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MULTIPLIER PHOTOTUBE

14-STAGE, HEAD-ON, FLAT-FACEPLATE TYPE WITH 4-7/16" CURVED, SEMITRANSSPARENT CATHODE AND EXTENDED S-11 RESPONSE VERY-SHORT TIME-RESOLUTION CAPABILITY

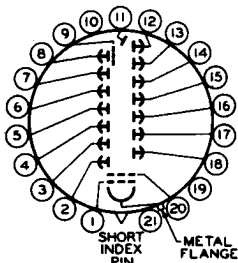
DATA

General:

- Spectral Response. Extended S-11 (See Curve)
- Wavelength of Maximum Response 4200 ± 500 angstroms
- Faceplate, with flat external surface Ultraviolet-Transmitting Glass
- Cathode, Semitransparent:
 - Shape. Curved Circular
 - Window:
 - Area 15.5 sq. in.
 - Minimum diameter 4-7/16 in.
 - Index of refraction. 1.468
- Direct Interelectrode Capacitances (Approx.):
 - Anode to dynode No.14. 2.4 μf
 - Anode to all other electrodes. 5 μf
 - Dynode No.14 to all other electrodes 7 μf
- Maximum Overall Length 11-1/8"
- Seated Length. 9-3/4" ± 1/4"
- Envelope See Dimensional Outline
- Cathode Terminal Metal Flange
- Operating Position Any
- Weight (Approx.) 1 lb 14 oz
- Socket Alden Part No.435SBA, or equivalent
- Base Small-Button Thirtyfivar 21-Pin (JETEC No.E21-40)

Basing Designation for BOTTOM VIEW 21A

- Pin 1 - Grid No.1
- 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 - Dynode No.13
- Pin 9 - Grid No.3 (Accelerating Electrode)
- Pin 10 - No Connection
- Pin 11 - Anode
- Pin 12 - Dynode No.14
- Pin 13 - Dynode No.12
- Pin 14 - Dynode No.10
- Pin 15 - Dynode No.8
- Pin 16 - Dynode No.6
- Pin 17 - Dynode No.4
- Pin 18 - Dynode No.2
- Pin 19 - No Connection



DIRECTION OF LIGHT: INTO END OF BULB

- Pin 20 - Grid No.2
- Pin 21 - No Connection
- Metal Flange - Cathode



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Maximum Ratings, Absolute Values:

DC ANODE-SUPPLY VOLTAGE.	3400 max.	volts
DC SUPPLY VOLTAGE BETWEEN DYNODE No.14 AND ANODE.	400 max.	volts
DC SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES.	400 max.	volts
DC SUPPLY VOLTAGE BETWEEN GRID No.3 AND DYNODE No.13	500 max.	volts
DC GRID-No.2 SUPPLY VOLTAGE.	1500 max.	volts
DC SUPPLY VOLTAGE BETWEEN GRID-No.2 AND ANODE.	2300 max.	volts
DC GRID-No.1 SUPPLY VOLTAGE.	1200 max.	volts
DC SUPPLY VOLTAGE BETWEEN DYNODE No.1 AND GRID No.2.	400 max.	volts
AVERAGE ANODE CURRENT*	2 max.	ma
AMBIENT-TEMPERATURE RANGE.	-125 to +75	°C

Characteristics Range Values for Equipment Design:

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

With $E = 2800$ volts (except as noted), and with grid-No.3, grid-No.1, and dynode-No.1 voltages adjusted to give maximum gain

	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4200 angstroms	-	0.140	-	amp/ μ w
Cathode radiant, at 4200 angstroms.	-	0.046	-	μ a/ μ w
Luminous:†				
At 0 cps.	40	180	1500	amp/lumen
With dynode No.14 as output electrode†.	-	108	-	amp/lumen
Cathode luminous:				
With tungsten light source‡	40	60	-	μ a/lumen
With blue light source**♦	4	-	-	μ a
Current Amplification	-	3×10^6	-	
Equivalent Anode-Dark- Current Input*■	{ -	2×10^{-9}	1.2×10^{-8}	lumen
	{ -	$26 \times 10^{-5} \downarrow$	$156 \times 10^{-5} \downarrow$	watt
Equivalent Noise Input*.	{ -	1×10^{-11}	-	lumen
	{ -	$13 \times 10^{-7} \downarrow$	-	watt

•, †, ‡, **, ♦, ■, ↓, * : See next page.



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	Min.	Median	Max.	
Greatest Transit-Time Spread:				
Within a circle centered on tube face and having a diameter of—				
3 inches.	—	0.5	—	milli μ sec
4 inches.	—	4	—	milli μ sec
<i>With E = 3400 volts (except as noted), and with grid-No.3, grid-No.1, and dynode-No.1 voltages adjusted to give maximum gain</i>				
	Min.	Median	Max.	
Sensitivity:				
Radiant, at 4200 angstroms				
	—	0.91	—	amp/ μ W
Cathode radiant, at 4200 angstroms. . .				
	—	0.046	—	μ a/ μ W
Luminous:*				
At 0 cps.				
	—	1200	—	amp/lumen
With dynode No.14 as output electrode†.				
	—	800	—	amp/lumen
Cathode luminous:				
With tungsten light source [▲]				
	40	60	—	μ a/lumen
With blue light source** [◆]				
	4	—	—	μ a
Current Amplification				
	—	20×10^6	—	

* 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. This type of operation is suitable only for small output signals or for applications where linearity is not required.

▲ 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.

●, ■, ▲, ◆: See next page.



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- Measured at a tube temperature of 25° C and with the supply voltage (E) adjusted to give a luminous sensitivity of 500 amperes per lumen. Dark current caused by thermionic emission and ion feedback 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.
- Measured at 4200 angstroms.
- Under the following conditions: Supply voltage (E) is 2800 volts, 25° C tube temperature, 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.

TABLE I

VOLTAGE TO BE PROVIDED BY DIVIDER

Between	3.8% of Supply Voltage (E) Multiplied By
Cathode and Grid No.1	2 approx.*
Cathode and Grid No.2	11.5
Grid No.2 and Dynode No.1	1 approx.*
Grid No.2 and Dynode No.2	2
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 Dynode No.13	1
Dynode No.13 and Dynode No.14	1
Dynode No.14 and Anode	1
Anode and Cathode	26.5

* Adjusted to give maximum gain.

OPERATING CONSIDERATIONS

Connection to the *metal flange* is made by a spring-finger ring bearing against the edge of the flange.

The *operating stability* of the 7046 is dependent on the magnitude of the anode current and its duration. When the 7046 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



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7046 usually recovers a substantial percentage of such loss in sensitivity.

The use of an average anode current well below the maximum-rated value of 2 milliamperes is recommended when stability of operation is important. When maximum stability is required, the anode current should not exceed 100 microamperes.

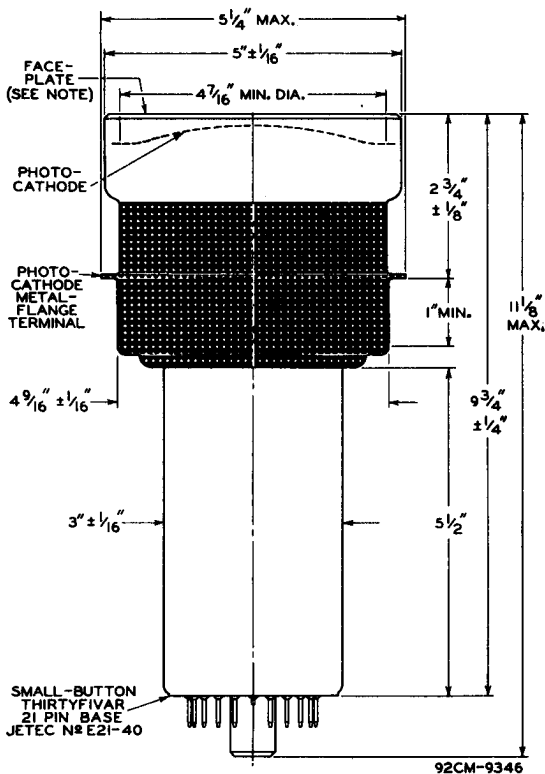
With certain orientations of the 7046, it will be observed that the earth's magnetic field is sufficient to cause a noticeable decrease in the response of the tube. To prevent such decrease in response of the tube, magnetic shielding must be provided. A suitable shield may be obtained from James Millen Mfg. Co., Malden, Mass. by ordering Part No.80805P. In general, it is recommended that the shield be connected to cathode potential.

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

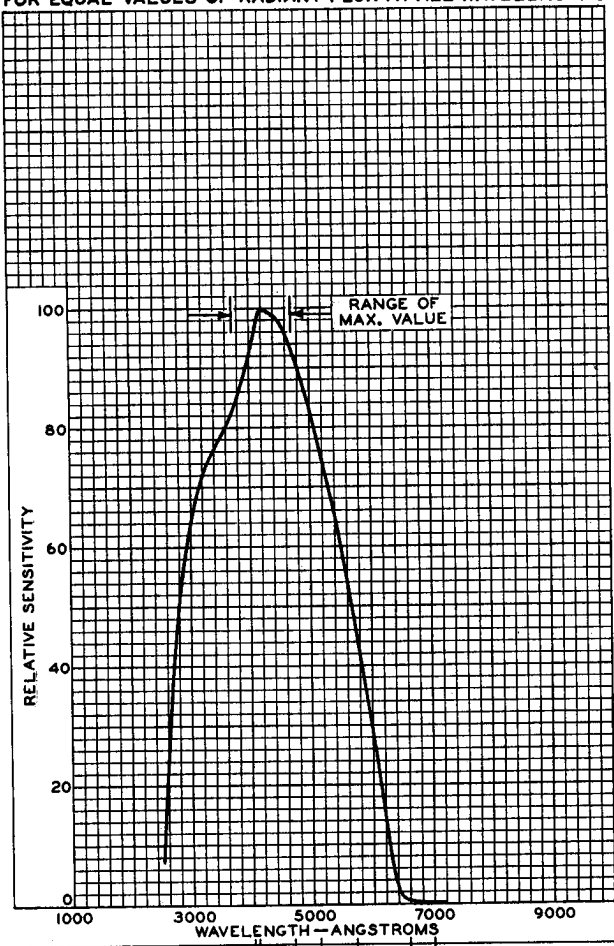
NOTE: WITHIN $4\frac{7}{16}$ " DIAMETER, DEVIATION FROM FLATNESS OF EXTERNAL SURFACE OF FACEPLATE WILL NOT EXCEED 0.015" FROM PEAK TO VALLEY.



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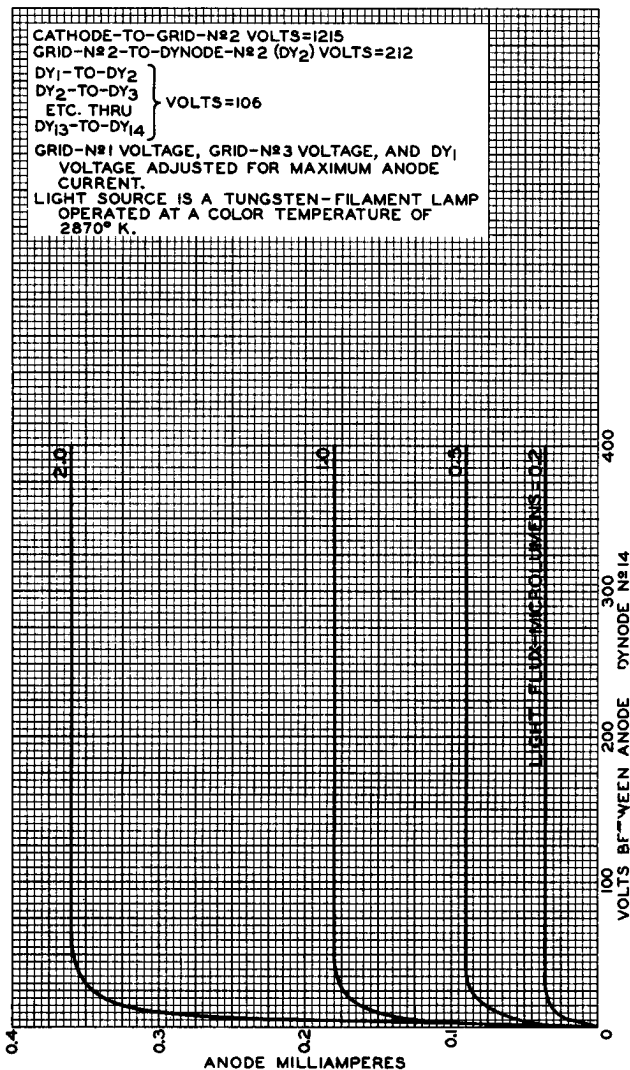
TENTATIVE SPECTRAL SENSITIVITY CHARACTERISTIC FOR EQUAL VALUES OF RADIANT FLUX AT ALL WAVELENGTHS



ULTRA
VIOLET
VIOLET
BLUE
GREEN
YELLOW
RED
INFRA
RED



AVERAGE ANODE CHARACTERISTICS





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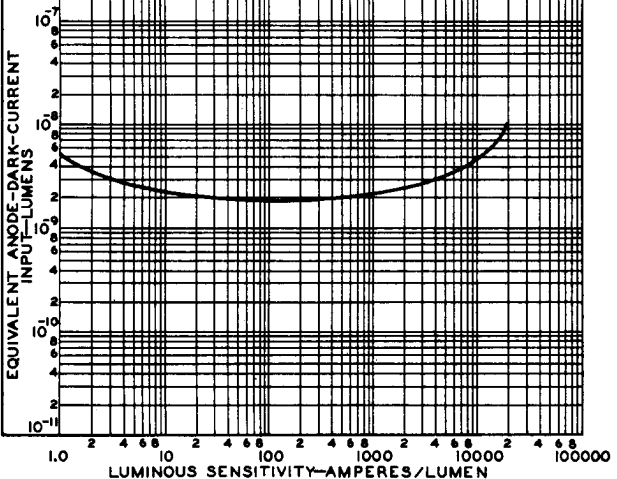
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TYPICAL ANODE-DARK-CURRENT CHARACTERISTIC

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

BETWEEN	3.6% OF E MULTIPLIED BY
CATHODE & GRID N ^o 1	2 APPROX.*
CATHODE & GRID N ^o 2	11.5
GRID N ^o 2 & DYNODE N ^o 1 (DY ₁)	1 APPROX.*
GRID N ^o 2 & DY ₂	2
DY ₂ & DY ₃	1
DY ₃ & DY ₄	1
DY ₄ & DY ₅	1
DY ₅ & DY ₆	1
DY ₆ & DY ₇	1
DY ₇ & DY ₈	1
DY ₈ & DY ₉	1
DY ₉ & DY ₁₀	1
DY ₁₀ & DY ₁₁	1
DY ₁₁ & DY ₁₂	1
DY ₁₂ & DY ₁₃	1
DY ₁₃ & DY ₁₄	1
DY ₁₄ & ANODE	1
ANODE & CATHODE	26.5

* ADJUSTED TO GIVE MAXIMUM GAIN.
 LIGHT SOURCE IS A TUNGSTEN-FILAMENT LAMP OPERATED AT A COLOR TEMPERATURE OF 2870° K.
 TUBE TEMPERATURE = 25° C



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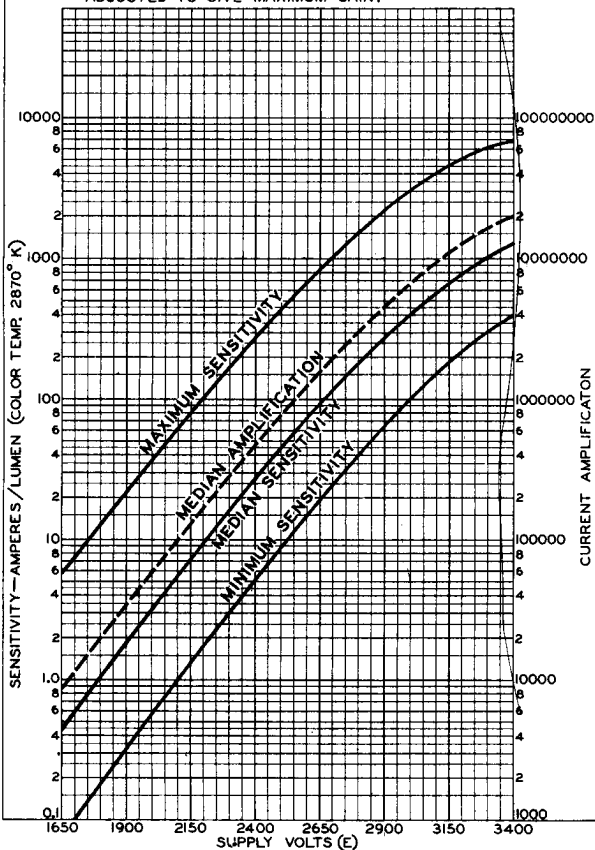
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CHARACTERISTICS

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

BETWEEN	3.8% OF E MULT. BY
CATHODE & GRID N°1	2 APPROX.*
CATHODE & GRID N°2	11.5
GRID N°2 & DYNODE N°1 (DY ₁)	1 APPROX.*
GRID N°2 & DYNODE N°2	2
DY ₂ & DY ₃	
ETC. THRU	
DY ₄ & ANODE	1

* ADJUSTED TO GIVE MAXIMUM GAIN.



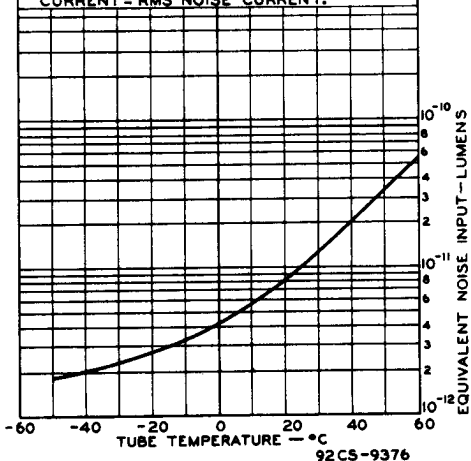


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EQUIVALENT-NOISE-INPUT CHARACTERISTIC

CATHODE-TO-GRID-N#2 VOLTS=1215
GRID-N#2-TO-DYNODE-N#2 (DY₂) VOLTS=212
DY₁-TO-DY₂
DY₂-TO-DY₃
ETC. THRU
DY₄-TO-ANODE } VOLTS=106
GRID-N#1 VOLTAGE, GRID-N#3 VOLTAGE, AND
DY₁ VOLTAGE ADJUSTED FOR MAXIMUM
ANODE CURRENT.
BANDWIDTH (CPS) = 1
LIGHT SOURCE: TUNGSTEN AT 2870° K INTER-
RUPTED AT 90 CPS TO PRODUCE PULSES
ALTERNATING BETWEEN ZERO AND FLUX
VALUE SHOWN FOR ANY GIVEN TUBE
TEMPERATURE; "ON" PERIOD OF PULSE
EQUAL TO "OFF" PERIOD; RMS SIGNAL
CURRENT = RMS NOISE CURRENT.





EFFECT OF MAGNETIC FIELD ON ANODE CURRENT

CATHODE-TO-GRID-N^o2 VOLTS=1215
 GRID-N^o2-TO-DYNODE-N^o2 (DY₂) VOLTS=212
 DY₁-TO-DY₂
 DY₂-TO-DY₃
 ETC. THRU
 DY₁₄-TO-ANODE } VOLTS=106

GRID-N^o1 VOLTAGE, GRID-N^o3 VOLTAGE, AND DY₁
 VOLTAGE ADJUSTED FOR MAXIMUM ANODE
 CURRENT.

MAGNETIC FIELD IS PERPENDICULAR TO DYNODE
 SPACERS AND IS CENTERED BETWEEN
 CATHODE & DYNODE N^o1.

POSITIVE VALUES ARE FOR LINES OF FORCE
 FROM RIGHT TO LEFT WITH INDEX PIN OF
 BASE TOWARD RIGHT OF OBSERVER.

CURVE	CONDITION
A	WITH EXTERNAL SHIELD MILLEN N ^o 80805P, OR EQUIVALENT.
B	WITHOUT EXTERNAL SHIELD.

