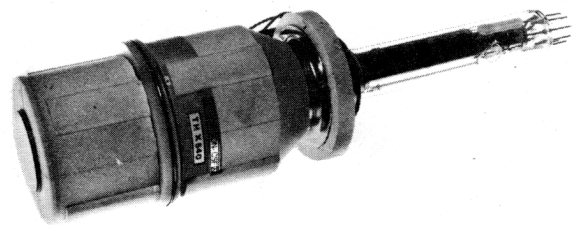
TH X540 SUPER ESICON

CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

The TH X540 SUPER-ESICON is a very high sensitivity camera tube composed of an ESICON (TH X538) mechanically coupled by fiber optics with an electrostatic focus image intensifier (TH 9473).



The useful diameter of the flat input faceplate is 25 mm and the photocathode is of the S 25 type with a spectral response in visible spectrum extended to the near infrared.

The high gain secondary emission target allows the tube to operate over a wide range of illumination and specially at low light level 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 and permits the integration of low light level images for extended period of time. The TH X 540 also performs well at slow scanning rate as used with narrow bandwidth transmission channel.

The high voltages required for the Intensifier and the image section of the Esicon can be obtained from a small size modular power supply. The requirements for the scanning section electrodes and the scanning power supply are similar to those of a standard 1" magnetically focused and deflected Vidicon.

PERFORMANCE DATA

Spectral response

The spectral response is that of a S25 type photocathode which is deposited on the fiber optics input window. The maximum quantum efficiency is 15 % and corresponding wavelength is 450 nm.

Typical sensitivities are 12 mA/W at 800 nm and 6 mA/W at 850 nm.

The photocathode has a white light sensitivity (2854 °K) in the order of 200 μA/lumen.

Overall sensitivity

High efficiency of the input photocathode combined with the gain of the Intensifier and the gain of the target permit a typical overall sensitivity of 2 mA/f.c (signal current/input illumination). With illuminated area of 15 x 20 mm^2, equivalent sensitivity is near to 700 mA/lumen.

Light transfer characteristics

The TH X540 can be used for photocathode illumination from 510^{-7} to 210^{-4} f.c. The gamma varies from 1 at very low light level to 0. 6 at 10^{-4} f.c. At higher light levels the target saturates at a potential near to that of the suppressor grid which provides a knee in the transfer curve. It is advisable not to exceed the indicated values because excessive illumination may cause temporary or permanent "burn-in". However, the tube can be safely operated at higher light levels by reducing the voltages applied to the intensifier and the Esicon. By combining these two parameters it is possible to cover a dynamic illumination range in the order of $5.\ 10^3$.

Persistence

The signal generating mechanism of the target is essentially lagless due to the target design.
Typical residual signal at third frame is 5 % for a signal current of 100 nA.

Resolution

The limiting resolution is 650 pts/line at center of image for stationary scenes and 10^{-4} f.c. faceplate illumination. Because of the low lag characteristics, good dynamic resolution can be obtained : a typical value of limiting dynamic resolution is 500 pts/line for an object moving across the picture width in 10 seconds.

Integration and storage

A signal can be integrated over a period of several minutes without degradation due to target leakage. It can be stored for many hours provided the photocathode voltage is turned off. The maximum integration period is limited by the dark current of the intensifier and the transfer section of the Esicon and the low illumination due to the electron gun cathode.

If excessive photon noise occurs, it may be found advantageous to reduce the gain of the tube by reducing the high voltage and to operate the tube with longer integration periods.

OPERATING CONSIDERATIONS

Supplies and circuits

When using a basic Vidicon camera three additional voltage supplies are required :
– 25 kV to be applied to the Intensifier photocathode
– 12 kV to be applied to the Esicon photocathode
and 30 V to be applied to the suppressor grid.
In order to maximize the signal to noise ratio, it is necessary to keep the input noise current as low as possible. For a shunt capacity of 25 pF and a bandwidth of 7 MHz, a 4 nA R.M.S. noise current can be obtained with a preamplifier using D3A tube or FET 2N 4416 transistor.

Environmental characteristics and life

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

2 - The tube can be operated between –30 °C and + 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.

TUBE CHARACTERISTICS

Geometrical characteristics

Length	285	mm
Maximum diameter (potted type)	80	mm
Useful field	25	mm
Scanning section diameter	26	mm

General characteristics

- Intensifier and image section	
Input window	flat fiber optics faceplate
Photocathode	S - 25
Image diameter	25 mm
Useful diameter	15 x 20 mm^2
Focus	Electrostatic
- Scanning section	
Diameter of scanned target	17 mm
Focus and deflection	Magnetic Gerhard 2001 K 1 coils or equivalent
Alignment	Gerhard BV 80/3 coils or BV 80/7 or equivalent
Filament	6. 3 V - 150 mA

OPERATING CONDITIONS

Absolute ratings

Intensifier photocathode voltage Vg9 (with respect to cathode)	−25	kV
Intensifier photocathode voltage (with respect to Esicon photocathode)	−15	kV
Esicon photocathode voltage Vg8 (with respect to cathode)	−12	kV
Esicon anode voltage Vg7	0	
Target voltage Vg6	40	V
Grid g5 voltage	30	V
Cathode voltage	0	
Electrode g1 voltage	−150	V
Electrode g2 voltage	400	V
Electrode g3 voltage	400	V
Electrode g4 voltage	600	V
Heater voltage	6. 9	V

Typical operation

Intensifier photocathode voltage Vg9 (with respect to cathode)	−23	kV
Esicon photocathode voltage Vg8 (with respect to cathode)	−8	kV
Esicon anode voltage Vg7	0	
Target voltage Vg6	5 to 30	V
Grid g5 voltage	15	V
Cathode voltage	0	
Electrode g1 voltage	−80	V
Electrode g2 voltage	300	V
Electrode g3 voltage	320	V
Electrode g4 voltage	360	V
Heater voltage	6. 3	V
Blanking peak to peak voltage		
- applied to cathode	+30	V
- applied to electrode g1	−80	V
Output capacitance (signal electrode to all other electrodes)	25	pF
Focusing magnetic field	40	Gausses

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Electronoptic performances

Overall sensitivity	2	mA/f.c.
Maximum signal current	300	nA
Resolution (i_S = 100 nA)		
300 pts/line . . . . . amplitude response.	40	%
600 pts/line . . . . . amplitude response.	5	%
Persistence (i_S = 100 nA)		
3rd frame after illumination is removed	≤5	%
10th frame after illumination is removed	<1	%

OPERATING RECOMMENDATIONS

The SUPER-ESICON is a rugged tube easy to use. However care must be taken so to avoid all risk of damage to the tube.

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 should be applied before electrode voltages applications. For shutdown, deflection power should be switched off only after the electron 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 the 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 Volts. 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.

7 - As high voltage is applied to the input faceplate a good design of the camera and particulary of lens fixture is necessary in order to prevent arcing and breakdown which would impair the fiber optics face plate or cause a high dark current equivalent illumination.

* *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 8. 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 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 0.01 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 0. 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.

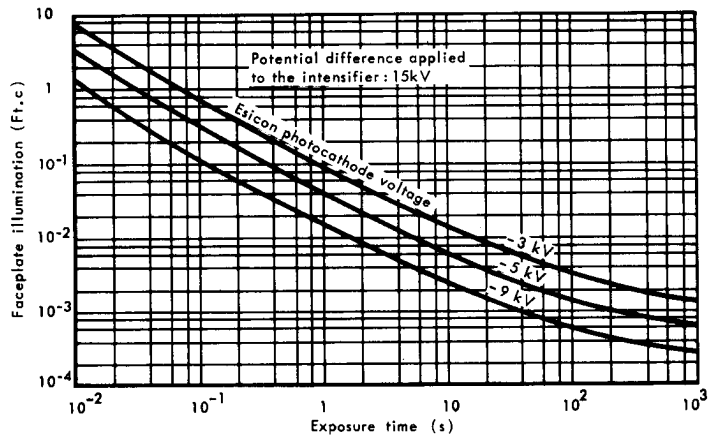

Fig1 - Maximum exposure levels.

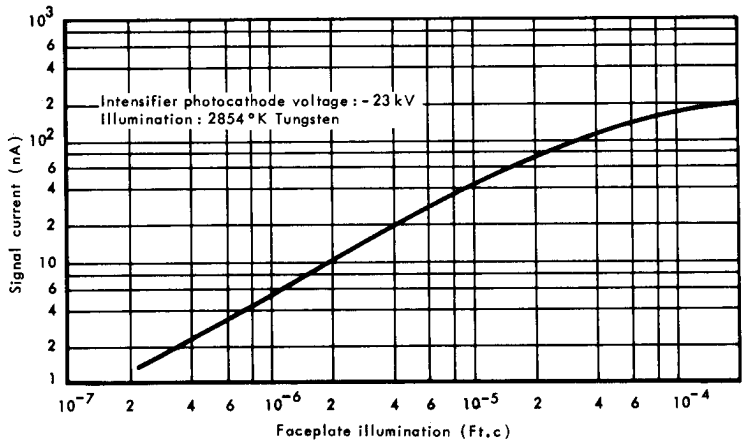

Fig 2 - Light transfer characteristic.

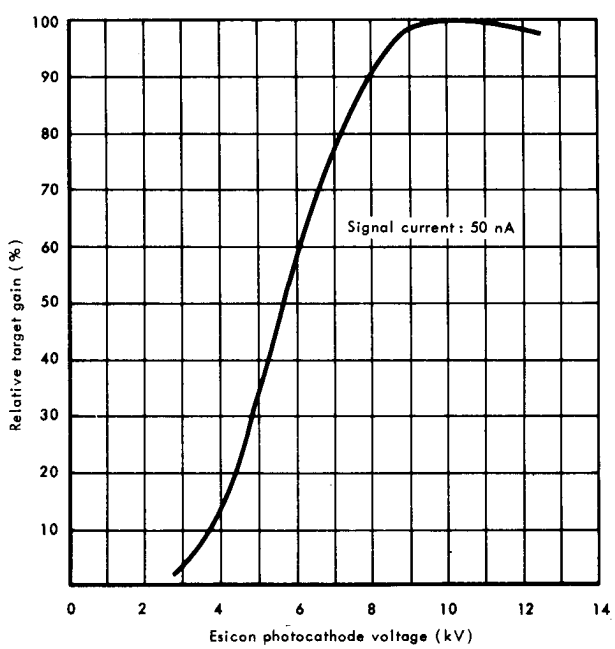

Fig 3 - Relative gain Vs. Esicon ohotocathode voltage.

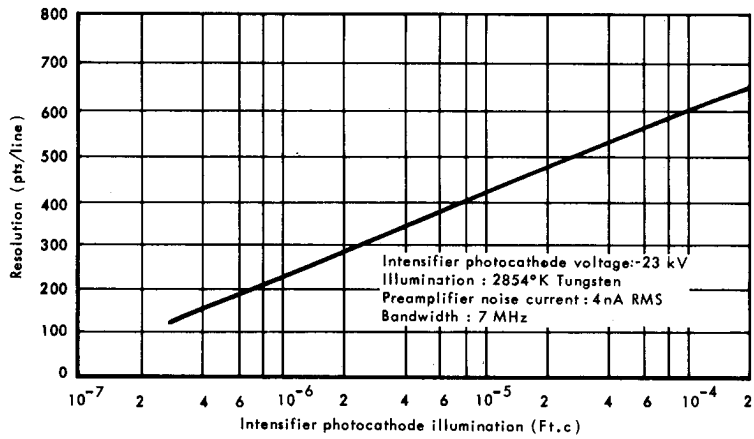

Fig. 4 - Resolution Vs. photocathode illumination.

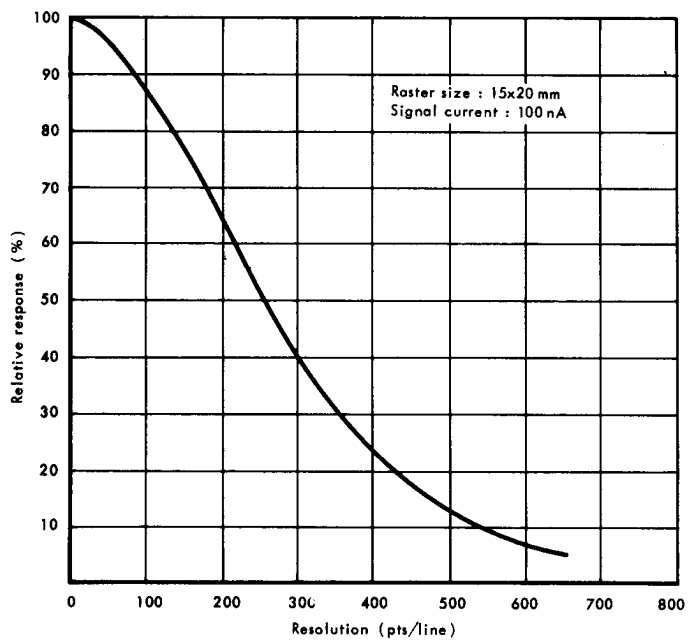

Fig. 5 - Modulation transfer function.

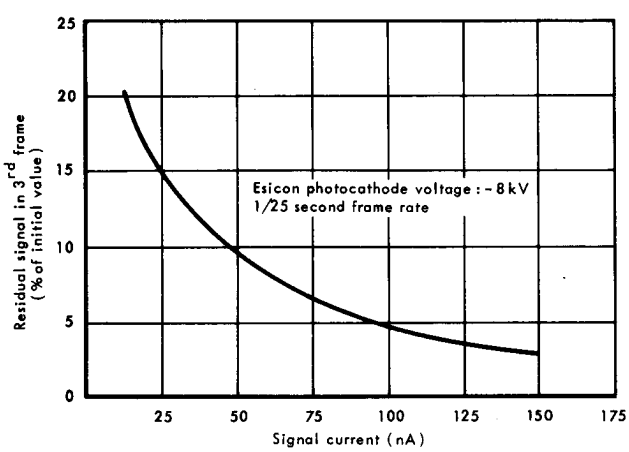

Fig. - Residual Vs. signal current.

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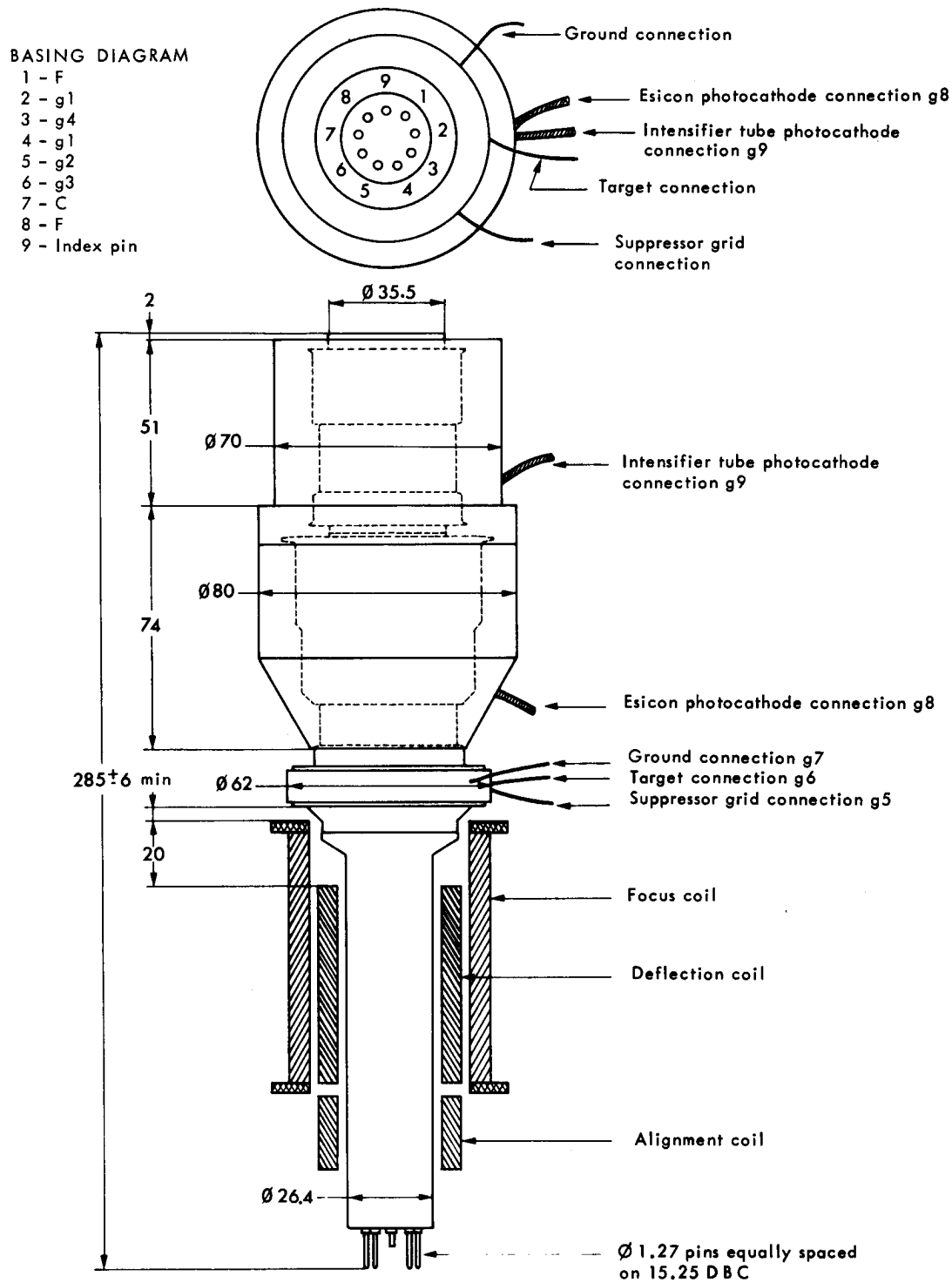
OUTLINE DRAWING



Encapsulated tube

Dimensions in mm.