TUBE TYPE NOMENCLATURE

The type nomenclature for Mullard Cathode Ray Tubes consists of two or three letters followed by two sets of figures. These symbols provide information concerning the method of focusing and deflecting the electron beam, the type of luminescent screen and the diameter of the screen.

The first letter indicates the method of deflection and focusing:

A — Electrostatic focusing, magnetic deflection.
D — Electrostatic focusing and deflection.
M — Magnetic focusing and deflection.

The second letter indicates the properties of the luminescent screen:

B — Short persistence. Bluish fluorescence.
C — Very short persistence. Blue-violet fluorescence.
F — Very long persistence. Orange fluorescence.
G — Medium persistence. Green fluorescence.
H — Medium persistence. Blue-green fluorescence.
L — Long persistence. Orange fluorescence.
M — Double layer screen. Medium persistence. Blue-green fluorescence.
P — Double layer screen. Bluish fluorescence of short persistence followed by greenish-yellow phosphorescence of long persistence.
W — Medium persistence. White fluorescence.

The third letter:

M — Indicates multiple trace.

The first group of figures, immediately following the letters, indicates the diameter or diagonal of the luminescent screen in cm:

Thus 7 represents a 7cm (3 in.) Screen.
13 represents a 13cm (5 in.) Screen.
43 represents a 43cm (17 in.) Screen.
53 represents a 53cm (21 in.) Screen.

The second group of figures is a serial number indicating a particular design or development.

Examples:

DG7-32. Cathode ray tube of 7cm screen diameter having a medium persistence green fluorescence, and employing electrostatic deflection and focusing.

AW53-88 Cathode ray tube of 53cm screen diagonal having a medium persistence white fluorescence, and employing magnetic deflection and electrostatic focusing.

The following recommendations should be interpreted in conjunction with British Standard Code of Practice No. CP1005: Parts 1 and 2: 1954, " The Use of Electronic Valves ", upon which these notes have, in part, been based.

LIMITING VALUES

The operating limits quoted on data sheets for individual tubes should on no account be exceeded. Two methods of specifying limiting values are used, the ' absolute ' and ' design centre ' systems, and these should be interpreted as follows:—

Absolute Ratings

The equipment designer must ensure that these ratings are never exceeded and in arriving at the actual tube operating conditions such variations as mains fluctuations, component tolerances and switching surges must be taken into account.

Design Centre Ratings

With a set of nominal valves inserted in an equipment connected to the highest permitted nominal supply voltage within a given tapping range, and in which all components have their nominal value, the tube ratings may at no time exceed the published maximum design centre value.

The phrase 'at no time' in the above paragraph means that increases in the tube working conditions, due to operating changes in equipment (e.g. a.g.c., switching, etc.) should be taken into account by the equipment designer. Normally encountered mains voltage variations (of up to ±10%) are allowed for in the tube ratings, provided normal good practice is followed in the design of the receiver. In television receiver design, the above definition of design centre ratings applies when the timebases are synchronised. When the timebases are not synchronised it is permissible for the final anode voltage of the cathode ray tube to rise by not more than 10%.

HEATER

Parallel Operation

The heater voltage must be within ±7% of the rated value when the supply voltage is at its nominal rated value, and when a tube having the published heater characteristics is employed.

This figure is permissible only if the voltage variation is dependent upon more than one factor. In these circumstances the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effect of the tolerances of the separate factors, providing no one of these deviations exceeds ±5%. Should the voltage variation depend on one factor only, the voltage variation must not exceed ±5%.

Series Operation

The heater current must be within ±5% of the rated value when the supply voltage is at its nominal rated value, and a tube having the published heater characteristics is employed.

This figure is permissible only if the current variation is dependent upon more than one factor. In these circumstances, the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effects of the tolerances of the separate factors, providing no one of these deviations exceeds ±3.5%. Should the total current variation depend upon one factor only, the current variation must not exceed ±3.5%.

When calculating the tolerances of associated components, the ratio of the change of heater voltage to the change of heater current in a typical series chain including a cathode ray tube is taken as 1.8, both deviations being expressed as percentages.

With certain combinations of valves and tube, differences in the thermal inertia may result in particular heaters being run at exceedingly high temperature during the warming-up period. During this period, unless otherwise stated in the published data, it is permissible for the heater voltage of the tube to rise to a maximum value of 50% in excess of the nominal rated value when using a tube with the published heater characteristics. A surge limiting device may be necessary in order to meet this requirement. When measuring the surge value of heater voltage, it is important to employ a peak reading device, such as an oscilloscope.

In addition to the tolerances quoted above, fluctuations in the mains supply voltage not exceeding ±10% are permissible. These conditions are, however, the worst which are acceptable and it is better practice to maintain the heater as close to its published ratings as is possible, particularly in television equipment where changes in valve characteristics can have an appreciable effect upon the picture. Furthermore, in all types of equipment closer adjustment of heater voltage or current will react favourably upon valve and tube life and performance.

CATHODE

The potential difference between cathode and heater should be as low as possible and in any case must not exceed the limiting value given on the data sheets for individual tubes. Operation with the heater positive with respect to cathode is not recommended. In order to avoid excessive hum the a.c. component of the heater-to-cathode voltage should be as low as possible, e.g. less than $20V_{r.m.s.}$

When the heater is in a series chain or earthed, the 50c/s impedance between heater and cathode should not exceed 100kΩ. If the heater is supplied from a separate transformer winding the resistance between heater and cathode must not exceed 1MΩ.

INTERMEDIATE ELECTRODES (between cathode and final anode)

In no circumstances should the tube be operated without a d.c. connection between each electrode and the cathode. The total effective impedance between any electrode and the cathode should be as low as possible and must never be allowed to exceed the published maximum value.

Grid (Modulator electrode)

Television and Radar Tubes

The value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1V.

The maximum positive grid excursion of the video signal under normal operating conditions is permitted to reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

Instrument Tubes

The tube should normally be operated so that the instantaneous grid voltage is not more positive than –1V.

Grid cut-off voltages

Curves showing the limits of grid cut-off voltage for specific values of first anode voltage are included in the data for individual tubes. The brightness control should be arranged so that it can handle any tube within the limits shown, at the appropriate first anode voltage (which is measured with respect to cathode).

LUMINESCENT SCREEN

To prevent permanent damage to the screen material, tubes should not be operated with a stationary or slowly moving spot, except at low beam current density. It is desirable that the scanning voltages are applied before cathode current is drawn from the tube.

Some television tubes have the face plate made of grey tinted glass in order to improve the contrast. The proportion of light transmitted through these screens is given on the data sheets for individual tubes. For a clear glass screen, approximately 90% of the light is transmitted.

Stray light falling upon the screen will result in loss of contrast. If it is difficult to shade the screen, the use of a suitable filter will improve the contrast.

Some types of screen material fluoresce under ultra-violet excitation, and where necessary, should be protected by an appropriate filter.

EXTERNAL CONDUCTIVE COATING

With those tubes having an external conductive coating, the capacitance of this to the final anode may be used to provide smoothing for the e.h.t. supply, and in all cases it must be earthed.

This coating is not a perfect conductor and in order to reduce radiation from the line timebase it may be necessary to make two separate connections to the coating on opposite sides of the bulb.

METAL CONE

Some tubes have a metal cone and where this cone and the glass face are operated at a high voltage any material in contact with the cone or the face must have insulating properties adequate for this voltage.

The metal cone must not come in contact with a magnet which would result in it becoming permanently magnetised. This would cause picture distortion.

HANDLING

The precautions taken in manufacture reduce the possibility of spontaneous implosion to a minimum but any additional stress due to mishandling considerably increases the risk of implosion; such an implosion may occur immediately or may be delayed. Particular care should be taken not to scratch any part of the bulb, particularly the face, as this will appreciably reduce the strength of the glass and may lead to implosion, often after a delay.

Care should be taken to prevent bumping or striking the rim around the face of a tube having a metal cone as rough treatment may damage the glass-to-metal seal.

When a tube is not in its equipment or original packing it should be placed screen downwards on a soft pad of suitable material free from abrasive substances. Tubes with relatively small necks and large bulbs (9 in. diameter and larger) should be handled by the bulb end. When it is necessary to handle the tube by the neck great care should be taken to avoid sideways leverage and the bulb should be supported when possible.

Attention is called to the fact that a high voltage charge may be carried by the internal conductive coating which is connected to the final anode connector and also by the external coating if not earthed, even after a tube has been removed from equipment. Anyone handling such a tube may receive a shock, which, while generally not dangerous to the person, might cause an involuntary reaction resulting in damage to the tube, which might, for example, be dropped.

PROTECTIVE SCREEN

The viewing screen of a cathode ray tube should be protected by means of a screen of transparent material of suitable strength to withstand implosion of the tube.

MOUNTING

Unless otherwise specified on the data sheets for individual tubes there are no restrictions on the position of mounting. Circular-faced all-glass television tubes should be mounted so that the position of the final anode connector is uppermost and adjustable within 15° of the vertical. This ensures that any major glass blemishes near the edge of the screen are behind the mask.

In mounting the tube the main support should be at the end nearer the screen and so arranged that no stresses are produced in the glass.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. Tubes having all-glass bases must not be soldered directly into the wiring and the use of a wiring jig is recommended when soldering connections to the holder.

It is very desirable that tubes should not be exposed to strong electrostatic and magnetic fields. In the case of electrostatic instrument tubes operating at low anode voltages a close fitting magnetic shield is generally necessary.

DIMENSIONS

Allowance should be made in the design of the equipment for the dimensional tolerances of the tube envelope and *reliance should not be placed upon dimensions taken from individual tubes.*

REFERENCE LINE

The reference line indicated on the tube outline drawing is determined by means of a suitable gauge. Drawings of several gauges follow these general operational recommendations.

X-RADIATION

No maximum permissible dosage rate has yet been accepted as a British Standard, but from work in progress at the time of printing it seems likely that a figure of 20mr per 8-hour period when measured on the outside surface of the equipment housing will be established.

CORNER CUTTING

Corner cutting, in general, is due to a direct obstruction of the electron beam after deflection before it reaches the screen and results in a blacking-out of the picture at the edges of the raster. It may be avoided by ensuring that:—

(1) the dimensions of the picture do not exceed the published

maximum *useful* screen dimensions and (2) the deflector coil system is such that the distance of its effective centre of deflection from the reference line does not exceed the maximum value given in the outline drawing.

The centre of deflection is positioned such that electrons deflected from this point in straight lines would reach the screen without being intercepted by the neck of the tube.

The maximum deflection angle is the angle subtended at the centre of deflection by the published maximum *useful* screen diameter, or diagonal in the case of rectangular tubes. (This should not be confused with the horizontal deflection angle.)

FOCUSING OF MAGNETIC TUBES

The magnetic field of the focus unit should be axially symmetrical.

The mounting should be such that upon insertion of the tube, the focus field is coaxial with the neck, and the magnetic centre is in the recommended position as indicated in the individual tube data.

In general, if the focus unit is moved toward the screen the required focusing power decreases, the resolution at the centre of the screen improves, and that at the edge deteriorates. However, with ion-trap tubes it is strongly recommended that the focus unit should be positioned as indicated, since this ensures a minimum of interaction between the magnetic field of the focus unit and the fields of the deflector coils and ion-trap magnet.

RASTER CENTERING OF MAGNETIC TUBES

To centre the raster on the screen it is recommended that either a magnetic field just behind the deflector coils be used or a direct current be passed through the deflector coils. The magnetic field should (1) lie as much as possible in a plane perpendicular to the axis of the tube; (2) be adjustable around it; (3) be variable in strength; (4) be self-magnetised and not depend on stray fields from other components; (5) extend over as short a length of the neck as possible; (6) be as uniform as possible over the cross-section of the neck. It is desirable that the zero shift position be indicated. It is not recommended that the focus field be used to centre the raster.

Unless otherwise specified the centering device should provide a shift of $\pm 3\%$ of the overall length of the tube to allow for non-centrality of the spot with respect to the geometric centre of the screen. In addition the centering device should provide the shift needed to allow for non-centrality of the visible raster (i.e. to compensate for line blanking and also timebase non-linearity, if any).

ION TRAPS

With those tubes which incorporate an ion trap, it is necessary to provide externally a magnetic field to deflect the electron beam through the final aperture of the gun towards the luminescent screen. This magnetic field is normally provided by a permanent magnet fitted with shaped pole pieces, and an adjustable clamp arranged so that the whole assembly may be moved along and around the neck of the tube. The limits of field strength for ion-trap magnet assemblies given in individual data sheets should be carefully observed. In particular, low field strength should be avoided and the assembly must not encroach further up the tube neck than the centre of the grid plane.

At e.h.t. voltages in excess of 10kV the ion-trap assembly should be earthed.

Notes on Adjustment of Ion-Trap Magnet

An arrow is marked on the magnet assembly so that when looking along the arrow the north pole is on the right hand side. An electron beam travelling between the pole pieces, in the direction of the arrow, will be deflected away from the actual magnet, which is located on the same side of the assembly as the arrow. Conversely, when the beam travels through the pole pieces in the direction opposite to that of the arrow it will be attracted towards the magnet. Hence there are two possible ways of using an ion-trap magnet to make the beam negotiate the bend in the gun; with the arrow pointing towards the screen or towards the base. The following procedure which has been found to give the better spot size should be adopted for adjusting the position of the magnet.

(1) (a) With the voltage supplies to the tube switched off and the base socket removed; slip the magnet assembly over the tube base with the arrow pointing *away* from the screen, and diametrically *opposite* the line marked on the neck of the tube. This line will normally be approximately in line with the position reserved for Pin No. 3 on the base. Adjust the assembly so that it is slightly in advance of the tube base.

(b) Fit the socket to the tube. Switch on the voltage supplies and adjust the brightness control. If necessary, adjust the position of the ion-trap magnet until a raster is obtained. Ensure that the picture centering controls are set at zero shift.

(c) Move the magnet assembly along the neck of the tube towards the screen until the raster brightness begins to decrease. Then move the magnet back towards the base until the brightness once more begins to decrease. Return the magnet to the position of maximum brightness lying between these two extremes. The magnet should now be rotated slightly to find the midpoint of the range of rotation which gives maximum brightness.

(d) Lock the magnet in position, taking care not to alter its position.

(2) With the procedure given above more accurate centering of the beam in the final aperture can be produced if the beam diameter is increased by underfocusing.

Where there is penetration of the field of the focus unit into the ion-trap region, an adjustment of the focus control will move the electron beam in the final aperture. This movement may be sufficiently large to 'black out' the picture. Accurate centering with an underfocused beam reduces this possibility.

(3) The movement produced by the focusing field, and hence 'blacking out', may also be reduced by the following additional procedure:—

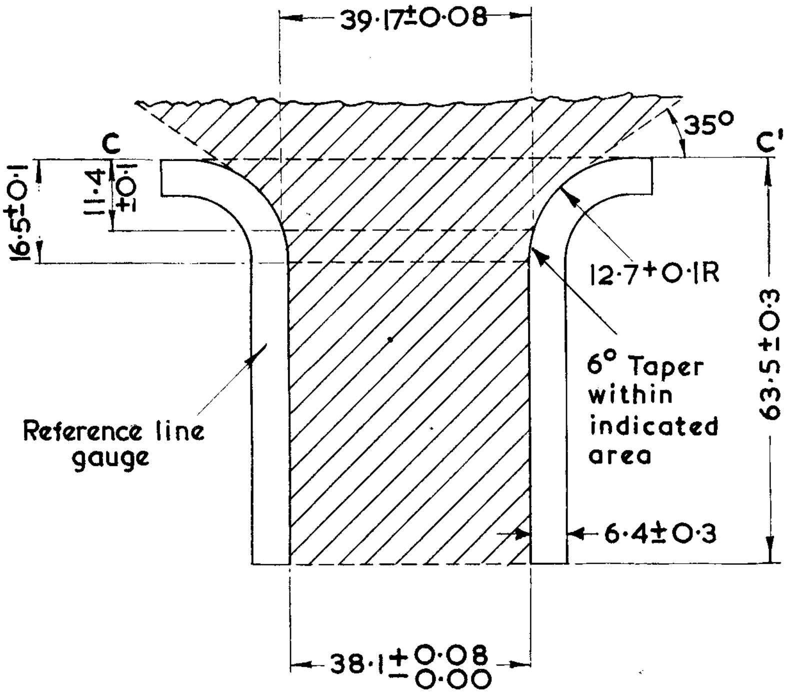
Note the angle between the centre line of the ion-trap assembly set by the procedure in (1), and the plane which passes through the bend in the gun of the cathode ray tube. If this angle is more than $\pm 10^{\circ}$, rotate the magnet in a direction to reduce the angle and compensate any reduction in brightness by adjusting the angle between the focus unit and the tube neck. By successive adjustments, it will be possible to place the ion-trap magnet in line with the plane containing the bend of the gun.

ELECTROSTATIC INSTRUMENT TUBES

The e.h.t. line should be earthed, if possible, in order to avoid instability of traces due to the effects of capacitance and leakage to the screen. This is particularly important where accurate quantitative measurements are made on the screen surface of the tube. If, for other reasons, earthing the e.h.t. positive line is impracticable, as with post-deflection accelerator tubes, adequate precautions should be taken to insulate the tube from any earthed object such as the chassis.

A resistive path must be provided between each deflector plate and the anode. Its resistance should be as low as possible and must not exceed the published maximum value. If for any reason higher values are used some instability of the trace may be expected.

In order to minimise the risk of trapezoidal distortion, tubes should not normally be used with asymmetrical deflection unless specifically designed for this purpose. In general the mean deflector plate potentials should approximate to the final anode voltage in order to reduce defocusing of the beam to a minimum.

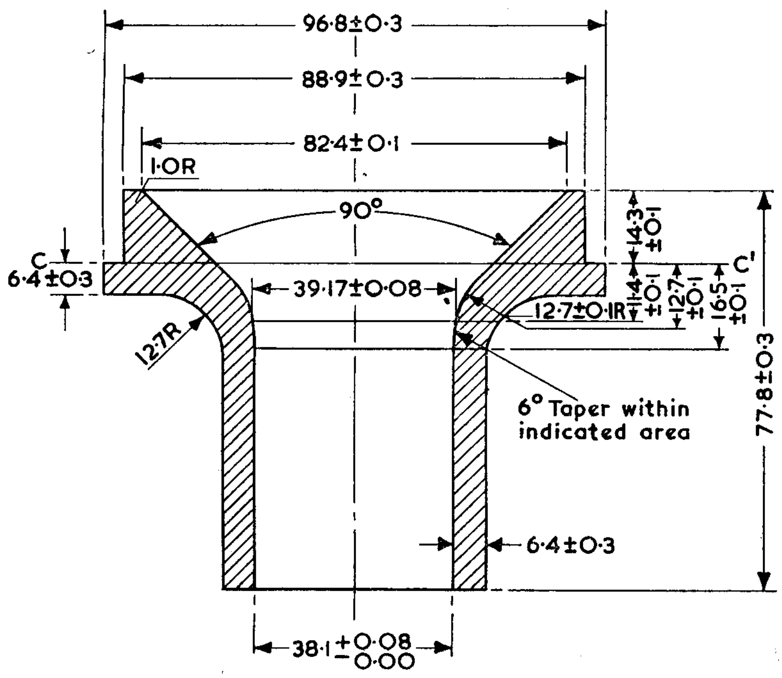


2331 **All dimensions in mm**

REFERENCE LINE GAUGE FOR CATHODE RAY TUBES HAVING 70 DEGREE SCANNING ANGLES

Reference Line

The reference line is determined by the plane C–C′ of the reference line gauge when the gauge is resting on the cone of the tube. To allow for dimensional tolerances the inner surface of the deflection coil must not extend into the shaded region indicated in the drawing.

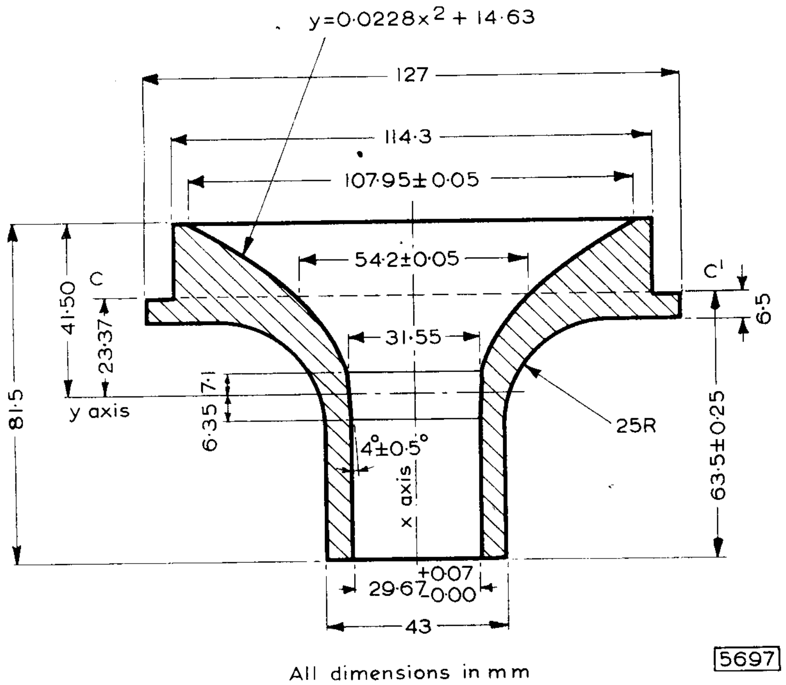


All dimensions in mm 2149

REFERENCE LINE GAUGE FOR CATHODE RAY TUBES HAVING 90 DEGREE SCANNING ANGLES

Reference Line

The reference line is determined by the plane C–C′ of the reference line gauge For the design of deflector coils see detailed drawing of cone on individual data sheets.

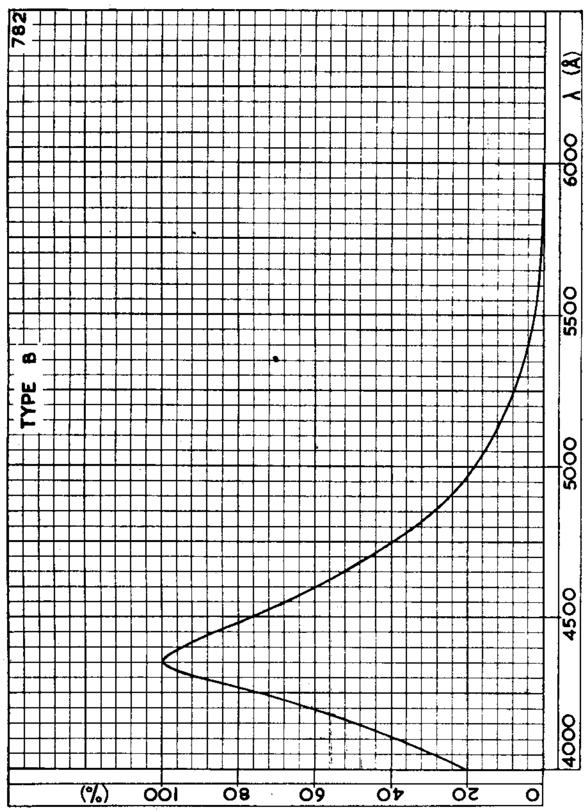


All dimensions in mm

REFERENCE LINE GAUGE J.E.T.E.C. 126 FOR CATHODE RAY TUBES HAVING 110° SCANNING ANGLES

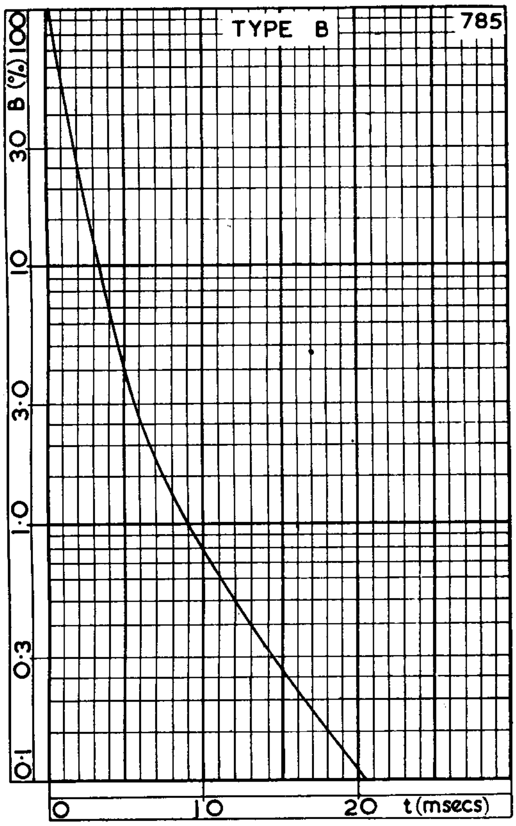
Reference Line

The reference line is determined by the plane C–C′ of the reference line gauge.

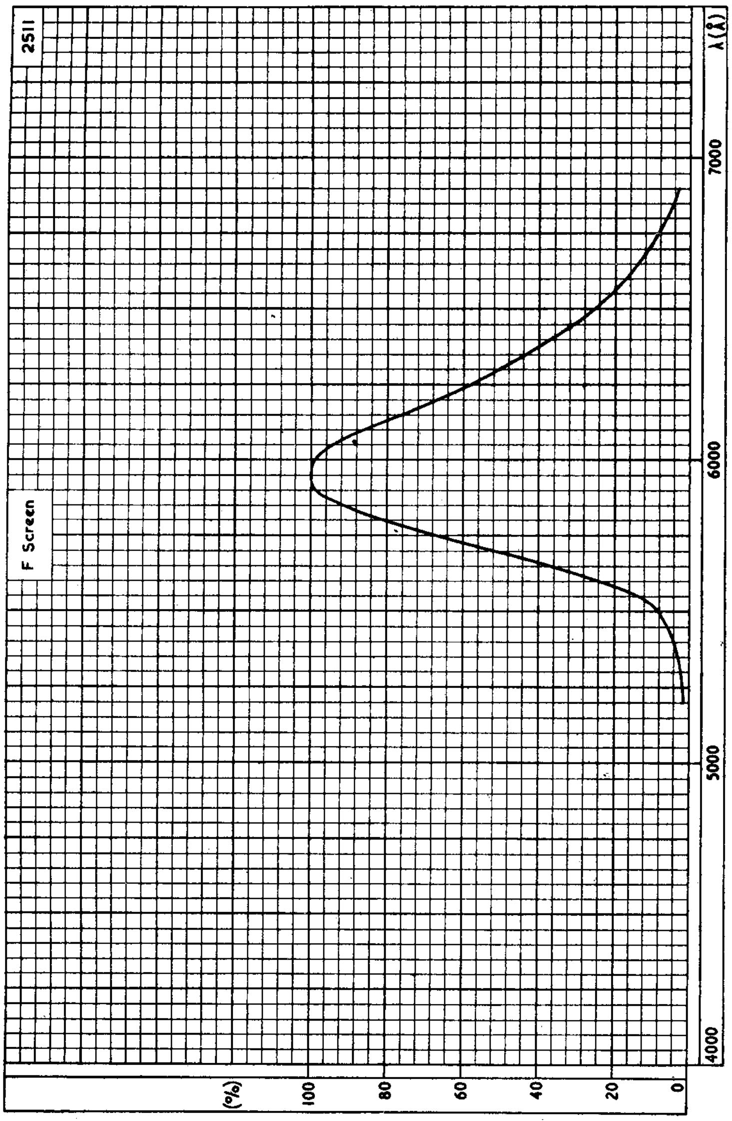


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE " B " LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE "B"

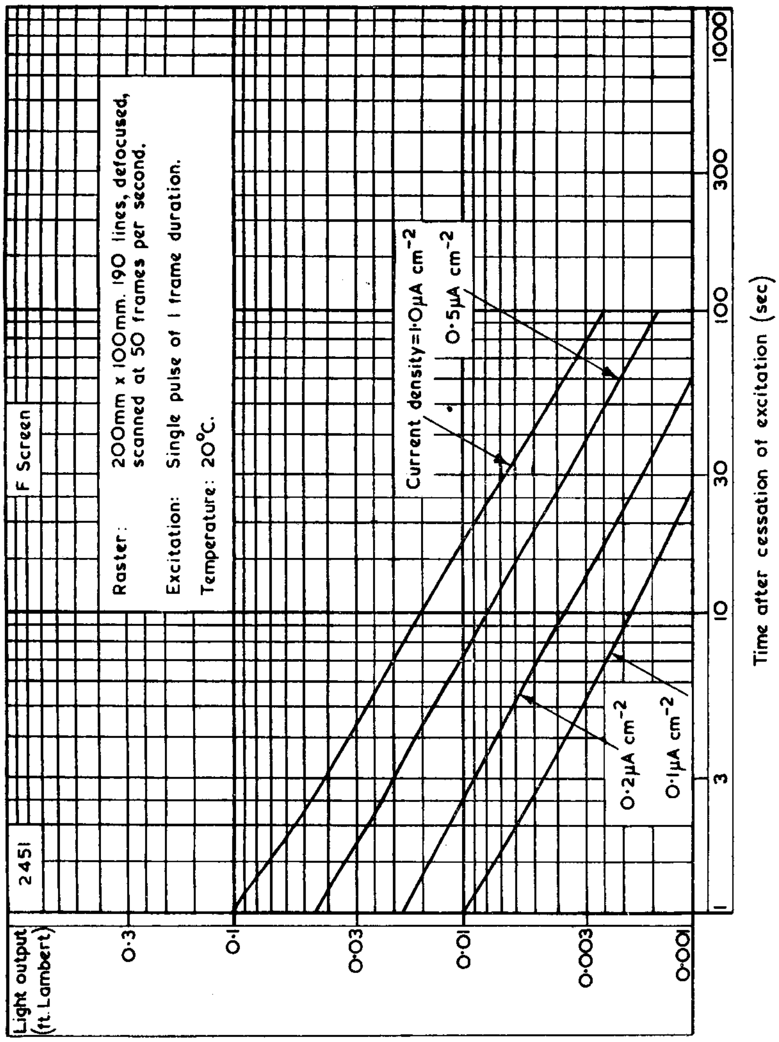


PERSISTENCE CHARACTERISTIC CURVE FOR
TYPE "B" LUMINESCENT SCREEN

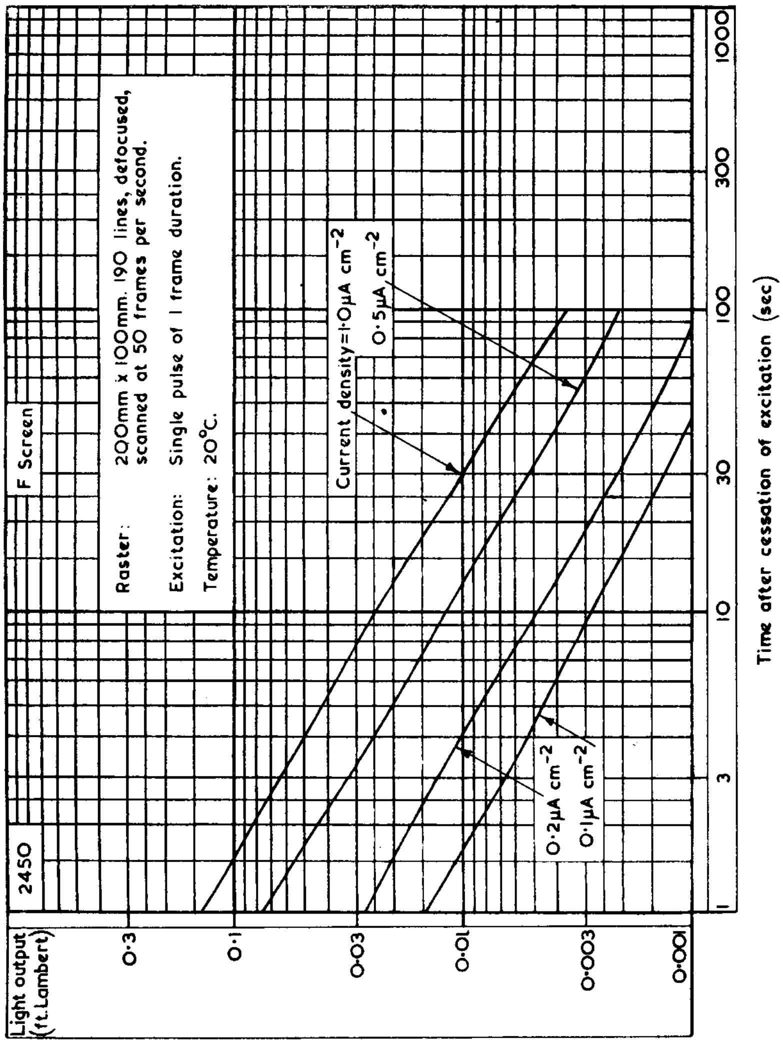


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'F' LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE 'F'

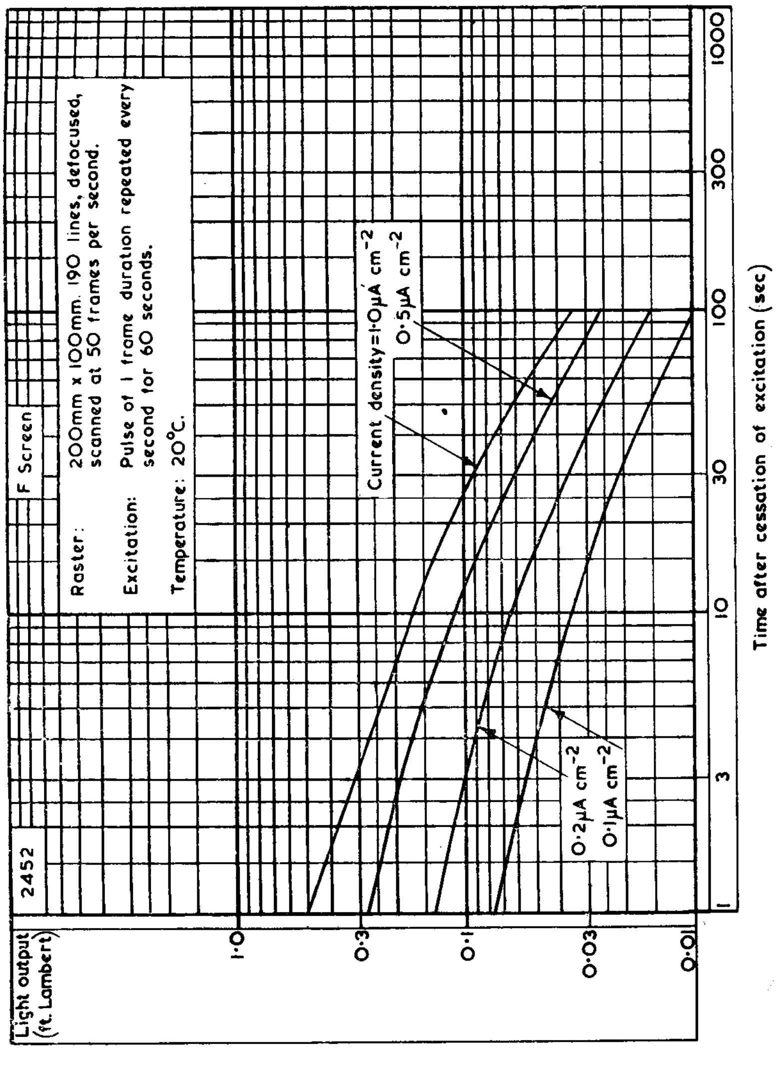


AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN;
SINGLE PULSE EXCITATION. E.H.T.=10kV

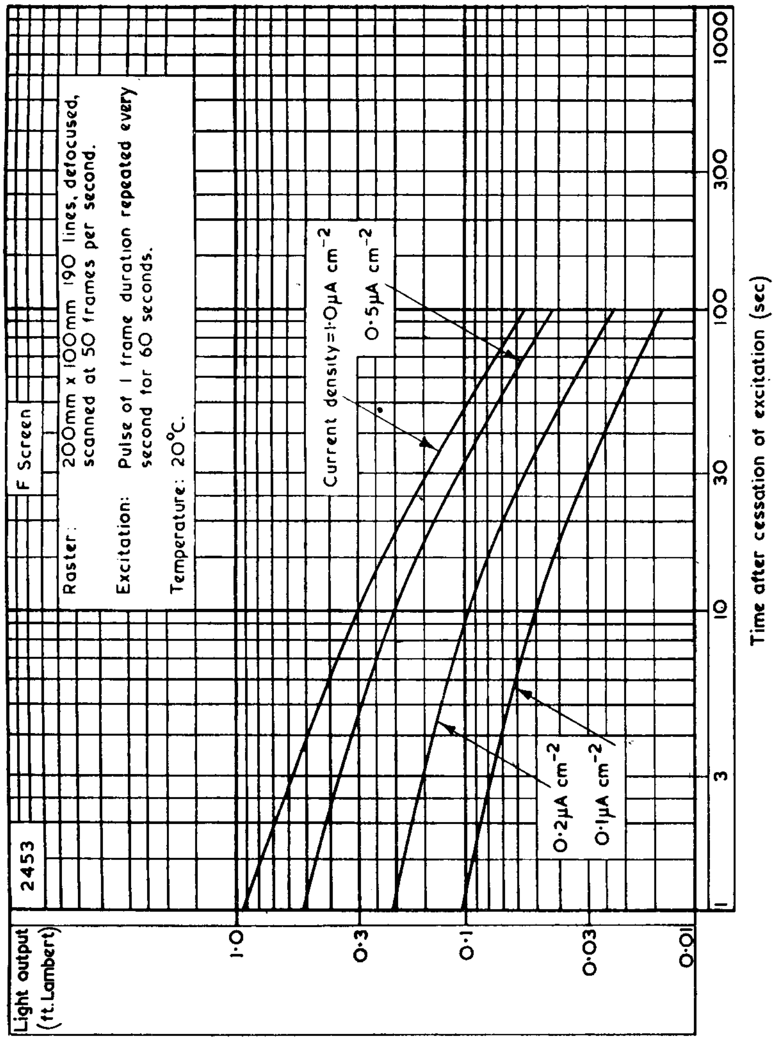


AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN;
SINGLE PULSE EXCITATION E.H.T.=15kV

CATHODE RAY TUBE
SCREEN TYPE 'F'



AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T. = 10kV



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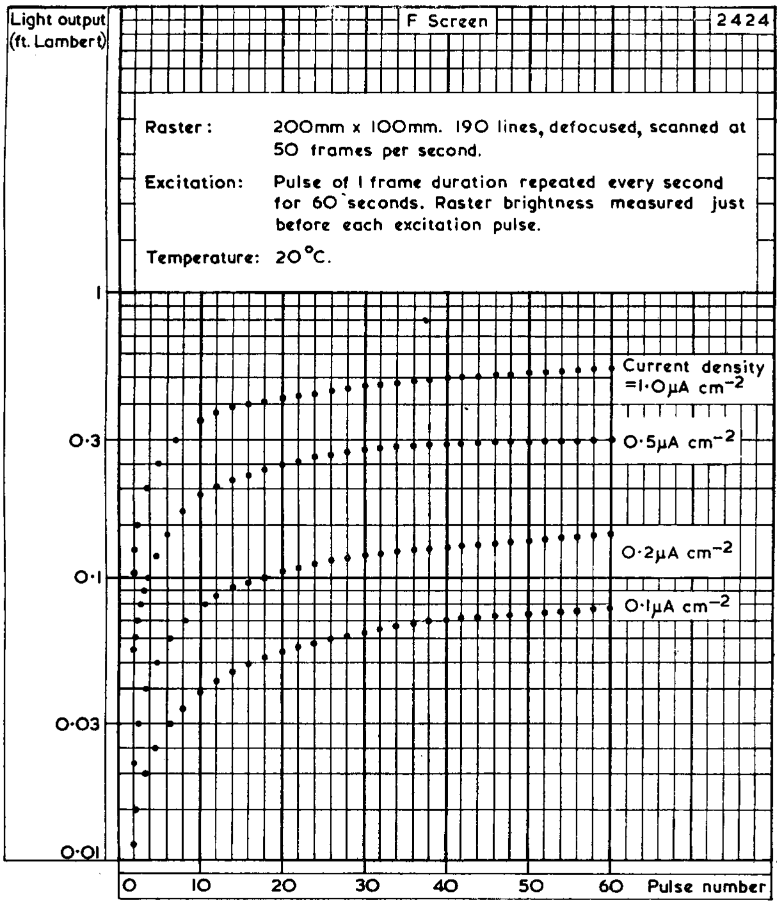
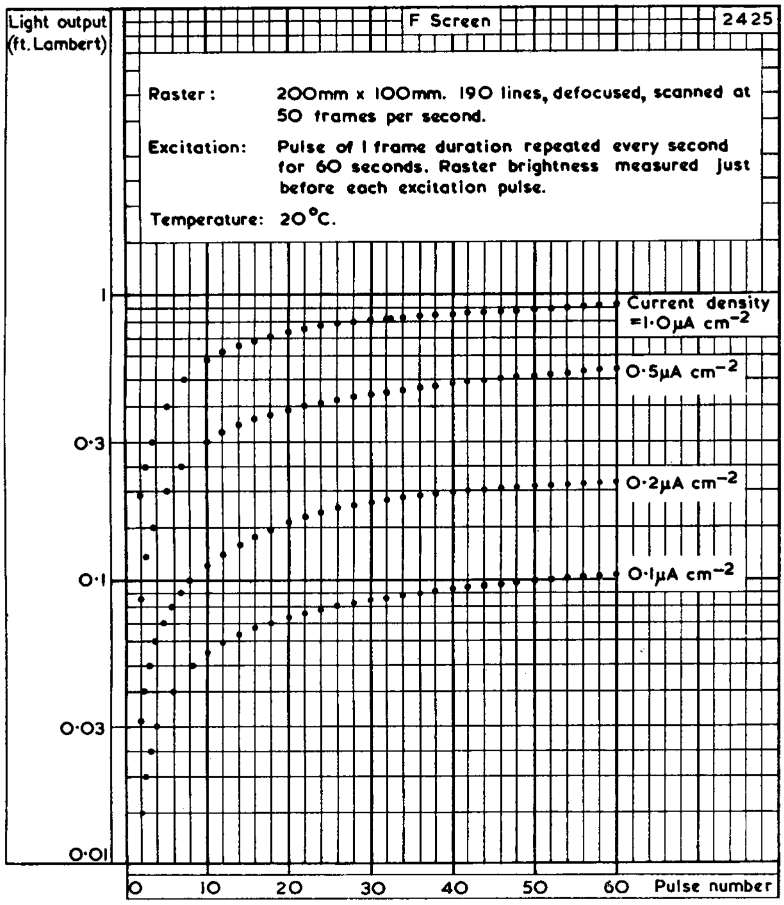
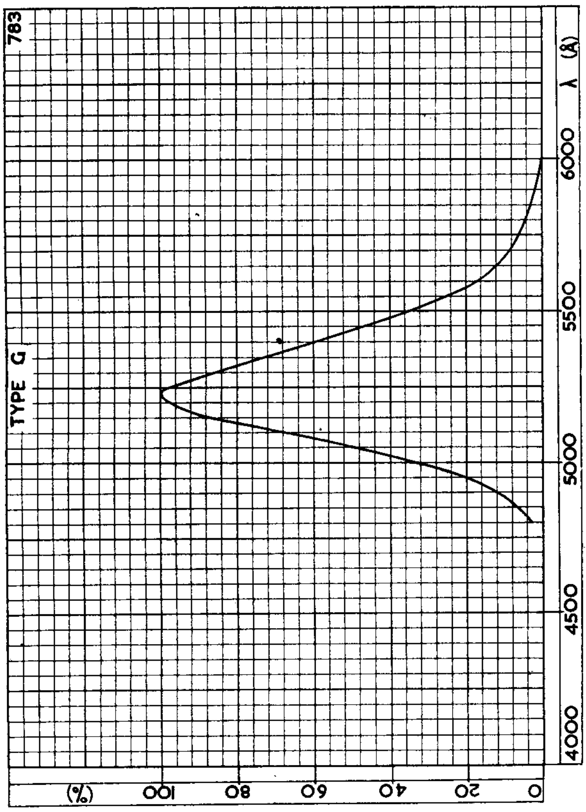
REPEATED PULSE EXCITATION E.H.T.=15kV



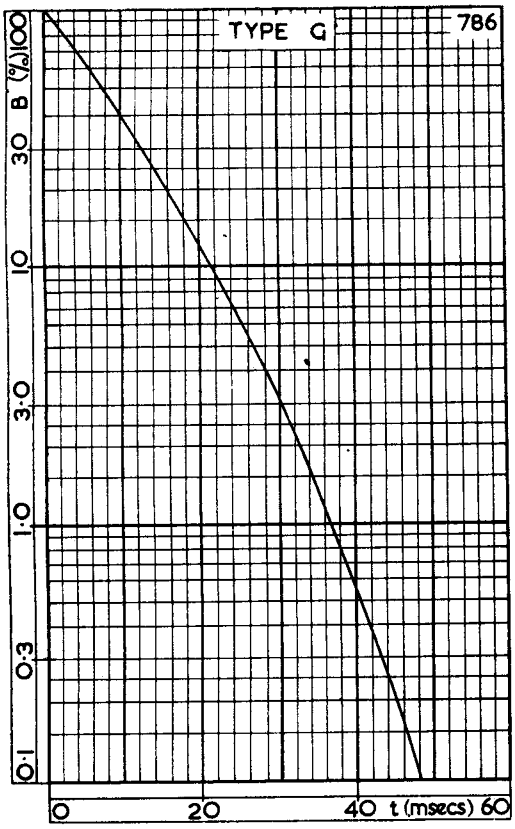
BUILD-UP CHARACTERISTIC OF TYPE 'F' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION E.H.T.=10kV



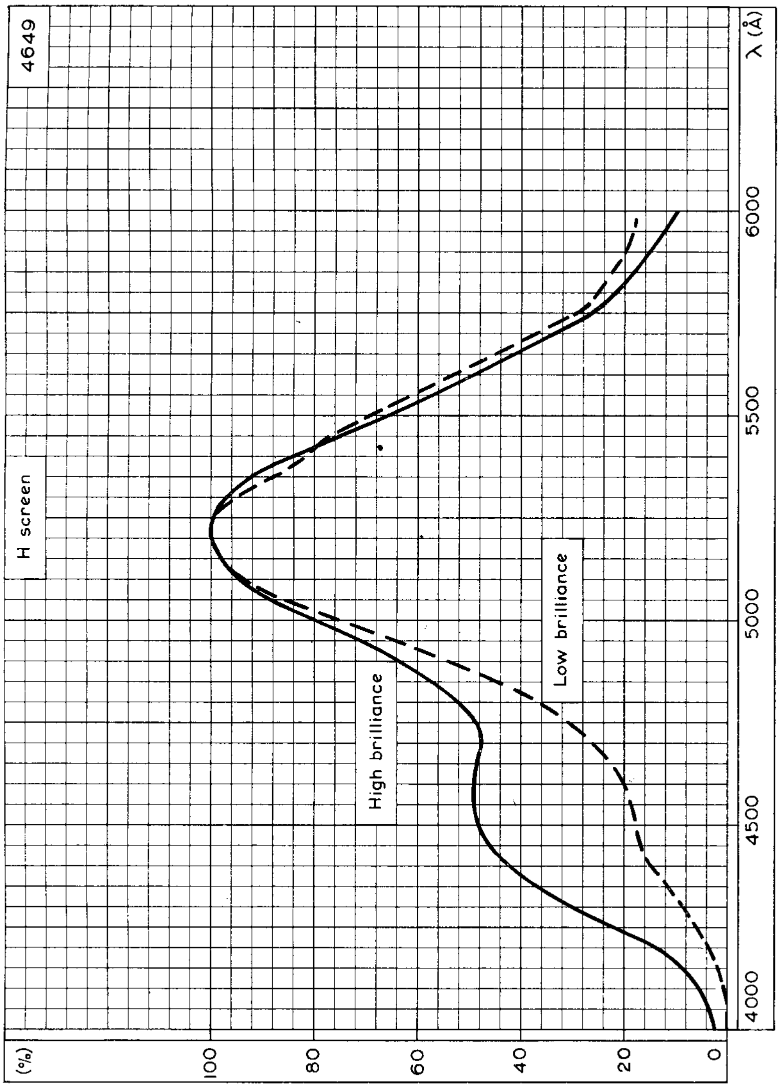
BUILD-UP CHARACTERISTIC OF TYPE 'F' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION E.H.T.=15kV



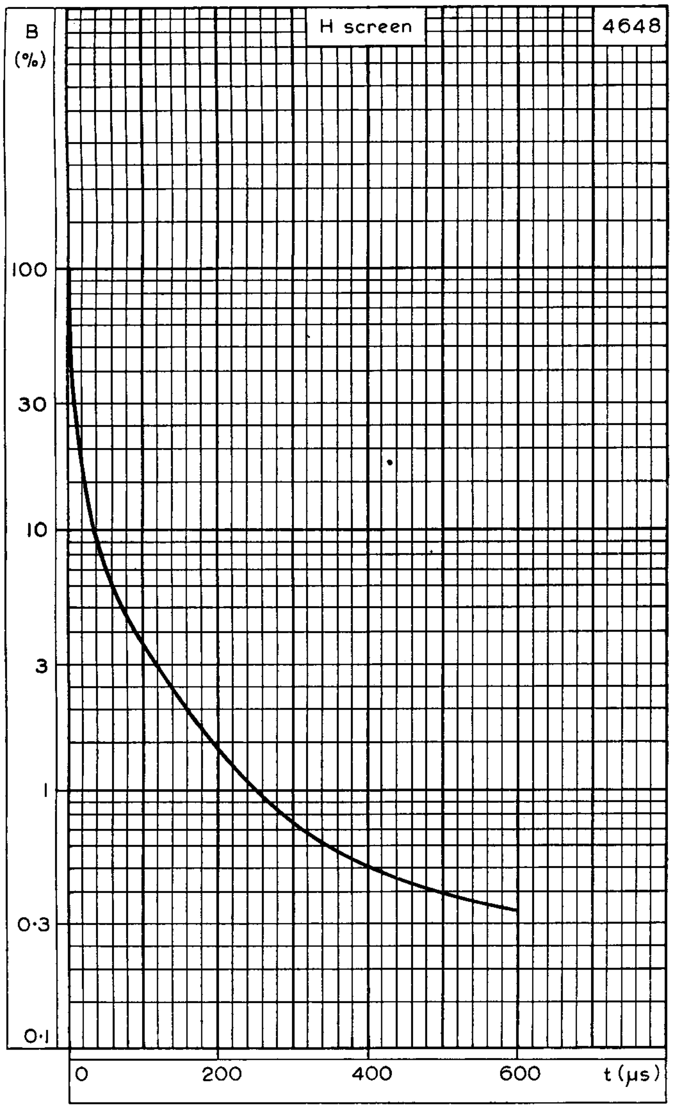
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE " G " LUMINESCENT SCREEN



PERSISTENCE CHARACTERISTIC CURVE FOR
TYPE " G " LUMINESCENT SCREEN

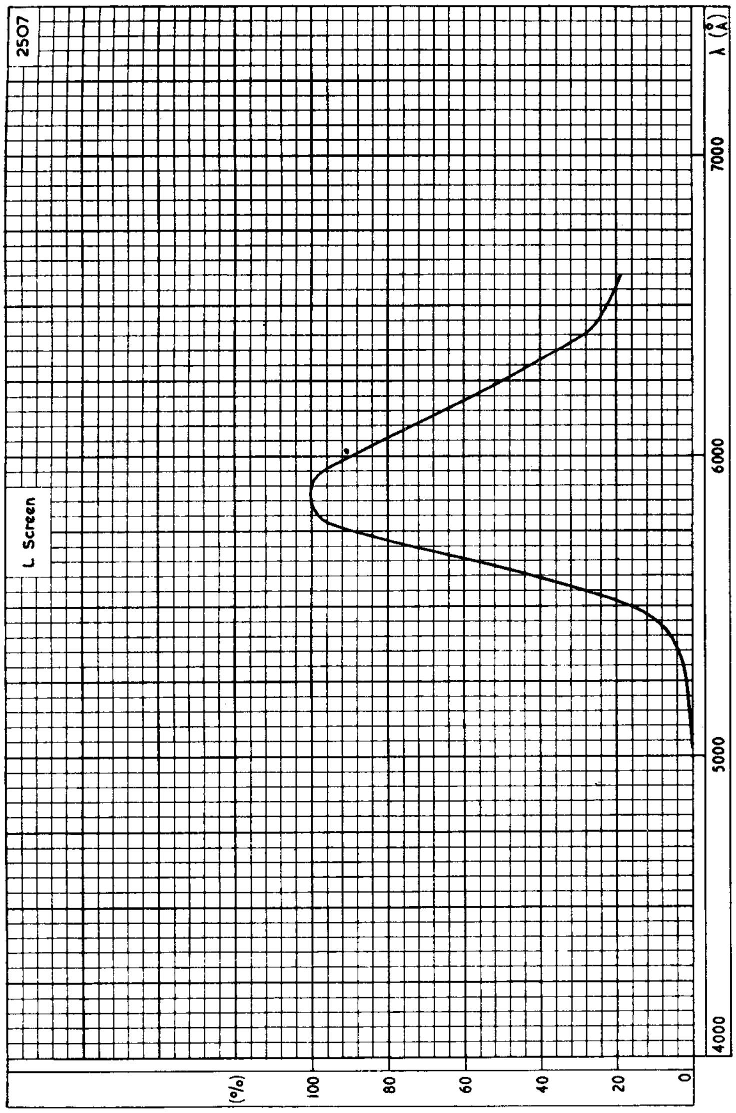


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE "H" LUMINESCENT SCREEN



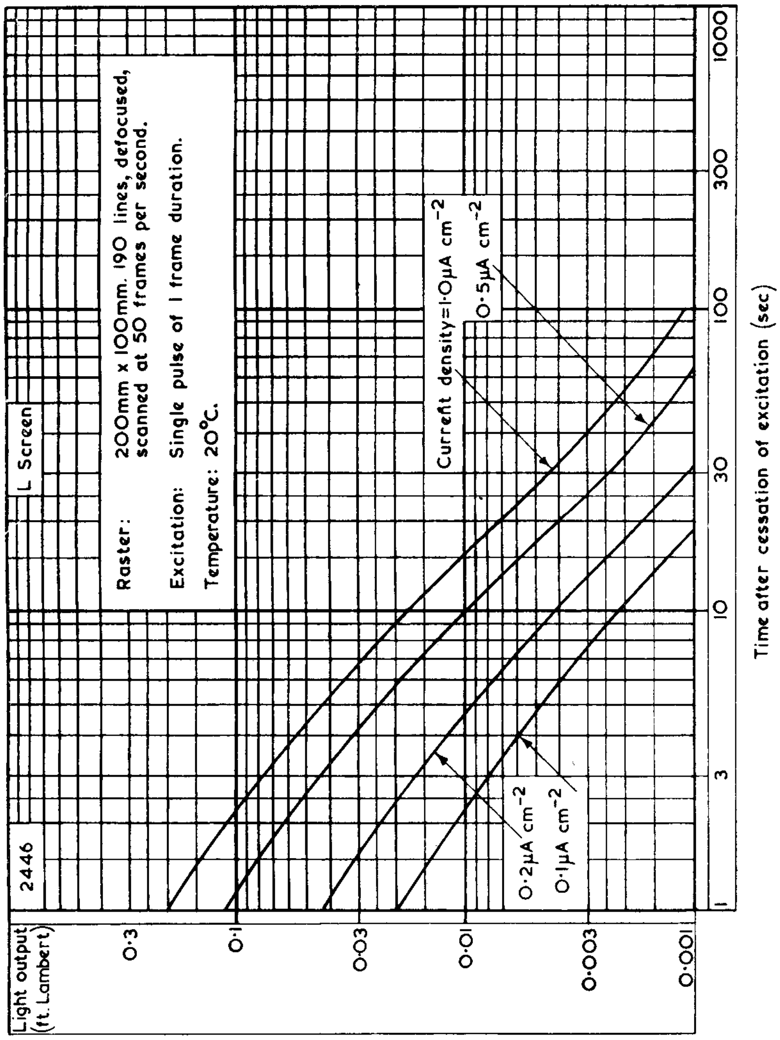
PERSISTENCE CHARACTERISTIC CURVE FOR TYPE "H" LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE 'L'

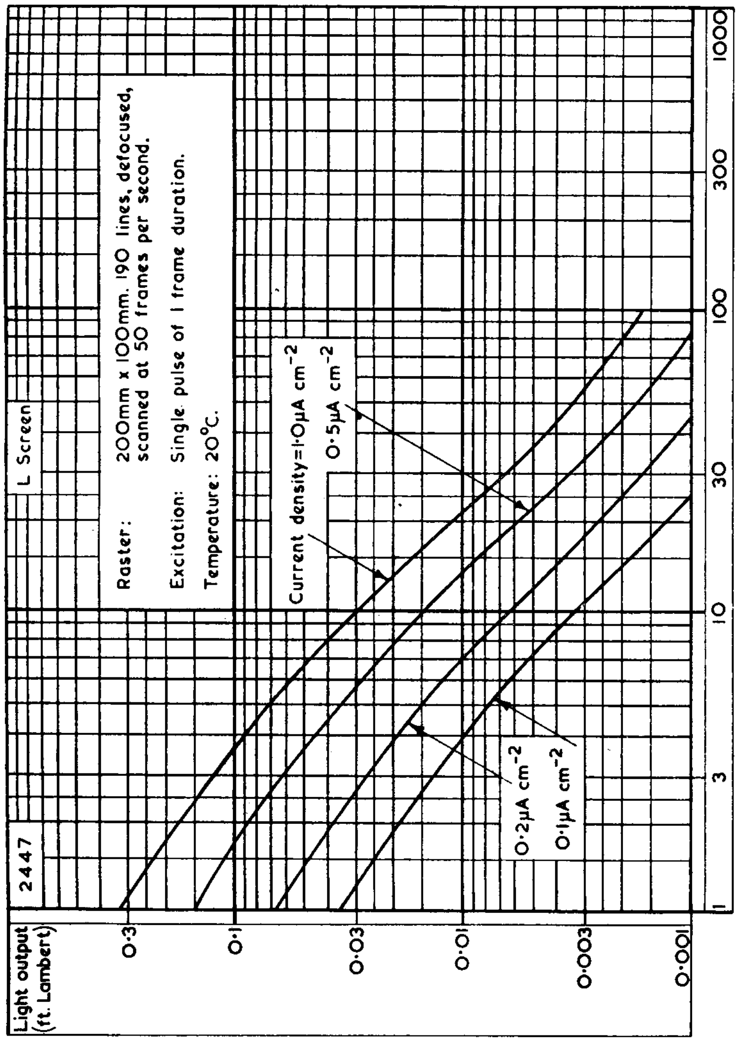


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'L' LUMINESCENT SCREEN

CATHODE RAY TUBE
SCREEN TYPE 'L'

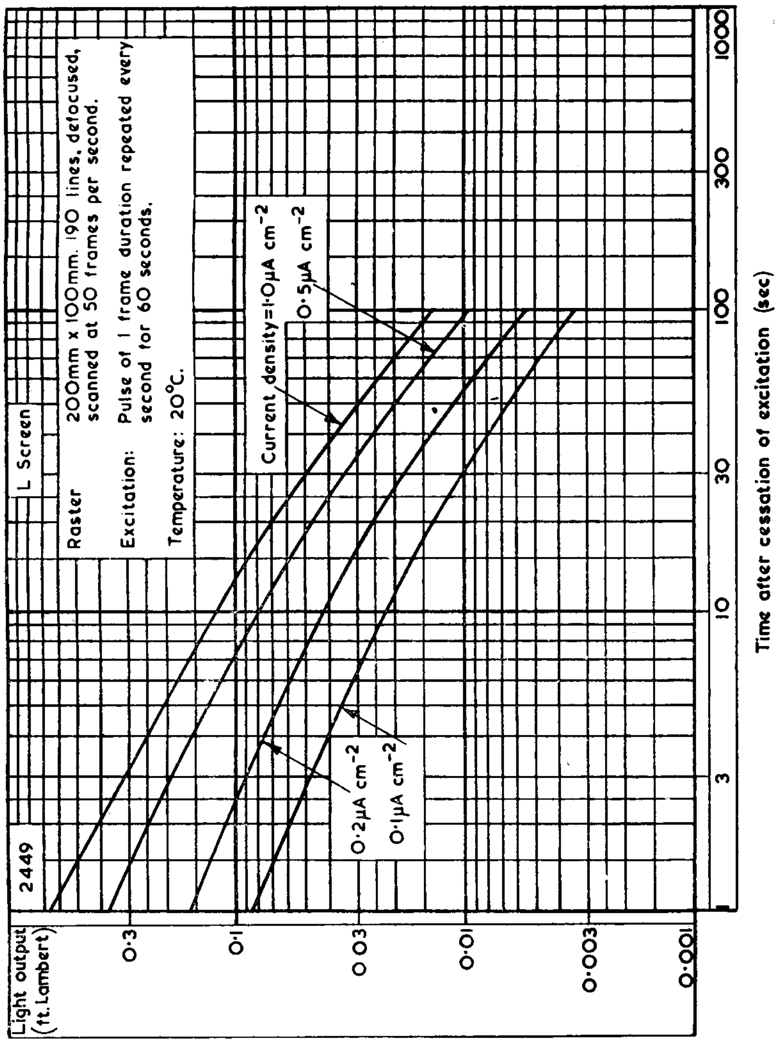


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN ; SINGLE PULSE EXCITATION. E.H.T.=10kV.

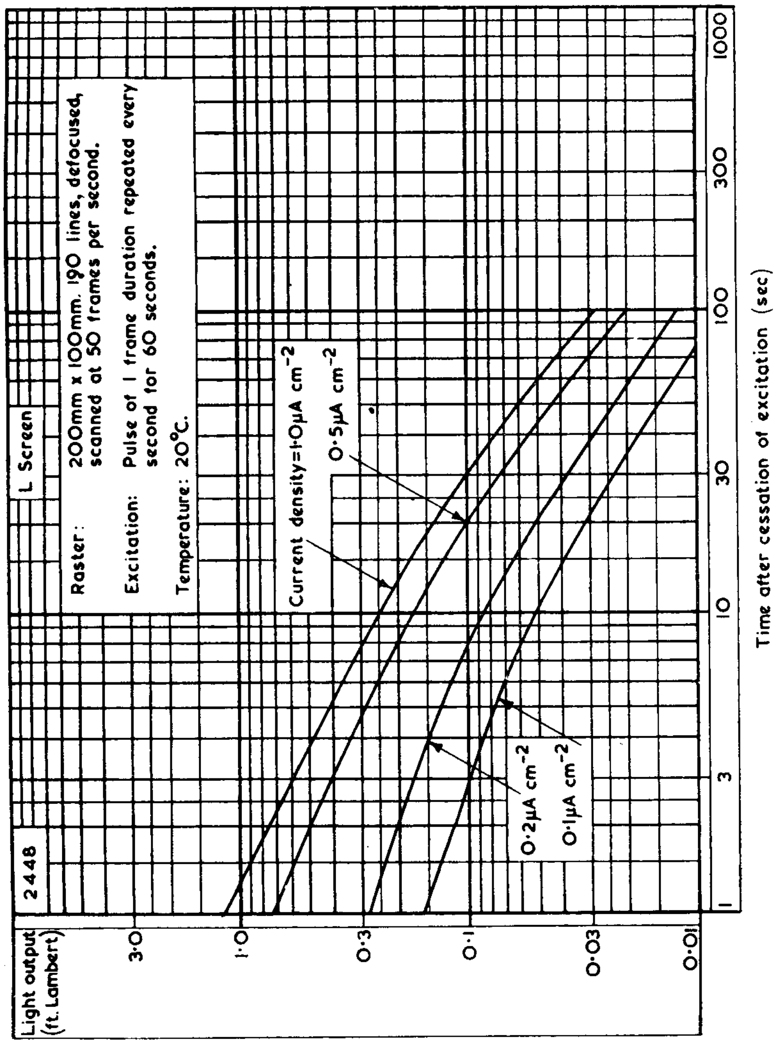


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN; SINGLE PULSE EXCITATION. E.H.T.=15kV

CATHODE RAY TUBE
SCREEN TYPE 'L'

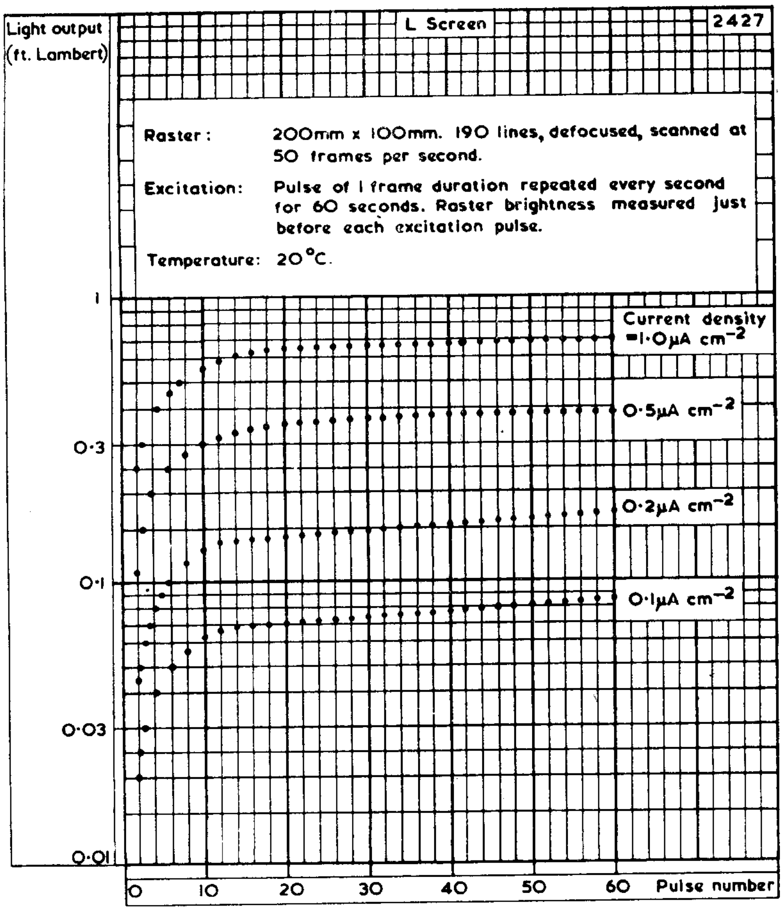


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T.=10kV

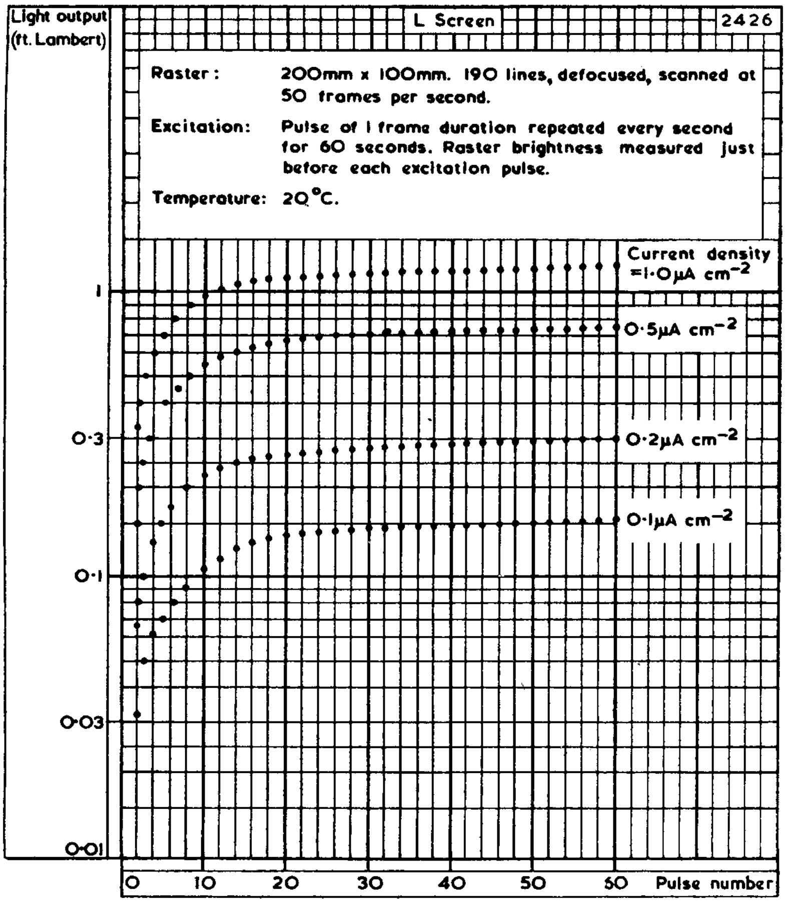


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T.=15kV

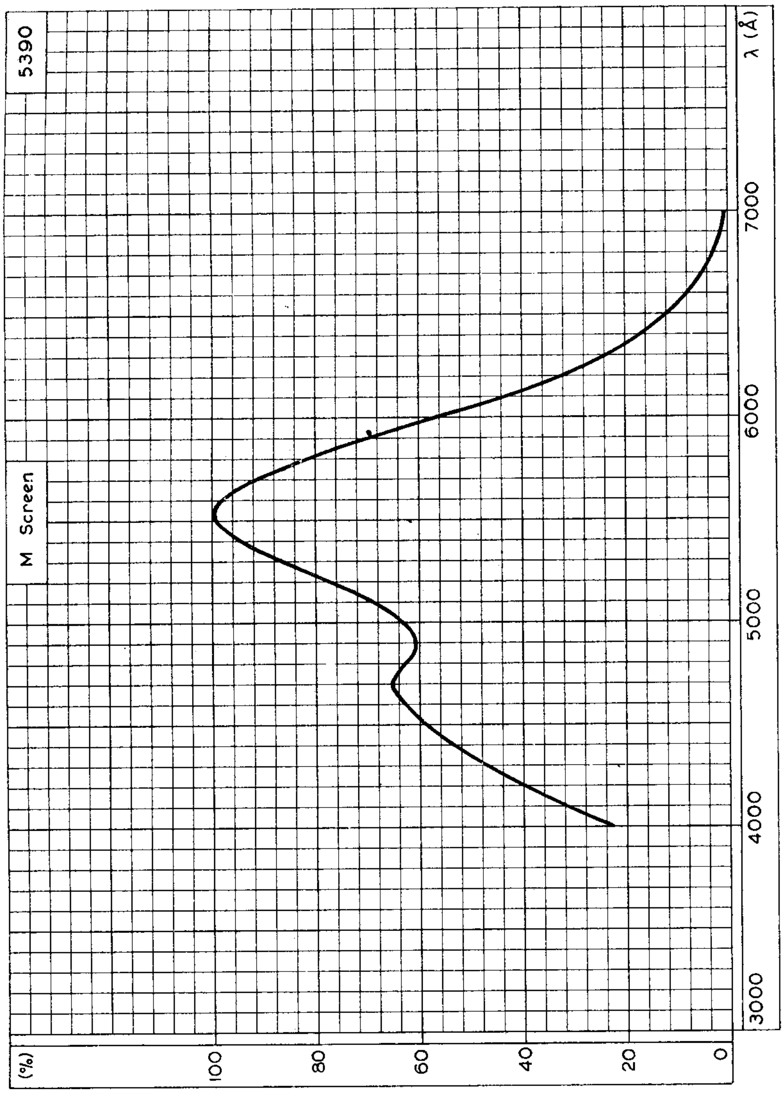
CATHODE RAY TUBE
SCREEN TYPE 'L'



BUILD-UP CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION. E.H.T.=10kV



BUILD-UP CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T. = 15kV.



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE 'M' LUMINESCENT SCREEN