Image-Intensifier Orthicon

COMBINED IMAGE-CONVERTER & IMAGE ORTHICON SECTIONS
THIN FILM SEMICONDUCTIVE TARGET

For Extremely Low-Light Level Television Cameras

GENERAL

Maximum Overall Length	**22.44 in**
Greatest Diameter	**5.016 in**
Operating Position . . . The tube should never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with the base up makes an angle of less than 20° with the vertical.	
Weight (Approx.)	**4 lbs 14 oz**

Image-Converter Section

Spectral Response	**S-20**
Wavelength of Maximum Response	**4200 ± 500 angstroms**
First Photocathode, Semitransparent	
Useful size of	**2 inches max diagonal**
Focusing Method	**Electrostatic**

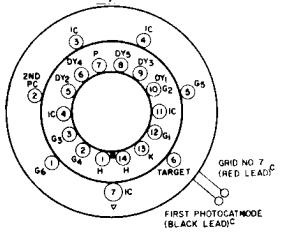
Image-Orthicon Section

Heater, for Unipotential Cathode	
Voltage (AC or DC)	**6.3 ± 10% V**
Current at 6.3 V	**0.6 A**
Direct Interelectrode Capacitance	
Anode to all other electrodes	**12 pF**
Focusing Method	**Magnetic**
Deflection Method	**Magnetic**
Socket . . . . . Cinch Part No.3M14,[a] or equivalent	
Minimum Deflection-Coil Inside Diameter	**2-3/8 in**
Deflecting Coil . . . . Cleveland Electronics, Part No.OY-1,[b] or equivalent	
Deflection-Coil Length	**5 in**
Focusing Coil . . . . . Cleveland Electronics, Part No.OF-2,[b] or equivalent	
Focusing-Coil Length	**10 in**
Alignment Coil . . . . . Cleveland Electronics, Part No.OA-3,[b] or equivalent	
Alignment-Coil Length	**15/16 in**

TERMINAL DIAGRAM (Bottom View)

Shoulder Base: Keyed
Jumbo Annular 7-Pin

Pin 1 – Grid No.6
Pin 2 – Second Photocathode
Pin 3 – Do Not Use
Pin 4 – Do Not Use
Pin 5 – Grid No.5
Pin 6 – Target
Pin 7 – Do Not Use



Direction of Light: Perpendicular to Large End of Tube

← Indicates a change.

Image-Converter Section

Two leads fitted with Alden Part No. 811IM, or equivalent.

Black Lead—First photocathode

Red Lead—Grid No. 7 (Focusing Electrode)

Image-Orthicon Section

End Base: Small-Shell Diheptal 14-Pin (JEDEC No. B14-45)

Pin 1 – Heater	Pin 8 – Dynode No. 5
Pin 2 – Grid No. 4	Pin 9 – Dynode No. 3
Pin 3 – Grid No. 3	Pin 10 – Dynode No. 1, Grid No. 2
Pin 4 – Do Not Use	Pin 11 – Do Not Use
Pin 5 – Dynode No. 2	Pin 12 – Grid No. 1
Pin 6 – Dynode No. 4	Pin 13 – Cathode
Pin 7 – Anode	Pin 14 – Heater

ABSOLUTE-MAXIMUM RATINGS

Maximum Continuous Operating Photocathode Illumination	1 x 10^{-6}	fc
Storage-Temperature Range	0 to 50	°C

Image-Converter Section

First Photocathode Voltage[d]	-15000	V
Grid-No. 7 Voltage (With respect to First Photocathode)	1800	V

Image-Orthicon Section

Second Photocathode Voltage	-550	V
Grid-No. 6 Voltage	-550	V
Target Voltage		
Positive Value	10	V
Negative Value	10	V
Grid-No. 5 Voltage	150	V
Grid-No. 4 Voltage	300	V
Grid-No. 3 Voltage	400	V
Grid-No. 2 & Dynode-No. 1 Voltage	350	V
Grid-No. 1 Voltage		
Negative bias value	125	V
Positive bias value	0	V
Peak Heater-Cathode Voltage		
Heater negative with respect to cathode	125	V
Heater positive with respect to cathode	10	V
Anode-Supply Voltage[e]	1350	V
Voltage Per Multiplier Stage	350	V
Operating Temperature[f]		
Of any part of bulb	35	°C
At 3"-diameter end of tube (target section)	25 min	°C
Temperature Difference Between target section and any part hotter than image-orthicon target section	5	°C

TYPICAL OPERATING VALUES

Image-Converter Section

First Photocathode Voltage[d]	-10000 to -15000	V
Grid-No. 7 (Focusing Electrode) Voltage	89% to 93% of First Photocathode Voltage	

Image-Orthicon Section

Second Photocathode Voltage	-400 to -540	V
Grid-No.6 Voltage (Approx. 75% of Second Photocathode Voltage)	-300 to -405	V
Target-Cutoff Voltage[g]	-3 to +1	V
Grid-No.5 Voltage (Decelerator)	0 to 125	V
Grid-No.4 Voltage (Beam Focus)	160 to 220	V
Grid-No.3 Voltage[h]	225 to 330	V
Grid-No.2 & Dynode-No.1 Voltage	300	V
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	V
Dynode-No.2 Voltage	600	V
Dynode-No.3 Voltage	800	V
Dynode-No.4 Voltage	1000	V
Dynode-No.5 Voltage	1200	V
Anode Voltage	1250	V
Target-Temperature Range	35 to 45	°C
Minimum Peak-to-Peak Blanking Voltage	5	V
Field Strength at Center of Focusing Coil[j]	75	G
Field Strength of Alignment Coil	0 to 3	G

[a] Made by Cinch Manufacturing Co., 1026 South Homan Ave., Chicago 24, Illinois.

[b] Made by Cleveland Electronics Inc., 1974 East 61st Street, Cleveland, Ohio.

[c] Image-Converter Section Electrode Lead

[d] An optimum value of image-converter-section supply voltage is supplied with each individual 4470.

[e] Dynode voltage values are shown under *Typical Operating Values*.

[f] The operating temperature may be 50° C max. within a distance of 7" from the diheptal base end of the tube.

[g] Normal setting of target voltage is +2 V from target cutoff. The target supply voltage should be adjustable from -3 to +5 V.

[h] Adjust to give the most uniformly shaded picture near maximum signal.

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

OPERATING CONSIDERATIONS

Signal current produced in the 4470 is directly proportional to the incident light level. Noise, on the other hand, is proportional to the square root of scanning-beam current. Therefore, maximum signal-to-noise ratio is obtained only when that value of beam current necessary to just discharge the scene highlights is employed. The maximum ratio of signal-to-noise attainable from the 4470 approaches the signal-to-noise ratio of the photoelectron image of the first photocathode. This ratio is low, however, due to the small number of quanta available at the very low light levels at which the 4470 is operated and also because the quantum efficiency of the photocathode is less than unity.

When the 4470 is used in image-orthicon cameras, the following instructions and camera modifications should be followed:

1. The camera should be of good electrical and mechanical design.

2. A high-voltage source must be provided to supply the necessary voltage for the image-converter section of the 4470. The

positive terminal of this voltage supply should be grounded and the negative terminal of the supply should be adjustable from -10kV to -15kV for optimum operation of the tube. This high-voltage supply should be connected to a voltage-divider network, such as that shown under *Typical Image-Converter Section Voltage-Divider Arrangement*, to obtain the proper photocathode and grid-No.7 voltages.

3. A spherical corrective lens system should be employed with the first photocathode (image-converter section) to minimize "pin cushioning" effects. The photocathode radius of curvature is 4 inches. The faceplate glass is 0.045 inch thick.

4. The video signal should be passed through a 2 megacycle low-pass filter to obtain optimum signal-to-noise ratio at threshold light levels.

5. Support for the image-converter section of the 4470 must be provided. Such support may be provided by any convenient method that does not introduce undue pressure to the "potting" material and thereby reduces its voltage-isolation properties. In addition, the mounting arrangement should not introduce torsion or forces that are perpendicular to the major axis of the tube. Any tube retaining plug or lens housing placed at the image-converter section (front end) of tube should be made of high-grade insulating material.

6. The 4470 should be operated with the key pin of the base in the direction of vertical scanning.

SET-UP PROCEDURE

The set-up procedure described below should be followed carefully to obtain optimum performance from the 4470. Care must be exercised at all times to prevent the inadvertent exposure of the 4470 to direct illumination from the sun or other bright light sources. The maximum first photocathode illumination level should not exceed 1×10^{-6} footcandle.

The 4470 should be inserted in its socket with all camera voltages in the "off" position. Before applying the heater voltage make sure that no light is incident on the photocathode, i.e., make sure that all camera doors and light shields are closed and that the camera lens is capped. Allow the 4470 to warm up for 2 minutes with only heater voltage applied.

Carefully check the camera lens system for the proper combination of neutral-density filter and lens aperture that limits the illumination on the first photocathode to 1×10^{-6} footcandle from a test chart or set-up scene. Now, uncap the lens after the lens system has been so adjusted. Apply the specified image-converter voltage to that section. NOTE: A specified voltage which assures proper image-converter section operation is supplied with each individual 4470.

Turn on scanning and image-orthicon-section voltage as indicated under *Typical Operating Values* making certain that the image-orthicon beam control (grid No.1) is adjusted to its most negative position and that the target-voltage control is adjusted to -3 volts, or its most negative position. The deflecting circuits must be adjusted for maximum output to assure overscanning of the target.

Next, slowly adjust the beam control (grid No.1) until noise or a rough-textured picture of dynode No.1 appears on the monitor. Cap the camera lens. Then adjust the beam control (grid No.1) and beam-focus control (grid No.4) so that the small white dynode spot appears on the monitor.

Then adjust the alignment-coil current so that the small white dynode spot does not move when the beam-focus control (grid No.4) is varied, but simply goes in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and to prevent excessive noise.

After the tube has warmed up for 1/4 hour, uncap the lens and point the camera at the test pattern or test scene, again making sure the light level on the first photocathode is between 1×10^{-7} and 1×10^{-6} footcandle. The target voltage is then increased until the test pattern is just discernible on the monitor. This value of target voltage is known as the "target-cutoff voltage". The target voltage should then be raised exactly 2 volts above the cutoff-voltage value, and the beam current control adjusted to give just sufficient beam current to discharge the highlights.

Then adjust the lens to produce best optical focus and the voltage on the second (image orthicon) photocathode as well as the voltage on grids No.4 and No.7 to produce the sharpest picture.

At this point, attention should be given to the grid-No.5 and grid-No.3 voltage controls. Grid No.5 is used to control the landing of the beam on the target and consequently the uniformity of signal output. The grid-No.5 voltage control should be adjusted to produce a picture that has most uniform shading from center to edge with the lens iris adjusted to permit operation at the highest light level involved in the application. The value of grid-No.5 voltage should be as high as possible consistent with uniform shading. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The grid-No.3 voltage control should be adjusted to produce the maximum signal output and uniformity.

Now with a test pattern consisting of a straight line centered on the face of the 4470 adjust the voltage on grid No.6 along with the voltage on the second photocathode to produce a sharply focused straight line on the monitor. Improper adjustment of the grid-No.6 voltage control will result in the straight-line pattern being reproduced with a slight S-shape.

Scanning may be adjusted until the target just fills the monitor picture.

The above adjustments constitute a rough setup of the 4470. Final adjustments necessary for the 4470 to produce the best possible picture include realignment of the beam with the lens capped. Beam alignment is necessary after each change of the grid-No.5 voltage control and sometimes after each adjustment of the grid-No.3 voltage control.

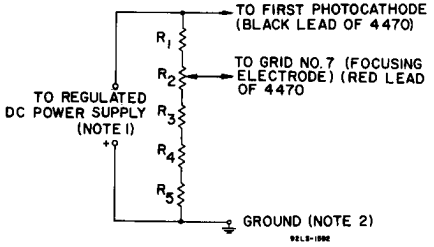
With the camera operating at the desired illumination level, the beam current should be slowly decreased by adjusting the grid-No.1 voltage control to the point where the beam is just sufficient to discharge the highlights of the picture. Each change of scene illumination should be accompanied by appropriate changes in the beam current and amplifier gain to obtain the best contrast and signal-to-noise ratio for each new scene condition.

For stand-by operation, adjust scanning for over-scan, cap camera lens, turn off image-converter voltage, and keep the beam and target voltage on.

To turn the 4470 off, put the camera in the standby operation described above, then adjust the target voltage to -3 volts, or its most negative position, turn the beam control (grid No.1) to its most negative position and immediately thereafter turn off all other image-orthicon voltages. To turn tube on again, repeat the set-up procedure.

SPECTRAL-SENSITIVITY CHARACTERISTIC OF PHOTOSENSITIVE DEVICE HAVING S-20 RESPONSE is shown at front of this section

TYPICAL IMAGE-CONVERTER SECTION VOLTAGE-DIVIDER ARRANGEMENT



R_1, R_3: 5 megohms, 2 watts, RPC HBMW, or equivalent.
R_2: 5-megohm potentiometer, 2 watts, Clarostat Series 51, or equivalent.
R_4, R_5: 30 megohms, 2 watts, RPC HBMW, or equivalent.

Note 1: Adjustable between approximately 10 kV and 15 kV.

Note 2: The positive high voltage lead should also be connected to the camera power supply ground.

Note 3: All components of this voltage-divider network must be isolated from ground. The control shaft of the focusing-electrode potentiometer (R_2) must be of insulating material and protrude through the wall of the housing through a grounding bushing. The compartment in which this voltage-divider network is housed should be filled with LTV-602 clear potting compound, or equivalent. This voltage-divider network packaged in suitable housing with high-voltage leads and connectors, is available from RCA as Dev. Part No.C21054.

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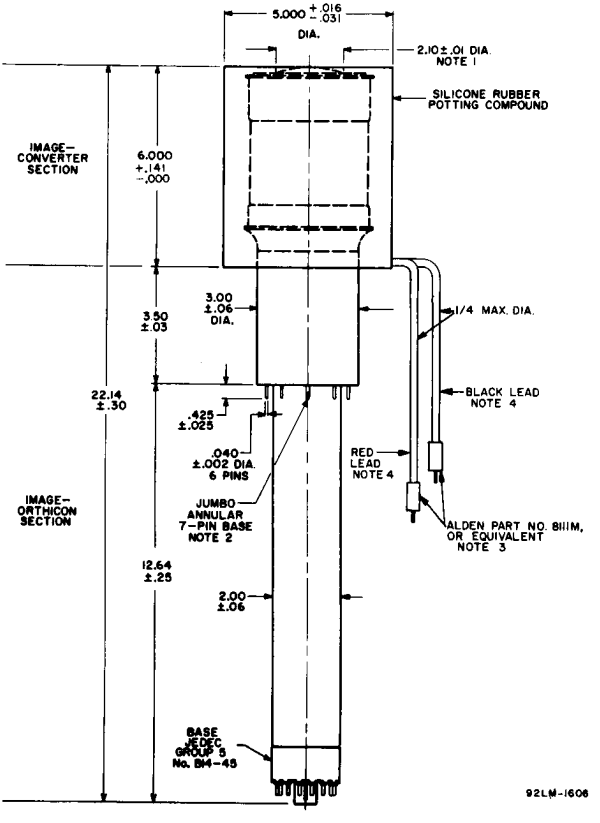
DIMENSIONAL OUTLINE



DIMENSIONS IN INCHES

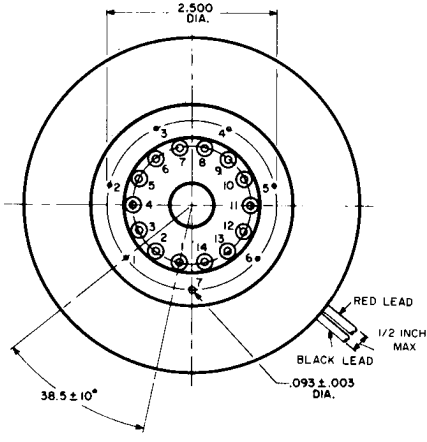
Note 1: The window area of the first photocathode is concentric with the image-converter section cylinder, and the image-orthicon section cylinders within 0.100" of the major axis of the tube.

Note 2: The index of the annular base and the key of the diheptal base are aligned within ± 7° with reference to the annular index pin.

Note 3: Alden Products Company, 9140 North Main Street, Brockton 64, Mass.

Note 4: Lead length is 28 ± 1/4" from potting to end plug.

ENLARGED-BOTTOM VIEW

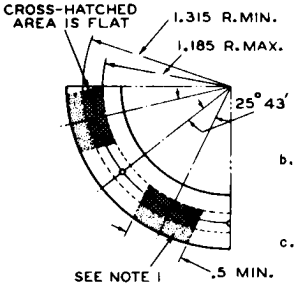


DIMENSIONS IN INCHES

ANNULAR-BASE GAUGE

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 gauge with:

Detail of Bottom View of Jumbo Annular Base



DIMENSIONS IN INCHES

Note 1: Dotted area is flat or extends toward diheptal-base end of tube by 0.060" max.

a. Six holes having diameter of 0.065" ± 0.001" and one hole having diameter 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 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".

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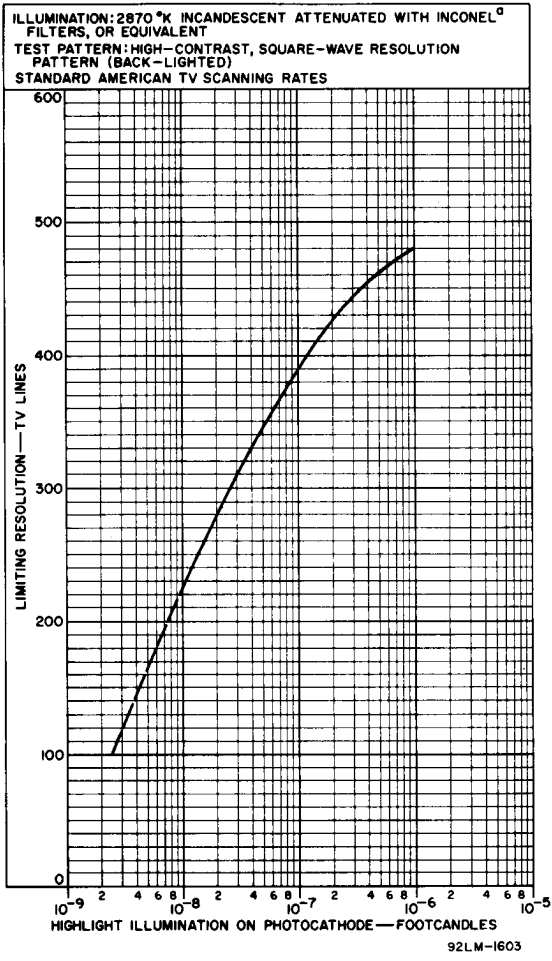
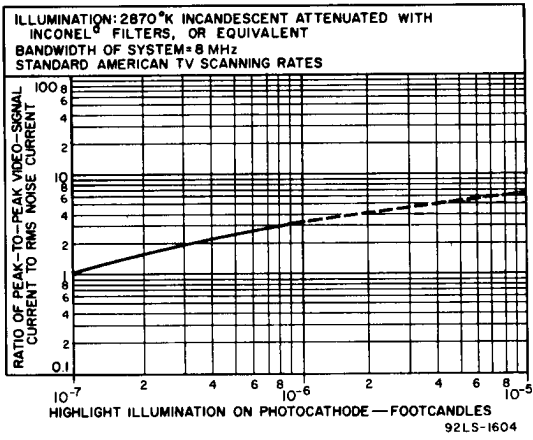
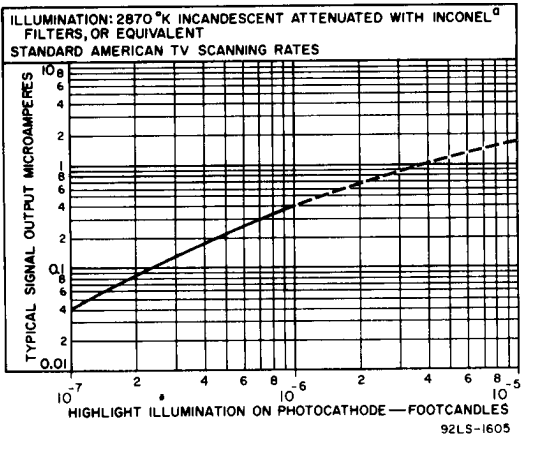
Typical Limiting Resolution Characteristic



Typical Signal-To-Noise Characteristic



Typical Light Transfer Characteristic



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