Z-7806, GL-7967

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 down to 1.5 x 10^{-7} foot-candles photocathode illumination for resolution of 100 television lines per target inch. The GL-7967 is designed for normal environmental operation. The Z-7806 is a ruggedized version 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 underwater observation, missile detection and tracking, and astronomical study of stars to the twentieth magnitude. The tubes are also suitable for service in scintillation experiments with the use of an image intensifier.

Electrical

Cathode—Unipotential		
Heater		
Voltage, AC or DC	6.3 ± 10%	Volts
Current	0.6	Amperes
Photocathode—Semi-Transparent		
Spectral Response—S-20		
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	2 3/8	Inches
Focusing-Coil Length	10	Inches
Alignment-Coil Length	15/16	Inches
Photocathode Distance Inside End of Focusing Coil	1/2	Inches
Weight, approximate		
Z-7806	1.4	Pounds
GL-7967	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.

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-7806

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″

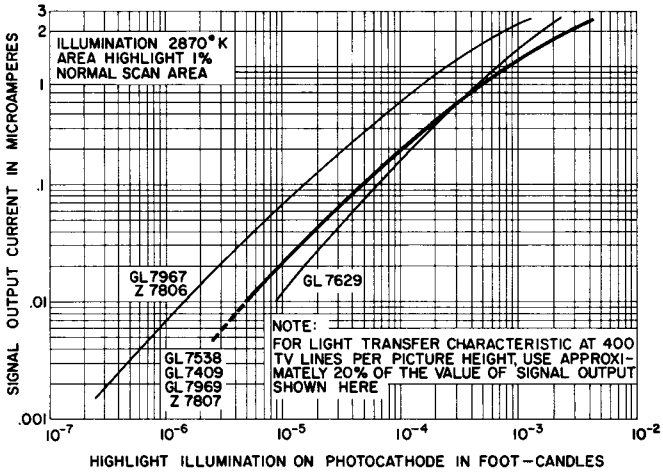
Horizontal TV lines = 1.12 x TV lines per target inch

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

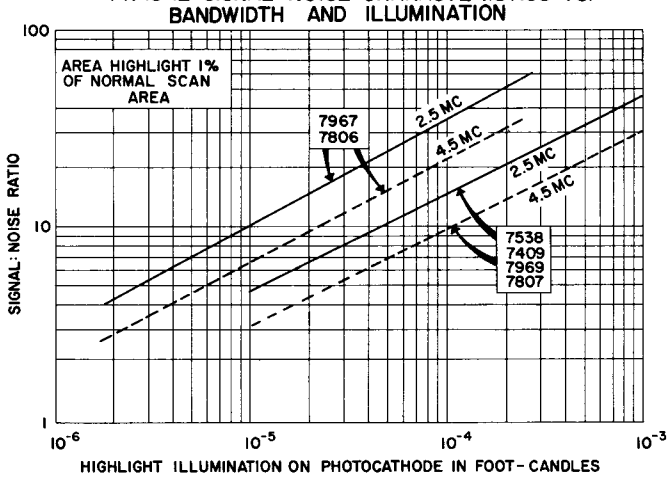
Resolution sensitivity data is recorded in TV lines per target inch

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

LIGHT TRANSFER CHARACTERISTICS

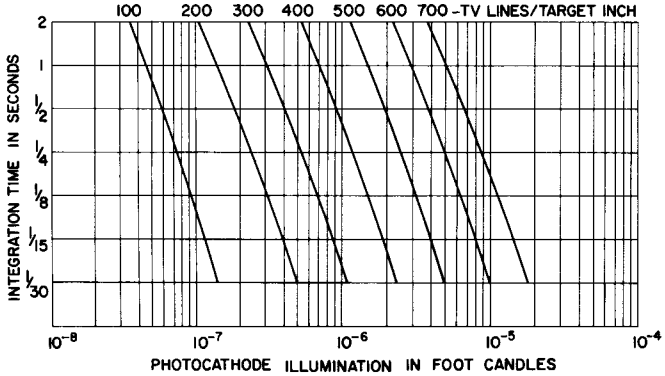


TYPICAL SIGNAL: NOISE CHARACTERISTICS VS. BANDWIDTH AND ILLUMINATION

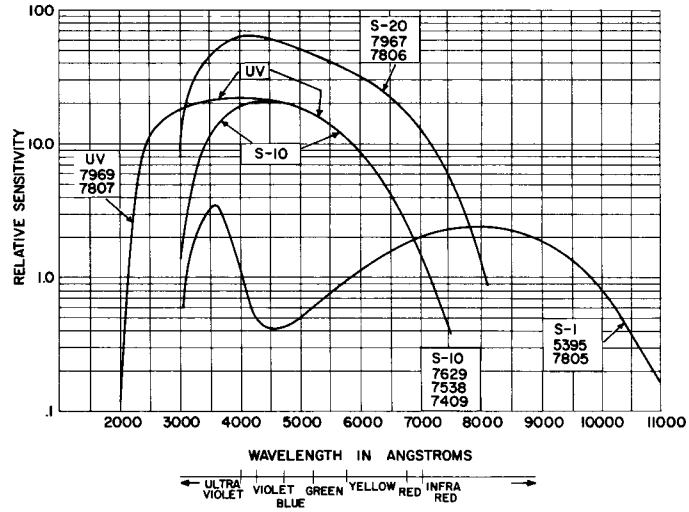


INTEGRATION EFFECT ON RESOLUTION SENSITIVITY

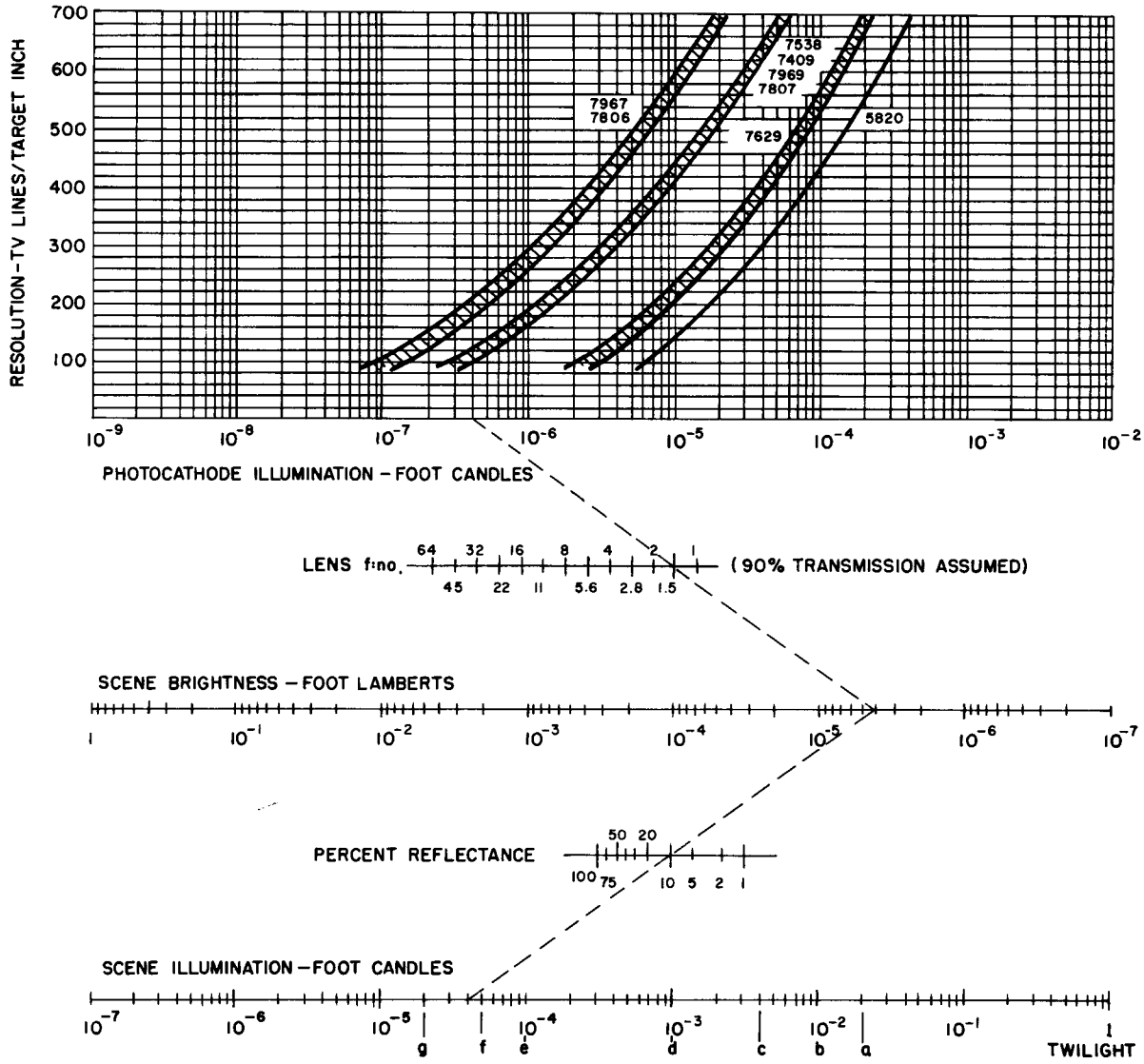
TYPES 7967 7806



PHOTOCATHODE SPECTRAL RESPONSE CHARACTERISTICS



SCENE ILLUMINATION VS TYPICAL RESOLUTION SENSITIVITY BY TYPE*

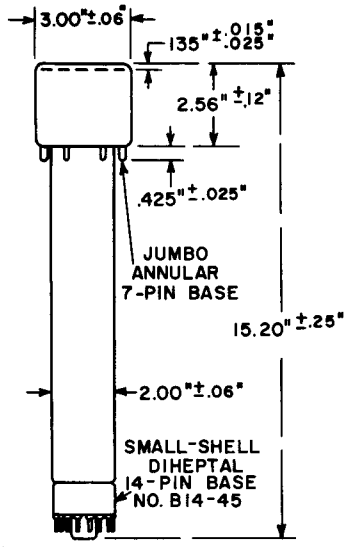


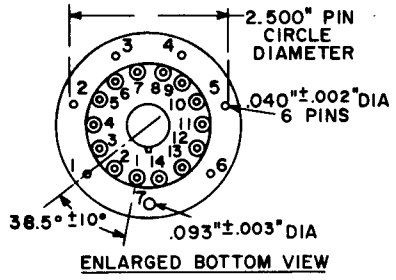
Code	Ambient Condition	Scene Illumination
a	Full moon–clear	2×10^{-2} ft-c
b	Half moon	1×10^{-2} ft-c
c	Full moon–moderately cloudy	4×10^{-3} ft-c
d	Quarter moon–clear	1×10^{-3} ft-c
e	No moon–clear	1×10^{-4} ft-c
f	No moon–moderately cloudy	5×10^{-5} ft-c
g	No moon–heavy cloud	2×10^{-5} ft-c

NEUTRAL DENSITY FILTERS FOR EXPOSURE CONTROL

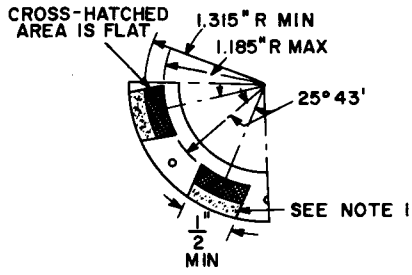
TYPE AND DENSITY	PERCENT TRANSMITTANCE	NUMBER OF STOPS
ND .30	50.0	1
ND .60	25.0	2
ND .90	13.0	3
ND 1.00	10.0	3.3
ND 2.00	1.0	6.6
ND 3.00	0.10	10.0
ND 4.00	0.010	13.2

*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:

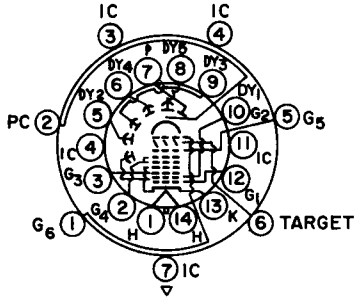
a. SIX HOLES HAVING DIAMETER OF 0.065"±.0.001" AND ONE HOLE HAVING DIA OF 0.150"±0.001". ALL HOLES HAVE DEPTH OF 0.265"±0.001". THE SIX 0.065" HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047". ALL HOLES ARE SPACED AT ANGLES OF 51° 26'±5' ON CIRCLE DIAMETER OF 2.500"±0.001".

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

GENERAL ELECTRIC

POWER TUBE DEPARTMENT

Pickup Tube Operation

Syracuse, New York

PRINTED IN U.S.A.

GL-7967

IMAGE ORTHICON

FOCUS—MAGNETIC **DEFLECTION—MAGNETIC**

The GL-7967 is an image orthicon with an S-20 photosurface. This photosurface has a sensitivity two to three times that of the S-10 with an improved red response and lower thermionic noise. Because of the low gamma, 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 twenty to fifty times that of glass-target tubes such as the 5820. This target has several advantages. Its extreme thinness and anisotropic property virtually eliminate sideways leakage, which increases the resolution 25 to 50 percent over that of the standard target. It adapts the tube for service where the signal is stored for long periods before being read off, which permits additional sensitivity by use of low frame rates or by beam pulsing. It completely eliminates both stickiness and burn-in since operation depends on electron conduction, which is not a depletion process, rather than on ion conduction. The curve shown on page 3 compares the resolution sensitivity of the 7967 with that of a 5820 with equivalent photocathode.

The target characteristics also assure a higher amplitude response than that of the 5820. Another advantage of the GL-7967 is a considerable reduction in the redistribution of target secondary electrons. This reduces image-edging effect, particularly at black-to-white transitions.

Electrical

Cathode—Unipotential		
Heater Voltage, AC or DC	6.3 ± 10%	Volts
Heater Current	0.6	Ampere
Photocathode—Semi-transparent		
Response—S-20		
Rectangular Image, 4 x 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		
Deflecting Method—Magnetic		
Direct Interelectrode Capacitance		
Anode to all other Electrodes	12	μμf

Mechanical

Over-all Length	15.20 ± 0.25	Inches
Greatest Diameter of Bulb	3.00 ± 0.06	Inches
Minimum Deflecting-Coil Inside Diameter	2⅜	Inches
Deflecting-Coil Length	5	Inches
Focusing-Coil Length	10	Inches
Alignment-Coil Length	⅛	Inch
Photocathode Distance Inside End of Focusing Coil	½	Inch
Weight, approximate	1.4	Pounds

Operating Position—Any, except with diheptal 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	Min C
Temperature Difference Between Target Section and Any Part of Bulb Hotter than Target Section	5	Max C

MAXIMUM RATINGS—ABSOLUTE VALUES

Photocathode Voltage	−550	Volts
Photocathode Illumination	50	Foot-Candles
Anode Supply Voltage*	1350	Volts
Grid-No. 1 Voltage		
Negative Bias Value	125	Volts
Positive Bias Value	0	Volts
Grid-No. 2 and Dynode-No. 1 Voltage	350	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
Target Voltage		
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

TYPICAL OPERATION

Photocathode Voltage, image focus	−400 to −540	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†, multiplier focus	225 to 330	Volts	
Grid-No. 4 Voltage, beam focus	140 to 180	Volts	
Grid-No. 5 Voltage, decelerator	0 to 125	Volts	
Grid-No. 6 Voltage, accelerator 75 Percent of Photocathode Voltage, approximate	−300 to −405	Volts	
Dynode-No. 2 Voltage	600	Volts	
Dynode-No. 3 Voltage	800	Volts	
Dynode-No. 4 Voltage	1000	Volts	
Dynode-No. 5 Voltage	1200	Volts	
Anode Voltage	1250	Volts	
DC Anode Current	3	Microamperes	
Target Voltage, without blanking voltage	0 to 2.0	Volts	
Peak-to-Peak Blanking Voltage	5 to 20	Volts	
Target Temperature Range	15 to 55	C	
Field Strength at Center of Focusing Coil‡	75	Gausses	
Field Strength of Alignment Coil, approximate	0 to 3	Gausses	

* Ratio of dynode 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 indicator 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 and complete decay, which will gradually diminish with life. This can be minimized by use of an arbiter or by eliminating forced-air cooling for short periods of time.

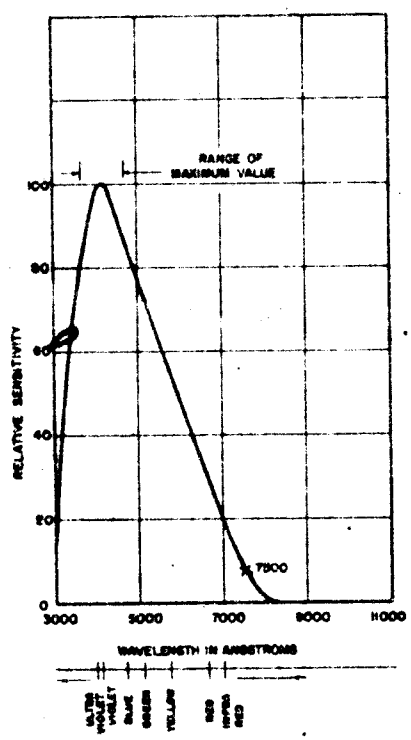
Although a warm-up time of one hour is desirable, the tube can be used immediately after alignment as it cannot be damaged permanently by target burn-in.

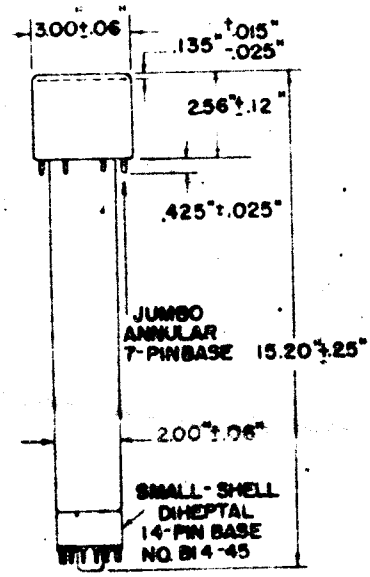
Some tubes may exhibit microphonic bars if used immediately while relatively cool. These will disappear as the tube warms up and can be minimized during this period by slight readjustments in target voltage.

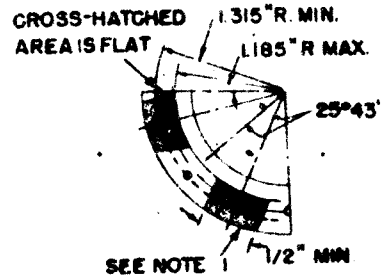
The target used in this tube greatly reduces the probability of permanent burn-in damage should a stationary highlight be imaged on the target for an extended period. However, imaging directly on the sun or other extremely bright sources should be avoided.

SPECTRAL-SENSITIVITY CHARACTERISTIC—S20 RESPONSE

For Equal Values of Radiant Flux at All Wavelengths

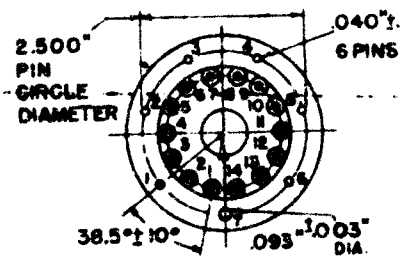






DETAIL OF BOTTOM VIEW OF JUMBO ANNULAR BASE

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



ENLARGED BOTTOM VIEW

ANNULAR BASE GAGE

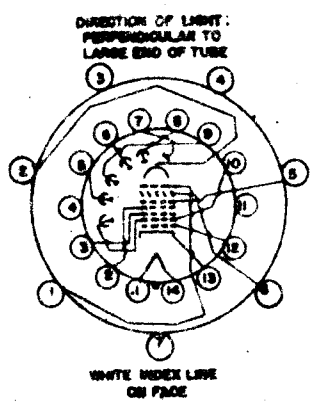
ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAGE WITH:

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