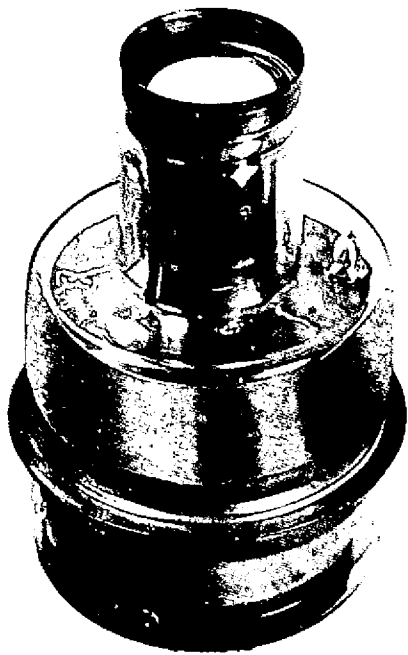


6839 Image Tube High Speed Electronic Shutter

FOR "STOPPING" HIGH SPEED EVENTS SUCH AS EXPLODING WIRES, ELECTRIC ARCS, HIGH SPEED PROJECTILES, AND ROTATING HIGH SPEED OBJECTS.



The 6839 is an image tube with exceptionally low image distortion. Designed principally for pulse operation, this tube may be used as an electronic shutter for high speed photography. In this application it is normally operated as a diode, however, provision has been made for triode operation when the maximum center resolution is desired. Electrical, optical, and mechanical characteristics and a typical application are described.

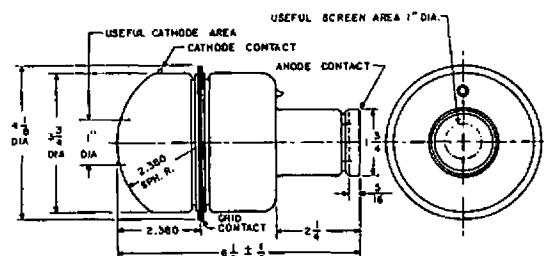
**COMPONENTS and
INSTRUMENTATION**

Laboratory
Fort Wayne, Indiana

TENTATIVE ELECTRICAL AND OPTICAL DATA

Overall length	6.5 ± .1 inch, nominal
Overall diameter	4.1 ± .1 inch
Weight	14 ounces
Diameter of active photocathode area (Note 1)	1.25 ± .05 inch
Diameter of active phosphor screen area	1.00 ± .05 inch
Overall D.C. operating potential	16 kv, nominal
Focus electrode to photocathode D.C. potential (Note 3)	20 kv, maximum (Note 2)
Focus electrode cut off potential	0 ± 1.5% of anode potential
Photocathode type	-25 ± 10% of anode potential
Photocathode luminous sensitivity (Note 4)	S-11 (semi-transparent)
Photocathode peak radiant sensitivity (Note 5)	30 μa/lumen, typical
Photocathode peak radiant sensitivity (Note 5)	0.024 ampere/watt, typical
Wavelength of peak photocathode response	4400 ± 500 Angstroms
Maximum permissible photocathode current density (Note 6 & 7)	0.1 μa/cm ² , average
Phosphor screen type	P-11 (aluminized)
Phosphor screen luminous efficiency (Notes 6 & 8)	0.18 lumen/μa, typical
Phosphor screen absolute efficiency (Notes 6 & 9)	0.082 watt/watt, typical
Peak radiant power gain (Notes 6 & 10)	31 watts/watt, typical
Luminous gain (Note 6)	5.4 lumens/lumen, typical
(Notes 6 & 11)	3.0 lumens/lumen, minimum
Resolution, paraxial (Note 6)	40 line pairs/mm on photocathode, typical
	25 line pairs/mm on photocathode, minimum (Note 12)
Resolution 10 mm from center of photocathode (Notes 6 & 13)	18 line pairs/mm on photocathode, typical
Image magnification, paraxial	1.00 ± .02
Image distortion, 10 mm from center of photocathode (Notes 6 & 14)	2%, maximum
Anode dark current	0.1 μampere, maximum
Background phosphor screen brightness (Notes 6 & 15)	0.1 μlambert, maximum
Focus electrode to anode capacitance	9.7 μμf, typical
Focus electrode to photocathode capacitance	23 μμf, typical
Anode to focus electrode and photocathode capacitance	10.8 μμf, typical
Ambient temperature	75°C, maximum

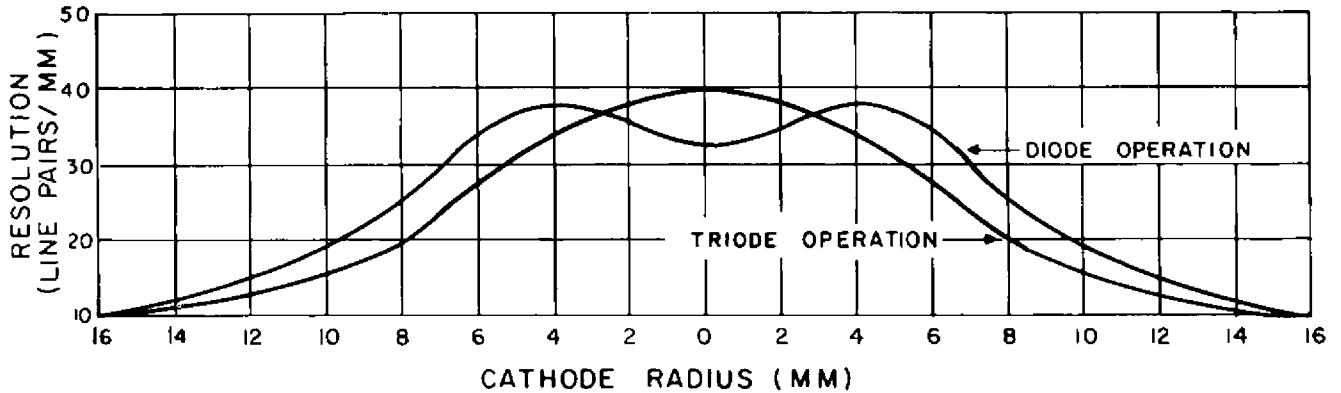
- NOTE 1: Maximum useful photocathode working area will normally be determined by the phosphor screen area and the magnification.
- NOTE 2: Pulsed voltages many times higher than this rated d-c maximum may normally be applied for microsecond intervals under low duty cycle conditions.
- NOTE 3: For optimum paraxial resolution.
- NOTE 4: With 200 volts collecting potential applied to focus electrode and anode, 0.1 lumen, 0.5 inch diameter test source of 2870°K color temperature radiation from tungsten lamp on central portion of the photocathode.
- NOTE 5: Calculated from the approximate relationship: peak radiant sensitivity in amperes per watt equals 8×10^{-4} times the measured luminous sensitivity in microamperes per lumen; this relationship being derived for a photocathode having a typical S-11 spectral response peaking at 4400 Angstroms.
- NOTE 6: At 16 kv overall.
- NOTE 7: Averaged over a 1 second time interval.
- NOTE 8: Total output flux connected with a calibrated lucite cone and measured with an eye-corrected meter.
- NOTE 9: Total radiated watts out per electrical watt in; calculated using the approximate relationship: 137 lumens of P-11 phosphor radiation equals 1 watt.
- NOTE 10: Total radiated wattage out per radiant watt in; the input being monochromatic radiation at the wavelength of peak photocathode sensitivity.
- NOTE 11: Acceptance standards for photocathode sensitivity and phosphor efficiency are combined in this specification.
- NOTE 12: Diode operated.
- NOTE 13: Off-axis resolution can be improved by adjustment of the focus electrode potential for maximum off-axis resolution.
- NOTE 14: In terms of the change of magnification from the paraxial value.
- NOTE 15: Photocathode in the dark, temperature 23°C, static operation. Can be expected to increase rapidly above 16 kv.



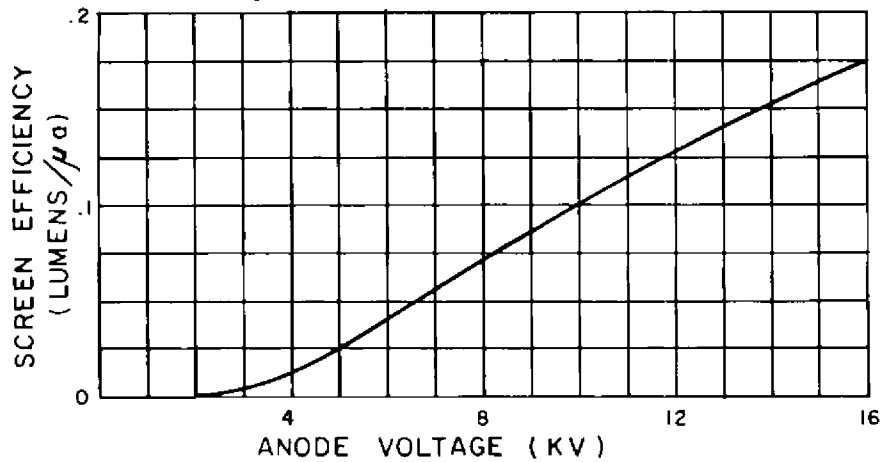
DIMENSIONAL OUTLINE DRAWING

6839 CHARACTERISTIC CURVES

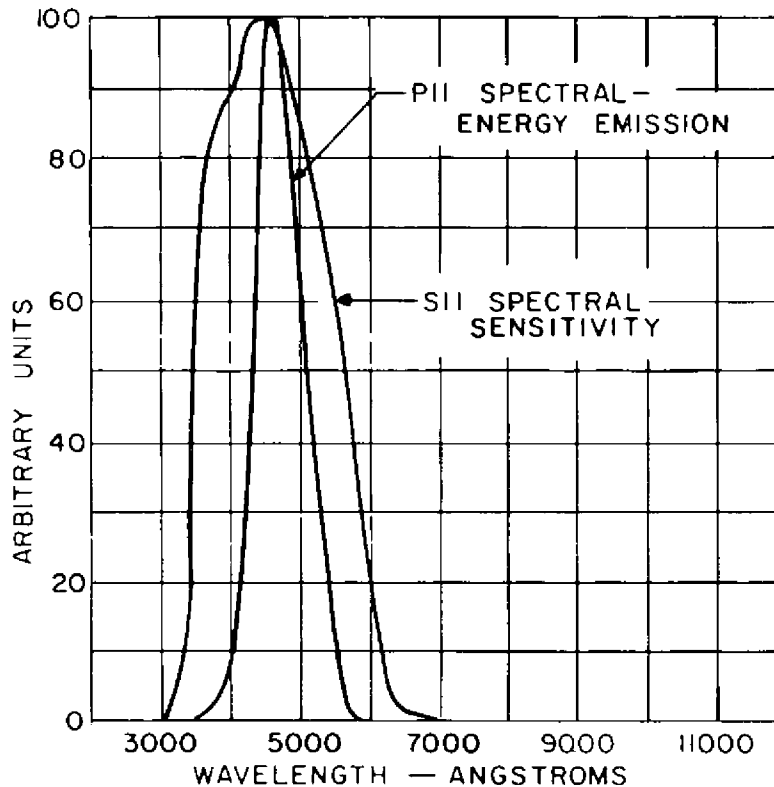
Resolution as a function of cathode radius



Screen efficiency as a function of anode voltage



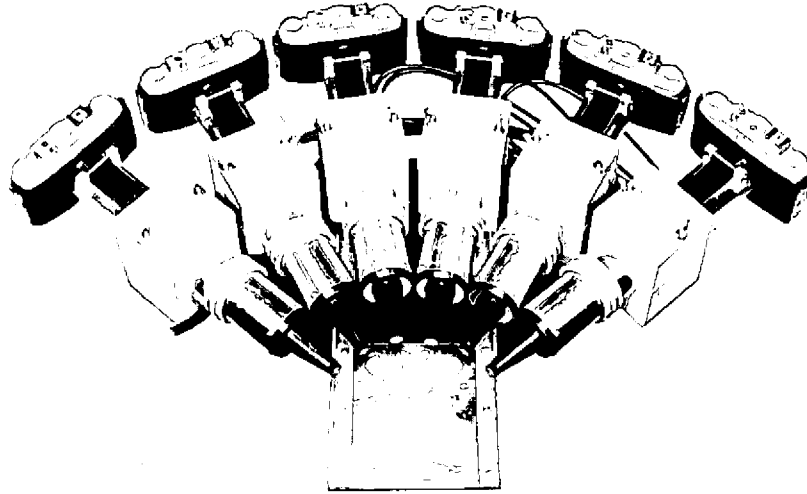
Spectral characteristics, S-11, P-11



TYPICAL APPLICATION

MICROSHUTTER CAMERA

FOR HIGH SPEED PHOTOGRAPHY



The ITT Microshutter Camera uses a pulse diode type image tube (ITT 7177 or ITT 6839) as an ultra-high speed photographic shutter. The Microshutter Camera records photographically high-speed events such as exploding wire, electric arcs, high-speed projectiles, and rotating high-speed objects. Such phenomenon may be "stopped" and captured on conventional film at speeds equal to the time required for light to travel 1 foot. The Microshutter Camera can be used single or in multiples up to 12 units with individual or time-sequenced electronic exposure systems. The exact exposure time, as short as 0.001 microsecond, may be set by the use of selected delay lines in the hydrogen-thyratron pulsing circuit. Thus it is possible to photo-

graph extremely short duration light flash phenomenon. The ITT 7177 or 6839 diode-type image converter tube used in the Microshutter Camera consists of a photocathode and a phosphor screen in opposite ends of a glass envelope with an intervening electrostatic lens. When a d-c voltage is applied between the cathode and the anode an image focused on the photocathode will appear on the phosphor screen. If the voltage applied is a pulse of short duration, only this "state" of the image at the instant of the pulse will transfer to the phosphor screen. The persistence of the phosphor will permit the "state" of the image to be photographed.

MICROSHUTTER CAMERA SPECIFICATIONS

Exposure time	10 ⁻⁹ second, minimum
Image tube	7177 or 6839
Photocathode	S-11
Phosphor	P-11

RESOLUTION

7177 Image tube	16 line pairs per mm on photocathode for center 1/4-inch diameter area on phosphor screen.
6839 Image tube	25 line pairs per mm on photocathode for center 5/8-inch diameter area on phosphor screen. Tapers to 10 line pairs per mm at periphery.

The Components and Instrumentation Laboratory developments range from basic research to pilot production, with contributions to the electronics industry over the years being varied and impressive. Other recent developments include the following:

Barrier grid storage tubes
Pulsed infrared storage tubes
Transparent phosphors
Infrared detectors
Stored nitrogen containers
AN/AAG-5 IR Search Set
AN/AAR-21 IR Search-Track Set

Direct view storage tubes
High current multipliers
Multialkali cathodes
Mosaic infrared cells
Switching tubes
Telephone line TV systems
Underwater TV systems
Advanced display systems

Image converter, 7177
Shutter tube, 6839
Coaxial phototubes
Cryostats
Flaw inspectors
Storage tube radar indicators
Storage tube IR indicators

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