TH 9650 ESICON*

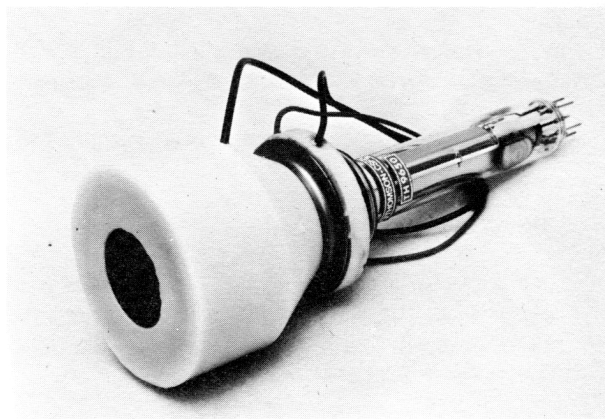
CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

- S 20 PHOTOCATHODE (25 mm useful diameter)
- IMAGE SECTION : diode - electrostatic focus
- SCANNING SECTION : electromagnetic focus and deflection
- HIGH SENSITIVITY (15 000 μA/lm)
- LOW LAG
- INTEGRATION AND STORAGE CAPABILITY
- INDUSTRIAL AND SCIENTIFIC APPLICATIONS

The TH 9650 is a compact tube featuring high sensitivity, good resolution and low persistence. It is also characterized by a simplicity in operation and is designed to be used in systems which must operate under severe environmental conditions.

The TH 9650 includes a photocathode deposited on the inner surface of a plano-concave fiber optics faceplate, an electrostatically focused diode image section, a high secondary emission photoelectron multiplier target and a reading gun similar to that of conventional Vidicons.

The target properties allow the tube to operate over a wide range of illuminations and specially at low light level (1 mlux or 0.1 mfc) where the low image persistence makes easier the viewing of moving scenes. Furthermore, regions of a scene which is sufficiently bright to cause saturation do not produce halation altering the surrounding information.



The very low dark current of the target enables excellent storage characteristics thus permitting the integration of low light level images for extended periods of time. The storage and integration characteristics permit its use in narrow bandwidth slow scan systems.

Because of those characteristics, the TH 9650 makes possible a great number of applications in black and white or color camera.

The TH 9650 can be used directly with an optical lens system or fiber optically coupled to an image intensifier in order to obtain an increased sensitivity or to convert X, U.V. or I.R. radiation to light image

The tube requires only low scanning power and the accessories of conventional Vidicons can be used.

PERFORMANCE DATA

Spectral response and sensitivity

The TH 9650 utilizes a S20 type photocathode the quantum efficiency of which is about 15 % at 440 nm. The high quantum efficiency of the photocathode combined with the high gain of the target permits to obtain a sensitivity in the order of 15 000 μA/lumen at 10 mlux (1 mf.c.).

* Registered Trade Mark.

This sensitivity allows the tube to operate without any adjustment for input illumination from 1 to 100 mlux (0.1 to 10 mf.c.). The gamma is 1 for light level between 5 and 10 mlux (0.5 and 1 mf.c.) and decreases to 0.6 for 100 mlux (10 mf.c.).

The gain control can be achieved by varying the high voltage applied to the photocathode without significant loss of resolution. This provides a gain control range from 1 to 10 and allows a dynamic illumination range of about $2.\ 10^3$.

Persistence

The mechanism of charges generation, storage and neutralization on the target allows to obtain a very low image persistence which is only limited by the reading beam acceptance. In the third frame, the residual signal is typically 8 % for a signal current of 50 nA and 5 % for 100 nA.

Resolution

The limiting resolution is about 600 T.V. lines at center of image and 450 T.V. lines at corners. The corner resolution can be improved by dynamic focusing.

Furthermore, the lag characteristics allow to obtain a good resolution in moving scenes.

Integration and storage

The very high resistance of the target permits the integration of a signal for several minutes without the image being degraded by leakage currents. The stored signal can be read out a few hours after the high voltage has been removed. The integration period is limited only by spurious emission in the image section of the tube which can saturate the target.

When the photon noise is excessive, it is advisable to reduce the gain by reducing the high voltage and to operate with longer integration period.

OPERATING CONSIDERATIONS

Supplies and circuits

System requirements are those utilized for 1'' magnetically focused and deflected Vidicons. Two additional voltages are required : one of −12 kV for the photocathode and one of 30 V for the suppressor grid g5 .

In order to maximize the signal to noise ratio it is necessary to keep the input noise current of the preamplifier as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA RMS can be obtained (D3A tube, FET 2N 4416 transistor).

Environmental characteristics and life

1 - The tube is designed to offer good resistance to shock and vibration. However, care should be taken in the design of camera head so to avoid microphonics. The tube can be provided encapsulated in a silicone rubber compound which protects the image section from humidity and breakdown.

2 - The tube can be operated between −30 °C to +50 °C without any appreciable effect upon its performances. However, it is advisable to operate at room temperature.

3 - The average life time is in excess of 500 hours.

GENERAL CHARACTERISTICS

Mechanical

Overall length	225	mm
Maximum diameter :		
- non potted type	71	mm
- potted type	80	mm
Diameter of scanning section	26	mm
Base (Ditetrar 8 pins)	UTE 9 C 15 (JEDEC E8 - 11)	
Socket (note 1)	METOX N° 30 520	
Deflecting yoke - Focus coil - Assembly (note 2)	GERHARD BV 200 - 1 k 1 or equivalent	
Alignment coil (note 2)	GERHARD BV 80/3 or equivalent	
or Deflecting yoke - Focusing and alignment coils - Assembly - (note 2)	CLEVELAND VYFA - 355.2 or equivalent	
Weight, approximate :		
- non potted type	280	g
- potted type	450	g
Operating position	any	

Electrical

– IMAGE SECTION :

Focus	electrostatic	
Type	diode	

– SCANNING SECTION :

Cathode	unipotential indirectly heated oxide coated	
Heater :		
- voltage	6. 3	V
- current at 6. 3 V	150 ± 10 %	mA
Minimum preheating time	60	s
Output capacitance (signal electrode to all other electrodes)	25	pF
Focus	electromagnetic	
Deflection	electromagnetic	

Optical

– IMAGE SECTION :

Photocathode	S 20	
Input window :		
- shape	circular - flat (1 μ flatness)	
- nature	fiber optics (6 μ elementary fibers)	
Useful diameter	25	mm
Useful area	4. 9	cm^2
Useful size	20 mm x 15 mm	

– SCANNING SECTION :

Photoconductrice layer :		
- normal dimension of image on target	12. 7 mm x 9. 5 mm	
- maximum useful diameter (4 x 3 aspect ratio)	17	mm

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OPERATING CONDITIONS

Voltages are given with respect to ground, the anode of the image section and the cathode of the scanning section being grounded.

Maximum ratings (absolute values)

Ambient temperature :			
- storage	max.	+ 70	°C
	min.	− 55	°C
- operation	max.	+ 50	°C
	min.	− 30	°C
− SECTION IMAGE :			
Photocathode voltage :			
- negative value	max.	12 000	V
- positive value	min.	0	V
Anode voltage		0	V
− SCANNING SECTION :			
Signal electrode voltage (target)	max.	40	V
Grid g5 voltage (suppressor)	max.	30	V
Cathode k voltage		0	V
Grid g1 voltage (image cut-off) :			
- negative bias value	max.	150	V
- positive bias value	max.	0	V
Grid g2 voltage (accelerator)	max.	400	V
Grid g3 voltage (wall electrode)	max.	400	V
Grid g4 voltage (field electrode)	max.	600	V
Heater voltage	max.	6.9	V
	min.	5.7	V
Peak heater - cathode voltage :			
- heater negative with respect to cathode	max.	125	V
- heater positive with respect to cathode	max.	10	V
Signal current	max.	300	nA

Typical operation

Temperature (note 3)	+ 25	°C
− IMAGE SECTION :		
Photocathode voltage	− 8 000	V
Anode voltage	0	V
− SCANNING SECTION :		
Target voltage	5 to 30	V
Grid g5 voltage	15	V
Cathode k voltage	0	V
Grid g1 voltage (note 4)	− 80	V
Grid g2 voltage	300	V
Grid g3 voltage	320	V
Grid g4 voltage	360	V
Minimum blanking peak to peak voltage :		
- applied to cathode	+ 30	V
- applied to grid g1	− 80	V
Focus magnetic field	40	Gauss
Alignment magnetic field	0 to 4	Gauss

Electro-optical performances

Light sensitivity	15 000	µA/lumen
Operating sensitivity	4. 5	µA/lux
Image size on the photocathode	20 mm x 15 mm	
Photocathode illumination (2854 °K) (note 5)	0. 1	lux
Signal current	200	nA
Limiting resolution (note 6) :		
- at center of image	550	TV lines
- at periphery of image	400	TV lines
M.T.F. for 400 T.V. lines at center of image (note 7)	20	%
Persistence (note 8) :		
- 3rd frame after illumination is removed	< 5	%
- 10th frame after illumination is removed	< 1	%

NOTES

1 - METOX - 86, rue de Villiers de l'Isle Adam - 75020 PARIS - France.

2 - GERHARD KG - Reichelsheim/ODW - Germany.
CLEVELAND ELECTRONICS Inc. - 2000 Highland Road - TWINSBURG - OHIO - 44. 087.

3 - All the data are given for a temperature of the tube in the proximity of the target of 25 °C, the recommended temperature range for a good operation being 25 °C to 30 °C.

4 - Without blanking pulses applied to grid g1.

5 - All the above mentioned illuminations assume 2854 °K incandescent tungsten source.

6 - Practically the limiting resolution corresponds to the resolution measured with twin bar test card with a modulation ratio of 7 %.

7 - For the C.C.I.R. Standard - 625 lines, line duration being 52 µs (line suppression period not included), 400 T.V. lines correspond to a 5 MHz bandwidth.

8 - The persistence is defined as the ratio of the residual signal current measured at the n^{th} frame after excitation is removed to the initial signal current (100 nA) ; these values assume 50 fields/second scanning rate.

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OPERATING RECOMMENDATIONS

The Esicon is a rugged tube easy to use. However, care must be taken so to avoid all risk of damage to the tube liable to alter its performances.

Important recommendations

1 - A protecting device is supplied to limit the potential difference between the target and the suppressor. This should not be disconnected.

2 - The scanning voltages must be applied before electrode voltages. For shutdown, deflection power should be switched off only after the reading beam has been removed.

3 - When operating the tube, apply the high voltage in the last sequence. For shutdown, switch off the high voltage before other voltages.

4 - The tube should not be operated at exposure levels greater than those given in figure 1*.

5 - It is recommended not to exceed the given values for target and suppressor voltages**. If destabilization occurs, resulting in loss of gain and sometimes in negative image, reduce exposure level and set the suppressor grid to 5 V. Check eventually the beam current to make sure that it is sufficient to discharge the target. When the stabilization voltage becomes normal, the tube recovers its characteristics.

6 - The horizontal and vertical deflection power should be adjusted to assure that the target is either normally scanned, or over scanned. Avoid underscanning.

* *However, damage due to unduly high light exposure disappears in a few minutes if over exposure time is not too long.*

** *See Data Sheet accompanying the tube.*

Set up procedure

1 - Install the tube in the camera head using focusing, deflection and alignment coils locations shown in figure page 10. If the tube is operated in horizontal position, the short index pin should be positioned in the horizontal plane parallel to the traces of line scannings. A mask of 15 mm x 20 mm dimensions can be used to prevent light reaching the unscanned zones of the photocathode.

2 - Connect all electrodes.

3 - Apply heater, focusing, deflection and alignment voltages.

4 - Apply − 120 V to g1. Then apply voltages to g2 ; g3 ; g4 electrodes.

5 - Increase the grid g1 voltage up to −50 V and adjust g5 and target voltage to obtain recommended values.

6 - Apply about 1 mlux (0. 1 mf.c.) illumination to the faceplate.

7 - Apply progressively the high voltage and adjust the g1 voltage until the beam current is sufficient to discharge the target.

8 - Focus and center a pattern on the faceplate. The illumination level should be 10 mlux (1 mf.c.).

9 - Adjust the deflection amplitude such that the target ring is visible at the corners of image. Decrease the deflection power so to obtain the normal scanning area.

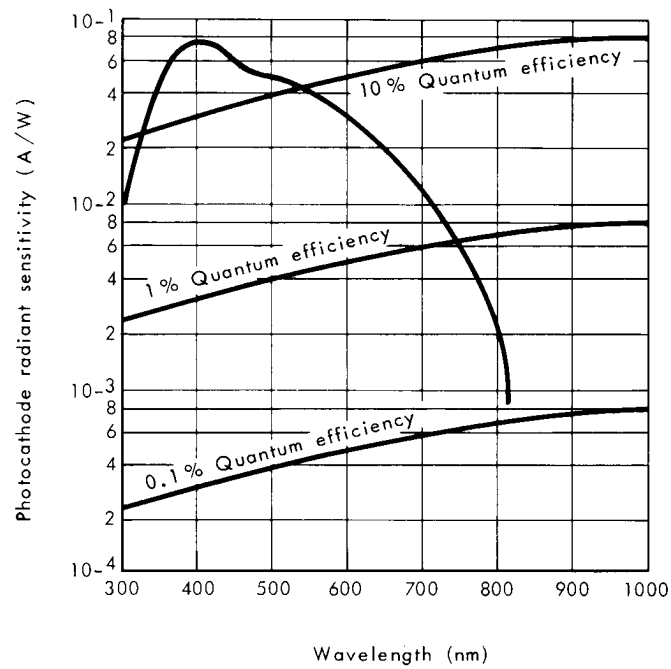
10- Adjust the focusing by varying g3 voltage and optimize the optical focus. The electrode g4 voltage should be maintained above that of electrode g3 by about 30 to 40 Volts.

11- Adjust alignment currents in the following manner :

- reduce g5 voltage to a value just above the threshold for beam landing ;
- adjust the alignment current to center the area over which the beam can land ;
- if more than 2 V on g5 is necessary for beam to land over the entire area, check the positions of focusing and deflection coils.

12- Shift g5 voltage to normal value, check g3 voltage and optical focus.

S 20 PHOTOCATHODE SPECTRAL RESPONSE



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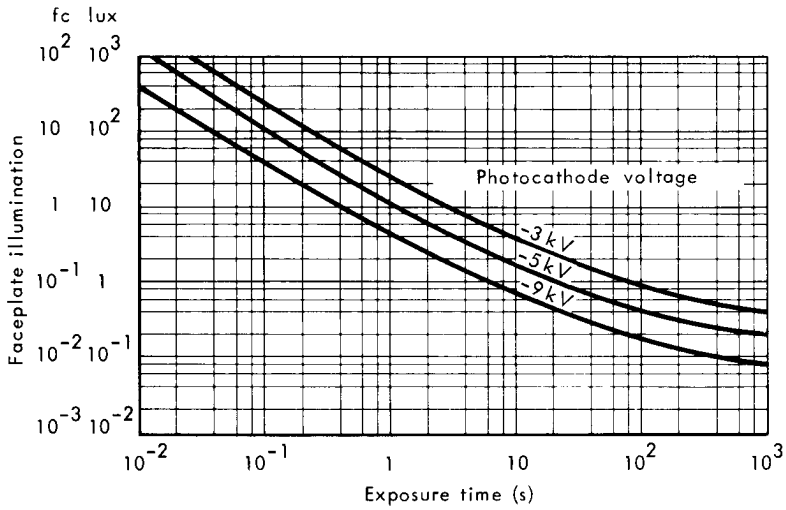

Fig. 1 - Maximum exposure levels

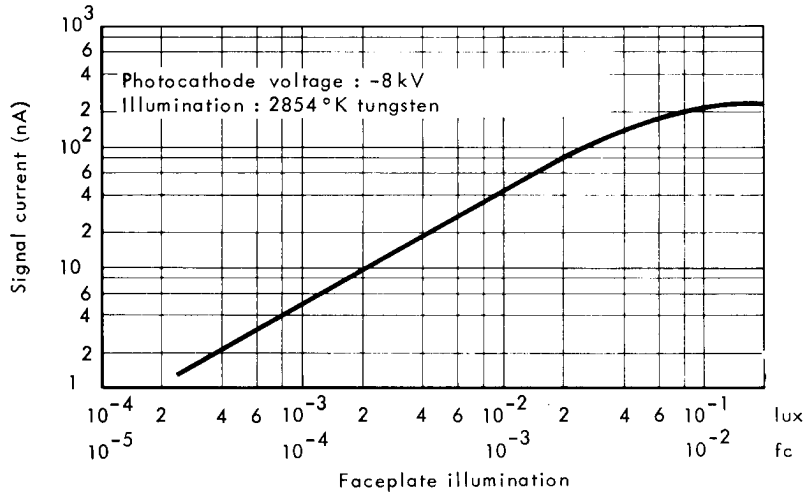

Fig. 2 - Light transfer characteristic

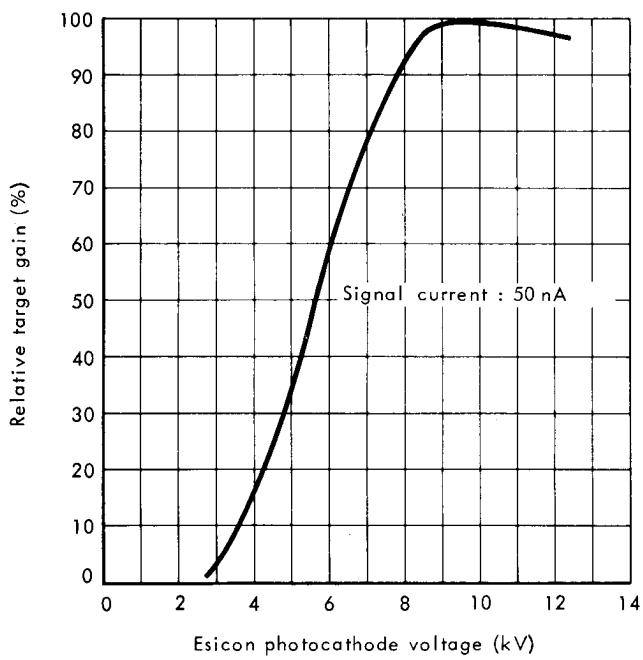

Fig. 3 - Relative gain vs. photocathode voltage

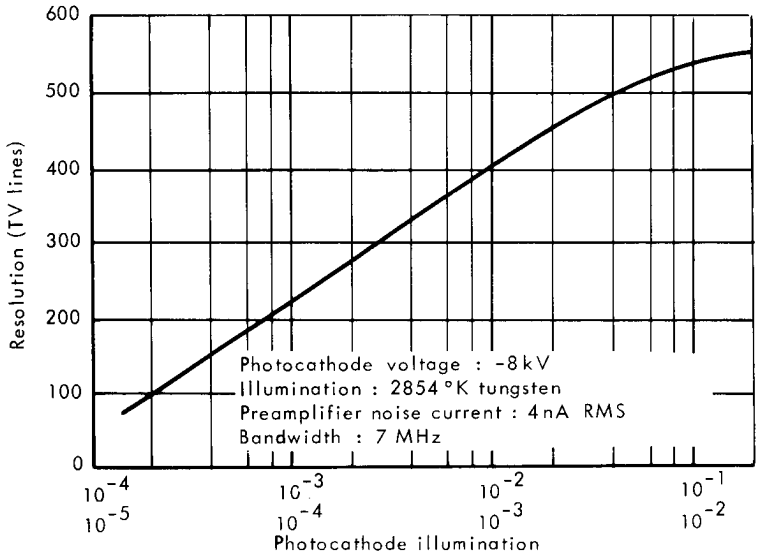

Fig. 4 - Resolution vs photocathode illumination

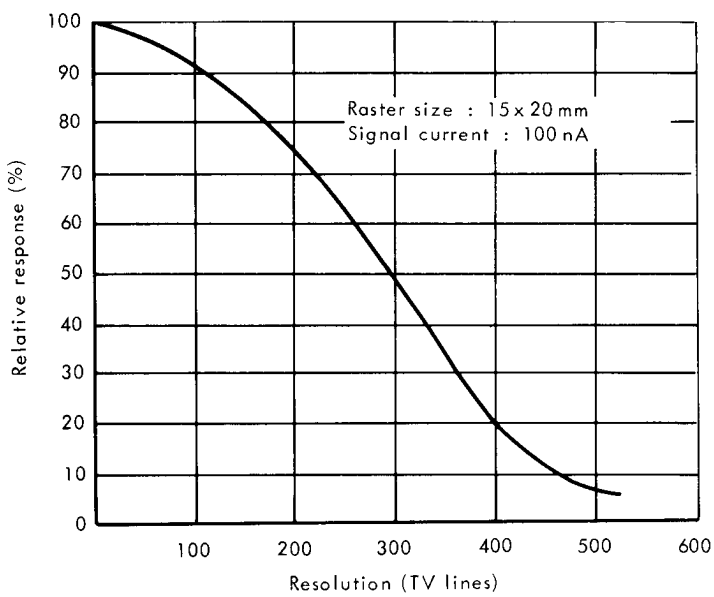

Fig. 5 - Modulation transfer function

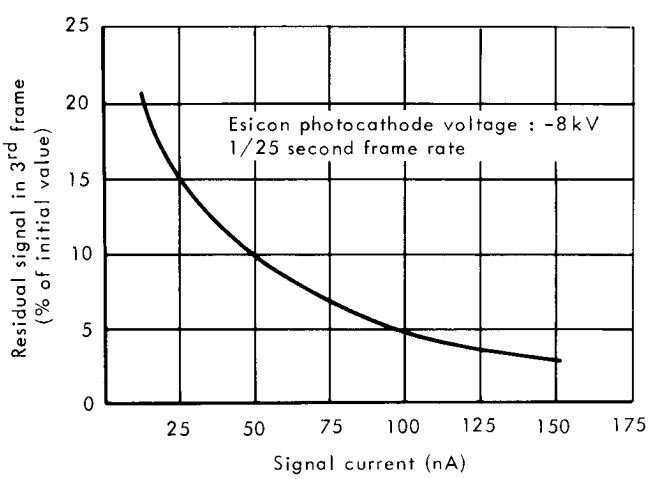

Fig. 6 - Residual vs signal current

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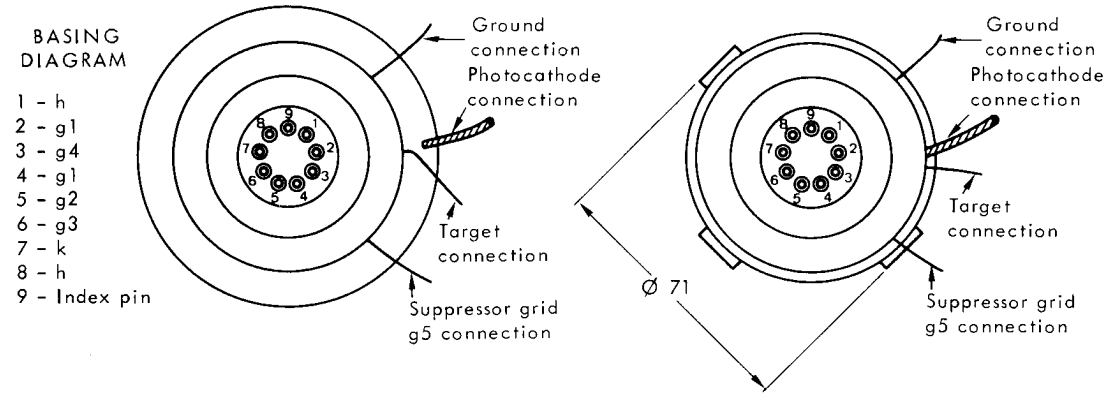
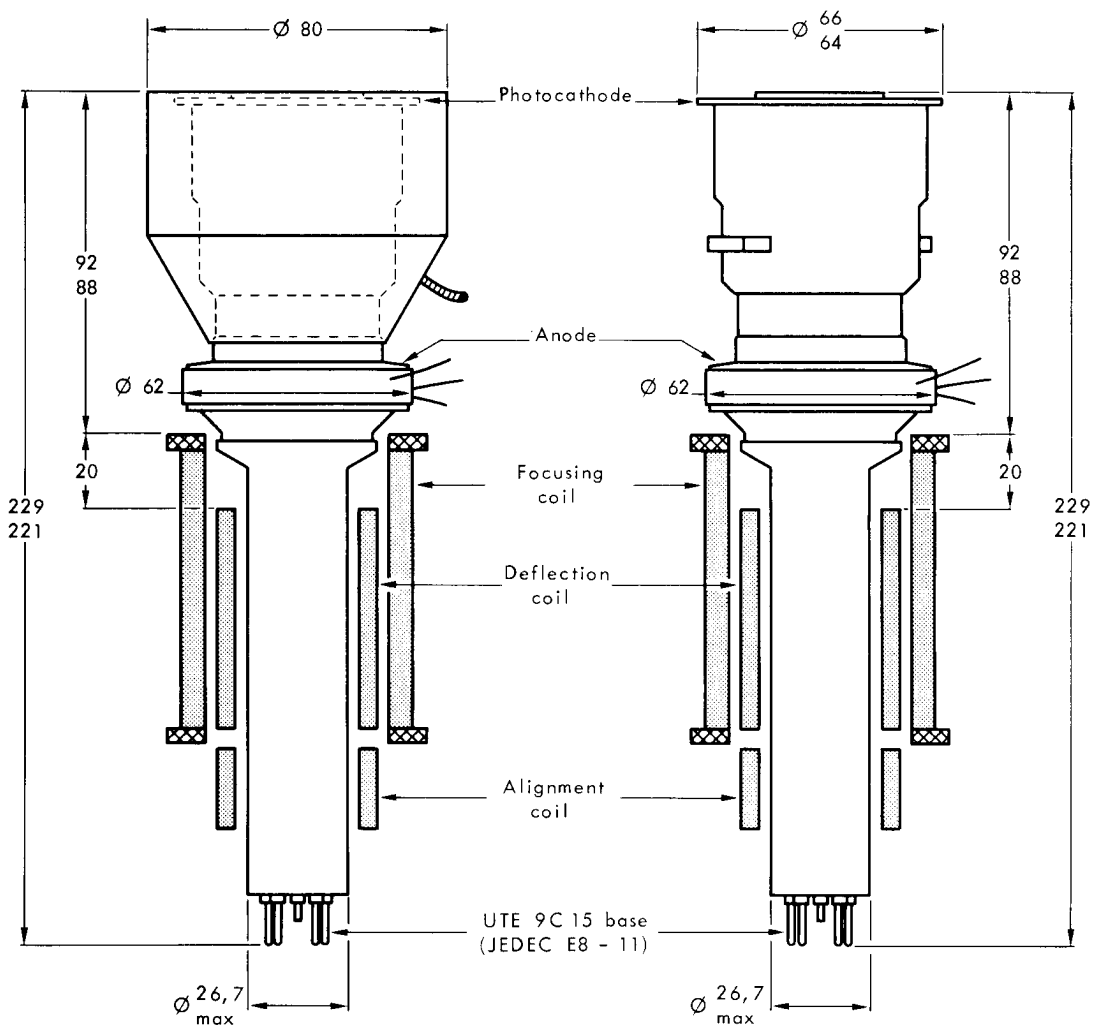
OUTLINE DRAWING





Potted type **Non potted type**

Dimensions in mm.