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 x 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 $\mu\mu$f

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 . . . . . 2⅜ Inches

Focusing-Coil Length . . . . . 10 Inches

Alignment-Coil Length . . . . . $\frac{15}{16}$ Inches

Photocathode Distance Inside
- End of Focusing Coil . . . . . ½ 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.

GENERAL ELECTRIC

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	Gausses
Field Strength of Alignment Coil, approximate#	0–3	0–3	Gausses

† 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: (10g) Per MIL-E-5272C (ASG) Paragraph 4.7.12 Procedure XII except at operating temperature only. Center horizontal resolution at 3 x 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: (70g) Constant acceleration when applied perpendicular to the longitudinal axis of the tube for 10 minutes.

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, ¼-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: 2870^0 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:

Aspect Ratio	Horizontal	Vertical
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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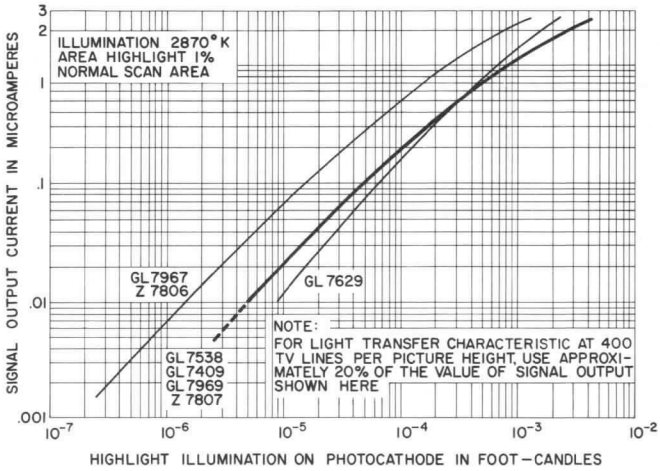
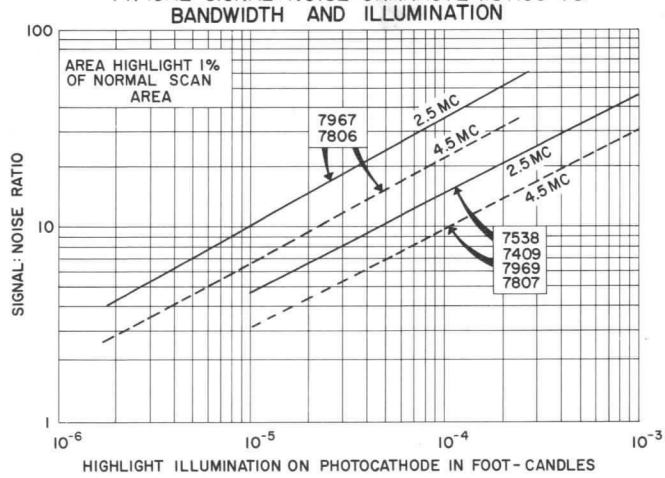
LIGHT TRANSFER CHARACTERISTICS

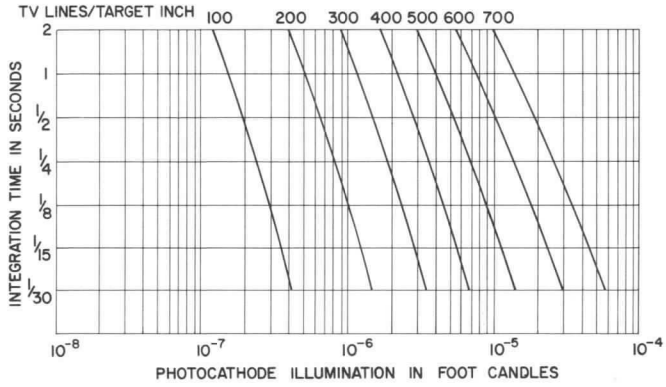


TYPICAL SIGNAL: NOISE CHARACTERISTICS VS. BANDWIDTH AND ILLUMINATION

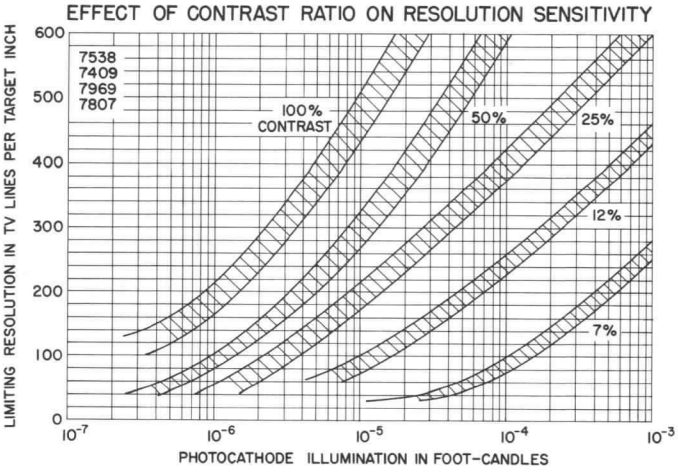


INTEGRATION EFFECT ON RESOLUTION SENSITIVITY

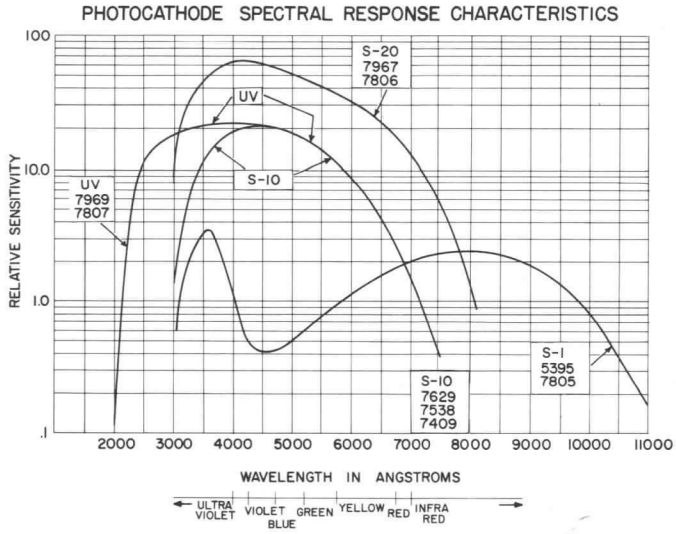
TYPES 7538 7409 7969 7807



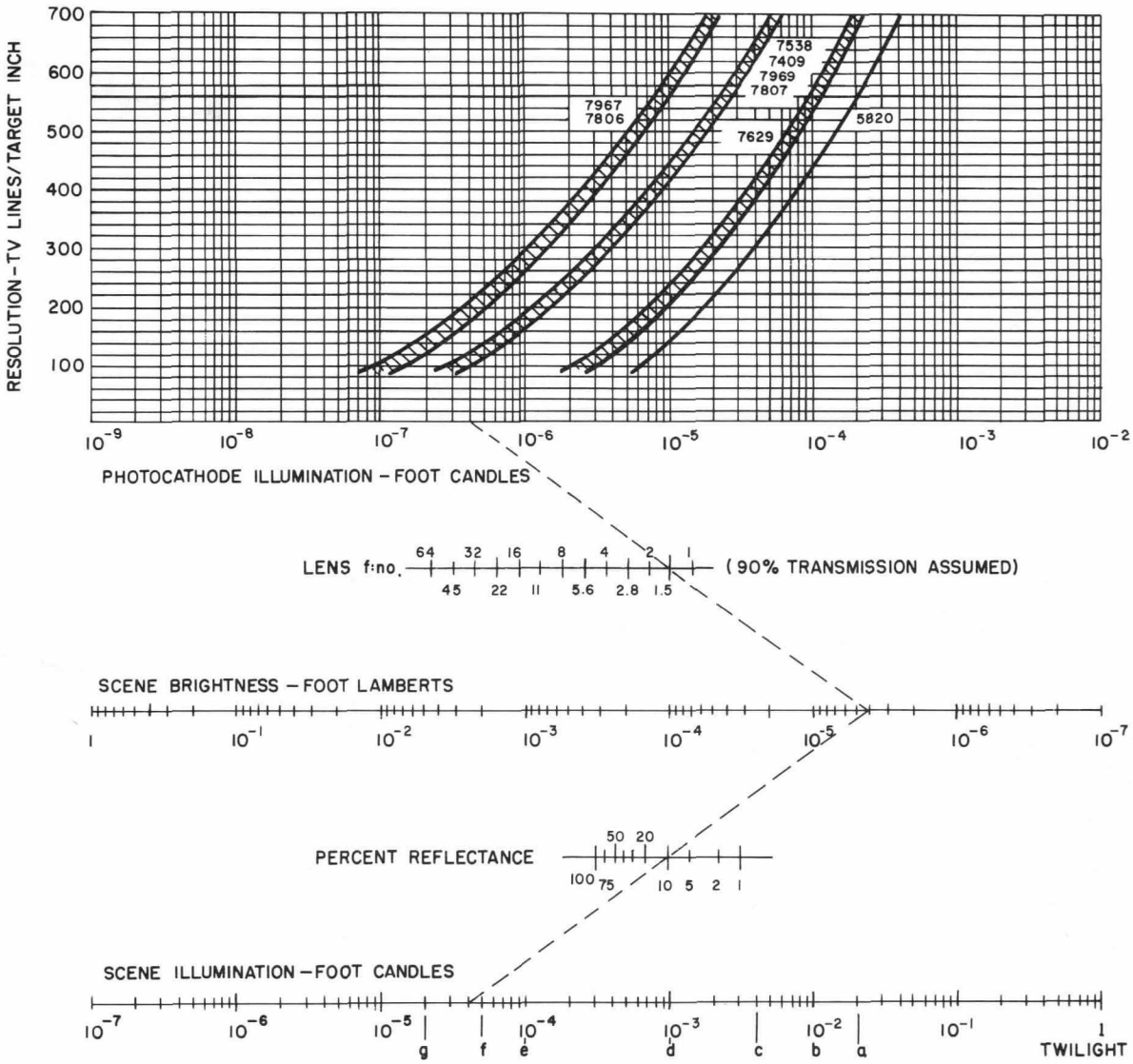
EFFECT OF CONTRAST RATIO ON RESOLUTION SENSITIVITY



PHOTOCATHODE SPECTRAL RESPONSE CHARACTERISTICS



SCENE ILLUMINATION VS TYPICAL RESOLUTION SENSITIVITY BY TYPE*

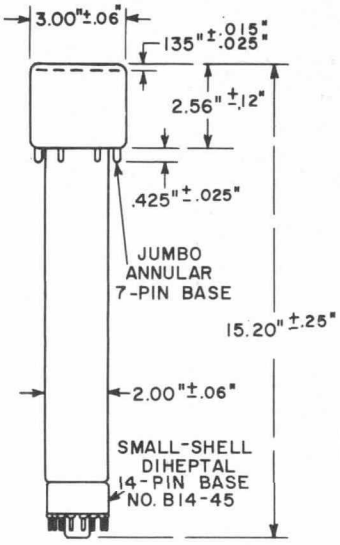


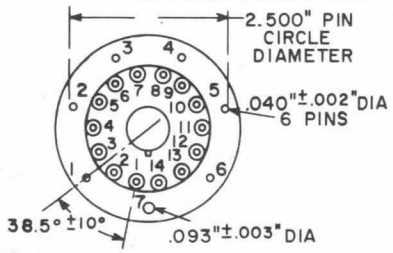
Code	Ambient Condition	Scene Illumination
a	Full moon–clear	2×10^{-2} ft-c
b	Half moon	1×10^{-2} ft-c
c	Full moon–moderately cloudy	4×10^{-3} ft-c
d	Quarter moon–clear	1×10^{-3} ft-c
e	No moon–clear	1×10^{-4} ft-c
f	No moon–moderately cloudy	5×10^{-5} ft-c
g	No moon–heavy cloud	2×10^{-5} ft-c

NEUTRAL DENSITY FILTERS FOR EXPOSURE CONTROL

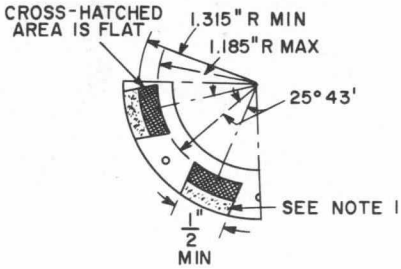
TYPE AND DENSITY	PERCENT TRANSMITTANCE	NUMBER OF STOPS
ND .30	50.0	1
ND .60	25.0	2
ND .90	13.0	3
ND 1.00	10.0	3.3
ND 2.00	1.0	6.6
ND 3.00	0.10	10.0
ND 4.00	0.010	13.2

*This chart reprinted by permission of B. A. Bang.





ENLARGED BOTTOM VIEW



DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE

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:

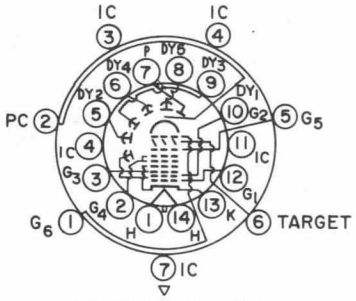
a. SIX HOLES HAVING DIAMETER OF 0.065"±.0.001" AND ONE HOLE HAVING DIA OF 0.150"±0.001". ALL HOLES HAVE DEPTH OF 0.265"±0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51° 26'±5' ON CIRCLE DIAMETER OF 2.500"±0.001".

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".

DIRECTION OF LIGHT:
PERPENDICULAR TO
LARGE END OF TUBE



WHITE INDEX LINE
ON FACE

BOTTOM VIEW

BASING DIAGRAM

SMALL-SHELL DIHEPTAL 14-PIN BASE

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

KEYED JUMBO ANNULAR 7-PIN BASE

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

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GL-7969

IMAGE ORTHICON

FOCUS—MAGNETIC

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

This tube features a high gain. Unlike magnesium oxide target with a sensitivity of ten to twenty times that of standard target tubes such as the 5820. This target has several other advantages. Its extreme ruggedness and non-frame properties are usually adequate advantages. Leakage will increase the resistance 25 to 50 percent over that of the standard target. It should be used for service where the signal is strong enough to bring it above noise level, which provides quality and reliability.

DEFLECTION—MAGNETIC

[illegible] by use of low frame rates [illegible] pulsing. It completely eliminates [illegible] and burn in spots [illegible] depends on electron conductivity [illegible] depletion process [illegible] photoconduction. The curve shown on page 3 compares the resolution [illegible] of the GL-7969 with that of the [illegible] photocathode.

The target characteristics also [illegible] higher sensitive response than the [illegible] another advantage of the GL-7969 is a considerable reduction in the distortions of target secondary [illegible] effect [illegible] image [illegible] to [illegible] transients.

Electrical

Cathode—Photosensitive		
Heater Voltage—AC or DC	6.3 to 7.5	Volts
Heater Current	0.6	Ampere
Photocathode—Semi-transparent		
Response—Ultraviolet sensitive		
Rectangular Image Dimensions		
Useful Scan Area (Diagonal)	0.8	Inches
Orientation of Image—Image is oriented when the [illegible] and the [illegible] the plane passing through the center of the cathode and the No. 1 [illegible] should be [illegible]		
Focusing Method—Magnetic		
Deflecting Method—Magnetic		
Direct Interelectrode Capacitance		
Anode to all other Electrodes	12	pf

Mechanical

Overall Length	7.20 ± 0.25	Inches
Greatest Diameter of Bulb	3.50 ± 0.0[illegible]	Inches
Magnetic Deflecting Coil Inside Diameter	2.[illegible]	Inches
Deflecting Coil Length	3	Inches
Focusing Coil Length	10	Inches
Alignment Coil Length	12	Inch
Electrical Overall Inside Diameter of Focusing Coil	14	Inches
Weight (approximate)	1.4	Pounds
Operating Position—Any except with Electrical Pins 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 Screen	15	Max C
Temperature Difference Between Target Screen and Any Part of Bulb (Excepting Target Screen)	[illegible]	Max C

MAXIMUM RATINGS—ABSOLUTE VALUES

Photocathode Voltage	550	Volts
Photocathode Illumination	40	Foot Candles
Anode Supply Voltage*	[illegible]	Volts
Grid No. 1 Voltage		
Negative Bias Value	0	Volts
Positive Bias Value	[illegible]	Volts
Grid No. 2 and Dynode No. 1 Voltage	150	Volts
Grid No. 3 Voltage	600	Volts
Grid No. 4 Voltage	300	Volts
Grid No. 5 Voltage	150	Volts
Grid No. 6 Voltage	[illegible]	Volts
Voltage per Multiplier Stage	150	Volts
Target Current		
Positive Voltage	2	Volts
Negative Voltage	10	Volts
Peak Heater-Cathode Voltage		
Heater Negative with Respect to Cathode	125	Volts
Heater Positive with Respect to Cathode	10	Volts

GENERAL ELECTRIC

TYPICAL OPERATION

Photocathode Voltage (Image Focus)	200 to	300	Volts
Grid No. 1 Voltage for Picture Cut-off, beam	45 to	115	Volts
Grid No. 2 and Dynode No. 1 Voltage		300	Volts
Grid No. 3 Voltage[1], multiplier focus	225 to	350	Volts
Grid No. 4 Voltage, beam focus	140 to	180	Volts
Grid No. 5 Voltage, decelerator	0 to	12	Volts
Grid No. 6 Voltage, accelerator			
Percent of Photocathode Voltage, approximate	100 to	105	Volts
Dynode No. 2 Voltage		500	Volts
Dynode No. 3 Voltage		800	Volts
Dynode No. 4 Voltage		1000	Volts
Dynode No. 5 Voltage		1200	Volts
Anode Voltage		1250	Volts
10" Anode Current		1	Microamperes
Target Voltage without blanking voltage	0 to	20	Volts
Peak-to-Peak Blanking Voltage	5 to	20	Volts
Target Temperature Range	15 to	55	C
Field Strength at Critical Focusing Coil		5	Gausses
Field Strength at Alignment Coil, approximate	0 to	3	Gausses

[1] Ratio of dynode voltages is shown under Typical Operation.

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

[3] 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.

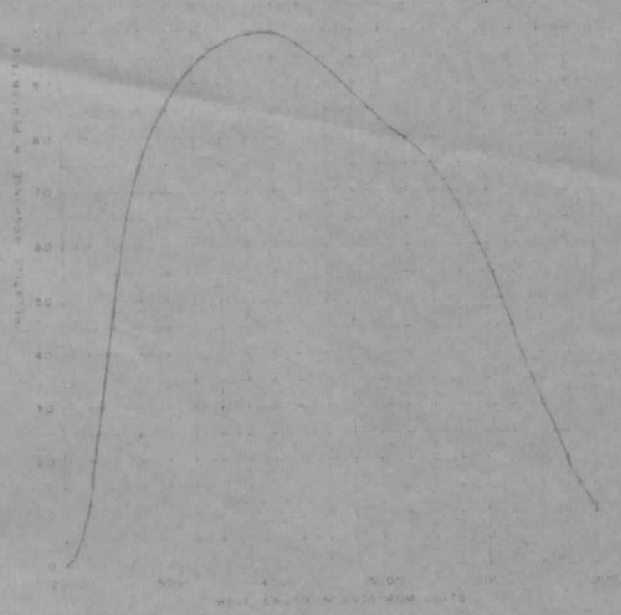
OPERATING NOTES

Normally a new tube will exhibit some slight "ice-image" characteristics, characterized by a rapid [illegible] which will gradually diminish with life. This can be minimized by use of an erasing or blanking force or an erasing 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.

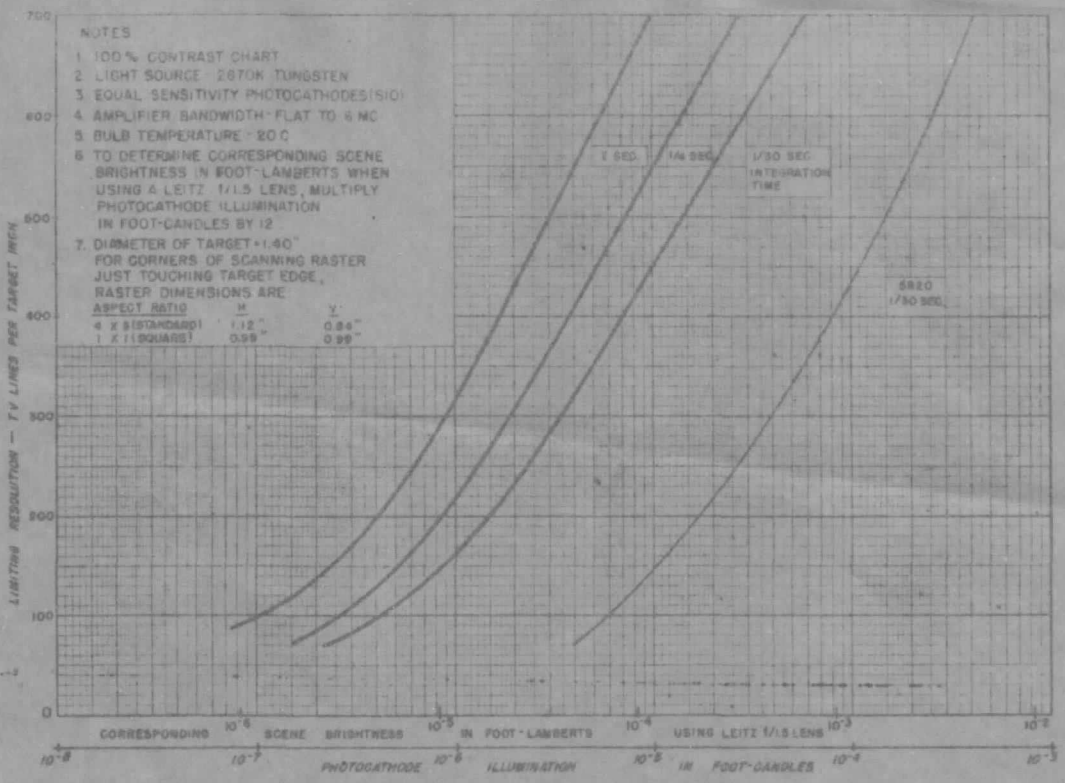
Some tubes may exhibit "micro-phonics" but if used immediately while relatively cool. These will disappear as the tube warms up and can be minimized during this period by slight readjustment in target voltage.

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 sun or other extremely bright sources should be avoided.

SPECTRAL SENSITIVITY CHARACTERISTIC



TYPICAL RESOLUTION—SENSITIVITY CHARACTERISTICS SHOWING EFFECTS OF IMAGE INTEGRATION



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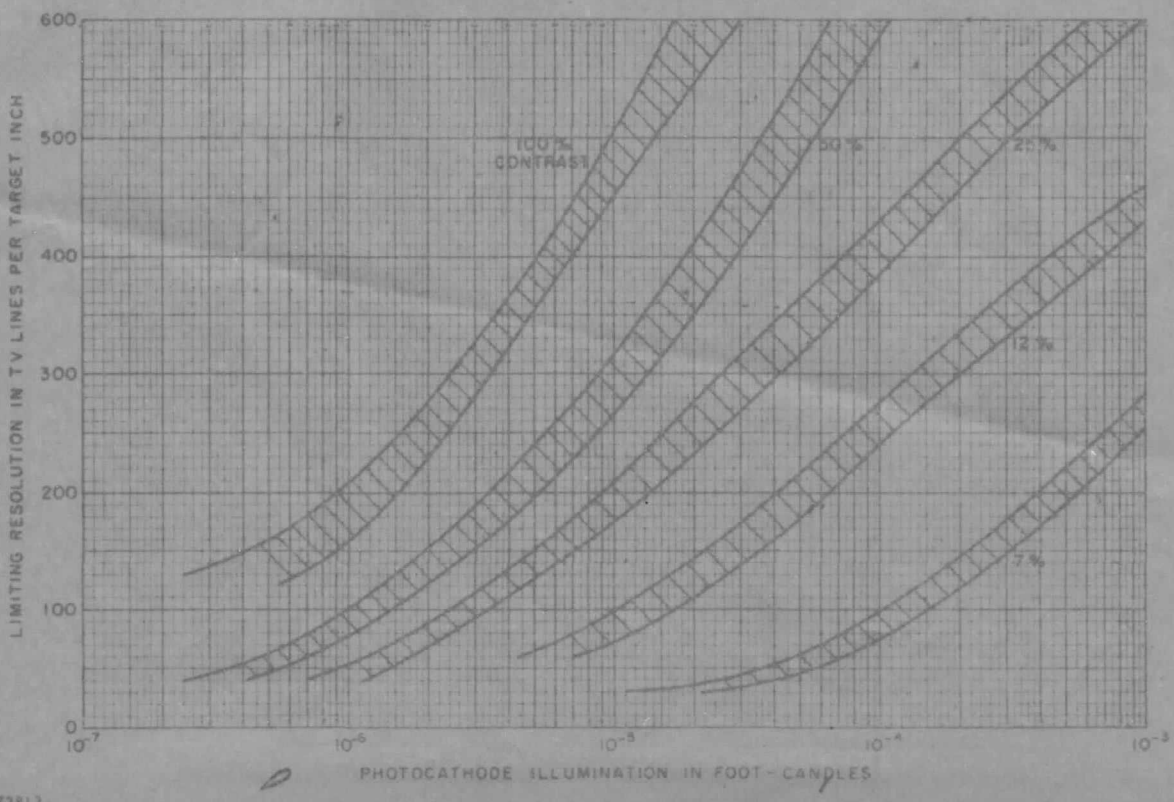
8-60

EFFECT OF CONTRAST RATIO ON RESOLUTION SENSITIVITY



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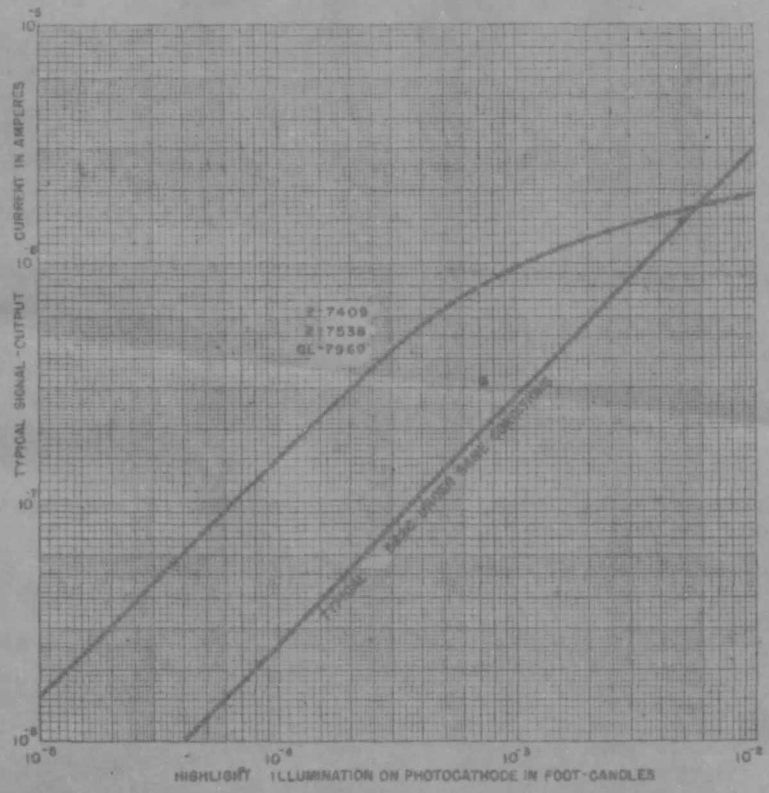
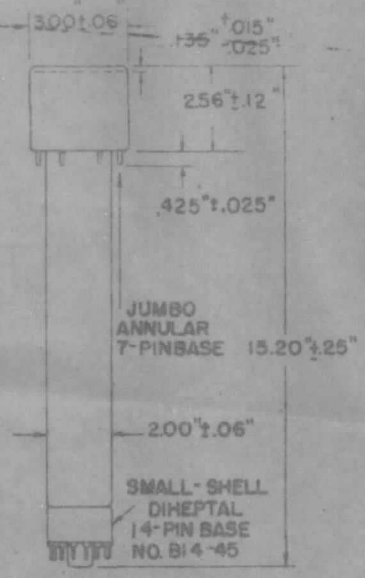
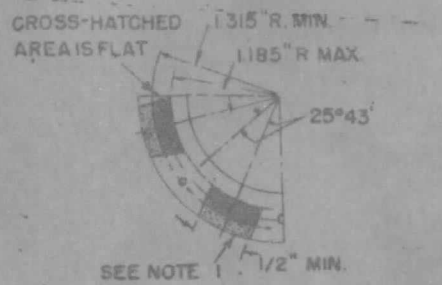
3-61

TRANSFER CHARACTERISTIC



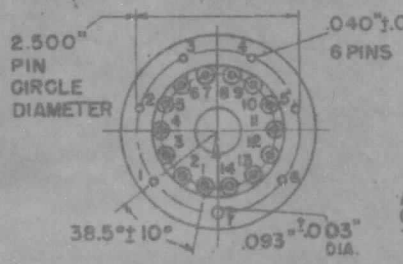
K-69087-72A913





DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE

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



ENLARGED BOTTOM VIEW

ANNULAR BASE GAGE

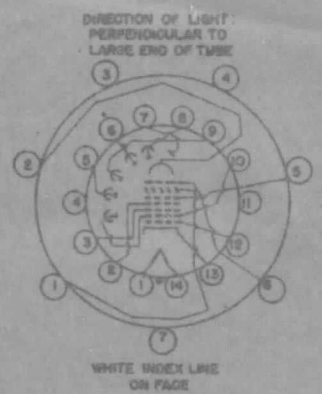
ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK-CYLINDER WILL FIT FLAT-PLATE GAGE WITH:

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°26'±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".



BASING DIAGRAM

SMALL-SHELL DIHEPTAL 14-PIN BASE

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

KEYED JUMBO ANNULAR 7-PIN BASE

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