7295C

(P811/E)

IMAGE ORTHICON

INTRODUCTION

The 7295C is a 4½-inch image orthicon with an operational sensitivity in the region of f/5.6 at 15 foot-lamberts scene luminance and with the lens adjusted half to one calibration stop above the 'knee' of the transfer characteristic. While requiring a slightly higher light input than the 5820 or 7293 series, it is completely satisfactory for studio use and the sensitivity is adequate for outside broadcasts under normal conditions. The tube is very stable in performance over a wide range of light levels.

The tube has an improved target with electronic conducting properties*; the performance of this target does not change significantly during life and therefore the 'gamma' and sensitivity remain substantially stable. Shading, normally associated with beam landing errors, is greatly reduced by the inclusion of a field mesh.

Relative to the 3-inch tube, the larger area of the target in the 4½-inch tube ensures an improvement in resolution and signal to noise ratio.

The photocathode has a spectral sensitivity which, when used with tungsten illumination, gives an overall response closely approaching that of the eye, so permitting the portrayal of colours in their true brightness levels.

This tube can be produced with a bialkali photocathode offering comparable performance

GENERAL DATA

Electrical

Cathode	indirectly heated, oxide coated	
Heater voltage	6.3	V
Heater current	0.6	A
Inter-electrode capacitance:		
anode to all other electrodes	12	pF max

* ELCON target (Brit. pat. no. 1048390). The name ELCON has been derived from the properties of the target material, namely ELectronic CONducting as opposed to ionic conducting as in the target materials formerly used. Normal exposures of the ELCON target to reasonable light levels as encountered in standard television camera practice will give negligible image retention (sticking).

February 1973

Supersedes November 1972 Issue

Electrical (continued)

Focusing method	magnetic
Deflection method	magnetic
Magnetic fields (see note 1):	
image section field, in plane of photocathode	12mT (120G) approx
scanning section field, in plane of target	7mT (70G) approx
alignment field, adjustable	0 to 0.3mT (0 to 3G)

Mechanical

Overall length	19.525 inches (496mm) max
Diameter of image section	4.594 inches (116.7mm) max
Diameter of scanning section	3.185 inches (80.9mm) max
Deflecting coil length	7.0 inches (177.8mm)
Focusing coil length	15.0 inches (381mm)
Alignment coil length	0.75 to 1.5 inches (19 to 38mm)
Alignment coil location	the alignment coil should be located on the tube so that its centre is at a distance of 15 inches (381mm) from the faceplate of the tube and so positioned that its axis is coincident with the axis of the tube, the deflecting yoke, and the focusing coil.
Useful size of rectangular image for standard operation	1.6 inches (40.7mm) maximum diagonal at photocathode. Electron image magnified electron-optically to diagonal of 2.4 inches (61mm) approximately at the target.
Orientation of rectangular image	proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through the centre of the faceplate and contact 3 of the shoulder base. This contact to be at the bottom.
Net weight	2¼ pounds (1.1kg) approx
Mounting position	any except with diheptal base up and with tube axis at an angle less than 20° from vertical.
End base	small shell diheptal 14-pin (JEDEC no. B14-45)
Shoulder base	special 5 contact

Storage

Recommended store temperature . . . . . 25 to 35 °C

Tubes should be stored in darkness. All tubes must be operated for at least 5 hours each month; this is one of the conditions of warranty.

WARNING

The following precautions should be observed when operating the tube:

1. Ensure that the temperature of the tube is within its recommended range.
2. Although image retention is virtually eliminated it is preferable to avoid long term exposure to high contrast test patterns, particularly before the tube has reached operating temperature.

MAXIMUM AND MINIMUM RATINGS (Absolute values)

No individual rating to be exceeded

	Min	Max	
Heater voltage	5.7	6.9	V
Photocathode voltage (image focus):			
negative value	—	700	V
Grid 6 voltage (image accelerator):			
negative value	—	700	V
Target voltage	—	± 10	V
Grid 5 voltage (decelerator)	—	300	V
Field mesh with respect to grid 4 voltage .	—	+ 30	V
Grid 4 voltage (beam focus)	—	350	V
Grid 3 voltage (multiplier focus)	—	400	V
Grid 2 and dynode 1 voltage	—	350	V
Grid 1 voltage (negative value, never positive)	0	125	V
Anode voltage	—	1650	V
Voltage per multiplier stage	—	350	V
Voltage between anode and dynode 5 when anode currents up to 100μA are drawn .	40	—	V
Peak heater to cathode voltage:			
heater negative with respect to cathode .	—	125	V
heater positive with respect to cathode .	—	10	V
Operating temperature of any part of bulb .	—	65	°C
Operating temperature of bulb at target section	35	60	°C
Temperature difference between target section and any hotter part of bulb	—	5	°C
Peak illumination of faceplate:			
non-operating	—	50	ft-candles
operating	—	10	ft-candles

TYPICAL OPERATION

Operational Conditions

Photocathode voltage (image focus) (see note 2)	−200 to −600	V
Grid 6 voltage (image accelerator) (see note 3)	−80 to −480	V
Target cut-off voltage	−2	V
Target voltage above cut-off (see note 4)	2.5 to 3	V
Target blanking voltage (peak to peak)	5	V min
Grid 5 voltage (decelerator) (see note 5)	−100 to +250	V
Field mesh voltage with respect to grid 4 voltage (see note 6)	5 to 15	V
Grid 4 voltage (beam focus) (see note 7)	100 to 200	V
Grid 3 voltage (multiplier focus) (see note 8)	215 to 350	V
Grid 2 and dynode 1 voltage	300	V
Grid 1 voltage:		
normal (see note 9)	−4 to −115	V
for picture cut-off	−45 to −115	V
Dynode 2 voltage	600	V
Dynode 3 voltage (see note 10)	600 to 800	V
Dynode 4 voltage	1050	V
Dynode 5 voltage	1250	V
Anode voltage (see note 10)	1300	V
Heater voltage	6.3	V
Recommended target temperature range (see note 11)	35 to 45	°C
Magnetic fields:		
image section field, in plane of photocathode	12mT (120G) approx	
scanning section field, in plane of target	7mT (70G) approx	
alignment field, adjustable (see page 5)	0 to 0.3mT (0 to 3G)	
Image size at target	see note 12	

Performance Specification

The results given on page 5 are obtained by operating as follows:

(i) With the operational conditions specified above but with an operating temperature of 35 to 50°C and the lens stop adjusted in accordance with Note 13. 625 Line System Standard.

(ii) Set up in accordance with the Sequence of Adjustments below.

	Min	Typical	Max	
Heater current	540	—	660	mA
Signal current (see note 14) . . .	20	—	60	μA
Signal to noise ratio (see note 15) .	37	39	—	db
Amplitude response (see note 17) .	60	75	—	%
Illumination required on photocathode to reach the 'knee' of the transfer characteristic (see notes 13 and 18)	—	0.035	0.07	ft-candle
After image (see note 19)	—	0	5	sec

The performance obtained may vary with the camera in which the tube is used.

SEQUENCE OF ADJUSTMENTS

(a) Insert the tube in the camera, then verify that the equipment is functioning and allow the tube to warm up† with lens capped, target biased off and scanning amplitude controls set at maximum. Adjust the beam controls to give a small amount of beam current. For optimum operating conditions the tube temperature must be between 40°C and 45°C.

(b) Adjust the beam bias and the gain control until noise appears on the monitor screen.

(c) Uncap the camera lens.

(d) Increase the target voltage until the picture appears.

(e) Adjust the alignment controls so that the maximum area of picture at the centre goes in and out of focus and does not rotate as grid 4 (beam focus) voltage is varied about its focus value.

(f) Adjust grid 6 (image accelerator) voltage for minimum 'S' distortion consistent with the highest photocathode focus voltage that can be obtained.

(g) Adjust the target voltage to 2.5 to 3 volts above the cut-off condition (see note 16).

(h) Adjust the beam current to the lowest value consistent with a satisfactory picture. Adjust the scanning raster to the correct size and aspect ratio (see note 12).

† Warm-up time can be considerably reduced if care is exercised with exposure in the first few minutes after switch-on. Slight adjustments to the tube electrode potentials may also be necessary as the camera equipment settles down. Optimum tube performance will only be obtained within the specified range of temperatures.

(j) Adjust grid 5 (decelerator) for minimum corner shading and best geometry, if a variable control is provided on the camera.

(k) Adjust the lens aperture so that the white content of the picture is at the 'knee' of the tube transfer characteristic and open the lens a further stop. Excessive white compression and a rapid decrease in signal indicate dynode saturation. Adjust dynode 3 to remove this effect. Attempts to eliminate the effect by decreasing the overall anode voltage will generally cause further deterioration unless the voltage difference between anode and dynode 5 is preserved independently of voltage changes in the multiplier chain. Dynode 3 may be operated at lower voltages within the typical range, to avoid overloading the head amplifier.

(l) With the line and frame shading controls at zero, adjust grid 3 (multiplier focus) for maximum output.

(m) Cap the lens and adjust as follows:

  (i) Field mesh voltage should be adjusted to eliminate parabolic shading. In some cameras the field mesh voltage has to be adjusted to remove moiré patterns; this should also be checked with the lens uncapped, with scenes having a range of background brightness. In cases where this affects the focus, grid 4 (beam focus) voltage must be readjusted.

  (ii) Line shading can be minimised by further slight adjustment of grid 3 (multiplier focus).

  (iii) Line and frame shading correction can be employed if the black shading has not been minimised satisfactorily by the adjustments in (i) and (ii) above. The practice of correcting non-uniform lighting in a studio by adjusting the tube shading controls is not recommended, as it leads to the need for continued adjustment as the camera is panned and introduces errors in the black level.

(n) (i) Uncap the lens and expose to a plain white scene.

  (ii) Readjust the beam current to just discharge the white.

  (iii) If necessary, minimise white shading by slight adjustment of the alignment controls.

(p) Readjust the photocathode and grid 4 (beam focus) voltages for best resolution.

NOTES

1. The direction of the focusing current should be such that a north pole is attracted to the image end of the focusing coil.
2. Adjusted for best focus but as near maximum as possible.
3. 40 to 80% of photocathode voltage. Adjusted for minimum 'S' distortion.

4. Supply adjustable from −5 to +5V with blanking voltage off.
5. Adjusted for minimum corner shading and best corner geometry.
6. Adjusted for minimum black shading. The supply for this electrode may be derived from that for grid 4.
7. Adjusted for picture focus. Focus may be obtained at several voltages in the range of adjustment provided, and a voltage should be selected to minimise moiré patterns and corner shading or to optimise geometry. This selection has to be made because of differences in yoke design between cameras of various manufacturers.
8. Adjusted to give the most uniform black shading near maximum signal. This adjustment must be made with the photocathode capped.
9. Adjusted for best picture. Excessive beam current increases noise.
10. The potential of dynode 3 relative to dynode 2 should be reduced to prevent the occurrence of a current reversal at the 5th dynode stage of tubes with a high d.c. output. The potential between the anode and dynode 5 must not drop below 40V when anode currents up to 100μA are drawn.
11. No part of the bulb may be more than 5°C hotter than the target section.
12. The size of the optical image of aspect ratio 4 x 3 focused on the photocathode should be adjusted so that its maximum diagonal does not exceed 1.6 inches. The corresponding electron image on the target should have a size such that the corners of the rectangle just touch the target ring. Alternatively, a ring mask may be used, consisting of a perspex disc on which are inscribed two concentric circles of 0.96 and 1.28 inches diameter, placed in contact and concentric with the photocathode. Light is allowed to fall on the photocathode and an image of the rings obtained on the monitor. No lens is necessary. The scan amplitude and centring controls on the camera are adjusted until the diameter of the larger circle is equal to the width of the raster and the diameter of the small circle is equal to the height. Verify that the scanned patch is centrally located with respect to the target ring.
13. Lens stop. The light level is adjusted until the 'knee' of the transfer characteristic is reached by gradually opening the lens from its minimum aperture and observing the increase of the signal amplitude on the oscilloscope. The 'knee' is defined as the point at which the difference between signals from chips having densities 0 and 0.15, and from 0.15 and 0.3 are equal. The recommended operating point is obtained by increasing the aperture of the lens by one calibration stop. If a lower target voltage is used, lower illumination is required to reach the 'knee'.
14. Signal current. With the tube set up to give best overall resolution, the gain is adjusted to give 0.7V output from the channel, measured from

white to black level as determined with the lens capped. The tube signal is then removed from the head amplifier by biasing off the beam and a line frequency test signal (amplitude during active line period 0.7V) is injected to the head amplifier via an attenuator. The attenuator is adjusted to give 0.7V amplitude signal output from the channel. The attenuator setting is read and the input signal voltage to the amplifier is calculated. From the values for the amplifier input signal voltage and the image orthicon load resistor, the signal current is then calculated. Dynode 3 voltage may require adjustment to obtain a signal current below the specified maximum.

15. The peak white amplitude of the video waveform is set to 0.7V with respect to capped black to provide the reference signal and the signal to noise ratio is measured using a Rohde & Schwarz video noise meter type UPSF (or equivalent instrument). Other methods of measurement may produce different values.

16. Values of target voltage other than 3V can be used but a compromise must be made as signal to noise ratio and signal output increase with target voltage, while a decrease in target voltage improves sensitivity and resolution.

17. Amplitude at 400 lines per picture height at the centre of the picture, without aperture correction, relative to the large area black-white signal.

18. With illumination from a source of colour temperature 2854°K. Note that this is not the 'preferred operating point', which requires double this illumination.

    The illumination required on the scene is given by

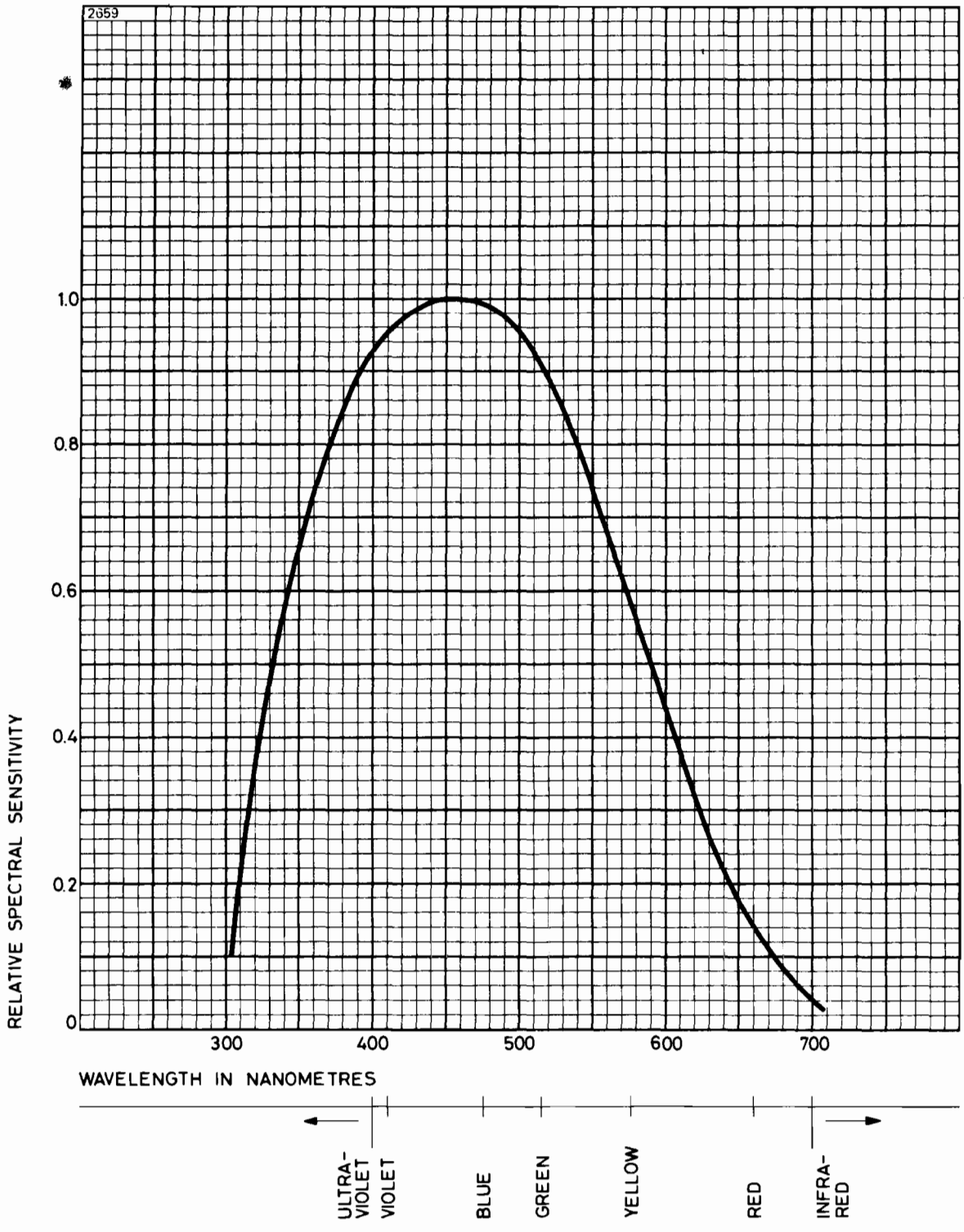
$$I_{sc} = \frac{I_{pc} \cdot 4f^2 (m+1)^2}{TR}$$

    where I_{sc} = scene illumination in foot-candles
    I_{pc} = photocathode illumination
    f = lens aperture number
    m = magnification from scene to photocathode
    T = lens transmission
    R = scene reflectance

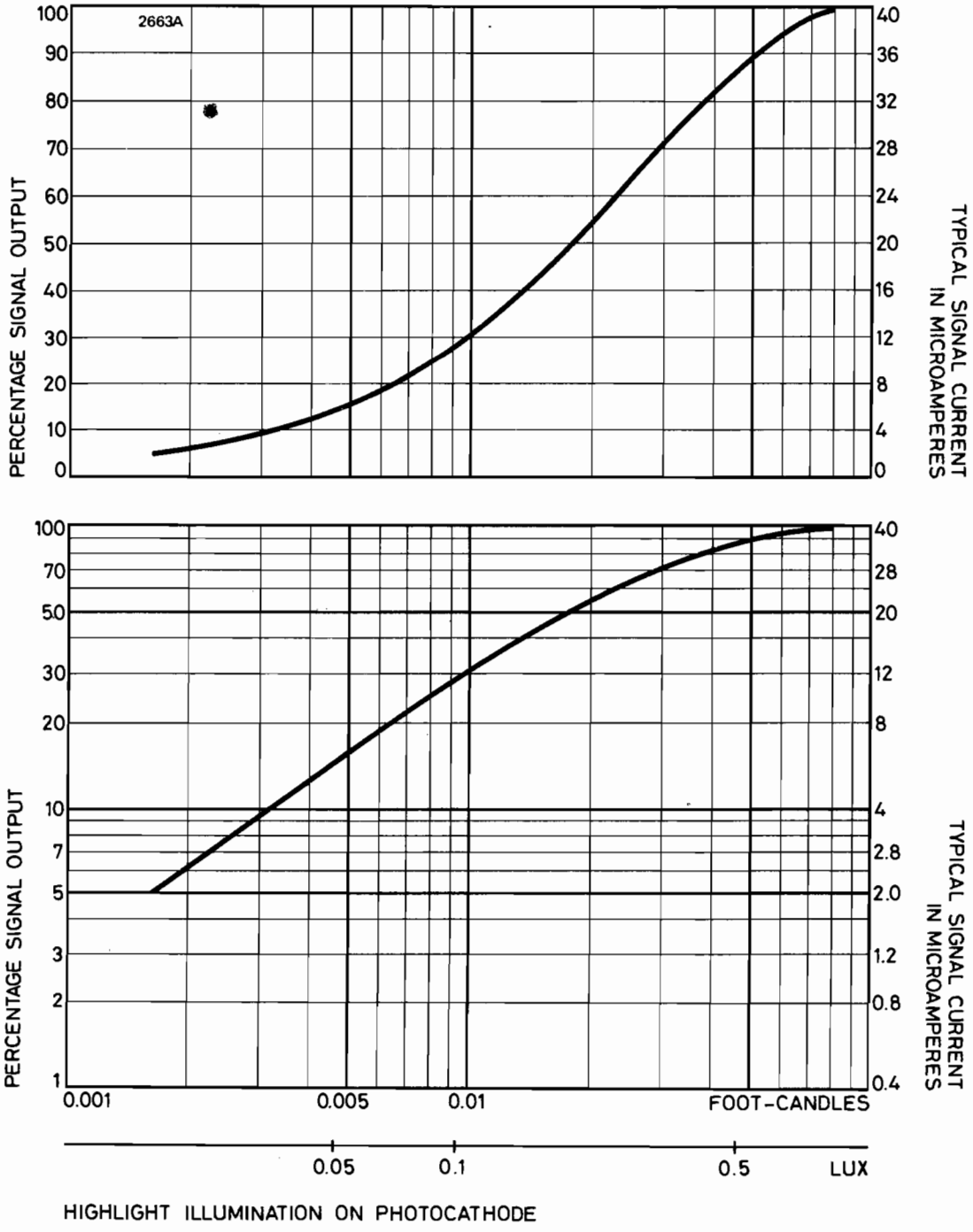
    For example, if a photocathode illumination of 0.035 ft-candle (I_{pc}) is required for the 'knee', the illumination required at the operating point would be 0.07 ft-candle. For a lens aperture of f/5.6 and transmission of 80%, scene reflectance of 60% and (m + 1) approximating closely to 1, the scene illumination required for a photocathode illumination of 0.07 ft-candle would be approximately 18 ft-candles (185 lux).

19. After an exposure of any reasonable duration to a scene, any after image will become insignificant within five seconds.

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTIC



TYPICAL TRANSFER CHARACTERISTIC

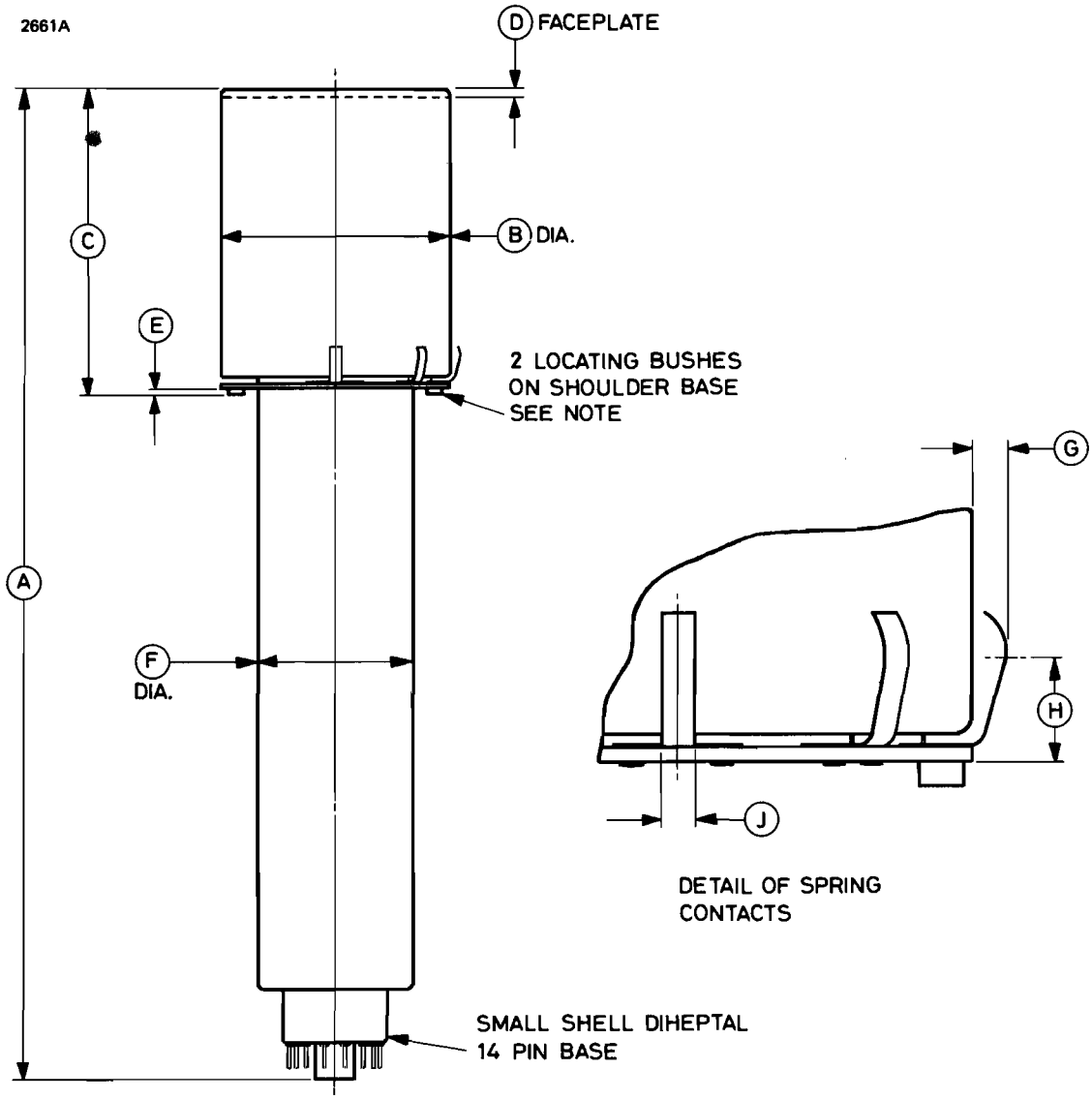


HIGHLIGHT ILLUMINATION ON PHOTOCATHODE

Method of Obtaining 7295C Transfer Characteristic

The camera was accurately set up on a normal picture and then moved to view a scene comprising one step of a step wedge, surrounded by black. The method is described by D. C. Brothers in 'The Testing and Operation of 4½-inch Image Orthicon Tubes', Journal Brit. I.R.E. Vol. 19, p. 777 (1959).

OUTLINE (All dimensions without limits are nominal)



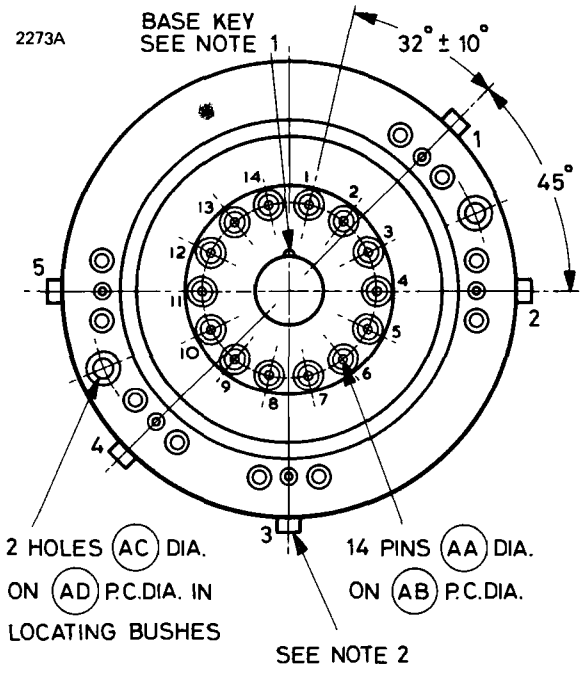
Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	19.375 ± 0.150	492.1 ± 3.8	F	3.185 max	80.90 max
B	4.500 ± 0.094	114.3 ± 2.4	G	0.175 min	4.45 min
C	5.721 ± 0.125	145.3 ± 3.2	H	0.800	20.32
D	0.188	4.78	J	0.250	6.35
E	0.175 max	4.45 max			

Millimetre dimensions have been derived from inches.

Note These bushes are a push fit and may be removed by the customer if required. If this is done, the holes remaining are 0.311 inch (7.90mm) diameter, equally spaced on 4.000 inches (101.6mm) pitch circle diameter.

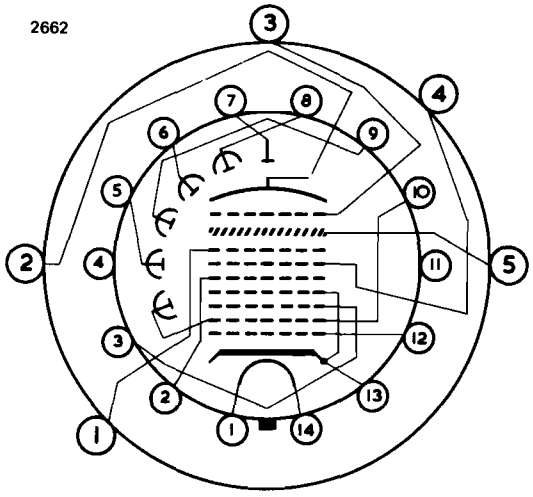
OUTLINE DETAILS

View on Base End of Tube



Note 1. The plane through the axis of the tube and the base key is co-incident with the plane through shoulder base contact 3 and the axis of the tube to within 10°.

Note 2. The faceplate has an index mark in line with shoulder base contact 3.



Base Dimensions

Ref	Inches	Millimetres
AA	0.093 ± 0.002	2.362 ± 0.051
AB	1.750 ± 0.002	44.450 ± 0.051
AC	0.204	5.18
AD	4.000 ± 0.005	101.60 ± 0.13

Millimetre dimensions have been derived from inches.

14-Pin Base Connections

Pin	Element
1	Heater
2	Grid 4
3	Grid 3
4	Internal connection. Do not use
5	Dynode 2
6	Dynode 4
7	Anode
8	Dynode 5
9	Dynode 3
10	Dynode 1, Grid 2
11	Internal connection. Do not use
12	Grid 1
13	Cathode, Suppressor
14	Heater

Shoulder Base Connections

Contact	Element
1	Field Mesh
2	Photocathode
3	Grid 6
4	Grid 5
5	Target