7265

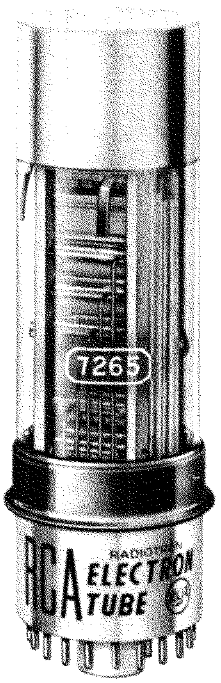
MULTIPLIER PHOTOTUBE

1.68" Dia. Curved Circular Semitransparent Photocathode

14-Stage, Head-On Type, Flat Faceplate
S-20 Response
Very-Short Time Resolution Capability
TENTATIVE DATA

7.5" Max. Length
2.38" Max. Diameter
Bidecal 20-Pin Base

RCA-7265 is a head-on type of multiplier phototube intended for use in scintillation counters for the detection and measurement of nuclear radiation, and in applications such as flying-spot scanning and low-level photometry, which require low dark current as well as high sensitivity over the entire visible spectrum.



The spectral response of the 7265 covers the range from about 3000 to 7500 angstroms, with maximum response at approximately 4200 angstroms, as shown in Fig. 1. It will be noted that the response extends beyond the visible region into the blue region on the one end and well into the red region on the other end.

The 7265 utilizes a new and improved semitransparent photocathode characterized by high sensitivity, low thermionic dark current, and high conductivity even at low temperatures. The photocathode may be cooled to liquid-air temperature to reduce its low thermionic dark current to an extremely low value without sacrificing its conductivity to such an extent that its current-carrying capability is impaired.

Design features of the 7265 include dynodes with stable high-current-carrying capability; focusing electrode with external connection for shaping the field which directs photoelectrons from the photocathode onto the first dynode; an accelerating electrode with external connection for minimizing the space-charge effect in the region of dynode No. 12; and a semitransparent photocathode on the curved inner surface of the face end of the bulb.

The focusing electrode permits optimizing the magnitude, uniformity, or speed of the response in critical applications.

The curved photocathode surface of the 7265 assures very good collection by dynode No. 1 of electrons from all parts of the useful photocathode area, and thus makes possible a typical pulse-height resolution of about 8 per cent. The use of the curved surface together with the electrode configuration employed in the 7265 results in extremely small variation in electron-transit time between the photocathode and dynode No. 1.

The 7265 is capable of delivering pulse currents having magnitudes up to 0.5 ampere without appreciable deviation from linearity. Consequently, the need for an associated wide-band amplifier to amplify the output pulse is eliminated in many applications.

The internal leads from dynode No. 14 and anode to their respective base-pin terminals are short and direct. This arrangement makes possible the use of a load circuit having a short time constant--an essential feature in pulse service.

The 7265 is capable of multiplying feeble photoelectric current produced at the cathode by a median value of 9,350,000 times when operated with a supply voltage of 2400 volts. The output current of the 7265 is a linear function of the exciting illumination under normal operating conditions.

DATA

General:

Spectral Response	S-20	
Wavelength of Maximum Response	4200 ± 500	angstroms
Cathode, Semitransparent:		
Shape	Curved Circular	
Window:		
Area	2.2	sq.in.
Minimum diameter	1.68	in.
Index of Refraction	1.51	

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

7265 9-58
Printed in U.S.A.

Direct Interelectrode Capacitances (Approx.):

Anode to dynode No.14	2.8	μμf
Anode to all other electrodes	6	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"
Bulb T-16
Base . . . .Small-Shell Bidecal 20-Pin (JETEC No.B20-102)
Socket . . Alden No.220FT with 20 Contacts⊕, or equivalent
Operating Position . . . . .Any
Weight (Approx.) . . . . 8 oz

Maximum Ratings, *Absolute Values:*

SUPPLY VOLTAGE BETWEEN ANODE AND CATHODE (DC)	3000 max.	volts
SUPPLY VOLTAGE BETWEEN DYNODE No.14 AND ANODE (DC)	500 max.	volts
SUPPLY VOLTAGE BETWEEN CONSECUTIVE DYNODES (DC)	600 max.	volts
SUPPLY VOLTAGE BETWEEN ACCELERATING ELECTRODE AND DYNODE No.13 (DC)	±600 max.	volts
DYNODE-No.1 SUPPLY VOLTAGE (DC)	500 max.	volts
FOCUSING-ELECTRODE SUPPLY VOLTAGE (DC)	500 max.	volts
AVERAGE ANODE CURRENT●	1 max.	ma
AMBIENT TEMPERATURE	85 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 1.

With E = 2400 volts (except as noted) and Accelerating-Electrode Voltage adjusted to give maximum gain.

	Min.	*Median*	*Max.*	
Sensitivity:				
Radiant, at 4200 angstroms	-	0.6	-	amp/μw
Cathode Radiant, at 4200 angstroms	-	0.064	-	μa/μw
Luminous:#				
At 0 cps	165	1400	6800	amp/lumen
With dynode No.14 as output electrode†	-	980	-	amp/lumen
Cathode Luminous:				
With tungsten light source▲	100	150	-	μa/lumen
With blue light source**	0.05	-	-	μa
With red light source□	0.30	-	-	μa
Current Amplification	-	9.35×10^6	-	
Equivalent Anode-Dark-Current Input⊕■	-	2×10^{-10}	8×10^{-10}	lumen
Equivalent Noise Input:★				
At +25° C	-	7.5×10^{-13}	3.3×10^{-12}	lumen
At -80° C	-	1×10^{-13}	-	lumen
Anode-Pulse Rise Time‡	-	3	-	milliμsec
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--				
1-1/8"	-	1♦	-	milliμsec
1-9/16"	-	3♦	-	milliμsec

⊕ Made by Alden Products Company, Brockton, Massachusetts.

TABLE 1

VOLTAGE TO BE PROVIDED BY DIVIDER	
Between	5.4% of Supply Voltage (E) multiplied by
Cathode and Focusing Electrode*	1.6
Cathode and Dynode No.1	2
Dynode No.1 and Dynode No.2	1
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	1.25
Dynode No.12 and Dynode No.13	1.5
Dynode No.13 and Dynode No.14	1.75
Dynode No.14 and Anode	2
Anode and Cathode	18.5

* The metal collar (See *Dimensional Outline*) is connected internally to the focusing electrode. Extreme care should be taken in the design of apparatus to prevent operating personnel from coming in contact with the collar when the circuit application is such that the collar is at high potential.

● 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.

□ Under the following conditions: Light incident on the cathode is transmitted through a red filter (Corning, Glass Code No.2418, or equivalent) 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.

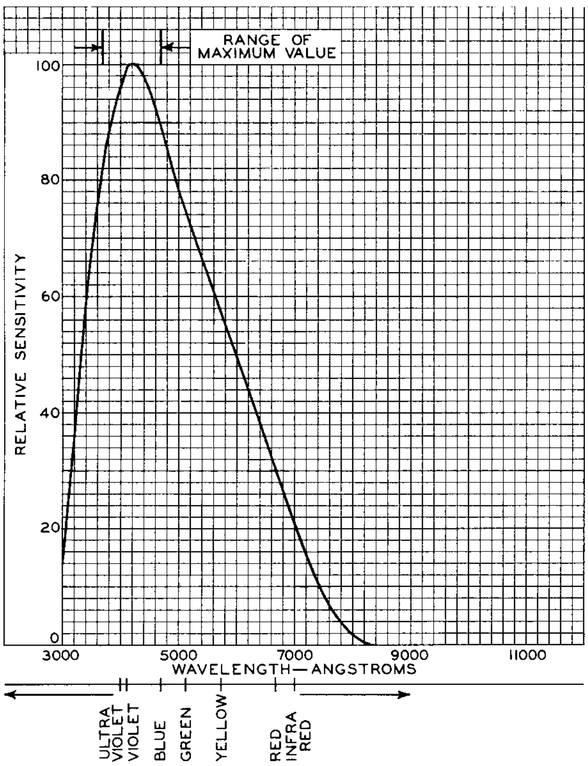
⊕ Measured at a tube temperature of 25° C and with the supply voltage (E) adjusted to give a luminous sensitivity of 1000 amperes per lumen. Dark current caused by thermionic emission may be reduced by the use of a refrigerant.

■ For maximum signal-to-noise ratio, operation with a supply voltage (E) below 2400 volts is recommended.

★ Under the following conditions: Supply voltage (E) is 2400 volts, external shield connected to metal collar, 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 the maximum anode-pulse height. This anode-pulse rise time is determined primarily by transit-time variations in the multiplier stages only 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 area.



92CM-9779

Fig. 1 - Tentative Spectral Sensitivity Characteristic of Type 7265 which has S-20 Response. Curve is shown for Equal Values of Radiant Flux at All Wavelengths.

DEFINITIONS

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

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.

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.

OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data are established in accordance with the following definition of the *Absolute-Maximum Rating System* for rating electron devices.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron device of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

The device manufacturer chooses these values to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environment variations, and the effects of changes in operating conditions due to variations in device characteristics.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in device characteristics.

In general, *supply voltages* for the electrodes of the 7265 should be provided as shown in Table 1.

The operating voltage between dynode No. 14 and anode should be kept as low as will permit operation with anode-current saturation. Referring to the anode characteristics curves, shown in Fig.2, it will be seen that saturation occurs in the approximate range of 50 to 100 volts. With low operating voltage between dynode No. 14 and anode, the dark current is reduced. As a result, the operating stability of the 7265 is improved without sacrifice in sensitivity. To obtain the indicated operating voltage between dynode No. 14 and anode, it will be necessary to increase the supply voltage between these electrodes above the operating voltage by an amount to allow for the signal-output voltage desired.

The *focusing-electrode potential* may be adjusted between that of the photocathode and that of dynode No. 1 to optimize the magnitude uniformity or speed of the response. The voltage for the focusing electrode can be obtained by connecting it to the arm of a potentiometer between cathode and dynode No. 1 in the voltage divider.

The *accelerating electrode*, when operated at a suitable potential with respect to dynode No. 13, serves to minimize the effect of space charge in the region of dynode No. 12. Provision should be made to adjust the accelerating-electrode voltage over a range extending from the value at which dynode No. 13 operates to that at which the anode operates. The adjustment may be accomplished by means of a high-resistance potentiometer connected between the voltage-divider tap for dynode No. 13 and the anode end of the voltage divider. Since the accelerating electrode draws at most only negligible current, the potentiometer can have sufficiently high resistance so that it will not substantially affect the voltage distribution at the taps of the shunted section of the divider. Within the specified adjustment range, it will be found that the accelerating-electrode voltage may be adjusted to obtain either maximum gain or maximum peak output current. In general, the adjustment to apply the highest voltage to the accelerating electrode will permit the highest peak current with some sacrifice in gain.

In applications where it is desired to keep the statistical fluctuations to a minimum, e.g., as in nuclear radiation spectroscopy, the potential between cathode and dynode No. 1 may be increased to the rated maximum value of 500 volts.

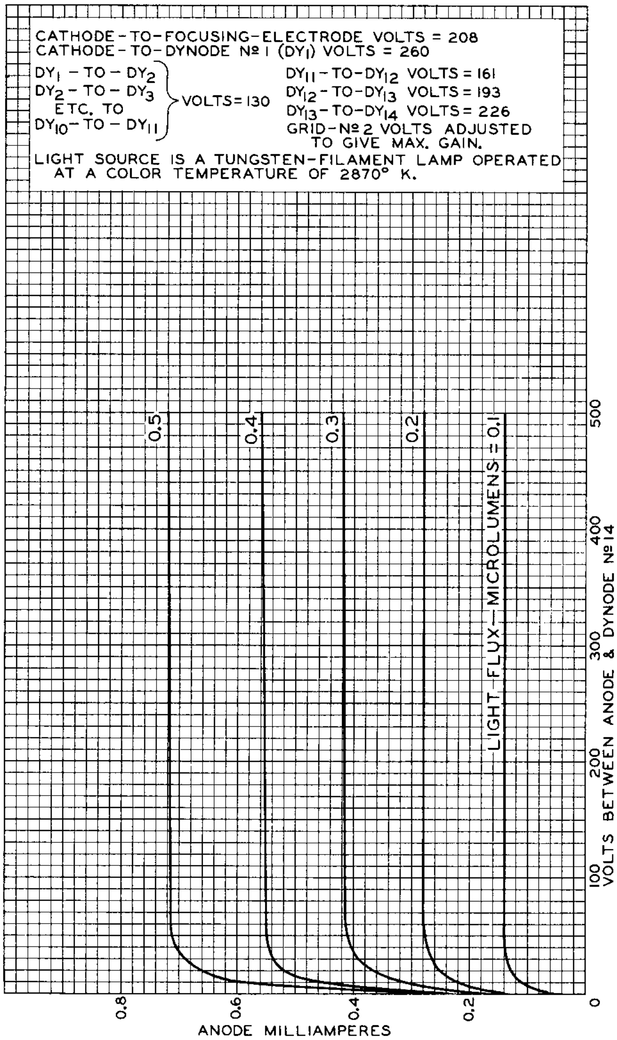


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Fig. 2 - Average Anode Characteristics of Type 7265.

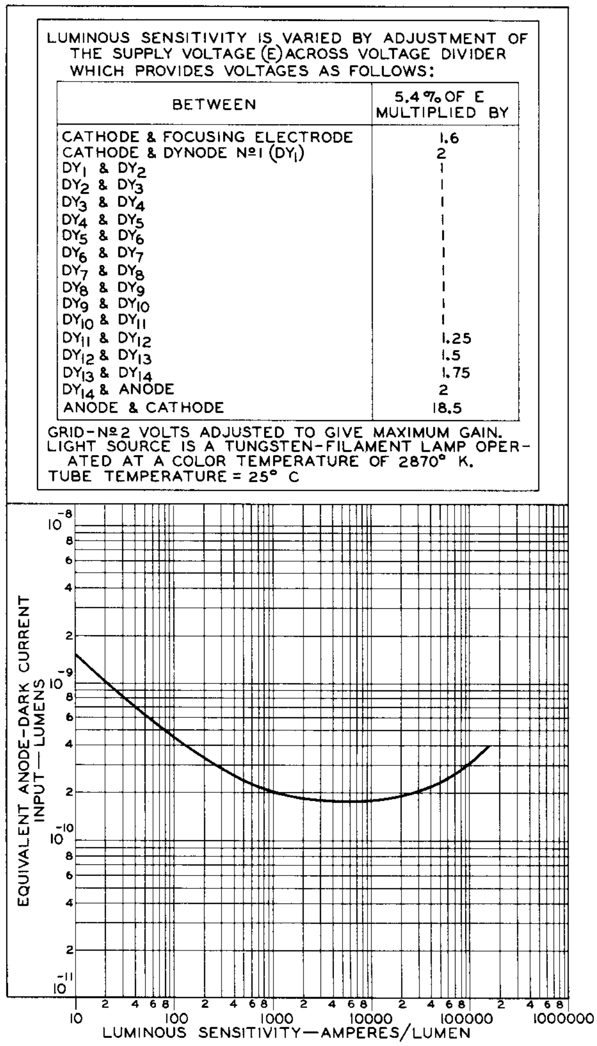

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Fig. 3 - Typical Anode-Dark-Current Characteristic of Type 7265.

A very small *dark current* is observed when voltage is applied to the electrodes of the 7265 in complete darkness. This current has a component caused by leakage, and a component consisting of pulses produced by electrons thermionically released from the cathode, by secondary electrons released by ionic bombardment of the dynodes or cathode, or by cold emission from the electrodes. The magnitude of the dark current establishes a limit below which the exciting radiation on the cathode can not be detected.

When the application utilizes *continuous luminous excitation and dc anode current*, and it is desired to have a high ratio of signal output to dark current, it is recommended that the operating supply voltage (E) be determined with reference to the curve in Fig.3 which shows the equivalent anode-dark-current input as a function of luminous sensitivity for the 7265 and the curve in Fig.4 which shows luminous sensitivity as a function of the supply voltage.

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 & FOCUSING ELECTRODE	1.6	DY_{11} & DY_{12}	1.25
CATHODE & DYNODE №1	2	DY_{12} & DY_{13}	1.5
DYNODE №1 (DY_1) & DY_2 ETC. THRU DY_{10} & DY_{11}	1	DY_{13} & DY_{14}	1.75
		DY_{14} & ANODE	2

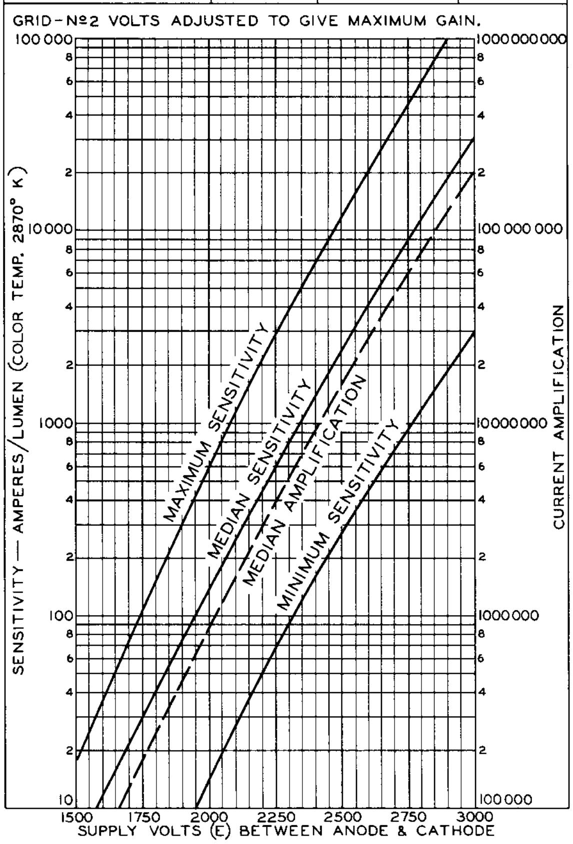
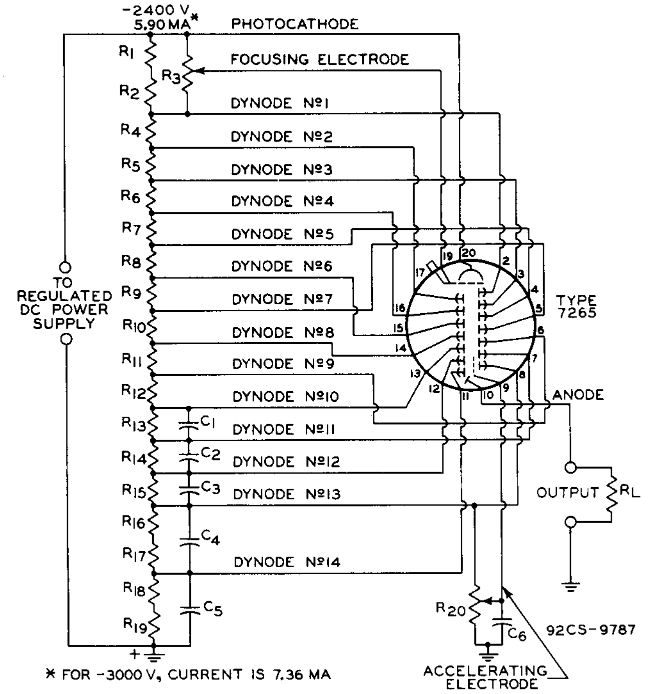


Fig.4 - Characteristics of Type 7265.

In applications involving low-light-level *pulsed excitation and ac coupling at the anode*, the best signal-to-noise ratio is obtained with a supply voltage (E) in the range from 2200 to 2600 volts. Within this range, the noise at the anode is produced primarily by the statistical release of thermal electrons, and the noise power spectrum is essentially flat up to about 50 megacycles per second. Regenerative phenomena, which may occur at voltages above 2000 volts, contribute to the noise.



C_1 = 25 μμf, disk ceramic, 600 volts (dc working)
C_2 = 50 μμf, disk ceramic, 600 volts (dc working)
C_3 = 100 μμf, disk ceramic, 600 volts (dc working)
C_4 = 250 μμf, disk ceramic, 600 volts (dc working)
C_5 = 500 μμf, disk ceramic, 600 volts (dc working)
C_6 = 100 μμf, disk ceramic, 1000 volts (dc working)
R_1 = 24000 ohms, 1 watt
R_2 = 22000 ohms, 1 watt
R_3 = 1 megohm, 2 watts, adjustable
R_4 through R_{13} = 22000 ohms, 1 watt
R_{14} = 27000 ohms, 2 watts
R_{15} = 33000 ohms, 2 watts
R_{16} = 22000 ohms, 2 watts
R_{17} = 18000 ohms, 2 watts
R_{18} = 22000 ohms, 2 watts
R_{19} = 22000 ohms, 2 watts
R_{20} = 10 megohms, 2 watts, adjustable
R_L = Value will depend on magnitude of peak pulse voltage desired. For a peak pulse amplitude of 100 volts, the value is approximately 300 ohms.

Note: Capacitors C_1 through C_6 should be connected at tube socket.

Fig.5 - Voltage-Divider Arrangement for Type 7265.

The noise spectrum of the 7265 is such that the threshold of pulse detection depends on the associated circuitry. The bandpass filter should be designed to pass only the frequency range of the exciting signal in order to eliminate as much noise as possible.

In applications where maximum gain with unusually low dark current is required, the *use of a refrigerant*, such as dry ice or liquid air, to cool the bulb of the 7265 is recommended. The resulting reduction in thermionic emission from the cathode lowers the detection threshold to give improved operation.

Exposing the 7265 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 7265 is dependent on the magnitude of the anode current and its duration. When the 7265 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 7265 usually recovers a substantial percentage of such loss in sensitivity.

The use of an average anode current well below the maximum rated value of 1 milliampere is recommended when stability of operation is important. When maximum stability is required, the anode current should not exceed 250 microamperes.

Electrostatic and/or magnetic shielding of the 7265 may be necessary. The shield should be connected to a potential near that of the cathode. It is to be noted that the use of an external magnetic and/or electrostatic shield at high negative potential presents a safety hazard unless the shield is connected through a high impedance in the order of 10 megohms to the potential. 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.*

Adequate *light shielding* should be provided to prevent extraneous light from reaching any part of the 7265. Although the metallic coating on the inner side wall of the glass bulb serves to reduce the amount of extraneous light reaching the electrodes, it is inadequate to shield completely the entire structure from extraneous light.

The *dc supply voltages* for each dynode and for the anode can be supplied by spaced taps on a voltage divider across a regulated dc power supply. The current through the voltage divider will depend on the voltage regulation and the linearity required by the application. In general, the current in the divider should be several times the maximum value of anode current. The value should also be adequate to prevent variations of the dynode potentials by the signal current.

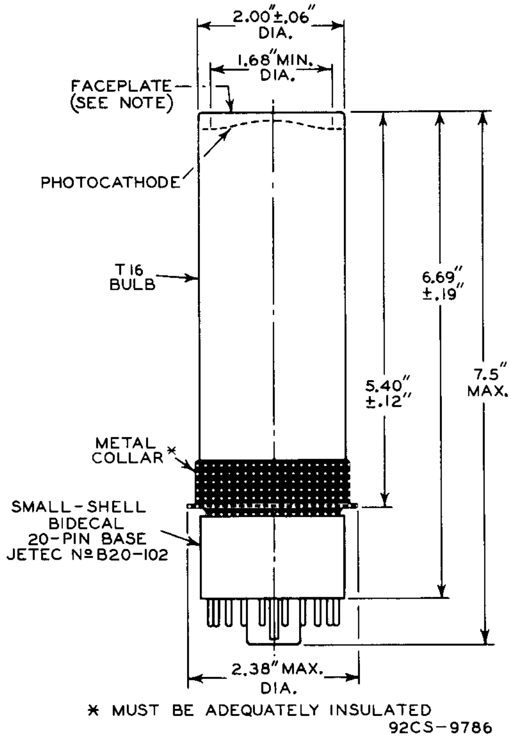
In most applications, it is recommended that the positive high-voltage terminal be grounded in order that the output signal will be produced between anode and ground. This method prevents power-supply fluctuations from being coupled directly into the signal-output circuit.

A typical voltage-divider arrangement for use with the 7265 is shown in Fig.5.

The high voltages at which the 7265 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.

In the use of the 7265, as with other tubes requiring high voltages, it should always be remembered that these high voltages may appear at points in the circuit which are normally at low potential, because of defective circuit parts or incorrect circuit connections. Therefore, before any part of the circuit is touched, the power-supply switch should be turned off and both terminals of any capacitors grounded.

DIMENSIONAL OUTLINE



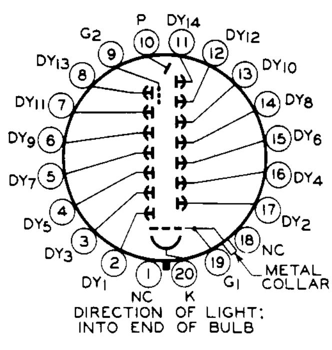
℄ OF BULB WILL NOT DEVIATE MORE THAN 2° IN ANY DIRECTION FROM THE PERPENDICULAR ERECTED AT THE CENTER OF BOTTOM OF THE BASE.

NOTE: WITHIN 1.68" DIAMETER, DEVIATION FROM FLATNESS OF EXTERNAL SURFACE OF FACEPLATE WILL NOT EXCEED 0.005" FROM PEAK TO VALLEY.

SOCKET CONNECTIONS

Bottom View

PIN 1: NO 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: 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
PIN 14: DYNODE No.8



PIN 15: DYNODE No.6
PIN 16: DYNODE No.4
PIN 17: DYNODE No.2
PIN 18: NO CONNECTION
PIN 19: GRID No.1 (FOCUSING ELECTRODE)
PIN 20: PHOTOCATHODE

METAL COLLAR: CONNECTED INTERNALLY TO FOCUSING ELECTRODE--DO NOT MAKE ELECTRICAL CONNECTION TO COLLAR.

NOTE - THE METAL COLLAR MAY BE AT HIGH POTENTIAL DEPENDING ON THE CIRCUIT APPLICATION AND SHOULD BE INSULATED ACCORDINGLY.