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# MULTIPLIER PHOTOTUBE

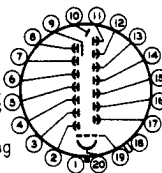
14-STAGE, HEAD-ON, SPHERICAL-FACEPLATE TYPE WITH 1.68"-DIA., SPHERICAL, SEMITRANSSPARENT PHOTOCATHODE AND S-11 RESPONSE VERY SHORT TIME-RESOLUTION CAPABILITY

## DATA

### General:

Spectral Response . . . . .		S-11
Wavelength of Maximum Response . . . . .	4400 ± 500 angstroms	
Cathode, Semitransparent:		
Shape . . . . .		Spherical
Window:		
Area . . . . .	2.2	sq. in.
Minimum diameter . . . . .	1.68	in.
Index of refraction . . . . .	1.51	
Direct Interelectrode Capacitances (Approx.):		
Anode to dynode No.14 . . . . .	2.4	μμf
Anode to all other electrodes . . . . .	5.5	μμf
Dynode No.14 to all other electrodes . . . . .	7.5	μμf
Maximum Overall Length . . . . .		7.5"
Seated Length . . . . .	6.69" ± 0.19"	
Maximum Diameter . . . . .		2.38"
Operating Position . . . . .		Any
Weight (Approx.) . . . . .		8 oz
Bulb . . . . .		T16
Socket . . . . .	Alden No.220FT with 20 contacts, or equivalent	
Base . . . . .	Small-Shell Bidecal 20-Pin (JETEC No.B20-102)	
Basing Designation for BOTTOM VIEW . . . . .		20D

Pin 1 - No Connection	Pin 14 - Dynode No.8
Pin 2 - Dynode No.1	Pin 15 - Dynode No.6
Pin 3 - Dynode No.3	Pin 16 - Dynode No.4
Pin 4 - Dynode No.5	Pin 17 - Dynode No.2
Pin 5 - Dynode No.7	Pin 18 - No Connection
Pin 6 - Dynode No.9	Pin 19 - Grid No.1 (Focusing Electrode)
Pin 7 - Dynode No.11	Pin 20 - Photocathode Metal Collar - No Connection (If used, connect only to photocathode)
Pin 8 - Dynode No.13	
Pin 9 - Grid No.2 (Accelerating Electrode)	
Pin 10 - Anode	
Pin 11 - Dynode No.14	
Pin 12 - Dynode No.12	
Pin 13 - Dynode No.10	



DIRECTION OF LIGHT: INTO END OF BULB



## MULTIPLIER PHOTOTUBE

### VERY-LOW-LIGHT-LEVEL, LOW-NOISE, HIGH-GAIN SERVICE

With supply voltage ( $E$ ) across voltage divider providing electrode voltages shown in Table I—Column A

#### Maximum Ratings, Absolute Values:

SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE (DC) . . . . .	2400 max.	volts
SUPPLY VOLTAGE BETWEEN DYNODE No.14 AND ANODE (DC) . . . . .	400 max.	volts
SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES (DC) . . . . .	500 max.	volts
SUPPLY VOLTAGE BETWEEN ACCELERATING ELECTRODE AND DYNODE No.13 (DC) . . . . .	±500 max.	volts
DYNODE-No.1 SUPPLY VOLTAGE (DC) . . . . .	400 max.	volts
FOCUSING-ELECTRODE SUPPLY VOLTAGE (DC) . . . . .	400 max.	volts
AVERAGE ANODE CURRENT* . . . . .	2 max.	ma
AMBIENT TEMPERATURE . . . . .	75 max.	°C

#### Characteristics Range Values for Equipment Design:

With  $E = 2000$  volts (except as noted) and focusing-electrode as well as accelerating-electrode voltage adjusted to give maximum gain

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4400 angstroms . . . . .	-	0.7	-	amp/ $\mu$ W
Cathode radiant, at 4400 angstroms . . . . .	-	0.056	-	$\mu$ a/ $\mu$ W
Luminous:*				
At 0 cps. . . . .	120	875	4500	amp/lumen
With dynode No.14 as output electrode† . . . . .	-	612	-	amp/lumen
Cathode luminous:				
With tungsten light source <sup>▲</sup> . . . . .	50	70	-	$\mu$ a/lumen
With blue light source <sup>**◆</sup> . . . . .	0.05	-	-	$\mu$ a
Current Amplification . . . . .	-	$12.5 \times 10^6$	-	
Equivalent Anode-Dark-Current Input <sup>■</sup> . . . . .	-	$5 \times 10^{-10}$	$2 \times 10^{-9}$	lumen
Equivalent Noise Input:*				
At +25° C . . . . .	-	$3.3 \times 10^{-12}$	$1.5 \times 10^{-11}$	lumen
At -50° C . . . . .	-	$9 \times 10^{-13}$	-	lumen
Anode-Pulse Rise Time <sup>□</sup> . . . . .	-	3	-	milli $\mu$ sec

\*, †, ▲, \*\*, ◆, ●, ■, ★, □: See next page.



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## MULTIPLIER PHOTOTUBE

	Min.	Median	Max.	
Greatest Delay Between Anode Pulses:				
Due to position from which electrons are simultaneously released within a circle centered on tube face and having a diameter of—				
1.12" . . . . .	-	0.5 <sup>†</sup>	-	milliμsec
1.5" . . . . .	-	1 <sup>†</sup>	-	milliμsec

## HIGH-OUTPUT-PULSE SERVICE

With supply voltage (E) across voltage divider providing electrode voltages shown in Table I—Column B

## Maximum Ratings, Absolute Values:

SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE (DC) . . . . .	2800 max.	volts
SUPPLY VOLTAGE BETWEEN DYNODE No.14 AND ANODE (DC) . . . . .	400 max.	volts
SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES (DC) . . . . .	500 max.	volts
SUPPLY VOLTAGE BETWEEN ACCELERATING ELECTRODE AND DYNODE No.13 (DC) . . . . .	±500 max.	volts
DYNODE—No.1 SUPPLY VOLTAGE (DC) . . . . .	400 max.	volts
FOCUSING—ELECTRODE SUPPLY VOLTAGE (DC) . . . . .	400 max.	volts
AVERAGE ANODE CURRENT* . . . . .	2 max.	ma
AMBIENT TEMPERATURE . . . . .	75 max.	°C

## Characteristics Range Values for Equipment Design:

With E = 2400 volts (except as noted) and focusing—electrode as well as accelerating—electrode voltage adjusted to give maximum gain

	Min.	Median	Max.	
Sensitivity:				
Radiant, at				
4400 angstroms. . . . .	-	0.7	-	amp/μW
Cathode radiant, at				
4400 angstroms. . . . .	-	0.056	-	μa/μW
Luminous:*				
At 0 cps. . . . .	-	875	-	amp/lumen
With dynode No.14 as output electrode† . . . . .	-	612	-	amp/lumen
Cathode luminous:				
With tungsten light source <sup>▲</sup> . . . . .	50	70	-	μa/lumen
With blue light source <sup>**♦</sup> . . . . .	0.05	-	-	μa

●, \*, †, ▲, \*\*, ♦, ◊, ★, □, ‡: See next page.



## MULTIPLIER PHOTOTUBE

	Min.	Median	Max.
Current Amplification. . .	-	$12.5 \times 10^6$	-
Equivalent Anode-Dark- Current Input*†. . . . .	-	$1.1 \times 10^{-9}$	- lumen
Equivalent Noise Input: **			
At +25° C. . . . .	-	$4.6 \times 10^{-12}$	- lumen
At -50° C. . . . .	-	$1.2 \times 10^{-12}$	- lumen

● Averaged over any interval of 30 seconds maximum.

\* Under the following conditions: The light source is a tungsten-filament lamp operated at a color temperature of 2870° K. A light input of 0.1 microlumen is used. The load resistor has a value of 0.01 megohm.

† An output current of opposite polarity to that obtained at the anode may be provided by using dynode No.14 as the output electrode. With this arrangement, the load is connected in the dynode-No.14 circuit and the anode serves only as collector.

▲ Under the following conditions: The light source is a tungsten-filament lamp 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 together as anode. The load resistor has a value of 0.01 megohm.

\*\* Under the following conditions: Light incident on the cathode is transmitted through a blue filter (Corning, Glass Code No.5113 polished to 1/2 stock thickness) from a tungsten-filament lamp operated at a color temperature of 2870° K. The value of light flux on the filter is 0.01 lumen. The load resistor has a value of 0.01 megohm, and 200 volts are applied between cathode and all other electrodes connected together as anode.

◆ For spectral characteristic of this source, see sheet 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.

• Measured at a tube temperature of 25° C and with the supply voltage (E) adjusted to give a luminous sensitivity of 2000 amperes per lumen. Dark current caused by thermionic emission may be reduced by the use of a refrigerant.

■ For maximum signal-to-noise ratio, operation with a supply voltage (E) below 2000 volts is recommended.

★ Under the following conditions: Supply voltage (E) is 2000 volts, 25°-C tube temperature, external-shield potential of -2000 volts, ac-amplifier bandwidth of 1 cycle per second, tungsten light source 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. The output current is measured through a filter which passes only the fundamental frequency of the pulses.

□ Measured between 10 per cent and 90 per cent of maximum anode-pulse height. This anode-pulse rise time is determined primarily by transit-time variations in the multiplier stages and with an incident-light spot approximately 1 millimeter in diameter centered on the photocathode.

† 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.

● For maximum signal-to-noise ratio, operation with a supply voltage (E) below 2300 volts is recommended.

★★ Same as (★) except the supply voltage (E) is 2400 volts, and the external-shield potential is -2400 volts.



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## MULTIPLIER PHOTOTUBE

TABLE I

## VOLTAGE TO BE PROVIDED BY DIVIDER

Between	COLUMN A	COLUMN B
	5.4% of Supply Voltage (E) multiplied by	2.75% of Supply Voltage (E) multiplied by
Cathode and Focusing Electrode	*	*
Cathode and Dynode No.1	2	2
Dynode No.1 and Dynode No.2	1	1
Dynode No.2 and Dynode No.3	1	1
Dynode No.3 and Dynode No.4	1	1
Dynode No.4 and Dynode No.5	1	1
Dynode No.5 and Dynode No.6	1	1
Dynode No.6 and Dynode No.7	1	1.2
Dynode No.7 and Dynode No.8	1	1.5
Dynode No.8 and Dynode No.9	1	1.9
Dynode No.9 and Dynode No.10	1	2.4
Dynode No.10 and Dynode No.11	1	3
Dynode No.11 and Dynode No.12	1.25	3.8
Dynode No.12 and Dynode No.13	1.5	4.8
Dynode No.13 and Dynode No.14	1.75	6
Dynode No.14 and Anode	2	4.8
Anode and Cathode	18.5	36.4

\* Focusing electrode is connected to arm of potentiometer between cathode and dynode No.1. Focusing-electrode voltage is adjusted to give maximum gain.



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**MULTIPLIER PHOTOTUBE****OPERATING CONSIDERATIONS**

*Exposure of the 7264 to strong ultraviolet radiation may cause an increase in anode dark current. After cessation of such irradiation, the dark current drops rapidly.*

*The operating stability of the 7264 depends on the magnitude and duration of the anode current. When the 7264 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 7264 usually recovers a substantial percentage of such loss in sensitivity.*

*Operation at an average anode current well below the maximum rated value of 2 milliamperes is recommended when stability is important. When maximum stability is required, the anode current should not exceed 250 microamperes.*

*Electrostatic and/or magnetic shielding of the 7264 may be necessary. It is to be noted that the use of an external magnetic and/or electrostatic shield at high negative potential is a safety hazard unless the shield is connected to the potential source through an impedance in the order of 10 megohms. If the shield is not so connected, extreme care should be observed in providing adequate safeguards to prevent personnel from coming in contact with the high potential of the shield.*

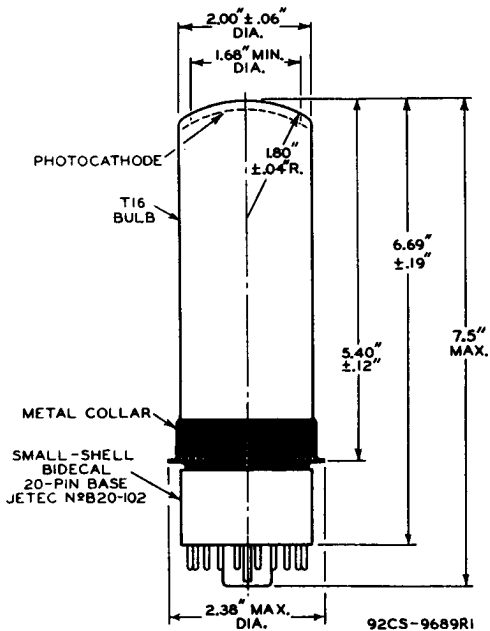
**SPECTRAL-SENSITIVITY CHARACTERISTIC  
of Phototube having S-11 Response  
is shown at the front of this Section**



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## MULTIPLIER PHOTOTUBE



☉ OF BULB WILL NOT DEVIATE MORE THAN  $2^{\circ}$  IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF THE BOTTOM OF THE BASE.

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## TYPICAL ANODE CHARACTERISTICS

VERY-LOW-LIGHT-LEVEL, LOW-NOISE, HIGH-GAIN SERVICE

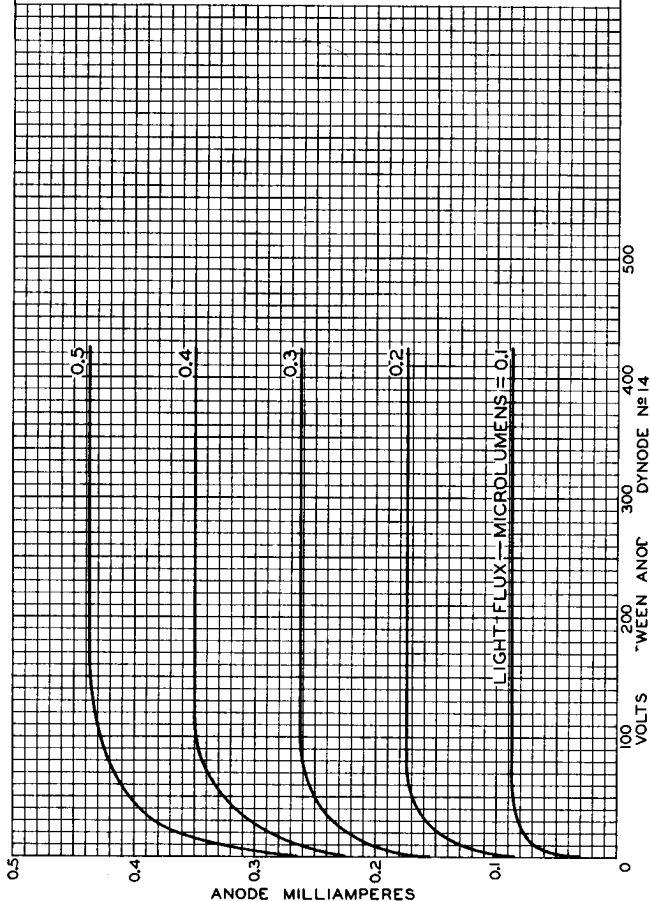
CATHODE - TO - GRID - N<sup>o</sup>1 VOLTS = 108GRID - N<sup>o</sup>1 - TO - DYNODE - N<sup>o</sup>1 (DY<sub>1</sub>) VOLTS = 108

DY<sub>1</sub> - TO - DY<sub>2</sub>  
 DY<sub>2</sub> - TO - DY<sub>3</sub>  
 ETC. TO  
 DY<sub>10</sub> - TO - DY<sub>11</sub>

VOLTS = 108

DY<sub>11</sub> - TO - DY<sub>12</sub> VOLTS = 135DY<sub>12</sub> - TO - DY<sub>13</sub> VOLTS = 160DY<sub>13</sub> - TO - DY<sub>14</sub> VOLTS = 189GRID - N<sup>o</sup>2 VOLTS ADJUSTED TO GIVE MAXIMUM GAIN.

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







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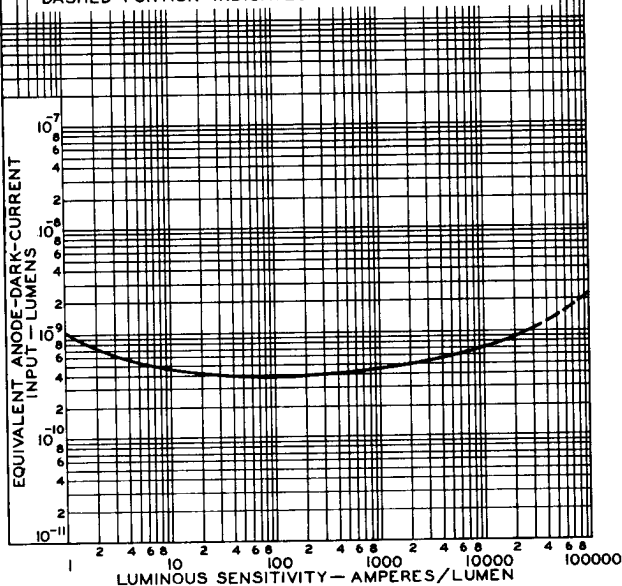
# TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

## VERY-LOW-LIGHT-LEVEL, LOW-NOISE, HIGH-GAIN SERVICE

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

BETWEEN	5.4% OF E MULTIPLIED BY
CATHODE & GRID N <sup>o</sup> 1	
GRID N <sup>o</sup> 1 & DYNODE N <sup>o</sup> 1 (DY <sub>1</sub> )	
DY <sub>1</sub> & DY <sub>2</sub>	
DY <sub>2</sub> & DY <sub>3</sub>	
DY <sub>3</sub> & DY <sub>4</sub>	
DY <sub>4</sub> & DY <sub>5</sub>	
DY <sub>5</sub> & DY <sub>6</sub>	
DY <sub>6</sub> & DY <sub>7</sub>	
DY <sub>7</sub> & DY <sub>8</sub>	
DY <sub>8</sub> & DY <sub>9</sub>	
DY <sub>9</sub> & DY <sub>10</sub>	
DY <sub>10</sub> & DY <sub>11</sub>	
DY <sub>11</sub> & DY <sub>12</sub>	1.25
DY <sub>12</sub> & DY <sub>13</sub>	1.5
DY <sub>13</sub> & DY <sub>14</sub>	1.75
DY <sub>14</sub> & ANODE	2.
ANODE & CATHODE	18.5

GRID-N<sup>o</sup>2 VOLTS ADJUSTED TO GIVE MAXIMUM GAIN.  
 LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP  
 OPERATED AT A COLOR TEMPERATURE OF 2870° K.  
 TUBE TEMPERATURE = 25° C  
 DASHED PORTION INDICATES INSTABILITY.



ELECTRON TUBE DIVISION

92CM-8848

RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

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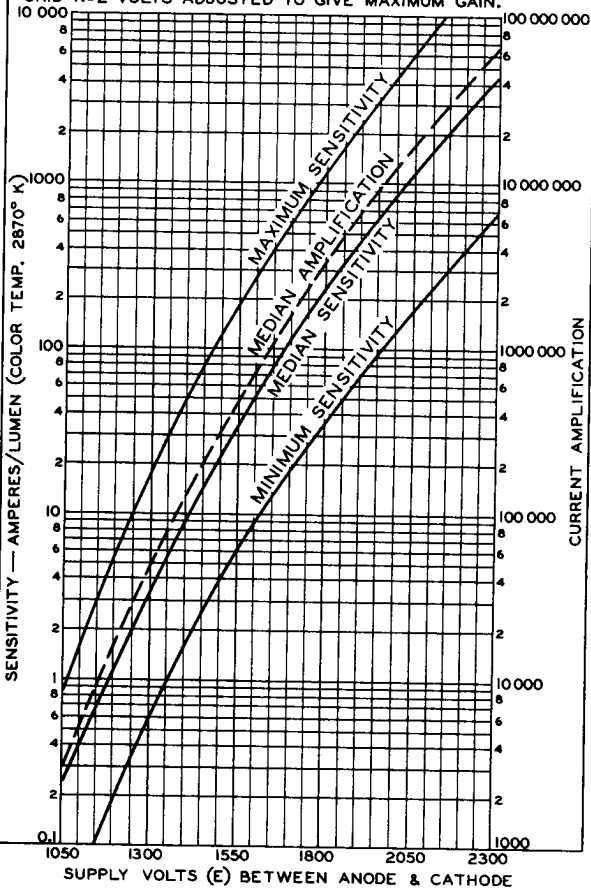
### CHARACTERISTICS

VERY-LOW-LIGHT-LEVEL, LOW-NOISE, HIGH-GAIN SERVICE

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

BETWEEN	5.4% OF E MULT. BY	BETWEEN	5.4% OF E MULT. BY
CATHODE & GRID N <sup>o</sup> 1	1	DY <sub>11</sub> & DY <sub>12</sub>	1.25
GRID N <sup>o</sup> 1 & DYNODE N <sup>o</sup> 1	1	DY <sub>12</sub> & DY <sub>13</sub>	1.5
DYNODE N <sup>o</sup> 1 (DY <sub>1</sub> ) & DY <sub>2</sub>	1	DY <sub>13</sub> & DY <sub>14</sub>	1.75
ETC. THRU DY <sub>10</sub> & DY <sub>11</sub>	1	DY <sub>14</sub> & ANODE	2

GRID-N<sup>o</sup>2 VOLTS ADJUSTED TO GIVE MAXIMUM GAIN.



ELECTRON TUBE DIVISION

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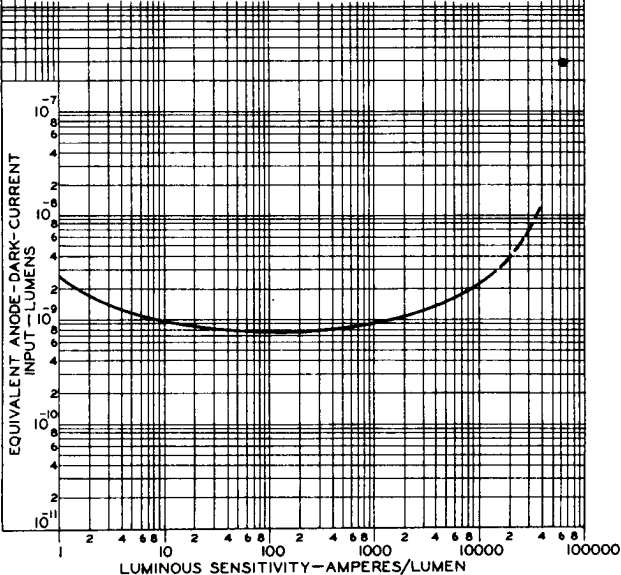
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# TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC HIGH-OUTPUT-PULSE SERVICE

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

BETWEEN	2.75 % OF E MULTIPLIED BY
CATHODE & GRID N <sup>o</sup> 1	1
GRID N <sup>o</sup> 1 & DYNODE N <sup>o</sup> 1 (DY <sub>1</sub> )	1
DY <sub>1</sub> & DY <sub>2</sub>	1
DY <sub>2</sub> & DY <sub>3</sub>	1
DY <sub>3</sub> & DY <sub>4</sub>	1
DY <sub>4</sub> & DY <sub>5</sub>	1
DY <sub>5</sub> & DY <sub>6</sub>	1
DY <sub>6</sub> & DY <sub>7</sub>	1.2
DY <sub>7</sub> & DY <sub>8</sub>	1.5
DY <sub>8</sub> & DY <sub>9</sub>	1.9
DY <sub>9</sub> & DY <sub>10</sub>	2.4
DY <sub>10</sub> & DY <sub>11</sub>	3
DY <sub>11</sub> & DY <sub>12</sub>	3.8
DY <sub>12</sub> & DY <sub>13</sub>	4.8
DY <sub>13</sub> & DY <sub>14</sub>	6
DY <sub>14</sub> & ANODE	4.8
ANODE & CATHODE	36.4

GRID-N<sup>o</sup>2 VOLTS ADJUSTED TO GIVE MAXIMUM GAIN.  
LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.  
TUBE TEMPERATURE = 25° C  
DASHED PORTION INDICATES INSTABILITY.



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### CHARACTERISTICS HIGH-OUTPUT-PULSE SERVICE

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

BETWEEN	2.75% OF E MULT. BY	BETWEEN	2.75% OF E MULT. BY
CATHODE & GRID N <sup>o</sup> 1	1	DY <sub>8</sub> & DY <sub>9</sub>	1.9
GRID N <sup>o</sup> 1 & DYNODE N <sup>o</sup> 1 (DY <sub>1</sub> )	1	DY <sub>9</sub> & DY <sub>10</sub>	2.4
DY <sub>1</sub> & DY <sub>2</sub> ETC. THRU } DY <sub>5</sub> & DY <sub>6</sub> } DY <sub>6</sub> & DY <sub>7</sub> } DY <sub>7</sub> & DY <sub>8</sub> }	1	DY <sub>10</sub> & DY <sub>11</sub>	3
	1	DY <sub>11</sub> & DY <sub>12</sub>	3.8
	1.2	DY <sub>12</sub> & DY <sub>13</sub>	4.8
	1.5	DY <sub>13</sub> & DY <sub>14</sub>	6
		DY <sub>14</sub> & ANODE	4.8

GRID-N<sup>o</sup>2 VOLTS ADJUSTED TO GIVE MAXIMUM GAIN.

