

Z-7807, GL-7969

IMAGE ORTHICONS

FOCUS-MAGNETIC

DEFLECTION-MAGNETIC

These low-light-level image orthicons are designed to meet a wide variety of requirements for industrial, military, and scientific applications. They provide an effective low-light-level sensitivity of 4×10^{-7} foot-candles photocathode illumination for resolution of 100 television lines per target-inch. The GL-7969 is designed for normal environmental operation. The Z-7807 is a ruggedized version especially designed to operate under severe shock and vibration conditions.

Both tubes feature a high-gain, thin-film magnesium-oxide target with a sensitivity ten to twenty times that of glass targets. The extreme thinness and the anisotropic property of this semiconductor target virtually eliminates lateral leakage and increases the resolution 25 to 50 percent over that of standard glass targets. Since operation of the target depends on electron conduction, which is not a depletion process, rather than on ion conduction, permanent stickiness and burn-in are virtually eliminated. Low gamma permits a very wide operating range.

These and other features of these image orthicons assure long life and reliable operation in such applications as medical biological studies, spectrographic detectors, underwater observation, and missile detection.

Electrical

Cathode—Unipotential	
Heater	
Voltage, AC or DC	6.3 ± 10% Volts
Current	0.6 Amperes
Photocathode—Semi-Transparent	
Spectral Response—UV	
Rectangular Image, 4 by 3 aspect ratio	
Useful Size, maximum diagonal	1.8 Inches
Orientation—Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through the center of the faceplate and pin No. 7 of the shoulder base.	
Focusing Method—Magnetic	
Deflection Method—Magnetic	
Direct Interelectrode Capacitance	
Anode to all other Electrodes	12 μf

Mechanical

Over-all Length	15.20 ± 0.25	Inches
Greatest Bulb Diameter	3.00 ± 0.06	Inches
Deflecting Coil		
Length	5	Inches
Minimum Inside Diameter	2 ³ / ₈	Inches
Focusing-Coil Length	10	Inches
Alignment-Coil Length	1 ⁵ / ₈	Inches
Photocathode Distance Inside		
End of Focusing Coil	1/2	Inches
Weight, approximate		
Z-7807	1.4	Pounds
GL-7969	0.8	Pounds
Operating Position—Any, except with diheptal base up and tube axis at an angle of less than 20 degrees from vertical.		

Thermal

Operating Temperature at any Part of Bulb, maximum	70	C
Operating Temperature of Bulb at Large End of Tube, Target Section, minimum	0	C
Temperature Difference Between Target Section and any Part of Bulb Hotter than Target Section	7.5	C

MAXIMUM RATINGS—ABSOLUTE VALUES

Photocathode			
Voltage	-600	Volts	
Illumination	50	Foot-candles	
Anode Supply Voltage*	1850	Volts	
Grid-No. 1 Voltage			
Negative Bias Value	135	Volts	
Positive Bias Value	0	Volts	
Grid-No. 2 and Dynode-No. 1 Voltage	380	Volts	
Grid-No. 3 Voltage	400	Volts	
Grid-No. 4 Voltage	300	Volts	
Grid-No. 5 Voltage	150	Volts	
Grid-No. 6 Voltage	-600	Volts	
Dynode-No. 2 to Dynode-No. 1 Voltage	350	Volts	
	Dynode-No. 3 to Dynode-No. 2 Voltage	350	Volts
	Dynode-No. 4 to Dynode-No. 3 Voltage	680	Volts
	Dynode-No. 5 to Dynode-No. 4 Voltage	350	Volts
	Anode to Dynode-No. 5 Voltage	100	Volts
	Voltage per Multiplier Stage	400	Volts
	Target Voltage		
	Above Target Cutoff, positive direction	10	Volts
	Negative	10	Volts
	Peak Heater-Cathode Voltage		
	Heater Negative with Respect to Cathode	125	Volts
	Heater Positive with Respect to Cathode	10	Volts

* Ratio of dynode voltages appears under Typical Operation.

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TYPICAL OPERATION—AVERAGE VALUES

	Normal Performance†	Maximum Sensitivity Performance‡
Photocathode Voltage, image focus.....	-400 to -540	-400 to -550 Volts
Grid-No. 1 Voltage for Picture Cutoff, Beam.....	-45 to -115	-45 to -115 Volts
Photocathode Illumination—See Page 5		
Scene Illumination—See Page 5		
Grid-No. 2 and Dynode-No. 1 Voltage.....	300	370 Volts
Grid-No. 3 Voltage, multiplier focus§.....	225-330	225-380 Volts
Grid-No. 4 Voltage, beam focus.....	140-180	140-250 Volts
Grid-No. 5 Voltage, decelerator.....	0-125	0-125 Volts
Grid-No. 6 Voltage, accelerator—75 percent of photocathode voltage, approximate.....	-300 to -405	-300 to -465 Volts
Dynode-No. 2 Voltage.....	600	770 Volts
Dynode-No. 3 Voltage.....	910	1080 Volts
Dynode-No. 4 Voltage.....	1200	1360 Volts
Dynode-No. 5 Voltage.....	1490	1610 Volts
Anode Voltage.....	1550	1700 Volts
DC Anode Current, maximum.....	30	30 Microamperes
Signal Output Current, peak-to-peak—See Light-Transfer Characteristic		
Target Cutoff Voltage¶.....	-3 to +1	-3 to +1 Volts
Target Temperature Range.....	15-55	15-55 C
Peak-to-Peak Blanking Voltage.....	5-20	5-20 Volts
Field Strength at Center of Focusing Coil**.....	75	75 Gauss
Field Strength of Alignment Coil, approximate#.....	0-3	0-3 Gauss

† Although these tubes will operate in standard equipment, modification to permit operation at these values will improve effective sensitivity for most applications.

‡ These values will permit the best low-light-level-sensitivity capability of the tube to be realized and will assure the maximum useful multiplier gain required in extreme low-light-level applications. The resolution sensitivity information in this data sheet was derived with these higher multiplier voltages.

§ Adjust to give the most uniformly shaded picture near maximum signal.

|| 75 to 85 percent of photocathode voltage.

¶ The target supply voltage should be adjustable from -3 to +5 volts with blanking voltage off. Maximum target voltage is +10 volts above target cutoff. Recommended target voltage is +2 volts above cutoff. Slight readjustment, usually only a small fraction of a volt, may be necessary to minimize microphonics.

**Direction of current 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.

Adjust to produce flattest field with maximum response. Alignment is correct when the center of the picture merely goes through focus and does not rotate when beam focus (Grid No. 4) is varied. For most commercial focus coils a 75-gauss field results from a focus-coil current of 75 milliamperes.

Z-7807

ENVIRONMENTAL

Shock: Per specification MIL-E-5272C (ASG) Paragraph 4.15.5 except:

A 12 impact shocks of 30g

B The shock shall be applied in the following directions:

1—Vertically perpendicular to longitudinal axis, 3 shocks in each direction.

2—Parallel to the minor horizontal axis, 3 shocks in each direction.

C The shock pulse width is defined by the use of a 0.2 to 250-cycle-per-second filter.

Vibration: Per MIL-E-5272C (ASG) Paragraph 4.7.12 Procedure XII except at operating temperature only. Center horizontal resolution at 3×10^{-5} maximum foot-candles, photocathode illumination will be at least 350 lines (EIA) with 5g applied acceleration in the frequency range from 50 to 500 cycles per second and a double amplitude of 0.036 inch from 5 to 50 cycles per second. Picture resolution of 350 TV lines (EIA) is defined as readable through any interference that may occur.

Humidity: Per MIL-E-5272C (ASG) Paragraph 4.4.1 Procedure 1. Following this test, the interelectrode insulation of the end pins 5, 6, 7, 8, 9, and 10 each with respect to all other end base pins grounded and with 350 volts (minimum) applied is greater than 500 ohms.

Acceleration: Constant acceleration when applied perpendicular to the longitudinal axis of the tube for 10 minutes. (70g)

OPERATING NOTES

Some magnesium-oxide targets may be damaged permanently if directly and intermittently exposed, while in operation, to extremely bright sources which cause high photoelectron densities to occur at the target. Such sources include the sun, photoflash lamps, and exploding wire flashes. Damage, if it does occur, takes the form of black image spots burned in the target by the intense light.

In most cases an 80-megohm, $\frac{1}{4}$ -watt resistor in series with the photocathode in the camera will protect the tube. This resistor will not interfere with normal operation of these or other image orthicons which may be used in the modified camera.

If these or similar bright sources are to be observed continuously, appropriate exposure control of photocathode illumination can be supplied by neutral-density filters.

SPECIFIC PARAMETERS ON RECORDED DATA

All curves except spectral-sensitivity characteristics were recorded under the following conditions:

- Camera Chain:** General Electric TE-5 (modified)
Amplifier bandwidth—total 20 mc, flat to 6 mc
- Resolution Chart:** National Bureau of Standards Lens Test Chart, 100% contrast transparency.
- Window Chart:** 100% contrast, 1% area window for signal-noise and transfer characteristic data.
- Light Source:** 2870⁰ Kelvin—tungsten
- Light Level:** Aperture and neutral density controlled (within specially constructed low-light-level box) to provide range from 10^{-8} to 10^{-2} foot-candles illumination on photocathode. For corresponding scene brightness in foot-lamberts when using Leitz f/1.5 lens (85 mm), multiply photocathode illumination in foot-candles by 12.
- Operating Temperature for Image End:** 25 to 30 C.
- Target Raster:** Target diameter is 1.40 inches. For corners of scanning raster just touching target edge raster dimensions are:

<u>Aspect Ratio</u>	<u>Horizontal</u>	<u>Vertical</u>
1 x 1 (square)	0.99"	0.99"
4 x 3 (standard)	1.12"	0.84"

Horizontal TV lines = 1.12 x TV lines per target inch

Vertical TV lines (EIA) = 0.84 x TV lines per target inch

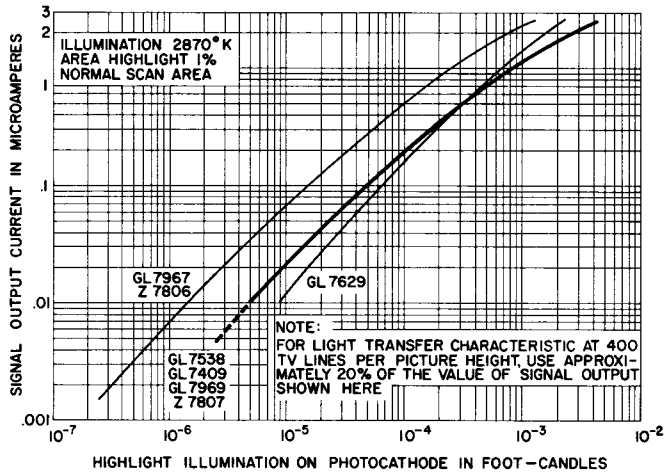
Resolution sensitivity data is recorded in TV lines per target inch

Therefore, 700 TV lines per target inch = 784 horizontal lines
= 588 vertical lines (EIA)

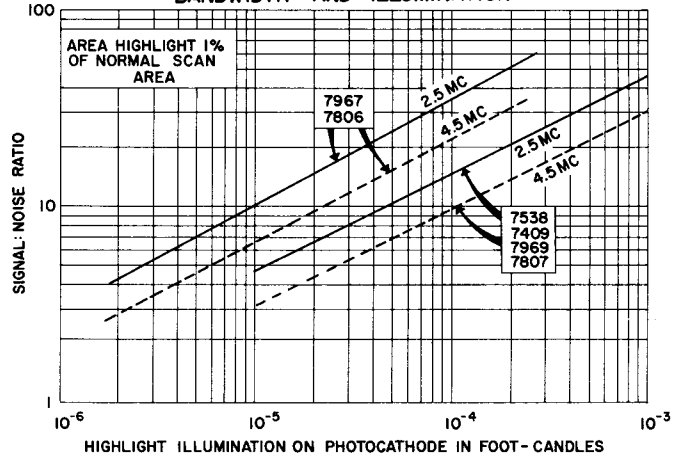
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LIGHT TRANSFER CHARACTERISTICS

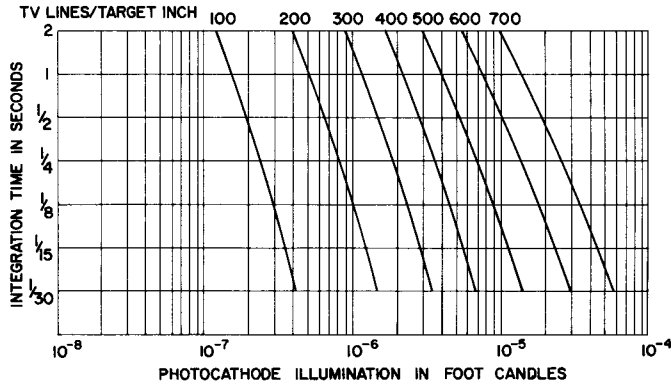


TYPICAL SIGNAL: NOISE CHARACTERISTICS VS. BANDWIDTH AND ILLUMINATION

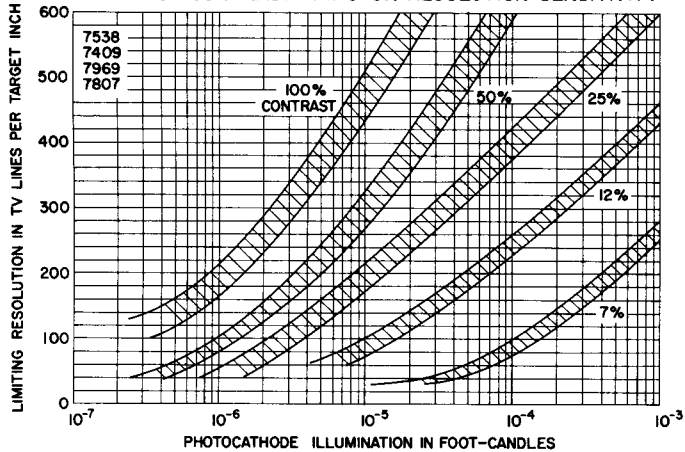


INTEGRATION EFFECT ON RESOLUTION SENSITIVITY

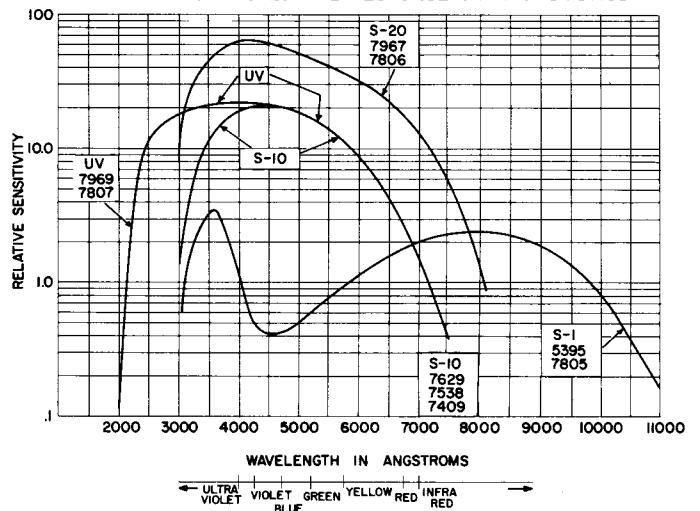
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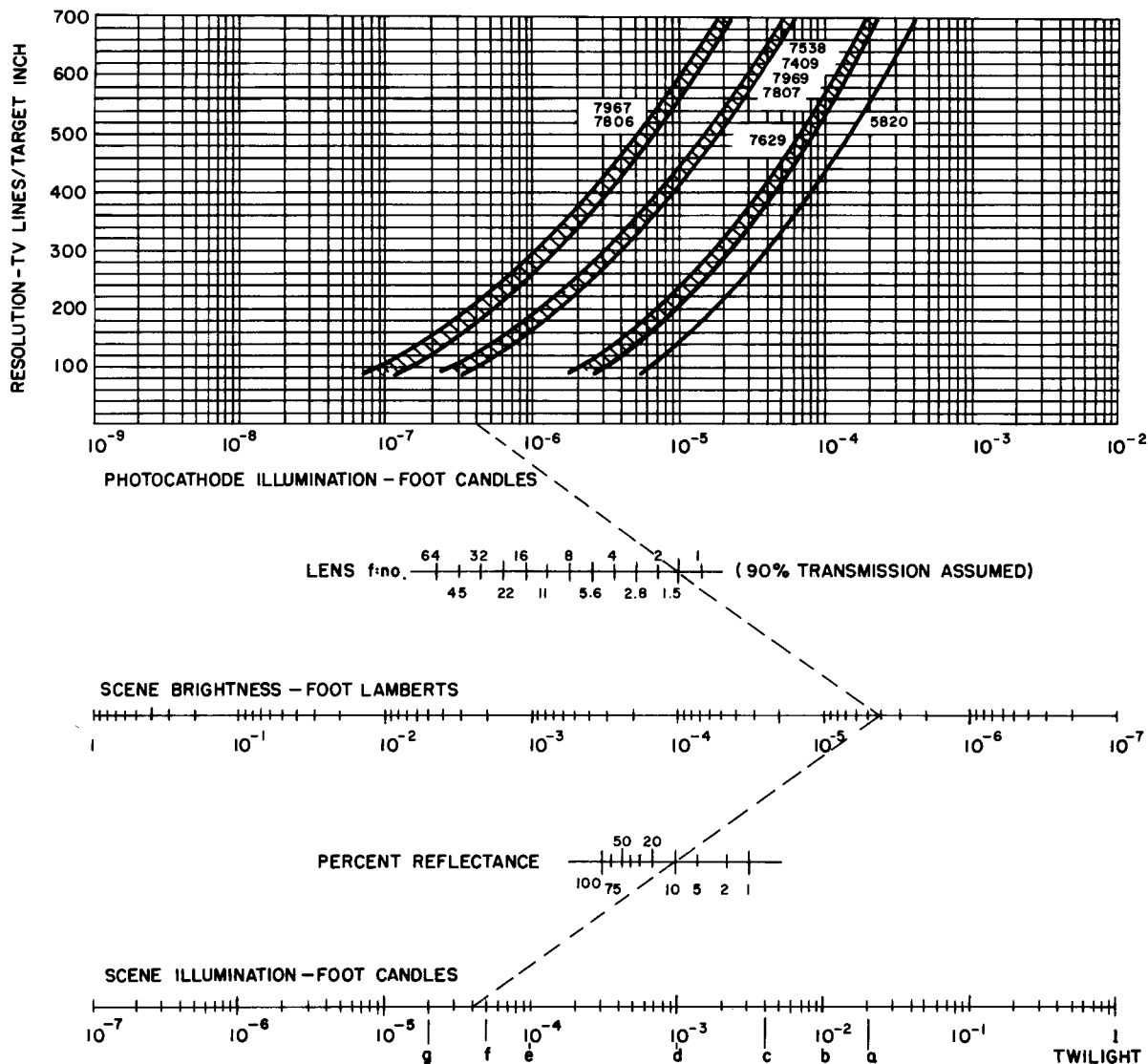
EFFECT OF CONTRAST RATIO ON RESOLUTION SENSITIVITY



PHOTOCATHODE SPECTRAL RESPONSE CHARACTERISTICS



SCENE ILLUMINATION VS TYPICAL RESOLUTION SENSITIVITY BY TYPE*



<u>Code</u>	<u>Ambient Condition</u>	<u>Scene Illumination</u>
a	Full moon-clear	2×10^{-2} ft-c
b	Half moon	1×10^{-2} ft-c
c	Full moon-moderately cloudy	4×10^{-3} ft-c
d	Quarter moon-clear	1×10^{-3} ft-c
e	No moon-clear	1×10^{-4} ft-c
f	No moon-moderately cloudy	5×10^{-5} ft-c
g	No moon-heavy cloud	2×10^{-5} ft-c

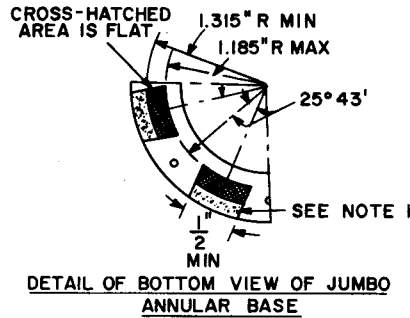
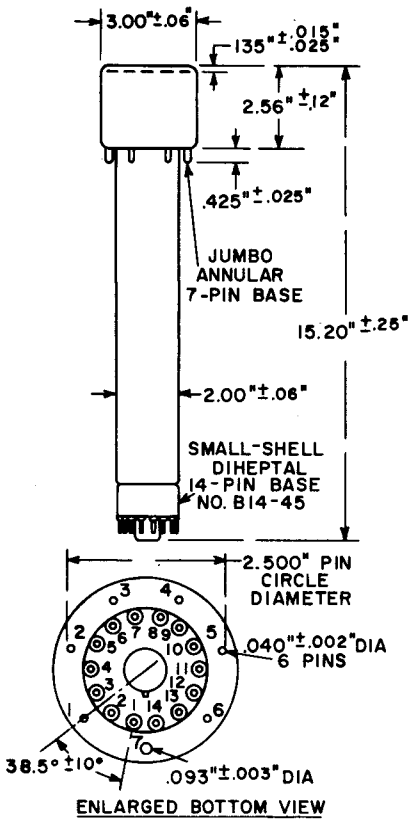
NEUTRAL DENSITY FILTERS FOR EXPOSURE CONTROL

<u>TYPE AND DENSITY</u>	<u>PERCENT TRANSMITTANCE</u>	<u>NUMBER OF STOPS</u>
ND .30	50.0	1
ND .60	25.0	2
ND .90	13.0	3
ND 1.00	10.0	3.3
ND 2.00	1.0	6.6
ND 3.00	0.10	10.0
ND 4.00	0.010	13.2

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NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAGE WITH:

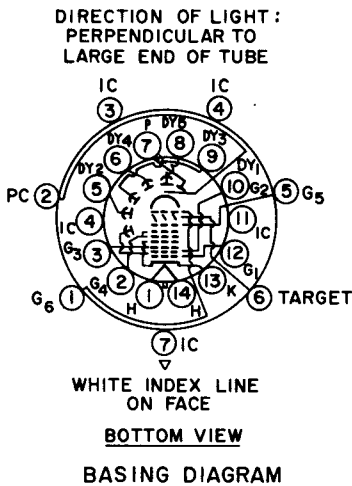
- a. SIX HOLES HAVING DIAMETER OF 0.065 ± 0.001 " AND ONE HOLE HAVING DIA OF 0.150 ± 0.001 ". ALL HOLES HAVE DEPTH OF 0.265 ± 0.001 ". THE SIX 0.065 " HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047 ". ALL HOLES ARE SPACED AT ANGLES OF $51^\circ 26' \pm 9'$ ON CIRCLE DIAMETER OF 2.500 ± 0.001 ".
- b. SEVEN STOPS HAVING HEIGHT OF 0.187 ± 0.001 ", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.
- c. RIM EXTENDING OUT OF A MINIMUM OF 0.125 " FROM 2.812 " DIAMETER AND HAVING HEIGHT OF 0.126 ± 0.001 ".
- d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200 ± 0.001 ".

SMALL-SHELL DIHEPTAL 14-PIN BASE

- | | |
|--|---|
| PIN 1: HEATER | PIN 9: DYNODE NO.3 |
| PIN 2: GRID NO. 4 & FIELD MESH | PIN 10: DYNODE NO. 1, GRID NO. 2 |
| PIN 3: GRID NO. 3 | PIN 11: INTERNAL CONNECTION- DO NOT USE |
| PIN 4: INTERNAL CONNECTION- DO NOT USE | PIN 12: GRID NO. 1 |
| PIN 5: DYNODE NO. 2 | PIN 13: CATHODE AND SUPPRESSOR GRID |
| PIN 6: DYNODE NO. 4 | PIN 14: HEATER |
| PIN 7: ANODE | |
| PIN 8: DYNODE NO. 5 | |

KEYED JUMBO ANNULAR 7-PIN BASE

- | | |
|--|--|
| PIN 1: GRID NO. 6 | PIN 5: GRID NO. 5 |
| PIN 2: PHOTOCATHODE | PIN 6: TARGET |
| PIN 3: INTERNAL CONNECTION- DO NOT USE | PIN 7: INTERNAL CONNECTION- DO NOT USE |
| PIN 4: INTERNAL CONNECTION- DO NOT USE | |



GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Pickup Tube Operation

Syracuse, New York

IMAGE ORTHICON

FOCUS—MAGNETIC

DEFLECTION—MAGNETIC



The GL-7969 is an image orthicon with an ultraviolet sensitive photocathode. Because of the low gain, the tube has a very wide operating range at low light levels.

This tube features a high gain thin film magnesium oxide target with a sensitivity ten to twenty times that of ion target tubes such as the 5820. This target has several advantages: its extreme thinness and anisotropic properties virtually eliminate sideways leakage, which increases the resolution 25 to 50 percent over that of the standard target. It absorbs all electrons leaving the target, so that the target is not being read off, which permits continuous

scanning by use of low frame rates or slow scanning. It completely eliminates both streaking and burn-in since evaporation depends on electron conduction, which is not a depletion process, rather than on ion conduction. The curve shown on page 3 compares the resolution of a GL-7969 with that of a 5820 with a conventional photocathode.

The target characteristics also assure a higher amplitude response than that of the 5820. Another advantage of the GL-7969 is a considerable reduction in the distribution of target secondary electrons. This reduces image blurring effect, particularly at a black-to-white

Electrical

Cathode Temperature	
Heater Voltage AC or DC	6.3-10 Volts
Heater Current	0.6 Ampere
Photocathode Sensitivity	
Response Ultraviolet sensitive	
Rectangular Image Extension Ratio	
Useful Scan Aspect Ratio	4:1 Inches
Orientation	Flange connections obtained when the vertical axis is essentially parallel to the tube passing through the center of the cathode and grid No. 2 of the shoulder base.
Focusing Method	Magnetic
Deflecting Method	Magnetic
Direct Inter-electric Capacitance	
Anode to all other Electrodes	12 pF

Mechanical

Overall Length	15.20 ± 0.25	Inches
Greatest Diameter of Bulb	3.60 ± 0.06	Inches
Minimum Deflecting Grid Inside Diameter	2.5	Inches
Deflecting Grid Length	5	Inches
Focusing Grid Length	10	Inches
Alignment Grid Length	3	Inches
Photocathode Diameter Inside End of Focusing Grid	1.2	Inch
Weight Approximate	1.4	Pounds
Operating Position Any, except with filament base up and the tube axis at an angle of less than 20 degrees from vertical		

Thermal

Operating Temperature of Any Part of Bulb	50	Max C
Operating Temperature of Bulb at Large End of Tube Target Section	15	Max C
Temperature Difference Between Target Section and Any Part of Bulb Higher than Target Section	5	Max C

MAXIMUM RATINGS—ABSOLUTE VALUES

Photocathode Voltage	550	Volts	Target Voltage		
Photocathode Illumination	50	Foot-Candles	Positive Voltage	2	Volts
Anode Supply Voltage	500	Volts	Negative Voltage	10	Volts
Grid No. 1 Voltage	0	Volts	Peak Heater-Cathode Voltage		
Negative Bias Value	125	Volts	Heater Negative with Respect to Cathode	125	Volts
Positive Bias Value	0	Volts	Heater Positive with Respect to Cathode	10	Volts
Grid No. 2 and Dynode No. 1 Voltage	150	Volts			
Grid No. 3 Voltage	400	Volts			
Grid No. 4 Voltage	300	Volts			
Grid No. 5 Voltage	150	Volts			
Grid No. 6 Voltage	550	Volts			
Voltage per Multiplier Stage	350	Volts			

TYPICAL OPERATION

Cathode Voltage (range)	200 to 340	Volts	Diode No. 1 Voltage	600	Volts
Grid No. 1 Voltage (to Plate Cathode) beam	15 to 115	Volts	Diode No. 2 Voltage	800	Volts
Grid No. 2 and Diode No. 1 Voltage	0 to 200	Volts	Diode No. 3 Voltage	1000	Volts
Grid No. 3 Voltage, multipole focus	225 to 230	Volts	Diode No. 4 Voltage	1200	Volts
Grid No. 4 Voltage, beam focus	140 to 180	Volts	Anode Voltage	1250	Volts
Grid No. 5 Voltage, decelerator	0 to 12	Volts	DC Anode Current	3	Microamperes
Grid No. 6 Voltage, accelerator	0 to 12	Volts	Target Voltage, without Marking Voltage	0 to 20	Volts
Percent of Photoelectron Voltage, approximate	50 to 100	Volts	Peak to Peak Blanking Voltage	0 to 20	Volts
			Target Temperature Range	15 to 35	C
			Field Strength at Center of Focusing Coil	7.5	Gauss/cm
			Field Strength of Alignment Coil, approximate	0 to 3	Gauss/cm

* Ratio of anode voltages is shown under Typical Operation.

† Adjust to give the most uniformly shaded picture near maximum signal.

‡ Direction of current should be such that a north seeking pole is attracted to the image end of the focusing coil, with the coil located outside of and at the image end of the focusing coil.

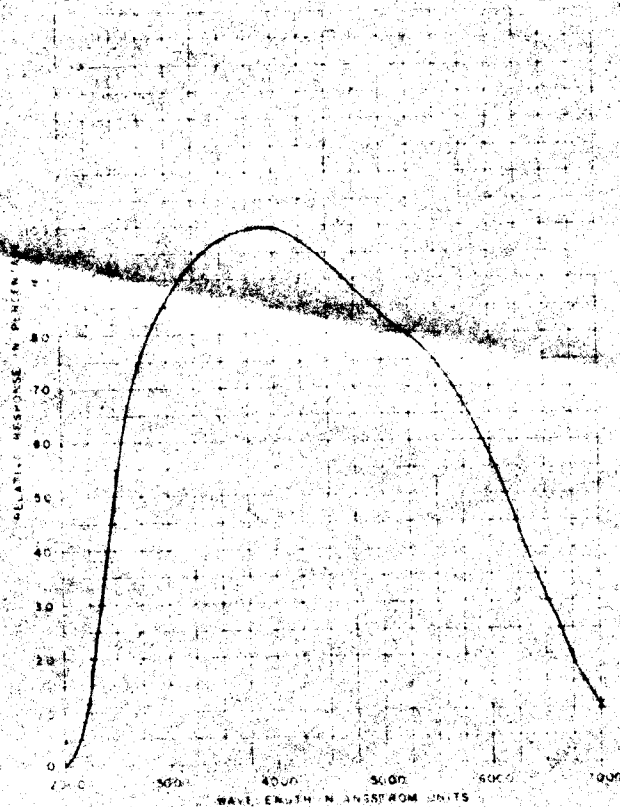
OPERATING NOTES

Normally a new tube will exhibit some slight after image, characterized by a rapid initial drop in decay which will gradually diminish with life. This can be minimized by use of an arbiter or by emitting a forced anode current for short periods of time. Although a warmup time of one hour is desirable, the tube can be used immediately after alignment as it cannot be permanently burned.

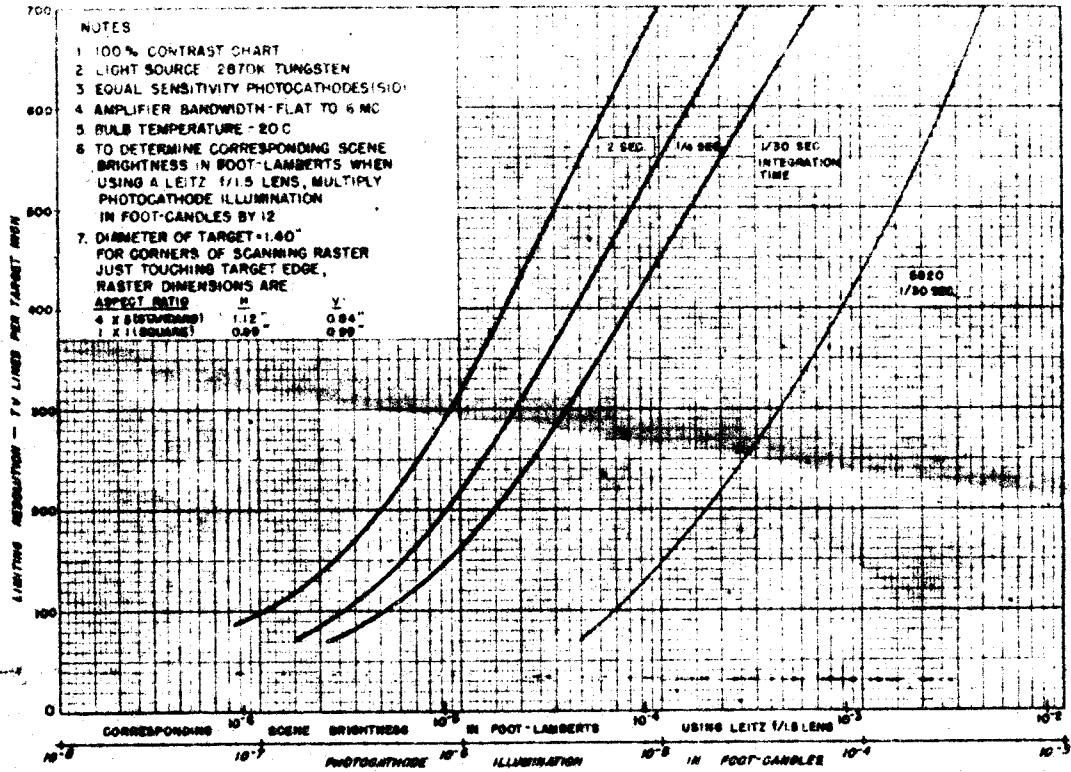
Some tubes may exhibit microphonic bars if used immediately while relatively cool. These will disappear as the tube warms up and can be minimized during this period by slight readjustments in target voltage.

The target used in this tube greatly reduces the probability of permanent burn-in damage, except a stationary highlight on the target for an extended period. However, imaging directly on the anode or other extremely bright sources should be avoided.

SPECTRAL SENSITIVITY CHARACTERISTIC



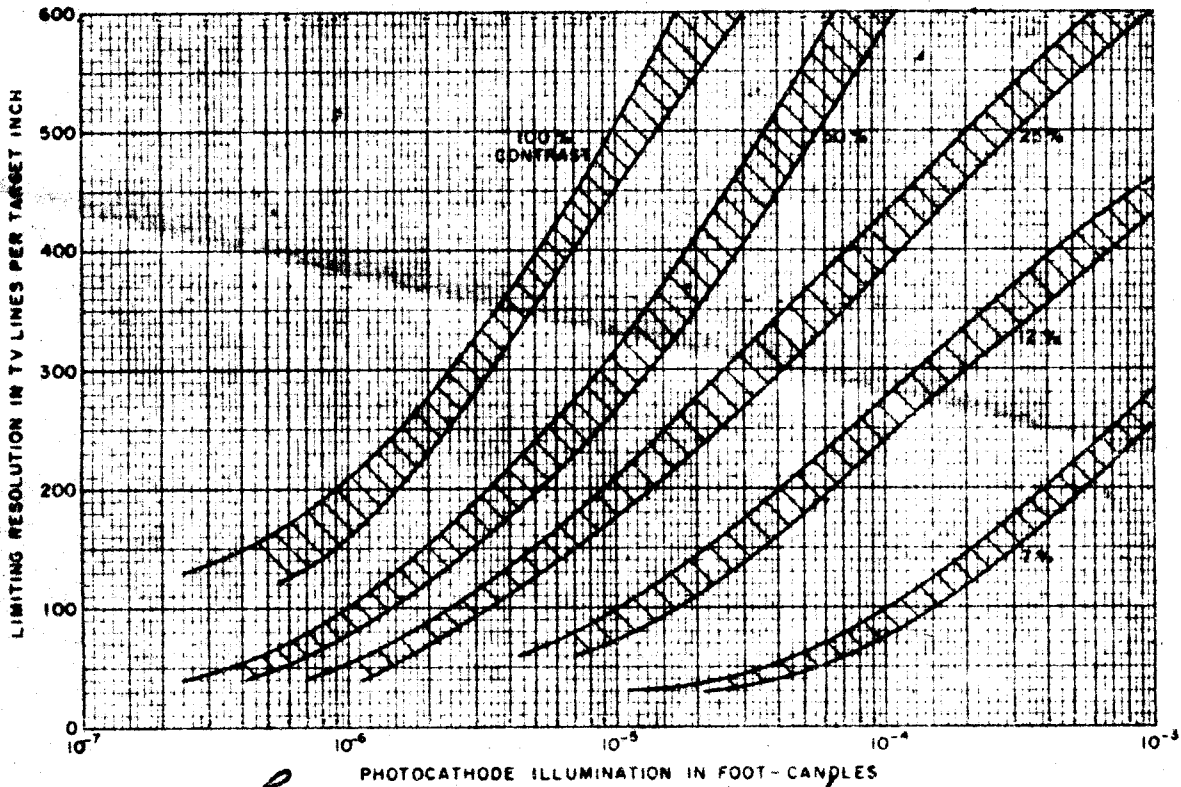
TYPICAL RESOLUTION - SENSITIVITY CHARACTERISTICS SHOWING EFFECTS OF IMAGE INTEGRATION



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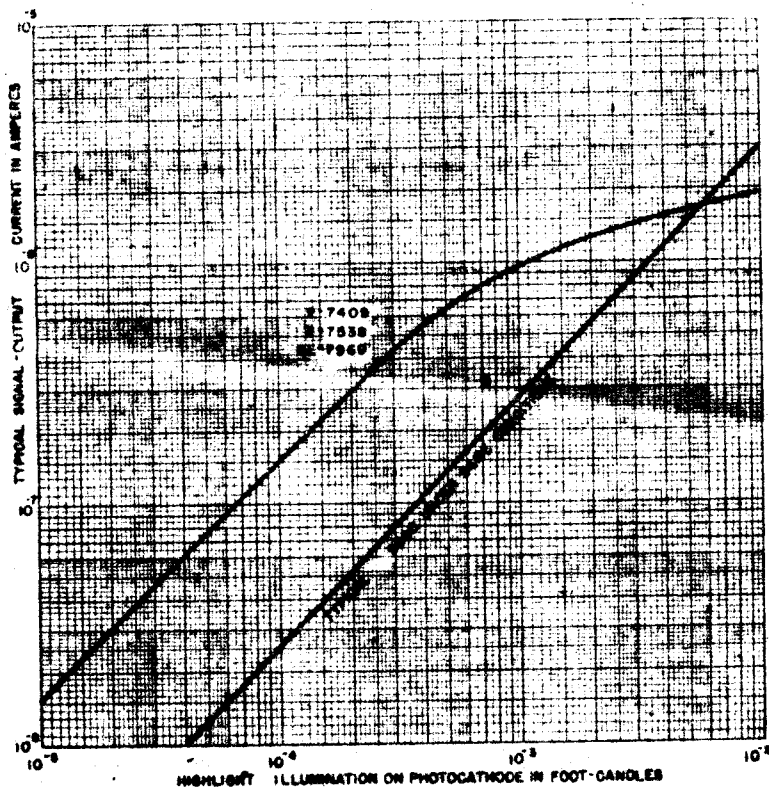
EFFECT OF CONTRAST RATIO ON RESOLUTION SENSITIVITY



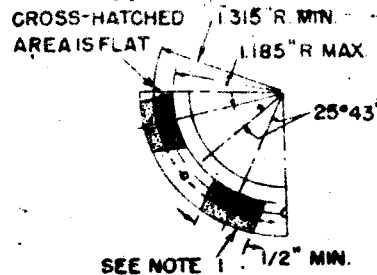
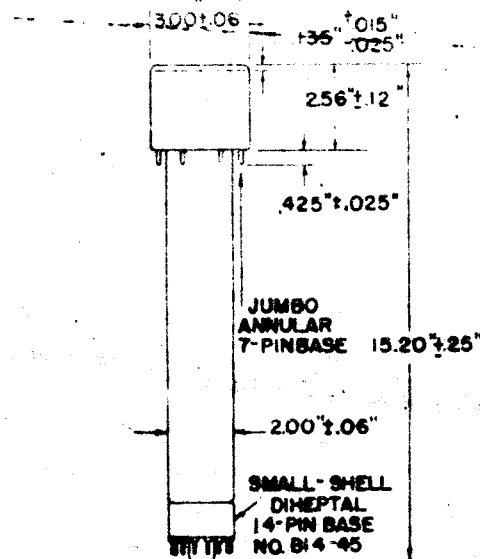
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TRANSFER CHARACTERISTIC

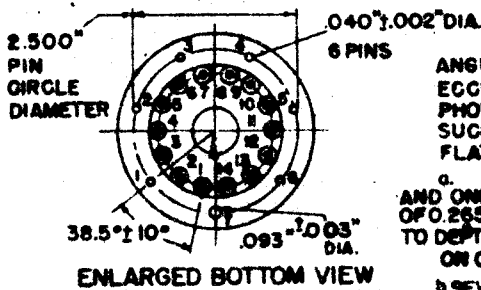


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DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE

NOTE: DOTTED AREA IS FLAT OR EXTENDS TOWARD DHEPTAL-BASE END OF TUBE BY 0.060" MAX.

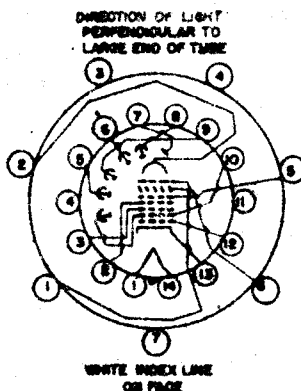


ENLARGED BOTTOM VIEW

ANNULAR BASE GAGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAGE WITH:

- SIX HOLES HAVING DIAMETER OF 0.065 ± 0.001 " AND ONE HOLE HAVING DIA. OF 0.150 ± 0.001 ". ALL HOLES HAVE DEPTH OF 0.265 ± 0.001 ". THE SIX 0.065 " HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047 ". ALL HOLES ARE SPACED AT ANGLES OF $51^\circ 26' \pm 5'$ ON CIRCLE DIAMETER OF 2.500 ± 0.001 ".
- SEVEN STOPS HAVING HEIGHT OF 0.187 ± 0.001 ", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.
- RIM EXTENDING OUT OF A MINIMUM OF 0.125 " FROM 2.812 " DIAMETER AND HAVING HEIGHT OF 0.126 ± 0.001 ".
- NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200 ± 0.001 ".



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BASINS DIAGRAM

SMALL-SHELL DHEPTAL 14-PIN BASE

PIN 1: HEATER	PIN 6: DYNODE NO. 4	PIN 11: INTERNAL CONNECTION DO NOT USE
PIN 2: GRID NO. 4	PIN 7: ANODE	PIN 12: GRID NO. 1
PIN 3: GRID NO. 3	PIN 8: DYNODE NO. 5	PIN 13: CATHODE
PIN 4: INTERNAL CONNECTION - DO NOT USE	PIN 9: DYNODE NO. 3	PIN 14: HEATER
PIN 5: DYNODE NO. 2	PIN 10: DYNODE NO. 1, GRID NO. 2	

KEYED JUMBO ANNULAR 7-PIN BASE

PIN 1: GRID NO. 6	PIN 6: GRID NO. 5
PIN 2: PHOTOCATHODE	PIN 6: TARGET
PIN 3: INTERNAL CONNECTION - DO NOT USE	PIN 7: INTERNAL CONNECTION DO NOT USE
PIN 4: INTERNAL CONNECTION DO NOT USE	