Mullard

TECHNICAL
HANDBOOK

CATHODE RAY TUBES
GASFILLED VALVES & TUBES
MICROWAVE DEVICES
POWER VALVES & RECTIFIERS
FOR
INDUSTRIAL & TRANSMITTING EQUIPMENT

VOLUME 3

ISSUED BY
DATA AND PUBLICATIONS SECTION
TECHNICAL SERVICE DEPT.

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Mullard Technical Handbook

GENERAL INDEX TO VOLUME THREE

This index of Mullard valves and tubes will be reissued periodically to incorporate the latest information.

Data sheets for types starred thus (*) have not yet been published but will be issued when they become available. A guarantee that these valves and tubes will become available is not implied by their inclusion in this list. Sheets for maintenance types are overprinted in red.

The issue number or date given against each type shows the latest information published and should correspond to that given on the data sheet at the bottom left-hand corner of each page.

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CATHODE RAY TUBES

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.

GENERAL OPERATIONAL RECOMMENDATIONS

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 $\pm 10\%$) 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 $\pm 7\%$ 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 $\pm 5\%$. Should the voltage variation depend on one factor only, the voltage variation must not exceed $\pm 5\%$.

Series Operation

The heater current must be within $\pm 5\%$ 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 $\pm 3.5\%$. Should the total current variation depend upon one factor only, the current variation must not exceed $\pm 3.5\%$.

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 $\pm 10\%$ 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:—

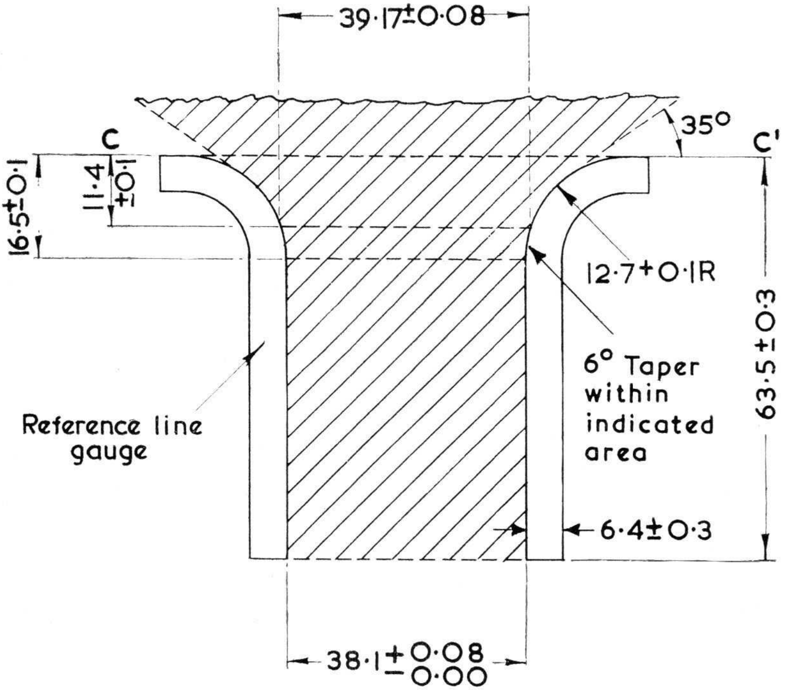
Note the angle between the centre line of the ion-trap assembly set by the procedure in (1), and the plane which passes through the bend in the gun of the cathode ray tube. If this angle is more than $\pm 10°$, rotate the magnet in a direction to reduce the angle and compensate any reduction in brightness 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.

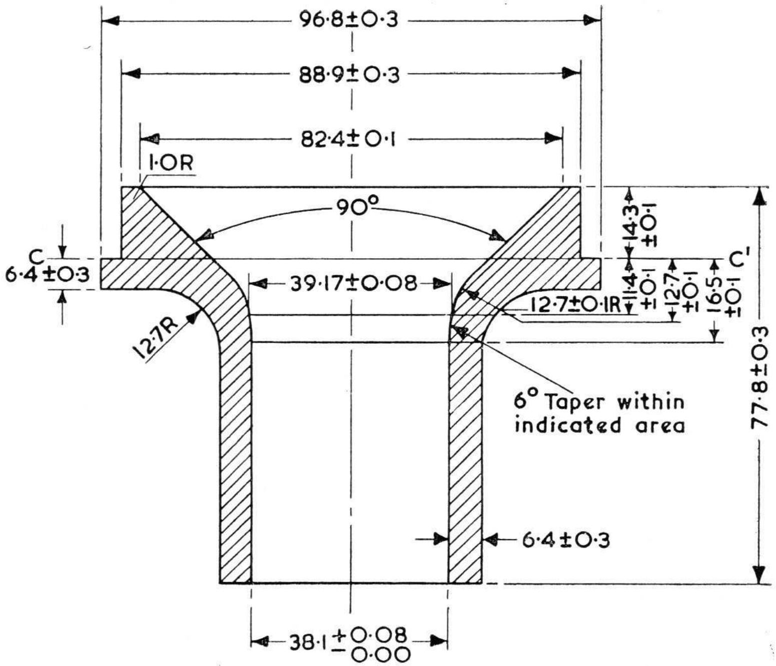


2331 **All dimensions in mm**

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.

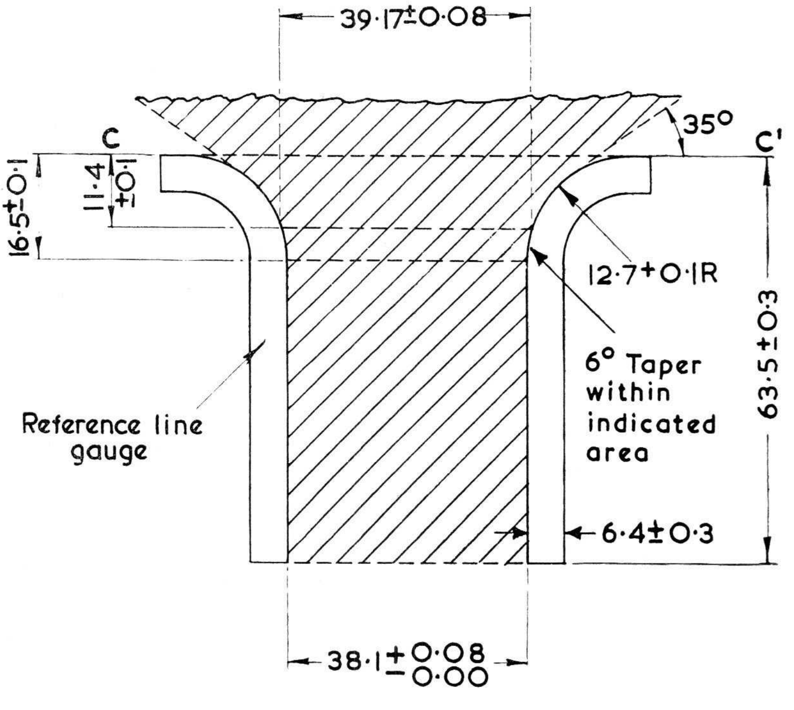


All dimensions in mm 2149

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.



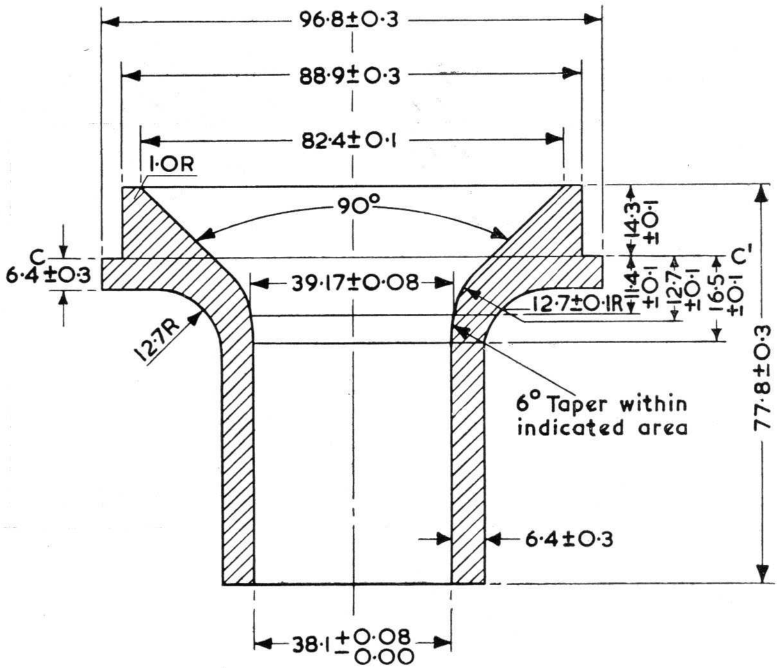
2331

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.

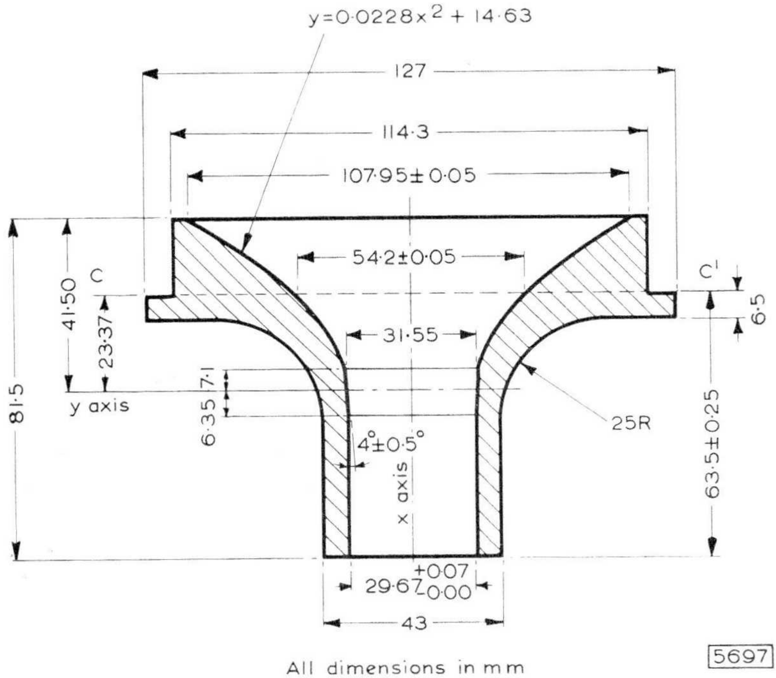


All dimensions in mm 2149

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

Reference Line

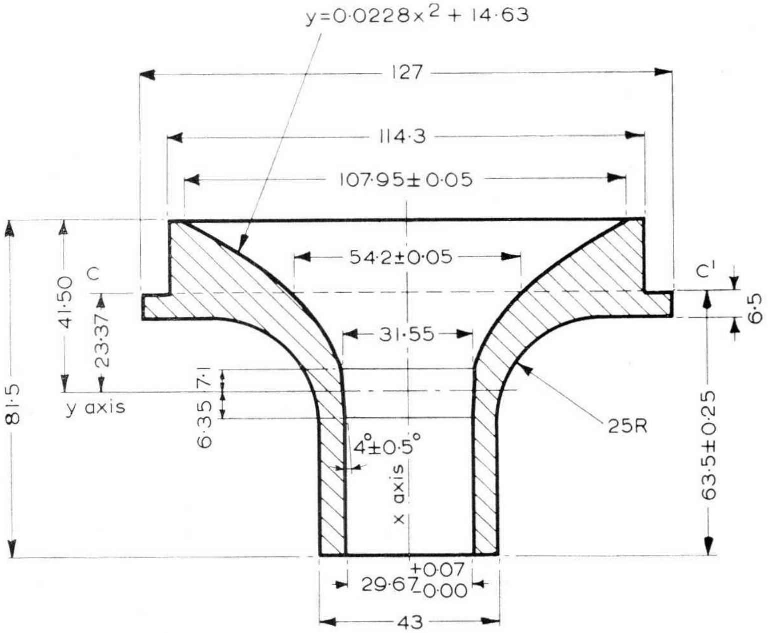
The reference line is determined by the plane C–C′ of the reference line gauge. For the design of deflector coils see detailed drawing of cone on individual data sheets.



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.



All dimensions in mm

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

Reference Line

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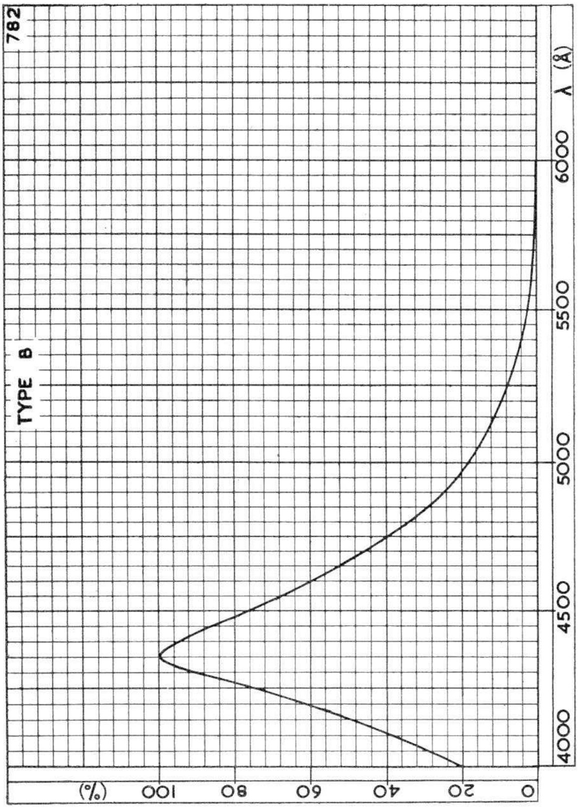
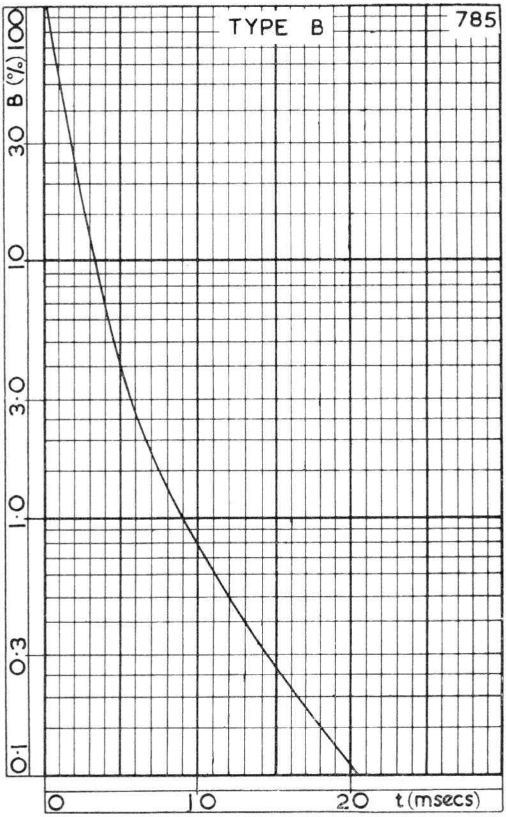
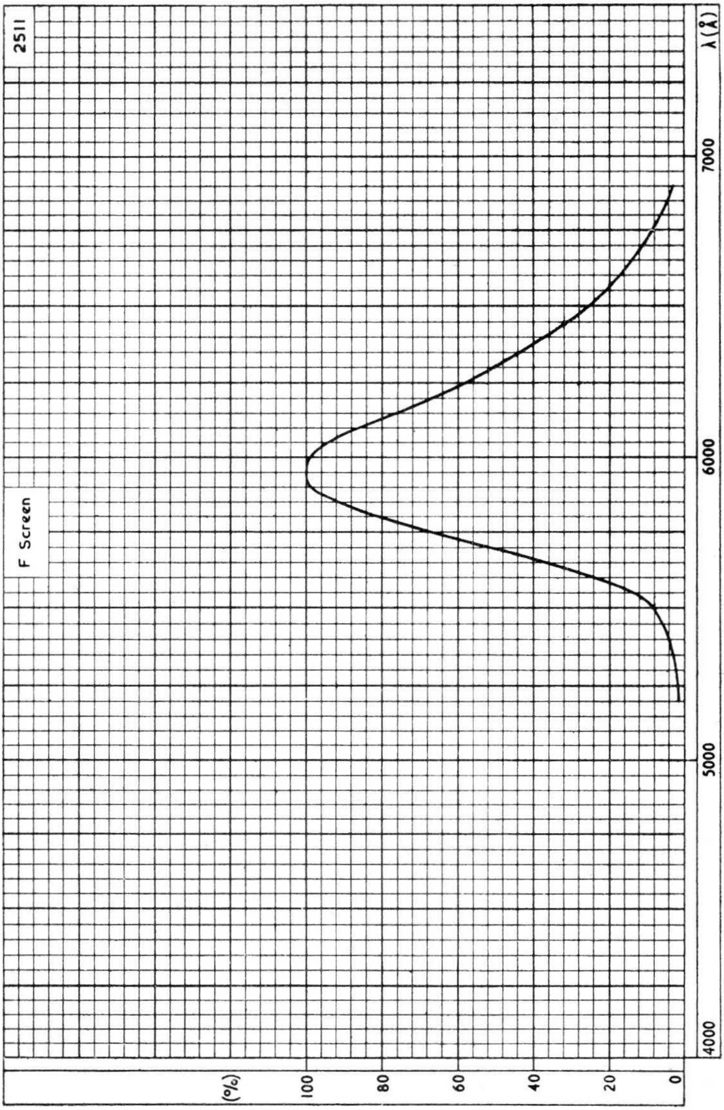


RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE " B " LUMINESCENT SCREEN



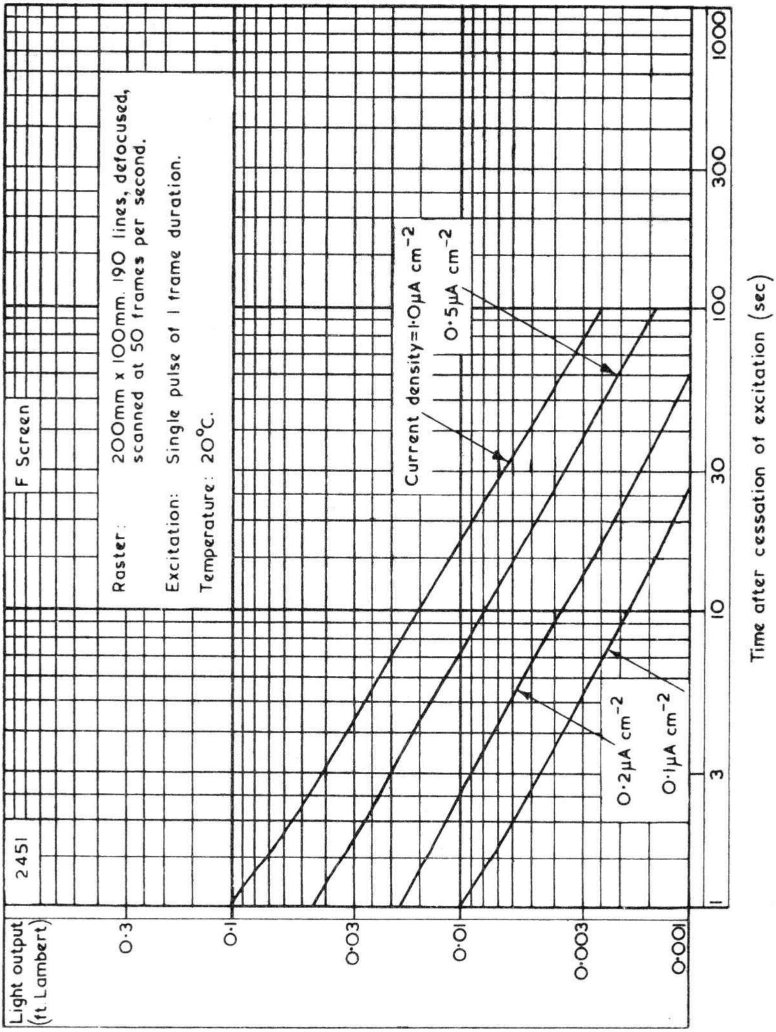
PERSISTENCE CHARACTERISTIC CURVE FOR
TYPE " B " LUMINESCENT SCREEN



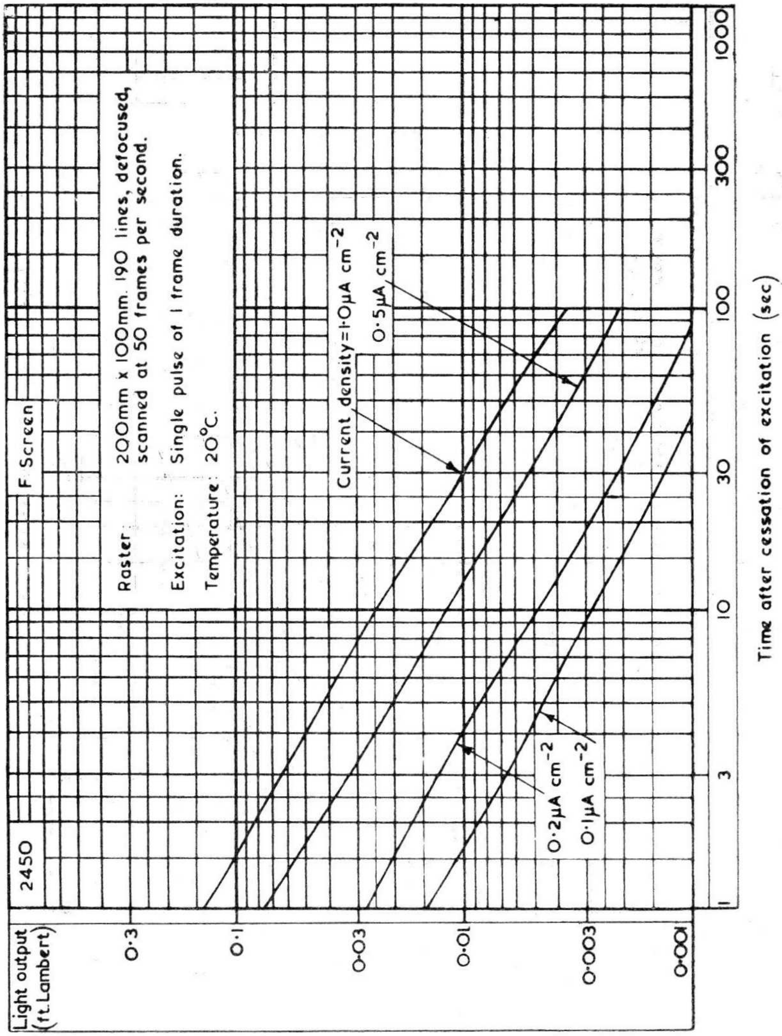
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'F' LUMINESCENT SCREEN

CATHODE RAY TUBE

SCREEN TYPE 'F'



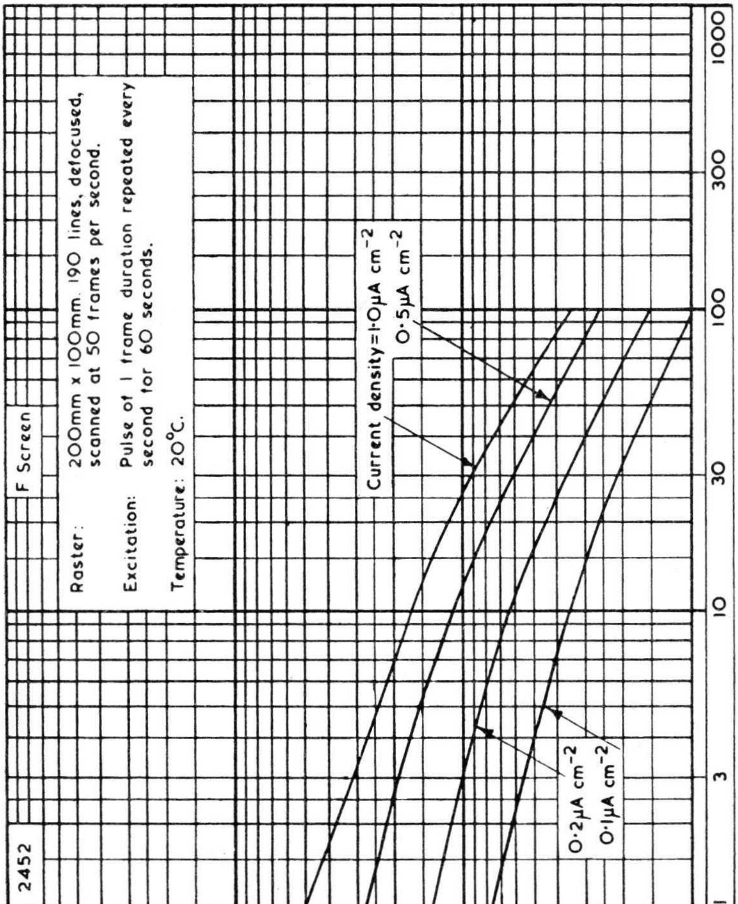
AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN; SINGLE PULSE EXCITATION. E.H.T. = 10kV



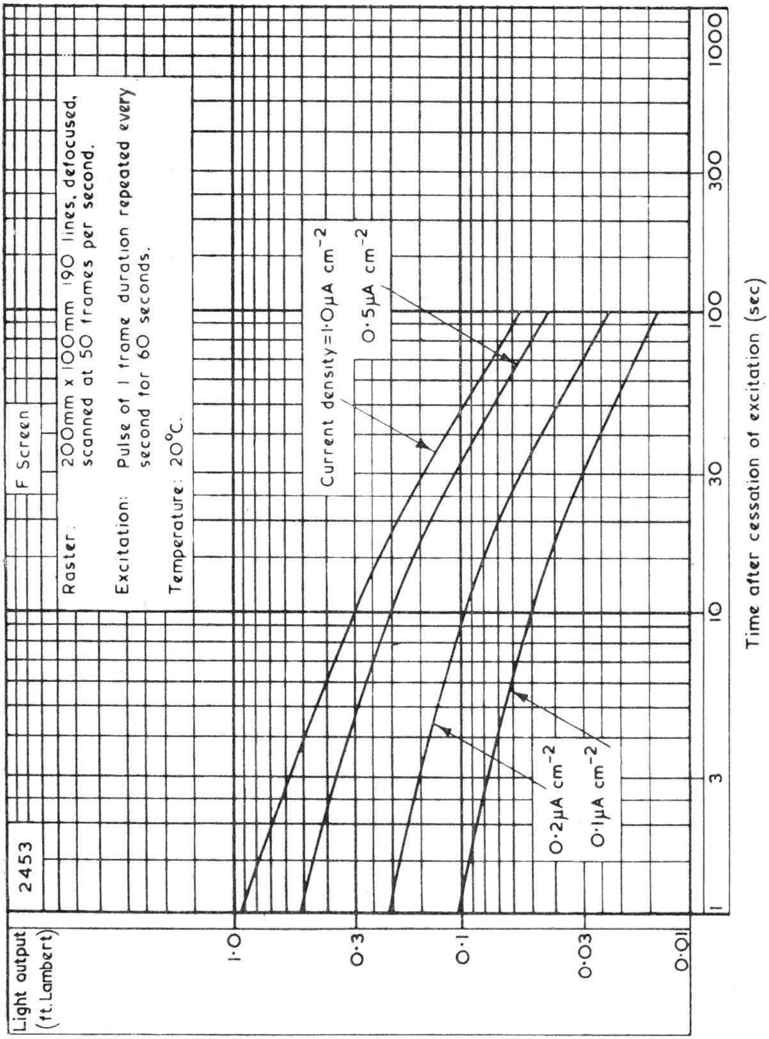
AFTERGLOW CHARACTERISTICS OF TYPE ‘F’ LUMINESCENT SCREEN; SINGLE PULSE EXCITATION E.H.T. = 15kV

CATHODE RAY TUBE

SCREEN TYPE 'F'

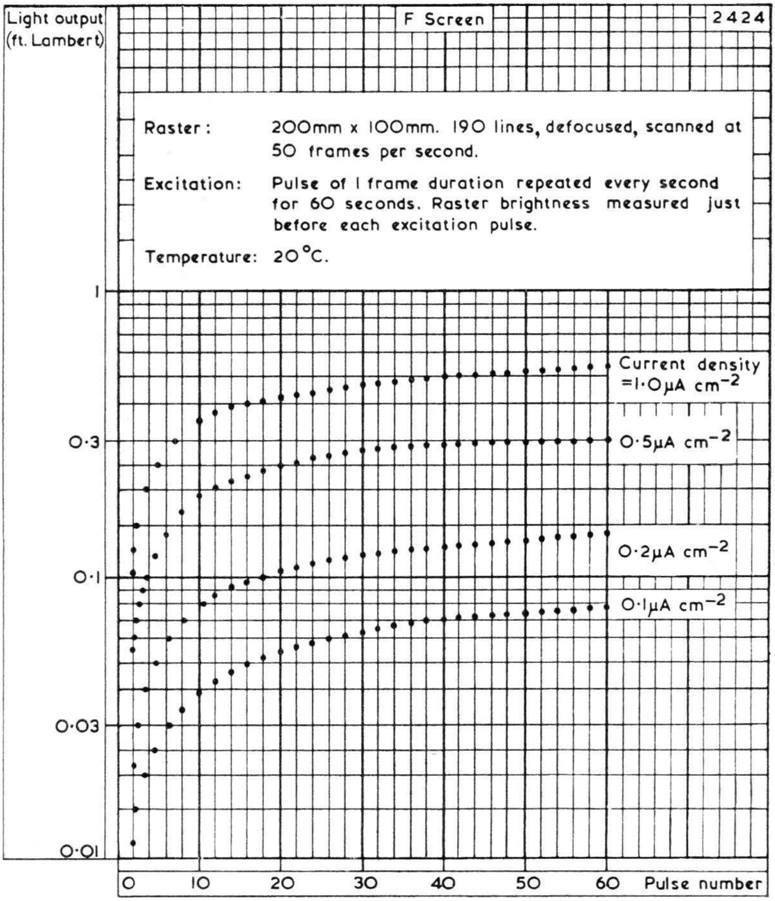


AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION. E.H.T. = 10kV

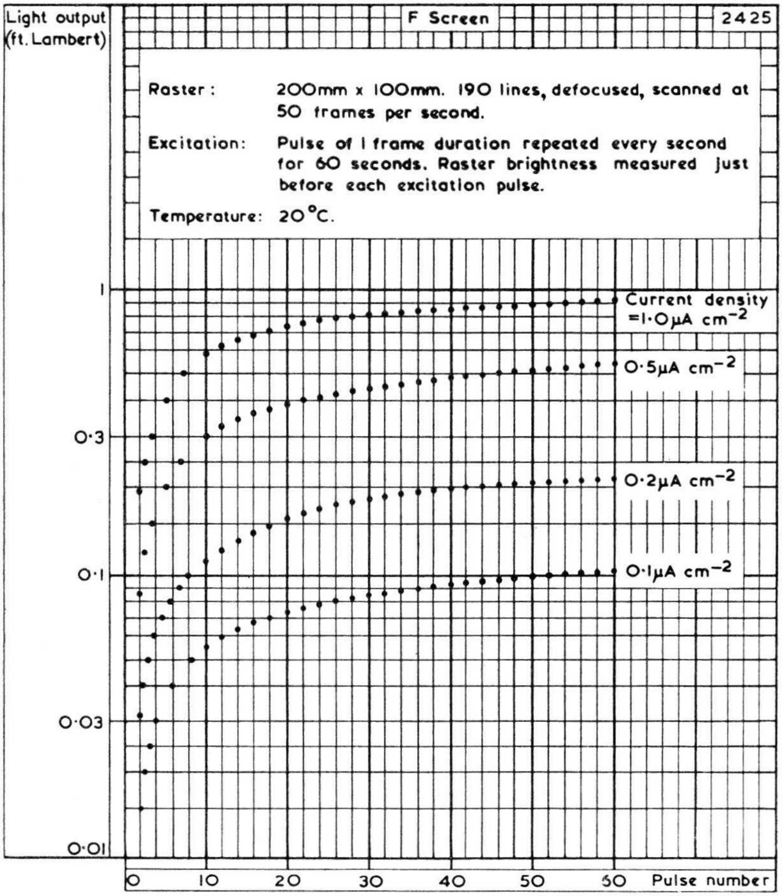


AFTERGLOW CHARACTERISTICS OF TYPE 'F' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION E.H.T. = 15kV

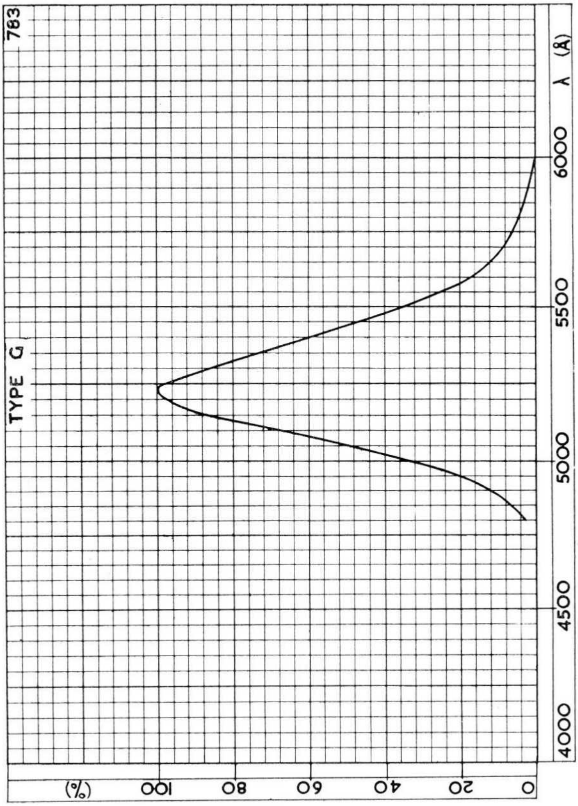
CATHODE RAY TUBE
SCREEN TYPE 'F'



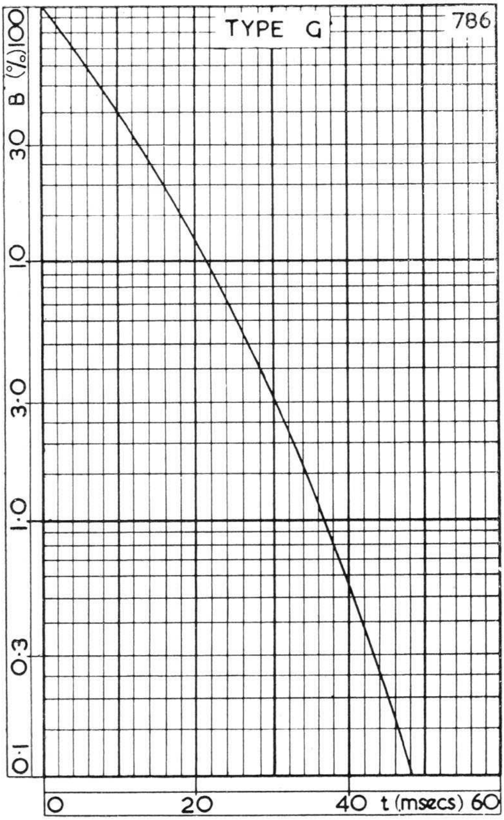
BUILD-UP CHARACTERISTIC OF TYPE 'F' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION E.H.T.=10kV



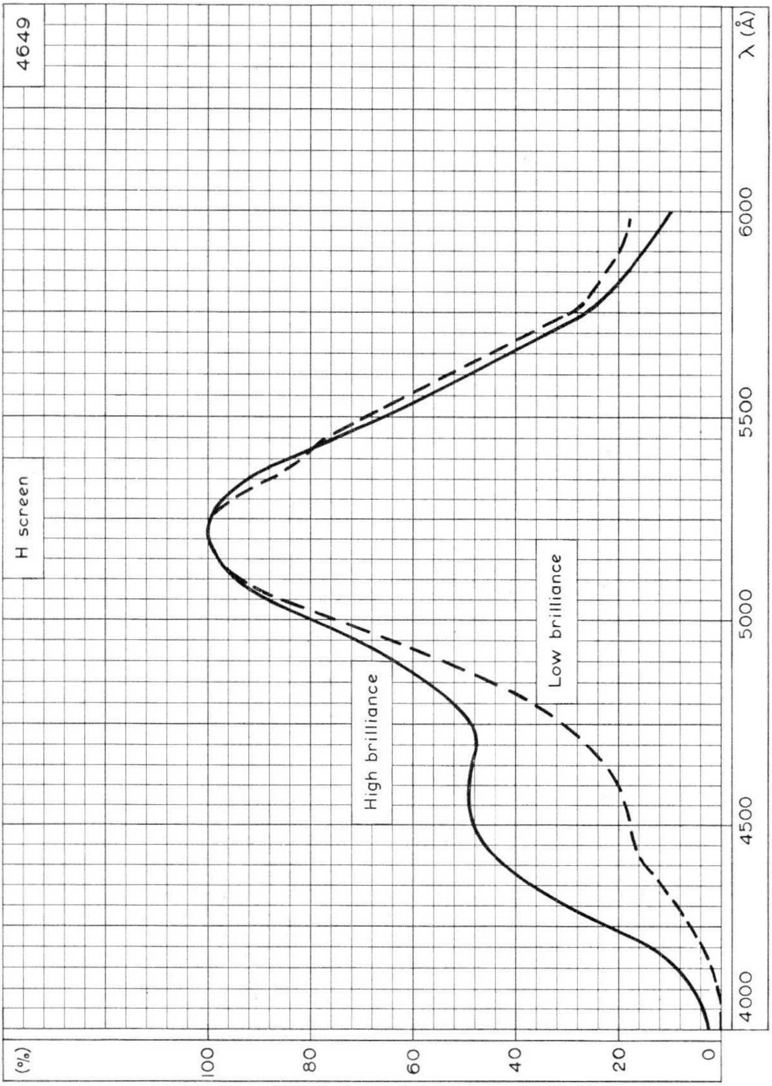
BUILD-UP CHARACTERISTIC OF TYPE 'F' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION E.H.T. = 15kV



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



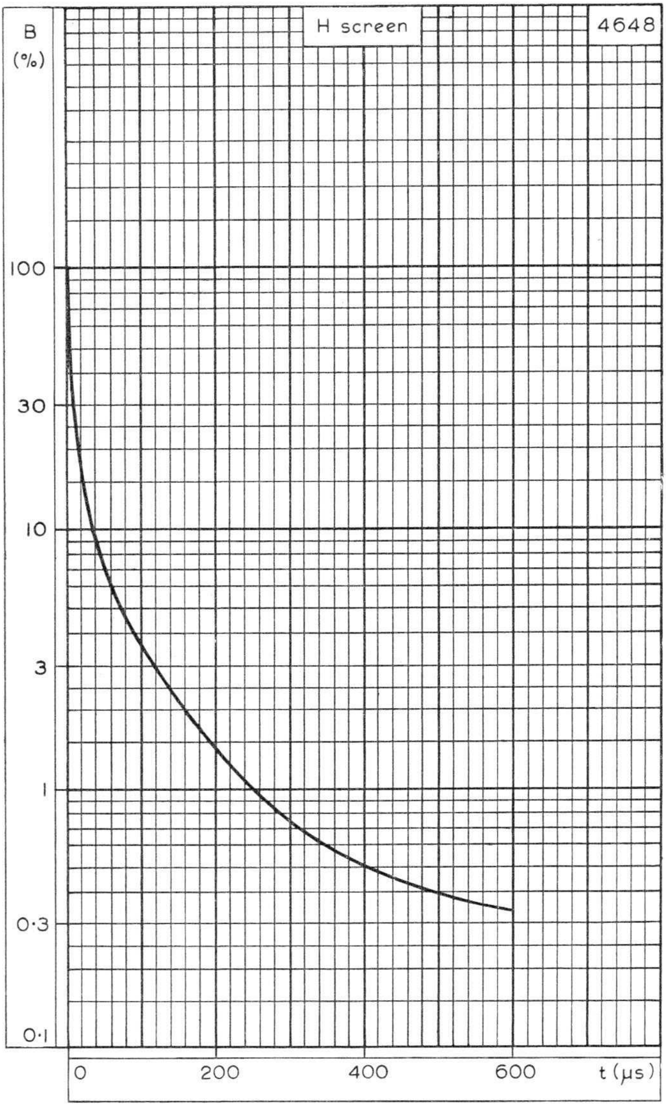
PERSISTENCE CHARACTERISTIC CURVE FOR
TYPE "G" LUMINESCENT SCREEN



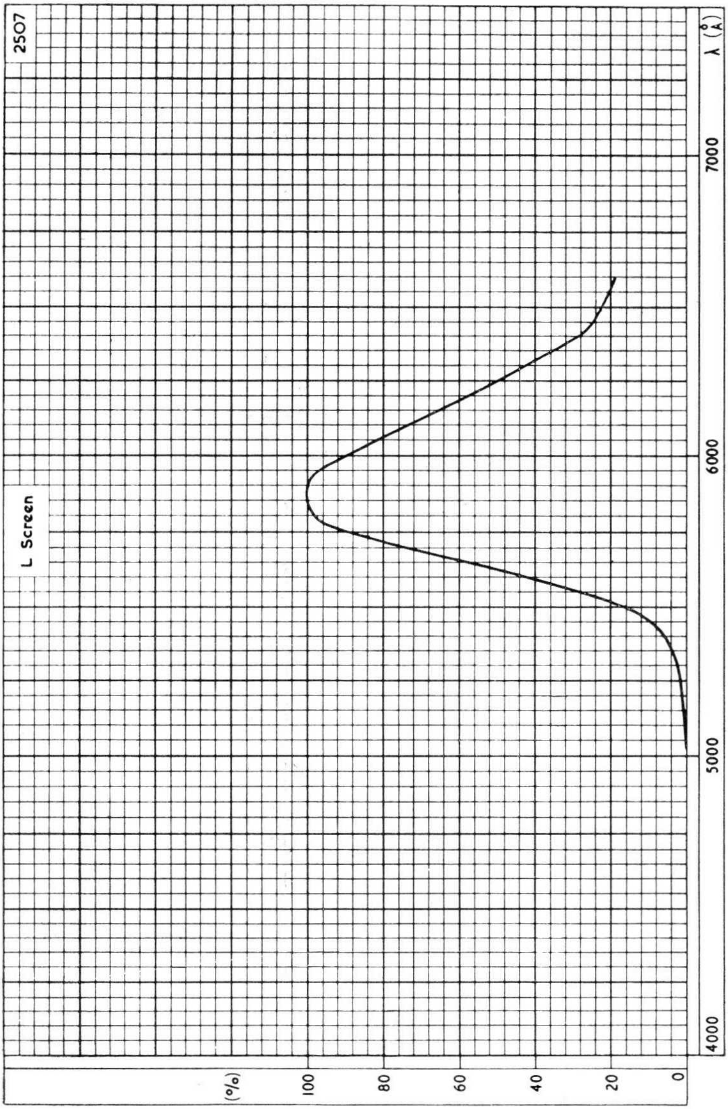
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR TYPE "H" LUMINESCENT SCREEN

CATHODE RAY TUBE

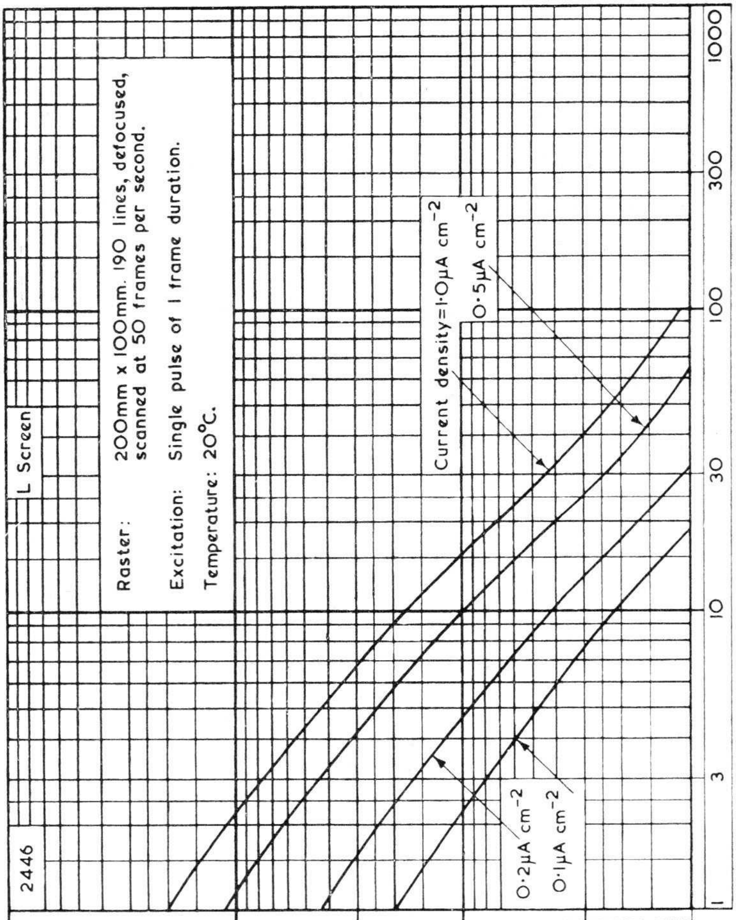
SCREEN TYPE "H"



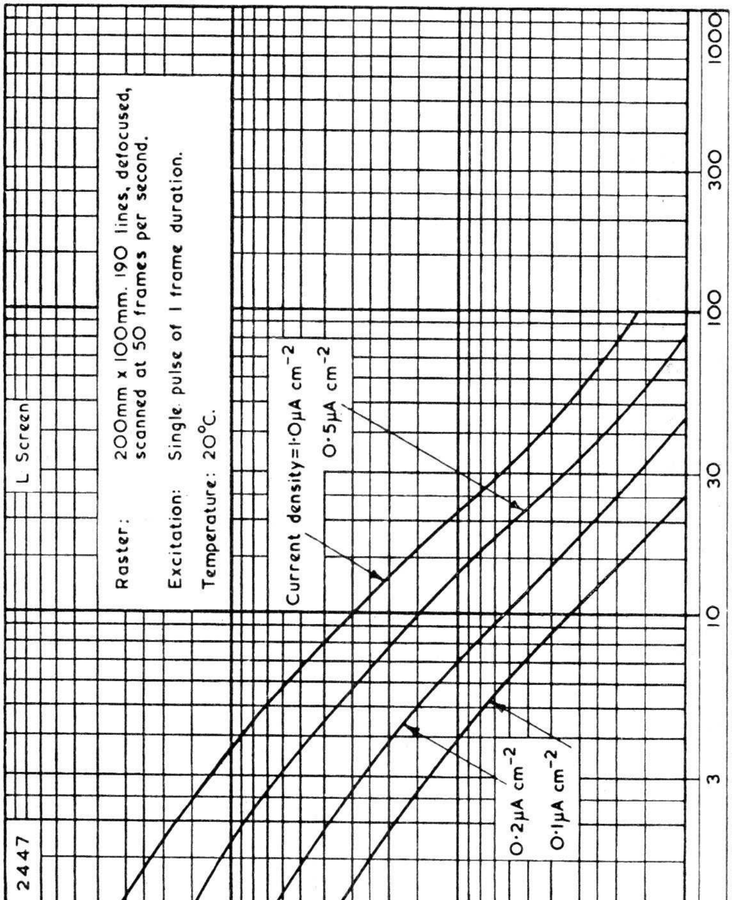
PERSISTENCE CHARACTERISTIC CURVE FOR TYPE "H" LUMINESCENT SCREEN



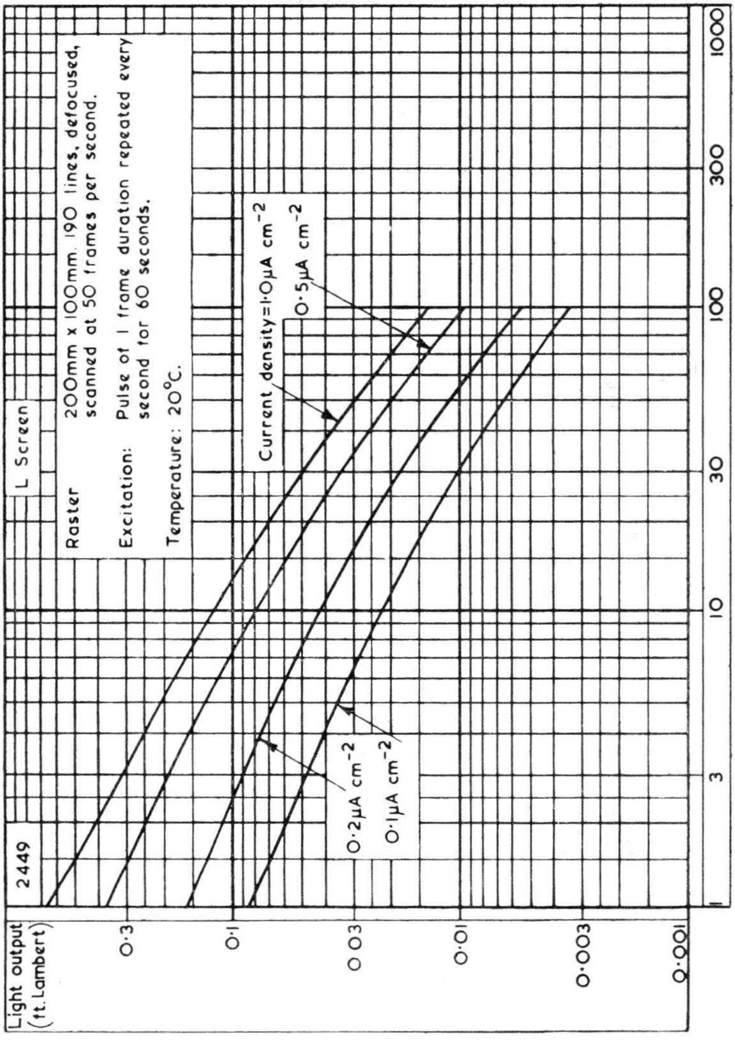
RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE 'L' LUMINESCENT SCREEN



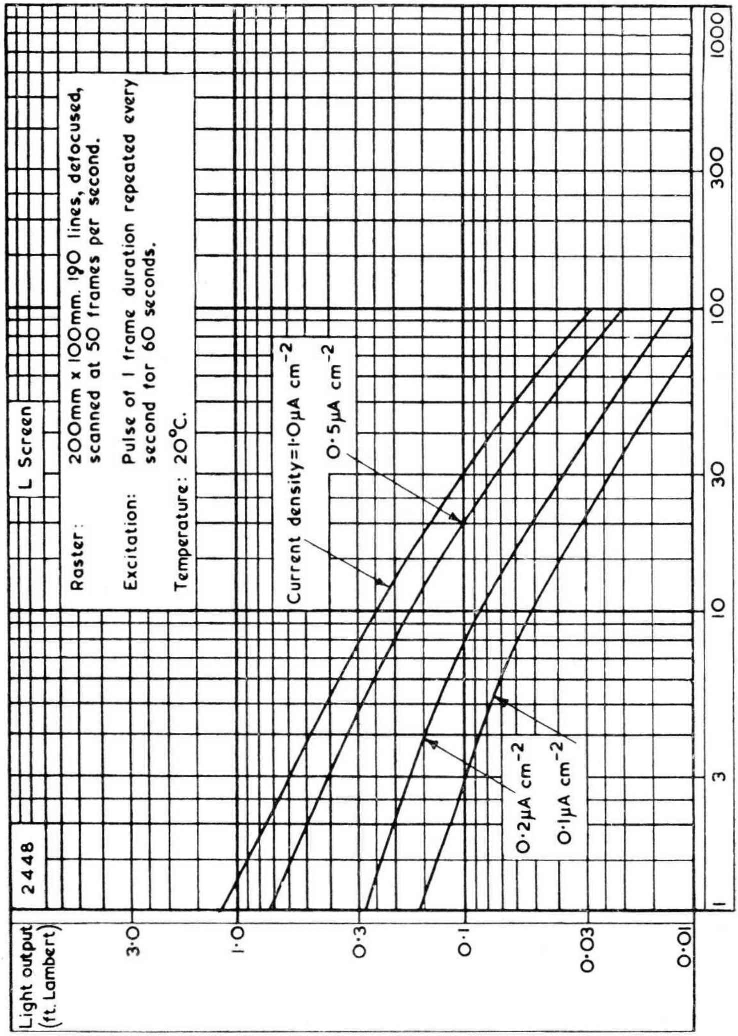
AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN ; SINGLE PULSE EXCITATION. E.H.T.=10kV.



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

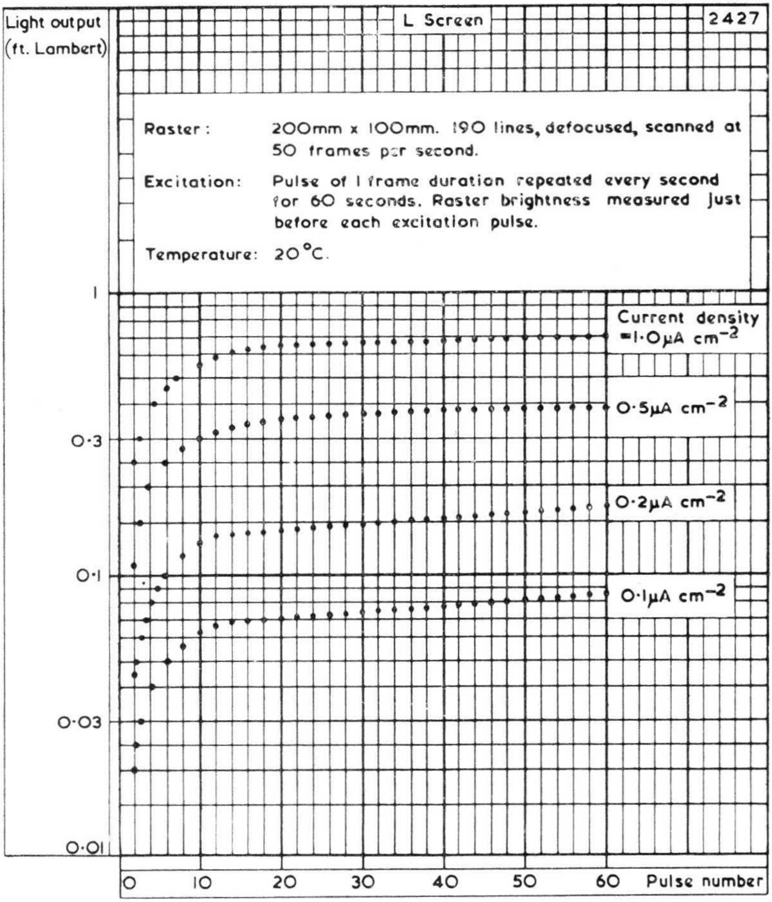


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T.=10kV

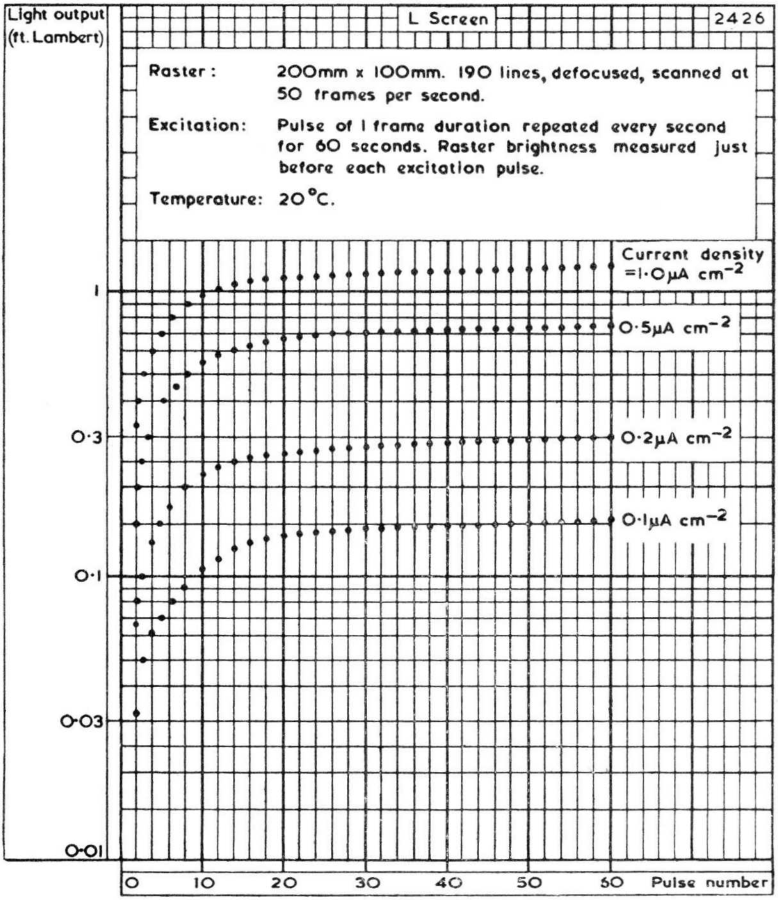


AFTERGLOW CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN;
REPEATED PULSE EXCITATION. E.H.T.=15kV

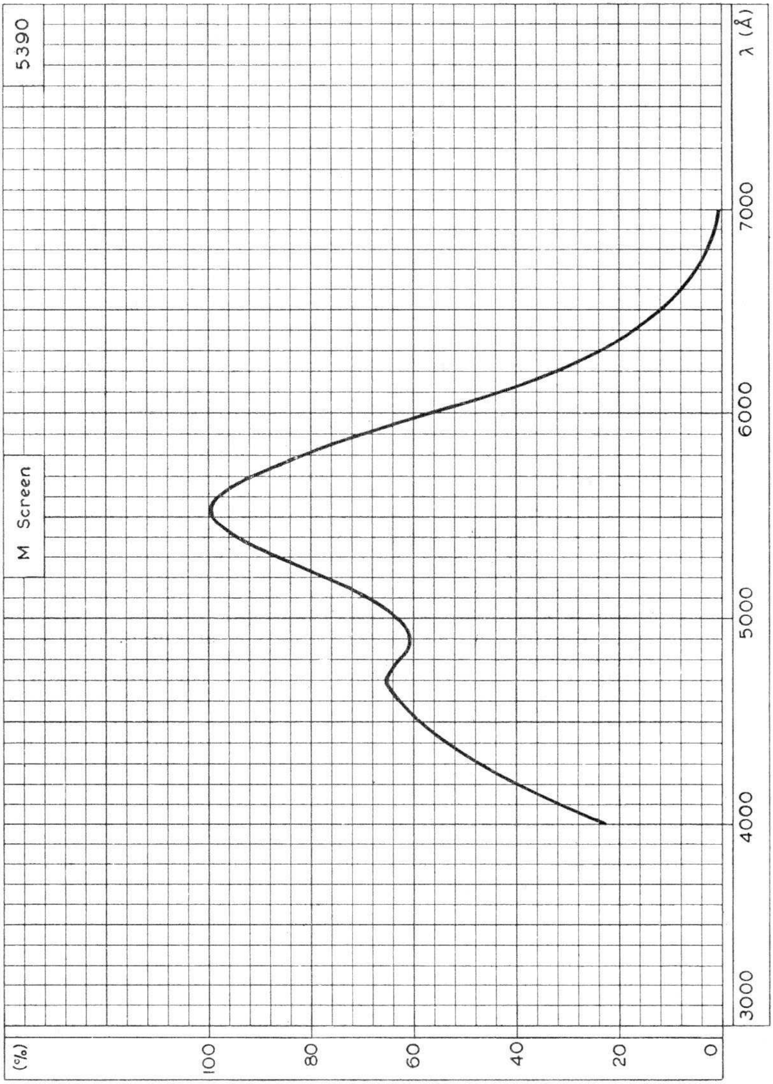
CATHODE RAY TUBE
SCREEN TYPE 'L'



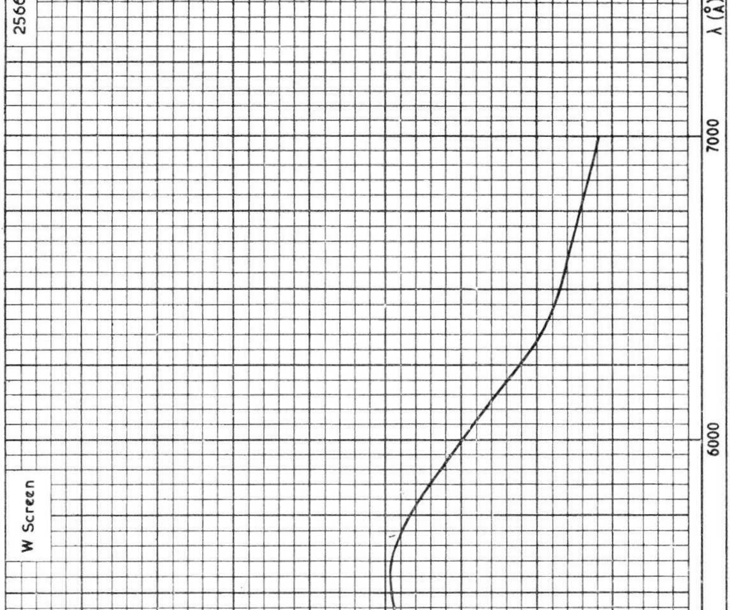
BUILD-UP CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION. E.H.T.=10kV



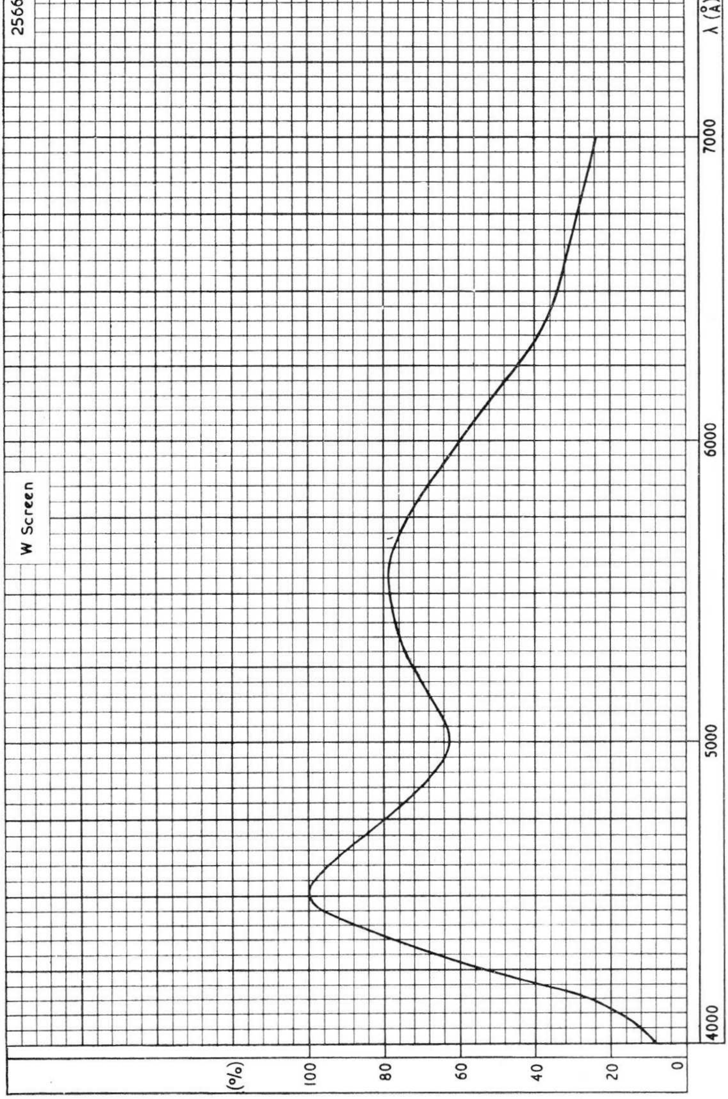
BUILD-UP CHARACTERISTIC OF TYPE 'L' LUMINESCENT SCREEN; REPEATED PULSE EXCITATION. E.H.T.=15kV.



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



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR
TYPE 'W' LUMINESCENT SCREEN (DIRECT VIEWING)



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE FOR
TYPE 'W' LUMINESCENT SCREEN (DIRECT VIEWING)

RADAR TUBE

AF22-10
AL22-10

Direct viewing radar tube with 9-in. diameter metal-backed magnesium fluoride screen, magnetic deflection and low voltage electrostatic focusing lens.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF
$c_{a2+a4-M}$	700	pF

SCREEN

Metal-backed		
Fluorescent colour	orange with orange afterglow	
Useful screen diameter	200	mm

PERSISTENCE

F screen	very long
L screen	long

See curves included in this section of the handbook for screen types F and L.

FOCUSING

Low voltage electrostatic

DEFLECTION

Double magnetic

AF22-10
AL22-10

RADAR TUBE

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

OPERATING CONDITIONS

V_{a2+a4}	12	kV
†V_{a3} (focus electrode)	–200 to +200	V
V_{a1}	300	V
I_{a3}	–15 to +15	μA
V_g for cut-off	–30 to –70	V

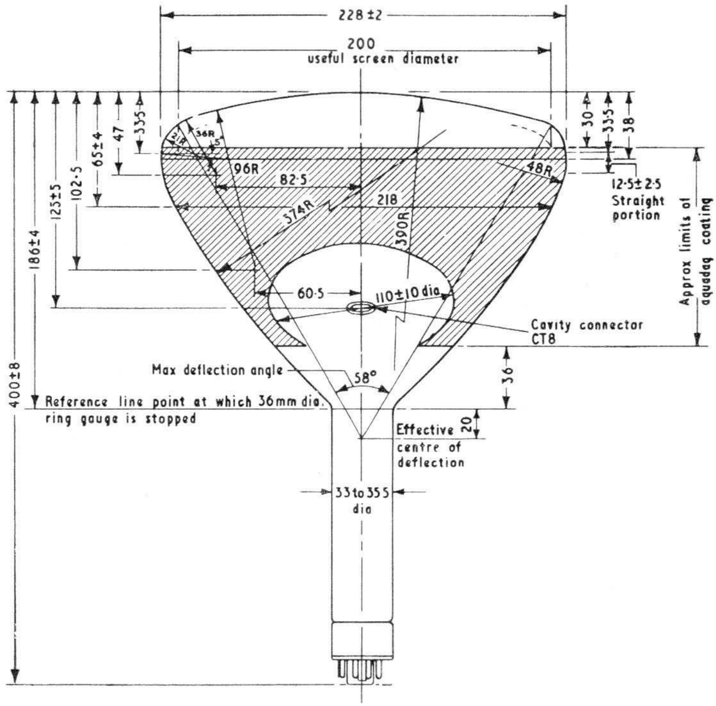
†With the small change in focus spot size with variation of focus voltage the limit of –200 to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least –300 to +300V will be required.

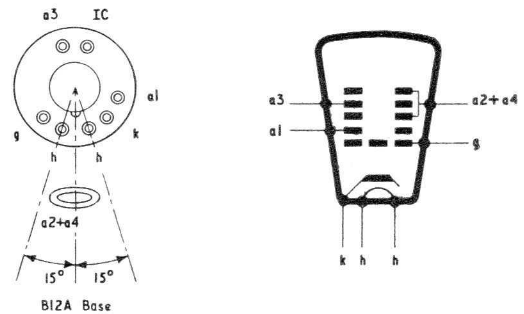
LIMITING VALUES (absolute ratings)

V_{a2+a4} max.	14	kV
V_{a2+a4} min.	8.0	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	500	V
V_{a1} max.	500	V
V_{a1} min.	200	V
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
Z_{g-k} max. (f = 50c/s)	500	kΩ
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	±150	V
R_{h-k} max.	See note*	

*When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

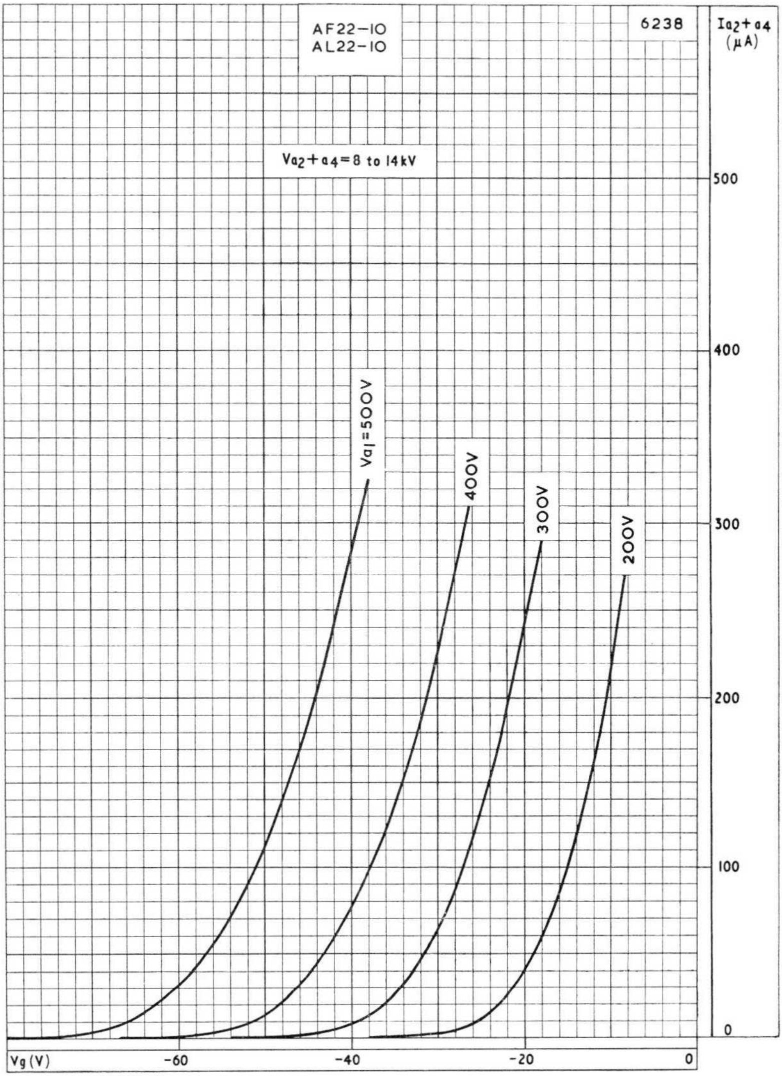
When the heater is in a series chain or earthed Z_k max. is 100kΩ where Z_k is the 50c/s impedance between earth and cathode.



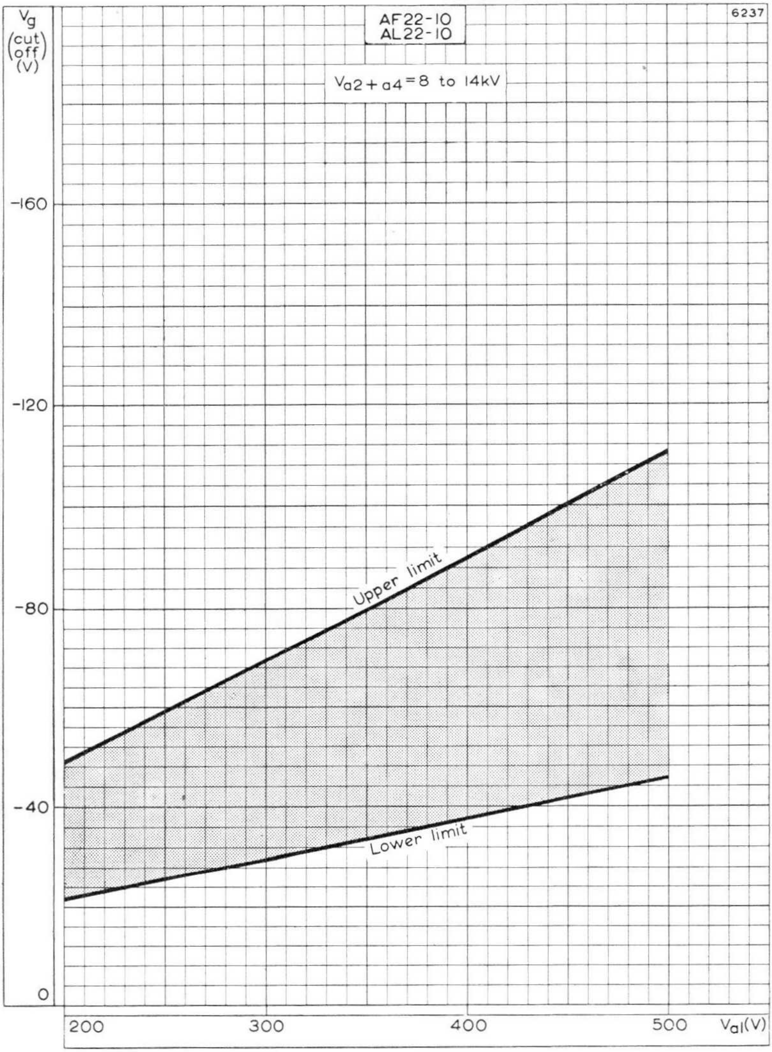


2036

All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200 TO 500V

RADAR TUBE

AF31-10
AL31-10

Direct-viewing radar tube with 12-in. diameter metal-backed magnesium fluoride screen, magnetic deflection and low voltage electrostatic focusing lens.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF
$c_{a2+a4-M}$	1200	pF

SCREEN

Metal-backed		
Fluorescent colour	orange with orange afterglow	
Useful screen diameter	265	mm

PERSISTENCE

F screen	very long
L screen	long

See curves included in this section of the handbook for screen types F and L.

FOCUSING

Low voltage electrostatic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

OPERATING CONDITIONS

V_{a2+a4}	12	kV
†V_{a3} (focus electrode)	−200 to +200	V
V_{a1}	300	V
I_{a3}	−15 to +15	μA
V_g for cut-off	−30 to −70	V

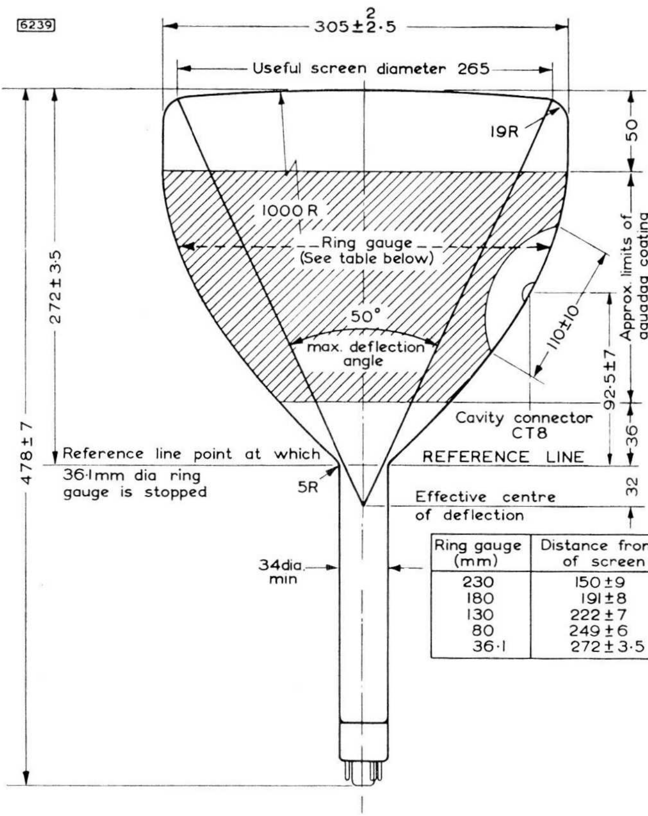
†With the small change in focus spot size with variation of focus voltage the limit of −200V to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least −300V to +300V will be required.

LIMITING VALUES (absolute ratings)

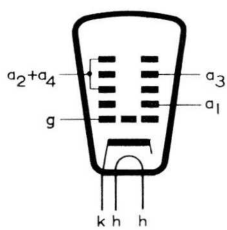
V_{a2+a4} max.	18	kV←
V_{a2+a4} min.	8.0	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	500	V
V_{a1} max.	500	V
V_{a1} min.	200	V
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
Z_{g-k} max. (f = 50c/s)	500	kΩ
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	±150	V
R_{h-k} max.	See note*	

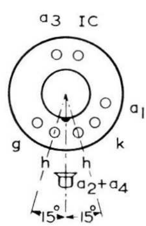
*When the heater is supplied from a separate transformer R_{h-k} max. is 1.0MΩ.

When the heater is in a series chain or earthed, Z_k max. is 100kΩ where Z_k is the 50c/s impedance between earth and cathode.



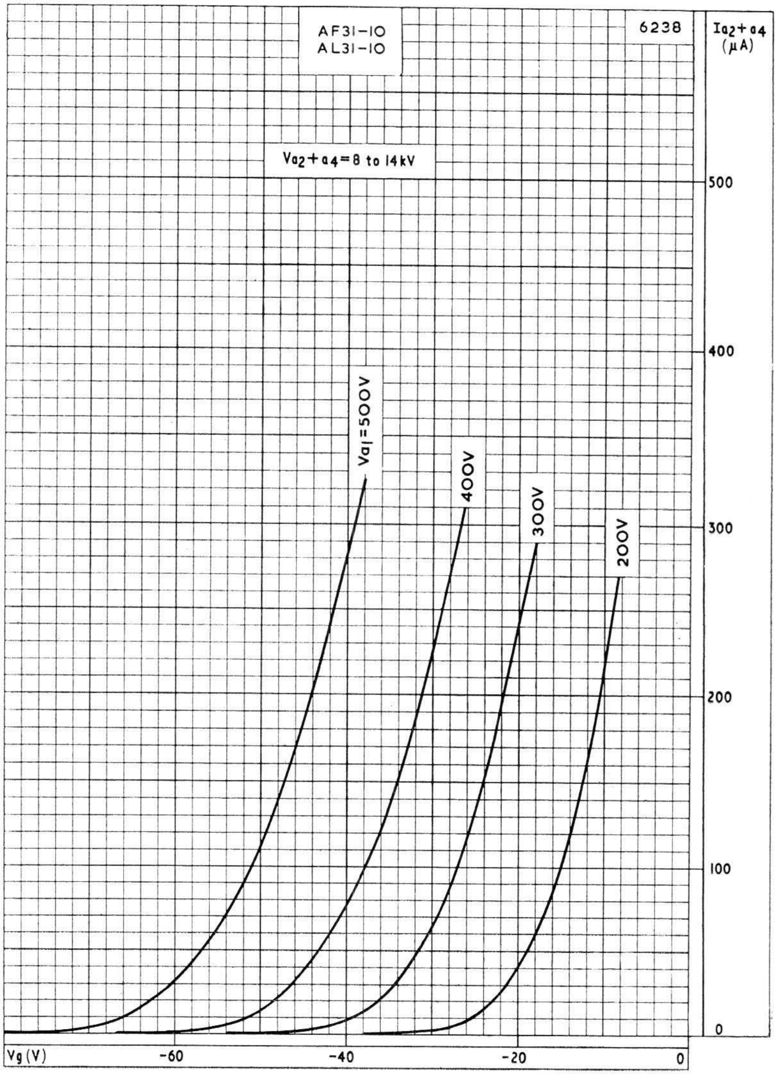
Ring gauge (mm)	Distance from centre of screen (mm)
230	150 ±9
180	191 ±8
130	222 ±7
80	249 ±6
36·1	272 ±3·5



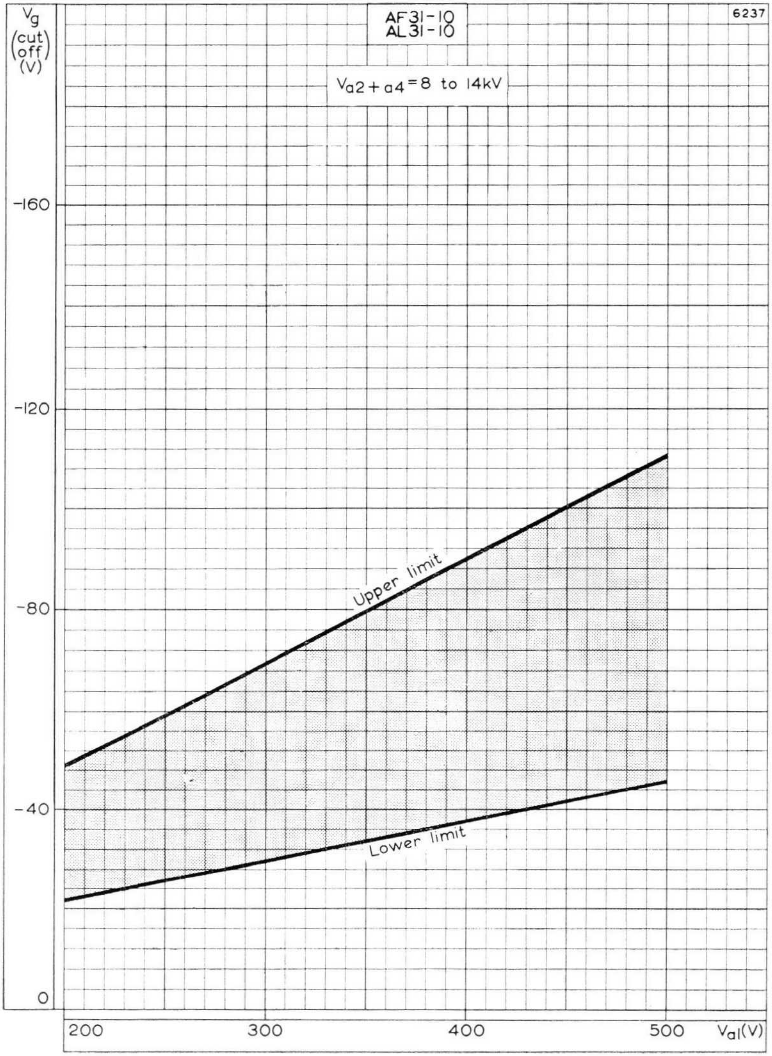


B12A Base

All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200V TO 500V

RADAR TUBE

AL13-36

Direct viewing radar tube with 5-in. metal-backed magnesium fluoride screen, magnetic deflection and low voltage electrostatic focusing.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF

SCREEN

Metal-backed		
Fluorescent colour	orange with orange afterglow	
Useful screen diameter	108	mm

PERSISTENCE

long

See curves preceding this section of the handbook for screen type L

FOCUSING

Low voltage electrostatic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downward and the axis of the tube making an angle less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a2+a4}	12	kV
V_{a1}	300	V
*V_{a3} (focusing electrode)	−200 to +200	V
I_{a3}	−15 to +15	μA
V_g (cut off)	−30 to −70	V

*With the small change in focus spot size with variation of focus voltage the limit of −200 to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least −300 to +300V will be required.

AL13-36

RADAR TUBE

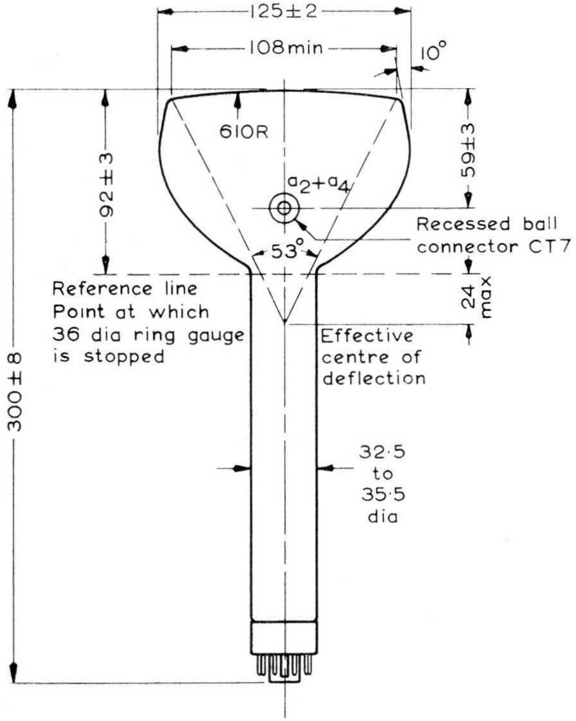
LIMITING VALUES (absolute ratings)

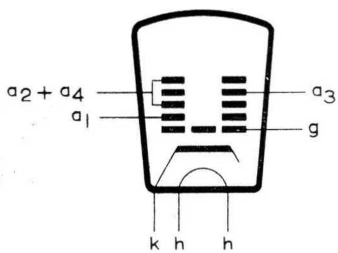
V_{a2+a4} max.	14	kV
V_{a2+a4} min	8.0	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	500	V
V_{a1} max.	500	V
V_{a1} min.	200	V
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
V_{h-k} max.	$\pm$150	V
Z_{g-k} max. ($f = 50c/s$)	500	kΩ
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	See note*	

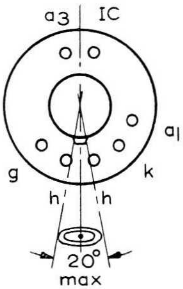
*When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

WEIGHT

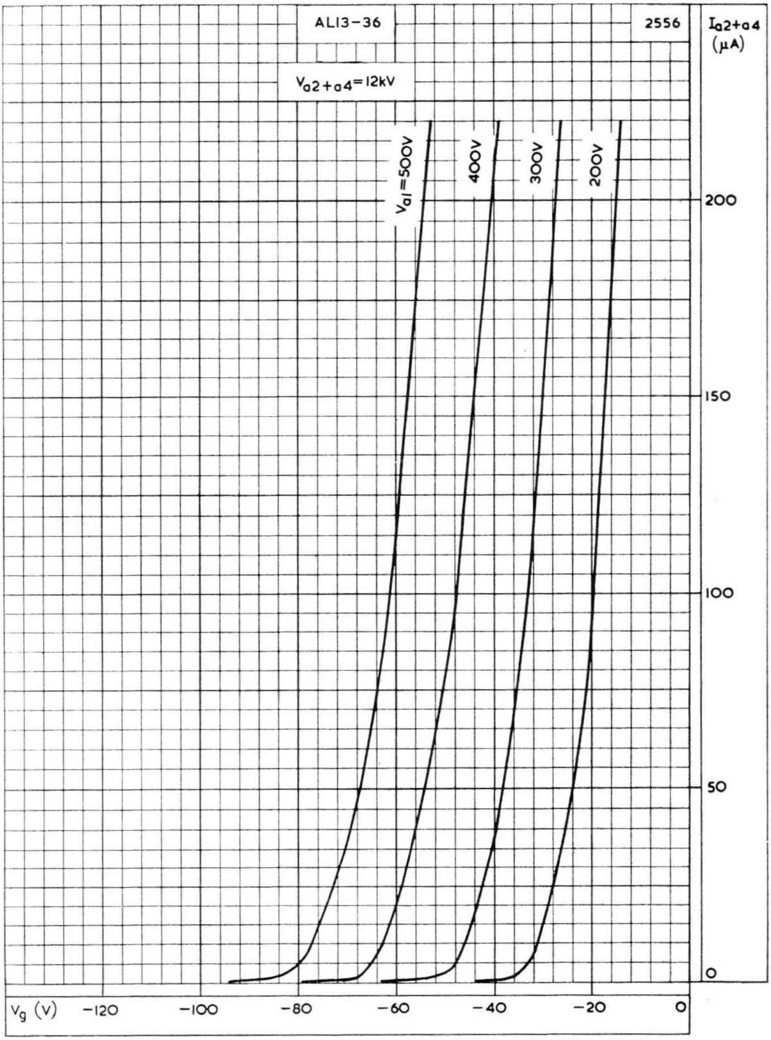
Tube only	500	g
	1 lb	2 oz



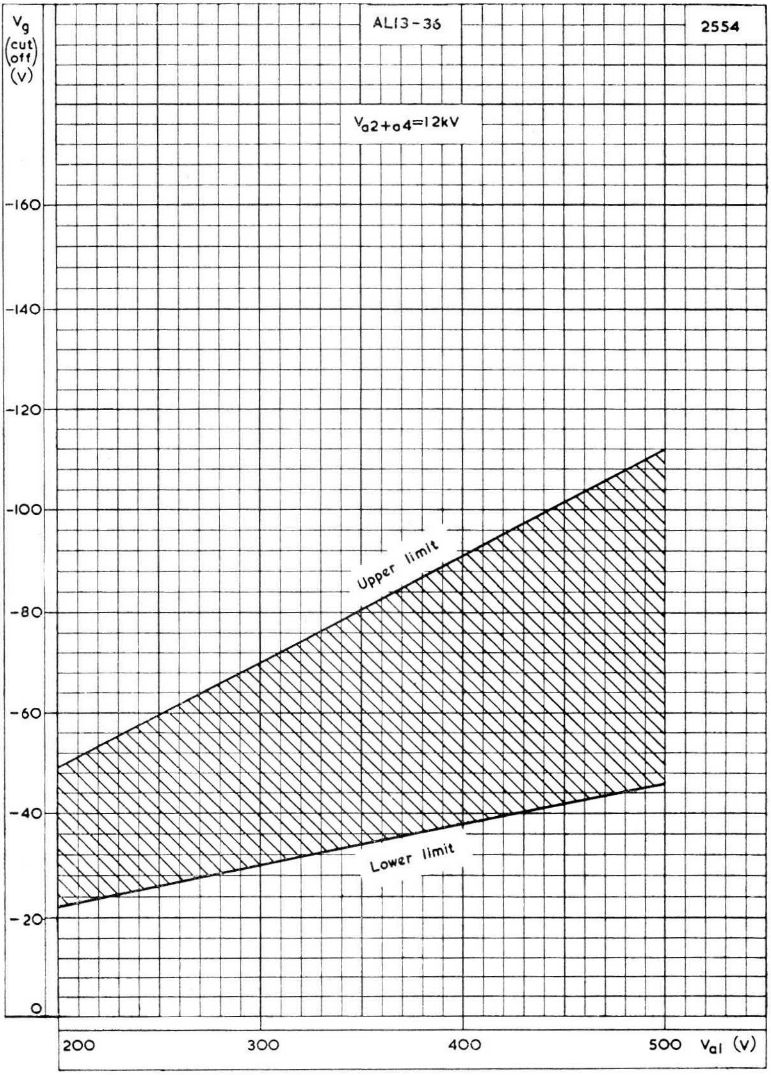




5970 All dimensions in mm B12A Base



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200 TO 500V

TELEVISION VIEWFINDER TUBE

AW13-36

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution it is primarily intended for use as a television camera viewfinder tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only)—The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF

SCREEN

Metal-backed		
Fluorescent colour	White	
Useful screen diameter	108	mm

FOCUSING

Low voltage electrostatic.

DEFLECTION

Double magnetic.

MOUNTING POSITION

Any, except vertical with the screen downward and the axis of the tube making an angle less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a2+a4}	12	kV
V_{a1}	300	V
*V_{a3} (focusing electrode)	−200 to +200	V
I_{a3}	−15 to +15	μA
V_g for cut-off	−30 to −70	V

*With the small change in focus spot size with variation of focus voltage the limit of −200 to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least −300 to +300V will be required.

AW13-36

TELEVISION VIEWFINDER TUBE

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution it is primarily intended for use as a television camera viewfinder tube.

LIMITING VALUES (absolute ratings)

**V_{a2+a4} max.	14	kV
V_{a2+a4} min.	8.0	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	500	V
V_{a1} max.	500	V
V_{a1} min.	200	V
$-V_g$ max.	200	V
*$-V_g$ min.	1.0	V
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
††$v_{h-k(pk)}$ max. (cathode positive)	410	V
Z_{g-k} max. (f = 50c/s)	500	kΩ
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	See note §	
Max. a_1 supply source impedance	1.5	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the equipment on or off when it may be allowed to rise to +1V. The maximum positive grid excursion of the video signal may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

**The product of V_{a2+a4} and I_t (average value for the whole screen) must not exceed 6W.

†In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

††During a warming-up period not exceeding 45s.

§When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

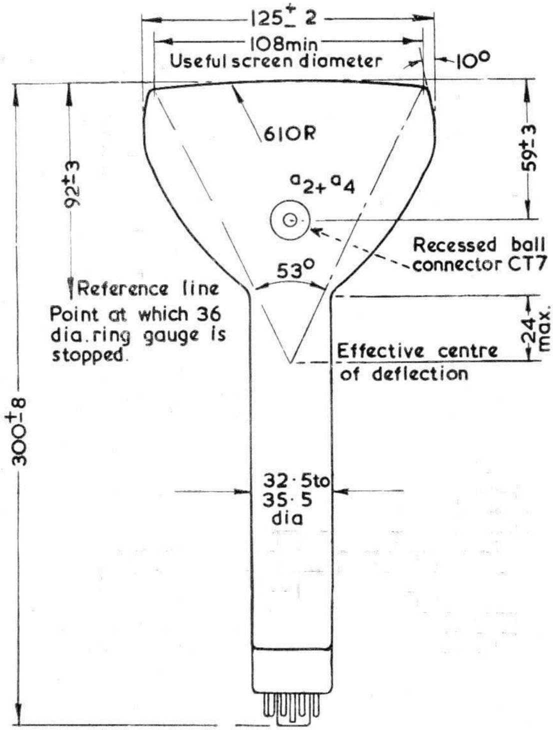
WEIGHT

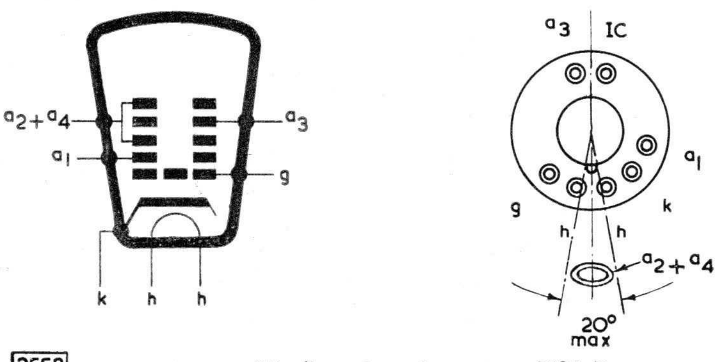
Tube alone	500	g
	1 lb	2 oz

TELEVISION VIEWFINDER TUBE

AW13-36

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution primarily intended for use as a television camera viewfinder tube.





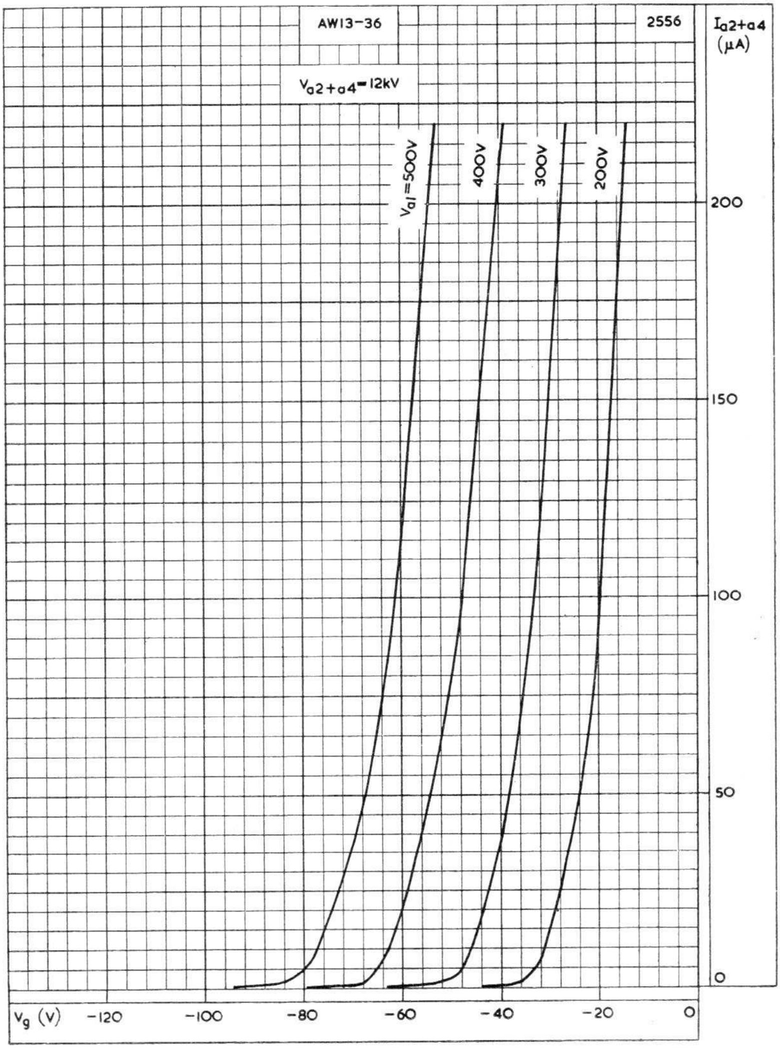
2558

All dimensions in mm. B12A Base

AW13-36

TELEVISION VIEWFINDER TUBE

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution it is primarily intended for use as a television camera viewfinder tube.

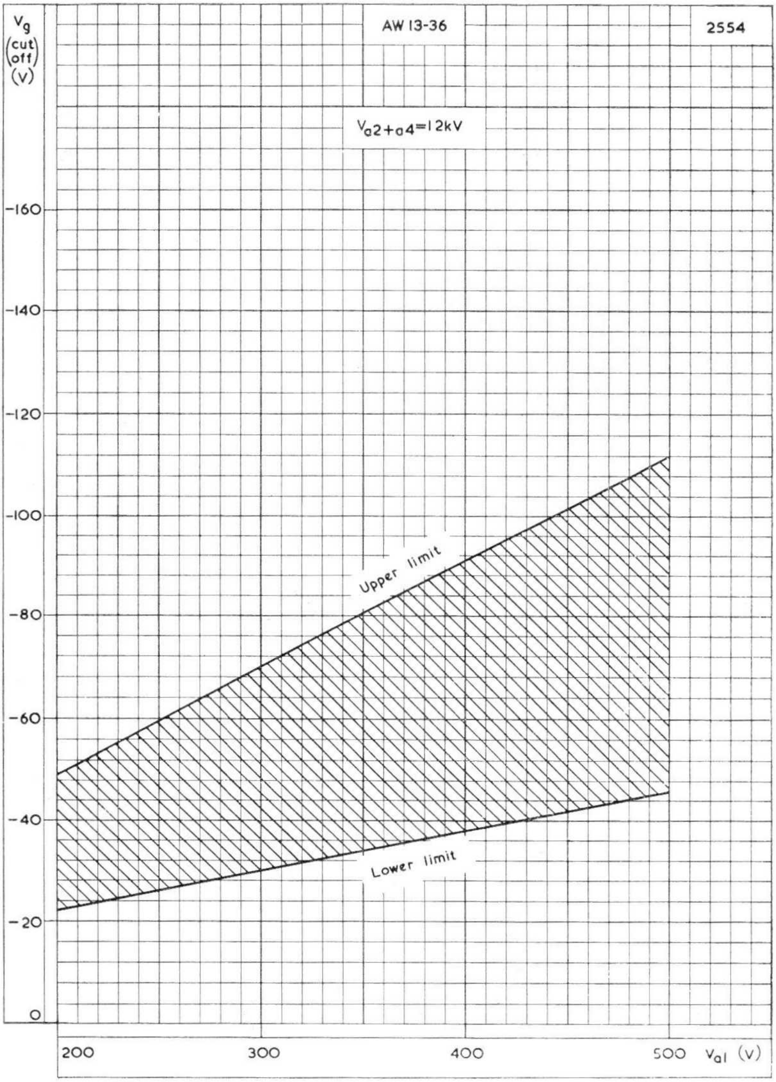


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

TELEVISION VIEWFINDER TUBE

AW13-36

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution it is primarily intended for use as a television camera viewfinder tube.

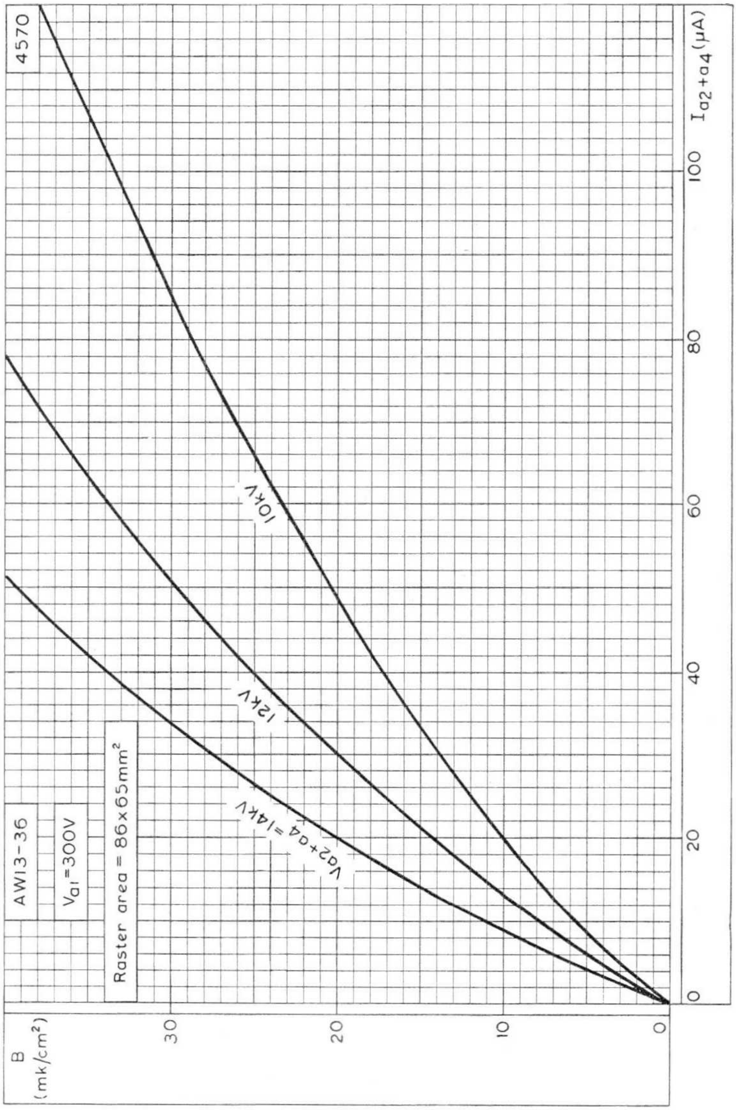


LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200 TO 500V

AW13-36

TELEVISION VIEWFINDER TUBE

Direct viewing television tube with 5-in. diameter metal-backed screen. Having electrostatic focusing and good resolution it is primarily intended for use as a television camera viewfinder tube.



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT ←
(1 mk/cm² = 2.9 e.f.c. = 2.9 ft—lambert)

TELEVISION MONITOR TUBE

AW17-20

Direct viewing television tube with 7-in. diagonal rectangular metal-backed screen. This tube has electrostatic focusing and magnetic deflection.

PRELIMINARY DATA

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES preceding this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note—(applies to series operation only)—The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF
$c_{a2+a4-M}$	>350	pF

SCREEN

Metal-backed	
Fluorescent colour	white
Useful screen area	see drawing on page D3

FOCUSING

Low voltage electrostatic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downward and the axis of the tube making an angle less than 20° with the vertical.

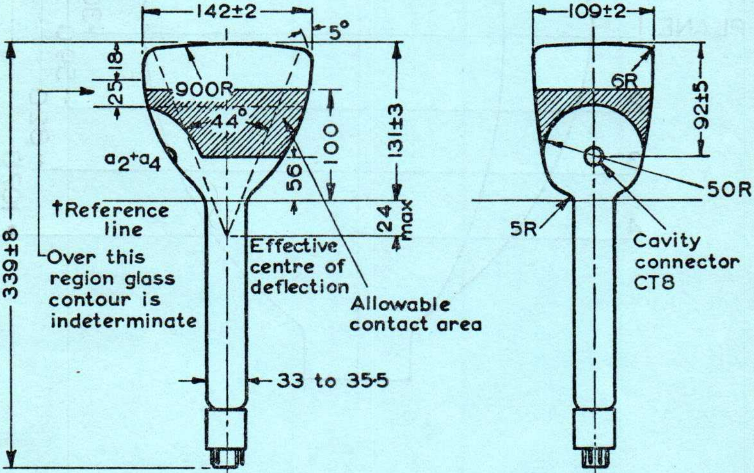
TYPICAL OPERATING CONDITIONS

V_{a2+a4}	12	kV
V_{a1}	300	V
$^*V_{a3}$ (focusing electrode)	−200 to +200	V
I_{a3}	−15 to +15	μA
V_g for cut-off	−30 to −80	V

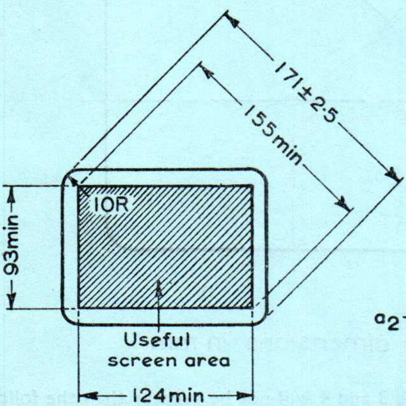
*With the small change in focus spot size with variation of focus voltage the limit of −200 to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least −300 to +300V will be required.

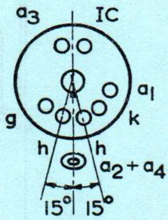
AW17-20

3850

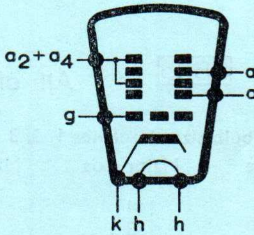


† Reference line is determined by position where gauge of 36·0 internal diameter rests.

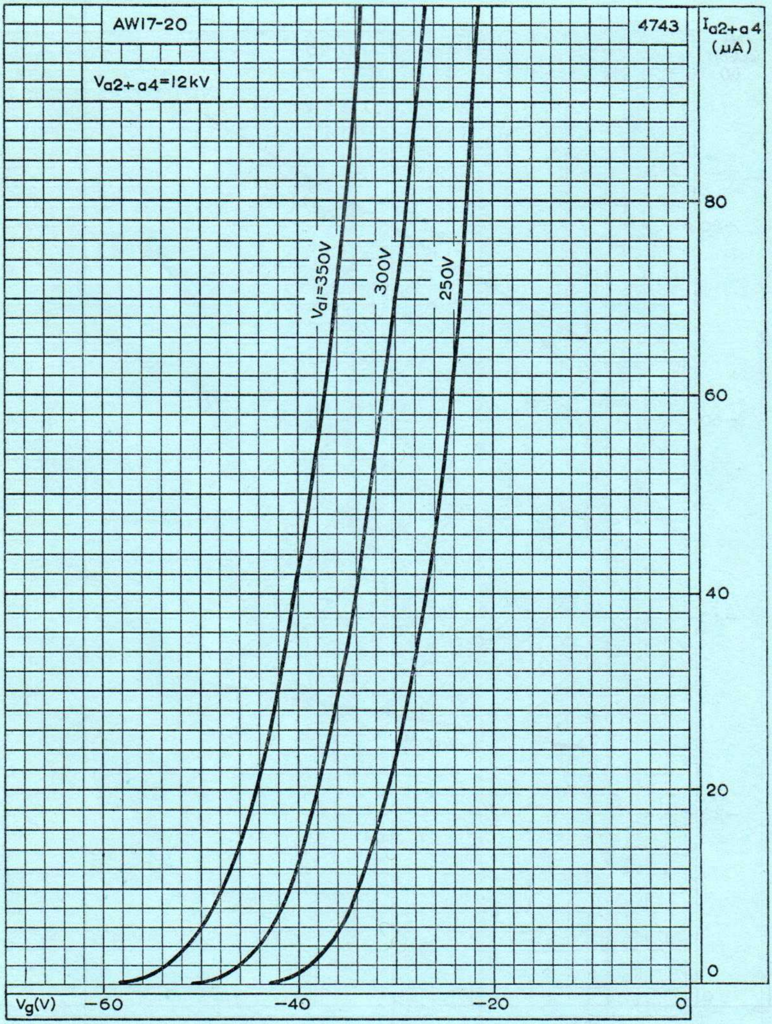




B12A Base



All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

TELEVISION MONITOR TUBE

AW22-10

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only). The surge heater voltage must not exceed $9.5V_{r.m.s}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF
$c_{a2+a4-M}$	700	pF

SCREEN

Metal-backed		
Fluorescent colour	white	
Useful screen diameter	200	mm

FOCUSING

Low voltage electrostatic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downward and the axis of the tube making an angle of less than 20° with the vertical.
The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

TYPICAL OPERATING CONDITIONS

V_{a2+a4}	12	kV
V_{a1}	300	V
**V_{a3} (focusing electrode)	–200 to +200	V
I_{a3}	–15 to +15	μA
V_g (for cut-off)	–30 to –70	V

**With the small change in focus spot size with variation of focus voltage the limit of –200 to +200V is such that an acceptable focus quality is obtained within this range. If it is required to pass through the point of focus a voltage of at least –300 to +300V will be required.

AW22-10

TELEVISON MONITOR TUBE

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.

LIMITING VALUES (absolute ratings)

‡V_{a2+a4} max.	14	kV
V_{a2+a4} min.	8.0	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	500	V
V_{a1} max.	500	V
V_{a1} min.	200	V
*$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
†V_{h-k} max. (cathode negative)	125	V
††$v_{h-k(pk)}$ max. (cathode positive)	410	V
†V_{h-k} max. (cathode positive)	200	V
Z_{g-k} max. (f=50c/s)	500	kΩ
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	See note §	
Max. $_{a1}$ supply source impedance	1.5	MΩ

*The d.c. 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 may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

‡The product of V_{a2} and I_t (average value for the whole screen) must not exceed 6W.

†In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

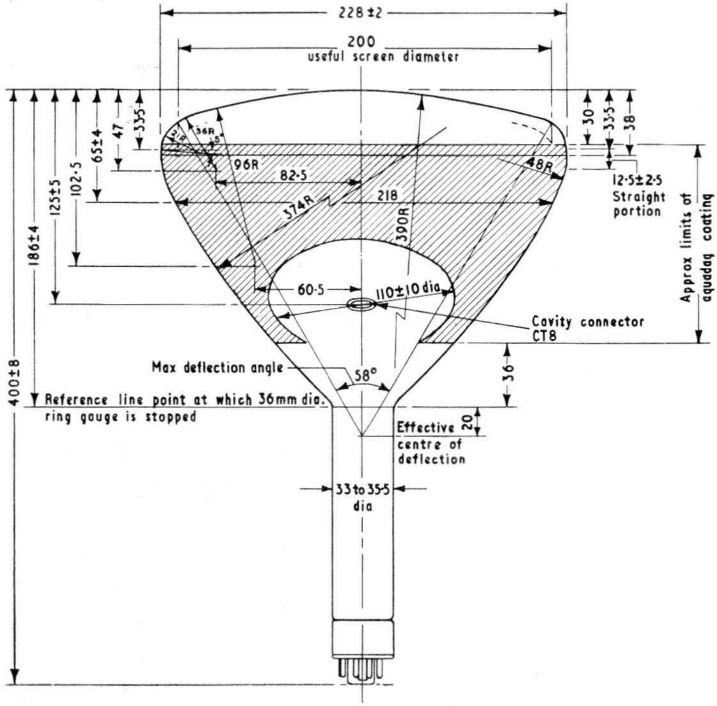
††During a warming-up period not exceeding 45sec.

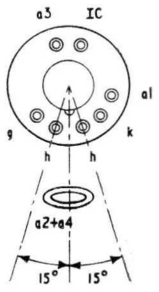
§When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

TELEVISION MONITOR TUBE

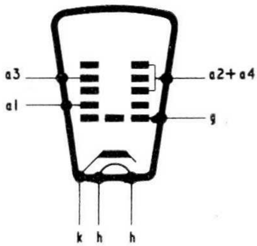
AW22-10

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.





B12A Base



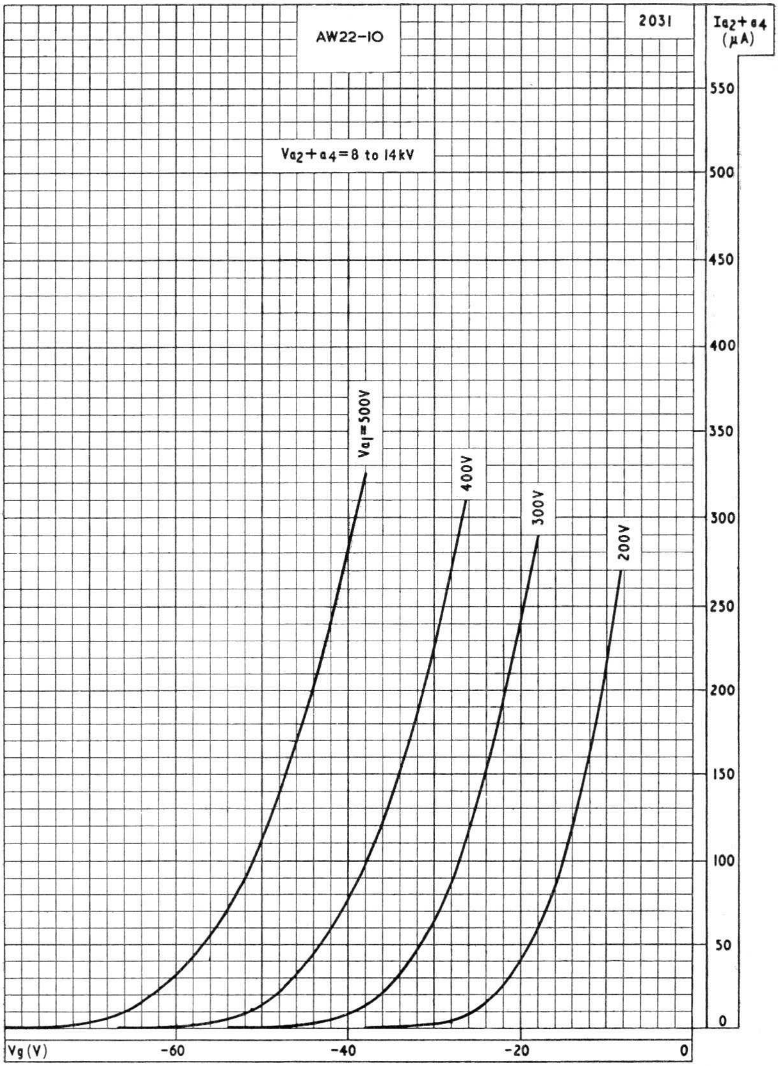
2036

All dimensions in mm

AW22-10

TELEVISION MONITOR TUBE

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.

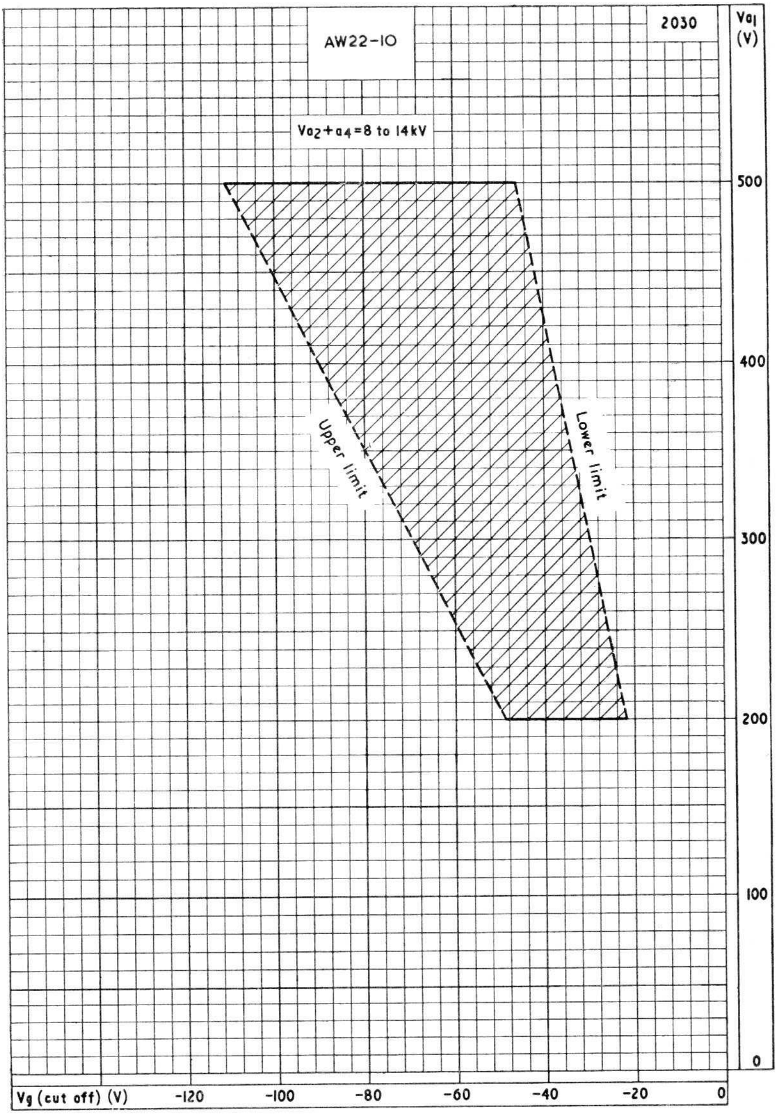


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

TELEVISION MONITOR TUBE

AW22-10

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.

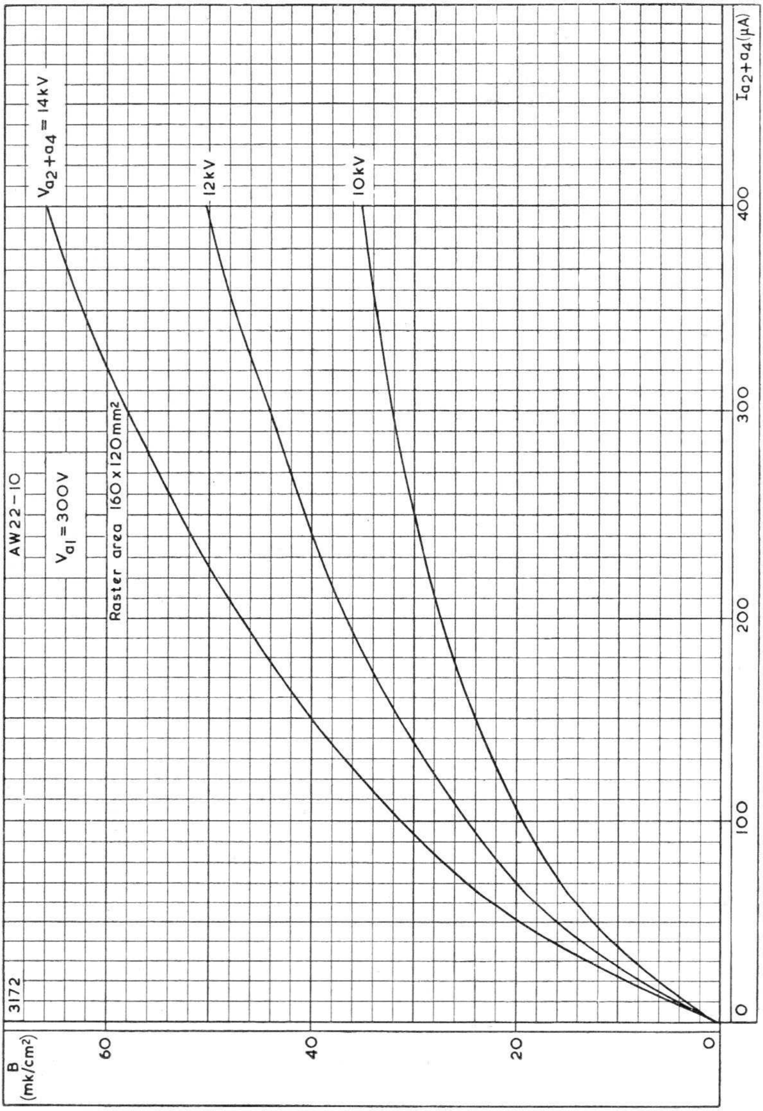


LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200 to 500V

AW22-10

TELEVISION MONITOR TUBE

Direct viewing television tube with 9-in. diameter metal-backed screen, magnetic deflection and low voltage electrostatic focusing lens. Primarily intended for use as a television studio monitor tube.



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT
(1mk/cm² = 2.9 e.f.c. = 2.9 ft-lambert)

OSCILLOSCOPE TUBES

DB7-5
DG7-5
DP7-5

Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for symmetrical deflection.

HEATER

Suitable for parallel operation only.

V_h	6.3	V
I_h	310	mA

CAPACITANCES

c_{g-all}	10	pF
$c_{x'-all}$ (x'' earthed)	4.5	pF
$c_{x''-all}$ (x' earthed)	4.5	pF
$c_{y'-all}$ (y'' earthed)	5.3	pF
$c_{y''-all}$ (y' earthed)	5.3	pF
$c_{x'x''-all}$	8.0	pF
$c_{y'y''-all}$	6.0	pF
$c_{x'x''-y'y''}$	0.2	pF

SCREEN

Fluorescent colour :—

DB7–5	blue
DG7–5	green
DP7–5	blue with green afterglow

Persistence :—

DB7–5	short
DG7–5	medium
DP7–5	long

FOCUSING
Electrostatic

DEFLECTION
Double electrostatic

Both x and y plates are suitable for symmetrical operation.
It is recommended that a_2 be earthed.

MOUNTING POSITION
Any

These tubes should not be supported by the base alone.

TYPICAL OPERATING CONDITIONS

V_{a2}	800	V
V_{a1}	200 to 300	V
* V_g	0 to −50	V
I_{a2}	0 to 205	μA
I_{a1}	0 to 500	μA
S_x	0.16	mm/V
S_y	0.25	mm/V
** Line width	0.7	mm

* In no circumstances must the grid be allowed to become positive with respect to the cathode.

** Measured on a circle of 50mm. diameter with $I_t = 0.5\mu A$

DB7-5
DG7-5
DP7-5

OSCILLOSCOPE TUBES

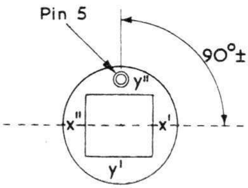
Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for symmetrical deflection.

DEFLECTION SENSITIVITY LIMITS

S_x	0.13 to 0.19	mm/V
S_y	0.21 to 0.28	mm/V

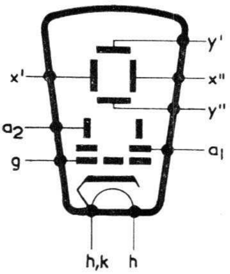
LIMITING VALUES (Design centre ratings)

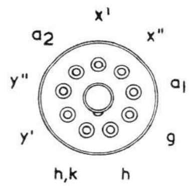
V_{a2} max.	1.0	kV
V_{a2} min.	800	V
V_{a1} max.	400	V
$-V_g$ max.	100	V
$v_{x'-x''\,(pk)}$ max.	750	V
$v_{y'-y''\,(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm²
R_{x-a2} max.	5.0	MΩ
R_{y-a2} max.	5.0	MΩ
R_{g-k} max.	500	kΩ



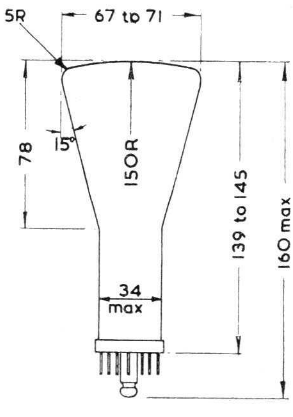
Orientation of axes of deflection as viewed from screen end.

2336





B9G Base

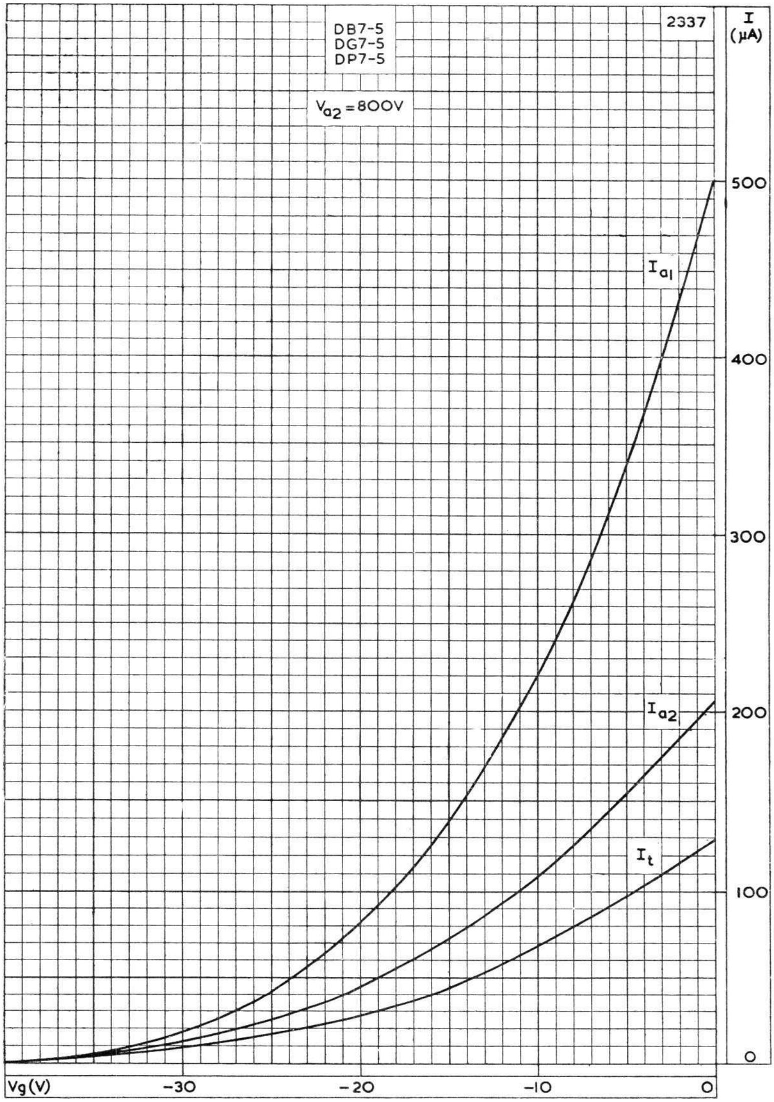


All dimensions in mm

OSCILLOSCOPE TUBES

DB 7-5
DG 7-5
DP 7-5

Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for symmetrical deflection.



FIRST AND SECOND ANODE AND SCREEN CURRENTS PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBES

DB 7-6
DG7-6
DP 7-6

Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for asymmetrical deflection.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	310	mA

CAPACITANCES

c_{g-all}	10	pF
$c_{x'-all}$ (x″ earthed)	4.5	pF
$c_{x''-all}$ (x′ earthed)	4.5	pF
$c_{y'-all}$ (y″ earthed)	5.3	pF
$c_{y''-all}$ (y′ earthed)	5.3	pF
$c_{x'x''-all}$	8.0	pF←
$c_{y'y''-all}$	6.0	pF←
$c_{x'x''-y'y''}$	0.2	pF←

SCREEN

Fluorescent colour:—

DB7–6	blue
DG7–6	green
DP7–6	blue with green afterglow

Persistence:—

DB7–6	short
DG7–6	medium
DP7–6	long

FOCUSING Electrostatic

DEFLECTION Double electrostatic

x plates suitable for asymmetrical operation

y plates suitable for symmetrical operation

Plate x′ must be connected to a_2 and it is recommended that a_2 be earthed.

MOUNTING POSITION Any

These tubes should not be supported by the base alone.

TYPICAL OPERATING CONDITIONS

V_{a2}	800	V
V_{a1}	200 to 300	V
* V_g	0 to −50	V
I_{a2}	0 to 205	μA←
I_{a1}	0 to 500	μA
S_x	0.16	mm/V
S_y	0.25	mm/V←
** Line width	0.7	mm

* In no circumstances must the grid be allowed to become positive with respect to the cathode.

** Measured on a circle of 50 mm. diameter with $I_t = 0.5\mu A$

DB7-6
DG7-6
DP7-6

OSCILLOSCOPE TUBES

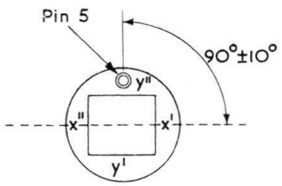
Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for asymmetrical deflection.

DEFLECTION SENSITIVITY LIMITS

S_x	0.13 to 0.19	mm/V
S_y	0.21 to 0.28	mm/V

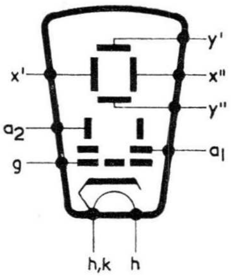
LIMITING VALUES (Design centre ratings)

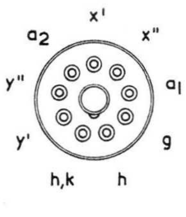
V_{a_2} max.	1.0	kV
V_{a_2} min.	800	V
V_{a_1} max.	400	V
$-V_g$ max.	100	V
$v_{x'-x''\,(pk)}$ max.	750	V
$v_{y'-y''\,(pk)}$ max.	450	V
$p_{t\,(av)}$ max.	3.0	mW/cm²
R_{x-a_2} max.	5.0	MΩ
R_{y-a_2} max.	5.0	MΩ
R_{g-k} max.	500	kΩ



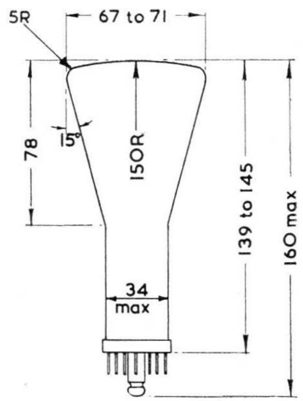
Orientation of axes of deflection as viewed from screen end.

2336



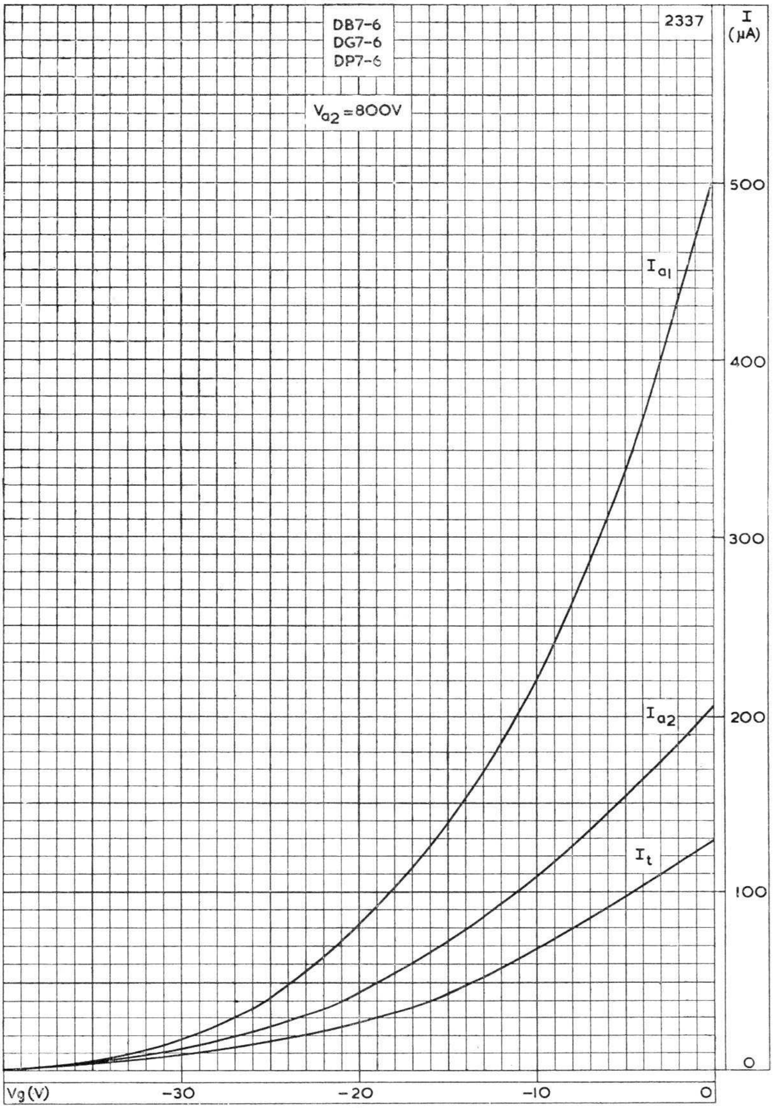


B9G Base

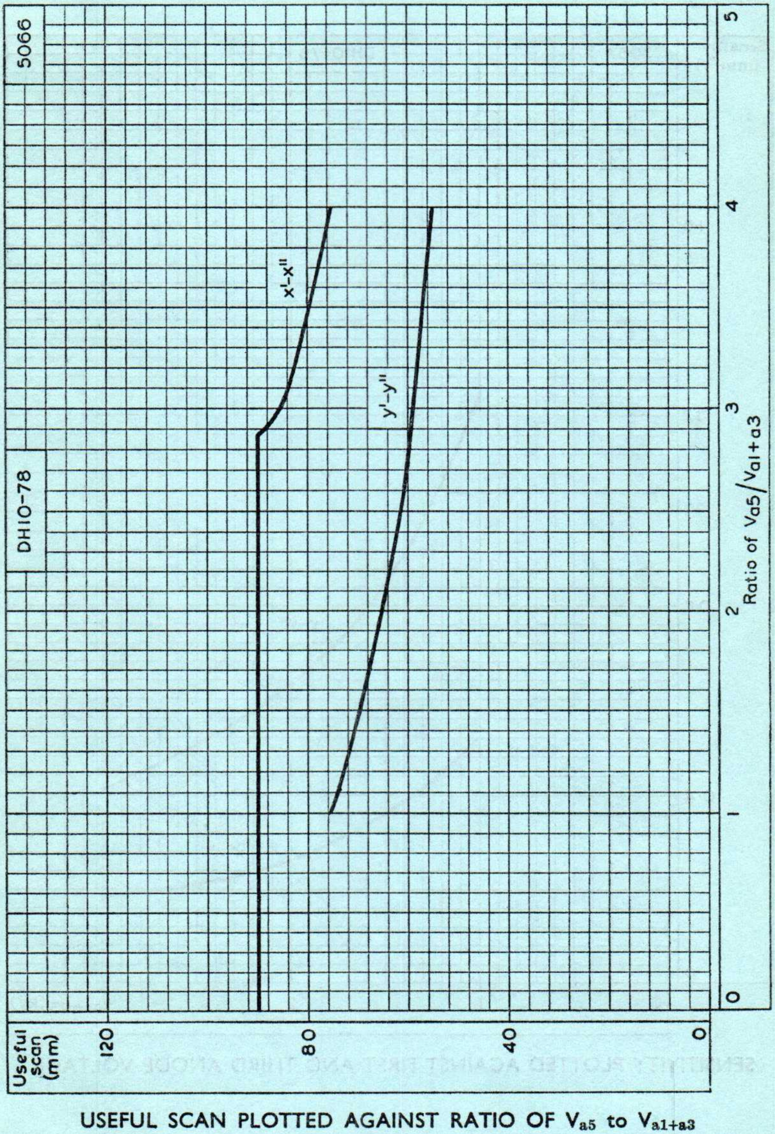


All dimensions in mm

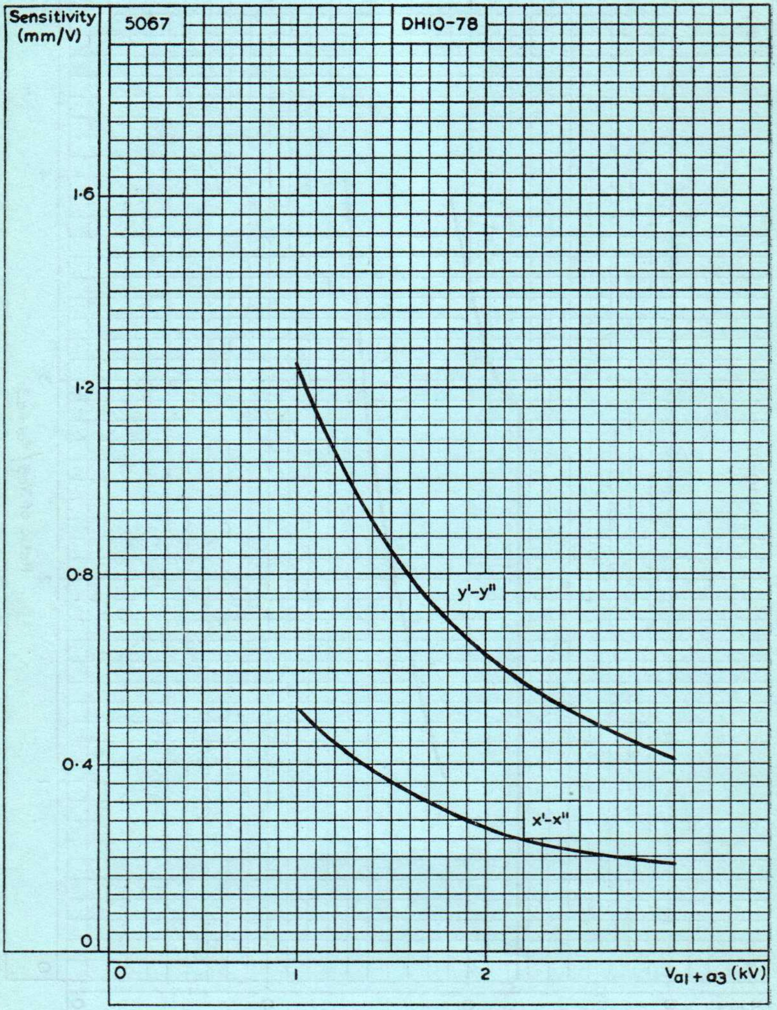
Direct viewing oscilloscope tubes with $2\frac{3}{4}$ in. diameter screen. Intended for asymmetrical deflection.



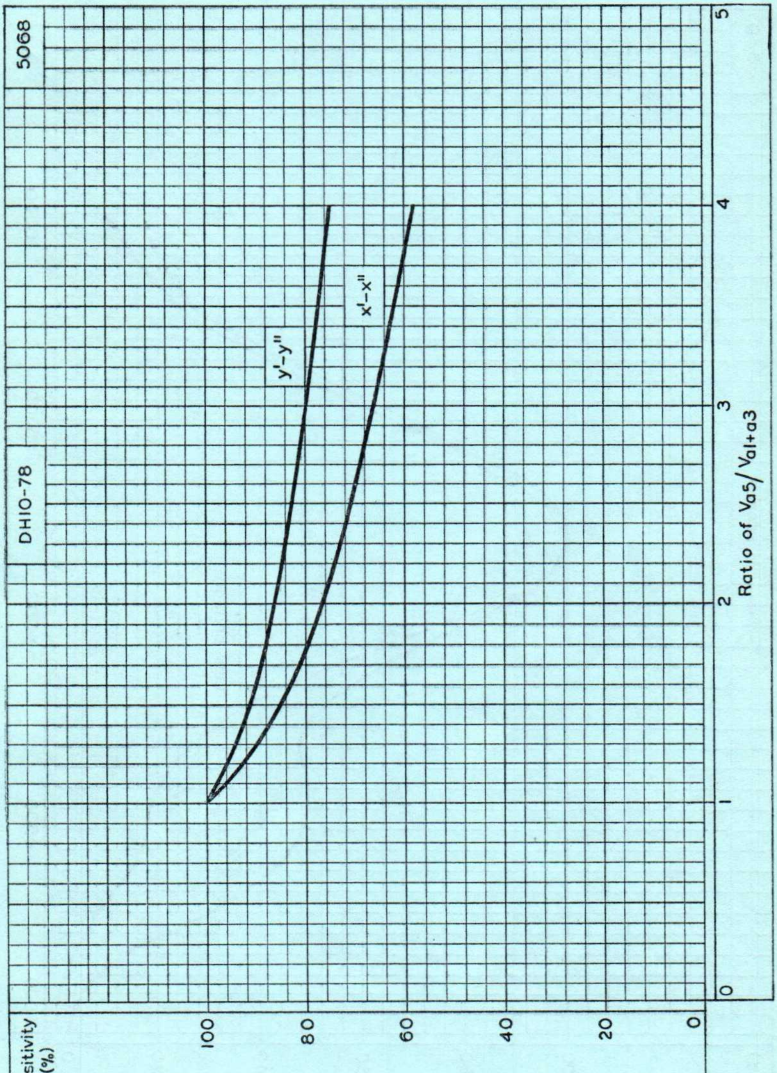
FIRST AND SECOND ANODE AND SCREEN CURRENTS PLOTTED AGAINST GRID VOLTAGE



USEFUL SCAN PLOTTED AGAINST RATIO OF V_{a5} to V_{a1+a3}



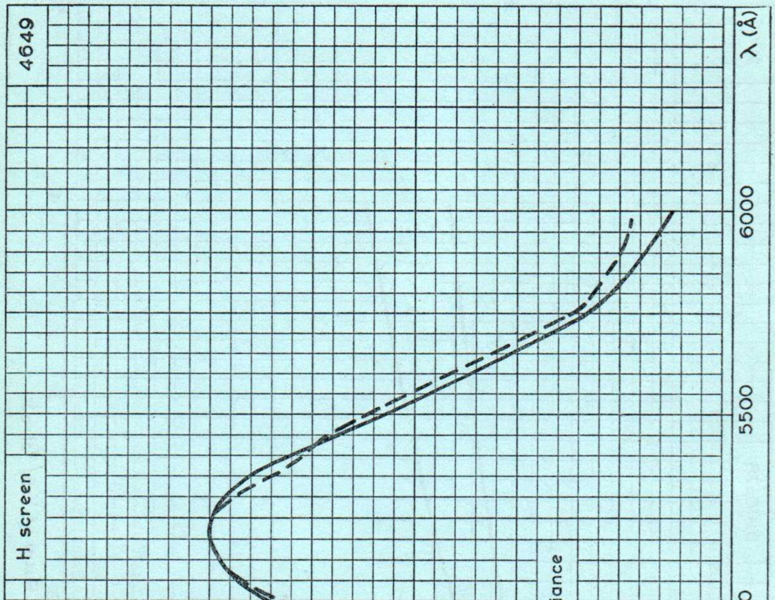
SENSITIVITY PLOTTED AGAINST FIRST AND THIRD ANODE VOLTAGE



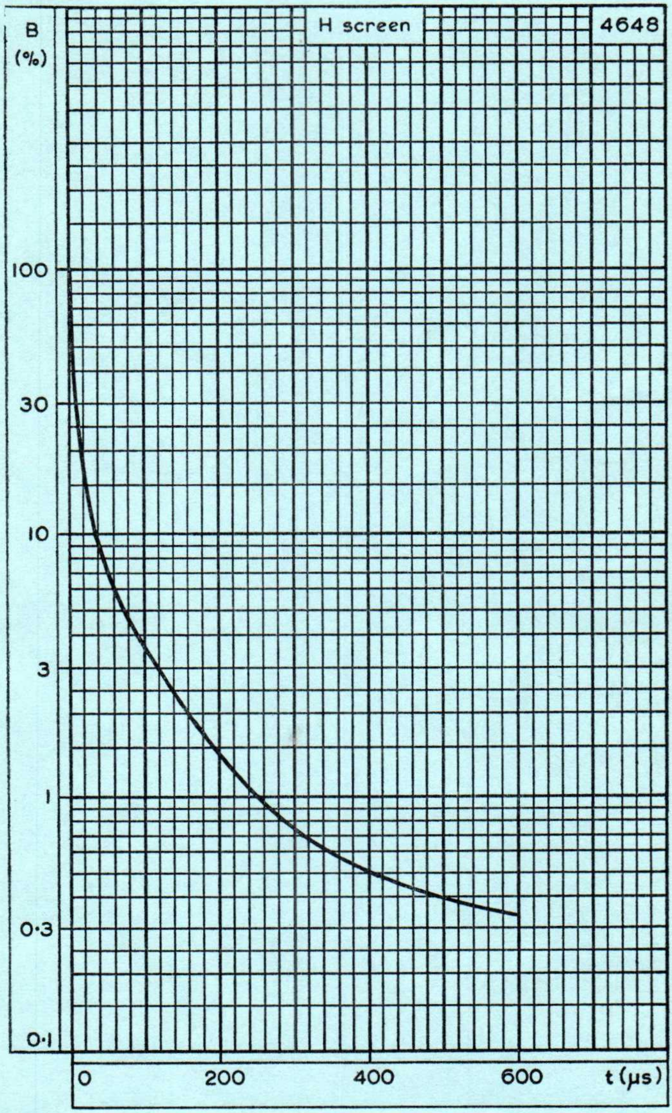
RELATIVE SENSITIVITY PLOTTED AGAINST RATIO OF V_{a5} to V_{a1+a3}

DB 10-78
DH10-78
DP 10-78

OSCILLOSCOPE TUBE



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



PERSISTENCE CHARACTERISTIC CURVE FOR TYPE "H" LUMINESCENT SCREEN

OSCILLOSCOPE TUBE

Direct viewing oscilloscope tube with 4-in. diameter screen. This tube is fitted with a post-deflection accelerator.

DB 10-78
DH 10-78
DP 10-78

The only difference between the DB10-78, DH10-78 and DP10-78 is in the screen properties (see appropriate section of data).

PRELIMINARY DATA

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES preceding this section of the handbook.

HEATER

Suitable for parallel operation only, a.c. or d.c.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	5.0	pF
c_{k-all}	3.4	pF
$c_{x'-all}$ (x″ earthed)	4.5	pF
$c_{x''-all}$ (x′ earthed)	4.5	pF
$c_{y'-all}$ (y″ earthed)	3.5	pF
$c_{y''-all}$ (y′ earthed)	3.5	pF
$c_{x'-x''}$	2.1	pF
$c_{y'-y''}$	1.7	pF

SCREEN

	DB10-78	DH10-78	DP10-78
Fluorescent colour	blue	blue/green	blue with green afterglow
Persistence	short	medium	long

Minimum useful scan from the centre of the tube face

	$V_{a5} = V_{a1+a3}$	$V_{a5} = 2V_{a1+a3}$	$V_{a5} = 4V_{a1+a3}$	
x′–x″	90	90	75	mm
y′–y″	75	65	55	mm

This useful scan can be shifted with respect to the geometric centre of the face plate by 3mm max.

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for symmetrical deflection. For optimum focus the average potentials of the deflection plates and a_1+a_3 should be equal.

Deviation of linearity of deflection.

The sensitivity (for both x′–x″ and y′–y″ plate pairs separately) for a deflection of less than 75% of the useful scan will not differ from the sensitivity for a deflection of 25% of the useful scan by more than 2%.

Pattern distortion

With a raster pattern the size of which is adjusted so that the widest points of the pattern just touch the sides of a square 51mm on a side, no point on these pattern sides will lie within an inscribed square 49mm on a side.

Angle between x and y deflection $90^\circ \pm 1^\circ$

Inter-plate shield (a_4)

The fourth anode forms an electrostatic shield between the x and y plates, and is connected to the low potential end of the helix The inter-plate shield voltage and the average potential of the deflection plates should be equal. Variation of the inter-plate shield voltage serves to correct pincushion and barrel pattern distortion.

HELIX RESISTANCE

Minimum post deflection acceleration helix resistance	50	MΩ

MOUNTING POSITION

Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a5}	2.0	4.0	4.0	kV
V_{a4}	2.0	2.0	1.0	kV
V_{a1+a3}	2.0	2.0	1.0	kV
V_{a2}	400 to 700	400 to 700	200 to 350	V
*V_g	−45 to −75	−45 to −75	−22.5 to −37.5	V
S_x	0.26	0.2	0.3	mm/V
S_y	0.63	0.55	0.93	mm/V
**Line width	0.45	0.35	0.45	mm

*In no circumstances must the d.c. value of the grid bias be allowed to become positive with respect to the cathode.

**Measured on a circle of 50mm diameter with $I_t = 0.5\mu A$.

DEFLECTION SENSITIVITY LIMITS

	Without acceleration ($V_{a5} = V_{a1+a3}$)	($V_{a5} = 2V_{a1+a3}$)	With acceleration ($V_{a5} = 4V_{a1+a3}$)	
S_x	$\frac{460 \text{ to } 580}{V_{a1+a3}}$	$\frac{360 \text{ to } 460}{V_{a1+a3}}$	$\frac{260 \text{ to } 330}{V_{a1+a3}}$	mm/V
S_y	$\frac{1140 \text{ to } 1380}{V_{a1+a3}}$	$\frac{1000 \text{ to } 1200}{V_{a1+a3}}$	$\frac{840 \text{ to } 1020}{V_{a1+a3}}$	mm/V

EQUIPMENT DESIGN RANGE

Focusing voltage (V_{a2})		200 to 350V per kV of accelerator voltage (V_{a1+a3})
Grid cut-off voltage		−22.5 to −37.5V per kV of accelerator voltage (V_{a1+a3})
Deflection factor		
$V_{a5} = V_{a1+a3}$	(x′−x″)	1.72 to 2.17V/mm per kV of accelerator voltage (V_{a1+a3})
	(y′−y″)	0.72 to 0.89V/mm per kV of accelerator voltage (V_{a1+a3})
$V_{a5} = 2V_{a1+a3}$	(x′−x″)	2.17 to 2.78V/mm per kV of accelerator voltage (V_{a1+a3})
	(y′−y″)	0.83 to 1.00V/mm per kV of accelerator voltage (V_{a1+a3})
$V_{a5} = 4V_{a1+a3}$	(x′−x″)	3.03 to 3.85V/mm per kV of accelerator voltage (V_{a1+a3})
	(y′−y″)	0.98 to 1.19V/mm per kV of accelerator voltage (V_{a1+a3})

Grid to cathode circuit resistance (R_{g-k})	1.5	MΩ
Deflection plate resistance	5.0	MΩ
Focusing anode current (I_{a2})	−30 to +15	μA

LIMITING VALUES (design centre ratings)

V_{a5} max.	8.0	kV
V_{a5} min.	1.5	kV
V_{a4} max.	2.2	kV
V_{a1+a3} max.	2.0	kV
V_{a1+a3} min.	1.0	kV
V_{a2} max.	1.5	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
$v_{x-a1+a3(pk)}$ max.	500	V
$v_{y-a1+a3(pk)}$ max.	500	V
p_{a1+a3} max.	6.0	W
$p_{t(av)}$ max.	3.0	mW/cm^2
V_{h-k} max.	180	V
Max. ratio of V_{a5}/V_{a1+a3}	4.0	

WEIGHT Tube alone $\left\{\begin{array}{ll} 660 & g \\ 1\ lb\ 7.2 & oz \end{array}\right.$

CIRCUIT NOTES FOR DH10-78

1. With the post accelerator voltage (V_{a5}) of 2.6kV and the accelerator voltage (V_{a1+a3}) of 1.1kV, the ratio of $V_{a5}/V_{a1+a3} = 2.36$. From page C1 it can be seen that the useful scan is:

   $x'-x'' = 90mm$
   $y'-y'' = 63mm$

2. Without post acceleration and with $V_{a1+a3} = 1.1kV$, the sensitivity for $x'-x'' = 0.485mm/V$ and for $y'-y'' = 1.15mm/V$.

3. Due to the influence of post acceleration, a correction factor on the sensitivities is necessary. With $V_{a5}/V_{a1+a3} = 2.36$ the correction factor is 0.73 for $x'-x''$ and 0.84 for $y'-y''$. The sensitivity with post acceleration therefore becomes:

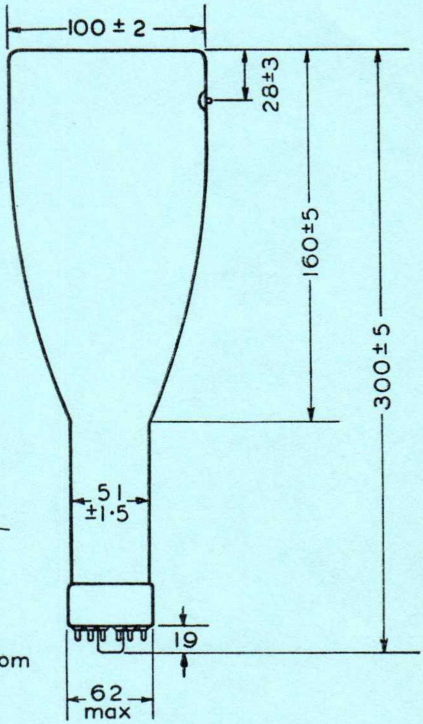
   $x'-x'' = 0.73 \times 0.485 = 0.354mm/V$
   $y'-y'' = 0.84 \times 1.15 = 0.966mm/V$

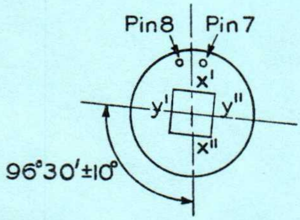
   Thus at $V_{a5} = 2.6kV$ and $V_{a1+a3} = 1.1kV$ the following values can be found with reference to pages C1 and C2:

The useful scan	$x'-x'' = 90mm$
	$y'-y'' = 63mm$
The sensitivity	$x'-x'' = 0.354mm/V$
	$y'-y'' = 0.966mm/V$

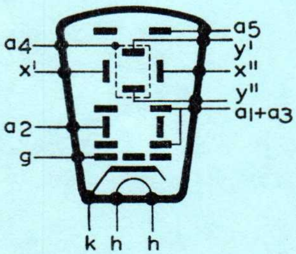
DB 10-78
DH10-78
DP 10-78

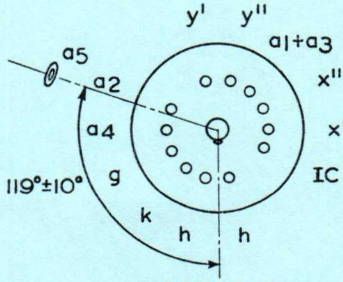
5076





Orientation of axes of deflection as viewed from screen end.





B14A Base

All dimensions in mm

OSCILLOSCOPE TUBES

DB13-2 DG13-2 DP13-2

Direct viewing oscilloscope tubes with 5-in. diameter screen. These tubes are fitted with a post-deflection accelerator.

HEATER

Suitable for parallel operation only.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	4.6	pF
c_{k-all}	6.0	pF
$c_{x'-all}$ (x'' earthed)	5.5	pF
$c_{x''-all}$ (x' earthed)	5.5	pF
$c_{y'-all}$ (y'' earthed)	4.7	pF
$c_{y''-all}$ (y' earthed)	4.7	pF
$c_{x'-x''}$	2.5	pF
$c_{y'-y''}$	1.9	pF
$c_{x'x''-y'y''}$	0.2	pF
$c_{g-(x'+x''+y'+y'')}$	0.15	pF
$c_{k-(x'+x''+y+'+y'')}$	0.35	pF

Fluorescent colour—

DB13–2	blue
DG13–2	green
DP13–2	blue with green afterglow

Persistence—

DB13–2	short
DG13–2	medium
DP13–2	long

FOCUSING Electrostatic

DEFLECTION Double electrostatic

Both x and y plates are suitable for symmetrical deflection only.

For optimum spot quality the mean deflector plate potential should be the same as $a_1 + a_3$ potential.

DB13-2
DG13-2
DP13-2

OSCILLOSCOPE TUBES

Direct viewing oscilloscope tubes with 5-in. diameter screen. These tubes are fitted with a post-deflection accelerator.

MOUNTING POSITION

Any

These tubes should not be supported by the base alone.

TYPICAL OPERATING CONDITIONS

	Without acceleration	With acceleration	
V_{a4}	2.0	4.0	kV
V_{a1+a3}	2.0	2.0	kV
V_{a2}	400 to 720	400 to 720	V
$*V_g$	–45 to–100	–45 to –100	V
I_{a1+a3}	0 to 1.6	0 to 1.6	mA
I_{a2}	–15 to +10	–15 to +10	µA
S_x	0.37 to 0.45	0.29 to 0.37	mm/V
S_y	0.43 to 0.51	0.34 to 0.42	mm/V
**Line width	0.4	0.3	mm

*In no circumstances must the grid be allowed to become positive with respect to the cathode.

**Measured on a circle of 50mm diameter with I_t=0.5µA.

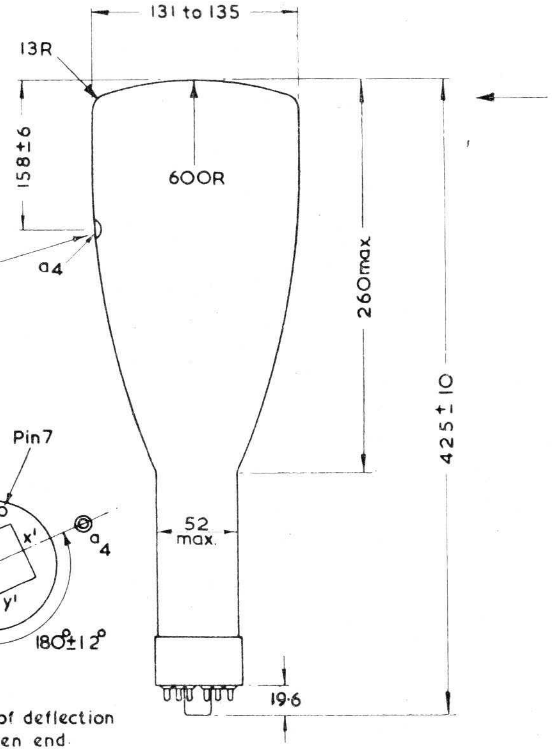
LIMITING VALUES (Design centre ratings)

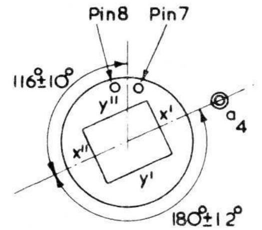
V_{a4}	5.0	kV
V_{a1+a3} max.	2.5	kV
p_{a1+a3} max.	4.0	W
V_{a2} max.	1.0	kV
$-V_g$ max.	150	V
$v_{x'-x''(pk)}$ max.	450	V
$v_{y'-y''(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm²
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	125	V

OSCILLOSCOPE TUBES

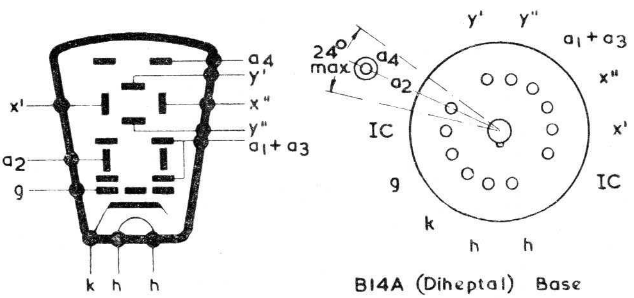
DB13-2
DG13-2
DP13-2

Direct viewing oscilloscope tubes with 5-in. diameter screen. These tubes are fitted with a post-deflection accelerator.





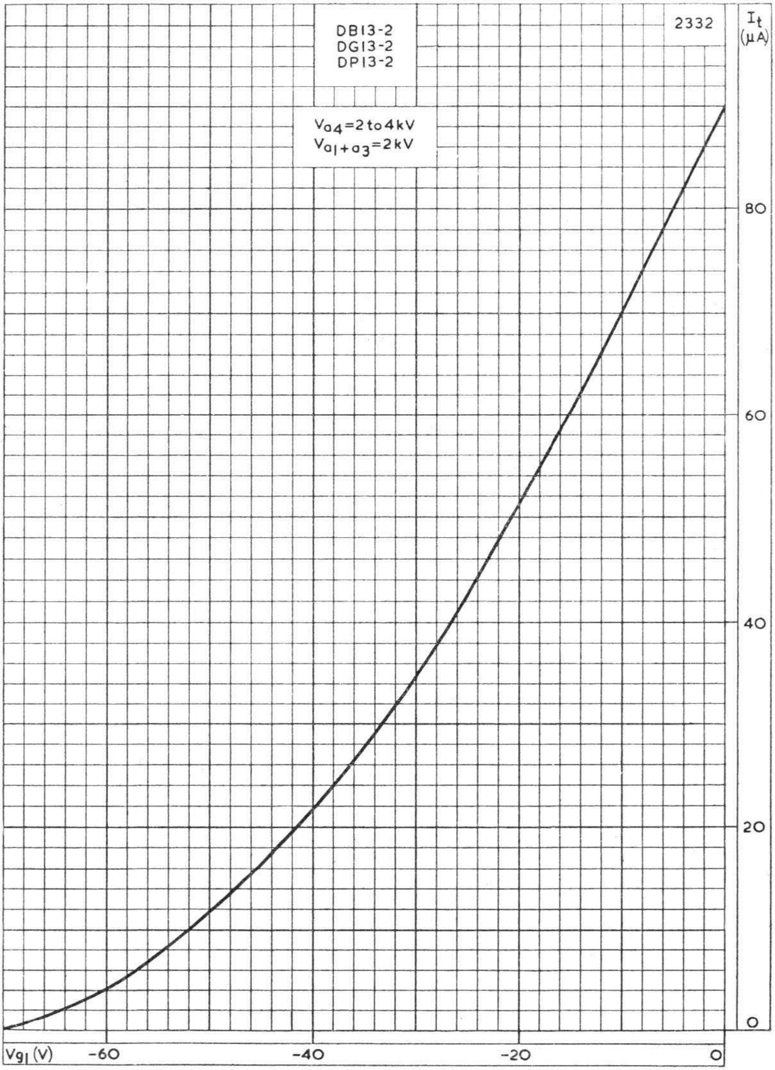
Orientation of axes of deflection as viewed from screen end



B14A (Diheptal) Base

2335

All dimensions in mm

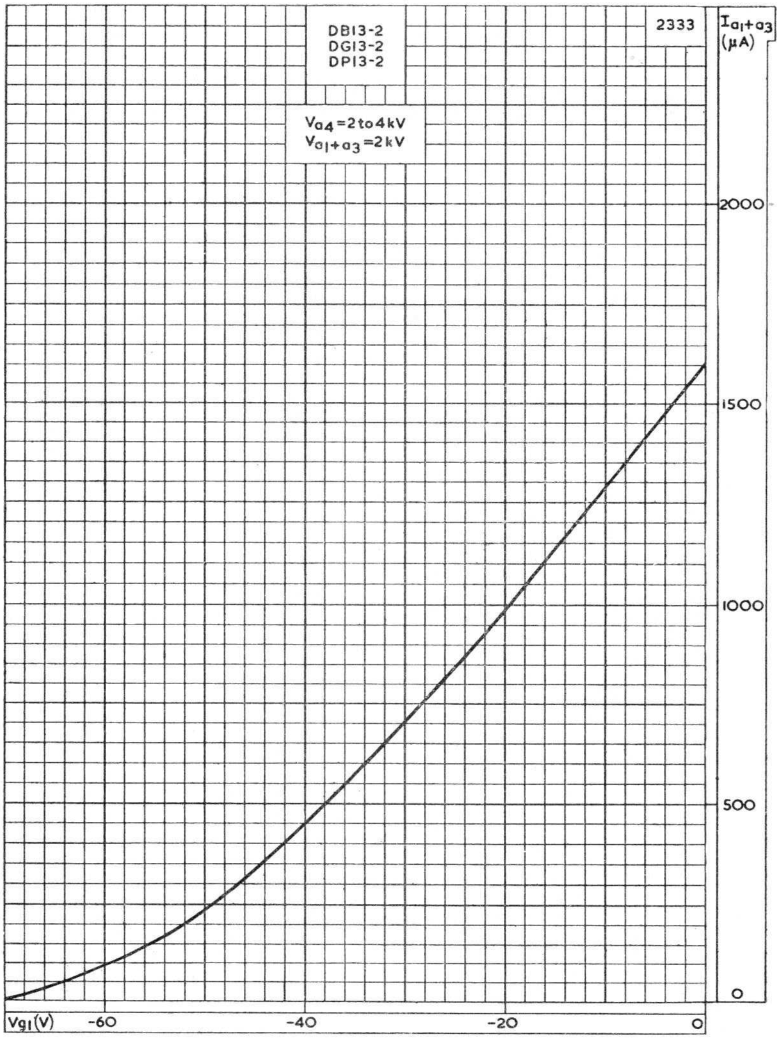


SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBES

DB13-2
DG13-2
DP13-2

Direct viewing oscilloscope tubes with 5-in. diameter screen. These tubes are fitted with a post-deflection accelerator.



FIRST AND THIRD ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

INSTRUMENT TUBE

DB 16-22
DG 16-22
DP 16-22

Direct viewing instrument tube with a rectangular screen having an area of $5\frac{1}{2}$ in. x $1\frac{1}{2}$ in. This tube is intended for radar or oscilloscope applications particularly where its shape provides a considerable saving of space compared with a circular tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES included in this volume of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note – (applies to series operation only). The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<10	pF
$c_{x'-all}$ (x'' earthed)	<20	pF
$c_{x''-all}$ (x' earthed)	<20	pF
$c_{y'-all}$ (y'' earthed)	<16	pF
$c_{y''-all}$ (y' earthed)	<16	pF
$c_{x'-y'}$	3.0	pF
$c_{x'-y''}$	3.0	pF
$c_{x''-y'}$	3.0	pF
$c_{x''-y''}$	3.0	pF

SCREEN

Fluorescent colour:–

DB16–22	blue
DG16–22	green
DP16–22	blue with green afterglow

Persistence:–

DB16–22	short
DG16–22	medium
DP16–22	long

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic.
Both x and y plates are suitable for symmetrical or asymmetrical deflection.

DB 16-22
DG 16-22
DP 16-22

INSTRUMENT TUBE

Direct viewing instrument tube with a rectangular screen having an area of $5\frac{1}{2}$ in. x $1\frac{1}{2}$ in. This tube is intended for radar or oscilloscope applications particularly where its shape provides a considerable saving of space compared with a circular tube.

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a3}	5.0	kV
V_{a2}	600 to 700	V
V_{a1}	1.8	kV
*V_g	−25 to −70	V
S_x	0.19	mm/V
S_y	0.21	mm/V

*In no circumstances must the grid be allowed to become positive with respect to the cathode.

DEFLECTION SENSITIVITY LIMITS

S_x	$\frac{850 \text{ to } 1000}{V_{a3}}$	mm/V
S_y	$\frac{900 \text{ to } 1100}{V_{a3}}$	mm/V

LIMITING VALUES (absolute ratings)

*V_{a3} max.	6.0	kV
V_{a2} max.	1.1	kV
V_{a1} max.	2.5	kV
$-V_g$ max.	150	V
I_k max.	300	μA
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	±150	V

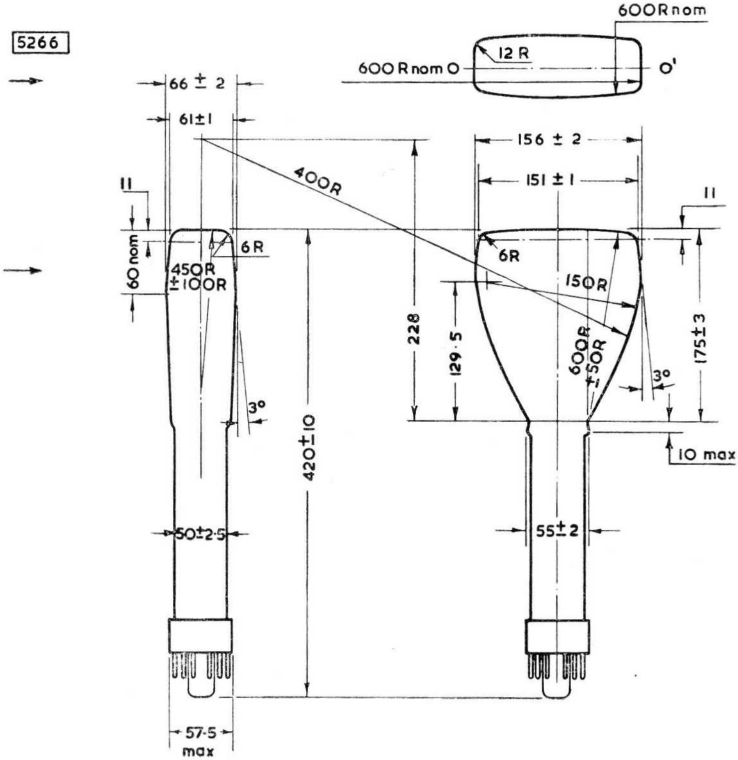
*For optimum focus quality the potential between the screen and a_3 must not exceed 10V.

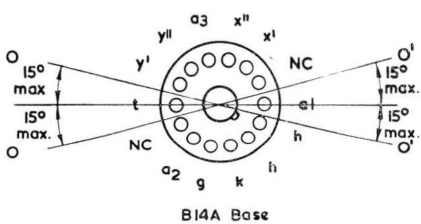
Note – Viewed from the screen end with the major axis of the screen horizontal and pins 9 and 10 on the base uppermost, a positive voltage on x′ will deflect the spot to the left and a positive voltage on y′ will deflect the spot upwards.
The horizontal deflection will be within 2° of the centre line through the screen. The angle between the x and y deflection will be 88° to 92°.

INSTRUMENT TUBE

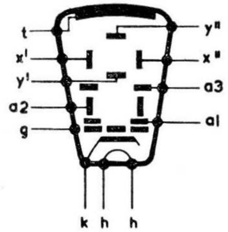
DB16-22
DG16-22
DP16-22

Direct viewing instrument tube with a rectangular screen having an area of 5½ in. x 1½ in. This tube is intended for radar or oscilloscope applications particularly where its shape provides a considerable saving of space compared with a circular tube.





B14A Base

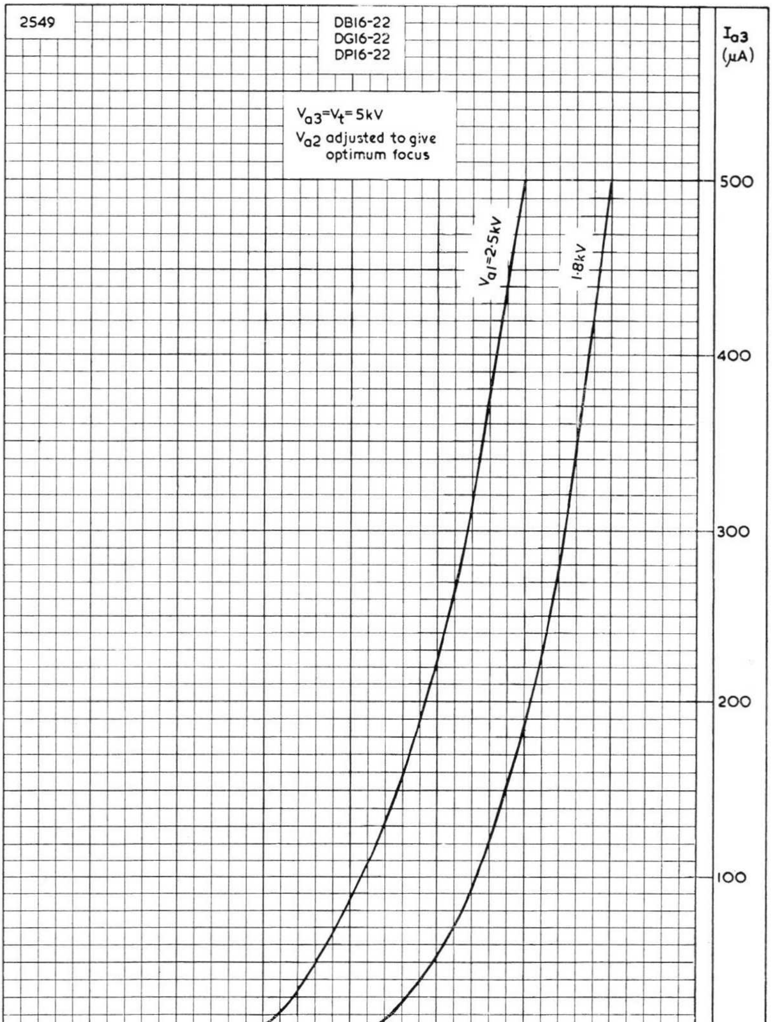


All dimensions in mm

DB 16-22
DG 16-22
DP 16-22

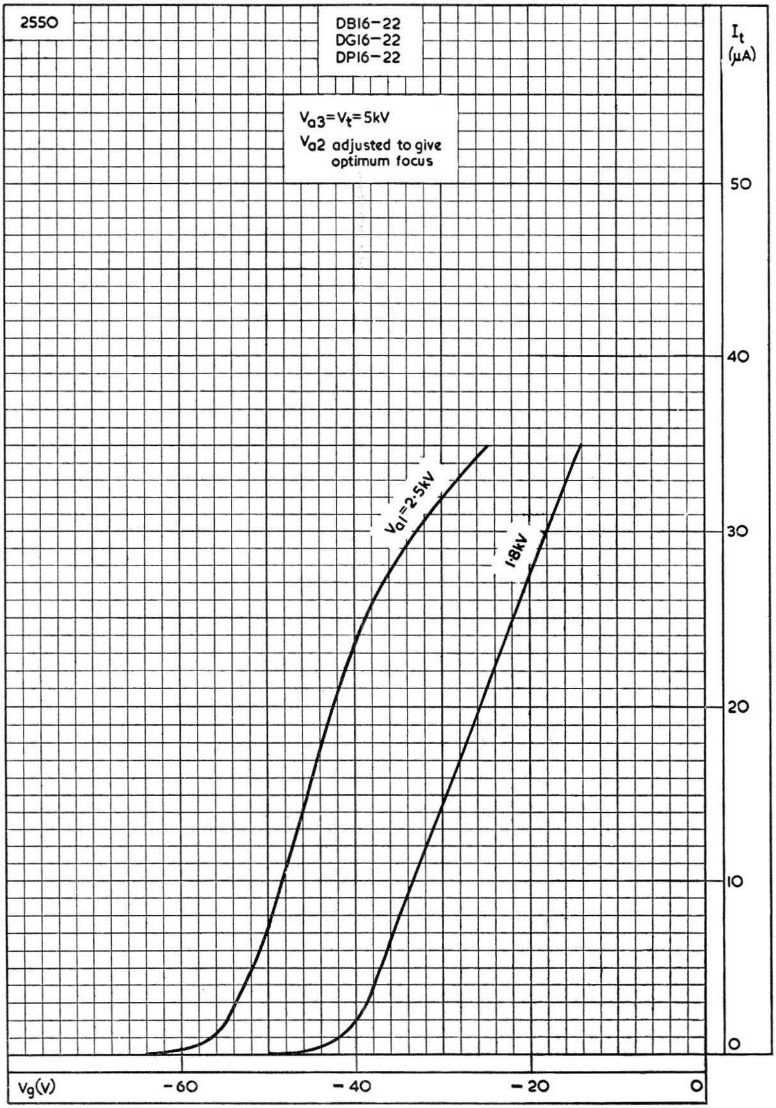
INSTRUMENT TUBE

Direct viewing instrument tube with a rectangular screen having an area of $5\frac{1}{2}$ in. x $1\frac{1}{2}$ in. This tube is intended for radar or oscilloscope applications particularly where its shape provides a considerable saving of space compared with a circular tube.



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

Direct viewing instrument tube with rectangular screen having an area of 5½ in. x 1½ in. This tube is intended for radar or oscilloscope applications particularly where its shape provides a considerable saving of space compared with a circular tube.

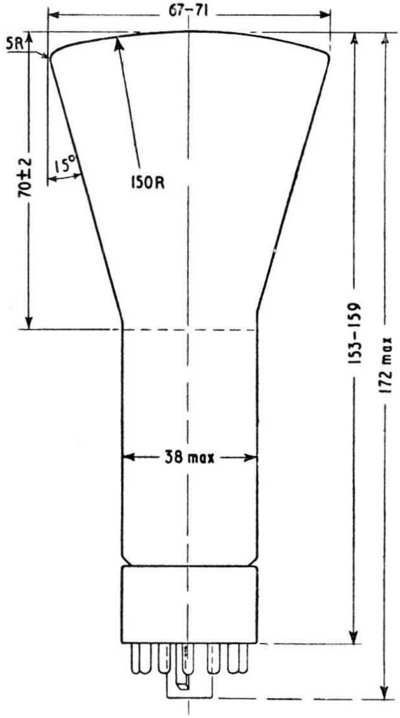


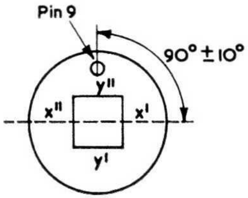
SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

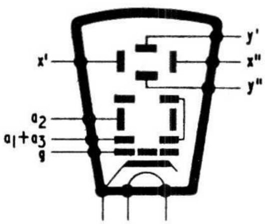
DG7-31

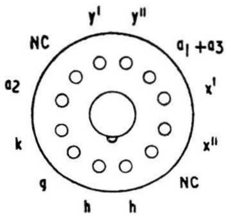
Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.





Orientation of axes of deflection as viewed from screen end





B12A Base

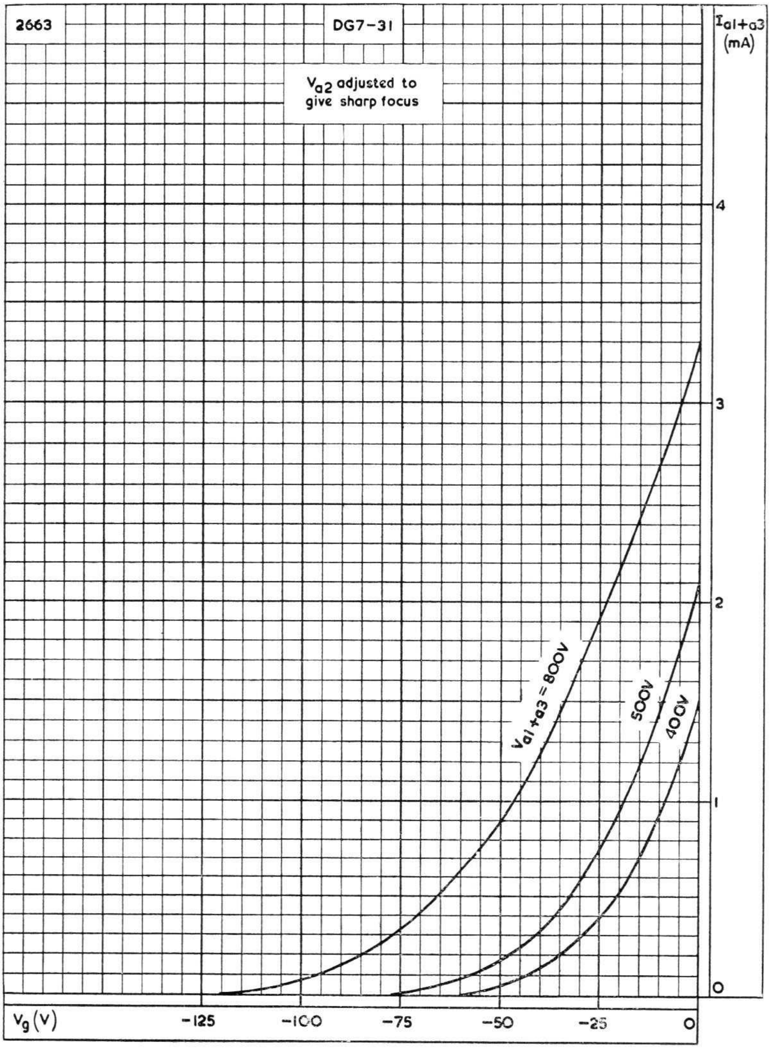
1883

All dimensions in mm

DG7-31

OSCILLOSCOPE TUBE

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

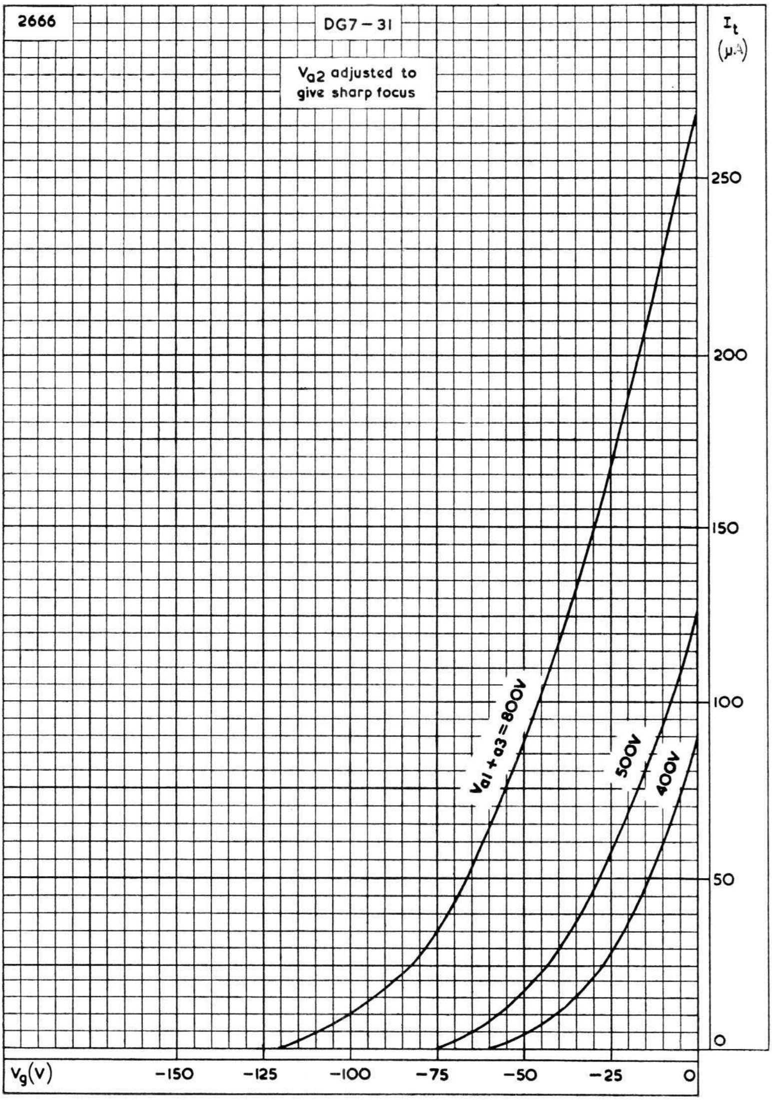


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG7-31

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG7-31

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	7.6	pF
$c_{k\ all}$	3.2	pF
$c_{x'-all}$ (x″ earthed)	3.4	pF
$c_{x''-all}$ (x′ earthed)	3.0	pF
$c_{y'-all}$ (y″ earthed)	2.5	pF
$c_{y''-all}$ (y′ earthed)	2.5	pF
$c_{x'-x''}$	1.8	pF
$c_{y'-y''}$	1.1	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic
x plates suitable for asymmetrical operation
y plates suitable for symmetrical operation

Plate x′ must be connected to a_1+a_3 and it is recommended that a_2 be earthed.

MOUNTING POSITION — Any

This tube should not be supported by the base alone.
The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a1+a3}	500	V
V_{a2}	0 to 120	V
*V_g	−50 to −100	V
I_{a2}	−15 to +10	μA
S_y	0.39	mm/V
S_x	0.27	mm/V
**Line width	0.5	mm

*In no circumstances must the grid be allowed to become positive, with respect to the cathode.

**Measured on a circle of 50mm diameter with $V_{a1+a3}=500V$ and $I_t=0.5\mu A$.

A transparent conductive coating connected to a_1+a_3 is present between the glass and fluorescent layer. This makes possible applications of the tube with a_1+a_3 at high potential with respect to earth without the raster being distorted if the faceplate is touched.

DG7-31

OSCILLOSCOPE TUBE

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

DEFLECTION SENSITIVITY LIMITS

S_x	$\dfrac{120 \text{ to } 150}{V_{a1+a3}}$	mm/V
S_y	$\dfrac{175 \text{ to } 215}{V_{a1+a3}}$	mm/V

LIMITING VALUES (design centre ratings)

V_{a1+a3} max.	800	V
V_{a1+a3} min.	400	V
p_{a1+a3} max.	500	mW
V_{a2} max.	200	V
$-V_g$ max.	160	V
$v_{x'-x''(pk)}$ max.	750	V
$v_{y'-y''(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm^2
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	500	kΩ
V_{h-k} max.	125	V

OSCILLOSCOPE TUBE

DG7-31/01

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	7.6	pF
c_{k-all}	3.2	pF
$c_{x'-all}$ (earthed)	3.4	pF
$c_{x''-all}$ (x' earthed)	3.0	pF
$c_{y'-all}$ (y'' earthed)	2.5	pF
$c_{y''-all}$ (y' earthed)	2.5	pF
$c_{x'-x''}$	1.8	pF
$c_{y'-y''}$	1.1	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

x plates suitable for asymmetrical deflection

y plates suitable for symmetrical operation

Plate x′ must be connected to a_1+a_3 and it is recommended that a_2 be earthed

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

DG7-31/01

OSCILLOSCOPE TUBE

OPERATING CONDITIONS

V_{a1+a3}	500	V
V_{a2}	0 to 120	V
*V_g	−50 to −100	V
I_{a2}	−15 to +10	μA
S_y	0.48	mm/V
S_x	0.27	mm/V
†Line width	0.5	mm

*In no circumstances must the grid be allowed to become positive, with respect to the cathode.

†Measured on a circle of 50mm diameter with $V_{a1+a3} = 500V$ and $I_t = 0.5\mu A$.

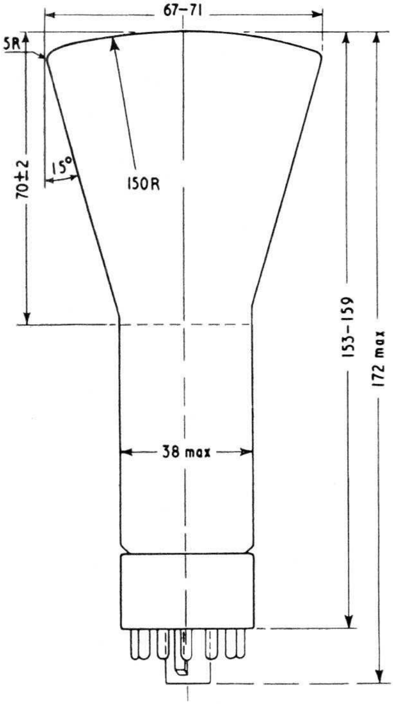
A transparent conductive coating connected to a_1+a_3 is present between the glass and fluorescent layer. This makes possible applications of the tube with a_1+a_3 at high potential with respect to earth without the raster being distorted if the faceplate is touched.

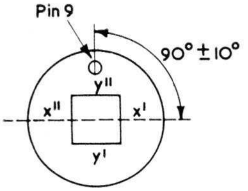
DEFLECTION SENSITIVITY LIMITS

S_x	$\dfrac{120 \text{ to } 150}{V_{a1+a3}}$	mm/V
S_y	$\dfrac{215 \text{ to } 265}{V_{a1+a3}}$	mm/V

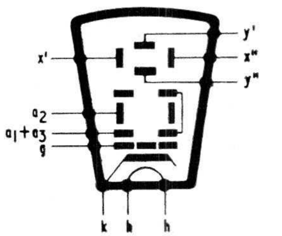
LIMITING VALUES (design centre ratings)

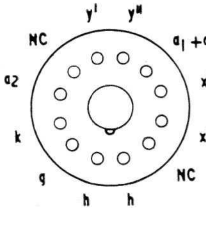
V_{a1+a3} max.	800	V
V_{a1+a3} min.	400	V
p_{a1+a3} max.	500	mW
V_{a2} max.	200	V
$-V_g$ max.	160	V
$v_{x'-x''(pk)}$ max.	750	V
$v_{y'-y''(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm^2
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	500	kΩ
V_{h-k} max.	125	V





Orientation of axes of deflection as viewed from screen end

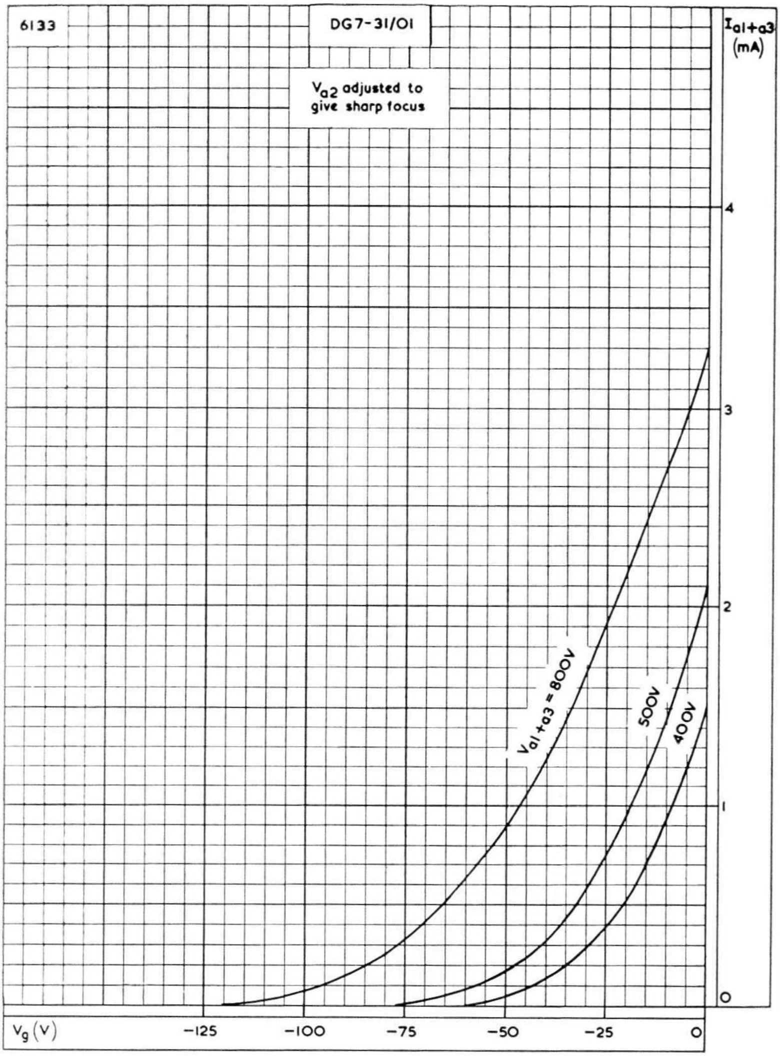




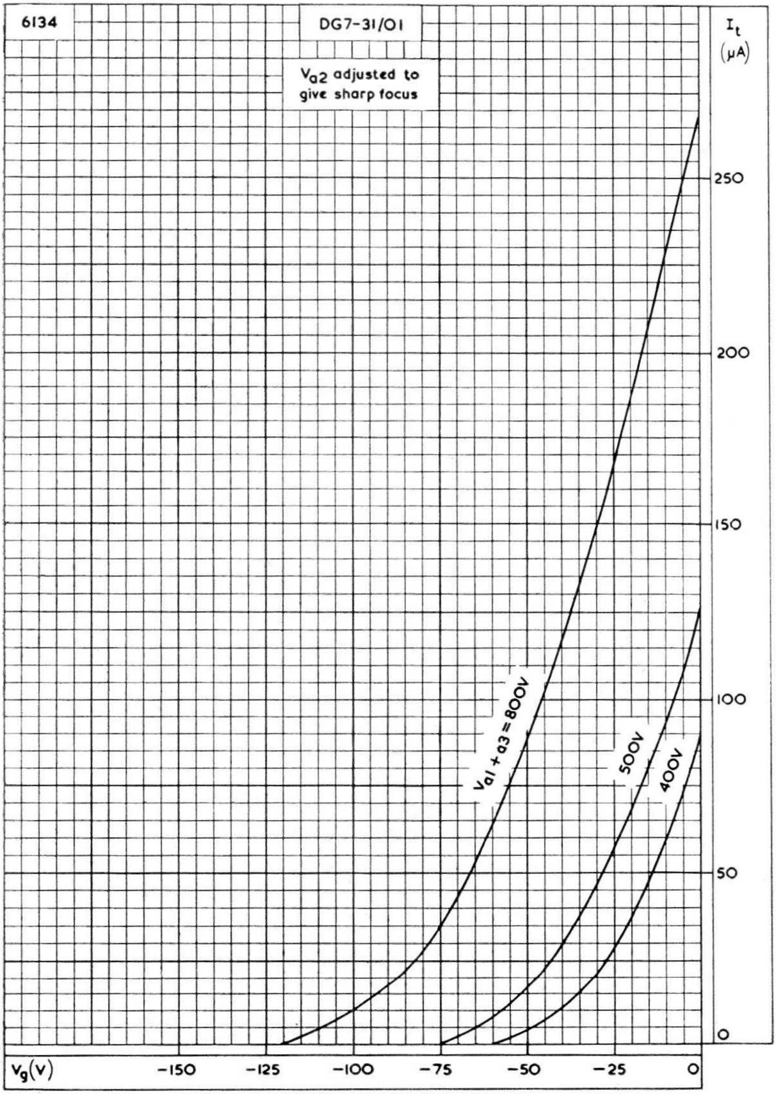
B12A Base

1883

All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG7-32

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	7.6	pF←
c_{k-all}	3.2	pF←
$c_{x'-all}$ (x″ earthed)	3.7	pF
$c_{x''-all}$ (x′ earthed)	3.0	pF←
$c_{y'-all}$ (y″ earthed)	2.5	pF←
$c_{y''-all}$ (y′ earthed)	2.5	pF←
$c_{x'-x''}$	1.7	pF←
$c_{y'-y''}$	1.0	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for symmetrical deflection

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

DG7-32

OSCILLOSCOPE TUBE

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

TYPICAL OPERATING CONDITIONS

V_{a1+a3}	500	V
V_{a2}	0 to 120	V
*V_g	−50 to −100	V
I_{a2}	−15 to +10	μA
S_y	0.39	mm/V
S_x	0.27	mm/V ←
†Line width	0.5	mm

*In no circumstances must the grid be allowed to become positive, with respect to the cathode.

†Measured on a circle of 50mm diameter with $V_{a1+a3} = 500V$ and $I_t = 0.5\mu A$.

A transparent conductive coating connected to a_1+a_3 is present between the glass and fluorescent layer. This makes possible applications of the tube with a_1+a_3 at high potential with respect to earth without the raster being distorted if the faceplate is touched.

DEFLECTION SENSITIVITY LIMITS

S_x	$\frac{120 \text{ to } 150}{V_{a1+a3}}$	mm/V ←
S_y	$\frac{175 \text{ to } 215}{V_{a1+a3}}$	mm/V

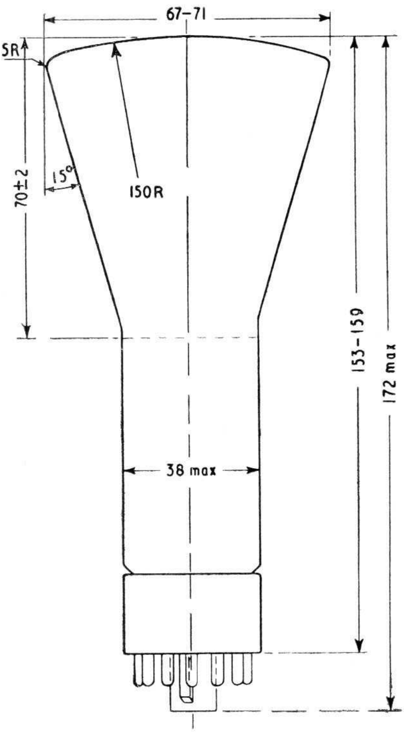
LIMITING VALUES (design centre ratings)

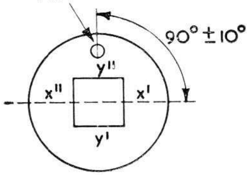
V_{a1+a3} max.	800	V
V_{a1+a3} min.	400	V
p_{a1+a3} max.	500	mW
V_{a2} max.	200	V
$-V_g$ max.	160	V
$v_{x'-x''(pk)}$ max.	750	V
$v_{y'-y''(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm²
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	500	kΩ
V_{h-k} max.	125	V

OSCILLOSCOPE TUBE

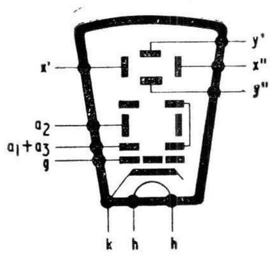
DG7-32

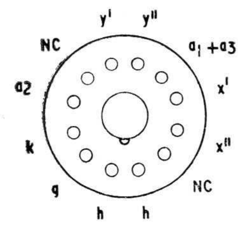
Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.





Orientation of axes of deflection as viewed from screen end





B12A Base

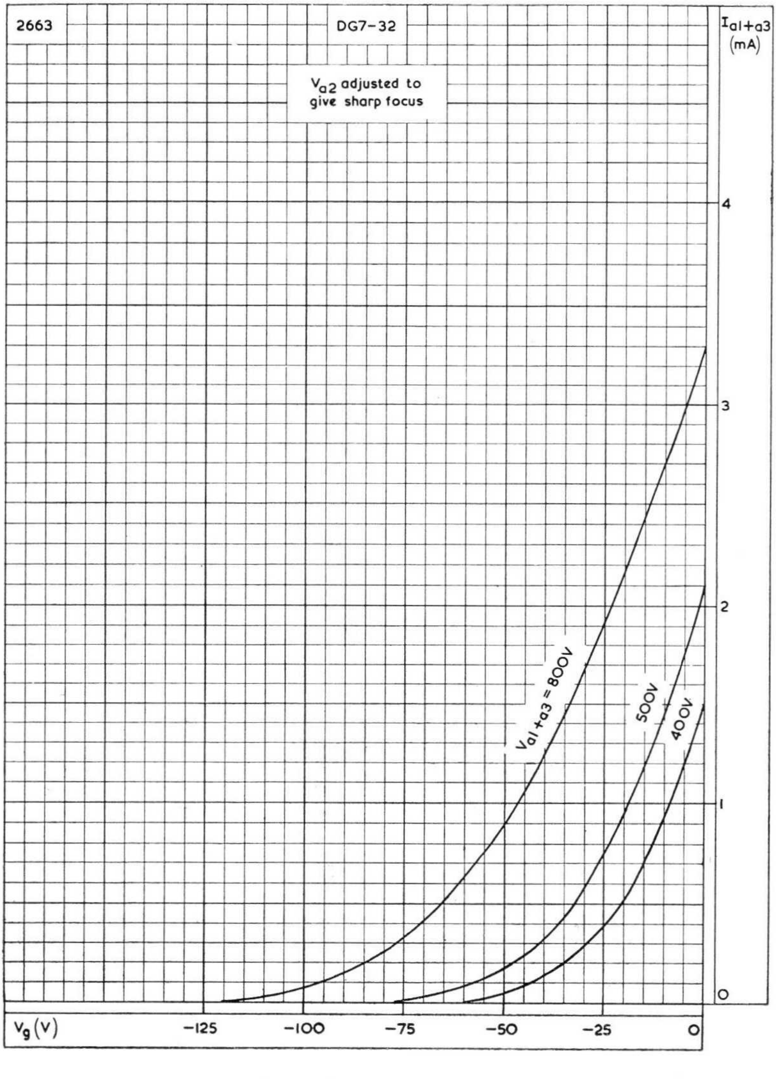
1883

All dimensions in mm

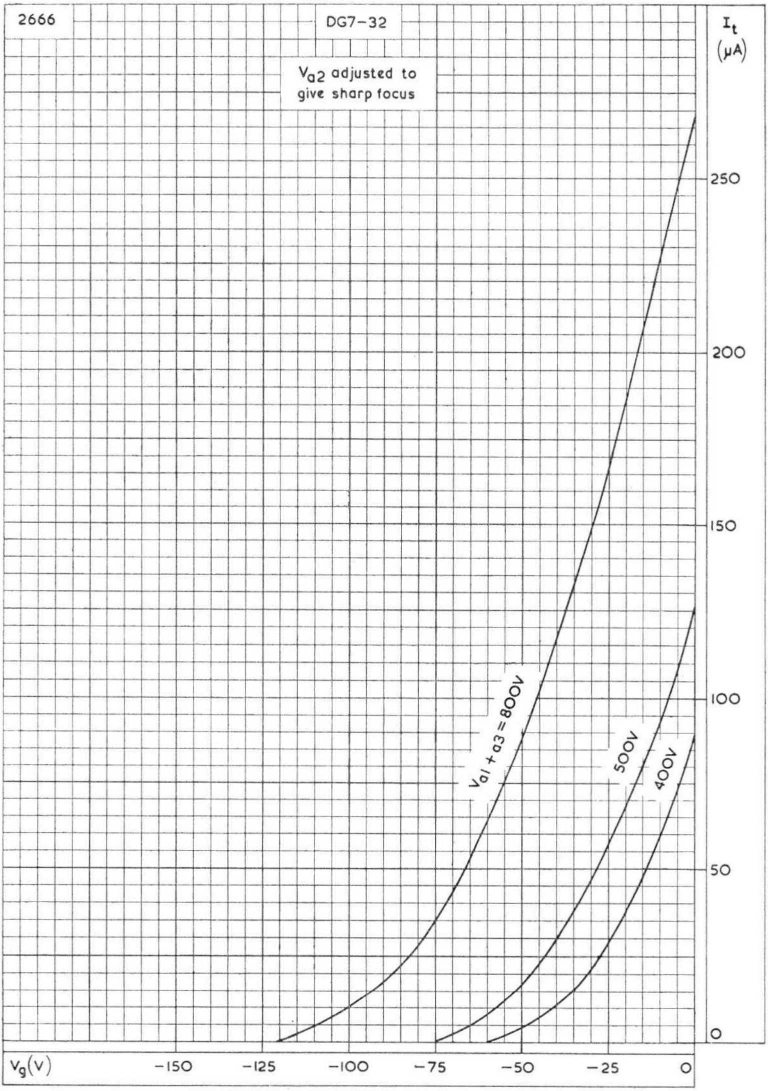
DG7-32

OSCILLOSCOPE TUBE

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG7-32/01

Direct viewing low voltage oscilloscope tube with 3-in. diameter screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	7.6	pF
c_{k-all}	3.2	pF
$c_{x'-all}$ (x″ earthed)	3.7	pF
$c_{x''-all}$ (x′ earthed)	3.0	pF
$c_{y'-all}$ (y″ earthed)	2.5	pF
$c_{y''-all}$ (y′ earthed)	2.5	pF
$c_{x'-x''}$	1.7	pF
$c_{y'-y''}$	1.0	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for symmetrical deflection

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

DG7-32/01

OSCILLOSCOPE TUBE

OPERATING CONDITIONS

V_{a1+a3}	500	V
V_{a2}	0 to 120	V
*V_g	–50 to –100	V
I_{a2}	–15 to +10	μA
S_y	0.48	mm/V
S_x	0.27	mm/V
†Line width	0.5	mm

*In no circumstances must the grid be allowed to become positive, with respect to the cathode.

†Measured on a circle of 50mm diameter with $V_{a1+a3} = 500V$ and $I_t = 0.5\mu A$.

A transparent conductive coating connected to a_1+a_3 is present between the glass and fluorescent layer. This makes possible applications of the tube with a_1+a_3 at high potential with respect to earth without the raster being distorted if the faceplate is touched.

DEFLECTION SENSITIVITY LIMITS

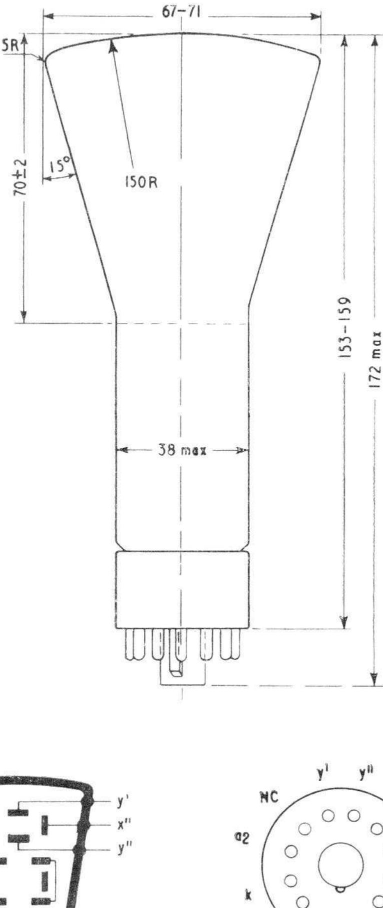
S_x	$\dfrac{120 \text{ to } 150}{V_{a1+a3}}$	mm/V
S_y	$\dfrac{215 \text{ to } 265}{V_{a1+a3}}$	mm/V

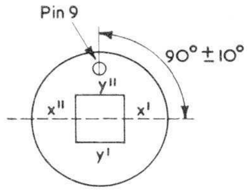
LIMITING VALUES (design centre ratings)

V_{a1+a3} max.	800	V
V_{a1+a3} min.	400	V
p_{a1+a3} max.	500	mW
V_{a2} max.	200	V
$-V_g$ max.	160	V
$v_{x'-x''(pk)}$ max.	750	V
$v_{y'-y''(pk)}$ max.	450	V
$p_{t(av)}$ max.	3.0	mW/cm²
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	500	kΩ
V_{h-k} max.	125	V

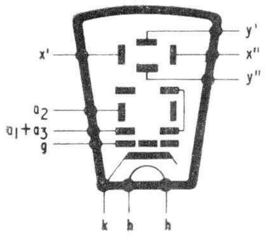
DG7-32/01

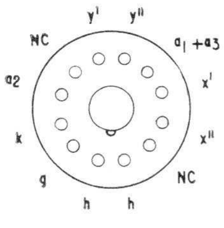
OSCILLOSCOPE TUBE





Orientation of axes of deflection
as viewed from screen end

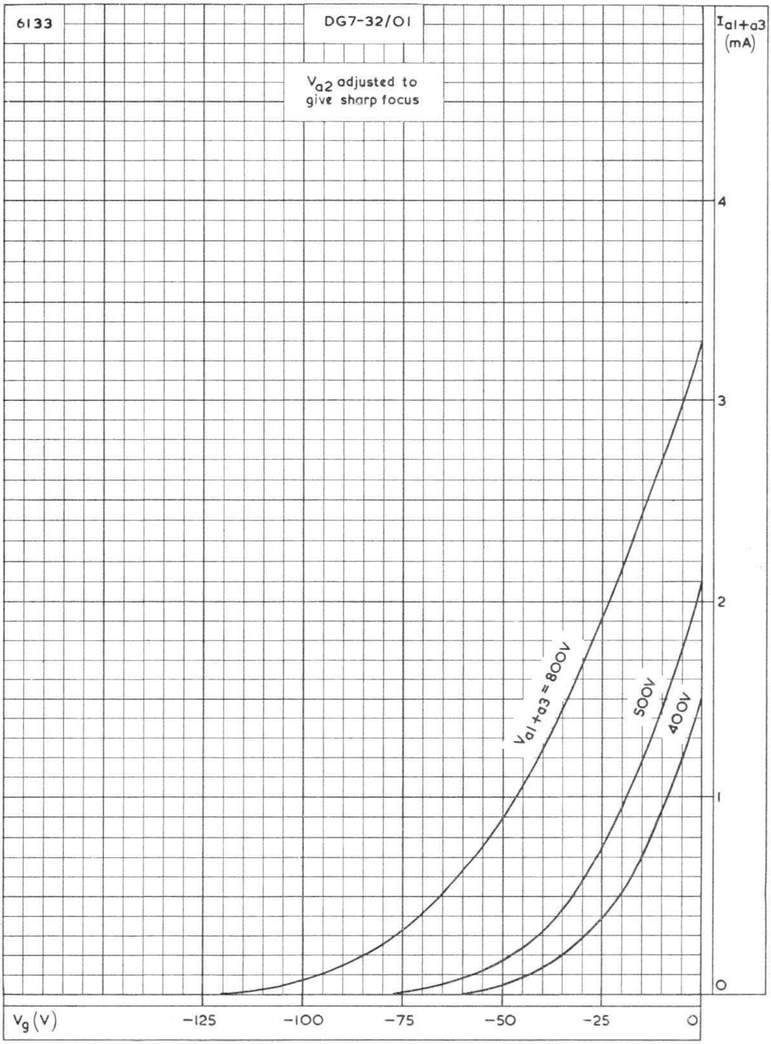




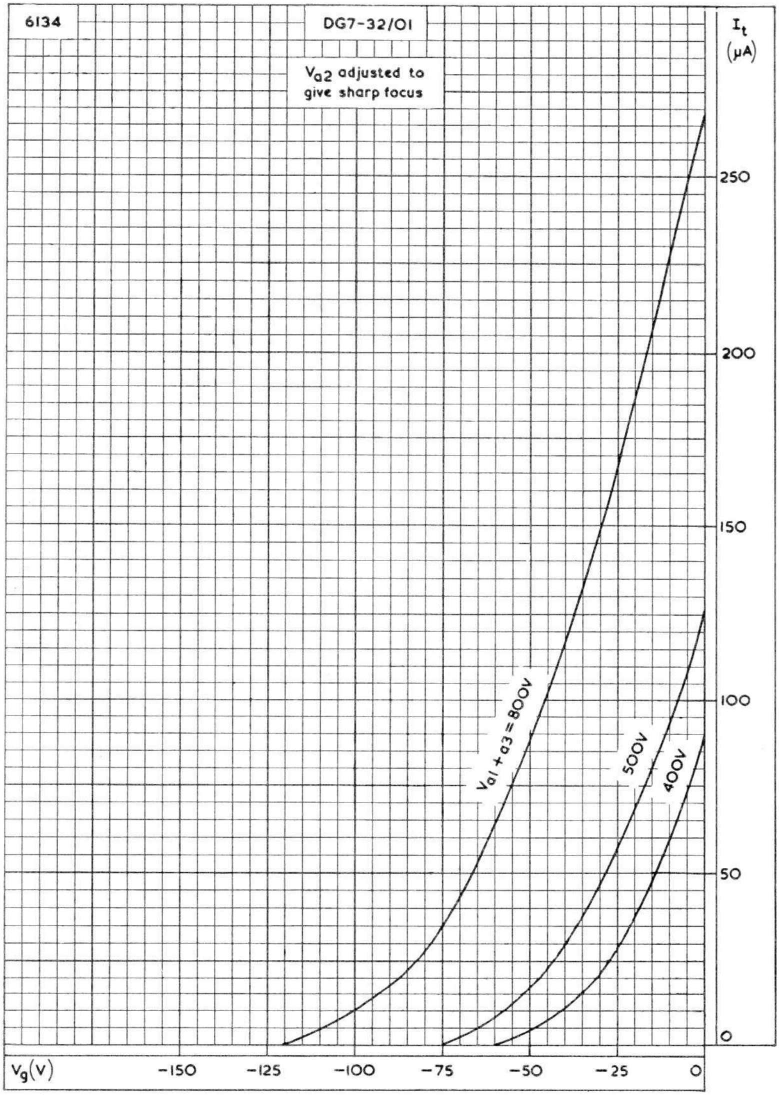
B12A Base

1883

All dimensions in mm



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG7-36

Direct viewing high sensitivity oscilloscope tube with 3-in. flat face screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, preceding this section of the handbook.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	300	mA

CAPACITANCES

$c_{g\text{-}all}$	5.7 ± 1.0	pF
$c_{k\text{-}all}$	3.3 ± 0.8	pF
$c_{x'\text{-}all}$ (x″ earthed)	6.0 ± 1.0	pF
$c_{x''\text{-}all}$ (x′ earthed)	6.0 ± 1.0	pF
$c_{y'\text{-}all}$ (y″ earthed)	4.7 ± 1.0	pF
$c_{y''\text{-}all}$ (y′ earthed)	4.7 ± 1.0	pF
$c_{x'\text{-}x''}$	1.9 ± 0.5	pF
$c_{y'\text{-}y''}$	1.7 ± 0.5	pF

SCREEN

Fluorescent colour	green	
Persistence	medium	
Minimum useful scan from the centre of the tube face (y′–y″)	±28.5	mm
Minimum useful scan from the centre of the tube face (x′–x″)	±34	mm

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are for symmetrical operation.

For optimum focus the average potentials of the deflection plates and $a_1 + a_3$ should be equal.

Pattern distortion

The length of the edges of a raster whose mean dimensions are less than 75% of the useful scan will not deviate from these mean dimensions by more than 2.5%.

Deviation of linearity of deflection

The sensitivity (for both x′–x″ and y′–y″ plate pairs separately) for deflection of less than 75% of the uesful scan will not differ from the sensitivity of a deflection of 25% of the useful scan by more than ±2%.

Angle between x and y deflection 90°±1 0°

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

DG7-36 OSCILLOSCOPE TUBE

TYPICAL OPERATING CONDITIONS

V_{a1+a3}	1.5	kV
V_{a2}	247 to 397	V
*V_g	−40 to −80	V
I_{a2}	−15 to +10	μA
S_x	0.37	mm/V
S_y	0.54	mm/V
**Line width	0.4	mm

*In no circumstances must the d.c. value of the grid bias be allowed to become positive with respect to the cathode.

**Measured on a circle of 50mm diameter with $I_t = 0.5\mu A$.

DEFLECTION SENSITIVITY

S_x	$\dfrac{495 \text{ to } 615}{V_{a1+a3}}$	mm/V
S_y	$\dfrac{735 \text{ to } 885}{V_{a1+a3}}$	mm/V

EQUIPMENT DESIGN RANGE

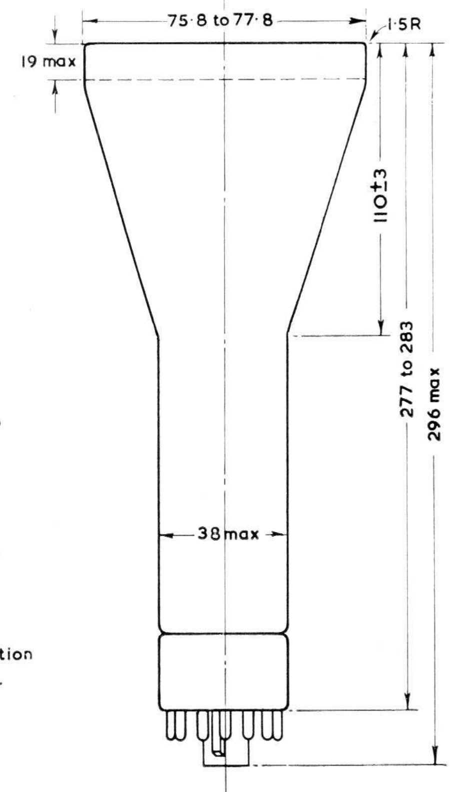
Focusing voltage (V_{a2})	165 to 265V per kV of final anode voltage
Grid cut-off voltage (V_g)	−27 to −53V per kV of final anode voltage
Deflection factor ($y'-y''$)	11.2 to 13.7V/cm per kV of final anode voltage
Deflection factor ($x'-x''$)	16.2 to 20V/cm per kV of final anode voltage

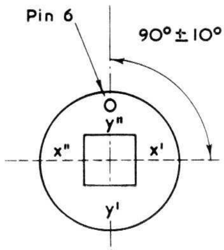
LIMITING VALUES (design centre ratings)

V_{a1+a3} max.	2.5	kV
V_{a1+a3} min.	1.0	kV
p_{a1+a3} max.	6.0	W
V_{a2} max.	1.0	kV
$-V_g$ max.	200	V
$v_{g(pk)}$ max.	2.0	V
$p_{t(av)}$ max.	3.0	mW/cm^2
†$R_{x-a1+a3}$ max.	5.0	MΩ
†$R_{y-a1+a3}$ max.	5.0	MΩ
R_{g-k} max.	1.5	MΩ
V_{h-k} max.	180	V
$v_{a1+a3-x(pk)}$ each plate	500	V
$v_{a1+a3-y(pk)}$ each plate	500	V

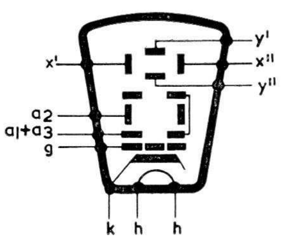
†It is recommended that the deflector plate resistances should be approximately equal.

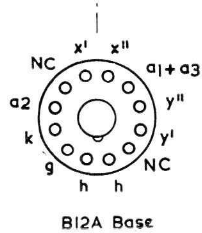
3166





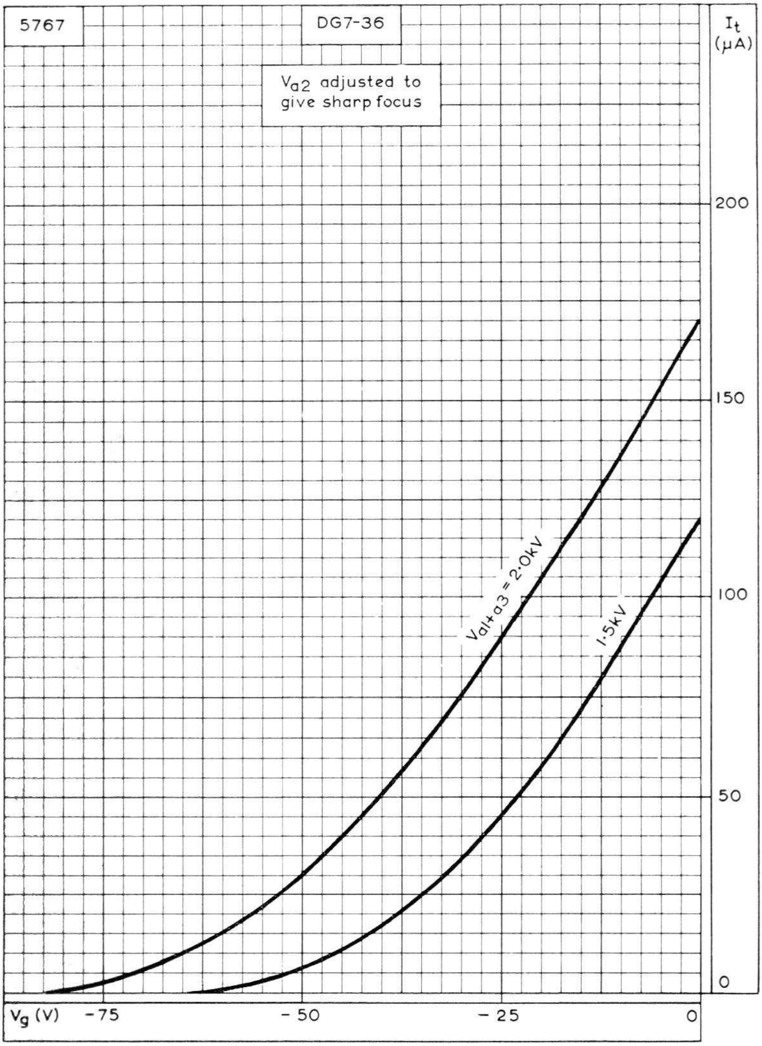
Orientation of axes of deflection
as viewed from screen end.



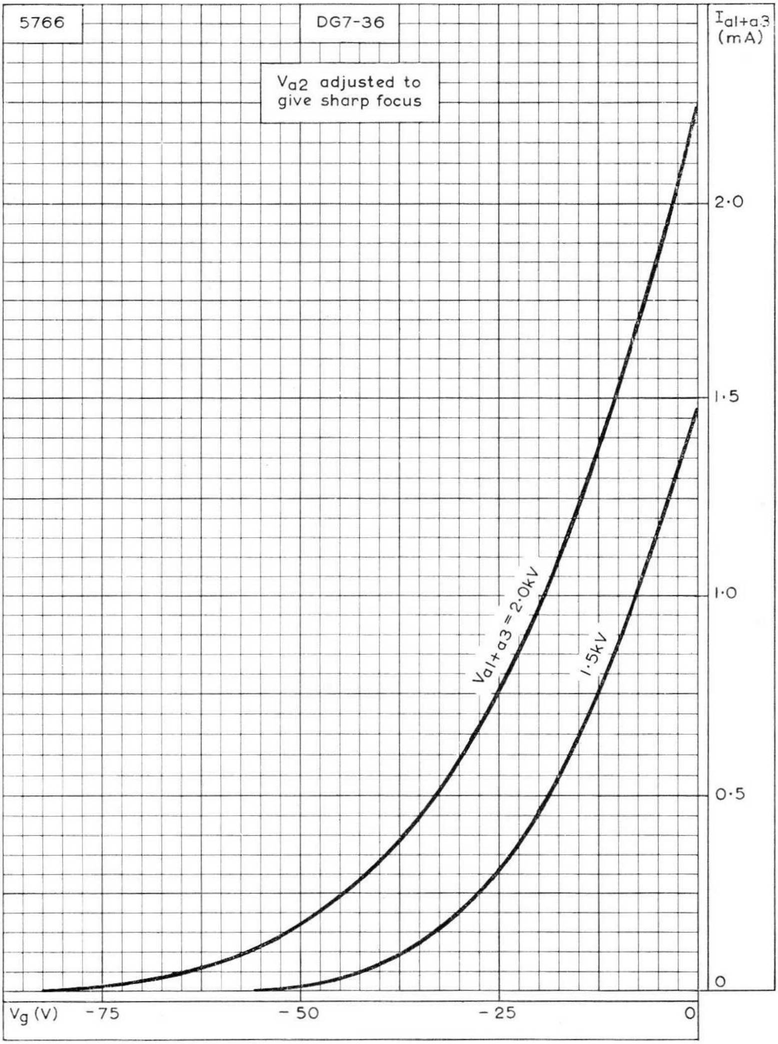


B12A Base

All dimensions in mm



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DG13-34

Direct-viewing oscilloscope tube with 5-in. flat face screen. This tube is fitted with a post-deflection accelerator.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, which precede this section of the handbook.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	600	mA

CAPACITANCES

c_{g-all}	<7.9	pF
c_{k-all}	<5.8	pF
$c_{x'-all(x''earthed)}$	<6.1	pF
$c_{x''-all(x'earthed)}$	<6.1	pF
$c_{y'-all(y''earthed)}$	<5.0	pF
$c_{y''-all(y'earthed)}$	<5.0	pF
$c_{x'-x''}$	<3.1	pF
$c_{y'-y''}$	1.3	pF

SCREEN

Fluorescent colour	green	
Persistence	medium	
Minimum useful scan from the centre of the tube face	$(y'-y'')\pm54$	mm
Minimum useful scan from the centre of the tube face	$(x'-x'')\pm54$	mm

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are intended for symmetrical deflection.
For optimum focus the average potentials of the deflection plates and a_1+a_3 should be equal.

Deviation of linearity of deflection

The sensitivity (for both $x'-x''$ and $y'-y''$ plate pairs separately) for a deflection of less than 75% of the useful scan will not differ from the sensitivity for a deflection of 25% of the useful scan by more than 2%.

Pattern distortion

With a raster pattern the size of which is adjusted so that the widest points of the pattern just touch the sides of a square 3.075 in. on a side, no point on these pattern sides will lie within an inscribed square 2.925 in. on a side.

Angle between x and y deflection $90°\pm1°$

MOUNTING POSITION Any

This tube should not be supported by the base alone.
The socket should under no circumstances be used to support the tube.

DG13-34

OSCILLOSCOPE TUBE

OPERATING CONDITIONS

V_{a4}	3.0	kV
V_{a1+a3}	1.5	kV
**V_{a2}	345 to 515	V
*V_g	−34 to −56	V
I_{a2}	−15 to +10	μA
S_x	0.57	mm/V
S_y	0.76	mm/V

*In no circumstances must the d.c. value of the grid bias be allowed to become positive with respect to the cathode.

**At 75% of V_g cut-off value.

DEFLECTION SENSITIVITY LIMITS

	Without acceleration ($V_{a4} = V_{a1+a3}$)	With acceleration ($V_{a4} = 2V_{a1+a3}$)	
S_x	$\frac{965 \text{ to } 1170}{V_{a1+a3}}$	$\frac{765 \text{ to } 950}{V_{a1+a3}}$	mm/V
S_y	$\frac{1245 \text{ to } 1560}{V_{a1+a3}}$	$\frac{1020 \text{ to } 1260}{V_{a1+a3}}$	mm/V

EQUIPMENT DESIGN RANGE

Focus voltage (V_{a2})	200 to 345V per kV of accelerator voltage (V_{a1+a3})
Grid cut-off voltage	−22.7 to −37.5V per kV of accelerator voltage (V_{a1+a3})
*Deflection factor (y′ −y″)	6.4 to 7.9V/cm per kV of accelerator voltage (V_{a1+a3})
*Deflection factor (x′ −x″)	8.5 to 10.4V/cm per kV of accelerator voltage (V_{a1+a3})

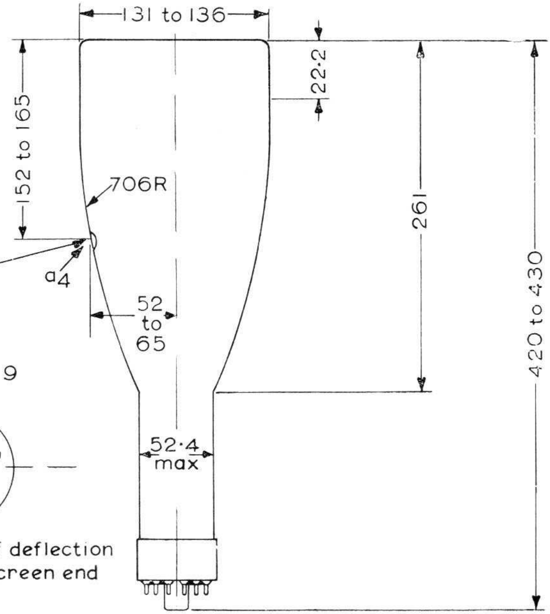
*$V_{a4} = V_{a1+a3}$

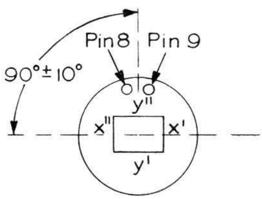
LIMITING VALUES (absolute ratings)

V_{a4} max.	6.6	kV
V_{a4} min.	1.5	kV
V_{a1+a3} max.	2.85	kV
V_{a1+a3} min.	1.5	kV
V_{a2} max.	1.1	kV
$-V_g$ max.	200	V
$v_{x'-x''(pk)}$ max.	550	V
$v_{y'-y''(pk)}$ max.	550	V
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	1.5	MΩ
V_{h-k} max. (cathode positive)	180	V
Max. ratio of V_{a4}/V_{a1+a3}	2.3	

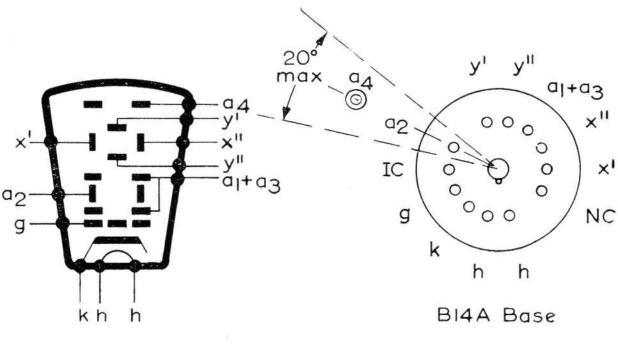
WEIGHT

840	g
1lb	14oz



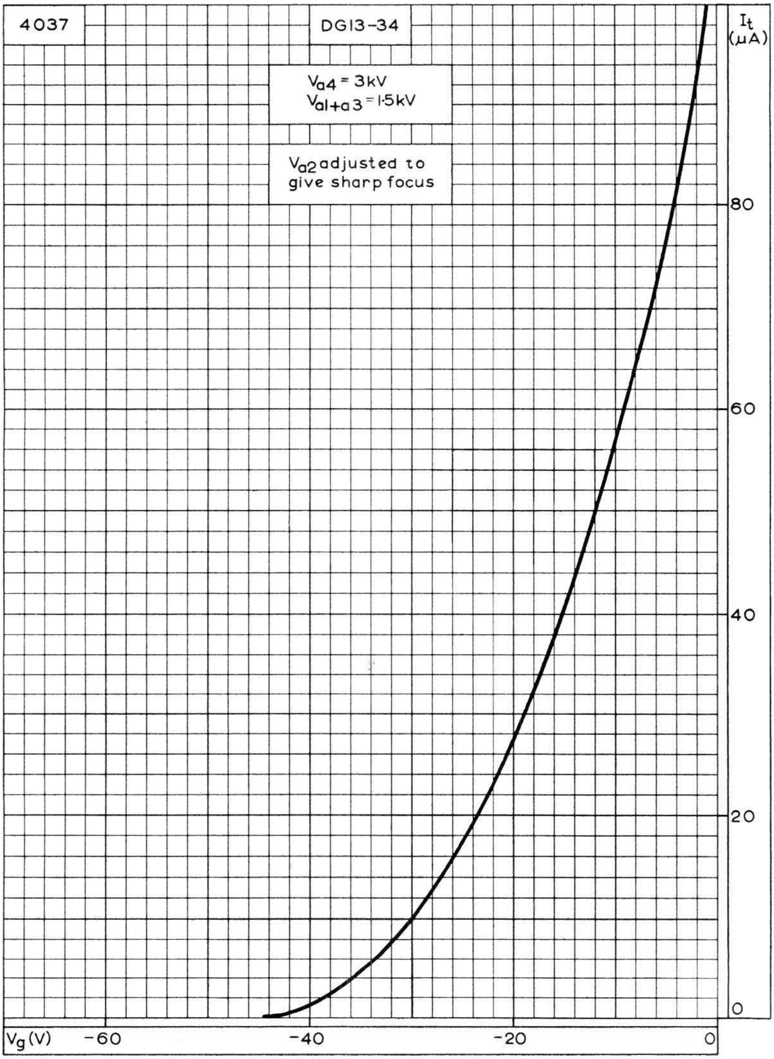


Orientation of axes of deflection as viewed from screen end

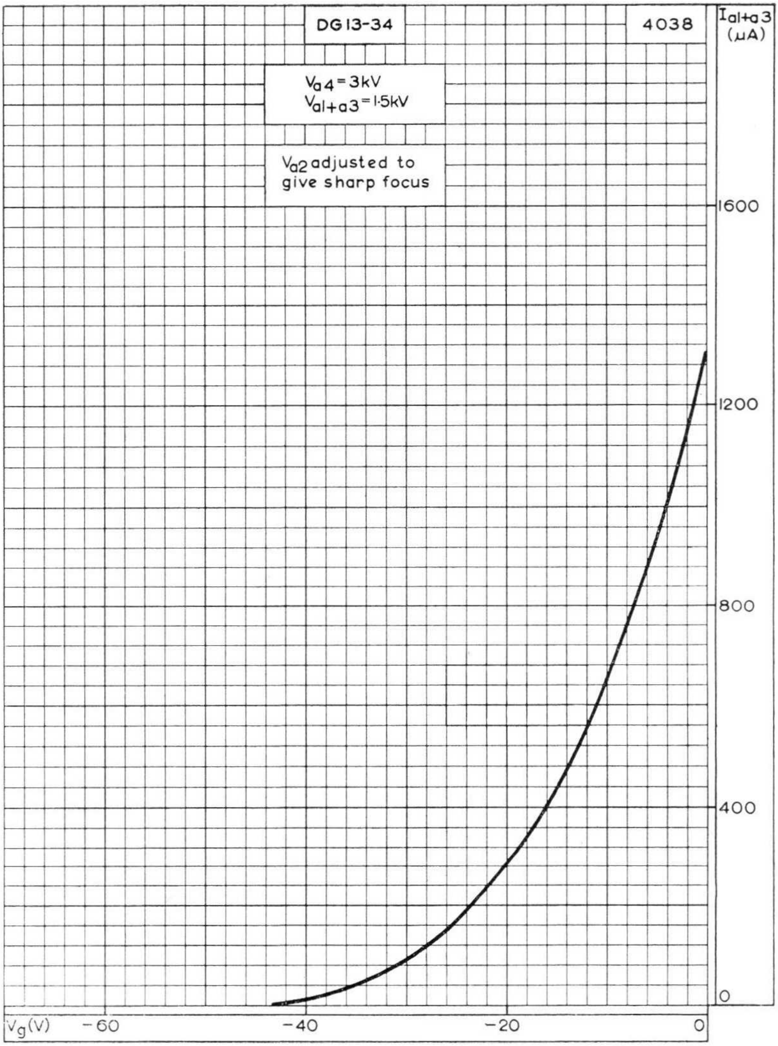


4075

All dimensions in mm



SCREEN CURRENT PLOTTED AGAINST GRID VOLTAGE



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

OSCILLOSCOPE TUBE

DH3-91

Direct viewing low voltage oscilloscope tube with 1-in. diameter screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, preceding this section of the handbook.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	550	mA

CAPACITANCES

c_{g-all}	4.8 to 7.7	pF
$c_{x'-all}$	4.8 to 7.2	pF
$c_{x''-all}$	4.8 to 7.2	pF
$c_{y'-all}$	2.3 to 4.7	pF
$c_{x'-x''}$	0.5 to 1.5	pF
$c_{x''-y'}$	<0.3	pF
$c_{x'-y'}$	<0.3	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic (self-focusing)

DEFLECTION

Double electrostatic

x plates suitable for symmetrical operation

y plates only for asymmetrical operation

For optimum focus, with symmetrical operation, the average potential of the x plates and a_1+a_3+y'' should be equal. With asymmetrical operation, the potential on any one deflection plate should not differ from $V_{a1+a3+y''}$ by more than the deflection voltage.

MOUNTING POSITION Any

This tube may be supported by the base alone but care must be taken to minimise the effects of sudden acceleration and shock.

DH3-91

OSCILLOSCOPE TUBE

TYPICAL OPERATING CONDITIONS

$V_{a1+a3+y''}$	500	V
*V_g	−8 to −27	V
S_x	0.19	mm/V
S_y	0.22	mm/V
†Line width	0.6	mm

*In no circumstances must the grid be allowed to become positive.

†Measured on a line of 30mm length with $V_{a1+a3+y''} = 500V$ at an intensity of 0.001cd.

DEFLECTION SENSITIVITY LIMITS

S_x	$\frac{65 \text{ to } 125}{V_{a1+a3+y''}}$	mm/V
S_y	$\frac{75 \text{ to } 145}{V_{a1+a3+y''}}$	mm/V

With the tube magnetically shielded, an undeflected spot will lie within 2.0mm of the screen centre.

LIMITING VALUES

$V_{a1+a3+y''}$ max.	1.0	kV
$V_{a1+a3+y''}$ min.	350	V
$-V_g$ max.	100	V
$-V_g$ min.	1.0	V
$p_{t(av.)}$ max.	2.0	mW/cm^2
$R_{x-a1+a3+y''}$ max.	5.0	MΩ
$R_{y'-a1+a3+y''}$ max.	5.0	MΩ
R_{g-k} max.	1.0	MΩ
$v_{h-k(pk)}$ max.	±250	V

WEIGHT (approx.) { 39 g / 1.4 oz

CIRCUIT NOTES FOR DH3-91

In view of the simplicity of the operating requirements no additional supplies may be required when the tube is incorporated in some equipment. An arrangement suitable for use in such a case is shown in Fig. 1. Fixed bias is provided by the cathode resistor R3 which may be by-passed if necessary by a 0.5μF capacitor. Although tubes may not be identical in respect of their 'brightness-grid voltage' characteristic this method of auto-bias produces almost constant brilliance in changing from tube to tube.

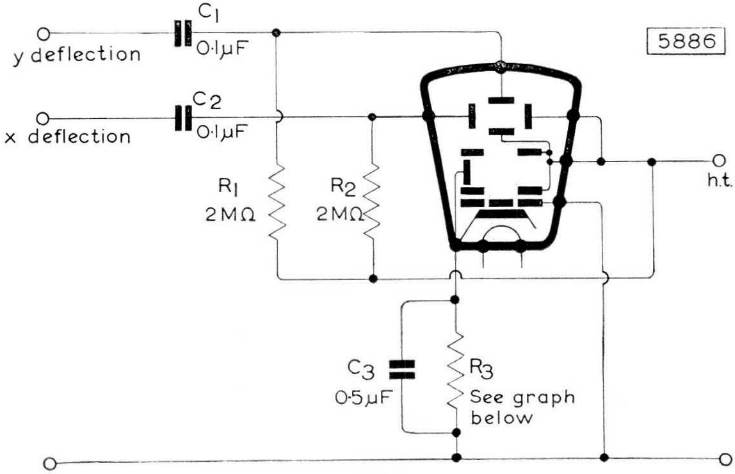
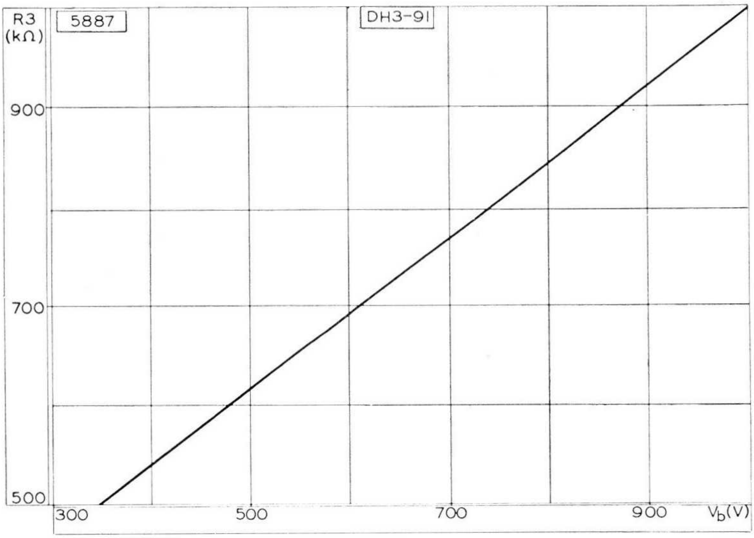


Fig. 1



Owing to the presence of a transparent conducting film connected to anode between the screen of the tube and the glass, the tube may be operated with its cathode at earth potential without any oscillogram distortion when an earthed body is brought near the screen.

Depending on the individual application, the simple arrangement shown may be unsuitable for a variety of reasons. Two of the commonest drawbacks, with suggestions for overcoming them, are:

1. If various patterns are to be displayed on the same tube it is probable that different beam currents will be required to produce the same brightness on each oscillogram. A modified variable brilliance control can be provided merely by using a variable cathode bias resistor. Alternatively, if it is required to 'black-out' the trace a combination of tube current and bleed can be used. In either case it is desirable to incorporate a limiting resistor in order to prevent excessive beam current being drawn.
2. Since the deflector plates are essentially at h.t. potential it is not normally possible to incorporate d.c. coupling to them. Should this be required it is necessary to run the tube anode at the mean potential of the deflector plates, which usually involves tapping the anode across the h.t. supply. If there is no point from which the d.c. signal can be taken which allows the necessary minimum h.t. to be obtained, it is recommended that a negative supply be utilised. This may already be incorporated in the apparatus.

Note—If it is required to run the y plate only from a d.c. signal the anode tap can be used as a centring device.

Fig. 2 shows the two modifications listed above. In it the y plates are shown d.c. connected and the x plates a.c. connected. No x shift network is included. V1 is the actual working voltage of the tube.

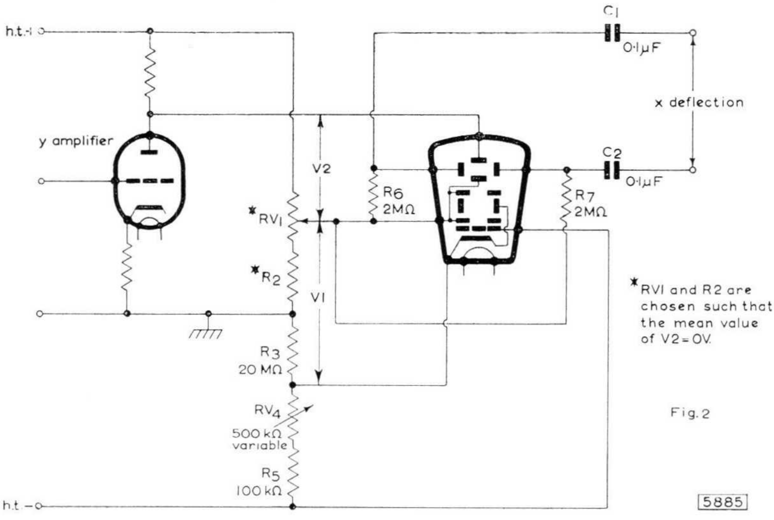
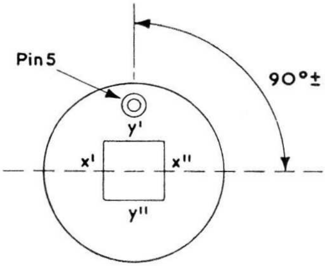
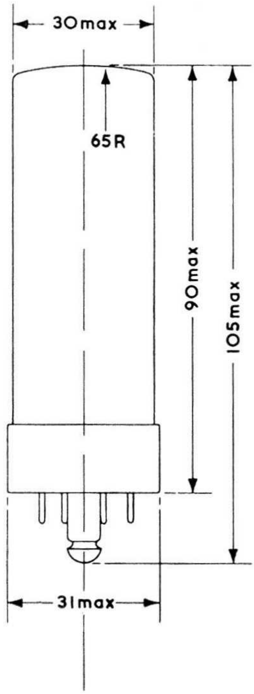


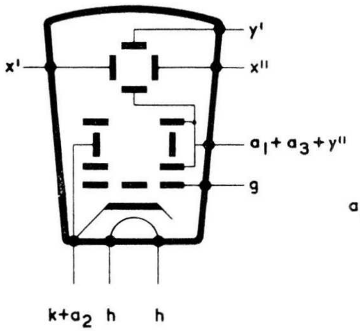
Fig. 2

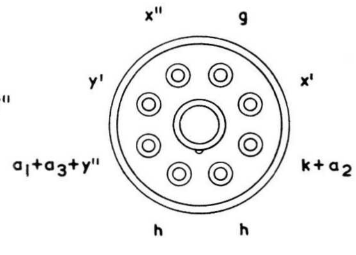
3862



Orientation of axes of deflection as viewed from screen end.







B8G Base

All dimensions in mm

OSCILLOSCOPE TUBE

DH7-91

Direct viewing high sensitivity oscilloscope tube with $2\frac{3}{4}$-in. diameter screen.

PRELIMINARY DATA

HEATER

Suitable for parallel operation only.

V_h	6.3	V
I_h	550	mA

CAPACITANCES

c_{g-all}	5.6 to 7.6	pF
c_{k-all}	2.3 to 3.1	pF
$c_{x'-all}$ (x″ earthed)	4.3 to 7.3	pF
$c_{x''-all}$ (x′ earthed)	4.3 to 7.3	pF
$c_{y'-all}$ (y″ earthed)	2.8 to 4.2	pF
$c_{y''-all}$ (y′ earthed)	2.8 to 4.2	pF
$c_{x'-x''}$	1.4 to 2.6	pF
$c_{y'-y''}$	2.2 to 3.0	pF
$c_{x'+x''-y'+y''}$	<0.33	pF
$c_{x'+x''-g+k}$	1.6	pF
$c_{y'+y''-g+k}$	1.6	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are suitable for symmetrical or asymmetrical operation.

For optimum focus, with symmetrical operation, the average potentials of the deflection plates and a_1+a_3 should be equal. With asymmetrical operation, the potential on any one deflection plate should not differ from V_{a1+a3} by more than the deflection voltage.

Pattern distortion

The length of the edges of a raster pattern whose **mean** dimensions are less than 72% of the useful scan will not deviate from these mean dimensions by more than 3.5% in the case of asymmetrical operation, or 2.5% in the case of symmetrical operation.

Angle between x and y deflection $90° \pm 2.0°$

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

DH7-91

OSCILLOSCOPE TUBE

Direct viewing high sensitivity oscilloscope tube with $2\frac{3}{4}$-in. diameter screen.

TYPICAL OPERATING CONDITIONS

V_{a1+a3}	1.0	kV
V_{a2}	210 to 320	V
*V_g	−28 to −65	V
†I_{a2}	−50	μA
S_x	0.5	mm/V
S_y	0.87	mm/V
**Line width	0.6	mm

*In no circumstances must the grid be allowed to become positive.

**Measured on a circle of 40mm diameter with $V_{a1+a3} = 10$kV and $I_t = 1.0\mu$A.

†With V_{a2} set for focus and $V_g = -1.0$V

DEFLECTION SENSITIVITY LIMITS

S_x	$\dfrac{410 \text{ to } 610}{V_{a1+a3}}$	mm/V
S_y	$\dfrac{685 \text{ to } 1050}{V_{a1+a3}}$	mm/V

With the tube magnetically shielded an undeflected spot will lie within 5.0mm of the screen centre.

LIMITING VALUES (absolute ratings)

	Symmetrical	Asymmetrical	
V_{a1+a3} max.		1.5	kV
V_{a1+a3} min.		700	V
$p_{a(tot)pk}$ max.		2.0	W
V_{a2} max.		500	V
$V_{a1+a3}-V_{a2}$ max.		1.2	kV
$-V_g$ max.		200	V
$-V_g$ min.		1.0	V
$p_{t(av.)}$ max.		3.0	mW/cm²
$R_{x-a1+a3}$ max.	4.0	2.0	MΩ
$R_{y-a1+a3}$ max.	4.0	2.0	MΩ
R_{g-k} max.		1.0	MΩ

WEIGHT

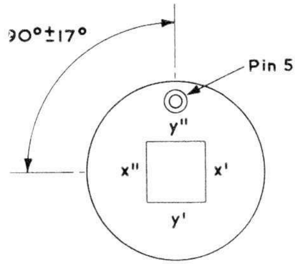
128	g
4.5	oz

OSCILLOSCOPE TUBE

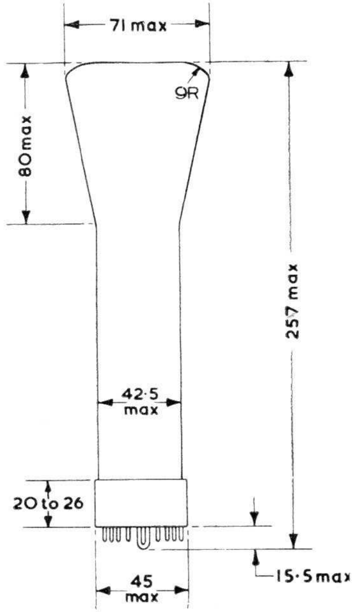
DH7-91

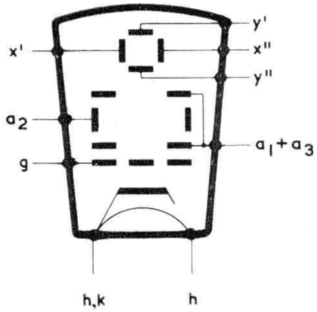
Direct viewing high sensitivity oscilloscope tube with $2\frac{3}{4}$-in. diameter screen.

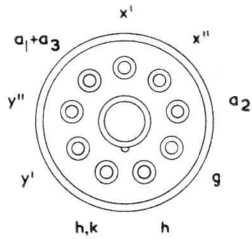
3861



Orientation of axes of deflection as viewed from screen end







B9G Base

All dimensions in mm

OSCILLOSCOPE TUBE

DH10-94

Direct viewing oscilloscope tube with 4-in. flat-face screen. This tube is fitted with a post deflection accelerator, and has side connections to the x and y plates.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	550	mA

CAPACITANCES

c_{g-all}	3.8 to 5.6	pF
c_{k-all}	3.2 to 4.8	pF
$c_{x'-all}$ (x″ earthed)	2.9 to 4.4	pF
$c_{x''-all}$ (x′ earthed)	2.9 to 4.4	pF
$c_{y'-all}$ (y″ earthed)	2.4 to 3.6	pF
$c_{y''-all}$ (y′ earthed)	2.4 to 3.6	pF
$c_{x'-x''}$	1.2 to 1.8	pF
$c_{y'-y''}$	1.3 to 1.9	pF
$c_{x'+x''-y'+y''}$	<0.1	pF
$c_{x'+x''-g+k}$	<0.1	pF
$c_{y'+y''-g+k}$	<0.1	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

Both x and y plates are for symmetrical operation.

For optimum focus, the average potentials of the deflection plates should not differ from V_{a3} by more than 50V.

Pattern distortion

The length of the edges of a raster pattern whose **mean** dimensions are less than 65% of the useful scan will not deviate from these mean dimensions by more than 2.5% providing $V_{a4}/V_{a3} \ngtr 2$.

Angle between x and y deflection 90°±1.5°

MOUNTING POSITION

Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a4}	4.0	kV
V_{a3}	2.0	kV
V_{a2}	460 to 530	V
V_{a1}	2.0	kV
V_g	–28 to –60	V
*$V_{x'-a3}$	220 to 340	V
†I_{a2}	–50	μA
S_x	0.27	mm/V
S_y	0.435	mm/V

*Beam trapping voltage. In order to obviate the necessity for pulsing the grid when displaying pulse or single stroke phenomena, a beam trap is provided on the x′ plate. When a positive voltage of suitable magnitude is applied to the x′ plate, the beam is contained on that plate, and a state of minimum brilliance exists.

†With V_{a2} set for focus, and at $V_g = -1.0$V

DH10-94

OSCILLOSCOPE TUBE

Direct viewing oscilloscope tube with 4-in. flat-face screen. This tube is fitted with a post deflection accelerator, and has side connections to the x and y plates.

LINE WIDTH (measured under d.c. conditions)

V_{a4}	4.0	kV
V_{a3}	2.0	kV
V_{a2}	adjusted for focus	
V_{a1}	2.0	kV
V_g	value corresponding to 0.05	candelas
Writing speed	0.6	km/s ←
Repetition period	10	ms ←
Distance from screen centre (any direction)	0	mm
Line resolution (min.)	30	lines/cm ←

DEFLECTION SENSITIVITY

	Without acceleration ($V_{a4} = V_{a3}$)	With acceleration ($V_{a4} = 2V_{a3}$)	
S_x	$\frac{600}{V_{a3}}$	$\frac{480 \text{ to } 625}{V_{a3}}$	mm/V
S_y	$\frac{1000}{V_{a3}}$	$\frac{790 \text{ to } 985}{V_{a3}}$	mm/V

With $V_{a4} = V_{a3}$, an undeflected spot will lie within 8.0mm of the screen centre.

LIMITING VALUES

V_{a4} max.	10	kV
V_{a4} min.	1.0	kV
V_{a3} max.	5.0	kV
V_{a2} max.	1.5	kV
V_{a1} max.	5.0	kV
V_{a4-a3} max.	5.0	kV
$p_{a(tot)}$ max.	3.0	W
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
V_{x-a3} max.	1.0	kV
V_{y-a3} max.	1.0	kV
$p_{t(av.)}$ max.	3.0	mW/cm^2
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	1.0	MΩ
$v_{h-k(pk)}$ max.	250	V
Max. ratio of V_{a4}/V_{a3} for full screen x deflection	2.0	

WEIGHT

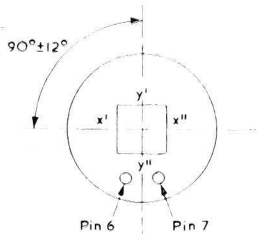
WEIGHT	560	g
	20	oz

OSCILLOSCOPE TUBE

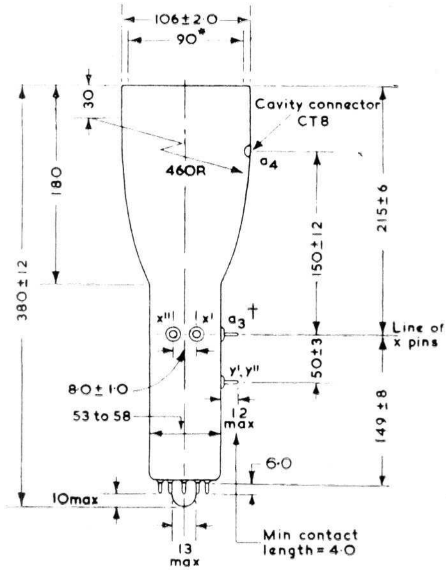
DH10-94

Direct viewing oscilloscope tube with 4-in. flat-face screen. This tube is fitted with a post deflection accelerator, and has side connections to the x and y plates.

5163



Orientation of axes of deflection as viewed from screen end.

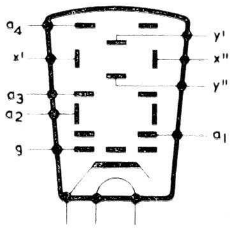


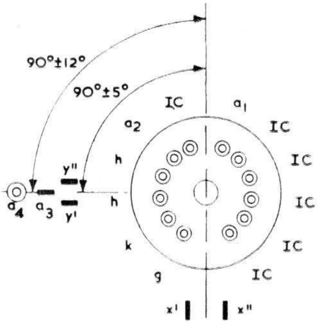
Notes

* This face flat over a minimum area of 90 mm diameter.

† The axial distance between the radial planes of the x pins and the a_3 pin ⊁ 2·0 mm

Side connectors = 1·27dia





B12F Base

All dimensions in mm

OSCILLOSCOPE TUBE

DH13-78

Direct viewing oscilloscope tube with 5-in. flat face metal-backed screen, helical post-deflection accelerator, and side connections to the x and y plates. Intended for applications where high sensitivity, high writing speed and low pattern distortion are required.

PRELIMINARY DATA

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for parallel operation only, a.c. or d.c.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	6.0	pF
c_{k-all}	3.5	pF
$c_{y'-all}$ (y″ earthed)	2.8	pF
$c_{y''-all}$ (y′ earthed)	2.8	pF
$c_{x'-all}$ (x″ earthed)	3.0	pF
$c_{x''-all}$ (x′ earthed)	3.0	pF
$c_{y'-y''}$	1.5	pF
$c_{x'-x''}$	2.0	pF

SCREEN

Fluorescent colour	blue-green	
Persistence	medium	
Minimum useful screen diameter	108	mm
Minimum useful scan ($V_{a6} = 6V_{a1+a3}$)		
x′–x″	100	mm
y′–y″	40	mm

The midpoint of the useful scan will be within 3mm of the geometric centre of the faceplate with $V_{a6} = 6V_{a1+a3}$.

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic.
Both x and y plates are intended for symmetrical deflection.

Deviation of linearity of deflection

The sensitivity (for both x′–x″ and y′–y″ plate pairs separately) for a deflection of less than 75% of the useful scan will not differ from the sensitivity for a deflection of 25% by more than 2%.

Pattern distortion

With a raster pattern the size of which is adjusted so that the widest points of the pattern just touch the sides of a rectangle 40mm × 100mm, no point of these pattern sides will be within a rectangle 38.8mm × 97mm, the rectangle being placed concentrically.

DH13-78

OSCILLOSCOPE TUBE

Angle between x and y deflection $90° \pm 1°$

Isolation screen (a_5)

In general the voltage on a_5 and the average voltage on the deflection plates should be equal. Adjustment of V_{a5} up to a maximum of $\pm 10\%$ of the a_1+a_3 potential serves to correct pincushion and barrel pattern distortion. This screen is also internally connected to the lower end of the helical post deflection accelerator.

Deflection plate screen (a_4)

In general the voltages on a_4 and a_1+a_3 and the average voltage on the deflection plates should be equal. Variation of V_{a4} up to a maximum of $\pm 5\%$ of a_1+a_3 potential serves to correct pincushion and barrel pattern distortion.

Deflection plates $x'-x''$ and $y'-y''$

In general the average voltage on the deflection plates and the voltage on a_1+a_3 should be equal. To provide some measure of astigmatism control it may be desirable to apply a small potential difference between the x plates and a_1+a_3.

A low impedance deflection voltage source is desirable, as if the tube is fully deflected the deflection plates will intercept part of the electron beam near the edge of scan.

Spot position

With the tube shielded the undeflected spot will lie within a radius of 5mm from the geometric centre of the tube face.

HELICAL RESISTANCE

Minimum post deflection acceleration helix resistance	300	MΩ

MOUNTING POSITION

Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

OPERATING CONDITIONS

V_{a6}	10	12	kV
V_{a5}	1.67	2.0	kV
V_{a4}	1.67	2.0	kV
V_{a1+a3}	1.67	2.0	kV
V_{a2}	180 to 590	220 to 710	V
V_g for visual cut-off	−50 to −80	−60 to −96	V
S_y	1.32 to 1.78	1.08 to 1.47	mm/V
S_x	0.3 to 0.36	0.25 to 0.3	mm/V

LINE WIDTH

V_{a6}	10	kV
V_{a1+a3}	1.67	kV
I_{a6}	0.5	µA
*Line width	0.4	mm

*Measured on a circle of 30mm diameter.

EQUIPMENT DESIGN RANGE

Focusing voltage (V_{a2})	110 to 355V per kV of accelerator voltage (V_{a1+a3})
Grid cut-off voltage (V_g)	-30 to -48V per kV of accelerator voltage (V_{a1+a3})
Deflection factor	
$y'-y''$ ($V_{a6} = 6V_{a1+a3}$)	3.4 to 4.6V/cm per kV of accelerator voltage (V_{a1+a3})
$x'-x''$ ($V_{a6} = 6V_{a1+a3}$)	16.7 to 20V/cm per kV of accelerator voltage (V_{a1+a3})
Focus electrode current (I_{a2})	−15 to +10μA

LIMITING VALUES (design centre ratings)

V_{a6} max.	12	kV
V_{a6} min.	6.0	kV
V_{a5} max.	2.1	kV
V_{a4} max.	2.2	kV
V_{a1+a3}	2.0	kV
Max. ratio of V_{a6}/V_{a1+a3}	6.0	
V_{a2} max.	1.5	kV
$-V_g$ max.	200	V
$+V_g$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
$v_{x-a1+a3(pk)}$ max.	500	V
$v_{y-a1+a3(pk)}$ max.	500	V
p_{a1+a3} max.	6.0	W
$p_{t(av)}$ max.	3.0	mW/cm^2
V_{h-k} max. (cathode negative)	125	V
V_{h-k} max. (cathode positive)	200	V

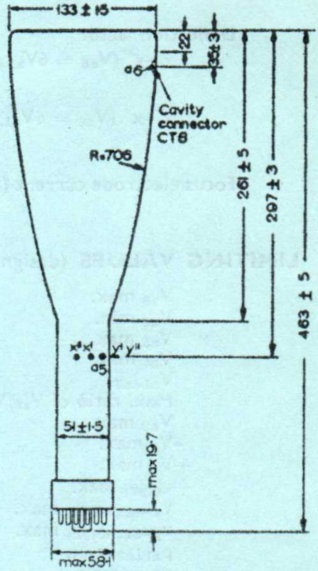
WEIGHT

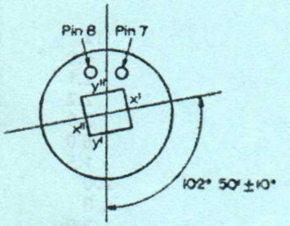
Tube alone	910	g
	32	oz

DH13-78

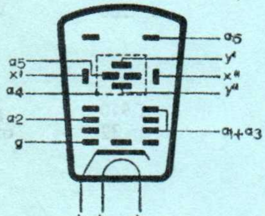
OSCILLOSCOPE TUBE

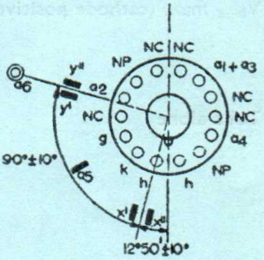
6273





Orientation of axes of deflection as viewed from screen end





B14A Base

All dimensions in mm.

OSCILLOSCOPE TUBE

DH13-97

Direct viewing precision oscilloscope tube with 5-in. diameter flat screen. This tube is fitted with two stages of distributed post deflection acceleration and the deflection plates are brought out to side connections.

PRELIMINARY DATA

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES preceding this section of the handbook.

HEATER

Suitable for parallel operation only.

V_h	6.3	V
I_h	550	mA

CAPACITANCES

c_{g-all}	7.4	pF
c_{k-all}	4.1	pF
$c_{x'-all}$ (x″ earthed)	3.6	pF
$c_{x''-all}$ (x′ earthed)	3.6	pF
$c_{y'-all}$ (y″ earthed)	1.6	pF
$c_{y''-all}$ (y′ earthed)	1.7	pF
$c_{x'-x''}$	2.3	pF
$c_{y'-y''}$	1.7	pF
$c_{x'+x''-y'+y''}$	<0.1	pF
$c_{x'+x''-g+k}$	<0.1	pF
$c_{y'+y''-g+k}$	<0.1	pF

SCREEN

Fluorescent colour	blue/green	
Persistence	medium	
*Minimum useful scan from the centre of tube face (x′–x″)	±47.5	mm
*Minimum useful scan from the centre of tube face (y′–y″)	±30	mm

*With $V_{a5}/V_{a3} = 5.5$, $V_{a4}/V_{a3} = 2.2$

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

x plates are suitable for symmetrical operation only

y plates are suitable for both symmetrical and asymmetrical operation.

Vertical deflection, defocusing and linearity may be a little worse with asymmetrical operation.

Pattern distortion and deviation of linearity of deflection.

Compared with a normal post deflector accelerator the use of a distributed system enables much greater p.d.a. ratios to be used, with a consequent gain in sensitivity before serious pattern distortion occurs.

With $V_{a5}/V_{a3} = 5.5$, $V_{a4}/V_{a3} = 2.2$ and the mean potential of the x and y plates being equal to the potential of a_3, the interplate screen and the external conductive coating, the following figures apply:

(a) A nominally rectangular raster may be inserted into the frame bounded by the rectangles 76.5mm × 45.9mm and 73.5mm × 44.1mm i.e. maximum total pattern distortion is 2%.

(b) With the spot undeflected in the y direction the difference in deflection sensitivity at 25% useful x scan and at 75% useful x scan is less than 2%. With the spot undeflected in the x direction the difference in deflection sensitivity at 25% useful y scan and at 75% useful y scan is less than 2% i.e. maximum non linearity of deflection is 2%.

Angle between x and y deflection 90 ± 1.5°

MOUNTING POSITION

Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a5}	10	kV
V_{a4}	4.0	kV
†V_{a3}	1.8	kV
V_{a2}	440 to 560	V
V_{a1}	1.4	kV
V_g for cut-off	−45 to −90	V
*Grid drive	20	V
I_{a5}	25	µA
**I_{a2}	−100	µA
S_x	0.38	mm/V
S_y	0.8	mm/V

*For intensity of 0.45cd

**With V_{a2} set for focus and $V_{g1} = -1.0V$

†Inter-plate screen (i.p.s.) connected to a_3.

DEFLECTION SENSITIVITY LIMITS

S_x	0.33 to 0.43	mm/V
S_y	0.7 to 0.89	mm/V

The sensitivities vary inversely with V_{a5} provided that the p.d.a. ratios remain constant.

LIMITING VALUES (absolute ratings)

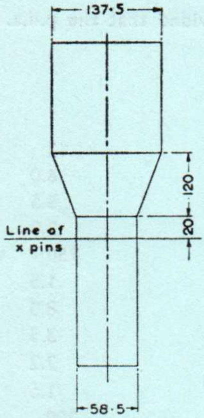
V_{a5} max.	12	kV
V_{a5} min.	6.0	kV
V_{a4} max.	5.5	kV
V_{a3} max.	2.0	kV
V_{a2} max.	750	V
V_{a1} max.	1.5	kV
$V_{a5}-V_{a4}$ max.	8.0	kV
$V_{a4}-V_{a3}$ max.	3.5	kV
$V_{a3}-V_{a2}$ max.	2.2	kV
$V_{a2}-V_{a1}$ max.	1.5	kV
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
p_{a1+a3} max.	2.0	W
V_{x-a3} max.	500	V
V_{y-a3} max.	500	V
$p_{t(av.)}$ max.	5.0	mW/cm^2
R_{x-a3} max.	5.0	MΩ
R_{y-a3} max.	5.0	MΩ
R_{g-k} max.	1.0	MΩ
r_{a5-a3} min.	80	MΩ
$v_{h-k(pk)}$ max.	250	V
Max. ratio of V_{a5}/V_{a3} (for scan size of 60mm × 95mm $V_{a4}/V_{a3} = 2.2$)	5.5	

WEIGHT

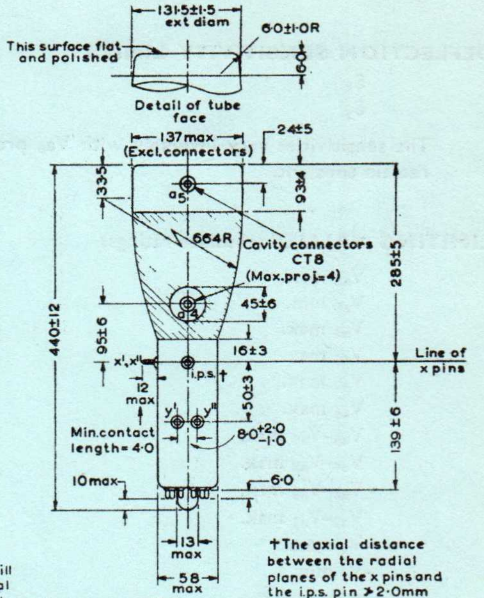
WEIGHT	1.25	kg
	44	oz

DH13-97

OSCILLOSCOPE TUBE

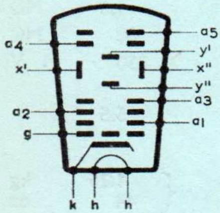


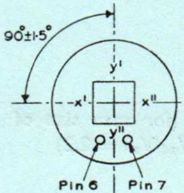
Excluding connectors, tube will fit into a radially symmetrical housing of the above internal dimensions.



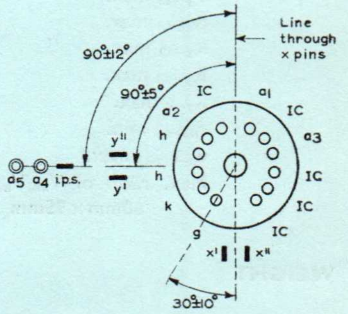
Side connectors 1·27 diam

†The axial distance between the radial planes of the x pins and the i.p.s. pin ≯ 2·0mm





Orientation of axes of deflection as viewed from screen end.



B12F Base

4415

All dimensions in mm

DUAL TRACE OSCILLOSCOPE TUBE

DHM10-93

Direct viewing dual trace oscilloscope tube with 4-in. flat-face screen, and independent y signal deflections. This tube is fitted with a post deflection accelerator and has side connections to the x and y plates.

PRELIMINARY DATA

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES preceding this section of the handbook.

HEATER

Suitable for parallel operation only

V_h	6.3	V
I_h	550	mA

CAPACITANCES

$c_{g\text{-}all}$	4.2 to 5.9	pF
$c_{k\text{-}all}$	3.5 to 4.9	pF
$c_{x'\text{-}all}$ (x″ earthed)	2.7 to 3.8	pF
$c_{x''\text{-}all}$ (x′ earthed)	2.7 to 3.8	pF
$c_{y'\text{-}all}$ (y″ earthed)	2.5 to 3.8	pF
$c_{y''\text{-}all}$ (y′ earthed)	2.5 to 3.8	pF
$c_{x'\text{-}x''}$	1.4 to 2.0	pF
$c_{y'\text{-}y''}$	<0.1	pF
$c_{y'\text{-}x'+x''}$	<0.1	pF
$c_{y''\text{-}x'+x''}$	<0.1	pF

SCREEN

Fluorescent colour	green
Persistence	medium

FOCUSING

Electrostatic

DEFLECTION

Double electrostatic

The x plates are intended for symmetrical deflection only. The y plates may be used for asymmetrical deflection only, since the two plates are separated by a common beam dividing plate internally connected to a_3.

Pattern distortion

The length of the edges of a raster pattern whose mean dimensions are less than 65% of the useful scan will not deviate from these mean dimensions by more than 2.5% providing $V_{a4}/V_{a3} > 2$.

Angle between x and y deflection	$90° \pm 1.5°$
Angle between the two y deflections	$<1.0°$

MOUNTING POSITION Any

This tube should not be supported by the base alone. The socket should under no circumstances be used to support the tube.

TYPICAL OPERATING CONDITIONS

V_{a4}	3.0	kV
V_{a3}	1.5	kV
*V_{a2}	320 to 420	V
V_{a1}	1.5	kV
V_g	−40 to −95	V
**$V_{x'-a3}$	170 to 290	V
†I_{a2}	0 to 200	μA
S_x	27	V/cm
$S_{y'}$	27	V/cm
$S_{y''}$	27	V/cm

*For focus with Vg set for light intensity of 0.1cd. To accommodate a wide range of V_g settings it is recommended that the available range of V_{a2} should be 150 to 450V with $V_{a1} = V_{a3} = 1.5$kV, $V_{a4} = 3$kV.

**Beam trapping voltage. In order to obviate the necessity for pulsing the grid when displaying pulse or single stroke phenomena, a beam trap is provided on the x′ plate. When a positive voltage of suitable magnitude is applied to the x′ plate, the beam is contained on that plate, and a state of minimum brilliance exists.

†With V_{a2} set for focus, and at $V_g = -1.0$V.

RESOLUTION (measured under d.c. conditions)

V_{a4}	3.0	kV
V_{a3}	1.5	kV
V_{a2}	adjusted for focus	
V_{a1}	1.5	kV
V_g	Value corresponding to 0.08cd	
Writing speed	0.6	km/s
Repetition period	10	ms
Line resolution	35	lines/cm

DEFLECTION SENSITIVITY

	With acceleration ($V_{a4} = 2V_{a3}$)	
S_x	$\frac{475 \text{ to } 650}{V_{a3}}$	mm/V
$S_{y'}$	$\frac{475 \text{ to } 650}{V_{a3}}$	mm/V
$S_{y''}$	$\frac{475 \text{ to } 650}{V_{a3}}$	mm/V

With $V_{a4} = V_{a3}$, both undeflected spots will be within 8.0mm of the screen centre.

LIMITING VALUES (absolute ratings)

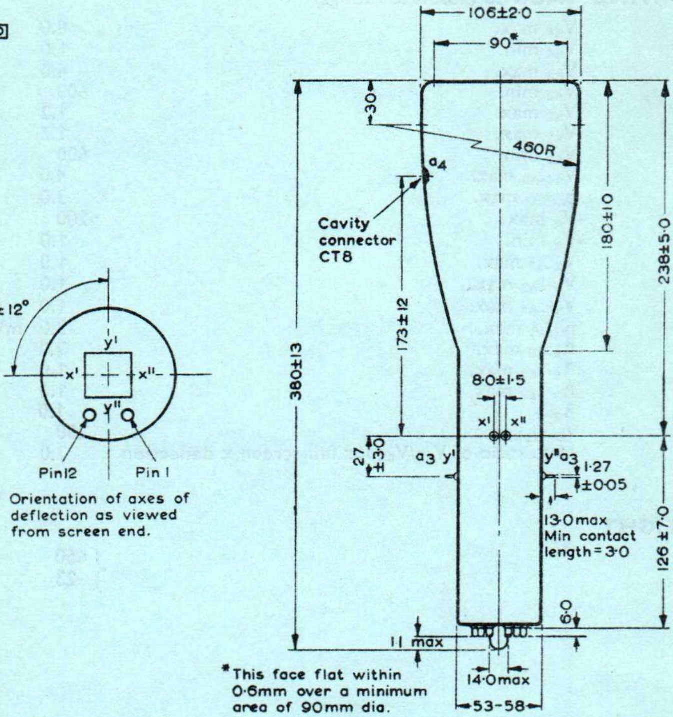
V_{a4} max.	8.0	kV
V_{a4} min.	1.0	kV
V_{a3} max.	4.0	kV
V_{a3} min.	600	V
V_{a2} max.	1.2	kV
V_{a1} max.	1.7	kV
V_{a1} min.	600	V
V_{a4-a3} max.	4.0	kV
$p_{a(tot)}$ max.	3.0	W
$-V_g$ max.	200	V
$-V_g$ min.	1.0	V
V_{x-a3} max.	1.0	kV
$V_{y'-a3}$ max.	1.0	kV
$V_{y''-a3}$ max.	1.0	kV
$p_{t(av)}$ max.	3.0	mW/cm^2
R_{x-a3} max.	2.0	MΩ
$R_{y'-a3}$ max.	1.0	MΩ
$R_{y''-a3}$ max.	1.0	MΩ
R_{g-k}	1.0	MΩ
$v_{h-k(pk)}$ max.	250	V
Max. ratio of V_{a4}/V_{a3} for full screen x deflection	2.0	

WEIGHT

	650	g
	23	oz

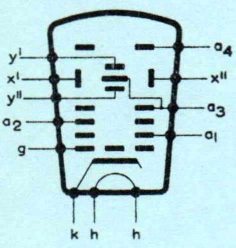
DHM10-93 DUAL TRACE OSCILLOSCOPE TUBE

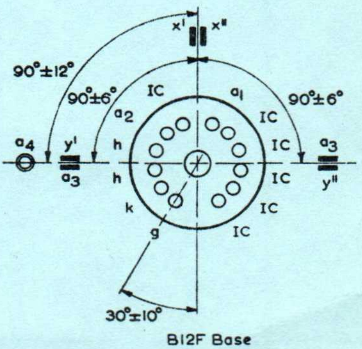
6190



Orientation of axes of deflection as viewed from screen end.

*This face flat within 0·6mm over a minimum area of 90mm dia.





All dimensions in mm

B12F Base

RADAR TUBE

MB22-75
MF22-75

Direct viewing radar tube with 9-in. diameter flat-faced metal-backed screen primarily intended for use in P.P.I. applications.

The only difference between the MB22-75 and the MF22-75 is in the screen properties (see appropriate section of data).

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES included in this section of the handbook.

HEATER

Indirectly heated

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<10	pF
c_{k-all}	<10	pF

SCREEN

Metal-backed

Max. picture diameter 200 mm

	MB22-75	MF22-75
Fluorescent colour	blue	orange—with orange afterglow
Persistence	short	long

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_a	15	kV
V_g for cut-off	−60 to −140	V
†Recommended distance of centre of magnetic length of focus unit from reference line	117	mm

†See appropriate section of 'General operational recommendations—cathode ray tubes'.

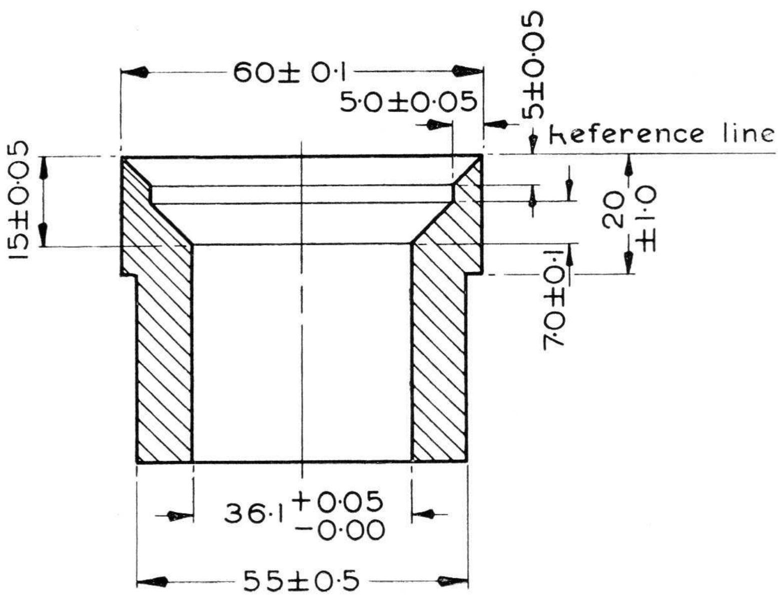
MB22-75
MF22-75

RADAR TUBE

LIMITING VALUES (absolute ratings)

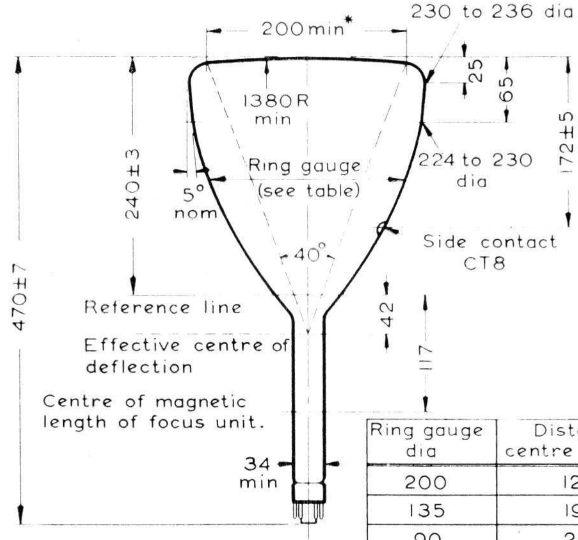
V_a max.	15.5	kV
V_a min.	9.0	kV
$-V_g$ max.	200	V
*I_k max.	150	μA
V_{h-k} max.	± 150	V
R_{g-k} max.	1.5	$M\Omega$
R_{h-k} max.	1.0	$M\Omega$

*The MF22-75 has a magnesium fluoride screen which is liable to burn if a stationary or slowly moving spot is used even with low values of mean beam current.



All dimensions in mm [5614]

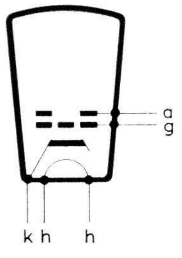
REFERENCE LINE GAUGE

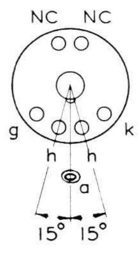


Ring gauge dia	Distance from centre of tube face
200	123 ± 20
135	190 ± 15 (Note)
90	222 ± 10

Note: The 135 dia gauge may have a chord of 30mm cut from the gauge face to a depth of 10mm to avoid the anode side contact.

*Diameter of useful screen area.

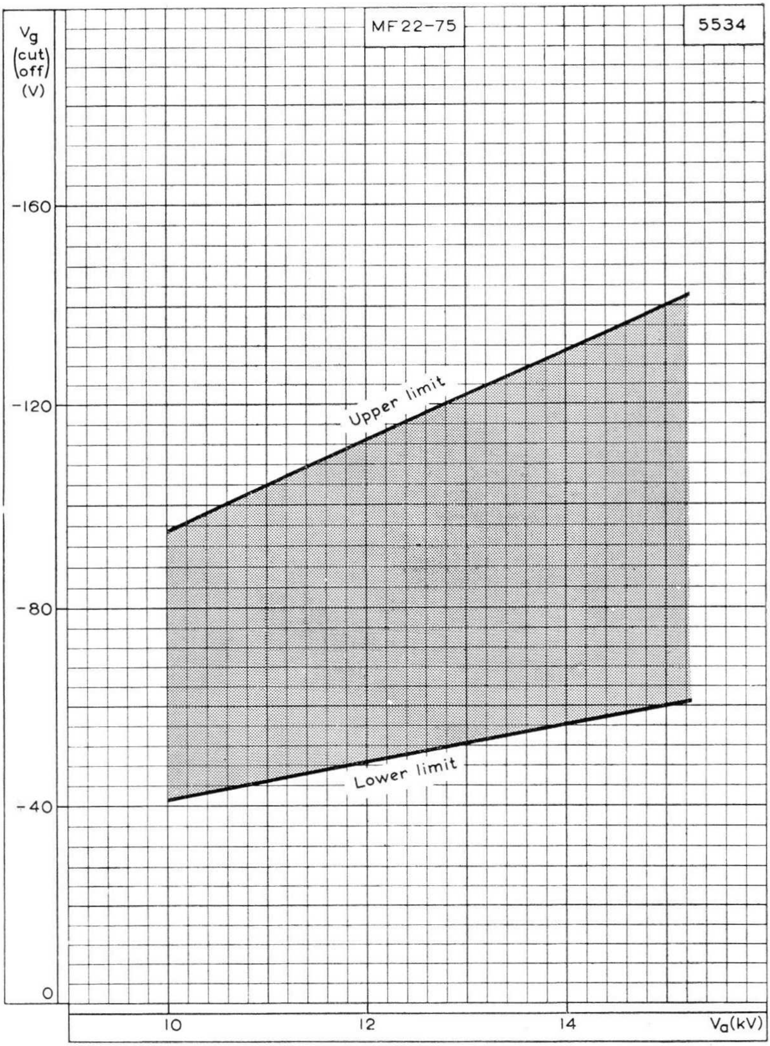




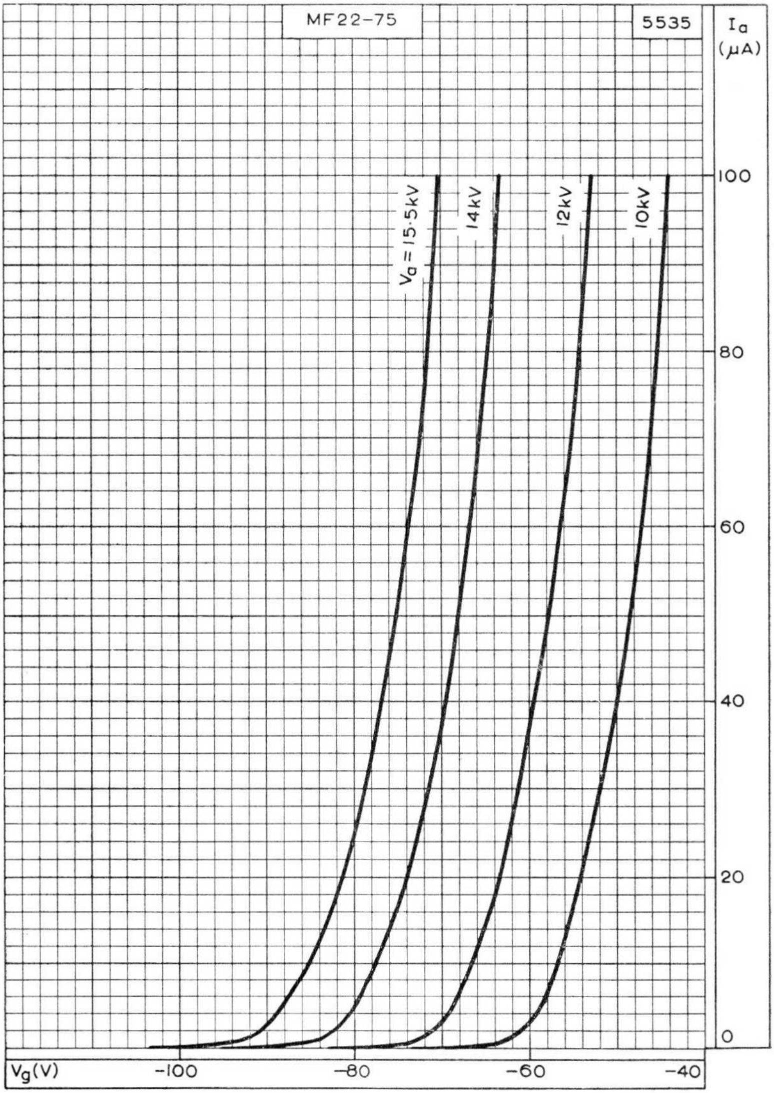
B12A Base

5610

All dimensions in mm



LIMITS OF GRID CUT-OFF VOLTAGE FOR FINAL ANODE VOLTAGES FROM 10 TO 15kV



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

FLYING SPOT SCANNER TUBE

MC13-16

Flying spot scanner tube with 5-in. diameter metal-backed screen.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

V_h	6.3	V
I_h	300	mA

SPARK TRAP AND EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating (M) around the neck of the tube, and the capacitance of this to the anode may be used to provide smoothing for the e.h.t. supply.

The insulating coating around the cone of the tube should not be in close proximity to any earthed metal parts.

Incorporated within the tube is a spark trap so positioned that it prevents any internal flashover taking place between the anode and the grid.

The spark trap and external conductive coating around the neck of the tube must be connected to the chassis.

CAPACITANCES

c_{g1-all}	6.5	pF
c_{k-all}	6.5	pF
c_{a-M}	250 to 450	pF

SCREEN

Metal-backed

Fluorescent colour	blue-violet	
Persistence	killed	

The brightness is reduced to 36% (e^{-1}) of the initial peak value $<0.1\mu s$ after the excitation is removed.

Minimum useful screen diameter	108	mm

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except with screen downwards and the axis of the tube making an angle of less than 50° with the vertical.

MC13-16 FLYING SPOT SCANNER TUBE

OPERATING CONDITIONS

V_a	25	kV
I_a	50 to 100	μA
*V_g for cut-off	−50 to −100	V
Resolution at centre of screen	>1000	lines

LIMITING VALUES (design centre)

V_a max.	27	kV
V_a min.	20	kV
*$-V_g$ max.	200	V
I_k max.	150	μA
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
‡$v_{h-k(pk)}$ max. (cathode positive)	410	V
R_{h-k} max.	1.0	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode except during the periods immediately after switching the equipment on or off, when it may be allowed to rise to +1V. The maximum positive grid excursion of the video signal may reach 2V, and at this voltage the grid current may be expected to be approximately 2mA.

†In order to avoid excessive hum, the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

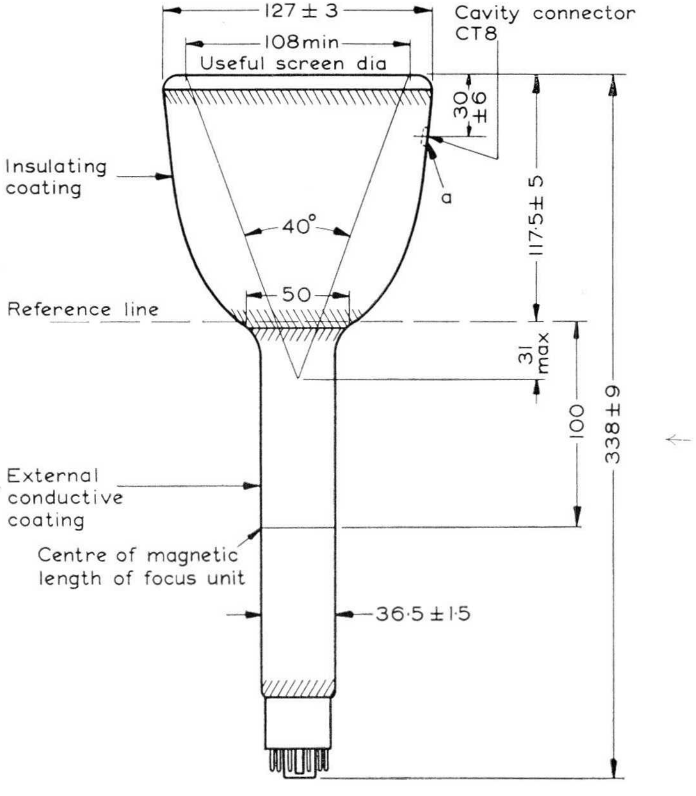
‡During a warming-up period not exceeding 45s.

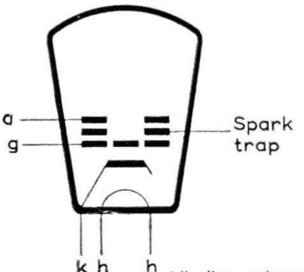
TUBE PROTECTION

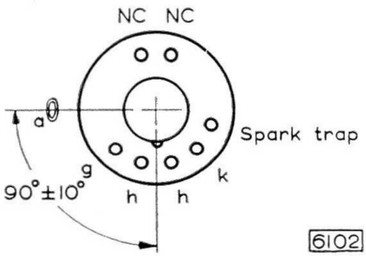
It is essential that means be provided for the instantaneous removal of the beam current in the event of a failure of either one or both of the timebases. Unless such a safety device is incorporated a failure of this type will result in the immediate destruction of the screen of the tube.

X-RADIATION PROTECTION

Shielding equivalent to a lead glass thickness of 0.5mm is required to protect the observer against X-radiation.



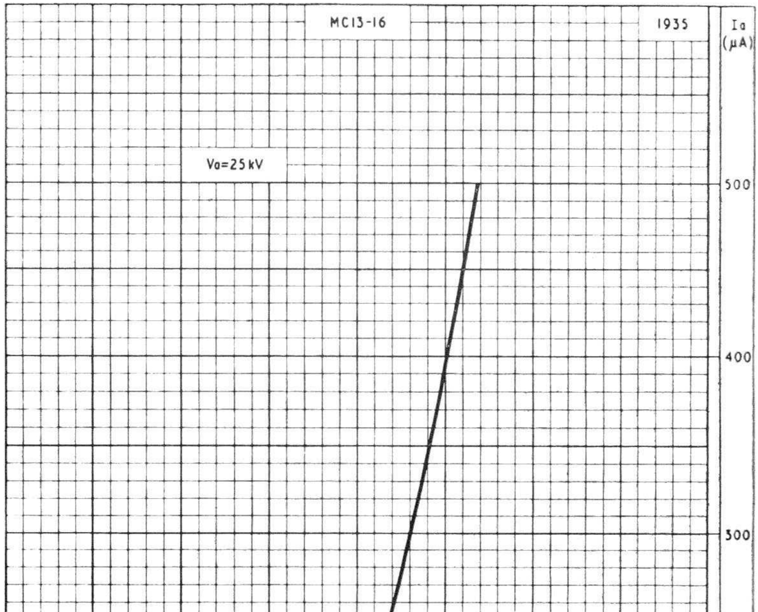




All dimensions in mm.

B12A Base.

6102



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

RADAR TUBE

MF13-1

Direct viewing radar tube with 5-in. diameter metal-backed magnesium fluoride long persistence screen. Primarily intended for use in P.P.I. applications.

HEATER Indirectly heated.
This tube is suitable for series or parallel operation.

V_h	6.3	V
I_h	0.3	A

CAPACITANCES

c_{g-all}	<10	$\mu\mu F$
c_{k-all}	<10	$\mu\mu F$

SCREEN Metal-backed.

Fluorescent colour	orange—with orange afterglow	
Persistence	long	
Min. useful screen diameter	108	mm.

FOCUSING Magnetic.

DEFLECTION Double magnetic.

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a_2}	7	kV
†V_{a_1}	250	V
V_g for cut-off	–28 to –63	V
†Recommended distance of centre of magnetic length of focus unit from reference line	73	mm

†See appropriate section of " General Operational Recommendations —Cathode Ray Tubes ".

LIMITING VALUES (Absolute ratings)

V_{a_2} max.	11	kV
V_{a_2} min.	5.5	kV
V_{a_1} max.	500	V
V_{a_1} min.	200	V
$-V_g$ max.	200	V
*I_k max.	150	μA
V_{h-k} max.	± 150	V
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	1.0	MΩ

*This tube has a magnesium fluoride screen which is liable to burn if a stationary or slowly moving spot is used, even with low values of mean beam current.

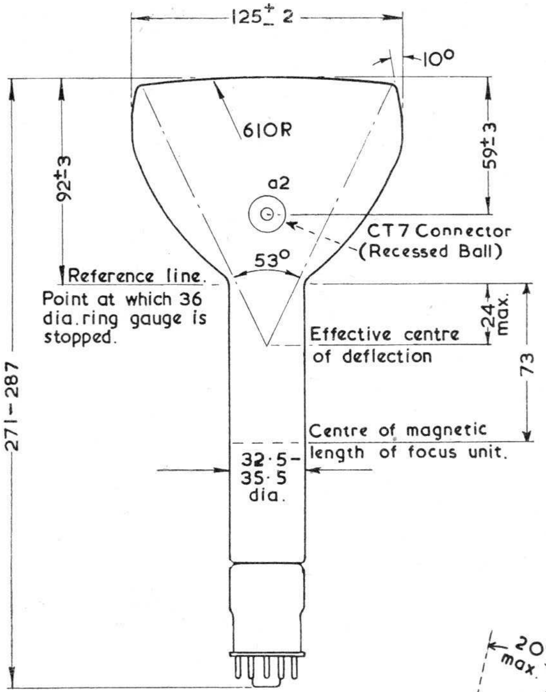
WEIGHT

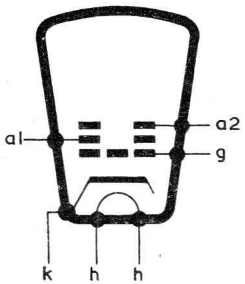
Tube alone 500 g (1 lb. 2 oz.)

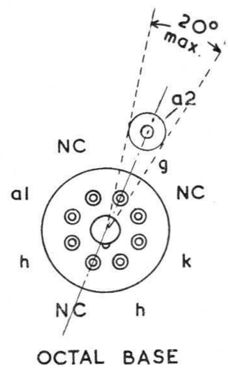
MF13-1

RADAR TUBE

Direct viewing radar tube with 5-in. diameter metal-backed magnesium fluoride long persistence screen. Primarily intended for use in P.P.I. applications.







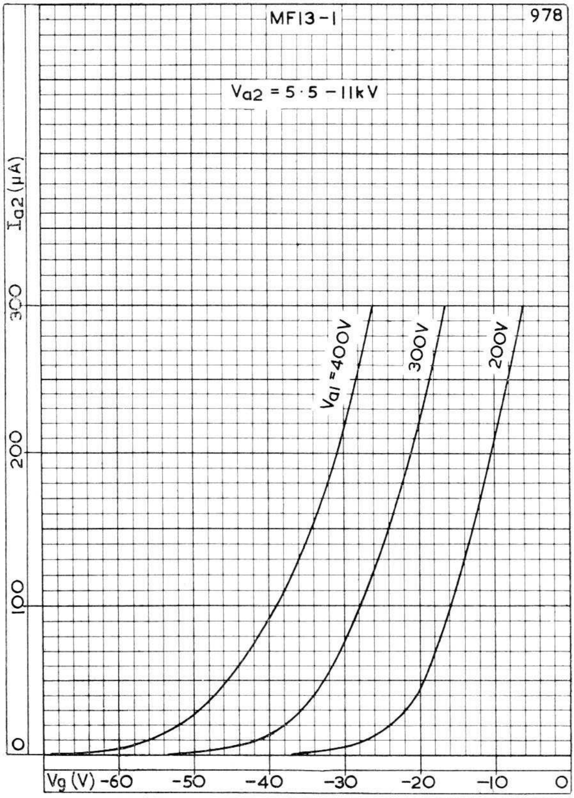
OCTAL BASE

All dimensions in mm. 977

RADAR TUBE

MF13-1

Direct viewing radar tube with 5-in. diameter metal-backed magnesium fluoride long persistence screen. Primarily intended for use in P.P.I. applications.

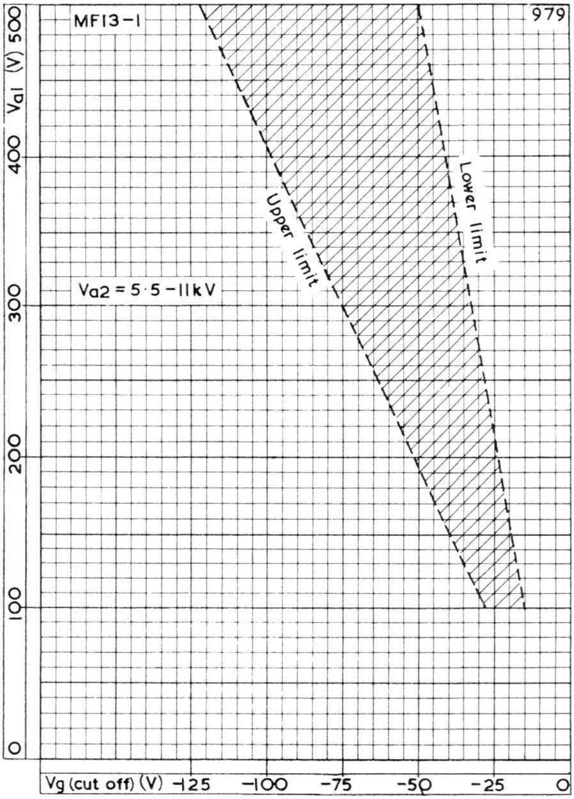


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
WITH FIRST ANODE VOLTAGE AS PARAMETER

MF13-1

RADAR TUBE

Direct viewing radar tube with 5-in. diameter metal-backed magnesium fluoride long persistence screen. Primarily intended for use in P.P.I. applications.



LIMITS OF GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE VOLTAGE

RADAR TUBE

MF31-55

Direct viewing radar tube with 12-in. diameter flat-faced metal-backed magnesium fluoride long persistence screen. Primarily intended for use in P.P.I. applications.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF

SCREEN

Metal-backed		
Fluorescent colour	orange with orange afterglow	
Persistence	long	
Minimum useful screen diameter	265	mm

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

OPERATING CONDITIONS

V_{a2}	15	kV
V_{a1}	300	V
V_g for cut-off	−30 to −90	V
Recommended distance of centre of magnetic length of focus unit from reference line	120	mm

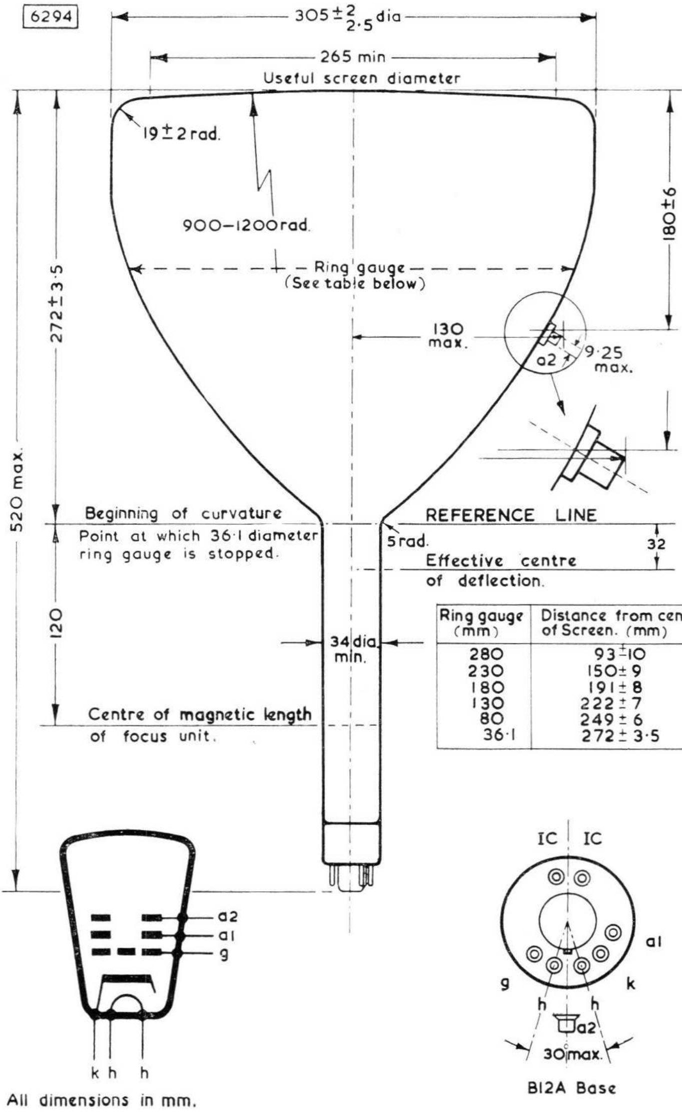
LIMITING VALUES (absolute ratings)

V_{a2} max.	15.5	kV
V_{a2} min.	9.0	kV
V_{a1} max.	600	V
V_{a1} min.	250	V
$-V_g$ max.	250	V
*I_k max.	150	μA
V_{h-k} max.	±150	V
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	1.0	MΩ

*This tube has a magnesium fluoride screen which is liable to burn if a stationary or slowly moving spot is used, even with low values of mean beam current.

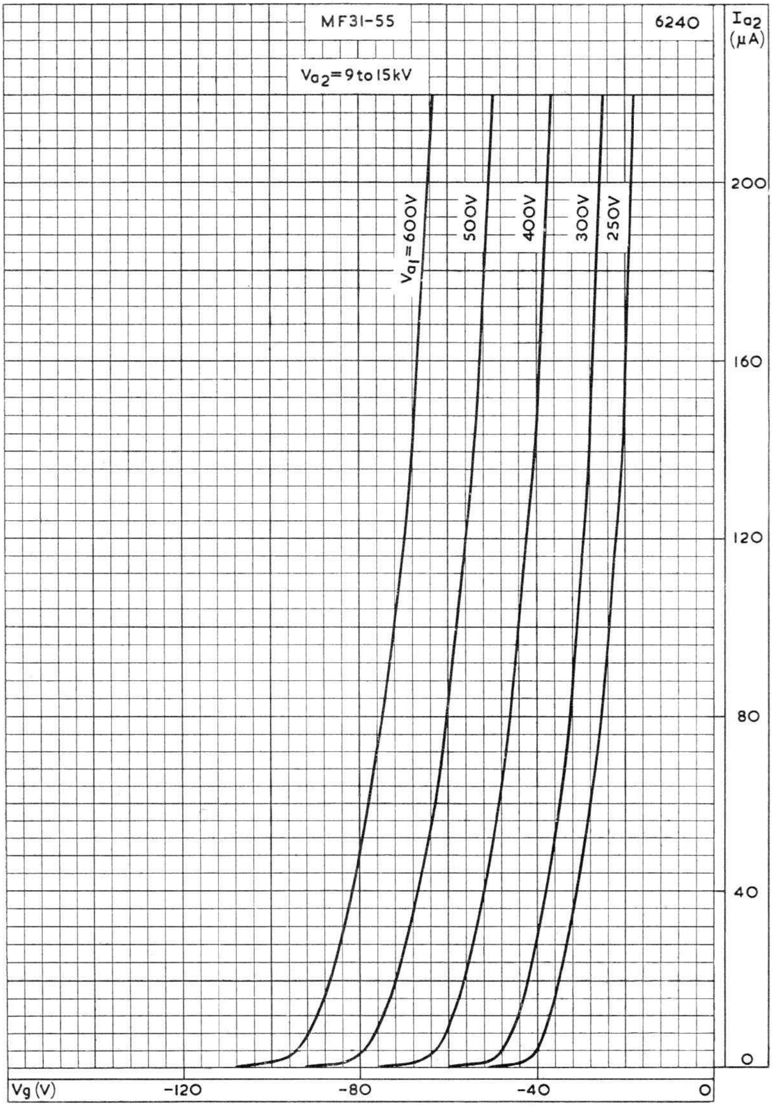
MF31-55

RADAR TUBE

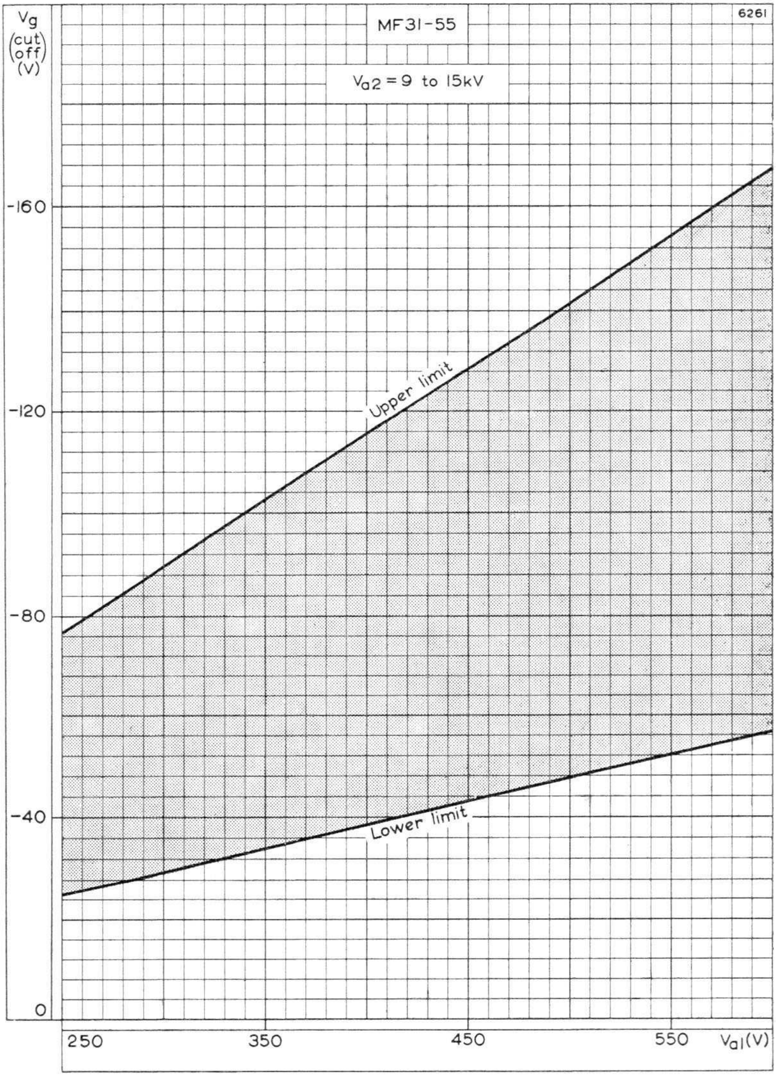


Ring gauge (mm)	Distance from centre of Screen. (mm)
280	93 ± 10
230	150 ± 9
180	191 ± 8
130	222 ± 7
80	249 ± 6
36·1	272 ± 3·5

All dimensions in mm.



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 250V TO 600V

RADAR TUBE

MF31-95

Direct viewing radar tube with 12-in. diameter flat-faced metal-backed long persistence screen. Primarily intended for use in p.p.i. applications.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF

SCREEN

Metal-backed		
Fluorescent colour	orange—with orange afterglow	
Persistence	long	
Min. useful screen diameter	265	mm

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a2}	10	kV
*V_{a1}	800	V
V_g for cut-off	−50 to −115	V
*Recommended distance of centre of magnetic length of focus unit from reference line	98	mm

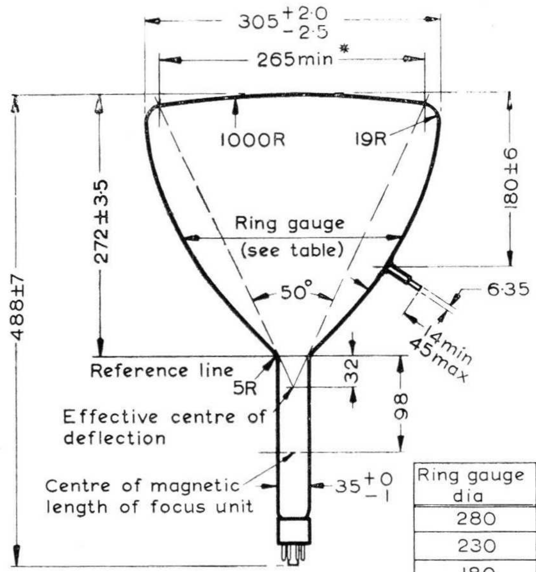
*See appropriate section of 'General Operational Recommendations—Cathode Ray Tubes'.

LIMITING VALUES (absolute ratings)

V_{a2} max.	12	kV
V_{a2} min.	8.0	kV
V_{a1} max.	850	V
V_{a1} min.	250	V
$-V_g$ max.	200	V
†I_k max.	150	μA
V_{h-k} max.	±150	V
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	1.0	MΩ

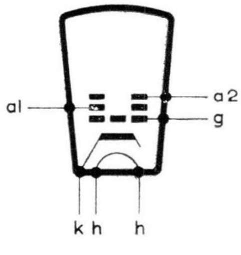
†This tube has a magnesium fluoride screen which is liable to burn if a stationary or slowly moving spot is used, even with low values of mean beam current.

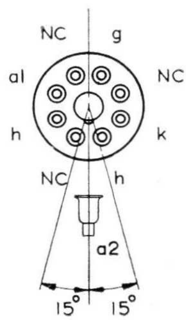
5618



*Diameter of useful screen area

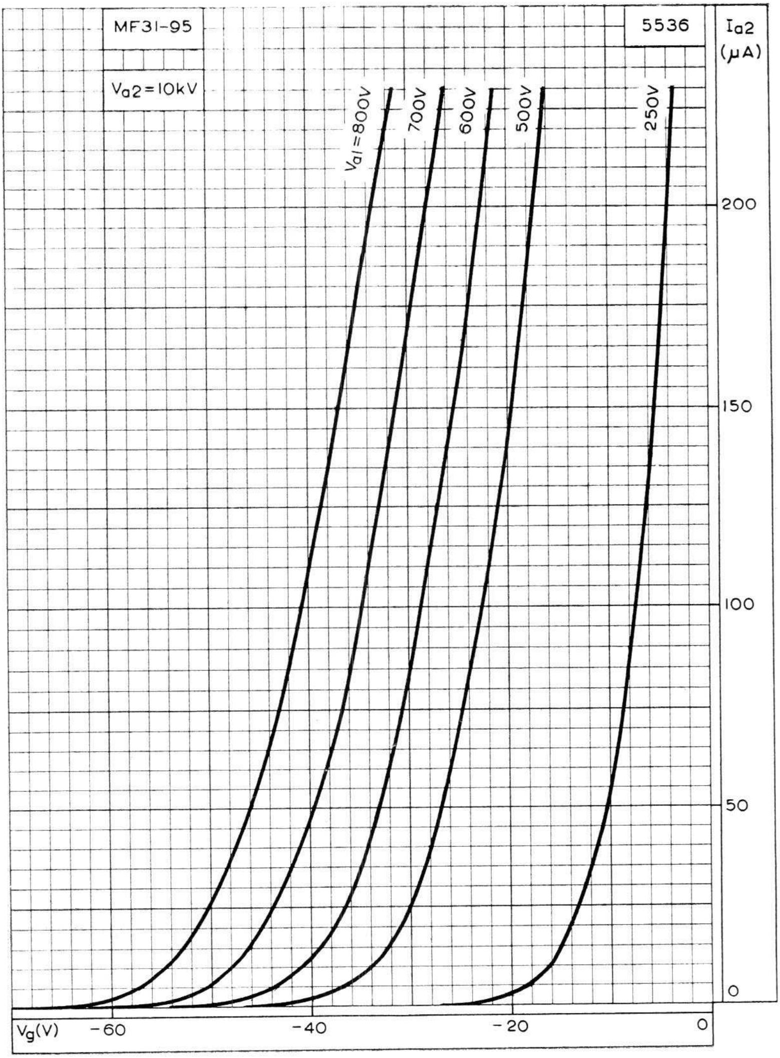
Ring gauge dia	Distance from centre of tube face
280	93±10
230	150±9
180	191±8
130	222±7
80	249±6
36·1	272±3·5





All dimensions in mm

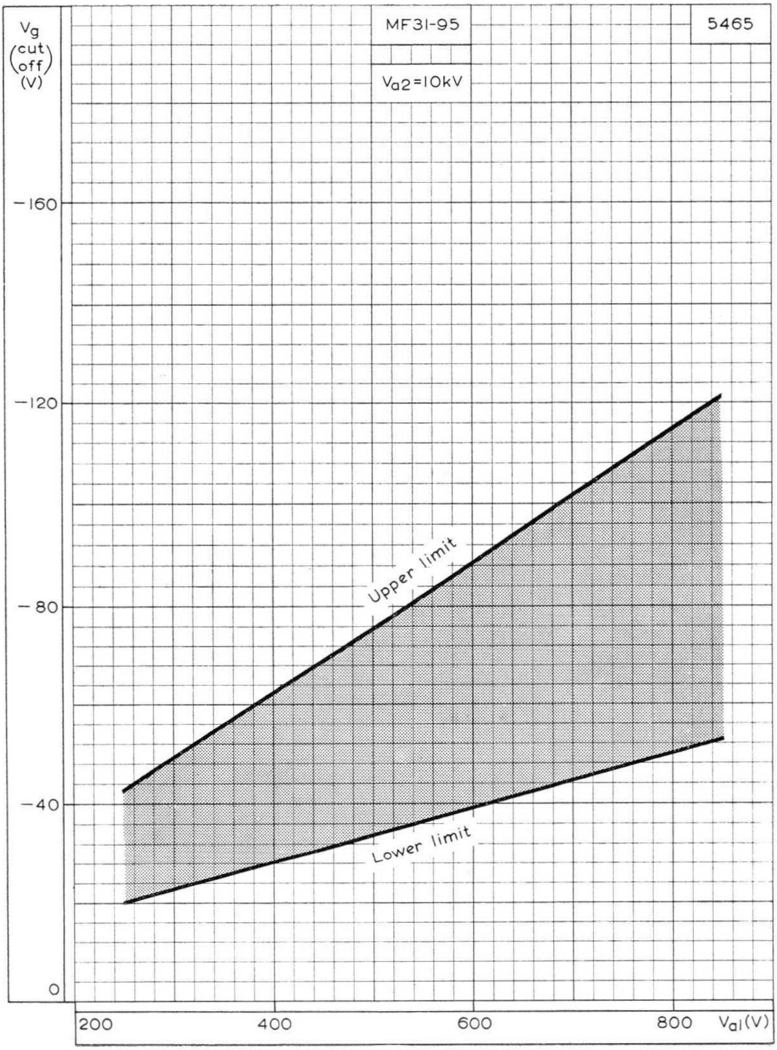
Octal base



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

MF31-95

RADAR TUBE



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 250V TO 850V.

RADAR TUBE

MF41-10

Direct viewing radar tube with 16-in. diameter metal-backed magnesium fluoride long persistence screen, primarily intended for use in P.P.I. applications.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF

SCREEN

Metal-backed.
Fluorescent colour—orange with orange afterglow.

Useful screen diameter	368	mm←

PERSISTENCE

F screen — Very long

See curves included in this section of the handbook for screen type F.

FOCUSING

Magnetic

DEFLECTION

Double magnetic

REFERENCE LINE GAUGE

See 'General operational recommendations—cathode ray tubes'.

MOUNTING POSITION

Any, except vertical with screen downward and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a2}	15	kV
*V_{a1}	300	V
V_g for cut-off	−30 to −70	V
*Recommended distance of focus unit from reference line	118	mm

*See appropriate section of 'General operational recommendations—cathode ray tubes'.

MF41-10

RADAR TUBE

Direct viewing radar tube with 16-in. diameter metal-backed magnesium fluoride long persistence screen, primarily intended for use in P.P.I. applications.

LIMITING VALUES (Absolute ratings)

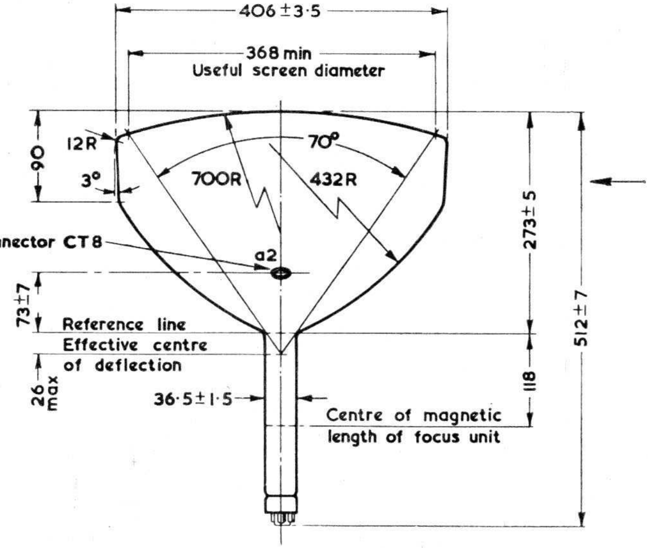
V_{a2} max.	16	kV
V_{a2} min.	8.0	kV
V_{a1} max.	500	V
V_{a1} min.	200	V
$-V_g$ max.	200	V
$-V_g$ min	1.0	V
V_{h-k} max.	$\pm$150	V
Z_{g-k} max. (f=50c/s)	500	kΩ
R_{g-k} max.	1.5	MΩ
R_{h-k} max.	See note *	

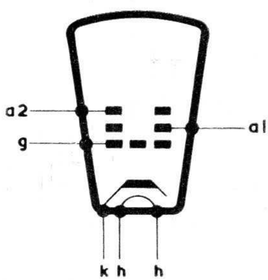
*When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.
When the heater is in a series chain or earthed Z_k max. is 100kΩ where Z_k is the 50c/s impedance between earth and cathode.

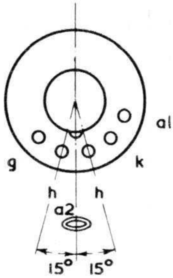
RADAR TUBE

MF41-10

Direct viewing radar tube with 16-in. diameter metal-backed magnesium fluoride long persistence screen, primarily intended for use in P.P.I. applications.







B12A Base

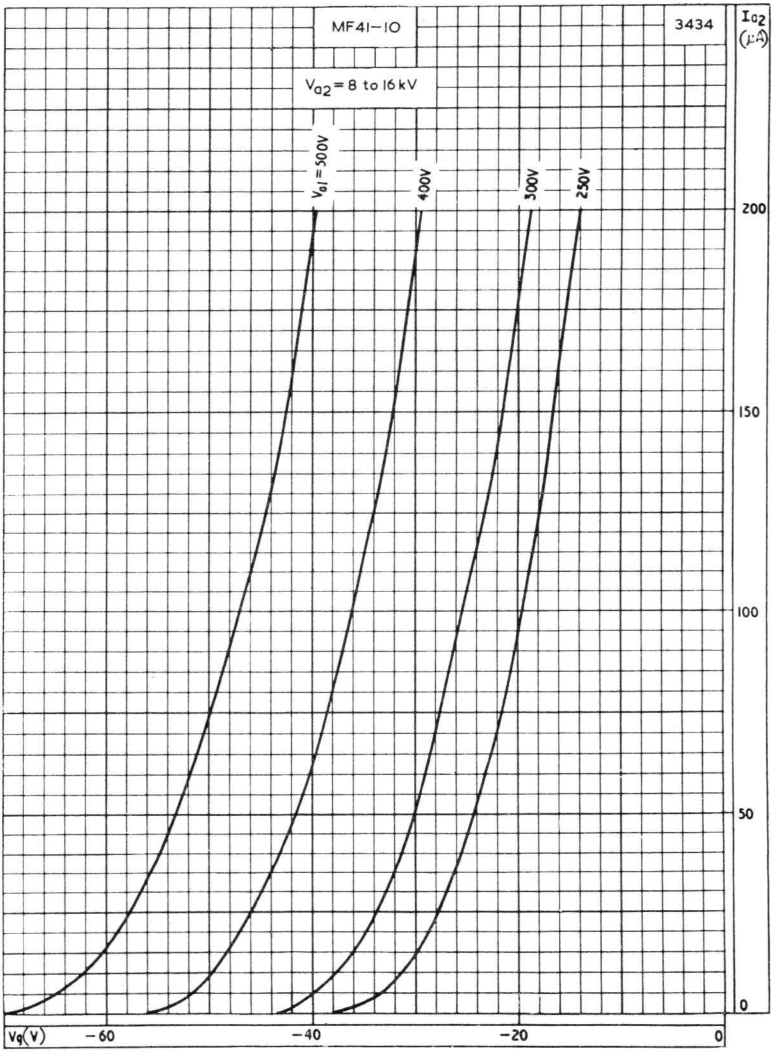
3429

All dimensions in mm

MF41-10

RADAR TUBE

Direct viewing radar tube with 16-in. diameter metal-backed magnesium fluoride long persistence screen, primarily intended for use in P.P.I. applications.

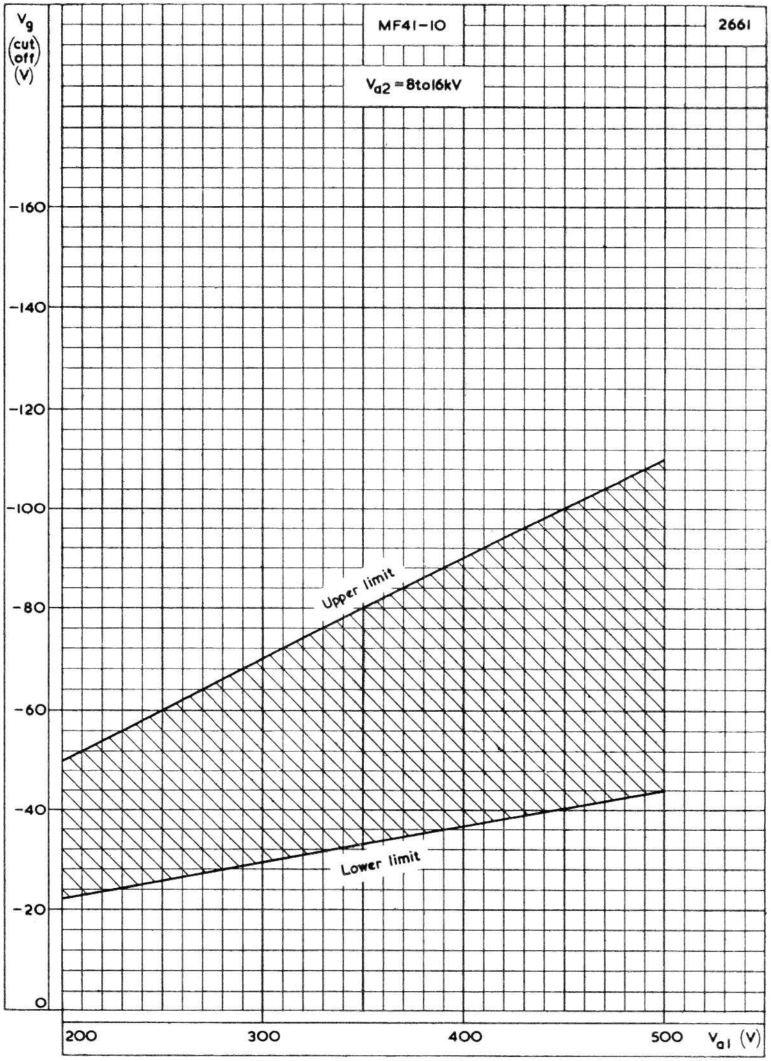


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

RADAR TUBE

MF41-10

Direct viewing radar tube with 16-in. diameter metal-backed magnesium fluoride long persistence screen, primarily intended for use in P.P.I. applications.



LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 200 TO 500V

RADAR TUBE

MM13-10

Direct-viewing high brightness radar tube with 5-in. diameter metal-backed double layer screen and external lacquered coating.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS — CATHODE RAY TUBES which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{g-all}	<9.0	pF
c_{k-all}	<7.0	pF
c_{a-M}	500 to 1500	pF

SCREEN

Metal-backed		
Double layer		
Fluorescent colour	blue with green-yellow afterglow	
Useful screen diameter	100	mm

PERSISTENCE

Blue fluorescence of short persistence followed by green-yellow phosphorescence of long persistence.

FOCUSING

Magnetic

DEFLECTION

Double magnetic

Deflection angle (approx.) 40°

MOUNTING POSITION

Any, except with the screen downward and the axis of the tube making an angle less than 20° with the vertical.

OPERATING CONDITIONS

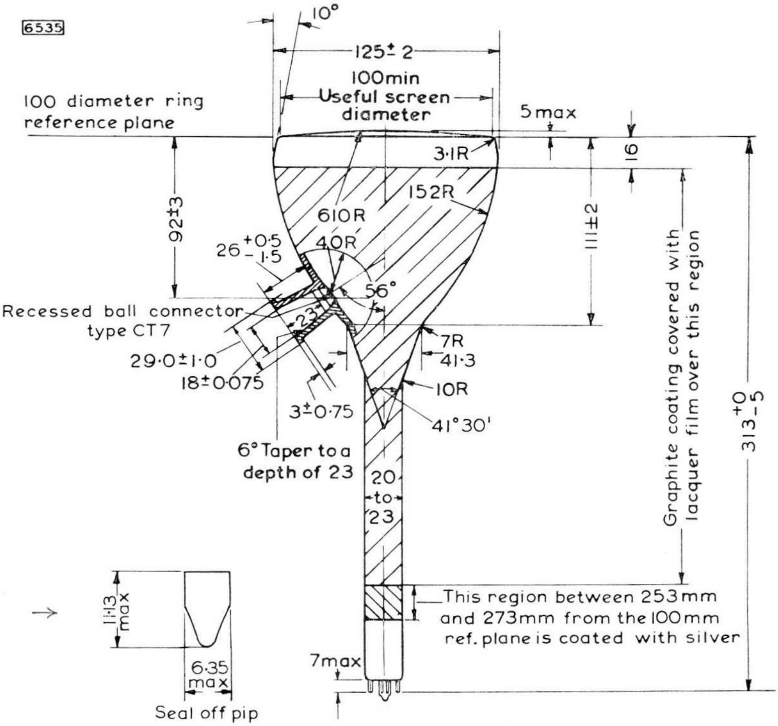
V_a	22	kV
V_g for cut-off	−50 to −100	V

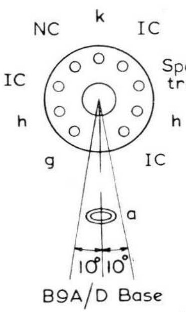
LIMITING VALUES (absolute ratings)

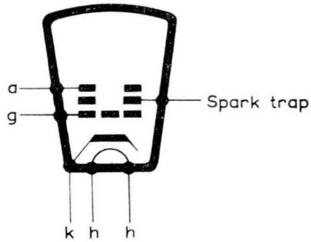
V_a max.	27	kV
V_a min.	18	kV
$-V_g$ max.	150	V
$+V_g$ max.	0	V
$+v_{g(pk)}$ max.	2.0	V
I_k max.	200	μA
R_{g-k} max.	1.5	MΩ
V_{h-k} max. (cathode positive)	300	V
V_{h-k} max. (cathode negative)	90	V

WARNING

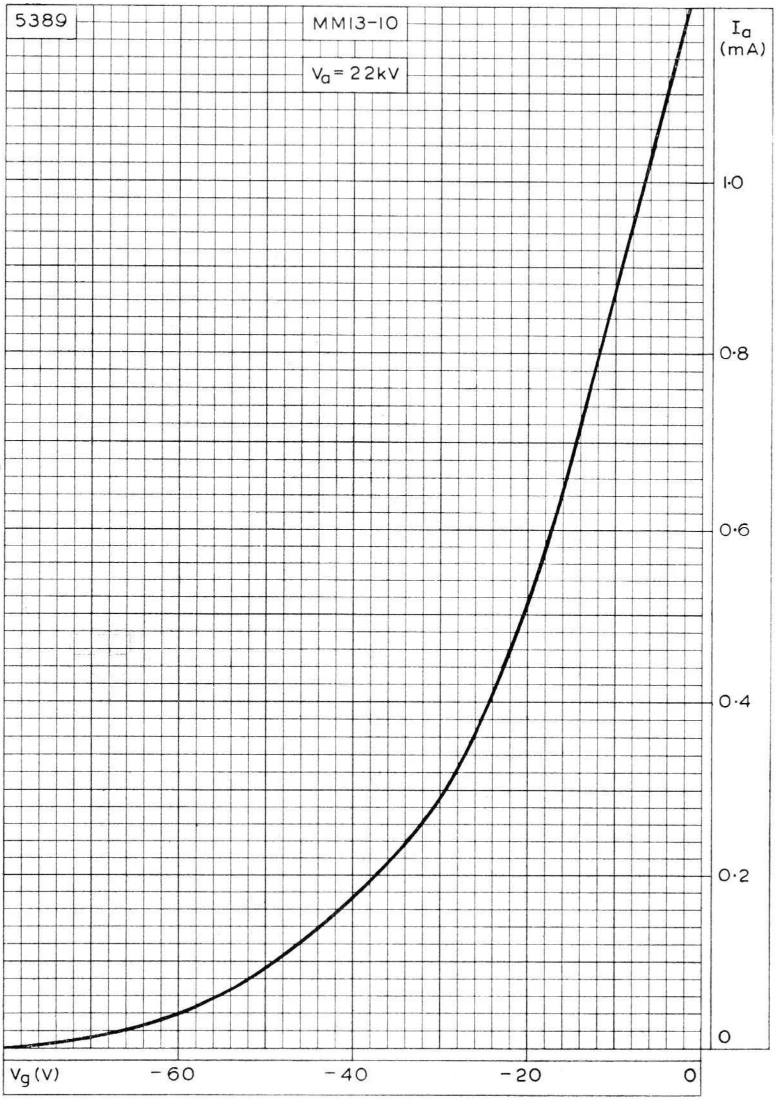
At $V_a = 27$kV and $I_a = 200\mu$A, the level of 'X' radiation expected may be of the order of 10 mr/hr, and adequate shielding must be provided.







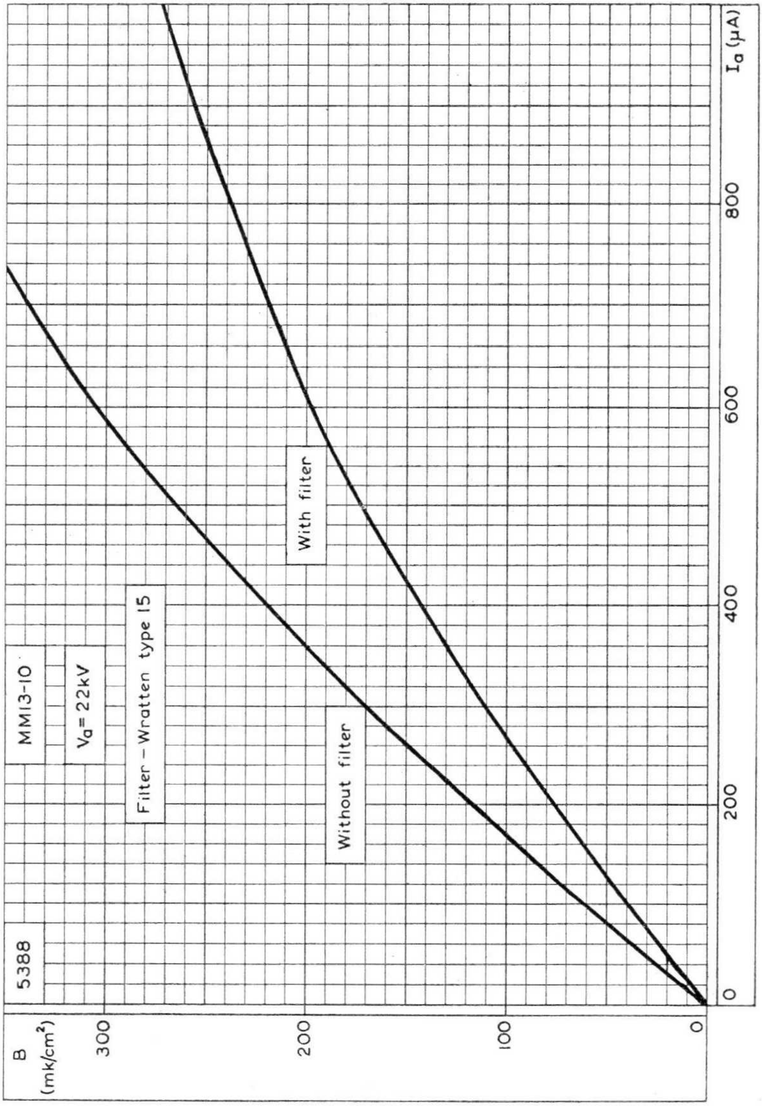
All dimensions in mm



FINAL ANODE CURRENT FLOTTED AGAINST GRID VOLTAGE

MM13-10

RADAR TUBE



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT
($1 mk/cm^2 = 2.9$ e.f.c. $= 2.9$ft lambert)

TELEVISION VIEWFINDER TUBE

MW13-35

Direct viewing television tube with 5-in. diameter metal-backed screen. Having good resolution, it is primarily intended for use as a television camera viewfinder tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, which precede this section of the handbook.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only)—The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<10	pF
c_{k-all}	<10	pF

SCREEN

Metal-backed		
Fluorescent colour	white	
Minimum useful screen diameter	108	mm

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with the screen downwards and the axis of the tube making an angle of less than 20° with the vertical.

OPERATING CONDITIONS

V_{a2}	7.0	kV
V_{a1}	300	V
*V_g for cut-off	−30 to −70	V
Recommended distance of focus unit from reference line	73	mm

MW13-35

TELEVISION VIEWFINDER TUBE

LIMITING VALUES (absolute ratings)

V_{a2} max.	11	kV
V_{a2} min.	5.5	kV
V_{a1} max.	500	V
V_{a1} min.	200	V
$*-V_g$ max.	200	V
R_{g-k} max.	1.5	MΩ
V_{h-k} max. (cathode negative)	125	V
V_{h-k} max. (cathode positive)	200	V
R_{h-k} max.	See note**	
Max. a_1 supply source impedance	1.5	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode. The maximum positive grid excursion may reach +2V and at this voltage the grid current may be expected to be approximately 2mA.

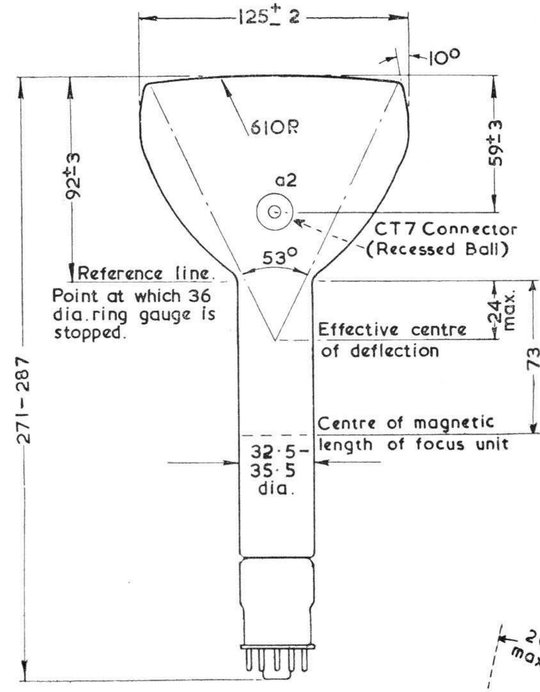
**When the heater is in a series chain, or earthed to a.c. Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode.
When the heater is supplied from a separate transformer R_{h-k} max. is 1.0MΩ.

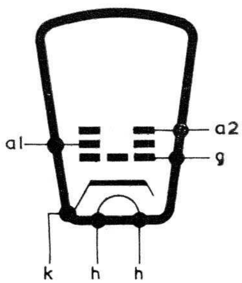
WEIGHT

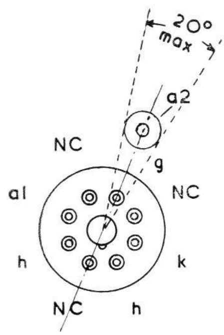
Tube alone	500	g
	1 lb	2 oz

TELEVISION VIEWFINDER TUBE

MW13-35

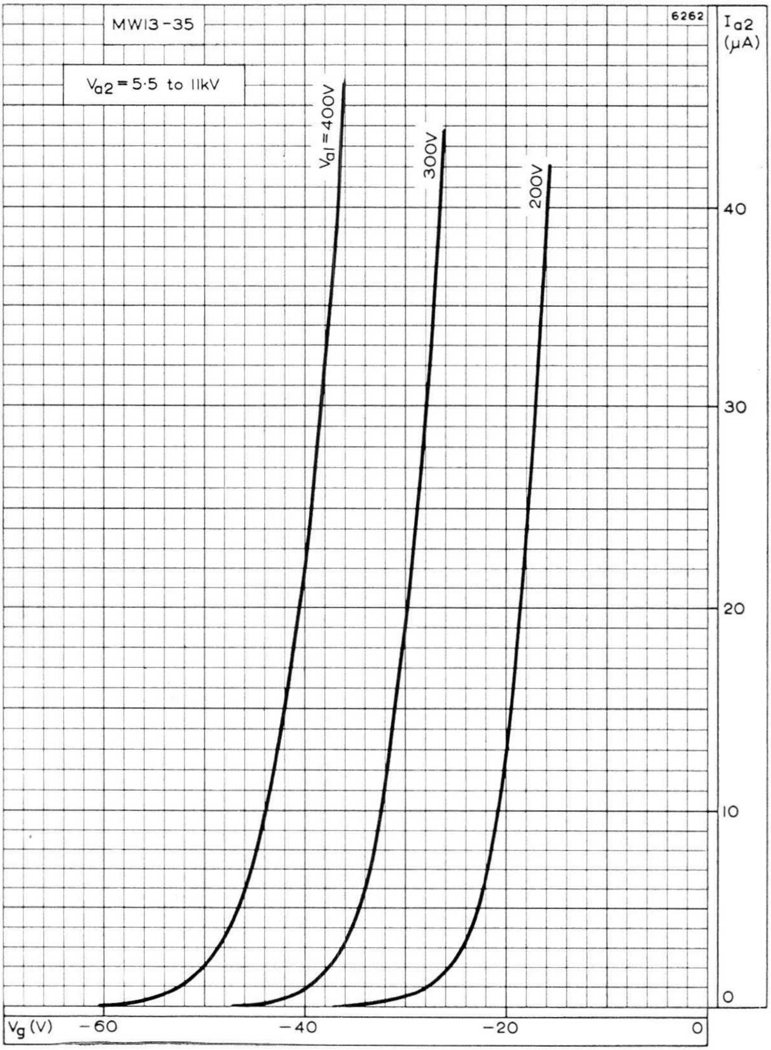




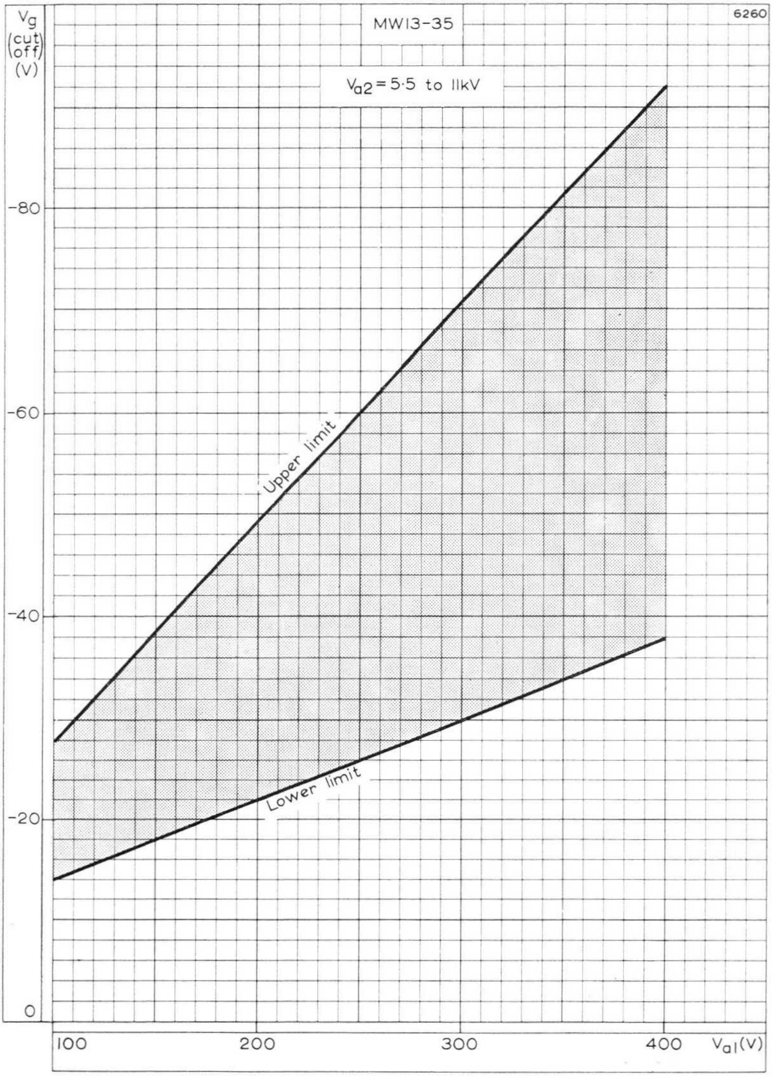


OCTAL BASE

All dimensions in mm. 977



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



LIMITS OF GRID CUT–OFF VOLTAGE FOR FIRST ANODE VOLTAGE FROM 100V TO 400V

TELEVISION MONITOR TUBE

MW22-22

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS – CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only)—The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

CAPACITANCES

c_{g-all}	<8	pF
c_{k-all}	<8	pF

SCREEN

Metal-backed		
Fluorescent colour	White	
Useful screen diameter	214	mm

FOCUSING

Magnetic

DEFLECTION

Double magnetic

MOUNTING POSITION

Any, except vertical with screen downward and the axis of the tube making an angle of less than 20° with the vertical.

TYPICAL OPERATING CONDITIONS

V_{a2}	9.0	kV
V_{a1}	300	V
*V_g for cut-off	–30 to –70	V

MW22-22

TELEVISION MONITOR TUBE

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.

LIMITING VALUES (Absolute ratings)

**V_{a_2} max.	14	kV ←
V_{a_2} min.	7.0	kV
V_{a_1} max.	410	V
V_{a_1} min.	200	V
*$-V_g$ max.	150	V
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
††$v_{h-k(pk)}$ max. (cathode positive)	410	V
R_{g-k} max.	1.5	MΩ ←
Z_{g-k} max. (f=50 c/s)	500	kΩ ←
R_{h-k} max.	See note §	
Max. a_1 supply source impedance	1.5	MΩ

*The d.c. 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 may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

**The product of V_{a_2} and I_t (average value for the whole screen) must not exceed 6W.

†In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

††During a warming-up period not exceeding 45 sec.

§When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

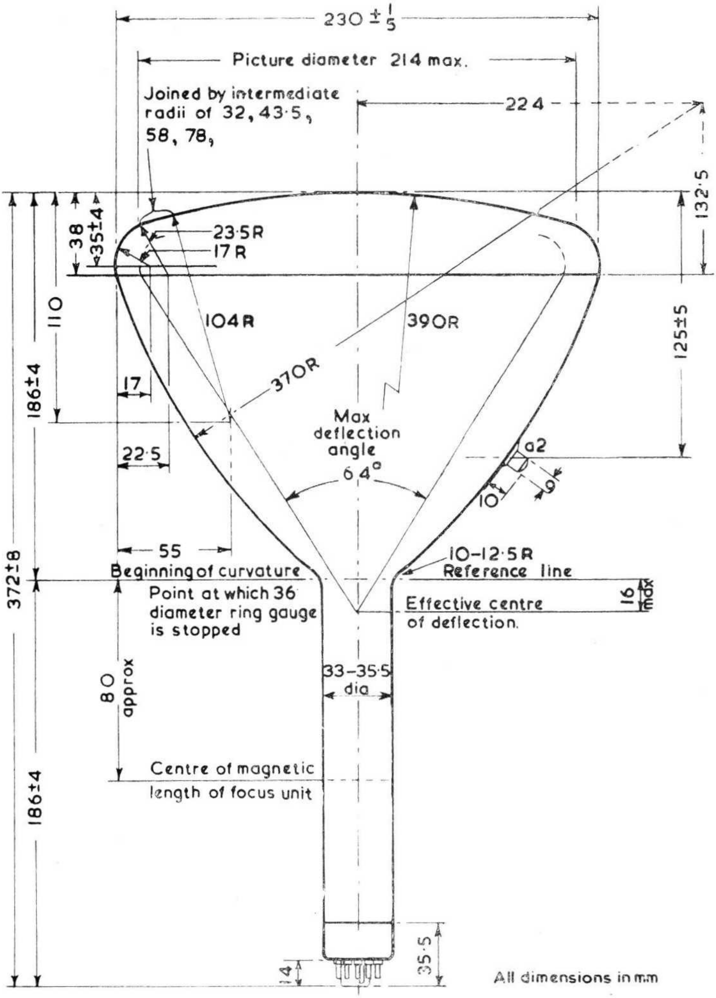
WEIGHT

Tube alone { 2 kg / 4lb 6 oz

TELEVISION MONITOR TUBE

MW22-22

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.



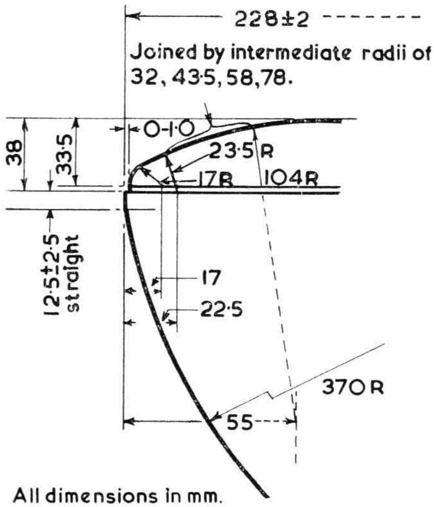
This drawing shows the blown bulb. Some tubes are made with a pressed bulb. A detailed drawing showing the points of difference of the pressed bulb is given on page 4. The base connections are also shown on that page. 2512

MW22-22

TELEVISION MONITOR TUBE

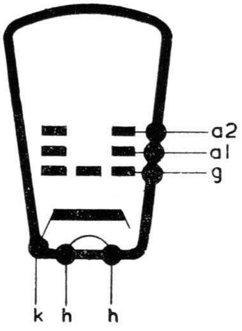
Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.

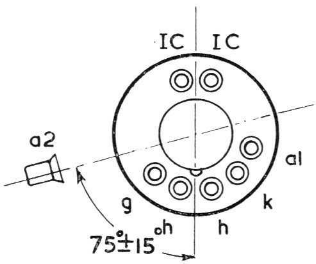
2513



All dimensions in mm.

The pressed bulb has the same dimensions as the blown bulb (page 3) apart from the differences shown in the detailed drawing above.



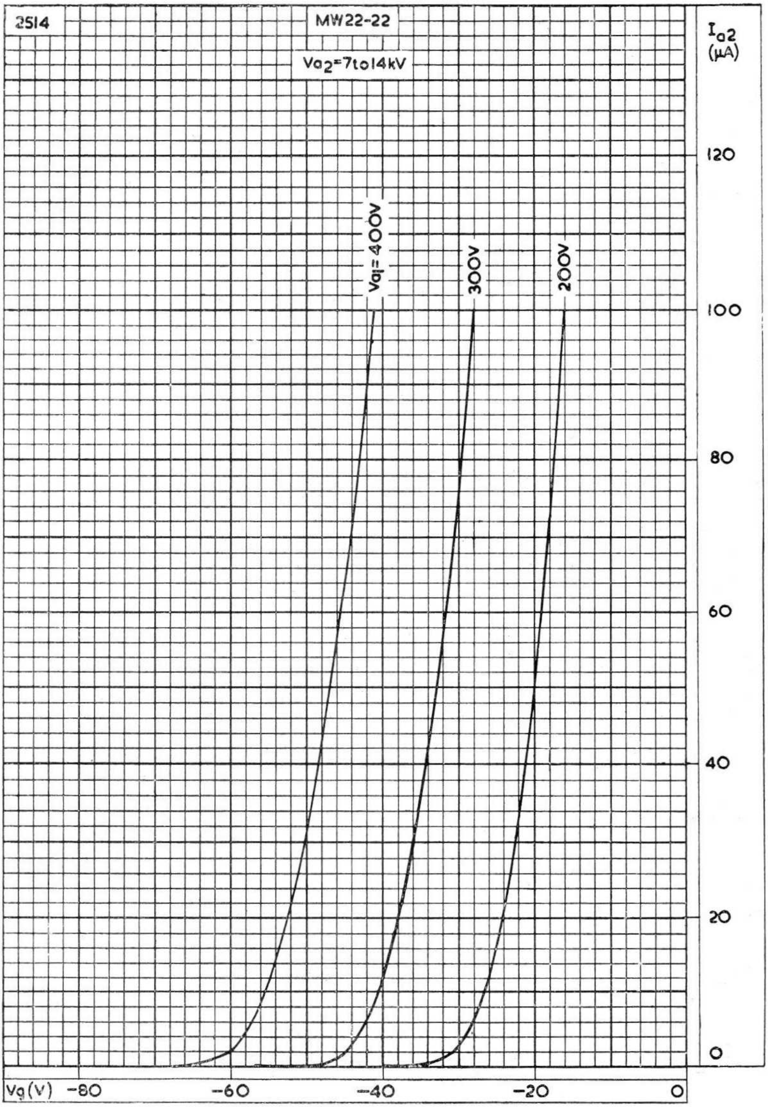


B12A Base

TELEVISION MONITOR TUBE

MW22-22

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.

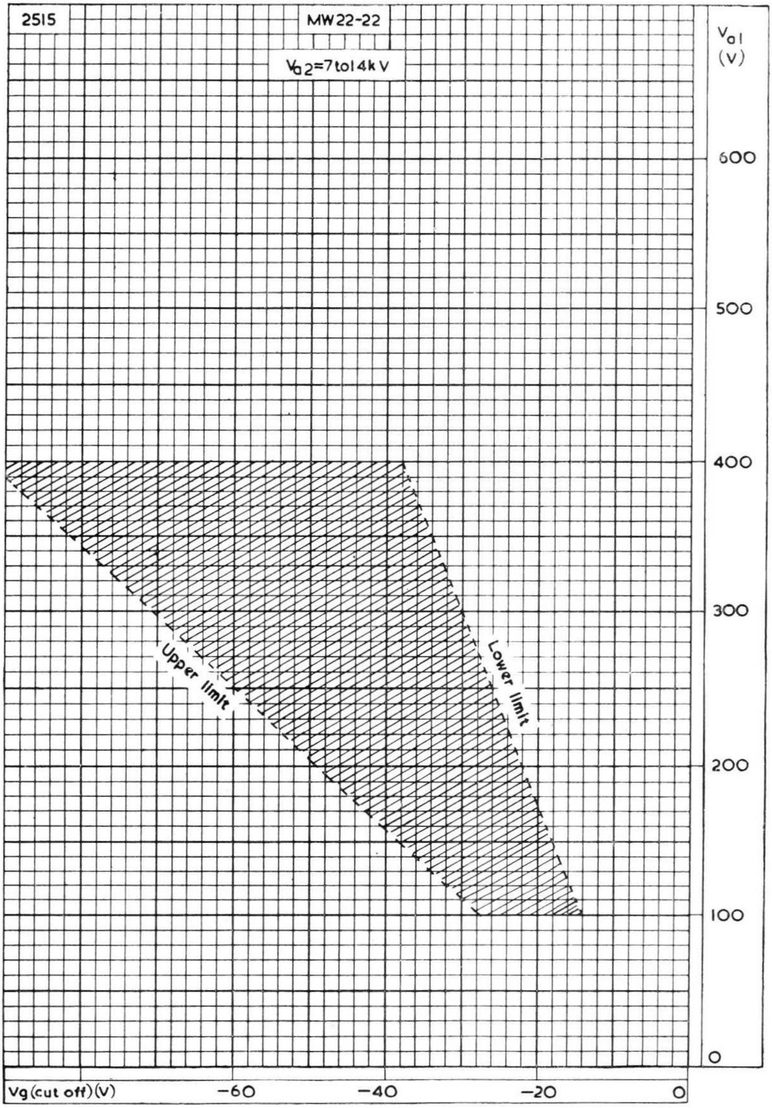


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

MW22-22

TELEVISION MONITOR TUBE

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.



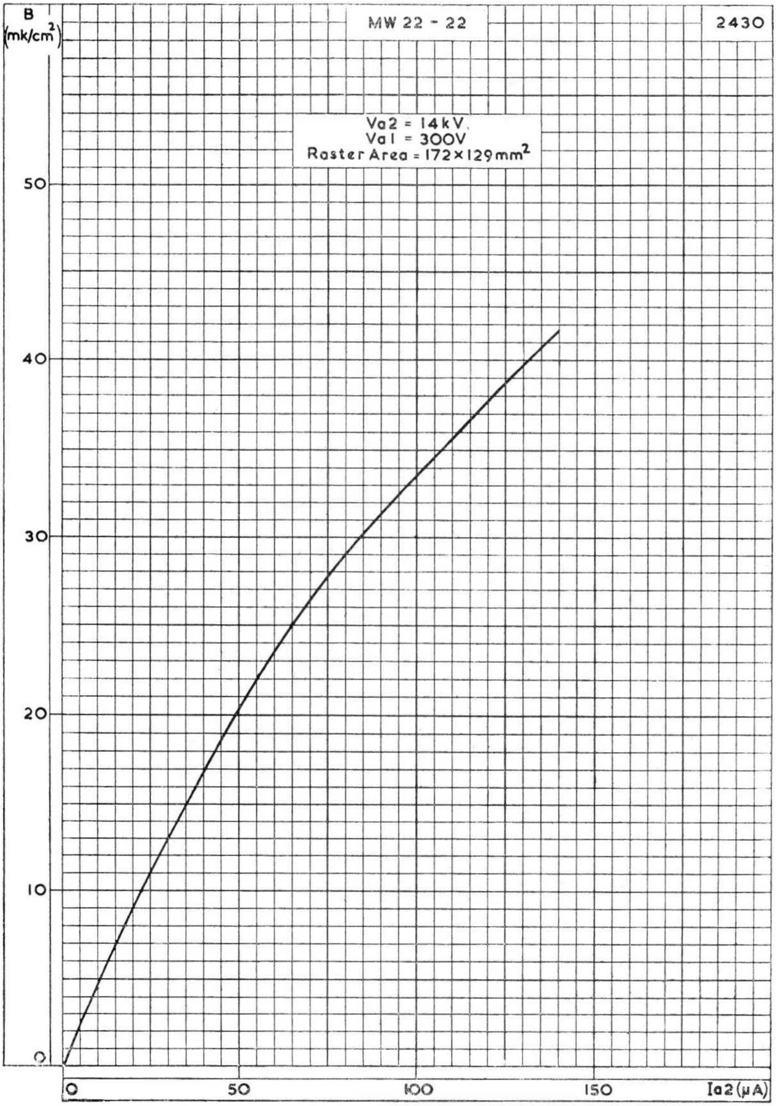
LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 100 TO 400V

Mullard

TELEVISION MONITOR TUBE

MW22-22

Direct viewing television tube with 9-in. diameter metal-backed screen. Primarily intended for use as a television studio monitor tube.



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT

(1 mk/cm² = 2.9 e.f.c. = 2.9 ft. – lambert)

TELEVISION MONITOR TUBE

MW36-67

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only). The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, and the capacitance of this to the final anode may be used to provide smoothing for the e.h.t. supply. The tube marking and warning labels are on the side of the cone opposite the final anode connector and this side should not be used for making contact to the external conductive coating.

CAPACITANCES

c_{g-all}	<8.0	pF
c_{k-all}	<8.0	pF
c_{a_2-M}	1100	pF

SCREEN

Metal-backed		
Fluorescent colour	white	
Light transmission	66	%
Useful screen area	see drawing on p. 3	

FOCUSING

Magnetic

DEFLECTION

Double magnetic

REFERENCE LINE GAUGE

See 'General operational recommendations—cathode ray tubes'.

MOUNTING POSITION

Any, except vertical with screen downward and the axis of the tube making an angle of less than 20° with the vertical.

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. The bottom circumference of the base shell will fall within a circle having a diameter of 55mm which is centred upon the perpendicular from the centre of the face.

MW36-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.

TYPICAL OPERATING CONDITIONS

V_{a2}	14	kV
V_{a1}	300	V
*V_g for cut-off	−30 to −70	V
Recommended distance of centre of magnetic length of focus unit from reference line	100	mm

LIMITING VALUES (absolute ratings)

**V_{a2} max.	15	kV
V_{a2} min.	9.0	kV
V_{a1} max.	500	V
V_{a1} min.	250	V
*$-V_g$ max.	150	V
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
††$v_{h-k(pk)}$ max. (cathode positive)	410	V
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
R_{h-k} max.	See note §	
Max. a_1 supply source impedance	1.5	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the equipment on or off when it may be allowed to rise to +1V. The maximum positive grid excursion of the video signal may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

**The product of V_{a2} and I_t (average value for the whole screen) must not exceed 6W.

†In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

††During a warming-up period not exceeding 45s.

§When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1.0MΩ.

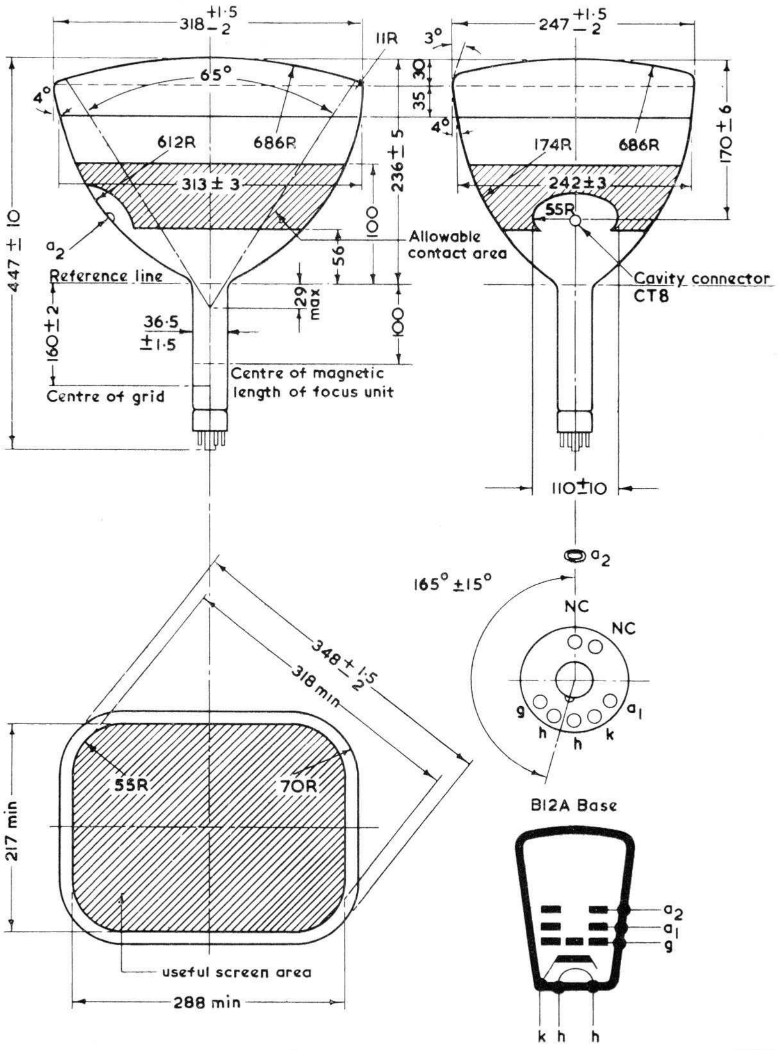
WEIGHT

Tube alone: 4.5 kg / 9 lb 14oz

TELEVISION MONITOR TUBE

MW36-67

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.



All dimensions in mm

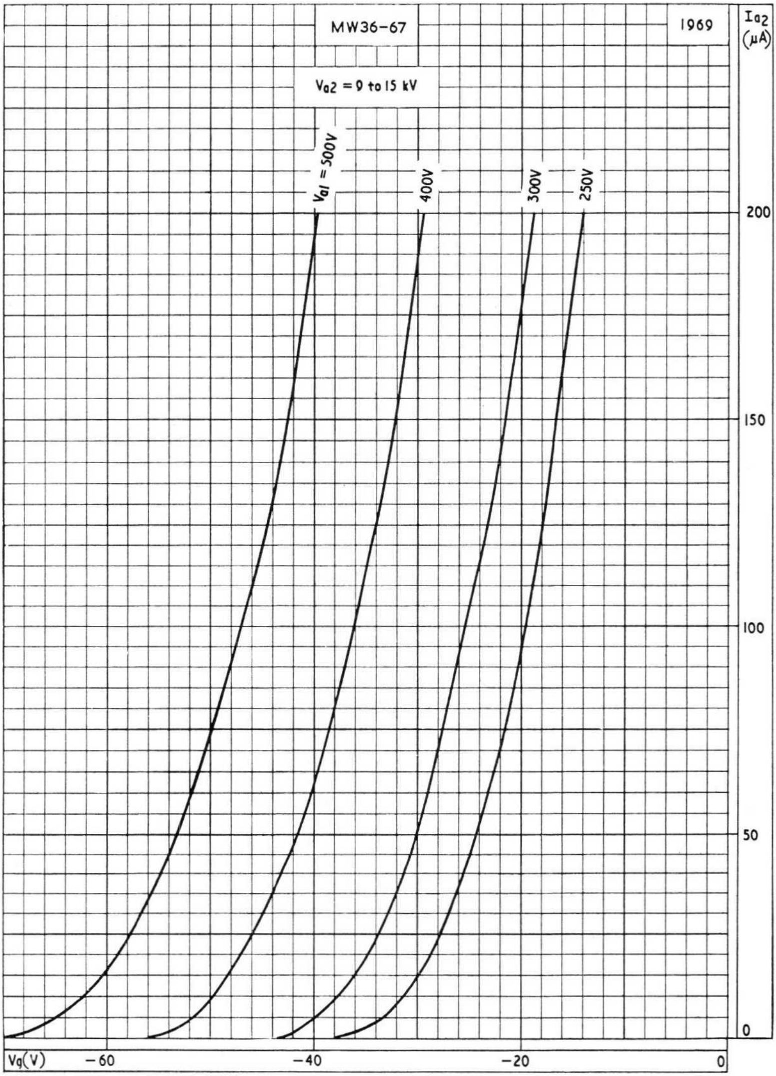
3428

The indicated radius of curvature of the faceplate is not an exact but an average value

MW36-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.

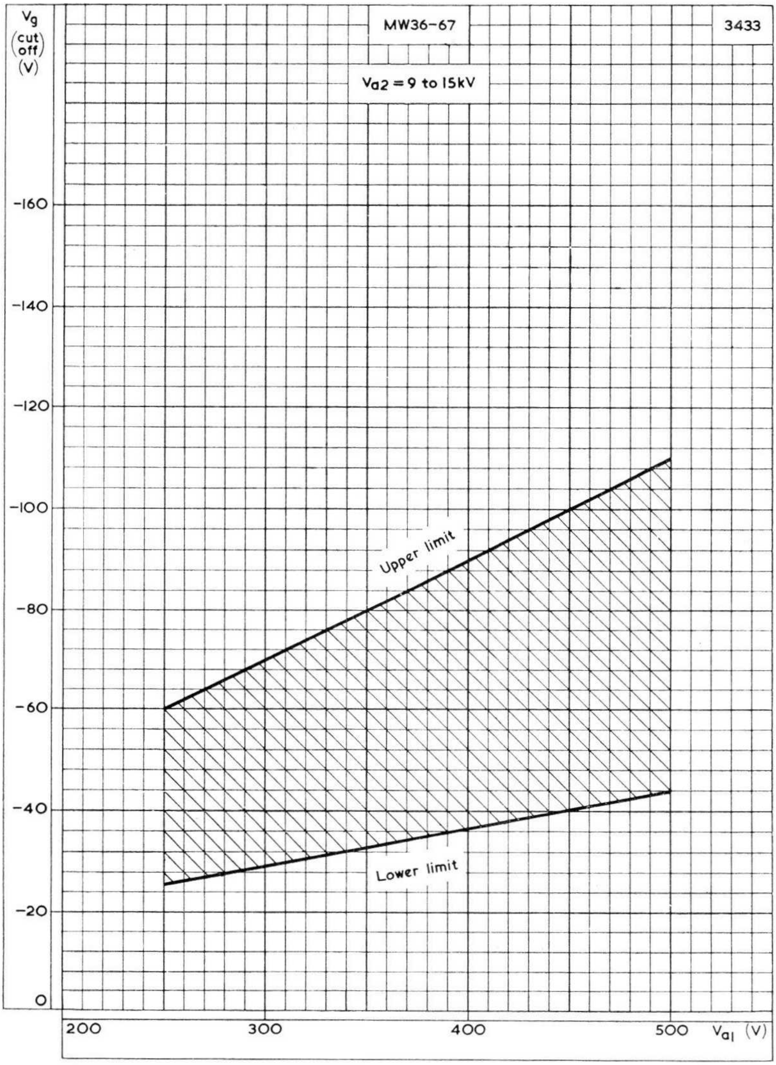


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

TELEVISION MONITOR TUBE

MW36-67

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.

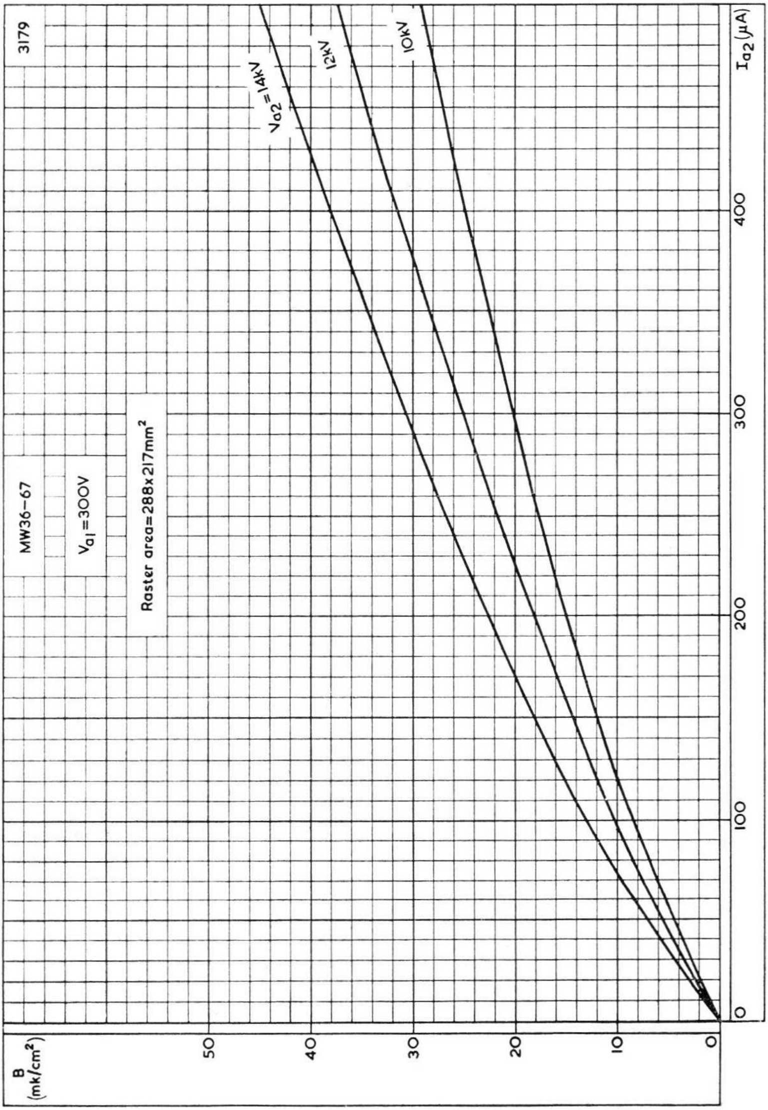


LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 250 TO 500V

MW36-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 14-in. diagonal rectangular metal-backed grey glass screen. Primarily intended for use as a television studio monitor tube.



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT
(1 mk/cm^2 = 2.9 e.f.c. = 2.9 ft.-lambert)

TELEVISION MONITOR TUBE

MW43-67

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS—CATHODE RAY TUBES, included in this volume of the handbook.

HEATER

Suitable for series or parallel operation.

V_h	6.3	V
I_h	300	mA

Note (applies to series operation only). The surge heater voltage must not exceed $9.5V_{r.m.s.}$ when the supply is switched on. When used in a series heater chain a current limiting device may be necessary in the circuit to ensure that this voltage is not exceeded.

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, and the capacitance of this to the final anode may be used to provide smoothing for the e.h.t. supply. The tube marking and warning labels are on the side of the cone opposite the final anode connector and this side should not be used for making contact to the external conductive coating.

CAPACITANCES

c_{g-all}	<8	pF
c_{k-all}	<8	pF
c_{a2-M}	1100	pF

SCREEN

Metal-backed		
Fluorescent colour	White	
Light transmission	66	%
Useful screen area	See drawing on p. 3	

FOCUSING

Magnetic

DEFLECTION

Double magnetic

REFERENCE LINE GAUGE

See 'General operational recommendations—cathode ray tubes'

MOUNTING POSITION

Any, except vertical with screen downward and the axis of the tube making an angle of less than 20° with the vertical.
The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely. The bottom circumference of the base shell will fall within a circle having a diameter of 55mm which is centred upon the perpendicular from the centre of the face.

MW43-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.

TYPICAL OPERATING CONDITIONS

V_{a2}	14	kV
V_{a1}	300	V
*V_g for cut-off	–30 to –70	V
Recommended distance of centre of magnetic length of focus unit from reference line	100	mm

LIMITING VALUES (Absolute ratings)

**V_{a2} max.	15	kV
V_{a2} min.	9.0	kV
V_{a1} max.	500	V
V_{a1} min.	250	V
*$-V_g$ max.	150	V
†V_{h-k} max. (cathode negative)	125	V
†V_{h-k} max. (cathode positive)	200	V
††$v_{h-k(pk)}$ max. (cathode positive)	410	V
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f=50c/s)	500	kΩ
R_{h-k} max.	See note §	
Max. a_1 supply source impedance	1.5	MΩ

*The d.c. value of grid bias must not be allowed to become positive with respect to the cathode, except during the period immediately after switching the equipment on or off when it may be allowed to rise to +1V. The maximum positive grid excursion of the video signal may reach 2V and at this voltage the grid current may be expected to be approximately 2mA.

**The product of V_{a2} and I_t (average value for the whole screen) must not exceed 6W.

†In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible ($<20V_{r.m.s.}$).

††During a warming-up period not exceeding 45 sec.

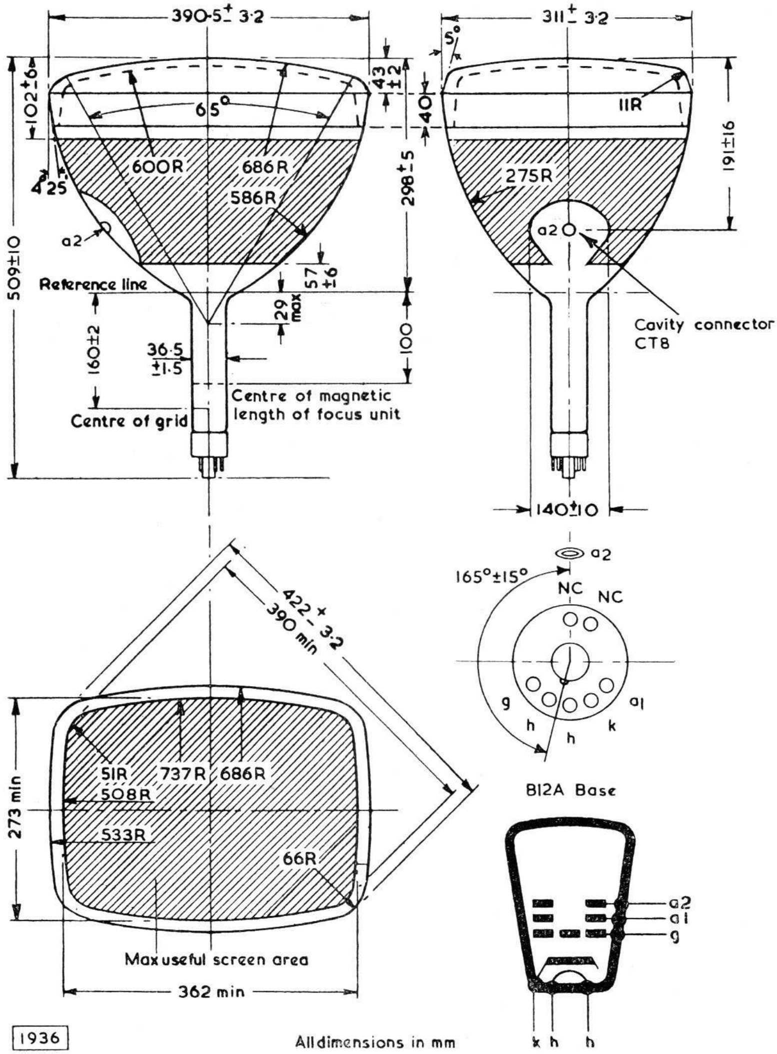
§When the heater is in a series chain, or earthed, Z_k max. is 100kΩ, where Z_k is the 50c/s impedance between earth and the cathode. When the heater is supplied from a separate transformer R_{h-k} max. is 1MΩ.

WEIGHT Tube alone $\begin{cases} 7.7 \text{ kg} \\ 17 \text{ lb} \end{cases}$

TELEVISION MONITOR TUBE

MW43-67

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.



1936

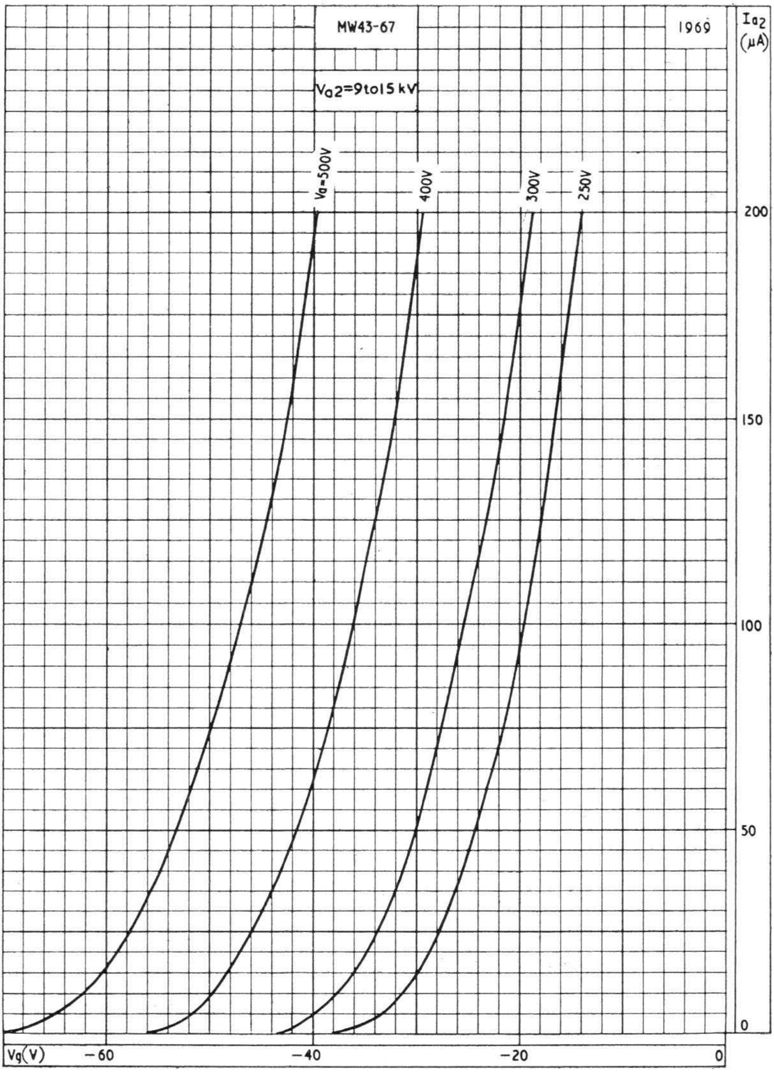
All dimensions in mm

The indicated radius of faceplate curvature is not an exact but an average value.

MW43-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.

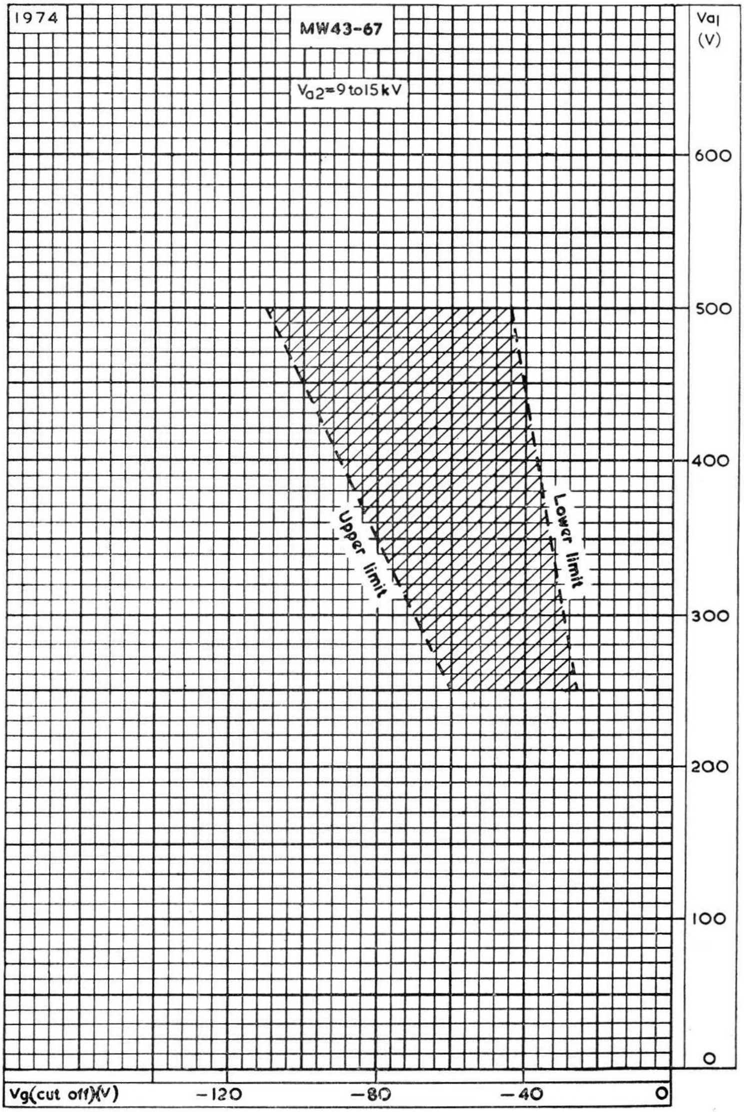


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

TELEVISION MONITOR TUBE

MW43-67

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.

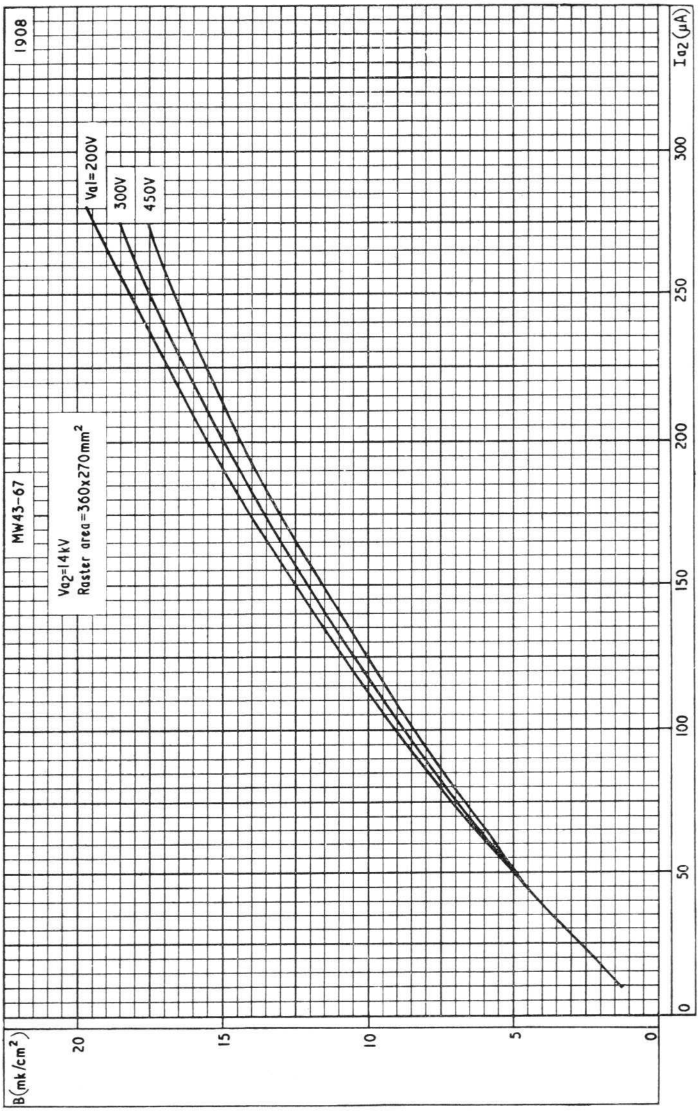


LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES FROM 250 TO 500V

MW43-67

TELEVISION MONITOR TUBE

Direct viewing television tube with 17-in. diagonal rectangular metal-backed grey-glass screen. Primarily intended for use as a television studio monitor tube.



LIGHT OUTPUT PLOTTED AGAINST FINAL ANODE CURRENT FOR VARIOUS FIRST ANODE VOLTAGES

($1 mk/cm^2 = 2.9$ e.f.c. $= 2.9$ft.-lambert)

VOLTAGE STABILISER &
REFERENCE LEVEL TUBES

Ignition Voltage (starting voltage, striking voltage)

The minimum voltage which must be applied between the anode and cathode of a tube in order to initiate a glow discharge.

Burning Voltage (maintaining voltage)

The voltage between anode and cathode when a glow discharge has been established and the tube is passing current within its specified limits.

Regulation Voltage

The change in the burning voltage when the current is changed from the maximum to the minimum value.

Incremental Resistance

The slope of the burning voltage against burning current characteristic at some specified tube current.

Temperature Coefficient of Burning Voltage

The rate of change of burning voltage with tube ambient temperature for a fixed tube current.

Stability

The change in burning voltage with life caused by changes in tube characteristics. This excludes changes due to variations in tube current, temperature, etc.

Ignition Voltage

This is the voltage at which the discharge in a tube will be initiated. Normally the average tube will ignite at a voltage somewhat lower than the maximum figure quoted but the latter should always be available. Certain tubes are affected by ambient light, and in complete darkness some delay may occur between the application of the ignition voltage and the actual firing of the tube.

Burning Current

Except for a temporary overload during starting, the circuit values must be such that the current through a tube always falls within the maximum and minimum limits quoted in the data. Excessive current will lead to high heat dissipation with possible loss of stability while at very low current the tube may effectively become extinguished. At starting, a current of up to 2.5 times the maximum mean current may be drawn for a period of 10 seconds or less. This covers the period while thermionic valves in an equipment warm up and draw their normal current. This overload should not be applied at intervals of less than a few minutes.

For **reference tubes** a preferred operating current is also quoted. Whenever possible this current should be adopted and maintained constant since it represents an operating point which is both free from discontinuities in characteristics and also has a maximum stability over life. If the current is changed during life and then returned to its original value the high order of stability may be impaired.

Reversal of Polarity

Reference tubes and stabilisers should never be operated in such a way that they can draw reverse current. This can be met by ensuring that the maximum reverse voltage ever applied to a tube does not exceed 90% of the normal burning voltage.

Series and Parallel Operation

Where different types of stabilisers are connected in series care must be taken to ensure that the burning current falls within the permitted limits of all tubes. At first sight it would seem that a supply voltage must be available which is equal to the sum of all the individual ignition voltages of the several tubes; however, the supply voltage requirements for series operation will be eased by connecting a resistor network (to ensure successive striking of the tubes) across one or more of the tubes. These resistors should have values of the order of 200 kΩ.

Stabilisers should not be connected in parallel with each other because of the difficulty of ensuring equal current distribution.

Stabiliser Behaviour with an Alternating Component of Tube Current

In certain applications the current supplied to a stabiliser or reference tube consists of a predominantly direct current with a superimposed alternating component caused by rapid fluctuations in load, supply voltage ripple, etc.

Because of the finite internal impedance of a gas-filled discharge tube this alternating component may give rise to undesired coupling. In addition, the internal impedance of stabiliser tubes increases with increasing frequency.

In order to avoid coupling effects the stabiliser should be shunted by a capacitor whose value will be determined by the tube impedance that can be tolerated and by the impedance of the remainder of the circuit. However, the value of the capacitor should be made as small as possible in order to minimise the chance of relaxation oscillations and also to reduce the transient tube current at starting. Normally a capacitance of the order of 0.5μF is suitable.

These general notes include definitions and general test procedures. They should be read in conjunction with the data sheets for Special Quality Tubes. Where reference should be made to a specific note, this is indicated on the data sheet by an index number, e.g. Group Quality Level[7].

1. *Limiting Values.* The limiting values quoted on the data sheets are absolute ratings. Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any tube of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

   These values are chosen by the tube manufacturer to provide acceptable serviceability of the tube, taking no responsibility for equipment variations, environmental variations, and the effects of change in operating conditions due to variations in the characteristics of the tube under consideration, and of all other electron devices in the equipment.

   The equipment manufacturer should design so that initially and throughout life no absolute maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply variations, equipment control adjustment, load variations, signal variation, environmental conditions and variations in characteristics of the valve under consideration and of all other devices in the equipment.

   The life expectancy of a tube may be appreciably reduced if the maximum ratings are exceeded. Furthermore, in gas-filled tubes certain limiting values, such as the minimum voltage necessary for ignition must be met completely or the tube may show a total failure to operate at any time after installation.

   In the interests of reliability the bulb temperature should always be kept as low as possible.

2. *The A.Q.L.* (Acceptable quality level) is the limit below which the average level of defectives is controlled.

3. *Maximum and minimum values for the individuals* are the limits to which tubes are tested.

4. *Maximum and minimum for lot average* are the limits between which the average value of the characteristic of a lot or batch is controlled.

5. *Lot standard deviation* is the standard deviation of a lot or batch.

6. *Bogey value* is the target value.

7. *Group quality level.* This is the A.Q.L. over a whole group of tests.

   Sub-group quality level. The A.Q.L. over a number of tests which do not constitute a complete group.

8. *Glass envelope strain test.*

   (*A*) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water at a temperature between 97 and 100°C for 15 seconds and then immediately plunging them in ice cold water for 5 seconds. The tubes are then examined for glass cracks.

   (*B*) This test is carried out on a sampling basis and consists of completely submerging the tubes in boiling water not less than 85°C for 15 seconds and then immediately plunging them in ice cold water not more than 5°C for 5 seconds. The tubes are then examined for glass cracks.

9. *Base strain test.* This test is carried out on a sampling basis and consists of forcing the pins of the tubes over specified cones and then completely submerging the tubes and cones in boiling water at a temperature between 97 and 100°C for 10 seconds. The tubes and cones are allowed to cool to room temperature before examining for glass cracks.

10. *Lead fragility test.*

    (*A*) This test is carried out on a sampling basis and consists of holding the tubes vertically and having a 1-lb weight freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 45°, back to 45° in the other direction, back to 45° in the first direction and finally back to the vertical, the entire action taking place in one vertical plane. The tubes are examined for cracks and broken leads.

(*B*) This test is carried out on a sampling basis and consists of holding the tubes vertically and having a 1-lb weight freely suspended from the lead under test. The tubes are inclined slowly so as to bend the weighted lead through 90° and return it to the vertical, the entire action taking place in one vertical plane. This cycle is repeated for the number of times shown on the data sheet. The tubes are examined for broken leads.

11. This test is carried out on a sampling basis under the conditions detailed in the data.

12. *Shock test.* This test is carried out on a sampling basis and subjects the tubes to 5 blows of the specified acceleration in each of 4 directions.

13. *Inoperatives.* An inoperative is defined as a tube having an open or short circuit electrode, an air leak or a broken pin.

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

M8098

Special quality 85V gas-filled voltage reference tube for use in equipment where mechanical vibration and shocks are unavoidable.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER & REFERENCE TUBES which precede this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

*Minimum voltage necessary for ignition	115	V
Burning current		
Maximum	10	mA
Minimum	1.0	mA
Maximum negative anode voltage	75	V
Ambient temperature limits	−55 to +90	°C

*This value covers operation in daylight and complete darkness.

PREFERRED OPERATING CONDITION

Burning current	6.0	mA

CHARACTERISTICS

Measured at preferred operating condition and $T_{ambient} = 25°C$

Maintaining voltage (variation from tube to tube)	83 to 87	V
Incremental resistance		
Average	300	Ω
Maximum	450	Ω
Maximum increase in maintaining voltage as current is varied from 1 to 10mA	4.0	V
*Maximum percentage variation of maintaining voltage over first 1000 hours of life	0.5	%
Typical percentage drift of maintaining voltage per 1000 hours after 1300 hours	0.1	%

*After the initial warming-up period of 3 minutes

Discontinuities of the I_a/V_a characteristic

Typical voltage jumps over current range 4 to 10mA	5.0	mV
Maximum voltage jumps over current range 1 to 10mA	100	mV

SHORT-TERM STABILITY

Maximum short-term variation of maintaining voltage for any 8 hour period after the first 100 hours life will be better than 0.01% provided there is an initial warming-up period of 3 minutes.

Maximum short-term (100 hours max.) variation of maintaining voltage after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations it will in general be sufficient to draught shield the tube.

M8098

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

OPERATING NOTES

A steady maintaining voltage is reached within 3 minutes.

The greatest constancy of maintaining voltage is obtained if the tube is operated at the preferred current.

The noise generated by the tube over a frequency band of 30 to 10,000c/s is of the order of 60μV, which is equivalent to the noise generated by a resistor of approximately 22MΩ at a temperature of 300°K. The noise is evenly distributed over the frequency range.

The bulb and base dimensions of this tube are in accordance with BS448, Section B7G.

TEST CONDITIONS (unless otherwise specified)

R_{lim} (kΩ)	$I_{burning}$ (mA)
5.0	6.0

After initial warming-up period of 3 minutes at burning current of 6mA.

TESTS	A.Q.L.[2] (%)	Individuals[3] Min.	Max.	
GROUP A				
Ignition voltage. Illumination 5 to 50 ft. cd.	†	—	115	mV
Maintaining voltage	†	83	87	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	†	—	180	mV
Voltage jumps. Burning current varies from 1 to 10mA. $R_a = 500\Omega$	†	—	100	mV (pk–pk)
Oscillation. Burning current varies from 1 to 10mA. $R_a = 500\Omega$	†	—	5	mV (pk–pk)
Microphonic noise. $R_a = 500\Omega$	†	—	15	mV (pk–pk)
Leakage current. Supply voltage = 55V, $R_a = 1M\Omega$	†	—	5	μA

†This test is carried out on a 100% basis.

GROUP B				
Ignition voltage in darkness, after 24 hours in darkness	2.5	—	115	V
Change in maintaining voltage for burning current change from 1 to 10mA	2.5	—	4.0	V

TESTS	A.Q.L.[2] (%)	Individuals[3] Min.	Max.	
GROUP C				
Glass strain test [8A]. No applied voltage	6.5	—	—	
Base strain test [9]. No applied voltage	6.5	—	—	
Resonance search				
Vibrated at 2g over frequency range specified.				
25 to 500c/s	2.5	—	5	mV (r.m.s.)
500 to 2500c/s	2.5	—	15	mV (r.m.s.)
Fatigue[11]				
No applied voltage, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes				
Post fatigue tests				
Change in maintaining voltage	2.5	—	±0.7	V
Microphonic noise as in Group A	2.5	—	30	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	
Shock[12]				
No applied voltage, 500g				
Post shock tests				
Change in maintaining voltage	2.5	—	±0.7	V
Microphonic noise as in Group A	2.5	—	30	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	

GROUP D

Life test[11]

Burning current = 6mA continuous

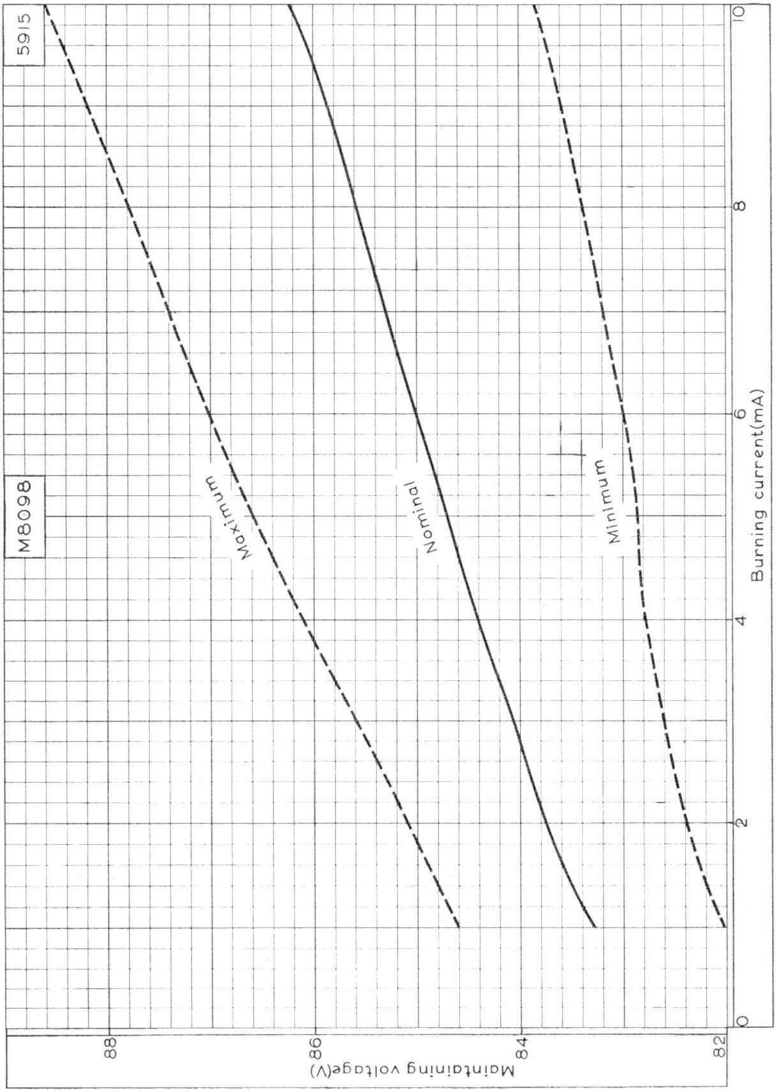
Life test end points. 1000 hours

Inoperatives[13]	2.5	—	—	
Ignition voltage	2.5	—	115	V
Change in maintaining voltage	2.5	—	±0.4	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	2.5	—	180	mV

GROUP E

Tubes are held for 28 days and retested for

Inoperatives[13]	0.5	—	—	
Ignition voltage	0.5	—	115	V
Maintaining voltage	0.5	83	87	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	0.5	—	180	mV



MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

M8142

Special quality 85V gas-filled voltage reference tube with flying leads, for use in equipment where mechanical vibration and shocks are unavoidable.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER & REFERENCE TUBES which precede this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

*Minimum voltage necessary for ignition	115	V
Burning current		
Maximum	10	mA
Minimum	1.0	mA
Maximum negative anode voltage	75	V
Ambient temperature limits	−55 to +90	°C

*This value covers operation in daylight and complete darkness.

PREFERRED OPERATING CONDITION

Burning current	6.0	mA

CHARACTERISTICS

Measured at preferred operating condition and $T_{ambient} = 25°C$

Maintaining voltage (variation from tube to tube)	83 to 87	V
Incremental resistance		
Average	300	Ω
Maximum	450	Ω
Maximum increase in maintaining voltage as current is varied from 1 to 10mA	4.0	V
*Maximum percentage variation of maintaining voltage over first 1000 hours of life	0.5	%
Typical percentage drift of maintaining voltage per 1000 hours after 1300 hours	0.1	%

*After the initial warming-up period of 3 minutes

Discontinuities of the I_a/V_a characteristic

Typical voltage jumps over current range 4 to 10mA	5.0	mV
Maximum voltage jumps over current range 1 to 10mA	100	mV

SHORT-TERM STABILITY

Maximum short-term variation of maintaining voltage for any 8 hour period after the first 100 hours life will be better than 0.01% provided there is an initial warming-up period of 3 minutes.

Maximum short-term (100 hours max.) variation of maintaining voltage after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations it will in general be sufficient to draught shield the tube.

M8142

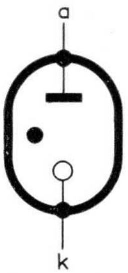
SPECIAL QUALITY VOLTAGE REFERENCE TUBE

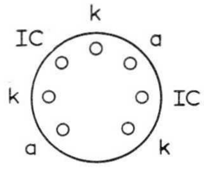
OPERATING NOTES

A steady maintaining voltage is reached within 3 minutes.

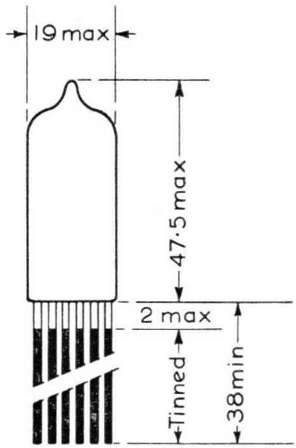
The greatest constancy of maintaining voltage is obtained if the tube is operated at the preferred current.

The noise generated by the tube over a frequency band of 30 to 10,000c/s is of the order of $60\mu V$, which is equivalent to the noise generated by a resistor of approximately $22M\Omega$ at a temperature of $300°K$. The noise is evenly distributed over the frequency range.





B7G/F Base



5806 All dimensions in mm

The bulb dimensions of this tube are in accordance with BS448, Section B7G

Note.—Direct soldered connections to the leads of the tube must be at least 5mm from the seal and any bending of the leads must be at least 1.5mm from the seal.

TEST CONDITIONS (unless otherwise specified)

R_{lim} (kΩ)	$I_{burning}$ (mA)
5.0	6.0

After initial warming-up period of 3 minutes at burning current of 6mA.

TESTS	A.Q.L.[2] (%)	Individuals[3] Min.	Individuals[3] Max.	
GROUP A				
Ignition voltage. Illumination 5 to 50 ft. cd.	†	—	115	V
Maintaining voltage	†	83	87	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	†	—	180	mV
Voltage jumps. Burning current varies from 1 to 10mA. $R_a = 500\Omega$	†	—	100	mV (pk–pk)
Oscillation. Burning current varies from 1 to 10mA. $R_a = 500\Omega$	†	—	5	mV (pk–pk)
Microphonic noise. $R_a = 500\Omega$	†	—	15	mV (pk–pk)
Leakage current. Supply voltage = 55V, $R_a = 1M\Omega$	†	—	5	µA

†This test is carried out on a 100% basis.

GROUP B	A.Q.L. (%)	Min.	Max.	
Ignition voltage in darkness, after 24 hours in darkness	2.5	—	115	V
Change in maintaining voltage for burning current change from 1 to 10mA	2.5	—	4.0	V

TESTS

GROUP C	A.Q.L.[2] (%)	Individuals[3] Min.	Individuals[3] Max.	
Glass strain test [8A]. No applied voltage	6.5	—	—	
Lead fragility test [10A]. No applied voltage	6.5	—	—	
Resonance search				
Vibrated at 2g over frequency range specified.				
25 to 500c/s	2.5	—	5	mV (r.m.s.)
500 to 2500 c/s	2.5	—	15	mV (r.m.s.)
Fatigue[11]				
No applied voltage, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes				
Post fatigue tests				
Change in maintaining voltage	2.5	—	±0.7	V
Microphonic noise as in Group A	2.5	—	30	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	
Shock[12]				
No applied voltage, 500g				
Post shock tests				
Change in maintaining voltage	2.5	—	±0.7	V
Microphonic noise as in Group A	2.5	—	30	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	

GROUP D

Life test[11]

Burning current = 6mA continuous

Life test end points. 1000 hours

Inoperatives[13]	2.5	—	—	
Ignition voltage	2.5	—	115	V
Change in maintaining voltage	2.5	—	±0.4	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	2.5	—	180	mV

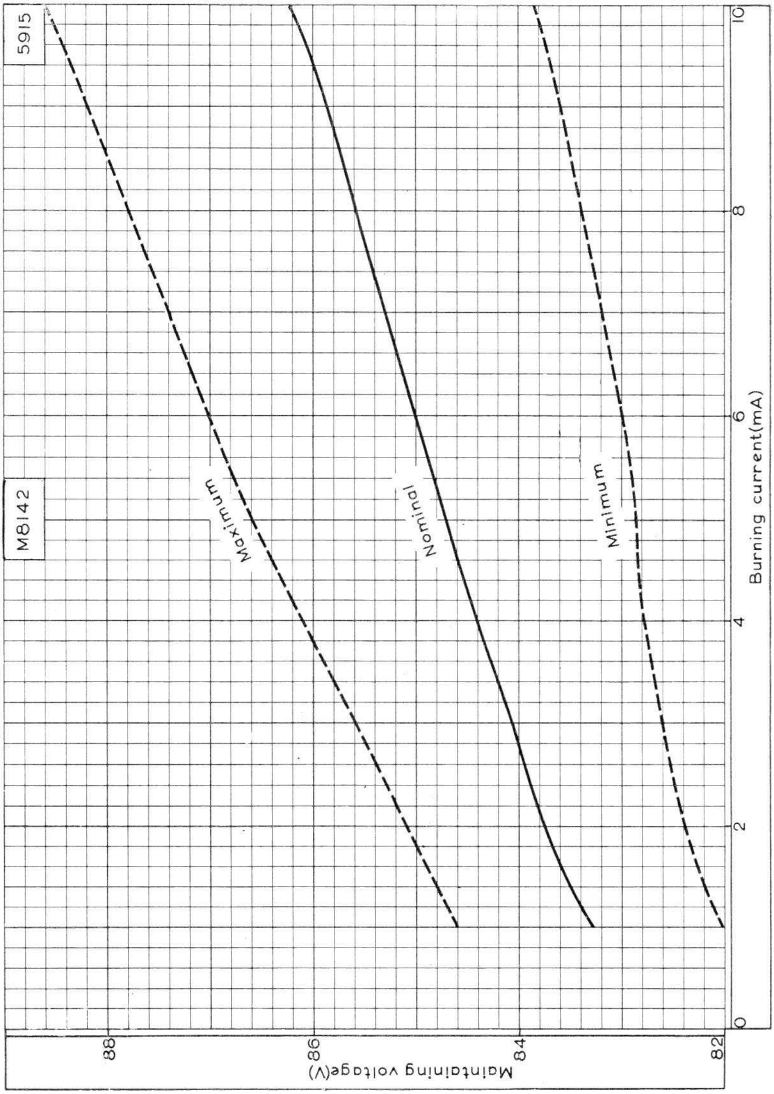
GROUP E

Tubes are held for 28 days and retested for

Inoperatives[13]	0.5	—	—	
Ignition voltage	0.5	—	115	V
Maintaining voltage	0.5	83	87	V
Change in maintaining voltage for burning current change from 5.8 to 6.2mA	0.5	—	180	mV

SPECIAL QUALITY VOLTAGE REFERENCE TUBE

M8142



MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT

SPECIAL QUALITY SUBMINIATURE VOLTAGE REFERENCE TUBE

M8190

Special quality 85V subminiature gas-filled voltage reference tube.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER & REFERENCE TUBES which precede this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

*Minimum voltage necessary for ignition	125	V
Burning current		
Maximum	3.5	mA
Minimum	0.5	mA
Maximum negative anode voltage	75	V
Minimum ambient temperature	−55	°C
Maximum bulb temperature	+90	°C

*This value covers operation in daylight and complete darkness.

PREFERRED OPERATING CONDITION

Burning current	2.0	mA

CHARACTERISTICS

Measured at preferred operating condition and $T_{ambient} = 25°C$

Maintaining voltage (variation from tube to tube)	84 to 88	V
Maximum maintaining voltage difference over current range 0.5 to 3.5mA	3.0	V
Maximum incremental resistance	1.0	kΩ
Variation of maintaining voltage during the first 1000 hours of life		
Maximum	±1.0	%
Typical	±0.5	%

OPERATING NOTES

A steady maintaining voltage is reached within 3 min.

The greatest constancy of maintaining voltage is obtained if the tube is operated at the preferred current.

TEST CONDITIONS (unless otherwise specified)

$R_{lim.}$ (kΩ)	$I_{burning}$ (mA)
30	2.0

After initial warming-up period of 3 minutes at burning current of 2.0mA

TESTS	A.Q.L.[2] (%)	Individuals[3] Min.	Individuals[3] Max.	
GROUP A				
Ignition voltage	†	—	125	V
Maintaining voltage	†	84	88	V
Change in maintaining voltage for burning current change from 1.9 to 2.1mA	†	—	0.2	V
Voltage jumps. Burning current varies from 1.2 to 3.5mA	†	—	25	mV (pk–pk)
Oscillation. Burning current varies from 1.2 to 3.5mA	†	—	15	mV (pk–pk)
Microphonic noise	†	—	25	mV (pk–pk)

†This test is carried out on a 100% basis.

TESTS	A.Q.L.[2] (%)	Individuals[3] Min.	Individuals[3] Max.	
GROUP B				
Ignition voltage in darkness after 24 hours in darkness	2.5	—	125	V
Leakage current. Supply voltage = 50V R_a = 1MΩ	2.5	—	15	μA
Change in maintaining voltage for burning current change from 0.5 to 3.5mA	2.5	—	3.0	V
Maintaining voltage at burning current of 3.5mA	2.5	—	89	V
Group quality level[7]	6.5	—	—	
GROUP C				
Glass strain test [8A]. No applied voltage	6.5	—	—	
Lead fragility test [10A]. No applied voltage	6.5	—	—	
Resonance search				
Vibrated at 2g over frequency range specified.				
25 to 500c/s	2.5	—	5.0	mV (r.m.s.)
500 to 2500c/s	2.5	—	15	mV (r.m.s.)

Fatigue[11]

No applied voltage, 5g min. peak acceleration, $f = 170 \pm 5$c/s for 33 hours in each of 3 mutually perpendicular planes

Post fatigue tests

Change in maintaining voltage	2.5	—	±0.8	V
Microphonic noise	2.5	—	50	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	

Shock[12]

No applied voltage, 750g

Post shock tests

Change in maintaining voltage	2.5	—	±0.8	V
Microphonic noise	2.5	—	50	mV (pk–pk)
Sub-group quality level[7]	4.0	—	—	

GROUP D

Life test[11]

Burning current = 2mA continuous

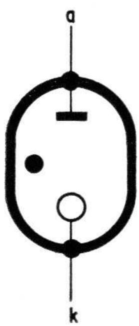
Life test end points. 1000 hours

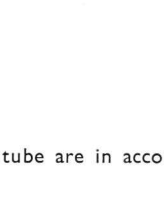
Ignition voltage	2.5	—	125	V
Change in maintaining voltage from 0 to 300 hours	2.5	—	±0.4	V
Change in maintaining voltage from 0 to 1000 hours	2.5	—	±0.8	V
Change in maintaining voltage for burning current change from 1.9 to 2.1mA	2.5	—	+0.2	V
Group quality level[7]	6.5	—	—	

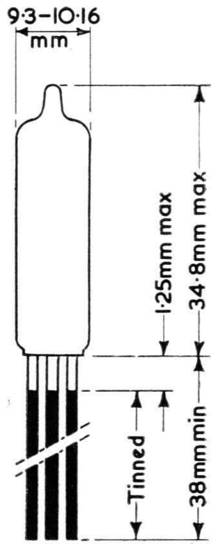
M8190

SPECIAL QUALITY SUBMINIATURE VOLTAGE REFERENCE TUBE

5807







The bulb dimensions of this tube are in accordance with BS448, Section B8D.

Note.—Direct soldered connections to the leads of the tube must be at least 5mm from the seal and any bending of the leads must be at least 1.5mm from the seal.

SPECIAL QUALITY STABILISING TUBE

M8223

Special quality 150V gas-filled voltage stabiliser for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER & REFERENCE TUBES preceding this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

†Minimum voltage necessary for immediate ignition		
In some ambient light (50ft.cd.)	165	V
In complete darkness	225	V
Burning current		
Maximum	30	mA
Minimum	5.0	mA
Maximum starting current	75	mA
Maximum negative anode voltage	125	V
Minimum ambient temperature	−55	°C
Maximum bulb temperature	150	°C

†These values cover life.

CHARACTERISTICS

Maximum maintaining voltage at 30mA (all tubes over life)	158	V
Minimum maintaining voltage at 5.0mA (all tubes over life)	142	V
Difference between maintaining voltages at 30mA and 5.0mA (individual tube)		
Maximum	5.0	V
Typical	3.0	V
Typical variation of maintaining voltage at 20mA during 500 hours life at $T_{bulb} = 150°C$	±2.0	%

TESTS	A.Q.L.[2] (%)	Individuals[3] Bogey[6]	Individuals[3] Min.	Individuals[3] Max.	Lot average[4] Min.	Lot average[4] Max.	Lot standard deviation[5] Max.	
GROUP A								
Ignition voltage. Illumination 5 to 50ft.cd.	0.65	—	—	165	—	—	—	V
Maintaining voltage								
Burning current = 30mA	0.65	150	—	156	—	—	—	V
	—	—	—	—	—	152	2.1	V
Burning current = 5.0mA	0.65	149	143	—	—	—	—	V
	—	—	—	—	147	—	2.1	V
Change in maintaining voltage for burning current change from 5.0 to 30mA	0.65	—	—	5.0	—	—	—	V
Group quality level[7]	1.0	—	—	—	—	—	—	
GROUP B								
Continuity and short	0.4	—	—	—	—	—	—	
*Microphonic noise. Burning current = 30mA	2.5	—	—	5.0	—	—	—	mV
Oscillation. $V_{sig} = 100mV$, burning current change from 5.0 to 30mA	2.5	—	—	—	—	—	—	
Ignition voltage in complete darkness, after 24 hours in darkness	6.5	—	—	225	—	—	—	V
Leakage current. $V_a = 50V$, $R_a = 3.0k\Omega$	6.5	—	—	5.0	—	—	—	μA

*The tube is tapped with a specified hammer and the output observed on a meter of specified dynamic response.

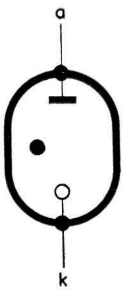
GROUP C

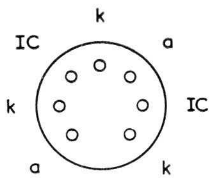
Glass strain[8A]. No applied voltage ..	2.5	—	—	—	—	—	—	
Fatigue[11]								
No applied voltage, 2.5g min. peak acceleration $f = 25 \pm 2$c/s for 32 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Ignition voltage as in Group A	—	—	—	165	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	158	—	—	—	V
Burning current = 5.0mA	—	—	142	—	—	—	—	V
Change in maintaining voltage for burning current change from 5.0 to 30mA ..	—	—	—	5.0	—	—	—	V
Sub-group quality level[7]	6.5	—	—	—	—	—	—	
Shock[12]								
No applied voltage, 500g								
Post shock tests								
Ignition voltage as in Group A	—	—	—	165	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	158	—	—	—	V
Burning current = 5.0mA	—	—	142	—	—	—	—	V
Change in maintaining voltage for burning current change from 5.0 to 30mA ..	—	—	—	5.0	—	—	—	V
Sub-group quality level[7]	20	—	—	—	—	—	—	

	A.Q.L.[2] (%)	Individuals[3] Bogey[6]	Individuals[3] Min.	Individuals[3] Max.	Lot average[4] Min.	Lot average[4] Max.	Lot standard deviation[5] Max.	
GROUP D								
Intermittent life test								
Burning current = 20mA								
T_{bulb} min = 150°C								
Intermittent life test end point 500 hours								
Change in maintaining voltage for current change from 5.0 to 30mA	—	—	—	8.0	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	158	—	—	—	V
Burning current = 5.0mA	—	—	142	—	—	—	—	V
Ignition voltage as in Group A	—	—	—	165	—	—	—	V
Change in maintaining voltage								
Burning current = 30mA	—	—	—	—	—	2.0	—	%
Burning current = 5.0mA	—	—	—	—	—	2.0	—	%
GROUP E								
Valves are held for 28 days and tested for								
Inoperatives	0.5	—	—	—	—	—	—	—

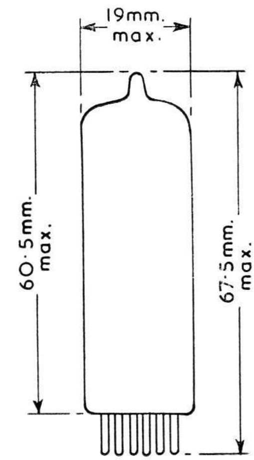
M8223

1616

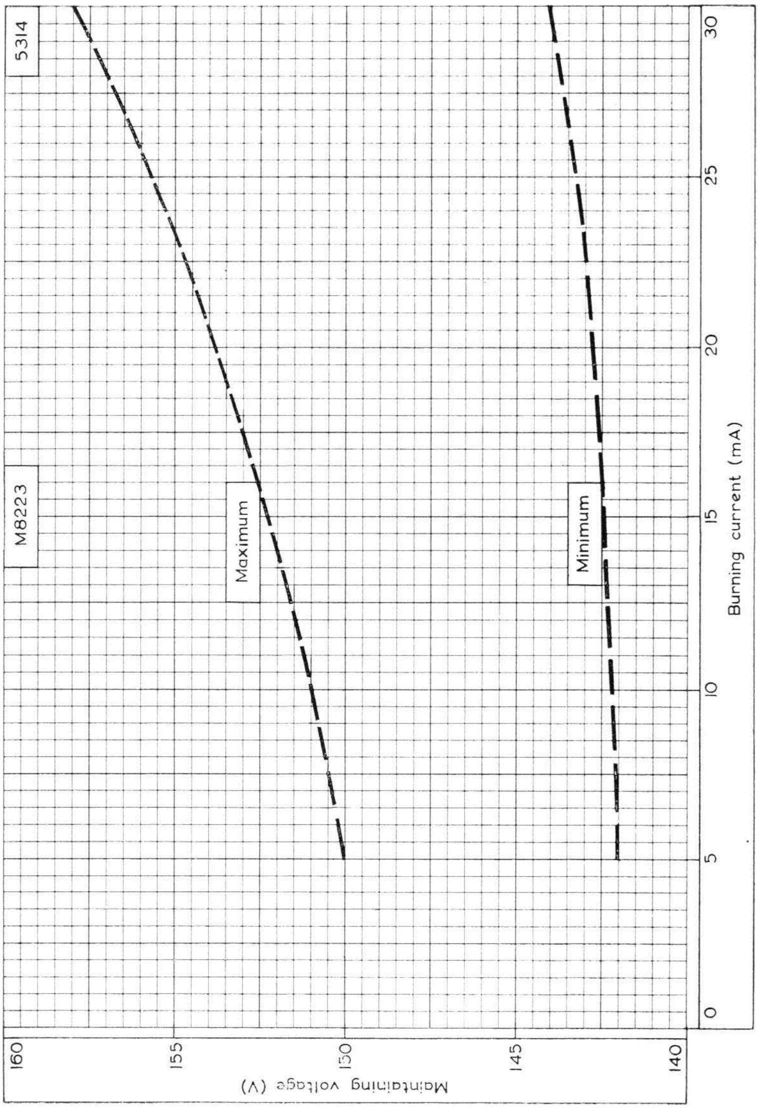




B7G Base.



The bulb and base dimensions of this tube are in accordance with BS448 Section B7G



MAXIMUM DEVIATION OF CHARACTERISTIC (ALL TUBES OVER LIFE)

SPECIAL QUALITY STABILISING TUBE

M8224

Special quality 108V gas-filled voltage stabiliser for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES preceding this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

†Minimum voltage necessary for immediate ignition		
In some ambient light (50 ft.cd.)	133	V
In complete darkness	210	V
Burning current		
Maximum	30	mA
Minimum	5.0	mA
Maximum starting current	75	mA
Maximum negative anode voltage	75	V
Minimum ambient temperature	–55	°C
Maximum bulb temperature	150	°C

†These valves cover life.

CHARACTERISTICS

Maximum maintaining voltage at 30mA (all tubes over life)	113	V
Minimum maintaining voltage at 5.0mA (all tubes over life)	103	V
Difference between maintaining voltages at 30mA and 5.0mA (individual tube)		
Maximum	4.0	V
Typical	1.5	V
Typical variation of maintaining voltage at 20mA during 500 hours life at $T_{bulb}=150°C$	±2.0	%

TESTS	A.Q.L.[2] (%)	Individuals[3] Bogey[6]	Individuals[3] Min.	Individuals[3] Max.	Lot average[4] Min.	Lot average[4] Max.	Lot standard deviation[5] Max.	
GROUP A								
Ignition voltage. Illumination 5 to 50ft.cd.	0.65	—	—	130	—	—	—	V
Maintaining voltage								
Burning current = 30mA	0.65	108.5	—	111	—	—	—	V
	—	—	—	—	—	109.5	0.87	V
Burning current = 5.0mA	0.65	101.5	105	—	—	—	—	V
	—	—	—	—	106.5	—	0.87	V
Change in maintaining voltage for burning current change from 5.0 to 30mA ..	0.65	—	—	3.0	—	—	—	V
Group quality level[7]	1.0	—	—	—	—	—	—	
GROUP B								
Continuity and short	0.4	—	—	—	—	—	—	
*Microphonic noise. Burning current = 30mA	2.5	—	—	5.0	—	—	—	mV
Oscillation. V_{sig}=100mV, burning current change from 5.0 to 30mA	2.5	—	—	—	—	—	—	
Ignition voltage in complete darkness, after 24 hours in darkness	6.5	—	—	210	—	—	—	V
Leakage current. V_a = 50V, R_a = 3.0kΩ	6.5	—	—	5.0	—	—	—	μA

*The tube is tapped with a specified hammer and the output observed on a meter of specified dynamic response.

GROUP C

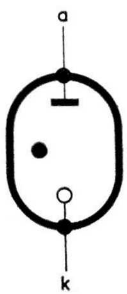
Glass strain[8A]. No applied voltage ..	2.5	—	—	—	—	—	—	
Fatigue[11]								
No applied voltage, 2.5g min. peak acceleration f = 25±2c/s for 32 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Ignition voltage as in Group A	—	—	—	133	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	113	—	—	—	V
Burning current = 5.0mA	—	—	103	—	—	—	—	V
Change in maintaining voltage for burning current change from 5.0 to 30mA ..	—	—	—	4.0	—	—	—	V
Sub-group quality level[7]	6.5	—	—	—	—	—	—	
Shock[12]								
No applied voltage, 500g								
Post shock tests								
Ignition voltage as in Group A	—	—	—	133	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	113	—	—	—	V
Burning current = 5.0mA	—	—	103	—	—	—	—	V
Change in maintaining voltage for burning current change from 5.0 to 30mA ..	—	—	—	4.0	—	—	—	V
Sub-group quality level[7]	20	—	—	—	—	—	—	

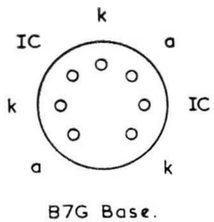
	A.Q.L.[2] (%)	Individuals[3] Bogey[6]	Min.	Max.	Lot average[4] Min.	Max.	Lot standard deviation[5] Max.	
GROUP D								
Intermittent life test								
Burning current = 20mA								
T_{bulb} min = 150°C								
Intermittent life test end points 500 hours								
Change in maintaining voltage for current change from 5.0 to 30mA	—	—	—	4.0	—	—	—	V
Maintaining voltage								
Burning current = 30mA	—	—	—	113	—	—	—	V
Burning current = 5.0mA	—	—	103	—	—	—	—	V
Ignition voltage as in Group A	—	—	—	133	—	—	—	V
Change in maintaining voltage								
Burning current = 30mA	—	—	—	—	—	2.0	—	%
Burning current = 5.0mA	—	—	—	—	—	2.0	—	%
GROUP E								
Valves are held for 28 days and tested for Inoperatives	0.5	—	—	—	—	—	—	

SPECIAL QUALITY STABILISING TUBE

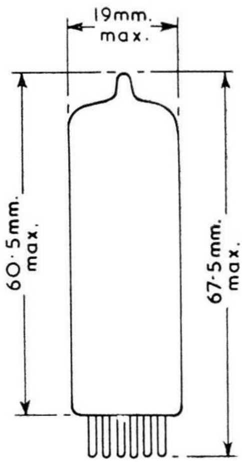
M8224

1616

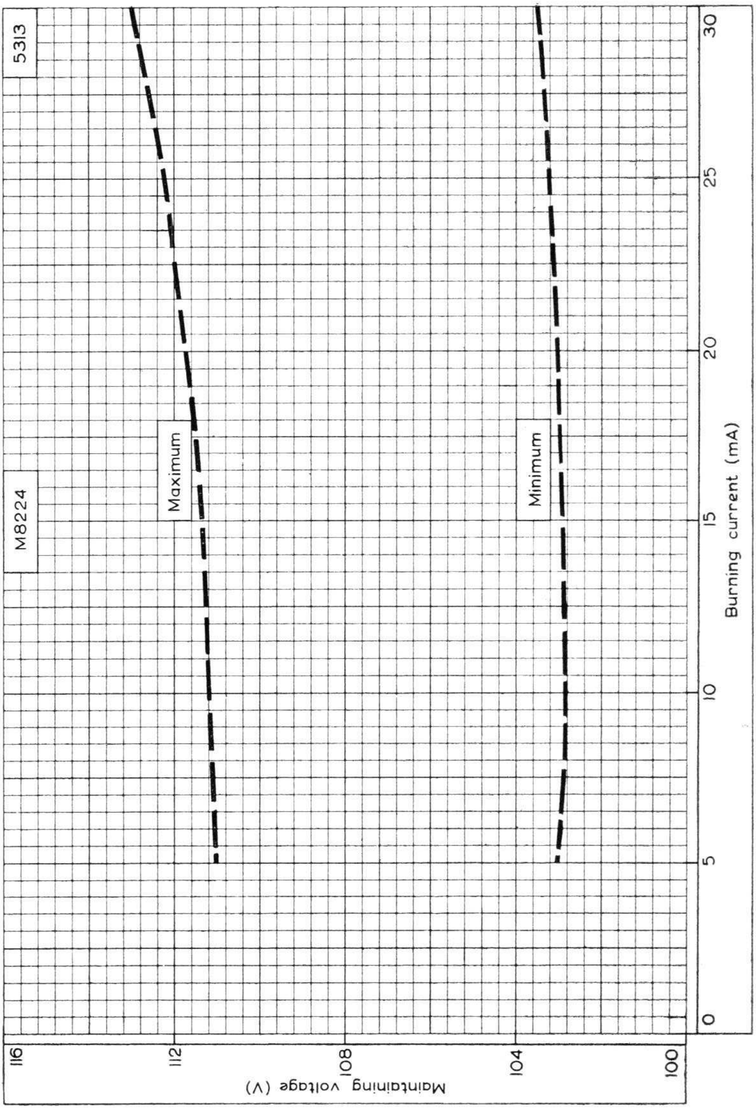




B7G Base.



The bulb and base dimensions of this tube are in accordance with BS448 Section B7G



MAXIMUM DEVIATION OF CHARACTERISTIC (ALL TUBES OVER LIFE)

STABILISING TUBE

75B1

Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

PRELIMINARY DATA

LIMITING VALUES (absolute ratings)

Min. voltage necessary for ignition	110	V
Max. burning current	22	mA
Min. burning current	2.0	mA

CHARACTERISTICS (measured at 10mA)

*Max ignition voltage	110	V
Burning voltage (variation from tube to tube)	70 to 80	V
Max. burning voltage difference over current range 2 to 20mA	6.0	V

*The auxiliary ignition electrode (priming anode) should be connected to the anode through a nominal 15kΩ resistor.

OPERATING NOTES

1. To obtain a good life a reverse current must not be drawn from this tube. This condition is satisfied if any inverse voltage does not exceed 65V.

2. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of an ambient illumination of 5 to 50 foot-candles. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there may be some delay in igniting the tube.

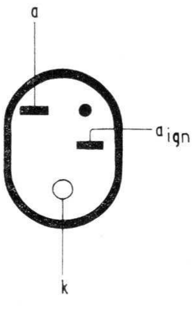
3. The noise generated by the tube over the frequency range (50 to 5,000 c/s) and at a constant current (2 to 20mA) is less than $15mV_{r.m.s.}$

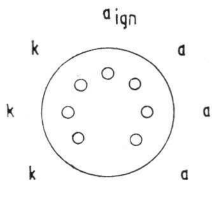
75B1

STABILISING TUBE

Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

1881





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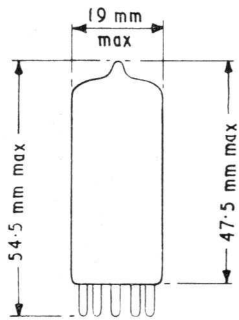


STABILISING TUBE

75 Volt gas-filled stabiliser with a current range of 2.0 to 60mA.

75C1

PRELIMINARY DATA

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition (light or dark)	115	V
Maximum burning current	60	mA
Minimum burning current	2.0	mA
*Maximum starting current	100	mA
Maximum ambient temperature limits	−55 to +90	°C
Maximum negative anode voltage	50	V

*To be restricted for long life to approximately 30 seconds in each 8 hours use.

CHARACTERISTICS

Burning voltage at $I_a = 30$mA (see curve on page 3)	75 to 81	V
Maximum difference between maximum and minimum burning voltages over current range	8.0	V
Typical difference between maximum and minimum burning voltages over current range	5.0	V
Typical percentage variation of burning voltage in first 1000 hours	±1.0	%
Typical variation of burning voltage with temperature	see curve on page 4	
*Typical voltage jumps in the current range		
10 to 20mA	20	mV
above 20mA	<10	mV
Maximum burning current above which the incremental resistance is always positive	7.0	mA
Maximum incremental resistance	200	Ω

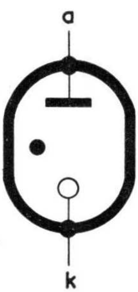
*Larger jumps may be experienced at currents below 10mA.

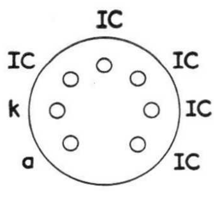
75C1

STABILISING TUBE

75 Volt gas-filled stabiliser with a current range of 2.0 to 60mA.

3529





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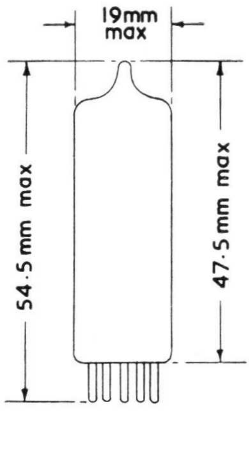
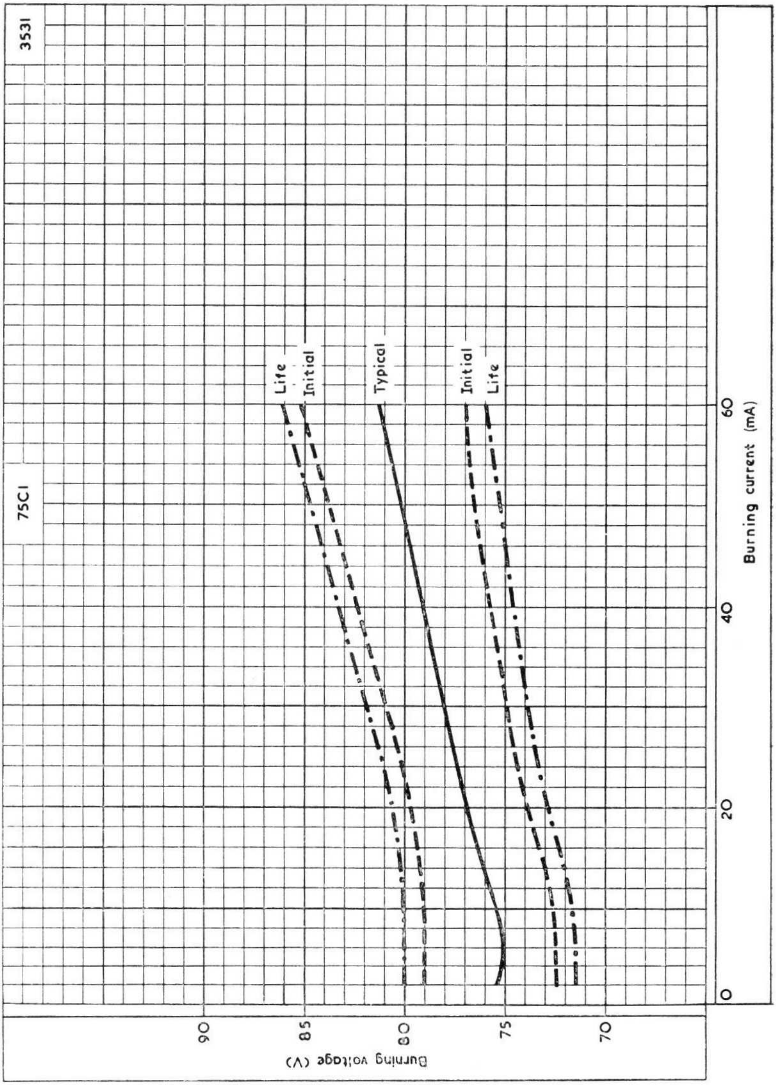


STABILISING TUBE

75C1

75 Volt gas-filled stabiliser with a current range of 2.0 to 60mA.

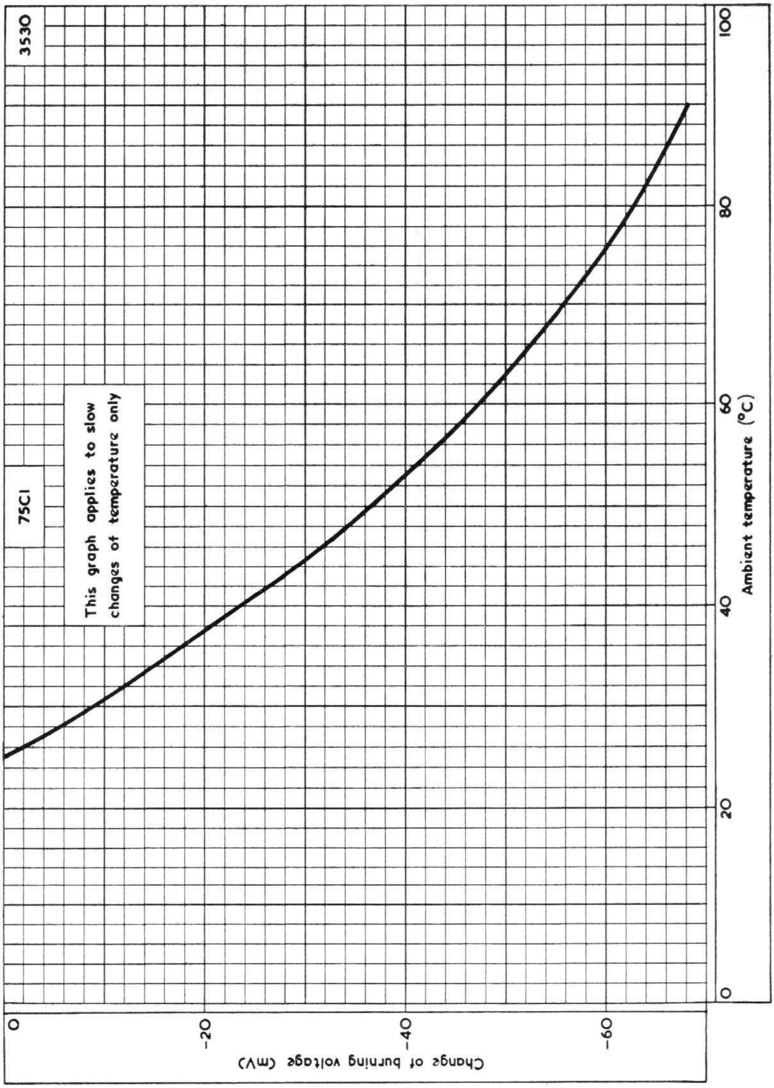


BURNING VOLTAGE PLOTTED AGAINST BURNING CURRENT

75C1

STABILISING TUBE

75 Volt gas-filled stabiliser with a current range of 2.0 to 60mA.



CHANGE OF BURNING VOLTAGE PLOTTED AGAINST AMBIENT TEMPERATURE FOR SLOW CHANGES IN TEMPERATURE

VOLTAGE REFERENCE TUBE

83A1

83V gas-filled reference tube.

PRELIMINARY DATA

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition (*Notes 1 and 2*)	130	V
Burning current		
Maximum	6.0	mA
Minimum	3.5	mA
Maximum bulb temperature (*Note 3*)		
During operation	150	°C
During storage and stand-by	100	°C
Maximum negative anode voltage	50	V
Maximum starting current (*Note 4*)	10	mA

PREFERRED OPERATING CONDITION

Cathode current	4.5	mA

CHARACTERISTICS (*Note 5*) at preferred operating condition

Initial values (measured at 25 to 30°C)

Maintaining voltage (variation from tube to tube)	82.6 to 84.1	V
*Maximum jump voltage (3.5 to 6.0mA)	1	mV
*Typical r.m.s. noise voltage (30c/s to 10kc/s)	100	µV
*Incremental resistance		
Maximum	350	Ω
Minimum	110	Ω
*Nominal temperature coefficient (*Note 7*) average over the range 25 to 120°C	−0.003%/°C(−2.5mV/°C)	

*See *note 6*.

Life performance

Limits of the typical variations of maintaining voltage at the temperatures shown and over the period indicated.

(a) For continuous operation at preferred current

Bulb temperature	25	100	150	°C
Life period				
0 to 300 hrs.	0 to +0.35	−0.1 to +0.5	0 to +2	V
300 to 2500 hrs.	0 to +0.2	0 to +0.2	−2 to +4	V
300 to 10,000 hrs.	+0.05 to +0.35	+0.05 to +0.35	—	V

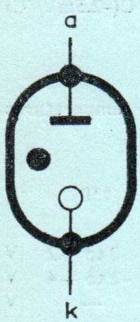
(b) For storage or stand-by

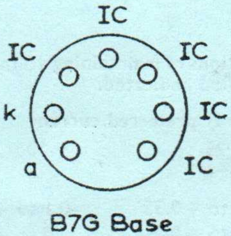
0 to 500 hrs.	Negligible	<1.5 (*Note 8*)	—	V
0 to 3000 hrs.	Negligible	<6 (*Note 8*)	—	V

NOTES

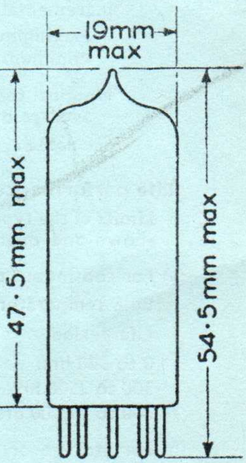
1. The effective resistance in series with the tube should never be less than 2kΩ.
2. This value holds good over life, in light or darkness. In total darkness an ignition delay of up to 5s may occur.
3. During conduction the bulb temperature is approximately 20°C above ambient temperature.
4. To be restricted for long life to approx. 30s once or twice in each 8hrs. use.
5. Equilibrium conditions are reached within 1min.
6. Information to date indicates that these values hold good, with little or no change, over life.
7. The characteristics curve connecting temperature coefficient and bulb temperature is continuous and repeatable. The typical tube to tube variations in maintaining voltage with temperature are shown on page C1.
8. Subsequent operation of the tube for approximately 50hrs. at 4.5mA at not more than 100°C will restore the maintaining voltage to within 0.2V of its original value.

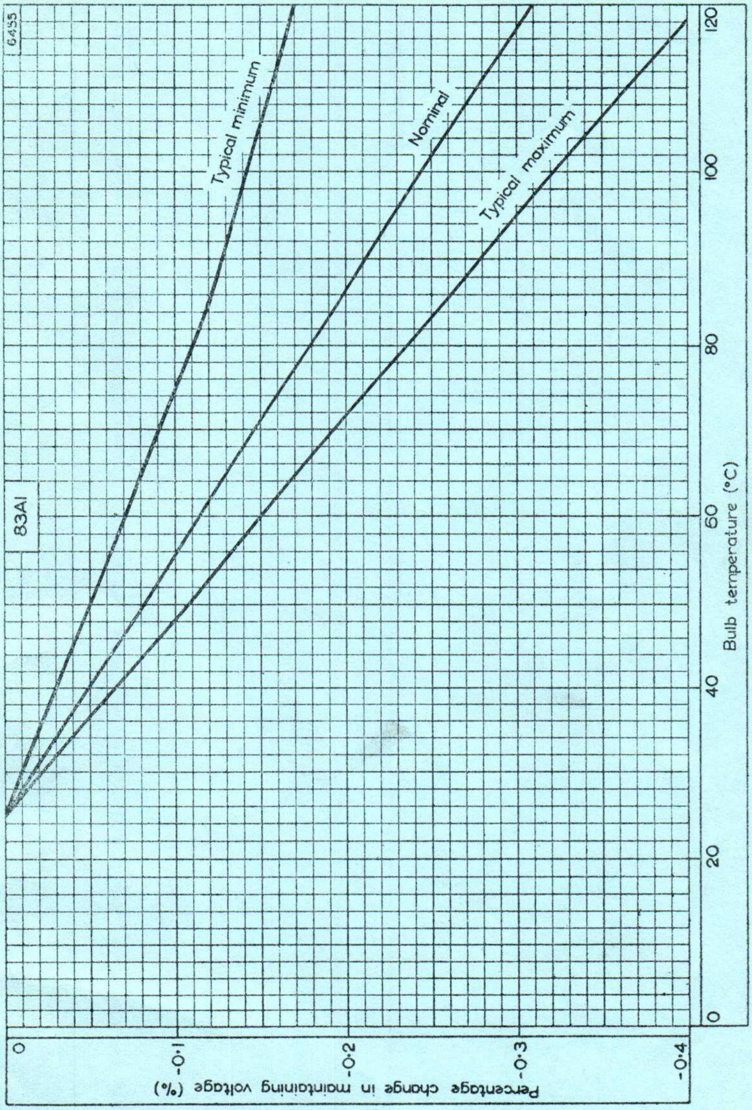
4716





B7G Base





PERCENTAGE CHANGE IN MAINTAINING VOLTAGE PLOTTED AGAINST BULB TEMPERATURE

VOLTAGE REFERENCE TUBE

85A1

Neon-filled two-electrode tube having a high order of stability over both long and short periods and very small variations from tube to tube.

This data should be read in conjunction with the GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition	125	V
Burning current		
Maximum	8.0	mA
Minimum	1.0	mA
Maximum negative anode voltage	75	V

PREFERRED OPERATING CONDITION

Burning current	4.5 ± 0.2	mA

CHARACTERISTICS

Measured at preferred operating condition

Maintaining voltage (variation from tube to tube)	83 to 86	V
Incremental resistance		
Average	290	Ω
Maximum	450	Ω
Maximum percentage variation of maintaining voltage for current change of 4.3 to 4.7mA	0.17	%
*Maximum percentage variation of maintaining voltage during life	0.5	%
Maximum percentage variation of maintaining voltage after the first 300 hours of life	0.2	%
Maximum short term ($\leq$ 100 hours) variation of maintaining voltage after the first 300 hours of life	0.1	%

*After initial warming-up period of 3 minutes.

MAINTENANCE TYPE

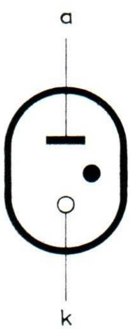
85A1

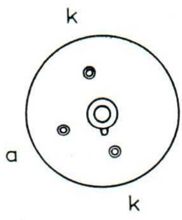
VOLTAGE REFERENCE TUBE

NOTES

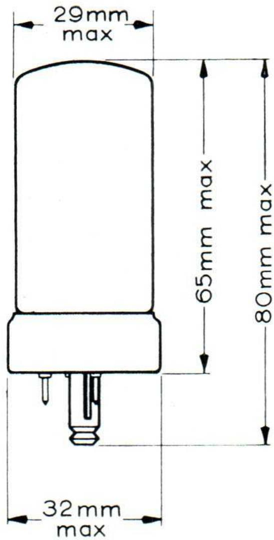
1. Equilibrium conditions are normally reached after 3 minutes' operation.
2. Over life, the incremental resistance will remain sensibly constant but the temperature coefficient of the maintaining voltage can be expected to decrease slightly.
3. The noise generated by the tube over a frequency band of 30 to 10,000c/s, is of the order of 70μV, which is equivalent to the noise generated by a resistance of approximately 30MΩ. The noise is evenly distributed over the frequency range.
4. This tube should not be subjected to shock or continuous vibration.

6130





B8G Base



VOLTAGE REFERENCE TUBE

85A2

Gas-filled two-electrode tube intended for use as a voltage reference.

LIMITING VALUES (Absolute Ratings)

Min. voltage necessary for ignition	115	V ←
Max. burning current	10	mA
Min. burning current	1	mA
Ambient temperature limits	−55 to +90	°C

PREFERRED OPERATING CONDITION

Burning current	6	mA

CHARACTERISTICS

At Preferred Operating Condition

Max. ignition voltage	115	V ←
Burning voltage (variation from tube to tube)	83 to 87	V
Incremental resistance		
Average	300	Ω
Maximum	450	Ω
Temperature coefficient of burning voltage over temperature range 15 to 90°C	−4.0	mV/°C
*Max. percentage variation of burning voltage		
During the first 300 hours of life	0.3	%
During the subsequent 1,000 hours	0.2	%
Typical percentage drift of burning voltage per 1,000 hours after 1,300 hours	0.1	%

*After the initial warming-up period of 3 minutes.

DISCONTINUITIES OF THE I_a/V_a CHARACTERISTIC

Typical voltage jumps over current range 4 to 10 mA	5.0	mV
Maximum voltage jumps over current range 4 to 10 mA	50	mV

SHORT-TERM STABILITY

Maximum short-term variation of burning voltage for any 8 hour period after the first 100 hours life will be better than 0.01% provided there is an initial warming-up period of 3 minutes. ←

Maximum short-term (100 hours max.) variation of burning voltage after the first 300 hours of life is 0.1%.

In order to avoid voltage variations due to temperature fluctuations it will in general be sufficient to draught shield the tube (see temperature coefficient of tube).

85A2

VOLTAGE REFERENCE TUBE

Gas-filled two-electrode tube intended for use as a voltage reference.

OPERATING NOTES

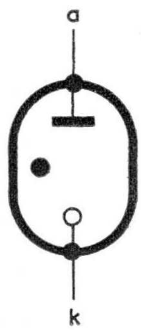
1. To obtain a good life a reverse current must not be drawn from this tube. This condition is satisfied if any inverse voltage does not exceed 75 V. ←

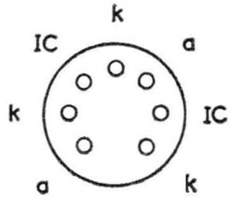
2. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of some ambient illumination. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there may be considerable delay in igniting the tube.

3. A steady burning voltage is reached within 3 minutes.

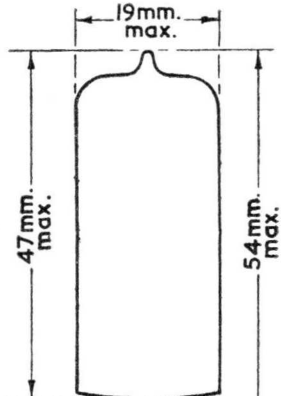
4. The greatest constancy of burning voltage is obtained if the tube is operated at only one value of current.

5. The noise generated by the tube over a frequency band of 30 to 10,000 c/s is of the order of 60 μV, which is equivalent to the noise generated by a resistor of approximately 22 M Ω at a temperature of 300°K. The noise is evenly distributed over the frequency range.





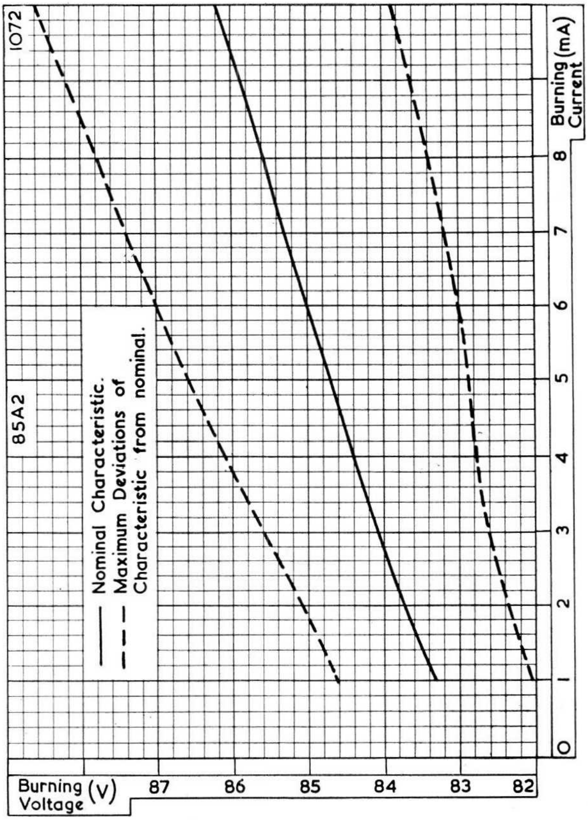
B7G BASE



VOLTAGE REFERENCE TUBE

Gas-filled two-electrode tube intended for use as a voltage reference.

85A2



BURNING VOLTAGE PLOTTED AGAINST BURNING CURRENT

STABILISING TUBE

90C1

90-volt gas-filled voltage stabiliser with a current range of 1 to 40mA.

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition (Note 1)	115	V
Burning current		
Maximum	40	mA
Minimum	1.0	mA
Maximum negative anode voltage	80	V

CHARACTERISTICS

Maintaining voltage at $I_a = 20mA$		
Maximum	94	V
Minimum	86	V
Burning current above which the incremental resistance is positive	2	mA

	Initial	Over life (Note 2) $I_a = 20mA$	Over life (Note 2) $I_a = 40mA$	
Increase in maintaining voltage as burning current is increased over the current range				
Maximum	14	—	—	V
Typical	12	13	15	V
Percentage variation of maintaining voltage at running current (room temperature)				
In 1000 hrs. (maximum)	—	± 1	$+5$	%
In 10,000 hrs. (typical)	—	$+3.5$	$+5$	%

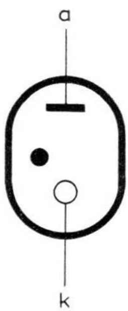
OPERATING NOTES

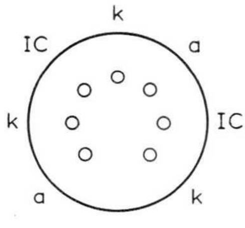
1. This value covers operation in light or darkness. If the tube is to be operated continuously at currents below 5mA a voltage of at least 125V should be available.
2. These figures apply when the tube is operated continuously at the currents stated.
3. Equilibrium conditions are reached within 3 minutes of igniting the tube.

90C1

STABILISING TUBE

6317





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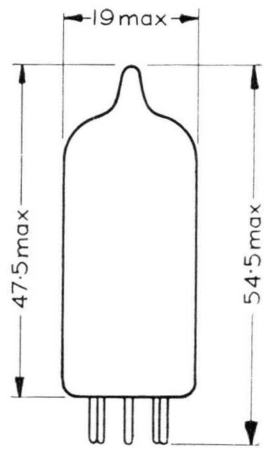
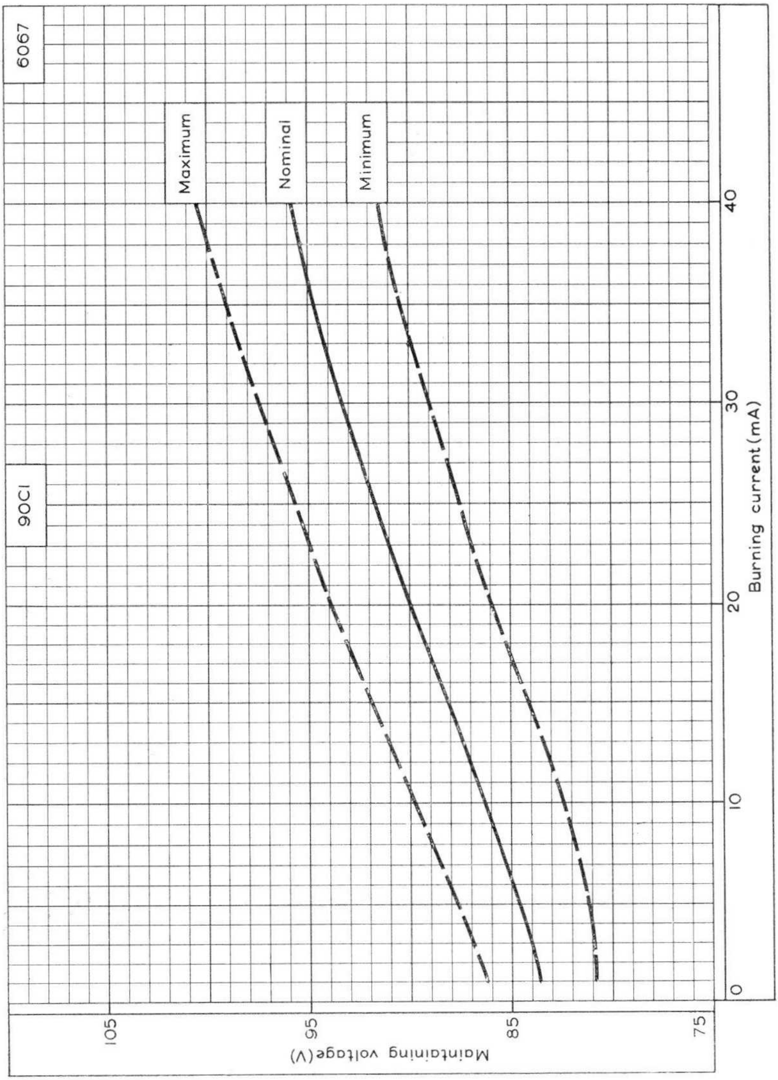


All dimensions in mm



MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT
(Initial values)

STABILISING TUBE

95A1

Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

PRELIMINARY DATA

LIMITING VALUES (absolute ratings)

*Min. voltage necessary for ignition	110	V
Max. burning current	10	mA
Min. burning current	2.0	mA
Max. auxiliary anode current	0.5	mA

CHARACTERISTICS (measured at 5mA)

Max. auxiliary anode ignition voltage	150	V
*Max. ignition voltage	110	V
Burning voltage (variation from tube to tube)	90 to 100	V
Max. burning voltage difference over current range 2 to 10mA	5.0	V

*Auxiliary ignition electrode (priming anode) connected to 150V line through a nominal 270kΩ resistor.

If the auxiliary ignition electrode (priming anode) is not used it should be connected to the anode through a 3.3kΩ resistor. Under these conditions a line voltage of at least 150V will be required to strike the tube.

OPERATING NOTES

1. To obtain a good life a reverse current must not be drawn from this tube. This condition is satisfied if any inverse voltage does not exceed 85V.

2. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of an ambient illumination of 5 to 50 foot-candles. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there may be some delay in igniting the tube.

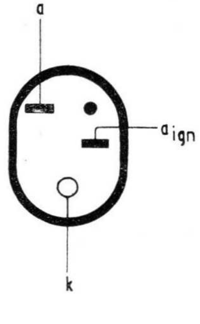
3. The noise generated by the tube over the frequency range (50 to 5,000 c/s) and at a constant current (2 to 10mA) will be less than $15\text{mV}_{\text{r.m.s.}}$

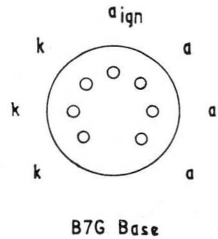
95A1

STABILISING TUBE

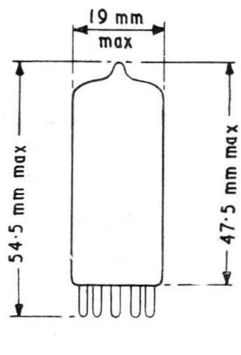
Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

1881





B7G Base



Mullard

STABILISING TUBE

108C1

108Volt gas-filled stabiliser with current range 5.0 to 30mA.

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition in some ambient light	133	V
Minimum voltage necessary for ignition in complete darkness	210	V
Maximum burning current	30	mA
Minimum burning current	5.0	mA
Maximum starting current	75	mA
Maximum ambient temperature limits	−55 to +90	°C
Maximum negative anode voltage	75	V

CHARACTERISTICS

	Initial	*Over Life**	
Maximum burning voltage at $I_a = 30$mA (all tubes)	112	114	V
Minimum burning voltage at $I_a = 5.0$mA (all tubes)	105	101	V
Maximum difference between burning voltages at $I_a = 30$mA and $I_a = 5.0$mA (individual tube)	3.5	4.0	V
Typical difference between burning voltages at $I_a = 30$mA and $I_a = 5.0$mA (individual tube)	1.5	1.5	V
Maximum percentage variation of burning voltage at $I_a = 17.5$mA during 1000 hours life		±3.0	%
Typical percentage variation of burning voltage at $I_a = 17.5$mA during 1000 hours life		±1.0	%

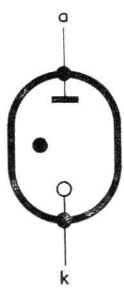
*This condition corresponds to an average current of 17.5mA

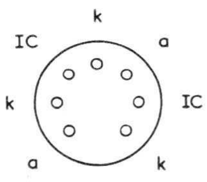
108CI

STABILISING TUBE

108Volt gas-filled stabiliser with current range 5.0 to 30mA.

1616





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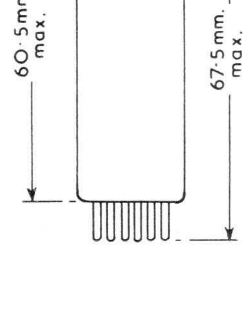


STABILISING TUBE

150B2

150 volt gas-filled voltage stabiliser with a current range of 5 to 15mA.

This data should be read in conjunction with the GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER and REFERENCE LEVEL TUBES which precede this section of the handbook.

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition (*Note 1*)	180	V
Burning current		
Maximum	15	mA
Minimum	5.0	mA
Maximum negative anode voltage	130	V

CHARACTERISTICS (*Note 2*)

Initial values

Maintaining voltage at $I_a = 10mA$		
Maximum	154	V
Minimum	146	V
Burning current above which the incremental resistance is positive	5.0	mA
Incremental resistance (approx.) at $I_a = 10mA$	250	Ω
Temperature coefficient of maintaining voltage (approx.) at $I_a = 10mA$	0.007	% per °C
Typical maximum voltage jumps over current range 10 to 15mA	75	mV ←

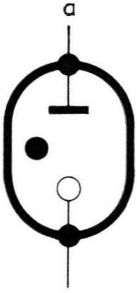
Life performance

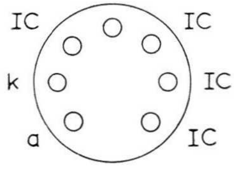
	Initial	Over life $I_a = 10mA$	
Increase in maintaining voltage as burning current is increased over the range 5 to 15mA			
Maximum	5.0	—	V
Typical	<4.0	<6.0	V ←
Percentage variation of maintaining voltage at running current (room temperature)			
In 1000 hrs. (maximum)	—	±1.0	%
In 10,000 hrs. (typical)	—	±2.0	% ←

NOTES

1. This value covers operation in light or darkness.
2. Equilibrium conditions are reached within 3 minutes of igniting the tube

4716





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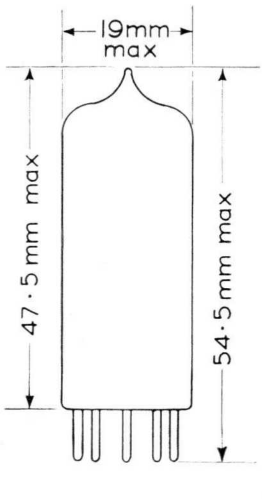
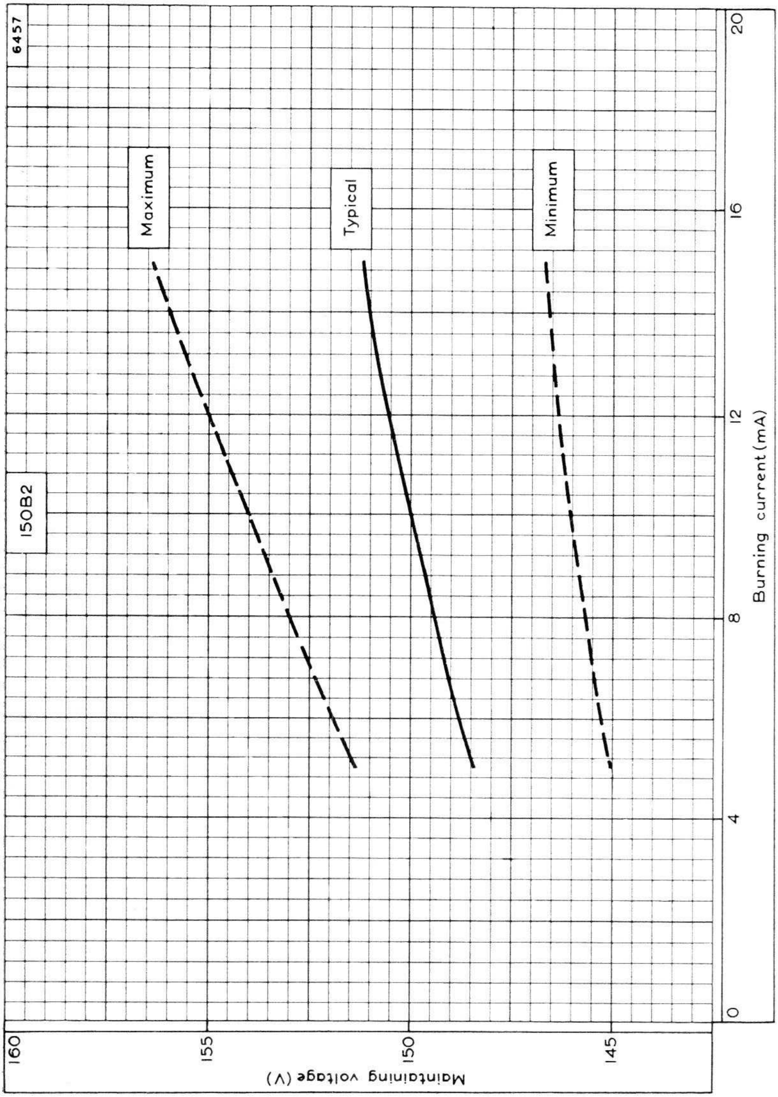




MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT

STABILISING TUBE

150B3

Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

PRELIMINARY DATA

LIMITING VALUES (absolute ratings)

*Min. voltage necessary for ignition	170	V
Max. burning current	20	mA
Min. burning current	2.0	mA
Max. auxiliary anode current	0.5	mA

CHARACTERISTICS (measured at 10mA)

Max. auxiliary anode ignition voltage	240	V
*Max. ignition voltage	170	V
Burning voltage (variation from tube to tube)	145 to 160	V
Max. burning voltage difference over current range 2 to 20mA	5.0	V

*Auxiliary ignition electrode (priming anode) connected to 240V line through a nominal 270kΩ resistor.

If the auxiliary ignition electrode (priming anode) is not used, it should be connected to the anode through a 68kΩ resistor. Under these conditions a line voltage of at least 240V will be required to strike the tube.

OPERATING NOTES

1. To obtain a good life a reverse current must not be drawn from this tube. This condition is satisfied if any inverse voltage does not exceed 140V.

2. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of an ambient illumination of 5 to 50 foot-candles. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there may be some delay in igniting the tube.

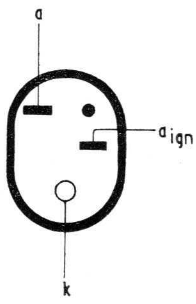
4. The noise generated by the tube over a frequency range (50 to 5,000 c/s) and at any constant current (2 to 20mA) is less than $15mV_{r.m.s.}$

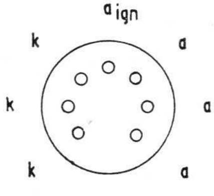
150B3

STABILISING TUBE

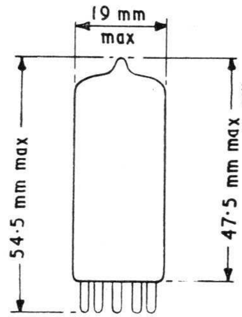
Miniature gas-filled tube with auxiliary ignition electrode (priming anode) and intended for use as a voltage stabiliser.

1881





B7G Base



STABILISING TUBE

150C2

Gas-filled two-electrode tube intended for use as a voltage stabiliser.

This data should be read in conjunction with the GENERAL OPERATIONAL RECOMMENDATIONS — VOLTAGE STABILISER AND REFERENCE LEVEL TUBES which precede this section of the handbook.

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition	185	V
Burning current		
Maximum	30	mA
Minimum	5.0	mA
Maximum negative anode voltage	140	V
Ambient temperature limits	−55 to +90	°C

CHARACTERISTICS (measured at 17.5mA)

Maintaining voltage	150	V
Maximum difference between maintaining voltages at $I_a = 30$mA and $I_a = 5.0$mA	6.0	V
Maximum percentage variation of maintaining voltage during 1000 hours	±2.0	%

OPERATING NOTES

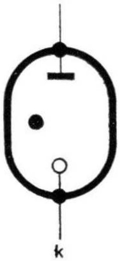
1. The maximum ignition voltage quoted is the greatest voltage which is necessary to ignite any tube in the presence of some ambient illumination. A voltage of at least this value must be available if reliability of ignition is to be obtained. In complete darkness there may be considerable delay in igniting the tube. If instantaneous ignition is required in darkness a voltage of not less than 225V is required.

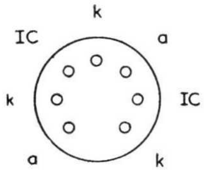
2. Equilibrium conditions are normally reached after 3 minutes' operation.

150C2

STABILISING TUBE

1616





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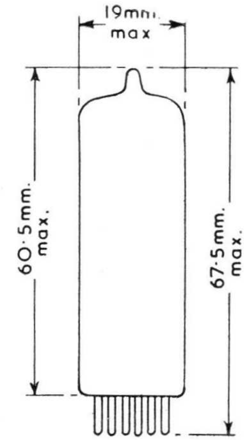


STABILISING TUBE

150Volt gas-filled stabiliser with current range of 5.0 to 30mA.

150C4

LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition in some ambient light	185	V
Minimum voltage necessary for ignition in complete darkness	225	V
Maximum burning current	30	mA
Minimum burning current	5.0	mA
Maximum starting current	75	mA
Maximum ambient temperature limits	−55 to +90	°C
Maximum negative anode voltage	125	V

CHARACTERISTICS

	Initial	*Over life**	
Maximum burning voltage at $I_a = 30mA$ (all tubes)	158	161	V
Minimum burning voltage at $I_a = 5.0mA$ (all tubes)	142	139	V
Maximum difference between burning voltages at $I_a = 30mA$ and $I_a = 5.0mA$ (individual tube)	5.0	8.0	V
Typical difference between burning voltages at $I_a = 30mA$ and $I_a = 5.0mA$ (individual tube)	3.0	3.0	V
Maximum percentage variation of burning voltage at $I_a = 17.5mA$ during 1000 hours life		±3.0	%
Typical percentage variation of burning voltage at $I_a = 17.5mA$ during 1000 hours life		±1.0	%

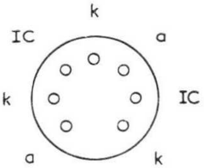
*This condition corresponds to an average current of 17.5mA

150C4

STABILISING TUBE

150Volt gas-filled stabiliser with current range of 5.0 to 30mA.

1616



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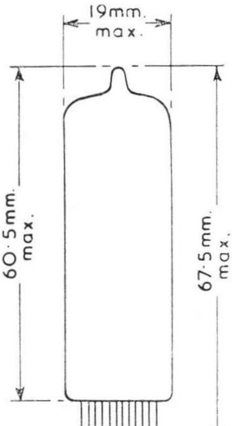


STABILISING TUBE

4687

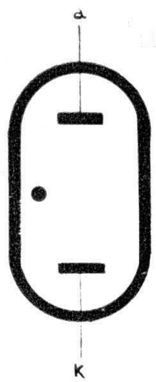
Neon-filled two-electrode tube intended for use as a voltage stabiliser.

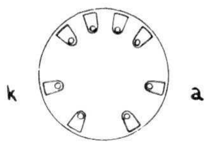
LIMITING VALUES (Absolute Ratings)

Min. voltage necessary for ignition	130	V
Max. burning current	40	mA
Min. burning current	10	mA

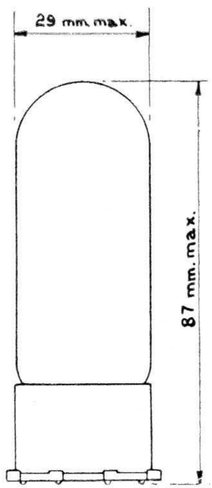
CHARACTERISTICS (Measured at 20 mA)

Max. ignition voltage	130	V
Burning voltage (variation from tube to tube)	90 to 110	V
Max. incremental resistance	250	Ω





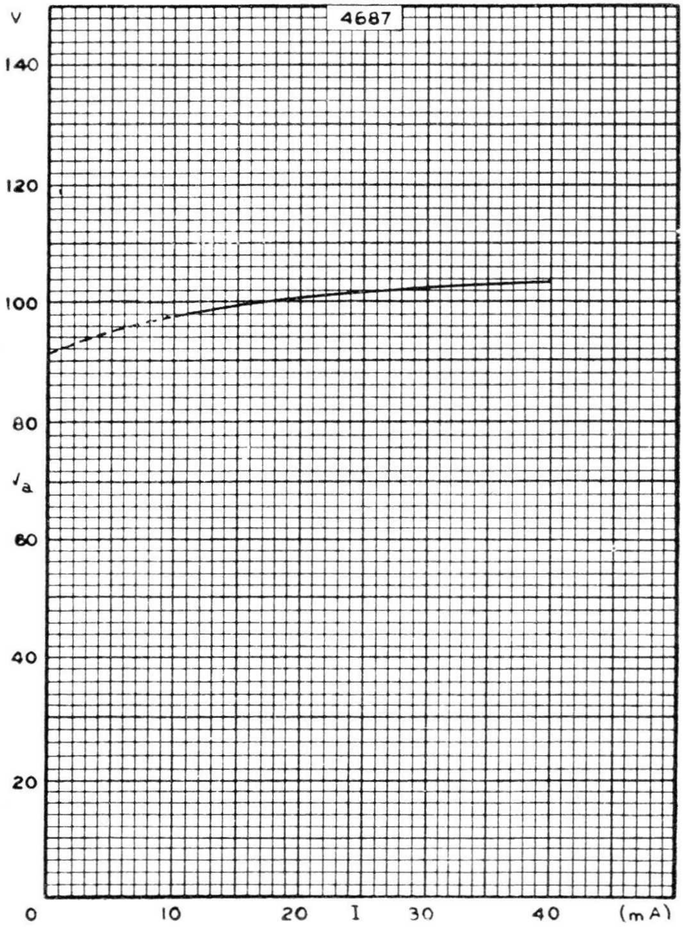
SIDE CONTACT BASE



4687

STABILISING TUBE

Neon-filled two-electrode tube intended for use as a voltage stabiliser.



BURNING VOLTAGE PLOTTED AGAINST BURNING CURRENT

SPECIAL QUALITY SUBMINIATURE STABILISING TUBE

5644

Special quality subminiature gas-filled 90V voltage stabiliser for use in equipment where mechanical vibration and shocks are unavoidable.

PRELIMINARY DATA

This data should be read in conjunction with GENERAL NOTES—SPECIAL QUALITY VOLTAGE STABILISER AND REFERENCE TUBES which precede this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[1] (absolute ratings)

†Minimum voltage necessary for ignition		
In some ambient light	130	V
In complete darkness	175	V
Burning current		
Maximum	25	mA
Minimum	5.0	mA
Maximum starting current	60	mA
Maximum negative anode voltage	75	V
Minimum ambient temperature	−55	°C
Maximum bulb temperature	*	

†These values cover life.

*Information on the performance of the tube at high bulb temperatures (up to 220°C) can be supplied on request.

CHARACTERISTICS

Maximum maintaining voltage at 25mA (all tubes over life)	108	V
Minimum maintaining voltage at 5.0mA (all tubes over life)	82	V
Difference between maintaining voltages at 25mA and 5.0mA (individual tube)		
Maximum	5.0	V
Typical	3.0	V

TESTS	A.Q.L.[2] (%)	Individuals[4] Min.	Max.	
GROUP A				
Ignition voltage. Illumination 5 to 50ft. cd.	*	—	120	V
Maintaining voltage				
Burning current = 25mA	*	—	105	V
Burning current = 5.0mA	*	85	—	V
Change in maintaining voltage for burning current change from 5.0 to 25mA	*	—	5.0	V

*This test is carried out on a 100% basis

GROUP B				
†Microphonic noise. Burning current = 25mA	4.0	—	15	mV
Leakage current. Supply voltage = 50V, $R_a < 100k\Omega$	6.5	—	10	μA

†The tube is tapped with a specified hammer and the output observed on a meter of specified dynamic response.

GROUP C				
Lead fragility test[10B] 4 arcs. No applied voltage	4.0	—	—	

Fatigue[11]

No applied voltage, 2.5g min. peak acceleration f = 25c/s min. 60c/s max. for 32 hours in each of 3 mutually perpendicular planes.

Post fatigue tests				
Ignition voltage as in Group A	—	—	130	V
Change in maintaining voltage for burning current change from 5.0 to 25mA	—	—	5.0	V
Sub-group quality level[7]	20	—	—	
Shock[12]				
No applied voltage, 500g				
Post shock tests				
Ignition voltage as in Group A	—	—	130	V
Change in maintaining voltage for burning current change from 5.0 to 25mA	—	—	5.0	V
Sub-group quality level[7]	20	—	—	

GROUP D

Intermittent life test, 500 hours duration.

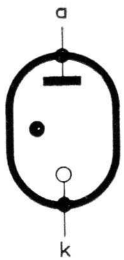
Burning current = 25mA, room temperature

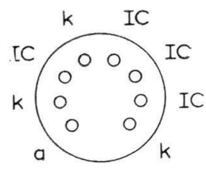
Intermittent life test end points				
Ignition voltage as in Group A	—	—	125	V
Maintaining voltage				
Burning current = 25mA	—	—	108	V
Burning current = 5.0mA	—	82	—	V
Change in maintaining voltage for change in burning current from 5.0 to 25mA	—	—	5.0	V
Average life per lot	—	475	—	hrs

5644

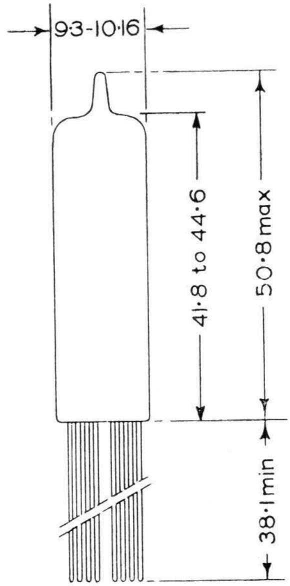
SPECIAL QUALITY SUBMINIATURE STABILISING TUBE

3937





B8D/F Base



All dimensions in mm

The bulb and base dimensions of this tube are in accordance with BS448, Section B8D/F

Note: Direct soldered connections to the leads of the tube must be at least 5mm from the seal and any bending of the leads must be at least 1.5mm from the seal.

STABILISING TUBE

7475

Neon-filled voltage stabiliser.

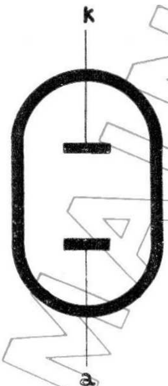
This data should be read in conjunction with the 'GENERAL OPERATIONAL RECOMMENDATIONS—VOLTAGE STABILISER AND REFERENCE LEVEL TUBES' which precede this section of the handbook.

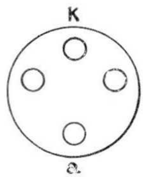
LIMITING VALUES (absolute ratings)

Minimum voltage necessary for ignition	140	V
Burning current		
Maximum	8.0	mA
Minimum	1.0	mA

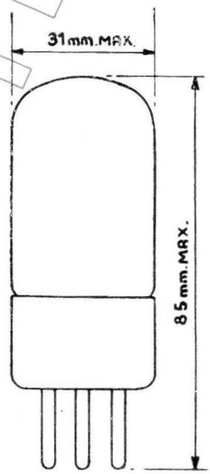
CHARACTERISTICS (measured at 4mA)

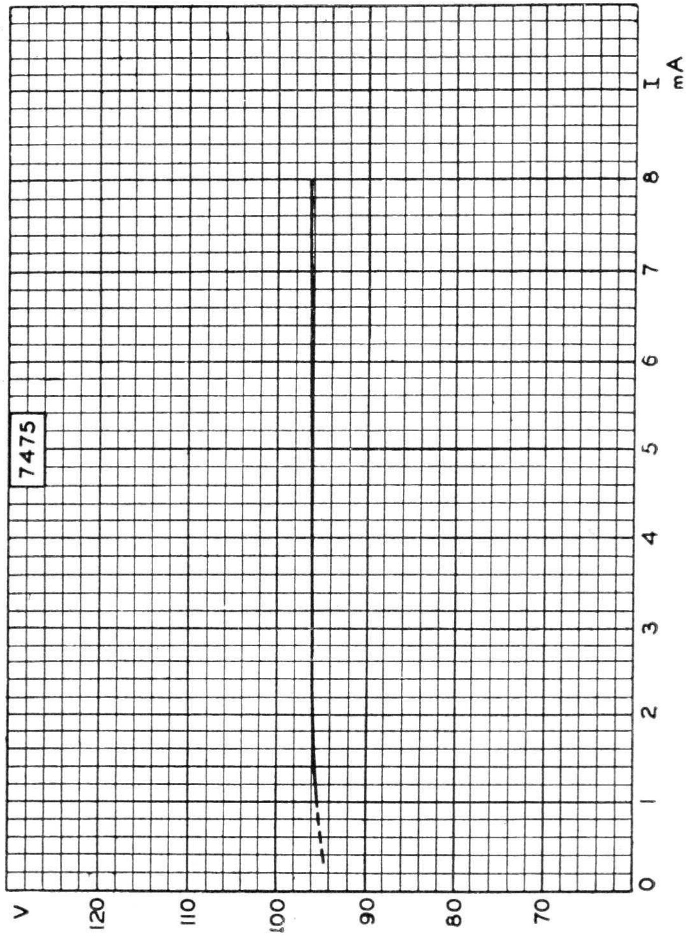
Maintaining voltage (variation from tube to tube)	90 to 110	V
Incremental resistance	300	Ω





British 4-pin base





MAINTAINING VOLTAGE PLOTTED AGAINST BURNING CURRENT

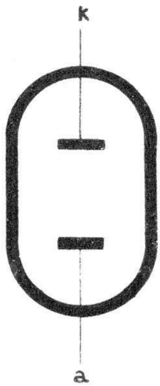
STABILISING TUBE

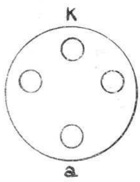
Neon-filled voltage stabiliser.

7475

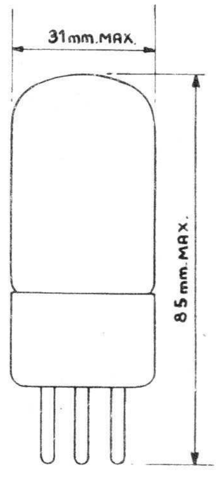
OPERATING CONDITIONS

V ignition max.	140	V
V burning	90–110	V
I quiescent	4	mA
I max.	8	mA
I min.	1	mA
A.C. resistance	300	Ω





BRITISH 4-PIN BASE

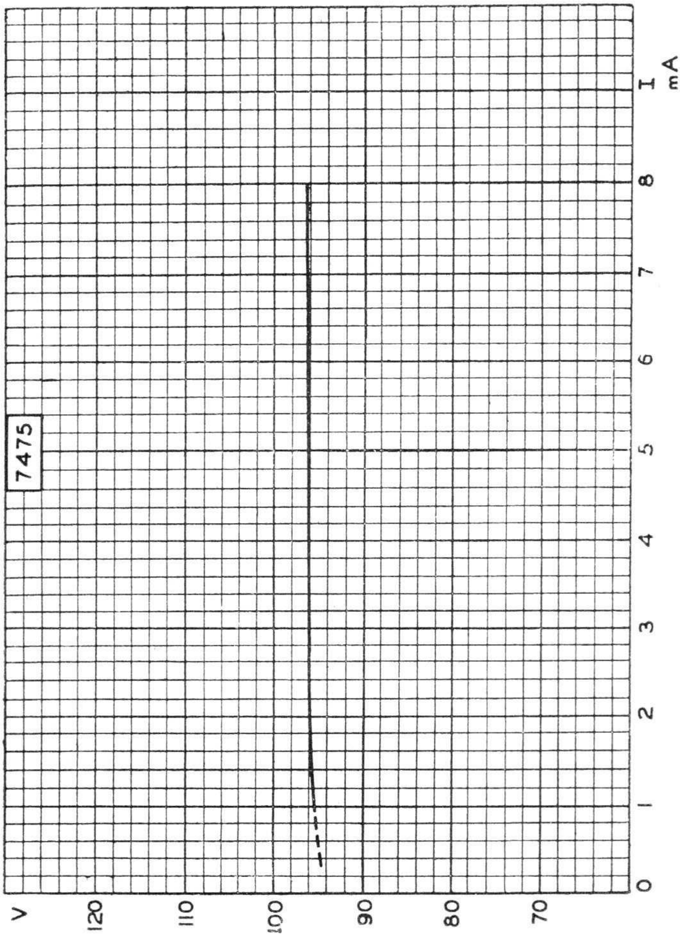


Mullard

7475

STABILISING TUBE

Neon-filled voltage stabiliser.



DECADE COUNTER AND
INDICATOR TUBES

The type nomenclature for Mullard Cold Cathode Tubes (excluding photocells and stabilisers) consists of one letter followed by a group of three figures which are followed by a second letter.

The first letter is always Z, indicating a cold cathode gas-filled tube.

The first figure indicates the type of base, the significance of the figure being the same as for Mullard Receiving Valves:—

2—B8G (loctal) base
3—Octal base
4—B8A base
5—B9G and other special bases
6 & 7—Subminiature construction
8—B9A (Noval) base
9—B7G base

The second and third figures are serial numbers indicating a particular design or development.

The second letter indicates the function of the tube:

A—Amplifier tube (continuous operation)
B—Binary counter or switching tube
C—Multistage counter tube
E—Electrometer trigger or amplifier tube
G—Gating tube
M—Indicator (metering) tube
S—Multistage switching tube
T—Trigger tube
U—Trigger tube with auxiliary electrodes

Example:—

Z300T Cold cathode trigger tube with octal base.

Construction

The Mullard counter and selector tubes consist of 30 identical rod-shaped cathodes arranged in a circle concentric with the common circular plate anode. The 30 cathodes are divided into three groups of ten and arranged so that every third electrode going around the ring belongs to the same group. The three groups are called main cathodes, guide A cathodes, and guide B cathodes. The order of the electrodes proceeding in a clockwise direction around the tube as seen from the dome is a main cathode, a guide A cathode, guide B cathode, next main cathode etc.

In both the counter tube and the selector tube all the guide A electrodes are connected internally and brought out to a single pin. The guide B electrodes are similarly connected and brought out. In the counter tube the main cathodes 1 to 9 are connected together internally and connected to a single pin. The 0 or tenth main cathode is brought out separately so that the tube can be set to zero and also an electrical output obtained for driving a succeeding tube. In the selector tube all the main cathodes are brought out individually so that an electrical output pulse can be obtained at any point around the tube.

Function of the electrode groups

Main cathodes

The glow normally rests on a main cathode thus providing indication, and electrical output may also be obtained from this cathode. The position of the discharge may be seen through the dome of the tube as an orange 'cathode glow' at the tip of the cathode concerned. The position of the discharge can be related to the number of input pulse by the use of an external numbered escutcheon aligned so that the numbers coincide with the position of the main cathodes.

Guide cathodes (A and B)

The function of the guide cathodes is to transfer the discharge from one main cathode to the next on the receipt of an input signal.

Basic circuit

The basic circuit is shown in Figure 1 on the individual data sheets and is essentially the same for both counter and selector tubes. An h.t. voltage, normally 475V, (which is greater than the anode-cathode ignition voltage) is applied to the circuit and breakdown to one of the main cathodes will, therefore, occur. Breakdown to more than one cathode cannot occur since conduction causes a voltage drop across the anode resistor and reduces the anode voltage across the tube to the maintaining voltage.

The transfer mechanism

The method usually employed to move the discharge around the tube is to convert the input signal into a pair of negative pulses. The first pulse is applied to all guide A cathodes followed immediately by the second pulse applied to all guide B cathodes.

Assume that the discharge is resting on the third main cathode k_3: when the pulse is applied to guides A the voltage between anode and guides A exceeds the ignition voltage and breakdown can therefore occur. Because of the priming from the discharge to the conducting main cathode k_3, breakdown will always occur to the adjacent guide A cathode GA_4. The discharge to k_3 will be extinguished since the anode voltage falls by the magnitude of the applied negative pulse. Similarly breakdown to GB_4 will take place on the arrival of the second pulse and the potential of guides A will return to the bias level. Finally at the end of the second pulse the potential of guides B will also return to the bias level. The anode voltage rises towards a potential equal to the guide bias plus the maintaining voltage. However, when the anode to k_4 voltage exceeds the ignition value the discharge will move to k_4 and the transfer has then been completed. This sequence results in rotation in the clockwise direction. Counting in the anti-clockwise direction can be obtained by applying pulses to guides A and B in the reverse order.

Output pulse

A resistor is connected in series with k_o (in Figure 1) so that an output pulse can be obtained when the discharge rests on k_o. This resistor must be chosen so that when the glow rests on k_o, the voltage on k_o does not exceed the positive guide bias. It is common practice to take the earthy end of the resistor back to a negative bias supply to obtain a larger pulse. However, the magnitude of the bias should not at any time be more negative than –20 volts.

In the selector tube an output can be obtained by inserting a resistor in series with any of the main cathodes.

The maximum value of the main cathode resistor for either selector or counter is given by

$$R_k \text{ max.} = \frac{(V_G + V_k - 10)\, R_a}{(V_{ht} - V_M - V_G + 10)}$$

and the output voltage for any value of R_k is

$$V_{out} = \frac{(V_{ht} - V_M + V_k)\, R_k}{(R_k + R_a)}$$

where V_{ht} is the supply voltage
V_M is the maintaining voltage
V_G is the positive guide bias
V_k is bias to k_o (numerical value only)
R_k is the cathode resistor
R_a is the anode resistor

Set zero

The discharge can conveniently be returned to k_o by momentarily disconnecting all cathodes except k_o. An alternative method is to pulse k_o negatively to –120 volts. Care must be taken if this method is adopted that spurious pulses are not fed down the chain of counter tubes at the termination of the pulse.

DECADE COUNTER TUBE

E1T

Indirectly heated decade counter tube designed to operate at high counting speeds.

The E1T is an indirectly heated decade counting tube designed to operate at high counting speeds. A ribbon shaped electron beam is moved in a horizontal plane and passes in succession through the ten apertures of a cylindrical anode, and impinges on a fluorescent layer on the wall of the tube.

This tube is particularly suitable for use in computers, radiation counters and industrial counting and batching applications.

With the circuit shown in this data the maximum counting speed is limited to 30 kc/s.

HEATER Suitable for series or parallel operation a.c. or d.c.

V_h	6.3	V
I_h	300	mA

MOUNTING POSITION Any, except with tube horizontal and the fluorescent screen downward.

CAPACITANCES

c_{a_1-all}	4.9	pF
c_{a_2-all}	10.5	pF
$c_{x'-all}$	3.5	pF
$c_{x''-all}$	3.8	pF
c_{g_1-all}	6.8	pF
c_{g_4-all}	7.7	pF

OPERATING CONDITIONS

$*V_b$	300	V
$*V_t$	300	V
$*V_{g_2}$	300	V
$*V_{g_1}$	11.9 ± 0.15	V
$*V_{x'}$	156 ± 1.5	V
I_{g_2}	100	μA
I_k	950	μA
R_k	15	kΩ± 1%
R_{a_1}	39	kΩ±10%
R_{a_2}	1.0	MΩ± 1%
R_{g_4}	47	kΩ± 5%

*All voltages are quoted with respect to the chassis. Provided the ratios of the supply voltages are strictly maintained by using a suitably designed voltage divider consisting of 1% precision resistors, there is no need to stabilise the supply unit, voltage fluctuations of ±10% then being permissible.

Note—The operation of this tube can be influenced by external magnetic fields and for satisfactory operation the flux density of these fields should not exceed 2 gauss in any direction.

DECADE COUNTER TUBE

Indirectly heated decade counter tube designed to operate at high counting speeds.

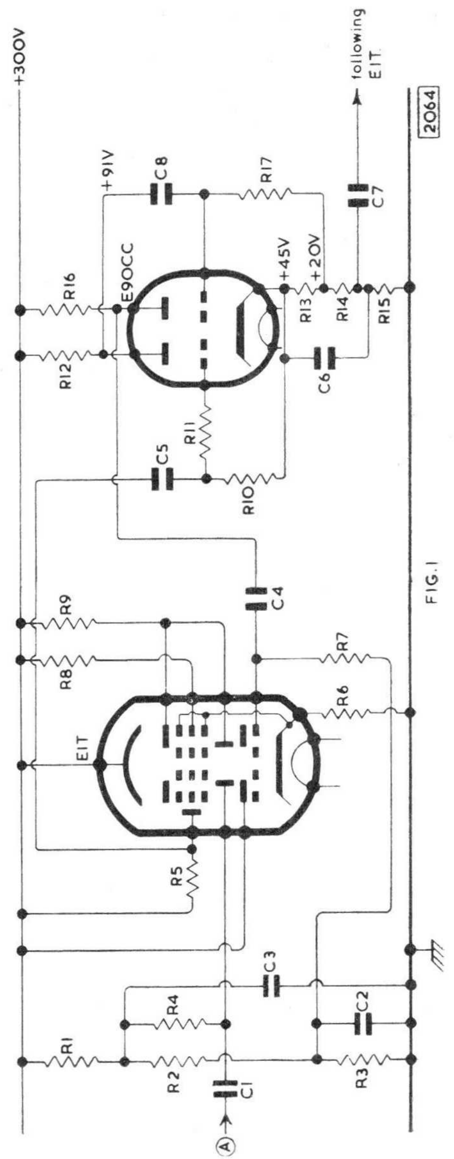
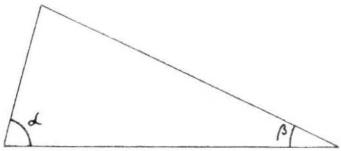


FIG. 1

Indirectly heated decade counter tube designed to operate at high counting speeds.

ADDITIONAL NOTES

In order to move the ribbon beam from any one position to the next a pulse of correct shape must be applied to the left hand deflection plate A as shown in Fig. 1.



$\tan\alpha > 20 \times 10^6$ V/sec
$\tan\beta < 1{\cdot}2 \times 10^6$ V/sec

Fig. 2

The required pulse is shown in Fig. 2. The slope of the leading edge should be at least 20×10^6 volts/sec, that of the trailing edge should not exceed 1.2×10^6 volts/sec. The amplitude of the pulse should have an average value of 13.6 volts and must lie between 11.5 volts and 15.5 volts.

When the beam is moved on from the 9th position it will strike the reset anode a_1. The negative pulse thus produced must be employed to generate two signals, one to reset the beam to its zero position and another to act as a counting pulse for the 2nd E1T in the counting chain.

The reset pulse is negative going and is applied to the E1T control grid so that the tube is temporarily cut off. The necessary reset time is a function of the circuit used and imposes the limit on maximum counting speed. However, if the reset pulse is too short the beam may return to an intermediate position instead of to the zero position. Referring again to the circuit of Fig. 1 the reset pulse should have an average duration of 27.2μsec with minimum and maximum limits of 23μsec and 32μsec respectively. It is essential for operation at maximum counting speed that the stray capacitance associated with anode(a_2) be kept to a minimum. The minimum amplitude of the reset pulse must be 27 volts.

CIRCUIT COMPONENTS

R1	68 kΩ ± 1%	R10	560 kΩ ± 10%
R2	68 kΩ ± 1%	R11	5.6 kΩ ± 10%
R3	5.6kΩ ± 1%	R12	39 kΩ ± 2%
R4	15 kΩ ± 2%	R13	4.7 kΩ ± 2%
R5	39 kΩ ± 10%	R14	2.7 kΩ ± 2%
R6	15 kΩ ± 1%	R15	1 kΩ ± 1%
R7	330 kΩ ± 10%	R16	3.3 kΩ ± 2%
R8	47 kΩ ± 5%	R17	150 kΩ ± 2%
R9	1 MΩ ± 1%		
C1	*	C5	220 pF ± 10%
C2	0.39 μF ± 20%	C6	68 pF ± 2%
C3	0.15 μF ± 20%	C7	680 pF ± 5%
C4	6800 pF ± 10%	C8	68 pF ± 2%

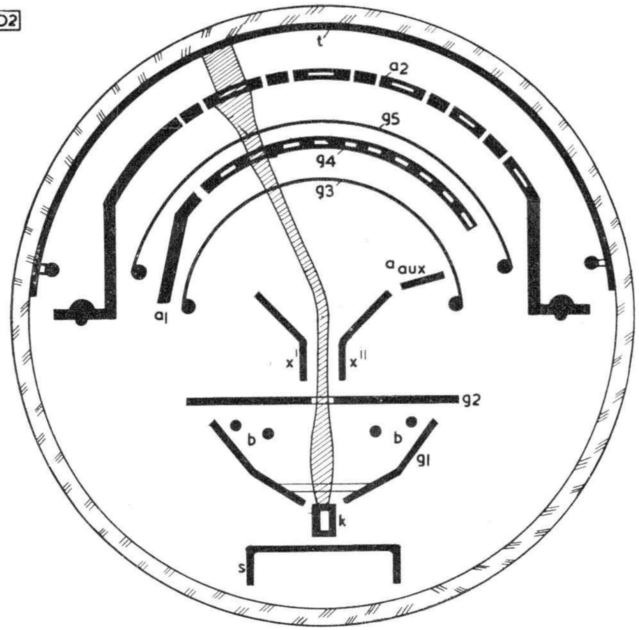
*To preceding E90CC input pulse shaper (C1 = 6800pF ± 10%) or preceding coupling stage pulse shaper (C1 = 680pF ± 5%).

E1T

DECADE COUNTER TUBE

Indirectly heated decade counter tube designed to operate at high counting speeds.

1402



CONSTRUCTIONAL DETAILS

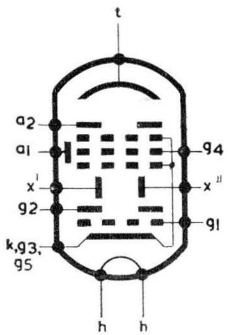
The following letter symbols refer to the cross-sectional diagram.

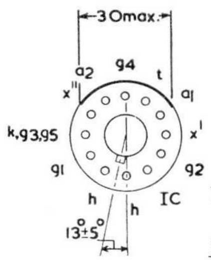
h	heater	a_{aux}	auxiliary anode
k	cathode	g_3, g_5	suppressor grids
s	screen	g_4	slotted electrode
g_1	control grid	a_1	reset anode
b	beam-forming electrodes	a_2	anode
g_2	accelerating electrode	t	conducting layer coated with fluorescent material
x′	left deflection electrode		
x″	right deflection electrode		

DECADE COUNTER TUBE

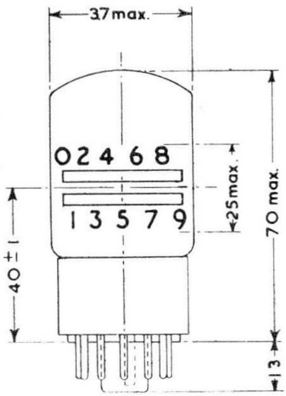
E1T

Indirectly heated decade counter tube designed to operate at high counting speeds.





B12A Base



All dimensions in mm.

DECADE COUNTER TUBE

Z303C

Cold cathode gas-filled bi-directional decade counter tube. This tube has ten main cathodes, nine of which are brought out together and one separately. It gives visual indication and operates at speeds up to 4kc/s.

This data should be read in conjunction with OPERATING NOTES – COUNTING AND SELECTOR TUBES preceding this section of the handbook.

CATHODES Cold

MOUNTING POSITION Any

For visual indication the tube is viewed through the dome of the envelope.

k_0 is aligned with pin 6 to within $\pm 12°$

CHARACTERISTICS

Maximum counting rate (sine or pulse drive)	4.0	kc/s
Minimum time difference between two successive input signals	250	μs
Maintaining voltage at $I_k = 300\mu A$	186 to 196	V
Minimum pulse required for forced resetting to k_0	120	V

RECOMMENDED OPERATING CONDITIONS

Supply voltage	475	V
Bias voltage on k_0	–12	V
Anode load	820	kΩ
Output cathode load	120	kΩ
Anode current	340	μA
Resultant output pulse	35	V
For double pulse drive		
Guide bias	+40	V
Pulse amplitude	100	V
Pulse width	75	μs
For integrated pulse drive		
Guide bias	+40	V
Pulse amplitude	See fig. 1	
Pulse width	75	μs
For sine wave drive		
Guide bias	+10	V
Sine wave drive voltage (r.m.s.)	40 to 70	V

LIMITING VALUES (absolute ratings)

*Minimum supply voltage	350	V
Maximum voltage between any two electrodes (except anode)	140	V
†Minimum positive guide bias for pulse drive and integrated pulse drive at 4kc/s	+35	V
Maximum k_0 negative bias	–20	V
Minimum guide pulse width	65	μs
Main and guide cathode current		
Maximum	550	μA
Minimum	250	μA

*This limit applies in light and darkness.

†At lower frequencies a lower value of positive bias can be used down to an absolute minimum of +18V.

Z303C

DECADE COUNTER TUBE

Cold cathode gas-filled bi-directional decade counter tube. This tube has ten main cathodes, nine of which are brought out together and one separately. It gives visual indication and operates at speeds up to 4kc/s.

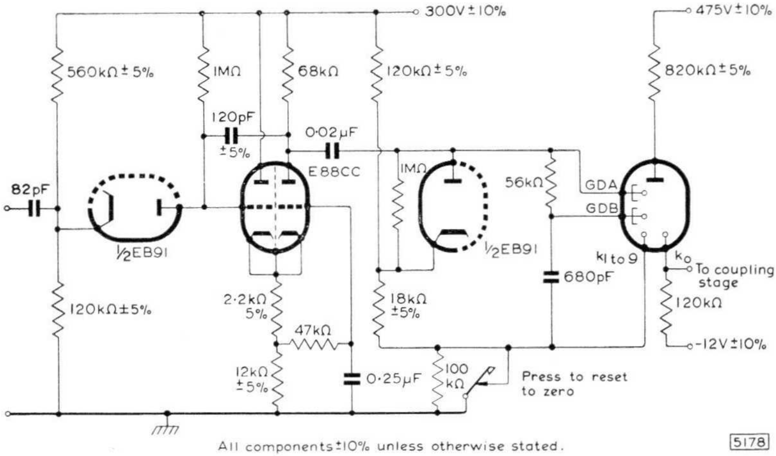


FIG. 1. INTEGRATED PULSE DRIVE CIRCUIT

Input pulse: Amplitude $\geqq$ 30V; Rise time $\frac{dV}{dt} \geqq 10^8$ v/s

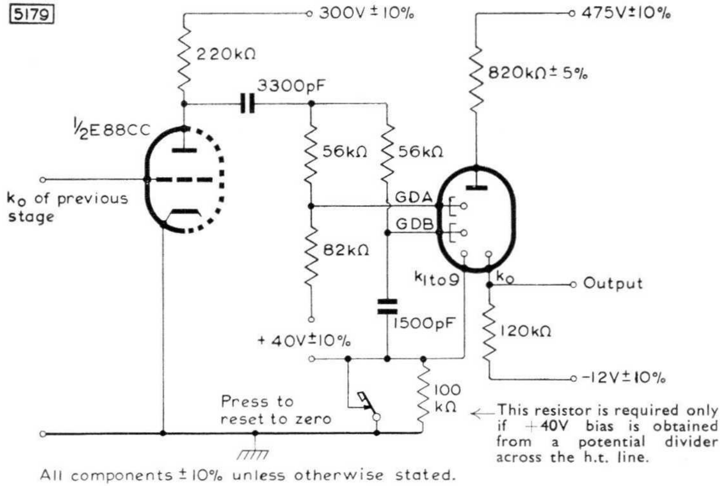


FIG. 2. INTEGRATED PULSE COUPLING CIRCUIT

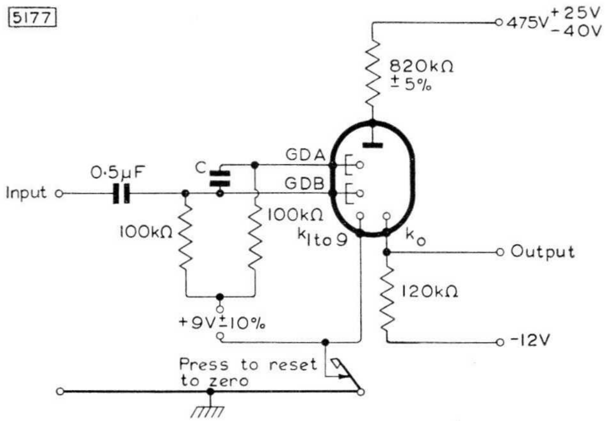
In the above circuits where E88CC is specified the ECC81 may also normally be used.

DECADE COUNTER TUBE

Z303C

Cold cathode gas-filled bi-directional decade counter tube. This tube has ten main cathodes, nine of which are brought out together and one separately. It gives visual indication and operates at speeds up to 4kc/s.

5177

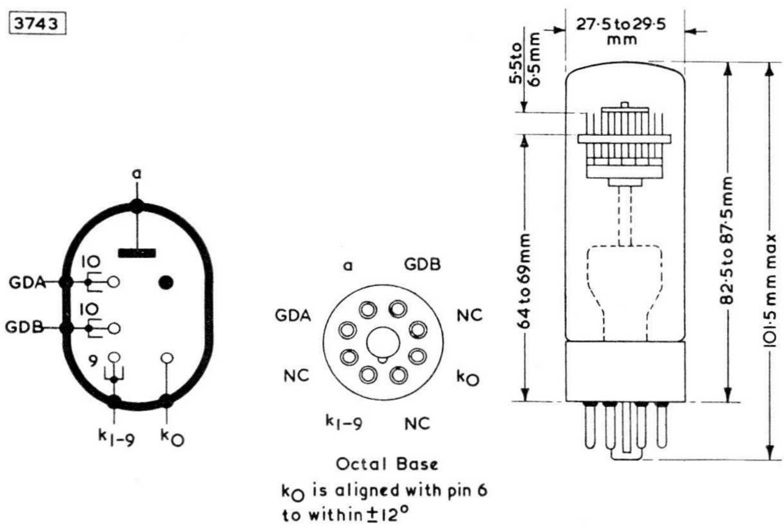


All components ±10% unless otherwise stated.

Frequency (c/s)	50	100	200	500	1000	2000	4000
Capacitor C (μF)	0·1	0·05	0·02	0·01	0·005	0·002	0·00068

FIG. 3. CIRCUIT FOR SINE WAVE DRIVE

3743



Octal Base

k_O is aligned with pin 6 to within ±12°

DECADE SELECTOR TUBE

Z502S

Cold cathode gas-filled bi-directional decade selector tube. This tube has ten main cathodes all of which are brought out separately. It gives visual indication and operates at speeds up to 4kc/s.

This data should be read in conjunction with OPERATING NOTES – COUNTING AND SELECTOR TUBES preceding this section of the handbook.

CATHODES Cold

MOUNTING POSITION Any

For visual indication the tube is viewed through the dome of the envelope.

k_1 is aligned with pin 11 to within $\pm 12°$

CHARACTERISTICS

Maximum counting rate (sine or pulse drive)	4.0	kc/s
Minimum time difference between two successive input signals	250	μs
Maintaining voltage at $I_k = 300\mu A$	186 to 196	V
Minimum pulse required for forced resetting to any main cathode	120	V

RECOMMENDED OPERATING CONDITIONS

Supply voltage	475	V
Bias voltage on output cathode	−12	V
Anode load	820	kΩ
Output cathode load	120	kΩ
Anode current	340	μA
Resultant output pulse	35	V
For double pulse drive		
Guide bias	+40	V
Pulse amplitude	100	V
Pulse width	75	μs
For integrated pulse drive		
Guide bias	+40	V
Pulse amplitude	See fig. 1	
Pulse width	75	μs
For sine wave drive		
Guide bias	+10	V
Sine wave drive voltage (r.m.s.)	40 to 70	V

LIMITING VALUES (absolute ratings)

*Minimum supply voltage	400	V
Maximum voltage between any two electrodes (except anode)	140	V
†Minimum positive guide bias for pulse drive and integrated pulse drive at 4kc/s	+35	V
Maximum negative bias to any main cathode	−20	V
Minimum guide pulse width	65	μs
Main and guide cathode current:		
Maximum	550	μA
Minimum	250	μA

*This limit applies in light and darkness.

†At lower frequencies a lower value of positive bias can be used down to an absolute value of 18V.

Z502S

DECADE SELECTOR TUBE

Cold cathode gas-filled bi-directional decade selector tube. This tube has ten main cathodes all of which are brought out separately. It gives visual indication and operates at speeds up to 4kc/s.

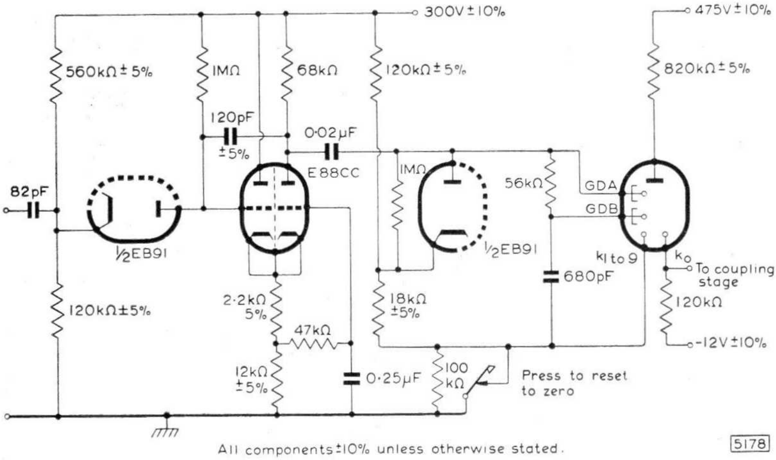


FIG. 1. INTEGRATED PULSE DRIVE CIRCUIT

Input pulse: Amplitude $\geqq$ 30V; Rise time $\frac{dV}{dt} \geqq 10^8$ v/s

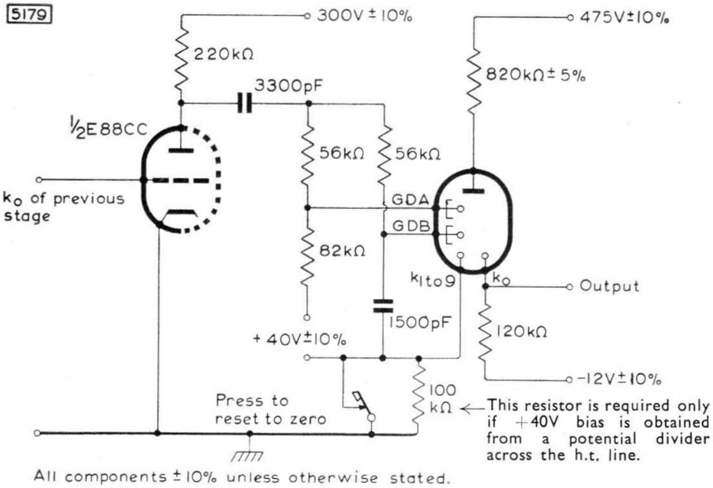


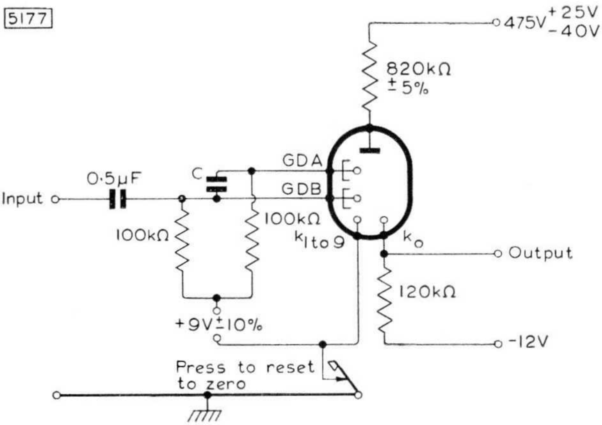
FIG. 2. INTEGRATED PULSE COUPLING CIRCUIT

In the above circuits where E88CC is specified the ECC81 may also be normally used.

DECADE SELECTOR TUBE

Z502S

Cold cathode gas-filled bi-directional decade selector tube. This tube has ten main cathodes all of which are brought out separately. It gives visual indication and operates at speeds up to 4kc/s.



All components ±10% unless otherwise stated.

Frequency (c/s)	50	100	200	500	1000	2000	4000
Capacitor C (μF)	0·1	0·05	0·02	0·01	0·005	0·002	0·00068

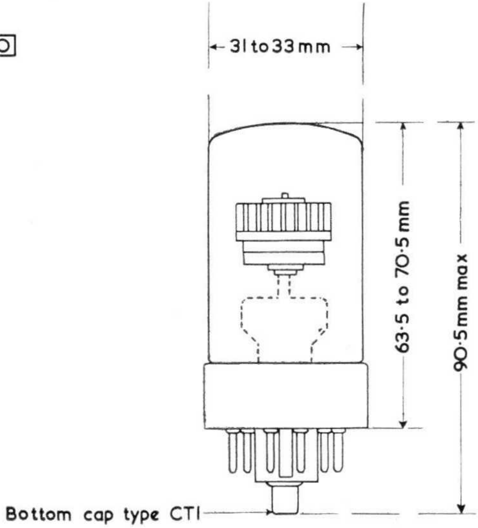
FIG. 3. CIRCUIT FOR SINE WAVE DRIVE

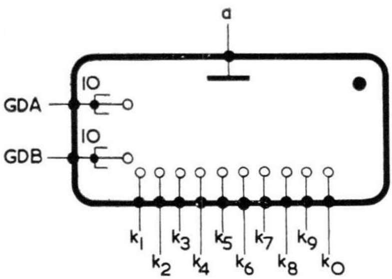
Z502S

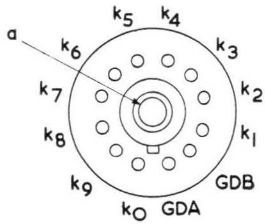
DECADE SELECTOR TUBE

Cold cathode gas-filled bi-directional decade selector tube. This tube has ten main cathodes all of which are brought out separately. It gives visual indication and operates at speeds up to 4kc/s.

3740







B12E Base

k_1 is aligned with pin 11 to within $\pm 12°$

SMALL THYRATRONS
AND TRIGGER TUBES

These general notes include definitions and general test procedures. They should be read in conjunction with the data sheets for Special Quality Thyratrons. Where reference should be made to a specific note, this is indicated on the data sheet by an index number, e.g. Group quality level.[9]

1. *Heater voltage.* Life and reliability of performance are a function of the value and degree of regulation of the heater voltage. In order to achieve the maximum useful life the heater should be maintained as close as possible to its rated value, and unless specific recommendations are made on individual data sheets, designers should aim to maintain the voltage at the valve pins within $\pm 5\%$ of the published nominal value.

2. *Capacitances.* Unless otherwise stated the capacitances quoted are measured with the valve cold in a fully screened socket. The measurements are made with or without an external shield, as stated on the individual data sheets.

3. *Limiting Values.* The limiting values given on the data sheets are absolute ratings. Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any valve of a specified type as defined by its published data, and should not be exceeded under the worst probable conditions.

   These values are chosen by the valve manufacturer to provide acceptable serviceability of the valve, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the valve under consideration and of all other electron devices in the equipment.

   The equipment manufacturer should design so that initially and throughout life no absolute maximum value for the intended service is exceeded with any valve under the worst probable operating conditions with respect to supply voltage variations, equipment component variation, equipment control adjustment, load variations, signal variation, environmental conditions, and variations in characteristics of the valve under consideration and of all other devices in the equipment.

   Heater to cathode voltage. In the interests of reliability the heater to cathode voltage should always be kept as low as possible, and it is preferable to have the cathode positive with respect to the heater.

   Bulb temperature. In the interests of reliability the bulb temperature should always be kept as low as possible.

4. *The A.Q.L.* (Acceptable quality level) is the limit below which the average percentage of defectives is controlled.

5. *Maximum and minimum values for the individuals* are the limits to which valves are tested.

6. *Maximum and minimum for lot average* are the limits between which the average value of the characteristic of a lot or batch is controlled.

7. *Lot standard deviation* is the standard deviation of a single lot or batch.

8. *Bogey value* is the target value.

9. *Group quality level.* This is the A.Q.L. over a whole group of tests. *Sub-group quality level.* The A.Q.L. over a number of tests, which do not constitute a complete group.

10. *Glass envelope strain test.*
    (*A*) This test is carried out on a sampling basis and consists of completely submerging the valves in boiling water at a temperature between 97 and 100°C for 15 seconds and then immediately plunging them in ice cold water for 5 seconds. The valves are then examined for glass cracks.
    (*B*) This test is carried out on a sampling basis and consists of completely submerging the valves in boiling water not less than 85°C for 15 seconds and then immediately plunging them in ice cold water not more than 5°C for 5 seconds. The valves are then examined for glass cracks.

11. *Base strain test.* This test is carried out on a sampling basis and consists of forcing the pins of the valves over specified cones and then completely submerging the valves and cones in boiling water at a temperature between 97 and 100°C for 10 seconds. The valves and cones are allowed to cool to room temperature before examining for glass cracks.

12. This test is carried out on a sampling basis under the conditions detailed in the data.

13. *Shock test.* This test is carried out on a sampling basis and subjects the valves to 5 blows of the specified acceleration in each of 4 directions.

14. *Inoperatives.* An inoperative is defined as a valve having an open or short circuited electrode, an air leak or a broken pin.

TRIODE THYRATRON

AN1

Triode inert-gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

This data sheet should be read in conjunction with "DEFINITIONS AND OPERATIONAL RECOMMENDATIONS—THYRATRONS", preceding this section of the Handbook.

LIMITING VALUES (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

Max. peak anode voltage		
Inverse	1.3	kV
Forward	650	V
Max. cathode current		
Peak	2.0	A
Average (max. averaging time 15 secs.)	300	mA
Surge (fault protection max. duration 0.1 secs.)	15	A
Max. negative control-grid voltage		
Before conduction	125	V
During conduction	10	V
Max. average positive control-grid current for anode voltage more positive than –10 V (averaging time 1 cycle)	20	mA
Max. peak positive control-grid current during the time that the anode voltage is more negative than –10 V	1.0	mA
Max. control-grid resistor	1.0	MΩ
Max. peak heater-cathode voltage		
Heater positive	25	V
Heater negative	100	V
Heater voltage limits	3.7 to 4.3	V
Min. valve heating time	30	s
Ambient temperature limits	–75 to +90	°C

AN1

TRIODE THYRATRON

Triode inert-gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

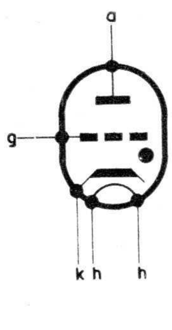
CHARACTERISTICS

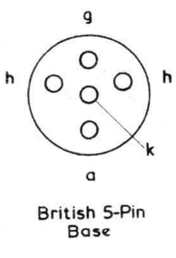
Electrical

Heater voltage	4.0	V
Heater current at 4.0 V		
Average	1.45	A
Maximum	1.6	A
Anode to control-grid capacitance	3.3	μμF
Control-grid to cathode capacitance	4.5	μμF
Deionisation time (approx.)	500	μs
Anode voltage drop (approx.)	9	V
Control ratio	28	

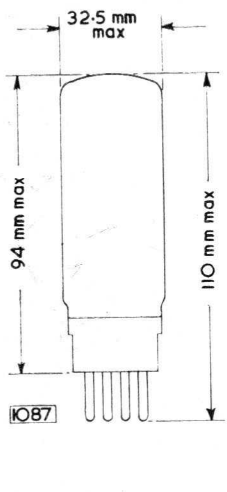
Mechanical

Type of cooling	Convection	
Mounting position	Any	
Max. net weight	1.4	oz
	40	g





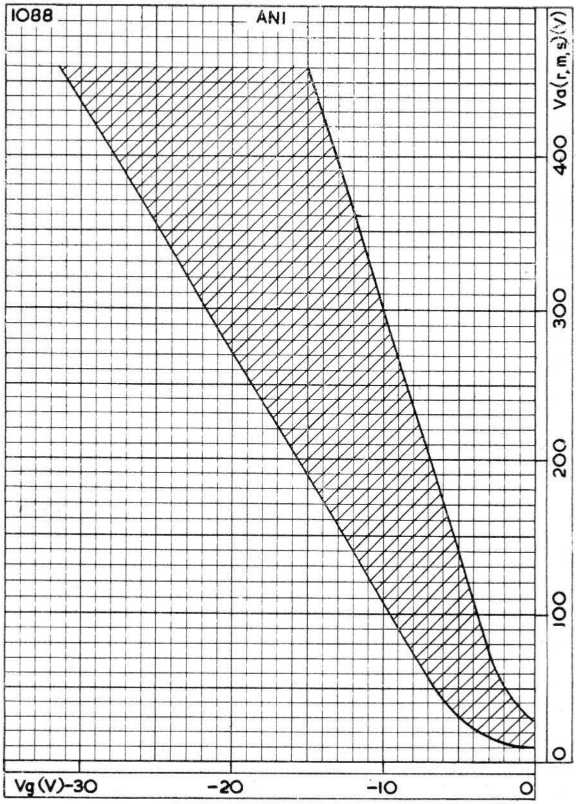
British 5-Pin Base



TRIODE THYRATRON

AN1

Triode inert-gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

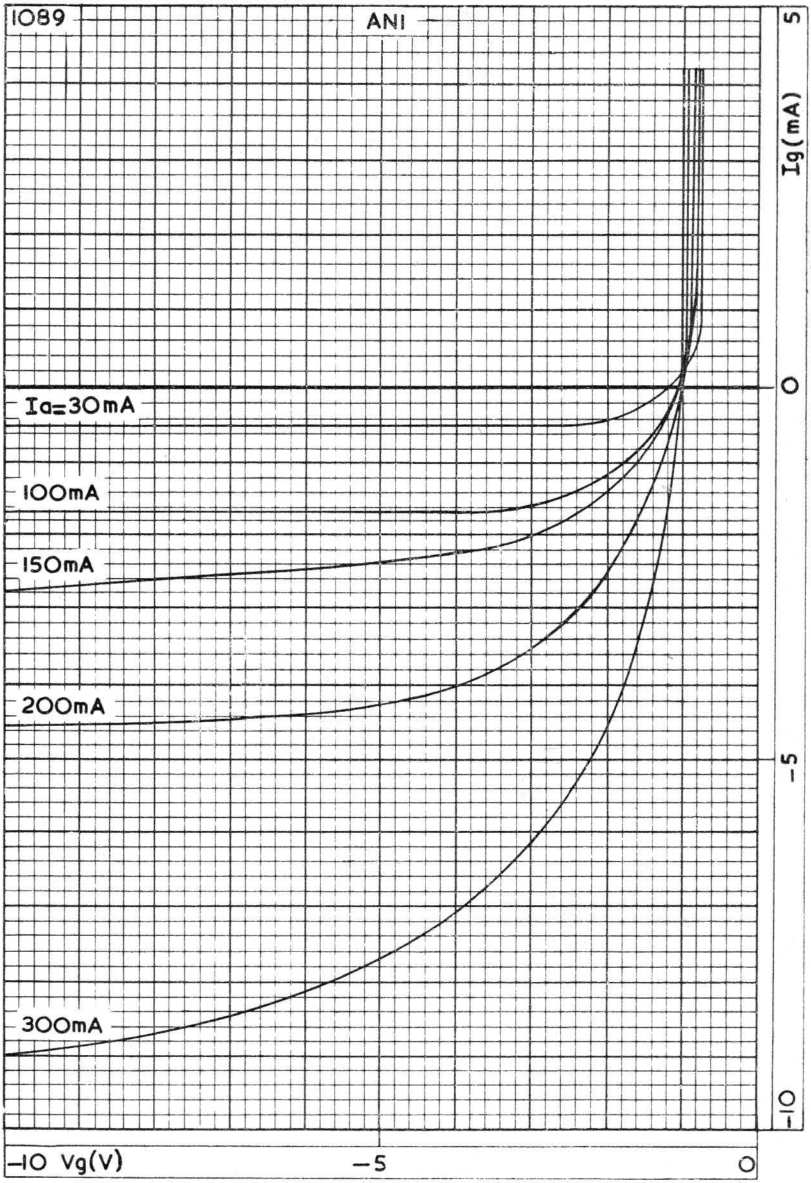


CONTROL CHARACTERISTIC

ANI

TRIODE THYRATRON

Triode inert-gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.



GRID ION CURRENT CHARACTERISTIC

GAS-FILLED TRIODE

EN31

Thyratron for use in h.f. time bases and control equipment.

HEATER

V_h	6.3	V
I_h	1.3	A

CAPACITANCES

c_{in}	6.1	pF
c_{out}	4.2	pF
c_{a-g}	2.3	pF
c_{g-h}	$<$1.5	pF

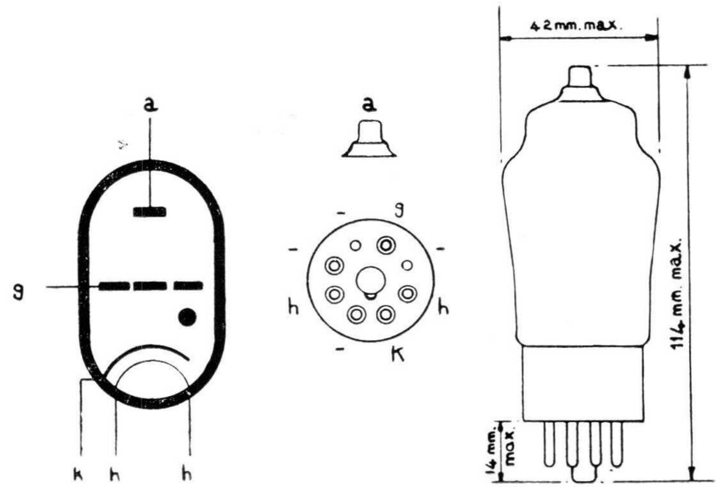
OPERATING CONDITIONS AS TRIODE

$v_{a-g\ (pk)}$ max.	1.5	kV
$v_{a\ (pk)}$ max.	1.0	kV
I_a max.	10	mA
$i_{a\ (pk)}$ max.	750	mA
R_{g-k} min.	750	Ω/V
R_{g-k} max.	750	kΩ
V_{h-k} max. (cathode positive)	100	V
V_{h-k} max. (cathode negative)	0	V
Valve voltage drop	33	V
Control ratio	35	
f max.	150	kc/s

OPERATING CONDITIONS AS HALF WAVE RECTIFIER

(Grid connected to cathode)

V_a max.	350	V
I_{out} max.	40	mA
R_{lim} min.	100	Ω
C max.	6	μF
V_{h-k} max.	100	V



a
g
k h h
a
g
h h
K
42 mm. max.
114 mm. max.
14 mm. max.

TETRODE THYRATRON

EN32

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

This data should be read in conjunction with DEFINITIONS AND GENERAL OPERATIONAL RECOMMENDATIONS—THYRATRONS, preceding this section of the handbook.

LIMITING VALUES (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

Max. peak anode voltage		
Inverse	1.3	kV
Forward	650	V
Max. cathode current		
Peak	2.0	A
Average (max. averaging time 15s)	300	mA
Surge (fault protection max. duration 0.1s)	10	A
Max. negative control-grid voltage		
Before conduction	250	V
During conduction	10	V
Max. average positive control-grid current for anode voltage more positive than −10V (averaging time 1 cycle)	20	mA
Max. control-grid resistance		
$I_a < 200mA$	10	MΩ
$I_a > 200mA$	2.0	MΩ
Max. negative shield-grid voltage		
Before conduction	100	V
During conduction	10	V
Max. average positive shield-grid current for anode voltage more positive than −10V (averaging time 1 cycle)	20	mA
Max. screen-grid resistor	1.0	MΩ
Max. peak heater-cathode voltage		
Cathode negative	25	V
Cathode positive	100	V
Min. valve heating time (for $i_{k(pk)}$ max = 2.0A)	20	s
Ambient temperature limits	-75 to +90	°C

Note—Where circuit conditions permit, the shield-grid should be connected directly to the cathode.

EN32

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current at 6.3V	950	mA
Capacitances		
Anode to grid	0.25	pF
Anode to cathode	0.06	pF
Grid to cathode	0.2	pF
Anode to shield-grid	3.0	pF
Control ratio		
g_2 to k and $R_{g1}=0\Omega$	275	
g_1 to k and $R_{g2}=0\Omega$	370	
Anode voltage drop	10	V
Recovery (deionisation) time		
$V_a=650V$, $i_{a(pk)}=2A$, $R_{g1}=100k\Omega$		
$V_{g1}=-100V$	240	μs
$V_{g1}=-50V$	1.0	ms

Mechanical

Type of cooling	Convection
Mounting position	Any

CONTROL CHARACTERISTIC (See page 5).

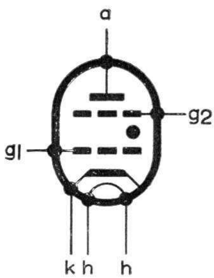
The curves given indicate the spread in characteristics due to:

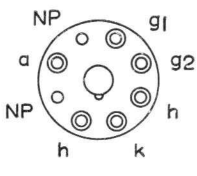
(a) Variations in characteristics due to changes in heater voltage.

(b) Variations in characteristics during life.

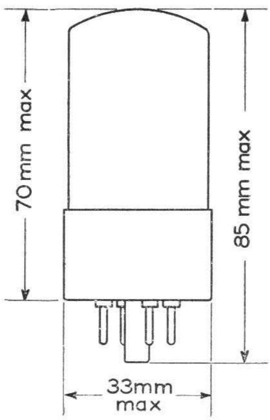
(c) Variation in grid resistor.

4718





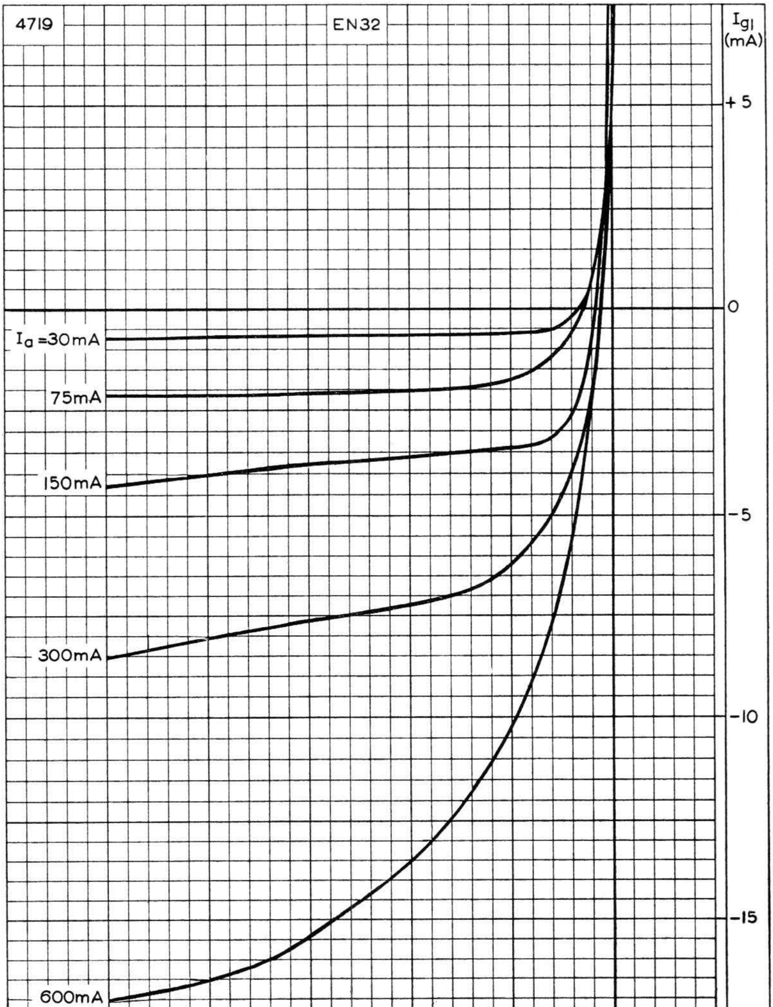
Octal Base



TETRODE THYRATRON

EN32

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

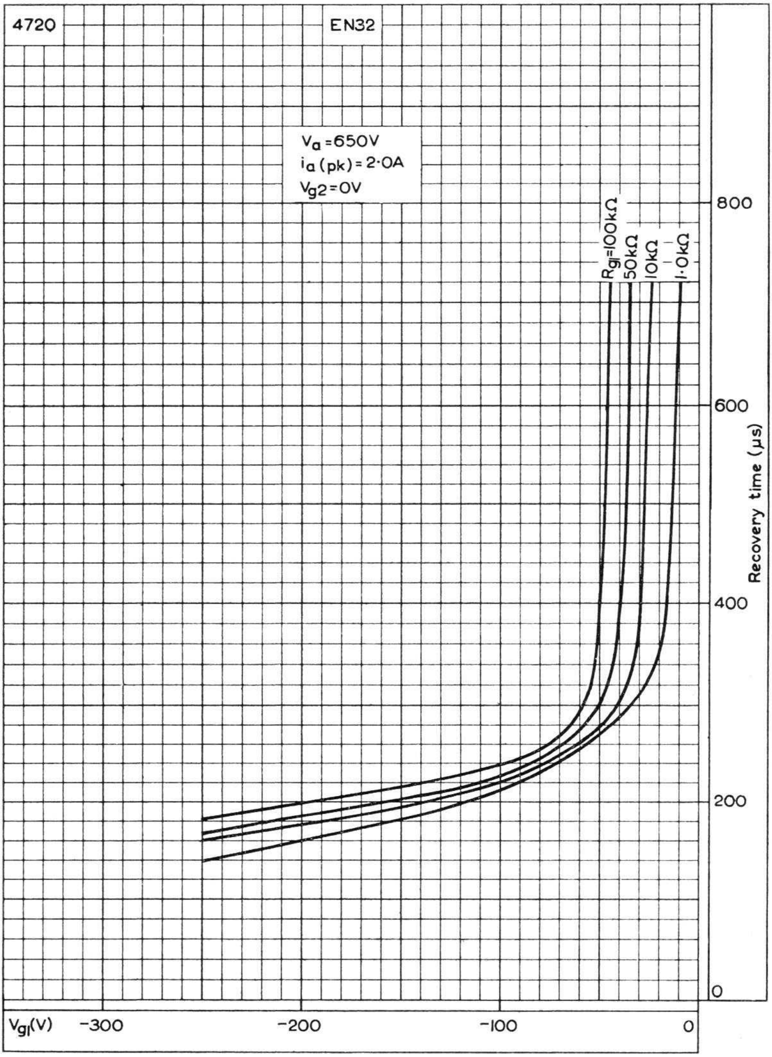


GRID ION CURRENT CHARACTERISTICS

EN32

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

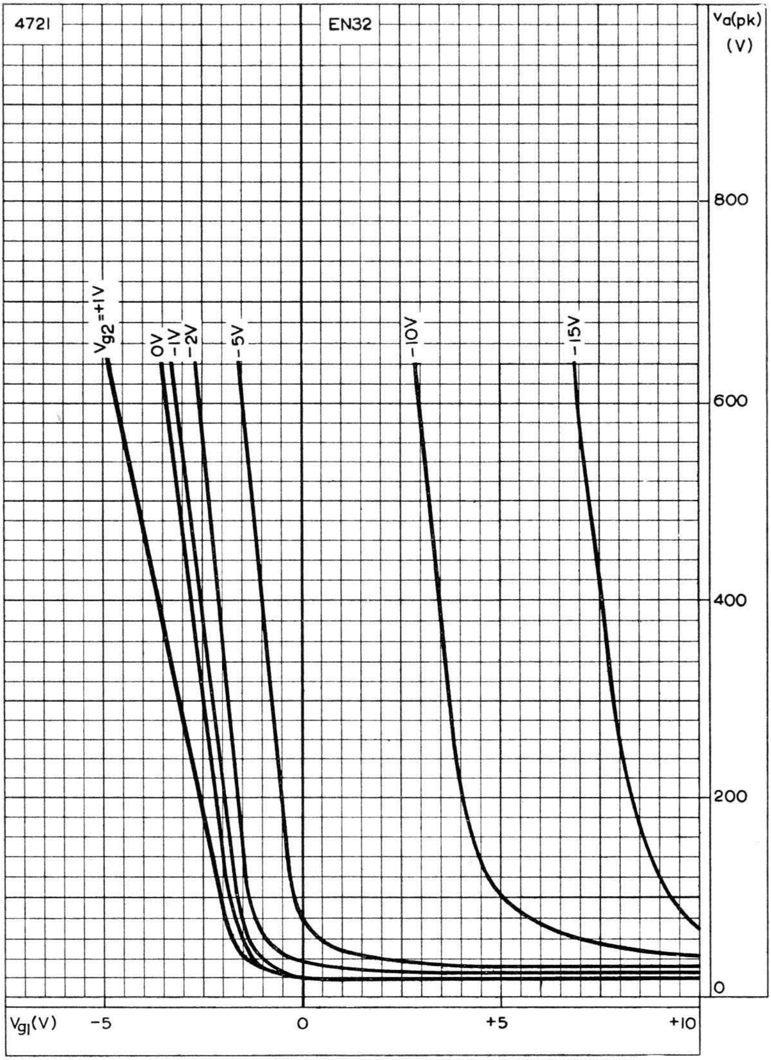


RECOVERY TIME PLOTTED AGAINST CONTROL-GRID VOLTAGE

TETRODE THYRATRON

EN32

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.

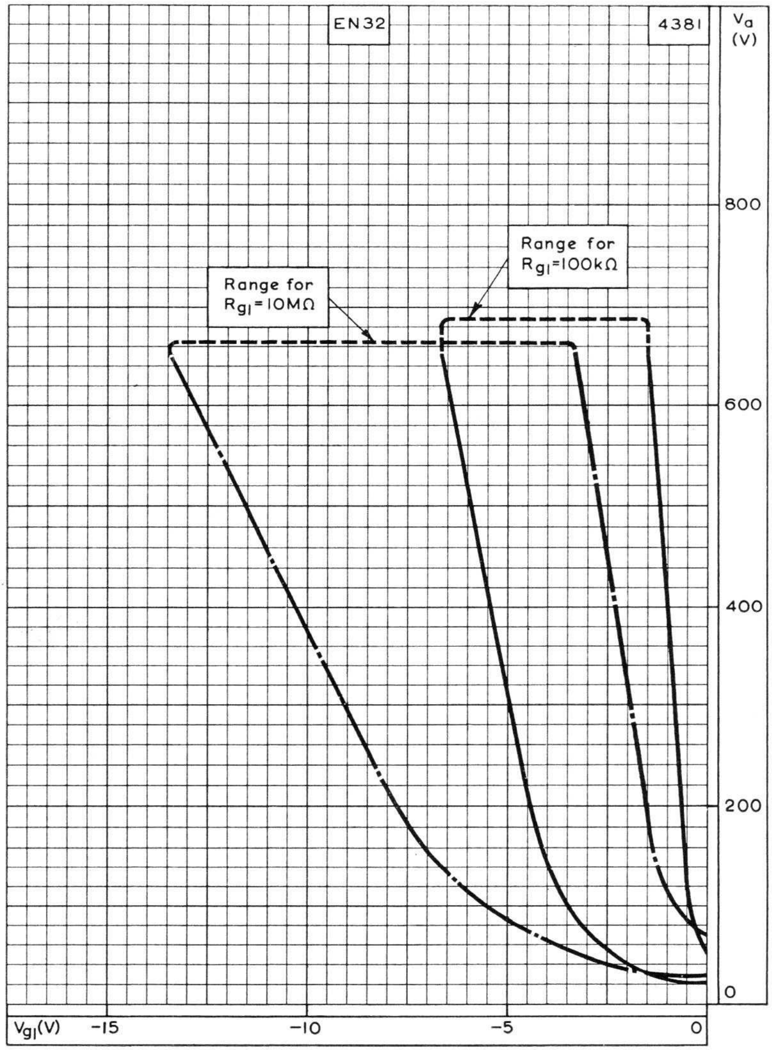


CONTROL CHARACTERISTIC (see page 2)

EN32

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for industrial control applications.



OPERATING RANGE OF CRITICAL GRID VOLTAGE

SUBMINIATURE TETRODE THYRATRON

EN70

Subminiature tetrode inert gas-filled thyratron with negative control characteristic.

LIMITING VALUES (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

Max. peak anode voltage		
Inverse	500	V
Forward	500	V
Max. cathode current		
Peak	100	mA
Average (max. averaging time 15s)	20	mA
Max. negative control-grid voltage		
Before conduction	200	V
During conduction	10	V
Max. average positive control-grid current for anode voltage more positive than −10V (averaging time 1 cycle)	700	μA
Max. peak positive control-grid current during the time that the anode voltage is more positive than −10V	2.0	mA
Max. peak positive control-grid current during the time that the anode voltage is more negative than −10V	30	μA
Max. control-grid resistor	10	MΩ
*(Recommended min. control-grid resistor 100kΩ)		
Max. negative shield-grid voltage		
Before conduction	100	V
During conduction	5.0	V
Max. average positive shield-grid current for anode voltage more positive than −10V (averaging time 1 cycle)	700	μA
**Max. shield-grid resistor	1.0	MΩ
Max. peak heater to cathode voltage		
Cathode negative	25	V
Cathode positive	100	V
Heater voltage limits	5.7 to 6.9	V
Min. valve heating time	10	s
Max. operating frequency	100	c/s
Ambient temperature limits	−55 to +70	°C

*It is not desirable that the control-grid should be positive when the anode is more negative than −10V, but where this condition is unavoidable the control-grid resistor may need to be greater than the recommended minimum value.

**Where circuit conditions permit, the shield-grid should be connected directly to the cathode.

EN70

SUBMINIATURE TETRODE THYRATRON

CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current at 6.3V		
Average	150	mA
Maximum	165	mA
Anode to control-grid capacitance	0.08	pF
Input capacitance	1.1	pF
Output capacitance	1.2	pF
Ionisation time (approx.)	0.5	μs
Anode voltage drop	11	V
Critical control-grid current at $V_a = 350V_{r.m.s.}$	0.2	μA

Mechanical

Type of cooling	Convection
Mounting position	Any

Note—Direct soldered connections to the leads of this valve must be at least 5mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

Max. net weight	0.1	oz
	3.0	g

TYPICAL OPERATING CONDITIONS

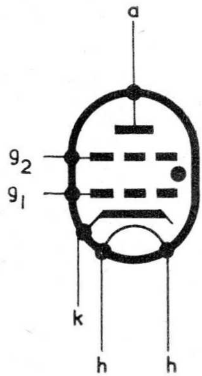
Heater voltage	6.3	V
R.M.S. anode voltage	150	V
Shield-grid voltage	0	V
R.M.S. control-grid voltage (180° out of phase with anode voltage)	5.0	V
*Peak control-grid signal voltage	5.0	V
Control-grid circuit resistance	1.0	MΩ
Anode circuit resistance	3.75	kΩ

*The frequency of the signal is high compared with 50c/s

SUBMINIATURE TETRODE THYRATRON

EN70

Subminiature tetrode inert gas-filled thyratron with negative control characteristic.



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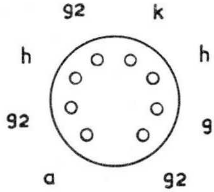
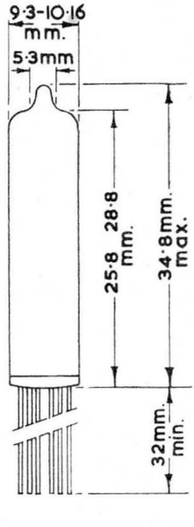


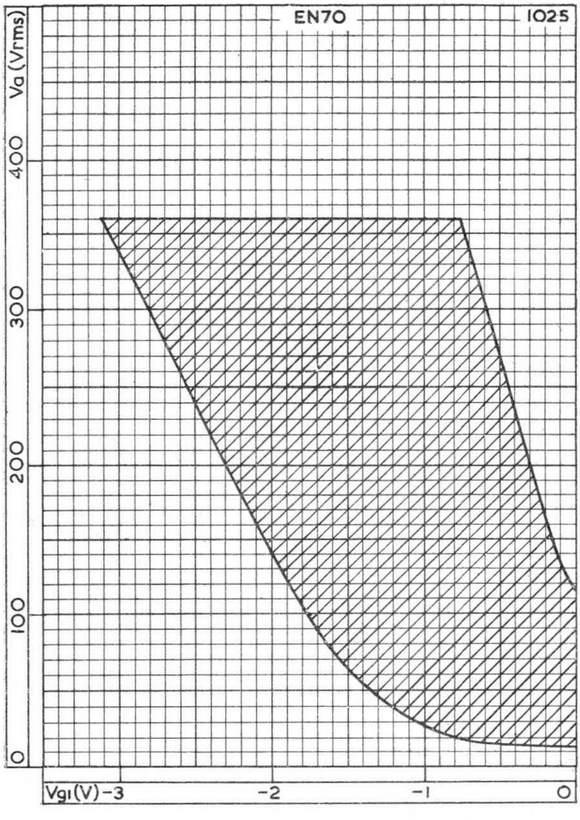
B8D BASE
(10mm. subminiature)



EN70

SUBMINIATURE TETRODE THYRATRON

Subminiature tetrode inert gas-filled thyratron with negative control characteristic.

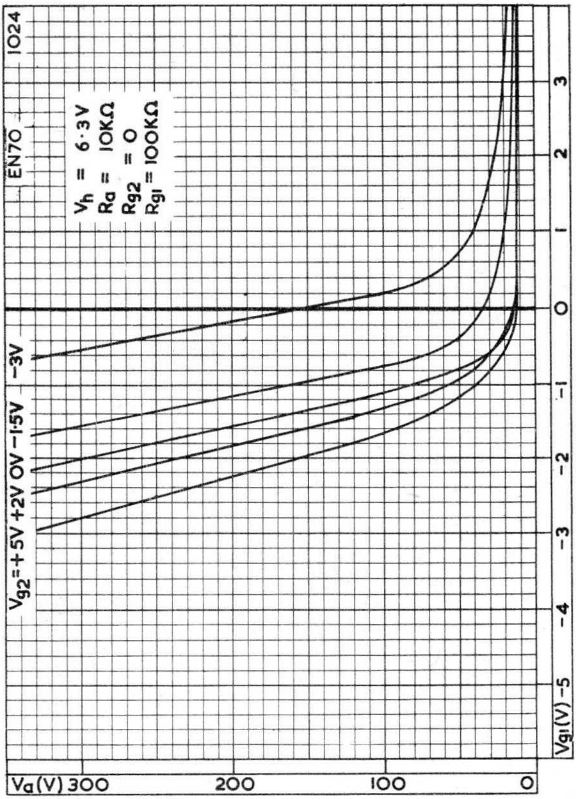


CONTROL CHARACTERISTIC

SUBMINIATURE TETRODE THYRATRON

EN70

Subminiature tetrode inert gas-filled thyratron with negative control characteristic.

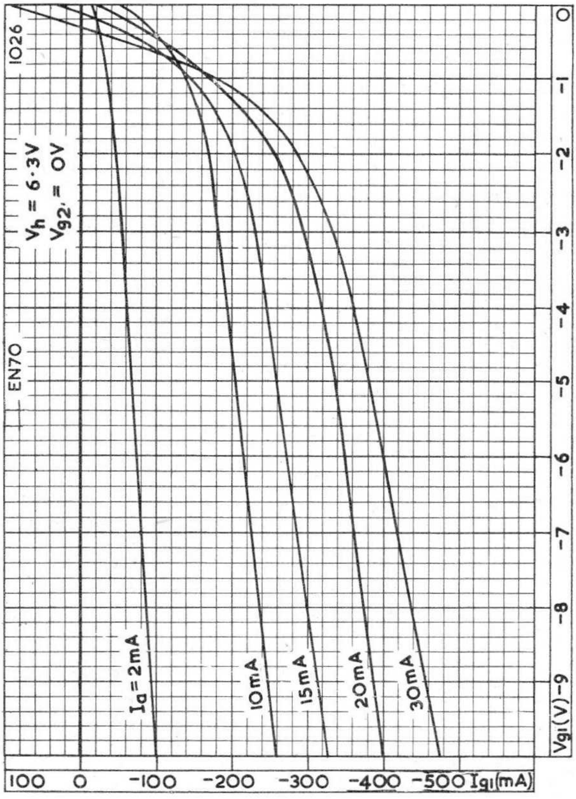


SPREAD OF CONTROL CHARACTERISTIC

EN70

SUBMINIATURE TETRODE THYRATRON

Subminiature tetrode inert gas-filled thyratron with negative control characteristic.



GRID ION CURRENT CHARACTERISTIC

TETRODE THYRATRON

EN91

(2D21)

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.

This data sheet should be read in conjunction with "DEFINITIONS AND OPERATIONAL RECOMMENDATIONS—THYRATRONS", preceding this section of the Handbook.

LIMITING VALUES (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

Max. peak anode voltage		
Inverse	1.3	kV
Forward	650	V
Max. cathode current		
Peak	500	mA
Average (Max. averaging time 30 secs.)	100	mA
Surge (Fault protection max. duration 0.1 secs.)	10	A
Max. negative control-grid voltage		
Before conduction	100	V
During conduction	10	V
Max. average positive control-grid current for anode voltage more positive than –10 V (averaging time 1 cycle)	10	mA
Max. peak positive control-grid current during the time that the anode voltage is more positive than –10 V	50	mA
*Max. peak positive control-grid current during the time that the anode voltage is more negative than –10 V	30	μA
Max. control-grid resistor	10	MΩ
*(Recommended min. control-grid resistor 0.1 MΩ)		
Max. negative shield-grid voltage		
Before conduction	100	V
During conduction	10	V
Max. average positive shield-grid current for anode voltage more positive than –10 V (averaging time 1 cycle)	10	mA
**Max. shield-grid resistor	1.0	MΩ
Max. peak heater-cathode voltage		
Heater positive	25	V
Heater negative	100	V
Heater voltage limits	5.7 to 6.9	V
Min. valve heating time	10	s
Max. operating frequency	500	c/s
Ambient temperature limits	–75 to +90	°C

*It is not desirable that the control-grid should be positive when the anode is more negative than –10 V, but where this condition is unavoidable the control-grid resistor may need to be greater than the recommended minimum value.

**Where circuit conditions permit, the shield-grid should be connected directly to the cathode.

EN91

(2D21)

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.

CHARACTERISTICS

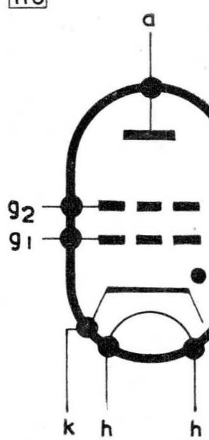
Electrical

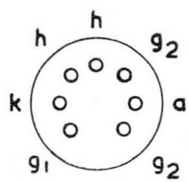
Heater voltage	6.3	V
Heater current at 6.3 V		
Average	0.60	A
Maximum	0.66	A
Anode to control-grid capacitance	0.03	$\mu\mu$F
Control-grid to cathode and shield-grid capacitance	2.5	$\mu\mu$F
Deionisation time (approx.)		
(a) $V_{g1}=-100$ V, $I_a=100$ mA	35	μs
(b) $V_{g1}=-10$ V, $I_a=100$ mA	75	μs
Ionisation time (approx.)	0.5	μs
Anode voltage drop	8	V
Critical grid current at $V_a=460$ V r.m.s.	0.5	μA

Mechanical

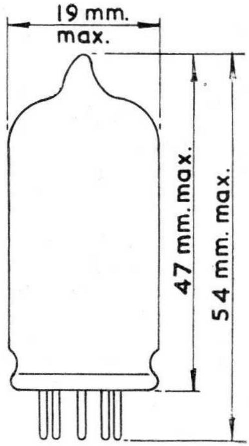
Type of cooling	Convection	
Mounting position	Any	
Max. net weight	0.5	oz.
	14	g

116





B7G BASE

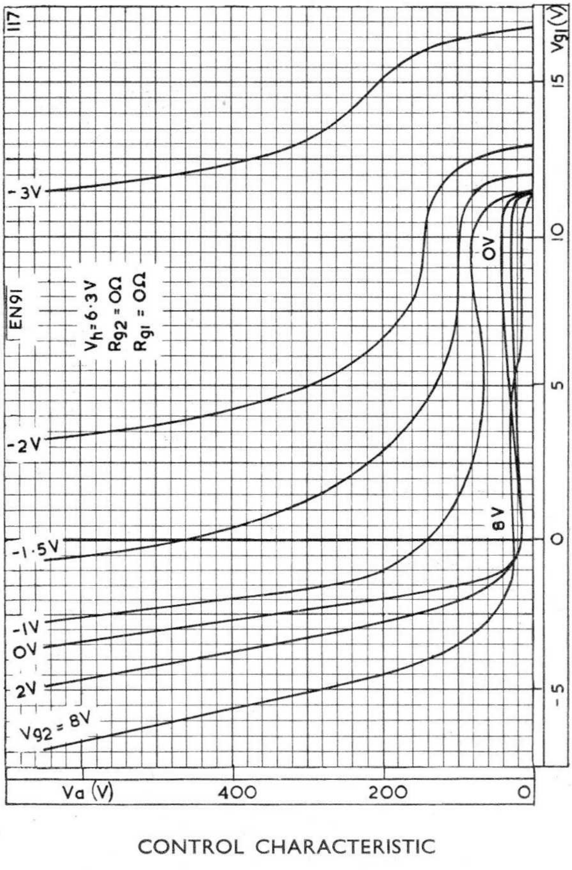


TETRODE THYRATRON

EN91

(2D21)

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.



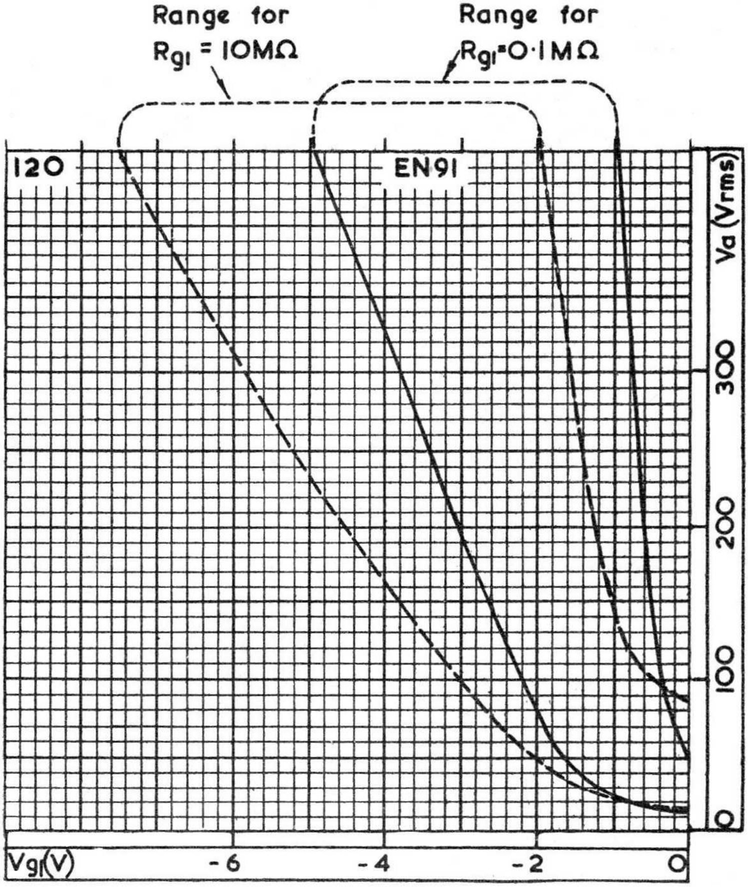
CONTROL CHARACTERISTIC

EN91

(2D21)

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.



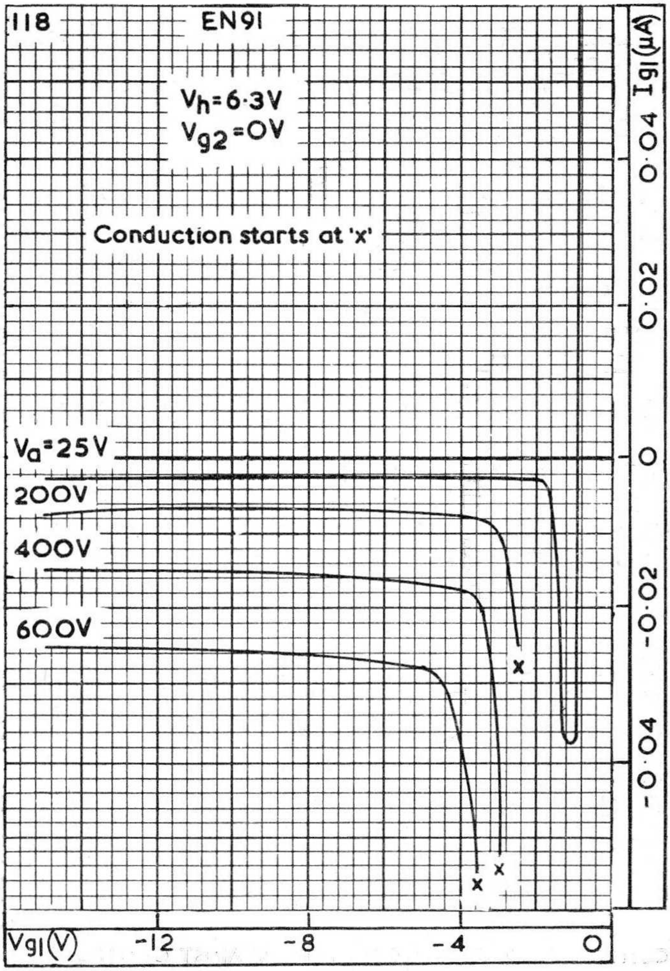
OPERATING RANGE OF CRITICAL GRID VOLTAGE

TETRODE THYRATRON

EN91

(2D21)

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.



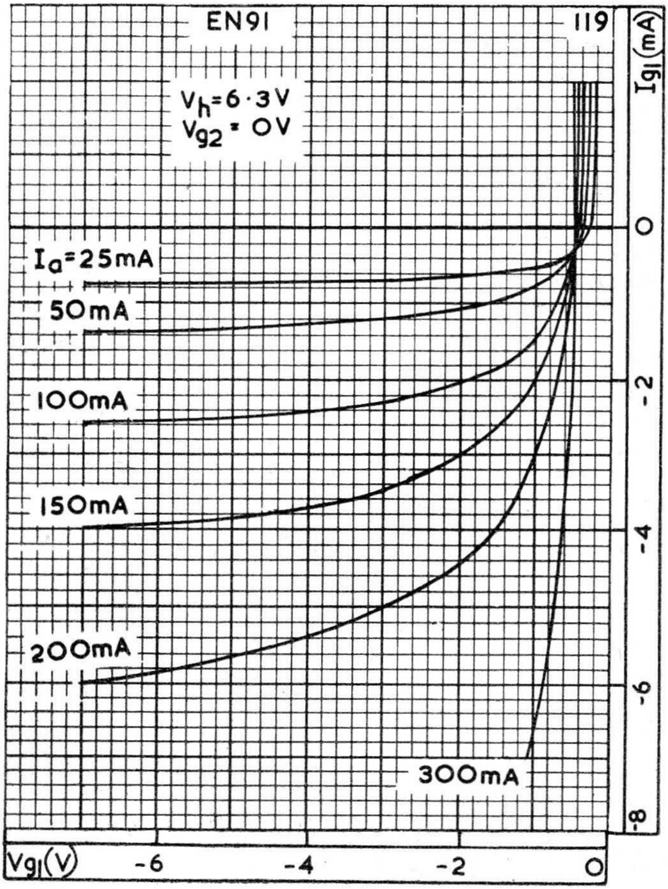
CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE BEFORE CONDUCTION

EN91

(2D21)

TETRODE THYRATRON

Tetrode inert gas-filled thyratron with negative control characteristic. Primarily designed for use in relay or grid-controlled rectifier circuits.



CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE DURING CONDUCTION

TETRODE THYRATRON

EN92

25mA tetrode inert gas-filled thyratron with negative control characteristic. Primarily intended for industrial control applications.

This data should be read in conjunction with DEFINITIONS AND GENERAL OPERATIONAL RECOMMENDATIONS—THYRATRONS which precede this section of the handbook.

PRELIMINARY DATA

LIMITING VALUES (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

Max. peak anode voltage		
Inverse	500	V
Forward	500	V
Max. cathode current		
Peak	100	mA
Average (max. averaging time = 30s)	25	mA
Surge (fault protection, max. duration = 0.1s)	2.0	A
Max. negative control-grid voltage		
Before conduction	100	V
During conduction	10	V
Max. positive control-grid current for anode voltage more positive than –10V		
Peak	25	mA
Average (averaging time 1 cycle)	5.0	mA
Max. peak positive control-grid current for anode voltage more negative than –10V	30	μA
Max. control-grid resistor		
Grid-controlled rectifier service	10	MΩ
Stand-by service	100	kΩ
~~Recommended minimum control-grid resistor~~	~~5~~	~~kΩ~~
Max. negative shield-grid voltage		
Before conduction	50	V
During conduction	10	V
Max. average positive screen-grid current for anode voltage more positive than –10V	5.0	mA
Max. peak heater-to-cathode voltage		
Cathode negative	25	V
Cathode positive	100	V
Min. valve heating time	10	s
Ambient temperature limits	–55 to +90	°C

Note: Where circuit conditions permit the shield-grid should be connected directly to the cathode.

EN92

TETRODE THYRATRON

CHARACTERISTICS

Electrical

Heater voltage	6.3	V
Heater current at 6.3V	150	mA
Capacitances		
c_{a-g1}	0.03	pF
c_{in}	2.0	pF
c_{out}	1.5	pF
Control ratio		
g_1 to k, with $R_{g2} = 0\Omega$	250	
g_2 to k, with $R_{g1} = 0\Omega$	15	
Anode voltage drop	10	V
Recovery (deionisation) time (20μs pulse) $V_a = 500V$, $i_{k(pk)} = 100mA$. $R_{g1} = 50k\Omega$ $V_{g1} = -50V$	40	μs
Critical grid current at $V_a = 350V$ r.m.s.	0.5	μA

Mechanical

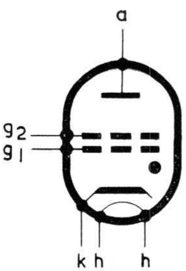
Type of cooling	Convection
Mounting position	Any

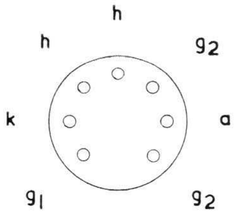
CONTROL CHARACTERISTIC (see page C4)

The curves given indicate the spread in characteristics due to:

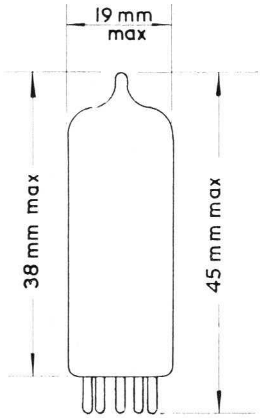
(a) Variations in characteristics due to changes in heater voltage.
(b) Variations in characteristics during life.
(c) Variation in grid resistor.

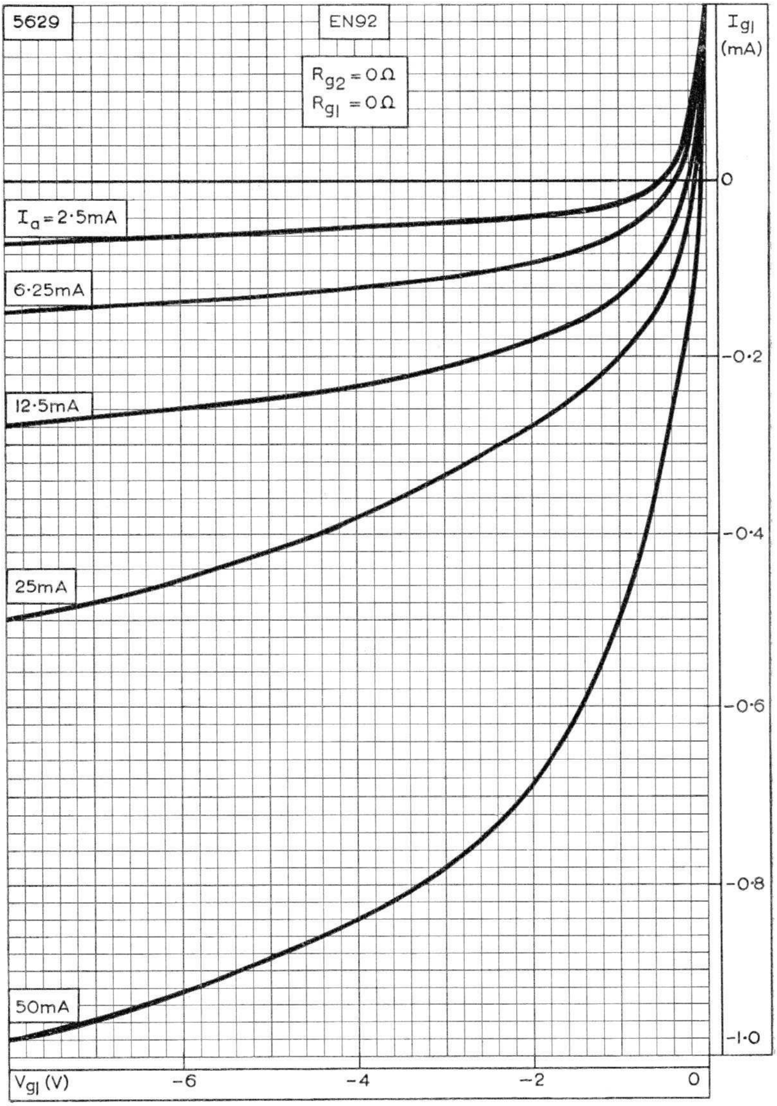
3539



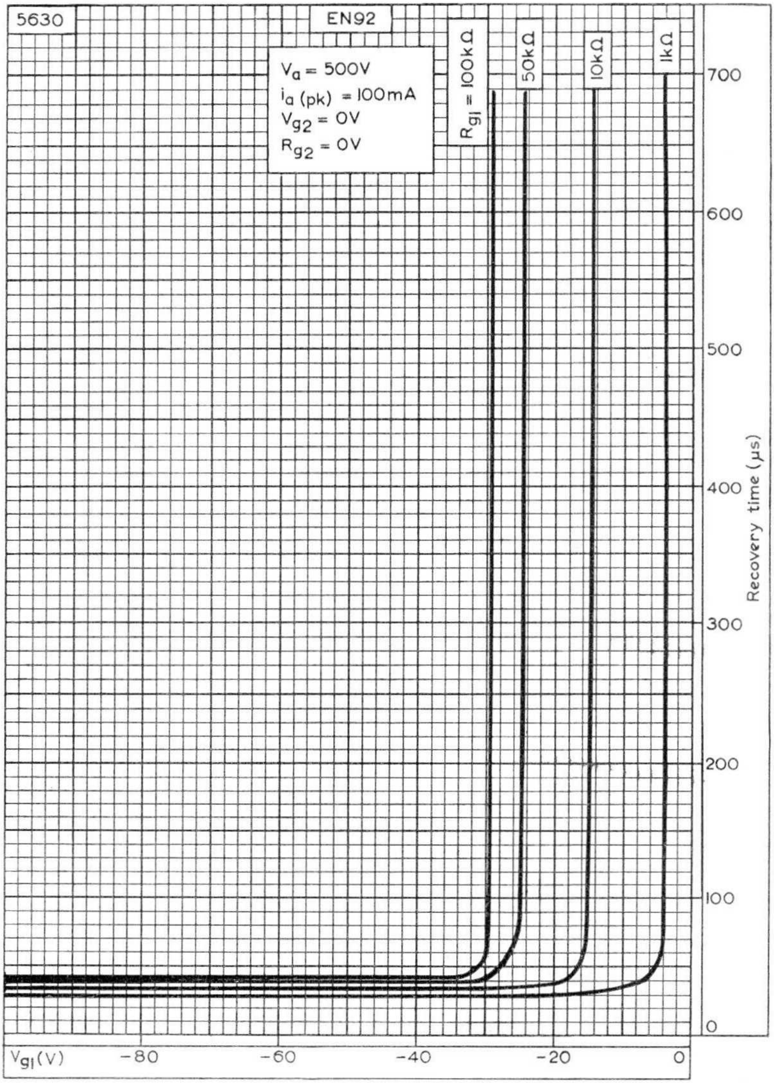


B7G Base

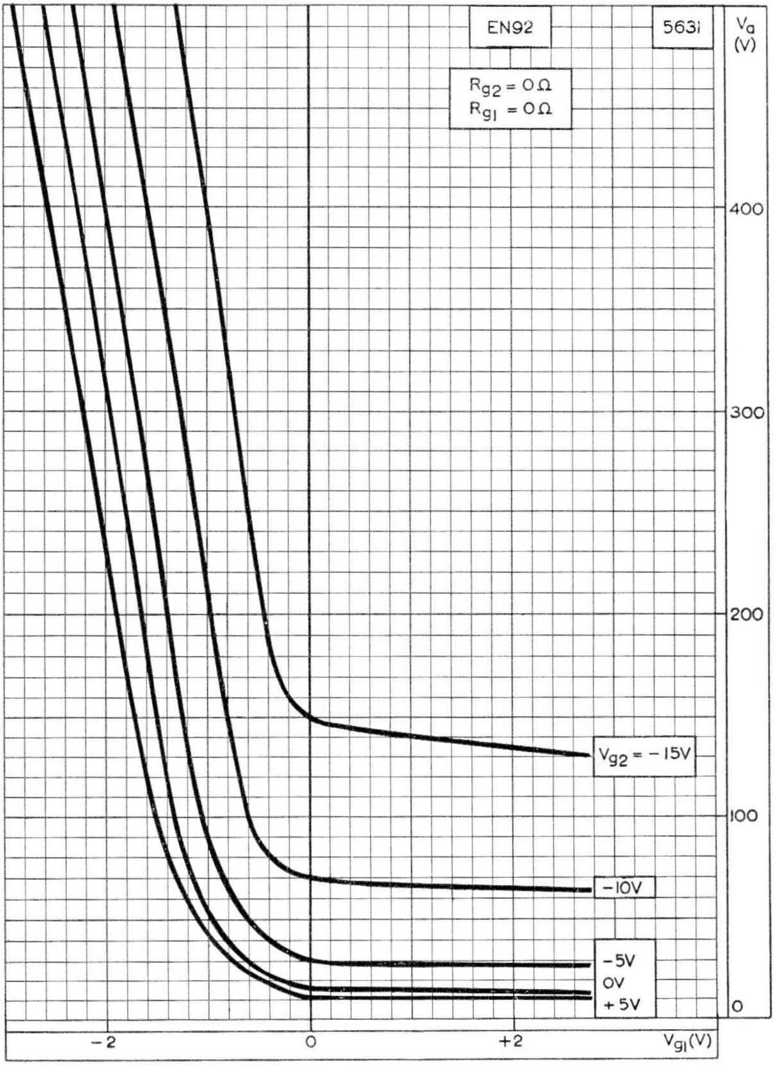




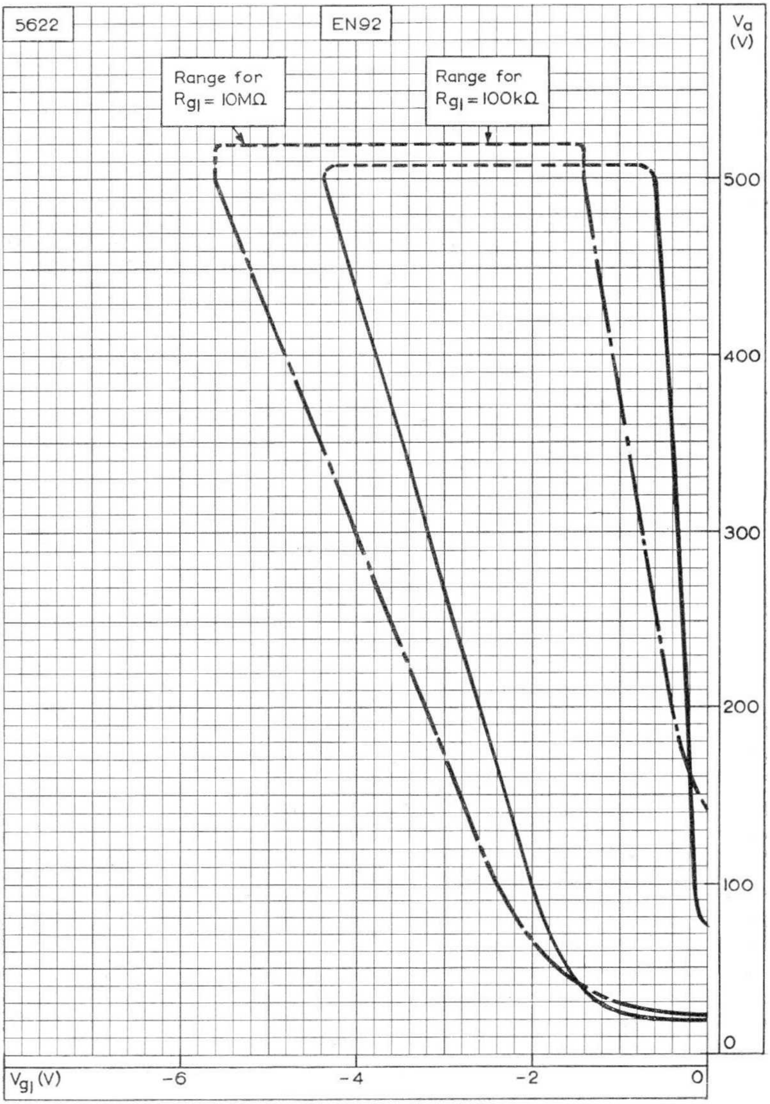
GRID ION CURRENT CHARACTERISTICS



RECOVERY TIME PLOTTED AGAINST CONTROL-GRID VOLTAGE



CONTROL CHARACTERISTICS



OPERATING RANGE OF CRITICAL GRID VOLTAGE

(See Page D2)

SPECIAL QUALITY TETRODE THYRATRON

M8204

100mA special quality tetrode xenon thyratron with negative control characteristic for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

PRELIMINARY DATA

This data should be read in conjunction with the GENERAL NOTES – SPECIAL QUALITY THYRATRONS preceding this section of the handbook, and the index numbers are used to indicate where reference should be made to a specific note.

LIMITING VALUES[3] (absolute ratings, not design centre)

It is important that these limits are never exceeded and such variations as mains fluctuations, component tolerances and switching surges must be taken into consideration in arriving at actual valve operating conditions.

	Relay service and grid-controlled rectifier	*Pulse modulator service*	
*Max. anode supply voltage	—	500	V
Max. peak anode voltage			
Inverse	1300	100	V
Forward	650	500	V
Max. cathode current			
Peak	0.5	10	A
Average (max. averaging time 30s)	100	10	mA
Surge (fault protection max. duration 0.1s)	10	10	A
Max. negative control-grid voltage			
Before conduction	100	100	V
During conduction	10	10	V
Max. average positive control-grid current for anode voltage more positive than −10V (averaging time 30s)	10	—	mA
Max. peak positive control-grid current during the time that the anode voltage is more positive than −10V	50	20	mA
Max. peak positive control-grid current during the time that the anode voltage is more negative than −10V	30	—	μA
Max. control-grid resistor	10	0.5	MΩ
Recommended min. control-grid resistor	100	—	kΩ
Max. negative shield-grid voltage			
Before conduction	100	50	V
During conduction	10	10	V

M8204

SPECIAL QUALITY TETRODE THYRATRON

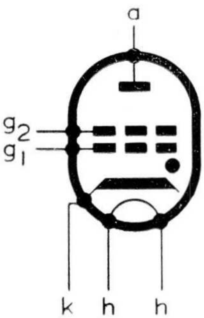
Max. average positive shield-grid current for anode voltage more positive than –10V (averaging time 30s)	10	—	mA
Max. shield-grid resistor	—	25	kΩ
Max. peak heater to cathode voltage			
Cathode negative	25	0	V
Cathode positive	100	0	V
Heater voltage	6.3V ±10%	6.3V $^{+10}_{-5}$%	
Min. valve heating time	20	20	s
Ambient temperature limits	–75 to +90	–75 to +90	°C
Max. pulse duration	—	5.0	µs
*Max. pulse repetition frequency	—	500	c/s
Max. duty cycle	—	0.001	
Max. rate of rise of current pulse	—	100	A/µs

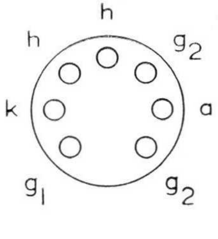
*After completion of a pulse a 20µs delay is required before a positive voltage of more than 10V is applied to the anode.

CAPACITANCES[2]

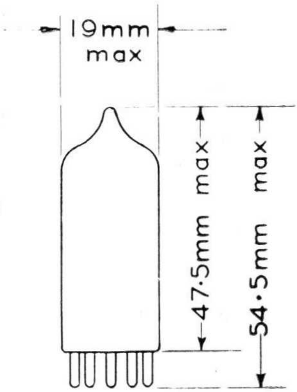
Anode to control-grid	—	0.03	pF
Control-grid to cathode and shield-grid	—	2.5	pF

4087





B7G Base



The bulb and base dimensions of this valve are in accordance with BS 448, Section B7G

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_{g2} (V)
6.3	0

TESTS
GROUP A

Test	A.Q.L.[4] (%)	Bogey[8]	individuals[5] Min.	individuals[5] Max.	Lot average[6] Min.	Lot average[6] Max.	
Heater current	0.65	600	540	660	—	—	mA
	—	—	—	—	567	633	mA
Heater to cathode leakage current							
V_{h-k} = 25V cathode negative	0.65	—	—	15	—	—	µA
V_{h-k} = 100V cathode positive	0.65	—	—	15	—	—	µA
*Grid 1 voltage V_a = 460V r.m.s., R_{g1} = 100kΩ, R_a = 3.0kΩ	0.65	−3.7	−2.9	−4.5	—	—	V
	—	—	—	—	−3.4	−4.0	V
*Grid 1 voltage V_a = 460V r.m.s., R_{g1} = 10MΩ, R_a = 3.0kΩ	0.65	−4.2	—	−5.6	—	—	V
*Anode voltage V_{g1} = 0V, R_{g1} = 100kΩ, R_a = 1.0kΩ	0.65	22	—	38	—	—	V
	—	—	—	—	—	33	V
Anode voltage V_h = 0V, V_{g1} = −100V, R_a = 1.0kΩ No breakdown must occur	0.65	—	650	—	—	—	V
Operation. $I_{load\ (pulse)}$	0.65	—	16	—	—	—	A

Measured at $V_{a(b)}$ = 500V, $v_{a(pk)}$ = 1.0kV,
$v_{g1(pk)}$ = 100V, V_{g1} = −50V, R_{g1} = 10kΩ,
R_{g2} = 25kΩ.
p.r.f. = 500pps, t_p = 2±0.2µs.
Modulator line impedance Z_o = 25Ω.
Load resistance = 20Ω, Min. P.I.V. = 100V.
Pulse rise time = 0.2µs max.
Pulse fall time = 0.4µs max.

	A.Q.L[4] (%)	Bogey[8]	Individuals[5] Min.	Individuals[5] Max.	Lot average[6] Min.	Lot average[6] Max.	
Pulse emission $V_h = 6.3V$, $V_a = V_{g2} = V_{g1} = 180 \pm 9V$, min. P.I.V. = 100V, $t_p = 5 \pm 0.25\mu s$, pulse rise time = $0.5\mu s$ max., pulse fall time = $1.0\mu s$ max., p.r.f. = 100 ± 5pps. Pulse applied across valve and 10Ω resistor in series. Voltage measured across valve	0.65	—	—	76	—	—	V
	—	—	—	—	—	65	V
Group quality level[9]	1.0	—	—	—	—	—	
*Adjust voltage to initiate conduction							
GROUP B							
Inoperatives[14]	0.4	—	—	—	—	—	
GROUP C							
Insulation g_2–a measured at $V_{a-g2} = \pm 380V$	2.5	—	760	—	—	—	MΩ
*Anode voltage. $V_h = 5.7V$, $V_{g1} = 0V$, $R_{g1} = 100k\Omega$, $R_a = 1.0k\Omega$	2.5	—	—	50	—	—	V
	—	—	—	—	—	45	V
*Grid 1 voltage. $V_h = 7.0V$, $V_a = 460V$ r.m.s., $R_{g1} = 10M\Omega$, $R_a = 3.0k\Omega$ (Following special pre-heat condition)	6.5	−4.6	—	−6.4	—	—	V
*Grid 2 voltage. $V_a = 150V$ r.m.s., $R_a = 1.0k\Omega$, $R_{g1} = 2.5k\Omega$ V_{g1} supply in phase with V_a supply, V_{g2} in antiphase: r.m.s. voltage	6.5	2.45	1.85	3.05	—	—	V
Vibration. No applied voltages. Vibrate for 60s at 25c/s 2.5g then repeat Group B test	6.5	—	—	—	—	—	

*Adjust voltage to initiate conduction

GROUP D

Shock[13]

No applied voltages, 750g.

Post shock tests

Heater to cathode leakage current							
$V_{h-k} = 25V$ cathode negative	—	—	—	40	—	—	μA
$V_{h-k} = 100V$ cathode positive	—	—	—	40	—	—	μA
Anode voltage as in Group A ($V_{g1} = 0V$)	—	—	—	50	—	—	V
Pulse emission as in Group A	—	—	—	76	—	—	V
Grid 1 voltage as in Group A ($R_{g1} = 100k\Omega$) ..	—	—	−2.9	−4.5	—	—	V
Sub-group quality level [9]	20						

Fatigue[14]

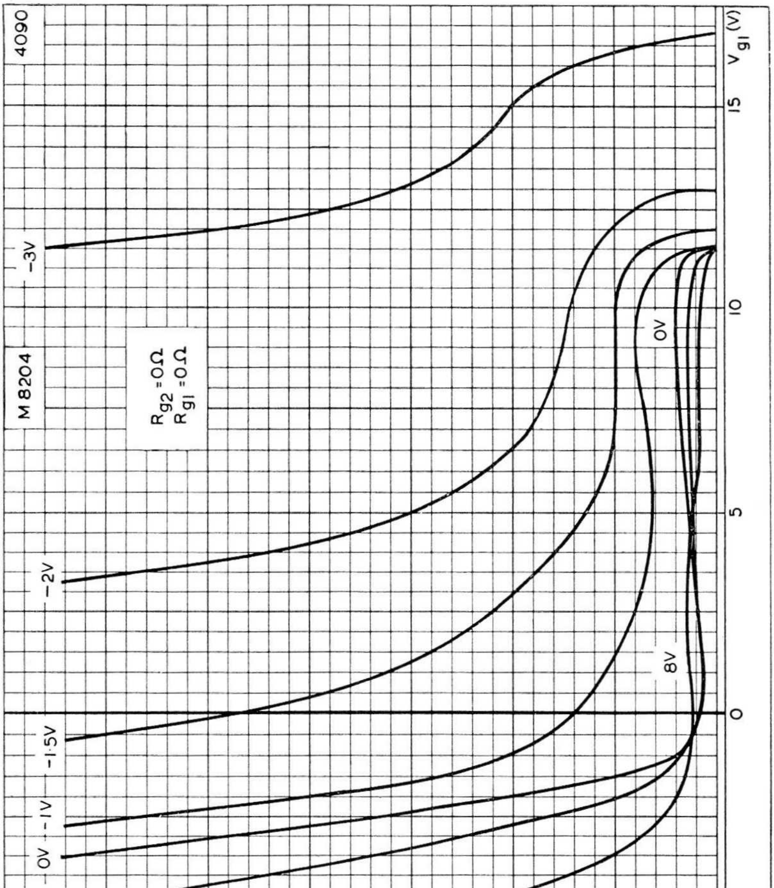
$V_h = 6.3V$, no other applied voltages, 2.5g acceleration, $f = 25 \pm 2c/s$ for 32 hours in each of three mutually perpendicular planes

Post fatigue tests

Heater to cathode leakage current							
$V_{h-k} = 25V$ cathode negative	—	—	—	40	—	—	μA
$V_{h-k} = 100V$ cathode positive	—	—	—	40	—	—	μA
Anode voltage as in Group A ($V_{g1} = 0V$)	—	—	—	50	—	—	V
Pulse emission as in Group A	—	—	—	76	—	—	V
Grid 1 voltage as in Group A ($R_{g1} = 100k\Omega$) ..	—	—	−2.9	−4.5	—	—	V
Sub-group quality level [9]	20	—	—	—	—	—	
Base strain test[11]	6.5	—	—	—	—	—	

GROUP E

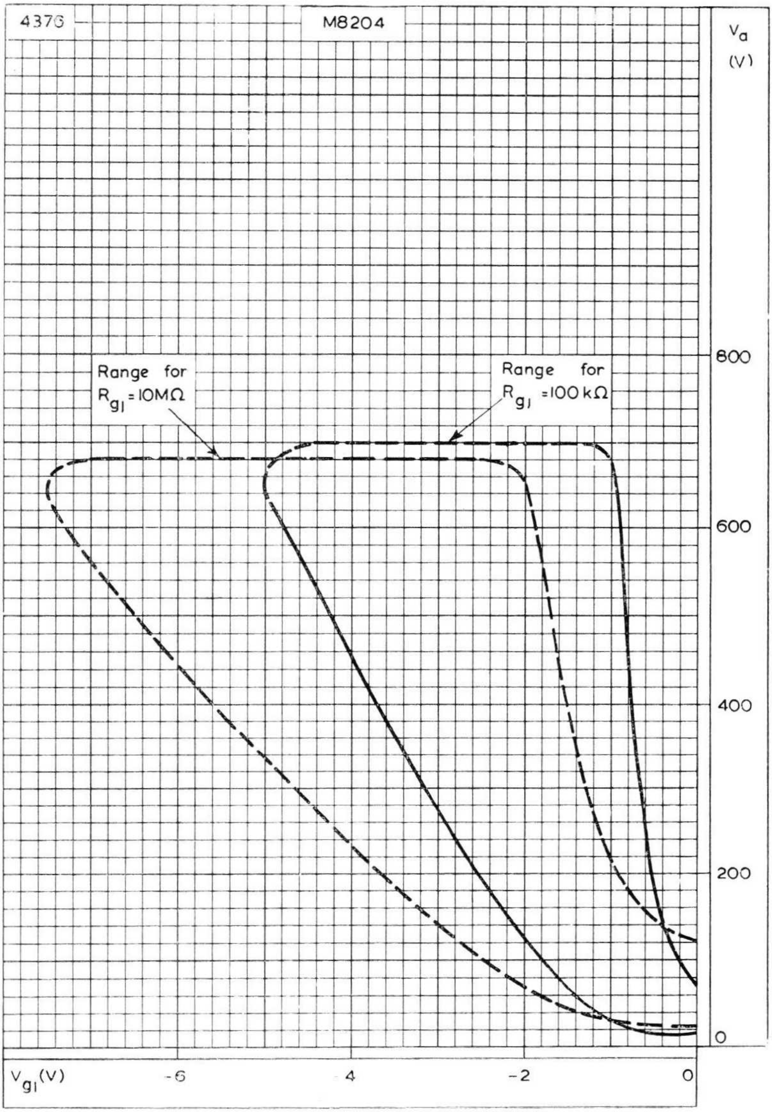
	A.Q.L.[4] (%)	Individuals[5] Min.	Individuals[5] Max.	
Heater cycling life test $V_h = 7.5V$, 1 minute on, 1 minute off, 2000 cycles. $V_{h-k} = 100V$ cathode positive. No other applied voltages	1.0	—	—	
Heater cycling life test end points				
Heater to cathode leakage current				
$V_{h-k} = 25V$ cathode negative	—	—	20	μA
$V_{h-k} = 100V$ cathode positive	—	—	20	μA
Intermittent life[12]				
Running conditions as grid controlled rectifier 500 hours $V_a = 460V$r.m.s., $I_k = 80mA$ (d.c.) $R_{g1} = 50k\Omega$, $i_{k(pk)} = 0.5A$, Cathode heating time $= 20^{+0}_{-1}s$ Room temperature				
Intermittent life test end points				
Inoperatives[14]				
Heater to cathode leakage current				
$V_{h-k} = 25V$ cathode negative	—	—	20	μA
$V_{h-k} = 100V$ cathode positive	—	—	20	μA
Anode voltage as in Group A ($V_{g1} = 0V$)	—	—	50	V
Pulse emission as in Group A	—	—	100	V
Insulation g_2–a as in Group C	—	380	—	MΩ
Continuous life, 200 hours' duration[12]				
Adjust $v_{a(pk)}$ for $I_{load\ pulse} = 20A$ initially				
Running conditions, pulse modulator service $V_{a(b)} = 250V$, $v_{a(pk)} = 500V$, $v_{g1(pk)} = 100V$, $V_{g1} = -50V$, $V_{g2} = 0V$, $R_{g1} = 10k\Omega$, $R_{g2} = 25k\Omega$, p.r.f. = 1000pps., modulator line impedance $Z_o = 12.5\Omega$, load resistance $= 7.5\Omega$. $t_p = 2 \pm 0.2\mu s$				
Life test end points				
$I_{load\ pulse}$	—	16	—	A
Average life	—	180	—	hrs
Pulse emission as in Group A	—	—	100	V



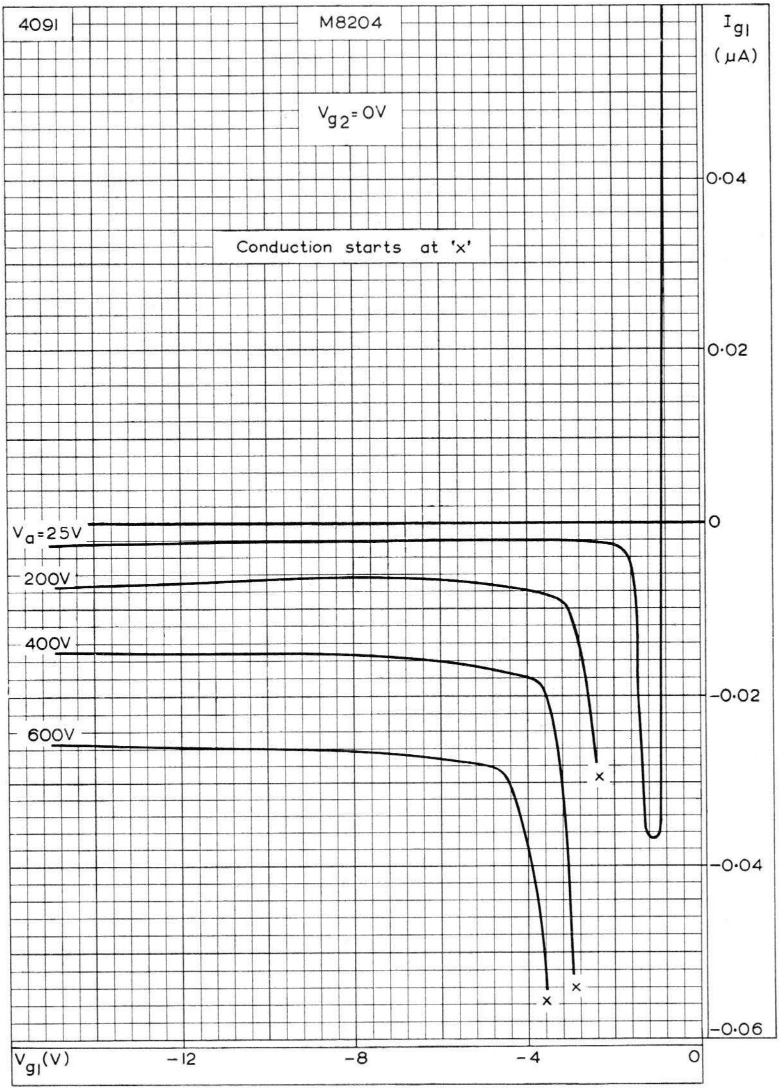
CONTROL CHARACTERISTIC

M8204

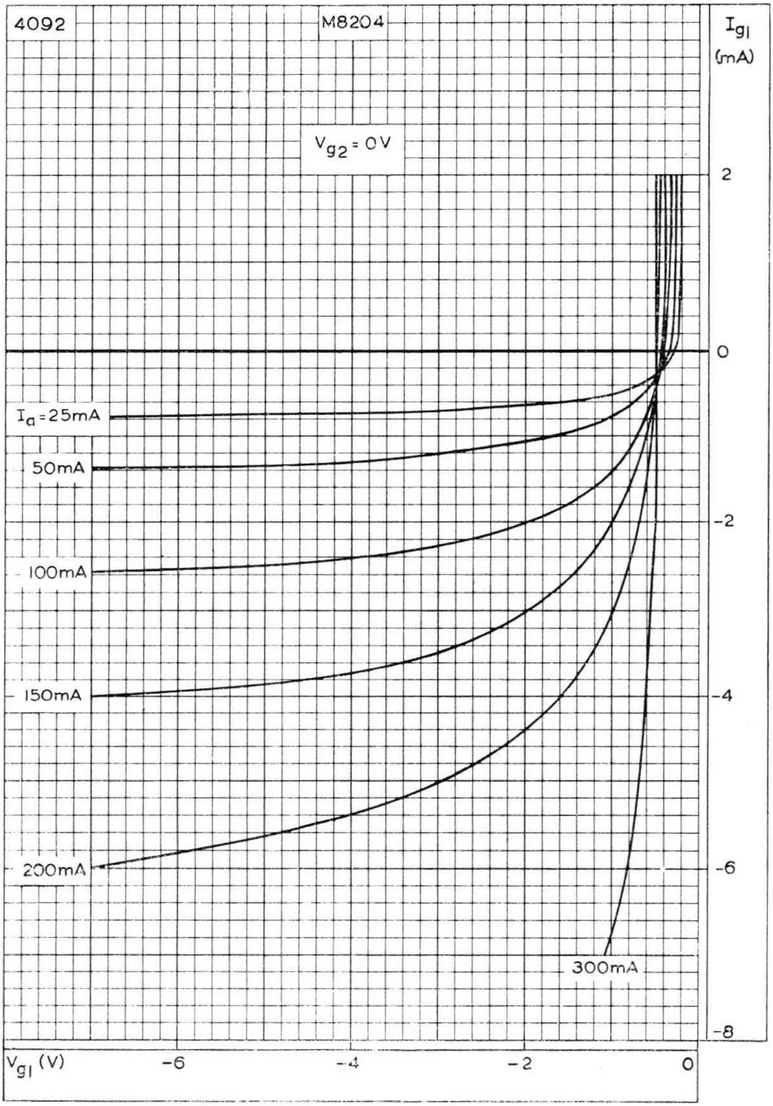
SPECIAL QUALITY TETRODE THYRATRON



OPERATING RANGE OF CRITICAL CONTROL-GRID VOLTAGE



CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE BEFORE CONDUCTION



CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE DURING CONDUCTION

COLD CATHODE GAS-FILLED TRIODE

Z300T

(1267)

Cold cathode inert gas-filled triode designed for use as a general purpose trigger tube.

CATHODE

Cold

CHARACTERISTICS

Typical anode to cathode breakdown voltage with trigger connected to cathode	255	V
Typical anode to cathode burning voltage (at 25mA)	70	V
Typical trigger to cathode breakdown voltage	85	V
Typical trigger to cathode burning voltage	60	V

LIMITING VALUES (Absolute Ratings)

With anode and trigger both positive

Maximum anode voltage at which self ignition will not occur in any tube. (trigger voltage=0V)	225	V
Minimum anode voltage necessary for self ignition of all tubes. (trigger voltage=0V)	310	V
Minimum trigger voltage necessary to cause trigger breakdown in all tubes	90	V
Maximum trigger voltage at which trigger breakdown will not occur in any tube	70	V
Minimum trigger to cathode current necessary to cause transfer in all tubes (V_a=140V)	100	μA
Maximum permissible cathode current		
Peak	100	mA
Average (max. averaging time 15 secs)	25	mA

OPERATING NOTES

(a) It is recommended that strong light such as direct sunlight should not be allowed to fall on the tube when it is operating.

(b) The typical breakdown characteristic shows the potentials at which breakdown will occur between different electrodes of a typical tube. If the tube is to remain unstruck, the applied voltages must be represented by a point inside the characteristic. Any excursion of the working point into the region outside the characteristic will result in ignition.

(c) This tube is recommended for operation only in quadrant I of the breakdown characteristic, i.e. with anode and trigger both positive. The limits within which all tubes fall in the first quadrant are shown under "Limiting Values".

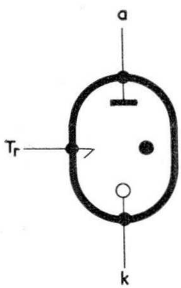
Z300T

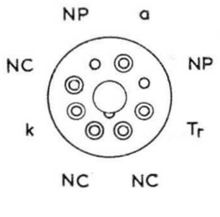
(1267)

COLD CATHODE GAS-FILLED TRIODE

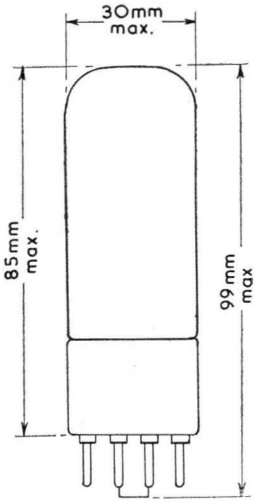
Cold cathode inert gas-filled triode designed for use as a general purpose trigger tube.

1612





Octal Base

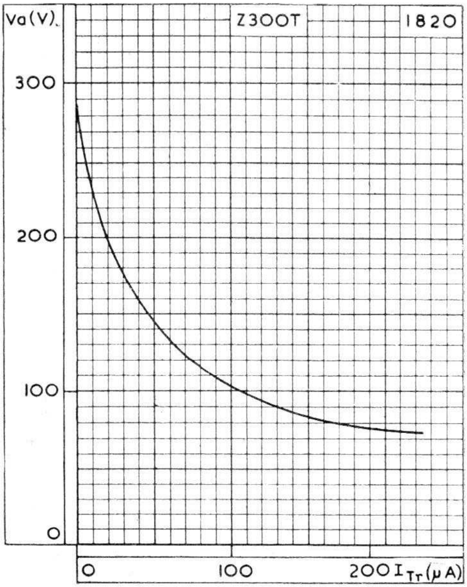


COLD CATHODE GAS-FILLED TRIODE

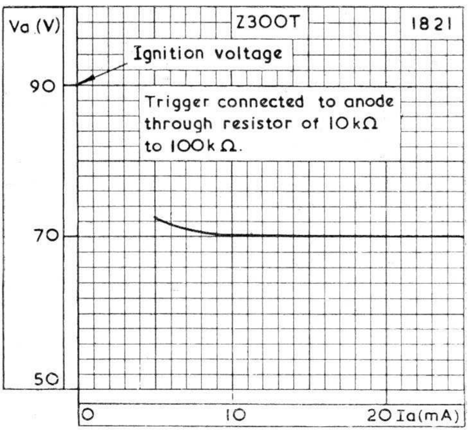
Z300T

(1267)

Cold cathode inert gas-filled triode designed for use as a general purpose trigger tube.



AVERAGE TRANSITION CHARACTERISTIC
(Trigger current required to initiate anode-to-cathode ignition)



ANODE CURRENT/ANODE VOLTAGE CHARACTERISTIC

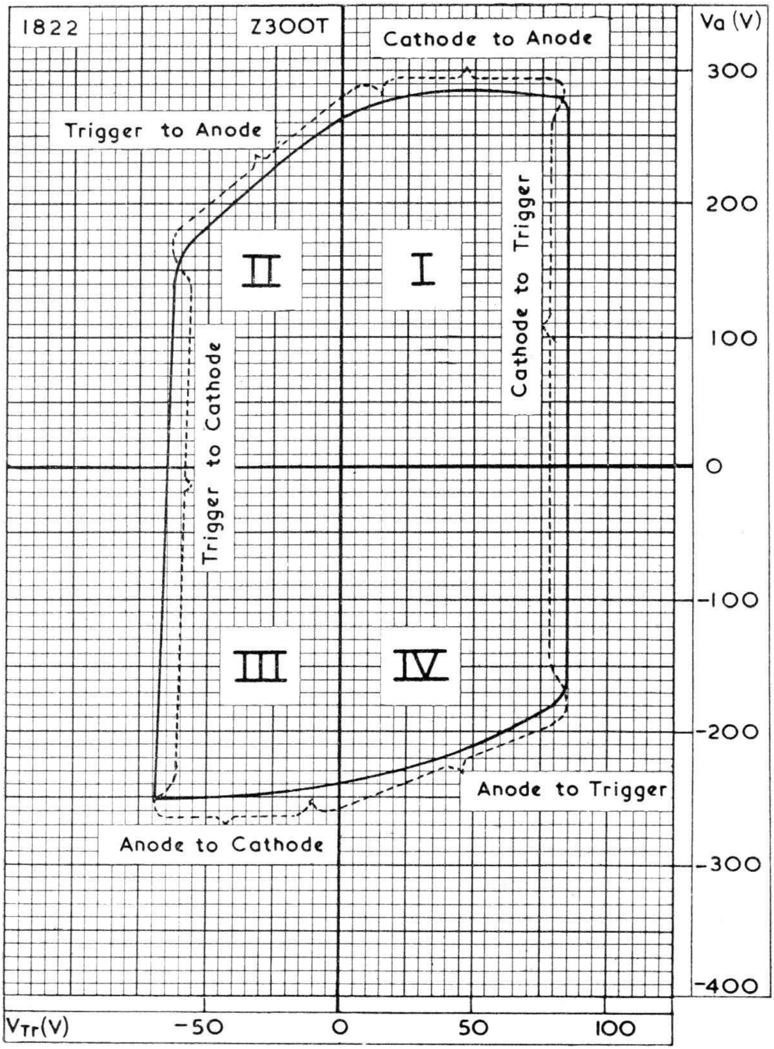
Mullard

Z300T

(1267)

COLD CATHODE GAS-FILLED TRIODE

Cold cathode inert gas-filled triode designed for use as a general purpose trigger tube.



TYPICAL BREAKDOWN CHARACTERISTIC
FOR DIFFERENT ELECTRODE POLARITIES

SUBMINIATURE COLD CATHODE TRIGGER TUBE

Z700U

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.

To ensure that the characteristics of the tube are maintained in both light and darkness a priming discharge of some 3μA flowing continuously between anode and priming cathode is necessary.

PRELIMINARY DATA

CATHODE cold

CHARACTERISTICS

†*Trigger ignition voltage (V_a = 250V d.c.)	137 to 153	V
Recommended anode working voltage range	200 to 310	V
*Anode to cathode maintaining voltage (I_a = 3mA)	111 to 121	V
Typical trigger to cathode maintaining voltage (see page 6)	115	V
Recommended average cathode current range	2.0 to 4.0	mA
Recommended priming cathode resistor	18	MΩ
Minimum anode to priming cathode supply voltage	200	V

†The drift in trigger ignition voltage per tube is generally less than 3V. However, when the tube is ignited for very long periods, drawing negative starter current, a shift of trigger ignition voltage up to 175V may occur.

TRANSFER REQUIREMENTS

Current triggering:		
*Maximum transfer current (V_a = 250V)	30	μA

*These limits apply over life.

LIMITING VALUES (absolute ratings)

Maximum anode voltage	310	V
Maximum cathode current		
Peak	16	mA
Average (max. averaging time 1s)	4.0	mA
Maximum negative trigger current	See note 4	

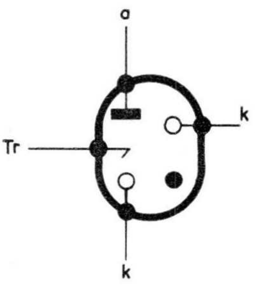
OPERATING NOTES

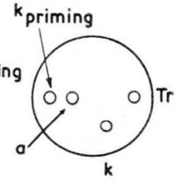
1. The trigger and priming cathode resistors should be mounted close to the tube.
2. Direct soldered connections to the leads of this tube must be at least 5mm from the seal and any bending of the tube leads must be at least 2.0mm from the seal.
3. If a tube is ignited with short pulses (20μs), the total trigger voltage (bias + pulse) must exceed 153V. A typical value with a 100pF coupling capacitor is 175V.
4. With the tube ignited the negative trigger current must not exceed 100μA.
5. The tube should not be mounted in contact with external conductive elements or spurious triggering may occur.

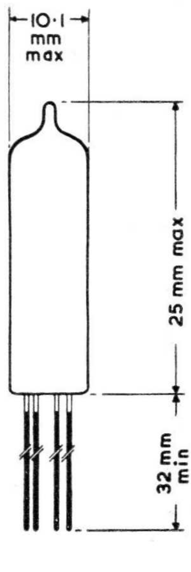
Z700U

SUBMINIATURE COLD CATHODE TRIGGER TUBE

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.







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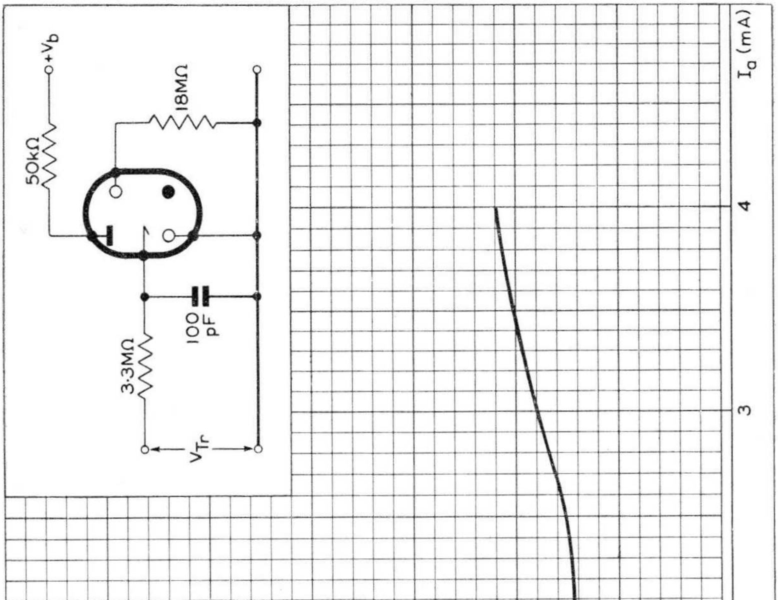
SUBMINIATURE COLD CATHODE TRIGGER TUBE

Z700U

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.

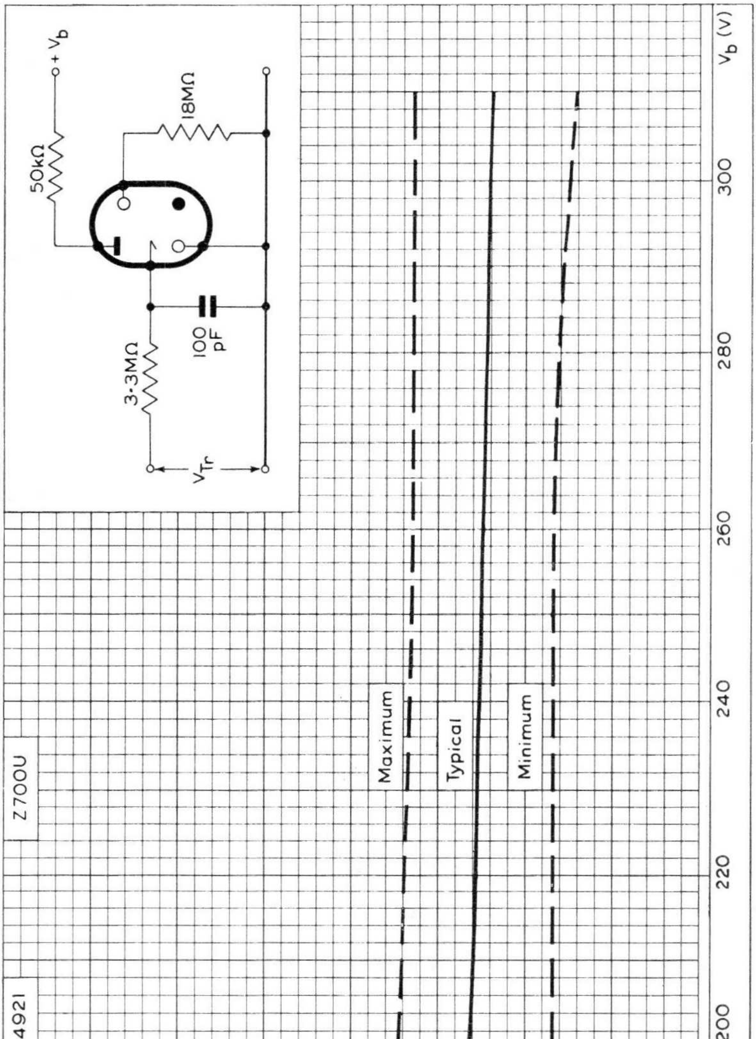


TYPICAL ANODE MAINTAINING VOLTAGE CHARACTERISTIC

Z700U

SUBMINIATURE COLD CATHODE TRIGGER TUBE

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.

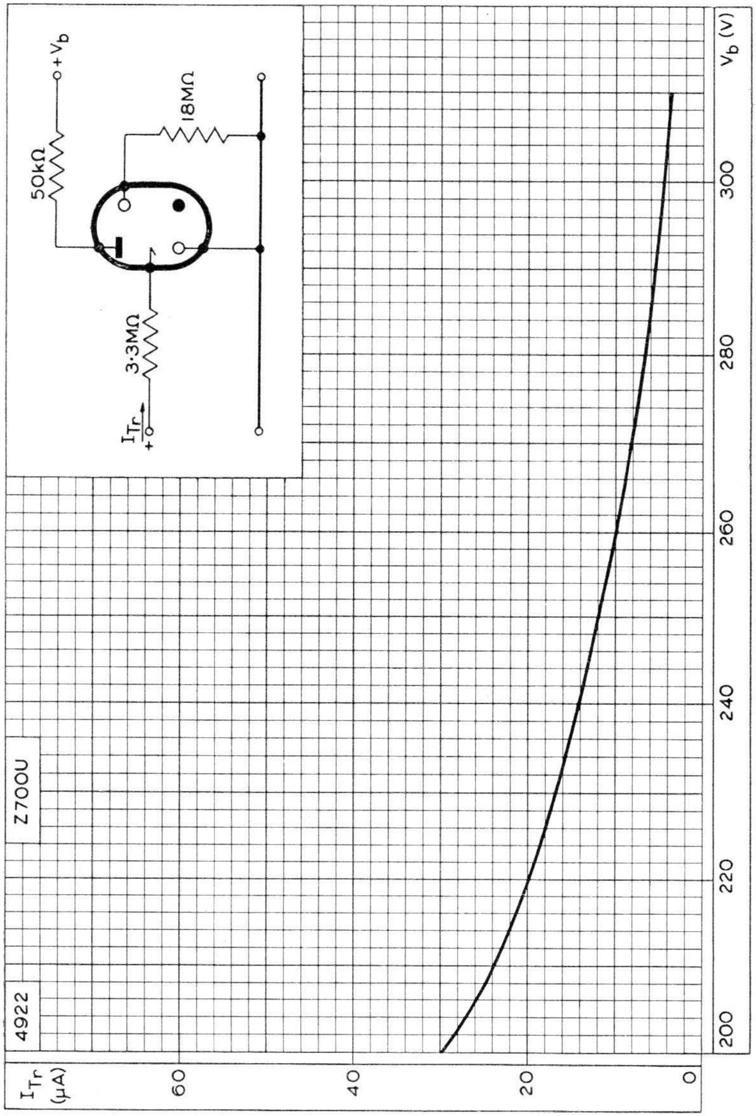


TRIGGER BREAKDOWN CHARACTERISTIC

SUBMINIATURE COLD CATHODE TRIGGER TUBE

Z700U

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.

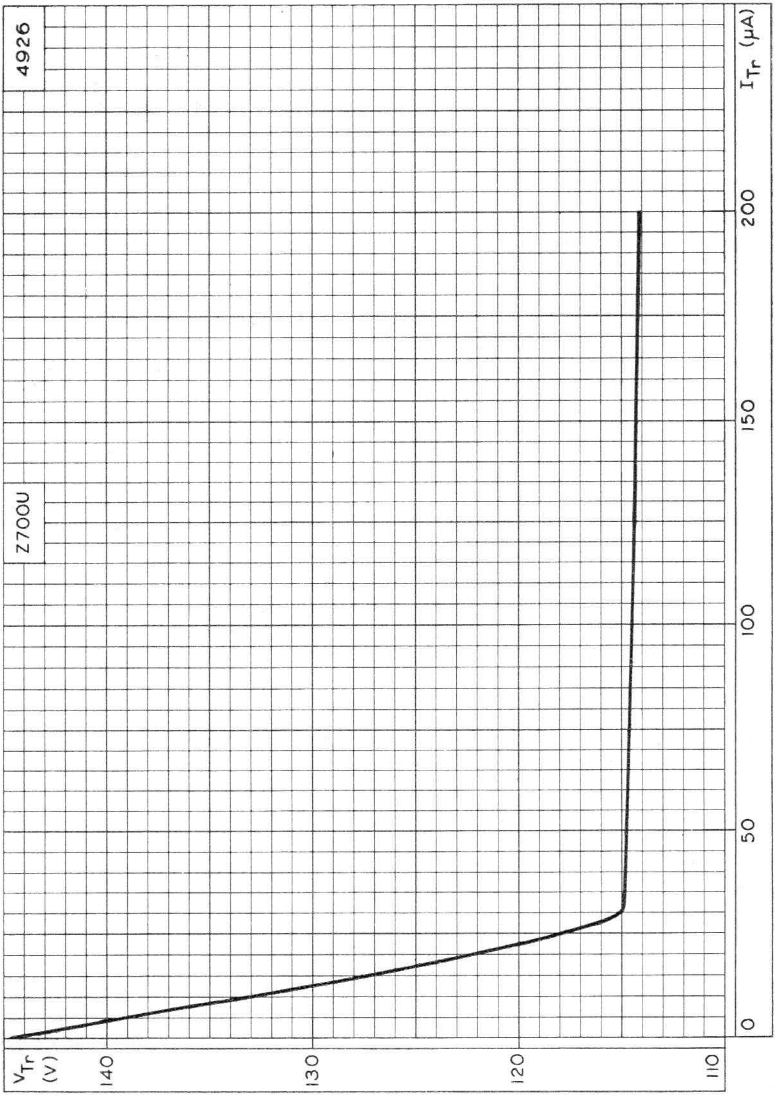


TYPICAL TRANSFER CHARACTERISTIC

Z700U

SUBMINIATURE COLD CATHODE TRIGGER TUBE

Subminiature cold cathode trigger tube with primer cathode and ignited by a positive trigger potential. Primarily intended for use in decade counting and switching circuits up to maximum counting speeds in the region of 2 to 5kc/s.



TYPICAL TRIGGER MAINTAINING VOLTAGE CHARACTERISTIC

COLD CATHODE TRIGGER TUBE

Z803U

Long life cold cathode inert gas-filled tube with stable trigger striking characteristics. Primarily intended for use in timers, voltage control and sensitive relay applications.

The predominant characteristic of the Z803U is its very stable trigger ignition voltage. To ensure that the characteristics of the tube are maintained in both light and darkness a priming discharge of some 10 μA flowing continuously between priming anode and cathode is necessary. Apart from the priming discharge the tube behaves as a triode trigger tube. It is designed for operation with positive voltages on the anode and trigger.

CATHODE

Cold

CHARACTERISTICS

Nominal trigger ignition voltage	132	V
Recommended anode voltage working range	170 to 290	V
Nominal anode to cathode maintaining voltage	105	V
Typical trigger to cathode maintaining voltage	95	V
Priming current range	2.0 to 25	μA
*Recommended priming discharge resistor	10	MΩ
Deionisation time (approx.): $i_{k(pk)}$ 0 to 20mA	3.5	ms
20 to 60mA†	16	ms
Ionisation time: $V_{Tr} = V_{Tr\,(ignition)} + 0.5V$	approx. 2	ms
$V_{Tr} = V_{Tr\,(ignition)} + 4.0V$	0.1	ms

Transfer requirements

1. Current triggering (see page C3):
   Max. transfer current over life ($V_a = 240V$) 25 μA

2. Capacitor triggering (see fig. 1):
   Min. value of C1

V_a min. (V)	**R4 max. (kΩ)	C1 min. (pF)
170	2.2	2700
200	2.2	1000
240	2.2	500

Minimum value of trigger resistance R4**

C1 < 4700pF	0	Ω
4700 to 15,000pF	2.2	kΩ
> 15,000pF	5.6	kΩ

Guidance on lower values of C1 suitable for pulse firing circuits is available on request.

Unless otherwise stated all resistors are ±20%.

*This resistor must be soldered directly to pin 6 of the valve socket. Stray capacitance at the priming anode must be kept to a minimum.

†In self-extinguishing circuits the deionisation time is much shorter.

**See Operating Notes 2 and 4.

Z803U COLD CATHODE TRIGGER TUBE

LIMITING VALUES (absolute ratings)

Maximum anode voltage	290	V
Maximum peak positive trigger current (see 4.3)	8.0	mA
Trigger ignition voltage range (all tubes initial value) $V_a = 280V$	128 to 137	V
Maximum increase in trigger ignition voltage when anode voltage is changed from 290V to 170V	1.0	%
Minimum priming anode supply voltage	150	V

Maximum cathode current and trigger stability.

	Self-extinguishing circuit	*General operation*		
Maximum cathode current				
Average	0.8	8.0	25	mA
Peak	200	50	100	mA
Max. averaging time	0.5	15	15	s
Max. variation of trigger ignition voltage per 2000 hrs.	±2	±2	±2	%
Typical variation of trigger ignition voltage per 10,000 hrs.	< ±2	< ±2	*	%
Typical variation of trigger ignition voltage per 20,000 hrs.	< ±2	—	—	%

*Over long periods a systematic drift of –0.7% per 1000 hrs. may be expected.

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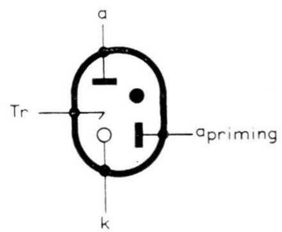
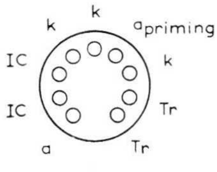
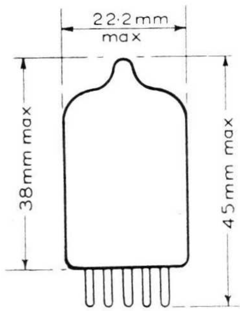




B9A Base



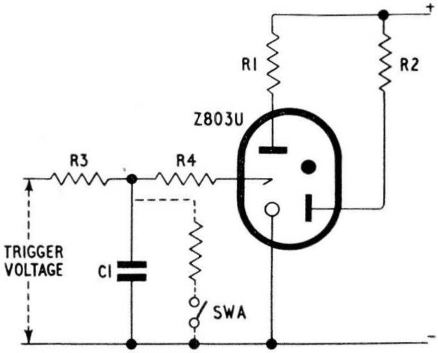


FIG.1

OPERATING NOTES

1. ANODE VOLTAGE SUPPLY

A basic circuit for a number of applications is shown in Fig. 1. To ensure reliable operation of the tube the anode voltage must lie within the published range of 170 to 290V. Above 290V the tube may fire spontaneously, whilst below 170V a trigger discharge can fail to initiate an anode-to-cathode discharge and also the priming discharge may not be established. To obtain a high stability of trigger ignition it is essential to have a priming discharge flowing during any period in which the tube is to be triggered.

R1 determines the magnitude of the anode-to-cathode current which must always fall within published limits. R2 determines the priming current and should be of the order of 10MΩ.

2. TRIGGERING THE TUBE

The Z803U can be triggered either by the discharge of a capacitor between trigger and cathode or by a direct current flowing between trigger and cathode.

2.1 Capacitive triggering

The basic circuit is shown in Fig. 1; minimum values for C1 are quoted in the data. A limiting resistor R4 equal to that quoted in the data is essential to prevent an excessive rate of discharge of the capacitor C1, causing damage to the tube.

R3 is the charging resistance in the trigger circuit. The minimum value of R3 is limited to 1MΩ in circuits in which the trigger discharge must be self-extinguishing but if external extinguishing circuits are provided, such as switch SWA then R3 need only be sufficient to limit the trigger current to within the permitted limits. The maximum value of R3 is set by a pre-ignition trigger current of the order of 4×10^{-8}A, which commences to flow at trigger voltages approximately 100mV below the trigger ignition voltage. Thus if R3 is made too large, the voltage at the trigger will not reach the ignition value.

2.2 Direct current triggering

The basic circuit is as shown in Fig. 1 with C1 and R4 omitted. The curve on page C3 shows the d.c. trigger current (transfer current) required to cause anode-cathode conduction as a function of the applied anode voltage. To ensure that anode-cathode conduction occurs when the input voltage reaches $V_{Tr\,(ignition)}$, the trigger resistance $R3_t < \frac{V_{Tr\,(ignition)} - V_{maint.}}{I_{trans}}$ where I_{trans} is the d.c. trigger current to cause anode conduction at the applied anode voltage. If R3 is made greater than this value, the input voltage must be greater than $V_{Tr\,(ignition)}$ to obtain anode conduction, the actual value being determined by a number of parameters.

3. EXTINGUISHING THE TUBE

To extinguish the tube it is necessary to reduce both the trigger-cathode and anode-cathode voltages below their respective maintaining voltages for a period longer than the deionisation time. It is preferable that this is done by lowering both the anode and trigger voltages so that the priming discharge is not extinguished. If the tube is extinguished by raising the cathode potential, the duration of the applied pulse should be less than 10ms, unless a period of 1s is allowed for the priming discharge to be re-established.

4. MISCELLANEOUS NOTES

4.1 Cathode loads

If a load resistor is inserted in the cathode lead the cathode potential will be slightly positive due to the flow of priming current, and thus the trigger voltage must rise by this extra amount to reach the ignition voltage. It should be noted that when a cathode load is employed the earthy end of C1 in Fig. 1 should be connected directly to the cathode as shown in Fig. 2. Unless this is done the cathode load is in series with the discharge limiting resistor R4 and will cause unreliable triggering.

4.2 Hysteresis effect

There is a hysteresis effect associated with the trigger and anode breakdown voltages. The effect is that the trigger and anode breakdown voltages are both lowered after a period of conduction, and return to their initial values after a recovery period.

The magnitude of the effect is proportional to the duration of conduction and the magnitude of the cathode current during conduction.

Curves showing the maximum depression of trigger ignition voltage for a repeated sequence of 'on' and 'off' periods are shown on page C2 as a function of the 'off' period. These curves are for constant 'on' periods of 10ms. It takes about 20s of repeated cycling to reach this maximum depression.

The temporary anode breakdown voltage depression is only important in applications in which long 'on' periods are followed by relatively short 'off' periods. Under these conditions an anode working voltage range of 170 to 270 volts is recommended.

A report giving fuller details of these effects, entitled 'Trigger and Anode voltage hysteresis effects in Z803U' is available.

4.3 Trigger input volts during anode conduction

During anode conduction the trigger is held by the discharge at a potential of approximately 90V above cathode and if the trigger input voltage is raised or lowered about this potential, trigger current will flow. Raising the trigger voltage above this potential causes a current to flow into the trigger and provided the current does not exceed the limiting value it will not harm the tube.

However, if the voltage is reduced below 90V, current flows in the reverse direction, the trigger now acting as a cathode. This current can harm the tube in any application in which the trigger is reset by a relay contact. It is desirable that the contact makes after the main anode-to-cathode discharge has been extinguished. The effect of reverse trigger current is to reduce both the maximum anode voltage which can be applied and the trigger stability.

4.4 Noise

In this tube, oscillations of up to 10V peak-to-peak are superimposed on the maintaining voltage. Due to this effect the measured value of maintaining voltage will depend on the circuit conditions. These are of no significance in normal applications.

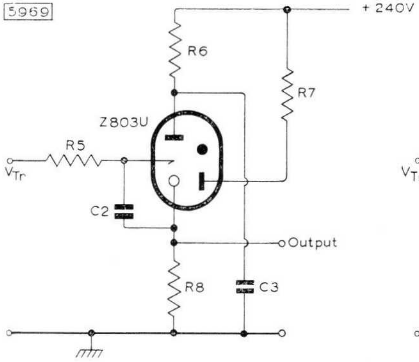


Fig 2

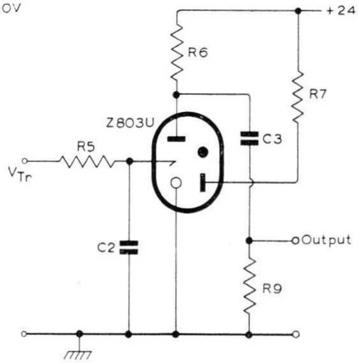


Fig 3

SELF-EXTINGUISHING CIRCUITS

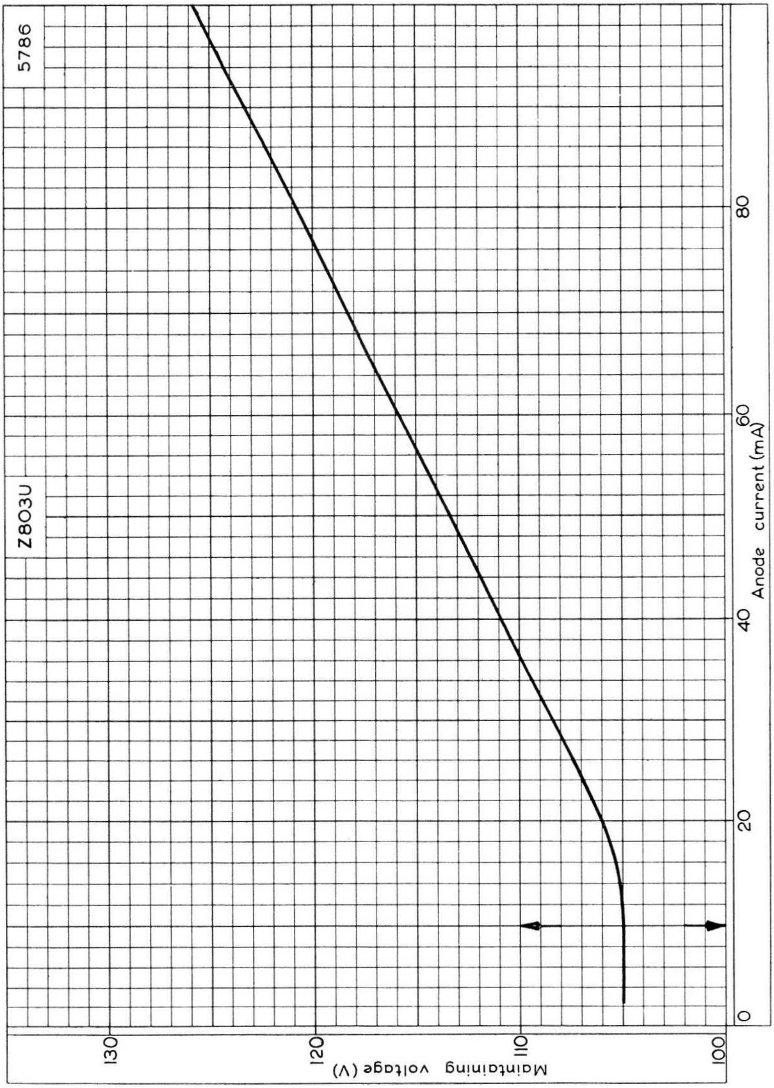
The Z803U may be used in the normal type of RC self-extinguishing circuits as shown in Figs. 2 and 3. To ensure stable operation, R6 should be 1MΩ or greater and C3 must be of a value to give a time constant R6.C3 in excess of 2ms.

A short positive pulse may be obtained across R8 in Fig. 2 or a negative pulse across R9 in Fig. 3.

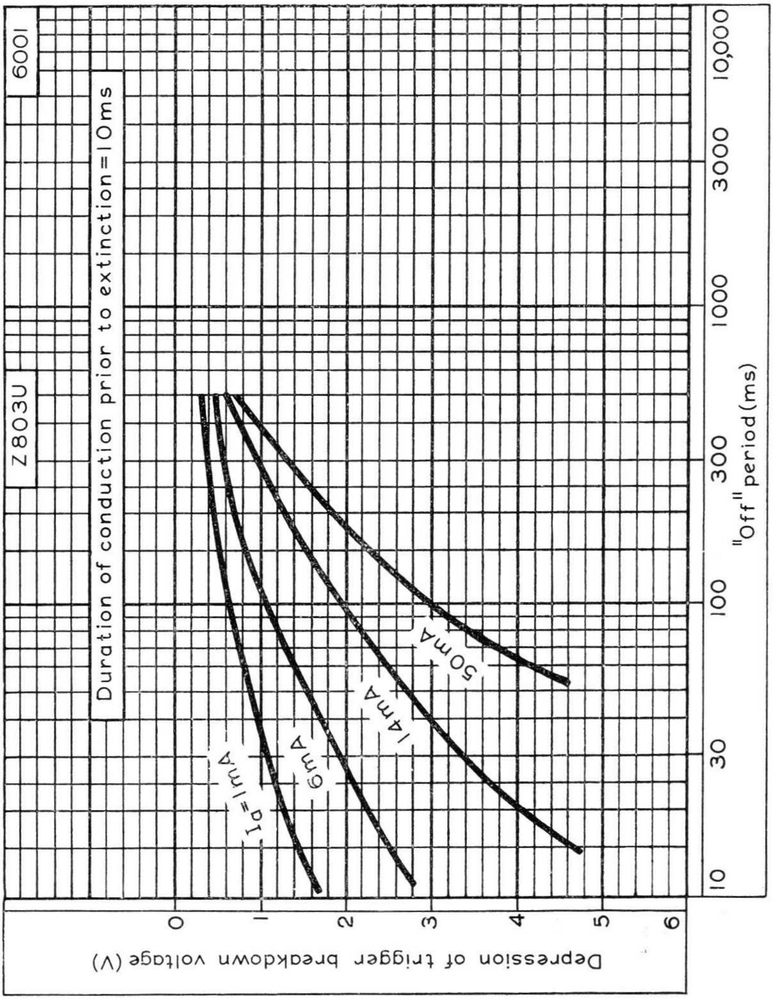
A long negative pulse may be obtained across R6; however, it can only be used to drive circuits whose input impedances are greater than 1MΩ.

Typical circuit component values

R5	1	MΩ	C2	2700	pF
R6	1	MΩ	C3	2700	pF
R8	<1	kΩ			
R9	<1	kΩ			



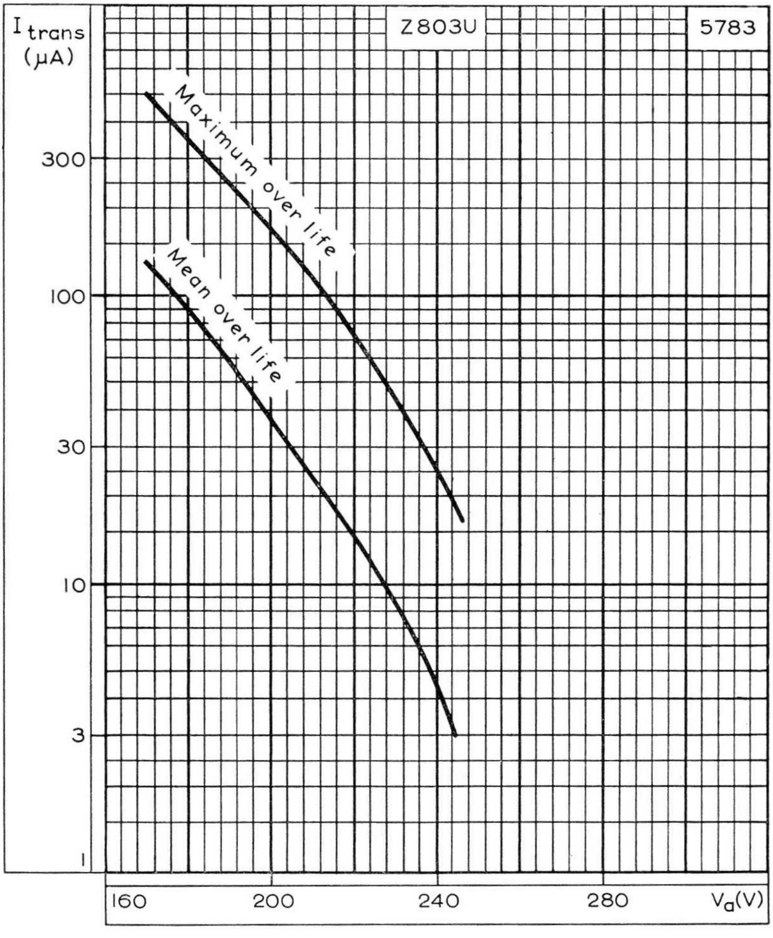
MAINTAINING VOLTAGE PLOTTED AGAINST ANODE CURRENT
(See note 4.4)
The arrows show the initial limits



HYSTERESIS EFFECT

Curves showing cathode recovery time

(See note 4.2)



TRANSFER CURRENT PLOTTED AGAINST ANODE VOLTAGE

COLD CATHODE TRIGGER TUBE

Z804U

Cold cathode trigger tube suitable for direct operation from 200 to 250Vr.m.s. a.c. supplies at mains frequencies. The tube is ignited by a negative trigger potential.

PRELIMINARY DATA

CATHODE

	cold	

CHARACTERISTICS

*Trigger ignition voltage range, all tubes ($V_a = 210$ to 350V)	−115 to −131	V
*Anode maintaining voltage range, all tubes ($I_a = 20$mA)	106 to 115	V
Typical transfer current ($V_a = 210$V)	10	μA

*These limits apply over life

STABILITY

Maximum variation of trigger ignition voltage over life	±5·0	V
Maximum variation of anode maintaining voltage over life	±3·0	V

LIMITING VALUES (absolute ratings)

Maximum positive trigger current	400	μA
Maximum negative trigger current	400	μA

A.C. operation

R.M.S. mains voltage		
Maximum	275	V
Minimum	180	V
Frequency		
Maximum	100	c/s
Minimum	10	c/s
Mean anode current		
Maximum	25	mA
Minimum	5·0	mA
Maximum averaging time	1	cycle
Peak anode current	125	mA

D.C. operation

Supply voltage		
Maximum	350	V
Minimum	210	V
Anode current		
Maximum	40	mA
Minimum	5·0	mA

NOTES

The trigger may be operated either from d.c. or low frequency a.c.
Pin 2 should be connected to the cathode via a 2MΩ resistor.

Z804U

COLD CATHODE TRIGGER TUBE

Cold cathode trigger tube suitable for direct operation from 200 to 250Vr.m.s. a.c. supplies at mains frequencies. The tube is ignited by a negative trigger potential.

OPERATING NOTES

This tube is primarily intended for relay operation on 200 – 250V. 50 c/s single phase supplies. The following notes refer to this duty.

The anode circuit

In designing the anode circuit care must be taken to ensure that the cathode current and anode voltage ratings are never exceeded.

The average current through the tube for a given relay RA can be adjusted by the choice of the relay resistance R1, but care must be taken since R1 also determines the peak current passed by the tube. Thus, when a given average current is required, it is possible to exceed the peak current rating particularly if the tube is fired late in the positive half cycle.

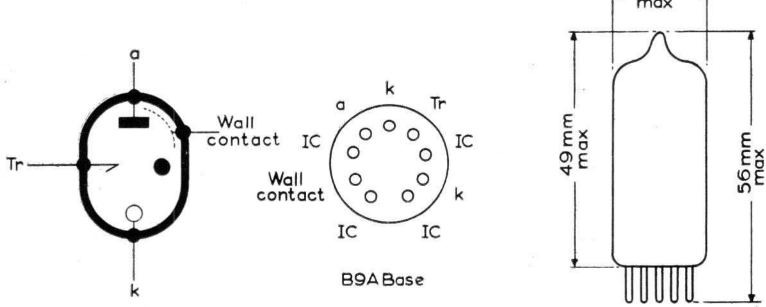
The forward and inverse voltages applied to the valve must not exceed the quoted values. Capacitor C connected across the relay provides a smooth relay current, thus avoiding 'chatter'. It should be remembered that the steady voltage across this capacitor adds to the a.c. inverse voltage across the tube but subtracts from the forward voltage.

The trigger circuit

The Z804U is ignited when the trigger voltage is approximately –120V. with respect to cathode. After ignition the trigger potential will rise to approximately +20V and remain there during anode conduction. Thus any capacitor connected between trigger and cathode has to be re-charged through about 140V every time the tube is fired, this compares with about 40V in tubes using conventional positive firing. Thus in direct current triggering any stray trigger – cathode capacitance should be reduced to a minimum.

There is a trigger ignition voltage hysteresis effect in the Z804U in that the trigger ignition voltage immediately following a conduction period is more positive, i.e. numerically smaller, by some 3V than the value after a long standby period.

3929

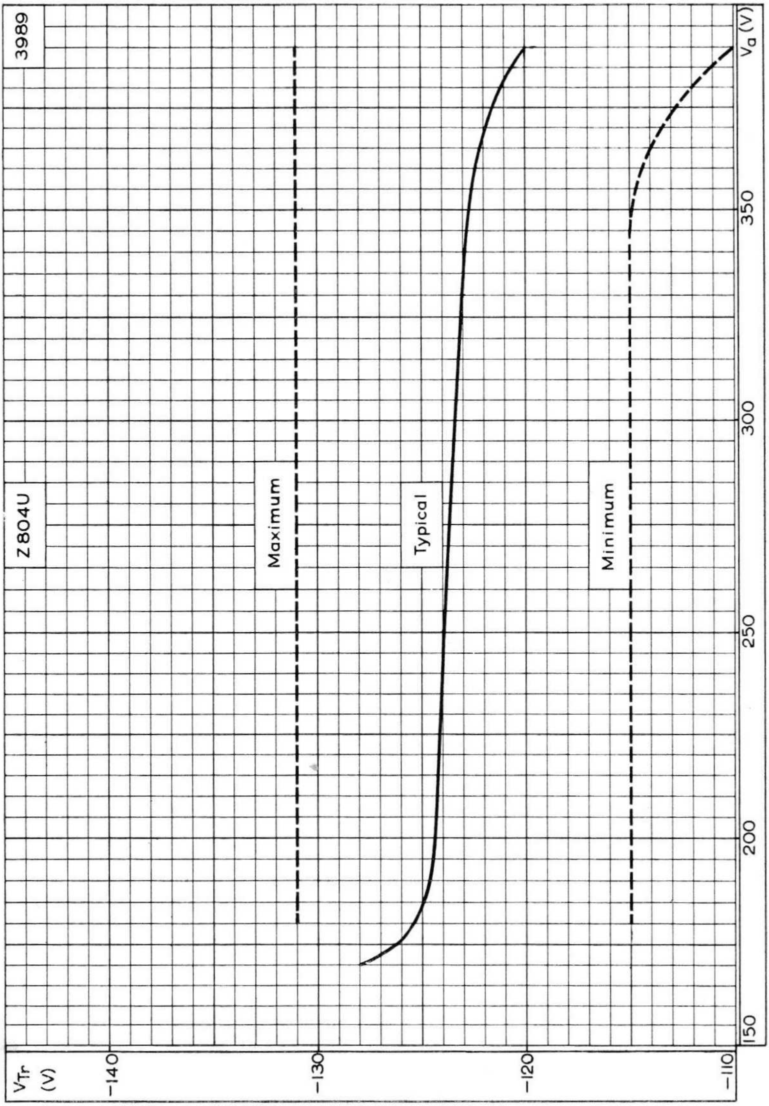


Wall contact(pin2)must be connected to cathode via a 2MΩ resistor.

COLD CATHODE TRIGGER TUBE

Z804U

Cold cathode trigger tube suitable for direct operation from 200 to 250Vr.m.s. a.c. supplies at mains frequencies. The tube is ignited by a negative trigger potential.

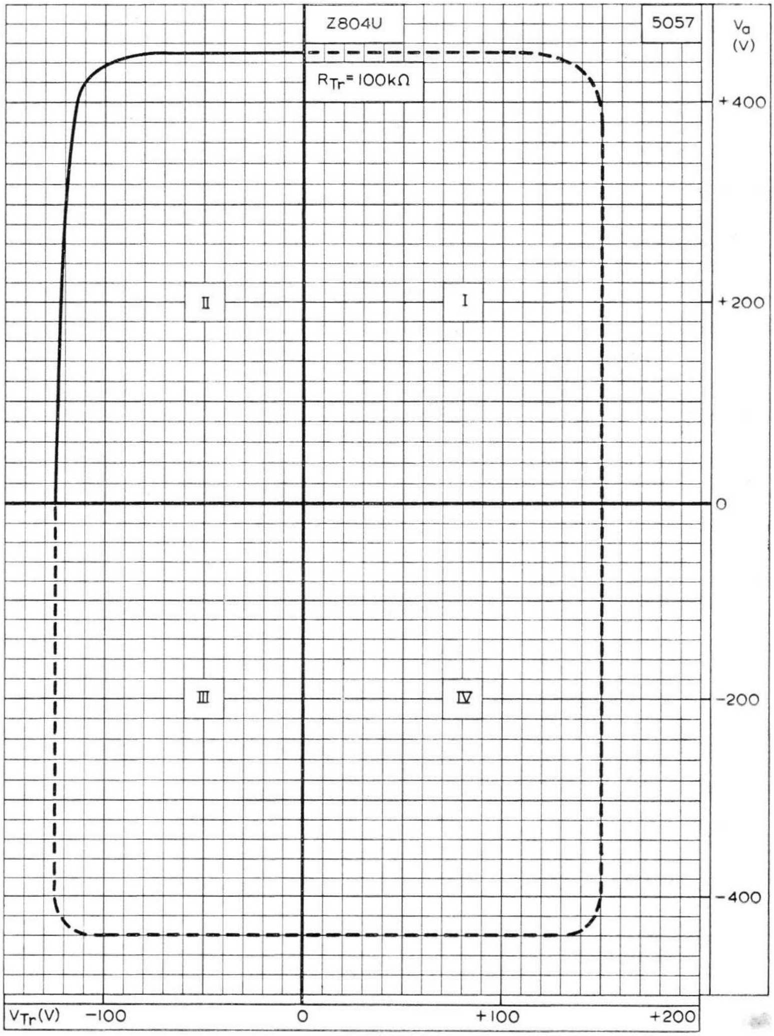


TRIGGER VOLTAGE PLOTTED AGAINST ANODE VOLTAGE FOR ALL TUBES OVER LIFE

Z804U

COLD CATHODE TRIGGER TUBE

Cold cathode trigger tube suitable for direct operation from 200 to 250Vr.m.s. a.c. supplies at mains frequencies. The tube is ignited by a negative trigger potential.



TYPICAL BREAKDOWN CHARACTERISTIC FOR DIFFERENT ELECTRODE POLARITIES

(The tube is recommended for operation in quadrant II only).

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

CATHODE

Cold

CHARACTERISTICS

Typical anode-to-cathode breakdown voltage with trigger voltage zero or positive	290	V
Typical anode-to-cathode burning voltage (at 25mA)	62	V
Typical trigger-to-cathode breakdown voltage with anode voltage zero or positive	80	V
Typical trigger voltage when breakdown has occurred (with an anode-to-cathode current of 25mA)	61	V
*Typical ionisation time	20	μs
*Typical deionisation time	500	μs

*With instantaneous anode voltage of 185V, trigger bias voltage of +70V, trigger input pulse of 50V, and trigger series resistor of 100kΩ.

LIMITING VALUES (Absolute ratings)

With anode and trigger both positive

Maximum anode voltage at which self-ignition will not occur in any tube	200	V
Minimum trigger voltage necessary to cause trigger breakdown in all tubes during life	105	V
Maximum trigger voltage at which trigger breakdown will not occur in any tube during life	73	V
Minimum trigger-to-cathode current necessary to cause transfer in all tubes during life		
(*a*) $v_{a(pk)}=140$V	400	μA
(*b*) $v_{a(pk)}=175$V	160	μA
Maximum permissible cathode current		
Peak	100	mA
Average (max. averaging time 15 secs)	25	mA
Maximum permissible peak trigger current	100	mA

With anode positive and trigger negative

Maximum applied anode-to-trigger voltage for which breakdown will not occur in any tube (trigger voltage between 0 and –65V)	200	V

With anode negative and trigger positive

Maximum permissible anode-to-trigger voltage (trigger voltage between 0 and +73V) (approx.)	180	V

Notes

(*a*) The tube must not be allowed to pass current while the anode is negative.

(*b*) This tube is recommended for operation in quadrant I of the breakdown characteristic, i.e. with anode and trigger both positive.

(*c*) Strong light such as sunlight should not be allowed to fall on the tube.

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

TYPICAL OPERATING CONDITIONS FOR USE AS A RELAY TUBE WITH 50 c/s A.C. SUPPLY

Anode supply voltage (r.m.s.)	117	V
A.C. trigger voltage		
Maximum peak positive pre-firing voltage	70	V
Minimum peak positive triggering voltage	35	V
*Minimum firing voltage	105	V

*Sum of in-phase instantaneous pre-firing voltage and instantaneous triggering voltage.

OPERATION AS A RECTIFIER

This tube may be used as a rectifier, having the following characteristics (trigger connected to anode through a 50k Ω resistor):

P.I.V. max.	200	V
$i_{k(pk)}$ max.	100	mA
I_k max.	25	mA

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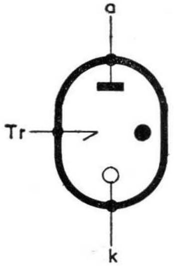
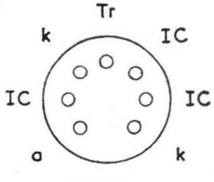
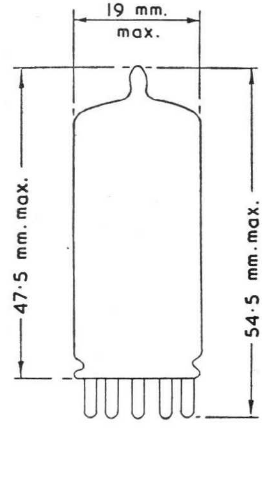




B7G Base.



Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

OPERATING NOTES

1. Trigger Tube

The operation of this tube depends on the initiation of two glow discharges. First a discharge is started between the trigger electrode and the cathode. When the current in this discharge is above a certain critical value, dependent on the anode voltage, and is of the order of 100μA, then the main discharge will be formed between anode and cathode.

To extinguish the tube and prepare it for further operation, both the trigger and anode potentials must be reduced below their burning voltage values.

The breakdown characteristic of the Z900T is shown graphically. This curve indicates the voltage conditions which will lead to breakdown between any two electrodes in the tube.

The area surrounded by the shaded portion represents the non-conducting region. The shaded area indicates the range of breakdown voltages covering tube to tube variations over life. The area outside the shaded portion represents definite conducting conditions. Dashed portions of the curves indicate approximate values only.

It is recommended that current is only drawn by the tube when it is operating in quadrant I on this graph. The details given in quadrants II, III, and IV indicate the precautions that must be taken in order that conduction shall not occur in these quadrants.

For operation of the Z900T in quadrant I, the anode voltage and pre-firing trigger voltage must not enter the shaded region of the curve. To fire the tube, a voltage in phase with the pre-firing voltage is applied to the trigger electrode. The minimum sum of these trigger voltages must take the trigger to the outer edge of the shaded portion. If the tube is operated with a.c. on either the anode or the trigger, care must be taken to ensure that the applied voltages never take these electrodes into the shaded region in quadrants II, III or IV. Failure to meet this requirement will lead to short tube life.

When this tube is operated with an inductive load such as a relay coil, care must be taken that the maximum peak inverse anode voltage is not exceeded by the inductive kick-back voltage.

The transfer characteristic gives the minimum trigger-to-cathode current required to initiate a discharge in the anode-cathode gap for any given value of anode voltage. Typical and maximum characteristics are given, but in the design of equipment the trigger circuit parameters should always give a trigger current which meets the requirements of all tubes over life. For example, with an anode voltage of 150V it is necessary to provide a trigger current of 300μA. If it is required to operate the trigger from a very high impedance supply, the transfer current may be obtained from a capacitor connected between the trigger and cathode. Under these conditions the capacitor is charged to the tube triggering voltage and is then discharged through the trigger circuit until its voltage has fallen to the trigger maintaining voltage.

The capacitor will, of course, cause a certain delay in triggering, depending on the value of resistor through which it is charged.

2. Rectifier

The average anode characteristic of the Z900T has the asymmetrical form necessary for rectification, and with this type of operation the ratings quoted in the data apply.

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

CIRCUIT NOTES

1763

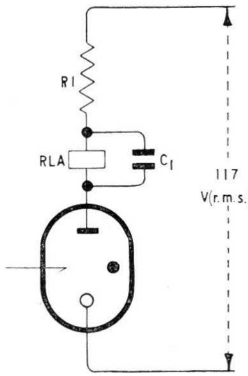


FIG. 1.

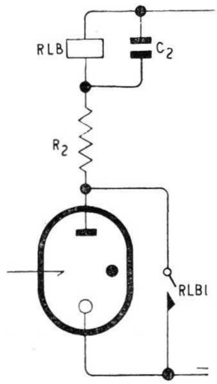


FIG. 2

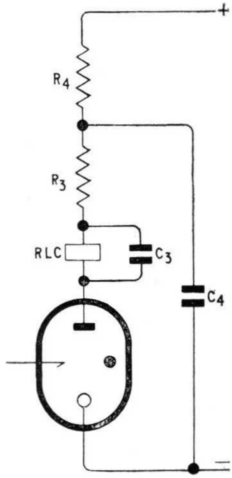


FIG. 3.

1. Anode Circuits

The circuit diagrams Figs. 1 to 3 show some typical methods of feeding the main anode-to-cathode circuit of a Z900T.

Fig. 1

The tube is fed from an a.c.supply of $117V_{(r.m.s.)}$ in order to operate a relay RLA. Capacitor C1 may be connected across the relay, in order to prevent chatter. Resistance R1 is included as a current limiting resistor.

Fig. 2

The supply is d.c. and the relay RLB has a contact RLB1 which short-circuits the tube on operation and keeps the relay energised. To de-energise the relay, the H.T. supplies must then be broken. R2 is a current limiting resistor.

Fig. 3

This shows another d.c.-operated system for relay operation. Capacitor C4 which has been charged by the supply will discharge through the tube when it is fired and thus energise the relay RLC until the current through the tube is insufficient to maintain a discharge. The relay will then be de-energised and the capacitor C4 will be re-charged through R4.

Circuit Components

R1, R2, R3	Current limiting resistors. The value depends upon the operating conditions	C1, C2, C3	Capacitor to prevent relay chatter Typical value $4\mu F$
R4	$1M\Omega$	C4	$0.1\mu F$

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

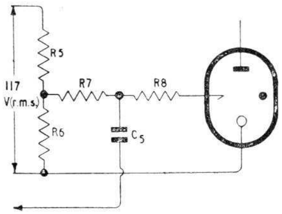


FIG 4

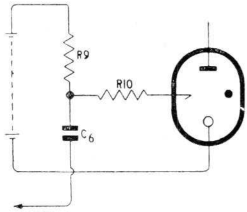


FIG 5

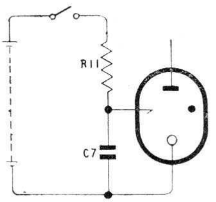


FIG 6

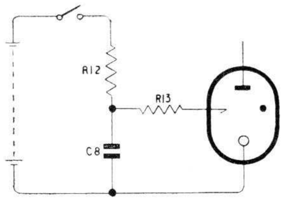


FIG 7

1764

2. Trigger Circuits

Figs. 4 to 7 show some typical trigger circuit connections.

Fig. 4

This indicates an a.c.-operated system in which the pre-firing voltage is a fraction of the supply voltage and is obtained by a potentiometer R5, R6. A triggering signal in phase with the supply voltage on the anode can then be supplied through C5 causing the tube to breakdown. R8 is a current limiting resistor for the trigger.

Fig. 5

A similar type of circuit to Fig. 4 in which the pre-firing voltage is obtained from a d.c. supply.

Fig. 6

This shows a trigger firing arrangement when the firing signal is supplied through a high impedance R11. Capacitor C7 is charged through R11 and when its potential reaches the critical trigger voltage it discharges through the trigger-to-cathode circuit thus providing the necessary trigger transfer current.

Fig. 7

The trigger-to-cathode circuit includes a large capacitor such as might be used in a simple timer. When the trigger breaks down this capacitor discharges, but in order to limit the trigger current to a safe value a resistance R13 must be included.

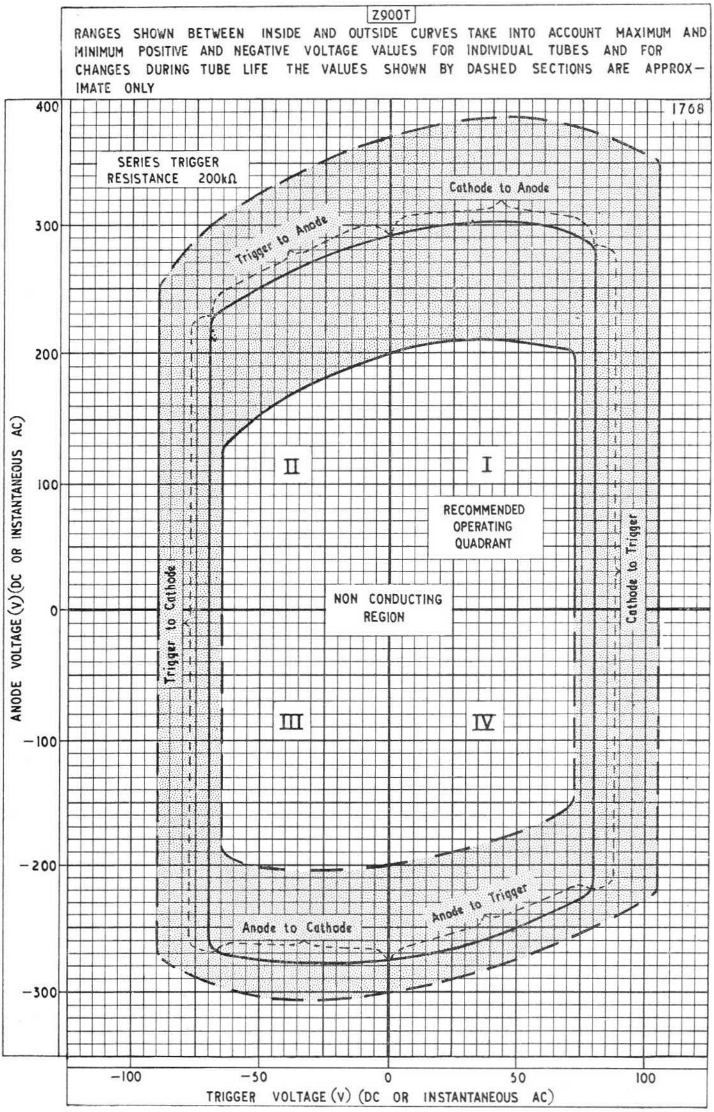
Circuit Components

R8, R10, R13	Current limiting resistors. The value depends upon the operating conditions	R11	High impedance signal source
R5	15k Ω	R12	Timer resistor
R6	10k Ω	C5	0.1 μF
R7	1MΩ	C6	0.1 μF
R9	1MΩ	C7	400 μμF
		C8	Timer Capacitor

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

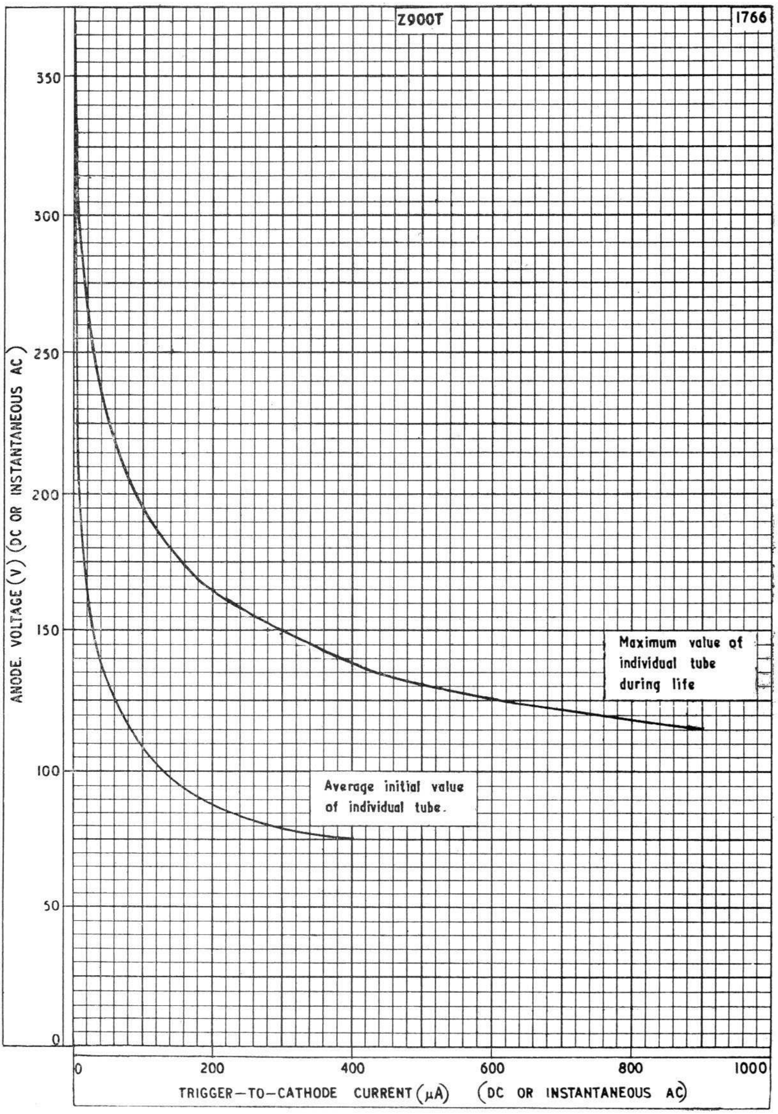


BREAKDOWN CHARACTERISTIC

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.

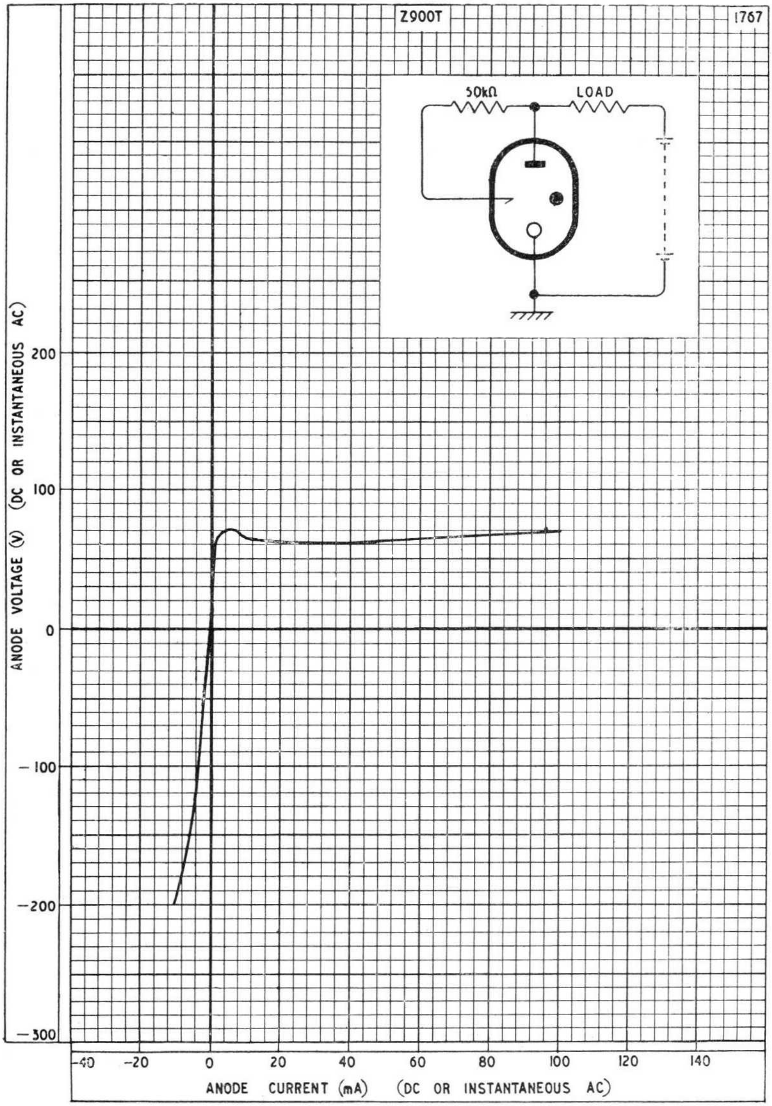


TRANSFER CHARACTERISTIC

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert-gas filled tube with three electrodes primarily designed for use as a general purpose trigger tube.



AVERAGE ANODE CHARACTERISTIC WHEN OPERATED AS A RECTIFIER

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

CATHODE

Cold

CHARACTERISTICS

Anode working voltage range	140 to 200	V
Typical anode-to-cathode burning voltage (at 25mA)	62	V
Typical trigger-to-cathode breakdown voltage with anode voltage zero or positive	80	V
Typical trigger voltage when breakdown has occurred (with an anode-to-cathode current of 25mA)	61	V
*Typical ionisation time in daylight	20	μs←
*Typical ionisation time in darkness	<100	μs←
*Typical deionisation time	500	μs

*With instantaneous anode voltage of 185V, trigger bias voltage of +70V, trigger input pulse of 50V, and trigger series resistor of 100kΩ.

LIMITING VALUES (absolute ratings)

With anode and trigger both positive

Maximum anode voltage at which self-ignition will not occur in any tube	200	V
Minimum trigger voltage necessary to cause trigger breakdown in all tubes during life	105	V
Maximum trigger voltage at which trigger breakdown will not occur in any tube during life	73	V
Minimum trigger-to-cathode current necessary to cause transfer (see transfer characteristic) $V_a = 175V$	160	μA
Maximum permissible cathode current		
Peak	100	mA
Average (max. averaging time 15s)	25	mA
Maximum permissible peak trigger current	100	mA

With anode positive and trigger negative

Maximum applied anode-to-trigger voltage for which breakdown will not occur in any tube (trigger voltage between 0 and –65V)	200	V

With anode negative and trigger positive

Maximum permissible anode-to-trigger voltage approx. (trigger voltage between 0 and +73V)	180	V

Note

Strong light such as direct sunlight should not be allowed to fall on the tube. ←

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

TYPICAL OPERATING CONDITIONS FOR USE AS A RELAY TUBE WITH 50c/s A.C. SUPPLY

Anode supply voltage (r.m.s.)	117	V
A.C. trigger voltage		
Maximum peak positive pre-firing voltage	70	V
Minimum peak positive triggering voltage	35	V
*Minimum firing voltage	105	V

*Sum of the in-phase instantaneous pre-firing voltage and instantaneous triggering voltage.

OPERATION AS A RECTIFIER

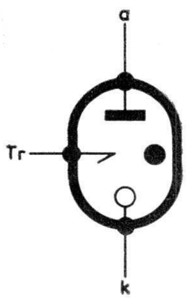
This tube may be used as a rectifier, having the following characteristics (trigger connected to anode through a 50kΩ resistor):–

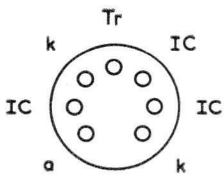
P.I.V. max.	200	V
$i_{k(pk)}$ max.	100	mA
I_k max.	25	mA

LIFE

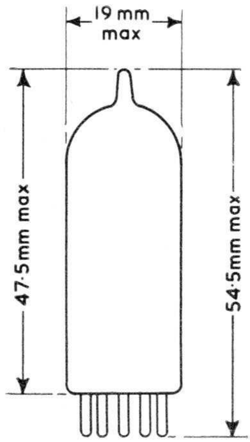
A typical life expectancy under a.c. conditions (f=50c/s) at maximum cathode current ratings is 45×10^6 firings. The life of this tube is greatly increased when the cathode current is reduced below the maximum ratings.

3354





B7G Base



COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

OPERATING NOTES

1. Trigger tube

The operation of this tube depends on the initiation of two glow discharges. First a discharge is started between the trigger electrode and the cathode. When the current in this discharge is above a certain critical value, dependent on the anode voltage, and is of the order of 100μA, the main discharge will be formed between anode and cathode.

To extinguish the tube and prepare it for further operation, both the trigger and anode potentials must be reduced below their burning voltage values.

The breakdown characteristic of the Z900T is shown graphically. This curve indicates the voltage conditions which will lead to breakdown between any two electrodes in the tube.

The area surrounded by the shaded portion represents the non-conducting region. The shaded area indicates the range of breakdown voltages covering tube to tube variations over life. The area outside the shaded portion represents definite conducting conditions. Dashed portion of the curves indicate approximate values only.

It is recommended that current is only drawn by the tube when it is operating in quadrant I on this graph. The details given in quadrants II, III, and IV indicate the precautions that must be taken in order that conduction shall not occur in these quadrants.

For operation of the Z900T in quadrant I, the anode voltage and pre-firing trigger voltage must not enter the shaded region of the curve. To fire the tube, a voltage in phase with the pre-firing voltage is applied to the trigger electrode. The minimum sum of these trigger voltages must take the trigger to the outer edge of the shaded portion.

When this tube is operated with an inductive load such as a relay coil, care must be taken that the maximum peak inverse anode voltage is not exceeded by the inductive kick-back voltage.

The transfer characteristic gives the minimum trigger-to-cathode current required to initiate a discharge in the anode-cathode gap for any given value of anode voltage. Typical and maximum characteristics are given, but in the design of equipment the trigger circuit parameters should always give a trigger current which meets the requirements of all tubes over life. For example, with an anode voltage of 150V it is necessary to provide a trigger current of 300μA.

If it is required to operate the trigger from a very high impedance supply, the transfer current may be obtained from a capacitor connected between the trigger and cathode. Under these conditions the capacitor is charged to the tube triggering voltage and is then discharged through the trigger circuit until its voltage has fallen to the trigger maintaining voltage. The capacitor will, of course, cause a certain delay in triggering, depending on the value of resistor through which it is charged.

2. Rectifier

The average anode characteristic of the Z900T has the asymmetrical form necessary for rectification, and with this type of operation the ratings quoted in the data apply.

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

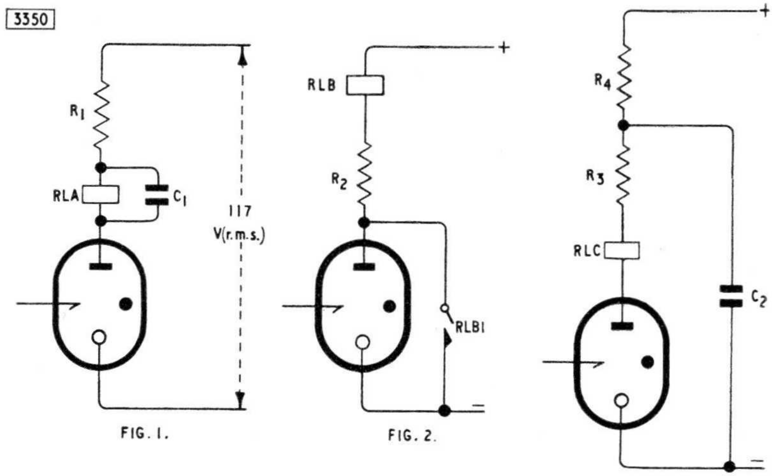


FIG. 1. FIG. 2. FIG. 3

1. Anode circuits

The circuit diagrams Figs. 1 to 3 show some typical methods of feeding the main anode-to-cathode circuit of a Z900T.

Fig. 1

The tube is fed from an a.c. supply of $117V_{r.m.s.}$ in order to operate a relay RLA. Capacitor C1 may be connected across the relay, in order to prevent chatter. Resistance R1 is included as a current limiting resistor.

Fig. 2

The supply is d.c. and the relay RLB has a contact RLB1 which short-circuits the tube on operation and keeps the relay energised. To de-energise the relay, the h.t. supplies must then be broken. R2 is a current limiting resistor.

Fig. 3

This shows another d.c.-operated self resetting system for relay operation. Capacitor C2 which has been charged by the supply will discharge through the tube when it is fired and thus energise the relay RLC until the current through the tube is insufficient to maintain a discharge. The relay will then be de-energised and the capacitor C2 will be recharged through R4.

Circuit components

R1, R2, R3	Current limiting resistors. The value depends upon the operating conditions	C1	Capacitor to prevent relay chatter. Typical value 4µF.
R4	1MΩ.	C2	0.1µF.

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

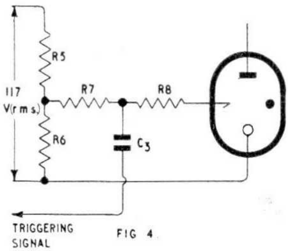


FIG 4

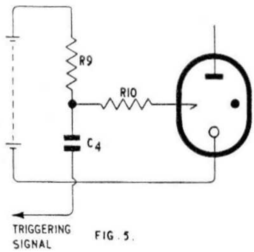


FIG 5

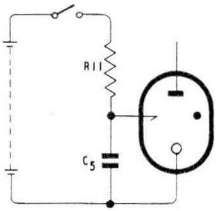


FIG 6

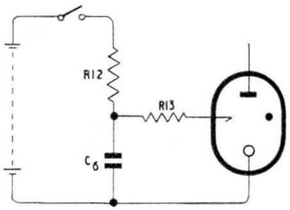


FIG 7

3351

2. Trigger circuits

Figs. 4 to 7 show some typical trigger circuit connections.

Fig. 4

This indicates an a.c.-operated system in which the pre-firing voltage is a fraction of the supply voltage and is obtained by a potentiometer R5, R6. A triggering signal in phase with the supply voltage on the anode can then be supplied through C3 causing the tube to break down. R8 is a current limiting resistor foı the trigger.

Fig. 5

A similar type of circuit to Fig. 4 in which the pre-firing voltage is obtained from a d.c. supply.

Fig. 6

This shows a trigger firing arrangement when the firing signal is supplied through a high impedance R11. Capacitor C5 is charged through R11 and when its potential reaches the critical trigger voltage it discharges through the trigger-to-cathode circuit thus providing the necessary trigger transfer current.

Fig. 7

The trigger-to-cathode circuit includes a large capacitor such as might be used in a simple timer. When the trigger breaks down this capacitor discharges, but in order to limit the trigger current to a safe value a resistance R13 must be included.

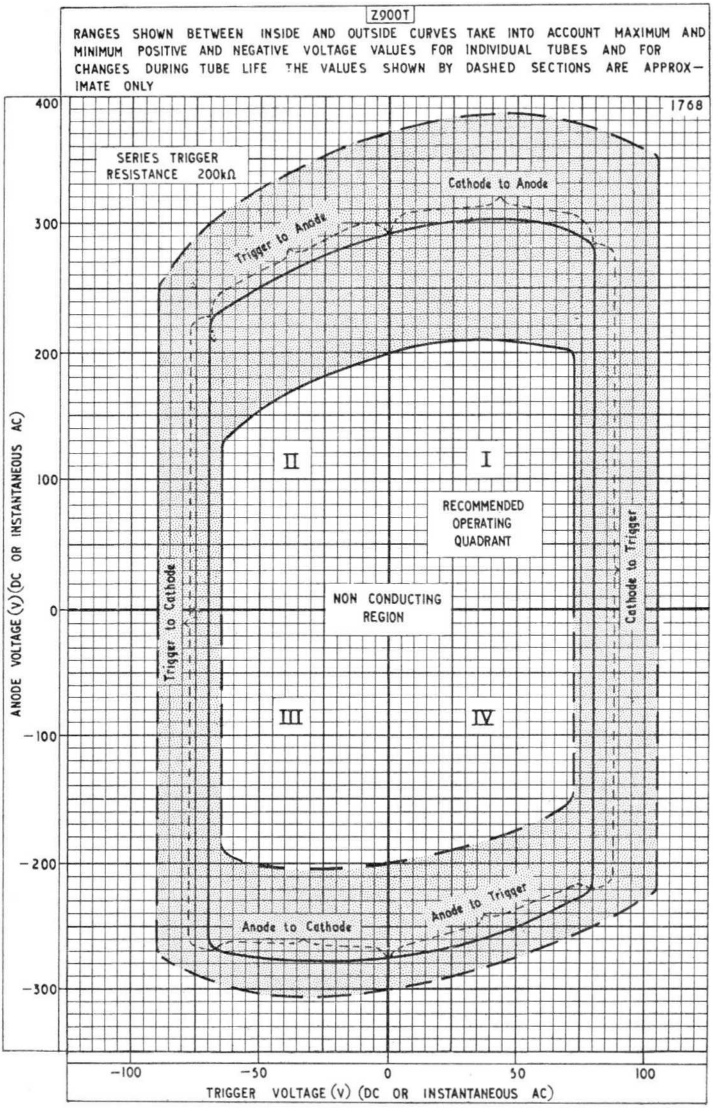
Circuit components

R8, R10, R13	Current limiting resistors. The value depends upon the operating conditions.	R11	High impedance signal source
		R12	Timer resistor
		C3	0.1μF
R5	15kΩ	C4	0.1μF
R6	10kΩ	C5	400pF
R7	1.0MΩ	C6	Timer capacitor
R9	1.0MΩ		

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

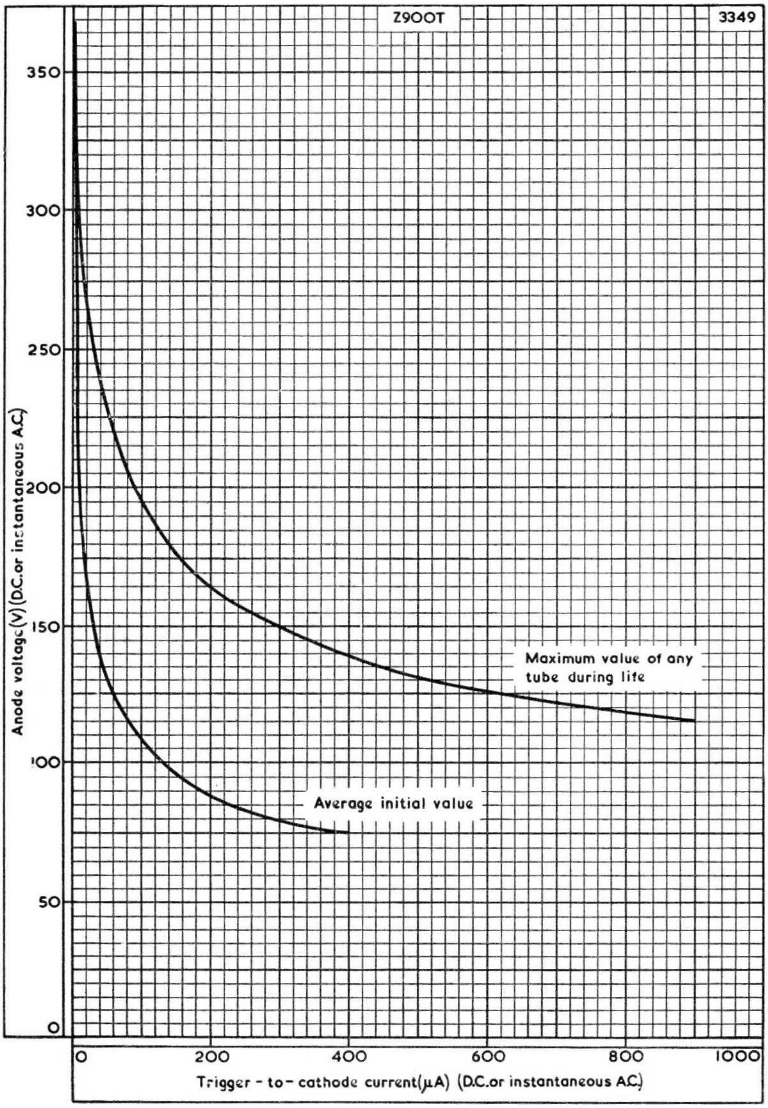


BREAKDOWN CHARACTERISTIC

COLD CATHODE TRIGGER TUBE

Z900T

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.

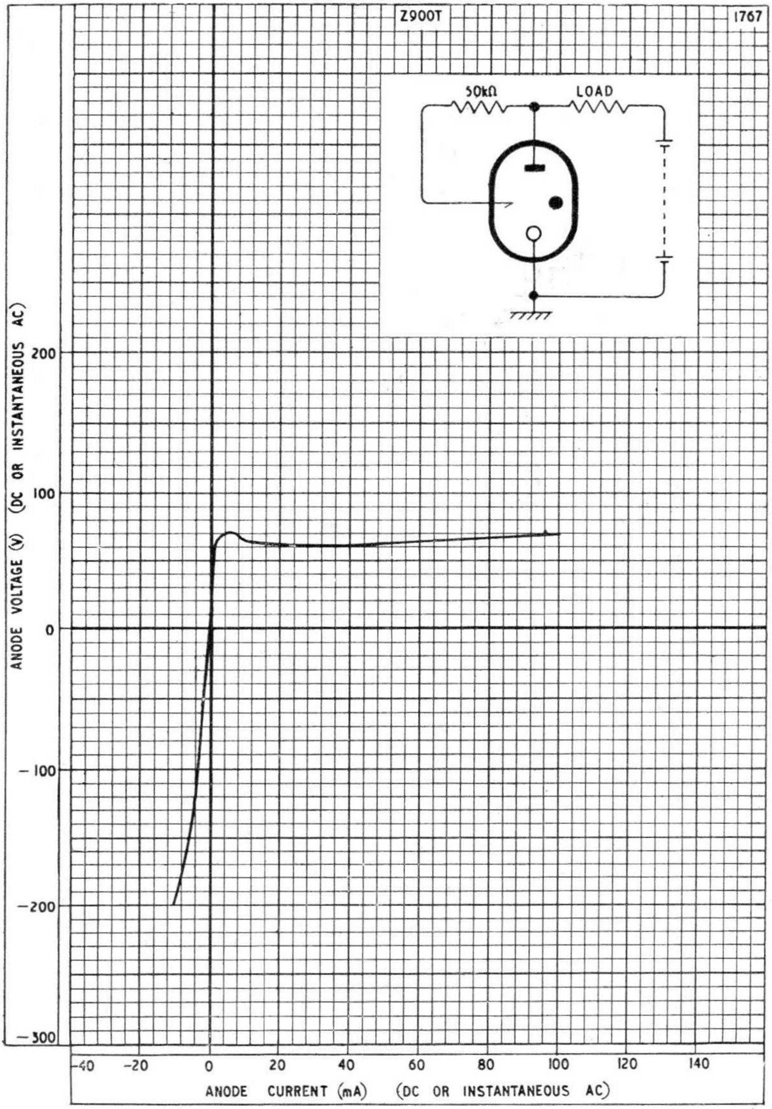


TRANSFER CHARACTERISTIC

Z900T

COLD CATHODE TRIGGER TUBE

Cold cathode inert gas-filled tube suitable for direct operation from 117V a.c. supplies. The tube is ignited by a positive trigger potential and is primarily intended for on-off relay applications.



AVERAGE ANODE CHARACTERISTIC WHEN OPERATED AS A RECTIFIER

LARGE THYRATRONS
AND IGNITRONS

TRANSMITTING AND
INDUSTRIAL HEATING
VALVES

MICROWAVE DEVICES

MISCELLANEOUS

FLASH TUBES

GENERAL

Mullard electronic flash tubes have been designed to cover a wide range of uses in industry, in research on the study of high-speed phenomena, and in commercial photography. The tubes are characterised by a high luminous efficiency, ease of triggering and short flash duration. They are capable of producing several thousand flashes without deterioration in the quality and intensity of the light output. The spectrum of the emitted light approximates closely to that of daylight and they may thus be used in colour photography (see curves following the general operational recommendations).

The time delay between application of the trigger pulse and production of the light flash is less than 50 microseconds, and since the duration of the flash itself is usually much less than 1 millisecond, a flash tube is capable of "freezing" movement for photographic purposes.

OPERATION OF FLASH TUBES

Connections

For reliable operation it is recommended that the anode be maintained at earth potential, the cathode being alive. The trigger electrode should be tied to the anode via the trigger transformer. Failure to do this may result in spontaneous breakdown.

Energy of Discharge

The energy dissipated in the tube must not exceed the maximum value given in the data sheet. If it is intended to use the tube at the maximum rated energy discharge, a high grade voltmeter should be used to measure the voltage across the discharge capacitor ; it is not sufficient to rely upon the nominal output rating of the transformer employed, since the energy is proportional to the square of the voltage ($E=\frac{1}{2}CV^2$). The time between flashes must not be less than the minimum value given in the data sheet for each tube. Failure to observe these points will reduce the life of the tube.

The effective resistance of a flash tube during discharge is very low. The leads connecting the discharge capacitor to the anode and cathode should therefore be as short and as thick as possible to ensure maximum delivery of energy to the tube.

Trigger Voltage

The trigger voltage specified in the data sheet is the peak pulse voltage obtained
→ from a damped oscillatory transient and must be such that it is positive with respect to the other electrodes over the first half cycle of its waveform, otherwise satisfactory operation of the tube may not be ensured. A practical method of obtaining this voltage is to discharge a 0.5μF capacitor through the primary of a transformer, the secondary of which is connected between trigger and anode. A typical trigger voltage waveform is shown in the accompanying curve. The faster the initial voltage rise, the smaller will be the delay time between the onset of the trigger voltage and the start of the flash.

Triggers for Linear Tubes

The type of trigger recommended for linear tubes is a helix of bare wire stretched along the tube from anode to cathode. The pitch of the turns is not critical—a figure of 3.5 to 5 cm is suggested. For reliable operation at the recommended trigger voltage it is necessary that the first turn should start not more than 2 cm from the cathode. Values of trigger voltage given in the data sheets are based on measurements using a trigger of this type.

Covered or enamelled wire should not be used, as permanent glass discoloration may result.

Ventilation

In no circumstances should the hole in the base of the tube be completely enclosed, as the expansion of air due to the heat developed within the dome of the tube may then fracture the envelope.

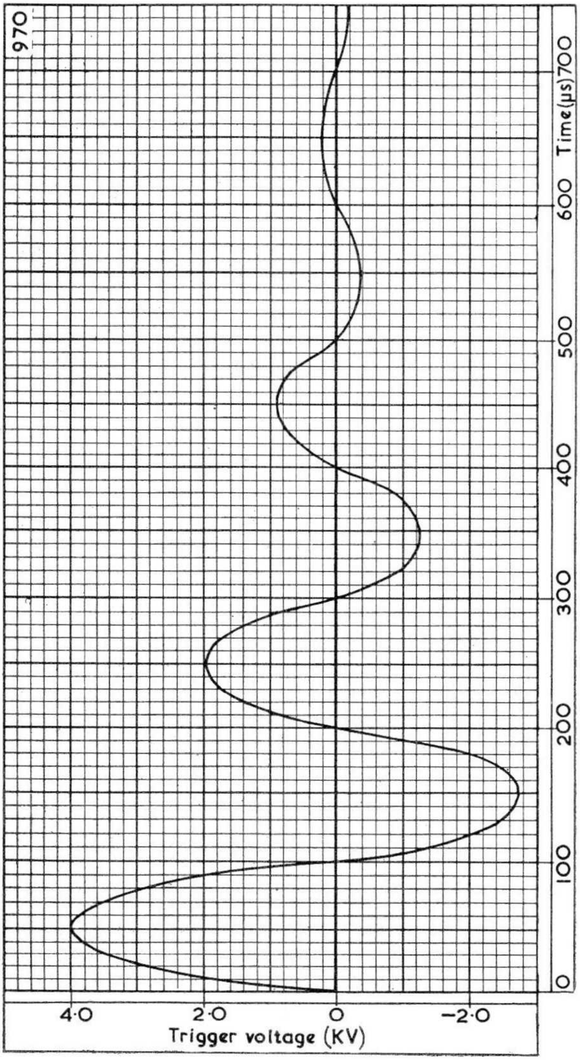
High Voltage Precautions

It is essential that the tube base be kept clean so as to prevent surface leakage between the pins. Soldering should be neat and sharp points avoided to prevent sparking in air.

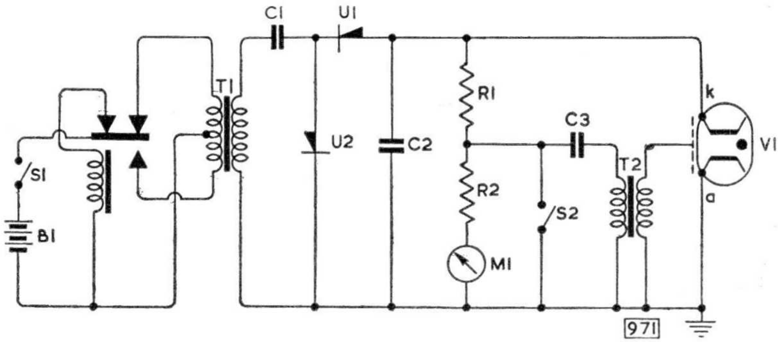
WARNING

IN VIEW OF THE HIGH VOLTAGES AND CAPACITANCES USED IN FLASH EQUIPMENT, CARE MUST BE TAKEN TO ENSURE THAT ALL PARTS WHICH ARE LIKELY TO BE HANDLED ARE ADEQUATELY INSULATED AND PROTECTED.

Flash equipment manufacturers are urged to affix warning labels on each unit pointing out that because of the dangers involved, only experienced servicemen should repair faulty equipment.



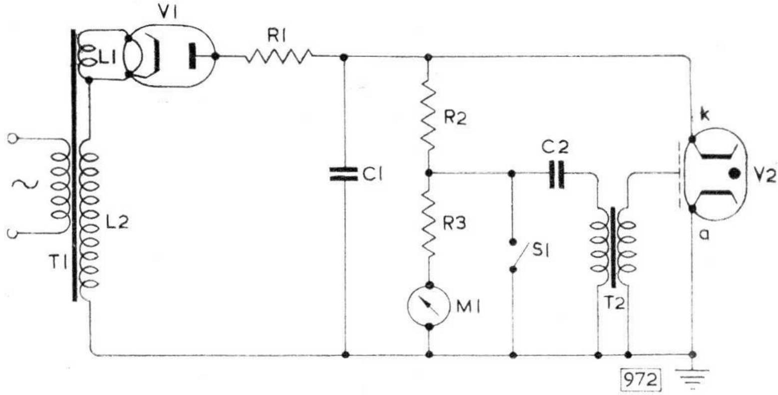
TYPICAL TRIGGER VOLTAGE WAVEFORM



BASIC CIRCUIT FOR BATTERY-OPERATED FLASH TUBE EQUIPMENT

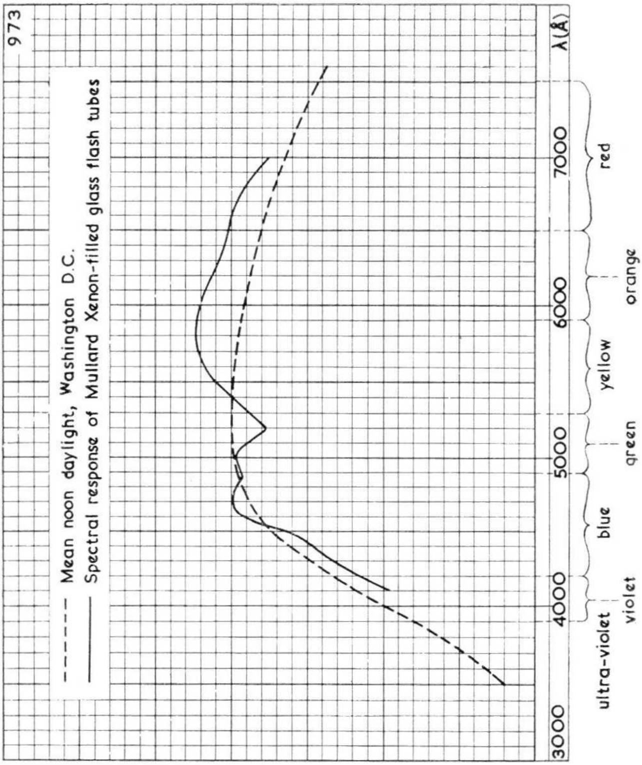
R1	10M Ω
R2	680k Ω
C1	0.05μF (1,000V working)
C2	See Flash Tube Data
C3	1.0μF (500V working)
V1	Flash Tube
M1	Micro-ammeter. 500μA full-scale deflection
*T1	Power transformer
T2	Trigger transformer
*B1	Accumulator or dry batteries
S1	Charging switch
S2	Firing switch
U1, U2	Metal rectifiers. Open circuit input voltage 900V r.m.s. Mean output current 8mA.

*Values should be chosen to provide the required voltage across C2.



BASIC CIRCUIT FOR MAINS-OPERATED FLASH TUBE EQUIPMENT

R1	45 kΩ	
R2	10 MΩ	
R3	680 kΩ	
C1	See Flash Tube Data	
C2	1.0μF (500V working)	
V1	HVR2	
V2	Flash Tube	
M1	Micro-ammeter. 500μA full-scale deflection	
T1	Mains Transformer	L1 = 4.0V, 0.8A L2 = Value chosen to provide required voltage across C1
T2	Trigger Transformer	
S1	Firing Switch	



LIGHT ENERGY DISTRIBUTION CURVE FOR XENON-FILLED GLASS TUBES

PHOTOGRAPHIC FLASH TUBE

LSD3

Cold cathode xenon-filled discharge tube for use in studio or portable photo-flash equipment.

MOUNTING POSITION

Any.

CHARACTERISTICS

Min. anode–to–cathode breakdown voltage	3,000	volts

Following measured at $V_a = 2{,}500$ volts and energy discharge = 100 joules

*Flash duration	100	μ secs
Peak light output	35	Megalumens
Total light output	3,000	Lumen–secs.
Luminous efficiency	30	Lumens/watt
Effective tube resistance (approx.)	3	ohms

*Time taken between rise and fall to 1/*e* (36%) of the peak light output

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	27	100
2,500	32	100
2,000	50	100

LIMITING VALUES (Absolute ratings)

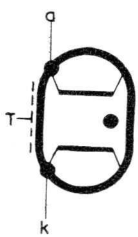
Max. energy discharge	100	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	4,000 to 8,000	volts
Min. time between flashes at 100 joules	10	secs.

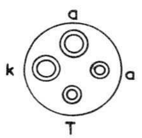
LSD3

PHOTOGRAPHIC FLASH TUBE

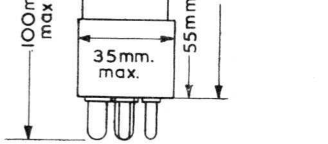
Cold cathode xenon-filled discharge tube for use in studio or portable photo-flash equipment.

1530





4-pin UX base



PHOTOGRAPHIC FLASH TUBE

LSD5

Cold cathode Xenon-filled discharge tube for use in studio photography. A modelling lamp may be inserted within the envelope for use while posing the subject.

MOUNTING POSITION Any.

CHARACTERISTICS

Min. anode-to-cathode breakdown voltage	3,000	V

Following measured at $V_a = 2{,}500$ volts and energy discharge = 1,000 joules

*Flash duration	500	μ secs.
Peak light output	80	Megalumens
Total light output	40×10^3	Lumen-secs.
Luminous efficiency	40	Lumens/watt
Effective tube resistance (approx.)	1.5	ohms

*Time taken between rise and fall to $1/e$ (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	275	1,000
2,500	320	1,000
2,000	500	1,000
2,700	110	400
2,500	128	400
2,000	200	400

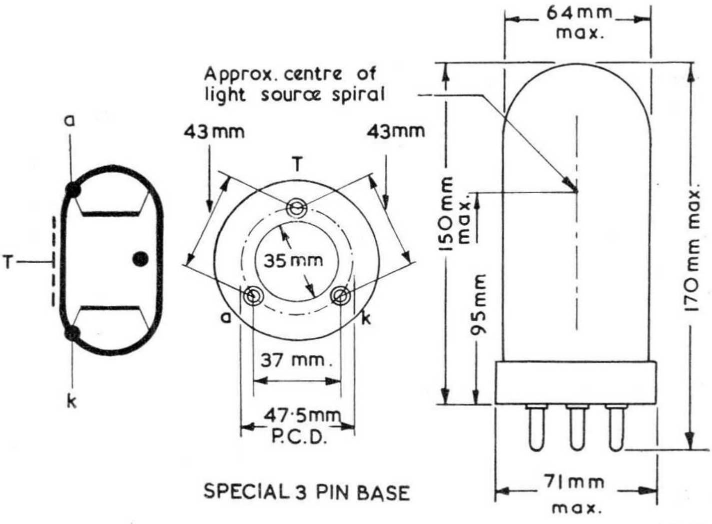
LIMITING VALUES (Absolute ratings)

Max. energy discharge	1,000	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	6,000 to 12,000	volts
Min. time between flashes at 1,000 joules	30	secs.

LSD5

PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio photography. A modelling lamp may be inserted within the envelope for use while posing the subject.



SPECIAL 3 PIN BASE

148

Mullard

PHOTOGRAPHIC FLASH TUBE

LSD7

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment.

MOUNTING POSITION Any

CHARACTERISTICS

Min. anode-to-cathode breakdown voltage	3,000	volts

Following measured at $V_a = 2{,}500$ volts and energy discharge $= 200$ joules

*Flash duration	200	μ secs.
Peak light output	44	Megalumens
Total light output	7,000	Lumens-secs.
Luminous efficiency	35	Lumens/watt
Effective tube resistance (approx.)	3	ohms

*Time taken between rise and fall to $1/e$ (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage (V)	Capacitance (μF)	Energy discharge (joules)
2,700	55	200
2,500	64	200
2,000	100	200

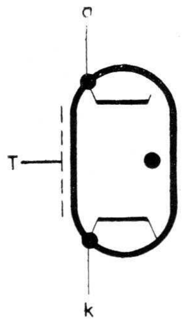
LIMITING VALUES (Absolute ratings)

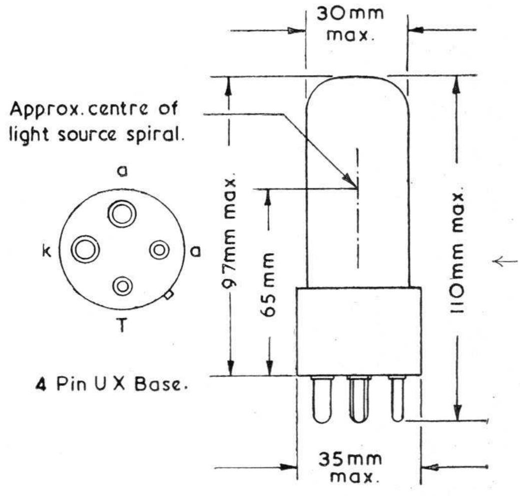
Max. energy discharge	200	joules
Anode voltage limits	2,000 to 2,700	volts
Peak trigger voltage limits	5,000 to 8,000	volts
Min. time between flashes at 200 joules	30	secs.

LSD7

PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment.





1617

PHOTOGRAPHIC FLASH TUBE

LSD24

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment. Designed for operation with an anode voltage of 1.0 kV.

MOUNTING POSITION

Any

CHARACTERISTICS

Min. anode-to-cathode breakdown voltage	1.5	kV

Following measured at $V_a = 1.0$ kV and energy discharge = 100 joules

*Flash duration	150	μ secs.
Peak light output	35	Megalumens
Total light output	3,800	Lumen-secs.
Luminous efficiency	38	Lumens/watt

*Time taken between rise and fall to 1/e (36%) of the peak light output.

OPERATING CONDITIONS

Anode voltage	1.0	kV
*Capacitance	200	μF
Energy discharge	100	joules

*With this type of tube, *electrolytic* capacitors are normally employed. Care should be taken in their selection in order that the maximum ratings of the tube are not exceeded.

LIMITING VALUES (Absolute ratings)

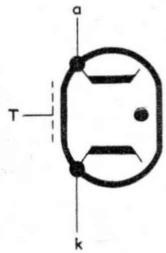
Max. energy discharge	100	joules
Anode voltage limits	0.8 to 1.1	kV
*Min. trigger voltage	6.0	kV
Min. time between flashes at 100 joules	10	secs.

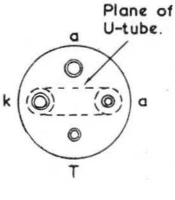
*The maximum time taken to reach the first peak of the trigger voltage waveform should be 10 μ secs. Reduction in the rate of rise of this voltage will result in reduced triggering efficiency.

LSD24

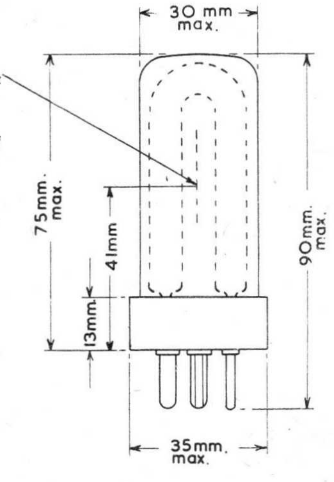
PHOTOGRAPHIC FLASH TUBE

Cold cathode Xenon-filled discharge tube for use in studio or portable photo-flash equipment. Designed for operation with an anode voltage of 1.0 kV.





4 - Pin UX Base.



1417