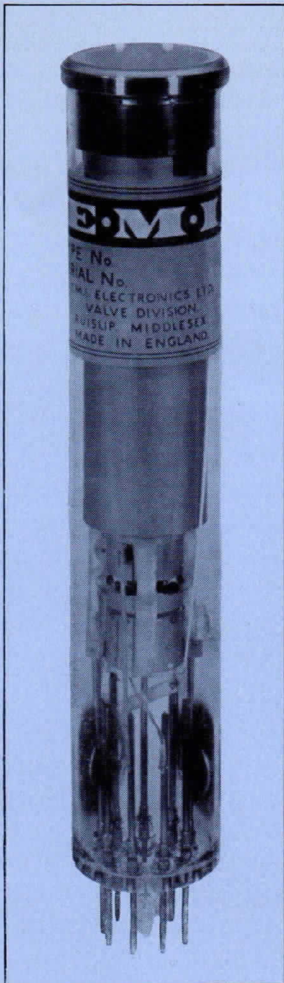
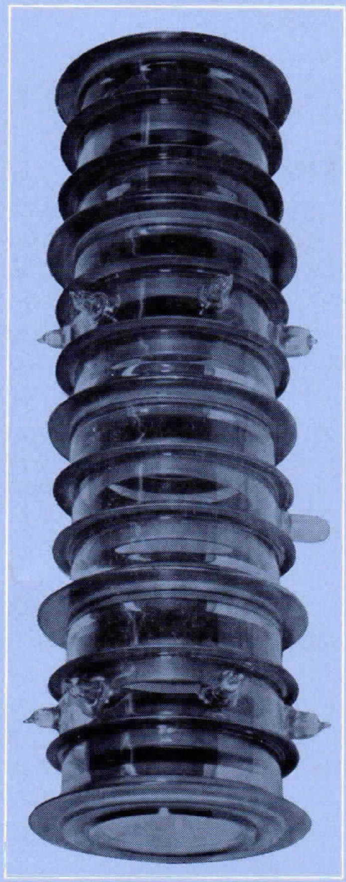
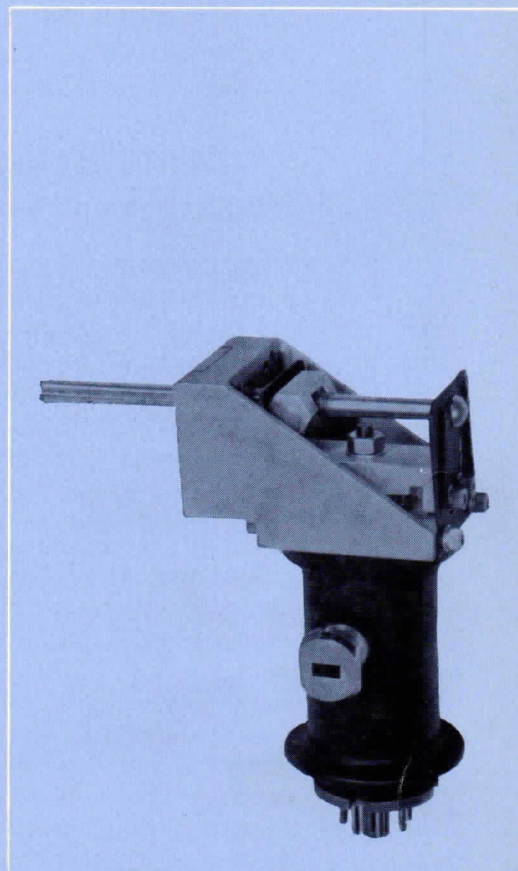
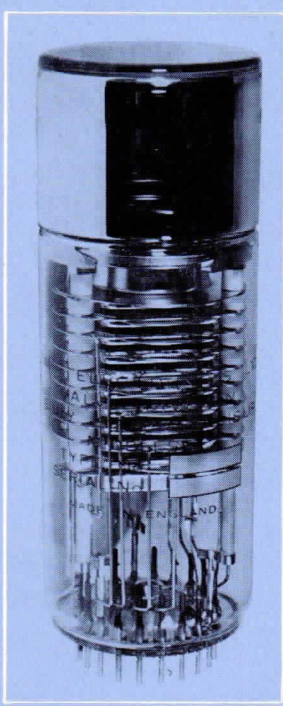
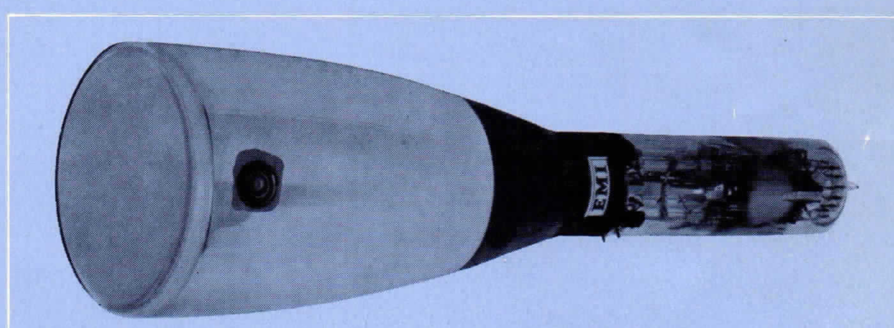
Special Valves and Tubes

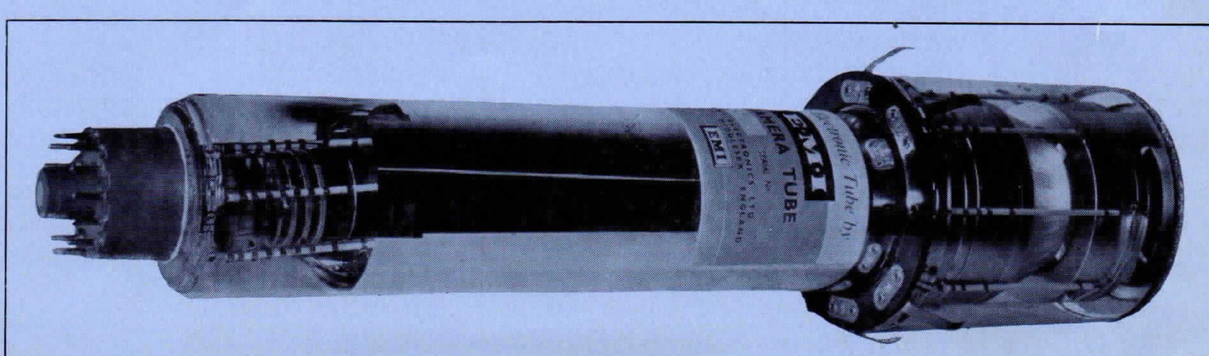












Valve Division, one of the most rapidly expanding divisions of EMI Electronics Ltd., manufactures a wide range of special valves and tubes for equipment used in broadcasting, radar, nuclear and scientific applications. Photomultiplier tubes, which convert very low levels of illumination into usable electric currents, are used extensively in astronomy, spectrophotometry, scintillation counting, γ-ray spectrometry and other applications. Tube diameters range from $\frac{1}{2}$ inch to 15 inches; spectral coverage is from 1200Å to 12000Å, while tube gains of up to 10^9 are available.

The range of EMI camera tubes includes the $4\frac{1}{2}$-inch Image Orthicon and High Resolution Vidicons, the latter also being available with ultra-violet and infra-red sensitivity.

The EMI range of Klystrons and Magnetrons covers a wide range of microwave frequencies with power outputs from milliwatts to several megawatts. These tubes are used extensively in radar and communications applications.

EMI Cathode Ray Tubes are available for a variety of applications, including radar and instrumentation, and with spot sizes down to less than 0.001 inches.

Other tubes include High Gain Multi-Stage Image Intensifiers, Barrier Grid Storage Tubes and the Electron Stick. Specialised components available include Honeycomb Grids, Fine Meshes and Ceramic Metal Seals. A small range of Photoconductive Cells is also produced.

Photomultiplier Tubes

The EMI range of photomultiplier tubes may be divided into four general groups:

Photometry and Spectrophotometry

For photometric applications a photomultiplier tube should have a good photosensitivity coupled with low dark current. The majority of EMI Photomultipliers satisfy these requirements and many types are available with quartz windows for operation in the ultra-violet region of the spectrum. Photocathodes are of the SbCsO (S11) type in general but some types have BiAgOCs (S10) or SbKNaCs (S20) cathodes. In many cases the standard S11 type is replaced by the S type cathode, specially processed for minimum thermionic emission. EMI tubes are widely used in commercial spectrometers, spectrophotometers and colorimeters, and by a great number of research workers in fields such as astronomy.

Scintillation Counting

Desirable features in the selection of a photomultiplier tube for scintillation counting are a good photo-cathode uniformity, high photosensitivity, good collection efficiency of electrons from the cathode into the first dynode and high first dynode gain. EMI tubes with S11 photocathodes are particularly suitable for this application, since a high blue sensitivity coupled with low dark current is available. Photomultiplier tubes used for tritium counting must have photocathodes giving low thermionic emission so that thermal electrons do not mask the effect of low energy particles. The specially processed S cathode gives about 100 times less thermionic emission than the conventional S11 cathode at room temperature and a range of tubes having this cathode is available for low energy counting applications.

Transducer Applications

A high sensitivity photomultiplier tube used with a short after-glow cathode ray tube in a flying spot scanner is an example of this type of application.

Other Applications

Infra-red sensitive and ruggedised tubes are available together with tubes for such special applications as particle detection and high temperature operation. Our extensive development programme includes work on small diameter and solar blind tubes suitable for satellite astronomy.

EMI Valve Division Engineers will be pleased to discuss individual requirements at any time.

Microwave Tubes

Magnetrons

Pulsed magnetrons suitable for civil and military radar are available in the 17 Gc/s and 35 Gc/s bands. Peak powers available range from some 40 kW to 80 kW, depending upon the frequency.

Plug-in Klystrons

The EMI range of plug-in klystrons includes both standard and rugged types suitable for numerous applications in radar and communications systems, production testing of microwave components and research work. Tubes covering a frequency range of 1 Gc/s to 20 Gc/s and a variety of external resonators, both tuneable and fixed frequency, are available. Outstanding features of these tubes are their relatively low replacement cost and the great flexibility in design which they afford.

High Frequency Klystrons

The EMI range of 2 kV integral-cavity reflex klystrons covers, in some twelve variants, the frequency bands 12.4 Gc/s to 40 Gc/s. Applications again are varied and include high-resolution radar systems and research into electron spin-resonance. Improvements to the cathode and internal insulation have made possible the introduction of 2.5 kV versions of these klystrons, giving a typical output power of 200 to 300 mW. These are in use as power sources for pumping parametric amplifiers.

A recent addition to the EMI range is the R9653 Reflex Klystron Oscillator, operating at 4 mm. This has a mechanical tuning range of 3 Gc/s to 5 Gc/s and is available at frequencies centred between 65 Gc/s and 85 Gc/s.

Klystrons for Microwave Links

This series of medium power transmitter klystrons has recently been enlarged to give comprehensive frequency coverage for the two communication bands 4.4 Gc/s to 4.8 Gc/s and 6.875 Gc/s to 7.8 Gc/s. Specially designed for frequency modulation, these 2 to 4 W tubes are ideal for television links where long life and reliability are of paramount importance.

Multi-Cavity Amplifier Klystrons

A special EMI factory also produces very high power multi-cavity klystron amplifiers for radar and accelerator applications in the S band. Tubes are available for long-pulse, high gain, wide-band systems with 3 to 10 MW peak power levels, or short pulse, narrow band accelerator systems with 10 to 15 MW peak power, and average power of 5 to 25 kW. Driver tubes, such as four-cavity, 150 kW peak power, 44 dB gain tubes are also available.

Camera Tubes

Image Orthicons

EMI 4½-inch image orthicons are available for studio operation and outside broadcasts under normal lighting conditions. The 9565 (JEDEC type 7389) has an average sensitivity of 25 foot lamberts at f8 for half a stop over the knee. The 9564 (JEDEC type 7295) has an average sensitivity of 25 foot lamberts at f11 for half a stop over the knee. Special features of the EMI image orthicons are absence of free running microphony and a very short decay time for mechanically excited microphony. Other features include freedom from low frequency noise, excellent signal to noise ratio and a high standard of background shading and sensitivity maintained throughout life.

Vidicons

A wide range of vidicons is available which includes a ½-inch tube in addition to the standard types.

The EMI 1-inch Vidicon type 9677 (JEDEC type 8566) has been designed for use in broadcast cameras, both studio and film pick-up, and in high definition industrial television equipment. This tube employs a separate mesh electrode structure which gives improved vertical and horizontal resolution, particularly in the corners. The tube may be operated at high beam current without loss of picture quality to handle large overload signals. Excellent signal uniformity is maintained over a wide range of target voltages. The target has high sensitivity and short lag and has a spectral characteristic without excessive red response which closely approaches that of the human eye.

The type 9677 has a low wattage heater (90mA) so that it is ideally suited for operation in transistorised cameras. Its high blue sensitivity and absence of picture rotation with variation of focus voltage make the tube ideal for multi-tube colour cameras.

Type 9677 is also available with a special target layer and a quartz window (for operation down to 2,300Å for ultra-violet microscopy applications) and with an infra-red sensitive target. Standard targets are also available with a fibre optic window or with a quartz window for operation in high nuclear radiation fields.

The type 9730 is a short 1-inch vidicon electrically similar to the 9677 with identical spectral response. It is a rugged tube developed and produced to a high specification for shock and vibration. The mesh is brought out to a separate ring adjacent to the target connection, with an overall length of 5¼ inches.

The type 9728 has medium wattage heater (300mA) and is identical to the 9677 in all other characteristics. This tube type is most suitable for continental cameras.

The ½-inch Vidicon type 9697 also employs a separate mesh and is capable of the same resolution as the non-separate mesh 1-inch vidicon.

The earlier tube type 10667 with a 0.6A heater and non-separate mesh structure is now out of production and only available for replacement use in older cameras.

Cathode Ray Tubes

Instrument tubes
EMI Oscilloscope tubes of advanced design are in development or production with 3-inch and 5-inch diameter faceplates. These tubes are notable for their high deflection sensitivity and low inter-electrode capacitances, making them well suited to operation over wide bandwidths.

Radar display tubes
Magnetically deflected cathode ray tubes are available in a considerable variety with medium and long afterglow phosphor characteristics. These range in size from the giant 21-inch diameter metal-coned tube CV2388 downwards. Such EMI tubes are in operation in both civil and military radar systems throughout the world. Of particular interest are the specialised projection tubes such as type CV6101, and the range of high resolution tubes for radar recording.

Tubes for special applications
EMI activities in pioneering electronic television and other advanced systems have generated demands for cathode ray tubes of unusual design and unique application. Those in the EMI range include cathode ray tubes designed for television film-scanning, character scanning, photographic recording, electronic printing and projection systems, and head-up displays.

Other products

The Barrier Grid Storage Tube is a device in which signals may be stored for several hours and finds application in data processing, frequency conversion, the storage of digital and analogue information and the integration of repetitive signals in the presence of excessive noise.

The EMI 4-Stage Image Intensifier is a cascade device of the phosphor/photocathode sandwich type giving a blue light gain of about 10^5 at 35 kV and a version is available capable of being switched in 1 μsec.

As by-products of special tube manufacture, various components can be made available; High Transmission Fine Pitch Metal Mesh is available in 3 × 3 inch squares having from 200 to 2,000 cells per linear inch. These meshes can be used in electron microscopy or for very fine sieves, and also as components in electron optical systems.

Honeycomb Grids are available in a range of sizes and can be supplied in lengths up to 2cm when they may be used as collimators.

Of considerable value in the field of technical education is the Electron Stick, a system of building sophisticated beam-employing electronic tubes from simple component parts. From the complete kit may be constructed a travelling wave tube, a two-cavity klystron amplifier and an Adler tube, and many other experiments and demonstrations may be devised.

Ceramic Metal Seals of widely varying types can be produced to meet special requirements, and a range of standard types is also available.

A small range of Cadmium Sulphide temperature stabilised photoconductive cells is produced together with some Cadmium Selenide types. EMI welcome enquiries concerning special applications involving these types of cells.

EMI

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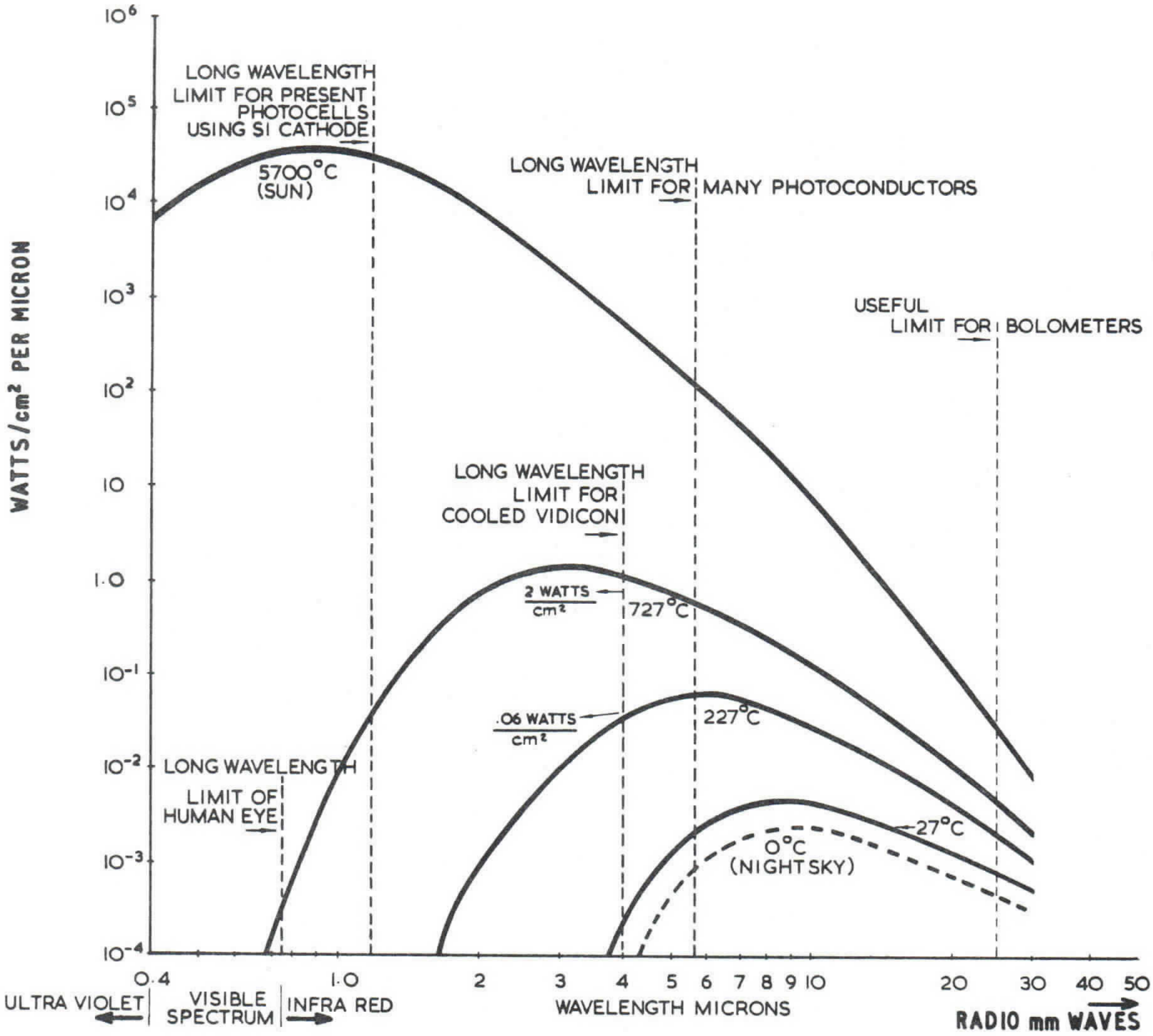
PHOTOMULTIPLIER TUBES

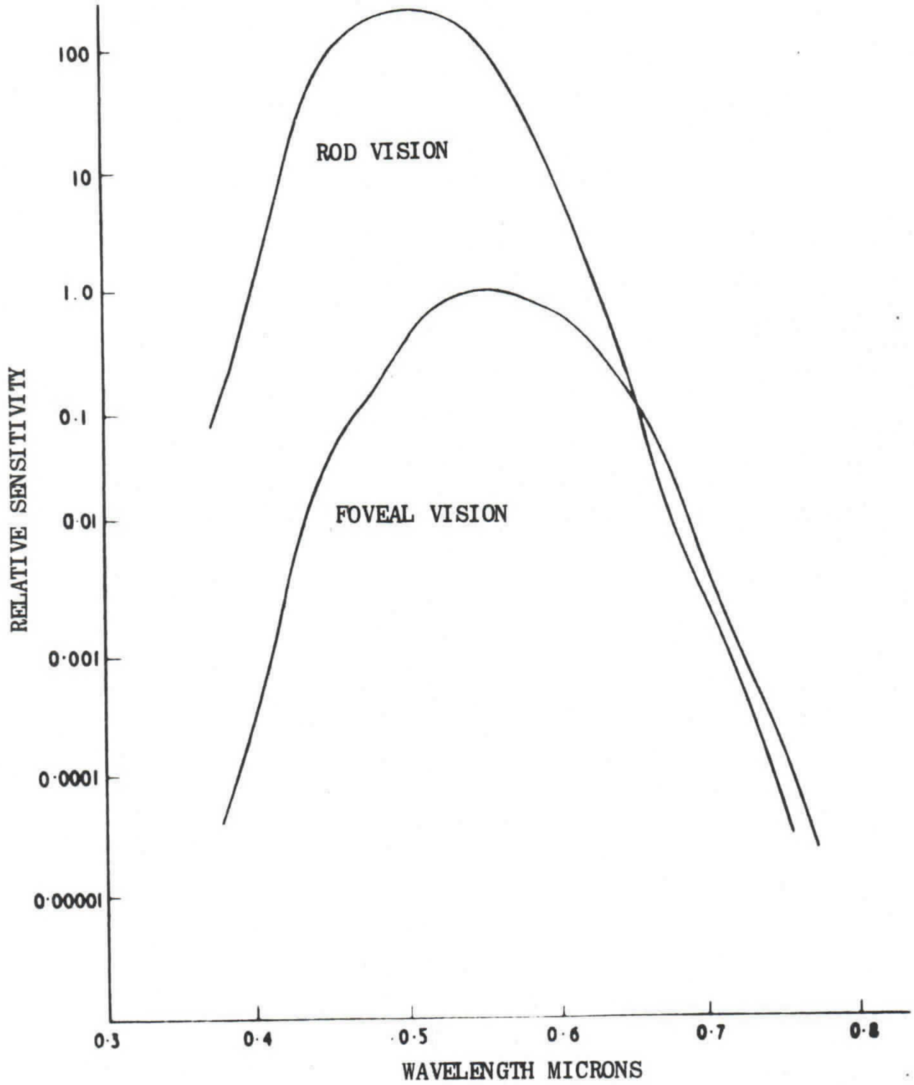
VALVE DIVISION

SPECTRAL DISTRIBUTION OF POWER EMITTED FROM BLACK BODIES AT VARIOUS TEMPERATURES



P013/1b
DS. 105/1

VARIATION OF EYE SENSITIVITY vs WAVELENGTH
(AVERAGE OF MANY OBSERVERS) FOR FOVEAL AND ROD VISION



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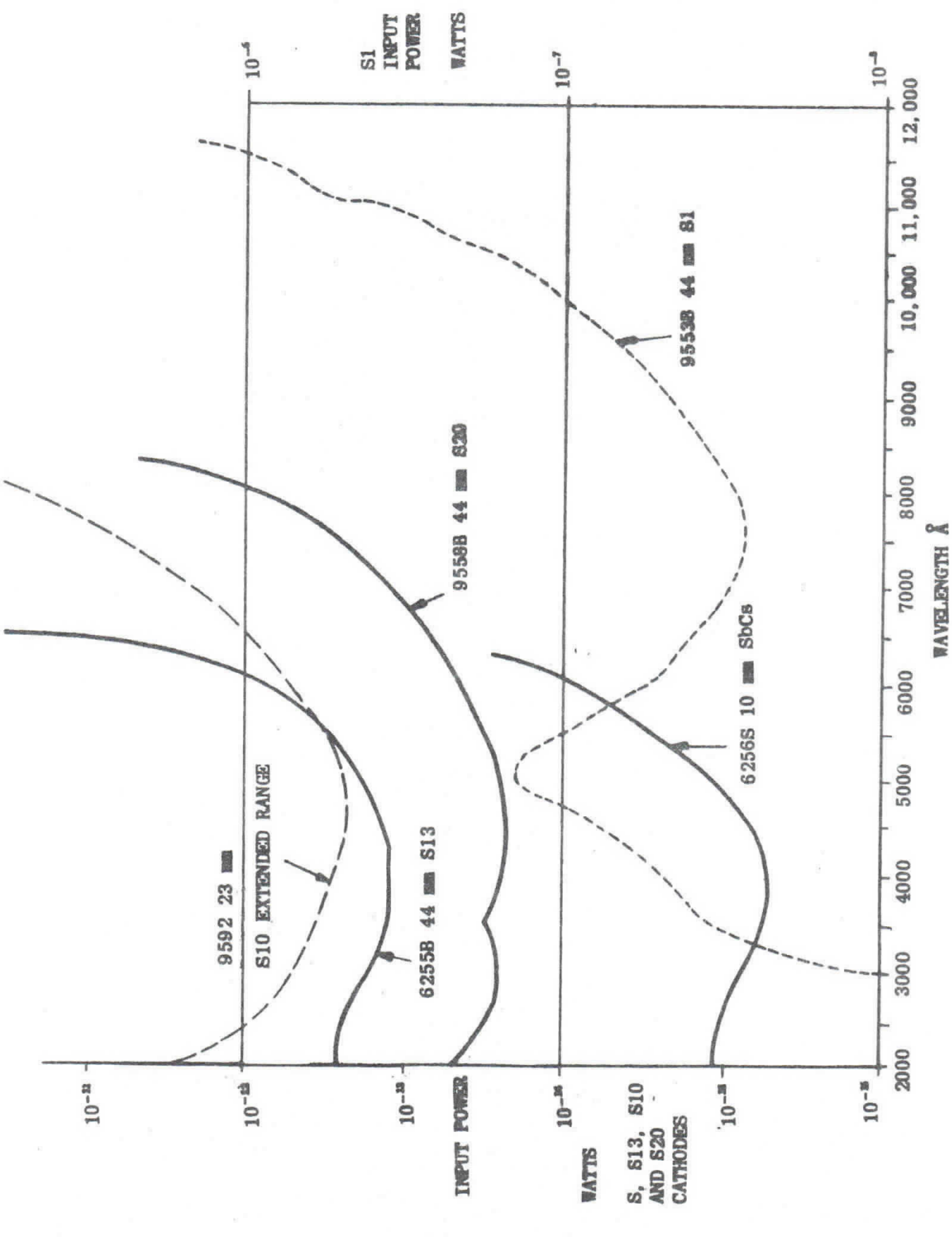
DARK CURRENT CHARACTERISTICS AS A FUNCTION OF INPUT POWER AT A SPECIFIED WAVELENGTH TO GIVE OBSERVED DARK CURRENT



P014/1a
DS. 106

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EQUIVALENT NOISE IN PHOTOMULTIPLIERS

Table 1 (below) gives typical values of cathode dark current at various wavelengths for representative Photomultiplier tubes.

The noise current measured over a bandwidth Δf for a cathode current i amp. is equal to $(2ei\Delta f)^{1/2}$ (e is charge on electron = 1.6×10^{-19} coulomb). If the power to give i amp. at wavelengths λ is $P\lambda$ watt, then the noise power to give $(2ei\Delta f)^{1/2}$ amp is $n_p = \frac{P\lambda\ (2ei\Delta f)^{1/2}}{i} = P\lambda \left(\frac{2e\Delta f}{i}\right)^{1/2}$ watt. At the anode, this will be increased by the statistics of secondary emission at the first dynode of stage gain $g_1\ \delta_1$ and succeeding dynodes of average gain $g\delta$, by a factor $a = F^{-1/2}\left(1 + \frac{1}{g_1\ \delta_1} + \frac{1}{g_1\ \delta_1\ (g\delta - 1)}\right)^{1/2}$. (F is collection efficiency of electrons into first dynode).

TABLE 1

	Type	Cathode (Type/Size)	Cathode Dark current amp (23°)	Wavelength (μ) 0.2	0.25	0.3	0.35	0.4
				Power in pW (10^{-12} watt)				
⌿	6256S	10 mm SbCs	2.5×10^{-17}	0.001	0.001	0.0007	0.0006	0.0006
Ø	9592B	23 mm BiAgOCs	4×10^{-15}	2.5	0.8	0.5	0.35	0.25
⌿	6255B	44 mm SbCsO	6×10^{-15}	0.25	0.24	0.17	0.13	0.12
⌿	9558Q	44 mm SbNaKCs	1.5×10^{-15}	0.046	0.03	0.027	0.03	0.026
				Power in μW (10^{-6} watt)				
*	9553B	44 mm AgO-Cs	10^{-10}				0.035	0.05

	Type	Cathode (Type/Size)	Cathode Dark current amp (23°)	Wavelength (μ) 0.5	0.6	0.7	0.8	1.0	1.1
				Power in pW (10^{-12} watt)					
⌿	6256S	10 mm SbCs	2.5×10^{-17}	0.001	0.01				
Ø	9592B	23 mm BiAgOCs	4×10^{-15}	0.25	0.63	2.5	2.5		
⌿	6255B	44 mm SbCsO	6×10^{-15}	0.2	0.9	1.00			
⌿	9558Q	44 mm SbNaKCs	1.5×10^{-15}	0.028	0.047	0.1	0.75		
				Power in μW (10^{-6} watt)					
*	9553B	44 mm AgO-Cs	10^{-10}	0.15	0.05	0.03	0.03	0.1	0.4

⌿ Fused quartz windows Ø U.V. transmitting glass window * Glass window

P020/1b
DS. 244/1

Table 2 gives typical values for 50 mm diameter venetian blind dynode tubes. For box and grid dynode tubes, such as types 9524 and 9592, the value of 'a' with C to D_1 voltage around 100 V will be 1.15. Adequate values of C to D_1 voltage must be used to minimise 'a'.

To express the anode dark current noise in terms of equivalent input lumens, we have $n_L = a.\frac{(2ei\Delta f)^{1/2}}{p \times 10^{-6}}$ where p is the photosensitivity in μA/lm.

TABLE 2

F	$g_1\ \delta_1$	$g\delta$	a	C to D_1 voltage
0.90	6	4	1.16	200 V
0.85	4	4	1.29	100 V
0.80	3	3	1.36	75 V

Table 3 gives values of n_p at $\lambda = 0.4\ \mu$, and n_L for tubes listed in Table 1, for $\Delta f = 1$ c.p.s., taking a = 1.15.

TABLE 3

Type	Cathode type/size		i amp	P μA/lm	n_p watt	n_L lm
6256S	10 mm SbCs	'S'	2.5×10^{-17}	50	2.5×10^{-17}	6.5×10^{-14}
9592B	23 mm BiAgOCs	S-10	4×10^{-15}	35	3×10^{-15}	1.2×10^{-12}
6255B	44 mm SbCsO	S-13	6×10^{-15}	70	10^{-15}	7×10^{-13}
9558Q	44 mm SbNaKCs	S-20	1.5×10^{-15}	150	4×10^{-15}	1.6×10^{-13}
9553B	44 mm AgO-Cs	S-1	10^{-10}	20	3×10^{-12}	3×10^{-10}

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NOISE IN PHOTOMULTIPLIER TUBES
A SAMPLE CALCULATION

The contribution to noise in the output current of a Photomultiplier tube due to dark current is very small, except in cases when very low light levels are being measured.

In most cases, the noise fluctuations arise from the statistical nature of the interaction of light quanta in the photocathode. The emission of photoelectrons is a random process, in which each event is independent of any other event and so for an average rate of emission of photoelectrons of N per second (N being a large number), the number actually observed during a time t will vary with a standard deviation of $(Nt)^{\frac{1}{2}}$ about an average of Nt electrons. The cathode current will be multiplied by the tube dynode system, of gain G, to give an anode current of Ne.G amperes (e = charge on electron, = 1.6×10^{-19} coulombs). The charge collected in time t will be $Nt.eG$ coulombs and the statistical fluctuation on this will have a standard deviation of $a(Nt)^{\frac{1}{2}}eG$ coulombs where "a" is an enhancement factor due to the statistical fluctuation of secondary emission at the first dynode and may be about 1.15.

The rms noise current at the anode, due to the statistical fluctuation in the sampling time t is then

$$\frac{a(Nt)^{\frac{1}{2}}eG}{t} \text{ amperes} = a(N)^{\frac{1}{2}}t^{-\frac{1}{2}}eG = a(NeG)^{\frac{1}{2}}e^{\frac{1}{2}}G^{\frac{1}{2}}t^{-\frac{1}{2}} = a(i_A eG/t)^{\frac{1}{2}}$$

If the sampling time t is due to an amplifier with a bandwidth Δf,

$$t = \frac{1}{2\Delta f} \text{ and } i_{noise} = i_n = a(2ei_A\Delta f)^{\frac{1}{2}}G^{\frac{1}{2}} \text{ or } a(2ei_c\Delta f)^{\frac{1}{2}}G$$

(i_c is cathode current)

For a tube with a gain of 10^7, anode current of 20 μA and a typical value of a of 1.15,

$$i_n = 1.15\,(2\text{x}\ 1.6 \times 10^{-19} \times 20 \times 10^{-6} \times 10^7)^{\frac{1}{2}}(\Delta f)^{\frac{1}{2}} \sim 10^{-8}\,\Delta f^{\frac{1}{2}} \text{ amperes.}$$

With an anode load of 150,000 ohms, the peak to peak noise voltage will be

$$\sim 6 \times i_n \times 1.5 \times 10^5 = 9 \times 10^{-3}\,\Delta f^{\frac{1}{2}}$$

If the output from the tube is fed into an oscilloscope amplifier, of input capacitance C, which may be typically 50×10^{-12} F, the time constant RC, at the tube anode, is $1.5 \times 10^5 \times C = 7.5 \times 10^{-6}$ seconds. This is compatible with an oscilloscope bandwidth Δf of 10^5 cps, so that the peak to peak noise voltage observed on the oscilloscope will be:

$$\Delta V_n = 9 \times 10^{-3}\,(10^5)^{\frac{1}{2}} \sim 3 \text{ V}$$

For a bandwidth of 10^4 cps $\Delta V_n \sim 0.9$ V

For a bandwidth of 10^3 cps $\Delta V_n \sim 0.3$ V

P154/1b
DS.564

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EMI SCINTILLATION COUNTERS - PHOSPHORS

The table below gives information on various phosphors. The value of W is the energy abstracted from a particle of minimum ionisation energy loss (e.g. 2 MeV electrons) to give a photoelectron from an S11 photocathode of 70 μA/lm sensitivity, with close optical coupling. (A subsidiary column (W′) gives the value of W for 5 MeV α particles). The values of τ_1 and τ_1' are the decay time constant (assumed exponential). The slow components τ_1' of the organic phosphors is of greater intensity with heavy particles (e.g. protons) than with electrons. (F.D.Brooks, Nucl. Inst. & Methods, 4, 1959, p.151, R.B. Owen, I.R.E.Trans, Nucl.Sci. NS5, No.3., 1958, p.198.).

Phosphor	W	W′	τ_1	τ_1'
	eV/photoelectron			
	Electron	α particle	ns	ns
NaI - Tl	250	400	250	—
CsI - Tl	500-1000	800-1600	1200	—
ZnS - Ag	—	250	3000 (t^{-n} low)	—
Ce Activated Glass (LiMgAl Silicate)	2500	—	—	—
Anthracene	500	5000	33	370
Stilbene	1200	15000	62	370
Plastic (Polyvinyl Toluene and Terphenyl +2-5 diphenyloxazole)	1500	—	5	—
Liquid (Toluene + 4g/l p-terphenyl + 0.04 g/l POPOP)	1500	—	< 28	200
Xe (Quartz window PM tube)	—	1000 gas (350 solid)	1000	—

EMI SCINTILLATION COUNTERS - PHOSPHORS (continued)

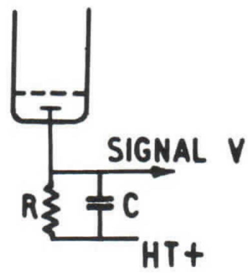
A scintillation counter gives an output charge $Q_o = Gn_o e$, where G is tube gain, e is electron charge, (1.6×10^{-19} coulombs) and $n_o = E/W$. The use of an output time constant RC too short compared with τ_1 gives a reduction in output voltage and may cause an appreciable worsening of energy resolution from Δ to $F\Delta$, where F is given in the curve below.

Output time constant = RC
Phosphor decay constant = τ_1

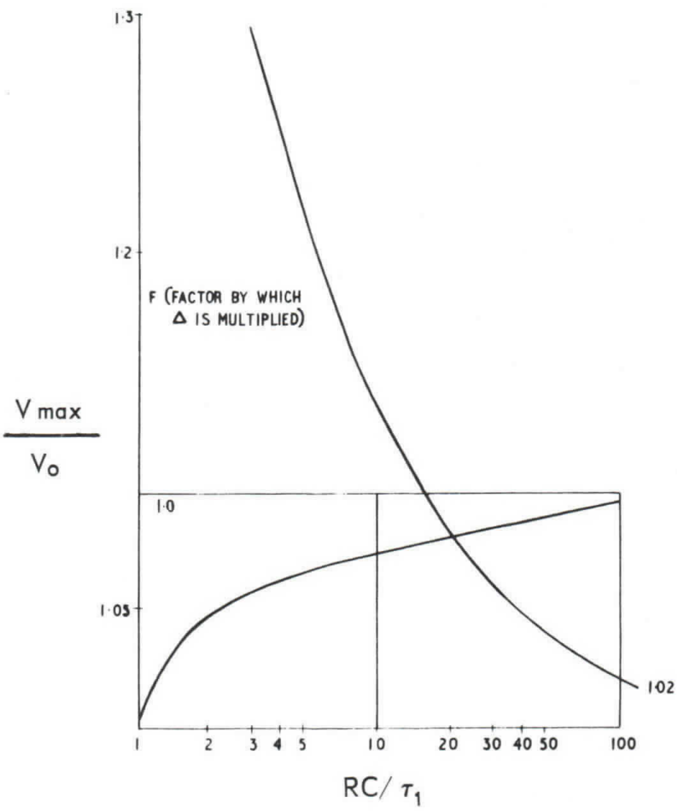
$$V_o = \frac{Q_o}{C} \left\{ \frac{RC}{\tau_1} \to \infty,\ t \to \infty \right\}$$

Anode current (at time t) = $\frac{Q_o}{\tau_1} e^{-t/\tau_1}$

Signal voltage (at time t) = $\frac{Q_o}{C} \frac{RC}{\tau_1 - RC} \left\{ e^{-t/\tau_1} - e^{-t/RC} \right\}$



V max. is at t max. $= \frac{\tau_1 RC}{\tau_1 - RC} \log_e (\tau_1/RC)$



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P024/2b
DS.295/2

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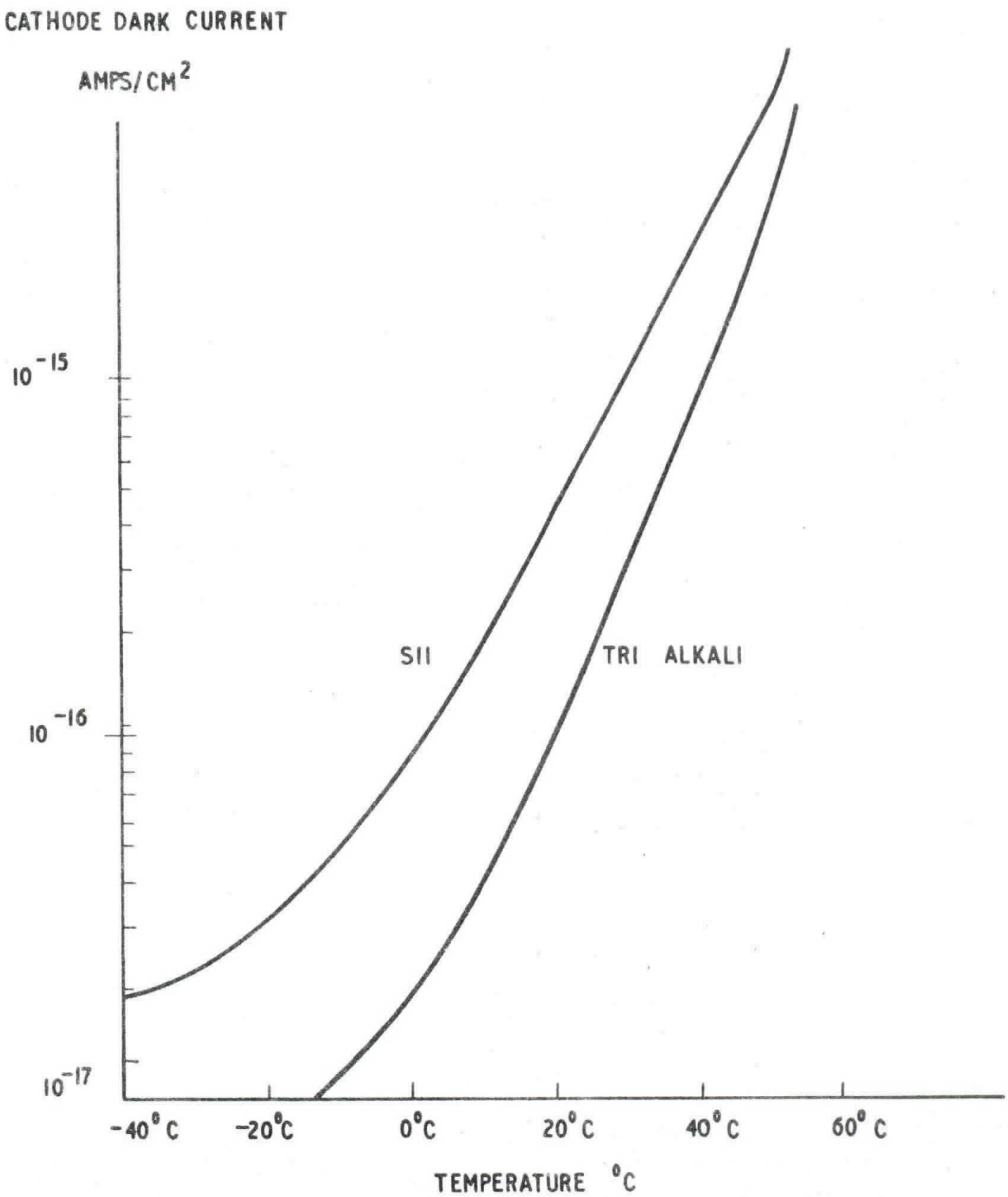
TYPICAL CURVES OF VARIATION OF THERMIONIC EMISSION
WITH TEMPERATURE



P027/1b
DS. 217

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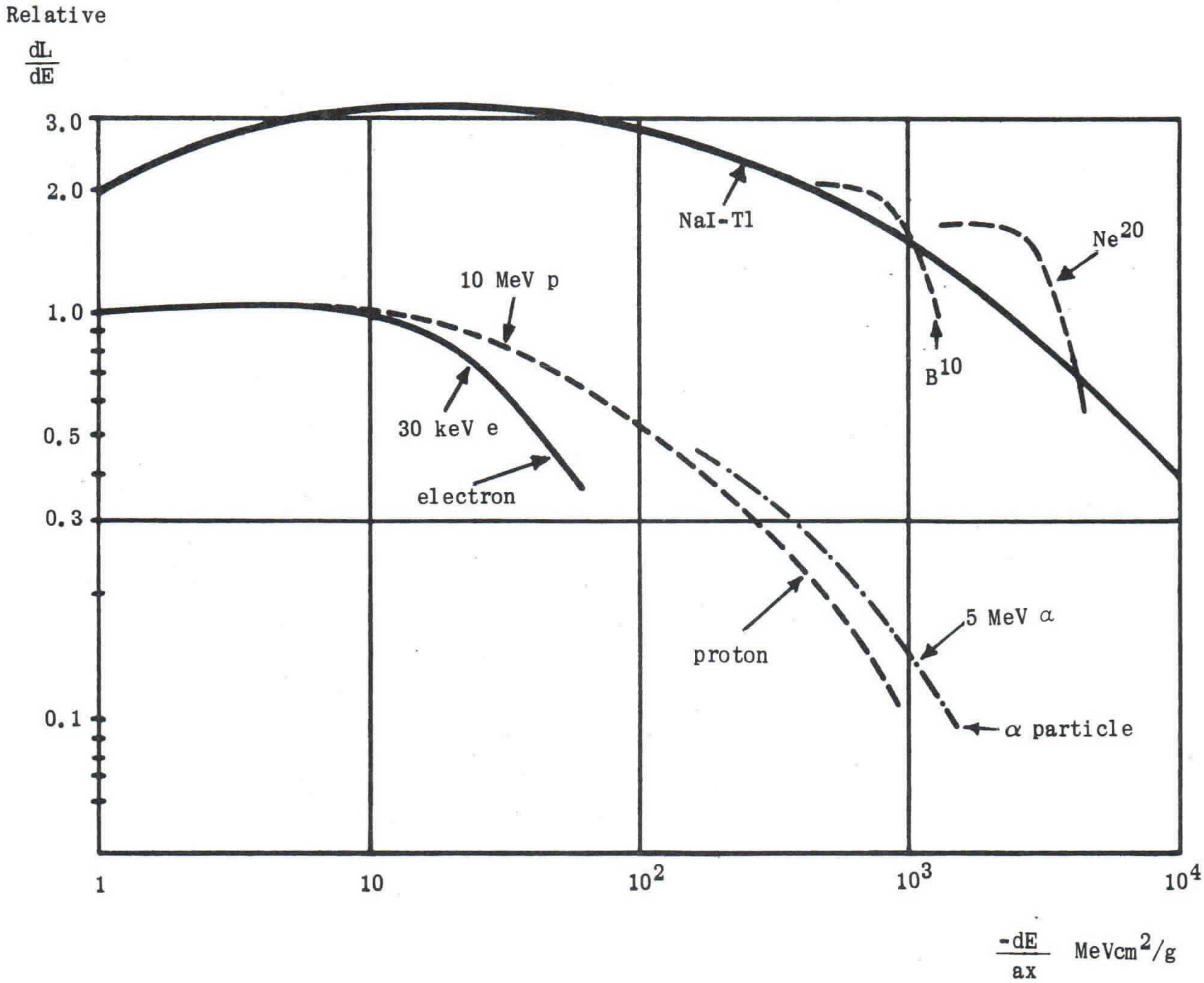
SCINTILLATION EFFICIENCY vs RATE OF ENERGY LOSS for NaI-Tl and ANTHRACENE



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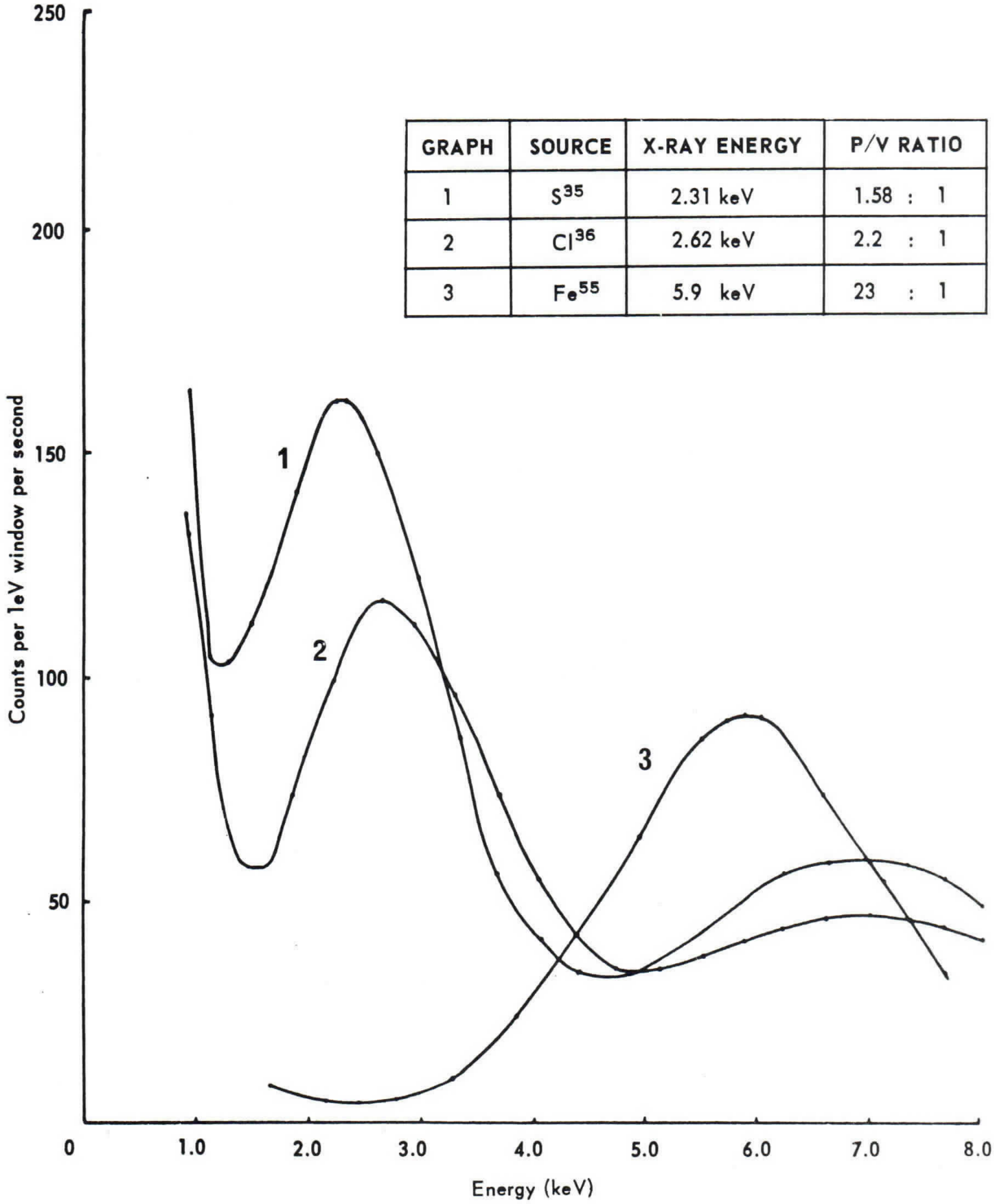
RESOLUTION CURVES FOR PHOTOMULTIPLIERS OF TYPE 9656 COUPLED TO HARSHAW NaI-Tl CRYSTALS

GRAPH	SOURCE	X-RAY ENERGY	P/V RATIO
1	S^{35}	2.31 keV	1.58 : 1
2	Cl^{36}	2.62 keV	2.2 : 1
3	Fe^{55}	5.9 keV	23 : 1



P043
DS.778

The Company reserves the right to modify the designs and specifications without notice

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Sr^{90} BETA PARTICLES IN NE 102 PHOSPHOR COUPLED TO EMI 9524B PHOTOMULTIPLIER TUBE

By J. Sharpe, B.Sc.,M.I.E.E. 10th July, 1964.

100 μc source gives 3.7×10^6 dps.

By collimation a beam of 2×10^4 betas per second is obtained.

After traversing material which absorbs 50%, 10^4 β/s reach a thin (½ mm) disc of NE 102 plastic phosphor. The Y^{90} 2.26 MeV (max.) betas reaching the plastic phosphor will have passed through an absorber of surface density about $\frac{1.12}{7}$ = 0.16 g/cm^2 which will have absorbed an energy of about 160 keV from the high energy betas and completely absorbed electrons of energy 0.4 MeV and below. Beta particles reaching the phosphor will thus have energies from 2 MeV down to zero, probably with a large number around 0.2 MeV.

The high energy particles will dissipate between 0.1 and 0.2 MeV/mm of phosphor and the lower energy particles more than this down to a limit of 0.1 MeV, falling off to zero. The signals available to the Photomultiplier tube may thus be considered as providing a rough plateau around 0.1 MeV mm, or 0.05 MeV per 0.5 mm. NE 102, coupled closely to a 9524 of photosensitivity around 60 μA/lm, will give a photoelectron signal of $\frac{50}{1.6} \sim 30$ electrons per 50 keV of beta energy dissipated.

The continuous current will thus be:

$30 \times 1.6 \times 10^{-19} \times 10^4 \sim 5 \times 10^{-14}$ A for 10^4 particles/s in the phosphor.

Operating a 9524 at a typical overall sensitivity of $\sim$ 200 A/lm, corresponding to the voltage on the ticket supplied with each tube (typically 1100 to 1200 V), gives a gain of approximately 4×10^6 and an anode current of $4 \times 10^6 \times 5 \times 10^{-14} = 0.2$ μA. The time-spread of the 9524 corresponds to a standard deviation $\tau 2$, of 10 ns. The decay time of the phosphor $\tau 1$, is ca. 3 ns so that 30 electrons are presented at the photocathode in a time short with $\tau 2$. The peak current per scintillation is then:

$$\frac{30 \times 1.6 \times 10^{-19}}{(2\pi)^{½}} \quad \frac{4 \times 10^6}{10 \times 10^{-9}} = 0.8 \text{ mA}$$

and in an anode load giving a time constant of 1 μs (to avoid pile up with count rate of 10^4) with stray capacities of 50 pF (i.e. $\frac{10^{-6}}{50 \times 10^{-12}} = 20$ kΩ) the output voltage will be $\sim$ 15 V peak. For higher stray capacities, the anode load must be lower.

P132/1a
DS. 562/1

A standard dynode chain giving 100 V between cathode and D1 and with a uniform voltage distribution down to D10, and twice this voltage between D10 and D11, and D11 and anode, will be satisfactory; the dynode chain current should be more than 20 x 0.2 μA, and 100 μA will be satisfactory, giving a total resistance of $\sim$ 12 MΩ. A suitable resistor chain would be:

Cathode to D1	1 MΩ	D9 to D10	850 kΩ
D1 to D2	850 kΩ	D10 to D11	1.7 kΩ
D2 to D3	850 kΩ	D11 to HT +	1.7 MΩ

Decoupling capacitors of 1000 pF should be connected across the last three stages.

Photomultiplier tube sensitivity to magnetic fields is shown in the short form catalogue.

Data on stability is also given in the catalogue.

Temperature coefficient of gain is ca. -0.5%/C^0

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WIDE RANGE GAMMA RAY DOSIMETER

APPLICATION NOTE

The requirement often arises for a γ and X-ray detector capable of dealing both with continuous radiation and with pulsed radiation. In the latter case, very high peak values of dose rate may occur even when the average dose rate is around 1 mr/h. For instance, with a pulsed generator giving a 100 μs pulse every 40 seconds, 1 mr/h average corresponds to a peak level of 400 r/h and 20 mr/h average corresponds to a peak level of 8000 r/h. Admittedly, this is an extreme case, but it will be seen that there could be an application for an instrument measuring from less than 0.2 mr/h average to 8000 r/h (peak), a peak intensity range of 4 x 10^7.

A plastic scintillator (NE102) 2.5 cm thick by 4.5 cm diameter in an aluminium light shield, 0.8 mm thick, gives a sensitivity falling at 50 keV γ ray energy to half that given at 661 keV.

Used with the dynode chain specified below, 6097B and 6097S Photomultiplier tubes, coupled to this scintillator could be adjusted to give a desirable sensitivity of 2.78 x 10^{-9} A of anode current per mr/h, with reasonable linearity up to peak intensities of several thousand r/h (2.78 nA/mr/h charges a 10 μF capacitor to 1V/mr). Table 1 shows the results on a few tubes type 6097B and one 6097S, from which it will be seen that the dark currents from the tubes gave equivalent dose rates of less than 0.06 mr/h and the use of an 'S' tube gives around 0.01 mr/h equivalent, which is about the same as the natural background in the laboratory where the measurements were made.

TABLE I

Type	S/No.	Photo-sens'y µA/lm	Overall * volts for 200 A/lm V1	Dark current at 200 A/lm	Sens'y at mr/h	Voltage ** at V2	Dark current background mr/h	Calculated dk. current nA ***
6097B	15531	80	1560	2 nA	2.78	1475 V	0.050	0.018
6097B	15573	60	1610	2 nA	2.78	-	0.061	0.022
6097B	15776	55	1450	1 nA	2.78	-	0.058	0.020
6097S	23006	58	1390	0.2 nA	2.78	-	0.0094	0.004

* Uniform dynode chain, 150 V cathode to D1

** Dynode chain as indicated in Table 2

*** From these dark current figures the tubes are operating at an overall sensitivity of about 3 A/lm.

TABLE 2

Dynode stage		Cathode to D1	D1 to D2 to D4 to D5	D5 to D6	D6 to D7	D7 to D8	D8 to D9	D9 to D10 (1)	D10 to D11 (2)	D11 to HT +
Resistor kΩ		470	100	100	120	180	270	Typical 1000	Typical 1300	680
Decoupling capacitor	μF	-	-	0.022	0.047	0.1	0.22	0.47	0.5	2.0
	working V	-	-	400	400	400	400	600	1000	400

Notes:

(1) Adjust D9 to D10 voltage to 310 ± 10 V

(2) Adjust D10 to D11 voltage to 395 ± 15 V, 0.5 μF capacitor between D10 and HT+

(3) Anode may be most conveniently operated at earth potential, i.e. Cathode ca. -1500 V with regard to earth. Care must be taken to avoid touching tube envelope with material not at cathode potential. Phosphor in contact with tube window is in order but aluminium light shield should not touch tube. Magnetic shielding is desirable. If magnetic shield is wrapped around tube envelope it must be insulated from earth and connected to cathode potential to avoid irregular operation with high dark current.

A suitable operating voltage with the above dynode chain is

$$V_2 = [1070 + (V_1 - 1070) \times 0.85]\ V$$

Under these conditions, tests with a 4 μs pulsed X-ray source showed acceptable linearity up to peak dose rates of 8000 r/h, but a fall off at 11,000 r/h.

From the gain figure in Table 1, of 3 A/lm, it may be inferred that for a monitor operating with purely continuous background of γ rays or X-rays a dynode chain giving 100 V cathode to D1 and uniform thereafter could be used with an overall voltage of about 800 V.

The anode current may be measured with an electrometer when the γ ray flux is essentially uniform with time to obtain a direct reading of dose rate.

Where pulsed conditions apply, the anode current should be allowed to charge up a 10 μF capacitor through a subsidiary integrating circuit consisting of a high quality 0.5 μF capacitor in series with a 220 Ω resistor. The integrating capacitor P.D. may be observed by a high impedance tube voltmeter or a feed-back operational amplifier and recorded on a suitable chart. A high insulation relay may be used for resetting the capacitor when full scale.

Acknowledgement

This application note is based on report MATT 193 from Princeton University, New Jersey, U.S.A., by Herman L. Miller, entitled 'Integrating Multipoint Remote Area Safety Monitor'.

P153/2c
DS.563/2

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VALVE DIVISION

EMI 9524B PHOTOMULTIPLIER TUBE USED IN SCINTILLATION COUNTER FOR I^{131}

By J. Sharpe, B.Sc., M.I.E.E. 21st July, 1964.

Requirement is to use the EMI 9524B with a 1 inch sodium iodide crystal to count microcurie quantities of I^{131} in conjunction with a single channel pulse-height analyser accepting only the photopeak.

I^{131} has a half life of 8.04 days and emits 80 0,36 MeV γ rays per 100 disintegrations and the 0.36 MeV γ ray is that normally used for tracer work. (9% γ is 0.64 MeV and 3% 0.72 MeV).

For a typical one inch NaI-Tl crystal, the energy deposited per 0.36 MeV γ ray scattered will be about 0.2 MeV γ (allowing 30% photo-peak efficiency and mean Compton energy of 0.7 x 0.66 x 0.2 MeV). A one inch crystal at 5 cm from a point source of 1 μc of I^{131} will receive $\frac{3.7 \times 10^4 \times 0.8}{63}$ γ rays and absorb roughly 50% giving a total count rate of 470 counts per second, of which roughly 140 counts per second would be in the photopeak.

The average energy deposition per second would be 0.2 x 470 = 235 MeV/s and with 0.3 KeV per photoelectron from NaI-Tl coupled to a 9524B, we have a cathode current of

$$\frac{235 \times 10^3}{0.3} \times 1.6 \times 10^{-19} \text{ A} = 1.25 \times 10^{-13} \text{ A.}$$

Other events will increase this and for calculation of dynode chain we may assume a cathode current of 2×10^{-13} A/μc at 5 cm. A photopeak pulse of 0.36 MeV will give

$$\frac{0.36 \times 10^3}{0.3} = 1200 \text{ electrons}$$

in an exponential decay of 1/3 μs time constant, giving a peak cathode current of

$$\frac{1200 \times 1.6 \times 10^{-19}}{0.33 \times 10^{-6}} = 6 \times 10^{-10} \text{ A.}$$

The peak anode current for a tube used with a gain of 4×10^6 would be 2.4×10^{-3} A, so that 3 mA peak must be drawn without running into trouble with space charge. A gain of approximately 4×10^6 is obtained using the 'ticket' voltage for 200 A/lm, at an overall voltage of 1100 to 1200 V.

A dynode chain giving 100 V between Cathode and D1 and 200 V between D10 and D11 and D11 and Anode will be satisfactory and since the mean current will be $1.25 \times 10^{-13} \times 4 \times 10^6 \sim 0.6$ μA per μc at 5 cm due to the 0.36 MeV γ's, or say 1 μA for all events, a dynode chain current 100 μA will be more than satisfactory, so that a total resistance of ca. 12 megohms is indicated, made up as shown:

Cathode to D1	1MΩ	D9 to D10	1.2 MΩ }	Decouple these stages
D1 to D2	800 kΩ	D10 to D11	2 MΩ }	with 1000 pF
D2 to D3	800 kΩ	D11 to HT +	2 MΩ }	capacitors
D8 to D9	800 kΩ			

An anode load giving a time constant of about 1 μs into stray capacities of 50 pF will be 20 kΩ giving peak voltages of about 40 V. These will be a little too large for most amplifiers so either the anode load can be reduced (and the capacitance increased) or the tube operated at a lower voltage, around 900 V, to give a pulse height reduction of 10 : 1. In this case, the resistor between Cathode and D1 should be increased to 1.5 MΩ to keep up the Cathode to D1 voltage. The anode current would then be (at 900 V) around 0.1 μA/μc at 5 cm, and a source of 10 μc would still be correct so far as dynode chain current was concerned.

The overall count rate would be ~ 5000 cps for 10 μc which is 300,000 counts per minute. The count rate in the photopeak channel would be around 1400 counts per second or 84,000 counts per minute for 10 μc.

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NOTES RELATING TO THE MEASUREMENT OF LOW ENERGY X-RAYS AND VACUUM U.V. RADIATION

By J. Sharpe, B.Sc., M.I.E.E., 9th July, 1964.

Transmission of 0.5 mm Be window to X-rays

Energy	keV	8	5.5	4.95	~ 4	~ 3	~ 2.5
λ	Å	1.54	2.25	2.5	3	4	5
Transmission	%	86	65	56	~ 12	~ 3	~ 0.1

Absorption of Zns, 10mg/cm²

Energy	keV	25	17	
λ	Å	~ 0.5	0.73	
Absorption	%	~ 9	Complete	

Appropriate value of signal from electron of energy E in ZnS, closely coupled to Photomultiplier tube ~ 70 μA/lm cathode

Energy E	keV	25	10	5	1
X-ray λ	Å	~ 0.5	~ 1.2	~ 2.5	~ 12
Number of photoelectrons per electron of energy E		~ 110	~ 50	~ 20	~ 3

Sodium Salicylate used as wavelength transformers

For X-rays of energy >80 eV, sodium salicylate has a conversion efficiency, (X-ray to blue light) of ca. 4% (Ref. 1). 1 keV would give 40 eV ~13 quanta, about half to one third of these would be got into photocathode, giving between 1 and 2 photoelectrons. 10 keV would give 10 to 20 electrons.

Light output peaks at ~ 4200 Å and extends from 3600 to 5000 Å matching standard CsSb photocathode response, may be supplied by spraying saturated solution in methanol onto glass slide, warmed with a flow of hot air to evaporate methanol. Light output decreases slowly after preparation and after 280 hours may be down by factor 2. From 400 Å to 800 Å response is level and rises by 30% to new plateau from 1500 Å onwards, as measured by a thermocouple and by gas ionisation (Ref. 2). Used in region 1200 to 1800 Å, effective quantum efficiency coupled to EMI 6256 Photomultiplier tube is between 0.05 and 0.10 photoelectrons/photon (Ref. 3).

Other Phosphors in Vacuum U.V. region (*Ref. 4.*)

Quantum efficiency on relative scale, referred to sodium salicylate as standard.

Phosphor		λ Angstrom Units							
		200	400	600	800	1000	1200	1400	1600
$CaMg(SiO_3)_2$: Ti	%	-	-	-	-	40	45	60	90
$CaSiO_3$: Mn : Pb	%	-	-	-	-	65	60	65	90
$CaWO_4$: Pb	%	100	85	40	20	12	18	25	37
Mg_2WO_5 : (W)	%	>100	87	30	25	20	18	18	18
$Zn_3(PO_4)_2$: Mn	%	>100	80	40	25	30	23	24	20
ZnS : Ag	%	-	10	10	Low ------------>			-	-

Photoelectric effect. Hard U.V.

	λ Angstrom Units									
	500	584	650	700	800	900	1000	1200	1250	Ref.
	Quantum efficiency electrons/photon									
Evaporated Gold	.075	-	.065	-	.075	-	.05	~.02		2
Gold black evaporated N_2 pressure of 1 Torr	<---------- .05 ---------->					-	-	.02	.01	
Evaporated gold	-	.10	-	-	-	-	-	-	-	5
Evaporated gold	.07	.09	-	.10	.08	-	-	-	.01	6
Aluminium evaporated film	.07	.08	-	.18		.20	-	-	.01	

For X-rays incident on gold, efficiency of production varies from about 1% at 100 keV to about 0.25% between 10 keV and 3 keV and rising to between 5 and 7% at very low energies of 30 eV.

References

1. Krokowski, Naturwis. *45* (21), 509, 1958
2. Samson, JOSA, *54*, 6, 1964
3. de Heer, Private communication
4. Thurnau, JOSA, *46*, 346, 1956 and Conklin, JOSA, *49*, 669, 1959
5. Walker et al, JOSA, *49*, 471, 1959
6. Walker et el, JOSA, *51*, 1357, 1961

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SOME TERMS USED IN PHOTOMETRY

Radiant flux	Power emitted, transferred or received in the form of radiation. Symbol P or ϕ_e
Light	Radiant flux capable of stimulating the eye to produce visual sensation
Luminous energy	This time integral of luminous flux. Symbol Q
Luminous flux	The quantity characteristic of radiant flux expressing its capacity to produce visual sensation evaluated according to the values of relative luminous efficiency for the light adapted eye adopted by the C.I.E. Symbol F or ϕ
Relative luminous efficiency	Ratio of luminous efficiency, K λ of monochromatic radiation to the maximum luminous efficiency. K_m (C.I.E) Symbol λ
Illumination	Quotient of luminous flux incident on an infinitesimal element of a surface, by the area of that element. Symbol E
Luminous intensity	In a given direction: the quotient of the luminous flux emitted by a sourse in an infinitesimal cone containing the given direction, by the solid angle of that cone. Symbol I
Luminance	At a point of a surface and in a given direction. The quotient of the luminous intensity in the given direction of an infinitesimal area of the surface by the orthogonally projected area of the element on a place perpendicular to the given direction. Symbol L
Lumen	Unit of luminous flux. The flux emitted in unit solid angle of one steradian by a point source having a uniform intensity of one candela. Abbreviation lm
Candela	Unit of luminous intensity. The luminance of a full radiator (whose spectral distribution is dependent only on temperature), at the temperature of solidification of platinum, is 69 candela per cm^2. Abbreviation cd
Lux	A unit of illumination, one lumen per square metre. Abbreviation lx
Lumen per square foot (Foot-candle)	A unit of illumination, one lumen per square foot. Abbreviation lm/ft^2
Nit	A unit of luminance: one candela per m^2
Stilb	A unit of luminance: one candela per cm^2. Abbreviation sb
Apostilb	A unit of luminance. Lumincance of a uniform diffuser emitting one lumen per $metre^2$. Abbreviation asb

Lambert	A unit of luminance. Luminance of a uniform diffuser emitting one lm/cm^2
Foot lambert	A unit of luminance. The luminance of a uniform diffuser emitting one lm/ft^2. Abbreviation ft-L
Full radiator (Black-body radiator)	A light source emitting radiation, the spectral distribution of which is dependent only on the temperature and not on the material and nature of the source.
Colour temperature	Of a light source: the temperature of a full radiator which would emit radiation of substantially the same spectral distribution in the visible region as the radiation from the light source and which would have the same colour.

TABLE 1 RELATIVE LUMINOUS EFFICIENCY, $V\lambda$

$\lambda\cdot(\mu)$	0	1	2	3	4	5	6	7	8	9
0.4	0.0004	0.0012	0.0040	0.0116	0.023	0.038	0.060	0.091	0.139	0.208
0.5	0.323	0.502	0.710	0.862	0.954	0.995	0.995	0.952	0.870	0.757
0.6	0.631	0.503	0.381	0.265	0.175	0.107	0.061	0.032	0.017	0.0082
0.7	0.0041	0.0021	0.00105	0.00052	0.00025	0.00012	0.00006	-	-	-

TABLE 2 UNITS OF LUMINANCE

	cd/m^2	cd/cm^2	cd/ft^2	ft-L	asb
$Candelas/m^2$ (nits)	1	0.0001	0.0929	0.2919	3.1416
Cd/cm^2 (stilbs	10000	1	929	2919	31416
Cd/ft^2	10.76	0.001076	1	3.1416	33.82
Foot lamberts	3.426	0.0003426	0.3183	1	10.764
Apostilbs (asb)	0.3183	0.00003183	0.02957	0.0929	1

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MICROWAVE TUBES

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Klystrons and Cavities

					AVERAGE CHARACTERISTICS						RATINGS				
NUMBER	TYPE (Note 1)	TUNER (Note 2)	BASE (Note 3)	FREQUENCY RANGE kMc/s	FREQUENCY kMc/s	V_A Volts	I_A mA	V_R Volts (Note 5)	POWER mW	$\triangle F$ Mc/s (Note 6)	V_H Volts Nominal	I_H Amps Nominal	V_A Volts Max.	I_A mA Max.	OUTPUT (Note 7)
R9653	Reflex Int. Cav.	Shaft	Octal	65·0–85·0	70·0	2,250	25	–300	20	100	6·3	1·3	2,500	30	WG26
R9674	Reflex Int. Cav.	Shaft	Octal	26·5–40·0	35·0	2,500	18	–300	200	60	6·3	0·8	2,500	20	WG22
R9521	Reflex Int. Cav.	Shaft	Octal	35·0–40·0	37·5	2,000	12	–300	40	60	6·3	0·8	2,200	15	WG22
R9546	Reflex Int. Cav.	Shaft	Octal	32·0–37·5	35·0	2,000	12	–300	40	60	6·3	0·8	2,200	15	WG22
R5146, CV6001	Reflex Int. Cav.	Shaft	Octal	34·0–36·5	34·7	2,000	10	–300	60	60	6·3	0·8	2,200	12	WG22
R9518	Reflex Int. Cav.	Shaft	Octal	27·8–32·2	30·0	2,000	12	–300	60	60	6·3	0·8	2,200	15	WG22
R9547	Reflex Int. Cav.	Shaft	Octal	24·0–27·8	26·0	2,000	12	–300	60	60	6·3	0·8	2,200	15	WG22
R9675	Reflex Int. Cav.	Shaft	Octal	18·0–26·5	22·0	2,500	18	–300	250	60	6·3	0·8	2,500	20	WG20
R9602	Reflex Int. Cav.	Shaft	Octal	22·0–26·0	24·0	2,000	12	–300	60	60	6·3	0·8	2,200	15	WG20
R9621	Reflex Int. Cav.	Shaft	Octal	20·0–24·0	22·0	2,000	12	–300	60	60	6·3	0·8	2,200	15	WG20
R9622	Reflex Int. Cav.	Shaft	Octal	18·0–22·5	20·0	2,000	12	–300	60	60	6·3	0·8	2,200	15	WG20
R9676	Reflex Int. Cav.	Shaft	Octal	12·0–18·0	15·0	2,500	18	–300	300	60	6·3	0·8	2,500	20	WG18
R9626	Reflex Int. Cav.	Shaft	Octal	15·0–18·0	16·5	2,000	12	–300	100	60	6·3	0·8	2,200	15	WG18
R9625	Reflex Int. Cav.	Shaft	Octal	13·5–16·5	15·0	2,000	12	–300	100	60	6·3	0·8	2,200	15	WG18
R9624	Reflex Int. Cav.	Shaft	Octal	12·4–15·0	14·0	2,000	12	–300	100	60	6·3	0·8	2,200	15	WG18
25182 & R9696	Reflex Ext. Cav.	Micro	B7G	8·2–11·7	10·0	350	40	–350	130	20	6·3	0·8	370	55	WG16
25157 & R9696	Reflex Ext. Cav.	Micro	B7G	7·0–10·3	8·5	350	40	–270	200	20	6·3	0·8	370	55	WG15
25181 & R9561	Reflex Ext. Cav.	Micro	B7G	5·4– 8·2	6·5	350	40	–300	150	20	6·3	0·8	370	55	WG15
25181A & R9701	Reflex Ext. Cav.	Micro	B7G	5·0– 5·9	5·5	350	40	–250	50	20	6·3	0·8	370	55	WG12
R5222 CV2346 **	Plug-in Reflex	—	B7G	5·0–11·7	Over range	350	40	– 50 to –500	30 to 200	—	6·3	0·7	370	55	—
*R9689 **	Plug-in Reflex	—	B7G	5·0–11·7	Over range	350	40	– 50 to –500	30 to 150	—	6·3	0·8	370	55	—
R9561	Modified R5222	To fit wide range cavities type 25181													
R9696	Modified R5222	To fit wide range cavities types 25182 & 25157													
R9501	Modified R5222	Increased $\triangle F$ at 9·2 kMc/s in $\frac{3\lambda}{4}$ Cavity				300	30	–200	35	30	6·3	0·7	370	55	WG16
††R9538P & R5222	Reflex Ext. Cav.	Single Screw	B7G	9·1– 9·3	9·2	350	40	–210	60	20	6·3	0·7	370	55	WG16
††R9539P & R5222	Reflex Ext. Cav.	Single Screw	B7G	9·3– 9·5	9·4	350	40	–220	60	20	6·3	0·7	370	55	WG16
††R9540P & R5222	Reflex Ext. Cav.	Single Screw	B7G	9·5– 9·7	9·6	350	40	–230	60	20	6·3	0·7	370	55	WG16
††R9541P & R5222	Reflex Ext. Cav.	Single Screw	B7G	9·7– 9·9	9·8	350	40	–240	60	20	6·3	0·7	370	55	WG16
††R9542P & R5222	Reflex Ext. Cav.	Single Screw	B7G	9·9–10·1	10·0	350	40	–250	60	20	6·3	0·7	370	55	WG16
††R9543P & R5222	Reflex Ext. Cav.	Single Screw	B7G	300 Mc/s within 10·1–10·6	10·3	350	40	–260	60	20	6·3	0·7	370	55	WG16
††R9544P & R5222	Reflex Ext. Cav.	Single Screw	B7G	300 Mc/s within 10·6–11·0	10·8	350	40	–300	45	20	6·3	0·7	370	55	WG16
R9655/3	Reflex Int. Cav.	Shaft	B8G	7·55–7·8	7·7	1,000	120	–300	2·2W	60	12·6	1·1	1,200	140	WG14
R9630/3	Reflex Int. Cav.	Shaft	B8G	7·3– 7·5	7·4	1,000	120	–300	2·2W	60	12·6	1·1	1,200	140	WG14
R9516/3	Reflex Int. Cav.	Shaft	B8G	7·05–7·3	7·2	1,000 800	120 80	–300 –300	2·2W 1·0W	60 40	12·6	1·1	1,200	140	WG14
R9556/3	Reflex Int. Cav.	Shaft	B8G	6·875–7·125	7·0	1,000	120	–300	2·2W	60	12·6	1·1	1,200	140	WG14
R9687		Selected R9689 for operation in calibrated cavity of 7·1 kMc/s mid frequency													
25212 & R9559	Reflex Ext. Cav.	Micro	Pee Wee 4-pin	3·95– 5·5	4·7	350	35	–500	80	25	6·3	1·2	370	55	WG12
R6010 CV2353	Reflex Int. Cav.	Shaft	B8G	4·4– 4·8	4·6	750	143	–290	3·7W	50	6·3	0·9	800	150	Co-ax line
R6015 CV2354	Reflex Int. Cav.	Shaft	B8G	4·27–4·76	4·5	250	40	–175	150	20	6·3	0·9	350	70	Co-ax line
25221 & R9559	Reflex Ext. Cav.	Micro	Pee Wee 4-pin	3·3– 4·9	4·1	350	35	–400	80	25	6·3	1·2	370	55	WG11
R5081	Reflex Int. Cav.	Shaft	B8G	3·9– 4·2	4·0	750	143	–350	4·0W	40	6·3	0·9	800	150	Co-ax line
RK6112 ** CV2116	Plug-in Reflex	—	B7G	1·0– 4·0	Over range	250	26	– 50 to –400	150	—	6·3	0·7	300	45	—
R9559 ** CV6071	Plug-in Reflex	—	Pee Wee 4-pin	1·0– 5·4 (Tentative)	Over range	300	35	– 50 to –400	100	—	6·3	1·2	370	55	—
R9585 6BM6 ** CV3615	Plug-in Reflex	—	Pee Wee 4-pin	0·5– 3·0	Over range	300	20	– 20 to –400	10 to 50	—	6·3	0·7	350	32	—
R9586 6BM6A ** CV3939	Plug-in Reflex	—	Pee Wee 4-pin	0·5– 3·0		As R9585 but selected for absence of jitter when pulsed.									
†25205 & R9559	Reflex Ext. Cav.	Shaft, with Vernier	Pee Wee 4-pin	3·28–3·72	3·5	300	35	–200	120	30	6·3	1·2	370	55	WG11
KR6/1 CV116	Reflex Ext. Cav.	Pre-set slugs	Octal	3·36–3·55	3·45	250	32	–140	150	30	4·0	1·3	300	40	Co-ax line
KR6/2 CV237	Reflex Ext. Cav.	Pre-set slugs	Octal	3·17–3·39	3·28	250	32	–140	150	30	4·0	1·3	300	40	Co-ax line
KR6/3 CV238	Reflex Ext. Cav.	Pre-set slugs	Octal	2·93–3·13	3·03	250	32	–140	150	30	4·0	1·3	300	40	Co-ax line
R9571	4 cavity amplifier (pulse)			2·7–3·05		20kV Duty cycle ·005	6·5A		15kW for 2W Input	30	9–11	6·5–8	25kV Duty cycle ·0034	8·8A	WG10

† Other cavities of tuning range 400 Mc/s in band 2·5 to 4·2 kMc/s are also available (Types 25203, 4 and 6).
†† Similar fixed-frequency cavities are also available, and either type may be used with the R9689 tube.
* Ion-oscillation-free version of the R5222.
** See Note 4

Ref. M201c

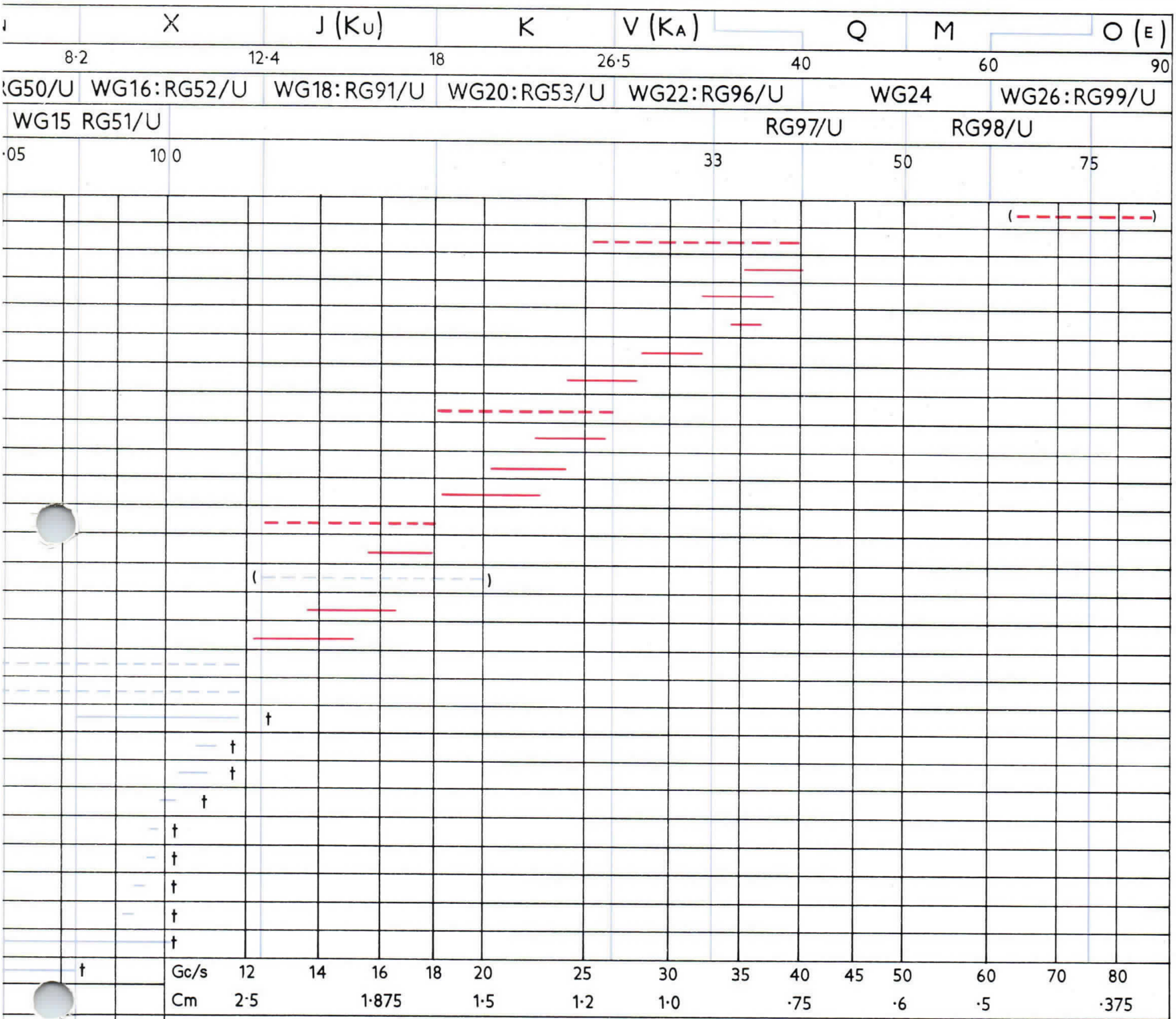
EMI KLYSTRON AND

BAND Gc/s	L	LS	S	C	X
	1·12	1·7	2·6	3·95	5·85
BRITISH (WG) AND U.S. (RG) WAVEGUIDE	WG6:RG69/U	WG8:RG104/U	WG10:RG48/U	WG12:RG49/U	WG14:
		WG9A:RG112/U		WG11A	WG13
EMI KLYSTRON Gc/s		2·2	3·3	4·9	

COMMERCIAL No	MILITARY No
R9653	
R9674	
R9521	
R9546	
R5146	CV6001
R9518	
R9547	
R9675	
R9602	
R9621	
R9622	
R9676	
R9626	
R9678	
R9625	
R9624	
R5222	CV2346
R9689	
25182	
R9544	
R9543	
R9542	
R9541	
R9540	
R9539	
R9538	
25157	
25181	
R9655/3	
R9630/3	
R9516/3	
R9556/3	
25181A	
25212	
R9559	CV6071
R6010	CV2353
R6015	CV2354
25221	
R5081	
RK6112	CV2116
25206	
25205	
25204	
25203	
	CV116
	CV237
	CV238
R9571	
25226	

FREQUENCY Gc/s	1·0	1·2	1·4	1·6	1·8	2·0	2·5	3·0	3·5	4·0	4·5	5·0	6·0	7
WAVELENGTH Cm.	30	25		18·75		15	12	10		7·5		6·0	5·0	

WAVEGUIDE DATA CHART



KEY

Low Voltage, Low Power Reflex Oscillators	thin blue line
High Voltage, Low Power Reflex Oscillators	thin red line
Narrow-band klystrons available over a wide frequency range	dashed red line
High Voltage, Medium Power Reflex Oscillators	thick red line
4-Cavity Pulse Amplifier Klystron	thick blue line
Plug-in Tubes for External Resonators	dashed blue line
Planned and under development	( )

† Using Replaceable Tubes

NOTES

Note 1. Klystrons with internal cavity, (Int. Cav.), have whole of cavity within vacuum envelope. Power is taken out either by a waveguide window, or by co-axial line (co-ax line). Tubes with external cavity (Ext. Cav.) detailed on this sheet are metal-glass tubes having the central part of the cavity within the vacuum envelope. The external cavity is connected to the copper electrodes by spring contacts.

Note 2. In tuners having shaft drive, rotation of the shaft transmits movement via a built-in reduction mechanism, (e.g. a differential screw as with type R6010).

Micro. indicates a micrometer tuner, with scale.

Single screw tuners are of the "puller" type, in which tuning of an auxiliary cavity pulls the frequency of the main cavity.

Pre-set slugs are threaded slugs around the periphery of the cavity, movement of which effectively vary the cavity volume.

Note 3. Octal—International octal.

B7G —Miniature 7 pin glass base without spigot.

B8G —8 pin glass base, with spigot.

Pee-wee 4 pin—Overcapped 4 pin base.

Note 4. Plug-in Klystrons, as R5222, may be used in variety of external cavities, and properties, e.g. $\triangle$ F, will depend critically on the cavity design.

Note 5. V_R refers to reflector voltage of reflex klystrons; this is always negative with respect to cathode.

Note 6. $\triangle$ F is the electronic tuning range between half power points in the case of reflex klystrons, and is the 3db bandwidth for amplifier tubes.

Note 7. Waveguide outputs are into guide of specified WG number. Flanges are of various types.

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M201c/2·5/M/1164 DPL

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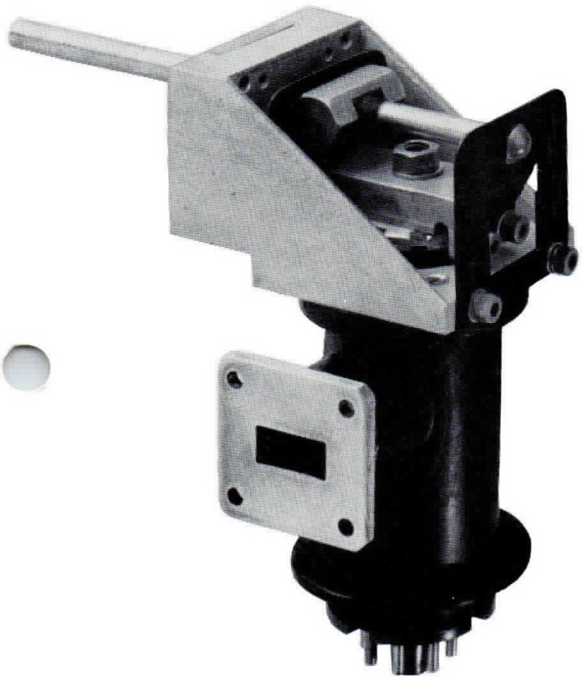
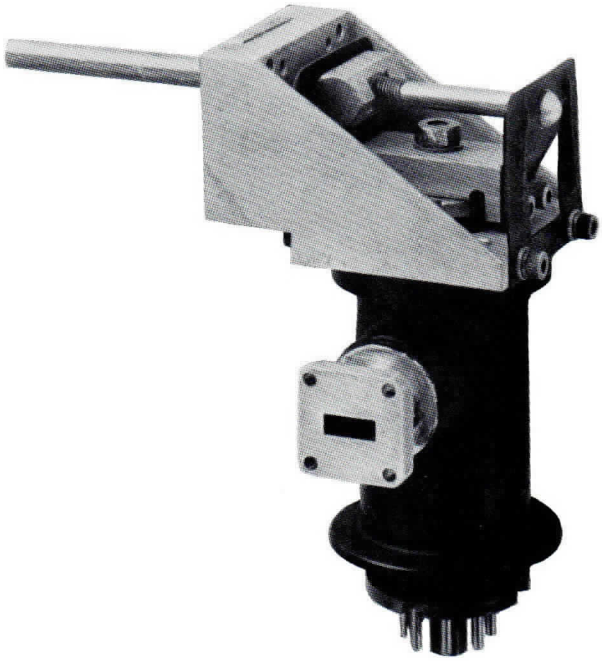




J- and K-Band Klystrons

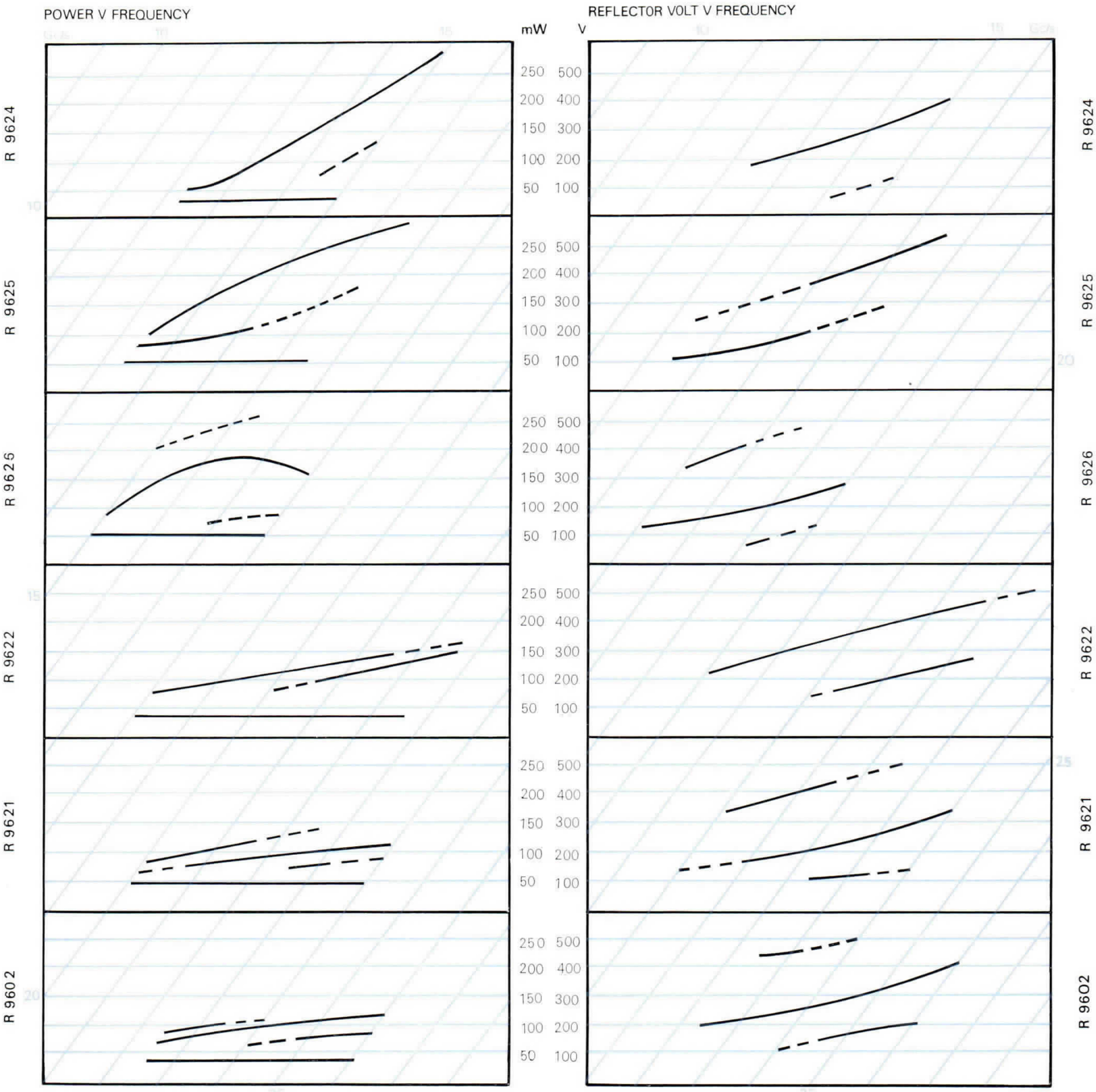
Two series of three 2kV velocity modulated oscillators which cover the frequency ranges 12·4 to 18·0 Gc/s and 18·0 to 26·0 Gc/s.

Each is of metal construction with integral tunable cavities and indirectly heated cathodes.

All types are similar externally, except that the J-band klystrons feature a WG 18 (WR 62) output section with British Joint Services flange 5985–99–083–0030 (UG 419/U). The K-band klystrons are fitted with WG 20 (WR 42) output section with 5985–99–011–9658 (UG 595/U) flange.

The tuner is of unique design and construction and imparts excellent frequency stability and freedom from microphony.

Klystron Type	Frequency Gc/s	Free Space Wavelength mm	Power Output into Matched Load (VSWR = 1) mW		Resonator Current mA
J-Band			Min.	Typical	Max.
R9624	12·4 to 15·0	20·0 to 24·2	40	100	15
R9625	13·5 to 16·5	18·2 to 22·2	50	100	15
R9626	15·0 to 18·0	16·7 to 20·0	50	100	15
K-Band					
R9622	18·0 to 22·5	13·3 to 16·7	40	100	15
R9621	20·0 to 24·0	12·5 to 15·0	50	100	15
R9602	22·5 to 26·0	11·5 to 13·3	40	85	15



Electrical Data

Base connections (international octal, specification BS448, B8–0)

Electrode	Grid	Heater	IC	IC	Reflector	IC	Heater/ Cathode	IC
Pin No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Note: IC = internal connection

Resonator Connection: Flange or Fixing Holes.

Ratings

(All voltage ratings are with respect to cathode potential)

Heater	6·3V	
Resonator voltage, Vrs	2000V	
Reflector voltage, Vr	−100V to −500V	*Max. reflector current*: 30 μA
Grid voltage	0 to −200V	*Max. grid current*: 1 mA

Notes on operation

Maximum impedance of reflector and grid supplies: 75 000 ohms. The h.t. supply must never be applied to the resonator in the absence of negative reflector and grid volts

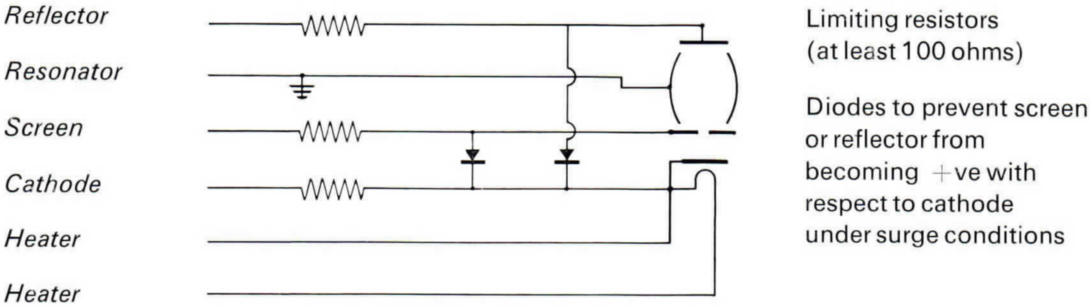
The tubes are normally operated with the resonator at earth potential, and the cathode should be preheated at normal voltage for a minimum period of one minute before *Vres* is applied

Power Supply

100 ohms limiting resistors should be incorporated in the power supply in order to protect both the klystron and the circuit breaker in the power unit

A suitable diode should be connected between reflector and cathode, and also between screen and cathode to avoid damage to the tube in the event of failure in the power unit

Recommended circuitry for the protection of Klystrons:



Where complete freedom is necessary from fluctuations of both power output and frequency, a choke should be connected in series with the resonator supply. The inductance of this choke should be 4 H with a d.c. resistance of about 60 ohms. It should be insulated for at least 2000V

The choke may be connected in either the positive or the negative side of the supply but care should be taken to avoid stray capacitance from leads and sub-units which might have a shunting effect

Mounting

The valve is designed with a floating base socket and no undue strain should be put on this or the output coupler, which is located with respect to the mounting face of the tuner block

Any orientation can be used and it is recommended that the four tapped holes on the mounting face be employed

To allow tuning of the valve the spindle must not be constrained axially or radially

On no account should any tuner assembly screws be loosened

Cooling

The temperature of the envelope should not be allowed to exceed 150°C at any point, and forced air cooling may be necessary if the klystron is used in a confined space

Warm-up Time

With full ventilation, but without forced cooling, operation within 40 Mc/s of the final frequency is possible within about 15 minutes of switching on. With forced cooling this period can be considerably reduced

Weight

K-Band	14 oz	0·40 kg	J-Band	15 oz	0·43 kg

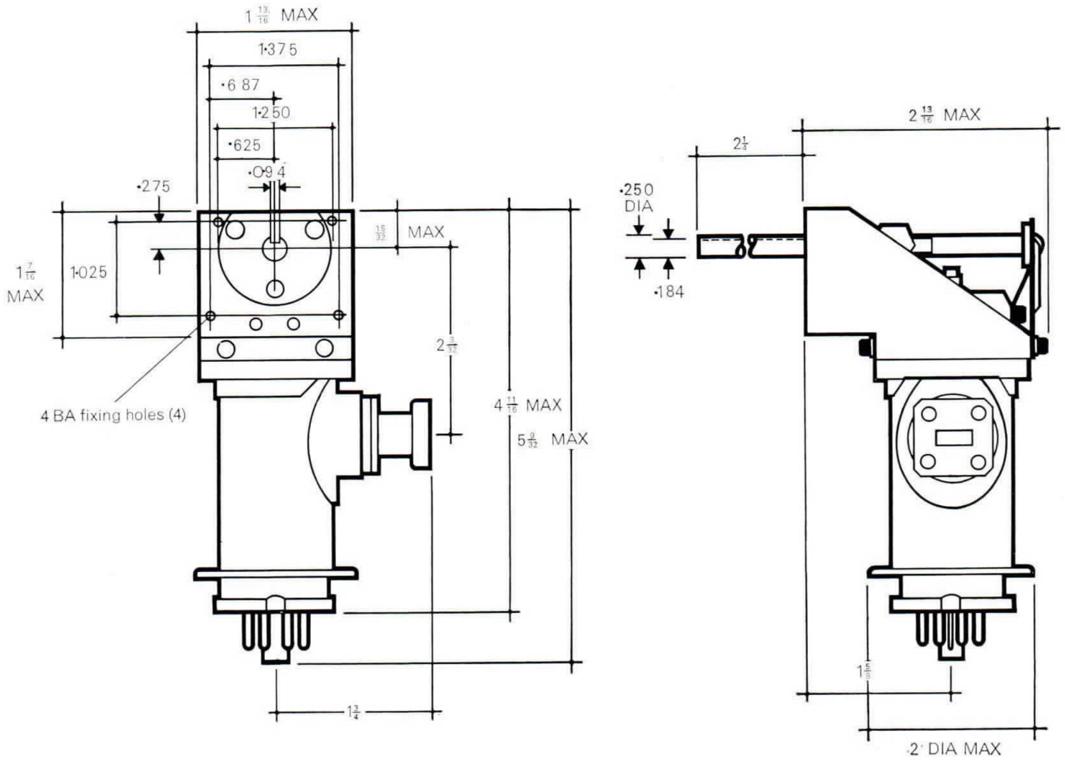
Performance

The curves opposite represent true average performance and approximately one-half of all tubes supplied have a power output higher than that indicated

The horizontal straight lines represent the minimum output allowed by the specification

Dimensions

K-Band Klystrons



J-Band Klystrons

All dimensions in inches

The Company reserves the right to modify these designs and specifications without notice M203/4a

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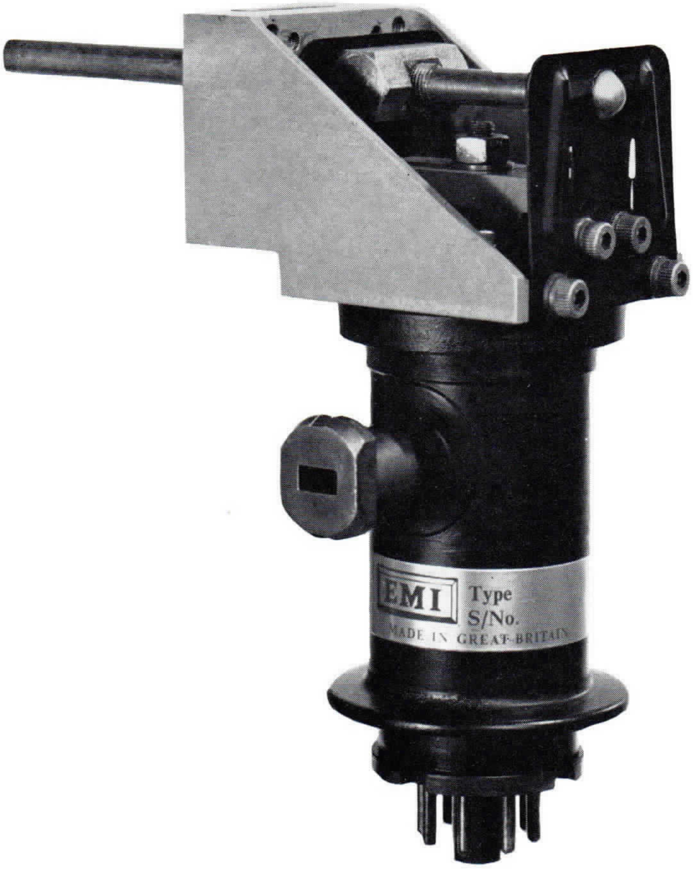
EMI Q-Band Reflex Klystrons



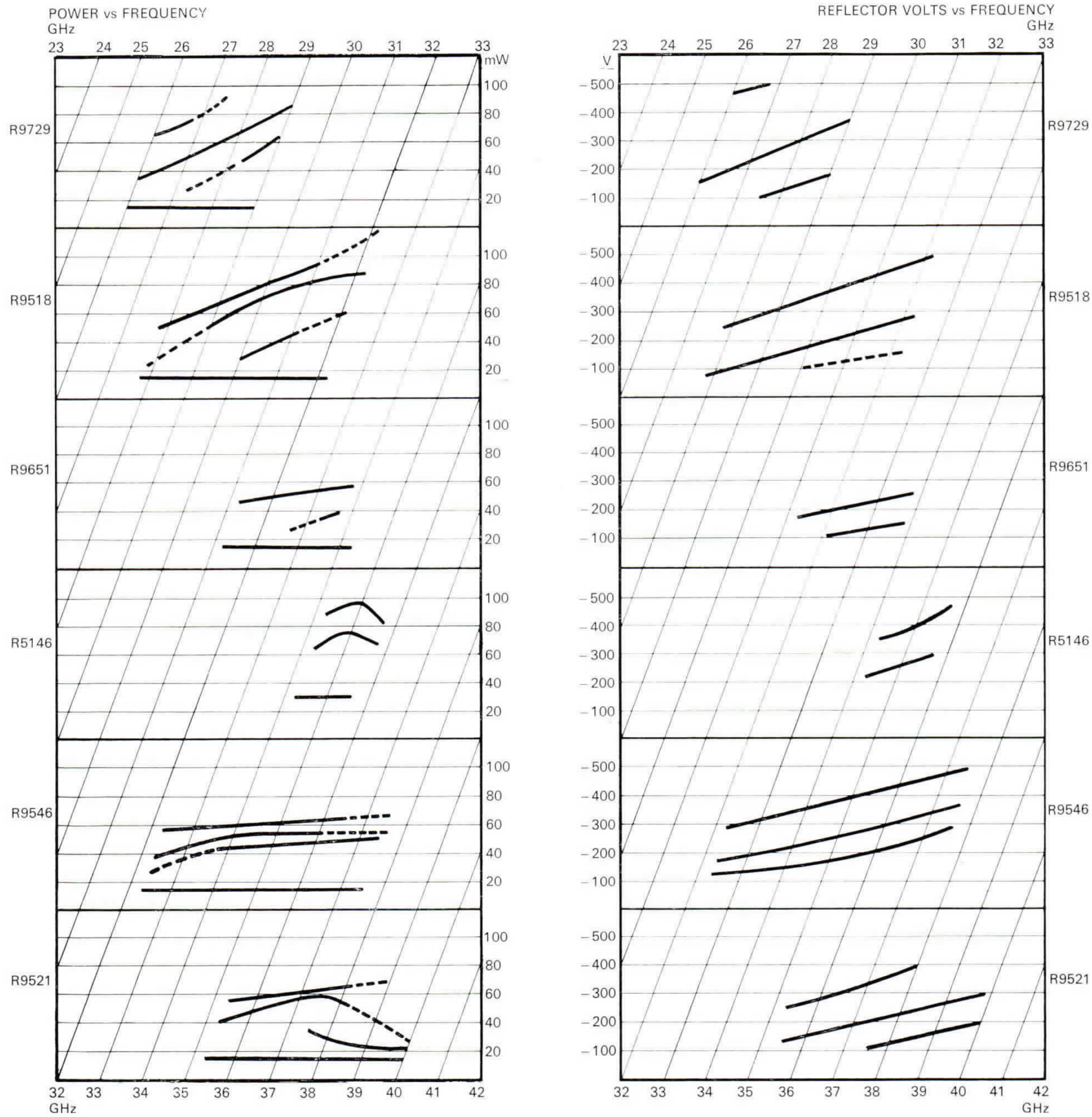
A series of six 2 kV velocity-modulated oscillators which cover the frequency range 26·0 to 40·0 GHz.

Each is of metal construction with integral tunable cavities and indirectly heated cathodes.

All types are similar externally and feature a WG22 (WR28) output with British Joint Services flange 5985-99-083-0018.

The tuner is of unique design and construction and imparts excellent frequency stability and freedom from microphony.

Klystron Type	Frequency GHz	Free Space Wavelength mm	Power Output into Matched Load (VSWR = 1) mW		Resonator Current mA	Average Electronic Tuning Range MHz	Average Change in Vr between –3dB Points
			Min.	Typical			
R9729	26·0 to 29·0	10·4 to 11·5	15	70	8 to 15	68	51
R9518	27·8 to 32·2	9·3 to 10·8	15	80	8 to 15	68	44
R9651	31·25 to 33·7	8·9 to 9·6	15	60	8 to 15	70	40
R5146	34·2 to 35·58	8·43 to 8·77	30	90	8 to 12	70	37
R9546	32·3 to 37·5	8·0 to 9·3	15	60	8 to 15	77	34
R9521	35·3 to 40·0	7·5 to 8·5	15	60	8 to 15	85	30



Electrical Data

Base connections (international octal, specification BS448, B8-0)

Electrode	Grid	Heater	IC	IC	Reflector	IC	Heater/ Cathode	IC
Pin No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**

Note: IC = internal connection

Resonator Connection: Flange or Fixing Holes.

Ratings

(All voltage ratings are with respect to cathode potential)

Heater	6·3V 0·8A	
Resonator voltage, Vres	2000V	
Reflector voltage, Vr	–100V to – 500V	*Max. reflector current:* 30 μA
Grid voltage	0 to – 200V	*Max. grid current:* 1mA

Notes on operation

Maximum impedance of reflector and grid supplies: 75 000 ohms. The h.t. supply must never be applied to the resonator in the absence of negative reflector and grid volts

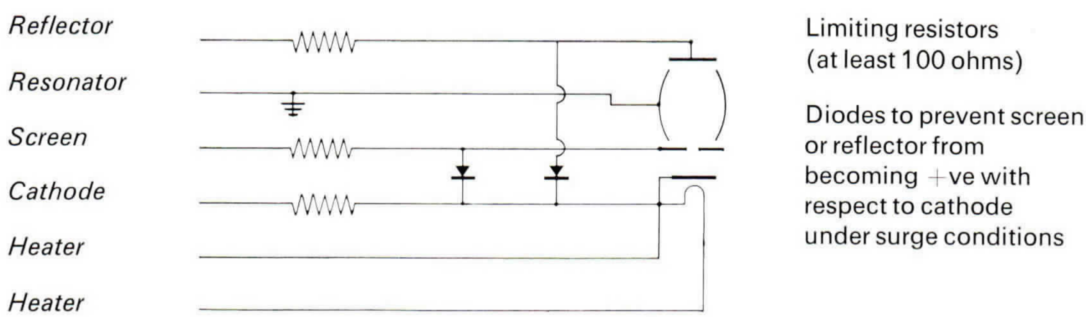
The tubes are normally operated with the resonator at earth potential, and the cathode should be preheated at normal voltage for a minimum period of one minute before *Vres* is applied

Power Supply

100 ohms limiting resistors should be incorporated in the power supply in order to protect both the klystron and the circuit breaker in the power unit

A suitable diode should be connected between reflector and cathode, and also between screen and cathode to avoid damage to the tube in the event of failure in the power unit

Recommended circuitry for the protection of Klystrons:



Where complete freedom is necessary from fluctuations of both power output and frequency, a choke should be connected in series with the resonator supply. The inductance of this choke should be 4 H with a d.c. resistance of about 60 ohms. It should be insulated for at least 2000V

The choke may be connected in either the positive or the negative side of the supply but care should be taken to avoid stray capacitance from leads and sub-units which might have a shunting effect

Mounting

The valve is designed with a floating base socket and no undue strain should be put on this or the output coupler, which is located with respect to the mounting face of the tuner block

Any orientation can be used and it is recommended that the four tapped holes on the mounting face be employed

To allow tuning of the valve the spindle must not be constrained axially or radially

On no account should any tuner assembly screws be loosened

Cooling

The temperature of the envelope should not be allowed to exceed 150°C at any point and forced air cooling may be necessary if the klystron is used in a confined space

Warm-up Time

With full ventilation, but without forced cooling, operation within 50 MHz of the final frequency is possible within about 15 minutes of switching on. With forced cooling this period can be considerably reduced

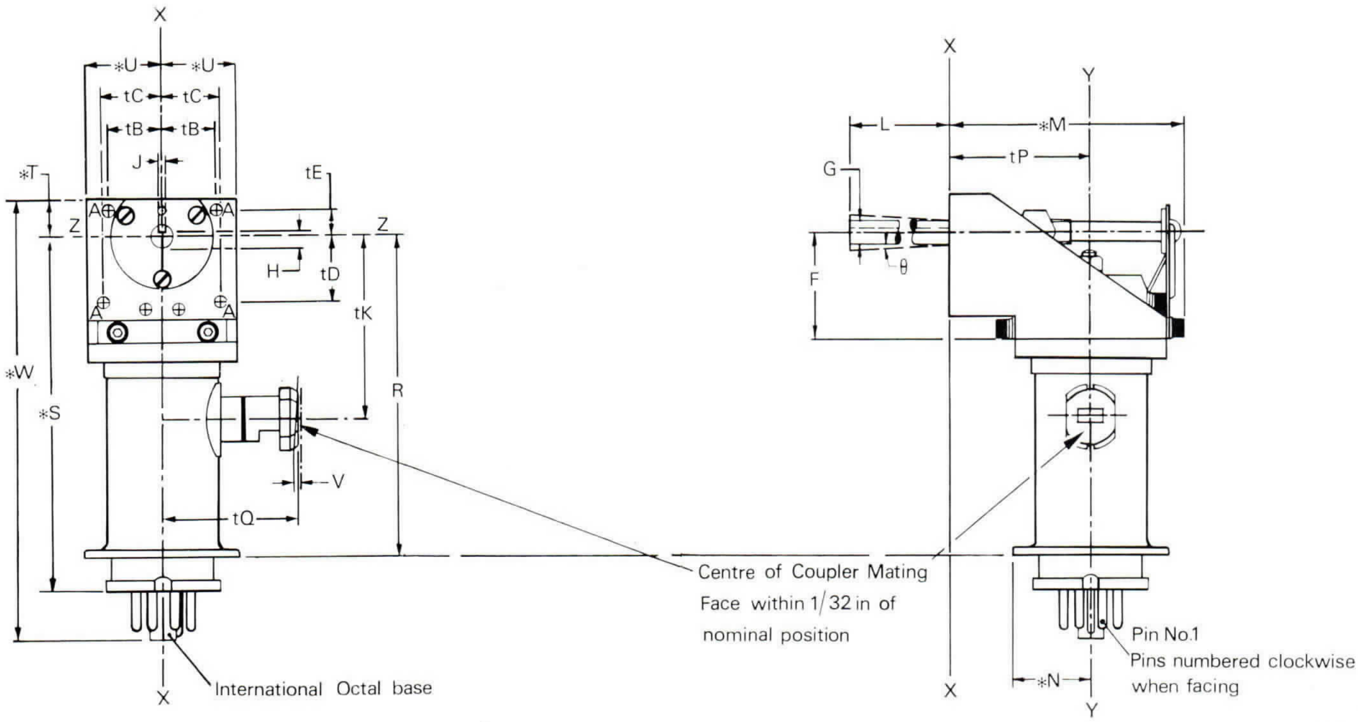
Weight

13 oz   370 g

Performance

The curves opposite represent true average performance

The horizontal straight lines represent the minimum output allowed by the specification



Dimensions

'X-X', and 'Z-Z' are reference axes only. The plane 'X-Z' is the plane of the mounting surface—see dim. P—holes 'A' being the mounting holes. 'X-X' and 'Z-Z' pass through the nom. axis of the spindle. The plane through 'X-X' and 'Y-Y' is perpendicular to the plane 'X-Z'. The axes 'X-X' and 'Y-Y' are 'P' apart, as shown.

The international octal base is within $\frac{1}{8}$ in. of nominal axis and has $\pm 15^\circ$ angular tolerance. The valve is designed for use with a floating base socket and no undue strain should be put on the output coupler. Dimensions marked * define max. envelope of the assy. and t true geometric position (T.P.).

The output is in WG22 (WR28 I.D. ·280in × ·140in) and the flange, British Joint Service type 5985-99-083-0018 mates with a similar flange, secured by locating ring 5985-99-083-0017 and ring nut 5985-99-083-0020.

Adaptors are available for connection to American flanges type UG 599/U or UG 381/U.

Symbol	Dimension	Tolerance	Remarks
A	4 BA Thd	·010 in posit'l	Tapped $\frac{1}{2}$ in deep c/drill. ·149 in dia × $\frac{1}{4}$ in deep
tB	·625 in	TP	
tC	·6875 in	TP	
tD	·750 in	TP	
tE	·275 in	TP	
F	1·250 in	max.	
G	·250 in dia	$^{+\cdot000\text{ in}}_{-\cdot005\text{ in}}$	
H	·184 in	± ·005 in	
J	·094 in	$^{+\cdot005\text{ in}}_{-\cdot000\text{ in}}$	
tK	2·105 in	TP	
L	$2\frac{1}{4}$ in	$\pm\frac{1}{4}$in	Spindle moves axially when rotated
*M	$2\frac{13}{16}$ in	max.	
*N	1 in rad.	max.	From axis 'Y-Y'
tP	$1\frac{5}{8}$ in	TP	
tQ	$1\frac{9}{16}$ in	TP	
R	$3\frac{3}{4}$ in	max.	
*S	$4\frac{1}{4}$ in	max.	
*T	$\frac{15}{32}$ in	max.	
*U	$\frac{29}{32}$ in	max.	
V		·012 in	Max. tilt of mating surface over ·520 in dia.
*W	$5\frac{9}{32}$ in	max.	
θ		1°	In any direction—may occur with spindle rotation

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EMI O-BAND KLYSTRON TYPE R9653

Provisional Data

This reflex klystron oscillator operates in the 65 Gc/s to 85 Gc/s band and has an output power of 10 mW minimum. The mechanical tuning range of an individual tube is about 5 Gc/s, and the electronic tuning range is typically 100 Mc/s.

PRELIMINARY SPECIFICATION

Heater voltage	:	6.3 V
Heater current	:	1.5 A maximum
Resonator voltage	:	2000 to 2500 V
Resonator current	:	30 mA maximum
Reflector voltage	:	-500 maximum
Modulator voltage	:	-200 maximum
Tuning range	:	3 Gc/s minimum
Frequency	:	65 to 85 Gc/s
Power output	:	10 mW minimum

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EMI KLYSTRON TYPE R9696

The R9696 is a modification of the R9689 having spring contact assemblies mounted in place of the upper copper electrodes. It is completely free from ion oscillation and is therefore ideally suited for applications using frequency modulation.

ELECTRICAL SPECIFICATIONS

Ratings (all voltages measured with respect to cathode)

Resonator voltage	350 V standard 370 V maximum	
Reflector voltage	-500 V maximum - 50 V minimum	 (must never be positive with respect to cathode)
Heater voltage	6.3 V standard 6.8 V maximum	

Typical performance (under standard voltage conditions) in EMI cavities 25157 and 25182 matched for maximum frequency coverage looking into VSWR < 1.1.

Resonator current	30 mA normal 55 mA maximum
Heater current	0.8 A normal 0.9 A maximum
Reflector current	4 μA maximum

Frequency	3¾ Mode			4¾ Mode			5¾ Mode			Cavity
GHz	V_{Ref}	Po	Δf	V_{Ref}	Po	Δf	V_{Ref}	Po	Δf	
7.0	-140	100	30	-	-	-	-	-	-	
8.7	-270	170	18	-120	50		-	-	-	25157
10.3	-400	50	11	-220	100		-	-	-	
8.2	-215	50	20	- 90	15		-	-	-	
10.0	-370	80		-200	70	21	-90	30	26	25182
11.7	-	-	-	-300	11		-180	20		

Minimum Power Output

25182 cavity	11.7-10 GHz.	5 mW
	10.0-8.2 GHz.	30 mW
25157 cavity	30 mW	over the whole range

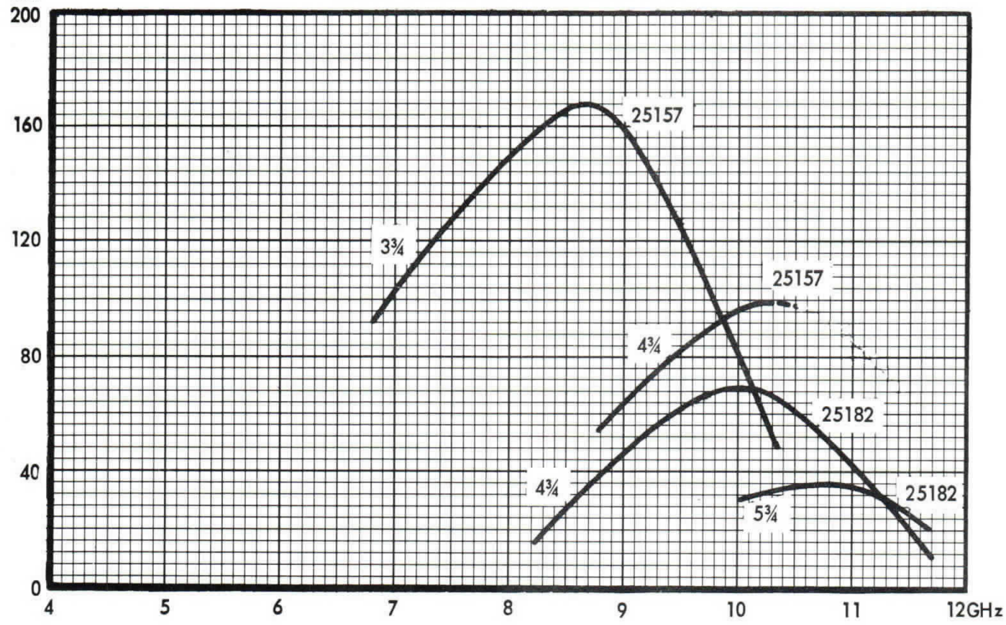
M219/1a
DS.866/1

Operational Notes

The temperature of the valve envelope and of the external parts of any point should not exceed 150^{o}C. Forced air cooling will be necessary if the valve is mounted in an enclosed space.

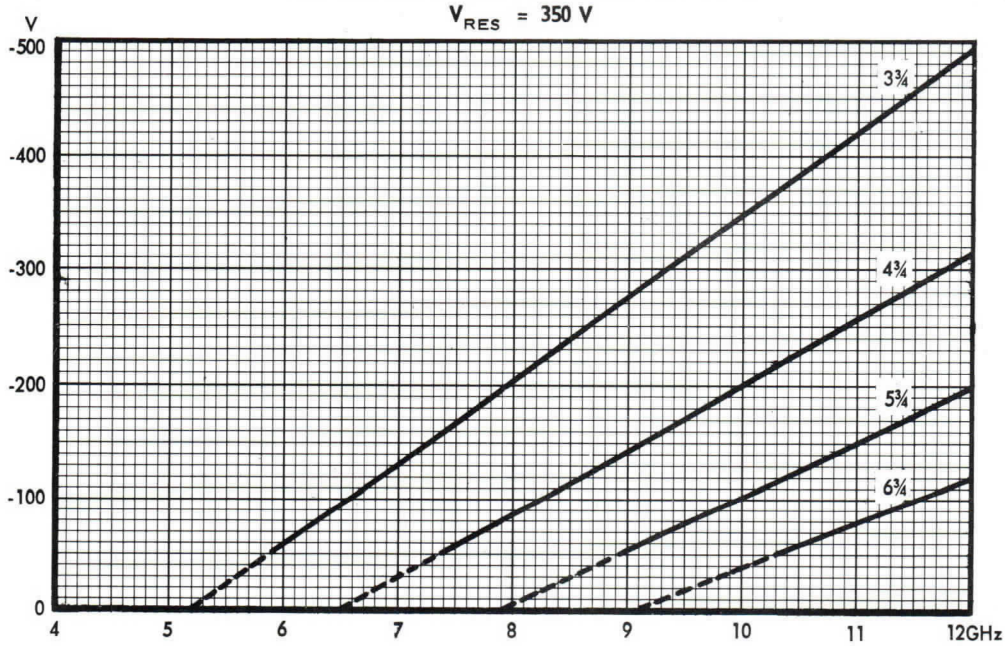
The cathode screen should normally be connected to the cathode. By applying a negative bias of 100 - 200 V to this electrode it is usually possible to prevent oscillation, but factory tests do not guarantee this.

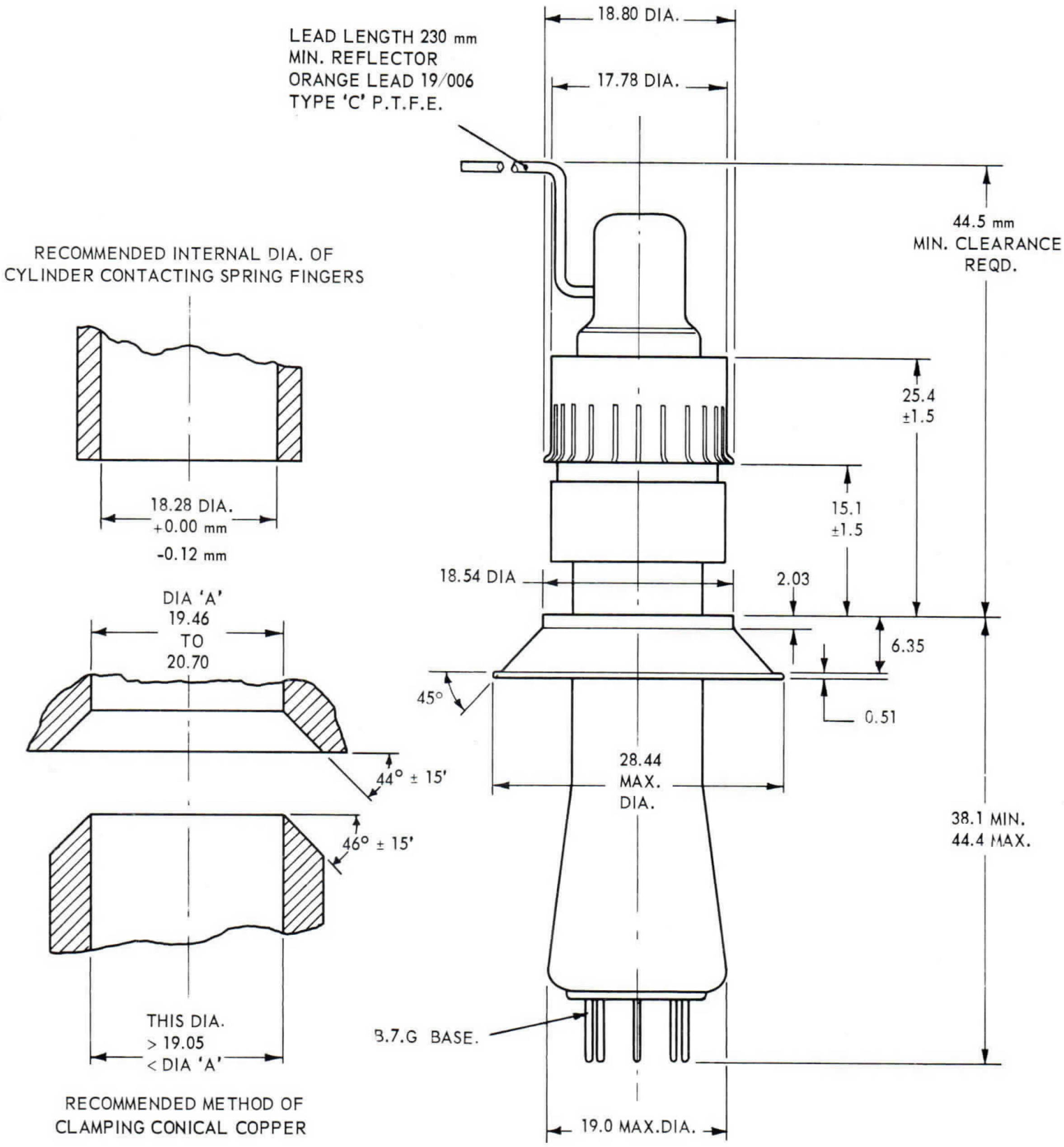
R9696 POWER CHARACTERISTICS



REFLECTOR CHARACTERISTICS FOR R9696

V_{RES} = 350 V





All dimensions are in millimetres

Base connections Base Type B7G

Pin No.	1	2	3	4	5	6	7	FL	DS
Electrode	IC	K	IC	IC	H	KS	H	RF	RS

DS = Disc seal
FL = Flying lead
H = Heater
IC = Internal connection
K = Cathode
KS = Cathode shield
RF = Reflector
RS = Resonator

M219/3a
DS.866/3

The Company reserves the right to modify the designs and specifications without notice

E M I Electronics Ltd. Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Ref. 11118 CP

EMI
EMI ELECTRONICS LTD
Serving Science and Industry

VALVE DIVISION

EMI WIDE TUNING RANGE CAVITIES
TYPES 25181, 25157, 25182

Cavities types 25181, 25157 amd 25182 are for use with plug-in reflex klystrons types R9701 and R9696, which are modifications of EMI klystron type R9689, having spring contact assemblies mounted in place of the upper copper electrode.

The cavities are of the concentric capacitance tuner type, consisting of a ¾ λ cavity, (which determines the upper frequency limit of oscillation), into which slides a concentric cylindrical tuning element. This electrode slides over the spring fingers mounted on the valve and provides the necessary connection to the upper copper electrode. When the tuner is fully inserted, the lower frequency of operation is determined by its diameter, the assembly then behaving as a fundamental cavity oscillator, coupled into the outer part of the ¾ λ cavity. Power is extracted by means of a waveguide window in the outer wall of the ¾ λ cavity.

Tuning ranges of over 30% are obtained, as shown in the table below, the band covered by the three cavities being 5.4 to 11.7 Gc/s.

Movement of the tuning electrode is controlled by rotation of a calibrated large diameter head, as shown in the figure on the reverse of the sheet. Alternative drives consist of:-

(a) A micrometer head which may be oriented at any angle in the horizontal plane.

(b) A cam drive for operation by a slow speed motor.

Basic Characteristic of R9701 and R9696:-

V_H 6.3 V I_H 0.78 A V_A(max.) 370 V I_A(max.) 55 mA V_R -50 to -500 V

Typical Operating Characteristics. (All at 6.3 V, 350 V) :-

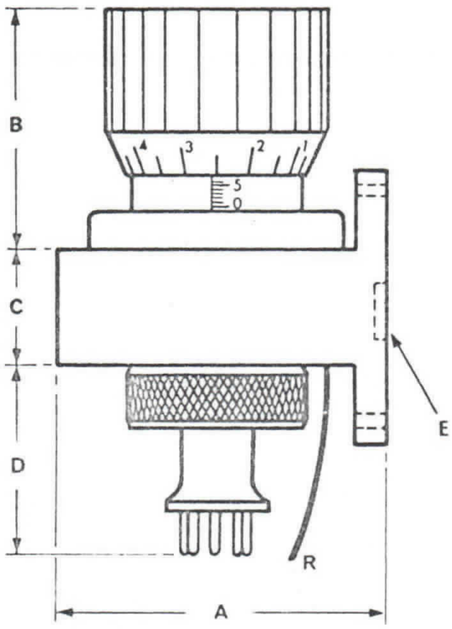
Matched for maximum frequency coverage, looking into VSWR < 1.1

Cavity	Klystron	Frequency Gc/s	V_R V	Po mW	V_R V	Po mW	V_R V	Po mW
25181	R9701	5.4	-220	50	-	-	-	-
		6.5	-360	100	-100	70	-	-
		8.2	-	-	-230	50	-	-
25157	R9696	7.0	-140	100	-	-	-	-
		8.7	-270	170	-120	50	-	-
		10.3	-400	50	-220	100	-	-
25182	R9696	8.2	-215	50	-90	15	-	-
		10.0	-370	80	-200	70	-90	30
		11.7	-	-	-300	10	-180	20

M271/1a
DS.575/1

EMI WIDE TUNING RANGE CAVITIES TYPES 25181, 25157, 25182 (continued

OUTLINE DRAWING



DIMENSIONS

	25181	25157	25182
A	2 5/16"	1 25/32"	1 29/32"
B	1¾" - 2⅛"	1½" - 1⅞"	1½" - 1⅞"
C	11/16"	5/8"	5/8"
D	1½"	1½"	1½"
E	WG15	WG15	WG16

R - Reflector connection

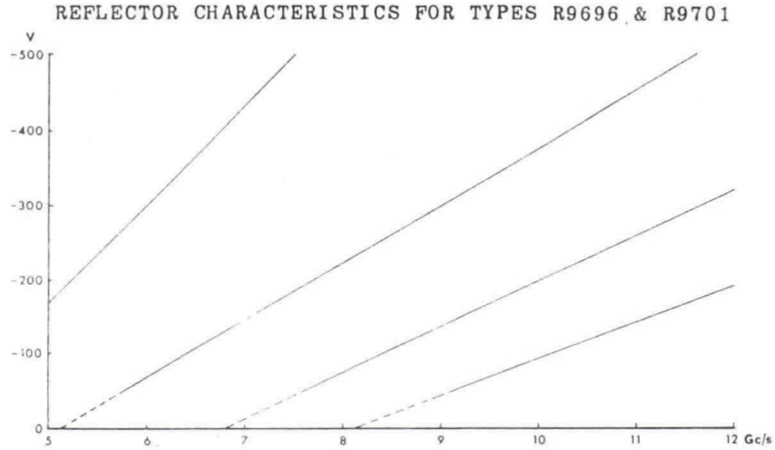
Base Connections Type B7G

Pin No.	1	2	3	4	5	6	7
Electrode	I.C.	K	I.C.	I.C.	H	C.S.	H

CS - Cathode shield H - Heater I.C. - Internal connection K - Cathode

Pins numbered clockwise from blank position, viewed from underside of tube

REFLECTOR CHARACTERISTICS FOR TYPES R9696 & R9701



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M271/2a
DS. 575/2

EMI

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

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Ref. 10772 CP

VALVE DIVISION

EMI C-BAND CAVITY TYPE 25212

This plug-in Klystron Cavity has been designed as a bench oscillator over the band 3950 Mc/s - 5500 Mc/s, but may also be found suitable for use as a local oscillator or carrier source within a system.

The tube employed is the R9559 low voltage plug-in klystron which is substantially free from hysteresis.

Tuning is effected by rotation of a large diameter micrometer head and resetting accuracy is high. Once calibrated, the cavity becomes independent of a wavemeter for many applications.

Output is by W.G.12 waveguide (RG49/U or WR187) and the cavity is mounted by means of a standard flange Type 5985-99-0042 (UG149 Å)

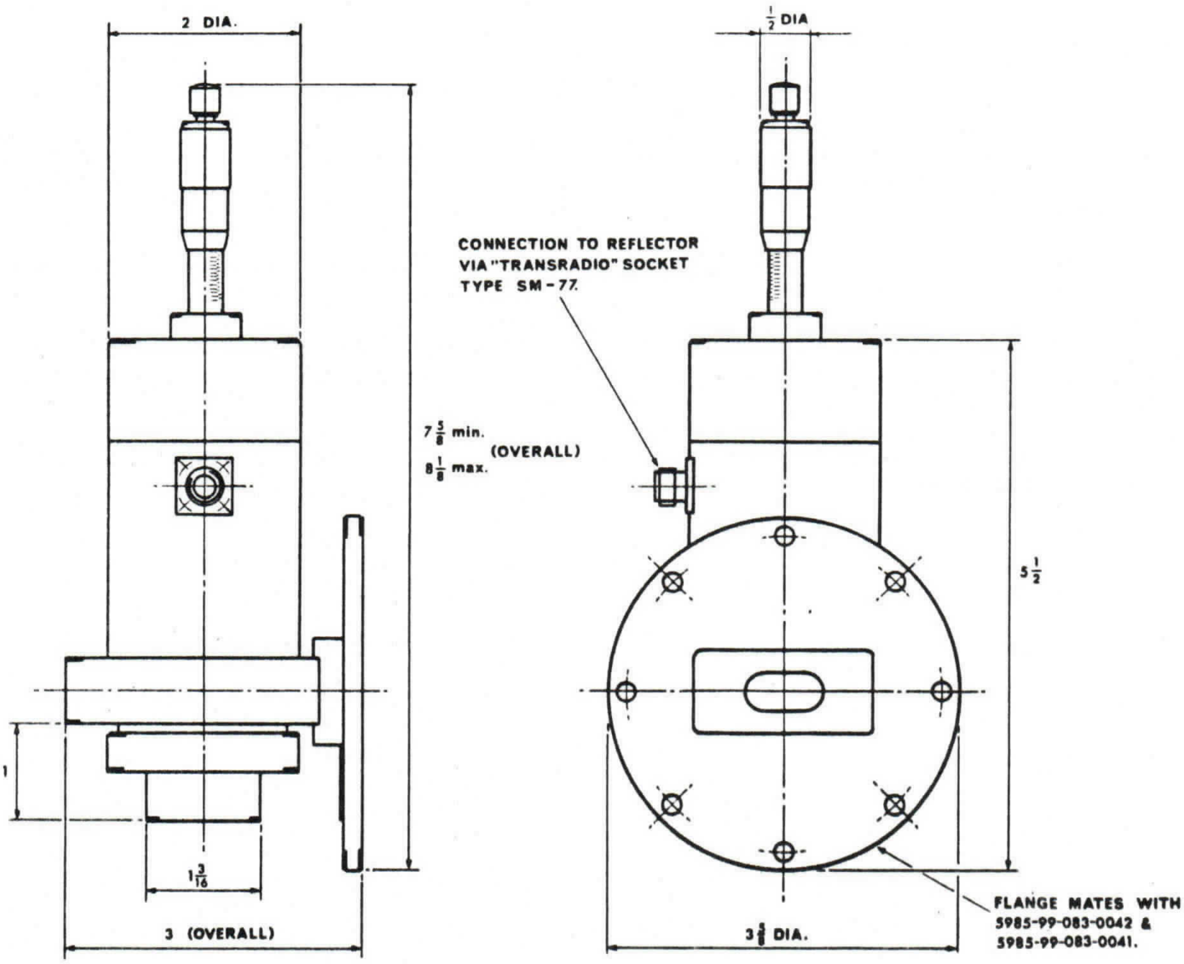
Nominal dimensions are indicated on the outline drawing overleaf.

Minimum frequency range		3950 - 5500 Mc/s		
Minimum power output	at	3950 - 5000 Mc/s	-	80 mW
Minimum power output	at	5000 - 5400 Mc/s	-	25 mW
Minimum power output	at	5400 - 5500 Mc/s	-	10 mW

Typical performance :- V_a 350 V V_H 6.3 V I_a 40 mA

Frequency Gc/s	Power Output mW	V_R Volts	Δf (½-power points)
5.5	20	-550	8
5.0	150	-420	10
4.5	240	-330	15
3.95	180	-250	20

M274/1a
DS. 139/1



ALL DIMENSIONS ARE IN INCHES

The Company reserves the right to modify the designs and specifications without notice

M274/2a
DS. 139/2

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Ref. 10772 CP

EMI

EMI ELECTRONICS LTD

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VALVE DIVISION

EMI REFLEX KLYSTRON TYPE R9559

DESCRIPTION

The R9559 is a low-voltage reflex klystron for use with an external cavity resonator. Plugged into suitable cavities, the valve will cover a frequency range of 2700 to 4100 Mc/s on the 2¾ mode; by using other reflector modes useful power can be obtained over the range 1-5 KMc/s. The valve is rugged, with low microphony, and was specially designed for use as a low cost local oscillator for radar applications. It may also be used as a wide frequency range signal source and as a low power transmitter.

MAXIMUM RATINGS

Heater voltage	6.8V
Resonator voltage	350V
Resonator dissipation	16W
Envelope temperature	150°C
Reflector voltage	-500V Must never be positive with respect to cathode.
Max. impedance in reflector circuit	250KΩ

TYPICAL OPERATION

Heater voltage	6.3V
(one side of heater is internally connected to cathode)	
Heater current	1.2A
Resonator voltage	300V
Resonator current	35mA
Reflector potential	-70 to -350
Power	100mW
Electronic tuning ragne	35Mc/s
Tuning slope	1 Mc/s/V

APPLICATION

The recommended method of clamping the lower resonator diaphragm is shown in the diagram, contact to the upper diaphragm should be made by spring fingers. Care should be taken that the spring pressure is not excessive and that an adequate lead-in is provided; otherwise, mechanical damage to the valve may result. The springs and housing should be designed to prevent leakage of R.F. power and spurious resonances, usually indicated by low power output at some frequencies. When inserting the valve into the cavity, the conical diaphragm should be pressed home in its seating (by pressure on the valve base) before clamping the copper. If the valve is pushed home by pressure on the conical diaphragm itself, the frequency of the valve may be changed as a result of mechanical deformation.

APPLICATION (continued)

A $\lambda/4$ radial line cavity, of depth 0.5 in may be used, the diameter being related to the frequency as shown:-

Cavity diameter (inches)	1.866	1.470	1.220	1.030
Frequency (Mc/s)	2690	3145	3580	4065
Loaded Q	100	200	200	400

If a waveguide output is used, the coupling iris should be adjusted to match the valve into the waveguide. As an indication of the iris size required, the slot width varies from .65 in at 4000 Mc/s to 1.3 in at 2700 Mc/s for a slot height of 0.25 in. Alternatively a concentric line output may be used.

Tuneable cavities are available for use with the R9559. Three cavities covering the S-band frequency range from 2.6 to 4.1 KMc/s. These cavities are tuned by the insertion of two metal rods, but any of the standard tuning techniques can be used, e.g. capacity loading or concentric line cavity.

The life of the valve is over 1000 hours, but this is affected by the temperature of operation. Unless an adequate heat sink is provided, forced air cooling should be used.

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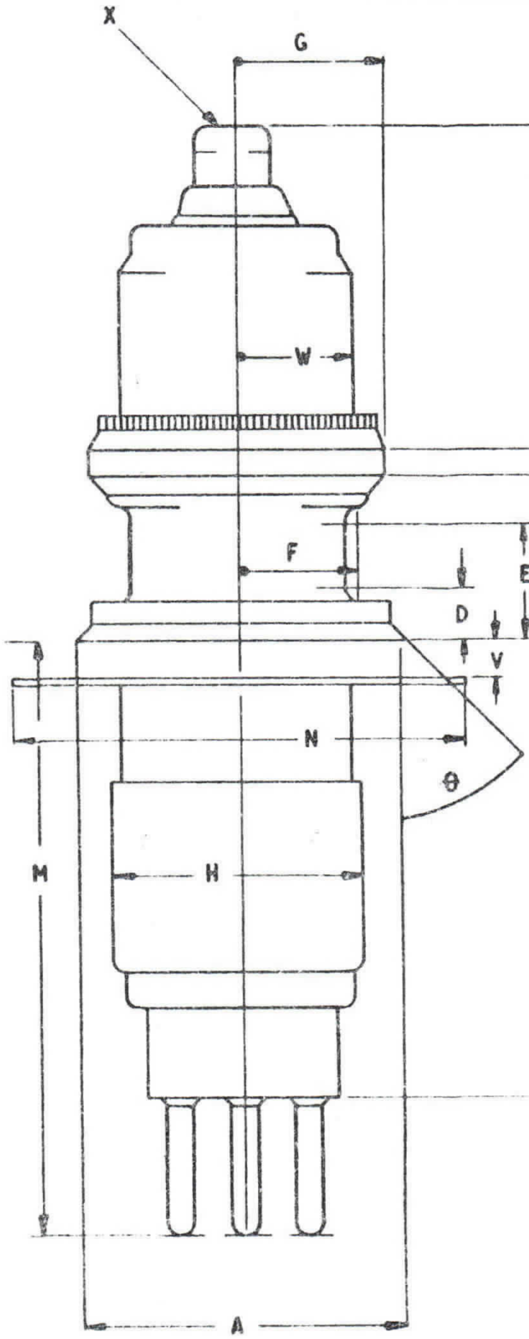
EMI KLYSTRON VALVE TYPE R 9559.



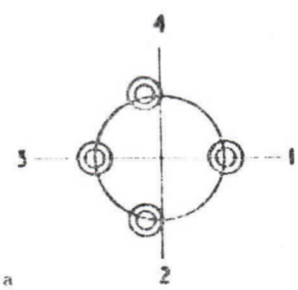
PHYSICAL DIMENSIONS.

	DIMENSIONS INCHES		REMARKS
A	0.985		REFERENCE SEATING
B	0.585	MAX.	– –
C	0.635	MIN.	– –
D	0.185	MAX.	– –
E	0.385	MIN.	– –
F	13/32	MAX.	BETWEEN DIMENSIONS D & E
G	0.470	MIN.	BETWEEN DIMENSIONS B & C
	0.485	MAX.	INCLUDING ECCENTRICITY
H	29/32	MAX.	
L	1 11/16	MIN.	
	1 15/16	MAX.	
M	2 7/32	MAX.	
N	1 7/16	MAX.	
V	0.120	MIN.	
W	13/32	MAX.	
X			TOP CAP CONFORMS TO BS 448 CT1 6/1.1
Y	1 9/32	MIN.	
	1 23/32	MAX.	
θ	45°		NOMINAL

BASE AMERICAN METAL SHELL MINIATURE 4 PIN 'PEE WEE' TYPE A4-76 BUT WITH LONGER SKIRT.

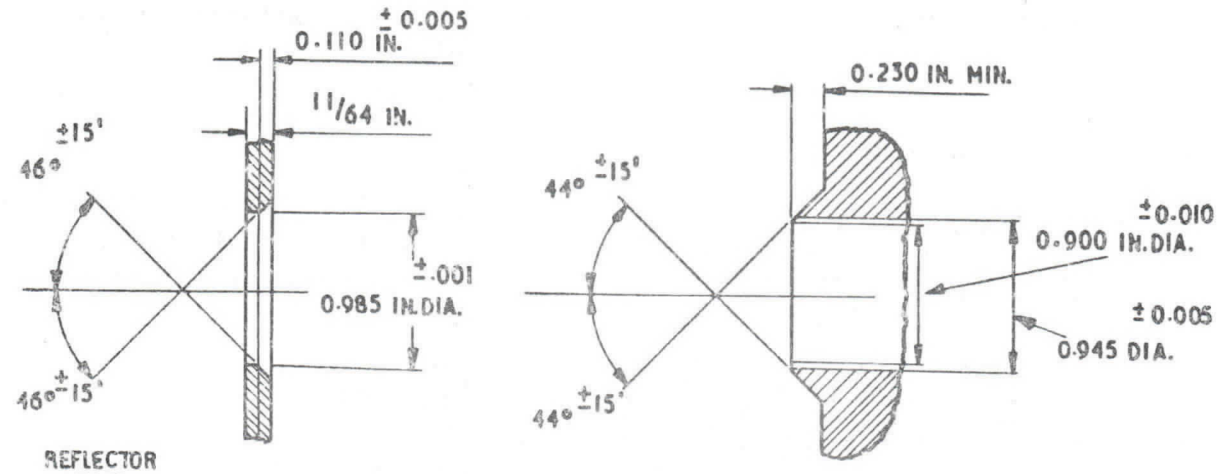
TUBE CONNECTIONS

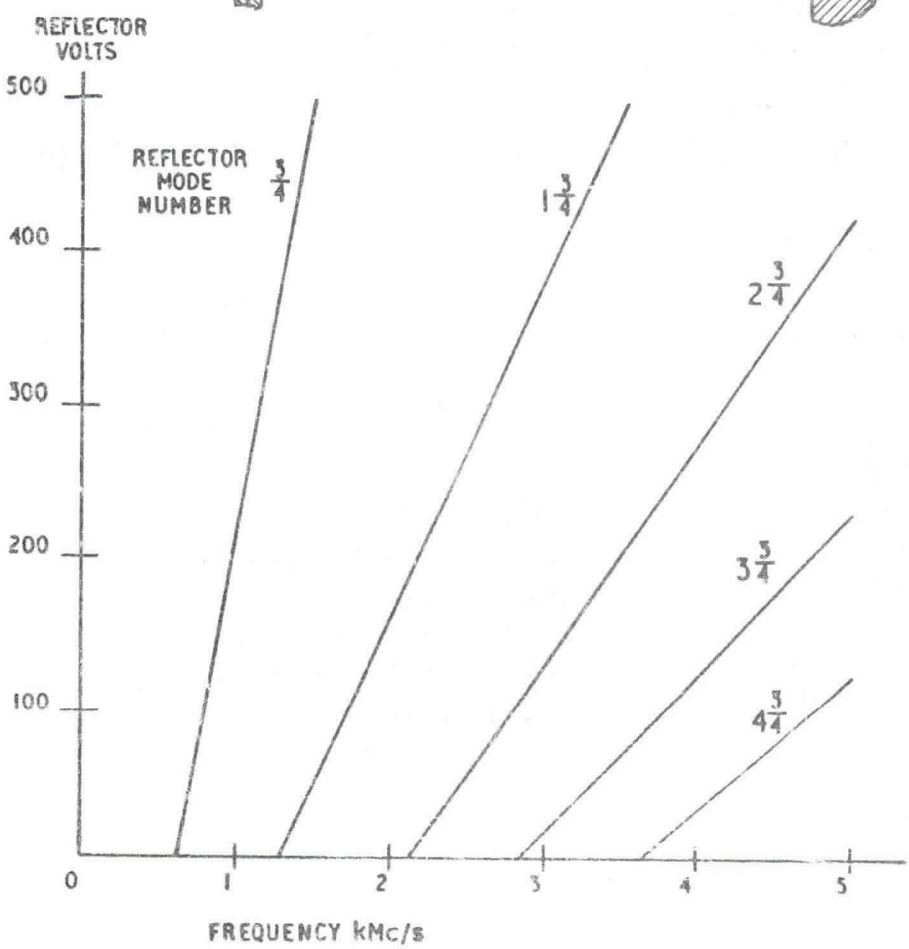
PIN 1 INTERNALLY CONNECTED
PIN 2 HEATER
PIN 3 INTERNALLY CONNECTED
PIN 4 HEATER AND CATHODE
TOP CAP REFLECTOR



M214/3a
DS254/3

RECOMMENDED METHOD OF CLAMPING REFERENCE SEATING





M214/4a

DS 254/4

EMI

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VALVE DIVISION

Reflex Klystron Type R6010

DESCRIPTION

A reflex velocity-modulated transmitting klystron, suitable for F.M. systems, with tunable internal cavity resonator giving 3½W over the range 4400 to 4800 Mc/s. The oxide coated cathode is indirectly heated.

MECHANICAL DATA *See diagram*

Output. Coaxial output line with launching probe.

Mounting. Any orientation may be used. The valve is designed to fit a mounting plate, specified in the diagram, and secured directly to a waveguide of internal dimensions 2″×1″. The launching probe should be approximately 2 cm from an adjustable reflecting piston.

Weight. 2¼ lb. 1 Kilogramme.

Cooling. The temperature of the valve envelope must not exceed 200° and the temperature of the external metal parts must be less than 150°C. Forced air cooling of the resonator is necessary and a minimum flow of 5 cu. ft./min. is normally satisfactory. Two tapped 6BA holes are provided for attachment of a cooling duct.

ELECTRICAL DATA

Connections. B8G base

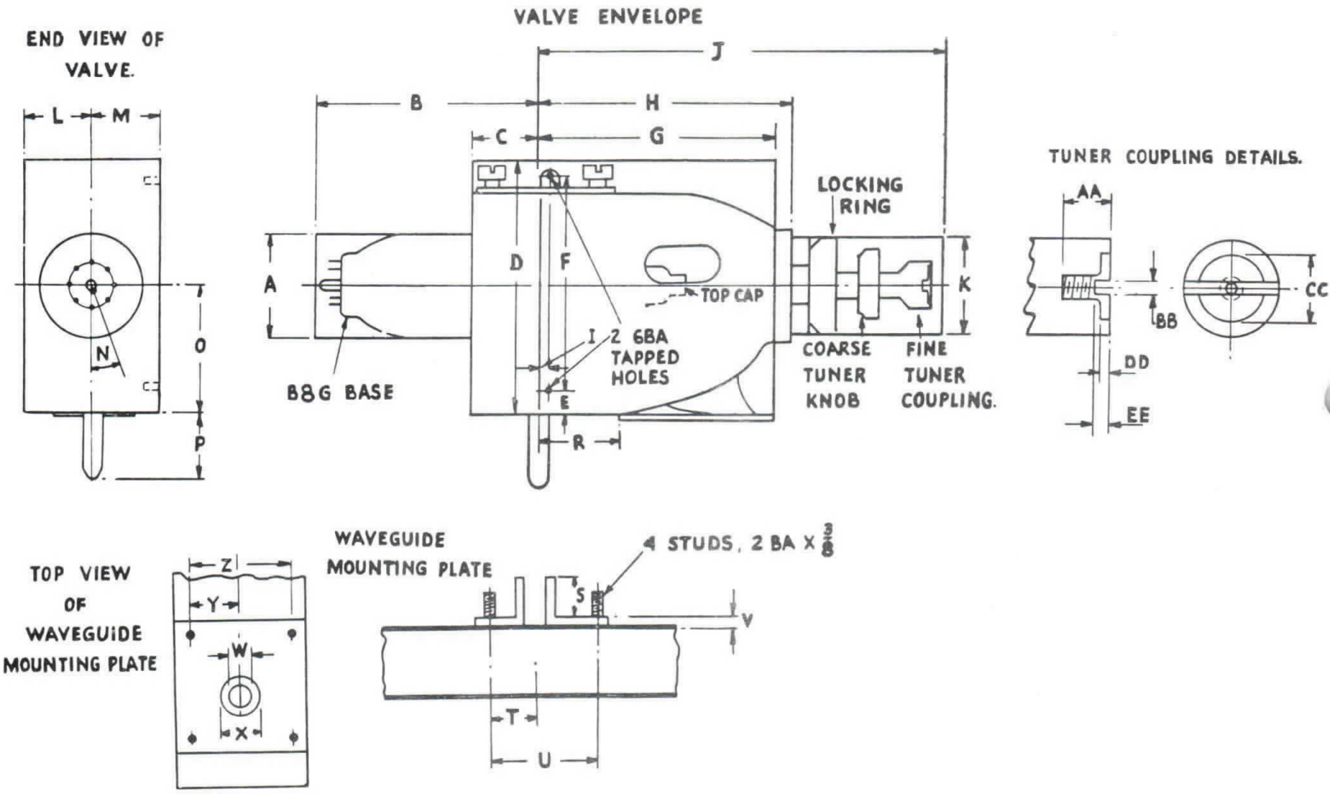
PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	TOP CAP	ENVELOPE
Cathode	Internally Connected	Cathode Shield	Heater	Cathode Shield	Heater	Internally Connected	Cathode Shield	Reflector	Resonator

RATINGS (Voltages measured with respect to the cathode)

Resonator Voltage V_A:	750V max.
Reflector Voltage V_R:	—150 to —550V.
Heater Voltage V_H:	6.3V nominal.
Cathode Shield Voltage V_S:	0 to —150V.
Electronic Tuning Range (Δf) between half power points:	20 Mc/s min.
Resonator Dissipation:	100W max.
Reflector Current I_R:	30μA max.
Heater Current I_H:	0.8 to 1.0A.
Cathode Shield Current I_S:	1mA max.
Change in V_R between half power points (ΔV_R):	110V nominal.

Power Output:	3W min.
Mechanical Tuning Range:	4400-4800 Mc/s.
Impedance in reflector-to-cathode circuit:	0.25 megohms max.
$\frac{\delta f}{\delta V_R}$:	0.18 Mc/s per V min.
Mechanical Tuning:	12 Mc/s per rev. on fine control.

Reflector must never be positive with respect to the cathode. Resonator voltage must never be applied in absence of reflector voltage. Cathode should be connected to one side of the heater. The heater should be switched on for at least 1 minute before V_A is applied.



ALL DIMENSIONS IN INCHES

A: 1.625" max. diameter
B: 3.500" max. length over base
C: 1.047" max.
D: 4.000" max. height
E: 3/8" nominal } Air duct fixing holes
F: 3 13/32" } Air duct fixing holes
G: 3.750" max.
H: 4.031"
I: 0.138"
J: 5.750" min. 6.375" max.
K: 1.500" diameter

L: 1.078" max.
M: 1.110" max.
N: 22½°±15°
O: 2.000" ± .001" Reference axis only. Base spigot is within 1/8" and tuner coupling within 1/16" of axis.
P: 1.094" max.
R: 1.250"
S: 0.625" max. height of output probe contacts.
T: 0.709"±.002"

U: 1.670"±.002"
V: 3/16" (from internal surface of waveguide).
W: 0.311"—.316" (see note).
X: 3/8" diameter
Y: 0.812"±.002"
Z: 1.625"±.002"
AA: .375" min. Hole tapped 2BA
BB: 0.096"±.004"
CC: 0.515"+.010", —.006"
DD: 0.062"±.010"
EE: 0.135"+.010", —.006"

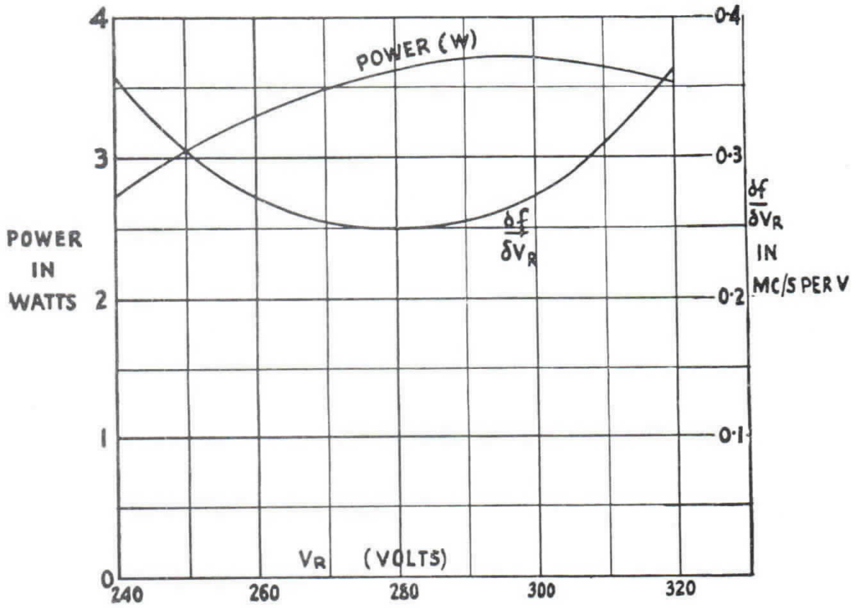
Note. Electrical contact with the outer surface of the coaxial output line, of diameter 0.311" to 0.314" must be made by resilient contact fingers, diameter W. The line of contact should be as close as possible to the waveguide.

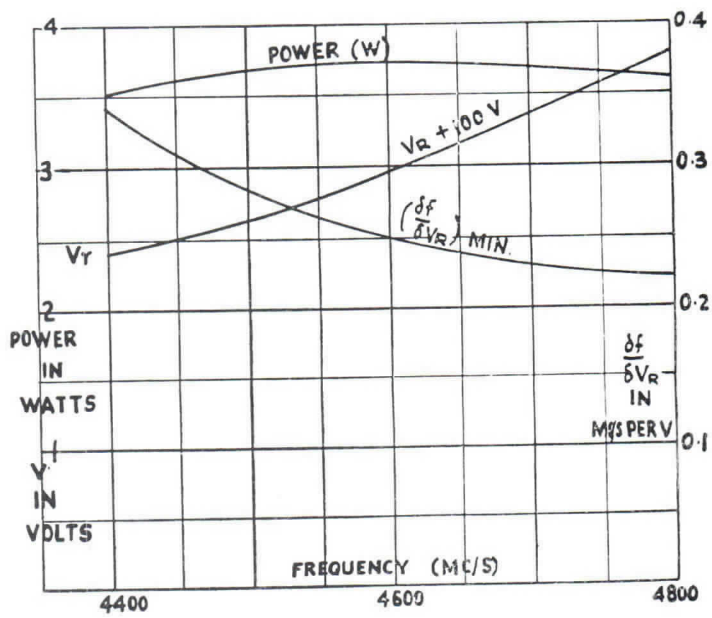
TYPICAL OPERATION Over band 4400-4800 Mc/s. Reflecting piston adjusted for maximum power into a matched load. $2\frac{3}{4}$ mode. V_A: 700V. I_A: 143mA. V_S: —60V. V_H: 6.3V. I_H: 0.9A.

Frequency:	Δf Mc/s	ΔV_R V	$\frac{\delta f}{\delta V_R}$ min. Mc/s per V	V_R for min. $\frac{\delta f}{\delta V_R}$ V	V_R for max. power V	Power W	Frequency range over which $\frac{\delta f}{\delta V_R}$ varies by 1.2 : 1. Mc/s
4400 Mc/s	55	115	.34	—220	—240	3.5	20
4600 Mc/s	50	115	.25	—275	—295	3.7	15
4800 Mc/s	35	115	.22	—360	—380	3.6	15

LINEARITY

Variation of $\frac{\delta f}{\delta V_R}$ over the mode is shown in the curve. It will be seen that the minimum value is obtained with V_R: 20V more positive than for maximum power. The values of $\left(\frac{\delta f}{\delta V_R}\right)$ min. and the frequency range for a given degree of linearity are critically dependent on adjustment of the reflecting piston. A displacement of about 5 mm. towards the valve from the position of the piston giving maximum power output, may increase $\left(\frac{\delta f}{\delta V_R}\right)$ min. and the linear range by more than 50% for only a small decrease in power. The actual value of piston displacement for maximum linear range varies from valve to valve.





LIFE

Laboratory life tests with the valve switched off for 1½ hours in every eight, show operating lives in excess of 2500 hours with V_H 6.3V. It is recommended that valves should not be run while not oscillating for any appreciable period.

WARMING-UP TIME

The valve is within 2 Mc/s of final frequency 5 minutes after the application of resonator voltage and characteristics are substantially stable after a further 10 minutes.

OVERALL TEMPERATURE COEFFICIENT

After thermal equilibrium is reached, the change in frequency, due to a variation in cooling air temperature, is about 2 Mc/s for a 20° temperature change.

HEATER MODULATION

If A.C. is used for the heater supply, about 60 kc/s modulation will be obtained on the R.F. output. In applications where this is not admissible, D.C. must be used.

MICROPHONY

The level of microphony is low and the valve is suitable for use in transportable frequency-modulated television links.

The Company reserves the right to modify these designs and specifications without notice.

EMI

E M I Electronics Ltd Valve Division

HAYES MIDDLESEX ENGLAND *(Controlled by Electric and Musical Industries Ltd)*

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EMI ELECTRONICS LTD

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VALVE DIVISION

Reflex Klystron Type R6015

DESCRIPTION

A reflex, velocity-modulated, local oscillator valve with tunable internal cavity resonator, covering the range 4270 to 4760 Mc/s. The oxide coated cathode is indirectly heated.

MECHANICAL DATA

(See diagram)

Output Coaxial output line with launching probe.

Mounting Any orientation may be used. The valve is designed to fit a mounting plate, specified in the diagram, and secured directly to a waveguide of internal dimensions 2″ × 1″. One end of the waveguide should be terminated by a reflecting piston.

Weight 2 lb. 1 Kilogramme.

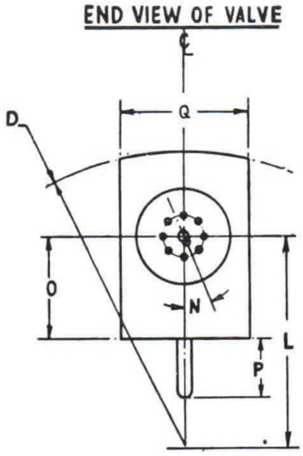
Cooling The temperature of the valve envelope must not exceed 200°C, and the temperature of the external metal parts should be less than 150°C. Forced air cooling is not usually necessary.

ELECTRICAL DATA

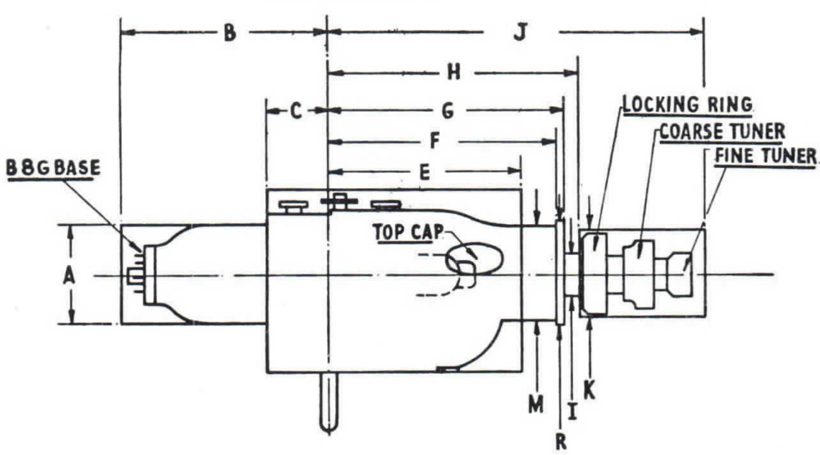
Connections B8G Base

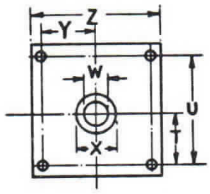
PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	TOP CAP	ENVELOPE
Cathode	Internally Connected	Cathode Shield	Heater	Cathode Shield	Heater	Internally Connected	Cathode Shield	Reflector	Resonator

END VIEW OF VALVE

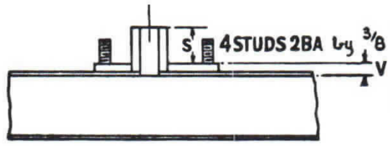


VALVE ENVELOPE





TOP VIEW OF WAVEGUIDE MOUNTING PLATE



WAVEGUIDE MOUNTING PLATE.

ALL DIMENSIONS IN INCHES

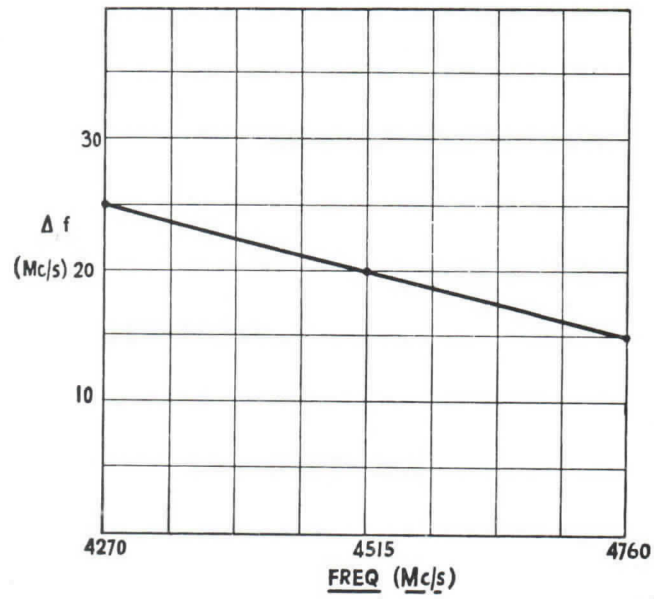
A : 1.625 max. diameter
B : 3.500 max. length over base
C : 1.047 max.
D : 4.938 max. radius
E : 3.250 max.
F : 3.875 min.
G : 4.031 max.
H : 4.250 max.
I : 0.656 max. diameter
J : 5.750 min. 6.375 max.
K : 1.500 max. diameter
L : 3.500
M : 1.540 max. diameter
N : $22\frac{1}{2}° \pm 15°$
O : 1.688 ± .001 Reference axis only. Base spigot is within $\frac{1}{8}$″ and tuner knobs within $\frac{1}{16}$″ of axis
P : 1.094 max.
Q : 2.188 max.
R : 1.656 max. diameter
S : 0.625 max. height of output probe contacts
T : 0.709 ± .002
U : 1.670 ± .002
V : $\frac{3}{16}$″
W : 0.311″ to .316″ (see Note)
X : $\frac{5}{8}$″ diameter
Y : 0.812 ± .002
Z : 1.625 ± .002

Note Electrical contact with the outer surface of the coaxial output line must be made by resilient contact fingers, of diameter W.

ELECTRICAL DATA—Ratings

(Voltages measured with respect to the cathode)

Resonator Voltage V_A:	300V max.
Reflector Voltage V_R:	—50 to —250
Heater Voltage V_H:	6.3V
Cathode Shield Voltage V_S:	0 to —100V
Resonator Current:	70mA max. at V_A 275V.
Reflector Current I_R:	10μA max.
Heater Current I_H:	0.8 to 1.0A
Cathode Shield Current I_S:	1mA max.
Electronic Tuning Range ($\triangle f$) between half power points:	10 Mc/s min. (± 5 Mc/s min. from max. power point)
Average reflector sensitivity $\frac{\triangle f}{\triangle V_R}$ between half power points:	0.2 Mc/s per V min.
Power Output:	30mW min. at V_A 250V.
Mechanical Tuning Range:	4270-4760 Mc/s
Impedance in reflector cathode circuit:	0.25 megohms max.
Mechanical Tuning:	12 Mc/s per rev. on fine control



TYPICAL OPERATION

Over band 4270-4760 Mc/s. Reflecting piston set 0.827" from launching probe. Waveguide terminated by matched load.

V_A: 250V. V_S: 0V. V_H: 6.3V. I_H: 0.9A.
Under these conditions I_A will not exceed 50mA.

	$\triangle f$ Mc/s	$\triangle V_R$ V	V_R for max. power	Power mW
Frequency 4270 Mc/s	25	40	160	130
4515 Mc/s	20	37	200	110
4760 Mc/s	15	22	130	60

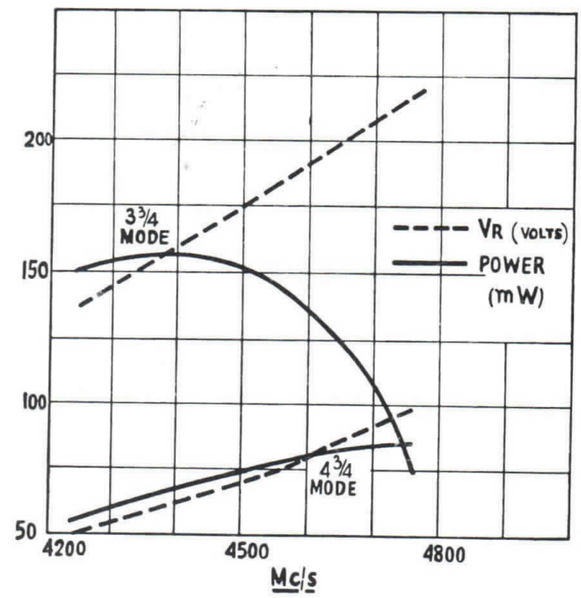
At V_A: 275V, V_S=0, I_A is not greater than 70mA; power and $\triangle f$ are increased by 10% to 15%

Life Laboratory life tests with the valve switched off 1½ hours in every twelve, show operating lives in excess of 2,500 hours with V_H: 6.3V. It is recommended that valves should not be run while not oscillating for any appreciable period.

Warming-up Time The valve characteristics, including frequency, are substantially stable 15 minutes after application of the resonator voltage. The total frequency drift during warming up is about 2 Mc/s.

Overall Temperature Coefficient After thermal equilibrium is reached, the change in frequency, due to a change of ambient temperature, is about 0.1 Mc/s per degree centigrade.

Microphony The valve is suitable for use in transportable frequency-modulated television links.



MADE IN GREAT BRITAIN

The Company reserves the right to modify these designs and specifications without notice.

EMI

EMI Electronics Ltd Valve Division

HAYES MIDDLESEX ENGLAND (*Controlled by Electric and Musical Industries Ltd*)

Telephone: *Southall 2468* Cables: *Emidata, London.* Telex *London 22417*

P.S. 1200

Printed in England by E.M.I. Ltd.

EMI ELECTRONICS LTD
Serving Science and Industry

VALVE DIVISION

EMI KLYSTRON TYPE RK6112A

The RK6112A is a low voltage, reflex velocity modulated valve for use as a local oscillator in the 10 cm ("S") Band. It is of the plug-in type, with disc seals for resonator connection, and is indirectly heated.

CHARACTERISTICS

MECHANICAL (See figure overleaf)

ELECTRICAL

Power output	100 mW minimum	Reflector current	4 μA max.
Frequency range (with suitable cavity)	2600 to 3700 Mc/s	Cathode shield voltage*	0 V
Resonator voltage*	+ 250 V	Heater voltage	6.3 V
Resonator current	18 to 34 mA	Heater current	0.7 A max.
Reflector voltage range*	-55 to -350 V		

* Measured with respect to Cathode

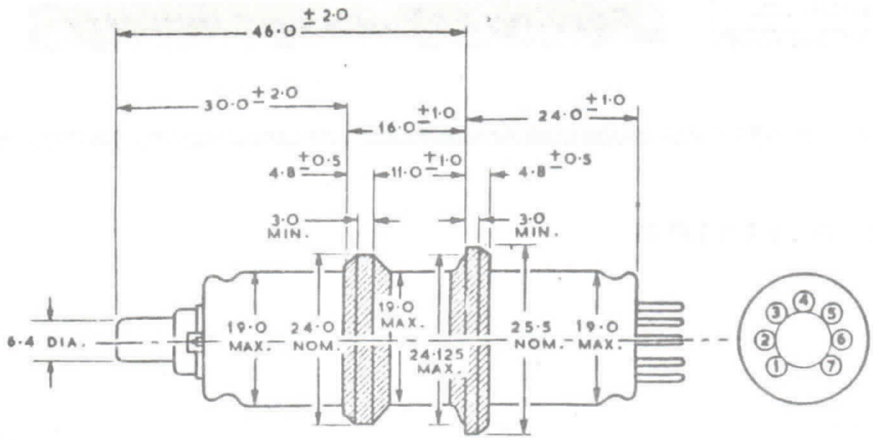
PERFORMANCE

The following figures were obtained from typical valves operating at three nominal frequencies and using the fixed frequency cavities mentioned below.

Nominal frequency	Peak power (min.)	½ Power point "A"		½ Power point "B"		Change in refl. voltage "A" to "B"	Change in frequency "A" to "B"
		Max. refl. V	Max. frequency	Min. refl. V	Min. frequency		
2640 Mc/s	100 mW	95 V	2640 Mc/s	95 V	2640 Mc/s	19 to 38 V	16 to 30 Mc/s
3200 Mc/s	100 mW	175 V	3200 Mc/s	175 V	3200 Mc/s	35 to 55 V	16 to 32 Mc/s
3700 Mc/s	100 mW	Peak power obtained at 3700 Mc/s ± 15 Mc/s with reflector voltage 255 V ± 35 V.					

Frequency	Type of cavity	Appropriate loaded Q
2640 Mc/s	¼ wave radial	140
3200 Mc/s	¼ wave radial	185
3700 Mc/s	¾ wave co-axial	680

DIMENSIONS



All dimensions are in millimetres.

BASE CONNECTIONS Base type B7G

Pin No.	1	2	3	4	5	6	7	TC	DS
Electrode	KS	K	NC	KS	H	KS	H	ReF	ReS

DS = Disc seals H = Heater K = Cathode KS = Cathode shield

NC = No connection ReF = Reflector ReS = Resonator TC = Top cap

DIMENSIONS OF CONTACT COPPERS

Contact copper	Nominal diameter	Will go through ring-gauge of dia:	Will not go through calipers separated by:
Large copper	25.5	25.63	25.37
Small copper	24.0	24.13	23..87

MAXIMUM ECCENTRICITIES RELATIVE TO LARGE COPPER

Small copper	Top cap	Base
0.30	0.45	0.75

M204/2b
DS.145/2

The Company reserves the right to modify the designs and specifications without notice

E M I Electronics Ltd Valve Division

Hayes Middlesex England (*Controlled by Electric & Musical Industries Limited*)

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Ref. 10772 CP

EMI ELECTRONICS LTD

Serving Science and Industry

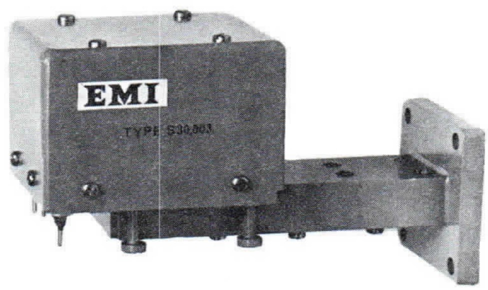
VALVE DIVISION

NEW PRODUCT DATA

EMI SOLID STATE X–BAND SOURCE TYPE S30.003

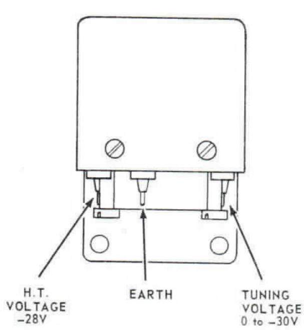
This voltage-tuned solid state source consists of a transistor oscillator circuit, varactor tuned, coupled to a step-recovery diode harmonic generator.

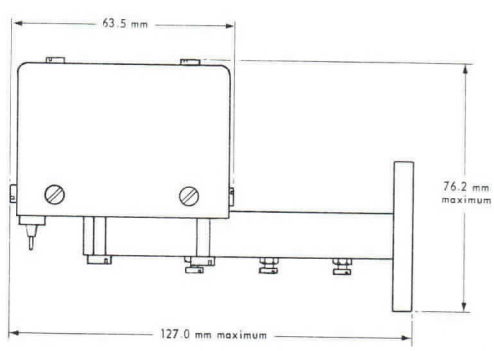
Three frequency variants are available in the range 8.5 GHz to 9.6 GHz, each tunable over 400 MHz, which is also the electronic tuning range.

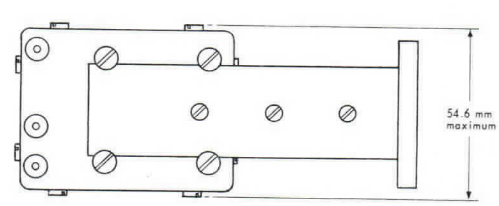


Provisional Specification

Power output	15 mW minimum	Input current	120 mA typical 150 mA max.
Tuning range		Ambient Temperature range	$-35^{\circ}C$ to $+75^{\circ}C$
S30.003/1	8.5 GHz to 8.9 GHz	Weight	0.68 kg (1.5 lb)
S30.003/2	8.85 GHz to 9.25 GHz	Output	Waveguide WG16 (RG52/U)
S30.003/3	9.2 GHz to 9.6 GHz	Flange	Square (5985–99–083–0052 or UG–40A/U)
Tuning voltage	0 to –30V d.c.		
Input voltage	–28V d.c. –30V d.c. max.		







M281/1a
DS.884

The Company reserves the right to modify the designs and specifications without notice

EMI

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *01-573 3888 Extension 2115* Cables: *Emidata, London* Telex: *London 22417*

Ref No. 10772B CP

CAMERA TUBES

Electron Tube Division

EMI VIDICON CAMERA TUBE TYPES

STANDARD 26 mm (1 in) SEPARATE MESH VIDICONS

Suitable for broadcast and closed circuit applications

Standard length 6.3 V 90 mA	Standard length 6.3 V 300 mA	Short length 6.3 V 90 mA	Rugged * short length 6.3 V 90 mA	Description and application
9677SC	9728SC			Selected tube for use in Colour Cameras.
9677S1	9728S1	9706S1		High grade tube for Broadcast Studio use.
9677S2	9728S2	9706S2		General tube for Broadcast and Educational Studio use.
9677F1	9728F1	9706F1		High grade tube for Broadcast Telecine use.
9677F2	9728F2	9706F2		General tube for Broadcast and Educational Telecine use.
9677B	9728B	9706B	9730B	High grade tube for Industrial use under low light level.
9677C	9728C	9706C	9730C	General Industrial tube.
9677M	9728M	9706M	9730M	Tube to relaxed blemish specification
9677 Amateur	9728 Amateur			Economical tube for experimental use.

SPECIAL PURPOSE 26 mm (1 in) SEPARATE MESH VIDICONS

Tubes with special faceplates, targets or other features making them suitable for particular applications.

9677Q 9728Q	(90 mA heater) (300 mA heater)	Tubes with quartz faceplates for use in fields of nuclear radiation.
9677UV/1 9728UV/1	(90 mA heater) (300 mA heater)	Tubes with quartz faceplates and unity gamma ultra violet sensitive targets. The red response is negligible (2500 Å to 6000 Å).
9677UV/2 9728UV/2	(90 mA heater) (300 mA heater)	As 9677UV/1 and 9728UV/1 but exhibiting small background blemishes at high sensitivity.
9677D	(90 mA heater)	Type 9677 with fibre-optic faceplate.
9730N *	(90 mA heater)	Similar to 9730 but meeting a rugged specification.
9745	(90 mA heater)	Tube with electrostatic deflection and focus. Other features include high resolution and good geometry.

13 mm (½ in) SEPARATE MESH VIDICONS*

9737	(90 mA heater)	Similar to 9738, with a unity gamma fine grain target for slow scan applications such as star tracking.
9738	(90 mA heater)	Rugged construction for general use. The resolution capability is exceptionally high for this size of vidicon. (Interchangeable with earlier type 9697).
9738N	(90 mA heater)	Similar to 9738 but meeting a rugged specification
9738Q	(90 mA heater)	Tube with quartz faceplate for use in field of high nuclear radiation.
9768	(90 mA heater)	Tube with electrostatic deflection and focus.

OBSOLESCENT 26 mm (1 in) INTEGRAL MESH VIDICON

10667M	(600 mA heater)	Tube with high wattage heater, incorporating a side pip and integral mesh. Suitable for amateur and experimental use.

* Mesh connection brought out adjacent to target connection.

Tube to be replaced			Suggested EMI replacement (Separate mesh construction)			
Type No.	Heater current at 6.3 V. mA	Integral or separate mesh	Direct replacement type	Similar replacement type	Heater current at 6.3 V. mA	Refer to notes
C102A	300	SM	9728C	–	300	–
C102B	95	SM	9677C	–	90	–
C103A	300	SM	9728S2	–	300	–
C103B	95	SM	9677S2	–	90	–
C104A	300	SM	9728F2	–	300	–
C104B	95	SM	9677F1	–	90	–
C105A	300	SM	9728Q	–	300	–
C105B	95	SM	9677Q	–	90	–
HS200	600	IM	–	9728C or M	300	1 & 2
HS200A	600	IM	–	9728S2	300	1 & 2
HS201	600	IM	–	9728B	300	1 & 2
HS201A	600	IM	–	9728B	300	1 & 2
P810	600	IM	–	9728C	300	1 & 2
P841	600	SM	–	9728C	300	1
P841X	600	SM	–	9728B	300	1
P842	95	SM	9677S2	–	90	–
P842X	95	SM	9677B	–	90	–
P843	600	SM	–	9728F2	300	1
P844	95	SM	9677F2	–	90	–
P846	600	SM	–	9728S1	300	1
P847	95	SM	9677S1	–	90	–
P848	600	SM	–	9728C	300	1
P849	95	SM	9677C	–	90	–
P860	600	IM	–	9728S1	300	1 & 2
P862	95	IM	–	9677M	90	2
P863	95	SM	9730B	–	90	–
P864	95	IM	–	9677C	90	2
XQ1001	300	SM	9728B	–	300	–
XQ1002	300	SM	9728S2	–	300	–
XQ1003	300	SM	9728C	–	300	–
XQ1004	300	SM	9728M	–	300	–
XQ1030	95	IM	–	9677M	90	2
XQ1040	95	SM	9677F2	–	90	–
XQ1041	95	SM	9677B	–	90	–
XQ1042	95	SM	9677S2	–	90	–
XQ1043	95	SM	9677C	–	90	–
XQ1044	95	SM	9677M	–	90	–
XQ1050	300	SM	9728F2	–	300	–
XQ1051	300	SM	9728B	–	300	–
XQ1052	300	SM	9728S2	–	300	–
XQ1053	300	SM	9728C	–	300	–
XQ1054	300	SM	9728M	–	300	–
2255AMR	300	SM	9728M	–	300	–
2255FIM	300	SM	9728F1 or F2	–	300	–
2255IND	300	SM	9728C	–	300	–
2255ROE	300	SM	9728S1 or S2	–	300	–
4478	600	IM	–	9728M	300	1 & 2
4488	600	IM	–	9728M	300	1 & 2
7038	600	IM	–	9728F1 or F2	300	1 & 2
7226	150	IM	–	9677B or C	90	1 & 2
7262A	95	IM	–	9706C or M	90	2
7325	600	IM	–	9728C	300	1 & 2
7735A	600	IM	–	9728C or M	300	1 & 2
7735B	600	IM	–	9728S2	300	1 & 2
8484	600	IM	–	9728B	300	1 & 2
8507A	600	SM	–	9728S2 or C	300	1
8541	95	SM	9677S2	–	90	–
8572	600	SM	–	9728F2	300	1
8573	95	SM	9706S2 or C	–	90	–
8604	95	SM	9677F2	–	90	–
8625	600	SM	–	9728S1	300	1
8626	95	SM	9677S1	–	90	–
C9132	300	IM	–	9728C	300	2
C9132A	300	SM	9728C	–	300	–
C9133	300	IM	–	9728S2	300	2
C9133A	300	SM	9728S2	–	300	–

GEABILITY INFORMATION

Tube to be replaced			Suggested EMI replacement (Separate mesh construction)			
Type No.	Heater current at 6.3 V. mA	Integral or separate mesh	Direct replacement type	Similar replacement type	Heater current at 6.3 V. mA	Refer to notes
TH9806	150	IM	–	9677S2	90	1 & 2
TH9806PA	150	SM	–	9677S2	90	1
TH9807	150	IM	–	9677F2	90	1 & 2
TH9807PA	150	SM	–	9677F2	90	1
TH9808	150	IM	–	9677C	90	1 & 2
TH9808PA	150	SM	–	9677C	90	1
TH9808N	150	IM	–	9677Q	90	1 & 2
TH9812	150	IM	–	9677B	90	1 & 2
TH9812PA	150	SM	–	9677B	90	1
TH9814	150	IM	–	9677B or C	90	1 & 2
TH9814PA	150	SM	–	9677B or C	90	1
TH9815	150	IM	–	9677B	90	1 & 2
TH9815PA	150	SM	–	9677B	90	1
TH9817	150	IM	–	9677S1	90	1 & 2
TH9817PA	150	SM	–	9677S1	90	1
TH9896	150	SM	–	9677UV	90	1
10667F	600	IM	–	9728F2	300	1 & 2
10667G	600	IM	–	9728C	300	1 & 2
10667M	600	IM	–	9728M	300	1 & 2
10667S	600	IM	–	9728S2	300	1 & 2
10667SC	600	IM	–	9728SC	300	1 & 2
10667UV	600	IM	–	9728UV	300	1 & 2
55850AM	90	IM	–	9677M	90	2
55850F	90	IM	–	9677F2	90	2
55850N	90	IM	–	9677C	90	2
55850S	90	IM	–	9677S2	90	2
55850SR	90	IM	–	9677B	90	2
55851AM	90	SM	9677M	–	90	–
55851F	90	SM	9677F2	–	90	–
55851N	90	SM	9677C	–	90	–
55851S	90	SM	9677S2	–	90	–
55851SR	90	SM	9677B	–	90	–
55852AM	300	SM	9728M	–	300	–
55852F	300	SM	9728F2	–	300	–
55852N	300	SM	9728C	–	300	–
55852S	300	SM	9728S2	–	300	–
55852R	300	SM	9728B	–	300	–

Suggested Direct Replacement Types are tubes which will operate directly in equipment designed around the original types. The tubes may not, however, be identical in all respects, e.g., spectral response.

Suggested Similar Replacement Types are tubes which will operate in the majority of equipment designed around the original types. It may, however, be necessary to make some minor modification to the equipment.

Note 1. Care should be taken when using tubes of differing heater currents, that the supply arrangement is suitable.

Note 2. When using a separate mesh (SM) tube in place of an integral mesh (IM) tube, pins 3 and 6 should be strapped together on the tube socket, or the camera modified electrically for separate mesh operation.

For further information on the relative operation of the above types or for suggested alternatives to types not listed, please contact the Electron Tube Division at our address overleaf or by telephone 01–573 3888, Ext.2078. Full data sheets on EMI manufactured tubes are available.

T402/3kY70 DS.537/3

PRODUCT RANGE OF
EMI ELECTRON TUBE AND MICROELECTRONICS DIVISION

The **EMI ELECTRON TUBE DIVISION** manufactures a wide range of special electron tubes for equipment used in broadcasting, radar, nuclear and scientific applications.

★ PHOTOMULTIPLIER TUBES Ext. 2074

Photomultiplier tubes, which convert very low levels of illumination into usable electric currents are used extensively in astronomy, spectrophotometry, scintillation counting, spectrometry and broadcast television.

★ CAMERA TUBES Ext. 2078

There is a wide range of vidicons, including all-electrostatic, available in various grades from general surveillance to broadcast studio.

★ IMAGE INTENSIFIERS Ext. 2075

The image intensifier tube, capable of multiplying light up to a million times, is important for such applications as microscopy and astronomy.

★ CATHODE RAY TUBES Ext. 2073

EMI activities in pioneering television have generated a range of specialised cathode ray tubes for radar and telecine work.

★ SPECIAL PRODUCTS Ext. 2551

New products include the Printicon, a small, low voltage, all-electrostatic monoscope, which is used for generating alpha-numeric symbols, spectroscopic lamps for atomic absorption and spectrometry and a range of printed circuit deflection coils, such as used in the successful EMI Colour TV Camera.

The EMI Electron Tube Division has great experience and comprehensive facilities in research, development and manufacture of light sensing and light emitting devices, and allied equipment.

NOTE:

For further information please telephone the extension shown opposite each product and service.

The **EMI MICROELECTRONICS DIVISION** provides for the increasing demands made upon the ability of electrical and electronic equipment designers to meet high density packaging, reliability, weight, and cost requirements. This can only be achieved by taking full advantage of modern fabrication and design methods. The EMI Microelectronics Division offers these facilities to its customers in the following product areas:–

★ Thin and Thick Film Passive Networks

Thin and Thick Film Hybrid Integrated Circuits

Temperature Sensing Elements

Flexible Printed Wiring

Double-sided and Through-plated Printed Circuit Boards

Multilayer Printed Circuit Boards Ext. 2463

Production facilities have been built up over several years to meet the need for economic batch, and large volume, manufacture. The production unit is supported by a comprehensive Circuit Design and Draughting Group, and a Quality Control Division.

A continuous R. & D. programme ensures that full advantage is taken of the latest technological developments in manufacturing processes. Microcircuit design is aided by the use of a computer programmed to predict thermal contours.

Continuous on-line monitoring of all processes is maintained during all stages of production and testing.

The environmental test facilities available within EMI Electronics together with the calibration and standardisation procedures, have been approved by the Ministry of Technology and the Air Registration Board.

★ CUSTOMER ENGINEERING SERVICE Ext. 2463

A team of engineers fully experienced in both circuit and systems design is available to assist customers in applying microelectronic techniques to the solution of particular problems. This facility covers all aspects of system design, the rationalization of integrated circuits, thermal management and packaging.

FLEXIBILITY

The EMI Microelectronics Division is an integrated unit, with design and manufacturing facilities not allied to any particular aspect of microelectronics technology. The resulting flexibility enables the achievement of the optimum design package to meet customers' needs.

G911a

EMI

EMI Electronics Ltd Electron Tube Division

Hayes Middlesex England Telephone: *01-573 3888*

Cables: *Emidata, London* Telex: *London 22417*

EMI

EMI ELECTRONICS LTD

Serving Science and Industry

VALVE DIVISION

EMI CAMERA TUBE TYPES

4½-INCH IMAGE ORTHICON

Type 9564	Wide-spaced tube for outside broadcast or studio use (JEDEC type 7295).
Type 9565	Close-spaced tube for studio use (JEDEC type 7389).

1-INCH VIDICON

The EMI Standard Vidicon is the 9677 (JEDEC type 8566). This tube employs a sensitive and uniform target of substantially panchromatic response. It employs the separate mesh construction, pioneered by EMI Electronics Ltd. to give increased resolution and ease of operation. The tube is fitted with a low-wattage heater (6.3 V, 95 mA). The 9677 is available in the following grades:-

Type 9677A	Here the "A" denotes a specially selected tube for individual requirements (e.g. 9677A/SC specially selected studio colour Vidicon).
Type 9677B	Standard high-quality tube for Broadcast and industrial use.
Type 9677C	General Industrial use.
Type 9677M	A tube which falls outside the "C" grade specification in one or more parameters.
Type 9728	Similar to all the above types with 0.3 A Heater at 6.3 V.
Type 9730	Rugged short length tube (5¼ in overall) with mesh connection ring close to target ring and low-wattage heater. Tested 40 to 2000 c/s vibration to 5 G.

1-INCH VIDICON WITH SPECIAL TARGET AND/OR FACEPLATE

Type 9677Q	Standard target with quartz faceplate for operation in high nuclear radiation fields.
Type 9677UV/1	Quartz faceplate and high ultra violet and blue sensitive target with negligible red response. Blemishes as 9677C (2500 Å to 6000 Å).
Type 9677UV/2	As above but with many very small white blemishes but quite acceptable for most ultra violet applications.
Type 9677IR	Tube with infra-red sensitivity to 1 micron (To special order).
Type 9686	Tube similar to 9677 but employing a fibre-optic faceplate.

½-INCH VIDICON

Type 9697	Low-wattage heater tube with exceptionally high resolution capabilities for this size vidicon. Separate mesh connection ring close to target ring.
Type 9738	Rugged ½-inch version of 9730
Type 9737	Similar to 9738 with the addition of a unity gamma fine grain target for slow scan applications (e.g. star tracking).

OBSOLETE TYPES OF 1-INCH VIDICON

Type 10667G	Industrial tube with 6.3 V, 0.6A, heater and incorporating a side-pip.
Type 10667M	As above but with relaxed specification for target blemishes.

E M I Electronics Ltd. Valve Division

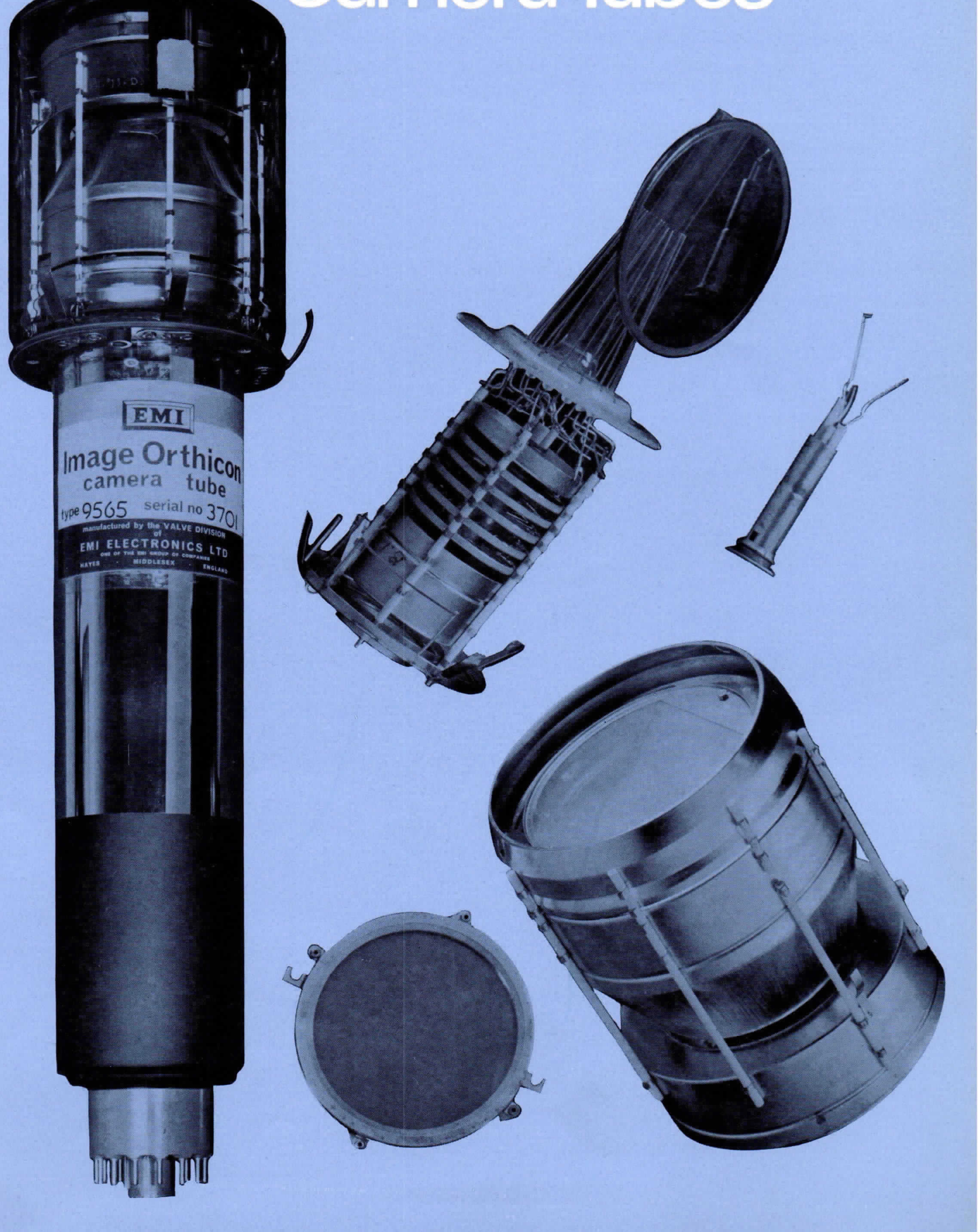
Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Ref. 10772 CP

EMI

4½-inch Image Orthicon Television Camera Tubes



Contents

Valve Division, one of the most rapidly expanding divisions of EMI Electronics Ltd., manufactures a wide range of special valves and tubes for equipment used in broadcasting, radar, nuclear and other applications; 4½-inch image orthicon camera tubes are described in detail in this brochure.

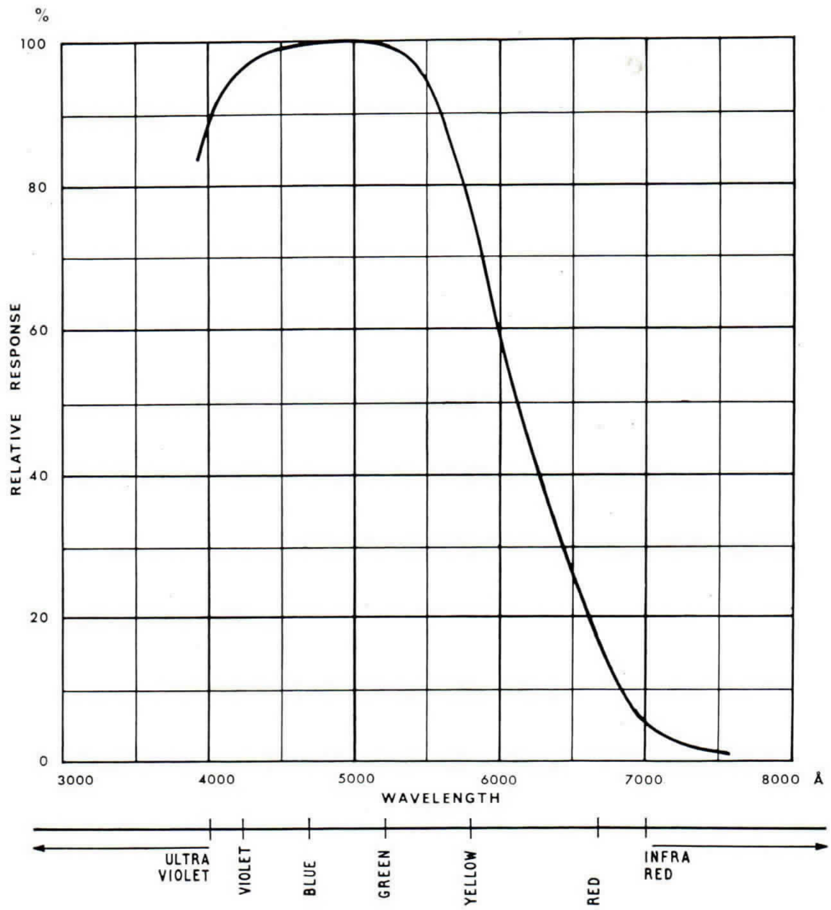
The range of camera tubes includes the 4½-inch image orthicons and 1-inch and ½-inch vidicons; the vidicons include both ultra-violet and infra-red sensitive versions.

Photomultiplier tubes suitable for astronomy, spectrophotometry, scintillation counting, X-ray spectrometry and other applications are produced. Their diameters range from ½ inch to 15 inches. Spectral coverage is from 1,200 Å to 12,000 Å and tube gains of up to 10^9 are available.

The range of klystrons and magnetrons covers wavelengths from 30 cm to 4 mm whilst power output ranges from a few milliwatts to several megawatts. These tubes are extensively used in military and civil radar and communications applications.

Other Valve Division products are high gain multi-stage image intensifiers, barrier grid storage tubes, and the electron stick, a versatile device for teaching the principles of microwave tubes. Specialised components include honeycomb grids, fine meshes, and ceramic metal seals. A small range of photoconductive cells is also produced.

S10 Relative Spectral Response



EMI $4\frac{1}{2}$-inch Image Orthicon Camera Tubes

JEDEC 7295 (EMI Type 9564)

JEDEC Type 7295 (**EMI Type 9564**) **and**

JEDEC Type 7389 (**EMI Type 9565**)

EMI $4\frac{1}{2}$-inch Image Orthicon Camera Tubes meet the most exacting requirements when used in a standard image orthicon television camera for any broadcast or closed-circuit applications.

JEDEC 7389 (EMI Type 9565), with standard target capacity, is intended for use in controlled studio lighting conditions. JEDEC 7295 (EMI Type 9564), with lower target capacity, is intended for general studio use and remote pick-up applications in poor lighting conditions.

Features

- No free-running microphony
- Minimal shock microphony
- Excellent stable shading characteristics
- Improved subjective signal-to-noise ratio
- Particularly faithful reproduction of facial tones
- Non-burning high-gain first diode
- High sensitivity free from sudden changes

Performance

Both the JEDEC Type 7295 and the JEDEC Type 7389 have an excellent signal-to-noise ratio with minimum low frequency noise. Minimum edge and black halo effects and a superior grey scale give pictures of very natural appearance. The low amplitudes of overshoots and halo result in a more faithful reproduction of the picture content, particularly important in the reproduction of facial tones. The depth of modulation at 400 television lines (using a sine wave test pattern) is typically 70%. Both types have a wide range of linear transfer characteristics which provide an improved grey scale. The background shading is stable and maintained at a high standard throughout life. The spectral response closely approaches that of the human eye.

When operated at 405 lines, 50 fields per second, the 7295 has an average sensitivity of 25 foot-Lamberts at f/11 for half a stop over the knee, and the 7389 has an average sensitivity of 25 foot-Lamberts at f/8 for half a stop over the knee.

At 625 lines and 525 lines, 60 fields per second, both have an average of half a stop lower sensitivity. However, for a bandwidth of 5 Mc/s on 525 and 625 lines, signal-to-noise ratio is the same as for a 405 line system with a 3 Mc/s bandwidth.

An outstanding feature is the complete absence of free running microphony. Induced microphony is rapidly damped, and the tubes have very little response to external mechanical excitation. A particular characteristic is the very fine grain non-burning first dynode. In the average tube the first dynode is barely visible in the dark even when the beam is brought to focus on it. However, the gain of the first dynode is such that an excellent signal-to-noise ratio is obtained. The non-burning first dynode and the uniform high quality meshes ensure a picture with minimum shading throughout life.

Electrical Operating Conditions

Note: All voltages are with respect to cathode unless otherwise stated

Electrode		*Recommended Voltage/Current*	*Must Not Exceed*	*Remarks*
Photocathode		–470V	–700V	adjust by *image focus* in some cameras
Grid 6 Image Accelerator		–330V	–700V	adjust by *image focus* in some cameras 40% to 80% of Photocathode Voltage
Target Voltage above Cut-off		2.7V	4V	normally 2V to 3V
Field Mesh with respect to Grid 4 *		15V	100V	must not be negative to Grid 4
Grid 5 Decelerator		100V	300V	compensate geometry and shading
Grid 4 Beam Focus		120V or 180V	350V	adjust for best focus node chosen to suit yoke
Grid 3 Multi-Focus		250V to 300V	350V	adjust for maximum signal and best shading
Grid 2 and Dynode 1		300V	350V	—
Grid 1 Modulator		—	–150V	adjust so that picture highlights are just discharged
Dynode 2		600V	max. interstage voltage : 350V	adjust for signal current required by camera
Dynode 3		800V		
Dynode 4		1050V		
Dynode 5		1250V		
Anode		1300V	1350V	—
Heater		6.3V (r.m.s.)	± 10%	—
		0.6A (nominal)	—	—
Heater or Cathode		0	+10V –125V peak	—
Anode		40μA	125μA	adjust dynode supply
Signal	7295	12μA	60μA	adjust dynode supply
	7389	16μA	60μA	adjust dynode supply
Target Blanking		–5V to –8V	—	—

* *If field mesh is run at a potential very close to that of Grid 4 the area of dynode scanned is reduced, with resultant possibility of dynode burn. It is therefore recommended that field mesh should be not less than 5V positive to Grid 4.*

Magnetic Fields

	Recommended	*Must Not Exceed*	*Remarks*
Image Section in Plane of Photocathode	120 gauss	—	—
Scanning Section in Plane of Target	70 gauss	—	—
Alignment Field	0 to 3 gauss	—	adjust for minimum centre movement on focus rock

Environmental and Mechanical Operating Conditions

	Recommended	*Must not Exceed*	*Remarks*
Photocathode Illumination 7295	0.04 foot-candles (typical)	50 foot-candles	adjust to ½ stop over knee
7389	0.08 foot-candles (typical)	50 foot-candles	
Target Temperature	40°C	50°C or fall below 35°C	

Temperature difference between target and hottest part of bulb must not exceed 5°C.

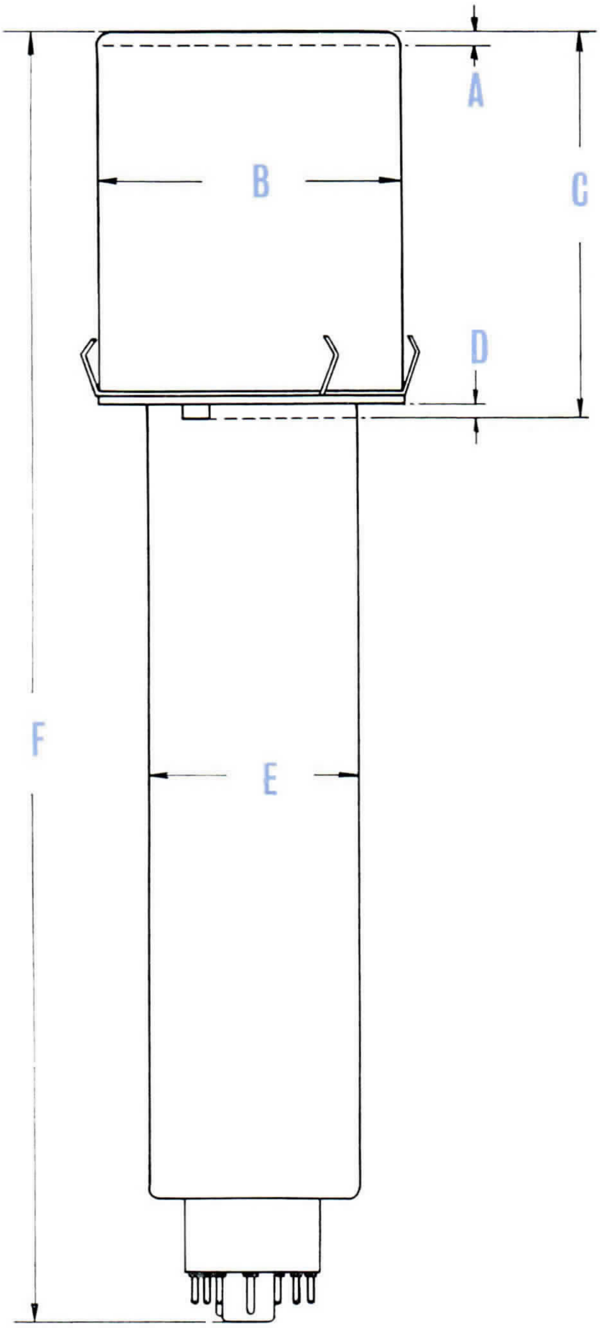
The tube should never be positioned so that the axis of the tube is less than 20° to the vertical with diheptal base uppermost.

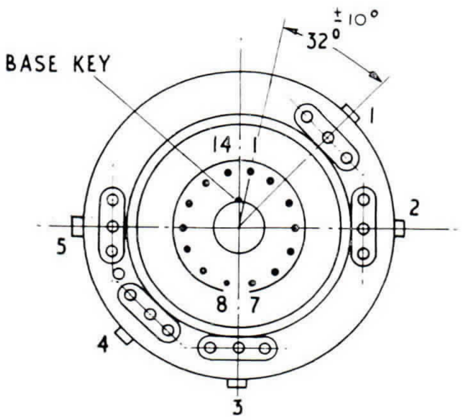
Design Characteristics

Faceplate			
Refractive Index		1.5076 (5876 A)	
Angle to Tube Axis		90° ±1°	
Thickness		0.188 in ±0.015 in	(4.8 mm)
Surfaces		parallel within 0.010 in	
Electrical			
Photocathode Response (S10 Spectral Response)		35 μA/Lumen minimum	
Capacity of Anode		12 pF $^{+4pF}_{-2pF}$ to all other electrodes	
Target Cut-off Voltage		between +5V and −3V with respect to cathode	
Signal Current (Adjust Dynode Supply)		must not exceed 60 μA	
Grid 1 Cut-off Voltage		maximum −115V minimum −45V	
Grid 1 Operating Voltage		approx 10V to 25V positive to Grid 1 cut-off	
Dimensions and Weight			
Faceplate Thickness	A	0·188 in ±0.015 in	(4.8 mm)
Image Section Diameter	B	4.5 in ± 0.094 in	(114.3 mm)
Overall Length of Image Section and Shoulder Spigot	C	5.781 in ± 0.015 in	(146.8 mm)
Length of Shoulder Spigot	D	0.175 in maximum	(4.4 mm)
Neck Diameter	E	3.125 in ± 0.06 in	(79.4 mm)
Overall Length	F	19.375 in ± 0.31 in	(492.1 mm)
Useful Size of Cathode Diameter		1.6 in maximum	(40.6 mm)
Average Weight		2.2 lb	(1.0 kg)

Performance Data

Performance Data	Type	Typical	Maximum or Minimum
Signal-to-Noise Ratio			
Peak Highlight Signal Current-to-Noise (r.m.s.)	7295	37dB	35dB min
(Bandwidth 5 Mc/s on 525 and 625 lines 3 Mc/s on 405 lines)	7389	39dB	37dB min
Resolution			
Drop in amplitude response at 400 lines per picture height (sine wave pattern) with respect to similar black and white signals without aperture correction		3dB	7dB max
Sensitivity			
Lens stop required for acceptable picture at scene luminance of 25 ft lamberts on 405 lines or 37 ft lamberts on 525 and 625 lines	7295	f/11	f/8 max
	7389	f/8	f/5.6 max
Microphony			
Decay Time seconds for mechanical or audio excited microphony		<1.0s	7.0s max
Free running Microphony		none	none





Shoulder base connections

Contact	*Electrode*
1	Field Mesh
2	Photocathode
3	Grid 6
4	Grid 5
5	Target

14 Pin base connections

Pin No.	*Electrode*
1	Heater
2	Grid 4
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
14	Heater

Recommended Setting Up Procedure

Notes

A It is important that the tube should **not** be allowed to look at the same scene for more than a minute or two at a time. The camera should be turned to change the position of highlights from time to time or capped up at intervals and whenever a picture is not specifically needed. Particular care is necessary when a diascope is used. If an image is burnt into the target, the tube should be exposed to a uniform white until the image is removed.

B Tube life will benefit if the lens is capped up either electronically or mechanically whenever pictures are not specifically required. It is therefore good practice to develop the habit of capping up whenever possible. A camera should never be left uncapped and static.

C The tube should never be left with the potentials applied and the beam cut off. The method of switching on, described below, with photoemission allowed to stabilise the target to mesh potential before beam is applied, will minimise the possibility of charging the target to field mesh potential and hence minimise the electrostatic attraction between mesh and target. This electrostatic attraction can strain the mesh and may result in a worsening of tube microphony with life. It is **strongly** recommended that this procedure is followed whenever electrode voltages are applied to the tube. In standby, cap mechanically, leaving beam on. When switching off, **uncap mechanically and electrically, switch off tube supplies and cap mechanically.**

Procedure

1 Note whether the tilt indicator shows that the mishandling has occurred. (You may have an insurance claim). Carefully remove the tube from its carrying container and take off the faceplate protector, preserving the protector for further use. Clean tube faceplate with lens tissue.

2 Insert tube into camera yoke. Correct orientation is with the Grid 6 connection at bottom centre. A white arrow is marked on the faceplate in line with this contact to facilitate correct orientation. Plug in face focus coil which should lie in contact with the tube faceplate. Fit socket to the tube 14 pin base.

3 Bring an **uncapped** lens into line with the tube and arrange the camera to view an illuminated blank wall or to be well de-focused on an illuminated portion of the studio.

4 Set BEAM (Grid 1) control for minimum beam. Set scans to overscan position. Switch on tube filament and allow one to two minutes for warm-up. Switch on all tube supplies including image section with electronic cap **not** applied (switch to UNCAP) so that emission from the photocathode can reach the target.

(Check that tube potentials are as recommended if trouble is suspected.)

5 Adjust BEAM control until some signal appears on the picture monitor. Adjust X and Y ALIGNMENT controls to give reasonably uniform white shading. Adjust DYNODE GAIN (multiplier voltage) to ensure that the multiplier is not overloaded.
Some cameras have a fine control of multiplier gain which adjusts the potential between two of the dynodes in addition to a coarse control which adjusts the overall voltage applied to the multiplier chain. Either or both may need to be adjusted.

6 Cap lens electronically or mechanically and allow tube to warm up for 15 to 20 minutes, leaving beam on, to ensure that the gun side of target remains stabilised and that any residual gas is removed by ionisation.

7 When the tube is warm, uncap, adjust OPTICAL, IMAGE AND BEAM focus, using a suitable scene with black and white straight line content. A standard resolution chart is recommended.

8 Adjust HEIGHT, WIDTH and CENTRING controls so that the target ring is just visible in the corners. Find the target cut-off by reducing TARGET voltage until picture highlights are just disappearing, then reset TARGET until it is 2.7V more positive than cut-off (or to the preferred operating voltage for the station). Switch on AUTOMATIC ALIGNMENT (FOCUS ROCK) and adjust X and Y ALIGNMENT for coincidence of straight lines at the centre of the picture and balanced non-coincidence in the corners. Switch off AUTOMATIC ALIGNMENT.

9 Adjust IRIS and BEAM controls until whites are just beginning to crush with further exposure, with sufficient beam fully to discharge the whites. Open the IRIS a half stop. Ensure that the whites are just discharging by BEAM adjustment.

10 Adjust MULTIFOCUS control (Grid 3) for maximum signal and most uniform dark and light shading.

11 Adjust DECELERATOR (Grid 5) for best compromise of capped-up corner shading and geometry of picture.

12 Check test waveform through amplifiers to give peak white signal (normally 0.7 V) for the desired working signal current. Check and adjust DYNODE GAIN for peak white signal when the tube is correctly exposed.

13 Readjust OPTICAL, IMAGE AND BEAM focus (using fine controls where available). It may be found that as BEAM is adjusted through best focus, the signal amplitude will fall slightly. BEAM FOCUS voltage should then be reduced below that at which the signal amplitude is minimum, to give maximum signal without loss of resolution. This will ensure dynode defocus without loss of resolution and most uniform white shading.

14 Repeat operations 7 to 13.

15 From this point on IRIS, LIFT (Pedestal), and possibly GAIN will be the only controls required for normal operation. Local operating practice may specify slightly modified settings of TARGET voltage and IRIS. For example, a 7295 may frequently be operated at 1 to 2 stops over the knee.

Guaranteed Specification

	7295 (EMI 9564)	7389 (EMI 9565)	Remarks
Sensitivity Scene luminance required to give highlights $\frac{1}{2}$ stop over knee at f/5.6 (405 line system)	25 foot-Lamberts	50 foot-Lamberts	maximum
Target Target cut-off voltage	–3V to +5V	–3V to +5V	with respect to cathode
Signal Current Signal current	8μA	8μA	minimum for maximum anode voltage of 1,300 V
Signal-to-Noise Ratio Peak highlights signal current to r.m.s. noise target 3V above cut-off and band-width 3 Mc/s on 405 line 5 Mc/s on 525 and 625 lines	35 dB	37 dB	minimum
Resolution Drop in amplitude response at 400 television lines (per picture height)	8 dB	8 dB	maximum
Microphony Duration of observed microphonic signal after mechanical or audible excitation	7 s	7 s	maximum

Sticking

Expose camera to test chart for 30 seconds with the tube correctly set up and then pan to a plain white scene of illumination equal to that of the test chart. The after-image must disappear within the following times :

Working Life of Tube (*hours*) *From*	*To*	Time (*seconds*)
0	50	50
50	100	60
100	150	70
150	200	80
200	250	90
250	300	100
300	350	120
350	500	180

NOTE: These parameters may be varied by prior negotiation

Image Orthicon Do's and Don'ts

Do clean faceplates with lens tissue only

Do use the prescribed setting-up procedure

Do uncap electronically and mechanically before applying d.c. potentials to the tube

Do warm the tube prior to operation

Do cap up during stand-by

Do keep beam on during stand-by

Do use overscan during rehearsal and stand-by, and use normal scanning during transmission

Do set up the target voltage to the correct value above cut off

Do minimise noise by keeping beam as low as possible

Do check new tubes immediately on receipt

Do notify rejections promptly and call for replacements early

Do notify your EMI representative of any difficulties with tube

Don't turn off beam for long periods when d.c. potentials are applied

Don't operate a tube without scanning

Don't operate or handle a tube with its axis at less than 20° to the vertical with 14 pin base uppermost

Don't underscan the target

Don't use more beam than necessary to discharge picture highlights

Don't operate a tube at voltages above those specified "must not exceed"

Don't overheat the tubes

Don't focus on stationary bright scenes, particularly with high contrast ratios

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Vidicon Camera Tubes

A wide range of vidicons is available which includes a ½-inch tube of exceptional performance.

EMI 1-inch Vidicon Type 9677 (JEDEC Type 8566) has been designed for use in broadcast cameras, both studio and film pick-up, and in high definition industrial television equipment. This tube employs a separate mesh electrode structure which gives improved vertical and horizontal resolution, particularly in the corners. The tube may be operated at high beam current without loss of picture quality to handle large overload signals. Excellent signal uniformity is maintained over a wide range of target voltages. The standard target has high sensitivity and short lag and has a spectral characteristic without excessive red response which closely approaches that of the human eye.

Type 9677 has a low wattage heater (0·6W) so that it is ideally suited for operation in transistorised cameras. Its high blue sensitivity and absence of picture rotation with variation of focus voltage make the tube ideal for multi-tube colour cameras.

Type 9677 is also available with a special target layer and a quartz window (for operation down to 2,300Å for ultra-violet microscopy applications) and with an infra-red sensitive target. Standard targets can be supplied with a fibre optic window or with a quartz window for operation in high nuclear radiation fields.

EMI ½-inch Vidicon Type 9697 also employs a separate mesh and is capable of the same resolution as a non-separate mesh 1-inch tube. It is fitted with a low wattage heater (0·6W).

EMI

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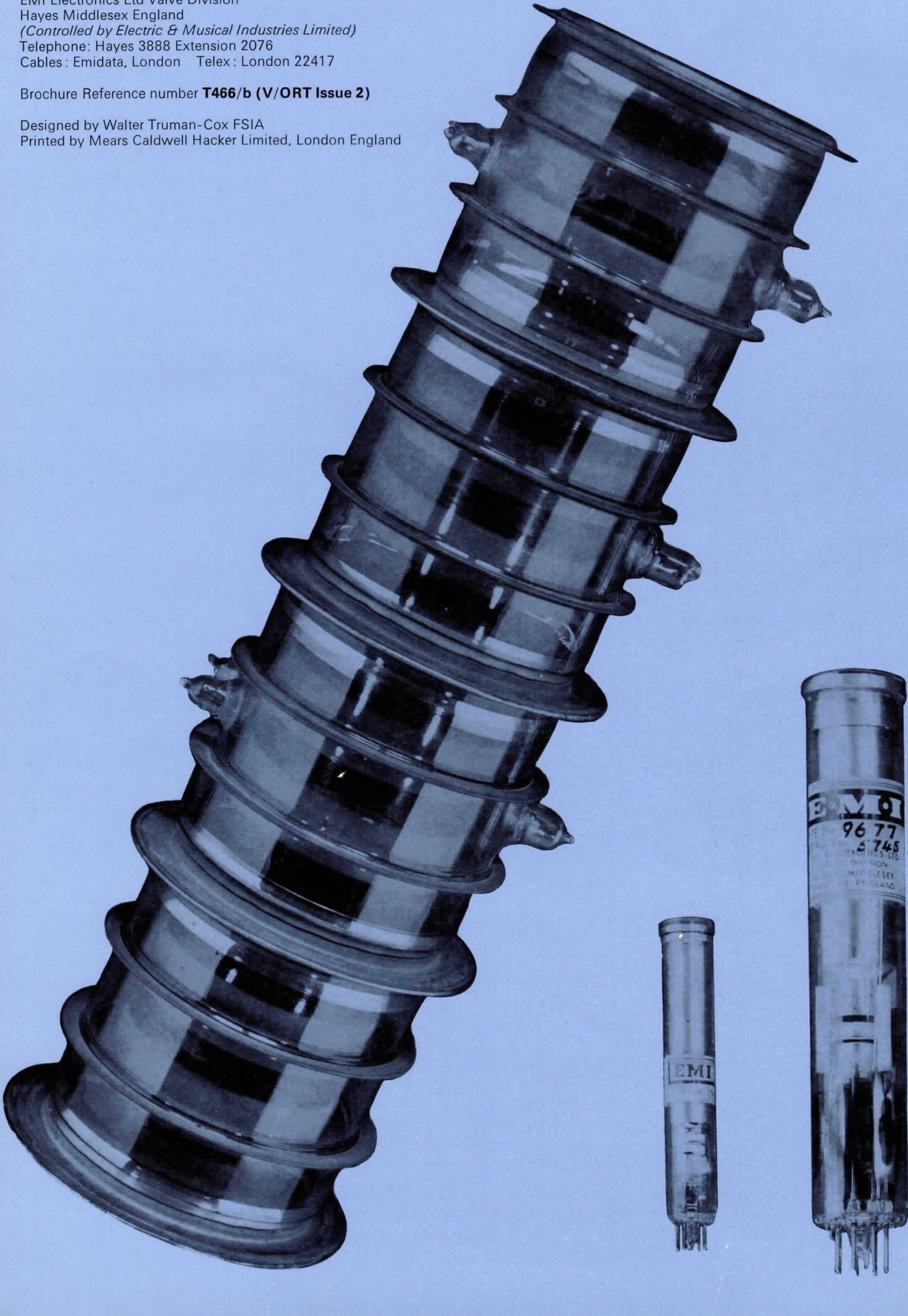
Brochure Reference number **T466/b (V/ORT Issue 2)**

Designed by Walter Truman-Cox FSIA
Printed by Mears Caldwell Hacker Limited, London England



EMI HIGH RESOLUTION VIDICON TYPE 9677

The EMI High Resolution Vidicon type 9677 has been designed for use in studio broadcast television cameras and in high quality industrial television cameras. The 9677 has the latest separate mesh electrode structure and a very uniform target layer. This has resulted in a vidicon with excellent signal uniformity over a wide range of target voltages and an exceptionally high resolution capability.

An important feature of the 9677 vidicon is its ability to operate at high beam currents and low target voltages without loss of picture quality.

The low heater wattage (0.6W) of the 9677 makes it very suitable for use in transistorised cameras and in cameras where heat dissipation must be kept to a minimum.

CHARACTERISTICS

General

Scanned area	12.8 mm x 9.6 mm (½ x ⅜ in)
Length	158.75 ± 3.30 mm (6.25 ± 0.130 in)
Maximum diameter	28.58 ± 0.20 mm (1.125 ± 0.008 in)
Bulb diameter	25.91 ± 0.64 mm (1.020 ± 0.030 in)
Focusing method	Magnetic
Deflection method	Magnetic
Alignment method	Magnetic
Orientation of image	The horizontal scan should be parallel to a plane passing through the tube axis and the short index pin.
Signal electrode capacitance to all other electrodes	4.5 pF
Spectral response	See fig. 2.
Operating position	Any (see operating note 5)
Socket	Small-Button Ditetrar 8 pin (Jedec type 8ME)

Cathode

The heater supply should be designed to give nominal 6.3 V and should be kept within the limits 5.7 V to 6.9 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V. If this figure is likely to be exceeded on switching on a surge limiting device must be incorporated.

Maximum Ratings (All potentials are relative to the cathode)

Modulator G1 negative bias	-150 V	
positive bias	0 V	
Limiter G2	750 V	(These maximum ratings are limiting values above which the life of the tube may be impaired).
Wall anode G3	750 V	
Mesh G4	1000 V	
Signal electrode voltage	100 V	
Dark current	0.6 μA	
Target illumination	10000 lx	
Target temperature	70°C	
Adjustable transverse alignment field	± 4 gauss	

Typical Operating Conditions

Modulator G1	-35 to -75 V
Cut-off voltage	-60 to -100 V
Limiter G2	300 V
Wall anode G3	280 to 300 V
Mesh G4	420 to 450 V
Minimum blackout pulses when applied to G1	-75 V
Minimum blackout pulses when applied to cathode	+10 V
Axial magnetic field	40 gauss

Studio Operation

Target illumination (Highlights)	6 foot candles
Signal electrode voltage	25 to 40 V
Dark current	0.01 μA
Signal current	0.25 μA to 0.3 μA

Industrial Operation

Target illumination (Highlights)	2 foot candles
Signal electrode voltage	30 to 60 V
Dark current	0.01 μA
Signal current	0.2 μA peak

Film Pick-up Operation

Average highlight for one frame	50 to 100 foot candles
Signal electrode voltage	10 to 25 V
Dark current	<0.005 μA
Signal current	0.25 to 0.30 μA

Leakage Specification

between pin No.	and pin No.	Test potential	Leakage current
2, 3, 5, 6, 7,	1 and 8 (negative)	100 V	100 μA max.
1, 3, 5, 6, 7, 8,	2 (negative)	150 V	15 μA max.
1, 2, 3, 6, 7, 8,	5 (positive)	500 V	50 μA max.
1, 2, 3, 5, 7, 8,	6 (positive)	500 V	5 μA max.
1, 2, 5, 6, 7, 8, and signal plate	3 (positive)	500 V	5 μA max.

Operating Notes

1. Resolution

For optimum resolution and beam landing at a given wall anode voltage the mesh should be kept at approximately 1.5 times the wall anode voltage. Under these conditions the percentage modulation at 5 MHz on a 625 line system is double that of a normal vidicon and the scanning current has only to be increased by approximately 20%. From fig. 3 it can be seen that an appreciable increase in depth of modulation can be obtained when the mesh is only a few volts positive to the wall anode and under these conditions negligible increase in scanning current is required.

The resolution can be further increased by increasing the wall anode voltage and the corresponding mesh voltage, but this will require additional focus current and scan power (see fig. 4). To operate the 9677 in a standard camera the mesh should be connected to the limiter by joining pin 3 (mesh) to pin 5 (limiter) provided the limiter is positive with respect to the wall anode.

On no account should the mesh be operated at a lower voltage than the wall anode since, under these conditions, an ion spot may be observed.

The increased vertical resolution obtained with a 9677 vidicon will give an obvious increase in picture sharpness compared with a standard tube since the relatively poor vertical resolution of a standard tube cannot be corrected by aperture correction.

The increased horizontal resolution of the 9677 compared with the standard tube (see fig.4) enables aperture correction in the head amplifier to be reduced, with corresponding increase in signal to noise ratio. If the 9677 is being fitted into a standard camera and the aperture correction is not reduced, high frequency "ringing" may occur.

2. Beam

The setting of the beam current in the 9677 is less critical than with a standard vidicon provided the mesh is positive with respect to the wall anode. The 9677 can be over-beamed without loss of resolution, thus the beam can be preset to discharge the peak highlights, no further adjustment being required.

Beam landing is considerably improved as the mesh voltage is increased to the optimum of 1.5 times the wall anode voltage. Under these conditions the "porthole effect" which occurs at low target voltages is eliminated.

Rotation of the picture, when the wall anode is varied, about electrical focus is considerably reduced when the mesh is 20 volts or more positive with respect to the wall anode.

3. Sensitivity

The uniform target layer of the 9677 ensures that when the target voltage is increased the dark current and sensitivity increase uniformly over the target area.

The dark current should not, however, be allowed to exceed 0.6 μA or a burnt-in picture may result.

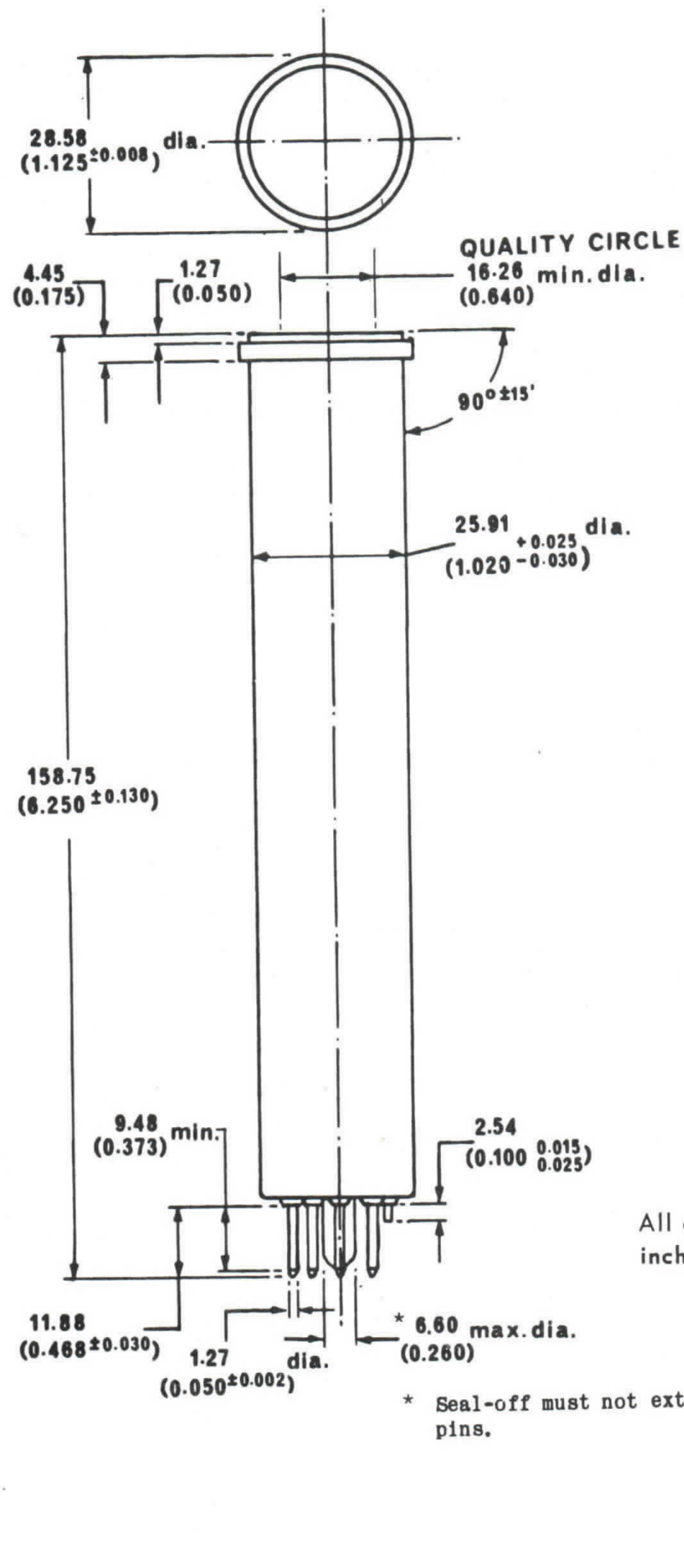
4. Scanned area

The tube should be operated with the target area 12.8 mm x 9.6 mm (½ in x ⅜ in) completely scanned to obtain the best signal to noise ratio and resolution. Small changes in sensitivity and dark current occur in the scanned area over a long period of time so that it is important to use the same scanned area throughout the life of the tube.

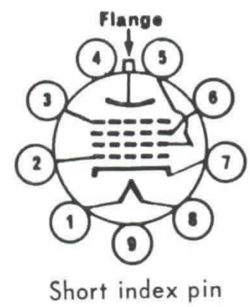
5. Operating position

When the 9677 is operated vertically with its face downwards care should be taken to avoid undue mechanical shock.

FIG.1. DIMENSIONAL OUTLINE DRAWING



* Seal-off must not extend beyond pins.



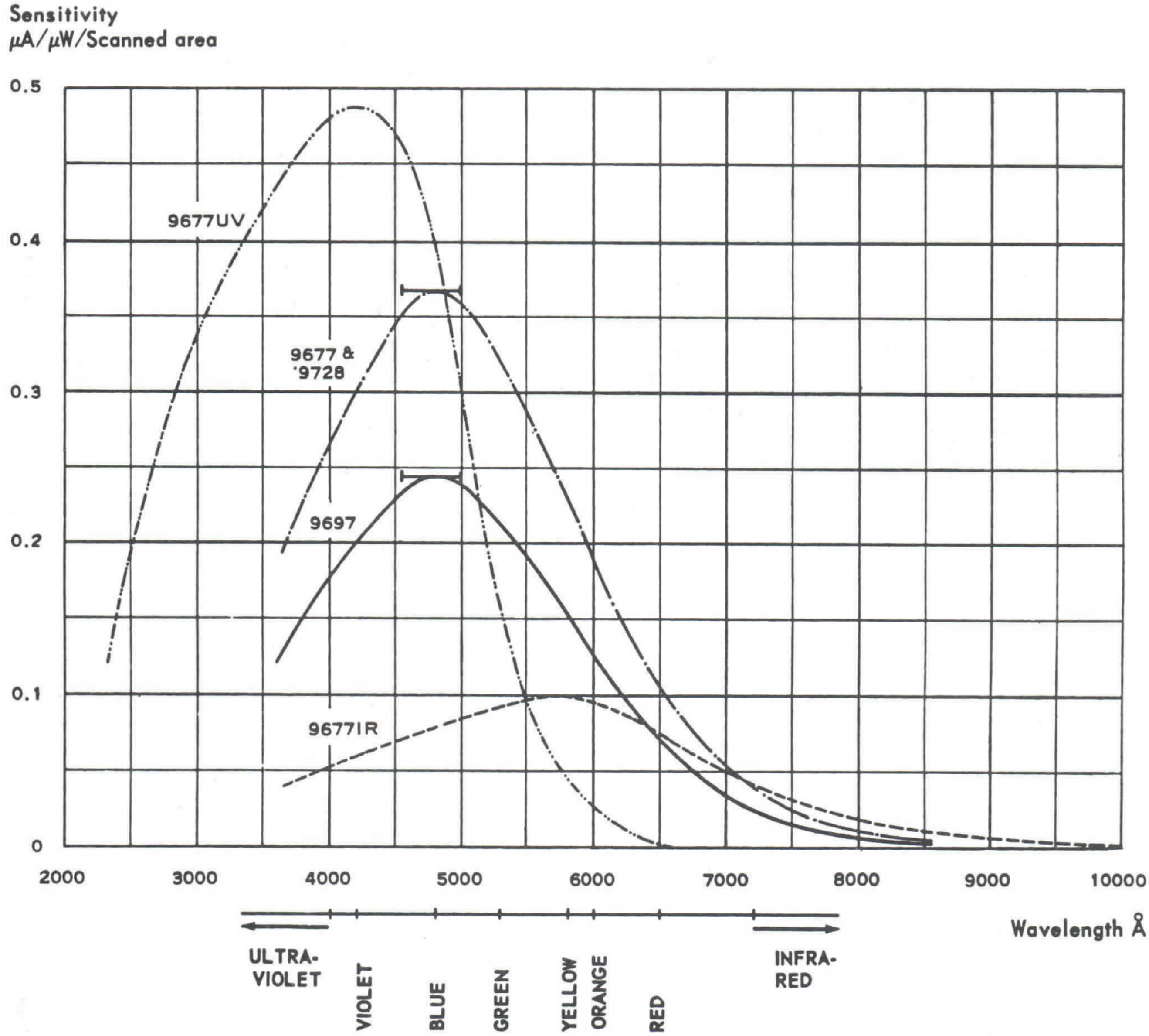
BASE 8ME
SMALL BUTTON DITETRAR

Pin No.	Connection
1	Heater
2	Modulator G_1
3	Mesh G_4
4	Do not use
5	Limiter G_2
6	Wall anode G_3
7	Cathode
8	Heater
Flange	Signal electrode
Short pin	Do not use

All dimensions are in millimetres with inches shown in parentheses.

EMI VIDICON CAMERA TUBE TYPE 9677 (continued)

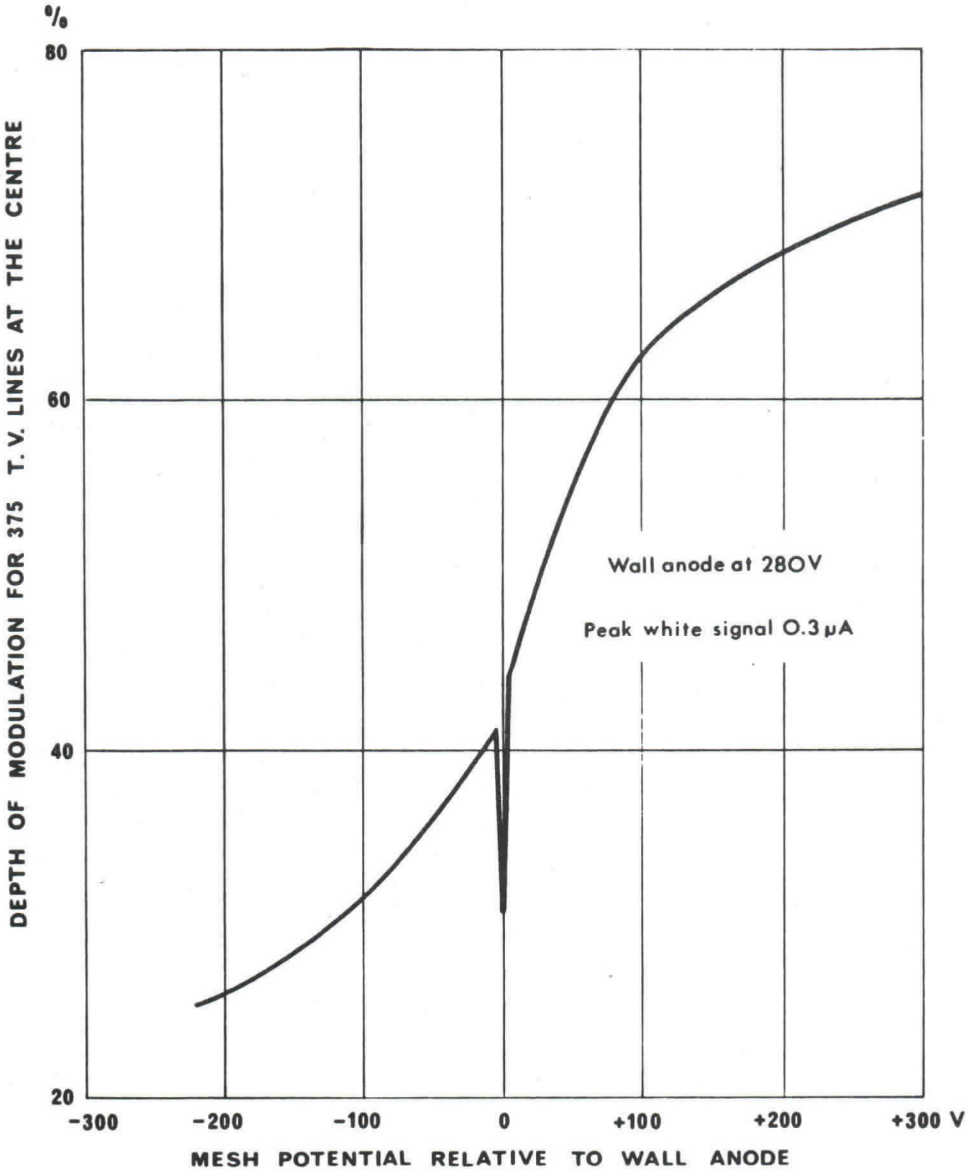
FIG.2. SPECTRAL RESPONSE OF EMI VIDICONS



ONE INCH VIDICON type	DARK CURRENT μA	SIGNAL μA	AREA SCANNED mm
—·——·— 9677/9728	0.01	0.05	12.80 × 9.60
—··——··— 9677 UV		0.05	12.80 × 9.60
-------- 9677 IR	0.04	0.05	12.80 × 9.60
HALF INCH VIDICON			
——— 9697	0.01	0.05	6.60 × 4.95

├——┤ Range of peak response

FIG.3. TYPICAL DISCONTINUITY IN MODULATION CURVE



T413/6f
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FIG.4. TYPICAL RESOLUTION CHARACTERISTICS

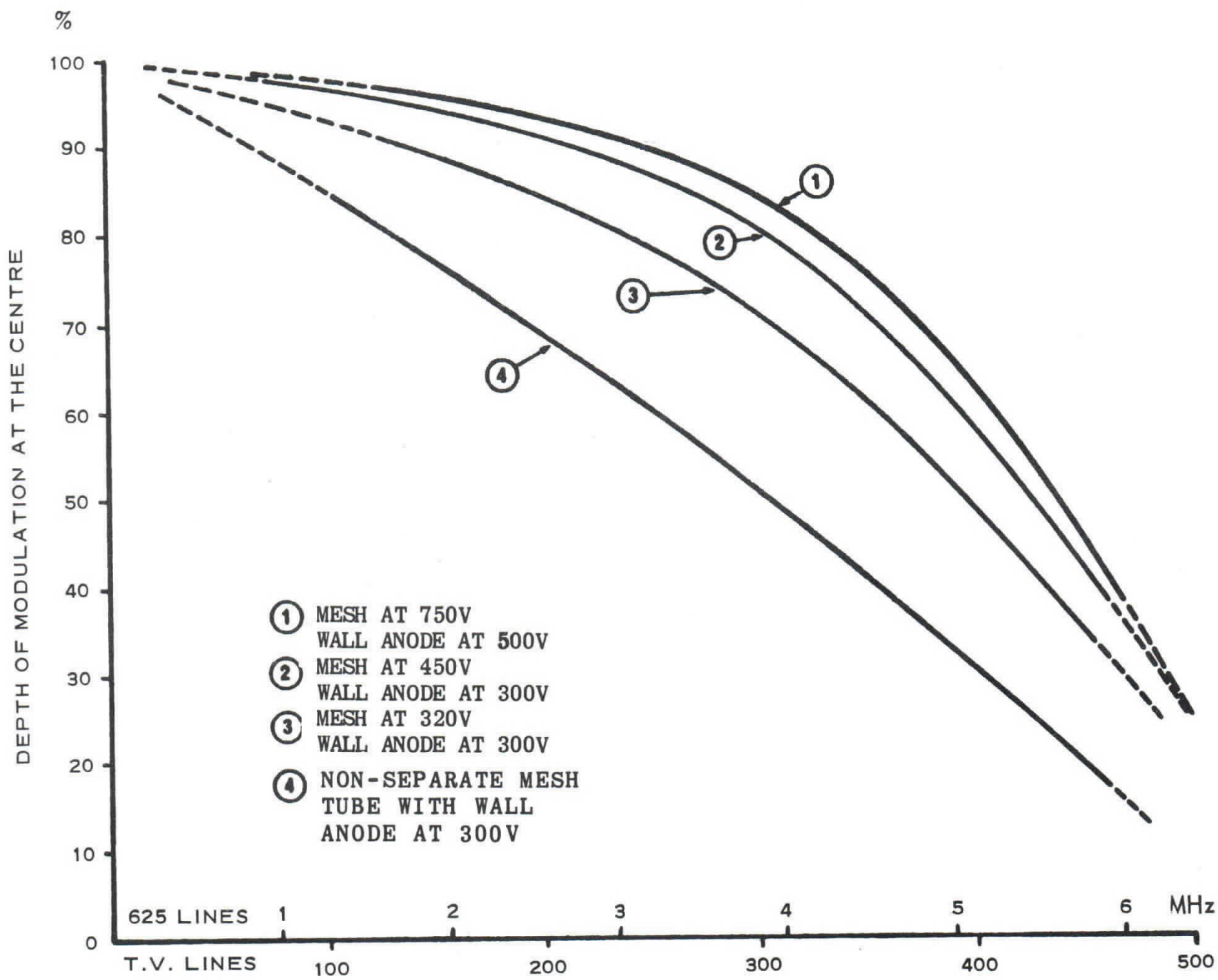


FIG.5. ILLUMINATION vs TARGET VOLTS TO GIVE 0.25 μA SIGNAL CURRENT

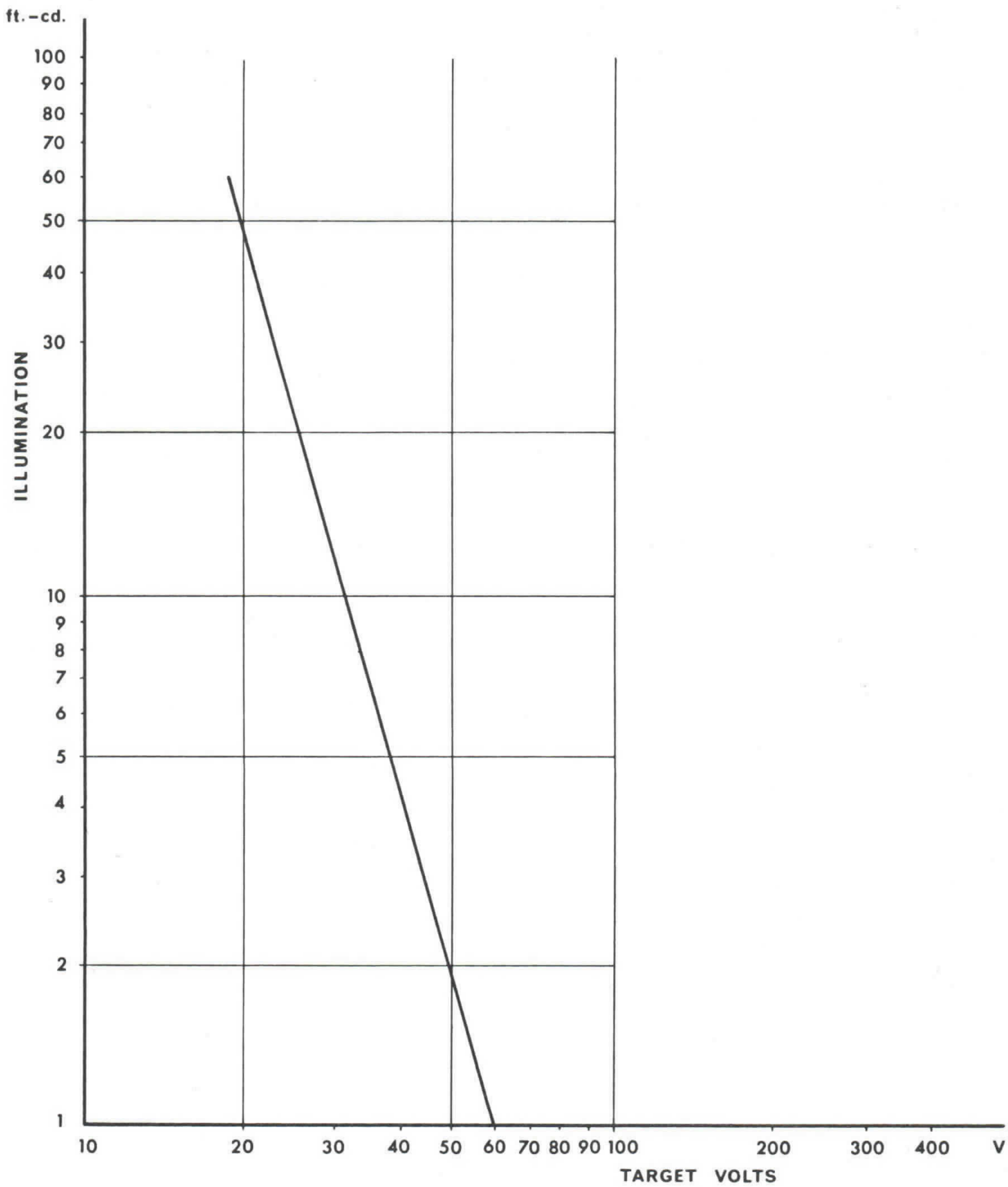


FIG.6 AVERAGE LAG CURVES

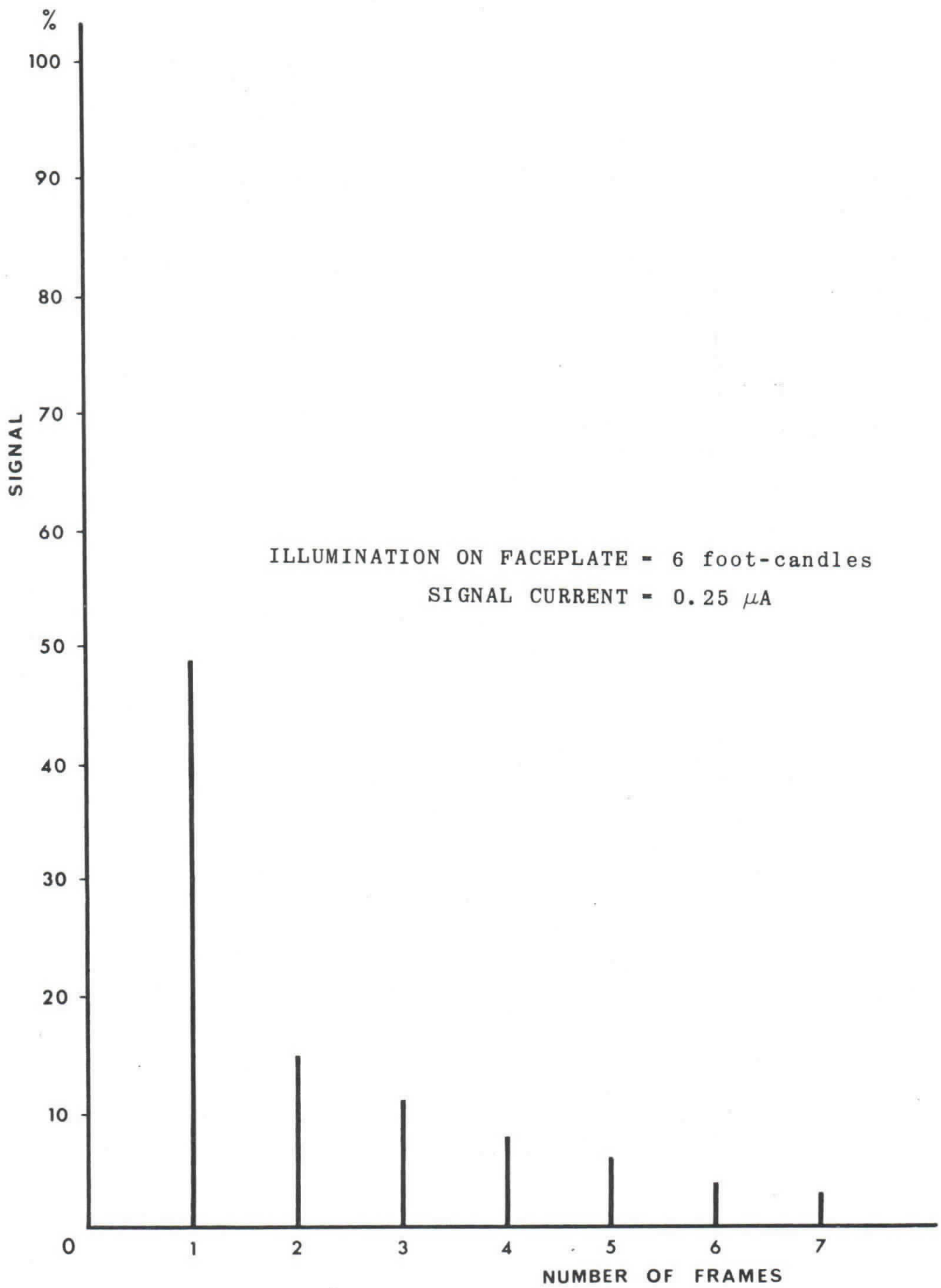
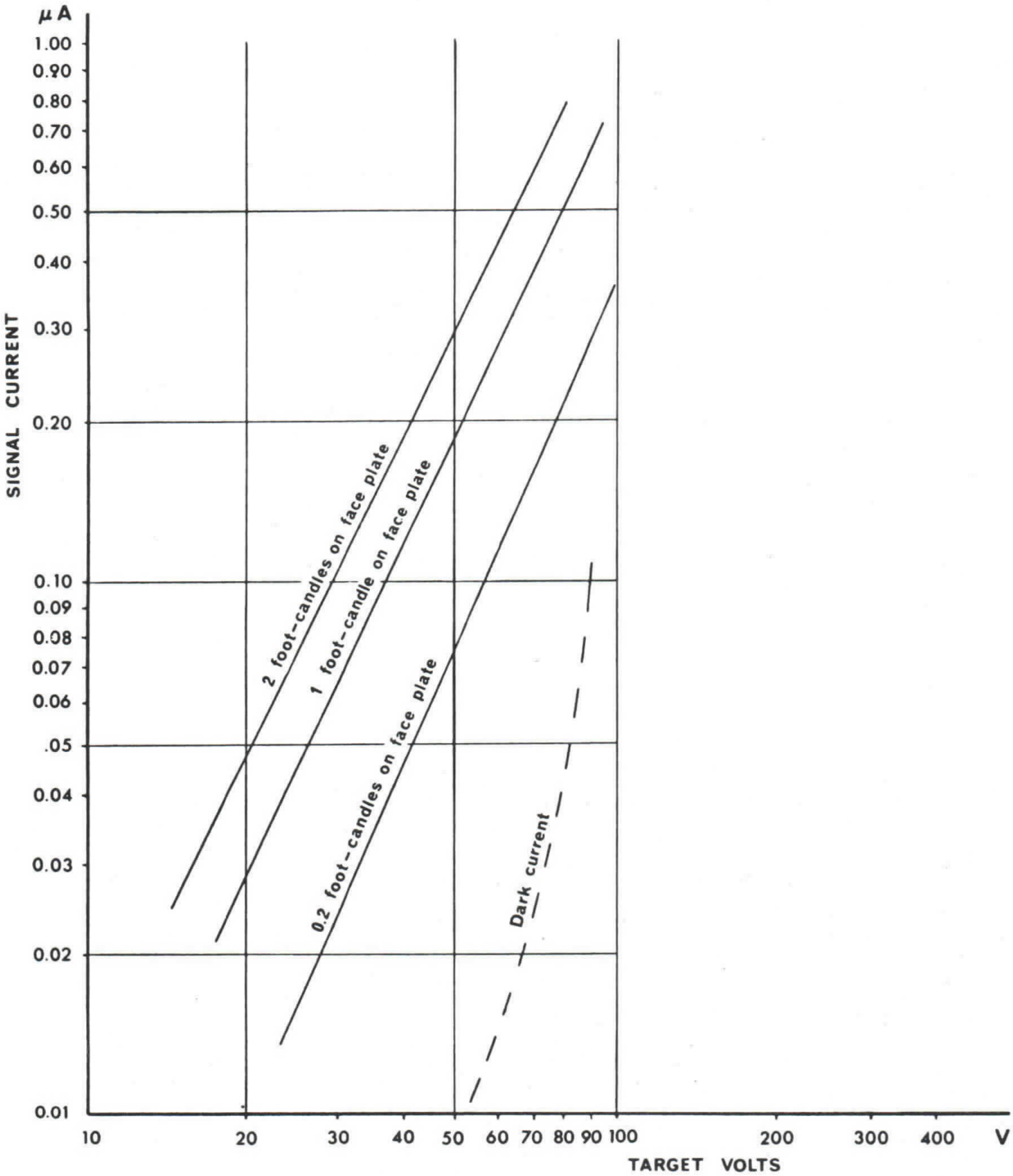


FIG.7 SIGNAL CURRENT vs TARGET VOLTS



The Company reserves the right to modify the designs and specifications without notice

E M I Electronics Ltd. Valve Division

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Ref. 11118 CP

VIDICON TYPE 9677B BLEMISH SPECIFICATION

Measurements in inches using a 10¾ x 8⅛ raster	% of raster height	Number allowed Zone 1	Number allowed Zone 2
Greater than 0.065	Greater than 0.80%	Nil	Nil
Greater than 0.050 to 0.065	Greater than 0.62% to 0.80%	Nil	1
Greater than 0.015 to 0.050	Greater than 0.19% to 0.62%	2	3
0.015 and under	0.19% and under	Do not count unless concentrated to form smudge	

NOTES

1. To be considered a black spot must have a contrast ratio greater than 2 to 1.
2. To be considered a white spot must have a contrast ratio greater than 1.5 to 1.
3. The minimum separation between any two spots greater than 0.19% of raster height is limited to 3.1% of raster height.
4. Tubes are rejected for smudges, lines, streaks, and mottled grainy or uneven background having contrast ratios greater than 1.5 to 1.
5. Zone 1 is the area of a centrally placed circle of diameter equal to the raster height.
6. Zone 2 is the raster area outside zone 1.

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VIDICON TYPE 9677C BLEMISH SPECIFICATION

Measurements in inches using a $10\frac{3}{4} \times 8\frac{1}{8}$ raster	% of raster height	Number allowed Zone 1	Zone 2
Greater than 0.065	Greater than 0.80%	Nil	Nil
Greater than 0.050 to 0.065	Greater than 0.62% to 0.80%	Nil	2
Greater than 0.015 to 0.050	Greater than 0.19% to 0.62%	3	4
0.015 and under	0.19% and under	Do not count unless concentrated to form smudge	

NOTES

1. To be considered a black spot must have a contrast ratio greater than 2 to 1.
2. To be considered a white spot must have a contrast ratio greater than 1.5 to 1.
3. The minimum separation between any two spots greater than 0.19% of raster height is limited to 3.1% of raster height.
4. Tubes are rejected for smudges, lines, streaks, and mottled grainy or uneven background having contrast ratios greater than 1.5 to 1.
5. Zone 1 is the area of a centrally placed circle of diameter equal to the raster height.
6. Zone 2 is the raster area outside zone 1.

T458/1a
DS.355

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EMI ULTRA-VIOLET SENSITIVE VIDICON TYPE 9677UV

The EMI ultra-violet sensitive Vidicon type 9677UV has a specially developed target deposited on a quartz faceplate to give high sensitivity in the ultra-violet region of the spectrum to at least 2,500 Å. The target layer is essentially blind to red light and has negligible response beyond 6,100 Å.

For most of its useful range of signal current the 9677UV has unity gamma. This results in an enhanced contrast ratio on the cathode ray tube display and also enables the T.V. waveform to be used to give a direct measure of the absorption of an object viewed under an u.v. microscope.

The 9677 employs the latest separate mesh electrode structure, this results in excellent overall resolution which is substantially independent of the beam setting and low target voltages may be used without loss of picture quality.

The low heater wattage (0.6W) of the 9677UV makes it suitable for use in transistorised cameras and in cameras where heat dissipation must be kept to a minimum.

D A T A

GENERAL

Scanned area	12.8 mm x 9.6 mm (½ in x ⅜ in)
Length	158.75 ± 3.30 mm (6.25 ± 0.130 in)
Max. diameter	28.58 ± 0.20 mm (1.125 ± 0.008 in)
Bulb diameter	25.91 ± 0.64 mm (1.020 ± 0.030 in)
Focusing method	Magnetic
Deflection method	Magnetic
Alignment method	Magnetic
Orientation of image	The horizontal scan should be parallel to a plane passing through the tube axis and the short index pin.
Signal electrode capacitance to all other electrodes	4.5 pF
Spectral response	See fig. 2
Operating position	Any (see note 1)
Socket	Small-button ditetrar 8 pin.

CATHODE

Heater voltage	6.3 V
Heater current	95 mA ± 10%

The heater supply should be designed to give a nominal 6.3 V and should be kept within the limits 5.7 V to 6.9 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V. If this figure is likely to be exceeded on switching on a surge limiting device must be incorporated.

MAXIMUM RATINGS
(All potentials are relative to the cathode)

Modulator G1 negative bias	-150 V
positive bias	0 V
Limiter G2	750 V
Wall anode G3	750 V

T415/1c
DS.317/1

Mesh G4	1000 V
Signal electrode voltage	100 V
Dark current	0.6 μA
Target illumination	10000 lux
Target temperature	$70^{o}C$
Adjustable transverse alignment field	± 4 gauss

These maximum ratings are limiting values above which the life of the tube may be impaired.

TYPICAL OPERATING CONDITIONS

Modulator G1	-35 to -75 V
Cut off voltage	-60 to -100 V
Limiter G2	300 V
Wall anode G3	280 to 300 V
Mesh G4	420 to 450 V
Minimum blackout pulses when applied to G1	-75 V
Minimum blackout pulses when applied to cathode	+10 V
Axial magnetic field	40 gauss
Signal electrode voltage	10 - 20 V (see note 1)
Dark current	0.0005 μA
Sensitivity	a) 0.2 $\mu A/\mu W\ cm^{-2}$ at 4,000 Å b) 0.1 $\mu A/\mu W\ cm^{-2}$ at 2,537 Å

(Note: The normal scanned area is approximately 1 square centimetre)

OPERATING NOTES

1. The maximum target voltage is marked on each tube. If the target voltage is allowed to exceed the recommended maximum the tube may become unstable. Should this occur, the target voltage should be reduced and the mesh (pin 3) set to approximately 10 volts for a few seconds.

2. The dark current of the 9677UV is negligible over its operating range of target voltages.

3. For optimum beam landing and resolution at a given wall anode voltage the mesh should be kept at approximately 1.5 times the wall anode voltage. Under these conditions, however, approximately 20% more scanning current may be required. The 9677UV can be operated to give very good results in a standard camera by connecting the mesh to a point which is positive with respect to the wall anode. This can usually be done by connecting the mesh (pin 3) to the limiter (pin 5).

T415/2c
DS. 317/2

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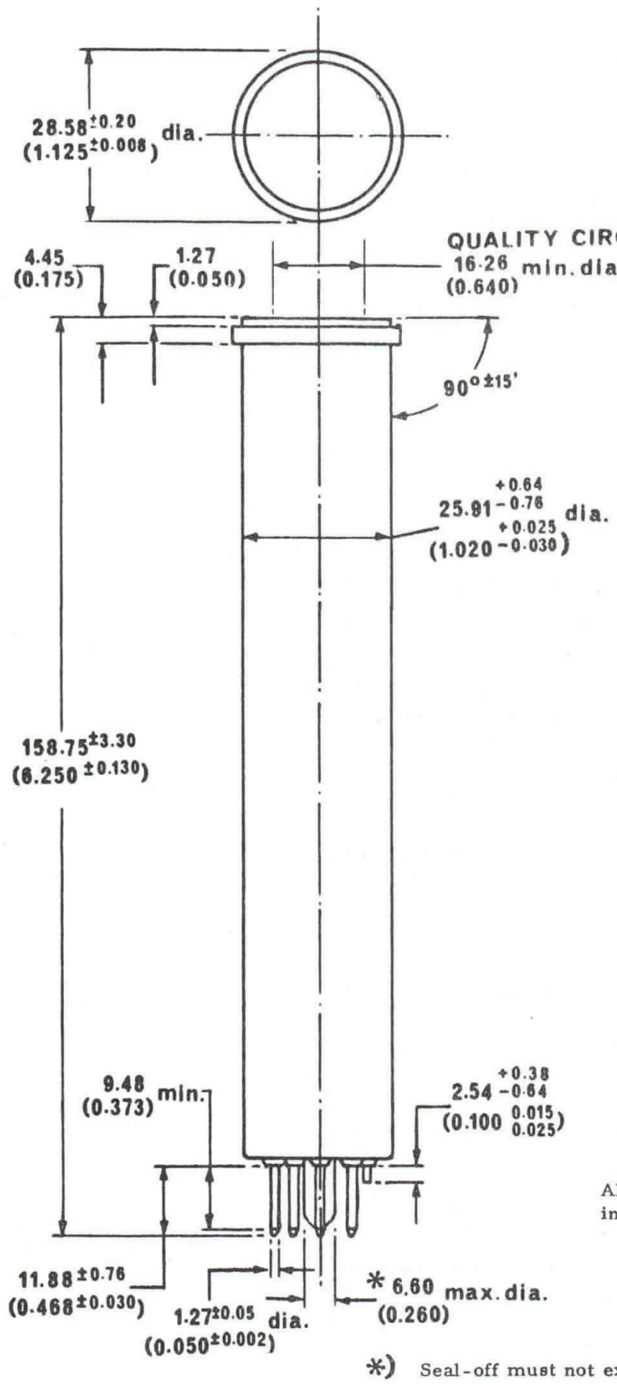
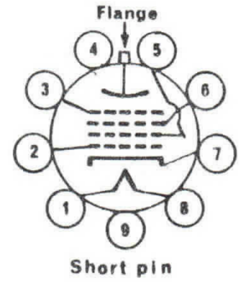
Ref. 10772 CP





BASE 8ME
SMALL BUTTON DITETRAR

Pin No.	Connections
1	Heater
2	Modulator G_1
3	Mesh G_4
4	Do not use
5	Limiter G_2
6	Wall anode G_3
7	Cathode
8	Heater
Flange	Signal electrode
Short pin	Do not use

All dimensions are in millimetres with inches shown in parentheses.

*) Seal-off must not extend beyond pins.

FIGURE 1

RELATIVE SPECTRAL RESPONSE

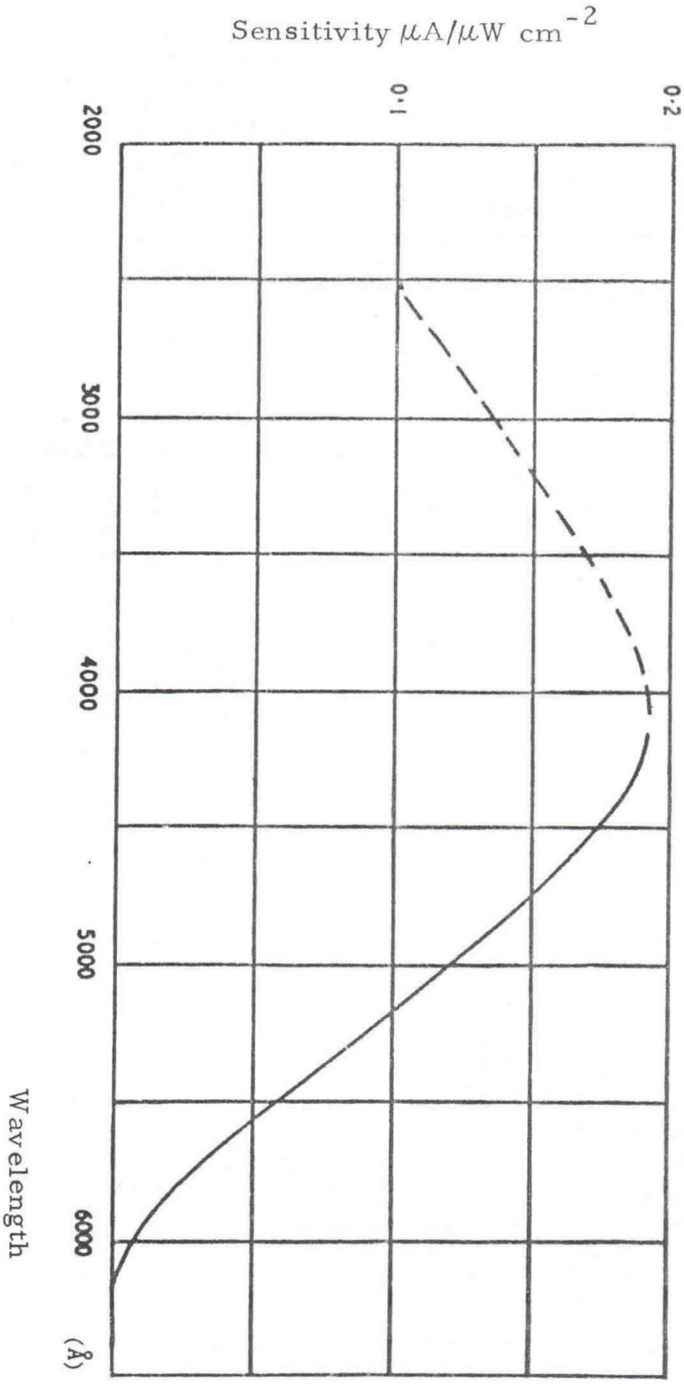


FIGURE 2

T415/4c
DS. 317/4

SIGNAL CURRENT vs ILLUMINATION

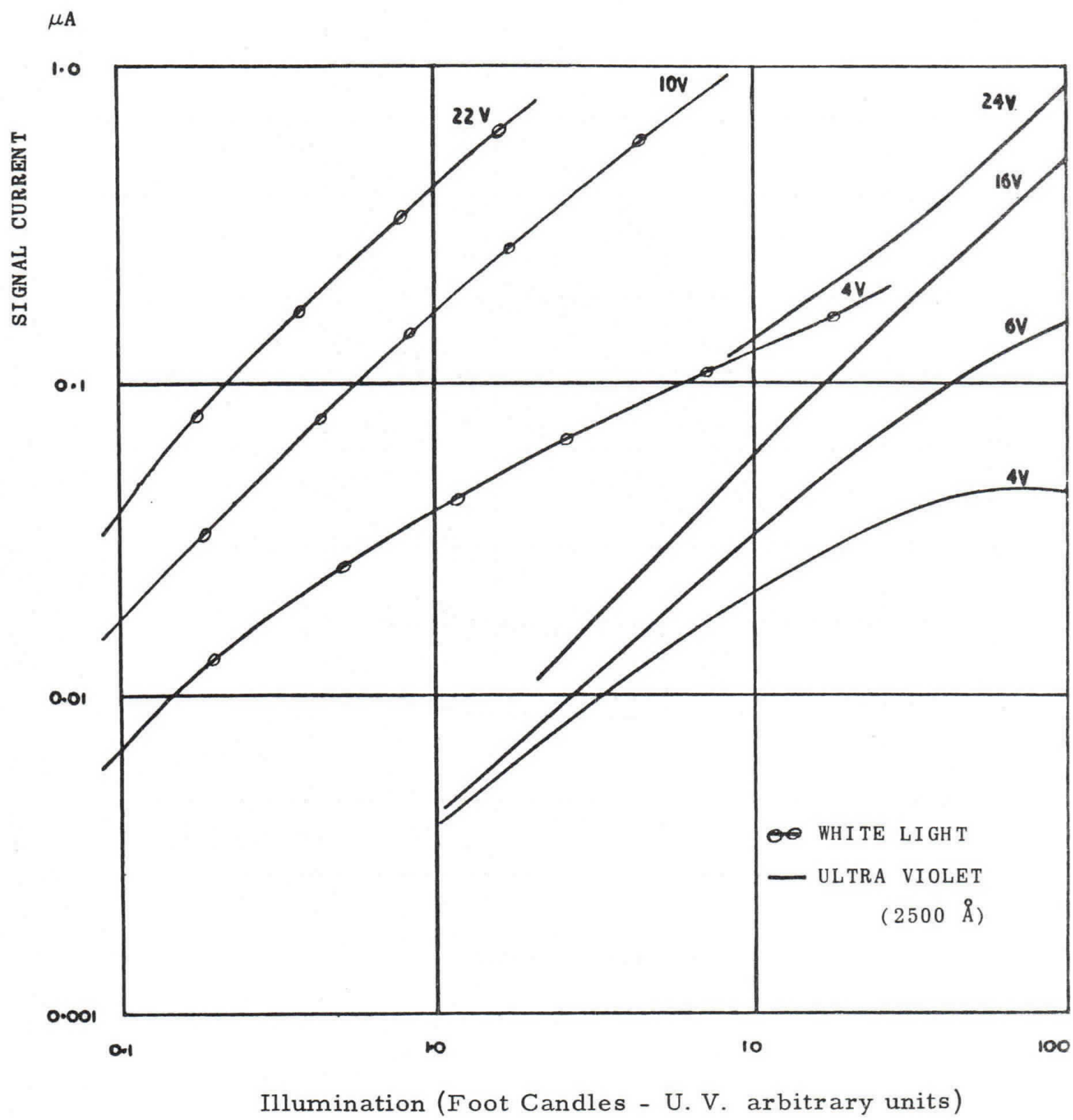


FIGURE 3

SIGNAL CURRENT vs TARGET VOLTS

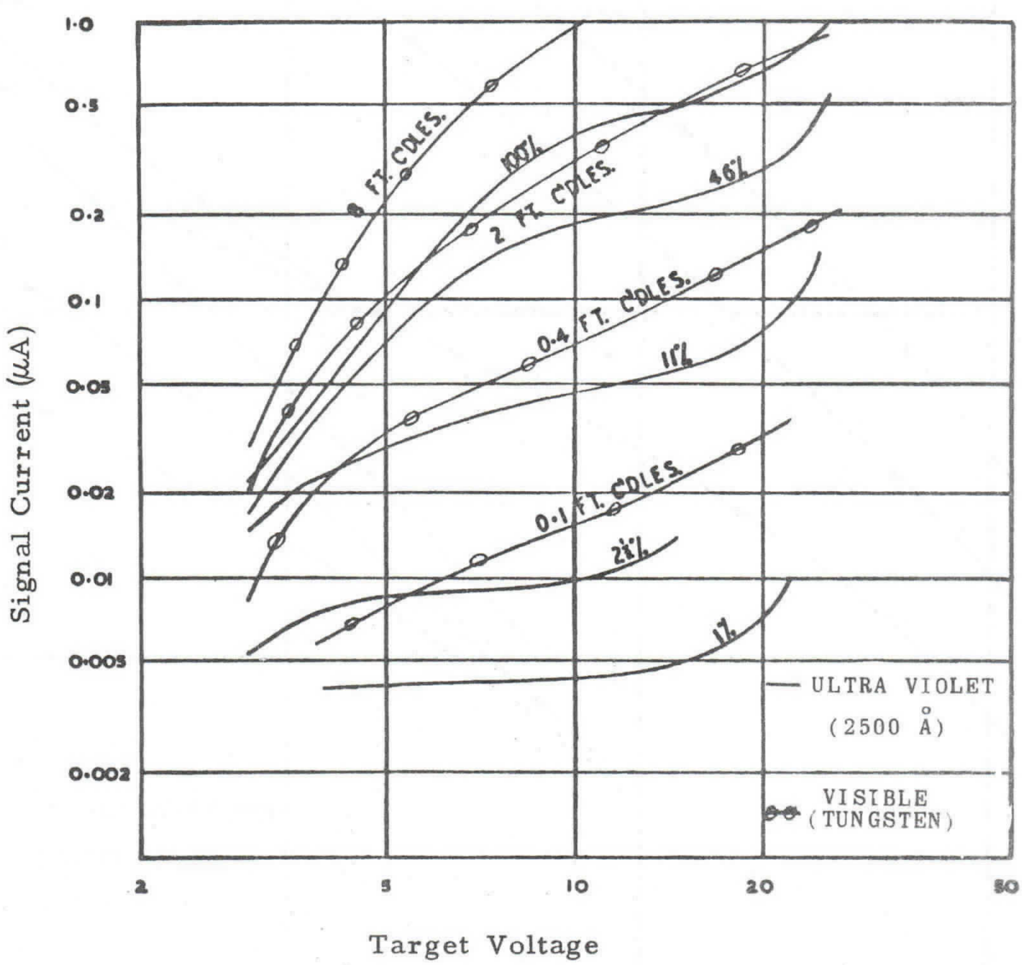


FIGURE 4

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EMI HALF INCH DIAMETER VIDICON TYPE 9697

The EMI Vidicon type 9697 is a half inch diameter low wattage heater (0.6 W) tube of robust construction possessing an exceptionally high resolution. It has been designed to operate in currently available half inch scan and focus coils.

The exceptionally high resolution of the type 9697 vidicon compared with previous half inch tubes is due to the use of a separate mesh electrode structure. (Please see data on EMI separate mesh one inch vidicon type 9677). The separate mesh connection is brought out to a connector ring adjacent to the signal plate contact around the face of the tube. To accommodate this extra connection in standard coils the tube has been extended by ¼ inch in length and a mesh contact spring must be provided.

CHARACTERISTICS

General

Area scanned	6.60 mm x 4.95 mm (0.26 in x 0.195 in)
Length overall	92.8 mm (3. 65 in)
Maximum diameter	14.6 mm (0.574 in)
Focusing method	Magnetic
Deflection method	Magnetic
Alignment method if desirable	Magnetic
Orientation of image	The horizontal scan should be parallel to a plane passing through the tube axis and the short index pin
Signal electrode capacitance to all other electrodes	1.8 pF
Spectral response	See page 6
Operating position	Any
Base	Small button sevenar 7 pin

Cathode

The heater supply should be designed to give a nominal 6.3 V and should be kept within the limits 5.7 to 6.9 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V. If this figure is likely to be exceeded on switching on, a surge limiting device must be incorporated.

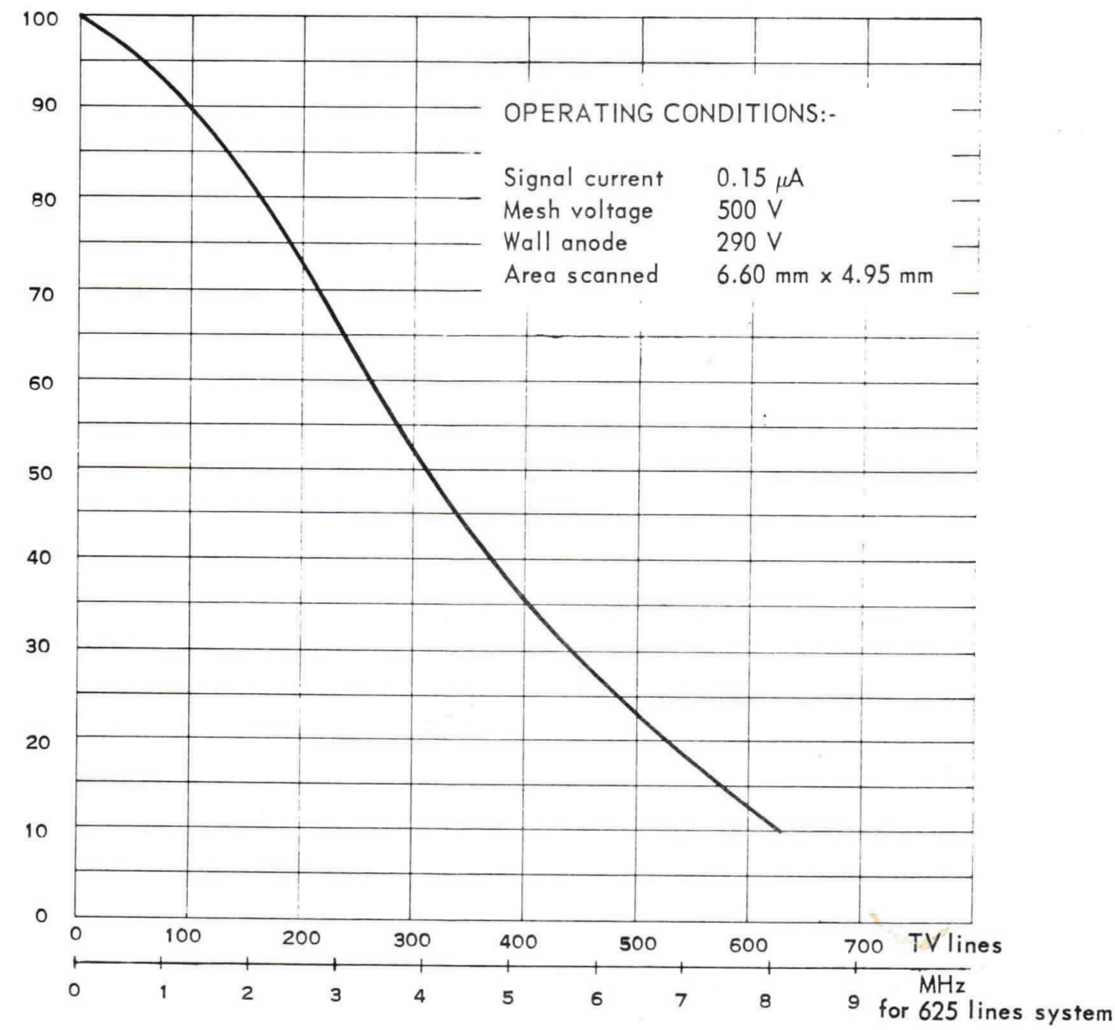
T416/1f
DS.516/1

Typical Operating Conditions

Modulator G1	-35 to -75 V
Limiter G2	300 V
Wall anode G3	Approx. 290 V
Mesh G4	500 to 550 V (max. 550 V)
Axial magnetic focus field	0.006 T (60 gauss)
Adjustable transverse alignment field	±0.0004 T (4 gauss)
Signal current	0.1 to 0.15 μA
Depth of modulation in centre of picture at 400 TV lines (5.1 MHz on 625 line system) at 0.15 μA signal current	36% (See Fig.1)
Lag	Slightly less than the EMI one inch vidicon type 9677 (See Fig.4)
Signal current for target illumination of 20 lx at a dark current of 0.01 μA	0.125 μA (See Fig.3)

Pin Connections (See page 5)

FIG.1. DEPTH OF MODULATION



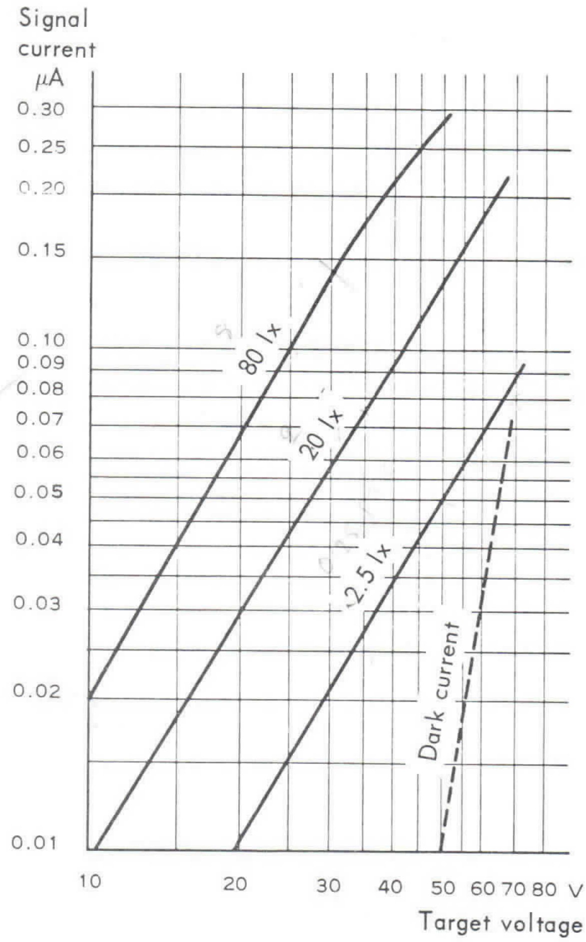


FIG.2.

SIGNAL CURRENT

vs TARGET VOLTAGE

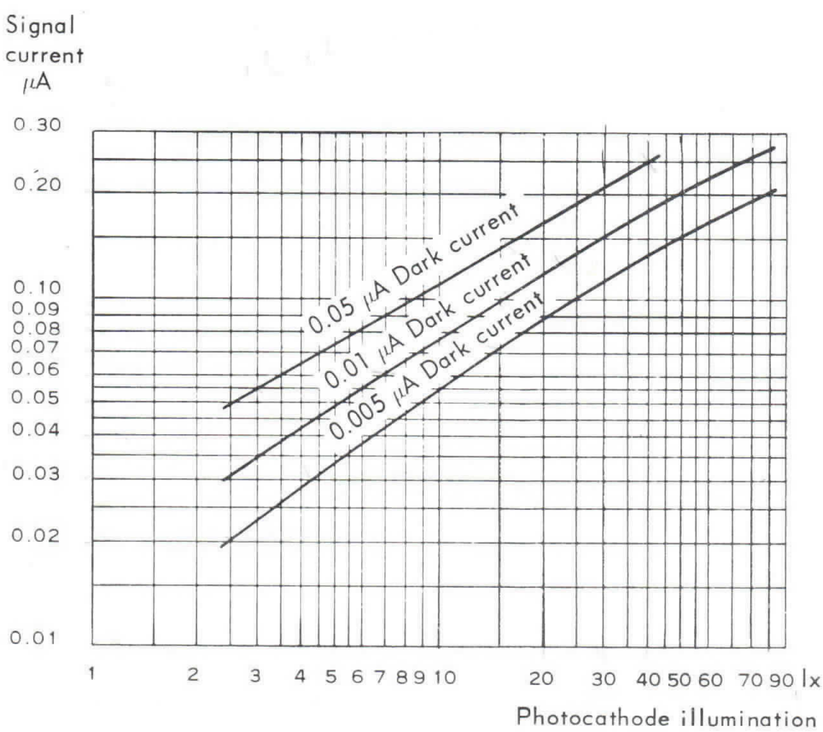


FIG.3.

SIGNAL CURRENT

vs ILLUMINATION

FIG.4. LAG CHARACTERISTICS

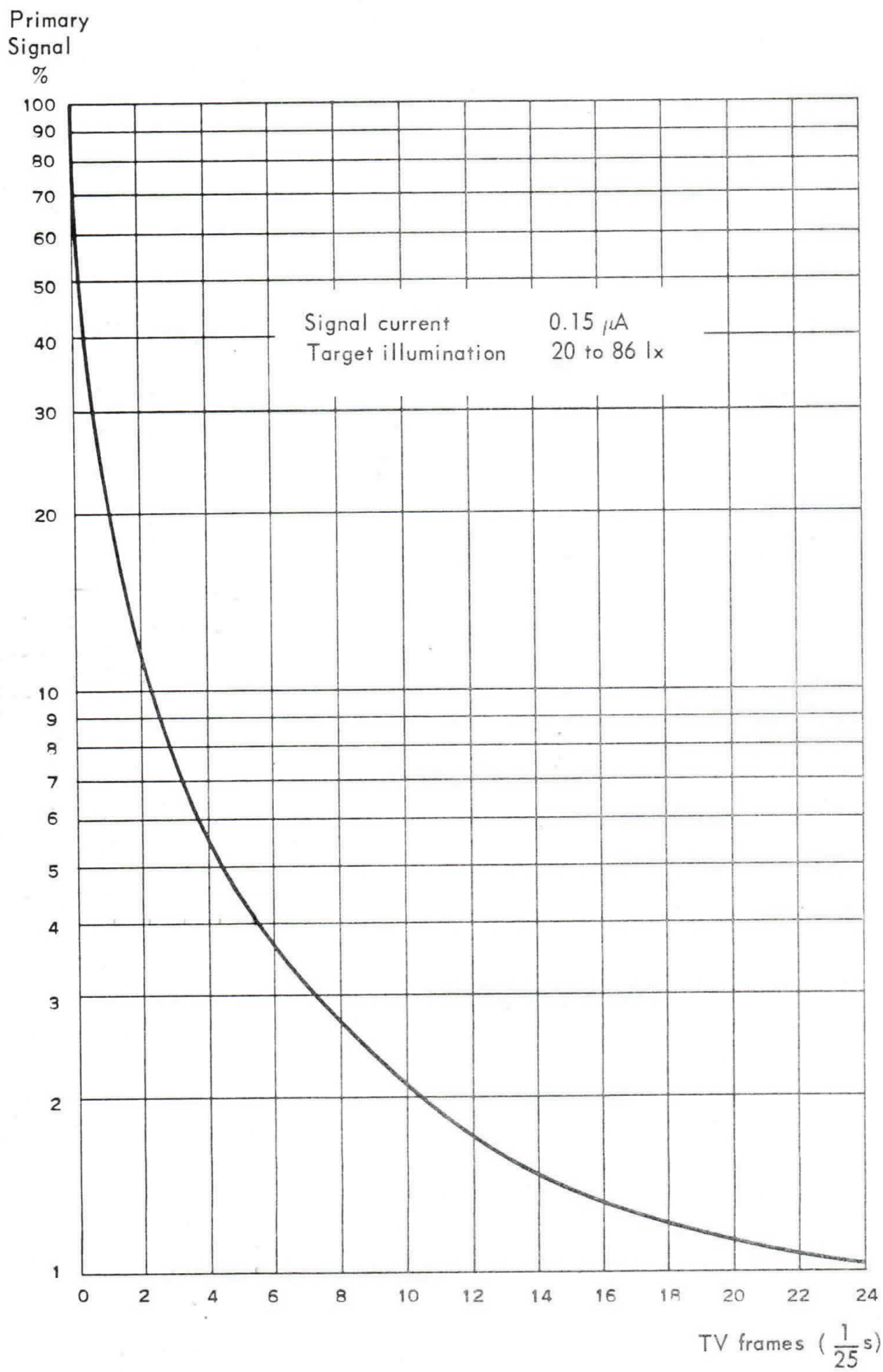
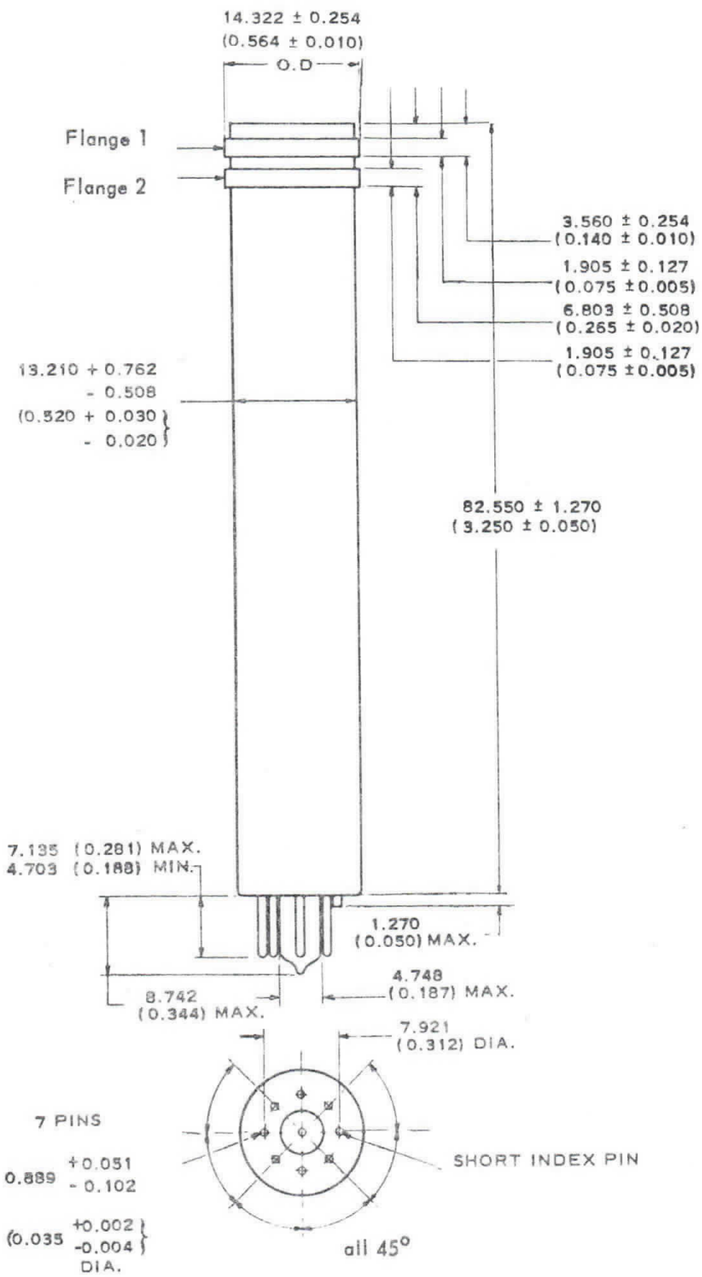


FIG.5. DIMENSIONAL OUTLINE DRAWING



FACEPLATE

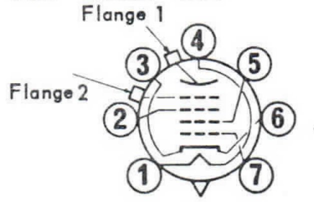
Thickness 2.362 ± 0.076 (0.093 ± 0.003)

Refractive index 1.507 at 5876 Å

Area scanned 4.830 × 6.600 (0.190 × 0.260)

SOCKET CONNECTIONS

View towards base



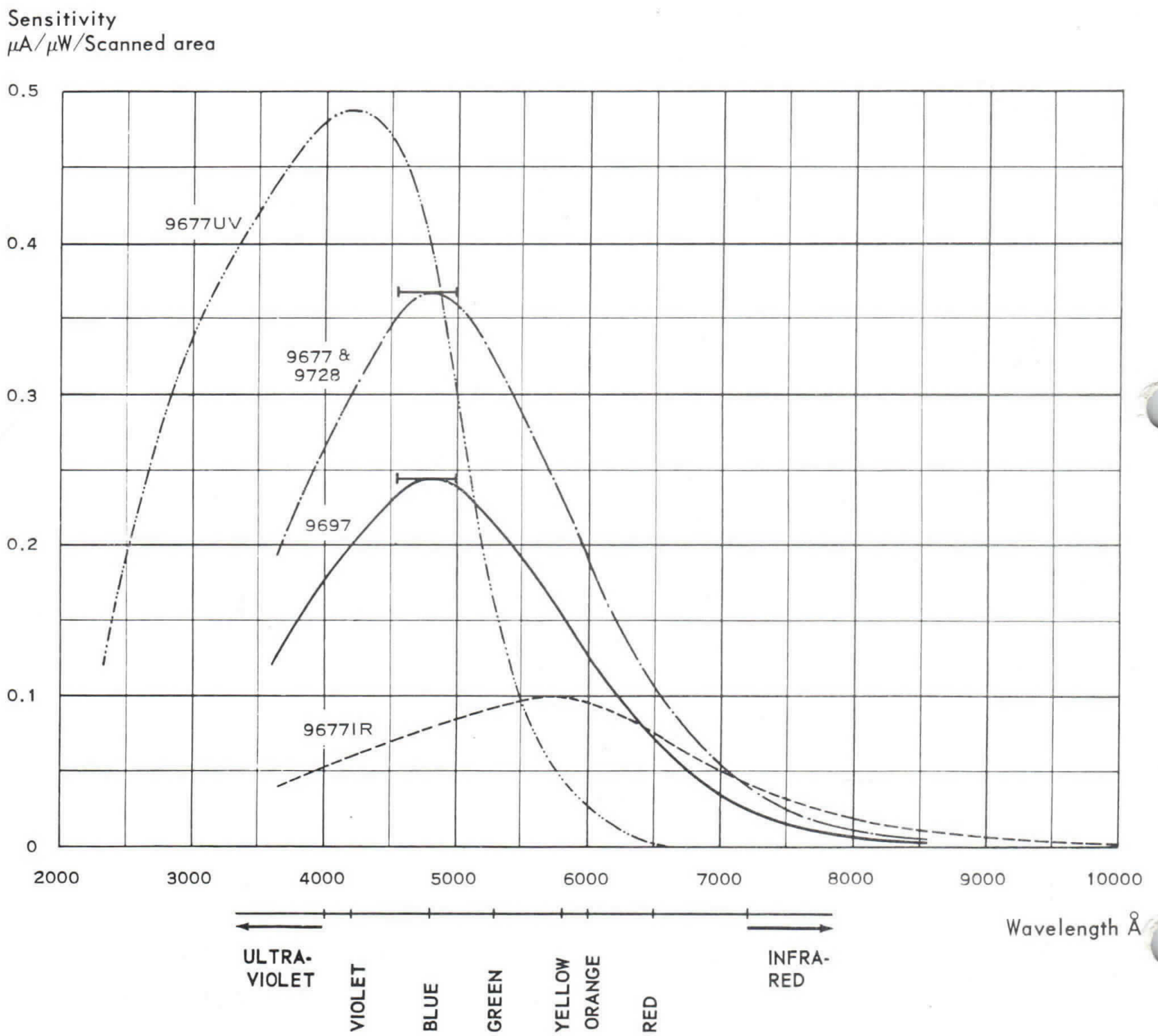
BASE 7
SMALL BUTTON SEVENAR

Pin No.	Connection
1	Heater
2	Wall anode G_3
3	Cathode
4	Heater
5	Limiter G_2
6	Cathode
7	Modulator G_1
Short index pin	Do not connect
Front connections	Flange 1 Signal plate
	Flange 2 Mesh G_4

All dimensions are in millimetres with inches shown in parentheses.

T416/5f
DS.516/5

FIG.6. SPECTRAL RESPONSE OF EMI VIDICONS



ONE INCH VIDICON type	DARK CURRENT μA	SIGNAL μA	AREA SCANNED mm
—·——·— 9677/9728	0.01	0.05	12.80 × 9.60
·—··—··— 9677 UV		0.05	12.80 × 9.60
-------- 9677 IR	0.04	0.05	12.80 × 9.60
HALF INCH VIDICON			
——— 9697	0.01	0.05	6.60 × 4.95

├──┤ Range of peak response

EMI Electronics Ltd Valve Division

Hayes Middlesex England (*Controlled by Electric & Musical Industries Limited*)

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EMI

Electron Tube Division

9738

EMI MAGNETIC 13mm VIDICON TUBE TYPE 9738

The EMI Vidicon type 9738 is a small diameter low wattage heater (0.6 W) tube of robust construction possessing an exceptionally high resolution. It has been designed to operate in standard 13 mm scan and focus coils. Suitable printed circuit coils are available from Electron Tube Division.

The exceptionally high resolution of the type 9738 vidicon compared with earlier 13 mm tubes is due to the use of a separate mesh electrode structure. The separate mesh connection is brought out to a connector ring adjacent to the signal plate contact around the face of the tube. To accommodate this extra connection in standard coils the tube has been extended in length and a mesh contact spring must be provided.

The Type 9738 has a wall anode which is directly evaporated on to the glass envelope to withstand greater mechanical shock. In all other respects the 9738 is similar to the original EMI vidicon type 9697.

CHARACTERISTICS

Mechanical

Nominal length (including pins)	92.8 mm (3.65 in)
Nominal diameter of bulb	13.2 mm (0.52 in)
Nominal diameter of target and mesh rings	14.6 mm (0.574 in)
Base type	Small button sevenar 7 pin
Scanned area	6.60 mm x 4.95 mm (0.26 in x 0.19 in) See Note 1.
Orientation of image	The horizontal scan should be parallel to a plane passing through the tube axis and the short pin.
Operating position	Any. See Note 2.
Weight (approximate)	12 g (0.43 oz)

Electrical

Focusing Method	Magnetic
Deflection Method	Magnetic
Alignment Method	Magnetic
Heater Voltage	6.3 V
Heater Current	90 mA ± 10%
Spectral Response	See Figure 2
Signal Electrode Capacitance to all other electrodes	1.8 pF

T423/1cZ70
DS. 921/1

Limiting Ratings (All potentials are shown relative to the tube cathode)

Heater voltage	5.7 V minimum 6.9 V maximum	See Note 3
Heater potential	10 V positive maximum 50 V negative maximum	Under maximum surge condition
Modulator G1 potential	-150 V negative bias 0 positive bias	
Limiter G2 potential	500 V maximum	
Wall anode G3 potential	500 V maximum	
Mesh G4 potential	550 V maximum	
Signal Electrode potential	100 V maximum	See Note 4
Dark current	0.2 μA maximum	See Note 4
Target illumination	10,000 lx maximum (tube not operating)	
Faceplate temperature	70°C maximum	

Typical Operating Conditions

Heater to cathode potential	± 10 V apart from blackout	
Modulator G1 potential	- 35 V to -75 V	
Cut off potential	- 50 V to -100 V	
Limiter G2 potential	300 V	
Wall anode G3 potential	280 V to 300 V	See Note 5
Mesh G4 potential	400 V to 450 V	
Minimum blackout pulses when applied to G1	70 V negative pulses	
Minimum blackout pulses when applied to cathode	10 V positive pulses	
Axial magnetic field	0.006T (60 gauss)	See Note 6
Adjustable transverse alignment field	± 0.0004T (± 4 gauss)	
Target illumination (highlights)	20 lx	
Signal electrode voltage	50 V	
Dark current	0.01 μA	
Signal current	0.12 μA	
Faceplate temperature	30°C	

Leakage Specification (Tube not operating)

Between pin No.	and pin No.	Test potential	Leakage current
2, 5, 6, 7 and flange 2	1 and 4 (negative)	100 V	100 μA
1, 2, 4, 5, 6 and flange 2	7 (negative)	150 V	15 μA
1, 2, 4, 6, 7 and flange 2	5 (positive)	500 V	50 μA
1, 4, 5, 6, 7 and flange 2	2 (positive)	500 V	50 μA
1, 2, 4, 5, 6, 7 and flange 1	flange 2 (positive)	500 V	5 μA

OPERATING NOTES

1. Scanned Area

The tube should be operated with the target area 6.60 mm x 4.95 mm (0.26 in x 0.19 in) completely scanned to obtain the best signal to noise ratio and resolution. Small changes in sensitivity and dark current occur in the scanned area over a long period of time so that it is important to use the same scanned area throughout the life of the tube.

2. Operating Position

When the tube is operated vertically with its face downwards care should be taken to avoid undue mechanical shock.

3. Heater

For optimum results and maximum life, the heater supply should be designed to give a nominal 6.3 V and should be kept within the limits 6.1 V to 6.5 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V under surge conditions. If this figure is likely to be exceeded on switching on, a surge limiting device must be incorporated.

4. Signal Electrode (Target)

The dark current should not be allowed to exceed 0.2 μA or a burnt-in picture may result. The signal electrode voltage supply should be limited to 100 V for this reason.

5. Wall Anode Potential

On no account should the wall anode be operated at a higher potential than the mesh G4, otherwise an ion spot may be observed. The setting of the beam current in this tube is less critical than with an integral mesh vidicon, provided the mesh is positive with respect to the wall anode.

6. Field

The focusing field should be such that a north seeking pole is attracted to the faceplate of the tube.

Fig.1 TYPICAL CENTRE RESOLUTION

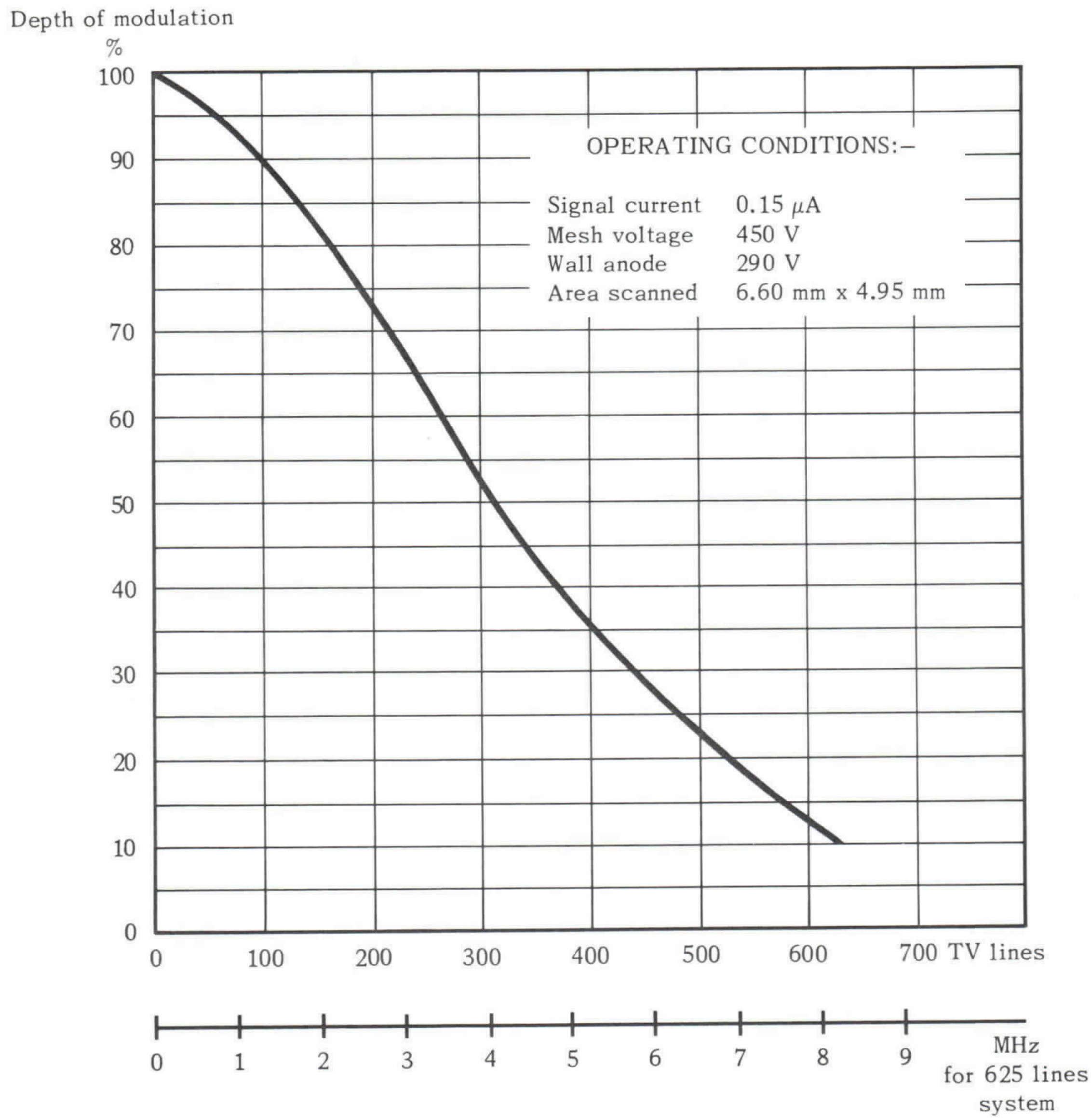


Fig.2 SPECTRAL RESPONSE

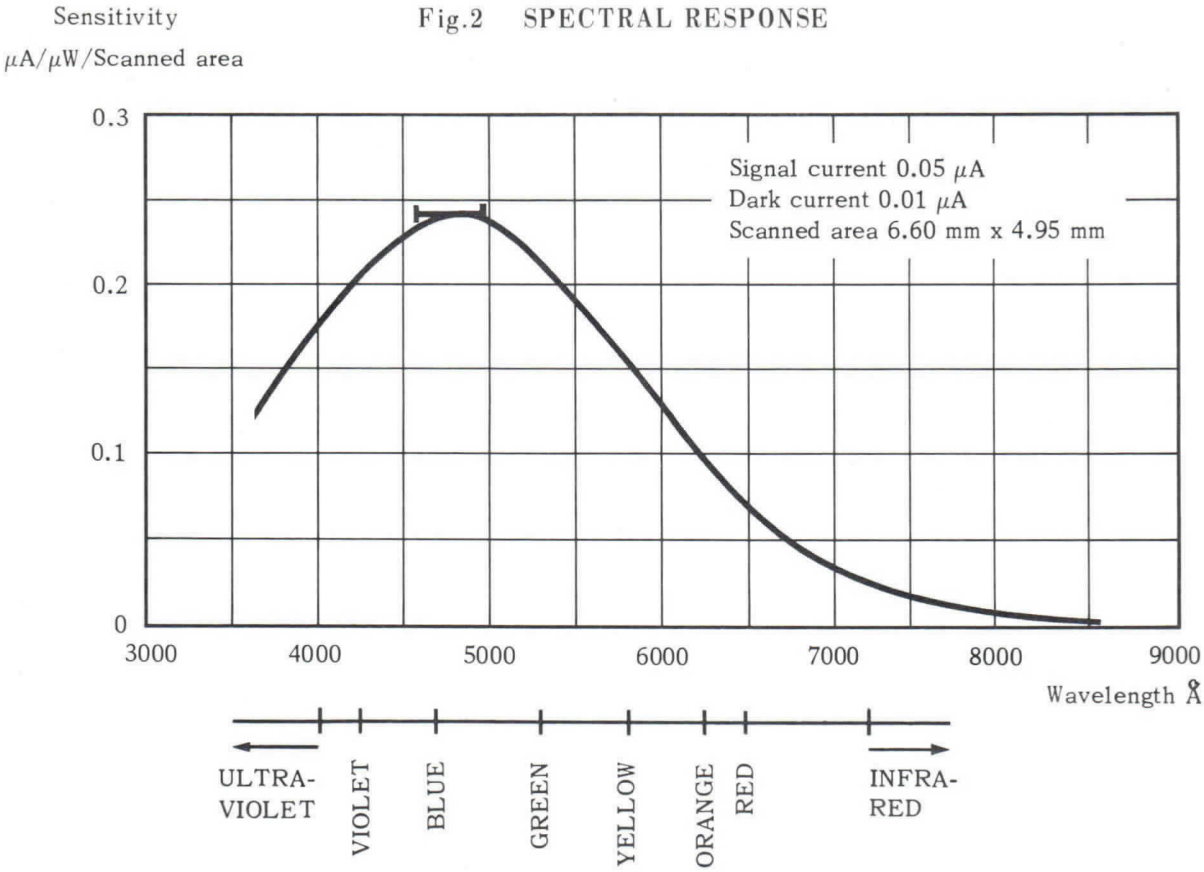


Fig.3 DARK CURRENT vs SIGNAL ELECTRODE POTENTIAL

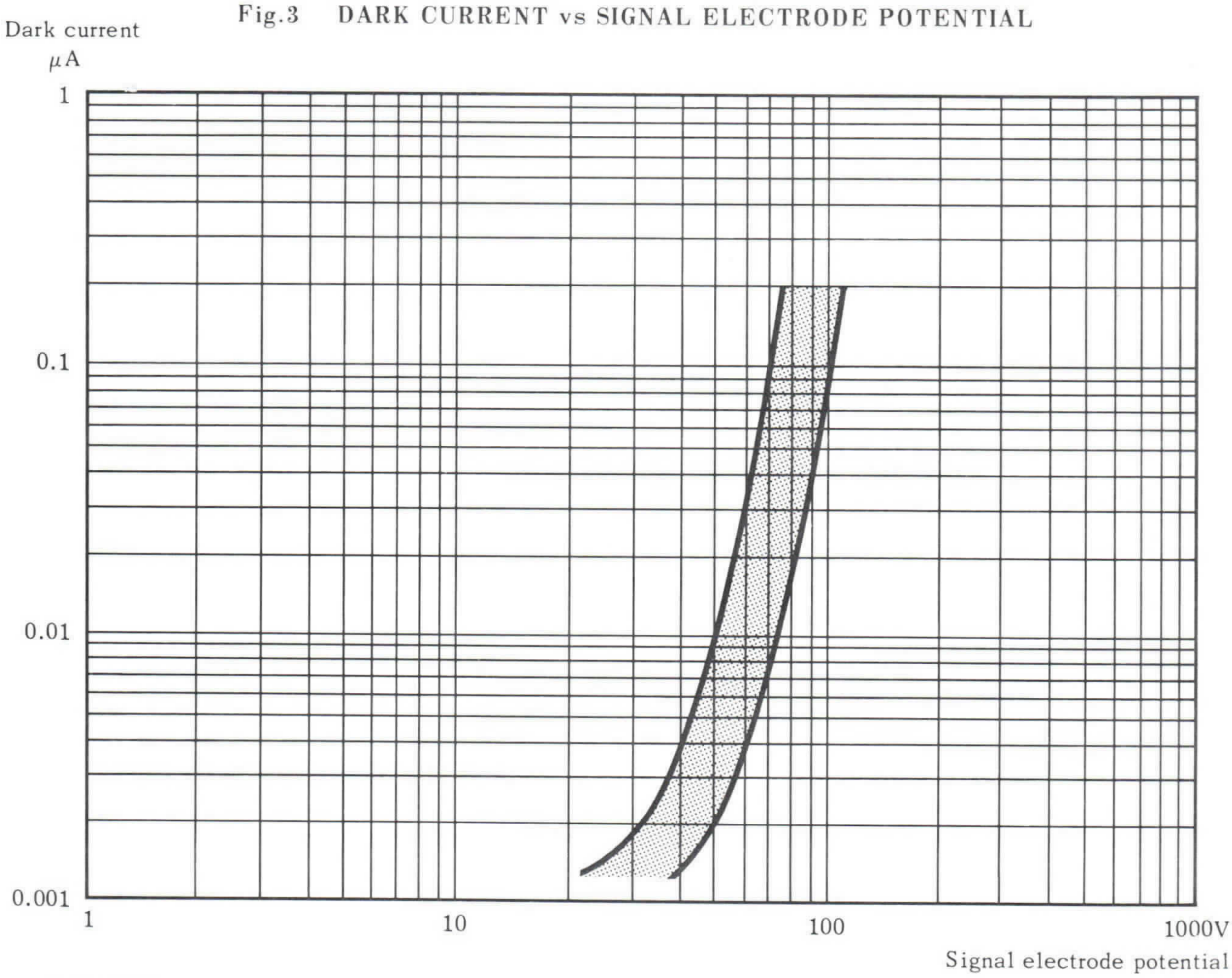


Fig.4 SIGNAL CURRENT vs ILLUMINATION

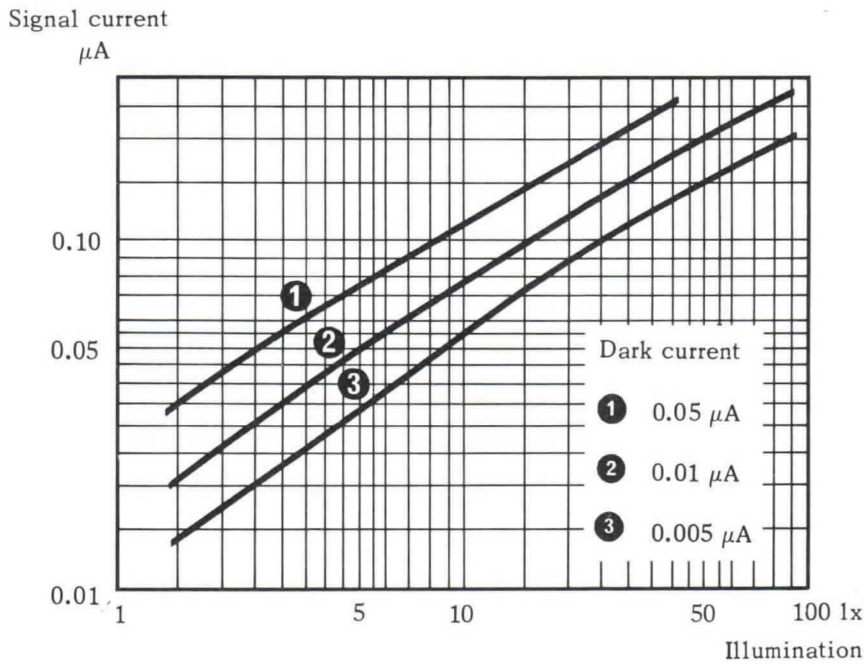


Fig.5 LAG CHARACTERISTICS

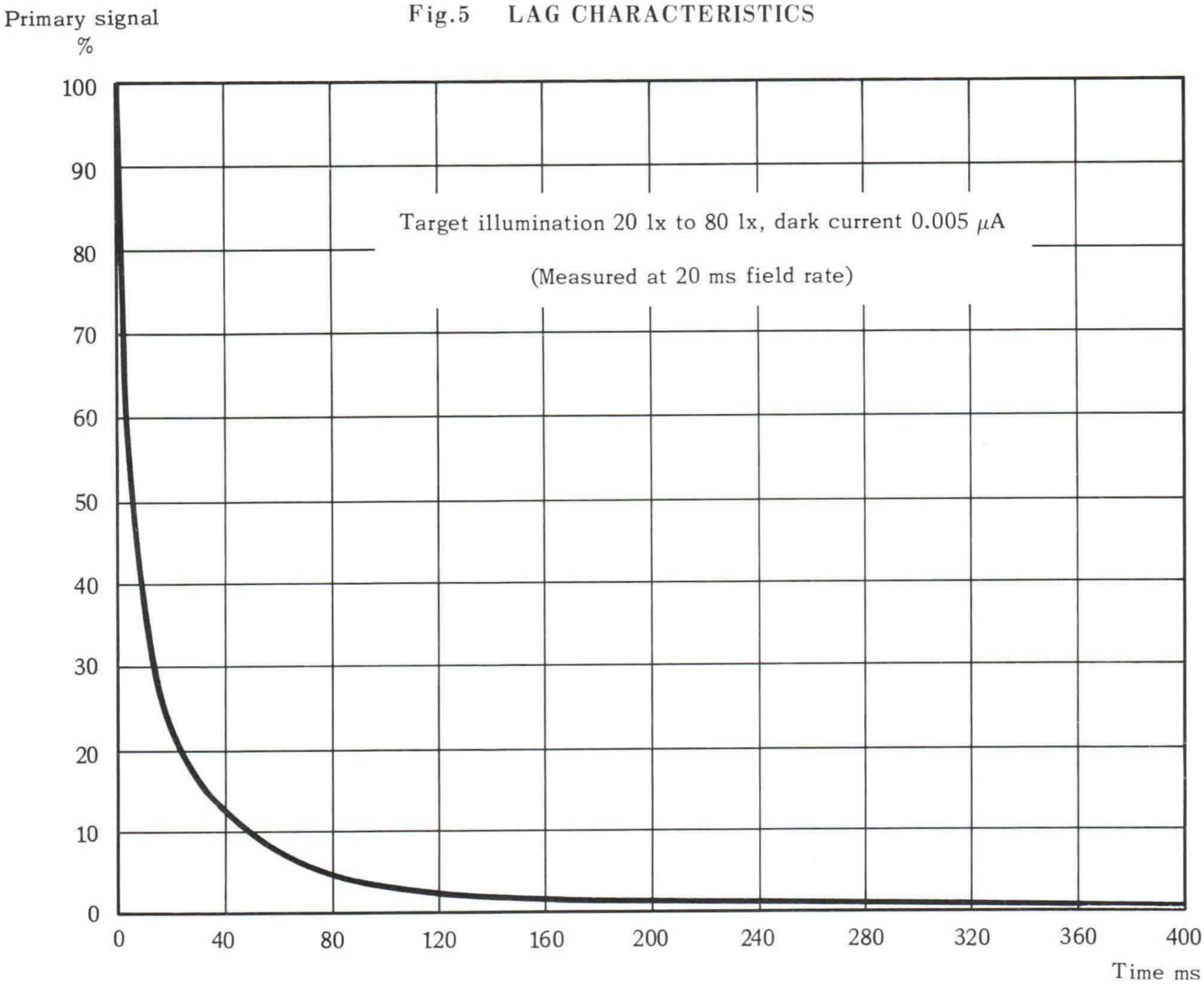
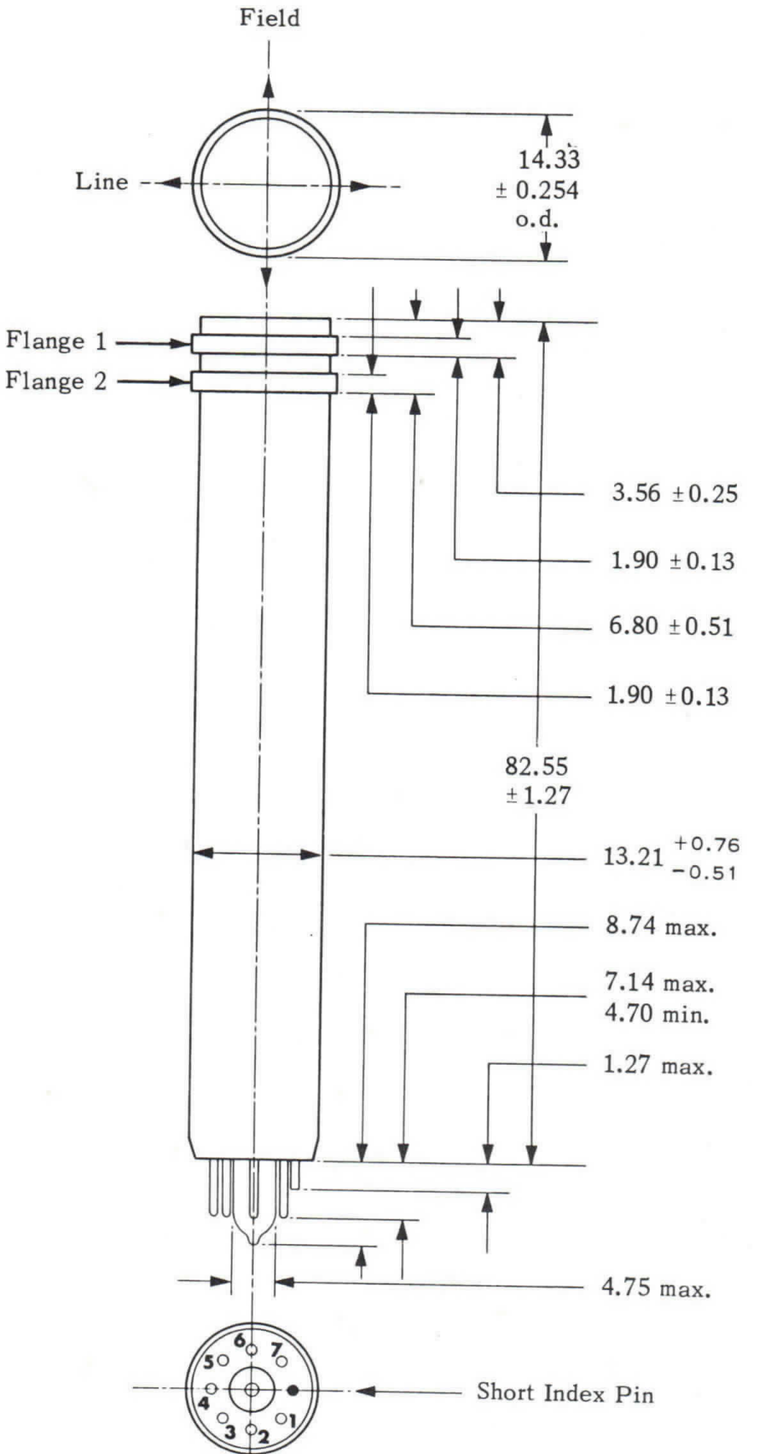


Fig.6 DIMENSIONAL OUTLINE DRAWING



7 pins 0.889 $^{+0.051}_{-0.102}$ dia.
at 45° on 7.92 ±0.127 P.C.D.

FACEPLATE

Thickness	2.362 ±0.076
Refractive index	1.507 at 5876Å
Area scanned	6.60 x 4.95

QUALITY CIRCLE
8.4 dia.min.

BASE:
SMALL BUTTON SEVENAR

Pin No.	Connection
1	Heater
2	Wall anode G_3
3	Cathode
4	Heater
5	Limiter G_2
6	Cathode
7	Modulator G_1
Short pin	Internally connected
Flange 1	Signal electrode
Flange 2	Mesh G_4

All dimensions are in millimetres

PRODUCT RANGE OF
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The **EMI ELECTRON TUBE DIVISION**
manufactures a wide range of special electron tubes for equipment used in broadcasting, radar, nuclear and scientific applications.

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Photomultiplier tubes, which convert very low levels of illumination into usable electric currents are used extensively in astronomy, spectrophotometry, scintillation counting, spectrometry and broadcast television.

★ CAMERA TUBES Ext. 2078

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★ IMAGE INTENSIFIERS Ext. 2075

The image intensifier tube, capable of multiplying light up to a million times, is important for such applications as microscopy and astronomy.

★ CATHODE RAY TUBES Ext. 2073

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★ SPECIAL PRODUCTS Ext. 2551

New products include the Printicon, a small, low voltage, all-electrostatic monoscope, which is used for generating alpha-numeric symbols, spectroscopic lamps for atomic absorption and spectrometry and a range of printed circuit deflection coils, such as used in the successful EMI Colour TV Camera.

The EMI Electron Tube Division has great experience and comprehensive facilities in research, development and manufacture of light sensing and light emitting devices, and allied equipment.

NOTE:

For further information please telephone the extension shown opposite each product and service.

The **EMI MICROELECTRONICS DIVISION**
provides for the increasing demands made upon the ability of electrical and electronic equipment designers to meet high density packaging, reliability, weight, and cost requirements. This can only be achieved by taking full advantage of modern fabrication and design methods. The EMI Microelectronics Division offers these facilities to its customers in the following product areas:–

★ Thin and Thick Film Passive Networks

Thin and Thick Film Hybrid Integrated Circuits

Temperature Sensing Elements

Flexible Printed Wiring

Double-sided and Through-plated Printed Circuit Boards

Multilayer Printed Circuit Boards Ext. 2463

Production facilities have been built up over several years to meet the need for economic batch, and large volume, manufacture. The production unit is supported by a comprehensive Circuit Design and Draughting Group, and a Quality Control Division.

A continuous R. & D. programme ensures that full advantage is taken of the latest technological developments in manufacturing processes. Microcircuit design is aided by the use of a computer programmed to predict thermal contours.

Continuous on-line monitoring of all processes is maintained during all stages of production and testing.

The environmental test facilities available within EMI Electronics together with the calibration and standardisation procedures, have been approved by the Ministry of Technology and the Air Registration Board.

★ CUSTOMER ENGINEERING SERVICE Ext. 2463

A team of engineers fully experienced in both circuit and systems design is available to assist customers in applying microelectronic techniques to the solution of particular problems. This facility covers all aspects of system design, the rationalization of integrated circuits, thermal management and packaging.

FLEXIBILITY

The EMI Microelectronics Division is an integrated unit, with design and manufacturing facilities not allied to any particular aspect of microelectronics technology. The resulting flexibility enables the achievement of the optimum design package to meet customers' needs.

G911a

T423/8cZ70
DS. 921/8

EMI

EMI Electronics Ltd Electron Tube Division

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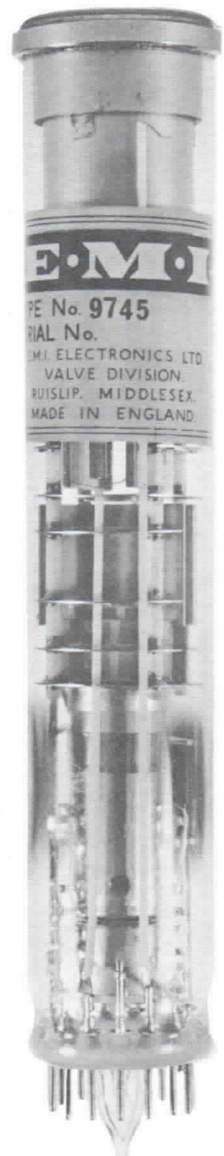
Cables: *Emidata, London* Telex: *London 22417*

Electron Tube and Microelectronics Division

EMI ELECTROSTATIC 26 mm VIDICON CAMERA TUBE TYPE 9745

The all electrostatic EMI vidicon type 9745 has an exceptional performance, particularly with regard to corner resolution and geometry. It employs a standard 26 mm vidicon envelope with a 14-pin base. The absence of scan and focus coils enables the tube to be readily used in small diameter cameras. The tube employs an 0.6 W heater and can be driven from solid state deflection circuits.



CHARACTERISTICS

Mechanical

Nominal length (excluding pins)	146.1 mm (5.75 in)
Maximum length (overall)	162.4 mm (6.40 in)
Nominal diameter of bulb	25.91 mm (1.02 in)
Nominal diameter of target contact ring	28.58 mm (1.125 in)
Base type	B14B
Scanned area	12.7 mm x 9.6 mm (½ in x ⅜ in) See Note 1
Orientation of image	The horizontal scan is approximately parallel to a plane passing through the tube axis and the short pin.
Magnetic shielding	A cylindrical mu-metal shield should be provided around the full length of the tube – suggested 20 SWG with an outside diameter of 35 mm
Operating position	Any. See Note 2
Weight (approximate)	70 g (2½ oz)

Electrical

Focusing method	Electrostatic	
Deflection method	Electrostatic	
Heater voltage	6.3 V	
Heater current	90 mA ± 10%	
Spectral response	See figure 3	
Inter-electrode capacities (nominal)	Signal Electrode to all other electrodes	6 pF
	Y1 to all other electrodes	7 pF
	Y2 to all other electrodes	7 pF
	X1 to all other electrodes	9 pF
	X2 to all other electrodes	9 pF
	Y1 to Y2	2.5 pF
	X1 to X2	3.5 pF
Orthogonality	± 24 minutes of arc max.	
Geometric Distortion	¾ % of picture height in corners. Distortion is seen as pincushion on picture monitor.	
Maximum white shading	30% from central peak	
Minimum sensitivity	0.15 μA signal current with 0.01 μA dark current for 20 lux on the target	

Limiting Ratings (all potentials are shown relative to the tube cathode)

Heater voltage	5.7 V minimum 6.9 V maximum	See Note 3
Heater potential	20 V positive maximum 100 V negative maximum	under maximum surge condition
Modulator G1 potential	−45 V to −250 V	
Cathode current	200 μA	
Anode G2 potential	1500 V maximum	
Signal Electrode potential	100 V maximum	See Note 4
Dark current	0.1 μA maximum	See Note 4
Target illumination	10,000 lx maximum (tube not operating)	
Faceplate temperature	70°C maximum	

Typical Operating Conditions

Modulator G1 potential	−120 V		
Cut off potential	−150 V		
Cathode current	20 μA to 50 μA		(200 μA) **
Anode G2 potential	1500 V	See Note 5	(200 μA) **
Focus grid G3 potential	650 V to 750 V	See Note 5	(5 μA) **
Focus grid G4 potential	400 V to 500 V	See Note 5	(5 μA) **
Target mesh G5 potential	750 V	See Note 5	(5 μA) **
Minimum blackout pulses when applied to G1	75 V negative pulses		
Minimum blackout pulses when applied to cathode	10 V positive pulses		
Line scan amplitude	110 V Peak to Peak at the potential of G4	See Note 6	
Field scan amplitude	70 V Peak to Peak at the potential of G3	See Note 6	

Target illumination (highlights)	2	20	60	500	lux
Signal electrode voltage	50–80	30–60	20–40	10–20	V
Dark current	0.1	0.01	0.005	0.005	μA
Signal current	0.15	0.25	0.25–0.3	0.25–0.3	μA
Faceplate temperature	30°C				

** These are maximum currents to indicate circuit impedances

OPERATING NOTES

1. Scanned Area

The tube should be operated with the target area 12.7 mm x 9.6 mm (½ in x ⅜ in) completely scanned to obtain the best signal to noise ratio and resolution. Small changes in sensitivity and dark current occur in the scanned area over a long period of time so that it is important to use the same scanned area throughout the life of the tube.

2. Operating Position

When the tube is operated vertically with its face downwards care should be taken to avoid undue mechanical shock.

3. Heater

For optimum results and maximum life, the heater supply should be designed to give a nominal 6.3 V and should be kept within the limits 6.1 V to 6.5 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V under surge conditions. If this figure is likely to be exceeded on switching on, a surge limiting device must be incorporated.

4. Signal Electrode (Target)

The dark current should not be allowed to exceed 0.1 μA or a burnt-in picture may result. The signal electrode voltage supply should be limited to 100 V for this reason.

5. Electrode Potentials

The various d.c. electrode potentials are best derived from a suitable potentiometer resistance chain fed from a stable high voltage supply connected to the anode G2. Small variations in the overall high voltage to G2, providing that the ratios of the electrode voltages are unaltered, will not affect picture focus but only the scanned area size. Picture focus is obtained by adjusting G3 and G4. G3 predominantly affects the horizontal focus and G4 the vertical focus. However some interaction occurs between these two.

6. Scanning Requirements

When the tube is operated at a lower overall voltage, proportionately less scanning voltages are necessary. See suggested push pull transistorised deflection circuit (Fig.7).

Fig.1 TYPICAL CENTRE RESOLUTION

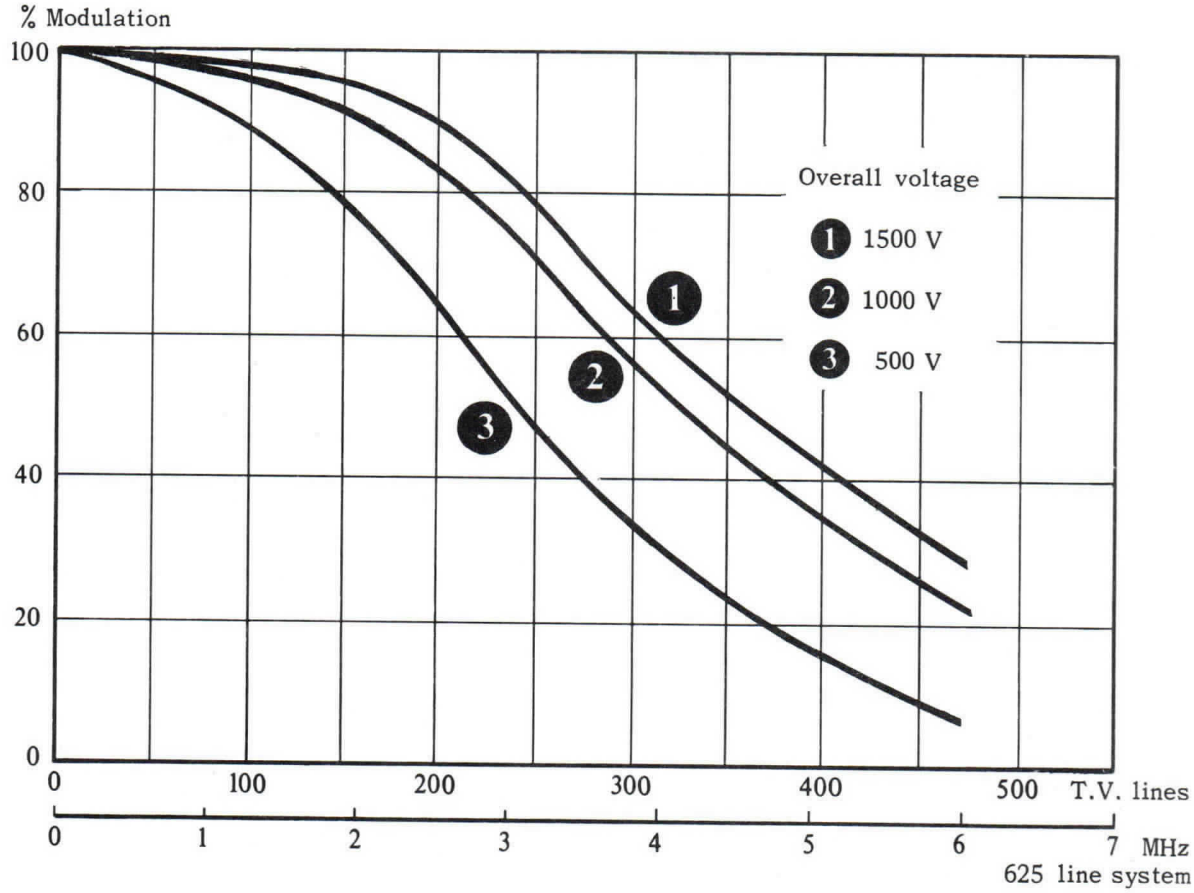


Fig.2 TYPICAL CORNER RESOLUTION
Measured at 15% from end of diagonals

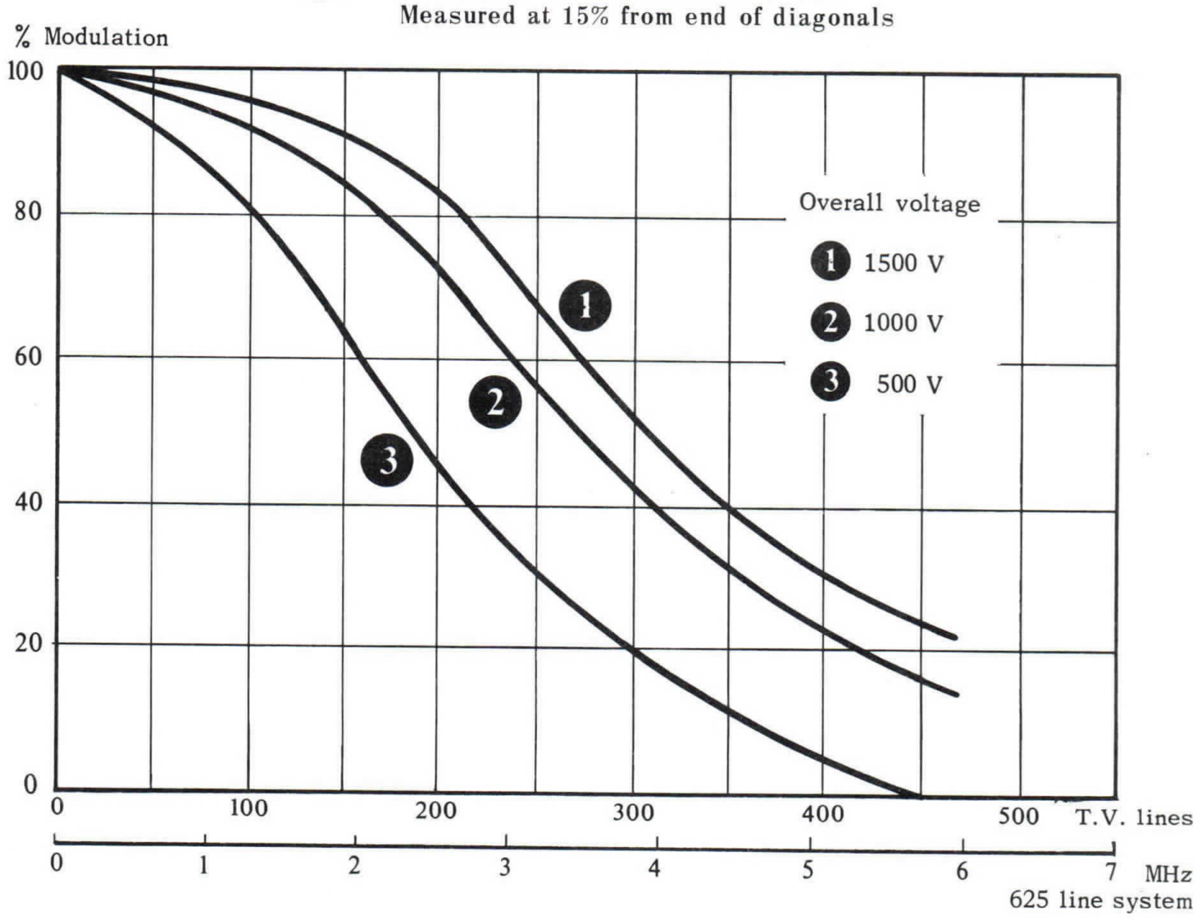


Fig.3 SPECTRAL RESPONSE

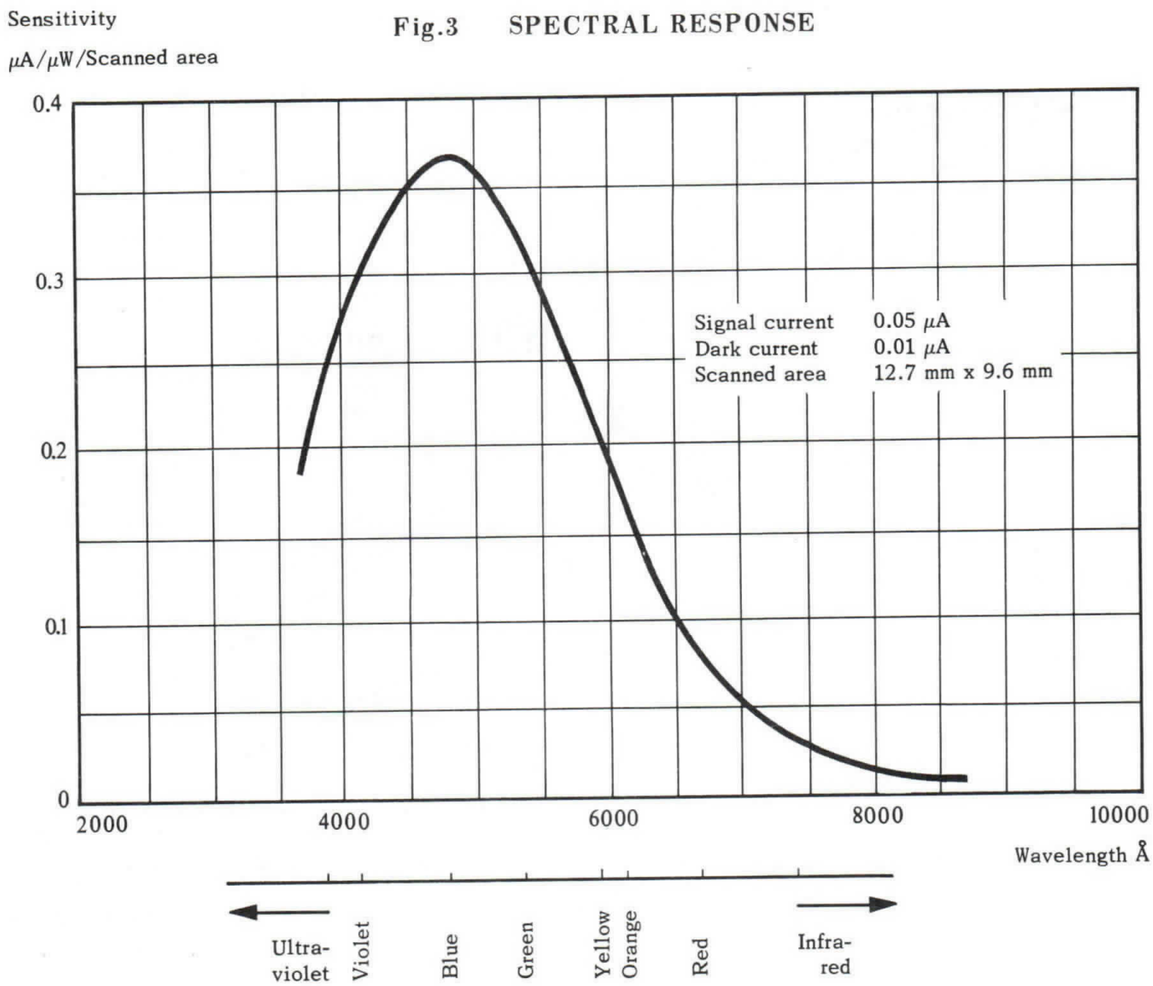


Fig.4 DARK CURRENT vs SIGNAL ELECTRODE POTENTIAL

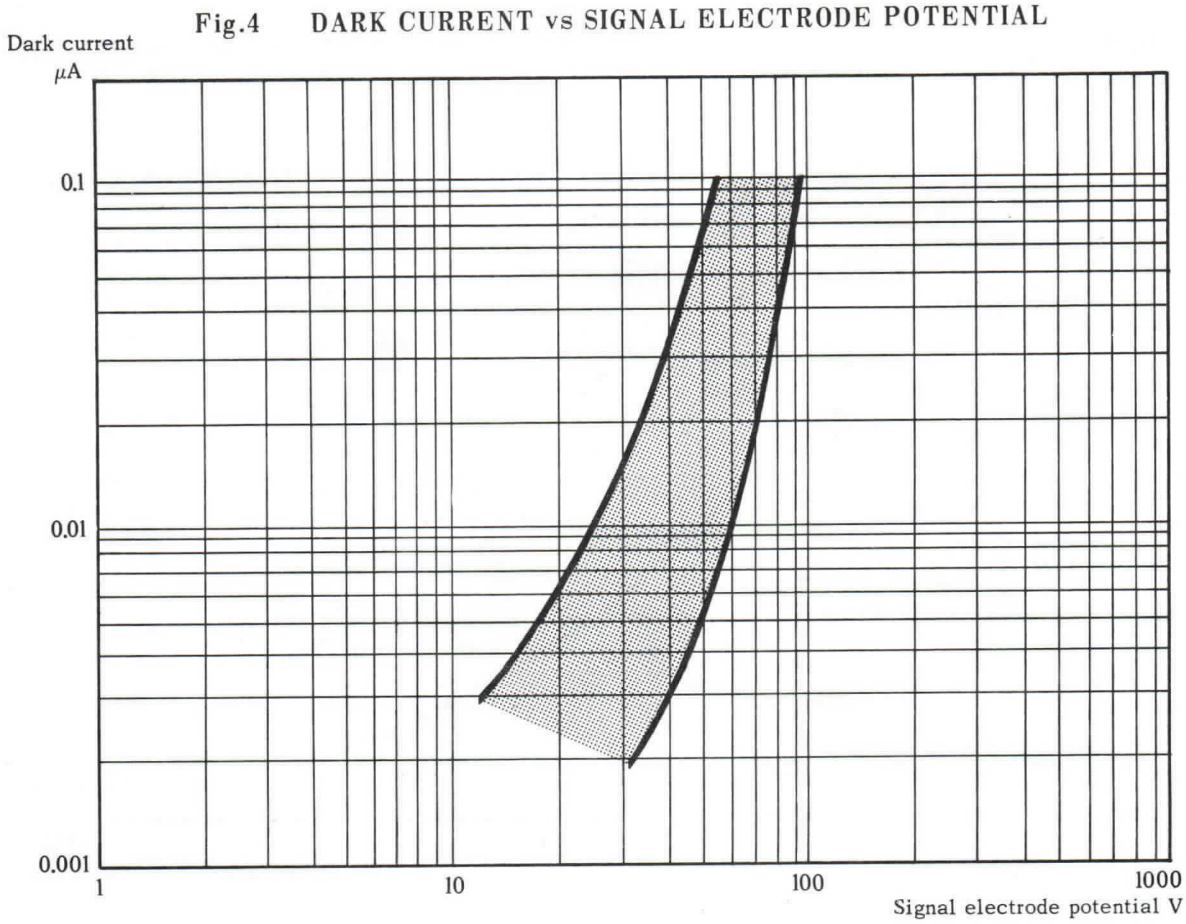


Fig.5 SIGNAL CURRENT vs ILLUMINATION

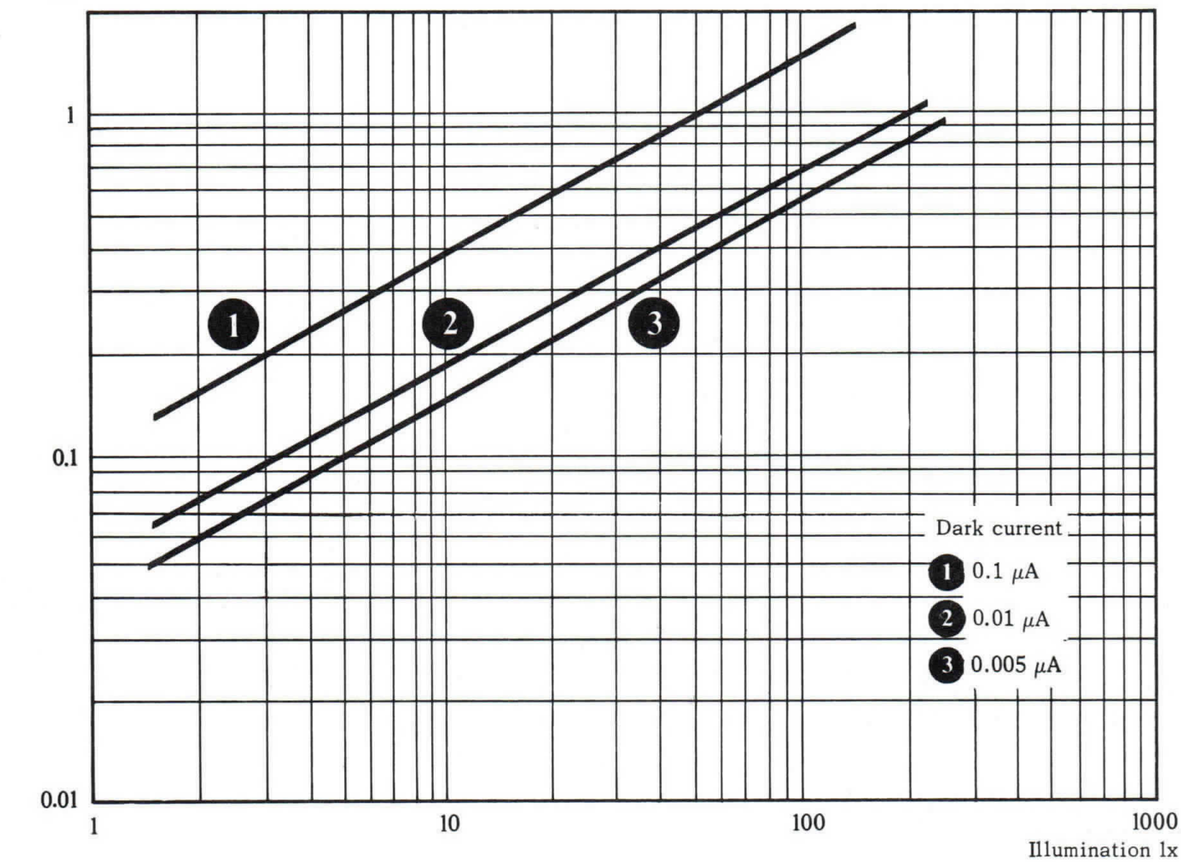


Fig.6 LAG CHARACTERISTICS

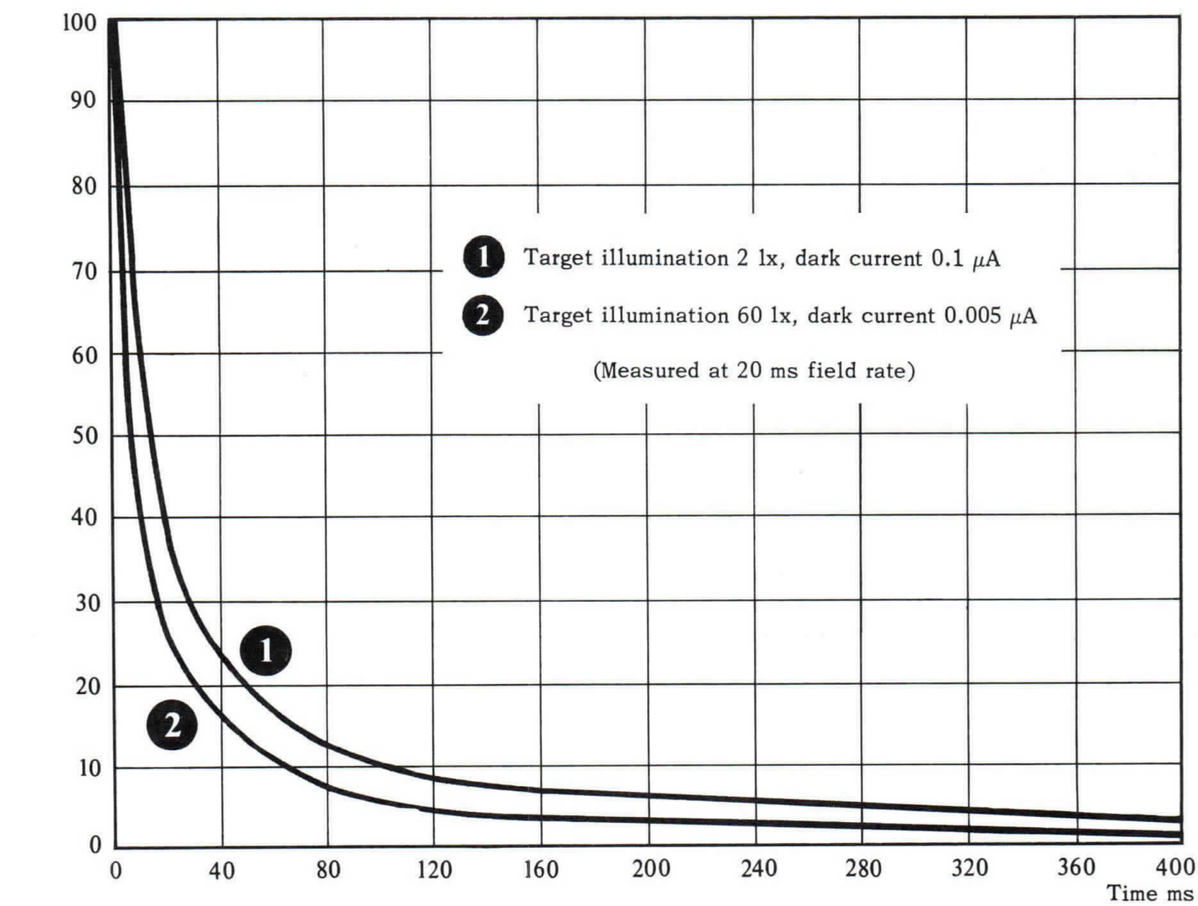
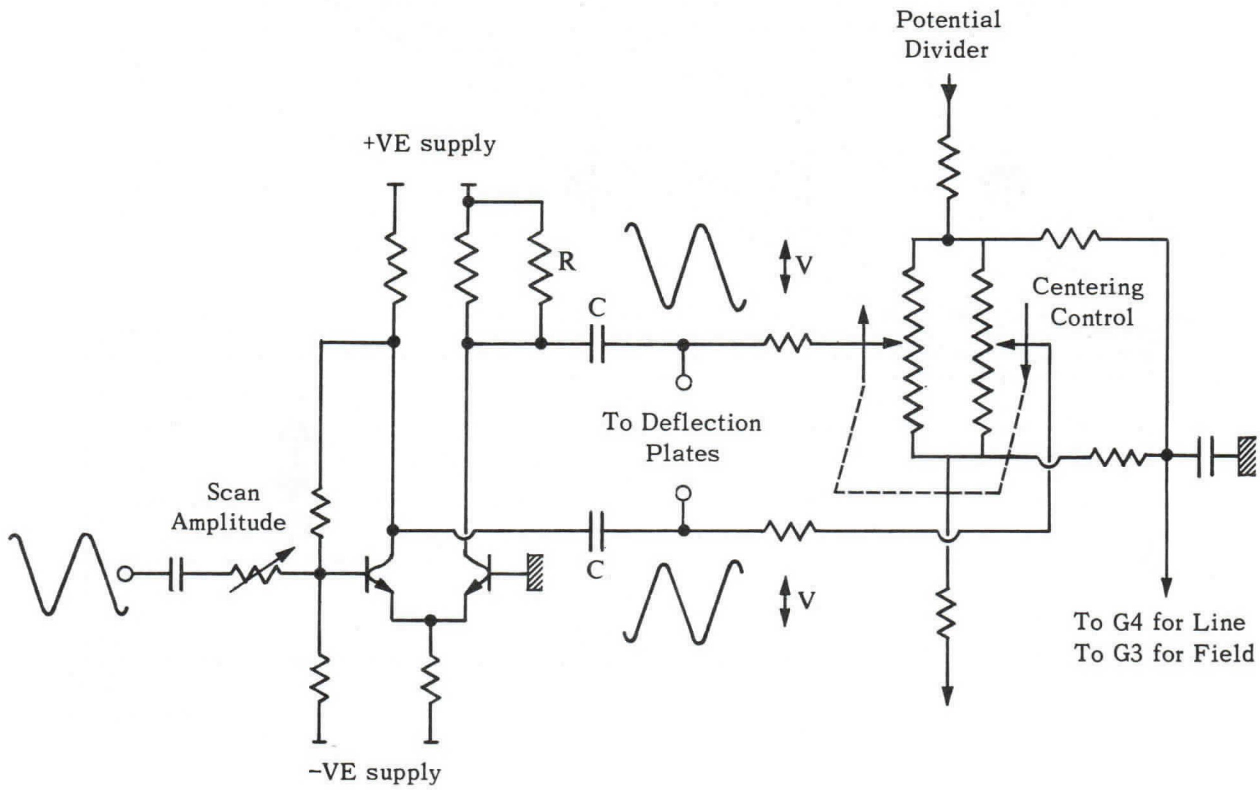


Fig.7 BASIC DEFLECTION OUTPUT CIRCUIT



NOTES:

1. Resistor "R" should be adjusted to give accurately PUSH-PULL Deflection. Otherwise Deflection Defocusing will occur.

2. The Deflection Voltages "V" required on each Plate are

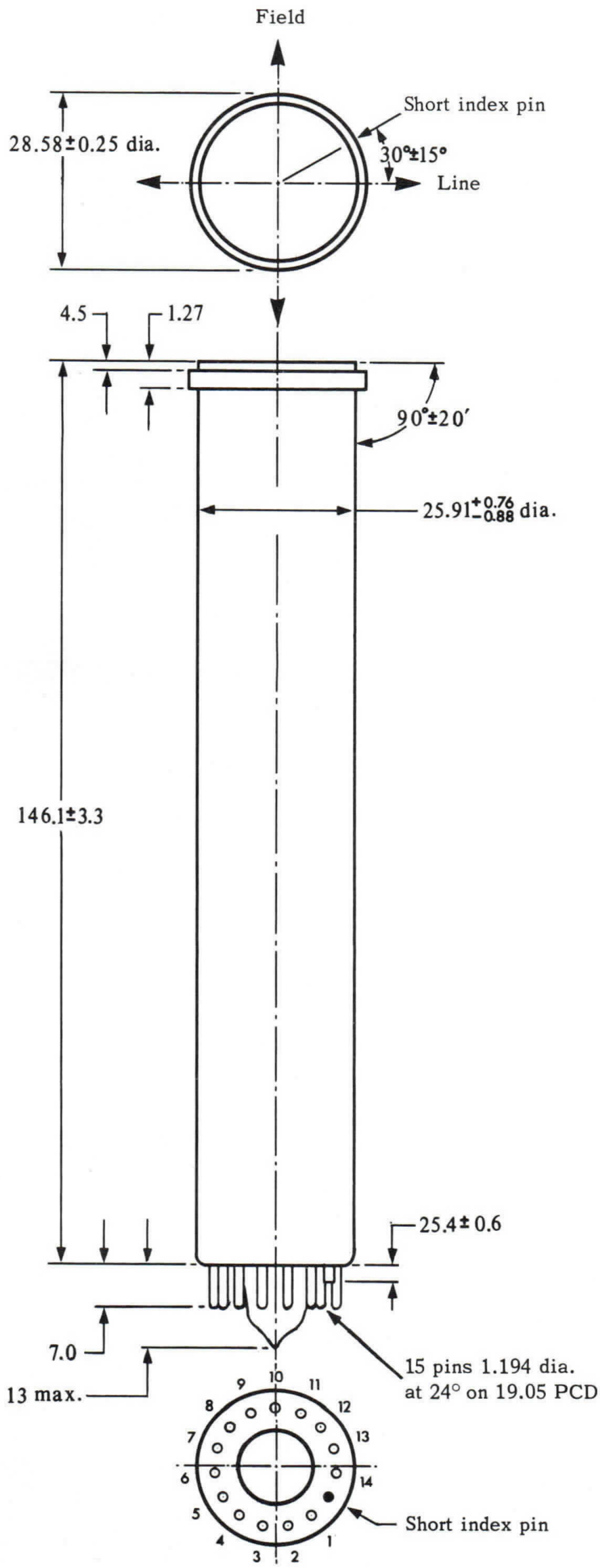
   55 V for LINE }
   35 V for FIELD } with 1500 V on G2

   Mean Potential of Plates is given in Data Sheet.

3. Suitable Transistor Types are 2N3440.

4. Required Value of Coupling Condensers 'C' may be minimised by Pre-Distortion of the Input Waveform.

Fig.8 DIMENSIONAL OUTLINE DRAWING



Faceplate

Thickness	2.362 ± 0.076
Refractive index	1.507 at 5876 Å
Area scanned	12.7 x 9.6

Quality Circle

16.26 dia. min.

Base connections

Base B14B

Pin No.	Connection
1	Heater
2	Anode G2
3	Focus grid G3
4	Field scan Y1
5	Modulator G1
6	Field scan Y2
7	Not connected
8	Line scan X1
9	Line scan X2
10	Modulator G1
11	Target mesh G5
12	Focus grid G4
13	Cathode K
14	Heater
Front flange	Signal plate

Do not connect to the short pin

All dimensions are in millimetres

PRODUCT RANGE OF EMI ELECTRON TUBE AND MICROELECTRONICS DIVISION

The **EMI ELECTRON TUBE DIVISION**
manufactures a wide range of special electron tubes for equipment used in broadcasting, radar, nuclear and scientific applications.

✱ PHOTOMULTIPLIER TUBES Ext. 2074

Photomultiplier tubes which convert very low levels of illumination into usable electric currents are used extensively in astronomy, spectrophotometry, scintillation counting, spectrometry and broadcast television.

✱ PHOTOMULTIPLIER TUBE HOUSINGS Ext. 2283

A range of cooled and uncooled photomultiplier tube housings, including thermoelectric, dry ice and liquid nitrogen versions are available for optimum photomultiplier tube operation.

✱ CAMERA TUBES Ext. 2078

There is a wide range of vidicons, including all-electrostatic, available in various grades from general surveillance to broadcast studio.

✱ IMAGE INTENSIFIERS Ext. 2075

The image intensifier tube, capable of multiplying light up to a million times, is important for such applications as microscopy and astronomy.

✱ CATHODE RAY TUBES Ext. 2073

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✱ SPECIAL PRODUCTS Ext. 2551

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✱ SOLID STATE PHOTODIODES Ext. 2126

These include a range of linear and avalanche silicon photodiodes including fast and rugged types having wide spectral response.

✱ PRECISION MICROMESH Ext. 2073

The very fine metallic mesh currently employed in EMI vacuum tubes is also used in various other branches of industry and science, such as microscopy, mass spectrometry, biology, filtering and optics.

The EMI Electron Tube Division has great experience and comprehensive facilities in research, development and manufacture of light sensing and light emitting devices and allied equipment.

The **EMI MICROELECTRONICS DIVISION**
provides for the increasing demands made upon the ability of electrical and electronic equipment designers to meet high density packaging, reliability, weight and cost requirements. This can only be achieved by taking full advantage of modern fabrication and design methods. The EMI Microelectronics Division offers these facilities to its customers in the following product areas:—

✱ Thin and Thick Film Passive Networks

Thin and Thick Film Hybrid Integrated Circuits

Flexible Printed Wiring

Double-sided and Through-plated Printed Circuit Boards

Multilayer Printed Circuit Boards Ext. 2463 or 594

Production facilities have been built up over several years to meet the need for economic batch and large volume manufacture. The production unit is supported by a comprehensive Circuit Design and Draughting Group and a Quality Control Division.

A continuous R. & D. programme ensures that full advantage is taken of the latest technological developments in manufacturing processes. Microcircuit design is aided by the use of a computer programmed to predict thermal contours.

Continuous on-line monitoring of all processes is maintained during all stages of production and testing.

The environmental test facilities available within EMI Electronics together with the calibration and standardisation procedures, have been approved by D Q A B and the Air Registration Board.

✱ CUSTOMER ENGINEERING SERVICE Ext. 2463 or 594

A team of engineers fully experienced in both circuit and systems design is available to assist customers in applying microelectronic techniques to the solution of particular problems. This facility covers all aspects of system design, the rationalization of integrated circuits, thermal management and packaging.

FLEXIBILITY

The EMI Microelectronics Division is an integrated unit, with design and manufacturing facilities not allied to any particular aspect of microelectronics technology. The resulting flexibility enables the achievement of the optimum design package to meet customers' needs.

NOTE: For further information please telephone the extension shown opposite each product and service.

G911c

T424/8f
DS.922/8

EMI

EMI Electronics Ltd Electron Tube Division

Hayes Middlesex England Telephone: *01-573 3888*

Cables: *Emidata, London* Telex: *London 22417*

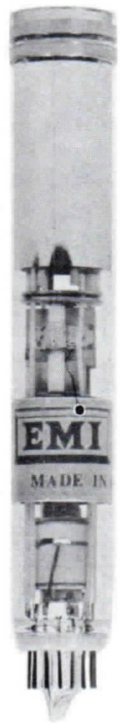
EMI Electronics Ltd

Valve Division

EMI ELECTROSTATIC 13 mm VIDICON CAMERA TUBE TYPE 9768

The all electrostatic EMI vidicon type 9768 employs a robust all-brazed electrode structure and makes possible a subminiature camera of only 15.25 mm diameter.

The tube employs an 0.6 W heater and can be driven from solid state deflection circuits.



CHARACTERISTICS

Mechanical

Nominal length (excluding pins)	82.55 mm (3.25 in)
Nominal diameter of bulb	13.21 mm (0.52 in)
Nominal diameter of target contact ring	14.32 mm (0.56 in)
Base type	14 pin wire base
Scanned area	6.4 mm x 4.8 mm (¼ in x 3/16 in)
Orientation of image	The vertical scan is approximately parallel to a plane passing through the tube axis and the short index pin.
Magnetic shielding	A cylindrical mu-metal shield should be provided around the full length of the tube – suggested 20 SWG with an outside diameter of 16 mm (5/8 in)
Weight	15 g (½ oz)

Electrical

Focusing method	Electrostatic
Deflection method	Electrostatic
Heater voltage	6.3 V
Heater current	95 mA ± 10%
Spectral response	See figure 2
Maximum white shading	30% from central peak
Minimum sensitivity	0.1 μA signal current with 0.01 μA dark current for 20 lux on the target.
Target voltage	100 V maximum
Signal current	Normal 0.15 μA. Maximum 0.2 μA
Dark current	Maximum 0.05 μA
Depth of modulation	At 300 TV lines and 0.15 μA signal current:–

Centre Typical	30%	Corner Typical	20% *
Centre Minimum	25%	Corner Minimum	15% *

* Corner 15% towards centre along diagonals.

Electrical (continued)

Orthogonality	± 25 minutes of arc
Geometric Distortion	½% of picture height in corners Distortion is seen as pincushion on picture monitor.

Variation in geometry between tubes is within ± 0.1% in quality circle (diameter equal to picture height).

Inter-electrode capacities	Y1 to all other electrodes	6.0 pF
	Y2 to all other electrodes	6.0 pF
	X1 to all other electrodes	6.0 pF
	X2 to all other electrodes	6.0 pF
	Y1 to Y2	2.5 pF
	X1 to X2	0.5 pF

Operating conditions (all potentials are relative to the cathode)

Modulator G_1 cut-off	Typical −170 V. Maximum −250 V	
Cathode current	Typical 20 μA. Maximum 100 μA) **‡	
Anode G_2	1500 V	(100 μA) **
Focus grid G_3	700 V to 800 V	(5 μA) **
Focus grid G_4	450 V to 550 V	(5 μA) **
Target mesh G_5	750 V	(5 μA) **
Line scan amplitude †	90 V Peak to Peak at the potential of G_4	
Field scan amplitude †	80 V Peak to Peak at the potential of G_3	

** These are maximum currents to indicate circuit impedances.

† Please see suggested push pull transistorised deflection circuit.

‡ The camera circuits should never allow more than 0.3 mA of cathode current to flow or the cathode may be damaged.

NOTES:

1. The various d.c. electrode voltages are best derived from a suitable potentiometer resistance chain fed from a stable high voltage supply connected to the anode G_2.

2. Picture focus is obtained by adjusting G_3 and G_4. G_3 predominantly affects the horizontal focus and G_4 the vertical focus. However some interaction occurs between these two.

3. Small variations in the overall high voltage to G_2, providing that the ratios of the electrode voltages are unaltered, will not affect picture focus but only the scanned area size.

4. The tube may be operated at a lower overall voltage, as low as 1000 V, with proportionately less scanning voltages necessary, but the resolution will be rather less than stated above.

Tube Pin Connections

Pin 1	Heater	Pin 8	Heater
Pin 2	Line Scan X_1	Pin 9	Cathode
Pin 3	Cathode	Pin 10	Focus Grid G_3
Pin 4	Field Scan Y_1	Pin 11	Do not connect
Pin 5	Field Scan Y_2	Pin 12	Anode G_2
Pin 6	Focus Grid G_4	Pin 13	Do not connect
Pin 7	Modulator G_1	Pin 14	Line Scan X_2
		Short Index Pin	Do not connect

FIG.1. TYPICAL RESOLUTION CHARACTERISTICS

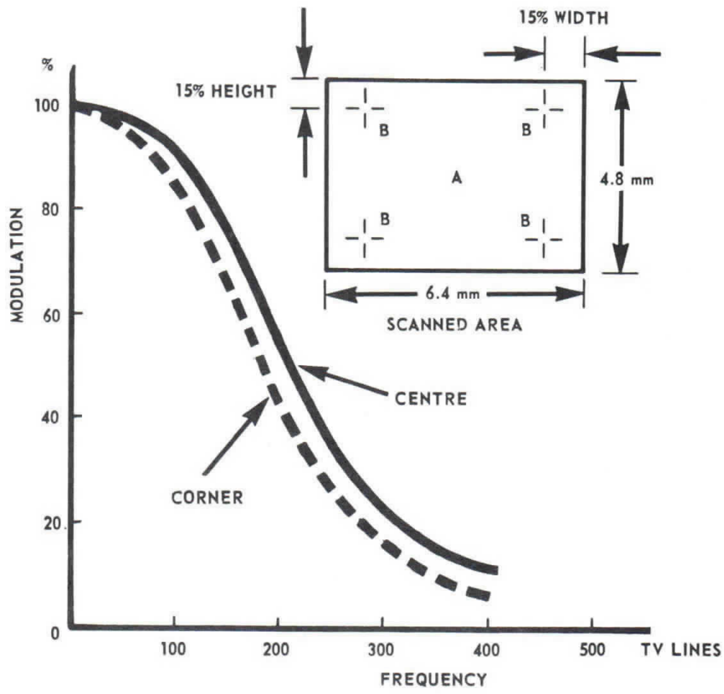


FIG.2 SPECTRAL RESPONSE

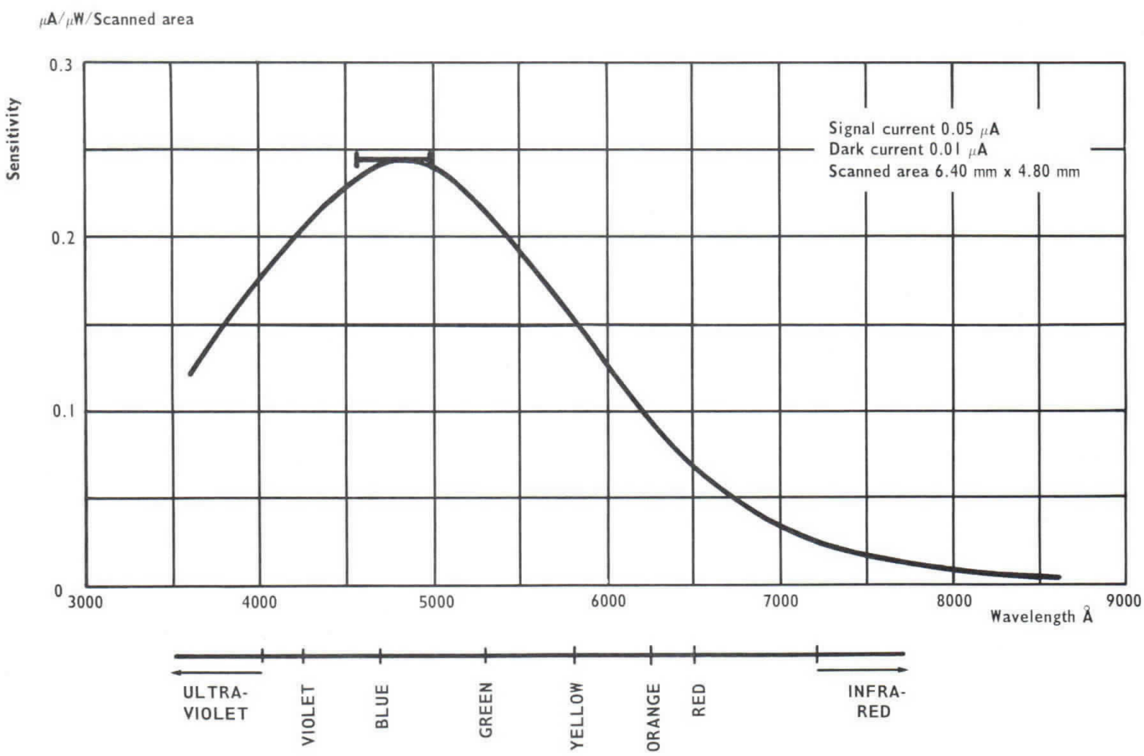
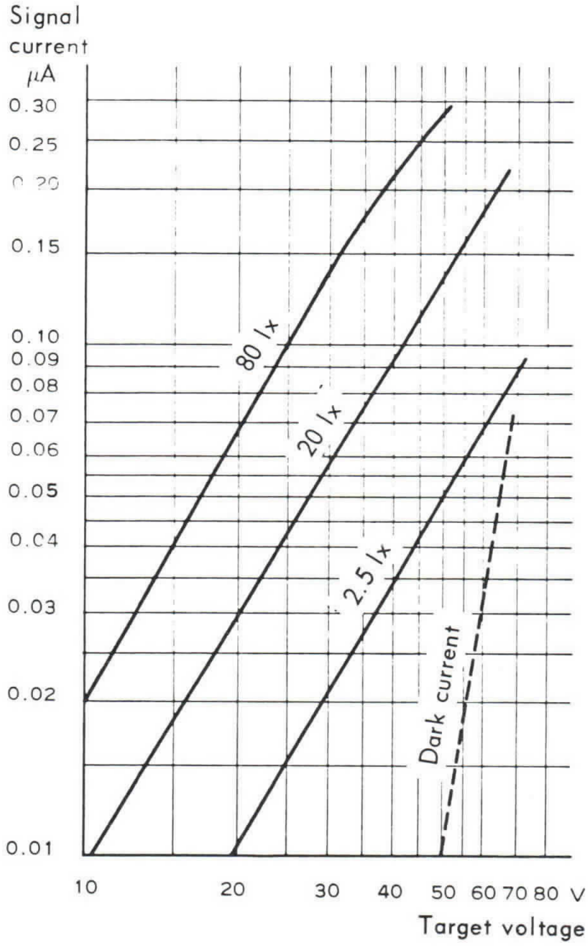


FIG.3
SIGNAL CURRENT
vs TARGET VOLTAGE



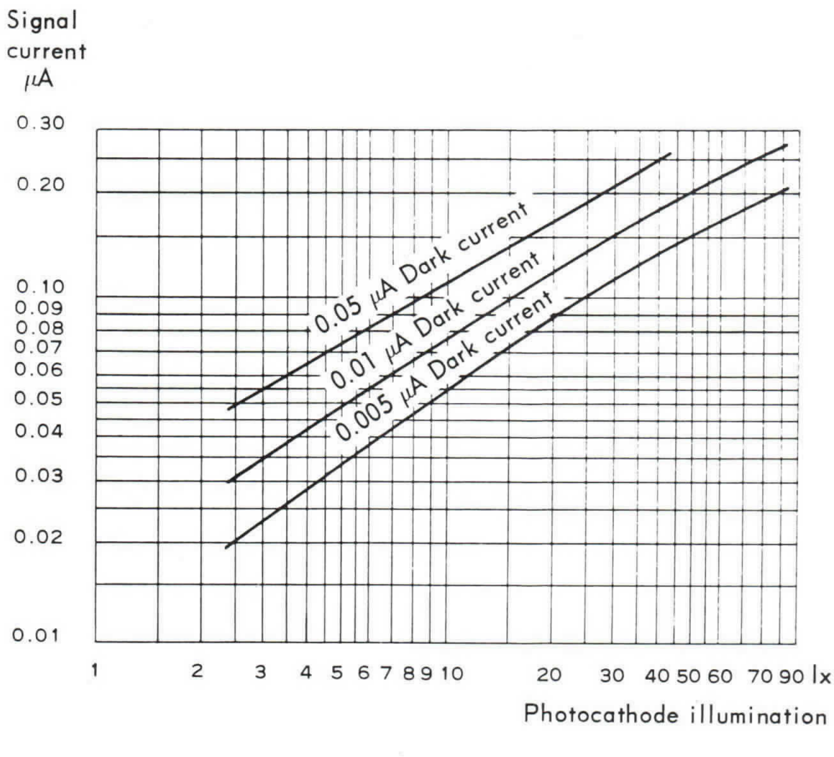


FIG.4
SIGNAL CURRENT
vs ILLUMINATION

FIG.5. LAG CHARACTERISTICS

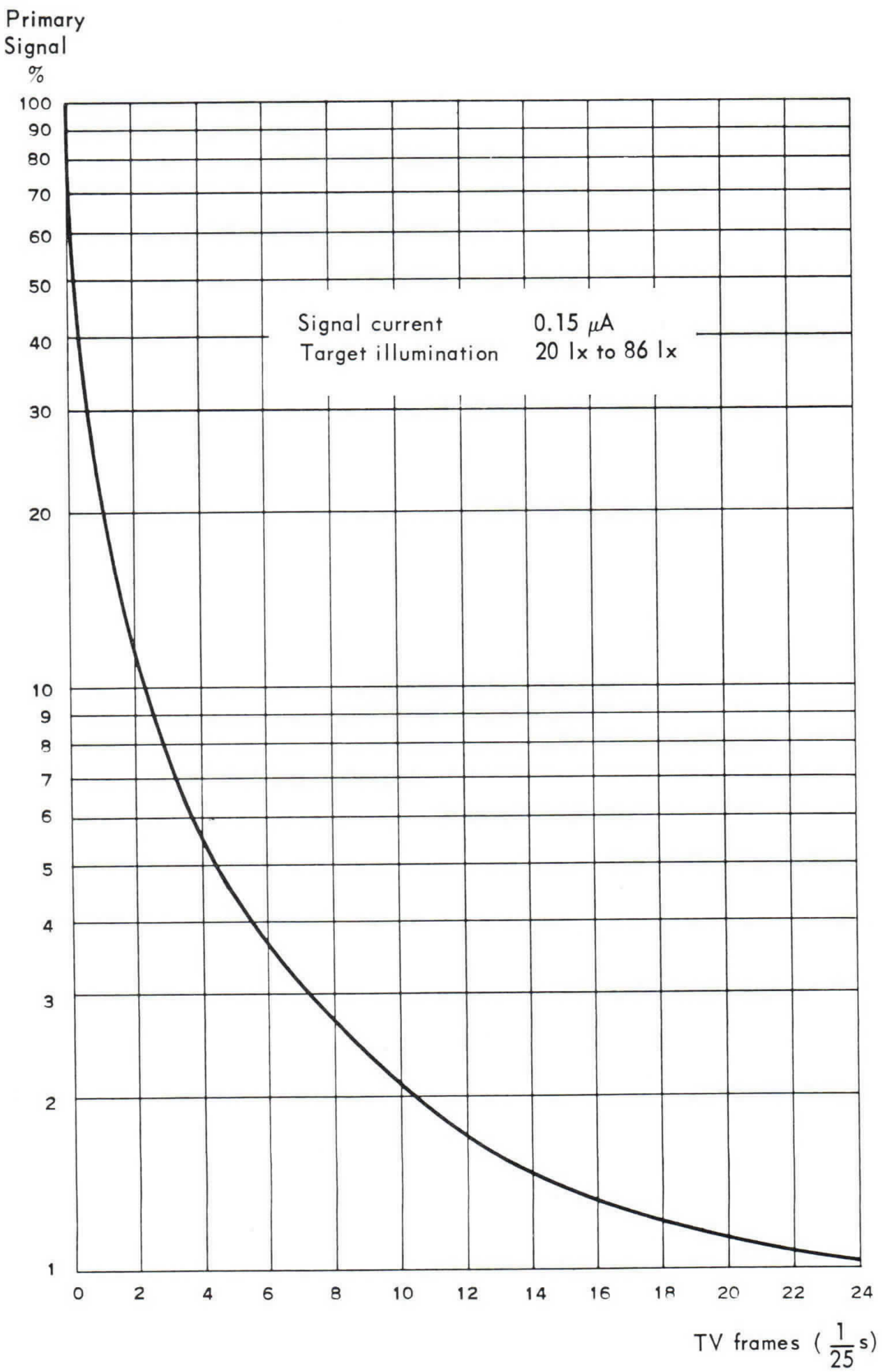
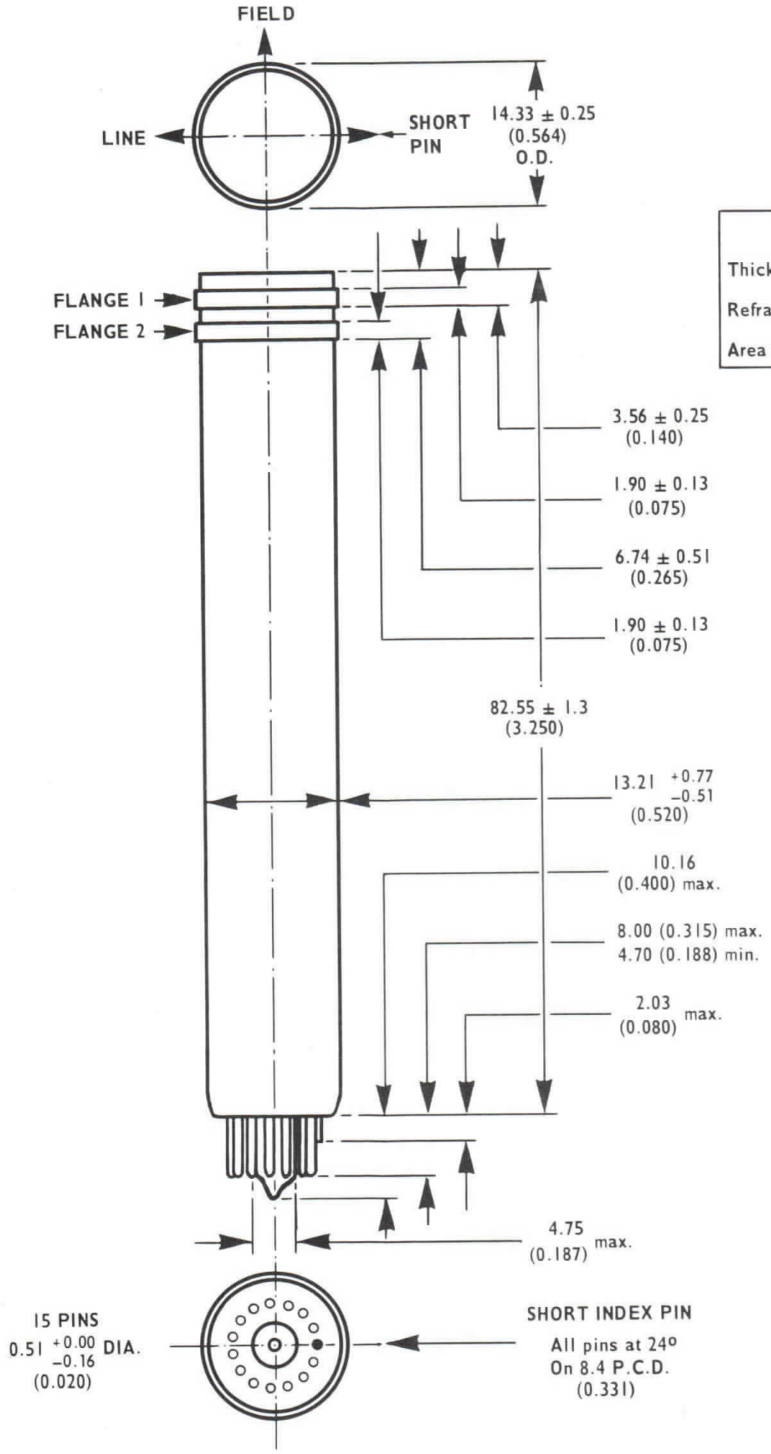


FIG.6. DIMENSIONAL OUTLINE DRAWING

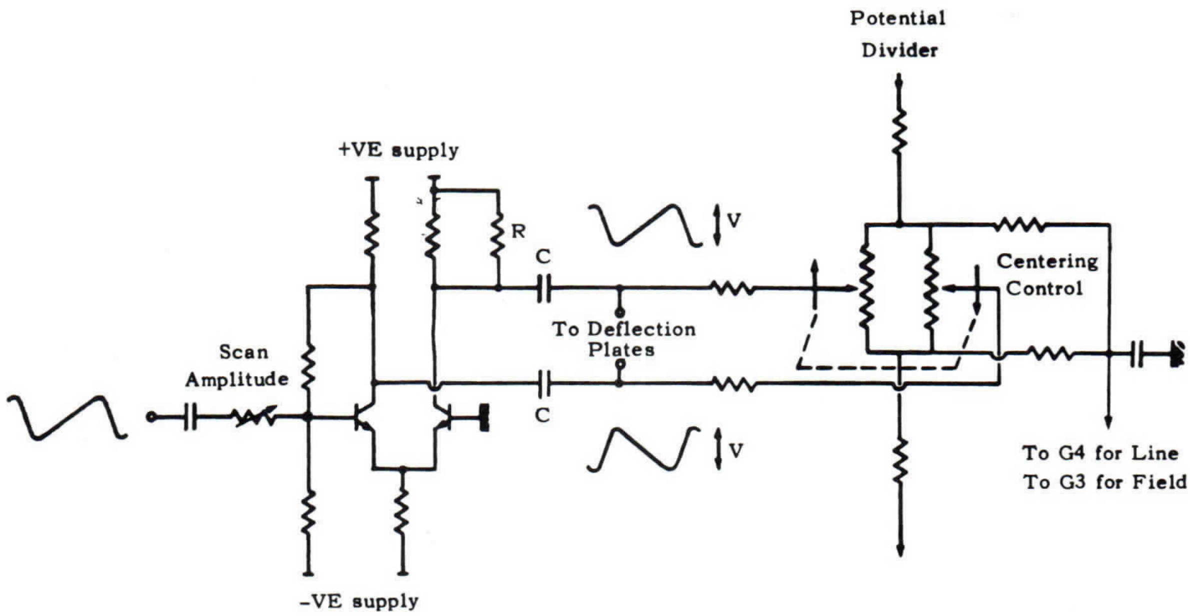


QUALITY CIRCLE
8.4 (0.33) MIN.DIA.

FACEPLATE	
Thickness	2.362 ± 0.076 (0.093)
Refractive index	1.507 at 5876 Å
Area Scanned	4.8 x 6.4 (0.189 x 0.252)

All dimensions are in **millimetres** with **inches** shown in parentheses

FIG.7. BASIC DEFLECTION OUTPUT CIRCUIT



NOTES:

1. Resistor "R" should be adjusted to give accurately PUSH-PULL Deflection. Otherwise Deflection Defocusing will occur.

2. The Deflection Voltages "V" required on each Plate are

   45 V for LINE } with 1500 V on LIMITER
   40 V for FIELD }

   Mean Potential of Plates is given in Data Sheet.

3. Suitable Transistor Types are 2N3440.

4. Required Value of Coupling Condensers 'C' may be minimised by Pre-Distortion of the Input Waveform.

EMI Electronics Ltd Valve Division
Hayes Middlesex England
Telephone: *01-573 3888 Extension 2115*
Cables: *Emidata, London* Telex: *London 22417*

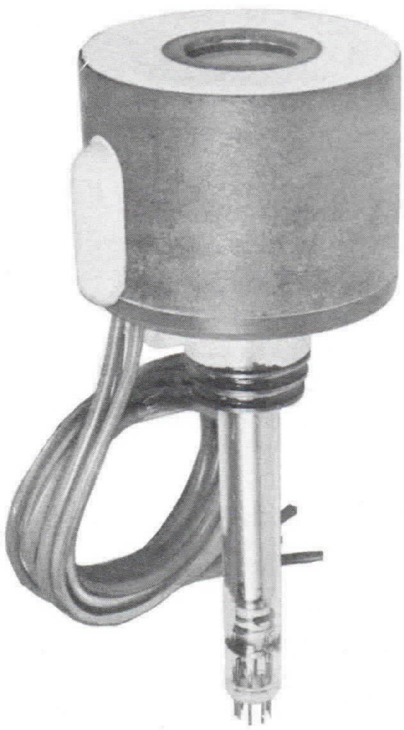
EMI

Electron Tube and Microelectronics Division

EBITRON – INTENSIFIER VIDICON 9777

The 9777 is an Intensifier Vidicon, employing electron bombardment induced conductivity in the target to produce television pictures at illumination levels down to half moonlight conditions. The high sensitivity photocathode (S20/S25) combined with a high target gain enables the tube to operate at low levels with overall sensitivity of the order 40,000 μA/1m. The image section is all electrostatic with a useful photocathode size of 18.2 mm diagonal, making it suitable for use with standard 26 mm vidicon lenses. The scanning section is similar to a conventional 13 mm magnetic vidicon, which allows similar coils to be used. This combination of image and scanning sections gives a small, conveniently sized tube which, with coils, is no bigger than a conventional 26 mm vidicon with coils whilst giving a sensitivity approximately 300 times greater.

Resolution is similar to that obtained from a 13 mm magnetic vidicon. The tube has some lag at low light levels which decreases as the light level is increased. The very wide light level range over which the tube operates enables it to be used under almost any lighting conditions. Light overload may, if applied potentials are not adjusted to suit, cause some burn-in on the target, but unlike some other low light level tubes, the target will subsequently continue to operate.



Storage in the target is such that one could, if desired, obtain some useful information at lower light levels by cutting off the beam for complete frames to subsequently scan off larger stored charges, e.g. omitting alternate scans would double the target storage time and hence double the read out signal. Scanning off on every fourth or eighth etc. scan increases the signal by appropriate factors at the expense of a flickering-display signal, but in some circumstances this is acceptable because of the lower light levels at which information can be obtained.

The image section can be gated by pulsing the image focus electrode from photocathode potential to the required operating potential. The image rear electrode is normally grounded and effectively screens the signal electrode from these pulses.

T490/1a
DS. 1079/1

CHARACTERISTICS

Mechanical

Nominal length (including pins) – unpotted	159 mm (6.25 in)
Nominal length (including pins) – potted	160 mm (6.28 in)
Nominal diameter of image section – unpotted	59 mm (2.31 in)
Nominal diameter of image section – potted	64 mm (2.50 in) (plus leads – see figure)
Base type	Small button sevenar 7 pin
Photocathode size	18.2 mm diagonal
Target useful size	6.4 mm x 4.8 mm
Operating position	Any
Tube orientation	Viewed from photocathode end flying leads at 3 o'clock
Weight	100 g unpotted 230 g potted
Faceplate thickness	2 ± 0.1 mm
Faceplate refractive index	1.5076 for sodium D line
Image focus electrode	9 pF

Electrical

Image section	All electrostatic
Scanning section	All magnetic – using 13 mm vidicon coils
Alignment method (not normally used)	Magnetic
Heater voltage	6.3 V (see note 1)
Heater current	90 mA ± 10%
Spectral response	S20/S25
Signal electrode capacitance to all other Electrodes	8 pF

Limiting Ratings (All potentials with respect to gun cathode)

Heater voltage	5.8 V to 6.8 V (see note 1)
Heater potential	-50 V to 10 V
Modulator G1 potential	-150 V to 0V
Limiter G2 potential	350 V
Wall anode G3 potential	400 V (see note 2)
Vidicon Mesh G4 potential	650 V
Target potential	50 V
Image rear electrode potential	0 V
Image focus electrode potential	-15 kV
Image section mesh potential	-9 kV
Photocathode potential	-12 kV to -15 kV (see note 3)
Faceplate temperature	50°C

Typical Operating Conditions (with respect to gun cathode)

Heater to cathode potential	±10 V apart from blackout
Modulator G1 potential	-30 V
Limiter G2 potential	300 V
Wall anode G3 potential	290 V to 330 V (see note 2)
Vidicon mesh G4 potential	600 V
Cathode potential	0 V
Target potential	10 V to 50 V
Minimum blackout pulses when applied to G1	70 V negative pulses
Minimum blackout pulses when applied to cathode	10 V positive pulses
Axial magnetic focus field (scanning section)	0.006 T (60 gauss)
Adjustable transverse alignment field (if used)	± 0.0004 T (4 gauss)
Signal output current	0.2 μA peak white
Overall sensitivity	1,000 to 40,000 μA/lm (see note 4)
Photocathode	-14 kV
Image mesh	-8.4 kV
Image focus electrode (adjust on installation)	-12.6 kV (equal or positive to photocathode, to cut off image section)
Image section rear electrode	0 V

If the overall E.H.T. voltage is varied, the above proportionality with respect to the photocathode must be maintained – i.e. image mesh volts to be 60% of photocathode volts and image focus volts to be 89% ± 1% of photocathode volts.

Notes

1 **Heater Voltage** The heater supply should be designed to give a nominal 6.3 V and should be kept within the limits 5.8 V to 6.8 V. Under no circumstances should the heater voltage be allowed to exceed 9.5 V. If this figure is likely to be exceeded on switching on, a surge limiting device must be incorporated.

2 **Wall Anode Potential** On no account should the wall anode be operated at a higher potential than the mesh G4, otherwise an ion spot may be observed.

3 **Overall Volts** Operation of this tube at less than -12 kV may cause permanent damage to the target.

4 **Overall sensitivity** The actual value is dependent on the target voltage setting.

5 **Resolution** Operation at signal currents in excess of 0.2μA will cause some loss of resolution.

For further information on this product please telephone Extension 2076.

Fig.1 SIGNAL CURRENT vs PHOTOCATHODE ILLUMINATION

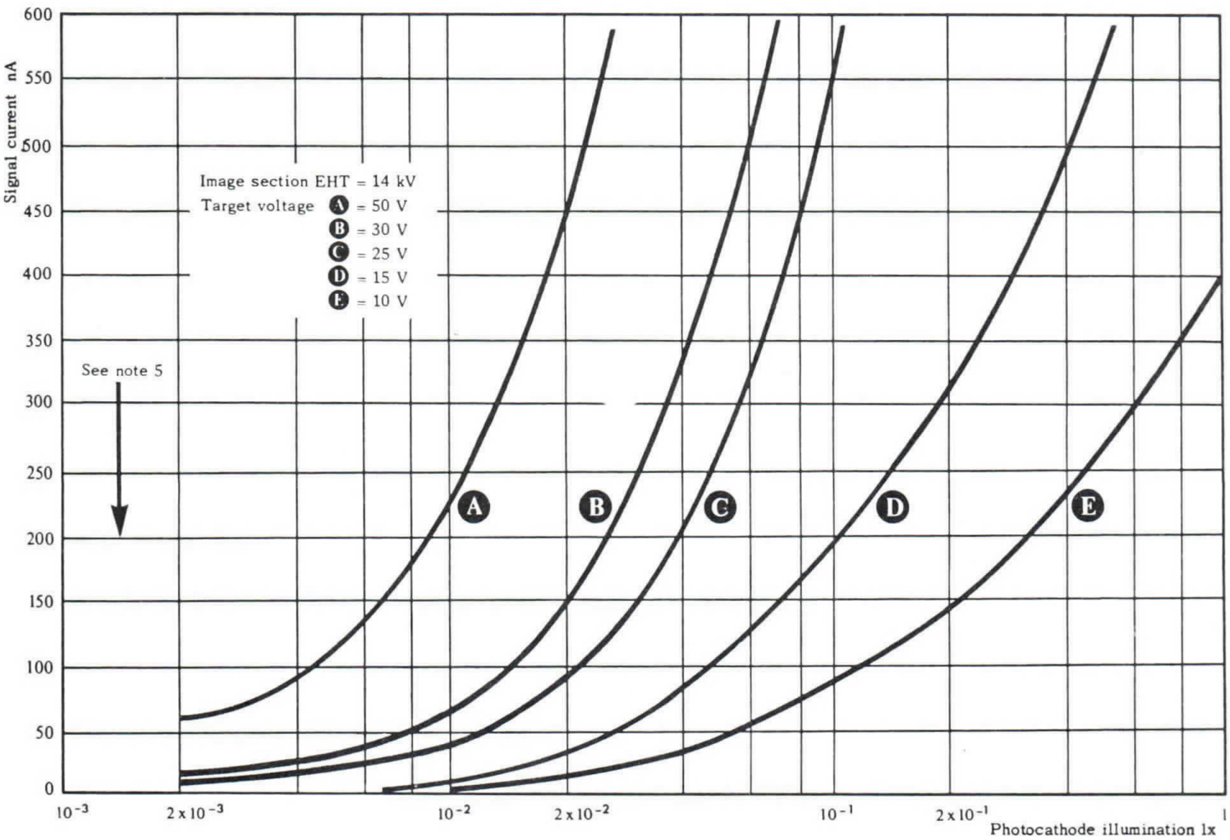


Fig.2 SIGNAL CURRENT AND OVERALL SENSITIVITY vs E.H.T. ON IMAGE SECTION

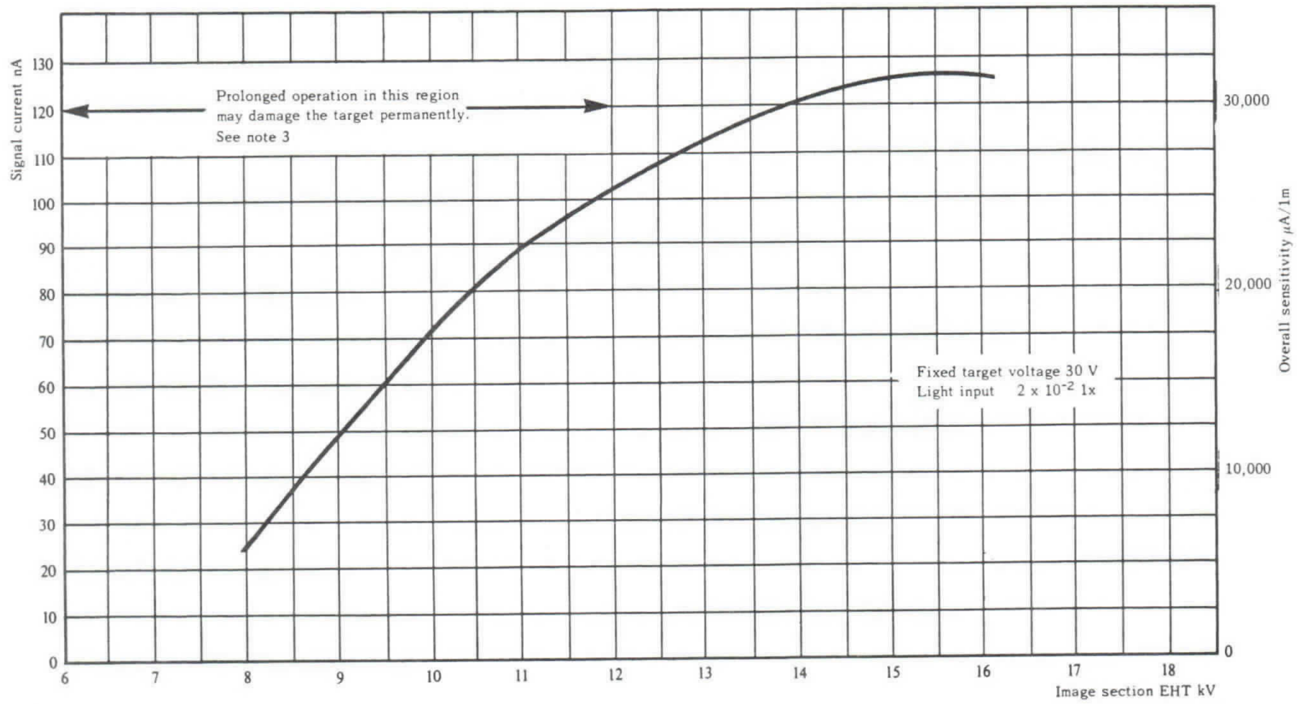


Fig.3 LAG vs PHOTOCATHODE ILLUMINATION

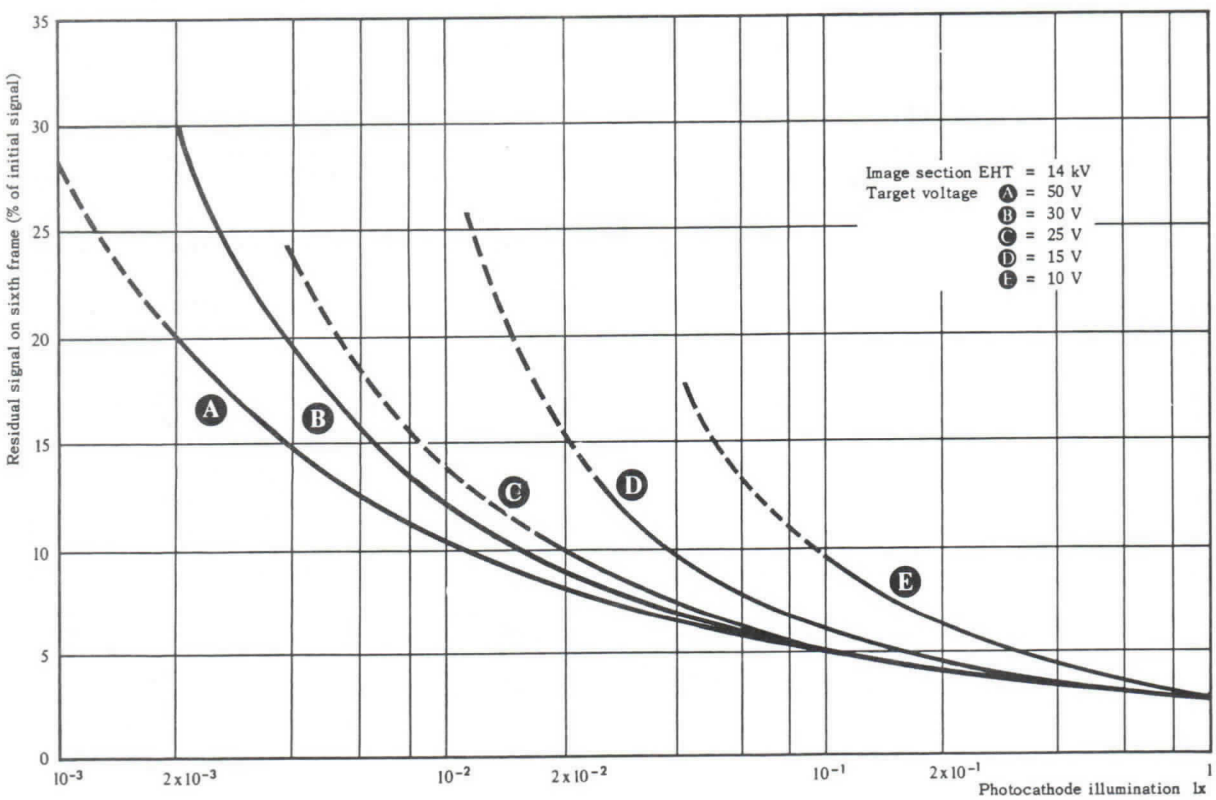


Fig.3a TYPICAL CENTRE RESOLUTION

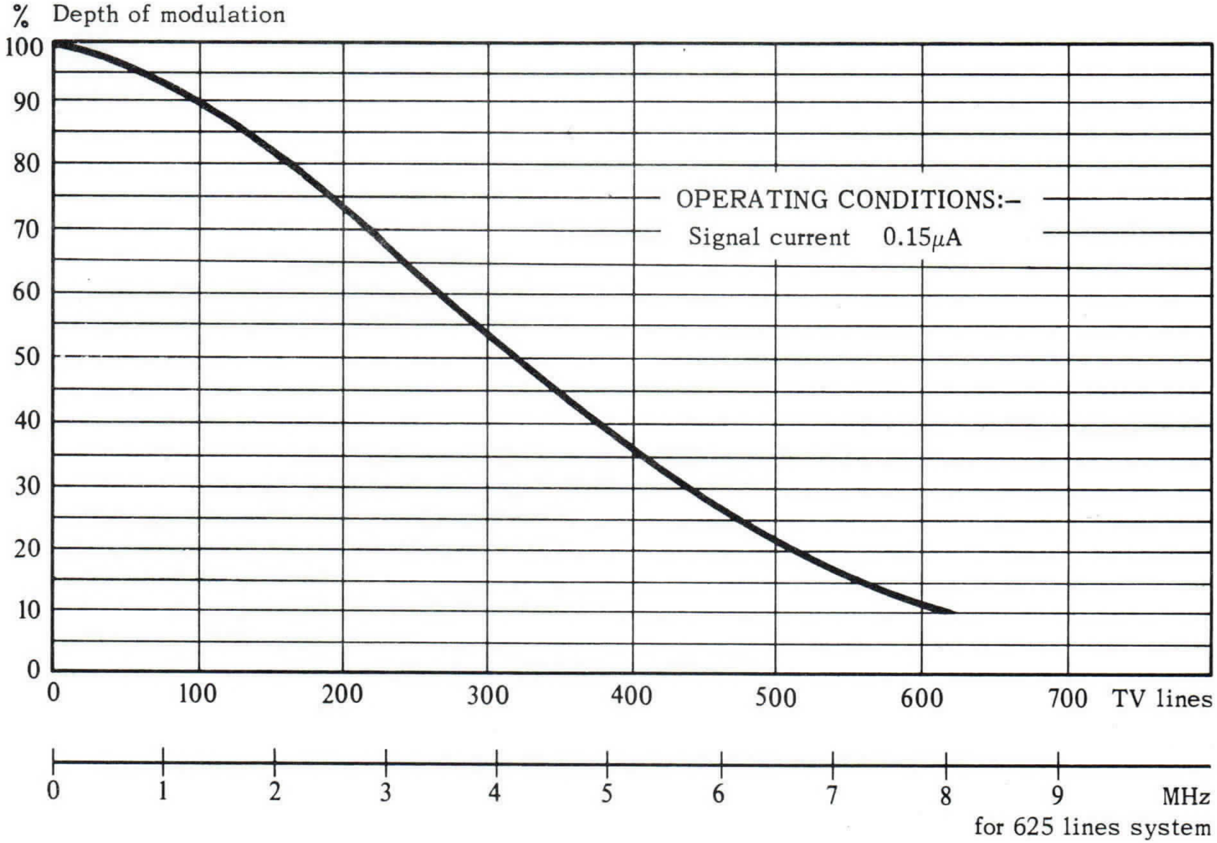


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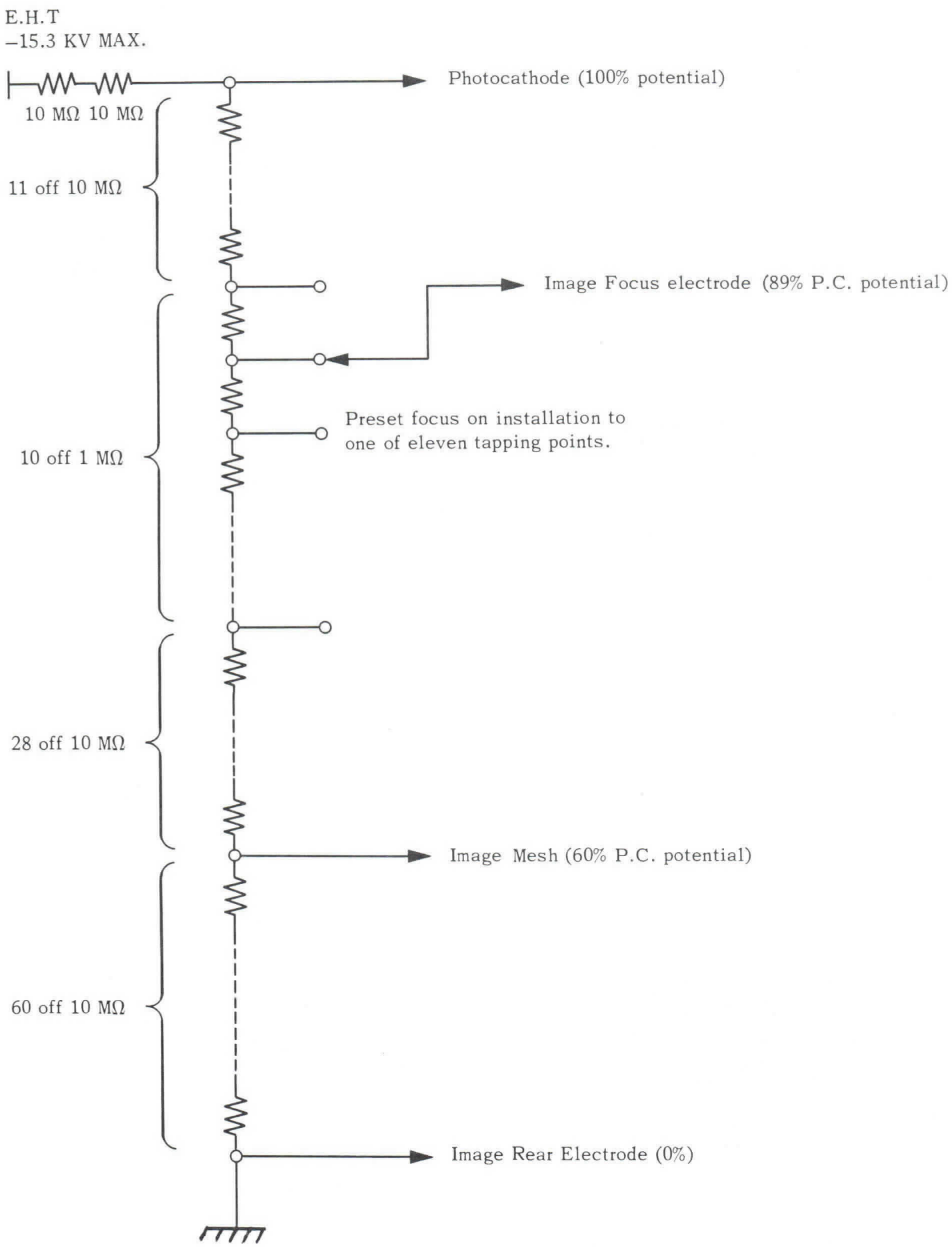
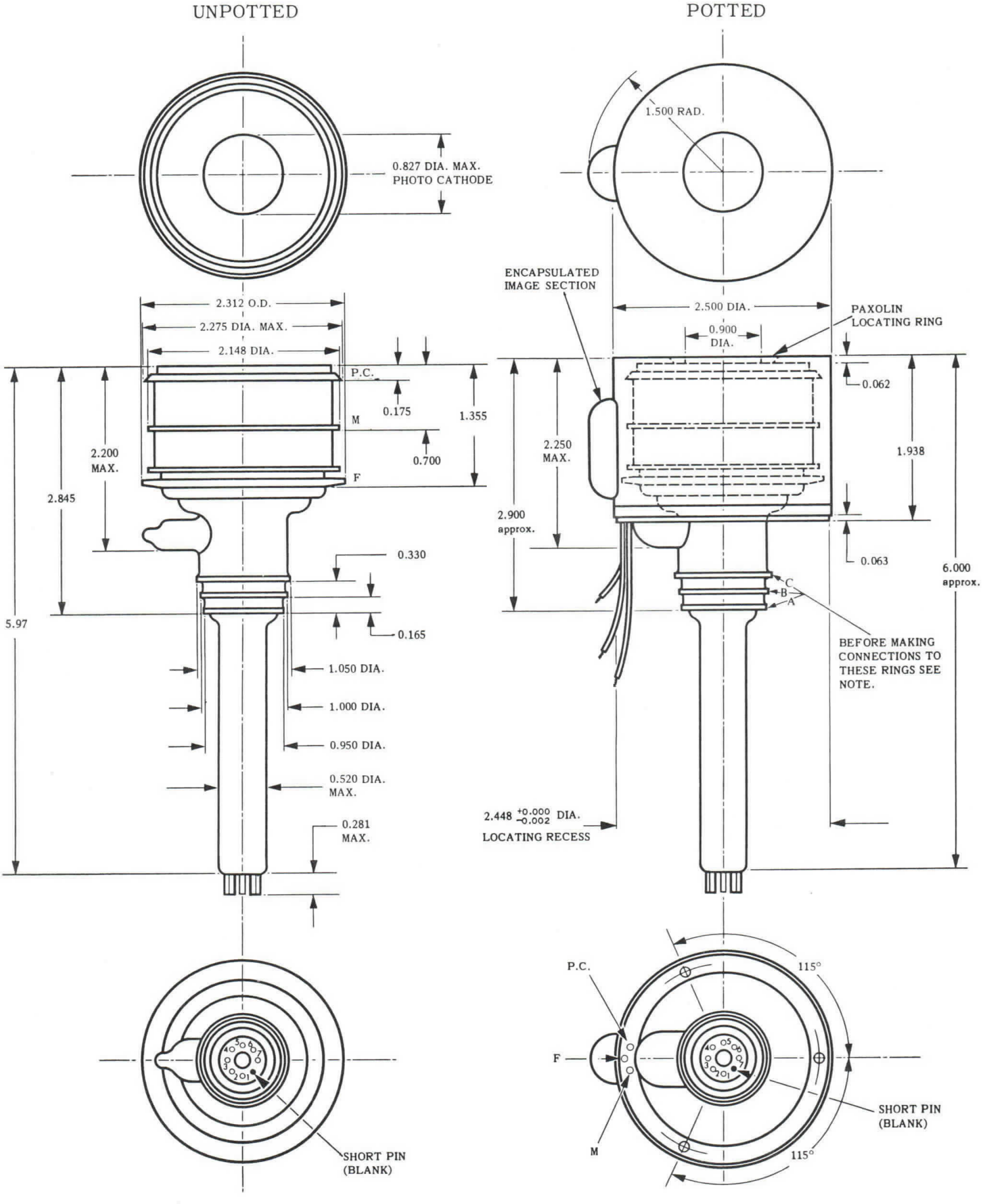
Fig.4 TYPICAL IMAGE SECTION DIVIDER CHAIN



This suggested circuit is based on miniature resistors to give a very compact unit. The exceptionally low electrode leakages in the tube allow the use of this high impedance chain. The 20 MΩ in series with the E.H.T. supply gives surge protection.

Fig.5 OUTLINE DRAWING



NOTE:- AVOID HEATING GLASS/METAL SEALS. FOR CONNECTIONS TO A B C SOLDER TO THE TAPES THAT ARE CONNECTED TO THE RINGS B AND C POSITIONED IN LINE WITH PIN 1 & RING A POSITIONED IN LINE WITH PIN 3.

BASE: SMALL BUTTON SEVENAR 7 PIN

PIN No.	CONNECTION
1	HEATER
2	WALL ANODE
3	CATHODE
4	HEATER
5	LIMITER
6	CATHODE
7	MODULATOR

CONTACT	CONNECTION
A	VIDICON MESH
B	TARGET
C	REAR ELECTRODE
M	MESH
F	FOCUS ELECTRODE
PC	PHOTO CATHODE

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The very fine metallic mesh currently employed in EMI vacuum tubes is also used in various other branches of industry and science, such as microscopy, mass spectrometry, biology, filtering and optics.

The EMI Electron Tube Division has great experience and comprehensive facilities in research, development and manufacture of light sensing and light emitting devices and allied equipment.

The **EMI MICROELECTRONICS DIVISION** provides for the increasing demands made upon the ability of electrical and electronic equipment designers to meet high density packaging, reliability, weight and cost requirements. This can only be achieved by taking full advantage of modern fabrication and design methods. The EMI Microelectronics Division offers these facilities to its customers in the following product areas:–

★ Thin and Thick Film Passive Networks

Thin and Thick Film Hybrid Integrated Circuits

Flexible Printed Wiring

Double-sided and Through-plated Printed Circuit Boards

Multilayer Printed Circuit Boards Ext. 2463 or 594

Production facilities have been built up over several years to meet the need for economic batch and large volume manufacture. The production unit is supported by a comprehensive Circuit Design and Draughting Group and a Quality Control Division.

A continuous R. & D. programme ensures that full advantage is taken of the latest technological developments in manufacturing processes. Microcircuit design is aided by the use of a computer programmed to predict thermal contours.

Continuous on-line monitoring of all processes is maintained during all stages of production and testing.

The environmental test facilities available within EMI Electronics together with the calibration and standardisation procedures, have been approved by D Q A B and the Air Registration Board.

★ CUSTOMER ENGINEERING SERVICE Ext. 2463 or 594

A team of engineers fully experienced in both circuit and systems design is available to assist customers in applying microelectronic techniques to the solution of particular problems. This facility covers all aspects of system design, the rationalization of integrated circuits, thermal management and packaging.

FLEXIBILITY

The EMI Microelectronics Division is an integrated unit, with design and manufacturing facilities not allied to any particular aspect of microelectronics technology. The resulting flexibility enables the achievement of the optimum design package to meet customers' needs.

NOTE: For further information please telephone the extension shown opposite each product and service.

G911c

EMI Electronics Ltd Electron Tube Division
Hayes Middlesex England Telephone: *01-573 3888*
Cables: *Emidata, London* Telex: *London 22417*

EMI
EMI ELECTRONICS LTD
Serving Science and Industry

VALVE DIVISION

EMI BARRIER GRID STORAGE TUBE TYPE 9511A

The 9511A is an electronic storage tube containing a dielectric sheet which is backed by a conducting signal plate, and faced by a barrier grid through which the scanning beam must pass to deposit charge on the storage surface, (see fig. on reverse of sheet). The charge deposited at any point will be proportional to the change in **p.d.** between the backing plate and the grid, so long as sufficient time is allowed for secondary emission equilibrium to be attained. Thus, at the conclusion of an equilibrium writing scan, an analogue charge pattern is left on the dielectric surface, which may be read off by scanning with the signal plate returned to a fixed potential w.r.t. the grid, the signal being taken either from the collector, (held at a positive potential of 180V w.r.t. the grid to collect secondary electrons), or from the grid or signal plate. In an alternative method of writing, the signal plate is **pulsed** +80V to the grid, and the information is applied by modulation of the electron beam. Under these non-equilibrium conditions, a higher writing speed is obtained at the expense of linearity. Unit signals may be applied in a time as short as 0.1μsec, while storage times of several hours are readily achieved.

The definition is adequate for the storage of more than 20,000 unit signals (i.e. ca 150 television lines) while registration errors are avoided by the use of the same gun and deflector system for reading and writing. Electrostatic focus and deflection are employed.

CHARACTERISTICS

Mechanical (See fig. on reverse of sheet)

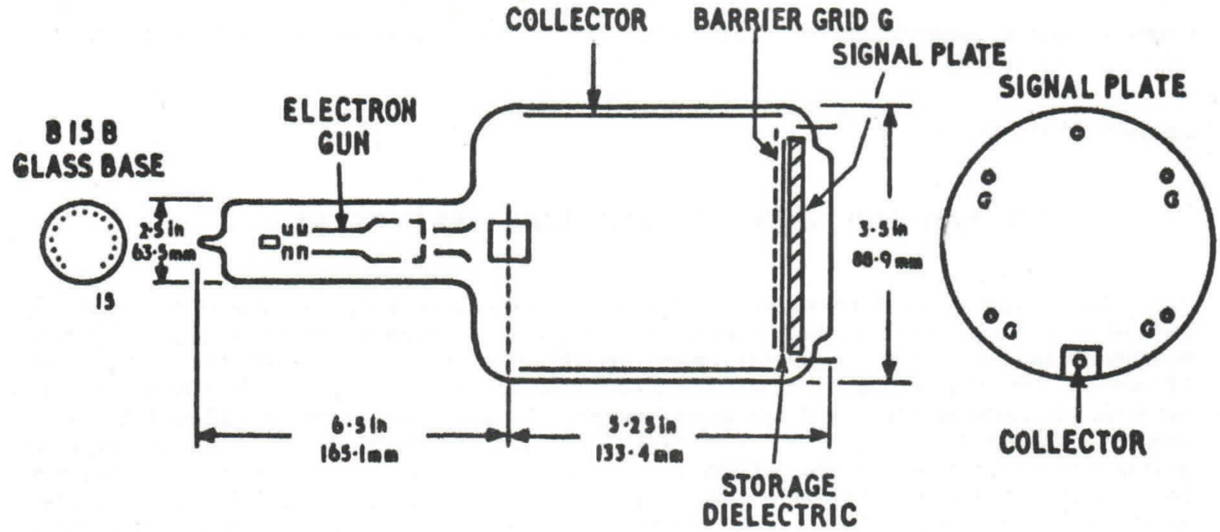
Bulb diameter: 3½ inches nominal. Overall length 12 inches nominal.

Electrical (*w.r.t. cathode. # VA1 & 3 = 1000V)		Max.	Typical	Min.
Heater voltage	Volts	6.8	6.3	5.8
Heater current	Amps	0.55	0.5	
*#Modulator voltage (for cut-off)	Volts	-50	-35	-23
*A1 and A3 (Connect together)	Volts	2000	1000	800
*#A2 for focus	Volts	200	165	150
Collector (+ve w.r.t. A3)	Volts	300	180	100
Barrier grid (w.r.t. A3)	Volts	100	0	-100
Signal plate (w.r.t. barrier grid)	Volts	100		-100
Collector (+ve w.r.t.barrier grid)	Volts	300	150	100
Beam current	μamps		6	
Cathode current	μamps	1200	500	-
Deflection sensitivity. #X 270V Y 300V		(Inscribed square raster).		

Capacitances. X1, X2, Y1, or Y2 to all electrodes. ϕ 12pf X1 to X2. 3pf
Y1 to Y2. 4pf. Y plates to collector 4pf.
(excluding shield, 10pf.) Collector to all electrodes.ϕ 35pf.
Collector to barrier grid 4.5pf.
Collector to signal plate, grid earthed, 0.35pf.
Signal plate to barrier grid. 1200 - 1350pf.

ϕ Measurements made with fairly close fitting earthed Mu-metal screen around tube.
Deflection plates and A3 may be run up to mean potential of +150V w.r.t. Barrier Grid.

EMI BARRIER GRID STORAGE TUBE TYPE 9511A



COLLECTOR PIN ON LARGE 6 WIRE PINCH IS IN LINE
WITH GAP BETWEEN PINS 1 & 15 ON B15B BASE

BASE TYPE B15B

Pin Connections	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Electrode	M	H	C	H	A_1	-	Y_1	A_3	Y_2	-	X_1	X_2	A_2	-	-

M - Modulator C - Cathode H - Heater

P.T.F.E. sockets for B15B base are available and one is provided with each tube. A Mu-metal screen will be required under conditions of appreciable or variable ambient magnetic field.

If the output signal is taken from the collector, a close fitting earthed electrostatic shield over the gun and extending to the collector electrode will be needed in addition to the Mμ-metal Screen.

NOTE

Under no circumstances should the modulator be allowed to be positive with respect to the cathode.

T475/2a
DS.141/2

EMI

E M I Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Ref. 10772 CP

CATHODE RAY TUBES

EMI

Cathode Ray Tubes

Valve Division, one of the most rapidly expanding divisions of EMI Electronics Ltd., manufactures a wide range of special valves and tubes for equipment used in broadcasting, radar, nuclear and other applications, but only cathode ray tubes are described in this brochure.

The range of camera tubes includes the C.P.S. Emitron, 4½-inch image orthicons and 1-inch and ½-inch vidicons; the vidicons include both ultra-violet and infra-red sensitive versions.

Photomultiplier tubes suitable for astronomy, spectrophotometry, scintillation counting, X-ray spectrometry and other applications are produced. Their diameters range from ½ inch to 15 inches. Spectral coverage is from 1,200 Au to 12,000 Au and tube gains of up to 10^9 are available.

The range of klystrons and magnetrons covers wavelengths from 30 cm to 4 mm whilst power output ranges from a few milliwatts to several megawatts. These tubes are extensively used in military and civil radar and communications applications.

Other Valve Division products are high gain multi-stage image intensifiers, barrier grid storage tubes, and the electron stick, a versatile device for teaching the principles of microwave tubes. Specialised components include honeycomb grids, fine meshes, and ceramic metal seals. A small range of photoconductive cells is also produced.

Instrument Tubes

Oscilloscope tubes of advanced design with 3, 5, and 6 inch diameter face-plates and aluminium-backed phosphors of the P11 and P31 type are in production. These tubes are notable for their high-deflection sensitivities and low inter-electrode capacitances, a band-width of 100 mc/s being within their capabilities.

Also included in this range is a compact 6-inch double-gun tube, and a tube with the unique feature of internal deflection coils of low inductance and resistance in the X-plane, which enable very high sensitivity to be achieved. The coils are wound on insulated aluminium cores which can be used as auxiliary Y-plates for d.c. shift or very low frequency deflection.

Those tubes having post-deflection acceleration employ electrode constructions designed to ensure that high deflection sensitivity and high brightness are achieved with minimum distortion. This is achieved by the positioning of screening electrodes in the deflection region of the gun, held at potentials equal to the mean deflection potential. Small variations of this potential provide second degree correction of the distortion of any remaining fields between the post deflection accelerator and the wall-coating. The function of each shield is as follows.

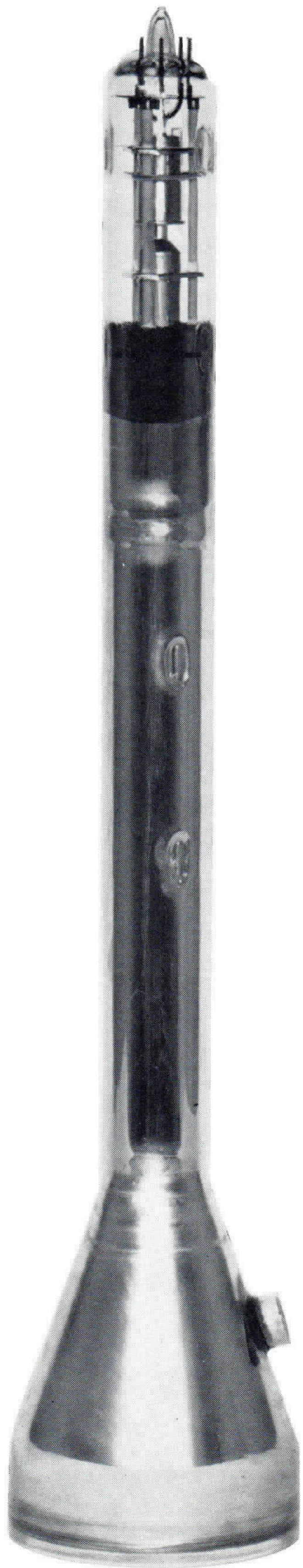
Inter-Plate Shield	To reduce inter-plate capacitance and cross-modulation by forming an electrostatic screen between X-plates and Y-plates.
Post-Deflection Shield (mesh) and X-plate Shield	To prevent penetration of the PDA field into the X-deflection region.
Spiral Return	To reduce internal glass charge effect

Radar Display Tubes

Magnetically deflected cathode ray tubes with medium and long afterglow phosphor characteristics, electrostatic and magnetic focusing, and rectangular and circular face plates, are available in considerable variety. These range downwards in size from the very large 21-inch metal cone tube CV 2388, with its very high safety factor, to a high-definition 2-inch tube. Such tubes are in operation on both civil and military radar systems throughout the world.

Of particular interest are the CV 6101, a specialised high-brightness projection tube, the MX 50, a compact rectangular tube with a low wattage heater and electrostatic deflection in the Y-plane, and a range of high resolution tubes for radar recording.

Photographic Radar
Recording Tube type MX10



Company Products

EMI Electronics Ltd., is one of the largest electronics companies in Europe and is part of the E M I group – the largest recording organisation in the world. From E M I's vast research and production resources comes equipment of original design and outstanding performance for industrial, scientific and military applications.

COMMERCIAL

Special Valves and Tubes
Photomultipliers, Klystrons, Magnetrons, Camera pick-up tubes, Cathode ray tubes, Storage tubes and other specialised electron tubes.

Computer Components
Magnetic thin-film stores.

Broadcast and Recording Equipment
Television and sound broadcasting equipment including: Colour and monochrome camera channels, Studio equipment, Telecine, Microwave links, Outside broadcast units, Aerial systems, Professional tape recorders, Studio sound equipment, Wired television systems.

Automation
Emicon positioning system for control of milling machines, borers and drilling tables; Robotug automatic driverless tractors; Emiac analogue computers; Emidata magnetic tape decks and instrumentation systems; Precision multi-track headstacks; Process control, automatic weighing, blending and mixing systems; Mechanical handling; Conveyor control; Automatic warehouses.

Instruments
Oscilloscopes, Stroboscopes, Nuclear health instruments, Nucleonic instruments, Closed-circuit television equipment in monochrome and colour, Commutator undercutters, Vibration equipment, Capacitors.

MILITARY

Naval
Operational plotting tables, Target acquisition and close range fire control radars, Radar trainers, Asdic (Sonar) equipment and trainers.

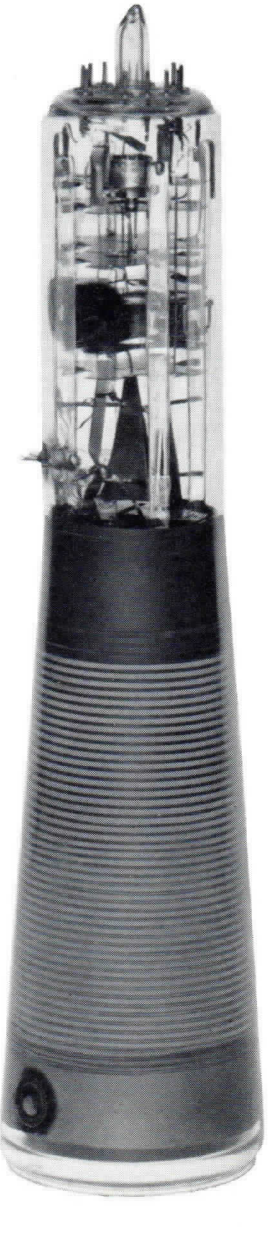
Army
Mortar and weapon locating radars, Fire control radar for Anti-aircraft weapons, Battlefield surveillance devices, Radar trainers.

Air Force
Airborne navigational, bombing and maritime search radars, Airborne homing device, Airborne reconnaissance radar, Optical and I.R. devices, Radio Altimeters, Radar trainers.

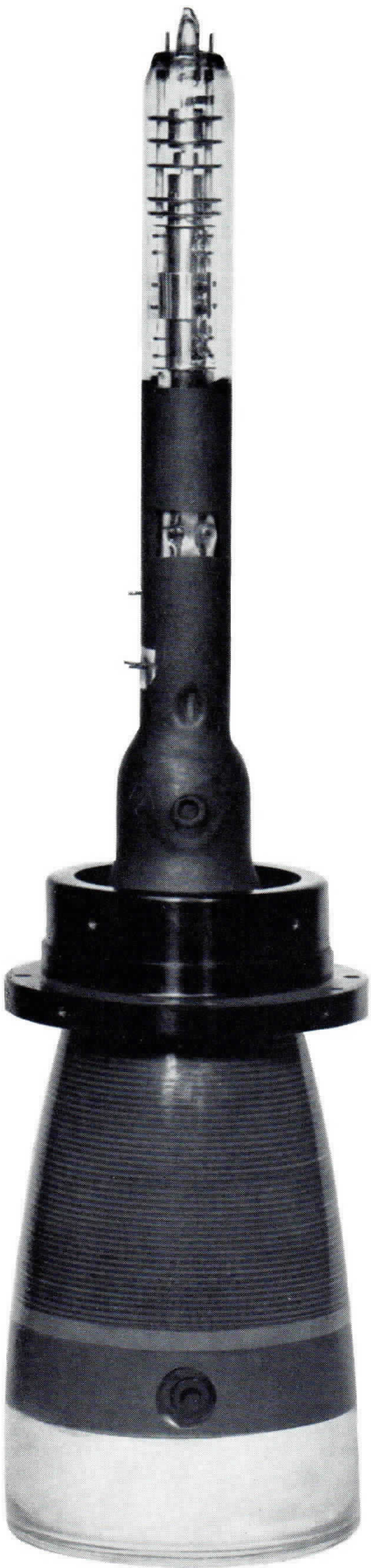
General
Telemetry equipment for missiles, Instrumentation for missile ranges. Proximity fuzes, Low light vision television cameras for reconnaissance and surveillance, Nuclear Monitors and Training Simulators, Ultra violet and infra red techniques for reconnaissance and communication purposes, Microwave techniques and Environmental testing.

Contents

Instrument Tube type MX54



Instrument Tube type MX46
fitted with collar



Tubes for Special Applications

In this range are tubes designed for photographic radar and other line scan applications where a minimum variation of brightness along a scanned line is essential. In general, such tubes have a resolution better than 200 cycles/cm.

The requirements of both high and low frequency film scanning are met by a series of tubes which are widely used in telecine equipment. Other tubes for television applications include picture monitor tubes and a projection colour television receiver tube which has also formed the basis of an EMI system for large projective 3-dimensional displays.

Further specialised cathode ray tubes include those for EMI LogEtronic photographic recording and reproducing apparatus, for character scanning and display, and for head-up displays.

Collaring

Several tube types, as indicated in the tube outline drawings, can be supplied with an external collar. This is located with respect to both the phosphor plane to facilitate easy setting up in an optical system, and to the electron beam to facilitate easy setting up of the focus coil. Replacement of tubes is simplified, as the collar is provided with mounting holes which orientate the tube with respect to the scanning axis. The collar also enables a mu-metal shield to be positively located.

Mounting

It is recommended that the following precautions be taken when a cathode ray tube is being mounted.

A magnetically deflected tube must be supported by the conical portion of the bulb, and the socket mounting should be flexible, so that its neck is not subjected to strain.

Leads to the socket should be of sufficient length to enable rotational adjustment.

Mu-metal shields must not be subjected to physical strain which would result in a reduction of the shielding effect.

To prevent damage to the bulb by heat, the temperature of nearby components should not exceed 60°C and that of the tube itself should not exceed 30°C.

Cathode ray tubes are best stored in their original packing cases but, if removed, should be stored face downwards upon a clean felt pad.

Characteristics Tables

The electrical characteristics of the cathode ray tubes in each section are listed under RATINGS and OPERATION. RATINGS are stated as both standard and maximum values. The standard value indicates the recommended applied voltage and the maximum value indicates the upper limit of a useful range or the absolute maximum (bold type). The values headed OPERATION are those to be expected under standard voltage conditions and are expressed as the possible range of values or simply as a typical value.

Instrument Tubes

Type number			MX[c,e] 17	MX 46	MX 47	MX 51	MX[d] 53	MX[e] 54	MX 56	MX 58
Ratings all voltages referred to Cathode										
Heater Voltage	Standard	V	4·0	6·3	6·3	6·3	6·3	6·3	6·3	6·3
A_1 Voltage	Standard	kV	3·5	2·0	2·0	1·5	2·0	1·0	1·0	1·5
	Maximum	**kV**	**4·0**	**3·0**	**2·5**	**2·0**	**3·0**	**1·5**	**1·5**	**1·8**
A_2 Voltage	Standard	V	450	300	480	350	500	100	230	375
	Maximum	V	525	500	550	500	750	180	330	500
A_3 Voltage	Standard	kV	3·5	4·0	4·0	1·5	2·0	1·0	1·0	1·5
	Maximum	**kV**	**4·0**	**5·0**	**5·0**	**2·0**	**3·0**	**1·5**	**1·5**	**3·3**
A_4 Voltage (I.P.S.)	Standard	kV	—	4·0	—	1·5	—	1·0	1·0	1·5
	Maximum	kV	—	5·0	—	2·0	—	1·5	1·5	3·3
A_5 Voltage (P.D.A.)	Standard	kV	—	20	—	12[f]	—	4	10[f]	15[f]
	Maximum	**kV**	—	**25**	—	**15**	—	**6**	**15**	**17**
P.D.A. Ratio to A_3	Maximum		—	5:1	—	10:1	—	4:1	15:1	10:1
P.D.S. (Mesh) Voltage with respect to X.P.S.	Standard	V	—	—	—	—15	—	—	—15	—15
	Maximum	V	—	—	—	—30	—	—	—30	—30
X.P.S. Voltage	Standard	V	—	—	—	A_3	—	—	A_3	A_3
	Maximum	V	—	—	—	$A_3 + 50$	—	—	$A_3 + 50$	$A_3 + 50$
Operation under standard voltage conditions										
Heater Current	Minimum	A	1·08	0·50	0·50	0·50	0·50	0·50	0·50	0·50
	Nominal	A	1·20	0·55	0·55	0·55	0·55	0·55	0·55	0.55
	Maximum	A	1·32	0·60	0·60	0·60	0·60	0·60	0·60	0·60
Modulator Voltage for Visual Cut-off	Minimum	V	—30	—100	—25	—45	—30	—35	—28	—45
	Nominal	V	—45	—150	—50	—65	—60	—50	—45	—65
	Maximum	V	—60	—200	—70	—85	—90	—65	—60	—85
X-Sensitivity	Typical	mm/V	0·175	0·230	0·210	0·90	2·25	0·380	1·4	0·90
Y-Sensitivity	Typical	mm/V	0·150	0·340	0·225	2·75	—[g]	1·40	5·0	3.40
Typical Inter-Electrode Capacitances	Modulator to all	pF	15	8·0	10	6·0	7·0	7·0	6·0	5·0
	Cathode to all	pF	8·0	6·0	7·0	6·0	6·0	6·0	4·5	3·6
	$X_{1,2}$ to all bar $X_{2,1}$	pF	15	3·5	7·0	6·0	—	3·6	5·5	5·5
	$Y_{1,2}$ to all bar $Y_{2,1}$	pF	10	4·0	7·0	3·5	3·5	3·4	4·0	3·4
	X_1 to X_2 & X_2 to X_1	pF	3·0	3·5	3·0	2·5	—	1·7	2·0	1·7
	Y_1 to Y_2 & Y_2 to Y_1	pF	3·0	2·5	3·0	1·5	2·0	1·5	2·0	1·7
Typical Spot Diameter		mm	0·8	0·2	0·6	0·6	0·5	0·35	0·7	0·6
Max. Spot Deviation[a]		mm	10	5	5	15	10	5	15	15
Typical Scan (X x Y)		mm	70 Dia.	40 x 10	120 x 100	100 x 60	100 x 60	60 x 50	100 x 60	100 x 60
Nominal Tube Diameter		inches	3½	5	6	5	5	3	5	5
EMI Phosphor Type[b]			GG3	BB2	GG6	GG3	GG3	GG3	GG3	GG3

Footnotes to table

a From centre of screen: unfocused spot

b See pages 10 and 11

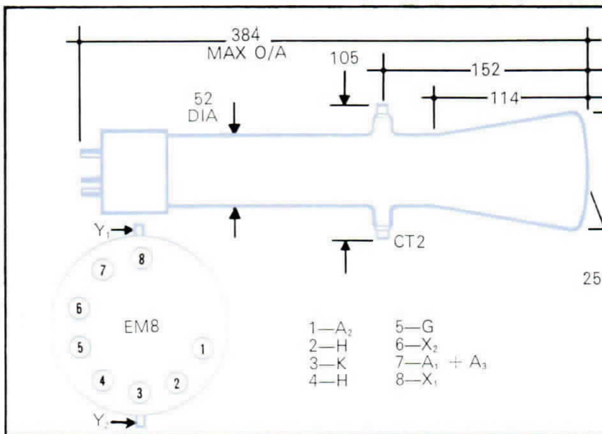
c Available to CV Specification 2222

d Internal Y-plane deflection coils

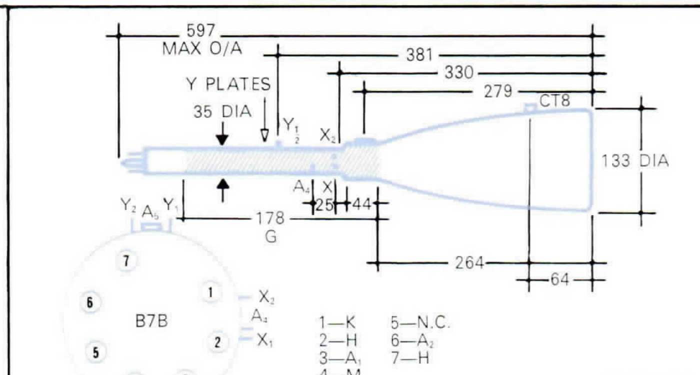
e Non-aluminised screen

f Spiral return voltage as A_4

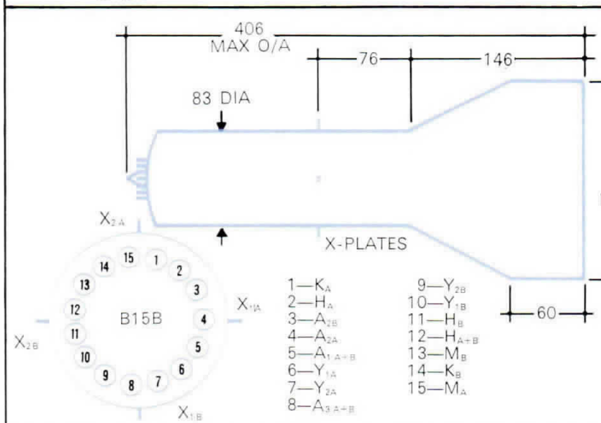
g 100 mm/A; Y-shift: 3·00 mm/V



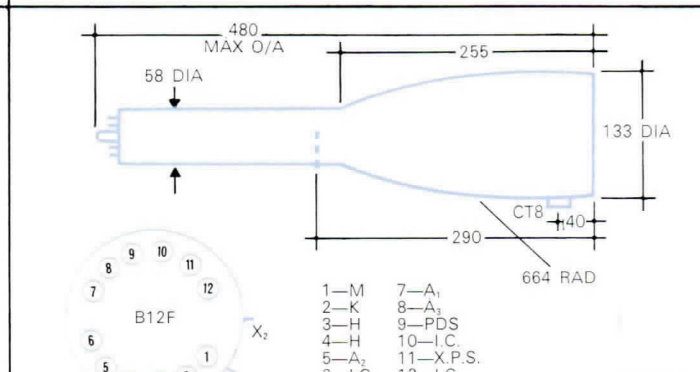
MX 17



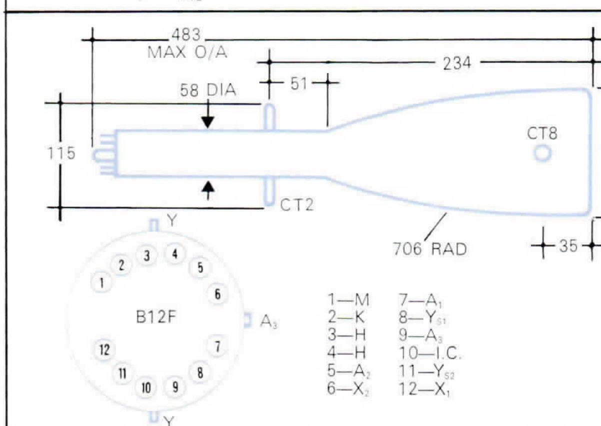
MX 46ᶜ



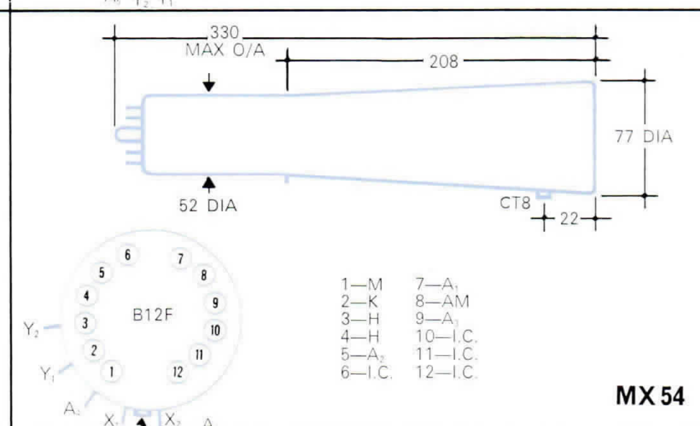
MX 47



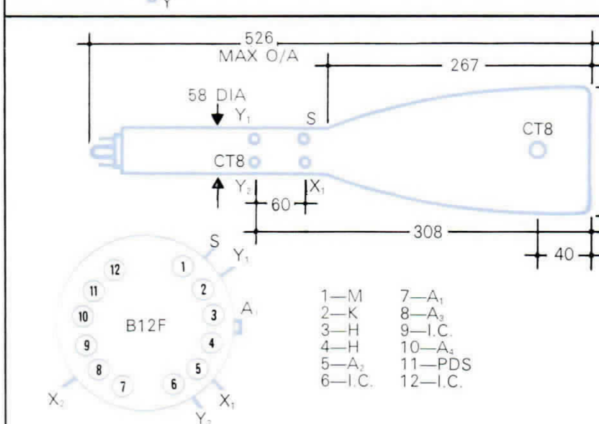
MX 51



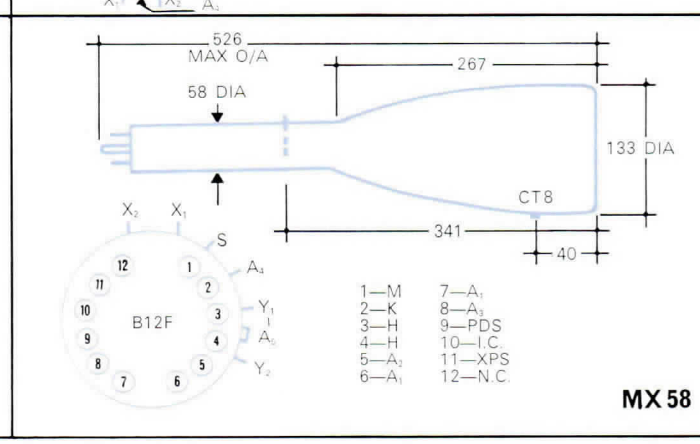
MX 53



MX 54



MX 56



MX 58

Key to Drawings

Y_1 & Y_2	Y-deflection plates	XPS	X-plate shield
X_1 & X_2	X-deflection plates	S-Post Deflection	Spiral return
A_1	Accelerator anode	AM	Anode modulator
A_2	Focus anode	H	Heater
A_3	Final anode	K	Cathode
A_4	Inter-plate shield	M	Modulator
A_5	Post deflection accelerator	Y_{s1} & Y_{s2}	Y-shift plates
PDS	Post deflection (mesh) shield	c	Available with collar
NC	No connection	IC	Internal connection

All dimensions in mm. and nominal except where indicated

Radar Display Tubes

Type number			MX 14	MX 18	MX 19	MX 21	MX[e] 24	MX 25	MX[f] 27	MX[g] 32	MX[f] 37	MX[f] 38	MX[f] 42	MX[f] 49	MX[h] 50
Ratings all voltages referred to Cathode															
Heater Voltage	Standard	V	6·3	4·0	4·0	6·3	6·3	4·0	6·3	6·3	4·0	4·0	6·3	6·3	6·3
A_1 Voltage	Standard	V	600	250	250	400	400	—	300	—	1250	1250	—	420	3kV
	Maximum	**V**	**750**	**300**	**400**	**600**	**600**	—	**350**	—	**1450**	**1450**	—	**600**	**5kV**
A_2 Voltage	Standard	V	—	—	—	—	—	—	0	—	1000	1000	0	0	100
	Maximum	V	—	—	—	—	—	—	200	—	1400	1400	300	300	150
A_3 Voltage	Standard	kV	15	5·5	5·5	15	15·0	4·0	12	28	7	7	15	15	3
	Maximum	**kV**	**17**	**7·0**	**9·0**	**17**	**15·5**	**5·0**	**13**	**32**	**8**	**8**	**17**	**17**	**5**
Operation under standard voltage conditions															
Heater Current	Minimum	A	0·44	0·84	0·84	0·50	0·44	0·84	0·54	0·44	0·7	0·7	0·50	0·44	0·080
	Nominal	A	0·50	1·0	1·0	0·55	0·50	1·0	0·60	0·50	1·0	1·0	0·55	0·50	0·095
	Maximum	A	0·58	1·1	1·1	0·60	0·58	1·1	0·66	0·56	1·2	1·2	0·60	0·56	0·120
Modulator Voltage for visual cut-off	Minimum	V	—30	—25	—25	—25	—40	—30	—30	—100	—30	—30	—40	—30	—30
	Nominal	V	—45	—40	—40	—45	—80	—45	—50	—160	—50	—50	—65	—45	—45
	Maximum	V	—60	—60	—60	—60	—100	—65	—70	—200	—100	—100	—90	—60	—60
Maximum Inter-electrode Capacitance	Modulator	pf[j]	15	15	15	15	15	25	12	15	25	25	15	15	15
	Cathode	pf[j]	15	10	10	15	8	15	12	10	10	10	10	15	10
Typical Spot Diameter[a]		mm	0·5	0·5	0·5	0·3	0·5	0·5	0·5	0·25	0·8	0·8	0·5	0·4	0·6
Maximum Spot Deviation[b]		mm	12	10	10	12	20	10	7	5	10	10	6	10	3
Useful Screen Diameter		mm	420	225	225	250	483	180	105	84	135	135	200	420[c]	86[c]
Deflection Angle			70°	50°	50°	50°	60°	50°	40°	40°	40°	40°	40°	70°	60°
Available to CV Specification			5163	487	2472	1965	2388	2278	2469	6101	2415	1530	—	5941	—
Nominal Tube Diameter		inches	17[c]	10	10	12	21	8	5	$3\frac{1}{2}$	$6\frac{1}{2}$	$6\frac{1}{2}$	9	17[c]	$3\frac{1}{2}$[c]
EMI Phosphor Type[d]			008	GG6	G08	008	009	008	GG5	BB4	008	GG5	008	008	GG3

Key to Pin Connections

- H Heater
- K Cathode
- M Modulator
- NP No pin
- A_1 Accelerator anode
- A_2 Focus anode
- A_3 Final anode
- IC Internal connection
- NC No connection

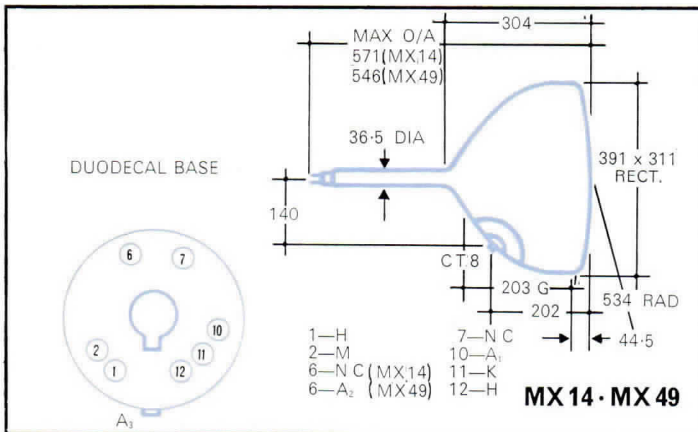
Key to Drawings

- c Available with collar
- G External graphite coating

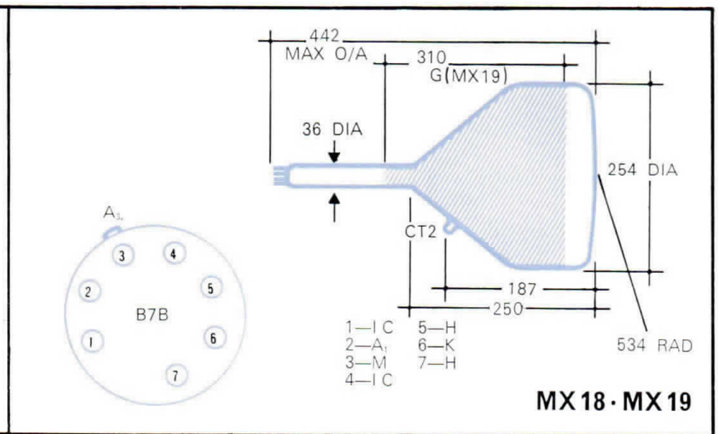
All dimensions in mm. and nominal except where indicated

Footnotes to table

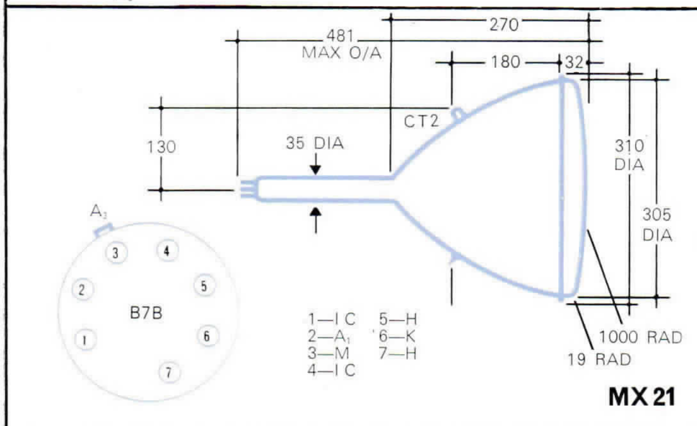
- a With specified coils
- b From centre of screen: unfocused spot
- c Rectangular screen: diagonal measurements
- d See pages 10 and 11
- e Metal-coned tube
- f E.S. focusing
- g Projection tube: non-solarising glass
- h E.S. Y-deflection; sensitivity 0·55 mm/V
- j To all other electrodes



MX 14 · MX 49



MX 18 · MX 19



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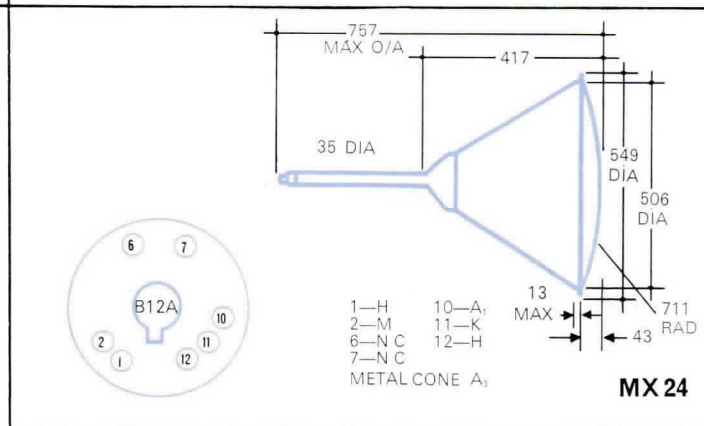

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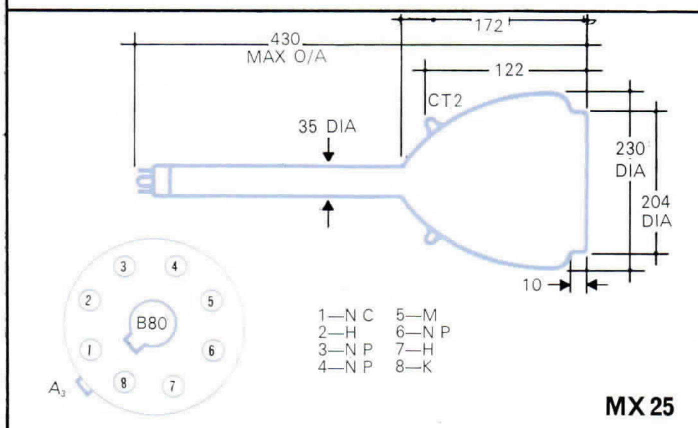

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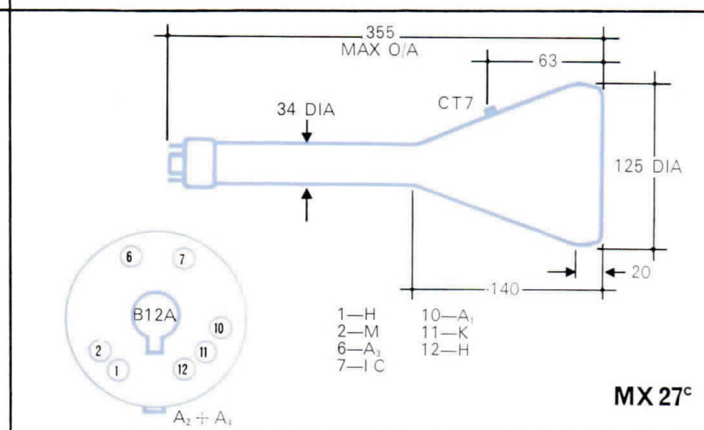
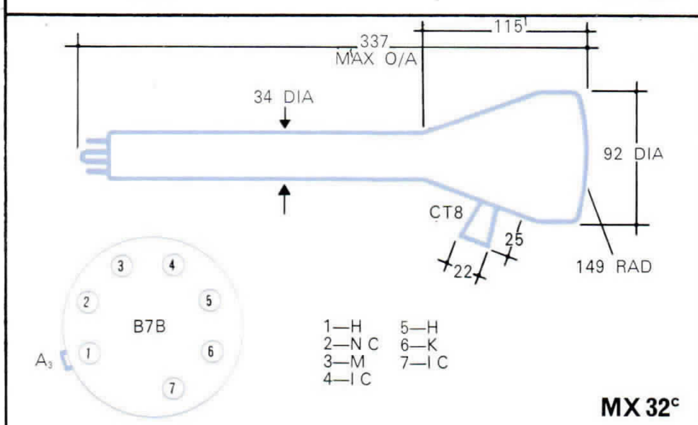
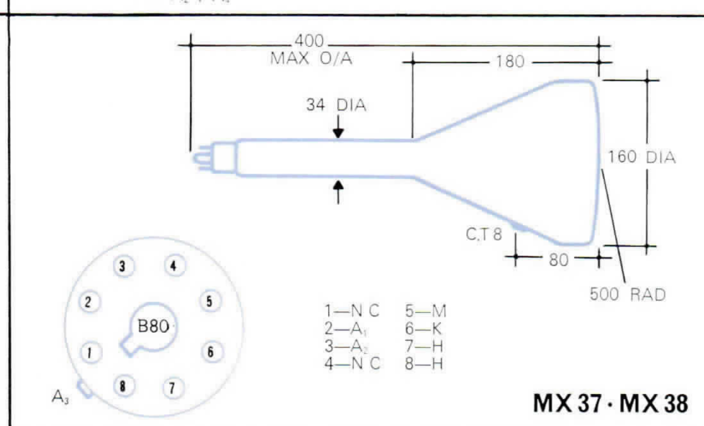


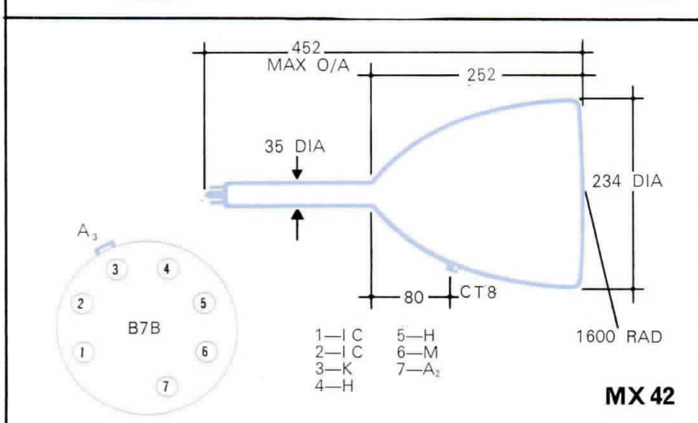
MX 27c



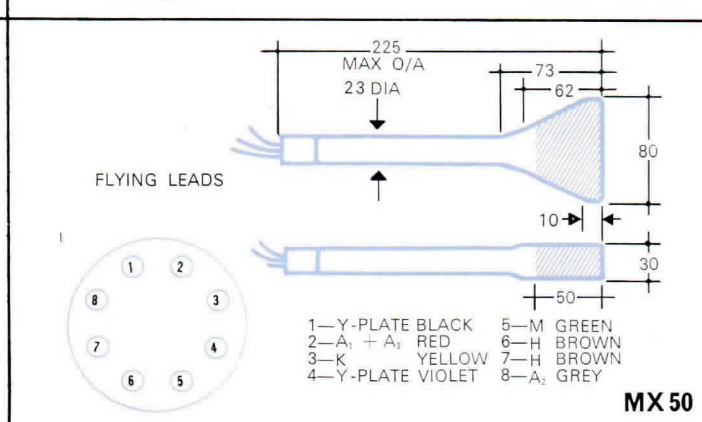
MX 32c



MX 37 · MX 38



MX 42



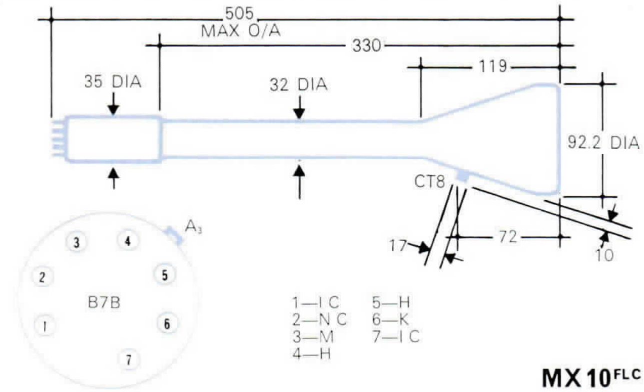
MX 50

Tubes for Special Applications

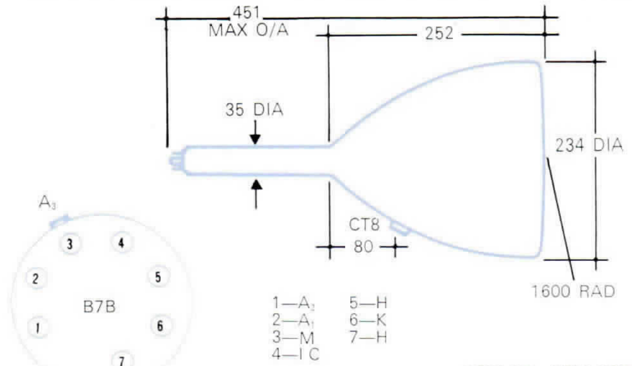
Type number			MX[g] 10	MX 12	MX 12B	MX[g] 16	MX[g] 29	MX[g] 29S	MX[fg] 30	MX 41	MX[g] 45	MX 48	MX[g] 57
Ratings all voltages referred to Cathode													
Heater Voltage	Standard	V	6·3	6·3	6·3	6·3	4·0	4·0	4·0	4·0	6·3	6·3	4·0
A_1 Voltage	Standard	V	—	400	400	—	—	—	—	250	—	—	—
	Maximum	**V**	—	**400**	**400**	—	—	—	—	**400**	—	—	—
A_2 Voltage	Standard	V	—	400	400	—	—	—	—	—	—	—	—
	Maximum	V	—	400	400	—	—	—	—	—	—	—	—
A_3 Voltage	Standard	kV	8	10	10	28	25	25	22	7	15	1	30
	Maximum	**kV**	**15**	**15**	**15**	**30**	**28**	**28**	**25**	**10**	**20**	**4[e]**	**32**
Operation under standard voltage conditions													
Heater Current	Minimum	A	0·50	0·44	0·44	0·44	0·8	0·8	0·8	0·8	0·50	0·45	0·8
	Nominal	A	0·55	0·50	0·50	0·50	1·0	1·0	1·0	1·0	0·55	0·55	1·0
	Maximum	A	0·60	0·56	0·56	0·56	1·1	1·1	1·1	1·1	0·60	0·60	1·1
Modulator Voltage for Visual Cut-off	Minimum	V	—8	—35	—35	—100	—40	—60	—30	—20	—20	—5	—87
	Nominal	V	—12	—50	—50	—150	—60	—90	—50	—30	—40	—10	—117
	Maximum	V	—20	—75	—75	—200	—90	—120	—70	—45	—60	—15	—147
Maximum Inter-electrode Modulator Capacitances	Modulator	pF	12	15	15	15	12	12	12	15	12	10	12
	Cathode	pF	12	15	15	10	12	12	12	15	12	6	10
Nominal Spot Diameter[a]		mm	0·25	0·5	0·5	0·25	0·15	0·15	0·15	0·4	0·25	—	0·5
Max. Spot Deviation[b]		mm	5	10	10	5	7	7	7	10	5	—	6
Useful Screen Diameter		mm	80	205	205	84	125[c]	135[c]	125[c]	228	127	25	125[c]
Deflection Angle			40°	40°	40°	40°	50°	50°	50°	50°	60°	—	42°
Nominal Tube Diameter		inches	3½	9½	9½	3½	6½	6½	6½	10	5	1	7¼
EMI Phosphor Type[d]			BB2	WW2	BB2	—	GG2	GG2	GG2	WW2	BB2	BB1	GG2
			Photographic radar recording and other line scan applications	As MX 12B, white screen	EMI LogEtronic photographic recording and reproducing	Colour television projection	EMI flying-spot television film scanning equipment	As MX 29, better overall focus	As MX 29, low slope	EMI studio equipment picture monitor tube	Photographic airborne radar	Pulsed light source for photomultiplier calibration	High-frequency flying-spot television film scanning

Footnotes to Table

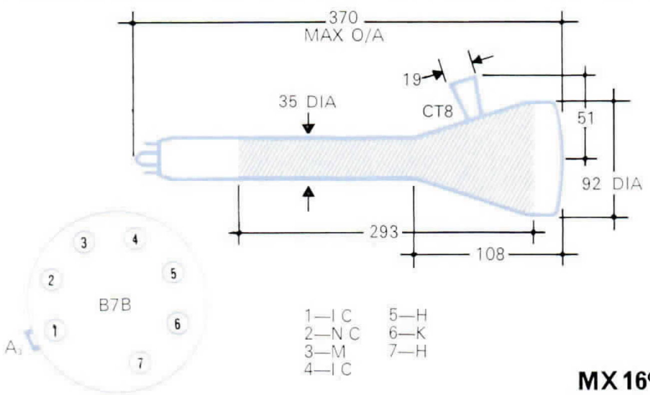
a With specified coils
b From centre of screen: unfocused spot
c Diagonal of raster
d See pages 10 and 11
e Dependent on base
f Available to CV1738
g Non-solarising glass face



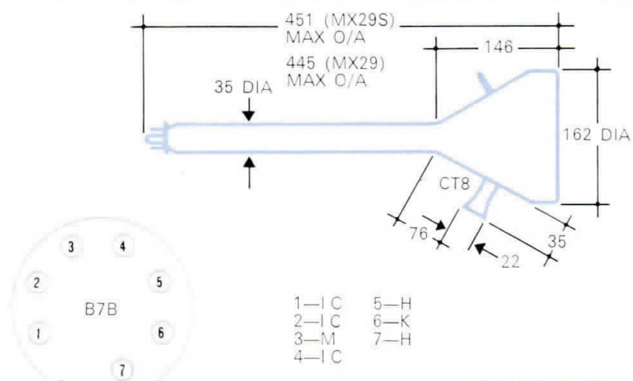
MX 10^{FLC}



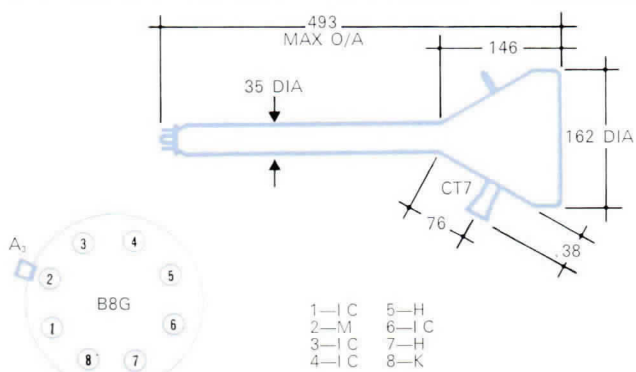
MX 12 · MX 12B



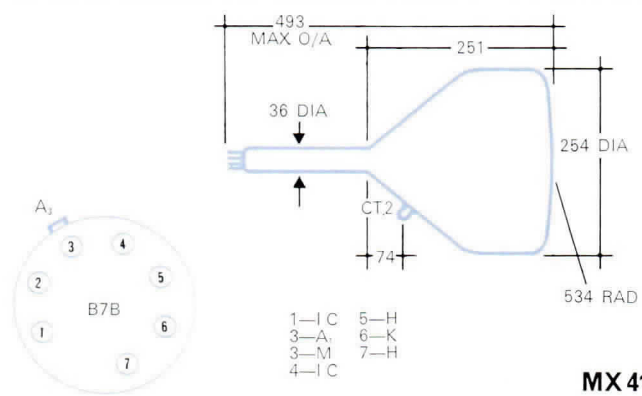
MX 16^{C}



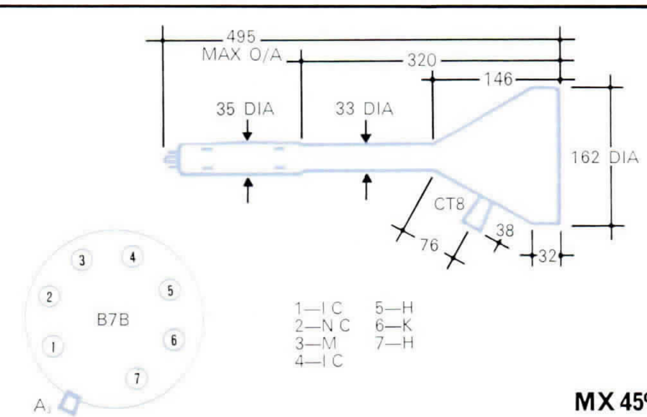
MX 29 · MX29S



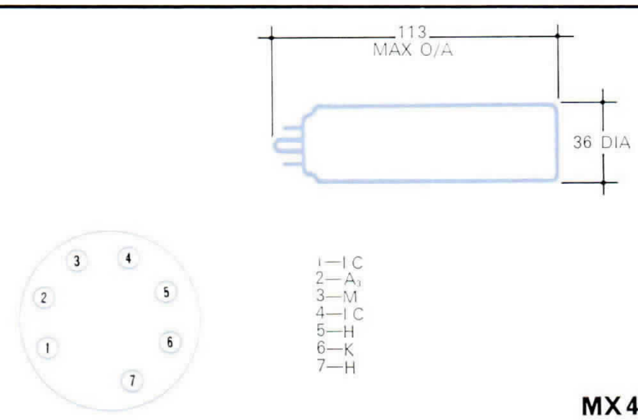
MX 30



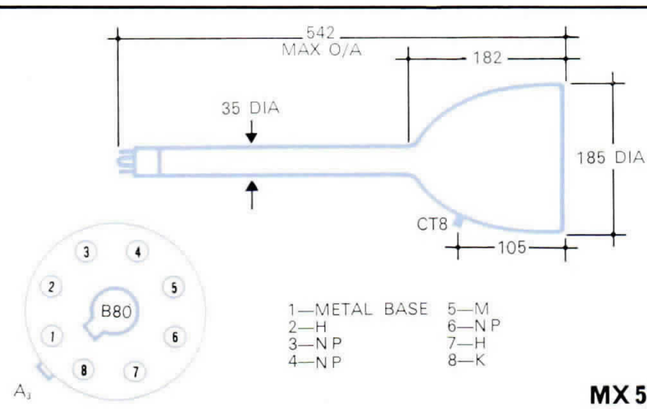
MX 41



MX 45^{C}



MX 48



MX 57

Key to Pin Connections

- H Heater
- K Cathode
- M Modulator
- NP No pin
- A_1 Accelerator anode
- A_2 Focus anode
- A_3 Final anode
- IC Internal connection
- NC No connection

Key to Drawings

- C Available with collar
- G External graphite coating
- FL Flying leads

All dimensions in mm. and nominal except where indicated

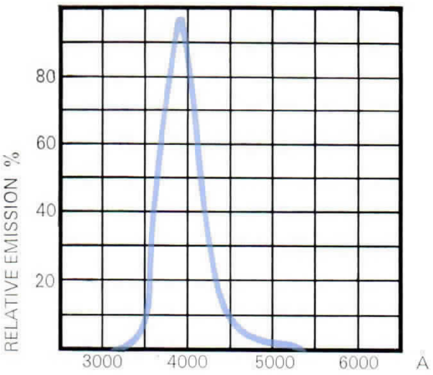
EMI produce phosphors which cover a wide range of persistence values and spectral response characteristics, to suit the many applications of EMI cathode ray tubes. The range includes phosphors of short persistence for film scanners, of high luminous intensity for projection tubes, and very long persistence cascade phosphors for radar tubes. The standard phosphor employed in each tube is that indicated in the table of tube characteristics. With two exceptions, the phosphors in all the listed tubes have an aluminised backing which is a necessary feature where high brightness is required, and "sticking" and ion burn are to be eliminated. It is frequently possible to supply tubes with alternative phosphors to suit particular applications.

EMI cathode ray tubes employ high-grade blemish-free faceplates which, in instrument tubes and film scanning tubes, are ground optically flat. All projection and film scanning tubes feature non-solarizing glass.

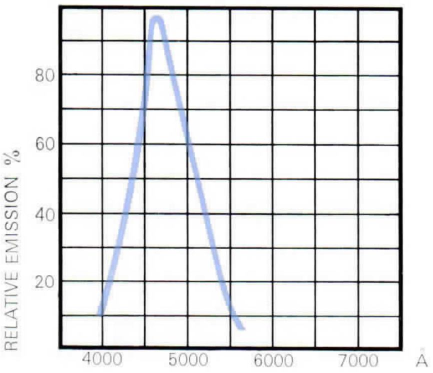
Table A

EMI type	EIA type	Flash and afterglow	Persistence to $\frac{1}{10}$th of Initial Intensity	Description and application
BB 1	P16	BLUE	0·1 μsec	A very short persistence phosphor for radar tube application.
BB 2	P11	BLUE	40 μsec	This phosphor is ideally suited to photographic radar recording applications because of the similarity of its spectral response to that of an orthochromatic film, and its medium short persistence.
BB 4	—	BLUE	2 msec	A very high brightness, medium persistence phosphor which is ideal for projection tubes applications.
GG 2	P24	GREEN	10 μsec	An ideal medium-short persistence phosphor for flying spot scanning tubes, having a spectral energy emission characteristic of sufficient range to provide useful energy over the visible spectrum as required for generating colour signals from colour transparencies.
GG 3	P31	GREEN	100 μsec	A general purpose medium-short persistence phosphor which is ideal for oscilloscope tubes. Photographic recording is facilitated by the similarity of its spectral response to that of panchromatic film.
GG 5	P1	GREEN	20 msec	A general purpose, medium persistence phosphor suitable for radar and oscilloscopic purposes.
GG 6	P7	GREEN	300 msec —4 sec	A radar tube phosphor of long persistence.
GO 8	P7/P26	GREEN/ ORANGE	20 sec	A cascade phosphor with a green flash and very long orange afterglow.
OO8	P26	ORANGE	84 sec	A radar tube type phosphor exhibiting high brightness together with a very long afterglow.
OO9	P19	ORANGE	170 sec	A very long persistence phosphor for radar tube application.
WW2	P4	WHITE	50 μsec	A white phosphor of medium short persistence ideal for television picture monitor tubes.

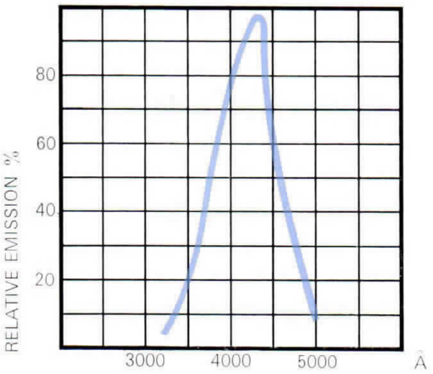
BB1



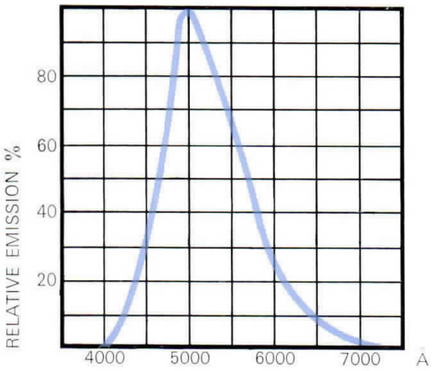
BB2



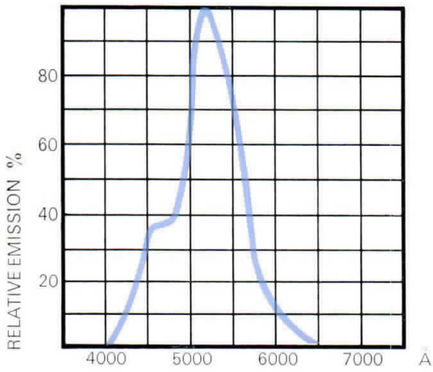
BB4



GG2

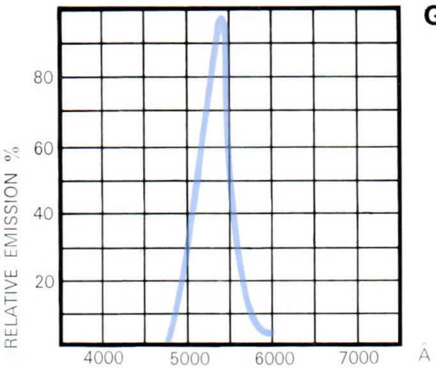


GG3

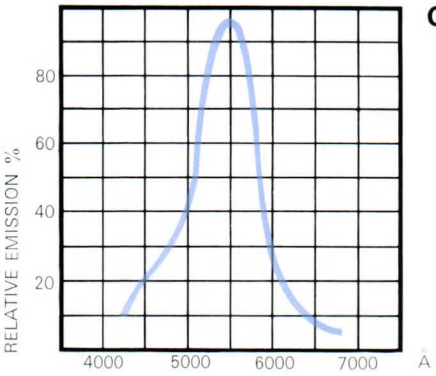


continued overleaf

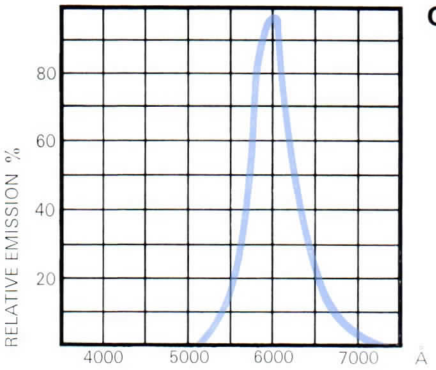
GG5



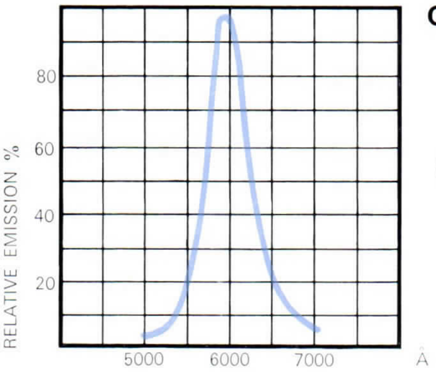
GG6



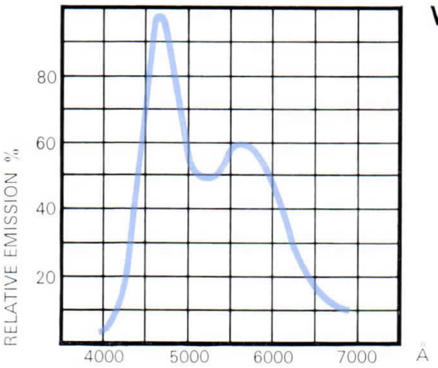
OO8



OO9



WW2



The EMI phosphor code comprises two of the letters listed below, which represent the phosphorescent and fluorescent colours respectively, followed by a figure which indicates the persistence.

B	Blue
G	Green
O	Orange
W	White

The persistence is measured as the decay time to one-tenth of the initial intensity and, in table B, the persistence values are categorised according to the EIA descriptions. Table A lists against each EMI type the nearest equivalent EIA type.

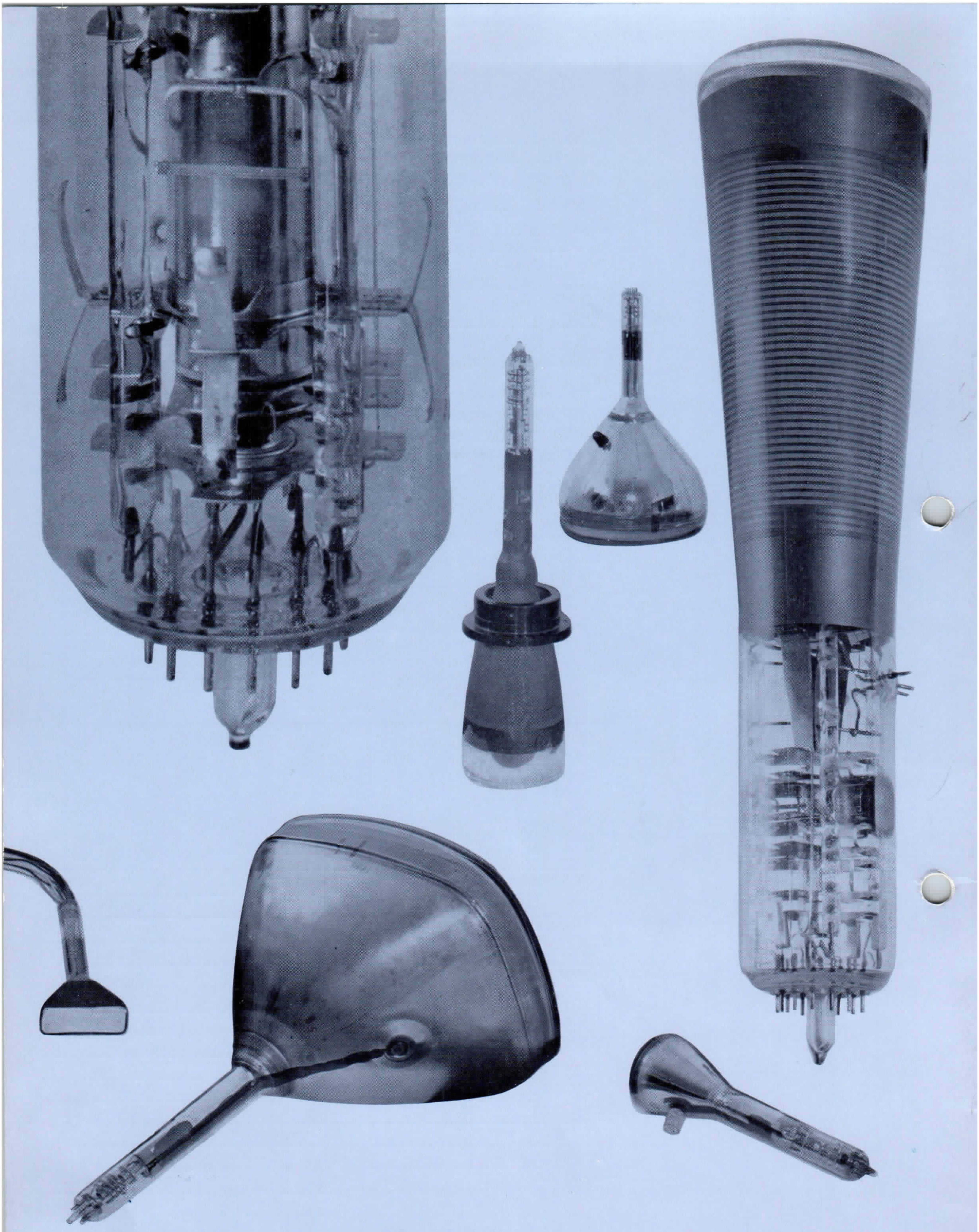
Table B

	EMI Code	1	2	3	4	5	6	7	8	9
Persistence to $\frac{1}{10}$ Initial Intensity	Minimum	—	10 μsec	100 μsec	1 msec	10 msec	100 msec	1 sec	10 sec	100 sec
	Maximum	10 μsec	100 μsec	1,000 μsec	10 msec	100 msec	1,000 msec	10 sec	100 sec	—
	E.I.A. Description	Short	Medium-short		Medium		Long		Very long	

EMI Cathode Ray Tube equivalents

CV Designation	**EMI Type Numbers**
CV487	MX18
CV1530	MX38
CV1738	MX30
CV1965	MX21
CV2222	MX17
CV2278	MX25
CV2388	MX24
CV2415	MX37
CV2469	MX27
CV2472	MX19
CV5163	MX14
CV5941	MX49
CV6101	MX32

Other Manufacturers' Types	**EMI Equivalents**
Sylvania SE3A	MX54
Etel/Mullard 5CLP31	MX56
Rank Cintel C212	MX57
Mullard D13-22-GH	MX58



EMI

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V/CRT ISSUE 1

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Design + Print by Mears Caldwell Hacker Limited, London England

EMI

EMI ELECTRONICS LTD

Serving Science and Industry

VALVE DIVISION

NEW PRODUCT DATA

EMI CATHODE RAY TUBE TYPE MX61

The MX61 is an electrostatically focused, magnetically deflected cathode ray tube with a short afterglow green phosphor with aluminium backing. It is intended for low resolution flying-spot character scanning.

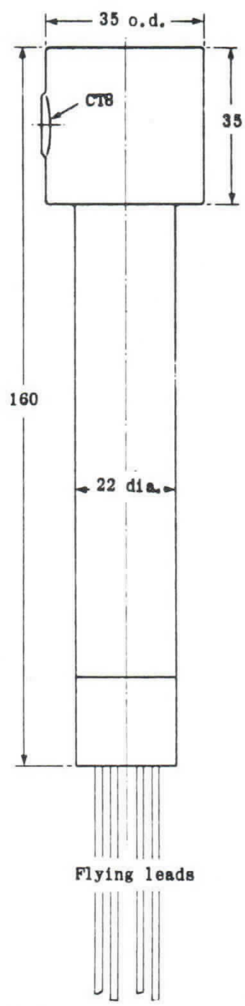
CHARACTERISTICS

Provisional Specification

MECHANICAL

Face diameter	35 mm	Overall length	160 mm
Useful screen dia.	30 mm	Deflection angle	40°
Neck diameter	22 mm	Phosphor:-	Green short persistence

ELECTRICAL		Max.	Typical	Min.
Heater voltage	V		6.3	
Heater current	A	0.105	0.095	0.085
A_1 & A_3 voltage	kV	7	5	4
A_2 voltage for focus (other potentials typical)	V	+ 150	0	-150
Deviation of un-deflected spot from centre of screen	mm	3		
Grid voltage for cut-off (other potentials typical)	V	100	70	40
Line width	mm		0.25	



All dimensions are in MILLIMETRES except where otherwise stated

BASE CONNECTIONS

Flying lead	Yellow	Brown	Green	Grey
Electrode	Cathode	Heater	Grid	A_2 Focus

C654/1p
DS.626

The Company reserves the right to modify the designs and specifications without notice

EMI

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Ref No. 10772 CP

EMI

EMI ELECTRONICS LTD

Serving Science and Industry

VALVE DIVISION

New Product Data

EMI CATHODE RAY TUBE TYPE MX62

The MX62 is a 5 inch diameter tube with a long persistence fluoride phosphor. It has been designed as a display tube for use in conjunction with the 1 inch diameter flying spot tube, Type MX61.

CHARACTERISTICS

Provisional specification

Mechanical (see figure overleaf)

Face diameter	:	133 mm ± 1.5 mm	Overall length	:	328 mm
Useful screen area	:	80 mm x 60 mm	Phosphor	:	Long persistence fluoride 009
Neck diameter	:	22.5 mm			

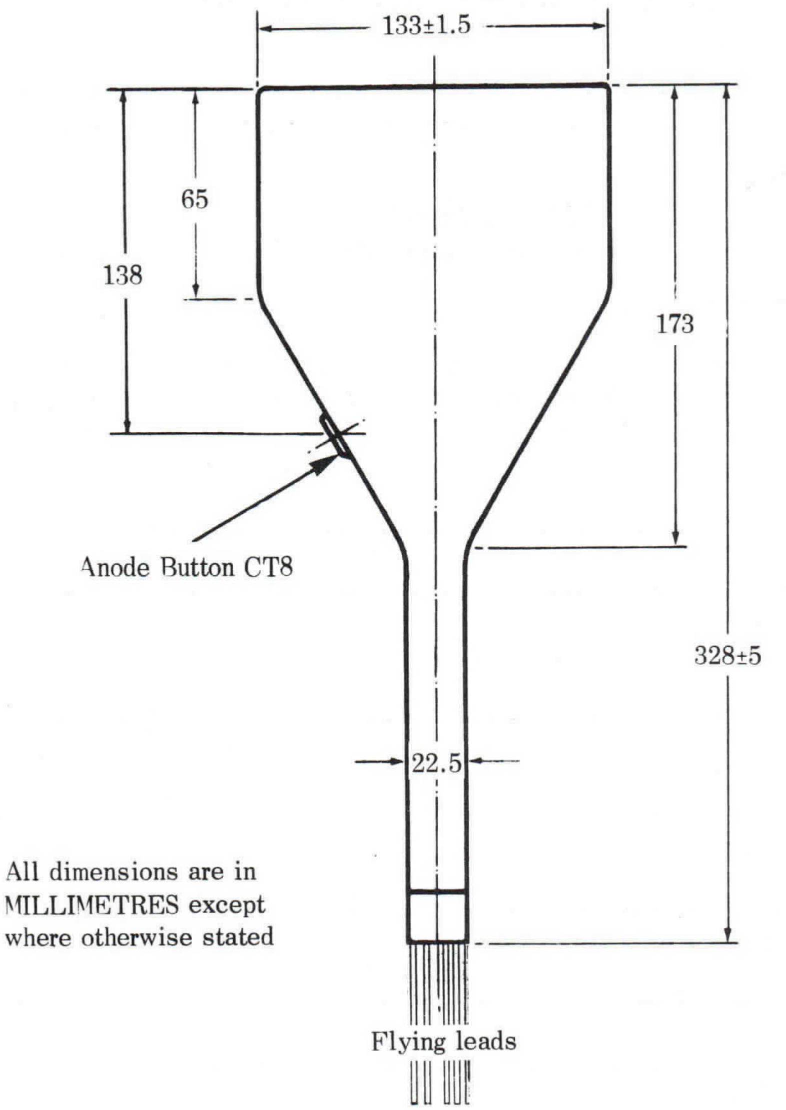
Electrical

			Max.	Typical	Min.
Heater voltage		V	-	6.3	-
Heater current		A	0.105	0.095	0.085
A_1 & A_3 voltage		kV	5.5	5.0	4.5
A_2 voltage for focus Other potentials typical		V	300	150	0
Grid voltage for cut-off Other potentials typical		V	-100	-80	-60
Deviation of undeflected spot from centre of screen		mm	5	-	-
Grid insulation at -100V		MΩ	-	-	10
Line width (Drive 25 V) Other potentials typical		mm	0.5	-	-
Blemishes diameter		in	0.01	-	-
Cathode heater insulation at -100 V		MΩ	-	-	5
Capacitances	Cathode to all	pF	15	-	-
	Grid to all	pF	10	-	-

EMI CATHODE RAY TUBE TYPE MX62 (continued)

Base Connections Flying leads

Flying lead	Yellow	Brown	Green	Grey	Side contact
Electrode	Cathode	Heater	Grid	A2	A1 & A3



C655/2a
DS.634/2

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IMAGE INTENSIFIERS &
MISCELLANEOUS

EMI **EMI ELECTRONICS LTD**

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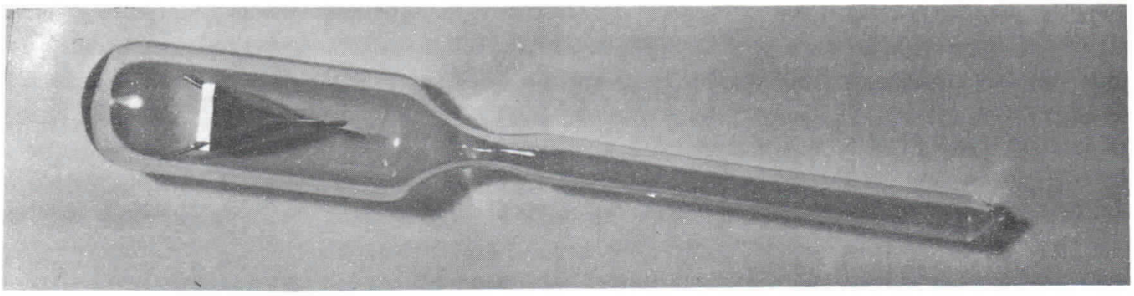
VALVE DIVISION

EMI ALKALI METAL GENERATORS



Large numbers of photoelectric devices which are sensitised by the alkali metals caesium, sodium and potassium are manufactured by EMI Electronics Ltd. The metals are produced by generators of the type shown in the picture.

These generators may be of value to workers in universities and industrial laboratories, in which small quantities of alkali metals need to be produced either for the production of experimental photoelectric devices or for chemical and physical experiments of a different nature. EMI Electronics is, therefore, making them available to interested workers.

The generators consist of a nickel container which holds a mixture of aluminium, tungsten and caesium chromate (in the case of a caesium generator). They are supplied under vacuum in either pyrex or lime soda glass ampoules, the nickel containers having been partially outgassed.

When a generator is required for use, the pump stem is cut open and sealed to the vacuum system. Once this has been evacuated the generators are outgassed further, first by baking, and then by heating the nickel container to a dull red colour, about 500°C to 600°C, by means of an induction heater. This procedure is continued until most of the gas has been liberated.

On completion of the foregoing the nickel container is heated by the induction heater to its firing temperature, 800°C to 1,200°C or higher, when an exothermal reaction takes place in the powder. The metal in vapour and liquid form drifts out of the container and condenses on the walls of the larger glass cylinder. It is then forced into the connecting length of glass with the aid of a flame and the larger cylinder is sealed off. The alkali metal condensed in the glass tube is now available for use and can be drifted into the system by gentle heating.

Typical quantities of the pure metals liberated by these generators are as follows:-

Caesium	0.11 g
Sodium	0.015 g
Potassium	0.025 g

Typical dimensions of the alkali generators shown above are as follows:-

Diameter of large tubing	18 mm
Diameter of small tubing	8 mm
Overall length	115 mm

S831/1a
DS.624

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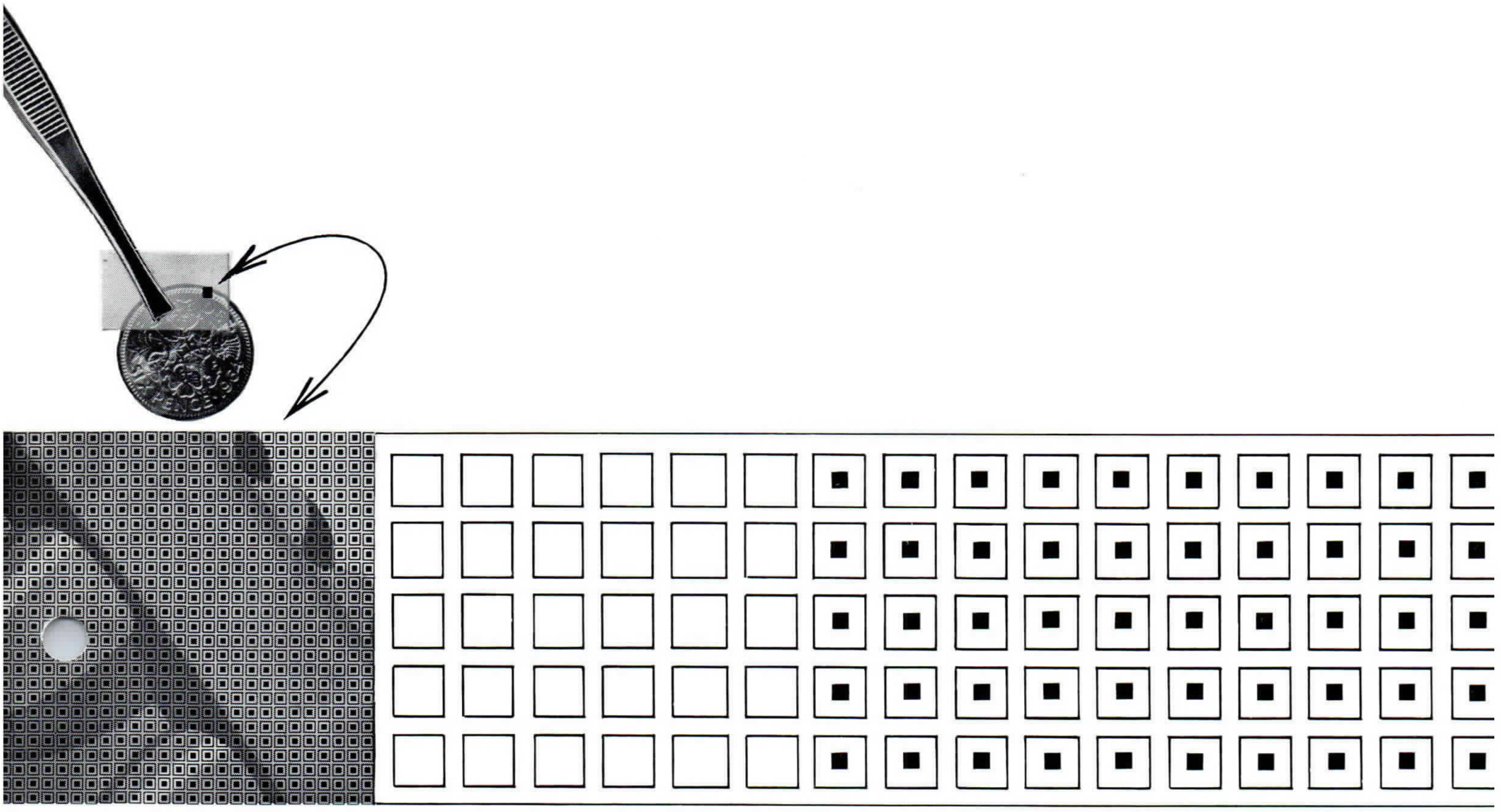
Ref. 10772 CP

EMI

Micromesh



One component of EMI special vacuum tubes is a very fine metallic mesh. This is used to present an equi-potential plane to an electron beam approaching it perpendicularly while at the same time allowing the beam to penetrate the mesh without distortions due to fringe effects and non-linearity.

Mesh for this purpose must be extremely uniform in geometry, without blocked apertures or missing web, and must have maximum transparency compatible with mechanical strength.

EMI micromesh, manufactured by a special technique of electro-plating from a ruled glass master, is a product so unusual that it has found applications in many branches of science and industry quite unconnected with electronics.

In its standard form, in grades and materials listed on page 2, this micromesh is fragile and care must be taken while handling it to prevent wrinkling and other damage. For special applications it can be supplied mounted on rings of, say, $\frac{1}{2}$ inch or 1 inch diameter and stretched and strengthened by heat treatment.

Additional electro-plating may be deposited in order to reduce the size of the apertures and the transparency, but beyond certain limits the uniformity of aperture size and thickness will not be maintained.

The reinforced micromesh, described on page 4, consists of standard micromesh mounted between two coarser support grids and finally electro-plated. This will be suitable for sifting and other applications requiring greater mechanical strength.

In addition to the normal range described in this leaflet, special micromesh can be manufactured to suit individual needs. For example, it is possible to supply micromesh with rectangular instead of square cells having, say, 100 cells to the inch in direction 'X' and 1000 in direction 'Y'. Micromesh with overlaid concentric rings or rectangles can be made. Enquiries for customs-engineered meshes will be welcomed.

Applications

The following uses are intended to serve as examples and have been selected from known applications.

Microscopy

In both optical and electron microscopes the wide variety of micro-mesh sizes make them extremely versatile specimen supports and stage micrometers.

Mass Spectrometry

Micromesh presents an accurate equi-potential plane surface while at the same time allowing the passage of particles.

Biology

Micromesh sieves are used to grade cells by size or to filter particles from liquid suspension. The web approaches a triangular cross-section and this is a considerable advantage as cleansing may be performed by reversing the direction of flow of clean carrier fluid.

Filtering

Apart from the special biological case, many industries handling fine powders or filtering liquids use the reinforced micromesh sieves.

Optics

As neutral density filters, micromeshes remove all doubt of possible colour presence. Simple classroom experiments may be devised employing the effect of interference patterns and the diffraction of light may be immediately demonstrated.

Standard Micromesh

The following are usually available at short notice in copper, silver or nickel.* Gold micromesh can be supplied to special order.

Size of mesh		Aperture size		Web size		Thickness		Transparency	Size of sheet	
Cells per in	*Cells per mm*	*in*	*μ*	*in*	*μ*	*in*	*μ*	%	*in (nominal)*	*mm (nominal)*
200	7·9	0·0043	108	0·0007	17	0·0002	5	70–80	3×3	76×76
375	14·8	0·0023	58	0·0004	10	0·0002	5	70–80	3×3	76×76
500	19·7	0·0017	43	0·0003	8	0·0002	5	65–75	3×3	76×76
600	23·6	0·0014	35	0·0003	8	0·0002	5	65–75	3×3	76×76
750	29·6	0·0011	28	0·0002	5	0·0002	5	60–70	3×3	76×76
1000	39·4	0·00076	18	0·0002	5	0·0002	5	55–60	3×3	76×76
1500	59·1	0·00046	11	0·0002	5	0·0002	5	45–50	3×3	76×76
2000	78·8	0·00033	8	0·0002	5	0·0002	5	40–45	3×3	76×76

Tolerances

Mesh size is precise (the metric figures are derived from original inch figures).

Hole size may vary slightly but will remain within the limits quoted for transparency.

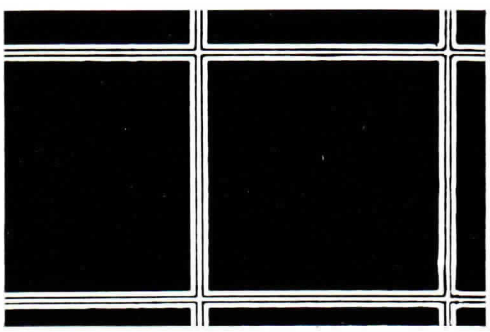
Uniformity over any one sheet will not vary by more than a few per cent.

In the factory, transparency is measured both geometrically and by optical transmission. Using the latter method, care should be taken to avoid inaccuracies due to scatter, diffraction and other aberrations.

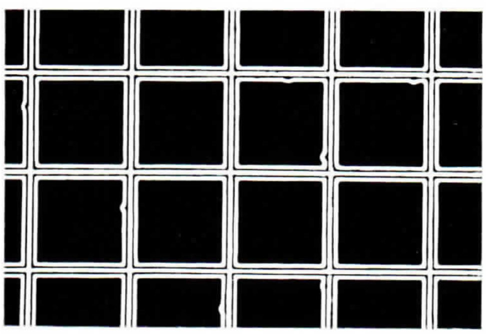
*N.B. When ordering, please state the material required.

All these photomicrographs are X260 and are not retouched.

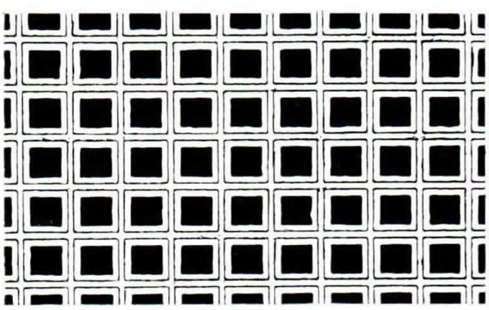
▼



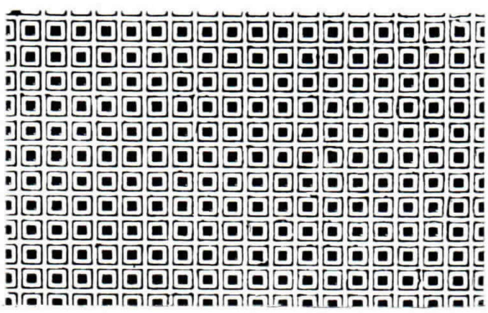
200 CPI



500 CPI

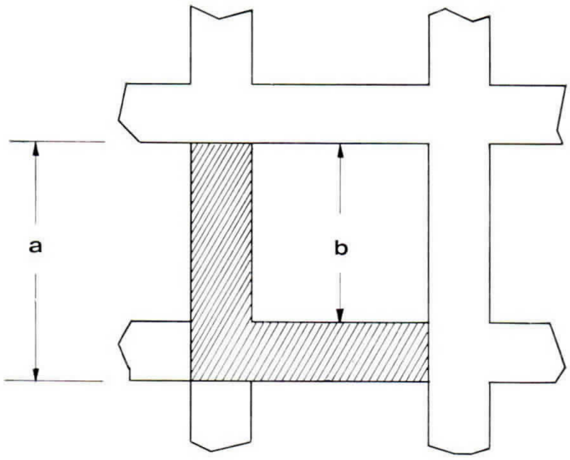


1000 CPI



2000 CPI

Plated Micromesh



For some applications eg neutral density filters a specified transparency may be required, other parameters being of less importance. For others eg sieves for grading powders a specified aperture size in between the standard sizes may be necessary.

Any of the standard micromesh sizes can be supplied with additional electro-plating to special order. In this case, the aperture size is reduced and transparency ratio reduced. Beyond a certain limit uniformity over the area of the sheet and, of course, aperture shape will be degraded.

The following graph represents, for various mesh sizes, the formula :

$$T = \left(\frac{b^2}{a^2} \times 100 \right) \%$$

(for area ›› aperture size)

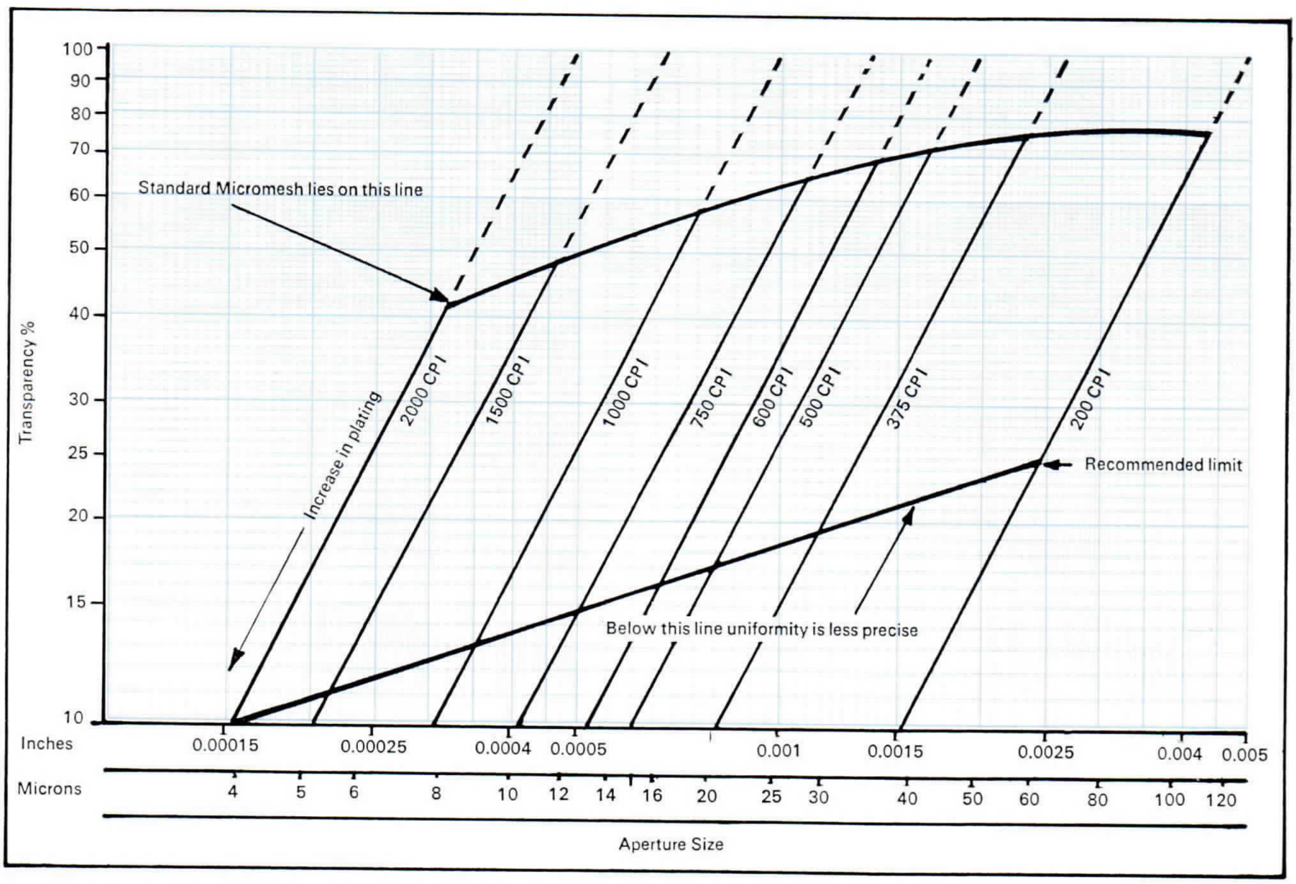
Where

T = per cent transparency

a = cell size

b = aperture size

Unless otherwise ordered, plating is of the same material as the basic mesh.

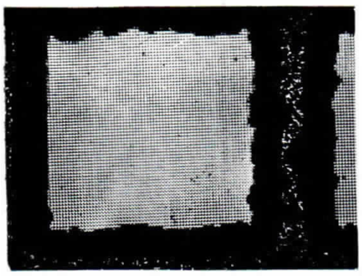


Reinforced Micromesh

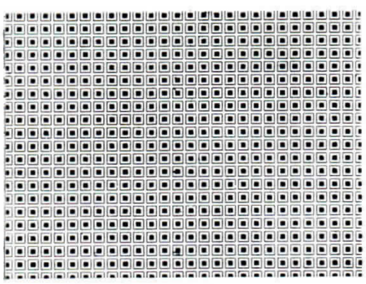
In order to give additional strength, mainly for filtering and sieving applications, the standard micromesh is available sandwiched between two 15 CPI support grids, accurately aligned and subsequently plated overall. The basic mesh, support grid and final plating are all in nickel.

The following standard sizes are available :

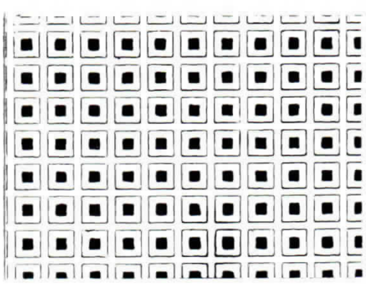
TYPE NO	FINE MESH								SUPPORT GRID				OVERALL		
	Mesh size		Aperture size		Web size		Trans-parency	Mesh size		Web size		Thickness		Trans-parency
	Cells per in	*Cells per mm*	*in*	*µ*	*in*	*µ*	%	*Cells per in*	*Cells per mm*	*in*	*µ*	*in*	*µ*	%
1/1500	1500	59·1	0·00022	5·5	0·00045	11·0	11	15	0·591	0·010	254	0·0045	110	8
2/1500	1500	59·1	0·00032	8·0	0·00035	9·0	23	15	0·591	0·010	254	0·0045	110	17
3/1000	1000	39·4	0·00044	11·0	0·00056	14·0	19	15	0·591	0·010	254	0·0045	110	14
4/1000	1000	39·4	0·00062	15·5	0·00038	9·5	38	15	0·591	0·010	254	0·0045	110	27
5/750	750	29·6	0·00088	22·0	0·00045	11·0	44	15	0·591	0·010	254	0·0045	110	32
6/600	600	23·6	0·00124	31·0	0·00043	11·0	55	15	0·591	0·010	254	0·0045	110	40



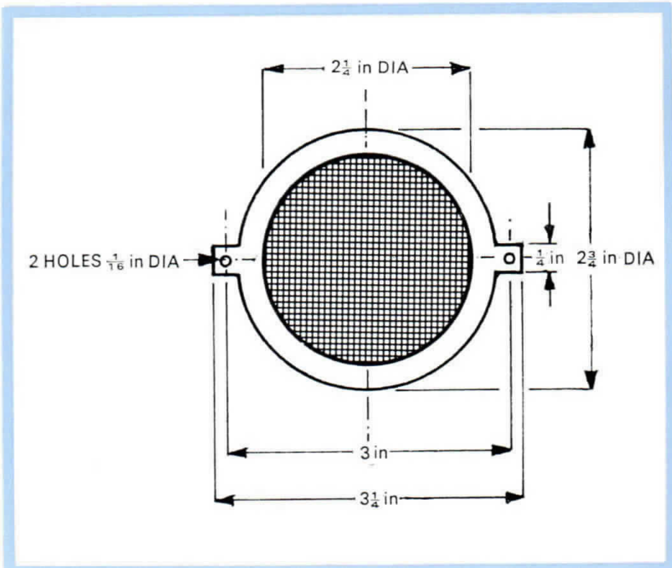
X24

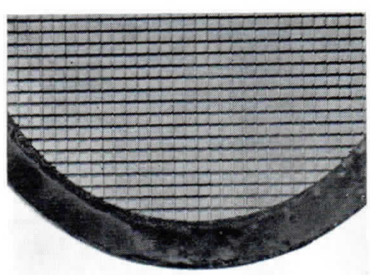


X103



X260





Full size

All these photographs are of a 1500 CPI reinforced micromesh type 1/1500 and are not retouched.

EMI

Ref: S817/a

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Printed in England by Mears Caldwell Hacker Ltd

EMI

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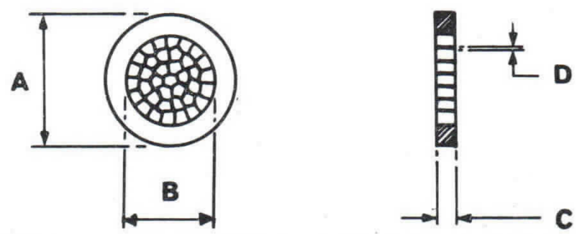
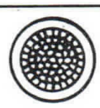
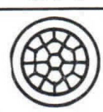
EMI HONEYCOMB GRIDS

These grids used in the manufacture of EMI klystrons, are available in various sizes for use in the control and modulation of electron beams. They are extremely robust and are employed in tubes meeting stringent requirements of ruggedness.

The dimensions quoted below are nominal, but are held to close limits and a high degree of consistency is maintained in production. Grids having thicknesses other than those listed can be supplied up to 2 cm if necessary for use as collimators.



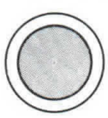
Grid No.	Drawing Scale	Number of Cells	Outside Dia. A	Inside Dia. B	Grid * Thickness C	Membrane Thickness D	Dims
13	 1 : 1	37	10.670 0.420	7.620 0.300	0.305 0.012	0.028 0.0015	mm in
15	 2 : 1	37	4.570 0.180	3.023 0.119	0.254 0.010	0.025 0.001	mm in
16	 2 : 1	61	5.482 0.216	3.988 0.157	0.152 0.006	0.025 0.001	mm in
19	 2 : 1	7	5.482 0.216	3.988 0.157	0.254 0.010	0.045 0.0018	mm in
20	 5 : 1	19	2.286 0.090	1.778 0.070	0.178 0.007	0.025 0.001	mm in
21	 2 : 1	61	4.316 0.163	3.023 0.119	0.178 0.007	0.025 0.001	mm in

* *Grids of normal thickness, as listed, will be supplied unless a particular dimension 'C' is specified.*

S821/1b
DS.276/1

continued overleaf

EMI HONEYCOMB GRIDS (continued)

Grid No.	Drawing Scale 2 : 1	Number of Cells	Outside Dia.A	Inside Dia.B	Grid * Thickness C	Membrane Thickness D	Dims
22		127	4.570 0.180	3.886 0.153	0.254 0.010	0.02032 0.0008	mm in
23		217	5.508 0.220	4.978 0.196	0.254 0.010	0.02032 0.0008	mm in
24		127	6.553 0.258	5.334 0.210	0.254 0.010	0.02032 0.0008	mm in
25		127	5.660 0.226	4.978 0.196	0.254 0.010	0.02032 0.0008	mm in
26		169	4.827 0.190	4.09 0.163	0.254 0.010	0.02032 0.0008	mm in
28		217	6.553 0.258	5.049 0.198	0.254 0.010	0.02032 0.0008	mm in
29		217	4.697 0.185	4.191 0.165	0.254 0.010	0.02032 0.0008	mm in
30		271	6.553 0.258	4.978 0.196	0.254 0.010	0.02032 0.0008	mm in

* *Grids of normal thickness, as listed, will be supplied unless a particular dimension 'C' is specified.*

S821/2b
DS.276/2

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *01-573 3888 Extension 2115* Cables: *Emidata, London* Telex: *London 22417*

Ref No. 10772B CP

EMI

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EMI INFRA-RED IMAGE CONVERTER TUBE TYPE 9606

This tube (Fig.1) consists of an infra-red sensitive photocathode deposited on the inner surface of the front window, on to which the infra-red image is focused. The photo-electrons are accelerated parallel to the axis of the tube by a high potential field until they strike the circular anode screen (32 mm diameter) and form a green coloured image. The anode screen is viewed through the rear window, usually by means of a magnifying eye-piece.

The photocathode spectral response (Fig.2) extends into the visible range so that an infra-red filter must be used if it is required to observe an infra-red image in the presence of visible illumination.

Typical uses of the tube are the observation of infra-red illuminated scenes for security purposes, and the examination of materials such as semi-conductors, documents, and paintings by infra-red radiation.

CHARACTERISTICS

Photocathode

The average photocathode sensitivity to Tungsten light (2870°K) is 15 μA/lm.

Operating Voltage (6kV maximum)

3kV for applications with strong infra-red radiation.

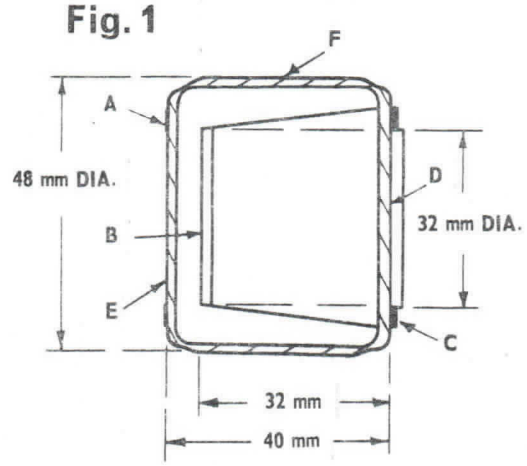
5 to 6 kV for applications where maximum sensitivity is essential. At this voltage some bright spots may be apparent on the anode screen.

Resolution

Typical resolution is 500 to 600 line pairs per target diameter.

S807/1b
DS.358/1

Fig. 1



A PHOTOCATHODE CONTACT RING

B ANODE SCREEN

C VIEWING SCREEN (ANODE) CONTACT RING

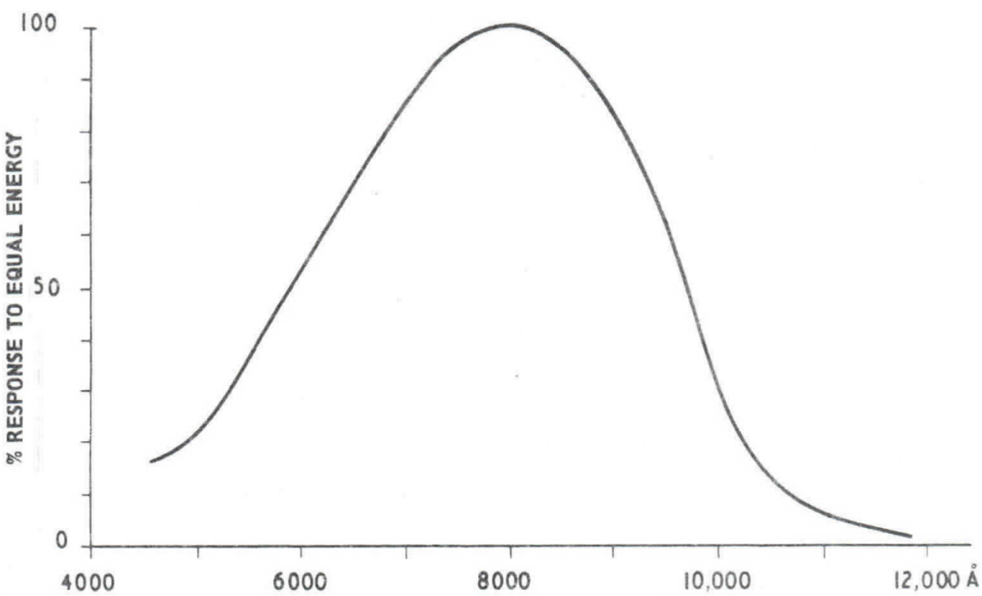
D REAR WINDOW

E PHOTOCATHODE & FRONT WINDOW

F ENVELOPE

MAX. USABLE PHOTOCATHODE DIAMETER 32 mm

Fig. 2



S807/2b
DS.358/2

The Company reserves the right to modify the designs and specifications without notice

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Ref No. 10772A CP

EMI ELECTRONICS LTD

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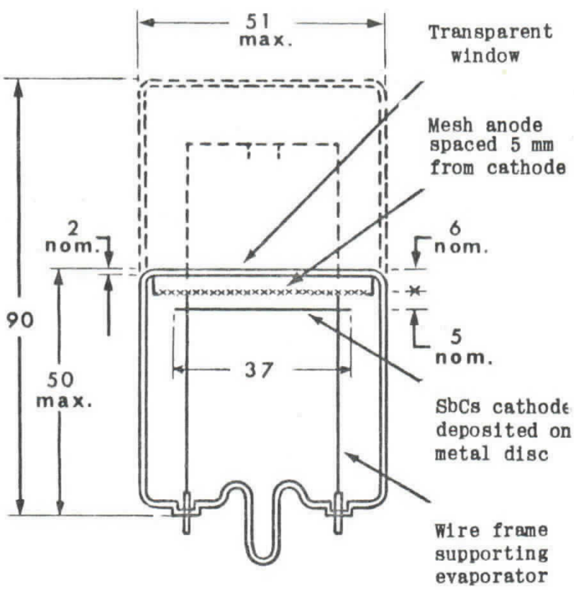
EMI PHOTODIODE TYPE 9608B

The tube described in this data sheet is an improved version of the type 9608, which originally had the dimensions as indicated by the dotted outline. It is intended for applications in which high intensity radiation of wavelengths between 3500 and 6500 Å is incident from a hemisphere upon the opaque photocathode. The photo surface is deposited on a disc as shown in the diagram and has an S4 spectral response, a typical response curve being shown below.

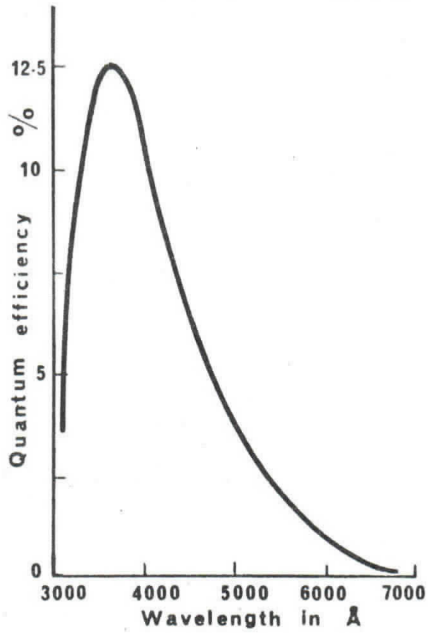
A mesh anode mounted above the photocathode may be operated at a voltage up to 2000 V to give good saturation of high output currents. It is estimated that the linear dynamic range is of the order of 10^5.

TUBE OUTLINE



All dimensions are in mm

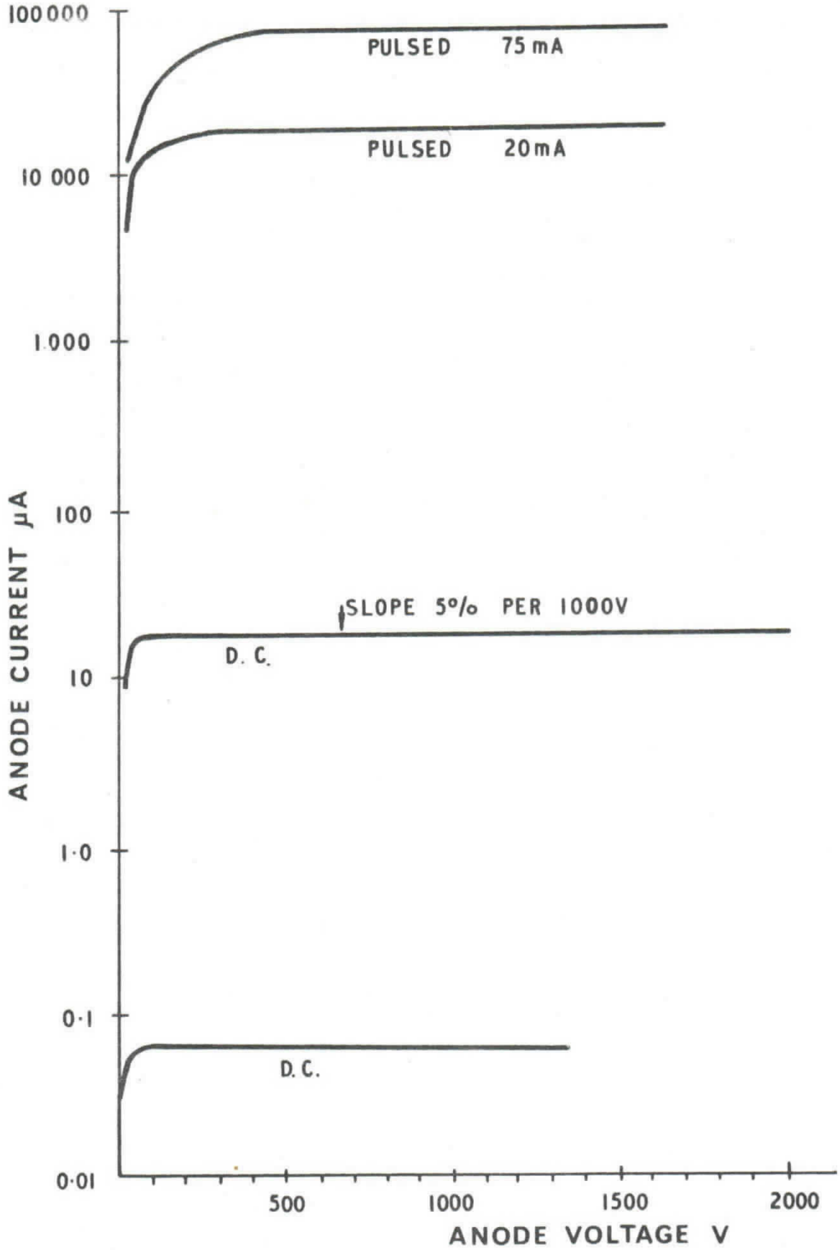
SPECTRAL RESPONSE OF SbCs CATHODE (S4) (opaque on metal)



Base type : B15B
Anode pins : 3, 11, 13, 14, 15.
Cathode pins : 6, 7, 8.

The tube envelope is of lime-soda glass and has a B15B base which fits a PTFE socket, available from E.M.I. Electronics Ltd. It may also be supplied to special order with a Corning glass window which will transmit down to approximately 2000 Å.

S810/1a
DS. 207/1



The Company reserves the right to modify the designs and specifications without notice

S810/2a
DS. 207/2

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

Telephone: *Hayes 3888 Extension 2165* Cables: *Emidata, London* Telex: *London 22417*

Electron Tube Division

NEW PRODUCT DATA

EMI IMAGE INTENSIFIER TYPE 9692
(Provisional Specification)

General

The 9692 tube is basically similar in construction and operation to the standard 9694 intensifier. The tube differs from the 9694 in that the 1st stage of the tube is provided with a phosphor (zinc silicate - titanium) having a decay period of 5μs. Pulsed operation of the second stage enables limited information stored on this phosphor (by virtue of its 5μs decay period) to be intensified. This method of operation allows time for checking the characteristics of the stored image by some external system before the intensification process is initiated. In this way tube noise is eliminated from the intensified image. Further, where noise is present in the incoming optical signal, noise rejection is possible if differentiation between noise and signal can occur without interfering with the image presented to the tube, so that intensification only occurs when image signals are present on the storage phosphor.

General Information

As 9694. (See EMI catalogue ref. S851)

Electrical Specification

		Min.	Typical	Max.
Cathode and dark current, as 9694				
Overall voltage for 10^5 gain at 4500Å (D.C.)	kV		30	35
Overall voltage for 10^6 gain at 4500Å (D.C.)	kV		40	45
Centre resolution	line pairs/mm.	20	25	

Capacity of 1st stage dynode to all other electrodes - 10 pF.
No. of ion scintillations induced due to pulse operation - $<1/250$ pulses.*
Maximum pulse rate - 10^5/sec.
Pulse voltage required to switch tube - 3.8 kV negative pulse when tube operated with 10 kV equivalent on each stage.
In pulsed operation, demagnification, distortion and signal induced background levels are the same as the 9694 tube operating under D.C. conditions.
Resolution in pulsed operation is dictated by pulse shape. The following example illustrates possible results.

Pulse rise time 0.5μs. Period 10μs. Decay time 1.5μs.

D.C. resolution - 25 line pairs/mm.
Pulsed resolution - 22.5 line pairs/mm.

*Measured with rise time of 0.5μs.

S853/1pV69
D.S.983/1

Notes

These tubes can be operated under D.C. or pulsed conditions.

Where discrimination is required between successive pulse images, displayed on the output of the tube, (such as might be required if each event is to be photographed) the P.11 phosphor used in the last three stages of the tube limits the framing rate possible. Where higher framing rates are required tubes can be supplied with zinc silicate phosphors throughout.

Maximum framing rate for tubes with P.11 phosphor output.
$5 \times 10^2/s$
Maximum framing rate for tubes with Zn_2SiO_4 throughout.
$2 \times 10^4/s$

Tubes with zinc silicate phosphors throughout have lower gain and resolution due to limitations of this phosphor, as specified below.

Gain at 4500Å - Minimum 10^4) Maximum overall potential
Typical 4.10^4) (D.C.) 45 kV.

Resolution - Minimum 15 line pairs/mm.
Typical 20 line pairs/mm.

A full account of typical tube operation, pulse circuitry, and setting up instructions is provided in E.M.I. Document No. S870.

Sapphire U.V. transmitting input windows can be provided for these tubes.

Where high discrimination rates are required tubes can be supplied with P.24 storage phosphors (1μs decay). Tube details are available on application.

S853/2pV69
DS.983/2

EMI

EMI Electronics Ltd Electron Tube Division

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EMI

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EMI 4-STAGE IMAGE INTENSIFIERS TYPES 9692 & 9694

(Preliminary Data)

These are cascade image intensifiers of the phosphor/photocathode sandwich type employing magnetic focusing and all photocathodes are of the tri-alkali SbKNaCs type.

In the type 9692 the first stage incorporates the relatively fast zinc-oxide phosphor (P24) to enable the tube to be switched in 1 μsec. In subsequent stages the more efficient silver-activated zinc-sulphide (P11) phosphors are employed.

The type 9694 is a high gain low background tube with P11 phosphors throughout for night vision applications etc.

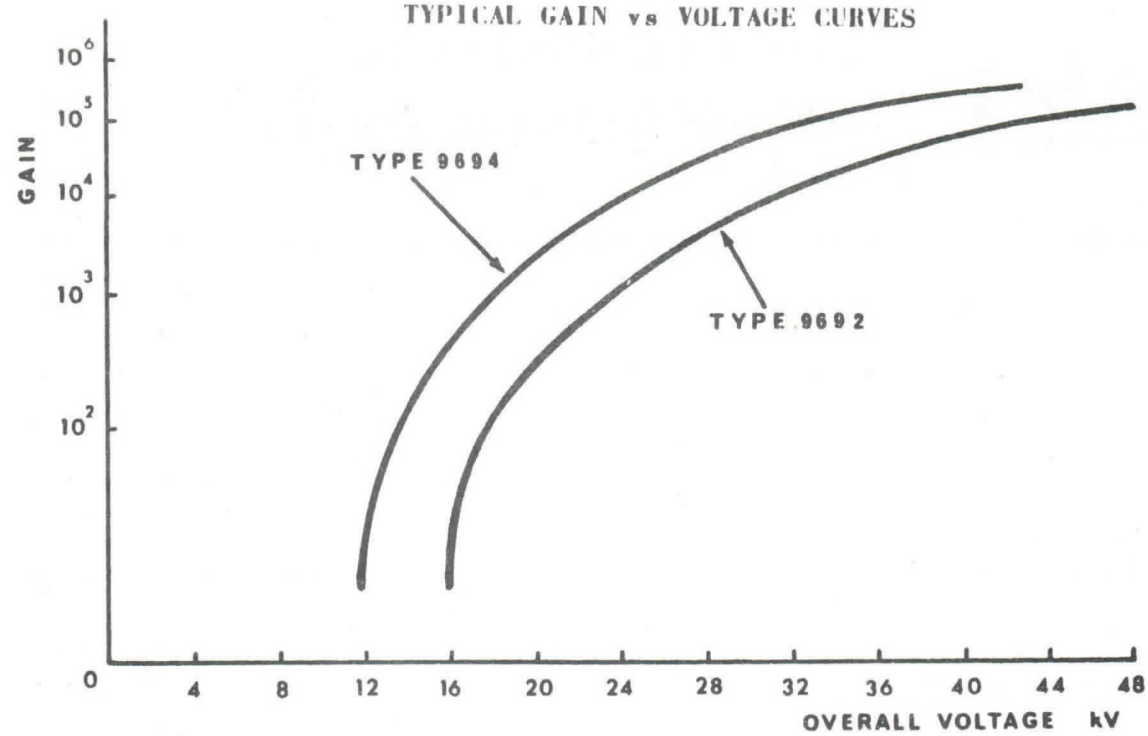
SPECIFICATIONS

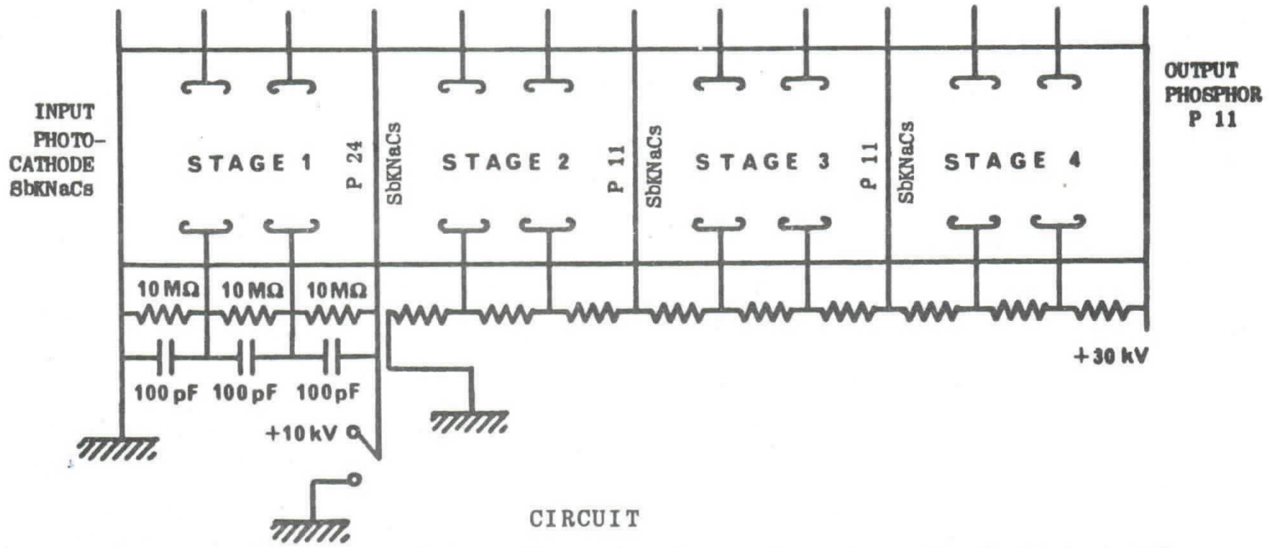
Overall length	304.80mm (12 in)
Overall diameter	95.25mm (3.75 in)
Focus coil	13 sections each 25.4mm (1 in) long and 152.4mm (6 in) internal diameter separated by 3.18mm (0.125 in) spacers. Each section consists of 1,200 turns of 22 SWG enamelled copper wire. Field required for single loop focusing 130 to 160 gauss.
End window material	Kodial
Input photocathode	Tri-alkali, 50.8mm (2 in) minimum useful diameter, sensitivity 100μA/lm.
Output phosphor	ZnSAg, useful diameter 50.8mm (2 in) minimum.

	TYPE	9692	9694	
Typical light gain at 4,500Å 35 kV overall		2×10^4	~~2×10^5~~	5×10^5
Minimum light gain at 42 kV overall		2×10^5	~~8×10^5~~	10^6
Maximum overall voltage	kV	45	45	
Maximum permissible mean output current	A	10^{-6}	10^{-6}	
Electron dark current from photocathode at 42 kV overall	A/cm^2	10^{-16}	~~10^{-16}~~	500 Scints/cm²/sec
Ion dark current at 42 kV overall	A/cm^2	10^{-17}	~~10^{-16}~~	1 Scint/cm²/sec
Resolution	line pairs per mm	15 to 18	~~15 to 18~~	16-20 Lp/mm

Water cooled aluminium foil coils are now in the final stages of development which give up to 500 gauss enabling 3 loop focusing which has been found to improve tube geometry and resolution.

TYPICAL GAIN vs VOLTAGE CURVES





CIRCUIT

Switching carried out by applying voltages as shown. Prior to event stages 1, 3 and 4 are on but stage 2 is off. When event arrives stage 1 is switched off and stage 2 on using hard valve circuitry by applying a negative pulse of 10kV to the first phosphor. The decay time of the phosphor is 1 μsec. and providing the switching pulse is much shorter, say 100 n. secs., the event will be further intensified by the last three stages sufficiently to enable photography of single electrons leaving the input photocathode. This is achieved by leaving the shutter of the camera open during the non-operative time.

1510/2c
DS. 388/2

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

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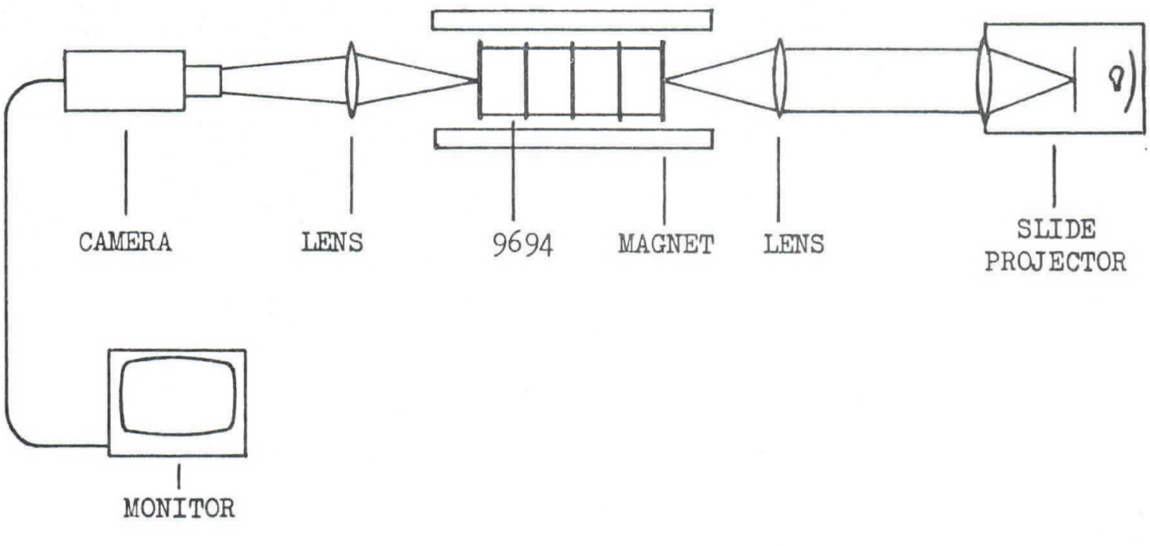
Ref. 10772 CP

DEMONSTRATION OF EMI IMAGE INTENSIFIER TYPE 9694

This demonstration uses the EMI 4 stage image intensifier type 9694 coupled to an EMI type 9 closed circuit television system. A standard 35 mm slide projector run at low voltage is used to project a series of slides on to the input photocathode of the image intensifier at a peak white intensity of about 10^{-4} foot candles. This input image is amplified by the tube gain of 10^5 to give an output phosphor brightness of 10 foot candles which is viewed by the vidicon camera.

The type 9694 image intensifier can be run in a permanent focusing magnet as in this demonstration but when it is required to vary the intensifier gain over a wide range a focusing solenoid is employed. The intensifier maximum gain is in excess of 10^6 and the input photocathode and output phosphor are 2 inches in diameter. The centre resolution is in excess of 20 line pairs per millimeter.



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R/S006

EMI

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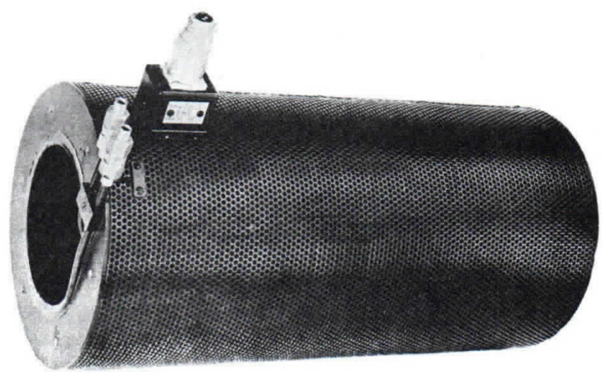
EMI IMAGE INTENSIFIER TUBE TYPE 9694

ALUMINIUM FOIL WATER COOLED FOCUSING COIL



Coil dimensions

Length of coil plus end plates	:	47 cm (18.5 in) max.
Overall length including water coupling unions	:	48.25 cm (19 in) max.
Inside diameter	:	12.7 cm (5 in) min.
Outside diameter	:	22.8 cm (9 in)
Water coupling unions extend beyond outer diameter by approximately	:	5.1 cm (2 in)
Electric supply connector extends beyond outer diameter by approximately	:	8.9 cm (3.5 in)

General information

Coil weight	:	60 lb (27 kg)
Maximum permissible outside temperature	:	150°C
Maximum permissible inside temperature	:	30°C
Rate of flow of water required when operating with three loop focusing	:	45 to 50 litres/hour
With tube operating with 45 kV overall field requirement for three loop focusing	:	480 gauss
Voltage requirement for 480 gauss	:	85 V
Current requirement for 480 gauss	:	9.6 A
Current stability should be better than	:	0.5%
Field uniformity over tube length	:	± 2% of mean

Supply connector pins numbers 1 and 2 must be connected to earth, pins 3 and 4 live

S863/1a
DS.696/1

EMI IMAGE INTENSIFIER TUBE TYPE 9694 (continued)

ALUMINIUM FOIL WATER COOLED FOCUSING COIL

To facilitate the mounting of a tube clamping device or lens holder the end plates of the coils have 6 tapped ¼ inch B.S.F. holes spaced equally on a 7$\frac{5}{16}$ inch P.C.D. It is important to note however that the ¼ inch B.S.F. bolts should NOT be screwed into the end plate by more than ¼ inch or damage to the coil windings will occur.

It is recommended that for best results the EMI 4-stage cascade image intensifier tube type 9694 is operated with three loop focusing, this requiring a field of 480 gauss (9.6 A, 85 V) when tubes are operated at 45 kV overall. It is suggested that the coil power supply should be capable of giving 0 to 10 A at 0 to 100 V, the current being stabilised with regulation and ripple better than 0.5%.

Under all conditions of operation the inner surface of the coil should be cooled by passing cold water through the cooling spiral provided at the rate of about 50 litres/hour. The water inlet temperature should not exceed 20°C.

If a certain degree of geometric 'S' distortion can be tolerated single or two loop focusing can be used requiring ⅓ and ⅔ of the field respectively. Under these conditions the water cooling requirement can be reduced if necessary, provided the temperature limitations are not exceeded.

S863/2a
DS.696/2

EMI Electronics Ltd Valve Division

Hayes Middlesex England *(Controlled by Electric & Musical Industries Limited)*

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Ref No. 10772B CP

Electron Tube Division

NEW PRODUCT DATA

EMI IMAGE INTENSIFIER TYPE 9723

(Provisional Specification)

The 9723 is a 2-stage, magnetically focused image intensifier. It yields high resolution and very good geometry and will find application where these factors are important, but where lower gain can be tolerated. Cathode and dark current conditions are the same as for 9694 tubes. This specification applies to tubes with P 11 phosphors throughout and is applicable to S 20 and Bi-alkali cathodes.

Specification – Changes or additions on those existing in catalogue S851

		Min.	Typical	Max.
Cathodes – as 9694				
Overall voltage for 10^3 gain at 4500 Å kV		–	20	25
Overall voltage for 5.10^3 gain at 4500 Å kV		–	30	35
Centre Resolution (tube voltage 30 kV)	line pairs/mm	50	55	–
Resolution on edge of 30 mm centre circle (tube voltage 30 kV)				
2 loops focus				
Tangential	line pairs/mm	45	50	–
Sagittal	line pairs/mm	35	40	–
4 loops focus				
Tangential	line pairs/mm	45	55	–
Sagittal	line pairs/mm	40	50	–

Demagnification 2 loops — As 9694 at 3 loops
'S' Distortion 2 loops — As 9694 at 3 loops

Demagnification 4 loops — Over 40 mm centre zone – better than 2%
'S' Distortion 4 loops — Over 40 mm centre zone – better than 1%

Signal induced background — For random 50% illumination of photocathode area signal induced background level in sample black area is less than 2% of mean signal level.

Maximum permissible operating voltage for this tube is 40 kV

At 30 kV 2 loops focus is obtained with 4 A through standard 9694 coil.
4 loops focus is obtained with 8 A through standard 9694 coil.

PRODUCT RANGE OF
EMI ELECTRON TUBE AND MICROELECTRONICS DIVISION

The **EMI ELECTRON TUBE DIVISION**
manufactures a wide range of special electron tubes for equipment used in broadcasting, radar, nuclear and scientific applications.

★ PHOTOMULTIPLIER TUBES Ext. 2074

Photomultiplier tubes, which convert very low levels of illumination into usable electric currents are used extensively in astronomy, spectrophotometry, scintillation counting, spectrometry and broadcast television.

★ CAMERA TUBES Ext. 2078

There is a wide range of vidicons, including all-electrostatic, available in various grades from general surveillance to broadcast studio.

★ IMAGE INTENSIFIERS Ext. 2075

The image intensifier tube, capable of multiplying light up to a million times, is important for such applications as microscopy and astronomy.

★ CATHODE RAY TUBES Ext. 2073

EMI activities in pioneering television have generated a range of specialised cathode ray tubes for radar and telecine work.

★ SPECIAL PRODUCTS Ext. 2551

New products include the Printicon, a small, low voltage, all-electrostatic monoscope, which is used for generating alpha-numeric symbols, spectroscopic lamps for atomic absorption and spectrometry and a range of printed circuit deflection coils, such as used in the successful EMI Colour TV Camera.

The EMI Electron Tube Division has great experience and comprehensive facilities in research, development and manufacture of light sensing and light emitting devices, and allied equipment.

★ PRECISION MICROMESH Ext. 2073

The very fine metallic mesh currently employed in EMI vacuum tubes is also used in various other branches of industry and science, such as microscopy, mass spectrometry, biology, filtering and optics.

NOTE:
For further information please telephone the extension shown opposite each product and service.

The **EMI MICROELECTRONICS DIVISION**
provides for the increasing demands made upon the ability of electrical and electronic equipment designers to meet high density packaging, reliability, weight, and cost requirements. This can only be achieved by taking full advantage of modern fabrication and design methods. The EMI Microelectronics Division offers these facilities to its customers in the following product areas:–

★ Thin and Thick Film Passive Networks

Thin and Thick Film Hybrid Integrated Circuits

Temperature Sensing Elements

Flexible Printed Wiring

Double-sided and Through-plated Printed Circuit Boards

Multilayer Printed Circuit Boards Ext. 2463

Production facilities have been built up over several years to meet the need for economic batch, and large volume, manufacture. The production unit is supported by a comprehensive Circuit Design and Draughting Group, and a Quality Control Division.

A continuous R. & D. programme ensures that full advantage is taken of the latest technological developments in manufacturing processes. Microcircuit design is aided by the use of a computer programmed to predict thermal contours.

Continuous on-line monitoring of all processes is maintained during all stages of production and testing.

The environmental test facilities available within EMI Electronics together with the calibration and standardisation procedures, have been approved by the Ministry of Technology and the Air Registration Board.

★ CUSTOMER ENGINEERING SERVICE Ext. 2463

A team of engineers fully experienced in both circuit and systems design is available to assist customers in applying microelectronic techniques to the solution of particular problems. This facility covers all aspects of system design, the rationalization of integrated circuits, thermal management and packaging.

FLEXIBILITY

The EMI Microelectronics Division is an integrated unit, with design and manufacturing facilities not allied to any particular aspect of microelectronics technology. The resulting flexibility enables the achievement of the optimum design package to meet customers' needs.

G911b

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EMI

Electron Tube Division

9753

PROVISIONAL SPECIFICATION

EMI IMAGE INTENSIFIER TUBE TYPE 9753

The 9753 is a 2-stage electrostatically focused image intensifier which employs a novel electron optical design. This enables an electrostatic cascaded tube to be made without using fibre optics. The principle advantages arising from this design are good resolution and geometry, and uniform gain over the operating area. Flat zinc crown windows are provided as standard for the input/output, but sapphire windows can be provided at the input giving a flat field and UV sensitivity. Fibre optic plates can be provided for the input or output where necessary and the tube can be supplied with the same range of cathodes and phosphors as are available in the 9694 series of tubes (see EMI catalogue, reference S851).

The 9753 tube can be gated and the high field gradient following the photocathode, that is a characteristic of the tube, ensures rapid space charge clearance when high illumination levels are used.

The EHT supply to the tube can be provided from a compact, battery driven EHT generator and the encapsulated tube can be contained in a special casing providing mounting facilities at the input and output, and sockets for attachment to standard pan and tilt heads.

SPECIFICATIONS

(for tube with zinc crown input and output windows)

Mechanical

Overall length	265 mm
Maximum diameter	98 mm
Weight (tube only)	0.75 kg

General

Minimum useful photocathode diameter	32 mm
Minimum useful phosphor diameter	19 mm
Refractive index of input and output windows	1.50759
Focusing method	Electrostatic (tetrode)
Maximum permissible overall voltage	25 kV
Maximum permissible mean output current	10^{-6} A
Maximum permissible brightness of output phosphor	10 cd/m^2 continuous 1000 cd/m^2 instantaneous
Maximum operating temperature	30° C if dark current to remain low 50° C if dark current not important
Minimum operating temperature	-20° C

S871/1bZ70
DS.952/1

Imaging Specification

	1st Class	2nd Class
Input photocathode sensitivity (see Note 1)	130 μA/lm	70 μA/lm min.
Effective input photocathode quantum efficiency at 4,200 Å	9%	7%
Input photocathode variation about mean	± 15%	± 20%
Photon gain (see Note 2)	500	250
Brightness gain (see Note 3)	3000	1000
Brightness gain uniformity	± 20%	± 30%
Magnification	0.64	0.64
Dark current (equivalent light input)	0.2 μlx	1 μlx
Centre resolution (see Note 4)	30 lp/mm	25 lp/mm
Edge resolution (see Note 5)	18 lp/mm	15 lp/mm
Distortion (see Note 6)	4.5%	5%
Alignment (see Note 7)	1 mm	2 mm
Blemishes :– Maximum number of spots of up to 0.25 mm diameter	2	5
Maximum number of spots of diameter 0.25 to 1 mm	1	2

Notes

1. Applies to tubes with S20 photocathode only.
2. Measured at peak response of the photocathode; applies to tubes with P11 output phosphors only.
3. Applies only to tubes with P20 output phosphor and S20 photocathode.
4. This parameter can be dependent on meshes used in the electrode structure. Ultra fine meshes can yield tubes having a centre resolution of 35 lp/mm to /40 lp/mm, but the gain is decreased by approximately 20%.
5. Measured at 80% of diameter of output.
6. Measured at 80% of diameter of output.

   Tube exhibits characteristic pin cushion distortion (D)

   $$D = 100 \frac{Md - Mc}{Mc} \%$$ where Md = magnification at 80% of diameter
   Mc = magnification at centre
7. Measurement indicates displacement from centre of output phosphor, of image of light spot projected on to centre of input photocathode.

For further information on this product please telephone Extension 2075

S871/2bZ70
DS.952/2

EMI

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ADVANCE INFORMATION

EMI SCAN CONVERTER TUBE TYPE 9759

The EMI Scan Converter Tube Type 9759 is a two gun storage tube suitable for the conversion of a radar PPI scan to a television scan.

Mechanical Data (see outline drawing overleaf)

Overall length	608 mm nominal
Max. diameter	90 mm nominal
Weight	455 g

Electrical Data (all voltages w.r.t. earth unless stated)

Write Gun

Focus		electrostatic
Deflection		magnetic
Heater voltage		6.3 V
Heater current		0.6 A
Cathode voltage		-8.0 kV
Modulator voltage		-40V to -90 V w.r.t. cathode
Anode voltage		0
Focus voltage		-5.5 kV to -6.0 kV

Read Gun

Focus		electrostatic
Deflection		magnetic
Heater voltage		6.3 V
Heater current		0.6 A
Cathode voltage		-1.5 kV
Modulator voltage		-100 V max w.r.t. cathode
Anode voltage		0 to -50 V
Erase voltage:	reading cycle	at anode voltage
	erase cycle	-1.5 kV to -1.9 kV
Focus voltage		-1.1 kV to -1.4 kV
Collector voltage		0 to 50 V
Corrector voltage		0 to 30 V w.r.t. collector
Target voltage:	reading cycle	0
	erasing cycle	-200 V

Electrical Performance (Typical)

Resolution	180 concentric circles at 50% modulation
Storage time	adjustable up to about 1 minute with continuous readout
Erase time	5 secs maximum by switching various electrode potentials.

S886/1cX70
DS.1050/1

Method of Operation (in radar PPI to TV scan conversion)

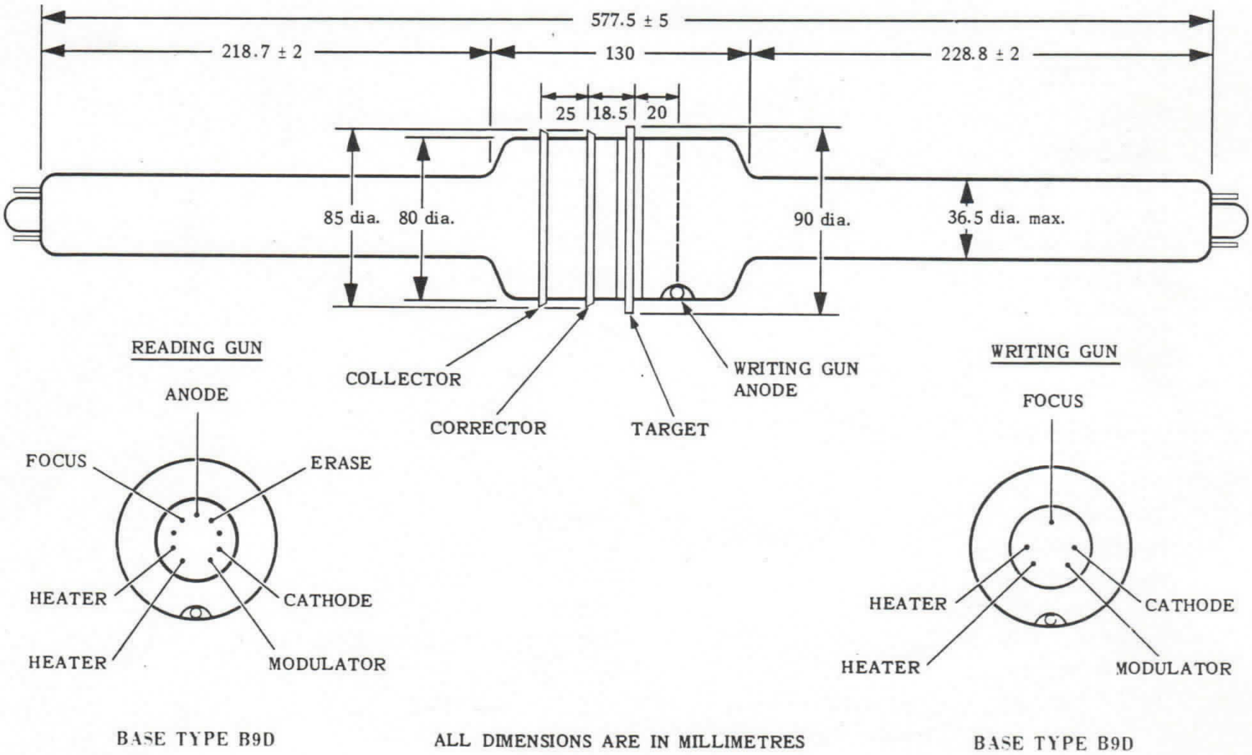
In operation the writing gun is intensity modulated by the radar signal, thus producing a charge pattern corresponding to that signal on the storage target. In the absence of reading, the charge pattern is capable of being stored for a considerable time, but in scan conversion it is usually read out continuously. The target is scanned in a television raster by the reading gun and a signal corresponding to the charge pattern is taken from the collector. The corrector potential is adjusted to give a uniform output from all parts of the target.

During reading the charge pattern is steadily discharged; the time taken to discharge a full signal down to noise level can be adjusted within the range of a few seconds to a minute by setting various electrode potentials. Thus a single reflection from, say, an aircraft may be seen, with gradually diminishing intensity, for up to 1 minute. However, if desired the signal may be erased in a few seconds by changing electrode potentials.

Advantages of Scan Conversion

The advantages of scan conversion to a TV picture are numerous. Displays are bright and flicker free and the rate of decay can be adjusted so that aircraft trails are of a convenient length. Scan conversion enables targets to be labelled with height, course etc., using character generators such as the EMI Printicon. This is done by mixing labelling data into the TV video system; the labels can thus be made to follow the targets without smear.

EMI SCAN CONVERTER TUBE TYPE 9759



For further information on this product please telephone Extension 2076.

S886/2cX70
DS.1050/2

EMI Electronics Ltd Electron Tube Division

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Electron Tube and Microelectronics Division

NEW PRODUCT DATA

EMI IMAGE INTENSIFIER TYPE 9794

(Provisional Specification)

The type 9794 is a 3-stage cascade, magnetically focused image intensifier. It has been developed from the well established 4-stage tubes from which it inherits stability, very low dark current and versatility. The 9794 exhibits a low level of image distortion and high limiting resolution.

The 9794 is available with S20 or Bi-alkali photocathodes and incorporates P11 phosphors as standard although alternative phosphors can be considered. Fibre optic plates on input or output or sapphire at the input giving UV response down to 150 nm can be provided.

SPECIFICATION

General

Overall length (tube only)	230 mm ± 2 mm (9 in)
Overall length encapsulated	317 mm ± 2 mm (12.5 in)
Maximum diameter (tube only)	100 mm (4 in)
Diameter encapsulated	120 mm ± 0.5 mm (4.75 in)
Minimum useful photocathode diameter	48 mm (1.9 in)
Minimum useful phosphor diameter	48 mm (1.9 in)
End window material	Zinc Crown Glass
End window refractive index	1.50759
End window thickness	4 mm ± 0.1 mm
Photocathodes	S20 (SbKNaCs) or Bi-alkali (SbKNa)
Phosphors	P11
Weight (tube only)	0.7 kg (1.5 lb) approx.
Weight tube encapsulated	5.5 kg (12 lb) approx.
Focusing method	Magnetic
Maximum permissible overall voltage	40 kV or as specified
Maximum permissible mean output current	10^{-6} A
Maximum permissible brightness of output phosphor	10 cd/m^2 continuous 1000 cd/m^2 instantaneous
Maximum operating temperature	35°C
Minimum operating temperature	-20°C

S858/1a S71
DS.1078/1

ELECTRICAL SPECIFICATION		Tubes incorporating S20 (SbKNaCs) photocathodes			Tubes incorporating Bi-alkali (SbKNa) photocathodes		
		Max.	Typ.	Min.	Max.	Typ.	Min.
Input photocathode sensitivity	μA/1m	–	110	90	–	40	30
Input photocathode quantum efficiency at 4,200 Å	%	–	18	12	–	18	12
Input photocathode variation about mean	%	±15	±7	–	±15	±7	–
Overall voltage for 10^5 gain at 4,500 Å	kV	36	30	–	40	35	–
Electron dark current	counts/cm^2/s	1000	200	–	50	10	–
Ion dark current	counts/cm^2/s	10	1	–	10	0.25	–
Dark current - equivalent light input	lux	10^{-8}	$2x10^{-9}$	–	$5x10^{-10}$	10^{-10}	–
Centre resolution	line pairs/mm	–	50	45	–	50	45

Blemishes and Shading

Maximum permissible variation in shading over tube diameter ... ... ± 20%
Maximum permissible spot diameter ... ... 1 mm
Maximum number of spots of diameter 0.25 mm to 0.5 mm permitted in 20 mm diameter centre zone 2
Maximum number of spots of diameter 0.25 mm to 1 mm permitted in 20 mm to 40 mm diameter zone 5
Maximum permissible diameter of pin holes in phosphor (0.005 in) ... ... 0.13 mm

Demagnification

Maximum demagnification over centre 20 mm diameter zone 2%
Maximum demagnification over 20 mm to 40 mm diameter zone 5%

Distortion

Maximum distortion over centre 20 mm diameter zone 1%
Maximum distortion over 20 mm to 40 mm diameter zone 2%

Signal induced background

For random 50% illumination of photocathode area, signal induced background level in sample black area is about 4% to 5% of mean signal level.

Associated Equipment

A versatile rack mounted unit is now available incorporating the coil current stabilised power supply, tube EHT supply and divider chain. Coarse and fine controls are provided for continuous independent control of current and voltage. These controls are coupled to a switch which can select, if required, three pre-set positions for current and voltage thereby giving three pre-set tube sensitivities. Remote control facilities can also be provided as standard.

An air cooled compact solenoid/tube system is in an advanced state of development. Power consumption will not exceed 250 watts and dimensions will be approximately 152 mm (6 in) x 152 mm (6 in) x 330 mm (13 in). Approximate weight 13.6 kg (30 lb).

S858/2a S71
DS. 1078/2

For further information on this product please telephone Extension 2075

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