

Photomultiplier Tube

Small, $\frac{3}{4}$ "-Diameter, 10-Stage, Head-On Type
Having S-11 Spectral Response

For Use In Compact Scintillation Counting Systems And
In Other Applications Involving The Detection And Mea-
surement Of Low-Level Light Sources

GENERAL

Spectral Response	S-11
Wavelength of Maximum Response	$4400 \pm 500 \text{ \AA}$
Cathode, Semitransparent	Cesium-Antimony
Minimum projected area	$0.2 \text{ in}^2 (1.26 \text{ cm}^2)$
Minimum diameter	0.5 in (1.27 cm)
Window	Lime Glass (Corning ^a No.0080), or equivalent
Shape	Plano-Concave
Index of refraction at 4360 angstroms	1.523

Dynodes:

Substrate	Copper-Beryllium
Secondary-Emitting Surface	Beryllium-Oxide
Structure	In-Line, Electrostatic-Focus Type

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) 3.94 in (10 cm) ←

Maximum Diameter	0.78 in (2 cm)
Tub	T6

Base See Dimensional Outline

Magnetic Shield Millen^b Part No.80801N, or equivalent

Operating Position Any

Weight (Approx.) 0.9 oz (25.5 g)

MAXIMUM RATINGS, Absolute-Maximum Values

DC Supply voltage:

Between anode and cathode	1500 max.	V
Between anode and dynode No.10	300 max.	V
Between consecutive dynodes	200 max.	V
Between dynode No.1 and cathode	400 max.	V

Average Anode Current^d 0.5 max. mA

Ambient Temperature^e 75 max. °C

CHARACTERISTICS RANGE VALUES FOR EQUIPMENT DESIGN

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

With E = 1250 volts (Except as noted)

	Min.	Typical	Max.	
Anode Sensitivity:				
Radiant ^f at 4400 angstroms . . .	—	1.3×10^4	—	A/W
Luminous ^g (2870° K)	7	16	60	A/lm
Cathode Sensitivity:				
Radiant ^h at 4400 angstroms . . .	—	0.048	—	A/W
Luminous ⁱ (2870° K)	4×10^{-5}	6×10^{-5}	—	A/lm
Current with blue light source ^k (2870° K + C.S. No.5-58) . . .	4×10^{-8}	6×10^{-8}	—	A
Quantum Efficiency at 4200 angstroms . .	—	14	—	%
Current Amplification.	—	2.7×10^5	—	
Anode Dark Current ^m .	—	4×10^{-9}	4×10^{-8}	A
Equivalent Anode Dark Current Input ^m	}	5×10^{-10}	5×10^{-9}	lm
		6×10^{-13n}	6×10^{-12n}	W
Equivalent Noise Input ^p	}	3.2×10^{-12}	—	lm
		4×10^{-15q}	—	W
Anode-Pulse Rise Timer, ^s at 1500 V . . .	—	1.8×10^{-9}	—	s
Electron Transit Time ^{r,t} at 1500 V	—	2×10^{-8}	—	s

^a Made by Corning Glass Works. Corning, New York 14830.

^b Made by James Millen Manufacturing Company, 150 Exchange Street, Malden, MA 02148.

^d Averaged over any interval of 30 seconds maximum.

^e Tube operation at room temperature or below is recommended.

^f This value is calculated from the typical anode luminous sensitivity rating using a conversion factor of 803 lumens per watt.

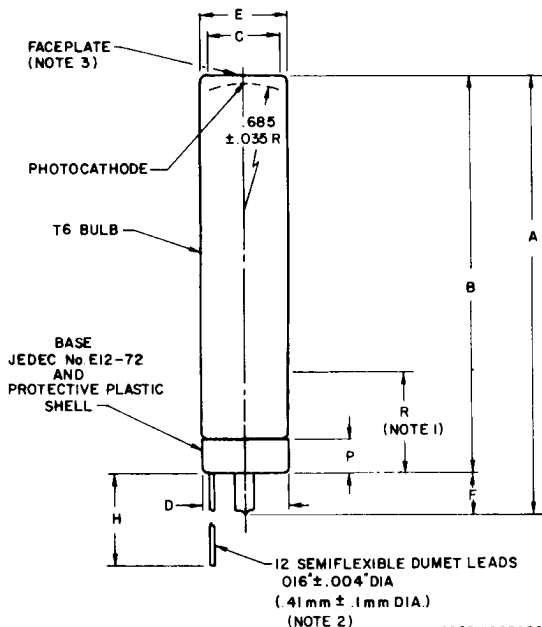
^g Under the following conditions: The light source is a tungsten-filament lamp having a lime-glass envelope. It is operated at a color temperature of 2870° K and a light input of 10 microlumens is used.

—> Indicates a change or addition.

- ^h This value is calculated from the typical cathode luminous sensitivity rating using a conversion factor of 803 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. The value of light flux is 0.01 lumen and 200 volts are applied between cathode and all other electrodes connected as anode.
- ^c 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.
- ^m At a tube temperature of 22° C. With supply voltage adjusted to give a luminous sensitivity of 7.5 amperes per lumen. Dark current caused by thermionic emission may be reduced by use of a refrigerant.
- ⁿ At 4400 angstroms. These values are calculated from the EADCI values in lumens using a conversion factor of 803 lumens per watt.
- ^p 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.
- ^q At 4400 angstroms. This value is calculated from the ENI value in lumens using a conversion factor of 803 lumens per watt.
- ^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.

DIMENSIONAL OUTLINE



92CS-10659R2

Dimensions	Inches	mm
A	3.94 max.	100.0 max.
B	3.50 + .06 - .12	88.9 + 1.5 - 3
C	.5 min. dia.	12.7 min. dia.
D	.78 max. dia.	19.8 max. dia.
E	.755 max. dia.	19.18 max. dia.
F	.38 max.	9.7 max.
G	.47 \pm .01 dia.	11.9 \pm .25 dia.
H	.75 min.	19.0 min.
P	.30 max.	7.6 max.
R	1.0 max.	25 max.

DIMENSIONAL OUTLINE NOTES

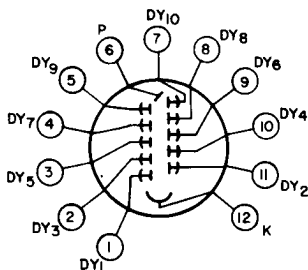
Note 1: Within this length, maximum diameter of tube is 1.78".

Note 2: The semiflexible leads of the tube may be soldered or welded into the associated circuit. If desired, the leads may be trimmed to within 1/4 inch of the protective shell. Care must be exercised when making such connections to prevent tube destruction due to thermal stress of the glass-metal seals. A heat sink placed in contact with the semiflexible leads between the point being soldered, or welded, and the protective shell is recommended. Excessive bending of the leads is to be avoided.

Note 3: Deviation from flatness will not exceed 0.006" from peak to valley.

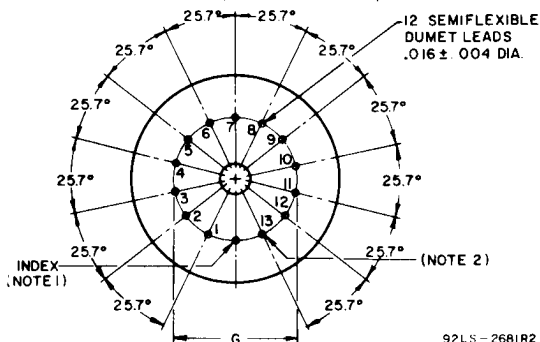
LEAD CONNECTIONS (BOTTOM VIEW)

- 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



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Lead 12: Photocathode

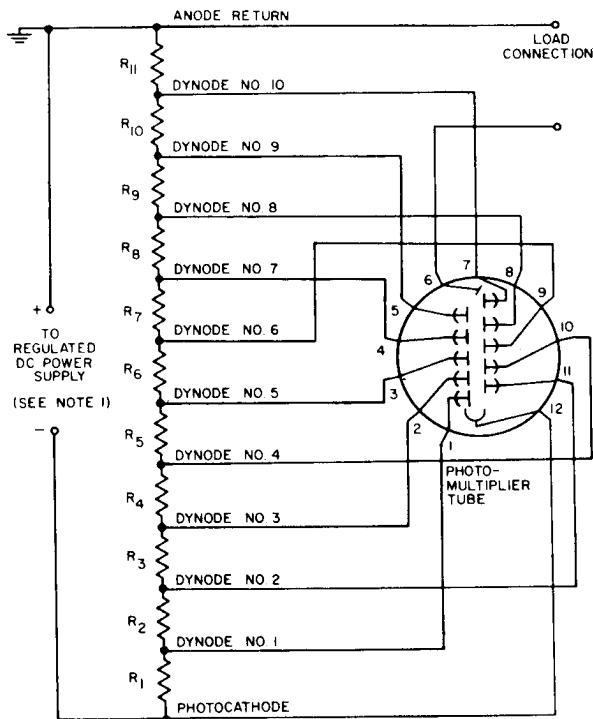
LEAD ORIENTATION (BOTTOM VIEW)

LEAD ORIENTATION NOTES

Note 1: Lead No.14 is cut off within 0.04 inch of the glass button for indexing.

Note 2: Lead No.13 is cut off within 0.04 inch of the glass button.

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



92LM-1927

R_1 and R_2 : 560,000 ohms, 1/2 watt

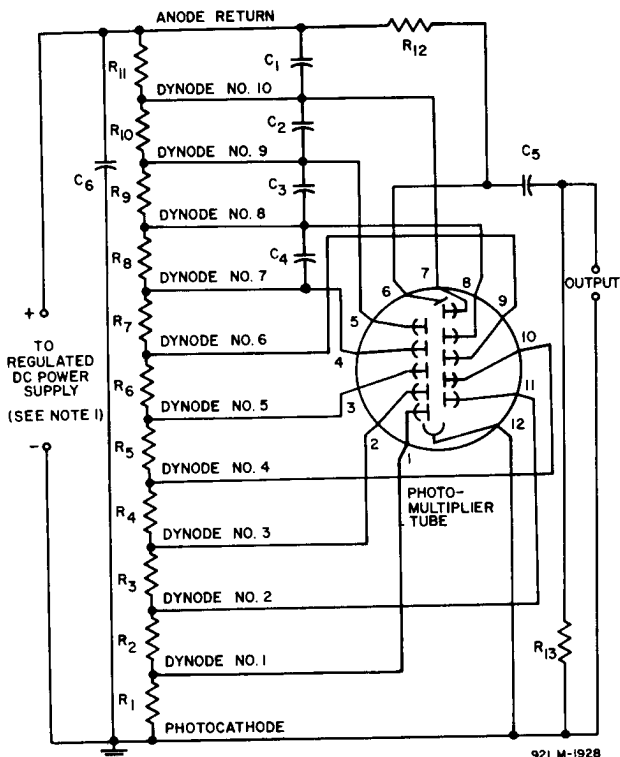
R_3 : 820,000 ohms, 1/2 watt

R_4 through R_{11} : 470,000 ohms, 1/2 watt

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

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

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



C₁: 0.05 μ F, 500 volts (dc working)

C₂: 0.02 μ F, 500 volts (dc working)

C₃: 0.01 μ F, 500 volts (dc working)

C₄: 0.005 μ F, 500 volts (dc working)

C₅ and C₆: 0.005 μ F, 3000 volts (dc working)

R₁ and R₂: 560,000 ohms, 1/2 watt

R₃: 820,000 ohms, 1/2 watt

R₄ through R₁₁: 470,000 ohms, 1/2 watt

R₁₂: 1 megohm, 1/2 watt

R₁₃: 100,000 ohms, 1/2 watt

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

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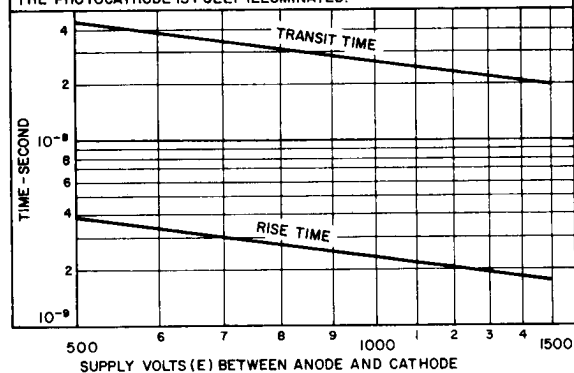
Note 2: Capacitors C_1 through C_6 should be connected at tube socket for optimum high-frequency performance.

Note 3: Component values are dependent upon nature of application and output signal desired.

TABLE I	
TYPICAL POTENTIAL DISTRIBUTION	
Between:	8.25% of Supply Voltage (E) Multiplied by:
Cathode and Dynode No.1	1.2
Dynode No.1 and Dynode No.2	1.2
Dynode No.2 and Dynode No.3	1.7
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	12.1

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.

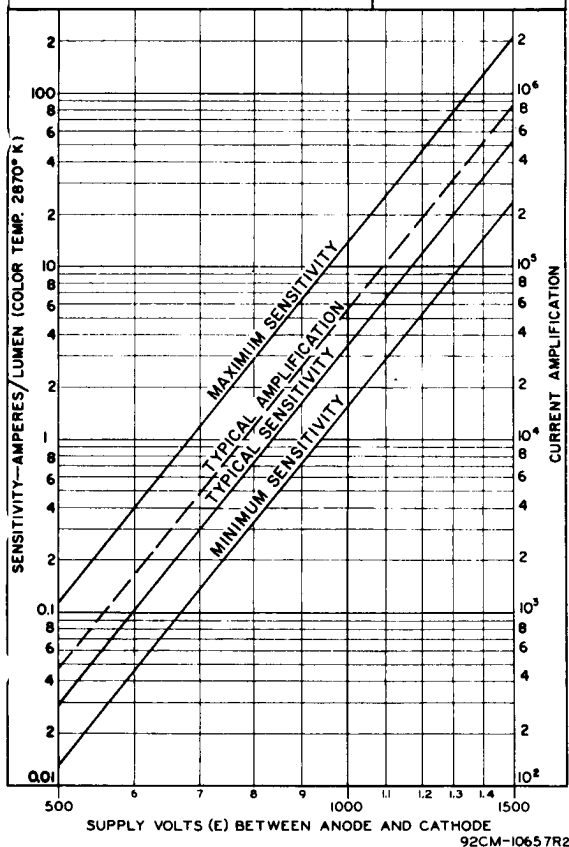


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SENSITIVITY AND CURRENT AMPLIFICATION CHARACTERISTICS

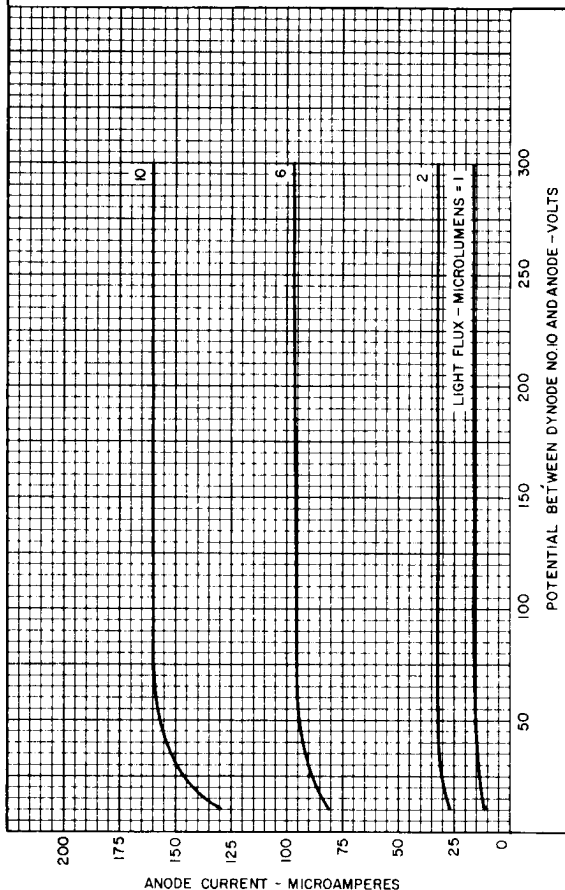
THE SUPPLY VOLTAGE (E) ACROSS A VOLTAGE DIVIDER WHICH PROVIDES VOLTAGES AS FOLLOWS:

BETWEEN	8.25% OF E MULTIPLIED BY
CATHODE AND DYNODE No. 1	1.2
DYNODE No. 1 AND DYNODE No. 2	1.2
DYNODE No. 2 AND DYNODE No. 3	1.7
EACH SUCCEEDING DYNODE-STAGE	1.0
ANODE AND CATHODE	12.1



TYPICAL ANODE CHARACTERISTICS

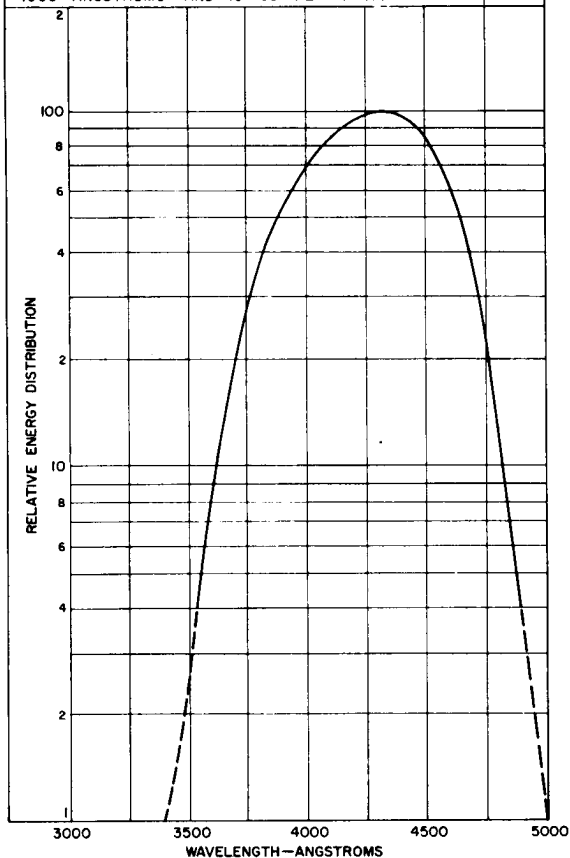
CATHODE - TO - DYNODE - NO.1 VOLTS = 124
 DYNODE - NO.1 - TO - DYNODE - NO. 2 VOLTS = 124
 DYNODE - NO.2 - TO - DYNODE - NO.3 - VOLTS = 175
 EACH SUCCEEDING DYNODE - STAGE VOLTS = 103
 LIGHT SOURCE IS A TUNGSTEN - FILAMENT LAMP OPERATED AT
 A COLOR TEMPERATURE OF 2870°K.



92 LM - 3020

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

SPECTRAL CHARACTERISTIC OF LIGHT FROM
2870° K SOURCE AFTER PASSING THROUGH BLUE
FILTER (CORNING C.S. No. 5-58 POLISHED TO
STOCK THICKNESS).
MAXIMUM FILTER TRANSMISSION OCCURS AT
4300 ANGSTROMS AND IS 60 PER CENT.



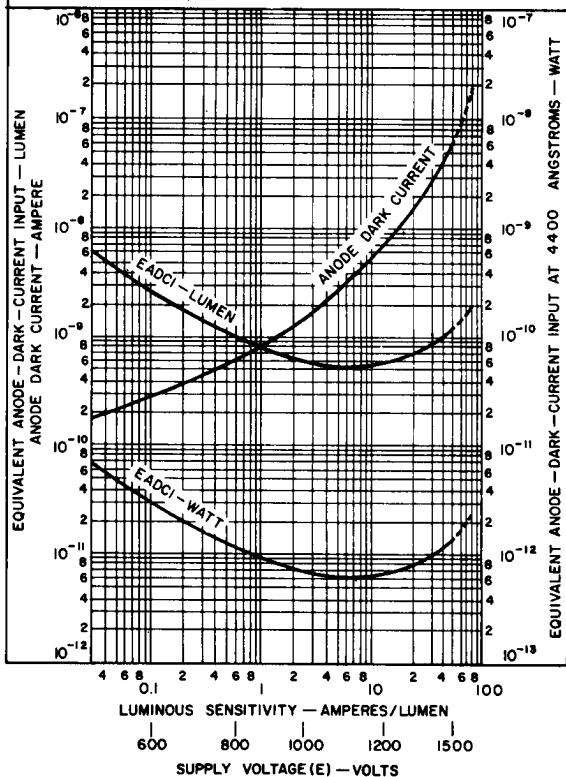
92CM-11081R1

TYPICAL ANODE 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	8.25% OF E MULTIPLIED BY
CATHODE AND DYNODE No.1	1.2
DYNODE No.1 AND DYNODE No.2	1.2
DYNODE No.2 AND DYNODE No.3	1.7
EACH SUCCEEDING DYNODE -STAGE	1.0
ANODE AND CATHODE	12.1

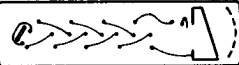
TUBE TEMPERATURE IS 22°C.



92LS-3028

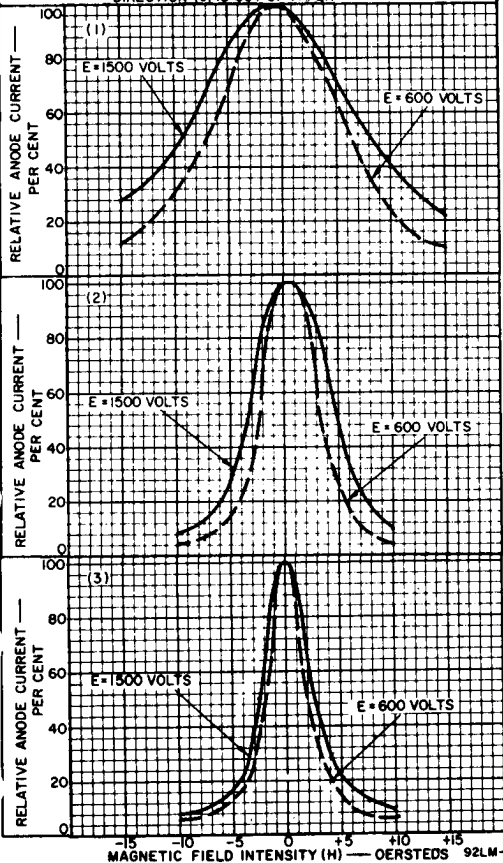
TYPICAL EFFECT OF INDICATED MAGNETIC FIELD ON ANODE CURRENT

SUPPLY VOLTAGE E IS 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. PHOTOCATHODE IS FULLY ILLUMINATED. TUBE IS ORIENTED IN MAGNETIC FIELD AS SHOWN BELOW:



POSITIVE VALUE OF H IN DIRECTION SHOWN:
(1) \rightarrow , (2) \downarrow , (3) \bullet

* DIRECTION (3) IS OUT OF PAPER



TYPICAL SPECTRAL RESPONSE CHARACTERISTICS

