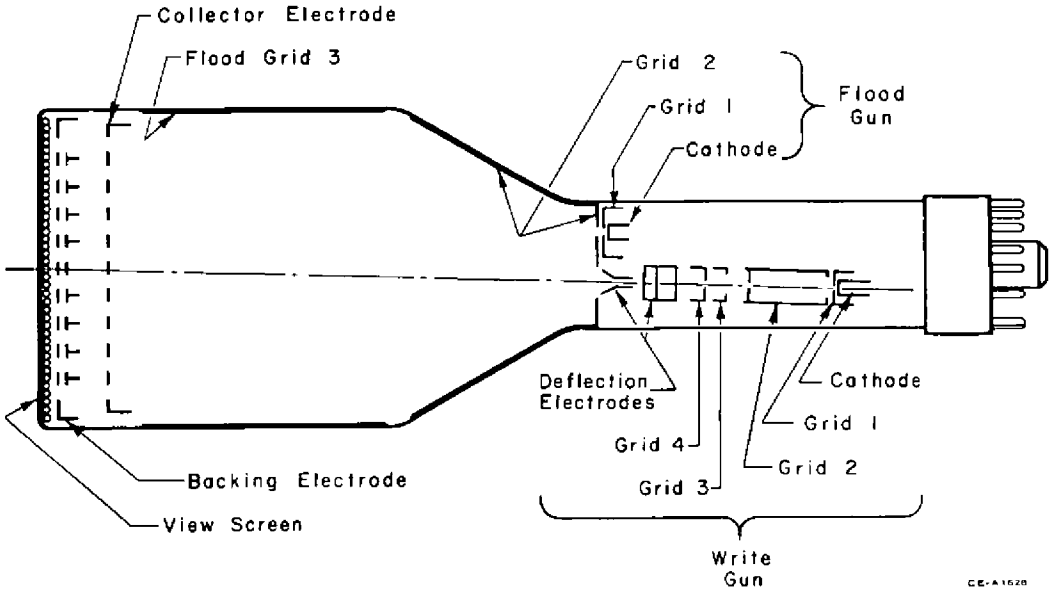
Contrast Ratio: A trace is written to saturation brightness while continuously writing and erasing. Using positive rectangular erase pulses variable from 2 to 10 volts peak-to-peak, the persistence (time required for a written area to be reduced to 10% of saturated brightness) is adjusted to 2 seconds. The ratio of brightnesses in the written and unwritten areas is defined as the contrast ratio. This measurement is made with a maximum ambient brightness of 10 foot-lamberts.

Resolution: A 60 cps sawtooth voltage is applied between deflecting electrodes D_3D_4 and a 2100 to 6300 cps sawtooth voltage is applied between deflecting electrodes D_1 and D_2 giving a raster of approximately 40 lines. Blanking is used to eliminate trace return lines. Trace length shall be adjusted to 3.5 inches. Raster is expanded and number of lines determined. Focus electrode is adjusted for best focus at the center of the raster. Backing electrode is erased to cutoff and G_1, writing gun, is pulsed to write a single raster. Last step is repeated moving the lines progressively closer together until the individual lines in the written raster cannot be discerned visually. As the lines approach the merging condition, the grid pulse amplitude shall be adjusted to give brightness of 1800 ft-L. When the specified brightness is achieved and the lines cannot be discerned visually, the condition for visually limited contrast ratio exists, and the resolution measured at this condition is the limiting resolution.

The resolution in lines per inch is the number of horizontal lines counted when the raster was expanded divided by the height of the compressed raster.

Grid Drive: This is the drive required for writing to 90% of saturated brightness with a writing speed of 100,000 inches per second in 1 scan. Note the writing gun drive characteristic. In the useful region, writing speed is proportional to writing current.

CROSS SECTION VIEW



Principles of Operation

The WL-8067 contains, in addition to a phosphor screen and a write gun similar to that of a conventional cathode-ray tube, a storage surface, a secondary-electron collimating system, all of which can be seen in Cross Section View.

The storage surface is a dielectric material deposited on a fine metallic mesh called the backing electrode. Initially this surface is charged to a uniform potential near the flood gun cathode voltage. The write gun scans the storage surface and creates a charge pattern by secondary emission from the dielectric material. Because this dielectric material is an excellent insulator, the charge pattern does not leak away, but remains for a period of time, as long as a week under non-operating conditions. The secondary electrons liberated from the storage surface are attracted to a collecting mesh.

The reading or flood gun does not scan the screen, but produces a wide-angle beam of electrons which "floods" the entire storage mesh and penetrates through its holes to bombard the phosphor screen. The charge pattern written upon the storage surface controls the flood gun beam in a manner similar to the control of plate current by the signal applied to the control grid of a triode. In this way the signals applied to the write gun are converted to patterns on the storage surface, and these produce corresponding patterns on the phosphor screen. The penetration of electrons through the storage mesh is proportional to the charge written upon it, hence, intermediate shades of gray or half-tones may be reproduced. Because of the high current density of the flood beam, the high accelerating potential on the screen, and simultaneous bombardment of all portions of the view screen, the display is extremely bright.

The Viewing Section

The viewing section consists of the following elements: a cathode, control grid, accelerating grid, collimating electrode, collector electrode, backing electrode, and viewing screen.

The cathode is oxide coated and indirectly heated. Grids 1 and 2 are conventional aperture grids and the collimating electrode grid 3 is a conductive coating applied to the bulb wall. The collector electrode is a fine metallic mesh mounted slightly toward the cathode from the backing electrode.

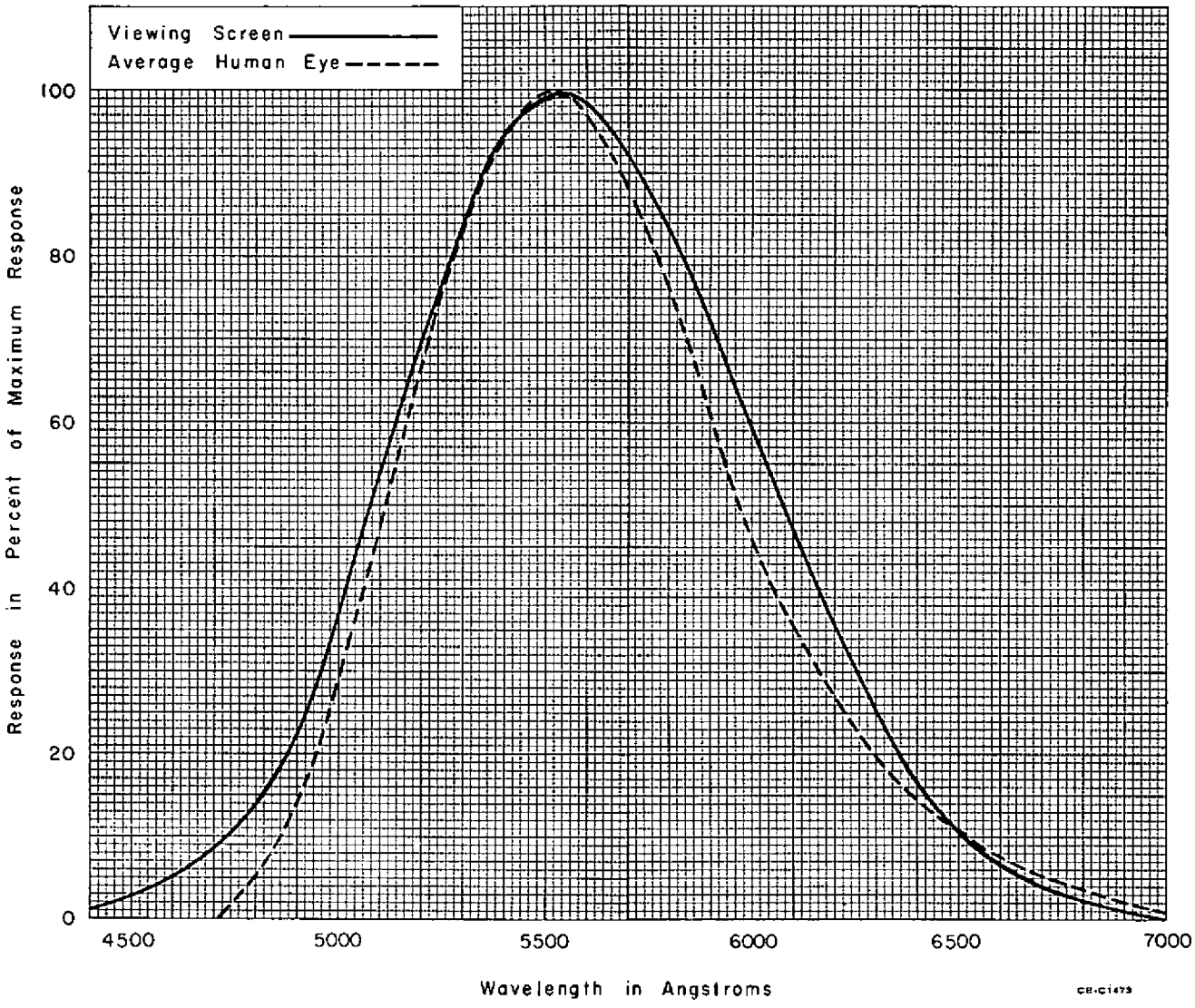
The backing electrode is an extremely fine metallic mesh upon which the dielectric or storage material is deposited. This material is on the cathode side of the mesh as shown in Cross Section View.

The view screen is an aluminized P20 phosphor having short persistence and high visual efficiency. The Spectral Response Curves show that the peak radiation from this phosphor coincides with the peak sensitivity of the human eye.

The Viewing Operation

The flood gun produces a wide angle, low energy, high density electron stream which continuously floods the storage surface. The electrons are highly divergent as they emerge from the aperture of the accelerating grid no. 2, but by proper adjustment of grids no. 2, 3, and 4, the electron stream is collimated to provide uniform, normal flooding of the backing electrode. It is necessary that all of the electrons of the viewing beam approach the storage surface in paths normal to the backing electrode in order that they will have equal energy components in this direction. Only under this operating condition will equal charges at various points on the storage surface have equal control of the flood beam. Thus, collimation is necessary for uniformity of display.

SPECTRAL RESPONSE CHARACTERISTICS



The functions of the collector electrode are several. In addition to its effect upon collimation, it serves to accelerate electrons in the beam; it repels positive ions produced by collisions of electrons with gas molecules in the region between cathode and collector, thus preventing destruction of the stored pattern by ions; it collects secondary electrons produced when the writing beams impinge upon the storage surface; and it collects viewing beam electrons turned back near the storage surface when its potential is negative.

When the flood section voltages are applied, some of the flood beam electrons are intercepted by the collector mesh, and others are decelerated to near zero velocity at the storage grid. Their velocity is so low at this point that fewer secondary electrons are emitted than strike the storage surface. Thus electrons accumulate until the potential is approximately the same as the flood gun cathode, or zero potential.

At this time when the collimated flood beam approaches the storage mesh, electrons cannot land upon the storage mesh, but will either return to the more positive collector electrode or penetrate through the holes of the backing electrode to be accelerated to the phosphor view screen producing a bright display. The brightness of the screen under this condition is designated as "saturated brightness" A condition of equilibrium exists, and the storage surface remains charged to approximately zero potential. It the storage surface is made positive by a write gnn or other means, the surface will be immediately restored to zero potential by the flood gun beam. If, now the backing electrode is suddenly made more positive by several volts, the storage surface will also become positive momentarily because of the very close capacitive coupling between the backing electrode and storage surface, but again the viewing beam will restore the storage surface to zero potential. It next the backing electrode is returned to its original value, the storage surface potential will drop by an equal amount to a negative potential and will retain this charge since viewing beam electrons cannot land. If this negative voltage is great enough, it will cut off the viewing beam electrons preventing them from reaching the phosphor and resulting in a dark screen.

The write gun is used to produce a charge pattern upon the storage surface varying in potential from the storage surface cutoff value to zero potential. Since these potentials are at or below flood gun cathode potential, no flood beam electrons may land upon the storage surface to destroy the written pattern and it will remain until erased or degraded by positive ions produced by collision of electrons in the flood beam with residual traces of gas between the view screen and collector electrode.

Without altering its own form the stored charge pattern in thus able to control the electrons impinging upon the screen, producing a bright stored image with full tone range from visual extinction to saturated brightness.

The Write Gun

The write gun is similar to those found in electrostatically focused and deflected oscilloscope tubes. It is capable of forming a well defined beam having high current-density resulting in excellent resolution and high writing speed.

The gun is shown in Cross Section View and consists of an oxide coated, indirectly heated cathode, a control grid 1, first and second anodes (grids 2 & 4) which are internally connected, a focusing grid 3, and horizontal and vertical deflection plates.

The Writing Operation

The write gun is generally operated with the cathode at −2400 volts with respect to the flood-gun cathode. At this potential the electrons from the write beam have sufficient energy to cause the secondary emission ratio at the storage surface to be greater than unity. Thus, since more electrons are leaving the storage surface than are arriving, the surface assumes a less-negative potential whenever the beam strikes, since the secondaries are attracted to the positive collector electrode it would appear that the write beam could charge the storage surface to collector electrode potential, but in practice the flood beam lands upon the surface whenever it tends to become positive and returns it to approximately flood-gun cathode potential.

The write-beam electrons striking the storage surface can then result in potentials varying from storage-grid-cutoff voltage to approximately zero potential. The storage surface potential is controlled over this range by the amplitude and duration of the write beam current which is determined by the signal applied to the control grid.

As was described previously, the potential at any point on the storage surface determines the number of flood beam electrons passing through the storage mesh holes in that immediate vicinity. When any point is sufficiently positive to allow passage of electrons, they will be accelerated by the high viewing screen potential and strike the phosphor directly opposite that point. The result is a bright spot on the viewing screen having a size only slightly larger than that of the corresponding point where the write gun beam struck the storage surface. The brightness of this spot is directly proportional to the density and velocity of the electrons landing on the element, the density being determined by the elemental charges of the storage surface, and the velocity by the potential of the view screen.

The image brightness may be varied by adjusting the screen potential, but because the screen is aluminized, the light output decreases rapidly below 8000 volts. Operation below this value is not recommended.

The Erasing Operation

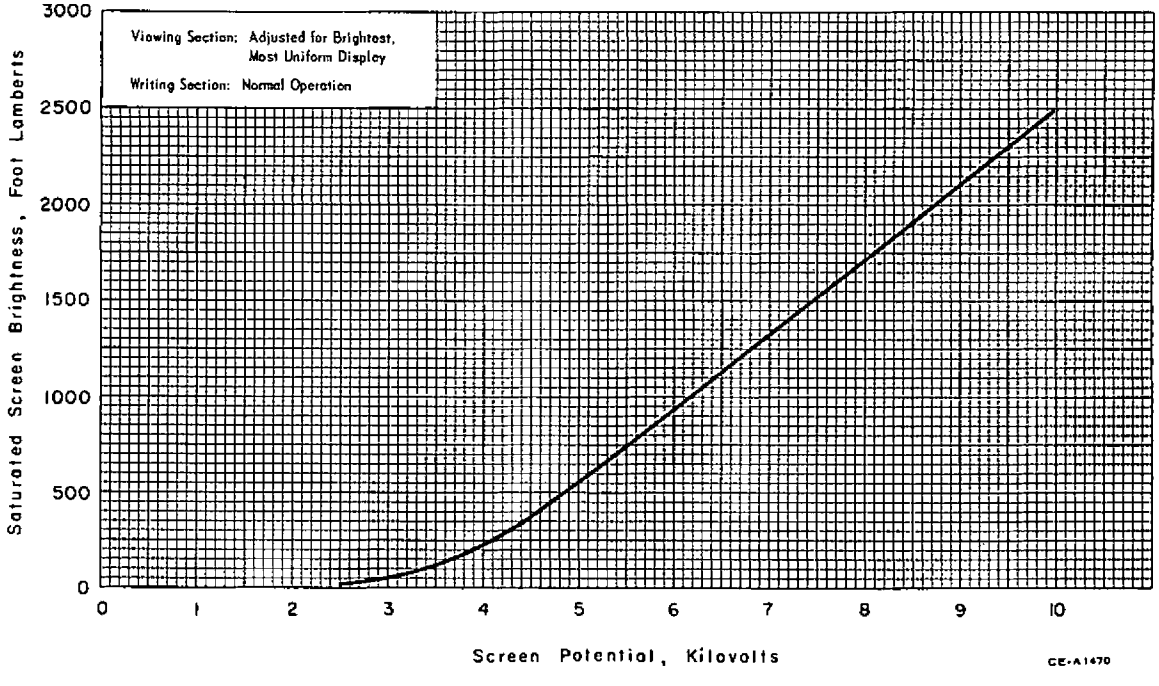
A method of preparing the storage surface for the writing operation has already been described under The Viewing Operation. This technique, which involves charging the storage surface to a negative value by the momentary application of a positive potential to the backing electrode, is actually an erasing method known as static erasure.

During the application of the positive potential to the backing electrode, flood-beam electrons land on the storage surface and drive it uniformly to cathode potential thus erasing any stored information.

A disadvantage of this method is that during erasure and subsequent re-writing no information or only incomplete information is displayed. Also the entire screen is illuminated to the saturation brightness level or higher during erasure.

In most applications it is desirable to present a display which gradually decays after a given interval of time. This type of operation may be obtained by applying a continuous series of positive pulses to the backing electrode at a rate sufficiently fast to prevent visible phosphor flicker. The technique of applying a series of pulses to the backing electrode is known as dynamic erasure.

SCREEN BRIGHTNESS AS A FUNCTION OF SCREEN POTENTIAL



The amount of charge erased during each erase pulse depends upon pulse duration, shape and amplitude. These factors together with erasing-pulse repetition frequency determine the rate at which the observed display decays.

If the erasing pulses are smaller in amplitude than the viewing-beam cutoff voltage, erasure will not be complete, whereas if the pulses are greater than cutoff they will eventually drive the storage surface below cutoff or "blacker than black." Therefore it is not advisable to use erase pulse amplitude as a means of adjusting erasing time.

When a rectangular erasing pulse is used, all portions of the storage surface will simultaneously become positive with respect to the flood-gun cathode and flood-beam electrons will be deposited at nearly the same rate over the entire surface regardless of initial charge. Thus charges representing the brighter elements will remain after other elements have been erased and the brighter areas will be visible for a longer period than the darker areas.

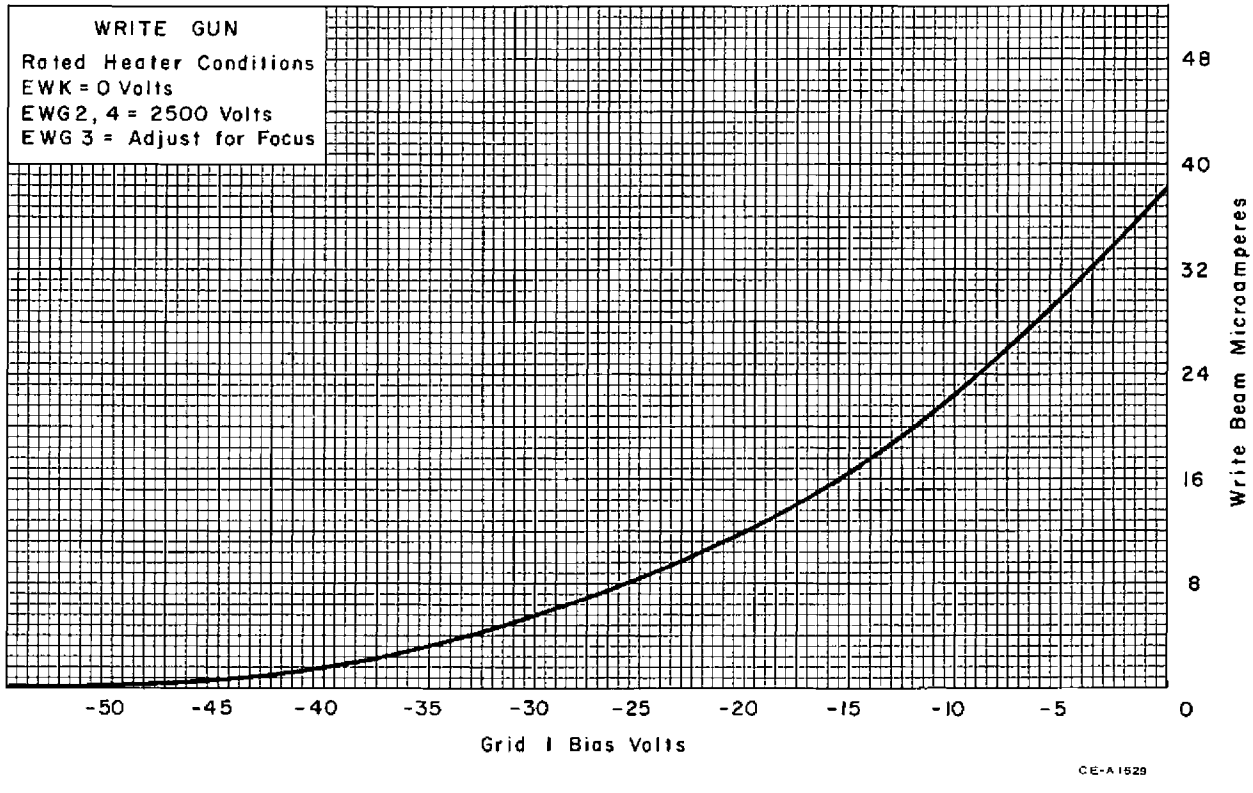
If a positive-going sawtooth erasing pulse is used, the least-negative storage elements will reach cathode potential before the remaining elements, thus allowing flood-beam electrons to land on elements representing brighter areas for a longer period than on those representing darker areas. With this type of proportional erasure, half-tones will persist as long as bright areas.

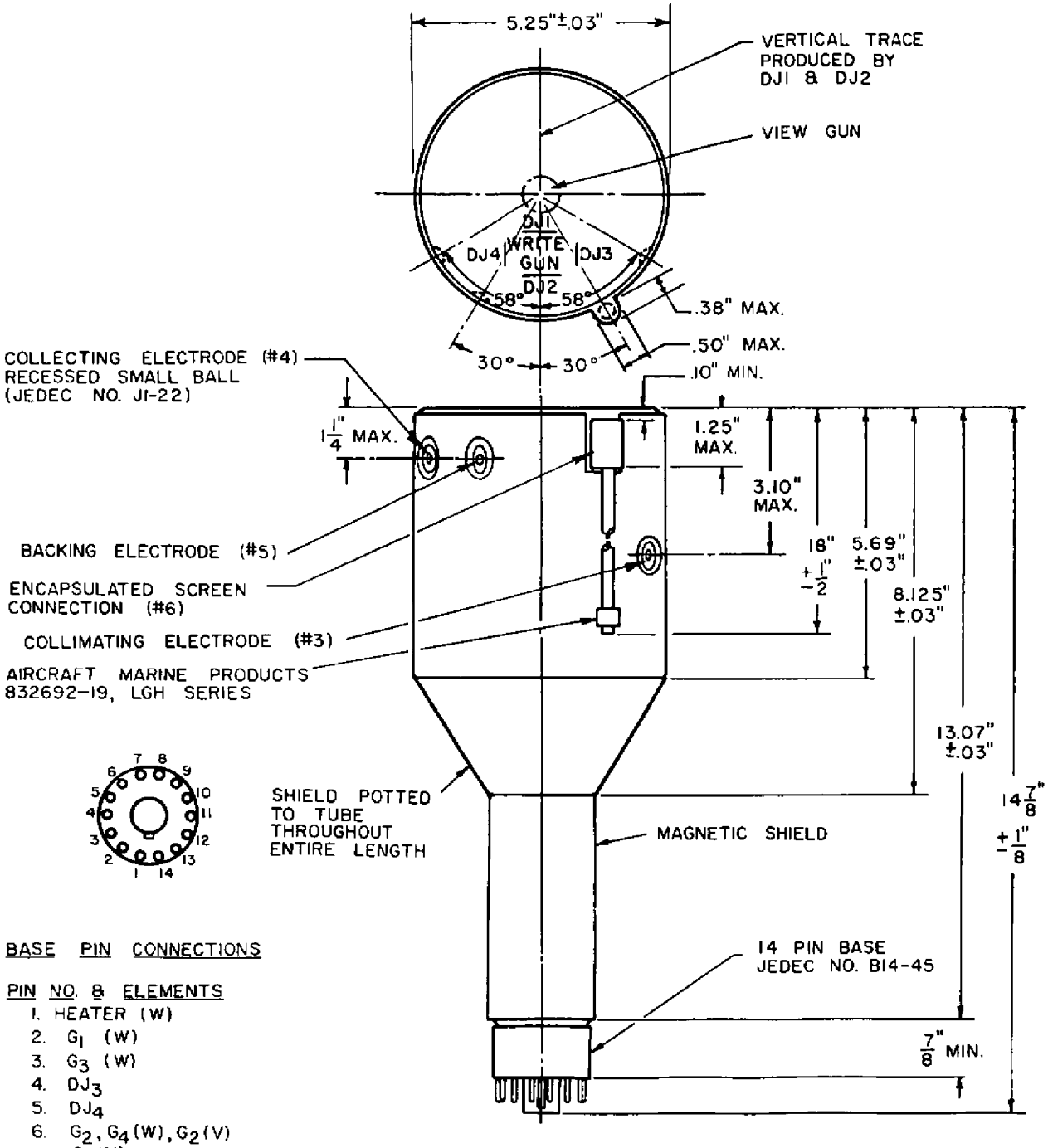
For applications involving half-tone display, the rectangular erase pulses should be adjusted in amplitude so that the storage surface is charged to exactly cutoff potential by the erasing operation.

For applications such as radar, where noise must be suppressed, a more positive erase pulse may be used to drive the storage surface several volts below cutoff. The write beam must then scan the surface several times to bring the written elements above cutoff.

If possible the erase-pulse amplitude should be adjusted so that the noise component of the writing gun signal is just sufficient to bring the storage surface to cutoff. The signal above this level will then allow flood-beam electrons to produce a display representing that signal without any noise background.

AVERAGE WRITE BEAM TRANSFER CHARACTERISTIC





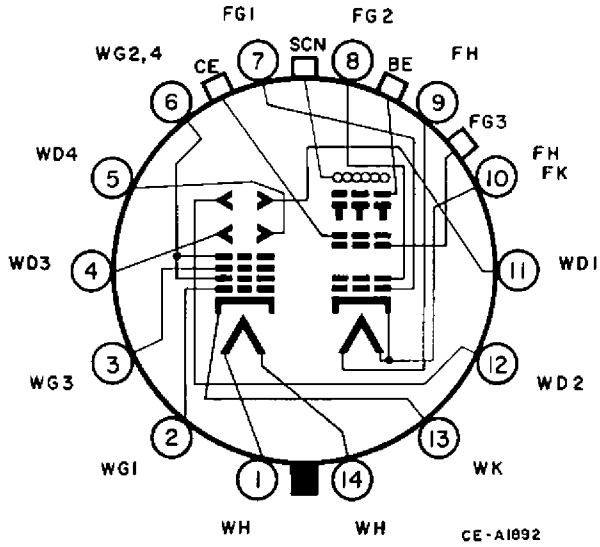
BASE PIN CONNECTIONS

PIN NO. & ELEMENTS

1. HEATER (W)
2. G_1 (W)
3. G_3 (W)
4. DJ_3
5. DJ_4
6. G_2, G_4 (W), G_2 (V)
7. G_1 (V)
8. N. C.
9. HEATER (V)
10. HEATER (V), CATHODE (V)
11. DJ_1
12. DJ_2
13. CATHODE (W)
14. HEATER (W)

(W) = WRITE

(V) = VIEW



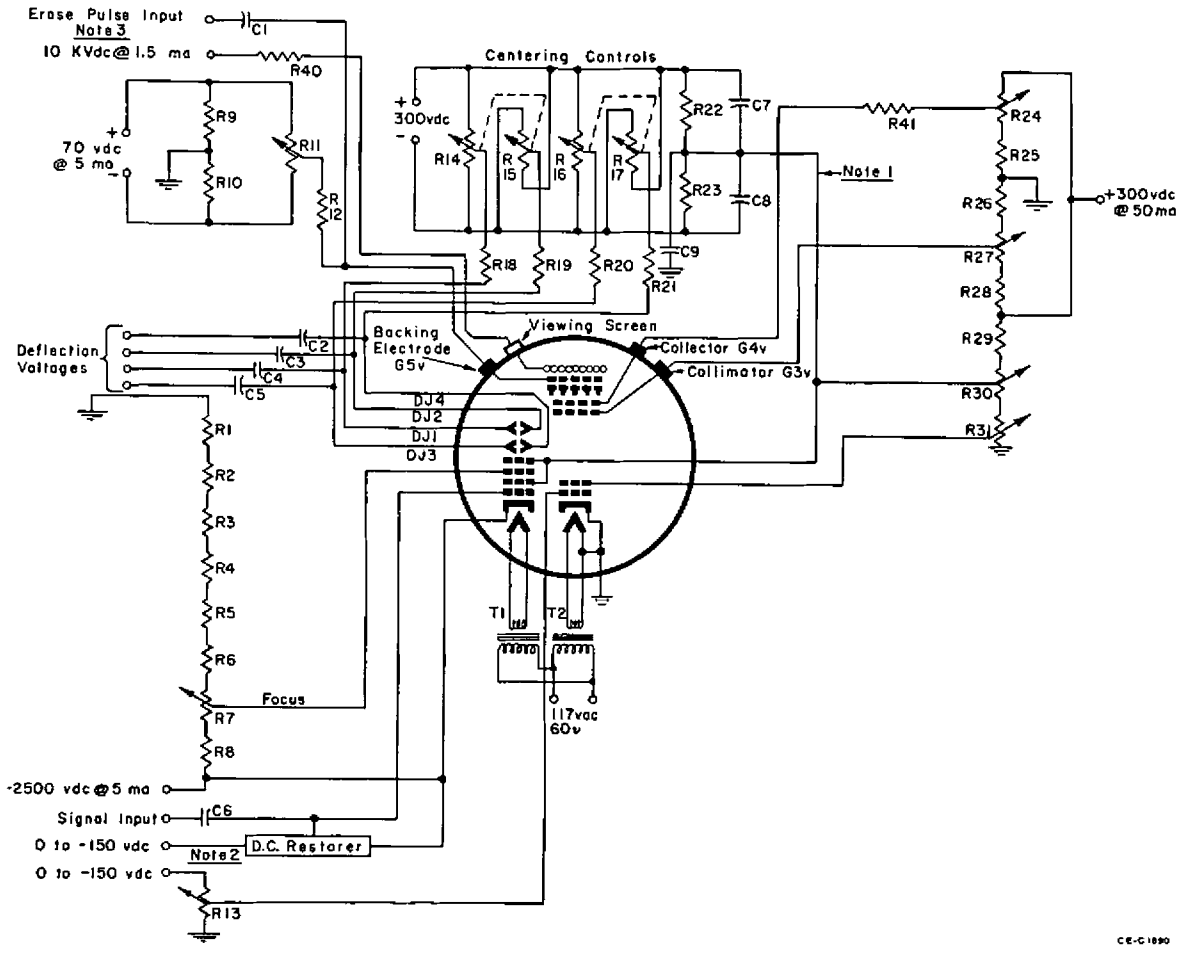
INDEX OF TERMINALS

BASE PINS

Pin No.	Gun	Element
1	Write	Heater
2	Write	Grid 1
3	Write	Grid 3 (Focus)
4	Write	Deflection Electrode 3
5	Write	Deflection Electrode 4
6	Write	Grids 2 & 4
7	Flood	Grid 1
8	Flood	Grid 2
9	Flood	Heater
10	Flood	Heater & Cathode
11	Write	Deflection Electrode 1
12	Write	Deflection Electrode 2
13	Write	Cathode
14	Write	Heater

CAPS ON LARGE END OF BULB

Gun	Element
Flood	Grid 3 (Collimating Electrode)
Flood	Collecting Electrode
Flood	Backing Electrode
Flood	View Screen



Note 1: The mean deflection potential is referred to the writing gun final anode potential to prevent astigmatism.
Note 2: Voltages are with respect to writing gun cathode. Entire supply must be insulated from ground for 4000 volts.
Note 3: Erase Pulse Characteristics, Amplitude: 0 to 10 volts peak-to-peak, Width: 2 to 10 microseconds, Frequency: 0 to 1000 pulses per second.

C_1: 0.1 μf, 200 volts
C_2, C_3, C_4, C_5: Value depends on deflection-voltage frequency and waveform
C_6: Value depends on signal-voltage frequency and waveform, 4000 volts
C_7, C_8: 0.05 μf, 600 volts
C_9: 0.5 μf, 600 volts
R_1: 91,000 ohms, 1 watt
R_2, R_{25}, R_{29}: 100,000 ohms, 1 watt
R_3, R_4, R_5, R_6: 470,000 ohms, 2 watts
R_7: Write Gun Focus Control: 250,000-ohm potentiometer, 2 watts
R_8: 180,000 ohm, 1 watt
R_9, R_{10}, R_{22}, R_{23}: 1 megohm, 0.5 watt
R_{11}: Backing Electrode Control: 100,000-ohm potentiometer, 2 watts
R_{12}: 5,000 ohm, 1 watt
R_{13}: Flood Gun Grid 1 Control: 250,000-ohm potentiometer 2 watts
R_{14}, R_{15}: Write Gun D_1 & D_2 Centering Controls: Dual 1 megohm potentiometers, 2 watts
R_{16}, R_{17}: Write Gun D_3 & D_4 Centering Controls: Dual 1 megohm potentiometers, 2 watts
R_{18}, R_{19}, R_{20}, R_{21}: 100,000 ohm, 0.5 watt
R_{24}: Collector Electrode Control: 200,000-ohm potentiometer, 2 watts
R_{26}, R_{28}: 51,000 ohm 1 watt
R_{27}: Collimating Electrode Control: 200,000-ohm potentiometer, 2 watts
R_{30}: Accelerating Anode Control: 150,000 ohm potentiometer, 2 watts
R_{31}: Flood-Gun Grid 2 Control: 50,000 ohm, 1 watt potentiometer
R_{40}: 1 megohm, 5 watts
R_{41}: 22,000 ohm, 1 watt
T_1: Filament Transformer: Primary 117 volts, Secondary 6.3 volts @ 1 ampere, Insulated for 4000 volts
T_2: Filament Transformer: Primary 117 volts, Secondary 6.3 volts @ 1 ampere

The information contained herein is furnished without assuming any obligations. The description and illustration of circuits herein does not convey to the purchaser of tubes any license for circuits under the patent claims of Westinghouse Electric Corporation or others.

Westinghouse

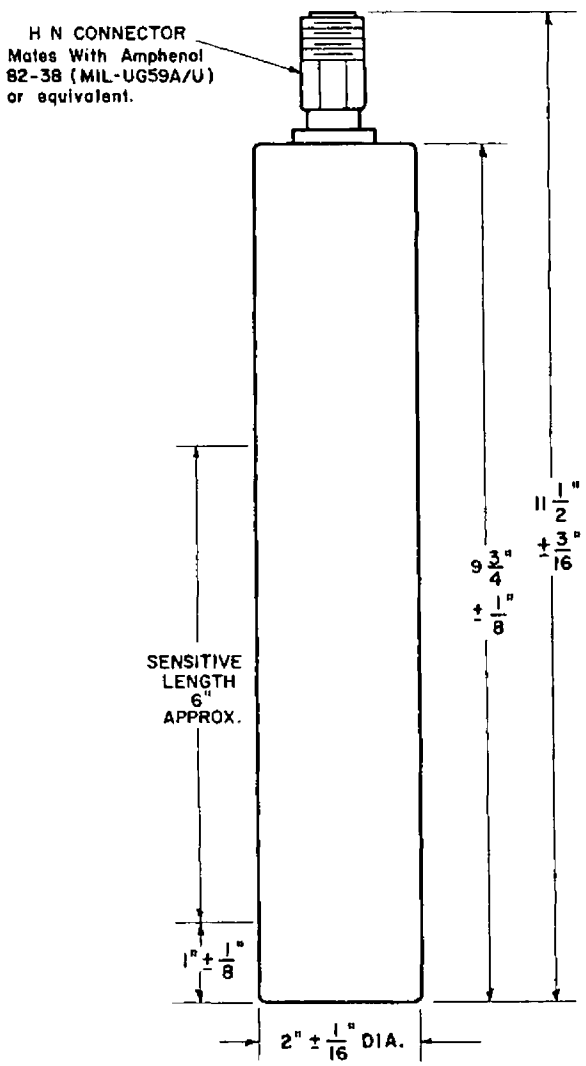
8073

May 15, 1961

DUAL RANGE FISSION CHAMBER TYPE 8073

The 8073 provides the instrumentation designer with a device which permits operation as a counter for low flux levels and as an ionization chamber for high flux, power range monitoring. The range as a counter is about 1.4 to 1.4×10^5 neutrons/cm^2/second; as a chamber, the range is approximately 5×10^5 to 1.4×10^{10} neutrons/cm^2/second.

The 8073 is of aluminum construction with high purity alumina insulation. The use of alumina thoughout the detector permits operation to 300°F and yields a design of extremely rugged construction with high resistance to deterioration due to radiation damage. Operated as a fission counter producing large pulses above background electrical and ground noise, the thermal neutron sensitivity is approximately 0.7 counts/neutron/cm^2. Operation as an ionization chamber yields a thermal neutron sensitivity of approximately 1.4×10^{-13} ampere/neutron/cm^2/second and a gamma sensitivity of approximately 4.2×10^{-11} amperes/R/hour.



MECHANICAL:		
Maximum Diameter	2-1/16	Inches
Maximum Overall Length	11-11/16	Inches
Approximate Sensitive Length	6	Inches
Net Weight	1-3/4	Pounds
Shipping Weight	12	Pounds
MATERIALS:		
Outer Case		Aluminum
Electrodes		Aluminum
Insulation		Alumina Ceramic
Neutron Sensitive Material:		
Content	U_3O_8 Enriched to more than 90% in U-235	
Thickness		2 mg/cm^2
Total Quantity		1.72 Grams
Gas Filling		Argon-Nitrogen Mixture
Gas Pressure		76 cm of Hg
IMPEDANCE:		
Resistance (minimum)	10^9	Ohms
Capacitance	190	$\mu\mu$f
MAXIMUM RATINGS:		
Voltage Between Electrodes	1000	Volts
Temperature	300	°F
External Pressure (Note 2)	180	Pounds/Inch^2
Thermal Neutron Flux	3×10^{10}	nv

from JEDEC release #3310, June 19, 1961

TYPICAL OPERATION AS A COUNTER: (Note 1)

Operating Voltage	300	Volts
Operating Voltage Plateau (See Figure 2)	200 to 800	Volts
Thermal Neutron Flux Range	1.4 to 1.4 x 10^5	nv
Sensitivity (Note 1)	0.7	CPS/nv
Output Pulse Characteristics:		
Amplitude (unloaded)	2 x 10^{-4}	Volts
Inherent Rise Time (average)	2 x 10^{-7}	Seconds

TYPICAL OPERATION AS A CHAMBER:

Operating Voltage (Note 3)	300 to 1000	Volts
Saturation Characteristics:	See Figure 3	
Thermal Neutron Flux Range (Note 4)	5 x 10^5 to 1.4 x 10^{10}	nv
Thermal Neutron Sensitivity	1.4 x 10^{-13}	Amperes/nv
Gamma Sensitivity	4.2 x 10^{-11}	Amperes/R/hour

1. The sensitivity is 0.7 counts/neutron/cm^2 when the alpha background counting rate of the naturally radioactive uranium is adjusted to 5 counts/second. By varying the pulse height selector on the associated circuitry other sensitivities are available. See Figure 1 and the section entitled "Fission Counter Operation".
2. The pressurizing atmosphere must be dry and non-corrosive.
3. The minimum voltage required for saturation is dependent upon the incident neutron flux level. See Figure 3.
4. The lower limit of operating range is determined by an inherent alpha background current of approximately 1.6 x 10^{-8} amperes.

COUNTER SENSITIVITY AS FUNCTION OF PULSE HEIGHT SETTING

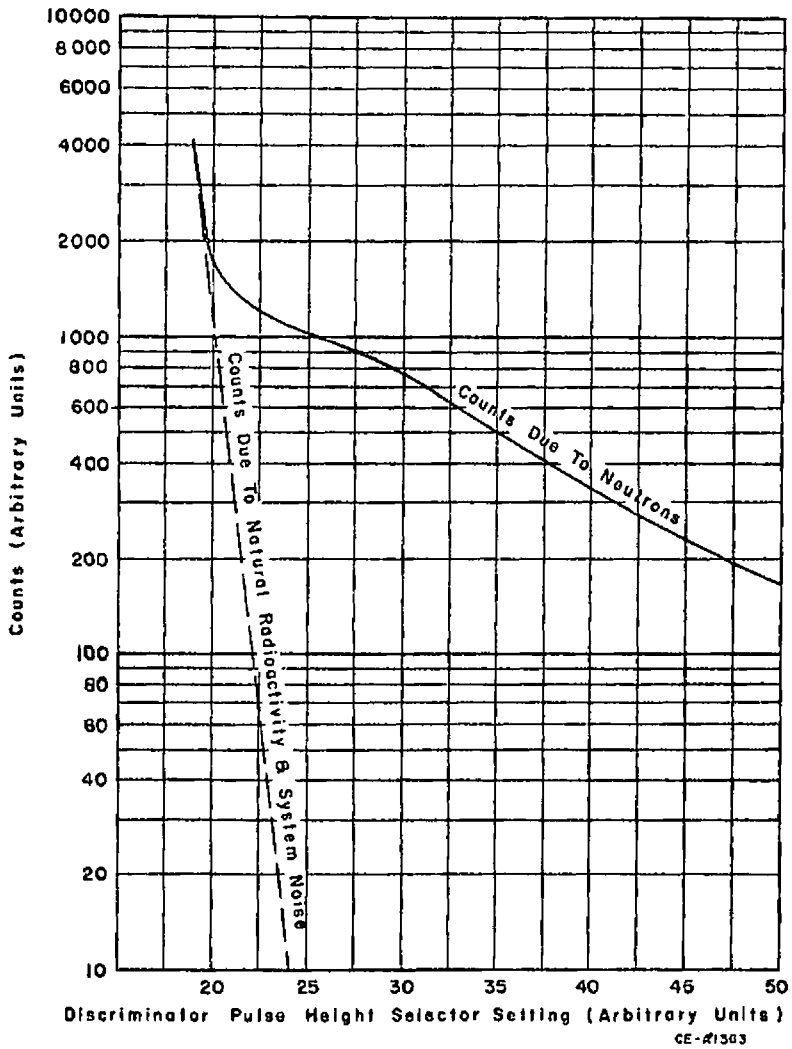


FIGURE 1

COUNTING RATE CHARACTERISTIC

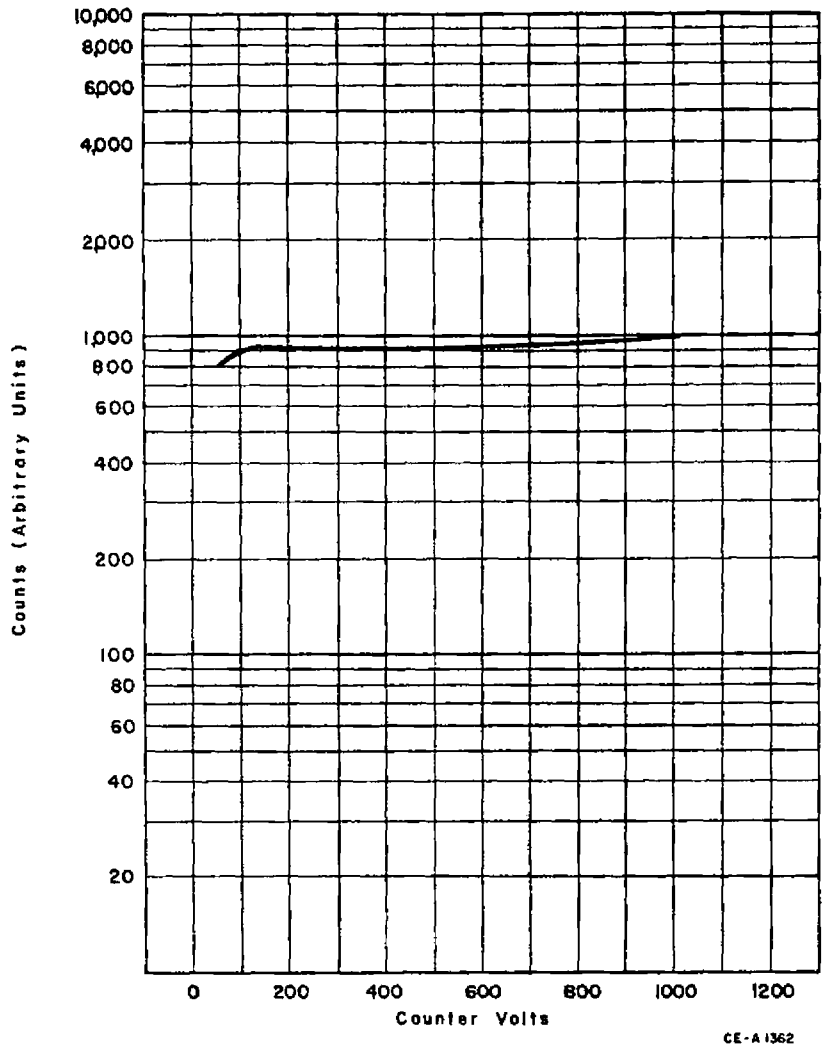


FIGURE 2

TYPICAL SATURATION CHARACTERISTICS
Ion Chamber Operation

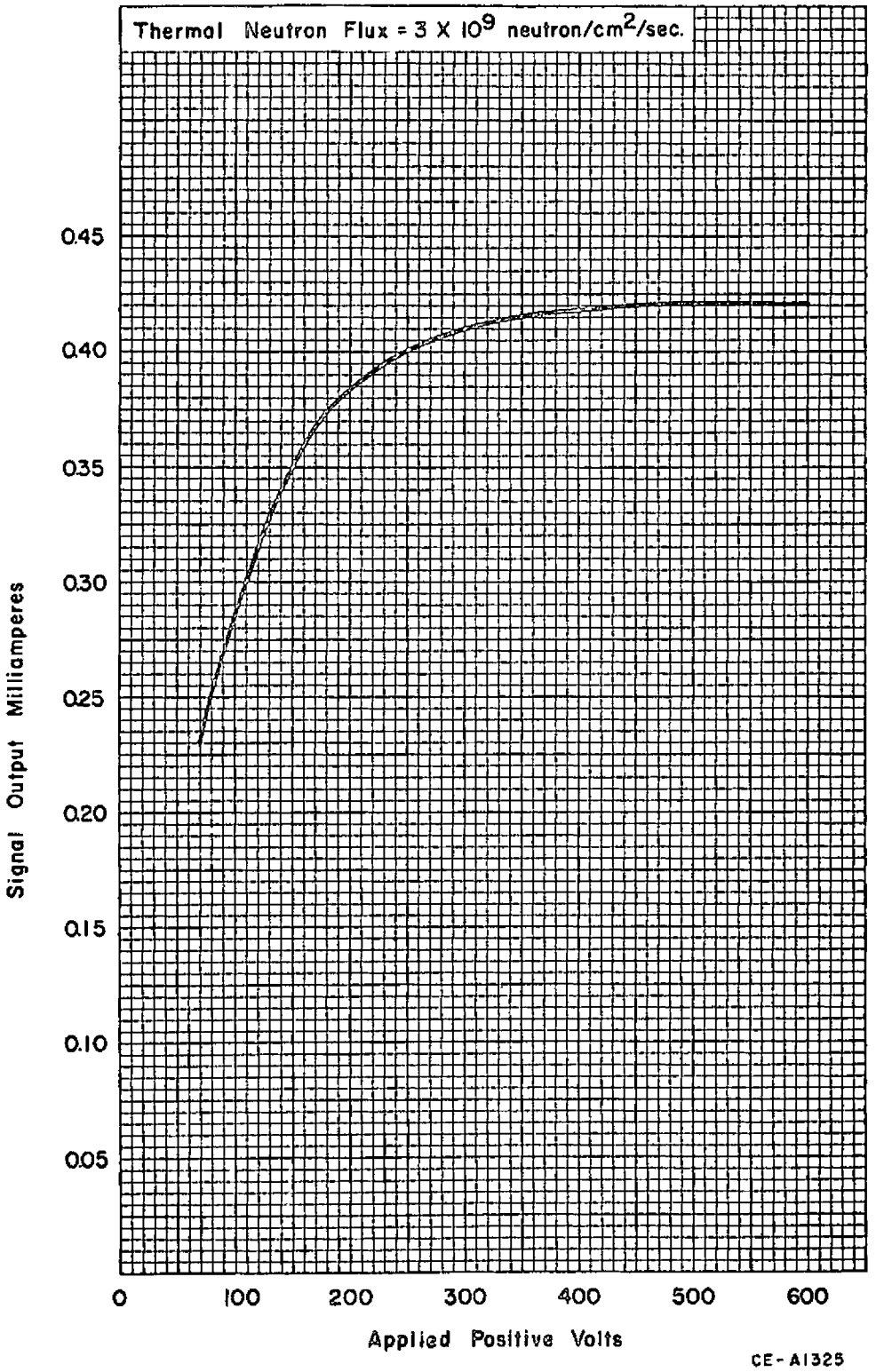


FIGURE 3

05673
3310A
4-19-65

Westinghouse Electric Corporation

Electronic Tube Division Box 284, Elmira, New York

April 2, 1965

* Mr. G. F. Hohn, Manager
EIA Engineering Laboratories
32 Green Street
Newark 2, New Jersey

Dear Mr. Hohn:

The following proposed re-registrations are hereby requested.

ITEM	AS REGISTERED	AS PROPOSED
Tube Type: 8073		
Rel. No. 3310		
Under Mat'ls:		
Neut. Sens. Mat'l.		
Total Quantity	1.72 Grams	1.68 Grams
Tube Types: 8105 8137 8214		
Ret. No. 3476 3522 3822		
Under TYP-OPER.		
Gamma Sens. (8137 only)	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.
Un-Comp.	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.

Thank you.

Very truly yours,

J. A. Scott
Commercial Engineering

JAS/cb

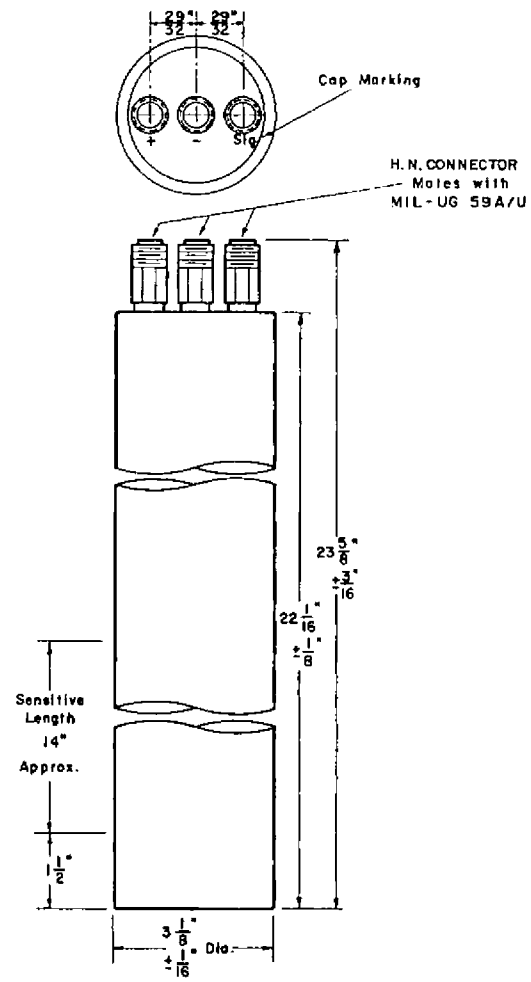
NBS STANDARDS LABORATORY
Apr - 5 1965

COMPENSATED IONIZATION CHAMBER TYPE 8074

The 8074 compensated ionization chamber is designed to detect thermal neutrons in the presence of high gamma radiation fields. Provision for electrical adjustment of compensation after installation makes it particularly useful for Intermediate and Power range operation in reactor facilities where high gamma gradients are encountered. The use of stabilized polystyrene and the rugged, guard-ring design assures noise-free operation and minimizes spurious signal currents due to electrical leakage.

The use of materials of low-activation cross section minimizes handling problems and shift of characteristics during exposure. Careful design of the sensitive volumes minimizes shift in compensation characteristics over a wide range of gamma dose rates (See Figure 3).

The thermal neutron sensitivity of the 8074 is approximately 4×10^{-14} amperes/neutron/cm^2/second. The gamma sensitivity, when operated uncompensated, is approximately 3×10^{-11} amperes/R/hour. The combination of these parameters permits highly reliable operation from 2.5×10^2 to 2.5×10^{10} neutrons/cm^2/second.



MECHANICAL:

Maximum Diameter	3-3/16	Inches
Maximum Overall Length	23-13/16	Inches
Approximate Sensitive Length	14	Inches
Net Weight	5-3/8	Pounds
Shipping Weight	19	Pounds

MATERIALS:

Outer Case	3% Al, 97% Mg Alloy
Electrodes	3% Al, 97% Mg Alloy
Insulation	Stabilized Polystyrene
Neutron Sensitive Material:	
Content	Boron enriched in B-10
Thickness	1 mg/cm^2
Gas Filling	Nitrogen

IMPEDANCE:

Resistance: (Note 2)		
Signal Electrode to Case (Minimum)	10^{13}	Ohms
H.V. Electrode to Case (Minimum)	10^{12}	Ohms
Compensating Electrode to Case (Minimum)	10^{12}	Ohms
Capacitance: (Note 1)		
Signal Electrode to Case (Approx.)	275	$\mu\mu f$
H.V. Electrode to Case (Approx.)	315	$\mu\mu f$
Compensating Electrode to Case (Approx.)	125	$\mu\mu f$

MAXIMUM RATINGS:

Voltage Between Electrodes (dc)	1500	max.	Volts
Temperature	175	max.	Degrees F
External Pressure (Note 3)	180	max.	Pounds/Inch^2
Thermal Neutron Flux	5×10^{11}	max.	nv

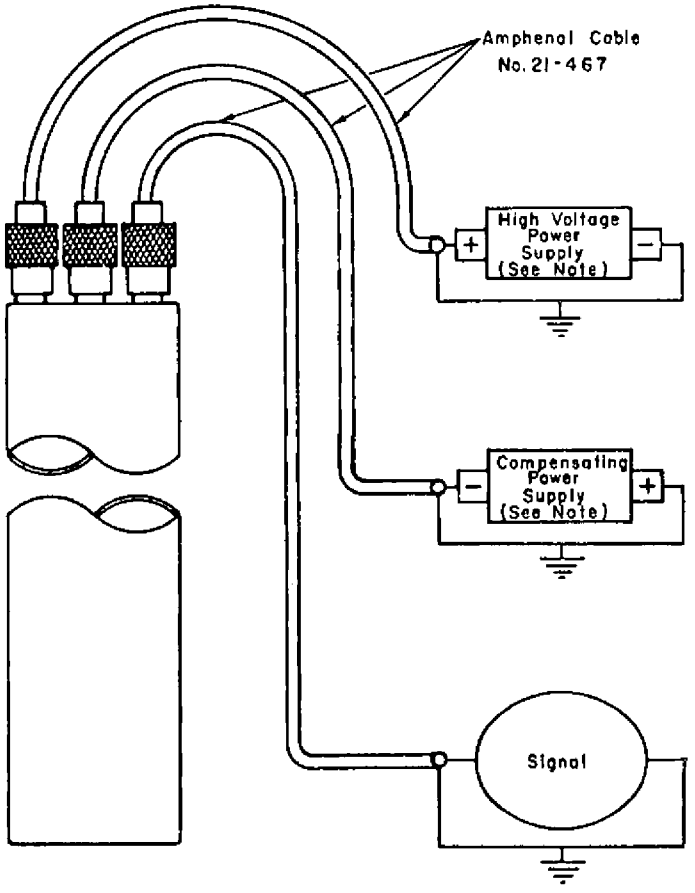
from JEDEC release #3310, June 19, 1961

TYPICAL OPERATION:

Typical Connection	See Figure 1	
Operating Voltage	300 to 800	Volts
Compensating Voltage (See Figure 3)	−10 to −80	Volts
Saturation Characteristics	See Figure 2	
Thermal Neutron Flux Range	2.5×10^{2} to 2.5×10^{10}	nv
Thermal Neutron Sensitivity	4×10^{-14}	Amperes/nv
Gamma Sensitivity:		
Total Compensation	zero	
Uncompensated	3×10^{-11}	Amperes/R/hour

1. Capacitance is measured between an electrode and case, with all other electrodes grounded.
2. The detector may not be immersed directly in water, and high humidity environments should be avoided as they will impair performance.
3. The pressurizing atmosphere must be dry and non-corrosive.

TYPICAL CONNECTION DIAGRAM



Note: Permissible power supply regulation and ripple will depend upon the particular application. See Section entitled "Ionization Chamber Operation."

CB-A1324 R1

FIGURE 1

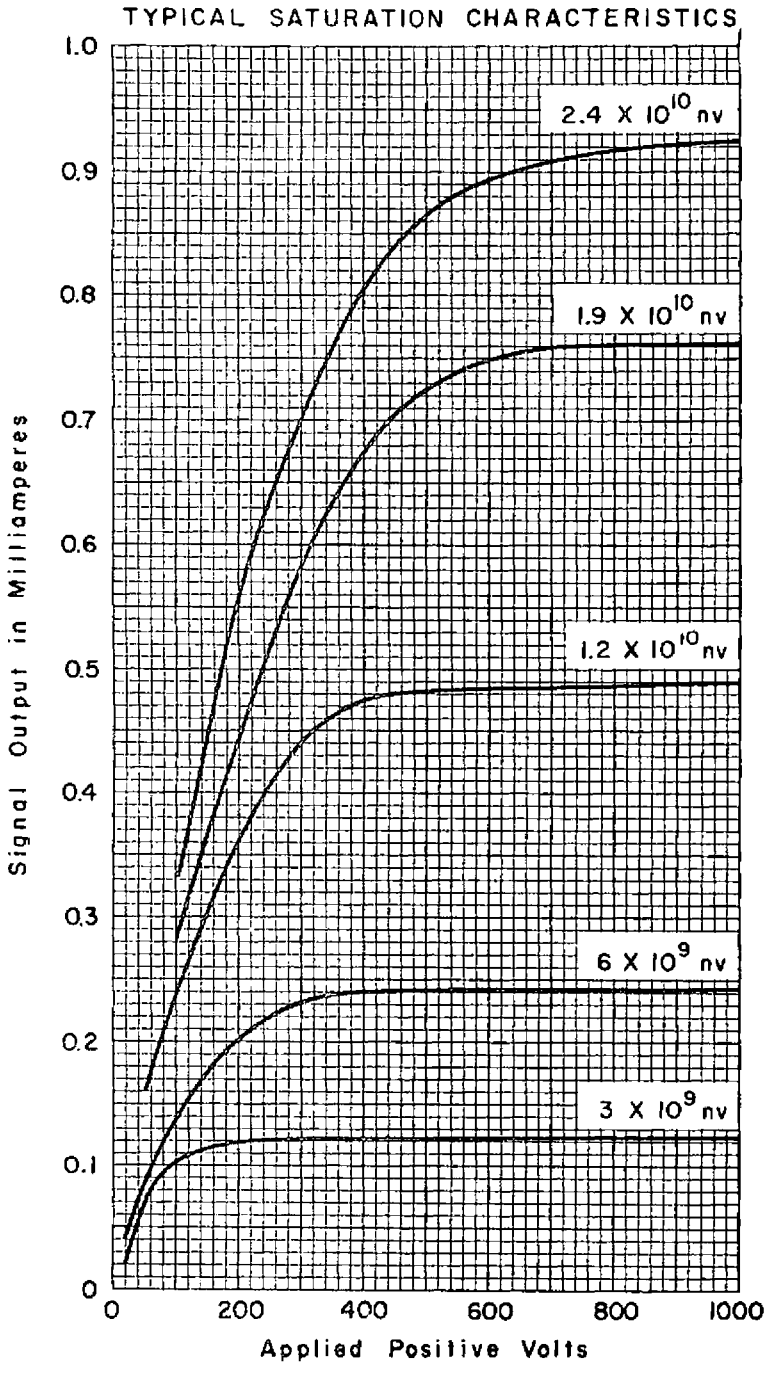

TYPICAL SATURATION CHARACTERISTICS
2.4 X 10^10 nv
1.9 X 10^10 nv
1.2 X 10^10 nv
6 X 10^9 nv
3 X 10^9 nv
Signal Output in Milliamperes
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
200
400
600
800
1000
Applied Positive Volts
CE-A1284 R2

FIGURE 2

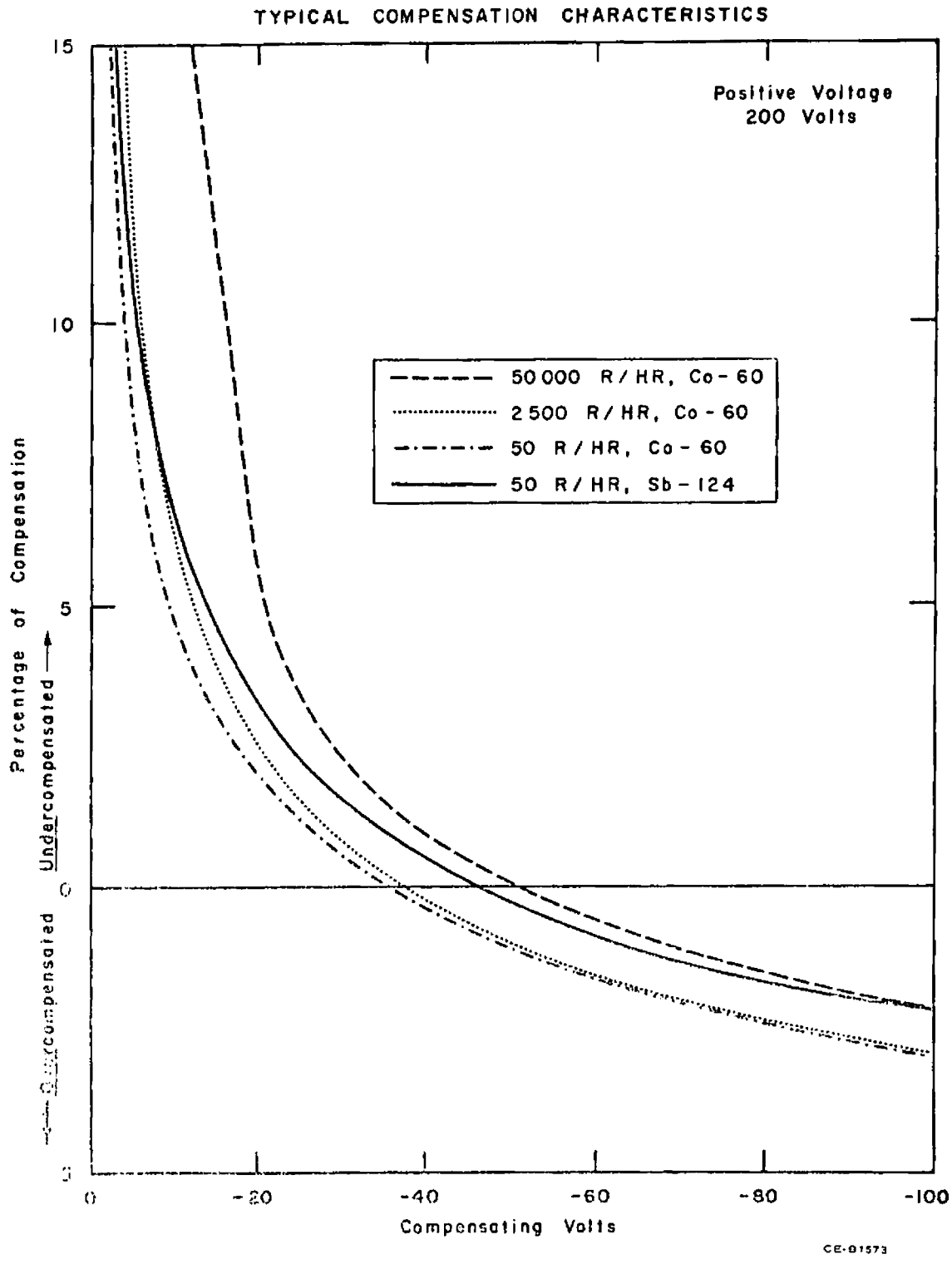

TYPICAL COMPENSATION CHARACTERISTICS
Positive Voltage
200 Volts
50 000 R/HR, Co-60
2 500 R/HR, Co-60
50 R/HR, Co-60
50 R/HR, Sb-124
Percentage of Compensation
Undercompensated
Overcompensated
15
10
5
0
-20
-40
-60
-80
-100
Compensating Volts
CE-01573

FIGURE 3

Westinghouse

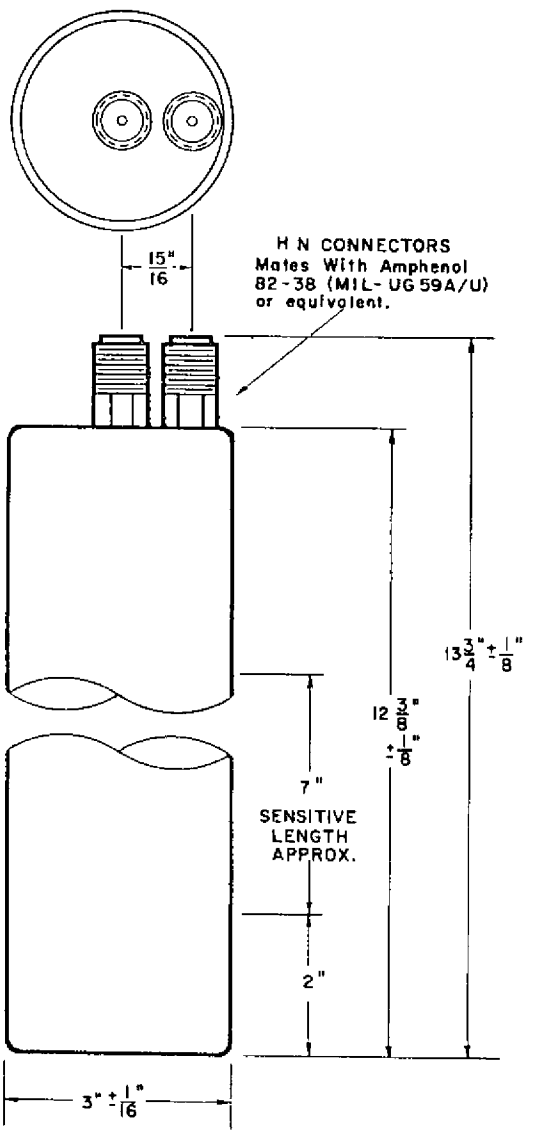
8075

May 15, 1961

UNCOMPENSATED IONIZATION CHAMBER TYPE 8075

The 8075 is a guard-ring ionization chamber designed to detect thermal neutrons in the range from 2.5×10^3 to 2.5×10^{10} neutrons/cm^2/second. The guard-ring construction combined with the use of high-purity alumina ceramics provides a design which minimizes leakage currents usually detrimental to low current operation. The detector is extremely rugged and the high alumina insulation used throughout permits operation to 300°F and minimized deterioration due to radiation damage.

The rugged construction makes the detector especially useful for Intermediate and Power range reactor instrumentations where mechanical shock and vibration present problems. The internal design provides a relatively high thermal neutron sensitivity of about 4.4×10^{-14} amperes/neutron/cm^2/second in a compact device. The gamma sensitivity is approximately 5×10^{-11} amperes/R/hour.



MECHANICAL:		
Maximum Diameter	3-1/16	Inches
Maximum Overall Length	13-7/8	Inches
Approximate Sensitive Length	7	Inches
Net Weight	2-1/2	Pounds
Shipping Weight	10	Pounds
MATERIALS:		
Outer Case		Aluminum
Electrodes		Aluminum
Insulation		Alumina Ceramic
Neutron Sensitive Material		Boron Enriched to 96% in B-10
Gas Filling		Argon-Nitrogen Mixture
IMPEDANCE:		
Resistance:		
Signal Electrode to Case (minimum)	10^{11}	Ohms
H.V. Electrode to Case (minimum)	10^{11}	Ohms
Capacity:		
Signal Electrode to Case (Note 3)	250	$\mu\mu$f
H.V. Electrode to Case (Note 4)	170	$\mu\mu$f
MAXIMUM RATINGS:		
Voltage Between Electrodes	1500	Volts
Temperature	300	°F
External Pressure (Note 2)	180	Pounds/Inch^2
Thermal Neutron Flux	10^{11}	nv
TYPICAL OPERATION:		
Operating Voltage (Note 1)	200 to 1000	Volts
Saturation Characteristics	Figure 2	
Thermal Neutron Flux Range	2.5×10^3 to 2.5×10^{10}	nv
Thermal Neutron Sensitivity (Approx.)	4.4×10^{-14}	Amperes/nv
Gamma Sensitivity (Approx.)	5×10^{-11}	Amperes/R/hr

1. The voltage necessary to produce saturation varies with the neutron flux level. Either polarity may be used. See Figure 2.
2. The pressurizing atmosphere must be dry and non-corrosive.
3. With H.V. electrode grounded to case.
4. With signal electrode grounded to case.

Neutron & Radiation Detector Section
WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #3298, June 12, 1961

TYPICAL CONNECTION DIAGRAM

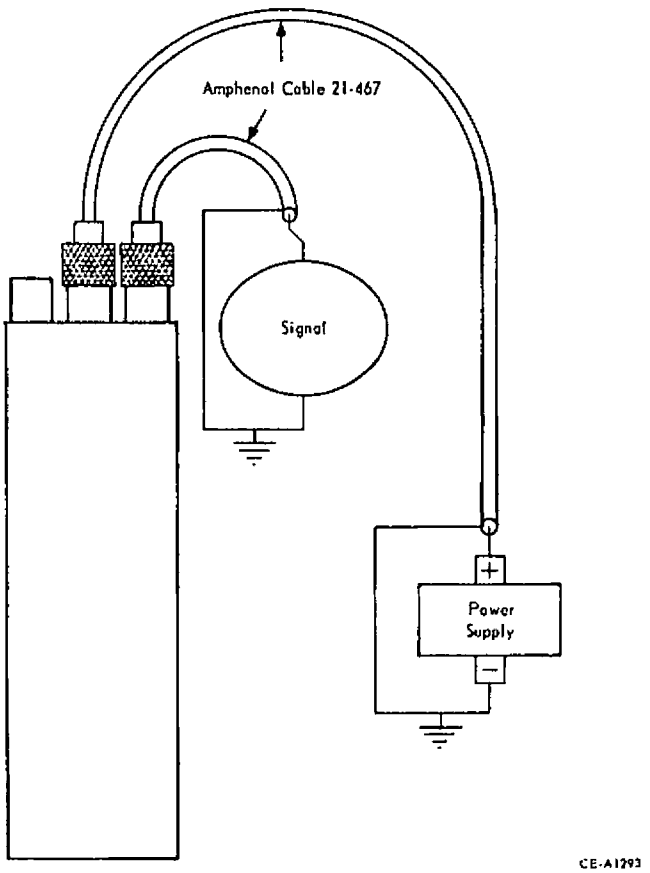


FIGURE 1

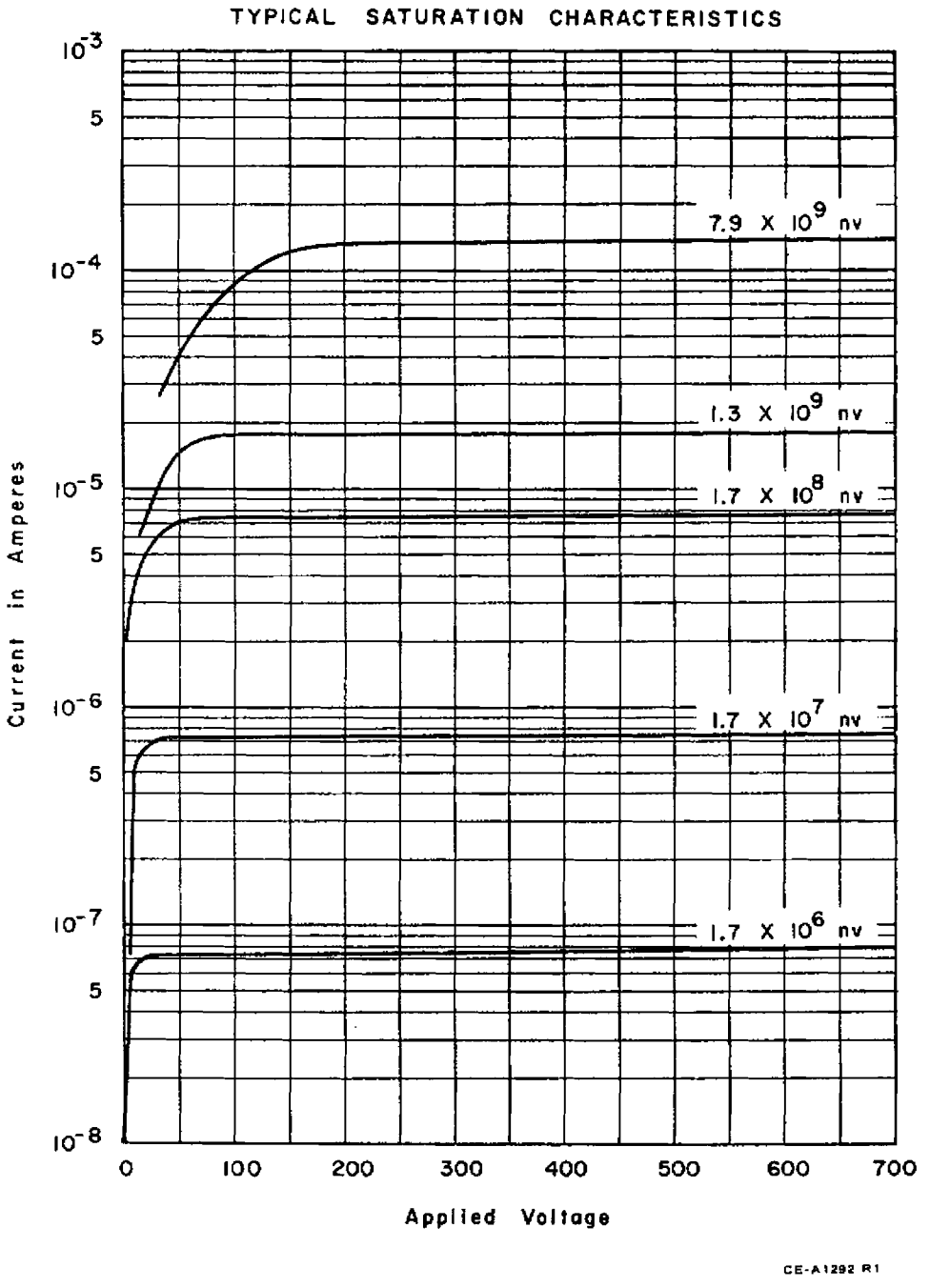

TYPICAL SATURATION CHARACTERISTICS
Current in Amperes
10^{-3}
5
10^{-4}
5
10^{-5}
5
10^{-6}
5
10^{-7}
5
10^{-8}
7.9 X 10^{9} nv
1.3 X 10^{9} nv
1.7 X 10^{8} nv
1.7 X 10^{7} nv
1.7 X 10^{6} nv
0
100
200
300
400
500
600
700
Applied Voltage
CE-A1292 R1

FIGURE 2

VHF FREQUENCY-MULTIPLIER TYPE 8084

The 8084 is a 7-pin miniature, sharp-cutoff frame grid pentode designed particularly for service in mobile communication equipment as a VHF frequency multiplier. The 8084 is also suitable for VHF amplifier and oscillator circuits. The 8084 features a heater-cathode structure designed to render reliable operation when operated from a 6-cell storage battery primary power system.

ELECTRICAL

Cathode	Coated Unipotential	
Heater:		
Voltage, ac or dc (Note 1)	13.5	Volts
Current	0.160	Amperes
Direct Interelectrode Capacitances (Shielded): (Note 2)		
Grid 1 to Plate	0.04 max.	μμf
Input	8.0	μμf
Output	3.0	μμf

MECHANICAL

Bulb	T-5-1/2
Base	Miniature 7-Pin (JEDEC E7-1)
Outline	5-2
Basing	7CM
Mounting Position	Any

AMPLIFIER - CLASS A_1

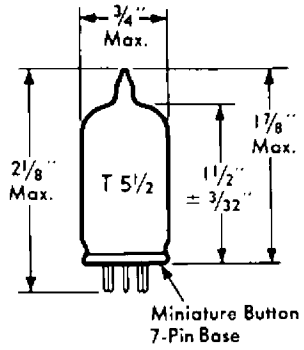
MAXIMUM RATINGS

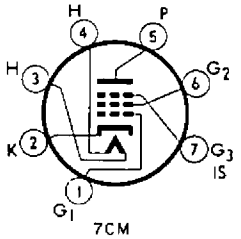
Absolute Maximum Values

Plate Voltage	250	max.	Volts
Grid 3 Voltage	0	max.	Volts
Grid 2 (Screen) Supply Voltage	180	max.	Volts
Grid 2 Voltage	See Grid 2 Input Rating Chart		
Plate Dissipation	2.3	max.	Watts
Grid 2 Dissipation	0.5	max.	Watts
Grid 1 Control Grid Voltage:			
Positive Value	0	max.	Volts
Cathode Current	20	max.	Ma.
Heater-Cathode Voltage:			
Heater Negative with Respect to Cathode:			
Total DC and Peak	100	max.	Volts
Heater Positive with Respect to Cathode:			
DC Component	50	max.	Volts
Total DC and Peak	100	max.	Volts

TYPICAL OPERATING CHARACTERISTICS:

Plate Voltage	125	Volts
Grid 2 Voltage	80	Volts
Grid 1 Voltage	−1	Volts
Transconductance	10500	μmhos
Grid 1 Cutoff Bias (Note 3)	−3.5	Volts
Plate Current	7	Ma.
Grid 2 Current	1.7	Ma.





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WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #4179, March 11, 1963

AMPLIFIER - CLASS C
OSCILLATOR - CLASS C
FREQUENCY MULTIPLIER - CLASS C

MAXIMUM RATINGS, CCS
Absolute Maximum Values

DC Plate Voltage	250	max.	Volts
DC Grid 3 Voltage	0	max.	Volts
DC Grid 2 Supply Voltage	180	max.	Volts
DC Grid 2 Voltage	See Grid 2 Input Rating Chart		
DC Grid 1 Voltage	-50	max.	Volts
DC Plate Current	15	max.	Ma.
DC Grid 2 Current	3	max.	Ma.
DC Grid 1 Current	1.5	max.	Ma.
Plate Dissipation	2.3	max.	Watts
Grid 2 Dissipation	0.5	max.	Watts
Grid 1 Circuit Resistance	0.1	max.	Megohms

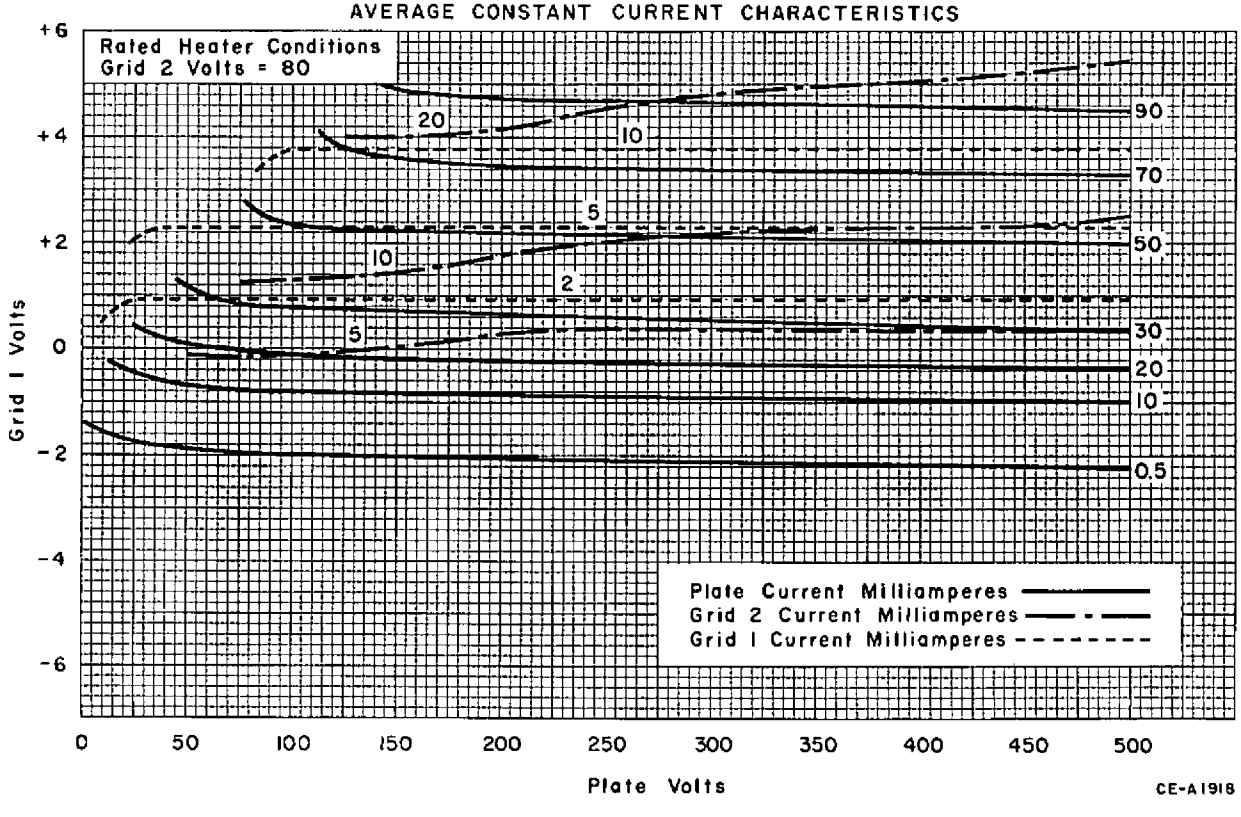
TYPICAL OPERATING CHARACTERISTICS
Tripler Service to 75 Mc. (Class C)

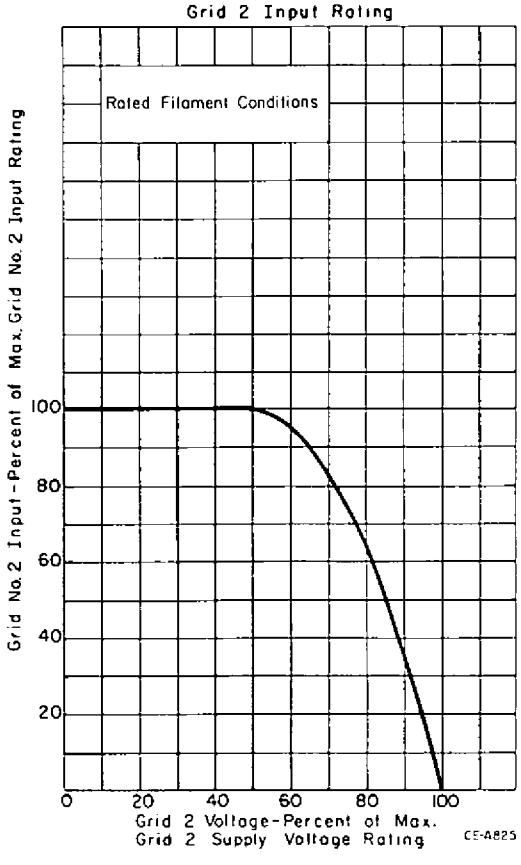
Plate Voltage	200	Volts
Grid 3 Voltage	0	Volts
Grid 2 Voltage	80	Volts
Grid 1 Voltage (Note 4)	-23	Volts
Peak RF Grid 1 Voltage	26	Volts
Plate Current	8.4	Ma.
Grid 2 Current	2.16	Ma.
Grid 1 Current (Approx.)	785	μAmperes
Driving Power	22	Milliwatts
Power Output (Approx.)	0.45	Watts

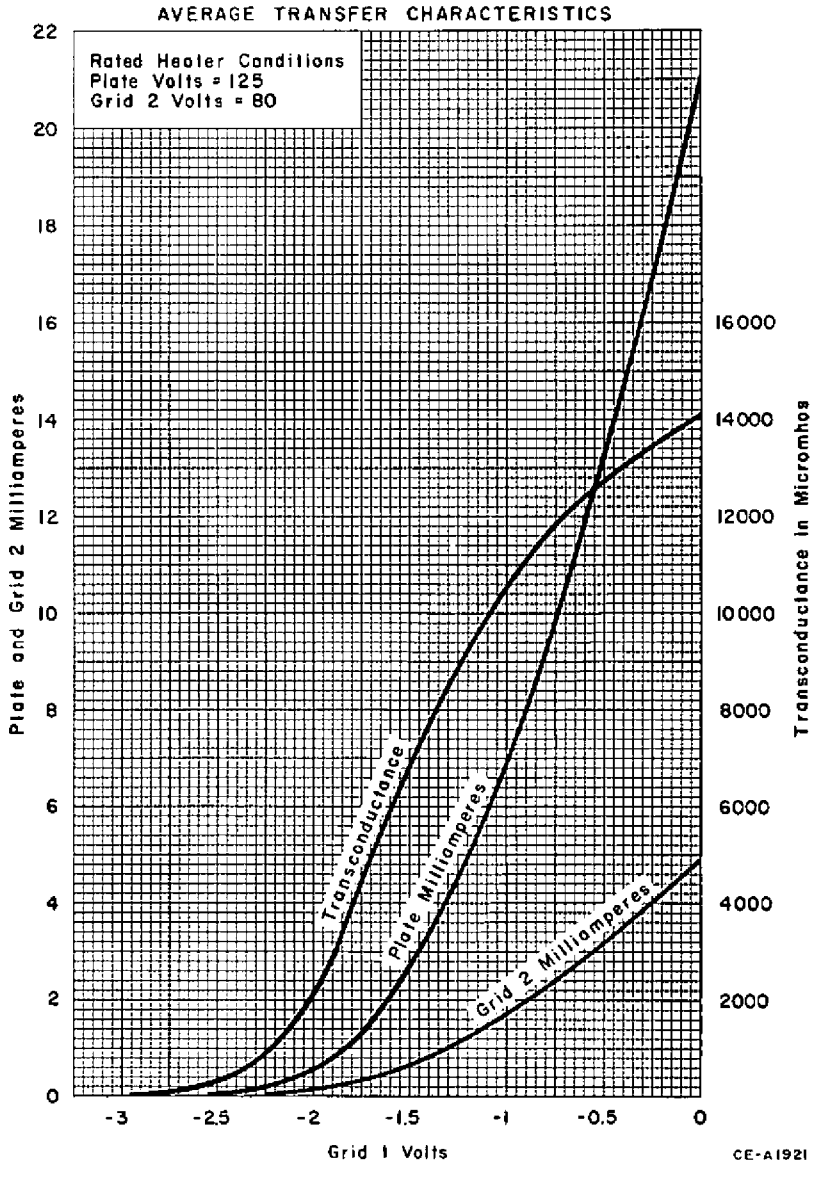
NOTES

1. Heater voltage range is 11.8 to 15.5 volts.
2. With JEDEC Shield No. 316 connected to pin 2.
3. For transconductance of 100 micromhos.
4. Developed across a grid resistor of 30,000 ohms.

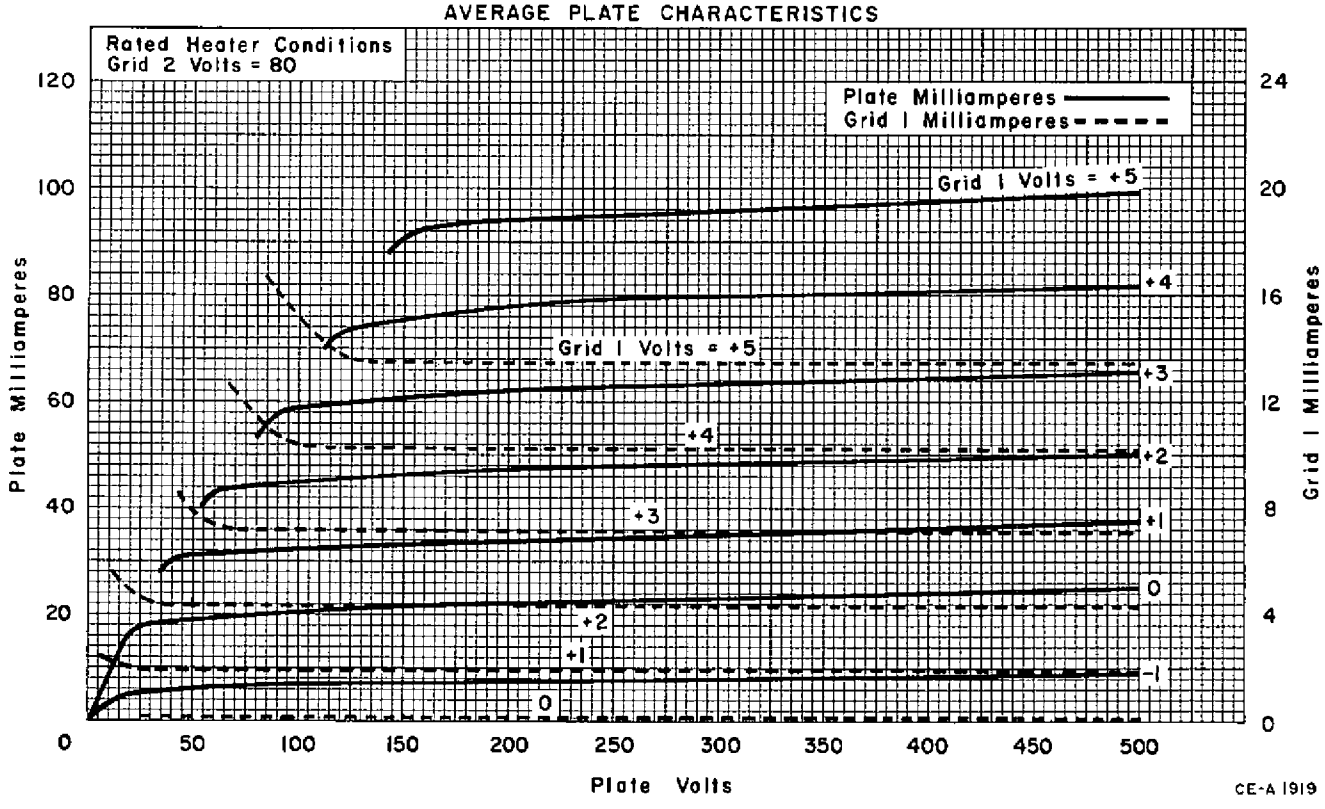
AVERAGE CONSTANT CURRENT CHARACTERISTICS




Grid 2 Input Rating
Rated Filament Conditions
Grid No. 2 Input-Percent of Max. Grid No. 2 Input Rating
100
80
60
40
20
0
20
40
60
80
100
Grid 2 Voltage-Percent of Max. Grid 2 Supply Voltage Rating
CE-A825

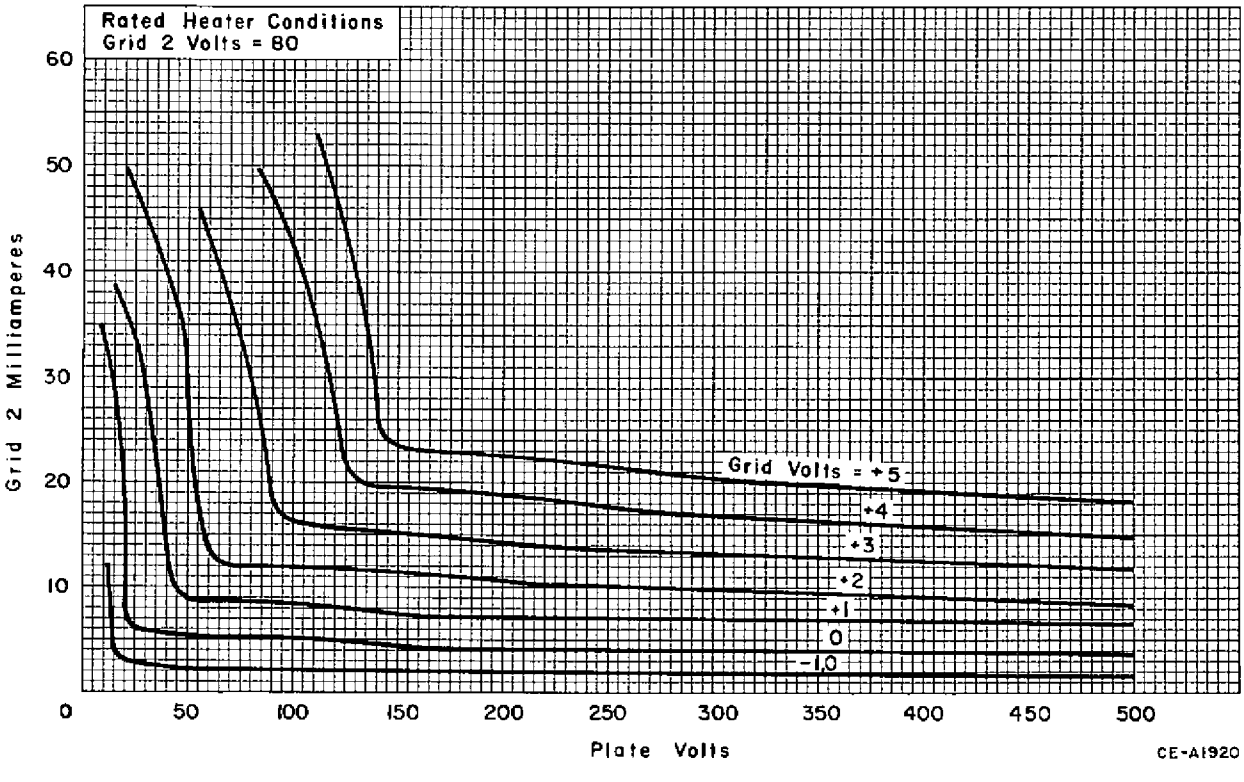

AVERAGE TRANSFER CHARACTERISTICS
Rated Heater Conditions
Plate Volts = 125
Grid 2 Volts = 80
Plate and Grid 2 Milliamperes
22
20
18
16
14
12
10
8
6
4
2
0
Transconductance in Micromhos
16000
14000
12000
10000
8000
6000
4000
2000
Transconductance
Plate Milliamperes
Grid 2 Milliamperes
-3
-2.5
-2
-1.5
-1
-0.5
0
Grid 1 Volts
CE-A1921

AVERAGE PLATE CHARACTERISTICS



CE-A 1919

AVERAGE GRID 2 CHARACTERISTICS



CE-A1920

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COMPENSATED IONIZATION CHAMBER TYPE 8105

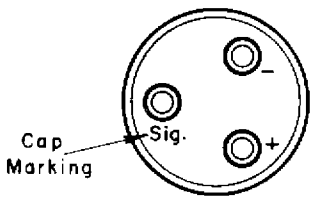
The 8105 is a compensated ionization chamber designed to detect thermal neutrons in the presence of relatively high gamma radiation fields. The chamber is a fixed, electrically compensated type and it should find wide application in critical core research and low and high power reactor facilities. The use of stabilized polystyrene and the rugged, guard-ring design minimizes signals due to electrical leakage.

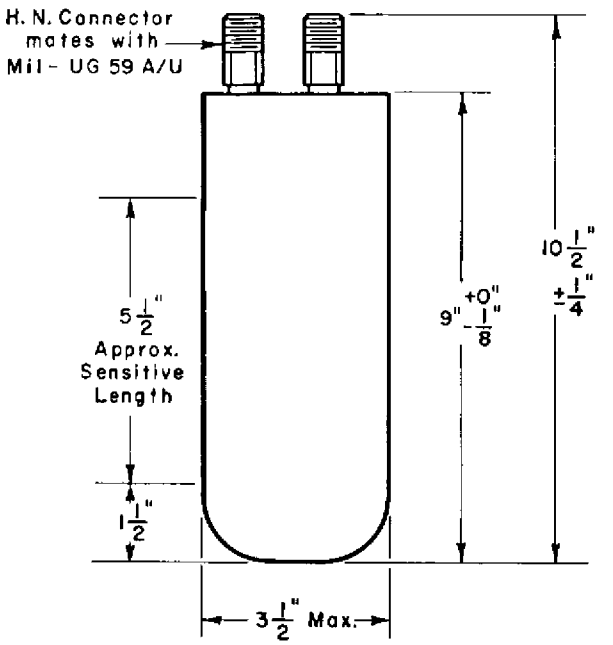
The chamber is constructed of high purity aluminum in the electrodes, case, and major support structures to minimize handling problems and shift in compensation due to activation.

The thermal neutron sensitivity of the 8105 is approximately 2×10^{-14} amperes/neutron/cm^2/second. The gamma sensitivity, when operated uncompensated, is approximately 5×10^{-12} amperes/R/hr.

MECHANICAL:

Maximum Diameter	3-1/2	Inches
Maximum Over-all Length	10-3/4	Inches
Approximate Sensitive Length	5-1/2	Inches
Net Weight	3-3/4	Pounds
Shipping Weight	12	Pounds





MATERIALS:

Outer Case	Aluminum
Electrodes	Aluminum
Insulation	Stabilized Polystyrene
Neutron Sensitive Material:	
Content	Boron Enriched in B-10
Thickness	1 mg/cm^2
Gas Filling	Nitrogen

IMPEDANCE:

Resistance: (Note 1)		
Signal-to-case, Minimum	10^{13}	Ohms
H.V.-to-case, Minimum	10^{12}	Ohms
Compensating-to-case, Minimum	10^{12}	Ohms
Capacitance: (Note 2)		
Signal-to-case, Approx.	130	$\mu\mu$f
H.V.-to-case, Approx.	140	$\mu\mu$f
Compensating-to-case, Approx.	75	$\mu\mu$f

MAXIMUM RATINGS:

Voltage Between Electrodes (dc)	1000	Volts
Temperature	175	°F
External Pressure (Note 3)	180	PSI
Thermal Neutron Flux	5×10^{11}	nv

TYPICAL OPERATION:

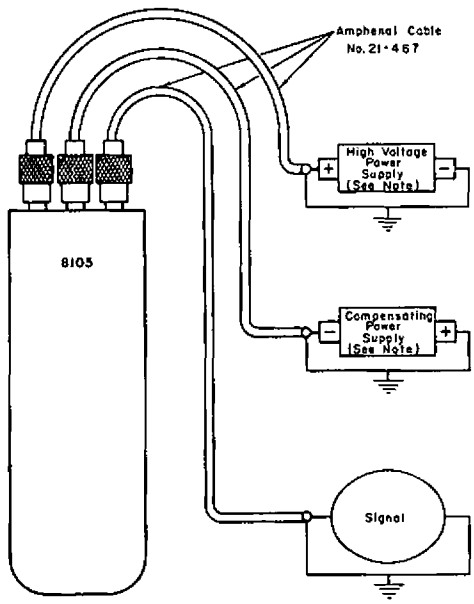
Typical Connections	See Figure 1	
Operating Voltage	300 to 800	Volts
Compensating Voltage	less than −200	Volts
Thermal Neutron Flux Range	2.5×10^{2} to 2.5×10^{10}	
Thermal Neutron Sensitivity	2×10^{-14}	Amperes/nv
Gamma Sensitivity:		
Compensated	2.5×10^{-13}	Amperes/R/hr
Uncompensated	5×10^{-12}	Amperes/R/hr

NOTES

1. The detector may not be immersed directly in water, and high humidity environments should be avoided as they will impair performance.
2. Capacitance is measured between an electrode and the case, with all other electrodes grounded to the case.
3. The pressurizing atmosphere must be dry and non-corrosive.

from JEDEC release #3476, Nov. 6, 1961,
& JEDEC release #3476A, April 19, 1965

TYPICAL CONNECTION DIAGRAM

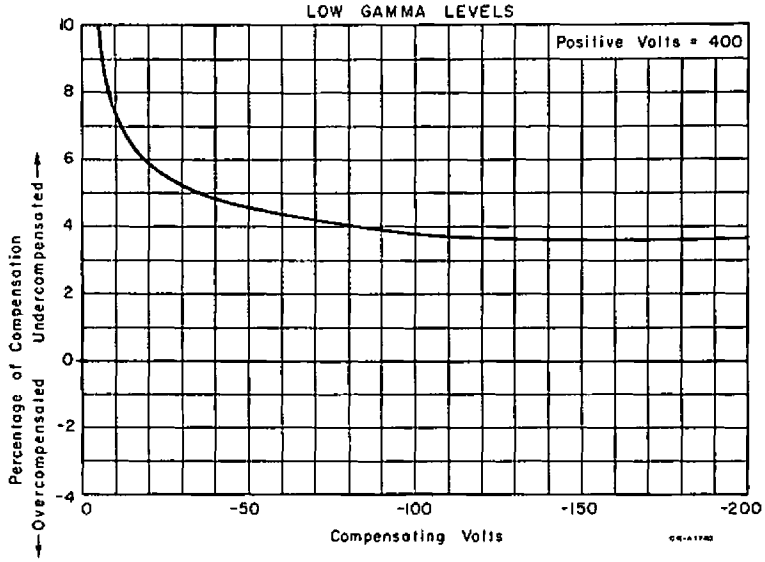


Note: Permissible power supply regulation and ripple will depend upon the particular application. See Section entitled "Ionization Chamber Operation."

CG-A1762

FIGURE 1

TYPICAL COMPENSATION CHARACTERISTIC
AT
LOW GAMMA LEVELS



CG-A1763

FIGURE 2

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05673

3476A
4-19-65

Westinghouse Electric Corporation

Electronic Tube Division Box 284, Elmira, New York

April 2, 1965

*Mr. G. F. Hohn, Manager
EIA Engineering Laboratories
32 Green Street
Newark 2, New Jersey

Dear Mr. Hohn:

The following proposed re-registrations are hereby requested.

ITEM	AS REGISTERED	AS PROPOSED
Tube Type: 8073		
Rel. No. 3310		
Under Mat'ls:		
Neut. Sens. Mat'l.		
Total Quantity	1.72 Grams	1.68 Grams
Tube Types: 8105 8137 8214		
Ret. No. 3476 3522 3822		
Under TYP-OPER.		
Gamma Sens. (8137 only)	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.
Un-Comp.	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.

Thank you.

Very truly yours,

J. A. Scott
Commercial Engineering

JAS/cb

EIA STANDARDS
APR - 5 1965
LABORATORY

Westinghouse®

8137

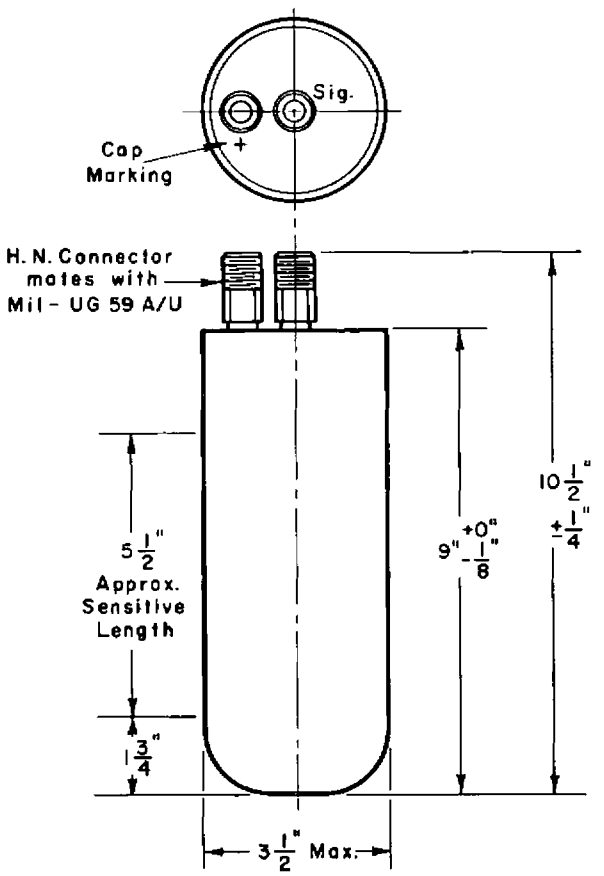
November 15, 1961

UNCOMPENSATED IONIZATION CHAMBER TYPE 8137

The 8157 uncompensated ionization chamber is designed to detect thermal neutrons for the control of reactors in the power range and to feed safety channel instrumentation. Rugged construction and guard-ring design reduce spurious signals due to mechanical vibration and electrical leakage.

The chamber electrodes, case, and major support members are constructed of high purity aluminum to minimize handling problems due to activation. The insulation is high stability, cross-linked polystyrene.

The thermal neutron sensitivity is approximately 2×10^{-14} amperes/cm^2/second. The gamma sensitivity is approximately 5×10^{-12} amperes/R/hr. These values allow operation in thermal neutron fluxes from 5×10^{3} to 5×10^{10} neutrons/cm^2/second.



MECHANICAL:

Maximum Diameter	3-1/2	Inches
Maximum Overall Length	10-3/4	Inches
Approximate Sensitive Length	5-1/2	Inches
Net Weight	3-1/2	Pounds
Shipping Weight	12	Pounds

MATERIALS:

Outer Case	Aluminum
Electrodes	Aluminum
Insulation	Stabilized Polystyrene
Neutron Sensitive Material:	
Content	Boron Enriched in B-10
Thickness	1 mg/cm^2
Gas Filling	Nitrogen

IMPEDANCE:

Resistance:		
Signal-to-Case, Minimum	10^{13}	Ohms
H.V.-to-Case, Minimum	10^{12}	Ohms
Capacitance: (Note 1)		
Signal-to-Case, Approx.	110	$\mu\mu$f
H.V.-to-Case, Approx.	150	$\mu\mu$f

MAXIMUM RATINGS:

Voltage Between Electrodes (dc)	1000	Volts
Temperature	175	°F
External Pressure (Note 2)	180	PSI
Thermal Neutron Flux	5×10^{11}	nv

TYPICAL OPERATION:

Operating Voltage	300 to 800	Volts
Thermal Neutron Flux Range	5×10^{3} to 5×10^{10}	nv
Thermal Neutron Sensitivity	2×10^{-14}	Amperes/nv
Gamma Sensitivity	5×10^{-12}	Amperes/R/hr

1. Capacitance is measured between an electrode and the case, with all other electrodes grounded to the case.
2. The pressurizing atmosphere must be dry and non-corrosive.

Neutron & Radiation Detector Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #3522, Dec. 4, 1961

8073
3522A
4-19-65

Westinghouse Electric Corporation

Electronic Tube Division Box 284, Elmira, New York

April 2, 1965

Mr. G. F. Hohn, Manager
EIA Engineering Laboratories
32 Green Street
Newark 2, New Jersey

Dear Mr. Hohn:

The following proposed re-registrations are hereby requested.

ITEM	AS REGISTERED	AS PROPOSED
Tube Type: 8073		
Rel. No. 3310		
Under Mat'ls:		
Neut. Sens. Mat'l.		
Total Quantity	1.72 Grams	1.68 Grams
Tube Types: 8105 8137 8214		
Ret. No. 3476 3522 3822		
Under TYP-OPER.		
Gamma Sens. (8137 only)	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.
Un-Comp.	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.

Thank you.

Very truly yours,

J. A. Scott
Commercial Engineering

JAS/cb

NBS STANDARDS
APR - 5 1965
LABORATORY

July 1, 1962

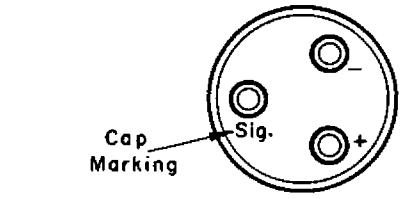
COMPENSATED IONIZATION CHAMBER TYPE WL-8214

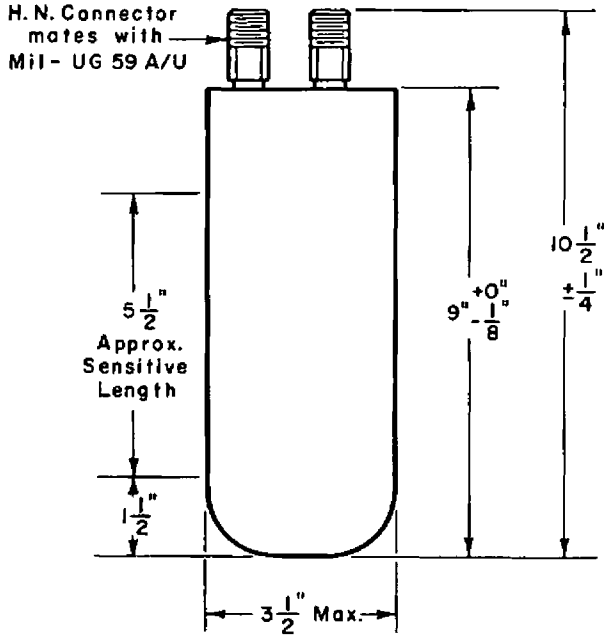
The WL-8214 ionization chamber is designed to detect thermal neutrons in the presence of relatively high gamma radiation fields when varying strength or a high gradient of the field is encountered. The chamber is a variable, electrically compensated type and should find wide application in high power facilities and in research institutions. The guard-ring design employs stabilized polystyrene to reduce electrical leakage and minimize spurious signals. The chamber is constructed of high purity aluminum in the electrodes, case, and major support structures to minimize handling problems and shift in compensation due to activation.

The thermal neutron sensitivity of the WL-8214 is approximately 2×10^{-14} amperes/neutron/cm^2/second. The gamma sensitivity is approximately 5×10^{-12} amperes/R/hr (uncompensated), and a reduction of this sensitivity by a factor of 100 may easily be achieved.

MECHANICAL

Maximum Diameter	3-1/2	Inches
Maximum Over-all Length	10-3/4	Inches
Approximate Sensitive Length	5-1/2	Inches
Net Weight	4	Pounds
Shipping Weight	12	Pounds





MATERIALS

Outer Case	Aluminum
Electrodes	Aluminum
Insulation	Stabilized Polystyrene
Neutron-Sensitive Material:	
Content	Boron Enriched in B-10
Thickness	1 mg/cm^2
Gas Filling	Nitrogen

IMPEDANCE

Resistance: (Note 1)		
Signal-to-case, minimum	10^{13}	Ohms
H.V.-to-case, minimum	10^{12}	Ohms
Compensating-to-case, minimum	10^{12}	Ohms
Capacitance: (Note 2)		
Signal-to-case, Approx.	135	$\mu\mu$f
H.V.-to-case, Approx.	140	$\mu\mu$f
Compensating-to-case, Approx.	80	$\mu\mu$f

MAXIMUM RATINGS

Voltage Between Electrodes, (d-c)	1000	Volts
Temperature	175	°F
External Pressure (Note 3)	180	PSI
Thermal Neutron Flux	5×10^{11}	nv

TYPICAL OPERATION

Typical Connections	See Figure 1	
Operating Voltage	300 to 800	Volts
Saturation characteristics	See Figure 2	
Compensating Voltage	See Figure 3	
Thermal Neutron Flux Range	2.5×10^{2} to 2.5×10^{10}	nv
Thermal Neutron Sensitivity	2×10^{-14}	Amperes/nv
Gamma Sensitivity:		
Uncompensated	5×10^{-12}	Amperes/R/hr
Total Compensation	Zero	

NOTES

1. The detector may not be immersed directly in water and high humidity environments should be avoided.
2. Capacitance is measured between an electrode and the case, with all other electrodes grounded to the case.
3. The pressurizing atmosphere must be dry and non-corrosive.

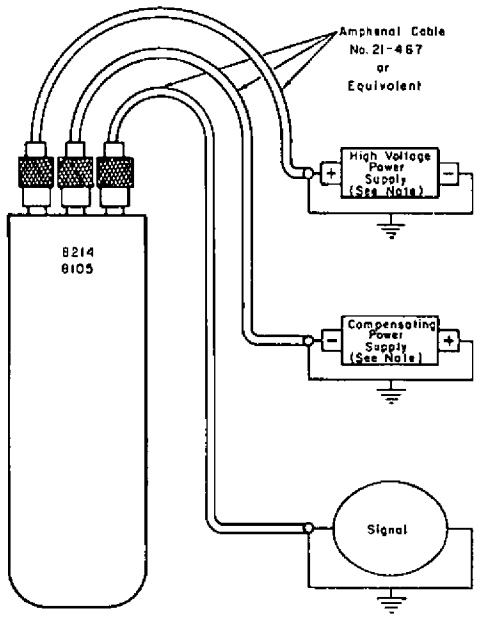
PRINTED IN U.S.A.

Neutron & Radiation Detector Section

WESTINGHOUSE ELECTRIC CORPORATION, ELECTRONIC TUBE DIVISION, ELMIRA, NEW YORK

from JEDEC release #3822, July 23, 1962

TYPICAL CONNECTION DIAGRAM

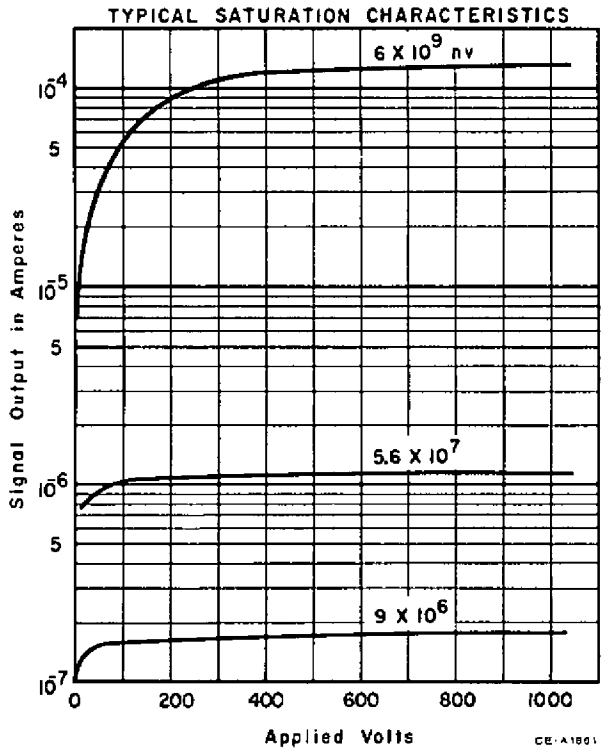


Note: Permissible power supply regulation and ripple will depend upon the particular application. See Section entitled "Ionization Chamber Operation."

CE-A1782

FIGURE 1

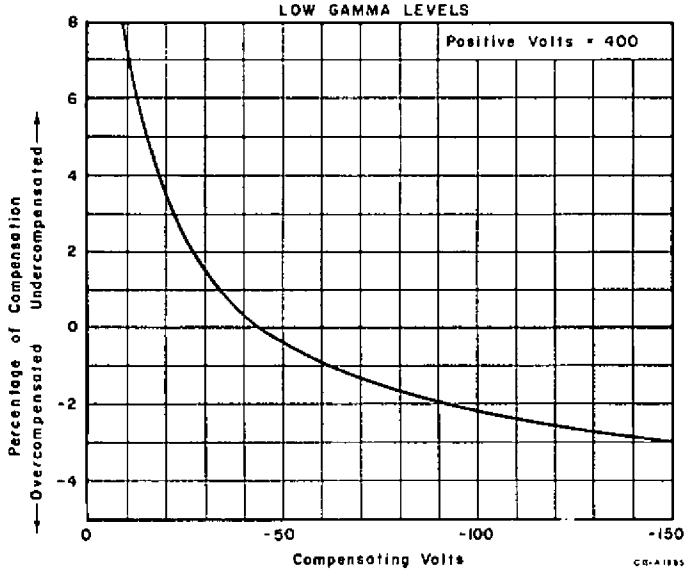
TYPICAL SATURATION CHARACTERISTICS



CE-A1861

FIGURE 2

TYPICAL COMPENSATION CHARACTERISTIC
AT
LOW GAMMA LEVELS



CE-A1885

FIGURE 3

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from JEDEC release #3822A, April 19, 1965

0573
3822A
4-19-65

Westinghouse Electric Corporation

Electronic Tube Division Box 284, Elmira, New York

April 2, 1965

* Mr. G. F. Hohn, Manager
EIA Engineering Laboratories
32 Green Street
Newark 2, New Jersey

Dear Mr. Hohn:

The following proposed re-registrations are hereby requested.

ITEM	AS REGISTERED	AS PROPOSED
Tube Type:	8073	
Rel. No.	3310	
Under Mat'ls:		
Neut. Sens. Mat'l.		
Total Quantity	1.72 Grams	1.68 Grams
Tube Types:	8105 8137 8214	
Ret. No.	3476 3522 3822	
Under TYP-OPER.		
Gamma Sens. (8137 only)	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.
Un-Comp.	5×10^{-12} A/R/hr.	3.5×10^{-12} A/R/hr.

Thank you.

Very truly yours,

J. A. Scott
Commercial Engineering

JAS/cb

EIA STANDARDS
APR - 5 1965
LABORATORY

VHF BEAM-POWER TYPES WL-8032 AND WL-8298

The WL-8032 and WL-8298 are new, improved octal based beam-power pentode type tubes. They are designed for service as very-high-frequency amplifiers or oscillators. They may also be used as audio amplifiers or modulators. Their small size makes them ideal for compact mobile and stationary communications equipment. These types are characterized by high power sensitivity, low plate and grid 2 voltages and low driving power.

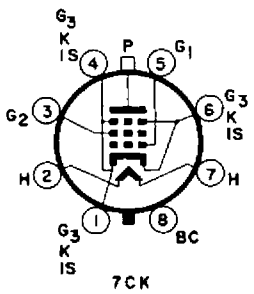
The cathode and grid 3 are connected to an internal shield and three base pins. These connections make possible an effective radio frequency ground. A T-12 bulb and a short internal lead button stem contribute to cooler operation and longer life. The short metal sleeve around the base provides shielding for the input. The top-cap plate connection isolates the input circuit from the output circuit. The top-cap is skirted to secure a better bond with the envelope and to increase its heat dissipation capabilities.

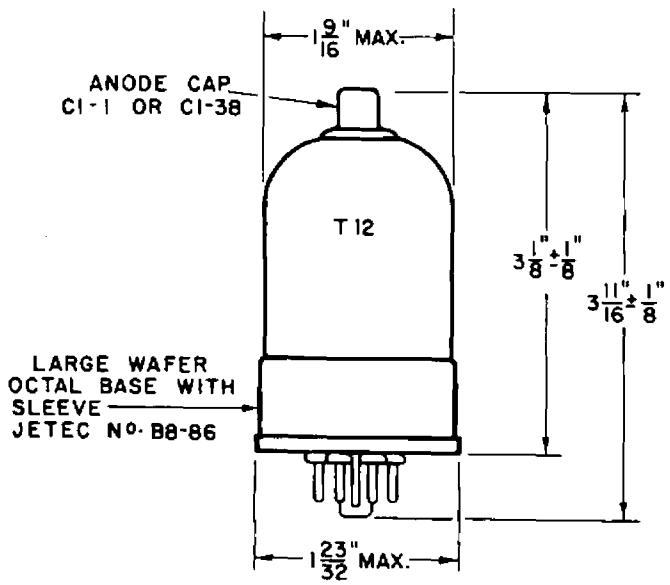
ELECTRICAL

Cathode	Coated Unipotential		
Heater:	WL-8298	WL-8032	
Voltage (ac or dc)	6.75	13.5	Volts
Current	1.165	0.585	Ampere
Direct Interelectrode Capacitances: (Unshielded)			
Grid 1 to Plate	0.22 max.		$\mu\mu f$
Input	13.5		$\mu\mu f$
Output	8.5		$\mu\mu f$

MECHANICAL

Bulb	T-12
Base	Large Wafer Octal with Sleeve (JEDEC B8-86) or Small Wafer Octal with Sleeve (JEDEC B8-150)
Basing	7CK
Top Cap	Small (JEDEC C1-1) or Small Skirted (JEDEC C1-38)
Mounting Position	Any
Max. Bulb Temperature at Hottest Point	220 °C





from JEDEC release #3973, Nov. 12, 1962

AF POWER AMPLIFIER AND MODULATOR

CLASS AB$_1$ OPERATION⊕
TRIODE CONNECTED

MAXIMUM RATINGS

Absolute Maximum Values	CCS▲	ICAS*		
DC Plate Voltage	400	400	max.	Volts
Grid 2	Connected to Plate			
DC Plate Current	90	90	max.	Ma.
DC Plate Power Input	35	35	max.	Watts
Plate Dissipation	20	25	max.	Watts
Peak Heater-Cathode Voltage:				
Heater Positive with Respect to Cathode	135	135	max.	Volts
Heater Negative with Respect to Cathode	135	135	max.	Volts
Grid 1 Circuit Resistance: •				
With Fixed Bias	0.1	0.1	max.	Megohm
With Cathode Resistor Bias	0.5	0.5	max.	Megohm

TYPICAL OPERATING CHARACTERISTICS

Two Tubes in Push-Pull	CCS▲		ICAS*	
Plate Voltage	250	400	400	Volts
Grid 1 Voltage	-50	-100	-100	Volts
Peak Signal Grid 1 to Grid 1 Voltage•	100	200	200	Volts
Peak Signal Grid Driving Power•	0	0	0	Watts
Plate Current:				
Zero-Signal	120	40	40	Ma.
Maximum-Signal	125	100	100	Ma.
Plate-to-Plate Load Resistance	5000	8000	8000	Ohms
Peak Signal Power Output	10	22	22	Watts

TYPICAL OPERATING CHARACTERISTICS IN CCS▲

Two Tubes in Push-Pull				
Plate Voltage	400	500	600	Volts
Grid 2 Voltage■	190	185	180	Volts
Grid 1 Voltage (Fixed Bias)	-40	-40	-45	Volts
Peak Signal Grid 1 to Grid 1 Voltage•	80	80	90	Volts
Peak Signal Driving Power•	0	0	0	Watts
Plate Current:				
Zero Signal	63	57	26	Ma.
Max. Signal	228	215	200	Ma.
Grid 2 Current:				
Zero Signal	2.5	2.0	1.0	Ma.
Max. Signal	25	25	23	Ma.
Plate-to-Plate Load Resistance	4000	5500	7000	Ohms
Peak Signal Power Output	55	70	82	Watts

TYPICAL OPERATING CHARACTERISTICS IN ICAS*

Two Tubes in Push-Pull			
Plate Voltage	600	750	Volts
Grid 2 Voltage■	200	195	Volts
Grid 1 Voltage (Fixed Bias)	-50	-50	Volts
Peak Signal Grid 1 to Grid 1 Voltage•	100	100	Volts
Peak Signal Driving Power•	0	0	Watts
Plate Current:			
Zero Signal	28	23	Ma.
Max. Signal	229	220	Ma.
Grid 2 Current:			
Zero Signal	1.0	1.0	Ma.
Max. Signal	27	26	Ma.
Plate-to-Plate Load Resistance	6000	8000	Ohms
Peak Signal Power Output	95	120	Watts

CLASS AB$_1$ OPERATION⊕

MAXIMUM RATINGS

Absolute Maximum Values	CCS▲	ICAS*		
DC Plate Voltage	600	750	max.	Volts
DC Grid 2 Voltage	250	250	max.	Volts
DC Plate Current	125	135	max.	Ma.
DC Plate Power Input	60	85	max.	Watts
DC Grid 2 Power Input	3	3	max.	Watts
Plate Dissipation	20	25	max.	Watts
Peak Heater-Cathode Voltage:				
Heater Positive with Respect to Cathode	135	135	max.	Volts
Heater Negative with Respect to Cathode	135	135	max.	Volts
Grid 1 Circuit Resistance:				
With Fixed Bias	0.1	0.1	max.	Megohms
With Cathode-Resistor Bias		Not Recommended		

CLASS AB$_2$ OPERATION□

MAXIMUM RATINGS

Absolute Maximum Values	CCS▲	ICAS*		
DC Plate Voltage	600	750	max.	Volts
DC Grid 2 Voltage	250	250	max.	Volts
DC Plate Current	125	135	max.	Ma.
DC Plate Power Input	62.5	90	max.	Watts
DC Grid 2 Power Input	3	3	max.	Watts
Plate Dissipation	20	25	max.	Watts
Peak Heater-Cathode Voltage:				
Heater Negative with Respect to Cathode	135	135	max.	Volts
Heater Positive with Respect to Cathode	135	135	max.	Volts
Grid 1 Circuit Resistance:				
With Fixed Bias:				
Operated at Max. Ratings	300000	300000	max.	Ohms
Operated below Max. Ratings	100000	100000	max.	Ohms
With Cathode-Resistor Bias		Not Recommended		

TYPICAL OPERATING CHARACTERISTICS IN CCS▲

Two Tubes in Push-Pull

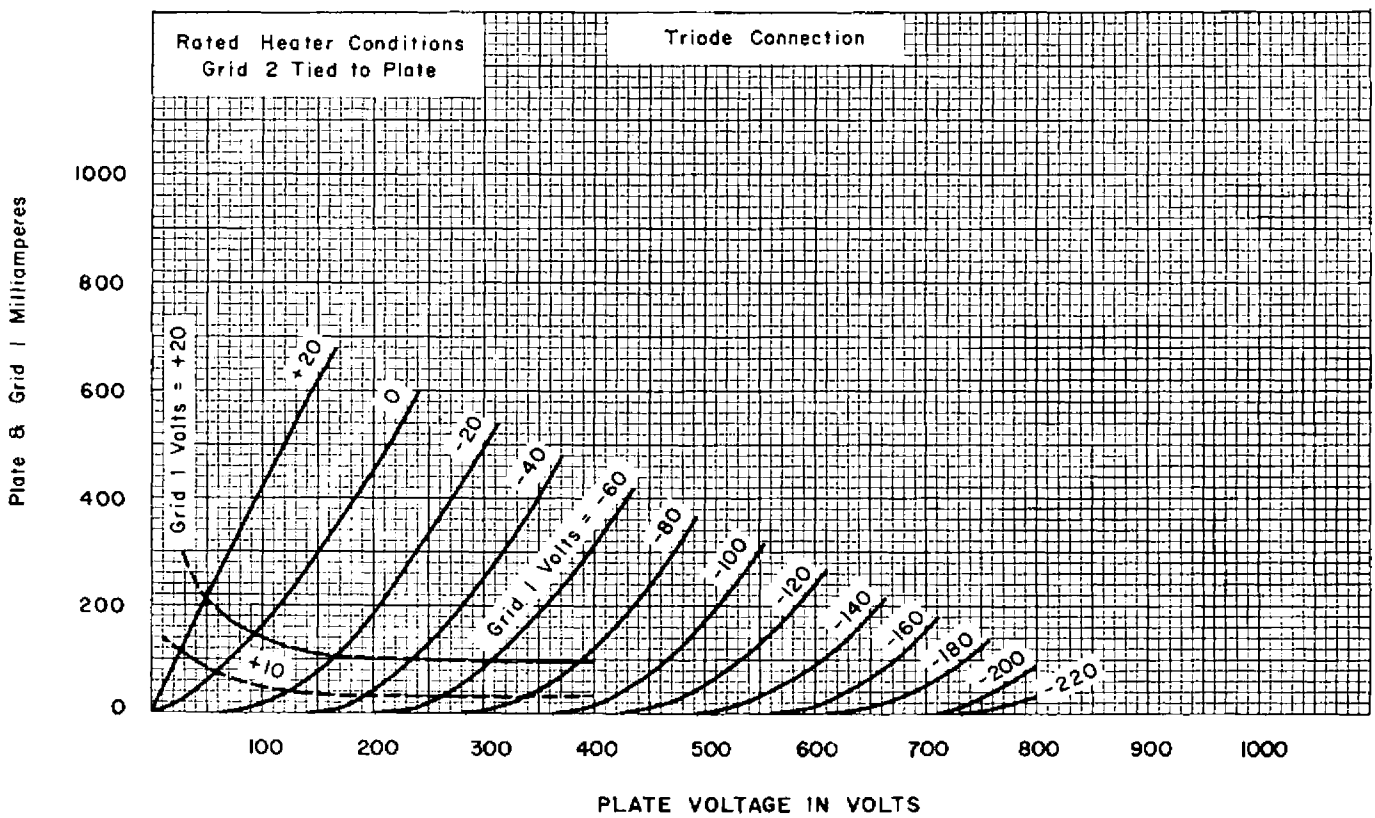
Plate Voltage	400	500	600	Volts
Grid 2 Voltage	175	175	165	Volts
Grid 1 Voltage (Fixed Bias)	-41	-44	-44	Volts
Peak Signal Grid 1 to Grid 1 Voltage*	95	102	97	Volts
Peak Signal Driving Power*	0.2	0.3	0.2	Watts
Peak Current:				
Zero Signal	33	27	22	Ma.
Max. Signal	232	242	207	Ma.
Grid 2 Current:				
Zero Signal	1.1	0.7	0.6	Ma.
Max. Signal	18	18	17	Ma.
Peak Signal Grid 1 Current	1.6	1.9	1.1	Ma.
Plate-to-Plate Load Resistance	3700	4600	6800	Ohms
Peak Signal Power Output	62	83	90	Watts

TYPICAL OPERATING CHARACTERISTICS IN ICAS*

Two Tubes in Push-Pull

Plate Voltage	600	750	Volts
Grid 2 Voltage	190	165	Volts
Grid 1 Voltage (Fixed Bias)	-48	-46	Volts
Peak Signal Grid 1 to Grid 1 Voltage*	109	108	Volts
Peak Signal Driving Power*	0.03	0.04	Watts
Plate Current:			
Zero Signal	28	22	Ma.
Max. Signal	270	240	Ma.
Grid 2 Current:			
Zero Signal	1.2	0.3	Ma.
Max. Signal	20	20	Ma.
Peak Signal Grid 1 Current	2.0	2.6	Ma.
Plate-to-Plate Load Resistance	5000	7400	Ohms
Peak Signal Power Output	113	131	Watts

AVERAGE PLATE CHARACTERISTICS



CE-A1338

RF POWER AMPLIFIER AND OSCILLATOR

PLATE MODULATED CLASS C TELEPHONY
MAX. MODULATED FACTOR OF 1.0

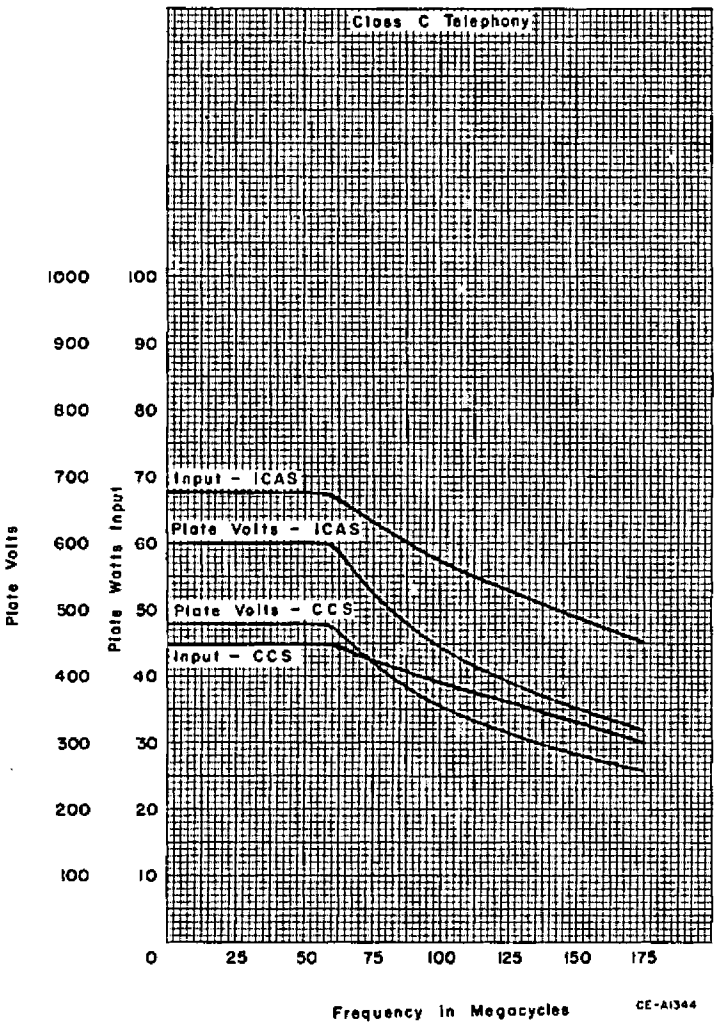
MAXIMUM RATINGS:

Absolute Maximum Values	CCS▲	ICAS*		
DC Plate Voltage	480	600	max.	Volts
DC Grid 2 Voltage	250	250	max.	Volts
DC Grid 1 Voltage	-150	-150	max.	Volts
DC Plate Current	117	125	max.	Ma.
DC Grid 1 Current	3.5	4.0	max.	Ma.
DC Plate Power Input	45	67.5	max.	Watts
DC Grid 2 Power Input	2	2	max.	Watts
Plate Dissipation	13.3	16.7	max.	Watts
Peak Heater-Cathode Voltage:				
Heater Negative with Respect to Cathode	135	135	max.	Volts
Heater Positive with Respect to Cathode	135	135	max.	Volts
Grid 1 Circuit Resistance♦				
Operated at Max. Ratings	30000	30000	max.	Ohms
Operated below Max. Ratings	100000	100000	max.	Ohms

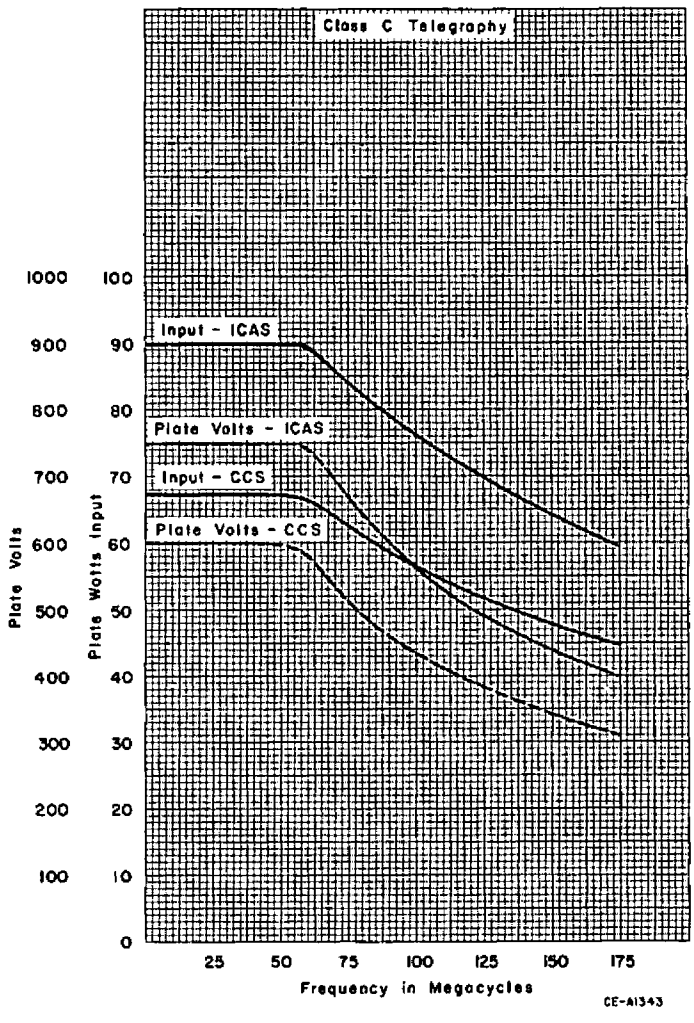
TYPICAL OPERATING CHARACTERISTICS

	CCS▲		ICAS*	
Plate Voltage	400	475	600	Volts
Grid 2 Voltage*	150	135	150	Volts
Grid 2 Series Resistor*	33000	51000	56000	Ohms
Grid 1 Voltage †	-87	-77	-87	Volts
Grid 1 Resistor †	27000	27000	27000	Ohms
Peak RF Driving Signal:				
Voltage	107	95	107	Volts
Power	0.4	0.3	0.4	Watt
Plate Current	112	94	112	Ma.
Grid 2 Current	7.8	6.4	7.8	Ma.
Grid 1 Current	3.4	2.8	3.4	Ma.
Power Output	32	34	52	Watts

POWER INPUT - FREQUENCY CHARACTERISTICS



POWER INPUT - FREQUENCY CHARACTERISTICS



CONTINUOUS WAVE CLASS C TELEGRAPHY AND FREQUENCY MODULATED CLASS C TELEGRAPHY

MAXIMUM RATINGS

Absolute Maximum Values	CCS▲	ICAS*		
DC Plate Voltage	600	750	max.	Volts
DC Grid 2 Voltage	250	250	max.	Volts
DC Grid 2 Key-Up Voltage	400	400	max.	Volts
DC Grid 1 Voltage	-150	-150	max.	Volts
DC Plate Current	140	150	max.	Ma.
DC Grid 1 Current	3.5	4.0	max.	Ma.
DC Plate Power Input	6 7.5	90	max.	Watts
DC Grid 2 Power Input	3.0	3.0	max.	Watts
Plate Dissipation	20	25	max.	Watts
Peak Heater-Cathode Voltage:				
Heater Negative with Respect to Cathode	135	135	max.	Volts
Heater Positive with Respect to Cathode	135	135	max.	Volts
Grid 1 Circuit Resistance♦				
Operated at Max. Ratings	30000	30000	max.	Ohms
Operated below Max. Ratings	100000	100000	max.	Ohms

TYPICAL OPERATING CHARACTERISTICS

Frequencies up to 60 Megacycles	CCS▲		ICAS*		
Plate Voltage	500	600	600	750	Volts
Grid 2 Voltage■	170	150	180	160	Volts
Grid 2 Series Resistor	36000	51000	43000	56000	Ohms
Grid 1 Voltage	-66	-58	-71	-62	Volts
From Grid Resistor of	27000	20000	24000	20000	Ohms
or Cathode-Bias Resistor of	470	470	430	470	Ohms
Peak RF Driving Signal:					
Voltage	84	73	91	79	Volts
Power	0.2	0.2	0.3	0.2	Watts
Plate Current	135	112	150	120	Ma.
Grid 2 Current	9	9	10	11	Ma.
Grid 1 Current	2.5	2.8	2.8	3.1	Ma.
Power Output	48	52	66	70	Watts

TYPICAL OPERATING CHARACTERISTICS

175 Megacycle Amplifier	CCS▲	ICAS*	
Plate Voltage	320	400	Volts
Grid 2 Voltage■	180	190	Volts
Grid 2 Series Resistor	13000	20000	Ohms
Grid 1 Voltage	-51	-54	Volts
From Grid Resistor of	27000	24000	Ohms
or a Cathode Resistor of	330	330	Ohms
Peak RF Driving Signal:			
Voltage	64	68	Volts
Power	3	3	Watts
Plate Current	140	150	Ma.
Grid 2 Current	10	10.4	Ma.
Grid 1 Current	2	2.2	Ma.
Power Output	25	35	Watts

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

	WL-8298	WL-8032	
Heater Voltage	6.75	13.5	ac Volts
Heater Current:			
Minimum	1.100	0.550	Ampere
Maximum	1.230	0.620	Ampere
Grid 1 Plate Capacitance:			
Maximum	0.22		uuf
Input Capacitance			
Minimum	11.1		uuf
Maximum	15.9		uuf
Output Capacitance:			
Minimum	6.4		uuf
Maximum	10.6		uuf
	Amplifier	Oscillator‡	
Plate Volts	300	600	Volts
Grid 2 Volts	200	180	Volts
Grid 1 Volts	-33	- -	Volts
Grid 1 Resistor	- -	30000	Ohms
Plate Current:			
Maximum	94	112	Ma.
Minimum	46	100	Ma.
Grid 2 Current:			
Maximum	5.5	- -	Ma.
Minimum	- -	- -	Ma.
Grid 1 Current:			
Maximum	- -	2.5	Ma.
Minimum	- -	2.0	Ma.
Power Output:			
Minimum	- -	47	Watts

NOTES

ϕ Pin 8 grounded.

⊕ Subscript 1 indicates that no grid current flows during any part of the input cycle.

▲ Continuous Commercial Service

* Intermittent Commercial and Amateur Service

♦ The input-coupling network used should not introduce too much resistance in the Grid 1 circuit. Transformer or impedance coupling arrangements are recommended.

● The driving stage should be capable of supplying these values of voltage and power at low distrotion.

■ The grid 1 voltage should not change with power supply load. A separate power supply or independent voltage-divider voltage source is recommended.

□ Subscript 2 indicates grid 1 draws current during some part of the input cycle.

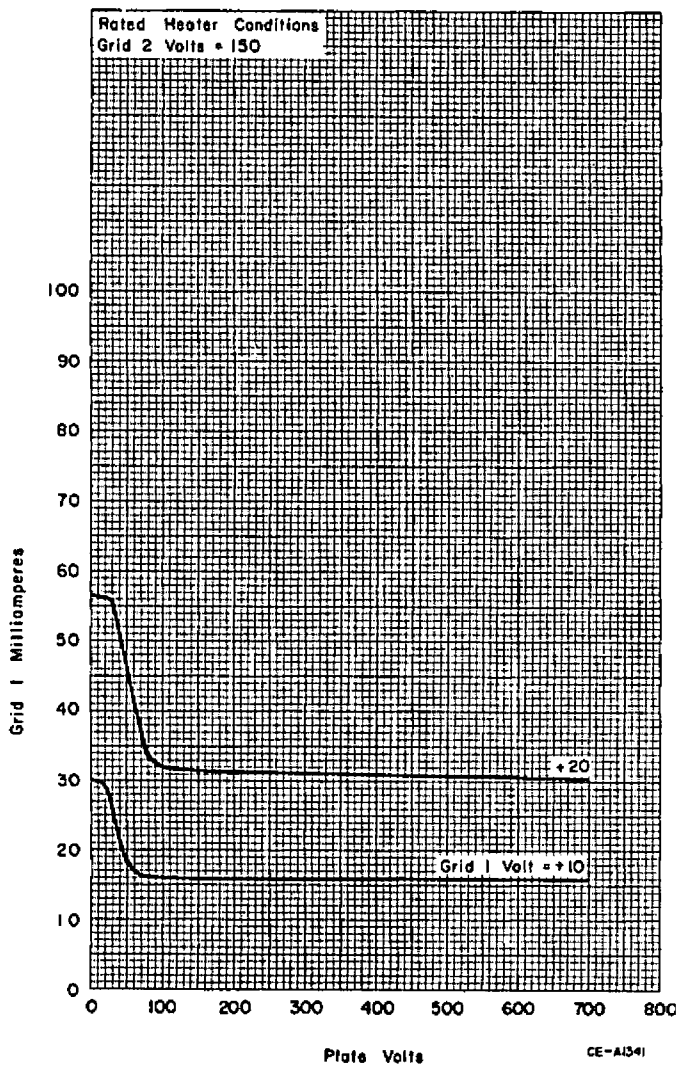
♦ When grid 1 is driven positive and draws current the listed values must not be exceeded. If these values are insufficient to provide proper operating bias, other biasing methods must be used to provide the required extra bias without increasing grid 1 circuit resistance.

* It is recommended that the screen voltage be modulated with the plate voltage. This can be accomplished by an independent modulated power supply or a series resistor from the plate voltage supply.

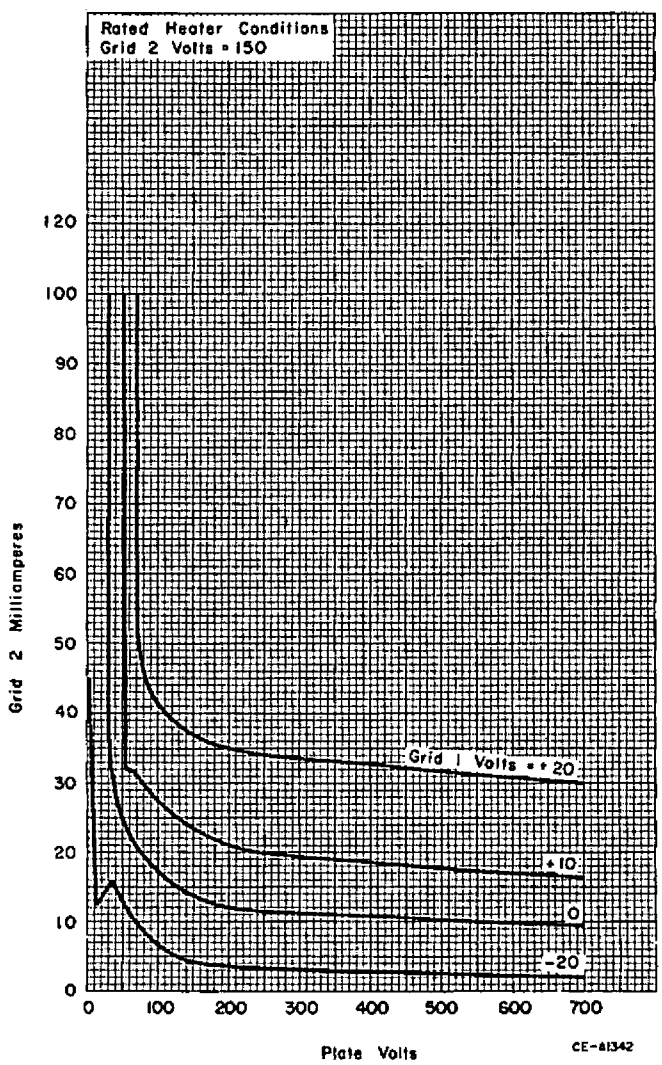
† The grid 1 bias should be generated by either grid resistor or combination grid resistor and cathode-bias resistor methods.

‡ Operated as a single tube self excited 15 Mc. Oscillator.

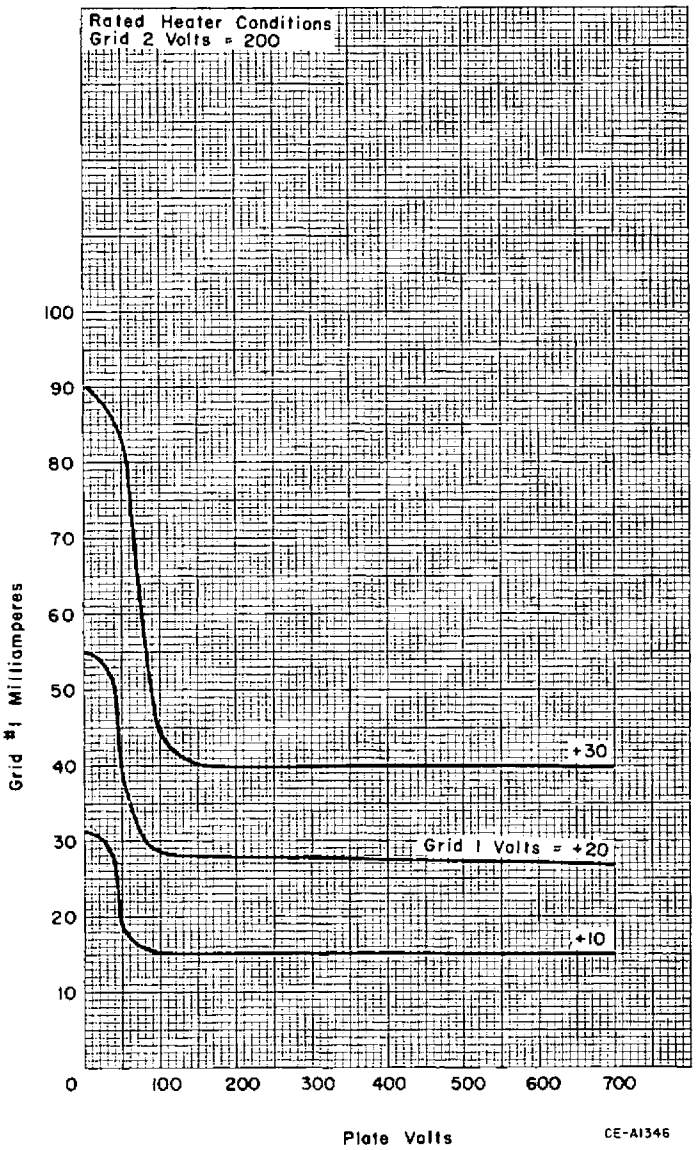
AVERAGE CHARACTERISTICS



AVERAGE CHARACTERISTICS

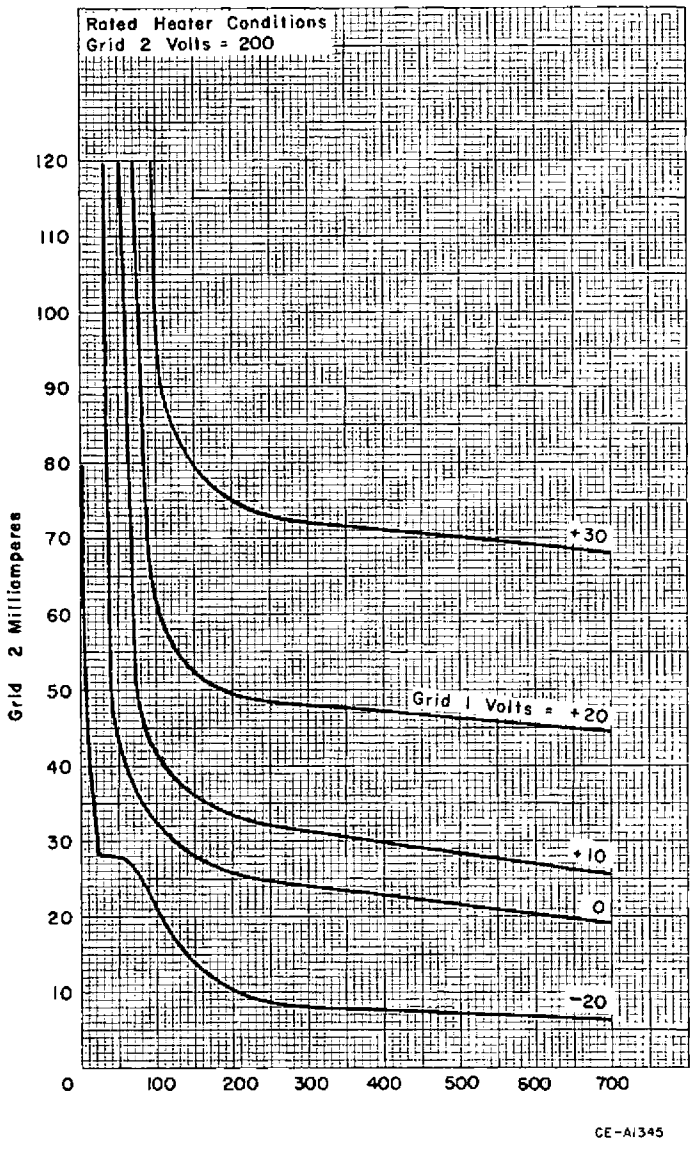


AVERAGE CHARACTERISTICS



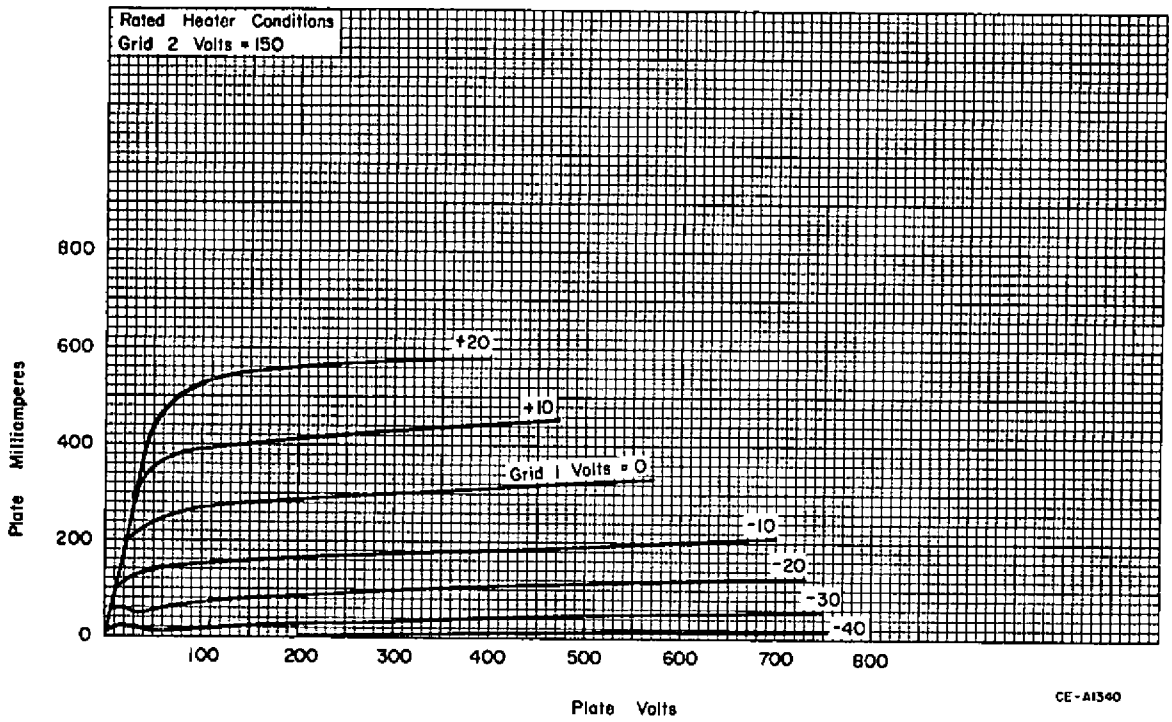
CE-AI346

AVERAGE CHARACTERISTICS

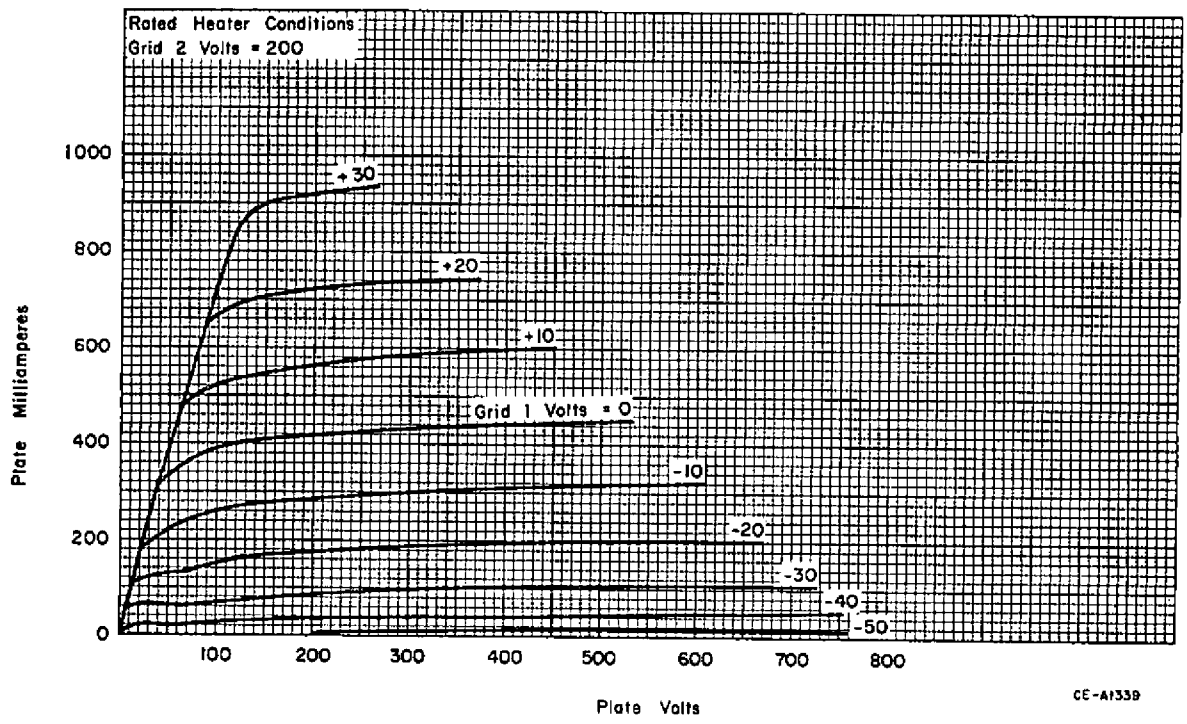


CE-AI345

AVERAGE PLATE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



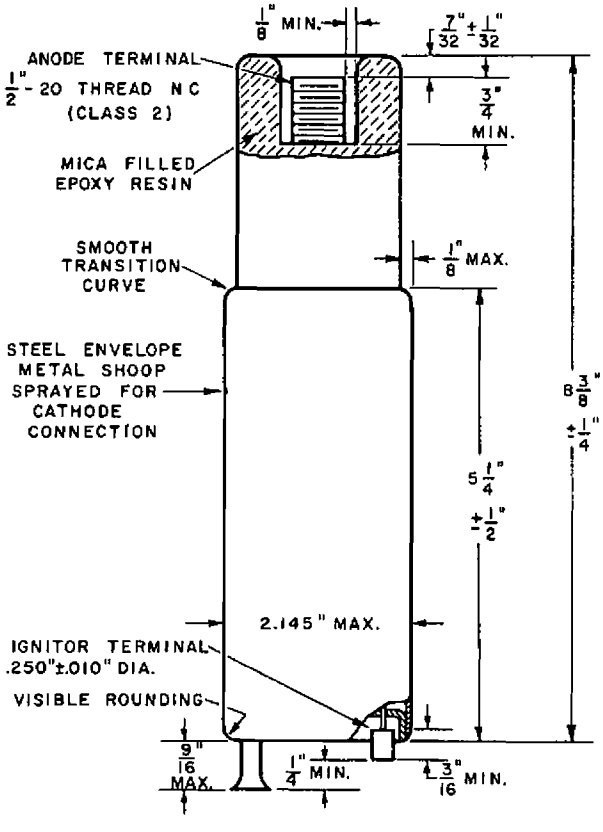
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IGNITRON FOR CAPACITOR DISCHARGE SERVICE TYPE WL-8306

The WL-8306 is a sealed, steel envelope tube with Shoop sprayed area where contact is made to the cathode. The anode connection is a threaded stud. The combination is suitable for connection in low inductance, high current circuits as used in high current capacitor discharge circuits operating up to 15000 volts. In this service the tube will discharge up to 35000 amperes.

GENERAL

Number of Electrodes:		
Anodes	1	
Cathodes	1	
Ignitors	1	
Ignitor Firing Circuit:		
Capacitor	0.5	μf
Capacitor Voltage	2.5	Kilovolts
Series Resistor	10	Ohms
Pulse Transformer Ratio (Note 1)	1/1	–
Firing Thyratron	Type 4C35	–



MECHANICAL

Mounting Position – Axis Vertical, Anode Lead up	
Net Weight	3.7 lbs.
Shipping Weight	4.6 lbs.
Type of Cooling	Air or Liquid, By Clamp Around Tube
Clamp Temperature	10 to 30 °C
Cathode Temperature	35 max. °C
Anode Insulating Compound Temperature (Note 1)	70 max. °C

MAXIMUM RATINGS FOR CAPACITOR DISCHARGE

Peak Anode Voltage: (Note 2)		
Inverse	15000 max.	Volts
Forward (Note 3)	15000 max.	Volts
Anode Current:		
Peak	35000 max.	Ampere
Coulombs Per Discharge	18.6 max.	Amp. Sec.
Repitition Rate	2 max.	Per Minute
Rise Time		Note 4
Average Current	0.6 max.	Ampere

NOTES

1. The use of a pulse transformer in the ignitor circuit is optional. It may be used for isolation where desired. The capacitor size and voltage and other constants should be adjusted according to the transformer turns ratio. Values shown are for 1/1 ratio.

2. Before installing, mercury must be evaporated from the anode. During operation the anode must always be at higher temperature than the tube envelope. After operation the anode must cool more slowly than the envelope to insure that no mercury condenses on the anode. Initial anode heating may be done by screwing anode threaded connection into metal block heated to 140°C for six to eight hours. Lower portion of envelope must be cooled by water or other method to 25°C or less.

   The tube may be capable of conducting current in both directions until the oscillatory current becomes damped.

   The tube is unable to hold off this voltage immediately after conduction. From 1 to 10 seconds should elapse before voltage is applied again.

3. Forward voltage (Hold-off voltage) is the voltage to which the capacitors, being switched by the ignitron, are charged.

4. Rise time depends on circuit natural frequency up to about 0.5 Mc. At higher frequencies the anode voltage fall time (Figure 2) becomes a factor. The inductance of the tube is approximately 0.04 microhenry.

from JEDEC release #3822, July 23, 1962

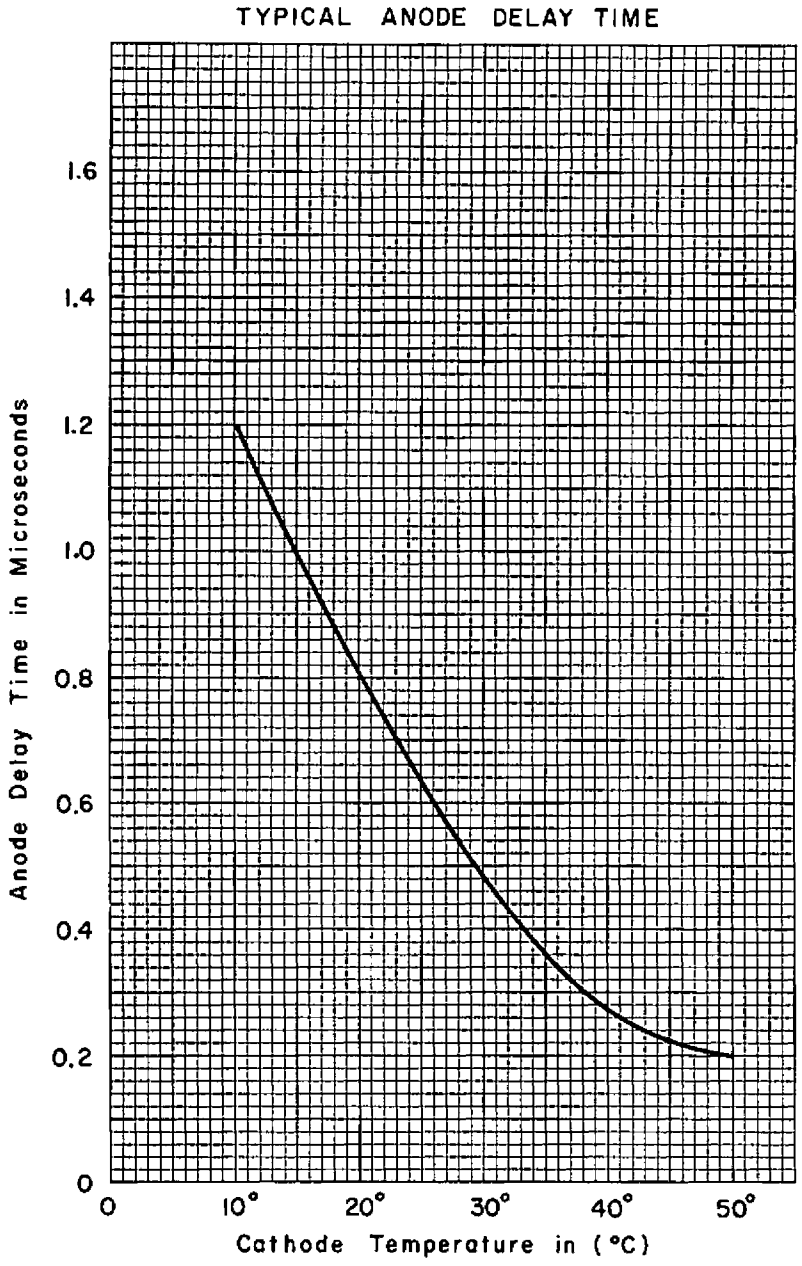


FIGURE 1

Anode Delay Time is the time from start of rise of ignitor signal voltage to reduction of anode voltage to 90% of the forward voltage.

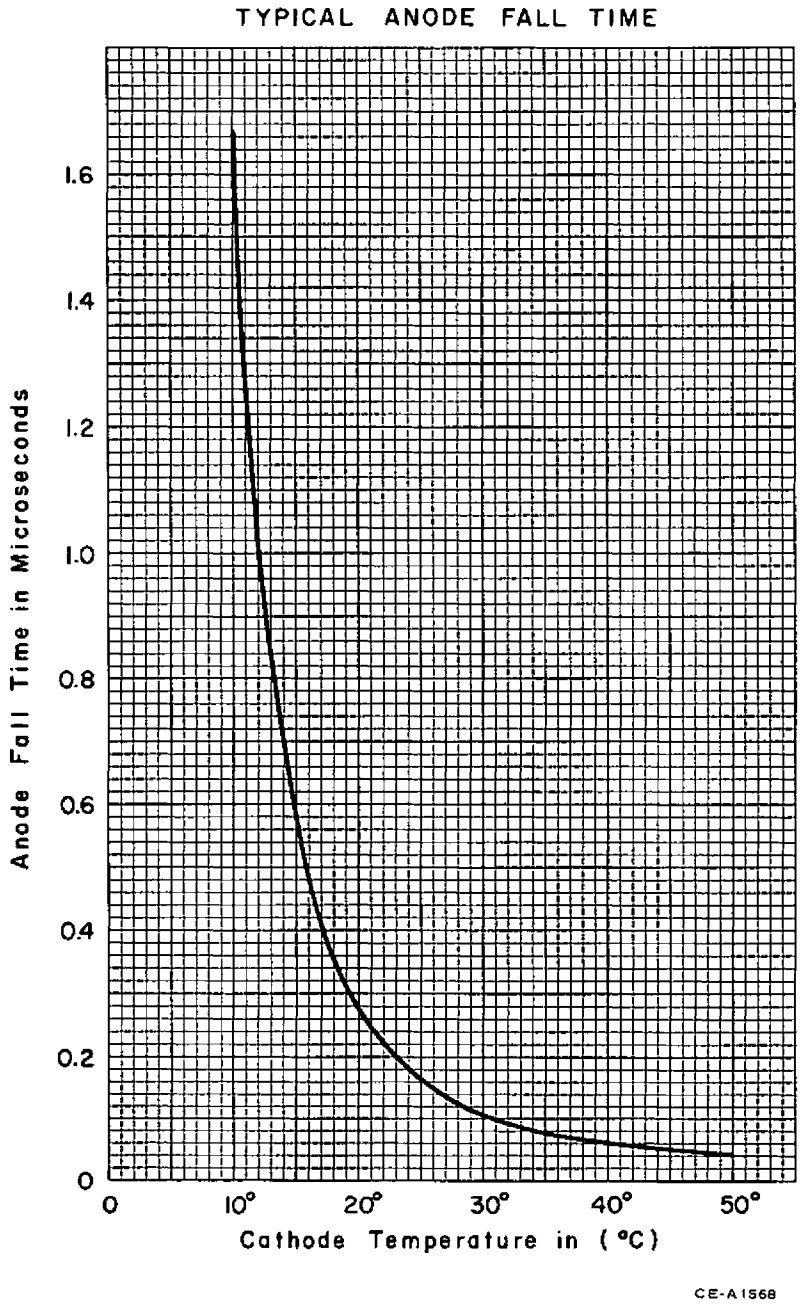


FIGURE 2

Anode Fall Time is the time for anode voltage to fall from 90% to 10% of the forward voltage.

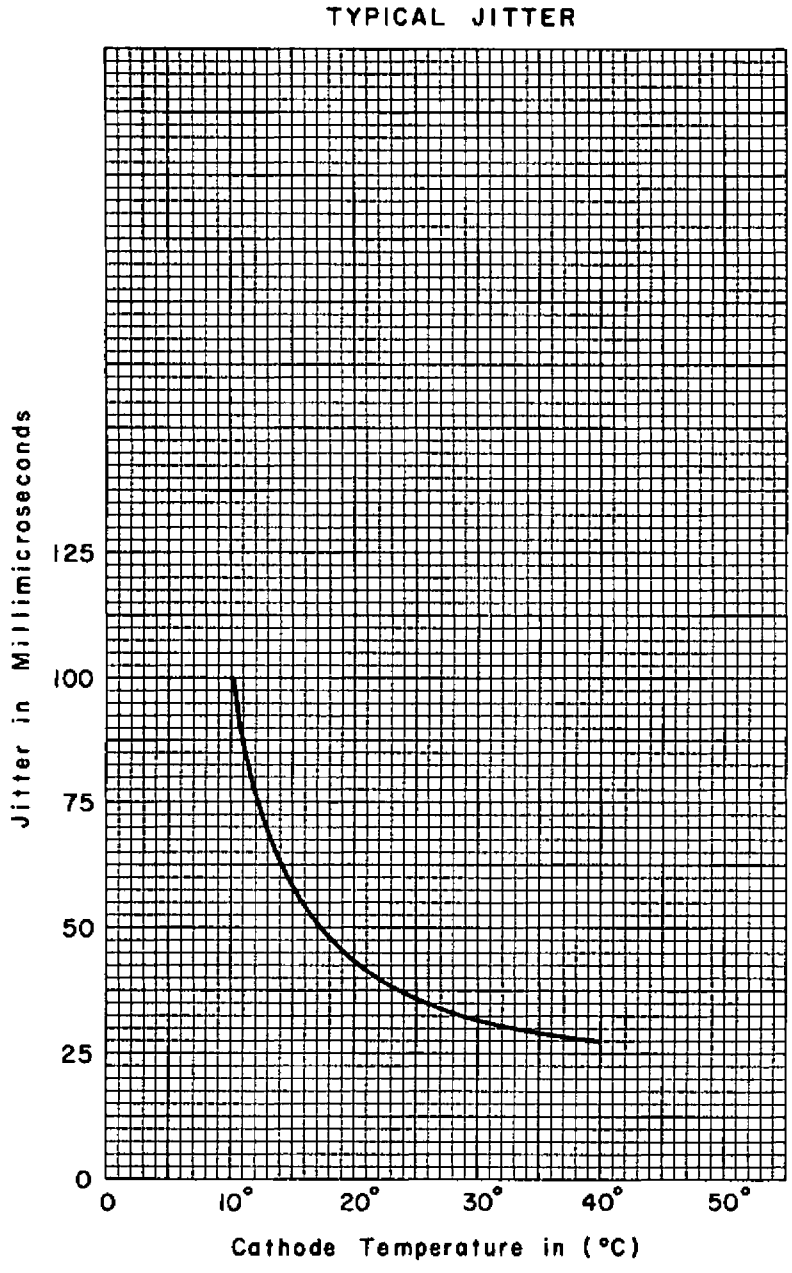


FIGURE 3

Jitter is the variation in time for anode voltage to fall to 50% of the forward voltage, stated as a plus-minus value from the average.

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BEAM-POWER PENTODE TYPE 8417

The 8417 is a glass octal, beam-power pentode designed for service as an output amplifier in high-fidelity, high-power sound systems. It has a 35 watt plate dissipation allowing design of push-pull amplifiers of 100 watts output. The 8417 features high power sensitivity and requires low drive for full power output. The 8417 is also suitable for use as a series tube in electronically regulated power supplies.

ELECTRICAL

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3	Volts
Current	1.6	Amperes
Direct Interelectrode Capacitances:		
Grid 1 - to - Plate	0.90	pf
Input	22	pf
Output	9.0	pf

MECHANICAL

Bulb	T-12
Base	Plaskon, Short Shell Octal, 6-Pin
Basing	7S
Mounting Position	Any

CHARACTERISTICS

Plate Voltage	300	Volts
Screen Voltage	300	Volts
Grid No. 1 Voltage	-12	Volts
Plate Current	100	Ma.
Screen Current	5.5	Ma.
Transconductance	23000	Micromhos
Plate Resistance	16000	Ohms
Triode Amplification Factor	16.5	-
Grid 1 Cutoff Voltage (Note 1)	-37	Volts

RATINGS

Design-Maximum Values:

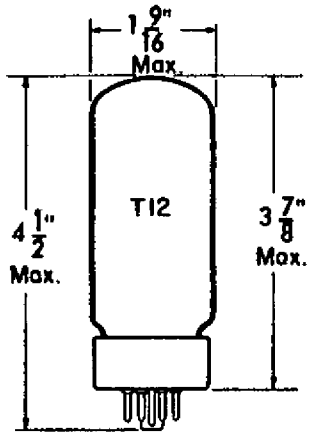
Plate Voltage	660	max.	Volts
Screen Voltage	500	max.	Volts
Plate Dissipation (Note 2)	35	max.	Watts
Screen Dissipation (Note 3)	5	max.	Watts
Cathode Current	200	max.	Ma.
Grid No. 1 Circuit Resistance:			
With Fixed Bias	0.1	max.	Megohm
With Cathode Bias	0.25	max.	Megohm
Heater-Cathode Voltage:			
Heater Negative with respect to Cathode			
Total DC + Peak	200	max.	Volts
Heater Positive with respect to Cathode			
DC Component	100	max.	Volts
Total DC + Peak	200	max.	Volts

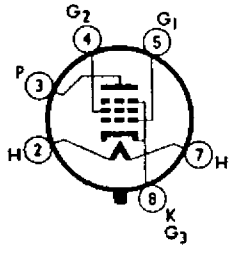
Push-Pull Class AB1 - Ultra-Linear (Note 4)
Operation (Values for Two Tubes)

Plate Supply Voltage	455	Volts
Grid 1 Voltage	-25	Volts
Peak A.F. Grid-to-Grid Voltage	45	Volts
Zero Signal Plate Current	146	Ma.
Maximum Signal Plate Current	314	Ma.
Effective Load, Plate-to-Plate	3500	Ohms
Total Harmonic Distortion	2.5	Percent
Maximum Signal Power Output	70	Watts

Push-Pull Class AB1 - Pentode Connection (Values for Two Tubes)

Plate Supply Voltage	400	560	Volts
Screen Supply Voltage	275	300	Volts
Grid 1 Voltage	-13	-15	Volts
Peak AF Grid-to-Grid Voltage	24	29	Volts
Zero Signal Plate Current	150	132 124	Ma.
Max. Signal Plate Current	294	290	Ma.
Zero Signal Screen Current	4.4	3.6	Ma.
Max. Signal Screen Current	34	36	Ma.
Effective Load, Plate-to-Plate	2800	4200	Ohms
Total Harmonic Distortion	2.5	2.5	Percent
Maximum Signal Power Output	65	100	Watts





Note: Pin-out changed to conform with 7S (actual prodution).

NOTES

1. For plate current of 1 milliampere.
2. The bulb becomes hot during operation. To ensure adequate cooling, it is essential that free circulation of air be provided around the bulb.
3. Screen dissipation may be permitted to reach 8 watts during the periods of maximum input of speech and music signals.
4. Screen tapped at 40% of primary turns. Stated plate current includes screen current.

from JEDEC release #4321, July 1, 1963

05764
4321B
6/7/65

Westinghouse Electric Corporation

Electronic Tube Division Box 284, Elmira, New York

May 25, 1965

Mr. G. F. Hohn, Manager
EIA Engineering Laboratories
32 Green Street
Newark 2, New Jersey

Dear Mr. Hohn:

Please reregister type 8417 (registered on July 1, 1963 in Release Number 4321) as follows.

Item	As Registered	As Proposed	Units
Push-Pull Class ABl Pentode Operation			
Grid 1 Voltage	-15	-15.5	Volts
Peak A-F Grid to Grid Voltage	29	31	Volts
Zero-Signal Plate Current	124	100	mA
Max-Signal Plate Current	290	270	mA
Zero-Signal Screen Current	3.6	3.4	mA
Max-Signal Screen Current	36	31	mA
Total Harmonic Distortion	2.5	2.0	Percent

Thank you.

Very truly yours

J. A. Scott

J. A. Scott
Commercial Engineering

JAS/cb

EIA STANDARDS
MAY 26 1965
LABORATORY

SHARP-CUTOFF PENTODE TYPE 8425

The 8425 is a 7-pin miniature, sharp-cutoff pentode type designed for service in wide band IF and RF amplifiers. It is operationally similar to type 6AU6 but has a higher transconductance-to-plate-current ratio.

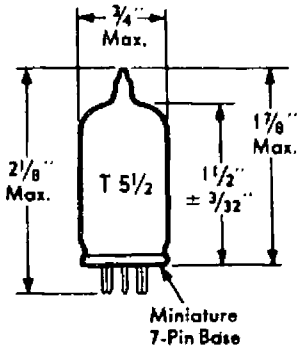
The 8425 features cathode materials and cathode coatings controlled for interface-free long life in industrial applications.

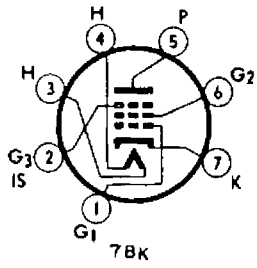
ELECTRICAL

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	6.3 ± 10%	Volts
Current	0.30	Ampere
Direct Interelectrode Capacitances:		
Pentode Connection:	Unshielded	
Grid to Plate (Max.)	0.0030	pf
Input	5.9	pf
Output	5.1	pf
Triode Connection (Note 1):		
Grid to Plate	2.5	pf
Input	3.6	pf
Output	1.1	pf

MECHANICAL

Bulb	T-5½
Base	Miniature 7-Pin (JEDEC E7-1)
Outline	5-2
Basing	78K
Mounting Position	Any





MAXIMUM RATINGS

Design Maximum Values

	Triode Connection	Pentode Connection		
Plate Voltage	275	330	max.	Volts
Grid 2 Supply Voltage	(Note 1)	330	max.	Volts
Grid 2 Voltage	(Note 1)	See Grid 2 Input Rating Chart		
Plate Dissipation	3.5	3.5	max.	Watts
Grid 2 Dissipation	–	0.75	max.	Watts
Grid 1 Voltage, Positive Bias Value	0	0	max.	Volts
Heater-Cathode Voltage:				
Heater Negative with Respect to Cathode				
Total DC + Peak		200	max.	Volts
Heater Positive with Respect to Cathode				
DC Component		100	max.	Volts
DC + Peak		200	max.	Volts
Cathode Interface Impedance after 1000 Hour Life Test (Note 2)		5	max.	Ohms

AMPLIFIER - CLASS A

CHARACTERISTICS AND TYPICAL OPERATION

Plate Voltage	100	250	250	Volts
Grid 2 Voltage	100	125	150	Volts
Grid 3 Voltage	Connected to Cathode			
Cathode Resistor	150	100	68	Ohms
Transconductance	4500	5500	6200	μmhos
Plate Resistance	0.6	1.3	1.1	Megohm
Grid 1 Cutoff Bias (Note 3)	–4.1	–4.9	–5.8	Volts
Plate Current	4.8	7.4	10.5	Ma.
Grid 2 Current	1.9	2.8	4.1	Ma.

CHARACTERISTICS (Triode Connected)

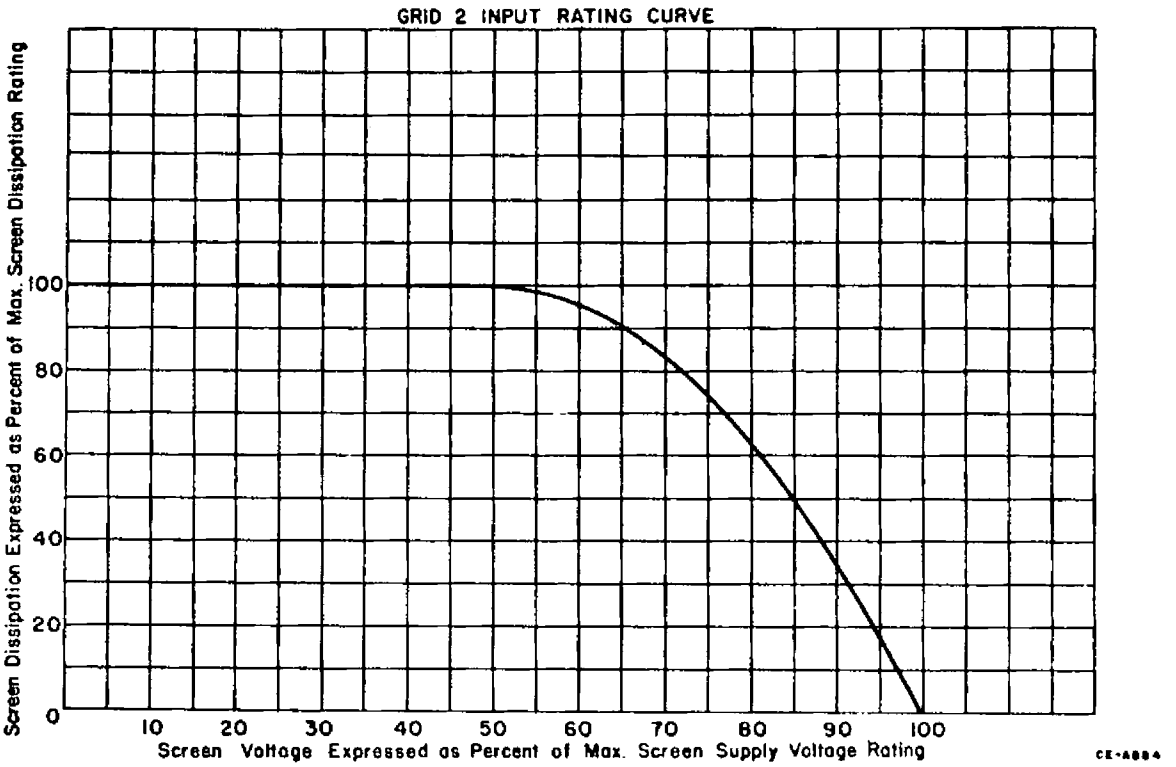
Plate Voltage	250	Volts
Cathode Resistor	330	Ohms
Amplification Factor	41	–
Transconductance	6000	μmhos
Plate Current	11.2	Ma.

NOTES

1. Grids 2 and 3 connected to plate.
2. Life Test Conditions:
   - Filament Volts = 6.5
   - Plate Volts = 250
   - Grid 2 Volts = 250
   - Grid 1 Resistor = 250K
   - Grid 1 Volts = –4.0
   - Grid 3 Volts = 0
   - Cathode ohms = 0
   - Heater to Cathode Volts = –200

   Cathode-Interface Impedance Test:
   As detailed in ASTM-F300-61T; appendix III with Filament Volts = 5.7.
3. For plate current of 10 μa.

from JEDEC release #4321, July 1, 1963



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SHARP-CUTOFF PENTODE TYPE 8426

The 8426 is a 7-pin miniature, sharp-cutoff pentode type designed for service in wide band IF and RF amplifiers. It is operationally similar to type 6AU6 but has a higher transconductance-to-plate-current ratio.

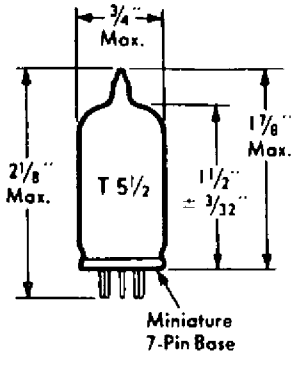
The 8426 features cathode materials and cathode coatings controlled for interface-free long life in industrial applications.

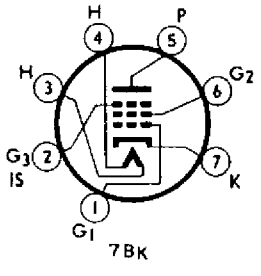
ELECTRICAL

Cathode	Coated Unipotential	
Heater:		
Voltage (ac or dc)	12.6 ± 10%	Volts
Current	0.15	Ampere
Direct Interelectrode Capacitances:		
Pentode Connection:	Unshielded	
Grid to Plate (Max.)	0.0030	pf
Input	5.9	pf
Output	5.1	pf
Triode Connection (Note 1):		
Grid to Plate	2.5	pf
Input	3.6	pf
Output	1.1	pf

MECHANICAL

Bulb	T-5½
Base	Miniature 7-Pin (JEDEC E7-1)
Outline	5-2
Basing	7BK
Mounting Position	Any





MAXIMUM RATINGS

Design Maximum Values

	Triode Connection	Pentode Connection		
Plate Voltage	275	330	max.	Volts
Grid 2 Supply Voltage	(Note 1)	330	max.	Volts
Grid 2 Voltage	(Note 1)	See Grid 2 Input Rating Chart		
Plate Dissipation	3.5	3.5	max.	Watts
Grid 2 Dissipation	–	0.75	max.	Watts
Grid 1 Voltage, Positive Bias Value	0	0	max.	Volts
Heater-Cathode Voltage:				
Heater Negative with Respect to Cathode				
Total DC + Peak		200	max.	Volts
Heater Positive with Respect to Cathode				
DC Component		100	max.	Volts
DC + Peak		200	max.	Volts
Cathode Interface Impedance after 1000 Hour Life Test (Note 2)		5	max.	Ohms

AMPLIFIER - CLASS A

CHARACTERISTICS AND TYPICAL OPERATION

Plate Voltage	100	250	250	Volts
Grid 2 Voltage	100	125	150	Volts
Grid 3 Voltage	Connected to Cathode			
Cathode Resistor	150	100	68	Ohms
Transconductance	4500	5500	6200	μmhos
Plate Resistance	0.6	1.3	1.1	Megohm
Grid 1 Cutoff Bias (Note 3)	-4.1	-4.9	-5.8	Volts
Plate Current	4.8	7.4	10.5	Ma.
Grid 2 Current	1.9	2.8	4.1	Ma.

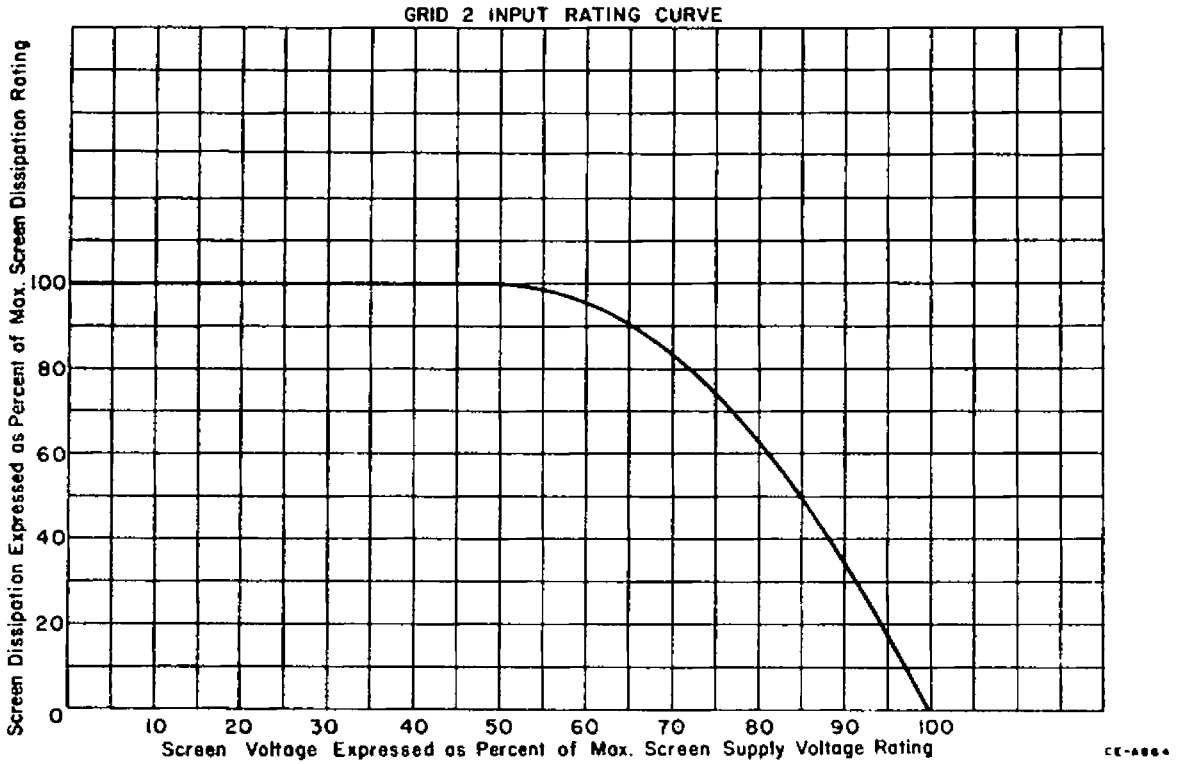
CHARACTERISTICS (Triode Connected)

Plate Voltage	250	Volts
Cathode Resistor	330	Ohms
Amplification Factor	41	–
Transconductance	6000	μmhos
Plate Current	11.2	Ma.

NOTES

1. Grids 2 and 3 connected to plate.
2. Life Test Conditions:
   Filament Volts = 13.0 — Grid 1 Volts = -4.0
   Plate Volts = 250 — Grid 3 Volts = 0
   Grid 2 Volts = 250 — Cathode ohms = 0
   Grid 1 Resistor = 250K — Heater to Cathode Volts = -200
   Cathode-Interface Impedance Test:
   As detailed in ASTM-F300-61T; appendix III with Filament Volts = 11.4
3. For plate current of 10 μa.

from JEDEC release #4321, July 1, 1963



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HARD TUBE PULSE MODULATOR TYPE WL-8461

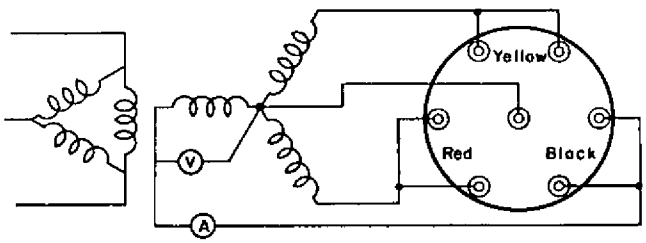
The WL-8461 is a large, three-electrode, immersion cooled tube designed for service as a hard-tube modulator or series regulator. The anode is capable of dissipating 30 Kilowatts, exclusive of filament heating power, when oil cooled or 200 Kilowatts when water cooled. The cathode is a multiple-stand, thoriated-tungsten filament operated 3 phase.

ELECTRICAL

Cathode	Thoriated-Tungsten Filament	
Filament:		
Voltage:		
3 Phase (to neutral)	15	Volts
Current:		
3 Phase (per phase)	200	Amperes
Min. Filament Heating Time	60	Seconds
Filament Starting Current, Max.	600	Amps.
Filament Cold Resistance	.0065	Ohms
Amplification Factor	25	
Direct Interelectrode Capacitances:		
Grid to Plate	72	$\mu\mu f$
Grid to Filament	180	$\mu\mu f$
Plate to Filament	3	$\mu\mu f$

FILAMENT CONNECTIONS

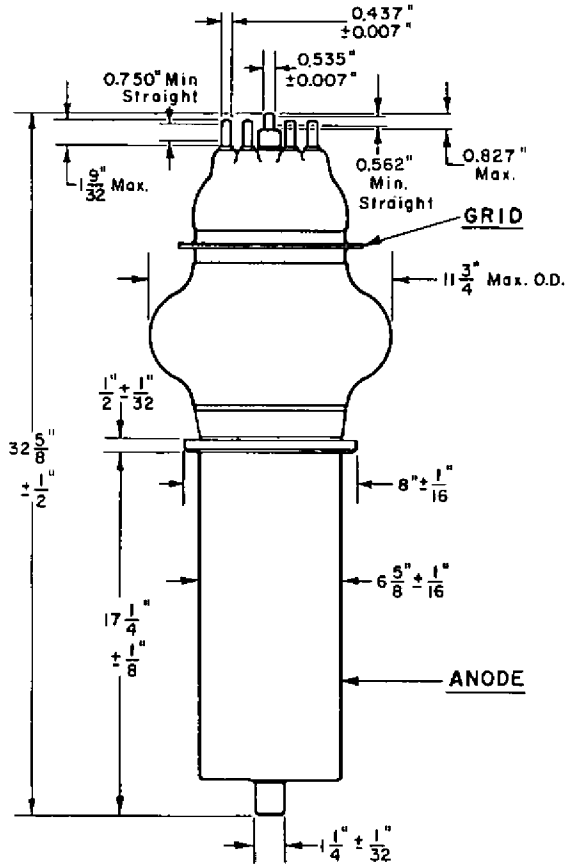
V = 15 Volts to Neutral
A = 200 Amperes per Phase



CE-A2061

MECHANICAL

Mounting Position	Vertical, Anode Down		
Net Weight (Approx.)	48 Pounds		
Cooling:			
Type	Oil	Water	
Maximum Fluid Temp.	80	45	°C
Maximum Bulb & Seal Temp.	180	180	°C
Minimum Water Flow	–	40	G.P.M.
Min. Air Flow on Bulb & Seals	–	75	C.F.M.



ACCESSORIES

NAME	QUANTITY	PART NO.
Water Jacket	1	WL-22688
Gasket	1	43-203
Filament Connector	6	WL-22677
Filament CT Connector	1	WL-22682
Grid Connector	1	WL-22689

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

Absolute Maximum Values

DC Plate Voltage	80 max.	Kilovolts
DC Grid Voltage	–5000 max.	Volts
Peak Pulse Plate Current	600 max.	Amperes
Peak Pulse Grid Current	150 max.	Amperes
Plate Dissipation:		
Oil Cooled	30 max.	Kilowatts
Water Cooled	200 max.	Kilowatts
Grid Dissipation	3.6 max.	Kilowatts
Pulse Length	1000 max.	μseconds
Duty Factor	0.01 max.	–
Peak Pulse Cathode Current	750 max.	Amperes

from JEDEC release #4571, Jan. 27, 1964

TYPICAL OPERATION

DC Plate Voltage	55	65	75	Kilovolts
DC Grid Voltage	-2750	-3350	-3750	Volts
Pulse Positive Grid Voltage	3500	3500	3500	Volts
Pulse Plate Current	600	600	600	Amperes
Pulse Grid Current	92	92	92	Amperes
Pulse Driving Power	575	630	665	Kilowatts
Pulse Power Output	28.5	34.5	40	Megawatts
Plate Output Voltage	47.5	57.5	67.5	Kilovolts

SERIES REGULATOR SERVICE

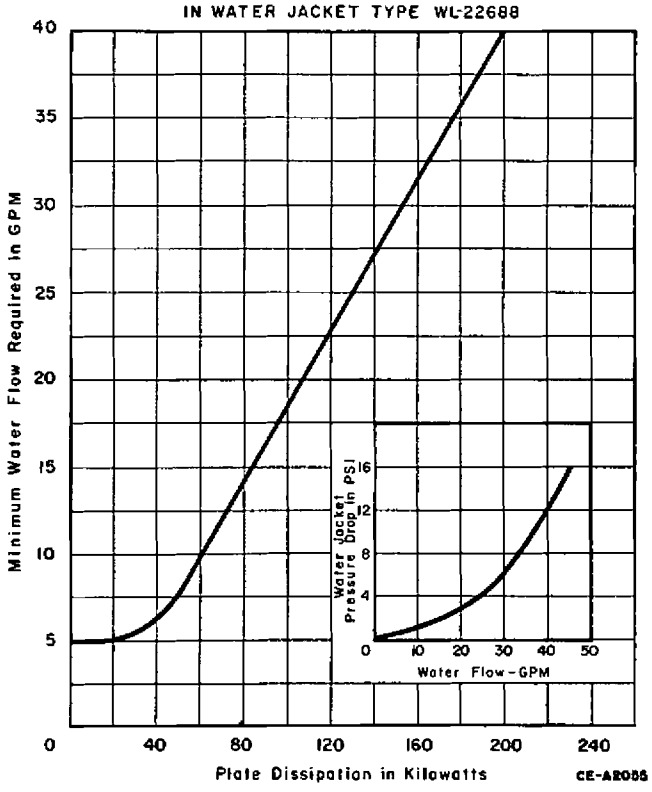
MAXIMUM RATINGS

Absolute Maximum Values

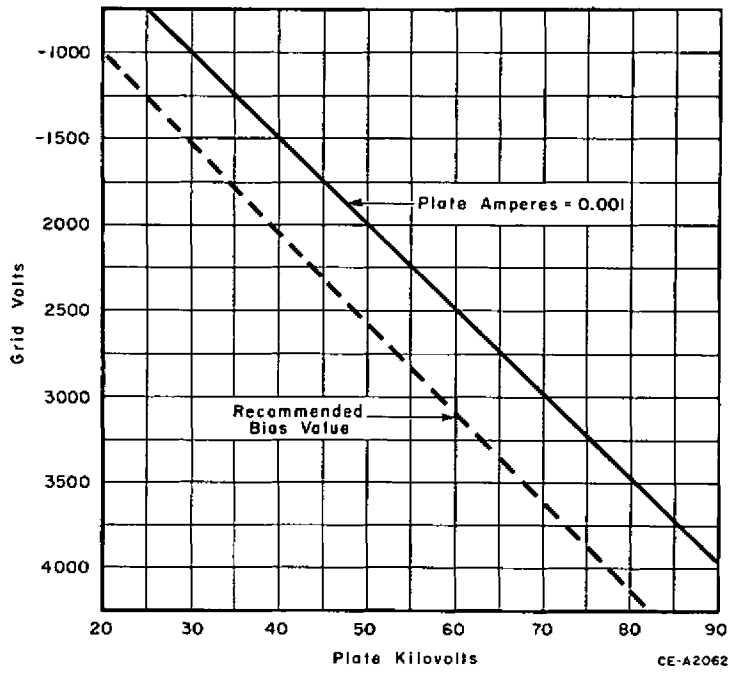
DC Plate Voltage	75 max.	Kilovolts
DC Grid Voltage	-5 max.	Kilovolts
DC Plate Current (Regulated)	50 max.	Amperes
Grid Dissipation	3.6 max.	Kilowatts
Plate Dissipation (Water Cooled)	200 max.	Kilowatts

X-Ray Warning: The Maximum Ratings of the WL-8461 permit operation at voltage in excess of 16 KV. Therefore equipment design consideration should include the generation of x-rays.

COOLING CHARACTERISTICS
IN WATER JACKET TYPE WL-22688



CUT-OFF CHARACTERISTIC



COOLING SYSTEMS

The water system should be the closed type using distilled or deionized water to preclude the possibility of scale formation and corrosion, both of which can be expected with tap water. Scale restricts water flow and prevents proper transfer of heat from the anode to the cooling water, and corrosion may damage the elements and pasages. The rates of scale formation and corrosion depend on the electrical conductivity of the water. To minimize the formation of scale and corrosion, the use of a coolant having an initial resistance of at least 100,000 ohms per cubic centimeter is recommended. Since a very small amount of contamination can change the conductivity of distilled water, frequent measurement is desirable. The water should be changed when its resistance falls below 20,000 ohms per cubic centimeter. A filter should be placed in the water supply line to the tube to trap foreign particles likely to impair the flow. It is suggested that a filter with a 100-mesh screen (0.005" openings) be used.

The water-cooling system must function properly at all times since even a momentary failure of flow will damage the WL-8461. Without cooling water, the heat of the filament alone is sufficient to cause serious harm. It is necessary to keep the water-flow interlocks in correct adjustment and never to set them to operate below the recommended level. The flow of water and air must start before the application of any tube voltages; it is recommended that the flow of coolants continue for 5 minutes after the removal of all tube voltages. In the event of emergency or fault conditions, however, the simultaneous shut down of all power will not damage the tube. Specific water-flow data are given in the Water-Cooling Characteristics. Under no circumstances should the outlet water temperature exceed 70°C nor should the temperature of the entering water be permitted to fall below 10°C with plate potential on. Water pressure at the tube socket should never exceed 100 psi.

Forced-air cooling of the cathode terminals, the grid flange, and the glass envelope is required, and the cooling should be uniformly distributed around the circumference of the seals. Air flow of 75 cfm provides adequate cooling.

TUBE PROTECTION NOTES

The handling of very high power requires particular attention to the removal of power from tubes during fault conditions (initiated by tube or circuit instabilities) since the larger amount of energy involved can cause tube damage if not properly controlled. The tube must, therefore, be protected by limiting the time elapsed from inception of a fault condition to diverting the energy from the tube, as well as the amount of energy expended in the tube during this interval.

In addition to the normal circuit breakers and overload relays, it is necessary that a fast-acting electronic protective device (crowbar) or equivalent be used. This device will in most cases be a triggered device connected across the output of the plate supply filter, if used, to dissipate the filter-circuit energy as well as the rectifier output. The complete energy source must be shorted out as quickly as possible after the inception of a "fault", and in most cases the time interval should not be allowed to exceed approximately ten microseconds. For some basic electronic-crowbar fault-protection circuit considerations, as well as tests of the effectiveness of a protection device, refer to the references listed.

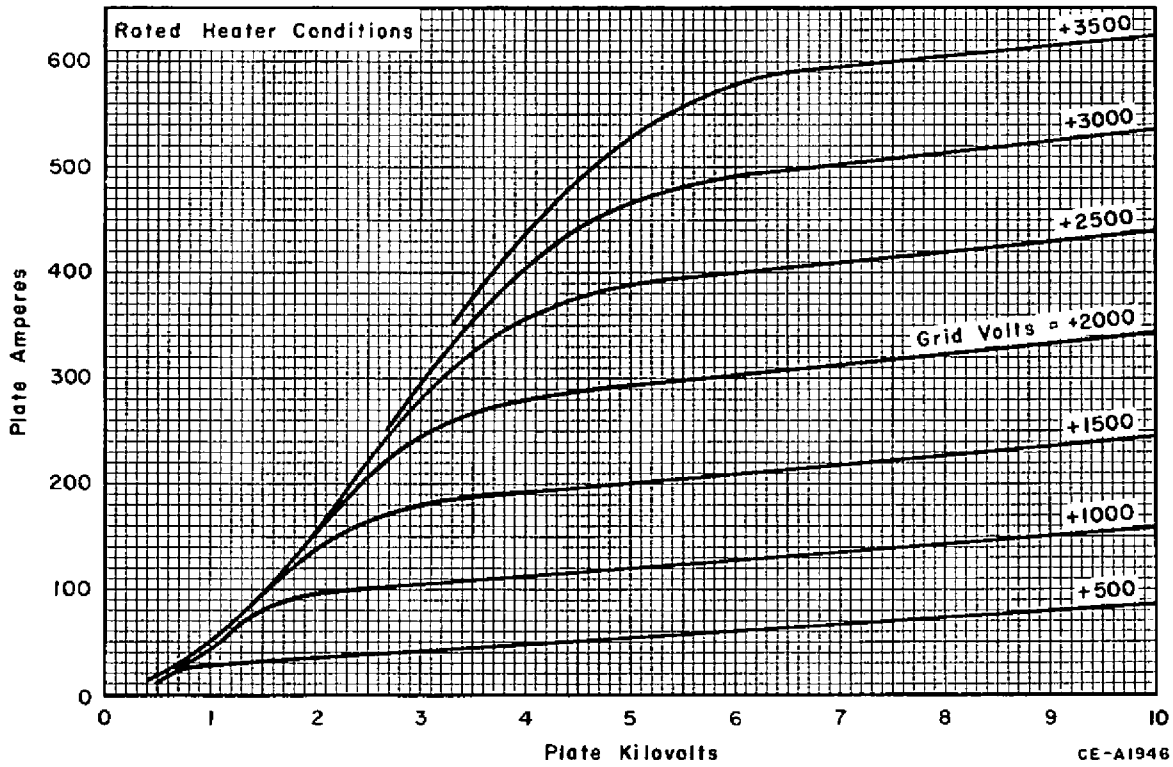
A nominal value of resistance must be placed inthe plate lead of the tube being protected in order to be assured that the impedance of this tube under a flash arc condition is greater than that of the crowbar device when the latter is triggered. Critical damping is required for the crowbar discharge circuit. It is also recommended that a minimum of five to ten ohms resistance be connected in series with each rectifier tube in order to limit surge currents.

In circuits where high transient voltages may be developed due to a shorted load or other fault, special precautions are necessary to keep these excessive voltages from appearing at the tube electrodes.

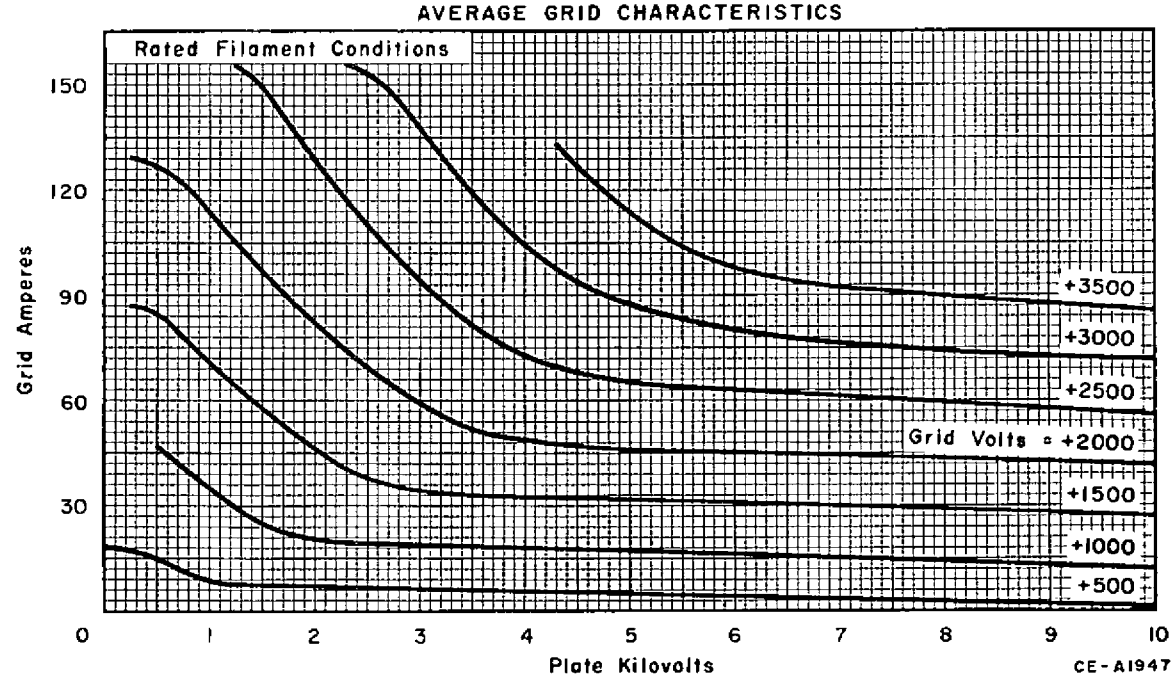
REFERENCES

1. W. N. Parker and M. V. Hoover, "Gas Tubes Protect High Power Transmitters", Electronics, 29, 144, January 1956.
2. A. J. Morris and J. P. Swanson, "The High Speed Protection of Microwave Tubes and Systems", The Microwave Journal, Vol. V, No 11, Nov. 1962.

AVERAGE PLATE CHARACTERISTICS

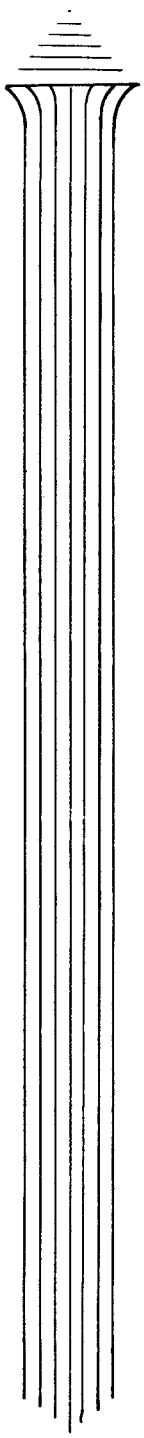


AVERAGE GRID CHARACTERISTICS



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Westinghouse ELECTRONIC TUBES



PHOTOTUBES

SR-50 , SR-51 , SR-53 , SR-58 , SK-60
SK-61 , SK-63 , SK-68 , WL-734
WL-735 , WL-737 , WL-770

WESTINGHOUSE LAMP DIVISION

WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY

SPECIAL PRODUCTS SALES DEPARTMENT

BLOOMFIELD, N. J.

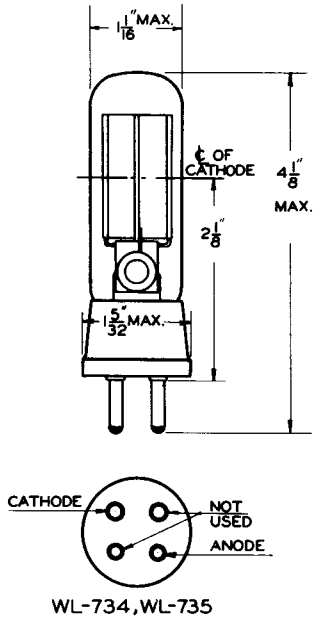
DISTRICT OFFICES

426 MARIETTA STREET	ATLANTA, GA.
20 NORTH WACKER DRIVE	CHICAGO, ILL.
411 NORTH 7TH. STREET	ST. LOUIS, MO.
150 BROADWAY	NEW YORK, N.Y.
1735 GULF BUILDING	PITTSBURGH, PA.
1 MONTGOMERY STREET	SAN FRANCISCO, CAL.

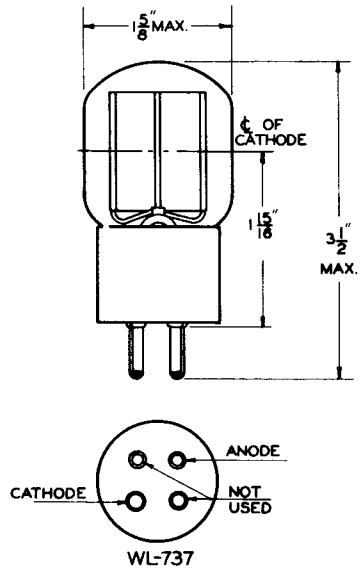
FEBRUARY 9, 1937

BULLETIN TD-76

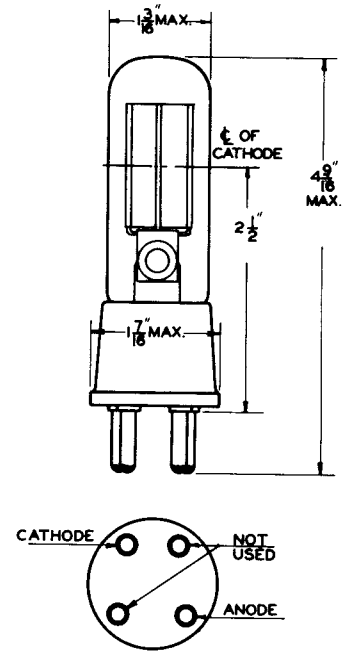
OUTLINE DIMENSIONS



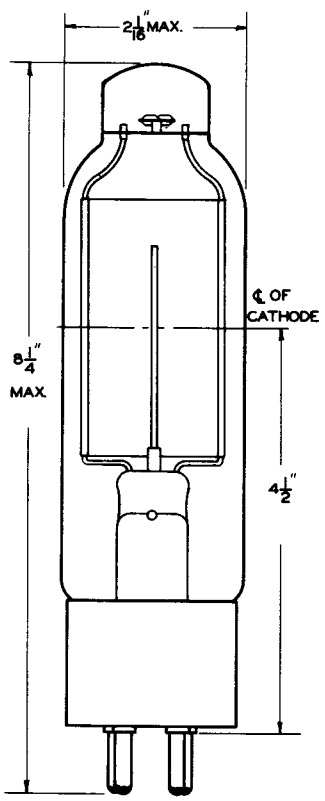
WL-734, WL-735

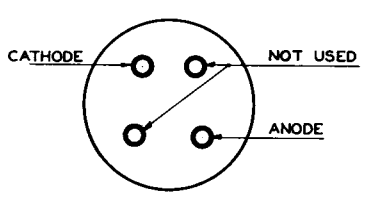


WL-737

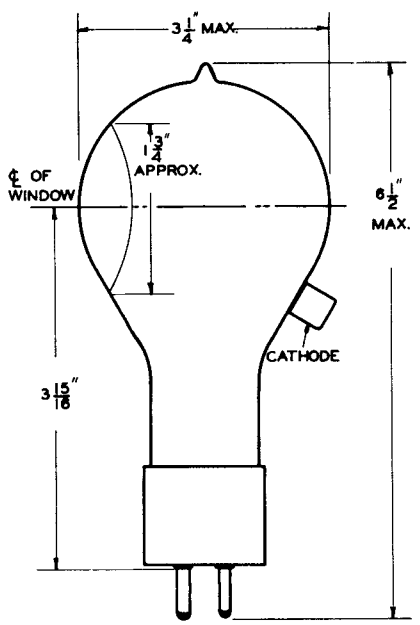


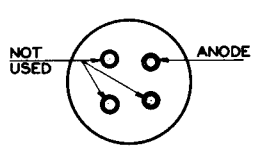
SR-50, SR-51, SR-53,
SK-60, SK-61, SK-63





SR-58, SK-68





WL-770

WESTINGHOUSE LIGHT SENSITIVE PHOTOTUBES

DESIGN DATA AND RATINGS

Type	Descript.	Spectral Region of Max. Response	Typical Sensitivity Microamps. Per Lumen	Maximum Operating Volts	CATHODE Surface	CATHODE Aperture (Inches)	Maximum Current Microamps. per sq.in.	Socket Style#	Top Connector Style#
SR-50	Vacuum	Deep red--near u-v*	15.0	500	Cs-O	13/16x1-3/8	20	766732	.....
SR-51	"	Violet	15.0	500	Cs-O	13/16x1-3/8	20	766732	.....
SR-53	Vacuum	Deep red--near u-v	25.0	500	Cs-O	13/16x1-3/8	20	766732	.....
SR-58	"	" " " "	15.0	500	Cs-O	1-5/8x3-1/2	20	766732	.....
SK-60	Gas	Deep red--near u-v	60.0	90	Cs-O	13/16x1-3/8	20	766732	.....
SK-61	"	Violet	60.0	90	Cs-O	13/16x1-3/8	20	766732	.....
SK-63	Gas	Deep red--near u-v	125.0	90	Cs-O	13/16x1-3/8	20	766732	.....
SK-68	"	" " " "	60.0	90	Cs-O	1-5/8x3-1/2	20	766732	.....
WL-734	Vacuum	Deep red--near u-v	15.0	500	Cs-O	13/16x1-3/8	20	684379	.....
WL-735	Gas	" " " "	60.0	90	Cs-O	13/16x1-3/8	20	684379	.....
WL-737	"	" " " "	60.0	90	Cs-O	1x1-1/4	20	684379	.....
WL-770	Vacuum	Near u-v	0.75	500	Cs-Mg	1-3/4 diam.	25	684379	829334

* Ultra-Violet

GENERAL INFORMATION

The phototubes listed in this bulletin are essentially two electrode tubes consisting of a semi-cylindrical cathode and a central anode sealed in a glass envelope. The cathode consists of a base metal such as silver with a light sensitive surface, usually caesium oxide, and is the larger element of the two. The anode consists of a straight wire electrode mounted along the axis of the cathode. The action of light upon the cathode results in the emission of electrons from the light sensitive surface, and the electrons which are released by this action are drawn to the anode by virtue of the voltage which is applied between the cathode and the anode. These phototubes are made in two different types, namely, vacuum and gas-filled. The two designs are identical as to structure, but differ in that there is a high vacuum in the vacuum type and an inert gas at a very low pressure in the gas-filled type. The SR-50, SR-51, SR-53, SR-58, WL-734 and WL-770 phototubes are all of the high vacuum type, and the SK-60, SK-61, SK-63, SK-68, WL-735 and WL-737 phototubes are of the gas-filled type.

In the gas-filled type, greater effective response is obtained due to gas amplification and secondary emission. When the applied voltage is above 25 or 30 volts, the electrons traveling from cathode to anode have sufficient velocity to knock out electrons from gas atoms with which they collide, thus splitting up the atoms into positive ions and free electrons. The electrons are, of course, attracted to the anode and the positive ions to the cathode, which they may strike sufficiently hard to knock out several "secondary" electrons. Thus these two factors produce an additional current which at higher voltages may be several times the value of the primary electron current.

The gas ratio of a phototube, that is, the ratio of its response at the operating voltage to its response at the voltage where gas amplification begins, for a given illumination, is a measure of the gas and secondary emission amplification. The gas ratio is often taken as the ratio of its response at 90 volts to that at 25 volts with a constant illumination. Care must be taken with gas-filled tubes not to exceed a certain maximum voltage (the value of which depends on the type of tube and the illumination on the tube) or a glow discharge will result which will ruin the sensitive surface. The limits are shown in the accompanying curve of lumens plotted against anode voltage. Anode voltages to the left of this curve are safe values.

APPLICATION

WESTINGHOUSE vacuum and gas-filled phototubes have a high instantaneous speed of response, which makes it practically impossible for any change in intensity of light to escape their reaction.

Phototubes are inherently suited to the control of artificial lighting for schools, factories, public buildings, streets and signs. They may be employed in starting, stopping or controlling mechanical operations, and for counting such objects as cartons, sheets of paper, steel ingots, vehicles or pedestrians. They may be so arranged as to have the objects intercept a beam of light. They may be arranged to record density of smoke, fumes and solutions or to detect the presence of smoke or fire. Materials can be graded in size, thickness or color or to a mechanical precision by the use of a phototube.

Since light is used as the controlling medium instead of mechanical or electrical contact, operations where friction should not be introduced or where mechanical contact cannot be made and which would otherwise be difficult to obtain, are readily and conveniently governed by phototube control.

INSTALLATION

Mechanical

Although these tubes may be mounted in any position, it is recommended that they be installed in a vertical position with the base of tube either up or down. It is, of course, imperative that the cathode emitting surface face the light source upon which the functioning of the tube is dependent. The SR-50, SR-51, SR-53, SR-58, SK-60, SK-61, SK-63 and SK-68 types are supplied with the specially designed and rugged industrial bases which have been widely adopted for tubes used in the industrial field. Several types are equipped with the UX type of base, namely, the WL-734, WL-735, WL-737 and WL-770. The industrial socket style #766732 is made of especially high quality moulded insulating material, and is recommended for use with the phototubes having the industrial bases. This socket has a high resistance which remains constant with an increase of temperature up to 70 degrees centigrade and humidity up to 90 percent. UX type of sockets made of high quality material should be used with the tubes which are supplied with UX bases.

While WESTINGHOUSE phototubes are uniformly rugged in all mechanical respects, they should be protected from unnecessary vibra-

tion. If they are mounted in locations where vibration exists, it is recommended that the sockets be cushioned properly. These tubes are not particularly sensitive to temperature changes although the maximum recommended operating temperature should not exceed 50 degrees centigrade. This refers to the ambient air temperature or the temperature of the air which comes in contact with the bulb. Operation of the phototube at too high a temperature may cause a change in the sensitivity of the light sensitive surface due to the evaporation of the volatile materials with consequent decrease in sensitivity and an adverse effect on life. In general, higher temperatures may slightly decrease the sensitivity. To cite an example, there is very little change in sensitivity with the WL-735 gas filled phototube operated within the temperature range of minus 20 degrees Centigrade to plus 20 degrees Centigrade, while from 20 degrees Centigrade to 50 degrees Centigrade there may be a decrease in sensitivity of about 0.4% per degree Centigrade. If it is necessary to mount the tubes in a place where natural ventilation is poor, best operating results will be secured if forced air cooling is provided by means of an electric fan or a stream of cool dry air.

Care should always be taken to avoid any extraneous or undesired light from reaching the phototube, otherwise erratic results may be obtained. In addition to the light shield, it is also desirable to shield the circuit carefully from stray fields. In extreme cases it may even be necessary to shield the leads to any external source of power.

The sensitivity values given in the accompanying table were taken when a Mazda projection lamp operating at a filament color temperature of 2870 degrees Kelvin was used as the light source. The test circuit includes a one megohm load resistance in series with a 90 volt supply source. The standard light flux value of 0.1 lumen was used.

Electrical

It is essential to minimize the detrimental shunting effects of leakage between electrode connections and capacitance between the leads. It is, therefore, important to use only high quality sockets and to properly insulate the leads, particularly the one connected with the anode or positive voltage supply.

For both steady and pulsating light, the sensitivity of gas filled phototubes within their normal operating range, is practically independent of the amount of light. However, sensitivity is affected by the frequency of light modulation. This is characteristic of gaseous phototubes and is due to the relatively large mass of the positive ions and their correspondingly sluggish motion. Because there is a time lag between the disruption of a gas atom and the increase in current due to the resultant positive ion, fluctuations in the gas component of current lag slightly behind fluctuations in the primary photo-emission component. For high frequency of modulation, this lag tends to smooth out the pulsations in phototube current, thus decreasing the alternating component of the current and, to some extent, the sensitivity. For low frequencies, however, the effect is not important and the low-frequency sensitivity is practically equal to the static sensitivity.

The sensitivity of the gas-filled phototube for pulsating light is measured with a light input that is varied sinusoidally about a specified mean value from zero to a maximum of twice the mean. Sensitivity values for the audio-frequency range give a sensitivity at 10000 cycles which is down approximately 17% or only about 2 decibels from the value at 100 cycles. The gas content is such that the tubes combine high sensitivity with good audio-frequency fidelity.

The sensitivity of a phototube is determined by the amount of current which the tube will pass with an applied potential of 90 volts d.c. across the tube in series with a one megohm resistor when the amount of light falling on the cathode is one lumen. The lumen is a standard unit of light flux equivalent to a luminous intensity of one foot-candle upon a projected area of one square foot. To obtain the value of the light flux in lumens, multiply the projected area of the illuminated aperture in square feet by the intensity in foot candles. A light source of one candle power will illuminate a surface one foot distant with an intensity of one foot-candle. The light intensity on a surface from a given small source varies inversely as the square of the distance. Thus:

$$F = \frac{CA}{D^2}$$

Where F is the flux in lumens, C is the candle power of the light source, A is the area in square inches of the surface or aperture and D is the distance in inches of the light source from the surface, D and A being in corresponding units. Mazda "C" lamps of 50 to 100 watts are rated approximately at 1.0 candle power per watt at marked voltages. For example, approximately one lumen of light flux strikes the cathode of a WL-735 phototube when placed 10 inches from a lighted 100 watt lamp.

The cathode sensitivity of these phototubes is of such uniformity that a beam of light projected upon a very small area of the cathode is quite effective. However, best uniformity is obtained when the incident light is projected over as large a portion of the cathode as possible.

When a phototube is used with a relay, the highest sensitivity is obtained by the use of a relatively large load resistance. The phototube may be used with any of the usual amplifier tubes as long as the grid circuit is not too high, say less than one or two megohms. When higher resistances are used in the coupling circuit, it is desirable to use one of the WESTINGHOUSE low grid current amplifier tubes and to take precautions to properly insulate the grid circuit.

OPERATION

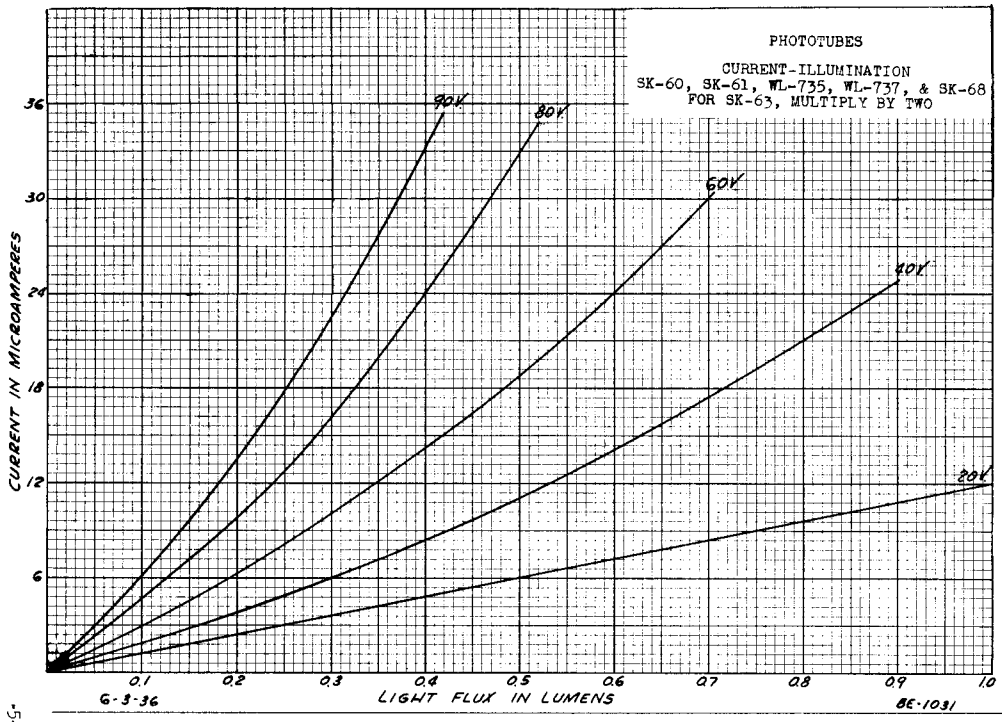
The current rating of a gas filled phototube depends upon the operating conditions, hence it is important to avoid the combination of too much current with too high a voltage. The reason is that these two factors govern the number of positive ions striking the cathode per second and their velocity. Too many ions bombarding the cathode with excessive velocity may disintegrate the cathode surface and cause the tube to lose its sensitivity.

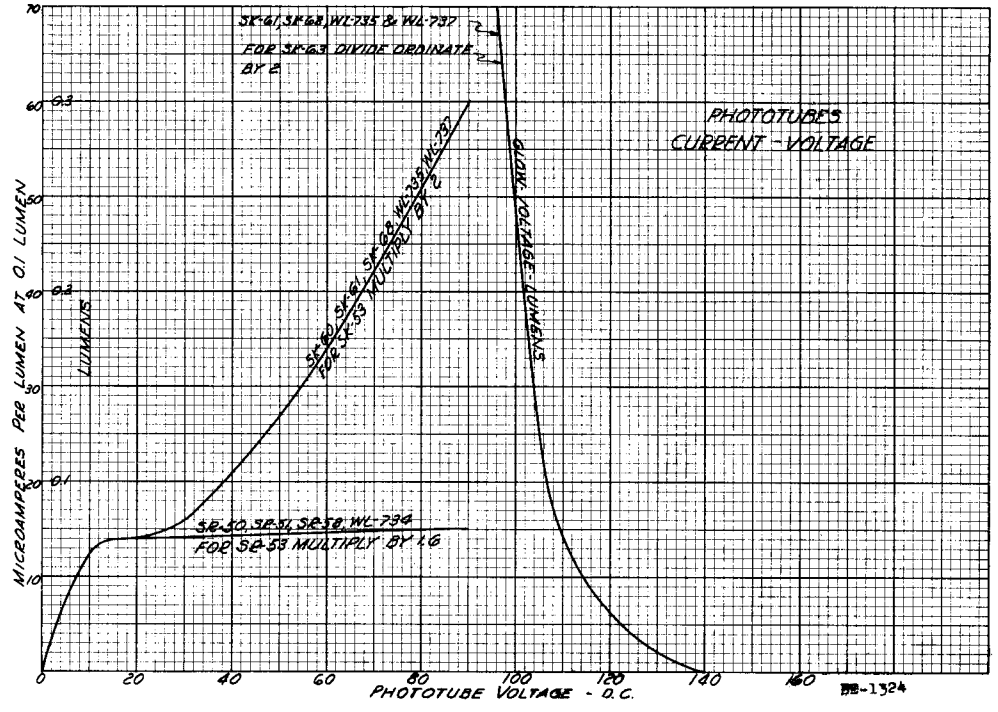
The voltage across the tube can be computed by subtracting the voltage drop through the load resistance from the supply voltage.

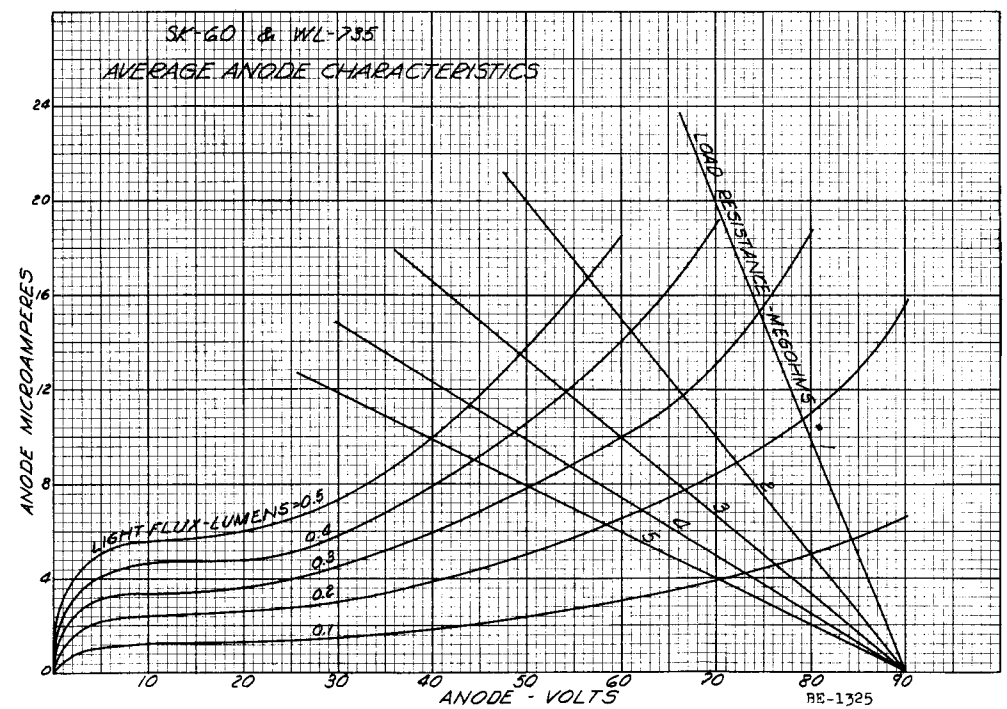
A gas discharge, evident as a faint blue glow, may occur if the current and especially the rated voltage of a gas-filled phototube is exceeded. If such a glow occurs, the anode voltage should be removed from the tube immediately in order to prevent permanent damage to the tube.

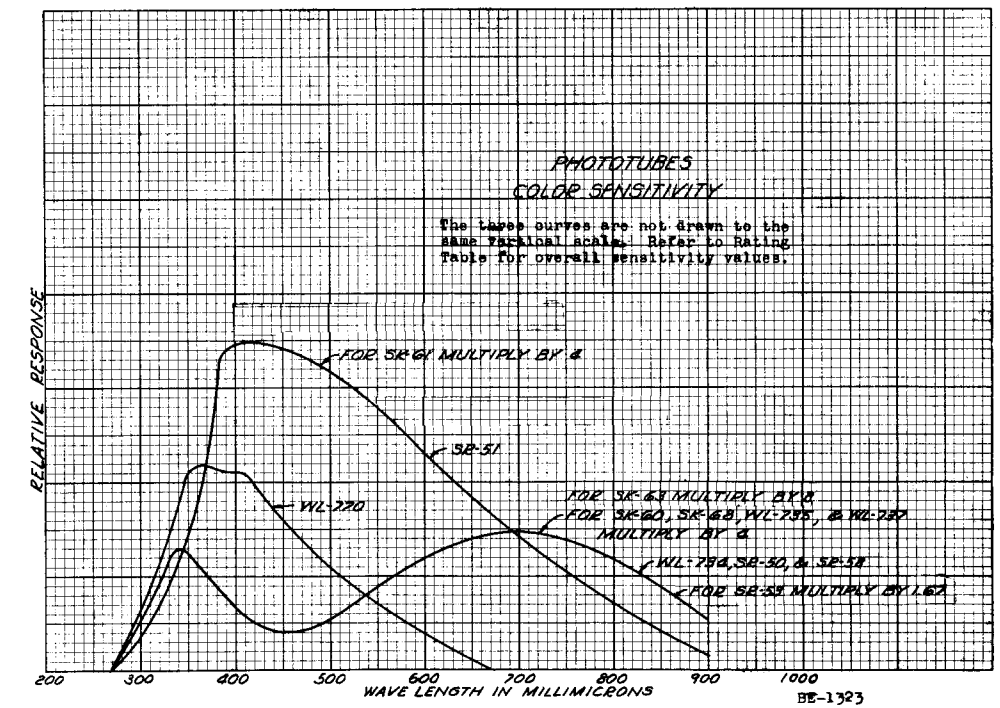
A phototube generally gives best results under constant use. The characteristics of a phototube which has not been used for a month or more may change somewhat, but can

PHOTOTUBES
CURRENT-ILLUMINATION
SK-60, SK-61, WL-735, WL-737, & SK-68
FOR SK-63, MULTIPLY BY TWO









be restored to normal by a short period of operation (about one or two hours) with the usual current and illumination. Exposure to large amounts of light, such as direct sunlight, may temporarily decrease the sensitivity of the tube even though there is no voltage applied. The magnitude and duration of this decrease depend upon the length of over-exposure

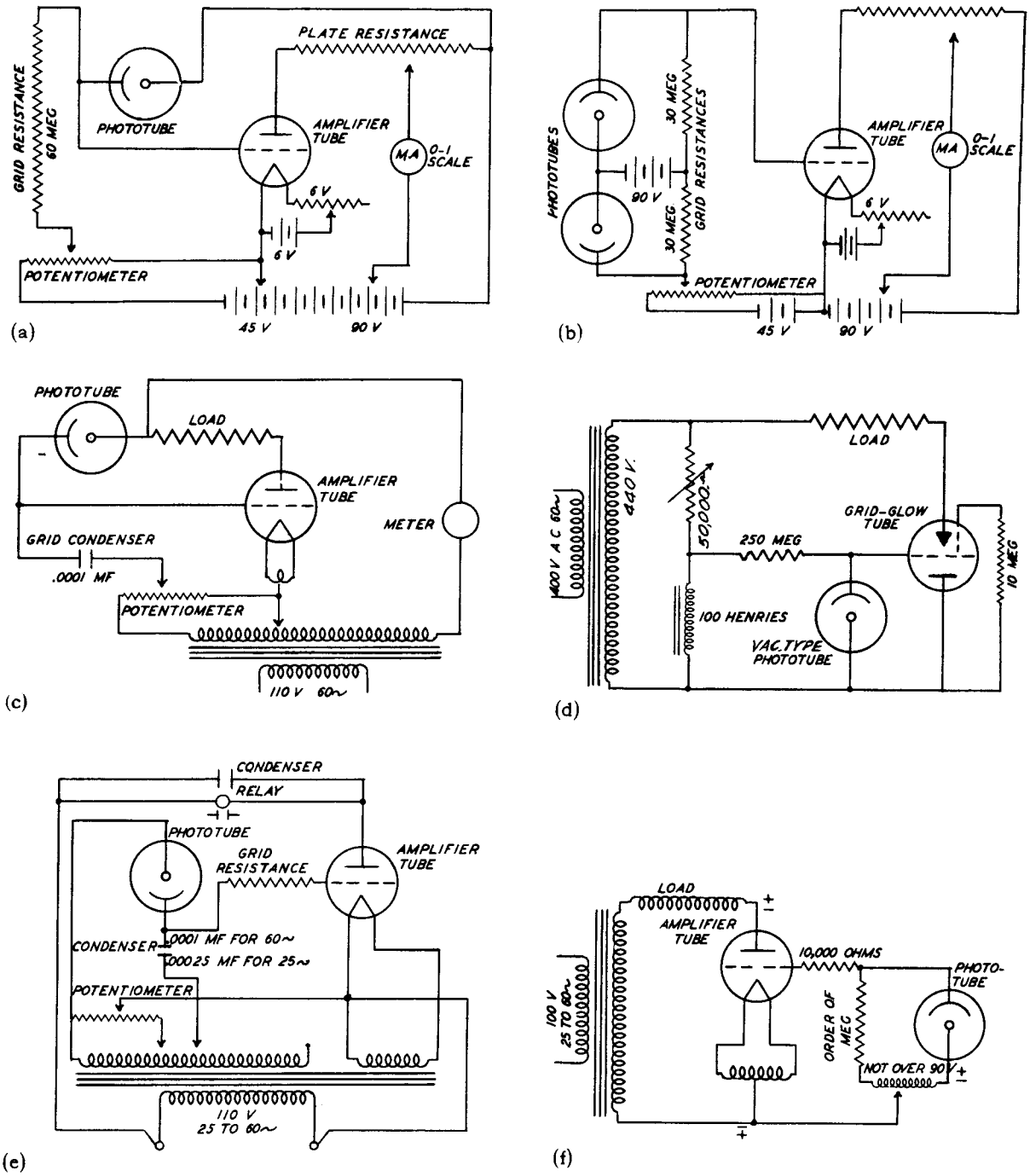
CHARACTERISTICS

The accompanying curves of anode current versus light flux for constant plate voltages are quite similar to the curves of anode current versus anode voltage for constant light flux values in that the two curves represent the same data plotted in two different forms. These curves show that the current output in all vacuum phototubes is exactly proportional to the light flux when saturation voltage is applied, whereas, in gas-filled phototubes the current output is only proportional to the light flux for low illuminations and low voltages, but not for high illuminations and high voltages. However, for a given gas-filled phototube a load resistance can always be chosen so that the current output becomes linear with the light flux over the permissible range of illumination.

As will be seen by the accompanying curves of current versus phototube voltage for the various tubes, the current in the vacuum type reaches saturation at approximately 14 volts, and any further increase in potential gives only a slight increase in the saturation current. This slight increase is due to geometrical construction of the tube. In a gas-filled tube, the same saturation value is reached at 14 volts, but this condition is temporary since the output current rises rapidly when the voltage is increased still further due to the effect of ionization of the gas in the tube. The sensitivity of the gas-filled phototubes may be several times the corresponding value of a vacuum tube of similar construction. This augumented sensitivity is due to gaseous ionization and is the chief merit of gas-filled phototubes.

Some curves are included which show the color sensitivity of the phototubes plotted as relative response versus wave length in millimicrons. These curves show the sensitivity characteristics of these various tubes due to light of various wave lengths. The cutoff of all of the curves to zero at wave lengths at a little less than 300 millimicrons is due to the absorption of shorter wave length light by the glass bulbs. Some types possess a large response in the longer wave length or infra-red region which make such tubes particularly useful for operation where Mazda lamps are employed as light sources. If desired, color filters may be used to alter the color sensitivity response of the phototube.

Several circuits are shown which illustrate typical methods of using the various phototubes. In most cases operating voltages and circuit constants are recommended. However, it will often be found that these do not represent the optimum condition for any particular installation, and the values which produce the best results should be used. The publication of these circuits does not imply or carry a license to use them. In several of the circuits the phototube controls the grid bias of a vacuum amplifier tube while one circuit is shown in which the phototube controls the grid bias of a thyratron. This latter circuit is particularly useful in that it operates entirely from alternating current and the controlled current may be relatively large.



(a) Flexible d-c amplifier with neutralized anode current
(b) Differential d-c circuit with neutralized anode current
(c) Simple amplifier for straight a-c operation
(d) Grid-Glow relay circuit a-c operation
(e) Simple amplifier for straight a-c operation
(f) Negative control Grid-Glow relay circuit for a-c operation

Fig. 4-19 - Typical phototube circuits

GUARANTEE

Westinghouse tubes are guaranteed to be free from electrical and mechanical defects. They have been designed and built to withstand reasonable service conditions and have passed rigid tests before shipment. Their performance will depend, to a large extent, upon the kind of equipment in which they are used and the care with which they are handled. In case of doubt as to the proper operating conditions, information should be secured from the Special Products Sales Department, Westinghouse Lamp Division, Westinghouse Electric & Manufacturing Company, Bloomfield, New Jersey.

If a tube is received with apparent defects or evidence of abuse in transit, suitable notation should be made on the receipt required by the transportation company. If, after a clear receipt has been given, acceptance tests reveal that the tube is inoperative or has been abused in transit, immediate steps should be taken to notify the transportation company, at the same time requesting inspection by the carrier's agent. Claims for concealed damage will be accepted by carriers only when such damage has been reported to them within fifteen days after delivery. Purchasers desiring the assistance of the manufacturer in filing such claims must report them to the manufacturer within a reasonable time to insure compliance with the common carriers' requirements.

The manufacturer assumes no responsibility for tubes which may become defective during re-shipment or handling by the user. If a tube shows a defect or trouble is experienced in its operation, a careful check should be made to see that the circuit or other equipment is not at fault. It is advisable to recheck the tube in another socket or replace it in the set in which it gave trouble as a check on its operability before it is returned to the manufacturer. The service report form must be completely filled in with the information concerning actual life obtained and the conditions of operation so that proper consideration may be given to the claim. This sheet must accompany the request for permission to return the tube.

No claim for adjustment, except obvious manufacturing defects, will be considered when a tube has been used for experimental purposes, or where the conditions of operation have not been in accordance with the electrical rating and accompanying operating instructions. If examination and test of the tube indicate a defect of quality, workmanship, or material, an adjustment will be allowed based upon the merit of each individual claim. Upon receipt of the authorization for return, the user should pack the tube for shipment as carefully as when it was originally received, since damage in shipment will make proper examination impossible. Complete shipping instructions are given on the return tag. This guarantee applies only within the period of one year after the tube is shipped from the factory.

LICENSE NOTICE

The sale of this device carries a license under patent claims of the device itself for power, therapeutic, medical, railway signalling, and x-ray purposes; for communication (not including programs) on, between, or with, and signalling, directing, or controlling land vehicles in connection with their operation; for communication by the owner or operator of apparatus for power purposes, but only in the business of such owner or operator involving such apparatus; for use on aircraft, for communication (not including public service or programs) on, between, or with, and in signalling, directing, or controlling aircraft in connection with their operation; for wireless telephony and wireless telegraphy transmitting apparatus for use by municipal, county, or state governments, solely or primarily for rendering an official service; and for laboratory use.

Westinghouse

WL-5736

February 15, 1960

POWER AMPLIFIER TRIODE TYPE WL-5736

The WL-5736 is a three-electrode tube designed for use as an oscillator, amplifier, and modulator. The forced-air-cooled anode is capable of dissipating 2.5 kilowatts. An efficient thoriated-tungsten filament is employed. Maximum ratings apply up to 60 megacycles. A low back-pressure radiator is provided as an integral part of the tube.

GENERAL DATA

Electrical	Minimum	Bogey	Maximum	
Filament Voltage	5.7	6.0	6.3	volts
Filament Current at Bogey Voltage	57	60	63	amp
Filament Starting Current	-	-	300	amp
Filament Cold Resistance	-	0.016	-	ohms
Amplification Factor	18	22	26	
Interelectrode Capacitances				
Grid to Plate	12	16	21	μμf
Grid to Filament	15	19	22	μμf
Plate to Filament	0.2	0.80	1.0	μμf
Mechanical				
Mounting Position			Vertical, anode up or down	
Type of Cooling			Forced air	
Maximum Incoming Air Temperature			45	°C
Minimum Required Air Flow on Anode (Except television ratings)				
Plate Dissipation, percent rating	100[1]	80	60	percent
Air Flow in Cubic Feet Per Minute	150	100	70	cfm
Pressure in Inches of Water, static	2.7	1.3	0.9	in.
Required Air Flow on Filament and Grid Seals				
Air flow through radiator normally is sufficient				
Maximum Glass Temperature			160	°C
Net Weight, approximate			3.75	lbs
Shipping Weight, approximate			9	lbs

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR, CLASS B

Maximum Ratings, Absolute Values	CCS[2]	
Maximum DC Plate Voltage	3000	volts
Maximum DC Plate Current at Maximum Signal[3]	1.75	amp
Maximum Plate Input at Maximum Signal[3]	4200	watts
Maximum Plate Dissipation[3]	2500	watts

Supersedes WL-5736 Data Sheet Dated June , 1949 High Vacuum Amplifier Section

AUDIO-FREQUENCY POWER AMPLIFIER AND MODULATOR, CLASS B (cont.)

Typical Operation Unless otherwise specified, values are for two tubes	CCS[2]	
DC Plate Voltage	3000	volts
DC Grid Voltage	−160	volts
Peak Audio-Frequency Voltage, grid to grid	820	volts
DC Plate Current at Zero Signal	0.66	amp
DC Plate Current at Maximum Signal	2.80	amp
Effective Load Resistance, plate to plate	3060	ohms
Maximum Signal Driving Power, approximate	140	watts
Maximum Signal Power Output	4350	watts
Load Resistance, per tube	765	ohms

RADIO-FREQUENCY POWER AMPLIFIER, CLASS B

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings, Absolute Values	CCS[2]	
DC Plate Voltage, maximum	3500	volts
DC Plate Current, maximum	1.75	amp
Plate Input, maximum	3500	watts
Plate Dissipation, maximum	2500	watts

Typical Operation	CCS[2]	
DC Plate Voltage	3000	volts
DC Grid Voltage	−160	volts
Peak Radio-Frequency Grid Voltage	280	volts
DC Plate Current	1.1	amp
DC Grid Current, approximate	0.050	amp
Driving Power, approximate[4]	15	watts
Power Output, approximate	800	watts

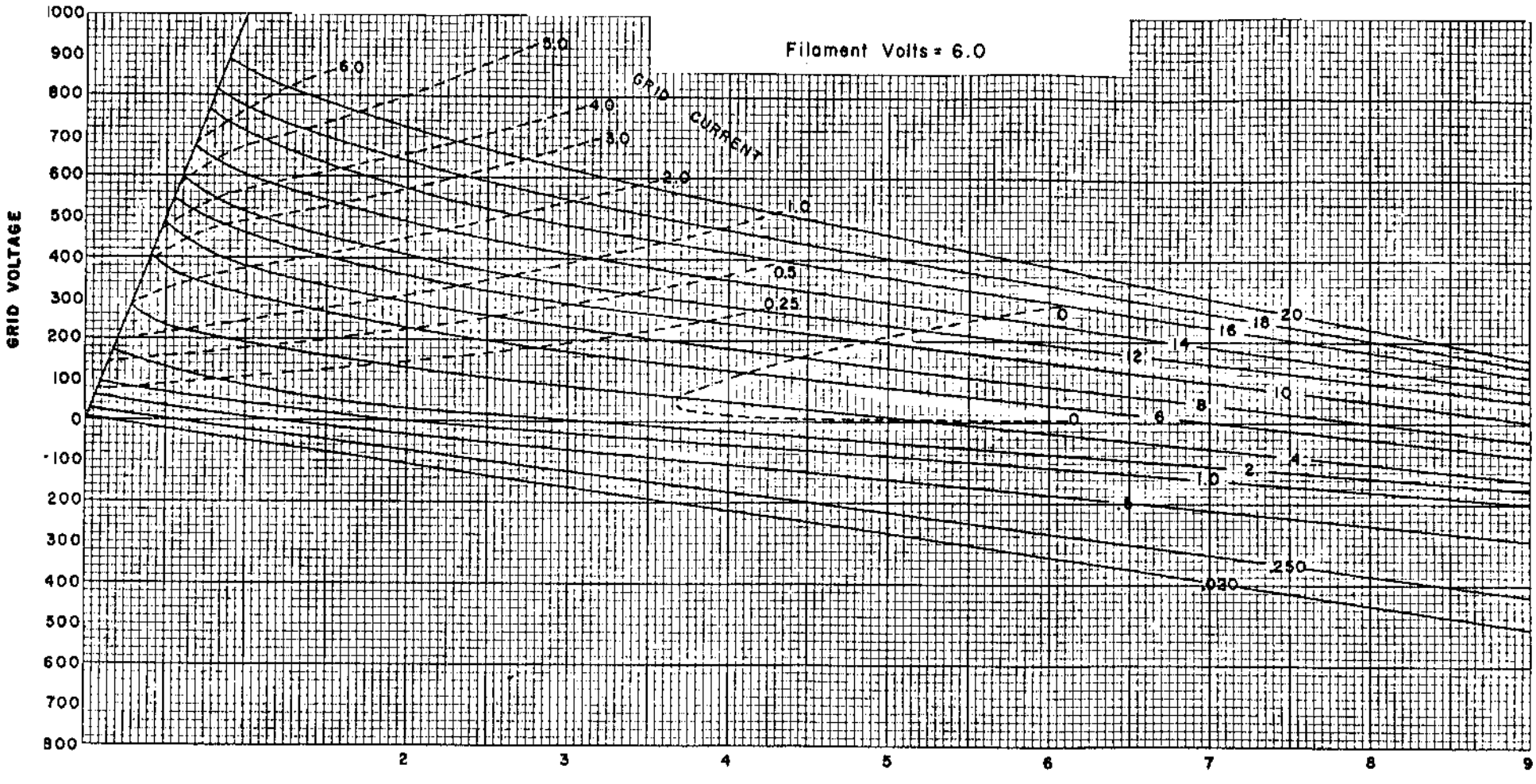
RADIO-FREQUENCY POWER AMPLIFIER, CLASS B

Grounded-grid, wide-band television service, maximum frequency 88 megacycles

Maximum Ratings, Absolute Values	CCS[2]	
DC Plate Voltage, maximum	3500	volts
DC Plate Current, maximum	1.75	amp
Plate Input, maximum	4000	watts
Plate Dissipation, maximum[5]	2800	watts

Typical Operation	CCS[2]	
DC Plate Voltage	2600	volts
DC Plate Current		
Synchronizing Level	2.32	amp
Black Level	1.87	amp
DC Grid Voltage	−160	volts

AVERAGE CONSTANT-CURRENT-CHARACTERISTICS



RADIO-FREQUENCY POWER AMPLIFIER, CLASS B (television service continued)

Typical Operation (cont.)	CCS[2]	
Peak Radio-Frequency Grid Voltage		
Synchronizing Level	535	volts
Black Level	480	volts
DC Grid Current		
Synchronizing Level	0.830	amp
Black Level	0.134	amp
Driving Power, approximate		
Synchronizing Level	1160	watts
Black Level	835	watts
Power Output, approximate[6]		
Synchronizing Level	3680	watts
Black Level	1690	watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR, CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation[7]

Maximum Ratings, Absolute Values	CCS[2] At 60 mc	CCS[2] At 110 mc	
Plate Voltage, maximum	5000	3500	volts
Plate Current, maximum	1.5	1.5	amp
Plate Input, maximum	5000	3500	watts
Plate Dissipation, maximum	2500	2500	watts
DC Grid Voltage, maximum	-1000	-700	volts
DC Grid Current, maximum	0.5	0.5	amp

Typical Operation	CCS[2] At 60 mc	CCS[2] At 110 mc		
DC Plate Voltage	5000	3500	3500	volts
DC Grid Voltage	-850	-600	-300	volts
Peak Radio-Frequency Grid Voltage	1200	940	555	volts
DC Plate Current	1.0	1.0	1.0	amp
DC Grid Current	0.210	0.250	0.155	amp
Driving Power, approximate	250	235	85	watts
Power Output, approximate	4100	2800	2550	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER, CLASS C TELEPHONY

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings, Absolute Values	CCS[2]	
DC Plate Voltage, maximum	3500	volts
DC Grid Voltage, maximum	-1000	volts
DC Plate Current, maximum	1.5	amp
DC Grid Current, maximum	0.5	amp
Plate Input, maximum	5000	watts
Plate Dissipation, maximum	1650	watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER, CLASS C TELEPHONY (cont.)

Typical Operation	CCS[2]	
DC Plate Voltage	3500	volts
DC Grid Voltage	-600	volts
Peak Radio-Frequency Grid Voltage	950	volts
DC Plate Current	1.15	amp
DC Grid Current, approximate	0.20	amp
Driving Power, approximate	270	watts
Power Output, approximate	3200	watts

HIGH FREQUENCY RATINGS

Maximum ratings apply up to 60 megacycles. The tube may be operated at higher frequencies provided the maximum values of the plate voltage and power input are reduced according to the tabulation below. All other maximum ratings remain as shown above. Special attention should be given to adequate ventilation of the bulb at these frequencies. See special television service ratings.

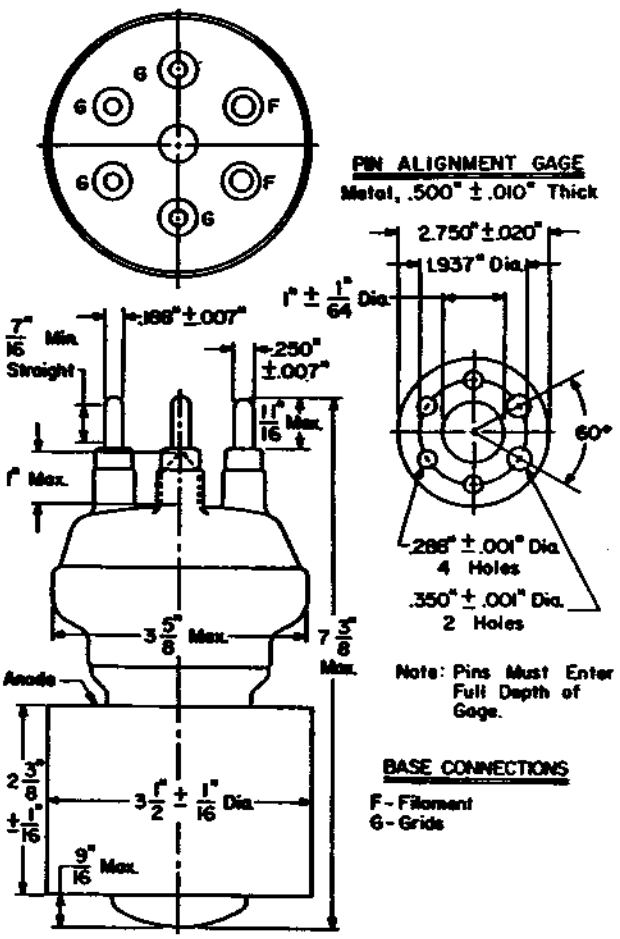
FREQUENCY	CLASS B		CLASS C PLATE MODULATED		CLASS C UNMODULATED	
	Percent of Maximum		*Percent of Maximum*		*Percent of Maximum*	
Megacycles	Plate Volts	Input Watts	Plate Volts	Input Watts	Plate Volts	Input Watts
60	100	100	100	100	100	100
100	85	85	80	80	80	80
200	60	60	50	50	50	50

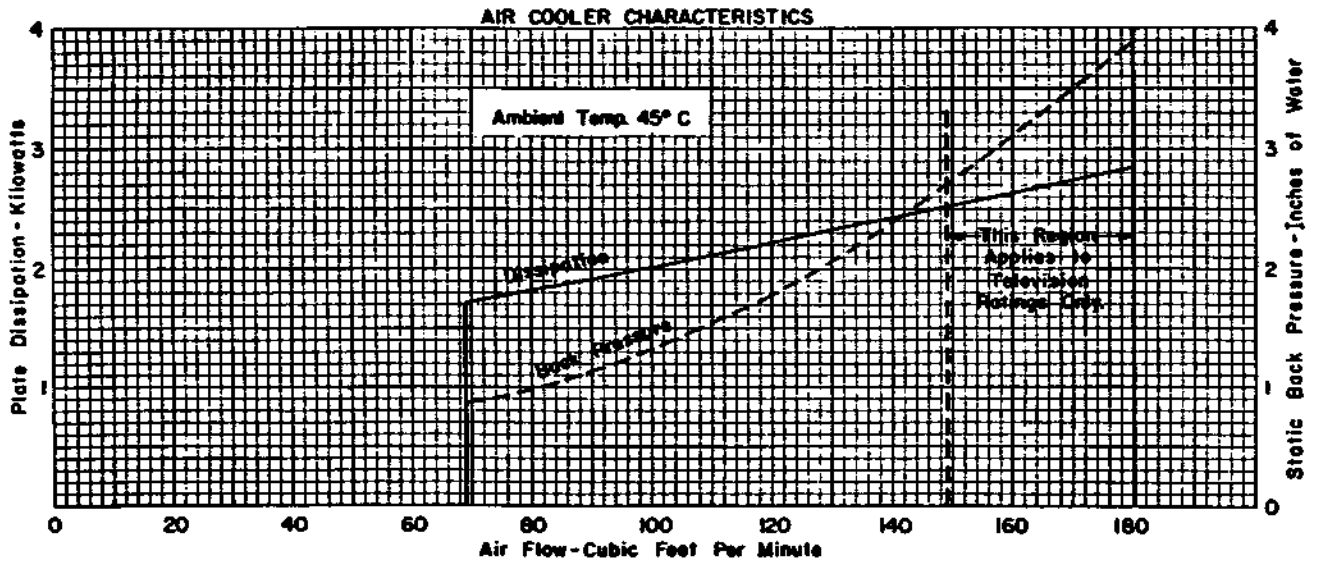
ELECTRICAL DATA AND LIMITS

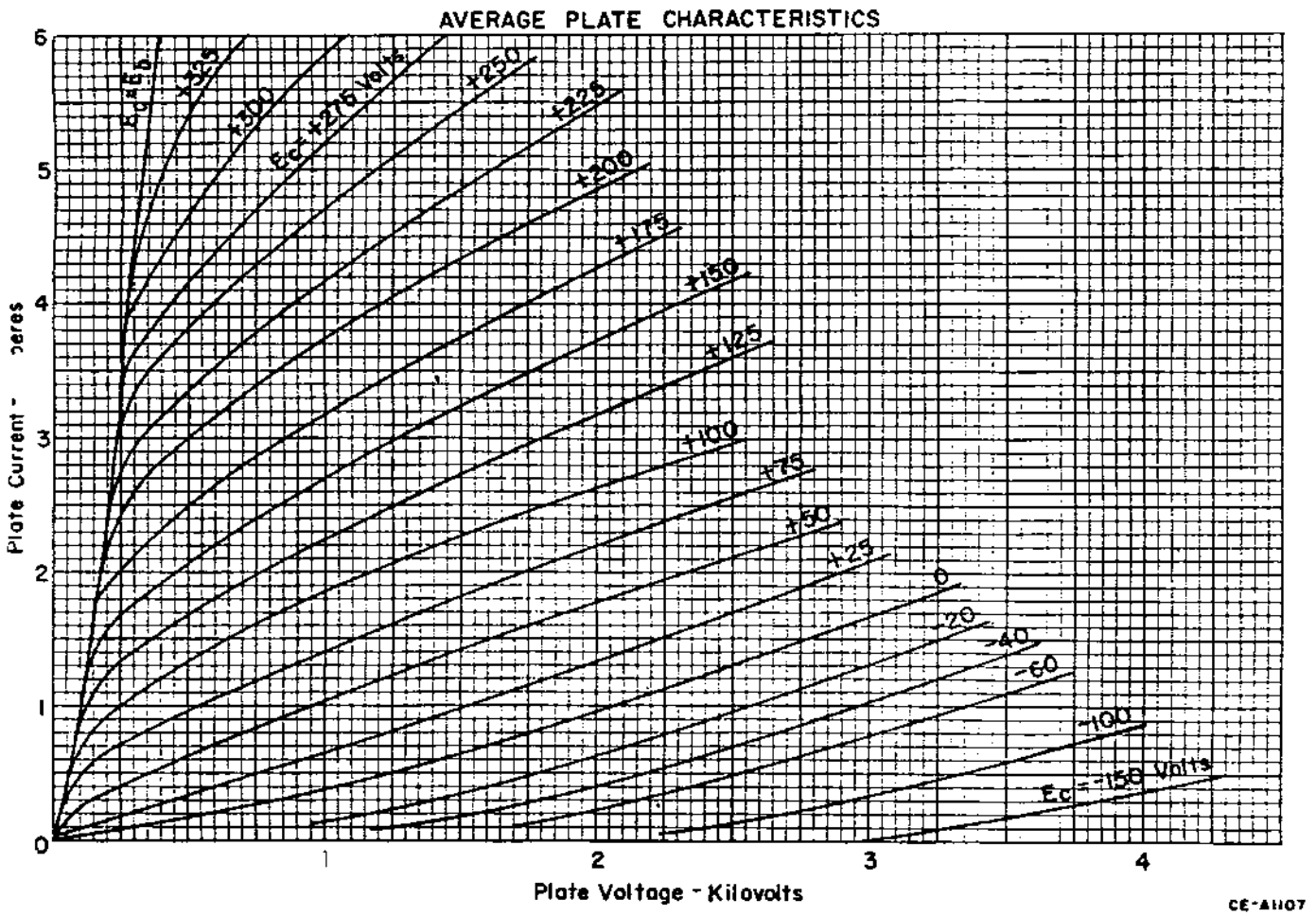
Characteristic	Conditions	LIMITS Minimum	LIMITS Design	LIMITS Maximum	
Grid Voltage	I_b = 6 amperes e_b = 1000 volts	-	-	360	volts
Grid Current	I_b = 6 amperes e_b = 1000 volts			2.2	amp
Plate Voltage	I_b = 0.40 amperes E_c = -20 volts	1350	1400	1650	volts
Plate Voltage	I_b = 0.40 amperes E_c = -90 volts	1570	1620	1870	volts
Peak Cathode Current[8]	(Symbol I_k)	10			amp
Power Output	E_b = 5000 volts E_c = -850 volts I_b = 1.0 amperes I_g = 0.3 amperes Freq. = 60 megacycles (Symbol P_o)	3800			watts

FOOTNOTES

1. Except as otherwise noted.
2. Continuous commercial service.
3. Averaged over any audio-frequency cycle of sine-wave form.
4. At crest of audio-frequency cycle with modulation factor of 1.0.
5. Requires 180 cubic feet per minute of cooling air at 4 inches of water static pressure.
6. Includes power transferred from the driver stage.
7. Modulation, essentially negative, may be used if the positive peak of the carrier envelope does not exceed 115 percent of the carrier conditions.
8. Represents maximum usable cathode current for the tube as plate current plus grid current for any condition of operation.






AVERAGE PLATE CHARACTERISTICS
Plate Current - Peres
Plate Voltage - Kilovolts
Ec=+6.0
+325
+300
Ec=+275 Volts
+250
+225
+200
+175
+150
+125
+100
+75
+50
+25
0
-20
-40
-60
-100
Ec=-150 Volts
0
1
2
3
4
5
6
CE-AIIO7