

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 $\pm$ 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 μ f

Mechanical

Over-all Length	15.20 $\pm$ 0.25	Inches
Greatest Bulb Diameter	3.00 $\pm$ 0.06	Inches
Deflecting Coil		
Length	5	Inches
Minimum Inside Diameter	2 $\frac{3}{8}$	Inches
Focusing-Coil Length	10	Inches
Alignment-Coil Length	1 $\frac{5}{16}$	Inches
Photocathode Distance Inside		
End of Focusing Coil	1 $\frac{1}{2}$	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			Dynode-No. 3 to Dynode-No. 2 Voltage.	350	Volts
Voltage	—600	Volts	Dynode-No. 4 to Dynode-No. 3 Voltage.	680	Volts
Illumination	50	Foot-candles	Dynode-No. 5 to Dynode-No. 4 Voltage.	350	Volts
Anode Supply Voltage*	1850	Volts	Anode to Dynode-No. 5 Voltage	100	Volts
Grid-No. 1 Voltage			Voltage per Multiplier Stage	400	Volts
Negative Bias Value	135	Volts	Target Voltage		
Positive Bias Value	0	Volts	Above Target Cutoff, positive direction	10	Volts
Grid-No. 2 and Dynode-No. 1 Voltage	380	Volts	Negative	10	Volts
Grid-No. 3 Voltage	400	Volts	Peak Heater-Cathode Voltage		
Grid-No. 4 Voltage	300	Volts	Heater Negative with Respect to		
Grid-No. 5 Voltage	150	Volts	Cathode	125	Volts
Grid-No. 6 Voltage	—600	Volts	Heater Positive with Respect to		
Dynode-No. 2 to Dynode-No. 1 Voltage	350	Volts	Cathode	10	Volts

* Ratio of dynode voltages appears under Typical Operation.

Z-7807 GL-7969

ET-T1690
Page 2
5-63

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

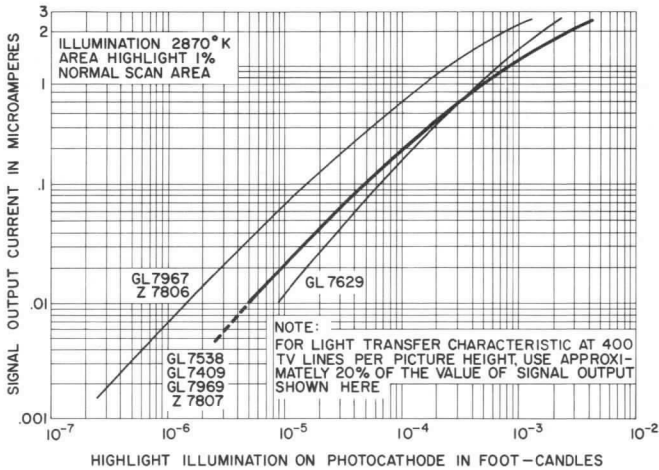
Resolution sensitivity data is recorded in TV lines per target inch

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

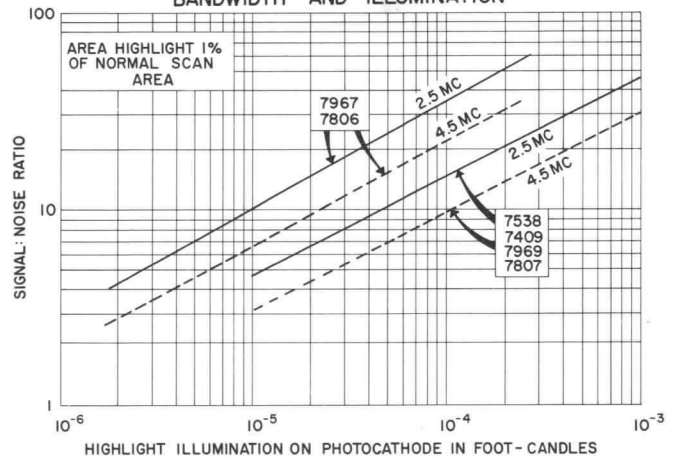
Z-7807 GL-7969

ET-T1690
Page 4
5-63

LIGHT TRANSFER CHARACTERISTICS

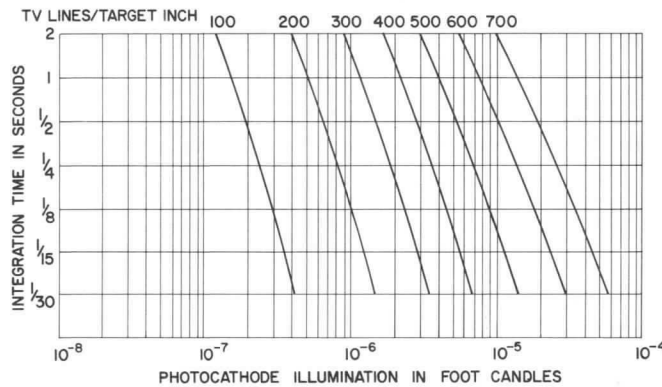


TYPICAL SIGNAL: NOISE CHARACTERISTICS VS. BANDWIDTH AND ILLUMINATION

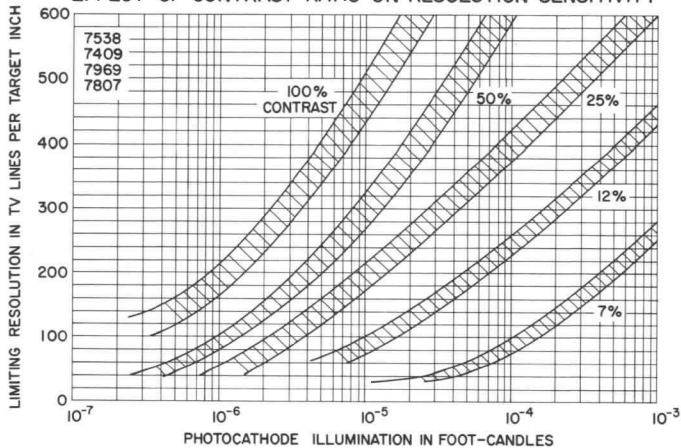


INTEGRATION EFFECT ON RESOLUTION SENSITIVITY

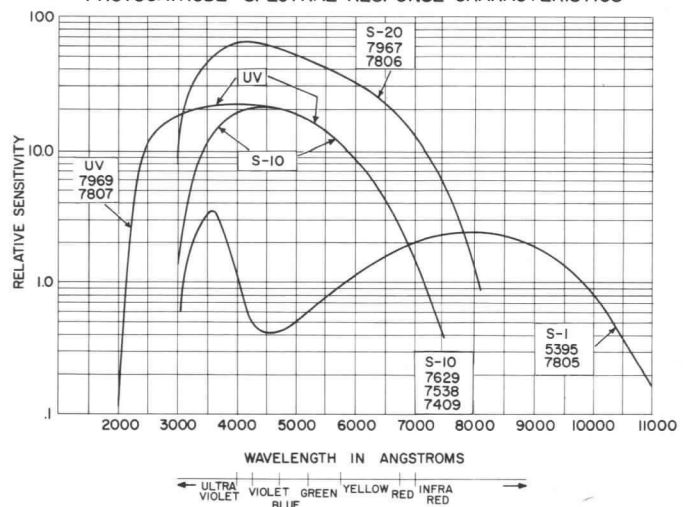
TYPES 7538 7409 7969 7807



EFFECT OF CONTRAST RATIO ON RESOLUTION SENSITIVITY



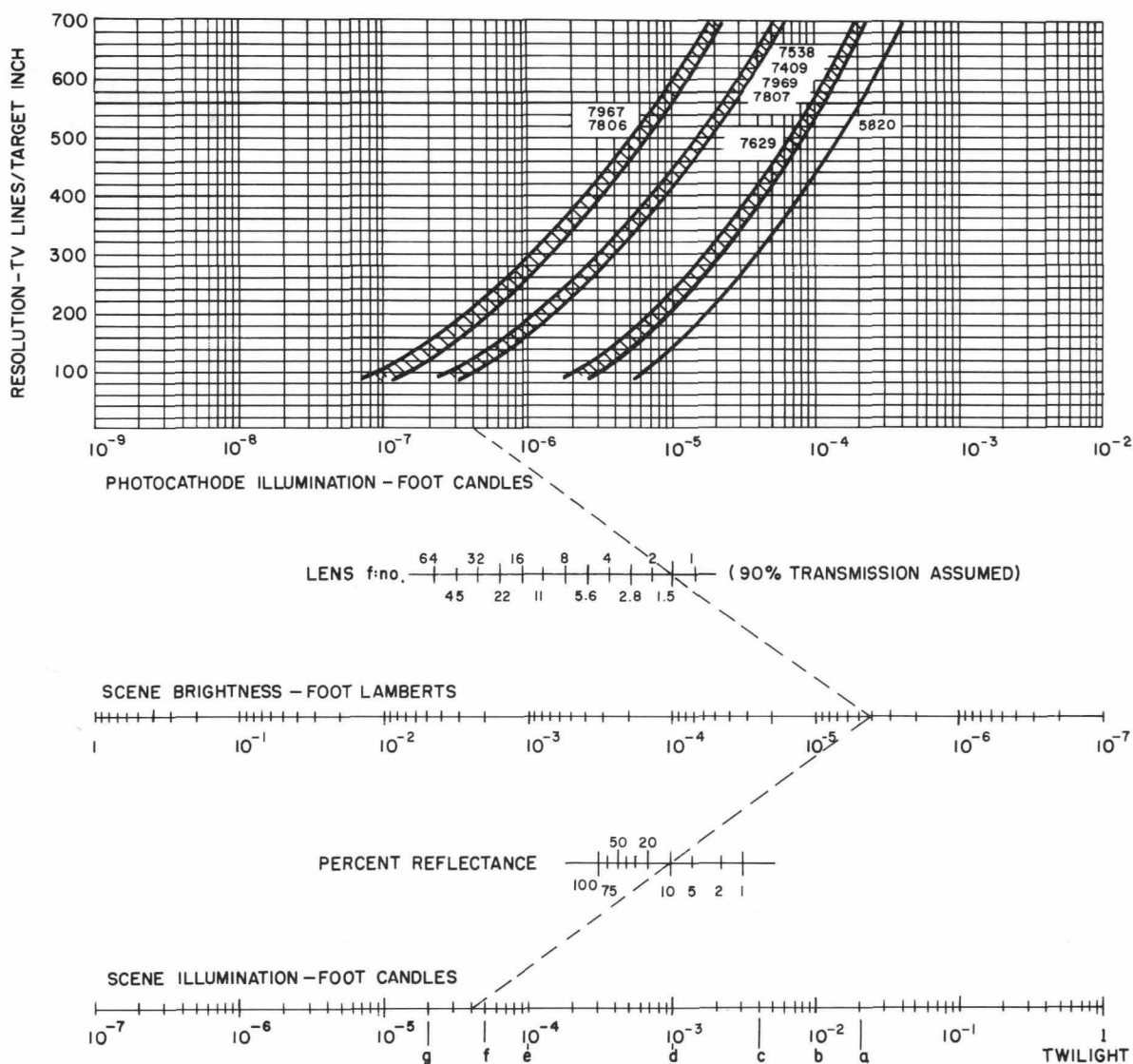
PHOTOCATHODE SPECTRAL RESPONSE CHARACTERISTICS



SCENE ILLUMINATION VS TYPICAL RESOLUTION SENSITIVITY BY TYPE *

Z-7807
GL-7969

ET-T1690
Page 5
5-63



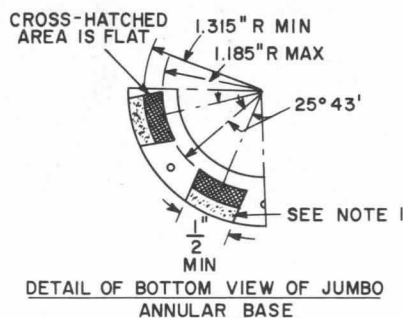
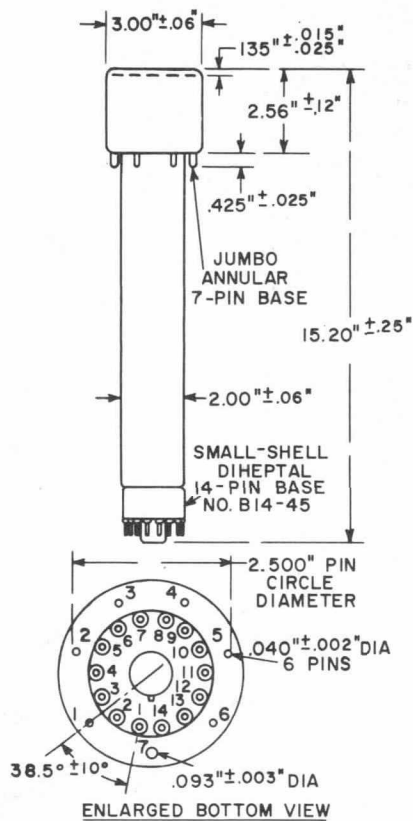
Code	Ambient Condition	Scene Illumination
a	Full moon-clear	2×10^{-2} ft-c
b	Half moon	1×10^{-2} ft-c
c	Full moon-moderately cloudy	4×10^{-3} ft-c
d	Quarter moon-clear	1×10^{-3} ft-c
e	No moon-clear	1×10^{-4} ft-c
f	No moon-moderately cloudy	5×10^{-5} ft-c
g	No moon-heavy cloud	2×10^{-5} ft-c

NEUTRAL DENSITY FILTERS FOR EXPOSURE CONTROL

TYPE AND DENSITY	PERCENT TRANSMITTANCE	NUMBER OF STOPS
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

Z-7807 GL-7969

ET-T1690
Page 6
5-63



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 $51^\circ 26' \pm 5'$ 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 ".

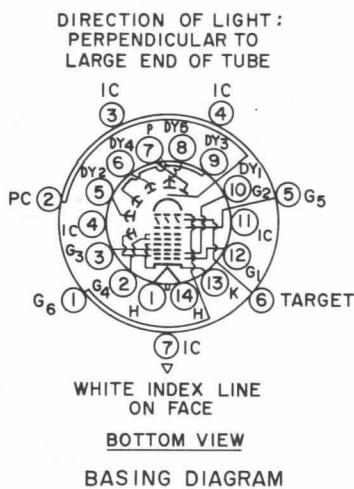
d. NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200 ± 0.001 ".

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

PRINTED
IN
U.S.A.

IMAGE ORTHICON

FOCUS—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 earlier target tubes such as the 3820. This target has several advantages. Its extreme flatness and insulative properties virtually eliminate adverse leakage voltages, increase the resolution 25 to 50 percent over that of the standard target. It reduces the tube life usage when the signal is steady for long periods before being read out, which permits unlimited

DEFLECTION—MAGNETIC

use of its by use of low frame rates and low deflection. It completely eliminates streaking and burn-in since the electron beams do not conduct the usual 10^{-4} to 10^{-5} A depletion process. It has a low noise action. The electron beam in grid 3 replaces the resolution resolution of the tube with that of a vacuum tube instead of photocathode.

The target characteristics also assist in high negative aspects than that of the standard target. Another advantage of the GL-7969 is a considerable reduction in the extractions of target secondary electrons. This reduces image distortion and target life at a black-to-white ratio.

Electrical

Cathode Temperature	
Heater Voltage—AC or DC	6.3 or 12 Volts
Heater Current	1.6 Amperes
Photocathode Sensitivity	
Response—Ultraviolet sensitive	
Rectangular Image—1/2 inch diameter	
Useful Screen diameter	4 inches
Orientation—Image orientation obtained when the vertical axis is parallel to the plane passing through the center of the cathode and grid No. 6, the shoulder base	
Focusing Method—Magnetic	
Deflecting Method—Magnetic	
Direct Inter-electrode Capacitance—Anode to all other Electrodes	12 pF

Mechanical

Overall Length	17.29 ± 0.25 Inches
Greatest Diameter of Bulb	3.50 ± 0.06 Inches
Maximum Diameter of Neck Diameter	2.4 Inches
Debeling Pin Length	5 Inches
Flange Pin Length	10 Inches
Alignment Pin Length	12 Inches
Photocathode Diameter	1/2 inch
Focusing Coil	1 inch
Weight—approximate	1.4 Pounds
Operating Position—Any, except with flange pins up and the tube axis at an angle of less than 20 degrees from vertical	

Thermal

Operating Temperature of Air Port of Bulb	50 Max C
Operating Temperature of Film at Large End of Tube Target Screen	15 Max C
Temperature Difference—Between Target Screen and Air Port of Bulb	
Operating Temperature of Target Screen	5 Max C

MAXIMUM RATINGS—ABSOLUTE VALUES

Photocathode Voltage	550 Volts	Target Voltage	10 Volts
Photocathode Illumination	50 Foot Candles	Negative Voltage	10 Volts
Anode Supply Voltage*	6 Volts	Grid-No. 1 Cathode Voltage	
Grid-No. 1 Voltage	12 Volts	Heater Negative Cathode to Grid-No. 1	125 Volts
Negative Bias Voltage	12 Volts	Heater Positive and Negative to Cathode	10 Volts
Pin 1 to Bias Voltage	12 Volts		
Grid-No. 2 and Dynode No. 1 Voltage	140 Volts		
Grid-No. 3 Voltage	200 Volts		
Grid-No. 4 Voltage	200 Volts		
Grid-No. 5 Voltage	150 Volts		
Grid-No. 6 Voltage	50 Volts		
Voltage per Multiplier Stage	550 Volts		

GENERAL  ELECTRIC

TYPICAL OPERATION

Photocathode Voltage, range	100 to 300 Volts	Diode No. 1 Voltage	500 Volts
Grid No. 1 Voltage for Positive Cut-off, beam	45 to 115 Volts	Diode No. 2 Voltage	800 Volts
Grid No. 2 and Diode No. 1 Voltage	100 Volts	Diode No. 3 Voltage	1000 Volts
Grid No. 3 Voltage, multiplex beam	225 to 350 Volts	Anode Voltage	1250 Volts
Grid No. 4 Voltage, beam focus	140 to 180 Volts	DC Anode Current	1 Microamperes
Grid No. 5 Voltage, decelerator	0 to 12 Volts	Target Voltage, without blanking voltage	0 to 25 Volts
Grid No. 6 Voltage, accelerator	0 to 12 Volts	Peak-to-Peak Blocking Voltage	5 to 20 Volts
Percent of Photocathode Voltage, approximate	100 to 300 Volts	Target Temperature Range	15 to 85 °C
		Field Strength at Center of Focusing Coil	0 to 5 Gauss
		Field Strength at Anode	0 to 3 Gauss

Range of anode voltages is shown under Typical Operation.

Adjust to give the most uniformly shaded picture and maximum signal.

Direction of current should be such that a retarding 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.

OPERATING NOTES

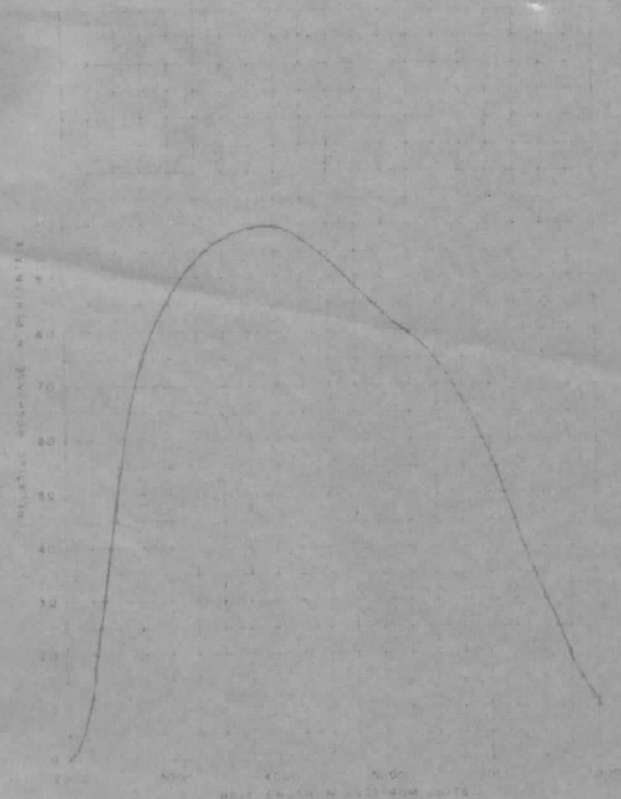
Normally a new tube will exhibit some light after images, characterized by a rapid initial drop in decay which will gradually diminish with life. This can be minimized by use of an eraser or by connecting forced air cooling for short periods of time.

Although a warmup time of one hour is desirable, the tube can be used immediately after alignment as it cannot be damaged permanently by target burn-in.

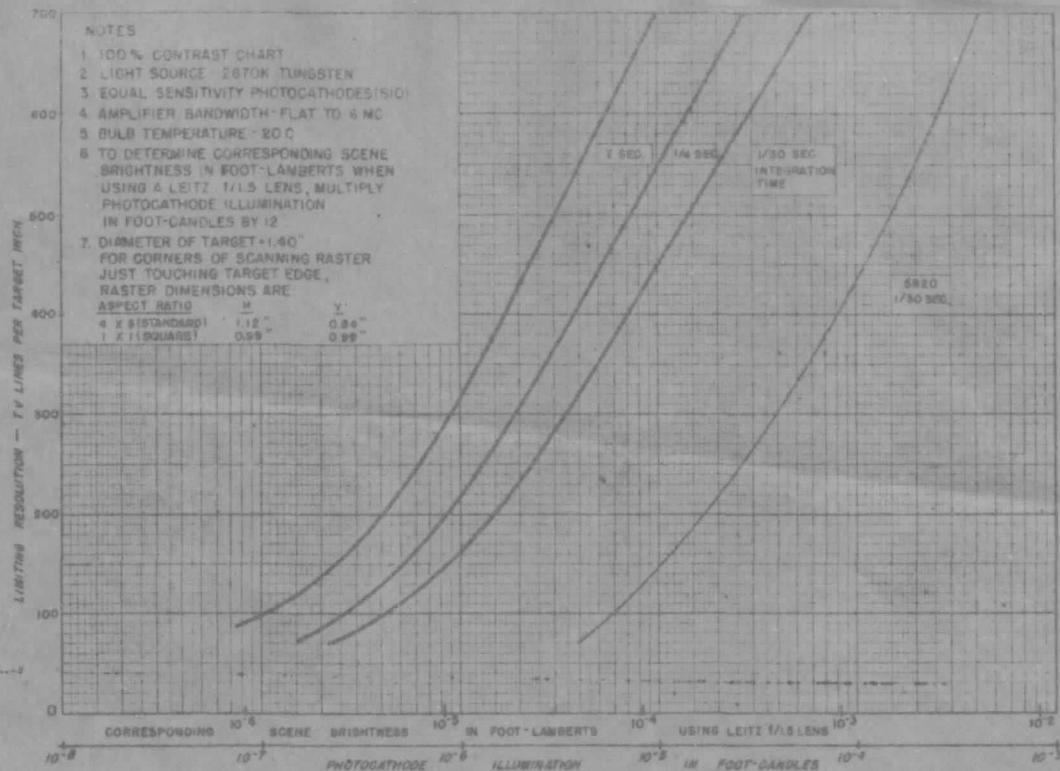
Some tubes may exhibit target burn-in if used immediately while relatively cool. These will disappear as the tube warms up and can be minimized during this period by slight readjustments in target voltage.

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

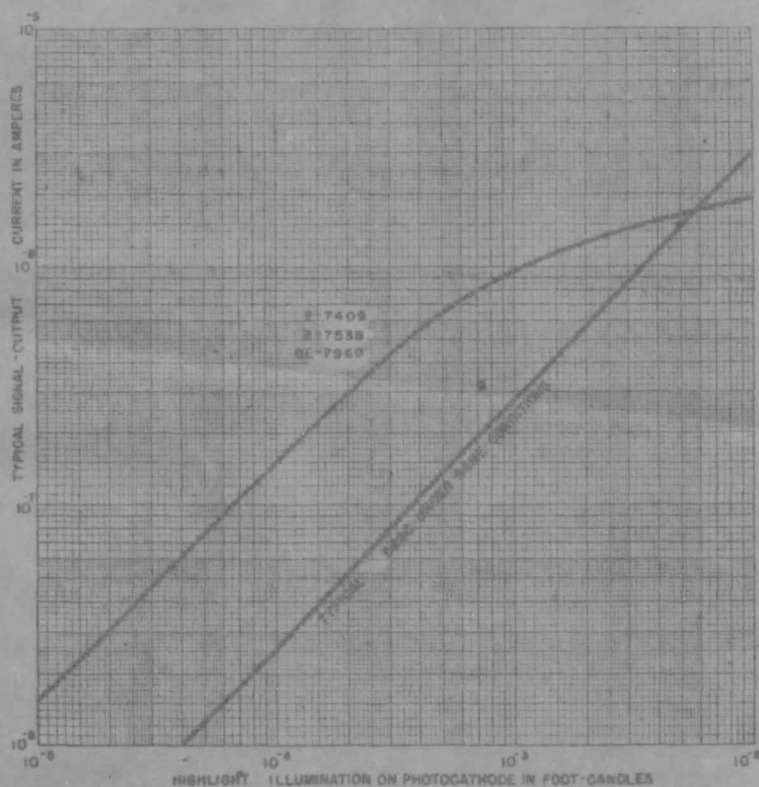
SPECTRAL SENSITIVITY CHARACTERISTIC



TYPICAL RESOLUTION-SENSITIVITY CHARACTERISTICS SHOWING EFFECTS OF IMAGE INTEGRATION

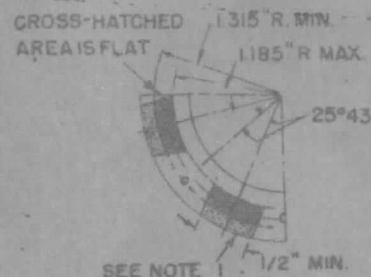
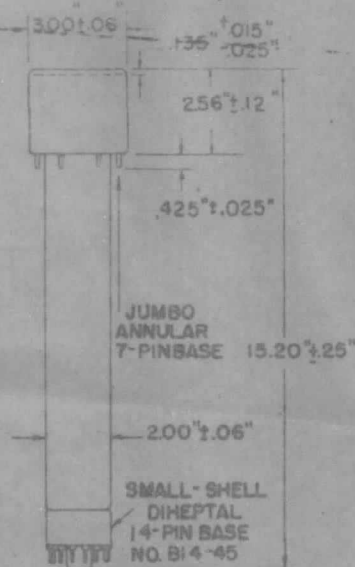


TRANSFER CHARACTERISTIC



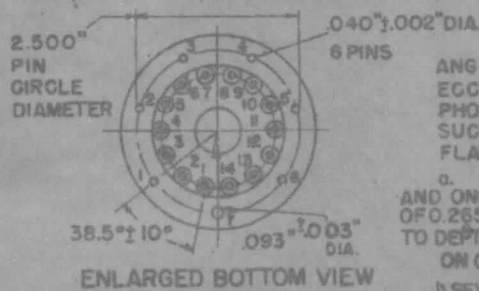
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3-61



DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE

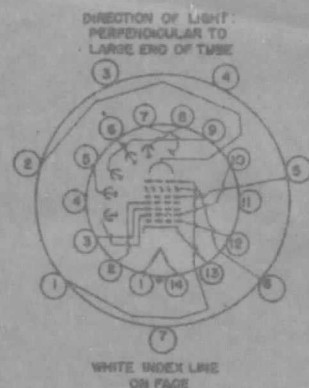
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- NECK CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200 ± 0.001 ".



BASING DIAGRAM

SMALL-SHELL DIHEPTAL 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 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	