P874

IMAGE ORTHICON

INTRODUCTION

The P874 is a 3-inch image orthicon intended for use in studio and outside broadcast applications both for colour and monochrome. It gives stable performance over a wide range of light levels from deep shadows to bright sunlight.

New electron optical design principles have been applied to the electron gun of the P874. This results in a reduction of noise components in the beam and also a total absence of dynode background in the picture, giving pictures of considerably higher quality.

The long life Elcon* target incorporated in the P874 produces pictures with virtually no image retention and results in stable sensitivity and gamma throughout the life of the tube. The special features of anti-ghost image design, suppressor electrode and field mesh developed for earlier types of tube are incorporated in this version.

The P874 has a high target capacitance relative to type P875 and may be used as a replacement for type 8093B. It will fit cameras using other types of 3-inch tube such as 7293B, 5820 etc. The operational sensitivity is in the region of f/5.6 at 8 foot-lamberts scene luminance with the lens adjusted to one stop above the 'knee' of the transfer characteristic.

The photocathode has a spectral sensitivity which when used with tungsten illumination gives an overall response closely approaching that of the eye.

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. Normal exposures of the Elcon target to reasonable light levels as encountered in standard television camera practice will give negligible image retention (sticking).

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Electrical (continued)

Focusing method	magnetic
Deflection method	magnetic
Magnetic fields:	
focusing field (see note 1)	7.5mT (75G) approx
alignment field, adjustable	0 to 0.3mT (0 to 3G)

Mechanical

Overall length	15.450 inches (393mm) max
Diameter of image section	3.060 inches (77.8mm) max
Diameter of scanning section	2.060 inches (52.4mm) max
Deflecting coil length	5.000 inches (127mm)
Focusing coil length	10.000 inches (254mm)
Photocathode distance inside end of focusing coil	0.500 inch (12.7mm)
Alignment coil length	0.940 inch (23.9mm)
Alignment coil location	The alignment coil should be located on the tube so that its centre is at a distance of approximately 10.5 inches (267mm) 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. The precise distance depends on the coil design.
Useful size of rectangular image for standard operation:	
Diagonal (centrally situated)	1.800 inches (45.7mm) max
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 Index Pin 7 of the shoulder base. Index Pin 7 should be at the bottom.
Net weight	1 pound (454g) 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	keyed jumbo annular 7-pin

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 should 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)	–	200	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	–	1350	V
Voltage per multiplier stage	–	350	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 part of bulb hotter than target section	–	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)	−300 to −500	V
Grid 6 voltage (image accelerator) (see note 3)	−150 to −350	V
Target cut-off voltage	−2	V
Target voltage above cut-off (see note 4)	2 to 4	V
Target blanking voltage (peak to peak)	5	V min
Grid 5 voltage (decelerator) (see note 5)	0 to 125	V
Grid 4 voltage (beam focus) (see note 6)	120 to 220	V
Grid 3 voltage (multiplier focus) (see note 7)	225 to 300	V
Grid 2 and dynode 1 voltage	300	V
Grid 1 voltage:		
normal (see note 8)	−25 to −115	V
for picture cut-off	−45 to −115	V
Dynode 2 voltage	600	V
Dynode 3 voltage (see note 9)	600 to 800	V
Dynode 4 voltage	1000	V
Dynode 5 voltage	1200	V
Anode voltage (see note 9)	1250	V
Heater voltage	6.3	V
Recommended target temperature range (see note 10)	35 to 45	°C
Magnetic fields:		
focusing field (see note 1)	7.5mT (75G)	
alignment field, adjustable (see page 5)	0 to 0.3mT (0 to 3G)	

Performance Specification

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

(i) With the operational conditions specified above but with the target voltage adjusted to 2V above cut-off,

(ii) operating temperature 35 to 45°C,

(iii) the lens stop adjusted in accordance with Note 11,

(iv) 625-line operation,

(v) set up in accordance with the Sequence of Adjustments on page 5.

	Min	Typical	Max	
Heater current	540	600	660	mA
Signal current (see note 12) . . .	10	15	30	μA
Signal to noise ratio (see note 13):				
target 2V above cut-off . . .	36	38	–	db
target 4V above cut-off . . .	–	42	–	db
Amplitude response (see note 14) .	60	75	–	%
Illumination required on photo-cathode to reach the 'knee' of the transfer characteristic (see notes 11 and 15)	–	0.025	0.045	ft-candle
After image (see note 16)	–	0	5	sec

The performance obtained may vary with the type of camera 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 for maximum uniform video output. Approximately correct alignment setting is indicated by

  (i) Superimposition of picture detail when using a 'wobulator' alignment aid.

  (ii) minimum swirl of picture content when grid 4 (beam focus) voltage is varied.

(f) Pan the camera so that a small area highlight moves horizontally across the picture. Adjust grid 6 (image accelerator) voltage to eliminate the 'ghost' image and adjust photocathode voltage for best focus. With the

† 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.

camera stationary, slightly readjust grid 6 and photocathode voltages for best centre-to-corner resolution; this will be the setting for minimum 'S' distortion.

(g) Set the target voltage approximately 2 volts above cut-off.

(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 17).

(j) Adjust grid 5 (decelerator) for minimum corner shading and best geometry.

(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) Line shading can be minimised by slight adjustment of grid 3 (multiplier focus)
   (ii) Line and frame shading correction can be employed if the black shading has not been minimised satisfactorily by grid 3 adjustment.

(n) Uncap the lens and expose to a plain white scene. Readjust the beam current to just discharge the white; if necessary minimise white shading by slight adjustments of the alignment controls.

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

N.B. 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.

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.
3. 50% to 70% of photocathode voltage. Adjusted to eliminate 'ghost' image of highlight with the photocathode and grid 5 voltages at correct values.
4. Supply adjustable from −3 to +5V with the blanking voltage off.
5. Adjusted for minimum corner shading and best corner geometry.
6. Adjusted for best focus. Focus may be obtained at several values of grid 4 (beam focus) voltage. Between these values small changes in shading, geometry and spurious signals may be observed, and the optimum value for the type of yoke should be chosen. This is usually 130 volts approximately.
7. Adjusted to give maximum signal.
8. Adjusted for best picture.
9. It is desirable to make provision for adjustments to the potential of dynode 3 relative to dynodes 2 and 4. It should be adjusted 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. This could occur at 4V target operation.
10. No part of the bulb may be more than 5°C hotter than the target section.
11. 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.
12. 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.

13. 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). A signal to noise ratio of 39db can be obtained with the target voltage adjusted to 4V above cut-off. Other methods of measurement may produce different values. See Note 9.

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

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

The illumination required on the scene is given by

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

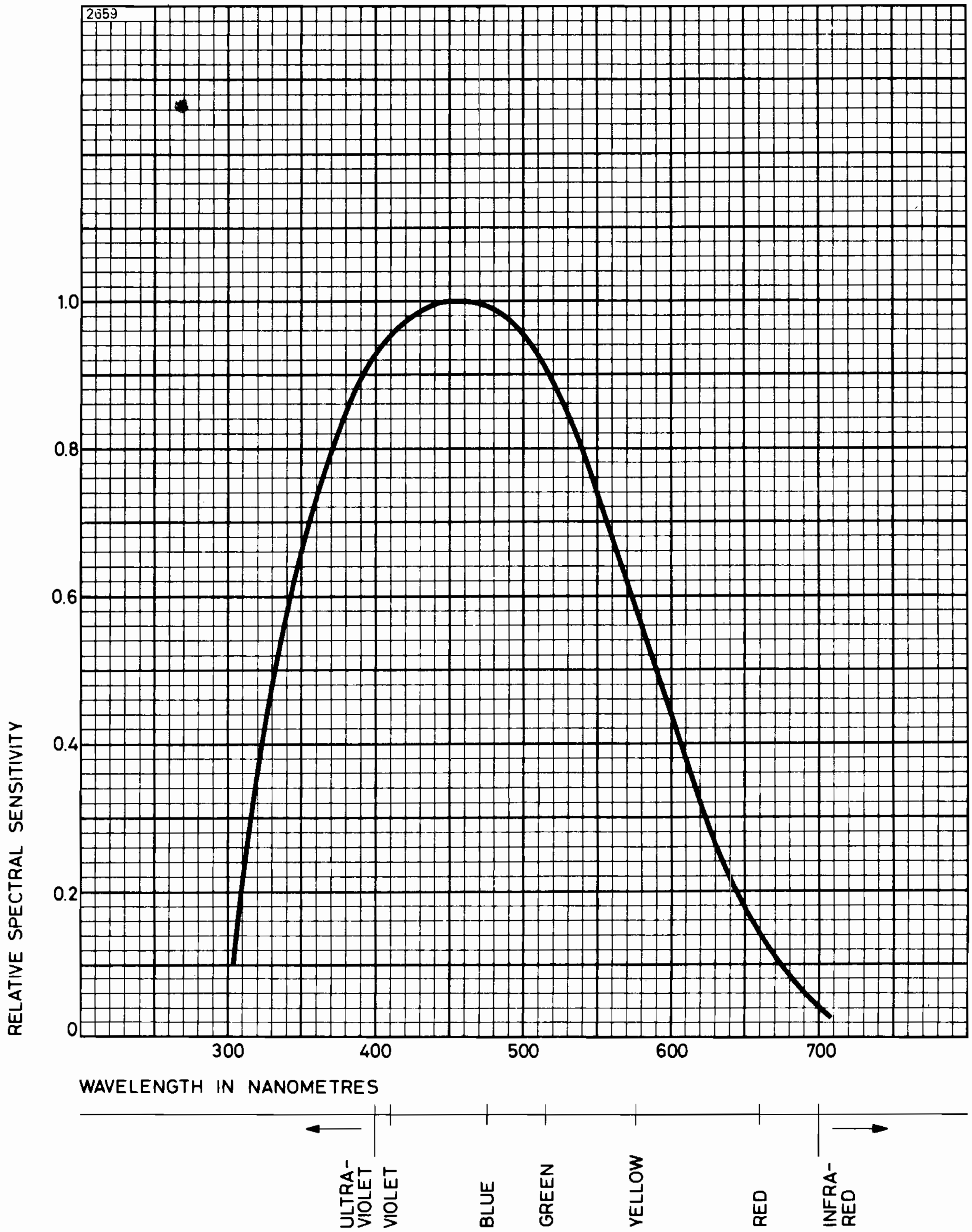
where I_{sc} = scene illumination in foot-candles
I_{pc} = photocathode illumination
f = lens aperture number
m = magnification from scene to photocathode
T = lens transmission
R = scene reflectance.

For example, if a photocathode illumination of 0.03 ft-candle (I_{pc}) is required for the 'knee', the illumination required at the operating point would be 0.06 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 0.06 ft-candle would be approximately 16 ft-candles (160 lux).

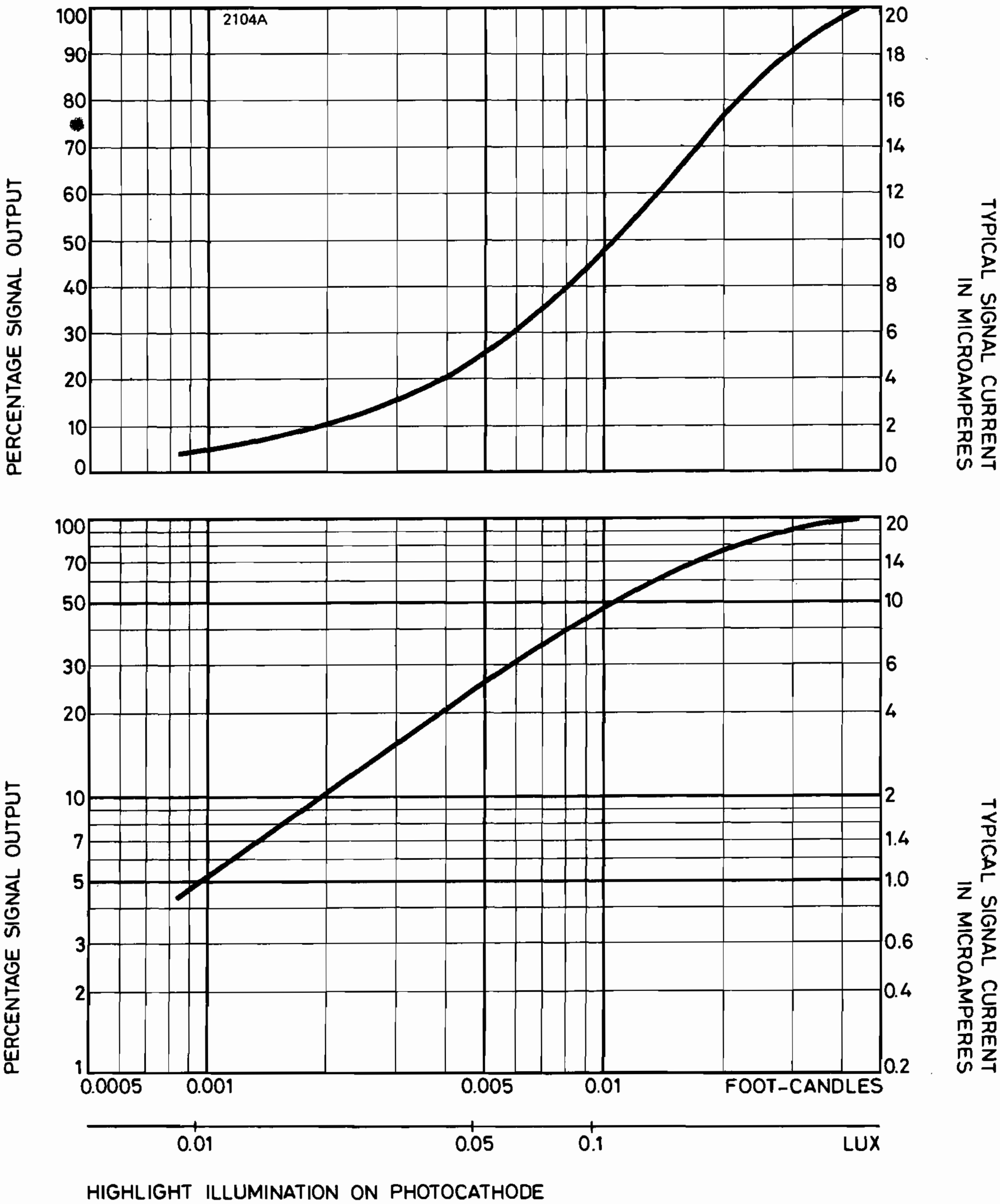
16. After an exposure of any reasonable duration to a scene, any after image will become insignificant within five seconds.

17. 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.

TYPICAL SPECTRAL SENSITIVITY CHARACTERISTIC



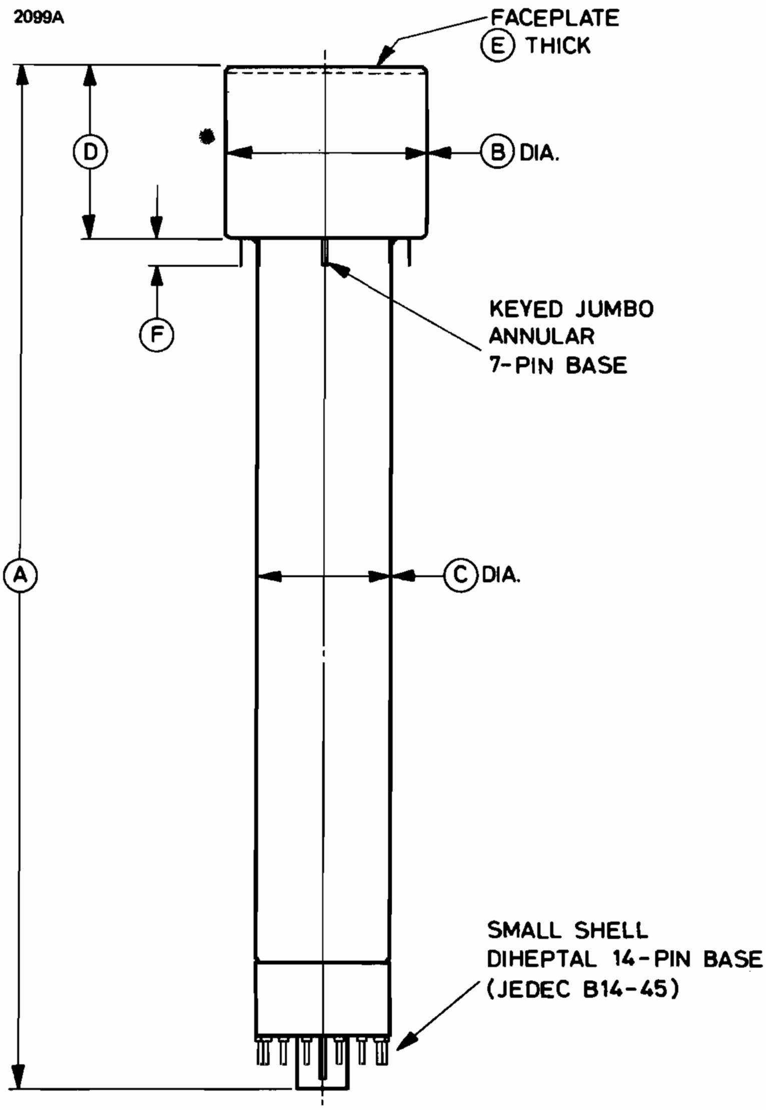
TYPICAL TRANSFER CHARACTERISTIC



Method of Obtaining P874 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

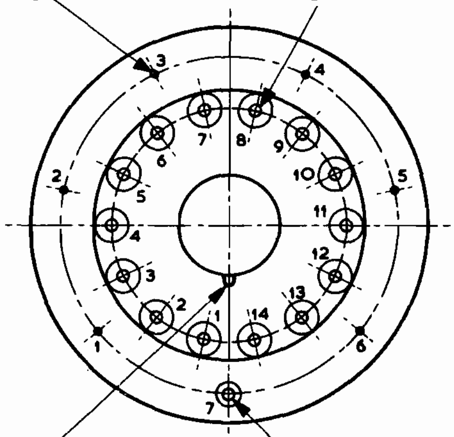


Ref	Inches	Millimetres
A	15.200 ± 0.250	386.1 ± 6.4
B	3.060 max	77.72 max
C	2.000 ± 0.060	50.80 ± 1.52
D	2.560 ± 0.120	65.02 ± 3.05
E	0.135 +0.015 −0.025	3.43 +0.38 −0.64
F	0.425 ± 0.025	10.80 ± 0.64

Millimetre dimensions have been derived from inches.

OUTLINE DETAILS

2100A



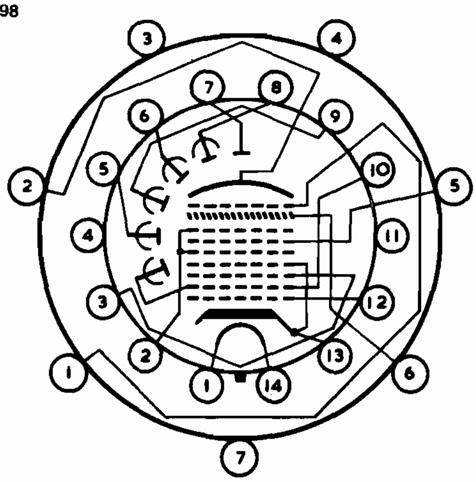
Ref	Inches	Millimetres
AA	0.040 ± 0.002	1.016 ± 0.051
AB	2.500 ± 0.015	63.50 ± 0.38
AC	0.093 ± 0.002	2.362 ± 0.051
AD	1.750 ± 0.002	44.450 ± 0.051
AE	0.093 ± 0.003	2.362 ± 0.076

Millimetre dimensions have been derived from inches.

Note 1. The plane through the axis of the tube and the base key is coincident with the plane through the index pin of the 7 pin base and the axis of the tube to within 10°.

Note 2. The faceplate has an index mark in line with index pin 7.

2098



14-PIN BASE CONNECTIONS

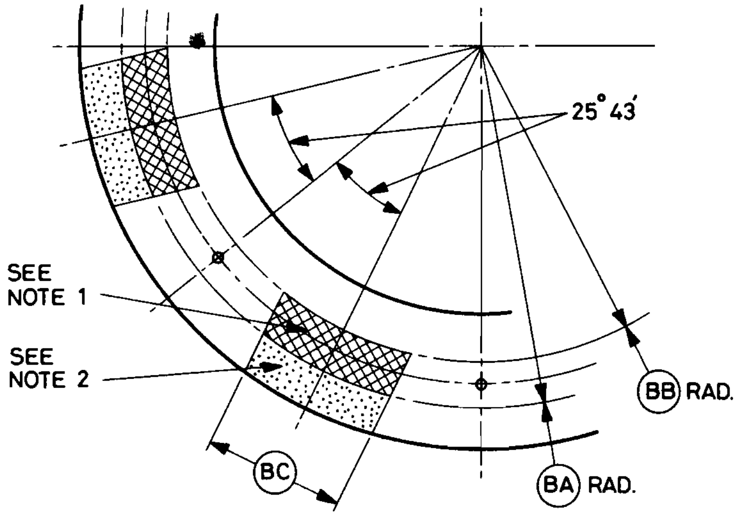
Pin	Element
1	Heater
2	Grid 4, Field Mesh
3	Grid 3
4	Internal connection. Do not use
5	Dynode 2
6	Dynode 4
7	Anode
8	Dynode 5
9	Dynode 3
10	Dynode 1, Grid 2
11	Internal connection. Do not use
12	Grid 1
13	Cathode, Suppressor
14	Heater

7-PIN ANNULAR BASE

Pin	Element
1	Grid 6
2	Photocathode
3	Internal connection. Do not use
4	Internal connection. Do not use
5	Grid 5
6	Target
7	Internal connection. Do not use

OUTLINE DETAILS
Detail of 7-pin Annular Base

2101A

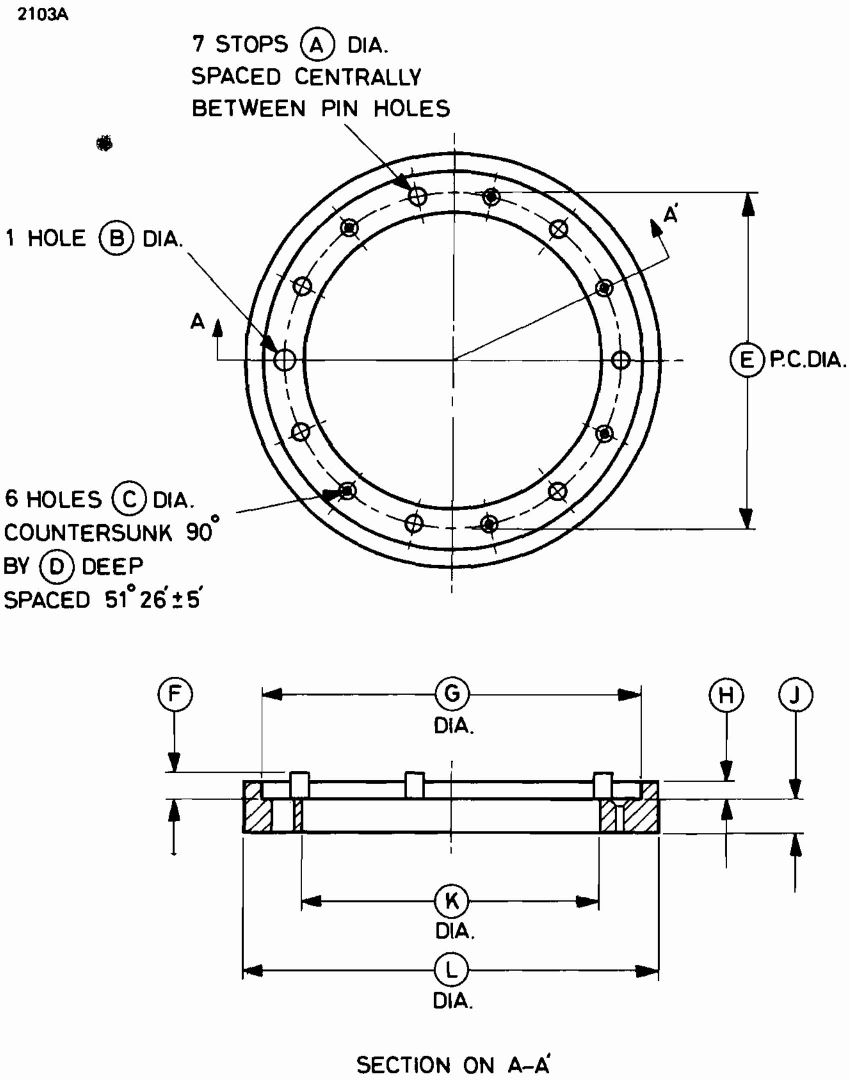


Ref	Inches	Millimetres
BA	1.315 min	33.40 min
BB	1.185 max	30.10 max
BC	0.500 min	12.70 min

Millimetre dimensions have been derived from inches.

NOTES
1. The cross-hatched area is flat.
2. The dotted area is flat, or extends towards the diheptal-base end of the tube by 0.060 inch (1.52mm) maximum.
3. The angular variations between pins, as well as the eccentricity of the neck cylinder, are held to tolerances such that the pins and neck cylinder will fit the gauge shown on page 15.

ANNULAR BASE GAUGE (All dimensions without limits are nominal)



Ref	Inches	Millimetres	Ref	Inches	Millimetres
A	0.125	3.18	G	2.812	71.42
B	0.150 ± 0.001	3.810 ± 0.025	H	0.126 ± 0.001	3.200 ± 0.025
C	0.065 ± 0.001	1.651 ± 0.025	J	0.265 ± 0.001	6.731 ± 0.025
D	0.047	1.19	K	2.200 ± 0.001	55.880 ± 0.025
E	2.500 ± 0.001	63.500 ± 0.025	L	3.062 min	77.77 min
F	0.187 ± 0.001	4.750 ± 0.025			

Millimetre dimensions have been derived from inches.