RCA TUBE
HANDBOOK
HB-3

PHOTOSENSITIVE DEVICE SECTION

This Section contains data on phototubes of the single-unit, twin-unit, and multiplier types; photocells; television camera tubes such as image orthicons, iconoscopes, and vidicons; and other devices employing photosensitive materials.

For further Technical Information, write to Commercial Engineering, Tube Division, Radio Corporation of America, Harrison, N. J.

PHOTOMULTIPLIER TUBES

Spectral Response	Diameter (nominal) in	No. of Stages	Secondary Emitting Surface	RCA Tube Types
S-1	1-1/2	10	Mg-O[a]	7102
S-4	1/2	9	Cs-Sb	8571
	1-1/8	9	Cs-Sb	IP21, 931A, 4471, 4472, 4473, 6328, 6472, 7117
S-5	1-1/8	9	Cs-Sb	IP28, IP28A
S-8	1-1/8	9	Cs-Sb	IP22
S-10	2	10	Cs-Sb	6217
S-11	3/4	6	Be-O	7764
		10	Be-O	4460, 7767
	1-1/2	10	Be-O	4461
		10	Cs-Sb	2060, 2067, 4438, 4439, 4440, 4441, 4441A, 6199
	2	10	Be-O	2020, 2061, 2063, 6342A, 7746, 8053
		10	Cs-Sb	2062, 5819, 6655A
		12	Be-O	7850
		14	Be-O	6810A, 7264
	3	10	Be-O	2064, 2064B, 8054
	5	10	Be-O	2065, 8055
S-11[b]	5	14	Be-O	7046
S-13	2	10	Cs-Sb	6903
S-19	1-1/2	9	Cs-Sb	7200
S-20	3/4	10	Be-O	8644, 8645
	2	10	Be-O	4463, 7326
		12	Be-O	4459
		14	Be-O	7265
	3	10	Be-O	4464
	5	10	Be-O	4465
(c)	2	10	Be-O	4523
	3	10	Be-O	4524
	5	10	Be-O	4525
	2	12	Be-O	8575

VACUUM AND GAS PHOTODIODES

Spectral Response	Single-Unit		Twin Unit	Anode-Cathode
	Vacuum	Gas	Gas	Vacuum
S-1	917 919 922 925 6570	1P40 1P41 868 918 921 923 927 930 6405/1640 6953	920	
S-3	926	1P29		
S-4	1P39 929 934 5653 7043	1P37 4409 5581 5582 5583		5652
S-5	935			
S-9	1P42			

IMAGE-CONVERTER TUBES[d]

Spectral Response	Recommended Service	
	Infrared	Photographic Shutter
S-1	6032A 6914 6914A 6929	
S-11		4449A

CAMERA TUBES

VIDICONS[e]			
Tube Diameter inches	Recommended Service		
	Television Film Pickup	Live Television and Industrial	Space Military and Industrial
1/2			4427
1	7038 8134/V1 8572	4478 4488 4493 4494 4495 7262A 7697 7735B 8134 8507 8573	2048[b] 4482[b] 4500 4503[b] 7263A[b] 8567[b]

CAMERA TUBES

VIDICONS[e] (Cont'd)

Tube Diameter inches	Recommended Service		
	Television Film Pickup	Live Television and Industrial	Space Military, and Industrial
1-1/2	8051 8480 8480/V1		8480 8521

IMAGE ORTHICONS

Tube Diameter inches	Recommended Service		
	Live Television Pickup		Military and Industrial
	Color	Black and White	
3	4415, 4416 4415/S, 4416/S[a] 7513[b] 7513/S, 4513/S[a] 7513/L 8092A/S	4401V1 4401V1/L 5820A 5820A/L 7293A 7293A/L 7513 7513/L 8092A 8093A 8093A/L	4401V1 4401V1/L 7198A[b] 7629A 7967 8092A
4-1/2	4462[d]	7295B 7295C 7389B 7389C	

IMAGE-INTENSIFIER ORTHICON

Tube Diameter inches	Combined Image-Converter and Image Orthicon Sections
	Recommended Service
	Extremely Low-Light Level Television Cameras
5	4470

[a] This surface is being replaced gradually by Be-O.

[b] Has extended spectral response in the near-ultraviolet. Maximum response occurs at about 4200 angstroms. The approximate spectral range, at the 10 per cent points, is from 2500 to 6500 angstroms.

[c] A spectral-response S- designation has not been assigned for these bialkali photocathode types. Maximum response occurs at about 3850 angstroms for approximate spectral range, at the 10 per cent points, is from 2600 to 6000 angstroms for type 8575 and from 3100 to 6100 for types 4523, 4524, and 4525.

[d] These types utilize a P20 phosphor screen except type 4449A which has a P11 phosphor screen.

[e] Variants of each vidicon type having fiber-optics faceplates, reticles, and/or radiation-resistant faceplates can often be supplied to meet the needs of specific applications.

[f] Ruggedized type.

[g] Types 4415/S, 4416/S are available as a trio having matched characteristics. The 4415/S's are for use in the red and green channels and the 4416/S is for use in the blue channel. Types 7513/S, 4513/S are also available as a set of three tubes having matched characteristics. Types 7513/S are for the red and green channels and type 4513/S for the blue.

[h] A trio of these tubes having matched characteristics is available as three type 7513/S.

[j] For the luminance channel in 4-tube color cameras.

DEFINITIONS

of Photosensitive-Device Terms

Radiant Sensitivity. The quotient of output current by incident radiant power of a given wavelength, at constant electrode voltages.

Radiant Intensity Sensitivity. The quotient of output current by incident radiant power per unit area, at constant electrode voltages.

Cathode Radiant Sensitivity. The quotient of current leaving the photocathode by incident radiant power of a given wavelength.

Luminous Sensitivity. The quotient of output current by incident luminous flux, at constant electrode voltages.

Luminous Intensity Sensitivity. The quotient of the output current by the incident luminous intensity, at constant electrode voltages.

Cathode Luminous Sensitivity. The quotient of current leaving the photocathode by the incident luminous flux.

Illumination Sensitivity. The quotient of output current by the incident illumination, at constant electrode voltages.

Dynamic Sensitivity. The quotient of the modulated component of the electrical output by the modulated component of the incident radiation.

Current Amplification. Ratio of the output current to the photocathode current, at constant electrode voltages.

Equivalent Anode-Dark-Current Input. The quotient of the anode dark current by the luminous sensitivity.

Equivalent Noise Input. That value of incident luminous flux which when modulated in a stated manner produces an rms output current equal to the rms noise current within a specified bandwidth.

Electrode Dark Current. The electrode current which flows when there is no radiant flux incident on the photocathode.

Transit-Time Spread. The increase in width of the output pulse over that of the input pulse. Pulse width is measured at 50 per cent of the pulse height.

Pulse Rise Time. The time required for the instantaneous amplitude of the pulse to go from 10 per cent to 90 per cent of the peak value.

Median. That value in a series such that half of the devices in the series are on one side of it, and half on the other.

PHOTOTUBE SENSITIVITY AND SENSITIVITY MEASUREMENTS

GENERAL CONSIDERATIONS

The range of luminous-sensitivity limits given for a phototube on the data sheets of this Section is that which the tube will display when operated under low-current conditions.

If the tube is to be operated under conditions approaching its maximum-current rating, the equipment design should provide for a wider sensitivity range having a minimum value equal to one-half of that shown for low-current operation. The sensitivity of a phototube under such high-current conditions is dependent upon the tube type, as follows:

1. Single-Unit and Twin Phototubes

a. Gas Types: For high-current operation, and particularly in applications in which the type is subjected to these higher values continuously, a drop in sensitivity below the values for low-current operation may be expected, the extent of the drop being affected by the severity of the operating conditions. After a period of idleness, a gas phototube usually recovers most of its initial sensitivity.

b. Vacuum Types: Unlike gas phototubes, this class of phototubes shows negligible drop in sensitivity values for different degrees of illumination and over long periods of use. The output current of a vacuum phototube is a linear function of the exciting illumination under normal operating conditions. The frequency response is flat up to frequencies at which transit-time effects become the limiting factor.

2. Multiplier Phototubes

Although RCA Multiplier Phototubes are vacuum types, a drop in sensitivity is to be expected from this class of phototubes when operated at high anode-current values. The extent of the drop is affected by the nature and severity of the operating conditions to which the tube is subjected. After a period of idleness, the multiplier phototube usually recovers a substantial percentage of this loss of sensitivity.

Multiplier-phototube-sensitivity values are dependent on the respective amplification of each dynode stage. Hence, large variations in sensitivity can be expected between individual tubes of a given type. The overall amplification of a multiplier phototube is equal to the average amplification per stage raised to the nth power, where n is the number of stages. Thus, very small variations in amplification per stage produce very large changes in overall tube amplification.

Because these overall changes are very large, it is advisable for designers to provide adequate adjustment of the supply voltage per stage so as to be able to adjust the amplification of individual tubes to the desired design value. It is suggested that an overall voltage-adjustment

(continued on next page)

range of at least 2 to 1 be provided. When the output current can be controlled by change in the illumination of the photocathode of the multiplier phototube, the required range of adjustment in the voltage per stage can be reduced.

SENSITIVITY MEASUREMENTS

The luminous-sensitivity values shown on the data pages of this Section are measured according to the following procedures:

1. Single-Unit and Twin Phototubes

a. Gas Types: The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. For the 0-cycle measurements, a light input of 0.1 lumen is used, unless otherwise specified. For the 5000- and 10000 cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean. For all measurements, a dc anode-supply voltage of 90 volts and a 1.0-megohm load resistor are employed. Under these conditions, the effect of tube capacitance is negligible.

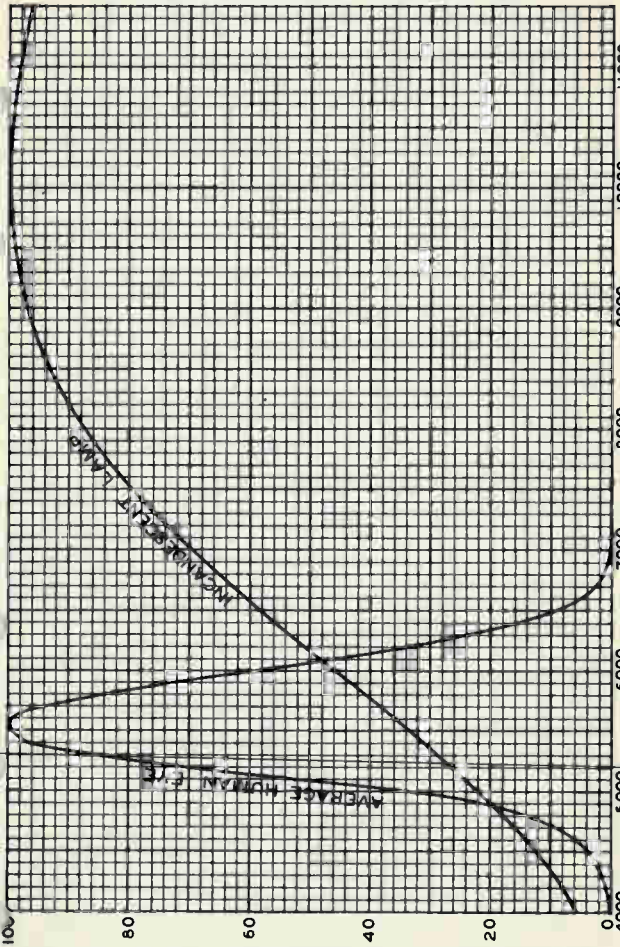
b. Vacuum Types: The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. A steady light input of 0.1 lumen is used, unless otherwise specified, together with a dc anode-supply voltage of 250 volts and a 1-megohm load resistor.

2. Multiplier Phototubes

The light source consists of a tungsten lamp operating at a filament color temperature of 2870°K. A light flux of 10 microlumens from a rectangular aperture approximately 0.8" long and 0.2" wide is projected normal to the cathode in the direction noted on the basing diagram and outline. The load resistor has a value of 0.01 megohm. The applied voltages are specified on the individual data sheets.

SPECTRAL CHARACTERISTIC OF HUMAN EYE & OF TUNGSTEN LAMP AT COLOR TEMPERATURE OF 2870 °K

EYE CURVE IS ON BASIS OF EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

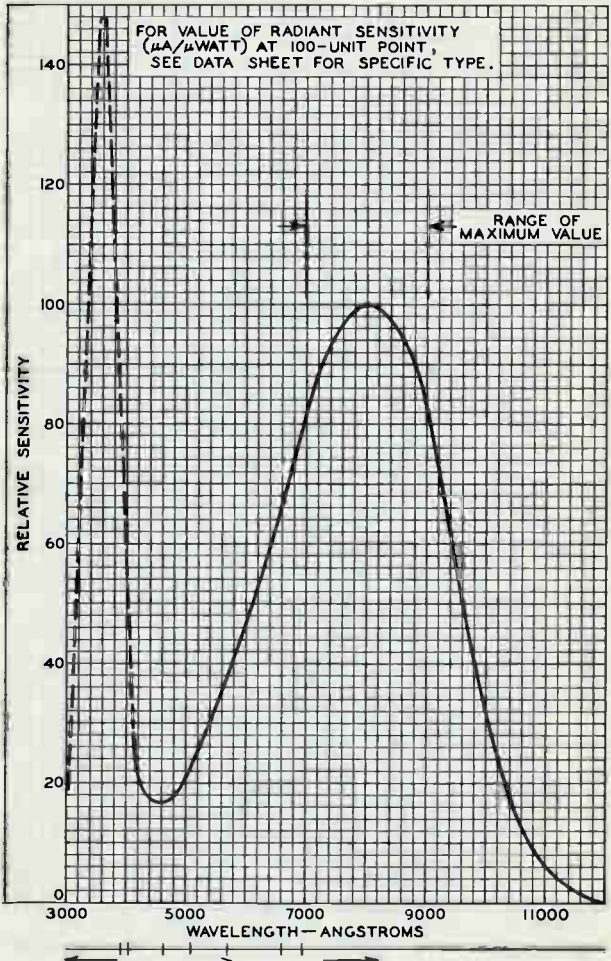


RELATIVE ENERGY DISTRIBUTION OF LAMP-ARBITRARY UNITS

RELATIVE SENSITIVITY OF EYE-ARBITRARY UNITS

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-1 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



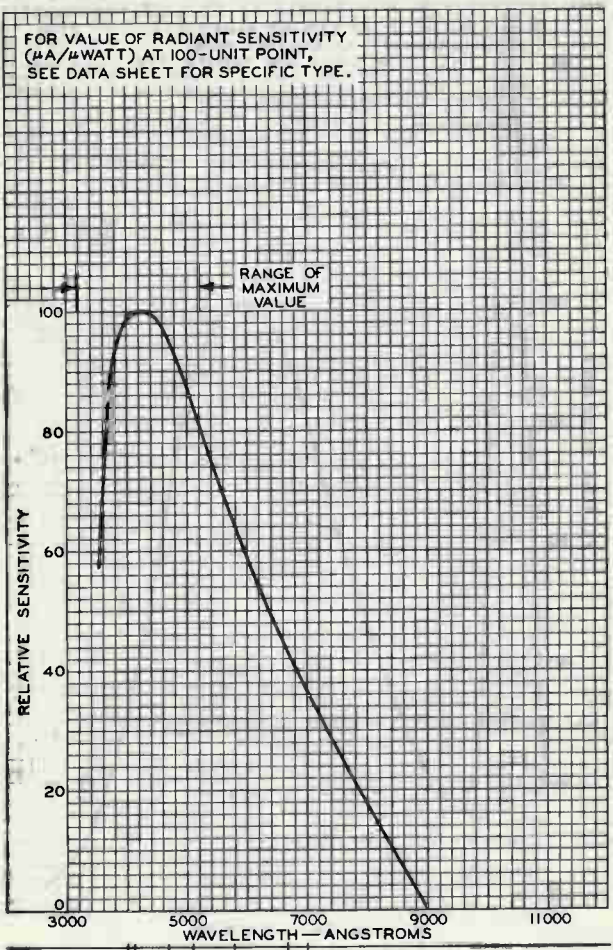
ELECTRON TUBE DIVISION

92CM-6056R6

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-3 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

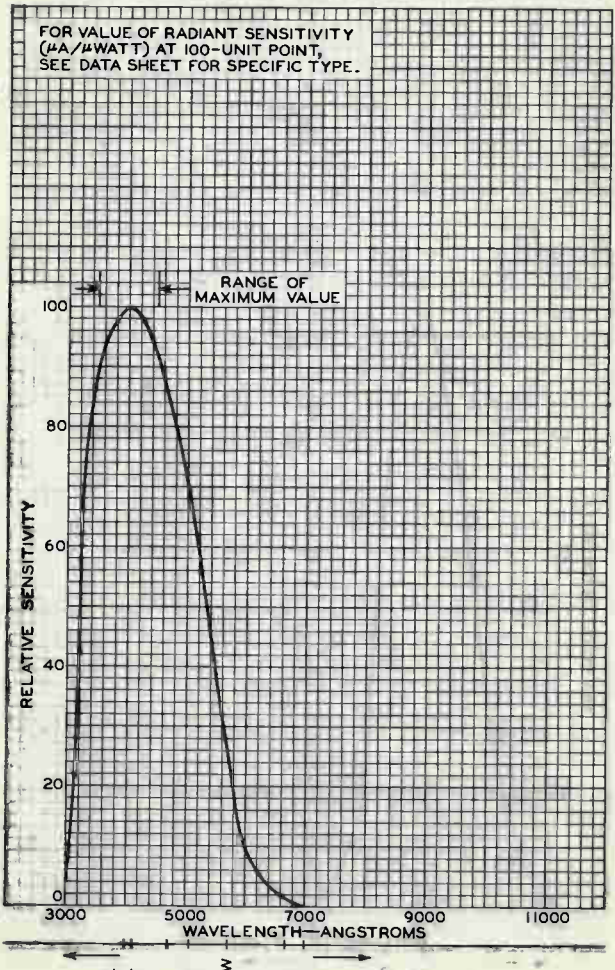


ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-6057R6

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-4 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



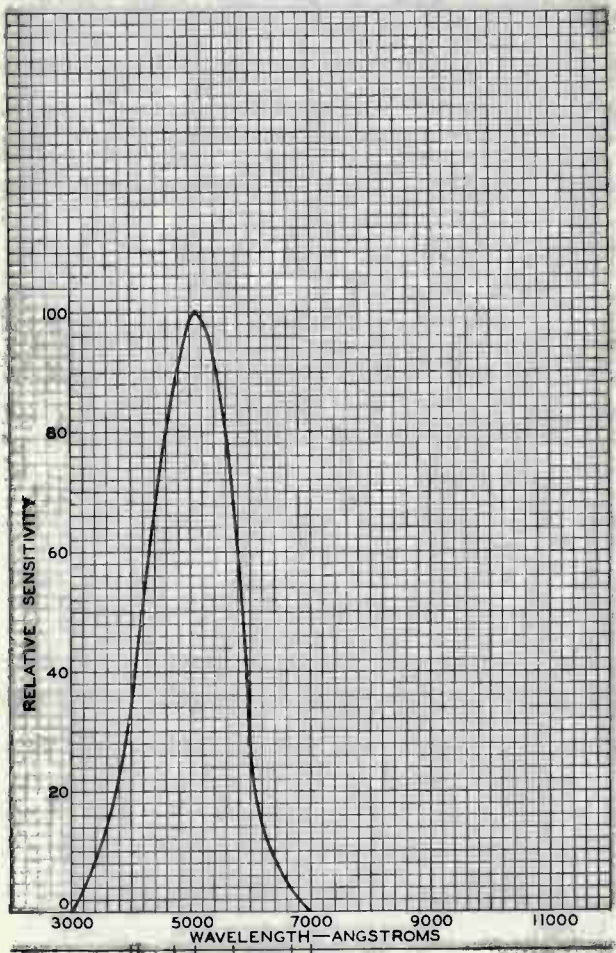
ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-6152R9

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-4 RESPONSE

RADIANT FLUX FROM TUNGSTEN SOURCE AT 2870° K



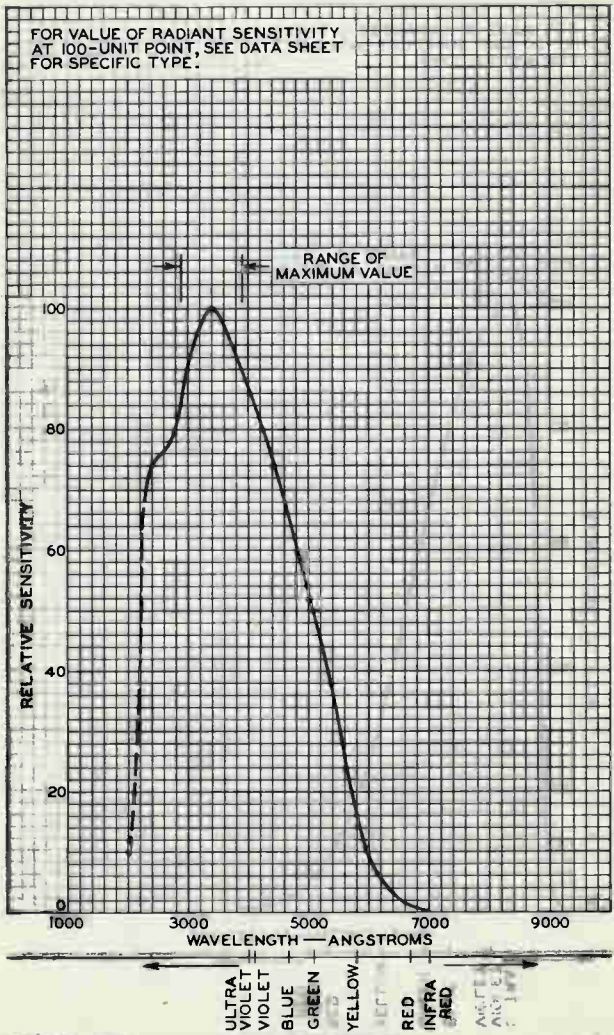
ELECTRON TUBE DIVISION

92CM-6652R3

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

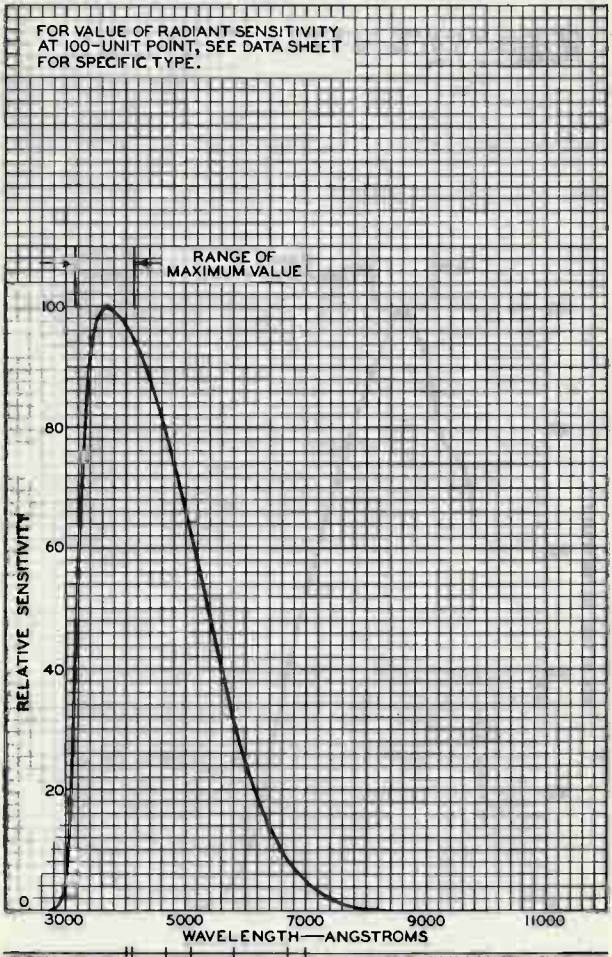
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-5 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



SPECTRAL—SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-8 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

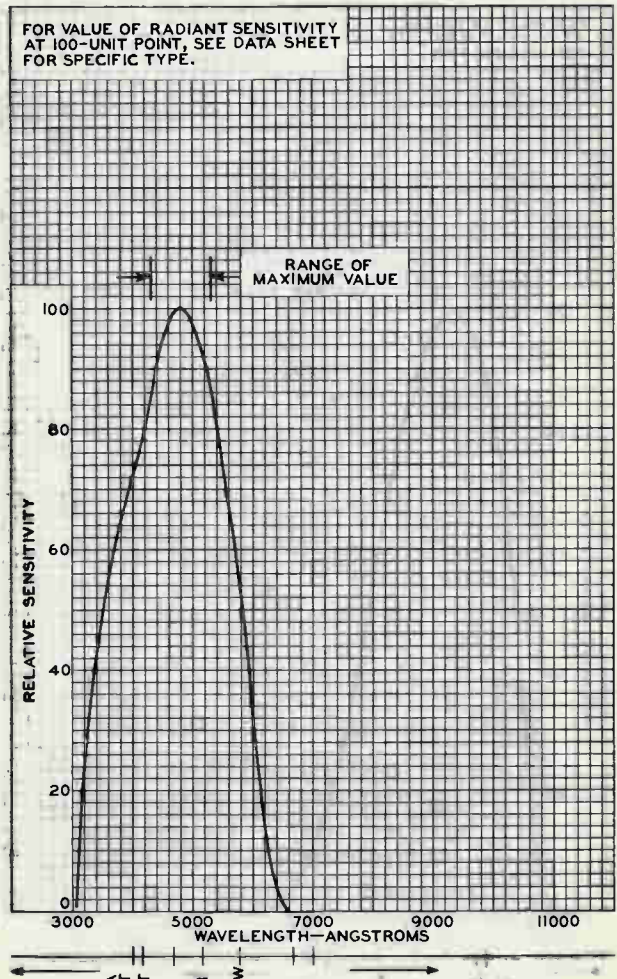


ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-6592R3

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-9 RESPONSE

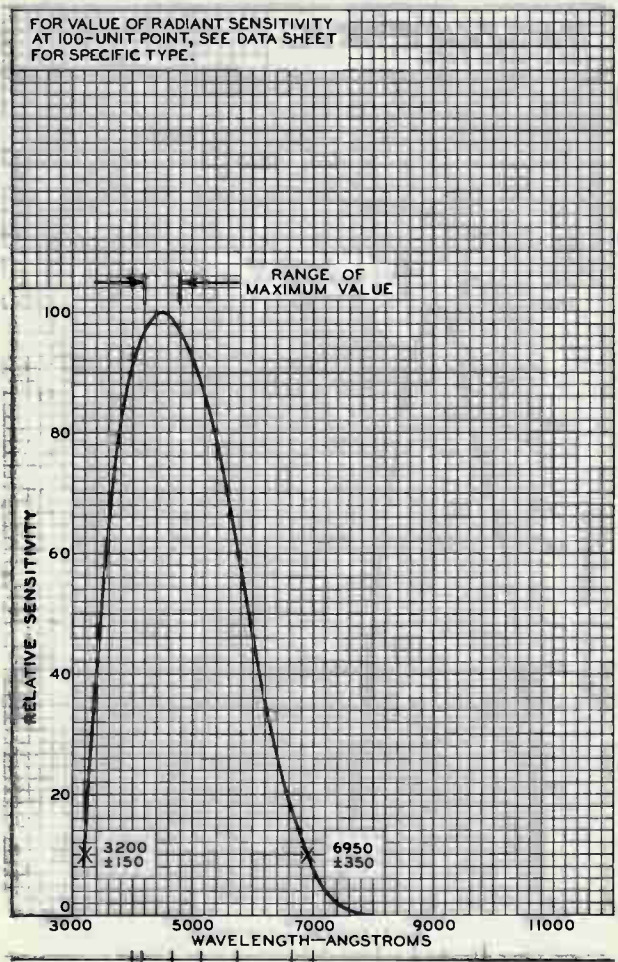
FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY
92CM-7274R2

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-10 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



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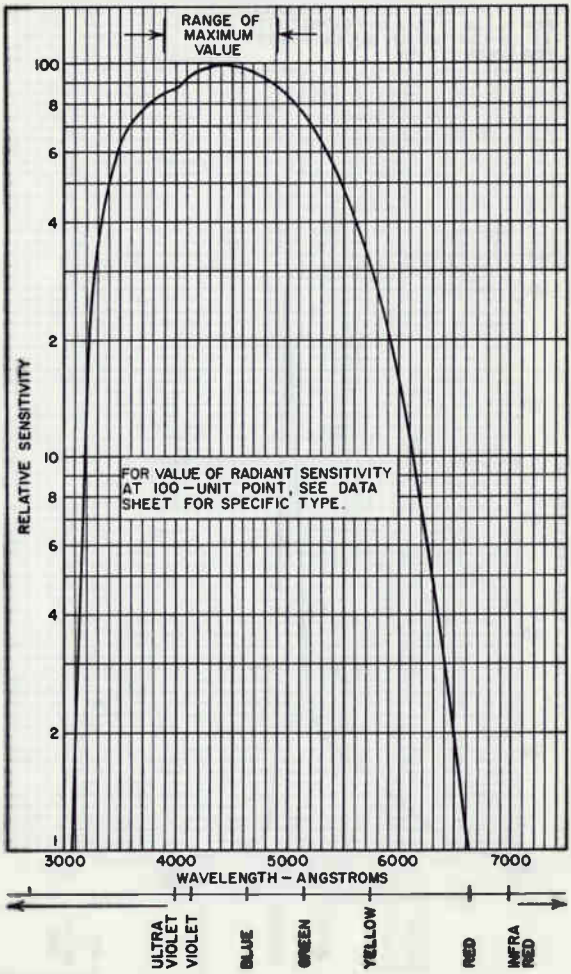
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-7821R2

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE

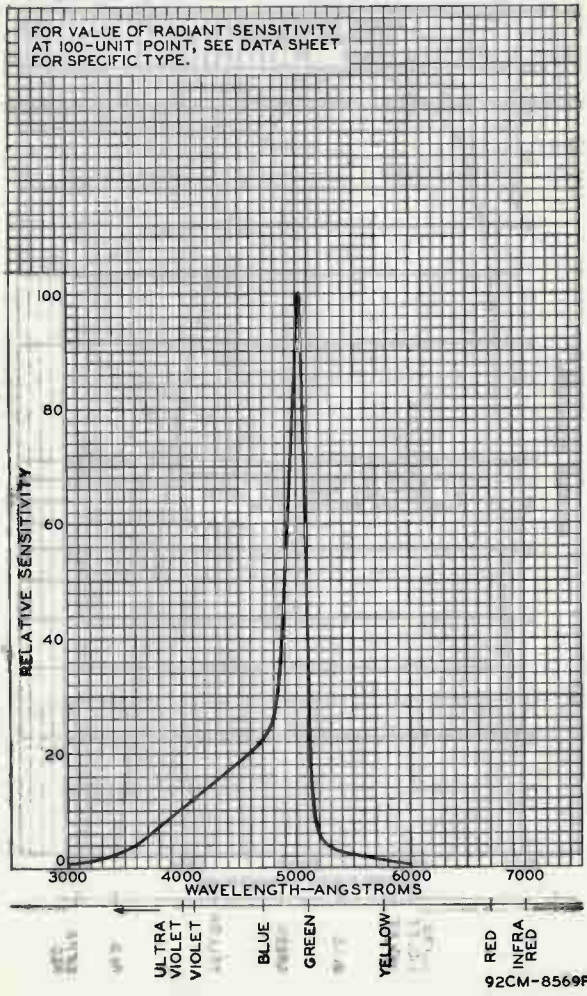
For Equal Values of Radiant Power at All Wavelengths



92CM-10662RI

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-12 RESPONSE

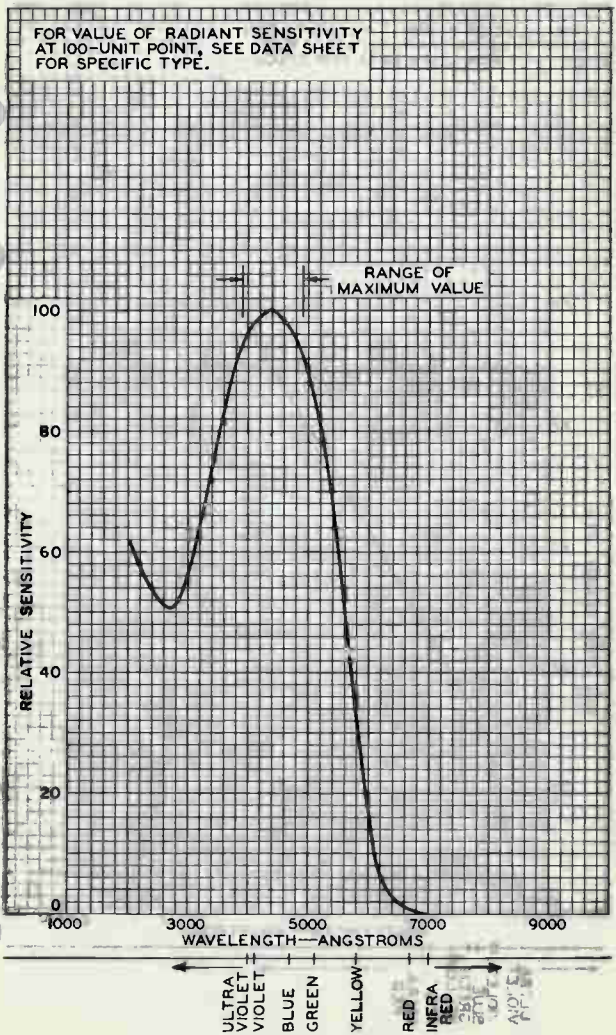
For Equal Values of Radiant Power at All Wavelengths



RADIO CORPORATION OF AMERICA
Electron Tube Division
Harrison, N. J.

TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-13 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



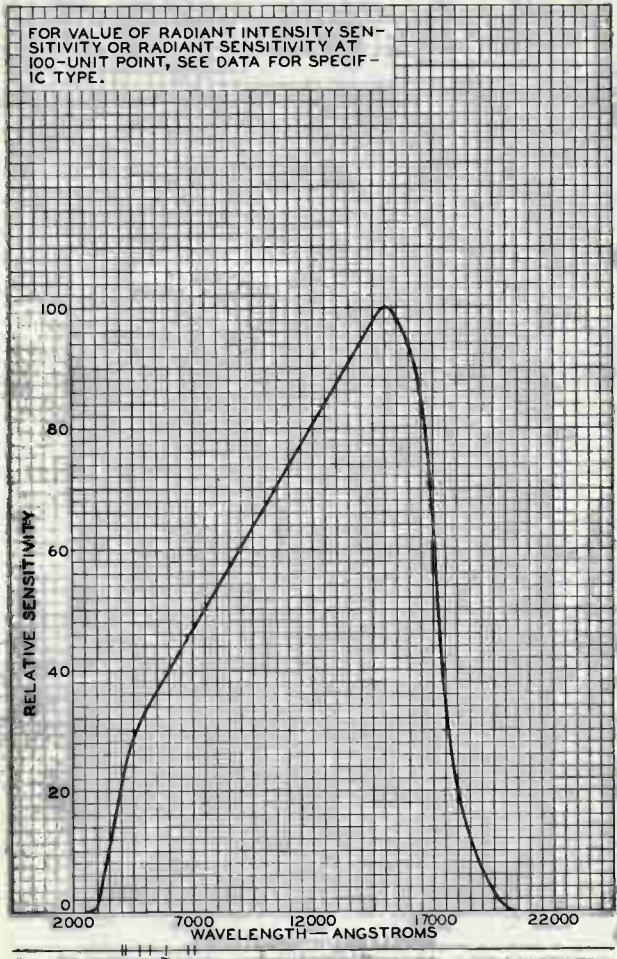
ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9037RI

TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOJUNCTION CELL HAVING S-14 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



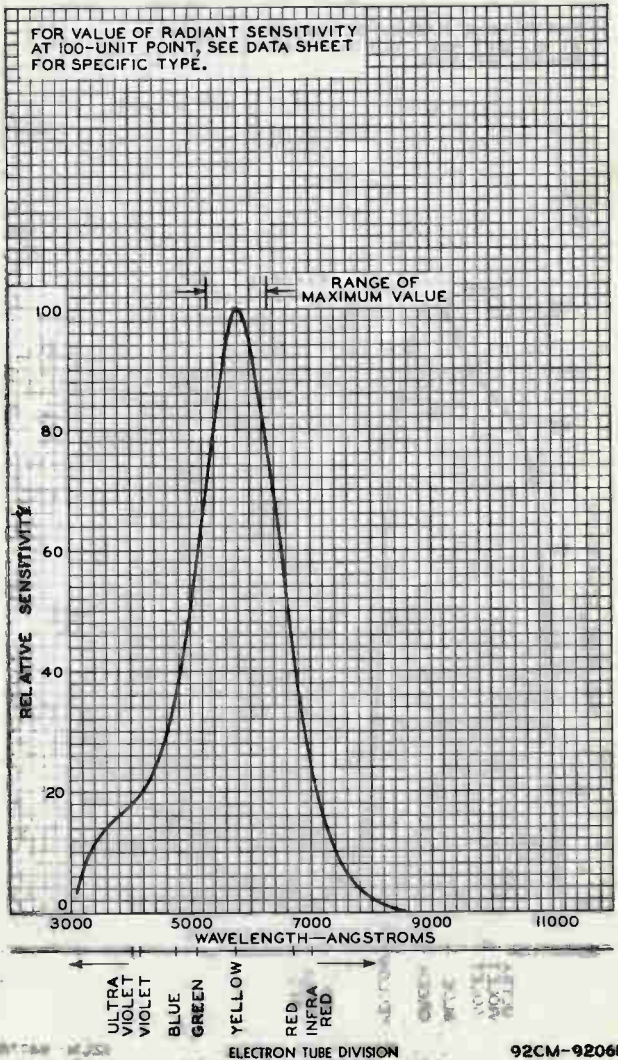
ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9647

TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOCONDUCTIVE CELL HAVING S-15 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS

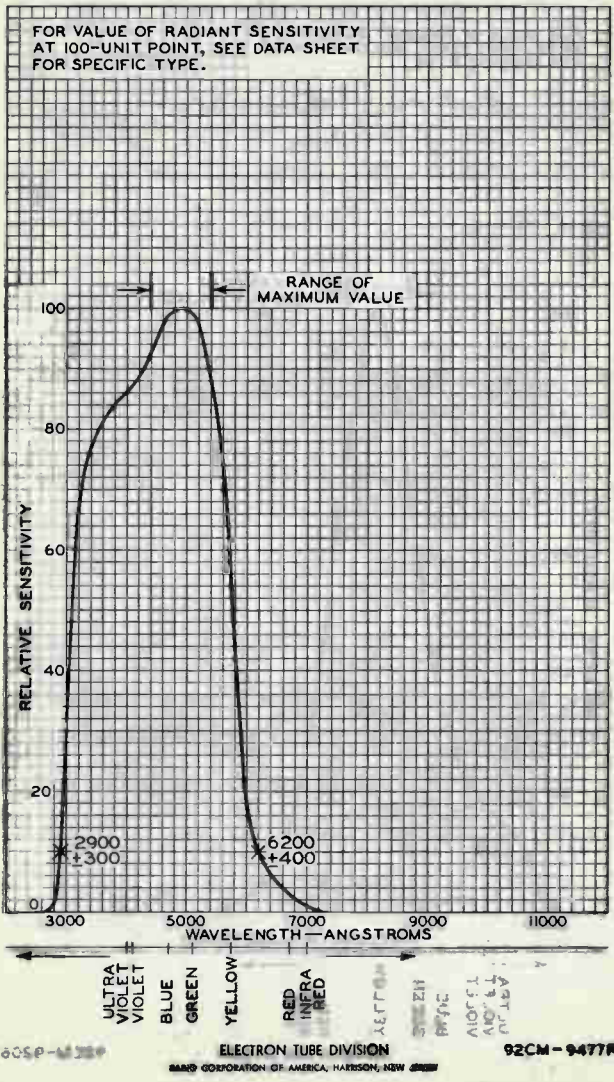


ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9206RI

TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-17 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



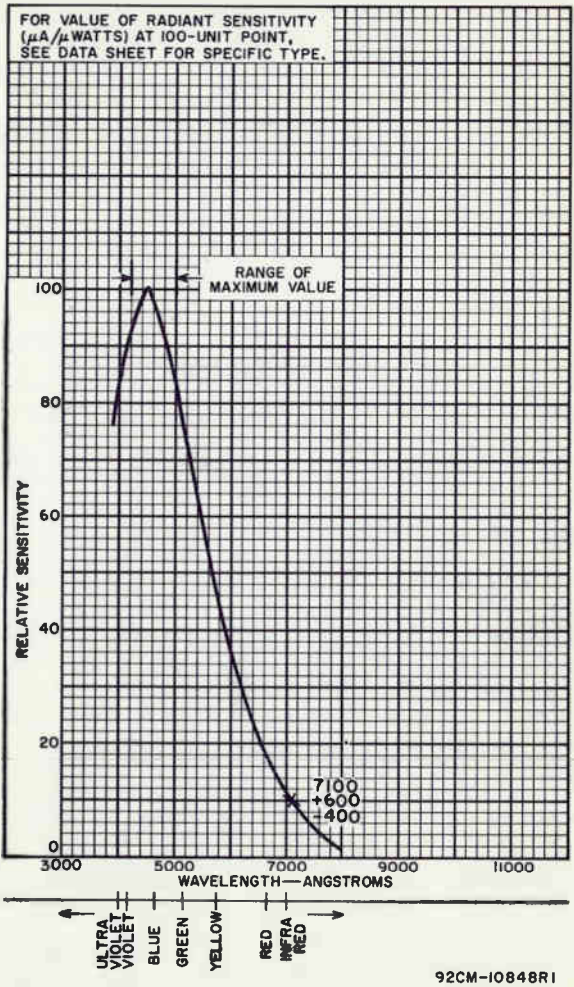
ELECTRON TUBE DIVISION

92CM-9477RI

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

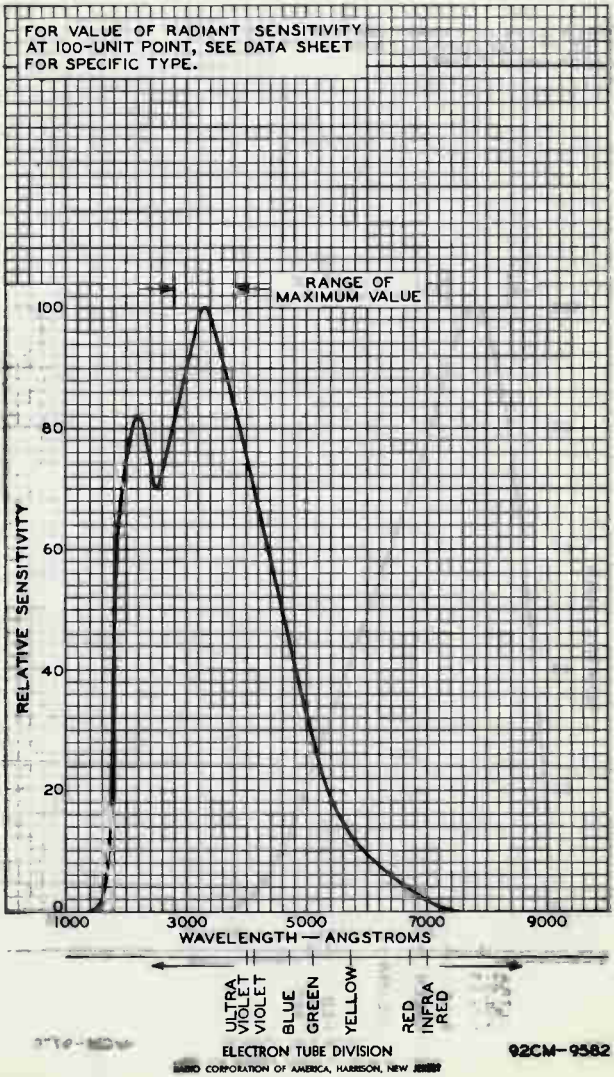
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-18 RESPONSE

For Equal Values of Radiant Power at All Wavelengths



TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-19 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



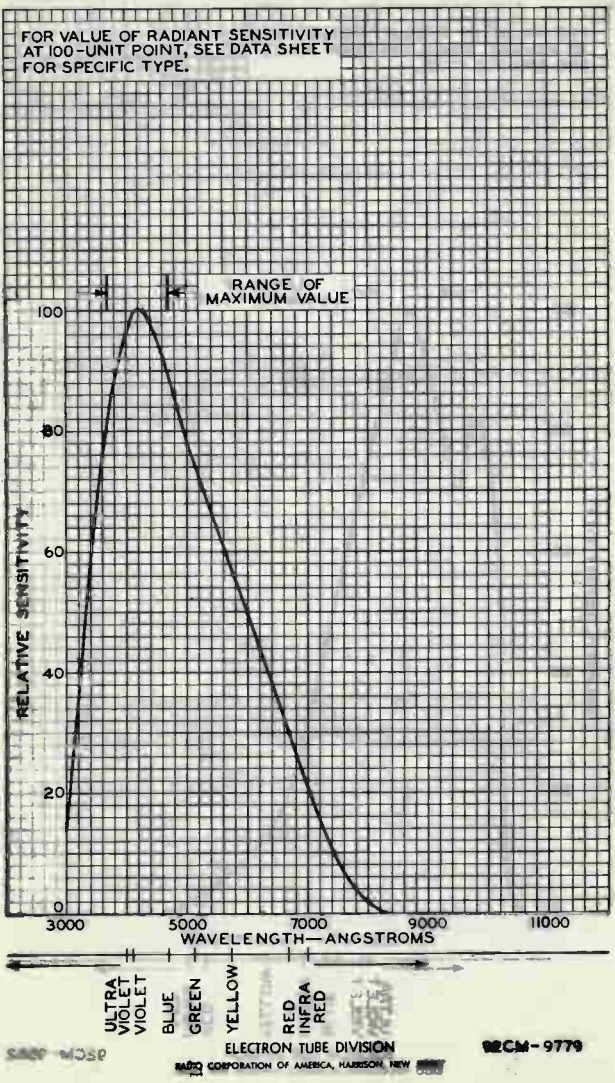
ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9582

TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOTUBE HAVING S-20 RESPONSE

FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



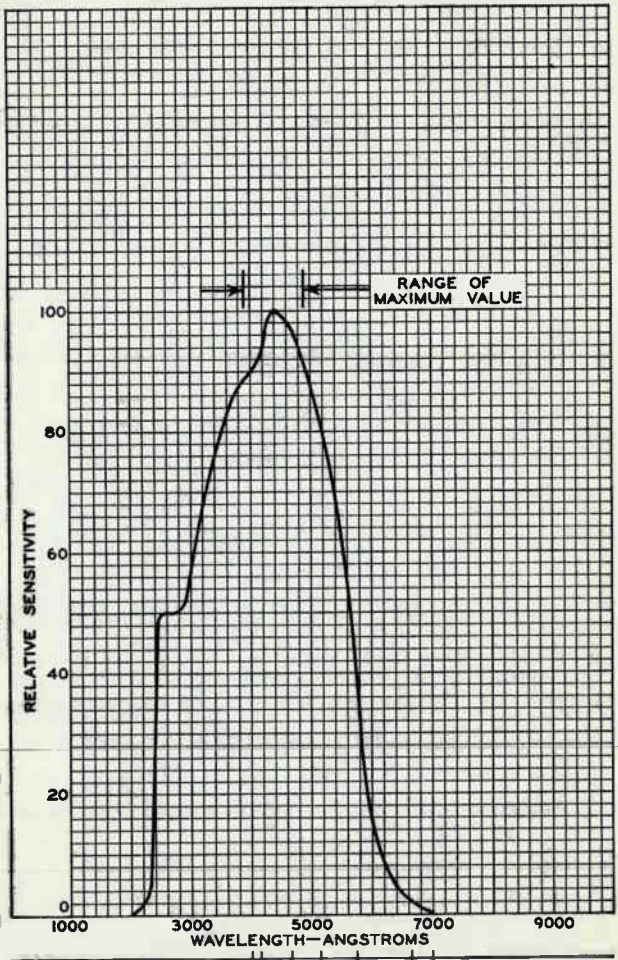
ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9779

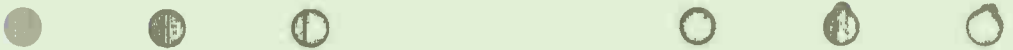
TENTATIVE SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-21 RESPONSE

FOR EQUAL VALUES OF RADIANT POWER AT ALL WAVELENGTHS

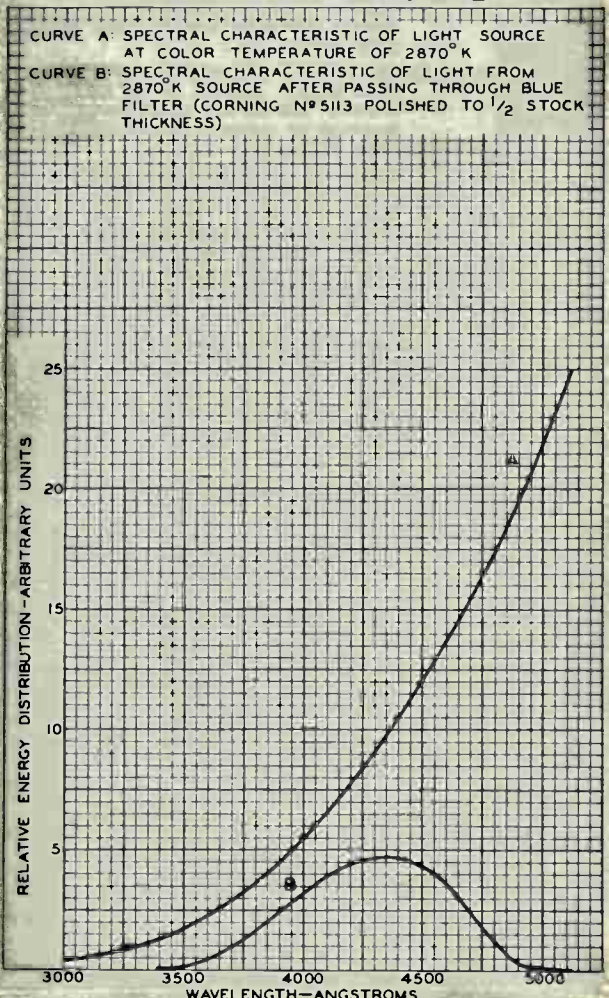


ELECTRON TUBE DIVISION

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY



SPECTRAL CHARACTERISTIC OF 2870°K LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870°K SOURCE AFTER PASSING THROUGH INDICATED BLUE FILTER



JULY 17, 1952

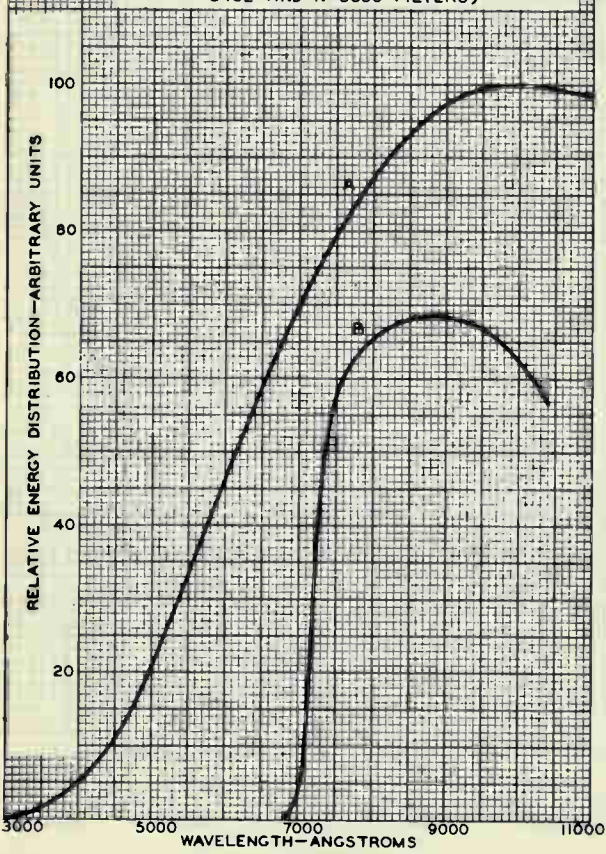
TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-7811

SPECTRAL CHARACTERISTIC OF 2870°K LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870°K SOURCE AFTER PASSING THROUGH INDICATED RED-INFRARED FILTER

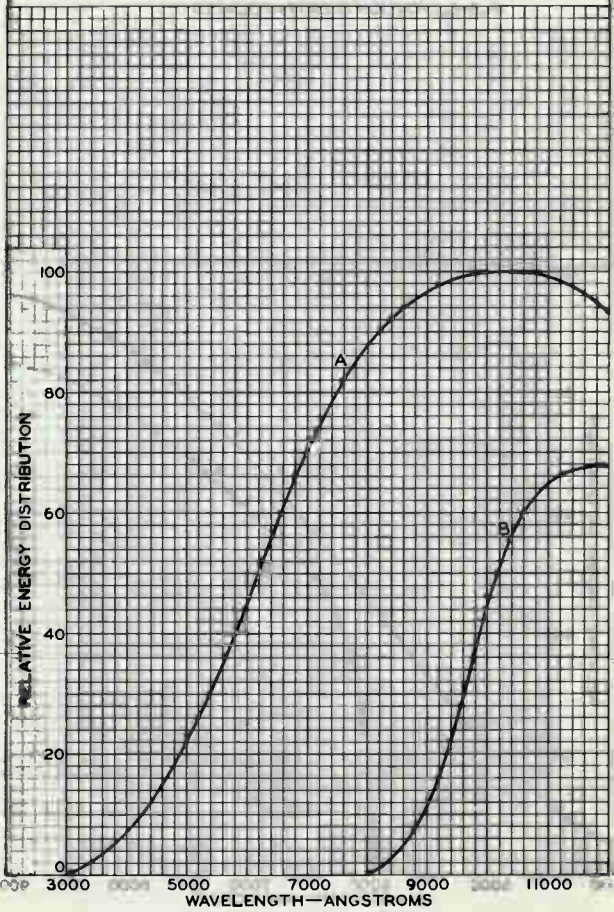
CURVE A: SPECTRAL CHARACTERISTIC OF LIGHT SOURCE AT COLOR TEMPERATURE OF 2870° K

CURVE B: SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870°K SOURCE AFTER PASSING THROUGH RED-INFRARED FILTER (COMBINATION OF CORNING, GLASS CODE Nº 3482 AND Nº 5850 FILTERS)



SPECTRAL CHARACTERISTIC OF 2870° K LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF RADIATION FROM 2870° K SOURCE AFTER PASSING THROUGH INDICATED INFRARED FILTER

CURVE A: SPECTRAL CHARACTERISTIC OF LIGHT SOURCE AT COLOR TEMPERATURE OF 2870° K.
CURVE B: SPECTRAL CHARACTERISTIC OF RADIATION FROM 2870° K SOURCE AFTER PASSING THROUGH INFRARED FILTER (CORNING Nº 2540).

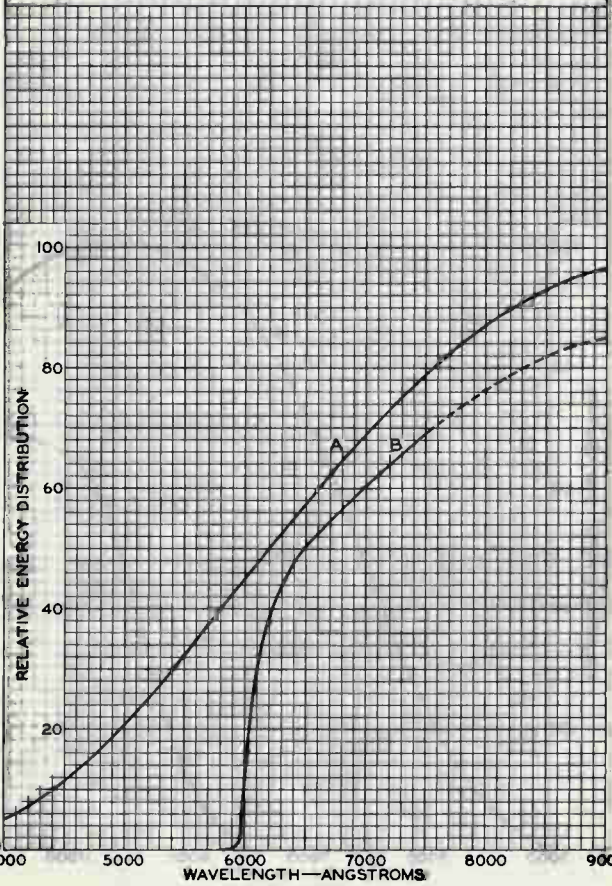


ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-9454

SPECTRAL CHARACTERISTIC OF 2870° K LIGHT SOURCE AND SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870° K SOURCE AFTER PASSING THROUGH INDICATED RED FILTER

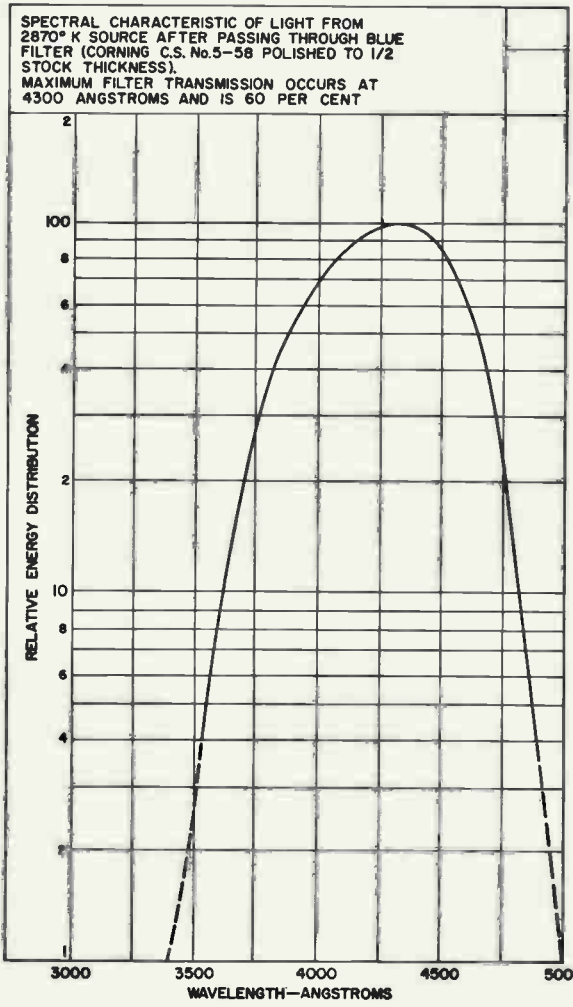
CURVE A : SPECTRAL CHARACTERISTIC OF LIGHT SOURCE AT COLOR TEMPERATURE OF 2870° K.
CURVE B : SPECTRAL CHARACTERISTIC OF LIGHT FROM 2870° K SOURCE AFTER PASSING THROUGH RED FILTER (CORNING Nº 2418).
DASHED PORTION IS EXTRAPOLATED.



ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, N.J.

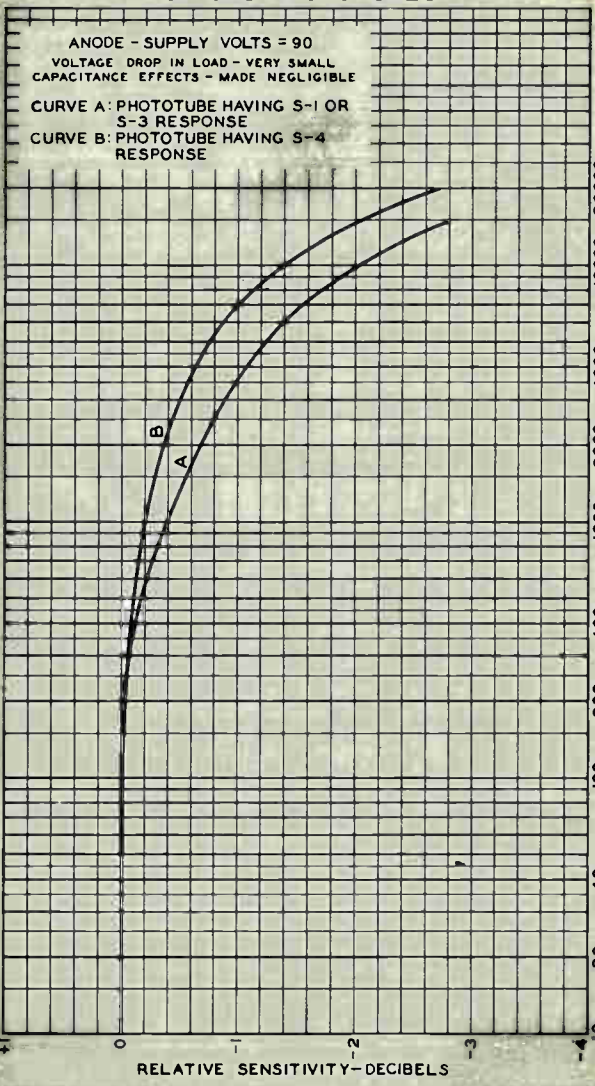
92CM-9683

SPECTRAL ENERGY DISTRIBUTION OF 2870° K LIGHT SOURCE AFTER PASSING THROUGH INDICATED FILTER



92CM—1108IRI

FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

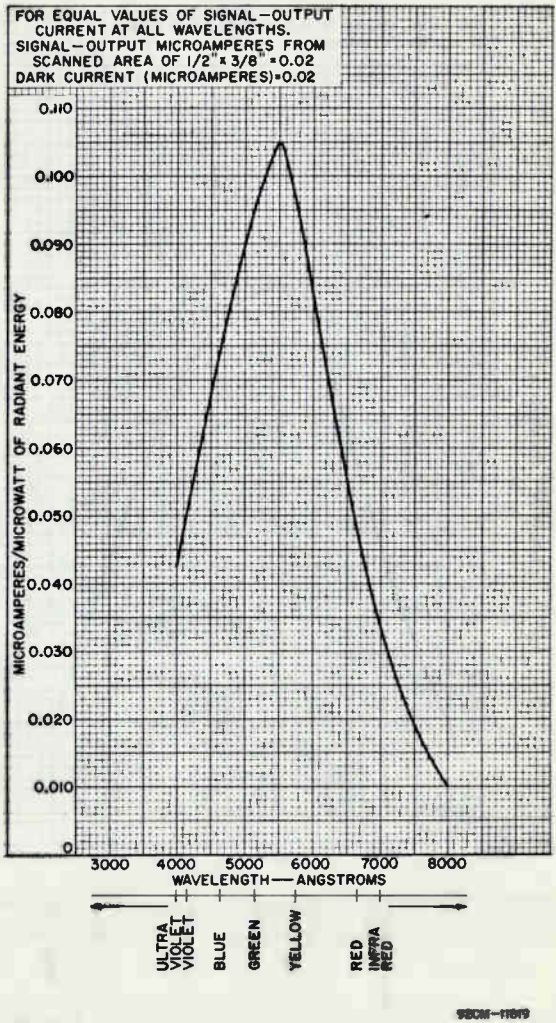


APRIL 30, 1947

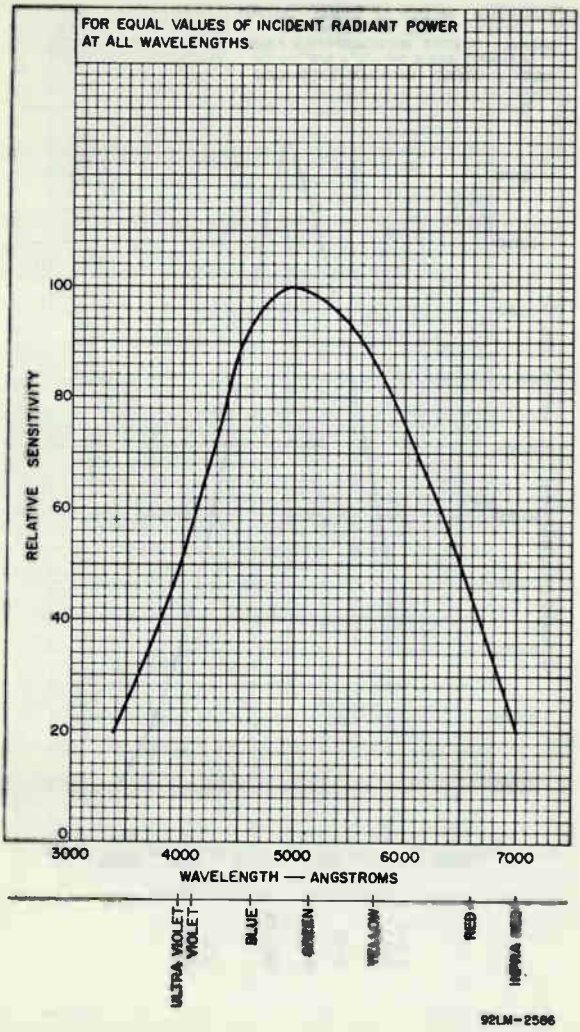
TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-6864

RCA Type II Spectral Response



RCA Type IV Spectral Response



Photomultiplier Tube

9-Stage, Side-On Type
Having S-4 Spectral Response

GENERAL

Spectral Response S-4
Wavelength of Maximum Response.. 4000 ± 500 angstroms
Cathode, Opaque ..... Cesium-Antimony
  Minimum projected length[a] ..... 0.94 in (2.4 cm)
  Minimum projected width[a] ..... 0.31 in (0.8 cm)
Window ..... Lime Glass (Corning[b] No.0080), or equivalent
  Index of refraction at 4360 angstroms 1.523
Dynodes:
  Substrate ..... Nickel
  Secondary-Emitting Surface ..... Cesium-Antimony
  Structure... Circular-Cage, Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):
  Anode to dynode No.9 ..... 4.4 pF
  Anode to all other electrodes ..... 6.0 pF
Maximum Overall Length ..... 3.68 in (9.3 cm)
Seated Length ..... 3.12 in (7.9 cm)
Maximum Diameter ..... 1.31 in (3.3 cm)
Bulb T9
Base .. Small-Shell Submagnal 11 Pin, (JEDEC Group 2, No.B11-88), Non-hygroscopic
  Socket ..... Amphenol[c] No.78S11T, or equivalent
Magnetic Shield ..... Millen[d] No.80801B, or equivalent
Operating Position ..... Any
Weight (Approx.) ..... 1.6 oz

ABSOLUTE-MAXIMUM RATINGS

DC or Peak AC Supply Voltage:
  Between anode and cathode ..... 1250 max. V
  Between anode and dynode No.9 ..... 250 max. V
  Between consecutive dynodes ..... 250 max. V
  Between dynode No.1 and cathode .... 250 max. V
Average Anode Current[f] ..... 0.1 max. mA
Ambient Temperature[g] ..... +75 max. °C

→CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing 1/10 of E between cathode and dynode No.1; 1/10 of E for each succeeding dynode stage; and 1/10 of E between dynode No.9 and anode.

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[h] at 4000 angstroms	–	1.2×10^{5}	–	A/W
Luminous[i] (2870° K)	40	120	800	A/lm
Cathode Sensitivity:				
Radiant[k] at 4000 angstroms	–	0.04	–	A/W
Luminous[m] (2870° K)	2×10^{-5}	4×10^{-5}	–	A/lm
Quantum Efficiency at 3800 angstroms	–	13	–	%
Current Amplification	–	3×10^{6}	–	
Anode Dark Current[n]	–	1×10^{-9}	1×10^{-8}	A
Equivalent Anode Dark Current Input[n]	–	5×10^{-11}	5×10^{-10}	lm
	–	4.8×10^{-14}p	4.8×10^{-13}p	W
Equivalent Noise Input[q]	–	6.7×10^{-13}	–	lm
	–	6.4×10^{-16}r	–	W
Anode-Pulse Rise Time[s] at 1250 V	–	1.6×10^{-9}	–	s
Electron Transit Time[t] at 1250 V	–	1.6×10^{-8}	–	s

[a] On plane perpendicular to the indicated direction of incident light and passing through the major axis of the tube.

[b] Made by Corning Glass Works, Corning, NY 14830.

[c] Made by Amphenol Electronics Corporation, 1830 South 54th Avenue, Chicago 50, IL 60650.

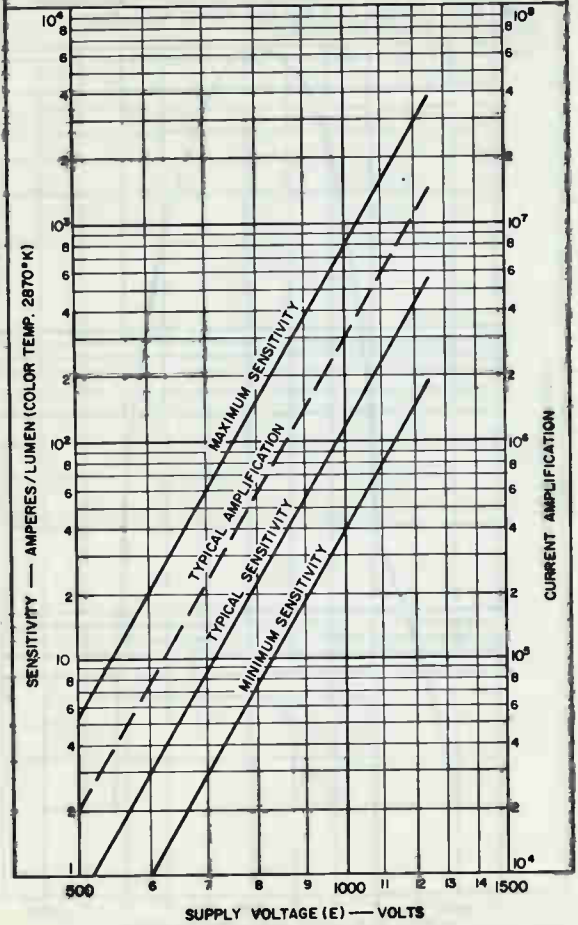
[d] Made by James Millen Manufacturing Company, 150 Exchange Street. Malden, MA 02148.

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

→ Indicates a change.

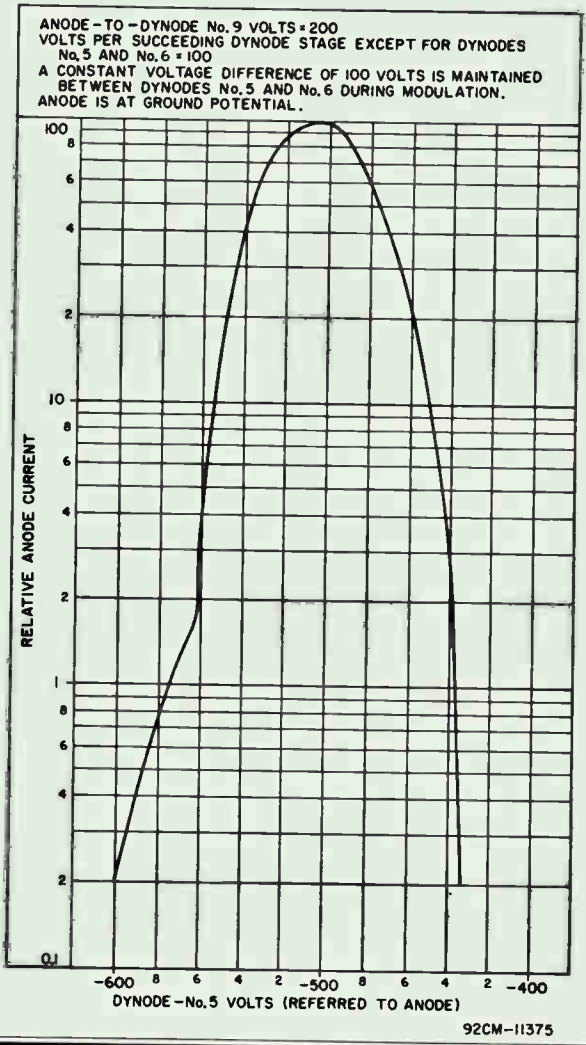
SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1; 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/10 OF E BETWEEN DYNODE No. 9 AND ANODE.



92LM – 3019

TYPICAL CHARACTERISTIC OF OUTPUT CURRENT AS A FUNCTION OF SIMULTANEOUS MODULATION OF DYNODES NO. 5 AND NO. 6



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

[h] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 1036 lumens per watt.

[j] 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 10 microlumens is used.

[k] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 1036 lumens per watt.

[m] 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 0.01 lumen and 100 volts are applied between cathode and all other electrodes connected as anode.

[n] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

[p] At 4000 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 1036 lumens per watt.

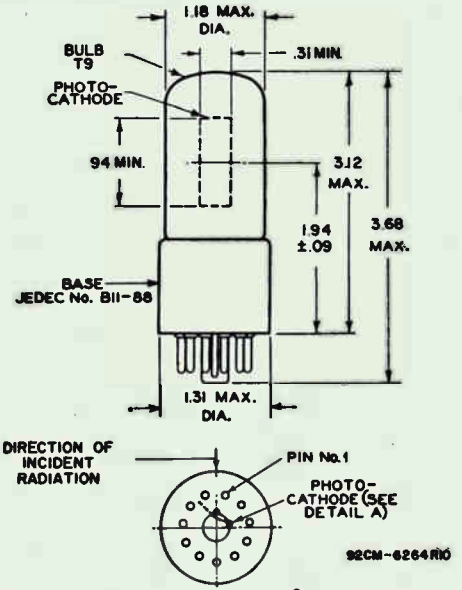
[q] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[r] At 4000 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 1036 lumens per watt.

[s] 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.

† 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.

DIMENSIONAL OUTLINE

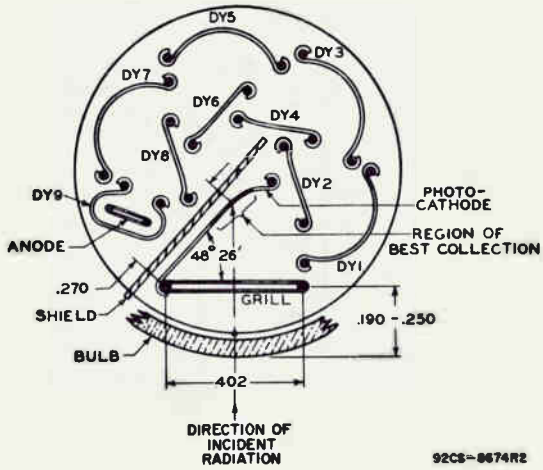


℄ of bulb will not deviate more than 2° in any direction from the perpendicular erected at center of bottom of base.

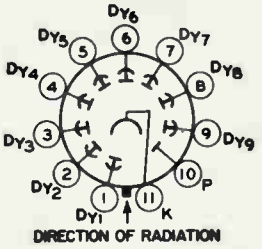
Dimensions are in inches unless otherwise stated. Dimensions tabulated below are in millimeters.

Inch Dimension Equivalents in Millimeters					
Inch	mm	Inch	mm	Inch	mm
.09	2.3	.31	7.9	1.31	33.2
.190	4.8	.402	10.2	1.94	49.2
.250	6.3	.94	23.8	3.12	79.2
.270	6.8	1.18	29.9	3.68	93.4

DETAIL A (Top View)

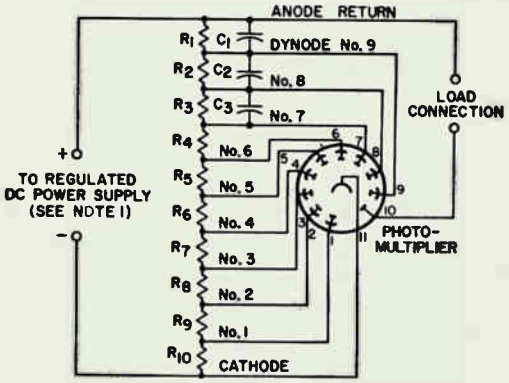


TERMINAL DIAGRAM (Bottom View)



Pin 1: Dynode No.1
Pin 2: Dynode No.2
Pin 3: Dynode No.3
Pin 4: Dynode No.4
Pin 5: Dynode No.5
Pin 6: Dynode No.6
Pin 7: Dynode No.7
Pin 8: Dynode No.8
Pin 9: Dynode No.9
Pin 10: Anode
Pin 11: Photocathode

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT



92CS-11362R1

R_1 through R_{10} = 20,000 to 1,000,000 ohms

Note 1: Adjustable between approximately 500 and 1250 volts.

Note 2: Capacitors C_1* through C_3* should be connected at tube socket for optimum high-frequency performance.

*Leads to all capacitors should be as short as possible to minimize inductance effects.

The capacitor values will depend upon the shape and the amplitude of the anode-current pulse, and the time duration of the pulse, or train of pulses. When the output pulse is assumed to be rectangular in shape, the following formula applies:

$$C = 100\,\frac{i \cdot t}{V}$$

where C is in farads

i is the amplitude of anode current in amperes

V is the voltage across the capacitor in volts

and t is the time duration of the pulse in seconds

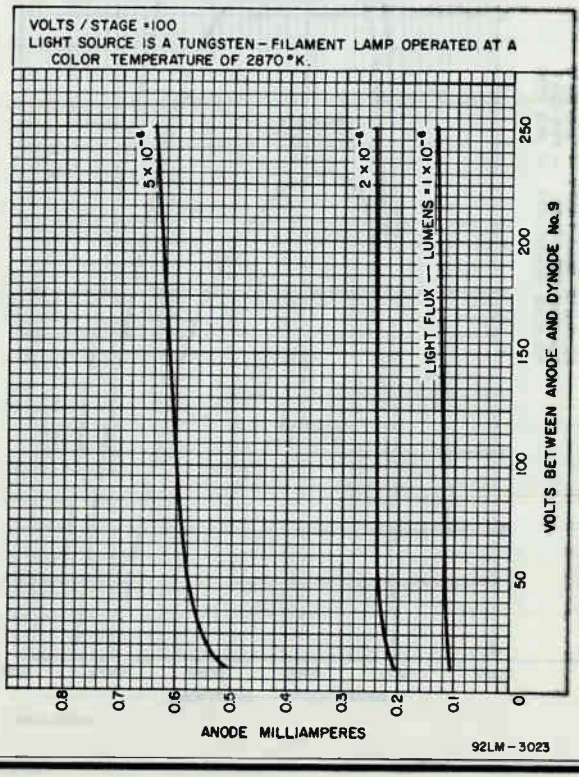
This formula applies for the anode-to-final dynode capacitor. The factor 100 is used to limit the voltage change across the capacitor to 1% maximum during a pulse. Capacitor values for preceding stages should

take into account the smaller values of dynode currents in these stages. Conservatively, a factor of approximately 2 per stage is used. Capacitors are not required across those dynode stages where the dynode current is less than 1/10 of the current through the voltage-divider network.

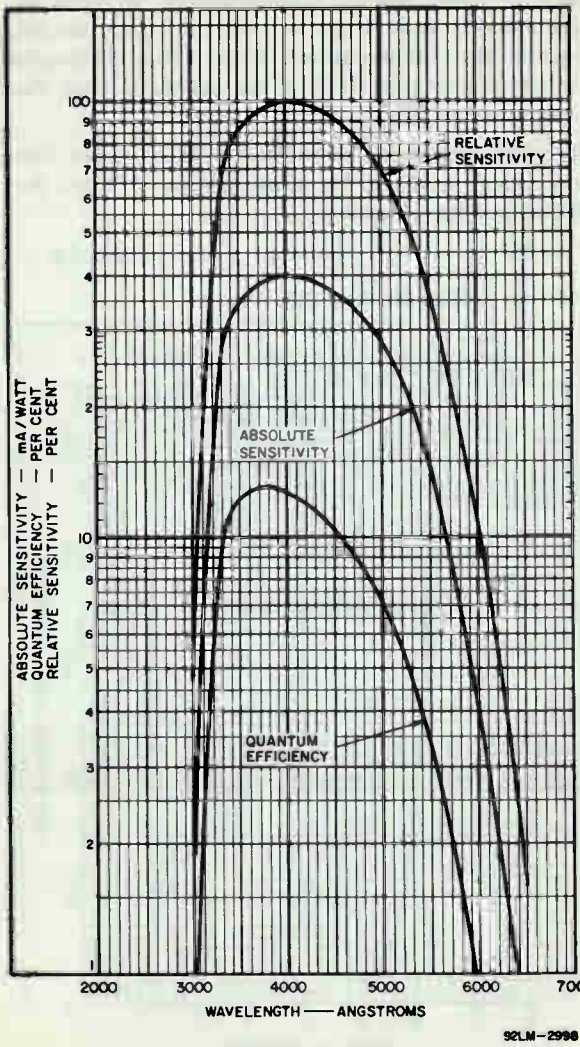
For other shaped pulses or for a train of pulses, the total charge q should be substituted for (i·t) and the following formula applies:

$$C = 100\,\frac{q}{V} \qquad \text{where } q = \int i(t)\,dt \text{ coulombs}$$

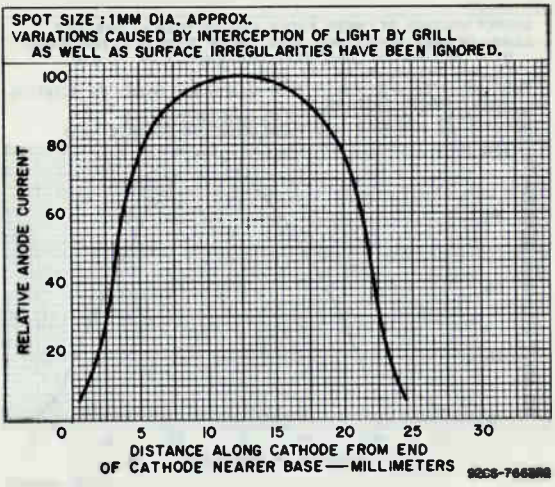
TYPICAL ANODE CHARACTERISTICS



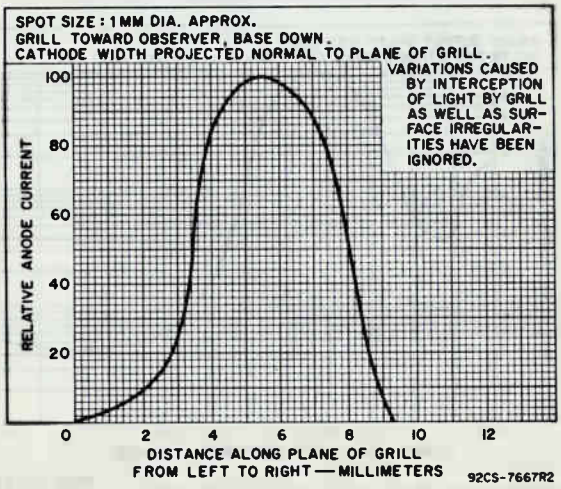
TYPICAL SPECTRAL RESPONSE CHARACTERISTICS



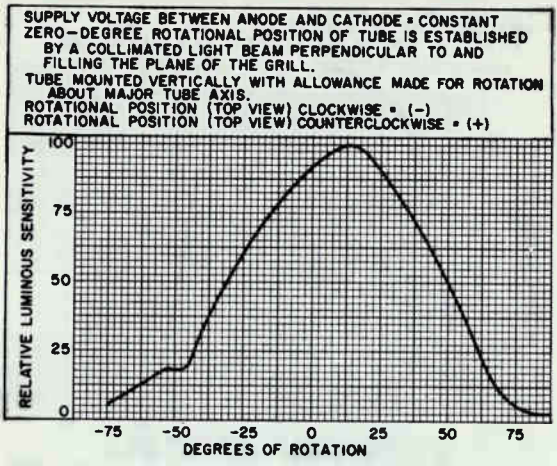
TYPICAL VARIATION OF PHOTOCATHODE SENSITIVITY ALONG TUBE LENGTH



TYPICAL VARIATION OF PHOTOCATHODE SENSITIVITY ACROSS PROJECTED WIDTH IN PLANE OF GRILL

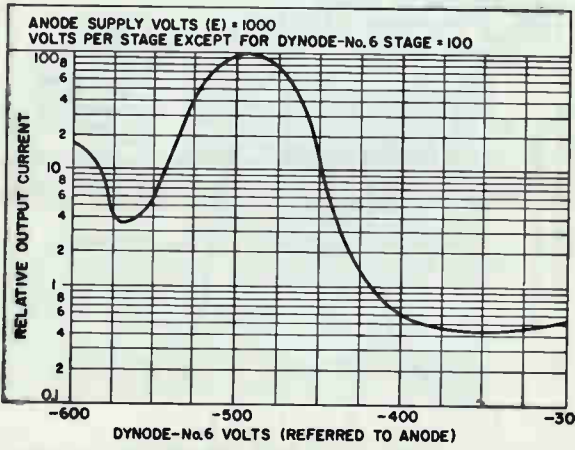


TYPICAL VARIATION OF SENSITIVITY AS TUBE IS ROTATED WITH RESPECT TO FIXED LIGHT BEAM



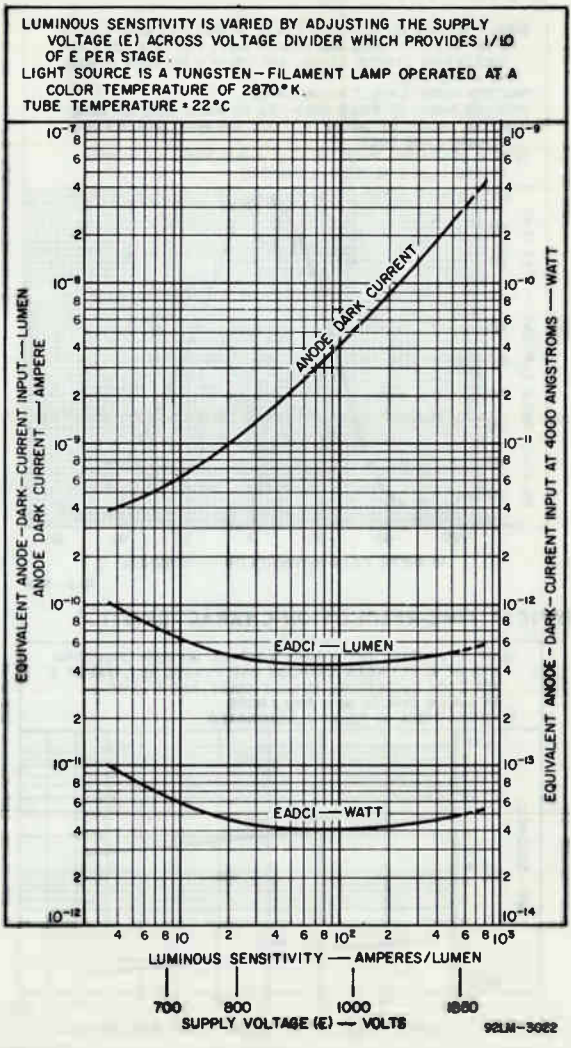
92CS-8671R2

TYPICAL CHARACTERISTIC OF OUTPUT CURRENT AS A FUNCTION OF DYNODE-NO. 6 VOLTS



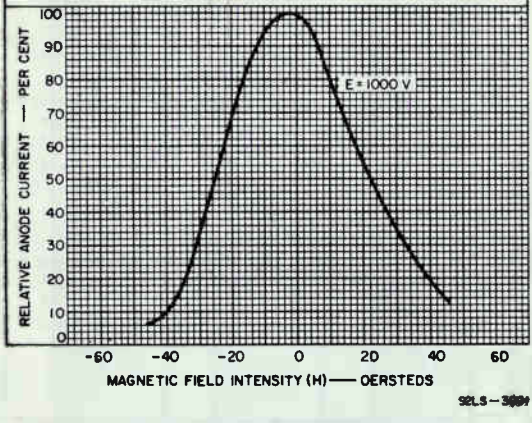
92CS-8672R1

TYPICAL EADCI AND DARK CURRENT CHARACTERISTICS



TYPICAL EFFECT OF MAGNETIC FIELD ON ANODE CURRENT

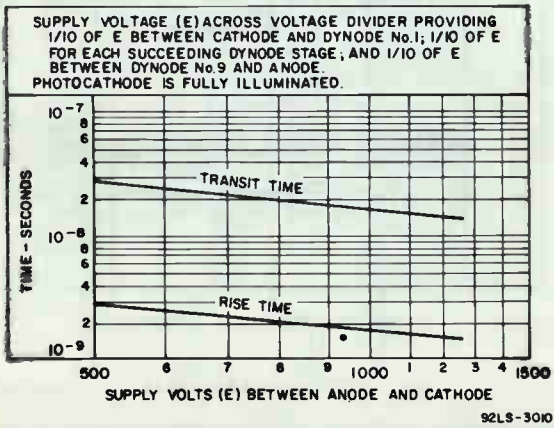
SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1, 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE, AND 1/10 OF E BETWEEN DYNODE No. 9 AND ANODE.
PHOTOCATHODE IS FULLY ILLUMINATED.
UNIFORM MAGNETIC FIELD PARALLEL TO MAJOR AXIS OF TUBE.
POSITIVE VALUES OF MAGNETIC FLUX ARE FOR LINES OF FORCE TOWARD TUBE BASE.
TUBE IS DEGAUSSED PRIOR TO TEST AND IS AGAIN DEGAUSSED BEFORE FLUX DIRECTION IS CHANGED.



92LS-3009

TYPICAL TIME-RESOLUTION CHARACTERISTICS

SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1; 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE, AND 1/10 OF E BETWEEN DYNODE No.9 AND ANODE.
PHOTOCATHODE IS FULLY ILLUMINATED.



92LS-3010

Multiplier Phototube

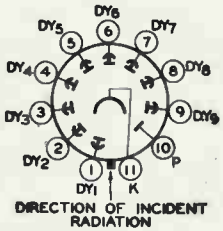
9-STAGE, SIDE-ON TYPE **S-8 RESPONSE**

Especially Useful in Colorimetric and Spectroscopic Applications. High Sensitivity to Green-and-Blue Rich Light

General:

Spectral Response	S-8
Wavelength of Maximum Response	3650 ± 500 angstroms
Cathode, Opaque	Cesium-Bismuth
Minimum projected length[a]	15/16"
Minimum projected width[a]	5/16"
Window	Lime Glass[b]
Dynode Material	Cesium-Antimony
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.9	4.4 pf
Anode to all other electrodes	6.0 pf
Maximum Overall Length	3-11/16"
Maximum Seated Length	3-1/8"
Length from Base Seat to Center of Useful Cathode Area	1-15/16" ± 3/32"
Maximum Diameter	1-5/16"
Operating Position	Any
Weight (Approx.)	1.6 oz
Bulb	T9
Socket	Amphenol[c] No.78S11T, or equivalent
Magnetic Shield	Perfection Mica Co.[d] No.P-101-2, or equivalent
Base	Small-Shell Submagnal 11-Pin (JEDEC Group 2, No.B11-88), Non-hygroscopic
Basing Designation for BOTTOM VIEW	11K

Pin 1 - Dynode No.1
Pin 2 - Dynode No.2
Pin 3 - Dynode No.3
Pin 4 - Dynode No.4
Pin 5 - Dynode No.5
Pin 6 - Dynode No.6
Pin 7 - Dynode No.7
Pin 8 - Dynode No.8
Pin 9 - Dynode No.9
Pin 10 - Anode
Pin 11 - Photocathode



DIRECTION OF INCIDENT RADIATION

Maximum Ratings, *Absolute-Maximum Values:*

Supply Voltage Between Anode and Cathode (DC or Peak AC)	1250 max.	volts
Supply Voltage Between Dynode No.9 and Anode (DC or Peak AC)	250 max.	volts
Supply Voltage Between Consecutive Dynodes (DC or Peak AC)	250 max.	volts
Supply Voltage Between Dynode No.1 and Cathode (DC or Peak AC)	250 max.	volts
Average Anode Current[e]	1 max.	ma
Ambient Temperature	50 max.	°C

← Indicates a change.

1P22

Characteristics Range Values:

Under conditions with supply voltage (E) across a voltage divider providing 1/10 of E between cathode and dynode No. 1; 1/10 of E for each succeeding dynode stage; and 1/10 of E between dynode No. 9 and anode

With E = 1000 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 3650 angstroms. .	–	750	–	a/w
Cathode radiant, at 3650 angstroms.	–	2.3×10^{-3}	–	a/w
Luminous, at 0 cps[f].	0.115	1	16	a/lm
Cathode luminous[g].	1.5×10^{-6}	3×10^{-6}	–	a/lm
Current Amplification.	–	3.3×10^{5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 0.4 a/lm[h,j]	–	7.5×10^{-9}	3.75×10^{-7}	lm
Equivalent Noise Input[k]. . . .	–	7.5×10^{-12}	–	lm

With E = 750 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 3650 angstroms . .	–	110	–	a/w
Cathode radiant, at 3650 angstroms.	–	2.3×10^{-3}	–	a/w
Luminous, at 0 cps[f].	0.016	0.145	1.85	a/lm
Cathode luminous[g].	1.5×10^{-6}	3×10^{-6}	–	a/lm
Current Amplification.	–	4.8×10^{4}	–	

[a] On plane perpendicular to the indicated direction of incident light and passing through the major axis of the tube.

[b] Corning No.0080, Corning Glass Works, Corning, New York, or equivalent.

[c] Made by Amphenol Electronics Corporation, 1830 South 54th Avenue, Chicago 64, Illinois.

[d] Made by Magnetic Shield Division, Perfection Mica Co., 1829 Civic Opera Bldg., 20 North Wacker Drive, Chicago 6, Illinois.

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

[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 10 microlumens 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 0.01 lumen and 100 volts are applied between cathode and all other electrodes connected as anode.

[h] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

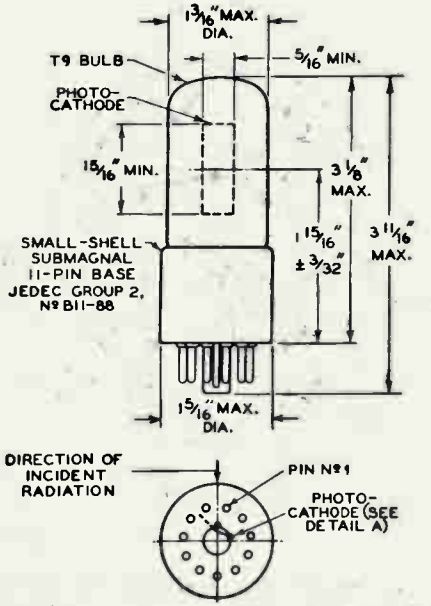
[j] For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1000 volts is recommended.

[k] Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

→ Indicates a change.

IP22

MULTIPLIER PHOTOTUBE



92CM-6264R7

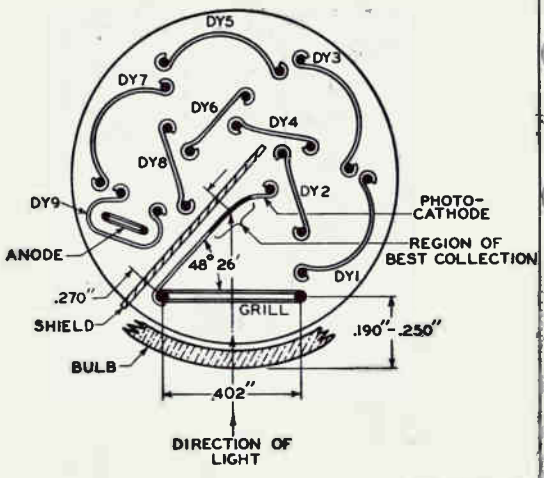
ELECTRON TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

RCA

IP22

MULTIPLIER PHOTOTUBE

DETAIL A

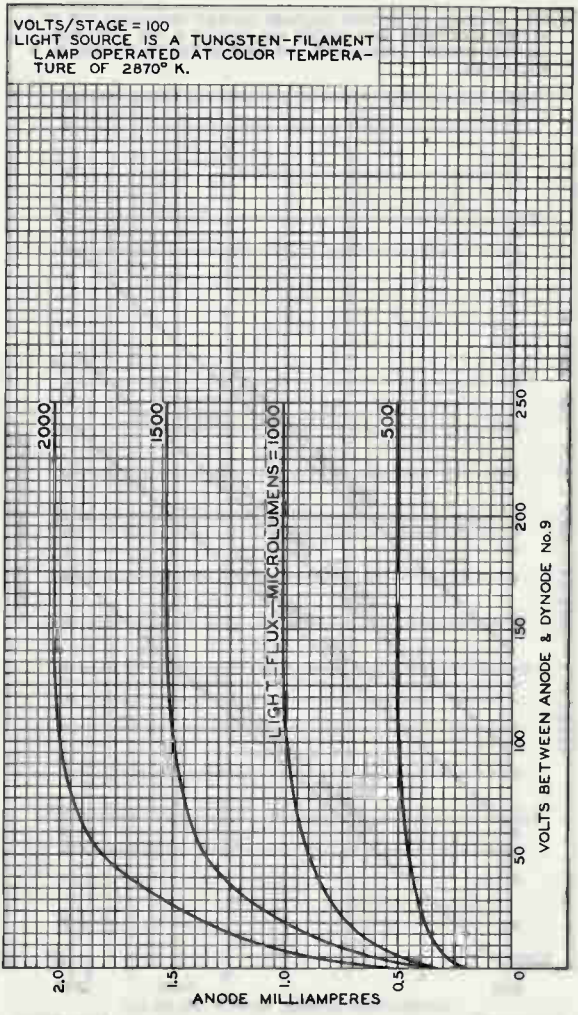


92CS-8674RI

NOTE 1: CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT CENTER OF BOTTOM OF BASE.

NOTE 2: THE MAXIMUM ANGULAR VARIATION BETWEEN THE PLANE THROUGH PINS I AND II AND THE PLANE OF THE GRILL WILL NOT EXCEED 6°.

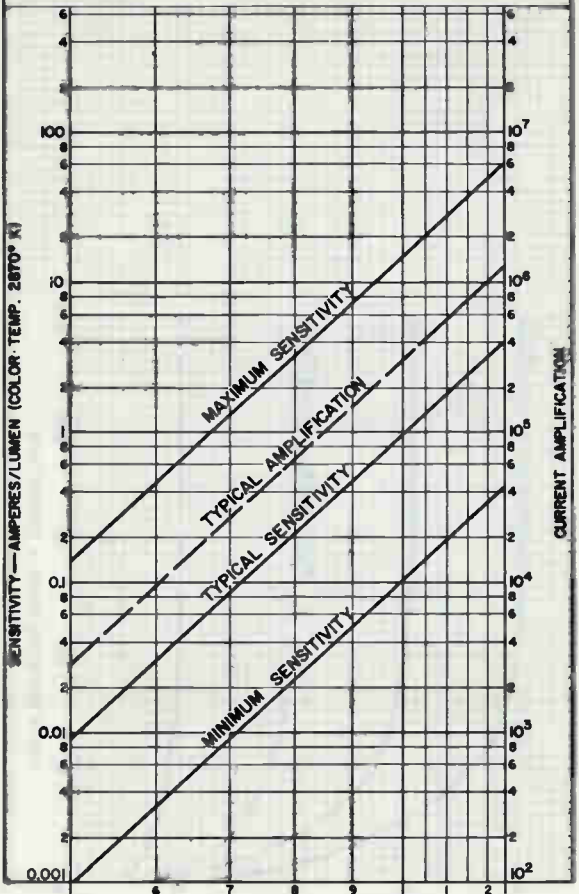
TYPICAL ANODE CHARACTERISTICS



92CM-6585RI

SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

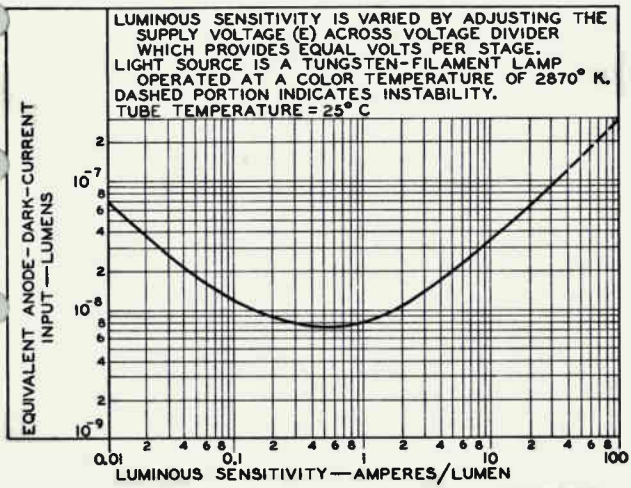
SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1; 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/10 OF E BETWEEN DYNODE No. 9 AND ANODE.



92CM-9674R1

IP22

TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC



Photomultiplier Tube

9-STAGE, SIDE-ON TYPE **S-5 RESPONSE**

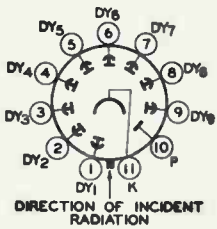
For Detection and Measurement of Ultraviolet and Visible Radiation

GENERAL

Spectral Response	**S-5**
Wavelength of Maximum Response	**3400 ± 500 angstroms**
Cathode, Opaque	**Cs-Sb**
Minimum projected length[a]	15/16 inch
Minimum projected width[a]	5/16 inch
Window	**Ultraviolet-Transmitting Glass[b]**
Index of refraction at 5893 angstroms	1.47 ←
Dynodes	←
Substrate	Ni
Secondary-emitting surface	Cs-Sb
Structure	Circular Cage
Direct Interelectrode Capacitances (Approx.)	
Anode to dynode No.9	4.4 pF
Anode to all other electrodes	6.0 pF
Maximum Overall Length	**3-11/16 inch**
Maximum Seated Length	**3-1/8 inch**
Length from Base Seat to Center of Useful Cathode Area	**1-15/16 ± 3/32 inch**
Maximum Diameter	**1-5/16 inch**
Operating Position	**Any**
Weight (Approx.)	**1.6 oz**
Envelope	**JEDEC T9**
Base	**Small-Shell Submagnal 11-Pin, (JEDEC Group 2, No.B11-88), Non-hygroscopic**
Socket	**Amphenol[c] No.78S11T, or equivalent**
Magnetic Shield	**Millen[d] Part No.80801B, or equivalent** ←

TERMINAL DIAGRAM (Bottom View)

Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7
Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Anode
Pin 11 – Photocathode



← Indicates a change.

ABSOLUTE-MAXIMUM VALUES

DC or Peak AC Supply Voltage		
Between anode and cathode	1250	V
Between dynode No.9 and anode	250	V
Between consecutive dynodes	250	V
Between dynode No.1 and cathode	250	V
Average anode current[e]	0.5	mA
Ambient temperature[f]	75	°C

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing 1/10 of E between cathode and dynode No.1, 1/10 of E for each succeeding dynode stage, and 1/10 of E between dynode No.9 and anode.

With E = 1000 V (Except as noted)

	Min	*Typ*	*Max*	
Sensitivity				
Radiant,[g] at 3400 angstroms	-	1.2×10^{6}	-	A/W
Cathode radiant,[h] at 3400 angstroms	-	0.05	-	A/W
Luminous[j]	17.5	100	500	A/lm
Cathode luminous[k]	1×10^{-5}	4×10^{-5}	-	A/lm
Quantum efficiency at 3200 angstroms	-	19	-	%
Current Amplification	-	2.5×10^{6}	-	
Equivalent Anode-Dark-Current Input[n]	-	2.5×10^{-10}[m]	1.25×10^{-9}[m]	lm
	-	2×10^{-13}[p]	1×10^{-12}[p]	W
Anode Dark Current at 20 A/lm[m,n]	-	5×10^{-9}	2.5×10^{-8}	A
Equivalent Noise Input[q]	-	7.5×10^{-13}	-	lm
	-	6×10^{-16}[p]	-	W
Anode-Pulse Rise Time[r]	-	1.9×10^{-9}	-	s
Electron Transit Time[s]	-	1.7×10^{-8}	-	s

[a] On plane perpendicular to the indicated direction of incident light and passing through the major axis of the tube.

[b] Corning No.9741, Corning Glass Works, Corning, New York, or equivalent.

[c] Made by Amphenol Electronics Corporation, 1830 South 54th Avenue, Chicago 50, Illinois.

[d] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Mass.

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

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

[g] This value is calculated from the typical luminous sensitivity rating using a conversion factor of 1252 lumens per watt.

[h] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 1252 lumens per watt.

[j] 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 10 microlumens is used.

[k] 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 0.01 lumen and 100 volts are applied between cathode and all other electrodes connected as anode.

→ Indicates a change.

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Electronic Components and Devices Harrison, N. J.

[m] At a tube temperature of 22°C and with supply voltage (E) adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current may be reduced by use of a refrigerant.

[n] For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1000 volts is recommended.

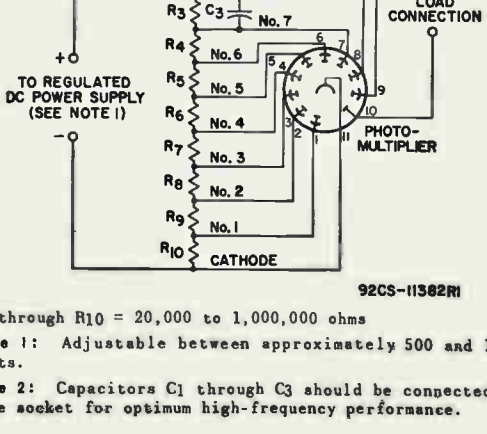
[p] At 3400 angstroms. This value is calculated from the rating in lumen using a conversion factor of 1252 lumens/watt.

[q] Under the following conditions: Supply voltage (E) is as shown, 22°C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870°K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[r] 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.

[s] 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.

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT



92CS-11382R1

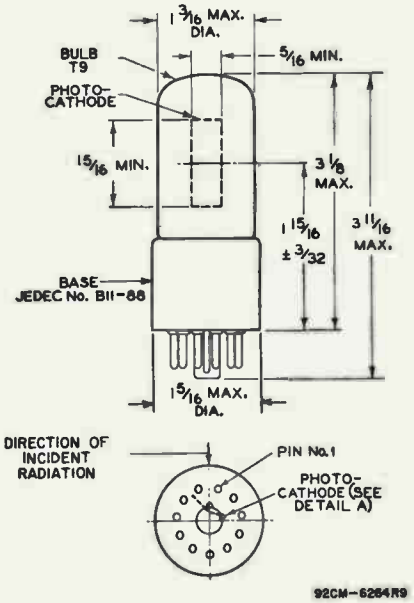
R_1 through R_{10} = 20,000 to 1,000,000 ohms

Note 1: Adjustable between approximately 500 and 1250 volts.

Note 2: Capacitors C_1 through C_3 should be connected at tube socket for optimum high-frequency performance.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-5 RESPONSE is shown at the front of this section

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Center line of bulb will not deviate more than 2° in any direction from the perpendicular erected at center of bottom of base.

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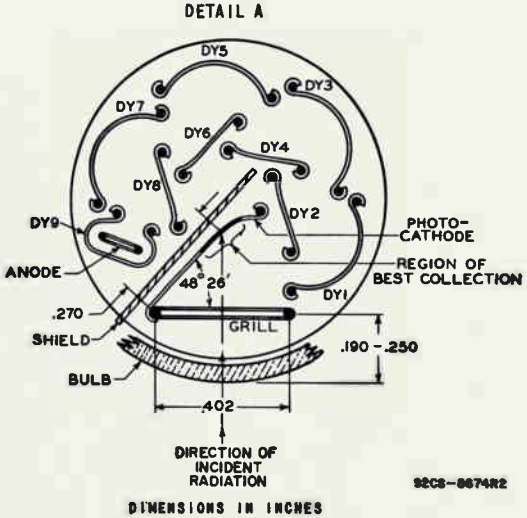
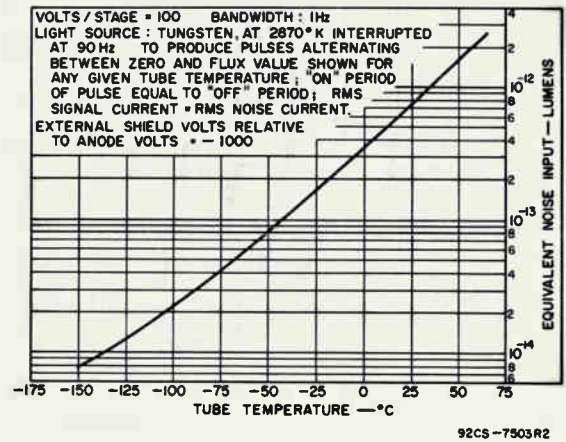
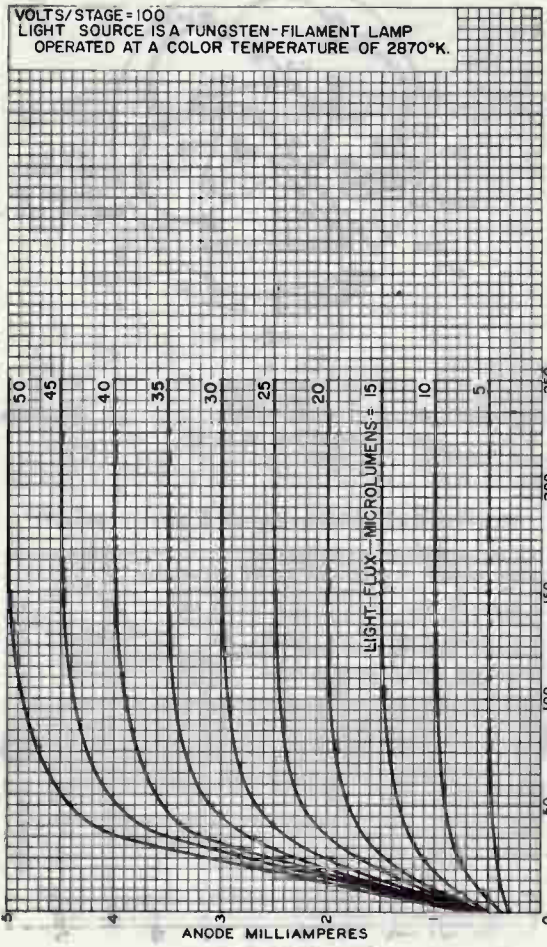


Equivalent-Noise-Input Characteristic



Typical Anode Characteristics



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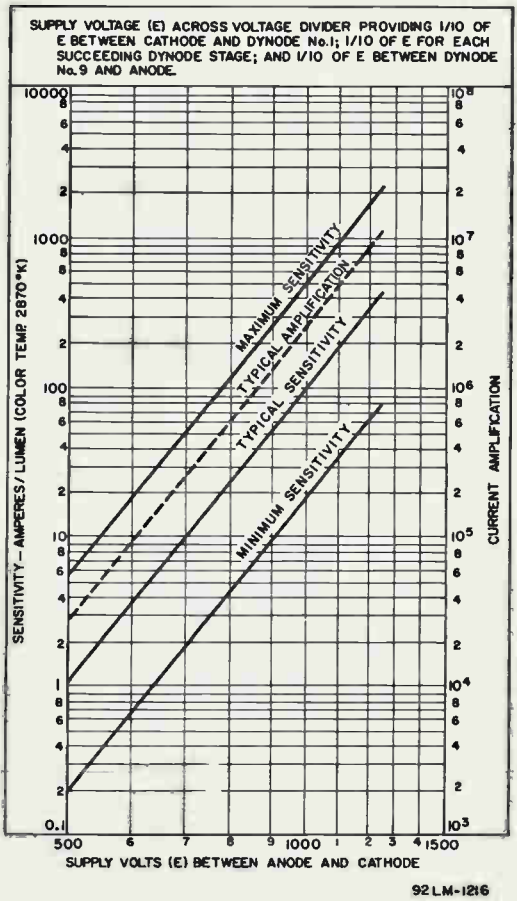
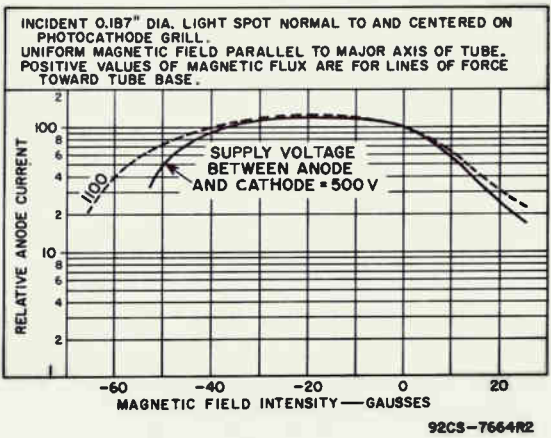
Typical Sensitivity and Current Amplification Characteristics

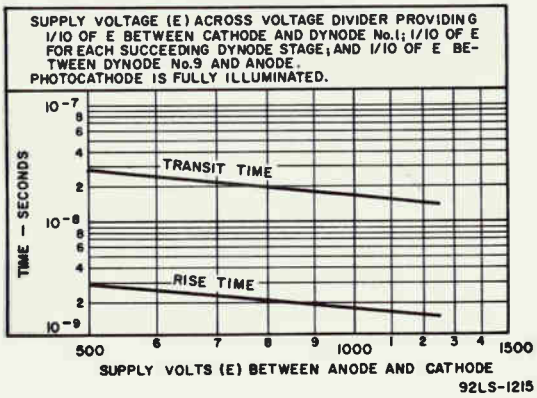


Typical Effect of Magnetic Field on Anode Current



92CS-7664R2

Typical Time-Resolution Characteristics



92LS-1215

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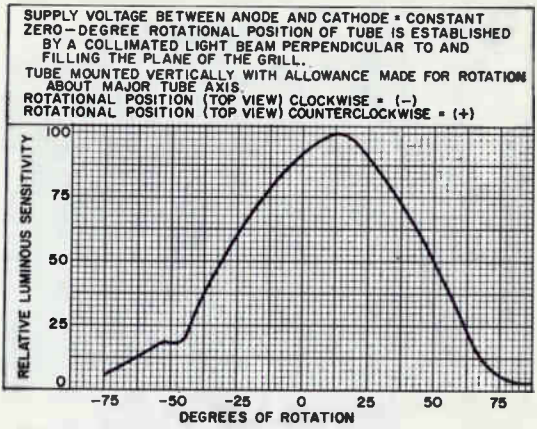
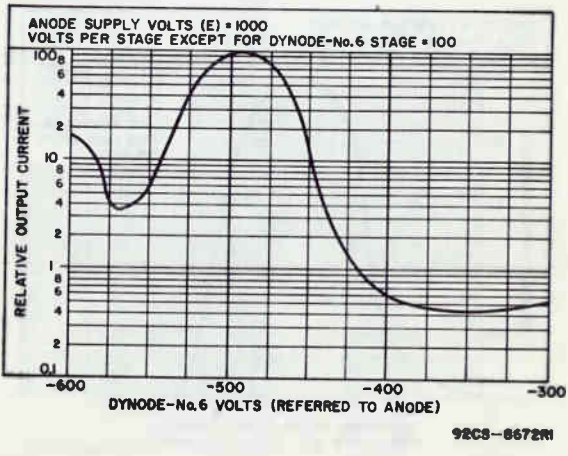
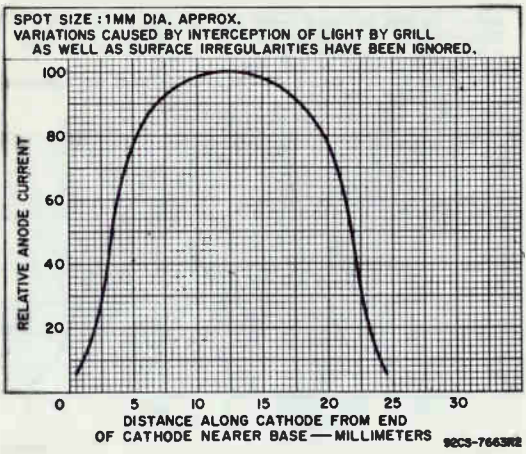
Typical Variation of Sensitivity as Tube is Rotated with Respect to Fixed Light Beam



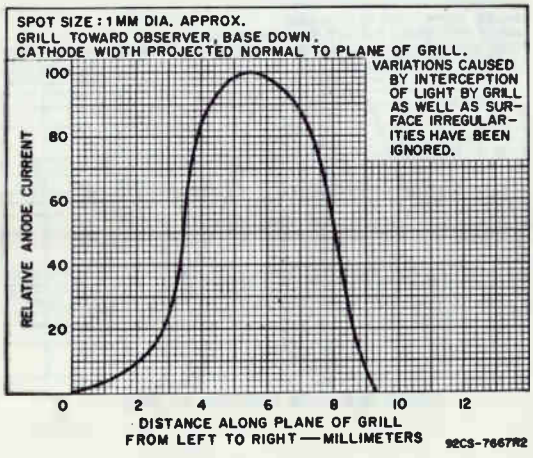
Dynode Modulation Characteristics



Typical Variation of Photocathode Sensitivity Along Tube Length



Typical Variation of Photocathode Sensitivity Across Projected Width in Plane of Grill



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Photomultiplier Tube

9-STAGE, SIDE-ON TYPE **S-5 RESPONSE**

For Detection and Measurement of Ultraviolet and Visible Radiation

The 1P28A is the same as the 1P28 except for the following items:

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing 1/10 of E between cathode and dynode No. 1; 1/10 of E for each succeeding dynode stage, and 1/10 of E between dynode No. 9 and anode.

With E = 1000 volts

	Min	Typ	Max	
Sensitivity,				
Luminous [1]	35	200	500	A/lm
"Red-to-White" Ratio	7	-	-	%

[1] 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 10 microlumens is used.

RED-TO-WHITE RATIO

The sensitivity of the 1P28A above the wavelength of 5800 angstroms is controlled. This control is important in applications where a high-level of sensitivity in the red region of the spectral-response characteristic is required. The degree of this controlled sensitivity in the red region is specified by a "red-to-white" ratio of anode currents. Anode current is measured first using a tungsten-lamp source, and then measured with a red filter interposed between the light source and phototube.

The anode current comprising the "white" portion of this ratio is measured with a light input of 10 microlumens. The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870 °K.

The anode current comprising the "red" portion of the ratio is measured under conditions identical with the "white" measurement except that the light input of 10 microlumens is transmitted through a red filter (Corning C.S. No. 2-112-manufactured by the Corning Glass Works, Corning, N.Y., or equivalent) which has the following characteristics: the transmittance of all wavelengths from 3000 to 5790 angstroms is less than 0.5%; the 37% transmittance point lies between 6030 and 6070 angstroms; the transmittance from 6400 to 7000 angstroms is greater than 80%; and the difference between the wavelengths where transmittance is 15% and 60% is not greater than 150 angstroms.

Gas Phototube

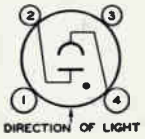
SIDE-ON TYPE HAVING S-3 RESPONSE

DATA

General:

Spectral Response	S-3
Wavelength of Maximum Response	4200 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	1-1/4"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	3 μμf
Maximum Overall Length	4-1/8"
Maximum Seated Length	3-1/2"
Seated Length to Center of Cathode	2-1/8" ± 3/32"
Maximum Diameter	1-1/8"
Operating Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T8
Socket	Amphenol No.77-MIP-4-T, or equivalent ←
Base	Dwarf-Shell Small 4-Pin (JEDEC No.A4-26) ←
Basing Designation for BOTTOM VIEW	2K

Pin 1 – No Connection
Pin 2 – Anode



Pin 3 – No Connection
Pin 4 – Photocathode

Maximum Ratings, ***Absolute-Maximum Values:*** ←

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	80 max.	100 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	50 max.	25 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	10 max.	5 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics: ←

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	0.011	–	amp/watt
Luminous:[c]				
At 0 cps	20	40	70	μa/lumen
At 5000 cps	–	35	–	μa/lumen
At 10000 cps	–	31	–	μa/lumen
Gas Amplification Factor[d]	–	–	9	
Anode Dark Current at 25° C	–	–	0.10	μa

←Indicates a change.

Minimum Circuit Values:

With an anode-supply voltage of	*80 or less*	*100*	*volts*
DC Load Resistance:			
For dc currents above 5 μa. . .	0.1 min.	–	megohm
For dc currents below 5 μa. . .	0 min.	–	megohms
For dc currents above 3 μa. . .	–	2.5 min.	megohms
For dc currents below 3 μa. . .	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of incident light.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply voltage of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10,000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[d] The ratio of luminous sensitivity at an anode supply voltage of 90 volts to luminous sensitivity at an anode supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-3 RESPONSE

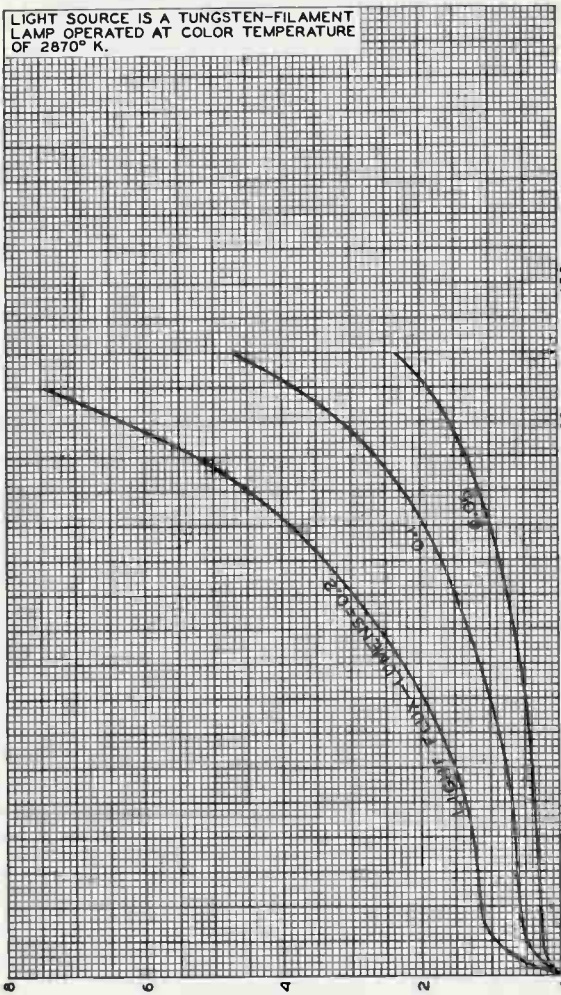
and

FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section

DIMENSIONAL OUTLINE shown under Type 1P37 also applies to the 1P29

AVERAGE ANODE CHARACTERISTICS



Gas Phototube

SIDE-ON TYPE HAVING S-4 RESPONSE

DATA

General:

Spectral Response	S-4
Wavelength of Maximum Response	4000 ± 500 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	1-1/4"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	3 μμf
Maximum Overall Length	4-1/8"
Maximum Seated Length	3-1/2"
Seated Length to Center of Cathode	2-1/8" ± 3/32"
Maximum Diameter	1-1/8"
Operating Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T8
Socket	Amphenol No.77-MIP-4-T, or equivalent ←
Base	Dwarf-Shell Small 4-Pin (JEDEC No.A4-26) ←
Basing Designation for BOTTOM VIEW	2K

Pin 1 – No Connection
Pin 2 – Anode

Pin 3 – No Connection
Pin 4 – Photocathode

Maximum Ratings, ***Absolute-Maximum Values:*** ←

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	80 max.	100 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	50 max.	25 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	10 max.	5 max.	μa
AMBIENT TEMPERATURE	75 max.	75 max.	°C

Characteristics: ←

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 4000 angstroms	–	0.13	–	μa/μw
Luminous:[c]				
At 0 cps	75	135	205	μa/lumen
At 5000 cps	–	124	–	μa/lumen
At 10000 cps	–	108	–	μa/lumen
Gas Amplification Factor[d]	–	–	5.5	
Anode Dark Current at 25° C	–	–	0.05	μa

← Indicates a change.

Minimum Circuit Values:

With an anode-supply voltage of	*80 or less*	*100*	*volts*
DC Load Resistance:			
For dc currents above 5 μa . .	0.1 min.	–	megohm
For dc currents below 5 μa . .	0 min.	–	megohms
For dc currents above 3 μa . .	–	2.5 min.	megohms
For dc currents below 3 μa . .	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of incident light.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply voltage of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10,000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[d] The ratio of luminous sensitivity at an anode supply voltage of 90 volts to luminous sensitivity at an anode supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

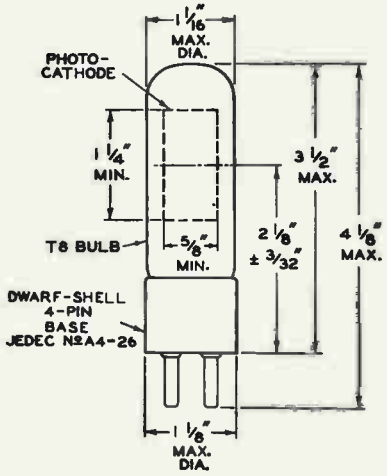
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-4 RESPONSE

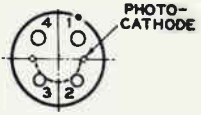
and

FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section

AVERAGE-ANODE-CHARACTERISTICS CURVE shown under Type 5581 also applies to the IP37


1 1/16" MAX. DIA.
PHOTO-CATHODE
1 1/4" MIN.
3 1/2" MAX.
T8 BULB
5/8" MIN.
2 1/8" ± 3/32"
4 1/8" MAX.
DWARF-SHELL 4-PIN BASE JEDEC NO. A4-26
1 1/8" MAX. DIA.


4
1
3
2
PHOTO-CATHODE

92CM-470R5

IP39

VACUUM PHOTOTUBE

WITH S-4 RESPONSE

For applications critical as to leakage under high-humidity conditions

The 1P39 is like the 929, except that the 1P39 has a maximum dark current of 0.005 μa at 250 volts, and has a non-hygroscopic base which insures a value of resistance between anode and cathode pins about 10 times higher than conventional bases under adverse service conditions of high humidity. ←

←indicates a change.

IP40

GAS PHOTOTUBE

WITH S-1 RESPONSE

For applications critical as to leakage under high-humidity conditions

The 1P40 is like the 930, except that the 1P40 has a maximum dark current of 0.005 μa at 90 volts, and has a non-hygroscopic base which insures a value of resistance between anode and cathode pins about 10 times higher than conventional bases under adverse service conditions of high humidity. ←

←indicates a change.

IP41

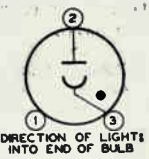
GAS PHOTOTUBE

HEAD-ON TYPE WITH S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Circular
Minimum diameter	9/16"
Direct Interelectrode Capacitance	1.8 μμf
Maximum Overall Length	2-1/16"
Maximum Seated Length	1-19/32"
Axial Distance from Bulb Top to Plane through Periphery of Cathode Area	5/16" ± 3/32" ←
Maximum Diameter	13/16"
Mounting Position	Any
Weight (Approx.)	0.3 oz ←
Bulb	T6
Base	Small-Shell Peewee 3-Pin (JETEC No.A3-1) ←
Basing Designation for BOTTOM VIEW	2AR ←



Pin 1 – No Connection
Pin 2 – Anode
Pin 3 – Cathode

Maximum Ratings, ***Absolute Values:***

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	70 max.	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[o]	40 max.	20 max.	μamp/sq.in. ←
AVERAGE CATHODE CURRENT[o]	3 max.	1.5 max.	μamp
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics, ***With 90 Volts on Anode:***

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.008	–	μamp/μwatt ←
Luminous:[♦]				
At 0 cps	50	90	145	μamp/lumen
At 5000 cps	–	77	–	μamp/lumen
At 10000 cps	–	67	–	μamp/lumen
Gas Amplification Factor	–	–	8.5	
Anode Dark Current at 25 °C	–	–	0.1	μamp ←

o, ♦: see next page.

← indicates a change.

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

RCA

IP41

GAS PHOTOTUBE

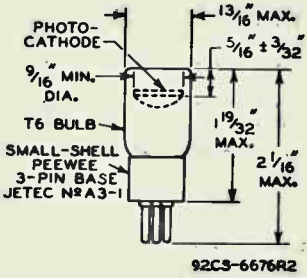
Minimum Circuit Values:

With anode-supply voltage of	*70 or less*	*90*	*volts*
DC Load Resistance:			
For dc currents above 1.5 μamp.	0.1 min.	–	megohm
For dc currents below 1.5 μamp.	0 min.	–	megohm
For dc currents above 1 μamp.	–	2.5 min.	megohms
For dc currents below 1 μamp.	–	0.1 min.	megohm

° Averaged over any interval of 30 seconds maximum.

For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870 °K. A dc anode supply of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurements, a light input of 0.06 lumen is used. For the 5000- and 10000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean.

SPECTRAL-SENSITIVITY CHARACTERISTIC
of Phototube having S-1 Response
and
FREQUENCY-RESPONSE CHARACTERISTICS
of Gas Phototubes
are shown at the front of this Section



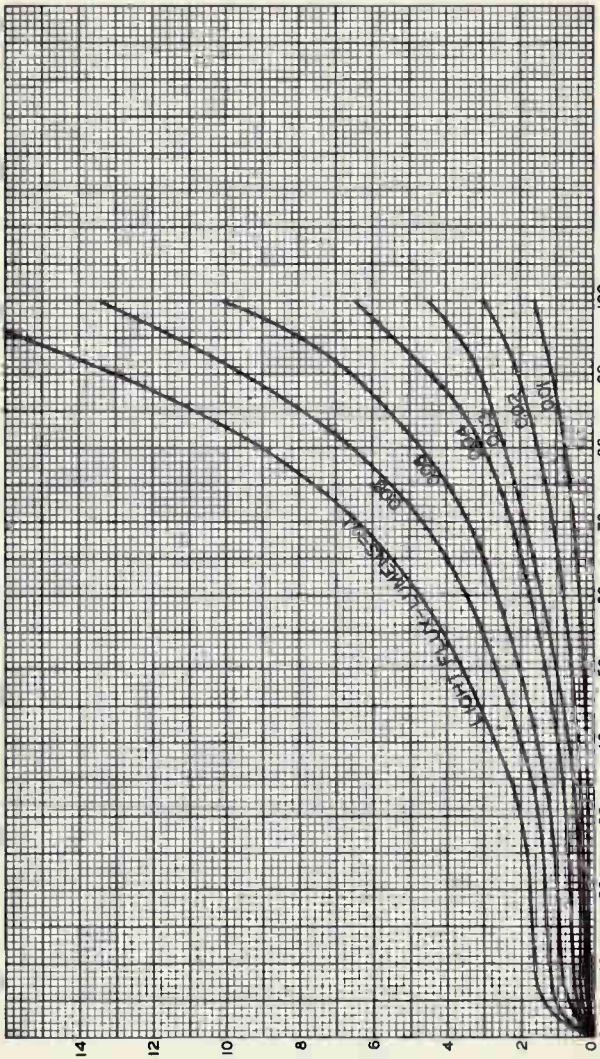
92CS-6676R2

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

RCA

IP41

AVERAGE ANODE CHARACTERISTICS



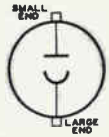
Vacuum Phototube

HEAD-ON TYPE WITH S-9 RESPONSE

DATA

General:

Spectral Response	S-9
Wavelength of Maximum Response	4800 ± 500 angstroms
Cathode, Semitransparent:	
Shape	Circular
Window:	
Area	0.03 sq. in.
Minimum diameter	0.19"
Direct Interelectrode Capacitance	1.9 μμf
Maximum Overall Length	1-11/32" ± 1/16"
Maximum Diameter	1/4"
Operating Position	Any
Weight (Approx.)	0.1 oz
Bulb	T2
Terminal Diagram (See *Dimensional Outline*)	2AT



Small End: Anode

Large End: Cathode

DIRECTION OF LIGHT: INTO END OF BULB

Maximum Ratings, ***Absolute-Maximum Values:***

ANODE-SUPPLY VOLTAGE (DC or PEAK AC)	180 max.	volts
AVERAGE CATHODE-CURRENT DENSITY●	25 max.	μa/sq. in.
AVERAGE CATHODE CURRENT●	0.4 max.	μa
AMBIENT TEMPERATURE	75 max.	°C

Characteristics:

With an anode-supply voltage of 180 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 4800 angstroms	–	0.025	–	μa/μw
Luminous#	20	37	70	μa/lumen
Anode Dark Current at 25° C.	–	–	0.005	μa

● Averaged over any interval of 30 seconds maximum.

For conditions where the light source is a tungsten-filament lamp operated a color temperature of 2870° K. The supply voltage is 180 volts, the load resistor is 1 megohm, and the light input is 0.015 lumen.

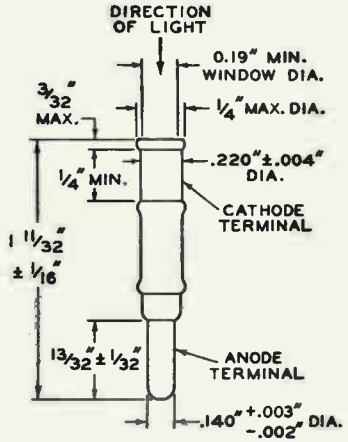
←Indicates a change.

OPERATING CONSIDERATIONS

Exposure to intense illumination, such as direct sunlight, may decrease the sensitivity of the 1P42 even though no voltage is applied to the tube. The magnitude and duration of the decrease depend on the length of the exposure.

Shielding of the 1P42 and its leads to the amplifier is recommended when amplifier gain is high or when the phototube load resistance is high. Whenever frequency response is important in a phototube circuit, the leads from the phototube to the amplifier should be made short so as to minimize capacitance shunting of the phototube load. It is important that insulation of associated circuit parts and wiring be adequate.

SPECTRAL-SENSITIVITY CHARACTERISTIC of Phototube having S-9 Response is shown at front of this Section

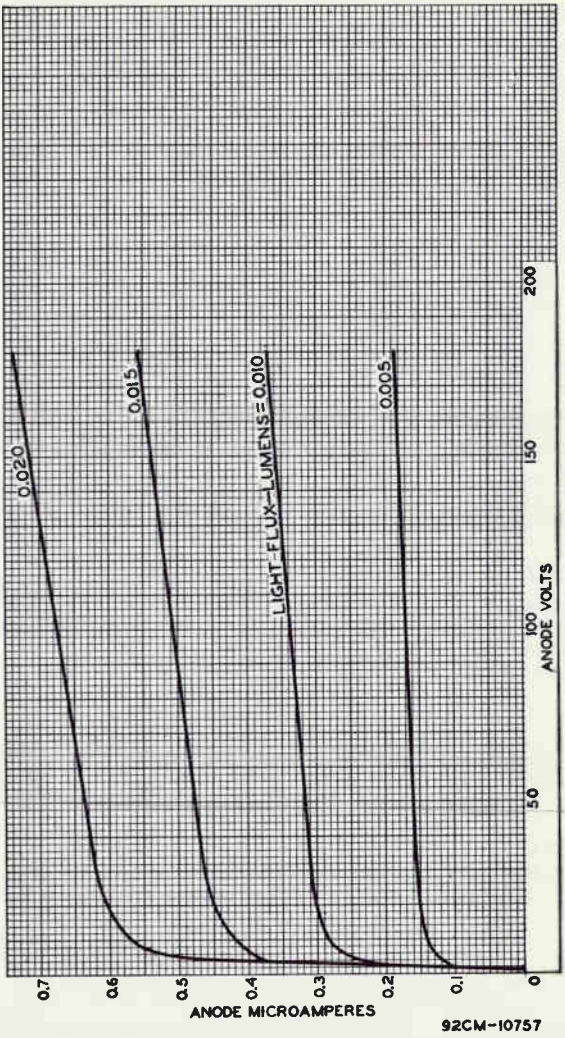


NOTE: WHEN TUBE IS ROTATED ABOUT THE LONGITUDINAL AXIS OF ITS CATHODE TERMINAL, NO PART OF THE ANODE TERMINAL WILL FALL OUTSIDE OF A 0.241"-DIAMETER CIRCLE CONCENTRIC WITH THE LONGITUDINAL AXIS OF THE CATHODE TERMINAL.

92CS-6791R2

→ Indicates a change.

AVERAGE ANODE CHARACTERISTICS



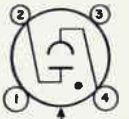
Gas Phototube

SIDE-ON TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	1-1/4"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	3 μμf
Maximum Overall Length	4-1/8"
Maximum Seated Length	3-1/2"
Seated Length to Center of Cathode	2-1/8" ± 3/32"
Maximum Diameter	1-1/8"
Operating Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T8
Socket	Amphenol No.77-MIP-4-T, or equivalent ←
Base	Dwarf-Shell Small 4-Pin (JEDEC No.A4-26) ←
Basing Designation for BOTTOM VIEW	2K



Pin 1 – No Connection
Pin 2 – Anode

Pin 3 – No Connection
Pin 4 – Photocathode

DIRECTION OF RADIATION

Maximum Ratings, ***Absolute-Maximum Values:*** ←

	Rating 1	*Rating 11*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	80 max.	100 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	50 max.	25 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	10 max.	5 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics: ←

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.0084	–	amp/watt
Luminous:[c]				
At 0 cps	50	90	145	μa/lumen
At 5000 cps	–	77	–	μa/lumen
At 10000 cps	–	67	–	μa/lumen
Gas Amplification Factor[d]	–	–	8	
Anode Dark Current at 25° C.	–	–	0.1	μa

← Indicates a change.

Minimum Circuit Values:

With an anode-supply voltage of	*80 or less*	*100*	*volts*
DC Load Resistance:			
For dc currents above 5 μa.	0.1 min.	–	megohm
For dc currents below 5 μa.	0 min.	–	megohms
For dc currents above 3 μa.	–	2.5 min.	megohms
For dc currents below 3 μa.	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of incident radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply voltage of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10,000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[d] The ratio of luminous sensitivity at an anode supply voltage of 90 volts to luminous sensitivity at an anode supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE

and

FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section

DIMENSIONAL OUTLINE
shown under Type IP37 also applies to the 868

AVERAGE-ANODE-CHARACTERISTICS CURVE
shown under Type IP41 also applies to the 868

917

VACUUM PHOTOTUBE

LOW-LEAKAGE TYPE WITH ANODE-TERMINAL CAP AND S-1 RESPONSE

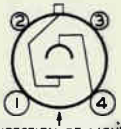
For light-measuring and relay applications

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length*	1-9/16"
Minimum projected width*	5/8"
Direct Interelectrode Capacitance	2.2 μμf
Maximum Overall Length	4-7/16"
Seated Length	3-11/16" ± 1/8"
Seated Length to Center of Cathode	2-1/8" ± 3/32"
Maximum Diameter	1-1/8"
Mounting Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T-8
Cap	Small (JETEC No.C1-1) ←
Base	Dwarf-Shell Small 4-Pin (JETEC No.A4-26) ←
Basing Designation for BOTTOM VIEW	1A ←

Pin 1 – No Connection
Pin 2 – No Connection



DIRECTION OF LIGHT

Pin 3 – No Connection
Pin 4 – Cathode
Cap – Anode

Maximum Ratings, *Absolute Values:*

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	500 max.	volts
AVERAGE CATHODE-CURRENT DENSITY°	30 max.	μamp/sq. in. ←
AVERAGE CATHODE CURRENT°	10 max.	μamp
AMBIENT TEMPERATURE	100 max.	°C

Characteristics, *At 250 Volts on Anode:*

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.0018	–	μamp/μwatt ←
Luminous▲	12	20	40	μamp/lumen
Anode Dark Current at 25°C	–	–	0.005	μamp

* On plane perpendicular to indicated direction of incident light.

° Averaged over any interval of 30 seconds maximum.

▲ For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870°K. A dc anode supply of 250 volts, a 1-megohm load resistor, and a light input of 0.1 lumen are used.

SPECTRAL-SENSITIVITY CHARACTERISTIC of Phototube having S-1 Response is shown at front of this Section

← Indicates a change.

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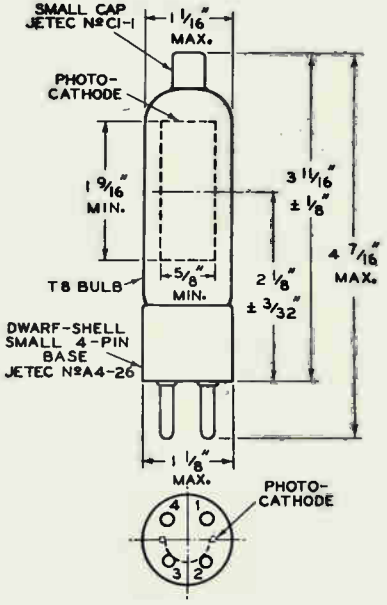
VACUUM PHOTOTUBE



TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

RCA

917

917

AVERAGE ANODE CHARACTERISTICS

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-4360R2

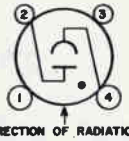
Gas Phototube

SIDE-ON TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	1-1/4"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	3 μμf
Maximum Overall Length	4-1/8"
Maximum Seated Length	3-1/2"
Seated Length to Center of Cathode	2-1/8" ± 3/32"
Maximum Diameter	1-1/8"
Operating Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T8
Socket	Amphenol No.77-MIP-4-T, or equivalent ←
Base	Dwarf-Shell Small 4-Pin (JEDEC No.A4-26) ←
Basing Designation for BOTTOM VIEW	2K



Pin 1 – No Connection
Pin 2 – Anode
Pin 3 – No Connection
Pin 4 – Photocathode

Maximum Ratings, ***Absolute-Maximum Values:*** ←

	Rating 1	*Rating 2*[1]	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	70 max.	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	50 max.	25 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	10 max.	5 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics: ←

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.014	–	amp/watt
Luminous:[c]				
At 0 cps	120	150	220	μa/lumen
At 5000 cps	–	120	–	μa/lumen
At 10000 cps	–	105	–	μa/lumen
Gas Amplification Factor[d]	–	–	10.5	
Anode Dark Current at 25° C.	–	–	0.1	μa

← Indicates a change.

Minimum Circuit Values:

With an anode-supply voltage of	*70 or less*	*90*	*volts*
DC Load Resistance:			
For dc currents above 5 μa.	0.1 min.	–	megohm
For dc currents below 5 μa.	0 min.	–	megohms
For dc currents above 3 μa.	–	2.5 min.	megohms
For dc currents below 3 μa.	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of incident radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply voltage of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10,000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[d] The ratio of luminous sensitivity at an anode supply voltage of 90 volts to luminous sensitivity at an anode supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE

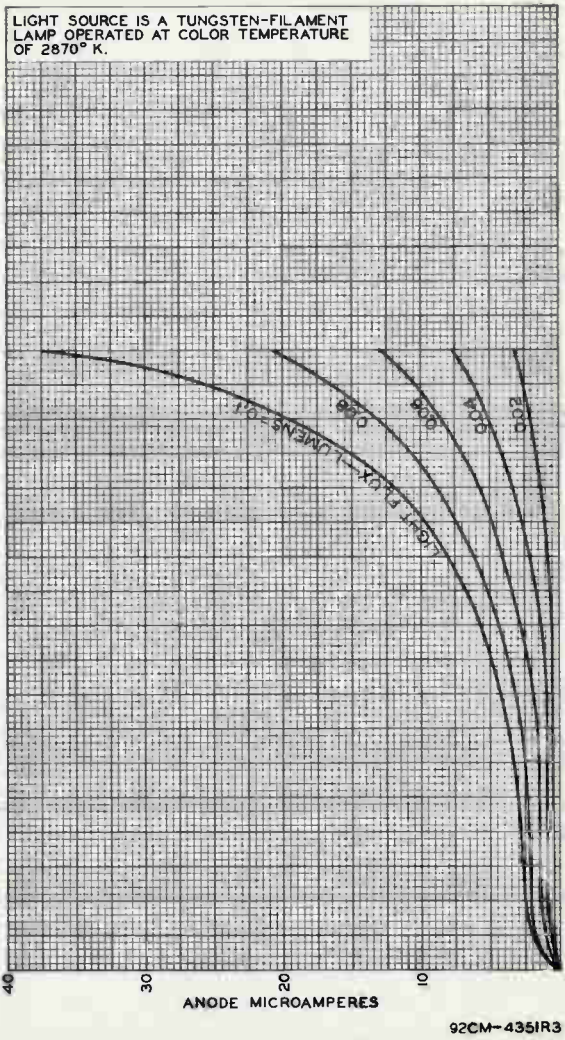
and

FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section

DIMENSIONAL OUTLINE shown under Type IP37 also applies to the 918

AVERAGE ANODE CHARACTERISTICS



919

VACUUM PHOTOTUBE

LOW-LEAKAGE TYPE WITH CATHODE-TERMINAL CAP AND S-1 RESPONSE

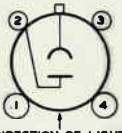
For light-measuring and relay applications

The 919 is the same as the 917 except for the following item:

General:

Base . . . . . Dwarf-Shell Small 4-Pin (JETEC No. A4-26)
Basing Designation for BOTTOM VIEW 1B

Pin 1 – No Connection
Pin 2 – Anode
Pin 3 – No Connection



Pin 4 – No Connection
Cap – Cathode

Gas Phototube

SIDE-ON, TWIN-UNIT TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode (Each):	
Shape	Quarter-Cylindrical
Minimum projected length[a]	1-3/16"
Minimum projected width[a]	1/4"
Direct Interelectrode Capacitances (Approx.):	
Cathode to cathode[b]	1.8 μμf
Cathode to anode[c]	1.6 μμf
Anode to anode[d]	0.4 μμf ←
Maximum Overall Length	4"
Maximum Seated Length	3-3/8"
Seated Length to Center of Cathodes	2-1/8" ± 3/32"
Maximum Diameter	1-3/16"
Operating Position	Any
Weight (Approx.)	1.1 oz ←
Bulb	T9
Socket	Amphenol No.77-M1P-4-T, or equivalent ←
Base	Small-Shell Small 4-Pin (JEDEC No.A4-5)
Basing Designation for BOTTOM VIEW	4BG

Pin 1 – Photocathode of Unit No.2
Pin 2 – Anode of Unit No.2
Pin 3 – Anode of Unit No.1
Pin 4 – Photocathode of Unit No.1

DIRECTION OF RADIATION

Maximum Ratings, *Absolute-Maximum Values:* ←

Values are for Each Unit

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	70 max.	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[e]	30 max.	15 max.	μa/sq.in.
AVERAGE CATHODE CURRENT[e]	4 max.	2 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

← Indicates a change.

→Characteristics:

Values are for each unit with an anode-supply voltage of 90 volts unless otherwise specified

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 8000 angstroms. .	–	0.0094	–	amp/watt
Luminous:[f]				
At 0 cps.	50	100	175	μa/lumen
At 5000 cps	–	85	–	μa/lumen
At 10000 cps.	–	74	–	μa/lumen
Ratio of Luminous Sensitivities (Unit No.1 to Unit No.2). . .	0.5	1.15	2.0	
Gas Amplification Factor[g] . . .	–	–	9	
Anode Dark Current at 25° C . .	–	–	0.1	μa

Minimum Circuit Values:

Values are for Each Unit

With an anode-supply voltage of	*70 or less*	*90*	*volts*
DC Load Resistance:			
For dc currents above 2 μa. .	0.1 min.	–	megohm
For dc currents below 2 μa. .	0 min.	–	megohm
For dc currents above 1 μa. .	–	2.5 min.	megohms
For dc currents below 1 μa. .	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of incident radiation.

[b] With anodes grounded.

[c] Each unit, with other unit grounded.

[d] With cathodes grounded.

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

[f] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.04 lumen is used. For the 5000- and 10000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[g] The ratio of luminous sensitivity at an anode-supply voltage of 90 volts to luminous sensitivity at an anode-supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.04 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE

and

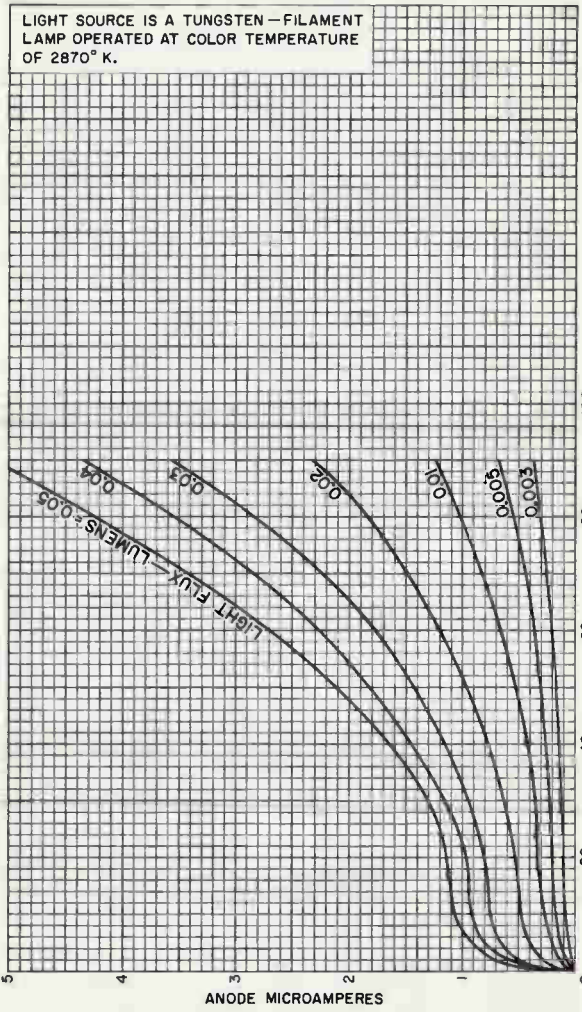
FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section

DIMENSIONAL OUTLINE shown under Type 5584 also applies to the 920

→ Indicates a change.

AVERAGE ANODE CHARACTERISTICS
Each Unit



92CM-4618R4

921

GAS PHOTOTUBE

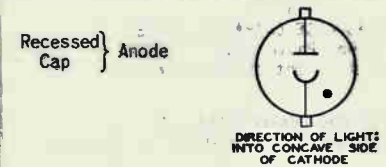
CARTRIDGE TYPE WITH S-1 RESPONSE

For relay applications

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length*	7/8"
Minimum projected width*	1/2"
Direct Interelectrode Capacitance	1 μμf
Overall Length	1-21/32" ± 1/16"
Seated Length	1-13/32" ± 1/32"
Length from Center of Useful Cathode Area to Plane A-A' *(See Dimensional Outline)*	11/16" ± 1/16"
Maximum Diameter	0.890"
Weight (Approx.)	0.4 oz ←
Mounting Position	Any
Terminals:	←
Recessed cap	JETEC No.J1-23
Protruding cap	JETEC No.J1-24
Basing Designation	2AQ ←



DIRECTION OF LIGHT INTO CONCAVE SIDE OF CATHODE

Maximum Ratings, *Absolute Values:*

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY°	30 max.	μamp/sq.in. ←
AVERAGE CATHODE CURRENT°	3 max.	μamp
AMBIENT TEMPERATURE	100 max.	°C

Characteristics, *At 90 Volts on Anode:*

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.012	–	μamp/μwatt ←
Luminous:▲				
At 0 cps	75	135	205	μamp/lumen
At 5000 cps	–	119	–	μamp/lumen
At 10000 cps	–	108	–	μamp/lumen
Gas Amplification Factor	–	–	10	
Anode Dark Current at 25°C	–	–	0.01	μamp ←

* On plane perpendicular to indicated direction of incident light.

°,▲: See next page. ← Indicates a change.

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

GAS PHOTOTUBE

Minimum Circuit Values:

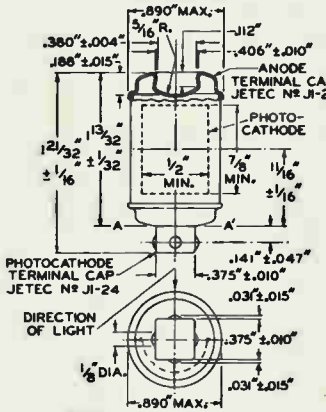
	With anode-supply voltage of 70 or less	*90 volts*	
DC Load Resistance:			
For dc currents above 3 μamp	0.1 min.	–	megohm
For dc currents below 3 μamp	0 min.	–	megohm
For dc currents above 2 μamp	–	2.5 min.	megohms
For dc currents below 2 μamp	–	0.1 min.	megohm

° Averaged over any interval of 30 seconds maximum. This value may be doubled when anode-supply voltage is limited to 70 volts.

▲ For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870°K. A dc anode supply of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurements, a light input of 0.1 lumen is used. For the 5000- and 10000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean.

SPECTRAL-SENSITIVITY CHARACTERISTIC
of Phototube having S-1 Response
and
FREQUENCY-RESPONSE CHARACTERISTICS
of Gas Phototubes
are shown at the front of this Section

AVERAGE ANODE CHARACTERISTICS
for Type 921 are the same as those shown for Type 930



TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

RCA

922

VACUUM PHOTOTUBE

CARTRIDGE TYPE WITH S-1 RESPONSE

For relay applications

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length*	5/8"
Minimum projected width*	1/2"
Direct Interelectrode Capacitance	1 μμf
Overall Length	1-21/32" + 1/32" - 1/16"
Seated Length	1-13/32" ± 1/32"
Length from Center of Useful Cathode Area to Plane A-A' *(See Dimensional Outline)*	11/16" ± 1/16"
Maximum Diameter	0.890"
Mounting Position	Any
Weight (Approx.)	0.4 oz
Terminals:	
Recessed cap	JETEC No.J1-23
Protruding cap	JETEC No.J1-24
Basing Designation	2AQ

Maximum Ratings, *Absolute Values:*

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	500 max.	volts
AVERAGE CATHODE-CURRENT DENSITY°	30 max.	μamp/sq. in.
AVERAGE CATHODE CURRENT°	5 max.	μamp
AMBIENT TEMPERATURE	100 max.	°C

Characteristics, *At 250 Volts on Anode:*

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.0018	–	μamp/μwatt
Luminous▲	10	20	40	μamp/lumen
Anode Dark Current at 25°C	–	–	0.005	μamp

* On plane perpendicular to indicated direction of incident light.

° Averaged over any interval of 30 seconds maximum.

▲ For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870°K. A dc anode supply of 250 volts, a 1-megohm load resistor, and a light input of 0.1 lumen are used.

← Indicates a change.

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

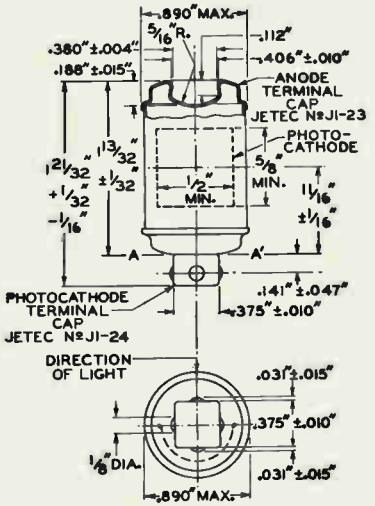
RCA

922

VACUUM PHOTOTUBE

SPECTRAL-SENSITIVITY CHARACTERISTIC
of Phototube having S-1 Response
is shown at the front of this Section

AVERAGE ANODE CHARACTERISTICS
for Type 922 are the same as those shown for Type 917



A-A'=PLANE PERPENDICULAR TO AXIS OF TUBE

92CM-4818R5

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

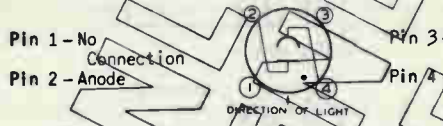
923
GAS PHOTOTUBE

WITH S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 Angstroms
Cathode:	
Shape	Semi-Cylindrical
Minimum Projected Length*	13/16"
Minimum Projected Width*	5/8"
Direct Interelectrode Capacitance	2 μμf
Maximum Overall Length	3-9/16"
Maximum Seated Length	2-15/16"
Seated Length to Center of Cathode	1-31/32" ± 3/32"
Maximum Diameter	1-3/16"
Bulb	T-9
Mounting Position	Any
Base	Small-Shell Small 4-Pin
Basing Designation for BOTTOM VIEW	2K

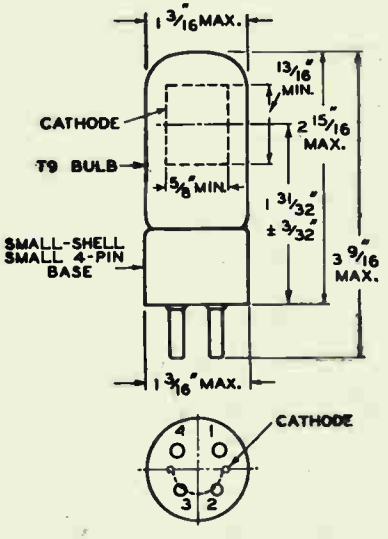


Maximum Ratings, Characteristics, and Curves for the 923 are the same as those shown for Type 930

* On plane perpendicular to indicated direction of incident light.

← Indicates a change.

923
GAS PHOTOTUBE



BOTTOM VIEW

92CM-4788R3

Vacuum Phototube

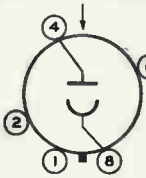
SIDE-ON TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response S-1
Wavelength of Maximum Response . . . . 8000 ± 1000 angstroms
Cathode:
  Shape . . . . . Semicylindrical
  Minimum projected length[a] . . . . . 13/16"
  Minimum projected width[a] . . . . . 5/8"
Direct Interelectrode Capacitance (Approx.) . . . . . 1.6 μμf
Maximum Overall Length . . . . . 2-5/8"
Maximum Seated Length . . . . . 2-1/16"
Seated Length to Center of Cathode . . . . . 1-13/32" ± 3/32" ←
Maximum Diameter . . . . . 1-9/32"
Operating Position . . . . . Any
Weight (Approx.) . . . . . 0.8 oz ←
Bulb T9
Socket . . . . . Cinch No.8JM-1, or equivalent ←
Base . . . . . Intermediate-Shell Octal 5-Pin, Arrangement 1 (JEDEC Group 1, No.B5-10)
Basing Designation for BOTTOM VIEW 3U

DIRECTION OF RADIATION



Pin 1 - No Internal Connection
Pin 2 - No Internal Connection
Pin 4 - Anode
Pin 6 - No Internal Connection
Pin 8 - Photocathode

Maximum Ratings, *Absolute-Maximum Values:* ←

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	250 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	30 max.	μa/sq.in.
AVERAGE CATHODE CURRENT[b]	5 max.	μa
AMBIENT TEMPERATURE	100 max.	°C

Characteristics: ←

With an anode-supply voltage of 250 volts

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 8000 angstroms	-	0.0019	-	amp/watt
Luminous[c]	12	20	40	μa/lumen
Anode Dark Current at 25° C.	-	-	0.0125	μa

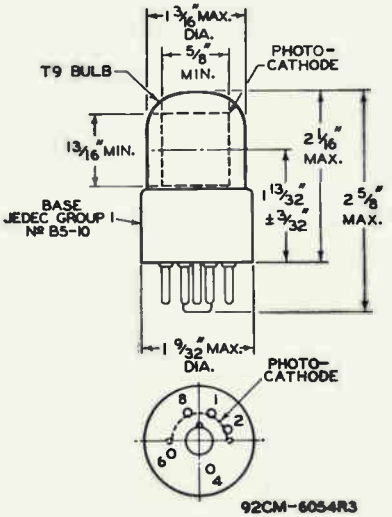
← Indicates a change.

[a] On plane perpendicular to indicated direction of radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A 1-megohm load resistor and a light input of 0.1 lumen are used.

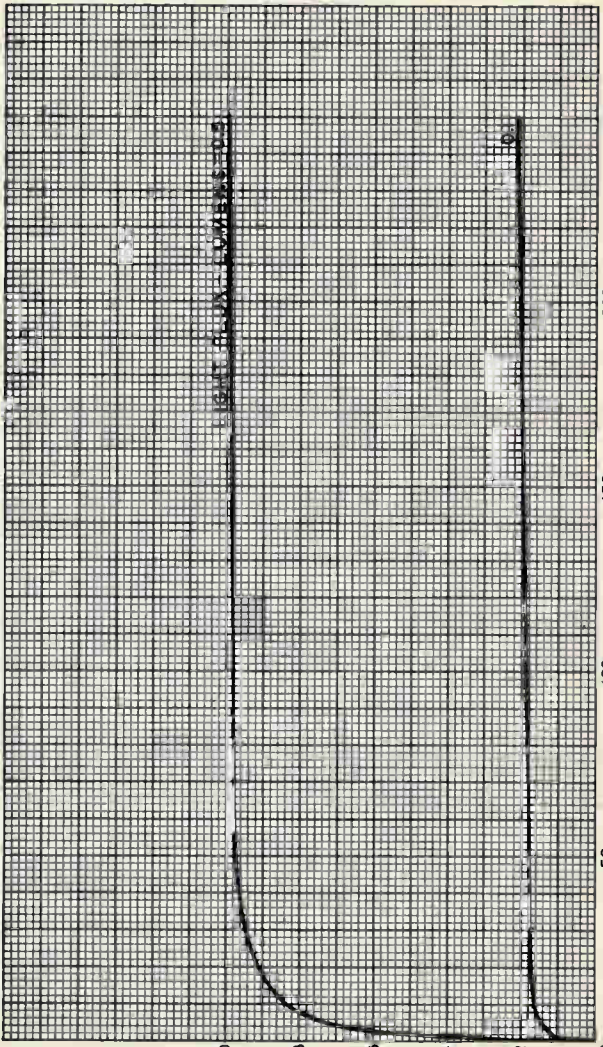
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE is shown at the front of this section



RCA

925

AVERAGE ANODE CHARACTERISTICS



JULY 31, 1947

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RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

92CM-6208RI

926

VACUUM PHOTOTUBE

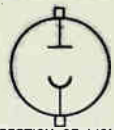
CARTRIDGE TYPE WITH S-3 RESPONSE

For colorimetric applications

DATA

General:

Spectral Response	S-3
Wavelength of Maximum Response	4200 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length*	7/8"
Minimum projected width*	1/2"
Direct Interelectrode Capacitance	1 μμf
Overall Length	1-21/32" ± 1/16"
Seated Length	1-13/32" ± 1/32"
Length from Center of Useful Cathode Area to Plane A-A' *(See Dimensional Outline)*	11/16" ± 1/16"
Maximum Diameter	0.890"
Weight (Approx.)	0.4 oz ←
Mounting Position	Any
Terminals:	←
Recessed cap	JETEC No. J1-23
Protruding cap	JETEC No. J1-24
Basing Designation	2AQ ←



Maximum Ratings, *Absolute Values:*

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	500 max.	volts
AVERAGE CATHODE-CURRENT DENSITY°	30 max.	μamp/sq. in. ←
AVERAGE CATHODE CURRENT°	5 max.	μamp
AMBIENT TEMPERATURE	100 max.	°C

Characteristics, *At 250 Volts on Anode:*

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4200 angstroms	–	0.0018	–	μamp/μwatt ←
Luminous▲	4	6.5	15	μamp/lumen
Anode Dark Current at 25°C	–	–	0.005	μamp

* On plane perpendicular to indicated direction of incident light.

° Averaged over any interval of 30 seconds maximum.

▲ For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870°K. A dc anode supply of 250 volts, a 1-megohm load resistor, and a light input of 0.1 lumen are used.

← Indicates a change.

TUBE DIVISION
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

926

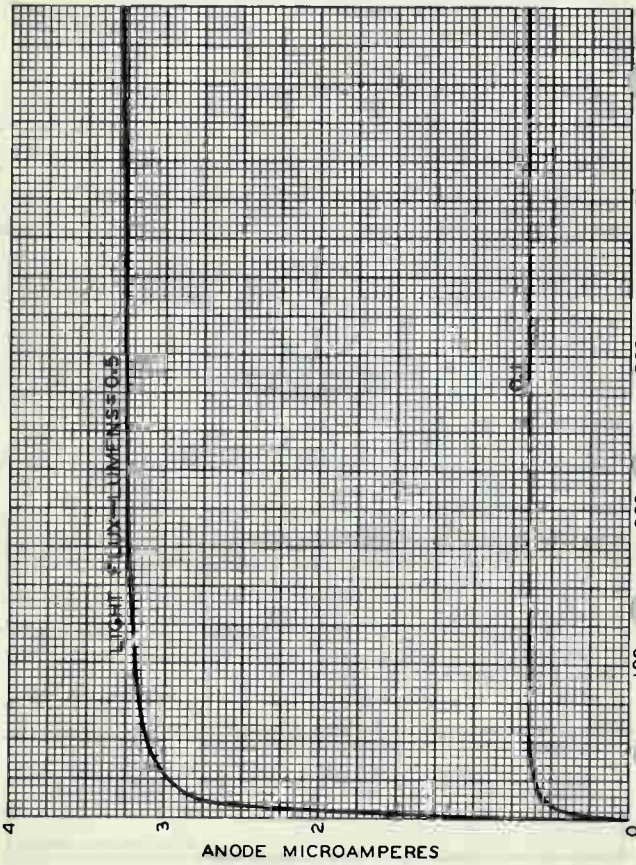
926

VACUUM PHOTOTUBE

DIMENSIONAL OUTLINE
for Type 926 is the same as that shown for Type 921

SPECTRAL-SENSITIVITY CHARACTERISTIC
of Phototube having S-3 Response
is shown at the front of this Section

AVERAGE ANODE CHARACTERISTICS



Gas Phototube

SIDE-ON TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	11/16"
Minimum projected width[a]	7/16"
Direct Interelectrode Capacitance (Approx.)	2 μμf
Maximum Overall Length	2-13/32"
Maximum Seated Length	1-15/16"
Seated Length to Center of Cathode	1-1/4" ± 3/32"
Maximum Diameter	0.669"
Operating Position	Any
Weight (Approx.)	0.3 oz ←
Bulb	T5-1/4
Socket	Amphenol No. 78S3S-T, or equivalent ←
Base	Small-Shell Peewee 3-Pin (JEDEC No. A3-1)
Basing Designation for BOTTOM VIEW	2F

Pin 1 – No Internal Connection

Pin 2 – Anode

Pin 3 – Photocathode

Maximum Ratings, ***Absolute-Maximum Values:*** ←

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	70 max.	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	60 max.	30 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	4 max.	2 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics: ←

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.012	–	amp/watt

←Indicates a change.

	Min.	Median	Max.	
Luminous:[c]				
At 0 cps.	75	125	185	μa/lumen
At 5000 cps	–	110	–	μa/lumen
At 10000 cps.	–	100	–	μa/lumen
Gas Amplification Factor[d] . .	–	–	10	
Anode Dark Current at 25° C .	–	–	0.1	μa

Minimum Circuit Values:

With an anode-supply voltage of	*70 or less*	*90*	*volts*
DC Load Resistance:			
For dc currents above 2 μa.	0.1 min.	–	megohm
For dc currents below 2 μa.	0 min.	–	megohm
For dc currents above 1 μa.	–	2.5 min.	megohms
For dc currents below 1 μa.	–	0.1 min.	megohm

[a] On plane perpendicular to indicated direction of radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

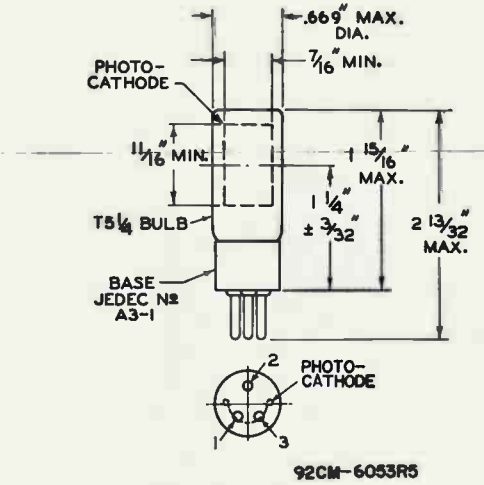
[d] The ratio of luminous sensitivity at an anode-supply voltage of 90 volts to luminous sensitivity at an anode-supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE

and

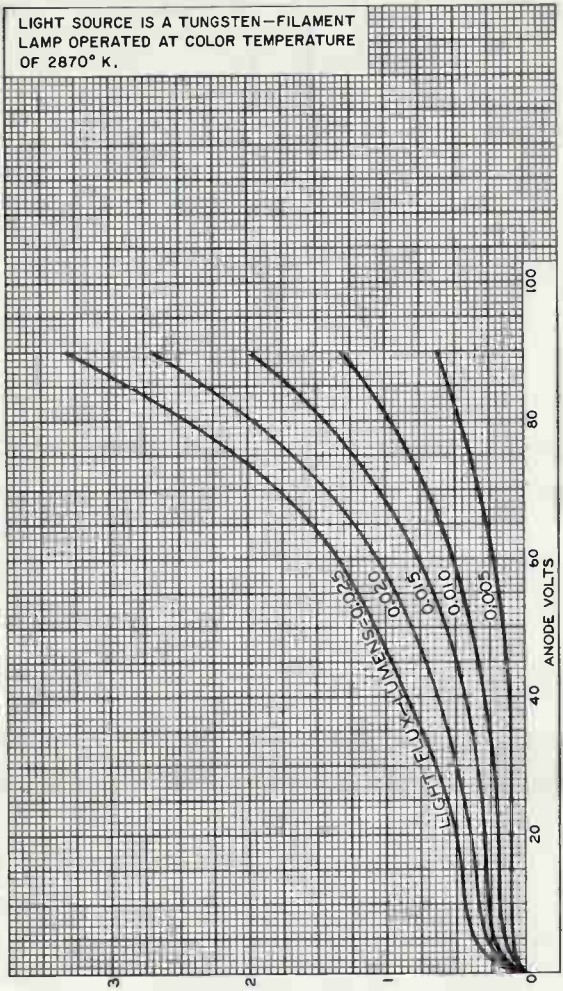
FREQUENCY-RESPONSE CHARACTERISTICS OF GAS PHOTOTUBES

are shown at the front of this section


.669" MAX.
DIA.
7/16" MIN.
PHOTO-
CATHODE
1 1/16" MIN.
1 15/16"
MAX.
1 1/4"
± 3/32"
2 13/32"
MAX.
T5 1/4 BULB
BASE
JEDEC No.
A3-1
2
PHOTO-
CATHODE
1
3

92CM-6053R5

AVERAGE ANODE CHARACTERISTICS



92CM-6258R3

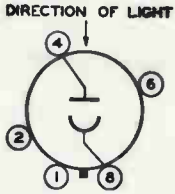
Vacuum Phototube

SIDE-ON TYPE HAVING S-4 RESPONSE

DATA

General:

Spectral Response	S-4
Wavelength of Maximum Response	4000 ± 500 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	13/16"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	2.6 μμf
Maximum Overall Length	3-1/16"
Maximum Seated Length	2-1/2"
Seated Length to Center of Cathode	1-5/8" ± 3/32"
Maximum Diameter	1-9/32"
Operating Position	Any
Weight (Approx.)	0.9 oz ←
Bulb	T9
Socket	Cinch No.8 JM-1, or equivalent ←
Base	Intermediate-Shell Octal 5-Pin, Arrangement 1 (JEDEC Group 1, No.B5-10) ←
Basing Designation for BOTTOM VIEW	3J



Pin 1 – No Internal Connection
Pin 2 – No Internal Connection
Pin 4 – Anode
Pin 6 – No Internal Connection
Pin 8 – Cathode

Maximum Ratings, *Absolute-Maximum Values:* ←

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	250 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	25 max.	μa/sq.in.
AVERAGE CATHODE CURRENT[b]	5 max.	μa
AMBIENT TEMPERATURE	75 max.	°C

Characteristics: ←

With an anode-supply voltage of 250 volts

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4000 angstroms	–	0.044	–	amp/watt
Luminous[c]	25	45	70	μa/lumen
Anode Dark Current at 25° C	–	–	0.0125	μa

←Indicates a change.

[a] On plane perpendicular to indicated direction of radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A 1-megohm load resistor and a light input of 0.1 lumen are used.

SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOSENSITIVE DEVICE HAVING S-4 RESPONSE
is shown at the front of this section

DIMENSIONAL OUTLINE
shown under Type 5581 also applies to the 929

AVERAGE ANODE CHARACTERISTICS

92CM-6151RI

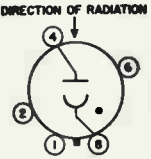
Gas Phototube

SIDE-ON TYPE HAVING S-1 RESPONSE

DATA

General:

Spectral Response	S-1
Wavelength of Maximum Response	8000 ± 1000 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	13/16"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	2.4 μμf
Maximum Overall Length	3-1/16"
Maximum Seated Length	2-1/2"
Seated Length to Center of Cathode	1-5/8" ± 3/32"
Maximum Diameter	1-9/32"
Operating Position	Any
Weight (Approx.)	0.9 oz
Bulb	T9
Socket	Cinch No.8JM-1, or equivalent ←
Base	Intermediate-Shell Octal 5-Pin Arrangement 1, (JEDEC No.B5-10)
Basing Designation for BOTTOM VIEW	3J



Pin 1 – No Connection
Pin 2 – No Connection
Pin 4 – Anode
Pin 6 – No Connection
Pin 8 – Photocathode

Maximum Ratings, ***Absolute-Maximum Values:***

	Rating I	*Rating II*	
ANODE-SUPPLY VOLTAGE (DC or Peak AC)	70 max.	90 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	60 max.	30 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	6 max.	3 max.	μa
AMBIENT TEMPERATURE	100 max.	100 max.	°C

Characteristics:

With an anode-supply voltage of 90 volts unless otherwise specified

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 8000 angstroms	–	0.013	←	amp/watt←

←Indicates a change.

	Min.	Median	Max.	
Luminous:[c]				
At 0 cps.	90	135	205	μa/lumen
At 5000 cps	–	111	–	μa/lumen
At 10000 cps.	–	101	–	μa/lumen
Gas Amplification Factor[d] . . .	–	–	10	
Anode Dark Current at 25° C . .	–	–	0.1	μa

Minimum Circuit Values:

With an anode-supply voltage of	*70 or less*	*90*	*volts*
DC Load Resistance:			
For dc currents above 3 μa. .	0.1 min.	–	megohm
For dc currents below 3 μa. .	0 min.	–	megohms
For dc currents above 2 μa. .	–	2.5 min.	megohms
For dc currents below 2 μa. .	–	1 min.	megohm

[a] On plane perpendicular to indicated direction of incident radiation.

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

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A dc anode supply voltage of 90 volts and a 1-megohm load resistor are used. For the 0-cycle measurement, a light input of 0.1 lumen is used. For the 5000- and 10,000-cycle measurements, the light input is varied sinusoidally about a mean value of 0.015 lumen from zero to a maximum of twice the mean value.

[d] The ratio of luminous sensitivity at an anode supply voltage of 90 volts to luminous sensitivity at an anode supply voltage of 25 volts. In each case, sensitivity is obtained under conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K, the light input is 0.1 lumen, and the load resistor has a value of 1 megohm.

SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOSENSITIVE DEVICE HAVING S-1 RESPONSE

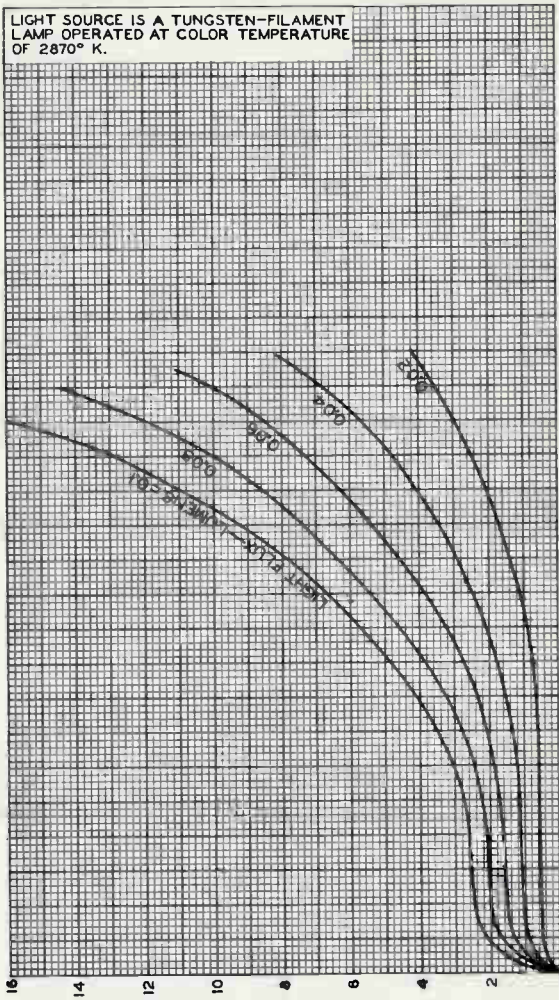
and

FREQUENCY-RESPONSE CHARACTERISTICS
OF GAS PHOTOTUBES

are shown at the front of this section

DIMENSIONAL OUTLINE
shown under Type 5581 also applies to the 930

AVERAGE ANODE CHARACTERISTICS



92CM-4806R2

Photomultiplier Tube

9-Stage, Side-On Type Having S-4 Spectral Response

For general purpose applications in low-light level detection and measurement systems.

GENERAL

Spectral Response	S-4
Wavelength of Maximum Response	4000 ± 500 angstroms
Cathode, Opaque	Cesium-Antimony
Minimum projected length[a]	0.94 in (2.4 cm)
Minimum projected width[a]	0.31 in (0.8 cm)
Window	Lime Glass (Corning[b] No. 0080), or equivalent
Index of refraction at 4360 angstroms	1.523
Dynodes:	
Substrate	Nickel
Secondary-Emitting Surface	Cesium-Antimony
Structure	Circular-Cage, Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.9	4.4 pF
Anode to all other electrodes	6.0 pF
Maximum Overall Length	3.68 in (9.3 cm)
Seated Length	3.12 in (7.9 cm)
Maximum Diameter	1.31 in (3.3 cm)
Bulb	T9
Base	Small-Shell Submagnal 11 Pin, (JEDEC Group 2, No. B11-88), Non-hygroscopic
Socket	Amphenol[c] No. 78S11T, or equivalent
Magnetic Shield	Millen[d] No. 80801B, or equivalent
Operating Position	Any
Weight (Approx.)	1.6 oz

MAXIMUM RATINGS, *Absolute-Maximum Values*

DC or Peak AC Supply Voltage:

Between anode and cathode	1250 max.	V
Between anode and dynode No.9	250 max.	V
Between consecutive dynodes	250 max.	V
Between dynode No.1, and cathode	250 max.	V

Average Anode Current[f]	1.0 max. mA
Ambient Temperature[g]	+75 max. °C

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing 1/10 of E between cathode and dynode No.1; 1/10 of E for each succeeding dynode stage; and 1/10 of E between dynode No.9 and anode.

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[h] at 4000 angstroms . . .	–	8.3×10^4	–	A/W
Luminous[i] (2870° K).	10	80	600	A/lm
Cathode Sensitivity:				
Radiant[k] at 4000 angstroms . . .	–	0.04	–	A/W
Luminous[m] (2870° K).	–	4×10^{-5}	–	A/lm
Quantum Efficiency at 3800 angstroms . . .	–	13	–	%
Current Amplification	–	2×10^6	–	
Anode Dark Current[n].	–	5×10^{-9}	5×10^{-8}	A
Equivalent Anode Dark Current Input[n]	–	2.5×10^{-10}	2.5×10^{-9}	lm
	–	2.4×10^{-13}p	2.4×10^{-12}p	W
Equivalent Noise Input[q]	–	3×10^{-12}	–	lm
	–	2×10^{-15}r	–	W
Anode-Pulse Rise Time[s] at 1250 V . .	–	1.6×10^{-9}	–	s
Electron Transit Time[t] at 1250 V.	–	1.6×10^{-8}	–	s

[a] On plane perpendicular to the indicated direction of incident light and passing through the major axis of the tube.

[b] Made by Corning Glass Works, Corning, NY 14830.

[c] Made by Amphenol Electronics Corporation, 1830 South 54th Avenue, Chicago 50, IL 60650.

[d] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.

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

→ Indicates a change or addition.

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

This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 1036 lumens per watt.

[i] 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 10 microlumens is used.

[k] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 1036 lumens per watt.

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 0.01 lumen and 100 volts are applied between cathode and all other electrodes connected as anode.

[n] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

[p] At 4000 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 1036 lumens per watt.

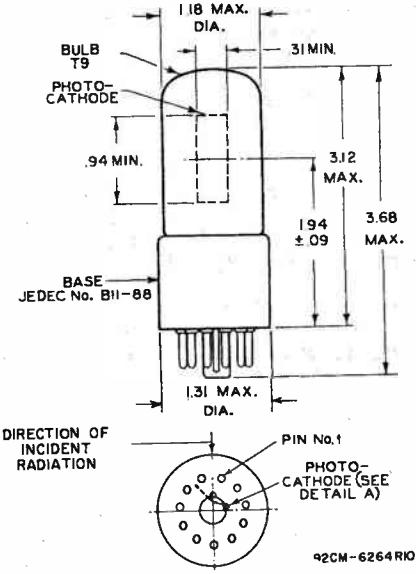
[q] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

At 4000 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 1036 lumens per watt.

[s] 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.

† 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.

DIMENSIONAL OUTLINE

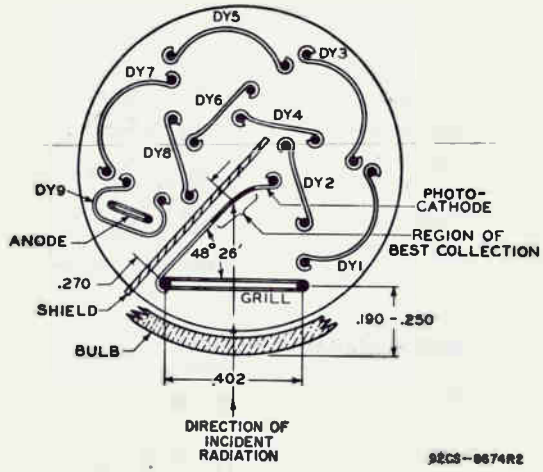


℄ of bulb will not deviate more than 2^{o} in any direction from the perpendicular erected at center of bottom of base. Dimensions are in inches unless otherwise stated.

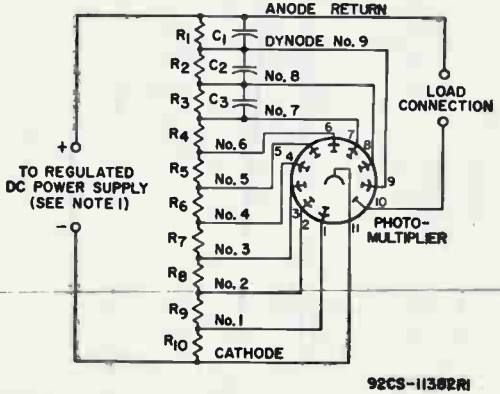
Inch Dimension Equivalents in Millimeters

Inch	mm	Inch	mm	Inch	mm
.09	2.3	.31	7.9	1.31	33.2
.190	4.8	.402	10.2	1.94	49.2
.250	6.3	.94	23.8	3.12	79.2
.270	6.8	1.18	29.9	3.68	93.4

DETAIL A (Top View)



TYPICAL VOLTAGE-DIVIDER ARRANGEMENT



R_1 through R_{10} = 20,000 to 1,000,000 ohms

Note 1: Adjustable between approximately 500 and 1250 volts.

Note 2: Capacitors C_1 through C_3 should be connected at tube socket for optimum high-frequency performance.

931A

TERMINAL DIAGRAM (Bottom View)

Pin 1: Dynode No.1

Pin 2: Dynode No.2

Pin 3: Dynode No.3

Pin 4: Dynode No.4

Pin 5: Dynode No.5

Pin 6: Dynode No.6

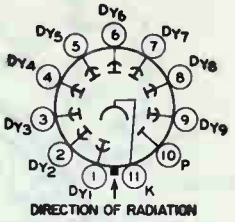
Pin 7: Dynode No.7

Pin 8: Dynode No.8

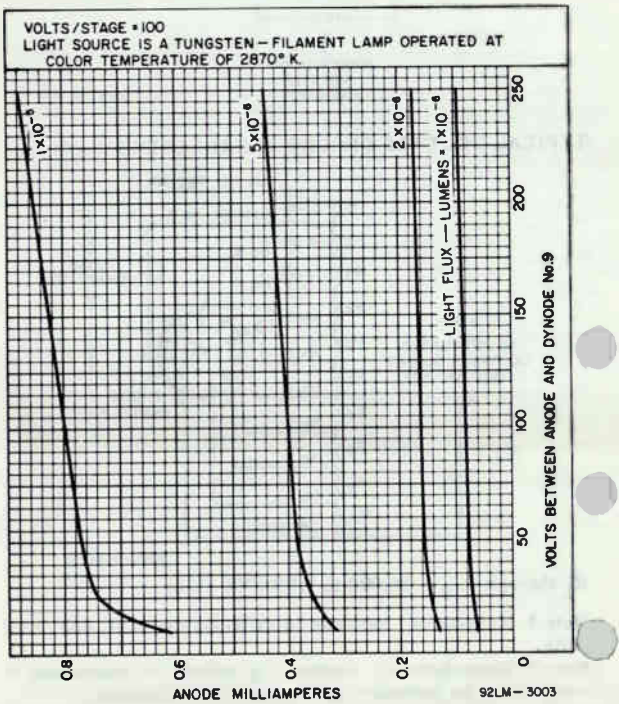
Pin 9: Dynode No.9

Pin 10: Anode

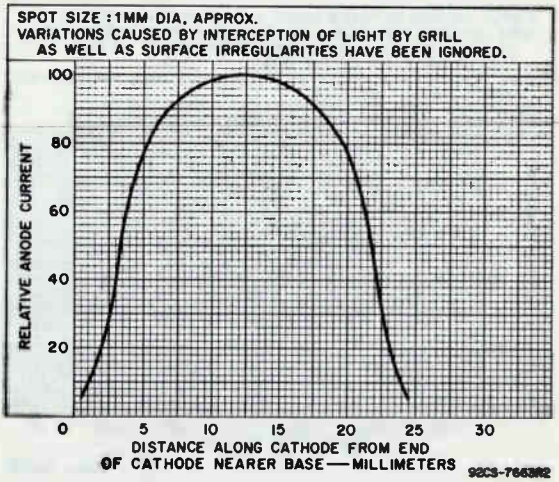
Pin 11: Photocathode



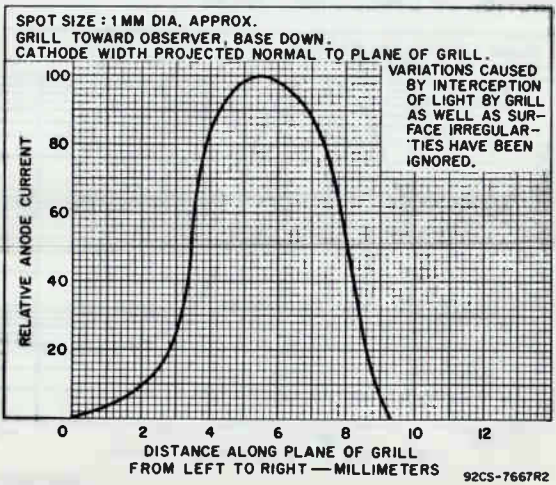
TYPICAL ANODE CHARACTERISTICS



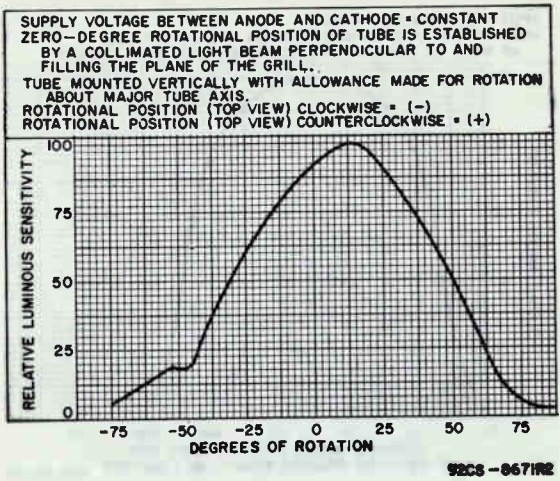
TYPICAL VARIATION OF PHOTOCATHODE SENSITIVITY ALONG TUBE LENGTH



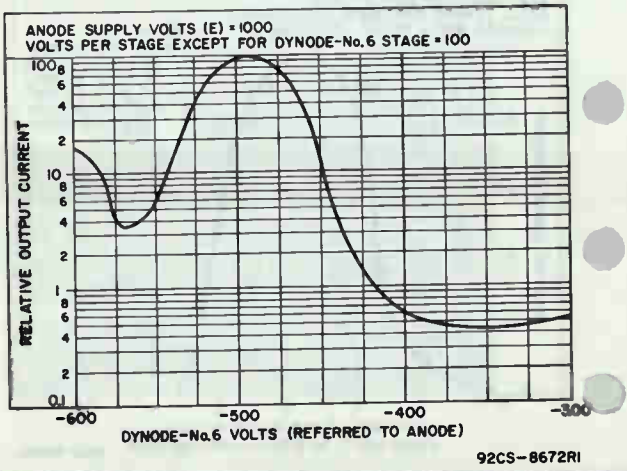
TYPICAL VARIATION OF PHOTOCATHODE SENSITIVITY ACROSS PROJECTED WIDTH IN PLANE OF GRILL



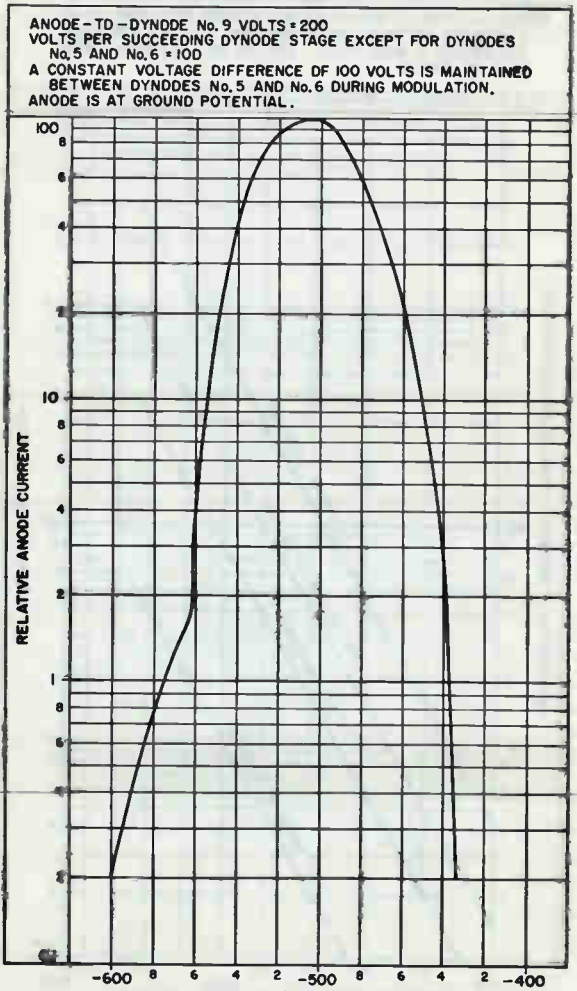
TYPICAL VARIATION OF SENSITIVITY AS TUBE IS ROTATED WITH RESPECT TO FIXED LIGHT BEAM



TYPICAL CHARACTERISTIC OF OUTPUT CURRENT AS A FUNCTION OF DYNODE-NO.6 VOLTS

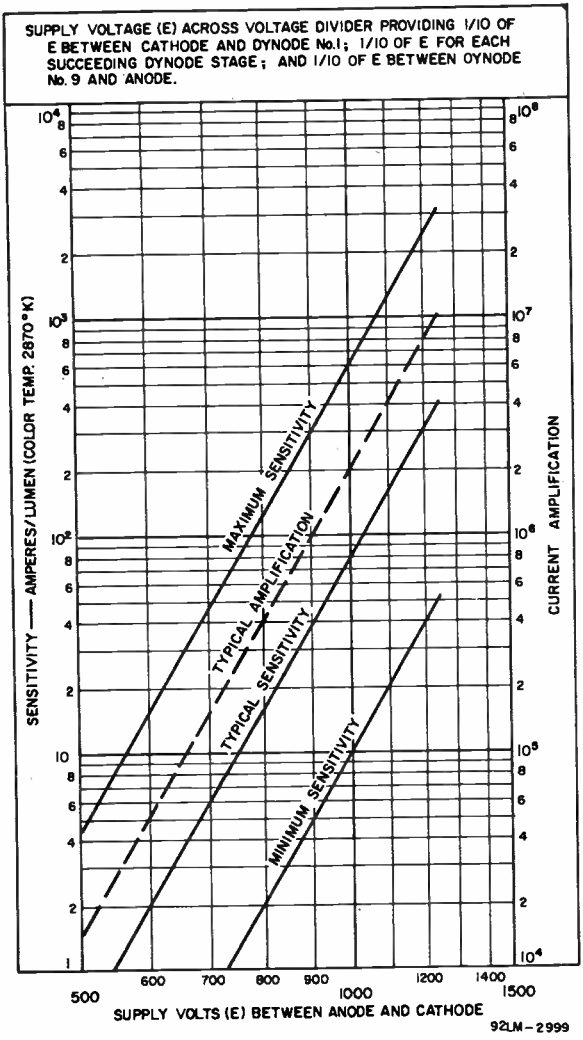


TYPICAL CHARACTERISTIC OF OUTPUT CURRENT AS A FUNCTION OF SIMULTANEOUS MODULATION OF DYNODES NO.5 AND NO.6



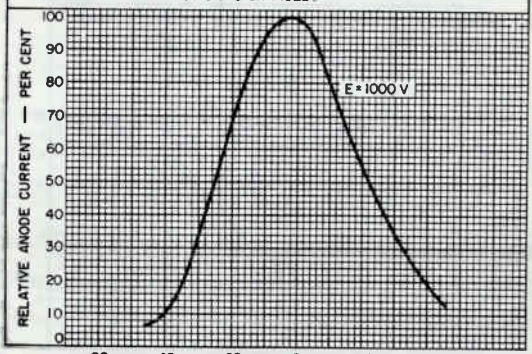
92CM-11375

TYPICAL SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS



TYPICAL EFFECT OF MAGNETIC FIELD ON ANODE CURRENT

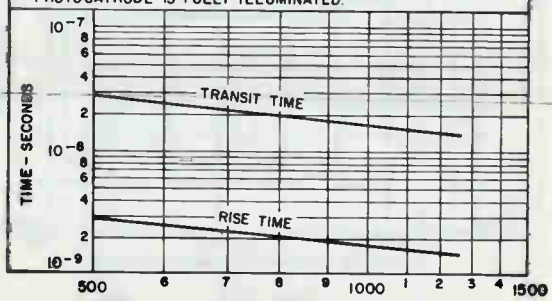
SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1; 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/10 OF E BETWEEN DYNODE No. 9 AND ANODE.
PHOTOCATHODE IS FULLY ILLUMINATED.
UNIFORM MAGNETIC FIELD PARALLEL TO MAJOR AXIS OF TUBE.
POSITIVE VALUES OF MAGNETIC FLUX ARE FOR LINES OF FORCE TOWARD TUBE BASE.
TUBE IS DEGAUSSED PRIOR TO TEST AND IS AGAIN DEGAUSSED BEFORE FLUX DIRECTION IS CHANGED.



92LS-3001

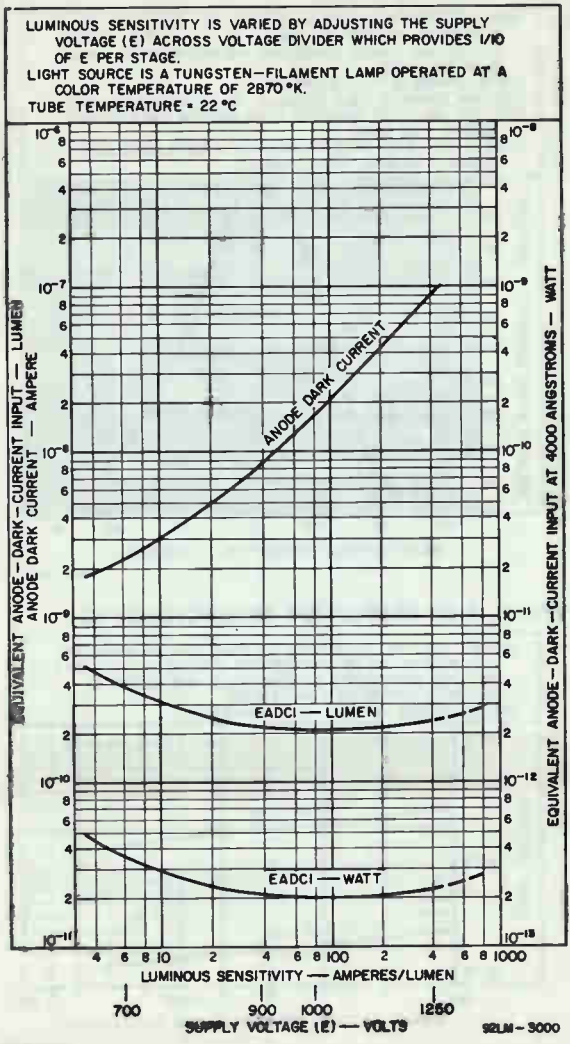
TYPICAL TIME-RESOLUTION CHARACTERISTICS

SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/10 OF E BETWEEN CATHODE AND DYNODE No.1; 1/10 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/10 OF E BETWEEN DYNODE No.9 AND ANODE.
PHOTOCATHODE IS FULLY ILLUMINATED.



92LS-3010

TYPICAL EADCI AND DARK CURRENT CHARACTERISTICS



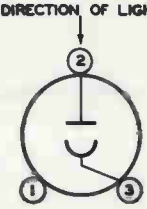
Vacuum Phototube

SIDE-ON TYPE HAVING S-4 RESPONSE

DATA

General:

Spectral Response	S-4
Wavelength of Maximum Response	4000 ± 500 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	11/16"
Minimum projected width[a]	7/16"
Direct Interelectrode Capacitance (Approx.)	1.5 μμf
Maximum Overall Length	2-13/32"
Maximum Seated Length	1-15/16"
Seated Length to Center of Cathode	1-1/4" ± 3/32"
Maximum Diameter	0.669"
Operating Position	Any
Weight (Approx.)	0.4 oz
Bulb	T5-1/4
Socket	Amphenol No.78S3S-T, or equivalent
Base	Small-Shell Peewee 3-Pin (JEDEC No.A3-1)
Basing Designation for BOTTOM VIEW	2F



Pin 1 – No Internal Connection

Pin 2 – Anode
Pin 3 – Photocathode

Maximum Ratings, *Absolute-Maximum Values:*

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	250 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	30 max.	μa/sq. in.
AVERAGE CATHODE CURRENT[b]	4 max.	μa
AMBIENT TEMPERATURE	75 max.	°C

Characteristics:

With an anode-supply voltage of 250 volts

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4000 angstroms	–	0.028	–	amp/watt
Luminous[c]	19	30	75	μa/lumen
Anode Dark Current at 25° C	–	–	0.005	μa

→ Indicates a change.

[a] On plane perpendicular to indicated direction of incident light.

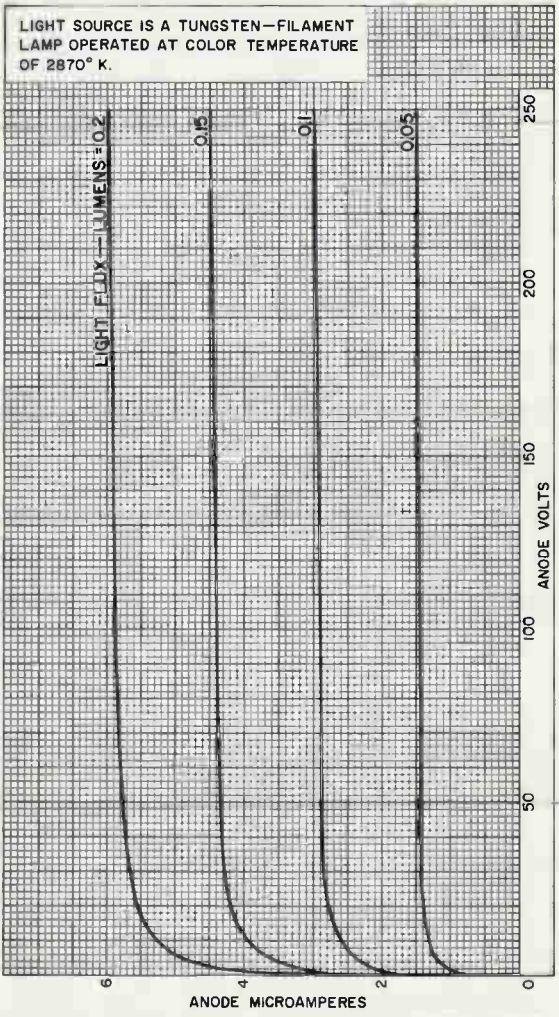
[b] Averaged over any interval of 30 seconds maximum.

[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A 1-megohm load resistor and a light input of 0.1 lumen are used.

SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOSENSITIVE DEVICE HAVING S-4 RESPONSE
is shown at the front of this section

DIMENSIONAL OUTLINE
shown under Type 927 also applies to the 934

AVERAGE ANODE CHARACTERISTICS



92CM—6479RI

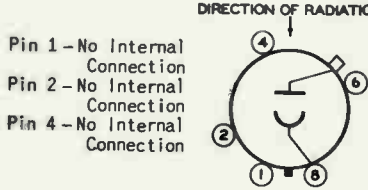
Vacuum Phototube

SIDE-ON TYPE HAVING S-5 RESPONSE

DATA

General:

Spectral Response	S-5
~~Wavelength of Maximum Response~~	3400 ± 500 angstroms
Cathode:	
Shape	Semicylindrical
Minimum projected length[a]	1-5/16"
Minimum projected width[a]	5/8"
Direct Interelectrode Capacitance (Approx.)	0.6 μμf
Maximum Overall Length	4-1/4"
Seated Length	3-9/16" ± 1/8"
Seated Length to Center of Cathode	2" ± 1/16"
Maximum Diameter	1-9/32"
Operating Position	Any
Weight (Approx.)	1 oz
Bulb	T9
Cap	Skirted Miniature (JEDEC No.C1-3)
Socket	Cinch No.8JM-1, or equivalent
Base	Intermediate-Shell Octal 5-Pin, Arrangement 1 (JEDEC Group 1, No.B5-10)
Basing Designation for BOTTOM VIEW	1C



Pin 1 – No Internal Connection
Pin 2 – No Internal Connection
Pin 4 – No Internal Connection
Pin 6 – No Internal Connection
Pin 8 – Photocathode
Cap – Anode

Maximum Ratings, ***Absolute-Maximum Values:***

ANODE-SUPPLY VOLTAGE (DC or Peak AC)	250 max.	volts
AVERAGE CATHODE-CURRENT DENSITY[b]	30 max.	μa/sq.in.
AVERAGE CATHODE CURRENT[b]	10 max.	μa
AMBIENT TEMPERATURE	75 max.	°C

Characteristics:

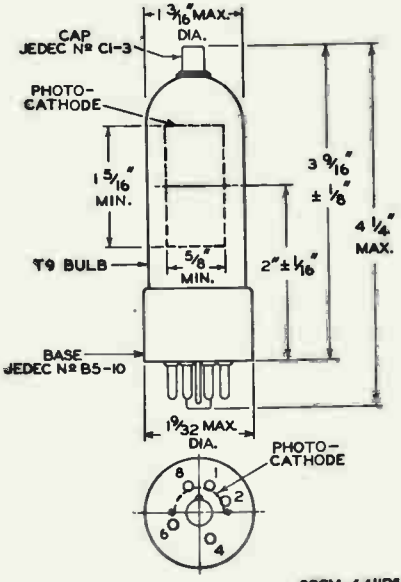
With an anode-supply voltage of 250 volts

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 3400 angstroms	–	0.043	–	amp/watt
Luminous[c]	18	35	70	μa/lumen
Anode Dark Current at 25° C.	–	–	0.0005	μa

← Indicates a change.

[a] On plane perpendicular to indicated direction of radiation.
[b] Averaged over any interval of 30 seconds maximum.
[c] For conditions where the light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A 1-megohm load resistor and a light input of 0.1 lumen are used.

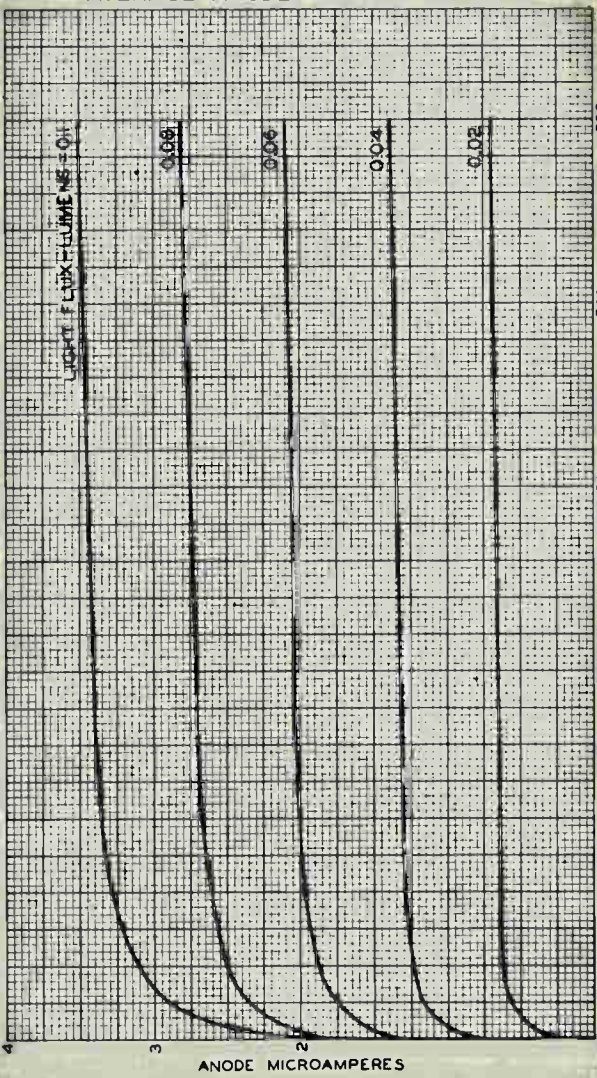
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-5 RESPONSE is shown at the front of this section



RCA

935

AVERAGE ANODE CHARACTERISTICS



APRIL 20, 1950

TUBE DEPARTMENT
RADIO CORPORATION OF AMERICA HARRISON, NEW JERSEY

92CM-6478RI

Multiplier Phototube

10-Stage, Head-On Type Having S-11 Spectral Response

GENERAL

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 Å
Cathode, Semitransparent	Cesium-Antimony with High-Conductivity Grating
Area including grating	1.8 in^2 (11.6 cm^2)
Minimum diameter	1.5 in (3.8 cm)
Window	Corning[c] No.0080, or equivalent
Shape	Plano-Plano
Index of refraction at 4360 angstroms	1.523
Dynodes:	
Substrate	Copper-Beryllium
Secondary-Emitting Surface	Beryllium-Oxide
Structure	Circular-Cage, Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4.4 pF
Anode to all other electrodes	7.0 pF
Maximum Overall Length	5.81 in (14.8 cm)
Seated Length	4.88 ± 0.19 in (12.4 ± 0.48 cm)
Maximum Diameter	2.31 in (5.9 cm)
Bulb	T-16
Base	Medium-Shell Diheptal 14-Pin (JEDEC No.B14-38), Non-hygroscopic
Socket	Eby[b] No.9709-7, or equivalent
Magnetic Shield	Millen[c] Part No.80802B, or equivalent
Operating Position	Any
Weight (Approx.)	5.2 oz (174 g)

ABSOLUTE-MAXIMUM RATINGS

DC Supply Voltage:		
Between anode and cathode	1500 max.	V
Between anode and dynode No.10	250 max.	V
Between consecutive dynodes	250 max.	V
Between dynode No.1 and cathode	400 max.	V

Between focusing electrode and cathode . .	400 max.	V
Average Anode Current[e]	2 max.	mA
Average Cathode Current[f]	5 max.	μA
Ambient Temperature[g]	75 max.	°C

CHARACTERISTICS RANGE VALUES

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode. Focusing-electrode voltage is adjusted to that value between 10 and 60 per cent of dynode No.1 potential (referred to cathode) which provides maximum anode current.

With E = 1250 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[h] at 4400 angstroms . .	—	4.8×10^3	—	A/W
Luminous (2870° K)[i]	2.5	6	75	A/lm
Cathode Sensitivity:				
Radiant[k] at 4400 angstroms . .	—	0.04	—	A/W
Luminous (2870° K)[m]	3×10^{-5}	5×10^{-5}	—	A/lm
Current with blue light source (2870° K + C.S. No.5-58)[n]	3×10^{-8}	5×10^{-8}	—	A
Quantum Efficiency at 4200 angstroms.	—	11.5	—	%
Current Amplification	—	1.2×10^5	—	
Anode Dark Current[p]	—	4×10^{-9}	4.5×10^{-8}	A
Equivalent Anode Dark Current Input[p]	— —	2×10^{-10} 2.5×10^{-13}[q]	2.25×10^{-9} 2.8×10^{-12}[q]	lm W
Equivalent Noise Input[r]	— —	5.6×10^{-12} 7×10^{-15}[s]	1.9×10^{-11} 2.3×10^{-14}[s]	lm W

[a] Made by Corning Glass Works, Corning, NY 14830.

[b] Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia, PA 19144.

[c] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.

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

[f] Above this value of average cathode current, serious loss in linearity between light input and anode current will be caused by the resistivity of the cathode.

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

[h] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 804 lumens per watt.

[i] 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 10 microlumens is used.

[k] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 804 lumens per watt.

[m] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[n] 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, NY 14830) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux incident on the filter is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

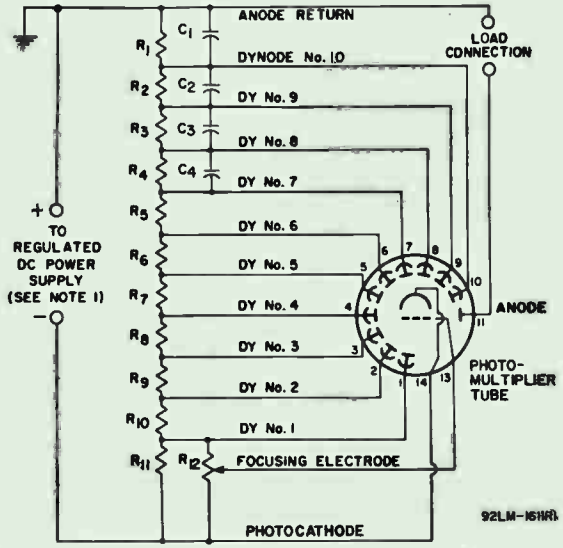
[p] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 20 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.

[q] At 4400 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 804 lumens per watt.

[r] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[s] At 4400 angstroms. These values are calculated from the ENI values in lumens using a conversion factor of 804 lumens per watt.

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT

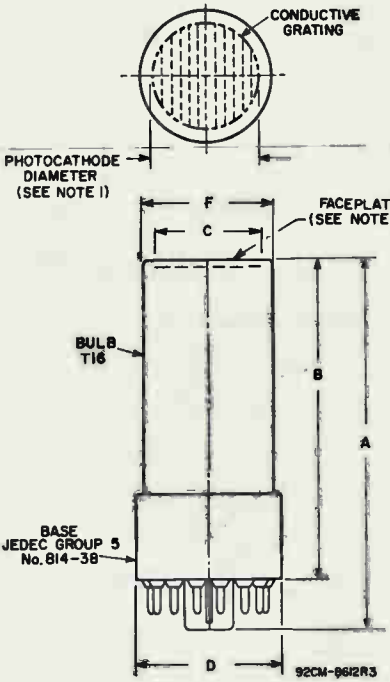


C_1: 0.05 μF, 20%, 500 volts (dc working), ceramic disc
C_2: 0.02 μF, 20%, 500 volts (dc working), ceramic disc
C_3: 0.01 μF, 20%, 500 volts (dc working), ceramic disc
C_4: 0.005 μF, 20%, 500 volts (dc working), ceramic disc
R_1 through R_{10}: 390,000 ohms, 5%, 1/2 watt
R_{11}: 910,000 ohms, 5%, 1/2 watt
R_{12}: 5 megohms, 20%, 1/2 watt, adjustable

Note 1: Adjustable between approximately 500 and 1500 volts dc.

Note 2: Component values are dependent upon nature of application and output signal desired.

DIMENSIONAL OUTLINE



℄ of bulb will not deviate more than 2^{o} in any direction from the perpendicular erected at the center of bottom of the base.

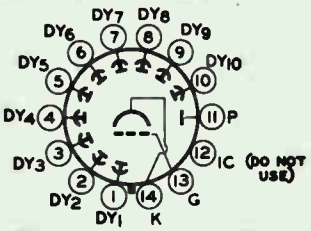
Note 1: The grating consists of 12 equally spaced conductive strips having a maximum width of 0.02" (0.5 mm).

Note 2: Deviation from flatness will not exceed 0.010" from peak to valley.

OUTLINE DIMENSIONS

Dimensions	Inches	mm
A	5.81 max.	147.5 max.
B	4.88 ± .19	123.9 ± 4.8
C	1.5 min. dia.	38 min. dia.
D	2.31 max. dia.	58.6 max. dia.
F	2.00 ± .06 dia.	50.8 ± 1.5 dia.

TERMINAL DIAGRAM (Bottom View)



DIRECTION OF RADIATION: INTO END OF BULB

Pin 1: Dynode No.1

Pin 2: Dynode No.2

Pin 3: Dynode No.3

Pin 4: Dynode No.4

Pin 5: Dynode No.5

Pin 6: Dynode No.6

Pin 7: Dynode No.7

Pin 8: Dynode No.8

Pin 9: Dynode No.9

Pin 10: Dynode No.10

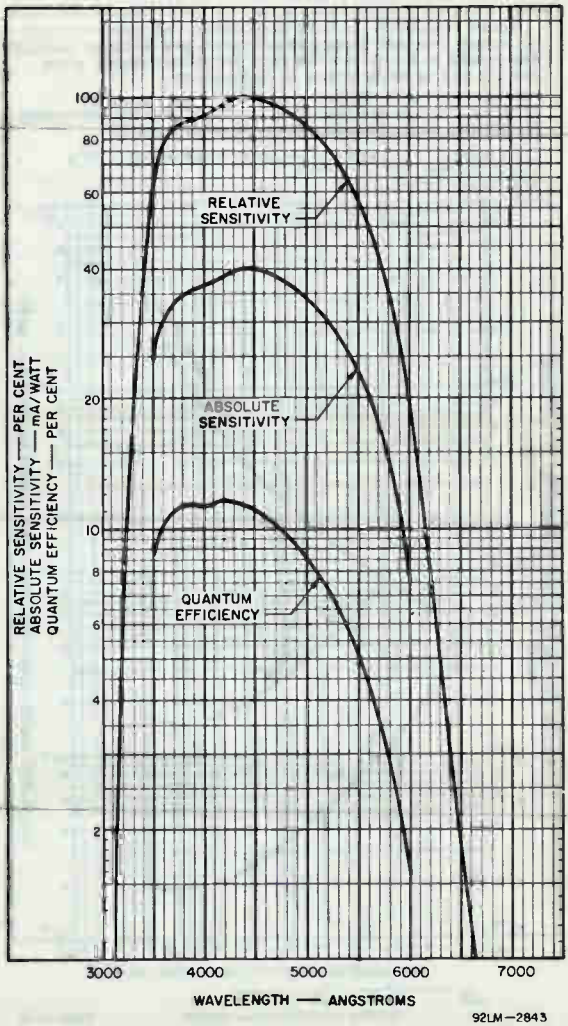
Pin 11: Anode

Pin 12: Internal connection-Do not use

Pin 13: Focusing Electrode

Pin 14: Photocathode

Typical Spectral Response Characteristics

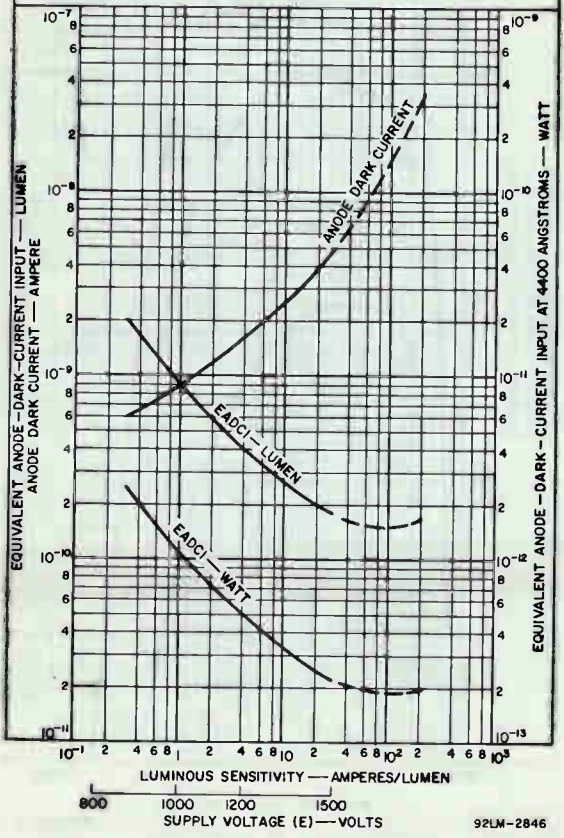


Typical EADCI and Anode Dark Current Characteristics

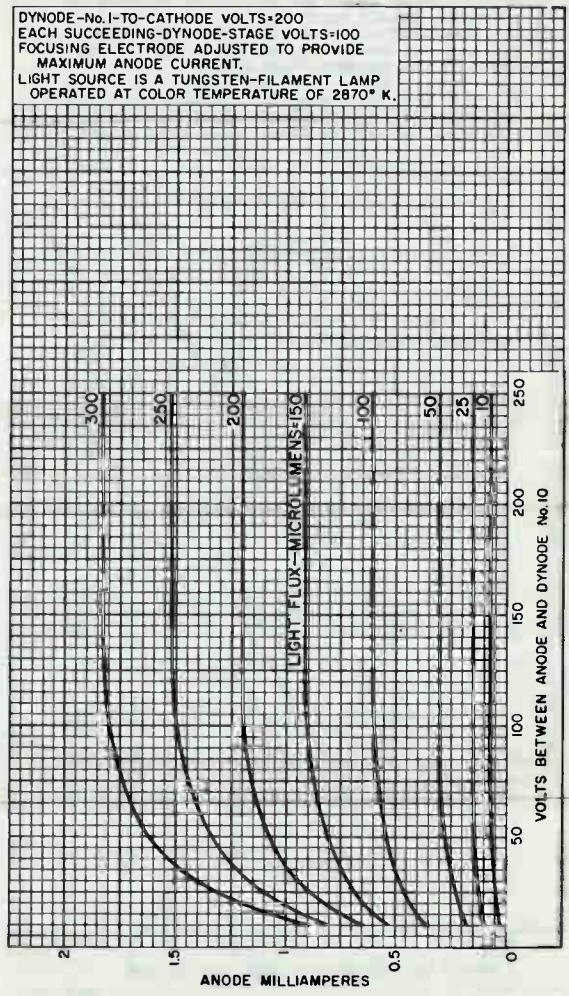
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTING THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER PROVIDING 1/6 OF E BETWEEN CATHODE AND DYNODE No. 1; 1/12 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/12 OF E BETWEEN DYNODE No. 10 AND ANODE.

FOCUSING ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 10 AND 60 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.

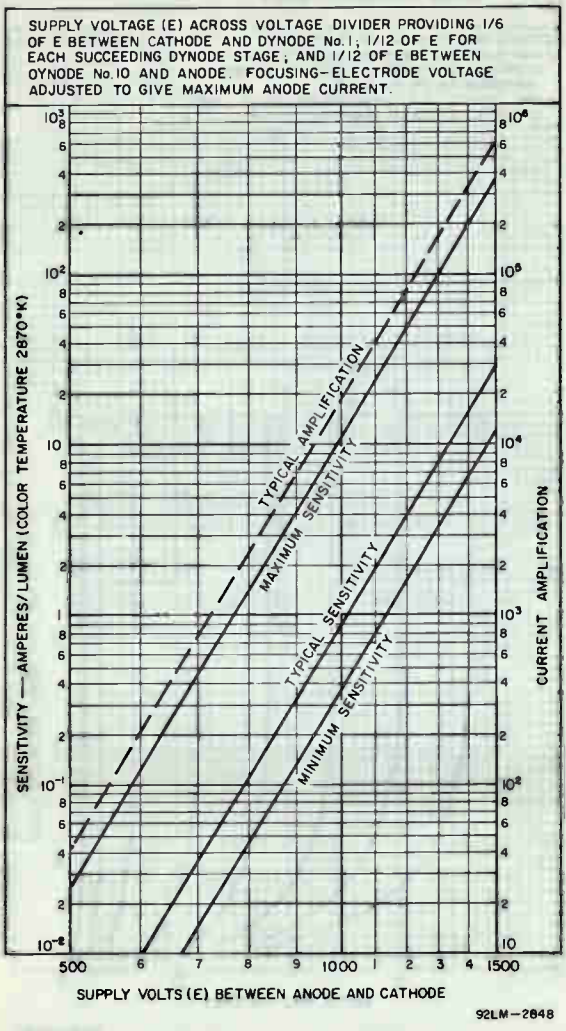
LIGHT SOURCE IS A TUNGSTEN – FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870°K.
TUBE TEMPERATURE = 22°C



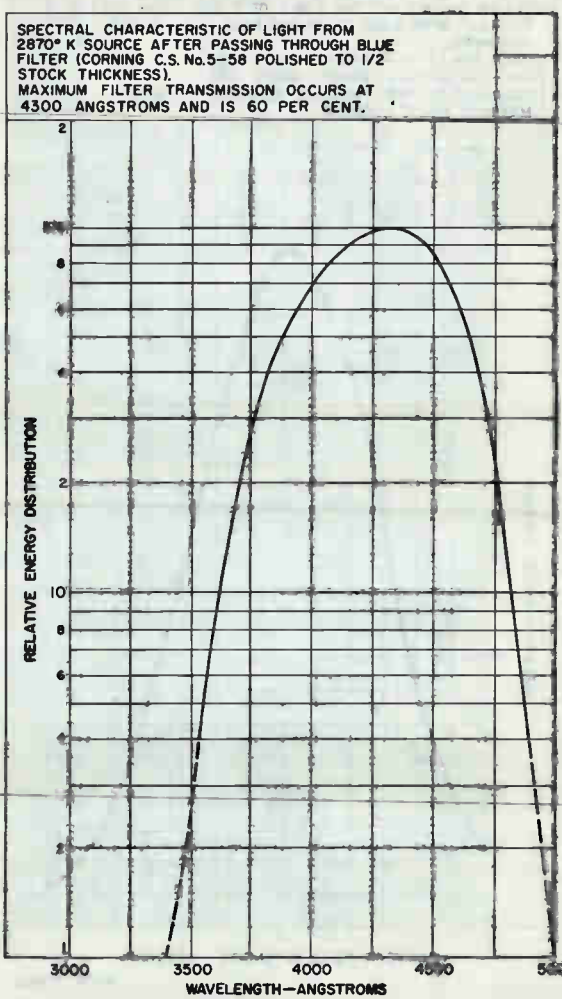
Typical Anode Characteristics



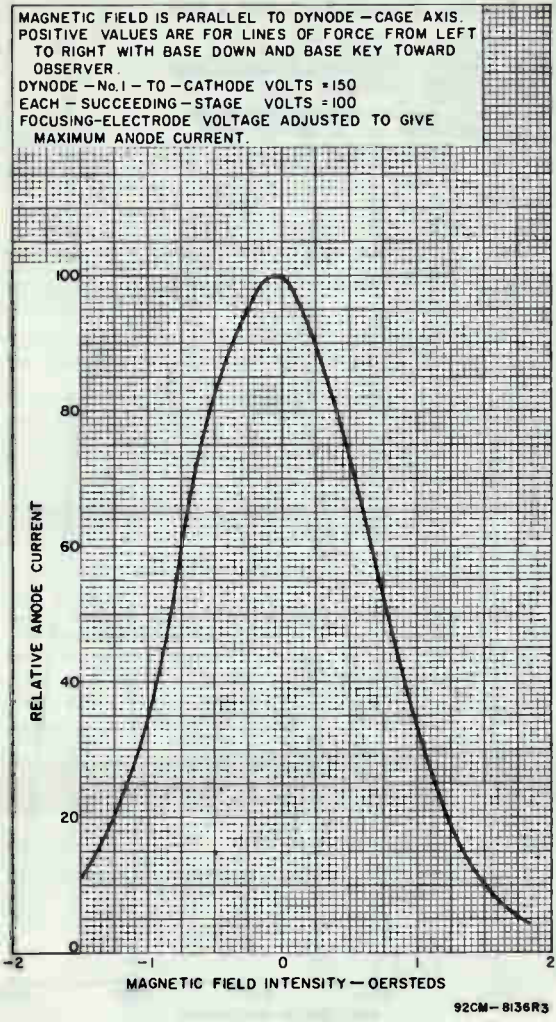
Sensitivity and Current Amplification Characteristics



Spectral Energy Distribution of 2870° K Light Source After Passing Through Indicated Filter



Typical Effect of Magnetic Field on Anode Current



Photomultiplier Tube

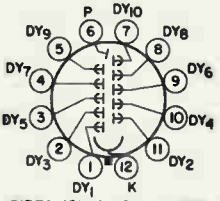
10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE HAVING S-11 RESPONSE 1.24 INCH MINIMUM DIAMETER FLAT PHOTOCATHODE

For Use in Scintillation Counters for the Detection and Measurement of Nuclear Radiation and Other Low-Level Light Sources

The 2060 *is identical to type* 6199 *in all respects except that it is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base should be removed prior to installing the* 2060 *in a given system.*

BASING DIAGRAM (Bottom View) With Base Attached

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 – Anode
Pin 7 – Dynode No.10
Pin 8 – Dynode No.8
Pin 9 – Dynode No.6
Pin 10 – Dynode No.4
Pin 11 – Dynode No.2
Pin 12 – Photocathode

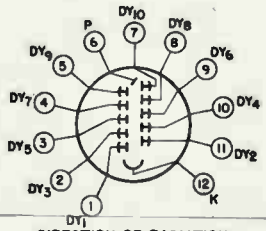


DIRECTION OF RADIATION: INTO END OF BULB

12AE

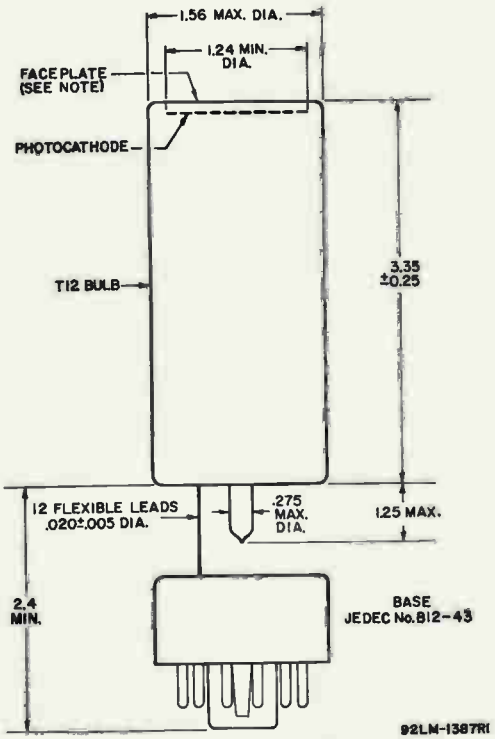
TERMINAL CONNECTIONS (Bottom View) With Base Removed

Lead 1 – Dynode No.1
Lead 2 – Dynode No.3
Lead 3 – Dynode No.5
Lead 4 – Dynode No.7
Lead 5 – Dynode No.9
Lead 6 – Anode
Lead 7 – Dynode No.10
Lead 8 – Dynode No.8
Lead 9 – Dynode No.6
Lead 10 – Dynode No.4
Lead 11 – Dynode No.2
Lead 13 – Photocathode



DIRECTION OF RADIATION: INTO END OF BULB

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 1.24-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010-inch from peak to valley.

Photomultiplier Tube

S-11 RESPONSE
10-STAGE, HEAD-ON, FLAT-FACEPLATE

ELECTROSTATICALLY FOCUSED DYNODE STAGES

For Detection and Measurement of Nuclear Radiation and Other Low-Level Light Sources in Scintillation Counters

The 2061 is electrically similar to type 6342A except for the following performance characteristic and that the anode luminous sensitivity and equivalent noise input ratings shown for the 6342A do not apply for type 2061.

The 2061 is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base of the 2061 should be removed prior to installing the tube in a given system.

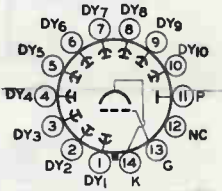
PERFORMANCE CHARACTERISTIC

Minimum Pulse Height[a]. . . . . 0.13 V

[a] Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 ± 5%-kilohm resistor and a total capacitance of 92 ± 3% pF in parallel. An anode-to-cathode voltage of 1130 volts is applied across a voltage-divider network having a 1.5 ± 5% megohm resistor between cathode and dynode No.1, 450 ± 5%—kilohm resistors between each succeeding stage including dynode No.10 to anode. The focusing electrode is adjusted to that value between 0% and 60% of dynode No.1 potential (referred to cathode) which will provide maximum anode current. The 662-KeV photon from an isotope of cesium having an atomic mass of 137 ($_{55}Cs^{137}$) and a cylindrical 2 inch x 2 inch thallium-activated sodium-iodide scintillator [NaI(Tl)] type 8D8, or equivalent are used. The scintillator is manufactured by the Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio. The $_{55}Cs^{137}$ is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the 2061 by a coupling fluid such as Dow Corning Corp., Type DC200 (Viscosity of 100 centipoise) manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

BASING DIAGRAM (Bottom View)
With Base Attached

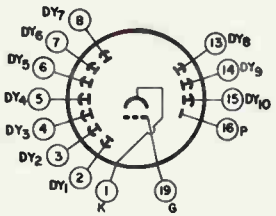
Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7
Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Dynode No.10
Pin 11 – Anode
Pin 12 – No Connection
Pin 13 – Focusing Electrode
Pin 14 – Photocathode



DIRECTION OF RADIATION: INTO END OF BULB

TERMINAL CONNECTIONS (Bottom View)
With Base Removed

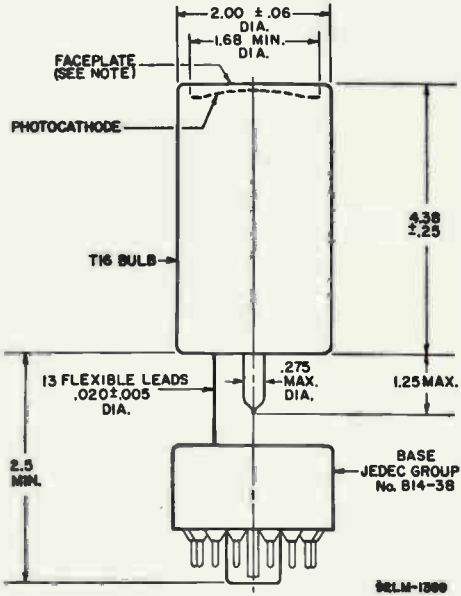
Lead 1 – Photocathode
Lead 2 – Dynode No. 1
Lead 3 – Dynode No. 2
Lead 4 – Dynode No. 3
Lead 5 – Dynode No. 4
Lead 6 – Dynode No. 5
Lead 7 – Dynode No. 6
Lead 8 – Dynode No. 7
Lead 13 – Dynode No. 8
Lead 14 – Dynode No. 9
Lead 15 – Dynode No. 10
Lead 16 – Anode
Lead 19 – Focusing Electrode



DIRECTION OF LIGHT: INTO END OF BULB

92LS-1307

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 1.68-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010 inch from peak to valley.

Photomultiplier Tube

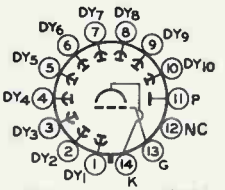
10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE HAVING S-11 RESPONSE
1.6B INCH MINIMUM DIAMETER CURVED PHOTOCATHODE

For Use in Scintillation Counters for the Detection and Measurement of Nuclear Radiation and Other Low-Level Light Sources

The 2062 *is identical to type* 6655A *in all respects except that it is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base should be removed prior to installing the* 2062 *in a given system.*

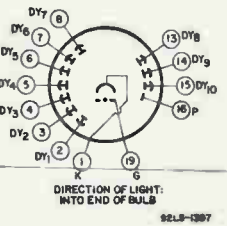
BASING DIAGRAM (Bottom View)
With Base Attached

Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7
Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Dynode No.10
Pin 11 – Anode
Pin 12 – No Connection
Pin 13 – Focusing Electrode
Pin 14 – Photocathode

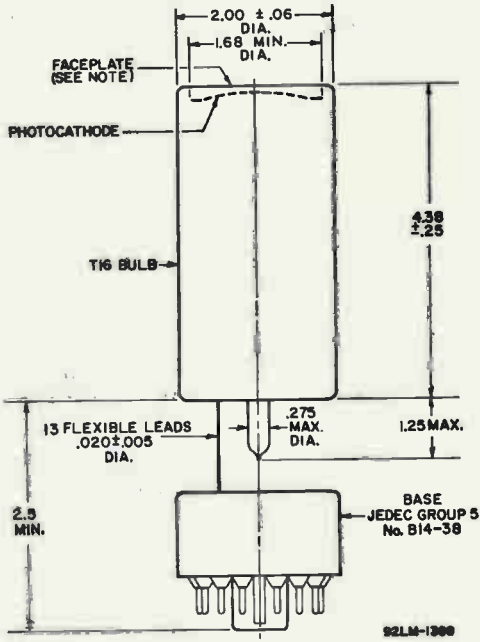


TERMINAL CONNECTIONS (Bottom View)
With Base Removed

Lead 1 – Photocathode
Lead 2 – Dynode No.1
Lead 3 – Dynode No.2
Lead 4 – Dynode No.3
Lead 5 – Dynode No.4
Lead 6 – Dynode No.5
Lead 7 – Dynode No.6
Lead 8 – Dynode No.7
Lead 13 – Dynode No.8
Lead 14 – Dynode No.9
Lead 15 – Dynode No.10
Lead 16 – Anode
Lead 19 – Focusing Electrode



DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 1.68-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010-inch from peak to valley.

Photomultiplier Tube

10-STAGE, HEAD-ON FLAT-FACEPLACE TYPE HAVING VENETIAN-BLIND-TYPE DYNODE STRUCTURE, 1.68-INCH MINIMUM-DIAMETER, FLAT, CIRCULAR, SEMITRANSPARENT PHOTOCATHODE AND S-11 RESPONSE

For Use in Scintillation Counting Applications

The **2063** *is electrically similar to type* **8053** *except for the following performance characteristics and that the anode luminous sensitivity and equivalent noise input ratings shown for the* **8053** *do not apply for type* **2063**.

The 2063 is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base of the 2063 should be removed prior to installing the tube in a given system.

PERFORMANCE CHARACTERISTICS

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No. 1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No. 10 and anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode No. 1 potential (referred to cathode) which will provide maximum anode current.

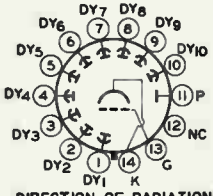
Maximum Anode Dark Current[a]	0.05 μA
Minimum Pulse Height[b]	0.13 V

[a] Measured under the following conditions: Light incident on the photocathode 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 light flux incident on the filter is 10 microlumens. The supply voltage is adjusted to obtain an anode current of 9 μA. Dark current is measured with the light source removed.

[b] Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 ± 5%-kilohm resistor and a total capacitance of 92 ± 3% pF in parallel. An anode-to-cathode voltage of 1130 volts is applied across a voltage divider network having a 1.5 ± 5%—megohm resistor between cathode and dynode No. 1, 450 ± 5%—kilohm resistors between each succeeding stage including dynode No. 10 to anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode No. 1 potential (referred to cathode) which will provide maximum anode current. The 662-keV photon from an isotope of cesium having an atomic mass of 137 (Cs^{137}) and a cylindrical 2 inch x 2 inch thallium-activated sodium-iodide scintillator [NaI(Tl)] type 8D8, or equivalent are used. This scintillator is manufactured by the Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio. The Cs^{137} is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the 2063 by a coupling fluid such as Dow Corning Corp., Type DC200 (Viscosity of 100 centipoise) manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

BASING DIAGRAM (Bottom View) With Base Attached

Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7

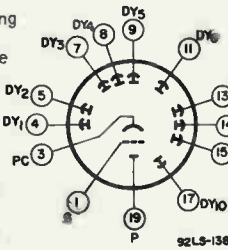


DIRECTION OF RADIATION: INTO END OF BULB

Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Dynode No.10
Pin 11 – Anode
Pin 12 – No Connection
Pin 13 – Focusing Electrode
Pin 14 – Photo-cathode

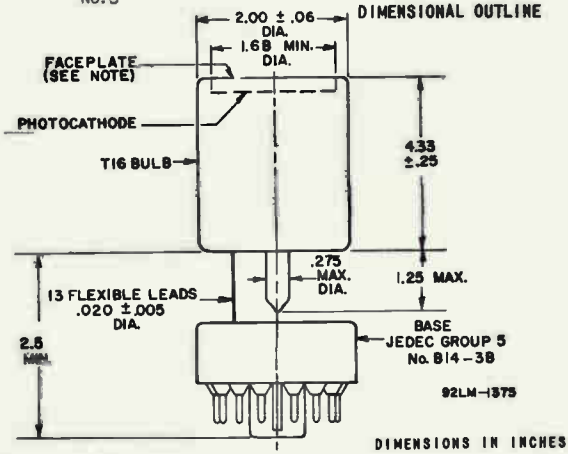
TERMINAL CONNECTIONS (Bottom View) With Base Removed

Lead 1 – Focusing
Lead 3 – Photo-cathode
Lead 4 – Dynode No.1
Lead 5 – Dynode No.2
Lead 7 – Dynode No.3
Lead 8 – Dynode No.4
Lead 9 – Dynode No.5



Lead 11 – Dynode No.6
Lead 13 – Dynode No.7
Lead 14 – Dynode No.8
Lead 15 – Dynode No.9
Lead 17 – Dynode No.10
Lead 19 – Anode

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 1.68-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010 inch from peak to valley.

2064B

Photomultiplier Tube

10-STAGE, HEAD-ON, FLAT-FACEPLACE TYPE HAVING VENETIAN-BLIND-TYPE DYNODE STRUCTURE, 2.59-INCH MINIMUM-DIAMETER, FLAT, CIRCULAR, SEMITRANSPARENT PHOTOCATHODE AND S-11 RESPONSE

For Use in Scintillation Counting Applications

The 2064B is electrically similar to type 8054 except for the following performance characteristics and that the anode luminous sensitivity and equivalent noise input ratings shown for the 8054 do not apply for type 2064B.

The 2064B is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base of the 2064B should be removed prior to installing the tube in a given system.

PERFORMANCE CHARACTERISTICS

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No. 1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No. 10 and anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode-No. 1 potential (referred to cathode) which will provide maximum anode current.

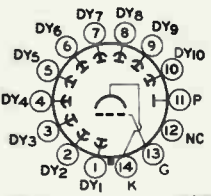
Maximum Anode Dark Current[a]	**0.05 μA**
Minimum Pulse Height[b]	**0.18 V**

[a] Measured under the following conditions: Light incident on the photocathode 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 light flux incident on the filter is 10 microlumens. The supply voltage is adjusted to obtain an anode current of 9 μA. Dark current is measured with the light source removed.

[b] Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 ± 5%-kilohm resistor and a total capacitance of 92 ± 3% pF in parallel. An anode-to-cathode voltage of 1130 volts is applied across a voltage-divider network having a 1.5 ± 5%-megohm resistor between cathode and dynode No. 1, 450 ± 5%-kilohm resistors between each succeeding stage including dynode No. 10 to anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode No. 1 potential (referred to cathode) which will provide maximum anode current. The 662-KeV photon from an isotope of cesium having an atomic mass of 137 (Cs^{137}) and a cylindrical 3 inch x 3 inch thallium-activated sodium-iodide scintillator [NaI(Tl)] type 12A12, or equivalent are used. This scintillator is manufactured by the Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio. The Cs^{137} is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the 2064B by a coupling fluid such as Dow Corning Corp., Type DC200 (Viscosity of 100 centipoise) manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

BASING DIAGRAM (Bottom View)
With Base Attached

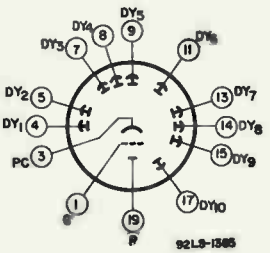
Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7
Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Dynode No.10
Pin 11 – Anode
Pin 12 – No Connection
Pin 13 – Focusing Electrode
Pin 14 – Photocathode



DIRECTION OF RADIATION:
INTO END OF BULB

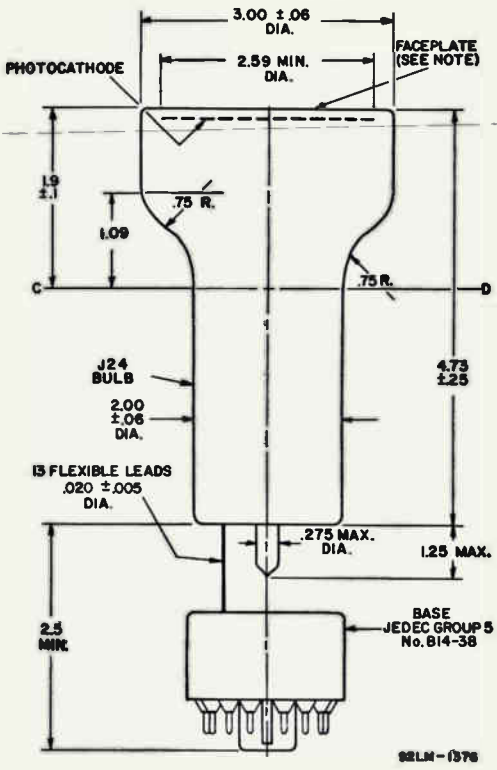
TERMINAL CONNECTIONS (Bottom View)
With base Removed

Lead 1 – Focusing Electrode
Lead 3 – Photocathode
Lead 4 – Dynode No.1
Lead 5 – Dynode No.2
Lead 7 – Dynode No.3
Lead 8 – Dynode No.4
Lead 9 – Dynode No.5
Lead 11 – Dynode No.6
Lead 13 – Dynode No.7
Lead 14 – Dynode No.8
Lead 15 – Dynode No.9
Lead 17 – Dynode No.10
Lead 19 – Anode



RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 2.59-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010 inch from peak to valley.

Photomultiplier Tube

10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE HAVING VENETIAN-BLIND-TYPE DYNODE STRUCTURE, 4.38-INCH MINIMUM DIAMETER, FLAT, CIRCULAR, SEMITRANSPARENT PHOTOCATHODE AND S-11 RESPONSE

For Use in Scintillation Counting Applications

The 2065 is electrically similar to type 8055 except for the following performance characteristics and that the anode luminous sensitivity and equivalent noise input ratings shown for the 8055 do not apply for type 2065.

The 2065 is supplied with a medium-shell diheptal base attached to flexible leads to facilitate testing. After testing, the attached base of the 2065 should be removed prior to installing the tube in a given system.

PERFORMANCE CHARACTERISTICS

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No. 1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No. 10 and anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode-No. 1 potential (referred to cathode) which will provide maximum anode current.

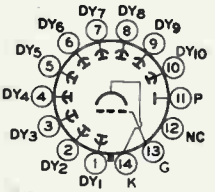
Maximum Anode Dark Current[a]	0.05 μA
Minimum Pulse Height[b]	0.13 V

[a] Measured under the following conditions: Light incident on the photocathode 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 light flux incident on the filter is 10 microlumens. The supply voltage is adjusted to obtain an anode current of 9 μA. Dark current is measured with the light source removed.

[b] Pulse height is defined as the amplitude of the anode pulse voltage (referred to anode) measured across a 100 ± 5%-kilohm resistor and a total capacitance of 92 ± 3% pF in parallel. An anode-to-cathode voltage of 1130 volts is applied across a voltage-divider network having a 1.5 ± 5%-megohm resistor between cathode and dynode No. 1, 450 ± 5%-kilohm resistors between each succeeding stage including dynode No. 10 to anode. The focusing electrode is adjusted to that value between 50% and 100% of dynode No. 1 potential (referred to cathode) which will provide maximum anode current. The 662-KeV photon from an isotope of cesium having an atomic mass of 137 (Cs^{137}) and a cylindrical 3 inch x 3 inch thallium-activated sodium-iodide scintillator [NaI(Tl)] type 12A12, or equivalent are used. This scintillator is manufactured by Harshaw Chemical Corporation, 1945 East 97th Street, Cleveland 6, Ohio. The Cs^{137} is in direct contact with the metal end of the scintillator. The faceplate end of the crystal is coupled to the 2065 by a coupling fluid such as Dow Corning Corp., Type DC200 (Viscosity of 100 centipoise) manufactured by the Dow Corning Corp., Midland, Michigan, or equivalent.

BASING DIAGRAM (Bottom View)
With Base Attached

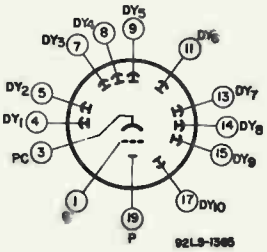
Pin 1 – Dynode No. 1
Pin 2 – Dynode No. 2
Pin 3 – Dynode No. 3
Pin 4 – Dynode No. 4
Pin 5 – Dynode No. 5
Pin 6 – Dynode No. 6
Pin 7 – Dynode No. 7
Pin 8 – Dynode No. 8
Pin 9 – Dynode No. 9
Pin 10 – Dynode No. 10
Pin 11 – Anode
Pin 12 – No Connection
Pin 13 – Focusing Electrode
Pin 14 – Photocathode



DIRECTION OF RADIATION:
INTO END OF BULB

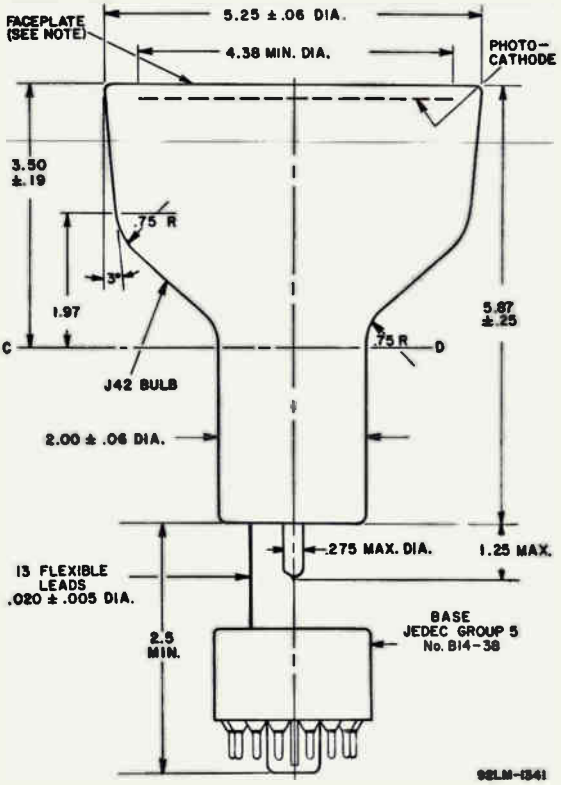
TERMINAL CONNECTIONS (Bottom View)
With Base Removed

Lead 1 – Focusing Electrode
Lead 3 – Photocathode
Lead 4 – Dynode No. 1
Lead 5 – Dynode No. 2
Lead 7 – Dynode No. 3
Lead 8 – Dynode No. 4
Lead 9 – Dynode No. 5
Lead 11 – Dynode No. 6
Lead 13 – Dynode No. 7
Lead 14 – Dynode No. 8
Lead 15 – Dynode No. 9
Lead 17 – Dynode No. 10
Lead 19 – Anode



RADIO CORPORATION OF AMERICA
Electronic Components and Devices Harrison, N. J.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Note: Within 4.38-inch diameter, deviation from flatness of external surface of faceplate will not exceed 0.010 inch from peak to valley.

Photomultiplier Tubes

Sturdy, 10-Stage, S-11, Head-On Types for Use Under Adverse Environmental Conditions

The 4439 differs from the 4438 in that it is supplied with a small-shell duodecal base attached to semi-flexible leads to facilitate testing prior to installation. After testing, the attached base should be removed.

GENERAL

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 Å
Cathode, Semitransparent	Cesium-Antimony
Minimum area	1.2 in^2 (7.7 cm^2)
Minimum diameter	1.24 in (3.1 cm)
Window	Corning[a] No.0080, or equivalent
Shape	Plane-Plano
Index of refraction at 4360 angstroms	1.523
Dynodes:	
Substrate	Nickel
Secondary-Emitting Surface	Cesium-Antimony
Structure	Circular-Cage Electrostatic-Focus Type
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4 pF
Anode to all other electrodes	5.5 pF
Maximum Overall Length (Excluding Semiflexible Leads)	3.91 in (9.9 cm)
Maximum Diameter	1.56 in (3.9 cm)
Bulb	T-12
Base (Temporary for 4439 only)	Small-Shell Duodecal 12-Pin (JEDEC No.B12-43), Non-hygroscopic
Socket	Eby[b] No.9058, or equivalent
Magnetic Shield	See footnote c
Operating Position	Any
Weight (Approx.)	2 oz

MAXIMUM RATINGS, *Absolute-Maximum Values:*

DC Supply Voltage:		
Between anode and cathode	1250 max.	V
Between anode and dynode No.10	250 max.	V
Between consecutive dynodes	200 max.	V
Between dynode No.1 and cathode	300 max.	V

Average Anode Current[e]	0.75 max. mA
Ambient Temperature[f]	75 max. °C

CHARACTERISTICS RANGE VALUES

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

With E = 1000 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant[g] at 4400 angstroms	–	2.2×10^{4}	–	A/W
Luminous[h]	10	27	300	A/lm
Cathode Sensitivity:				
Radiant[i] at 4400 angstroms	–	3.6×10^{-2}	–	A/W
Luminous[k]	3×10^{-5}	4.5×10^{-5}	–	A/lm
With blue light[m]	2.8×10^{-8}	–	–	A
Quantum Efficiency at 4200 angstroms	–	10.5	–	%
Current Amplification	–	6×10^{5}	–	
Anode Dark Current[n]	–	1.6×10^{-8}	5×10^{-8}	A
Equivalent Anode Dark Current Input[n]	–	8×10^{-10}	2.5×10^{-9}	lm
	–	1×10^{-12}[p]	–	W
Equivalent Noise Input[q]	–	6.5×10^{-12}	–	lm
Anode-Pulse Rise Time[r,s] at 1250 V.	–	2.5×10^{-9}	–	s
Electron Transit Time[r,t] at 1250 V.	–	2.9×10^{-8}	–	s

[a] Made by Corning Glass Works, Corning, New York 14830.

[b] Made by Hugh H. Eby Company, 4701 Germantown Avenue, Philadelphia, Pa. 19144.

[c] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1322 N. Elston Avenue, Chicago, Ill., 60622, or equivalent.

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

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

→ *Indicates additions or changes.*

[g] This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 804 lumens per watt.

[h] 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 10 microlumens is used.

[i] This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 804 lumens per watt.

[k] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[m] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[n] At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 20 amperes per lumen.

[p] At 4400 angstroms. This value is calculated from the EADCI value in lumens using a conversion factor of 804 lumens per watt.

[q] Under the following conditions: Tube temperature 22° C, external shield connected to cathode, bandwidth 1 Hz, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[r] Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

[s] 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.

[t] 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.

Table I

Typical Potential Distribution

Between	8.13% of Supply Voltage (E) multiplied by
Cathode and Dynode No.1	1.7
Dynode No.1 and Dynode No.2	1.3
Dynode No.2 and Dynode No.3	1.3
Dynode No.3 and Dynode No.4	1.0
Dynode No.4 and Dynode No.5	1.0
Dynode No.5 and Dynode No.6	1.0
Dynode No.6 and Dynode No.7	1.0
Dynode No.7 and Dynode No.8	1.0
Dynode No.8 and Dynode No.9	1.0
Dynode No.9 and Dynode No.10	1.0
Dynode No.10 and Anode	1.0
Anode and Cathode	12.3

OPERATING CONSIDERATIONS

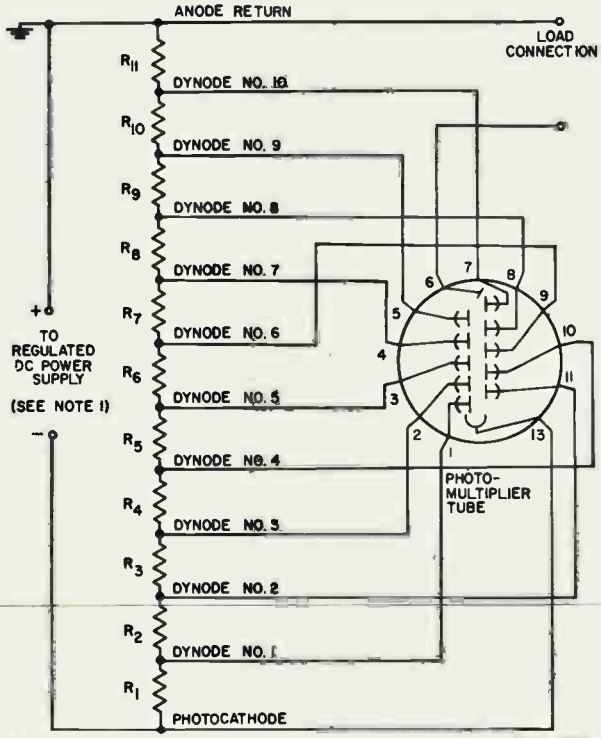
SHIELDING:

Electrostatic shielding of these tubes is ordinarily required. When a shield is used, it must be connected to the cathode terminal. The application of high voltage, with respect to cathode, to insulating or other materials supporting or shielding these tubes at the photocathode end of the tubes should not be permitted unless such materials are chosen to limit leakage current to the tube envelope to 1×10^{-12} ampere or less.

HIGH VOLTAGE WARNING:

The high voltages at which these tubes are operated are very dangerous. Before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

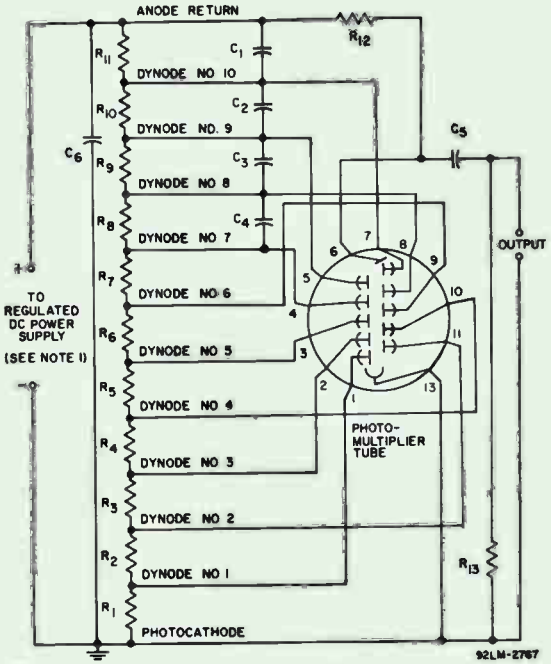
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT WHICH PERMITS DIRECT COUPLING TO THE ANODE



R_1: 680,000 ohms, 5%, 1/2 watt
R_2 and R_3: 510,000 ohms, 5%, 1/2 watt
R_4 through R_{11}: 390,000 ohms, 5%, 1/2 watt

Note 1: Adjustable between approximately 500 and 1250 volts dc.

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT FOR USE IN SCINTILLATION-COUNTING APPLICATIONS



C_1: 0.05 μF, 20%, 500 volts, ceramic disc
C_2: 0.02 μF, 20%, 500 volts, ceramic disc
C_3: 0.01 μF, 20%, 500 volts, ceramic disc
C_4: 0.005 μF, 20%, 500 volts, ceramic disc
C_5 and C_6: 0.005 μF, 20%, 3000 volts, ceramic disc
R_1: 680,000 ohms, 5%, 1/2 watt
R_2 and R_3: 510,000 ohms, 5%, 1/2 watt
R_4 through R_{11}: 390,000 ohms, 5%, 1/2 watt
R_{12}: 1 megohm, 5%, 1/2 watt
R_{13}: 100,000 ohms, 5%, 1/2 watt

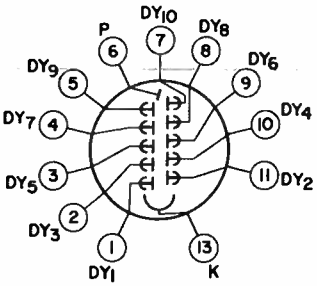
Note 1: Adjustable between approximately 500 and 1250 volts dc.

Note 2: Capacitors C_1 through C_6 should be connected at tube socket for optimum high-frequency performance.

LEAD CONNECTIONS

Bottom View

(With Base Removed)



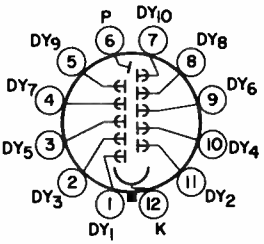
DIRECTION OF LIGHT:
INTO END OF BULB

Lead 1: Dynode No.1
Lead 2: Dynode No.3
Lead 3: Dynode No.5
Lead 4: Dynode No.7
Lead 5: Dynode No.9
Lead 6: Anode
Lead 7: Dynode No.10
Lead 8: Dynode No.8
Lead 9: Dynode No.6
Lead 10: Dynode No.4
Lead 11: Dynode No.2
Lead 13: Photocathode

TERMINAL DIAGRAM

Bottom View

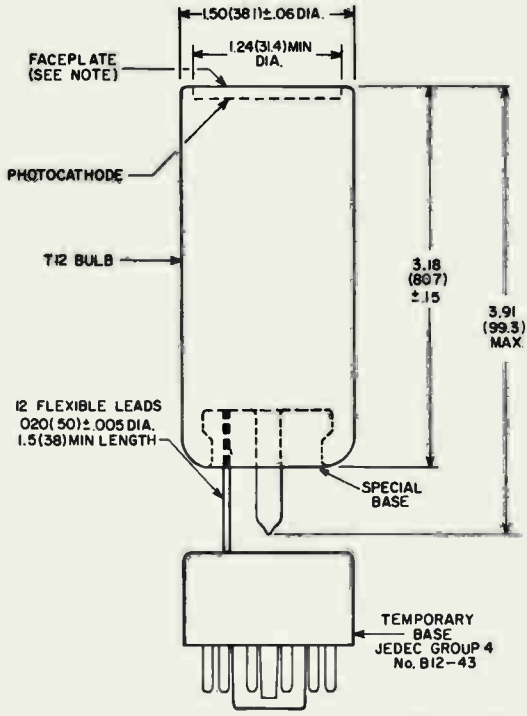
(With Temporary Base)



DIRECTION OF LIGHT:
INTO END OF BULB

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: Anode
Pin 7: Dynode No.10
Pin 8: Dynode No.8
Pin 9: Dynode No.6
Pin 10: Dynode No.4
Pin 11: Dynode No.2
Pin 12: Photocathode

DIMENSIONAL OUTLINE

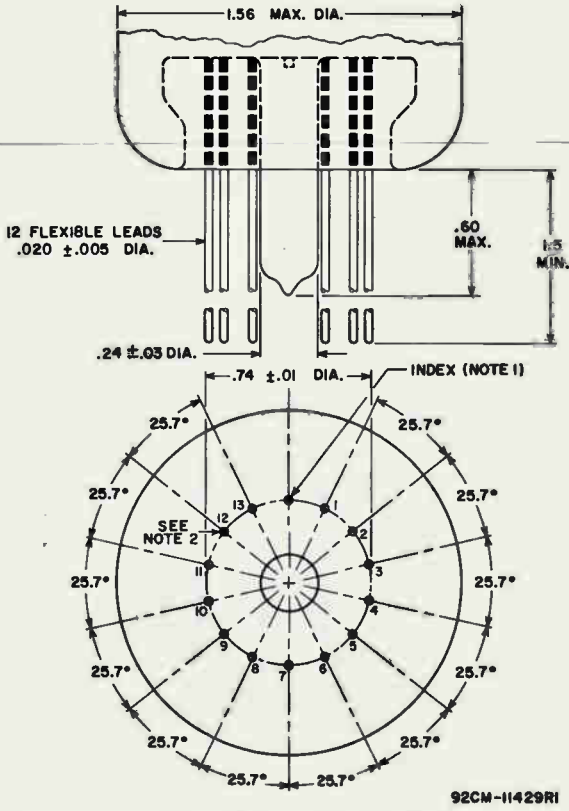


Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Note: Within 1.24" diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

Note: Type 4438 is supplied without temporary B12-43 base.

DETAIL OF BASE STEM

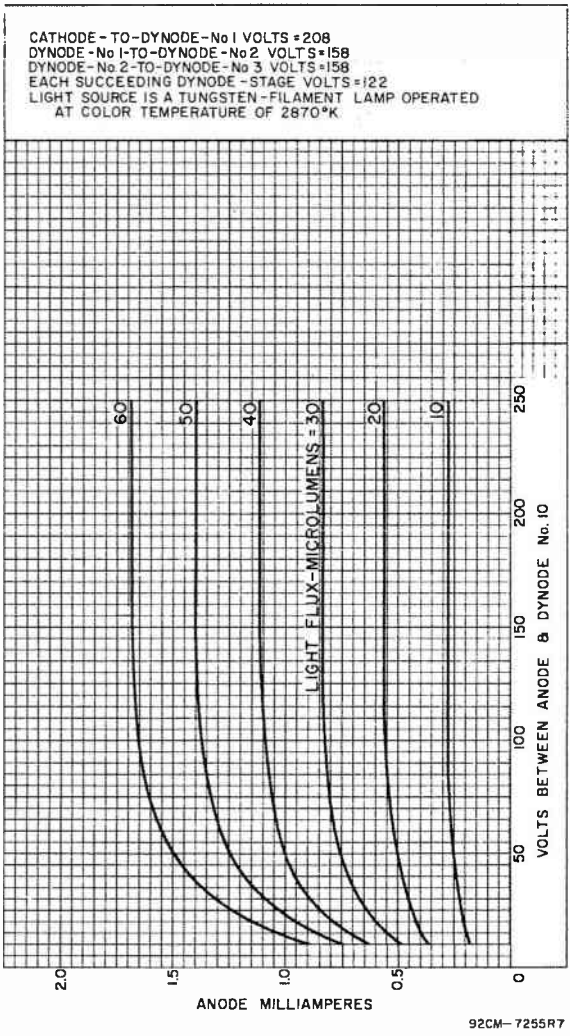


Note 1: Lead is cut off within 0.04 inch of the glass button for indexing.

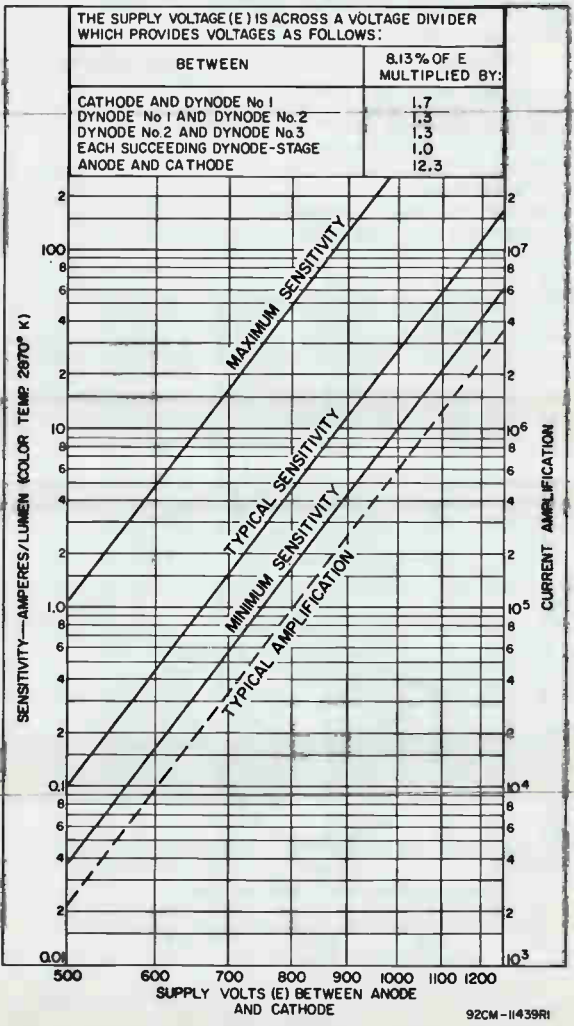
Note 2: Lead No.12 is cut off within 0.04 inch of the glass button.

See Spectral Energy Distribution Curve at Front of this Section.

TYPICAL ANODE CHARACTERISTICS



TYPICAL SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS



TYPICAL DARK CURRENT AND EADCI CHARACTERISTICS

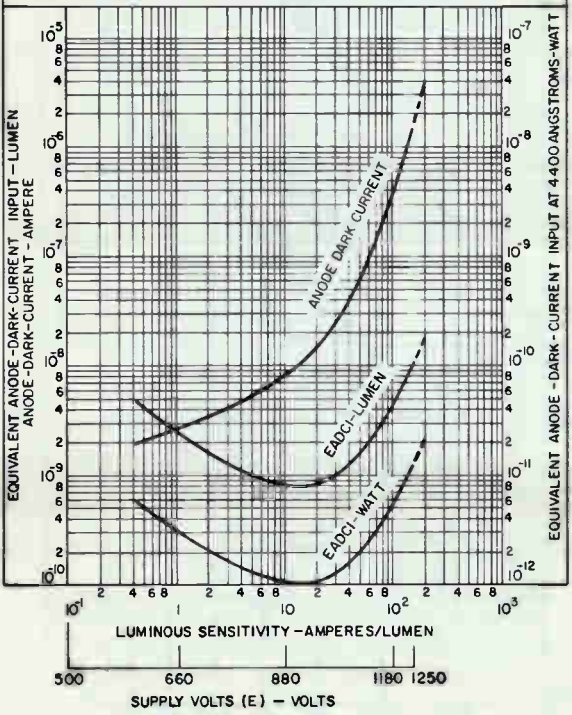
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN:	813% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	1.7
DYNODE No 1 AND DYNODE No. 2	1.3
DYNODE No. 2 AND DYNODE No. 3	1.3
EACH SUCCEEDING DYNODE-STAGE	1.0
ANODE AND CATHODE	12.3

TUBE TEMPERATURE =22°C

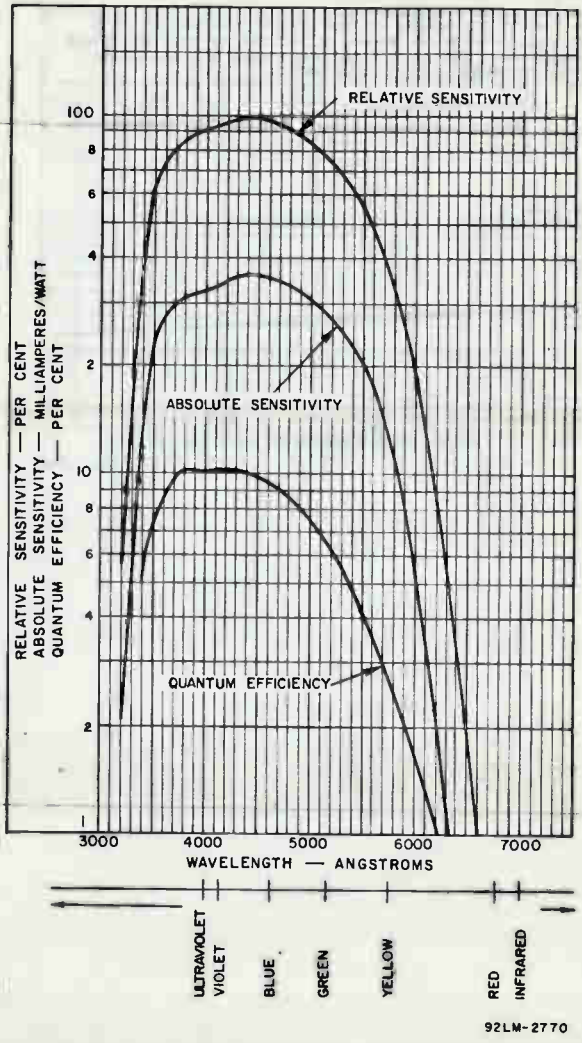
DASHED PORTION INDICATES INSTABILITY

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



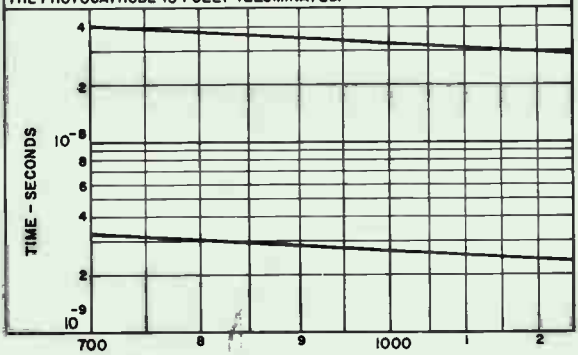
92LM-2769

TYPICAL SPECTRAL RESPONSE CHARACTERISTICS



TYPICAL TIME RESOLUTION CHARACTERISTICS

SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/6 OF E BETWEEN CATHODE AND DYNODE No.1; 1/12 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/12 OF E BETWEEN DYNODE No. 10 AND ANODE. THE PHOTOCATHODE IS FULLY ILLUMINATED.



92LS-2768

Multiplier Phototube

S-11 RESPONSE
"RUGGEDIZED", 10-STAGE, HEAD-ON, ELECTROSTATICALLY FOCUSED FLAT-FACEPLATE TYPE DYNODE STAGES

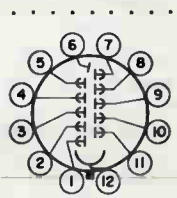
For Detection and Measurement of Nuclear Radiation and Other Low-Level Light Sources in Industrial, Military, and Missile Applications

DATA

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Shape	Flat, Circular
Minimum Area	1.2 sq. in.
Minimum diameter	1.24"
Window	Lime Glass (Corning[a] No.0080), or equivalent
Index of refraction	1.51
Dynode Material	Cesium-Antimony
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	4 pf
Anode to all other electrodes	7 pf
Maximum Overall Length	4.12"
Seated Length	3.80" ± 0.12"
Maximum Diameter	1.56"
Operating Position	Any
Weight (Approx.)	2.2 oz
Bulb	T12
Socket	Amphenol[b] No.59-402, or equivalent
Magnetic Shield	Millen[c] No.80802C, or equivalent
Base	Ultrashort Small-Shell Duodecal 12-Pin, (JEDEC Group 4, No.B12-186), Non-hygroscopic
Basing Designation for BOTTOM VIEW	12AE

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 – Anode
Pin 7 – Dynode No.10
Pin 8 – Dynode No.8
Pin 9 – Dynode No.6
Pin 10 – Dynode No.4
Pin 11 – Dynode No.2
Pin 12 – Photocathode



DIRECTION OF RADIATION: INTO END OF BULB

Maximum Ratings, *Absolute-Maximum Values:*

DC SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE	1250 max.	volts
DC SUPPLY VOLTAGE BETWEEN DYNODE No.10 AND ANODE	250 max.	volts
DC SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES	200 max.	volts

DC SUPPLY VOLTAGE BETWEEN DYNODE No.1 AND CATHODE	300 max.	volts
AVERAGE ANODE CURRENT[d]	0.75 max.	ma
AMBIENT TEMPERATURE	75 max.	°C

Characteristics Range Values for Equipment Design:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

With E = 1000 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms. . . .	–	2.2×10^{4}	–	a/w
Cathode radiant, at 4400 angstroms. . . .	–	0.036	–	a/w
Luminous:				
At 0 cps[e]. . . .	10	27	300	a/lm
With dynode No.10 as output electrode[f] . .	–	16	–	a/lm
Cathode luminous:				
With tungsten light source[g].	3×10^{-5}	4.5×10^{-5}	–	a/lm
With blue light source[h,n]. . .	2.8×10^{-8}	–	–	a
Current Amplification	–	6×10^{-5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 20 a/lm[j,k] . . .	–	8×10^{-10}	2.5×10^{-9}	lm
Equivalent noise Input[m]	–	4×10^{-12}	1.7×10^{-11}	lm
Dark Current to Any Electrode Except Anode at 25° C . .	–	–	7.5×10^{-7}	a

With E = 750 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms. . . .	–	2.2×10^{3}	–	a/w
Cathode radiant, at 4400 angstroms. . . .	–	0.036	–	a/w
Luminous:				
At 0 cps[e]. . . .	–	2.7	–	a/lm
With dynode No.10 as output electrode[f] . .	–	1.6	–	a/lm

	Min.	Typ.	Max.	
Cathode luminous:				
With tungsten light source[g]	3×10^{-5}	4.5×10^{-5}	—	a/lm
With blue light source[h,n]	2.8×10^{-8}	—	—	a
Current Amplification	—	6×10^{4}	—	

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

[b] Made by Amphenol Electronics Corporation, 1830 South 54th Avenue, Chicago 50, Illinois.

[c] Made by James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Massachusetts.

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

[e] 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 10 microlumens is used.

[f] An output current of opposite polarity to that obtained at the anode may be provided by using dynode No.10 as the output electrode. With this arrangement, the load is connected in the dynode-No.10 circuit and the anode serves only as collector. The curves shown in the accompanying *Typical Anode Characteristics* curve do not apply when dynode No.10 is used as the output electrode.

[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 0.01 lumen and 200 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, Glass Code No.5113 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

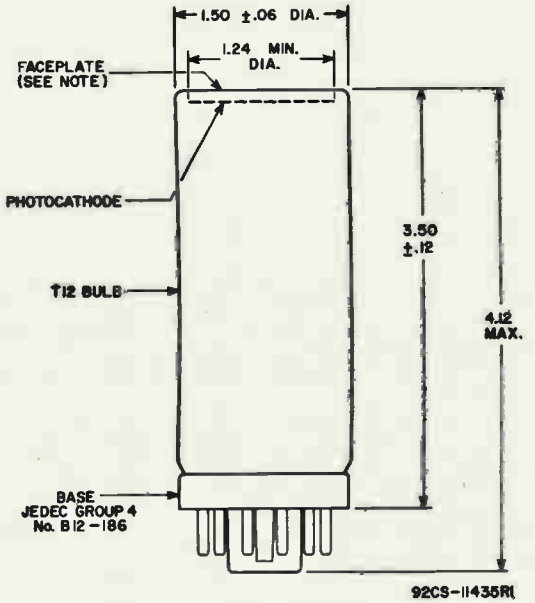
[j] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[k] For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1000 volts is recommended.

[m] Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[n] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

SPECTRAL-SENSITIVITY CHARACTERISTIC of PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE is shown at the front of this Section

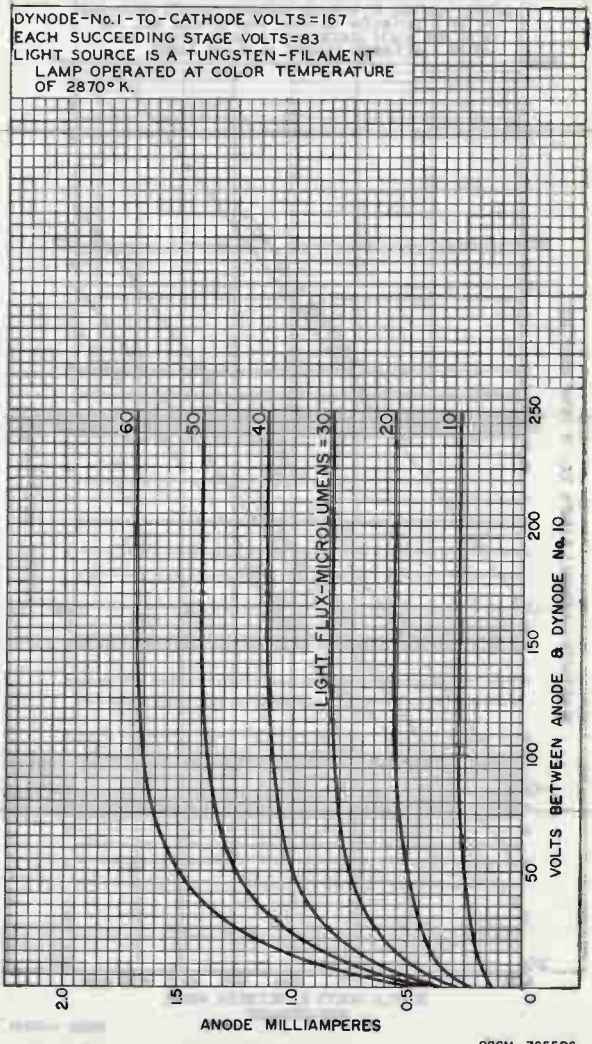


DIMENSIONS IN INCHES

CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

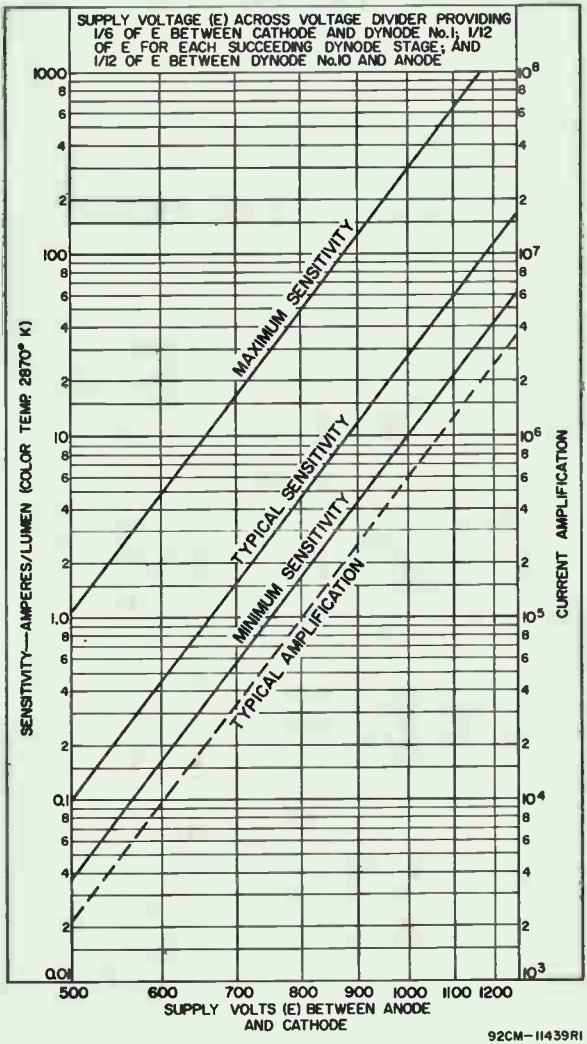
NOTE: WITHIN 1.24 INCH DIAMETER, DEVIATION FROM FLATNESS OF EXTERNAL SURFACE OF FACEPLATE WILL NOT EXCEED 0.010 INCH FROM PEAK TO VALLEY.

TYPICAL ANODE CHARACTERISTICS



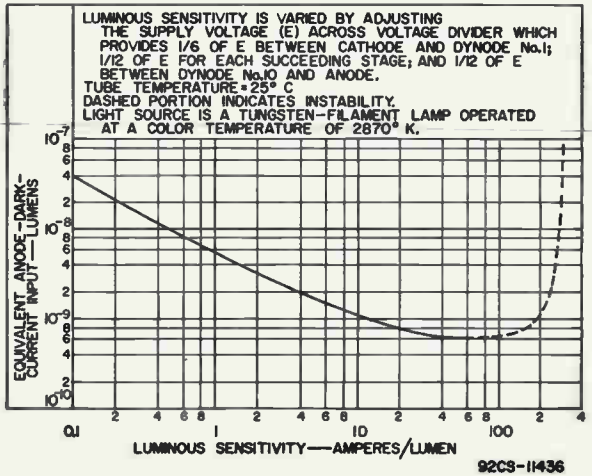
92CM-7255R6

TYPICAL CHARACTERISTICS



92CM-11439R1

TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC



Multiplier Phototube

S-11 RESPONSE
"RUGGEDIZED", 10-STAGE, HEAD-ON, ELECTROSTATICALLY FOCUSED
FLAT-FACEPLATE TYPE DYNODE STAGES

For Detection and Measurement of Nuclear Radiation and Other Low-Level Light Sources in Industrial, Military, and Missile Applications

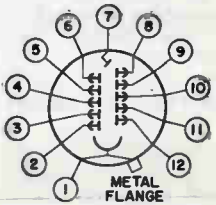
DATA

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Shape	Flat, Circular
Minimum area	1.2 sq. in.
Minimum diameter	1.24"
Window	Lime Glass (Corning® No.0080), or equivalent
Index of refraction	1.51
Dynode Material	Cesium-Antimony
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No. 10	3.2 pf
Anode to all other electrodes	5.0 pf
Maximum Overall Length (Excluding flexible leads)	3.18"
Maximum Diameter	1.56"
Operating Position	Any
Weight (Approx.)	3 oz
Bulb	T12
Magnetic Shield	b
Base	Special

Terminal Diagram: BOTTOM VIEW

Lead 1 & Metal Flange—Photocathode
Lead 2—Dynode No.1
Lead 3—Dynode No.3
Lead 4—Dynode No.5
Lead 5—Dynode No.7
Lead 6—Dynode No.9
Lead 7—Anode
Lead 8—Dynode No.10
Lead 9—Dynode No.8
Lead 10—Dynode No.6
Lead 11—Dynode No.4
Lead 12—Dynode No.2



DIRECTION OF RADIATION: INTO END OF BULB

Maximum Ratings, ***Absolute-Maximum Values:***

DC SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE	1250 max.	volts
DC SUPPLY VOLTAGE BETWEEN DYNODE No.10 AND ANODE	250 max.	volts
DC SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES	200 max.	volts

DC SUPPLY VOLTAGE BETWEEN DYNODE NO.1 AND CATHODE	300 max.	volts
AVERAGE ANODE CURRENT[c]	0.75 max.	ma.
AMBIENT TEMPERATURE	75 max.	°C

Characteristic Range Values for Equipment Design:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode.

With E = 1000 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms	–	2.2×10^4	–	a/w
Cathode radiant, at 4400 angstroms	–	0.036	–	a/w
Luminous:				
At 0 cps[d]	10	27	300	a/lm
With dynode No.10 as output electrode[e]	–	16	–	a/lm
Cathode luminous:				
With tungsten light source[f]	3×10^{-5}	4.5×10^{-5}	–	a/lm
With blue light source[g,m]	2.8×10^{-8}	–	–	a
Current Amplification	–	6×10^5	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 20 a/lm: [h,j]	–	8×10^{-10}	2.5×10^{-9}	lm
Equivalent Noise Input[k]	–	4×10^{-12}	1.7×10^{-11}	lm
Dark Current to Any Electrode Except Anode at 25° C	–	–	7.5×10^{-7}	a

With E = 750 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms	–	2.2×10^3	–	a/w
Cathode radiant, at 4400 angstroms	–	0.036	–	a/w
Luminous:				
At 0 cps[d]	–	2.7	–	a/lm
With dynode No.10 as output electrode[e]	–	1.6	–	a/lm
Cathode luminous:				
With tungsten light source[f]	3×10^{-5}	4.5×10^{-5}	–	a/lm
With blue light source[g,m]	2.8×10^{-8}	–	–	a
Current Amplification	–	6×10^4	–	

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

[b] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1829 Civic Opera Building, 20 North Wacker Drive, Chicago 6, Illinois, or equivalent.

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

[d] 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 10 microlumens is used.

[e] An output current of opposite polarity to that obtained at the anode may be provided by using dynode No.10 as the output electrode. With this arrangement, the load is connected in the dynode No.10 circuit and the anode serves only as collector. The curves shown in the accompanying *Typical Anode Characteristics* curve do not apply when dynode No.10 is used as the output electrode.

[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. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[g] Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning C.S. No.5-58, Glass Code No.5113 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

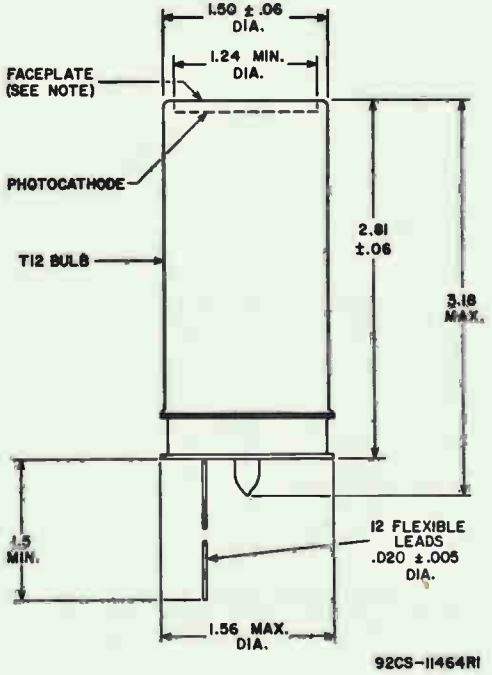
[h] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[j] For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1000 volts is recommended.

[k] Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[a] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this section.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE is shown at the front of this Section

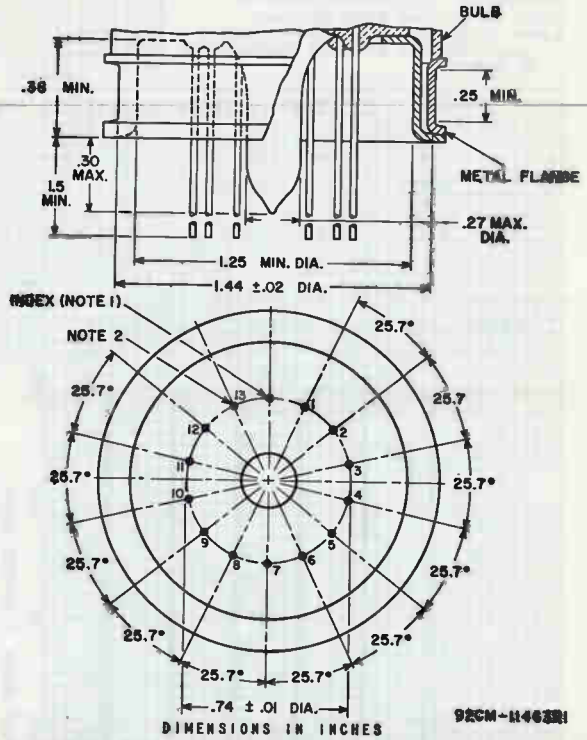


DIMENSIONS IN INCHES

CENTER LINE OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE FLANGE.

NOTE: DEVIATION FROM FLATNESS WITHIN THE 1.24 INCH DIAMETER AREA WILL NOT EXCEED 0.010 INCH FROM PEAK TO VALLEY.

SPECIAL BASE
Pin Dimensions and Orientation and Index Guide



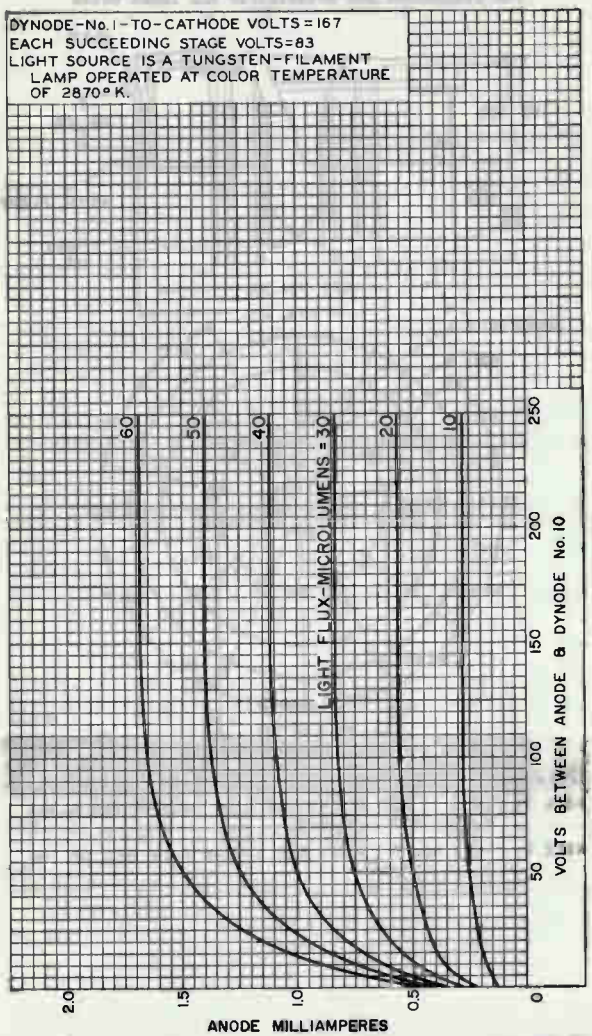
DIMENSIONS IN INCHES

12-Lead Base 1,2,3,4,5,6,7,8,9,10,11,12

NOTE 1: LEAD IS CUT OFF WITHIN 0.04 INCH OF THE GLASS BUTTON FOR INDEXING.

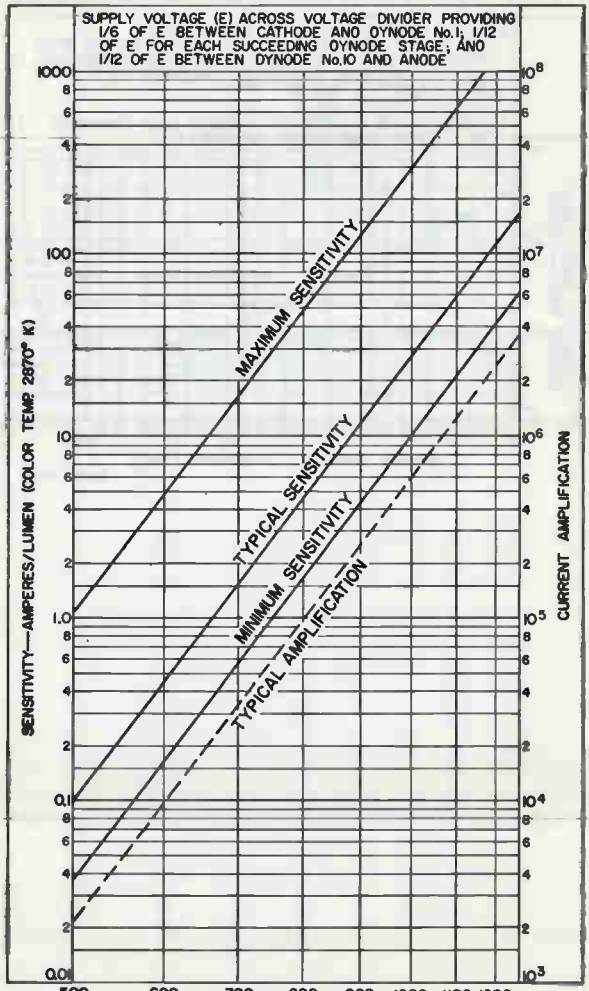
NOTE 2: LEAD NO. 13 IS CUT OFF WITHIN 0.06 INCH OF THE GLASS BUTTON.

TYPICAL ANODE CHARACTERISTICS



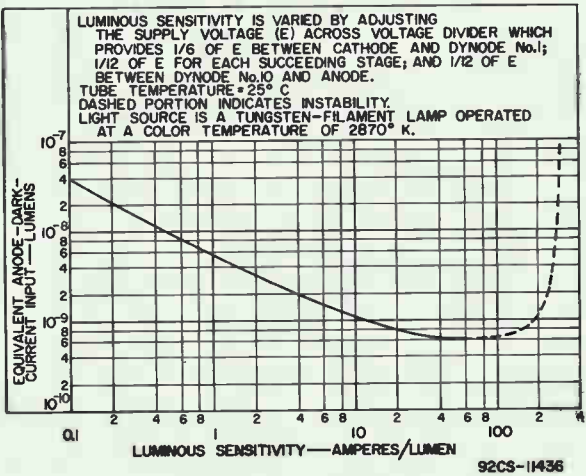
92CM-7255R6

TYPICAL CHARACTERISTICS



92CM-11439RI

TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC



Multiplier Phototube

RUGGED VIBRATION-RESISTANT STRUCTURE
S-11 RESPONSE **ELECTROSTATICALLY FOCUSED**
10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE **DYNODE STAGES**

For Detection and Measurement of Nuclear Radiation and other Low-Level Light Sources. Especially Useful in Missile and Rocket Service and other Industrial and Military Applications where Severe Environmental Conditions may be Encountered.

The 4441A is the same as the 4441 except for the following:

Characteristics Range Values for Equipment Design:

With E = 1000 volts

	Min.	Typ.	Max.	
Anode-Pulse Rise Time[a]	–	2.8×10^{-9}	–	sec.
With E = 750 volts				
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 20 a/lm[b,c]	–	8×10^{-10}	2.5×10^{-9}	lm

ENVIRONMENTAL TESTS:

The 4441A is designed to withstand environmental tests equivalent to those specified in MIL-E-5272C* for equipment mounted on the structures of missiles propelled or launched by high-thrust rocket engines. The accelerations specified in these tests are applied directly to the tubes.

One-Hundred Per-Cent Shock and Vibration Testing:

Shock. These tests are performed first, per method of MIL-E-5272C*, Par.4.15.5.1, Proc.V, on apparatus which provides a half-wave sinusoidal shock pulse. One-hundred per-cent testing of all 4441A's is performed. Each 4441A (non-operating) is subjected to three impact shocks in each direction of the three orthogonal axes. Each impact shock has a peak acceleration of 30 ± 3 g's and a time duration of 11 ± 1 milliseconds. Each tube is subjected to a total of 18 impact shocks.

Vibration. These tests are performed next, on apparatus which applies a variable-sinusoidal frequency vibration to the tube in accordance with MIL-E-5272C*, par.4.7.14 and par.4.7.14.1, except for the cycle duration. This test is performed on all 4441A tube types. Each 4441A (Operating under the conditions specified under *Tube Rejection Criterion*) is vibrated in each of the three orthogonal axes and as specified in the following schedule. A vibration cycle has a duration of 5 minutes per axis in which time the frequency is varied logarithmically from 20 to 2000 and back to 20 cycles per second. One vibration cycle is performed for each axis and the total test period for each tube is 15 minutes.

Double Amplitude inches	Acceleration g's	Frequency cps	Cycle Duration Per Axis minutes
0.050 ± 0.005	–	20–87	5
–	20	87–2000	
–	20	2000–87	
0.050 ± 0.005	–	87–20	

Tube Rejection Criterion. After completion of the shock tests, tubes are operated at an anode-to-cathode voltage of 1000 volts with the light level incident on the tube adjusted to provide an anode current of 8 microamperes. Electrical and/or mechanical tube failures due to shock or vibration are observed during the vibration test when the specified anode current is monitored. Tube rejection criterion for both tests is that the anode current of 8 microamperes will not change more than ± 20 per cent at any time during the vibration test for each axis.

Design Tests:

Vibration. These tests are performed under conditions equivalent to those described in MIL-E-5272C*, par.4.7.14 and par.4.7.14.1. The vibration cycle has a duration of one hour and two cycles are performed for each of the three orthogonal axes. The total test period for each tube is six hours.

Acceleration. These tests are performed in a centrifuge providing unidirectional acceleration by a method equivalent to that specified in MIL-E-5272C*, par.4.16.3, Proc.III except that tubes are subjected for one minute to an increased acceleration test level of 100 ± 10 g's in both directions of the three orthogonal axes and the tubes are non-operating.

* Military Specification MIL-E-5272C (ASG), 13 April 1959; and Amendment 1, 5 January 1960.

4445

Vidicon

SpectraPlex Type for Single-Tube Color Cameras

- Integral Dichroic Filter Stripes Optically Encode Color Information
- Signal Can Be NTSC (or PAL) Encoded
- Requires Only Moderate Studio Lighting—100 lumens/foot^2 (fc)
- Produces Fully Compatible Video for Black-and-White Monitors
- Familiar Vidicon Structure — Magnetic Focus and Deflection

General Data

Electrical:

Heater Voltage	6.3 ± 5% V
Heater Current at 6.3 Volts, ac or dc	0.6 nominal A
Focusing Method	Magnetic
Deflection Method	Magnetic

Direct Interelectrode Capacitance:[a]

Target to all other electrodes	4.6 pF

Optical:

Outer faceplate glass is Corning code 7056 having a thickness of 0.094" ± 0.012".

Inner faceplate	Dark-Clad Fiber Optics
Photoconductor	Antimony Trisulfide

Orientation of quality rectangle — Proper orientation is obtained when the horizontal scan is essentially parallel to the plane passing through the tube axis and short index pin.

Maximum Useful Diagonal of Image	0.625 in (16 mm)

Mechanical:

Maximum Length	6.475 in (164.5 mm)
Maximum Diameter	1.135 in (28.83 mm)
Bulb	T8
Base	Small-Button Ditetrar 8-Pin (JEDEC No.EB-11)
Socket	Cinch[b] No.8VT (133-98-11-015), or equivalent
Deflecting Yoke — Focusing Coil — Alignment Coil — Assembly	Cleveland Electronics[c,d] No.VDA-945, or equivalent
Operating Position	Any
Weight (Approx.)	2 oz

Maximum and Minimum Ratings, Absolute-Maximum Values:[e]

For scanned area of 1/2" x 3/8" (12.7 mm x 9.5 mm)

	Min.	Max.	
Grid-No.4 Voltage[f]	–	1000	V
Grid-No.4 and Grid-No.3 Voltage Difference	–	600	V
Grid-No.3 Voltage[f]	–	1000	V
Grid-No.2 Voltage	–	350	V
Grid-No.2 Power Dissipation	–	1	W
Grid-No.1 Voltage	−150	0	V
Heater-Cathode Voltage	−125	10	V
Heater-Voltage Tolerance	–	5	%
Target Voltage	–	70	V
Dark Current	–	0.25	μA
Peak Target Current[g]	–	0.75	μA
Faceplate:			
Illumination[h]	–	1000 / 10,000	lm/ft^2 / lux
Temperature:			
Operating and storage	–	71	°C

Typical Operation and Performance Data:

For scanned area of 1/2" x 3/8" –
Faceplate temperature of 30° ± 3° C and standard TV scanning Rate

Grid-No.4 (Decelerator) Voltage[f]	900	V
Grid-No.3 (Beam-Focus Electrode) Voltage[f]	540	V
Grid-No.2 (Accelerator) Voltage	300	V
Grid-No.1 Voltage for Picture Cutoff[i]	−65 to −100	V
Average "Gamma" of Transfer Characteristic for Signal-Output Current Between 30 nA and 300 nA	0.65	
Lag–Per Cent of Initial Value of Signal-Output Current 1/20 Second After Illumination is Removed[k]	25	%
Peak-to-Peak Blanking Voltage:		
When applied to grid No.1	75	V
When applied to cathode	20	V

Field Strength at Center of Focusing Coil[m]	60 ± 5	G
Field Strength of Adjustable Alignment Coil[n]	0 to 4	G
Peak Deflecting-Coil Current:		
Horizontal	200	mA
Vertical	45	mA
Sensitivity		
Conditions		
Faceplate illumination (highlight)	6	lm/ft^2 (fc)
Dark current[p]	30	nA
Performance		
Target voltage[q,r]	22 to 45	V
Signal-Output Current[s]	300	nA

a This capacitance, which effectively is the output impedance of the tube, is increased when the tube is mounted in the deflecting yoke and focusing-coil assembly. The resistive component of the output impedance is in the order of 100 megohms.

b Made by Cinch Manufacturing Corporation, 1501 Morse Ave., Elk Grove Village, ILL 60007.

c Made by Cleveland Electronics Inc., 17877 St. Clair Avenue, Cleveland, OH 44110.

d These components are chosen to maximize resolution uniformity over the useful picture area of the camera tube. Resolution uniformity is necessary for good color uniformity.

e A description of the Absolute Maximum Rating is given in the General Section titled Rating System for Electron Tubes.

f Grid-No.4 voltage must always be greater than grid-No.3 voltage. The maximum voltage difference between these electrodes, however, should not exceed 600 volts. The recommended ratio of grid-No.3 to grid-No.4 voltage is 6/10.

g Video amplifiers must be designed properly to handle target currents of this magnitude to avoid amplifier overload or picture distortion.

h For conditions where "white light" is uniformly diffused over entire tube face.

j With no blanking voltage on grid No.1.

k For initial signal-output current of 300 nanoamperes and a dark current of 30 nanoamperes.

m The polarity of the focusing coil 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.

n The alignment coil should be located on the tube so that its center is at a distance of 3-3/4 inches from the face of the tube, and be positioned so that its axis is coincident with the axis of the tube, the deflecting yoke, and the focusing coil.

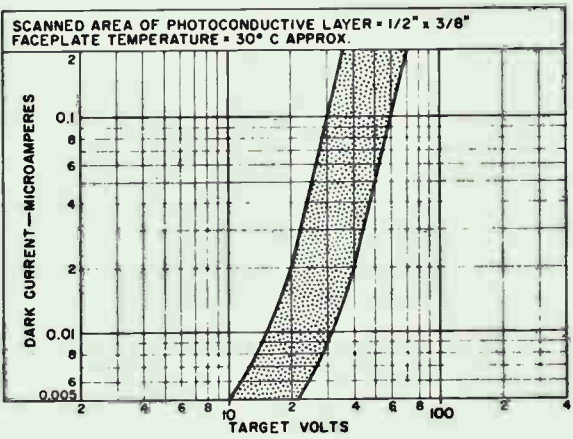
p The deflecting circuits must provide extremely linear scanning for good black-level reproduction. Dark-current signal is proportional to the scanning velocity. Any change in scanning velocity produces a black-level error in direct proportion to the change in scanning velocity.

q The target voltage for each tube must be adjusted to that value which gives the desired operating dark current.

r Indicated range serves only to illustrate the operating target-voltage range normally encountered.

s Defined as the component of the highlight target current after dark-current component has been subtracted.

Typical Range of Dark Current



92CS-12235

Spurious Signal Test

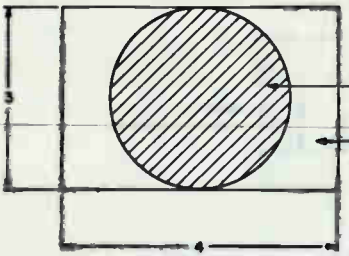


Figure 1
Spurious Signal
Test Zones

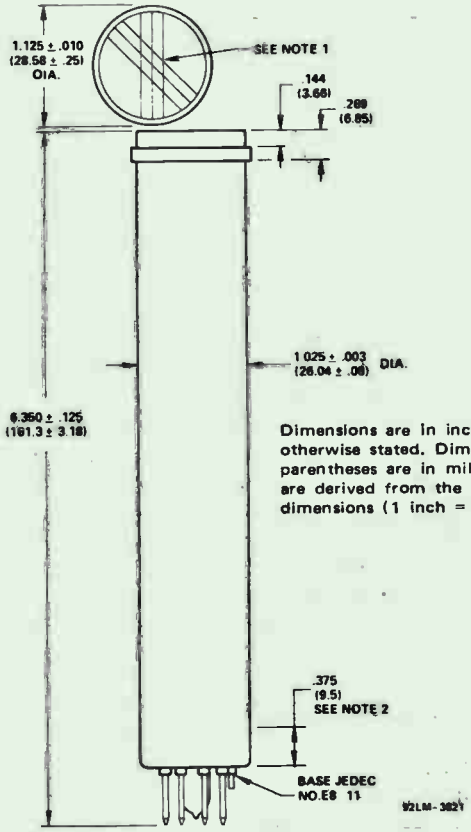
This test is performed using a uniformly illuminated test pattern containing two "zones" as shown in Figure 1. Illumination is for a peak signal current of 300 nanoamperes. Under these conditions, a blemish will be counted if its signal amplitude is greater than 45 nanoamperes under either illuminated or capped conditions. Some spots and fiber-optic distortion errors are more easily observed when viewing a red or a blue field. Therefore, Wratten filters numbers 25 or 47B (or equivalents) will be inserted into the light path to provide the red or blue fields. Table I shows the number of countable spots allowed. No two spots may be closer together than the distance equivalent to twenty TV lines.

Table I
For scanned area of 1/2" x 3/8" (12.7 mm x 9.5 mm)

Blemish Size (equivalent number of raster lines)	Zone 1	Zone 2
over 4	0	0
over 3	2	3
over 1	6	10
1 or less	*	*

*Spots of this size are allowed unless concentration causes a smudged appearance.

Dimensional Outline

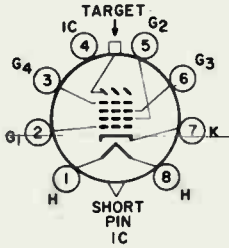


Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Note 1 – Color encoding stripes, 530 line pairs/inch. The yellow (minus blue) stripes are shown vertically on the center-line, the cyan (minus red) stripes are 45° counterclockwise from the yellow stripes. The yellow stripes are perpendicular to the plane passing through tube axis and short index pin. This plane also defines the direction of horizontal scan.

Note 2 – Within this distance, diameter of bulb is 1.025" + 0.003" – 0.030".

Basing Diagram

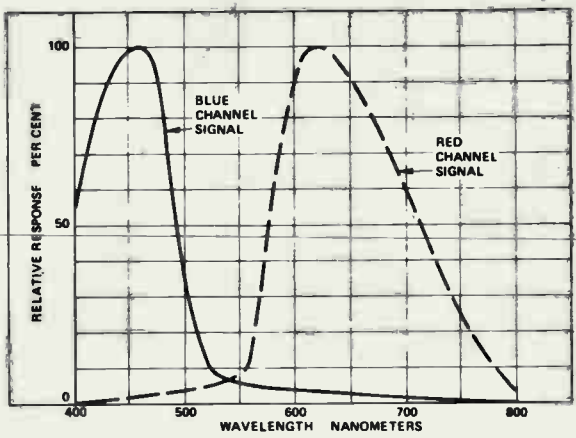


DIRECTION OF LIGHT:
INTO FACE END OF TUBE

Pin 1 – Heater
Pin 2 – Grid No.1
Pin 3 – Grid No.4
Pin 4 – Internal Connection – Do Not Use
Pin 5 – Grid No.2
Pin 6 – Grid No.3
Pin 7 – Cathode
Pin 8 – Heater
Flange – Target
Short Index Pin – Internal Connection – Make No Connection

Typical System Response

(These data are obtained by "sweeping" the input of a camera system, employing a SpectraPlex vidicon type 4445 with the output of a Bausch & Lomb Monochromator Model 33-86-02.



92LS 3819

Typical Light Transfer Characteristic

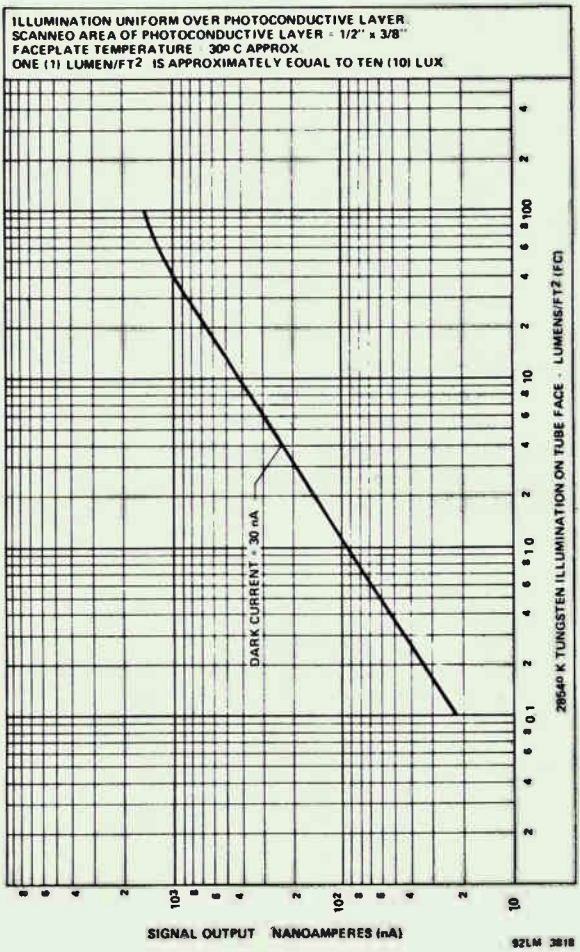


Image-Converter Tube

S-11 RESPONSE

For Use as a High-Speed Light Shutter in Extremely-High-Speed Photography

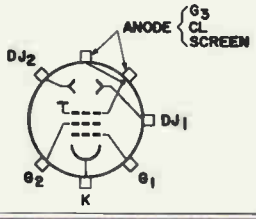
General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Photocathode, Semitransparent:	
Shape	Spherical, Circular
Window:	
Area	9.52 sq.cm (1.48 sq.in.)
Minimum diameter	3.48 cm (1.37 in.)
Index of refraction	1.48
Fluorescent Screen:	
Shape	Flat, Circular
Phosphor	P11[a], Aluminized
Fluorescence	Blue
Phosphorescence	Blue
Persistence[a]	Medium Short
Window:	
Useful deflection area (Approx.)	18 sq.cm (2.8 sq.in.)
Minimum diameter	7.1 cm (2.8 in.)
Index of refraction	1.48
Direct Interelectrode Capacitances (Approx.):	
Grid No.1 to all other electrodes	20 pf
Deflecting electrode DJ1 to deflecting electrode DJ2	1 pf
Deflecting electrode DJ1 to all other electrodes	6 pf
Deflecting electrode DJ2 to all other electrodes	6 pf
Focusing Method	Electrostatic
Deflection Method	Electrostatic
Overall Length	9.87" ±0.06"
Diameter	3.97" ±0.07"
Operating Position	Any
Weight (Approx.)	28 oz

Terminal Connections (See *Dimensional Outline*):

G_1 – Grid No.1
G_2 – Grid No.2
DJ1 – Deflecting Electrode No.1
K – Photocathode
DJ2 – Deflecting Electrode No.2
Anode – (Grid No.3, Collector, Screen)

DIRECTION OF LIGHT PERPENDICULAR TO PHOTOCATHODE END OF TUBE



4449A

Maximum Ratings, ***Absolute-Maximum Values:***

DC Anode Voltage[b]	15000 max.	volts
DC Grid-No.2 Voltage[b]	2200 max.	volts
Grid-No.1 Voltage[b]	190 max.	volts
Deflecting Electrode Voltage:		
DJ1 and DJ2[c]	±1500 max.	volts
Peak Photocathode Current[d]	0.02 max.	ampere
Photocathode Current Density:		
Peak[d]	0.002 max.	amp/cm^2
Average[e]	0.1 max.	μa/cm^2

Typical Operating Values:

Anode Voltage[b]	15000	volts
Grid-No.2 Voltage[b,f]	1500 to 1900	volts
Grid-No.1 Voltage:[b]		
Operating (Minimum)[f]	110 to 170	volts
Cutoff (Maximum)	-90	volts
Deflection Factor	1050 to 1250	volts/in.

Characteristics:

With conditions shown under Typical Operating Values and at an ambient temperature of 25° C

	Min.	*Typical*	*Max.*	
Photocathode Sensitivity:				
Radiant, at 4400 angstroms	-	0.04	-	amp/watt
Luminous, at 0 cps[g]	2×10^{-5}	5×10^{-5}	-	amp/lumen
Paraxial Image Magnification (Cmx)[h,j]	0.69	-	0.78	
Distortion[h,k]	-	-	0.03	
Paraxial Resolution[b,m]	25	-	-	line-pairs/mm
Edge Resolution[b,m,n]	15	-	-	line-pairs/mm
Radiant Power Gain,[p,q]	50	-	-	
Equivalent Background Screen Brightness Input[r]	-	-	5×10^{-12}	watts/sq.cm
Screen Uniformity Factor[s]	-	-	1.3	
Alignment	-	-	t	

[a] For P11 Spectral-Energy Emission Characteristic curve, see *front of Cathode-Ray Tube, Storage-Tube, & Monoscope Section.* See also accompanying *Operating Considerations.*

[b] Referred to photocathode.

[c] Referred to anode.

[d] Over an interval not exceeding 1 microsecond.

[e] Averaged over any interval of 8 minutes maximum.

[f] Adjusted to minimize shadowing effects in the displayed image caused by the wires of grid No.1.

[g] For conditions where the light source is a tungsten-filament lamp having a lime glass envelope (Corning Glass Code No.0080, or equivalent). The lamp is operated at a color temperature of 2870° K. A light input of 0.01 lumen is used to irradiate a centered 1/2-inch diameter of the photocathode.

[h] Defined as the ratio of the separation of two diametrically opposite image points on the screen to the separation of the corresponding image points on the photocathode.

[j] Determined as follows: The image incident on the photocathode is perpendicular to the grid-No.1 wires and consists of 2 parallel lines on a bright background approximately 0.16" in length and separated by a distance of 0.160" ± 0.002". The image on the photocathode is focused and positioned so that the separation between the image lines is an equal distance on both sides of the geometric center of the photocathode. The line spacing on the screen is measured adjacent to the faint image of the center grid-No.1 wire.

[k] A second magnification value (Emx) is measured under the conditions established in (j) except that the lines are separated by a distance of 1.00" ± 0.01". Distortion (D) is defined by the equation:

$$D = \frac{Emx}{Cmx} - 1$$

[m] Determined with a resolution pattern consisting of horizontal and vertical bars. The limiting resolution value is measured adjacent to the faint image of the center grid-No.1 wire and applies to both vertical and horizontal resolution.

[n] Measured at the edge of a 1-inch diameter circle positioned concentric with the geometric center of the photocathode under the same conditions established in (m).

[p] Under the following conditions: Light incident on the photocathode is transmitted through a blue filter (Corning C. S. No.5-58 filter from Melt No.5113 polished to 1/2 stock thickness—Manufactured by the Corning Glass Works, Corning, New York) from a tungsten-filament lamp having a lime glass envelope. The lamp is operated at a color temperature of 2870° K. A 1/2-inch diameter of the photocathode is irradiated and the value of light flux incident on the filter is 0.1 lumen. A calibrated receiver having S-11 spectral response and masked to have a 1/2-inch-diameter aperture is positioned 12 inches from the screen of the 4449A. The output current (I_1) of the receiver is noted. The same receiver is then positioned to receive the radiant flux originally incident on the photocathode and its output current (I_2) is noted. Radiant power gain (G) is defined by the equation:

$$G = 2000 \times \frac{I_1}{I_2}$$

The coefficient 2000 is derived by assuming that the integrated light radiated by the screen is 79 per cent of that value that would be obtained if the light emitted by the screen has a cosine distribution.

[q] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

[r] Defined as that value of incident radiation required to cause an increase in screen brightness equal to the screen background brightness.

[s] The ratio of the luminance values of the brightest area to the darkest area of the screen with the entire photocathode uniformly illuminated. The value of incident illumination on the photocathode is 1 footcandle and the light spot on the screen has a diameter of 0.10" ± 0.01".

[t] A trace produced on the screen, when the center of the photocathode is irradiated with a 0.025-inch diameter light spot and an ac voltage is applied to the deflecting electrodes, will not deviate more than 4° from the plane passing through the center of the recessed ball cap of grid No.1 and the major axis of the tube. The angle produced by the trace and the faint images of the grid wires, that are observed when the photocathode is uniformly illuminated, will be 90° ± 3°.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE is shown at front of this Section

OPERATING CONSIDERATIONS

Magnetic shielding of the 4449A is required to minimize the effects of extraneous fields on tube performance; ac magnetic fields are particularly objectionable in that they seriously impair tube resolution. If an iron or steel case is used, care should be taken in its construction to insure that the case is completely demagnetized.

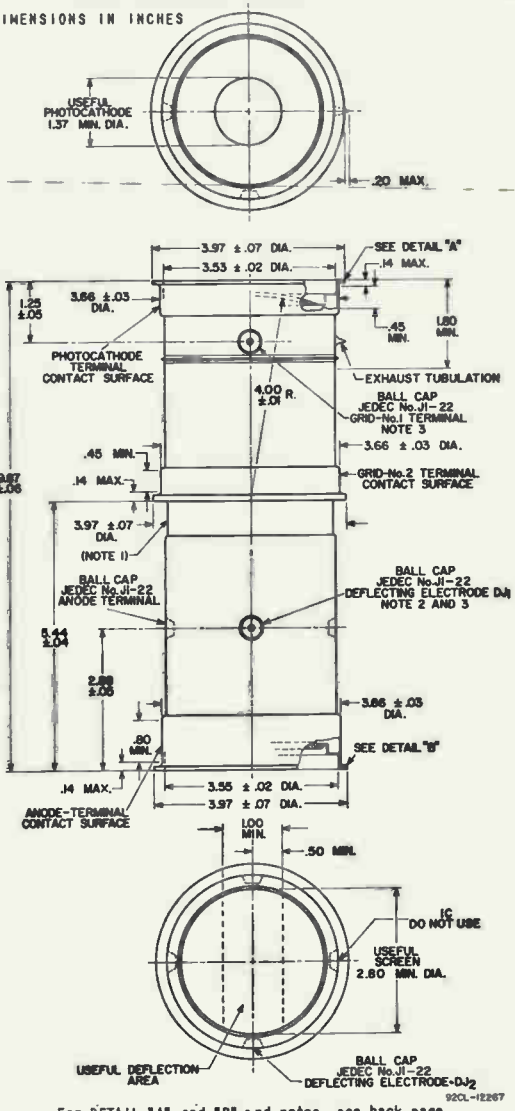
The *P-11 phosphor screen* employed by the 4449A emits high-intensity actinic blue fluorescence and has a persistence characteristic, within the range of 10 microseconds to 1 millisecond, that is dependent on the current density employed.

To prevent degradation in the resolution of deflected images care must be taken to assure that the deflecting voltage is free of ac ripple and that shielded semiflexible leads are used for making connection to the deflecting electrode terminals. Balanced deflection with respect to anode should be used.

Exposure Time. In practice, the shutter speeds attainable with the 4449A are limited by the ability of the external circuitry to supply to grid No.1 good rectangular-wave pulses of sufficiently short duration. With perfect pulse-forming circuits, the minimum exposure time of the 4449A is limited by electron transit time which, for an anode voltage of 15 kilovolts, is in the order of 10^{-9} seconds. Electrons are defocused if they are not beyond the influence of the gating (control) grid when its voltage returns to cutoff value at the end of the gating pulse.

The high voltage at which the 4449A is operated may be very dangereous. Great care should be taken in the design of apparatus to prevent the user from coming in contact with the high voltage. Precautions must include safeguards which eliminate all hazards to operating personnel. In the use of high-voltage tubes, such as the 4449A, it should always be remembered that high voltage may appear at normally low-potential points in the circuit because of capacitor breakdown or incorrect circuit connections. Before any part of the circuit is touched, the voltage-supply switch should be turned off and both terminals of any capacitors grounded.

DIMENSIONS IN INCHES



For DETAIL "A" and "B" and notes, see back page.

NOTES FOR DIMENSIONAL OUTLINE

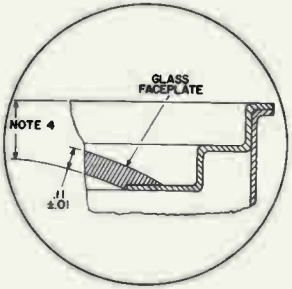
Note 1: Not to be used for mechanical support or electrical connection.

Note 2: The plane passing through the center of the recessed ball cap DJ2 and the major axis of the tube will not deviate more than 3° from the plane passing through the center of the recessed ball cap DJ1 and the major axis of the tube.

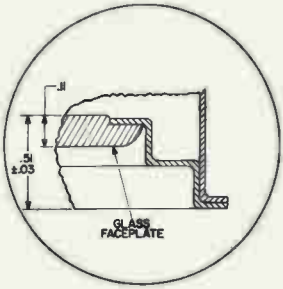
Note 3: The plane passing through the center of the recessed ball cap DJ1 and the major axis of the tube will not deviate more than 5° from the plane passing through the center of the recessed ball cap for grid No.1 and the major axis of the tube.

Note 4: This distance on the major axis of the tube is .33 ± .03.

DETAIL "A"



DETAIL "B"



DIMENSIONS IN INCHES

Multiplier Phototube

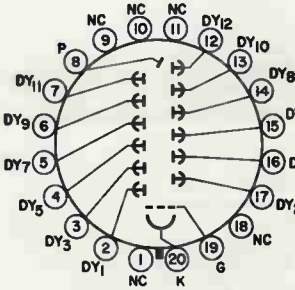
12-STAGE, HEAD-ON S-20 RESPONSE ENCLOSED, IN-LINE
SPHERICAL-FACEPLATE TYPE DYNODE STRUCTURE
HIGH CURRENT AMPLIFICATION EXTREMELY SHORT RISE TIME

For Near-Infrared Ruby-Laser Detector Systems, Flying-Spot Scanning, Photometry, and Scintillation Counters Requiring Low-Dark Current and High Sensitivity over the Visible and Near-Infrared Regions of the Spectrum.

General:

Spectral Response	S-20
Wavelength of Maximum Response	4200 ± 500 angstroms
Cathode, Semitransparent	K-Na-Cs-Sb (Multialkali)
Shape	Spherical, Circular
Minimum area	2.2 sq. in.
Minimum diameter	1.68 in.
Window	Borosilicate Glass[a]
Index of refraction	1.48
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.12	3.8 pf
Anode to all other electrodes	5.7 pf
Dynode No.12 to all other electrodes	6.8 pf
Maximum Overall Length	6.31"
Seated Length	5.50" ± 0.19"
Maximum Diameter	2.06"
Operating Position	Any
Weight (Approx.)	7 oz
Bulb	T16
Socket	Cinch[b] No.20-PM, or equivalent
Magnetic Shield	Perfection Mica Co.[c], or equivalent
Base	Small-Shell Bidecal 20-Pin (JEDEC No.B20-102), Non-hygroscopic
Basing Designation for BOTTOM VIEW	20E

Pin 1 – No Internal Connection
Pin 2 – Dynode No.1
Pin 3 – Dynode No.3
Pin 4 – Dynode No.5
Pin 5 – Dynode No.7
Pin 6 – Dynode No.9
Pin 7 – Dynode No.11
Pin 8 – Anode
Pin 9 – Same as Pin 1
Pin 10 – Same as Pin 1
Pin 11 – Same as Pin 1
Pin 12 – Dynode No.12
Pin 13 – Dynode No.10
Pin 14 – Dynode No.8
Pin 15 – Dynode No.6
Pin 16 – Dynode No.4
Pin 17 – Dynode No.2
Pin 18 – Same as Pin 1
Pin 19 – (Focusing Electrode)
Pin 20 – Photocathode



DIRECTION OF LIGHT: INTO END OF BULB

Maximum Ratings, ***Absolute-Maximum Values:***

DC Supply Voltage:		
Between anode and cathode	2800 max.	volts
Between anode and dynode No.12	400 max.	volts
Between consecutive dynodes	400 max.	volts
Between dynode No.1 and cathode	600 max.	volts
Between focusing electrode and cathode	600 max.	volts
Average Anode Current[d]	1 max.	ma
Ambient-Temperature Range	-200 to +85	°C

Characteristics Range Values:

Under conditions with dc supply voltage (E) across a voltage divider providing electrode voltages shown in Table I. Focusing electrode is connected to arm of a potentiometer between cathode and dynode No.1 and its voltage is adjusted to that value which provides maximum anode current.

With E = 2300 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	4.3×10^{5}	–	a/w
Cathode radiant, at 4200 angstroms	–	0.064	–	a/w
Luminous, at 0 cps[e]	250	1000	12000	a/lm
Cathode luminous:				
With tungsten light source[f]	1.1×10^{-4}	1.5×10^{-4}	–	a/lm
With blue light source[g,h]	5.5×10^{-8}	–	–	a
With red light source[j,k]	3×10^{-7}	5×10^{-7}	–	a
Current Amplification	–	6.6×10^{6}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 300 a/lm[m]	–	1×10^{-10}	1.3×10^{-9}	lm
Anode-Pulse Rise Time[n]	–	2×10^{-9}	–	sec
Greatest Delay Between Anode Pulses: Due to position from which electrons are simultaneously released within a circle centered on tube				

	Min.	Typ.	Max.	
face having a diameter of—				
1.4".	–	3×10^{-10}[p]	–	sec
1.6".	–	5×10^{-10}[p]	–	sec

With E = 1800 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4200 angstroms	–	4.3×10^{4}	–	a/w
Cathode radiant, at 4200 angstroms. .	–	0.064	–	a/w
Luminous, at 0 cps[e].	–	100	–	a/lm
Cathode luminous:				
With tungsten light source[f] .	1.1×10^{-4}	1.5×10^{-4}	–	a/lm
With blue light source[g,h] . . .	5.5×10^{-8}	–	–	a
With red light source[j,k] . . .	3×10^{-7}	5×10^{-7}	–	a
Current Amplification	–	6.6×10^{5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 300 a/lm[m]	–	1×10^{-10}	1.3×10^{-9}	lm
Equivalent Noise Input[q].	–	1.1×10^{-12}	2.4×10^{-12}	lm

[a] Corning No.7056, made by Corning Glass Works, Corning, New York, or equivalent.

[b] Made by Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago 24, Illinois.

[c] Magnetic shielding material in the form of foil or tape as available from the Magnetic Shield Division, Perfection Mica Company, 1829 Civic Opera Bldg., 20 North Wacker Drive, Chicago 6, Illinois, or equivalent.

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

[e] 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.

[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. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[g] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[h] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after Passing through Indicated Blue Filter* at front of this Section.

[j] Under the following conditions: Light incident on the cathode is transmitted through a red filter (Corning C.S. No.2-62--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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[k] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Red Filter* at front of this Section.

[m] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[n] 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.

[p] These values also represent the difference in time of transit between the photocathode and dynode No.1 for electrons simultaneously released from the center and from the periphery of the specified areas.

[q] Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER	
Between	**6.95% of Supply Voltage (E) multiplied by**
Cathode and Dynode No.1	2
Dynode No.1 and Dynode No.2	1.4
Dynode No.2 and Dynode No.3	1
Dynode No.3 and Dynode No.4	1
Dynode No.4 and Dynode No.5	1
Dynode No.5 and Dynode No.6	1
Dynode No.6 and Dynode No.7	1
Dynode No.7 and Dynode No.8	1
Dynode No.8 and Dynode No.9	1
Dynode No.9 and Dynode No.10	1
Dynode No.10 and Dynode No.11	1
Dynode No.11 and Dynode No.12	1
Dynode No.12 and Anode	1
Anode and Cathode	14.4
Focusing electrode is connected to arm of potentiometer between cathode and dynode No.1. The focusing-electrode voltage is varied to give maximum anode current.	

OPERATING CONSIDERATIONS

The *operating stability* of the 4459 is dependent on the magnitude of the anode current and its duration. When the 4459 is operated at high average values of anode current, a drop in sensitivity (sometimes called fatigue) may be expected. The extent of the drop below the tabulated sensitivity values depends of the severity of the operating conditions. After a period of idleness, the 4459 usually recovers a substantial percentage of such loss in sensitivity.

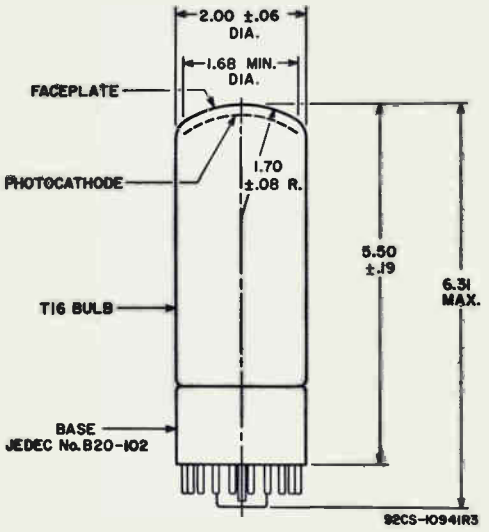
It is recommended that the average anode current be well below the maximum-rated value of 1 milliampere when stability of operation is important. When maximum stability is required, the average anode current should not exceed 10 microamperes.

Electrostatic and/or *magnetic shielding* of the 4459 may be necessary.

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 4459.

The *high voltages at which the 4459 is operated are very dangerous*. Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the exclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

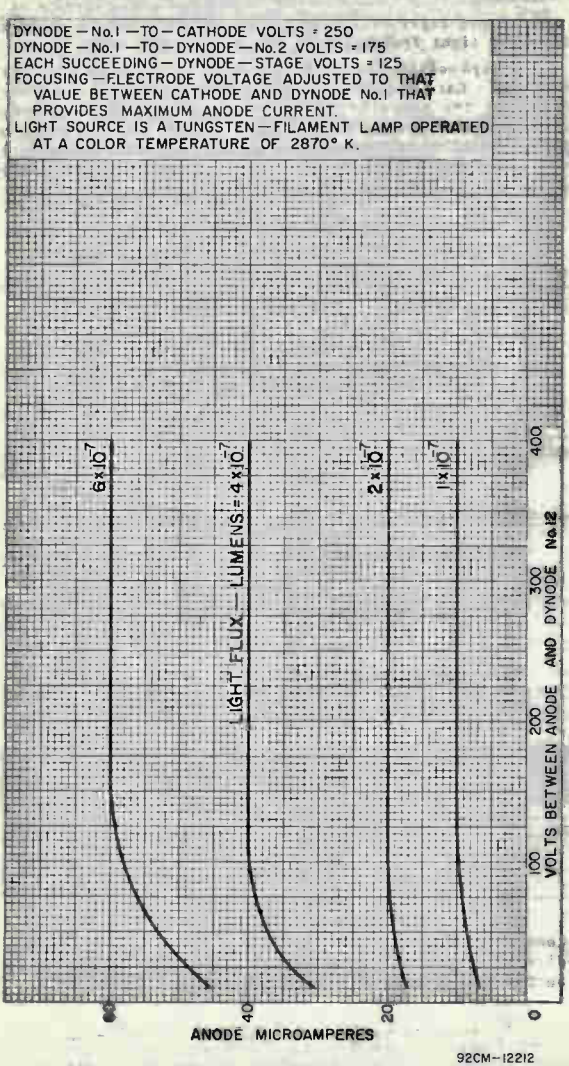
SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-20 RESPONSE is shown at the front of this Section



DIMENSIONS IN INCHES

Center line of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

TYPICAL ANODE CHARACTERISTICS

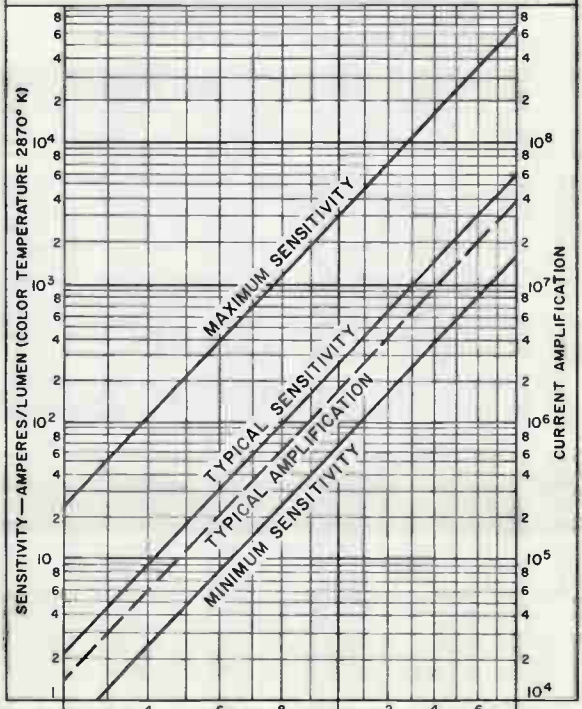


SENSITIVITY AND AMPLIFICATION CHARACTERISTICS

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

BETWEEN	6.95 % OF E MULTIPLIED BY
CATHODE & DY_1	2.0
DY_1 & DY_2	1.4
DY_2 & DY_3 THROUGH DY_{12} & ANODE	1.0
ANODE & CATHODE	14.4

FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN CATHODE AND DYNODE No. 1 THAT PROVIDES MAXIMUM ANODE CURRENT.

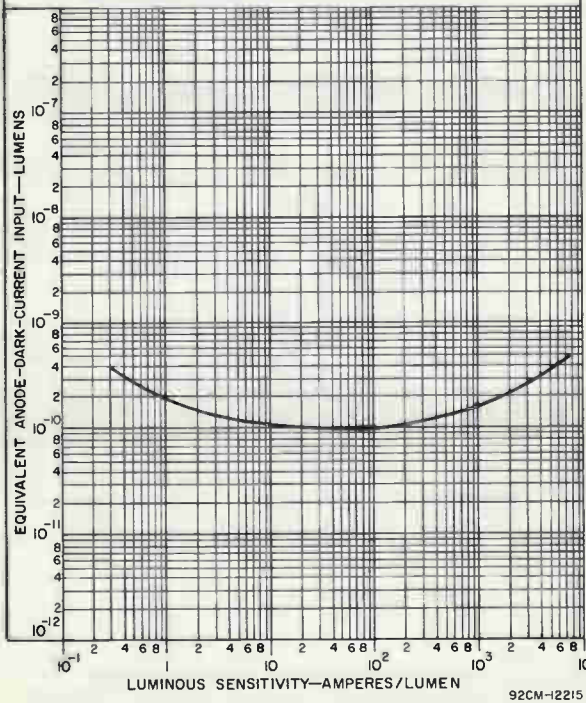


TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

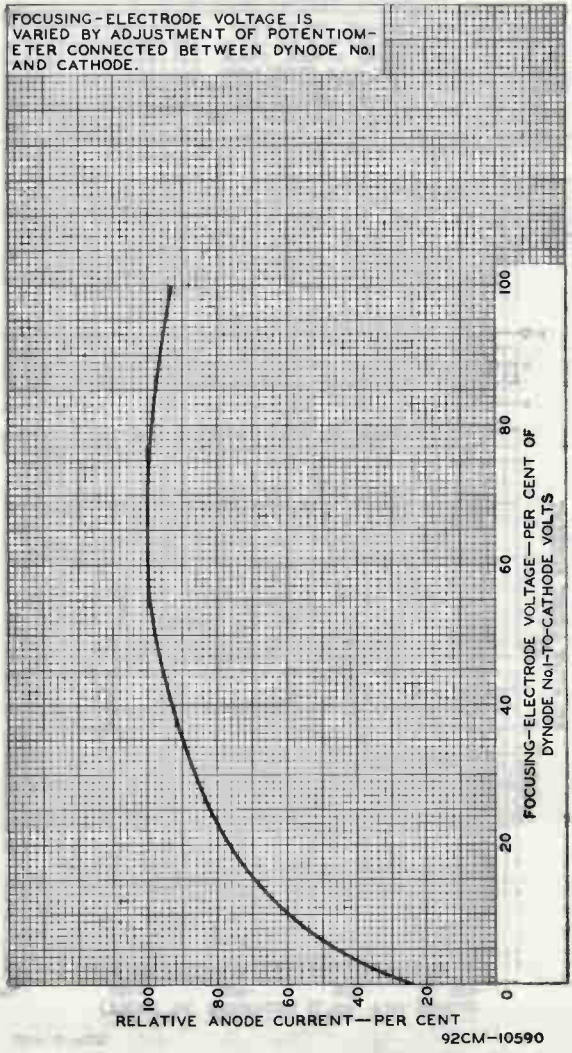
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	6.95% OF E MULTIPLIED BY
CATHODE & DY_1	2.0
DY_1 & DY_2	1.4
DY_2 & DY_3 THROUGH DY_{12} & ANODE	1.0
ANODE & CATHODE	14.4

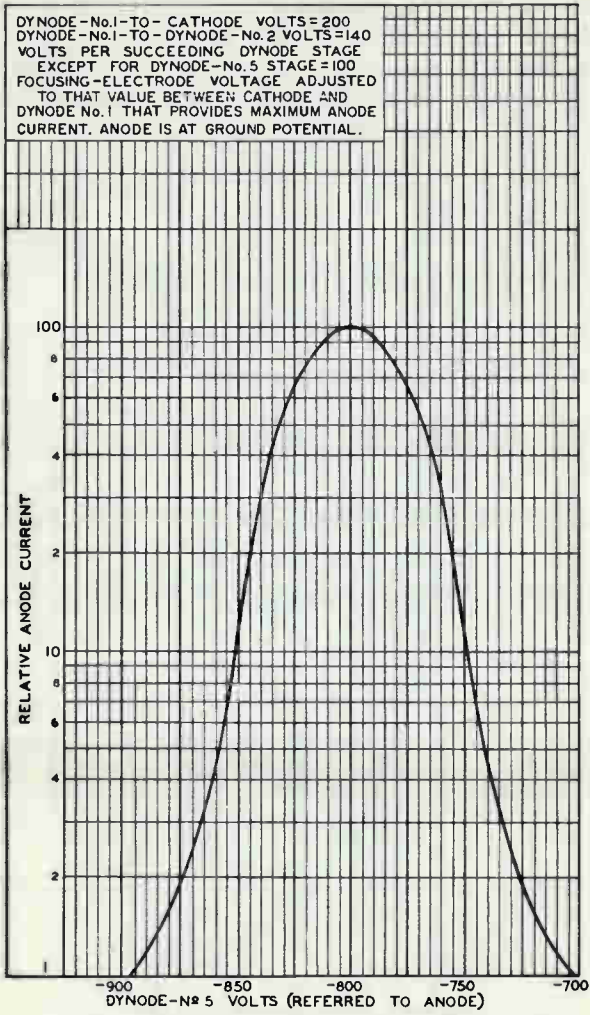
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN CATHODE AND DYNODE No.1 THAT PROVIDES MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.
TUBE TEMPERATURE=25° C



AVERAGE FOCUSING-ELECTRODE-VOLTAGE CHARACTERISTIC



TYPICAL ANODE-CURRENT CHARACTERISTIC



92CM-10959R1

Multiplier Phototube

S-11 RESPONSE

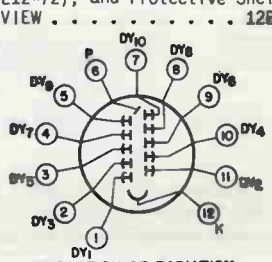
"RUGGEDIZED", 10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE — ELECTROSTATICALLY FOCUSED IN-LINE DYNODE STAGES

For Detection and Measurement of Nuclear-Radiation and Low-Level Light in Compact Industrial and Military Equipment

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Minimum area	0.2 sq. in.
Minimum diameter	0.5 in.
Window	Lime Glass (Corning[a] No.0080), or equivalent
Shape	Plano-Concave
Index of refraction at 5893 angstroms	1.51
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	2.4 pf
Anode to all other electrodes	3.2 pf
Maximum Overall Length (Excluding semiflexible leads)	3.38"
Maximum Diameter	0.78"
Operating Position	Any
Weight (Approx.)	0.9 oz
Bulb	T6
Magnetic Shield	Perfection Mica Co.[b], or equivalent
Base	Small-Button Thirteenar 12-Semiflexible Lead, (JEDEC No.E12-72), and Protective Shell
Basing Designation for BOTTOM VIEW	12BG

Lead 1 – Dynode No.1
Lead 2 – Dynode No.3
Lead 3 – Dynode No.5
Lead 4 – Dynode No.7
Lead 5 – Dynode No.9
Lead 6 – Anode
Lead 7 – Dynode No.10
Lead 8 – Dynode No.8
Lead 9 – Dynode No.6
Lead 10 – Dynode No.4
Lead 11 – Dynode No.2
Lead 12 – Photocathode



DIRECTION OF RADIATION: INTO END OF BULB

Maximum Ratings, *Absolute-Maximum Values:*

Supply Voltage (DC or Peak AC):		
Between Anode and Cathode	1500 max.	volts
Between Anode and Dynode No.10	300 max.	volts
Between Consecutive Dynodes	250 max.	volts
Between Dynode No.1 and Cathode	400 max.	volts
Average Anode Current[c]	0.5 max.	ma
Ambient Temperature	75 max.	°C

Characteristics Range Values:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between dynode No.10 and anode

With E = 1250 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4400 angstroms.	–	6×10^3	–	a/
Cathode radiant, at 4400 angstroms. . .	–	0.048	–	a/w
Luminous, At 0 cps[d].	3	7.5	60	a/lm
Cathode luminous:				
With tungsten light source[e].	4×10^{-5}	6×10^{-5}	–	a/l
With blue light source[f,g].	4×10^{-8}	6×10^{-8}	–	a
Current Amplification. . .	–	1.25×10^5	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 7.5 a/lm[h].	–	8×10^{-10}	2×10^{-9}	lm
Equivalent Noise Input[j]. .	–	3×10^{-12}	1×10^{-11}	lm
Anode-Pulse Rise Time[k] . .	–	2.1×10^{-9}	–	sec
Electron Transit Time[m] . .	–	2.3×10^{-8}	–	sec
Quantum Efficiency at 4300 angstroms	–	14	–	%

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

[b] 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.

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

[d] 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 10 microlumens is used.

[e] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[f] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[g] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

[h] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant such as dry ice.

[j] Under the following conditions: Supply voltage (E) is as shown, 25°C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[k] 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.

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.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE is shown at the front of this Section

ENVIRONMENTAL TESTS-

The 4460 is designed to withstand the shock, vibration, and acceleration tests shown below which are equivalent to those specified in MIL-E-5272C* for equipment mounted on the structures of missiles propelled or launched by high-thrust rocket engines. The accelerations specified in these tests are applied directly to the tubes.

One-Hundred Per-Cent Shock and Vibration Testing:

Each 4460 is subjected in sequence to shock and then to vibration as specified below with the tube non-operating.

Shock. These tests are performed first, per method of MIL-E-5272C*, Paragraph 4.15.5.1, Procedure V, on apparatus which provides a half-wave sinusoidal shock pulse. One-hundred per-cent testing of all 4460's is performed. Each 4460 is subjected to three impact shocks in each direction of the three orthogonal axes shown in the accompanying *Orthogonal Axes Used During Environmental Tests* drawing. The peak acceleration of the impact shock is 30 ± 3 g's and the time duration is 11 ± 1 milliseconds. Each tube is subjected to a total of 18 impact shocks.

Vibration. These tests are performed next, on apparatus which applies variable-sinusoidal frequency vibration to the tube, per method of MIL-E-5272C*, paragraph 4.7.14 and paragraph 4.7.14.1. One-hundred per-cent testing of all 4460's is performed. Each 4460 is vibrated in each of the three orthogonal axes shown in the accompanying *Orthogonal Axes Used During Environmental Tests* drawing and as specified in the schedule below. A vibration cycle has a duration of 5 minutes per axis in which time the frequency is varied logarithmically from 20 to 2000 and back to 20 cycles per second. One vibration cycle is performed for each axis and the total test period for each tube is 15 minutes.

Double Amplitude Inches	Acceleration g's	Frequency cps	Cycle Duration per axis minutes
0.050 ± 0.005	-	20 - 87	5
-	20 ± 2	87 - 2000	
-	20 ± 2	2000 - 87	
0.050 ± 0.005	-	87 - 20	

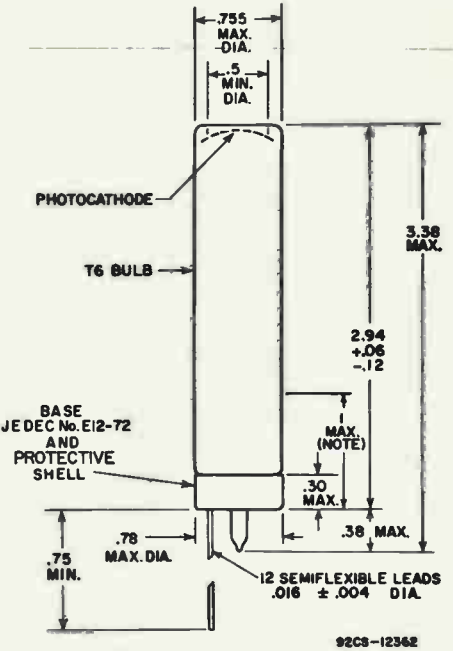
Tube Rejection Criterion. Upon completion of the *One-Hundred Per-Cent Shock and Vibration Testing* each tube is tested at a anode-to-cathode voltage of 1250 volts under the conditions shown under *Characteristics Range Values for Equipment Design* and will meet the specified values.

Design Tests:

Vibration. These tests are performed under conditions equivalent to those described in MIL-E-5272C*, paragraph 4.7.14 and paragraph 4.7.14.1. The vibration cycle has a duration of one hour and two cycles are performed for each of the three orthogonal axes shown in the accompanying *Orthogonal Axes Used During Environmental Tests* drawing. The total test period for each tube is six hours. Tubes are operating during the test.

Acceleration. These tests are performed in a centrifuge providing unidirectional acceleration by a method equivalent to that specified in MIL-E-5272C*, paragraph 4.16.3, Procedure III, except that tubes are subjected for one minute to an increased acceleration test level of 100 ± 10 g's in both directions of the three orthogonal axes shown in the accompanying *Orthogonal Axes Used During Environmental Tests* drawing and the tubes are non-operating.

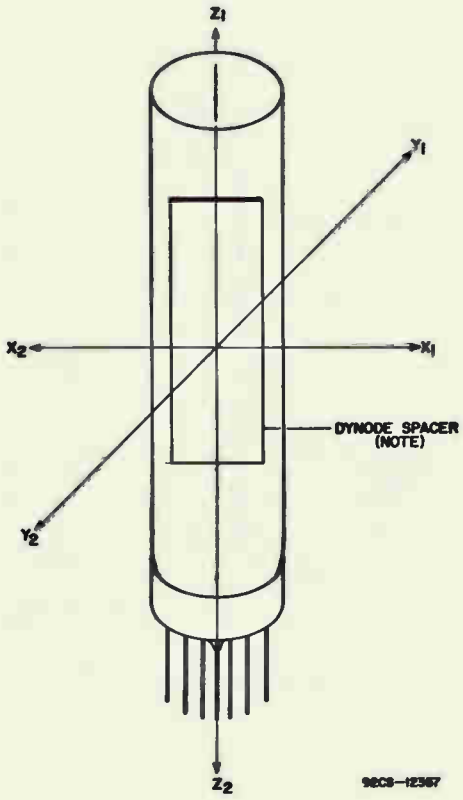
* Military Specification MIL-E-5272C (ASG), 13 April 1959; and Amendment 1, 5 January 1960.



DIMENSIONS IN INCHES

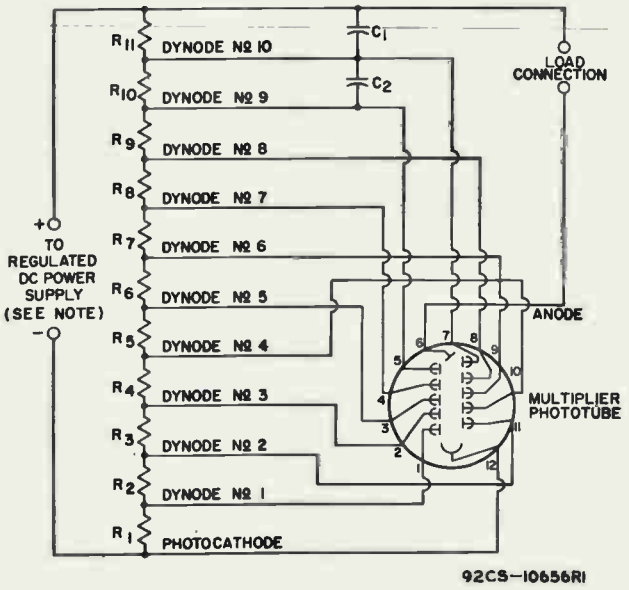
Note: Within this length, maximum diameter of tube is 0.78".

ORTHOGONAL AXES USED
DURING ENVIRONMENTAL TESTS



Note: The plane of each dynode spacer is parallel to the X–Z plane. The Z–axis is the major axis of the tube.

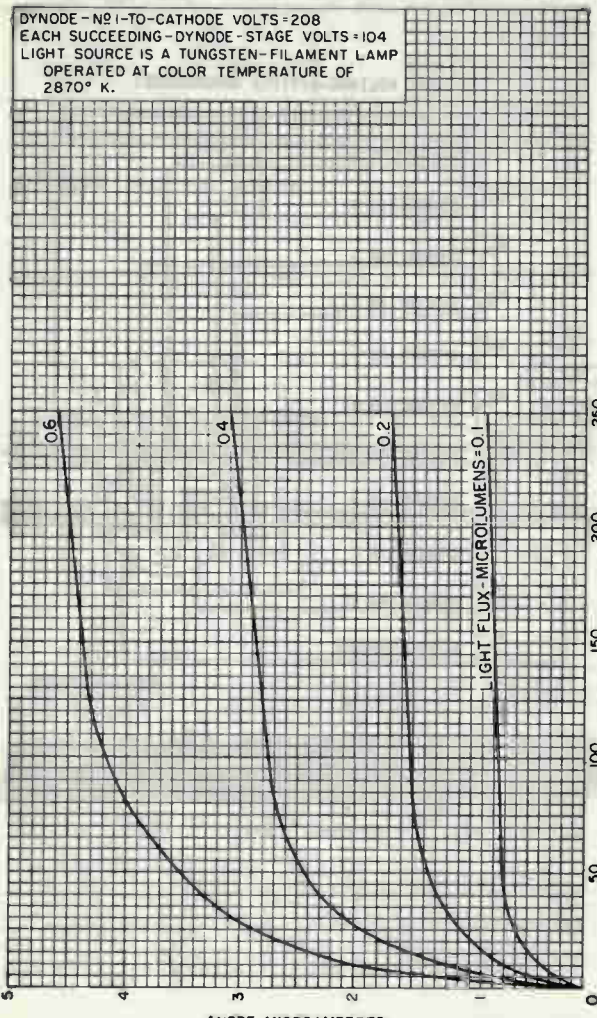
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT



Note: Adjustable between approximately 500 and 1500 volts DC.

C_1,C_2: 0.01 μf, 500 volts (dc working)
R_1: 91,000 ohms, 2 watts
R_2 through R_{11}: 47,000 ohms, 1 watt

AVERAGE ANODE CHARACTERISTICS



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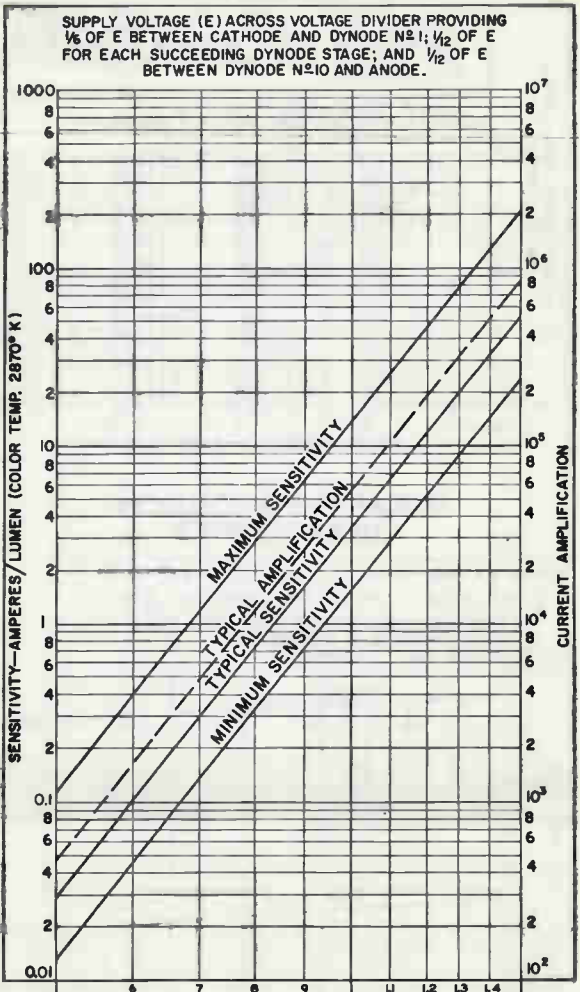
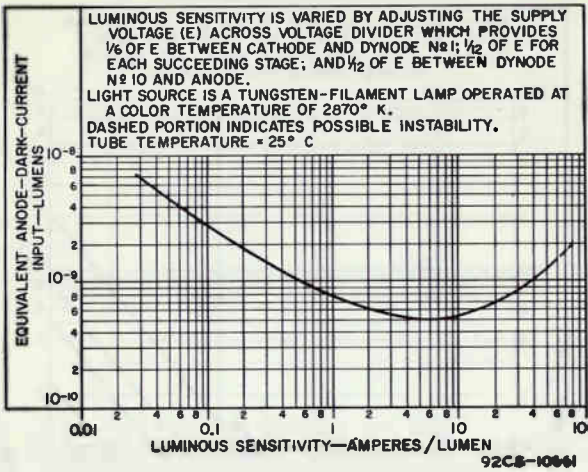
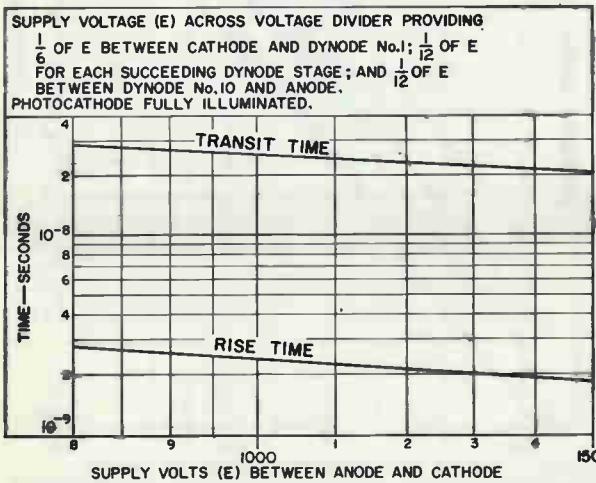
SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS



TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC



TYPICAL TIME RESOLUTION CHARACTERISTICS



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Photomultiplier Tube[g]

RUGGED VIBRATION-RESISTANT STRUCTURE
S-11 RESPONSE **ELECTROSTATICALLY FOCUSED**
10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE **DYNODE STAGES**

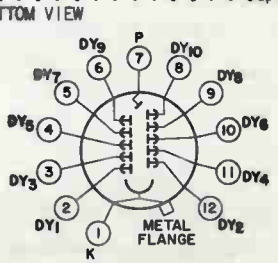
For Detection and Measurement of Nuclear Radiation and other Low-Level Light Sources. Especially Useful in Missile and Rocket Service and other Industrial and Military Applications where Severe Environmental Conditions may be Encountered.

General:

Spectral Response	S-11
Wavelength of Maximum Response	4400 ± 500 angstroms
Cathode, Semitransparent	Cesium-Antimony
Minimum area	1.2 sq. in.
Minimum diameter	1.24"
Window	Lime Glass (Corning[a] No.0080), or equivalent
Shape	Plano-plano
Index of refraction at 5893 angstroms	1.51
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	3.2 pf
Anode to all other electrodes	5.0 pf
Maximum Overall Length (Excluding semiflexible leads)	3.18"
Maximum Diameter	1.56"
Operating Position	Any
Weight (Approx.)	2.2 oz
Bulb	T12
Magnetic Shield	Millen Co.[b], or equivalent
Base	Special

Terminal Diagram: BOTTOM VIEW

Lead 1 & Metal Flange–Photocathode
Lead 2 – Dynode No.1
Lead 3 – Dynode No.3
Lead 4 – Dynode No.5
Lead 5 – Dynode No.7
Lead 6 – Dynode No.9
Lead 7 – Anode
Lead 8 – Dynode No.10
Lead 9 – Dynode No.8
Lead 10 – Dynode No.6
Lead 11 – Dynode No.4
Lead 12 – Dynode No.2



DIRECTION OF RADIATION: INTO END OF BULB

Maximum Ratings, *Absolute-Maximum Values:*

DC Supply Voltage:		
Between anode and cathode	1500	volts
Between anode and dynode No.10	250	volts
Between consecutive dynodes	200	volts
Between dynode No.1 and cathode	400	volts
Average Anode Current[c]	1	ma
Average Cathode Current[c,d]	2	μa
Ambient Temperature	75	°C

Characteristics Range Values:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No. 1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between anode and dynode No. 10 and anode.

With E = 1250 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms		8×10^{-3}	–	a/w
Cathode radiant, at 4400 angstroms	–	0.048	–	a/w
Luminous, at 0 cps[e]	3	10	90	a/lm
With dynode No. 10 as output electrode[f]	–	6	–	a/lm
Cathode luminous:				
With tungsten light source[g]	4×10^{-5}	6×10^{-5}	–	a/lm
With blue light source[h]	4×10^{-8}	6×10^{-8}	–	a
Current Amplification	–	1.7×10^{-5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 10 a/lm[j]	–	5×10^{-10}	2×10^{-9}	lm
Equivalent Noise input[k,a]	–	2.8×10^{-12}	1.8×10^{-11}	lm
Anode-Pulse Rise Time[n]	–	2.4×10^{-9}	–	sec
Electron Transit Time[p]	–	2.9×10^{-8}	–	sec
Quantum Efficiency at 4300 angstroms	–	14	–	%

With E = 750 volts (Except as noted)

	Min.	Typ.	Max.	
Sensitivity:				
Radiant, at 4400 angstroms	–	1.8×10^{-2}	–	a/w
Cathode radiant, at 4400 angstroms	–	0.048	–	a/w
Luminous, at 0 cps[e]	–	0.22	–	a/lm
Cathode luminous:				
With tungsten light source[g]	4×10^{-5}	6×10^{-5}	–	a/lm
With blue light source[h]	4×10^{-8}	6×10^{-8}	–	a
Current Amplification	–	3.7×10^{-3}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 10 a/lm[j]	–	5×10^{-10}	2×10^{-9}	lm
Anode-Pulse Rise Time[k]	–	3.1×10^{-9}	–	sec
Electron Transit Time[p]	–	3.8×10^{-8}	–	sec

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

[b] Magnetic shielding in the form of foil or tape as available from the James Millen Manufacturing Company, 150 Exchange Street, Malden 48, Massachusetts, or equivalent.

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

[d] For a uniformly illuminated area of 0.5 square inches minimum.

[e] 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 at a light input of 10 microlumens.

[f] An output current of opposite polarity to that obtained at the anode may be provided by using dynode No. 10 as the output electrode. With this arrangement, the load is connected in the dynode No. 10 circuit and the anode serves only as a collector. The curves under *Typical Anode Characteristics* do not apply when dynode No. 10 is used as the output electrode.

[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 0.01 lumen and 200 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[j] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[k] For maximum signal-to-noise ratio, operation with a supply voltage (E) below 1250 volts is recommended.

[m] Under the following conditions: Supply voltage (E) is as shown, 25° C tube temperature, external shield connected to cathode, bandwidth 1 cycle per second, tungsten-light source at a color temperature of 2870° K interrupted at a low audio-frequency to produce incident radiation pulses alternating between zero and the value stated. The "on" period of the pulse is equal to the "off" period.

[n] 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 variations and is measured under conditions with an incident-light fully illuminating the photocathode.

[p] 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.

[q] Alternate designation for Multiplier Phototube.

SPECTRAL-SENSITIVITY CHARACTERISTIC
OF PHOTOSENSITIVE DEVICE HAVING S-11 RESPONSE
is shown at the front of this Section

ENVIRONMENTAL TESTS:

The 4461 is designed to withstand the shock, vibration, and acceleration tests shown below which are equivalent to those specified in MIL-E-5272C* for equipment mounted on the structures of missiles propelled or launched by high-thrust rocket engines. The accelerations specified in these tests are applied directly to the tubes.

One-Hundred Per-Cent Shock and Vibration Testing:

Each 4461 is subjected in sequence to shock and then to vibration as specified below with the tube non-operating.

Shock. These tests are performed first, per method of MIL-E-5272C*, Paragraph 4.15-5.1, Procedure V, on apparatus which provides a half-wave sinusoidal shock pulse. One-hundred per-cent testing of all 4461's is performed. Each 4461 (non-operating) is subjected to three impact shocks in each direction of the three orthogonal axes. The peak acceler-

ation of the impact shock is 30 ± 3 g's and the time duration is 11 ± 1 milliseconds. Each tube is subjected to a total of 18 impact shocks.

Vibration. These tests are performed next, on apparatus which applies variable-sinusoidal frequency vibration to the tube, per method of MIL-E-5272C*, paragraph 4.7.14 and paragraph 4.7.14.1. One hundred per-cent testing of all 4461's is performed. Each 4461 is vibrated in each of the three orthogonal axes as specified in the schedule below. A vibration cycle has a duration of 5 minutes per axis in which time the frequency is varied logarithmically from 20 to 2000 and back to 20 cycles per second. One vibration cycle is performed for each axis and the total test period for each tube is 15 minutes.

Double Amplitude Inches	Acceleration g's	Frequency cps	Cycle Duration Per Axis minutes
0.050 ± 0.005	–	20 – 87	5
–	20 ± 2	87 – 2000	
–	20 ± 2	2000 – 87	
0.050 ± 0.005	–	87 – 20	

Tube Rejection Criterion. Upon completion of the *Shock and Vibration Testing* each tube is tested at a anode-to-cathode voltage of 1250 volts with the light level incident on the tube adjusted to provide an anode current of approximately 8 microamperes. Electrical and/or mechanical tube failures due to shock or vibration will be observed during the vibration test when the specified anode current is monitored. Tube rejection criterion for both tests is that the anode current of 8 microamperes will not change more than ±20 per cent upon completion of the vibration test for each axis.

Design Tests:

Vibration. These tests are performed under conditions equivalent to those described in MIL-E-5272C*, paragraph 4.7.14 and paragraph 4.7.14.1. The vibration cycle has a duration of one hour and two cycles are performed for each of the three orthogonal axes. The total test period for each tube is six hours.

Acceleration. These tests are performed in a centrifuge providing unidirectional acceleration by a method equivalent to that specified in MIL-E-5272C*, paragraph 4.16.3, Procedure III, except that tubes are subjected for one minute to an increased acceleration test level of 100 ± 10 g's in both directions of the three orthogonal axes. The tubes are non-operating during the test.

* Military Specification MIL-E-5272C (ASG), 13 April 1959; and Amendment 1, 5 January 1960.

OPERATING CONSIDERATIONS

The *operating stability* of the 4461 is dependent on the magnitude of the anode current and its duration. When operating at high average values of anode current, a drop in sensitivity (sometimes called fatigue) may be expected. The extent of the drop below the tabulated sensitivity values depends on the severity of the operating conditions. After a period of idleness, the 4461 usually recovers a substantial percentage of such loss in sensitivity.

It is recommended that the average anode current be well below the maximum rated value of 1 milliampere when stability of operation is important. When maximum stability is required, the average anode current should not exceed 10 microamperes.

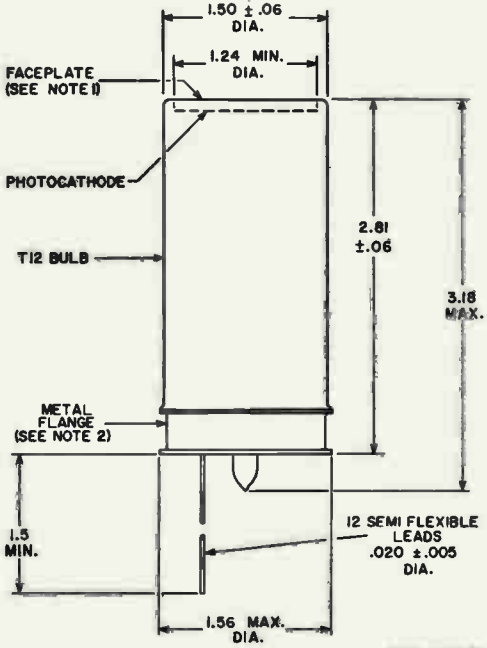
Electrostatic and/or *magnetic shielding* of the 4461 may be necessary.

Adequate *shielding* should be provided to prevent extraneous radiation from reaching any part of the 4461.

The *high voltages* at which the 4461 is operated are very dangerous. Before any part of the circuit is touched, the power supply switch should be turned off and both terminals of any capacitors grounded.

Accompanying *Typical Voltage-Divider Arrangement* is recommended for use with the 4461. *Resistance values* for the voltage-divider arrangement range from 10,000 ohms per stage to 1,000,000 ohms per stage. The choice of resistance values for the voltage-divider network is usually a compromise. If low values of resistance per stage are utilized, the power drawn from the regulated power supply and the required wattage rating of the resistors increase. Phototube noise may also increase due to heating if the divider network is near the photocathode. The use of resistance values near 1 megohm per stage may cause deviation from linearity if the voltage-divider current is not maintained at a value several times that of the maximum value of anode current, and may limit anode-current response to pulsed light. The latter effect may be reduced by connecting capacitors between the leads for dynodes No. 7 and No. 8, dynodes No. 8 and No. 9, dynodes No. 9 and No. 10, and between dynode No. 10 and anode return. In addition to non-linearity and pulse-limiting effects, the use of resistance values exceeding 1 megohm per stage make the 4461 more susceptible to leakage effects between terminals with possible resulting deviation in interstage voltage leading to a loss of current amplification.

DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

Center line of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base flange.

Note 1: Deviation from flatness within the 1.24 inch diameter area will not exceed 0.010 inch from peak to valley.

Note 2: The metal flange should never be employed for mechanical mounting purposes.

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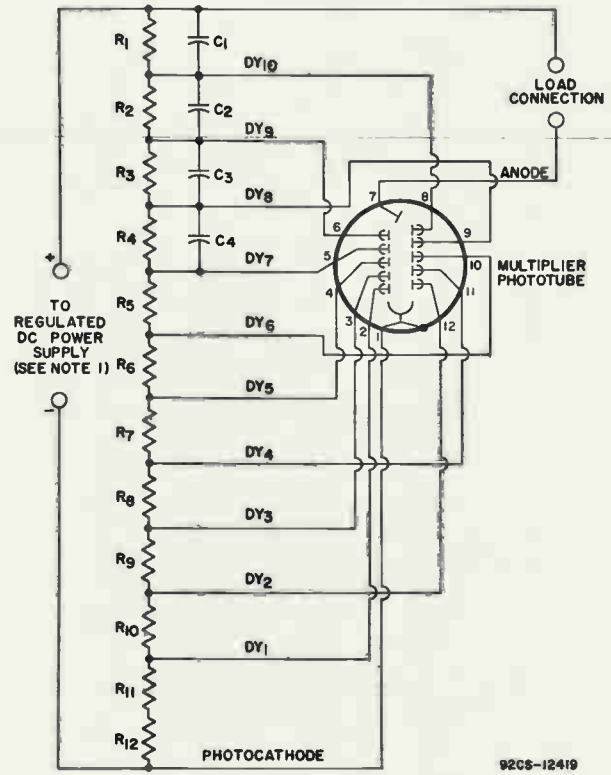
TYPICAL VOLTAGE-DIVIDER ARRANGEMENT

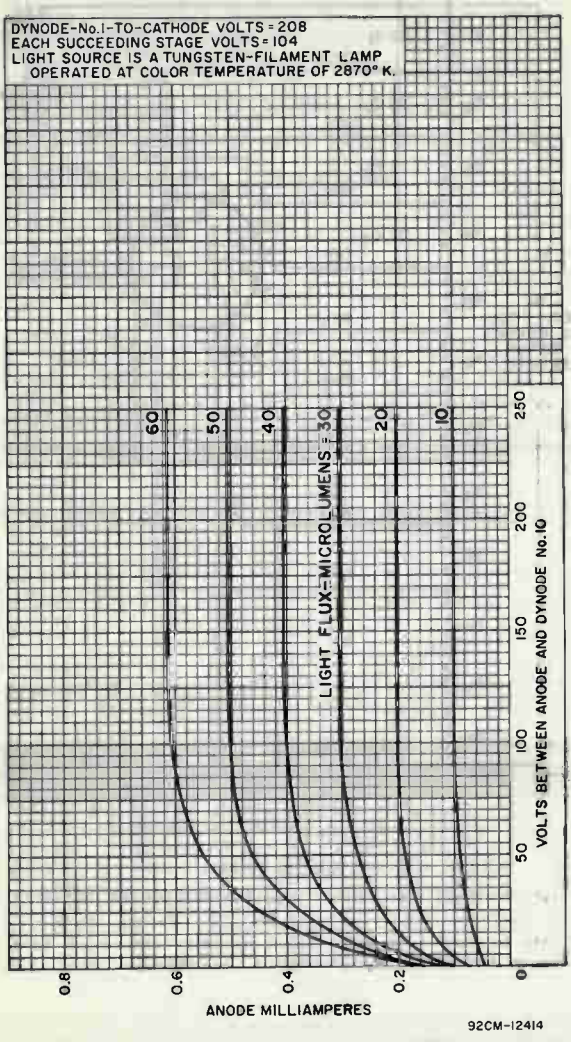


C_1: 0.05 μf, 500 volts (dc working)
C_2: 0.02 μf, 500 volts (dc working)
C_3: 0.01 μf, 500 volts (dc working)
C_4: 0.005 μf, 500 volts (dc working)
R_1 through R_{12}: 33,000 ohms, 2 watts

Note 1: Adjustable between approximately 500 and 1500 volts DC.

Note 2: Capacitors C_1 through C4 should be connected at tube socket for optimum high-frequency performance.

Typical Anode Characteristics



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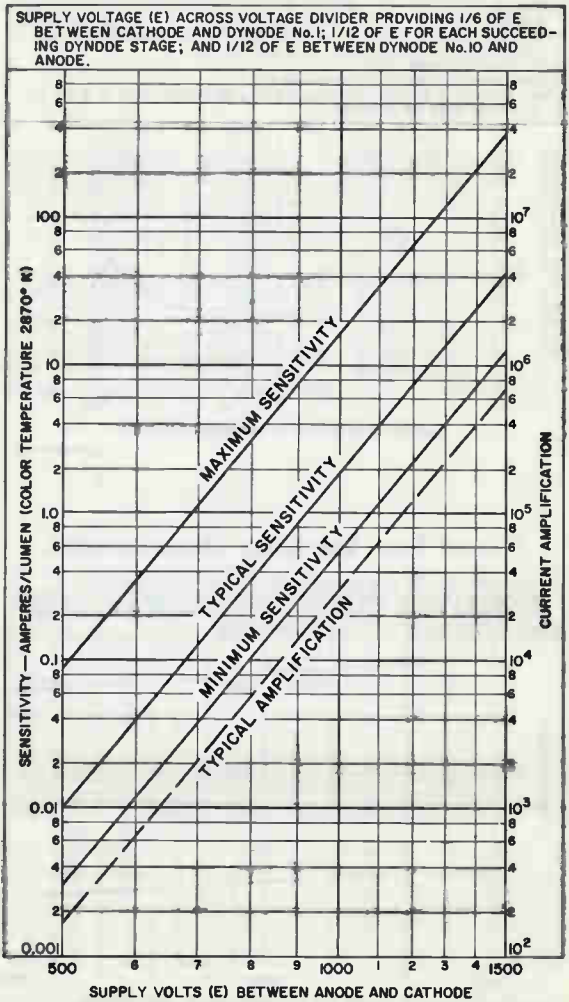
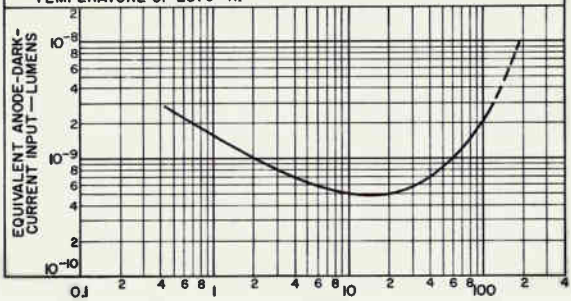
Typical Sensitivity And Current Amplification Characteristics



Typical Anode-Dark-Current Characteristic

LUMINOUS SENSITIVITY IS VARIED BY ADJUSTING THE SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER WHICH PROVIDES 1/6 OF E BETWEEN CATHODE AND DYNODE No1; 1/12 OF E FOR EACH SUCCEEDING STAGE; AND 1/12 OF E BETWEEN DYNODE No. 10 AND ANODE.
TUBE TEMPERATURE = 25° C
DASHED PORTION INDICATES INSTABILITY.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.



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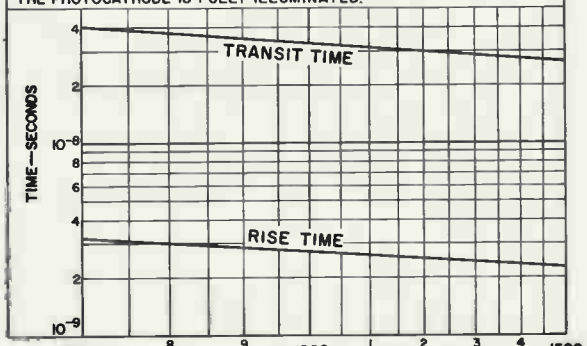
Typical Time Resolution Characteristics

SUPPLY VOLTAGE (E) ACROSS VOLTAGE DIVIDER PROVIDING 1/6 OF E BETWEEN CATHODE AND DYNODE No. 1; 1/12 OF E FOR EACH SUCCEEDING DYNODE STAGE; AND 1/12 OF E BETWEEN DYNODE No.10 AND ANODE.
THE PHOTOCATHODE IS FULLY ILLUMINATED.



92CS-12408

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Multiplier Phototube

S-20 RESPONSE

10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE

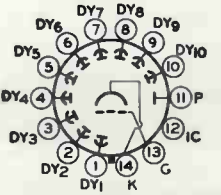
VENETIAN-BLIND-TYPE DYNODE STRUCTURE

For Photometry, Flying-Spot Scanning, and Scintillation-Counter Equipment Requiring Low-Dark Current and High Sensitivity Over a Wide Spectrum (Blue through Near-Infrared).

General:

Spectral Response	S-20
Wavelength of Maximum Response	4200 ± 500 angstroms
Cathode, Semitransparent	Potassium-Sodium-Cesium-Antimony (Multialkali)
Shape	Flat, Circular
Minimum area	2.2 sq. in.
Minimum diameter	1.68 in.
Window	Borosilicate Glass[a]
Index of refraction at 3893 angstroms	1.48
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No. 10	7 pf
Anode to all other electrodes	8.5 pf
Maximum Overall Length	5.81"
Seated Length	4.87" ± 0.19"
Maximum Diameter	2.31"
Operating Position	Any
Weight (Approx.)	7 oz
Bulb	T16
Socket	Cinch[b] No. 3M14, or equivalent
Magnetic Shield	JAN[c] No. S-2004, or equivalent
Base	Medium-Shell Diheptal 14-Pin (JEDEC Group 5, No. B14-38), Non-hygroscopic
Basing Designation for BOTTOM VIEW	14AA

Pin 1 – Dynode No. 1
Pin 2 – Dynode No. 2
Pin 3 – Dynode No. 3
Pin 4 – Dynode No. 4
Pin 5 – Dynode No. 5
Pin 6 – Dynode No. 6
Pin 7 – Dynode No. 7
Pin 8 – Dynode No. 8
Pin 9 – Dynode No. 9
Pin 10 – Dynode No. 10
Pin 11 – Anode
Pin 12 – Do Not Use
Pin 13 – Focusing Electrode
Pin 14 – Photocathode



DIRECTION OF RADIATION: INTO END OF BULB

Maximum Ratings, ***Absolute-Maximum Values:***

DC Supply Voltage:		
Between anode and cathode	2500 max.	volts
Between anode and dynode No. 10	300 max.	volts
Between consecutive dynodes	300 max.	volts
Between dynode No. 1 and cathode	600 max.	volts
Between focusing electrode and cathode	600 max.	volts
Average Anode Current[d]	1 max.	ma
Ambient Temperature	85 max.	°C

Characteristics Range Values:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No. 1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between anode and dynode No. 10. Focusing-electrode voltage is adjusted to that value between 50 and 100 per cent of dynode-No. 1 potential (referred to cathode) which provides maximum anode current.

With E = 2000 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	1.1×10^{4}	–	a/w
Cathode radiant, at 4200 angstroms	–	6.8×10^{-2}	–	a/w
Luminous, at 0 cps[e]	12	25	240	a/lm
Cathode luminous:				
With tungsten light source[f]	1.2×10^{-4}	1.6×10^{-4}	–	a/lm
With blue light source[g,h]	5×10^{-8}	–	–	a
With red light source[j,k]	3×10^{-7}	–	–	a
Current Amplification	–	1.6×10^{5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 12 a/lm[m]	–	4×10^{-10}	1×10^{-9}	lm
Equivalent Noise Input	–	–	3.8×10^{-12}	lm
Anode-Pulse Rise Time[n]	–	9.8×10^{-9}	–	sec
Electron Transit Time[p]	–	5.2×10^{-8}	–	sec

With E = 1500 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	2.1×10^{3}	–	a/w
Cathode radiant, at 4200 angstroms	–	6.8×10^{-2}	–	a/w
Luminous, at 0 cps[e]	–	5	–	a/lm

	Min.	Typ.	Max.	
Cathode luminous:				
With tungsten light source[f] .	1.2×10^{-4}	1.6×10^{-4}	-	a/lm
With blue light source[g,h] . . .	5×10^{-8}	-	-	a
With red light source[j,k] . . .	3×10^{-7}	-	-	a
Current Amplification	-	3.1×10^{6}	-	
Equivalent Anode-Dark Current Input at a luminous sensitivity of 12 a/lm[m]	-	4×10^{-10}	1×10^{-9}	lm

[a] Corning No.7056 made by Corning Glass Works, Corning, New York, or equivalent.

[b] Made by Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago 24, Illinois.

[c] Made by JAN Hardware Manufacturing Company, 38-01 Queens Blvd., Long Island City 1, New York.

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

[e] 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 1 microlumen is used.

[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. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[g] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[h] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

[j] Under the following conditions: Light incident on the cathode is transmitted through a red filter (Corning C.S. No.2-62, 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[k] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Red Filter* at front of this Section.

[m] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[n] 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.

[p] 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.

OPERATING CONSIDERATIONS

The *operating stability* of the 4463 is dependent on the magnitude of the anode current and its duration. When the 4463 is operated at high average values of anode current, a drop in sensitivity (sometimes called fatigue) may be expected. The extent of the drop below the tabulated sensitivity values depends on the severity of the operating conditions. After a period of idleness, the 4463 usually recovers a substantial percentage of such loss in sensitivity.

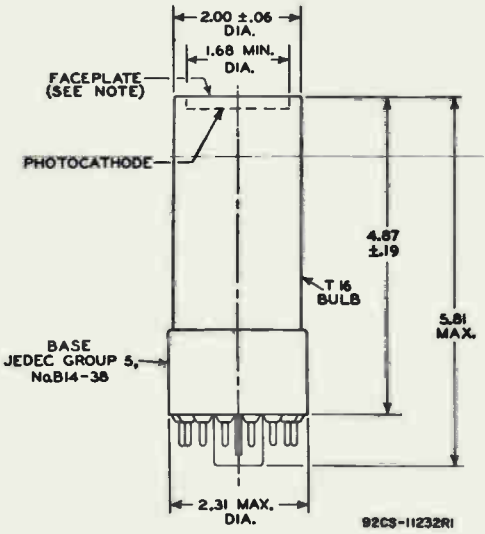
It is recommended that the average anode current be well below the maximum-rated value of 1 milliampere when stability of operation is important. When maximum stability is required, the average anode current should not exceed 10 microamperes.

Electrostatic and/or *magnetic shielding* of the 4463 may be necessary.

Adequate *shielding* should be provided to prevent extraneous radiation from reaching any part of the 4463.

The *high voltages at which the 4463 is operated are very dangerous.* Care should be taken in the design of apparatus to prevent the operator from coming in contact with these high voltages. Precautions should include the enclosure of high-potential terminals and the use of interlock switches to break the primary circuit of the high-voltage power supply when access to the apparatus is required.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-20 RESPONSE is shown at the front of this Section



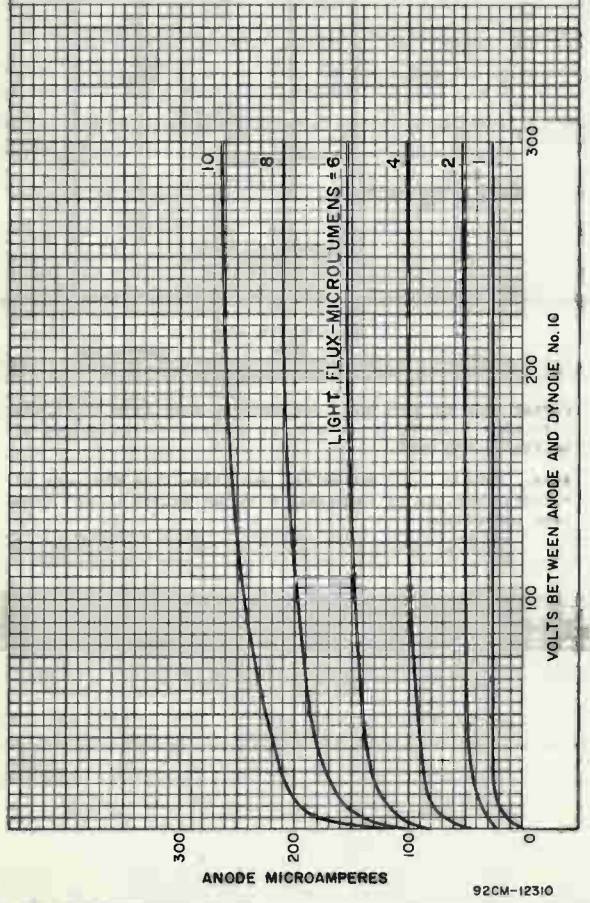
DIMENSIONS IN INCHES

Center line of bulb will not deviate more than 2^{o} in any direction from the perpendicular erected at the center of bottom of the base.

Note: Within 1.68" diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

TYPICAL ANODE CHARACTERISTICS

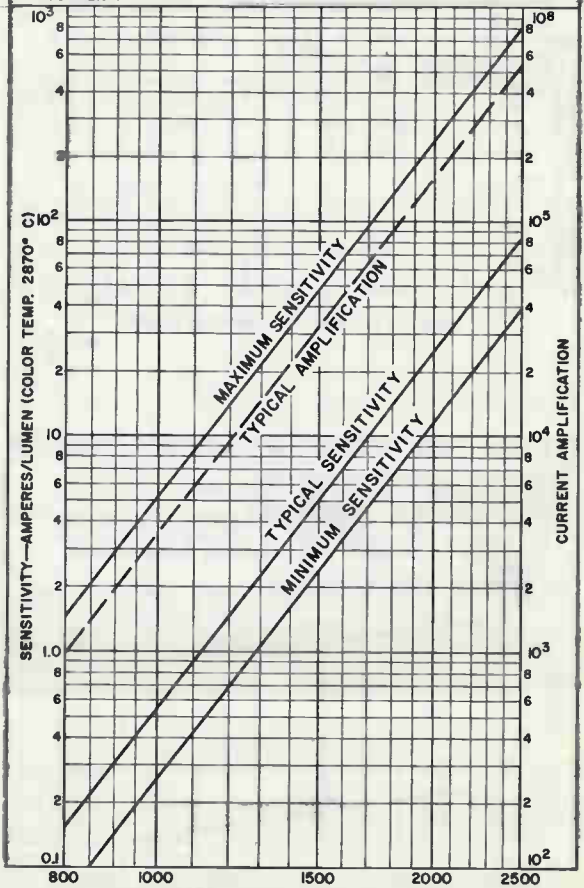
DYNODE No.1-TO-CATHODE VOLTS = 250
EACH SUCCEEDING DYNODE-STAGE VOLTS = 125
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No.1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.



92CM-12310

SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

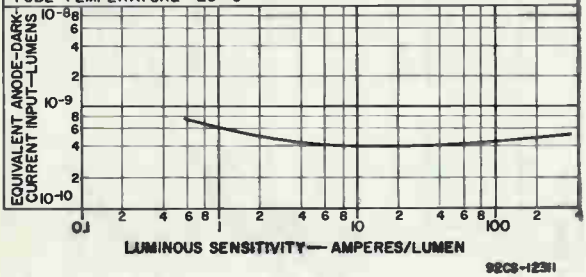
DYNODE No. 1-TO-CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNODE-STAGE VOLTS = 1/12 E
ANODE-TO-DYNODE No. 10 VOLTS = 1/12 E
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.



92CM-12312

TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

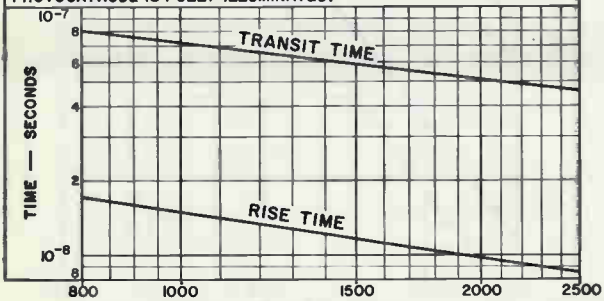
LUMINOUS SENSITIVITY IS VARIED BY ADJUSTMENT OF THE SUPPLY VOLTAGE (E).
DYNODE No. 1-TO-CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNODE-STAGE VOLTS = 1/12 E
ANODE-TO-DYNODE No. 10 VOLTS = 1/12 E
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.
TUBE TEMPERATURE = 25° C



92CS-12311

TYPICAL TIME RESOLUTION CHARACTERISTICS

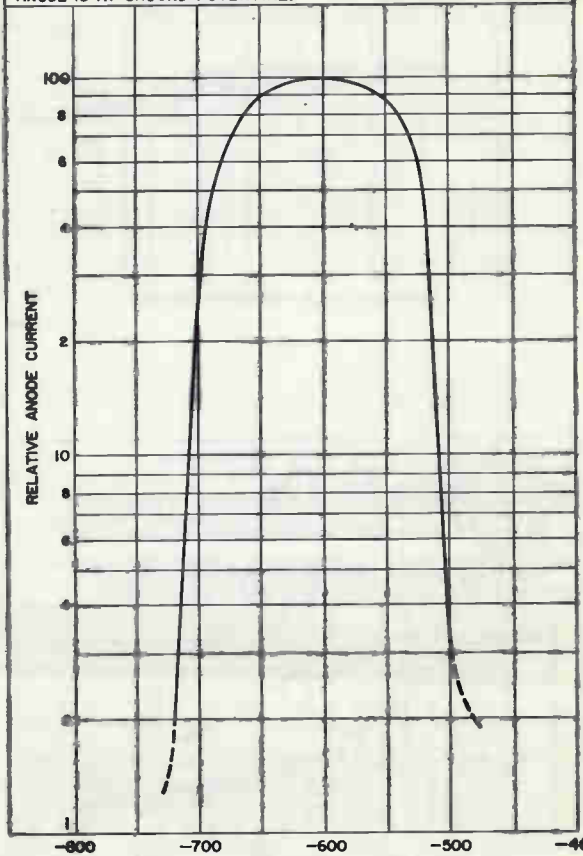
DYNODE No. 1-TO-CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNODE-STAGE VOLTS = 1/12 E
ANODE-TO-DYNODE No. 10 VOLTS = 1/12 E
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
PHOTOCATHODE IS FULLY ILLUMINATED.



92CS-12309

TYPICAL ANODE-CURRENT CHARACTERISTIC

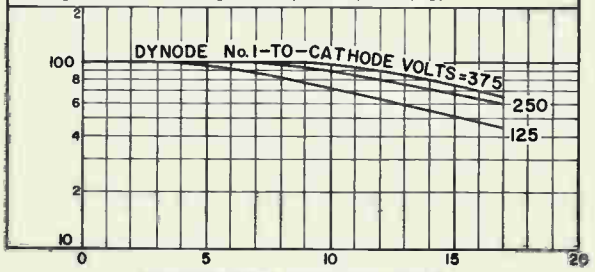
DYNODE No.1-TO-CATHODE VOLTS = 200
VOLTS PER SUCCEEDING DYNODE STAGE EXCEPT FOR DYNODE-No.5 STAGE = 100
ANODE-TO-DYNODE No.10 VOLTS = 100
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No.1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
ANODE IS AT GROUND POTENTIAL.



92CM-11078R1

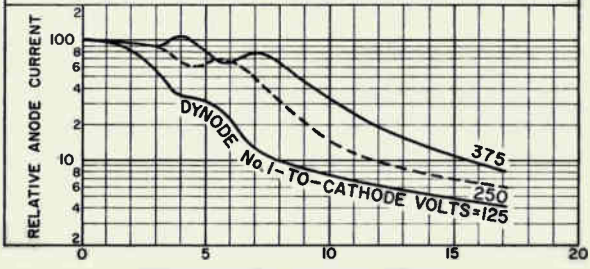
TYPICAL ANODE-CURRENT CHARACTERISTICS

DYNODE No. 1-TO-CATHODE VOLTS = AS INDICATED
EACH SUCCEEDING DYNODE-STAGE VOLTS = 125
ANODE-TO-DYNODE No. 10 VOLTS = 125
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
PHOTOCATHODE FULLY ILLUMINATED BY A POINT LIGHT SOURCE POSITIONED APPROX. 1 FOOT FROM CENTER OF TUBE FACE.
MAGNETIC FIELD PARALLEL TO MAJOR AXIS OF TUBE.



92CS-11235R2

DYNODE No. 1-TO-CATHODE VOLTS = AS INDICATED
EACH SUCCEEDING DYNODE-STAGE VOLTS = 125
ANODE-TO-DYNODE No. 10 VOLTS = 125
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
PHOTOCATHODE FULLY ILLUMINATED BY A POINT LIGHT SOURCE POSITIONED APPROX. 1 FOOT FROM CENTER OF TUBE FACE.
MAGNETIC FIELD PERPENDICULAR TO MAJOR AXIS OF TUBE.



92CS-11236R2

Multiplier Phototube

S-20 RESPONSE

10-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE

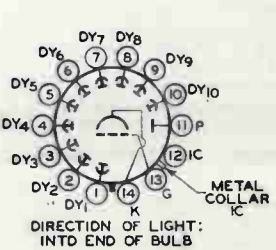
VENETIAN-BLIND-TYPE DYNODE STRUCTURE

For Photometry, Flying-Spot Scanning, and Scintillation-Counter Equipment Requiring Low-Dark Current and High Sensitivity Over a Wide Spectrum (Blue through Near-Infrared).

General:

Spectral Response	S-20
Wavelength of Maximum Response	4200 ± 500 angstroms
Cathode, Semitransparent	K-Na-Cs-Sb (Multialkali)
Shape	Flat, Circular
Minimum area	5.27 sq. in.
Minimum diameter	2.59 in.
Window	Lime Glass[a]
Index of refraction at 5893 angstroms	1.51
Dynode Material	Copper-Beryllium
Direct Interelectrode Capacitances (Approx.):	
Anode to dynode No.10	7 pf
Anode to all other electrodes	8.5 pf
Maximum Overall Length	6.31"
Seated Length	5.38" ± 0.18"
Maximum Diameter	3.06"
Operating Position	Any
Weight (Approx.)	7 oz
Bulb	J24
Socket	Cinch[b] No.3M14, or equivalent
Magnetic Shield	Perfection Mica Co.[c], or equivalent
Base	Medium-Shell Diheptal 14-Pin (JEDEC Group 5, No.B14-45) Non-hygroscopic
Basing Designation for BOTTOM VIEW	14AM

Pin 1 – Dynode No.1
Pin 2 – Dynode No.2
Pin 3 – Dynode No.3
Pin 4 – Dynode No.4
Pin 5 – Dynode No.5
Pin 6 – Dynode No.6
Pin 7 – Dynode No.7
Pin 8 – Dynode No.8
Pin 9 – Dynode No.9
Pin 10 – Dynode No.10
Pin 11 – Anode
Pin 12 – Do Not Use
Pin 13 – Focusing Electrode
Pin 14 – Photocathode
Metal Collar – Do Not Use



Maximum Ratings, *Absolute-Maximum Values:*

DC Supply Voltage:		
Between anode and cathode	2500 max.	volts
Between anode and dynode No.10	300 max.	volts
Between consecutive dynodes	300 max.	volts
Between dynode No.1 and cathode	600 max.	volts
Between focusing electrode and cathode	600 max.	volts
Average Anode Current[d]	1 max.	ma
Ambient Temperature	85 max.	°C

Characteristics Range Values:

Under conditions with dc supply voltage (E) across a voltage divider providing 1/6 of E between cathode and dynode No.1; 1/12 of E for each succeeding dynode stage; and 1/12 of E between anode and dynode No.10. Focusing-electrode voltage is adjusted to that value between 50 and 100 per cent of dynode-No.1 potential (referred to cathode) which provides maximum anode current.

With E = 2000 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	1.1×10^{4}	–	a/w
Cathode radiant, at 4200 angstroms	–	6.8×10^{-2}	–	a/w
Luminous, at 0 cps[e]	12	25	240	a/lm
Cathode luminous:				
With tungsten light source[f]	1.2×10^{-4}	1.6×10^{-4}	–	a/lm
With blue light source[g,h]	5×10^{-8}	–	–	a
With red light source[j,k]	3×10^{-7}	–	–	a
Current Amplification	–	1.6×10^{5}	–	
Equivalent Anode-Dark-Current Input at a luminous sensitivity of 12 a/lm[m]	–	4×10^{-10}	1×10^{-9}	lm
Equivalent Noise Input	–	–	3.8×10^{-12}	lm
Anode-Pulse Rise Time[n]	–	1.16×10^{-8}	–	sec
Electron Transit Time[p]	–	5.8×10^{-8}	–	sec

With E = 1500 volts (Except as noted)

	Min.	*Typ.*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	–	2.1×10^{3}	–	a/w
Cathode radiant, at 4200 angstroms	–	6.8×10^{-2}	–	a/w
Luminous, at 0 cps[e]	–	5	–	a/lm

	Min.	Typ.	Max.	
Cathode luminous:				
With tungsten light source[f]	1.2×10^{-4}	1.6×10^{-4}	-	a/lm
With blue light source[g,h]	5×10^{-8}	-	-	a
With red light source[j,k]	3×10^{-7}	-	-	a
Current Amplification	-	3.1×10^{4}	-	
Equivalent Anode-Dark Current Input at a luminous sensitivity of 12 a/lm[m]	-	4×10^{-10}	1×10^{-9}	lm

[a] Corning No.0080 made by Corning Glass Works, Corning, New York, or equivalent.

[b] Made by Cinch Manufacturing Company, 1026 South Homan Avenue, Chicago 24, Illinois.

[c] Magnetic shielding material 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.

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

[e] 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 1 microlumen is used.

[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. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[g] 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[h] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Blue Filter* at front of this Section.

[j] Under the following conditions: Light incident on the cathode is transmitted through a red filter (Corning C.S. No.2-62, 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 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.

[k] See *Spectral Characteristic of 2870° K Light Source and Spectral Characteristic of Light from 2870° K Source after passing through Indicated Red Filter* at front of this Section.

[m] At a tube temperature of 25° C. Dark current may be reduced by use of a refrigerant.

[n] 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.

[p] 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.

OPERATING CONSIDERATIONS

It is recommended that the average anode current be well below the maximum-rated value of 1 milliampere when stability of operation is important. When maximum stability is required, the average anode current should not exceed 10 microamperes.

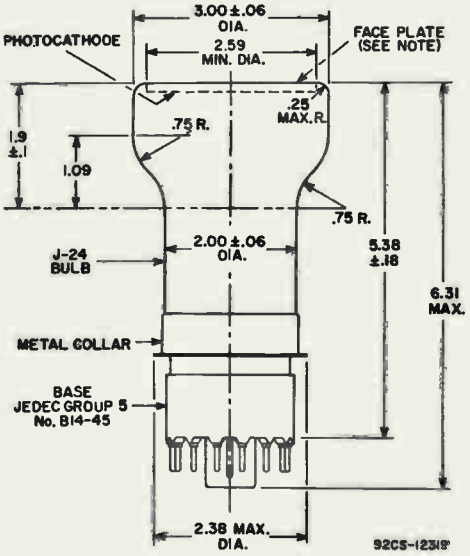
Electrostatic and/or *magnetic shielding* of the 4464 may be necessary.

Adequate *shielding* should be provided to prevent extraneous radiation from reaching any part of 4464.

The *operating stability* of the 4464 is dependent on the magnitude of the anode current and its duration. When the 4464 is operated at high average values of anode current, a drop in sensitivity (sometimes called fatigue) may be expected. The extent of the drop below the tabulated sensitivity values depends on the severity of the operating conditions. After a period of idleness, the 4464 usually recovers a substantial percentage of such loss in sensitivity.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-20 RESPONSE is shown at the front of this Section

TYPICAL VOLTAGE-DIVIDER ARRANGEMENT shown under Type 4463 also applies to Type 4464



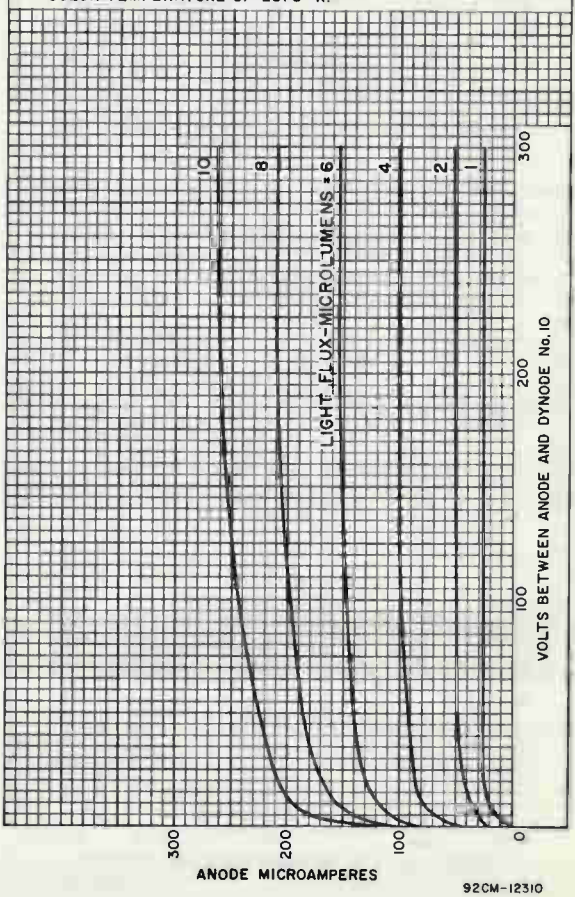
DIMENSIONS IN INCHES

Center line of bulb will not deviate more than 2° in any direction from the perpendicular erected at the center of bottom of the base.

NOTE: Within 2.59" diameter, deviation from flatness of external surface of faceplate will not exceed 0.010" from peak to valley.

TYPICAL ANODE CHARACTERISTICS

DYNODE No.1-TO-CATHODE VOLTS = 250
EACH SUCCEEDING DYNODE-STAGE VOLTS = 125
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No.1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.



92CM-12310

SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

DYNODE No. 1-TO-CATHODE VOLTS = 1/6 E
EACH SUCCEEDING DYNODE-STAGE VOLTS = 1/12 E
ANODE-TO-DYNODE No. 10 VOLTS = 1/12 E
FOCUSING-ELECTRODE VOLTAGE IS ADJUSTED TO THAT VALUE BETWEEN 50 AND 100 PER CENT OF DYNODE No. 1 POTENTIAL (REFERRED TO CATHODE) WHICH PROVIDES MAXIMUM ANODE CURRENT.