8575

Photomultiplier Tube

12-STAGE, HEAD-ON TYPE

BIALKALI PHOTOCATHODE OF HIGH QUANTUM EFFICIENCY
IN-LINE ELECTROSTATICALLY-FOCUSED DYNODE STRUCTURE

For use in pulse counting applications such as counting of low-activity radioactive materials releasing low-energy particles when used in conjunction with suitable scintillators.

GENERAL

Spectral Response	**See accompanying** *Spectral Response Characteristics*
Wavelength of Maximum Response	**3850 ± 500 angstroms**
Cathode, Semitransparent	**Cs-K Antimonide (Bialkali)**
Shape	**Spherical Section**
Minimum projected area	**2.54 sq in**
Minimum diameter	**1.80 in**
Window	**Pyrex, Corning[a] No.7740, or equivalent**
Shape	**Plano-Concave**
Index of refraction at 5893 angstroms	**1.47**
Dynodes	
Substrate	**Copper-Beryllium**
Secondary-emitting surface	**Beryllium-Oxide**
Structure	**In-Line Electrostatic-Focus Type**
Direct Interelectrode Capacitances (Approx.)	
Anode to dynode No.12	**5 pF**
Anode to all other electrodes	**6 pF**
Maximum Overall Length	**5.71 in**
Seated Length	**4.98 ± 0.08 in**
Maximum Diameter	**2.10 in**
Operating Position	**Any**
Weight (Approx.)	**6 oz**
Bulb	**T16**
Socket	**RCA Part No.DP2118[b] or No.DP2124[b]**
Magnetic Shield	**See** *footnote (c)*

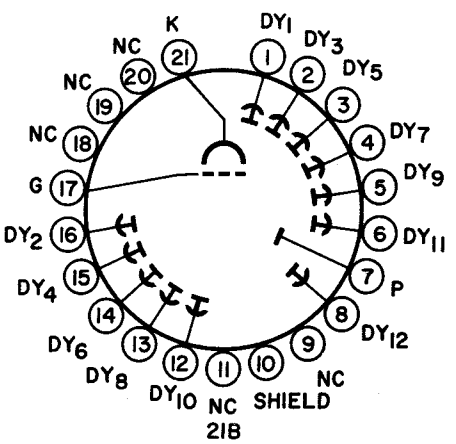
MAXIMUM AND MINIMUM RATINGS, ABSOLUTE-MAXIMUM VALUES

DC Supply Voltage		
Between anode and cathode:		
With *Voltage Distribution I* shown in Table I	3000 max 800 min	V V
With *Voltage Distribution II* shown in Table I	3500 max 800 min	V V
Between anode and dynode No.12	800 max	V
Between dynode No.12 and dynode No.11	800 max	V
Between consecutive dynodes	400 max	V
Between dynode No.1 and cathode	800 max 300 min	V V
Between focusing electrode and cathode	800 max	V
Average Anode Current[d]	0.2 max	mA
Ambient-Temperature Range[e]	-100 to +85	°C

BASING DIAGRAM

Basing Designation for Bottom View. 21B

Pin 1 – Dynode No.1
Pin 2 – Dynode No.3
Pin 3 – Dynode No.5
Pin 4 – Dynode No.7
Pin 5 – Dynode No.9
Pin 6 – Dynode No.11
Pin 7 – Anode
Pin 8 – Dynode No.12
Pin 9 – Do Not Use
Pin 10 – Electron Multiplier Shield
Pin 11 – Do Not Use
Pin 12 – Dynode No.10
Pin 13 – Dynode No.8
Pin 14 – Dynode No.6
Pin 15 – Dynode No.4
Pin 16 – Dynode No.2
Pin 17 – Focusing Electrode
Pin 18 – Do Not Use
Pin 19 – Do Not Use
Pin 20 – Do Not Use
Pin 21 – Photocathode



21B

DIRECTION OF RADIATION: INTO END OF BULB

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages shown in Table I.

With E = 1100 V (Except as noted)

Voltage Distribution I of Table I

	Min	*Typ*	*Max*	
Sensitivity				
Radiant, at 3850 angstroms. .	-	880	-	A/W
Cathode radiant, at 3850 angstroms.	-	0.088	-	A/W
Luminous[f]	-	0.8	-	A/lm
Cathode luminous:				
With tungsten light source[g]	-	7.7×10^{-5}	-	A/lm
With blue light source[h] . .	$.8\times10^{-10}$	10×10^{-10}	-	A
Cathode quantum efficiency at 3850 angstroms	-	28	-	%
Current Amplification	-	1×10^{4}	-	
Anode Dark Current[j]	-	1×10^{-9}	4×10^{-9}	A
Equivalent Anode-Dark-Current Input.	-	5×10^{-12}[k]	-	lm
	-	4.4×10^{-15}[m]	-	W
Pulse Height[n,p]	-	0.15	-	V
Pulse Height Resolution[p]. . . .	-	7.5	8.0	%
Dark Noise Spectrum[q].	-	z	-	
Pulse Height Spectrum with Fe^{55} Source[r].	-	aa	-	
Mean Gain Deviation[s]				
With count rate change of 10,000 to 1,000 c/s[t]. . . .	-	1	-	%
For a period of 16 hours at a count rate of 1,000 c/s[u]. .	-	1	-	%

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With E = 2000 V (Except as noted)

Voltage Distribution I of Table I

	Min	Typ	Max	
Sensitivity				
Radiant, at 3850 angstroms	-	3.5×10^{5}	-	A/W
Cathode radiant, at 3850 angstroms	-	0.088	-	A/W
Luminous[f]	100	300	3000	A/lm
Cathode luminous:				
With tungsten light source[g]	-	7.7×10^{-5}	-	A/lm
With blue light source[h]	$.8\times10^{-10}$	10×10^{-10}	-	A
Cathode quantum efficiency at 3850 angstroms	-	28	-	%
Current Amplification	-	4×10^{6}	-	
Anode Dark Current[j]	-	1×10^{-9}	4×10^{-9}	A
Equivalent Anode-Dark-Current Input	-	5×10^{-12}[k]	-	lm
	-	4.4×10^{-15}[m]	-	W
Anode-Pulse Rise Time[v]	-	2.7×10^{-9}	-	s
Electron Transit Time[w]	-	3.7×10^{-8}	-	s

With E = 2500 V (Except as noted)

Voltage Distribution I of Table I

	Min	Typ	Max	
Sensitivity				
Radiant, at 3850 angstroms	-	3.2×10^{6}	-	A/W
Cathode radiant, at 3850 angstroms	-	0.088	-	A/W
Luminous[f]	-	2.8×10^{3}	-	A/lm
Cathode luminous:				
With tungsten light source[g]	-	7.7×10^{-5}	-	A/lm
With blue light source[h]	$.8\times10^{-10}$	10×10^{-10}	-	A
Cathode quantum efficiency at 3850 angstroms	-	28	-	%
Current Amplification	-	3.6×10^{7}	-	
Anode Dark Current[j]	-	1×10^{-9}	4×10^{-9}	A
Equivalent Anode-Dark-Current Input	-	5×10^{-12}[k]	-	lm
	-	4.4×10^{-15}[m]	-	W
Anode-Pulse Rise Time[v]	-	2.3×10^{-9}	-	s
Electron Transit Time[w]	-	3.3×10^{-8}	-	s

With E = 3000 V

Voltage Distribution II of Table I

	Min	Typ	Max	
Pulse Current				
Space-charge limited (Saturated)[x]	-	0.75	-	A
Linear[y]	-	0.25	-	A

[a] Made by Corning Glass Works, Corning, New York.

[b] A socket is supplied with each 8575. The DP2118 is a molded teflon socket while the DP2124 is a printed-circuit board socket on a teflon base material. Additional sockets may be obtained from RCA, Photomultiplier Marketing, Lancaster, Pa.

[c] Magnetic shielding in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1322 North Elston, Chicago 24, Illinois, or equivalent. The shielding must be operated at cathode potential and be insulated from the tube envelope by material such as Scotch Electrical, Type 33, manufactured by Minnesota Mining and Manufacturing Company, St. Paul 6, Minnesota, or equivalent.

[d] Averaged over any interval of 30 seconds maximum.

[e] Tube operation at room temperature or below is recommended.

[f] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 0.1 microlumen is used.

[g] Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K. The value of light flux is 100 microlumens and 500 volts are applied between cathode and all other electrodes connected as anode.

[h] Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 100 microlumens and 500 volts are applied between cathode and all other electrodes connected as anode.

[j] At a tube temperature of 22° C. Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, polished to one-half stock thickness). The light flux incident on the filter is 0.1 microlumen. The supply voltage E is adjusted to obtain an anode current of 2.6 microamperes. Sensitivity of the 8575 under these conditions is approximately equivalent to 200 amperes per lumen. Dark current is measured with light source removed.

[k] With supply voltage E adjusted to give an equivalent luminous sensitivity of 200 amperes per lumen.

[m] At 3850 angstroms.

[n] Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 kilohm resistor and a total capacitance of 100 ± 3% pF in parallel. Under pulse conditions, the interstage voltages of the 8575 should not deviate more than 2% from the interstage voltage values during no-signal conditions. The 662 keV photon from an isotope of cesium having an atomic mass of 137 (Cs^{137}) and a cylindrical 2" x 2" thallium-activated sodium-iodide scintillator [NaI(Tl)-type 3D8S50, Serial No.AJ651, or equivalent] are used. This scintillator is manufactured by the Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio, and is rated by the manufacturer as having a resolving capability of 8.2 per cent to 8.3 per cent. The Cs^{137} source is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the 8575 by a coupling fluid such as Dow Corning Corp. Type DC200 (Viscosity of 60,000 centistokes) - manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

[p] Pulse height resolution is defined as the quotient of the full width of the photopeak at half height by the pulse height at maximum count rate under the conditions of (n).

[q] Measured under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a low color temperature to assure the high probability of single photoelectron emission from the photocathode of the 8575. The intensity of the light source is adjusted for approximately 50 per cent counting loss. A Nuclear Data Model No.ND-130A Multichannel Pulse-Height Analyzer is used to measure photoelectron pulse height.

[r] Measured using a Harshaw Type HG 0.005" beryllium window NaI(Tl) scintillator, 0.04" thick and 7/8" in diameter and an isotope of iron having an atomic mass of 55 (Fe^{55}) and an activity rate of one microcurie.

[s] Mean gain deviation is defined as the percentage change, regardless of sign, from the average pulse height for a given radiation source and scintillator over a specified time or count rate interval.

[t] Under the following conditions: The scintillator and Cs^{137} radiation source of (n) are employed. The radiation source is initially centered, on the major axis of the tube and the scintillator, at a point providing a pulse count rate of 10,000 c/s. The pulse height of the photopeak is measured under this condition. Next, the radiation source is

moved rapidly, in approximately 30 seconds, to a new position that is equivalent to a count rate of 1,000 c/s. The new position is also centered in the major axis of the tube. The pulse height under this condition is measured. The difference in pulse height between these two measurements is typically 1 per cent.

u Under the same conditions as (t) except the count rate position of 1,000 c/s is maintained for 16 hours and the pulse height is sampled at 1 hour intervals.

v Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is primarily a function of transit time variation and is measured under conditions with the incident light fully illuminating the photocathode.

w The electron transit time is the time interval between the arrival of a delta function light pulse at the entrance window of the tube and the time at which the output pulse at the anode terminal reaches peak amplitude. The transit time is measured under conditions with the incident light fully illuminating the photocathode.

x The interstage voltages of the 8575 do not deviate more than 2 per cent from the recommended voltage distribution shown by *Voltage Distribution I of Table I*. Capacitors are connected across the individual resistors making up the voltage-divider arrangement to insure the operating condition.

y Maximum deviation from linearity is 2 per cent.

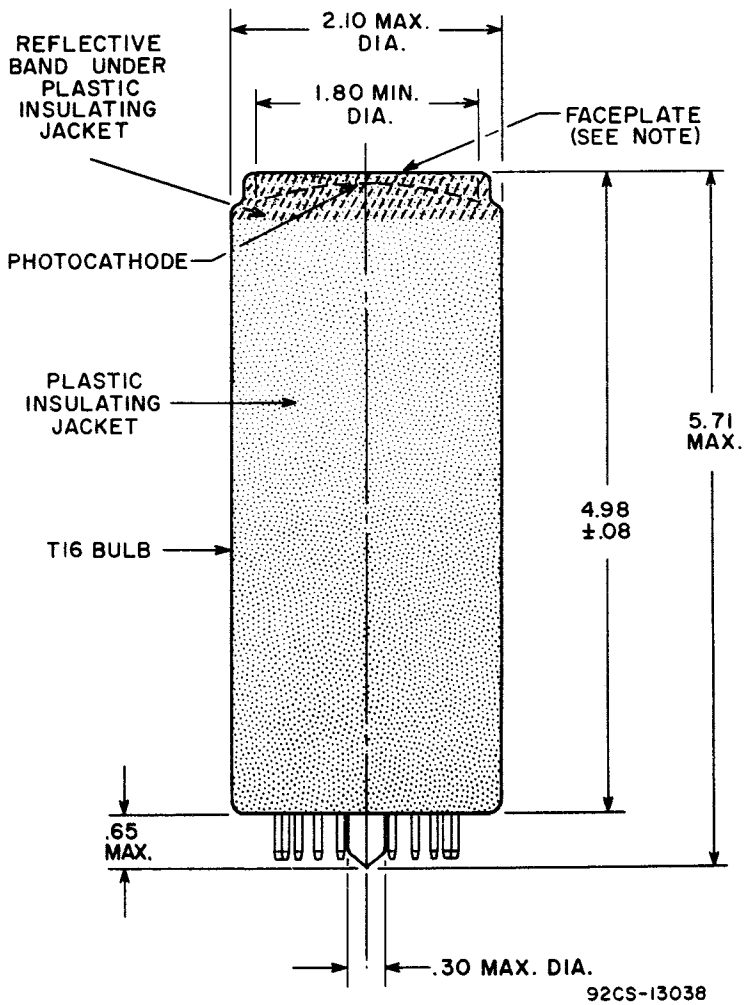
z See accompanying *Typical Noise Spectra*.

aa See accompanying *Differential Fe55 Spectrum*.

TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER		
Between	Distribution I 6.1% of Supply Voltage (E) multiplied by	Distribution II 4.6% of Supply Voltage (E) multiplied by
Cathode and Dynode No. 1	4.0	4.0
Dynode No. 1 and Dynode No. 2	1.0	1.0
Dynode No. 2 and Dynode No. 3	1.4	1.4
Dynode No. 3 and Dynode No. 4	1.0	1.0
Dynode No. 4 and Dynode No. 5	1.0	1.0
Dynode No. 5 and Dynode No. 6	1.0	1.0
Dynode No. 6 and Dynode No. 7	1.0	1.0
Dynode No. 7 and Dynode No. 8	1.0	1.0
Dynode No. 8 and Dynode No. 9	1.0	1.0
Dynode No. 9 and Dynode No. 10	1.0	1.5
Dynode No. 10 and Dynode No. 11	1.0	2.0
Dynode No. 11 and Dynode No. 12	1.0	4.0
Dynode No. 12 and Anode	1.0	2.0
Anode and Cathode	16.4	21.9
Focusing Electrode is connected to arm of potentiometer between cathode and dynode No. 1. The focusing-electrode voltage is varied to give maximum current amplification. Multiplier shield is operated at Dynode-No. 5 potential.		

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 1.80" minimum diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

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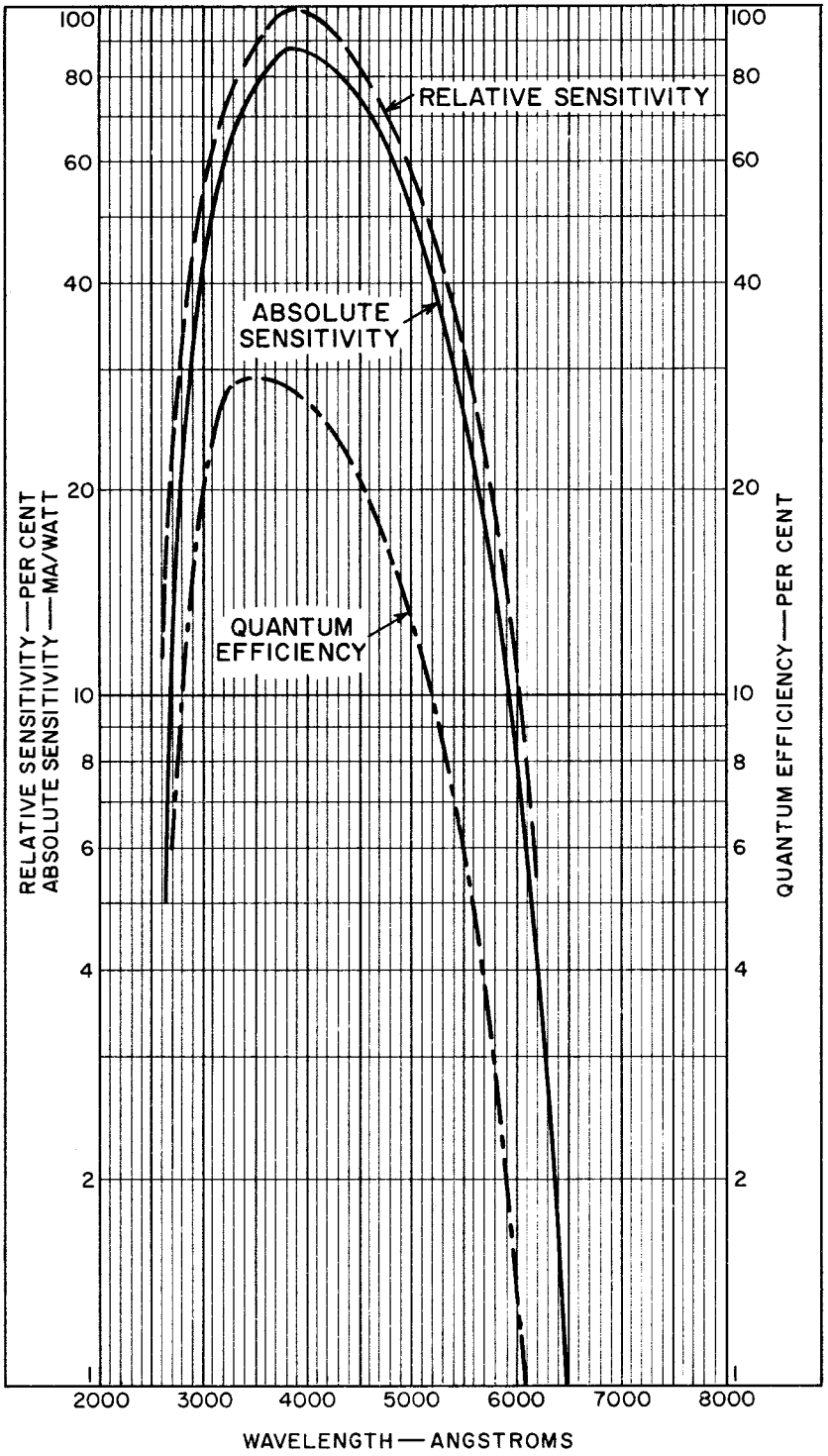
Spectral Response Characteristics



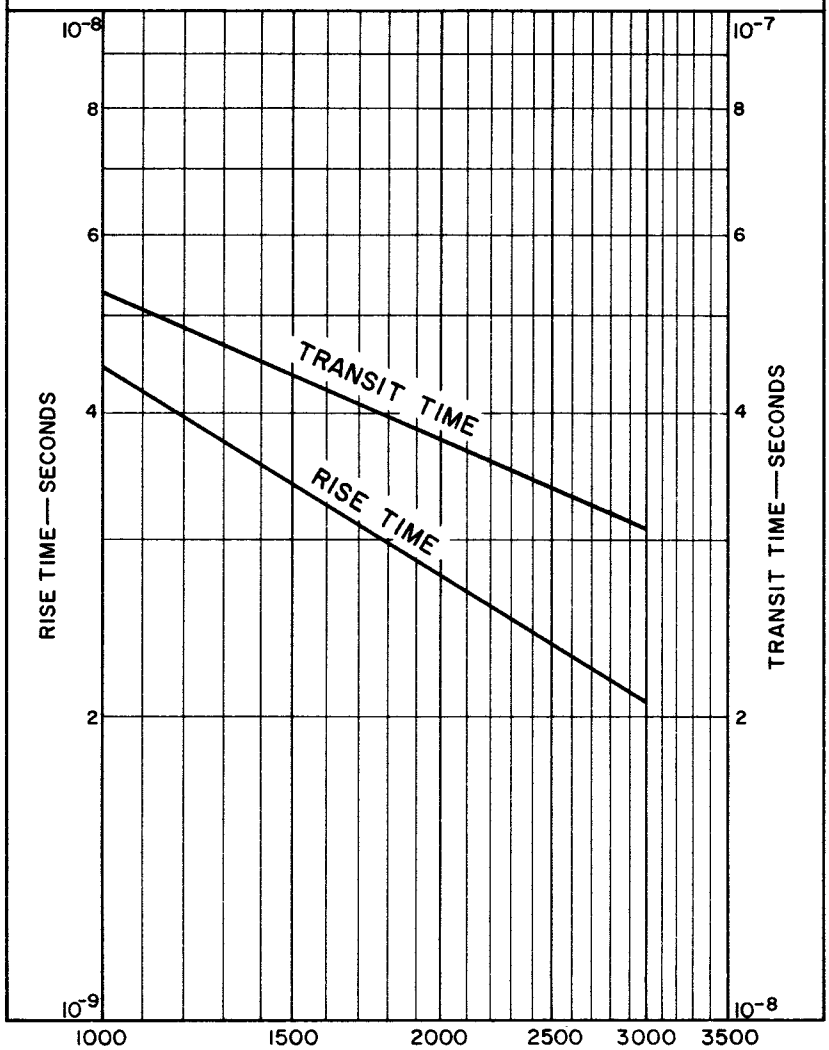
92CM-13041

Typical Time-Resolution Characteristics

THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



92CM-13042

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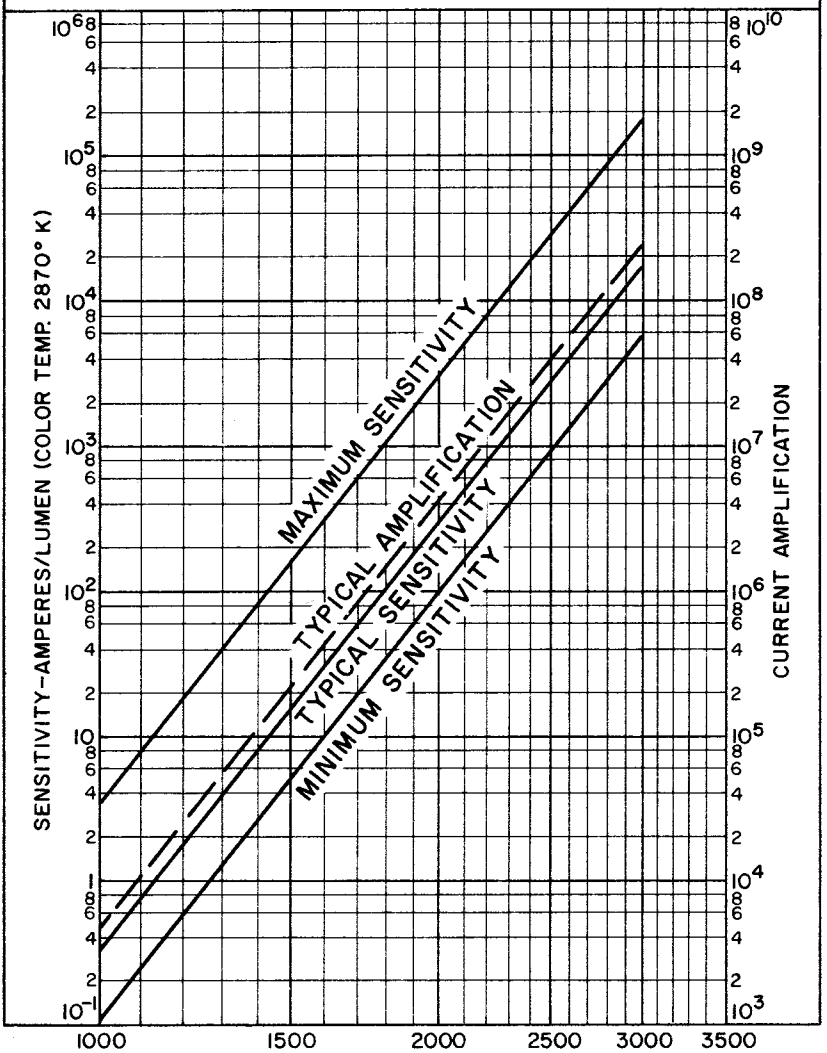
Typical Sensitivity and Current Amplification Characteristics

THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL. ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.

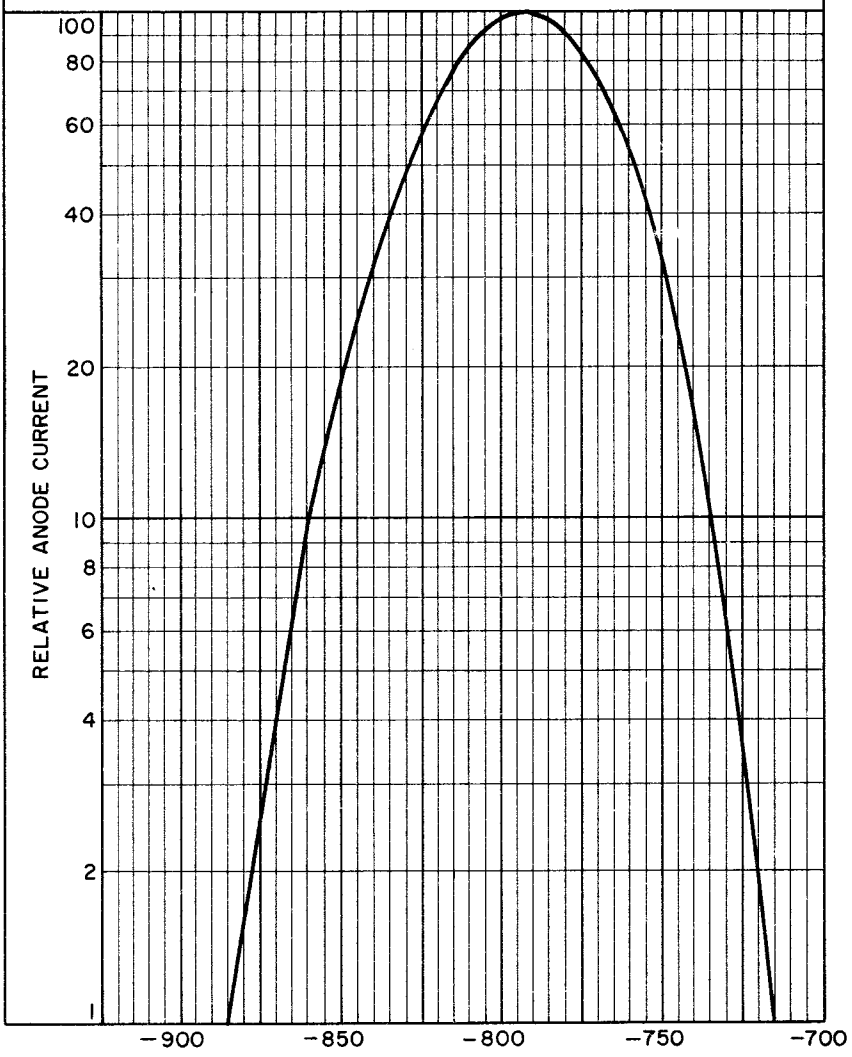


Typical Dynode Modulation Characteristic

THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
CATHODE IS AT GROUND POTENTIAL.



92CM-13044

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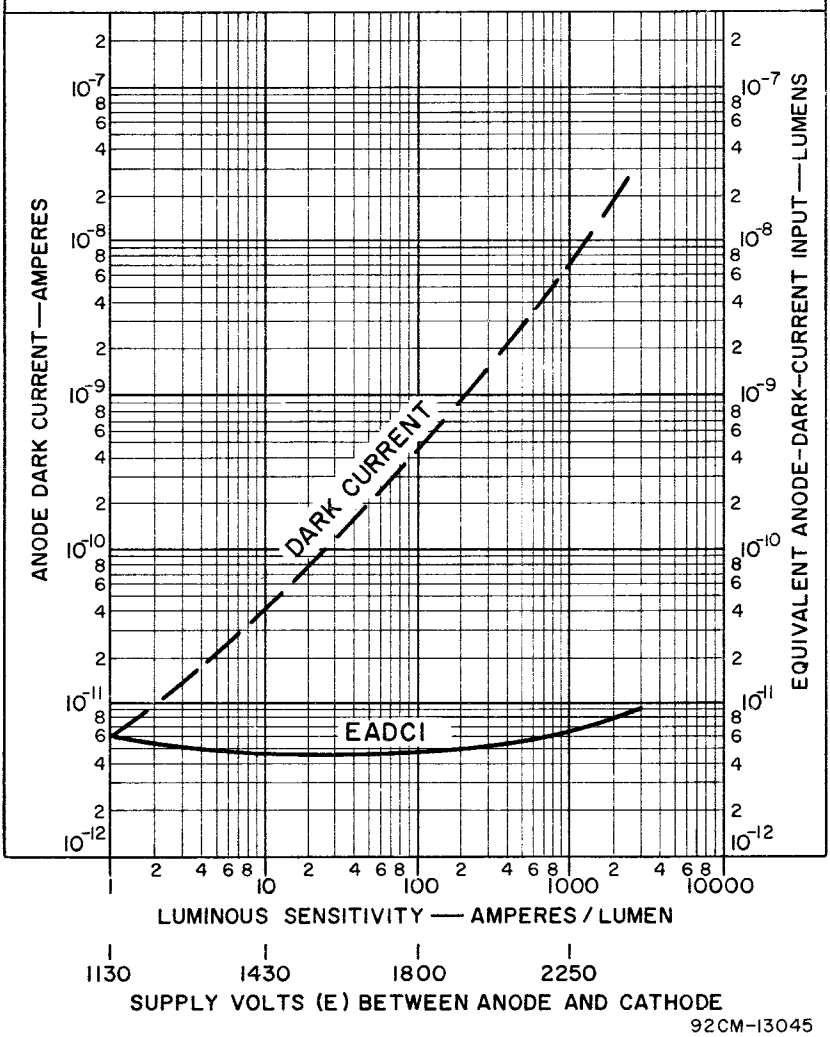
Typical Dark Current and EADCI Characteristics

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No.1 AND DYNODE No. 2	1.0
DYNODE No.2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

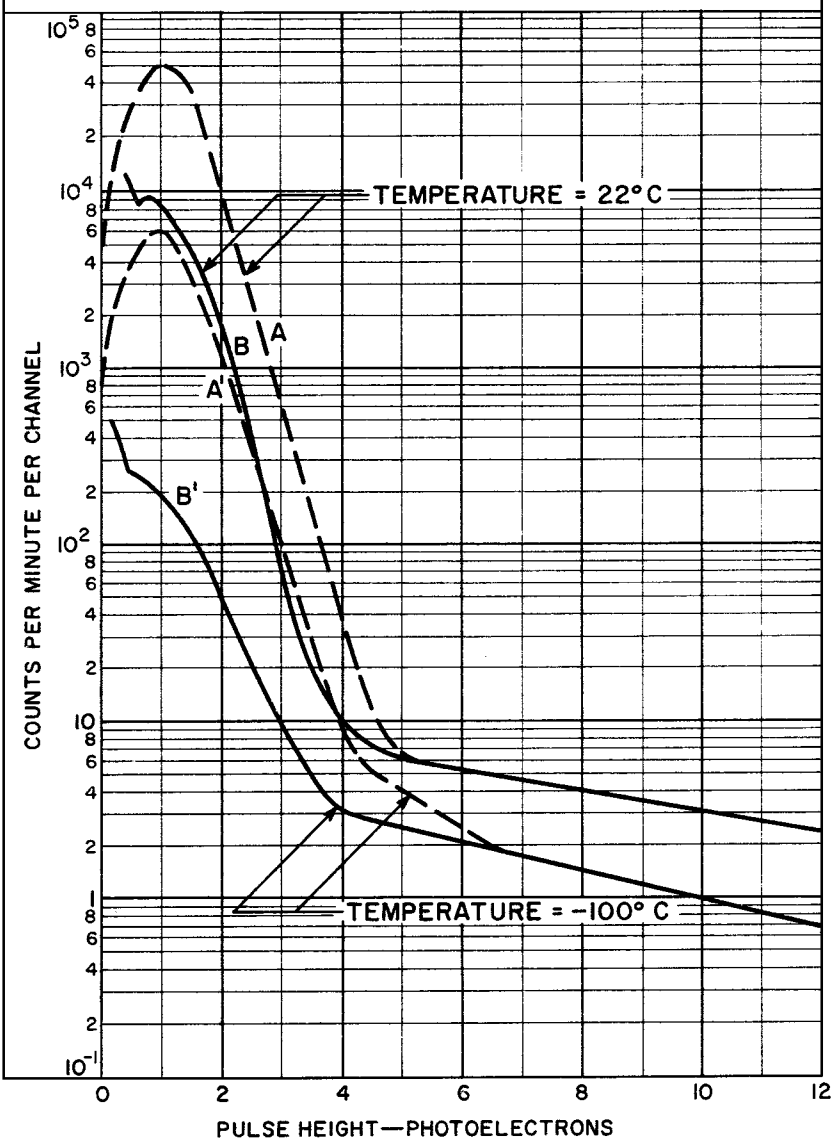
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED FOR MAXIMUM CURRENT AMPLIFICATION.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.
TUBE TEMPERATURE = 22° C



92CM-13045

Typical Noise Spectra

CATHODE-TO-DYNODE-No. 1 VOLTS = 420
DYNODE-No. 1-TO-DYNODE-No. 2 VOLTS = 105
DYNODE-No. 2-TO-DYNODE-No. 3 VOLTS = 155
EACH SUCCEEDING DYNODE-STAGE VOLTS = 105
ANODE-TO-CATHODE VOLTS = 1700
FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
CURVES A, A': PHOTOCATHODE FULLY ILLUMINATED BY A TUNGSTEN-FILAMENT LAMP OPERATED AT LOW COLOR TEMPERATURE. DARK PULSES ARE SUBTRACTED.
CURVES B, B': PHOTOTUBE IN DARK.



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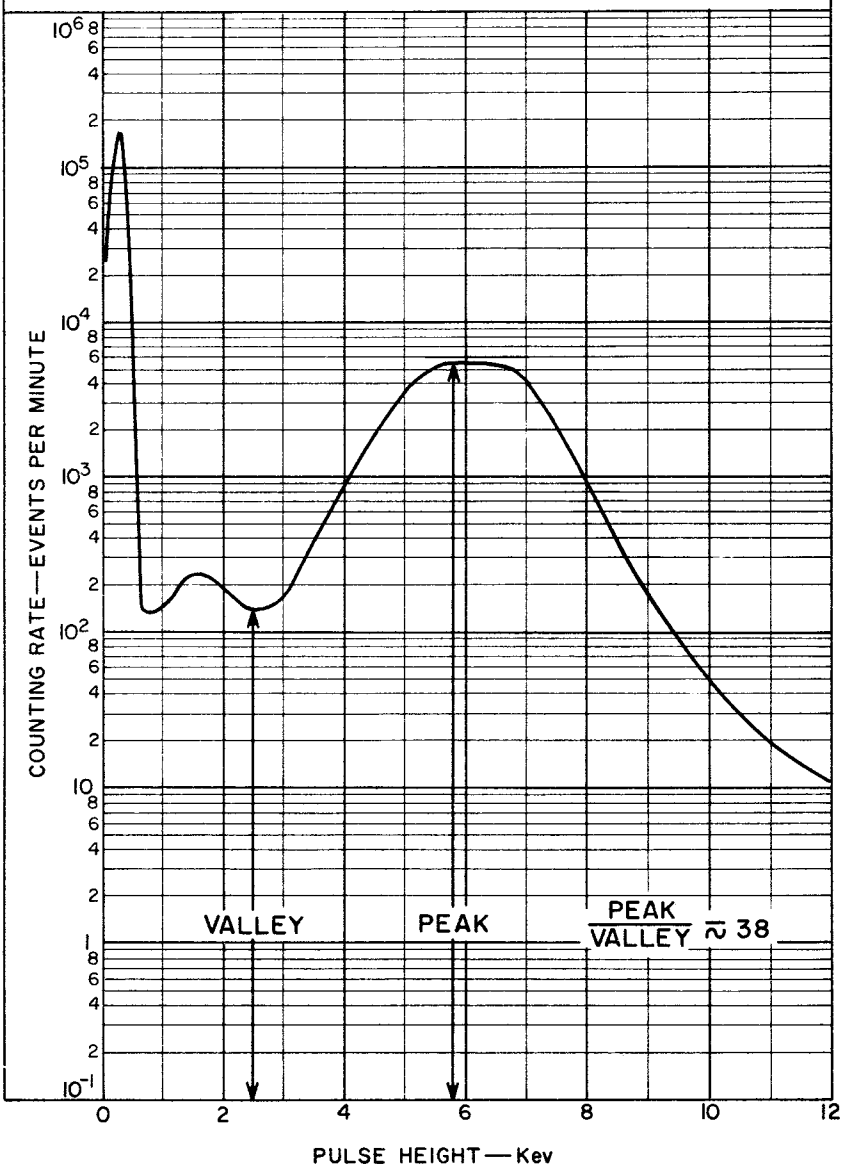
Differential Fe^{55} Spectrum

Fe^{55} SOURCE, ACTIVITY 1 μ CURIE
SCINTILLATOR: HARSHAW, TYPE HG 0.005" BERYLLIUM WINDOW, NaI(Tℓ), 7/8" DIAMETER, 0.040" THICK
CATHODE-TO-DYNODE-No. 1 VOLTS = 420
DYNODE-No. 1-TO-DYNODE-No. 2 VOLTS = 105
DYNODE-No. 2-TO-DYNODE-No. 3 VOLTS = 155
EACH SUCCEEDING DYNODE-STAGE VOLTS = 105
ANODE-TO-CATHODE VOLTS = 1700
FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.



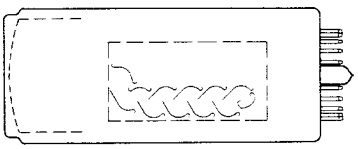
92CM-13047

Typical Effect of Magnetic Field on Anode Current

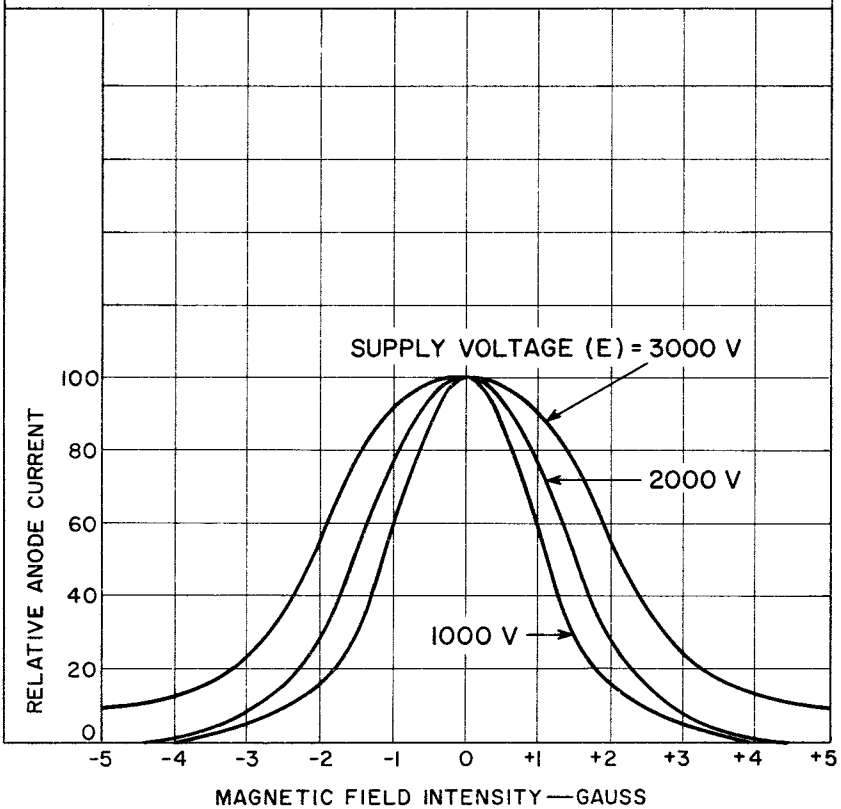
THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No.1 AND DYNODE No. 2	1.0
DYNODE No.2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No.1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUES OF MAGNETIC FLUX (B) ARE FOR LINES OF FORCE IN INDICATED DIRECTION.



92CM-13048

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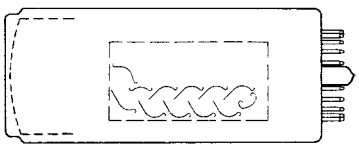
Typical Effect of Magnetic Field on Anode Current

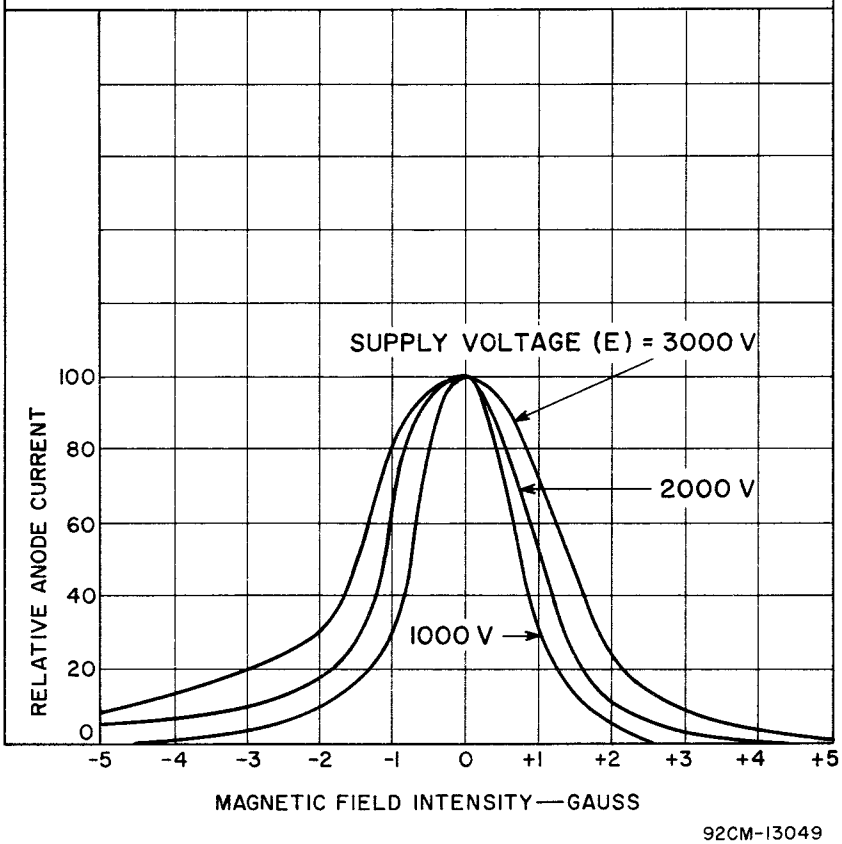
THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUES OF MAGNETIC FLUX (B) ARE FOR LINES OF FORCE OUT OF PAPER.



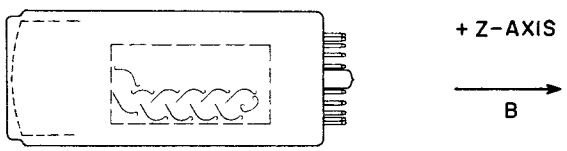
92CM-13049

Typical Effect of Magnetic Field on Anode Current

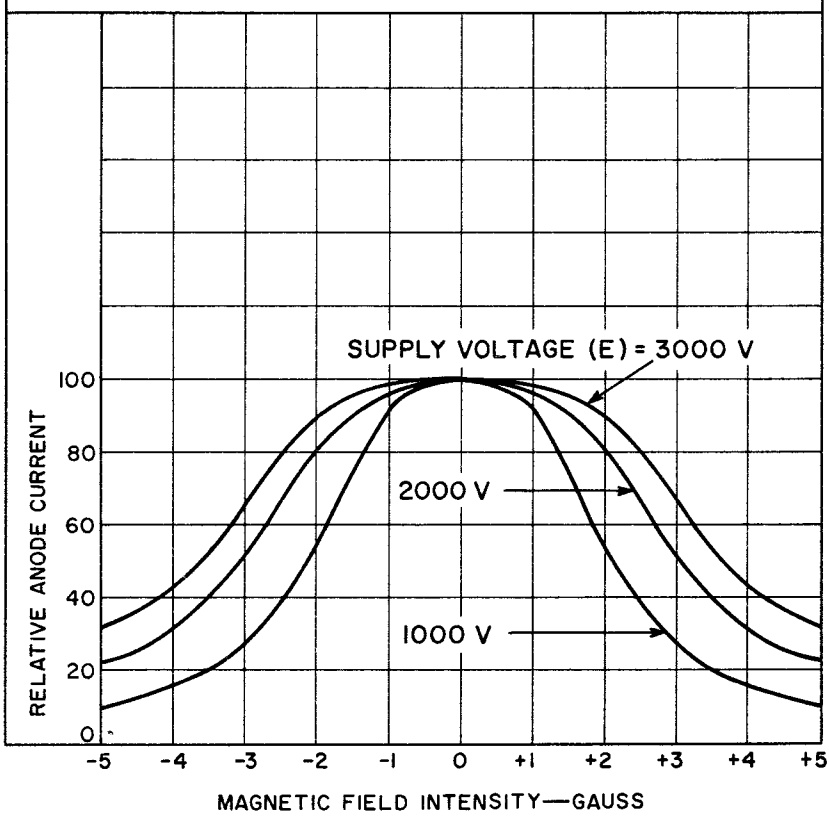
THE SUPPLY VOLTAGE (E) IS ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.1% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	4.0
DYNODE No. 1 AND DYNODE No. 2	1.0
DYNODE No. 2 AND DYNODE No. 3	1.4
EACH SUCCEEDING DYNODE-STAGE VOLTS	1.0
ANODE AND CATHODE	16.4

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.
ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.
PHOTOCATHODE IS FULLY ILLUMINATED.



POSITIVE VALUES OF MAGNETIC FLUX (B) ARE FOR LINES OF FORCE TOWARD TUBE BASE.



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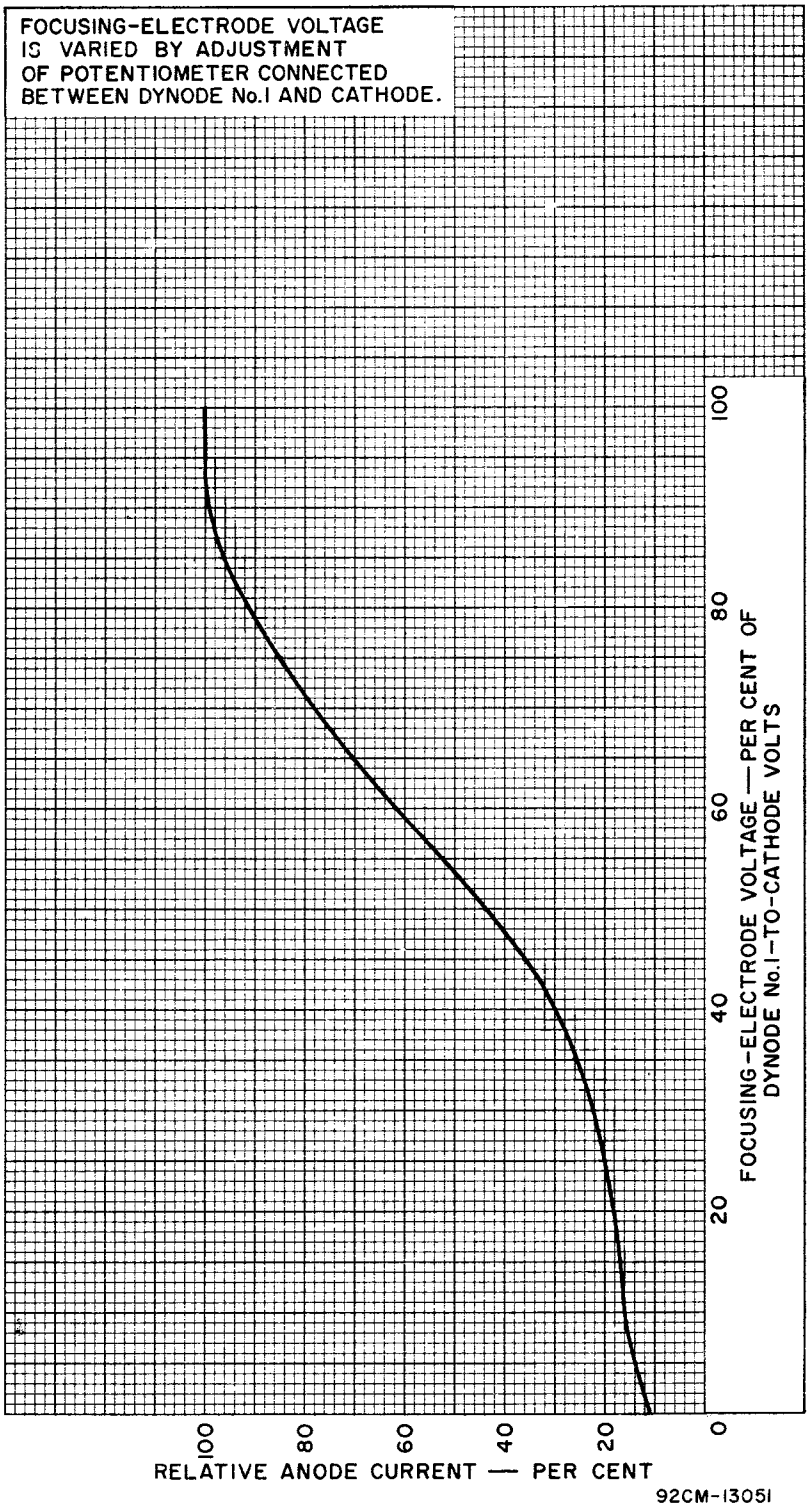
Typical Focusing-Electrode Characteristic



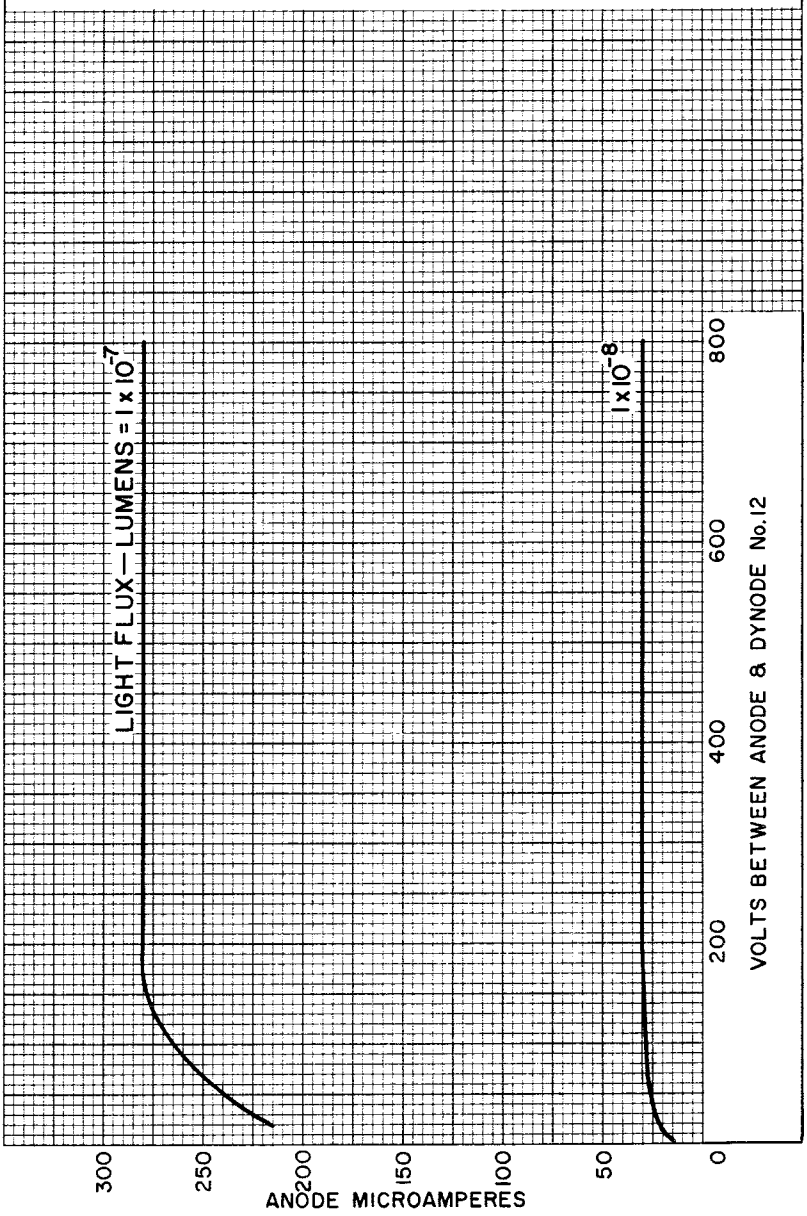
Typical Anode Characteristics

CATHODE-TO-DYNODE-No. 1 VOLTS = 600
DYNODE-No. 1-TO-DYNODE-No. 2 VOLTS = 150
DYNODE-No. 2-TO-DYNODE-No. 3 VOLTS = 210
EACH SUCCEEDING DYNODE-STAGE VOLTS = 150
ANODE-TO-CATHODE VOLTS = 2500

FOCUSING ELECTRODE IS CONNECTED TO DYNODE-No. 1 POTENTIAL.

ELECTRON MULTIPLIER SHIELD IS CONNECTED TO DYNODE-No. 5 POTENTIAL.

LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.



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