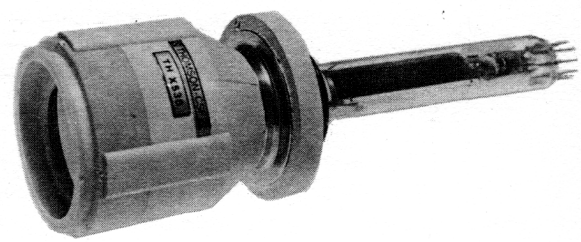
THX538 ESICON

CAMERA TUBE FOR LOW LIGHT LEVEL T.V.

The TH X538 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 X538 includes a photocathode deposited on the inner surface of a plano-concave fiber optics face-plate, 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 (0.1 mf.c) 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 X538 makes possible a great number of applications in black and white or color camera.

The TH X538 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 X538 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 1 mf.c.

This sensitivity allows the tube to operate without any adjustment for input illumination from 0.1 to 10 mf.c. The gamma is 1 for light level between 0.5 and 1 mf.c and decreases to 0.6 for 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 50nA and 5 % for 100 nA.

Resolution

The limiting resolution is about 800 pts/line at center of image and 600 pts/line 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 canbe 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.

TUBE CHARACTERISTICS

Geometrical characteristics :

Length	225	mm
Max. diameter (potted type)	80	mm
Useful field	25	mm
Scanning section diameter	26	mm

General characteristics :

- Image section	
Input window	fiber optics (6 μ elementary fiber)
Faceplate	Flat
Photocathode	S20
Image diameter	25 mm
Useful dimensions	15 x 20 mm^2
Focus	electrostatic (diode)
- Scanning section	
Diameter of scanned target	17 mm
Focus and deflection	magnetic
Alignment	Gerhard 200/1K1 coils or equivalent Gerhard BV 80/3 or BV 80/7 coils or equivalent
Heater	6.3 V - 150 mA

OPERATING CONDITIONS

Absolute ratings

Photocathode PC voltage	−12	kV
Anode voltage	0	
Target voltage	40	V
Grid g5 voltage	30	V
Cathode C voltage	0	
Electrode g1 voltage	−150	V
Electrode g2 voltage	400	V
Electrode g3 voltage (to be adjusted)	400	V
Electrode g4 voltage	600	V
Heater voltage	6.9	V

Typical operation

Photocathode PC voltage	−8	kV
Anode voltage	0	
Target voltage	5 to 30	V
Grid g5 voltage	15	V
Cathode C voltage	0	
Electrode g1 voltage	−80	V
Electrode g2 voltage	300	V
Electrode g3 voltage (to be adjusted)	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

Absolute sensitivity		15 000	μA/lumen
Operating sensitivity		45	μA/f.c.
Maximum signal current		300	nA
Resolution (i_s = 150 nA)			
400 pts/line	amplitude response	40	%
600 pts/line	amplitude response	10	%
Persistence (i_s = 100 nA)			
3rd frame after illumination is removed		⩽ 5	%
10th frame after illumination is removed		< 1	%

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 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 0.1 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 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.

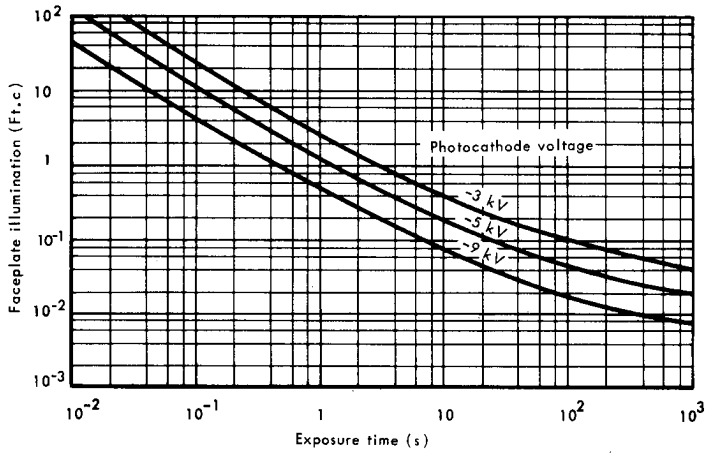

Fig 1 - Maximum exposure levels

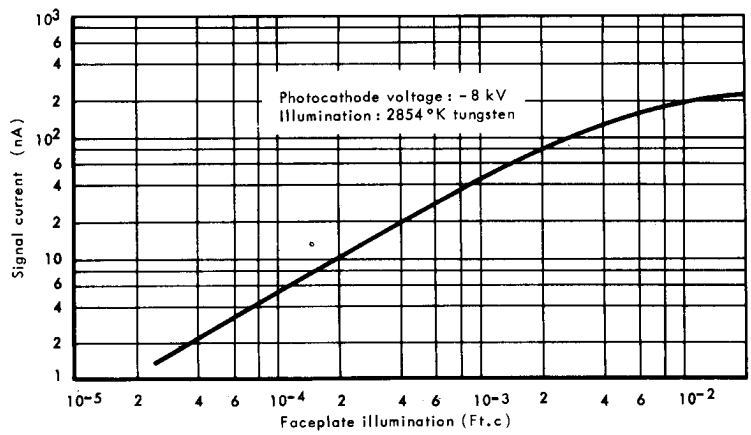

Fig 2 - Light transfer characteristic

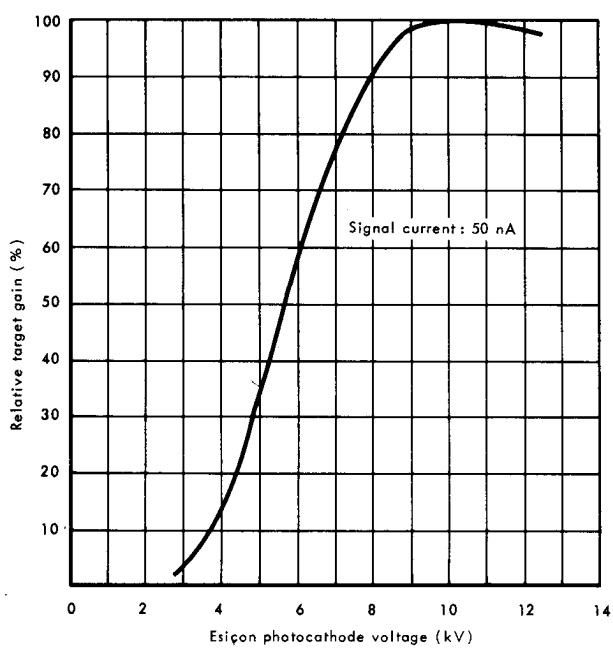

Fig 3 - Relative gain vs. photocathode voltage

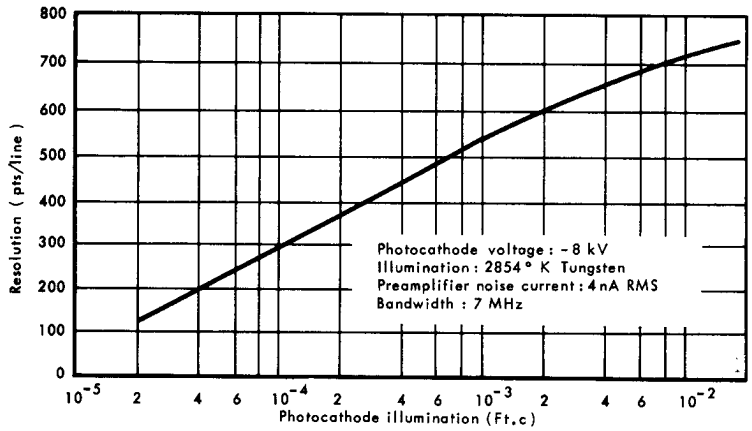

Fig 4 - Resolution vs photocathode illumination

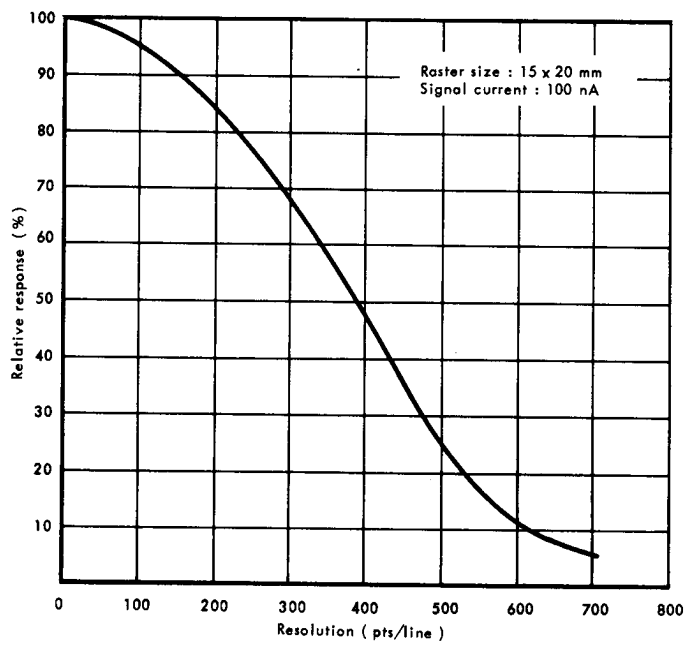

Fig 5 - Modulation transfer function

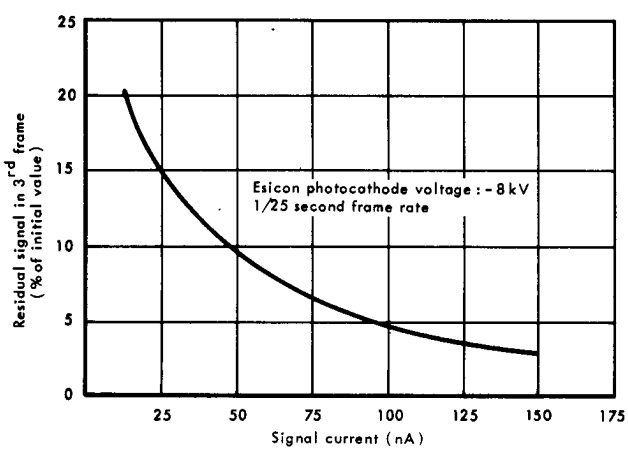

Fig 6 - Residual vs signal current

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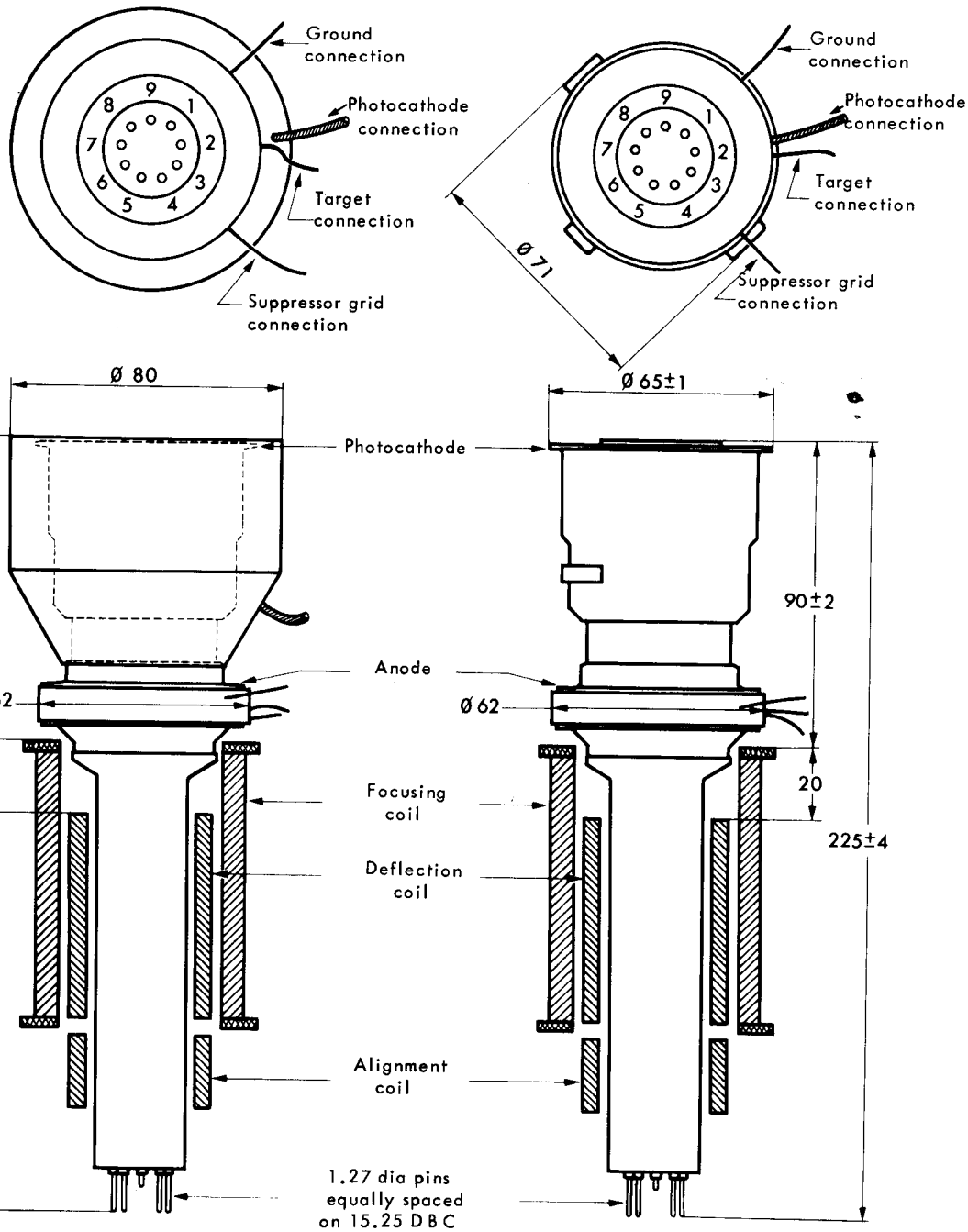
OUTLINE DRAWING

BASING DIAGRAM

1 - F
2 - g1
3 - g4
4 - g1
5 - g2
6 - g3
7 - C
8 - F
9 - Index pin



Encapsulated tube

Tube not encapsulated

Dimensions in mm.