Mullard

TECHNICAL HANDBOOK

VOL. 1

RECEIVING AND AMPLIFYING VALVES

SPECIAL QUALITY RECEIVING VALVES

TELEVISION PICTURE TUBES

TECHNICAL HANDBOOK SERVICE

PREFACE

In order that you may obtain the maximum benefit from your Mullard Technical Handbook, we ask you to read carefully this short description of the Handbook Service and how it is organised.

By following the simple suggestions given you will ensure that your Handbook is always up to date, and will avoid much unnecessary correspondence and work both at your end and ours.

THE HANDBOOK

The Mullard Technical Handbook is published in seven volumes plus a general index.

You may possess the complete Handbook, or only one or more of the volumes. Should you wish to obtain any volumes not in your possession, please write to Mullard Central Technical Services for subscription terms, quoting the serial number of your existing Handbook.

KEEPING THE HANDBOOK UP TO DATE

Each volume has a separate index, and is sent out complete with section dividers and all current data sheets in their correct positions. As new or revised sheets are issued, copies are sent to all subscribers, together with a list indicating the position in which each sheet should be filed.

ACKNOWLEDGMENT OF RECEIPT OF HANDBOOK

In order to ensure that these sheets reach the correct individual you are earnestly requested, immediately upon receipt of your Handbook, to detach and mail to us the "Acknowledgment of Receipt Card" which you will find just inside the cover. Please make sure that the name and full address to which supplements should be sent are clearly given in the space provided.

CHANGE OF ADDRESS OR OWNERSHIP

Any change in the name or address should be notified in a similar way by using the "Change of Address or Ownership Card" also included at the front of each Handbook.

FILING DATA SHEETS

The prompt use of these postcards will ensure that, as far as is humanly possible, our mailing records and your Handbook are maintained up to date. This can be achieved, however, only with the co-operation of Handbook owners, not only by notifying us of change of address but by filing new data sheets as soon as they are received and removing obsolete sheets.

Neglect of this simple task may lead to loss of data sheets, and an incomplete Handbook congested with out-of-date information.

We occasionally receive letters from Handbook subscribers who have allowed their Handbooks to become disorganised, asking whether they may return them to us to be made up to date. **Please note that we cannot undertake this service.** What we can do, however, is to send you a copy of the latest index so that you can check the contents of your Handbook. We will then send you, free of charge, copies of sheets which may be missing.

CORRESPONDENCE

Correspondence concerning the Handbook Service should be addressed to:

Mullard Limited,
Central Technical Services,
Mullard House,
Torrington Place,
London, W.C.1.

When writing, please quote the SERIAL NUMBER which is given on the introduction page of each Handbook. This number links up with our records and mailing system, and is repeated in the address on every set of supplementary sheets issued. By quoting this number you will save us a great deal of work and avoid delays in answering your letters.

CONTENTS

Volume 1

Part I

Receiving and amplifying valves (current types)

Part II

Special quality receiving valves
Television picture tubes (current types)
Miscellaneous valves

Volume 2

Maintenance type receiving and amplifying valves
Maintenance type cathode ray tubes

Volume 3

Part I

Cathode ray tubes
Photoconductive cells
Photoemissive cells
Camera tubes
Photomultiplier tubes
Image converter tubes

Part II

Switching and indicating gasfilled diodes
Voltage stabiliser and reference level tubes
Decade counter and indicator tubes
Small thyratrons and trigger tubes
Large thyratrons and ignitrons
Power rectifiers (valves)

Part III

Transmitting and industrial heating valves
Quartz crystal units

Volume 3A

Communications magnetrons
Industrial magnetrons
Klystrons
Travelling wave tubes
Disc seal triodes
Microwave components

Volume 4

Part I

Transistors (AC107 to AUY10)

Part II

Transistors (BC107 to GET898)

Part III

Transistors (OC16 to 2N3572)

Part IV

Semiconductor diodes
Photodiodes and phototransistors

Part V

Rectifier diodes
Rectifier diode stacks

Part VI

Thyristors
Thyristor stacks

Volume 5

Fixed capacitors
Variable capacitors
Fixed resistors
Variable resistors
Non-linear resistors
Electromechanical components
Ultra-high vacuum devices
Tuners
Piezoxide components

Volume 6

Part I

Permanent magnets
Wound ferrite assemblies
Magnetic recorder heads
Ferroxcube multi-aperture devices
Ferroxcube storage cores
Ferroxcube switch cores
Memory systems

Part II

Ferroxcube rods, tubes and beads
Ferroxcube U-cores and yokes
Ferroxcube toroids
Ferroxcube transformer cores
Ferroxcube pot cores

Part III

Vinkors
High frequency vinkors

Part IV

IEC size vinkors
IEC size transformer pot cores

Volume 7

Integrated circuits

Made and printed in England by Wightman & Co. Ltd., 1-3 Brixton Road, London, S.W.9

Mullard Technical Handbook

GENERAL INDEX TO VOLUME ONE

This index of Mullard receiving and amplifying valves, special quality receiving valves and television picture tubes will be reissued periodically to incorporate the latest information. It does not include data sheets for maintenance type receiving valves and cathode ray tubes which are contained in Volume 2.

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

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.

Issue No. or Date	*Type No.*	*Pages*
Sept. 67	Preface	4
Oct 67	General Index Vol. 1	4
4	List of Symbols	2

PART I

Receiving and Amplifying Valves (*Current Types*)

Issue No. or Date	*Type No.*	*Pages*
Mar 63	Valve Type Nomenclature	2
Mar 60	General Operational Recommendations	18
July 63	DM160	D1–D2
Mar 60	,,	C1–C2
Dec 65	DY51	D1–D2
Nov 65	,,	C1
Oct 63	DY86 / DY87	D1–D2
Jan 66	DY802	D1–D2
Jan 66	,,	C1
May 59	EA52	D1–D2
May 59	,,	C1
2	EABC80	10
2	EB91	3
1	EBC81	5
July 59	EBF83	D1–D2
July 59	,,	C1–C3
1	EBF89	7
3	ECC81	11

Receiving and Amplifying Valves (*Current Types*)—contd.

Issue No. or Date	*Type No.*	*Pages*
Feb 60	ECC82	D1–D3
Feb 60	,,	C1–C7
June 64	ECC83	D1–D2
May 60	,,	D3–D5
Aug 65	,,	C1–C3
Dec 65	ECC85	D1–D2
Dec 65	,,	C1–C6
Aug 59	ECC88	D1–D2
Oct 59	,,	C1–C3
1	ECF80	10
Sept 60	ECH83	D1–D3
Sept 60	,,	C1–C7
Nov 63	ECH84	D1–D2
Nov 63	,,	C1–C4
Mar 64	,,	C5–C6
2	ECL80	17
1	ECL82	15
Nov 63	ECL86	D1–D4
Nov 63	,,	C1–C8
Jan 60	EF80	D1–D2
Jan 60	,,	C1–C11
July 61	EF85	D1–D2
July 64	,,	C1–C2
Nov 60	,,	C3–C5
Dec 65	EF86	D1–D4
Dec 65	,,	C1–C11

GENERAL INDEX TO VOLUME ONE

Issue No. or Date	*Type No.*	*Pages*
Receiving and Amplifying Valves (*Current Types*)—contd.		
Oct 61	EF91	D1–D2
Oct 61	,,	C1–C13
Oct 61	EF92	D1–D2
Oct 61	,,	C1–C8
Jan 63	EF95	D1–D2
July 61	,,	C1–C6
Feb 62	EF183	D1–D4
Aug 61	,,	C1–C2
July 64	,,	C3–C4
Aug 61	,,	C5–C10
Feb 62	EF184	D1–D2
Sept 63	,,	C1–C6
May 63	,,	C7–C8
Sept 63	,,	C9–C12
Apr 64	EL360	D1–D2
Oct 58	,,	D3
July 60	,,	C1–C12
Mar 61	,,	C13–C16
June 63	,,	C17–C22
Feb 60	EM81	D1–D2
Feb 60	,,	C1
May 62	EM87	D1–D2
May 62	,,	C1
July 64	EY86 / EY87	D1–D2
July 64	,,	C1
Jan 60	EZ80	D1
Jan 60	,,	C1–C2
Jan 67	GY501	D1–D2
May 65	,,	C1
Apr 65	PC86	D1–D2
Oct 63	,,	C1–C2
July 63	PC88	D1–D2
July 63	,,	C1–C2
Dec 65	PC900	D1–D2
Dec 65	,,	C1–C5
Dec 65	PCC85	D1

Issue No. or Date	*Type No.*	*Pages*
Receiving and Amplifying Valves (*Current Types*)—contd.		
Mar 61	PCC89	D1–D2
Sept 60	,,	D3–D4
Feb 59	,,	C1–C2
July 64	,,	C3–C4
Sept 62	PCC189	D1–D2
Sept 62	,,	C1–C3
3	PCF80	11
June 63	PCF86	D1–D2
Jan 62	,,	C1–C2
Nov 60	,,	C3–C4
June 63	,,	C5–C6
Nov 60	,,	C7
Mar 64	PCF801	D1–D3
Mar 64	,,	C1–C2
July 64	,,	C3–C4
Mar 64	,,	C5–C12
Oct 63	PCF802	D1–D3
Oct 63	,,	C1–C6
Mar 63	PCF806	D1–D2
June 62	,,	C1–C7
Dec 65	PCH200	D1–D3
Dec 65	,,	C1–C4
Apr 60	PCL82	D1–D4
July 60	,,	C1–C14
July 59	PCL84	D1–D3
July 59	,,	C1–C8
June 62	,,	C9
May 65	PCL85	D1–D4
May 65	,,	C1–C4
Oct 61	,,	C5–C10
Oct 63	PCL86	D1–D3
Oct 63	,,	C1–C6
Apr 67	PD500	D1–D2
Apr 67	,,	C1
Feb 66	PFL200	D1–D2
Feb 66	,,	C1–C13

GENERAL INDEX TO VOLUME ONE

Issue No. or Date	*Type No.*	*Page*
Receiving and Amplifying Valves (*Current Types*)—contd.		
Sept 61	PL36	D1–D2
Apr 61	,,	C1–C2
Sept 59	,,	C3–C4
Apr 61	,,	C5–C6
June 62	,,	C7
Dec 65	PL81A	D1–D3
Dec 65	,,	C1–C6
2	PL83	5
May 59	PL84	D1–D2
Mar 60	,,	C1–C6
Dec 65	PL500	D1–D3
Dec 65	,,	C1–C7
Dec 65	PL504	D1–D3
Dec 65	,,	C1–C7
Mar 66	PL505	D1–D2
Mar 66	,,	C1–C2
Aug 67	PL508	D1–D2
Apr 66	,,	C1–C3
Mar 67	PL509	D1–D2
Mar 67	,,	C1–C4
May 67	PL802	D1–D3
May 67	,,	C1–C3
June 59	PY81	D1–D2
June 59	,,	C1
May 59	PY88	D1
June 61	,,	C1
July 65	PY500	D1–D2
July 65	,,	C1
May 65	PY800	D1
May 65	,,	C1
Feb 60	UABC80	D1–D3
Feb 60	,,	C1–C7
1	UBF89	9
Dec 65	UCC85	D1–D3
Dec 65	,,	C1–C8

Issue No. or Date	*Type No.*	*Pages*
Receiving and Amplifying Valves (*Current Types*)—contd.		
July 60	UCH81	D1–D3
July 60	,,	C1–C15
1	UCL82	13
Nov 59	UF89	D1–D2
Nov 59	,,	C1–C6
Mar 61	UL84	D1–D3
Mar 61	,,	C1–C11
Feb 60	UY85	D1–D2
Feb 60	,,	C1–C2
Jan 63	6AS6	D1–D2
Aug 59	,,	C1–C8
PART II		
Special Quality Receiving Valves		
Nov 58	General Notes	3
Apr 65	E55L	D1–D2
Sept 62	,,	D3
May 62	,,	C1–C10
Oct 61	E80CF	D1–D4
Oct 61	,,	C1–C6
July 64	E88C	D1–D2
Nov 64	,,	C1
Feb 63	E88CC	D1–D2
May 66	,,	D3–D4
Feb 64	,,	C1–C6
May 66	,,	C7–C8
Sept 63	E180F	D1–D2
Jan 64	,,	D3–D4
Aug 64	,,	C1–C8
July 67	E810F	D1–D4
Mar 66	,,	D5
Feb 64	,,	C1–C2
Jan 63	,,	C3–C4
Feb 64	,,	C5–C6
Jan 63	,,	C7–C8
Mar 66	,,	C9–C11

Issue No. or Date	*Type No.*	*Pages*
Special Quality Receiving Valves —contd.		
July 65	EC1000	D1–D3
July 65	,,	C1–C2
Apr 66	ECC2000	D1–D4
Apr 66	,,	C1–C5
June 60	M8079	D1–D6
June 60	,,	C1
Apr 60	M8083	D1–D6
Nov 58	,,	C1–C12
June 60	M8096	D1–D6
Oct 59	,,	C1–C2
Jan 63	M8100	D1–D2
June 60	,,	D3–D6
Mar 59	,,	C1–C6
June 60	M8136	D1–D6
Sept 59	,,	C1–C6
Apr 64	,,	C7–C8
June 60	M8137	D1–D6
Nov 59	,,	C1–C2
July 62	M8161	D1–D2
Sept 60	,,	D3–D6
Sept 59	,,	C1–C2
Mar 59	,,	C3–C10
June 63	M8162	D1–D2
June 60	,,	D3–D6
July 61	,,	C1–C6
Jan 63	M8196	D1–D2
Aug 60	,,	D3–D6
Apr 59	,,	C1–C6
Apr 61	5840	D1–D6
Oct 58	,,	C1–C2
Mar 61	6021	D1–D6
Apr 59	,,	C1–C2

Issue No. or Date	*Type No.*	*Pages*
Television Picture Tubes (*Current Types*)		
Data sheets for cathode ray tubes for other applications are in Volume 3.		
Sept 67	Tube Type Nomenclature	2
3	General Operational Recommendations	11
Sept 67	Screen Type 'W'	1
Sept 67	A28–14W	D1–D10
Sept 67	,,	C1–C4
Feb 66	A47–11W	D1–D10
Feb 66	,,	C1–C4
Jan 66	A47–14W	D1–D9
Jan 66	,,	C1–C4
Sept 67	A47–26W	D1–D8
May 67	,,	C1–C4
Apr 67	A49–11X	D1–D11
Apr 67	,,	C1–C3
Feb 66	A59–11W	D1–D10
Feb 66	,,	C1–C4
Jan 66	A59–15W	D1–D9
Jan 66	,,	C1–C4
May 67	A59–23W	D1–D8
May 67	,,	C1–C4
Apr 67	A63–11X	D1–D8
Jan 67	,,	D9–D12
Sept 67	,,	D13–D21
Jan 67	,,	C1–C3
Feb 66	A65–11W	D1–D10
Feb 66	,,	C1–C4
Miscellaneous Valves		
Apr 60	ME1400	D1–D2
Apr 60	,,	C1–C5
3	ME1401	4
Aug 66	ME1402	D1–D2
4	,,	3–5
Oct 58	ME1403	D1–D2
Oct 58	,,	C1–C6
May 59	ME1404	D1–D2
May 59	,,	C1–C2

GENERAL INDEX TO VOLUME ONE

Special Quality Receiving Valves—contd.

Issue No. or Date	*Type No.*	*Pages*
Jan 63	M8196	D1–D2
Aug 60	,,	D3–D6
Apr 59	,,	C1–C6
June 60	M8212	D1–D6
May 66	,,	C1
Apr 61	5840	D1–D6
Oct 58	,,	C1–C2
Mar 61	6021	D1–D6
Apr 59	,,	C1–C2

Television Picture Tubes (*Current Types*)

Data sheets for cathode ray tubes for other applications are in Volume 3.

Issue No. or Date	*Type No.*	*Pages*
July 62	Tube Type Nomenclature	2
3	General Operational Recommendations	11
1	Screen Type 'W'	1

Television Picture Tubes (*Current Types*)—contd.

Issue No. or Date	*Type No.*	*Pages*
Feb 66	A47–11W	D1–D10
Feb 66	,,	C1–C4
Jan 66	A47–14W	D1–D9
Jan 66	,,	C1–C4
Feb 66	A59–11W	D1–D10
Feb 66	,,	C1–C4
Jan 66	A59–15W	D1–D9
Jan 66	,,	C1–C4
*	A63-11X	
Feb 66	A65–11W	D1–D10
Feb 66	,,	C1–C4

Miscellaneous Valves

Issue No. or Date	*Type No.*	*Pages*
Apr 60	ME1400	D1–D2
Apr 60	,,	C1–C5
3	ME1401	4
4	ME1402	5
Oct 58	ME1403	D1–D2
Oct 58	,,	C1–C6
May 59	ME1404	D1–D2
May 59	,,	C1–C2

RECEIVING AND
AMPLIFYING VALVES

GENERAL OPERATIONAL RECOMMENDATIONS

The following recommendations have been based on the British Standard Code of Practice CP1005: Parts 1 and 2, 1954, " The Use of Electronic Valves ".

1. DEFINITIONS OF RATING SYSTEMS

Unless otherwise stated, all limiting values given in the Mullard Technical Handbook are in accordance wih the design-centre rating system. The design-maximum and absolute-maximum rating systems may be used in certain circumstances. The following definitions of these three rating systems are based on those agreed by the International Electrotechnical Commission:–

1.1 Design-centre rating system

Design-centre ratings are limiting values of operating and environmental conditions applicable to a bogey valve of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the valve manufacturer to provide acceptable serviceability of the valve in average applications, taking responsibility for normal changes in operating conditions due to rated supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electron devices in the equipment.

The equipment manufacturer should design so that initially no design-centre value for the intended service is exceeded with a bogey valve in equipment operating at the stated normal supply voltage. A bogey valve is one whose characteristics have the published nominal values for the type. For a bogey valve for any particular application, only those characteristics which are directly related to the application need be considered.

1.2 Design-maximum rating system

Design-maximum ratings are limiting values of operating and environmental conditions applicable to a bogey 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 responsibility for the effects of changes in operating conditions due to variations in the characteristics of the valve under consideration.

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

1.3 Absolute-maximum rating system

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 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.

2. INTERPRETATION OF DESIGN-CENTRE RATINGS

When the circuit designer uses the design-centre system he should realise that the valve manufacturer takes into account the effects of normal random variations in conditions and components and assumes that normal good practice is followed in the design and use of components. No allowance is made for discrete changes in conditions or components.

2.1 Rated supply voltage and its variation

In equipment which is to operate from the normal supply mains a voltage tap should be provided for every declared mains voltage. Where this is not practicable however, and two or more declared voltages are covered by one tap, compliance with the design-centre system must be checked on the highest and lowest declared voltages in each tap. For the purpose of checking, all devices must be bogey.

If the equipment is checked in this way and the designer has complied with all other relevant sections in these recommendations the equipment can be operated from a supply that has normally-encountered voltage variations of up to $\pm 10\%$. (The normal ratio of power variation to voltage variation of approximately 2 : 1 is assumed. If the ratio is greater than 2 : 1 in a particular circuit, the maximum permissible dissipation at which any valve can operate must be reduced accordingly below the limiting value.) Where a valve is recommended solely for low voltage operation (as in the car-radio range) allowance has already been made for the variations in accumulator voltage, which can be greater than 10%. For further recommendations see section 3.1.5.

For valves intended for operation from dry batteries where the relevant maximum battery voltage is quoted under limiting values, due allowance has already been made for the fact that the battery terminal voltage is higher for a new battery and falls during life. For mains operation, the maximum battery voltage quoted under limiting values should be taken as the limiting value on the design centre system. For further recommendations on battery and battery-mains operation of filamentary valves see section 3.2.

2.2 Equipment components and their variations

In an equipment the operation of any one component is to some extent dependent on every other component in that equipment. It is good practice to use self bias, such as provided by a cathode resistor or grid current bias (see section 5.3), rather than fixed bias. When this is done, further components can be added as long as the added variations are not large compared with those already existing, as in general the addition of a component to a circuit reduces the effects of the variations of the other components already in that circuit, besides adding the effect of its own variations.

If a power valve or high-slope valve is operated within 20% of its maximum dissipation rating, a ±10% tolerance cathode-bias resistor should be used. If a cathode-bias resistor cannot be used, then with a pentode or other multigrid valve a screen-grid dropping resistor having a ±10% tolerance should be incorporated (see section 5.4). Similarly, with a triode a dropping resistor should be used in the anode circuit (see section 5.6). Valves should not be used in circuits where their operating conditions are dependent on another circuit or valve, unless the more important transferred variations are small compared with the variations in the operating conditions. When two valves are used in push-pull, for example, separate cathode-bias resistors should be used.

2.3 Equipment control adjustment

The valve manufacturer's responsibilities do not include conditions produced by gross maladjustment of controls which result in incorrect operation of the equipment.

When a pentode or other multigrid valve is used under conditions where the equipment control adjustment affects the valve operating conditions, special attention must be paid to the screen-grid operating conditions (see section 5.4).

In equipment which has multiple functions (e.g. transmitter/receivers, t.v./f.m. receivers, etc.), it is assumed that the valves are used within their ratings in all modes of equipment operation.

2.4 Load variation

The valve manufacturer takes responsibility for the changes in valve operating conditions which are caused by the normal random variations of any component connected externally as a load, provided that normal good practice has been followed in the design and use of the component. Where definite changes occur in the load, all ratings should be checked at the worst long period running condition.

2.5 Signal variation

The valve manufacturer accepts responsibility for changes in the operating conditions due to random variations in signal (fading etc.) but not due to discrete changes (switching, or tuning to stations of varying strengths). When a.g.c. is used, the operating conditions of the valves will change with the strength of signal received. The operating conditions of all the stages (controlled and uncontrolled) must therefore be checked under their worst long period running conditions.

2.6 Environment

It is good practice to ensure that the bulb and base temperatures are kept low. They should not exceed the published limiting values in the environment for which the equipment is designed. Where equipment may be run under more than one condition it should be checked at each condition. If the maximum temperature ratings are not given on the data sheet of the valve in question, see Fig. 1 (Appendix III).

Care should be taken to ensure that the minimum pressure in the environment for which the equipment is designed is not less than the published limit. In general, B7G and B9A based valves can be used at pressures down to approximately 50mm Hg (that is up to altitudes of about 60,000ft). The manufacturer's advice should be sought if it is desired to operate octal-based valves at pressures below 525mm Hg (that is above altitudes of about 10,000ft).

2.7 Other electron devices

The valve manufacturer takes responsibility for changes in operating conditions caused by the variations in the characteristics of all other electron devices in the equipment, provided that normal good practice has been followed in the use of each electron device, i.e. the added variations are not large compared with those already existing.

3. HEATER AND FILAMENT RATINGS

3.1 Indirectly heated valves

3.1.1 Parallel operation (mains supply)

The heater voltage of individual valves must be within $\pm 7\%$ of the rated value (unless otherwise stated) when the supply voltage is at its nominal value, and valves with bogey heater characteristics are employed.

This variation is normally dependent upon more than one factor. The total variation may be taken as the square root of the sum of the squares of the individual variations arising from the effects of the tolerances of the separate factors, provided that no one of these deviations exceeds $\pm 5\%$.

If a tap is used for more than one input voltage (as provided for in paragraph 2.1) the heater voltage of each valve must be checked on the highest and lowest declared voltages covered by the tap and should be within $\pm 4\%$ of the rated value.

3.1.2 Series operation (mains supply)

The heater current of series connected valves should be within $\pm 3.5\%$ of the rated value when the supply voltage is at its nominal value, and valves with bogey heater characteristics are employed.

This variation is normally dependent upon more than one factor. The total variation may be taken as the square root of the sum of the squares of the individual variations arising from the effects of the tolerances of the separate factors, provided that no one of these variations exceeds $\pm 2.5\%$.

If a tap is used for more than one input voltage (as provided for in paragraph 2.1) the heater current must be checked on the highest and lowest declared voltages covered by the tap and should be within $\pm 2\%$ of the rated value.

In applications where a wide variation in the dynamic characteristics of the valve is acceptable, as for example in simple a.m. broadcast receivers and low-cost amplifiers, the heater current tolerance may be increased from $\pm 3.5\%$ to $\pm 5\%$. This allows for the use of three taps to cover the range 200 to 250V even in applications where the chain consists mainly of a dropping resistor. It is permissible for the heater voltage to rise to a maximum value 50% in excess of the nominal rated value during switching and the warming-up period when using valves with nominal heater characteristics, unless otherwise stated.

3.1.3 Pulse and r.f. operation of heaters

When a valve heater is operated from a pulse or r.f. supply, special care should be taken to ensure that the correct power is delivered to the heater and that the peak voltage across the heater is not excessive.

In many rectifier applications, the valve will be required to supply only small currents. In these cases a relaxation of the normal ±7% heater voltage tolerance is allowed for some valve types. Details of the permissible relaxation are given on the appropriate data sheets.

3.1.4 Fluctuations in mains supply voltage

In addition to the tolerances quoted in 3.1.1, 3.1.2 and 3.1.3 above, fluctuations in the mains supply voltage not exceeding ±10% are permissible. These conditions are, however, the worst which are acceptable, and it is better practice to maintain the heater as close to its nominal rating as is possible.

Closer adherence to the rated heater voltage or current produces optimum valve life and performance.

3.1.5 Parallel, series or series-parallel operation from accumulators

When valve heaters are supplied in parallel from a 6.3V "on charge" accumulator, a resistor must be included to make up the difference between the heater voltage and the "on charge" battery voltage of 7V.

When valve heaters are supplied from an accumulator and are connected in a series-parallel arrangement, as is common for mobile operation, equalising bars should be used: that is, the points in the parallel chains which are at equal potential should be interconnected. It is necessary to have at least two, and preferably three, heaters connected in parallel in the resulting series-parallel arrangements, so that the variations are reduced to those which are expected with parallel operation. If this is done, up to four 6.3V valves can be connected in series and fed from an "on charge" 24V accumulator, or two from a 12V accumulator, provided that a resistor is included to make up the difference between the total heater voltage and the nominal "on charge" battery voltage. The nominal "on charge" battery voltages may be taken as 28V and 14V respectively.

If it is then required to operate from an accumulator that is not on charge, e.g. under emergency conditions, the equipment designer must ensure that his circuits will operate satisfactorily with any valves of the types in question, both when new and throughout life. It is suggested that the series dropping resistor should be switched out of circuit during "off charge" operation. The advice of the valve manufacturer can be sought on any specific points. Where life and reliability are of particular importance, with a series-parallel heater arrangement the supply voltage variation should be kept to a minimum, preferably less than ±2%.

3.2 Filamentary Valves

3.2.1 Parallel operation

3.2.1.1 *1.25V filamentary valves*

Valves with 1.25V filaments are designed to be operated from a dry cell with a rated terminal voltage of 1.3V. The lowest filament voltage at which the valve may be expected to operate satisfactorily is approximately 1.0V. If these valves are operated from dry cells with a rated terminal voltage of 1.5V, a suitable dropping resistor must be used.

3.2.1.2 *1.4V filamentary valves*

Valves with 1.4V filaments are designed to be operated from a dry cell with a rated terminal voltage of 1.5V. The lowest filament voltage at which the valve may be expected to operate satisfactorily is approximately 1.1V.

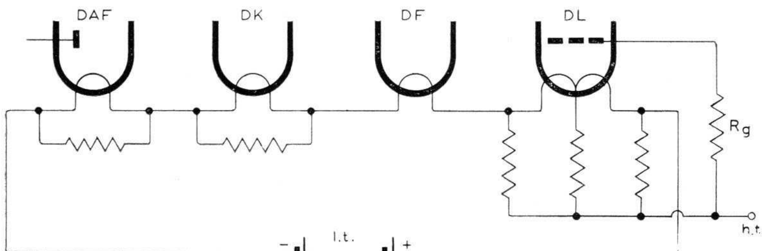
3.2.2 Series operation

Valves with 1.4V filaments may be used with their filaments in series. Valves with 1.25V filaments are not recommended for this form of operation.

3.2.2.1 *Operation from dry cells*

If valves with 1.4V filaments are operated with their filaments in series from dry cell batteries, shunting resistors will be required to by-pass sufficient cathode current to ensure that the correct filament current flows in the chain. In order to calculate the required value of shunt resistor the division of cathode current between the two filament limbs must be known or determined by measurement. In equipment which has separate h.t. and l.t. batteries, the question of battery replacement must be considered. If the bias for the output valve is not made independent of the l.t. battery, large variations can occur in the cathode current of the output stage when the h.t. and l.t. batteries are renewed at different times.

For this reason the following circuit is preferred:



3.2.2.2 *Mains operation*

When valves are operated in series from the mains supply via a dropping resistor, the voltage drop across each 1.4V filament section should have a nominal value of 1.3V. At 1.3V the filament current of the 25mA range is 24mA and of the 50mA range is 48mA. The filament current in the chain should be within $\pm 2\%$ of these values. The voltage drop across the series resistor should be at least six times the sum of the filament voltages in order to minimise the effect of variation in the resistance of individual filaments. The series resistor should preferably be adjusted in each receiver to the required nominal value. It must have a positive temperature coefficient and should be designed to reach a stable temperature shortly after switching on. If these recommendations are followed the equipment can be operated from a mains supply that has normally-encountered voltage variations of up to $\pm 10\%$.

If the equipment is to be used on mains only, and not on dry cells, shunt resistors can be used throughout, instead of the by-pass resistors shown in the recommended circuit. In order to calculate the value of shunt resistor required, the division of cathode current between the two filament limbs must again be known.

4. CAPACITANCES

Unless otherwise stated, the capacitances quoted are measured at 1Mc/s with the valve cold in a fully screened socket, with or without an external shield, as stated on the individual data sheets. In practice, allowance should be made for the increase in capacitances due to space-charge effects in the valve, the capacitance of the valve holder itself, and the wiring.

An explanation of symbols for capacitances is given in Appendix II (p. 15).

5. VALVE ELECTRODES

5.1 General

Valves should always be operated with a d.c. connection between each electrode and the cathode.

It should be noted that the secondary-emission characteristics of valve electrodes may vary from valve to valve, and the use of these characteristics is not in general recommended, except in the case of valves designed as secondary-emission valves.

5.2 Cathode

5.2.1 Voltage between cathode and heater

The maximum values of cathode-to-heater voltage quoted on individual data sheets are the maximum d.c. values (unless otherwise stated) and apply to that side of the heater where the cathode-to-heater voltage is greater.

Where a.c. or a.c. and d.c. exist between heater and cathode, the d.c. component must not exceed the published value, and in addition the maximum instantaneous value occurring must never exceed twice the published value, or 300V whichever is the lesser, unless a specific rating is quoted. This applies to pulse voltages as well as sine-wave voltages.

The cathode-to-heater voltage should always be kept as low as possible, and it is preferable to have the cathode positive with respect to the heater. Where the cathode-to-heater voltage cannot be kept low, it is helpful, in the interests of reliability, if the d.c. resistance is kept as high as possible, consistent with the circuit requirements for hum and cathode-to-heater leakage current.

5.2.2 External resistance between cathode and heater

When cathode resistors of high value are used, the valve performance may be influenced by leakage between heater and cathode, which may give rise to difficulties when valves are replaced or the leakage between heater and cathode varies during life. A maximum value of 20kΩ is therefore recommended for the external resistance between cathode and heater. The maximum may however be increased up to 1MΩ if the d.c. component of the cathode-to-heater voltage is such that its instantaneous value never drops below three times the r.m.s. value of the heater voltage. The hum voltage produced across the resistance might assume a rather high value under these conditions.

5.2.3 Rectifier cathodes

Disintegration of the cathode coating may occur in both indirectly heated and directly heated rectifiers if the total resistance in series with the anode is less than that specified on the data sheet for the particular valve. The value of the resistance depends upon the effective resistance, R_t due to the transformer.

$$R_t = R_s + n^2 R_p$$

Where:

Rs = Resistance of the transformer secondary in anode circuit.

Rp = Resistance of the transformer primary.

n = Secondary to primary ratio in half-wave circuits or half-secondary to primary ratio in full-wave circuits.

If the resistance R_t is less than the minimum specified value for the limiting resistance, an additional series resistance must be included in the lead to each anode. The wattage rating of this resistor should be at least three times that required for d.c. only.

5.3 Control grid

In general, it is good practice to keep the resistance of the circuit between the control grid and the cathode as low as possible. It should not exceed the maximum value quoted on the data sheet.

Unless otherwise stated the value of R_{g1-k} max. given in the limiting values refers to operation of the valve with fixed bias. The maximum value for cathode bias operation can be obtained from Fig. 3 (Appendix III).

If grid current biasing is employed, the value of grid resistor will depend on the application. For a.f. voltage amplifiers the grid resistor value should be high (preferably greater than 10MΩ) but not greater than 22MΩ. For r.f. and i.f. valves the value for normal cathode bias should not be exceeded (i.e. twice the fixed bias value).

The values of currents and dissipations should be checked when the grid is connected to cathode. High-slope valves ($g_m > 5$mA/V) should not generally be operated with grid current bias only unless some d.c. feed-back is included in the form of a screen-grid dropper (in the case of a pentode) or an anode dropper (in the case of a triode), and a low value of cathode resistor (such as that required to compensate for variations in input capacitance with a.g.c.) is incorporated. Compliance with the design-centre limiting values must then be checked with the grid connected directly to the negative end of this cathode resistor.

When valves are operated under conditions chosen to give low control-grid currents, the grid resistor value may be very high. If this mode of operation is required the advice of the valve manufacturer should be sought.

In circuits where positive control-grid current flows, either continuously or intermittently, the limiting values relevant to the control grid must never be exceeded.

Where large signals are applied to the grid of a valve, a grid resistor should be used so that the bias is obtained by grid current rectification, and the variations in the drive will not noticeably affect the valve operating conditions. When this is done, it should be ascertained that limiting values will not be exceeded in the event of loss of drive. This risk may be avoided by providing sufficient cathode bias.

If fixed bias is used for a valve, provision should be made for adjusting the bias so that the nominal value of anode current flows. This is particularly important in the case of class "B" output valves when separate adjust-ment should be provided for each valve.

5.4 Screen grid

The rating chart in Fig. 2(p. 17) can be used to relate screen-grid dissipation to screen-grid voltage, provided that other limiting values are not exceeded, and that a resistor is used in the screen-grid circuit.

For large signal applications, in which the operating conditions of the valve can be varied (for example, by varying the drive) the screen-grid dissipation must be checked at the worst long period running conditions and also during the warm-up period. With speech and music the average level is low compared with the peaks, and operation will be quite satis-factory if the screen-grid dissipation is checked at points up to one third of the output power.

In general, the effect of the cathode resistor is reduced by large signals, and a screen-grid resistor becomes necessary. This resistor normally need not drop more than 20% of the h.t. line voltage. If this resistor is un-bypassed, it need only drop about 10% of the h.t. line voltage.

When a valve with a screen grid is connected as a triode, and specific recommendations are not given in the data, the dissipations of the anode and screen grid should not exceed their individual maximum ratings.

5.5 Suppressor grid

The suppressor grid should normally be connected directly to the cathode or to the negative end of the cathode resistor whichever is more convenient. The suppressor grid should not be used as a control grid unless specific recommendations are made in the data. Where the suppressor grid is so used, care should be taken not to exceed the maximum screen-grid dissipation. When a valve is connected as a triode, the suppressor grid should be connected directly to the cathode, except where other recommendations are given in the data. In applications where the suppressor grid is liable to be driven positive, the value of R_{g3-k} should not exceed 50kΩ unless otherwise stated.

5.6 Anode

The rating chart given in Fig. 2 can be used to relate anode dissipation to anode voltage, providing that other limiting values are not exceeded, and that the load used in the anode circuit is a resistor. For large signal applications, the anode dissipation must be checked at the worst long period running condition.

When a triode is used in large signal applications, some resistance should be included in series with its anode. The value required is very dependent on the application, and in the extreme when a triode is biased beyond cut-off and driven well into the positive grid region, e.g. as in class "C" operation, the load impedance in the anode circuit may be sufficient. In this application, however, the use of a cathode resistor is generally recommended to safeguard the valve in the event of loss of drive. If class "B" operation is to be used without a cathode resistor, it must be remembered that large variations can occur near the cut-off point. It is therefore necessary to ensure that all valves will operate at about the same condition, e.g. adjust the bias of each valve to give the required no-signal anode current.

6. MECHANICAL CONSIDERATIONS

6.1 Mounting position

Unless otherwise stated in the published data, valves can be mounted in any position.

6.2 Valve holders

Detailed drawings of pin spacing, diameter and length are given in BS448: 1953 "Electronic–valve Bases, Caps and Holders". When wiring a valve holder for an all-glass based valve, a wiring jig should be inserted to prevent the contacts being displaced. Such displacement could cause damage to the pins when a valve is inserted in the holder. Dimensions for suitable jigs are given in BS448. Pins marked IC on the base diagram in the data sheet may have been used for connections within the valve. The corresponding contacts on the valve holder must be left free and not be used as anchoring points when wiring.

6.3 Valves with flexible leads

Valves with flexible leads do not normally employ plug-in valve holders and it is usually necessary to secure them in position solely by means of the envelope. Any such support should not cause undue stress to be placed on the flexible leads. Attention should also be given to the effect this mounting may have upon bulb temperature.

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

Precautions should be taken during soldering to ensure that the glass temperature at the seal is not allowed to rise excessively. One simple method is to clamp a thermal shunt to the wire between the glass and the point being soldered.

6.4 Dimensions

Only the dimensions given on the data sheets should be used in the design of equipment. Dimensions taken from individual valves must never be used for this purpose.

7. COOLING

As stated in Section 2.6 the bulb and/or base temperatures must not exceed the published maxima, and it is in general good practice to take steps to ensure that the bulb and base temperatures are kept low.

Use may be made of all three methods of cooling, namely convection, radiation and conduction.

7.1 Convection and radiation cooling

A valve mounted in free air is cooled by convection currents and by radiation to its surroundings. In order to make these methods most efficient it is necessary to ensure as free a circulation of air round the valve as possible and to maintain neighbouring bodies at as low a temperature as possible.

The design of valve screening or retaining devices should conform to the above principles; that is to say, the device should permit free circulation of cooling air and should reflect as little heat as possible back to the bulb. Where adequate convection cooling cannot be realised because of mechanical limitations, high altitude, or high temperature of the air available for circulation, forced-air cooling or conduction cooling must be adopted.

7.2 Conduction cooling

Conduction cooling is obtained by mounting the valve in contact with a mass of material which has good heat-conducting properties. This material then acts as a "heat sink." The clamp or can which is used to couple the valve to the heat sink should ensure good thermal contact with the bulb and base of the valve, and should also ensure that the maximum base temperature of 165°C is never exceeded. Heat-sink cooling is particularly suitable for use with flexible-lead valves, as the mechanical arrangements are not likely to allow "free air" cooling, although it should be remembered that the base temperature may be higher than with plug-in valves.

8. MICROPHONY

Whenever a valve is subjected to vibration, some disturbance in the output of the valve occurs. The effect of this disturbance will depend on the individual application. The published data often make reference to the microphonic sensitivity of different valve types, and this should be noted when a valve type is chosen for a specific application. Where the effects of microphony are found to be objectionable, special steps may have to be taken to reduce the vibration reaching the valve. The chassis itself may show wide variations in amplitude of vibration over its area, due to resonances; therefore favourable location of the valve, or local strengthening of the chassis, may appreciably reduce microphony.

A further reduction may be obtained by the use of antivibration mountings, but these are likely to be completely ineffective if the vibrations reaching the valve are being transmitted through the air and not through the chassis.

9. HUM

If an a.c. supply is used for valve heaters, the cathode current may be modulated by capacitance and leakage effects between the heater and other electrodes, or by the magnetic field of the heater. This modulation can give rise to hum. The most important electrodes in this respect are the cathode and the control grid. The published limiting value of V_{h-k} does not give any information about the resulting hum level, but is the maximum permissible voltage below which there is reasonably little danger of breakdown occurring between cathode and heater. The greater the a.c. component between heater and cathode (or control grid), the greater will be the hum. With a.f. valves the hum frequency will appear in the audio output; with i.f. and r.f. valves it will appear as modulation hum.

Hum can also be caused if the leakage resistance between cathode and heater is included in an a.f. or r.f. circuit. If it is included in a tuned circuit, the frequency to which the circuit is tuned may be altered by changes in the physical or electrical properties of the cathode-heater insulation (e.g. by vibration of the heater at the supply frequency), resulting in modulation hum.

The presence of leakage currents may become apparent as hum or background noise. It is particularly important that idle valve-holder contacts in the proximity of the control-grid contact should not be used as anchoring points for wires which are connected to the a.c. supply, as this practice may introduce hum via the capacitances or leakages between valve-holder contacts. This consideration is of particular importance at high supply frequencies.

APPENDIX I – DEFINITIONS AND INTERPRETATION OF DATA

The principal characteristics quoted for each receiving valve in this Handbook are normally those corresponding to the given value of anode current.

The values given are the mean values of measurements made on a large number of valves. All voltages are measured with respect to the cathode, unless otherwise stated.

The following definitions are intended to assist in interpreting the data, as some of these are not sufficiently well known:

V_a max. (V_{g2} max. etc.)
The maximum positive voltage which can be applied to the electrode at full dissipation. At higher electrode voltages the electrode dissipation must be reduced in accordance with the rating chart (Fig. 2).

$V_{a(b)}$ max. ($V_{g2(b)}$ max. etc.)
The maximum voltage (positive or negative) which can be applied to the valve electrode when the valve is cold. If semiconductor diodes or metal rectifiers are used to supply the h.t. in an equipment for instance, the h.t. rail may rise to this value after switching on but before the valves have warmed up.

$i_{a(pk)}$ max. (Rectifiers)
The maximum permissible steady-state peak anode current.

$i_{a(surge)}$ max. (Rectifiers)
The maximum permissible instantaneous anode current under switching conditions with the valve hot.

V_{g1} ($I_{g1} = +0.3\mu A$)
The control-grid voltage at which the positive grid current (with no other electrode voltages applied, unless otherwise stated) is $0.3\mu A$. The value is normally not more negative than $-1.3V$, and with a limit valve $+0.3\mu A$ will flow at this voltage. In any application where positive grid current is not permissible, the grid must always be biased more negative than this value.

g_m
The mutual conductance is the relation between a change in anode current and the corresponding change in control-grid voltage, with the anode (and screen-grid) voltage constant.

$$g_m = \frac{\delta I_a}{\delta V_g} \text{ } (V_a \text{ constant})$$

μ
The amplification factor is defined as the ratio of a change in anode voltage to the corresponding change in control-grid voltage, the anode current remaining constant.

$$\mu = \frac{\delta V_a}{\delta V_g} \text{ } (I_a \text{ constant})$$

r_a
The anode impedance is the ratio of a change in anode voltage to the corresponding change in anode current, with control-grid (and screen-grid) voltage constant.

$$r_a = \frac{\delta V_a}{\delta I_a} \text{ } (V_{g1} \text{ constant})$$

g_m, μ and r_a are related by the expression:

$$\mu = g_m . r_a$$

$g_{m\ (eff)}$

When a valve is used as a class "C" oscillator, the anode current contains components at the fundamental and harmonics of this frequency because the valve is driven over the whole of the grid base. The simple value of g_m is no longer useful for making calculations, so the effective mutual conductance is given. This is defined as:

$$g_{m(eff)} = \frac{\text{Fundamental frequency component of anode current}}{\text{Fundamental frequency component of grid voltage}}$$

g_c

The conversion conductance of a frequency changer is the relation between the intermediate frequency component of anode current to the grid input voltage at signal frequency.

$$g_c = \frac{\text{Intermediate frequency component of anode current}}{\text{Signal frequency component of grid input voltage}}$$

μ_{g1-g2}

The "inner-mu" is the amplification factor from control grid to screen grid.

$$\mu_{g1-g2} = \frac{\delta V_{g2}}{\delta V_{g1}} \ (I_k \text{ constant})$$

r_{g1}

Input damping resistance. This is given at a particular frequency and is the resistive component of the input impedance that the valve presents to the input circuit between grid and cathode. Over a limited range, the value at other frequencies can be calculated approximately from the formula:

$$r_{g1} \text{ (at } f_1) = r_{g1} \text{ (at } f_2) \times \left(\frac{f_2}{f_1}\right)^2$$

R_{eq}

Equivalent noise resistance. This is the value of a resistance which, if introduced into the grid circuit of a perfectly noiseless valve, would produce noise of the same level as that of the shot and partition noise occurring in the actual valve. It does not include flicker effect which occurs mainly in the audio frequency band. The figures quoted in the data are measured values. Curves showing R_{eq} plotted against g_m or I_a are given for some valve types.

Noise factor

The noise factor of a circuit is the ratio of the signal-to-noise ratio at the input to the signal-to-noise ratio at the output. It is dependent upon the equivalent noise resistance, the transit time component of input resistance, circuit resistance and source resistance. The figures quoted in the data are measured values.

K

Cross-modulation factor. This is the ratio of the modulation depth of the wanted signal caused by a modulated interfering carrier, to the modulation depth of the wanted signal appearing on the wanted carrier at the output of the valve. This assumes that both carriers are modulated to the same depth. It may be considered to be independent of the amplitude of the wanted signal where this amplitude is small, and to be proportional to the square of the amplitude of the interfering signal.

Cross-modulation figures and curves are given for valve types which are designed for a.g.c. operation. The curves given in the valve data show the amplitude of the interferring signal required to give a cross-modulation factor of 1%, plotted against g_m or g_c.

m_h Modulation hum. Curves of hum input voltage plotted against g_m or g_c are also given for valve types which are designed for a.g.c. operation. These curves show the input voltage at the control grid which will cause the carrier to be modulated to a depth of 1%.

APPENDIX II – CAPACITANCE SYMBOLS

The system of symbols for inter-electrode capacitances in general use at present does not always make it clear where certain of the valve electrodes are connected in making the measurement. For this reason the International Electrotechnical Commission has proposed an alternative system, for use in cases of ambiguity.

In both systems the symbol consists of a letter c followed by subscript letters indicating the valve electrodes between which the capacitance is measured. In addition, the IEC alternative system includes in brackets the valve elements which are connected to reference earth. In order to shorten the symbols in this system, the following two abbreviations are used:

R – remaining elements of the same unit(s), shields, metal parts (e.g. external shields, base sleeves, unused pins or leads, etc.).

u – Inactive units of multiple valves.

Examples

Present system	*Alternative system*	
c_{in}	$c_{g1-R(a)}$	Capacitance measured between the input electrode (g_1) and all other electrodes except the output electrode (a).
c_{out}	$c_{a-R(g1)}$	Capacitance measured between the output electrode (a) and all other electrodes except the input electrode (g_1).
$c_{a'-g'}$	$c_{a'-g'(Ru)}$	Capacitance measured between anode and grid of the first section of a double triode. Cathode of first section, all electrodes of second section, heater and any shield etc., earthed.
c_{g-k+h}	$c_{gt-R(atu)}$	Capacitance between triode grid and cathode + heater (in a triode pentode). Triode anode and pentode section earthed.

APPENDIX III – RATING CHARTS

Bulb Temperature Rating Chart

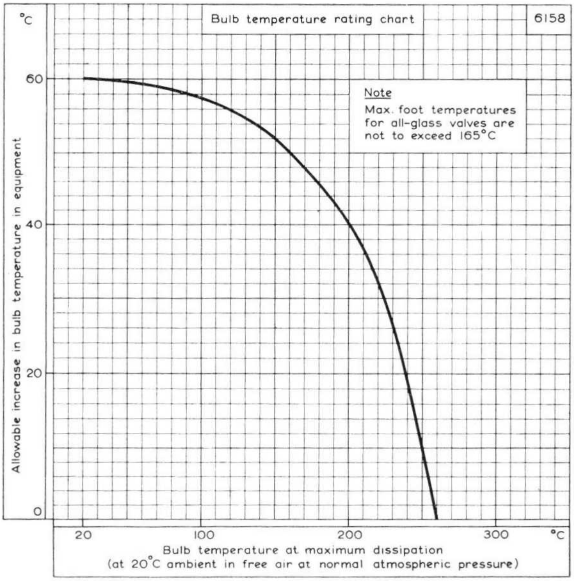


Fig. 1

The above chart shows the increase in bulb temperature that may be allowed, plotted against the bulb temperature attained by the valve when operated at full dissipation in free air at an ambient temperature of 20°C and normal atmospheric pressure.

To use the chart a measurement must first be made of the bulb temperature at the hottest point of the bulb under the conditions specified above. The hottest point of the bulb is normally opposite the centre of the anode, on the minor axis.

The chart can then be used to read off the permissible increase in bulb temperature, and hence establish a maximum bulb temperature for the valve type concerned.

For example, a power valve operated at full dissipation may be found to have a bulb temperature of 220°C. Reference to the chart shows the allowable increase in bulb temperature to be 32°C. The maximum bulb temperature for this type is therefore 252°C. A valve which has very little dissipation may have a bulb temperature of 120°C. The chart shows that in this case the bulb temperature may be allowed to rise (due to increased ambient) by 56°C, giving a final bulb temperature of 176°C.

This curve allows approximately 60°C increase in ambient temperature for valves having bulb temperatures up to 200°C (or 165°C in the case of sub-miniature valves).

The designer should ensure that the maximum bulb temperature rating given by the above chart is not exceeded in his equipment under normal operating conditions.

The maximum foot temperature of all-glass valves must not exceed 165°C, measured on the glass adjacent to the hottest pin. This is generally the anode pin in the case of high dissipation valves, or the heater pins in the case of low dissipation valves.

Electrode Dissipation Plotted Against Electrode Voltage

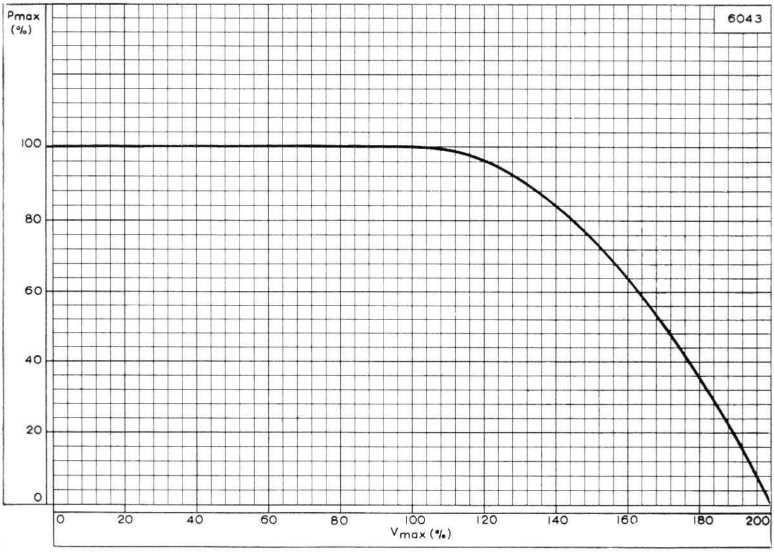


Fig. 2

The above chart shows the relation between the maximum positive electrode voltage and electrode dissipation. At voltages up to the maximum quoted in the data sheet, the maximum electrode dissipation can be used. At voltages in excess of this, the dissipation must be reduced in accordance with the above chart. This permits a supply voltage of twice the maximum permissible electrode voltage to be used, provided that a resistance is included in the circuit.

In cases where a value of $V_{a(b)}$ max. or $V_{g2(b)}$ max. is given which is less than twice the V_a max. or V_{g2} max. for the valve, the supply voltage must not exceed this value.

Maximum Value of Grid-to-Cathode Resistor

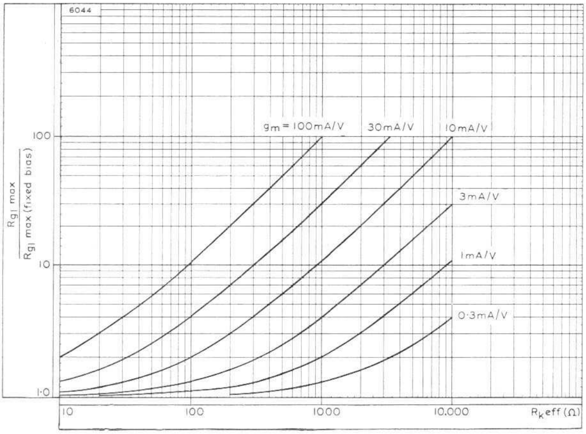


Fig. 3

To find the maximum value of grid-to-cathode resistor which can be used in a given circuit, the mutual conductance of the valve in circuit and the effective cathode resistor must be known. The mutual conductance of the valve in circuit can be determined by measurement.

The effective cathode resistor for a triode is given approximately by:

$$R_{k(eff)} = R_k + \frac{R_a}{\mu}$$

and for a tetrode or pentode by:

$$R_{k(eff)} = \frac{I_k}{I_a} \cdot R_k + \frac{I_{g2}}{I_a} \cdot \frac{R_{g2}}{\mu_{g1-g2}}$$

From these two values, the value of R_{g1-k} max. which may be used in the circuit can be obtained from the graph.

Example

A pentode is to be used in a circuit under the following conditions:

$I_a = 8mA$	$\mu_{g1-g2} = 47$	$R_k = 200\Omega$
$I_{g2} = 2mA$	$g_m = 5mA/V$	$R_{g2} = 47k\Omega$

The value of R_{g1-k} max. (fixed bias) is 1.0MΩ. The effective cathode resistor is therefore

$$\frac{10}{8} \times 0.2 + \frac{2}{8} \cdot \frac{47}{47} = 0.5k\Omega.$$

From the chart a value of $\frac{R_{g1}\ max.}{R_{g1}\ max.\ (fixed\ bias)}$ of 3.5 is obtained for these two values. The maximum value which can be used in this case is therefore 3.5MΩ.

SUBMINIATURE DIODE A.F. PENTODE

DAF70

Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.

FILAMENT

V_f	1.25	V
I_f	25	mA

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.

CAPACITANCES (measured with external shield) ←

c_{a-g1}	0.15	pF
c_{in}	2.0	pF
c_{out}	4.3	pF
c_{ad-g}	0.1	pF

CHARACTERISTICS

V_a	67.5	V
V_{g2}	67.5	V
I_a	1.0	mA
I_{g2}	250	μA
V_{g1}	0	V
g_m	440	μA/V
r_a	400	kΩ
μ_{g1-g2}	16	

OPERATING CONDITIONS AS R.C. COUPLED A.F. AMPLIFIER

V_b	67.5	V
R_a	1.0	MΩ
R_{g2}	4.7	MΩ
*R_{g1}	3.3	MΩ
$\frac{V_{out}}{V_{in}}$	73	

* Grid resistor of following valve.

DAF70

SUBMINIATURE DIODE A.F. PENTODE

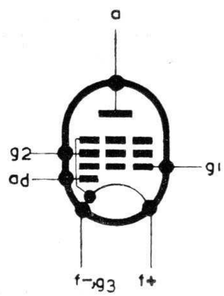
Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.

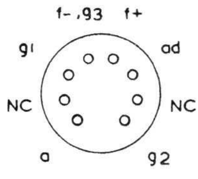
OPERATING CONDITIONS AS CLASS "A" AMPLIFIER

V_a	67.5	90	V
V_{g2}	67.5	90	V
V_{g1}	–1.8	–2.6	V
$I_{a(o)}$	400	600	μA
$I_{g2(o)}$	85	135	μA
R_a	150	150	kΩ
P_{out}	10.5	20	mW
D_{tot}	10	10	%

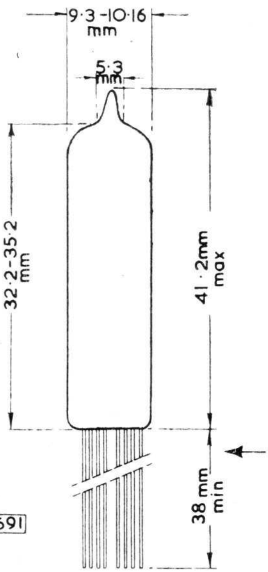
LIMITING VALUES

V_a max.	90	V
V_{g2} max.	90	V
I_k max.	1.3	mA
I_{ad} max.	250	μA





B8D/F Base

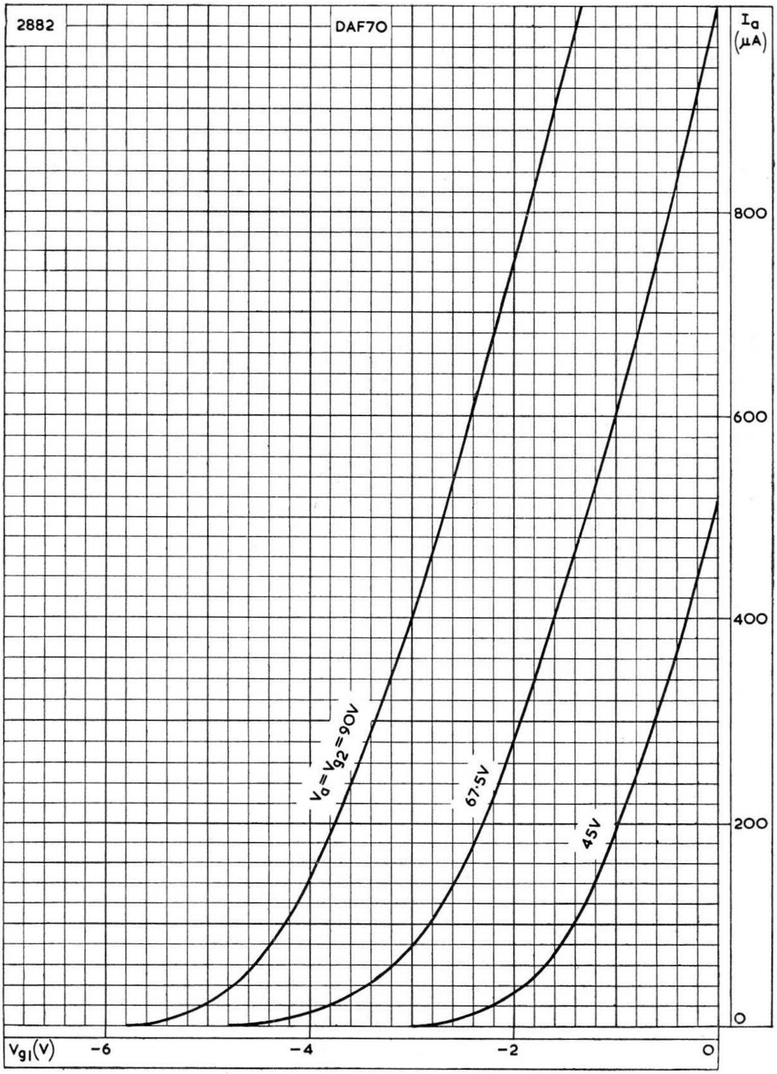


2691

SUBMINIATURE DIODE A.F. PENTODE

DAF70

Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.

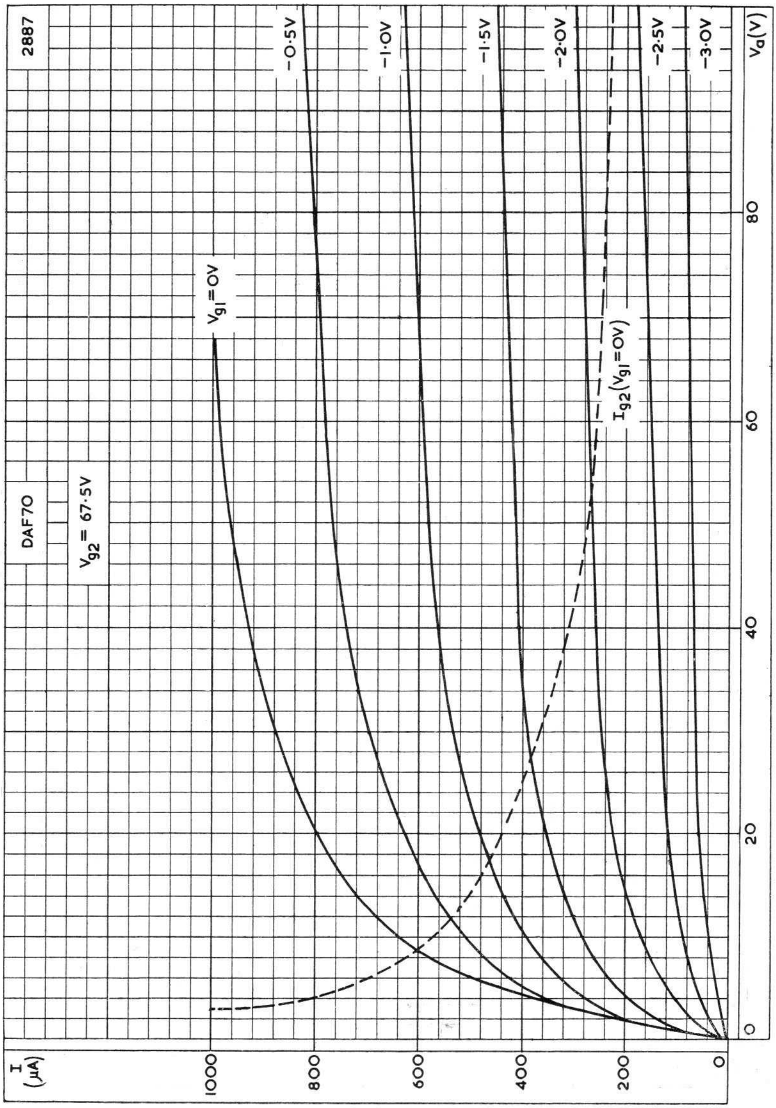


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE

DAF70

SUBMINIATURE DIODE A.F. PENTODE

Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.

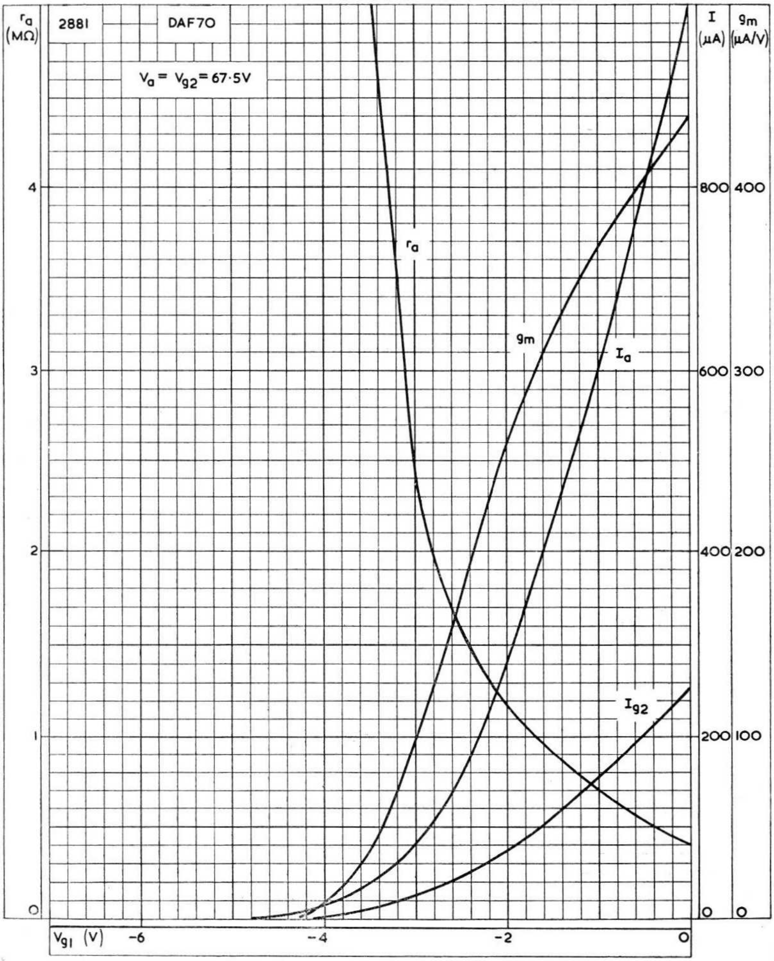


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

SUBMINIATURE DIODE A.F. PENTODE

DAF70

Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.

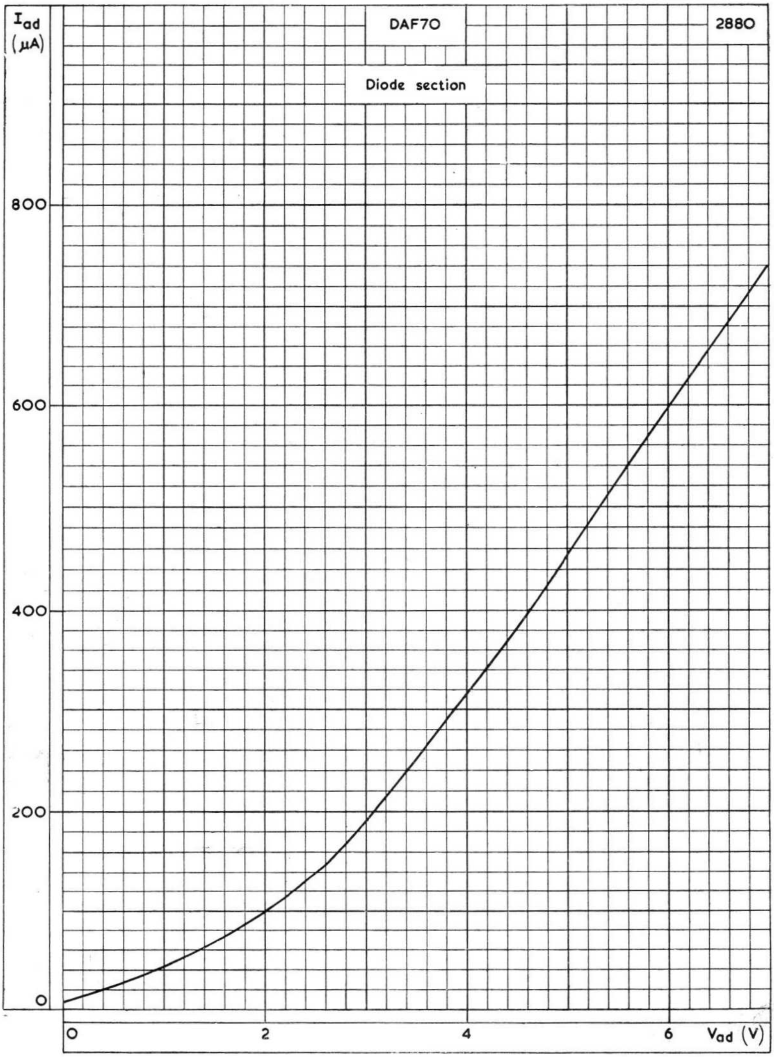


ELECTRODE CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE

DAF70

SUBMINIATURE DIODE A.F. PENTODE

Subminiature a.f. pentode, combined with a single diode, suitable for battery operation.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE (DIODE SECTION)

SPECIAL QUALITY SUBMINIATURE VOLTAGE INDICATOR

DM160

Special quality, directly heated subminiature voltage indicator for use in industrial equipment such as transistorised computers.

This data should be read in conjunction with GENERAL NOTES - SPECIAL QUALITY VALVES, and the index numbers are used to indicate where reference should be made to a specific note.

FILAMENT

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

V_f (see RATINGS section)	1.0	V
I_f nom.	30	mA
I_f (initial range)	24 to 36	mA

CHARACTERISTICS, OPERATING CONDITIONS AND RANGE VALUES FOR EQUIPMENT DESIGN[3]

	Nominal value	Initial range	End of life	
V_a	50			V
R_g	100			kΩ
*$V_{g(b)}$ (max. light output)	0			V
*$V_{g(b)}$ (zero light output)	-3	-3	-3	V
I_a at $V_{g(b)}=0V$	585	430 to 740	>250	μA←
**I_a at $V_{g(b)}=-3V$		<5.0	<5.0	μA
Insulation resistance between any two electrodes at 50V		>100		MΩ

*Voltage with respect to the centre tap of the filament transformer.

**The residual electron current may be concentrated on one spot which may then be visible in dark surroundings. This effect cannot be mistaken for the indicator being in the conducting condition.

RATINGS (ABSOLUTE MAXIMUM SYSTEM)[4] ←

$V_{a(b)}$ max.	100	V
V_a max.	65	V
I_a max.	850	µA
$V_{g(b)}$ max. (R_g = 100kΩ ± 10%)	0	V
$V_{g(b)}$ max. (R_g = 1MΩ ± 10%)	6.0	V
$-V_g$ max.	50	V
R_g max.	1.1	MΩ
R_g min.	90	kΩ

Filament voltage

The average filament voltage should be 1.0V. Variations exceeding +0 or -10% will shorten the life of the valve.

SHOCK RESISTANCE[15] ←

The valve is subjected to an acceleration of 500g, 5 times in each of four positions in an NRL shock machine with the hammer lifted over an angle of 30°.

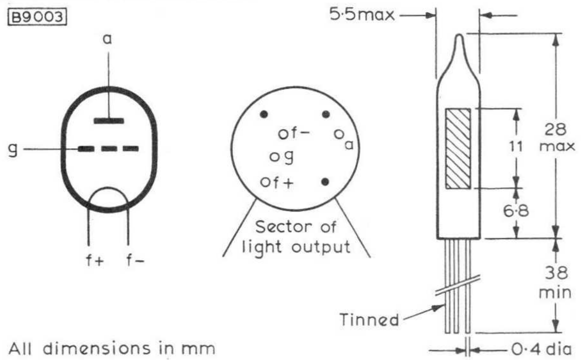
LIFE ←

Production samples are checked for the end of life values given on page 1 under the following conditions for 10 000 hours:

$V_{f(r.m.s.)}$	1.0	V
V_a	50	V
$*V_{g(b)}$	0	V
R_g	100	kΩ

*Voltage with respect to the centre tap of the filament transformer.

DIMENSIONS AND CONNECTIONS



Connections should not be soldered nearer than 5mm from the seal.
The leads should not be bent nearer than 1.5mm from the seal.

APPLICATION NOTES ←

The visibility of the phosphorescent light produced by the anode when the indicator is conducting depends upon the grid voltage and the illumination level of the surroundings. With $V_g = -3V$ for zero light output the visibility is best when $\Delta V_g = 3V$, but an unambiguous indication is still obtained at $\Delta V_g = 1.4V$ under nominal conditions and a low level of ambient light. With still smaller values of drive voltage a pre-amplifier is required. These points being taken into account, one can use the DM160 for reading out digital information from logic circuits. Figs.1 and 2 show typical arrangements for negative and positive logic, respectively.

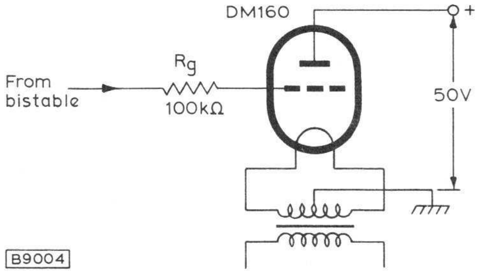


Fig.1 Digital read-out circuit with DM160 connected to negative logic circuit which uses bistables equipped with p-n-p transistors. The 'High' output level of the bistable may vary between 0V and -0.3V, and the 'Low' level between -3V and -6.8V.

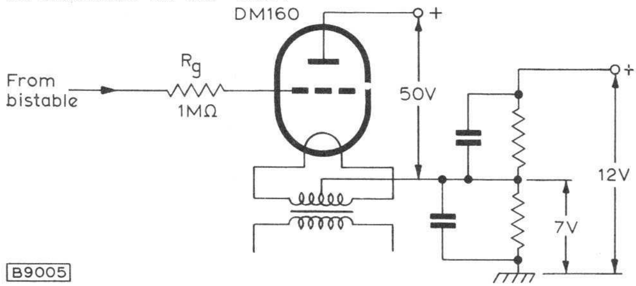


Fig.2 Digital read-out circuit with DM160 connected to positive logic circuit which uses bistables equipped with n-p-n transistors. The 'High' output level of the bistable may vary between +7.5V and +12V, and the 'Low' level between 0V and +0.4V. R_g protects the valve against excessive anode currents and positive grid currents in case the grid voltage exceeds the cathode potential.

When the minimum ΔV_g lies below 3V the spread in the 'High' level of the bistable will give rise to an extra spread in the brightness of the phosphorescent light. If this is undesirable the spread may be reduced by clamping the grid voltage (see page 4).

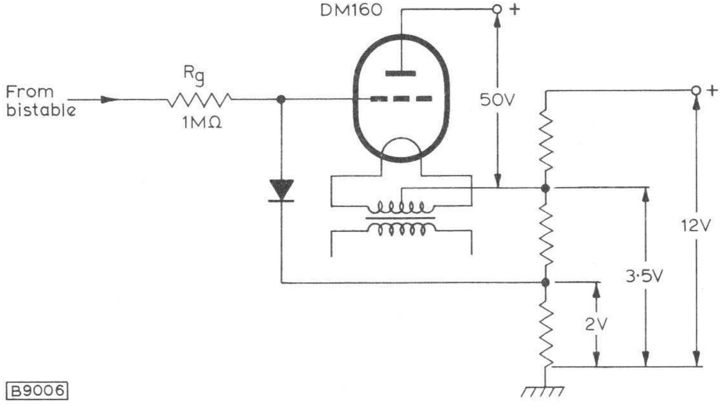
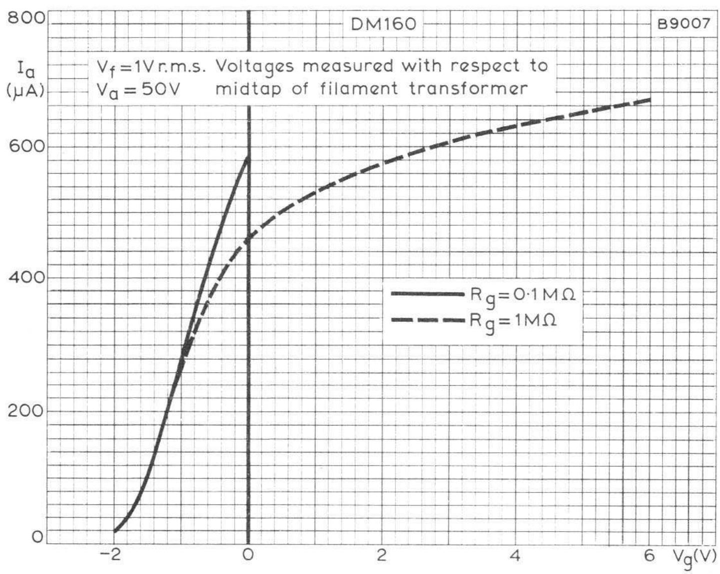
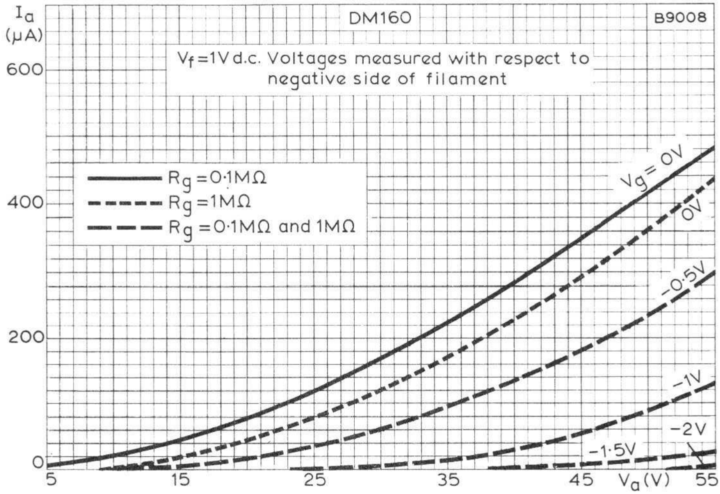
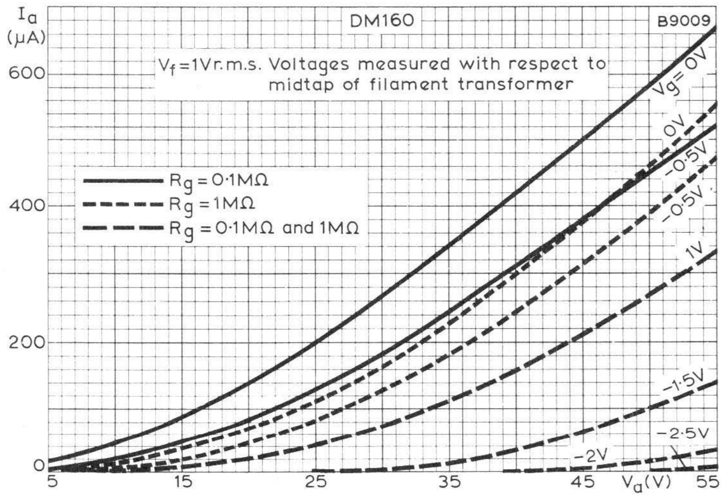


Fig.3 As Fig.2: 'High' voltage between +2V and +7V, and 'Low' level between 0V and +0.5V; grid voltage clamped.

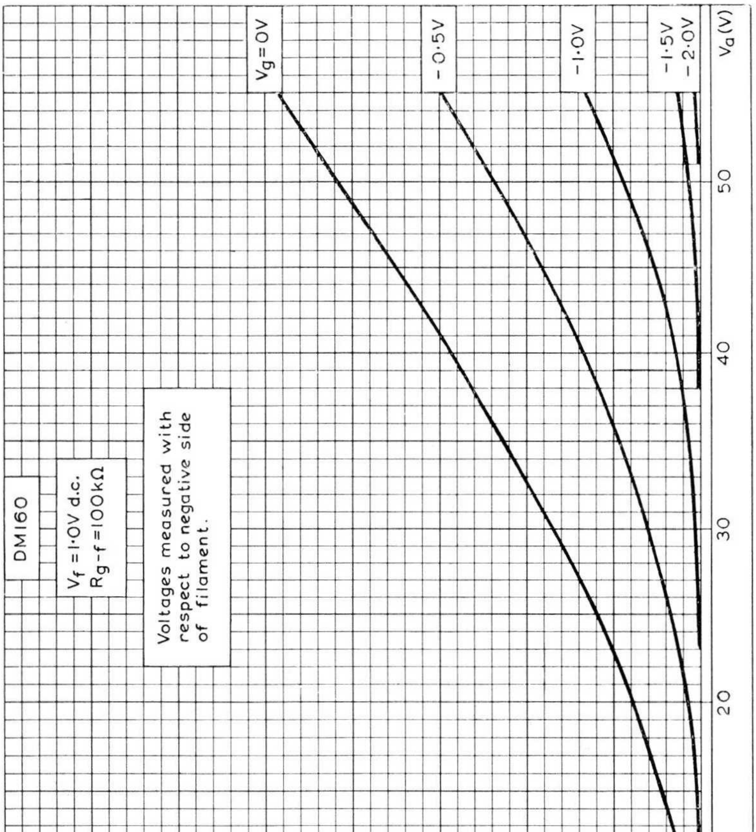


ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE

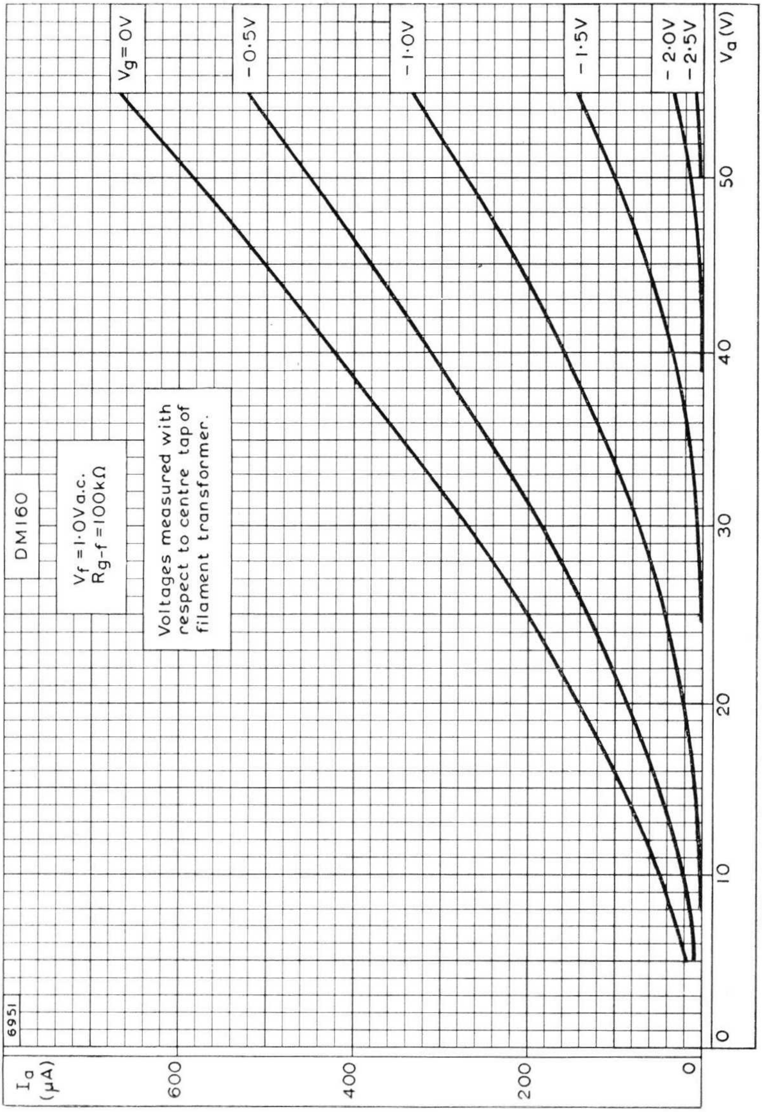




ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. D.C. APPLIED TO FILAMENT



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. A.C. APPLIED TO FILAMENT

HALF-WAVE RECTIFIER DY51

High voltage half-wave rectifier with wired-in connections. Suitable for application in portable t.v. receivers.

HEATER ←

V_h	1.4	V
I_h	550	mA
Heater voltage tolerances $I_{out} \leq 200\mu A$	±15*	%
$I_{out} > 200\mu A$	±7*	%

*These tolerances apply when the power supply voltage is at its nominal value and when a valve having bogey heater characteristics is employed. In addition, fluctuations in the mains supply voltage not exceeding ±10% are permissible.

MOUNTING POSITION Any

NOTE - Direct soldered connections to the leads of this valve must be at least 10mm from the seal and care should be taken not to bend the leads near the seal.

CAPACITANCE

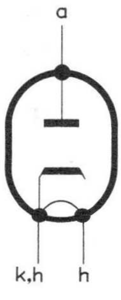
c_{a-k}	0.8	pF

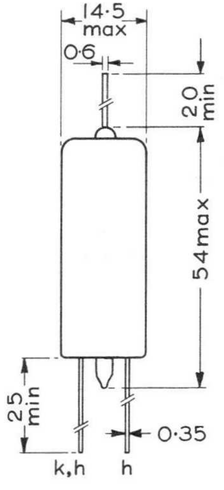
LIMITING VALUES

P.I.V. max.	15	kV
$I_{a\ (out)}$ max.	350	μA
*$i_{a(pk)}$ max	40	mA ←
C max.	2000	pF

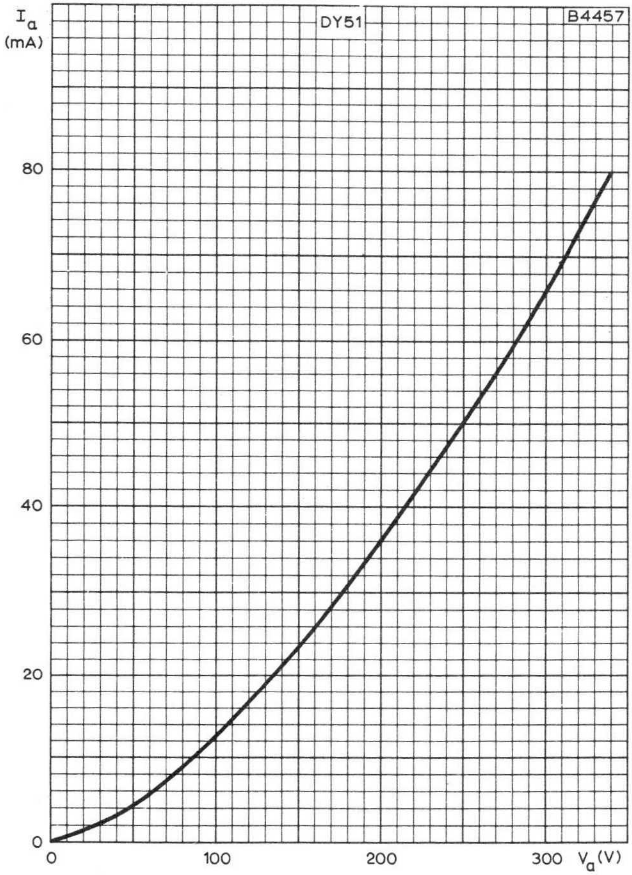
*Maximum pulse duration 10% of one cycle with a maximum of 10μs ←

4778





All dimensions in mm



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

High voltage half-wave rectifiers for television line fly-back e.h.t. supply. The DY87 is electrically identical to the DY86 but has a chemically treated bulb to prevent flash-over under conditions of high humidity.

HEATER

Vh		1.4	V
Ih		550	mA
Heater voltage tolerances	Iout < 200 μA	± 15*	%
	Iout > 200 μA	± 7*	%

* These tolerances apply when the power supply voltage is at its nominal value and when a valve having bogey heater characteristics is employed. In addition fluctuations in the mains supply voltage not exceeding ± 10 % are permissible.

CAPACITANCES

ca - (h + k + s)	1.55	pF

DESIGN CENTRE RATINGS

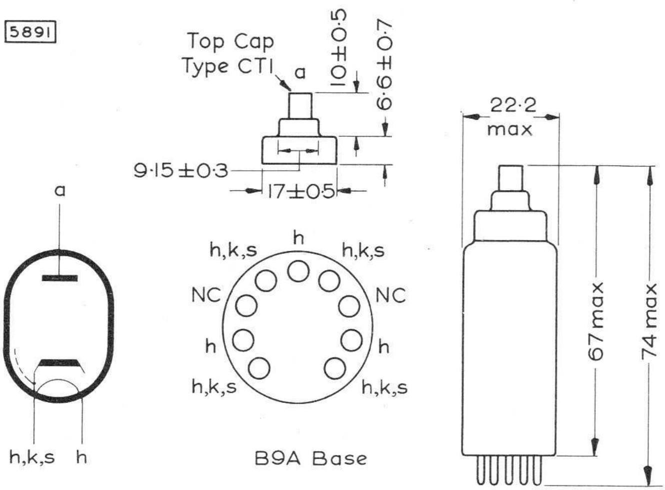
Pulsed input		
* P.I.V. max.	22	kV
‡ ia (pk) max.	40	mA
Iout max.	500	μA
C max.	2000	pF

* Maximum duration 22 % of a line scanning cycle with a maximum of 18 μs.
‡ Maximum duration 10 % of a line scanning cycle with a maximum of 10 μs.

WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16 kV. The level of X-radiation is likely to be considerably higher when the heater circuit of the tube is open.

5891



All dimensions in mm

Pins 1, 4, 6 and 9 may be used for fixing an anti-corona shield.

Pins 3 and 7 may only be connected to points in the heater circuit and must not be earthed.

ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

TENTATIVE DATA

High voltage half-wave rectifier for television line fly-back e.h.t. supply.

HEATER

V_h	1.4	V
I_h	550	mA
Heater voltage tolerances $I_{out} < 200\mu A$	±15	%
$I_{out} > 200\mu A$	±7	%

CAPACITANCES

$c_{a-(h+k+s)}$	1.1	pF

RATINGS (DESIGN CENTRE SYSTEM)

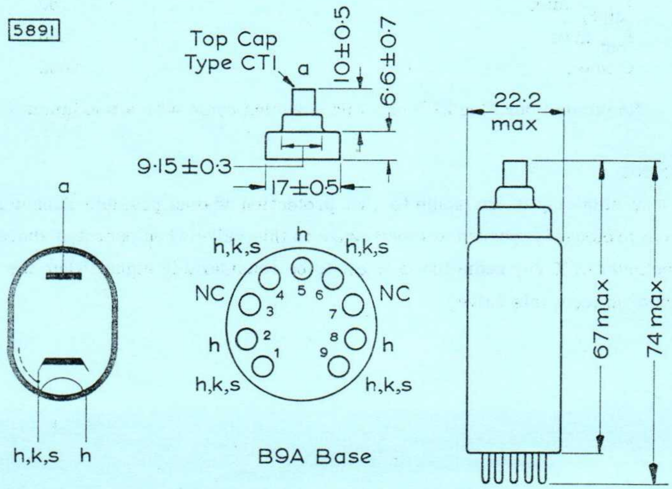
Pulsed input

*P.I.V. max.	25	kV
$i_{a(pk)}$ max.	50	mA
I_{out} max.	500	μA
C max.	2000	pF

*Maximum duration 22% of a line scanning cycle with a maximum of $22\mu s$.

WARNING

X-ray shielding is advisable to give protection against possible danger arising from prolonged exposure at close range to this valve when operated above 16kV. The level of X-ray radiation is likely to be considerably higher when the load is removed from this valve.



All dimensions in mm

Pins 1, 4, 6 and 9 may be used for fixing an anti-corona shield.

Pins 3 and 7 may only be connected to points in the heater circuit and must not be earthed.

U.H.F. DIODE

Disc seal diode primarily intended for use as a measurements diode at frequencies up to 1000Mc/s.

EA52

HEATER

Suitable for series or parallel operation a.c. or d.c.

V_h	6.3	V
I_h	300	mA

The absolute maximum variation of heater voltage is $\pm$0.7V

CAPACITANCE

c_{a-k}	$<$0.5	pF

CHARACTERISTICS

V_a ($I_a = 500\mu A$)	$<$3.0	V

INSULATION

Insulation between anode and cathode	$>10^4$	MΩ

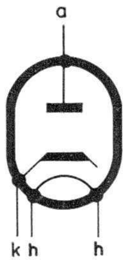
LIMITING VALUES (absolute ratings)

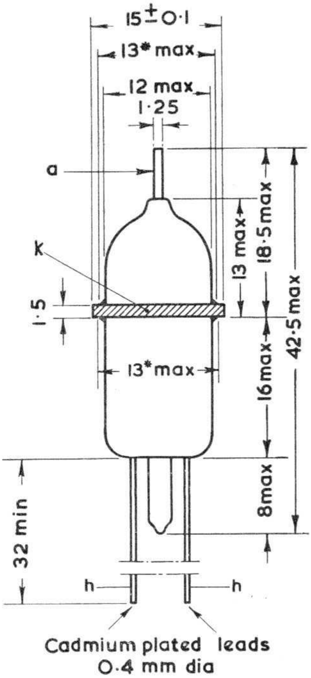
*P.I.V. max. (f $<$ 100Mc/s)	1.0	kV
I_k max.	300	μA
$i_{k(pk)}$ max.	5.0	mA
V_{h-k} max.	50	V
R_{h-k} max.	20	kΩ

*At frequencies greater than 100 Mc/s, the maximum P.I.V. is $\frac{10^5}{f}$ V, where f is the frequency in Mc/s.

EA52

U.H.F. DIODE

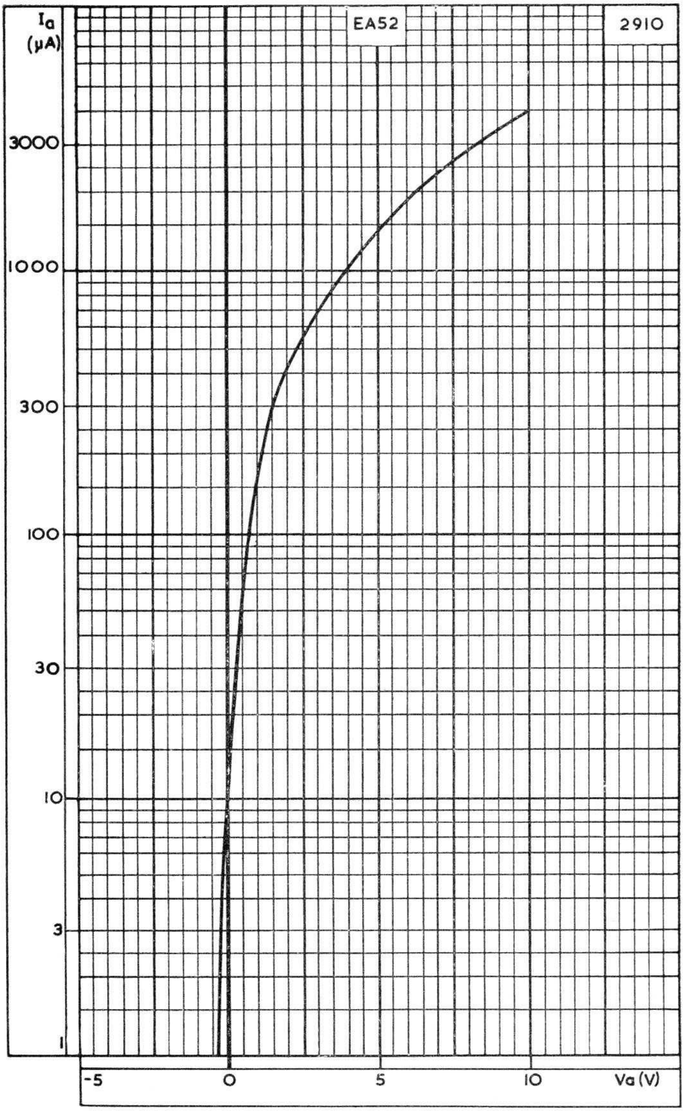




2922 All dimensions in mm

* Max diameter of the glass seal

Note.—Direct soldered connections to the leads of this valve must be at least 7mm from the seal and any bending of the valve leads must be at least 1·5mm from the seal.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

TRIPLE DIODE TRIODE

EABC80

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

HEATER

V_h	6.3	V
I_h	0.45	A

CAPACITANCES ←

$c_{at-a'd}$	<0.12	pF
$c_{at-k''d}$	<0.01	pF
$c_{at-a'''d}$	<0.1	pF
$c_{g-a'd}$	<0.07	pF
$c_{g-k''d}$	<0.005	pF
$c_{g-a'''d}$	<0.02	pF

Triode Section

c_{in}	1.9	pF
c_{out}	1.4	pF
c_{at-g}	2.0	pF
c_{g-h}	<0.04	pF

Diode Sections

$c_{a'd-(h+kt,k'd,k'''d,s)}$	0.8	pF
$c_{a''d-(h+k''d+kt,k'd,k'''d,s)}$	4.8	pF
$c_{a'''d-(h+kt,k'd,k'''d,s)}$	4.8	pF
$c_{k''d-all}$	4.9	pF
$c_{a'd-h}$	<0.25	pF
$c_{a'''d-h}$	<0.2	pF
$c_{k''d-h}$	2.5	pF

CHARACTERISTICS ←

Triode Section

V_a	100	250	V
V_g	−1.0	−3.0	V
I_a	0.8	1.0	mA
g_m	1.45	1.4	mA/V
μ	70	70	
r_a	48	50	kΩ

Diode Sections

$r_{a'd}$ ($V_{a'd}=+10V$)	5.0	kΩ ←
$r_{a''d}$ ($V_{a''d}=+5V$)	200	Ω
$r_{a'''d}$ ($V_{a'''d}=+5V$)	200	Ω
$r_{a''d}/r_{a'''d}$	0.65 to 1.5	

EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER* (with grid current biasing) ←

V_b (V)	R_a (k Ω)	I_a (mA)	$\frac{V_{out}}{V_{in}}$	D_{tot} (%) for $V_{out(r.m.s.)}$ =3V	=5V	=8V	R_g† (k Ω)
170	47	1.25	32	0.6	1.1	2.0	150
170	100	0.82	42	0.5	0.8	1.3	330
170	220	0.46	51	0.4	0.5	1.1	680
200	47	1.6	34	0.5	0.9	1.5	150
200	100	1.0	44	0.4	0.6	1.0	330
200	220	0.56	53	0.3	0.4	0.9	680
250	47	2.2	36	0.3	0.6	1.0	150
250	100	1.4	47	0.25	0.5	0.8	330
250	220	0.76	54	0.2	0.25	0.6	680

*Measured with a grid resistor of 10MΩ.

†R_g=grid resistor of following value.

LIMITING VALUES

Triode Section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.0	W
I_k max.	5.0	mA
V_g max. (I_g=+0.3μA)	–1.3	V
*R_{g-k} max.	3.0	M Ω
R_{h-k} max.	20	k Ω
V_{h-k} max.	150	V

*With grid current biasing R_{g-k} max.=22MΩ.

Diode Sections ←

P.I.V.$_{(a'd)}$ max.	350	V
P.I.V.$_{(a''d)}$ max.	350	V
P.I.V.$_{(a'''d)}$ max.	350	V
$I_{a'd}$ max.	1.0	mA
$I_{a''d}$ max.	10	mA
$I_{a'''d}$ max.	10	mA
$i_{a'd(pk)}$ max.	6.0	mA
$i_{a''d(pk)}$ max.	75	mA
$i_{a'''d(pk)}$ max.	75	mA

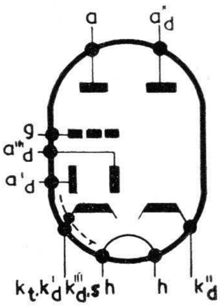
TRIPLE DIODE TRIODE

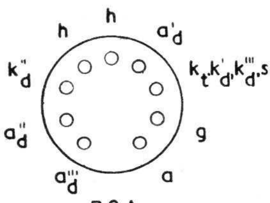
EABC80

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

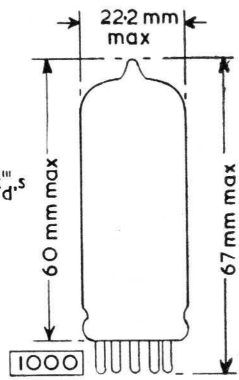
MICROPHONY

This valve can be used without special precautions against microphony in circuits in which the input voltage is not less than 10mV for an output of 50mW from the output stage at 800c/s and higher frequencies.





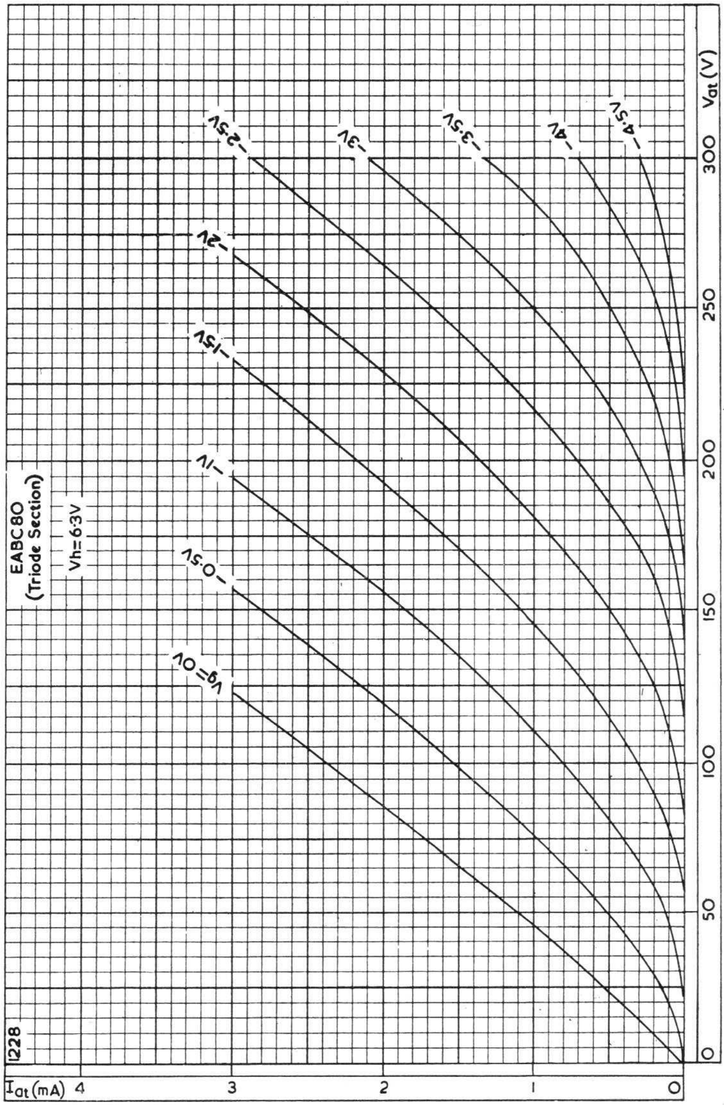
B9A
Noval Base



EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

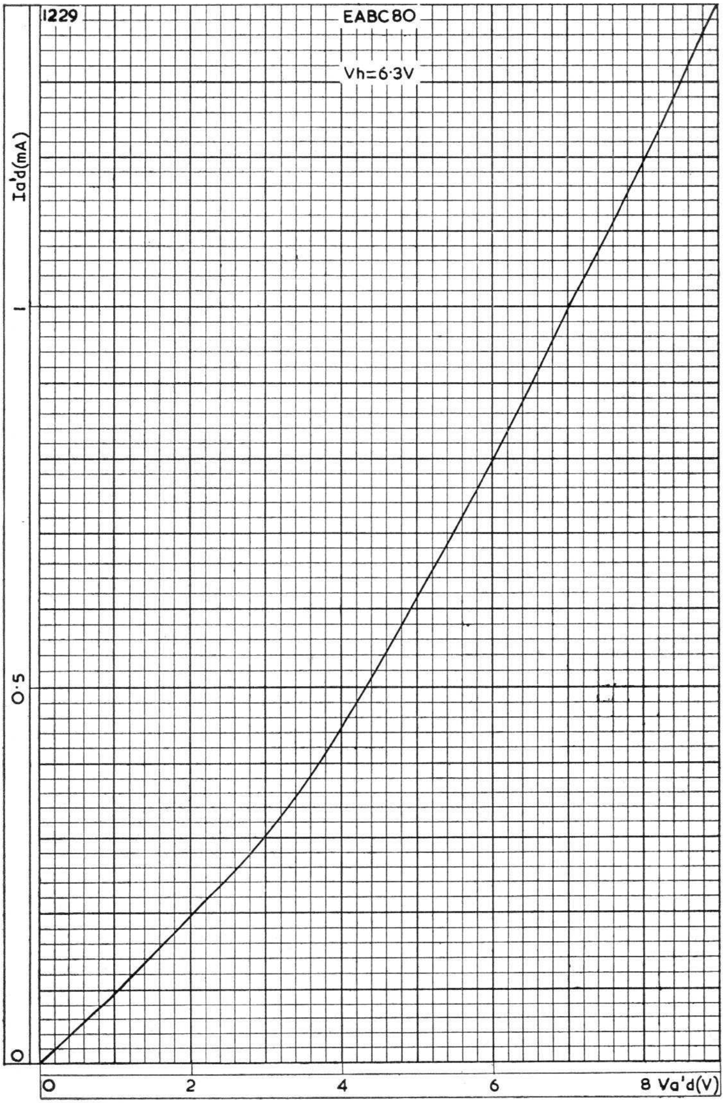


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

TRIPLE DIODE TRIODE

EABC80

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.



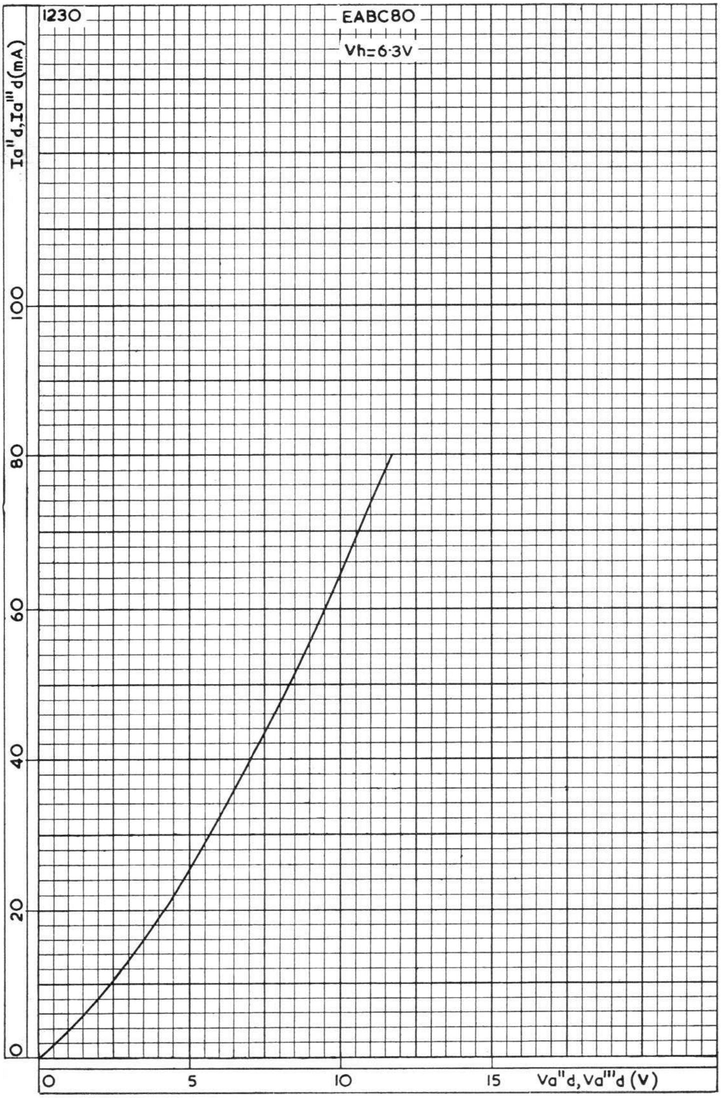
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR DIODE SECTION a′d

Mullard

EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

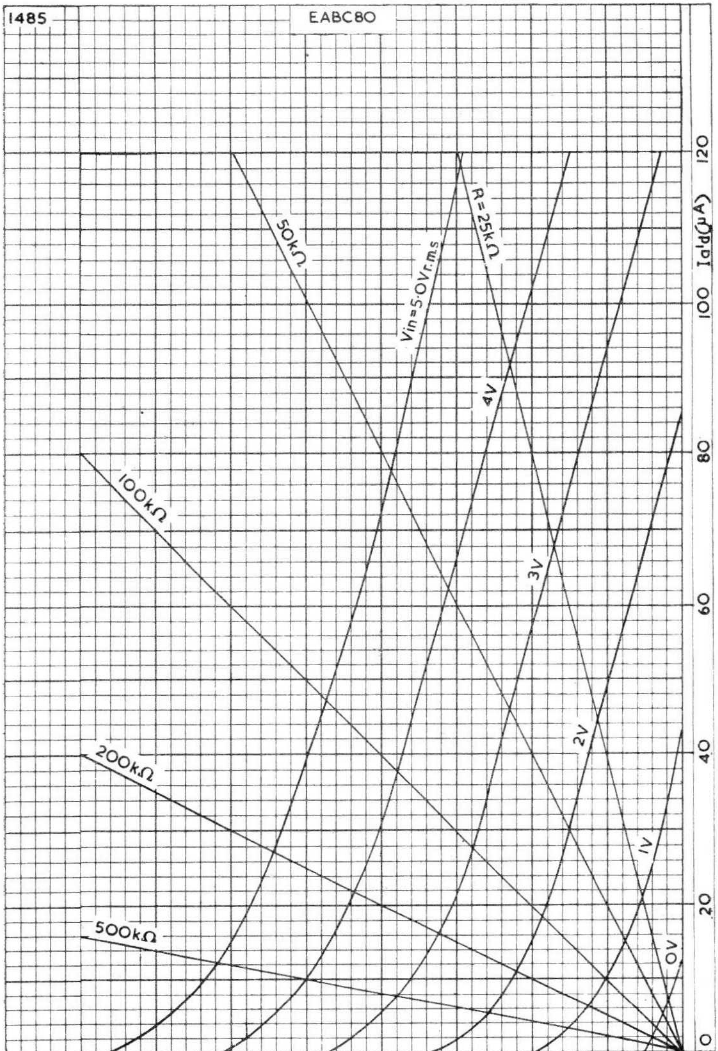


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR DIODE SECTIONS a''_d AND a'''_d

TRIPLE DIODE TRIODE

EABC80

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

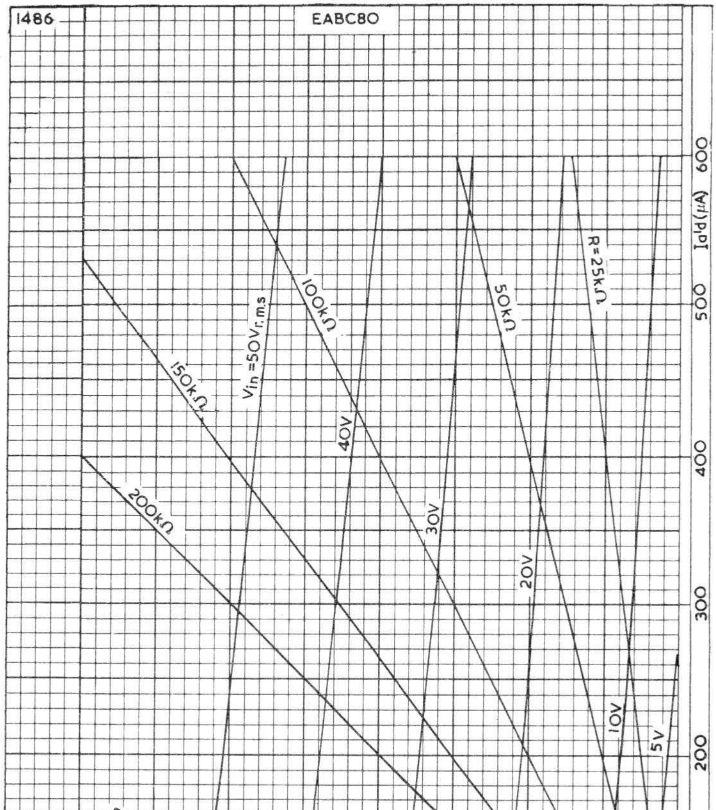


RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN 0V AND 5$V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTION a'_d

EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

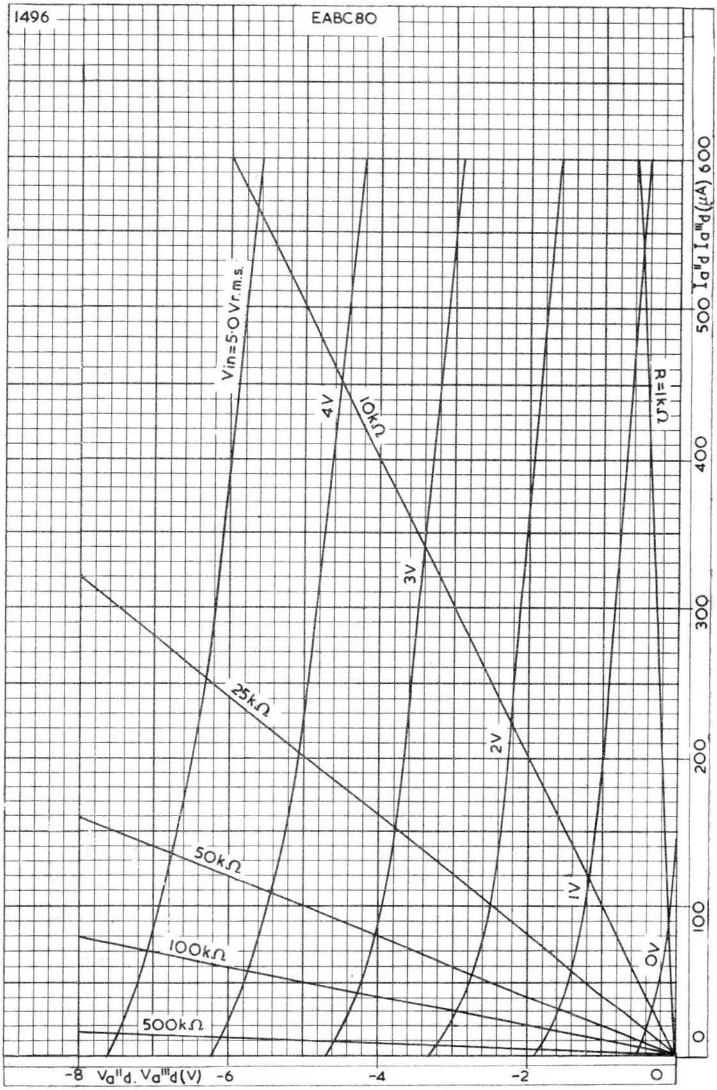


RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN $5V_{r.m.s.}$ AND $50V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTION a'_d

TRIPLE DIODE TRIODE

EABC80

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.

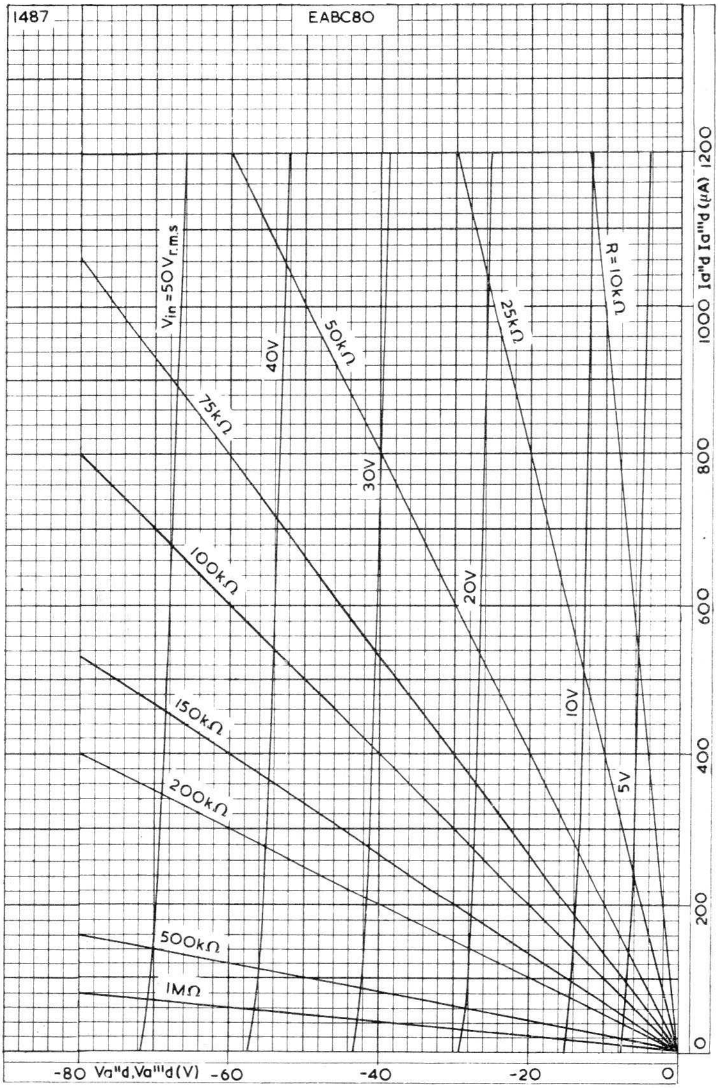


RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN 0 AND $5V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTIONS a''_d AND a'''_d

EABC80

TRIPLE DIODE TRIODE

Triple diode triode, one diode having a separate cathode. Primarily designed for use in F.M./A.M. receivers.



RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN $5V_{r.m.s.}$ AND $50V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTIONS a''_d AND a'''_d

DOUBLE DIODE TRIODE

EBC81

High gain triode for use as a.f. voltage amplifier combined with twin diodes.

HEATER

V_h	6.3	V
I_h	230	mA

MOUNTING POSITION

Any

CAPACITANCES

$c_{a'd-g}$	<0.007	pF
$c_{a''d-g}$	<0.007	pF
$c_{a'd-a}$	<0.005	pF
$c_{a''d-a}$	<0.01	pF

Triode section

c_{g-k}	2.3	pF
c_{a-k}	2.3	pF
c_{a-g}	1.2	pF
c_{g-h}	<0.05	pF

Diode sections

$c_{a'd-k}$	0.9	pF
$c_{a''d-k}$	0.9	pF
$c_{a'd-a''d}$	<0.2	pF
$c_{a'd-h}$	<0.25	pF
$c_{a''d-h}$	<0.05	pF

CHARACTERISTICS

V_a	250	V
V_g	−3.0	V
I_a	1.0	mA
g_m	1.2	mA/V
μ	70	
r_a	58	kΩ

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER (with cathode bias)

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$) ($D_{tot}=5\%$)	V_{out} ($V_{r.m.s.}$) ($D_{tot}=10\%$)	R_{g1}† (kΩ)
400	100	1.35	2.2	43.5	35.5	62.5	330
350	100	1.18	2.2	43	30.5	54	330
300	100	1.0	2.2	42.5	25.5	46	330
250	100	0.85	2.2	42	21	38	330
200	100	0.7	2.2	41	16	28.5	330
150	100	0.5	2.2	40	12	19.5	330
100	100	0.28	3.3	33.5	6.0	10.5	330
400	220	0.76	3.9	48	40	74.5	680
350	220	0.67	3.9	47.5	34.5	64	680
300	220	0.56	3.9	47	27	54	680
250	220	0.48	3.9	46.5	24.5	44.5	680
200	220	0.4	3.9	46	19	34	680
150	220	0.32	3.9	44	16.5	24	680
100	220	0.18	5.6	38	8.0	13.5	680

Mullard

EBC81

DOUBLE DIODE TRIODE

High gain triode for use as a.f. voltage amplifier combined with twin diodes.

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER* (with grid current bias)

V_b (V)	R_a (kΩ)	I_a (mA)	$\frac{V_{out}}{V_{in}}$	V_{out} ($V_{r.m.s.}$) ($D_{tot}=2.5\%$)	V_{out} ($V_{r.m.s.}$) ($D_{tot}=5\%$)	R_{g1}† (kΩ)
400	100	2.4	56.5	33	51	330
350	100	2.0	55	27	43	330
300	100	1.95	53.5	22	35	330
250	100	1.3	51	17	27	330
200	100	0.95	48.5	12	19	330
150	100	0.6	44	7.0	11	330
100	100	0.3	35.5	3.0	5.0	330
400	220	1.3	62.5	34	55.5	680
350	220	1.1	61.5	29	47	680
300	220	0.9	59.5	23	38	680
250	220	0.7	57	17	29.5	680
200	220	0.5	54	12.5	21	680
150	220	0.33	49	8.0	14	680
100	220	0.18	40	4.0	7.0	680

*Measured with grid resistor of 22MΩ and signal source impedance $Z_s=0\Omega$. The distortion figures quoted hold good for values of Z_s not exceeding 200kΩ. At this value of Z_s, the gain will be reduced by 10%.

†R_{g1} = Grid resistor of the following valve.

LIMITING VALUES

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	500	mW
I_k max.	5.0	mA
R_{g-k} max.	3.0	MΩ
R_{g-k} max. (grid current biasing)	22	MΩ
V_g max. ($I_g = +0.3\mu A$)	−1.3	V
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

Diode sections (each section)

P.I.V. max.	350	V
I_{ad} max.	800	μA
$i_{ad(pk)}$ max.	5.0	mA

MICROPHONY

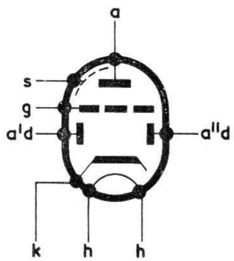
This valve can be used without special precautions against microphony in circuits in which the input voltage >10mV (r.m.s.) for an output of 50mW from the output valve.

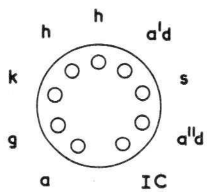
DOUBLE DIODE TRIODE

EBC81

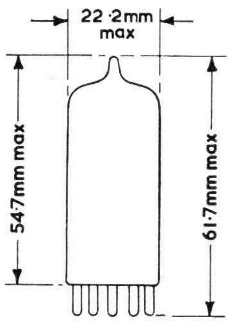
High gain triode for use as a.f. voltage amplifier combined with twin diodes.

3684





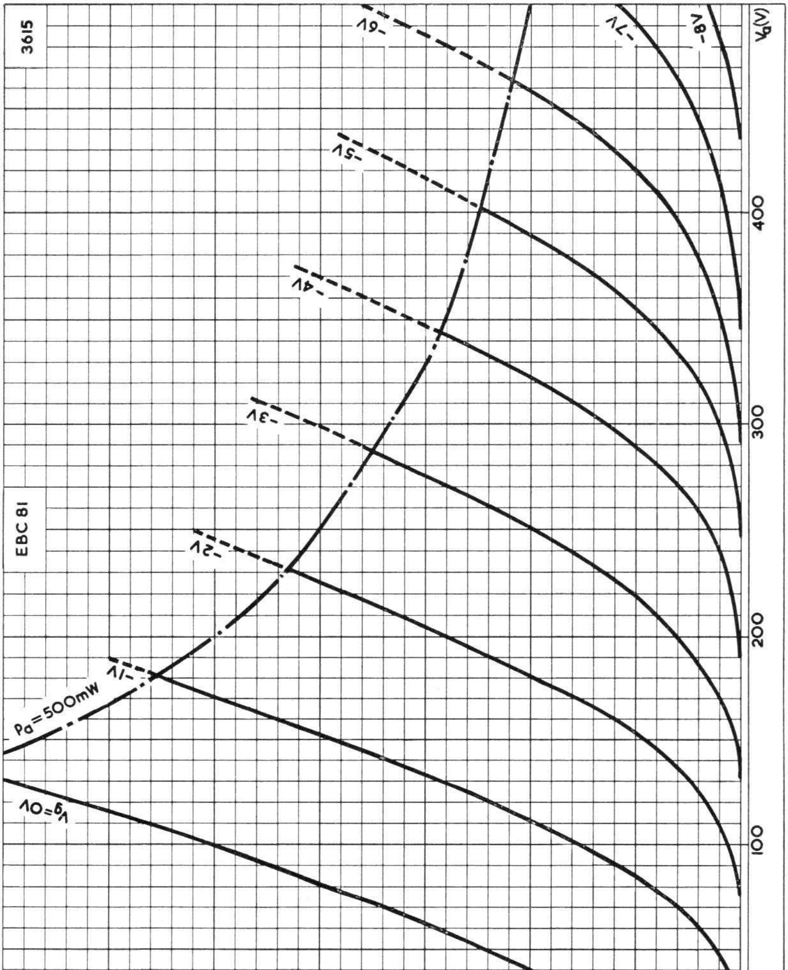
B9A Base



EBC81

DOUBLE DIODE TRIODE

High gain triode for use as a.f. voltage amplifier combined with twin diodes.

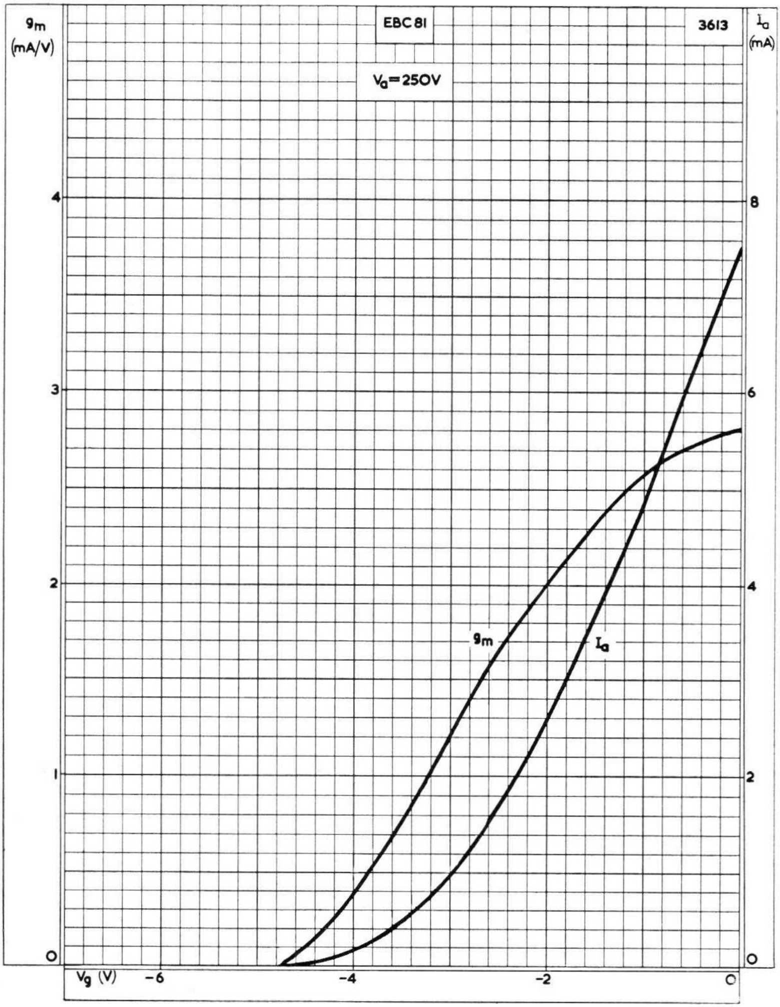


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

DOUBLE DIODE TRIODE

EBC81

High gain triode for use as a.f. voltage amplifier combined with twin diodes.



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF83

Double diode variable-mu pentode primarily intended for use in equipment operating directly from a 6V, 12V or 24V battery, on or off charge.

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

$c_{a'd-g1}$	<0.8	mpF
$c_{a''d-g1}$	<1.0	mpF
$c_{a'd-a}$	<150	mpF
$c_{a''d-a}$	<25	mpF

Pentode section

c_{a-g1}	<2.5	mpF
c_{out}	5.2	pF
c_{in}	5.0	pF

Diode sections

$c_{a'd-k}$	2.5	pF
$c_{a''d-k}$	2.5	pF
$c_{a'd-a''d}$	<250	mpF

CHARACTERISTICS

V_a	6.3	12.6	25	V
V_{g3}	0	0	0	V
V_{g2}	6.3	12.6	25	V
V_{g1}	†	†	†	
I_a	0.12	0.45	1.7	mA
I_{g2}	40	140	500	µA
g_m	0.45	1.0	2.1	mA/V
r_a	0.65	1.0	0.2	MΩ

†Obtained by grid current biasing with $R_{g1} = 2.2M\Omega$.

LIMITING VALUES

Pentode section

V_a max.	50	V
V_{g2} max.	50	V
I_k max.	5.0	mA
R_{g1-k} max.	5.0	MΩ
V_{h-k} max.	50	V

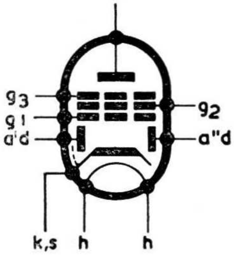
Diode sections (each section)

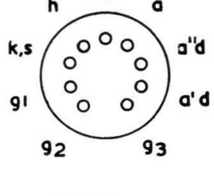
I_{ad} max.	800	µA
$i_{ad(pk)}$ max.	5.0	mA

EBF83

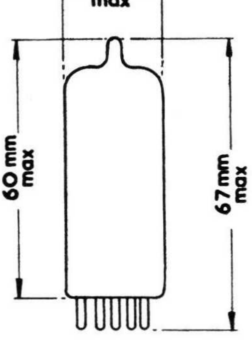
DOUBLE DIODE VARIABLE-MU R.F. PENTODE

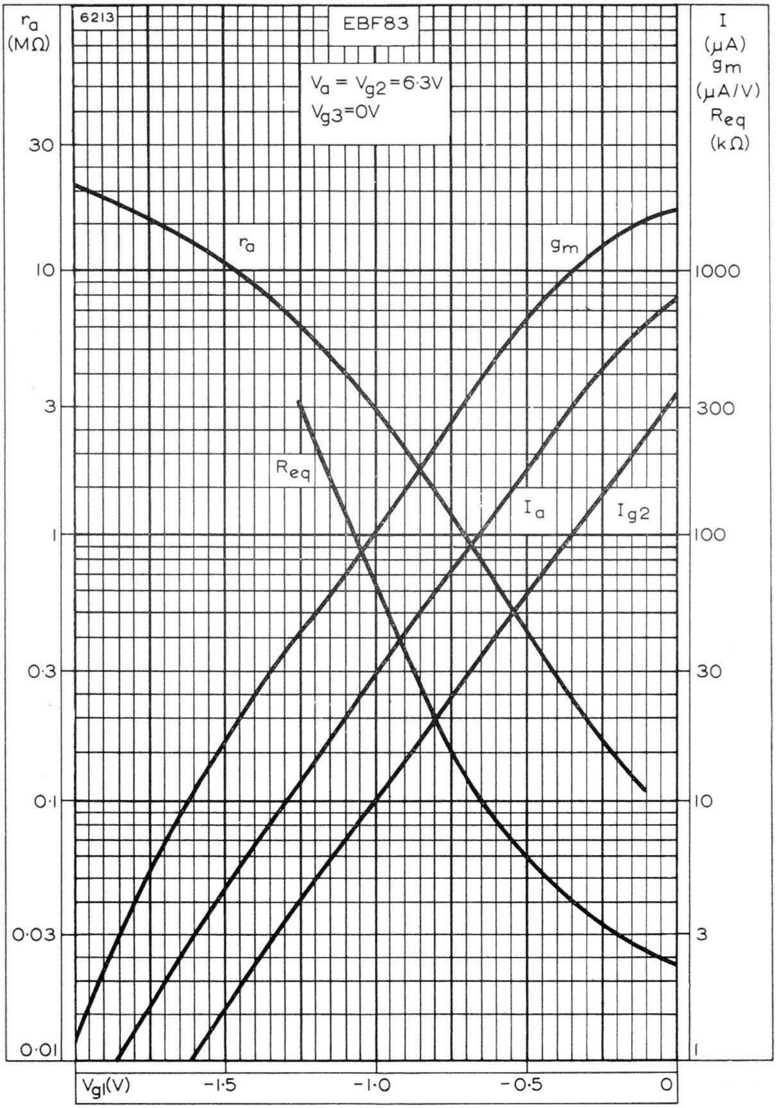
6070





B9A Base

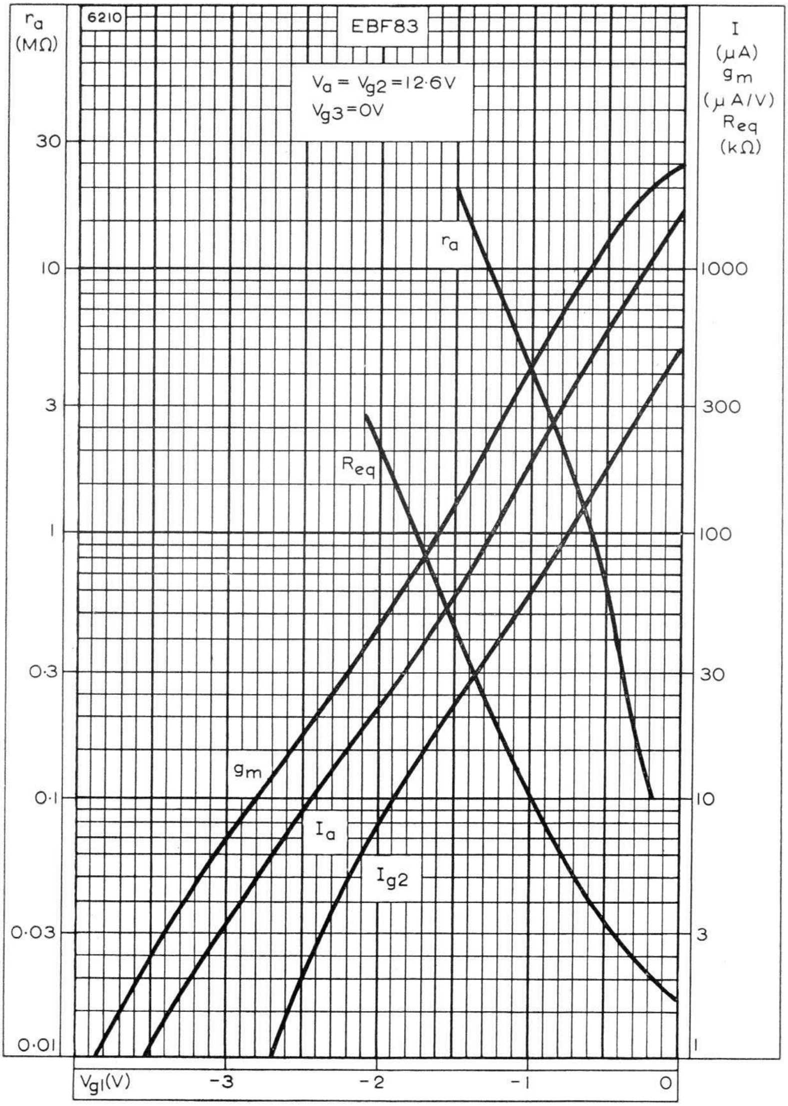




ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 6.3V$

EBF83

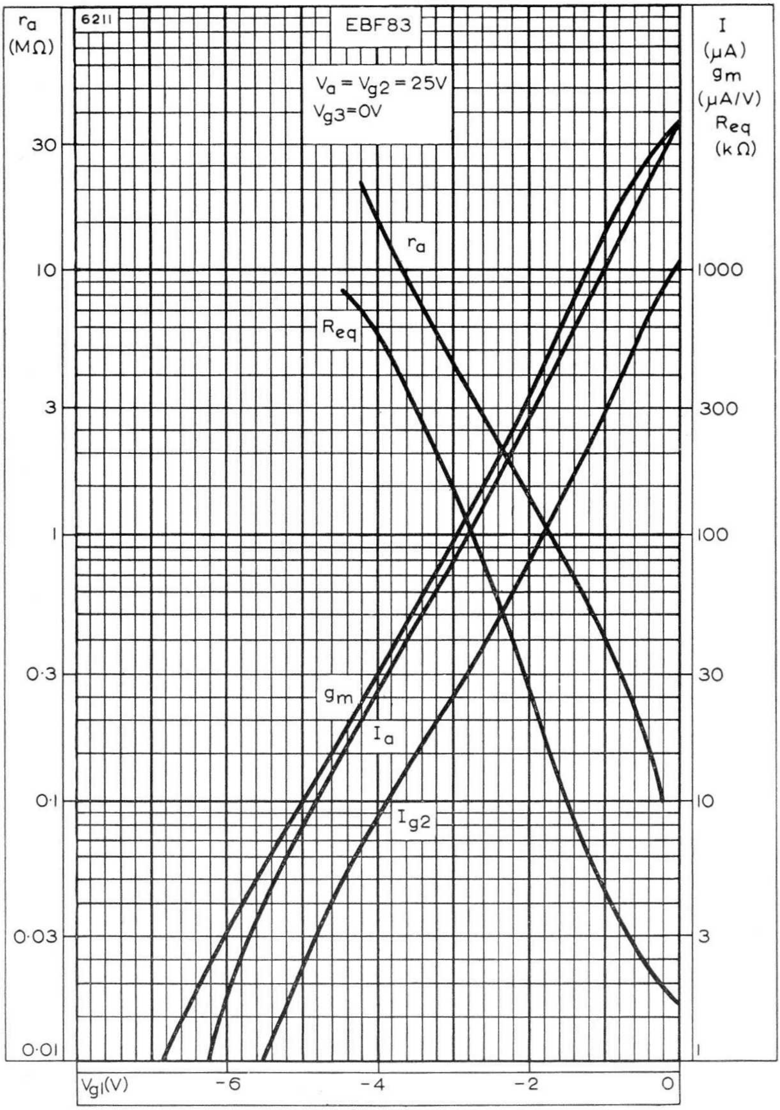
DOUBLE DIODE VARIABLE-MU R.F. PENTODE



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 12.6V$

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF83



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 25V$

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

HEATER

Suitable for series or parallel operation a.c. or d.c.

V_h	6.3	V
I_h	300	mA

MOUNTING POSITION

Any

CAPACITANCES

$c_{a'd-g1}$	<0.0008	pF
$c_{a''d-g1}$	<0.001	pF
$c_{a'd-a}$	<0.15	pF
$c_{a''d-a}$	<0.025	pF

Pentode section

c_{a-g1}	<0.0025	pF
c_{out}	5.2	pF
c_{in}	5.0	pF
c_{g1-h}	0.05	pF

Diode sections

$c_{a'd-k}$	2.5	pF
$c_{a''d-k}$	2.5	pF
$c_{a'd-a''d}$	<0.25	pF
$c_{a'd-h}$	<0.015	pF
$c_{a''d-h}$	<0.003	pF

CHARACTERISTICS

V_a	250	250	V
V_{g3}	0	0	V
V_{g2}	80	100	V
V_{g1}	-1.0*	-2.0	V
I_a	9.0	9.0	mA
I_{g2}	2.7	2.7	mA
g_m	4.5	3.8	mA/V
r_a	0.9	1.0	MΩ
μ_{g1-g2}	20	20	

*At this voltage grid current may occur. If this is not acceptable the negative bias voltage should be increased to –2.0V.

EBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

TYPICAL OPERATING CONDITIONS

$V_a = V_b$	200	200	250	250	V
V_{g3}	—	0	0	0	V
R_{g2}	47	30	82	56	kΩ
V_{g1}	−0.5*	−1.5	−0.5*	−2.0	V
R_k	—	105	—	170	Ω
I_a	9.5	11	8.0	9.0	mA
I_{g2}	2.8	3.3	2.2	2.7	mA
g_m	5.0	4.5	4.7	3.8	mA/V
r_a	0.6	0.6	0.8	1.0	MΩ
R_{eq}	2.5	3.5	2.3	4.0	kΩ
g_m ($V_{g1} = -20$V)	115	120	180	200	μA/V

*This voltage is produced by the grid current flowing through the grid resistor and the steady current of the diode. If this condition is not acceptable the negative grid bias should be increased to −1.5V at $V_a = 200$V and −2.0V at $V_a = 250$V.

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
*V_a max.	300	V
p_a max.	2.25	W
$V_{g2(b)}$ max.	550	V
*V_{g2} max. ($I_a < 4.0$mA)	300	V
V_{g2} max. ($I_a > 8.0$mA)	125	V
p_{g2} max.	450	mW
I_k max.	16.5	mA
V_{g1} max. ($I_{g1} = +0.3\mu$A)	−1.3	V
R_{g1-k} max.	3.0	MΩ
R_{g1-k} max. (grid current biasing)	22	MΩ
R_{g3-k} max.	10	kΩ
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

Diode sections (each section)

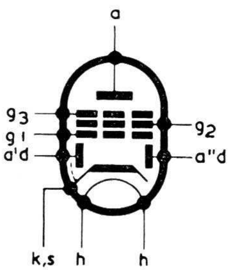
P.I.V. max.	200	V
I_{ad} max.	800	μA
$i_{ad(pk)}$ max.	5.0	mA
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

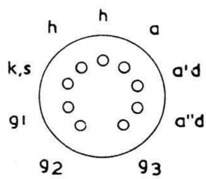
*If the heater, anode and screen-grid voltages are obtained from an accumulator by means of a vibrator, V_a max. = 250V, V_{g2} max. = 250V.

MICROPHONY

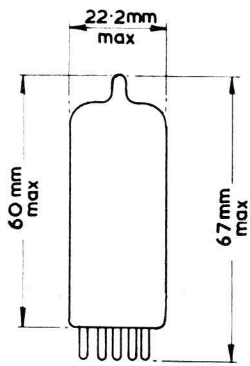
This valve can be used without special precautions against microphony in circuits in which the input voltage is >25mV (r.m.s.) for an output of 50mW from the output valve.

2845





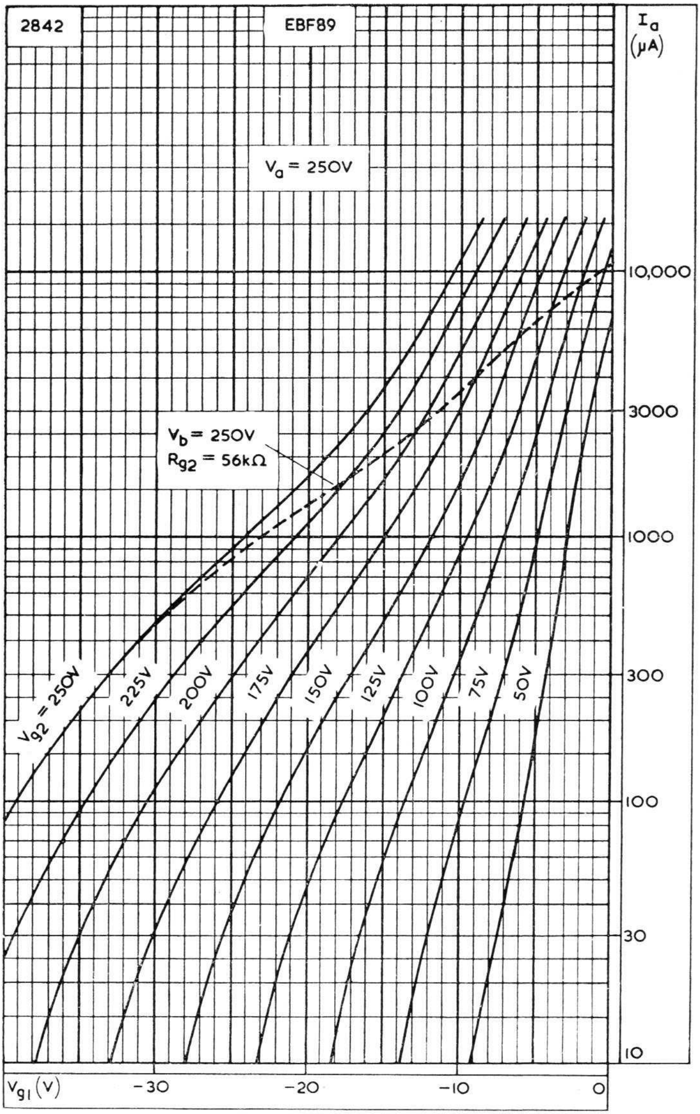
B9A Base



EBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

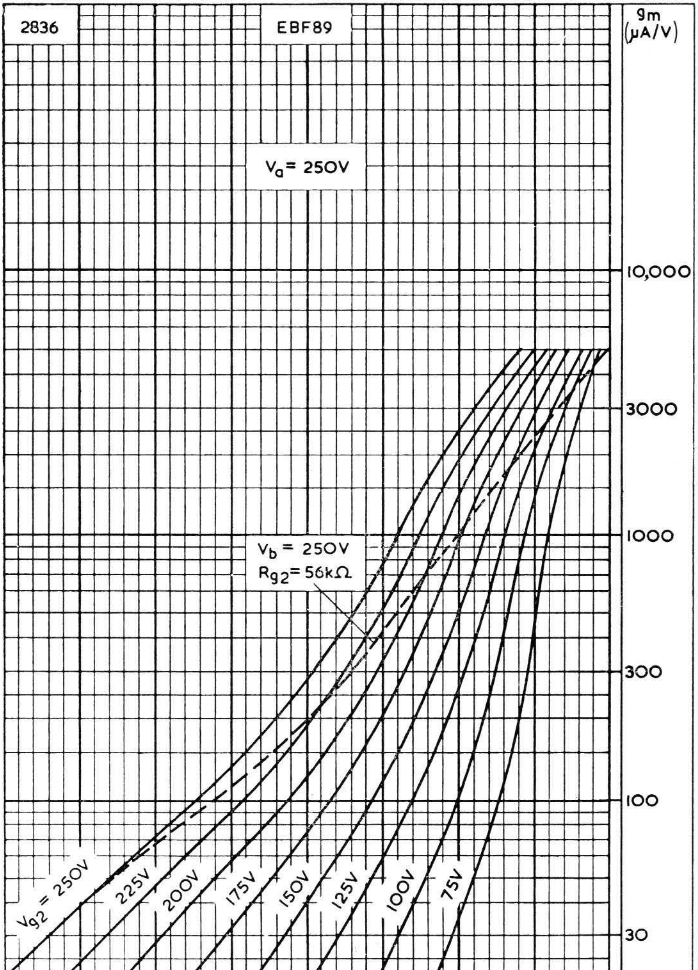


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

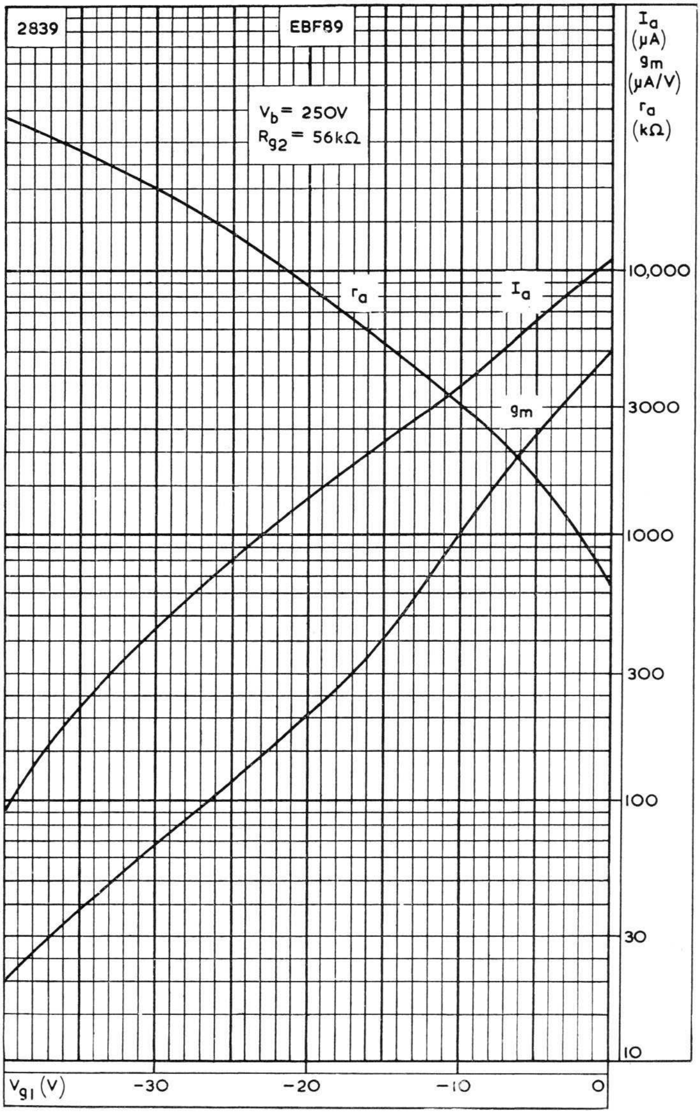


MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER

EBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

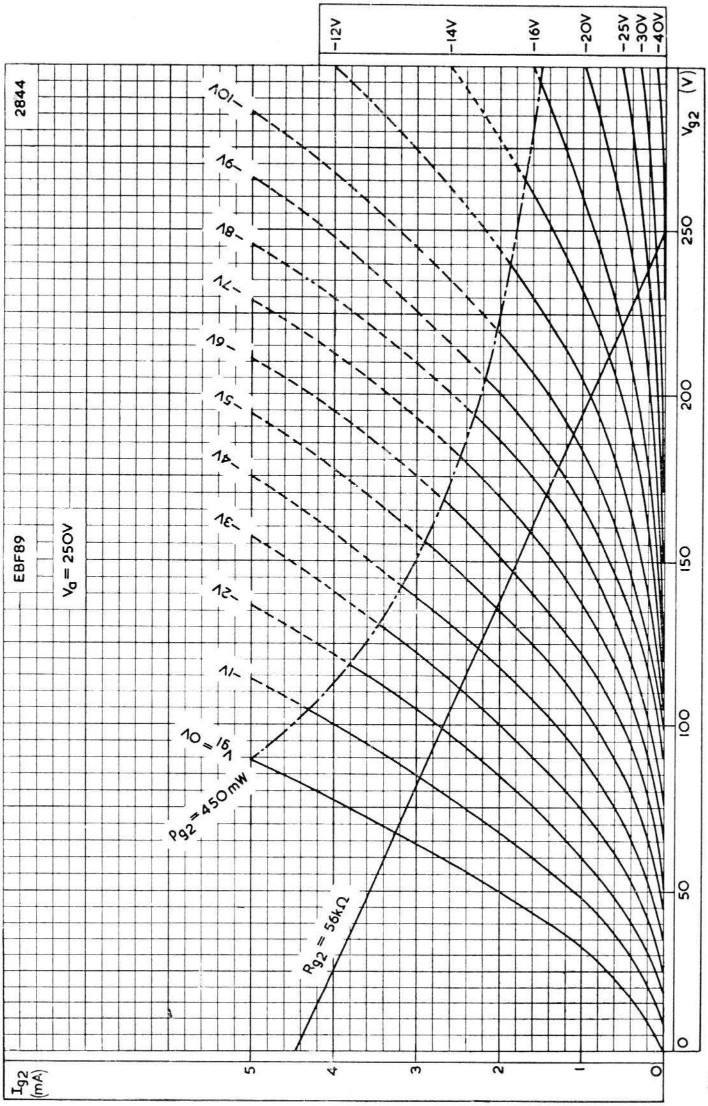


ANODE CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

EBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

ECF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

HEATER

V_h	6.3	V
I_h	430	mA

MOUNTING POSITION

Any

CAPACITANCES (measured without external shield)

c_{ap-at}	<0.06	pF
c_{ap-gt}	<0.02	pF
c_{gp-at}	<0.16	pF
c_{gp-gt}	<0.02	pF

Pentode section

$^*c_{a-g1}$	<0.025	pF
c_{in}	5.5	pF
c_{out}	3.8	pF

*May be reduced to <0.01pF by the use of a skirted base.

Triode section

c_{a-k+h}	1.8	pF
c_{g-k+h}	2.5	pF
c_{a-g}	1.5	pF

CHARACTERISTICS

Pentode section

V_a	250	V
V_{g2}	200	V
V_{g1}	−3.2	V
I_a	7.0	mA
I_{g2}	1.8	mA
g_m	5.5	mA/V
r_a	900	kΩ
μ_{g1-g2}	47	
R_{in} (f=50Mc/s)	11	kΩ
R_{eq}	1.5	kΩ

Triode section

V_a	100	V
I_a	14	mA
V_g	−2.0	V
g_m	5.0	mA/V
μ	20	
r_a	4.0	kΩ

ECF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

TYPICAL OPERATING CONDITIONS

As a frequency changer

$V_a = V_b$	250	250	V
R_{g2}	68	47	kΩ
R_{g1}	100	100	kΩ
R_k	0	820	Ω
I_a	5.6	5.7	mA
I_{g2}	1.52	1.4	mA
$V_{osc(r.m.s.)}$	4.0	3.5	V
I_{g1}	58	0	µA
g_c	1.95	2.1	mA/V
r_a	1.15	1.5	MΩ

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.7	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. ($I_k \leq 10$mA)	200	V
V_{g2} max. ($I_k > 10$mA)	175	V
p_{g2} max. ($p_a \leq 1.2$W)	750	mW
p_{g2} max. ($p_a > 1.2$W)	500	mW
I_k max.	14	mA
V_{g1} max. ($I_{g1} = +0.3\mu$A)	–1.3	V
R_{g1-k} max. (cathode bias)	1.0	MΩ
R_{g1-k} max. (fixed bias)	500	kΩ
V_{h-k} max. (cathode positive)	150	V
V_{h-k} max. (cathode negative)	100	V

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max	1.5	W
I_k max.	14	mA
*$i_{k(pk)}$ max.	200	mA
V_{g1} max. ($I_{g1} = +0.3\mu$A)	–1.3	V
$-v_{g1(pk)}$ max.	350	V
V_{h-k} max. (cathode positive)	150	V
V_{h-k} max. (cathode negative)	100	V

*Max. pulse duration 200µs

OPERATING NOTE

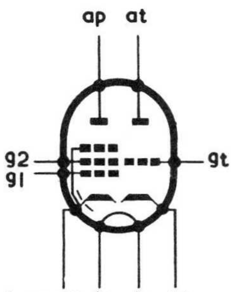
It is anticipated that variations in heater-to-cathode capacitance may render the valve unsuitable for use in Hartley oscillator circuits, particularly in f.m. receivers. For this reason it is recommended that a Colpitts type of circuit be employed.

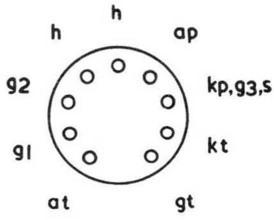
TRIODE PENTODE

ECF80

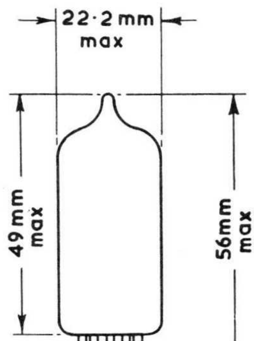
Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

3222





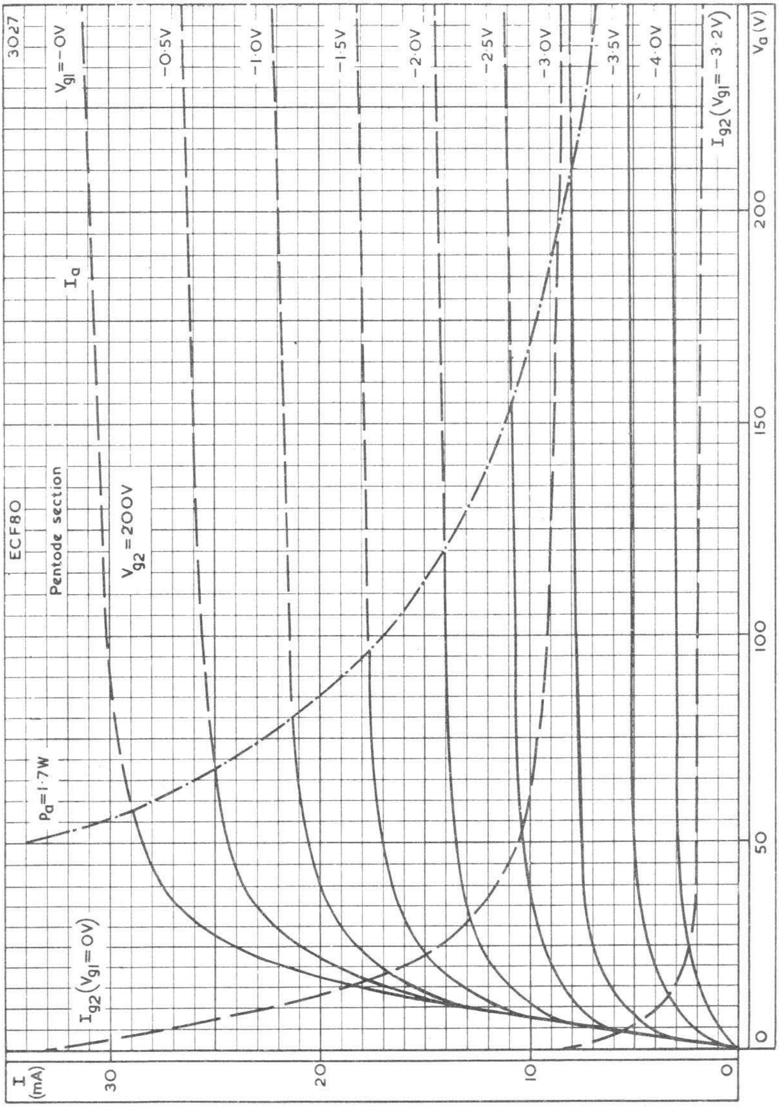
B9A Base



ECF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

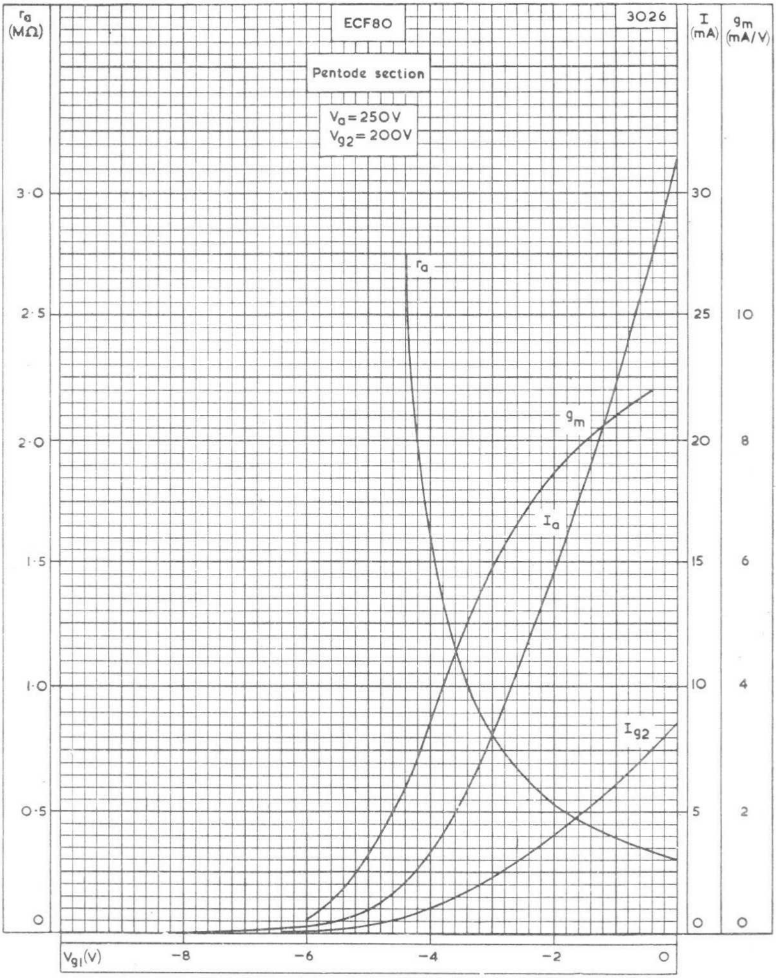


ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE FOR PENTODE SECTION WITH CONTROL-GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

ECF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

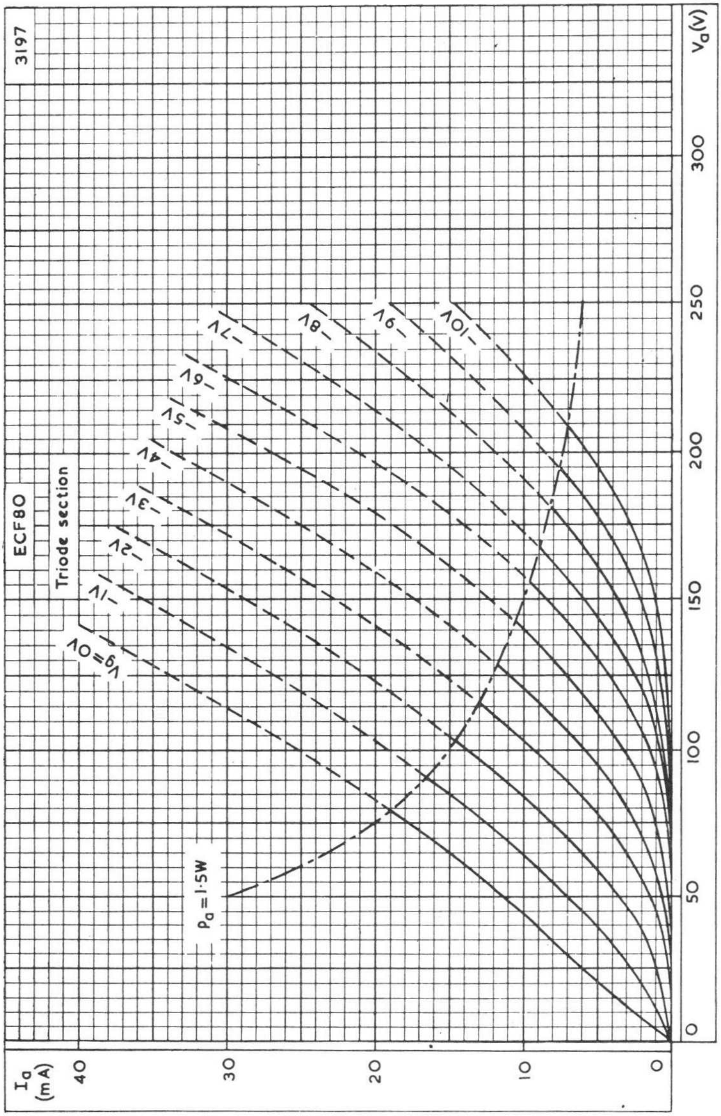


ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE OF PENTODE SECTION. V_a=250V, V_{g2}=200V

ECF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

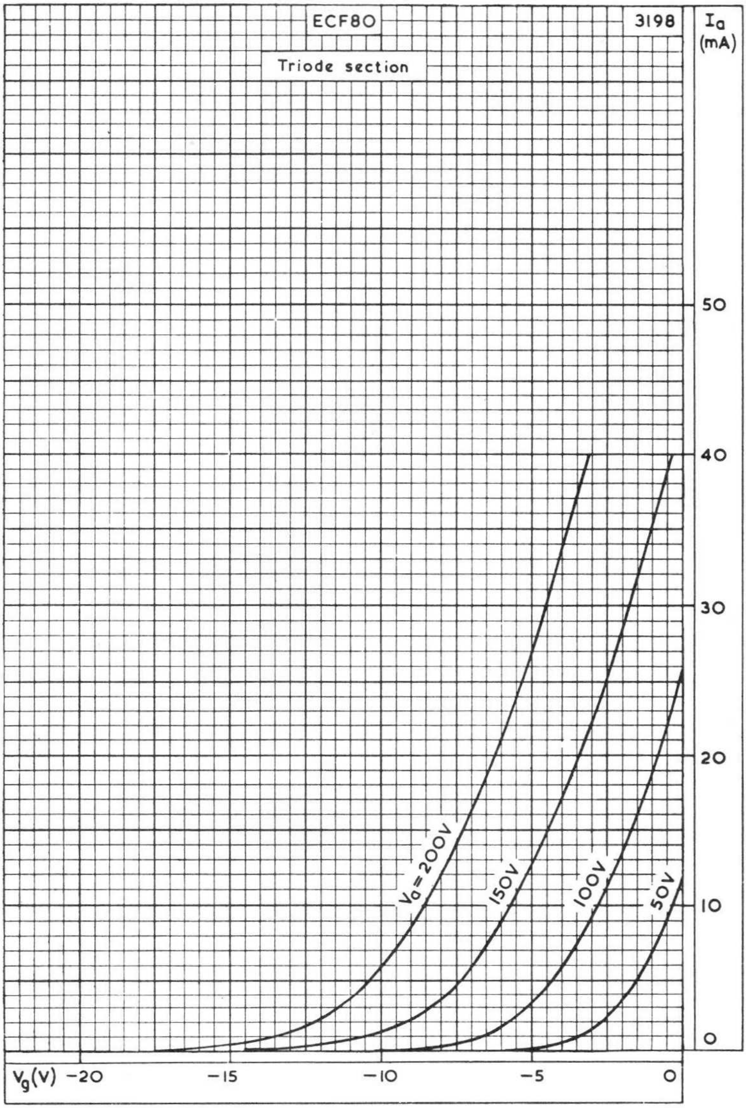


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR TRIODE SECTION WITH CONTROL-GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

ECF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

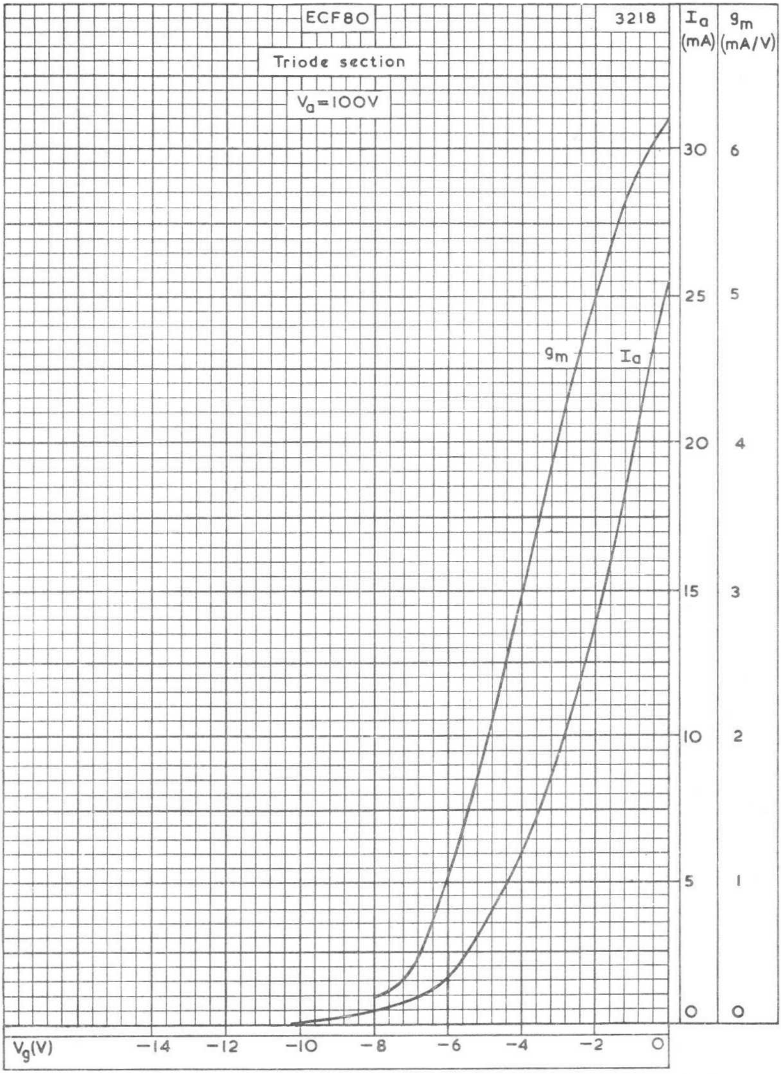


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR TRIODE SECTION FOR VARIOUS VALUES OF ANODE VOLTAGE

ECF80

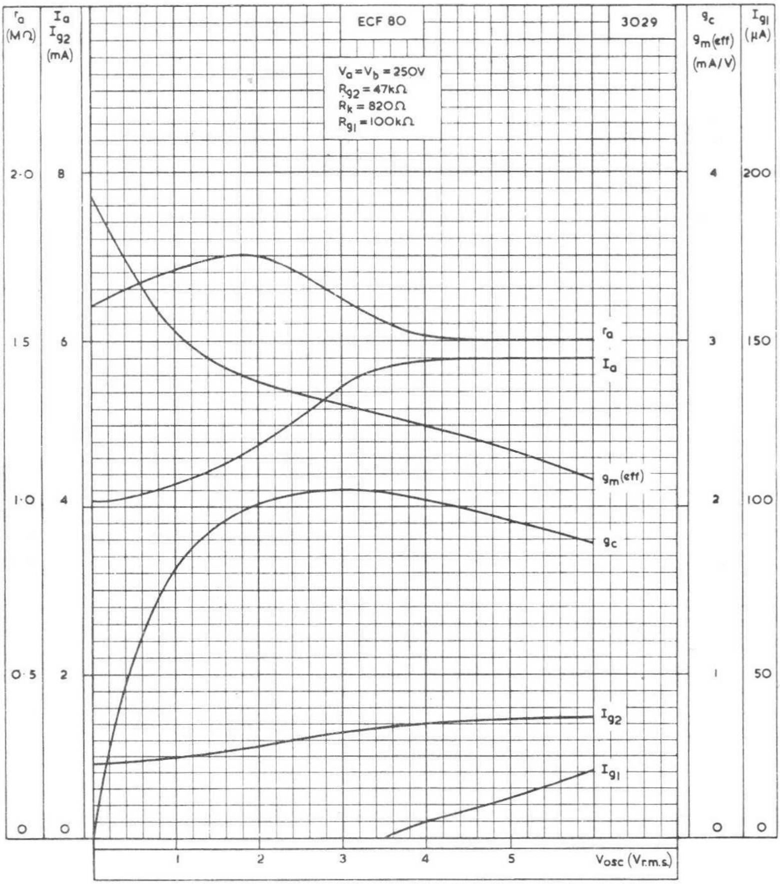
TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR TRIODE SECTION
$V_a = 100V$

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.

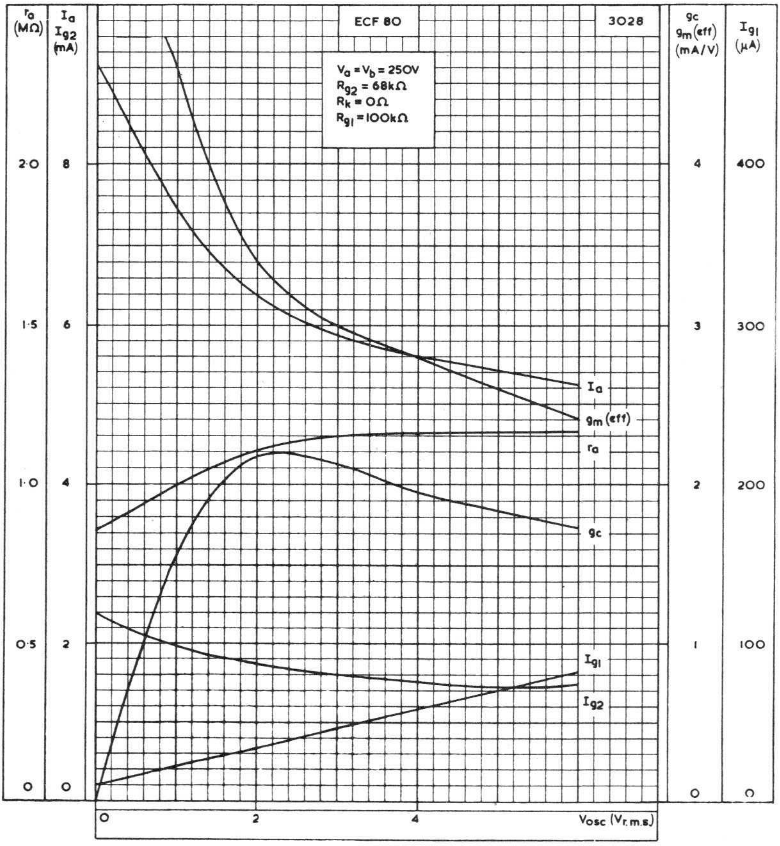


PERFORMANCE CURVES FOR USE AS FREQUENCY CHANGER WITH $R_k = 820\Omega$

ECF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily intended for use as a frequency changer at frequencies up to 220Mc/s.



PERFORMANCE CURVES FOR USE AS FREQUENCY CHANGER WITH $R_k = 0\Omega$

TRIODE HEPTODE

ECH81

Triode heptode primarily intended for use as a frequency changer.

HEATER

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

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{ah-at}	200	mpF
c_{ah-gt}	<90	mpF
$c_{ah-(g3+gt)}$	<350	mpF
c_{g1-at}	<60	mpF
c_{g1-gt}	<170	mpF
$c_{g1-(g3+gt)}$	<450	mpF

Heptode section

$c_{in(g1)}$	4.8	pF
$c_{in(g3)}$	6.0	pF
c_{out}	7.9	pF
c_{a-g1}	<6.0	mpF
c_{g1-g3}	<300	mpF
c_{g1-h}	<170	mpF
c_{g3-h}	<60	mpF

Triode section

c_{in}	2.6	pF
c_{out}	2.1	pF
c_{a-g}	1.0	pF
c_{g-h}	<20	mpF

OPERATING CONDITIONS OF HEPTODE SECTION AS R.F. OR I.F. AMPLIFIER ←

V_b	250	250	V
V_a	160	248	V
V_{g3}	0	0	V
R_{g2+g4}	22	22	kΩ
$*V_{g1}$	-	-35	V
V_{g2+g4}	96	245	V
I_a	11	-	mA
I_{g2+g4}	7	-	mA
I_{g1}	0.5	-	μA
g_m	4500	45	μA/V
r_a	0.24	>10	MΩ
μ_{g2-g1}	25	-	
R_{eq}	4.5	-	kΩ
R_a	8.2	8.2	kΩ
R_{g2+g4}	22	22	kΩ

*Operating with grid current bias as obtained with R_{g1-k} = 1MΩ and with zero a.g.c. volts; resulting V_{g1} = -500mV.

OPERATING CONDITIONS OF HEPTODE SECTION AS A.M. FREQUENCY CHANGER* ←

V_b	250	250	V
V_a	225	240	V
R_{g2+g4}	22	22	kΩ
R_{g3+gt}	47	47	kΩ
V_{g1}	-	-28	V
V_{g2+g4}	78	235	V
I_a	3.3	-	mA
I_{g2+g4}	7.8	-	mA
I_{g3+gt}	200	200	μA
$**I_{g1}$	0.5	-	μA
g_c	1100	11	μA/V
R_a	8.2	8.2	kΩ
R_{eq}	30	-	kΩ

*Triode operating with V_b = 250V, R_a = 33kΩ and $V_{osc\ (r.m.s.)}$ = 8V.

**Operating with grid current bias as obtained with R_{g1-k} = 1MΩ and with a.g.c. volts; resulting V_{g1} = -500mV.

TRIODE HEPTODE

ECH81

CHARACTERISTICS

Triode section

V_a	100	V
I_a	13.5	mA
V_g	0	V
g_m	3.7	mA/V
μ	22	
r_a	6.0	kΩ
V_g max. (I_g = +0.3μA)	-1.3	V

Heptode section

←

V_a	160	V
V_{g3}	0	V
V_{g2+g4}	100	V
I_{g1}	0.5	μA
V_{g1}	-0.5	V
I_a	11	mA
I_{g2+g4}	7	mA
g_m	4.5	mA/V
μ_{g2-g1}	25	

OPERATING CONDITIONS OF TRIODE SECTION AS R.F. OSCILLATOR

V_b	250	V
R_{at}	33	kΩ
R_{gt+g3}	47	kΩ
I_{gt+g3}	200	μA
I_{at}	4.5	mA
g_m (eff)	650	μA/V

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

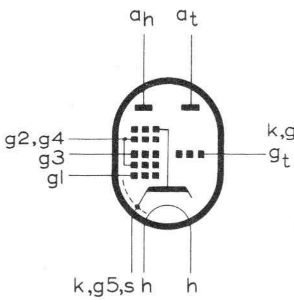
Triode section

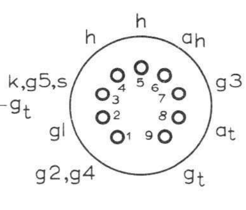
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	800	mW
I_k max.	6.5	mA
R_{g-k} max.	3.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

Heptode section

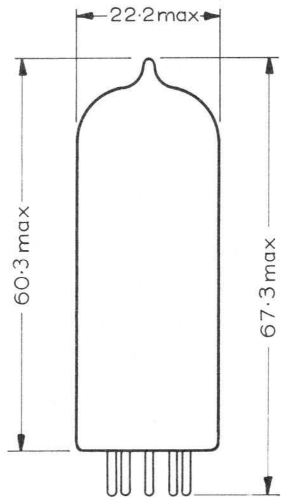
$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.0	W←
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max.	125	V
V_{g2+g4} max. (I_a <1mA)	300	V
p_{g2+g4} max.	0.8	W←
I_k max.	18	mA←
R_{g1-k} max.	3.0	MΩ
*R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

*If the two sections of the valve are switched during operation so that there is no direct connection between g_3 and g_t, as may occur in f.m./a.m. receivers, then R_{g3-k} max. = 20kΩ.



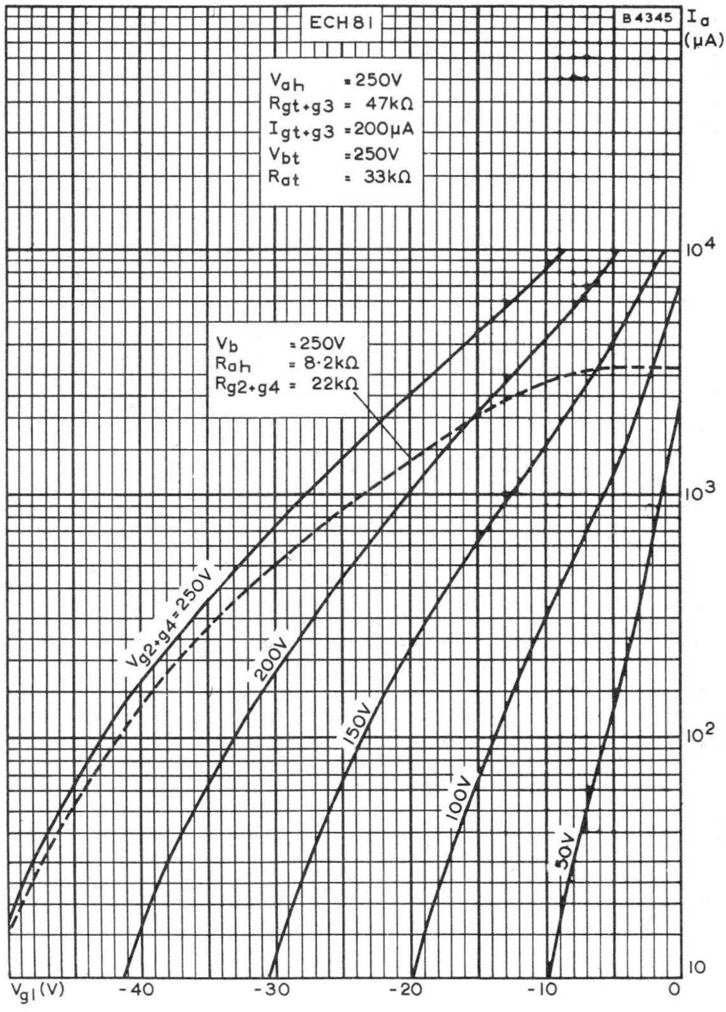


B9A Base

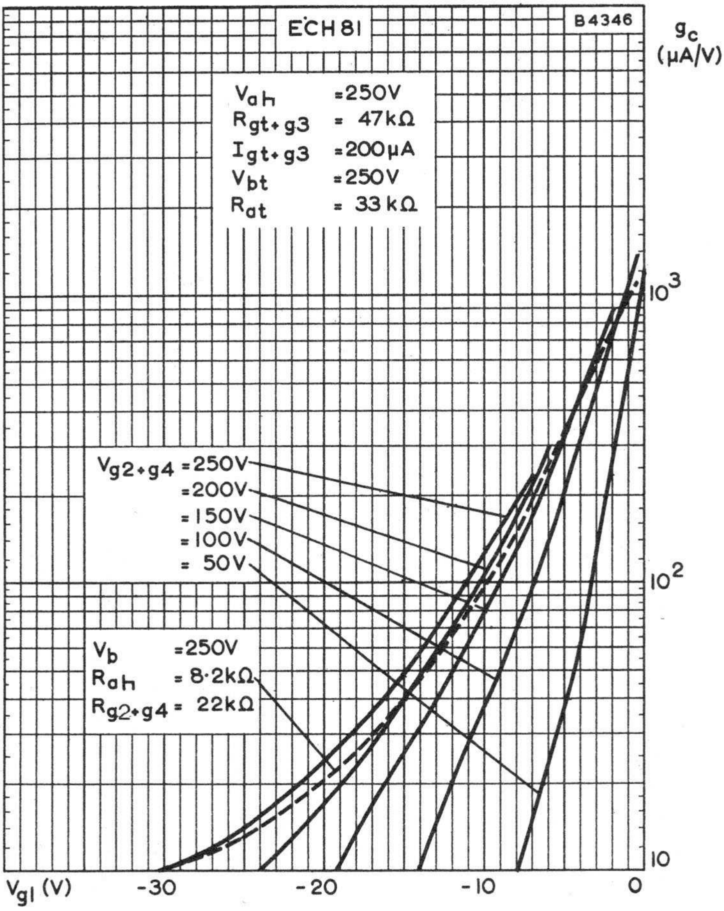


All dimensions in mm

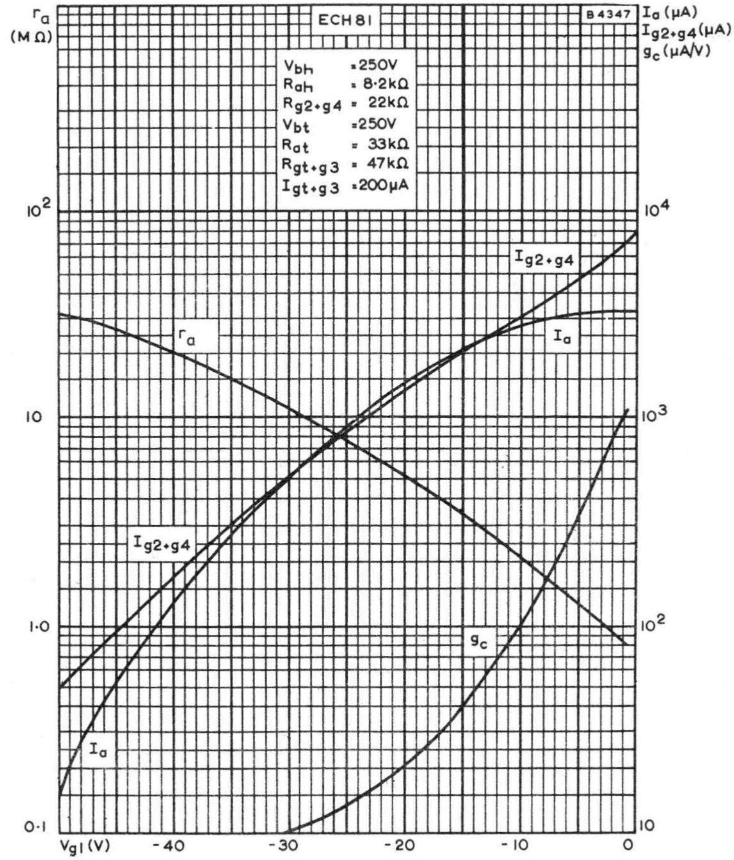
B 4464



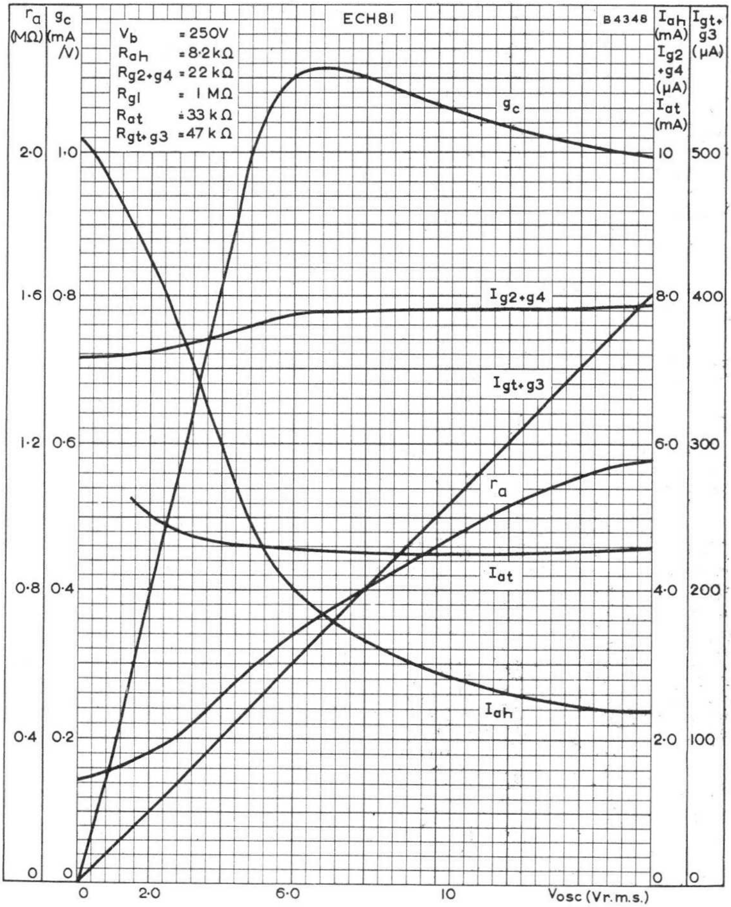
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER



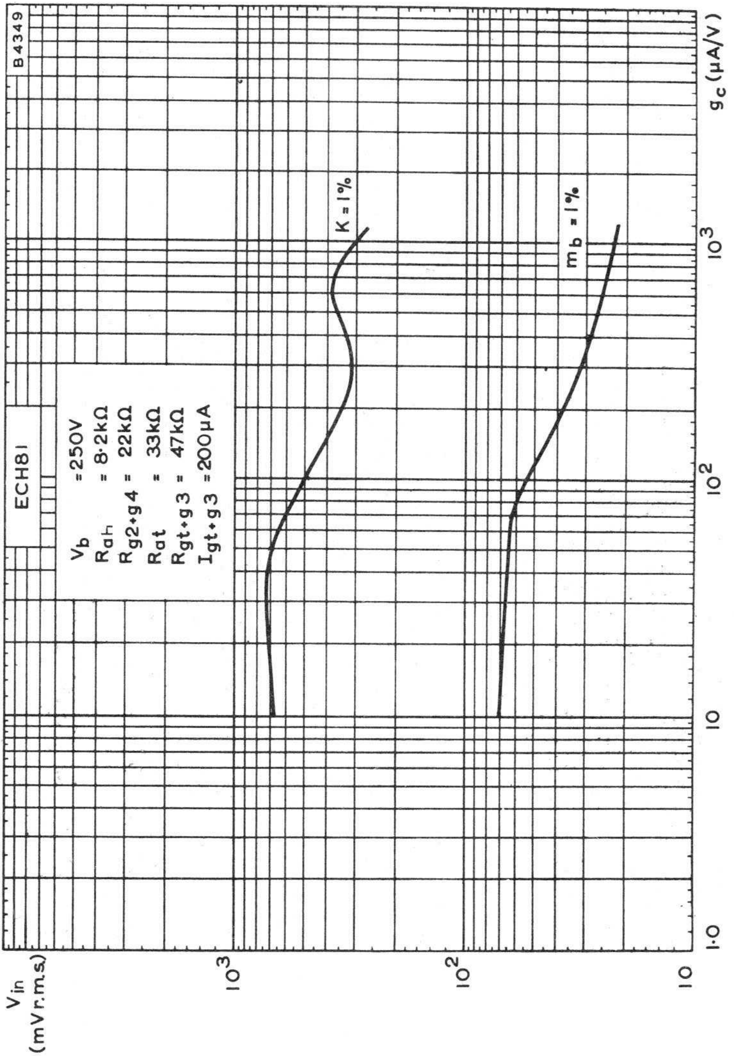
CONVERSION CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER



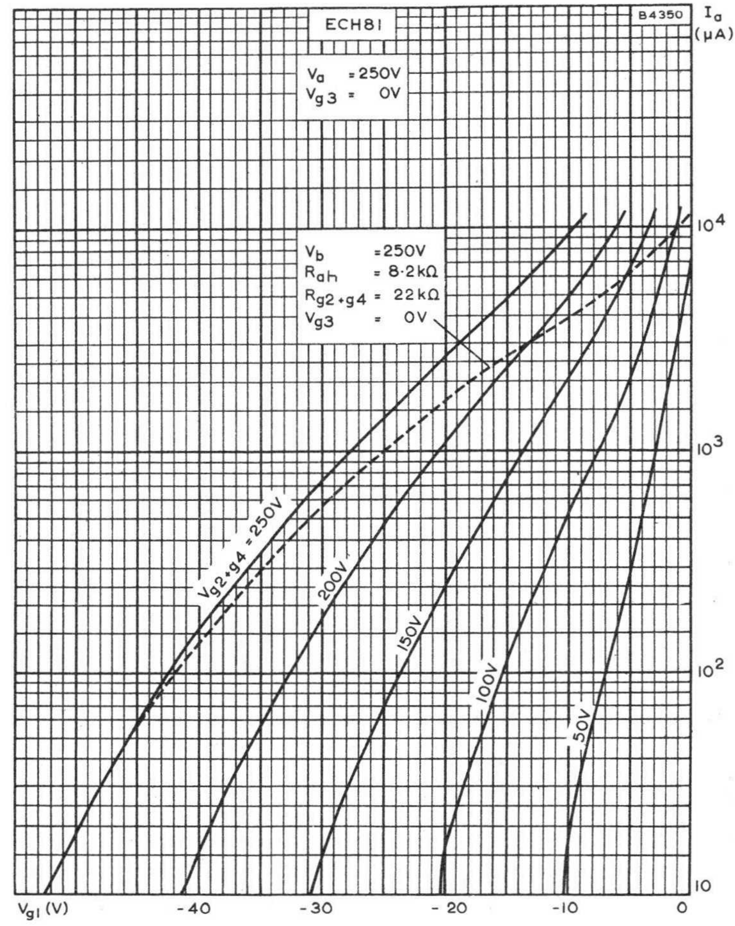
ANODE AND SCREEN-GRID CURRENTS, CONVERSION CONDUCTANCE ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER



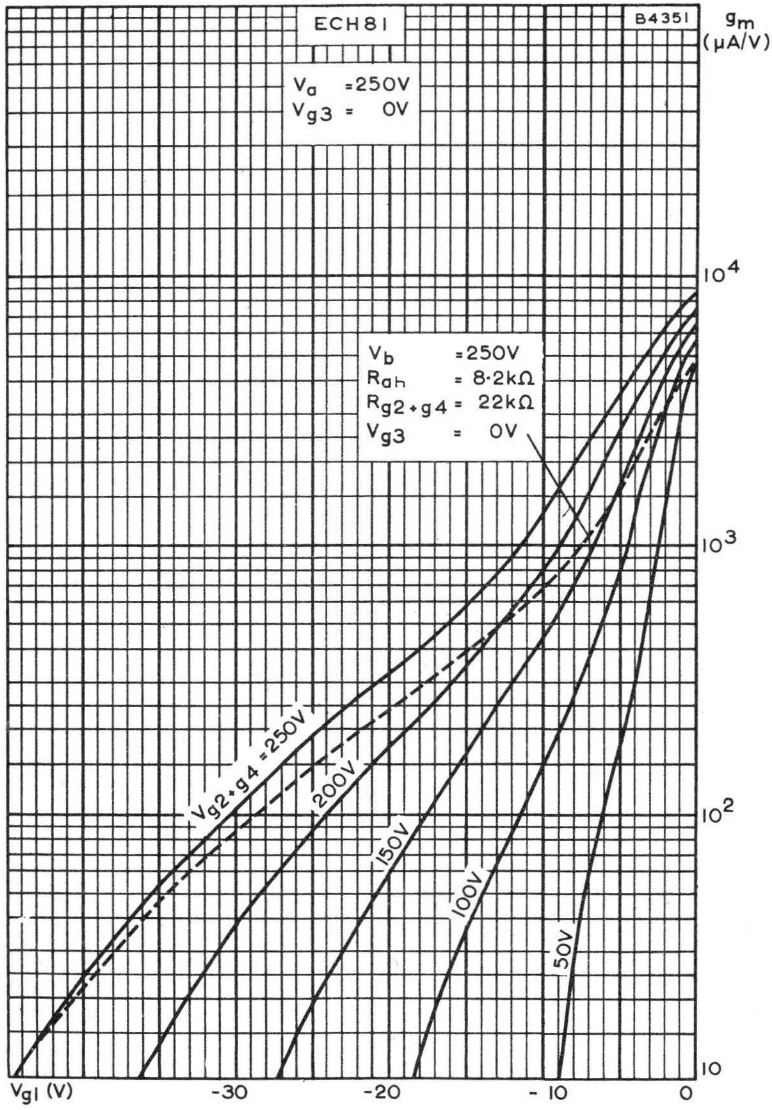
ANODE, SCREEN AND OSCILLATOR GRID CURRENTS, CONVERSION CONDUCTANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST OSCILLATOR VOLTAGE



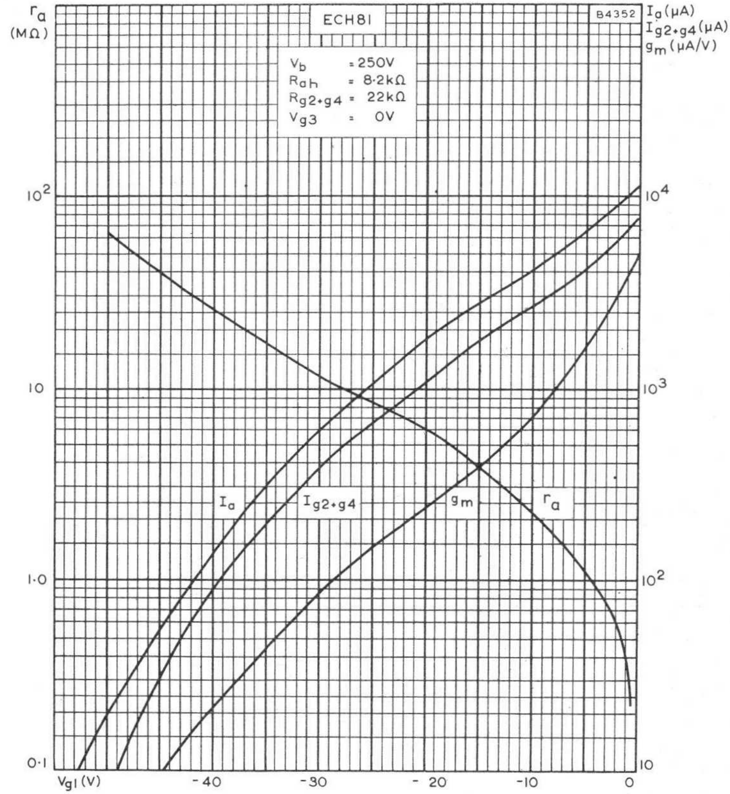
INDICATING THE R.M.S. VALUE OF THE VOLTAGE OF AN INTERFERING SIGNAL AT THE GRID PRODUCING 1% CROSS AND HUM MODULATION AS A FUNCTION OF THE CONVERSION CONDUCTANCE



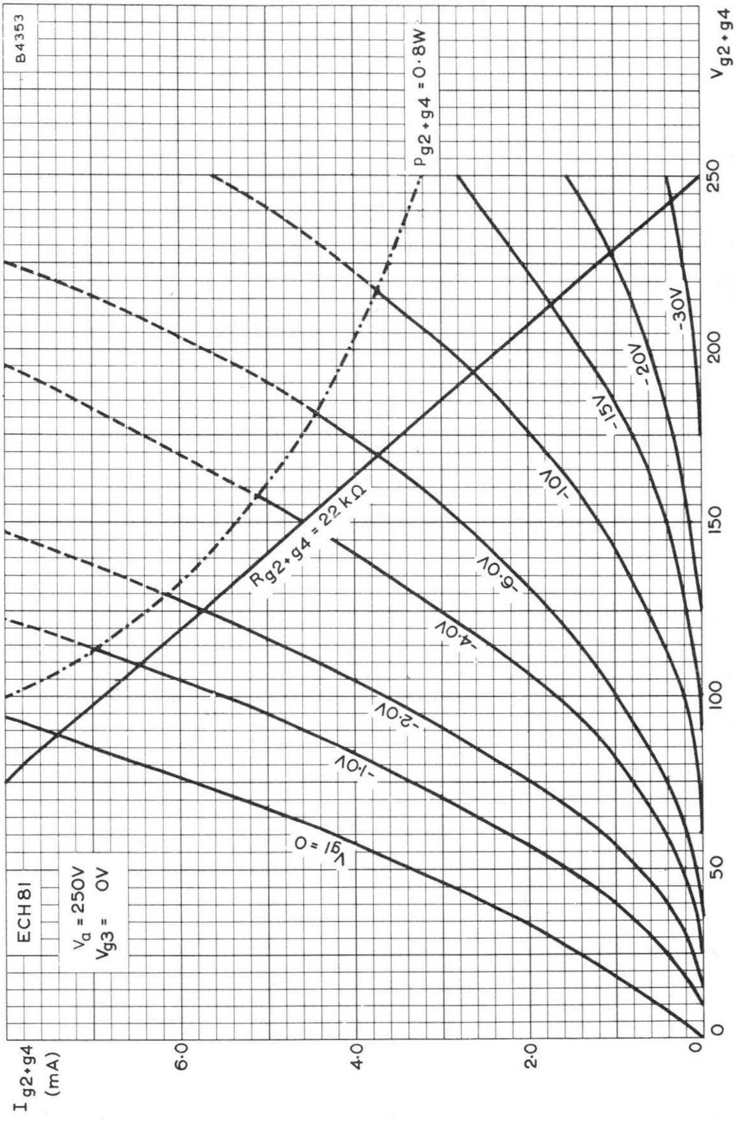
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION



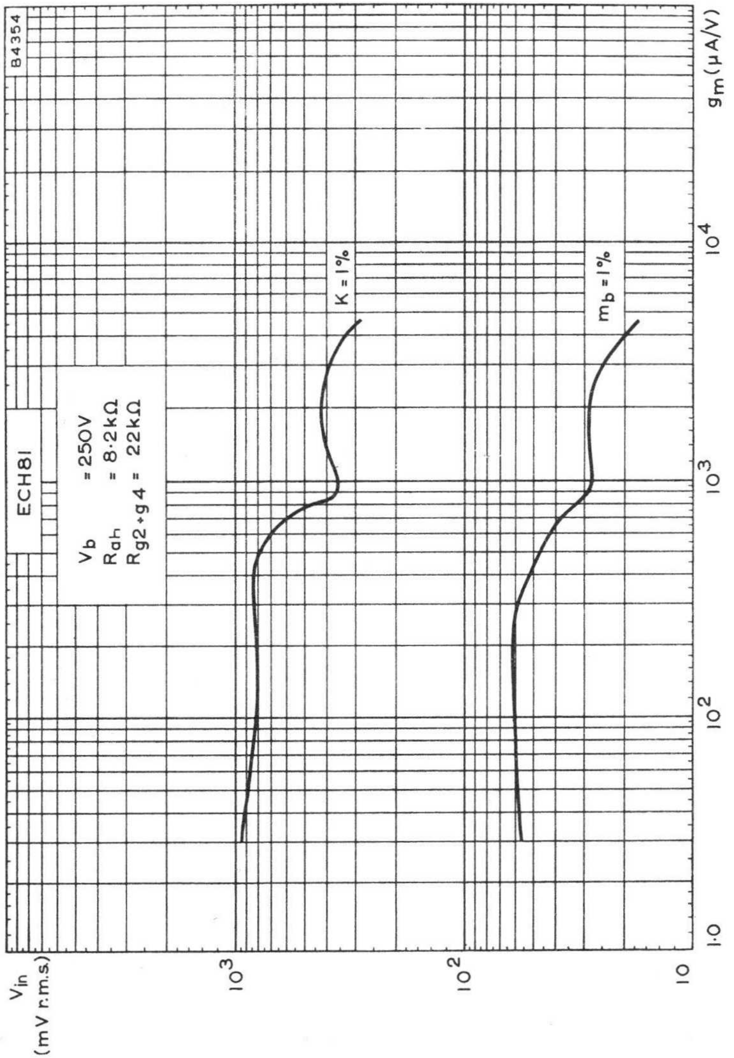
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION



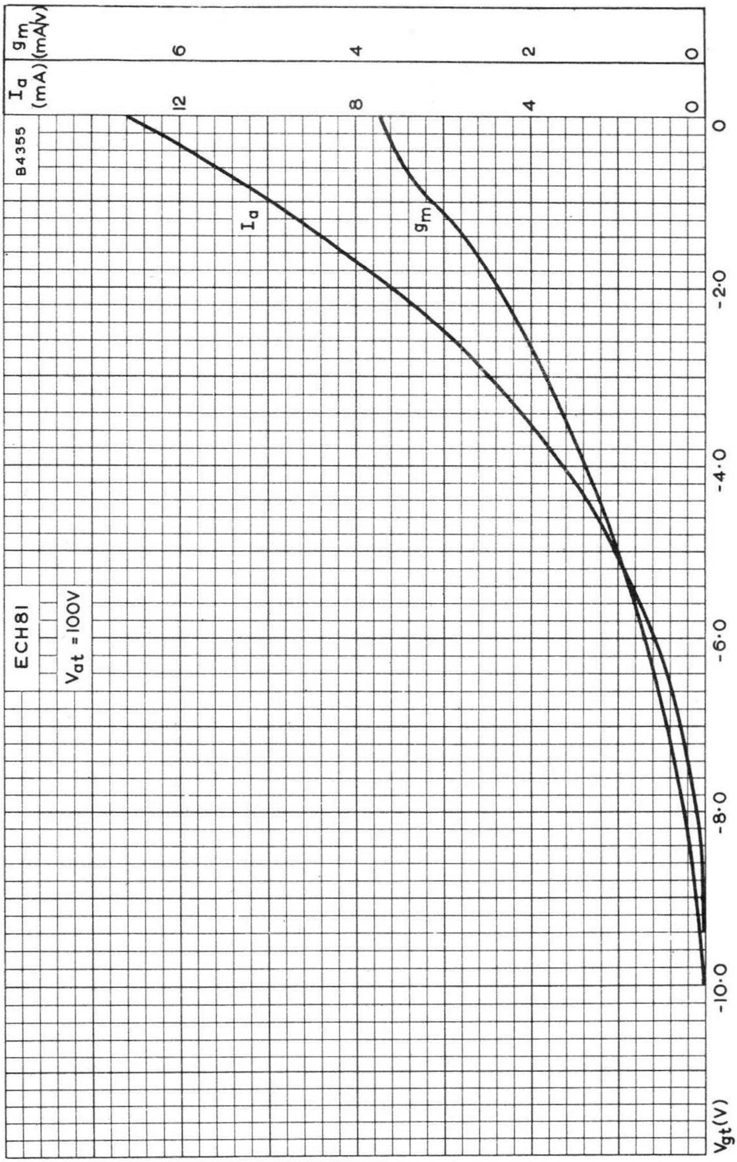
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION



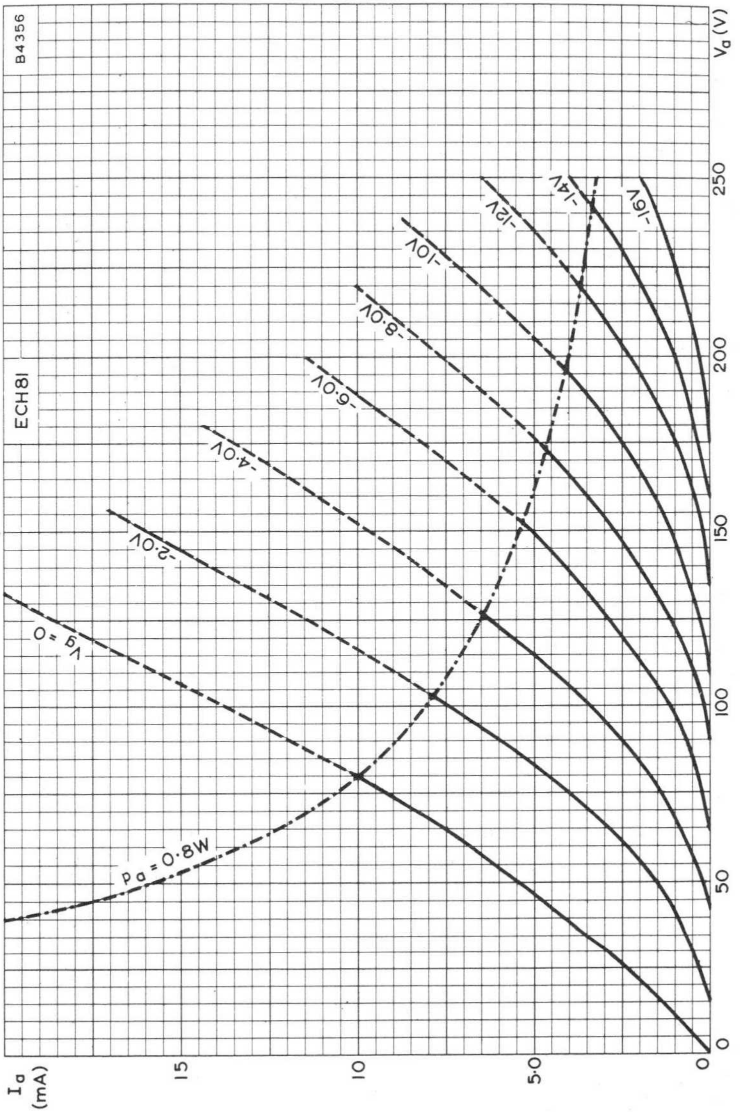
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER FOR HEPTODE SECTION



INDICATING THE R.M.S. VALUE OF THE VOLTAGE OF AN INTERFERING SIGNAL AT THE GRID PRODUCING 1% CROSS AND HUM MODULATION AS A FUNCTION OF THE MUTUAL CONDUCTANCE



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE FOR TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER FOR TRIODE SECTION

TRIODE HEPTODE

ECH83

Triode heptode intended for use as a frequency changer or combined r.f. and a.f. amplifier in equipment operating directly from a 6V, 12V or 24V battery, on or off charge.

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{ah-at}	200	mpF
c_{ah-gt}	<90	mpF
$c_{ah-g3+gt}$	<350	mpF
c_{g1-at}	<60	mpF
c_{g1-gt}	<170	mpF
$c_{g1-g3+gt}$	<450	mpF

Heptode section

$c_{in(g1)}$	4.8	pF
$c_{in(g3)}$	6.0	pF
c_{out}	7.9	pF
c_{a-g1}	<12	mpF
c_{g1-g3}	<300	mpF

Triode section

c_{in}	2.6	pF
c_{out}	2.1	pF
c_{a-g}	1.0	pF

OPERATING CONDITIONS OF HEPTODE SECTION AS R.F. AMPLIFIER

$V_a = V_b$	6.3	12.6	25	V
$V_{g2+g3+g4}$	6.3	12.6	25	V
$*V_{g1(b)}$	0	0	0	V
V_{g1}	†	†	†	
R_{g1}	1.0	1.0	1.0	MΩ
I_a	0.11	0.4	1.25	mA
$I_{g2+g3+g4}$	80	250	850	μA
g_m	0.35	0.75	1.5	mA/V
r_a	600	850	200	kΩ
R_{eq}	8.5	6.5	5.0	kΩ
V_{g1} (for 100 : 1 reduction in g_m)	–2.0	–2.8	–4.4	V

$*V_{g1(b)}$ = Voltage at earthy end of grid leak.
†Obtained by grid current biasing.

OPERATING CONDITIONS AS A.M. FREQUENCY CHANGER (multiplicative mixer)

Heptode section

$V_a = V_b$	6.3	12.6	25	V
V_{g2+g4}	6.3	12.6	25	V
$*V_{g1(b)}$	0	0	0	V
V_{g1}	†	†	†	
R_{g1}	1.0	1.0	1.0	MΩ
I_a	18	100	460	μA
I_{g2+g4}	0.1	0.35	1.25	mA
I_{g3+gt}	28	32	54	μA
$V_{osc(r.m.s.)}$	0.9	1.2	2.0	V
R_{g3+gt}	47	47	47	kΩ
g_c	50	160	390	μA/V
r_a	3.75	3.8	1.1	MΩ

$*V_{g1(b)}$ = Voltage at earthy end of grid leak.
†Obtained by grid current biasing with $R_{g1} = 1.0\text{M}\Omega$.

Triode section

$V_a = V_b$	12.6	V
V_g	0	V
I_a	750	μA
g_m	1.4	mA/V
I_{gt+g3}	42	μA
R_{gt+g3}	47	kΩ
$V_{gt+g3(r.m.s.)}$	1.7	V

OPERATING CONDITIONS OF TRIODE SECTION AS A.F. AMPLIFIER

V_b	12.6	V
R_a	150	kΩ
R_g	10	MΩ
R_{g1} (of following valve)	10	MΩ
V_{out}/V_{in}	8.0	
V_{out}	1.8	V
D_{tot}	5.0	%

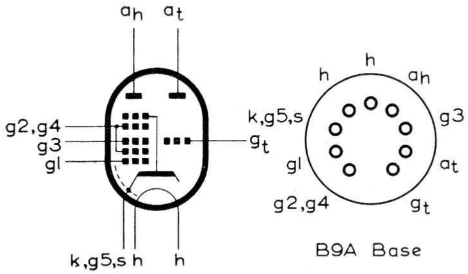
LIMITING VALUES

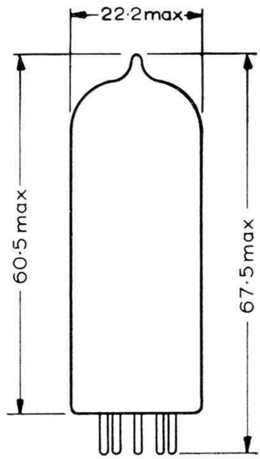
Heptode section

V_a max.	30	V
V_{g2+g4} max.	30	V
I_k max.	5.0	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	50	kΩ

Triode section

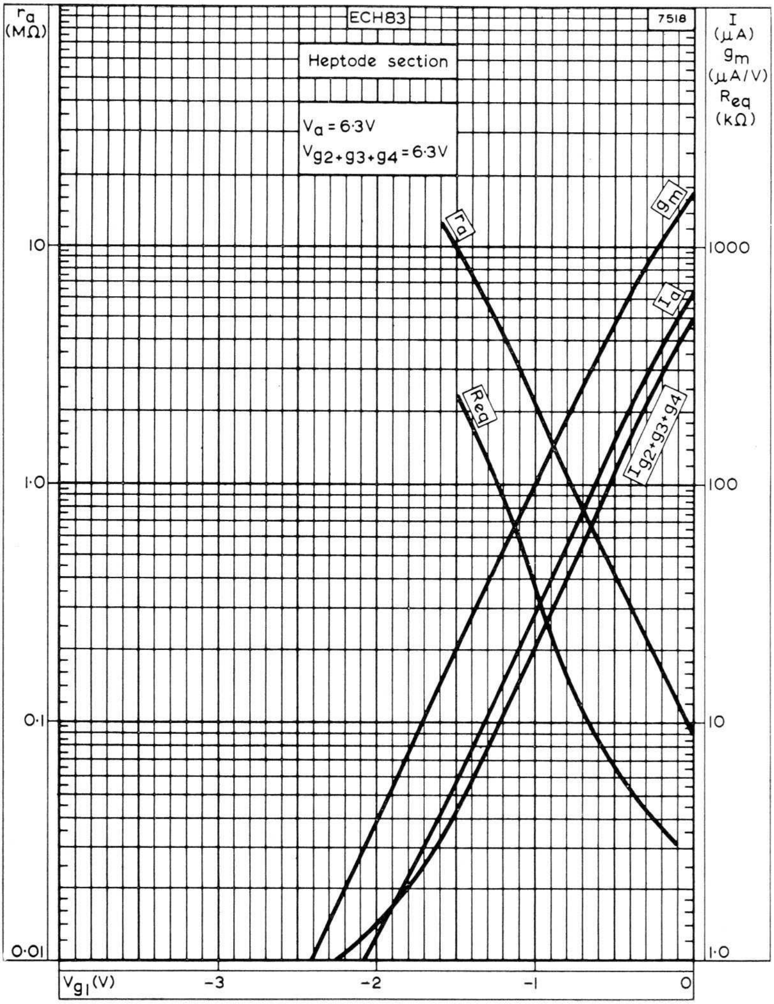
V_a max.	30	V
I_k max.	3.0	mA





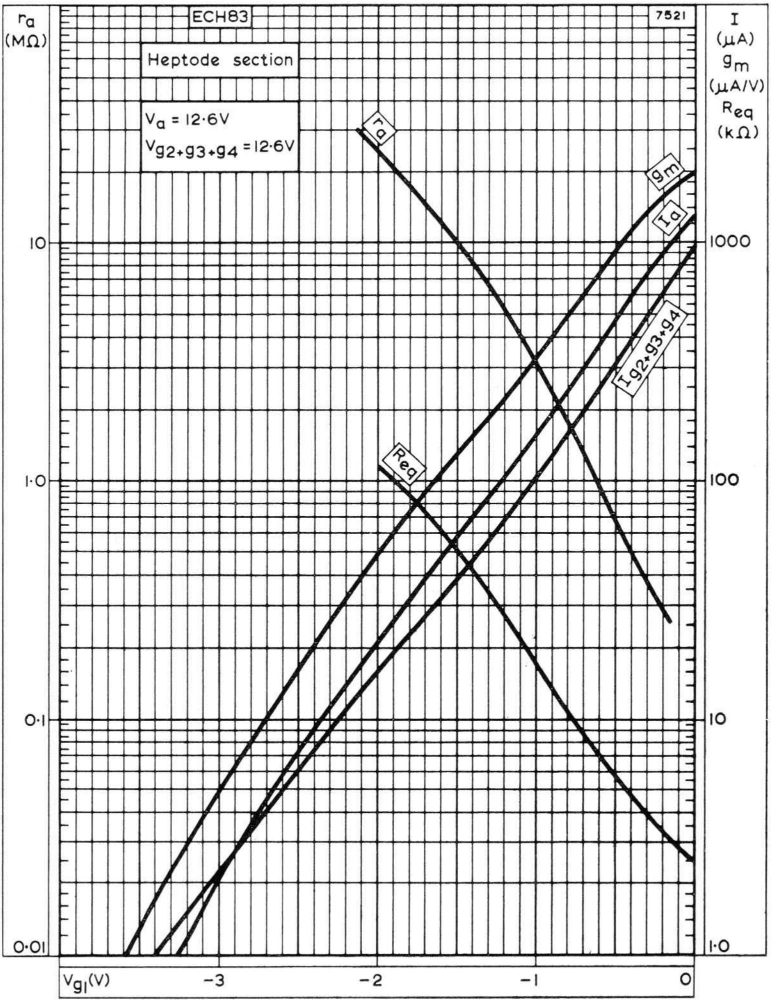
All dimensions in mm

6397



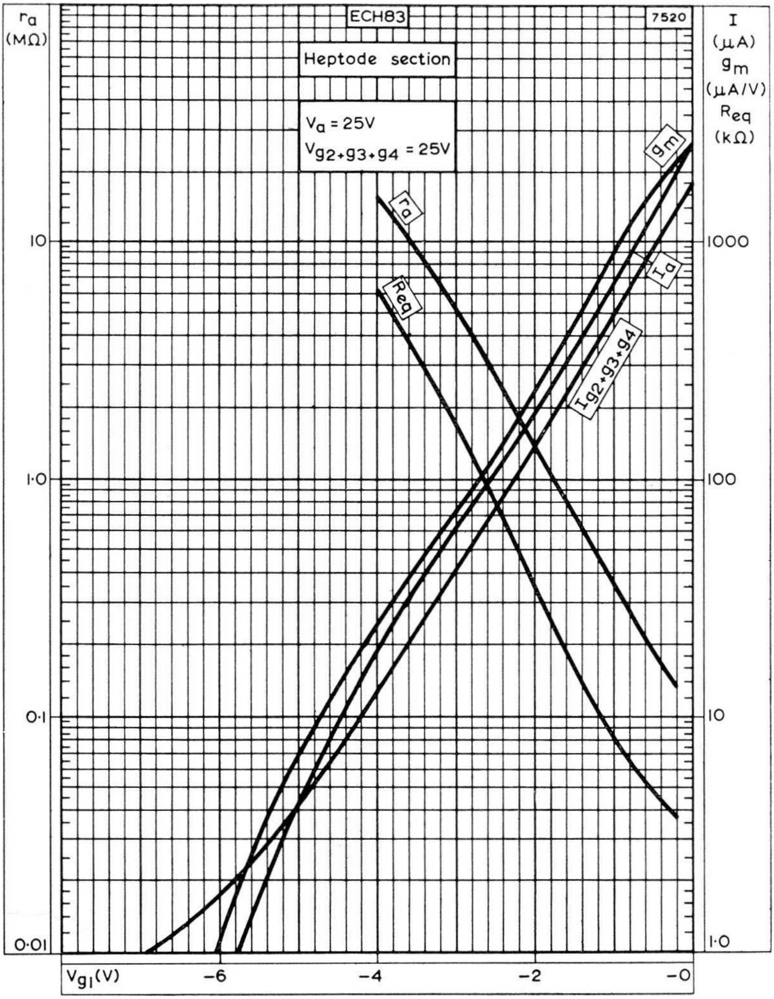
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION

$V_a = V_{g2+g3+g4} = 6.3V$



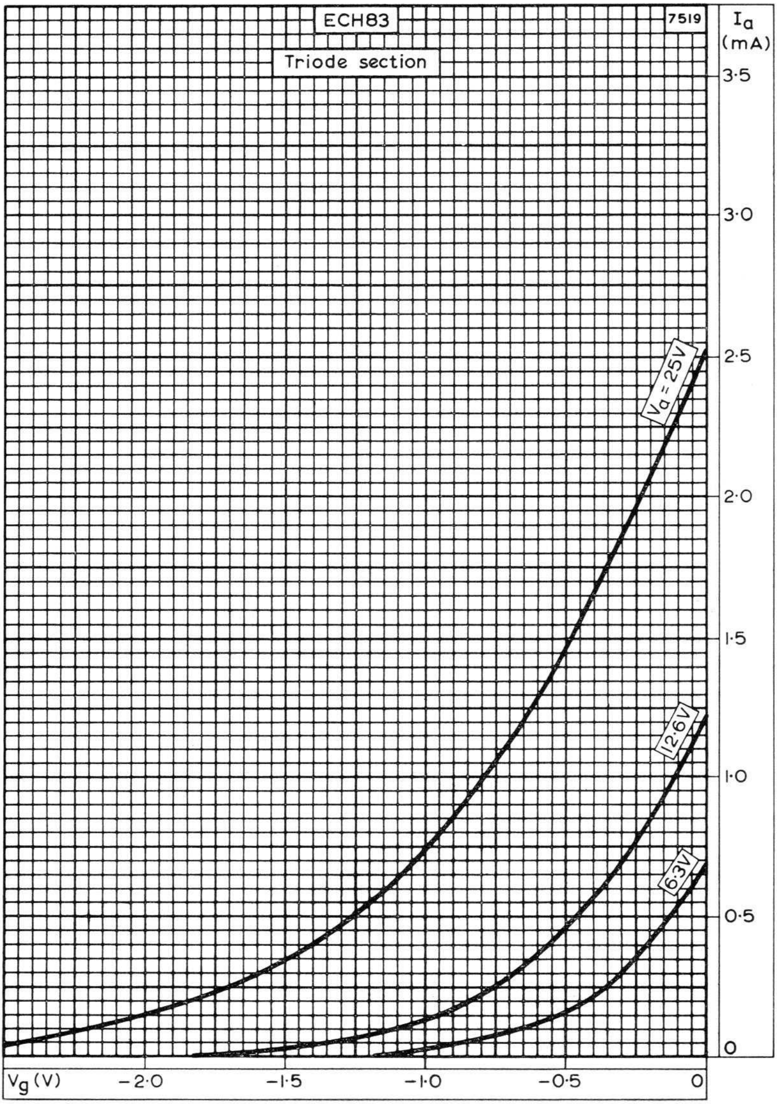
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION

$V_a = V_{g2+g3+g4} = 12.6V$

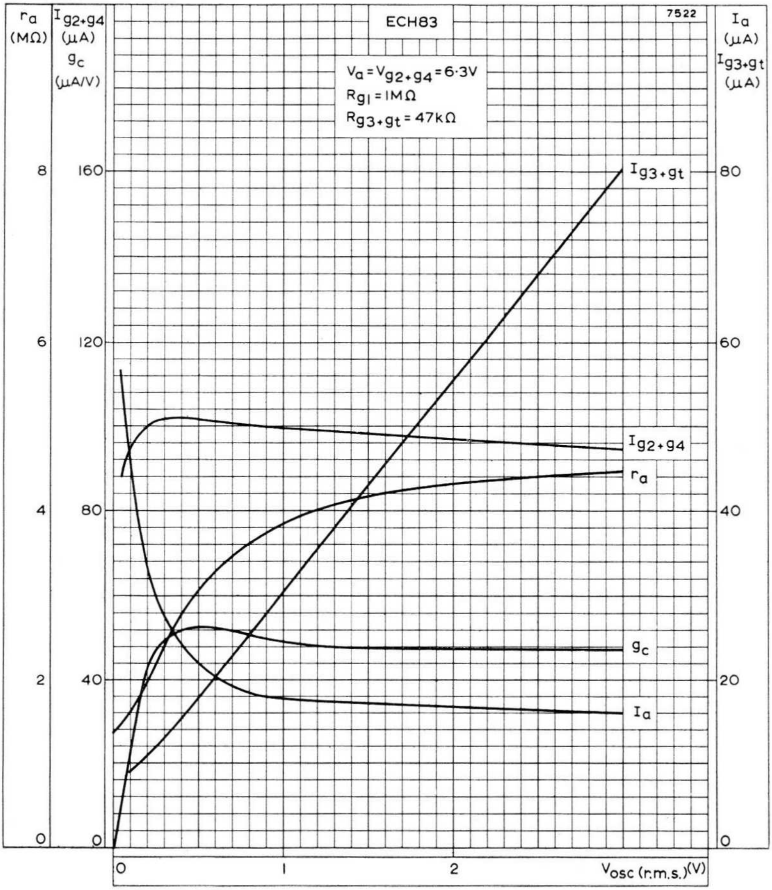


ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION

$V_a = V_{g2+g3+g4} = 25V$

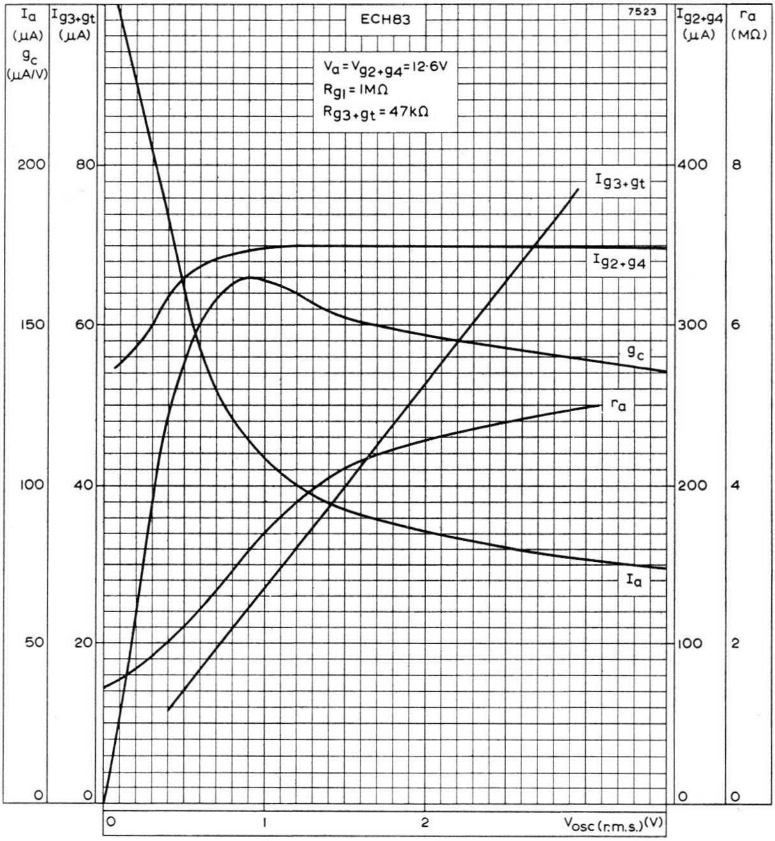


ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER. TRIODE SECTION

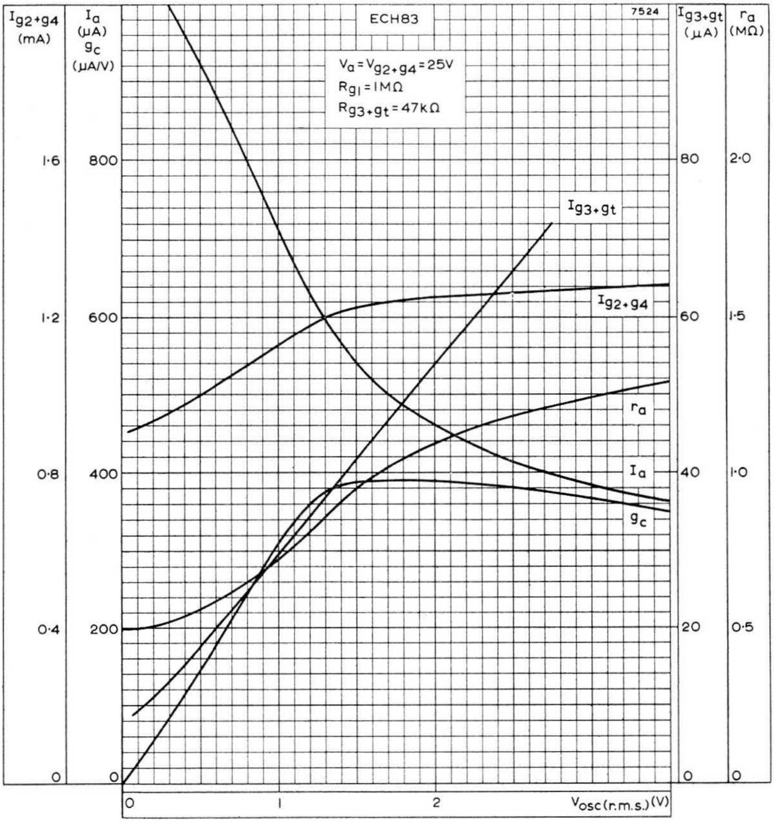


PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER

$V_a = V_{g2+g4} = 6.3V$



PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER
$V_a = V_{g2+g4} = 12.6V$



PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER

$V_a = V_{g2+g4} = 25V$

TRIODE HEPTODE

ECH84

Triode heptode intended for use as a noise cancelled synchronising pulse separator and time base oscillator.

HEATER

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

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{ah-at}	<250	mpF
c_{ah-gt}	<90	mpF
c_{g1-at}	<80	mpF
c_{g1-gt}	<100	mpF
c_{g3-at}	<130	mpF
Heptode section		
c_{a-g1}	<9.0	mpF
Triode section		
c_{in}	3.0	pF
c_{a-g}	1.1	pF

CHARACTERISTICS ←

Heptode section		
V_a	135	V
V_{g3}	0	V
V_{g2+g4}	14	V
V_{g1}	0	V
I_a	1.7	mA
I_{g2+g4}	900	µA
g_m	2.2	mA/V
V_{g3} ($I_a = 20\mu A$)	−2.0	V
V_{g1} ($I_a = 20\mu A$)	−1.9	V
$-V_{g3}$ max. ($I_{g1} = +0.3\mu A$)	1.3	V
$-V_{g1}$ max. ($I_{g3} = +0.3\mu A$)	1.3	V
Triode section		
V_a	50	V
V_g	0	V
I_a	3.0	mA
g_m	3.7	mA/V
μ	50	
I_a ($V_a = 200V$, $V_g = -11V$)	<100	µA
$-V_g$ max. ($I_g = +0.3\mu A$)	1.3	V

ECH84

TRIODE HEPTODE

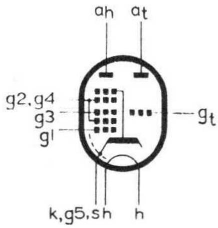
DESIGN CENTRE RATINGS

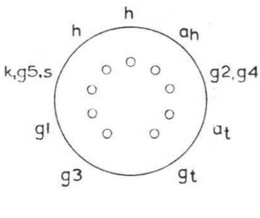
Heptode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.7	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max.	250	V
V_{g2+g4} min.	10	V
p_{g2+g4} max.	800	mW
$-v_{g1(pk)}$ max.	150	V
$-v_{g3(pk)}$ max.	150	V
I_k max.	12.5	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	100	V

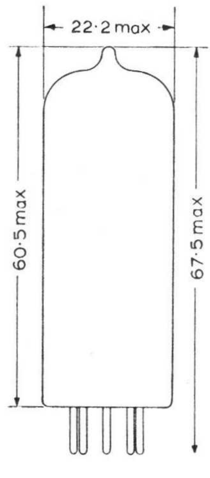
Triode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.3	W
$-v_{g(pk)}$ max.	200	V
I_k max.	10	mA
R_{g-k} max.	3.0	MΩ



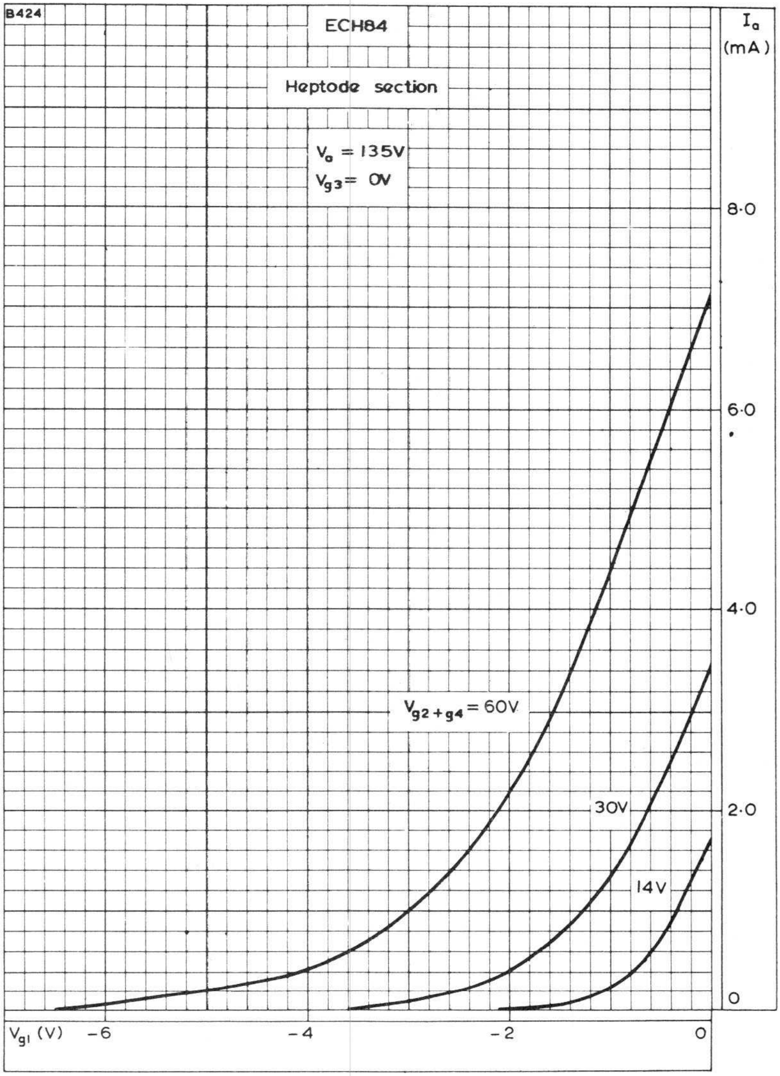


B9A Base

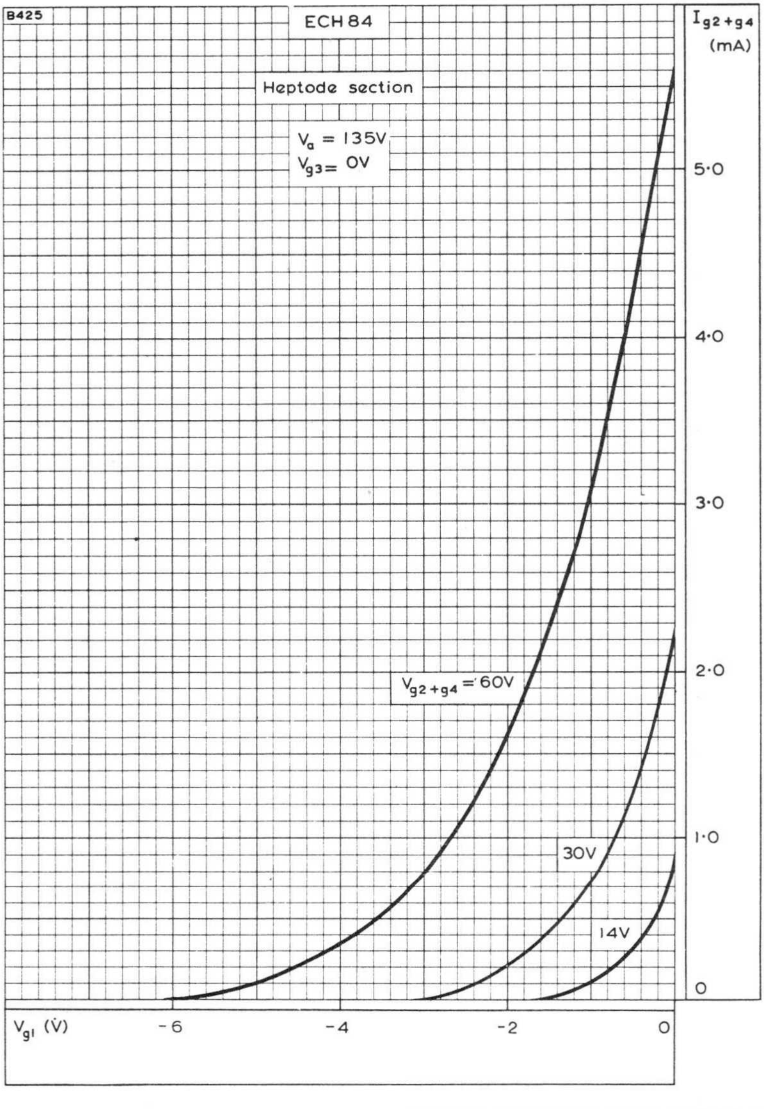


All dimensions in mm

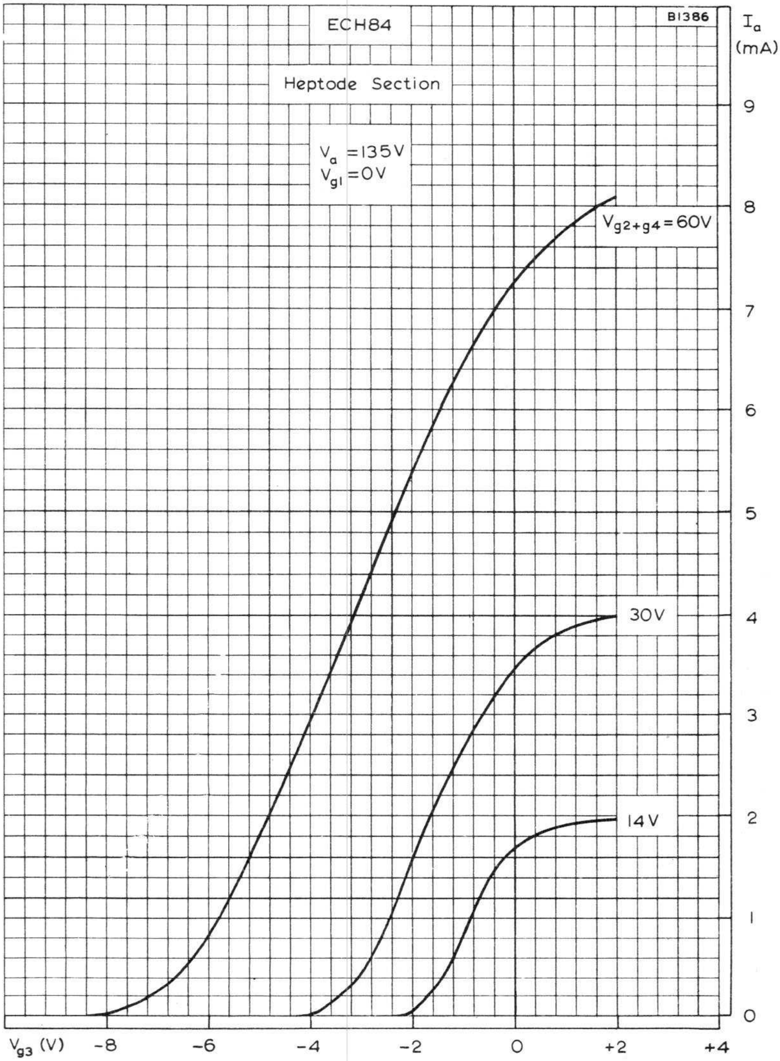
8808



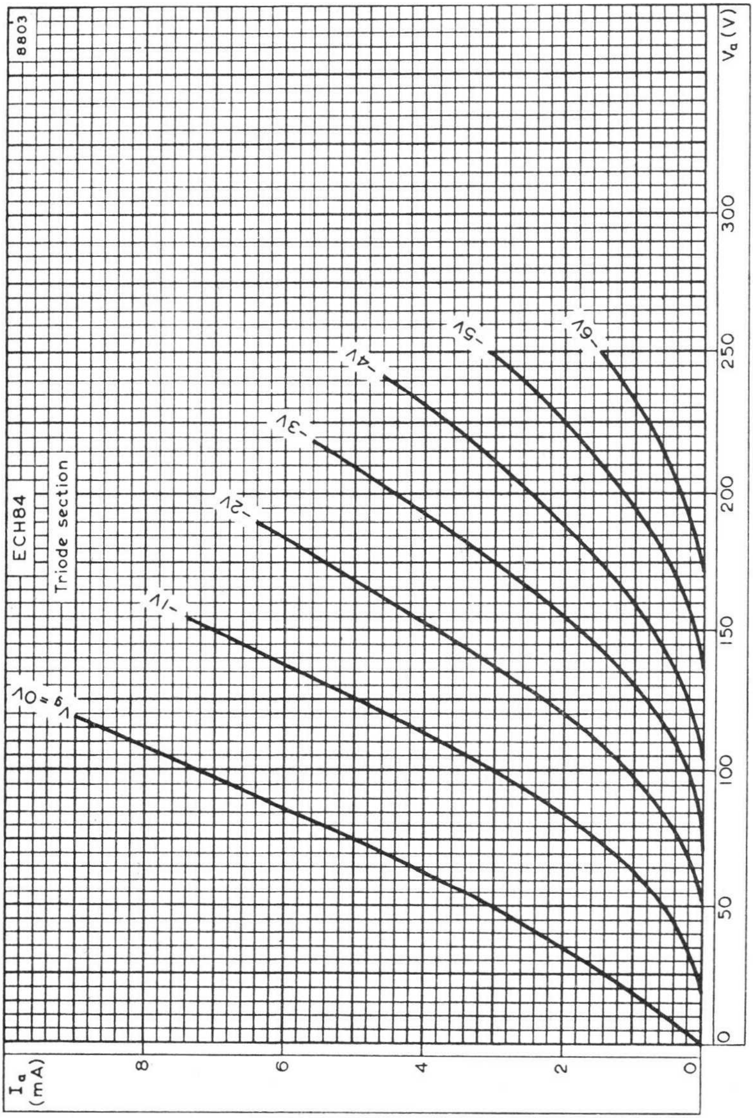
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



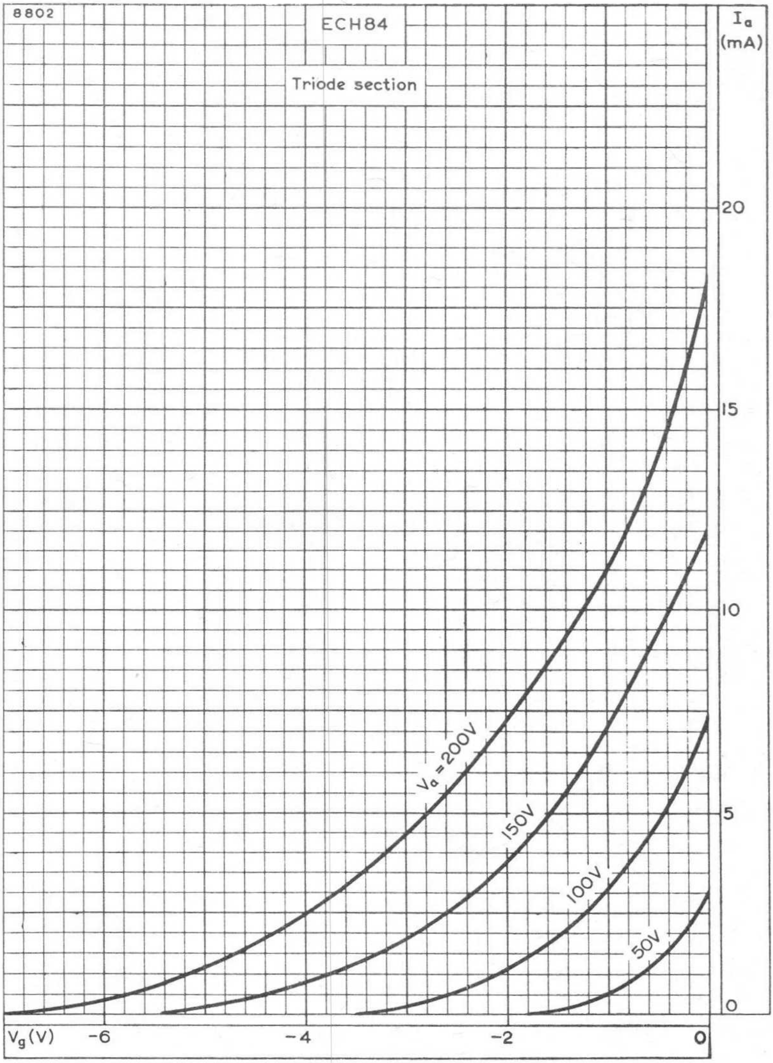
SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



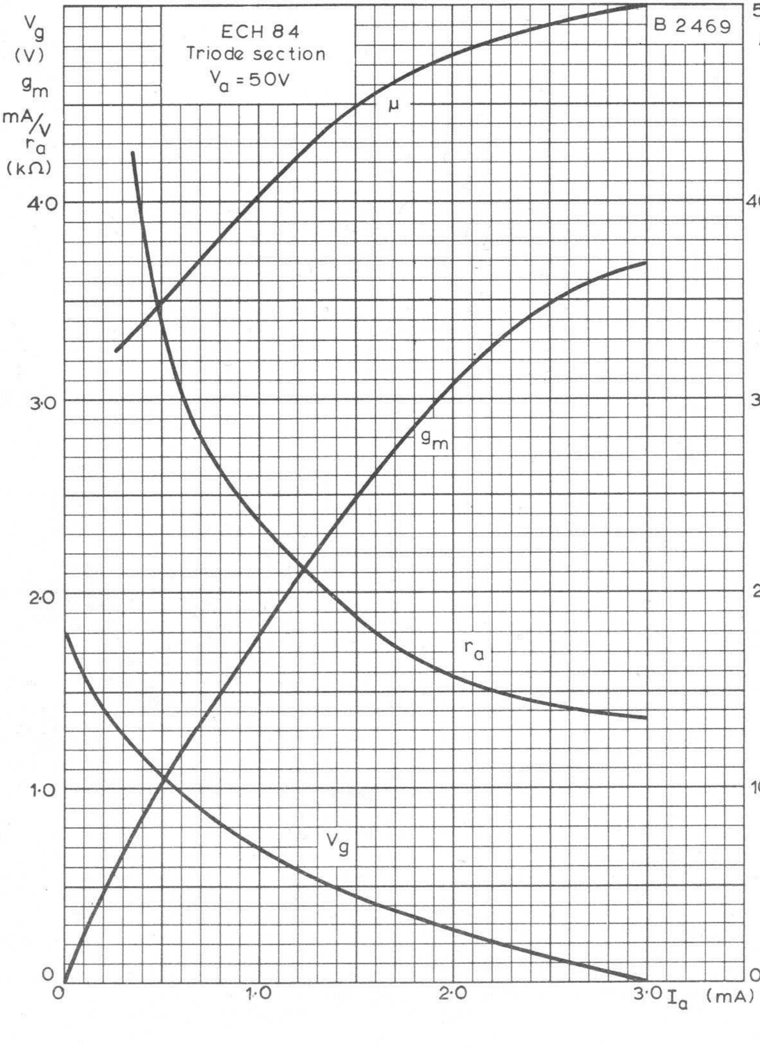
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID (g_3) VOLTAGE.
HEPTODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER. TRIODE SECTION



AMPLIFICATION FACTOR, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND CONTROL-GRID VOLTAGE PLOTTED AGAINST ANODE CURRENT. $V_a = 50V$. TRIODE SECTION

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

TRIODE SECTION AS A.F. VOLTAGE AMPLIFIER

Operating Conditions

V_b (V)	R_a (k Ω)	I_{at} (mA)	$-V_{gt}$ (V)	$\frac{V_{out}}{V_{in}}$	V_{out}* ($V_{r.m.s.}$)	D_{tot}* (%)	R_{g1}† (k Ω)
170	47	1.8	3.5	9.5	22	8.7	150
170	400	1.0	3.5	10.5	24	7.6	330
170	220	0.5	3.5	11	24.5	6.5	680
200	47	2.2	4.2	9.5	27	9.0	150
200	100	1.2	4.2	10.5	29	8.0	330
200	220	0.6	4.2	11	30	6.5	680

* Output voltage and distortion at the start of positive grid current. At lower output voltages the distortion is approximately proportional to the voltage.

† Grid resistor of the following valve.

LIMITING VALUES

Pentode Section

$V_{a(b)}$ max.	550	V
$v_{a(pk)}$ max.	1.2	kV
V_a max.	400	V
p_a max.	3.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.2	W←
I_k max.	25	mA
* $i_{k(pk)}$ max.	350	mA←
V_{g1} max. ($I_{g1}=+0.3\mu A$)	−1.3	V
R_{g1-k} max. (I_k=12 mA) (frame output valve)	2.2	M Ω
R_{g1-k} max. (I_k=20 mA) (audio output valve)	1.0	M Ω
R_{h-k} max.	20	k Ω
V_{h-k} max.	150	V

* Max. pulse duration 10% of one cycle, with a maximum of 2 m secs.

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

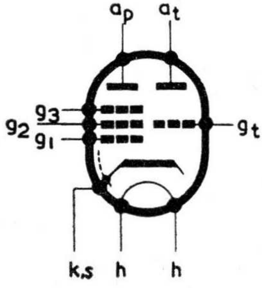
LIMITING VALUES

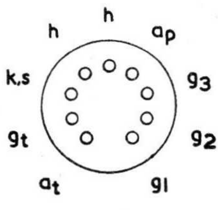
Triode Section

$V_{at(b)}$ max.	550	V
V_{at} max.	200	V
p_{at} max.	1.0	W
I_k max.	8	mA ←
* $i_{k(pk)}$ max.	200	mA
V_{gt} max. ($I_{gt} = +0.3$ µA)	−1.3	V
R_{gt-k} max.	3	MΩ
R_{h-k} max.	20	kΩ
V_{h-k} max.	150	V

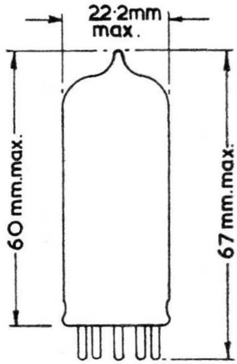
* Max pulse duration 10% of one cycle, with maximum of 2 m secs.

When the triode section is used in amplifier circuits, where the input voltage, for an output of 50 mW is less than 50 mV, no special precautions need be taken against microphonic effects.





B9A
Noval Base

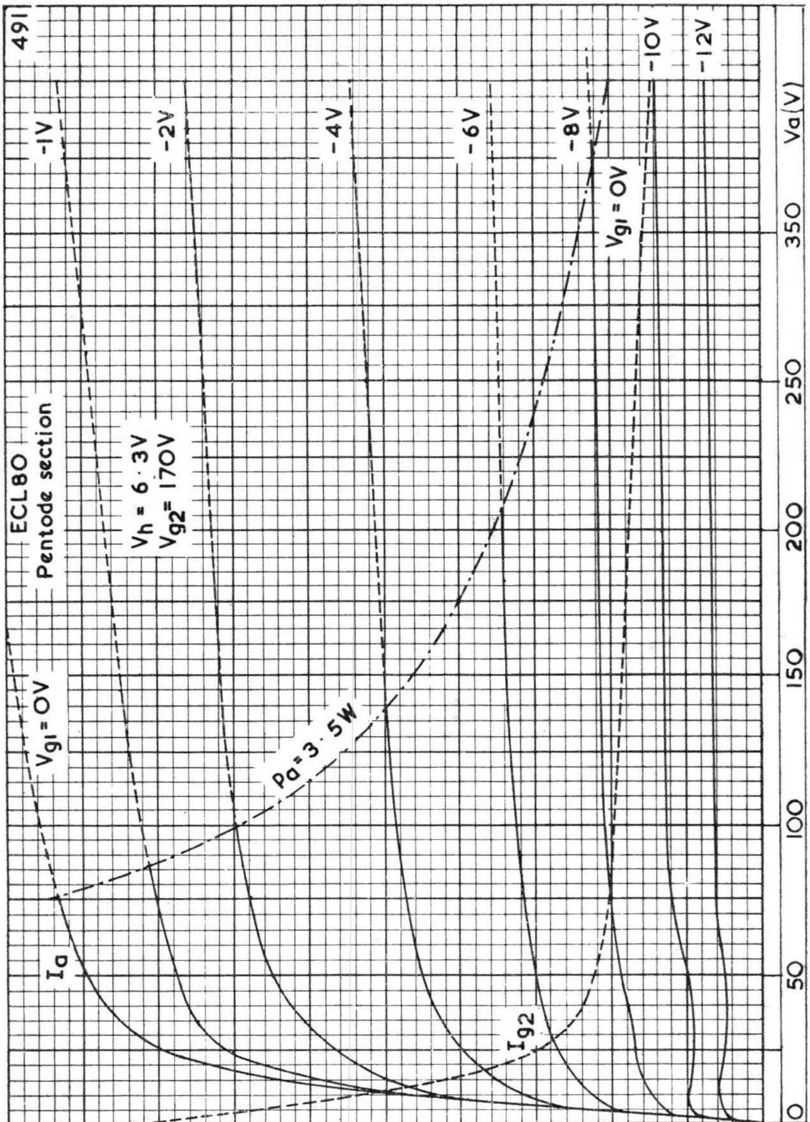


519

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.



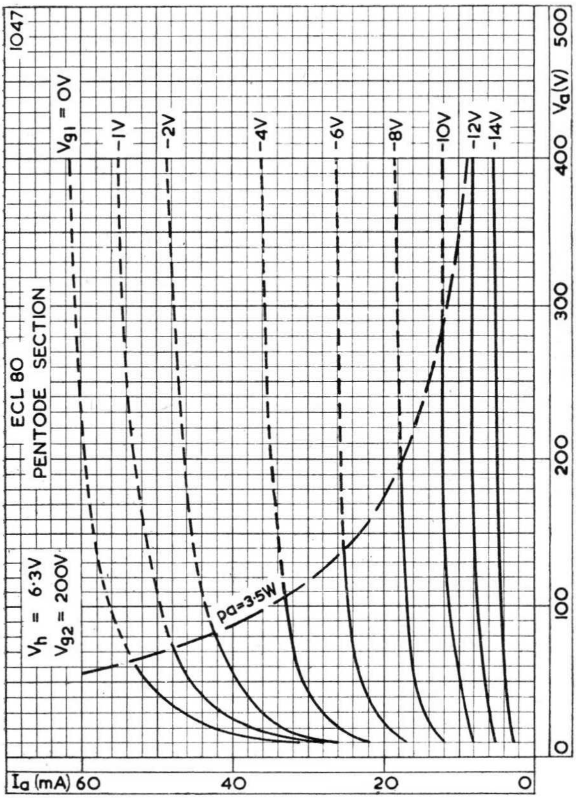
ANODE CURRENT AND SCREEN-GRID CURRENT OF PENTODE SECTION PLOTTED AGAINST ANODE VOLTAGE, FOR SCREEN-GRID VOLTAGE OF 170 V

Mullard

ECL80

TRIODE PENTODE

Combined triode and output pentode designed primarily for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

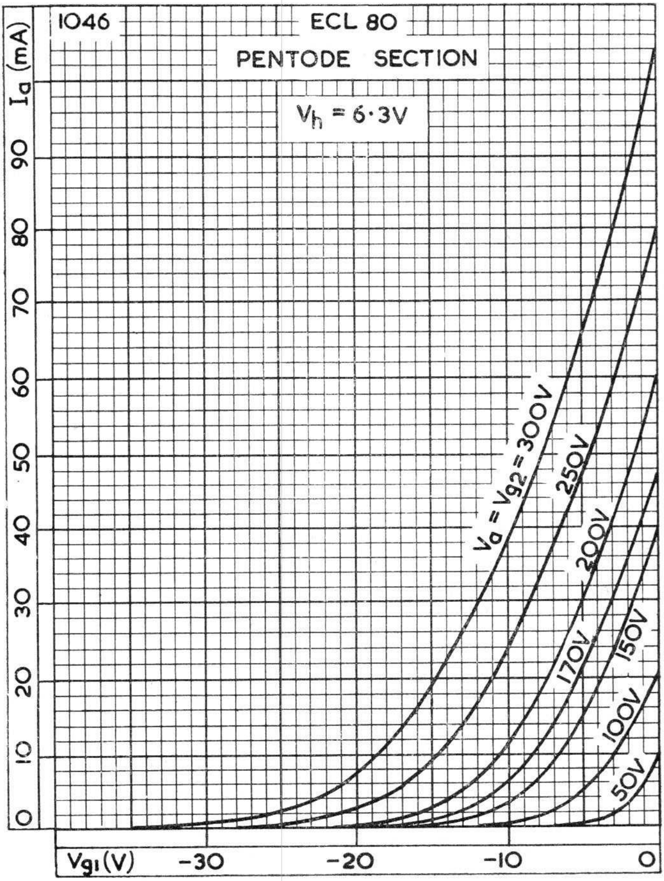


ANODE CURRENT AND SCREEN-GRID CURRENT OF PENTODE SECTION PLOTTED AGAINST ANODE VOLTAGE, FOR SCREEN-GRID VOLTAGE OF 200V

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

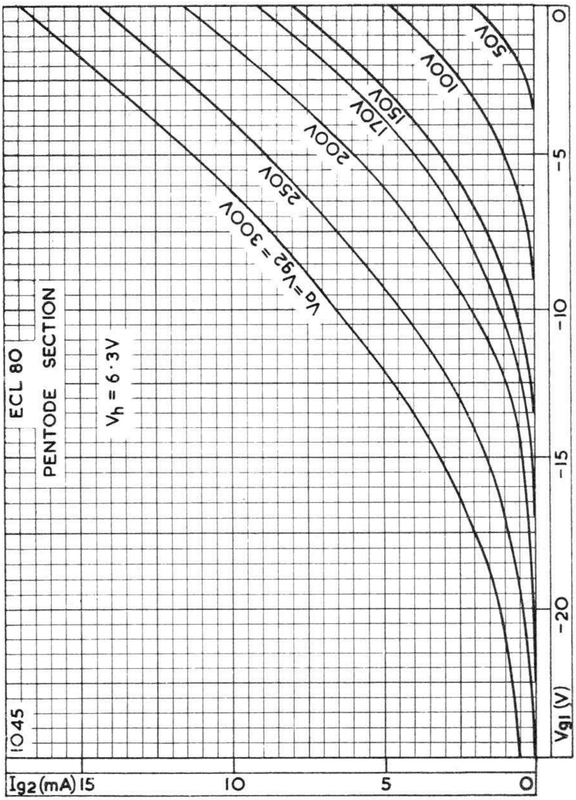


ANODE CURRENT OF PENTODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE, FOR ANODE AND SCREEN-GRID VOLTAGES BETWEEN 50V AND 300V

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

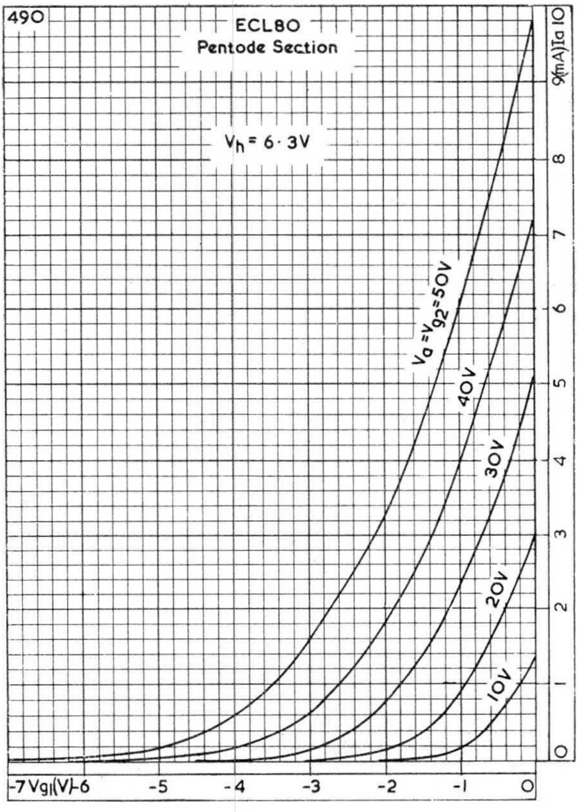


SCREEN-GRID CURRENT OF PENTODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE, FOR ANODE AND SCREEN-GRID VOLTAGES BETWEEN 50V AND 300V

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

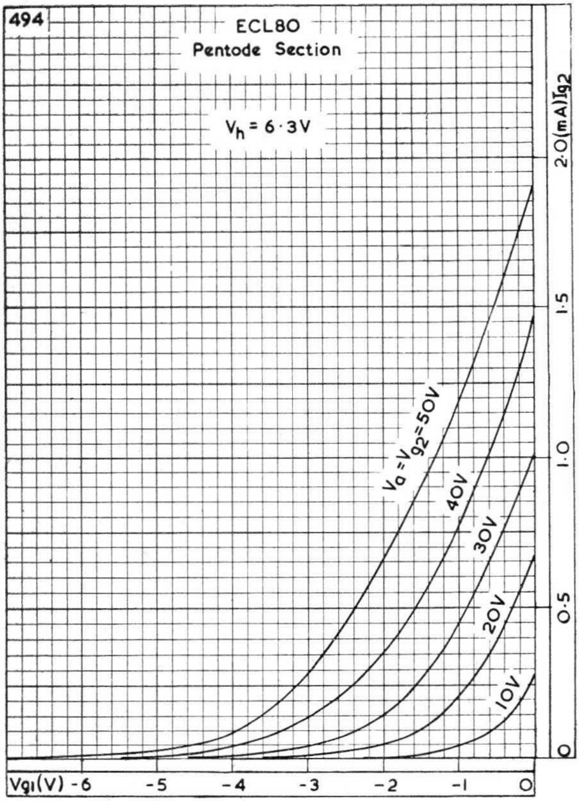


ANODE CURRENT OF PENTODE SECTION PLOTTED AGAINST CONTROL GRID VOLTAGE, FOR ANODE AND SCREEN-GRID VOLTAGES BETWEEN 10V AND 50V

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

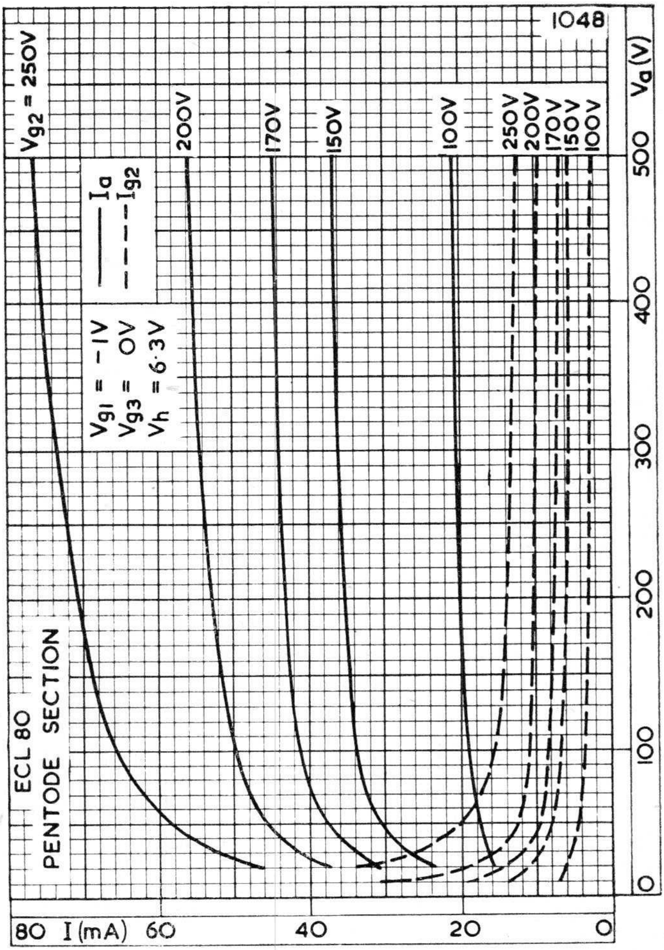


SCREEN-GRID CURRENT OF PENTODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE, FOR ANODE AND SCREEN-GRID VOLTAGES BETWEEN 10V AND 50V

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

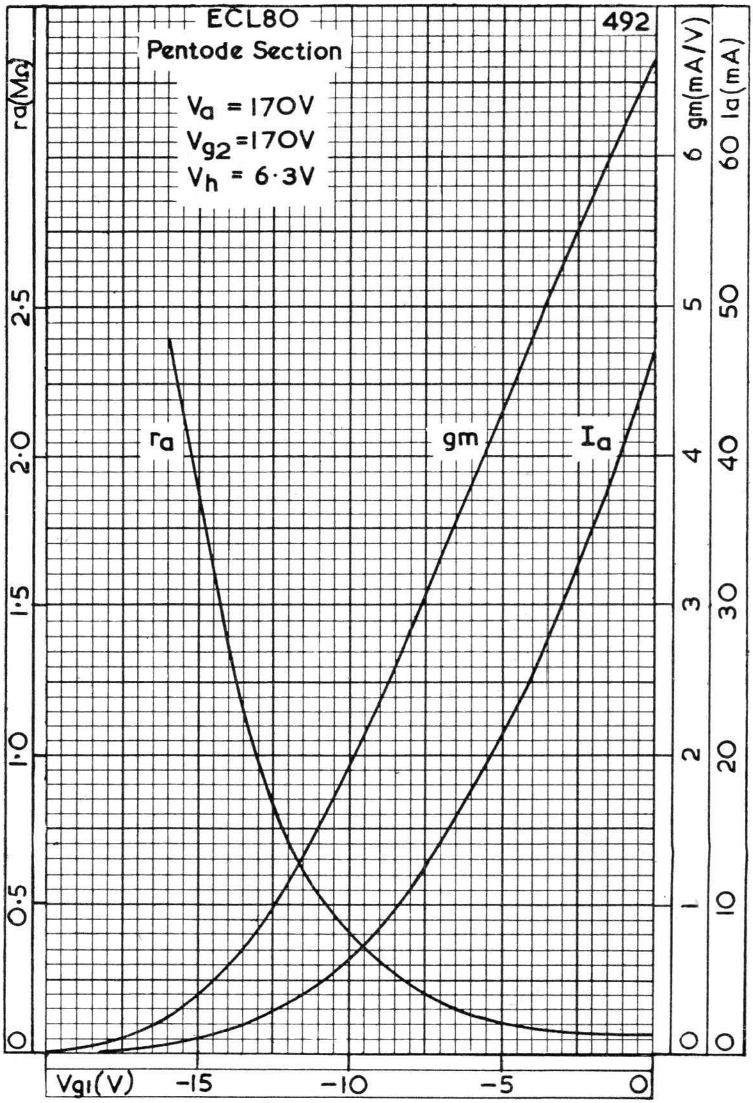


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE, WITH CONTROL-GRID VOLTAGE AT —1V

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

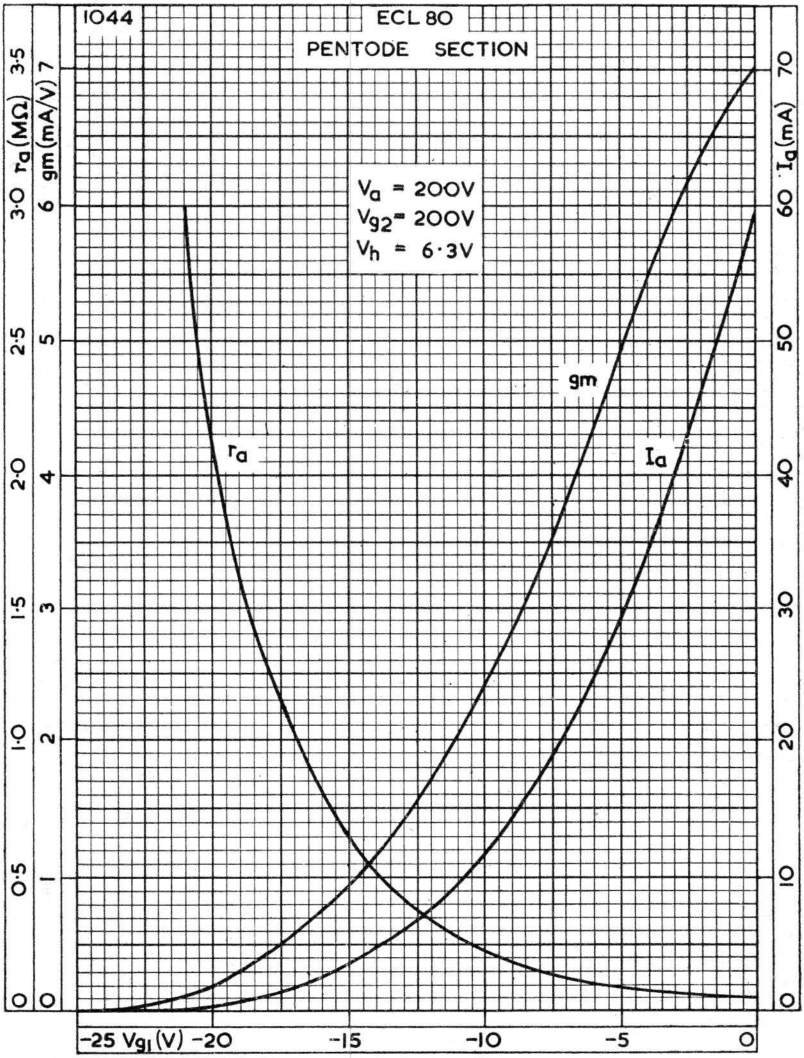


ANODE CURRENT, MUTUAL CONDUCTANCE AND INTERNAL RESISTANCE OF PENTODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR SCREEN-GRID VOLTAGE OF 170V

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

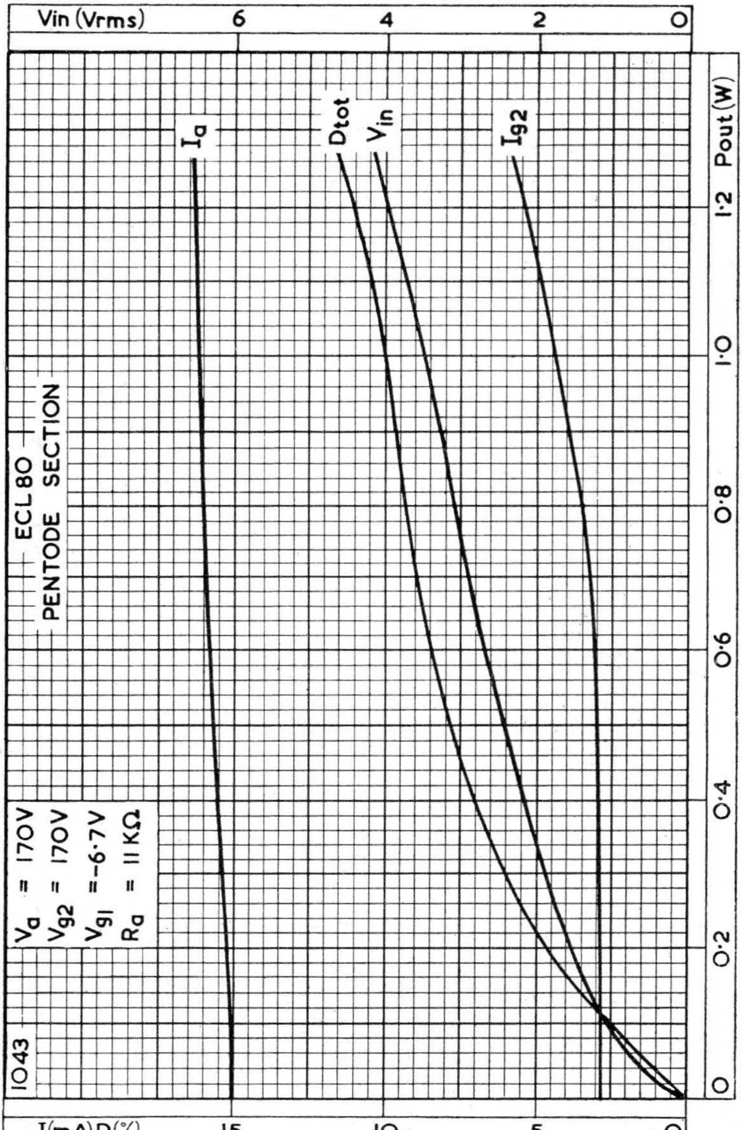


ANODE CURRENT, MUTUAL CONDUCTANCE AND INTERNAL RESISTANCE OF PENTODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE, FOR SCREEN-GRID VOLTAGE OF 200V

ECL80

TRIODE PENTODE

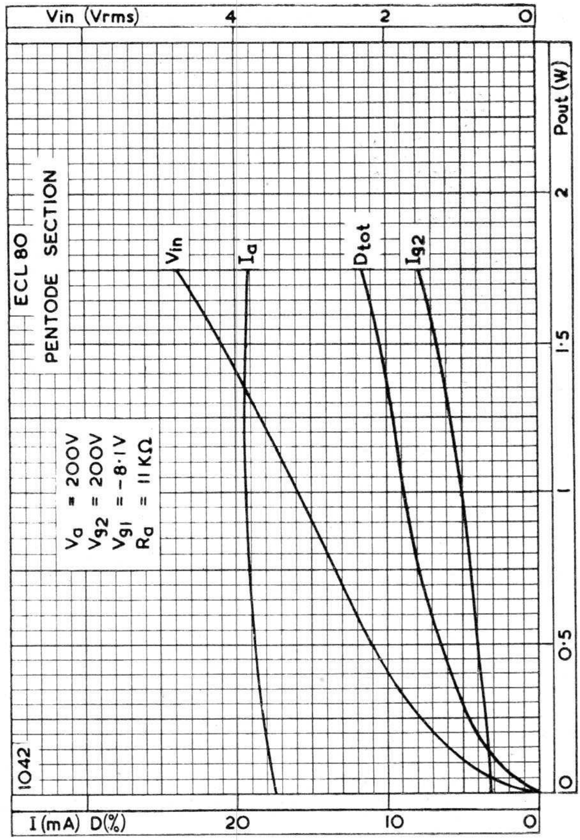
Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.



ANODE CURRENT, SCREEN-GRID CURRENT, INPUT VOLTAGE AND TOTAL DISTORTION PLOTTED AGAINST POWER OUTPUT, FOR SCREEN-GRID VOLTAGE OF 170 V

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

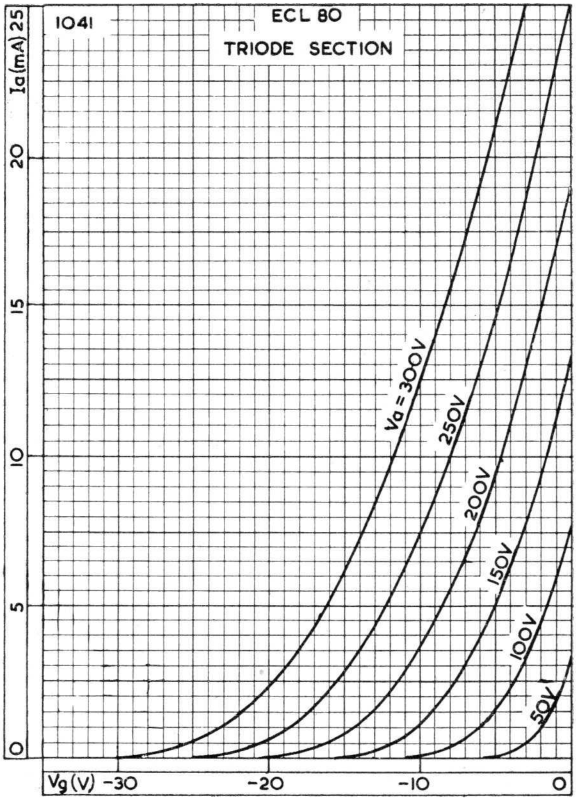


ANODE CURRENT, SCREEN-GRID CURRENT, INPUT VOLTAGE AND TOTAL DISTORTION PLOTTED AGAINST POWER OUTPUT, FOR SCREEN-GRID VOLTAGE OF 200V

ECL80

TRIODE PENTODE

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.

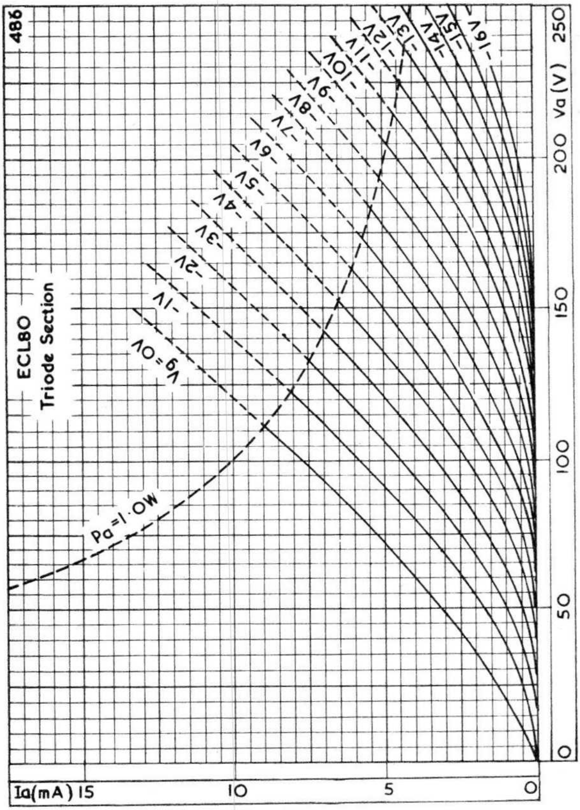


ANODE CURRENT OF TRIODE SECTION PLOTTED AGAINST GRID VOLTAGE, WITH ANODE VOLTAGE AS PARAMETER

TRIODE PENTODE

ECL80

Combined triode and output pentode primarily designed for use in television receivers with the triode as a frame blocking oscillator and the pentode as a frame output valve. Other applications include the use of the triode as a line blocking oscillator, A.F. voltage amplifier or in multivibrator circuits and the operation of the pentode as an audio output valve or a synchronising pulse separator.



ANODE CURRENT OF TRIODE SECTION PLOTTED AGAINST ANODE VOLTAGE, WITH GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

HEATER

V_h	6.3	V
I_h	780	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{ap-at}	<0.25	pF
c_{ap-gt}	<0.02	pF
c_{g1p-at}	<0.02	pF
c_{g1p-gt}	<0.025	pF

Pentode section

c_{a-g1}	<0.3	pF
c_{in}	9.3	pF
c_{out}	8.0	pF
c_{g1-h}	<0.3	pF

Triode section

c_{a-g}	4.2	pF
c_{in}	2.7	pF
c_{out}	4.3	pF
c_{g-h}	<0.1	pF

CHARACTERISTICS

Pentode section

V_a	200	250	V
V_{g2}	200	250	V
I_a	35	28	mA
I_{g2}	7.0	5.7	mA
V_{g1}	−16	−22.5	V
g_m	6.4	5.0	mA/V
r_a	20	25	kΩ
μ_{g1-g2}	9.5	9.5	

Triode section

V_a	100	V
I_a	3.5	mA
V_g	0	V
g_m	2.5	mA/V
r_a	28	kΩ
μ	70	

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

PENTODE SECTION AS FRAME OUTPUT VALVE

Circuit design

To allow for valve spread and deterioration during life the frame output circuit should be designed around the following values

V_a	50	V
V_{g2}	170	V
$i_{a(pk)}$	85	mA

For an average new valve the following figures will apply

V_a	50	V
V_{g2}	170	V
$i_{a(pk)}$	135	mA

V_{g1} adjusted so that $I_{g1} = +0.3\mu A$

PENTODE SECTION AS AUDIO OUTPUT VALVE

Single valve class 'A'

V_a	200	250	V
$V_{g2(b)}$	200	250	V
*R_{g2}	0	2.2	kΩ
$I_{a(o)}$	35	28	mA
$I_{g2(o)}$	7.0	5.5	mA
I_{g2} (max. sig.)	16	10.5	mA
V_{g1}	–16	–22.5	V
R_k	390	680	Ω
$V_{in(r.m.s.)}$ (P_{out} = 50mW)	600	780	mV
R_a	5.6	9.0	kΩ
$V_{in(r.m.s.)}$	6.6	9.5	V
†P_{out}	3.5	3.4	W
D_{tot}	10	10	%

Two valves in class 'AB' push-pull

V_a	200	250	V
$V_{g2(b)}$	200	250	V
**R_{g2}	0	2.7	kΩ
$I_{a(o)}$	2×35	2×21.5	mA
I_a (max. sig.)	2×39.5	2×27.5	mA
$I_{g2(o)}$	2×7.0	2×4.2	mA
I_{g2} (max. sig.)	2×16.5	2×9.2	mA
††R_k	190	390	Ω
$V_{in(g1-g1)r.m.s.}$	25	38	V
R_{a-a}	6.0	10	kΩ
P_{out}	9.8	9.0	W
D_{tot}	4.0	5.0	%

*Undecoupled screen-grid resistor.

†P_{out} and D_{tot} are measured at fixed bias and therefore represent the power output available duing the reproduction of speech and music.

**Common screen-grid resistor undecoupled.

††Common cathode bias resistor.

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

TRIODE SECTION AS A.F. VOLTAGE AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	R_g (MΩ)	Z_{source} (kΩ)	$\frac{V_{out}}{V_{in}}$	D_{tot} (%)	R_{g1}* (kΩ)
250	100	1.05	1.5	3.3	0	48	0.8	330
200	100	0.85	1.5	3.3	0	47	1.0	330
150	100	0.6	1.8	3.3	0	45	1.9	330
100	100	0.38	1.8	3.3	0	41	6.0	330
250	100	1.05	1.5	3.3	220	44	0.75	330
200	100	0.85	1.5	3.3	220	43	0.85	330
150	100	0.6	1.8	3.3	220	41	1.05	330
100	100	0.38	1.8	3.3	220	34	3.6	330
250	220	0.63	2.2	3.3	0	55.5	0.75	680
200	220	0.52	2.2	3.3	0	54.5	1.0	680
150	220	0.36	2.7	3.3	0	52	1.85	680
100	220	0.23	2.7	3.3	0	47	4.25	680
250	220	0.63	2.2	3.3	220	51.5	0.7	680
200	220	0.52	2.2	3.3	220	50	0.5	680
150	220	0.36	2.7	3.3	220	47	1.0	680
100	220	0.23	2.7	3.3	220	38	3.75	680
250	100	1.4	0	22	0	50	0.5	330
200	100	1.05	0	22	0	48.5	0.7	330
150	100	0.7	0	22	0	46	1.55	330
100	100	0.37	0	22	0	44	8.0	330
250	100	1.4	0	22	220	46	2.2	330
200	100	1.05	0	22	220	44	2.1	330
150	100	0.7	0	22	220	42.5	1.6	330
100	100	0.37	0	22	220	37	5.9	330
250	220	0.78	0	22	0	58	0.5	680
200	220	0.59	0	22	0	56	0.8	680
150	220	0.4	0	22	0	53	1.7	680
100	220	0.21	0	22	0	46	5.6	680
250	220	0.78	0	22	220	52.5	2.2	680
200	220	0.59	0	22	220	51	2.0	680
150	220	0.4	0	22	220	48.5	1.4	680
100	220	0.21	0	22	220	42	3.1	680

*Grid resistor of following valve

$\frac{V_{out}}{V_{in}}$ measured with an input voltage of 100mV

D_{tot} measured for $V_{out} = 10V$

MICROPHONY AND HUM

The triode section can be used without special precautions against microphony and hum in circuits in which the input voltage is $>$10mV(r.m.s.) for an output of 50mW from the output stage.

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
‡$+v_{a(pk)}$ max.	2.5	kV
‡$-v_{a(pk)}$ max.	500	V
p_a max. (frame output)	5.0	W
p_a max. (audio applications)	7.0	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	1.8	W
p_{g2} max. (speech and music)	3.2	W
I_k max.	50	mA
R_{g1-k} max. (fixed bias)	1.0	MΩ
R_{g1-k} max. (cathode bias)	2.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
‡$+v_{a(pk)}$ max.	600	V
p_a max.	1.0	W
I_k max.	15	mA
*$i_{k(pk)}$ max.	200	mA
R_{g-k} max. (fixed bias)	1.0	MΩ
R_{g-k} max. (cathode bias)	3.0	MΩ
R_{g-k} max. (grid current biasing)	22	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

*Maximum pulse duration 200μs

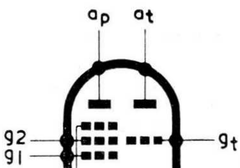
‡Maximum pulse duration 4% of one cycle with a maximum of 800μs

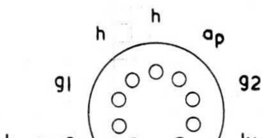
TRIODE PENTODE

ECL82

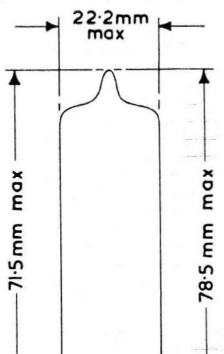
Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

2324





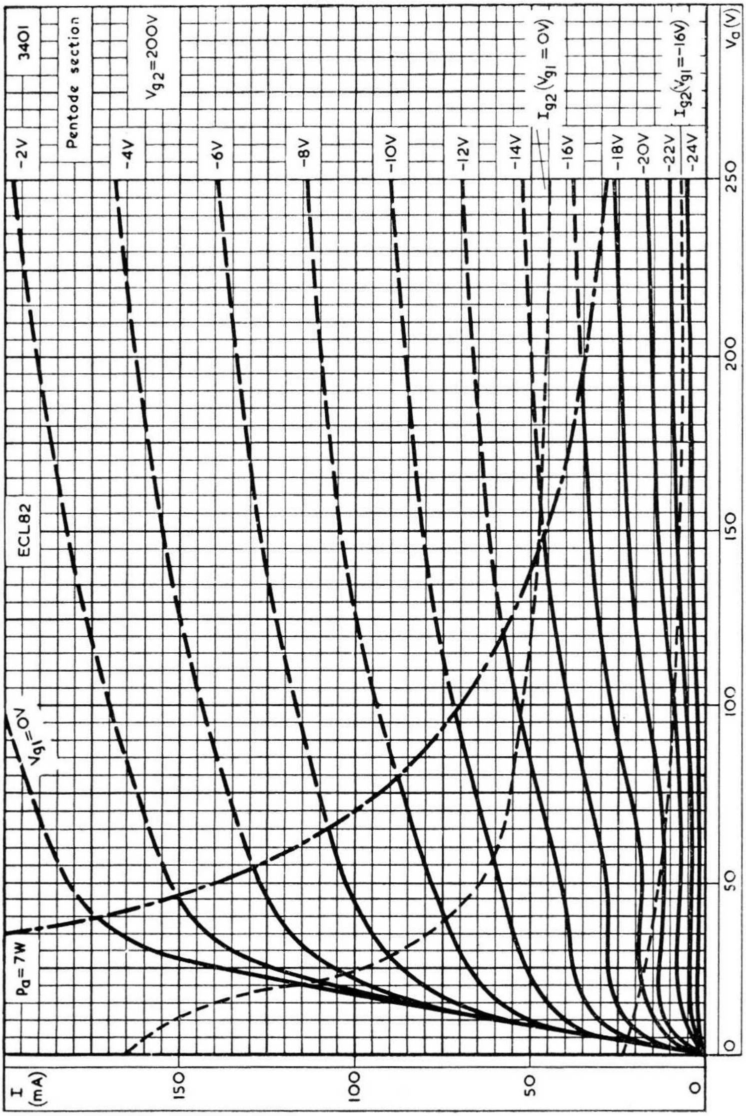
B9A Base



ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.



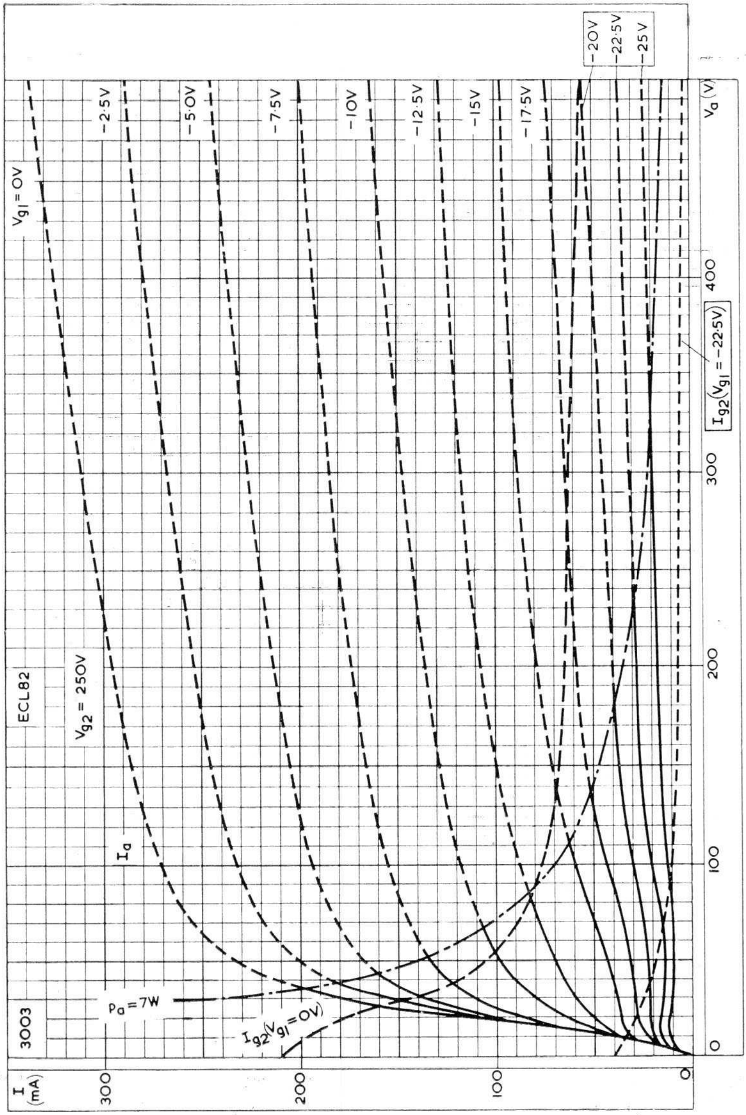
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

Mullard

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.



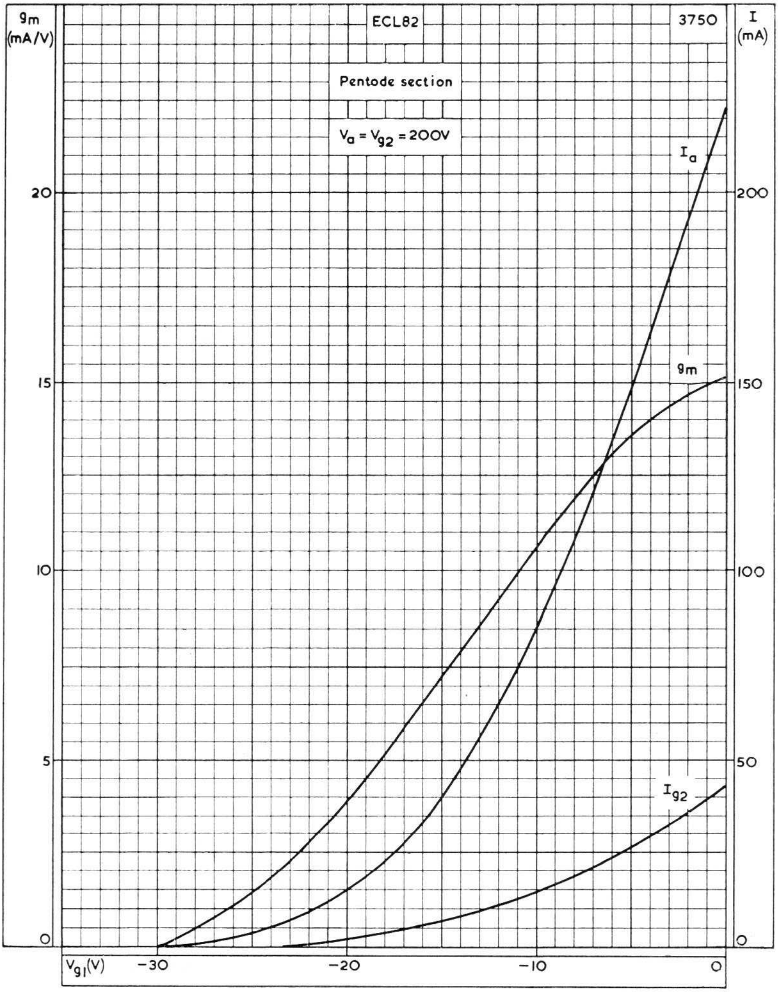
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 250V

Mullard

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

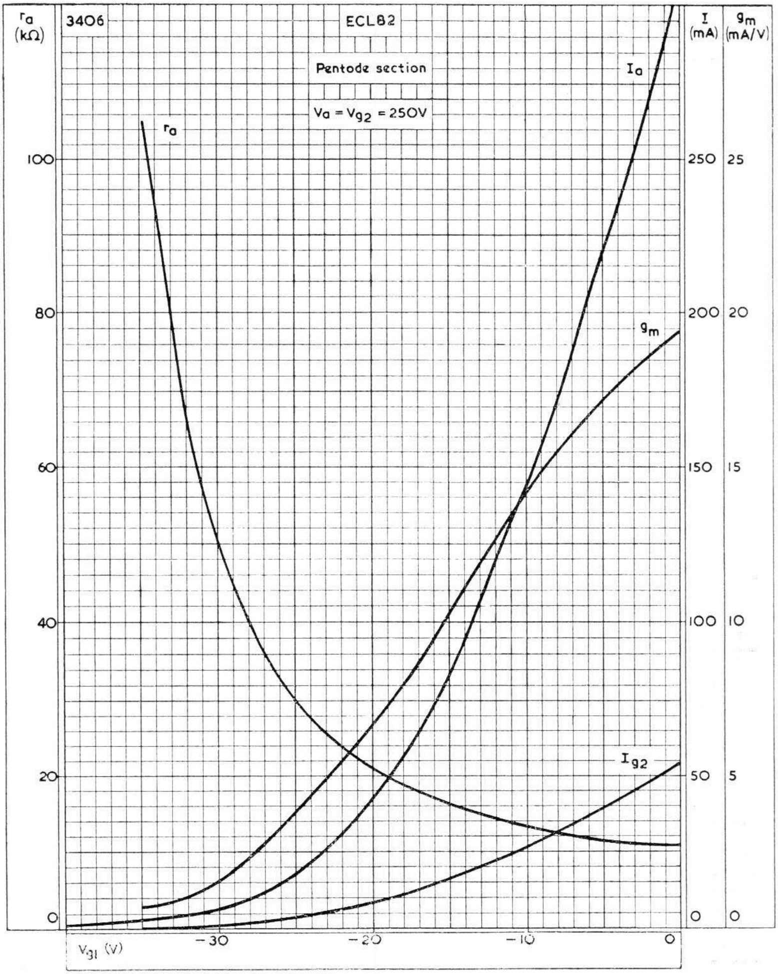


ANODE AND SCREEN-GRID CURRENTS AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 200V$

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

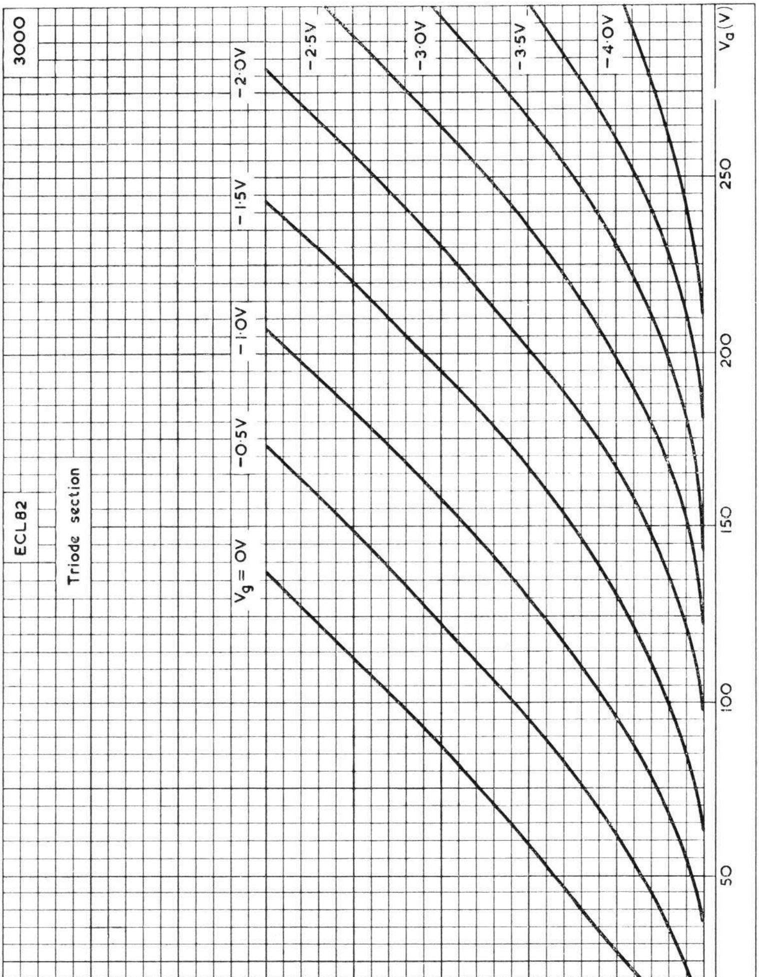


ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 250V$

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

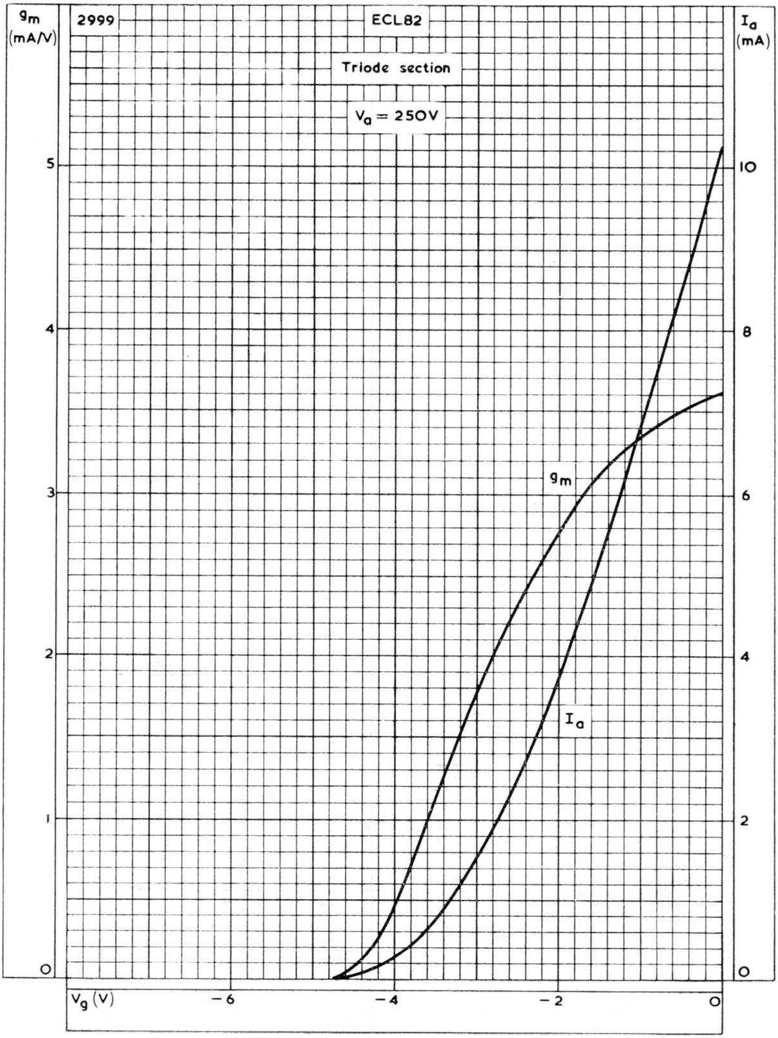


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER FOR TRIODE SECTION

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

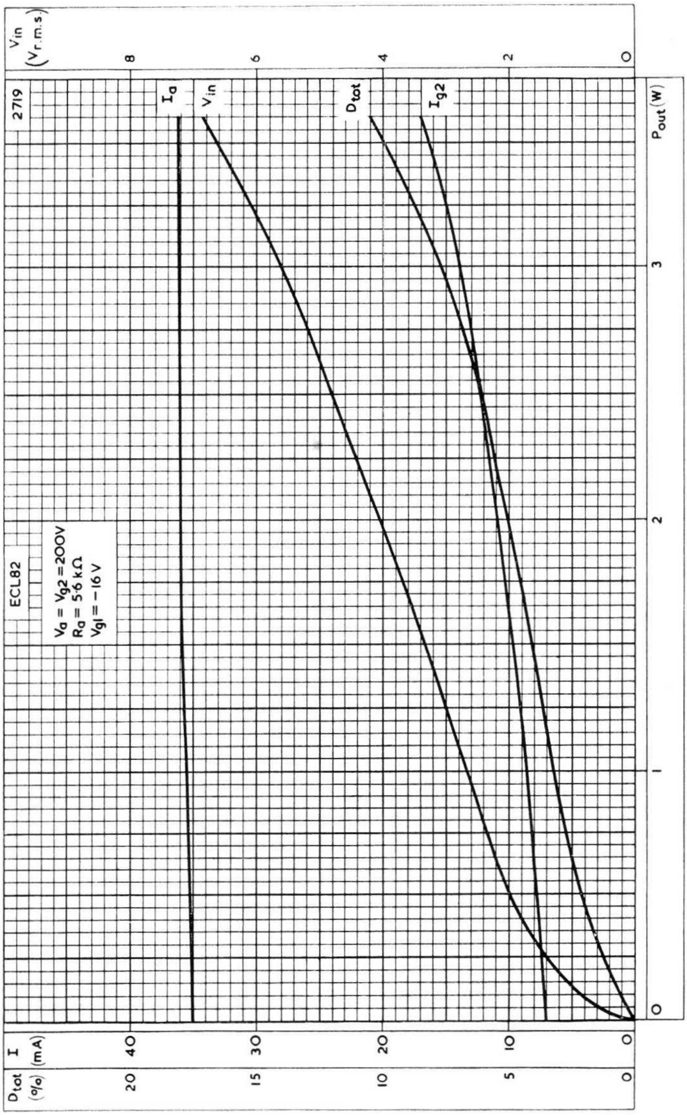


ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE FOR TRIODE SECTION. V_a = 250V

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

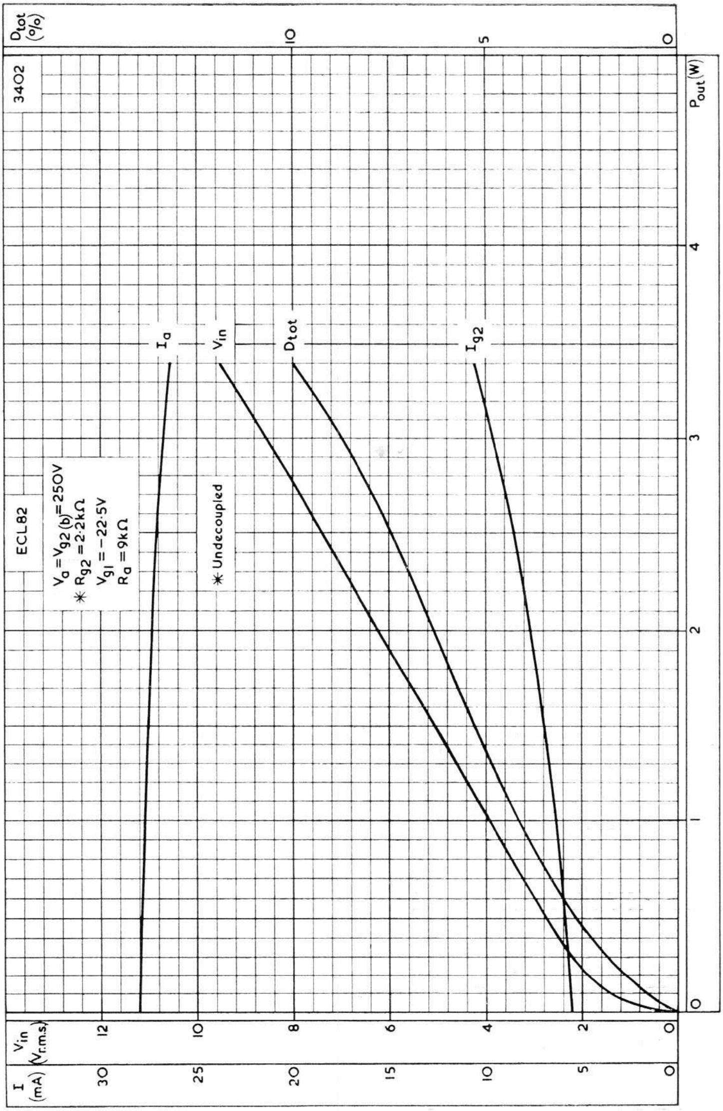


PERFORMANCE OF SINGLE ECL82 CLASS 'A' AMPLIFIER. $V_a = V_{g2} = 200V$

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

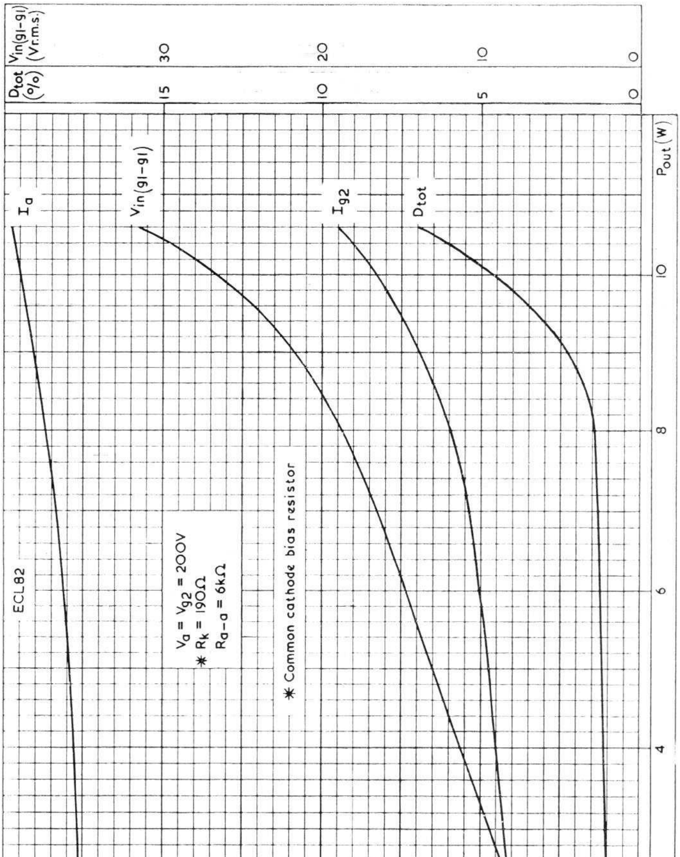


PERFORMANCE OF SINGLE ECL82 CLASS 'A' AMPLIFIER. $V_a = V_{g2(b)} = 250V$

ECL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.

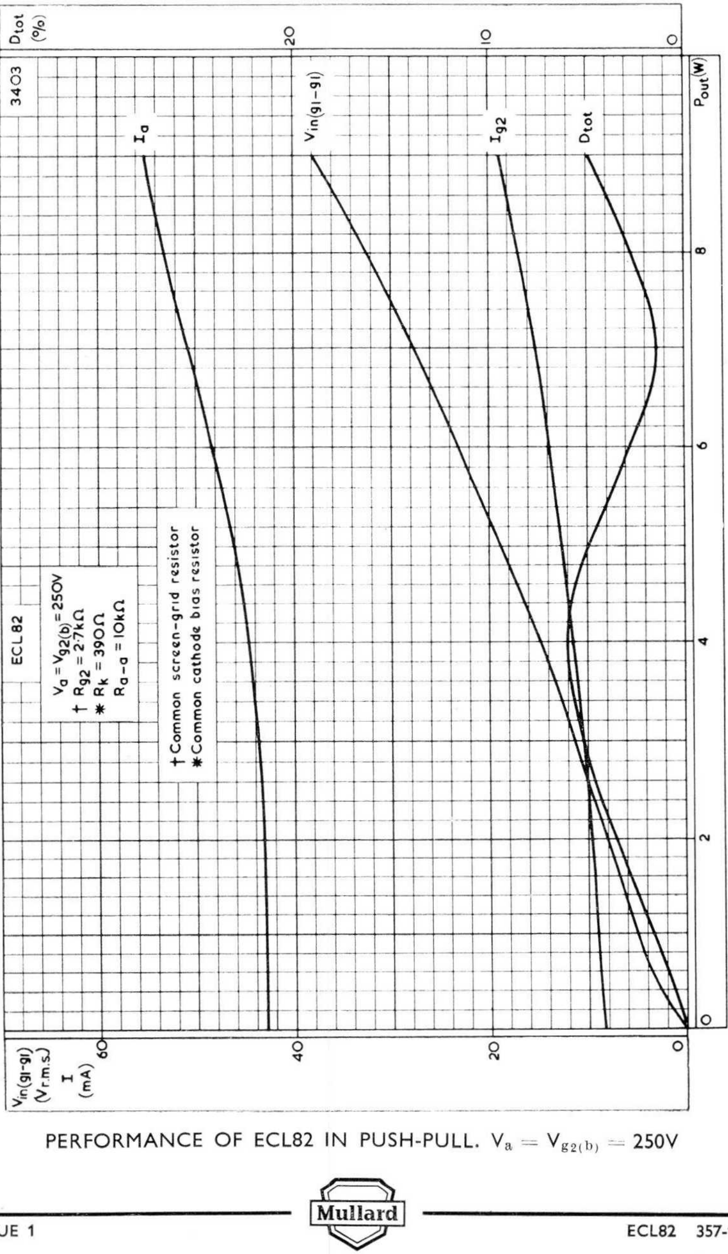


PERFORMANCE OF ECL82 IN PUSH-PULL. $V_a = V_{g2} = 200V$

TRIODE PENTODE

ECL82

Combined triode and output pentode with separate cathodes intended for use as a combined a.f. amplifier and output valve or frame oscillator and output valve.



PERFORMANCE OF ECL82 IN PUSH-PULL. $V_a = V_{g2(b)} = 250V$

R.F. PENTODE

EF80

High slope r.f. pentode primarily intended for r.f. or i.f. amplification in television receivers. It is suitable for use as a video amplifier, mixer or synchronising pulse separator.

HEATER

Suitable for series or parallel operation a.c. or d.c.

V_h	6.3	V
I_h	300	mA

CAPACITANCES

$c_{in(g1)}$	7.0	pF ←
$c_{in(g2)}$	5.4	pF
c_{out}	3.1	pF ←
c_{a-g1}	<7.0	mpF
c_{g2-g1}	2.6	pF
c_{a-k}	<10	mpF
c_{g1-h}	<150	mpF

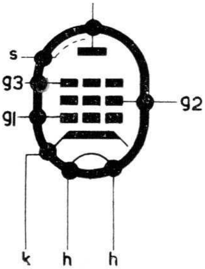
CHARACTERISTICS

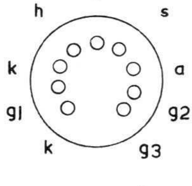
V_a	170	V
V_{g2}	170	V
V_{g3}	0	V
I_a	10	mA
I_{g2}	2.5	mA
V_{g1}	-2.0	V
g_m	7.4	mA/V
r_a	400	kΩ
μ_{g1-g2}	50	
R_{eq}	1.0	kΩ
r_{g1} (f = 50Mc/s)	10	kΩ
V_{g1} max. (I_{g1} = +0.3μA)	-1.3	V

LIMITING VALUES

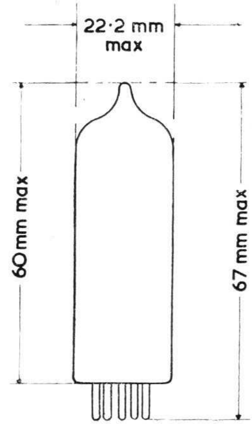
$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	700	mW
I_k max.	15	mA
R_{g1-k} max.	500	kΩ
V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ

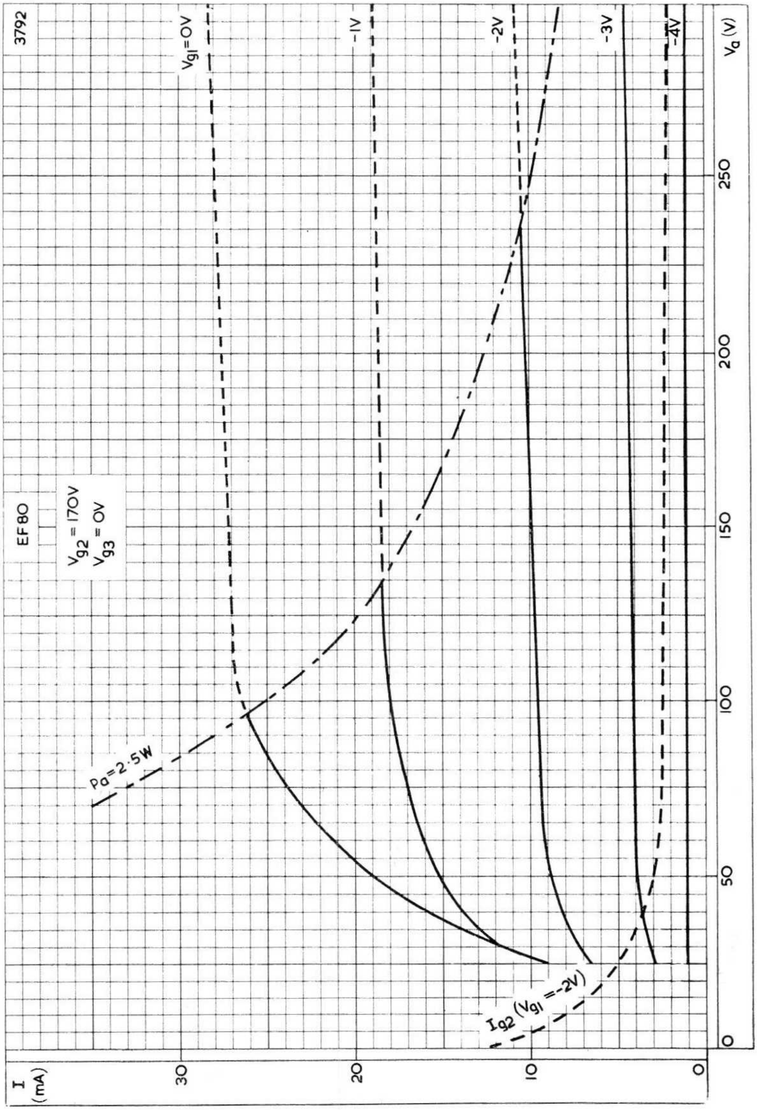
3785



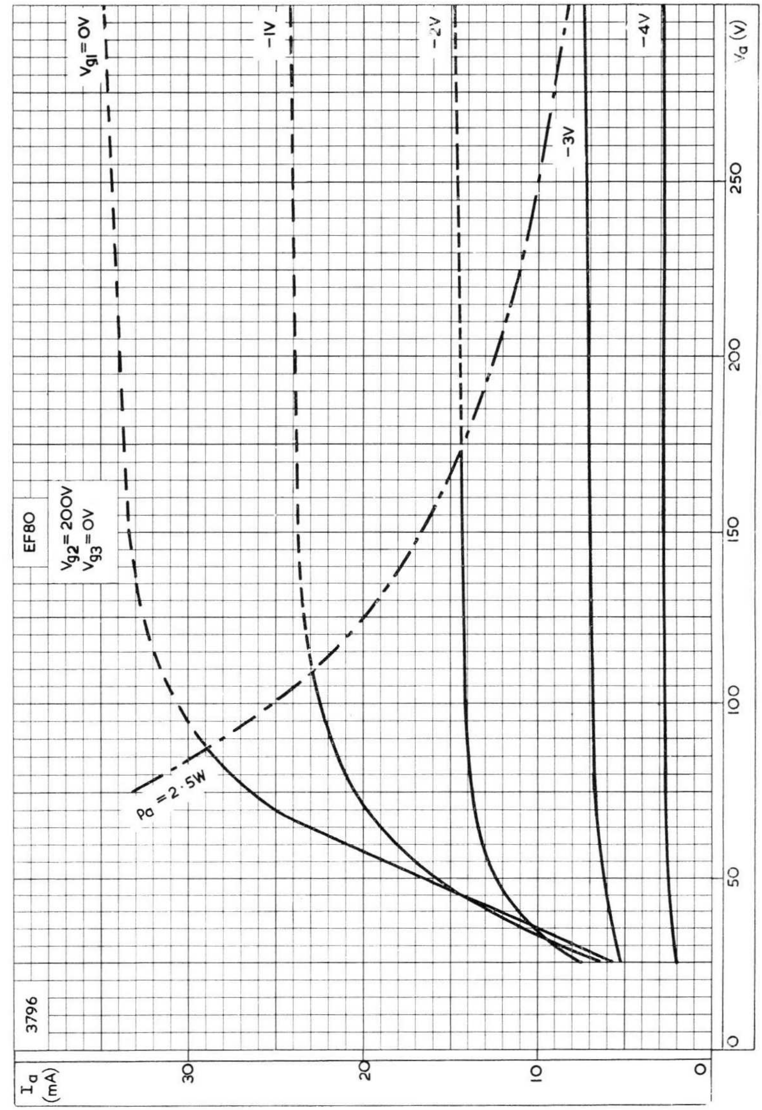


B9A Base

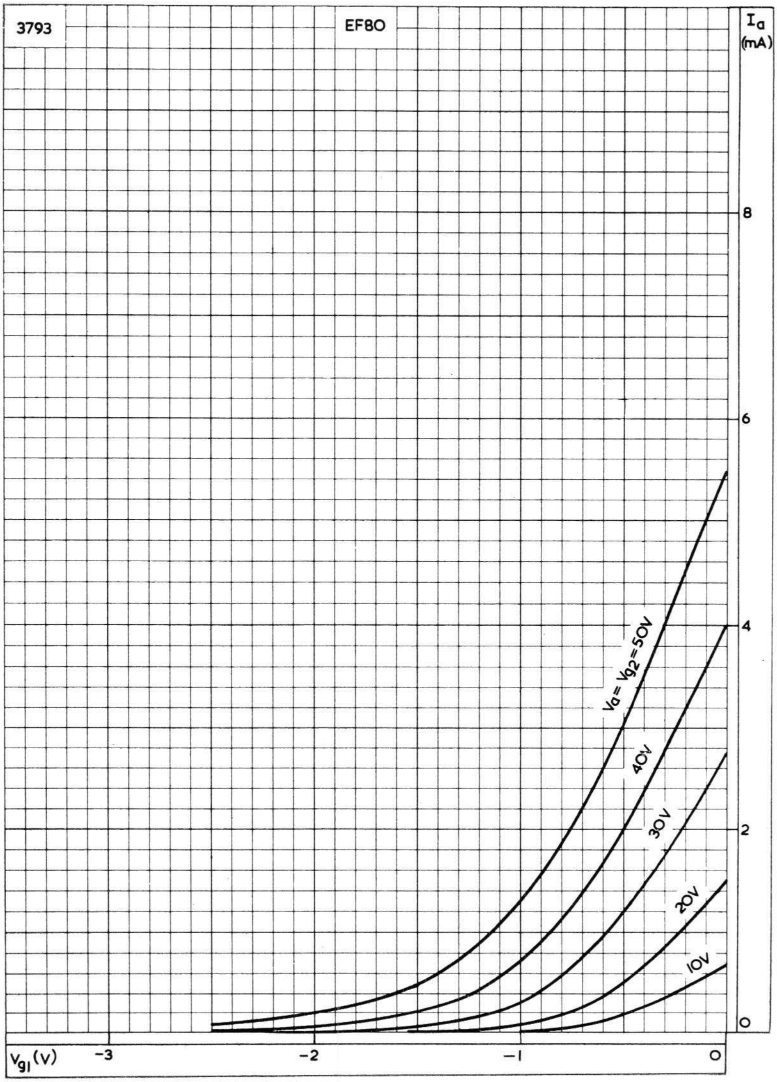




ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE, WITH SCREEN-GRID VOLTAGE AS PARAMETER. $V_{g2} = 170V$



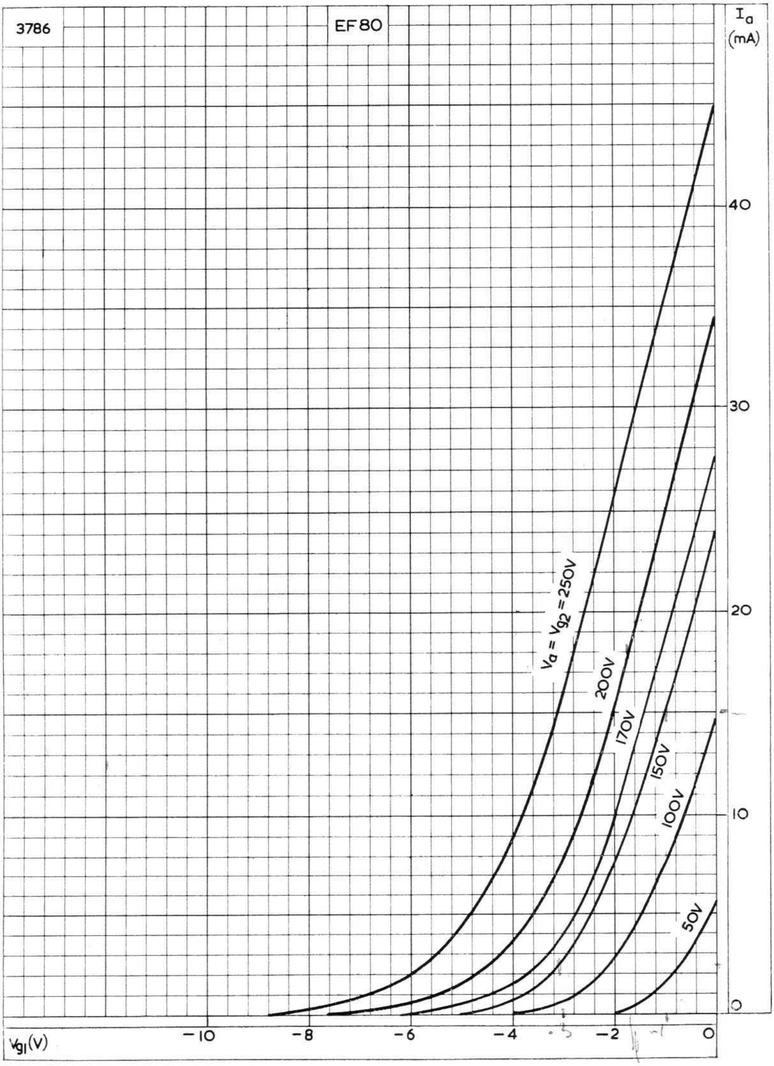
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V



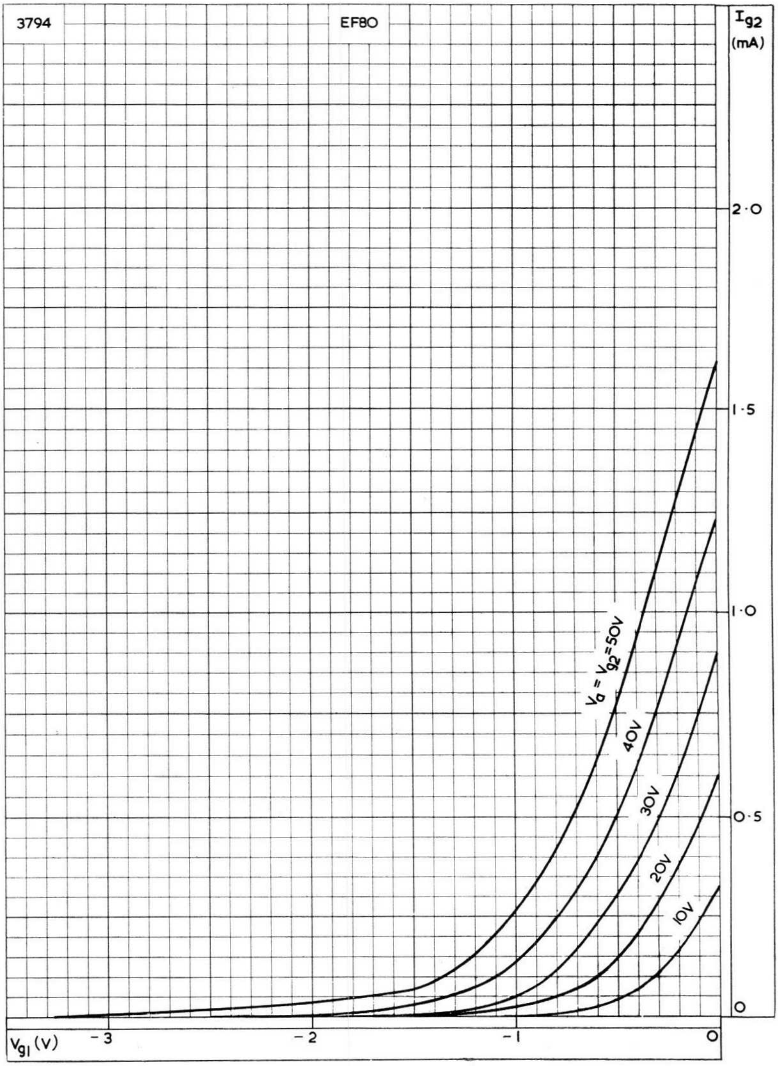
ANODE CURRENT IN THE REGION OF THE ORIGIN PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER

EF80

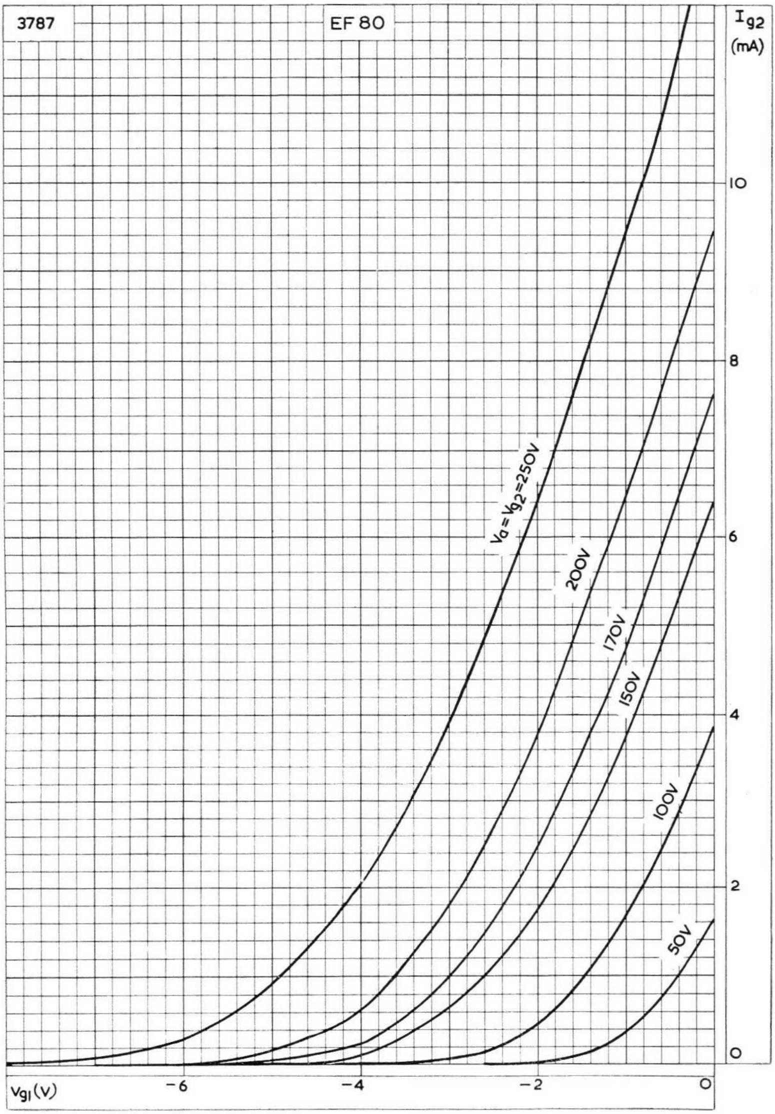
R.F. PENTODE



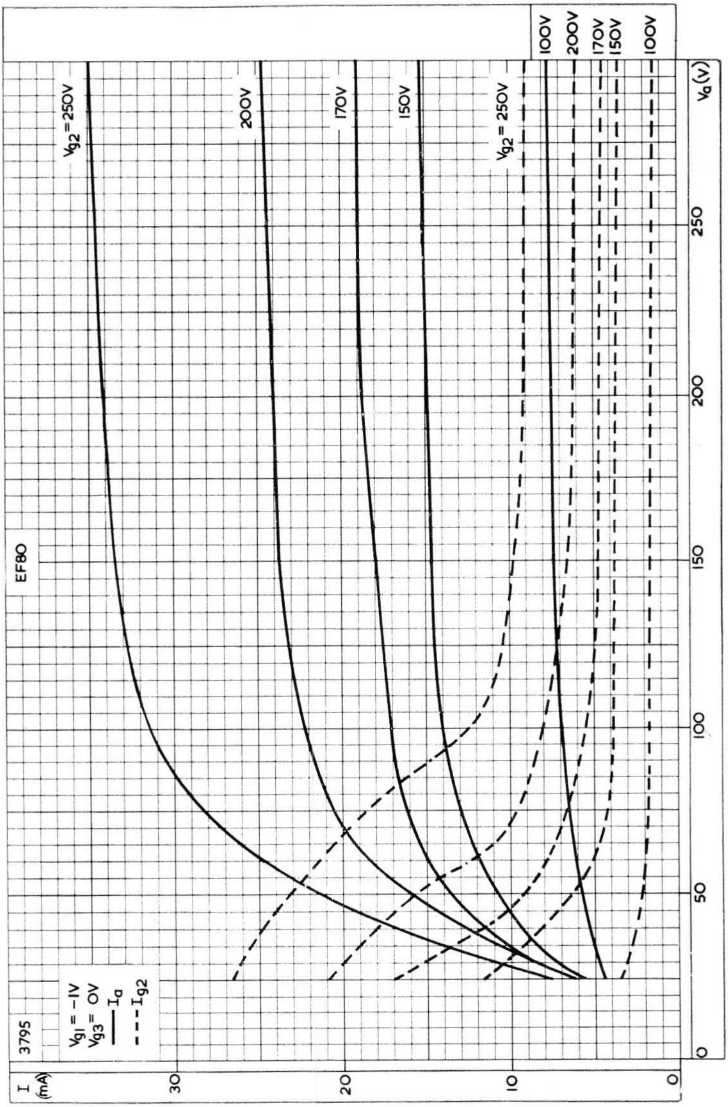
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



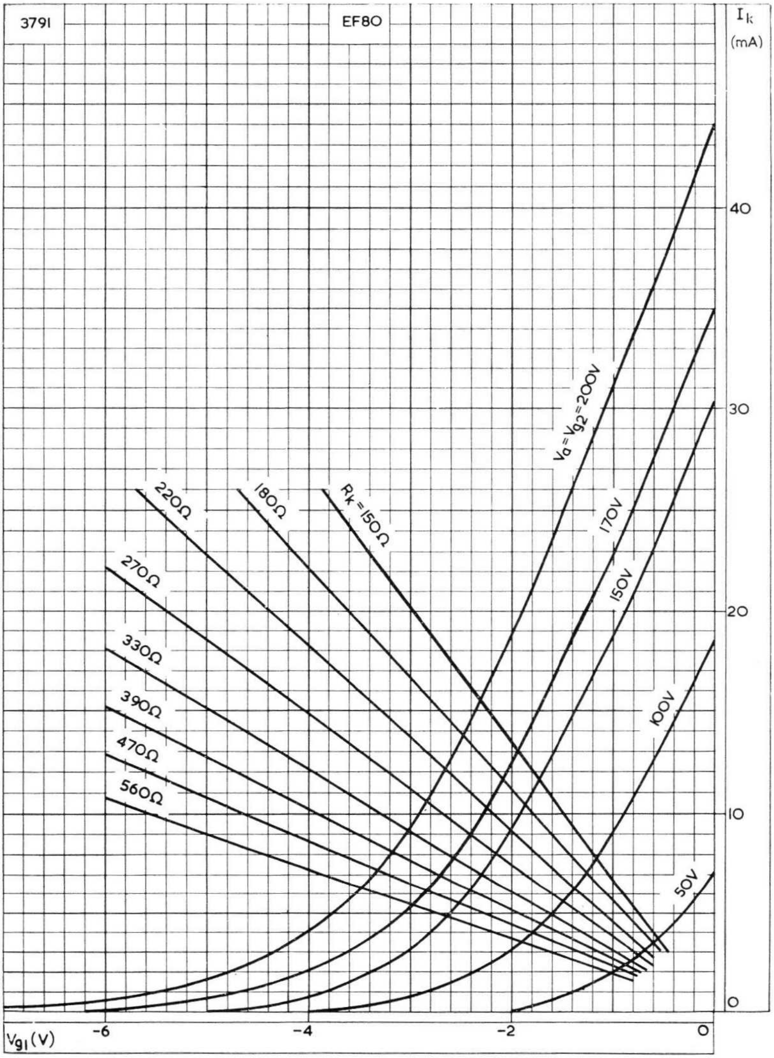
SCREEN-GRID CURRENT IN THE REGION OF THE ORIGIN PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



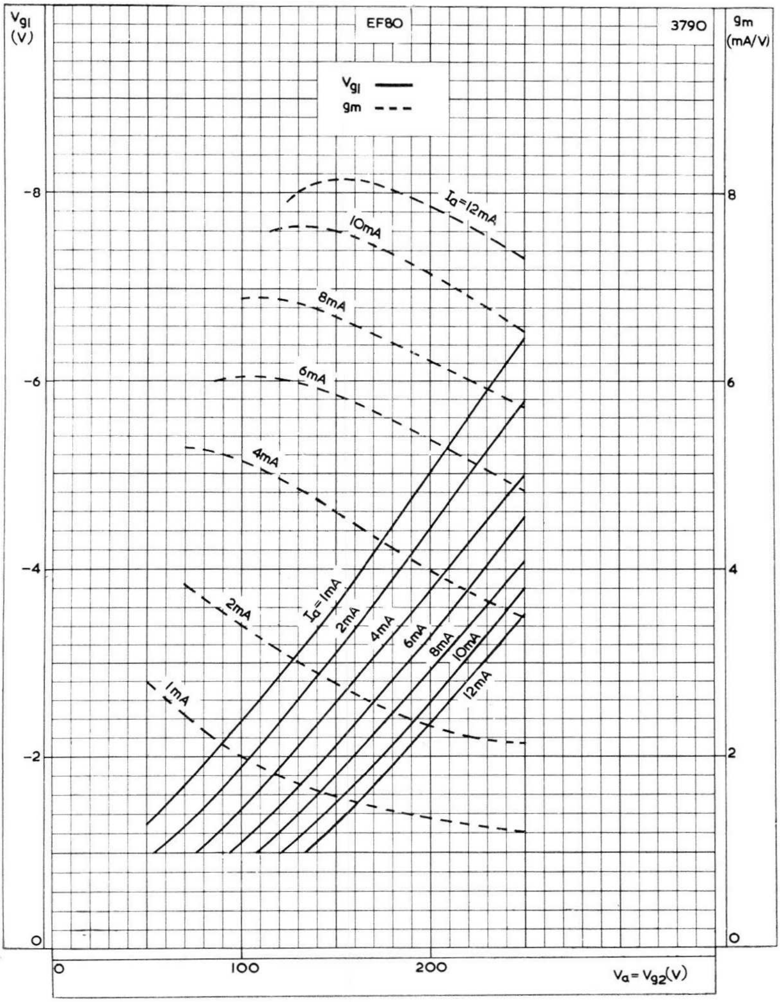
SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



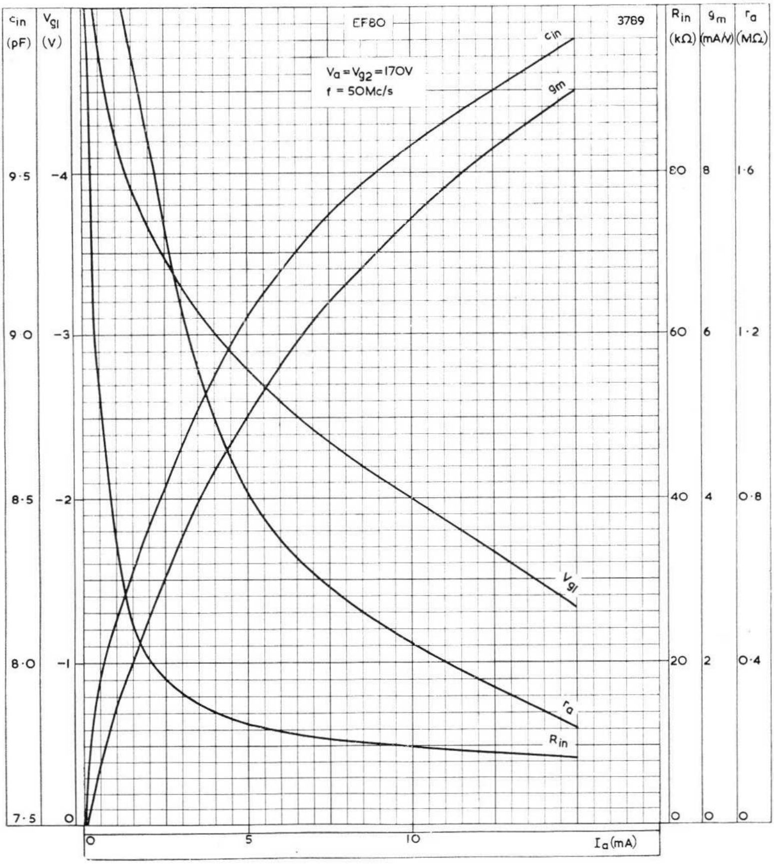
CATHODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



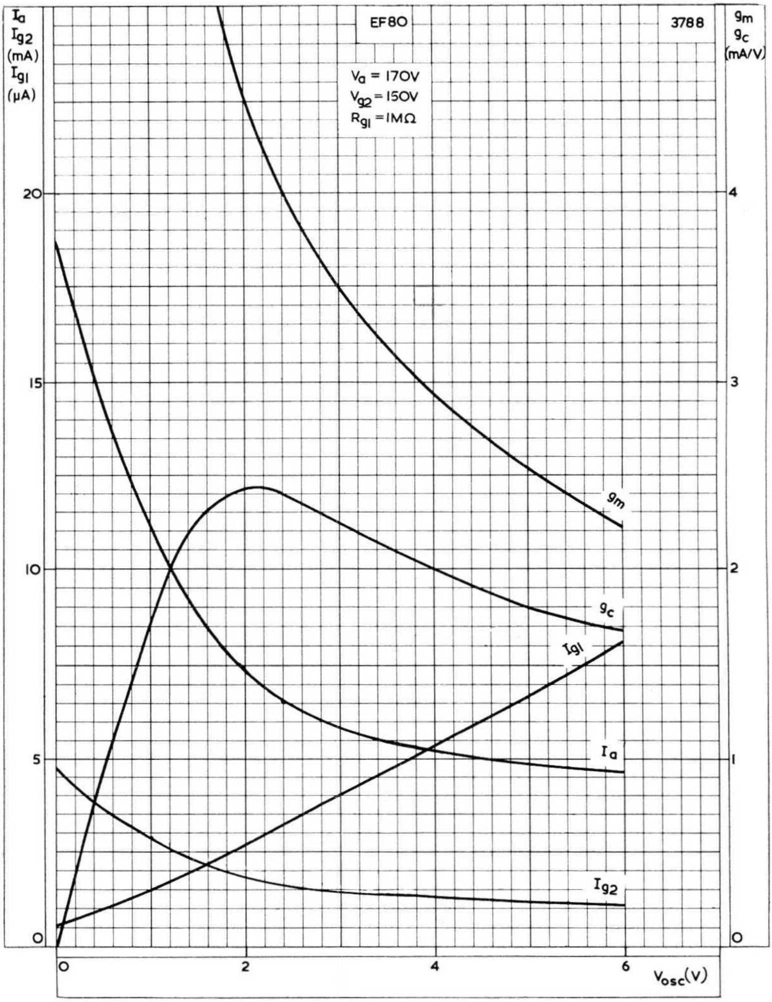
RELATION BETWEEN CONTROL-GRID VOLTAGE, MUTUAL CONDUCTANCE AND ANODE AND SCREEN-GRID VOLTAGES, WITH ANODE CURRENT AS PARAMETER

EF80

R.F. PENTODE



CONTROL-GRID VOLTAGE, MUTUAL CONDUCTANCE, ANODE IMPEDANCE, INPUT CAPACITANCE AND INPUT DAMPING PLOTTED AGAINST ANODE CURRENT



PERFORMANCE CURVES AS FREQUENCY CHANGER. $V_a = 170V$, $V_{g2} = 150V$

VARIABLE-MU R.F. PENTODE

EF85

High slope variable-mu r.f. pentode, primarily intended for use in television receivers.

HEATER

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

V_h	6.3	V
I_h	300	mA

CAPACITANCES (measured without an external shield)

c_{in}	7.2	pF
c_{out}	3.7	pF
c_{a-g1}	< 7.0	mpF
c_{g1-h}	< 150	mpF

CHARACTERISTICS

$V_b = V_a$	250	V
V_{g3}	0	V
R_{g2}	60	kΩ
V_{g2}	100	V
I_a	10	mA
I_{g2}	2.5	mA
V_{g1}	–2.0	V
g_m	6.0	mA/V
r_a	500	kΩ
R_{eq}	1.5	kΩ

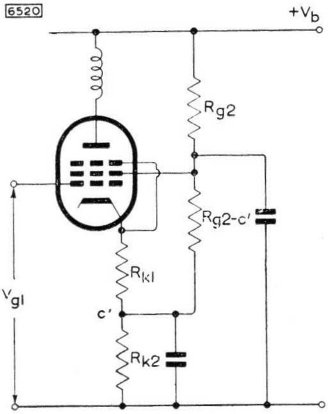
OPERATING CONDITIONS (See circuit on page D2)

Condition	*1*	*2*	*3*	*4*	
V_b	190	190	190	190	V
R_{g2}	22	6.8	8.2	10	kΩ
$R_{g2-c'}$	—	8.2	12	18	kΩ
R_{k1}	47	47	47	47	Ω
R_{k2}	100	56	68	82	Ω
I_a	11.8	9.2	9.6	10	mA
I_{g2}	3.0	2.2	2.2	2.5	mA
g_m	6.0	5.7	5.8	6.0	mA/V
V_{g1} for 60 : 1 reduction in g_m	–18.5	–9.0	–10	–11	V
I_{total}	15	23.5	20.5	18.5	mA

Condition	*5*	*6*	*7*	
V_b	190	190	190	V
R_{g2}	12	15	18	kΩ
$R_{g2-c'}$	27	47	82	kΩ
R_{k1}	47	47	47	Ω
R_{k2}	82	82	82	Ω
I_a	10.7	11.3	11.7	mA
I_{g2}	2.5	2.7	2.8	mA
g_m	6.0	6.2	6.0	mA/V
V_{g1} for 60 : 1 reduction in g_m	–12	–13.5	–15	V
I_{total}	17.5	16.5	16	mA

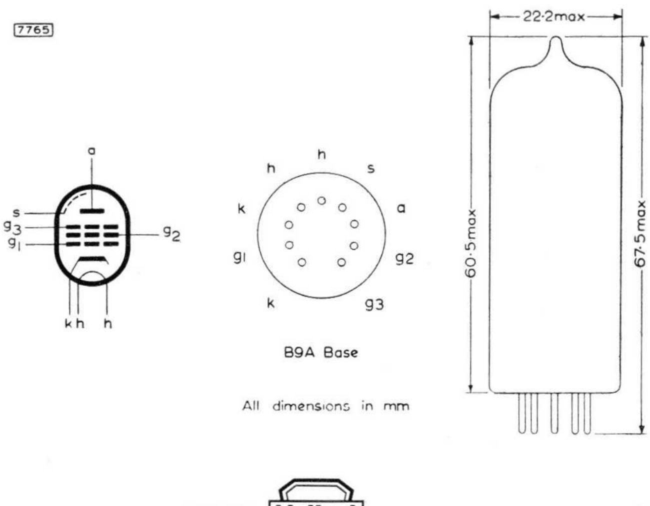
EF85

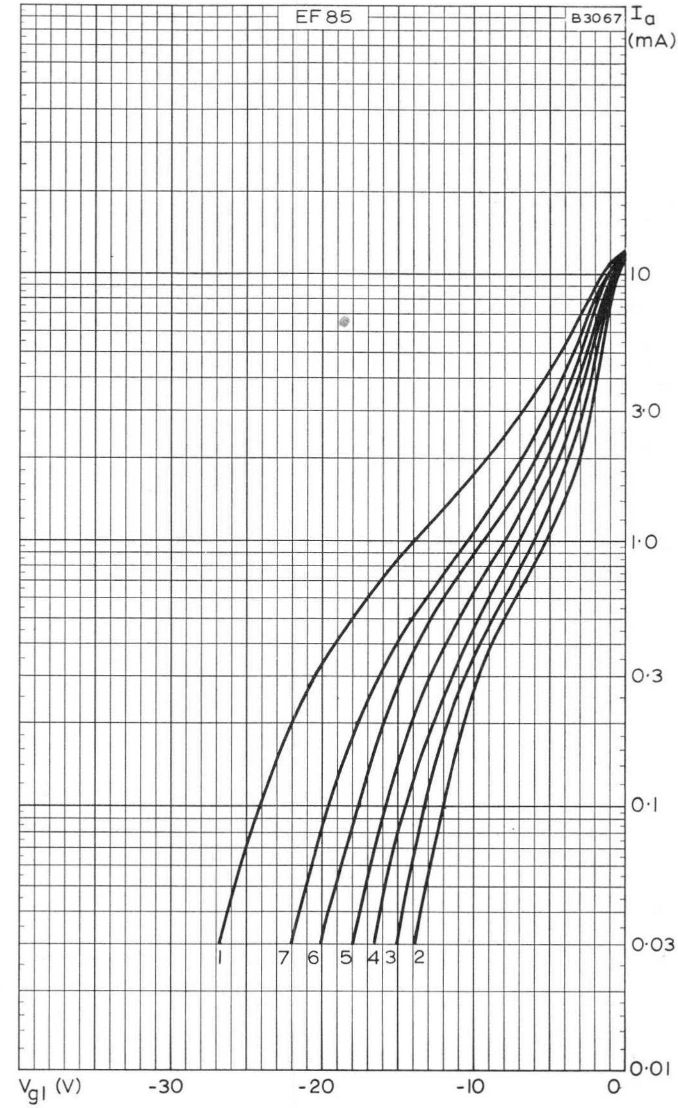
VARIABLE-MU R.F. PENTODE



LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	650	mW
I_k max.	15	mA
R_{g1-k} max.	3.0	MΩ
V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ

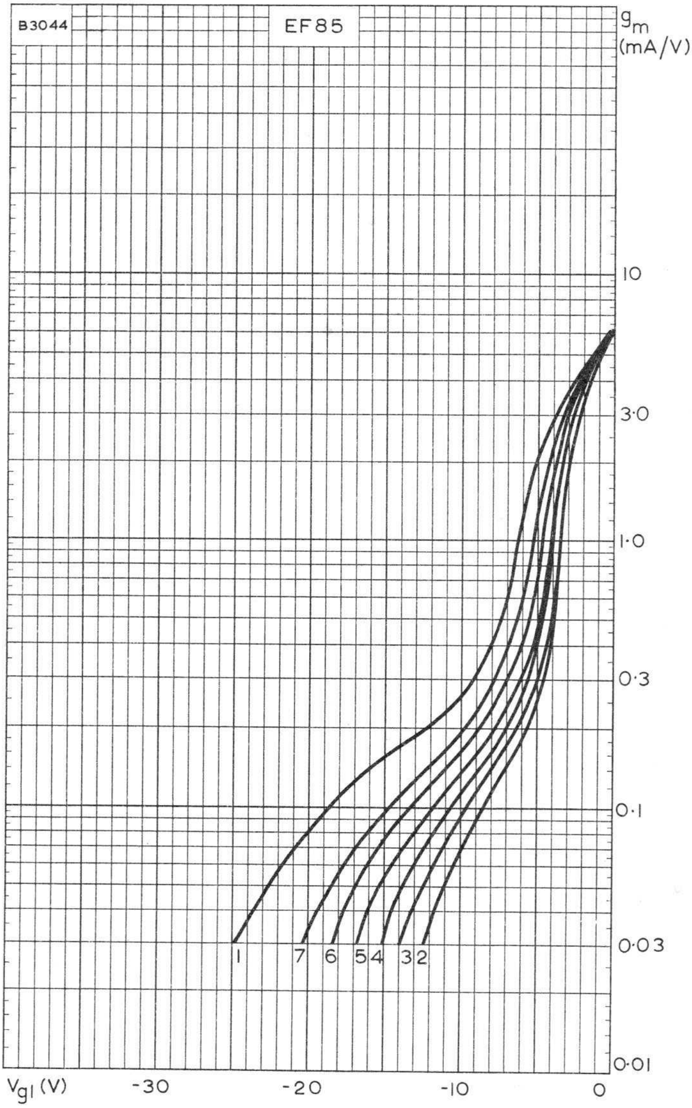




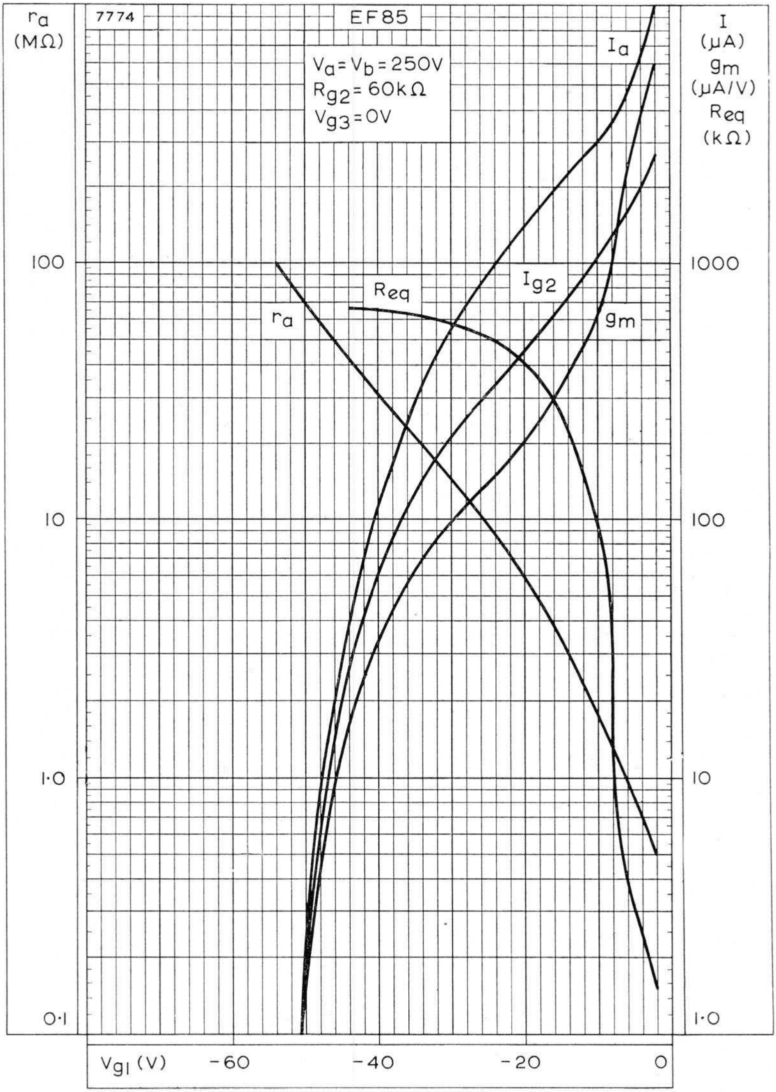
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE UNDER CONDITIONS 1 to 7 (See page D1)

EF85

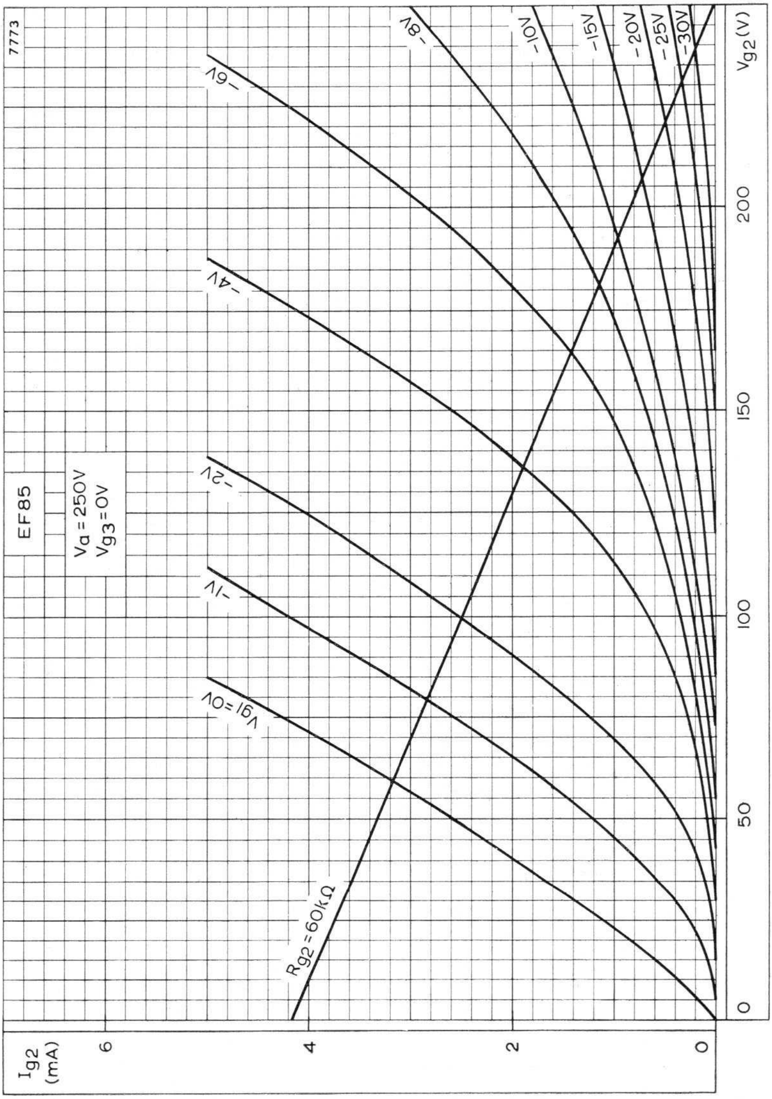
VARIABLE-MU R.F. PENTODE



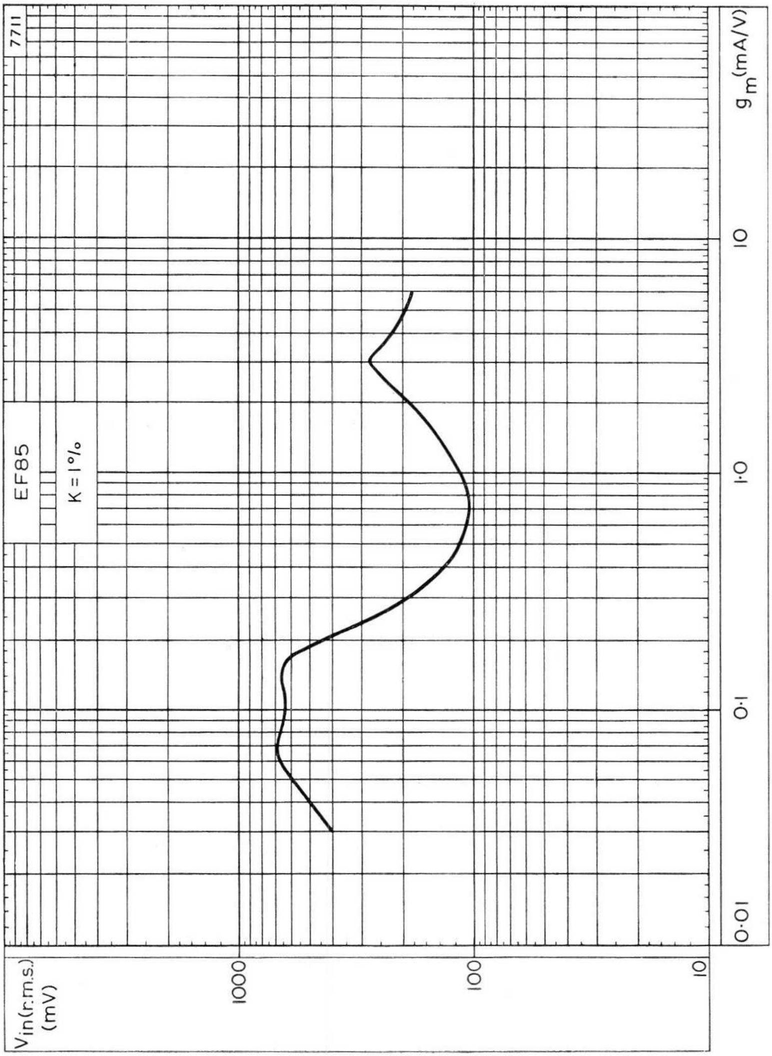
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE UNDER CONDITIONS 1 to 7 (See page D1)



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE ANODE IMPEDANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



CROSS MODULATION CURVE

VARIABLE-MU R.F. PENTODE

EF89

Variable-mu pentode for use as r.f. or i.f. amplifier in f.m./a.m. receivers.

HEATER

V_h	6.3	V
I_h	200	mA

CAPACITANCES

c_{in}	5.5	pF
c_{out}	5.1	pF
c_{a-g1}	<2	mpF
c_{g1-g2}	2.1	pF
c_{g1-h}	50	mpF

CHARACTERISTICS

V_a	250	250	V
V_{g3}	0	0	V
V_{g2}	85	100	V
V_{g1}	−1.0*	−2.0	V
I_a	9.0	9.0	mA
I_{g2}	3.2	3.0	mA
g_m	4.0	3.6	mA/V
r_a	>0.8	1.0	MΩ
μ_{g1-g2}	19	—	

*At this voltage grid current may occur. If this is not acceptable the negative bias voltage should be increased to −2.0V.

OPERATING CONDITIONS

$V_a = V_b$	250	250	250	250	V
V_{g3}	0	0	0	0	V
R_{g2}	62	51	18†	18†	kΩ
V_{g1}	−0.5*	−2.0	−0.5*	−2.0	V
R_k	—	160	—	190	Ω
R_{g1}	10	—	10	—	MΩ
I_a	8.5	9.0	8.0	8.7	mA
I_{g2}	2.8	3.0	2.6	2.9	mA
g_m	4.4	3.5	4.2	3.5	mA/V
r_a	1.0	1.0	1.05	1.0	MΩ
R_{eq}	2.4	4.2	2.3	4.1	kΩ
g_m (V_{g1} = −20V)	220	240	230	230	μA/V
r_{g1} (f = 50Mc/s)	—	10	—	10	kΩ

*This voltage is produced by the grid current flowing through the grid resistor and the steady current of the diode. If this condition is not acceptable the negative grid bias should be increased to −2.0V.

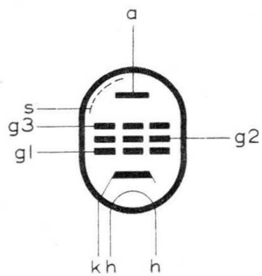
†Common screen-grid resistor for EF89 and ECH81 used as a frequency changer. The current through this resistor is 8.6mA at V_{g1} = −2.0V and 9.8mA at V_{g1} = −0.5V.

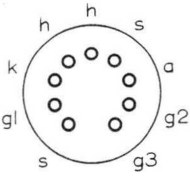
EF89

VARIABLE-MU R.F. PENTODE

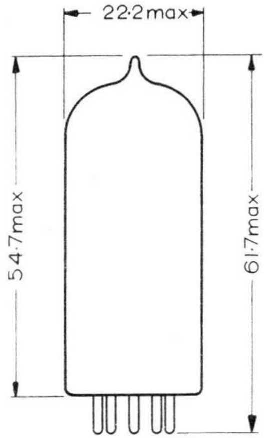
LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.25	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	450	mW
I_k max.	16.5	mA
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	10	kΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ



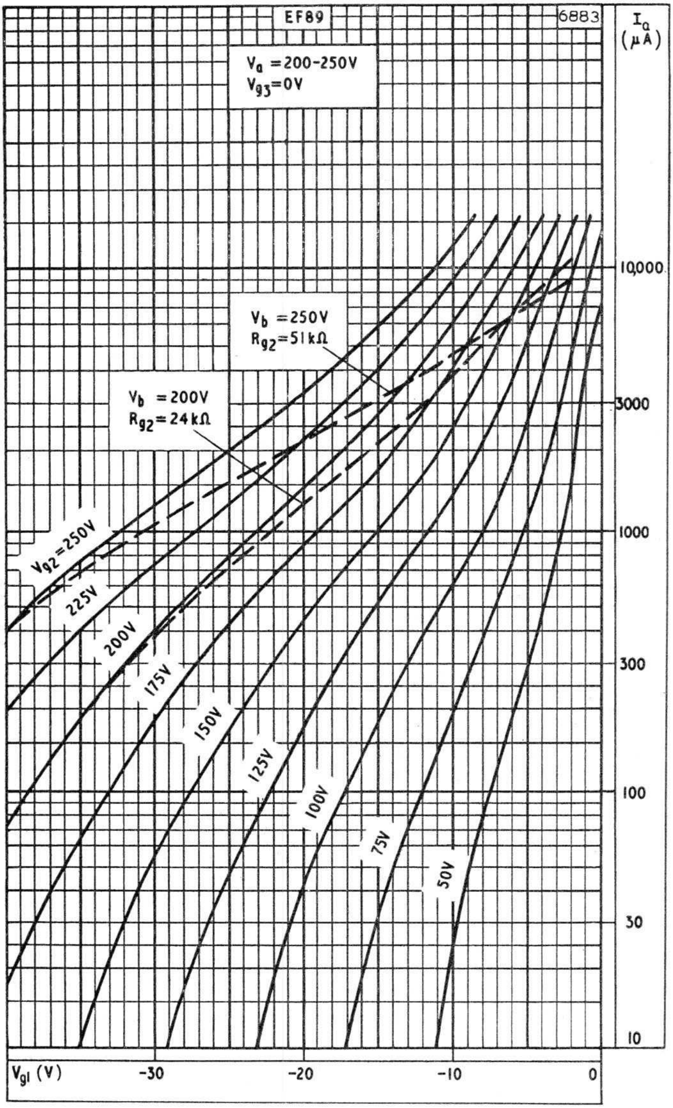


B9A Base

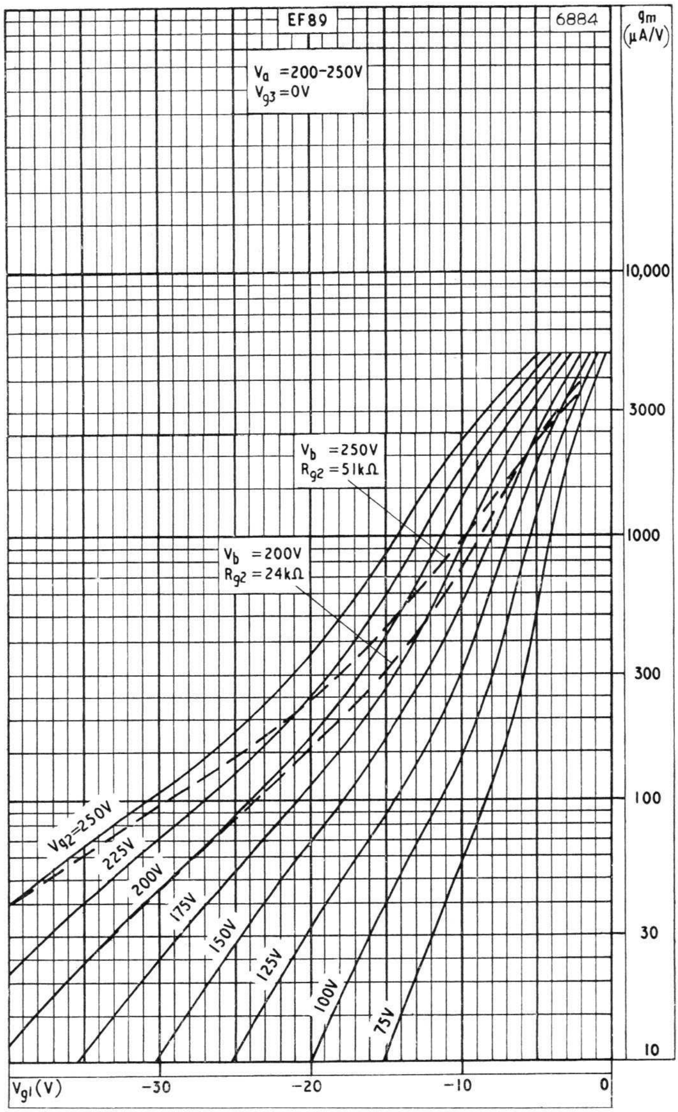


6394

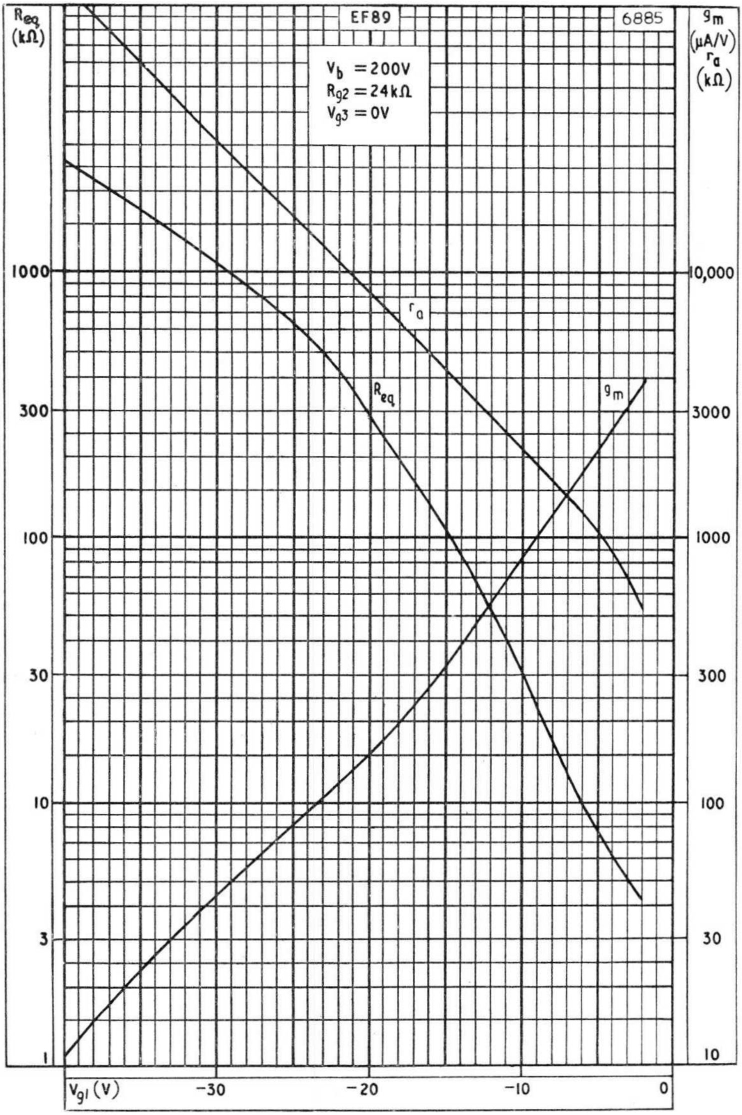
All dimensions in mm



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



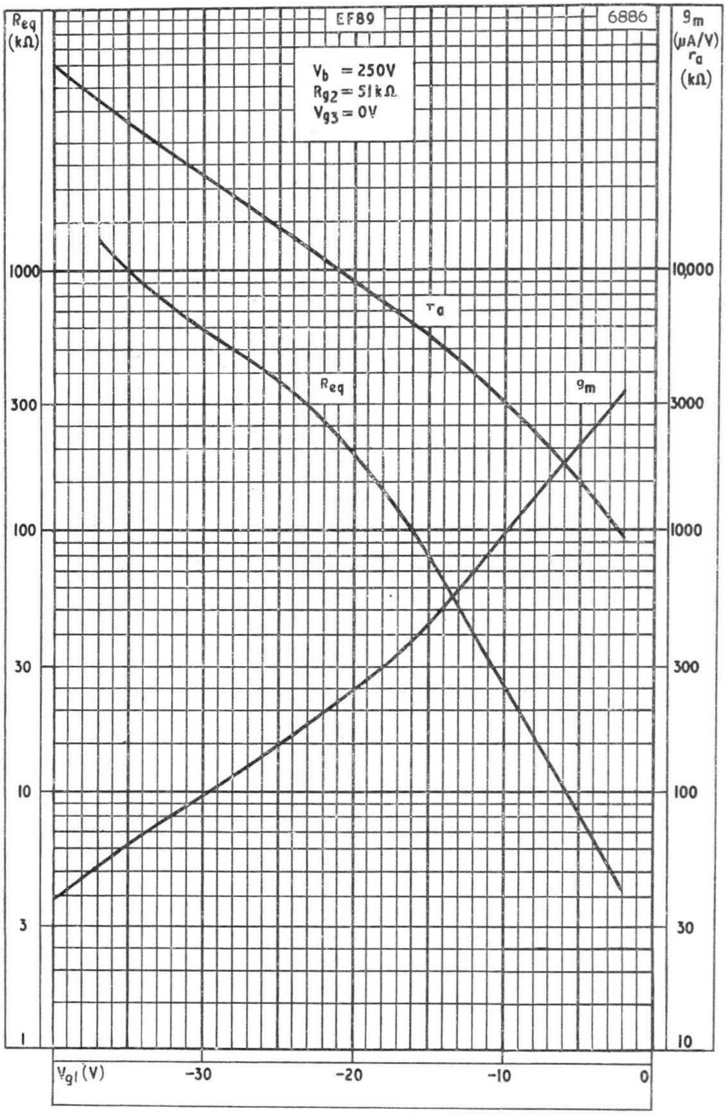
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



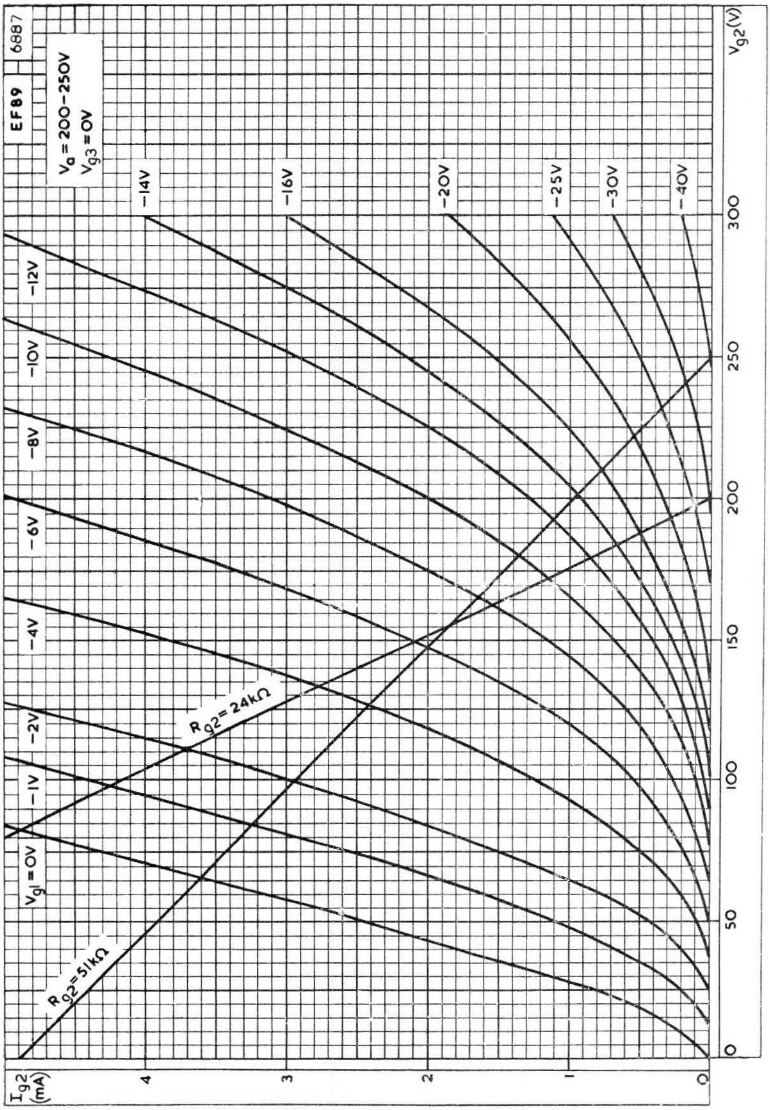
MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_b = 200V$.

EF89

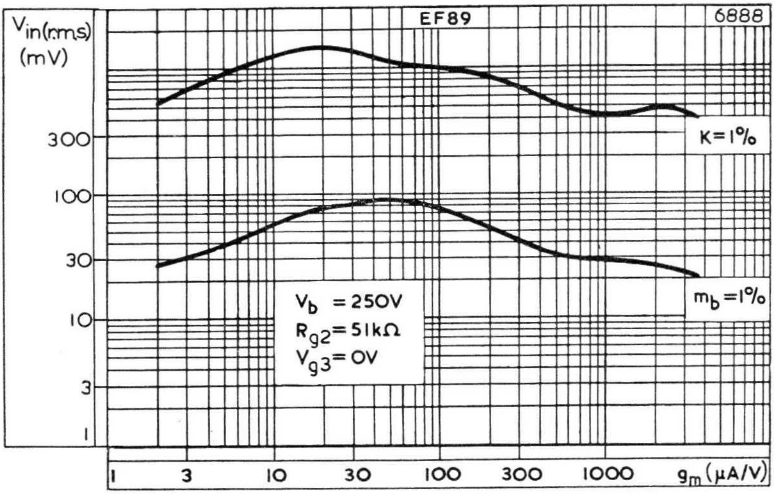
VARIABLE-MU R.F. PENTODE

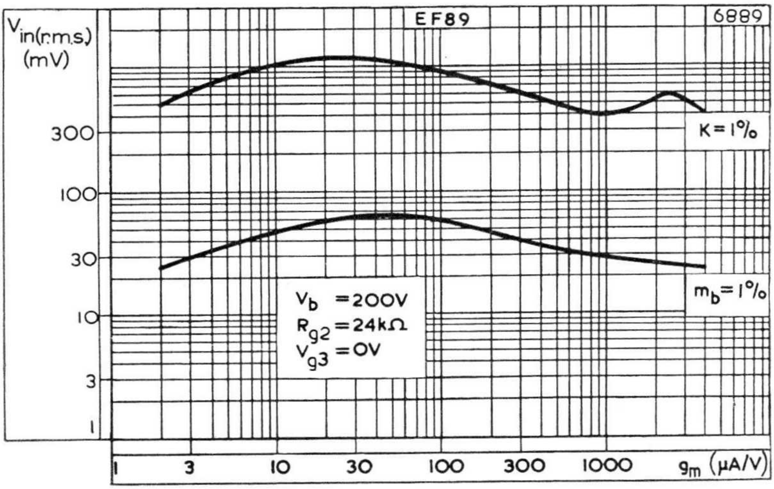


MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. V_b = 250V.



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER





CROSS MODULATION AND MODULATION HUM CURVES

R.F. PENTODE

EF91

High slope pentode primarily intended for use as r.f. and i.f. amplifier or mixer valve.

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

CAPACITANCES

	Unshielded	Shielded	←
c_{in}	7.1	7.1	pF
c_{out}	2.1	3.1	pF
c_{a-g1}	<20	<10	mpF

CHARACTERISTICS

V_a	250	V
V_{g3}	0	V
V_{g2}	250	V
V_{g1}	−2.0	V
I_a	10	mA
I_{g2}	2.6	mA←
g_m	7.6	mA/V
r_a	>500	kΩ←
μ_{g1-g2}	70	
R_{eq}	1.2	kΩ
r_{g1} (f = 50Mc/s)	6.5	kΩ←
V_{g3} for cut-off ($I_a < 50\mu A$)	−120	V←

OPERATING CONDITIONS AS MIXER

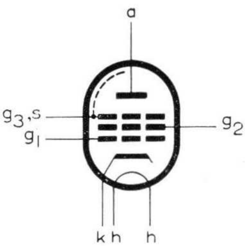
V_b	250	V
V_{g3}	0	V
R_k	470	Ω
R_{g1}	1.0	MΩ
I_a	6.0	mA←
I_{g2}	1.5	mA←
I_{g1}	2.0	μA←
$V_{osc\ (r.m.s.)}$	4.0	V←
g_c	2.5	mA/V
$g_{m(eff.)}$	3.2	mA/V←
r_a	880	kΩ←

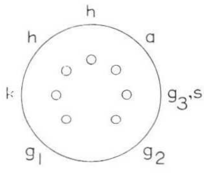
EF91

R.F. PENTODE

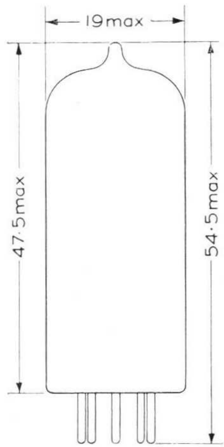
LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	300	V
p_{g2} max.	650	mW
$-V_{g1}$ max.	50	V
I_k max.	15	mA
R_{g1-k} max.	250	kΩ←
V_{h-k} max.	150	V
T_{bulb} max.	210	°C←



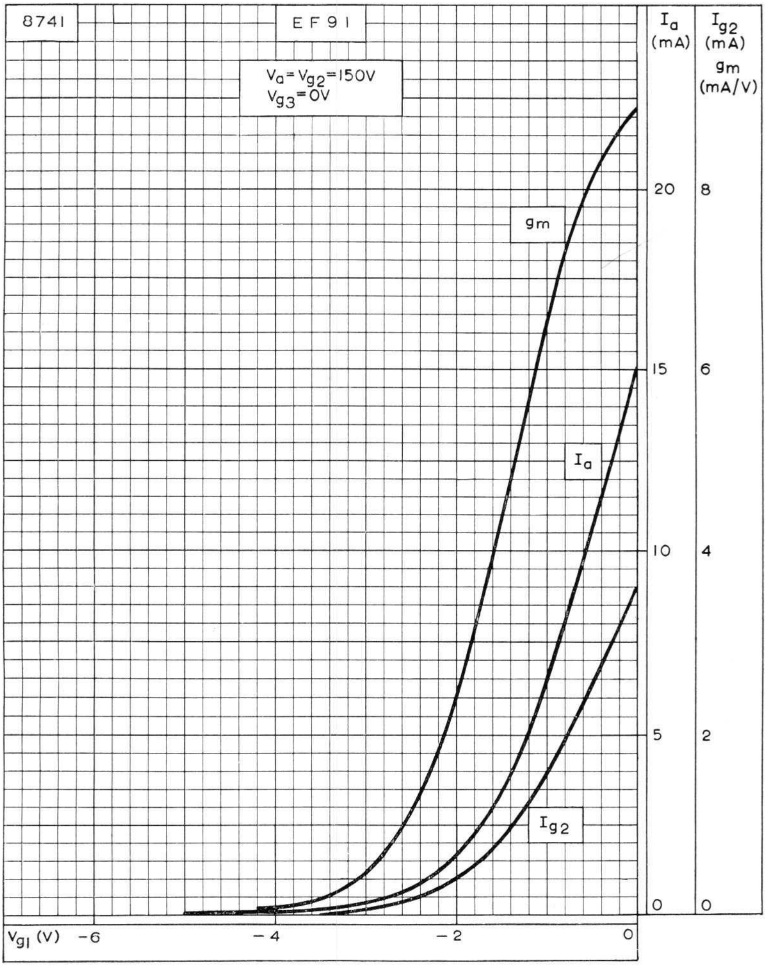


B7G Base

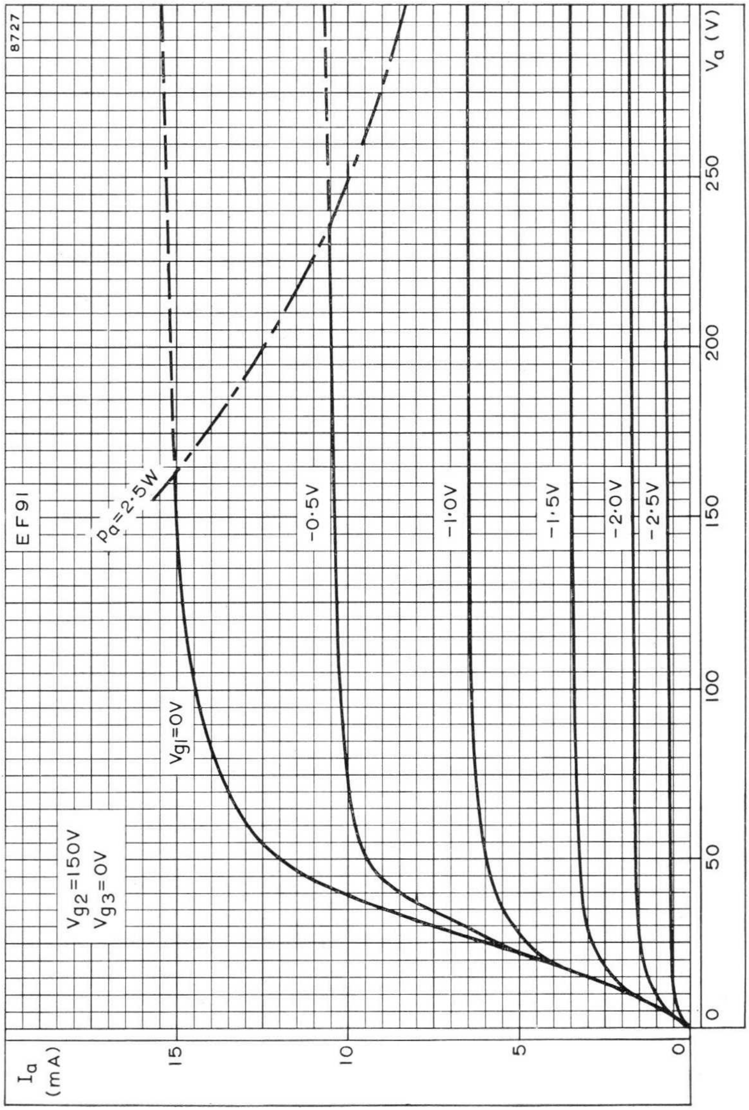


All dimensions in mm

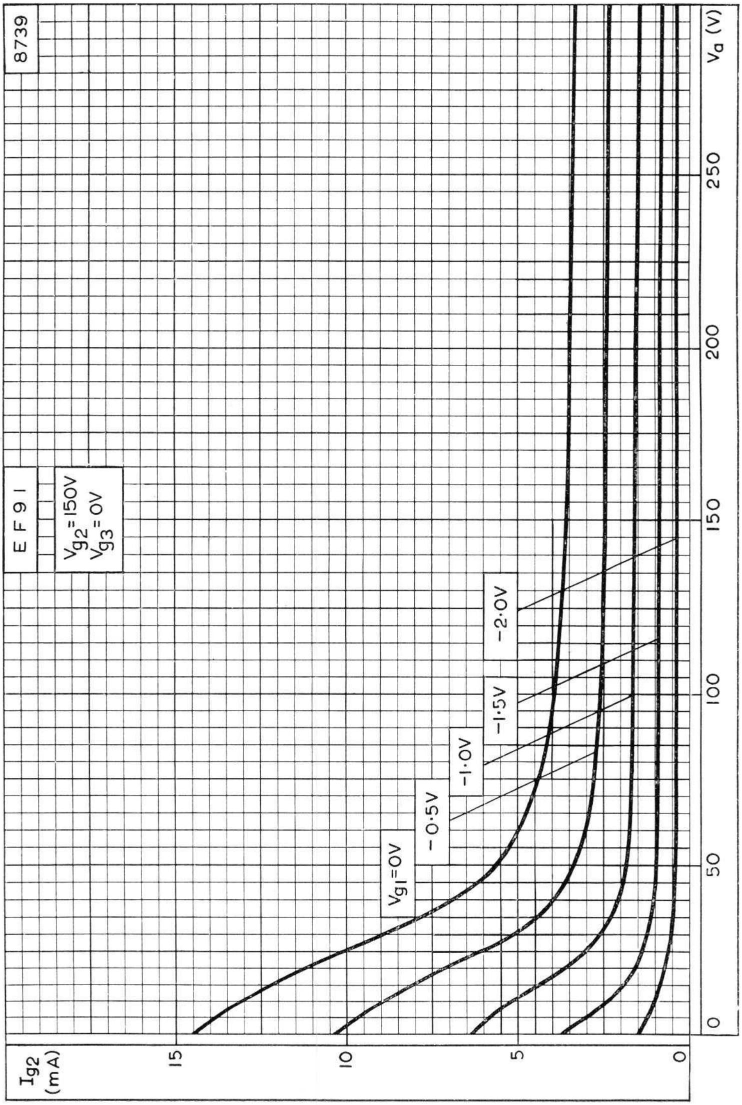
8723



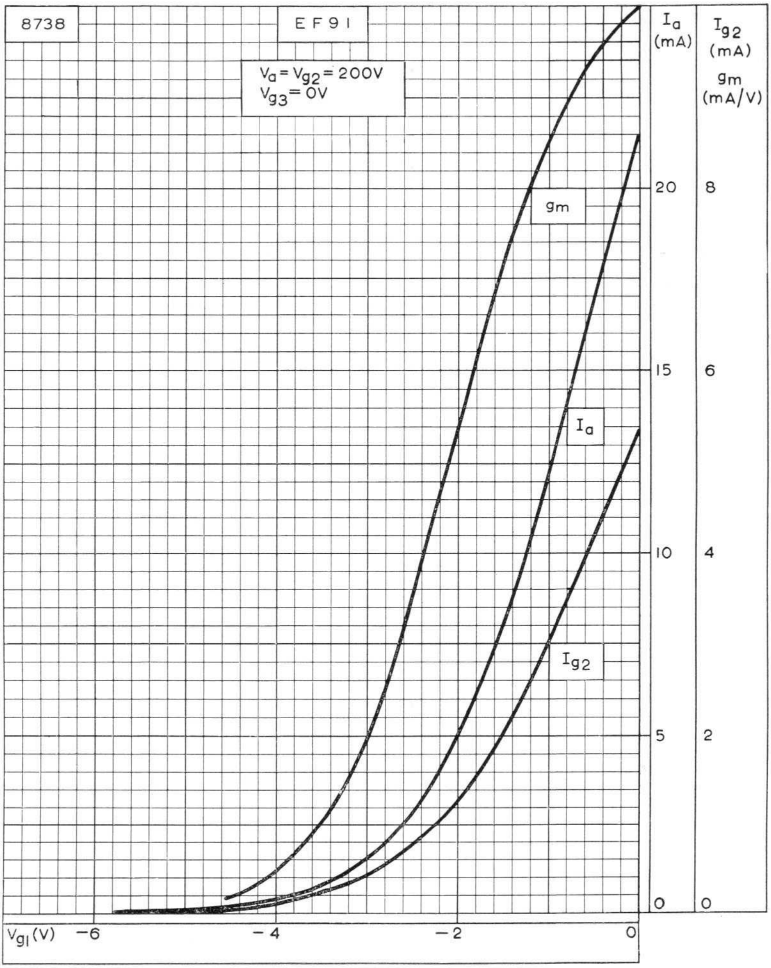
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 150V$



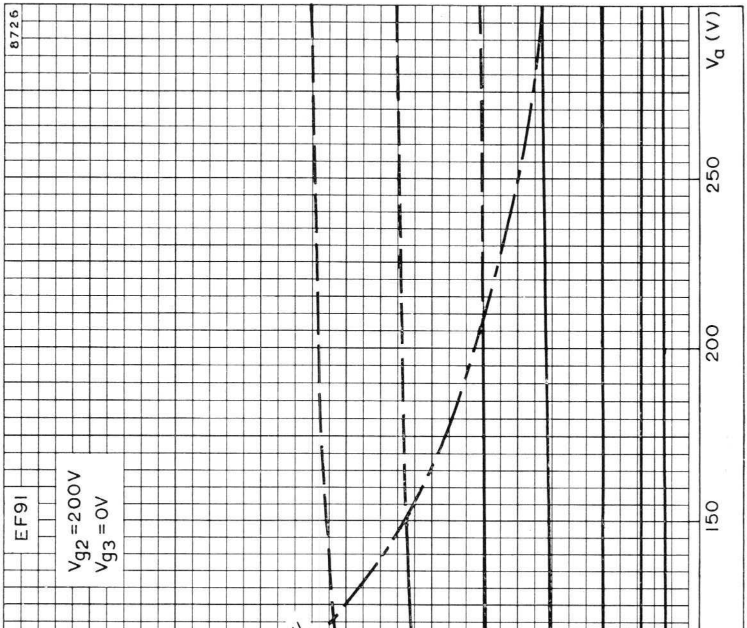
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$



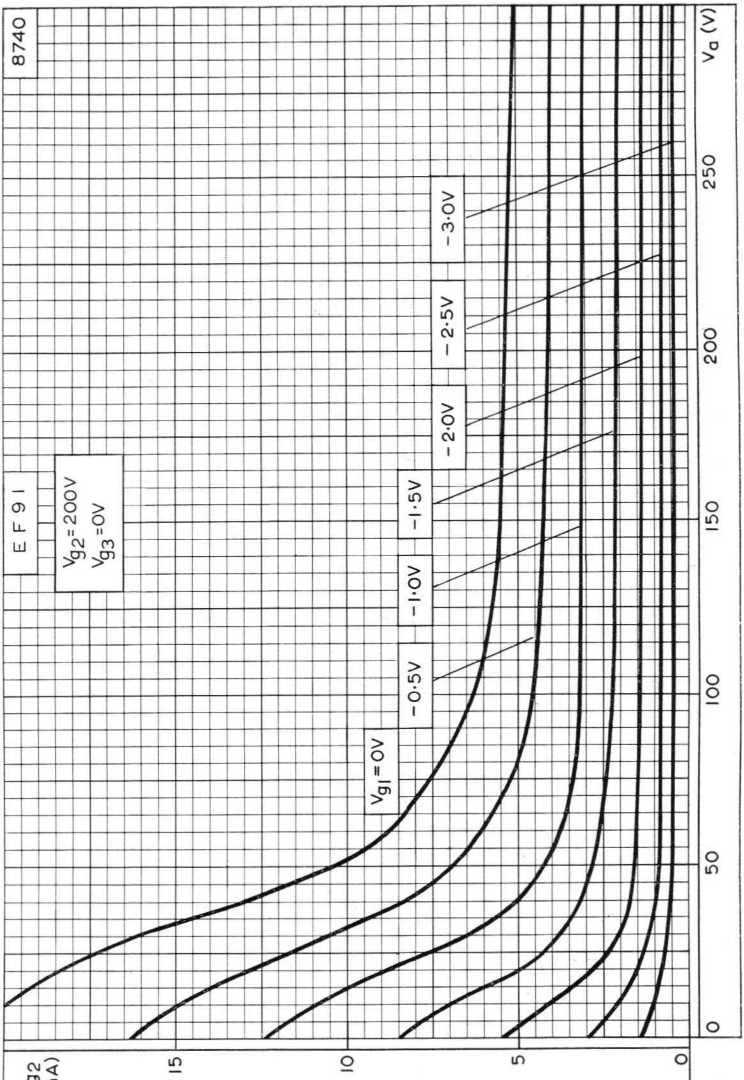
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V



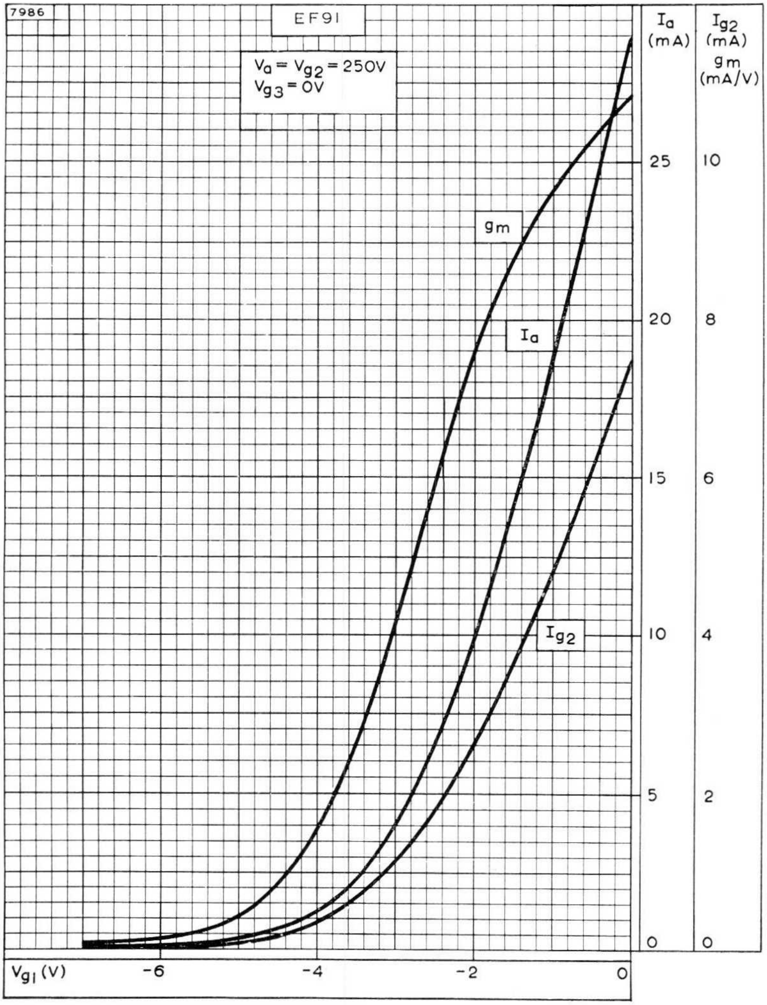
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 200V$



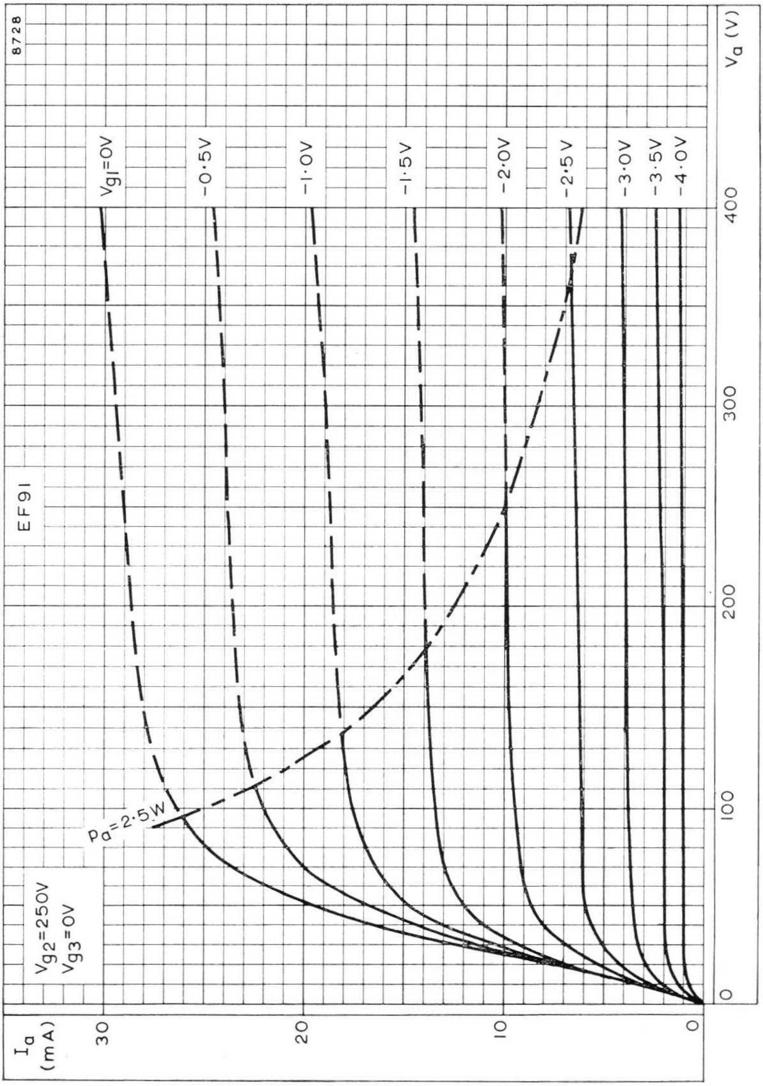
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V



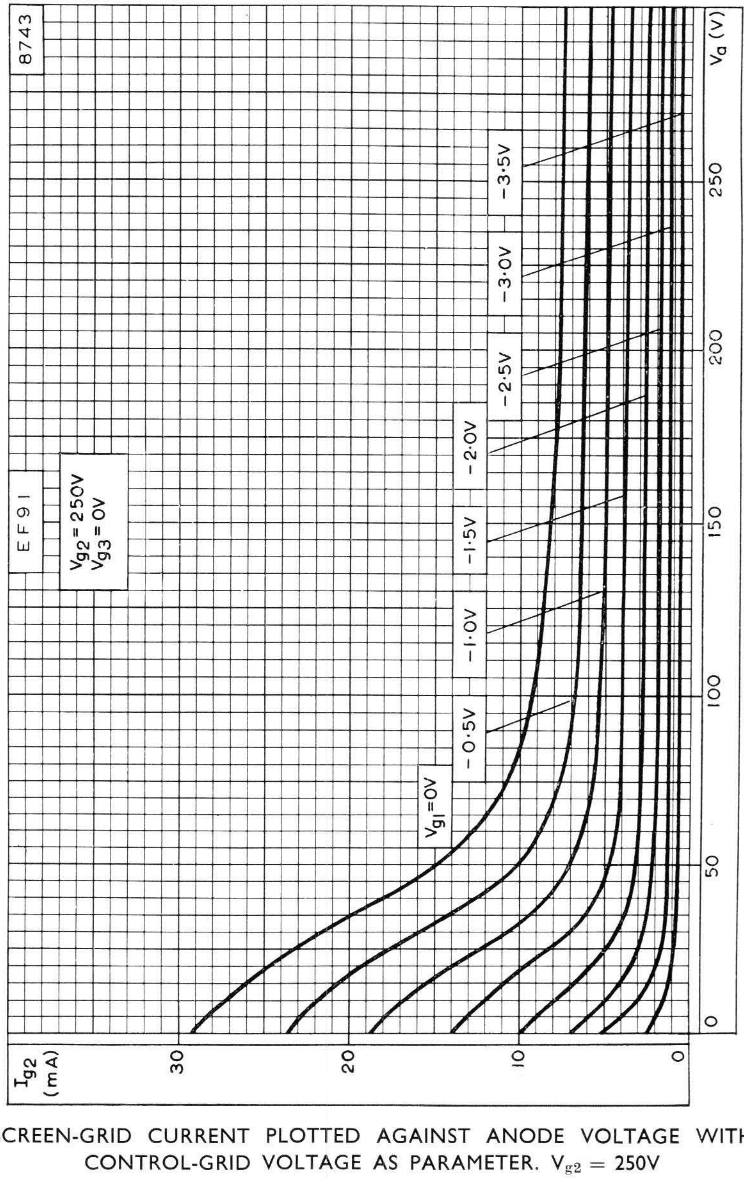
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$



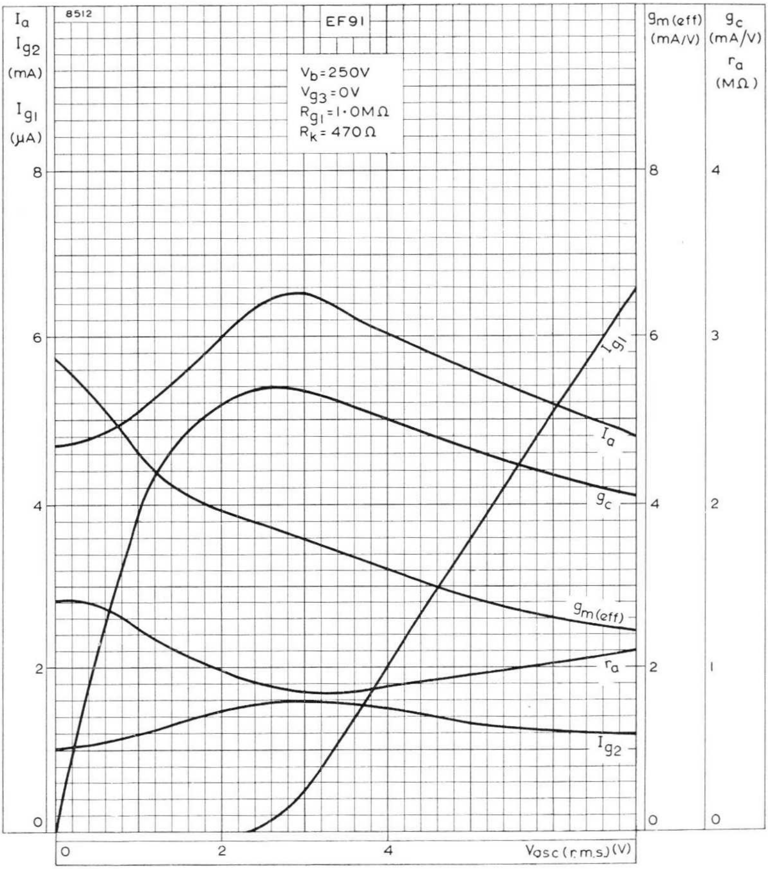
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 250V$



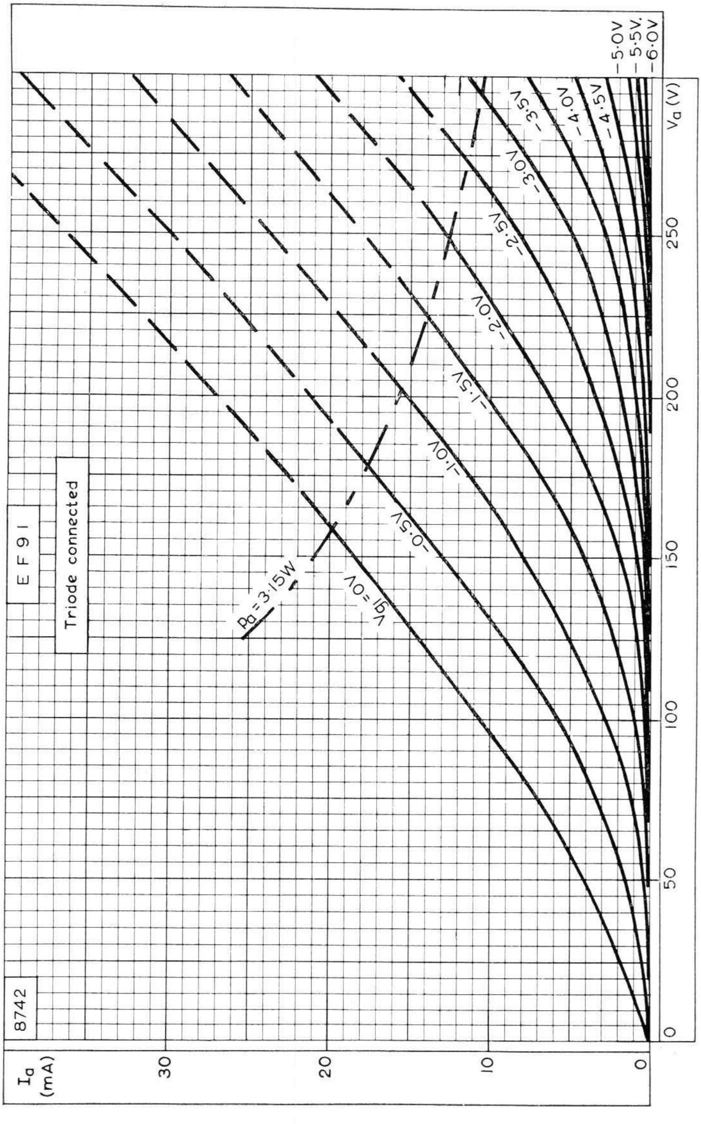
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$



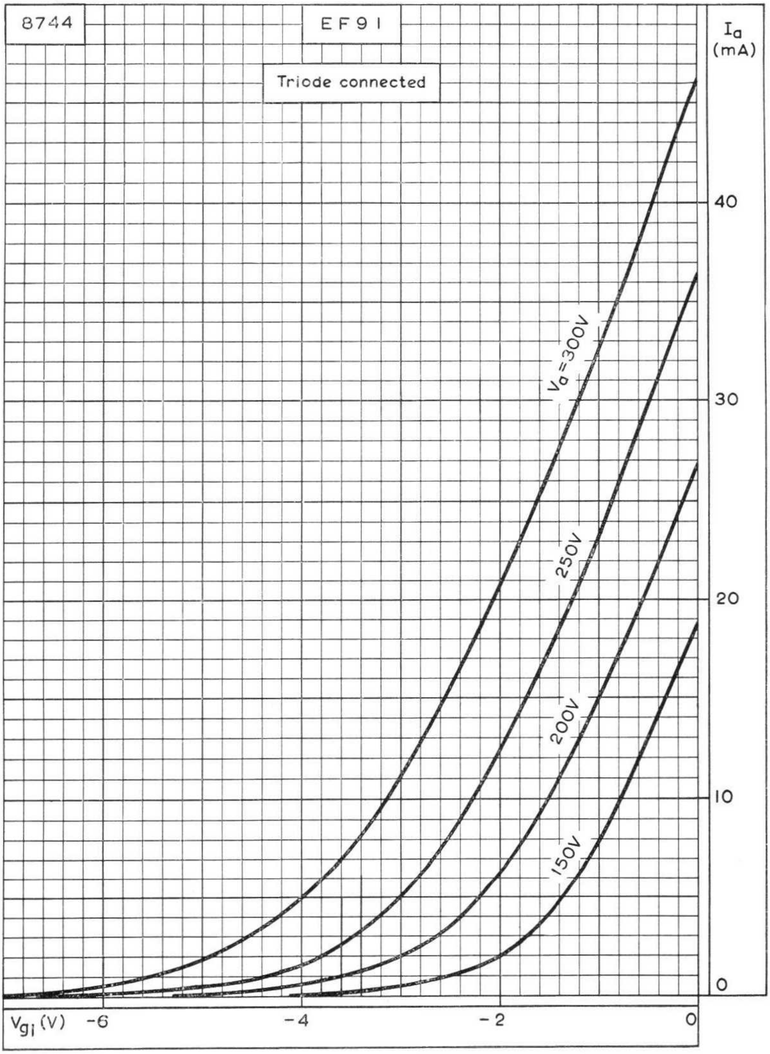
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$



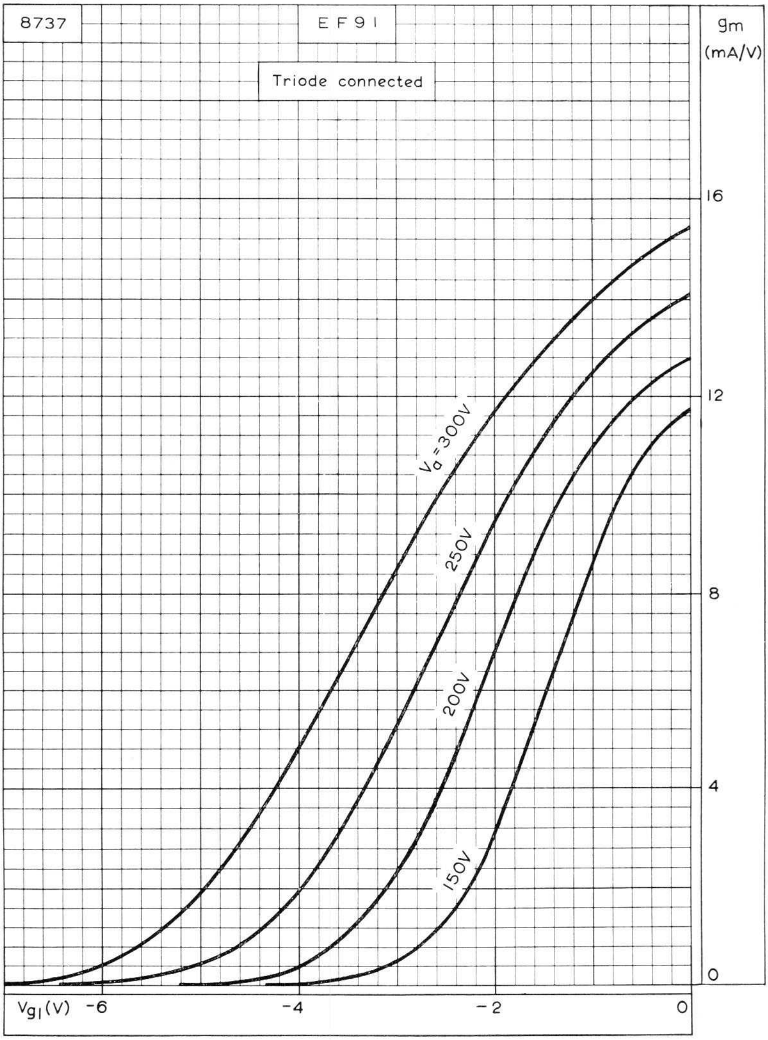
PERFORMANCE CURVES WHEN USED AS FREQUENCY CHANGER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED



MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

VARIABLE-MU R.F. PENTODE

EF92

Variable-mu r.f. pentode for use as a controlled r.f. or i.f. amplifier.

HEATER

V_h	6.3	V
I_h	200	mA

CAPACITANCES

	Unshielded	Shielded ←	
c_{in}	4.8	5.0	pF
c_{out}	6.3	6.5	pF
c_{a-g1}	$<$ 15	$<$ 10	mpF
c_{h-k}	2.3	2.3	pF

CHARACTERISTICS ←

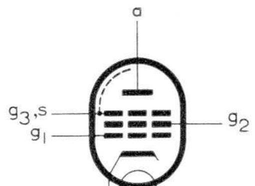
V_a	200	V
V_{g2}	200	V
V_{g3}	0	V
I_a	8.25	mA
I_{g2}	2.1	mA
V_{g1}	−2.5	V
g_m	2.45	mA/V
r_a	900	kΩ
μ_{g1-g2}	30	
V_{g1} (for 100 : 1 reduction in g_m)	−27	V

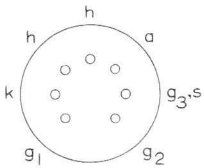
LIMITING VALUES

$V_{a(b)}$ max.	500	V ←
V_a max.	250	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	500	V ←
V_{g2} max.	250	V
p_{g2} max.	600	mW
$-V_{g1}$ max.	50	V ←
I_k max.	12	mA
R_{g1-k} max.	100	kΩ ←
V_{h-k} max.	100	V
T_{bulb} max.	170	°C ←

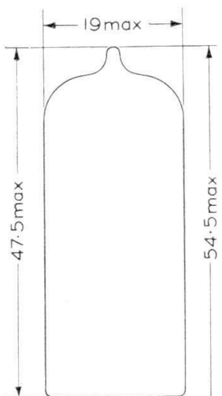
EF92

VARIABLE-MU R.F. PENTODE



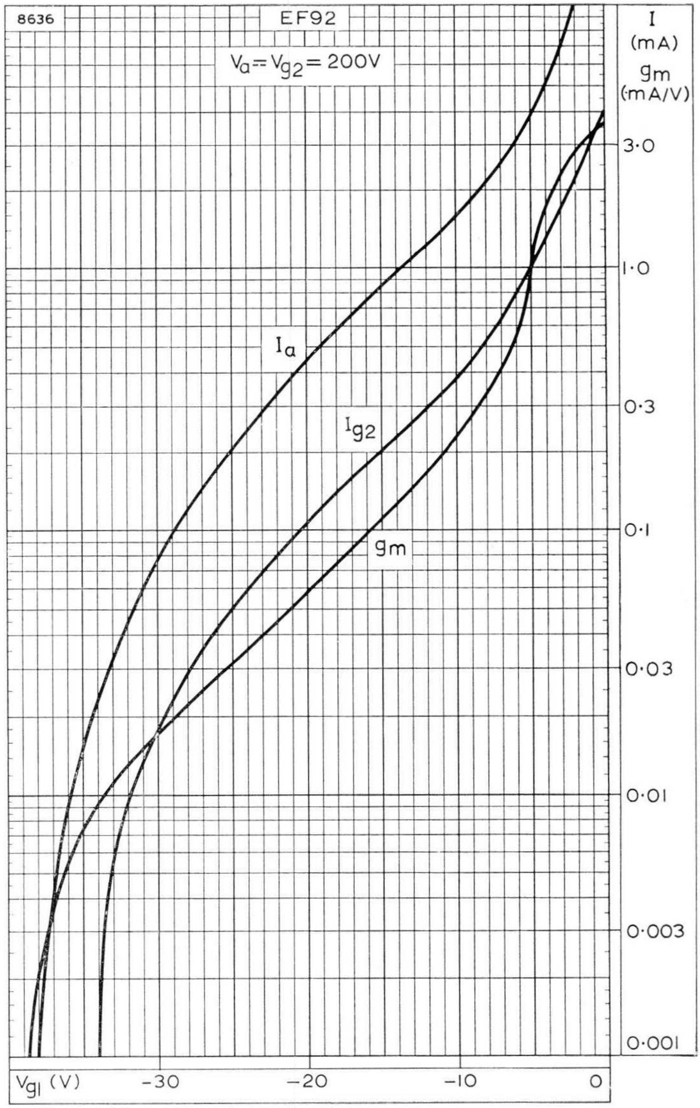


B7G Base

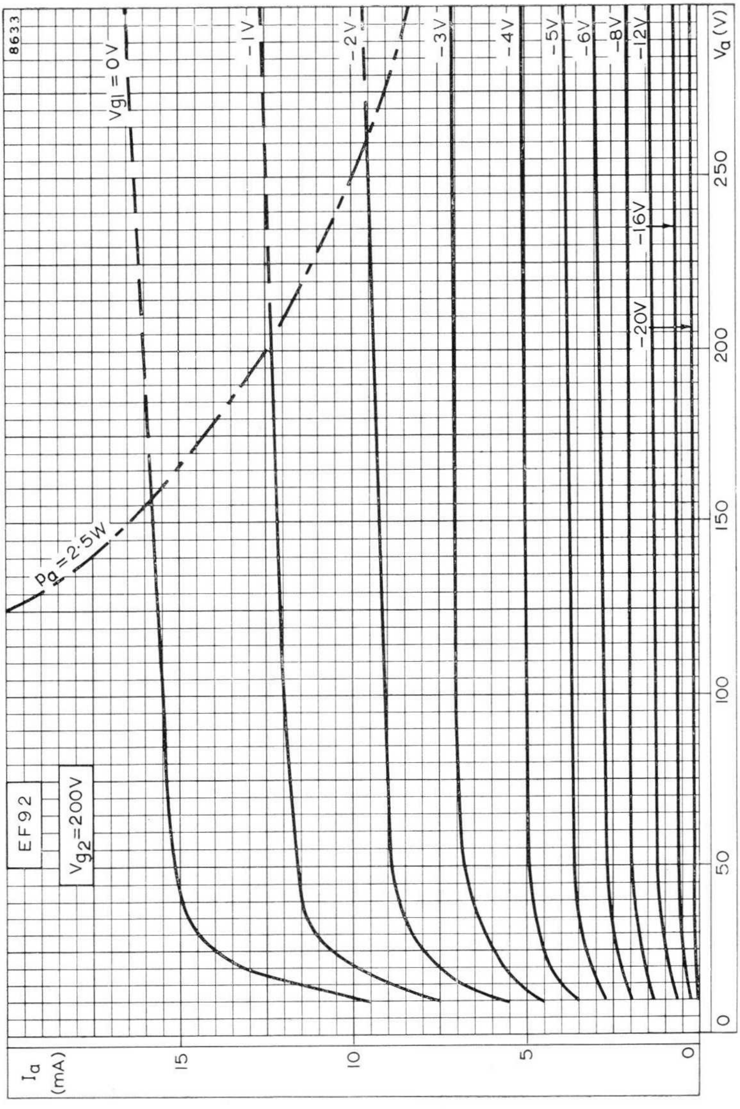


All dimensions in mm

8723

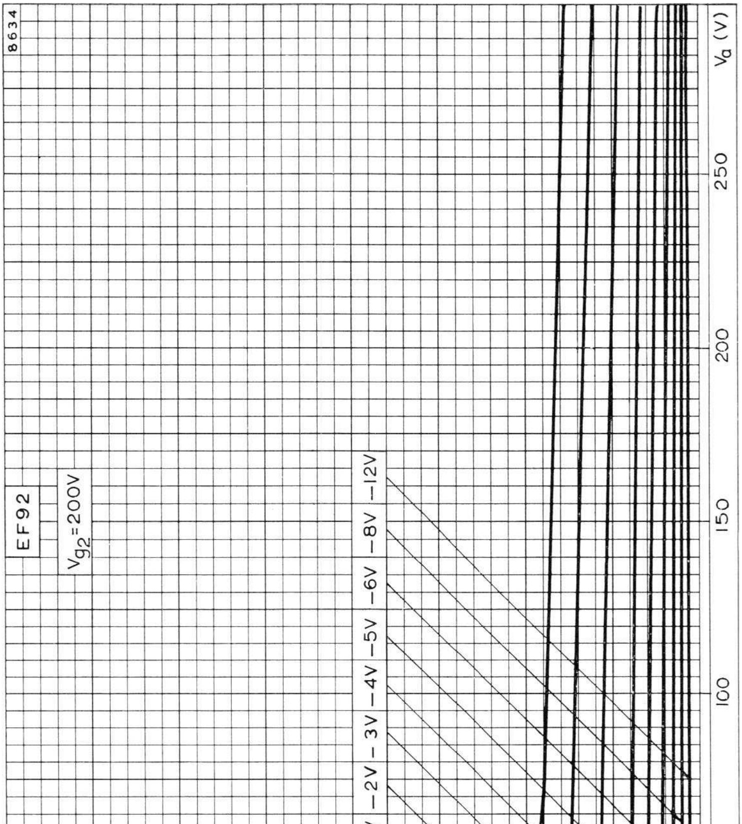


ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 200V$

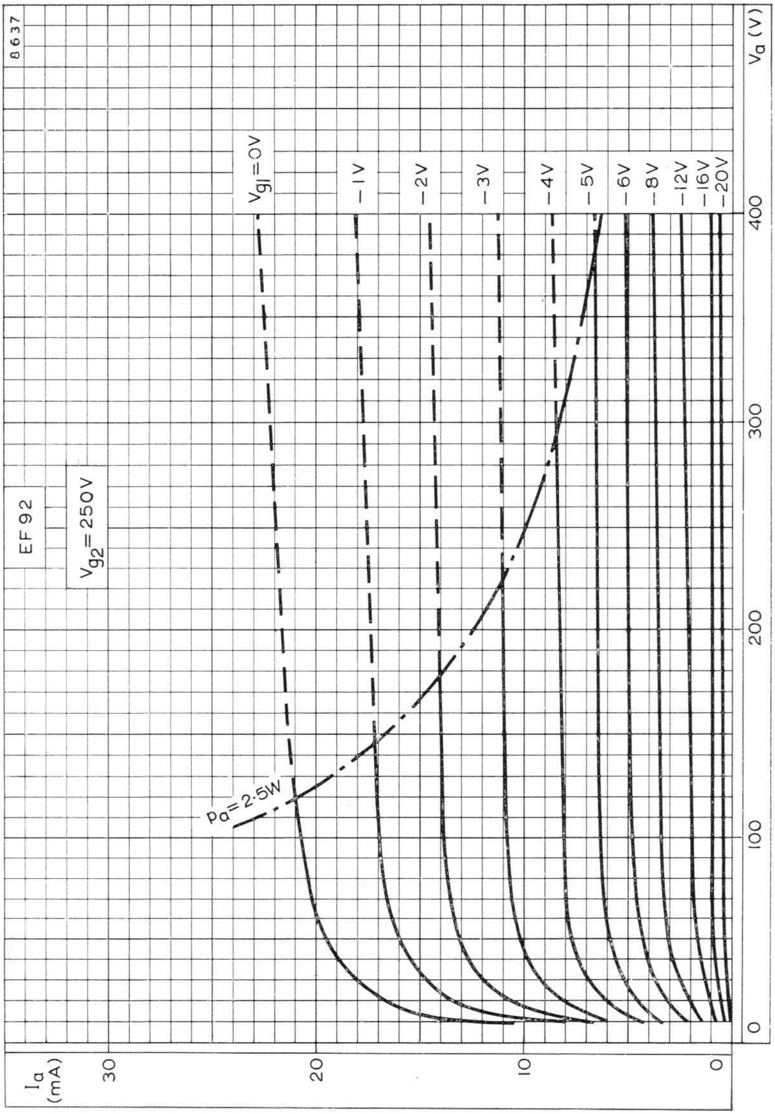


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.

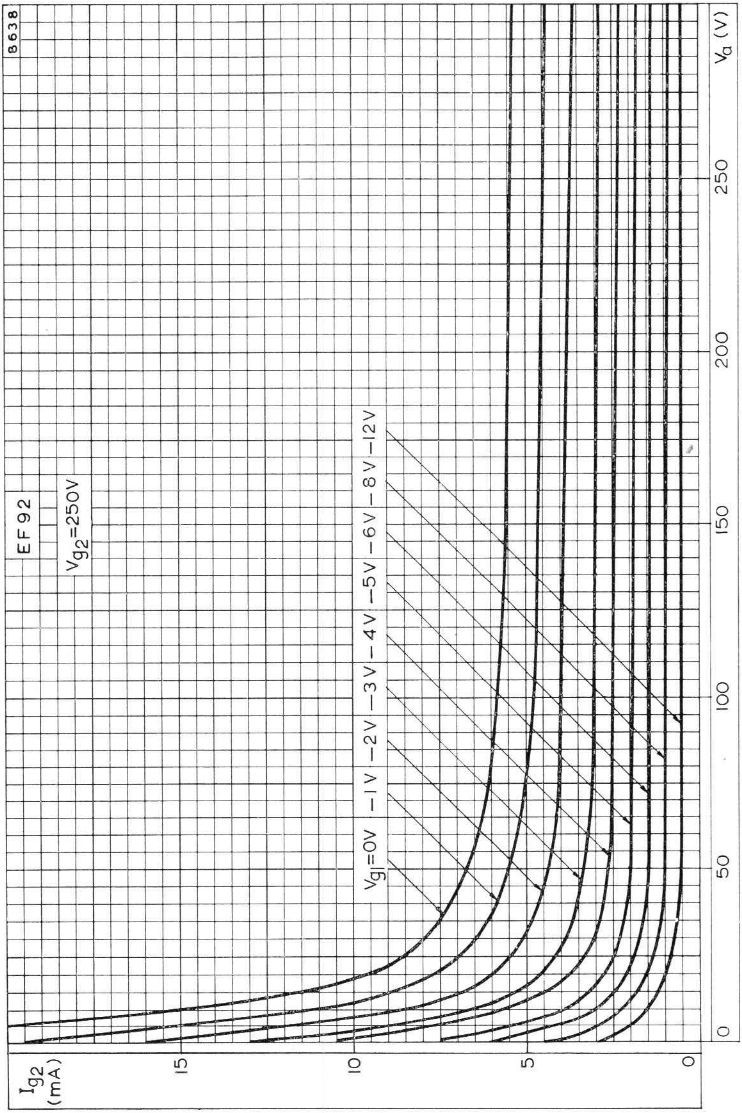
$V_{g2} = 200V$



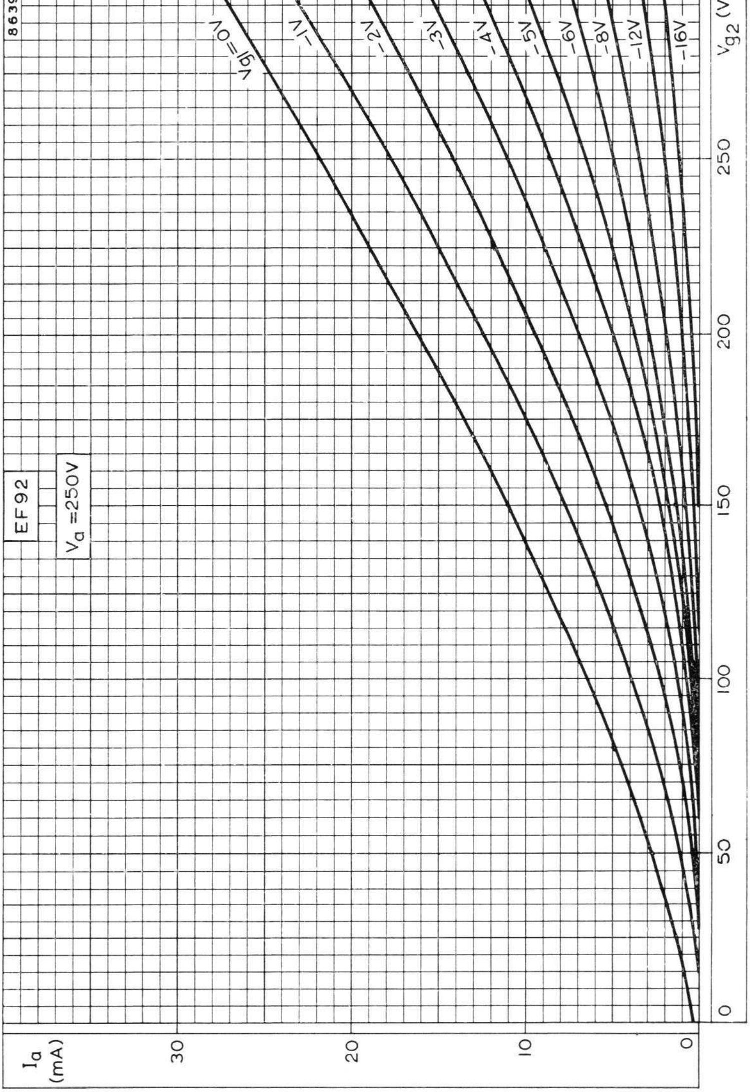
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_{g2} = 200V$



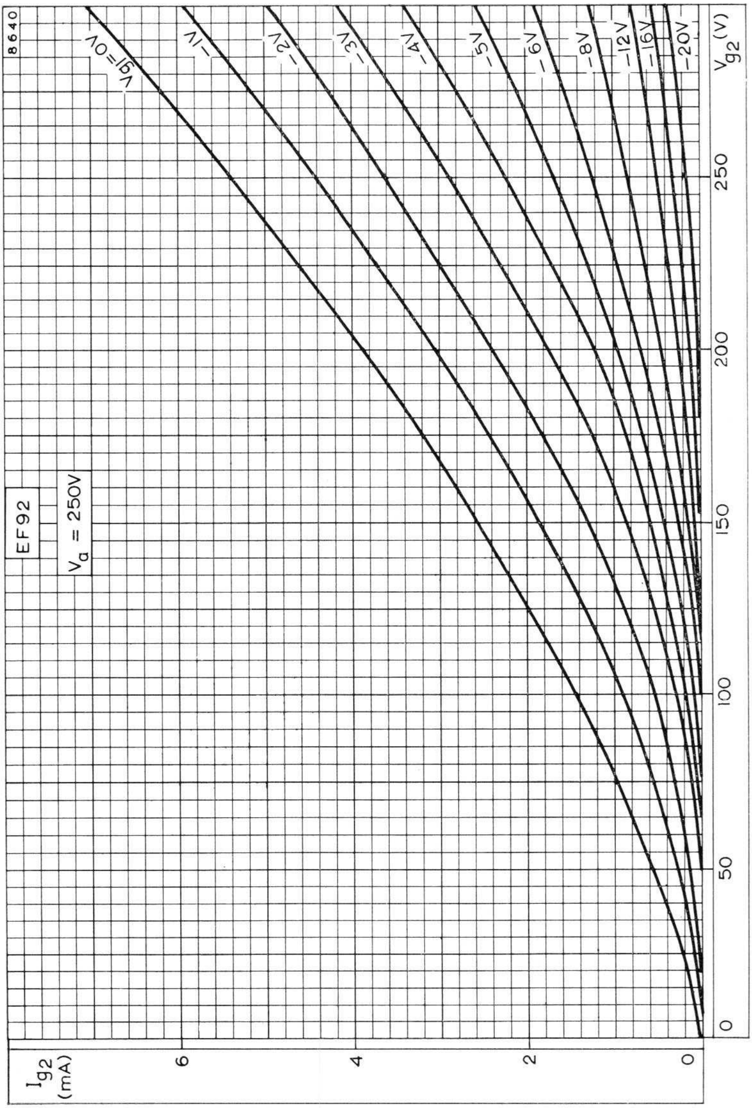
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_{g2} = 250V$



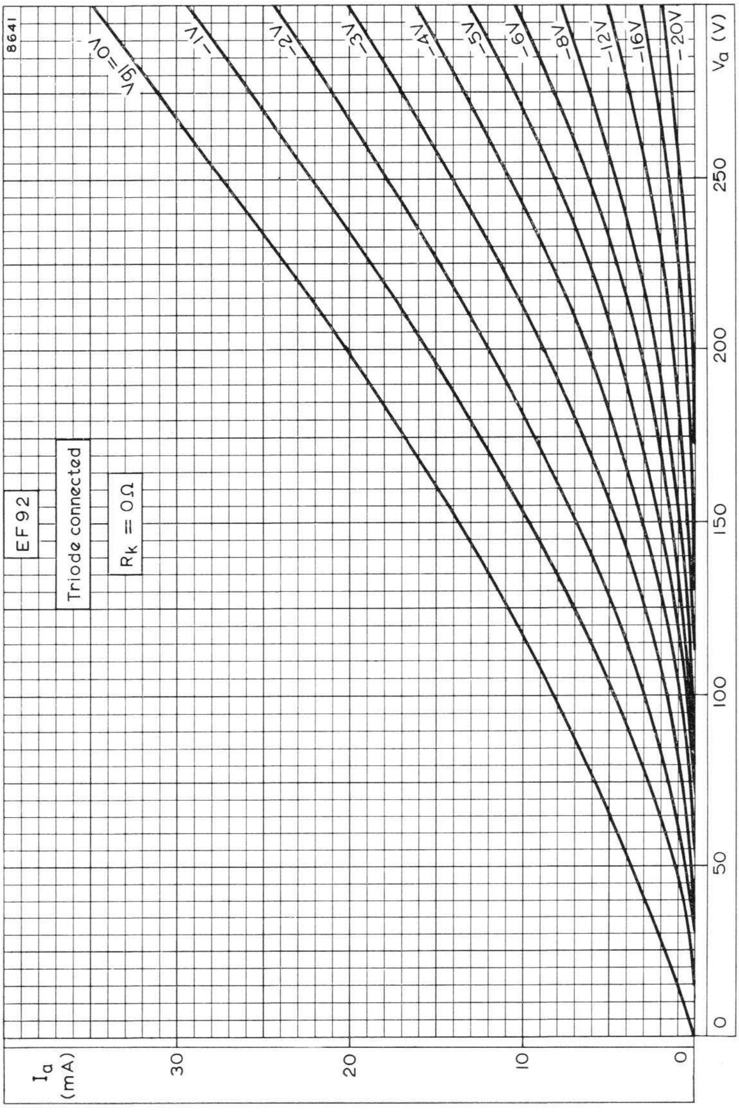
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_{g2} = 250V$



ANODE CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_a = 250V$



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_a = 250V$



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER,
WHEN TRIODE CONNECTED

V.H.F. PENTODE

EF95

Low noise, high slope pentode primarily intended for use as an r.f. and i.f. amplifier.

HEATER

V_h	6.3	V
I_h	175	mA

CAPACITANCES

	Unshielded	Shielded	
Pentode connection			
c_{in}	4.0	4.0	pF
c_{out}	2.2	3.1	pF
c_{a-g1}	23	$<$ 20	mpF
c_{h-k}	2	2	pF
Triode connection			
c_{in}	2.7	2.8	pF
c_{out}	4.2	5.1	pF
c_{a-g}	1.4	1.4	pF

CHARACTERISTICS

Pentode connection

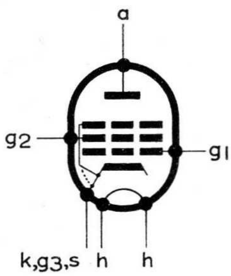
V_a	120	180	V
V_{g2}	120	120	V
I_a	7.5	7.7	mA
I_{g2}	2.5	2.4	mA
V_{g1}	−2.0	−2.0	V
g_m	5.0	5.1	mA/V
r_a	250	400	kΩ
μ_{g1-g2}	35	35	
R_{eq}	2	2	kΩ
r_{g1} (f = 50Mc/s)	25	25	kΩ

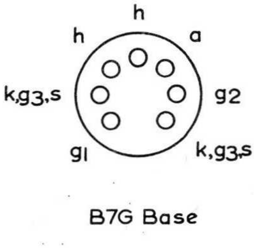
Triode connection

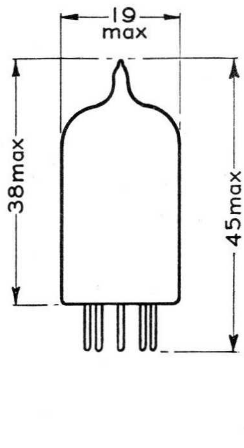
V_a	120	V
I_a	10	mA
V_g	−2	V
g_m	6.8	mA/V
r_a	5.2	kΩ
μ	35	
R_{eq}	900	Ω

DESIGN CENTRE RATINGS

$V_{a(b)}$ max.	300	V
V_a max.	180	V
p_a max.	1.7	W
$V_{g2(b)}$ max.	300	V
V_{g2} max.	140	V
p_{g2} max.	500	mW
$-V_{g1}$ max.	50	V
R_{g1-k} max.	3.0	MΩ ←
I_k max.	18	mA
V_{h-k} max.	120	V
T_{bulb} max.	170	°C

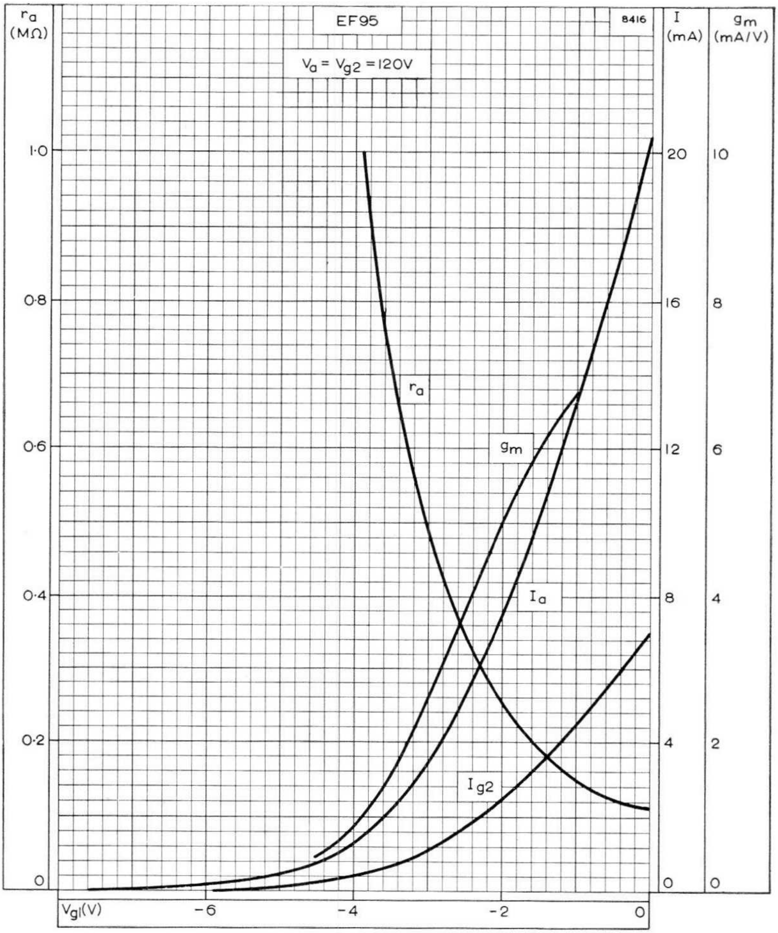




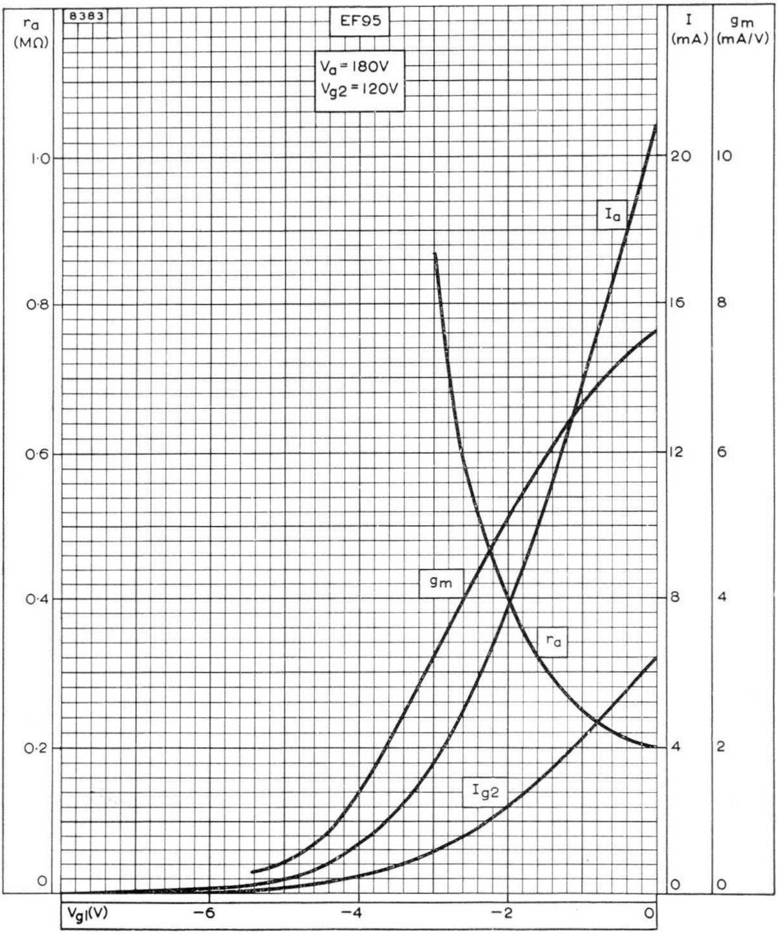


4748

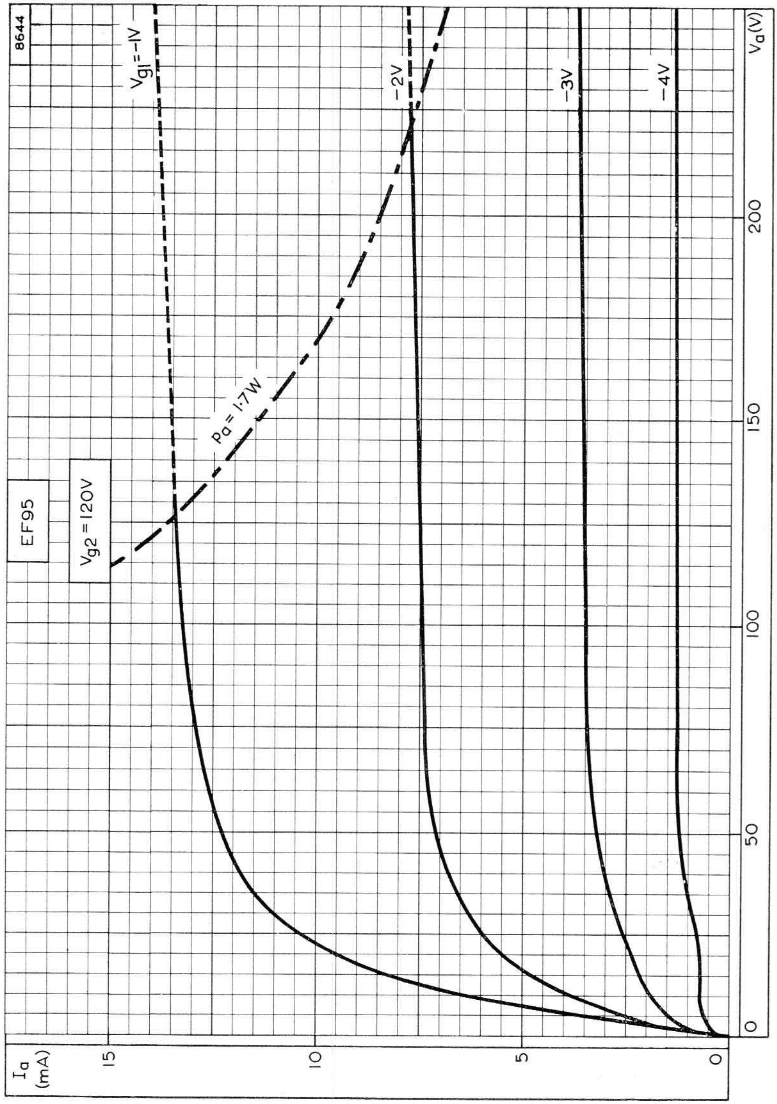
All dimensions in mm



ANODE CURRENT, SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 120V$



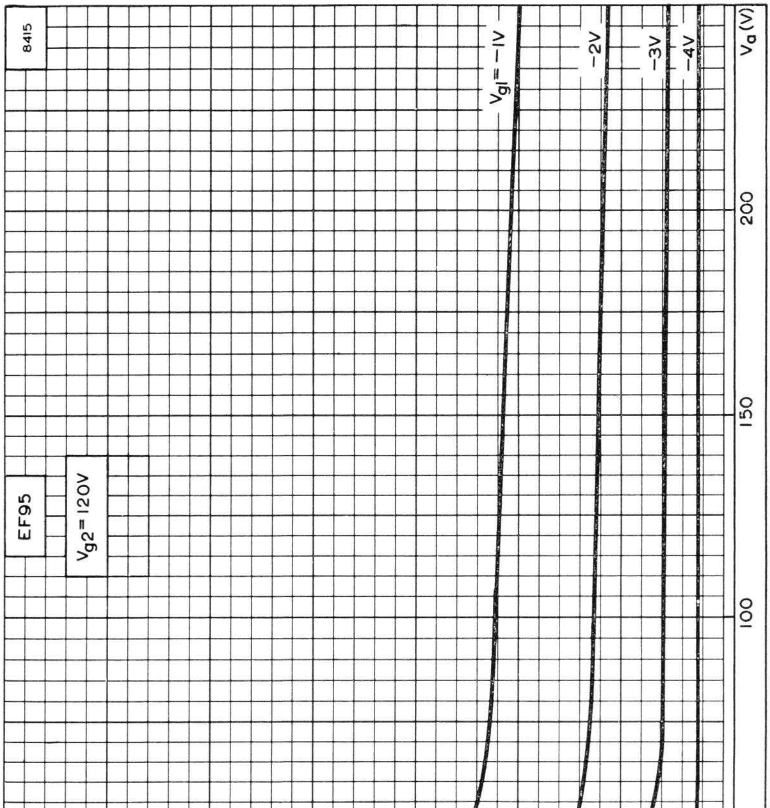
ANODE CURRENT, SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
Va = 180V



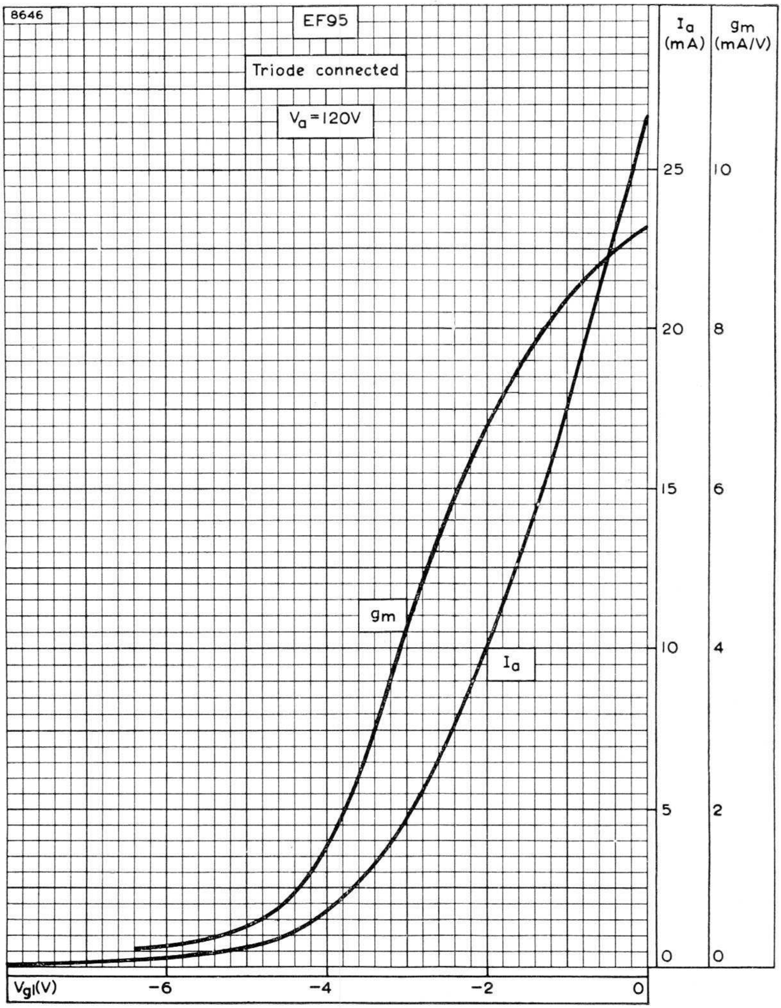
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER

EF95

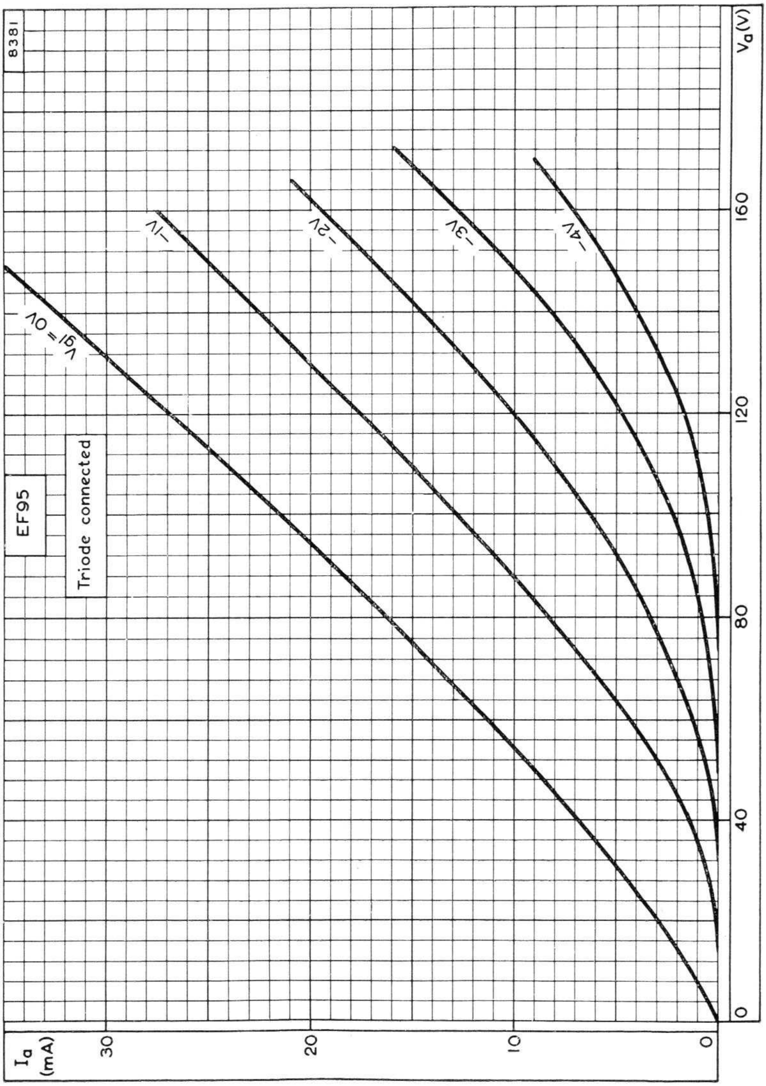
V.H.F. PENTODE



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER,
WHEN TRIODE CONNECTED

VARIABLE-MU R.F. PENTODE

EF183

Frame-grid variable-mu r.f. pentode for use as an automatic gain controlled i.f. amplifier in television receivers.

HEATER

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

V_h	6.3	V
I_h	300	mA

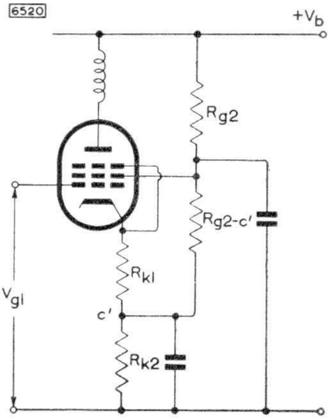
CAPACITANCES

c_{in}	9.5	pF
c_{out}	3.0	pF
c_{a-g1}	5.5	mpF←
c_{g1-g2}	2.8	pF

CHARACTERISTICS

V_a	170	200	230	V
V_{g2}	90	90	90	V
V_{g3}	0	0	0	V
I_a	14	12	10.5	mA
I_{g2}	5.3	4.5	3.6	mA
V_{g1}	−1.8	−2.0	−2.1	V
g_m	14	12.5	10.6	mA/V
r_a	350	500	650	kΩ
r_{g1} (f = 40Mc/s)	11.6	13	15.3	kΩ
R_{eq} (f = 40Mc/s)	—	490	—	Ω←

OPERATING CONDITIONS

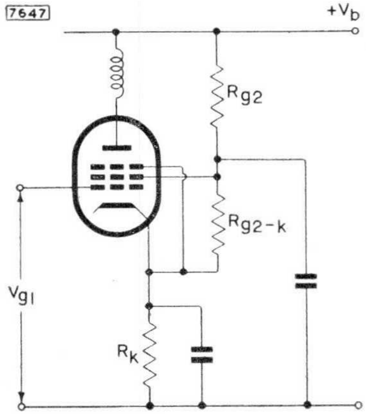


With compensating resistor R_{k1} (e.g. vision i.f. amplifier)

Condition	*1*	*2*	*3*	*4*	
*V_b	190	190	190	190	V
R_{g2}	22	6.8	8.2	10	kΩ
$R_{g2-c'}$	—	8.2	12	18	kΩ
R_{k1}	22	22	22	22	Ω
R_{k2}	100	56	68	82	Ω
R_{g1}	—	—	—	—	kΩ
I_a	11.6	11.8	11.7	11.4	mA
I_{g2}	4.3	4.4	4.4	4.3	mA
g_m	12.3	12.4	12.2	12	mA/V
V_{g1} for 100 : 1 reduction in g_m	–18.5	–9.0	–10	–11	V
I_{total}	16	27	24	21	mA

Condition	*5*	*6*	*7*	*8*	
*V_b	190	190	190	190	V
R_{g2}	12	15	18	33	kΩ
$R_{g2-c'}$	27	47	82	—	kΩ
R_{k1}	22	22	22	22	Ω
R_{k2}	82	82	82	0	Ω
R_{g1}	—	—	—	470	kΩ
I_a	11.8	11.9	12	11.6	mA
I_{g2}	4.4	4.5	4.5	4.4	mA
g_m	12.3	12.5	12.5	15.5	mA/V
V_{g1} for 100 : 1 reduction in g_m	–12	–13.5	–14.5	–17	V
I_{total}	19.7	18.5	14.7	16	mA

*For other values of V_b up to 210V, the above conditions can be used providing the values of R_{g2} are changed to keep V_{g2} at approx. 90V.



Without compensating resistor (e.g. sound i.f. amplifier)

Condition	1	2	3	4	
*V_b	190	190	190	190	V
R_{g2}	22	6.8	8.2	10	kΩ
R_{g2-k}	—	8.2	12	18	kΩ
R_k	120	68	82	100	Ω
I_a	11.7	12	11.8	11.4	mA
I_{g2}	4.3	4.5	4.4	4.3	mA
g_m	12.4	13	12.3	12	mA/V
V_{g1} for 10 : 1 reduction in g_m	–5.0	–3.0	–3.25	–3.5	V
V_{g1} for 100 : 1 reduction in g_m	–18.5	–9.0	–10	–11	V
I_{total}	16	27	24	21	mA

Condition	5	6	7	
*V_b	190	190	190	V
R_{g2}	12	15	18	kΩ
R_{g2-k}	27	47	82	kΩ
R_k	100	100	100	Ω
I_a	11.8	12	12	mA
I_{g2}	4.4	4.5	4.5	mA
g_m	12.4	12.5	12.5	mA/V
V_{g1} for 10 : 1 reduction in g_m	–4.0	–4.4	–4.6	V
V_{g1} for 100 : 1 reduction in g_m	–12	–13.5	–14.5	V
I_{total}	19.7	18.5	17.5	mA

*For other values of V_b up to 210V, the above conditions can be used providing the values of R_{g2} are changed to keep V_{g2} at approx. 90V.

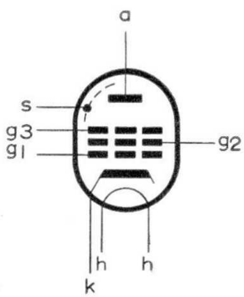
EF183

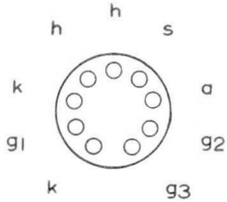
VARIABLE-MU R.F. PENTODE

DESIGN CENTRE RATINGS

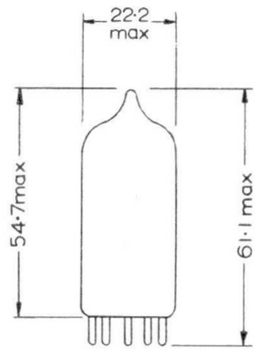
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	650	mW
$-v_{g1(pk)}$ max.	50	V
I_k max.	20	mA
R_{g1-k} max.	1.0	MΩ
R_{g3-k} max.	50	kΩ
V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ
T_{bulb} max.	180	°C

6688

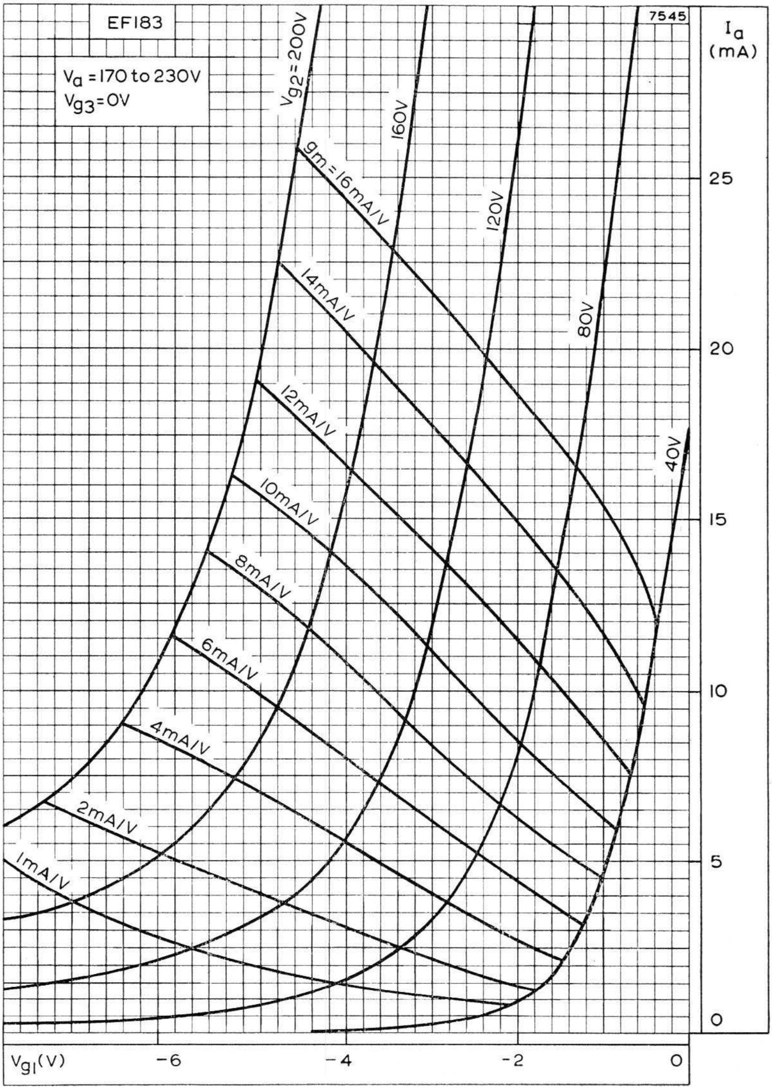




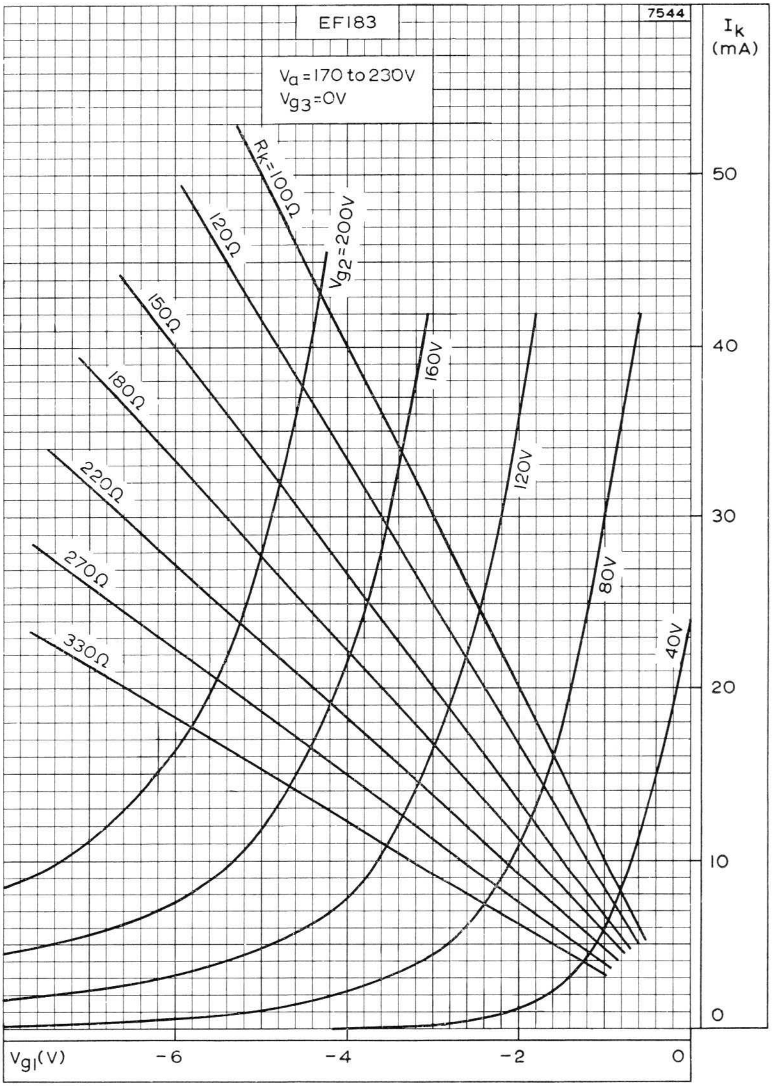
B9A Base



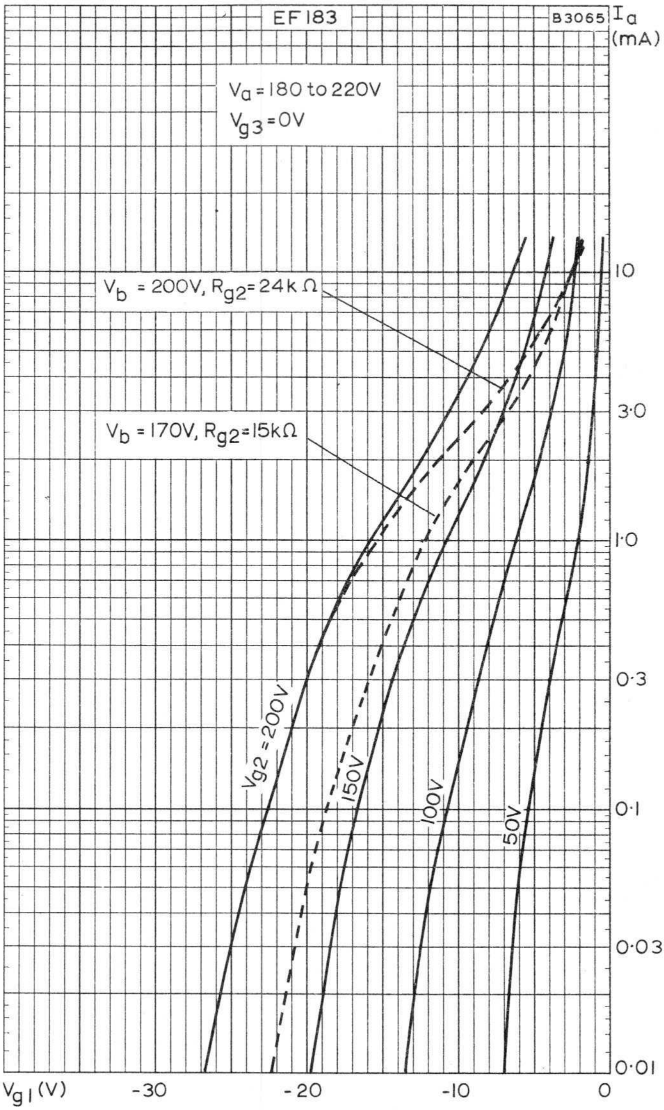
All dimensions in mm



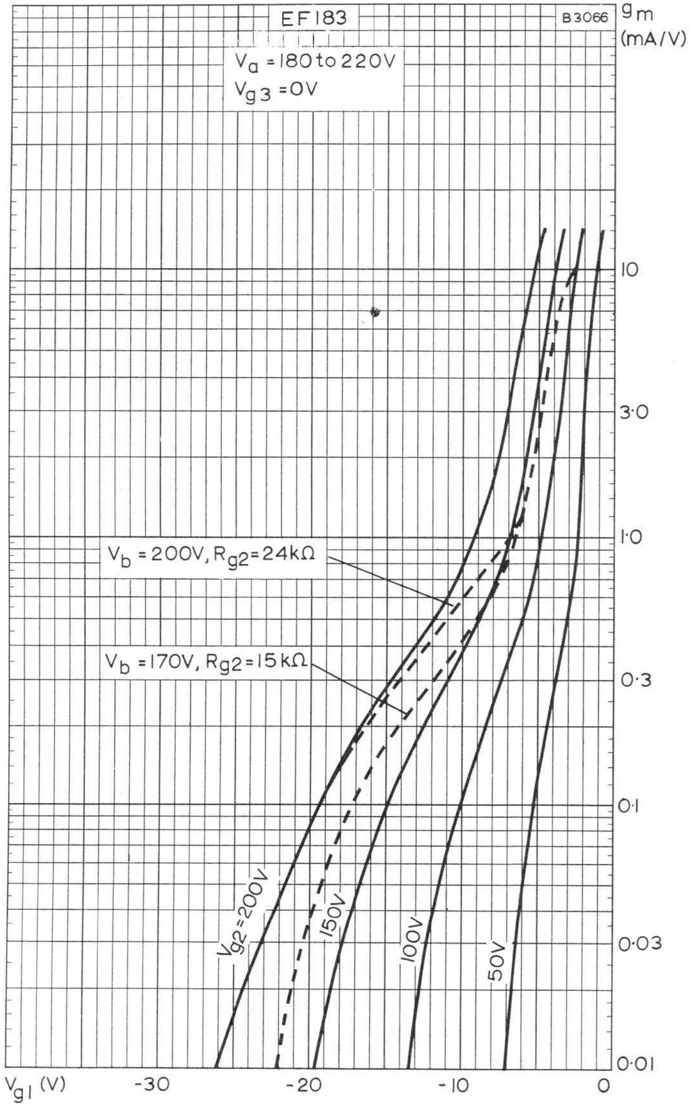
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER AND WITH MUTUAL CONDUCTANCE CONTOURS



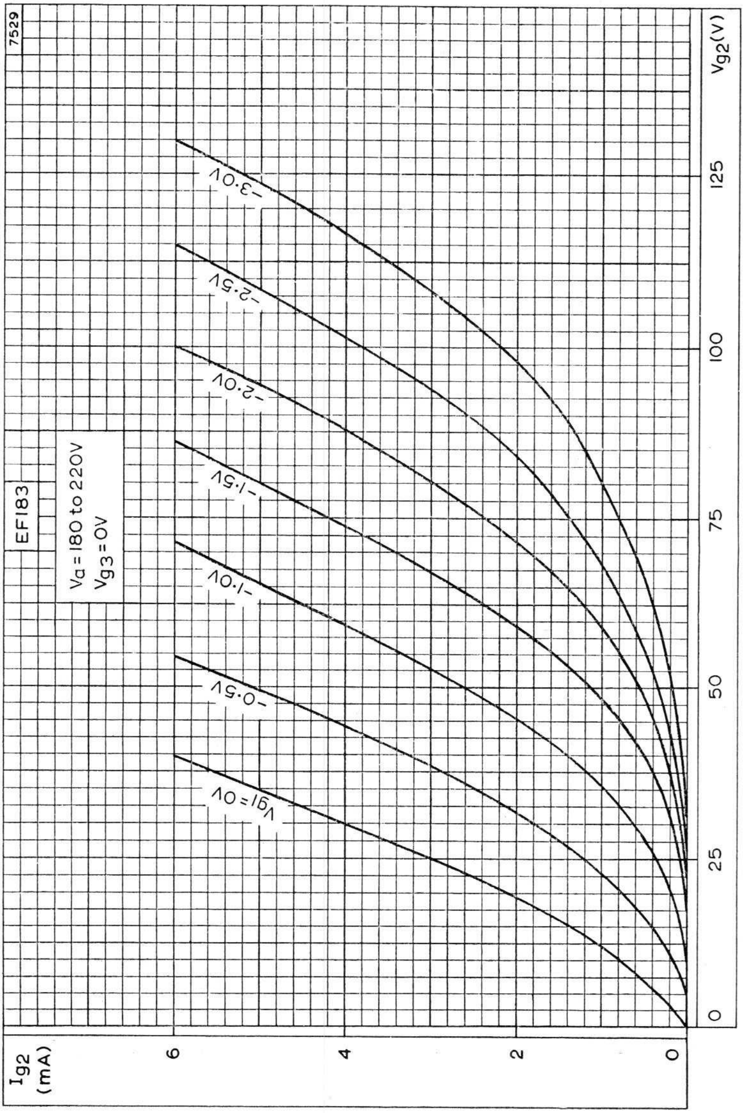
CATHODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



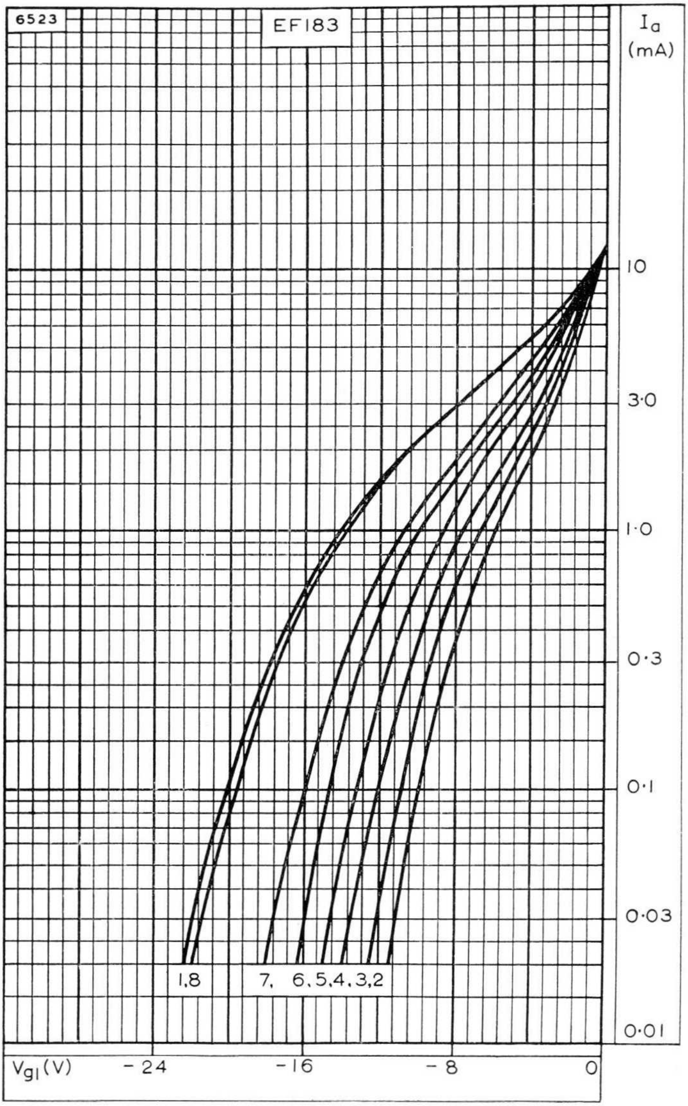
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



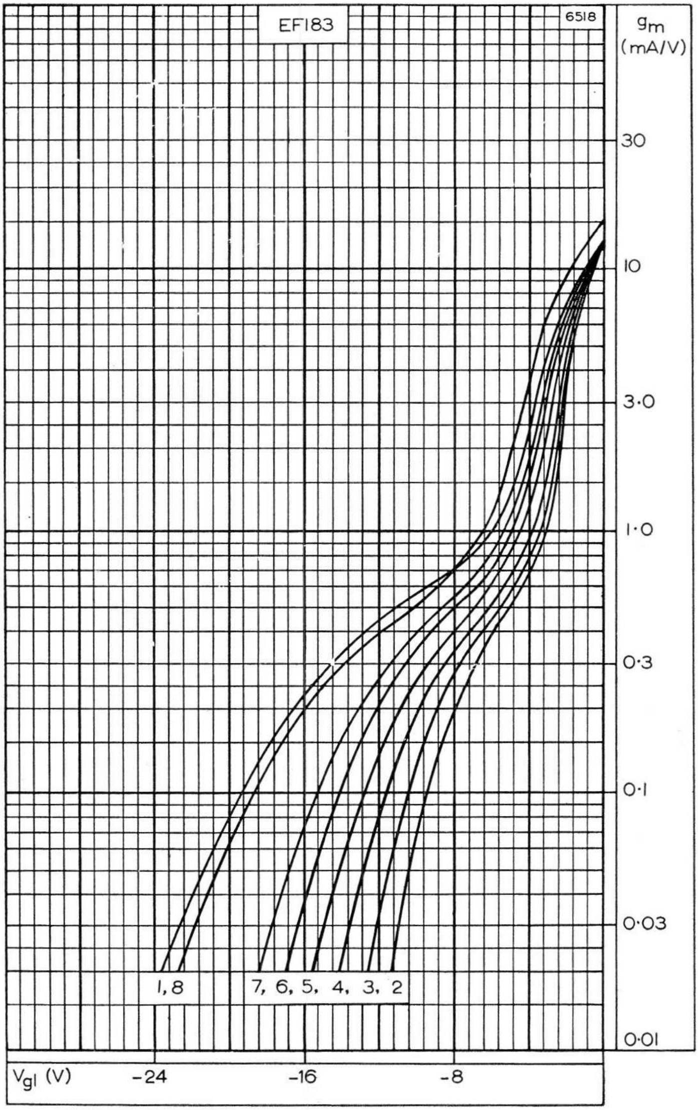
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

EF183

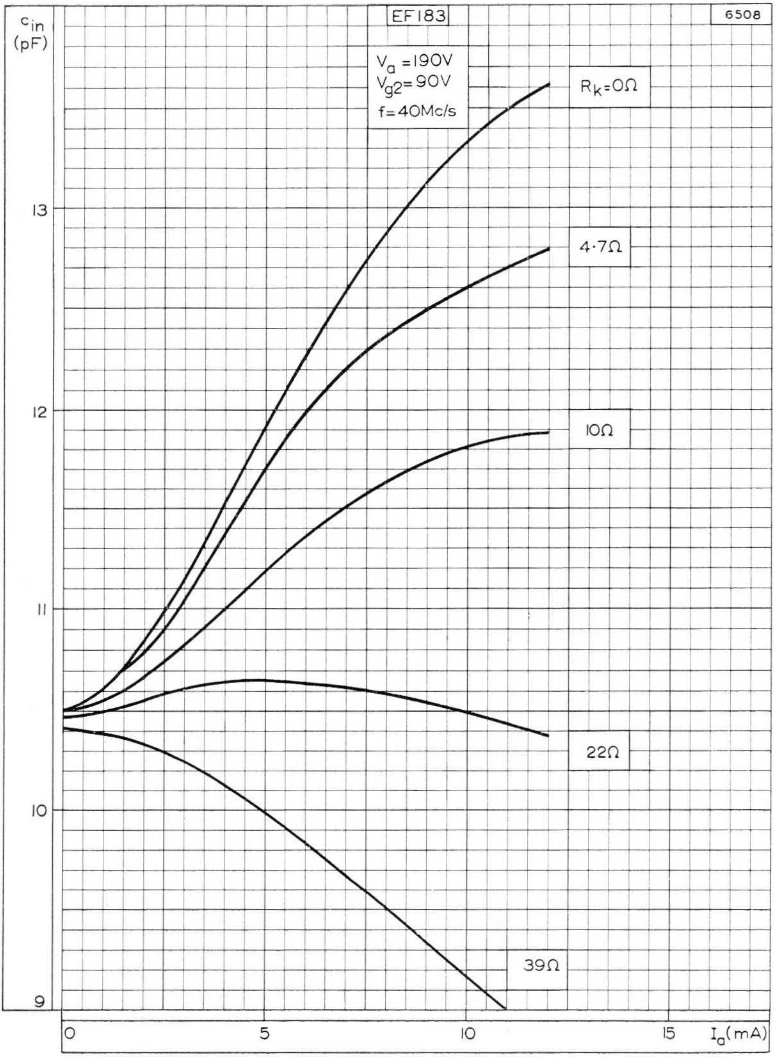
VARIABLE-MU R.F. PENTODE



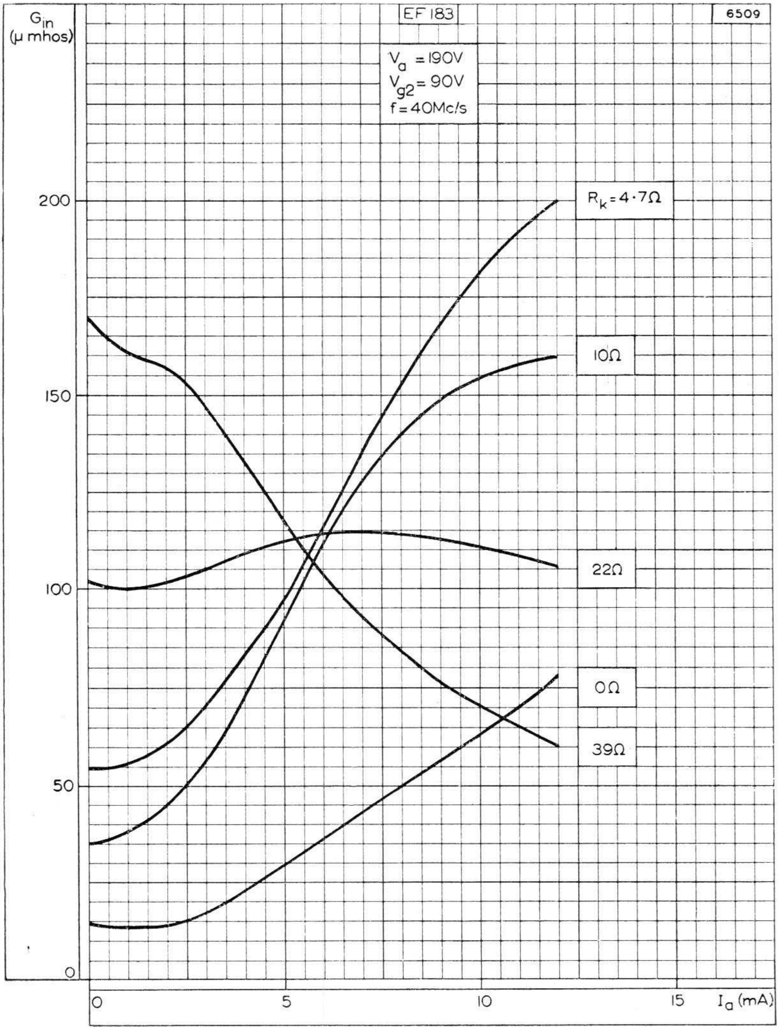
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE.
Curve numbers refer to operating conditions on pages D2, D3



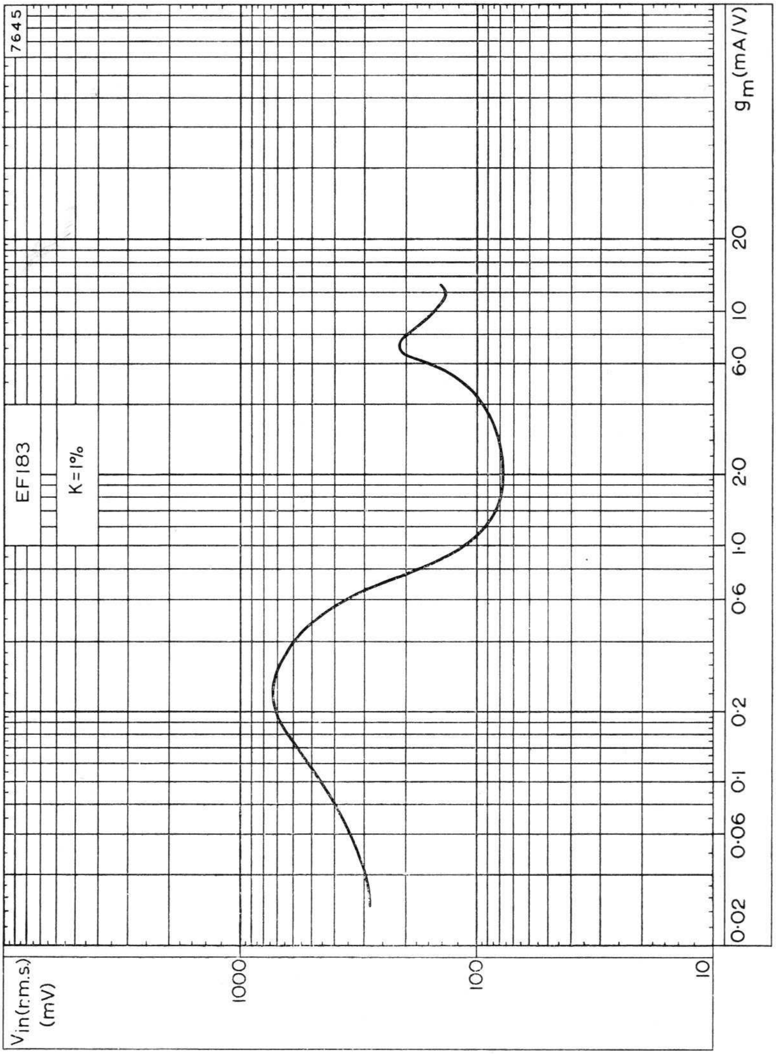
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
Curve numbers refer to operating conditions on pages D2, D3



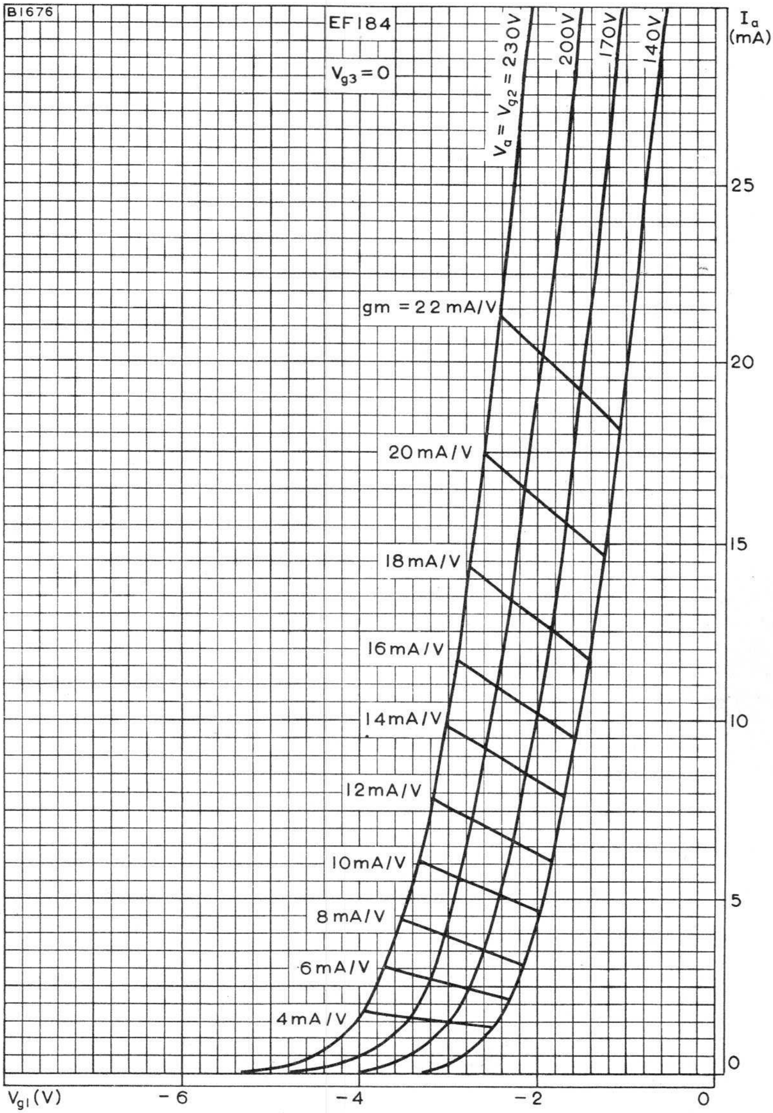
INPUT CAPACITANCE PLOTTED AGAINST ANODE CURRENT FOR VARIOUS VALUES OF CATHODE RESISTOR



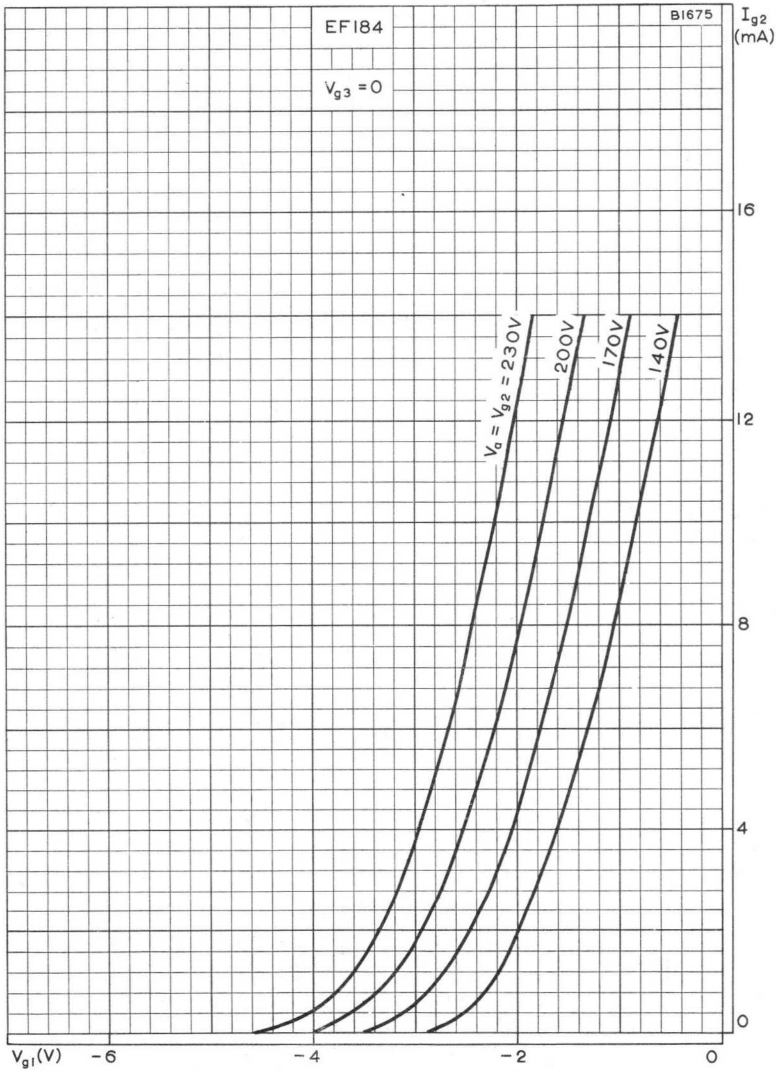
INPUT CONDUCTANCE PLOTTED AGAINST ANODE CURRENT FOR VARIOUS VALUES OF CATHODE RESISTOR



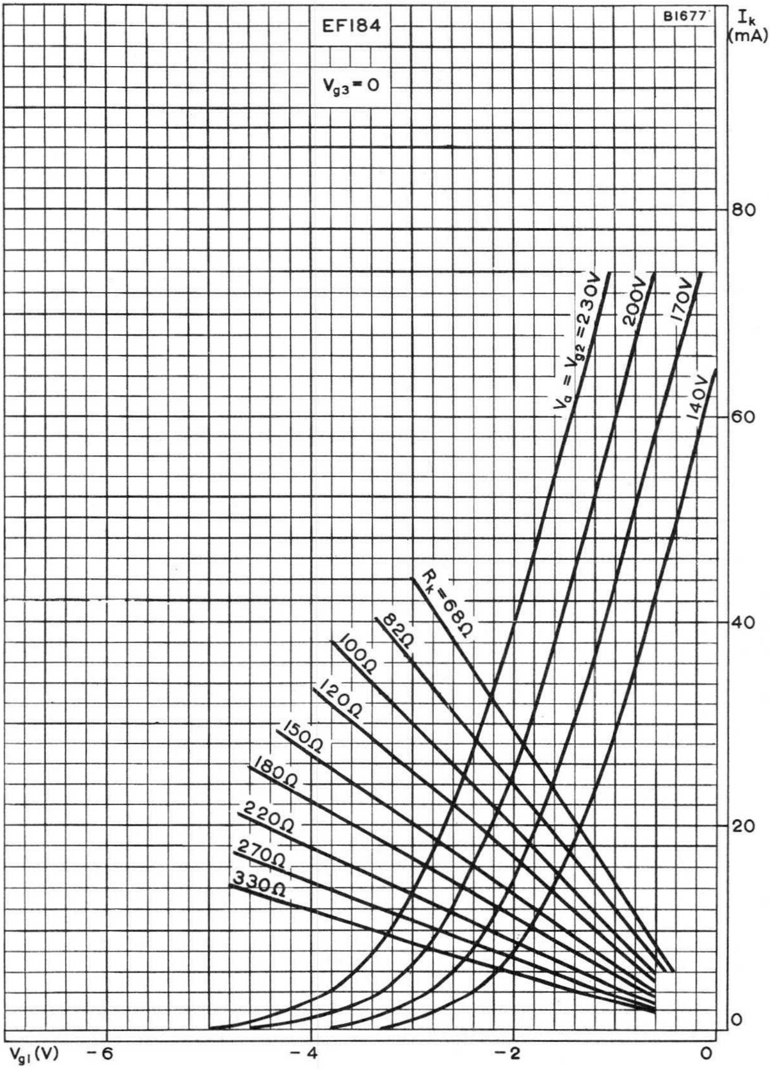
CROSS-MODULATION CURVE



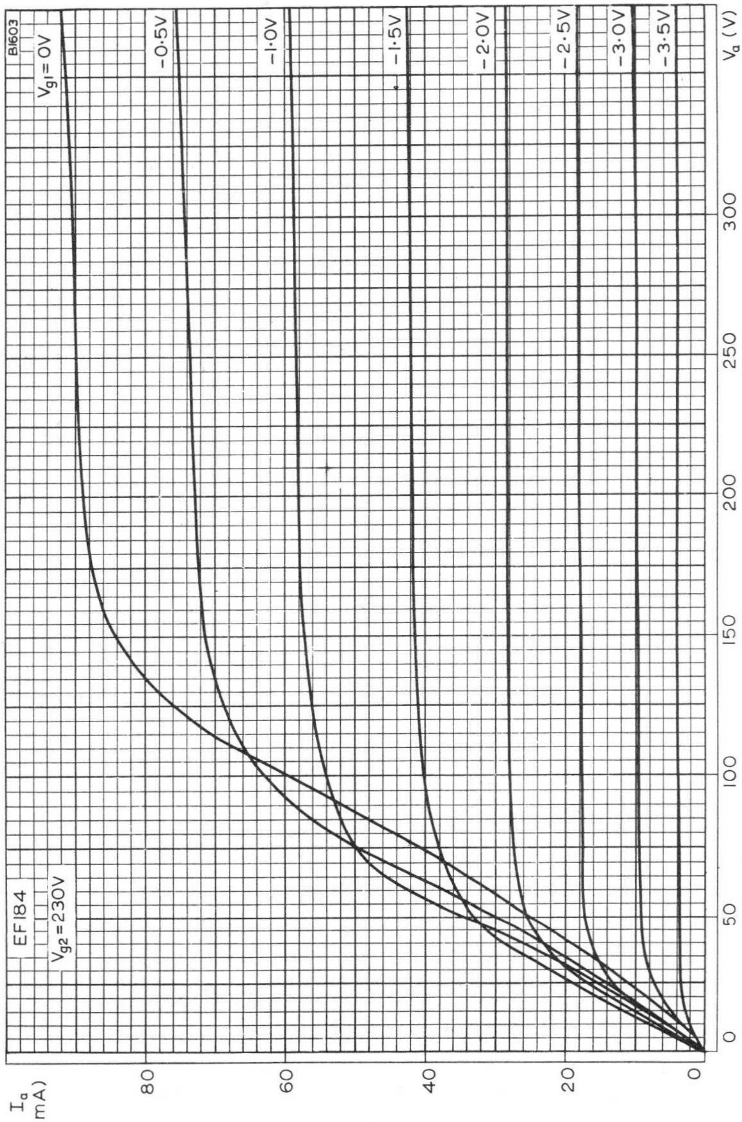
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER AND WITH MUTUAL CONDUCTANCE CONTOURS



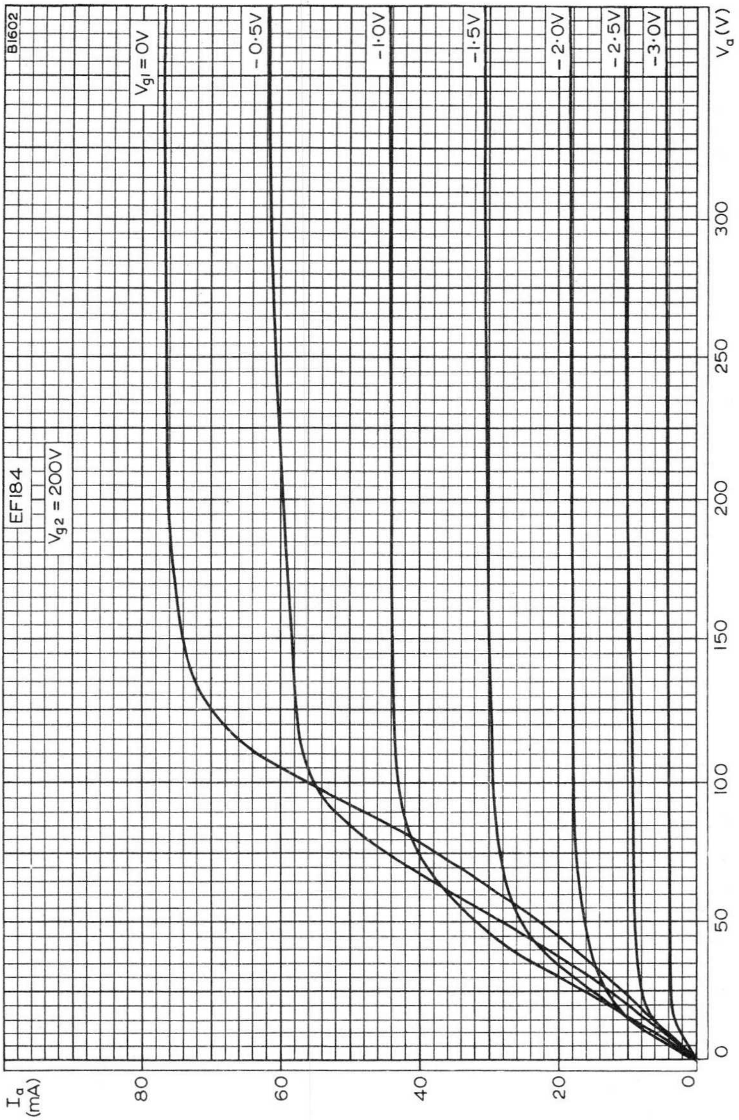
SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



CATHODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



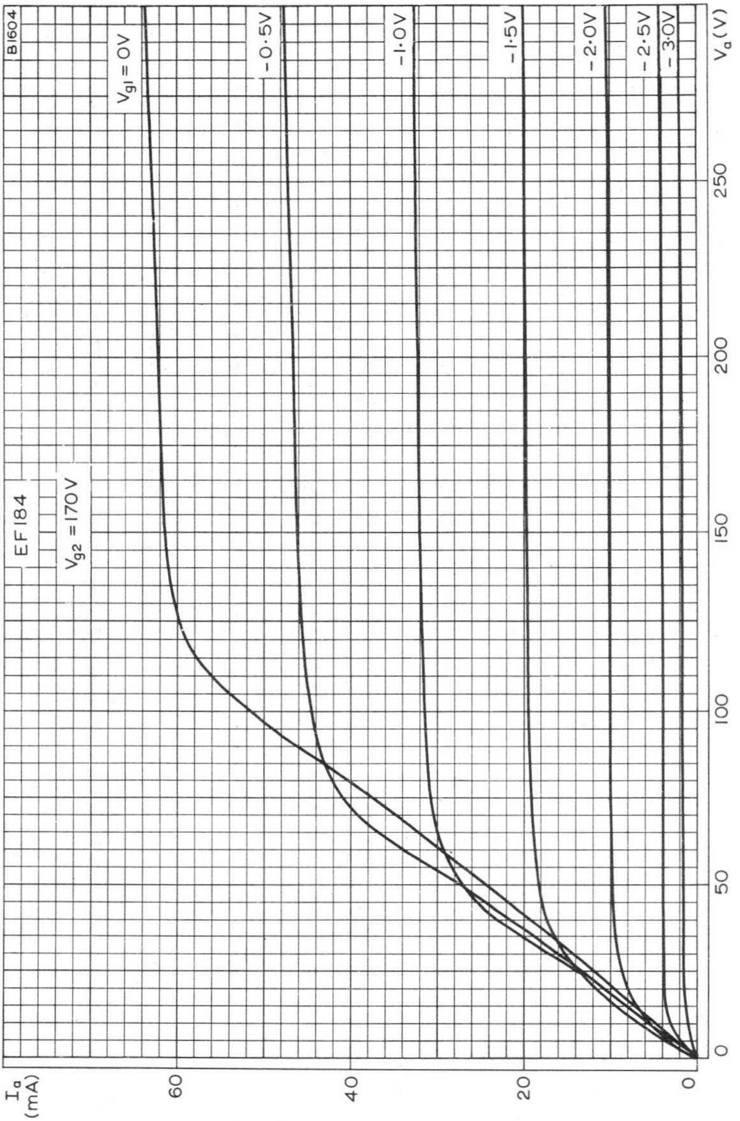
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 230V$



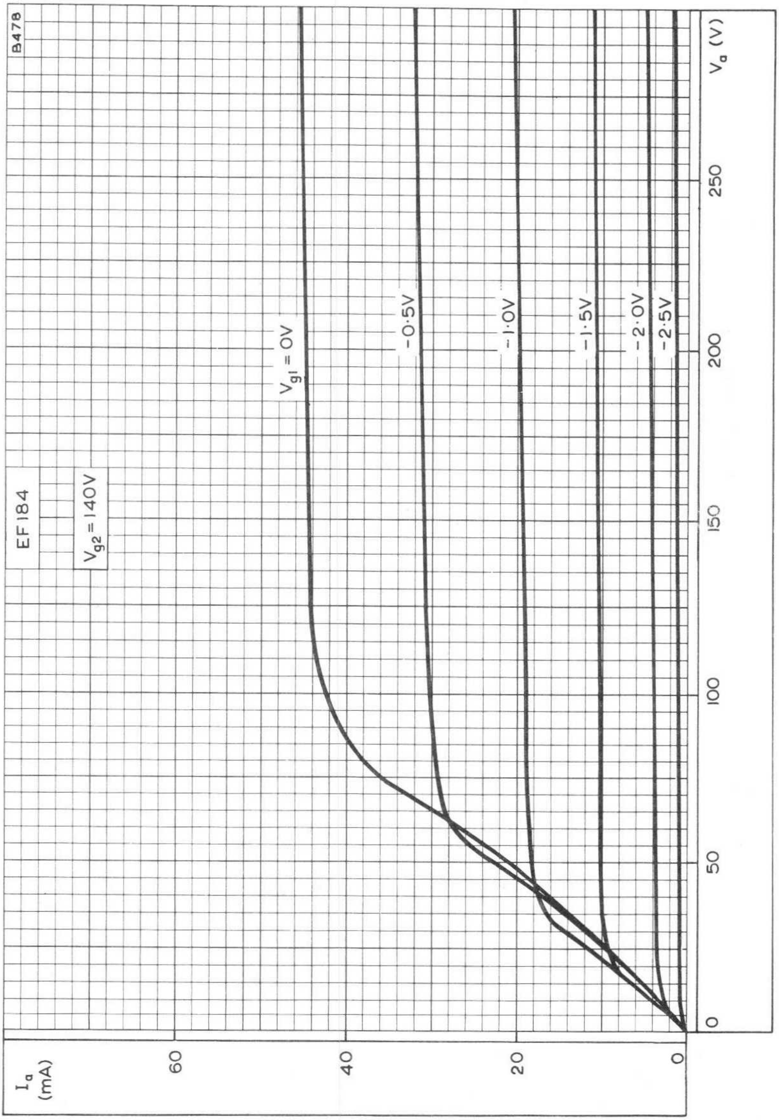
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

EF184

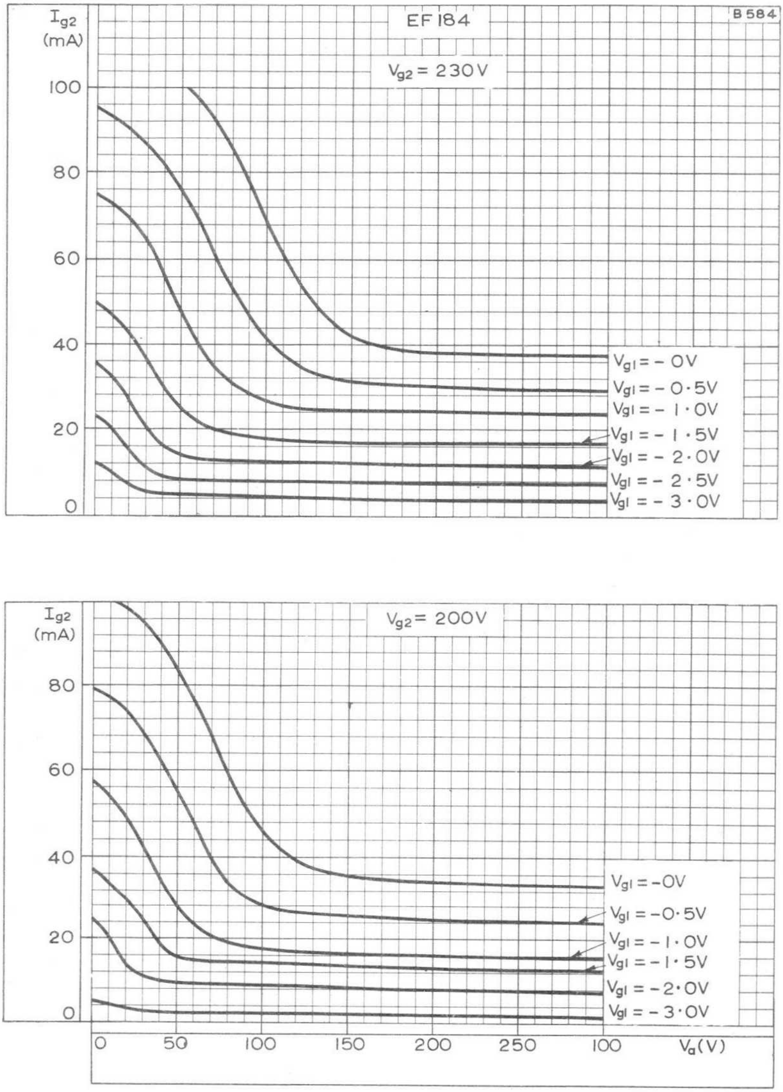
R.F. PENTODE



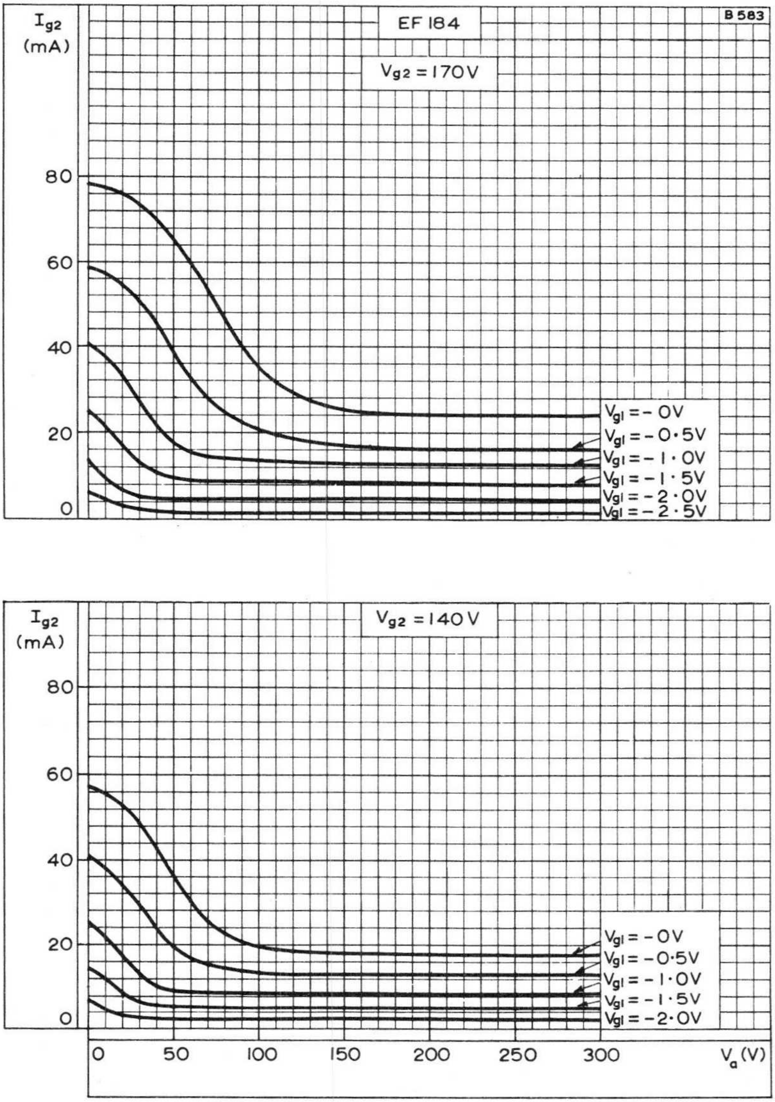
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 170V$



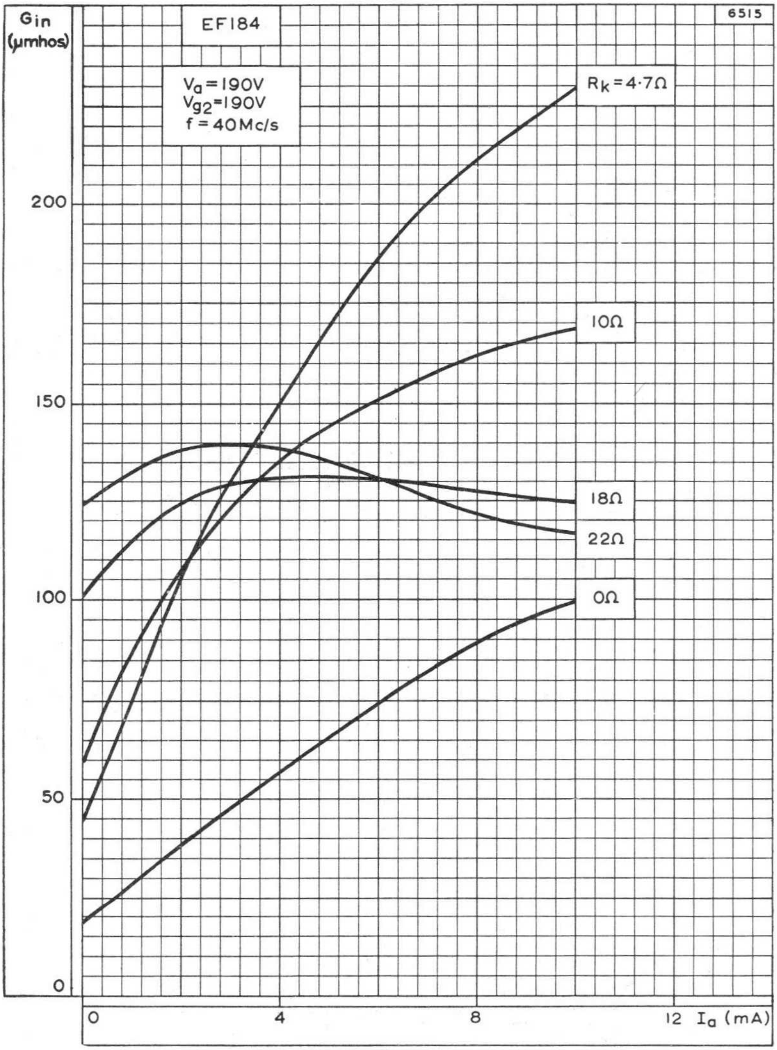
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 140V$



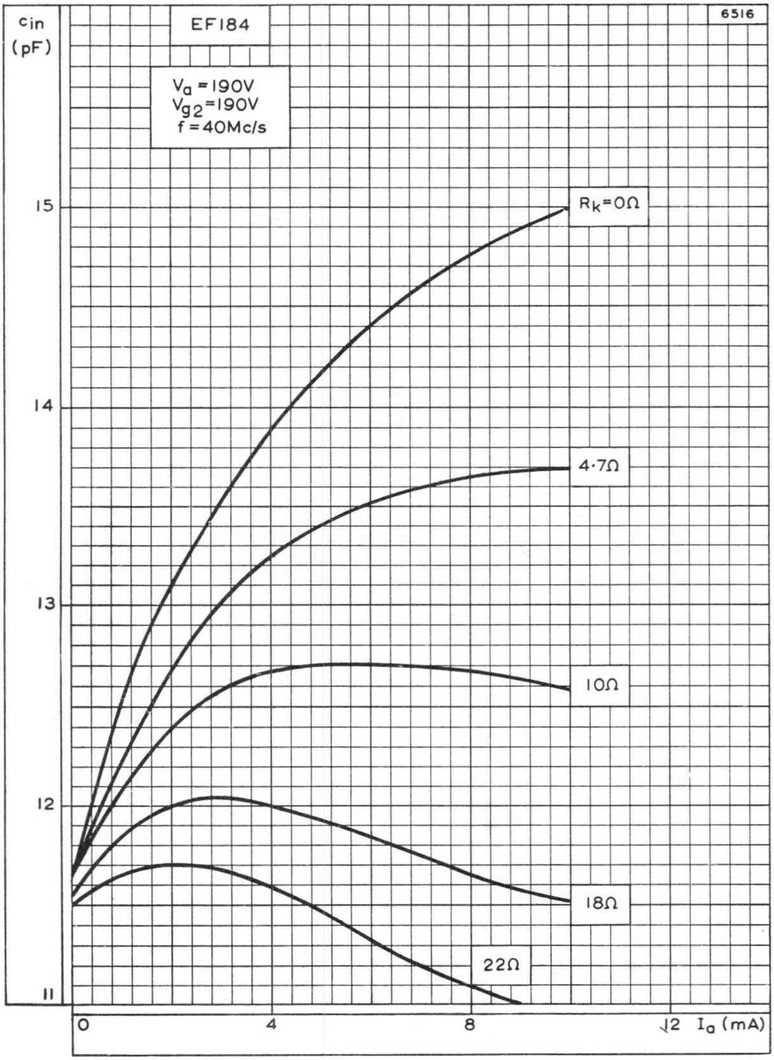
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



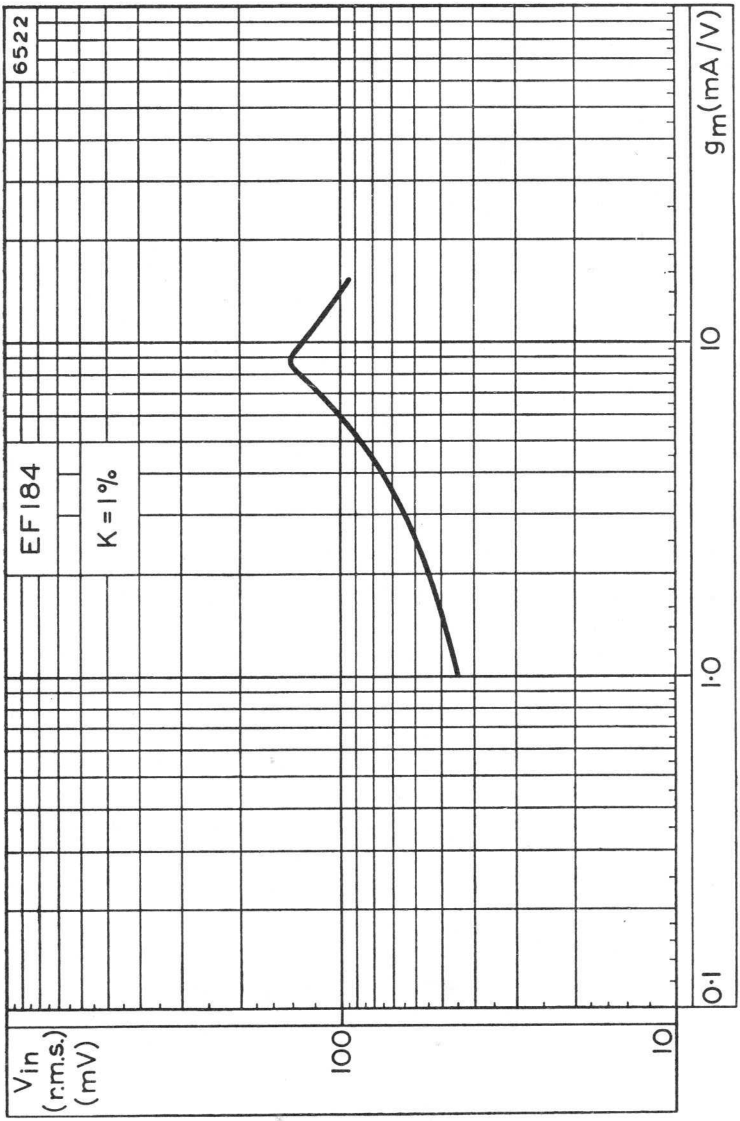
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



INPUT CONDUCTANCE PLOTTED AGAINST ANODE CURRENT WITH VARIOUS VALUES OF CATHODE RESISTOR



INPUT CAPACITANCE PLOTTED AGAINST ANODE CURRENT WITH VARIOUS VALUES OF CATHODE RESISTOR



CROSS-MODULATION CURVE

DUAL-CONTROL HEPTODE

EH90

Dual-control heptode for use in television receivers.

HEATER

V_h	6.3	V
I_h	300	mA

CAPACITANCES

c_{a-g1}	<70	mpF
c_{a-g3}	<360	mpF
$c_{in(g1)}$	5.5	pF
$c_{in(g3)}$	7.0	pF
c_{out}	7.5	pF
c_{g1-g3}	<220	mpF

CHARACTERISTICS

V_a	10	100	100	V
V_{g2+g4}	30	30	30	V
V_{g1}	0	0	−1.0	V
V_{g3}	0	−1.0	0	V
I_a	2.0	0.8	0.75	mA
I_{g2+g4}	3.5	4.0	1.1	mA
$g_{m(g1-a)}$	—	—	1.2	mA/V
$g_{m(g3-a)}$	—	1.55	—	mA/V
r_a	—	400	900	kΩ
V_{g1} ($I_a = 50\mu A$)	—	—	−2.5	V
V_{g3} ($I_a = 50\mu A$)	—	−2.2	—	V

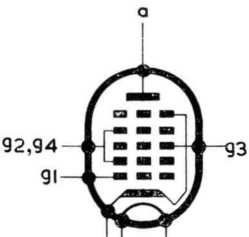
DESIGN CENTRE RATINGS

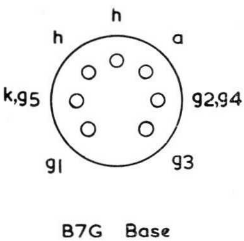
$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	1.0	W
$V_{g2+g4(b)}$ max.	300	V
V_{g2+g4} max.	100	V
p_{g2+g4} max.	1.0	W
I_k max.	14	mA
R_{g1-k} max.	470	kΩ
R_{g3-k} max.	2.2	MΩ
R_{g3-k} max. ($V_{g2+g4} \leq 30V$)	5.0	MΩ
V_{h-k} max. (cathode positive)	200	V
V_{h-k} max. (cathode negative)	100	V

EH90

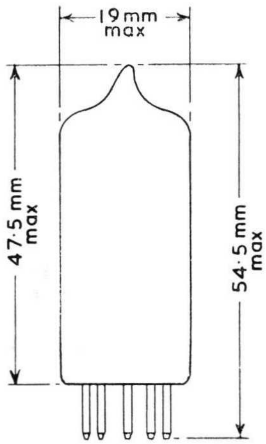
DUAL-CONTROL HEPTODE

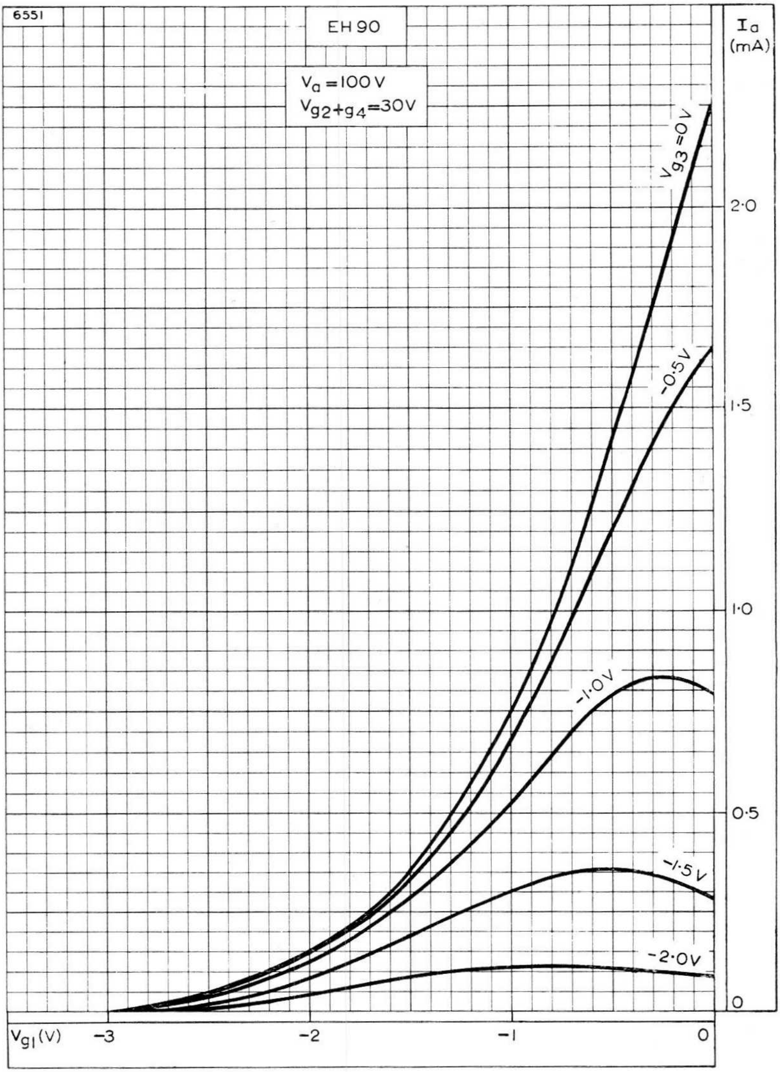
6642



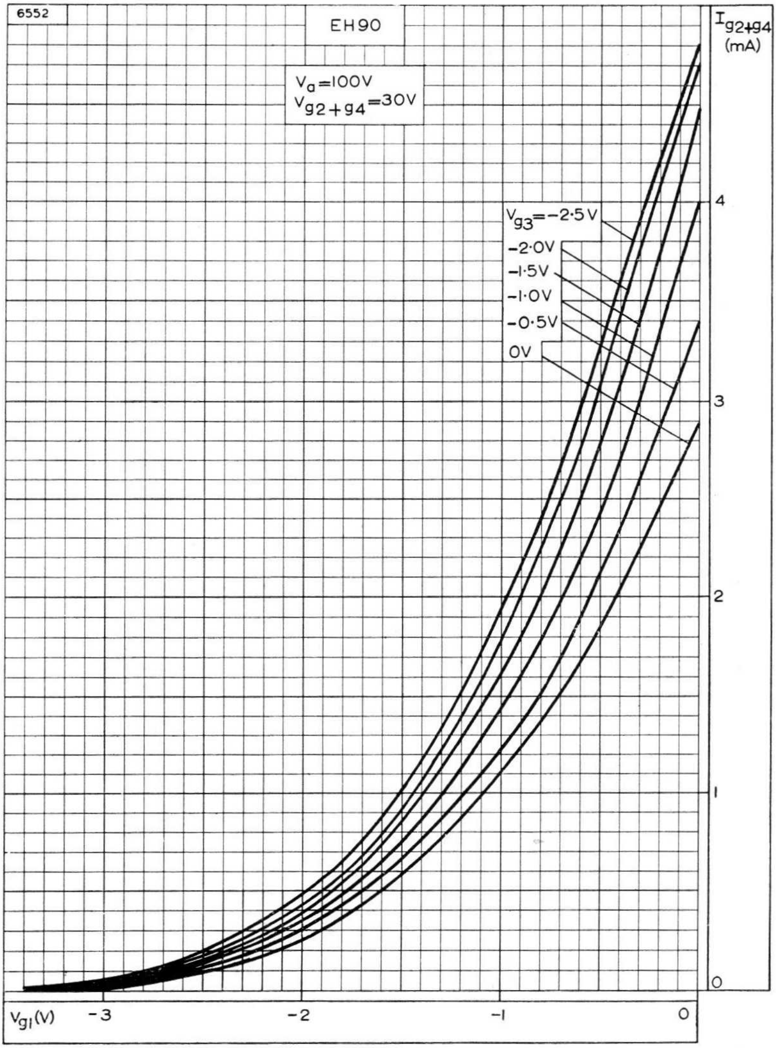


B7G Base

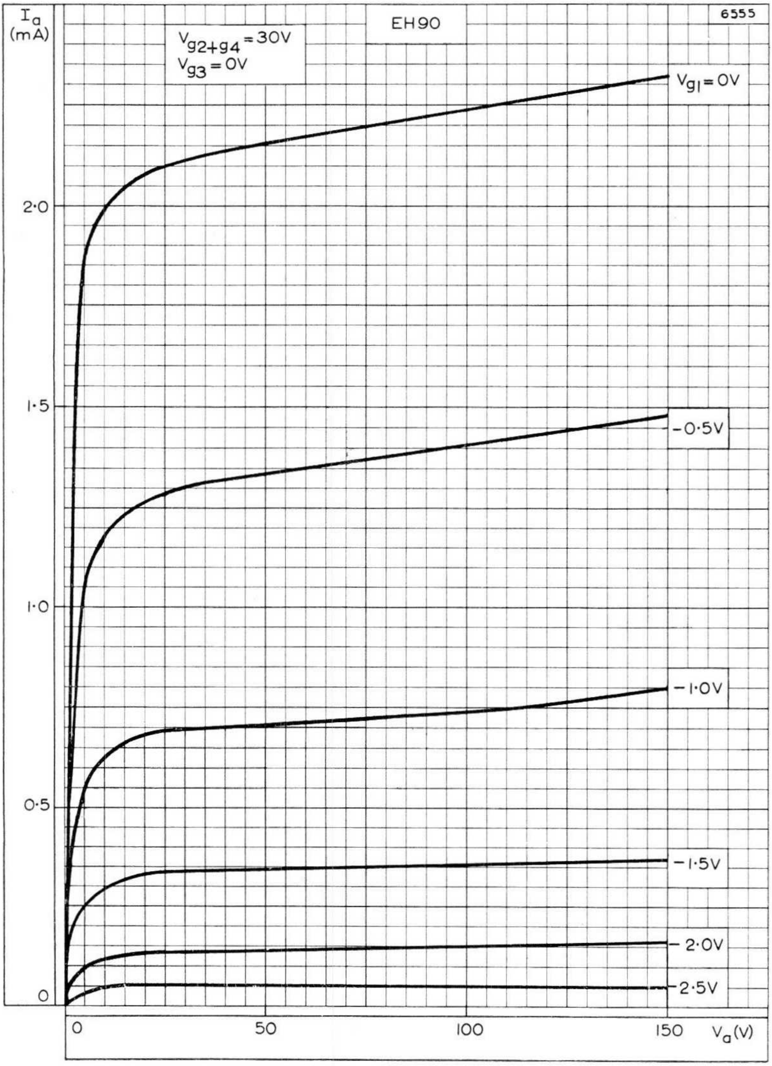




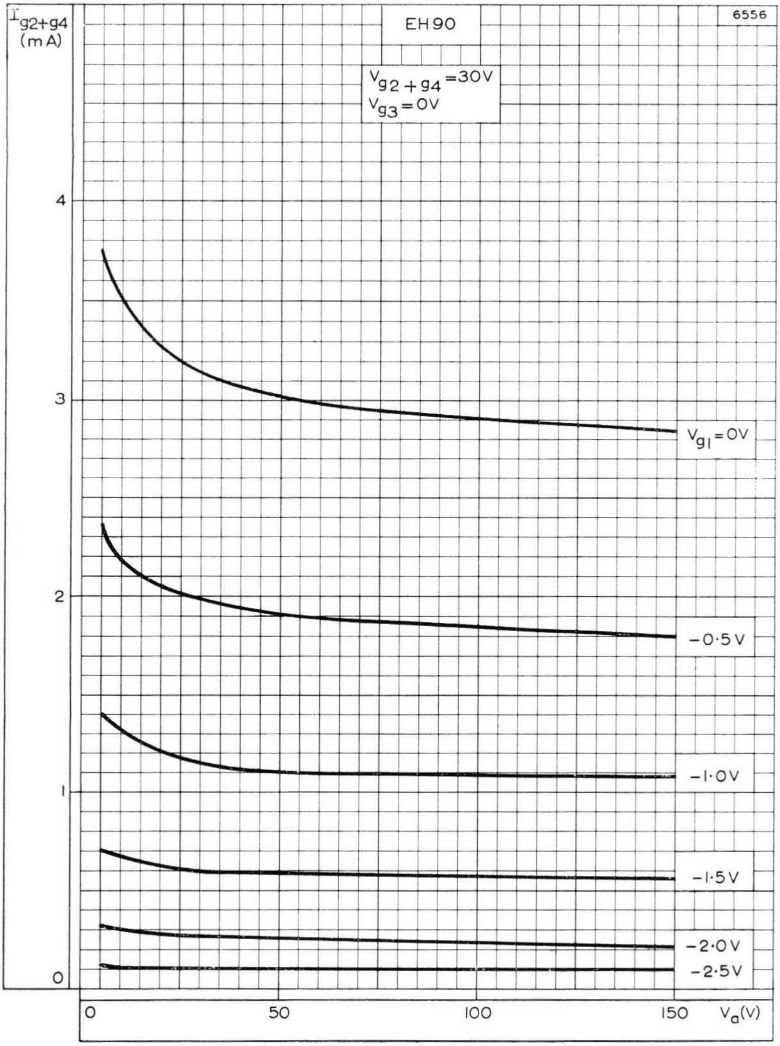
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID (g_1) VOLTAGE WITH CONTROL-GRID (g_3) VOLTAGE AS PARAMETER



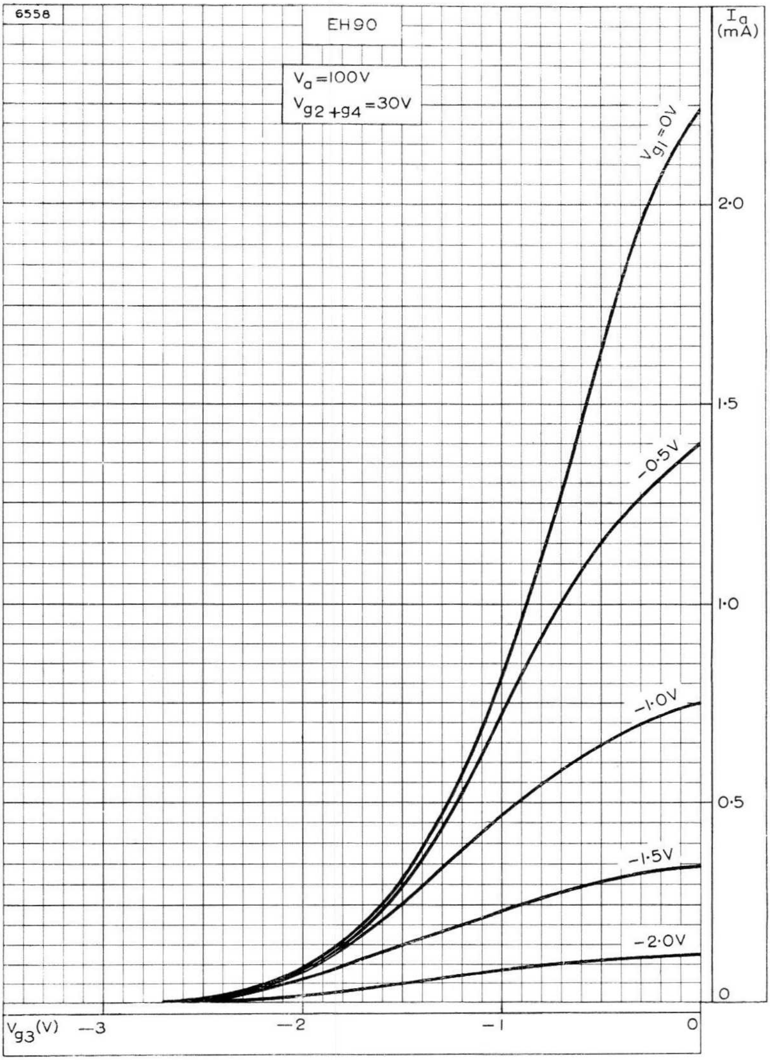
SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID (g_1) VOLTAGE WITH CONTROL-GRID (g_3) VOLTAGE AS PARAMETER



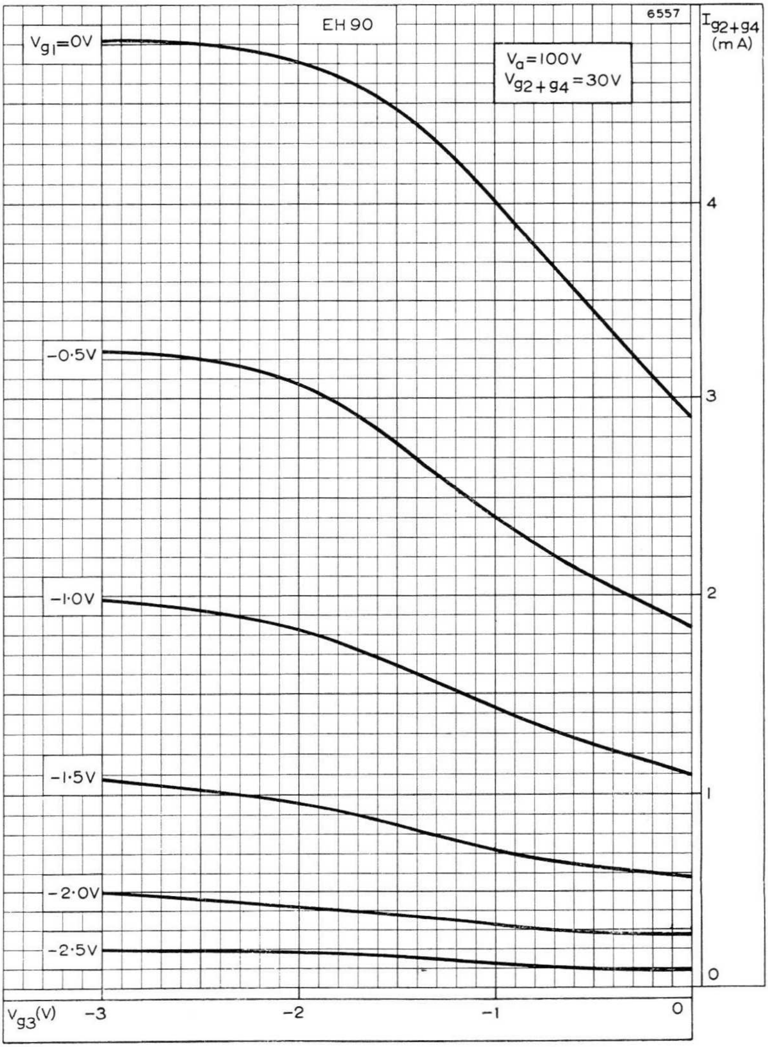
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID (g_1) VOLTAGE AS PARAMETER



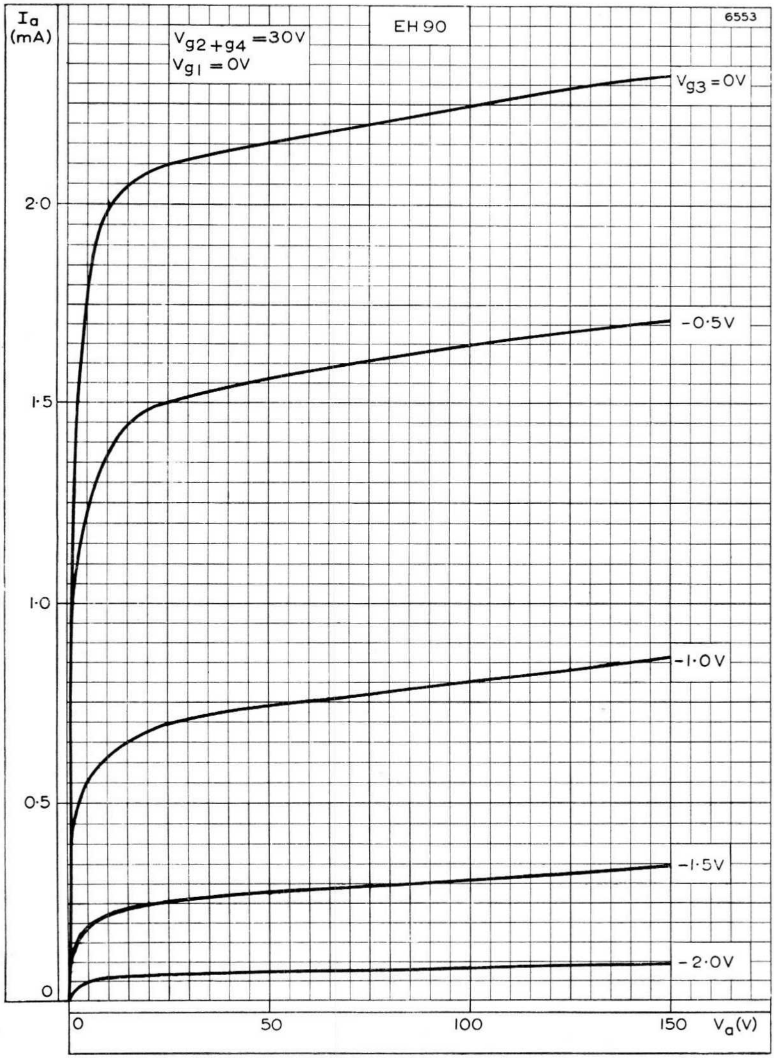
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID (g_1) VOLTAGE AS PARAMETER



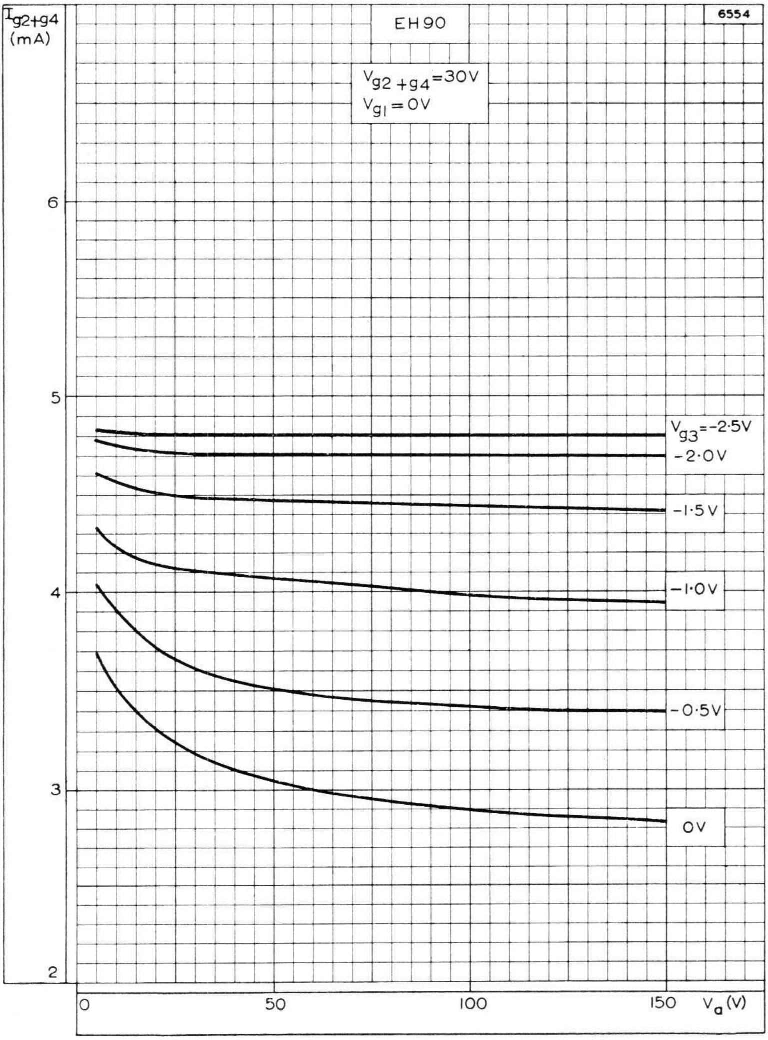
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID (g_3) VOLTAGE WITH CONTROL-GRID (g_1) VOLTAGE AS PARAMETER



SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID (g_3) VOLTAGE WITH CONTROL-GRID (g_1) VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID (g_3) VOLTAGE AS PARAMETER



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID (g_3) VOLTAGE AS PARAMETER

OUTPUT PENTODE

EL91

Output pentode rated for 4W anode dissipation suitable for use as an r.f. or a.f. amplifier.

HEATER

V_h	6.3	V
I_h	200	mA

CAPACITANCES

	Unshielded	*Shielded*	
c_{in}	3.7	3.8	pF
c_{out}	4.0	6.5	pF
c_{a-g1}	<300	<300	mpF

CHARACTERISTICS

Pentode connection

V_a	250	V
V_{g3}	0	V
V_{g2}	250	V
I_a	16	mA
I_{g2}	2.3	mA
V_{g1}	−13.5	V
g_m	2.5	mA/V
r_a	130	kΩ
μ_{g1-g2}	12	

Triode connection (g_2 connected to a)

V_a	250	V
I_a	18.3	mA
V_{g1}	−13.5	V
g_m	2.7	mA/V
r_a	4.3	kΩ
μ	12	

OPERATING CONDITIONS AS SINGLE VALVE AMPLIFIER

Pentode connection

V_{a-k}	250	V
$V_{g2(b)-k}$	250	V
R_{g2}	470	Ω
R_k	700	Ω
R_a	18	kΩ
$I_{a(o)}$	16	mA
$I_{g2(o)}$	2.3	mA
$V_{in(r.m.s.)}$ (P_{out} = 50mW)	820	mV
$V_{in(r.m.s.)}$	5.8	V
P_{out}	1.7	W
D_{tot}	10	%
$I_{g2(max.\ sig.)}$	6.3	mA

OPERATING CONDITIONS FOR 2 VALVES IN PUSH-PULL

Pentode connection

Cathode bias

V_{a-k}	250	V
V_{g2-k}	250	V
R_k (per valve)	820	Ω
R_{a-a}	15	kΩ
$I_{a(o)}$	2 × 14.5	mA
$I_{g2(o)}$	2 × 2.0	mA
$V_{in(g1-g1)r.m.s.}$ (P_{out} = 50mW)	1.8	V
$V_{in(g1-g1)r.m.s.}$	19.8	V
P_{out}	5.8	W
D_{tot}	2.5	%
$I_{a(max.\ sig.)}$	2 × 21.5	mA
$I_{g2(max.\ sig.)}$	2 × 5.0	mA

Fixed bias

V_{a-k}	250	V
V_{g2-k}	250	V
V_{g1}	−16	V
R_{a-a}	15	kΩ
$I_{a(o)}$	2 × 10	mA
$I_{g2(o)}$	2 × 1.4	mA
$V_{in(g1-g1)r.m.s.}$ (P_{out} = 50mW)	2.1	V
$V_{in(g1-g1)r.m.s.}$	21.5	V
P_{out}	5.6	W
D_{tot}	1.7	%
$I_{a(max.\ sig.)}$	2 × 19.5	mA
$I_{g2(max.\ sig.)}$	2 × 4.7	mA

P_{out} and D_{tot} are measured at fixed bias and therefore represent the power output available during the reproduction of speech and music. When a sustained sine wave is applied to the control grid, the bias across the cathode resistor will re-adjust itself as a result of the increased anode and screen-grid currents. This will result in approximately 10% reduction in power output.

OPERATING CONDITIONS AS R.F. AMPLIFIER

f	50	100	Mc/s
V_a	250	250	V
$V_{g2(b)}$	250	250	V
R_{g2}	33	33	kΩ
V_{g1}	−14	−14	V
R_{g1-k}	10	12	kΩ
R_k	470	470	Ω
I_a	16.6	16.8	mA
I_{g2}	2.9	2.8	mA
I_{g1}	500	400	μA
P_{load}	2.4	1.85	W
η_{load}	59	44	%

OPERATING CONDITIONS AS FREQUENCY DOUBLER

f_{out}	50	100	Mc/s
V_a	250	250	V
$V_{g2(b)}$	250	250	V
R_{g2}	33	33	kΩ
V_{g1}	−40	−40	V
R_{g1-k}	27	27	kΩ
R_k	470	470	Ω
I_a	16	16.3	mA
I_{g2}	2.8	2.6	mA
I_{g1}	1.2	1.1	mA
P_{load}	1.6	1.3	W
η_{load}	41	32	%

OPERATING CONDITIONS AS FREQUENCY TREBLER

f_{out}	50	100	Mc/s
V_a	250	250	V
$V_{g2(b)}$	250	250	V
R_{g2}	33	39	kΩ
V_{g1}	−75	−75	V
R_{g1-k}	39	39	kΩ
R_k	470	470	Ω
I_a	15	16	mA
I_{g2}	2.6	2.3	mA
I_{g1}	1.7	1.7	mA
P_{load}	1.25	1.0	W
η_{load}	32	25	%

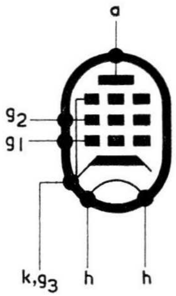
EL91

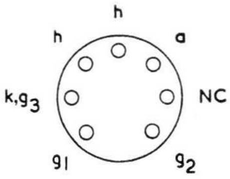
OUTPUT PENTODE

DESIGN CENTRE RATINGS

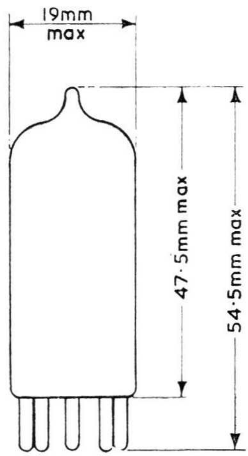
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	4.0	W
p_{a+g2} max.	4.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	600	mW
$-V_{g1}$ max.	100	V
I_{g1} max.	3.0	mA
I_k max.	20	mA
R_{g1-k} max.	500	kΩ
V_{h-k} max.	150	V

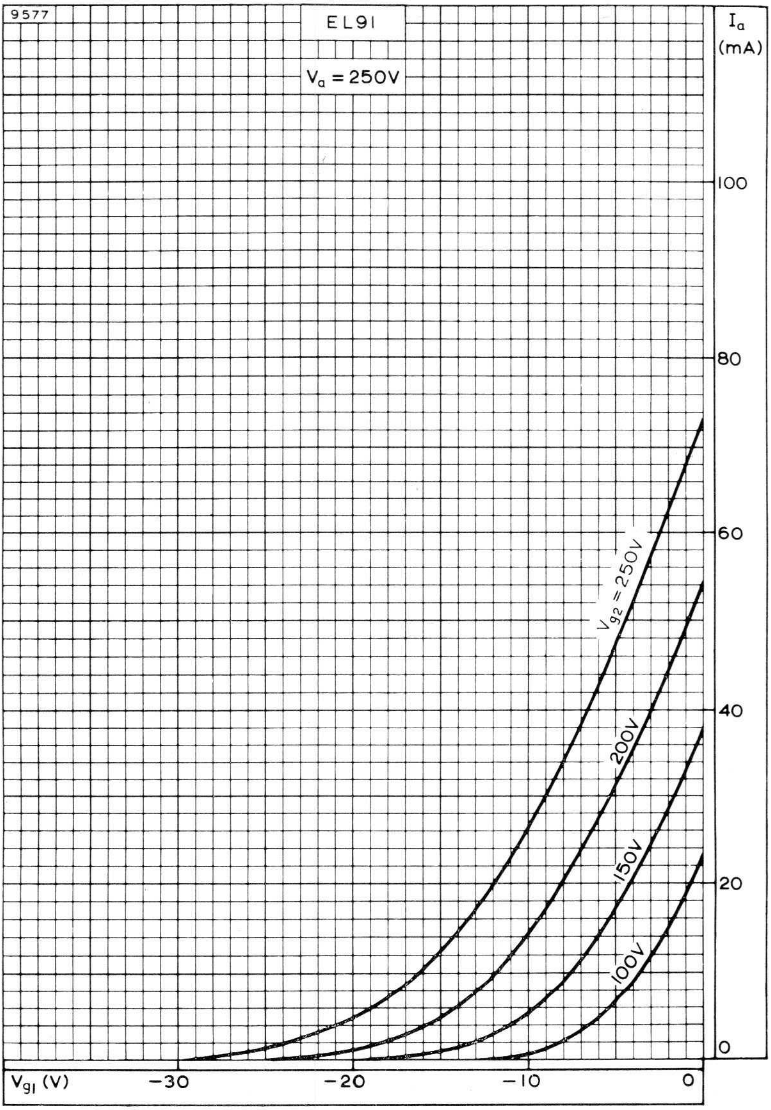
2831



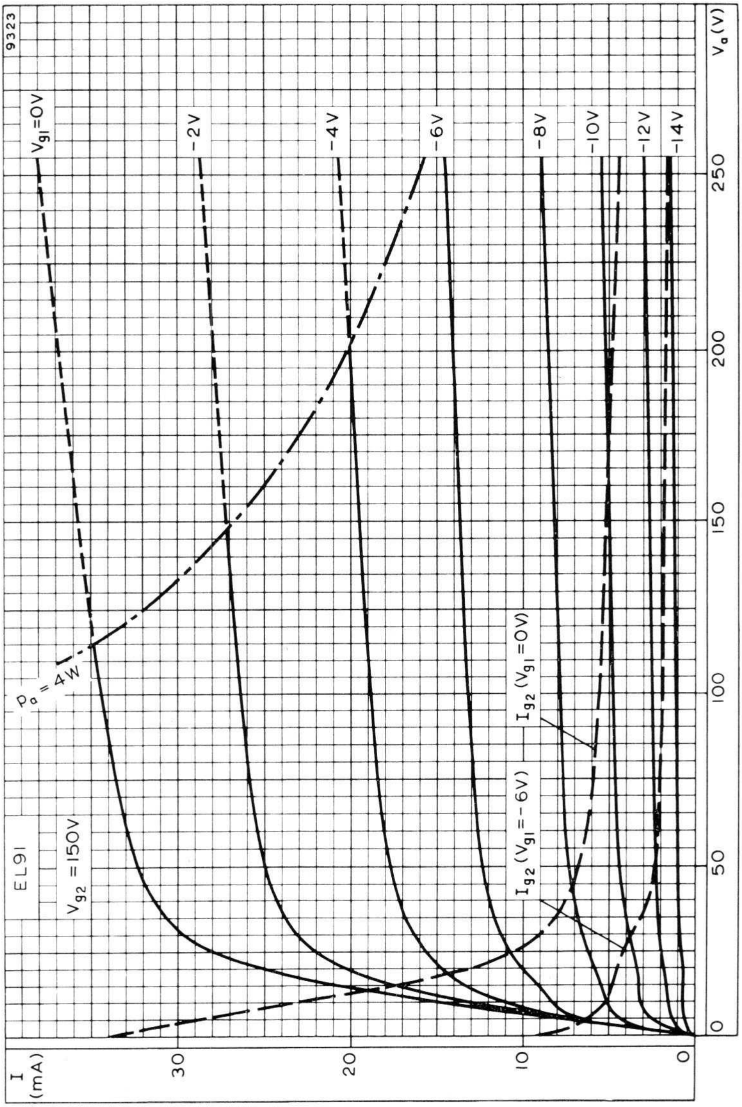


B7G Base

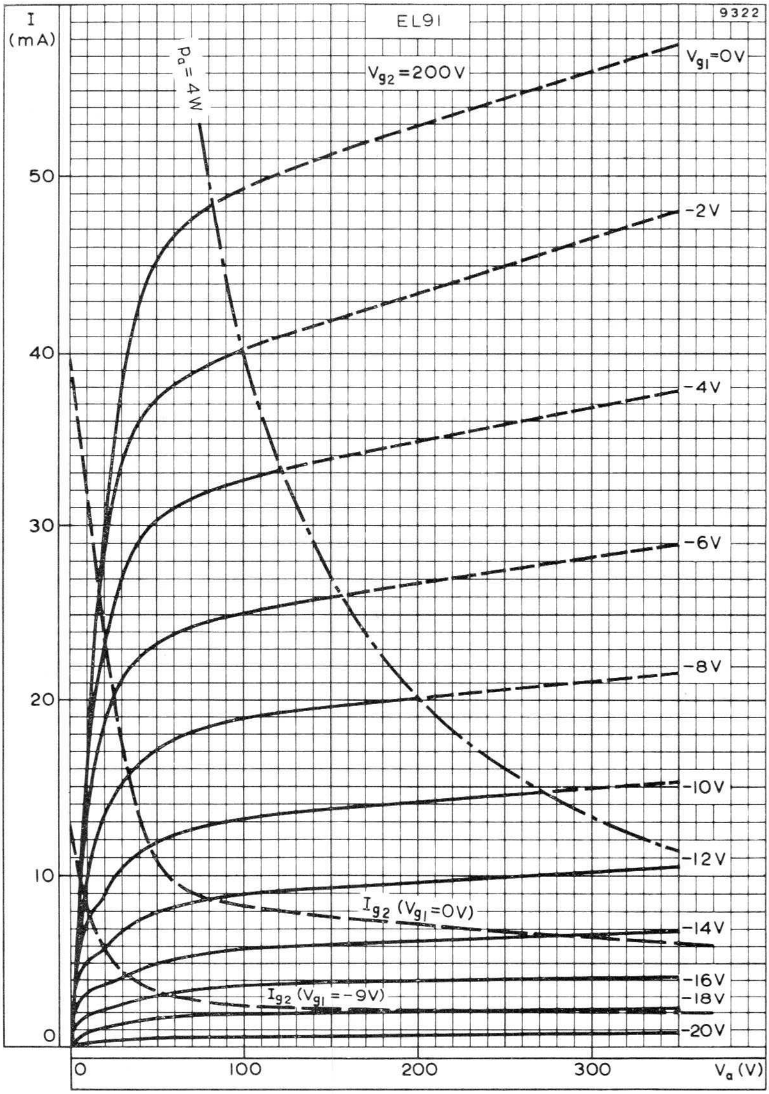




ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



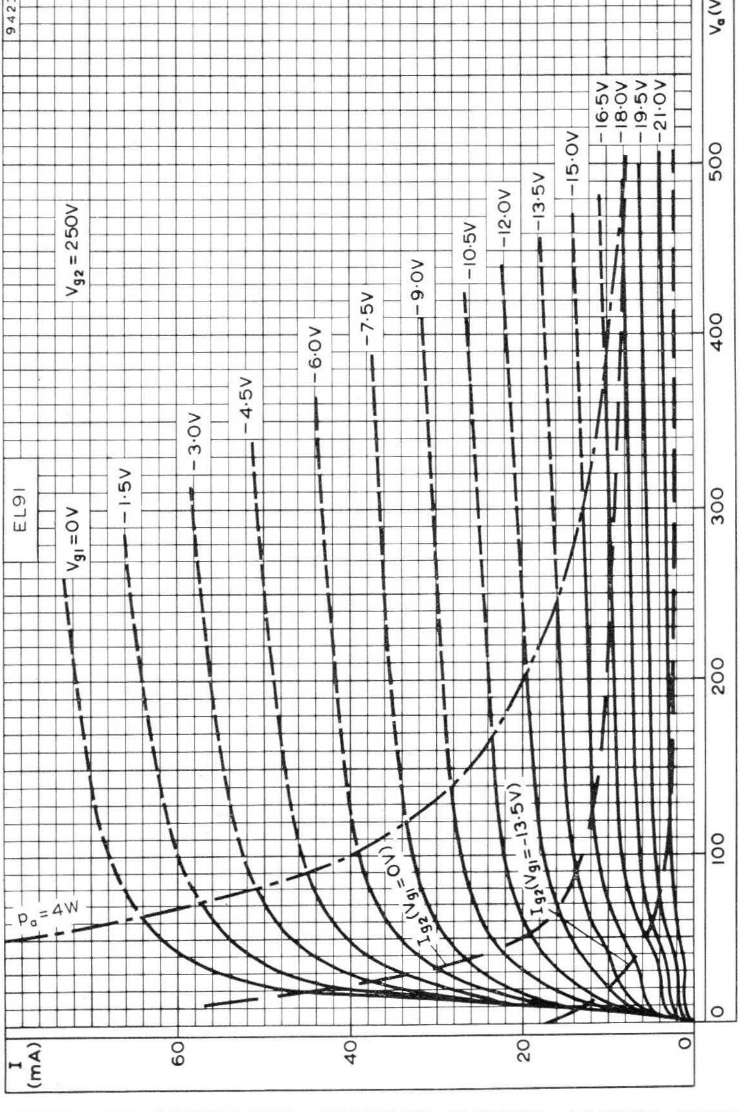
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V



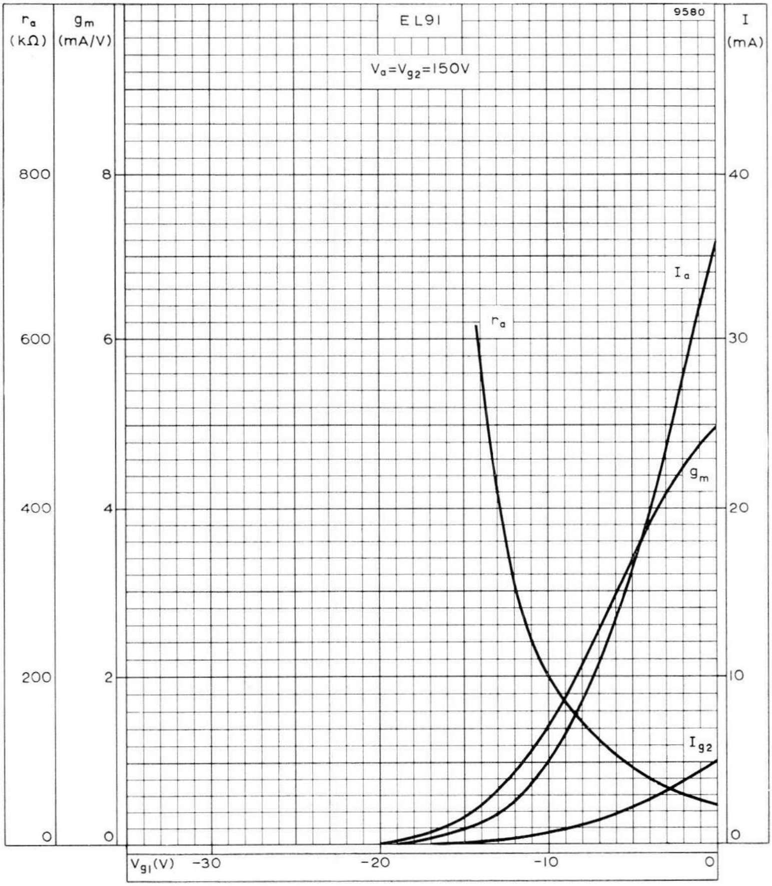
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

EL91

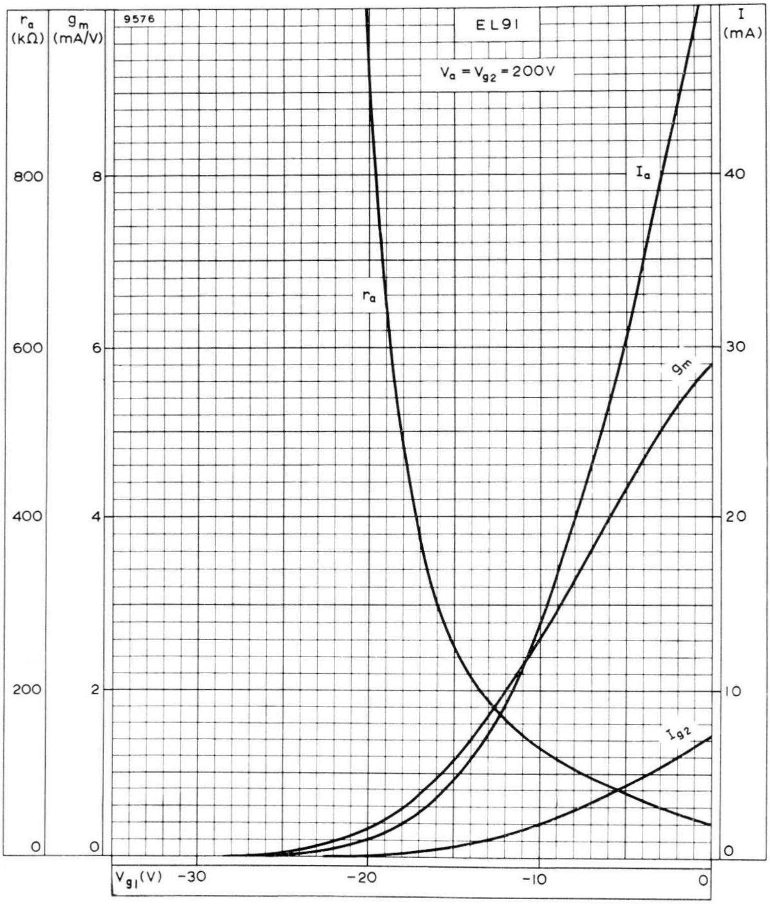
OUTPUT PENTODE



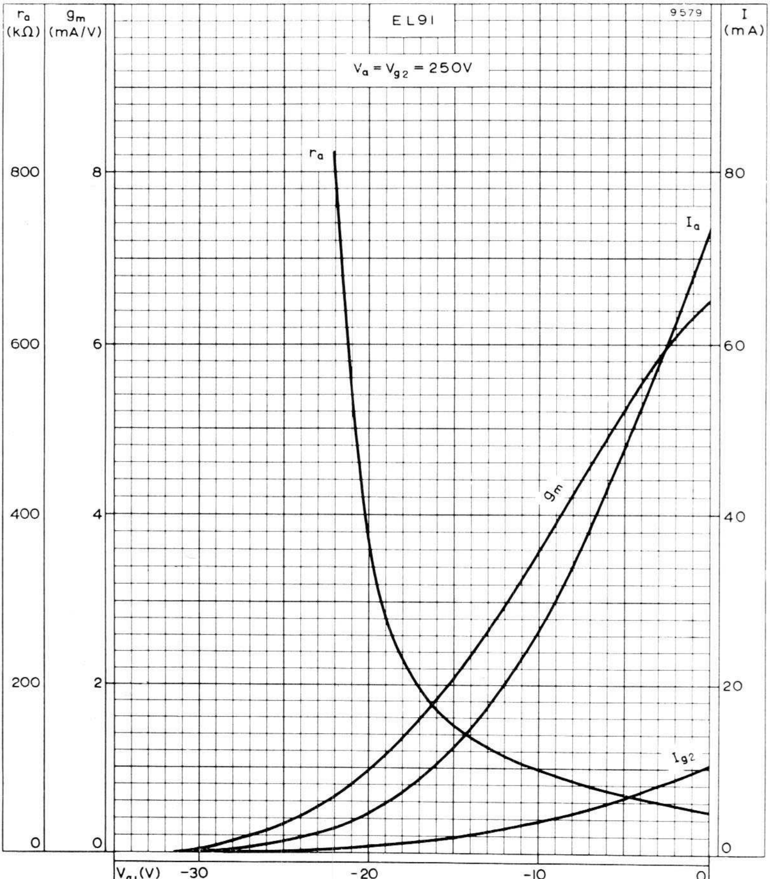
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$



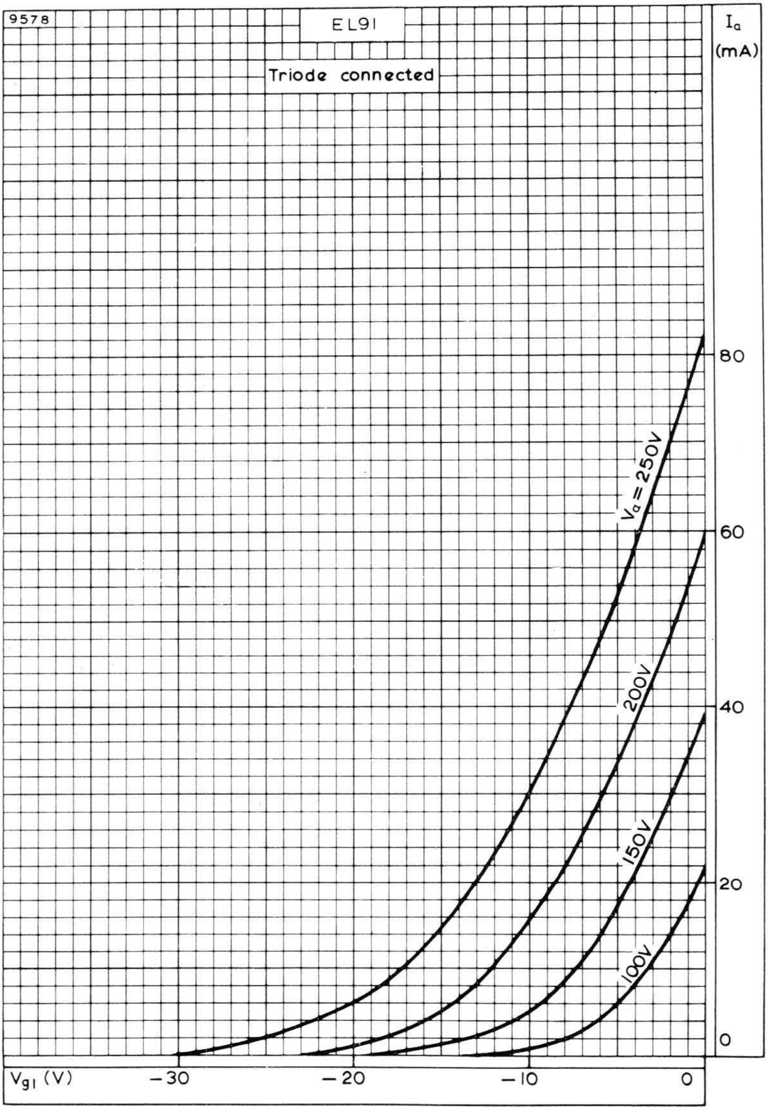
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 150V$



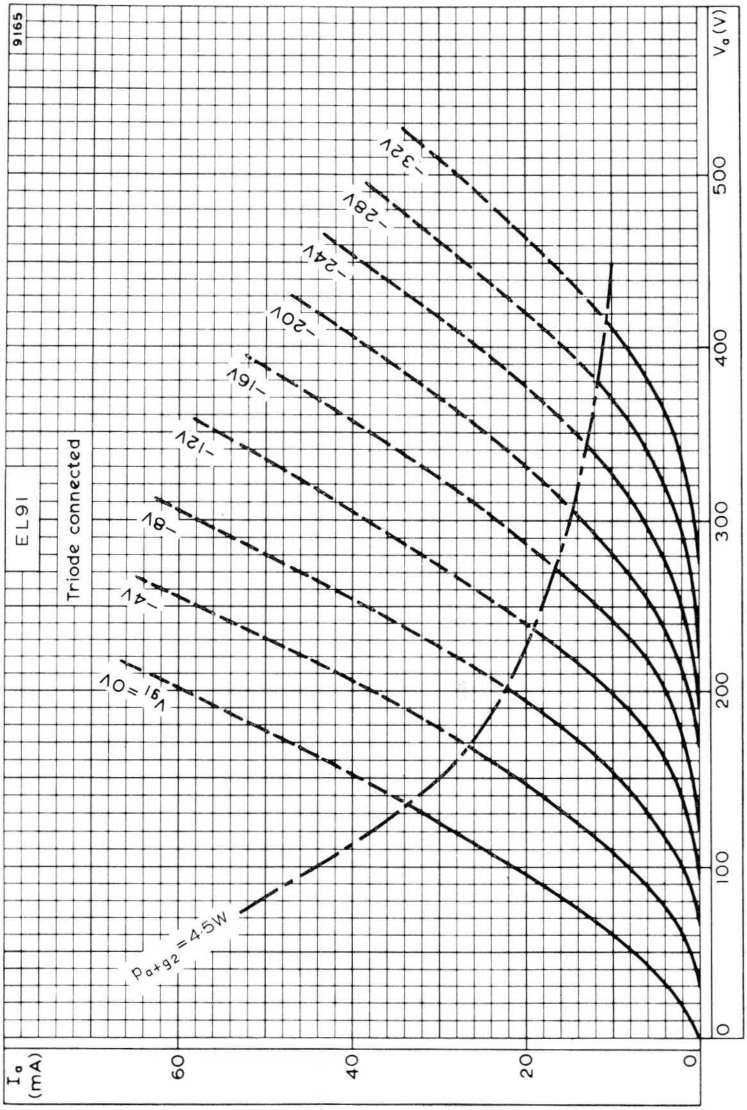
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 200V$



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 250V$



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

OUTPUT PENTODE

EL360

Output pentode for use in radar scanning, series regulator and similar applications and in pulse modulator applications.

HEATER

V_h	6.3	V
I_h	1.27	A

CAPACITANCES

c_{out}	7.7	pF
c_{in}	17.5	pF
c_{a-g1}	<1.1	pF

CHARACTERISTICS

Pentode connection

V_a	100	250	V
V_{g2}	100	250	V
V_{g1}	−6.3	−46	V
I_a	120	48	mA
I_{g2}	8.3	5.5	mA
g_m	16.5	6.9	mA/V
r_a	3.7	13.5	kΩ
μ_{g1-g2}	6.0	5.0	

←

Triode connection (g_2 connected to a)

V_a	100	V
I_a	100	mA
V_{g1}	−8.0	V
g_m	14.5	mA/V
r_a	380	Ω
μ	5.5	

DESIGN CENTRE RATINGS (unless otherwise stated)

Scanning, low voltage series regulator, and similar applications

$V_{a(b)}$ max.	1.0	kV
$v_{a(pk)}$ max.	7.0	kV
$-v_{a(pk)}$ max. (p_a = 15W)	1.0	kV
$-v_{a(pk)}$ max. (p_a = 10W)	1.5	kV
V_a max.	800	V
$V_{g2(b)}$ max.	800	V
V_{g2} max.	400	V
$-v_{g1(pk)}$ max.	1.0	kV
p_a max.	15	W
p_{g2} max.	5.0	W
V_{a+g2} max.	400	V
p_{a+g2} max.	18	W
I_k max.	200	mA
R_{g1-k} max.	500	kΩ
V_{h-k} max.	200	V

High voltage series regulator applications

$V_{a(b)}$ max.	4.0	kV
$V_{g2(b)}$ max.	550	V
V_a max.	2.0	kV
V_{g2} max.	400	V
p_a max.	6.0	W
p_{g2} max.	2.0	W
I_k max.	5.0	mA

Pulse modulator applications

V_a max. (absolute)	5.0	kV
p_a max.	10	W
* $i_{k(pulse)}$ max. (absolute)	4.0	A
V_{g2} max.	550	V
p_{g2} max.	3.0	W
$-V_{g1}$ max.	300	V
$+v_{g1(pulse)}$ max.	60	V

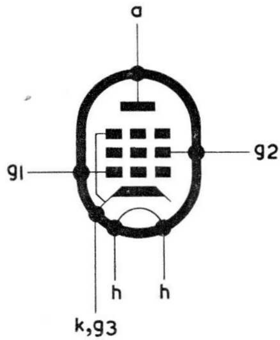
*Max. pulse duration 1μs, duty factor 0.001

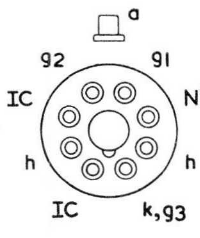
OUTPUT PENTODE

EL360

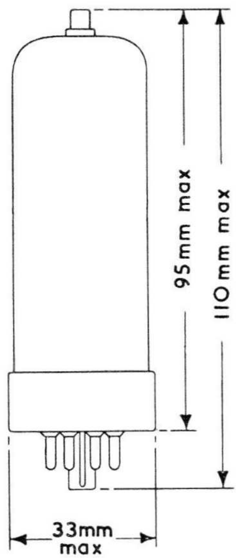
Output pentode for use in radar scanning, series regulator and similar applications and in pulse modulator applications.

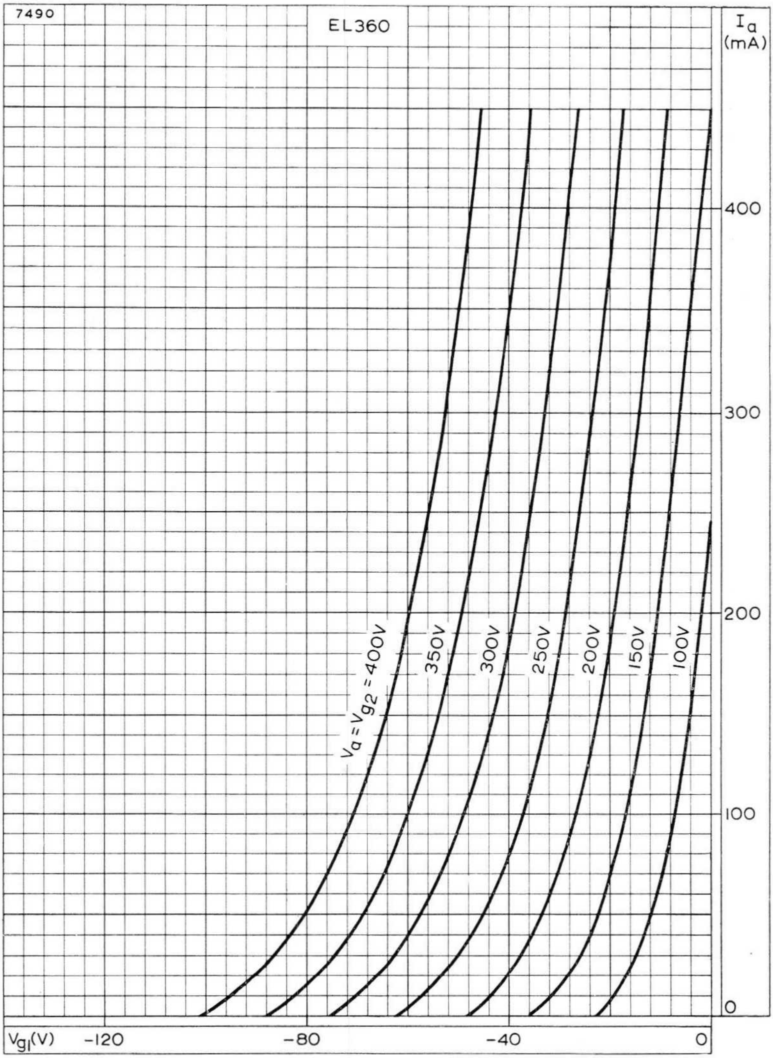
2277



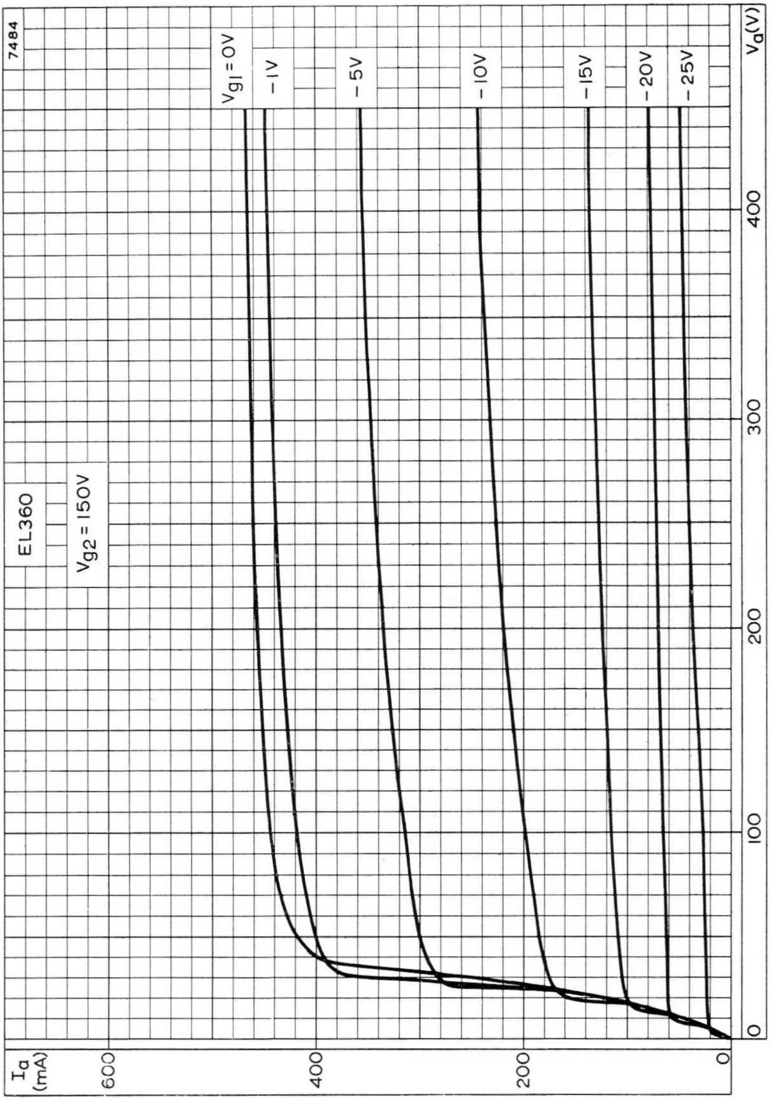


Octal Base

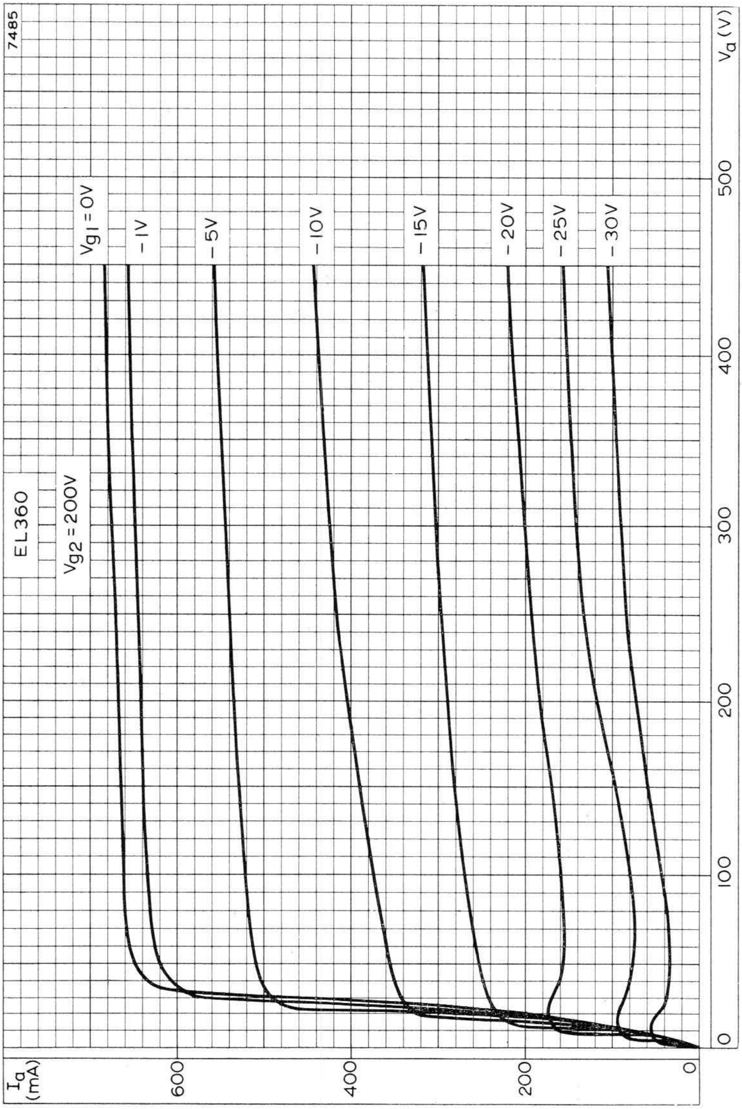




ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETERS

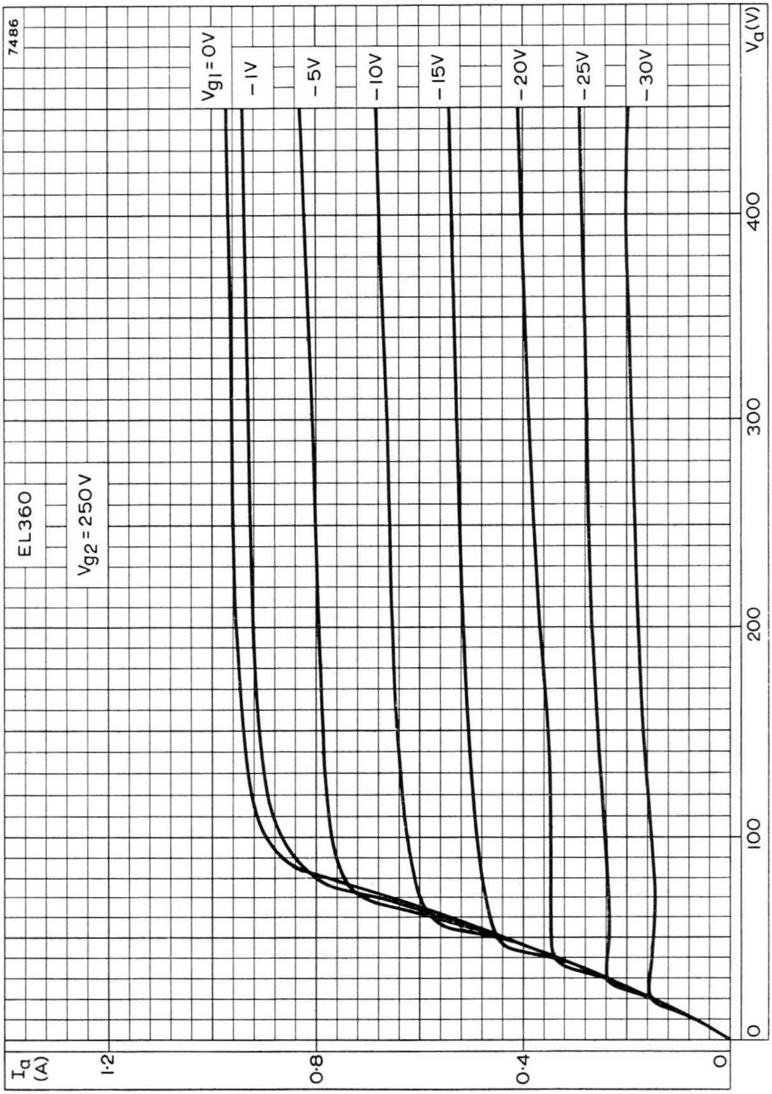


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$

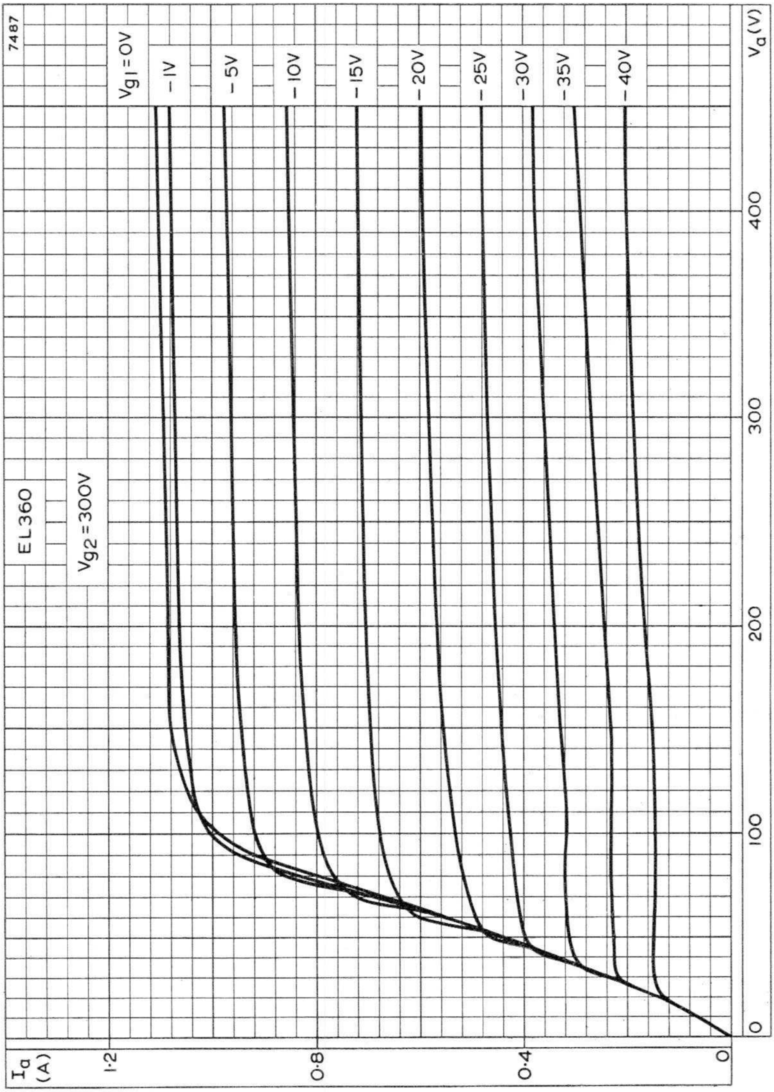


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

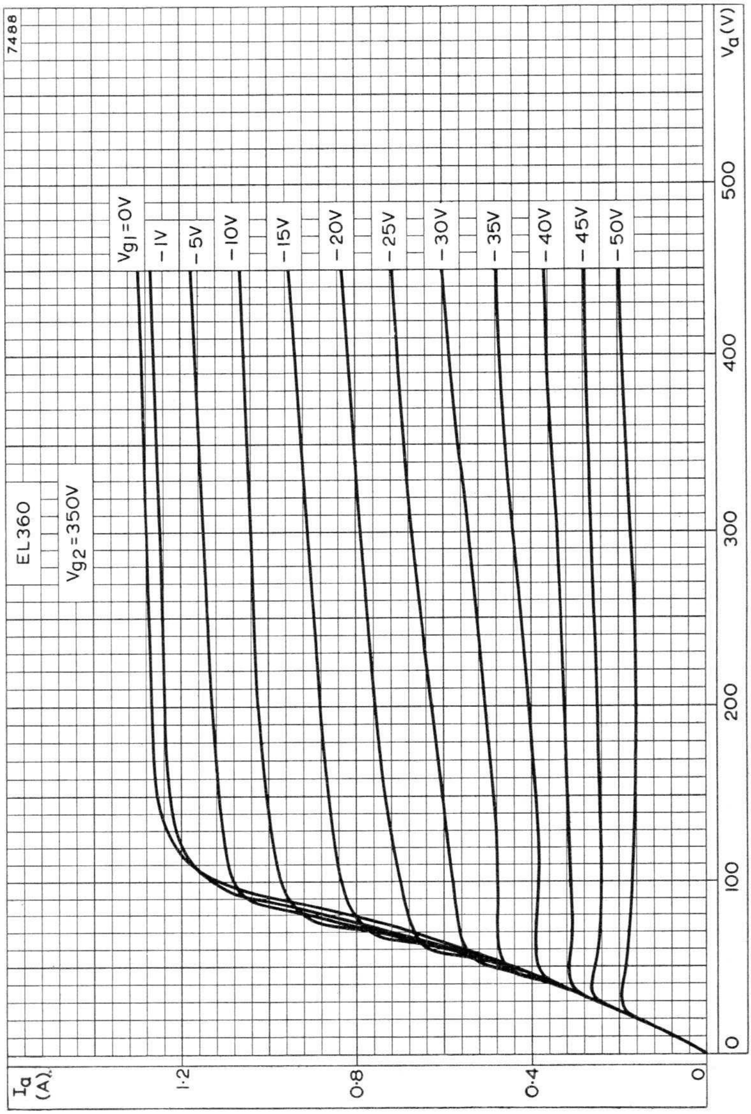
Mullard



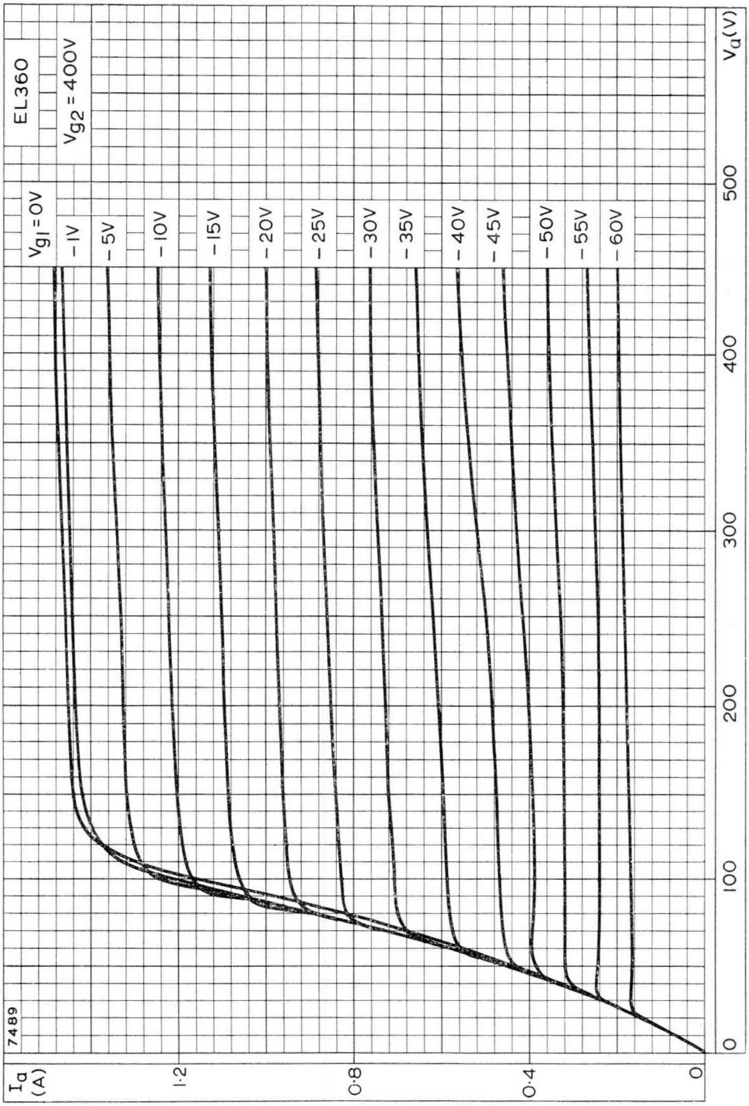
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 250V



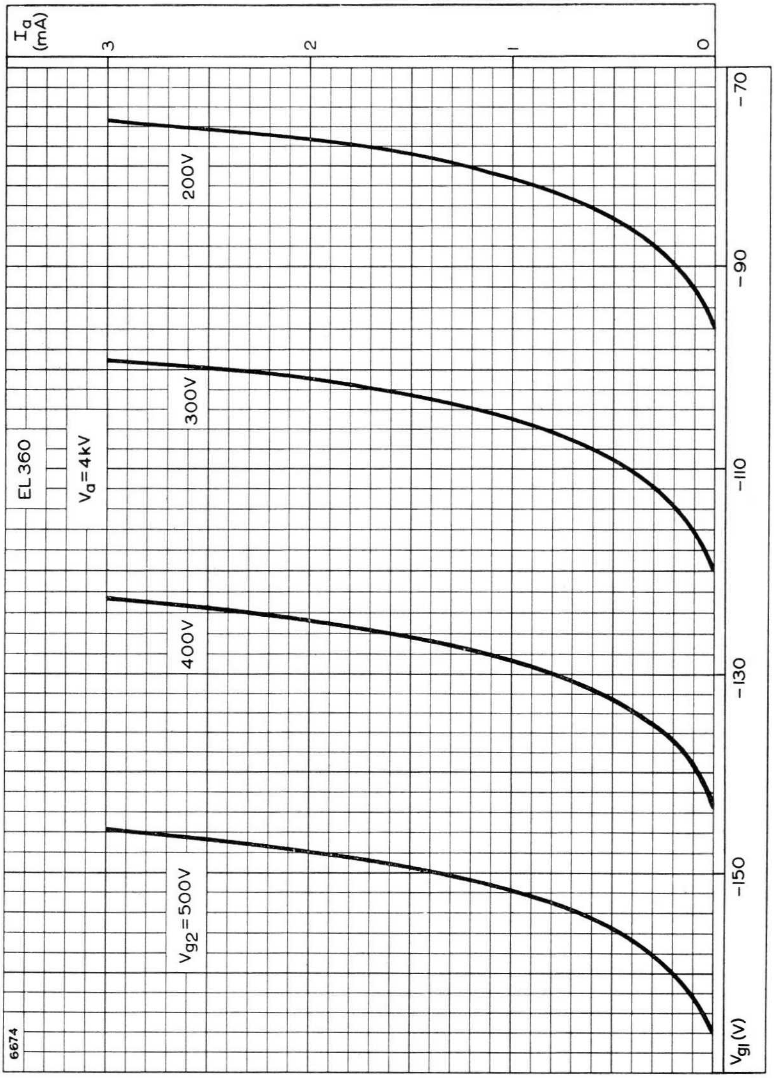
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 300V$



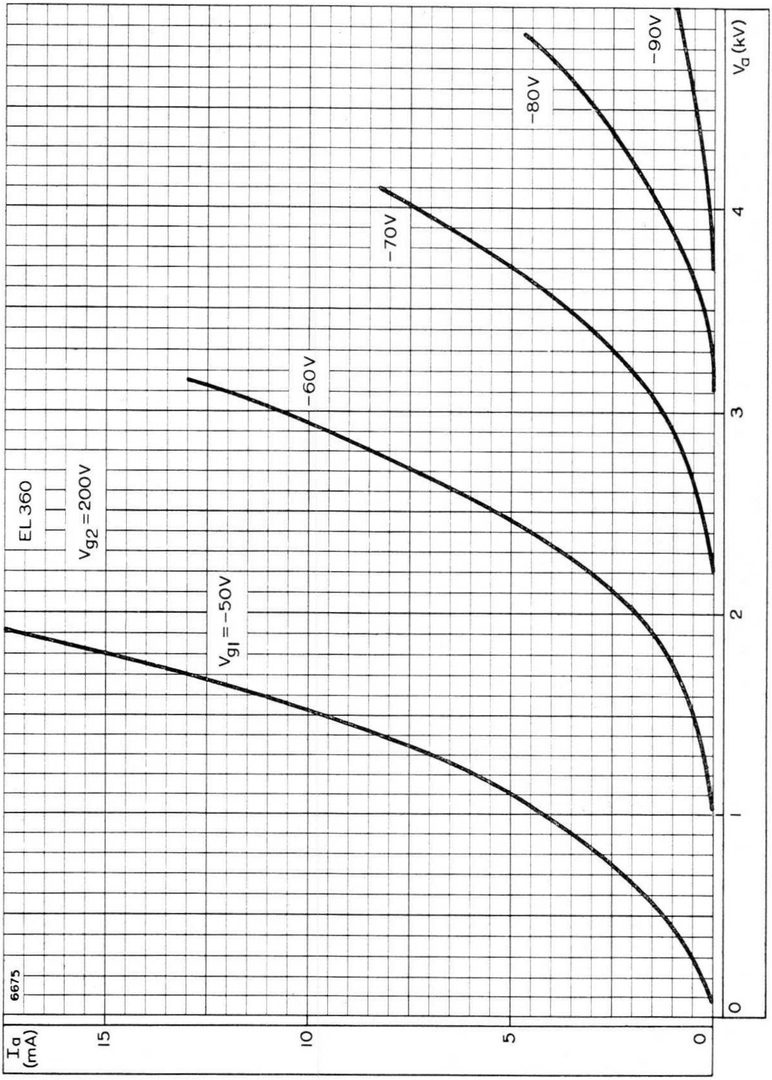
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 350V



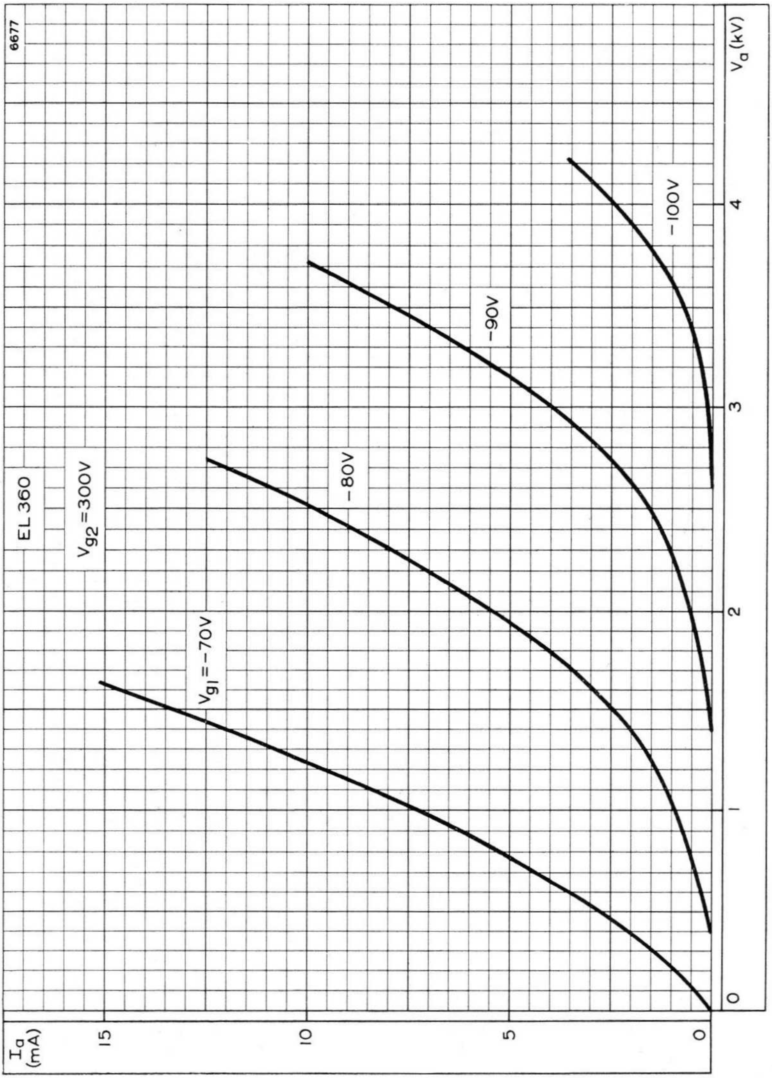
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 400V$



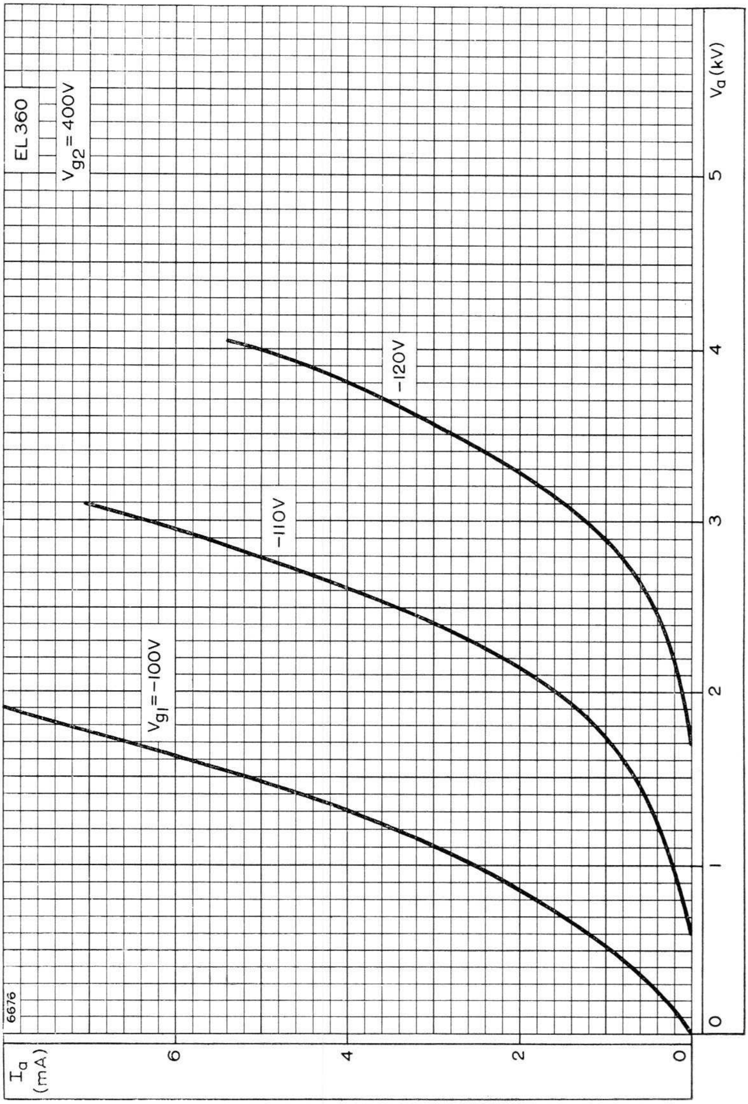
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER. $V_a = 4kV$



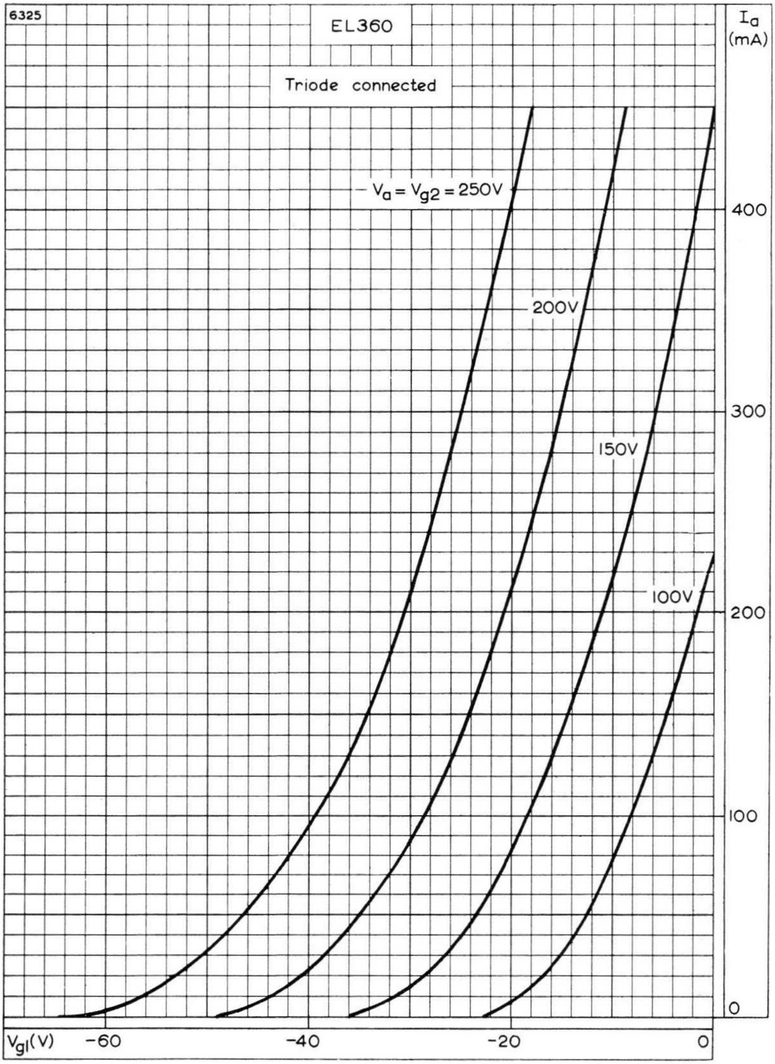
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE UP TO 5kV WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$



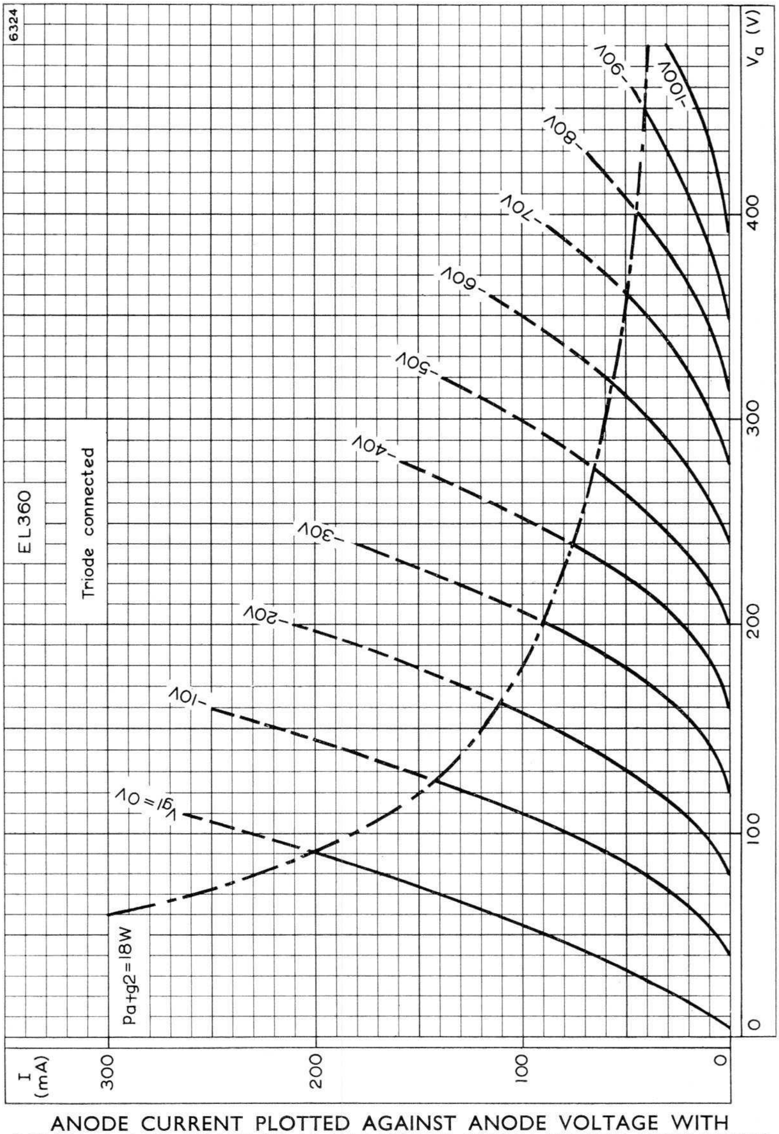
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE UP TO 4kV WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 300V$



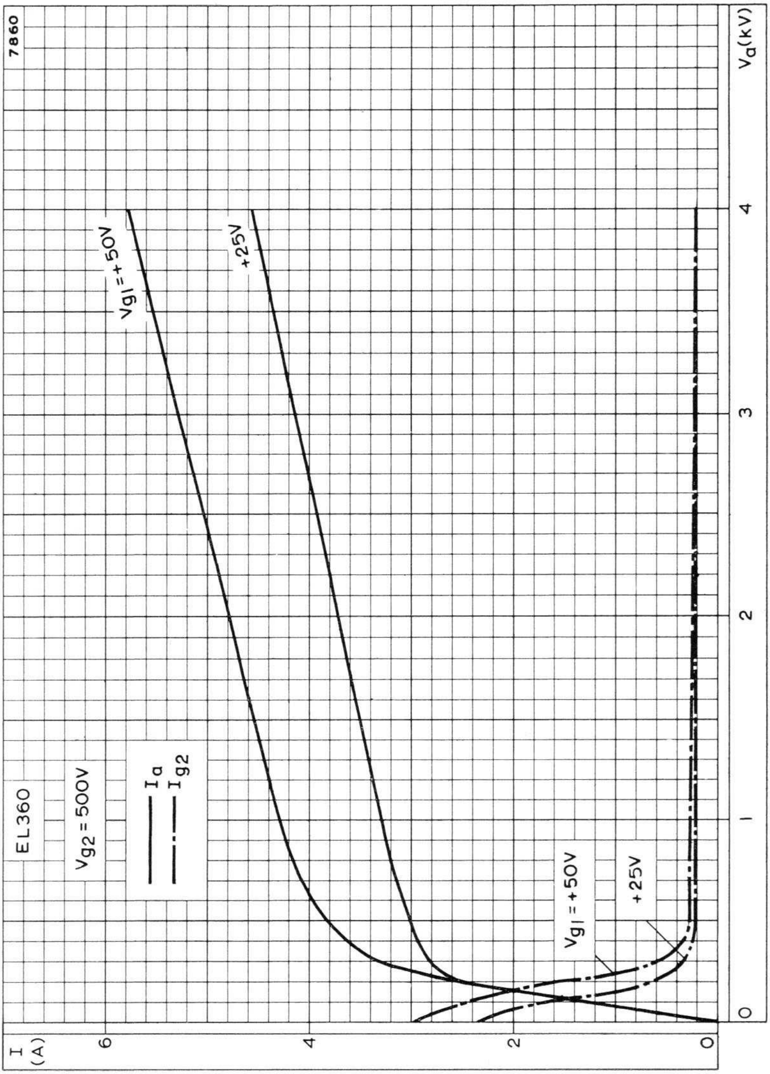
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE UP TO 4kV WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 400V$



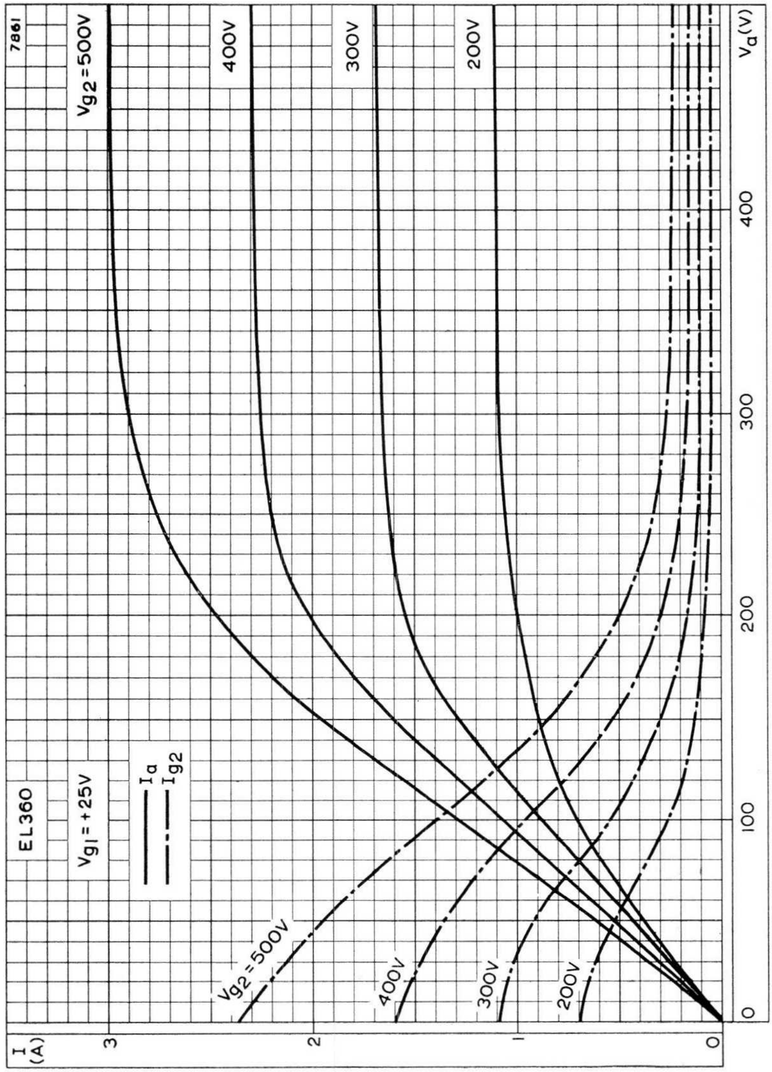
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER WHEN TRIODE CONNECTED



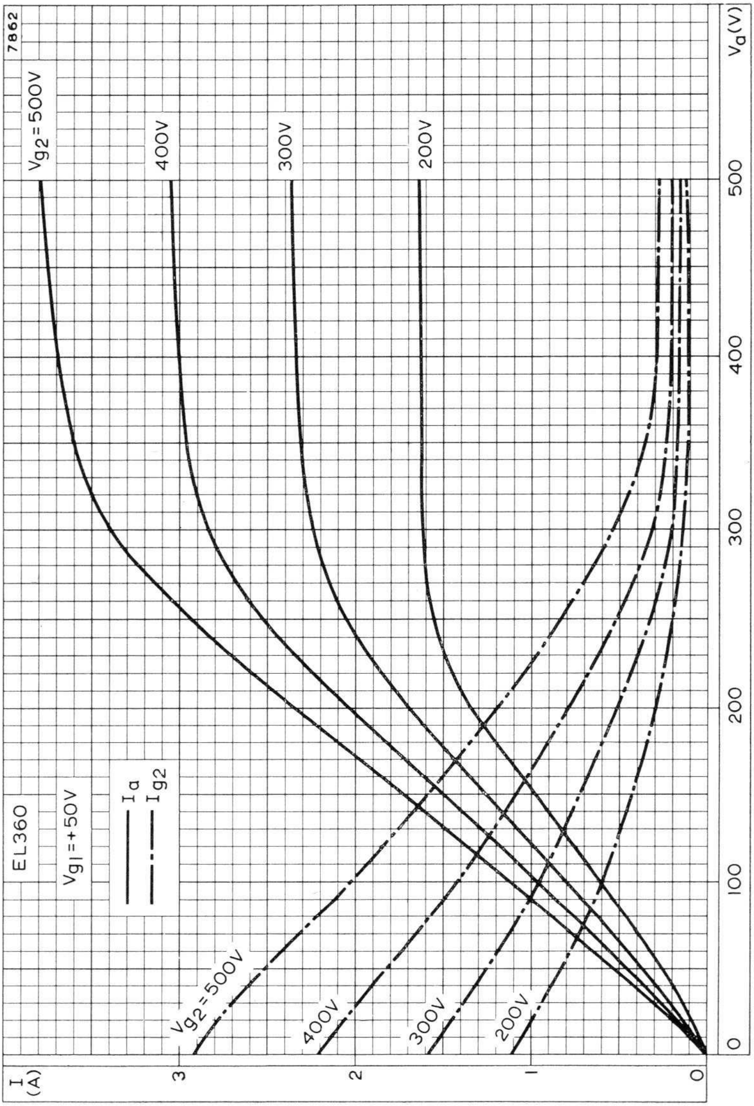
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



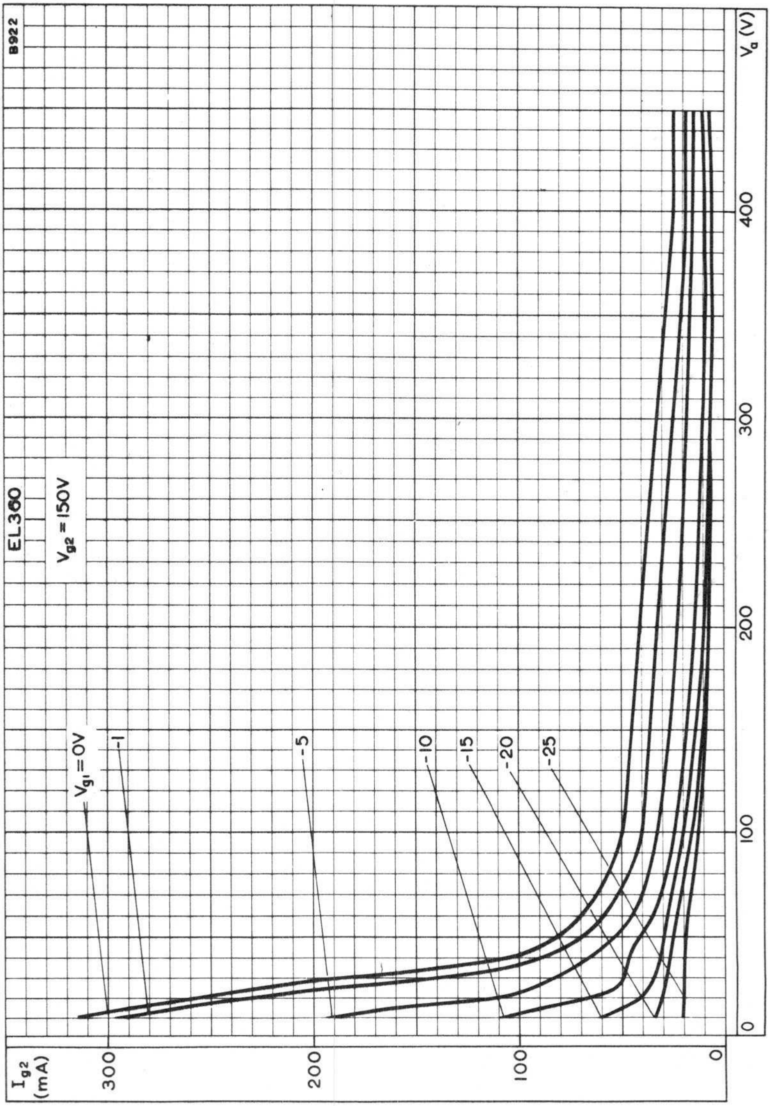
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER. $V_{g1} = +25V$

EL360

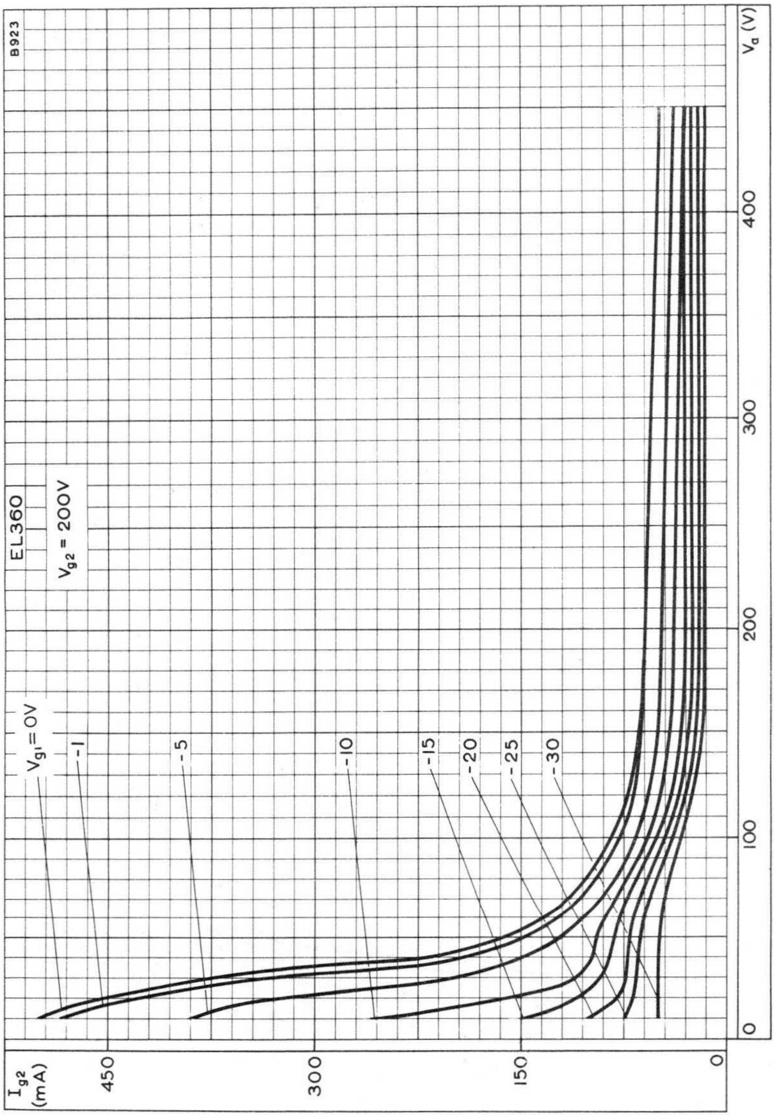
OUTPUT PENTODE



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER. $V_{g1} = +50V$

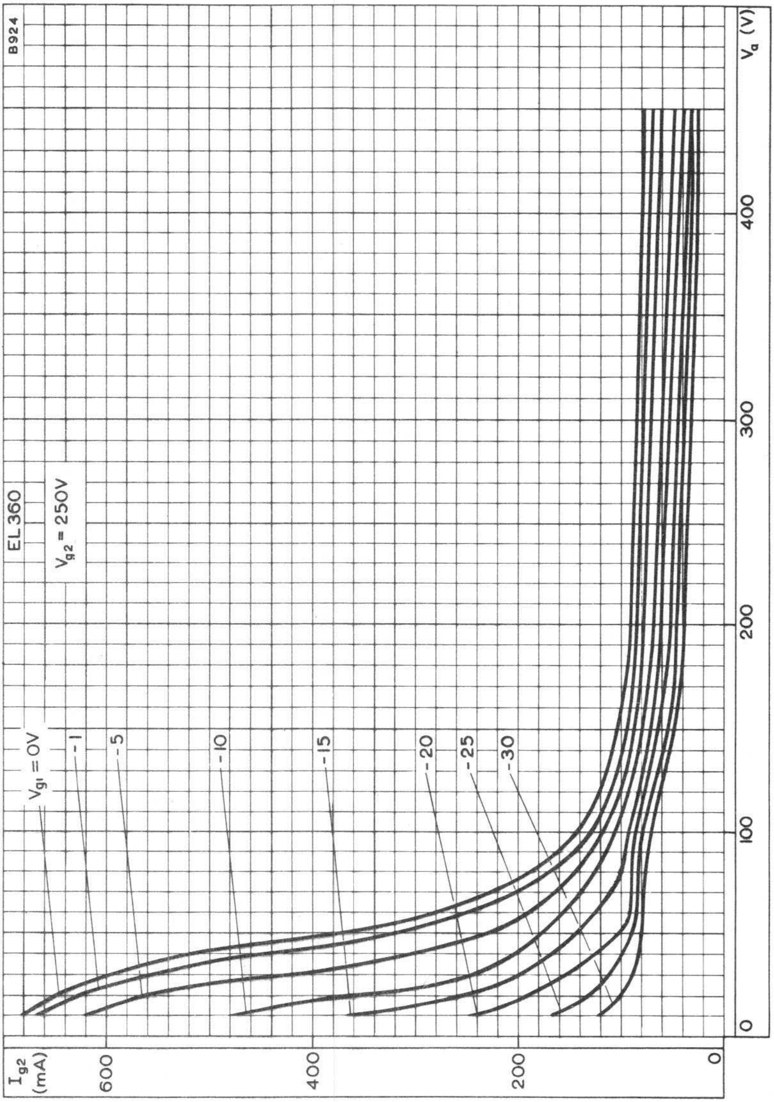


SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$

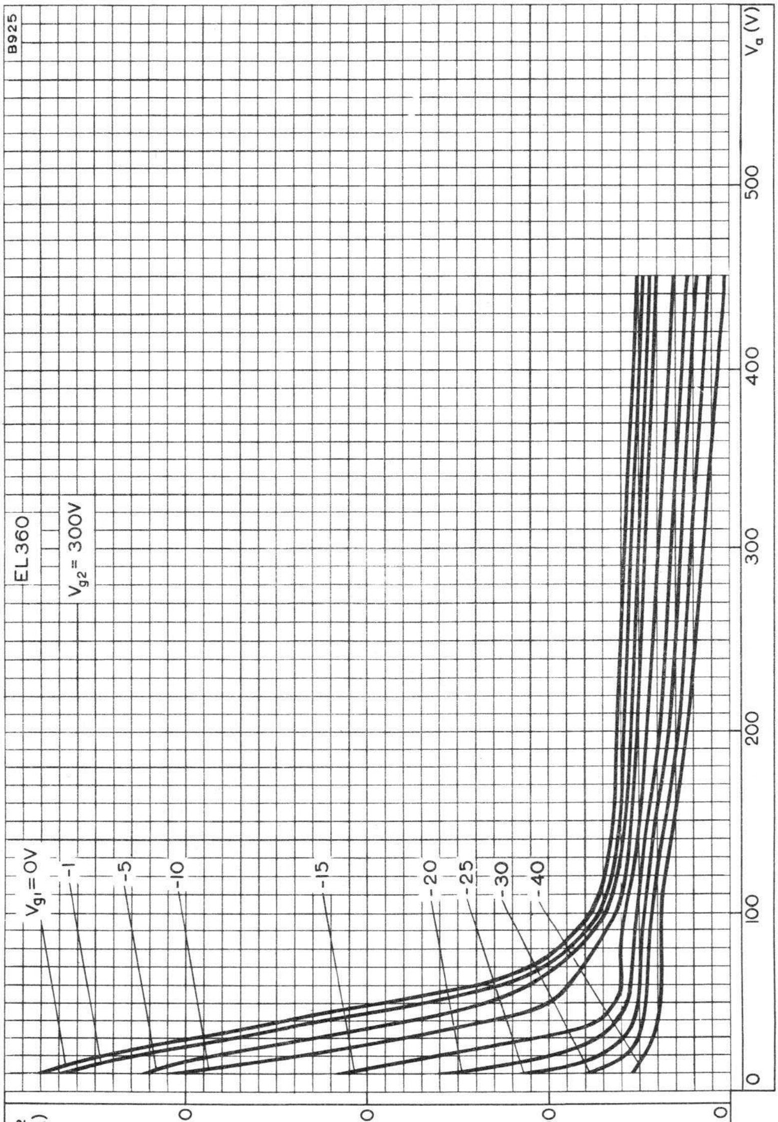


SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

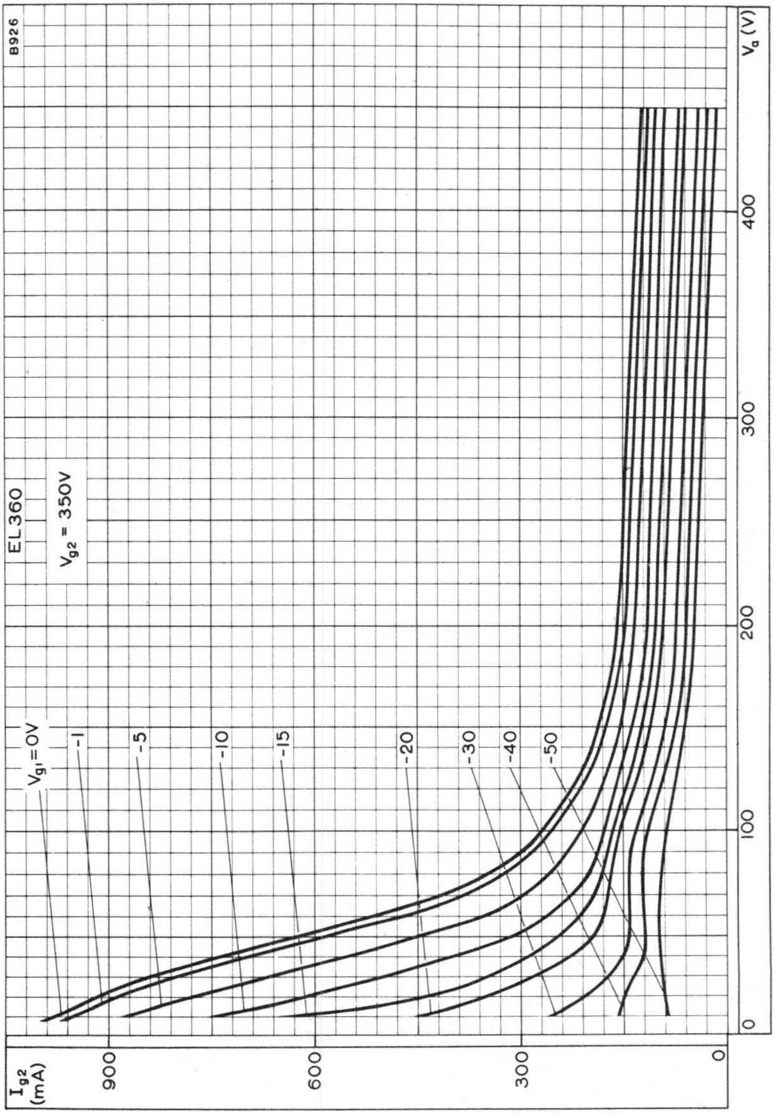
Mullard



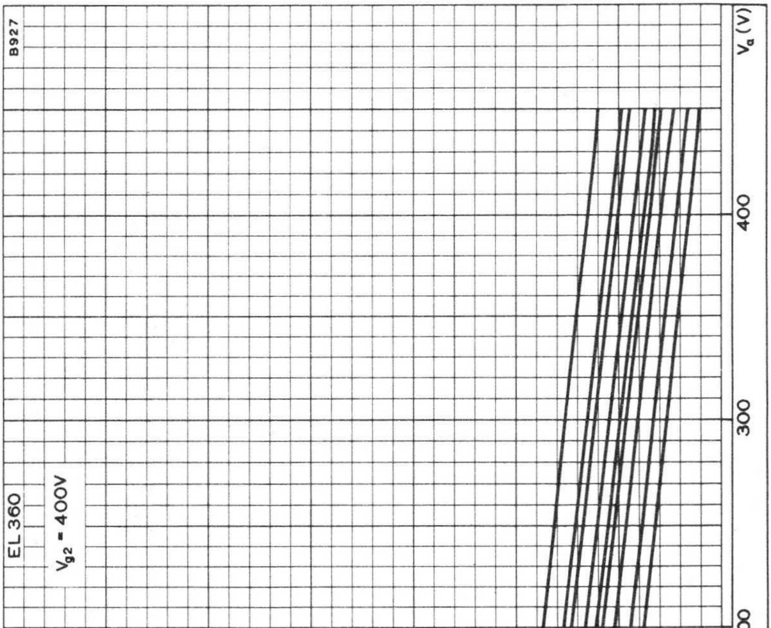
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 300V



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 350V$



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 400V$

TUNING INDICATOR

EM81

Electron beam tube for use as a tuning indicator in f.m. or a.m. receivers or as a level indicator in tape recorders.

HEATER

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

V_h	6.3	V
I_h	300	mA

OPERATING CONDITIONS

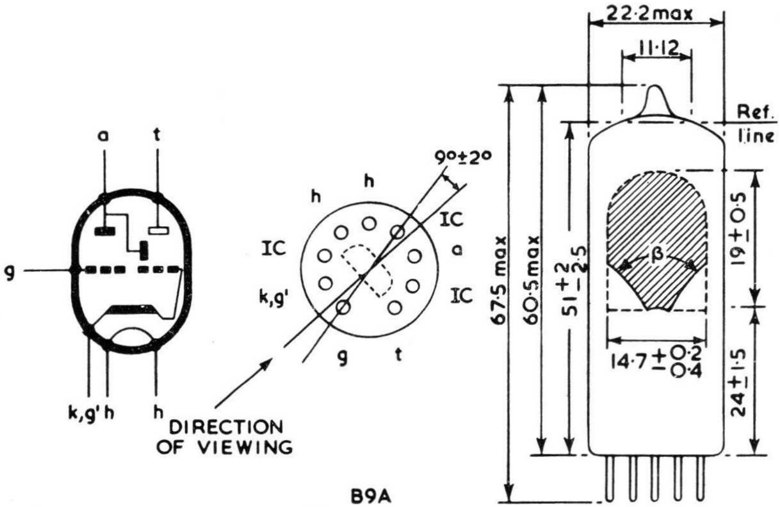
V_b		250		V
V_t		250		V
R_a		500		kΩ
R_{g-k}		3.0		MΩ
V_g	–1.0		–10.5	V
I_a	370		20	μA
I_t	2.0		2.3	mA
β	65		5.0	deg.
V_g max. ($I_g = +0.3\mu A$)			–1.3	V

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	200	mW
$V_{t(b)}$ max.	550	V
V_t max.	300	V
V_t min.	165	V
I_k max.	3.0	mA
R_{g-k} max.	3.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

EM81

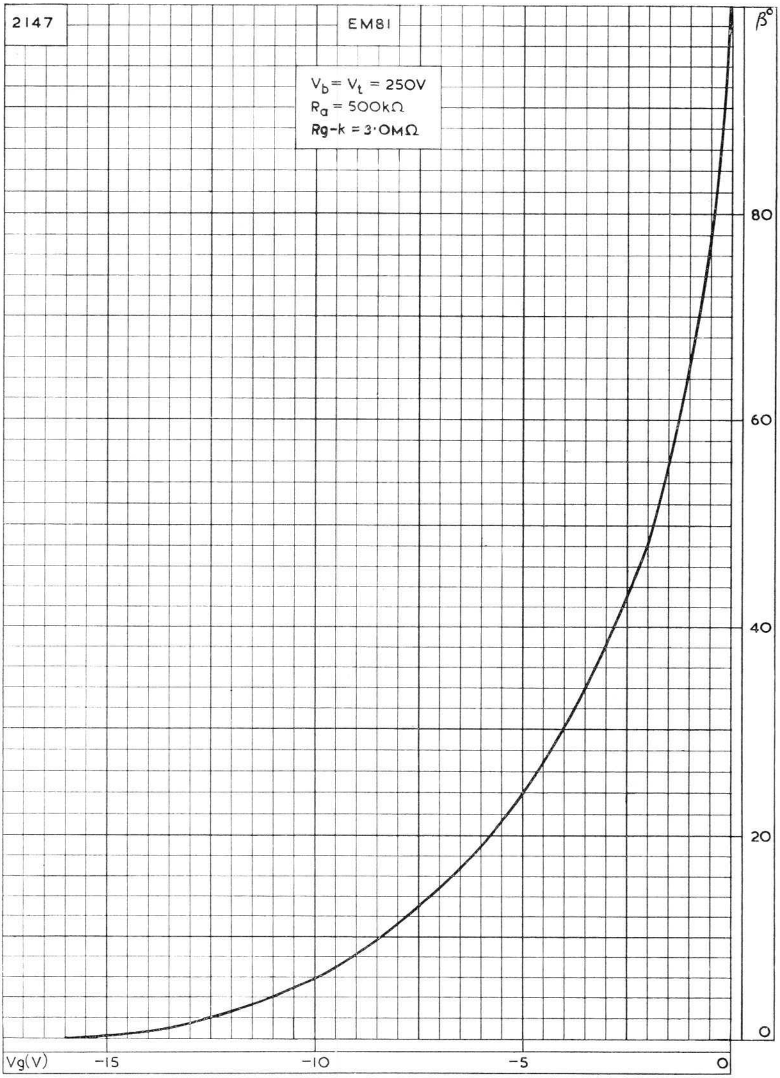
TUNING INDICATOR



B9A
Noval Base

2149

All dimensions in mm



LIGHT ANGLE PLOTTED AGAINST CONTROL-GRID VOLTAGE

VOLTAGE INDICATOR

EM84

Electron beam tube for use as a voltage indicator in broadcast receivers and tape recorders.

HEATER

V_h	6.3	V
I_h	210	mA

MOUNTING POSITION

Any

TYPICAL OPERATING CONDITIONS

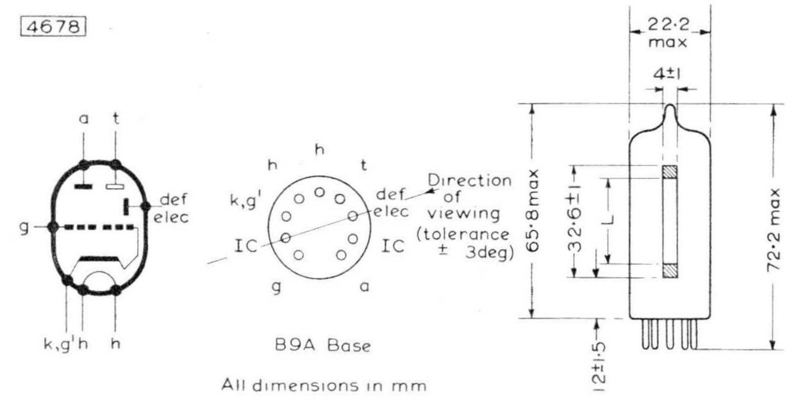
(deflection electrode connected to anode)

V_b		250		V
V_t		250		V
R_a		470		kΩ
R_{g-k}		3.0		MΩ
V_g	0		−22	V
I_a	450		60	μA
I_t	1.0		1.8	mA
*L	21±5		0	mm←

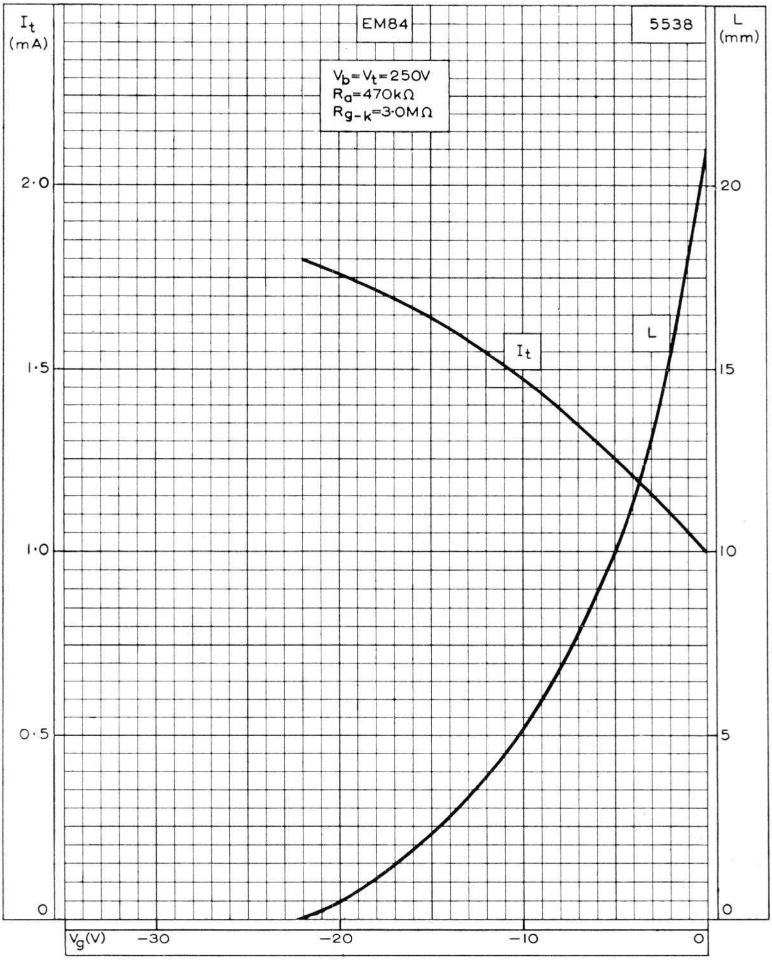
*Length of column

DESIGN CENTRE RATINGS

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	500	mW
$V_{t(b)}$ max.	550	V
V_t max.	300	V
V_t min.	170	V
I_k max.	3.0	mA
V_g max. ($I_g = +0.3\mu A$)	−1.3	V
R_{g-k} max.	3.0	MΩ
V_{h-k} max.	100	V
T_{bulb} max.	120	°C



4678
a
t
def
elec
g
k,g'h
h
h
h
t
k,g'
def
elec
IC
IC
g
a
Direction
of
viewing
(tolerance
± 3deg)
B9A Base
All dimensions in mm
22·2
max
4±1
65·8 max
32·6±1
L
72·2 max
12±1·5



LENGTH OF COLUMN AND TARGET CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE

VOLTAGE INDICATOR

EM87

Short grid-base electron beam tube for use as a voltage indicator in tape recorders. The pattern consists of a vertical column with a fluorescent area at the top and bottom. As the grid is driven negative these fluorescent areas converge, until they meet at $V_g = -10V$. At $V_g = -15V$ there is a 1.5mm cross-over which can be utilised to indicate overloading.

HEATER

V_h	6.3	V
I_h	300	mA

TYPICAL OPERATING CONDITIONS

(deflection electrode connected to anode)

V_b		250		V
V_t		250		V
R_a		100		kΩ
R_{g-k}		3.0		MΩ
V_g	0	–10	–15	V
I_a	2.0	0.5	0.2	mA
I_t	1.0	1.8	2.0	mA
*L	21	0	–1.5	mm

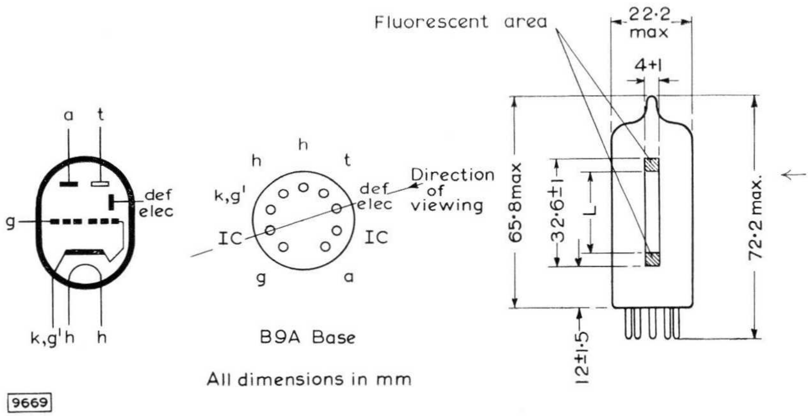
*Length of column. A negative value of L indicates overlapping.

DESIGN CENTRE RATINGS

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	600	mW
$V_{def.elec.(b)}$ max.	550	V
$V_{def.elec.}$ max.	300	V
$V_{t(b)}$ max.	550	V
V_t max.	300	V
V_t min.	170	V
I_k max.	5.0	mA
R_{g-k} max.	3.0	MΩ
R_{h-k} max.	100	kΩ
V_{h-k} max.	250	V
T_{bulb} max.	120	°C

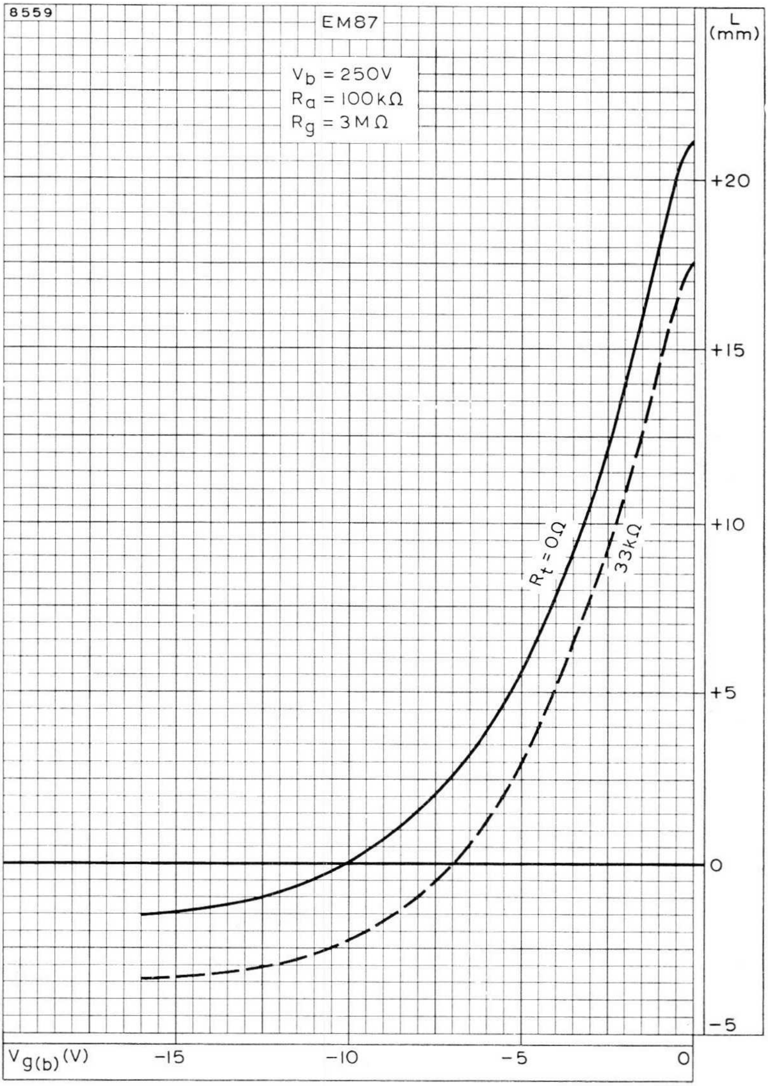
EM87

VOLTAGE INDICATOR



All dimensions in mm

9669



LENGTH OF COLUMN PLOTTED AGAINST CONTROL-GRID VOLTAGE

HALF-WAVE RECTIFIER

EY84

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

HEATER

V_h	6.3	V
I_h	1.0	A

LIMITING VALUES

P.I.V. max.	2.0	kV
$i_{a(pk)}$ max.	900	mA
$i_{a(surge)}$ max.	3.2	A
V_{h-k} max. (cathode positive)	650	V

Capacitor input

I_{out} max. $V_{in(r.m.s.)}$ max.	See rating chart 1
R_{lim} min.	See rating charts 2 and 3 and capacitor input regulation curves.

Choke input

I_{out} max. $V_{in(r.m.s.)}$ max.	See rating chart 1
L min. (at 50c/s)	See choke regulation curves

CHARACTERISTICS

Anode voltage drop (I_{out}=150mA)	22	V

TYPICAL OPERATION OF TWO EY84 AS FULL-WAVE RECTIFIER

Capacitor input

$V_{in(r.m.s.)}$	2×500	2×625	V
R_{lim} (per anode)	150	250	Ω
*C (50c/s)	16	16	μF
I_{out}	300	250	mA
V_{out}	500	635	V

*For 1.6kc/s operation the same I/V relation would be obtained using a capacitor of 0.5μF.

Choke input

$V_{in(r.m.s.)}$	2×500	2×700	V
L	10	10	H
I_{out}	365	300	mA
V_{out}	408	592	V

OPERATING NOTES

The design of a power supply circuit starts with a knowledge of the output conditions and from this information the transformer and secondary or input voltage can be chosen. Reference to the rating charts will indicate whether a rectifier is suitable for a particular application.

Rating chart 1

This shows all the combinations of input voltage and output current considered safe for both capacitor and choke input filters.

EY84

HALF-WAVE RECTIFIER

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

Rating chart 2

This chart shows the minimum series resistance per anode necessary to restrict the maximum switching surge in a capacitor input filter, to its limiting value over the range of supply voltage.

Rating chart 3

This shows the relationship between the maximum rectification efficiency and output current.

Capacitor input filter circuits

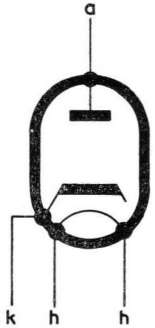
Reference should be made to rating charts 2 and 3 and the regulation curves. The circuit is set-up and the input and output voltage and output current are measured. If the operating conditions lie within the boundary lines of the regulation curves an improvement in the rectification efficiency may be effected by reducing the value of the limiting resistance. Rating chart 2 gives the minimum value of the limiting resistance against open circuit secondary voltage; this resistance will guard against excessive switching currents.

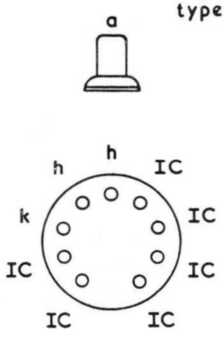
Comparison of the calculated rectification efficiency $\frac{V_{out}}{\sqrt{2} \times V_{in(r.m.s.)}}$ with rating chart 3 will show whether the limiting resistance must be increased to lower the rectification efficiency to the area of safe operation. Operation within this area indicates that the limiting value $i_{a(pk)}$ has not been exceeded.

Choke input circuit

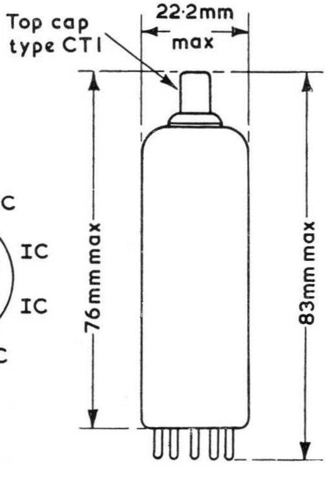
Reference should be made to rating chart 1. A suitable value of choke can be obtained from the choke regulation curves.

3367





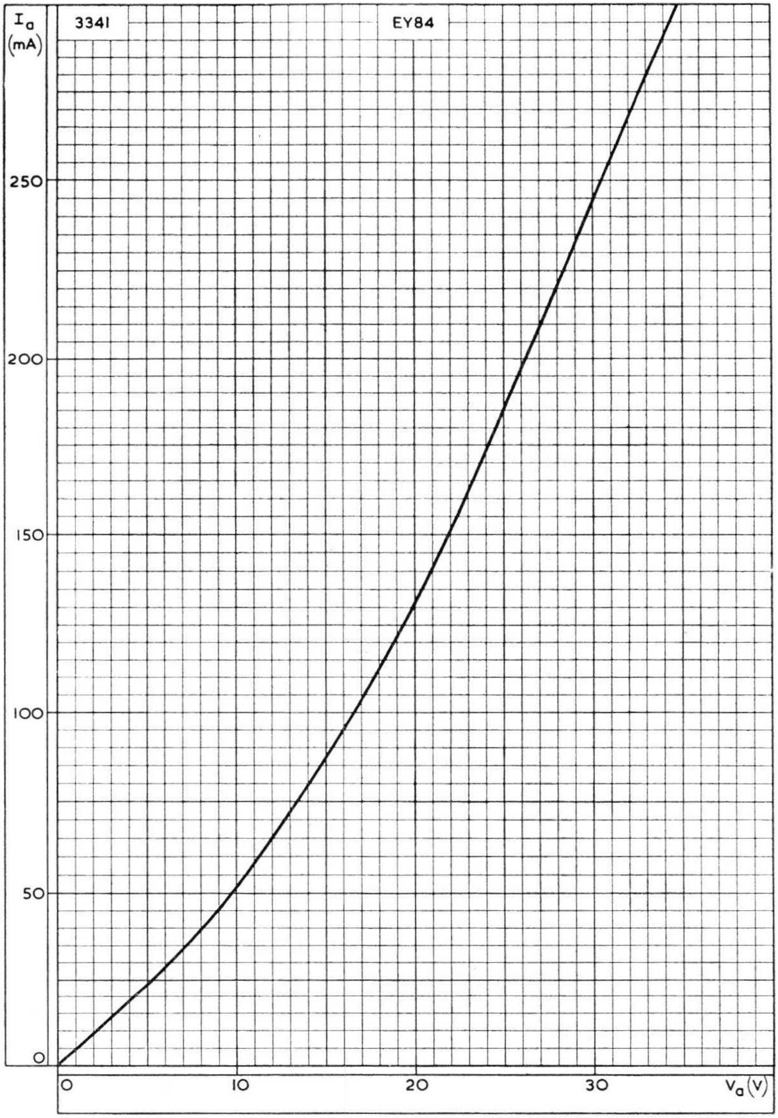
B9A Base



HALF-WAVE RECTIFIER

EY84

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

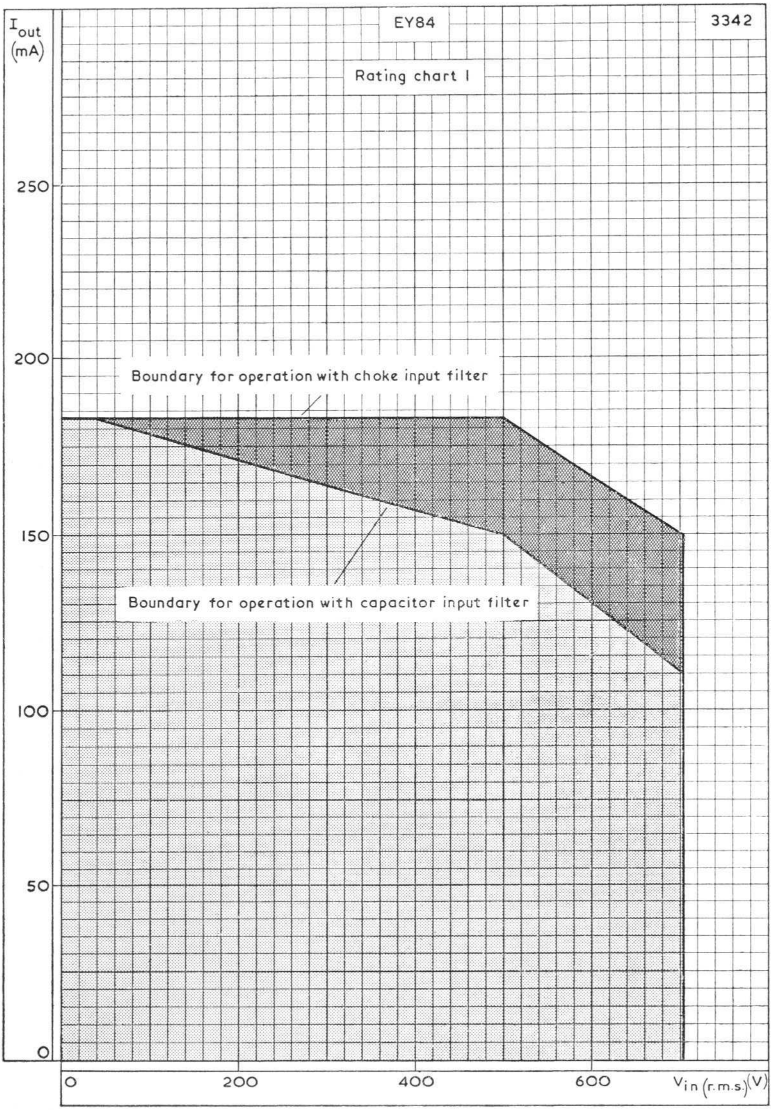


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

EY84

HALF-WAVE RECTIFIER

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

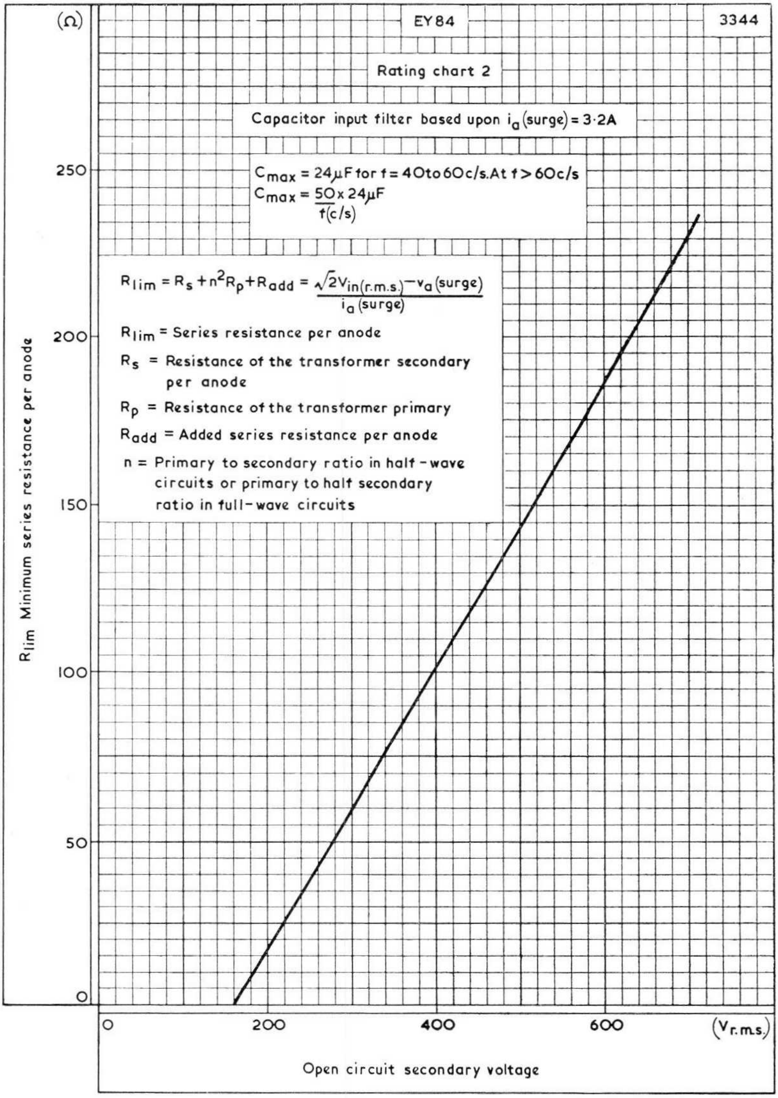


BOUNDARY OF OPERATION WITH CAPACITOR OR CHOKE INPUT FILTER

HALF-WAVE RECTIFIER

EY84

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.



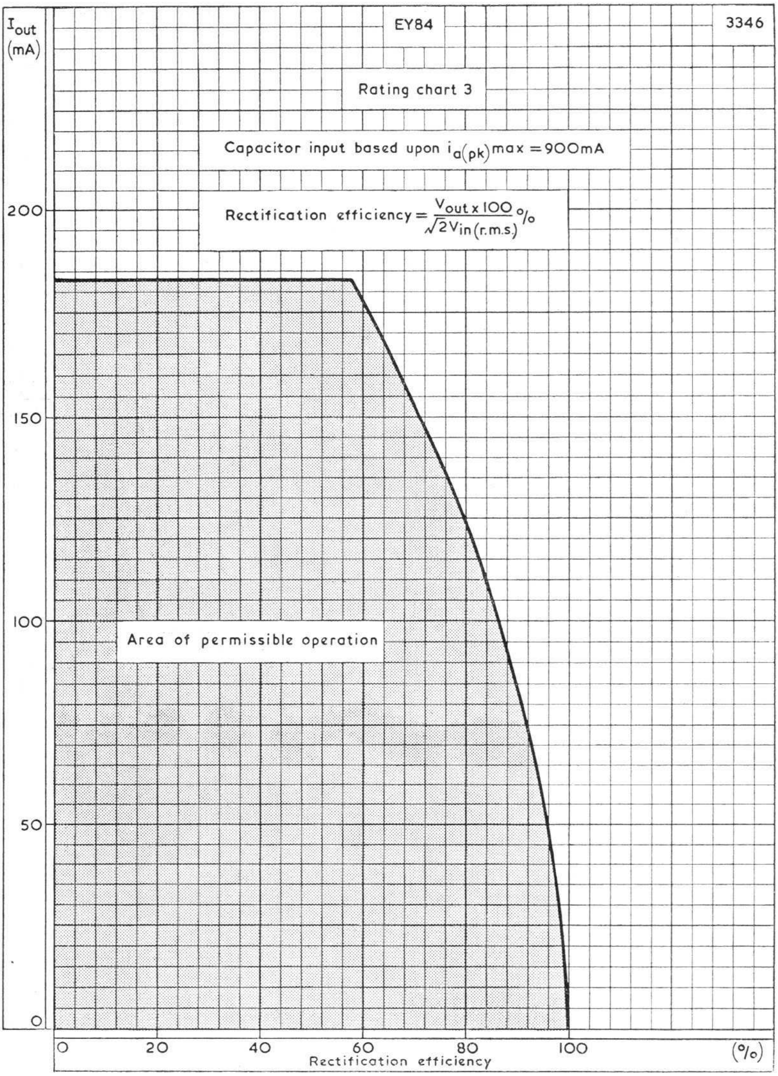
MINIMUM SERIES ANODE RESISTANCE PLOTTED AGAINST OPEN CIRCUIT SECONDARY VOLTAGE

Mullard

EY84

HALF-WAVE RECTIFIER

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

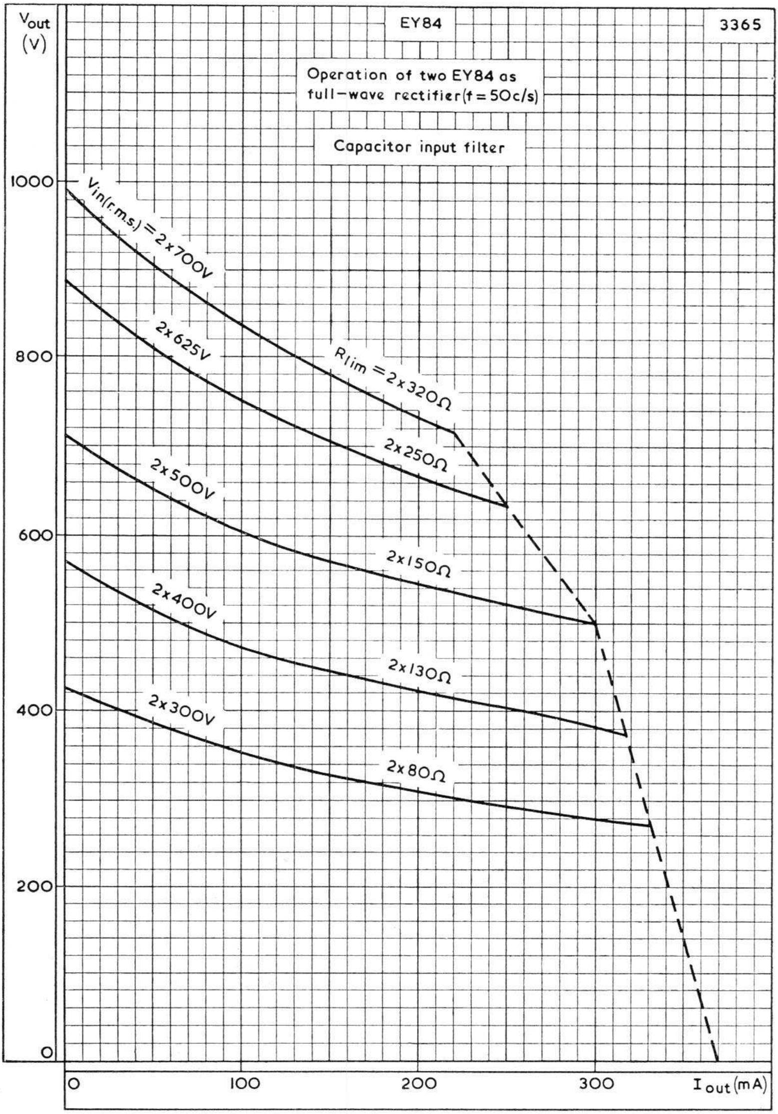


OUTPUT CURRENT PLOTTED AGAINST RECTIFICATION EFFICIENCY

HALF-WAVE RECTIFIER

EY84

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.

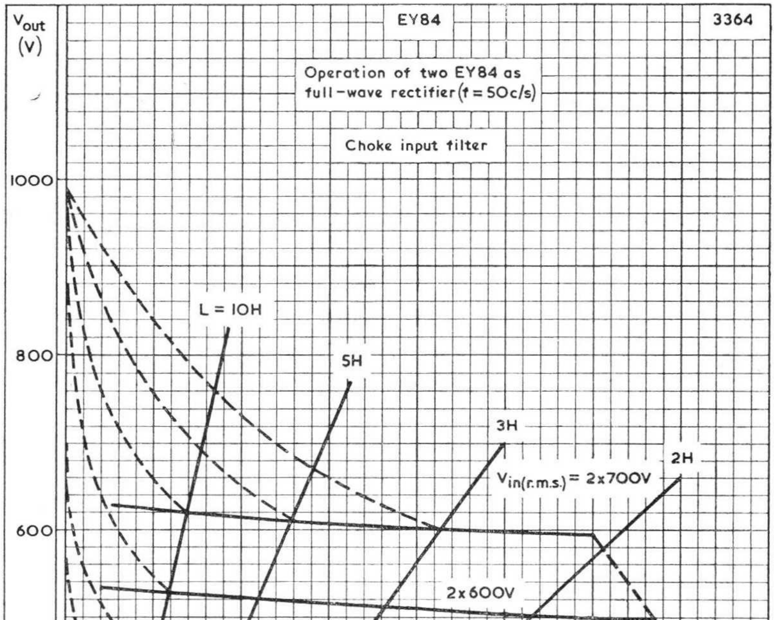


CAPACITOR INPUT FILTER REGULATION CURVES

EY84

HALF-WAVE RECTIFIER

Indirectly heated half-wave rectifier primarily intended for operation at high altitudes.



CHOKE INPUT FILTER REGULATION CURVES

HALF-WAVE RECTIFIERS

EY86 EY87

High voltage half-wave rectifiers particularly suitable for use in cathode ray tube e.h.t. supply units. The EY87 is electrically identical to the EY86 but has a chemically treated bulb to prevent flash-over under conditions of high humidity.

HEATER

V_h	6.3	V
I_h	90	mA
Heater voltage tolerances $I_{out} \leqq 200\mu A$	±15*	%
$I_{out} > 200\mu A$	±7*	%

*These tolerances apply when the power supply voltage is at its nominal value and when a valve having bogey heater characteristics is employed. In addition, fluctuations in the mains supply voltage not exceeding ±10% are permissible.

CAPACITANCE

$c_{a-(h+k+s)}$	1.7	pF

LIMITING VALUES

Pulsed input

†P.I.V. max.	22	kV
I_{out} max.	800	μA
††$i_{a(pk)}$ max.	40	mA
C max.	2000	pF

†Max. duration 18% of a line scanning cycle with a max. of 18μs.

††Max. duration 10% of a line scanning cycle with a max. of 10μs.

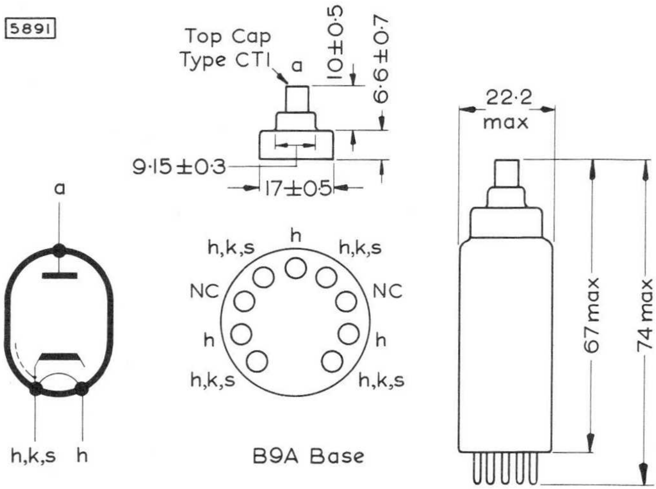
Sinusoidal input (50c/s)

$V_{in(r.m.s.)}$ max.	5.0	kV
I_{out} max.	3.0	mA
C max.	0.2	μF
R_{lim} min.	100	kΩ

WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 16kV. The level of X-radiation is likely to be considerably higher when the heater circuit of the tube is open.

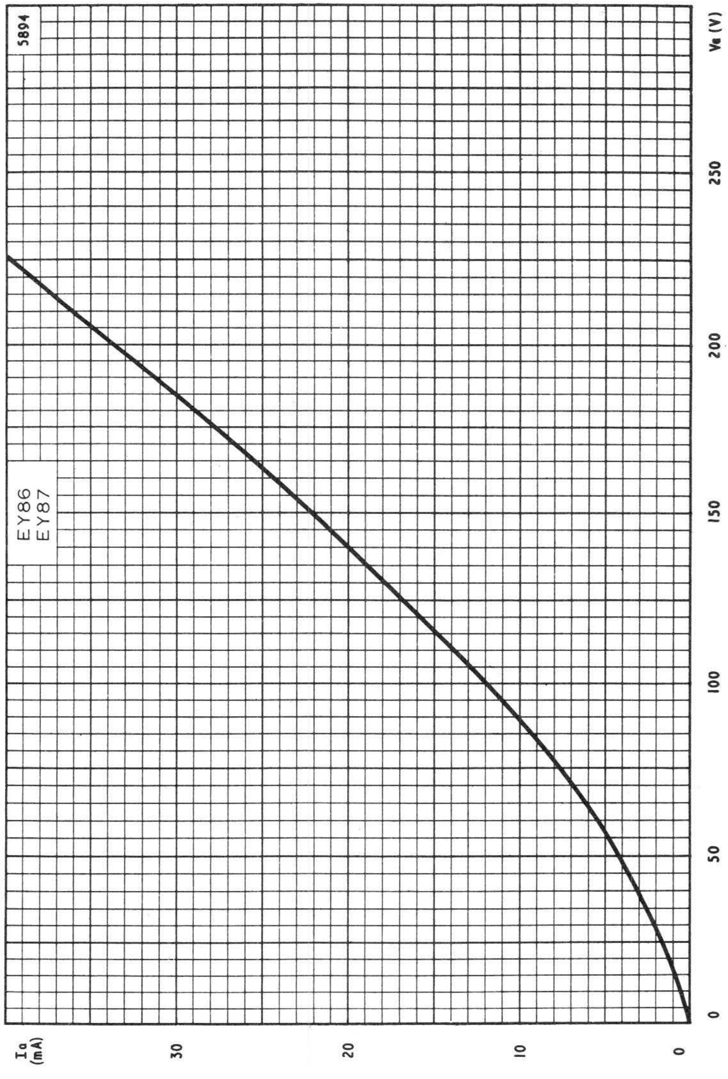
5891



All dimensions in mm

Pins 1, 4, 6 and 9 may be used for fixing an anti-corona shield.

Pins 3 and 7 may only be connected to points in the heater circuit and must not be earthed.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

FULL-WAVE RECTIFIER

EZ81

Indirectly heated full-wave rectifier with 6.3V heater.

HEATER

V_h	6.3	V
I_h	1.0	A

LIMITING VALUES

P.I.V. max.	1.3	kV ←
$i_{a(pk)}$ max.	500	mA ←
$i_{a(surge)}$ max.	1.8	A ←
V_{h-k} max. (cathode positive)	500	V

Capacitor input

I_{out} max. }
$V_{in(r.m.s.)}$ max. } See rating chart 1

R_{lim} min. See rating charts 2 and 3 and capacitor input regulation curves.

Choke input

I_{out} max. }
$V_{in(r.m.s.)}$ max. } See rating chart 1

L_{min} (at 50c/s) See choke regulation curves

CHARACTERISTIC

Anode voltage drop (I_{out} = 150mA)	19.8	V

OPERATING CONDITIONS ←

Capacitor input

$V_{in(r.m.s.)}$	2×250	2×350	2×450	V
R_{lim} (per anode)	150	230	310	Ω
C	50	50	50	μF
I_{out}	160	150	100	mA
V_{out}	245	352	497	V

Choke input

$V_{in(r.m.s.)}$	2×250	2×350	2×450	V
L	10	10	10	H
I_{out}	180	180	150	mA
V_{out}	199	288	378	V

OPERATING NOTES

The design of a power circuit starts with a knowledge of the output conditions and from this information the transformer and secondary or input voltage can be chosen. Reference to the rating charts will indicate whether a rectifier is suitable for a particular application.

Rating chart 1

This shows all the combinations of input voltage and output current considered safe for both capacitor and choke input filters.

Rating chart 2

This chart shows the minimum series resistor per anode necessary to restrict the maximum switching surge in a capacitor input filter, to its limiting value over the range of supply voltages.

Rating chart 3

This shows the relationship between the maximum rectification efficiency and output current.

Capacitor input filter curcuits

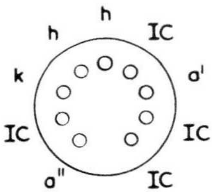
Reference should be made to rating charts 2 and 3 and the regulation curves. The circuit is set up and the input and output voltage and output current are measured. If the operating conditions lie within the boundary lines of the regulation curves, an improvement in the rectification efficiency may be effected by reducing the value of the limiting resistance. Rating chart 2 gives the minimum value of the limiting resistance against open circuit secondary voltage; this resistance will guard against excessive switching currents.

Comparison of the calculated rectification efficiency $\frac{V_{out}}{\sqrt{2}\times V_{in(r.m.s.)}}$ with rating chart 3 will show whether the limiting resistance must be increased to lower the rectification efficiency to the area of safe operation. Operation within this area indicates that the limiting value $i_{a(pk)}$ has not been exceeded.

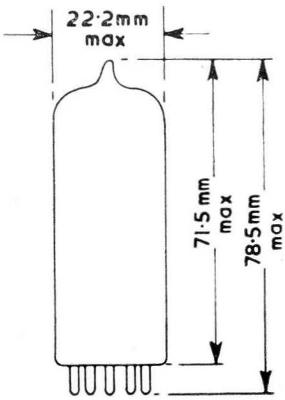
Choke input circuit

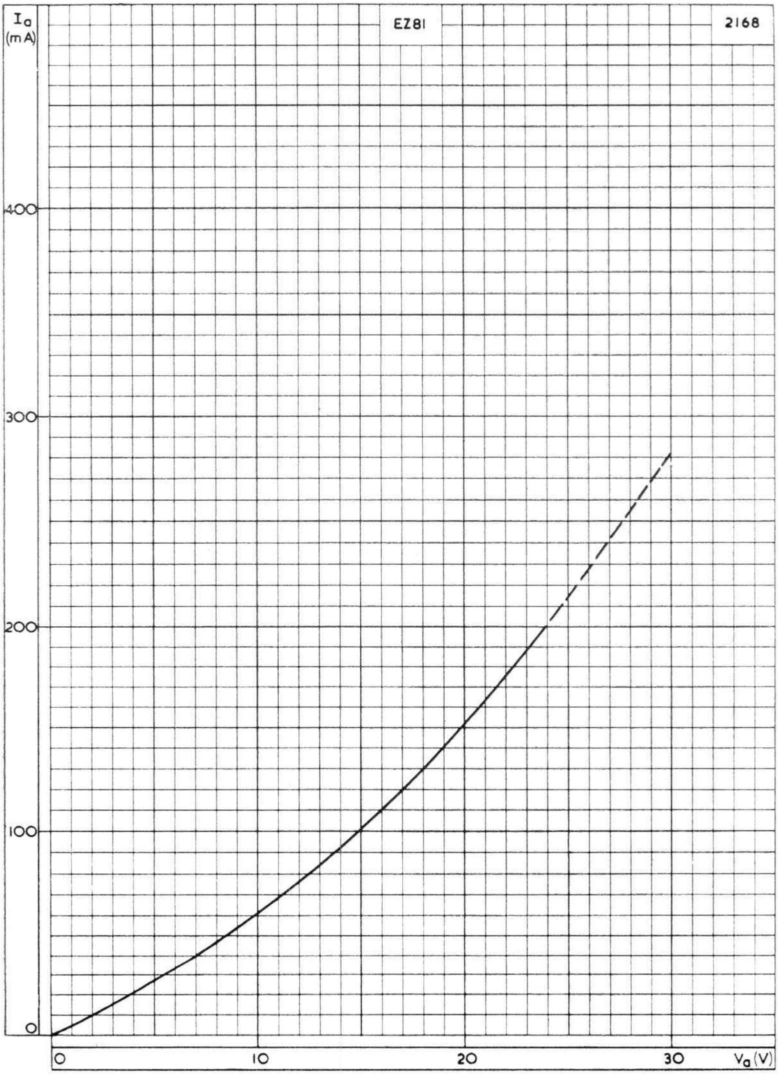
Reference should be made to rating chart 1. A suitable value of choke can be obtained from the choke regulation curves.

2170

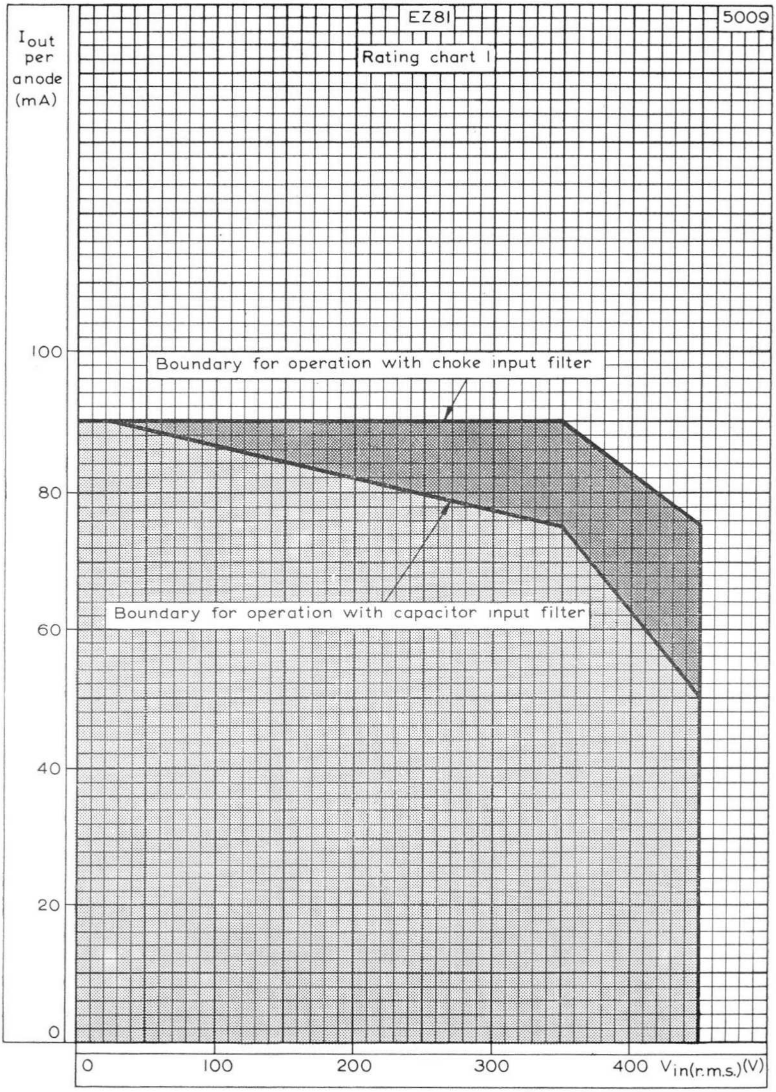


B9A
Noval Base

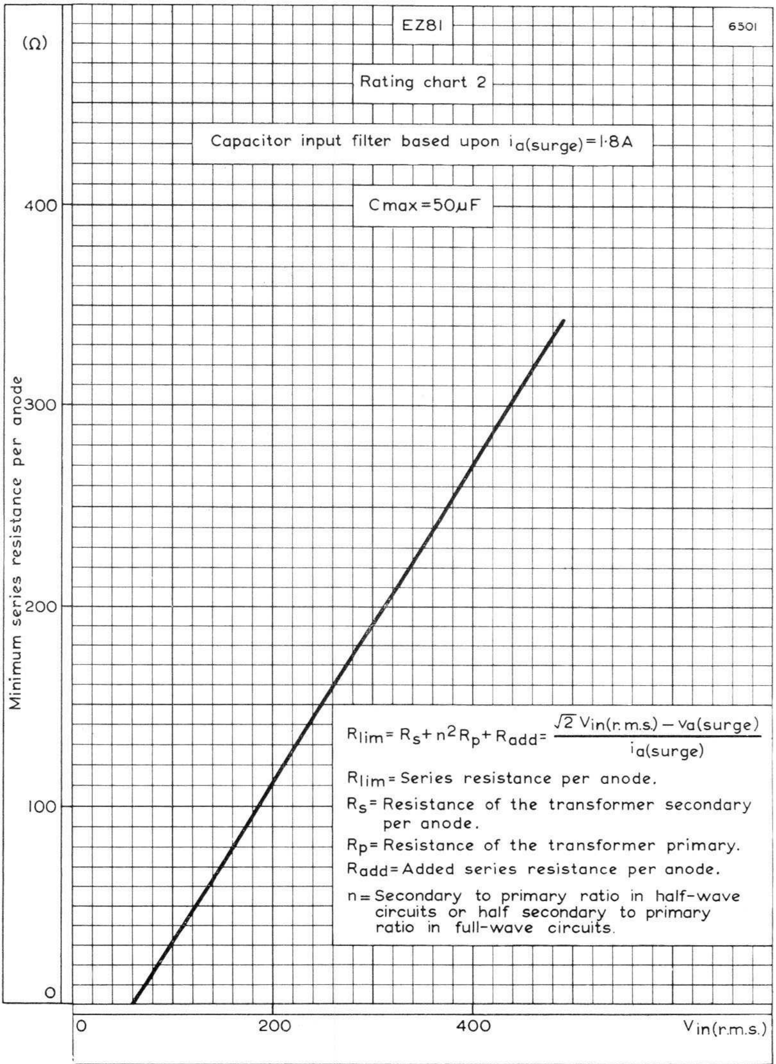




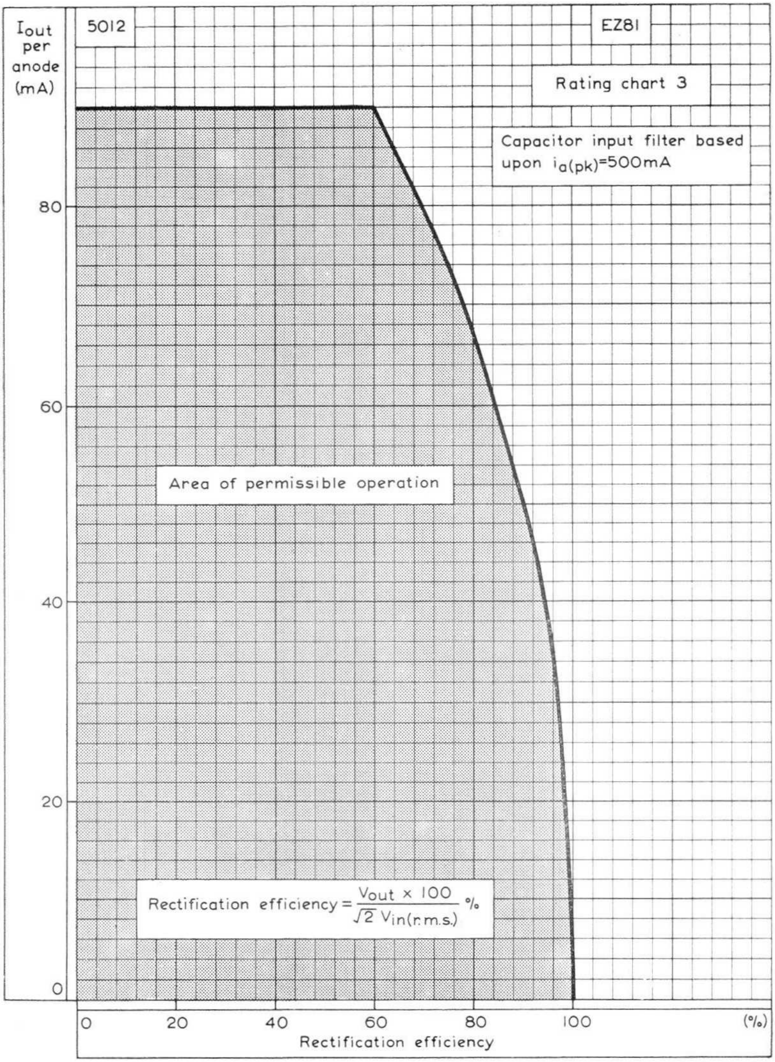
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE



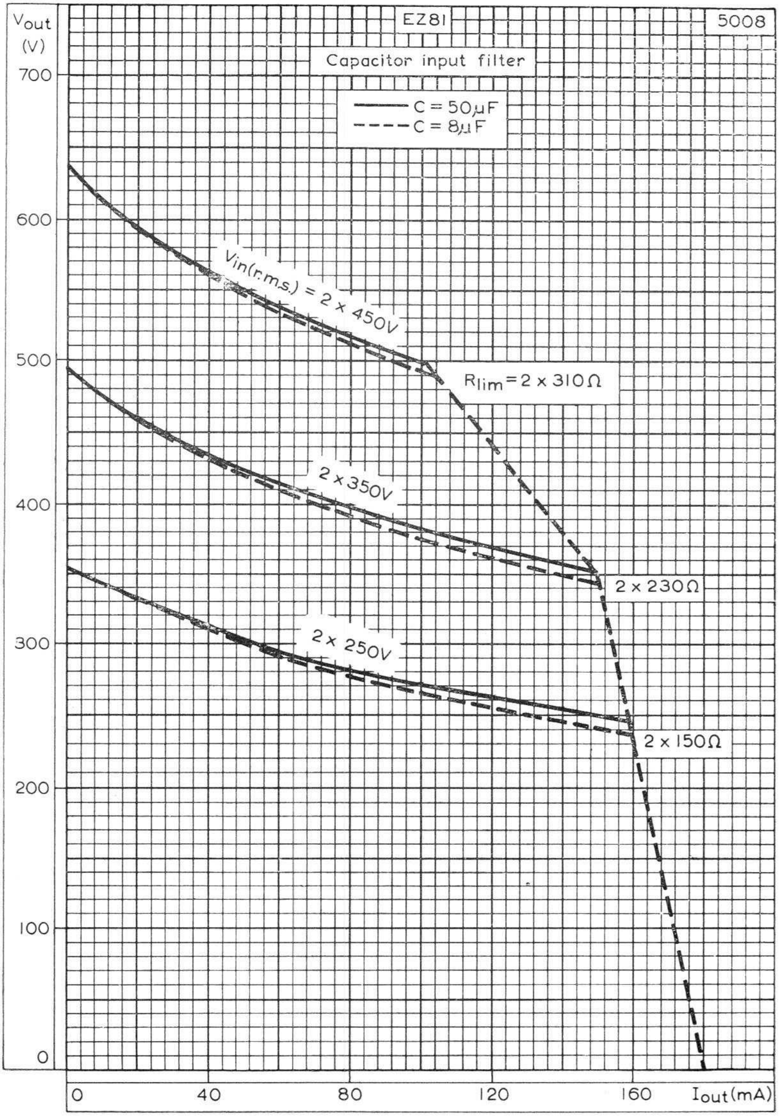
BOUNDARY OF OPERATION WITH CAPACITOR OR CHOKE INPUT FILTER



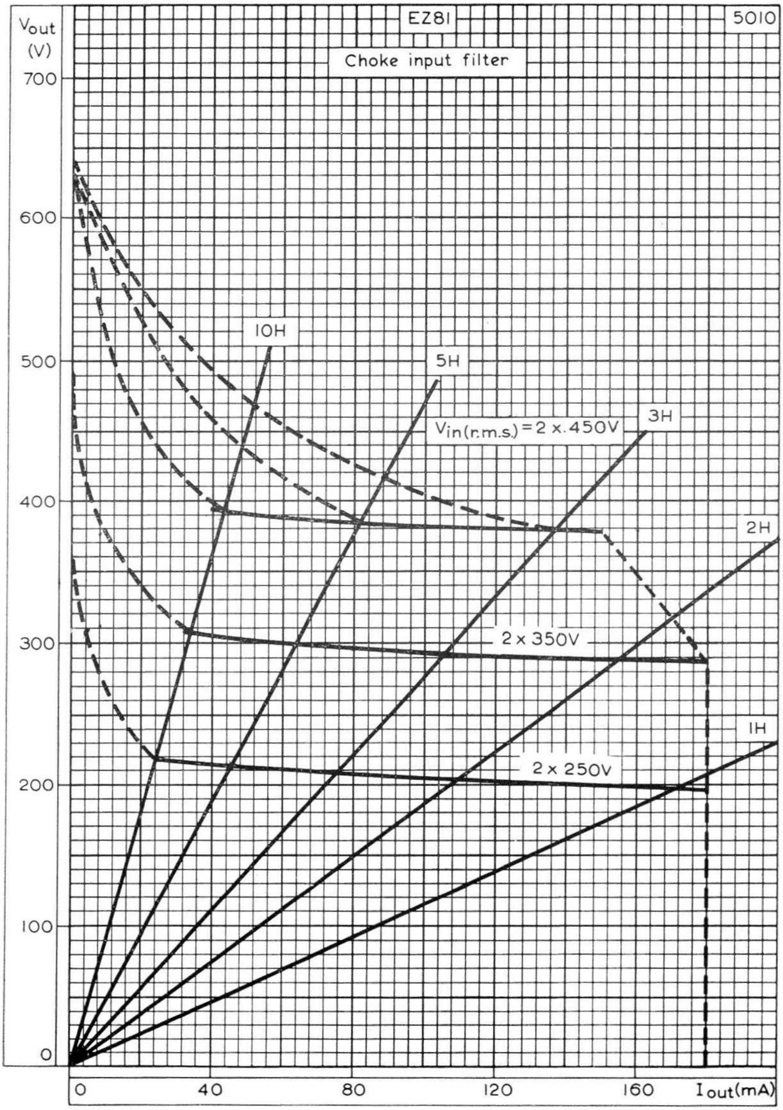
MINIMUM SERIES ANODE RESISTANCE PLOTTED AGAINST OPEN CIRCUIT SECONDARY VOLTAGE



OUTPUT CURRENT PER ANODE PLOTTED AGAINST RECTIFICATION EFFICIENCY



CAPACITOR INPUT FILTER REGULATION CURVES



CHOKE INPUT FILTER REGULATION CURVES

HALF-WAVE RECTIFIER GY501

E.H.T. rectifier for colour television receivers. This valve has a chemically treated envelope to avoid flashover under conditions of high humidity and low atmospheric pressure (450mm of mercury).

HEATER

V_h (see note 1)	3.15	V
I_h	400	mA

CAPACITANCES

c_{a-h+k}	1.2	pF ←

OPERATING CONDITIONS

I_{out}	1.5	mA
V_{out}	25	kV

RATINGS (DESIGN CENTRE SYSTEM)

P.I.V. max. (see note 2)	31	kV
V_{out} max.	25	kV
$I_{a(out)}$ max.	1.7	mA

OPERATING NOTES

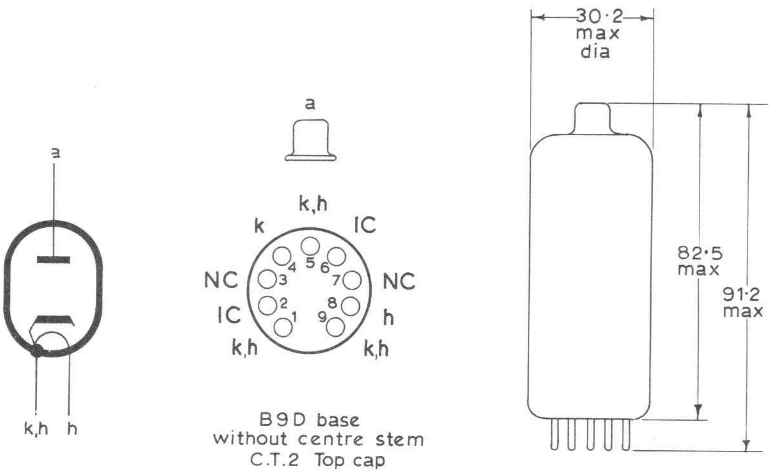
1. The nominal heater voltage value applies to operation with the average beam current to be expected in practice. Heater voltage variations up to max. ±15% are permitted for a nominal tube under the worst probable conditions.

2. Maximum pulse duration 22% of one cycle with a maximum of 18μs. The negative peak due to ringing in the line output transformer should be taken into account.

3. When operated in a television receiver this valve will produce X-radiation in excess of permissible dosage and a suitable screen should be incorporated.

OUTLINE DRAWING OF GY501

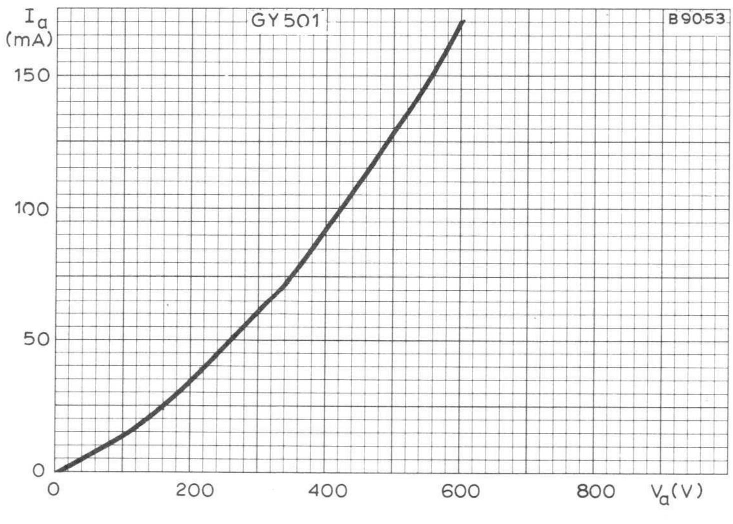
B9052 ←



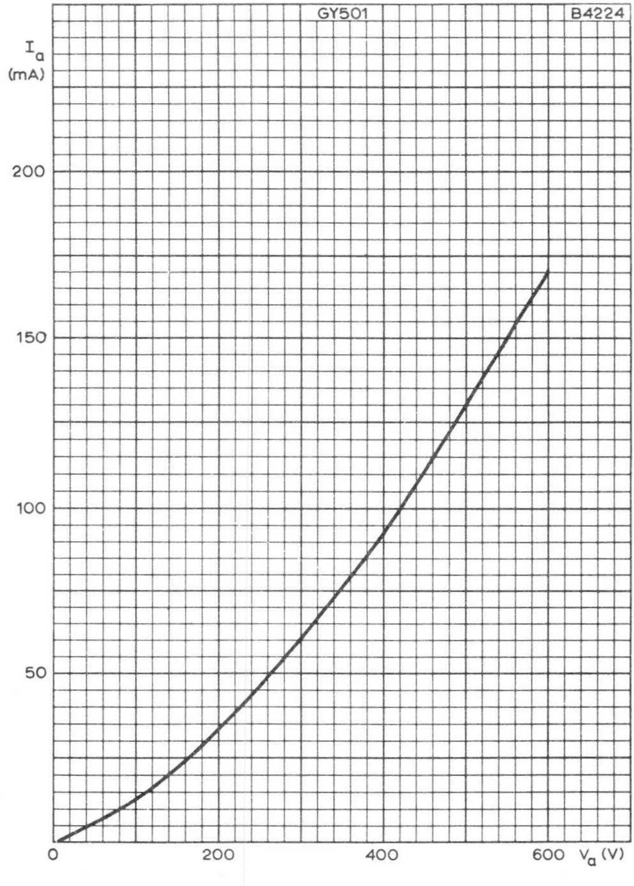
B9D base
without centre stem
C.T.2 Top cap

All dimensions in mm

Pins 1, 5 and 9 may be used to connect an anti-corona ring. Circuit elements having the same potential as the heater, eg. series resistor, may be connected to pins 3 and 7. These pins must not be earthed



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

FULL-WAVE RECTIFIER

GZ34

Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.

HEATER

V_h	5.0	V
I_h	1.9	A

LIMITING VALUES

P.I.V. max.						1.5	kV
$i_{a(pk)}$ max.						750	mA
C max.						60	μF
$V_{a(r.m.s.)}$	2×300	2×350	2×400	2×450	2×500	2×550	V
Capacitor input							
I_{out} max.	250	250	250	250	200	160	mA
R_{lim} min. (per anode)	50	75	100	125	150	175	Ω
Choke input							
I_{out} max.	250	250	250	250	250	225	mA
R_{lim} min. (per anode)	0	0	0	0	0	0	Ω

TYPICAL OPERATING CONDITIONS ←

Capacitor input

$V_{a(r.m.s.)}$ (V)	I_{out} (mA)	C (μF)	R_{lim} (per anode) (Ω)	V_{out} (V)
2×300	250	60	75	330
2×350	250	60	100	380
2×400	250	60	125	430
2×450	250	60	150	480
2×500	200	60	175	560
2×550	160	60	200	640

Choke input

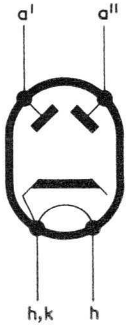
$V_{a(r.m.s.)}$ (V)	I_{out} (mA)	L (H)	R_{lim} (per anode) (Ω)	V_{out} (V)
2×300	250	10	0	250
2×350	250	10	0	290
2×400	250	10	0	330
2×450	250	10	0	375
2×500	250	10	0	420
2×550	225	10	0	465

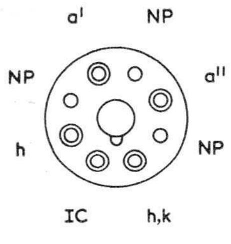
GZ34

FULL-WAVE RECTIFIER

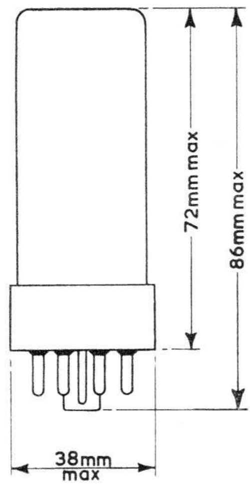
Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.

5305





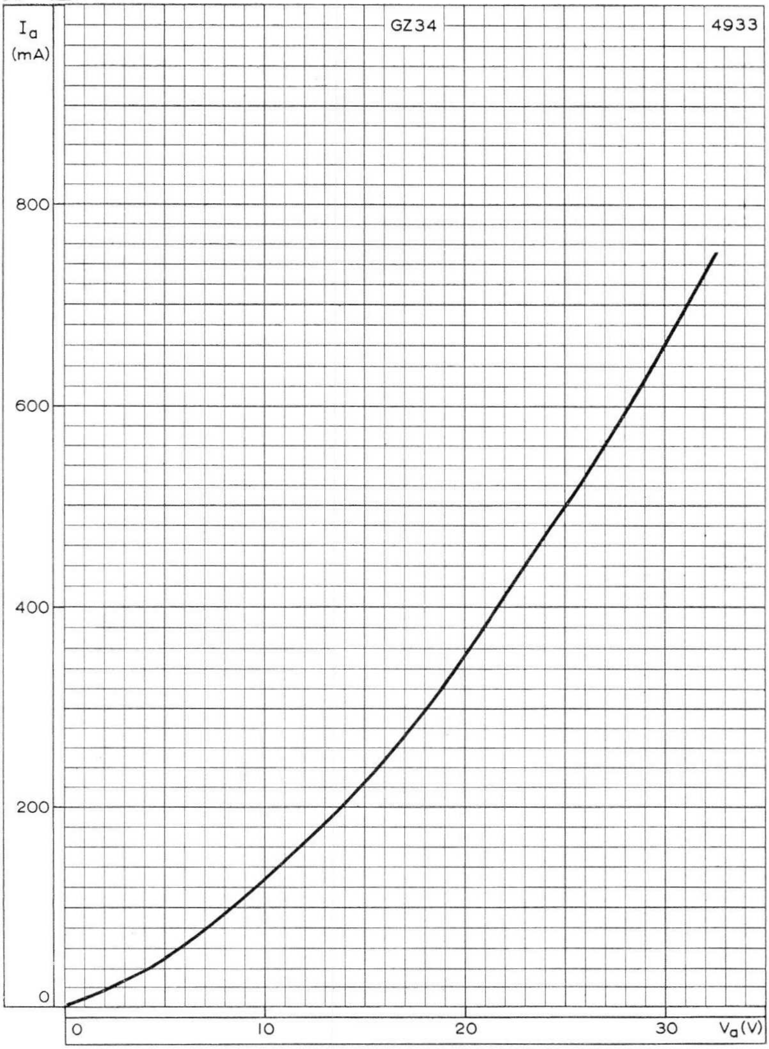
Octal Base



FULL-WAVE RECTIFIER

GZ34

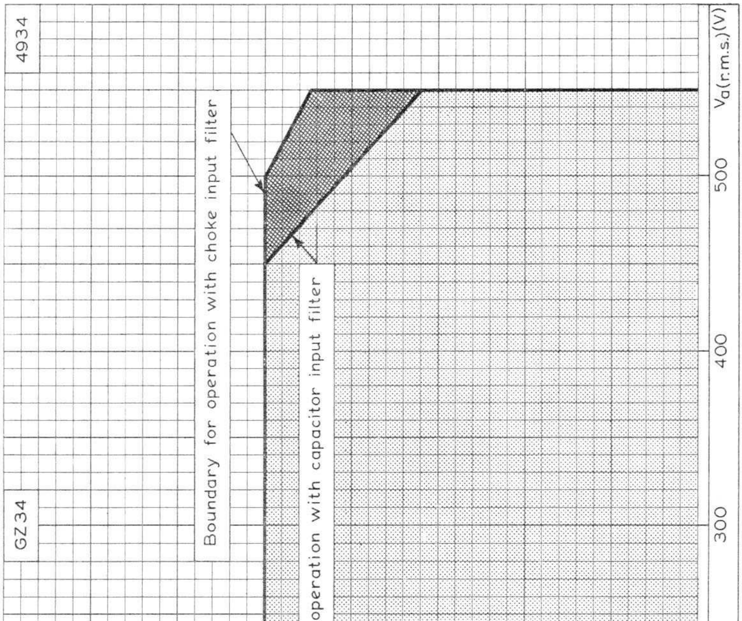
Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

FULL-WAVE RECTIFIER

Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.

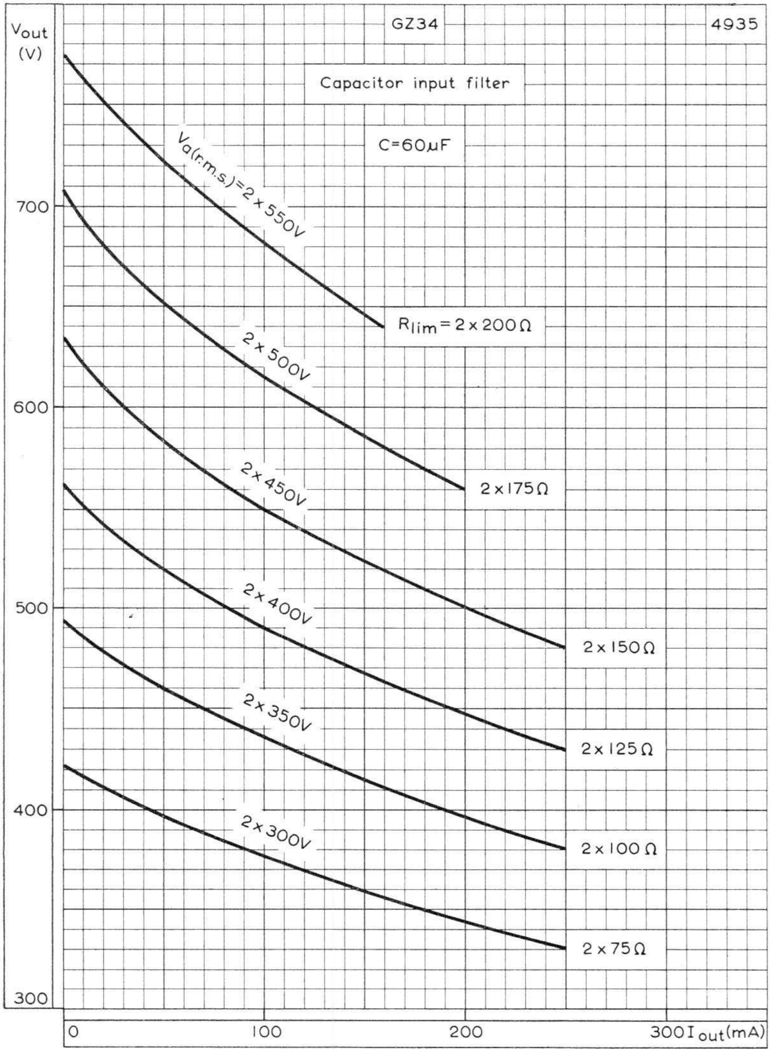


BOUNDARY OF OPERATION WITH CAPACITOR OR CHOKE INPUT FILTER

FULL-WAVE RECTIFIER

GZ34

Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.

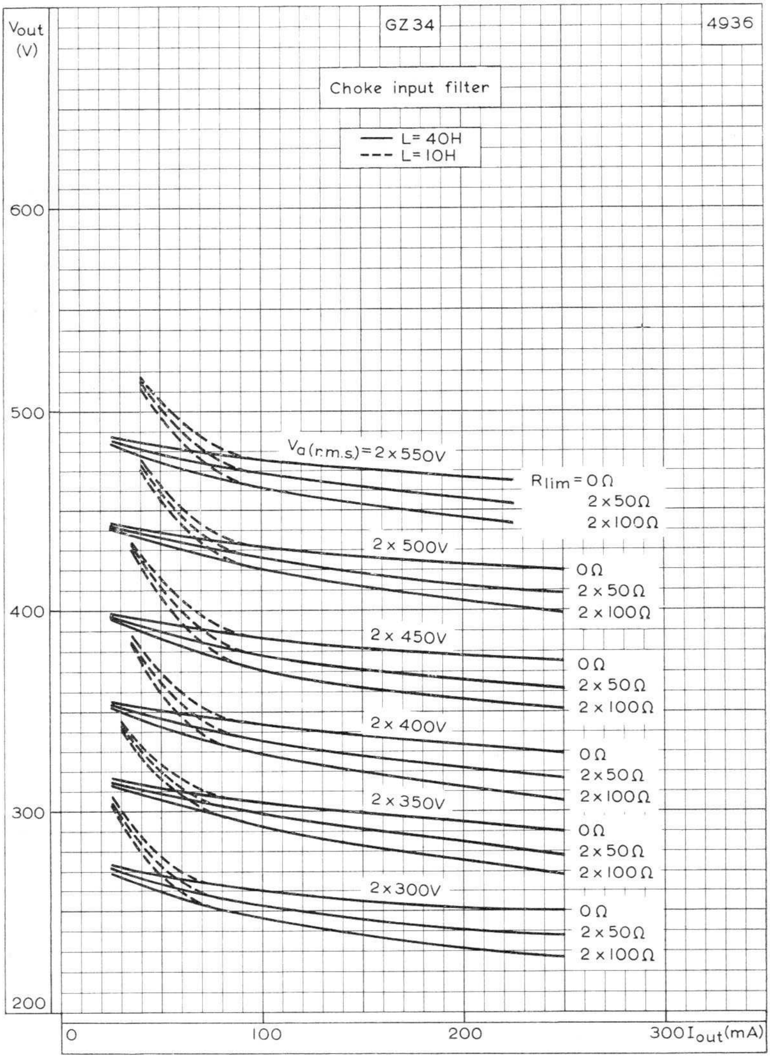


CAPACITOR INPUT FILTER REGULATION CURVES

GZ34

FULL-WAVE RECTIFIER

Indirectly heated full-wave rectifier primarily intended for use in a.c. mains operated equipment.



CHOKE INPUT FILTER REGULATION CURVES

U.H.F. TRIODE

PC86

Frame-grid triode for use as grounded-grid amplifier or self-oscillating mixer in Bands IV and V.

HEATER

I_h	300	mA
V_h	4.0	V ←

CAPACITANCES ←

Unshielded

c_{a-g}	2.2	pF
c_{a-k}	240	mpF
c_{a-k+h}	350	mpF
c_{a-g+h}	2.3	pF
c_{g-k}	3.5	pF
c_{g-k} (I_a = 12mA)	5.6	pF
c_{g-k+h}	3.8	pF
c_{g-h}	300	mpF
c_{k-g+h}	6.3	pF

Shielded

$c_{h+k-g+s}$	4.1	pF
c_{a-g+s}	3.3	pF
c_{a-k+h}	300	mpF

CHARACTERISTICS

V_a	175	V
V_g	-1.5	V
I_a	12	mA
g_m	14	mA/V
r_a	4.85	kΩ
μ	68	
R_{eq}	230	Ω

OPERATING CONDITIONS

As grounded-grid amplifier

V_a	175	V
I_a	12	mA
R_k	125	Ω
g_m	14	mA/V

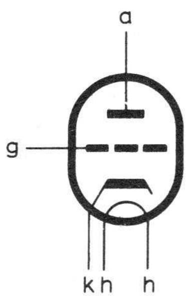
As self-oscillating mixer

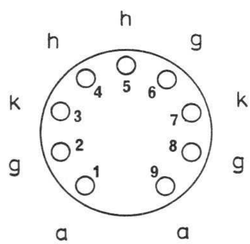
$V_{a\ (b)}$	220	V
R_a	5.6	kΩ
R_g	47	kΩ
I_a	12	mA
I_g	50	µA
v_{osc} (r.m.s.)	2.5	V
g_c	5.5	mA/V

DESIGN CENTRE RATINGS

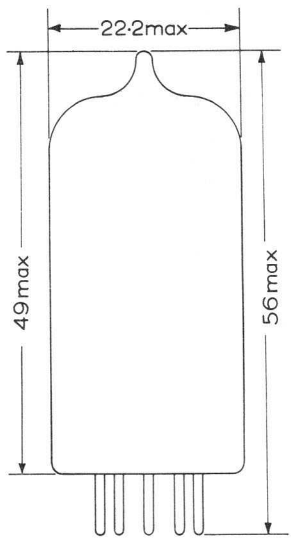
$V_{a\ (b)}$ max.	550	V
V_a max.	220	V
p_a max.	2.2	W
I_k max.	20	mA
$-V_g$ max.	50	V
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	100	V

B4187

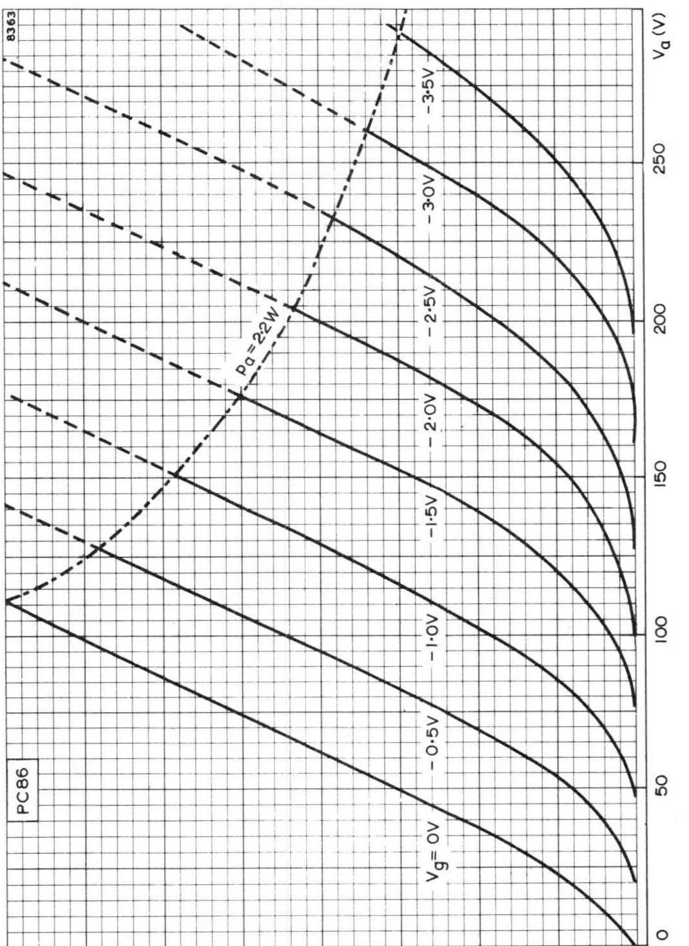




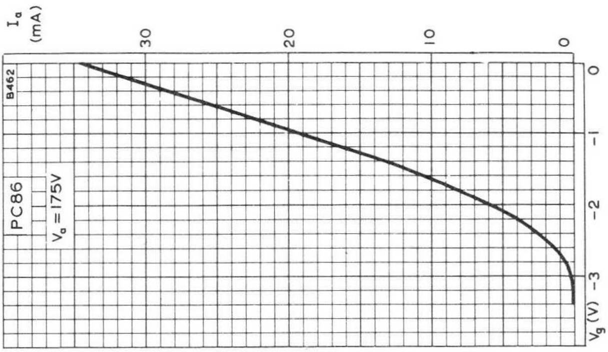
B9A Base

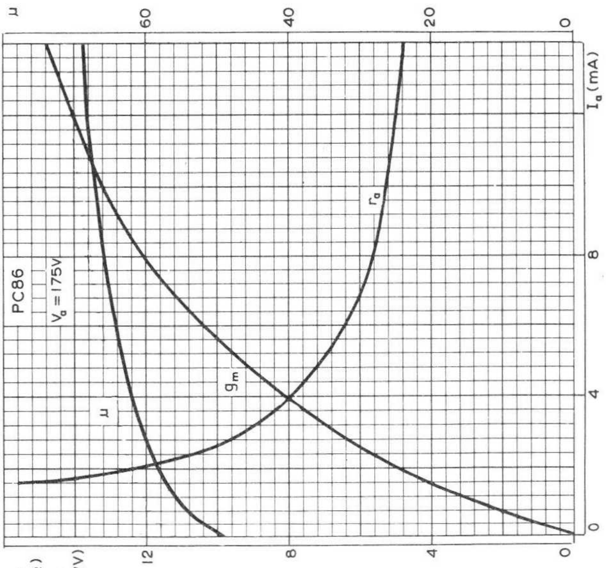


All dimensions in mm



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.





ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE. Va = 175V

MUTUAL CONDUCTANCE, AMPLIFICATION FACTOR AND ANODE IMPEDANCE PLOTTED AGAINST ANODE CURRENT. Va = 175 V

U.H.F. TRIODE

PC88

Frame-grid triode for use as grounded-grid amplifier in Bands IV and V.

HEATER

I_h	300	mA
V_h	3.8	V

CAPACITANCES *(measured with close fitting shield connected to the grid)*

$c_{h+k-g+s}$	3.8	pF
c_{a-g+s}	1.7	pF
c_{a-k+h}	55	mpF
	Unshielded	
c_{a-g}	1.2	pF

CHARACTERISTICS

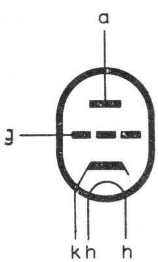
V_a	160	V
I_a	12.5	mA
V_g	–1.25	V
g_m	13.5	mA/V
r_a	4.8	kΩ
μ	65	
R_{eq}	240	Ω

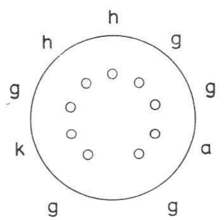
OPERATING CONDITIONS

V_a	160	V
R_k	100	Ω
I_a	12.5	mA
g_m	13.5	mA/V
r_a	4.8	kΩ
μ	65	
Noise factor	10	dB

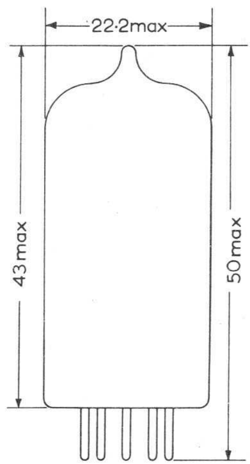
DESIGN CENTRE RATINGS

$V_{a(b)}$ max.	550	V
V_a max.	175	V
p_a max.	2.0	W
I_k max.	13	mA
$-V_g$ max.	50	V
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	100	V



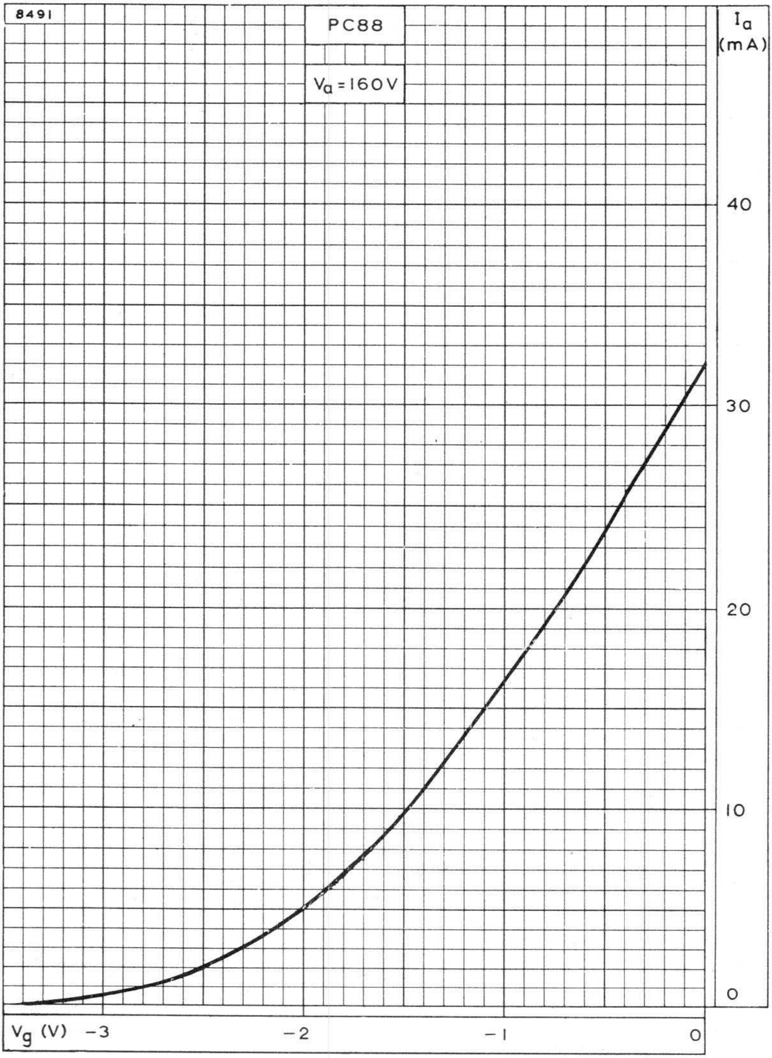


B9A Base

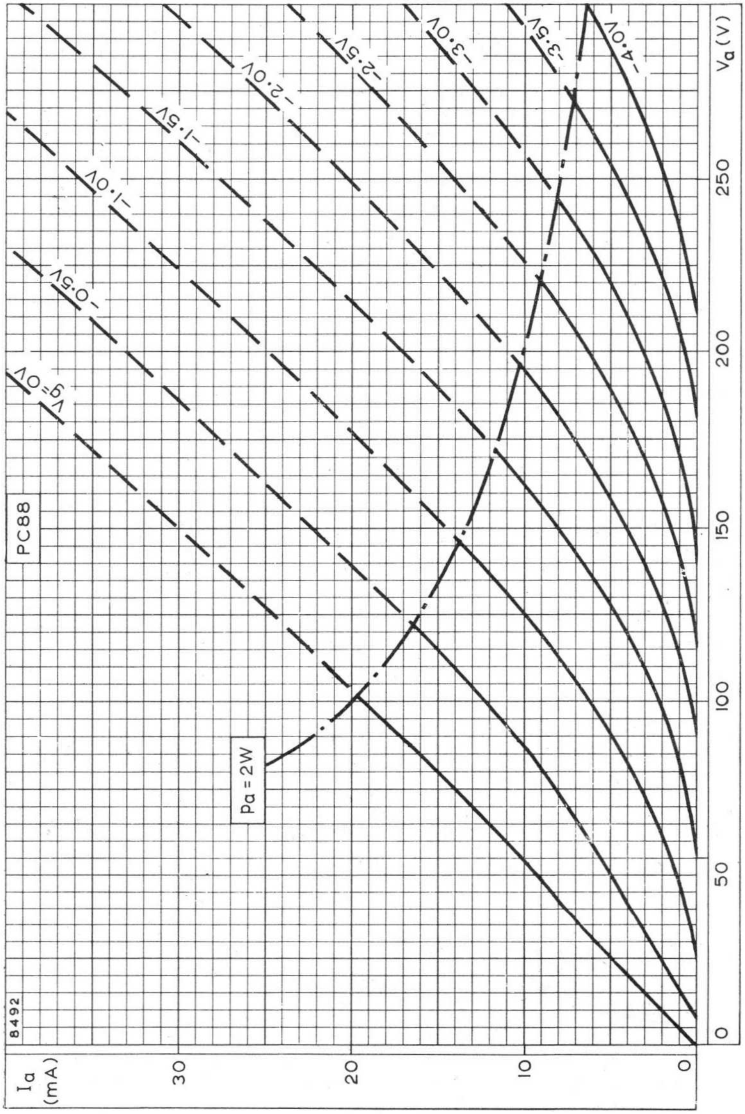


All dimensions in mm

8371



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

R.F. TRIODE

PC900

Triode with low anode-to-grid capacitance intended for use as an r.f. amplifier in v.h.f. television receivers.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	3.9	V←

CAPACITANCES (with external shield)

c_{a-g}	350	mpF
$c_{a-k+h+s}$	3.0	pF
$c_{g-k+h+s}$	4.5	pF
c_{a-k}	80	mpF
c_{g-k}	3.3	pF
c_{g-h}	<70	mpF
c_{k-h}	2.3	pF

CHARACTERISTICS

V_a	135	V
I_a	11.5	mA
V_g	-1.0	V
g_m	14.5	mA/V
μ	76	←
r_a	5.25	kΩ←

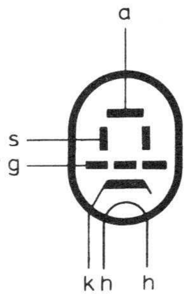
OPERATING CONDITIONS	1	2	3	
V_b	200	200	135	V
R_a	5.6	5.6	1.5	kΩ←
R_k	0	87	0	Ω←
I_a	16.5	11.5	16.5	mA←
I_g	20	0	20	μA←
V_g	-0.5	1.0	-0.5	V
g_m	20	14.5	20	mA/V
μ	84	76	84	←
V_g for 10 : 1 reduction in g_m	-3.2	-3.8	-2.3	V←
V_g for 100 : 1 reduction in g_m	-7.7	-8.3	-5.3	V←

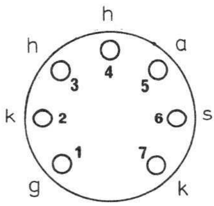
RATINGS (DESIGN CENTRE SYSTEM)

$V_{a(b)}$ max.	550	V
V_a max.	200	V
p_a max.	2.2	W
I_k max.	20	mA
$-V_g$ max.	50	V
Rg-k max.	1.0	MΩ
R_{g-k} max. (a.g.c. circuits)	3.0	MΩ
*V_{h-k} max.	100	V

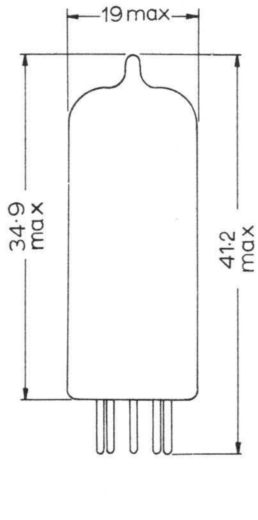
*To fulfil modulation hum requirement, V_{h-k} should not exceed 55V r.m.s. ←

B4370

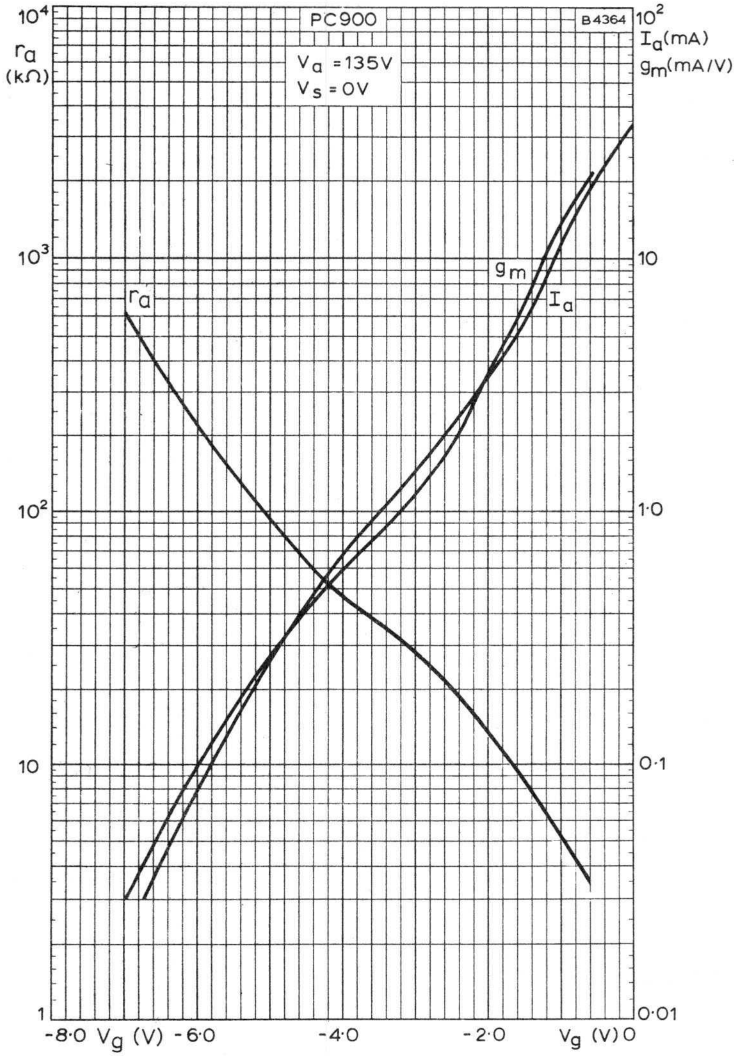




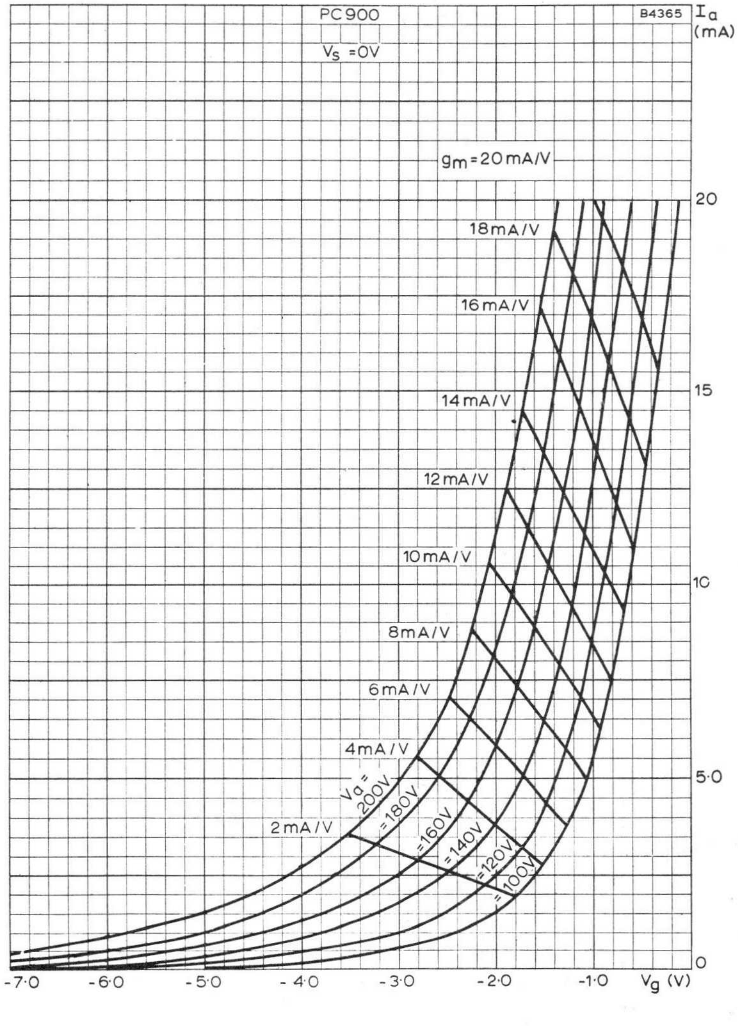
B7G Base



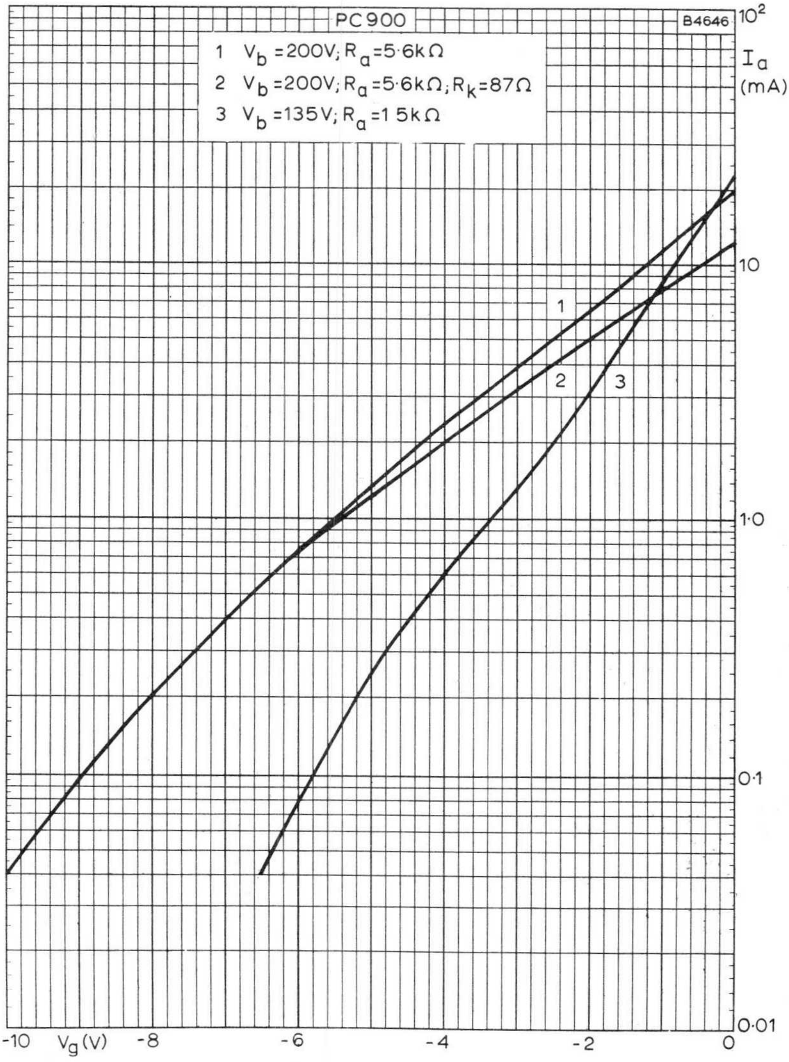
All dimensions in mm



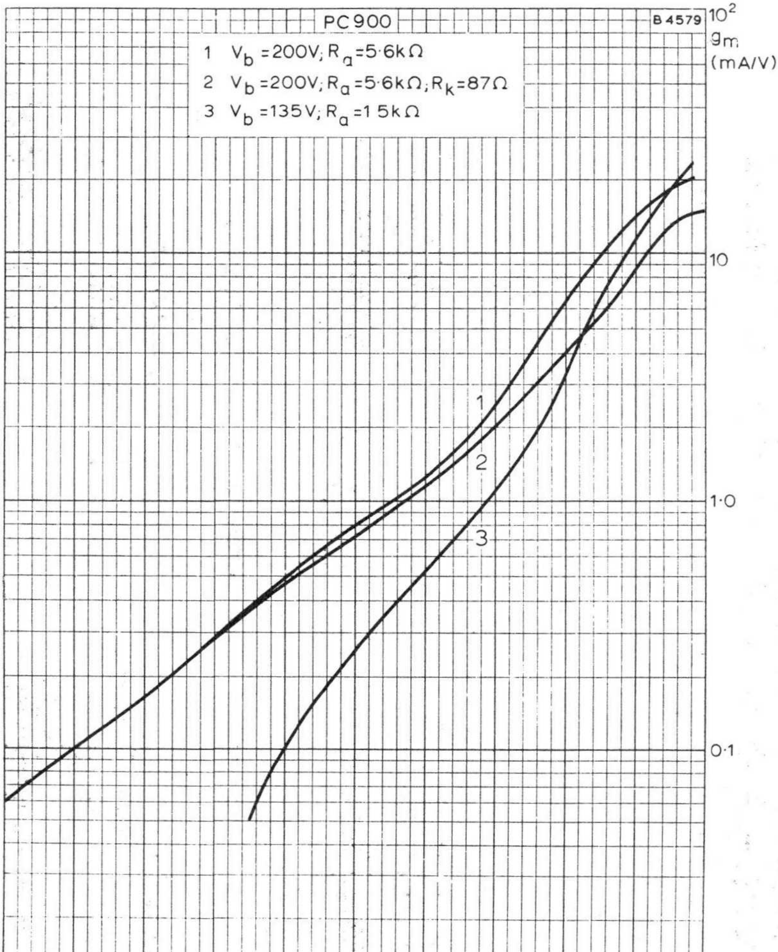
ANODE CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST GRID VOLTAGE



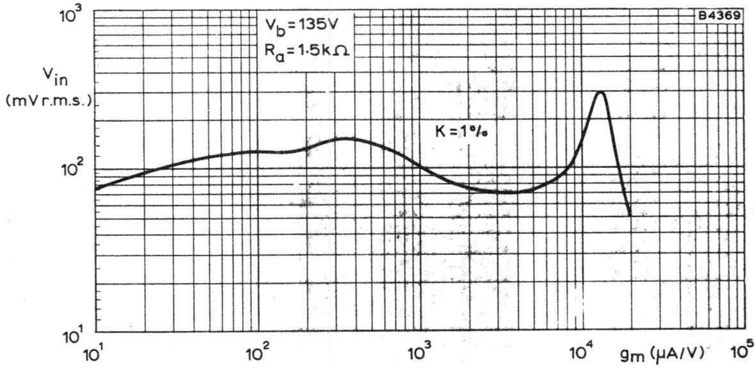
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AND MUTUAL CONDUCTANCE AS PARAMETERS

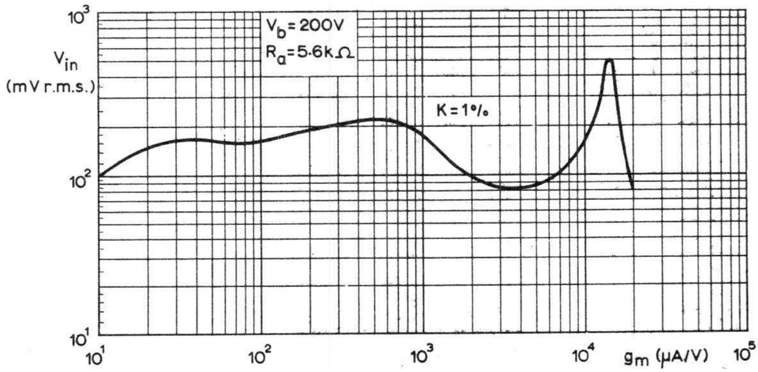


ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE



MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE





CROSS MODULATION CURVE

R. F. DOUBLE TRIODE

PCC85

Double triode primarily intended for use as an oscillator and mixer at frequencies up to 200Mc/s in television receivers.

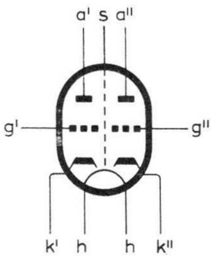
HEATER

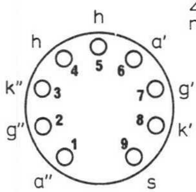
Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	9.0	V

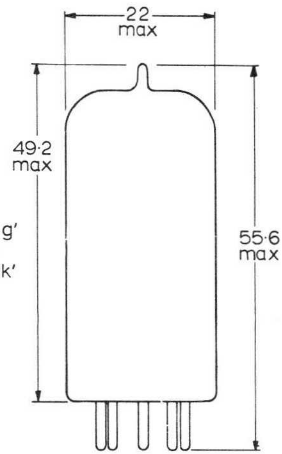
For characteristics, operating conditions and limiting values see type UCC85.

B4669





B9A Base



All dimensions in mm

The triode on pins 6,7 and 8 should be used as the r.f. amplifier and that on pins 1,2 and 3 as the self-oscillating additive mixer.

R.F. DOUBLE TRIODE

PCC89

Variable-mu frame grid double triode primarily intended for use as a cascode amplifier at frequencies up to 220Mc/s in television receivers with series connected heaters.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	7.5	V ←

CAPACITANCES (measured with an external shield)

$c_{a'-a''}$	<15	mpF
$c_{g'-a''}$	<5	mpF

Grounded cathode section

$c_{a'-g'}$	1.9	pF
$c_{g'-k'+h+g''+s}$	3.8	pF
$c_{a'-k'+h+g''+s}$	2.5	pF
$c_{g'-h}$	<300	mpF

Grounded grid section

$c_{a''-g''}$	4.1	pF
$c_{a''-k''}$	<200	mpF
$c_{k''-g''+h+s}$	6.3	pF
$c_{a''-g''+h+s}$	4.5	pF
$c_{k''-h}$	2.9	pF

CHARACTERISTICS (each section)

V_a	90	V
I_a	15	mA
V_g	–1.2	V
g_m	12.3	mA/V
r_a	2.9	kΩ
μ	36	

PCC89

R.F. DOUBLE TRIODE

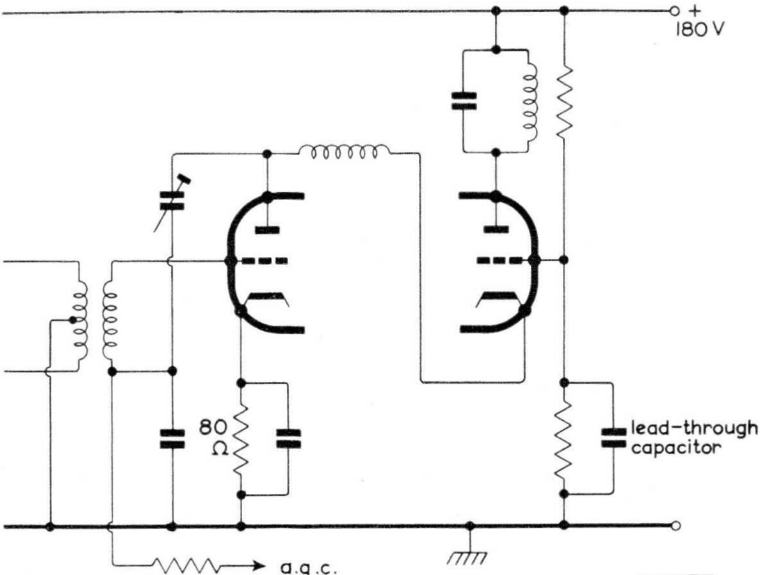
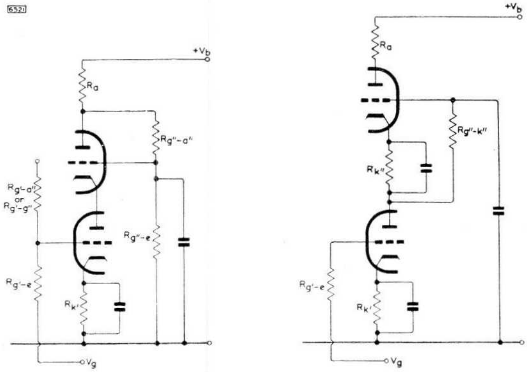


Fig. 1

CHARACTERISTICS (cascode—see Fig. 1)

V_b	180	V
I_a	15	mA
g_m	12	mA/V
$*V_{g'}$	−9.0	V
Noise factor	5.5	dB

*For 100 : 1 reduction in cascode slope.



Circuit A   Circuit B

OPERATING CONDITIONS

Condition	1	2	3	4	
Circuit	A	A	A	A	
V_b	190	190	190	190	V
$R_{a''}$	1.5	3.3	3.9	3.9	kΩ
$R_{g''-a''}$	100	100	100	100	kΩ
$R_{g''-e}$	100	100	100	100	kΩ
$R_{g'-e}$	—	470	470	470	kΩ
$R_{g'-g''}$	—	—	22	15	MΩ
$R_{k'}$	68	0	0	0	Ω
I_a	15	14.8	14.7	14.9	mA
g_m	13	14.4	14.7	14.8	mA/V
V_g for 100 : 1 reduction in g_m	−9.3	−9.0	−11	−12	V

Condition	5	6	7	8	9	
Circuit	A	A	A	B	B	
V_b	190	190	190	190	190	V
$R_{a''}$	3.9	3.9	4.7	1.5	3.3	kΩ
$R_{g''-a''}$	100	100	100	—	—	kΩ
$R_{g''-e}$	100	100	100	—	—	kΩ
$R_{g''-k''}$	—	—	—	—	470	kΩ
$R_{k''}$	0	0	0	68	0	Ω
$R_{g'-e}$	470	470	470	470	470	kΩ
$R_{g'-g''}$	—	10	—	—	—	MΩ
$R_{g'-a''}$	22	—	15	—	—	MΩ
$R_{k'}$	0	0	0	68	0	Ω
I_a	15	15.1	14	15	14.4	mA
g_m	14.9	15	14.7	13	14.3	mA/V
V_g for 100 : 1 reduction in g_m	−12.5	−13.5	−15	−16.5	−16	V

The gain/slope ratio depends upon the circuit and will differ at high and low frequencies.

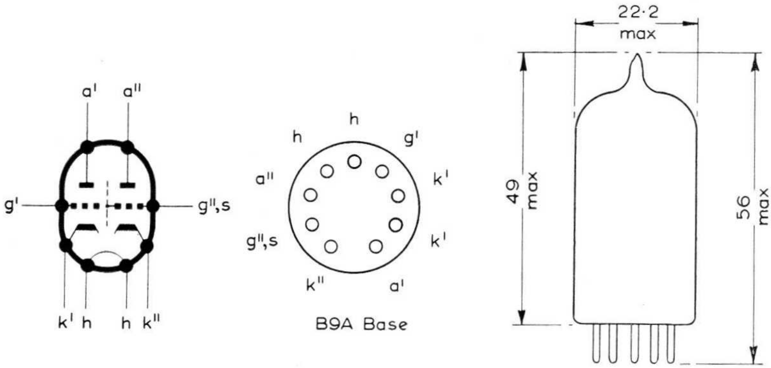
PCC89

R.F. DOUBLE TRIODE

LIMITING VALUES (each section, unless otherwise stated)

V_a max.	130	V
p_a max.	1.8	W
I_k max.	18	mA ←
$-V_g$ max.	50	V
$R_{g'-k'}$ max.	1.0	MΩ
$R_{g''-k''}$ max.	500	kΩ
$V_{h-k''}$ max. (cathode positive)	200	V ←
R_{h-k} max.	20	kΩ

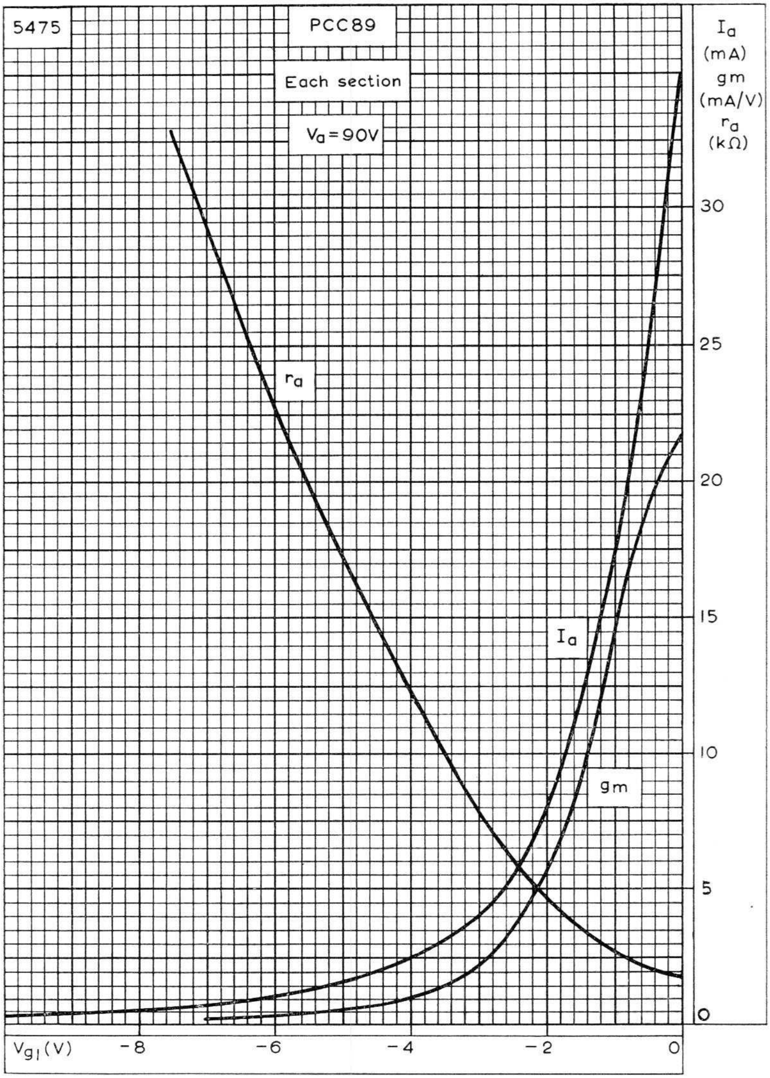
To fulfil hum requirements, $V_{h-k'}$ must be less than $50V_{r.m.s.}$



4473

All dimensions in mm

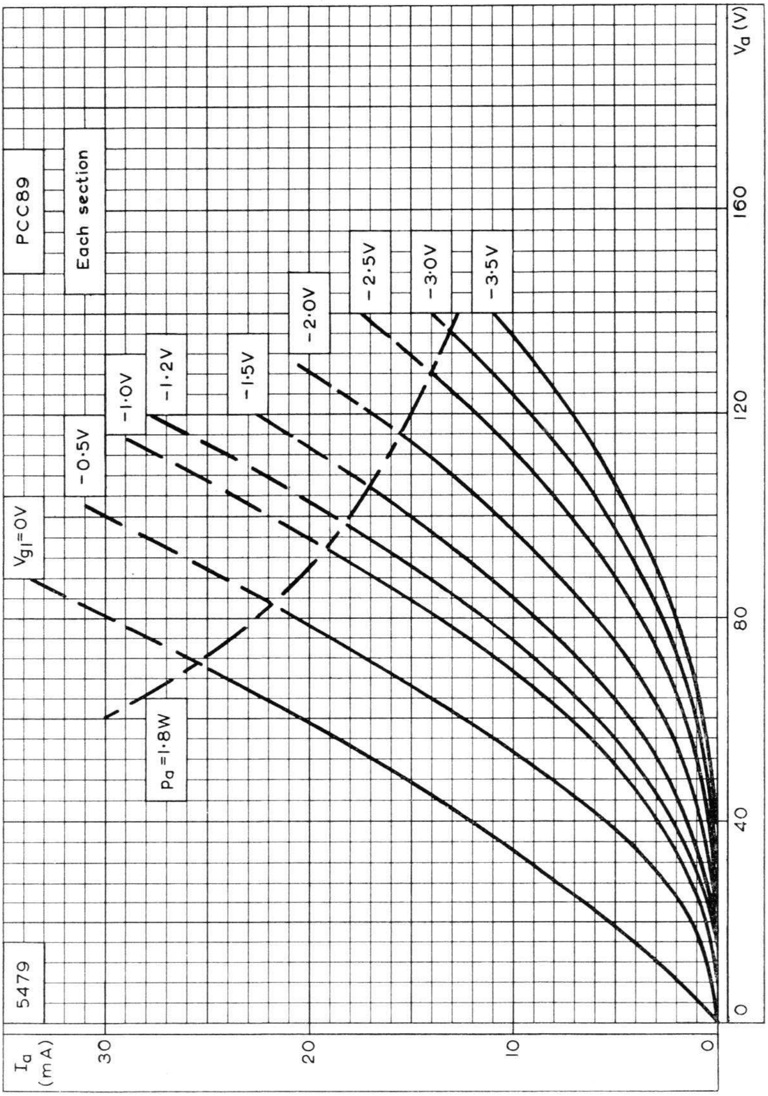
The triode on pins 6, 7, 8 and 9 should have the grounded cathode connection, and that on pins 1, 2 and 3 should have the grounded grid connection. It is recommended that pins 7 and 8 be strapped.



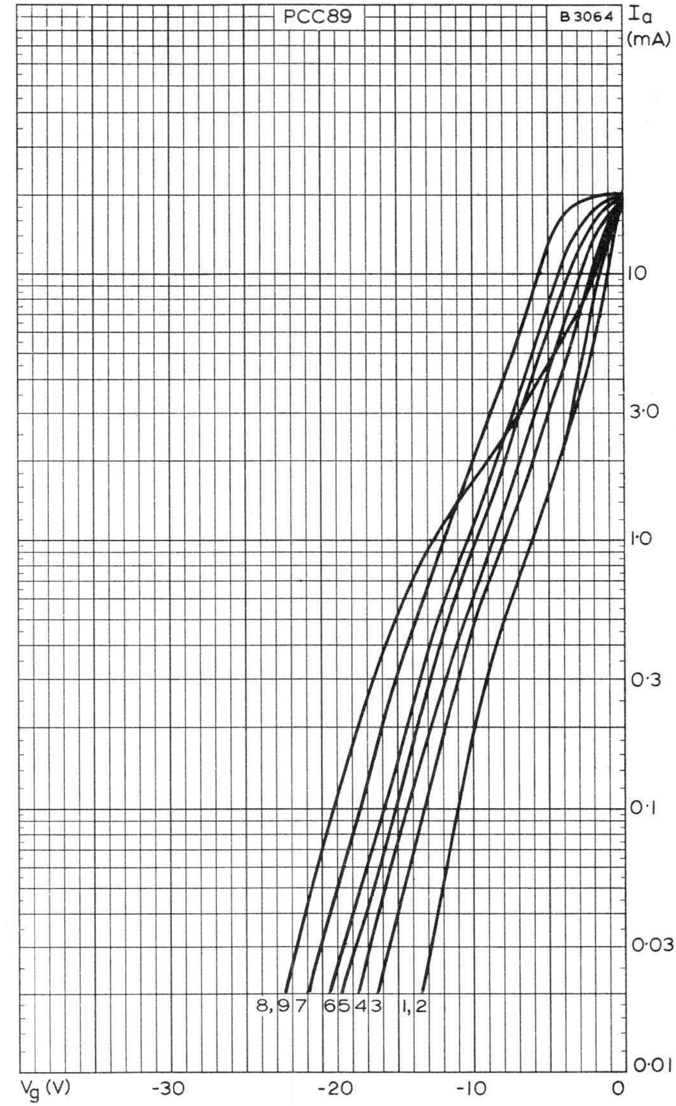
ANODE CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST GRID VOLTAGE

PCC89

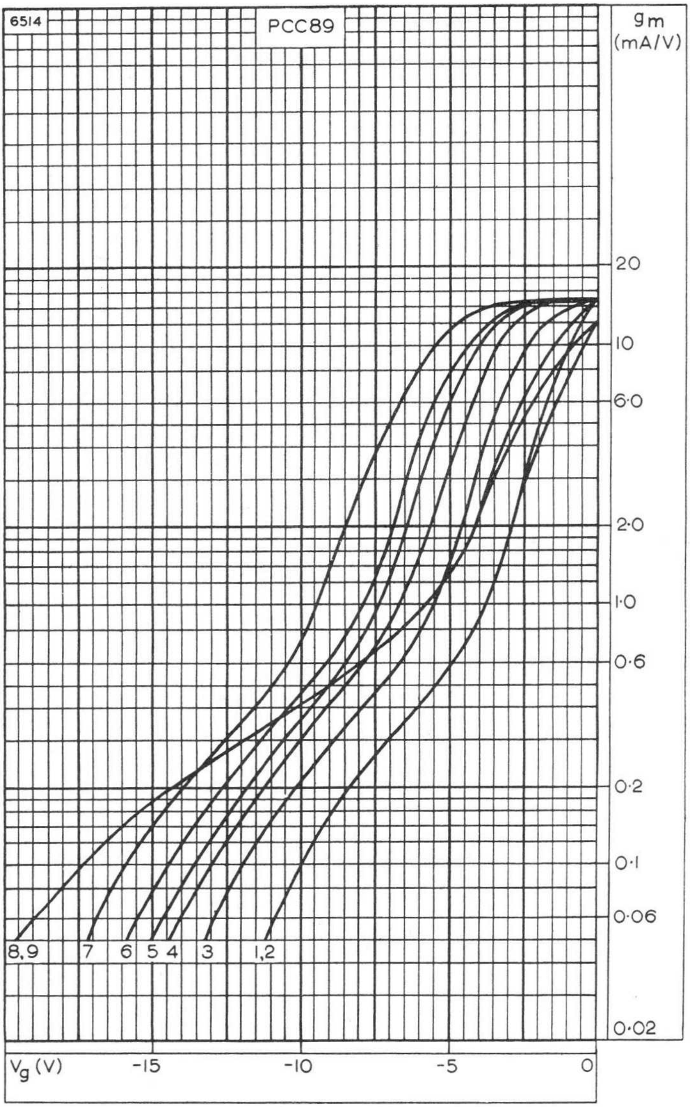
R.F. DOUBLE TRIODE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE UNDER CONDITIONS 1 to 9 (See page D3)



MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE UNDER CONDITIONS 1 to 9 (See page D3)

V.H.F. DOUBLE TRIODE

PCC189

Variable-mu, low noise v.h.f. frame grid double triode with high mutual conductance for use as a cascode amplifier.

HEATER

I_h	300	mA
V_h	7.6	V

CAPACITANCES

	Shielded	*Unshielded*	
$c_{a'-a''}$	<15	<45	mpF
$c_{g'-a''}$	<4.0	<4.0	mpF
Grounded cathode section			
$c_{a'-g'}$	1.9	1.9	pF
$c_{g'-k'+h+s}$	3.5	3.5	pF
$c_{a'-k'+h+s}$	2.3	1.7	pF
$c_{g'-h}$	<280	<280	mpF
Grounded grid section			
$c_{a''-g''}$	1.9	1.9	pF
$c_{k''-g''+h+s}$	6.0	6.0	pF
$c_{a''-g''+h+s}$	4.0	3.4	pF
$c_{k''-h}$	3.0	3.0	pF
$c_{a''-k''}$	170	180	mpF

CHARACTERISTICS (each section)

V_a	90	V
V_g	−1.4	V
I_a	15	mA
g_m	12.5	mA/V
r_a	2.5	kΩ
μ	34	
V_g (for 20 : 1 reduction in g_m)	−5.0	V
V_g (for 100 : 1 reduction in g_m)	−9.0	V

DESIGN CENTRE RATINGS (each section)

$V_{a(b)}$ max.	550	V
V_a max.	130	V
p_a max.	1.8	W
I_k max.	22	mA
$-V_g$ max.	50	V
$R_{g'-k}$ max.	1.0	MΩ
$R_{g''-k}$ max.	500	kΩ
$V_{h-k'}$ max.	80	V
$V_{h-k''}$ max. (cathode positive)	180	V
R_{h-k} max.	20	kΩ

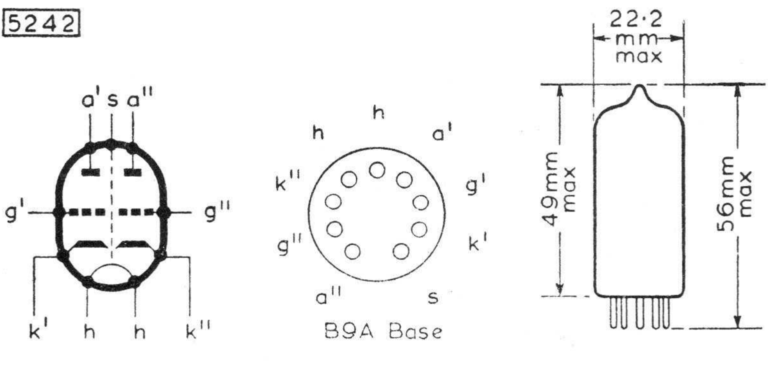
PCC189

V.H.F. DOUBLE TRIODE

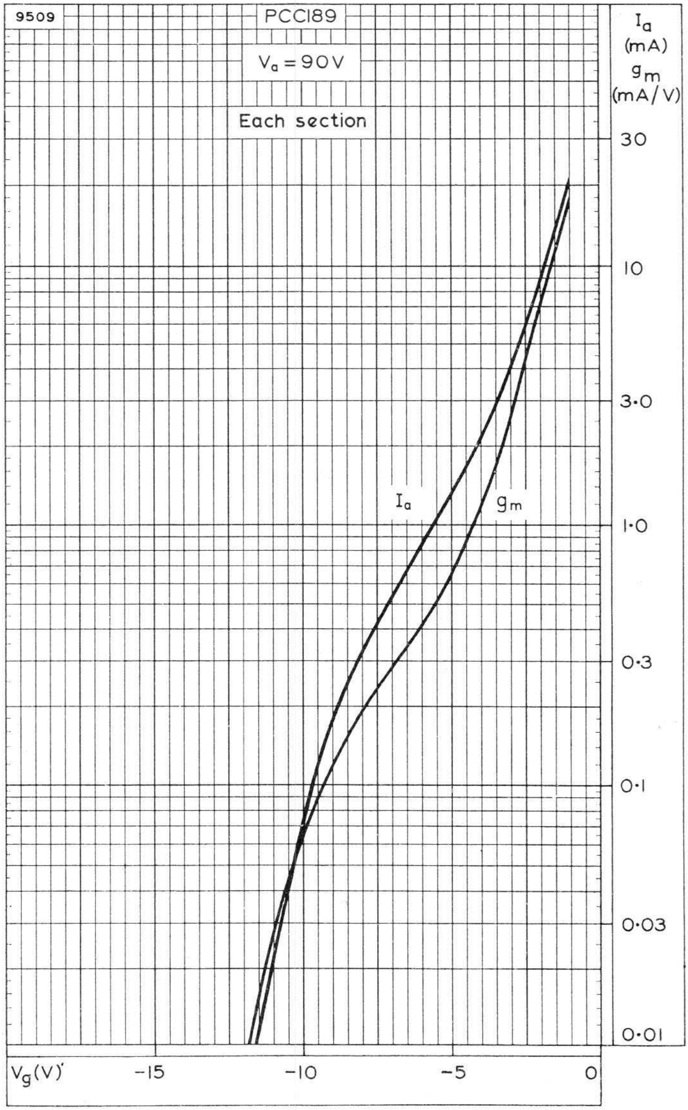
NOTE

In order not to exceed the maximum permissible anode voltage when the cascode amplifier is controlled, it is necessary to use a voltage divider for the grid of the grounded grid section.

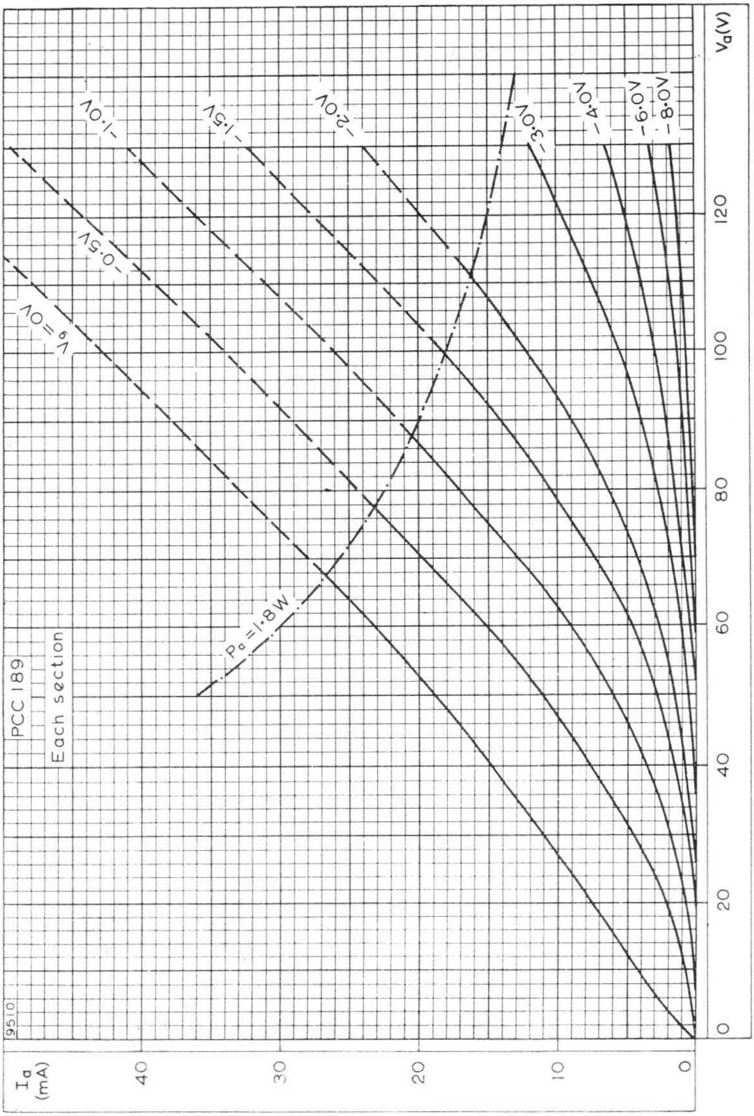
5242



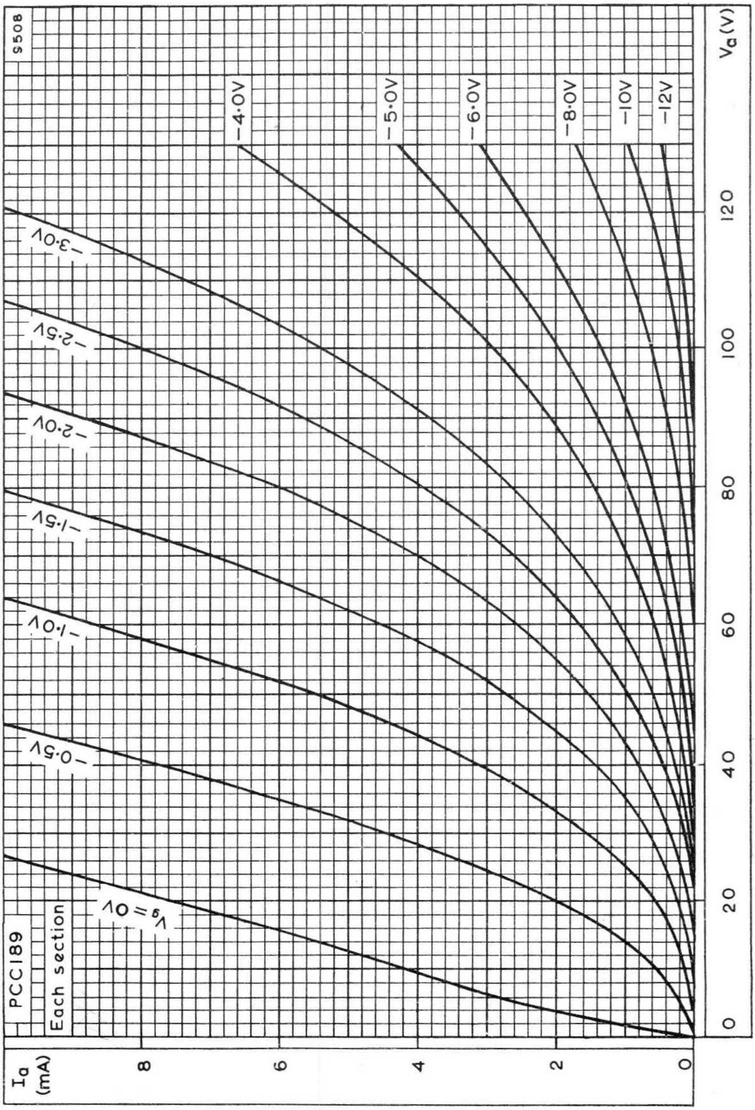
The triode on pins 6, 7, 8, should have the grounded cathode connection and that on pins 1, 2, 3, should have the grounded grid connection.



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER IN THE REGION OF THE ORIGIN

TRIODE PENTODE

PCF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	9.0	V

MOUNTING POSITION

Any

CAPACITANCES (measured without external shield)

c_{ap-at}	<0.06	pF
c_{ap-gt}	<0.02	pF
c_{gp-at}	<0.16	pF
c_{gp-gt}	<0.02	pF

Pentode section

$^*c_{a-g1}$	<0.025	pF
c_{in}	5.5	pF
c_{out}	3.8	pF

*May be reduced to <0.01pF by the use of a skirted base.

Triode section

c_{g-k+h}	2.5	pF
c_{a-k+h}	1.8	pF
c_{a-g}	1.5	pF

CHARACTERISTICS

Pentode section

V_a	170	V
V_{g2}	170	V
I_a	10	mA
V_{g1}	−2.0	V
I_{g2}	2.8	mA
g_m	6.2	mA/V
μ_{g1-g2}	47	
r_a	400	kΩ
R_{in} (f = 50Mc/s)	10	kΩ
R_{eq}	1.5	kΩ

Triode section

V_a	100	V
I_a	14	mA
V_g	−2.0	V
g_m	5.0	mA/V
μ	20	
r_a	4.0	kΩ

PCF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

TYPICAL OPERATING CONDITIONS

As a frequency changer

V_a	170	170	V
V_{g2}	170	170	V
R_{g1}	100	100	kΩ
R_k	820	0	Ω
I_a	5.2	6.3	mA
I_{g2}	1.5	2.5	mA
$V_{osc(r.m.s.)}$	3.5	4.0	V
I_{g1}	0	53	μA
g_c	2.1	2.05	mA/V
r_a	870	720	kΩ

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V	
V_a max.	250	V	
p_a max.	1.7	W	
$V_{g2(b)}$ max.	550	V	
V_{g2} max. ($I_k \leq 10$mA)	200	V	
V_{g2} max. ($I_k > 10$mA)	175	V	
p_{g2} max. ($p_a \leq 1.2$W)	750	mW	←
p_{g2} max. ($p_a > 1.2$W)	500	mW	←
I_k max.	17	mA	←
V_{g1} max. ($I_{g1} = +0.3\mu$A)	−1.3	V	
R_{g1-k} max. (cathode bias)	1.0	MΩ	
R_{g1-k} max. (fixed bias)	500	kΩ	
*V_{h-k} max. (cathode positive)	225	V	←
V_{h-k} max. (cathode negative)	100	V	←

*Max. d.c. component 150V

Triode section

$V_{a(b)}$ max.	550	V	
V_a max.	250	V	
p_a max.	1.5	W	
I_k max.	17	mA	←
†$i_{k(pk)}$ max.	200	mA	
R_{g-k} max.	500	kΩ	
V_g max. ($I_{g1} = +0.3\mu$A)	−1.3	V	
$-v_{g(pk)}$ max.	350	V	←
*V_{h-k} max. (cathode positive)	225	V	←
V_{h-k} max. (cathode negative)	100	V	←

*Max. d.c. component 150V

†Max. pulse duration 200μs ←

OPERATING NOTE

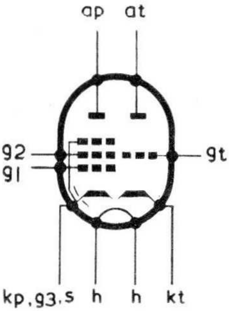
It is anticipated that variations in heater-to-cathode capacitance may render this valve unsuitable for use in Hartley oscillator circuits, particularly in f.m. receivers. For this reason it is recommended that a Colpitts type of circuit be employed.

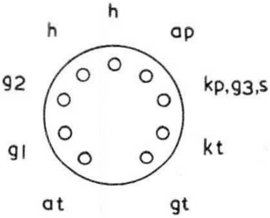
TRIODE PENTODE

PCF80

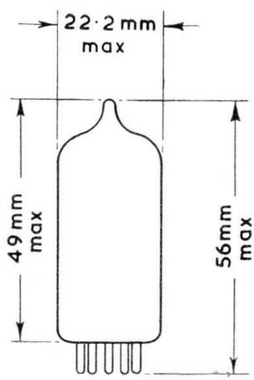
Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

3222





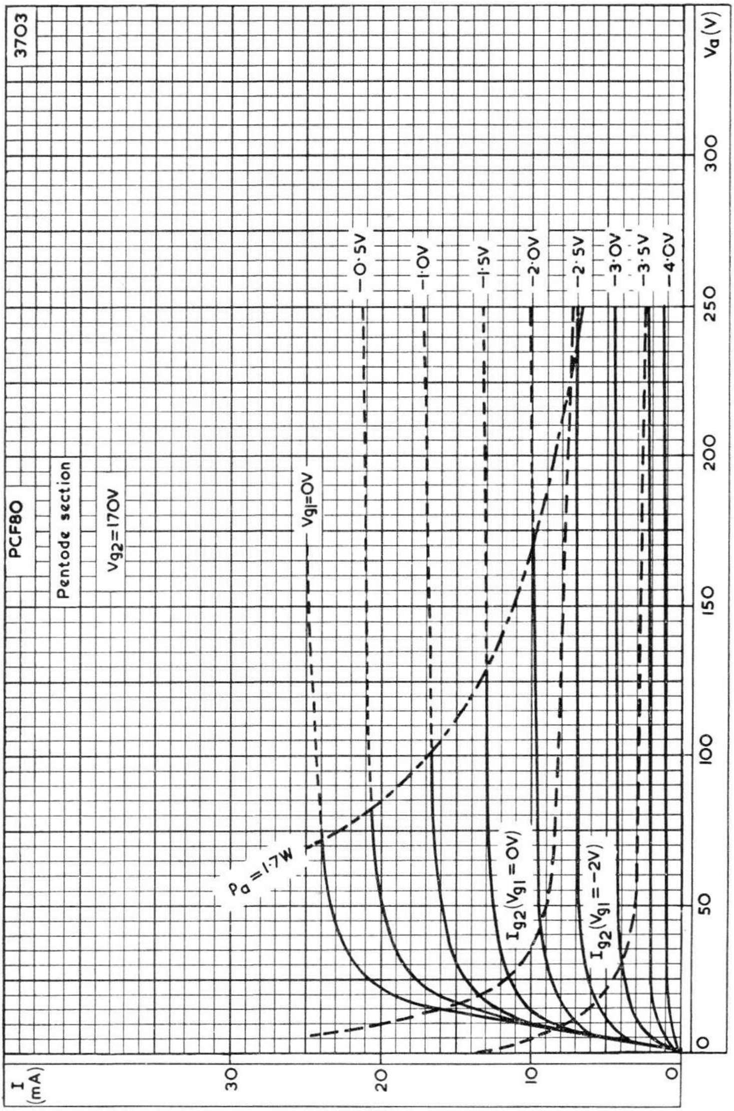
B9A Base



PCF80

TRIODE PENTODE

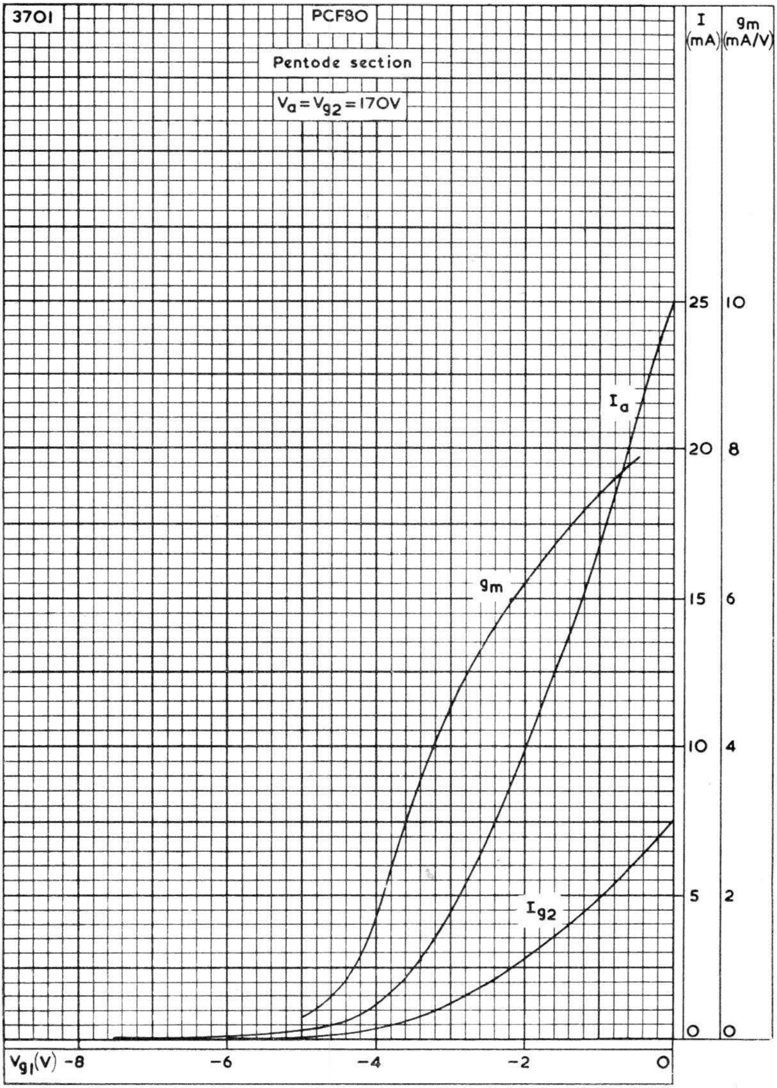
Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE FOR PENTODE SECTION WITH CONTROL-GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

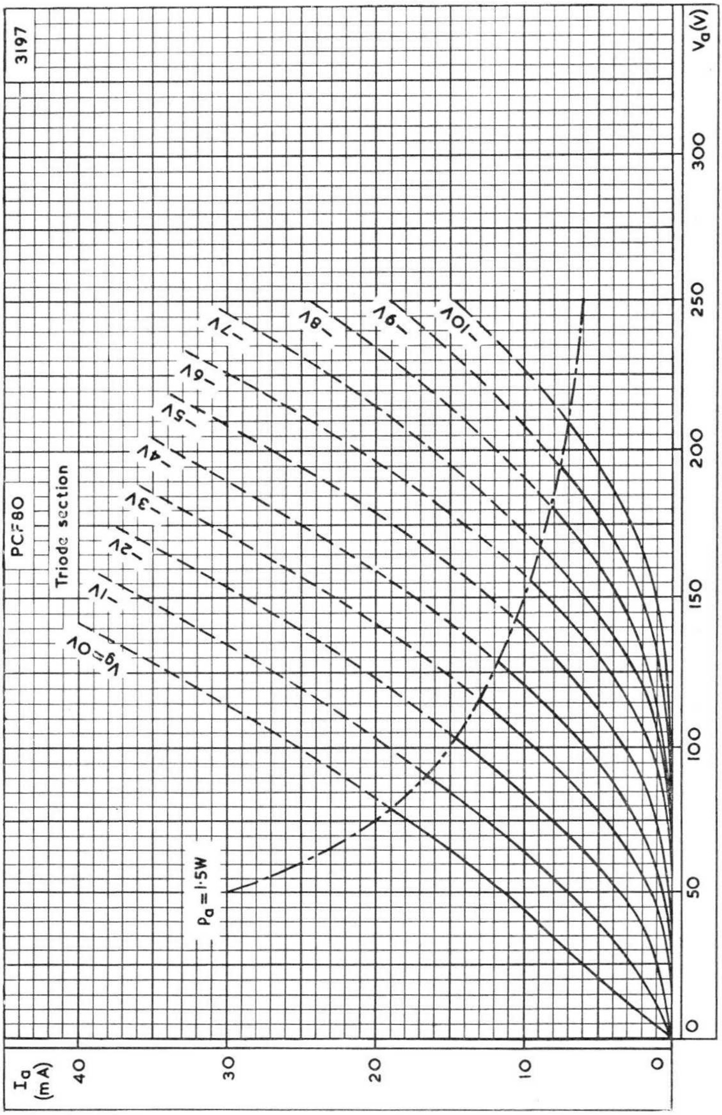


ANODE AND SCREEN-GRID CURRENTS AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE OF PENTODE SECTION.
$V_a = V_{g2} = 170V$

PCF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

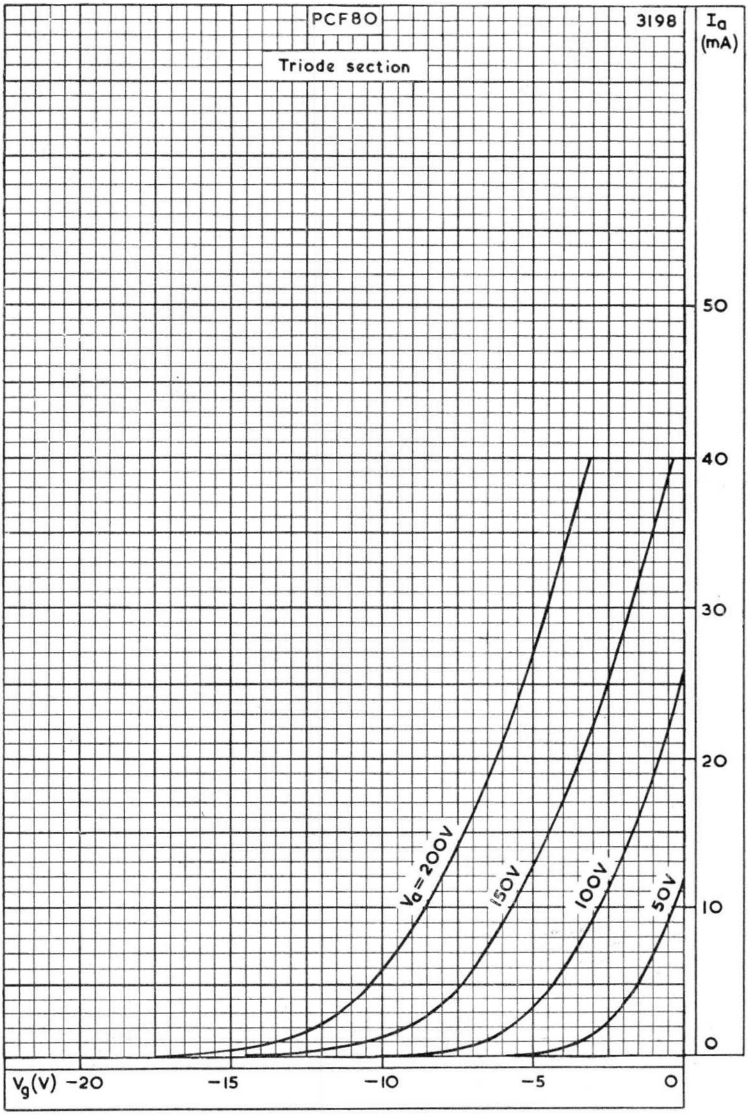


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR TRIODE SECTION WITH GRID VOLTAGE AS PARAMETER

TRIODE PENTODE

PCF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

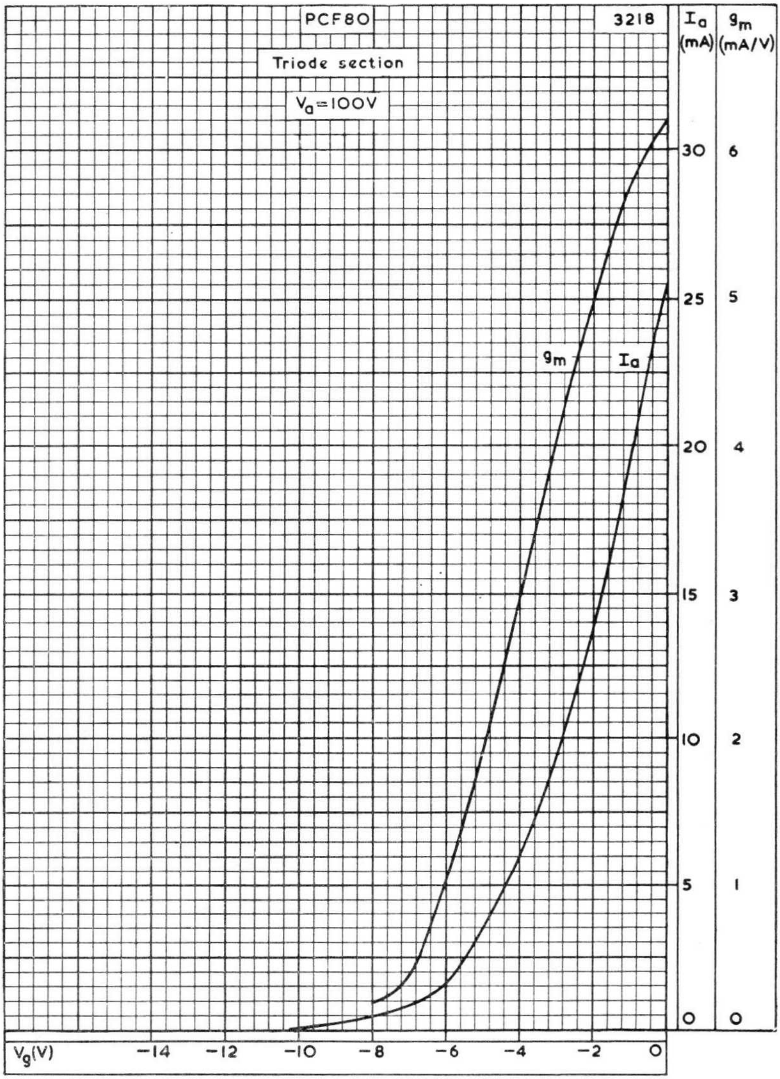


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR TRIODE SECTION FOR VARIOUS VALUES OF ANODE VOLTAGE

PCF80

TRIODE PENTODE

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

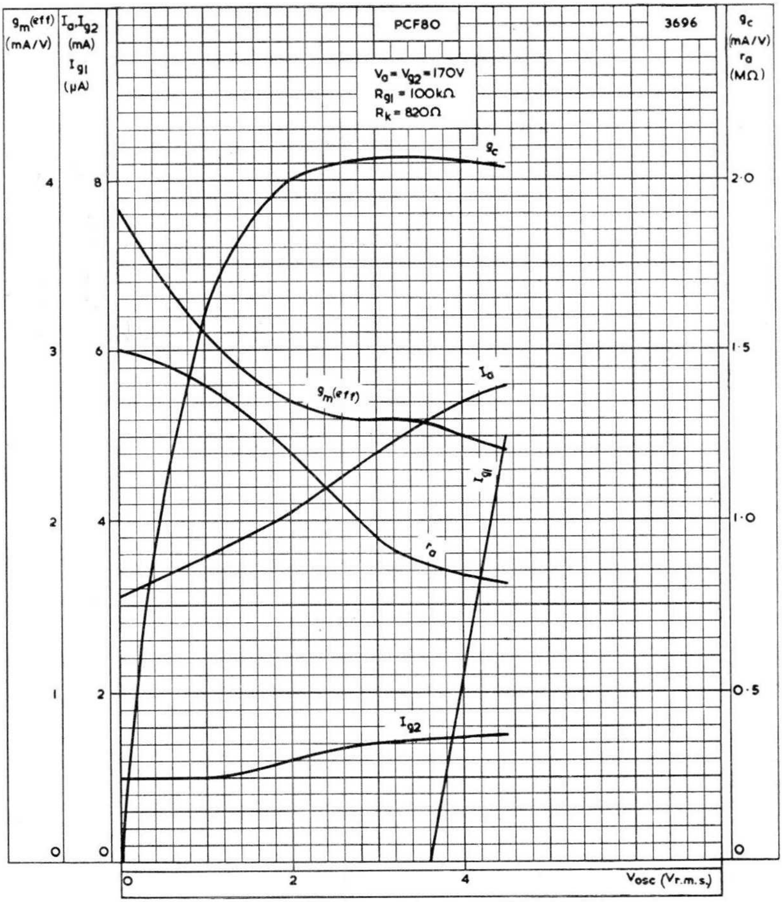


ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE FOR TRIODE SECTION. $V_a = 100V$

TRIODE PENTODE

PCF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.

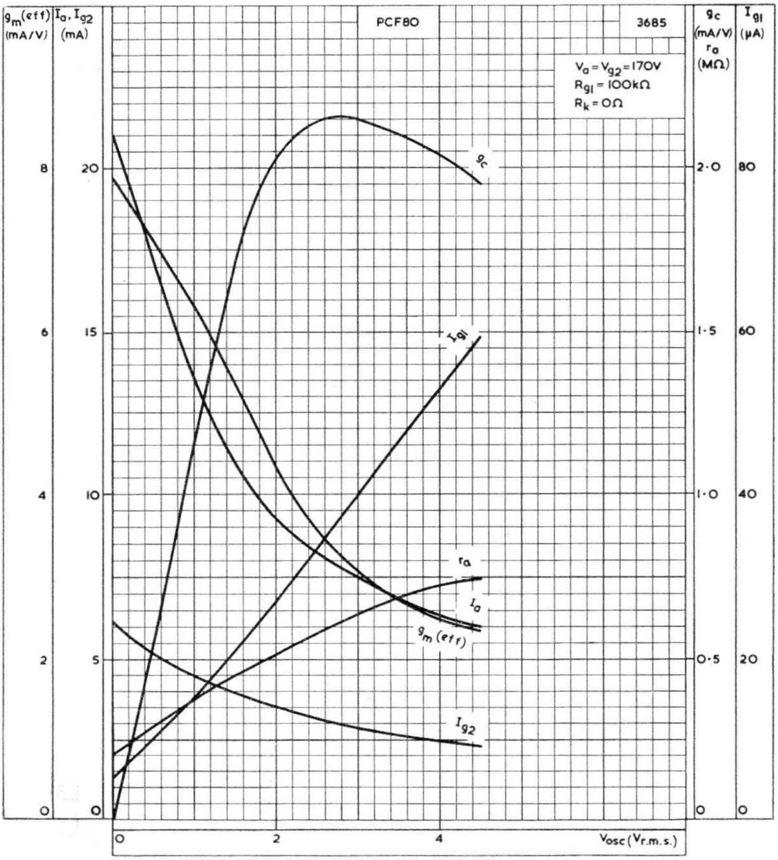


PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER WITH $R_k = 820\Omega$

PCF80

TRIODE PENTODE

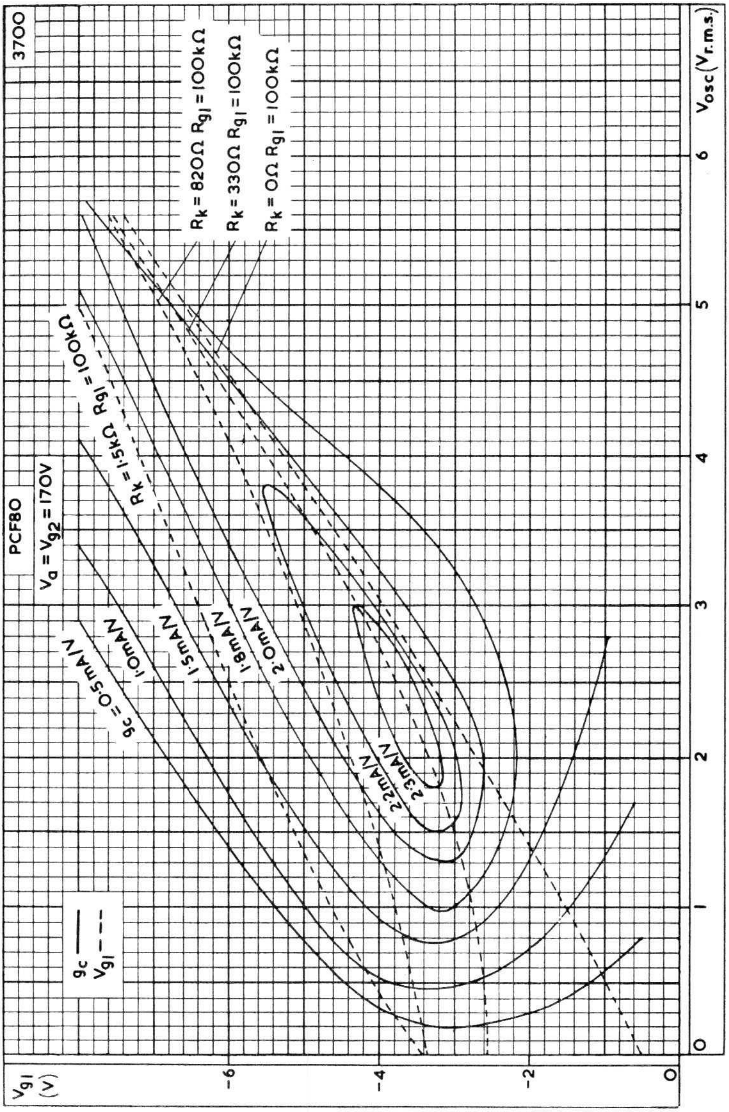
Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.



PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER WITH $R_k = 0\Omega$

PCF80

Combined triode and high slope r.f. pentode with separate cathodes. Primarily designed for use as a frequency changer at frequencies up to 220Mc/s in television equipment with series connected heaters.



CONTROL-GRID BIAS PLOTTED AGAINST OSCILLATOR VOLTAGE FOR VARIOUS VALUES OF CATHODE RESISTOR AND GRID RESISTOR, TOGETHER WITH 'CONTOUR LINES' OF CONSTANT CONVERSION CONDUCTANCE

TRIODE PENTODE

PCF86

Combined triode and high slope frame grid r.f. pentode for use as a frequency changer at frequencies up to 220Mc/s in television tuners.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	8.0	V

CAPACITANCES (measured without an external shield)

c_{ap-at}	125	mpF←
c_{ap-gt}	14	mpF
c_{g1-at}	<10	mpF
c_{g1-gt}	<10	mpF

Pentode section

c_{a-g1}	12	mpF
c_{g1-g2}	1.7	pF
c_{in}	5.8	pF←
c_{out}	3.5	pF

Triode section

c_{g-k+h}	2.4	pF
c_{a-k+h}	1.1	pF
c_{a-g}	2.0	pF

CHARACTERISTICS

Pentode section

V_a	170	V
V_{g2}	150	V
I_a	10	mA
I_{g2}	3.3	mA
g_m	12	mA/V
r_a	>350	kΩ
μ_{g1-g2}	70	
V_{g1}	−1.2	V
R_{eq}	1.0	kΩ

Triode section

V_a	100	V
I_a	14	mA
g_m	5.7	mA/V←
μ	17	
V_g	−3.0	V

PCF86

TRIODE PENTODE

OPERATING CONDITIONS AS A FREQUENCY CHANGER

Pentode section

V_a	190	V
$V_{g2(b)}$	190	V
R_{g2}	18	kΩ
R_{g1}	100	kΩ
I_a	8.5	mA
I_{g2}	2.7	mA
$V_{osc(r.m.s.)}$	2.3	V
g_c	4.5	mA/V

LIMITING VALUES

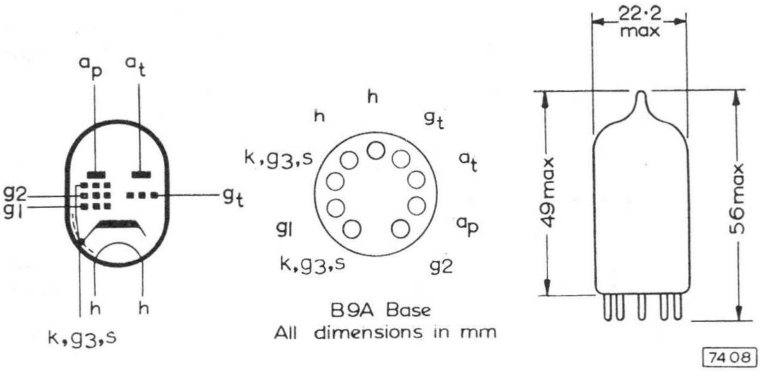
Pentode section

V_a max.	250	V
p_a max.	2.0	W
V_{g2} max.	150	V
p_{g2} max.	500	mW
I_k max.	18	mA
R_{g1-k} max.	250	kΩ

Triode section

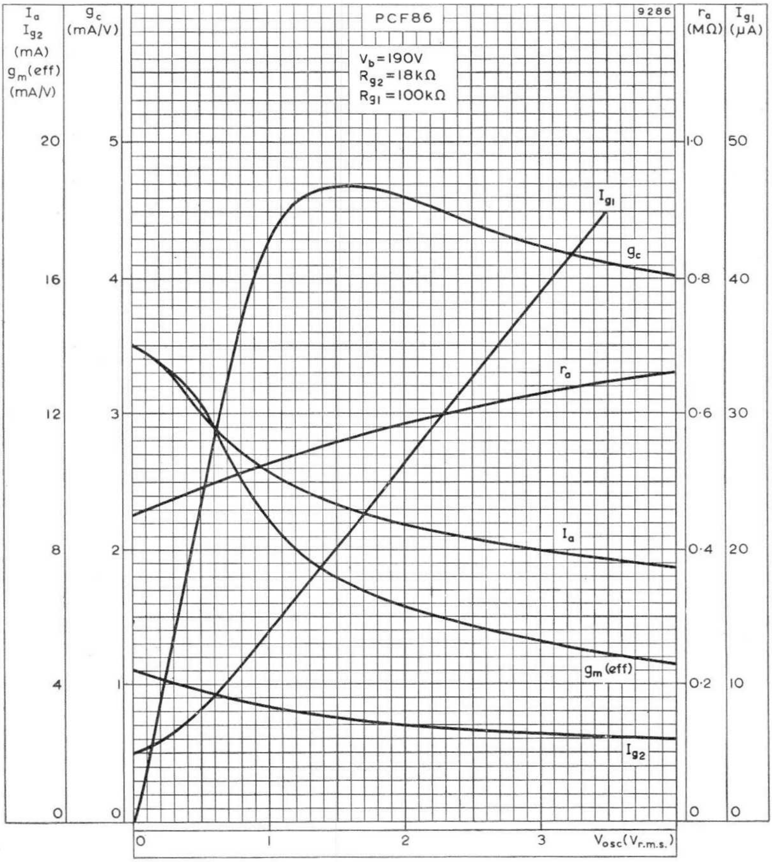
V_a max.	125	V
p_a max.	1.5	W
I_k max.	15	mA
R_{g-k} max.	500	kΩ
*V_{h-k} max.	100	V

*To fulfil hum requirements on a.m. sound, it will be necessary for V_{h-k} to be less than $50V_{r.m.s.}$ For intercarrier receivers V_{h-k} should not exceed $75V_{r.m.s.}$

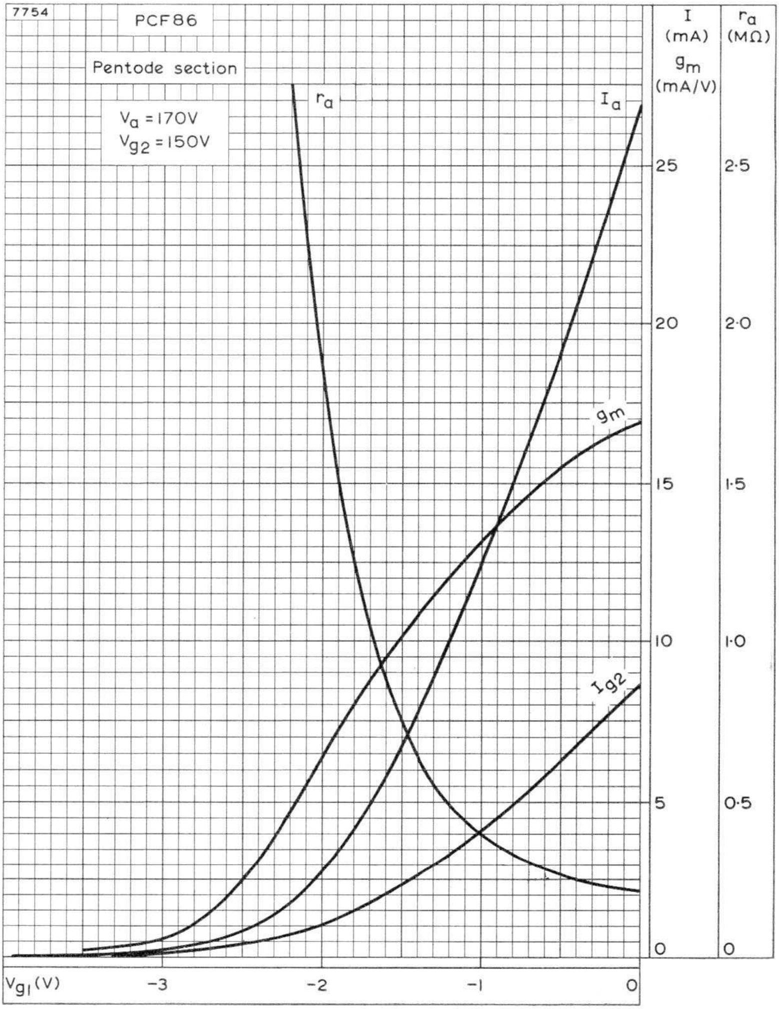


B9A Base
All dimensions in mm

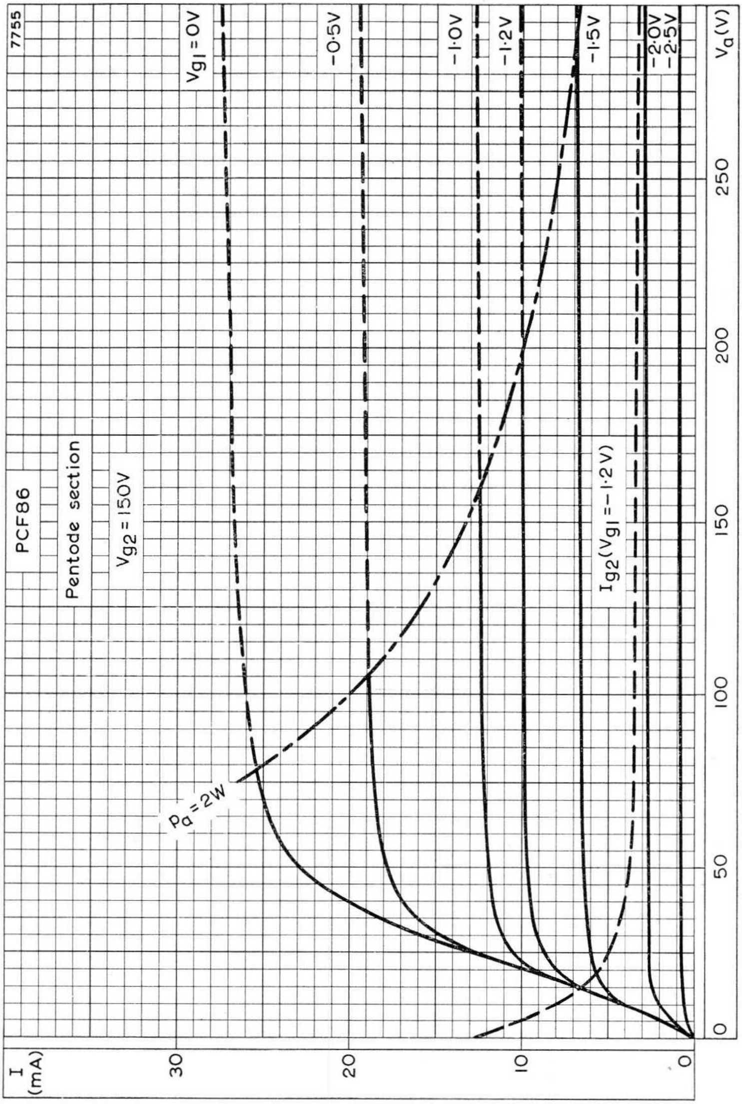
7408



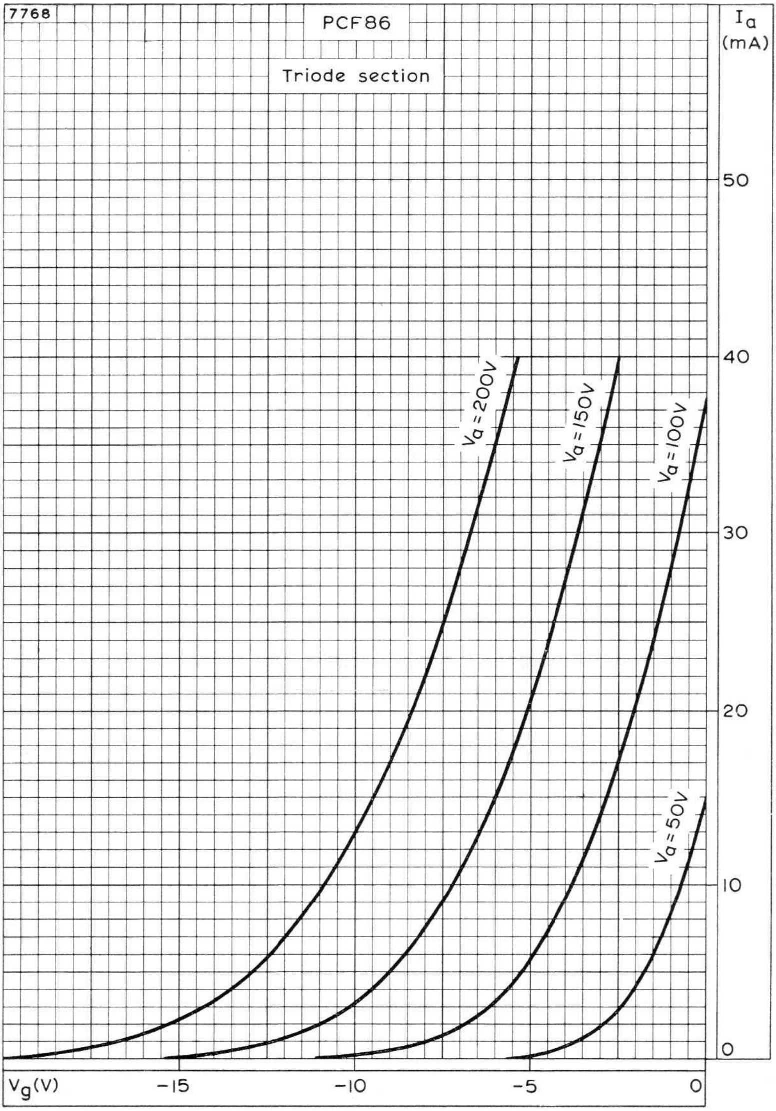
PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER



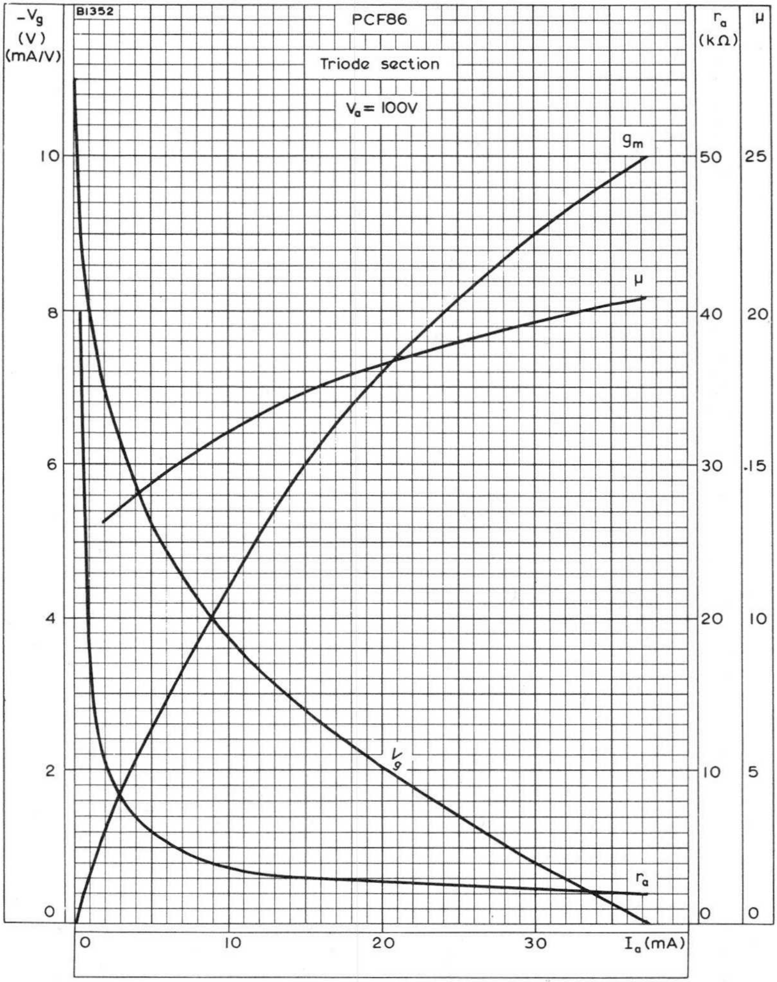
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. PENTODE SECTION



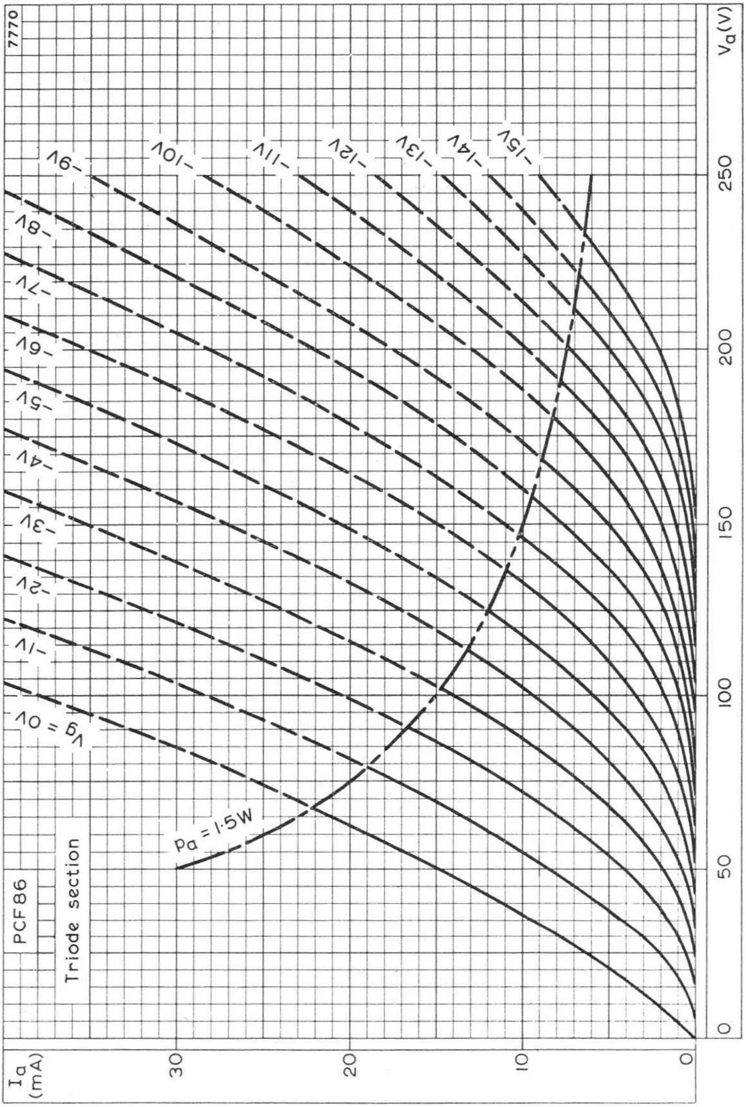
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION



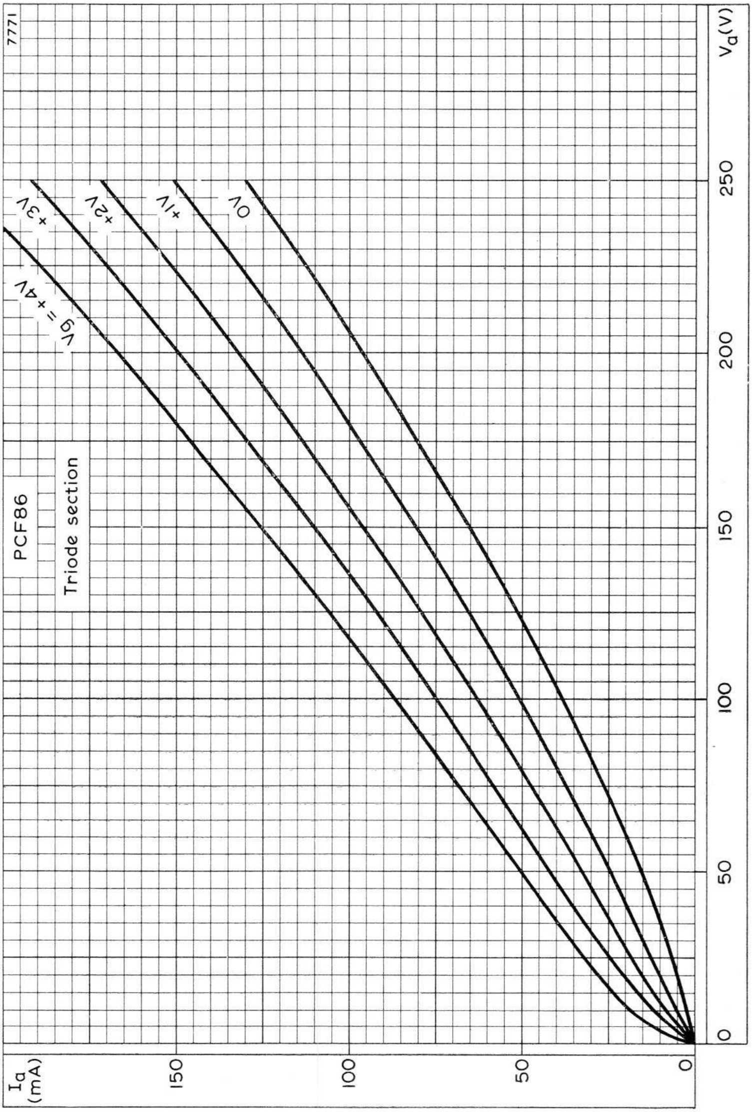
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE FOR VARIOUS VALUES OF ANODE VOLTAGE. TRIODE SECTION



GRID VOLTAGE, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH POSITIVE GRID VOLTAGE AS PARAMETER. TRIODE SECTION

Combined triode and frame-grid, variable-mu pentode for use as a frequency changer and i.f. amplifier at frequencies up to 200Mc/s in television receivers.

HEATER

Suitable for series operation a.c. or d.c.

Ih	300	mA
Vh	8.5	V

CAPACITANCES (shielded)

cap-at	< 25	mpF
cap-gt	< 10	mpF
cg1-at	< 10	mpF
cg1-gt	< 10	mpF

Pentode section

ca-g1	9.0	mpF
ca-g1 max.	12	mpF
cg1-g2	1.6	pF
cin	6.2	pF
cout	3.7	pF

Triode section

ca-g	1.8	pF
cin	3.3	pF
cout	1.7	pF

CHARACTERISTICS

Pentode section

Va	170	V
Vg2	120	V
Ia	10	mA
Ig2	3.0	mA
Vg1	- 1.4	V
gm	11	mA/V
ra	> 350	kΩ
μg1-g2	55	
Req	1.5	kΩ

Triode section

Va	100	V
Ia	15	mA
Vg	- 3.0	V
gm	9.0	mA/V
μ	20	

OPERATING CONDITIONS AS FREQUENCY CHANGER

Pentode section

Vb	200	200	V
Ra	2.7	4.7	kΩ
Rg2	27	27	kΩ
Rg1	0.1	1.0	MΩ
Ia	10	9.3	mA
Ig2	3.0	2.9	mA
Ig1	8.0	2.3	µA
Vg1	- 1.4	*	V
Vosc (r.m.s.)	1.6	1.6	V
gc	5.0	4.7	mA/V

* With grid current bias.

OPERATING CONDITIONS AS I.F. AMPLIFIER

Pentode section

Vb	200	200	V
Ra	2.7	4.7	kΩ
Rg2	27	27	kΩ
Rg1	0.1	1.0	MΩ
Ia	10	13	mA
Ig2	3.0	3.9	mA
Vg1	- 1.4	*	V
gm	11	14.5	mA/V
Vg1 for 100 : 1 reduction in gm	- 12		V
Rin (f = 50 Mc/s)	10	10	kΩ

* With grid current bias.

OPERATING CONDITIONS AS OSCILLATOR

Triode section

Va	200	200	V
Ra	8.2	12	kΩ

Rg	10	10	kΩ
Vosc	4.5	3.3	Vr.m.s.
Ia	16	12	mA
gm	3.7	3.7	mA/V

DESIGN CENTRE RATINGS

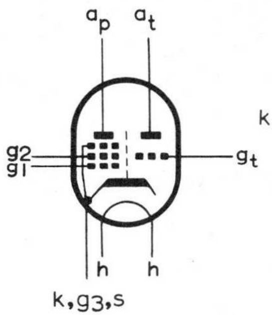
Pentode section

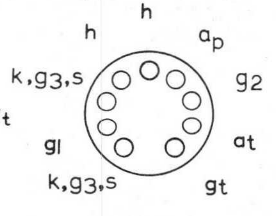
Va(b) max.	550	V
Va max.	250	V
pa max.	2.0	W
Vg2(b) max.	550	V
Vg2 max.	250	V
pg2 max.	see page C4	
Ik max.	18	mA
- Vg1 max.	50	V
Rg1-k max.	1.0	MΩ

Triode section

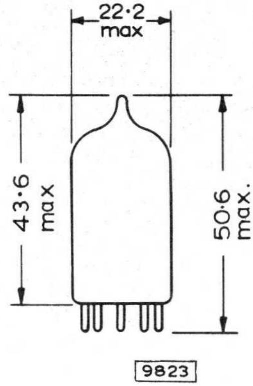
Va(b) max.	550	V
pa max.	1.5	W
Ik max.	20	mA
- Vg max.	50	V
Rg-k max.	500	kΩ
* Vh-k max.	100	V

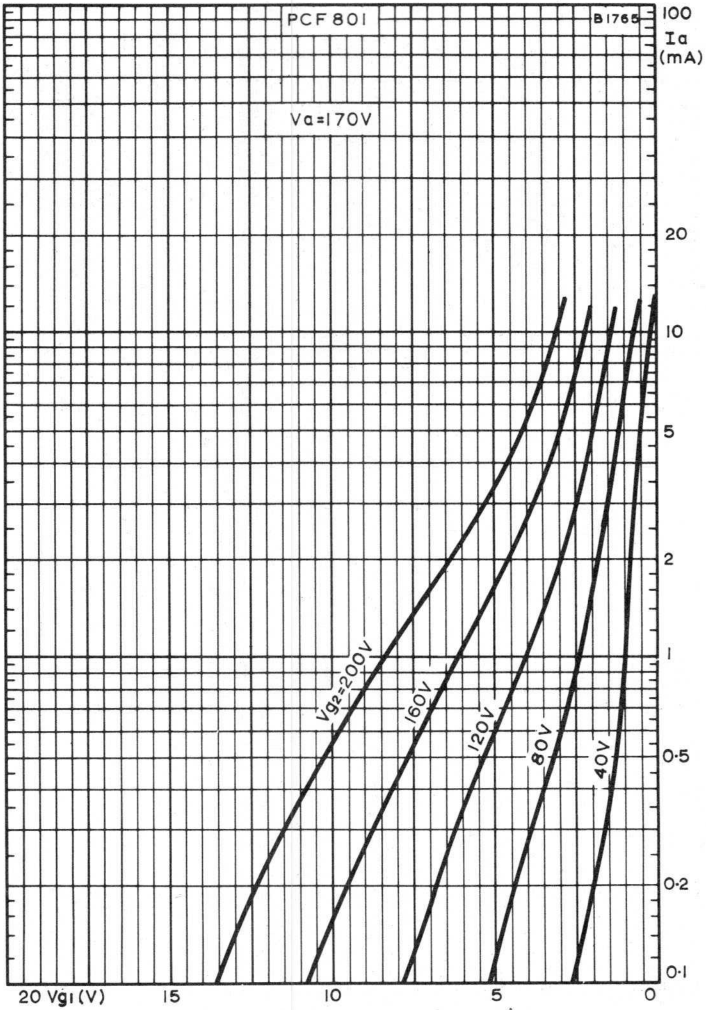
* To fulfil hum requirements on a.m. sound, it will be necessary for Vh-k to be less than 50 Vr.m.s.



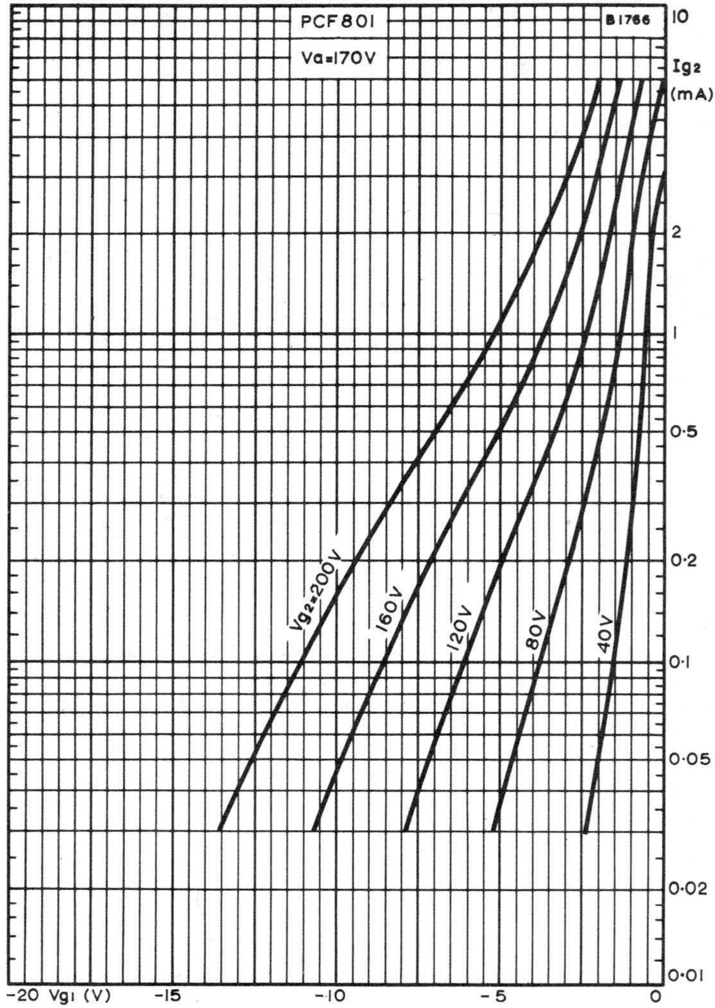


B9A Base
All dimensions in mm

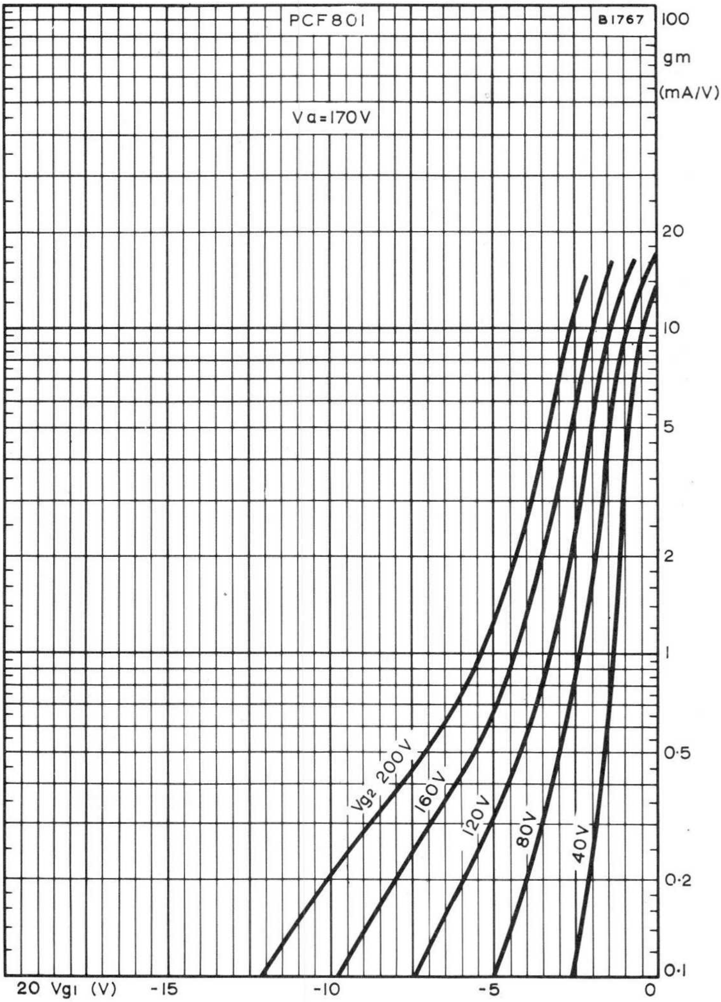




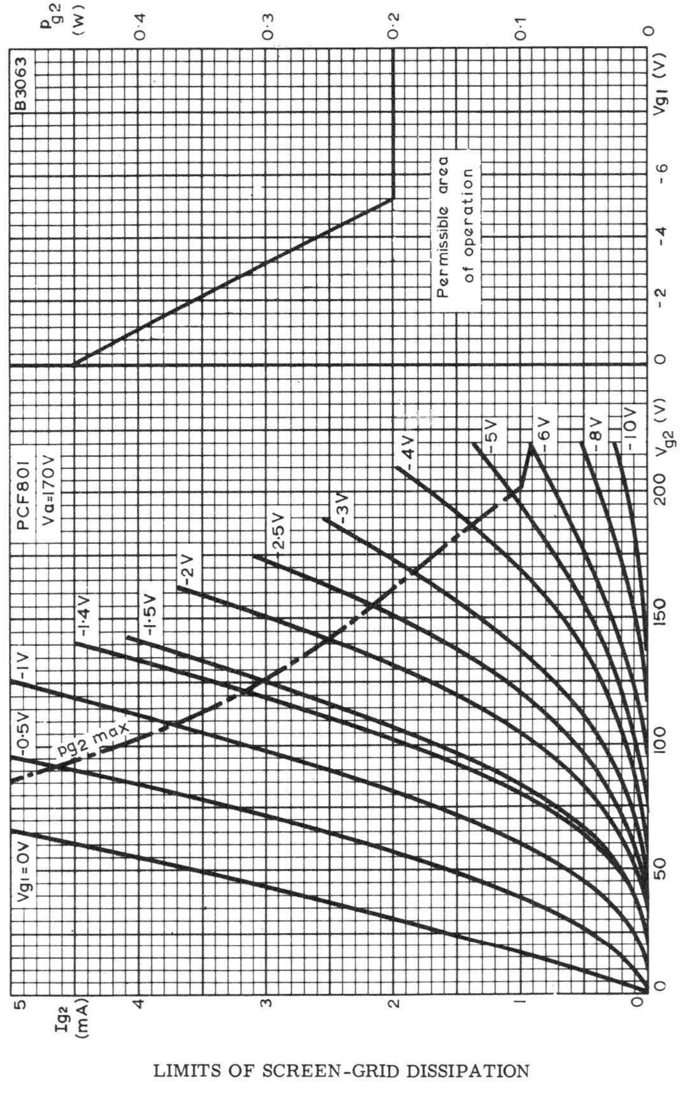
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER Va = 170V



SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER Va = 170V

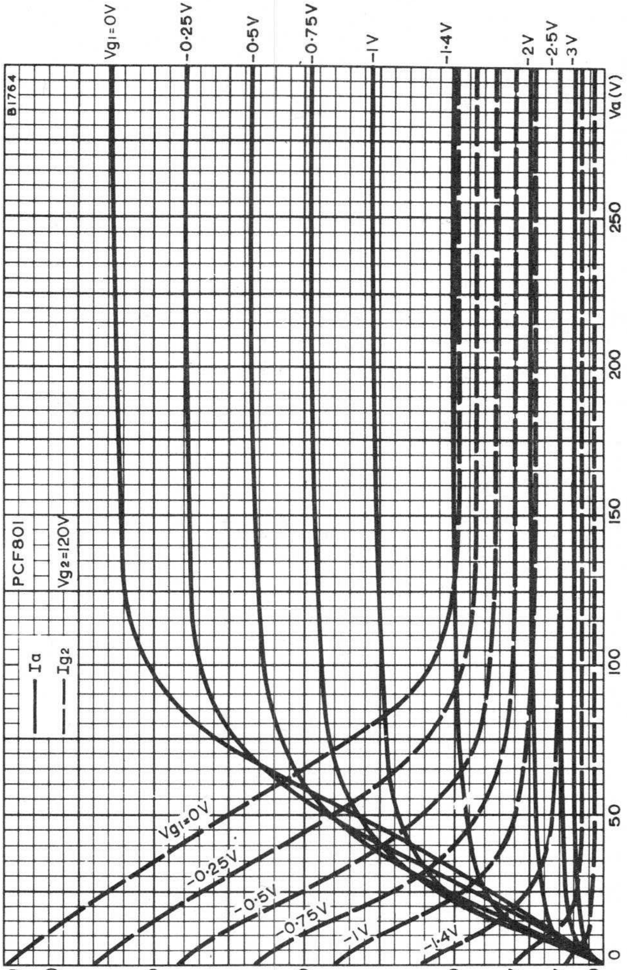


MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID AS PARAMETER, Va = 170V.

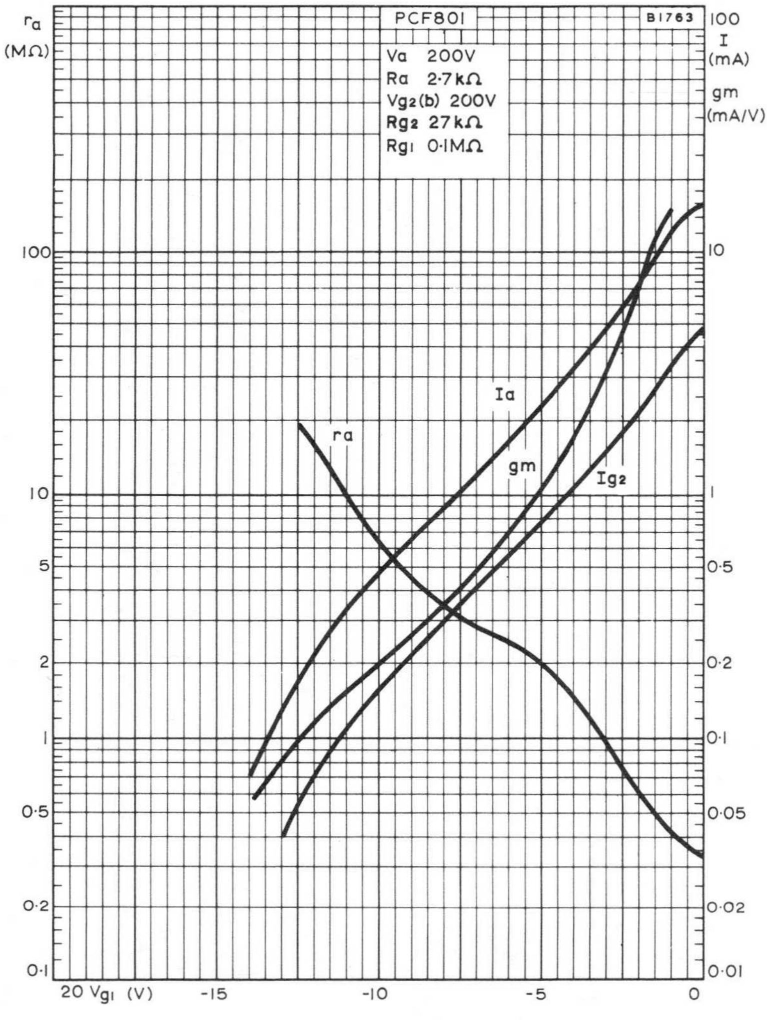


LIMITS OF SCREEN-GRID DISSIPATION

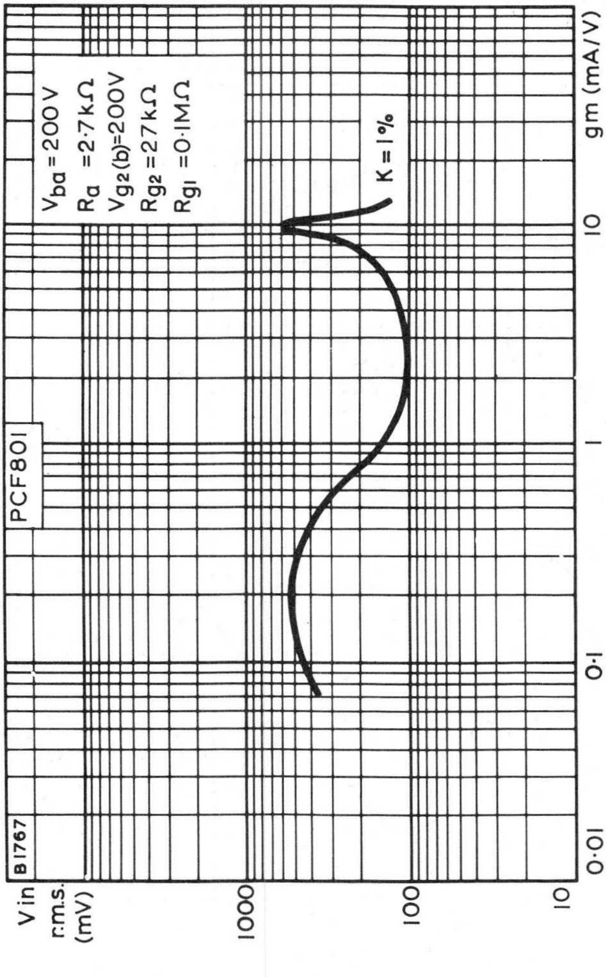
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, Va = 170V.



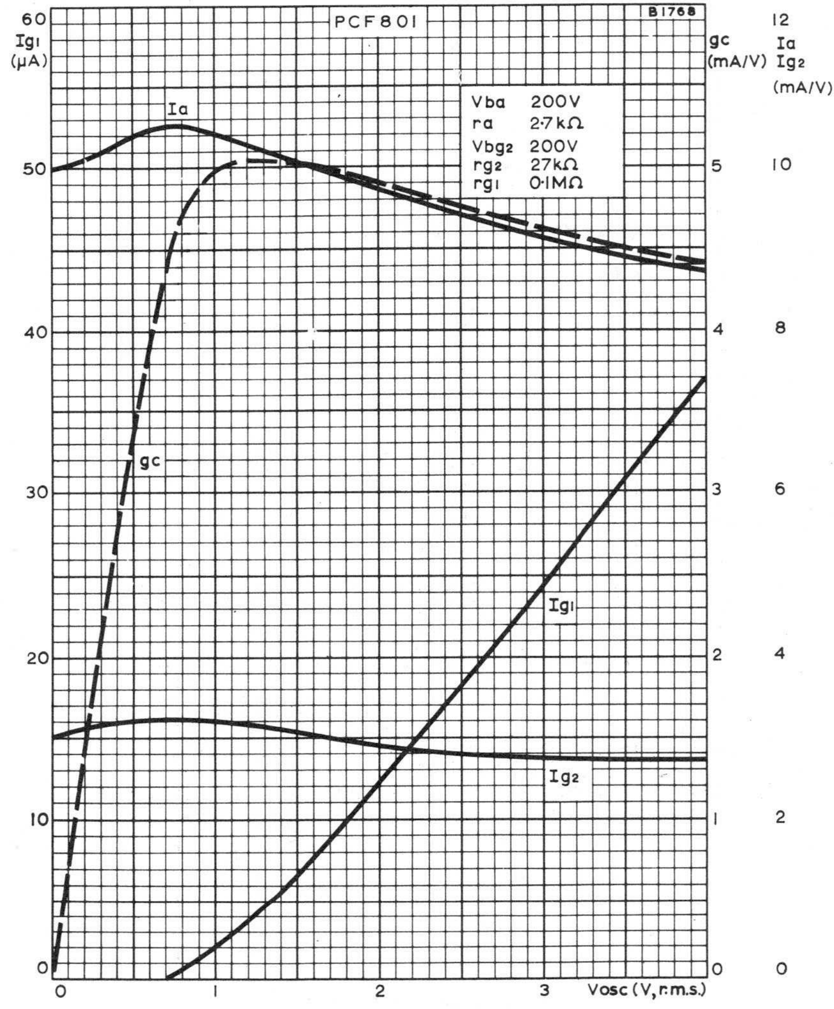
ANODE CURRENT AND SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER (Vg2 = 120 V)



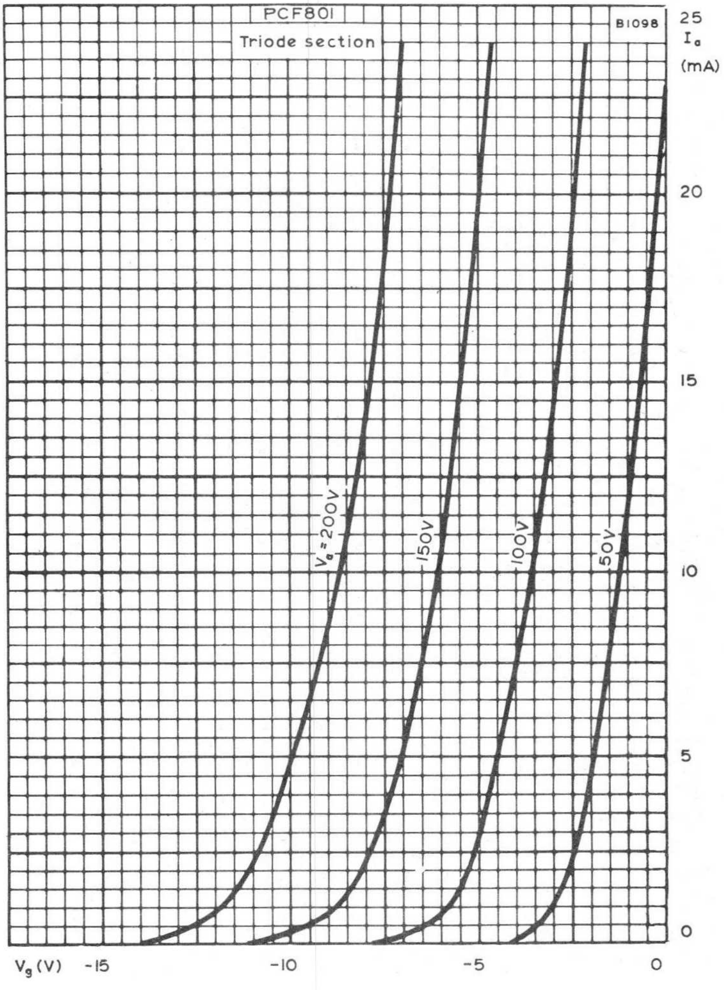
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.



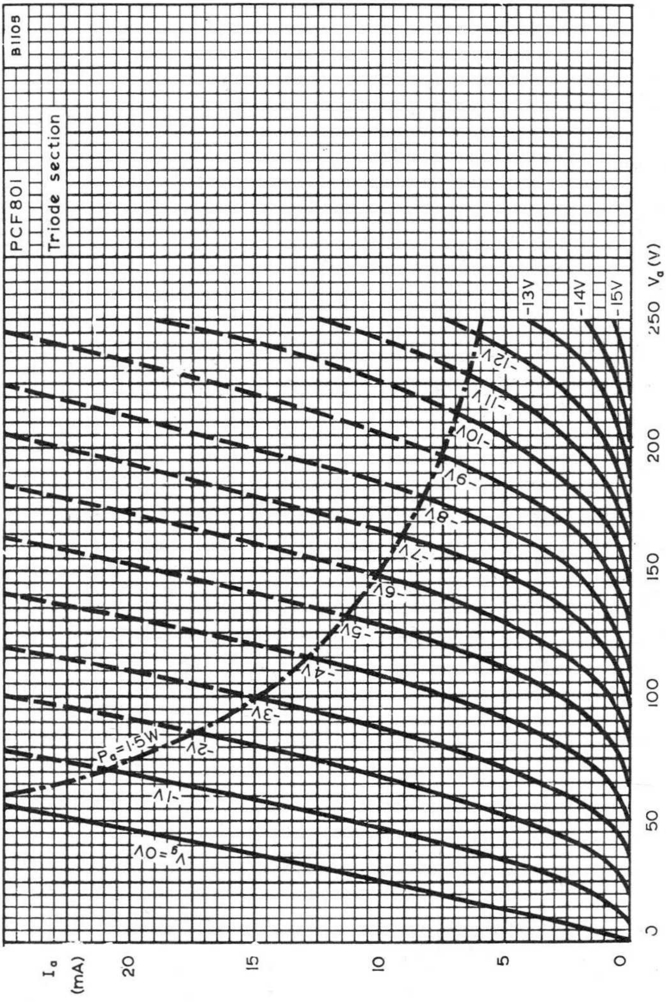
CROSS MODULATION CURVE



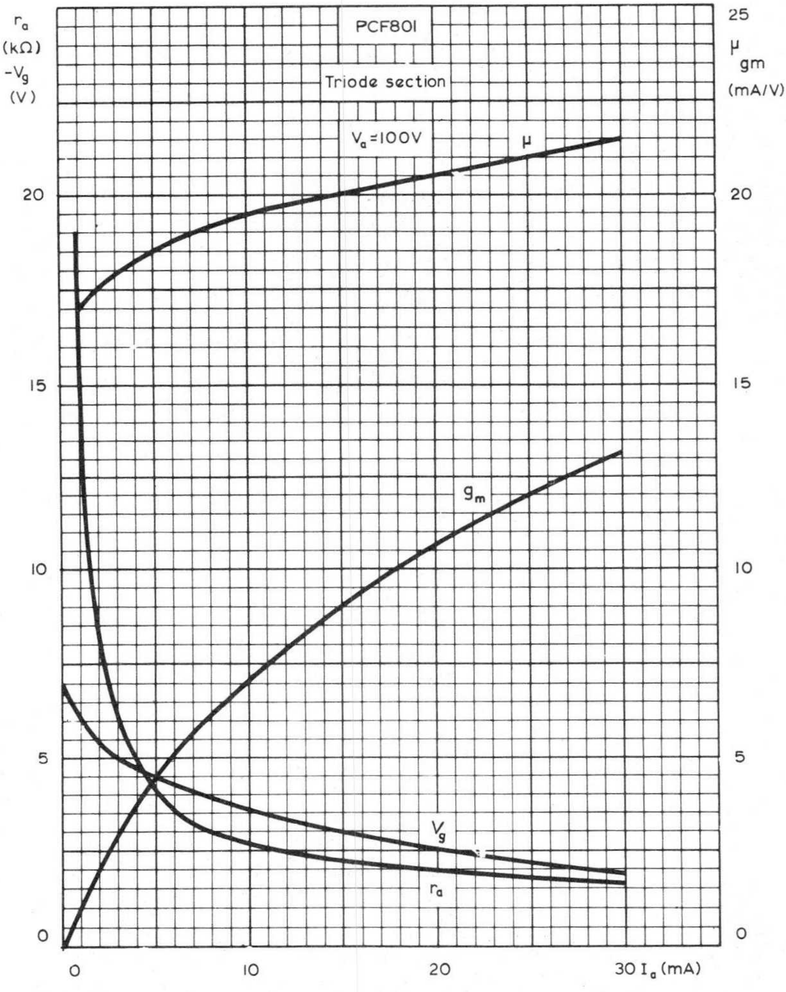
PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER.



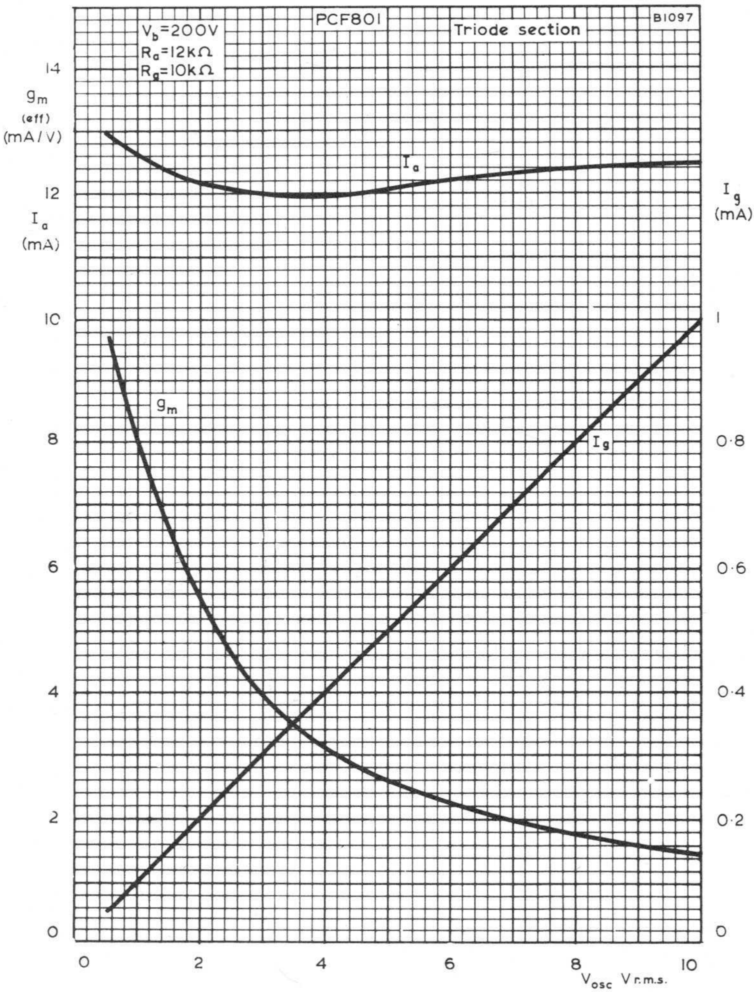
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETERS. TRIODE SECTION.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETERS. TRIODE SECTION.



ANODE IMPEDANCE, MUTUAL CONDUCTANCE, GRID VOLTAGE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT. Va = 100V. TRIODE SECTION.



PERFORMANCE CURVES FOR USE AS OSCILLATOR. TRIODE SECTION.

TRIODE PENTODE

PCF802

Triode pentode for use in line oscillator circuits, the pentode section as an oscillator and the triode section as a reactance valve.

HEATER

Suitable for series operation a.c. or d.c.

Ih	300	mA
Vh	9.0	V

CAPACITANCES

Pentode section

ca-g1	60	mpF
cg1-h	< 100	mpF
cin	5.4	pF

Triode section

ca-g	1.5	pF
cg-h	< 100	mpF
cin	2.4	pF

CHARACTERISTICS

Pentode section

Va	100	V
Vg2	100	V
Ia	6.0	mA
Ig2	1.7	mA
Vg1	- 1.0	V
gm	5.5	mA/V
μg1-g2	47	
ra	400	kΩ
Ia (Vg1 = 0V)	12.5	mA
Ig2 (Vg1 = 0V)	3.5	mA

- Vg1 (Va = Vg2 = 200V, Ia = 10μA)	< 16	V
- Vg1 max. (Ig1 = +0.3μA)	- 1.3	V

Triode section

Va	200	V
Ia	3.5	mA
Vg	- 2.0	V
gm	3.5	mA/V
μ	70	
ra	20	kΩ
Ia (Ig =+10μA, Va = 200V)	10	mA
-Vg max. (Ig = +0.3μA)	- 1.3	V

DESIGN CENTRE RATINGS

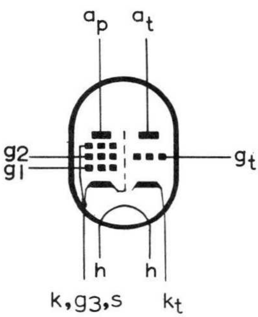
Pentode section

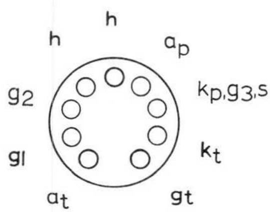
Va(b) max.	550	V
Va max.	250	V
pa max.	1.2	W
Vg2(b) max.	550	V
Vg2 max.	250	V
pg2 max.	800	mW
Ik max.	15	mA
* ik(pk) max.	50	mA
Rg1-k max.	560	kΩ

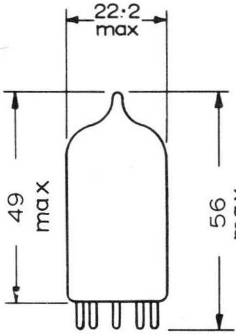
* Duty factor max. = 30%, tp max. = 30μs

Triode section

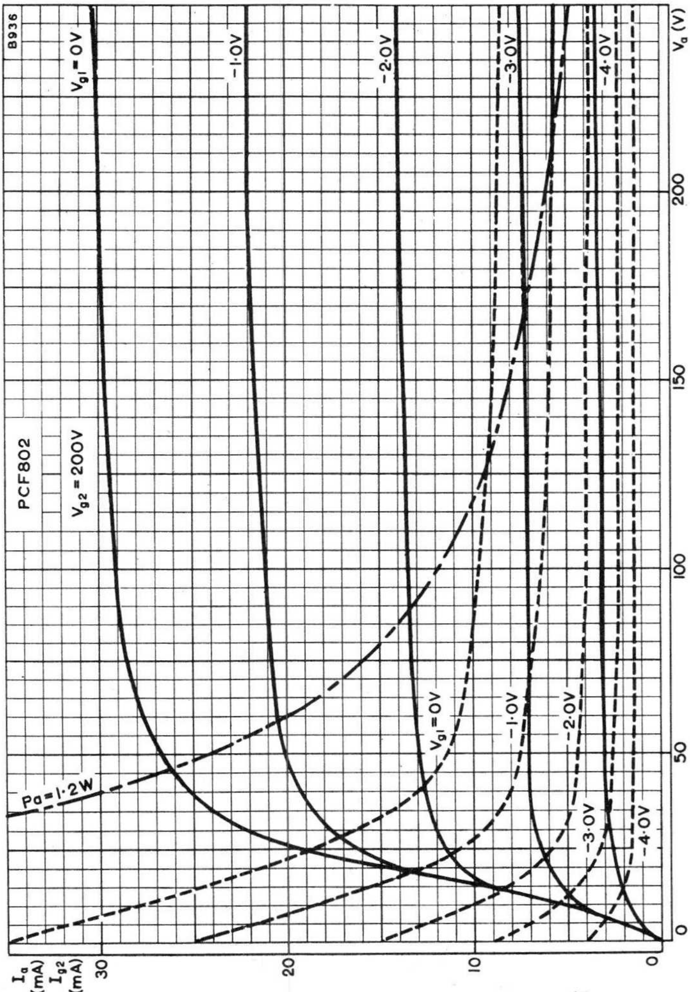
Va(b) max.	550	V
Va max.	1.4	W
Ik max.	10	mA
Rg-k max.	3.0	MΩ
* Vh-k max.	100	V



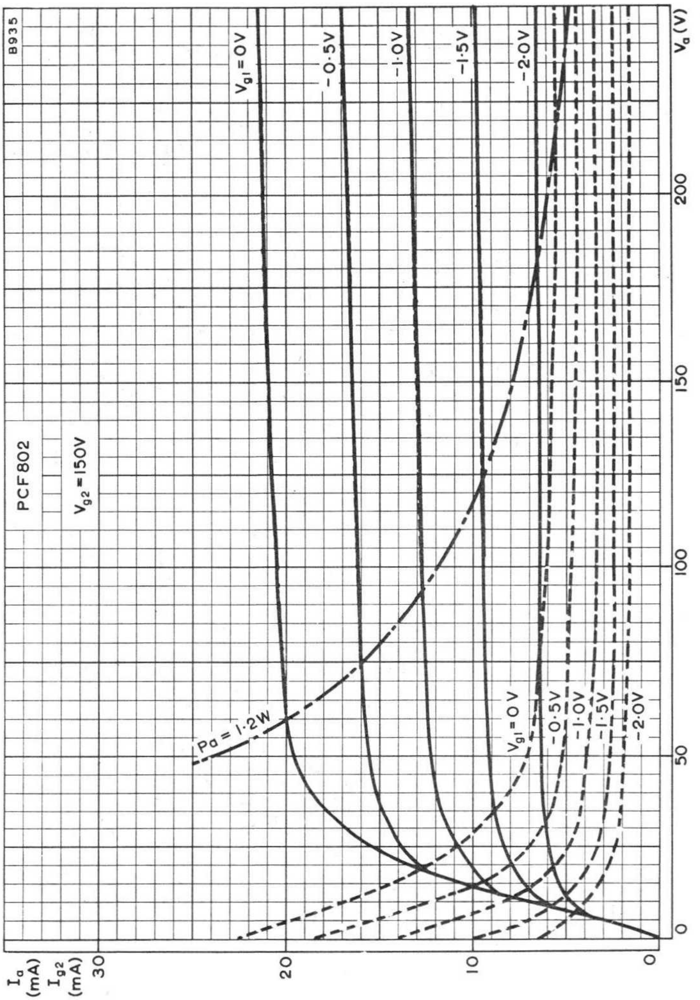




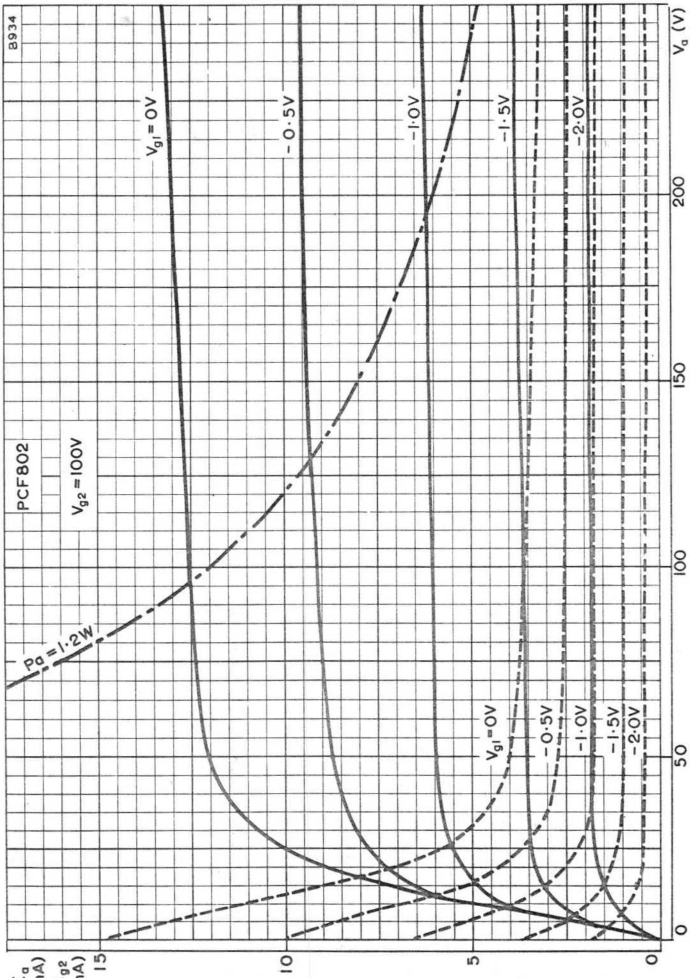
B9A Base
All dimensions in mm



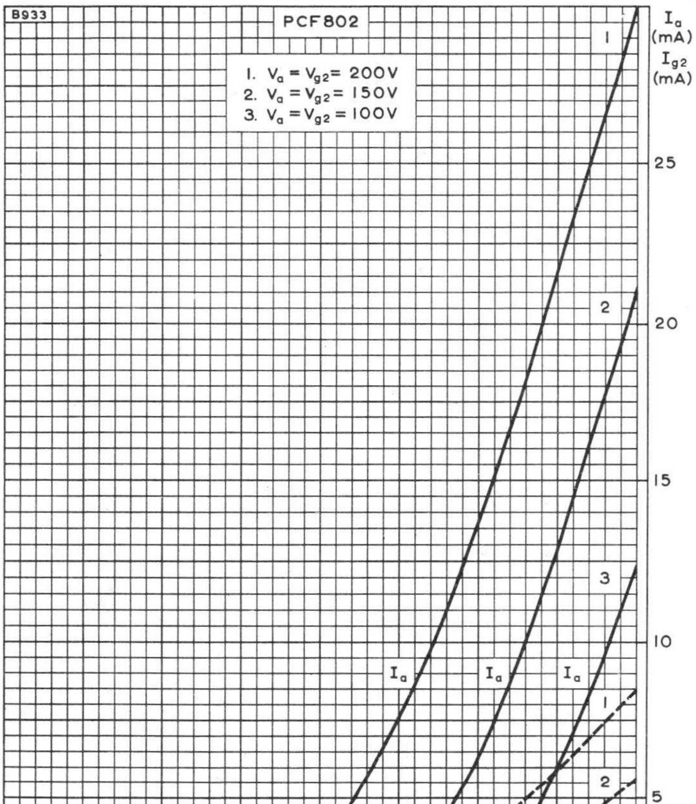
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. Vg2 = 200V



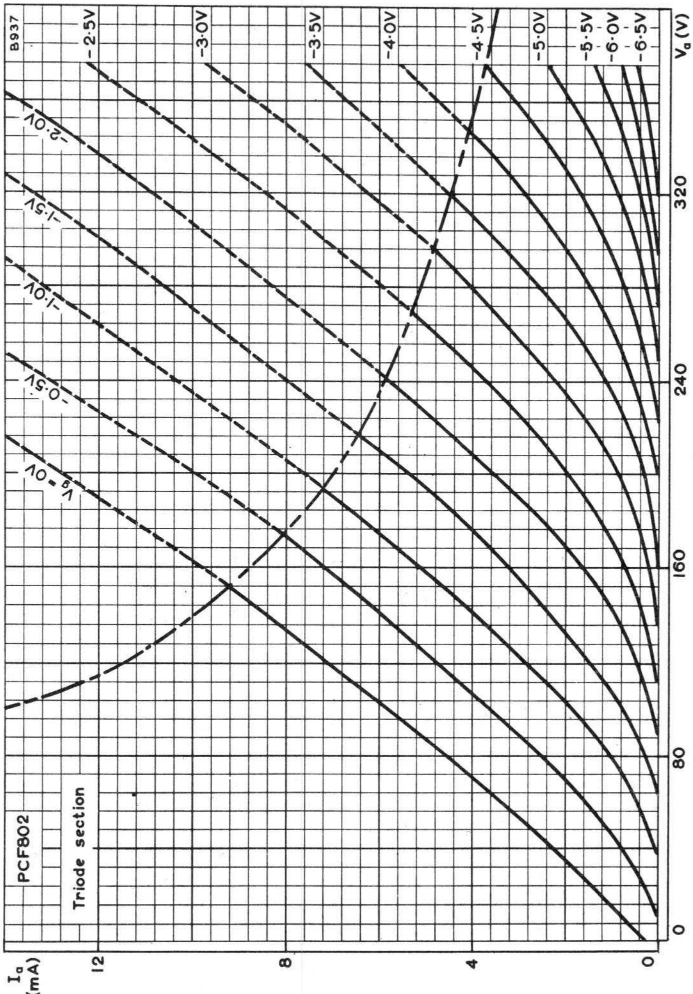
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER. Vg2 = 150V



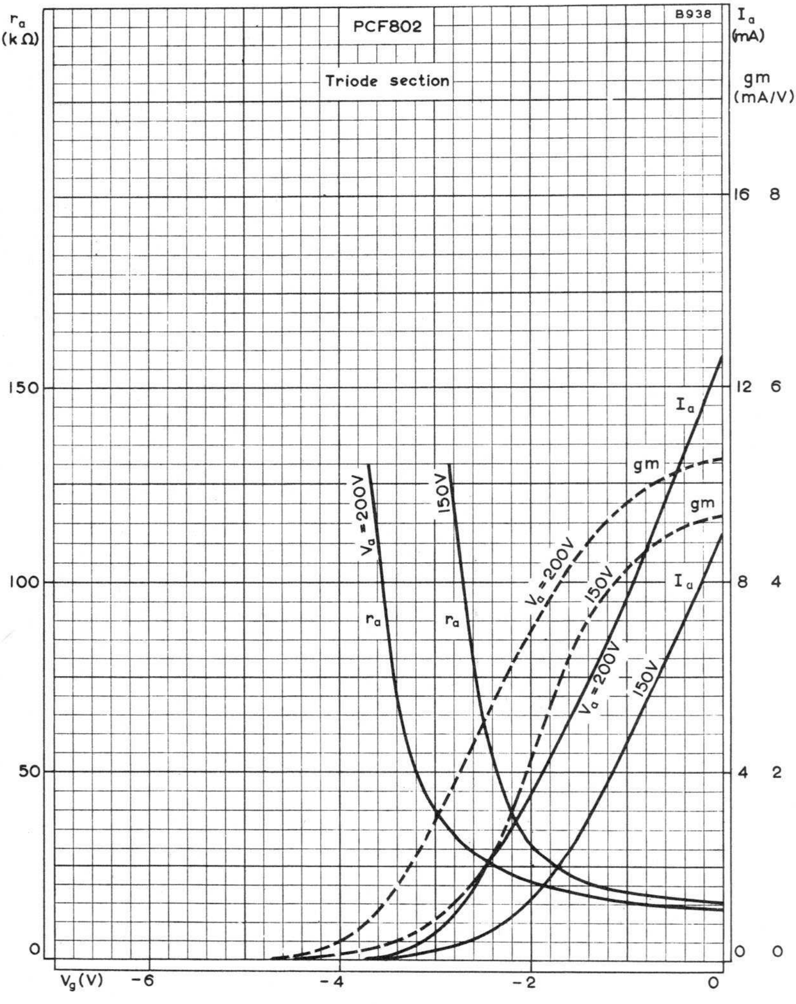
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. Vg2 = 100V



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE CURRENT, MUTUAL CONDUCTANCE, AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. TRIODE SECTION

TRIODE PENTODE

PCF806

Combined triode and high slope frame grid r.f. pentode for use as a frequency changer at frequencies up to 220Mc/s in television tuners.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	8.0	V

CAPACITANCES (measured without an external shield)

c_{ap-at}	<30	mpF
c_{ap-gt}	<10	mpF
c_{g1-at}	<10	mpF
c_{g1-gt}	<10	mpF

Pentode section

c_{a-g1}	12	mpF
c_{g1-g2}	1.6	pF ←
c_{in}	6.0	pF
c_{out}	3.3	pF ←

Triode section

c_{g-k+h}	2.2	pF ←
c_{a-k+h}	1.2	pF ←
c_{a-g}	2.0	pF

CHARACTERISTICS

Pentode section

V_a	170	V
V_{g2}	150	V
I_a	10	mA
I_{g2}	3.3	mA
g_m	12	mA/V
r_a	>350	kΩ
μ_{g1-g2}	70	
V_{g1}	−1.2	V
R_{eq}	1.0	kΩ

Triode section

V_a	100	V
I_a	14	mA
g_m	5.5	mA/V
μ	17	
V_g	−3.0	V

PCF806

TRIODE PENTODE

OPERATING CONDITIONS AS A FREQUENCY CHANGER

Pentode section

V_b	190	V
$V_{g2(b)}$	190	V
R_{g2}	18	kΩ
R_{g1}	100	kΩ
I_a	8.5	mA
I_{g2}	2.7	mA
$V_{osc(r.m.s.)}$	2.3	V
g_c	4.5	mA/V

DESIGN CENTRE RATINGS

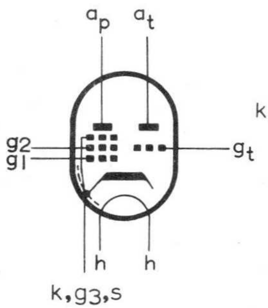
Pentode section

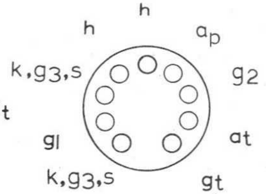
V_a max.	250	V
p_a max.	2.0	W
V_{g2} max.	150	V
p_{g2} max.	500	mW
I_k max.	18	mA
R_{g1-k} max.	250	kΩ

Triode section

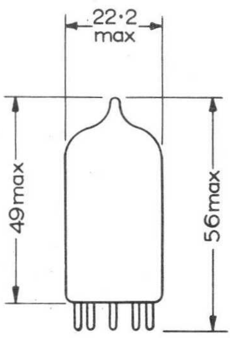
V_a max.	125	V
p_a max.	1.5	W
I_k max.	15	mA
R_{g-k} max.	500	kΩ
*V_{h-k} max.	100	V

*To fulfil hum requirements on a.m. sound, it will be necessary for V_{h-k} to be less than $50V_{r.m.s.}$

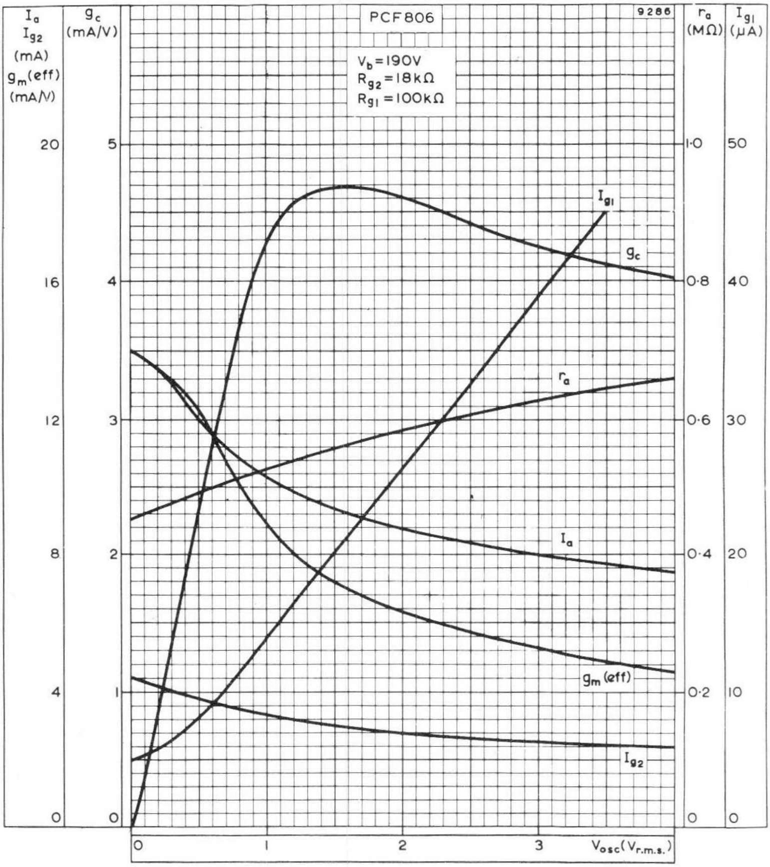




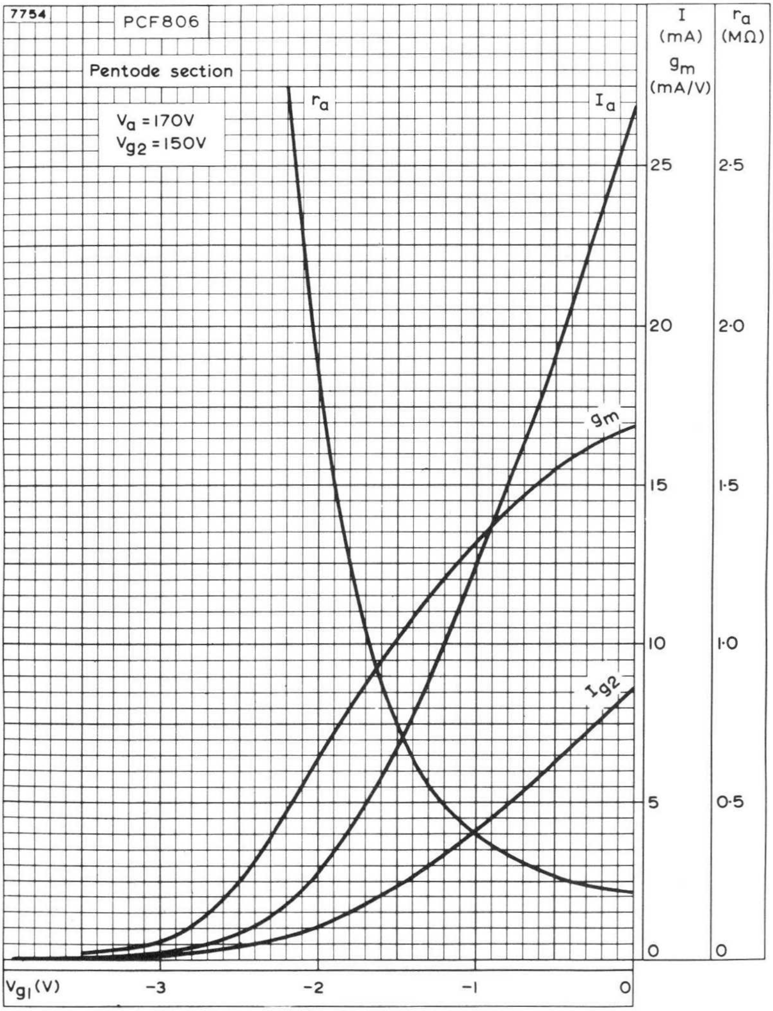
B9A Base
All dimensions in mm



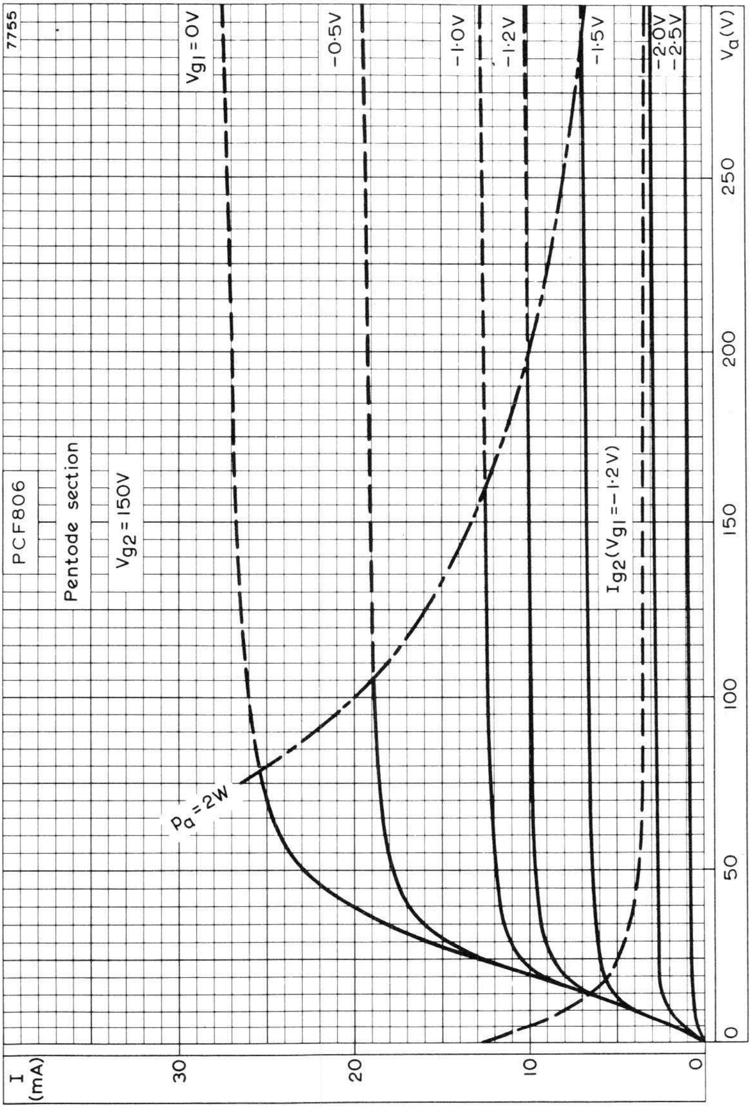
9111



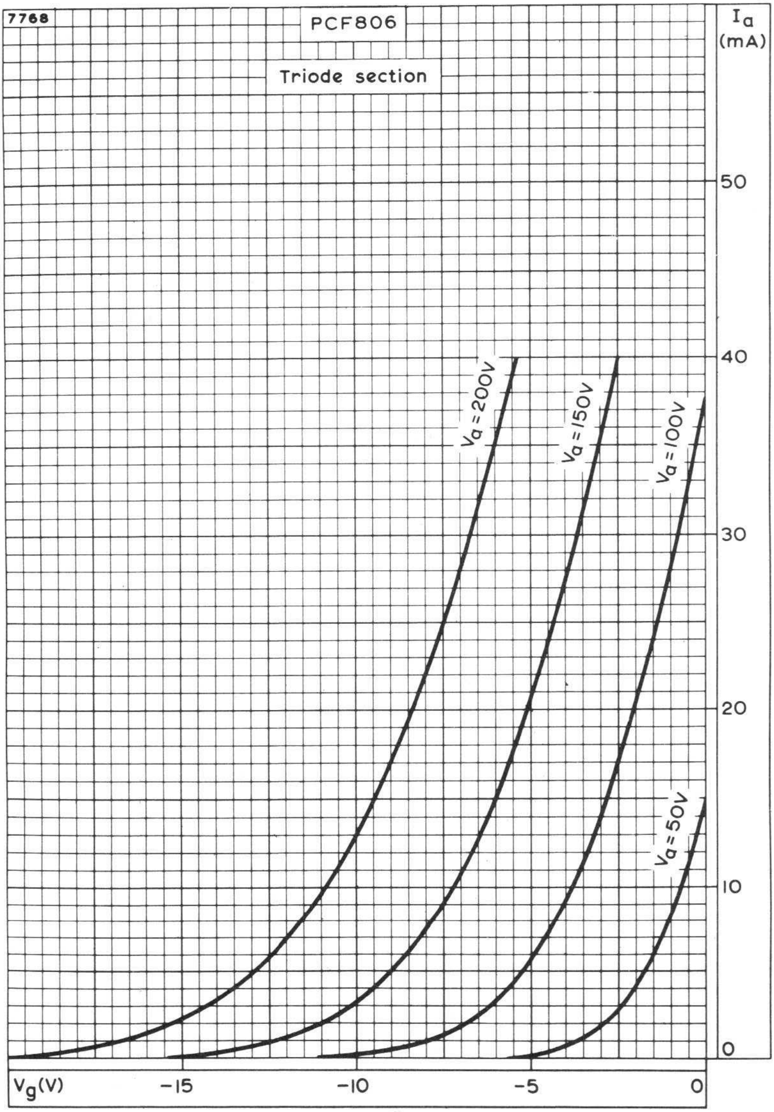
PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER



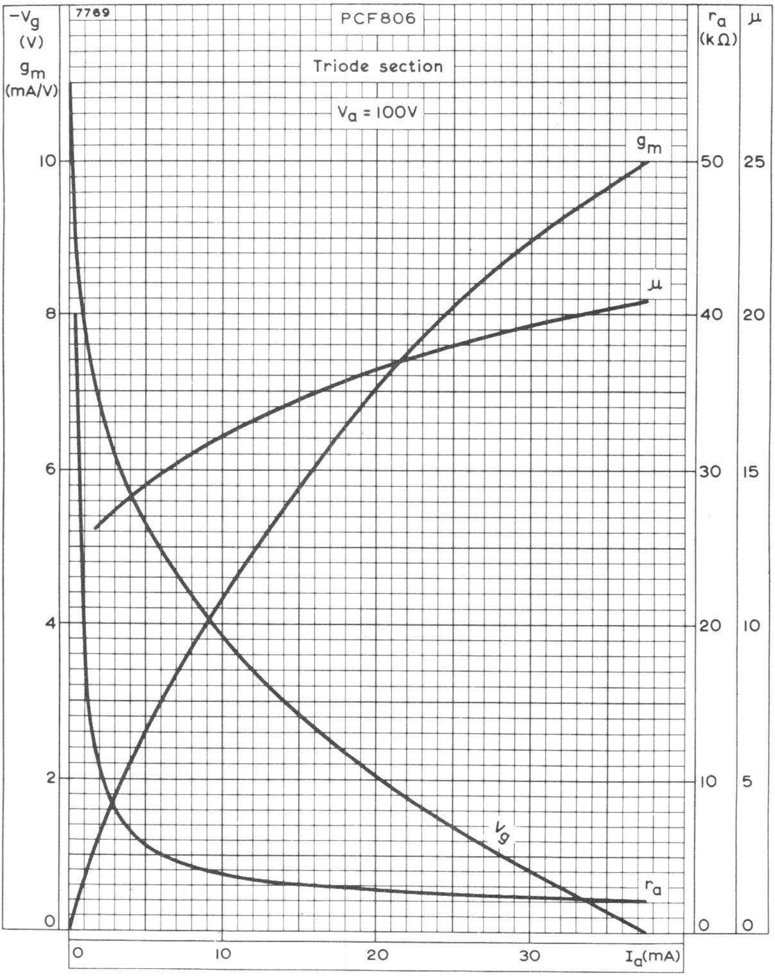
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. PENTODE SECTION



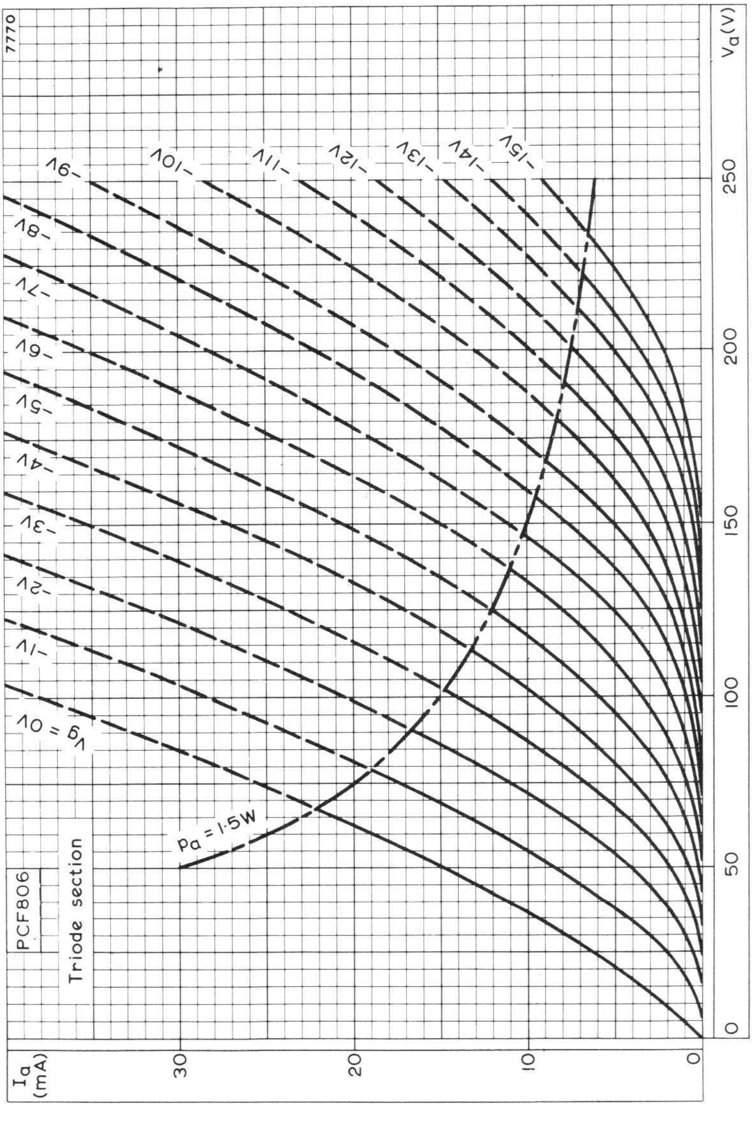
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION



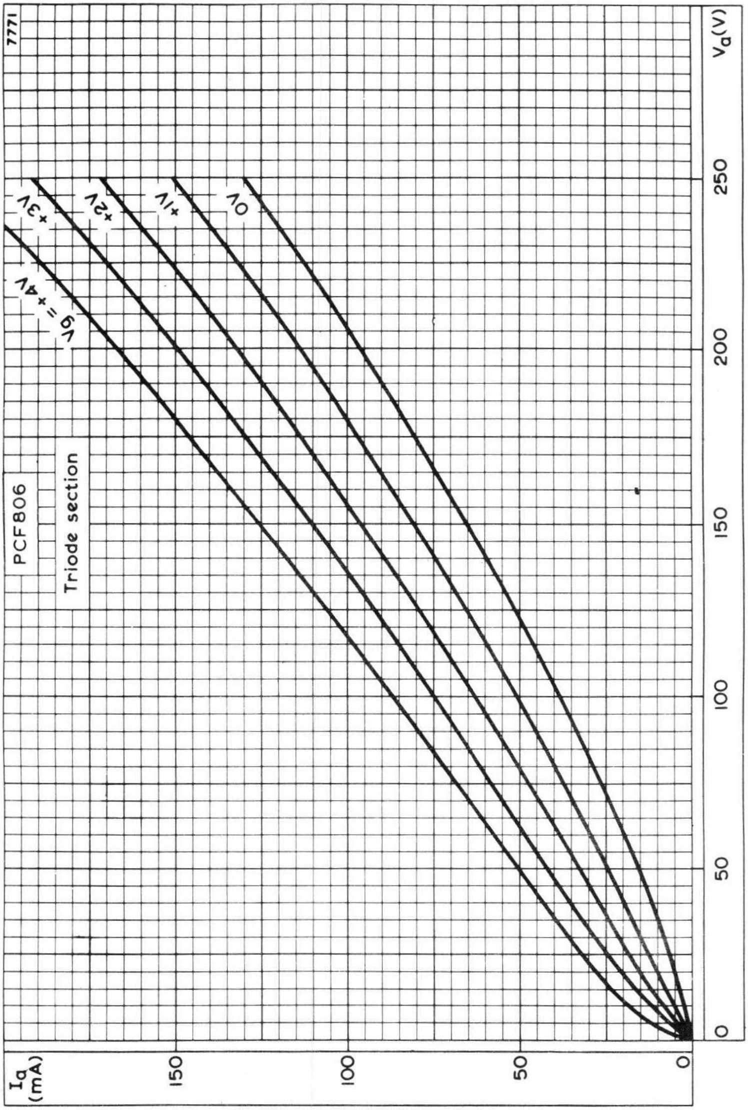
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE FOR VARIOUS VALUES OF ANODE VOLTAGE. TRIODE SECTION



GRID VOLTAGE, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH POSITIVE GRID VOLTAGE AS PARAMETER. TRIODE SECTION

TENTATIVE DATA

Triode heptode intended for use as a noise cancelled synchronising pulse separator and clipper.

HEATER

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

I_h	300	mA
V_h	8.5	V ←

CAPACITANCES

c_{ah-at}	<150	mpF
c_{g1-at}	<10	mpF
c_{g1-gt}	<5.0	mpF ←
c_{g3-gt}	<20	mpF
Heptode section		
c_{in}	4.4	pF
c_{out}	5.4	pF ←
c_{a-g1}	<100	mpF
c_{a-g3}	<250	mpF
c_{g1-g3}	300	mpF
Triode section		
c_{in}	3.3	pF ←
c_{out}	1.7	pF ←
c_{a-g}	1.8	pF

CHARACTERISTICS

Heptode section		
V_a	14	V
V_{g2+g4}	14	V
I_a	1.5	mA ←
I_{g2+g4}	1.3	mA ←
I_{g3}	1.0	μA
V_{g3}	0	V
V_{g1}	0	V
V_{g3} max. ($I_{g3} = 0.3\mu A$)	<-1.3	V
V_{g1} max. ($I_{g1} = 0.3\mu A$)	<-1.3	V

Triode section

V_a		100	V
I_a		9.0	mA ←
V_g		-1.0	V
g_m		8.8	mA/V ←
μ		50	←

OPERATING CONDITIONS

Heptode section

V_{ah}	1.0	14	V
V_{g2+g4}	14	14	V
I_{ah}	>300	750	μA
I_{g3}	1.0	1.0	μA
I_{g1}	100	100	μA

RATINGS (DESIGN CENTRE SYSTEM)

Heptode section

$V_{a(b)}$ max.	550	V
V_a max.	100	V ←
p_a max.	500	mW ←
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max. (see note 1)	50	V
p_{g2+g4} max.	500	mW
$-v_g$ (pk) max.	100	V ←
$-v_{g3}$ (pk) max.	150	V
I_k max.	8.0	mA ←
R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	3.0	MΩ
V_{h-k} max.	100	V

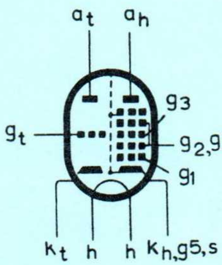
Triode section

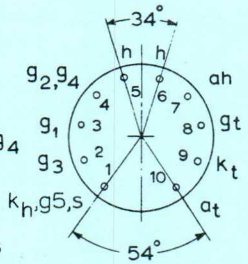
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.5	W
$-v_{g1}$ (pk) max.	200	V
I_k max.	20	mA
R_{g-k} max.	2.0	MΩ
V_{h-k} max. (cathode positive)	70V d.c. + 100V r.m.s. ←	

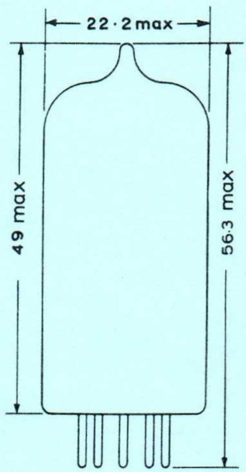
NOTES

1. The minimum V_{g2+g4} is 6V under design maximum conditions.

B4461



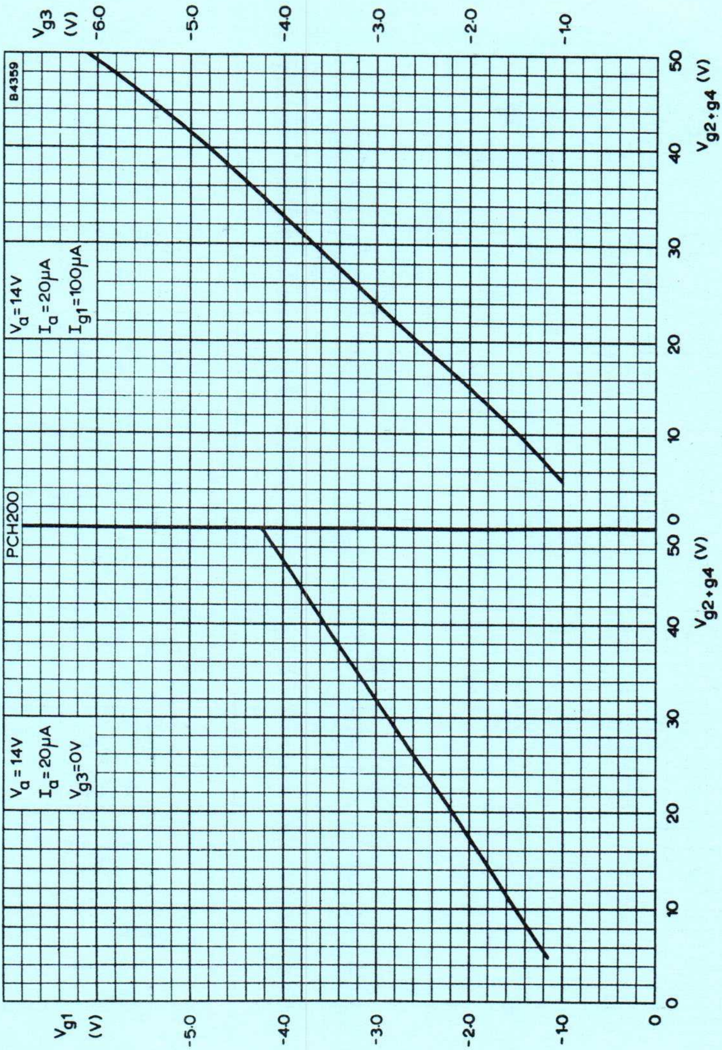




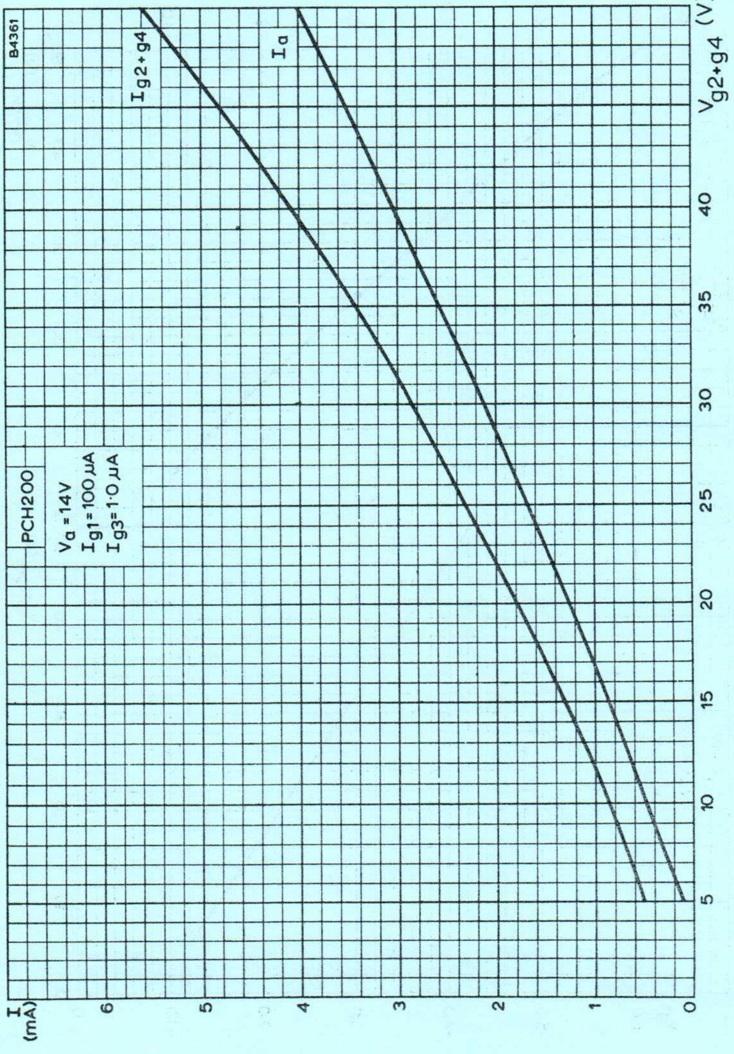
Pin circle diameter = 11·9mm
Pin diameter = 1·0mm

B10B base

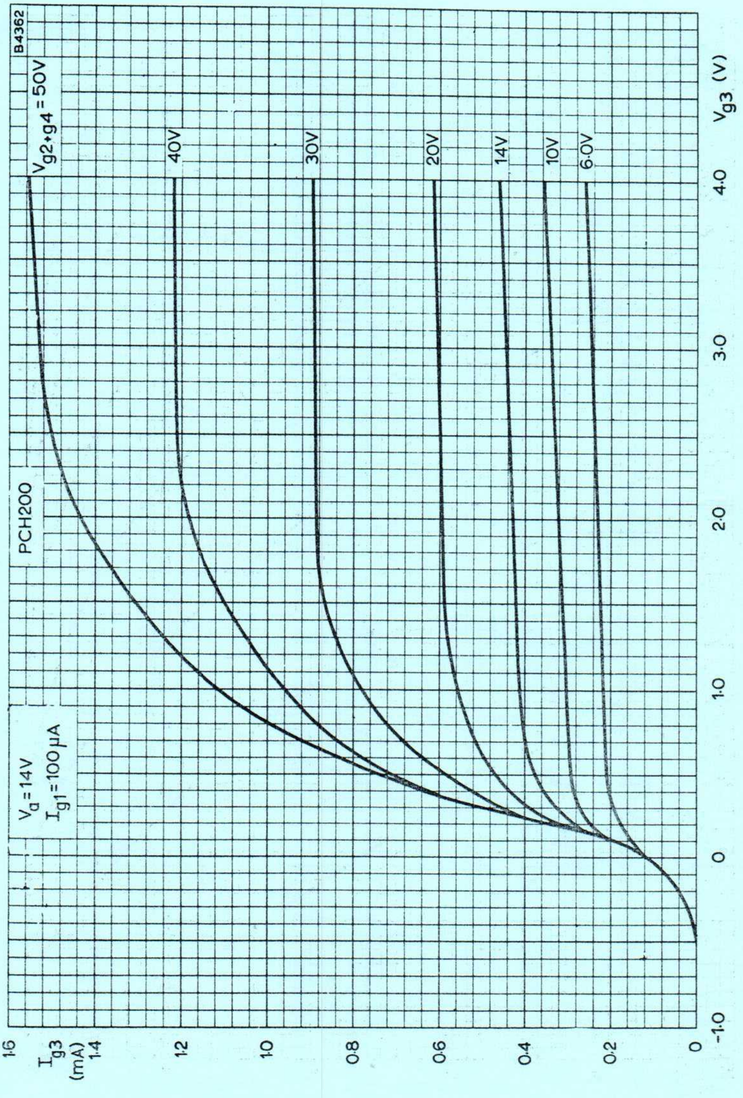
All dimensions in mm



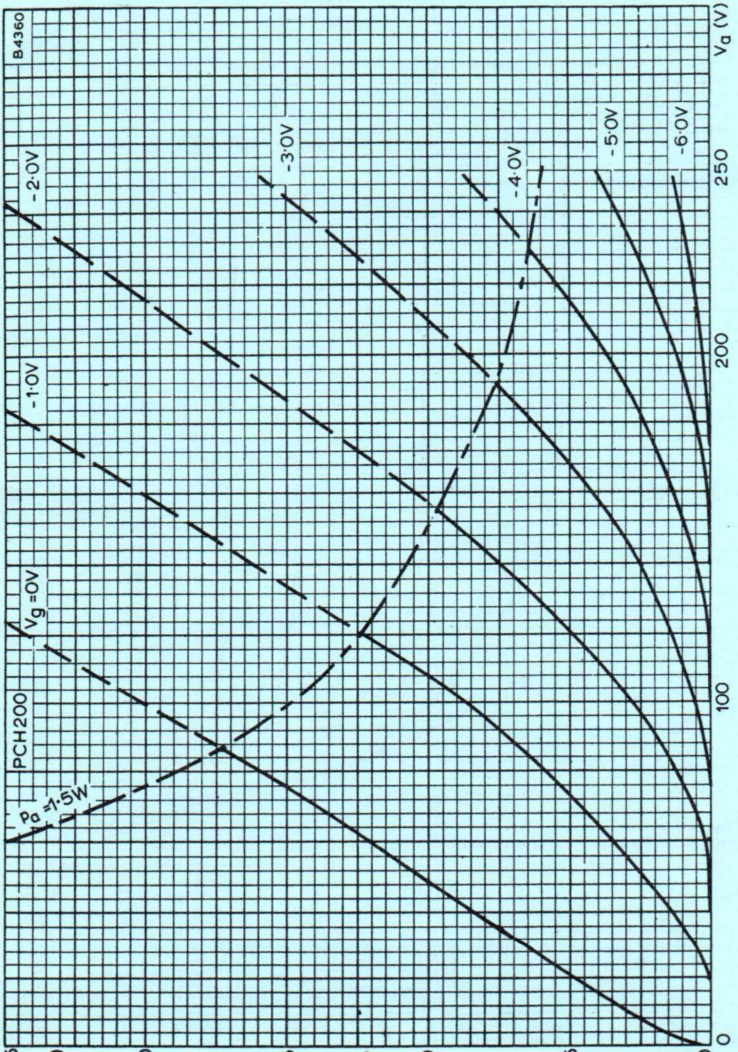
FIRST-GRID AND THIRD-GRID VOLTAGES PLOTTED AGAINST SCREEN-GRID VOLTAGE HEPTODE SECTION



ANODE AND SCREEN-GRID CURRENTS PLOTTED
AGAINST SCREEN-GRID VOLTAGE
HEPTODE SECTION



THIRD-GRID CURRENT PLOTTED AGAINST THIRD-GRID VOLTAGE
WITH SCREEN-GRID VOLTAGE AS PARAMETER
HEPTODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
TRIODE SECTION

TRIODE PENTODE

PCL82

Combined triode and output pentode with separate cathodes for use in television receivers with the triode as an a.f. amplifier or frame blocking oscillator and the pentode as frame or audio output valve.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	16	V

CAPACITANCES (measured without an external shield)

c_{at-g1p}	<20	mpF
c_{gt-ap}	<20	mpF
c_{gt-g1p}	<25	mpF
c_{at-ap}	<250	mpF

Pentode section

c_{in}	9.3	pF
c_{out}	8.0	pF
c_{a-g1}	<300	mpF
c_{g1-h}	<300	mpF

Triode section

c_{a-k+h}	4.3	pF ←
c_{g-k+h}	2.7	pF
c_{a-g}	4.0	pF
c_{g-h}	<20	mpF

CHARACTERISTICS

Pentode section

V_a	170	200	V
V_{g2}	170	200	V
I_a	41	35	mA
I_{g2}	9.0	8.0	mA ←
V_{g1}	–11.5	–16	V
g_m	7.5	6.4	mA/V
r_a	16	20	kΩ
μ_{g1-g2}	9.5	9.5	

Triode section

V_a	100	V
I_a	3.5	mA
V_g	0	V
g_m	2.2	mA/V ←
r_a	32	kΩ ←
μ	70	

PENTODE SECTION AS FRAME OUTPUT VALVE

See nomogram on page C1 and notes on page D4.

PCL82

TRIODE PENTODE

TRIODE SECTION AS A.F. AMPLIFIER

Measured using grid current bias. $R_g = 10M\Omega$

V_b	R_a	I_a	R_{source}	$\frac{V_{out}}{V_{in}}$*	$V_{out(r.m.s.)}$†	R_{g1}‡
(V)	(kΩ)	(mA)	(kΩ)		(V)	(kΩ)
200	47	1.83	0	41	23	150
170	47	1.40	0	39	18.3	150
150	47	1.18	0	38	14.8	150
100	47	0.60	0	34	6.7	150
200	47	1.83	220	31	25.5	150
170	47	1.40	220	30	20.5	150
150	47	1.18	220	29	17.1	150
100	47	0.60	220	27	9.0	150
200	100	1.08	0	51	28.5	330
170	100	0.83	0	50	22	330
150	100	0.72	0	49	18.2	330
100	100	0.38	0	44	8.7	330
200	100	1.08	220	39	33	330
170	100	0.83	220	38	26.5	330
150	100	0.72	220	37	22	330
100	100	0.38	220	34	12.2	330
200	220	0.60	0	58	30.5	680
170	220	0.47	0	56	24	680
150	220	0.40	0	55	20	680
100	220	0.23	0	50	10.3	680
200	220	0.60	220	44	38.5	680
170	220	0.47	220	42	31	680
150	220	0.40	220	41	26	680
100	220	0.23	220	38	14.9	680

*V_{out}/V_{in} measured with an input voltage of 100mV.

†V_{out} measured for $D_{tot} = 5\%$.

‡Grid resistor of following valve.

MICROPHONY

The triode section can be used without special precautions against microphony and hum in circuits in which the input voltage is $\geqq$ 10mV for an output of 50mW from the output stage. The a.c. voltage between pin 4 and triode cathode should not exceed 6.3V.

PENTODE SECTION AS AUDIO OUTPUT VALVE

Single valve class 'A'

V_{a-k}	170	170	200	200	V
V_{g2-k}	170	170	200	200	V
R_k	450	230	650	380	Ω
R_a	7.0	3.9	9.0	5.6	kΩ
$I_{a(o)}$	25	41	22	35	mA
$I_{g2(o)}$	4.8	8.0	4.3	7.0	mA
$V_{in(r.m.s.)}$ (P_{out} = 50mW)	660	590	690	600	mV
$V_{in(r.m.s.)}$	5.3	6.0	5.7	6.6	V
*P_{out}	2.0	3.3	2.0	3.5	W
*D_{tot}	9.2	10	8.5	10	%

*P_{out} and D_{tot} are measured at fixed bias and therefore represent the power output available during the reproduction of speech and music. When a sustained sine wave is applied to the control grid, the bias voltage developed across the cathode resistor will readjust itself as a result of the increased anode and screen-grid currents. This will result in a reduction in P_{out} of approximately 10%

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
*$+v_{a(pk)}$ max.	2.5	kV
$-v_{a(pk)}$ max.	500	V
p_a max. (audio applications)	7.0	W
p_a max. (frame output)	5.0	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	2.2	W ←
I_k max.	50	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

*Maximum pulse duration is 4% of one cycle with a maximum of 800μs

Triode section

V_a max.	250	V
*$+v_{a(pk)}$ max.	600	V
p_a max.	1.0	W
I_k max.	15	mA
*$i_{k(pk)}$ max.	200	mA
R_{g-k} max.	1.0	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

*Maximum pulse duration = 200μs

PEAK ANODE CURRENT NOMOGRAM

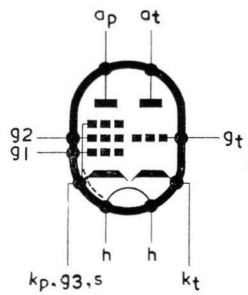
The nomogram shown on the following page gives directly the values of peak anode current and corresponding values of anode voltage at end of scan for various values of screen-grid voltage.

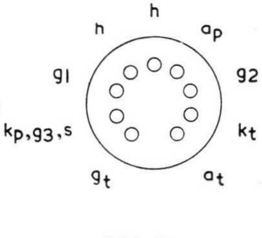
No indication of anode and screen-grid dissipation limits is given in the nomogram: these must be checked independently.

Example

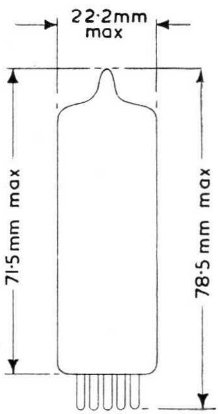
Suppose the screen-grid voltage is 170V. From the nomogram, the optimum working conditions at $V_{g2} = 170V$ are $i_{a(pk)} = 90mA$, and v_a at end of scan = 70V.

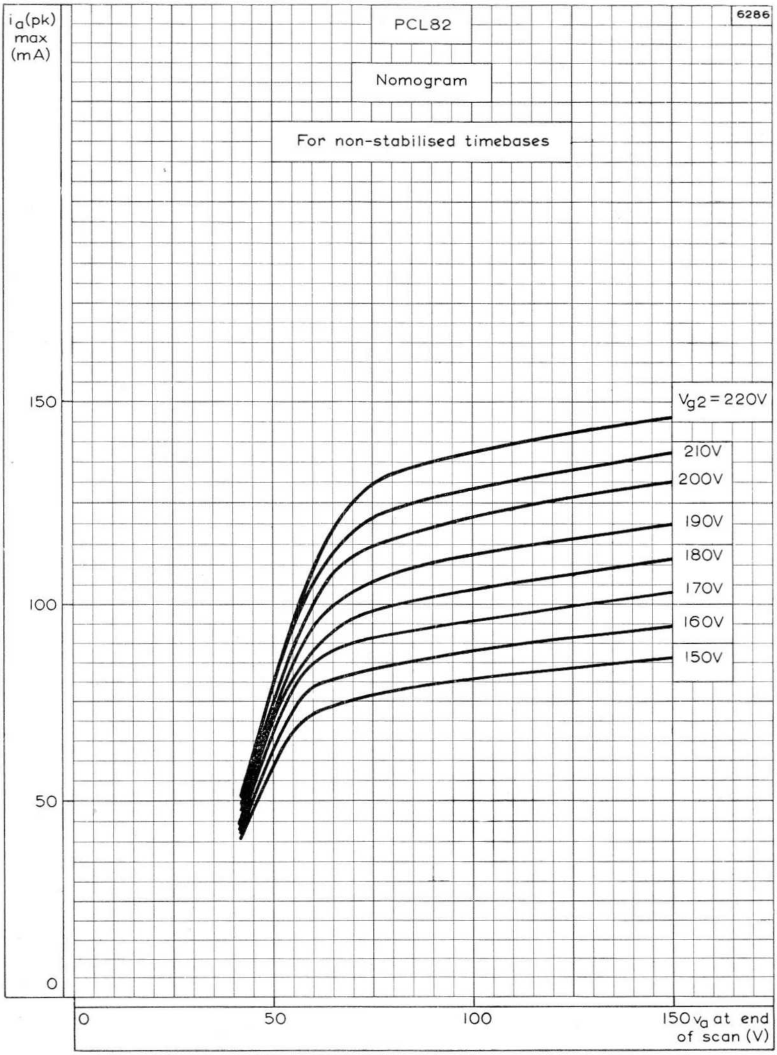
2324



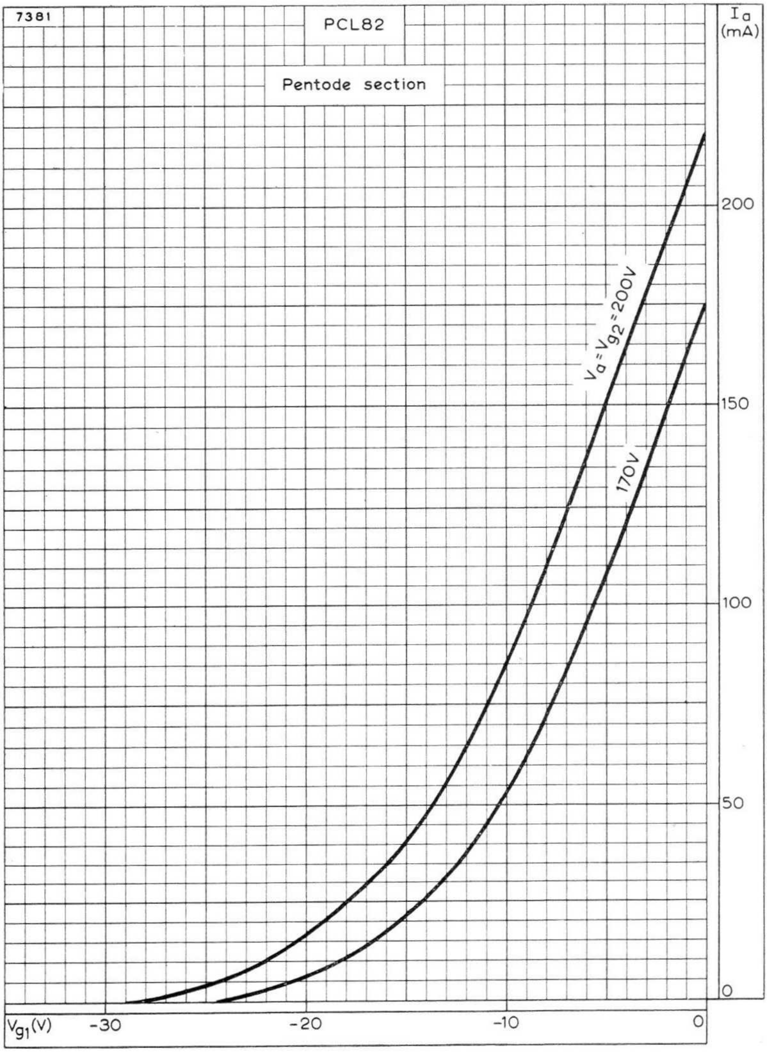


B9A Base

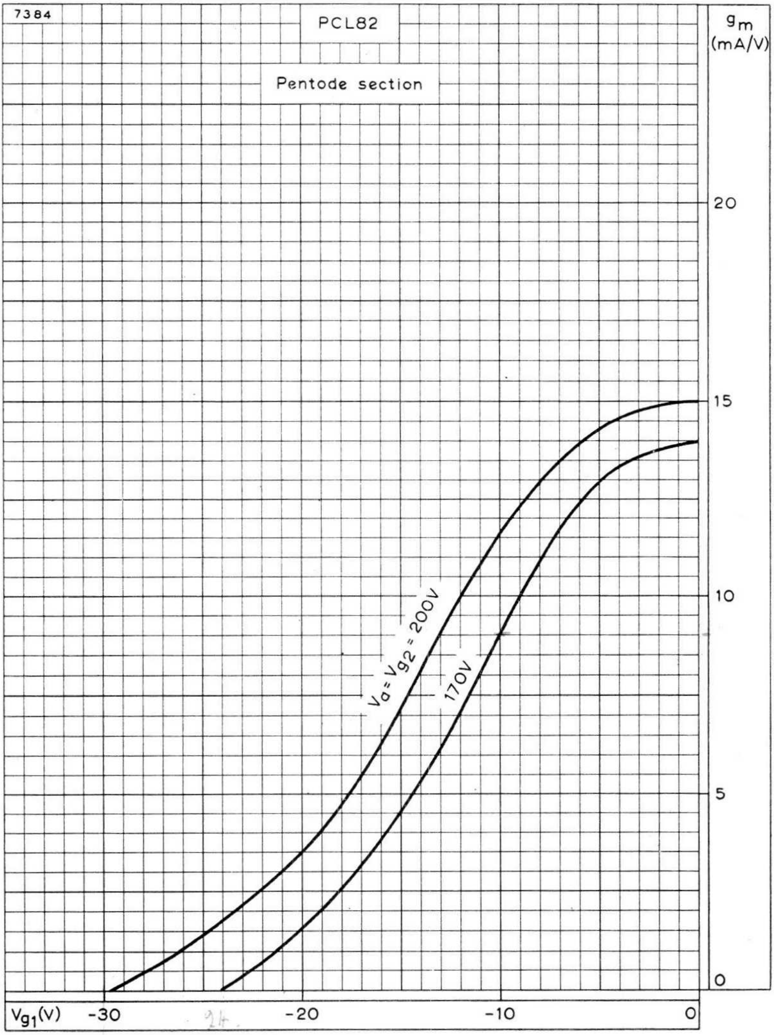




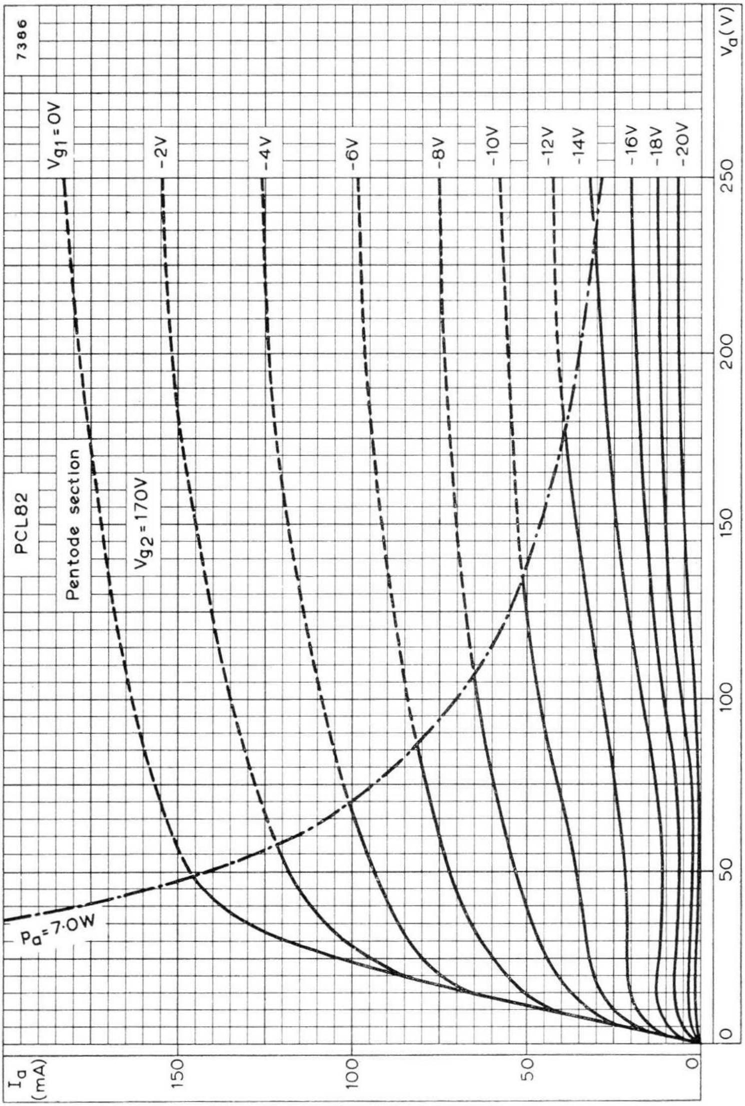
PEAK ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE AT THE END OF SCAN



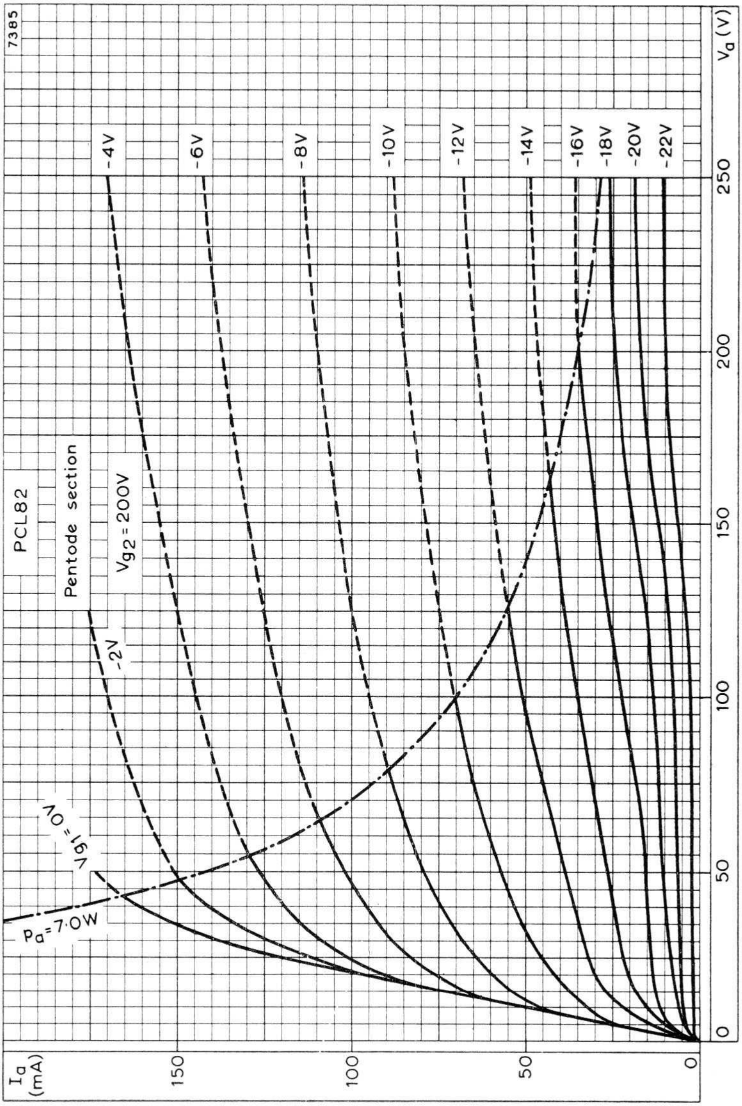
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER. PENTODE SECTION



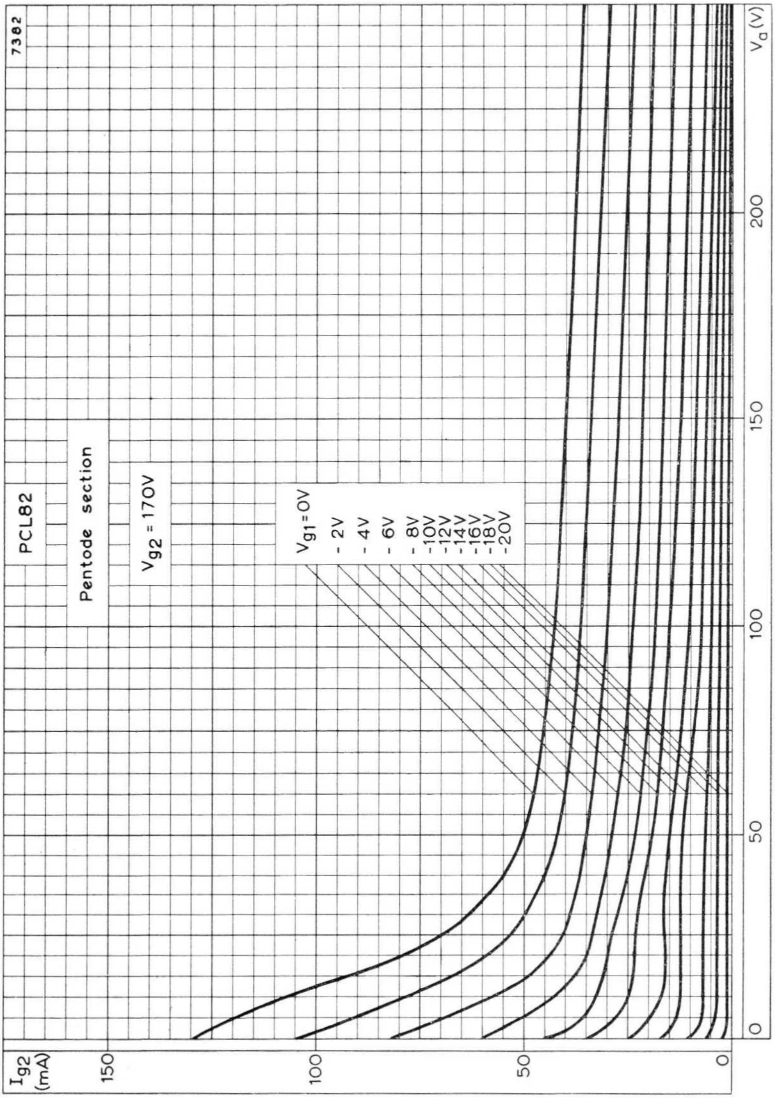
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER. PENTODE SECTION



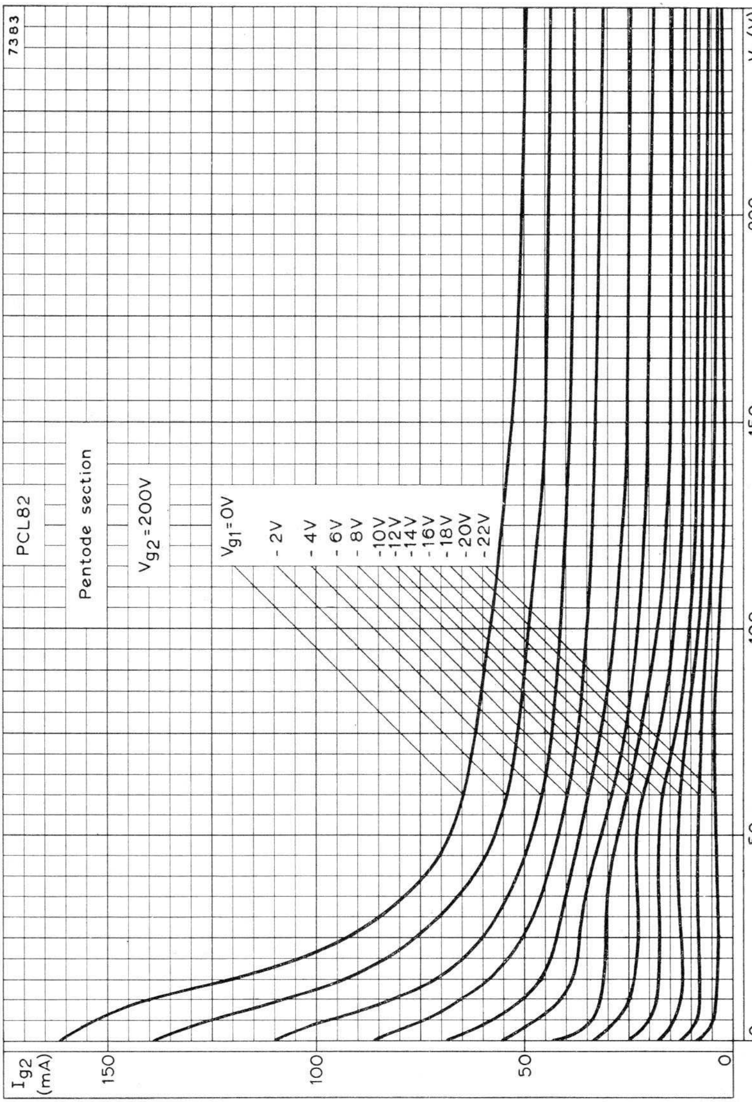
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION. $V_{g2} = 170V$



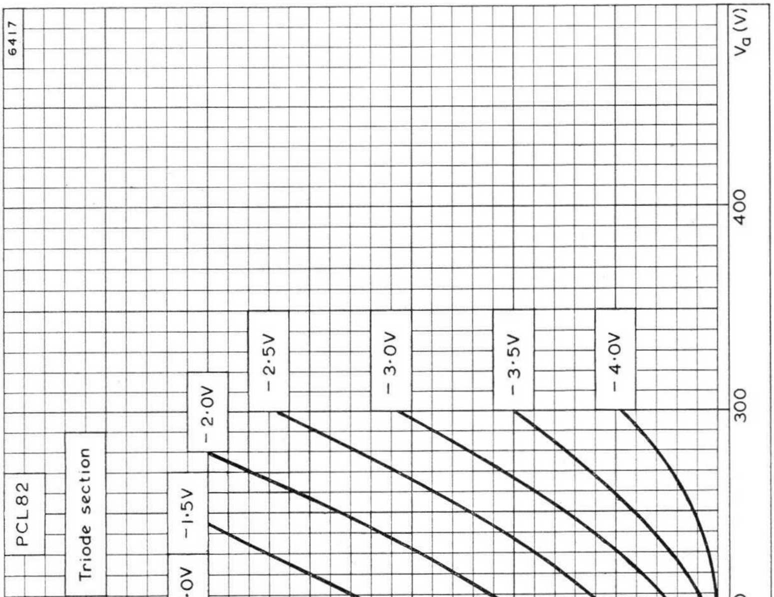
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION. $V_{g2} = 200V$



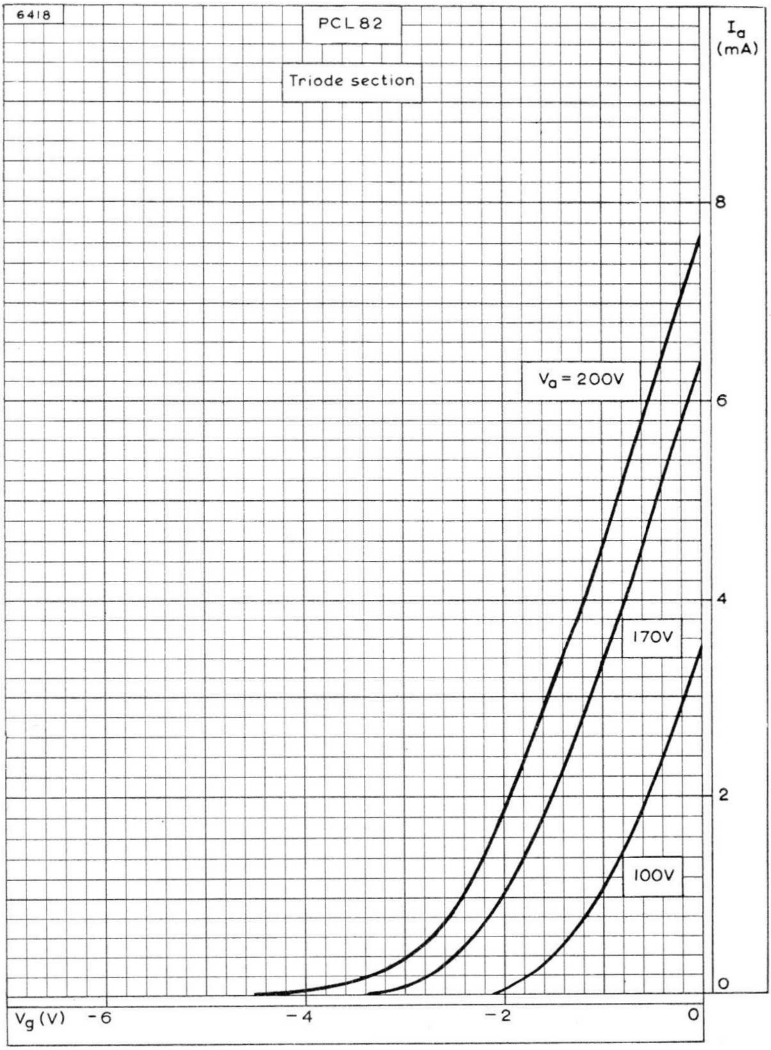
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION. $V_{g2} = 170V$



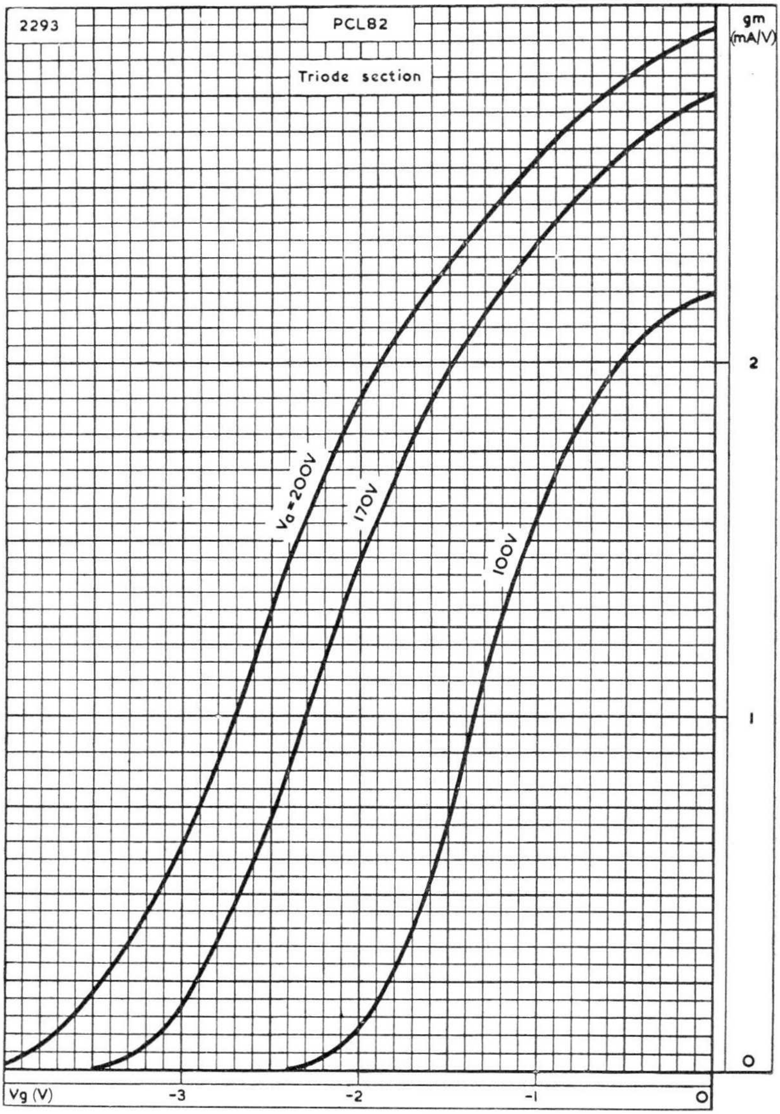
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. PENTODE SECTION. $V_{g2} = 200V$



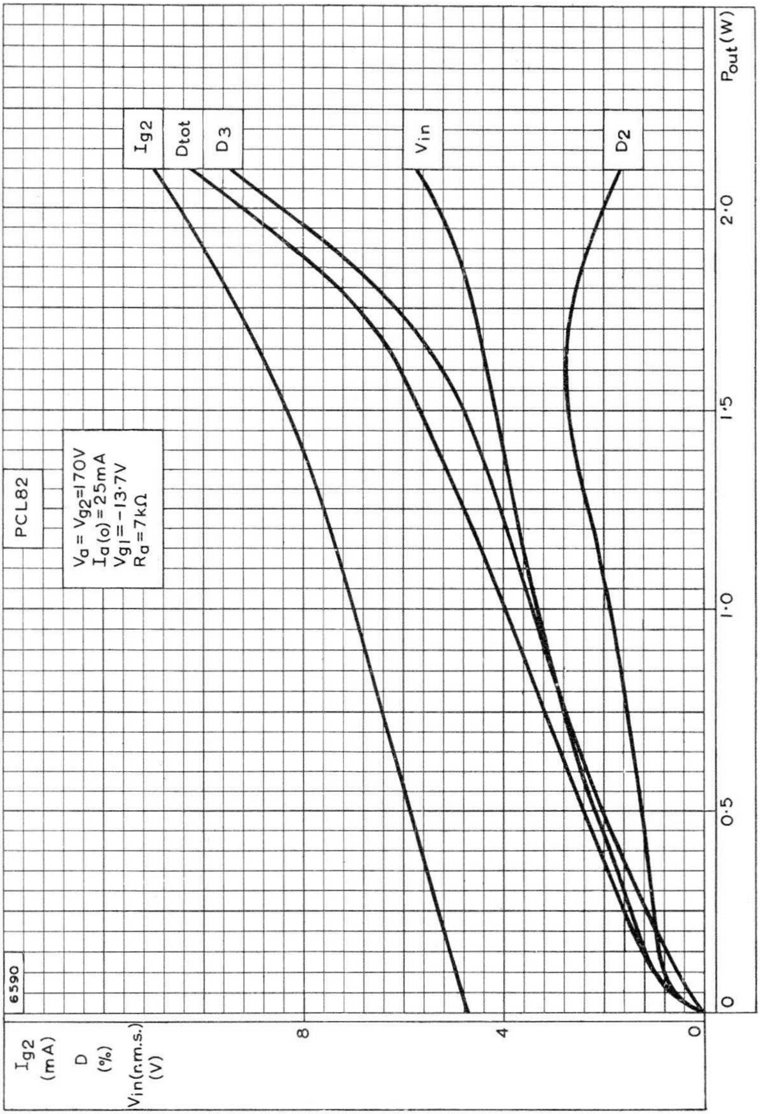
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE.
TRIODE SECTION



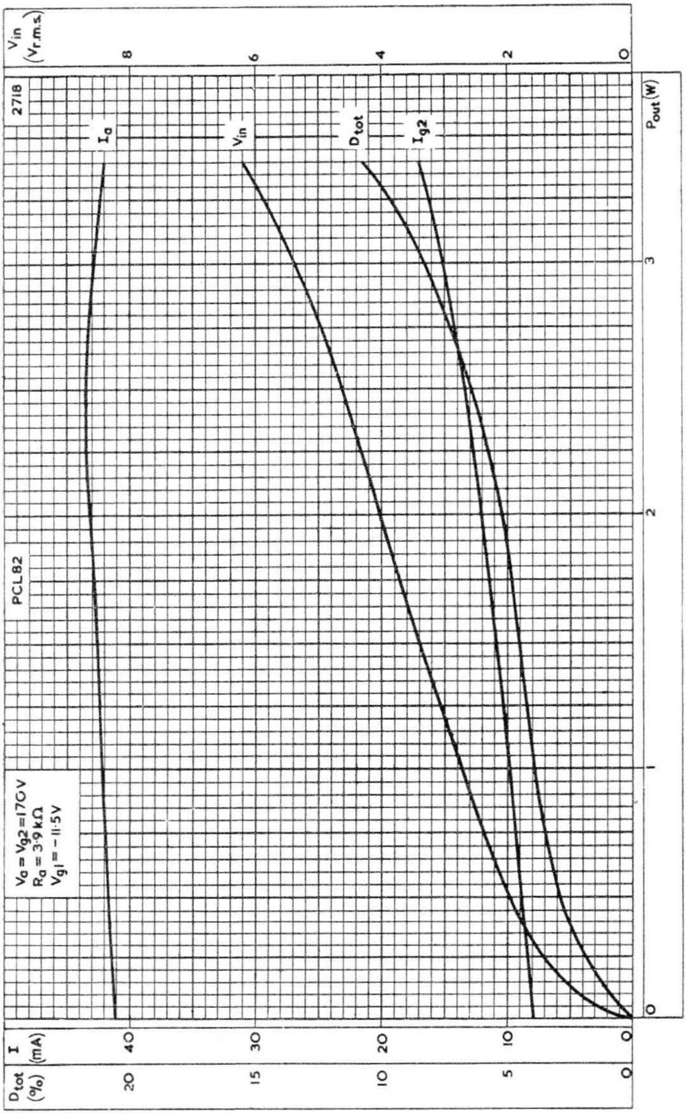
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
TRIODE SECTION



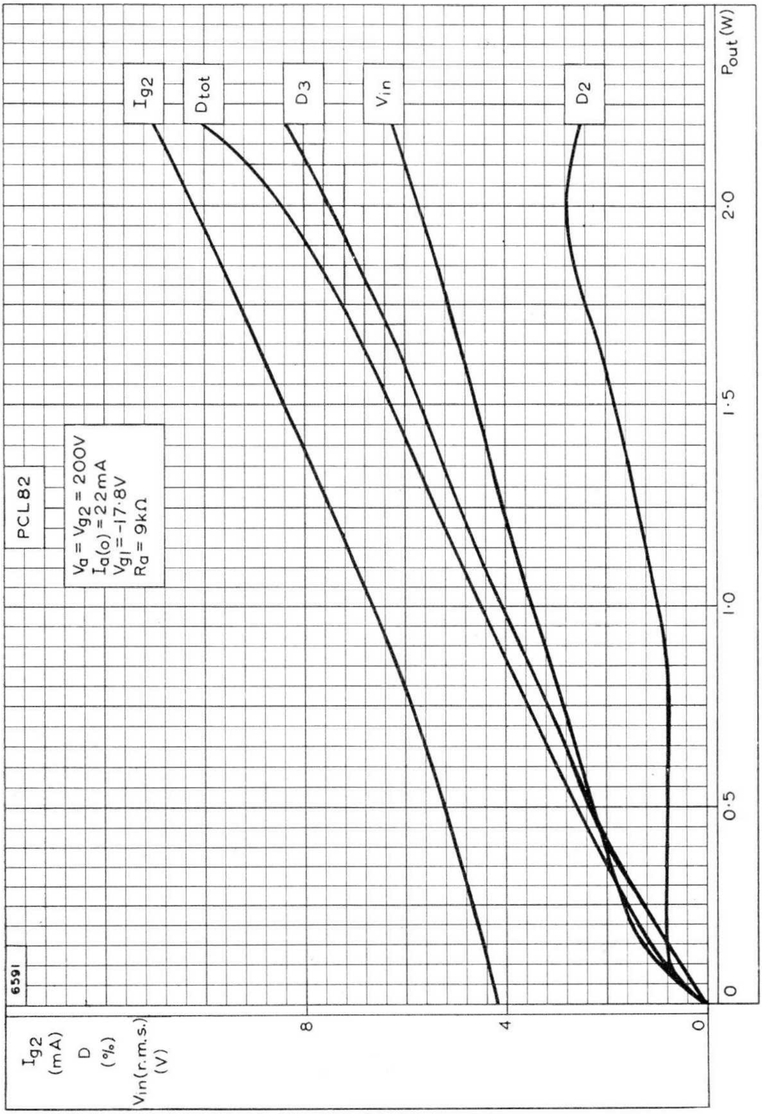
MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE. TRIODE SECTION



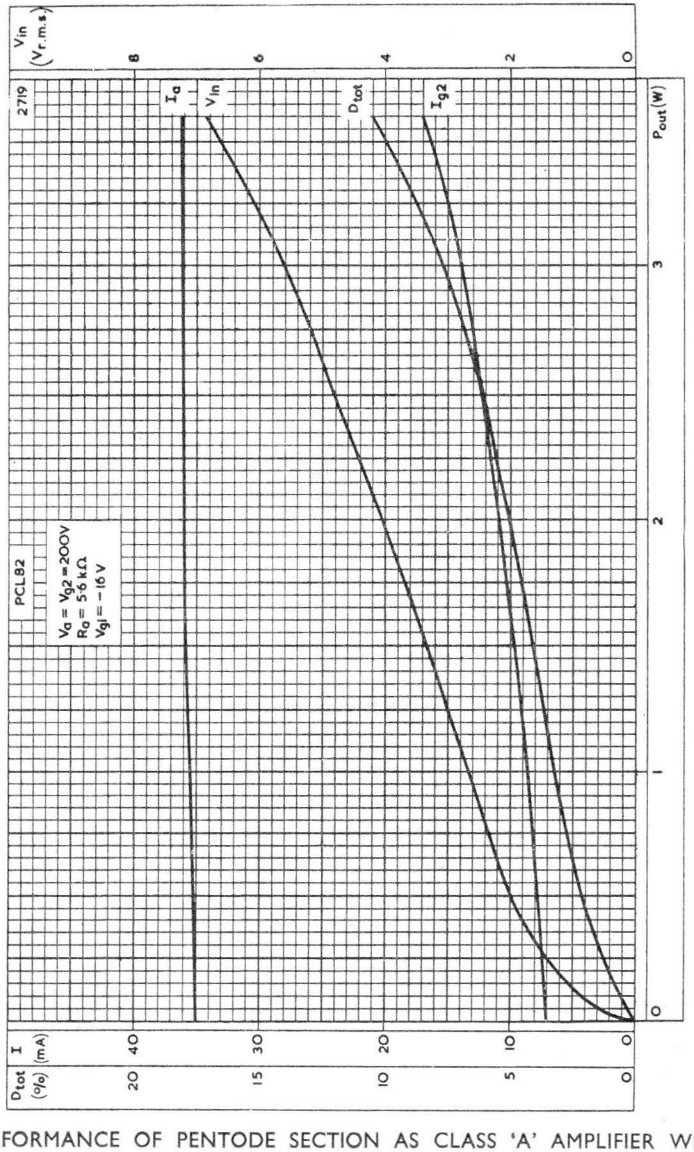
PERFORMANCE OF PENTODE SECTION AS CLASS 'A' AMPLIFIER WITH FIXED BIAS. $V_a = 170V$, $R_a = 7k\Omega$



PERFORMANCE OF PENTODE SECTION AS CLASS 'A' AMPLIFIER WITH FIXED BIAS. $V_a = 170V$, $R_a = 3.9k\Omega$



PERFORMANCE OF PENTODE SECTION AS CLASS 'A' AMPLIFIER WITH FIXED BIAS. $V_a = 200V$, $R_a = 9k\Omega$



PERFORMANCE OF PENTODE SECTION AS CLASS 'A' AMPLIFIER WITH FIXED BIAS. $V_a = 200V$, $R_a = 5.6k\Omega$

TRIODE PENTODE

PCL84

Triode pentode for use in television circuits as keyed a.g.c. valve, sync-separator, sync-amplifier or in noise suppression circuits. Pentode section for use as video output valve.

HEATER

I_h	300	mA
V_h	15	V

CAPACITANCES

c_{at-g1}	<10	mpF
c_{gt-g1}	<10	mpF
Pentode section		
c_{in}	8.7	pF
c_{out}	4.2	pF
c_{a-g1}	<100	mpF
Triode section		
c_{g-k}	3.8	pF
c_{a-k}	2.3	pF
c_{a-g}	2.7	pF
c_{g-h}	<100	mpF

CHARACTERISTICS

Pentode section

V_a	170	200	220	V
V_{g2}	170	200	220	V
V_{g1}	−2.1	−2.9	−3.4	V
I_a	18	18	18	mA
I_{g2}	3.0	3.0	3.0	mA
g_m	11	10.4	10	mA/V
r_a	100	130	150	kΩ
μ_{g1-g2}	36	36	36	
V_{g1} max. ($I_{g1} = +0.3\mu A$)			−1.3	V

Triode section

V_a	200	V
V_g	−1.7	V
I_a	3.0	mA
g_m	4.0	mA/V
r_a	16.2	kΩ
μ	65	
V_g max. ($I_g = +0.3\mu A$)	−1.3	V

PCL84

TRIODE PENTODE

PENTODE SECTION AS VIDEO OUTPUT VALVE

$V_b = V_{g2}$	170	200	220	V
V_{g1}	−2.0	−2.8	−3.3	V
R_a	3.0	3.0	3.0	kΩ
I_a	18	18	18	mA
I_{g2}	3.2	3.1	3.1	mA
g_m	10.4	10	9.7	mA/V

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	4.0	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.7	W
I_k max.	40	mA
R_{g1-k} max. (fixed bias)	1.0	MΩ
R_{g1-k} max. (self bias)	2.0	MΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

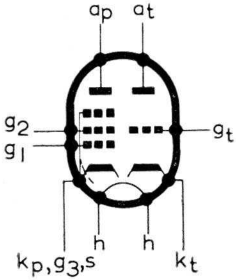
Triode section

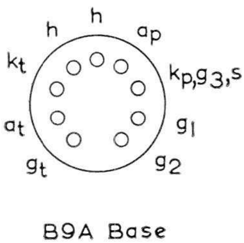
$V_{a(b)}$ max.	550	V
V_a max.	250	V
$v_{a(pk)}$ max.	600	V
p_a max.	1.0	W
*$i_{k(pk)}$ max.	160	mA
I_k max.	12	mA
R_{g-k} max. (fixed bias)	1.0	MΩ
R_{g-k} max. (self bias)	3.0	MΩ
V_{h-k} max. (cathode negative)	150	V
†V_{h-k} max. (cathode positive)	350	V
R_{h-k} max.	20	kΩ

*Maximum pulse duration = 800μs.

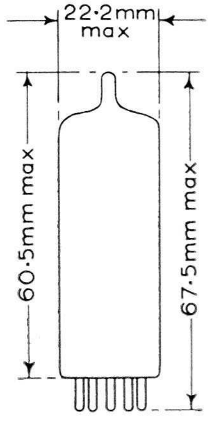
†Maximum d.c. component = 200V.

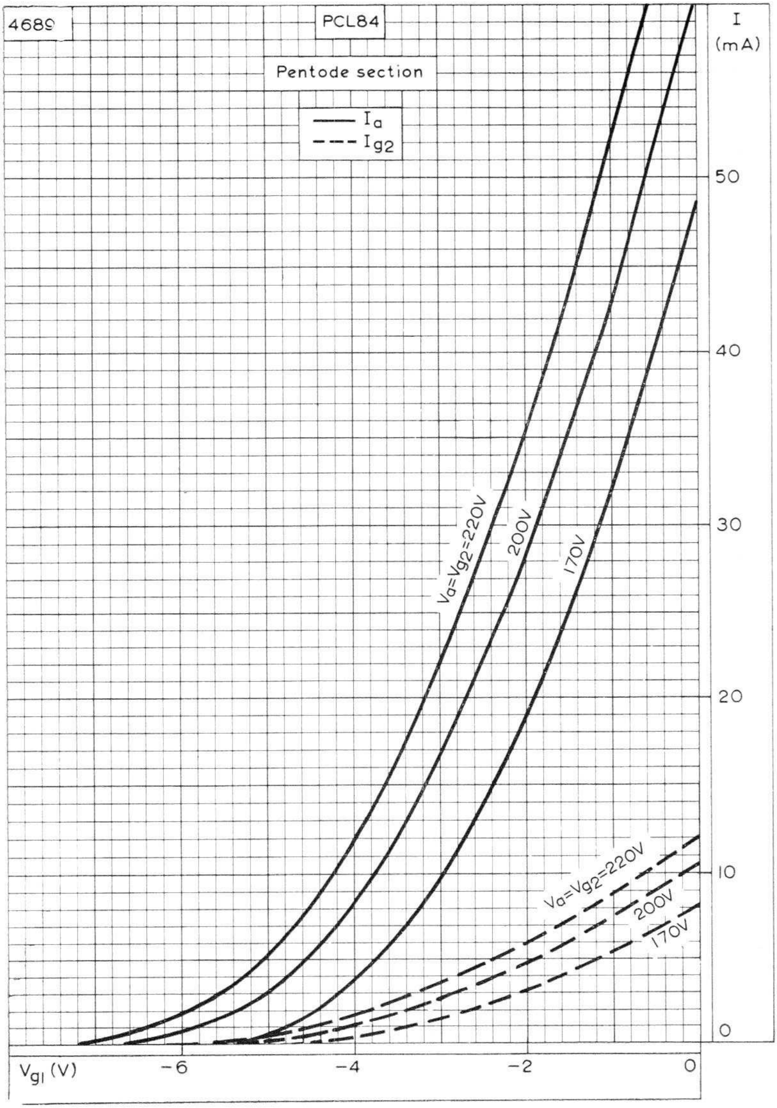
4690



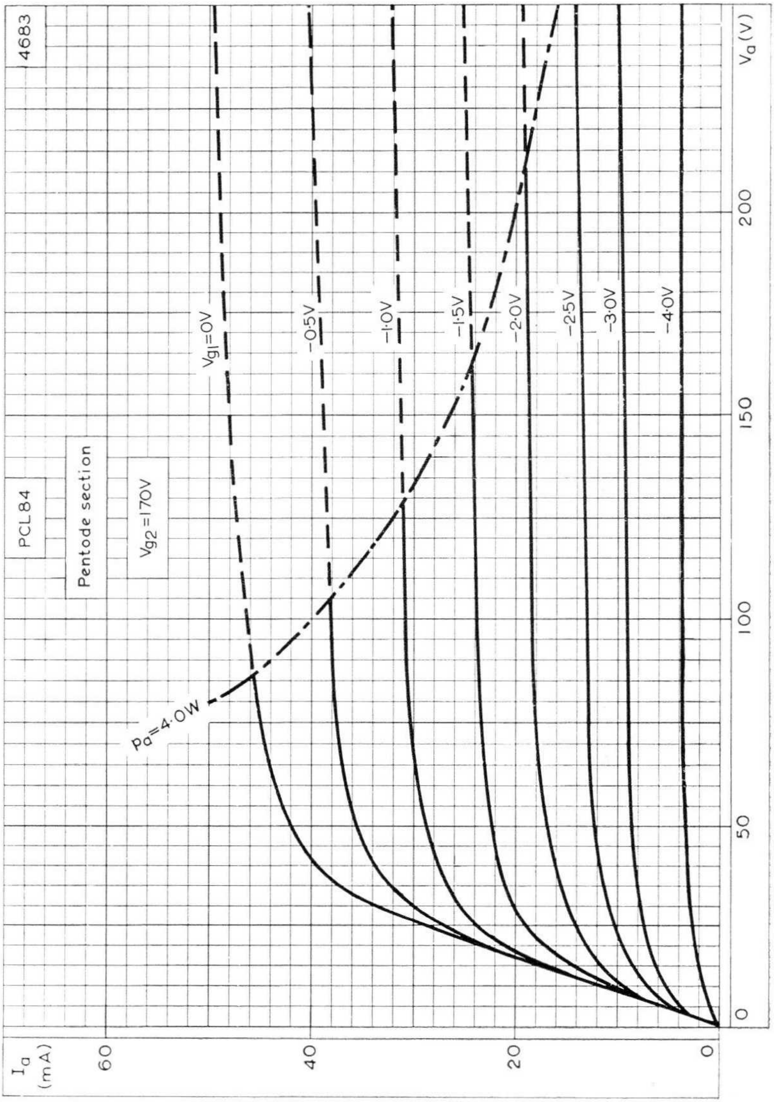


B9A Base

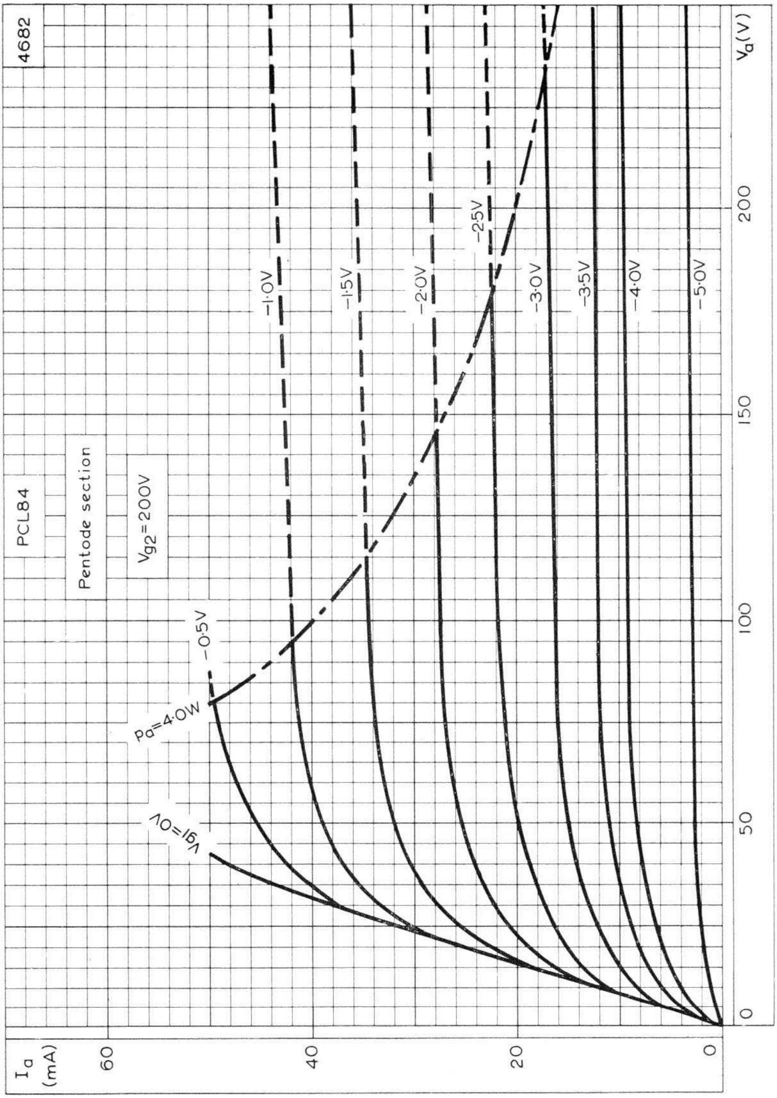




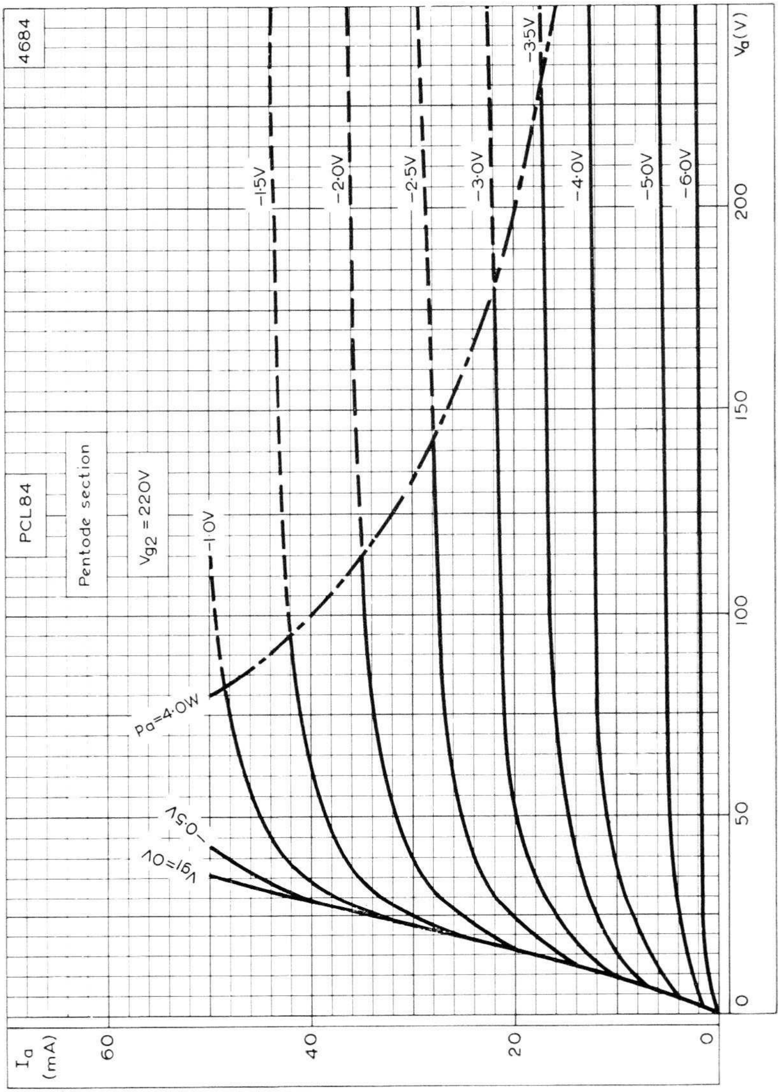
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR VARIOUS ANODE AND SCREEN-GRID VOLTAGES



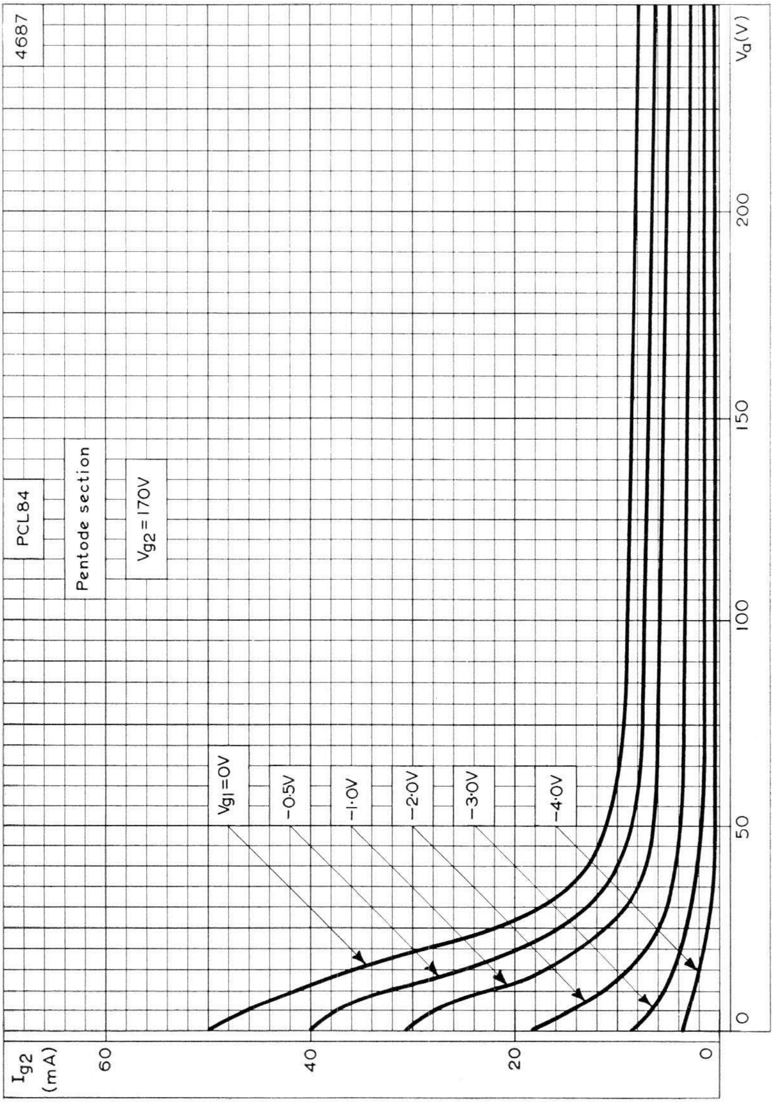
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER.
$V_{g2} = 170V$



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER
$V_{g2} = 200V$



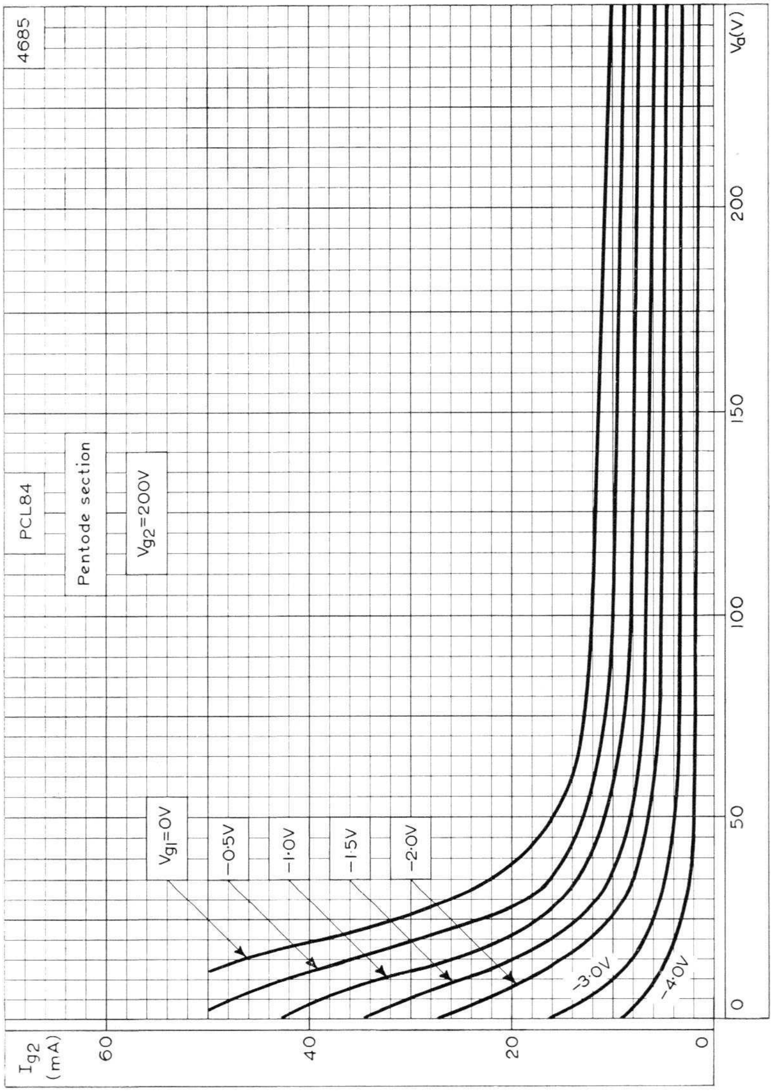
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER
$V_{g2} = 220V$



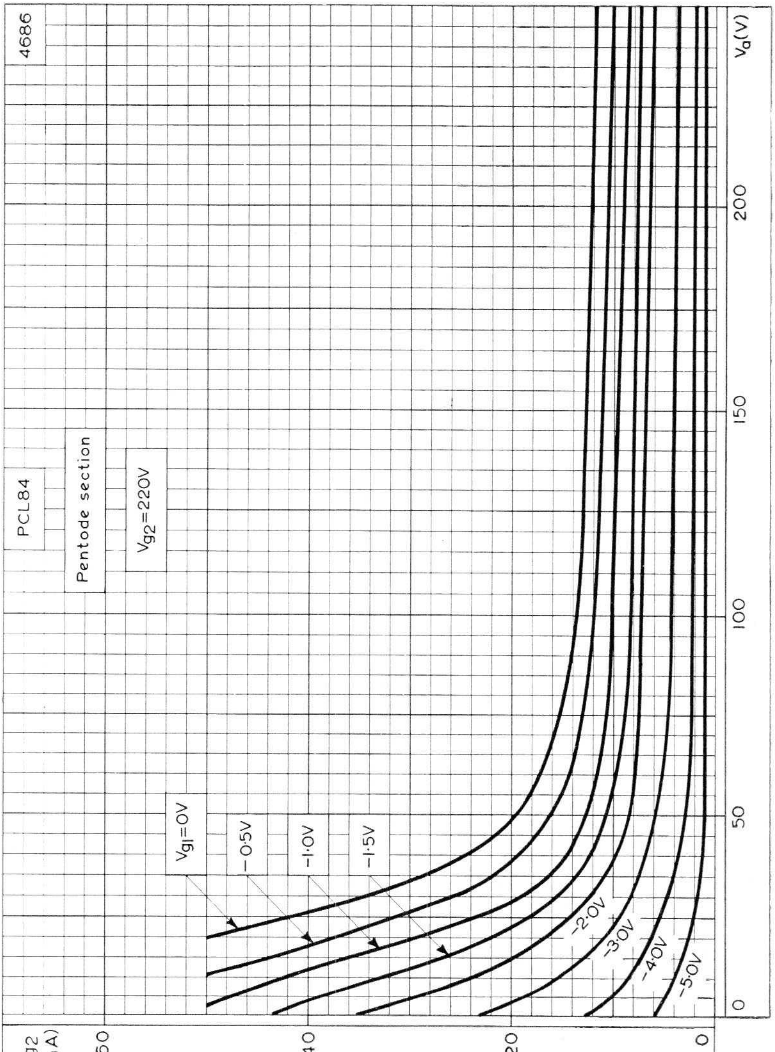
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER
$V_{g2} = 170V$

PCL84

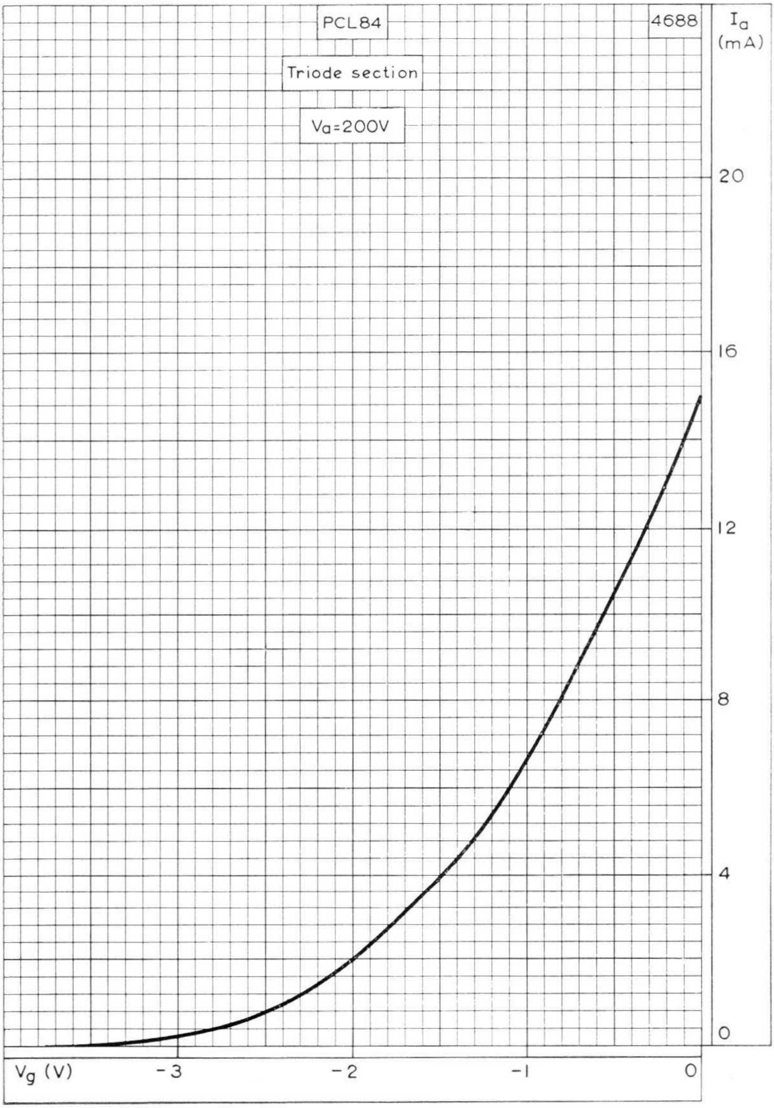
TRIODE PENTODE



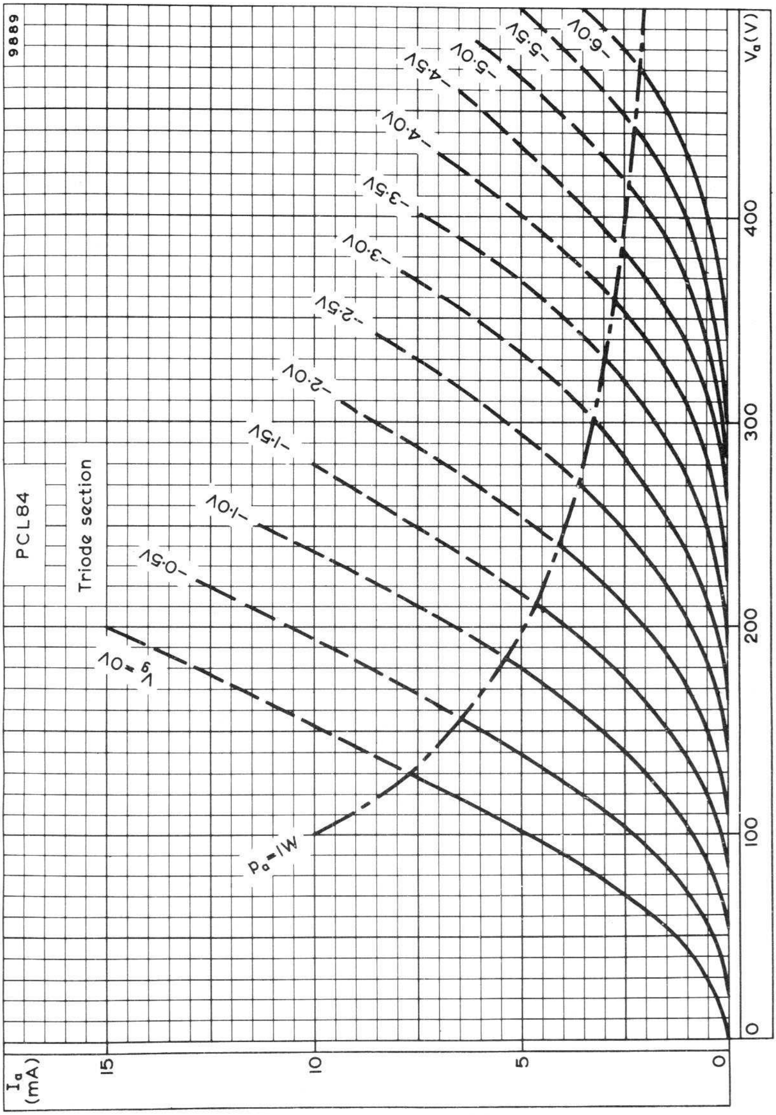
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER
$V_{g2} = 200V$



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER
$V_{g2} = 220V$



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
FOR TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. TRIODE SECTION

TRIODE PENTODE PCL85

Combined triode pentode with separate cathodes for use as a field oscillator and field output valve in television receivers employing 110° tubes.

HEATER

I_h	300	mA
V_h	18	V

CAPACITANCES

c_{ap-gt}	<40	mpF
c_{at-g1}	<80	mpF
c_{gt-g1}	<30	mpF
c_{at-ap}	130	mpF

Pentode section

c_{in}	12.5	pF
c_{out}	9.0	pF
c_{a-g1}	450	mpF
c_{g1-h}	<200	mpF

Triode section

c_{a-k+h}	350	mpF
c_{g-k+h}	2.8	pF
c_{a-g}	1.9	pF
c_{g-h}	< 140	mpF

CHARACTERISTICS

Pentode section

V_a	50	65	170	V
V_{g2}	170	210	170	V
I_a	200	285	41	mA
I_{g2}	35	45	2.7	mA
V_{g1}	-1.0	-1.0	-15	V
g_m	-	-	7.25	mA/V
μ_{g1-g2}	-	-	7.0	
r_a	-	-	25	kΩ

Triode section

V_a	100	V
I_a	5.0	mA
V_g	-0.85	V
g_m	5.5	mA/V
μ	60	
r_a	11	kΩ

TYPICAL OPERATION

Pentode section as field output valve

Stabilised circuits

See design chart on page C1.

Non-stabilised circuits

To allow for valve spread and deterioration during life the field output circuit should be designed around the following values

V_a min.	55	V
V_{g2}	170	V
i_a (pk)	130	mA

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
*$+v_a$ (pk) max.	2.0	kV
p_a max.	8.0	W ←
$V_{g2\ (b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	2.0	W
I_k max.	75	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	220	V
R_{h-k} max.	20	kΩ

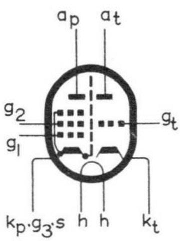
*Maximum pulse duration 7% of one cycle with a maximum of 1.4ms.

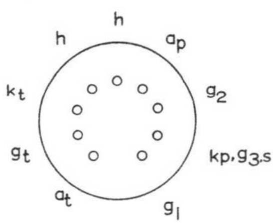
Triode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	500	mW
I_k max.	15	mA
*i_k (pk) max.	200	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	220	V
R_{h-k} max.	20	kΩ
T_{bulb} max.	240	°C

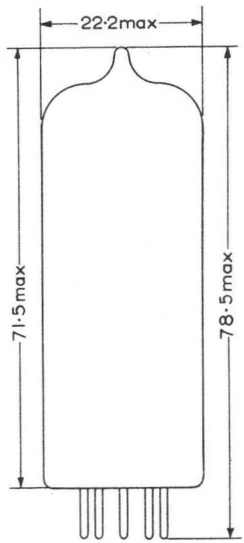
*Maximum pulse duration 3% of one cycle with a maximum of 200µs.

6978

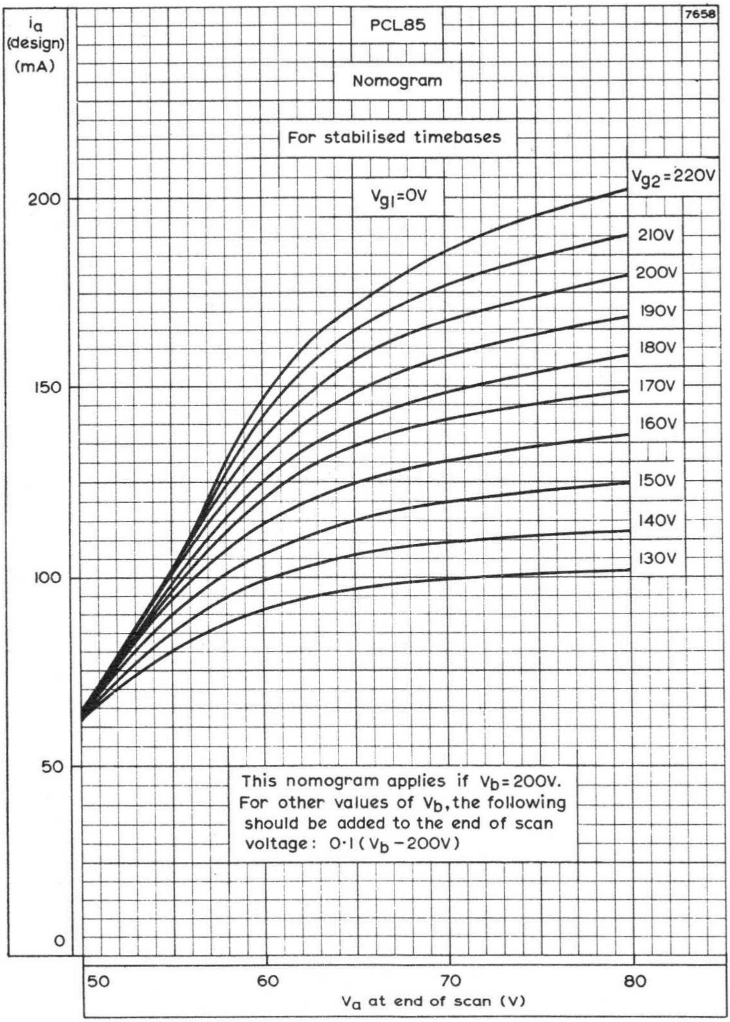




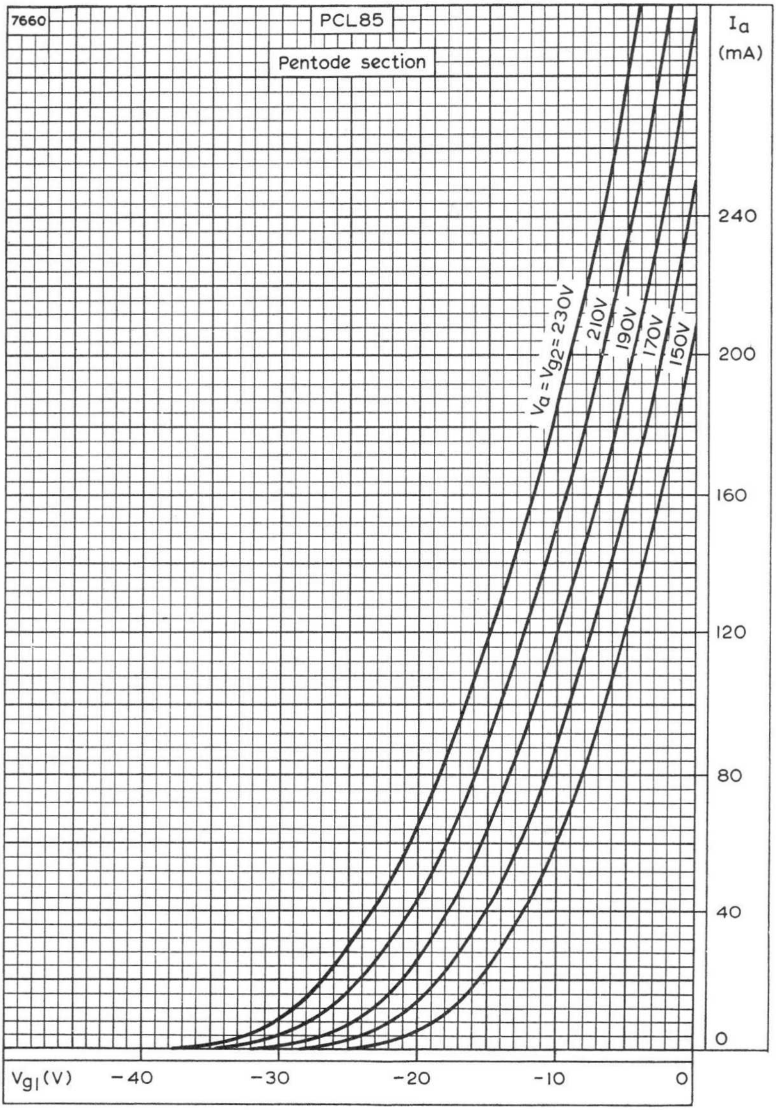
B9A Base



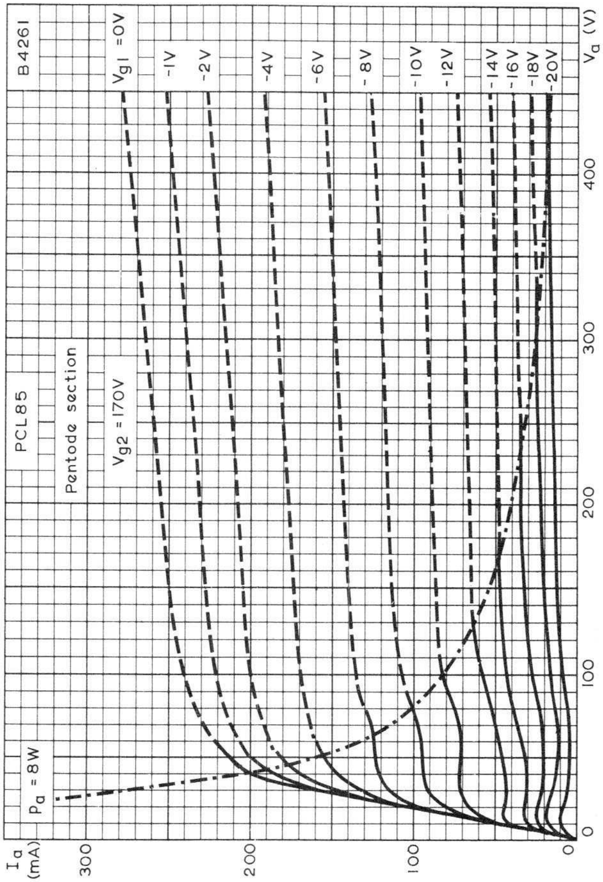
All dimensions in mm



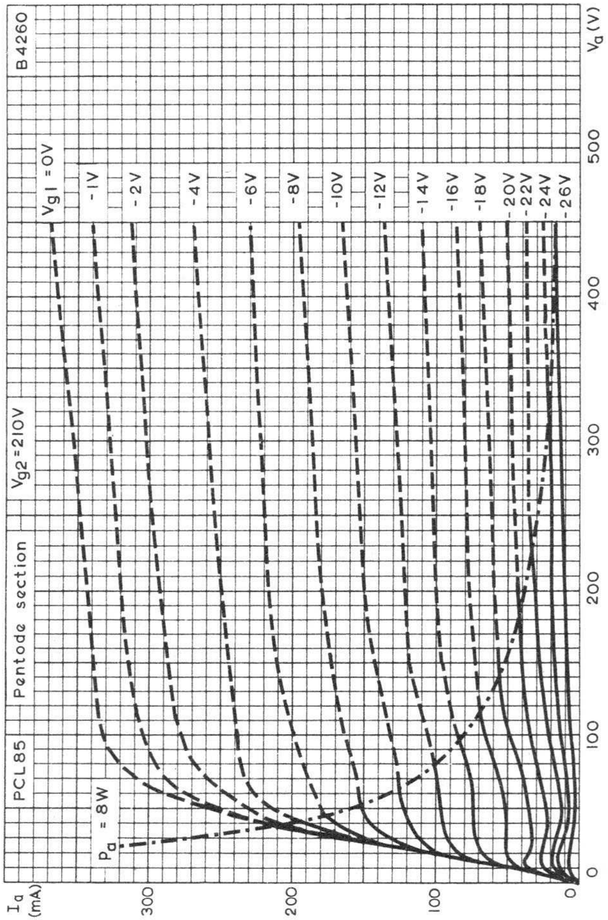
DESIGN CHART



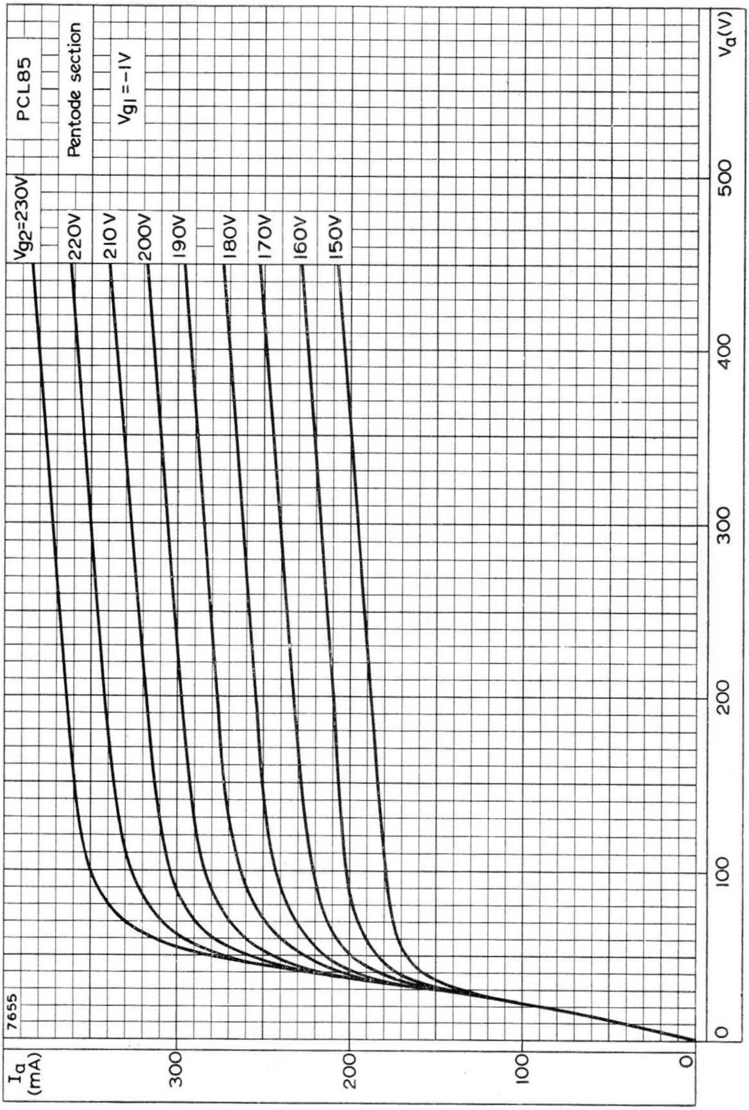
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER. PENTODE SECTION



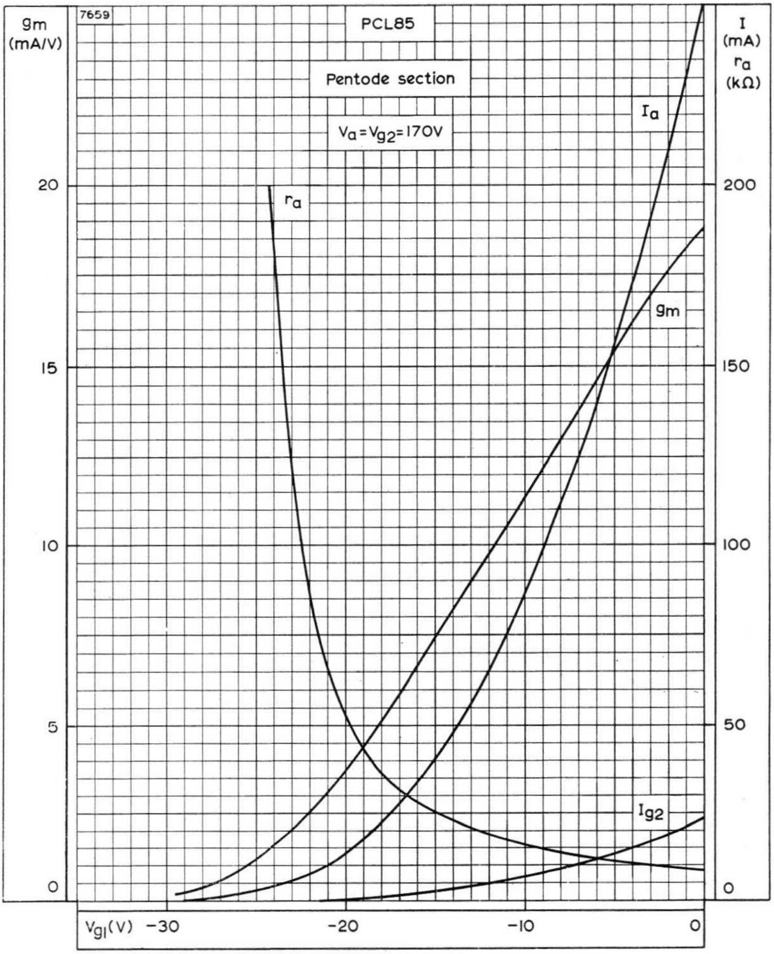
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V. PENTODE SECTION



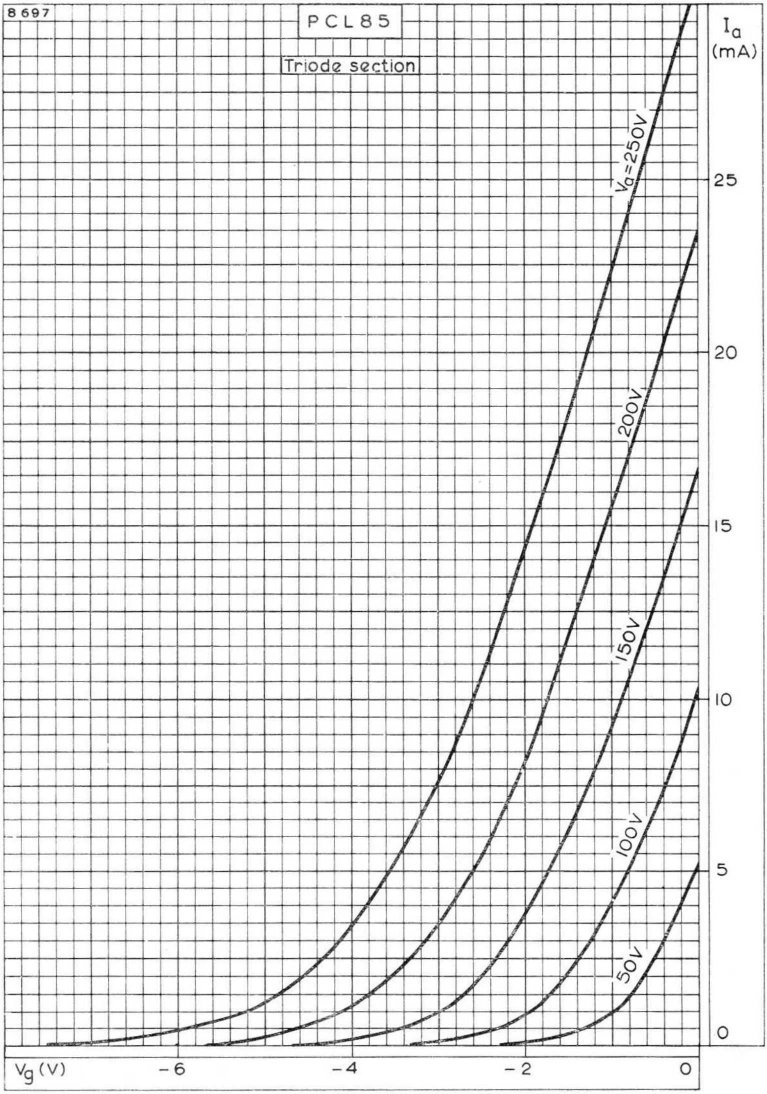
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 210V. PENTODE SECTION



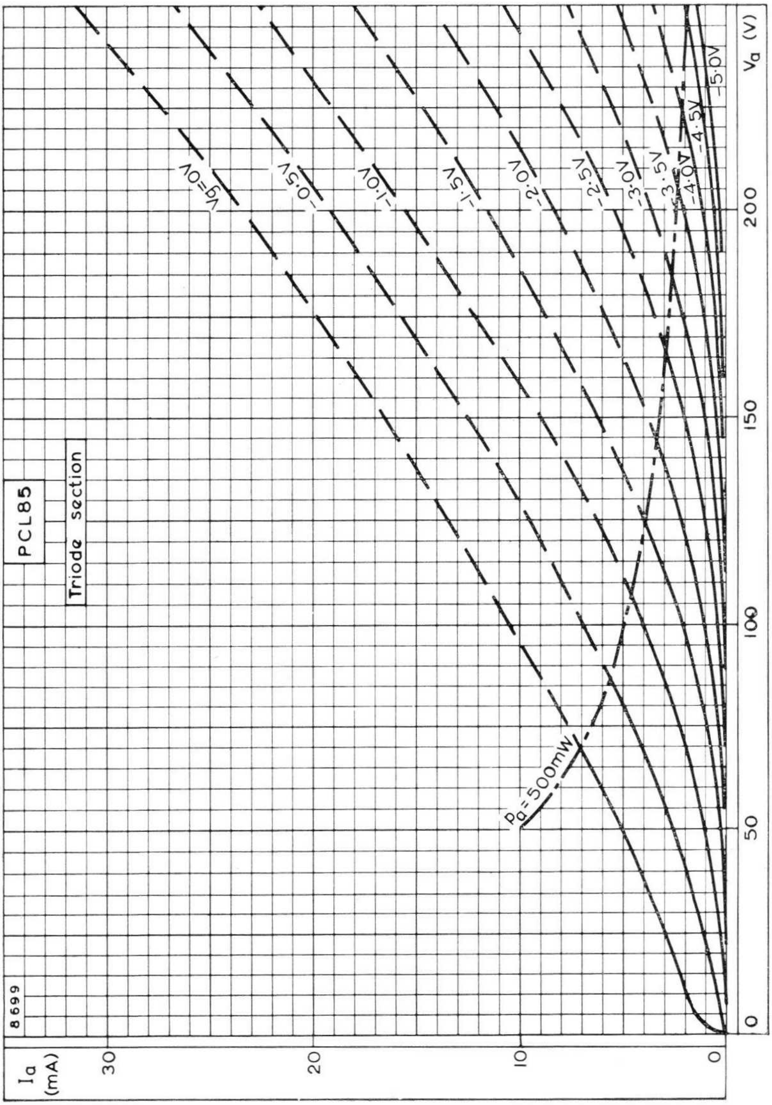
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER. $V_{g1} = -1V$. PENTODE SECTION



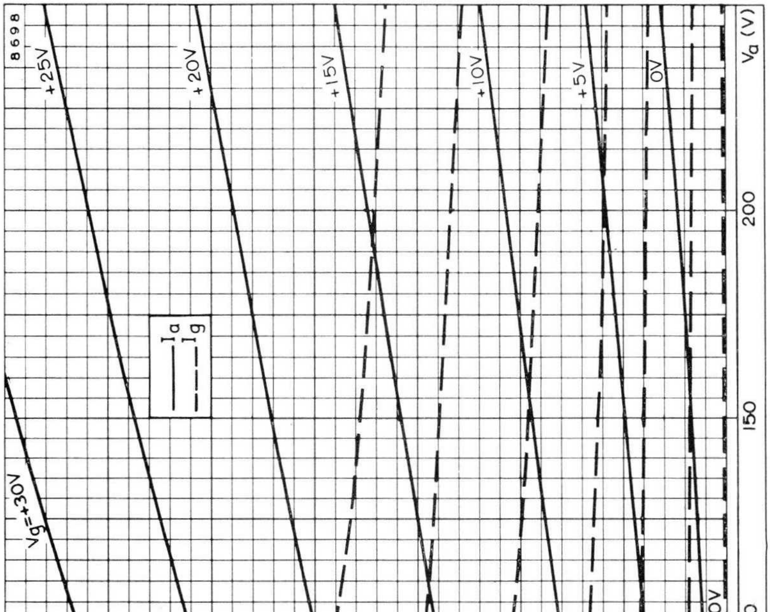
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 170V$. PENTODE SECTION



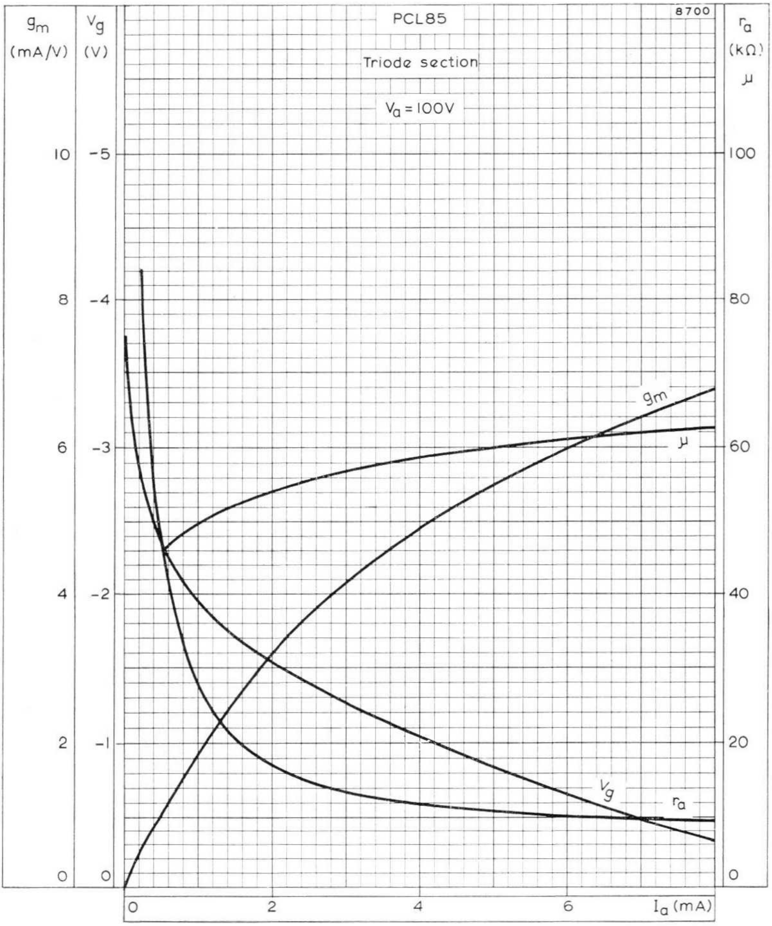
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. TRIODE SECTION



ANODE AND GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER. TRIODE SECTION



GRID VOLTAGE, MUTUAL CONDUCTANCE, ANODE IMPEDANCE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT. TRIODE SECTION

TRIODE PENTODES

PCL805
PCL85

Combined triode pentode with separate cathodes for use as a field oscillator and field output valve in television receivers

Data is applicable to both types

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	17.5	V ←

CAPACITANCES ←

c_{ap-gt}	< 0.03	pF
c_{ap-g1}	< 0.6	pF
c_{at-g1}	< 0.08	pF
c_{g1-h}	< 0.2	pF
c_{gt-h}	< 0.15	pF

CHARACTERISTICS (See NOTES) ←

Pentode section (field output application)

V_a	50	65	V
V_{g2}	170	210	V
V_{g1}	-1	-1	V
$I_{a(pk)}$	200	285	mA
$I_{g2(pk)}$	35	45	mA

Triode section

V_a	100	100	V
V_g	-0.85	0	V
I_a	5	10.5	mA
g_m	5.5	7	mA/V
μ	60	63	
r_a	11	9	kΩ

HUM ←

The equivalent pentode grid hum voltage without negative feedback is ≤ 10mV when Z_{g1} (f = 50Hz) ≤ 500kΩ, c_{g1-h} = 0.2pF and V_{h-k} = 150V r.m.s.

RATINGS (DESIGN CENTRE SYSTEM unless otherwise stated)

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
*$v_{a(pk)}$ max.	2.0	kV
P_a max.	8.0	W
P_a max. (design maximum rating)	10.5	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
P_{g2} max.	1.5	W
P_{g2} max. (design maximum rating)	2.0	W
I_k max.	75	mA
R_{g1-k} max. (fixed bias)	1.0	MΩ
R_{g1-k} max. (automatic bias)	2.2	MΩ
V_{h-k} max.	200	V

*Maximum pulse duration 5% of one cycle with a maximum of 1ms.

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	300	V
P_a max.	0.5	W
I_k max.	15	mA
**$i_{k(pk)}$ max.	150	mA
***$i_{k(pk)}$ max.	100	mA
R_{g-k} max. (fixed bias)	1.0	MΩ
R_{g-k} max. (automatic bias)	3.3	MΩ
†V_{h-k} max.	200	V

**Maximum pulse duration 2% of one cycle with a maximum of 0.4ms.

***Maximum pulse duration 4% of one cycle with a maximum of 0.8ms.

†During warm-up the d.c. component of V_{h-k} may rise to a maximum of 315V, cathode positive.

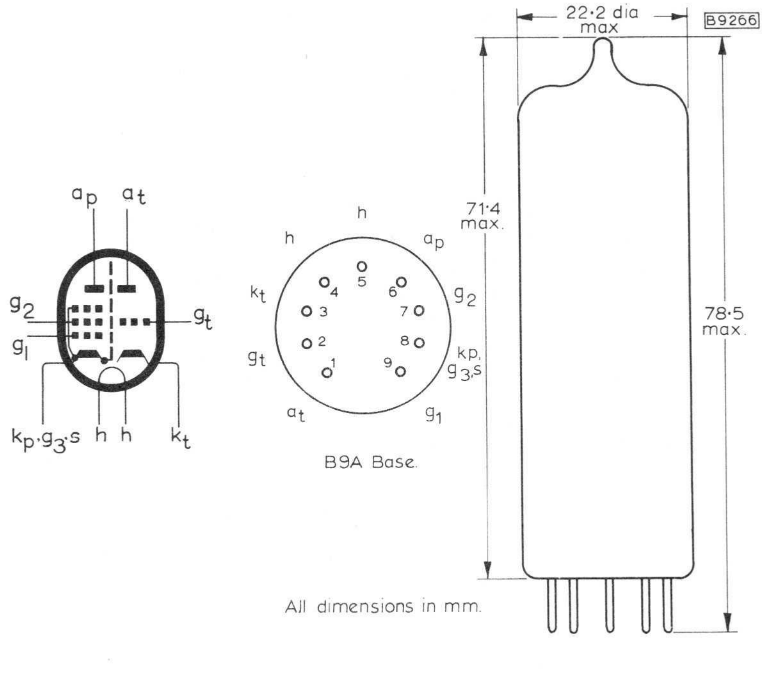
NOTES ←

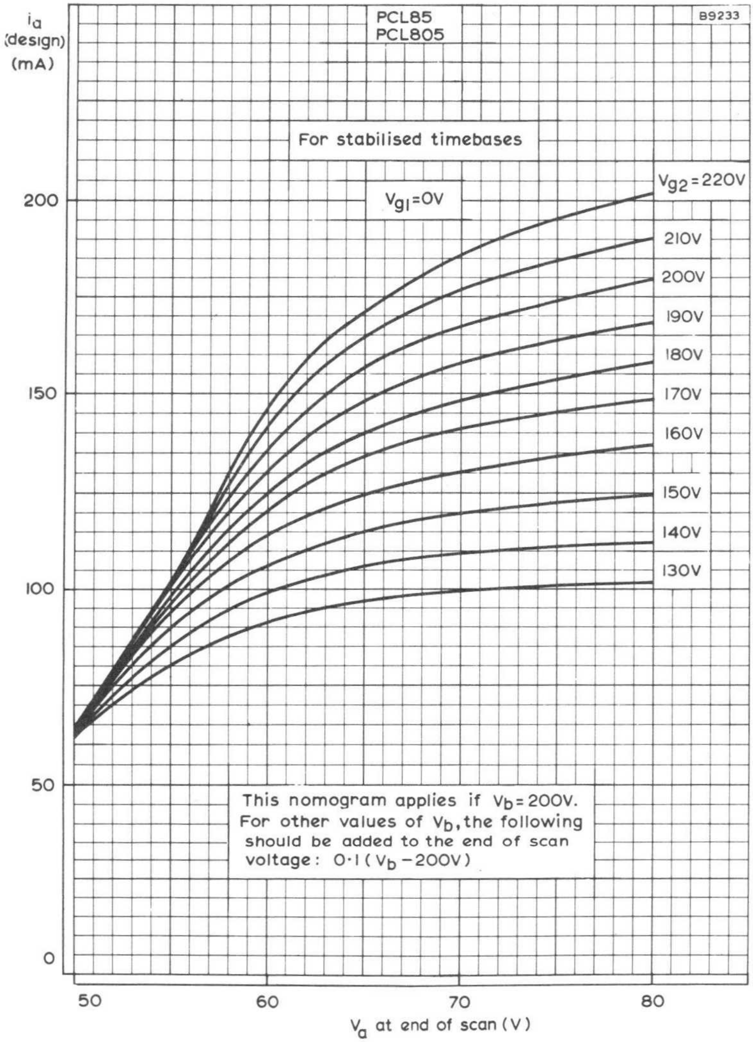
The minimum value of $i_{a(pk)}$ (pentode section) to be expected as a result of spread in valve characteristics, valve deterioration during life and decrease of the mains voltage by 10% of its nominal value, can be derived from the curves on page 9 by applying the formula:

$$i_{a(pk)} \text{ min.} = 0.6\ I_{a(1)}$$

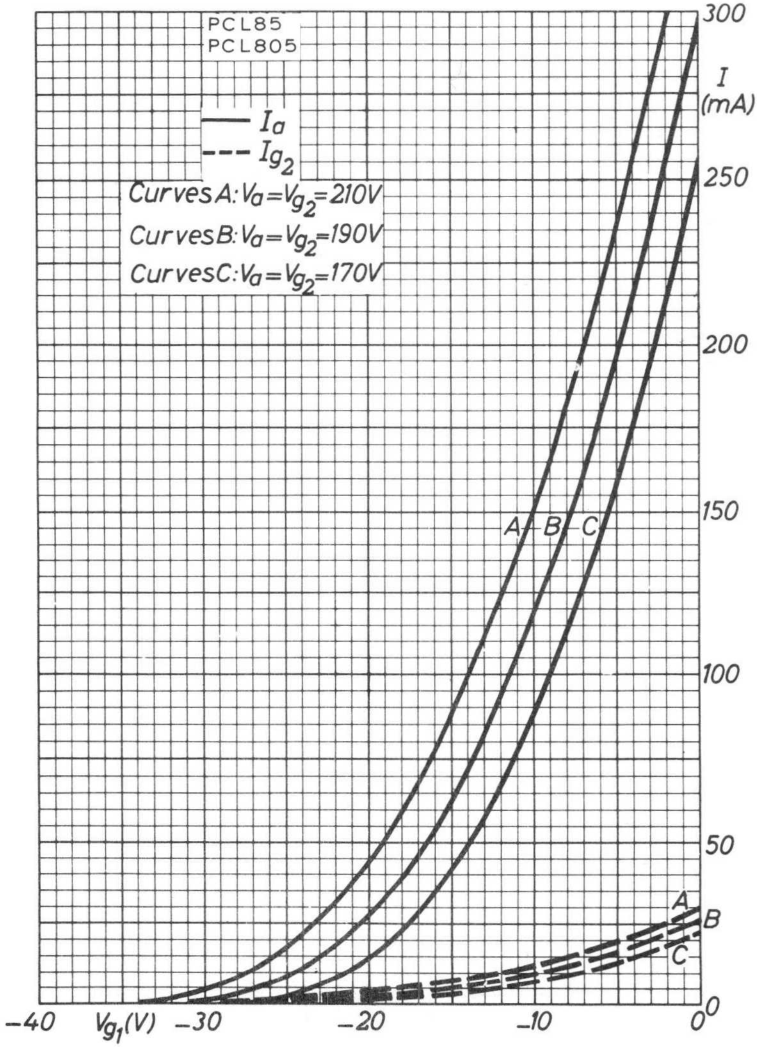
where $I_{a(1)}$ is the value of I_a at the intersection of line AB and the curve for the value of V_{g2} at the reduced mains voltage.

OUTLINE AND SCHEMATIC DRAWINGS

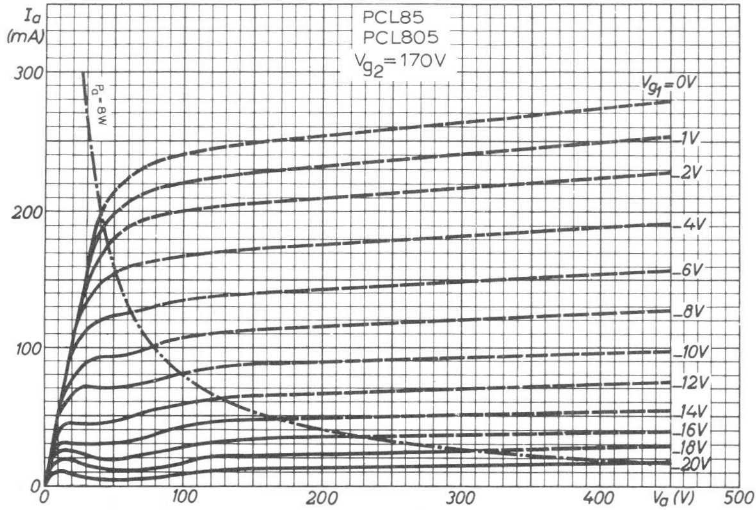




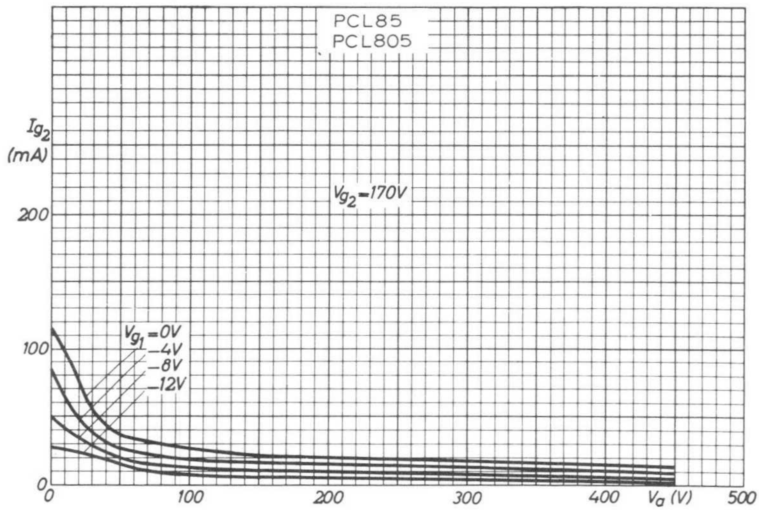
DESING CHART FOR STABILISED TIME BASES:
PENTODE SECTION



ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST GRID VOLTAGE WITH ANODE AND SCREEN GRID VOLTAGE AS PARAMETER. PENTODE SECTION

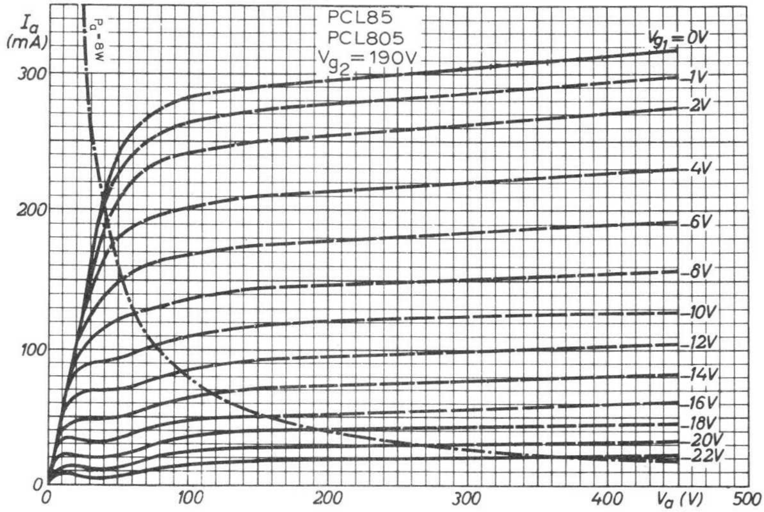


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH GRID VOLTAGE AS PARAMETER:
PENTODE SECTION

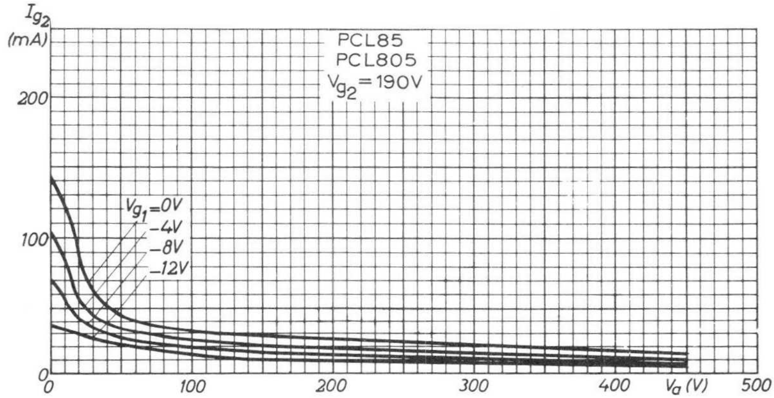


SCREEN GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID AS PARAMETER:
PENTODE SECTION

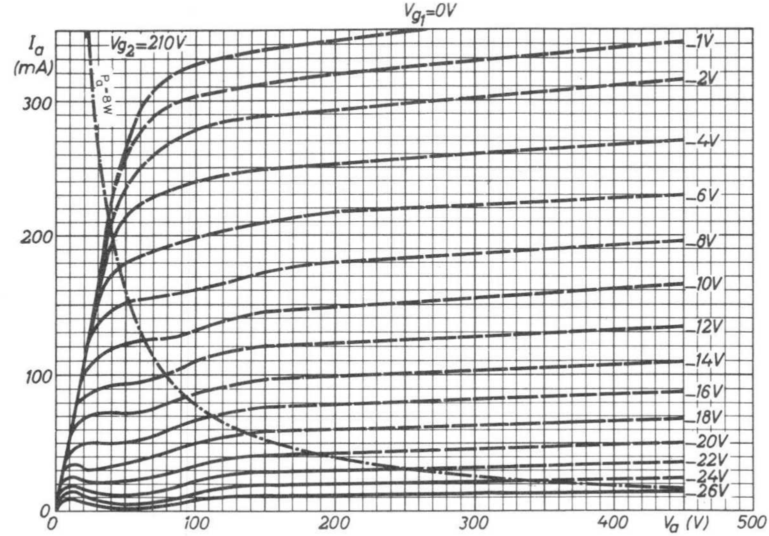
←



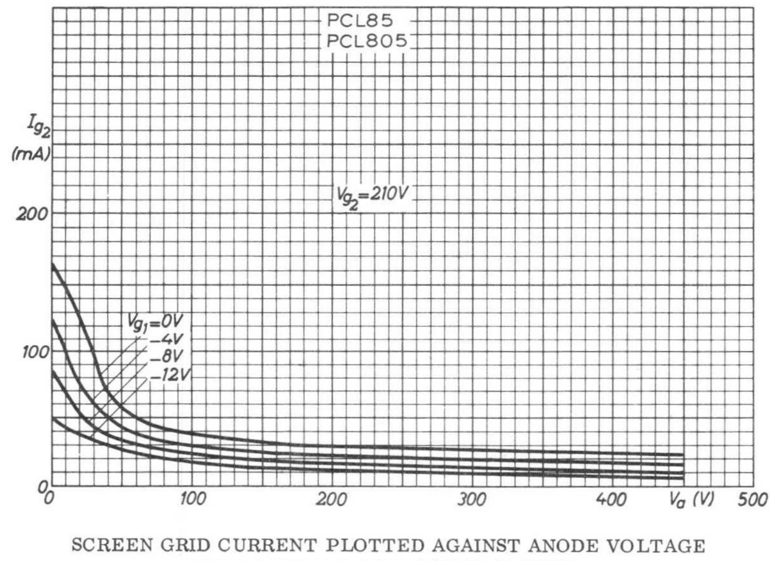
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH GRID VOLTAGE AS PARAMETER:
PENTODE SECTION



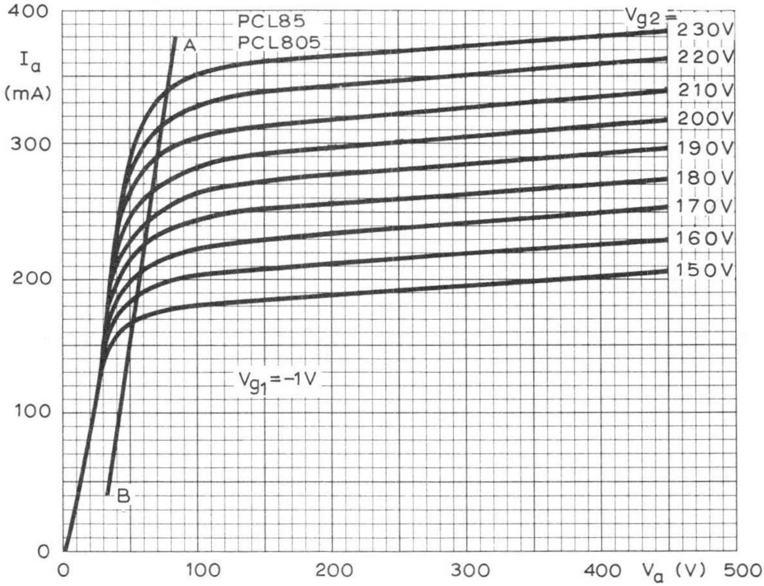
SCREEN GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID AS PARAMETER:
PENTODE SECTION



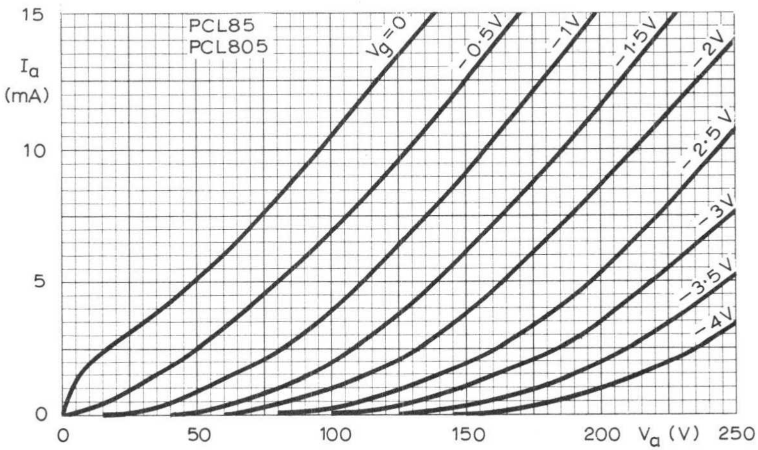
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH GRID VOLTAGE AS PARAMETER:
PENTODE SECTION



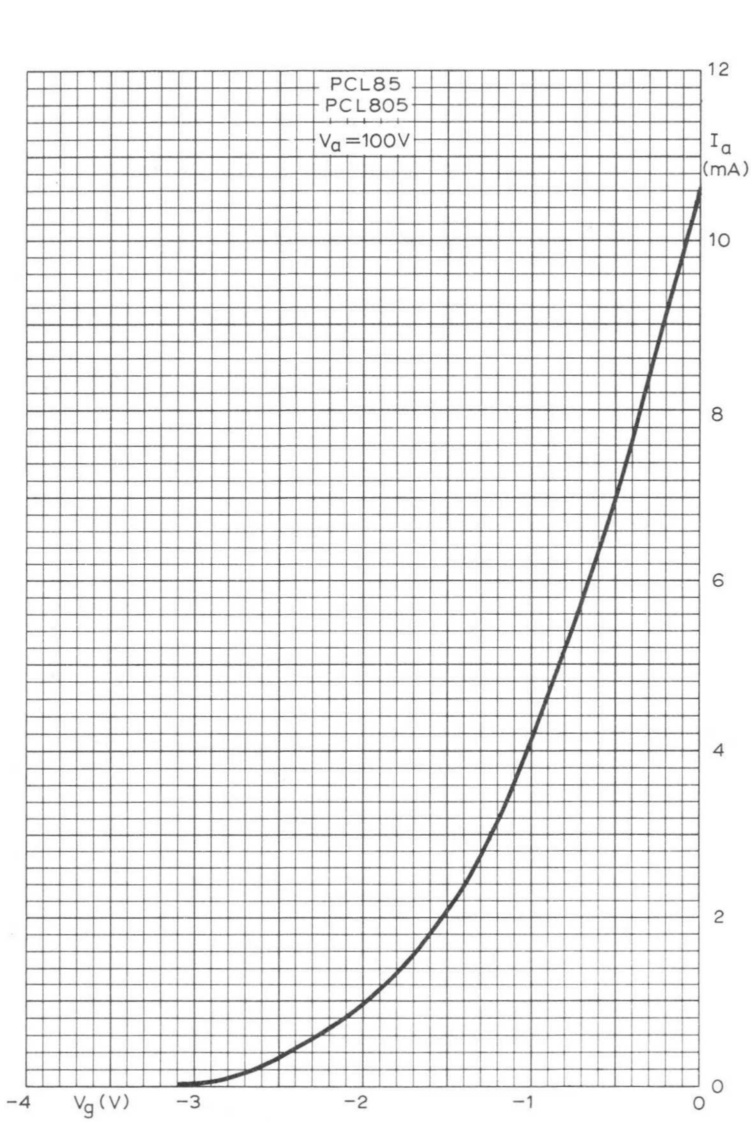
SCREEN GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID AS PARAMETER:
PENTODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH SCREEN GRID VOLTAGE AS PARAMETER:
PENTODE SECTION



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID VOLTAGE AS PARAMETER:
TRIODE SECTION



ANODE CURRENT PLOTTED AGAINST CONTROL GRID VOLTAGE:
TRIODE SECTION

TRIODE PENTODE

Combined high-μ triode and output pentode for use in the audio amplifier stage of television receivers.

PCL86

HEATER

I_h	300	mA
V_h	13.3	V

CAPACITANCES

c_{ap-gt}	<6.0	mpF
c_{at-g1}	<200	mpF
c_{gt-g1}	<20	mpF
c_{at-ap}	<150	mpF
Pentode section		
c_{in}	10	pF
c_{a-g1}	<400	mpF
c_{g1-h}	<240	mpF
Triode section		
c_{in}	2.3	pF
c_{out}	2.5	pF
c_{a-g}	1.4	pF
c_{g-h}	<6.0	mpF

CHARACTERISTICS

Pentode section		
V_a	230	V
V_{g2}	230	V
V_{g1}	−5.7	V
I_a	39	mA
I_{g2}	6.5	mA
g_m	10.5	mA/V
r_a	45	kΩ
μ_{g1-g2}	21	
$-V_{g1}$ max ($I_{g1} = +0.3\mu A$)	1.3	V
Triode section		
V_a	230	V
V_g	−1.7	V
I_a	1.2	mA
g_m	1.6	mA/V
μ	100	
r_a	62	kΩ
$-V_{g1}$ max ($I_{g1} = +0.3\mu A$)	1.3	V

OPERATING CONDITIONS AS SINGLE VALVE AMPLIFIER

Pentode section

V_a	230	200	V
V_{g2}	230	200	V
V_{g1}	−5.7	−4.7	V
R_k	125	115	Ω
I_a	41	34	mA
I_{g2}	10.5	9.0	mA
R_a	5.1	5.6	kΩ
P_{out}	4.1	3.1	W
$V_{in(r.m.s.)}$	3.6	3.2	V
D_{tot}	10	10	%
$V_{in(r.m.s.)}$ (P_{out} = 50mW)	300	290	mV

OPERATING CONDITIONS FOR TRIODE SECTION AS RESISTANCE COUPLED A.F. AMPLIFIER

Grid current bias (R_g = 10MΩ)

V_b (V)	R_a (kΩ)	R_g† (kΩ)	I_a (mA)	Z_s = 0kΩ: $\frac{V_{out}}{V_{in}}$	Z_s = 0kΩ: $V_{out(r.m.s.)}$* (V)	Z_s = 220kΩ: $\frac{V_{out}}{V_{in}}$	Z_s = 220kΩ: $V_{out(r.m.s.)}$** (V)
230	47	150	1.37	40	15	32	18
170	47	150	0.82	36	9	29	11
230	100	330	0.90	57	22	45	26
170	100	330	0.58	53	13	42	16
230	220	680	0.57	72	26	55	33
170	220	680	0.37	67	15	52	21

*Output voltage measured at D_{tot} = 5%.

$\frac{V_{out}}{V_{in}}$ measured with $V_{in(r.m.s.)}$ = 100mV.

†Grid resistor of following valve.

**When operating this valve with grid current bias and a high source impedance, the second harmonic distortion rises to a peak at quite low levels of output (about 10$V_{r.m.s.}$) and then falls with increasing drive. The third harmonic then begins to rise, and D_{tot} finally reaches 5% at a much higher output level than with zero source impedance. The maximum value of this distortion peak varies inversely with the anode load, being about 5.5% with R_a = 47kΩ, 4.5% with R_a = 100kΩ and 4% with R_a = 220kΩ.

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9.0	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.8	W
I_k max.	55	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	500	mW
I_k max.	4.0	mA
R_{g-k} max.	1.0	MΩ
V_{h-k} max.	100	V
†R_{h-k} max.	20	kΩ

†When used as a phase inverter immediately preceding the output stage, R_{h-k} max. may be 120kΩ.

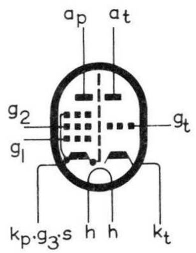
OPERATING NOTES

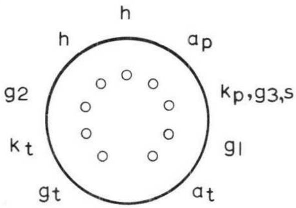
1. **Microphony**

   This valve may be used without special precautions against microphony in equipment where the input voltage is not less than 10mV for an output of 50mW.

2. **Hum**

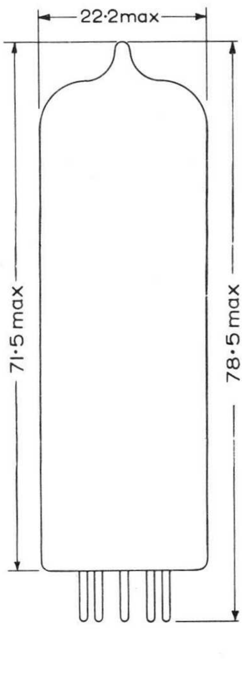
   To obtain the minimum value of hum, the a.c. voltage between pin 4 and triode cathode should not exceed 30V.



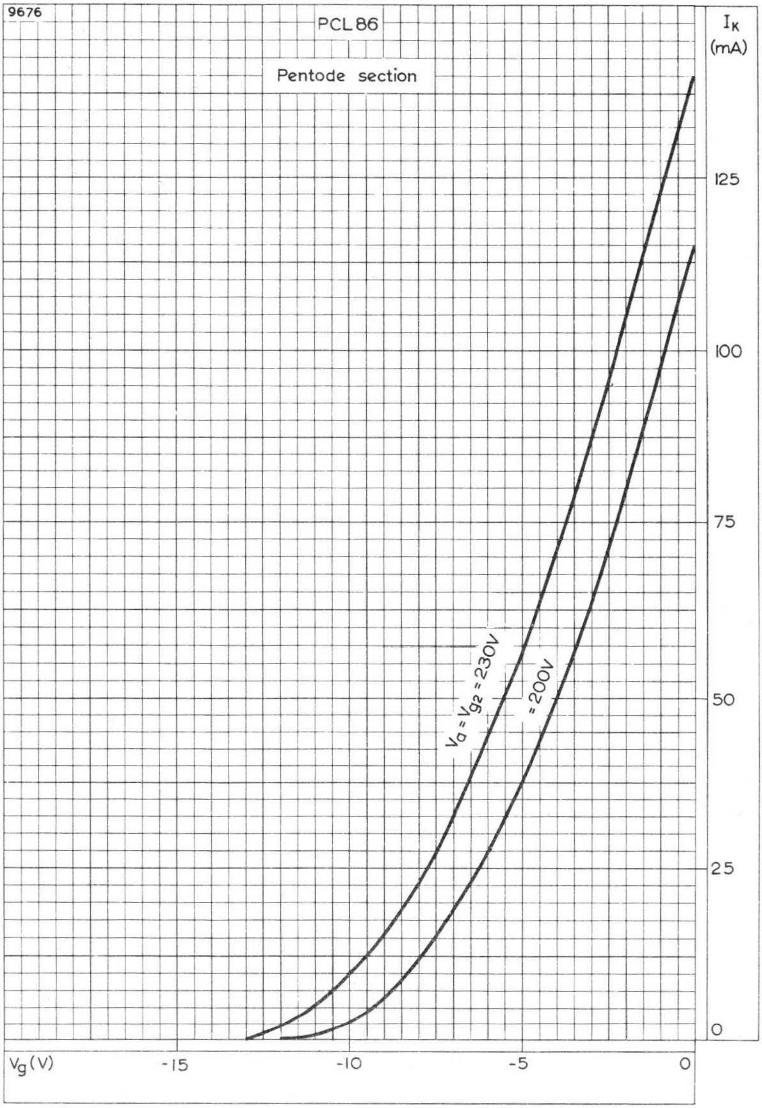


B9A Base

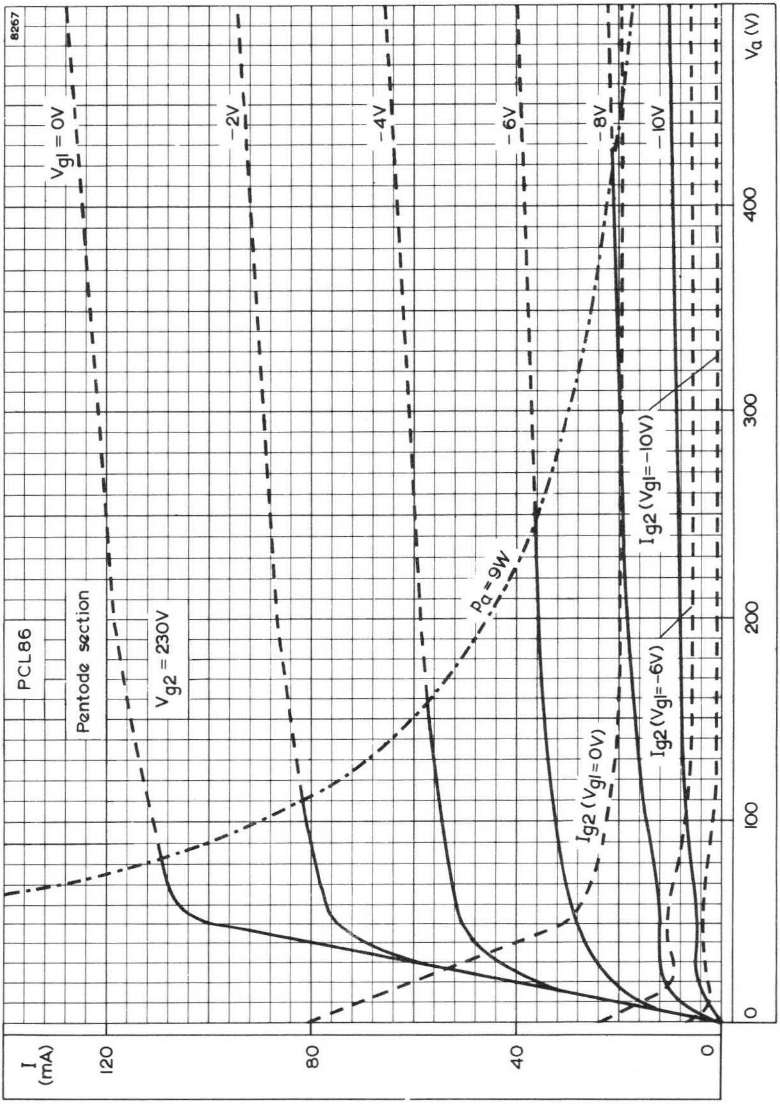
All dimensions in mm



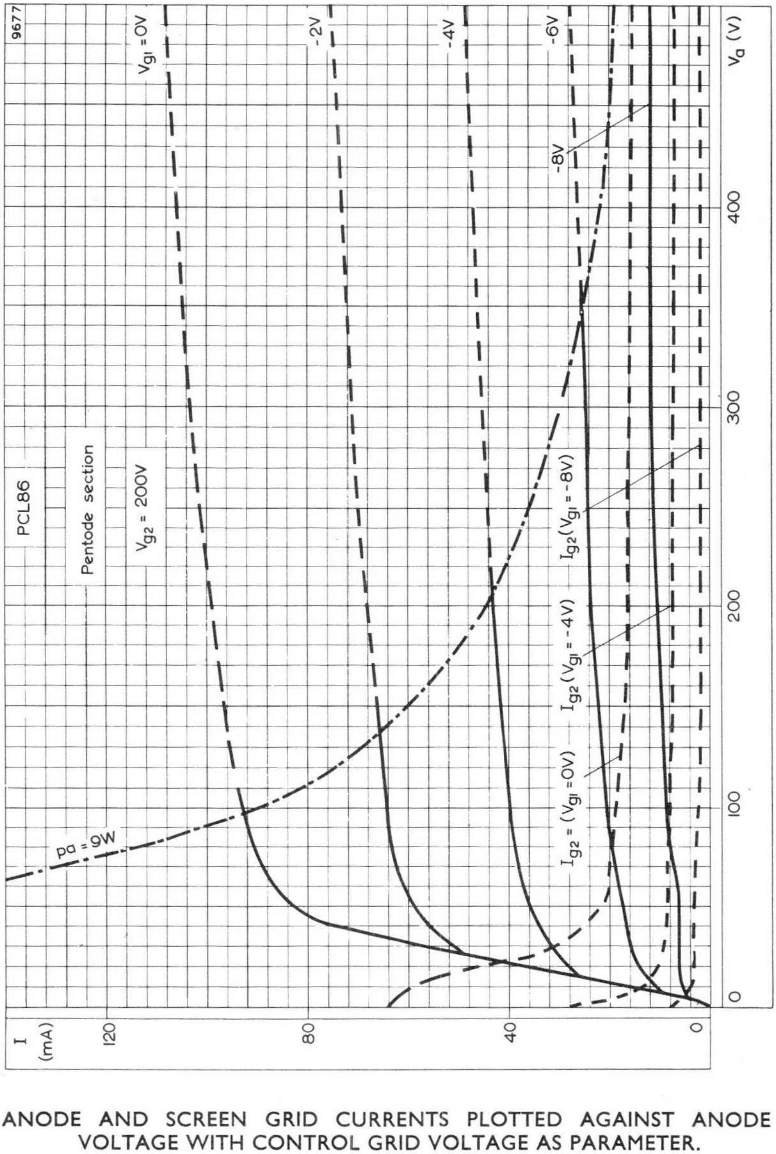
7471



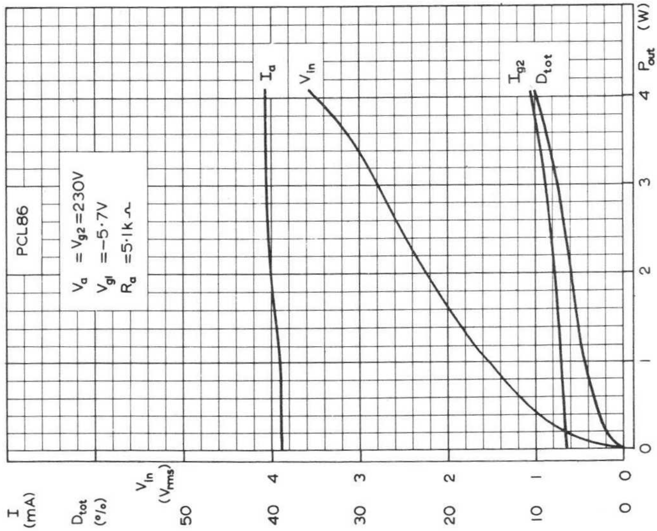
CATHODE CURRENT PLOTTED AGAINST CONTROL GRID VOLTAGE WITH ANODE AND SCREEN GRID VOLTAGES AS PARAMETER. PENTODE SECTION



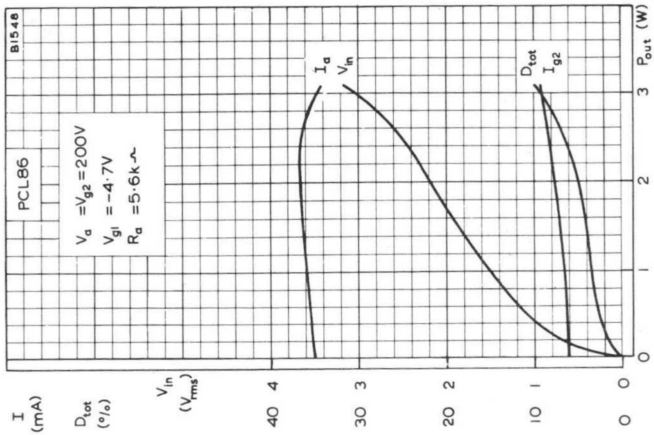
ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL GRID VOLTAGE AS PARAMETER.
PENTODE SECTION $V_{g2} = 230V$



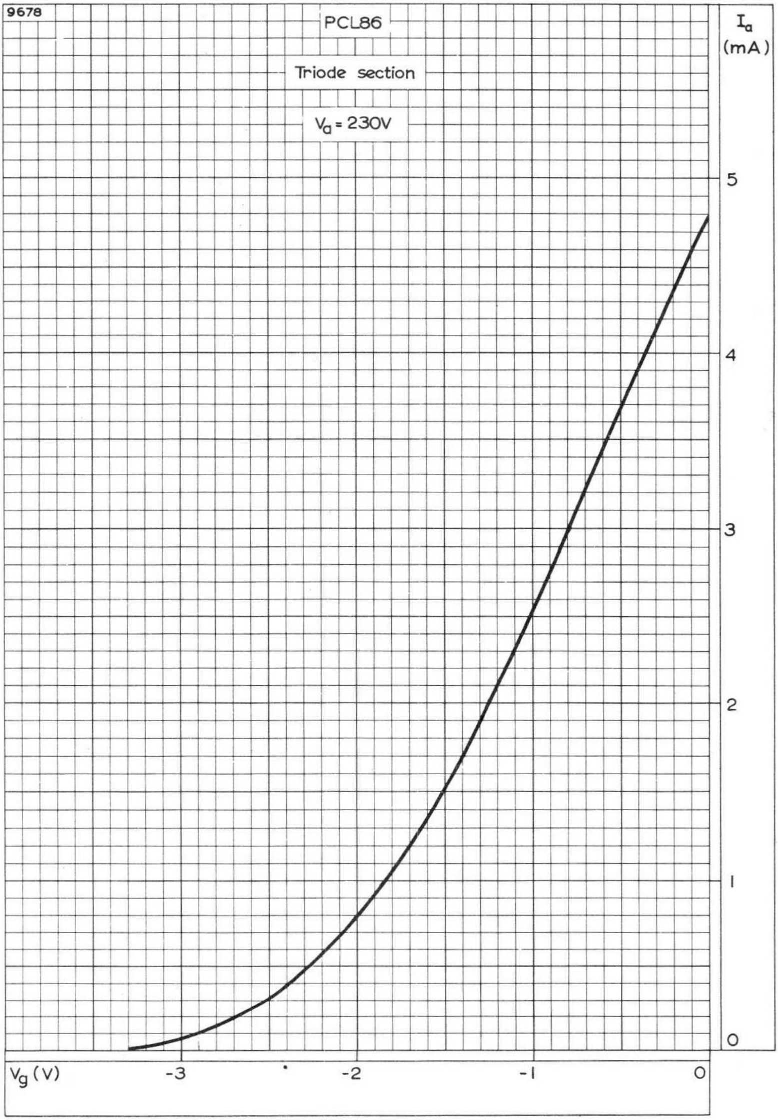
ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL GRID VOLTAGE AS PARAMETER.
PENTODE SECTION $V_{g2} = 200V$



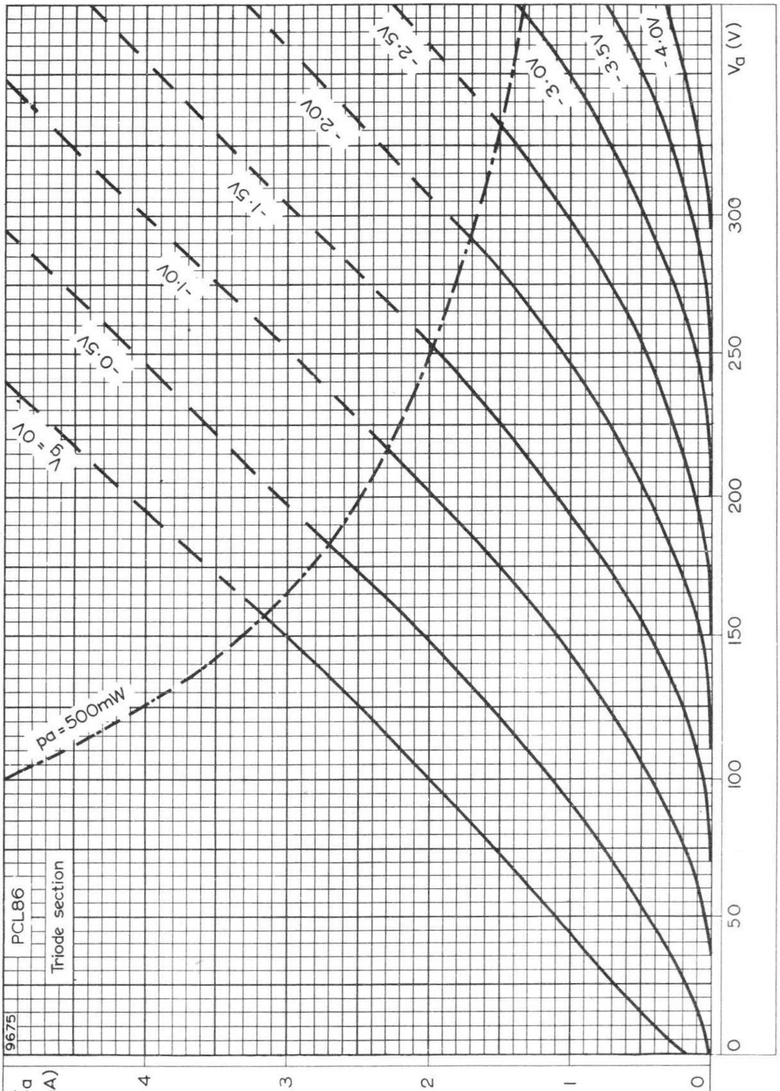
PERFORMANCE OF PCL86 AS SINGLE VALVE AMPLIFIER. PENTODE SECTION $V_a = V_{g2} = 230V$, $R_k = 125\Omega$



PERFORMANCE OF PCL86 AS SINGLE VALVE AMPLIFIER. PENTODE SECTION $V_a = V_{g2} = 200V$, $R_k = 115\Omega$



ANODE CURRENT PLOTTED AGAINST CONTROL GRID VOLTAGE.
TRIODE SECTION $V_a = 230V$



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL GRID VOLTAGE AS PARAMETER.
TRIODE SECTION

SHUNT STABILISER TRIODE

PD500

High voltage triode for use as a shunt stabiliser in colour television receivers.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	7.3	V

CHARACTERISTICS

V_a	25	kV
V_s	0	V
$-V_g$ at $I_a = 1.5$mA	7 to 30	V
$-V_g$ max. at $I_a = 0.1$mA	40	V
ΔV_g max. between $I_a = 0.1$mA and $I_a = 1.5$mA	10	V

RATINGS (DESIGN CENTRE SYSTEM)

V_a max.	25	kV
V_a (absolute max. see note 1)	27.5	kV
$-V_g$ max. (see note 2)	150	V
p_a	30	W
p_a max. (intermittent rating t.v. shunt stabiliser - see note 3)	40	W
I_a max.	1.6	mA ←
R_{g-k} max.	5.0	MΩ
V_{h-k} max. (cathode positive)	400V d.c.+250V a.c.	
V_{h-k} max. (cathode negative)	250	V
V_{s-k} max. (shield negative - see note 4)	400	V
$T_{anode\ seal}$ (absolute max.)	200	^{o}C

NOTES

1. If due to a circuit failure the anode current becomes zero, the anode voltage should never exceed 45kV (abs. max.).

2. During equipment warm-up period and for brief intervals during equipment adjustment only, the grid voltage may rise to 440V maximum.

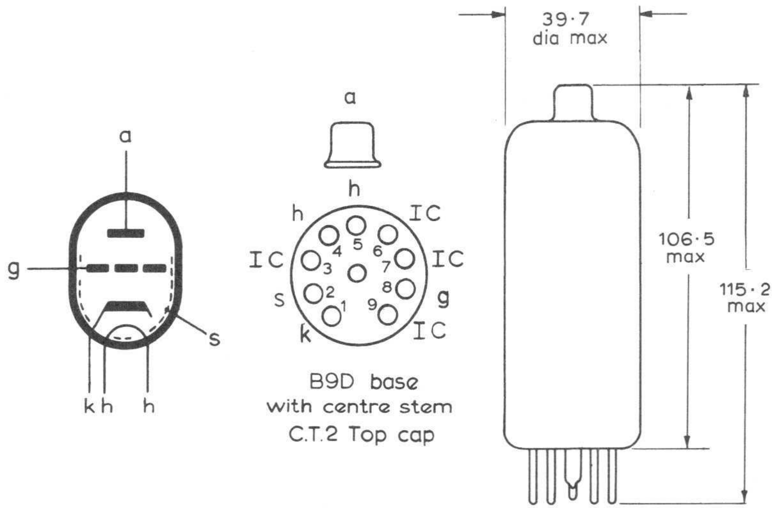
3. This rating applies to operation for a maximum of 10% of the time.

4. Operation with the shield positive with respect to cathode is not recommended. The shield may function as a spark trap and should have a low impedance return path to the external coating of the picture tube. A.C. potential between the shield and cathode can modulate the anode current; the maximum sensitivity is 2.5μA/V.

5. Additional support is required at the top of the valve. To prevent corona effects, any metal screening around the valve should be at least 50mm from the nearest point of the bulb. Adequate ventilation should be provided for. ←

X-RAYS

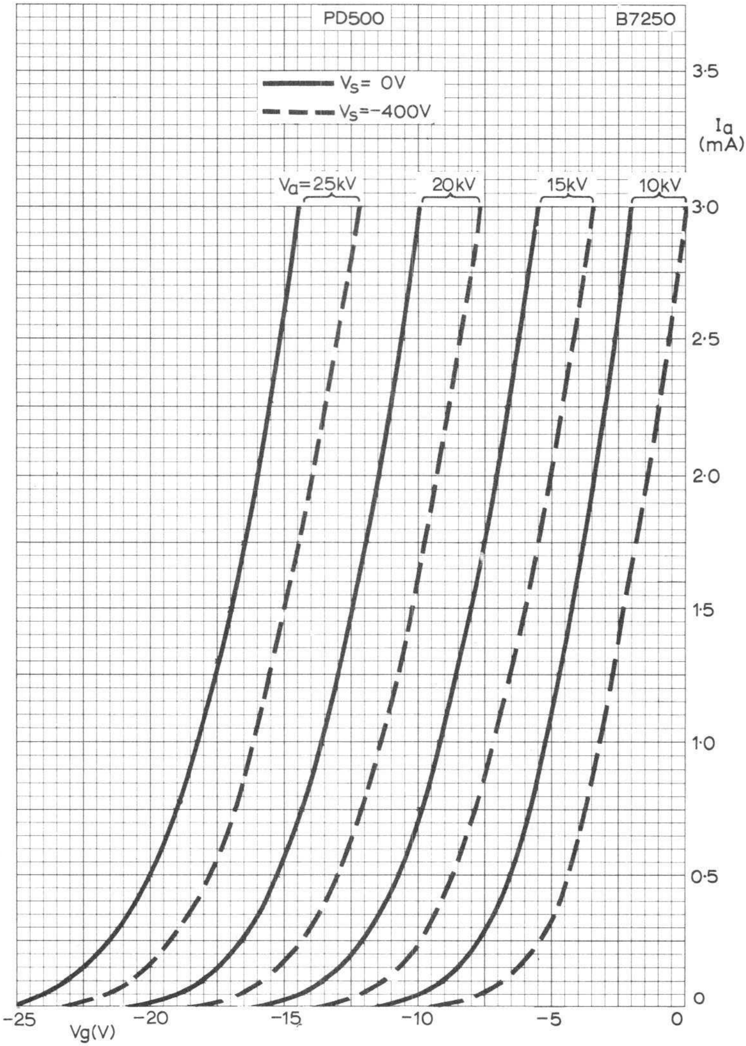
When operated in a television receiver this valve will produce X-radiation in excess of permissible dosage, and a suitable screen should be incorporated.



All dimensions in mm

SHUNT STABILISER TRIODE

PD500



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
WITH ANODE VOLTAGE AS PARAMETER

DOUBLE PENTODE

PFL200

Double pentode for video output plus sync, separator, a.g.c. amplifier or i.f. amplifier applications.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	17	V ←

CAPACITANCES (unshielded) ←

$c_{a'-a''}$	<150	mpF
$c_{g1'-g1''}$	<10	mpF
$c_{a'-g1''}$	<100	mpF
$c_{a''-g1'}$	<5.0	mpF
L Section		
$c_{in'}$	12.5	pF
$c_{out'}$	6.5	pF
$c_{a'-g1'}$	100	mpF
F Section		
$c_{in''}$	10.5	pF
$c_{a''-g2''+k''g3''+h+k'g3',s}$	10.5	pF
$c_{a''-g1''}$	150	mpF
$c_{g1''-h}$	<150	mpF

CHARACTERISTICS ←

	Amplifier section		Output section	
V_a	150	50	170	V
V_{g2}	150	75	170	V
I_a	10	5.0	30	mA
I_{g2}	3.0	1.6	7.0	mA
V_{g1}	-2.1	-0.65	-2.7	V
g_m	8.5	6.8	22	mA/V
μ_{g1-g2}	38	34	38	
r_a	150	110	33	kΩ

RATINGS (DESIGN CENTRE SYSTEM)

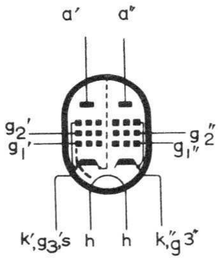
Output section

V_a max.	250	V
V_{g2} max.	250	V
p_a max.	5.0	W
p_{g2} max.	2.5	W
p_{g2} max. (intermittent rating, short duration)	3.2	W
I_k max.	60	mA
I_k max. (intermittent rating, short duration)	85	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	200	V

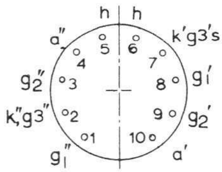
Amplifier section

$V_{a(b)}$ max.	550	V
$V_{g2(b)}$ max.	550	V
V_a max.	250	V
V_{g2} max.	250	V
p_a max.	1.5	W
p_{g2} max.	0.5	W
I_k max.	15	mA
R_{g1-k} max.	1.0	MΩ
V_{h-k} max.	200	V

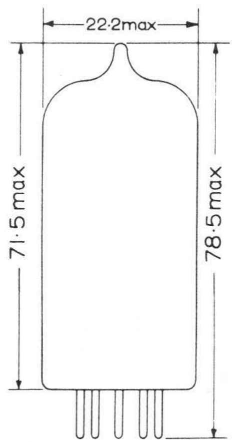
B4679

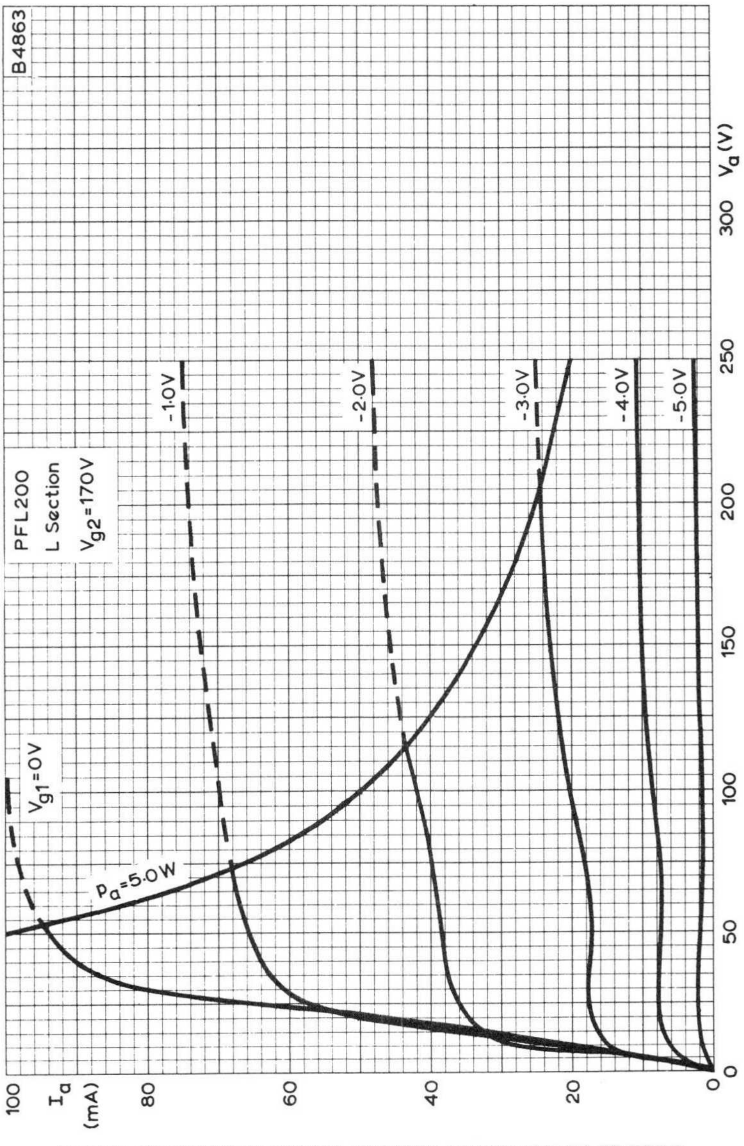


"F section
'L section

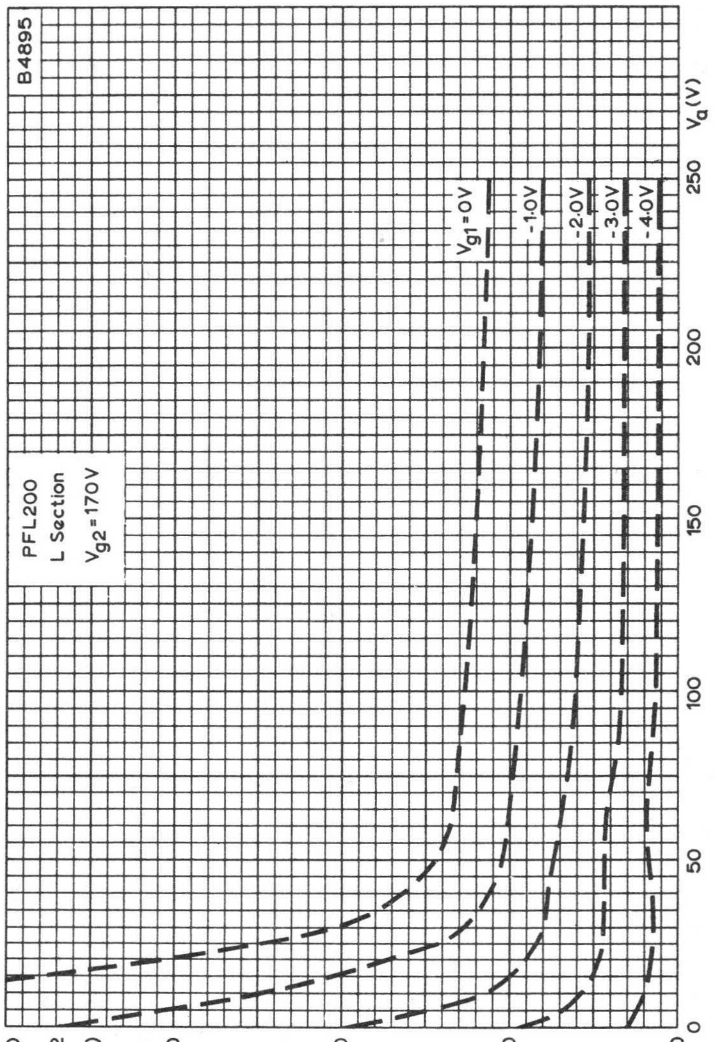


B10B base

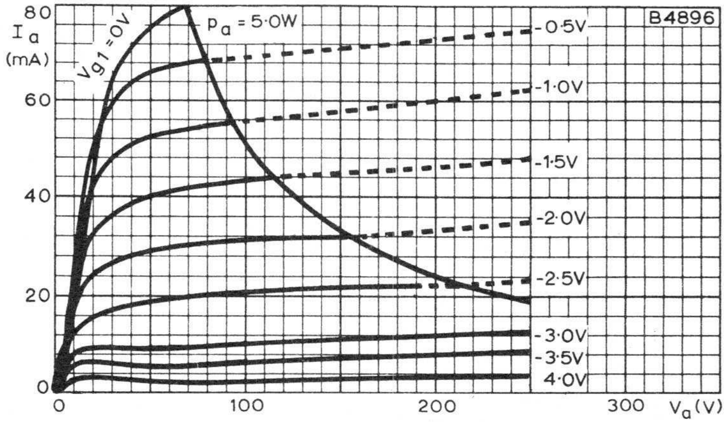


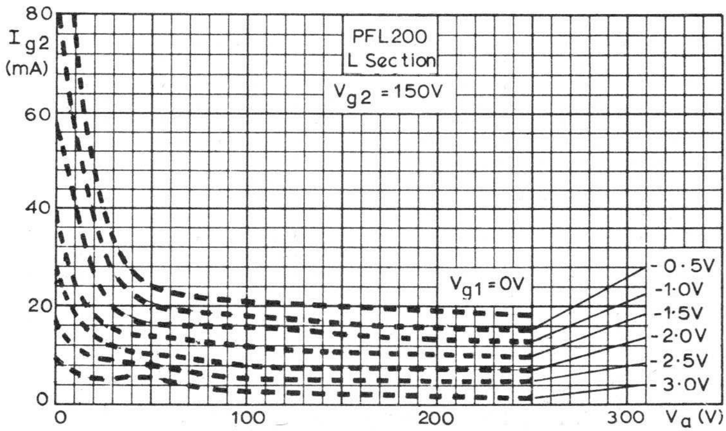


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V.
L SECTION

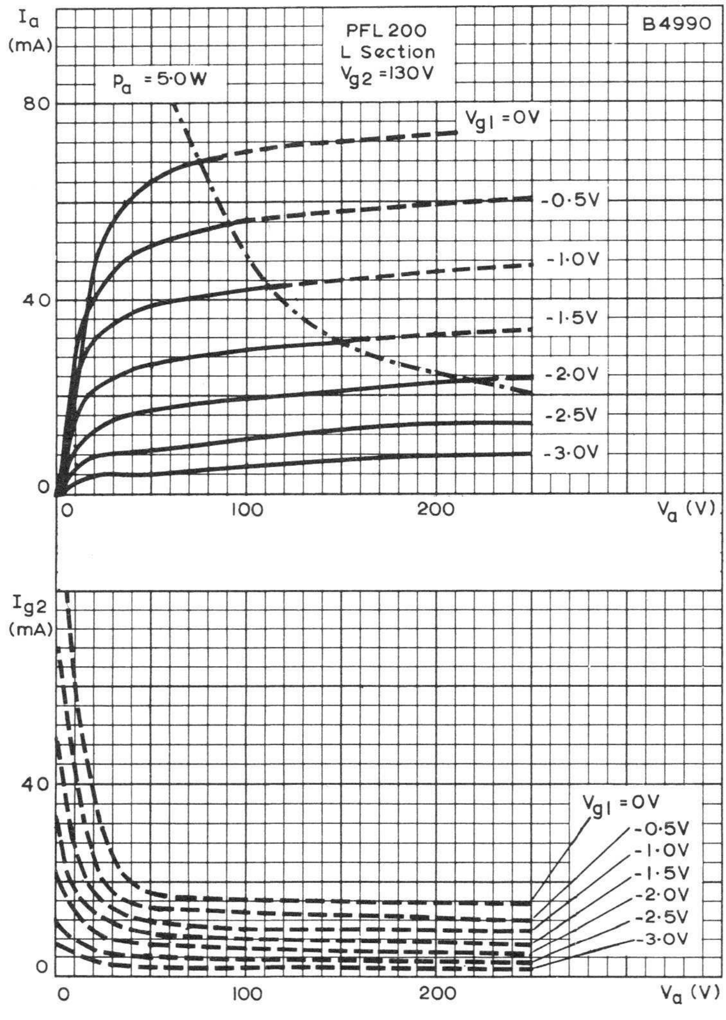


SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE, WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V.
L SECTION

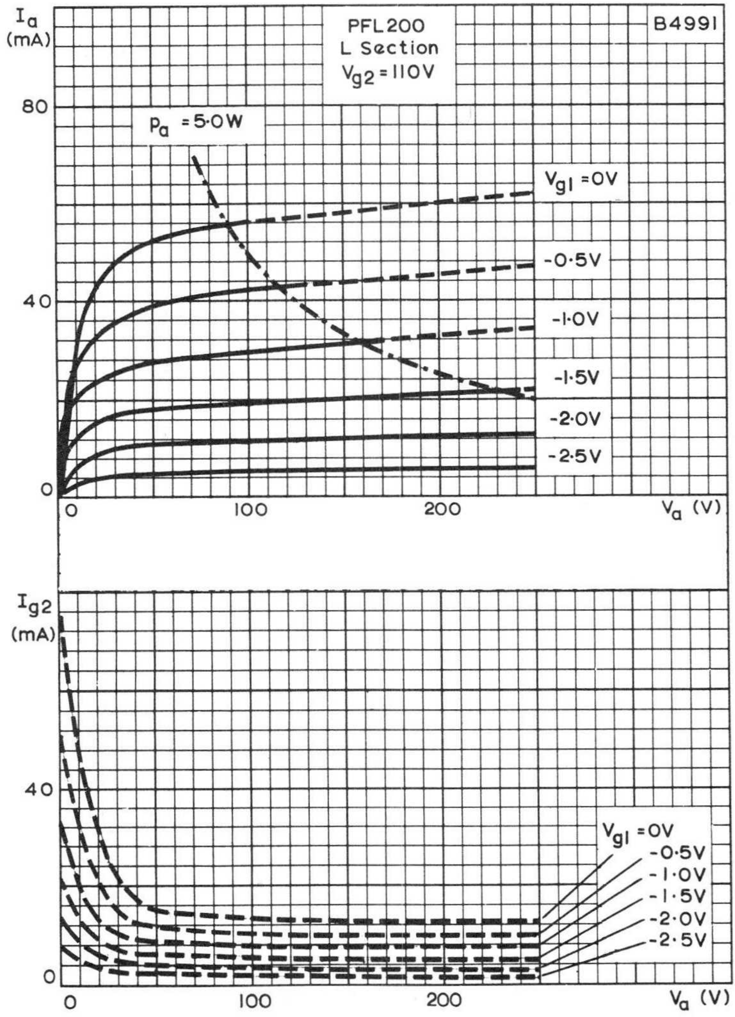




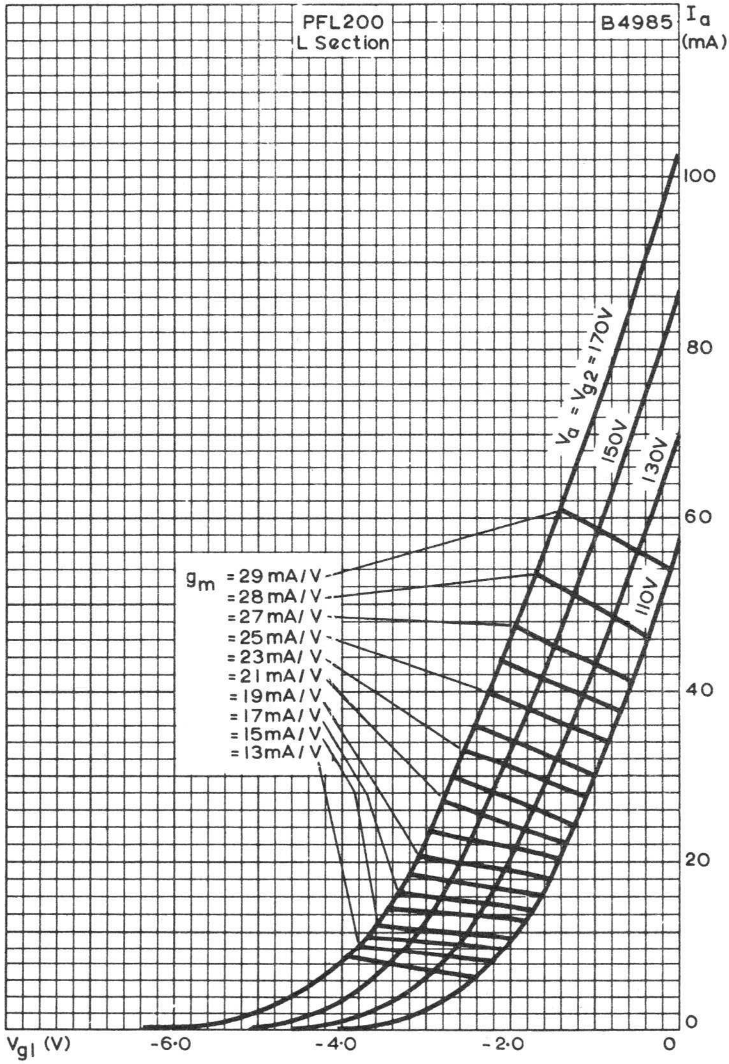
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V. L SECTION



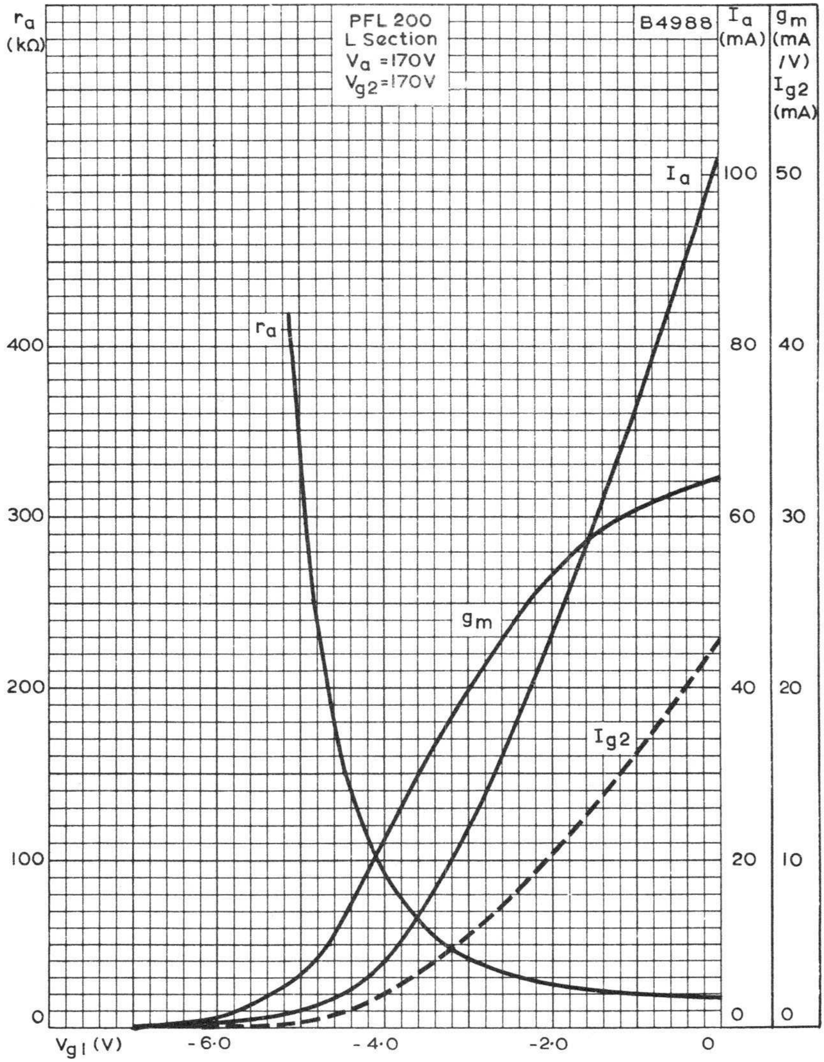
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 130V. L SECTION



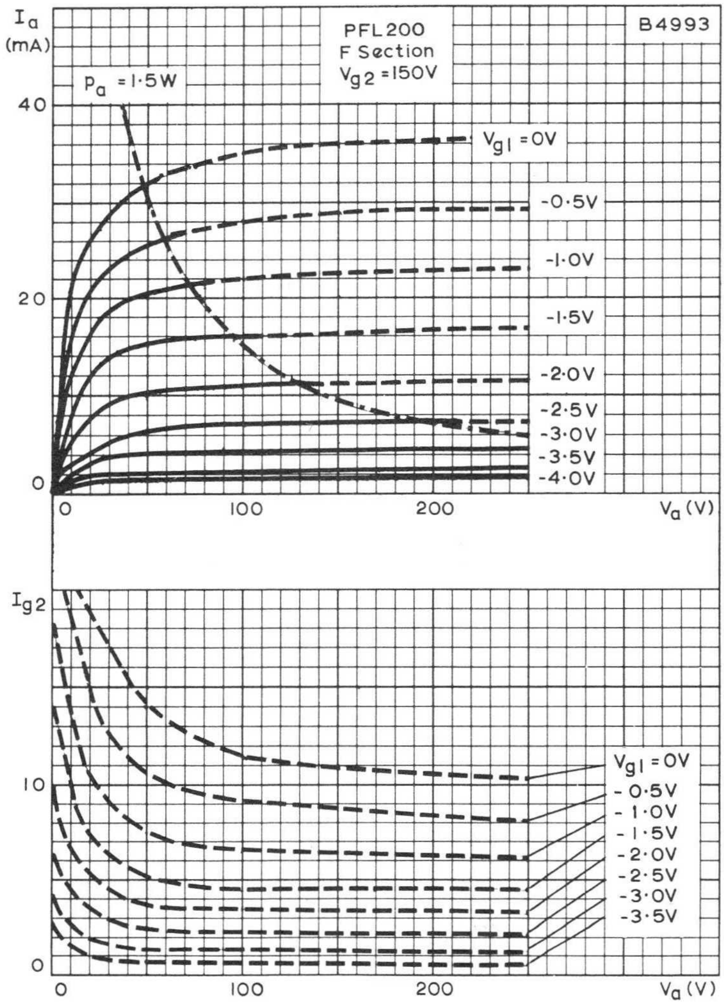
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 110V. L SECTION



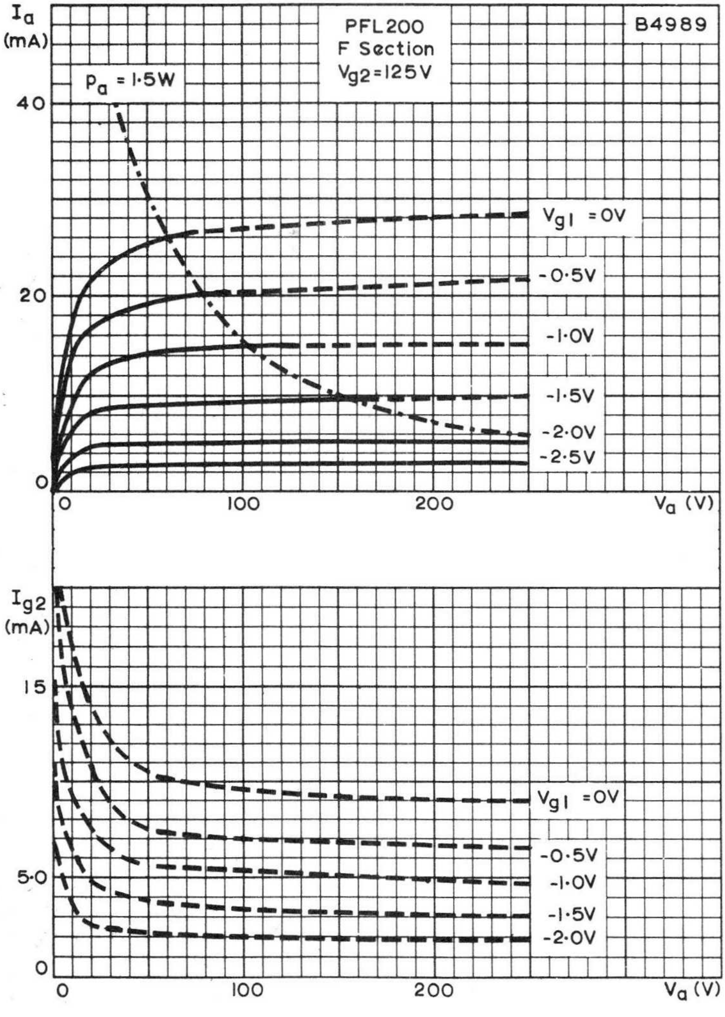
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETERS AND WITH MUTUAL CONDUCTANCE CONTOURS.
L SECTION



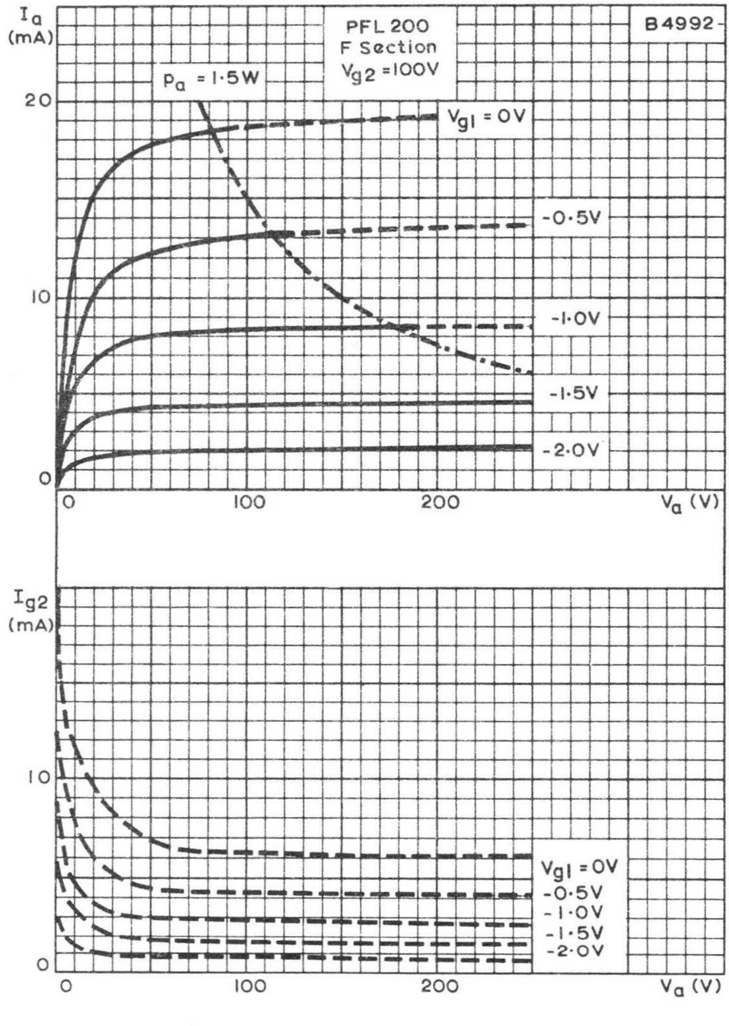
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 170V$.
L SECTION



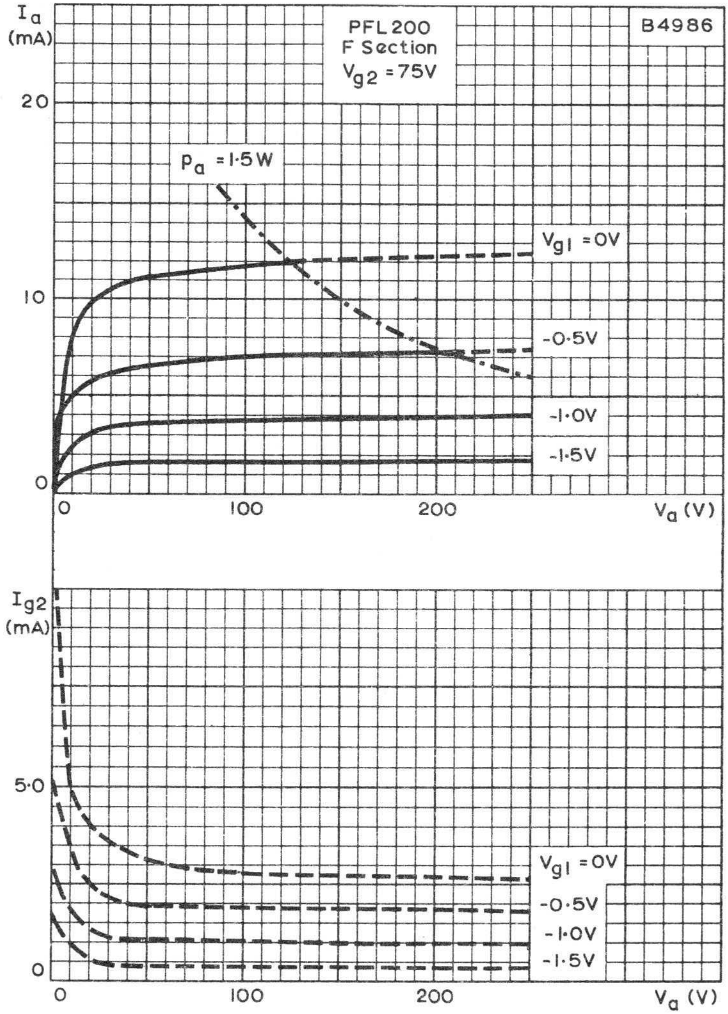
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V. F SECTION



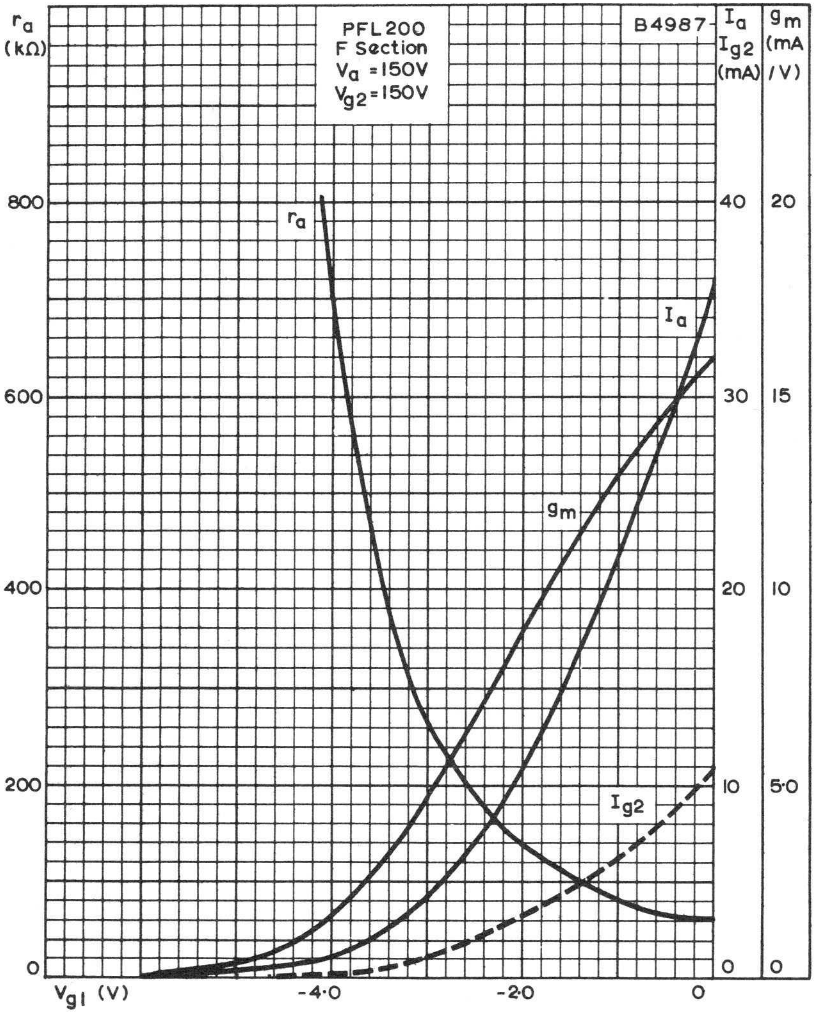
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 125V. F SECTION



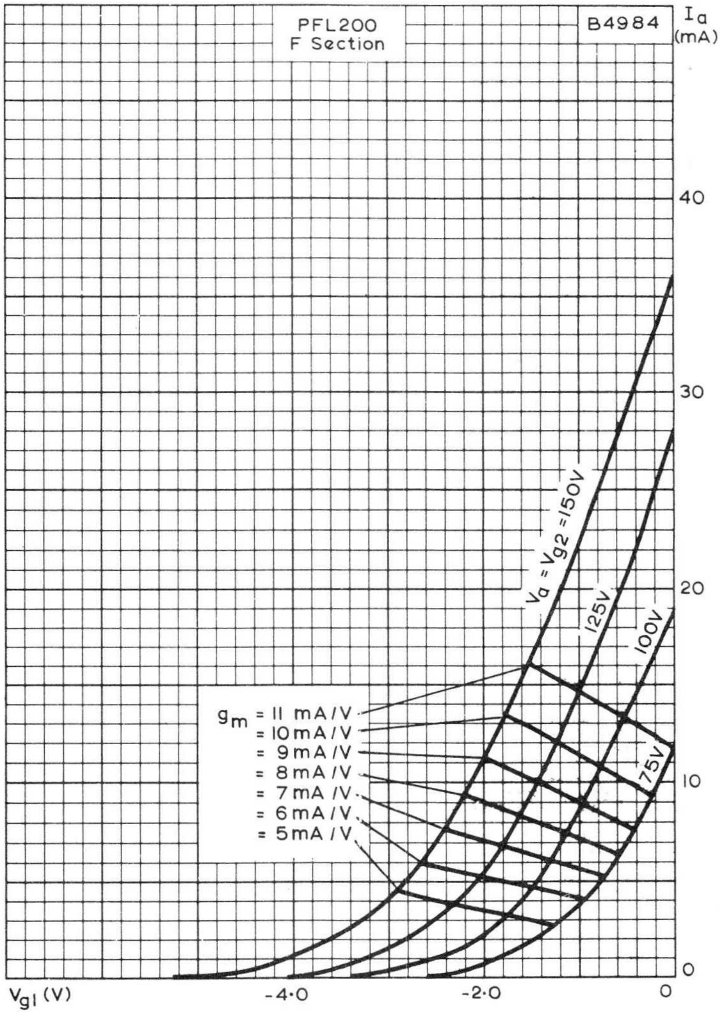
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 100V. F SECTION



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 75V. F SECTION



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 150V.$
F SECTION



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETERS AND WITH MUTUAL CONDUCTANCE CONTOURS.
F SECTION

LINE OUTPUT PENTODE

PL36

Output pentode primarily intended for use in the line timebase of television receivers.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	25	V

CAPACITANCES

c_{in}	17.5	pF
c_{out}	8.0	pF
c_{a-g1}	$<$ 1.1	pF

CHARACTERISTICS

V_a	100	V
V_{g2}	100	V
V_{g1}	−8.2	V
I_a	100	mA
I_{g2}	7.0	mA
g_m	14	mA/V
r_a	5.0	kΩ
μ_{g1-g2}	5.6	

OPERATION AS LINE OUTPUT PENTODE

Circuit design

In calculating the peak anode current for circuit design purposes the knee is taken as the reference point. Operation so that the anode potential of the output valve at the end of scan is above the knee of the anode characteristic is only recommended when an effective feedback stabilising circuit is employed. A nomogram is given on page C1.

For operation below the knee of the characteristic the nomogram on page C2 should be used.

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
*$+v_{a(pk)}$ max.	7.0	kV
*$-v_{a(pk)}$ max.	1.5	kV
p_a max.	12	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
*$-v_{g1(pk)}$ max.	1.0	kV
†p_{g2} max.	5.0	W
$p_{a+}p_{g2}$ max.	13	W
I_k max.	200	mA
V_{h-k} max. (cathode negative)	200	V
V_{h-k} max. (cathode positive)	250	V
R_{g1-k} max. (fixed bias)	500	kΩ
R_{g1-k} max. (line timebase applications)	3.3	MΩ
Min. drive at $v_{a(pk)}$ = 5kV	100	V
Min. drive at $v_{a(pk)}$ = 7kV	120	V
T_{bulb} max.	250	°C←

*Max. duration 22% of one cycle with a maximum of 18μs.

†Max. average p_{g2} is 7W during the period between the commencement of I_{g2} and the instant when I_a attains one half of its normal operating value.

Mullard

PEAK ANODE CURRENT NOMOGRAMS

Stabilised timebases

The nomogram shown on page C1 gives directly the values of peak anode current and end-of-scan anode voltage which should be used in designing a stabilised line timebase. The nomogram is based on an h.t. line voltage of 200V, and a correction factor is included for other h.t. voltages.

Non-stabilised timebases

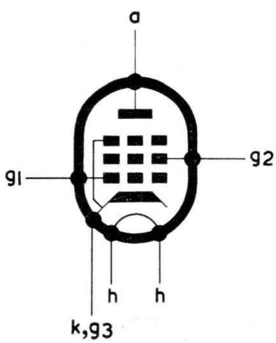
The nomogram shown on page C2 gives directly the values of peak anode current and end-of-scan anode voltage which should be used in designing a non-stabilised line timebase. It assumes 'below-the-knee' operation, undecoupled screen-grid resistor (excluding capacitors of a few hundred microfarad), and control-grid potential of +1V.

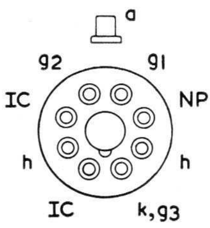
Measurements

When measurements are made specifically for the purpose of comparison with the nomogram, all the components comprising the timebase, including the valves, should be nominal. The h.t. line should also be nominal. In receivers designed for a range of declared values of mains voltage, measurements should be made at the nominal declared value of mains voltage producing the lowest nominal h.t. voltage. The timebase should be synchronised and the raster adjusted to nominal scan. The beam current drawn from the e.h.t. supply should be 300μA.

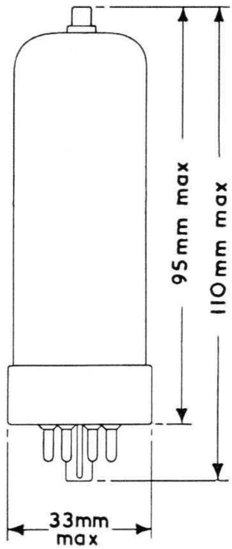
The use of the nomogram does not exempt the designer from checking that the valve is operating within its limiting values.

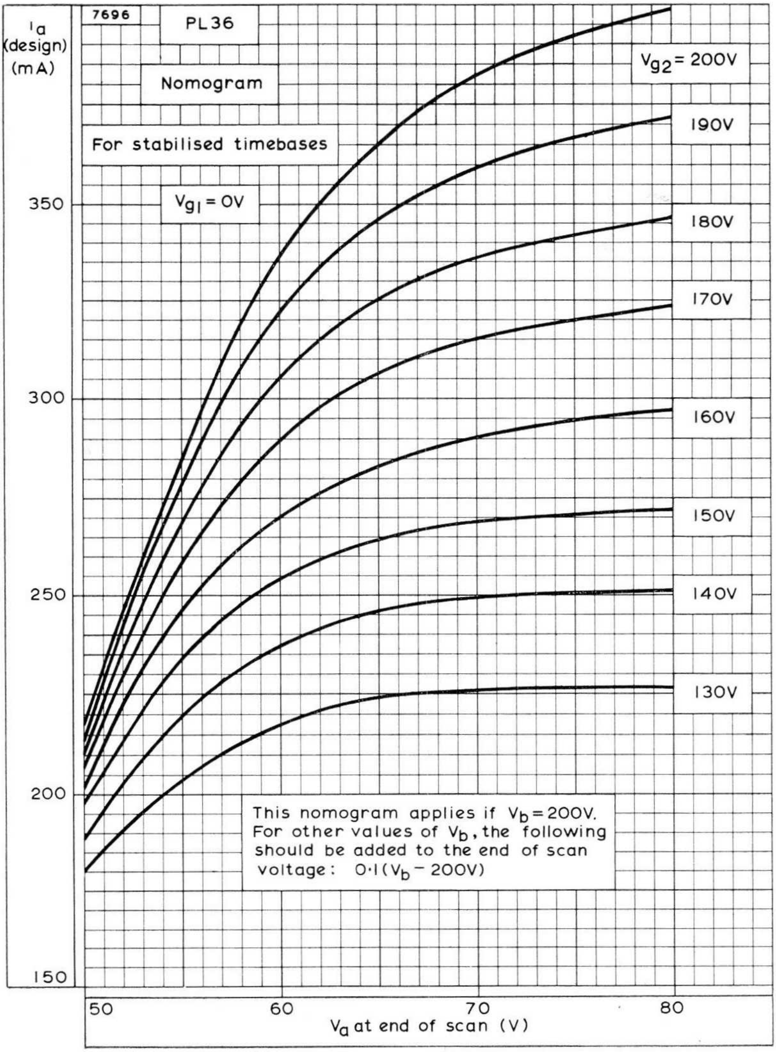
2277



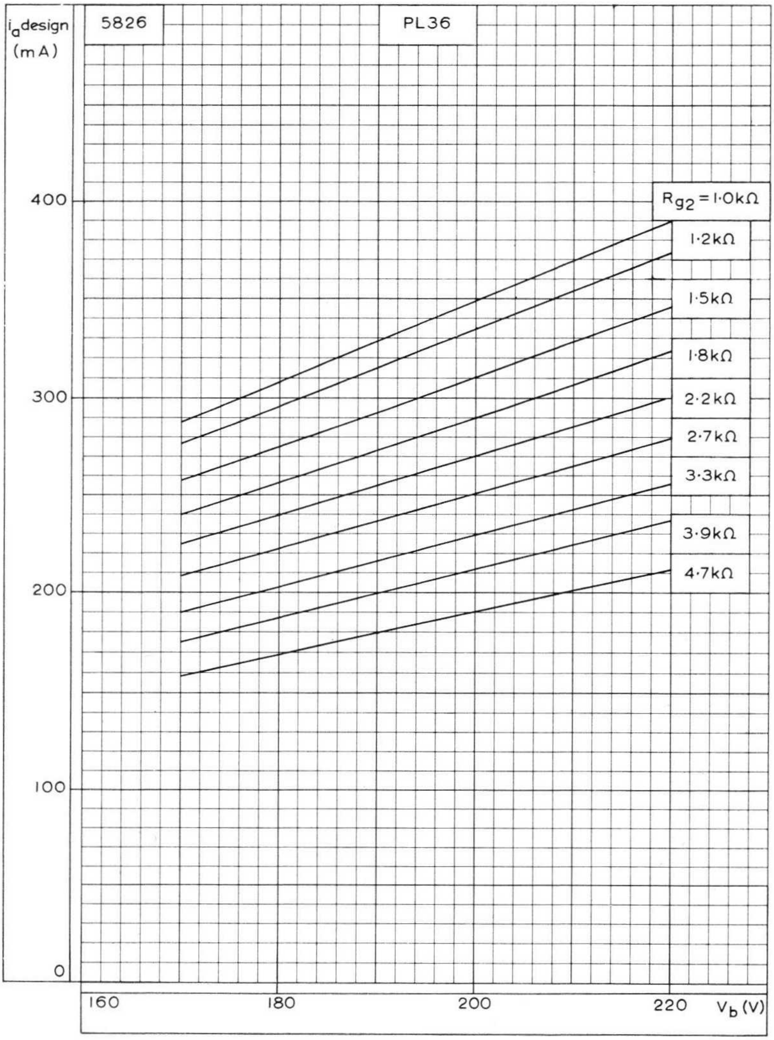


Octal Base

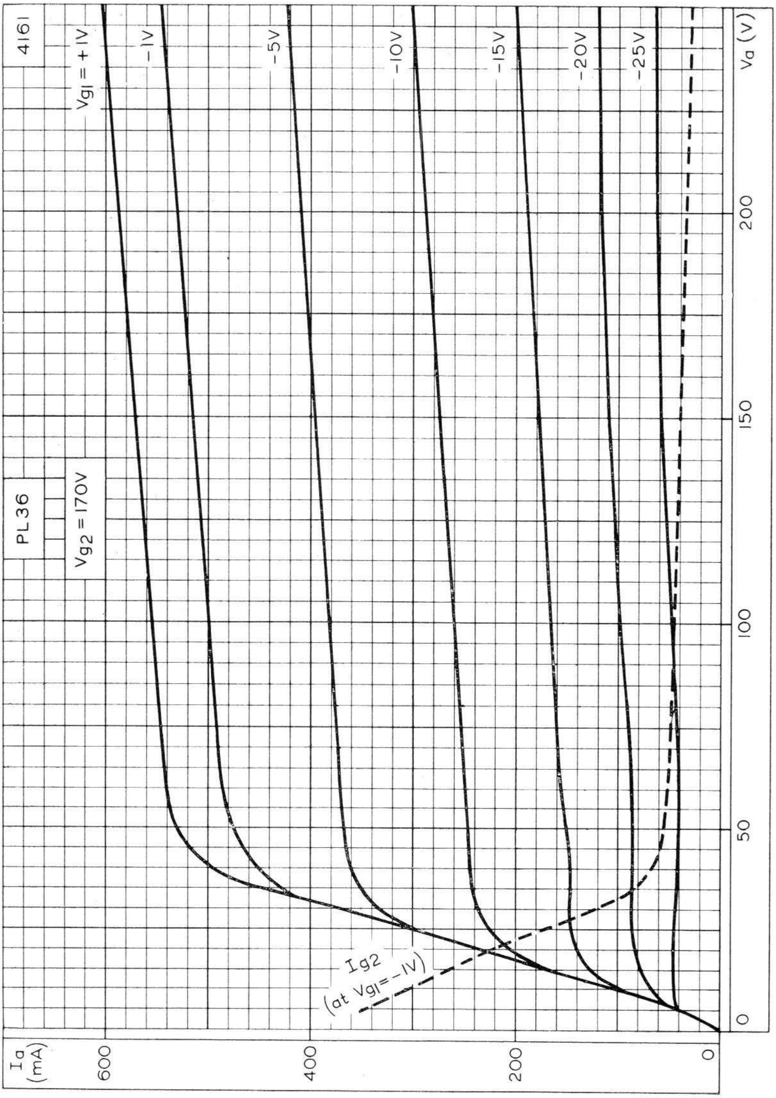




NOMOGRAM FOR STABILISED TIMEBASES



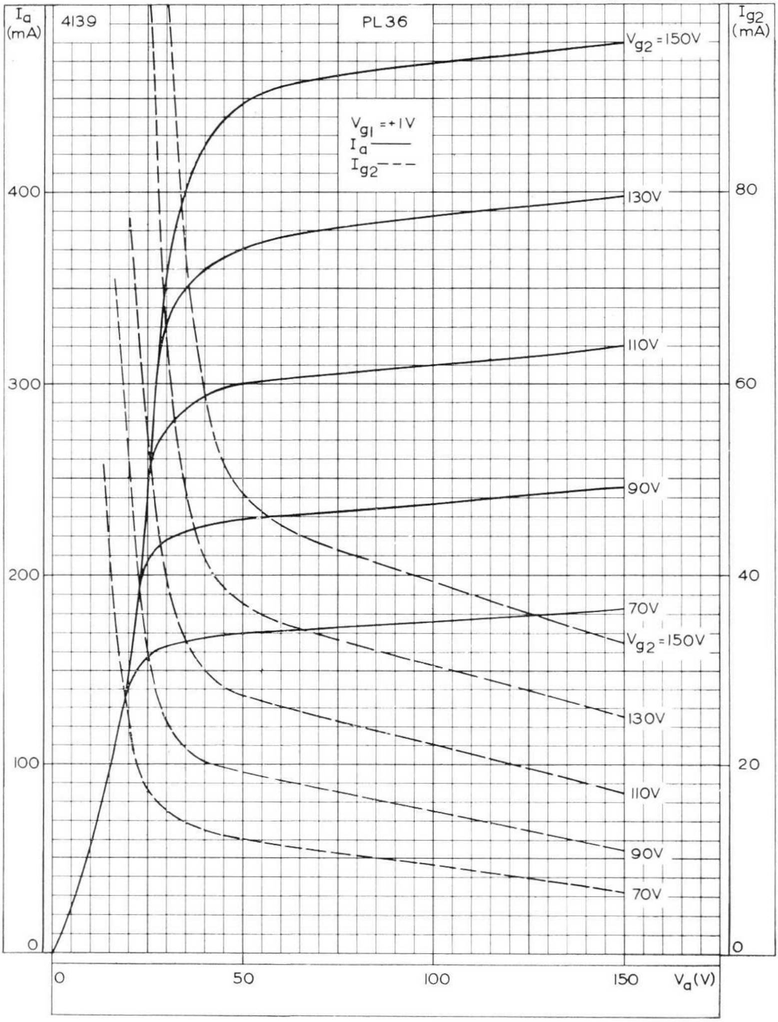
NOMOGRAM FOR NON-STABILISED TIMEBASES



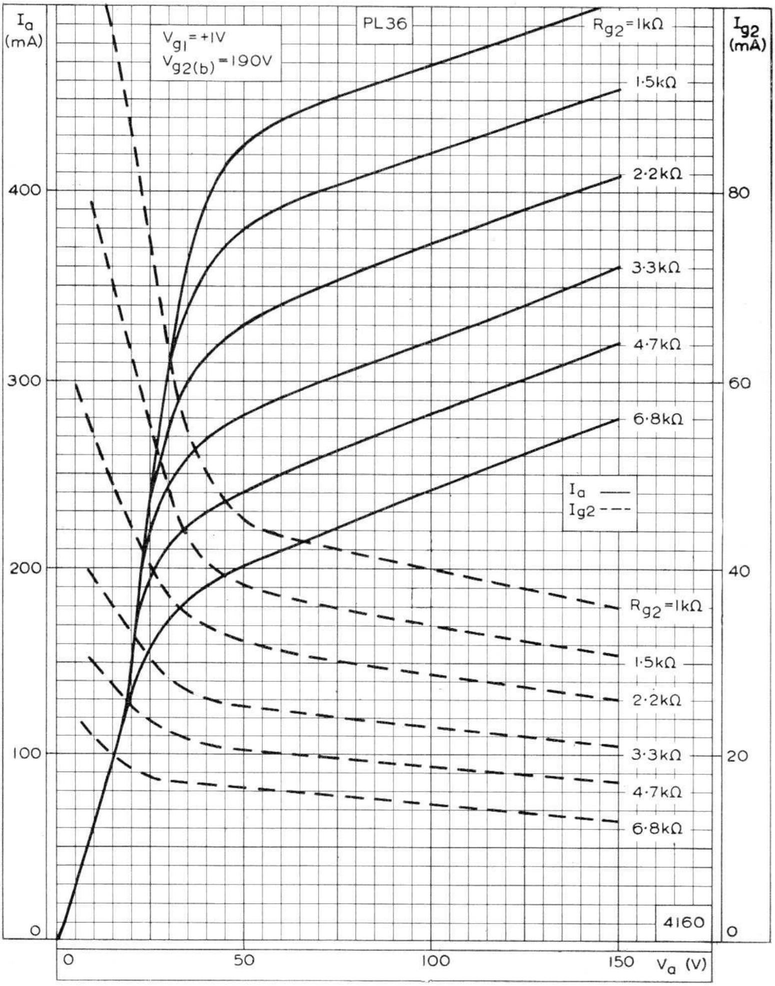
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

PL36

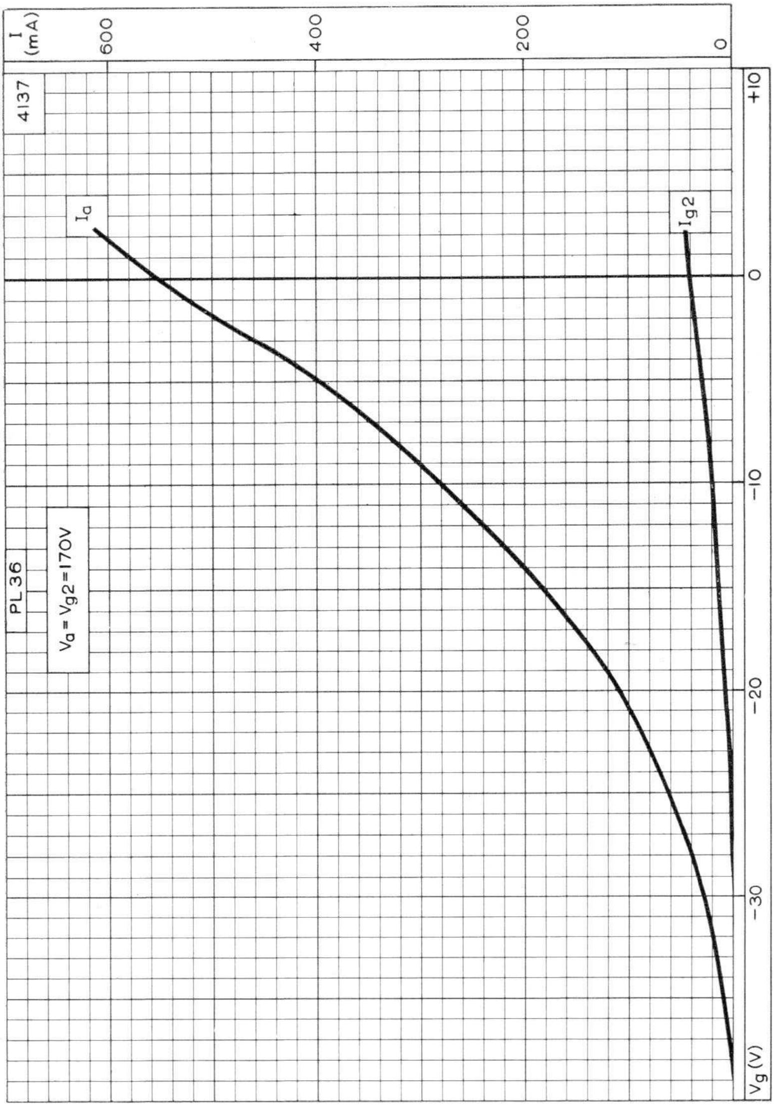
LINE OUTPUT PENTODE



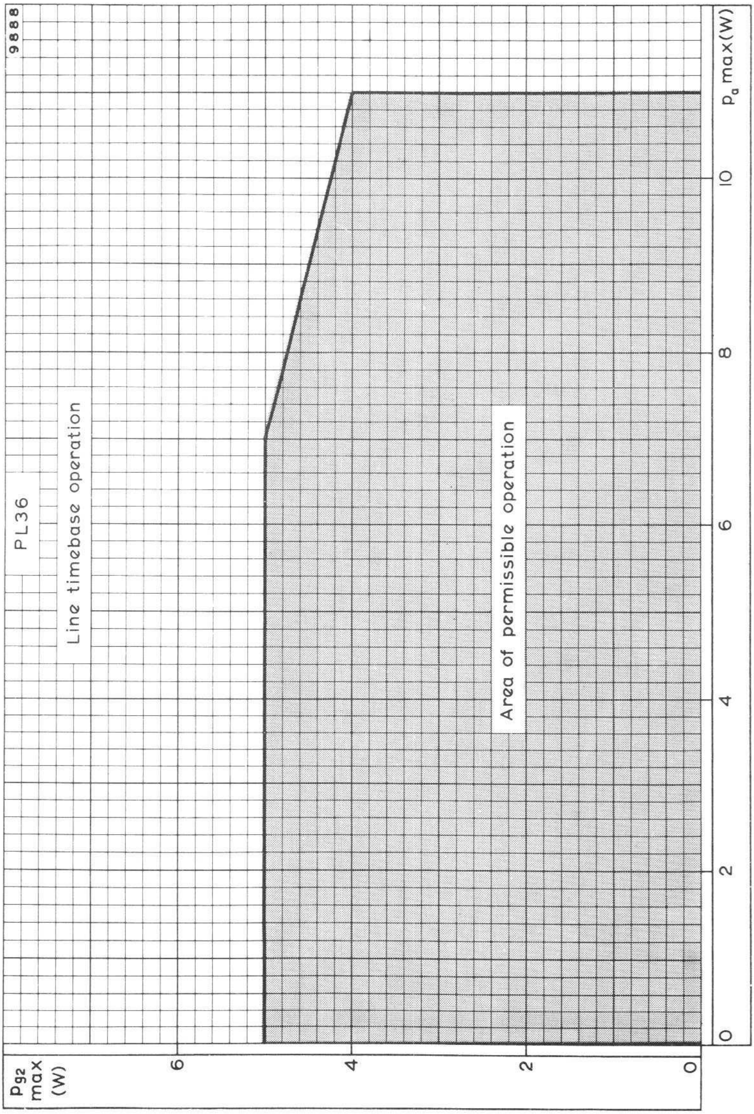
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID RESISTANCE AS PARAMETER



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE



BOUNDARY OF OPERATION FOR LINE TIMEBASE APPLICATIONS

Line output pentode for use in portable television receivers.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	21.5	V

CAPACITANCES

c_{in}	14	pF
c_{out}	6.0	pF
c_{a-g1}	<800	mpF
c_{g1-h}	<200	mpF
c_{a-k}	<100	mpF

CHARACTERISTICS

V_a	170	V
V_{g2}	170	V
V_{g1}	-24.5	V
I_a	45	mA
I_{g2}	2.2	mA
g_m	6.0	mA/V
r_a	11.5	kΩ
μ_{g1-g2}	4.9	

OPERATION AS LINE OUTPUT VALVE

Circuit design

Operation so that the anode potential of the output valve at the end of the scan is above the knee of the anode characteristic is recommended. An effective feedback stabilising circuit should be employed. A design chart is given on page C5.

Minimum values of R_{g2} required to prevent excessive screen-grid dissipation during the warming-up period.

V_b	170	200	230	V
R_{g2} min.	1.2	1.8	2.2	kΩ

High voltage cut-off

The minimum value of V_{g1} for cut-off during the fly-back period, when $v_{a(pk)}$ = 7.0kV, is -120V.

PEAK ANODE CURRENT DESIGN CHARTS

Stabilised timebases

The design chart shown on page C5 gives directly the values of peak anode current and end-of-scan anode voltage which should be used in designing a stabilised line timebase. The design chart is based on an h.t. line voltage of 200V, and a correction factor is included for other h.t. voltages.

Measurements

When measurements are made specifically for the purpose of comparison with the design chart, all the components comprising the timebase, including the valves, should be nominal. The h.t. line should also be nominal. In receivers designed for a range of declared values of mains voltage, measurements should be made at the nominal declared value of mains voltage producing the lowest nominal h.t. voltage. The timebase should be synchronised and the raster adjusted to nominal scan. The beam current drawn from the e.h.t. supply should be 300μA.

The use of the design chart does not exempt the designer from checking that the valve is operating within its limiting values.

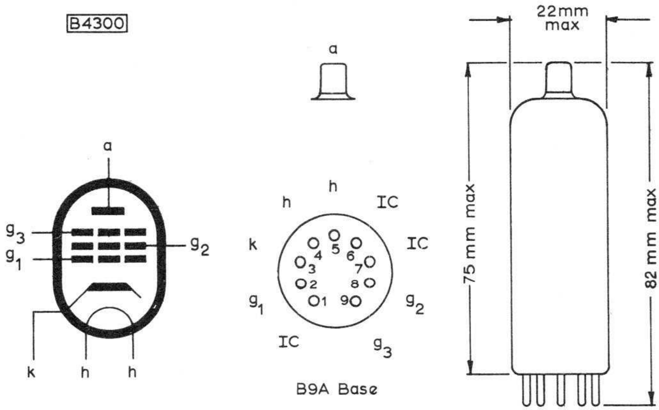
LINE OUTPUT PENTODE

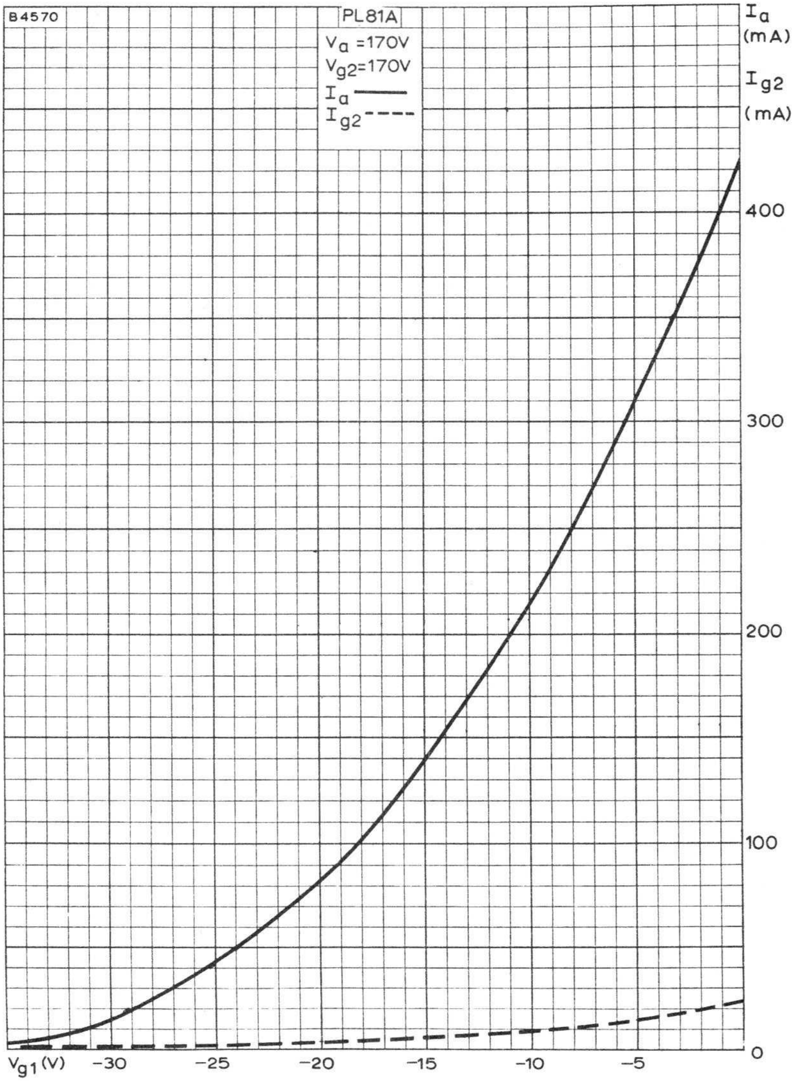
PL81A

RATINGS (DESIGN CENTRE SYSTEM)

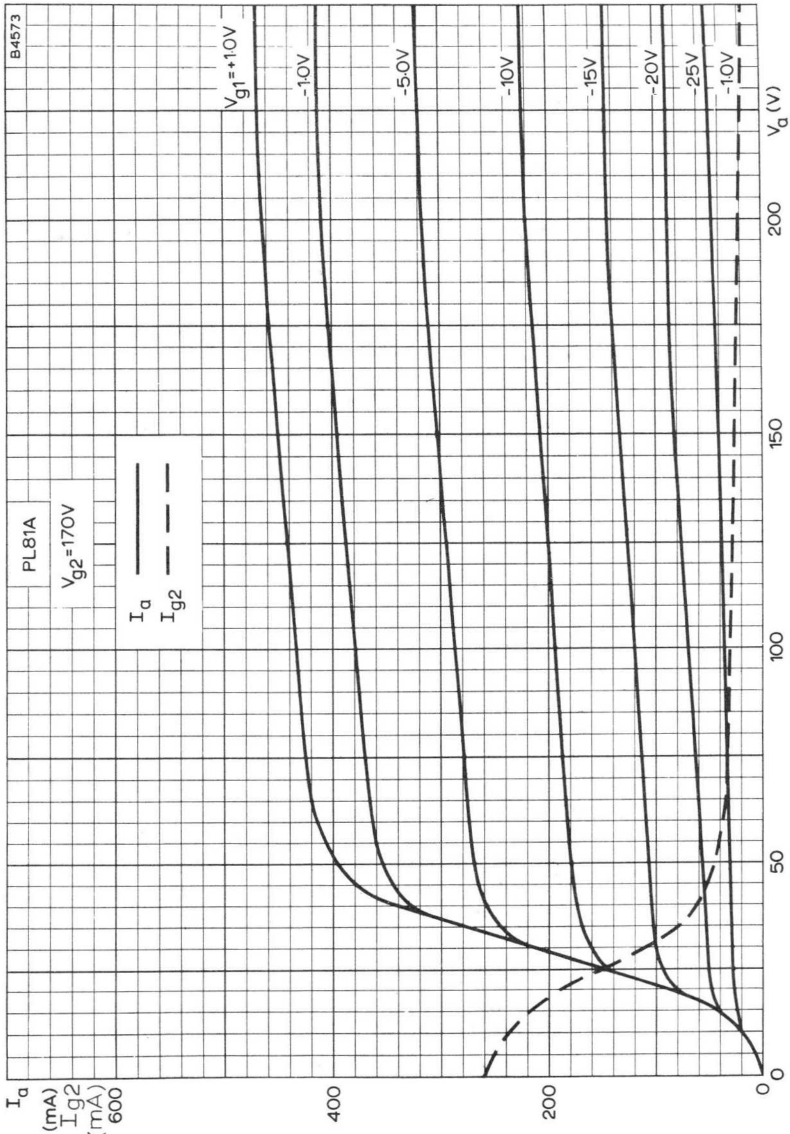
$V_{a(b)}$ max.	650	V
V_a	250	V
* $v_{a(pk)}$ max.	7.0	kV
p_a max.	see page C6	
$p_a + p_{g2}$	see page C6	
$V_{g2\ (b)}$ max.	550	V
V_{g2} max.	250	V
$v_{g1\ (pk)}$ max.	1.0	kV
p_{g2} max.	see page C6	
I_k max.	180	mA
R_{g1-k} max.	500	kΩ
R_{g1-k} max. (line timebase applications)	2.2	MΩ
R_{h-k} max.	20	kΩ
V_{h-k} max. (cathode negative)	200	V
V_{h-k} max. (cathode positive)	200	V
T_{bulb} max.	240	°C

*Maximum pulse duration 22% of one cycle with a maximum of 18μs.

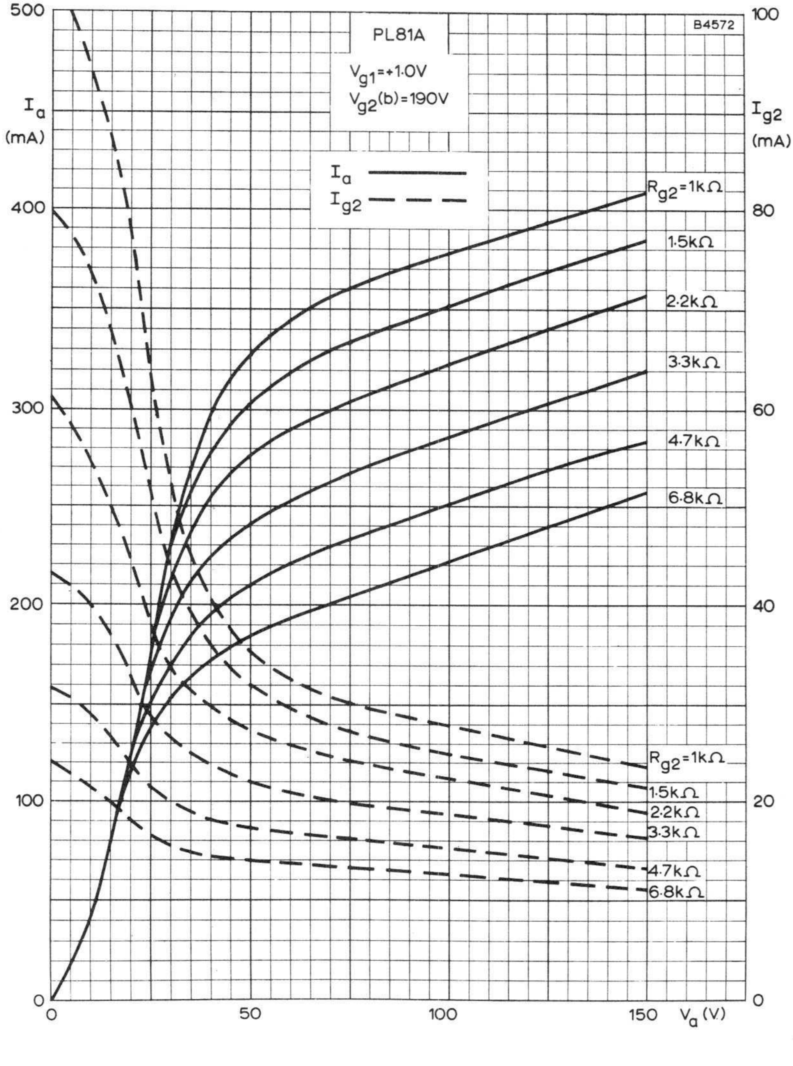




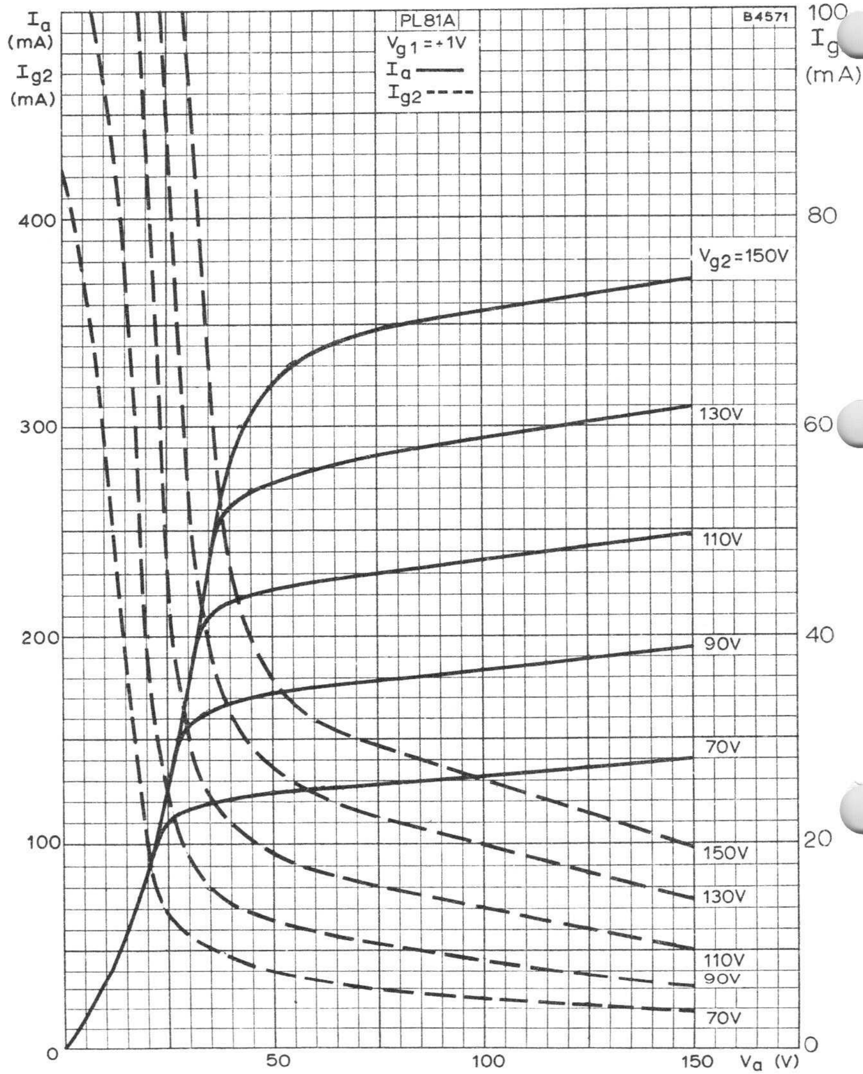
ANODE AND SCREEN CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE



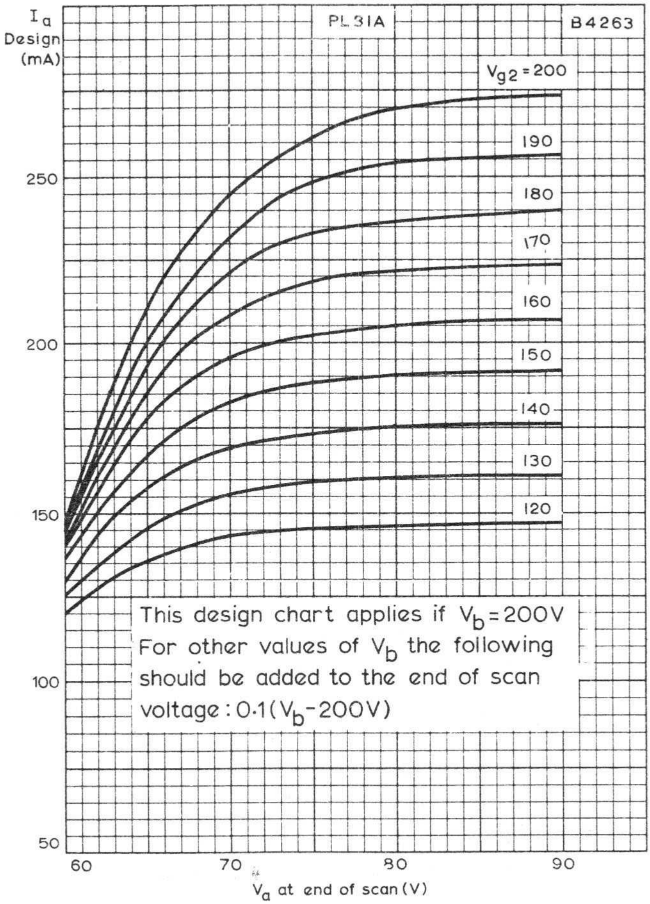
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER



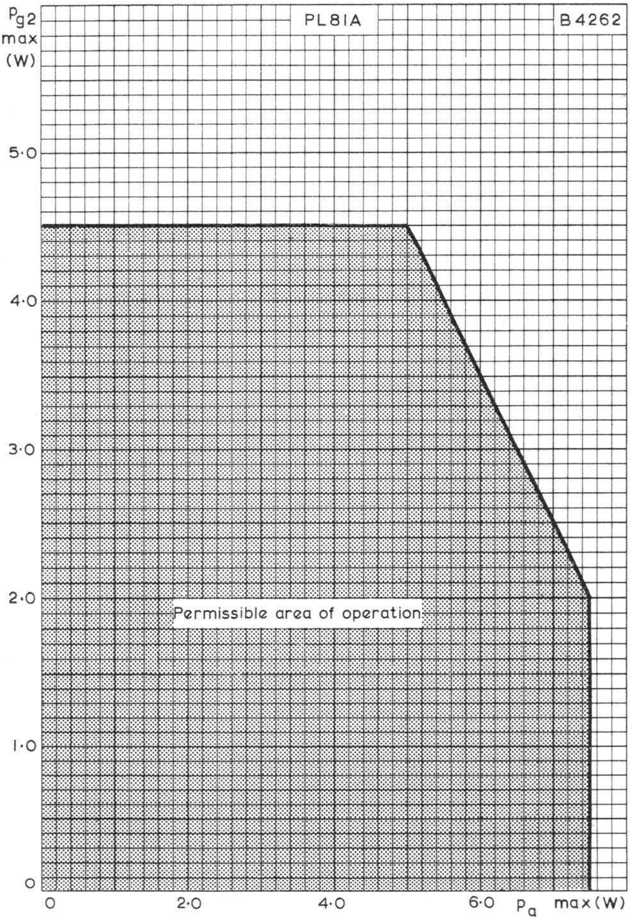
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID RESISTOR AS PARAMETER



ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



DESIGN CHART FOR STABILISED TIMEBASES



DESIGN CENTRE RATINGS FOR p_a max. AND p_{g2} max.

VIDEO OUTPUT PENTODE

PL83

Video output pentode for use in television receivers with series connected heaters. It is particularly suitable for use in projection television receivers or with high definition television systems.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	0.3	A
V_h	15	V

CAPACITANCES

c_{in}	10.4	μμF
c_{out}	6.6	μμF
c_{a-g1}	<0.06	μμF
c_{g1-h}	<0.15	μμF

CHARACTERISTICS

V_a	170	200	V
V_{g2}	170	200	V
V_{g3}	0	0	V
I_a	36	36	mA
I_{g2}	5	5	mA
V_{g1}	−2.3	−3.5	V
g_m	10	10	mA/V
r_a	100	100	kΩ
μ_{g1-g2}	24	24	

TYPICAL OPERATING CONDITIONS FOR DRIVING A CATHODE RAY TUBE WITH CATHODE INJECTION

V_b	170	V
V_{g2}	170	V
V_{g3}	0	V
I_a	4	mA
I_{g2}	0.25	mA
V_{g1}	−6.7	V
R_a	2.2	kΩ
$v_{out\ (pk)}$	>70	V

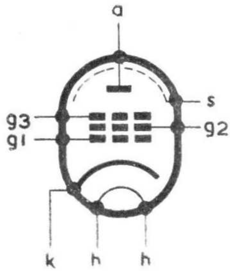
PL83

VIDEO OUTPUT PENTODE

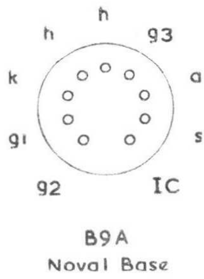
Video output pentode for use in television receivers with series connected heaters. It is particularly suitable for use in projection television receivers or with high definition television systems.

LIMITING VALUES

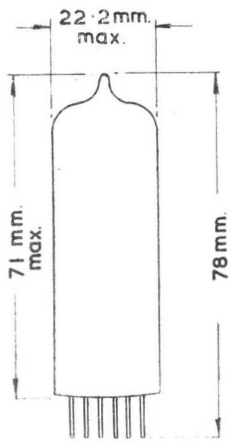
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	9	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	2	W
I_k max.	70	mA
V_{g1} max. ($I_{g1} = +0.3\ \mu A$)	-1.3	V
R_{g1-k} max. (self bias)	1.0	MΩ
R_{g1-k} max. (fixed bias)	500	kΩ
V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ



559



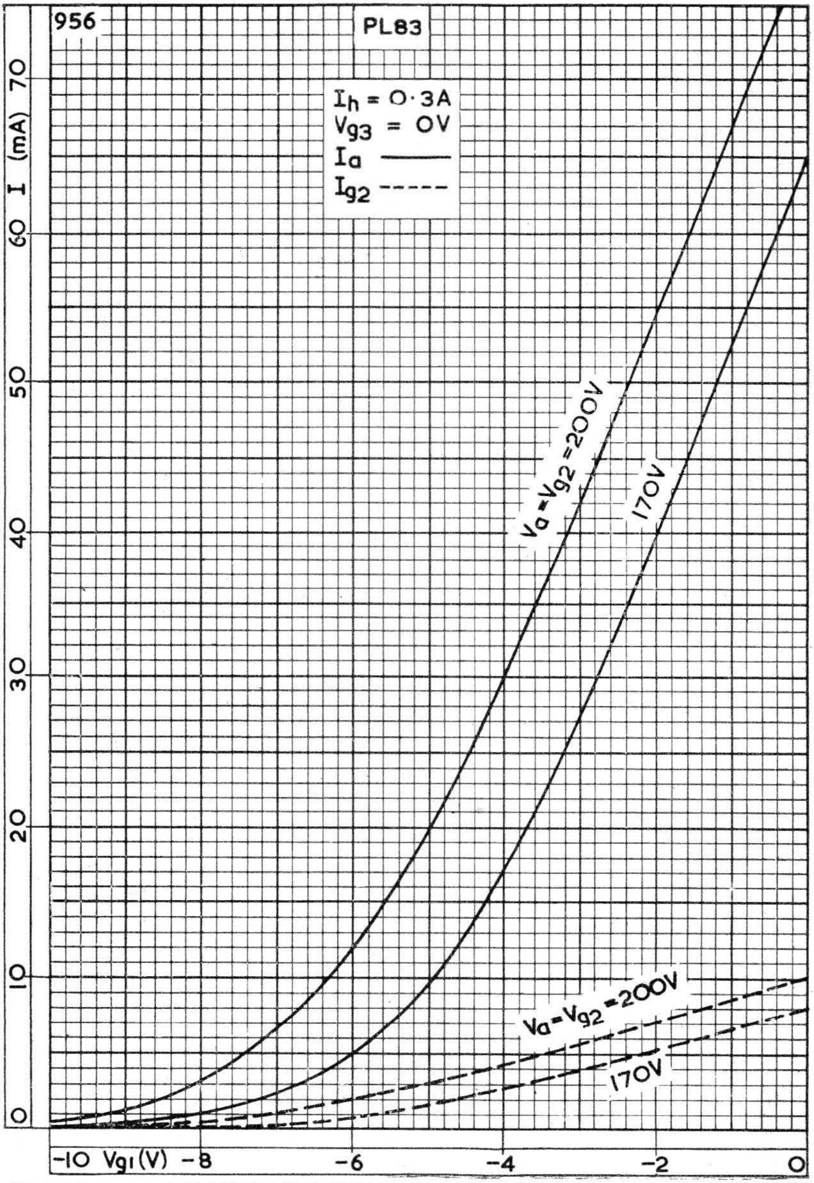
B9A
Noval Base



VIDEO OUTPUT PENTODE

PL83

Video output pentode for use in television receivers with series connected heaters. It is particularly suitable for use in projection television receivers or with high definition television systems.

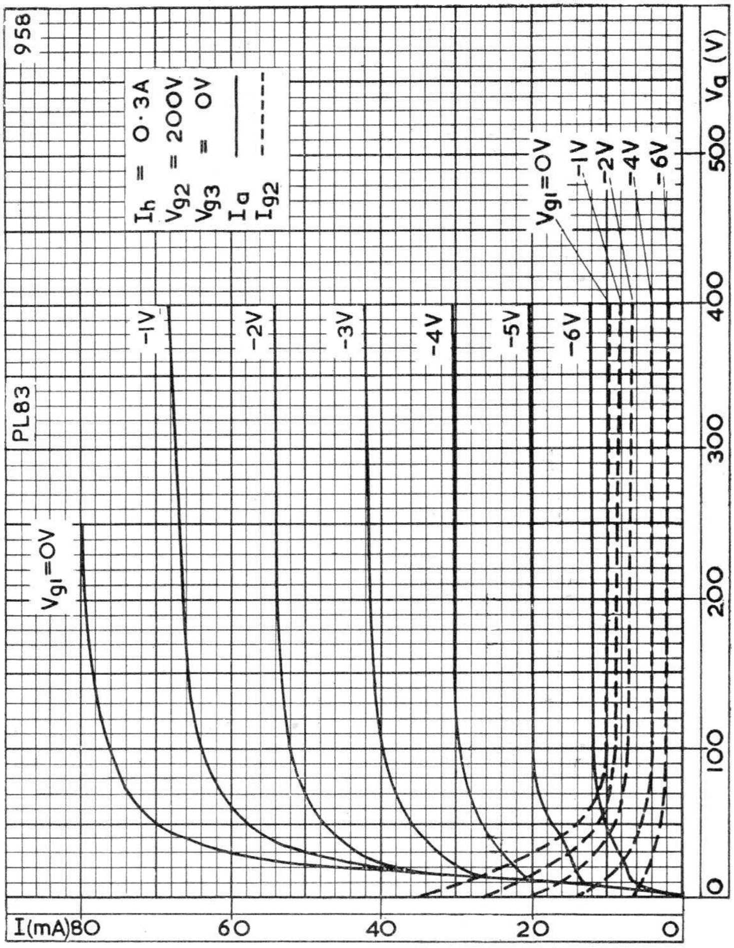


ANODE CURRENT AND SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE

PL83

VIDEO OUTPUT PENTODE

Video output pentode for use in television receivers with series connected heaters. It is particularly suitable for use in projection television receivers or with high definition television systems.

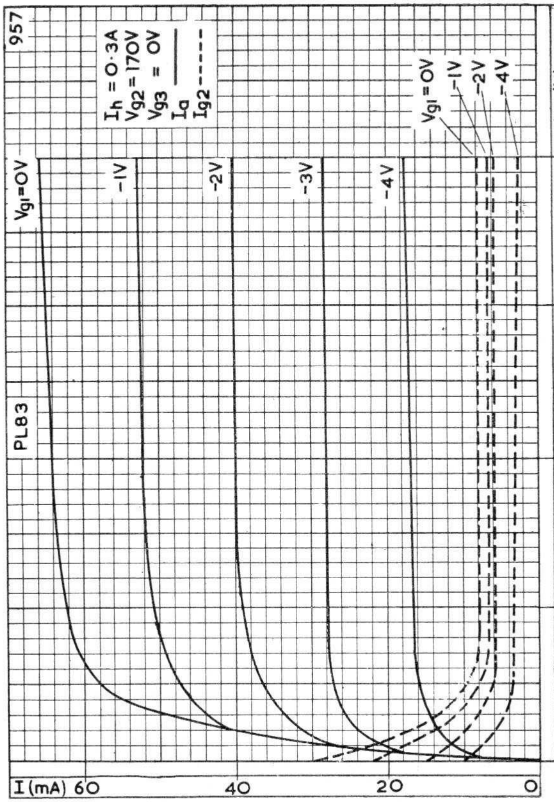


ANODE CURRENT AND SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE, WITH SCREEN-GRID VOLTAGE AT 200V

VIDEO OUTPUT PENTODE

PL83

Video output pentode for use in television receivers with series connected heaters. It is particularly suitable for use in projection television receivers or with high definition television systems.



ANODE CURRENT AND SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE, WITH SCREEN-GRID VOLTAGE AT 170V

OUTPUT PENTODE

PL84

Output pentode rated for 12W anode dissipation with 300mA heater for use as a frame output valve in television receivers.

HEATER

I_h	300	mA
V_h	15	V

CAPACITANCES

c_{in}	11.8	pF
c_{out}	6.0	pF
c_{a-g1}	$<$0.6	pF
c_{g1-h}	$<$0.25	pF

CHARACTERISTICS

V_a	170	200	V
V_{g2}	170	200	V
I_a	70	60	mA
I_{g2}	3.5	3.0	mA
V_{g1}	–12.5	–17.3	V
g_m	11	8.8	mA/V
r_a	26	28	kΩ
μ_{g1-g2}	8.0	8.0	

OPERATION AS FRAME OUTPUT VALVE

See nomogram on page C1 and notes on page D2.

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
*$+v_{a(pk)}$ max.	2.0	kV
$-v_{a(pk)}$ max.	500	V
p_a max.	12	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	200	V
p_{g2} max.	1.75	W
I_k max.	100	mA
R_{g1-k} max. (fixed bias)	500	kΩ
R_{g1-k} max. (cathode bias)	1.0	MΩ
R_{g1-k} max. (frame output)	3.3	MΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

*Max. pulse duration 4% of one cycle with a maximum of 800μs.

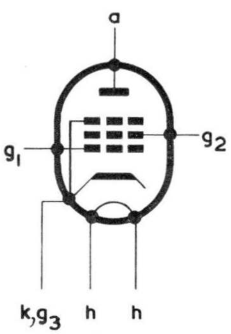
PEAK ANODE CURRENT NOMOGRAM

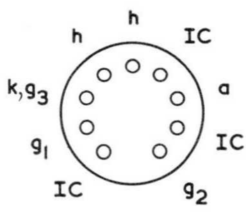
The nomogram shown on the following page gives directly the values of peak anode current and corresponding values of anode voltage at end of scan for various values of screen-grid voltage.
No indication of anode and screen-grid dissipation limits is given in the nomogram: these must be checked independently.

Example

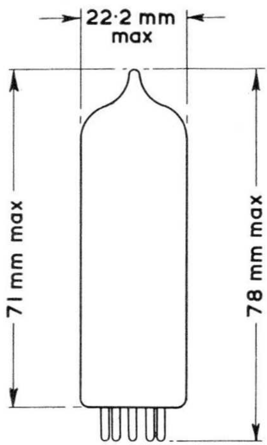
Suppose the screen-grid voltage is 170V. From the nomogram, the optimum working conditions at $V_{g2} = 170V$ are $i_{a(pk)} = 140mA$, and v_a at end of scan $= 70V$. If the designer requires a peak current of 160mA, the corresponding v_a at end of scan is 100V.

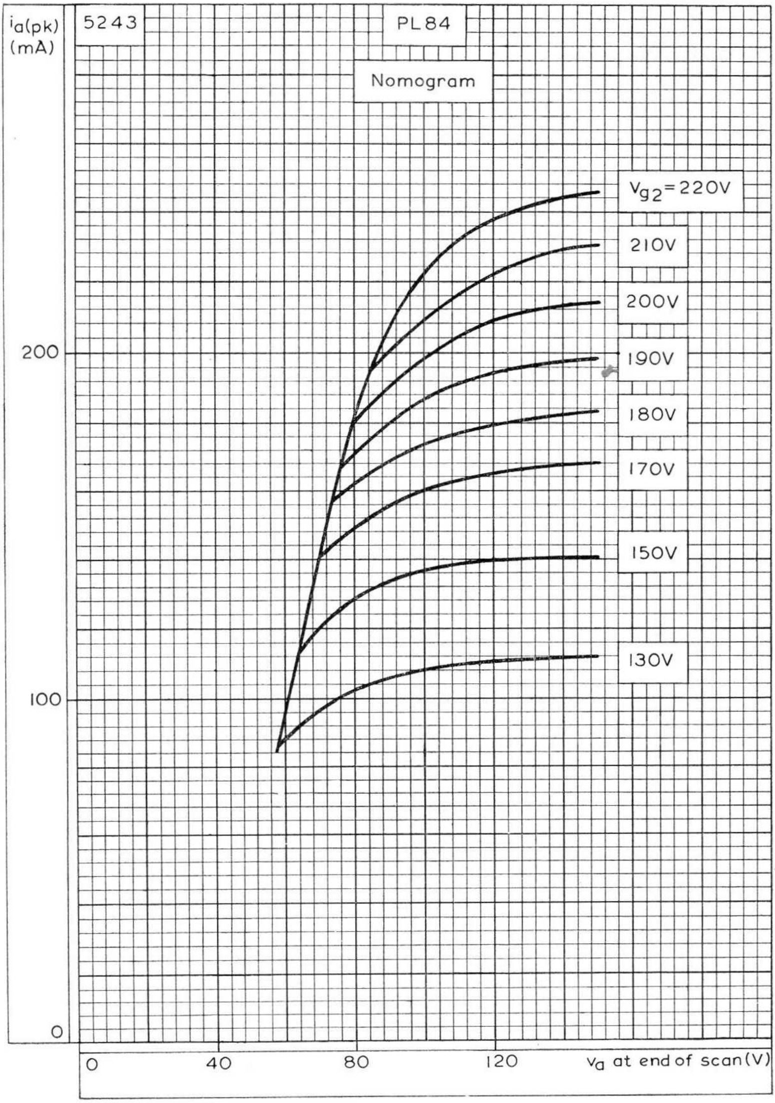
2834





B9A Base

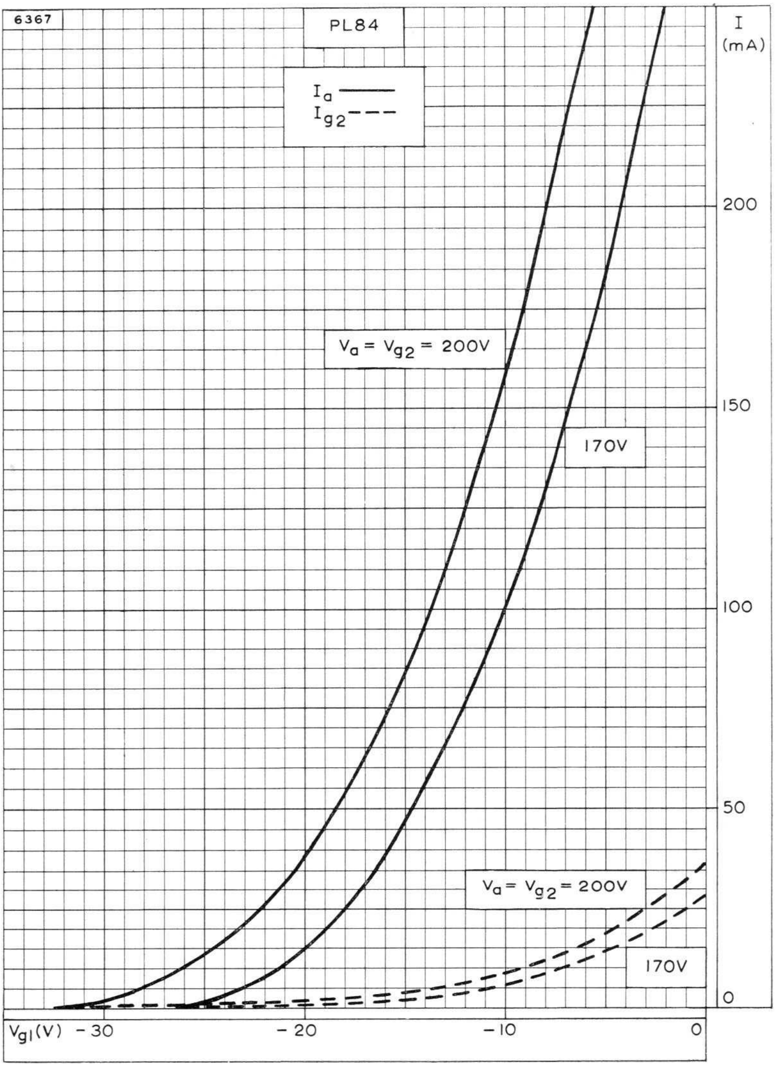




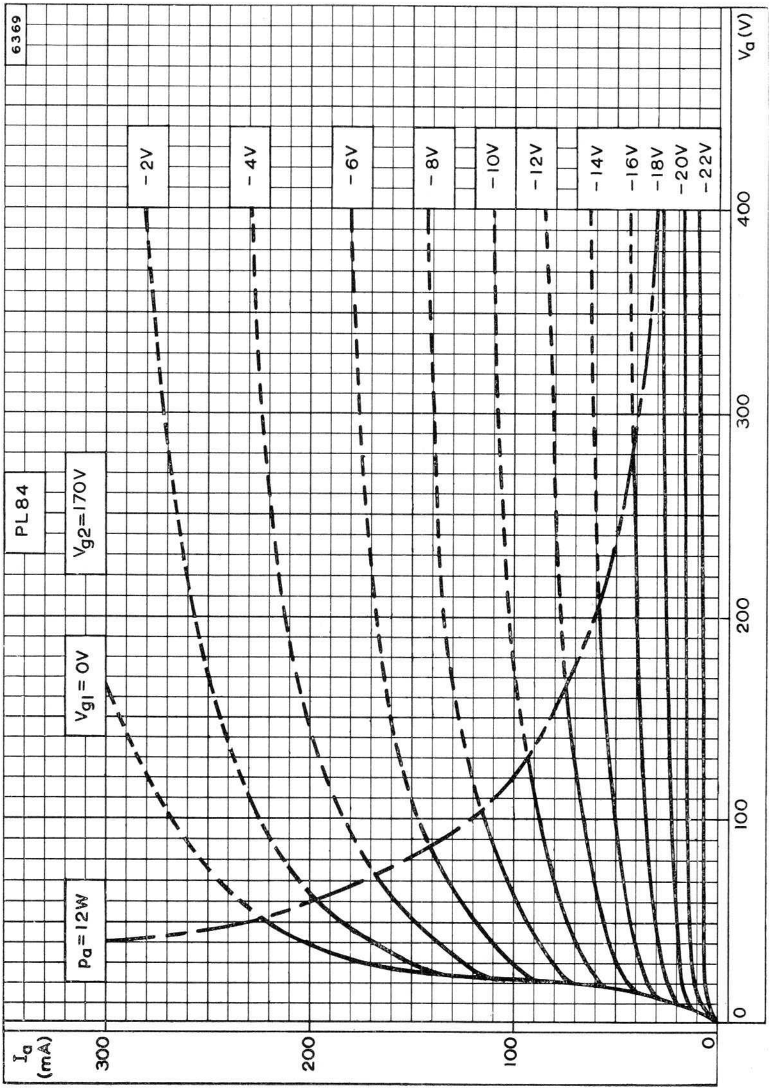
PEAK ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE AT THE END OF SCAN

PL84

OUTPUT PENTODE



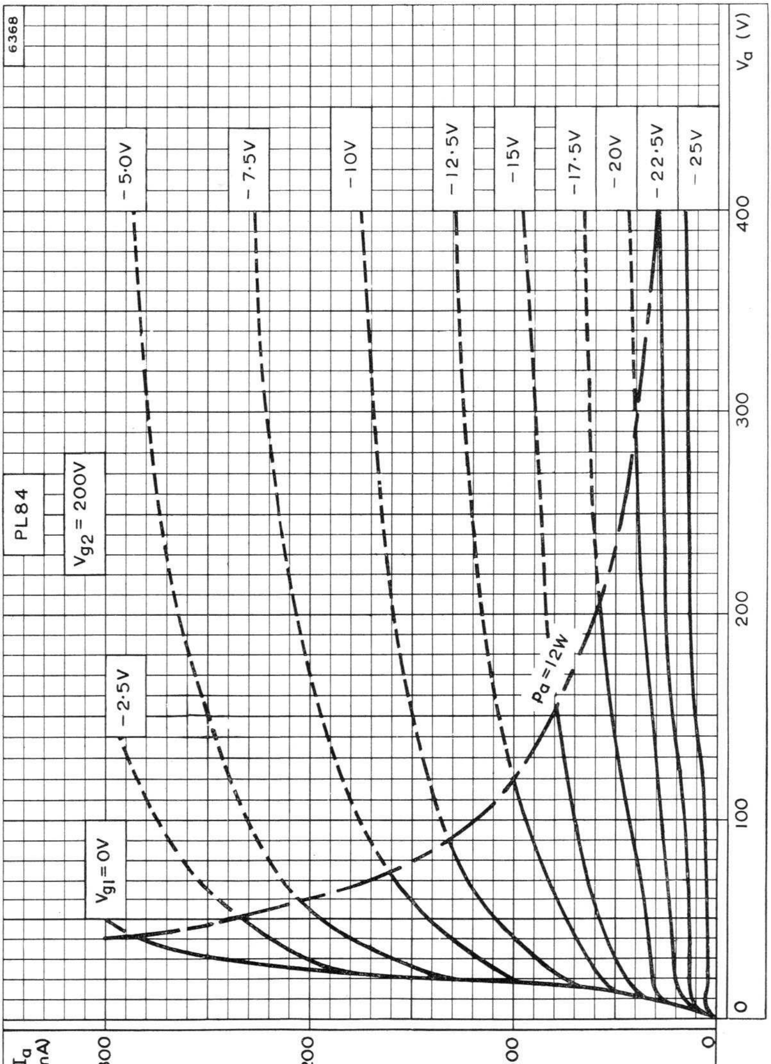
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR VARIOUS ANODE AND SCREEN-GRID VOLTAGES



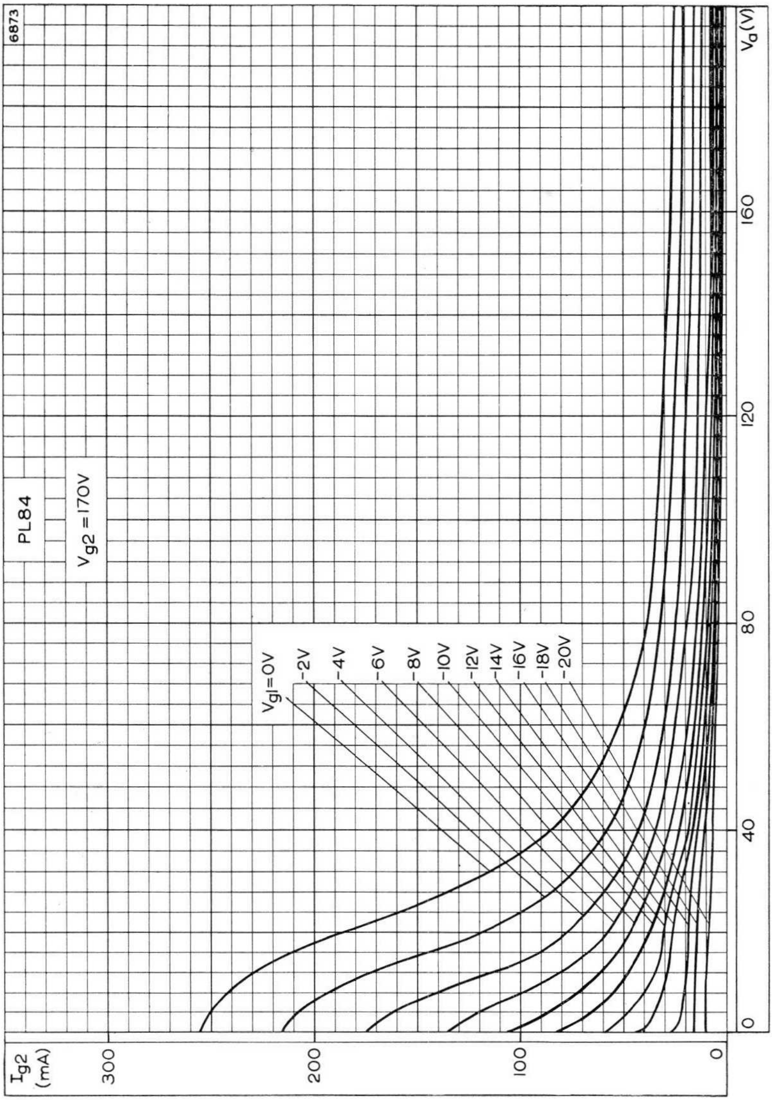
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 170V$

PL84

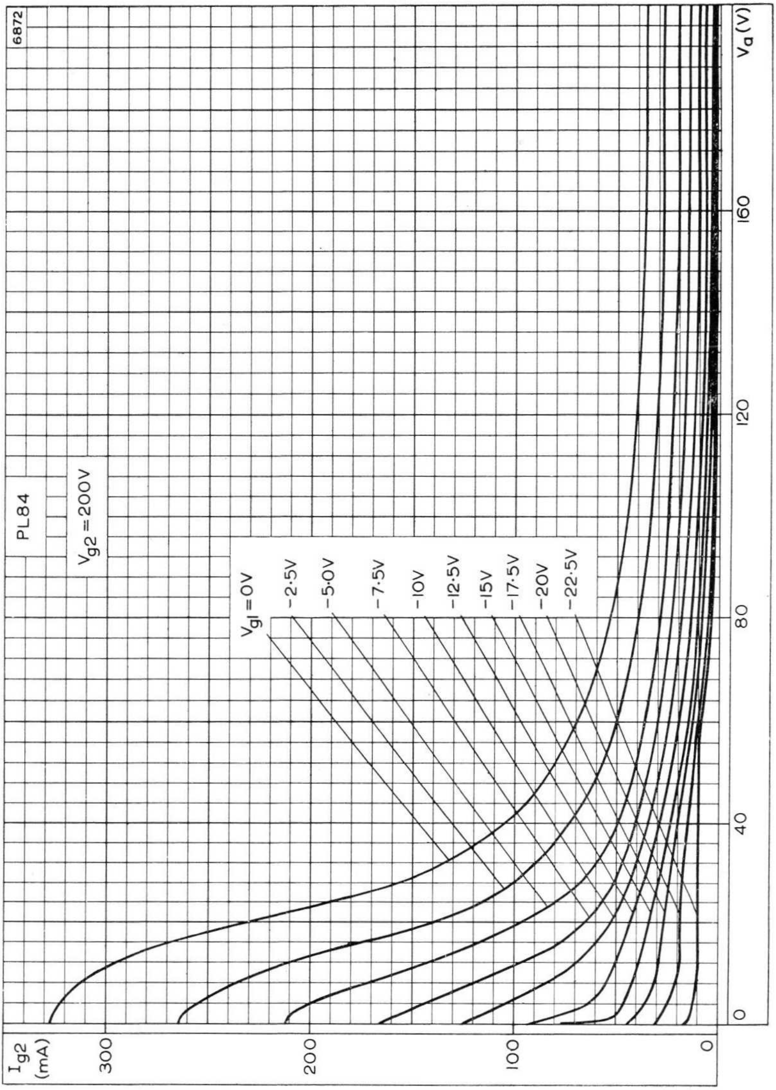
OUTPUT PENTODE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V

Output pentode primarily intended for use in the line timebase of television receivers.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	27	V

CAPACITANCES ←

c_{in}	22	pF
c_{out}	9.0	pF
c_{a-g1}	<1.75	pF
c_{g1-h}	<200	mpF

CHARACTERISTICS

V_a	75	V
V_{g2}	200	V
V_{g1}	-10	V
I_a	440	mA
I_{g2}	30	mA

OPERATION AS LINE OUTPUT VALVE ←

Circuit design

Operation so that the anode potential of the output valve at the end of the scan is above the knee of the anode characteristic is recommended. An effective feedback stabilising circuit should be employed. A design chart is given on page C7.

Minimum values of R_{g2} required to prevent excessive screen-grid dissipation during the warming-up period;

V_b	170	200	230	V
R_{g2} min.	1.0	1.5	1.8	kΩ

High voltage cut-off

The minimum value of V_{g1} for cut-off during the fly-back period, when $v_{a(pk)} = 7.0$kV, is -120V.

PEAK ANODE CURRENT DESIGN CHART

Stabilised timebases

The design chart shown on page C7 gives directly the values of peak anode current and end-of-scan anode voltage which should be used in designing a stabilised line timebase. The design chart is based on an h.t. line voltage of 200V, and a correction factor is included for other h.t. voltages.

Measurements

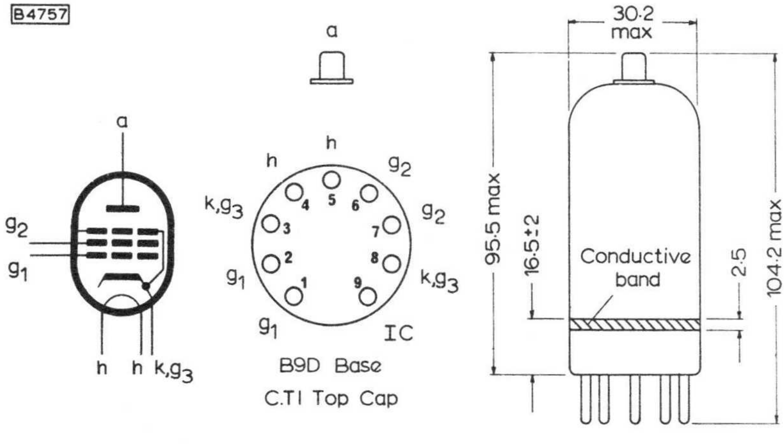
When measurements are made specifically for the purpose of comparison with the design chart, all the components comprising the timebase, including the valves, should be nominal. The h.t. line should also be nominal. In receivers designed for a range of declared values of mains voltage, measurements should be made at the nominal declared value of mains voltage producing the lowest nominal h.t. voltage. The timebase should be synchronised and the raster adjusted to nominal scan. The beam current drawn from the e.h.t. supply should be 300μA.

The use of the design chart does not exempt the designer from checking that the valve is operating within its limiting values.

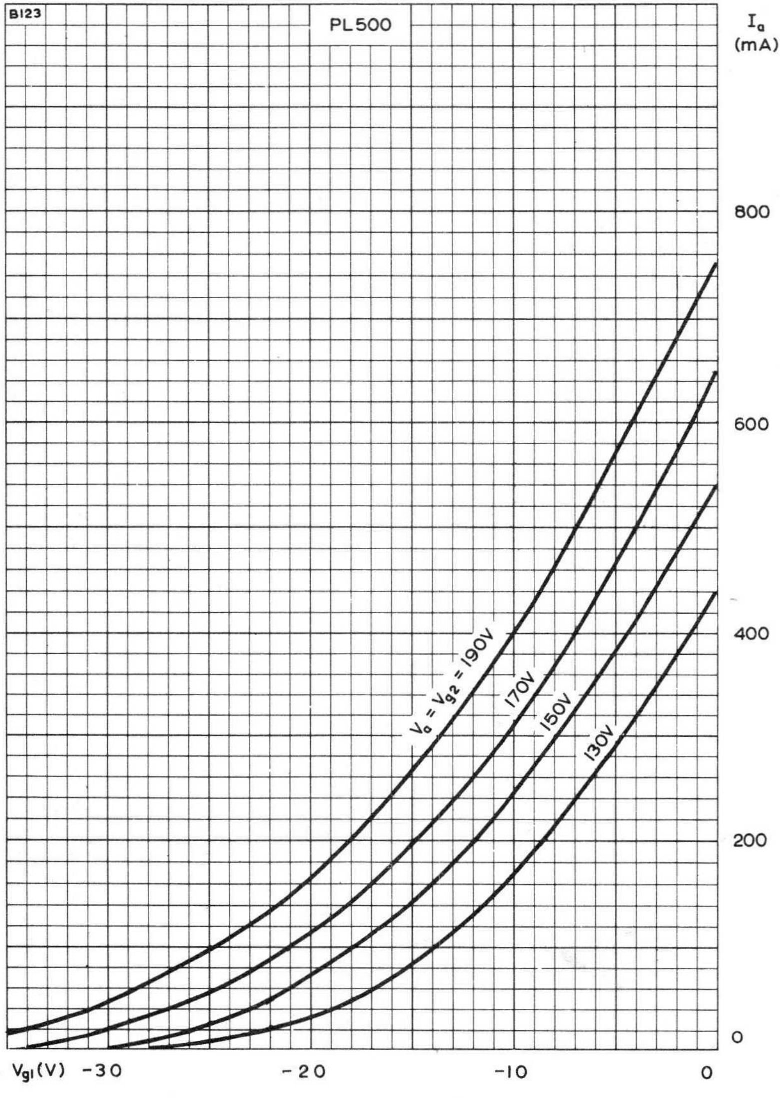
RATINGS (DESIGN CENTRE SYSTEM)

$V_{a(b)}$ max.	550	V
V_a max.	250	V
* $v_{a(pk)}$ max.	7.0	kV ←
p_a max.	see page C6	
$p_a + p_{g2}$	see page C6	
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	see page C6	
I_k max.	250	mA
R_{g1-k} max.	500	kΩ
R_{g1-k} max. (line timebase applications)	2.2	MΩ

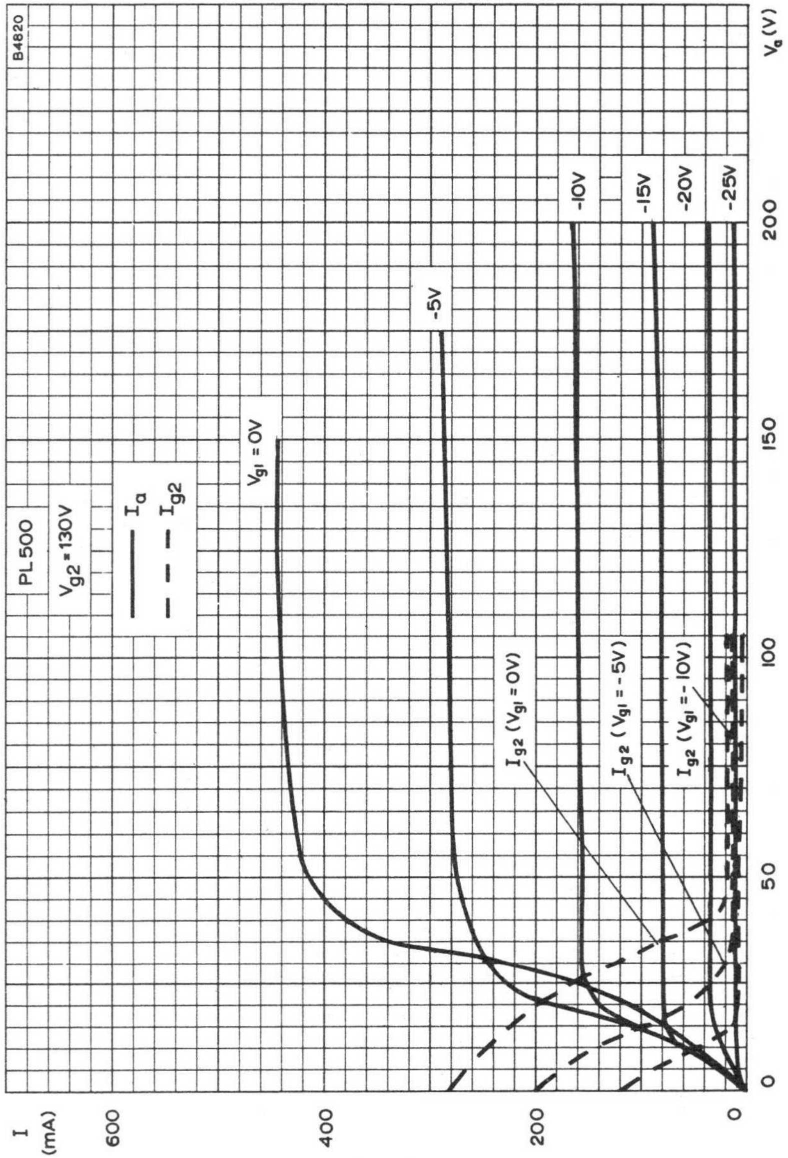
*Maximum pulse duration 22% of one cycle with a maximum of 22μs.



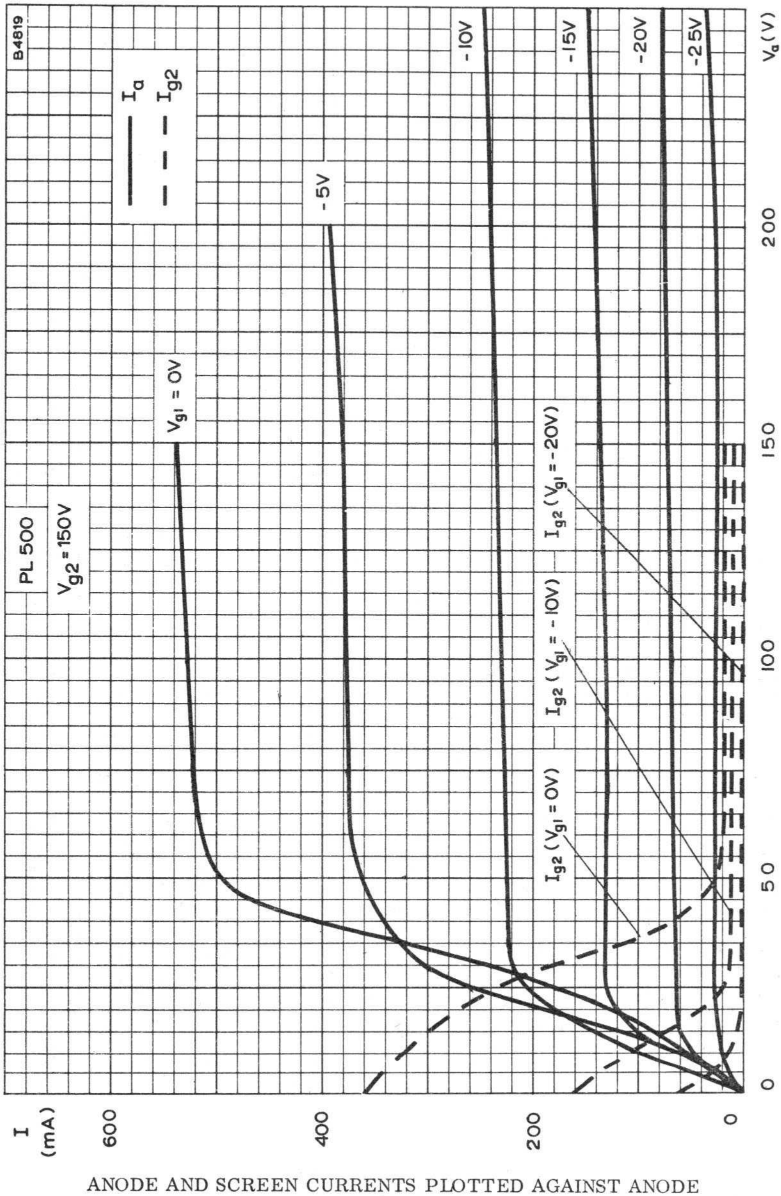
All dimensions in mm



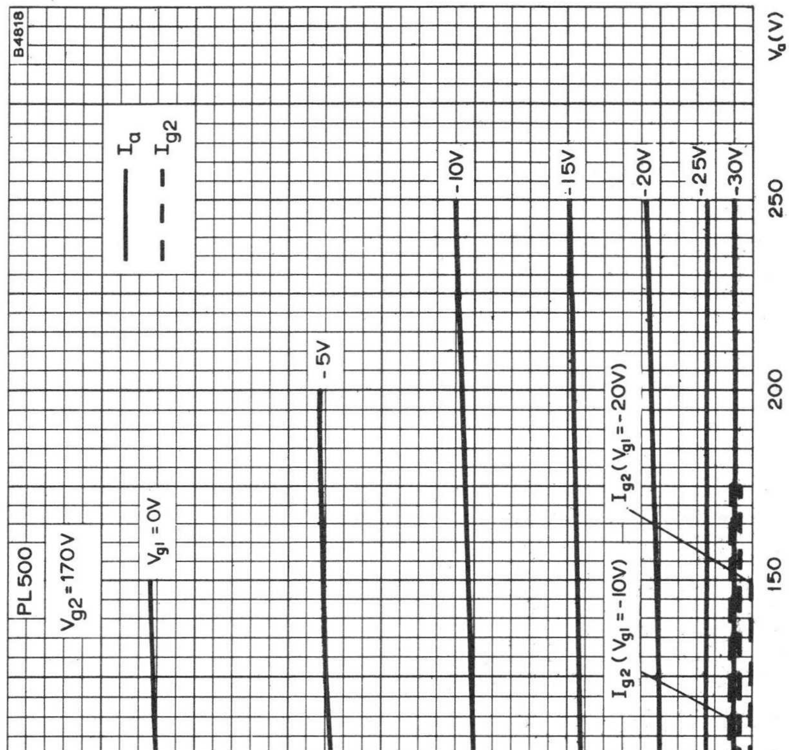
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE
WITH ANODE AND SCREEN-GRID VOLTAGE AS PARAMETER



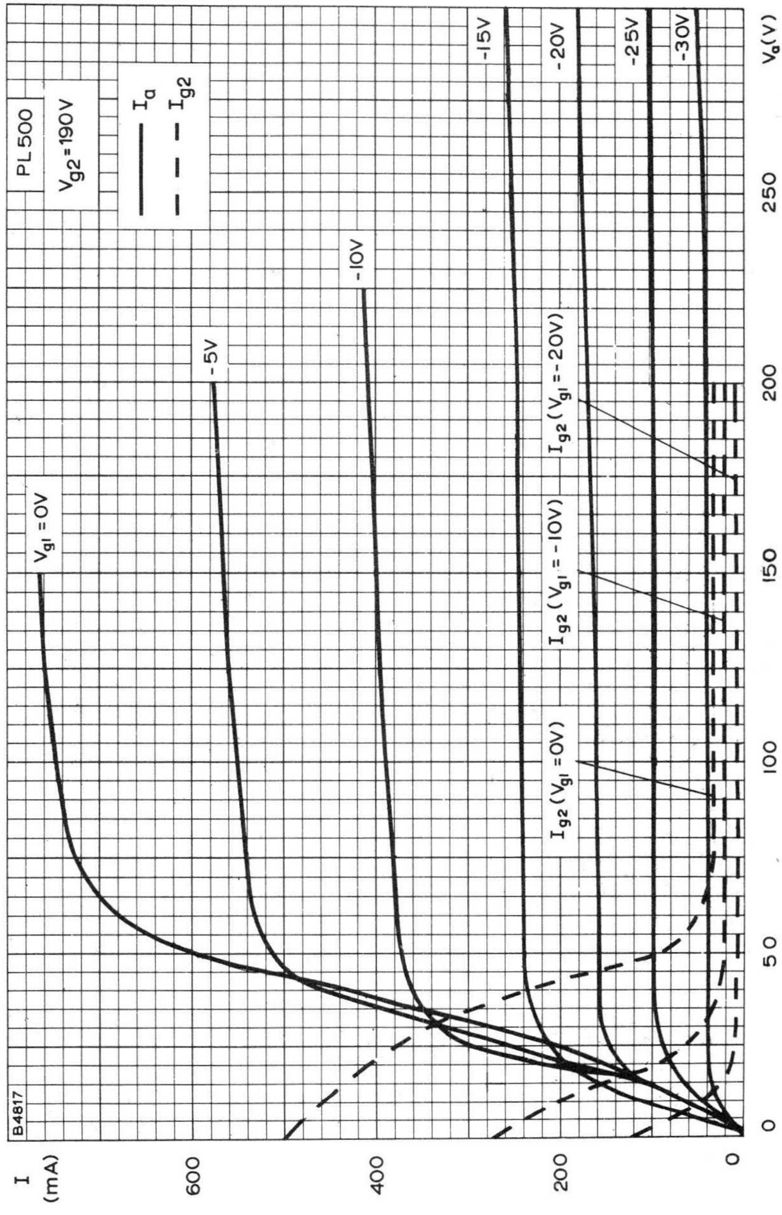
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 130V$



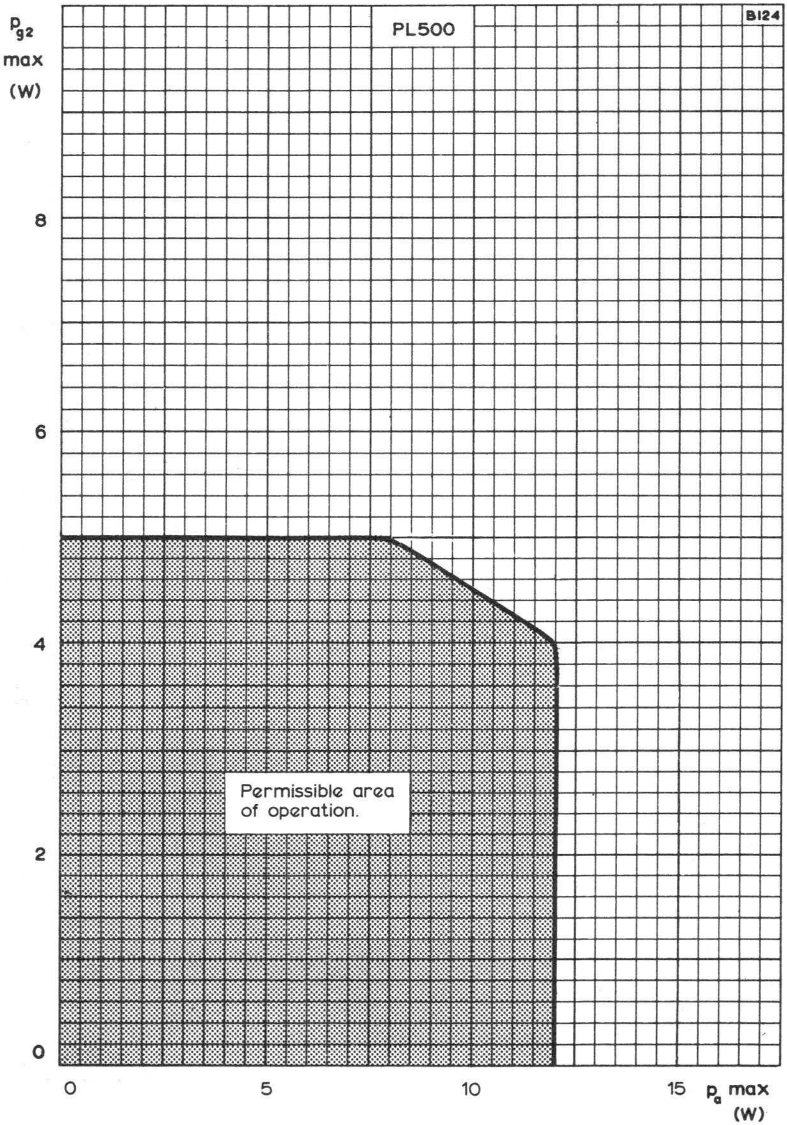
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$



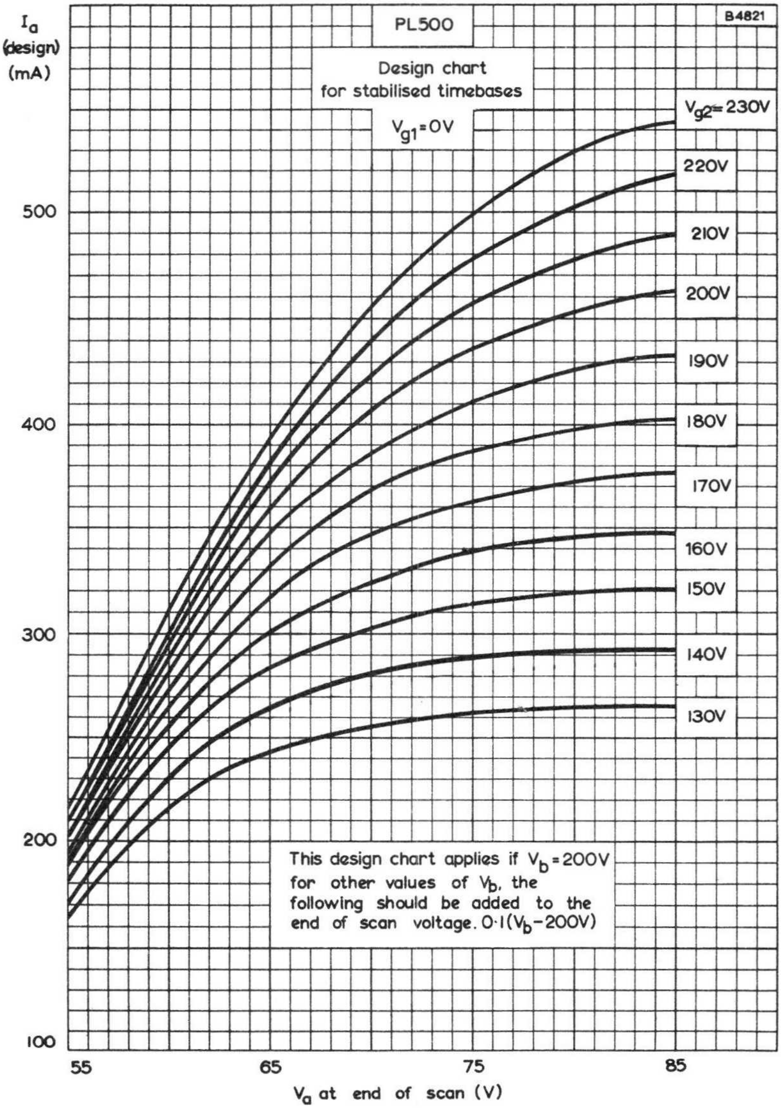
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V



ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 190V$



DESIGN CENTRE RATINGS FOR p_a max. AND p_{g2} max.



DESIGN CHART FOR STABILISED TIMEBASES

LINE OUTPUT PENTODE

PL504

Output pentode primarily intended for use in the line timebase of television receivers.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	27	V

CAPACITANCES

c_{in}	22	pF
c_{out}	9.0	pF
c_{a-g1}	<1.75	pF
c_{g1-h}	< 200	mpF

CHARACTERISTICS

V_a	75	V
V_{g2}	200	V
V_{g1}	-10	V
I_a	440	mA
I_{g2}	30	mA

OPERATION AS LINE OUTPUT VALVE

Circuit design

Operation so that the anode potential of the output valve at the end of the scan is above the knee of the anode characteristic is recommended. An effective feedback stabilising circuit should be employed. A design chart is given on page C7.

Minimum values of R_{g2} required to prevent excessive screen-grid dissipation during the warming-up period;

V_b	170	200	230	V
R_{g2} min.	1.0	1.5	1.8	kΩ

High voltage cut-off

The minimum value of V_{g1} for cut-off during the fly-back period, when $v_{a(pk)}$ = 7.0kV, is -120V.

PEAK ANODE CURRENT DESIGN CHARTS

Stabilised timebases

The design chart shown on page C7 gives directly the values of peak anode current and end-of-scan anode voltage which should be used in designing a stabilised line timebase. The design chart is based on an h.t. line voltage of 200V, and a correction factor is included for other h.t. voltages.

Measurements

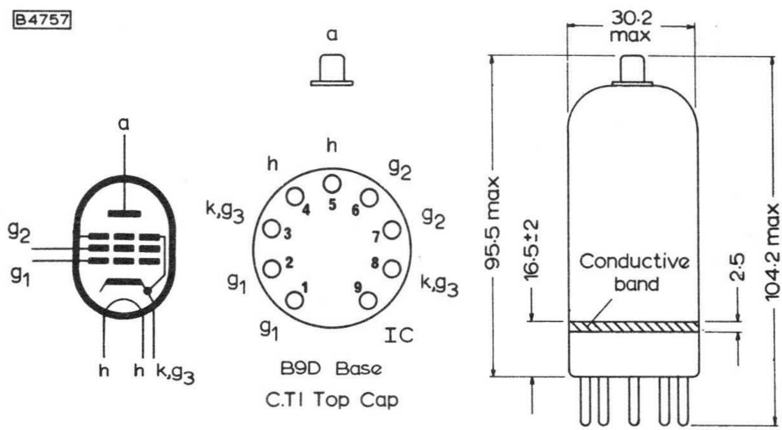
When measurements are made specifically for the purpose of comparison with the design chart, all the components comprising the timebase, including the valves, should be nominal. The h.t. line should also be nominal. In receivers designed for a range of declared values of mains voltage, measurements should be made at the nominal declared value of mains voltage producing the lowest nominal h.t. voltage. The timebase should be synchronised and the raster adjusted to nominal scan. The beam current drawn from the e.h.t. supply should be 300μA.

The use of the design chart does not exempt the designer from checking that the valve is operating within its limiting values.

RATINGS (DESIGN CENTRE SYSTEM)

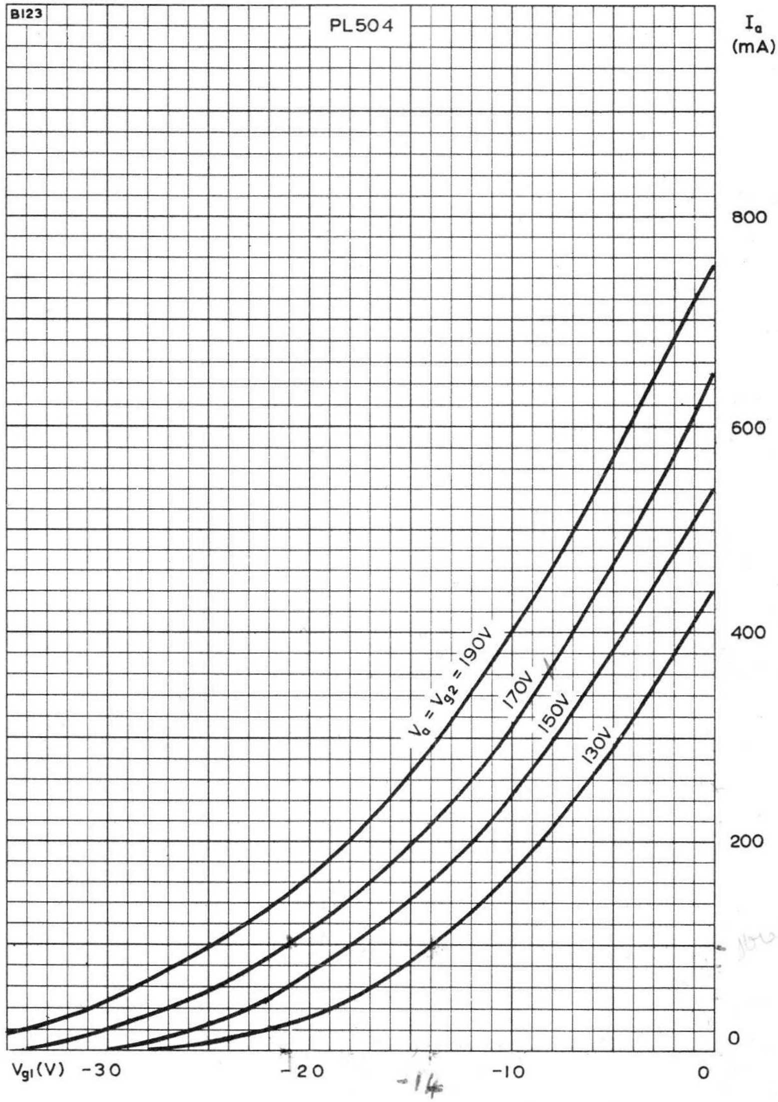
$V_{a(b)}$ max.	550	V
V_a max.	250	V
* $v_{a(pk)}$ max.	7.0	kV
p_a max.	see page C6	
$p_a + p_{g2}$	see page C6	
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	see page C6	
I_k max.	250	mA
R_{g1-k} max.	500	kΩ
R_{g1-k} max. (line timebase applications)	2.2	MΩ

*Maximum pulse duration of 22% of one cycle with a maximum of 22μs.

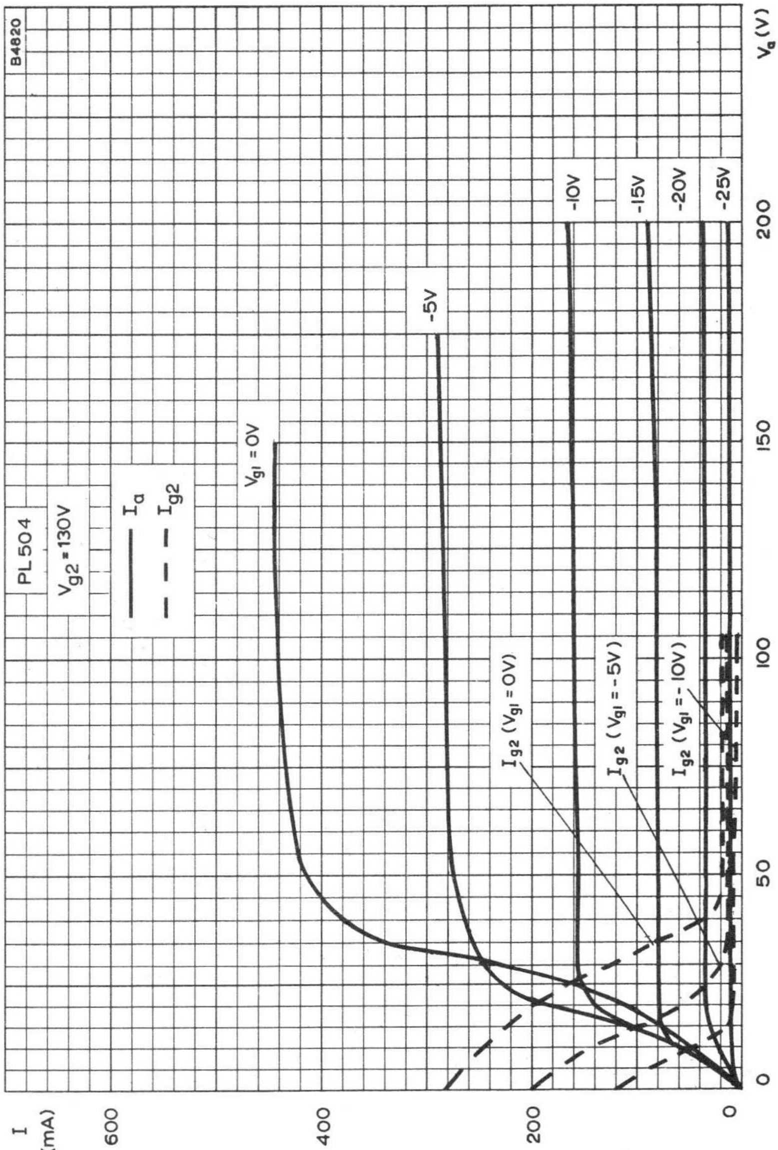


All dimensions in mm

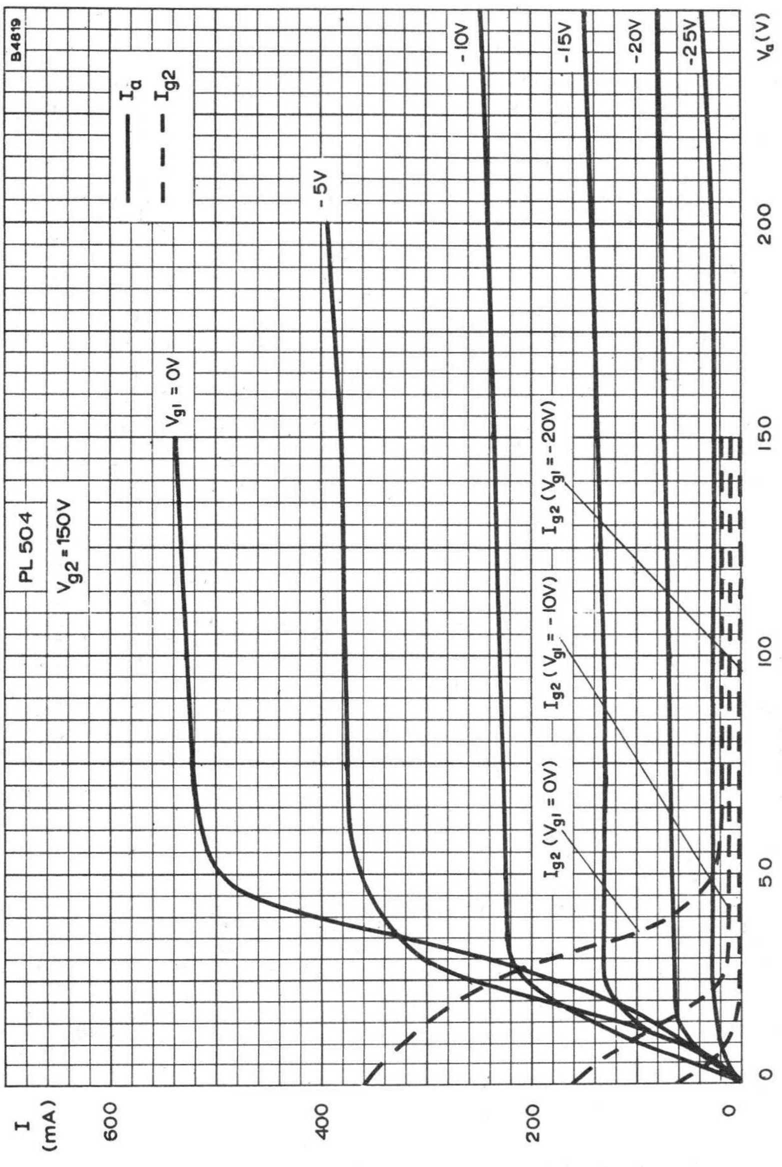
170, 170, 21, 12mA/V.



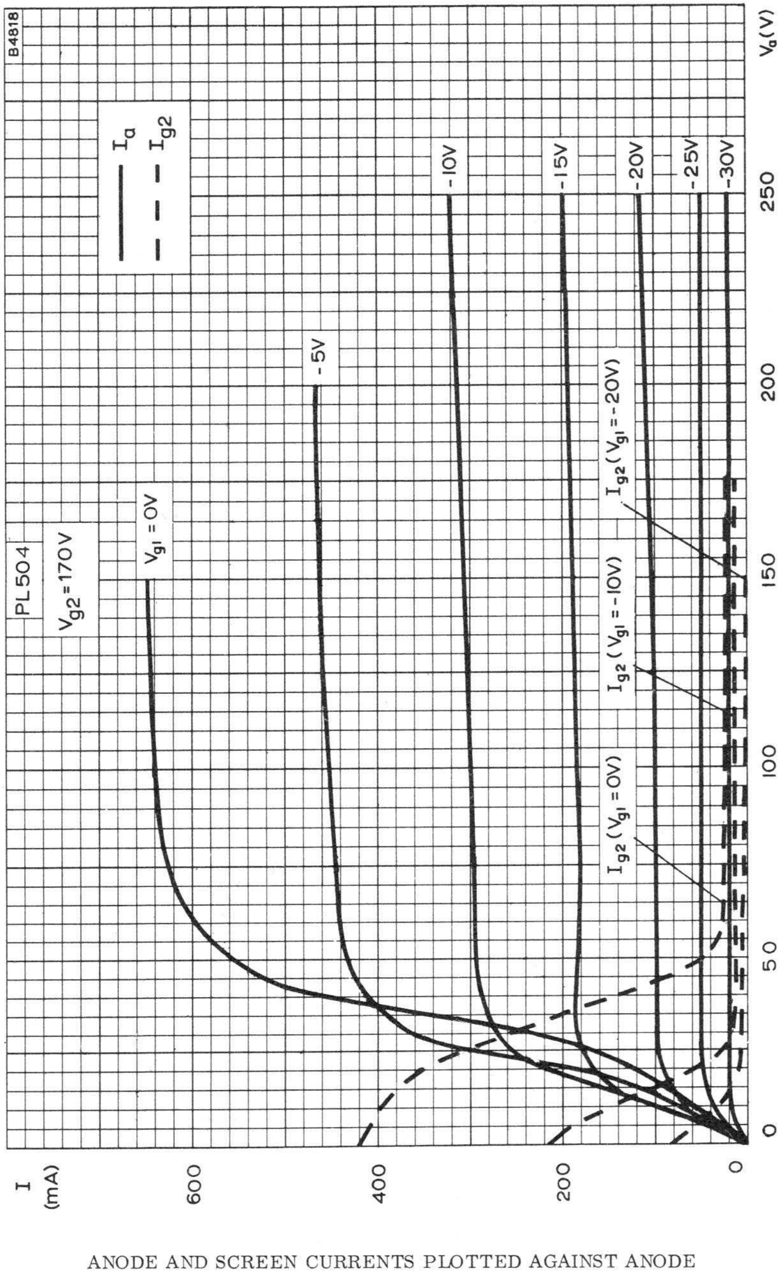
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE
WITH ANODE AND SCREEN-GRID VOLTAGE AS PARAMETER



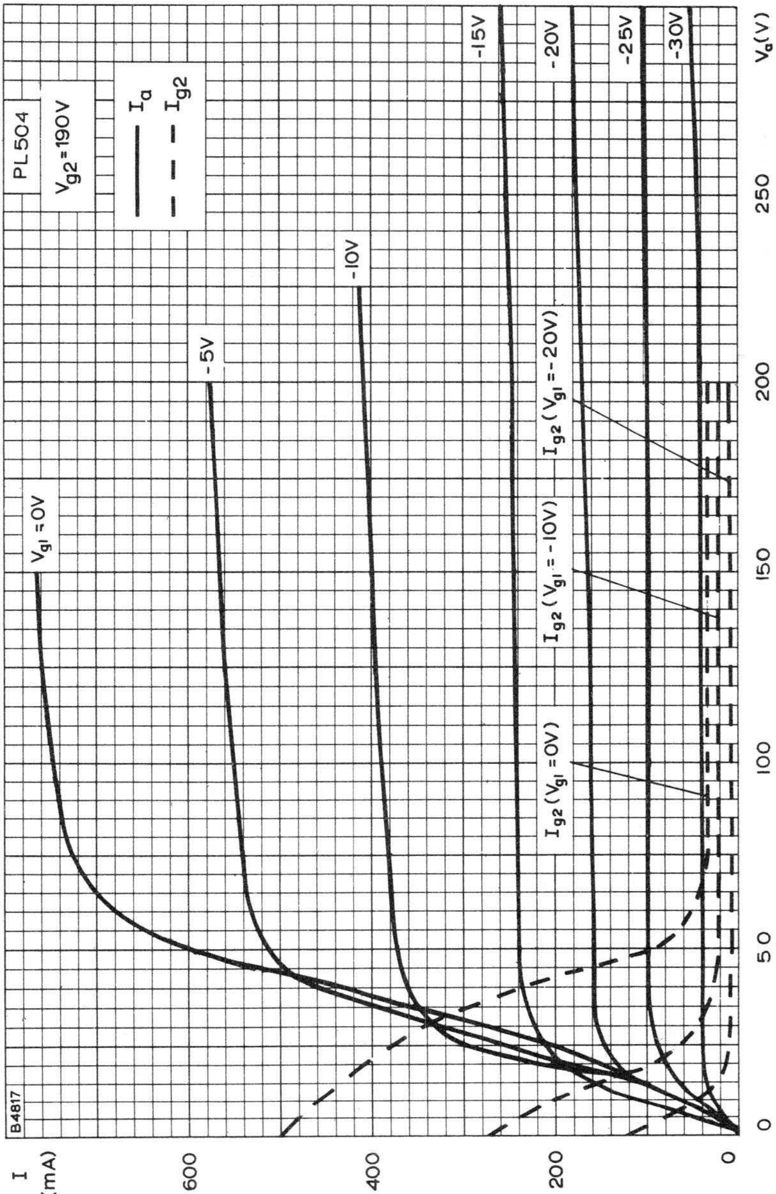
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 130V



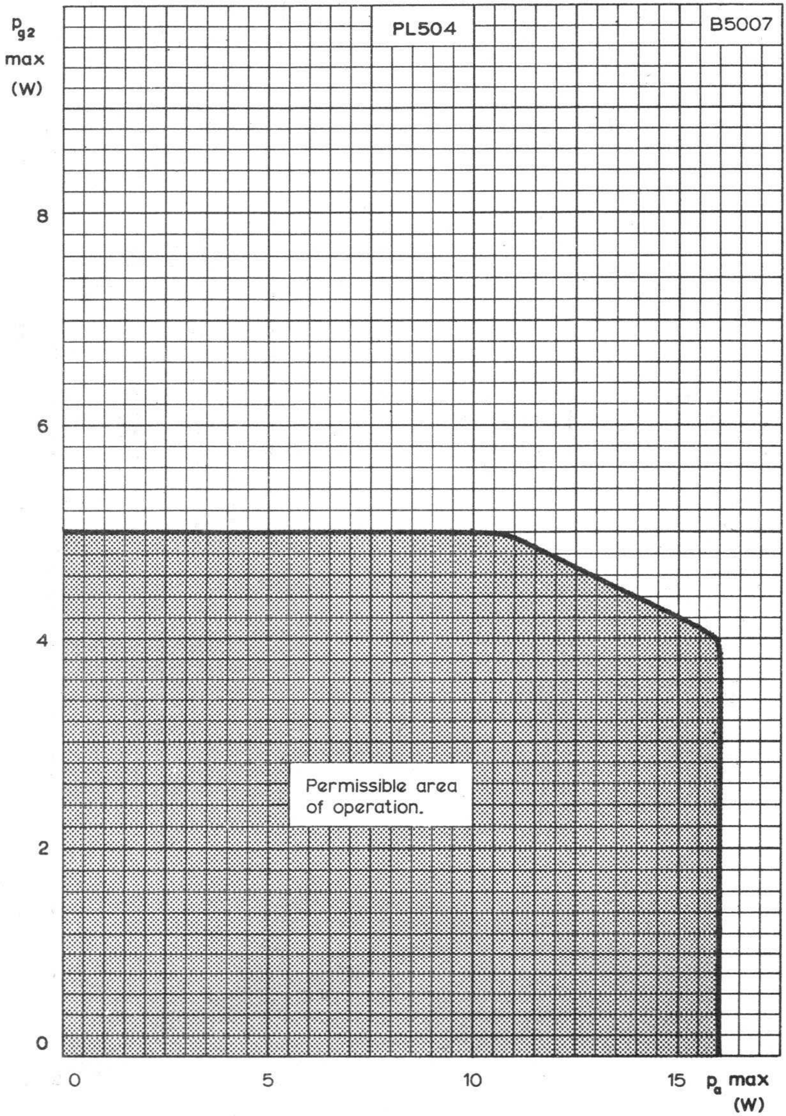
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V



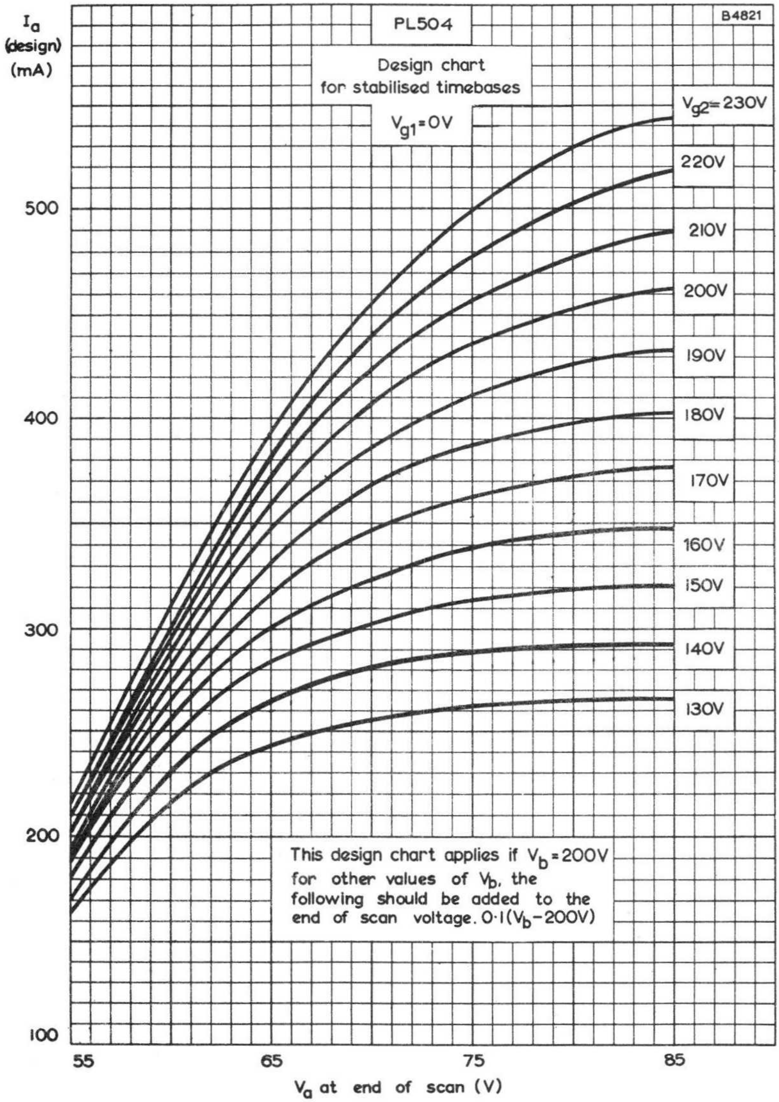
ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V



ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 190V



DESIGN CENTRE RATINGS FOR p_a max. AND p_{g2} max.



DESIGN CHART FOR STABILISED TIMEBASES

OUTPUT PENTODE PL505

TENTATIVE DATA

Output pentode for colour television line deflection circuits

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	40	V

CAPACITANCES

c_{a-g1}	2.5	pF
c_{g1-h} max.	200	mpF

DYNAMIC CHARACTERISTICS

V_a	160	V
V_{g3}	0	V
V_{g2}	160	V
V_{g1}	0	V
I_a	1.4	A
I_{g2}	45	mA

OPERATING CONDITIONS

v_a (end of scan)	60+10%V_b	V
*V_{g3}	0	V
V_{g2}	175	V
$i_{a(pk)}$	1.0	A
I_a	440	mA
I_{g2}	40	mA
$v_{a(pk)}$	7.0	kV

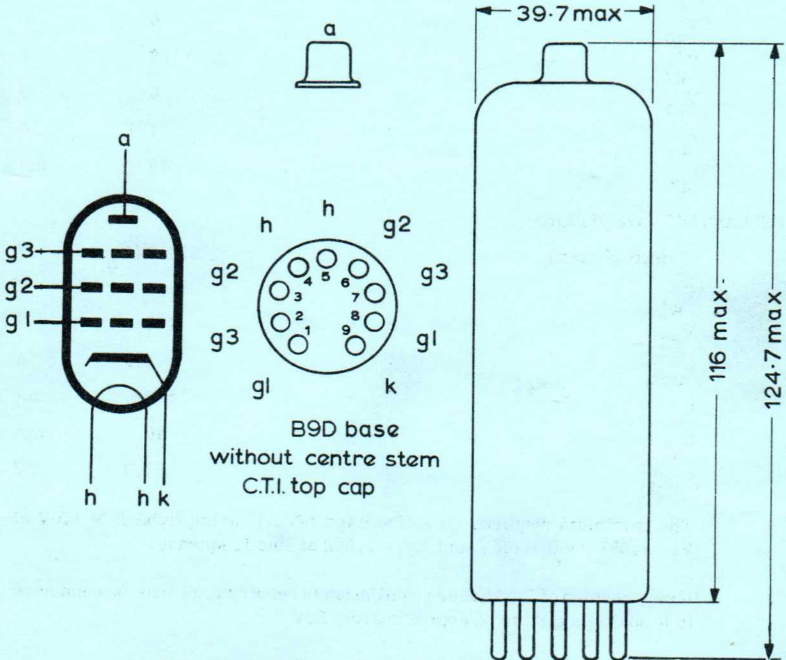
The minimum required cut-off voltage ($-V_{g1}$) during flyback is 170V at $V_a = 7.0$kV, $V_{g2} = 175$V and $Z_{g1} = 1.0$kΩ at line frequency.

*If suppression of Barkhausen oscillation is required, g3 may be connected to a positive voltage of approximately 20V.

RATINGS (DESIGN CENTRE SYSTEM)

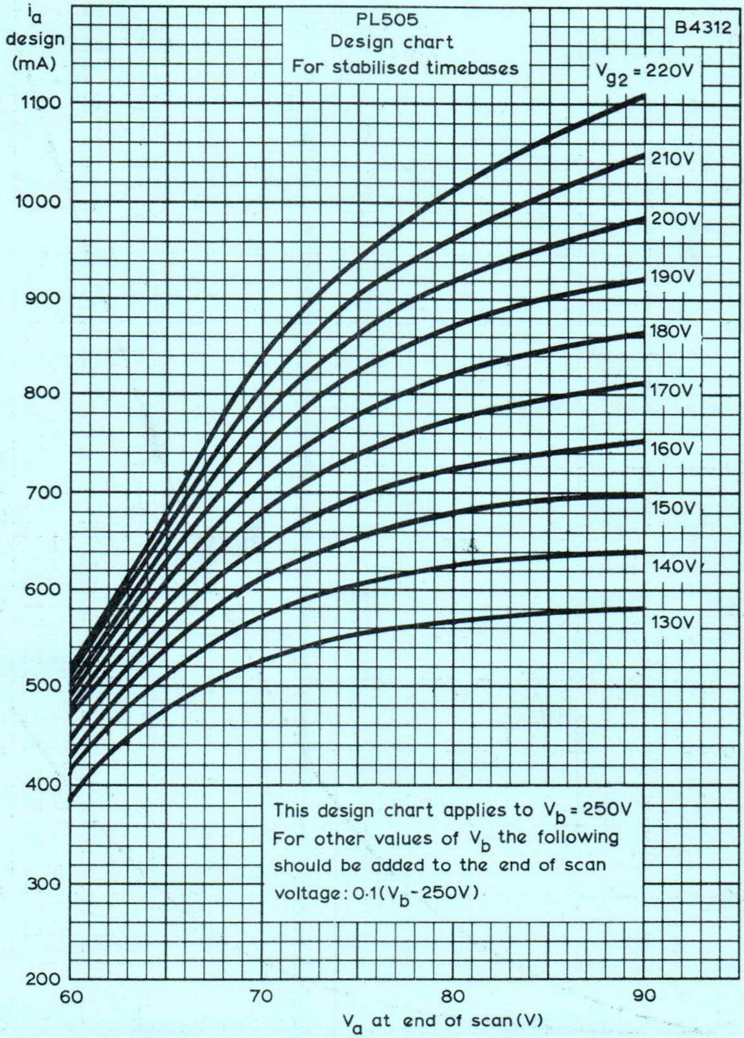
$V_{a(b)}$ max.	700	V
$v_{a(pk)}$ max.	7.0	kV
$V_{g2(b)}$ max.	700	V
V_{g2} max.	250	V
p_a max.	25	W
$*p_{g2}$ max.	7.0	W
I_k max.	500	mA
R_{g1} max. (stabilised line timebases)	2.2	MΩ
V_{h-k} max.	250	V

*During the heating-up time of the cathode, p_{g2} max. = 14W.

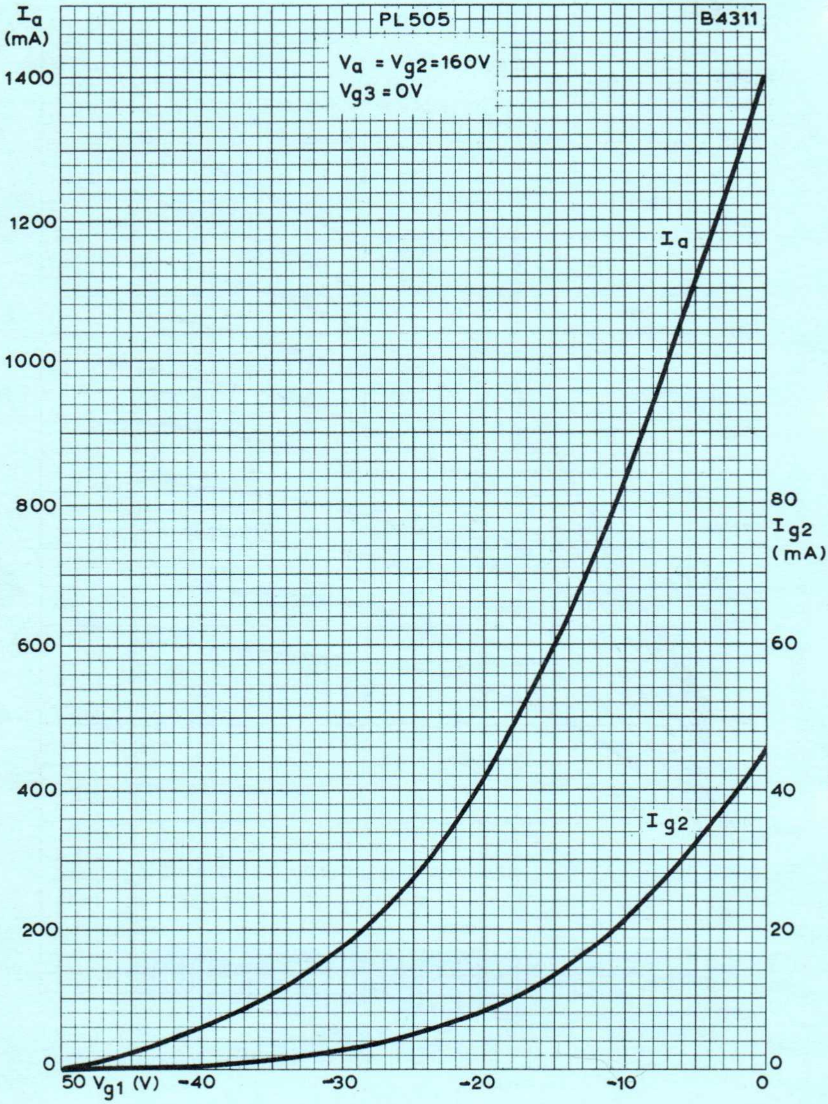


All dimensions in mm

B3533



DESIGN CHART FOR STABILISED TIMEBASES



ANODE AND SCREEN CURRENTS PLOTTED AGAINST
CONTROL-GRID VOLTAGE

Field output pentode for colour television

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	17	V

CAPACITANCES (unshielded)

c_{a-g1}	1.4	pF
c_{g1-h}	<0.2	pF

CHARACTERISTICS ←

V_a	50	190	V
V_{g2}	190	190	V
I_a	320 pk	60	mA
I_{g2}	approx. 60	5.0	mA
V_{g1}	-1.0	-17	V
g_m		9.0	mA/V
μ_{g1-g2}		8.0	
r_a		10	kΩ

OPERATING CONDITIONS

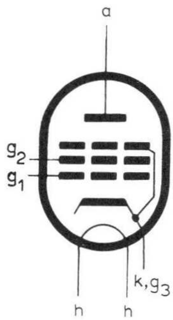
For operating conditions when used as a field output valve in stabilised timebases, see graph on page 5.

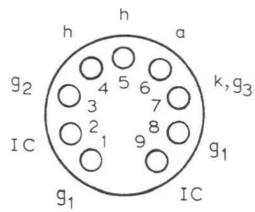
RATINGS (DESIGN CENTRE SYSTEM)

$V_{a(b)}$ max.	700	V
V_a max.	400	V
$^*v_{a(pk)}$ max.	2.5	kV
p_a max.	12	W
$V_{g2(b)}$ max.	700	V
V_{g2} max.	275	V
p_{g2} max.	3.0	W
I_k max.	100	mA
R_{g1-k} max. (fixed bias)	1.0	MΩ
R_{g1-k} max. (automatic bias)	2.2	MΩ
V_{h-k} max.	220	V

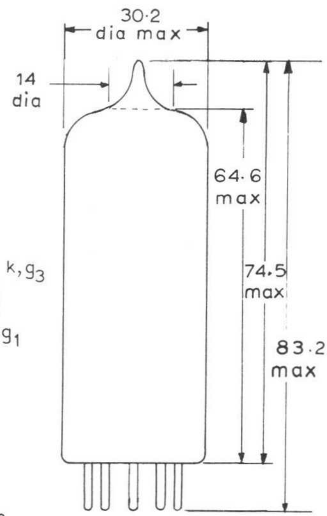
*Maximum pulse duration 5% of one cycle with a maximum of 1ms.

B8877 ←

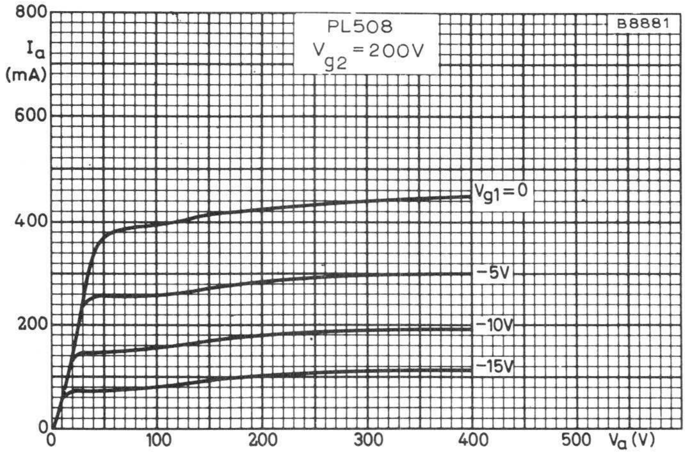


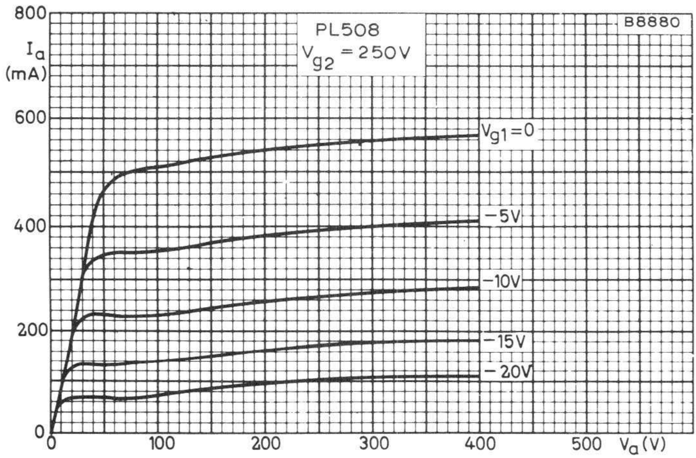


B9D Base
without centre stem

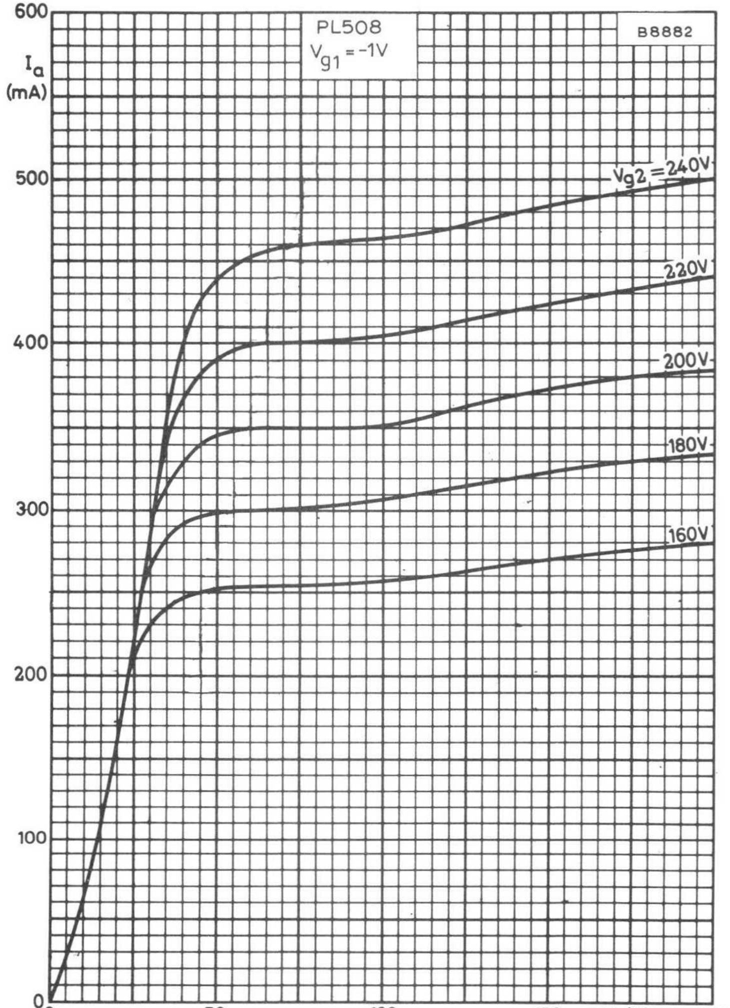


All dimensions in mm

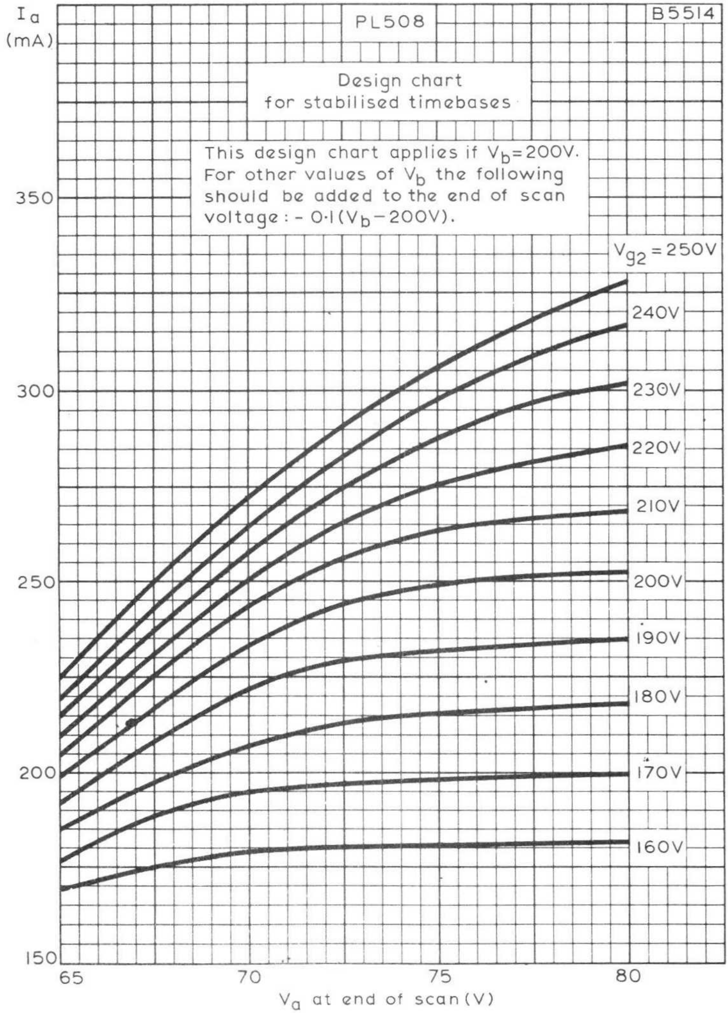




ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH SCREEN GRID VOLTAGE AS PARAMETER



DESIGN CHART FOR STABILISED TIMEBASES

OUTPUT PENTODE PL509

Output pentode for colour television line deflection circuits

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	40	V

CAPACITANCES

c_{a-g1}	2.5	pF
c_{a-g1} max.	3.0	pF ←
c_{g1-h} max.	0.2	pF

DYNAMIC CHARACTERISTICS ←

V_a	160	50	V
V_{g3}	0	0	V
V_{g2}	160	175	V
V_{g1}	0	-10	V
I_a	1.4	0.8	A
I_{g2}	45	70	mA

OPERATING CONDITIONS ←

Stabilised circuits (d.c. feedback)

The minimum required cut-off voltage ($-V_{g1}$) during flyback at V_a=7.0kV and Z_{g1} = 1.0kΩ at line frequency is:-

V_{g2} = 150V: V_{g1} = -175V
V_{g2} = 200V: V_{g1} = -195V
V_{g2} = 250V: V_{g1} = -215V

Design chart for stabilised timebases See page 4

In order to prevent Barkhausen interference and loss of stabilisation, care should be taken to ensure that the anode voltage never drops below the specified minimum value during the scanning period.

When optimum suppression of Barkhausen oscillations is required, g3 may be connected to a positive voltage of approximately 20V.

Hum

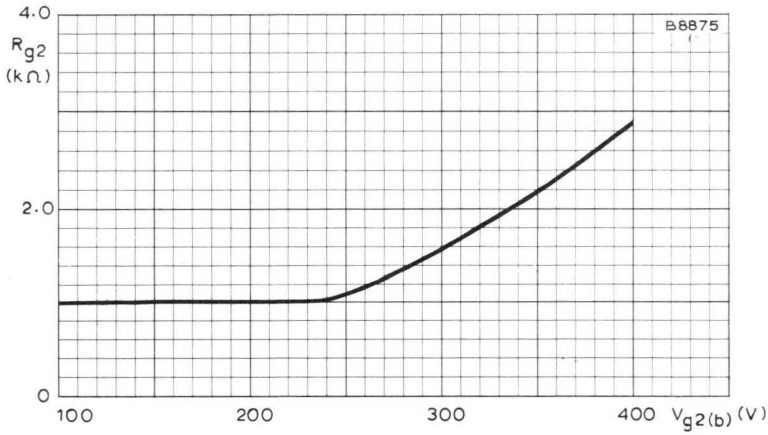
At Z_{g1} = 200kΩ (f = 50Hz), V_{h-k} = 220Vr.m.s. and without wiring and socket capacitances, the equivalent grid hum voltage is less than 5.0mV.

RATINGS (DESIGN CENTRE SYSTEM)

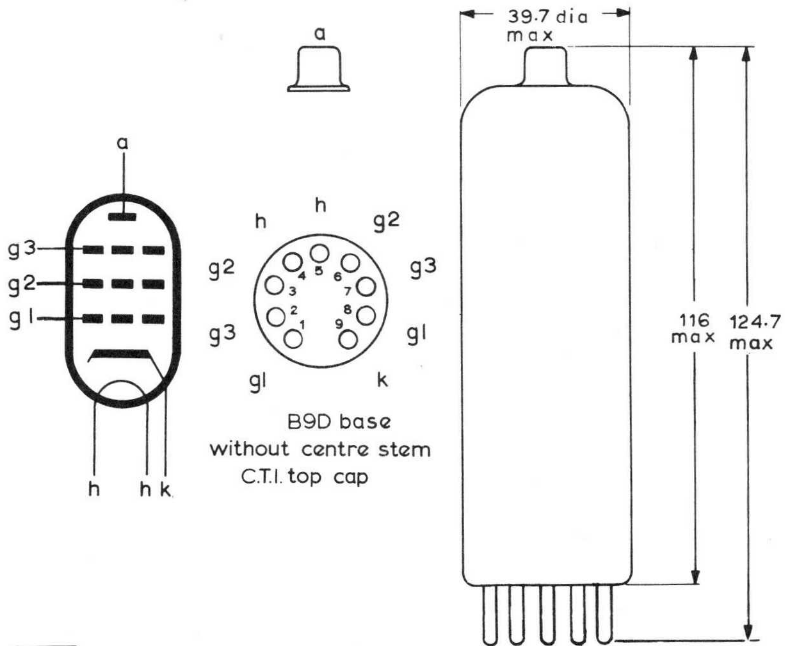
$V_{a(b)}$ max.	700	V
$v_{a(pk)}$ max. (see note 1)	7.0	kV
V_{g3} max.	50	V
$V_{g2(b)}$ max.	700	V
V_{g2} max.	275	V
$-v_{g1(pk)}$ max. (design maximum system) (see note 1)	550	V
p_a max.	30	W
p_{a+g2} max. (triode connected)	31	W
p_{g2} max. (see note 2)	7.0	W
I_k max.	500	mA
R_{g1} max. (fixed bias) (see note 3)	0.5	MΩ
R_{g1} max. (stabilised line timebases) (see note 3)	2.2	MΩ
R_{g3} max. (see note 4)	10	kΩ
V_{h-k} max.	250	V
T_{bulb} max. (absolute maximum rating)	300	°C

NOTES

1. Maximum pulse duration 22% of one cycle with a maximum of 18μs.
2. To prevent an excessive value of p_{g2} the minimum values of series resistance are given below.

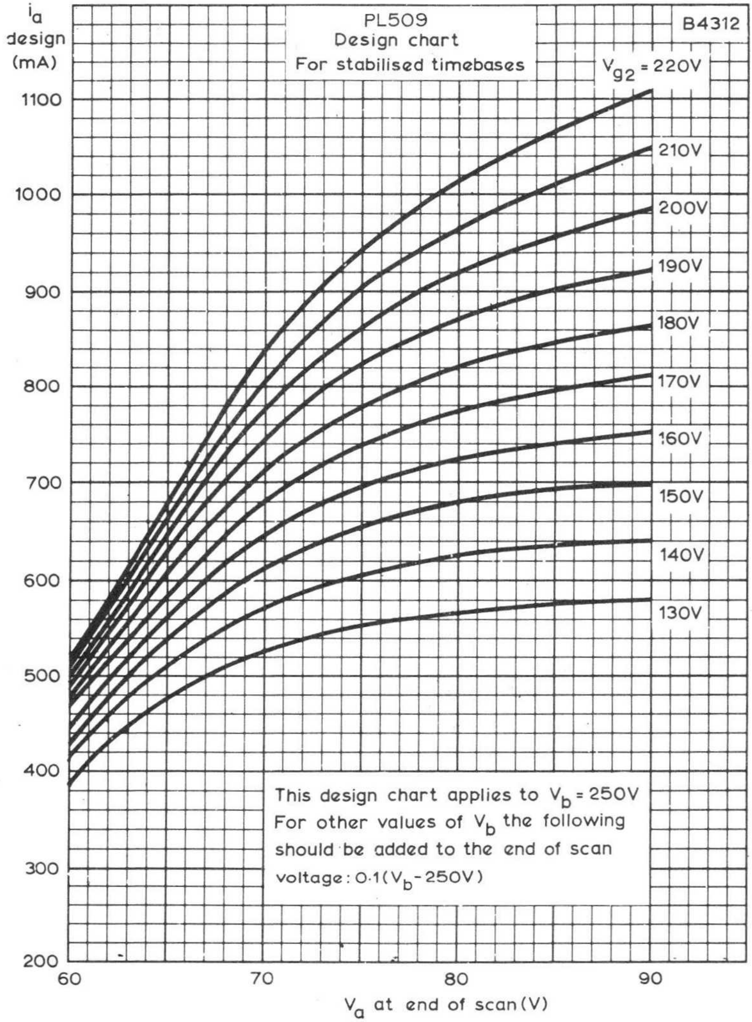


3. The circuit design must be such that negative control grid currents up to 5μA do not have any detrimental effect upon performance. Care should be taken that with 5μA grid current the limiting values for I_k, p_a and p_{g2} are not exceeded.
4. With $R_{g3} \leq 10k\Omega$ capacitive decoupling of g3 is not required.

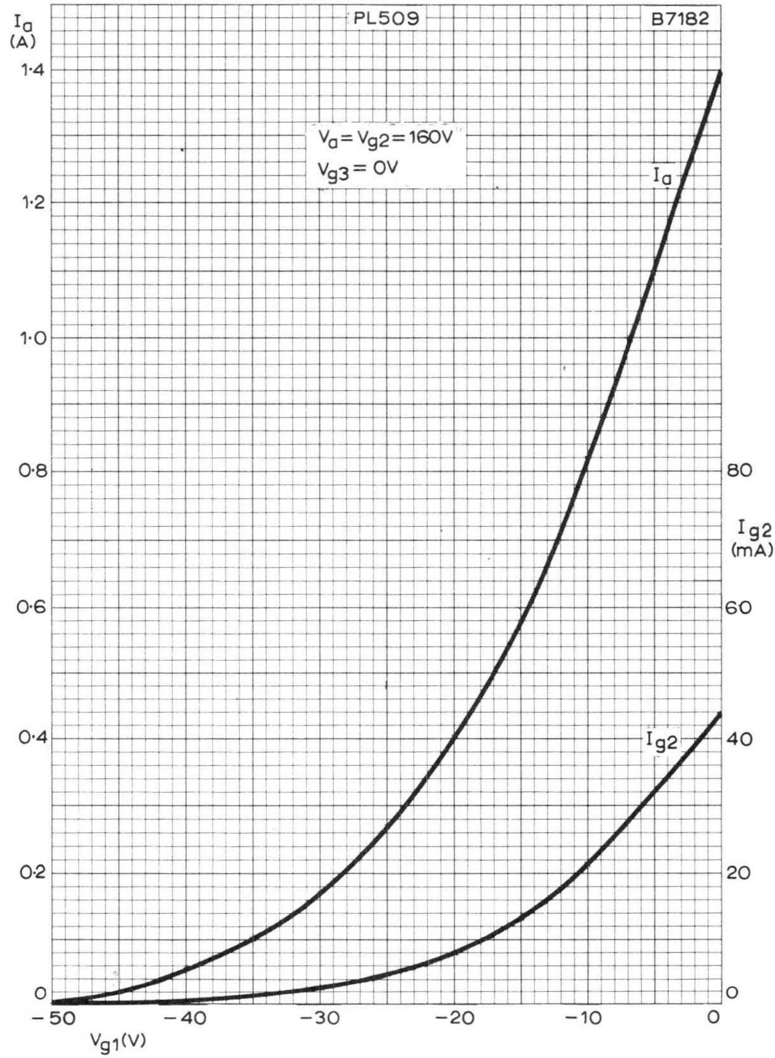


B3533

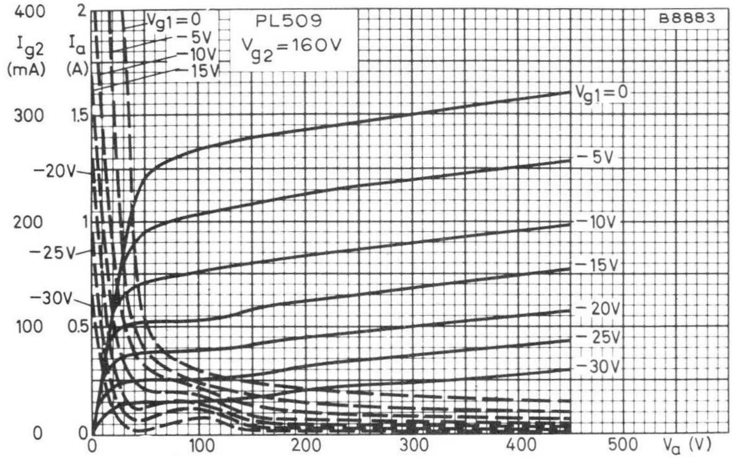
All dimensions in mm



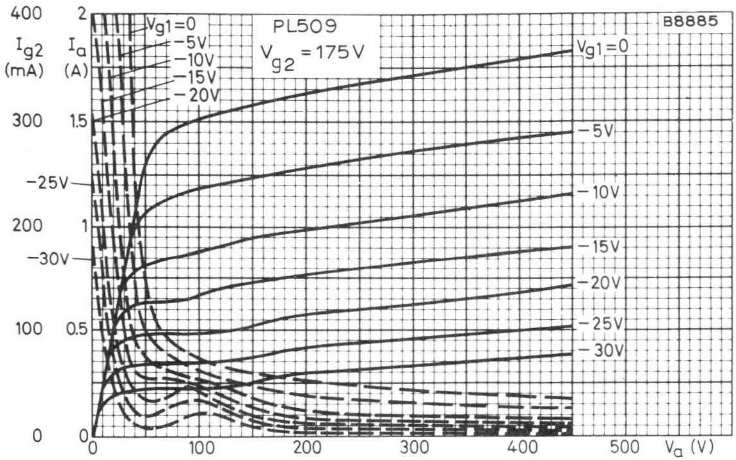
DESIGN CHART FOR STABILISED TIMEBASES



ANODE AND SCREEN CURRENTS PLOTTED AGAINST CONTROL GRID VOLTAGE

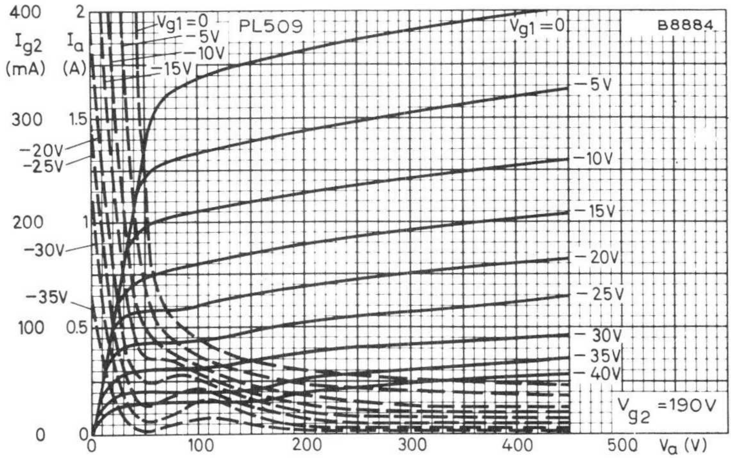


ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE: $V_{g2} = 160V$



ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE: $V_{g2} = 175V$

←



ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE: V_{g2} = 190V

VIDEO OUTPUT PENTODE PL802

Video output pentode for colour television receivers

HEATER

Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	16	v

CAPACITANCES

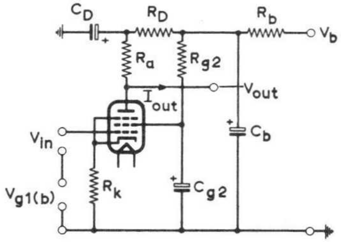
c_{in}	20	pF
c_{out}	4.0	pF
c_{a-g1}	0.075	pF
c_{a-g1} max.	0.1	pF ←

CHARACTERISTICS

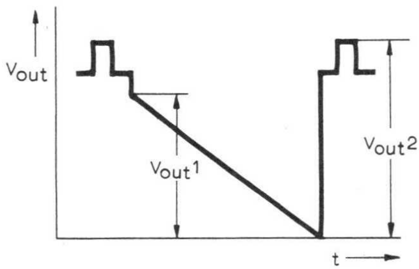
V_a	170	V
V_{g3}	0	V
V_{g2}	170	V
V_{g1}	-1.3	V ←
I_a	30	mA
I_{g2}	6.5	mA
g_m	40	mA/V
μ_{g1-g2}	70	

OPERATING CONDITIONS (negative modulation)

V_b	250V
R_b	330Ω
R_D	560Ω
C_D	16μF
R_a	2.7kΩ
R_{g2}	5.6kΩ
C_{g2}	2.0μF
R_k	39Ω
(no bypass capacitor)	
$V_{g1(b)}$	+4.0V



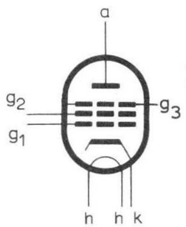
$V_{out(1)}$	100V
$V_{out(2)}$ p-p	≥140V
Video linearity	≥0.8
V_{in} p-p	approx. 5.0V
I_{out} max.	7.0mA

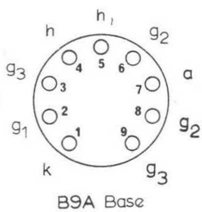


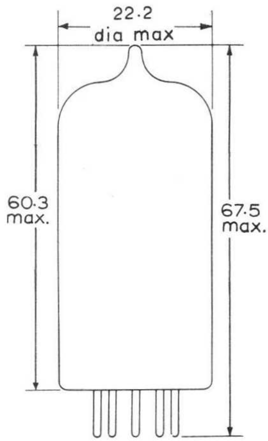
VIDEO OUTPUT PENTODE PL802

RATINGS (DESIGN CENTRE SYSTEM)

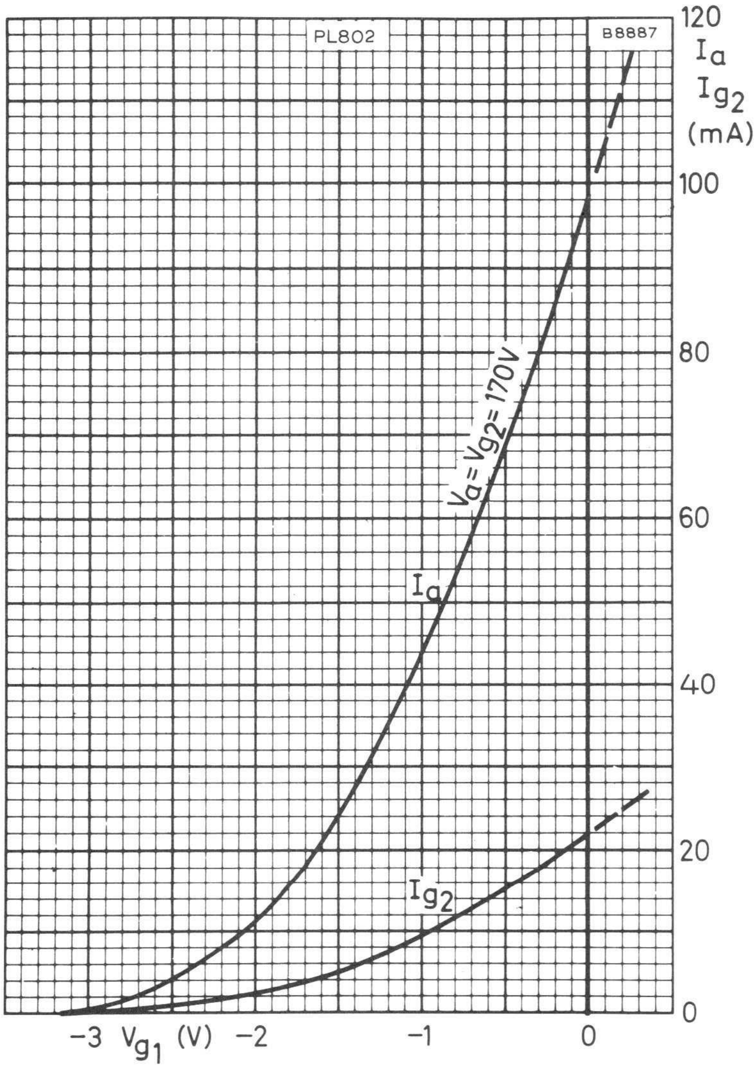
$V_{a(b)}$ max. (supply)	400	V
V_a max. (long term average)	300	V
V_a max. ($I_k = 0$)	550	V
p_a max.	6.0	W
V_{g2} max.	300	V
V_{g2} max. ($I_k = 0$)	550	V
p_{g2} max.	2.5	W
p_{g2} max. (intermittent rating, short duration)	3.0	W
I_k max.	100	mA
R_{g1-k} max.	100	kΩ
R_{g1-k} max. ($R_k \geq 39\Omega$)	500	kΩ
V_{h-k} max.	200	V



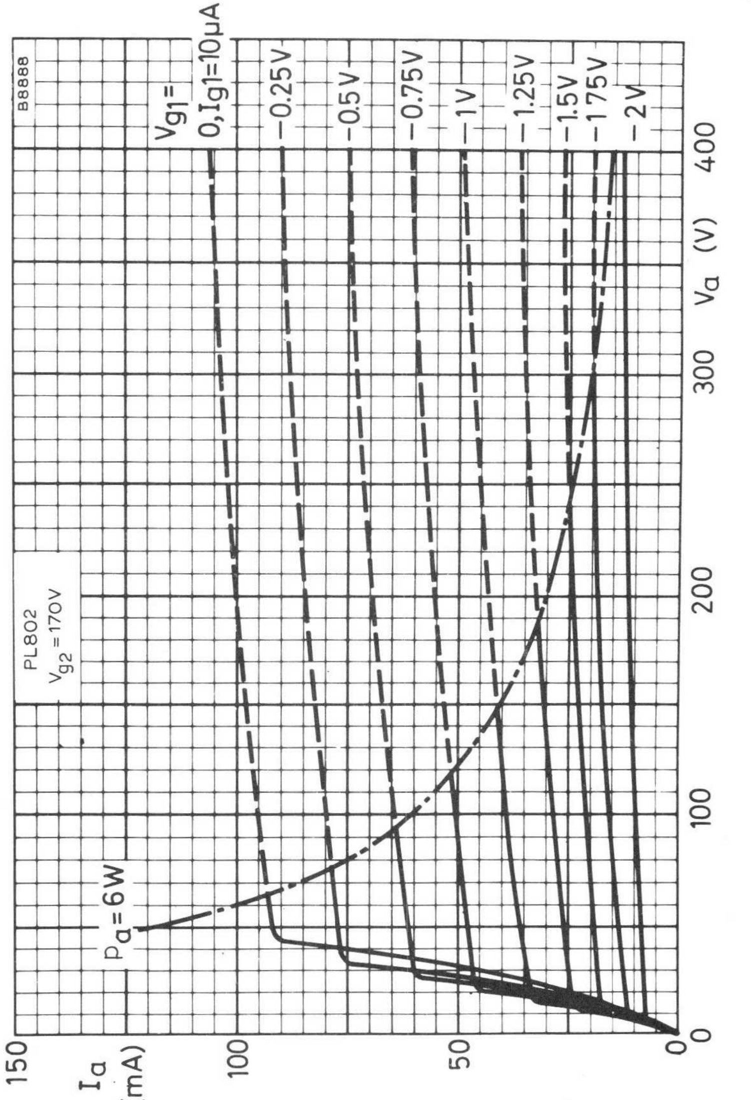




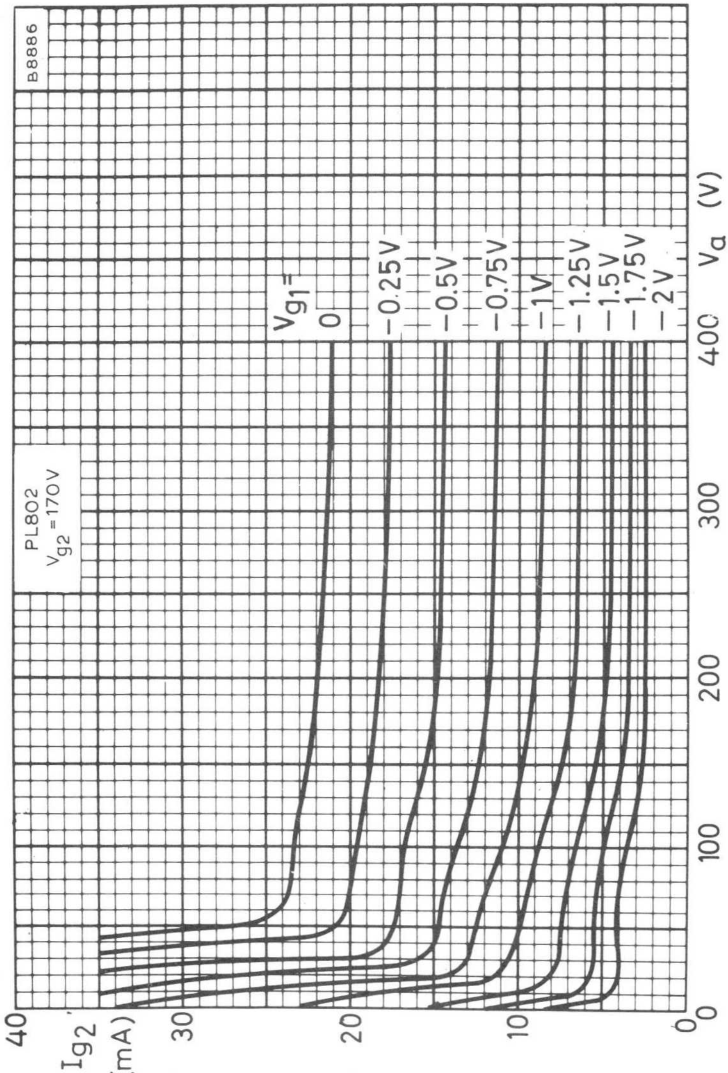
All dimensions in mm



ANODE AND SCREEN GRID CURRENTS PLOTTED AGAINST CONTROL GRID VOLTAGE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID VOLTAGE AS PARAMETER



SCREEN GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL GRID VOLTAGE AS PARAMETER

BOOSTER DIODE

PY81

Booster diode with a maximum peak inverse voltage of 4.75kV intended for use in television receivers with series connected heaters.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	17	V

CAPACITANCES

c_{a-k}	6.4	pF
c_{h-k}	2.8	pF←

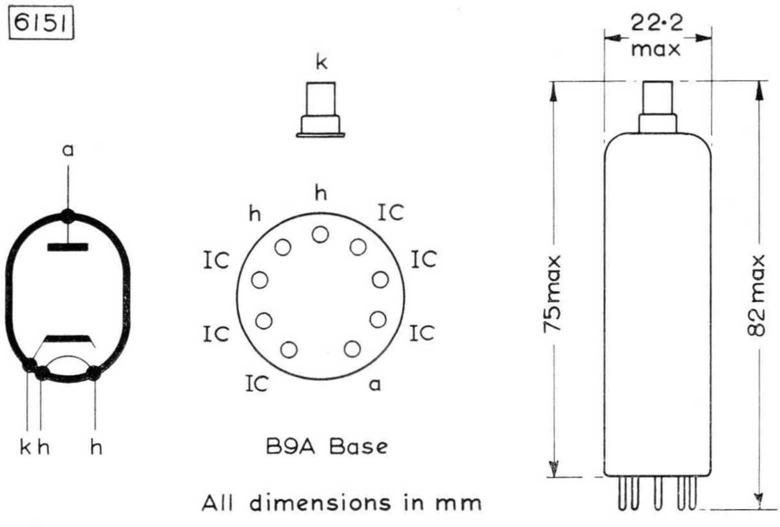
LIMITING VALUES

*P.I.V. max.	4.75	kV←
*$i_{a(pk)}$ max.	450	mA
$I_{a(av)}$ max.	150	mA
C max.	4.0	μF
$V_{h-e(r.m.s.)}$ max.	220	V
*$v_{h-k(pk)}$ max. (cathode positive)	4.75	kV←
*$v_{a-h(pk)}$ max. (anode negative)	3.0	kV

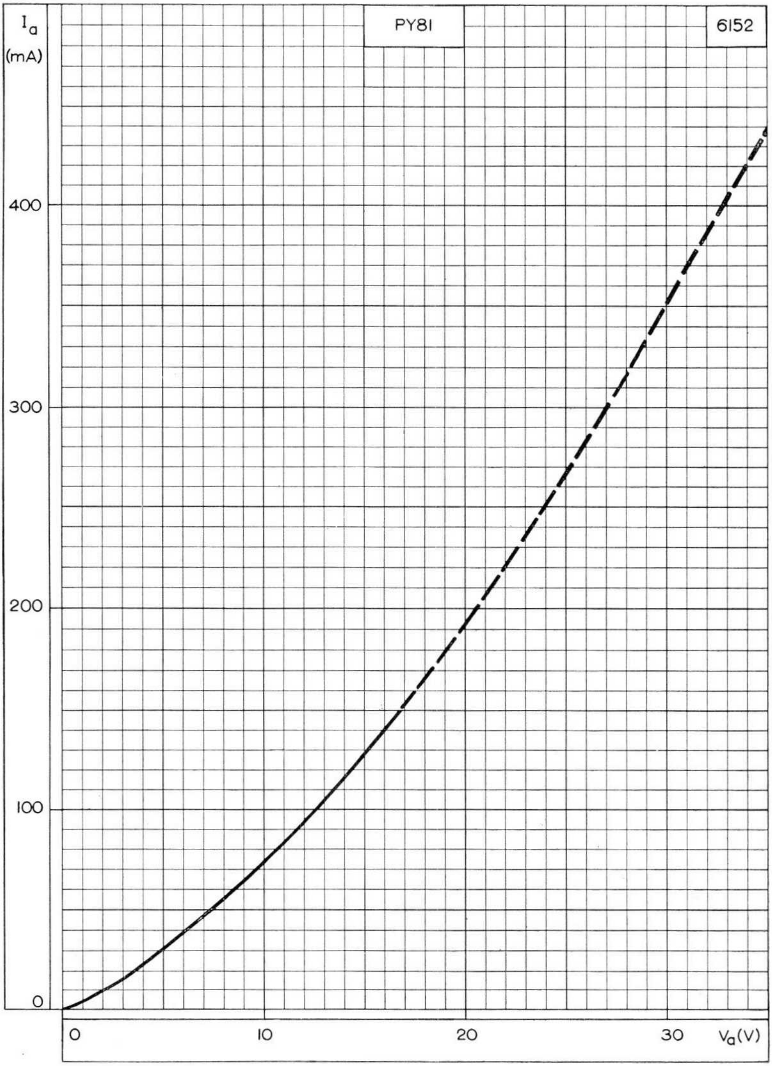
*Maximum pulse duration 22% of one cycle with a maximum of 18μs.

PY81

BOOSTER DIODE



All dimensions in mm



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

BOOSTER DIODE

PY88

Booster diode with a maximum peak inverse voltage of 6.6kV intended for use in transformerless television receivers with 110° deflection angle cathode ray tubes.

HEATER

Suitable for series operation a.c. or d.c.

I_h	300	mA
V_h	30	V

CAPACITANCES

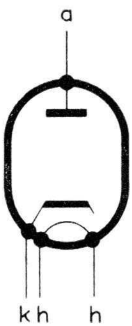
c_{a-k}	8.6	pF
c_{h-k}	2.0	pF

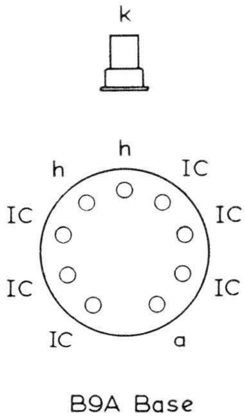
LIMITING VALUES

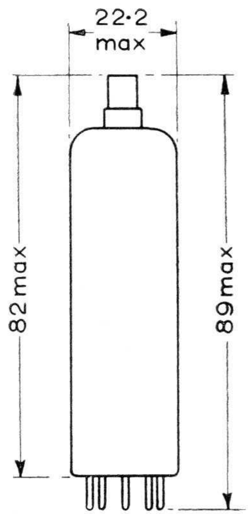
*P.I.V. max.	6.6	kV
*$i_{a(pk)}$ max.	550	mA
$I_{a(av)}$ max.	220	mA
$V_{h-e(r.m.s.)}$ max.	220	V
*$v_{h-k(pk)}$ max. (cathode positive)	6.6	kV

*Maximum pulse duration 22% of a cycle with a maximum of 18μs.

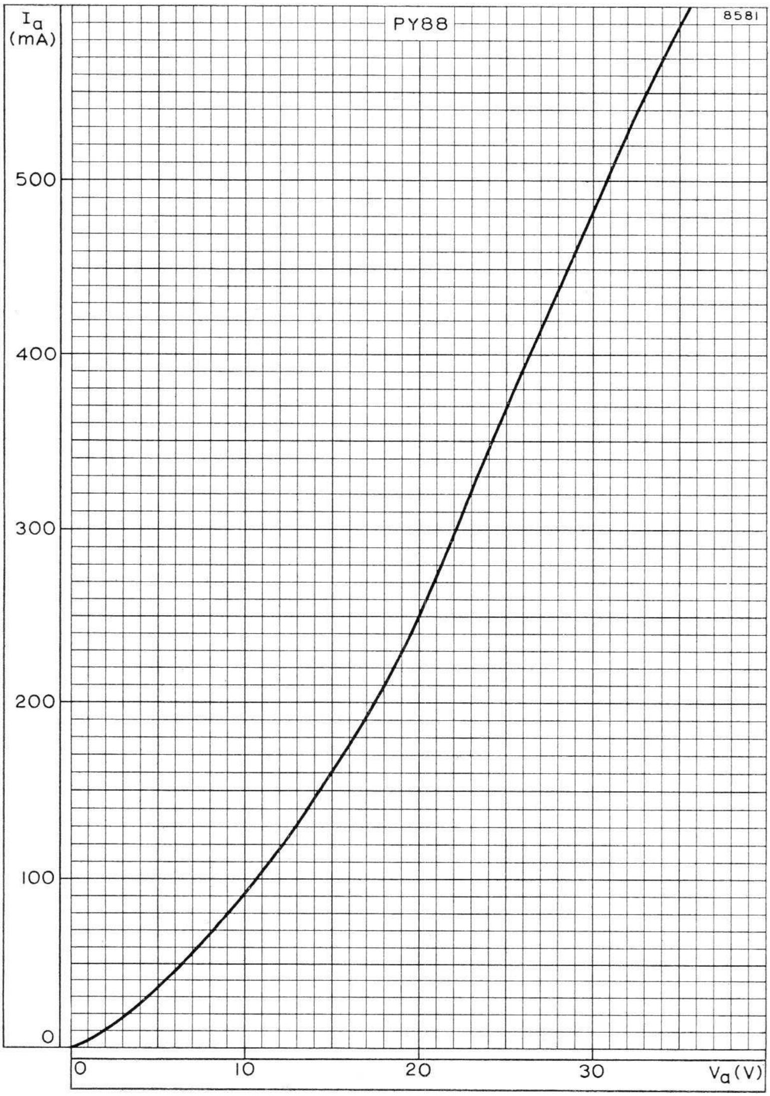
4947







All dimensions in mm



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

BOOSTER DIODE PY500

TENTATIVE DATA

Booster diode for colour television timebase circuits

HEATER : Suitable for series a.c. or d.c. operation

I_h	300	mA
V_h	42	V

During operation the minimum resistance between any heater pin and any mains terminal for the heater chain should be 100Ω. The hot heater resistances of the other valves in the chain can serve for this resistance.

CAPACITANCES

c_{a-k}	13.5	pF
c_{h-k}	3.7	pF

CHARACTERISTICS

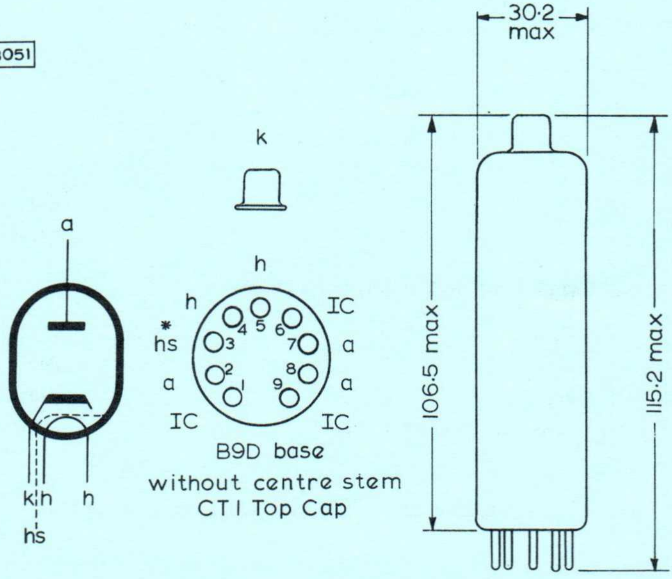
I_a	440	mA
r_i	42	Ω

LIMITING VALUES (DESIGN CENTRE RATINGS)

*P.I.V. max.	5.6	kV
i_a (pk) max.	800	mA
I_a max.	440	mA
*v_{h-k} (pk) max. (cathode positive)	6.3	kV
p_a max.	11	W

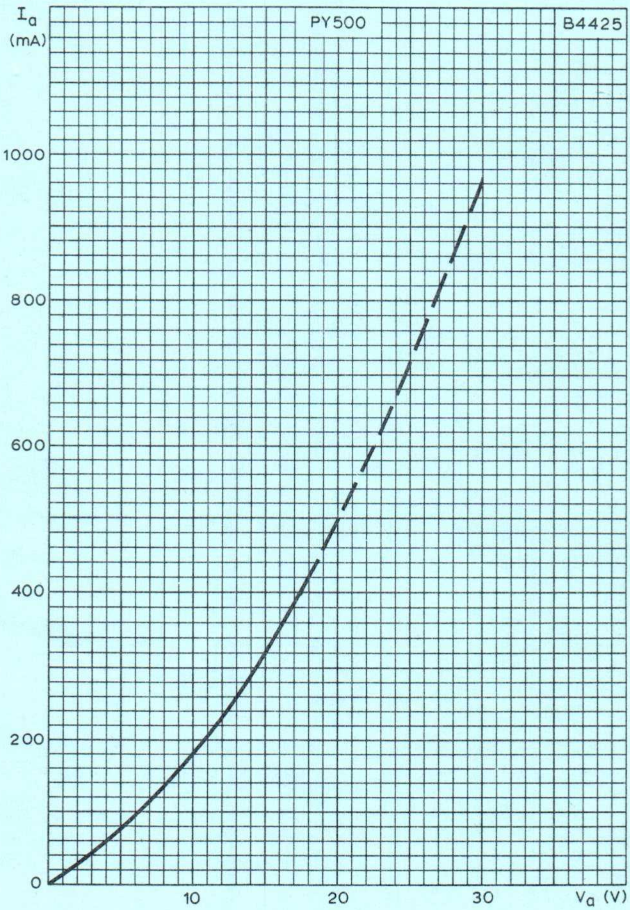
*Maximum pulse duration 22% of one cycle with a maximum of 18μs.

B3051



All dimensions in millimetres

*Insertion of a 1.0W non-inductive 330Ω carbon resistor between pins 3 and 4 is recommended to improve the high-tension properties of the tube. If no resistor is used, pins 3 and 4 should be interconnected.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

BOOSTER DIODE PY500A

Booster diode for colour television timebase circuits. In existing equipment the PY500A is a direct replacement for the PY500. In new equipment designs the 300Ω protection resistance from pin 3 to pin 4 or 5 is not required with the PY500A.

HEATER: Suitable for series operation, a.c. or d.c.

I_h	300	mA
V_h	42	V

During operation the minimum resistance between any heater pin and any mains terminal for the heater chain should be 100Ω. The hot heater resistances of the other valves in the chain can serve for this resistance.

CAPACITANCES

c_{a-k}	13	pF
c_{h-k}	3.7	pF

CHARACTERISTICS

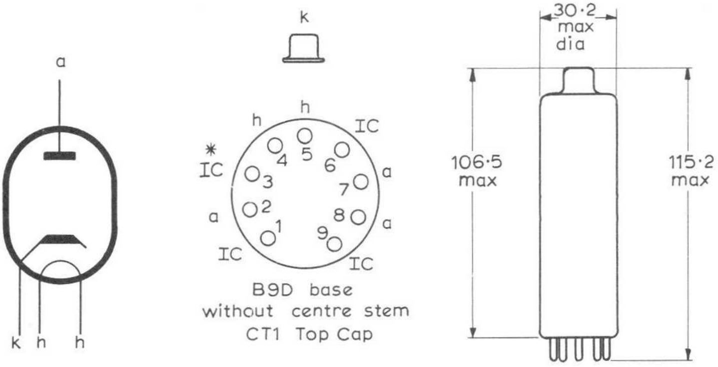
I_a	440	mA
r_i	45.5	Ω

RATINGS (DESIGN CENTRE SYSTEM)

*P.I.V. max.	5.6	kV
*P.I.V. max. (absolute rating)	7.0	kV
$i_{a(pk)}$ max.	800	mA
I_a max.	440	mA
*$v_{h-k(pk)}$ max. (cathode positive)	6.3	kV
p_a max.	11	W

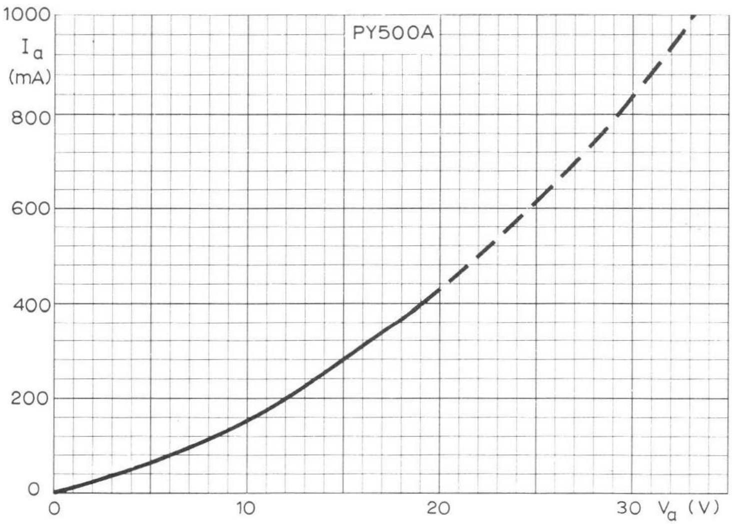
*Maximum pulse duration 22% of one cycle with a maximum of 18μs.

OUTLINE DRAWING



All dimensions in mm

*In existing equipment using the PY500 a resistor may be wired from pin 3 to pin 4 or 5, or pins 3 and 4 may be interconnected. When replacing the PY500 with the PY500A the resistor or interconnection need not be removed. In new equipment designs using the PY500A pin 3 should be left unconnected.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

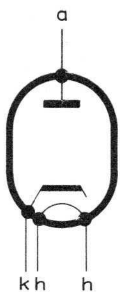
BOOSTER DIODE **PY800**

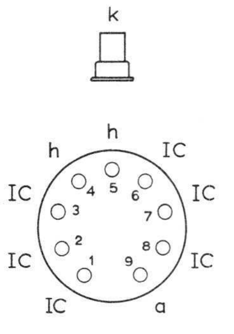
Booster diode for use in television receivers employing 110° deflection angle cathode ray tubes.

HEATER			
	I_h	300	mA
	V_h	19	V
CAPACITANCES			
	c_{a-k}	6.0	pF ←
	c_{h-k}	2.2	pF ←
LIMITING VALUES			
	*P.I.V. max.	5.75	kV ←
	i_a (pk) max.	450	mA ←
	I_a (av) max.	175	mA ←
	*v_{h-k} (pk) max. (cathode positive)	6.0	kV ←

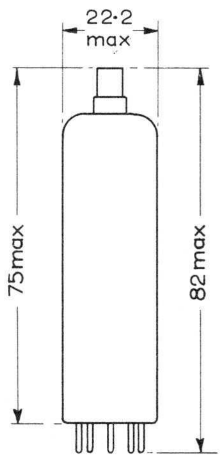
*Maximum pulse duration 22% of one cycle with a maximum of 18μs. ←

6151

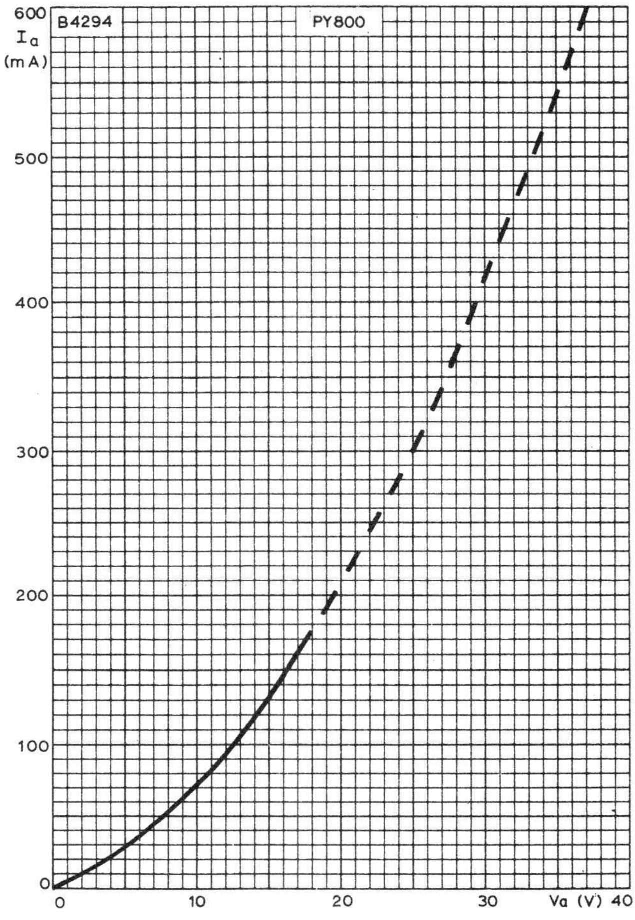




B9A Base



All dimensions in mm



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

TRIPLE DIODE TRIODE

UABC80

Triple diode triode with 100mA heater and one diode having a separate cathode. Primarily intended for use in f.m./a.m. receivers.

HEATER Suitable for series operation a.c. or d.c.

I_h	100	mA
V_h	28	V

CAPACITANCES

$c_{g-a'd}$	<70	mpF
$c_{at-a'd}$	<120	mpF
$c_{at-a'''d}$	<100	mpF
$c_{at-k''d}$	<10	mpF
$c_{g-a'''d}$	<20	mpF
$c_{g-k''d}$	<5.0	mpF

Triode section

c_{in}	1.9	pF
c_{out}	1.4	pF
c_{a-g}	2.0	pF
c_{g-h}	<40	mpF

Diode sections

$c_{a'd-(h+kt,k'd,k'''d,s)}$	800	mpF
$c_{a''d-(h+k''d+kt,k'd,k'''d,s)}$	4.8	pF
$c_{a'''d-(h+kt,k'd,k'''d,s)}$	4.8	pF
$c_{k''d-all}$	5.0	pF
$c_{a'd-h}$	<250	mpF
$c_{a'''d-h}$	<200	mpF
$c_{k''d-h}$	2.5	pF

CHARACTERISTICS

Triode section

V_a	170	200	V
V_g	−1.85	−2.3	V
I_a	1.0	1.0	mA
g_m	1.45	1.4	mA/V
μ	70	70	
r_a	48	50	kΩ
V_g max. ($I_g = +0.3\mu A$)		−1.3	V

Diode sections

$r_{a'd}$ ($V_{a'd} = +10V$)	5.0	kΩ
$r_{a''d}$ ($V_{a''d} = +5V$)	200	Ω
$r_{a'''d}$ ($V_{a'''d} = +5V$)	200	Ω
$r_{a''d}/r_{a'''d}$	0.65 to 1.5	

UABC80

TRIPLE DIODE TRIODE

OPERATING CONDITIONS AS RESISTANCE COUPLED A.F. AMPLIFIER* (with grid current biasing)

V_b (V)	R_a (kΩ)	I_a (mA)	$\frac{V_{out}}{V_{in}}$	D_{tot} (%) for $V_{out(r.m.s.)}$ =3V	=5V	=8V	R_g† (kΩ)
170	47	1.25	32	0.6	1.1	2.0	150
170	100	0.82	42	0.5	0.8	1.3	330
170	220	0.46	51	0.4	0.5	1.1	680
200	47	1.6	34	0.5	0.9	1.5	150
200	100	1.0	44	0.4	0.6	1.0	330
200	220	0.56	53	0.3	0.4	0.9	680
250	47	2.2	36	0.3	0.6	1.0	150
250	100	1.4	47	0.25	0.5	0.8	330
250	220	0.76	54	0.2	0.25	0.6	680

*Measured with a grid resistor of 10MΩ.

†R_g = grid resistor of following value.

LIMITING VALUES

Triode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.0	W
I_k max.	5.0	mA
R_{g-k} max.	3.0	MΩ
†V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ

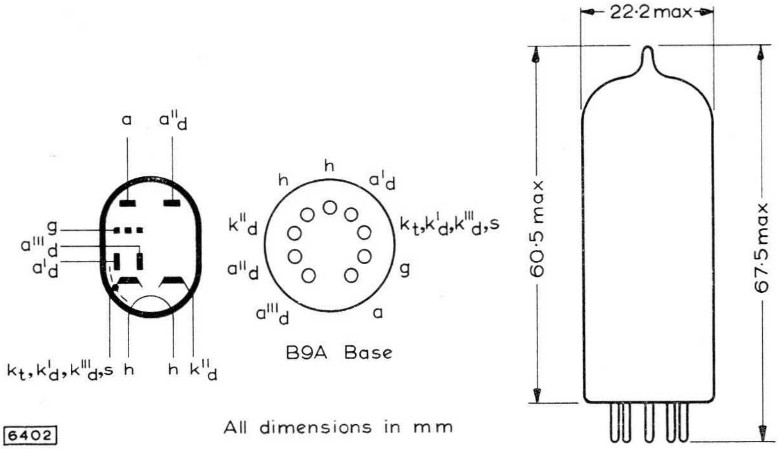
†In order to avoid excessive hum the a.c. component should be as low as possible ($<30V_{r.m.s.}$)

Diode sections

P.I.V.$_{(a'd)}$ max.	350	V
P.I.V.$_{(a''d)}$ max.	350	V
P.I.V.$_{(a'''d)}$ max.	350	V
$I_{a'd}$ max.	1.0	mA
$I_{a''d}$ max.	10	mA
$I_{a'''d}$ max.	10	mA
$i_{a'd(pk)}$ max.	6.0	mA
$i_{a''d(pk)}$ max.	75	mA
$i_{a'''d(pk)}$ max.	75	mA

MICROPHONY

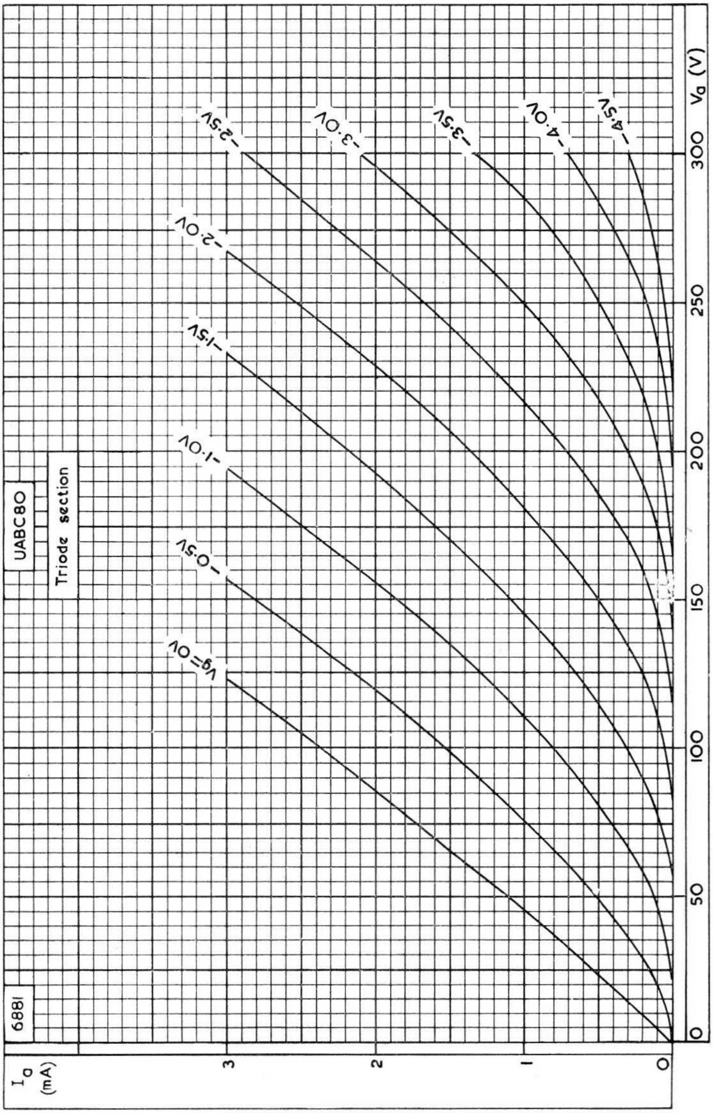
This valve can be used without special precautions against microphony in circuits in which the input voltage is not less than 10mV for an output of 50mW from the output stage at 800c/s and higher frequencies.



6402

All dimensions in mm

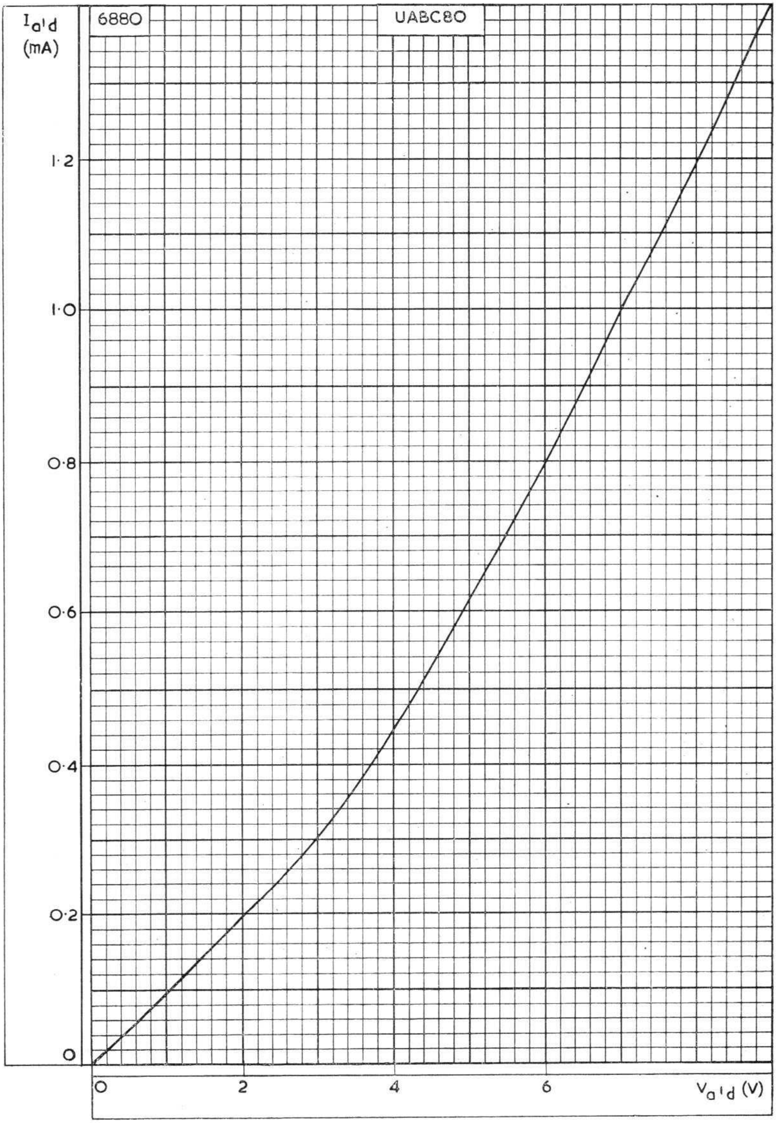
It is recommended that pin 5 be earthed.



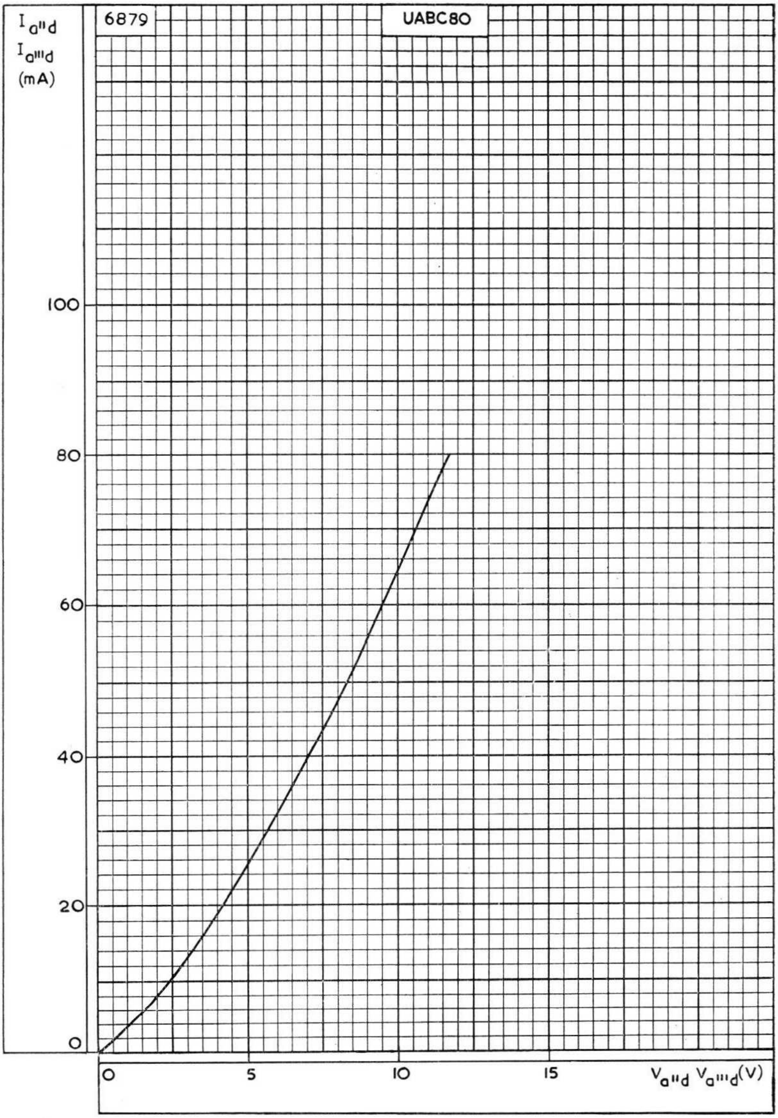
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

UABC80

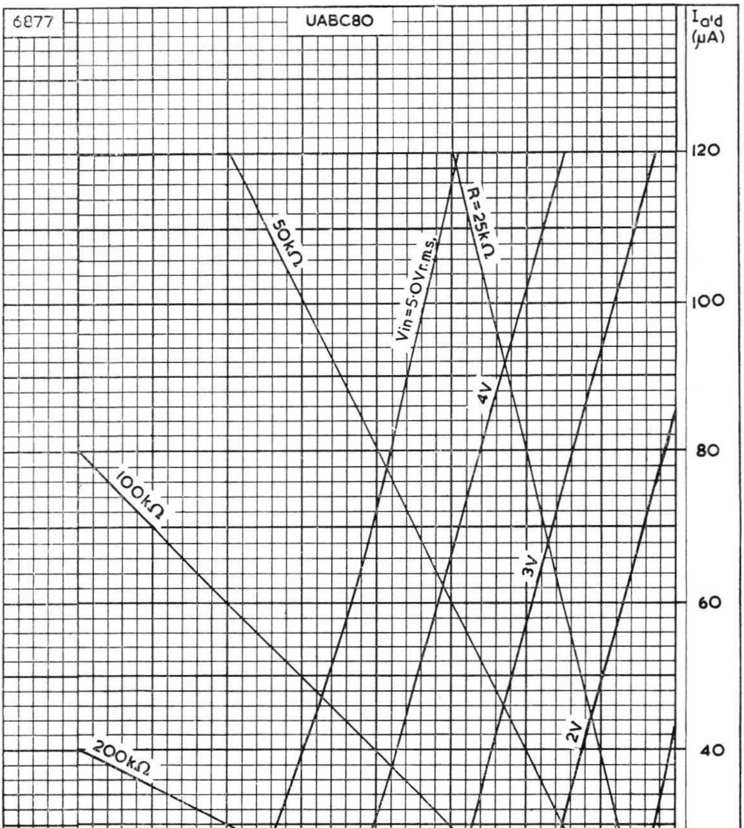
TRIPLE DIODE TRIODE



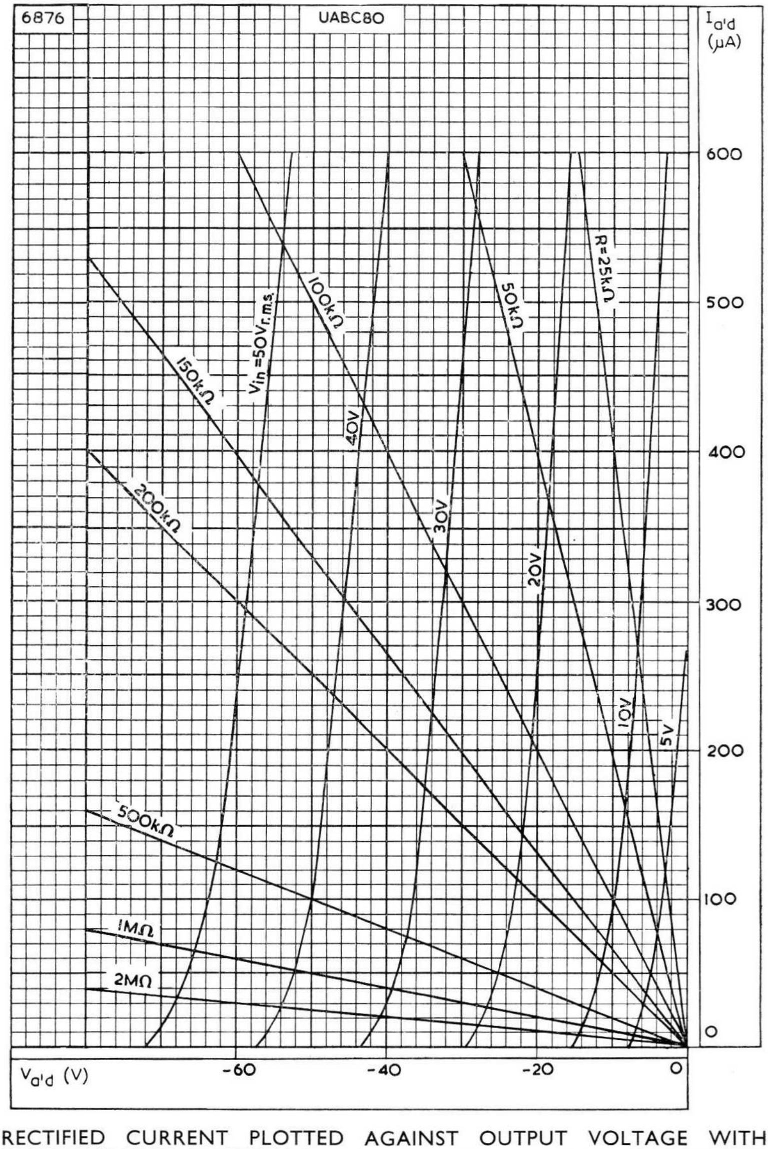
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR DIODE SECTION a'_d



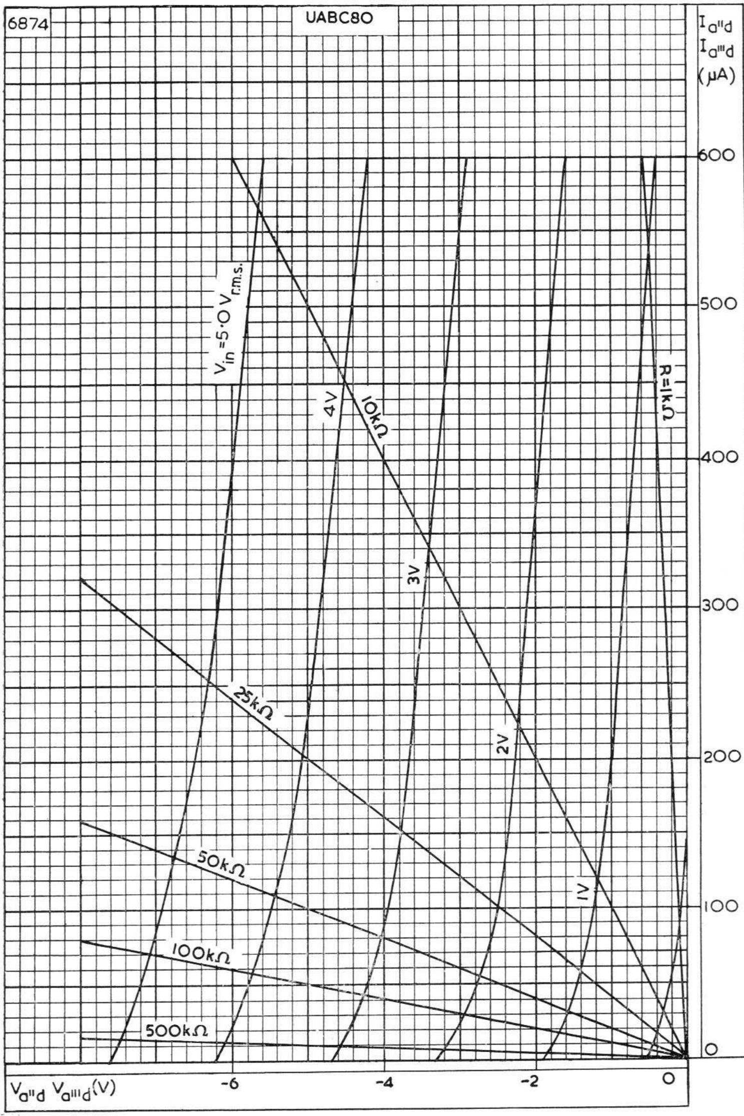
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR DIODE SECTIONS a''_d and a'''_d



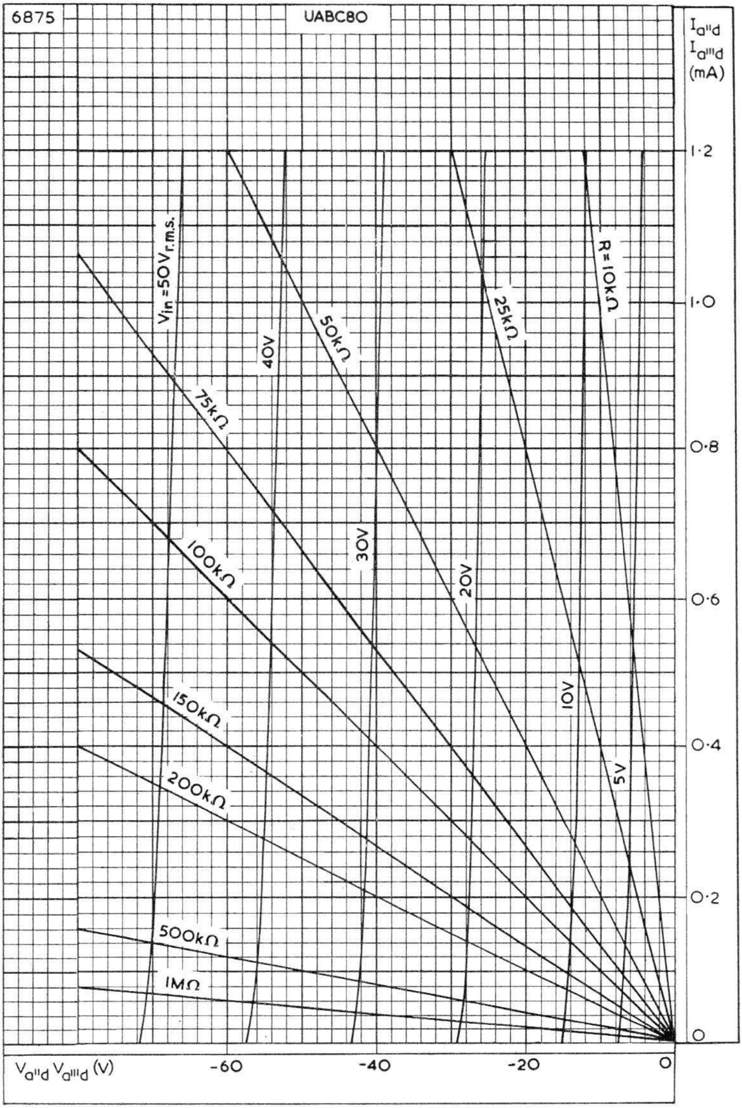
RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN 0V AND $5V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTION a'_d



RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN $5V_{r.m.s.}$ AND $50V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTION a'_d



RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN 0V AND $5V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTIONS a''_d AND a'''_d



RECTIFIED CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE BETWEEN $5V_{r.m.s.}$ AND $50V_{r.m.s.}$ AS PARAMETER FOR DIODE SECTIONS a''_d AND a'''_d

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

UBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

HEATER

Suitable for series operation a.c. or d.c.

I_h	100	mA
V_h	19	V

MOUNTING POSITION

Any

CAPACITANCES

$c_{a'd-g1}$	<0.0008	pF
$c_{a''d-g1}$	<0.001	pF
$c_{a'd-a}$	<0.15	pF
$c_{a''d-a}$	<0.025	pF

Pentode section

c_{a-g1}	<0.0025	pF
c_{out}	5.2	pF
c_{in}	5.0	pF
c_{g1-h}	0.05	pF

Diode sections

$c_{a'd-k}$	2.5	pF
$c_{a''d-k}$	2.5	pF
$c_{a'd-a''d}$	<0.25	pF
$c_{a'd-h}$	<0.015	pF
$c_{a''d-h}$	<0.003	pF

CHARACTERISTICS

V_a	100	200	V
V_{g3}	0	0	V
V_{g2}	100	100	V
V_{g1}	−2.0	−1.5	V
I_a	8.5	11	mA
I_{g2}	2.8	3.3	mA
g_m	3.5	4.5	mA/V
r_a	300	600	kΩ
μ_{g1-g2}	—	20	
V_{g1} ($g_m = 120\mu A/V$)	−10	−20	V

UBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f amplifier. The diode sections are only suitable for a.m. detection.

TYPICAL OPERATING CONDITIONS

$V_a = V_b$	170	170	200	200	V
V_{g3}	0	0	0	0	V
R_{g2}	27	21	47	30	kΩ
V_{g1}	–0.5*	–1.5	–0.5*	–1.5	V
R_k	—	105	—	105	Ω
I_a	11	11	9.5	11	mA
I_{g2}	3.4	3.4	2.8	3.3	mA
g_m	5.0	4.5	5.0	4.5	mA/V
r_a	450	450	600	600	kΩ
R_{eq}	2.5	3.5	2.5	3.5	kΩ
g_m (V_{g1} = –20V)	65	65	115	120	µA/V

*This voltage is produced by the grid current flowing through the grid resistor and the steady current of the diode. If this condition is not acceptable the negative grid bias should be increased to –1.5V.

LIMITING VALUES

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2.25	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. ($I_a < 4.0$mA)	250	V
V_{g2} max. ($I_a > 8.0$mA)	125	V
p_{g2} max.	450	mW
I_k max.	16.5	mA
V_{g1} max. ($I_{g1} = +0.3\mu$A)	–1.3	V
R_{g1-k} max.	3.0	MΩ
R_{g1-k} max. (grid current biasing)	22	MΩ
R_{g3-k} max.	10	kΩ
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

UBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

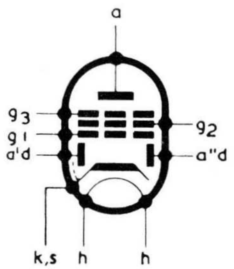
Diode sections (each section)

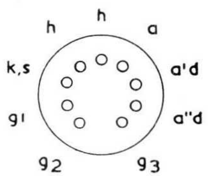
P.I.V. max.	200	V
I_{ad} max.	800	μA
$i_{ad(pk)}$ max.	5.0	mA
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

MICROPHONY

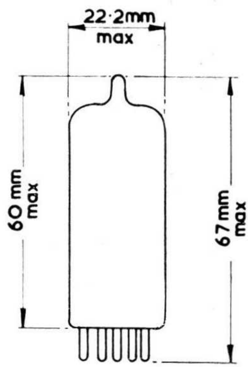
This valve can be used without special precautions against microphony in circuits in which the input voltage is >25mV (r.m.s) for an output of 50mW from the output valve.

2845





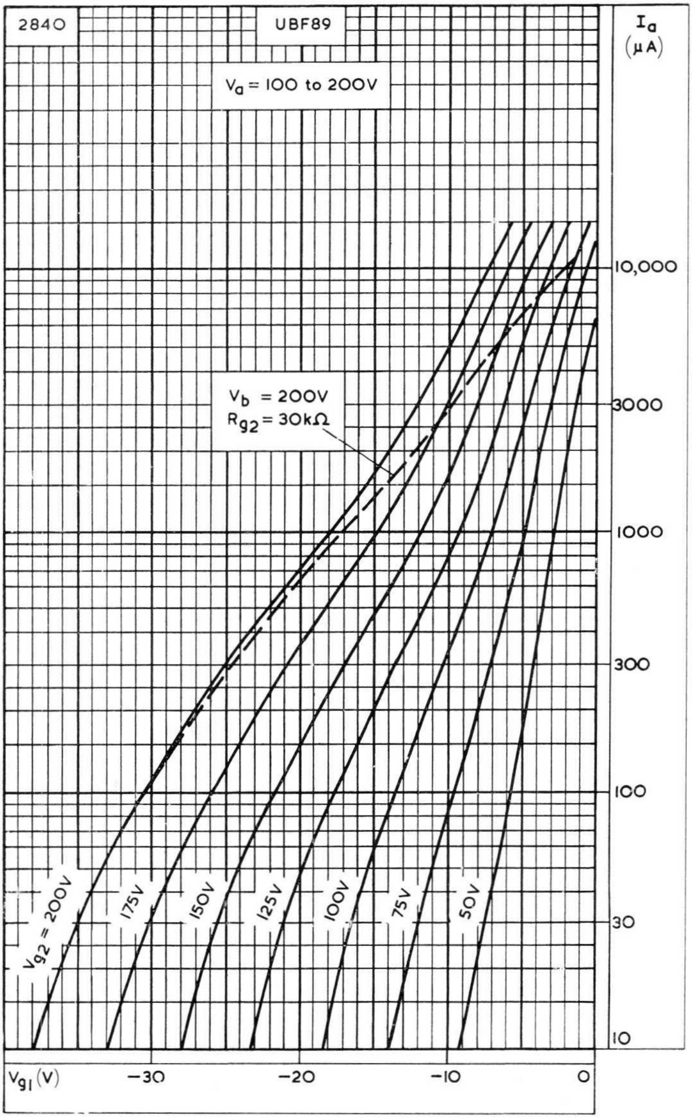
B9A Base



UBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

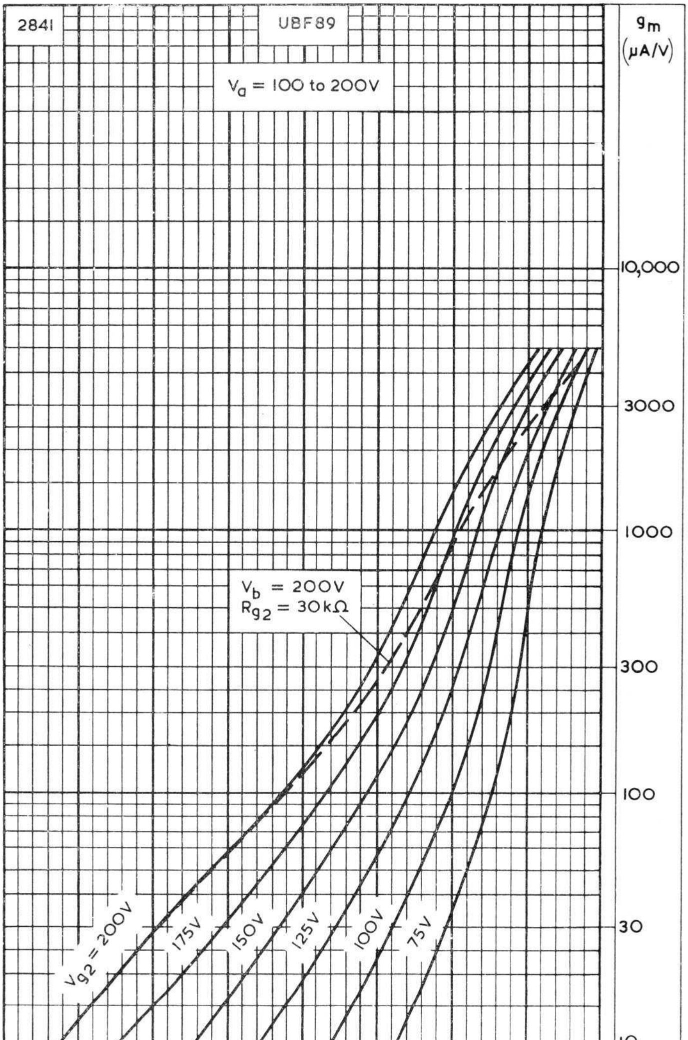


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

UBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

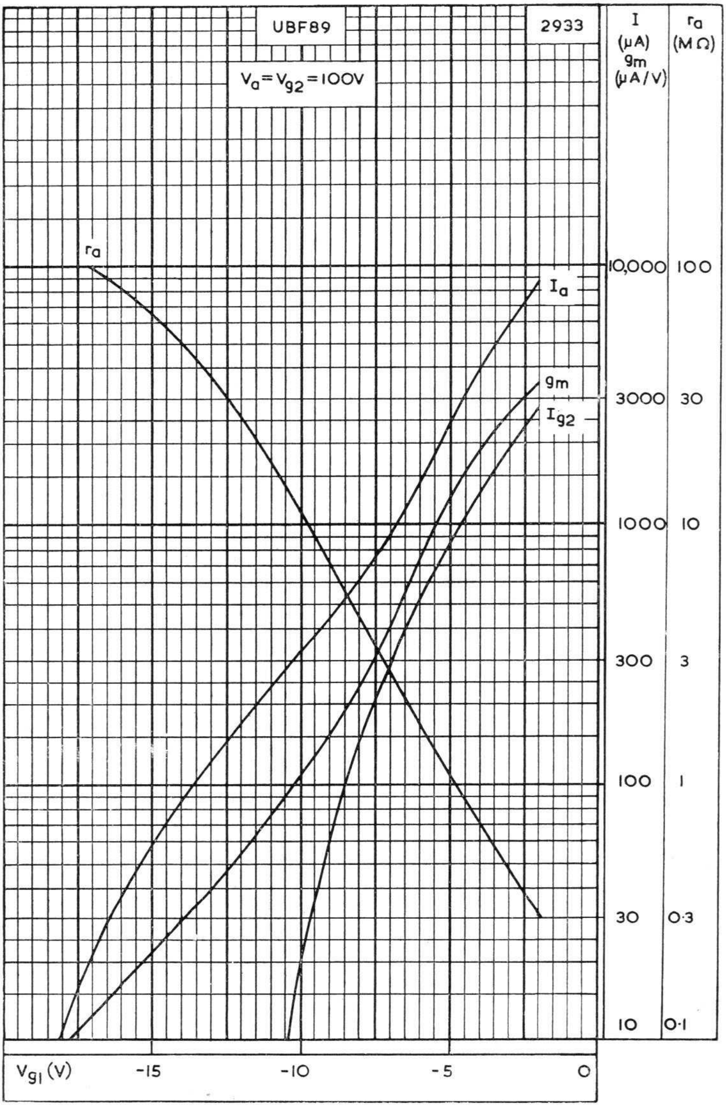


MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER

UBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

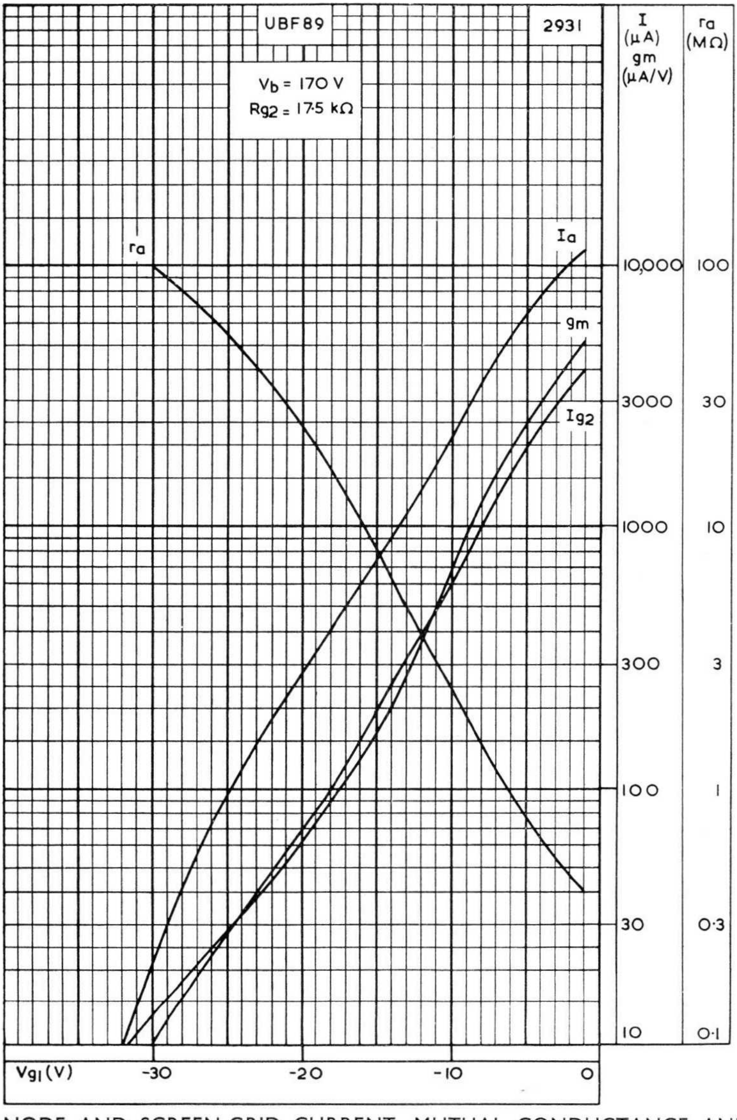


ANODE AND SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE $V_a = V_{g2} = 100V$

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

UBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.

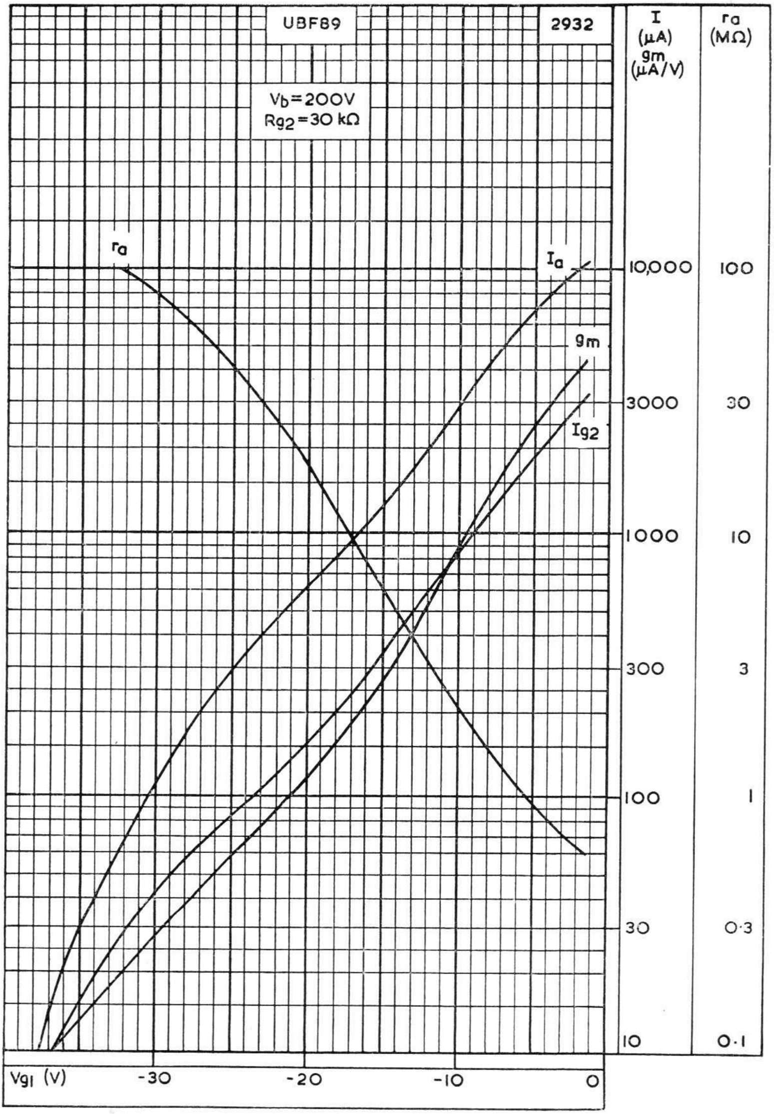


ANODE AND SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE
$V_b = 170V$

UBF89

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f amplifier. The diode sections are only suitable for a.m. detection.

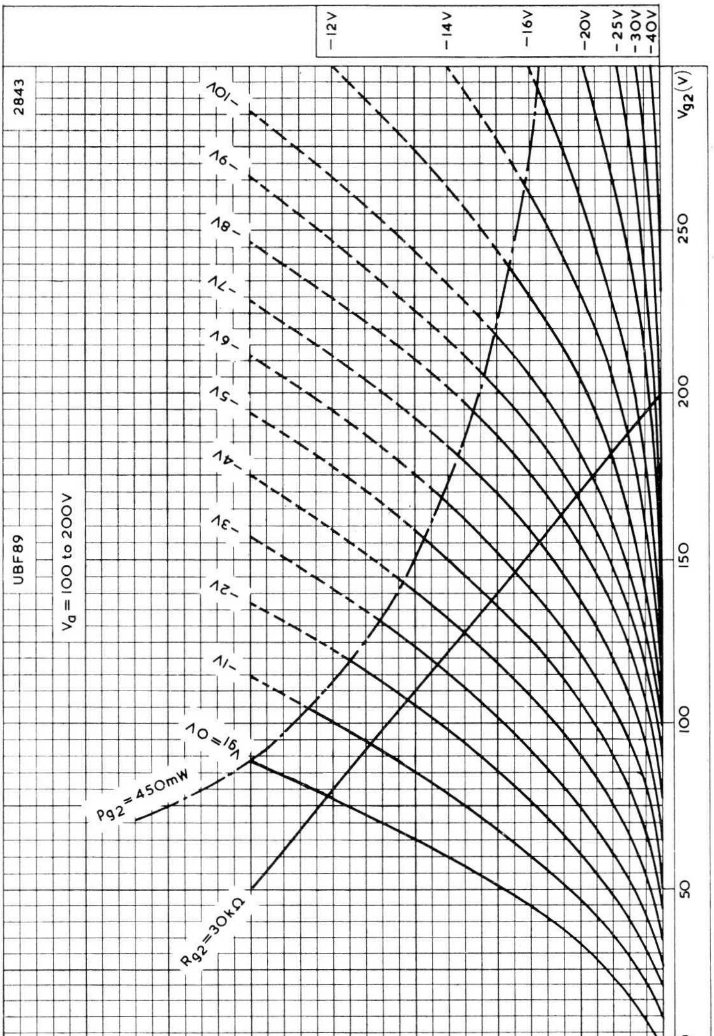


ANODE AND SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE
$V_b = 200V$

DOUBLE DIODE VARIABLE-MU R.F. PENTODE

UBF89

Double diode variable-mu pentode. The pentode section is suitable for use as an r.f. or i.f. amplifier. The diode sections are only suitable for a.m. detection.



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

R.F. DOUBLE TRIODE   UCC85

Double triode with 100mA heater primarily intended for use in f.m./a.m. receivers as an r.f. amplifier and self-oscillating additive mixer.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	100	mA	
V_h	26	V	

CAPACITANCES

*c_{a-g}	1.5	pF	
*$c_{g-k+h+s}$	3.1	pF	←
*c_{a-k}	180	mpF	
*$c_{a-k+h+s}$	1.2	pF	
*†$c_{a-k+h+s}$	1.8	pF	←
$c_{a'-a''}$	<40	mpF	
†$c_{a'-a''}$	<8.0	mpF	
$c_{g'-g''}$	<3.0	mpF	
$c_{a''-g'}$	<8.0	mpF	
$c_{a'-g''}$	<8.0	mpF	
$c_{a''-k'}$	<8.0	mpF	
$c_{a'-k''}$	<8.0	mpF	
$c_{g''-k'}$	<3.0	mpF	
$c_{g'-k''}$	<3.0	mpF	

*Each section

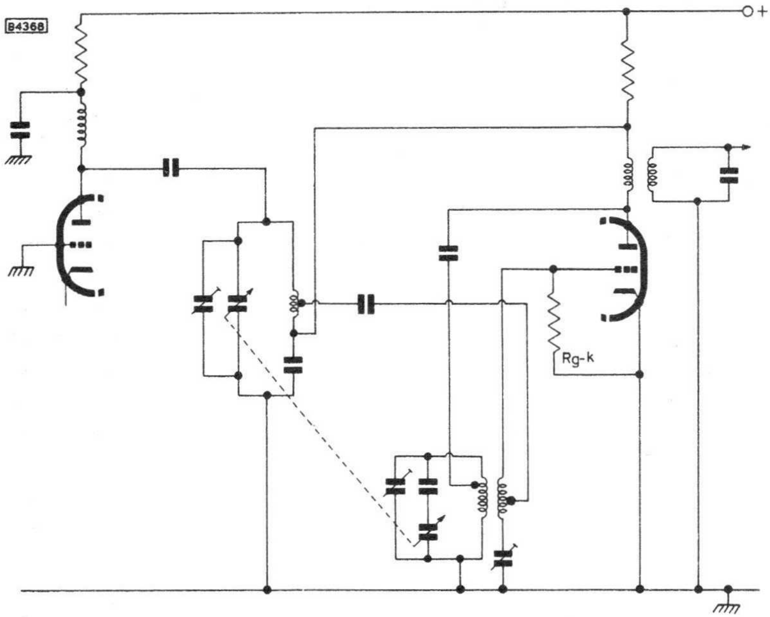
†Measured with an external shield.

CHARACTERISTICS (each section)

V_a	170	200	V	
I_a	10	10	mA	
V_g	-1.75	-2.4	V	←
g_m	6.7	6.0	mA/V	←
μ	48	46		←
r_a	7.1	7.7	kΩ	←

OPERATING CONDITIONS AS R.F. AMPLIFIER

V_a	155	161	V
V_b	170	170	V
R_a	1.5	1.3	kΩ
I_a	9.8	6.6	mA ←
R_k	150	330	Ω ←
g_m	6.7	5.1	mA/V ←
r_a	7.0	8.5	kΩ ←
r_{g1} (f = 100Mc/s)	3.8	5.2	kΩ ←
R_{eq}	550	820	Ω



OPERATING CONDITIONS AS SELF-OSCILLATING ADDITIVE MIXER (with i.f. feedback, see basic circuit in fig.1.)

V_b	170	200	V
R_a	4.7	8.2	kΩ
*R_{g-k}	1.0	1.0	MΩ
I_a	5.5	6.0	mA ←
V_{osc} (r.m.s.)	2.8	2.8	V
g_c	2.8	2.9	mA/V ←
r_a	15	14	kΩ

*The presence of the i.f. feedback voltage tends to stabilise the performance of the oscillator and hence permits this relatively high value to be used for the grid leak.

R.F. DOUBLE TRIODE

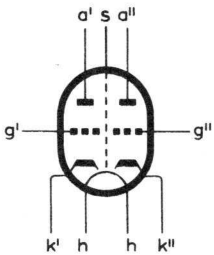
UCC85

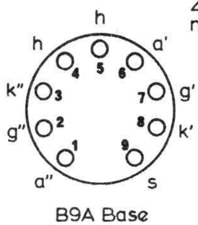
RATINGS (ABSOLUTE MAXIMUM SYSTEM)
(each section unless otherwise specified)

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2.5	W
$p_{a'} + p_{a''}$ max.	4.5	W
I_k max.	15	mA
$-V_g$ max.	100	V
R_{g-k} max.	1.0	MΩ
* V_{h-k} max.	90	V
R_{h-k} max.	20	kΩ

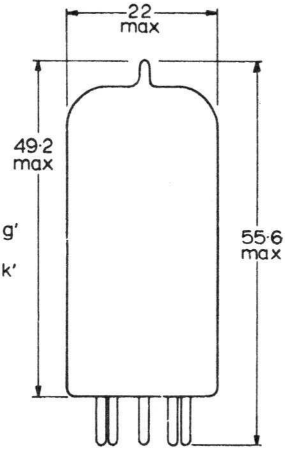
*When operating as an oscillator no r.f. voltage should be applied between heater and cathode. ←

B4669



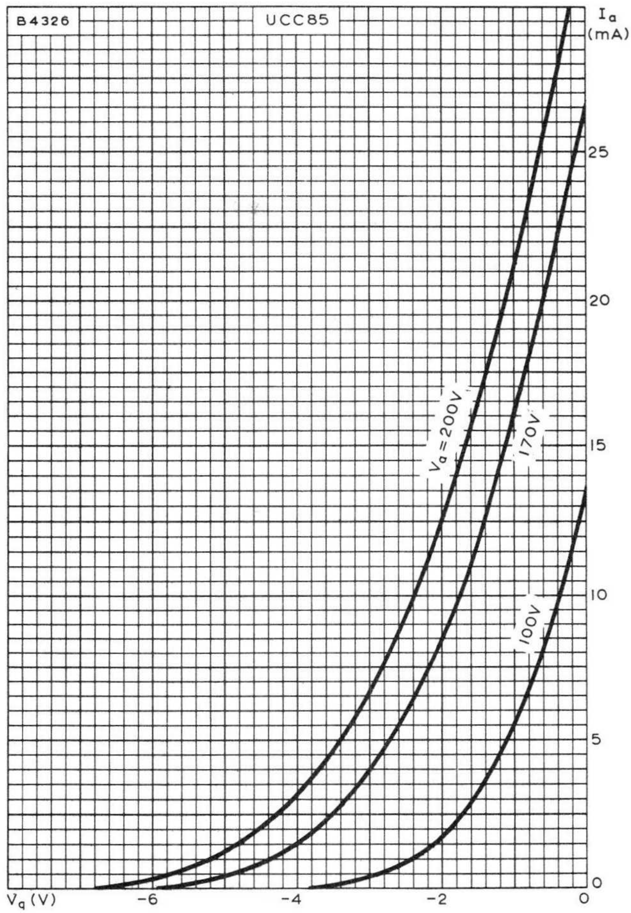


B9A Base

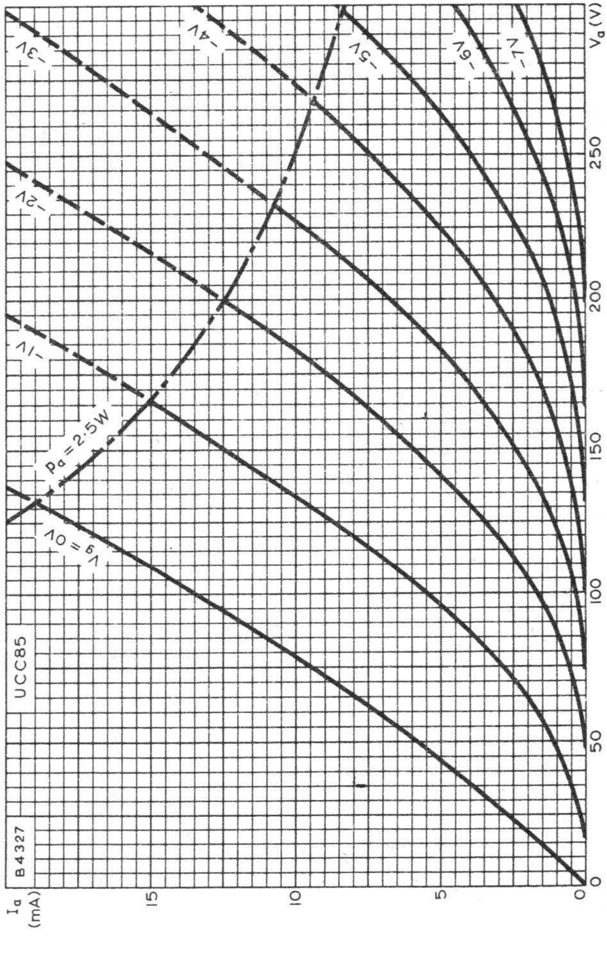


All dimensions in mm ←

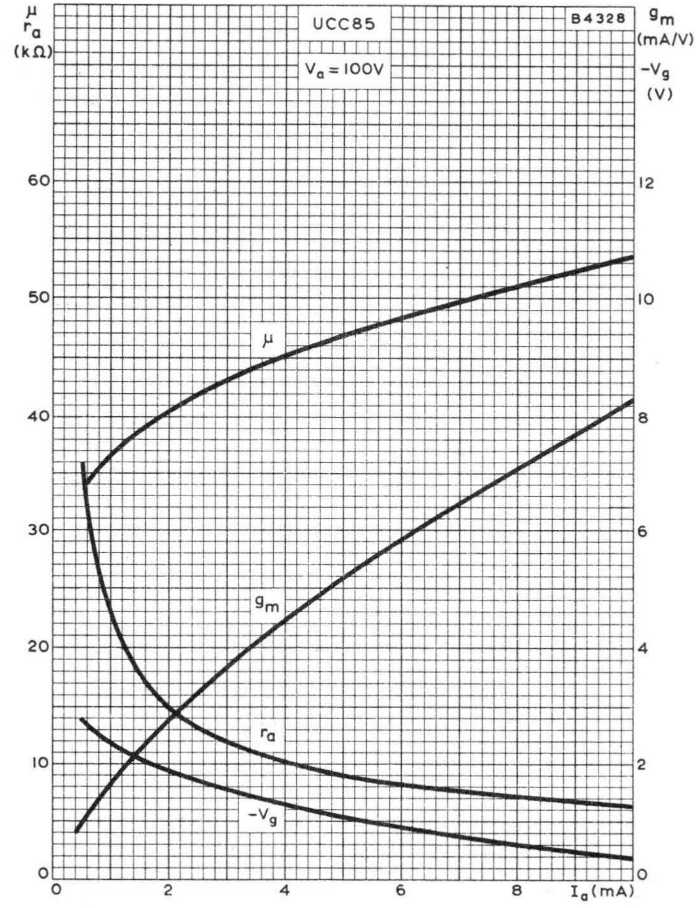
The triode on pins 6, 7, 8 should be used as the r.f. amplifier and that on pins 1, 2, 3 as the self-oscillating additive mixer.



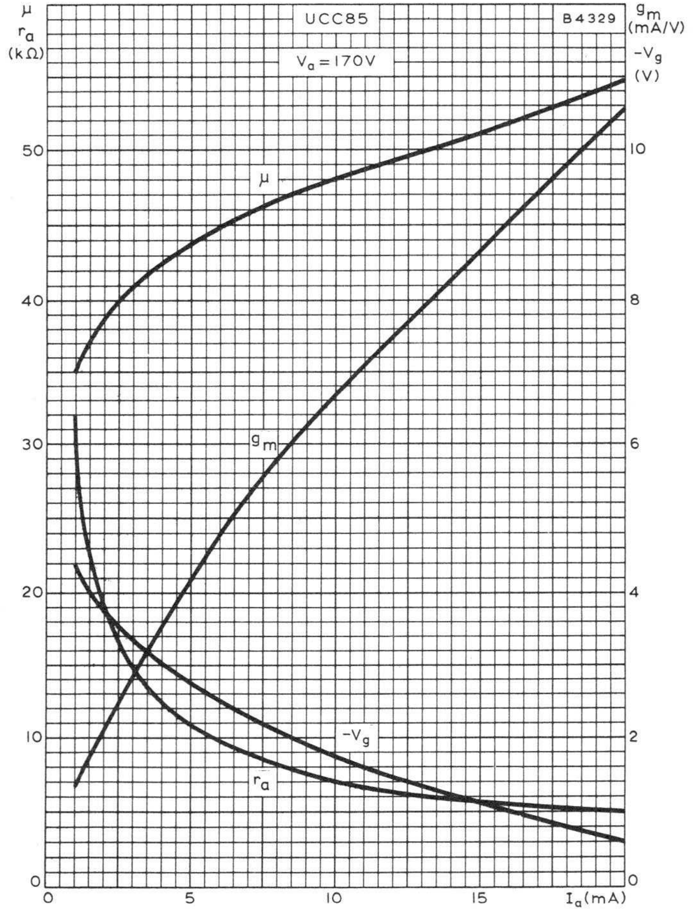
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER



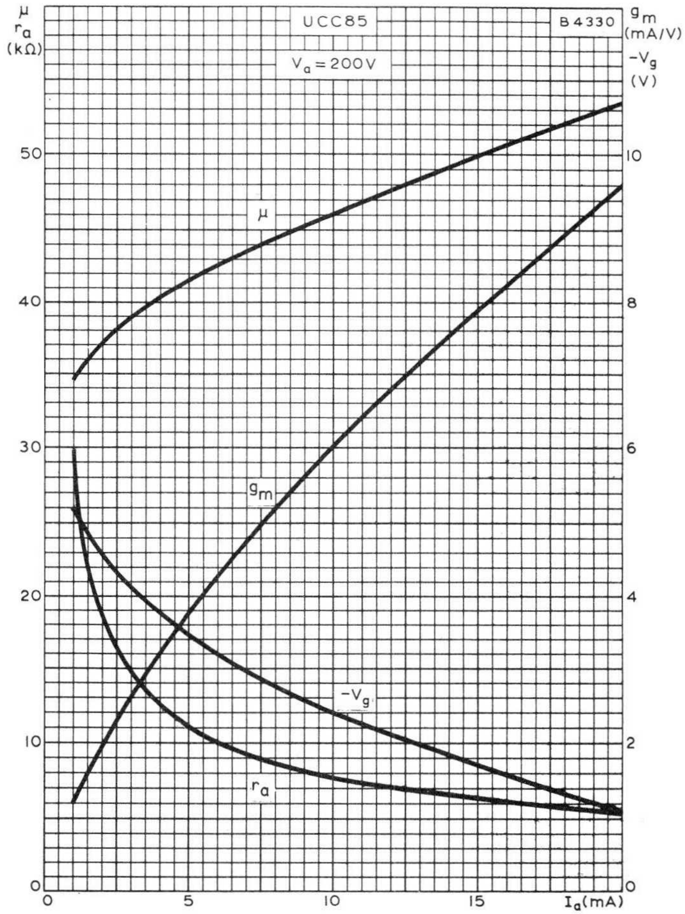
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER



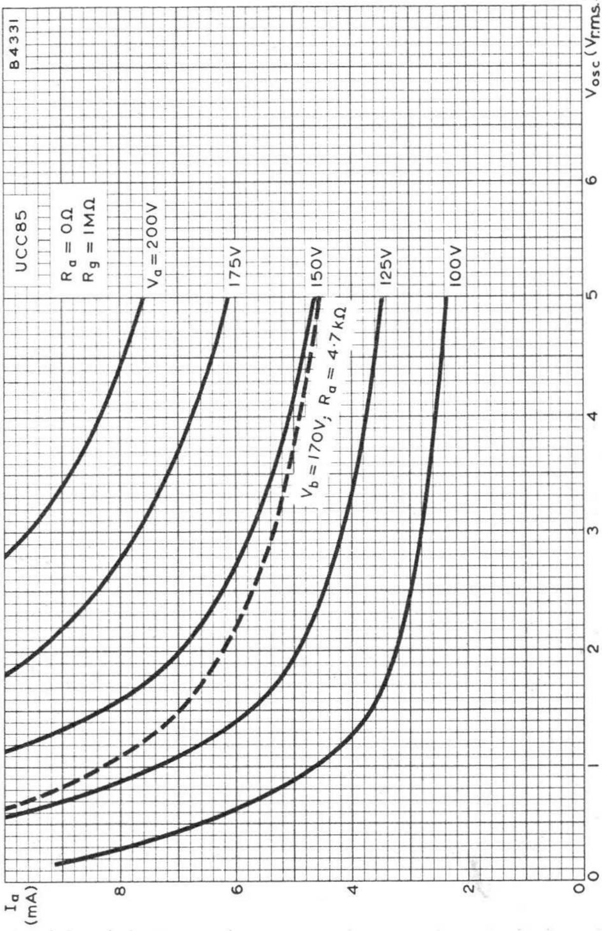
MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AMPLIFICATION FACTOR AND GRID VOLTAGE PLOTTED AGAINST ANODE CURRENT, V_a = 100V



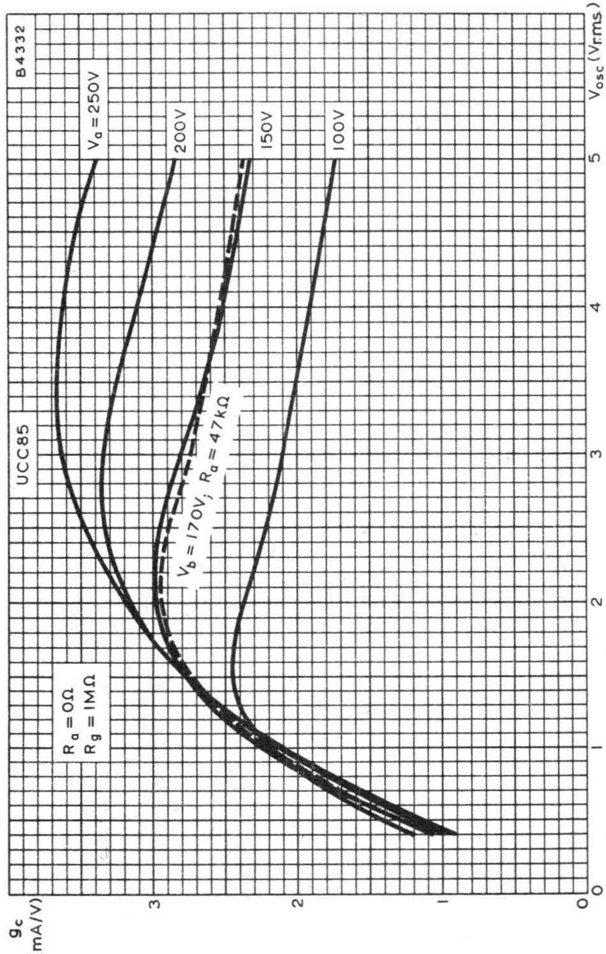
MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AMPLIFICATION FACTOR AND GRID VOLTAGE PLOTTED AGAINST ANODE CURRENT, $V_a = 170V$



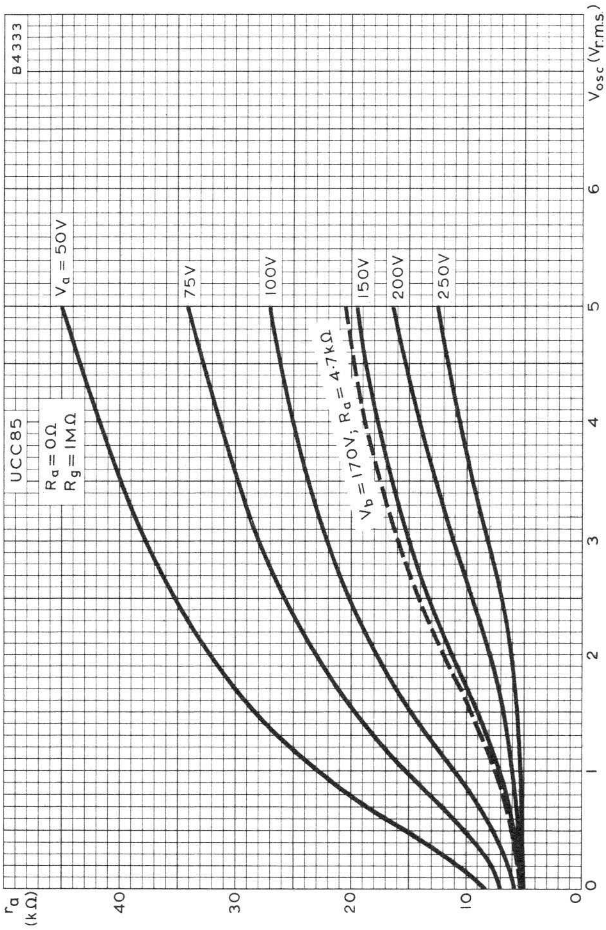
MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AMPLIFICATION FACTOR AND GRID VOLTAGE PLOTTED AGAINST ANODE CURRENT, V_a = 200V



ANODE CURRENT PLOTTED AGAINST OSCILLATOR VOLTAGE WITH ANODE VOLTAGE AS PARAMETER



CONVERSION CONDUCTANCE PLOTTED AGAINST OSCILLATOR VOLTAGE
WITH ANODE VOLTAGE AS PARAMETER



ANODE IMPEDANCE PLOTTED AGAINST OSCILLATOR VOLTAGE WITH ANODE VOLTAGE AS PARAMETER

TRIODE HEPTODE

UCH81

Triode heptode with 100mA heater primarily intended for use as a frequency changer.

HEATER

Suitable for series operation, a.c. or d.c.

I_h	100	mA
V_h	19	V

CAPACITANCES

c_{ah-at}	200	mpF
c_{ah-gt}	<90	mpF
$c_{ah-g3+gt}$	<350	mpF
c_{g1-at}	<60	mpF
c_{g1-gt}	<170	mpF
$c_{g1-g3+gt}$	<450	mpF

Heptode section

$c_{in(g1)}$	4.8	pF
$c_{in(g3)}$	6.0	pF
c_{out}	7.9	pF
c_{a-g1}	<6.0	mpF
c_{g1-g3}	<300	mpF
c_{g1-h}	<170	mpF
c_{g3-h}	<60	mpF

Triode section

c_{in}	2.6	pF
c_{out}	2.1	pF
c_{a-g}	1.0	pF
c_{g-h}	<20	mpF

OPERATING CONDITIONS FOR HEPTODE SECTION AS R.F. OR I.F. AMPLIFIER

$V_a = V_b$	170	200	V
V_{g3}	0	0	V
R_{g2+g4}	18	18	kΩ
V_{g1}	−2.2	−2.6	V
R_k	220	220	Ω
V_{g2+g4}	102	123	V
I_a	6.2	7.6	mA
I_{g2+g4}	3.8	4.3	mA
g_m	2.3	2.4	mA/V
r_a	600	600	kΩ
$\mu_{g1-(g2+g4)}$	20	20	
R_{eq}	8.8	9.7	kΩ
V_{g1} (for 100 : 1 reduction in g_m)	−28	−33	V
V_{g1} max. ($I_{g1} = +0.3\mu A$)		−1.3	V
V_{g3} max. ($I_{g3} = +0.3\mu A$)		−1.3	V

UCH81

TRIODE HEPTODE

OPERATING CONDITIONS OF HEPTODE SECTION AS A.M. FREQUENCY CHANGER

$V_a = V_b$	170	200	V
R_{g2+g4}	10	10	kΩ
R_{g3+gt}	47	47	kΩ
V_{g1}	−2.2	−2.6	V
V_{g2+g4}	102	119	V
I_a	3.2	3.7	mA
I_{g2+g4}	6.8	8.1	mA
I_{g3+gt}	200	230	μA
g_c	750	775	μA/V
r_a	0.9	1.0	MΩ
R_{eq}	70	75	kΩ
V_{g1} (for 100 : 1 reduction in g_c)	−24	−28	V

CHARACTERISTICS

Triode section

V_a	100	V
I_a	13.5	mA
V_g	0	V
g_m	3.7	mA/V
μ	22	
V_g max. ($I_g = +0.3\mu A$)	−1.3	V

OPERATING CONDITIONS OF TRIODE SECTION AS R.F. OSCILLATOR

V_b	170	200	V
R_{at}	15	15	kΩ
R_{gt+g3}	47	47	kΩ
I_{g3+gt}	200	240	μA
I_{at}	4.5	5.4	mA
g_m (eff)	580	580	μA/V

LIMITING VALUES

Heptode section

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.7	W
$V_{g2+g4(b)}$ max.	550	V
V_{g2+g4} max. ($I_a = 7.6mA$)	125	V
V_{g2+g4} max. ($I_a < 1mA$)	250	V
p_{g2+g4} max.	1.0	W
I_k max.	12.5	mA
R_{g1-k} max.	3.0	MΩ
*R_{g3-k} max.	3.0	MΩ
R_{h-k} max.	20	kΩ
V_{h-k} max.	100	V

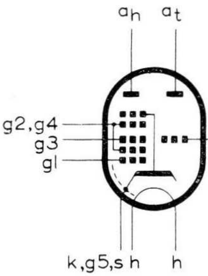
*If the two sections of the valve are switched during operation so that there is no direct connection between g_3 and g_t, as may occur in f.m./a.m. receivers, then R_{g3-k} max. = 20kΩ.

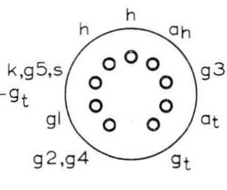
UCH81

Triode section

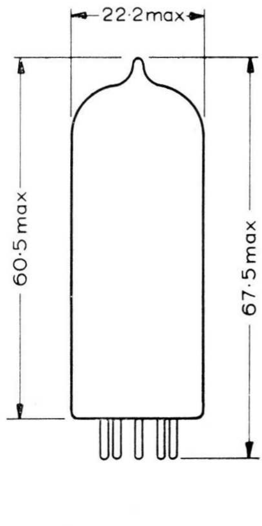
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	800	mW
I_k max.	6.5	mA
R_{g-k} max.	3.0	MΩ
V_{h-k} max.	100	V
R_{h-k} max.	20	kΩ

The heptode section of this valve can be used without special precautions against microphony in circuits in which the input voltage is not less than 50mV for an output of 50mW from the output stage. The corresponding figure for the triode section is 25mV.



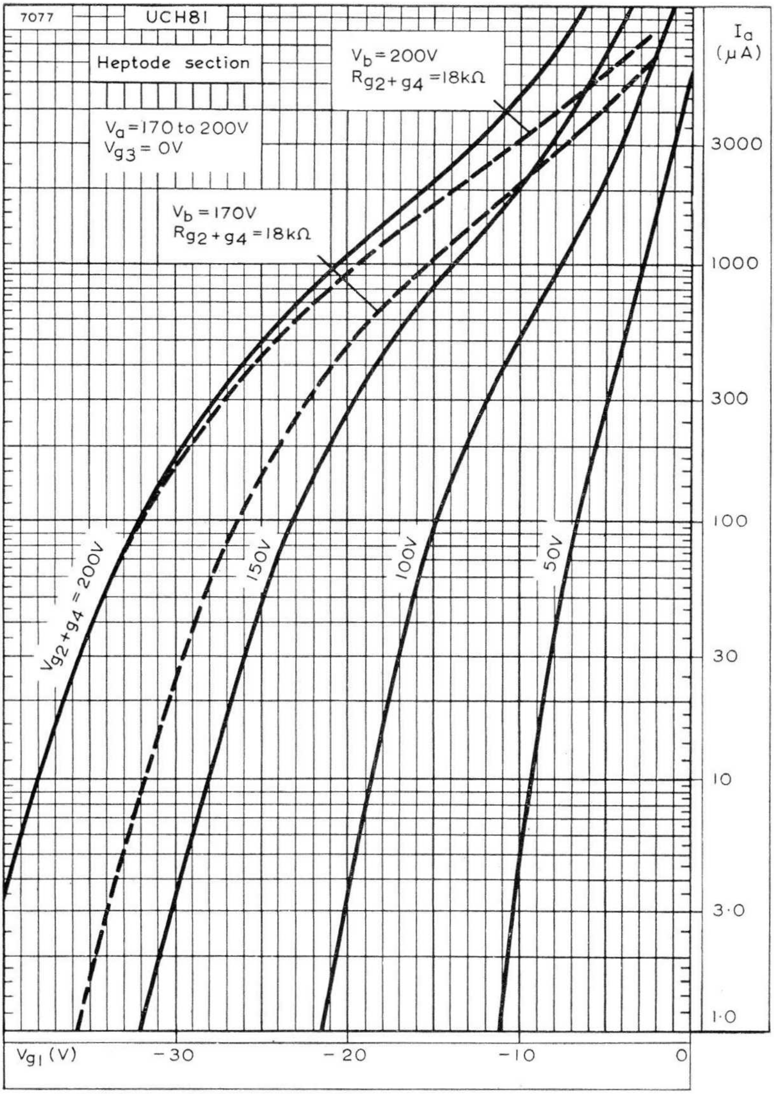


B9A Base

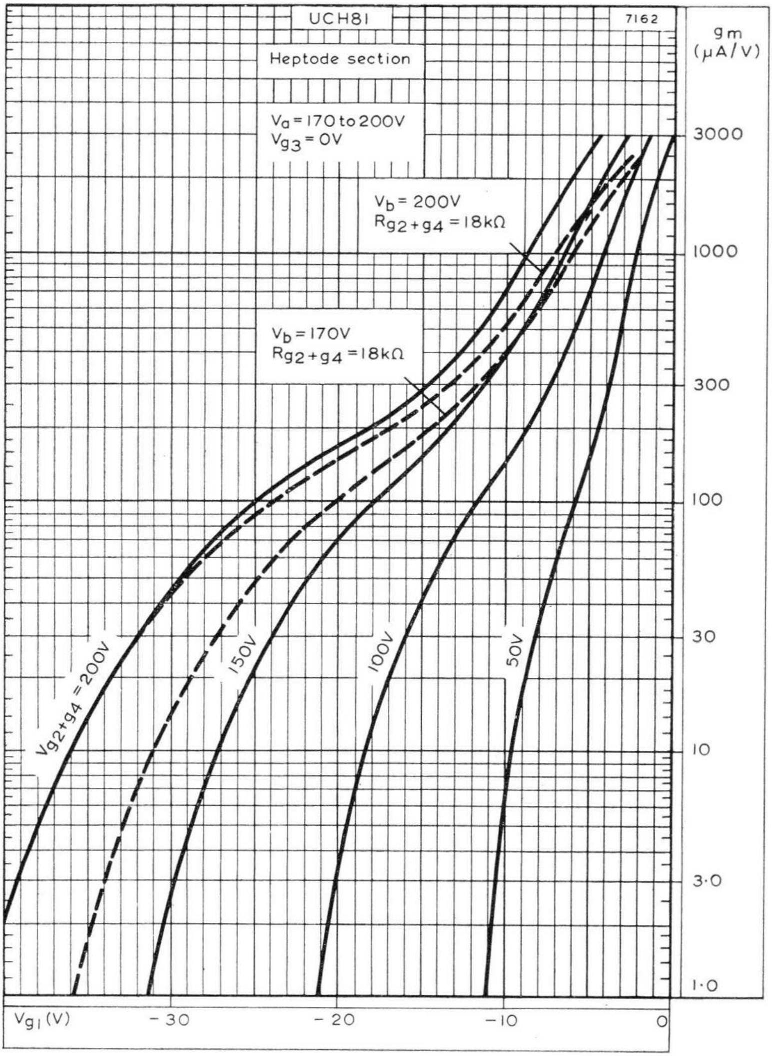


6397

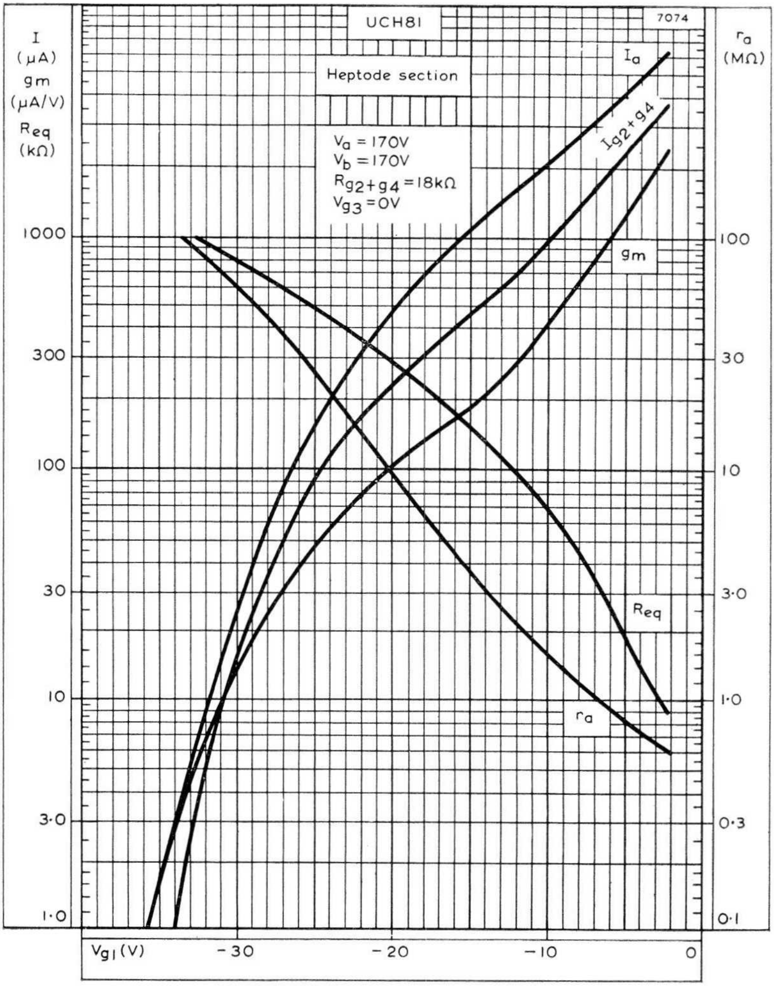
All dimensions in mm



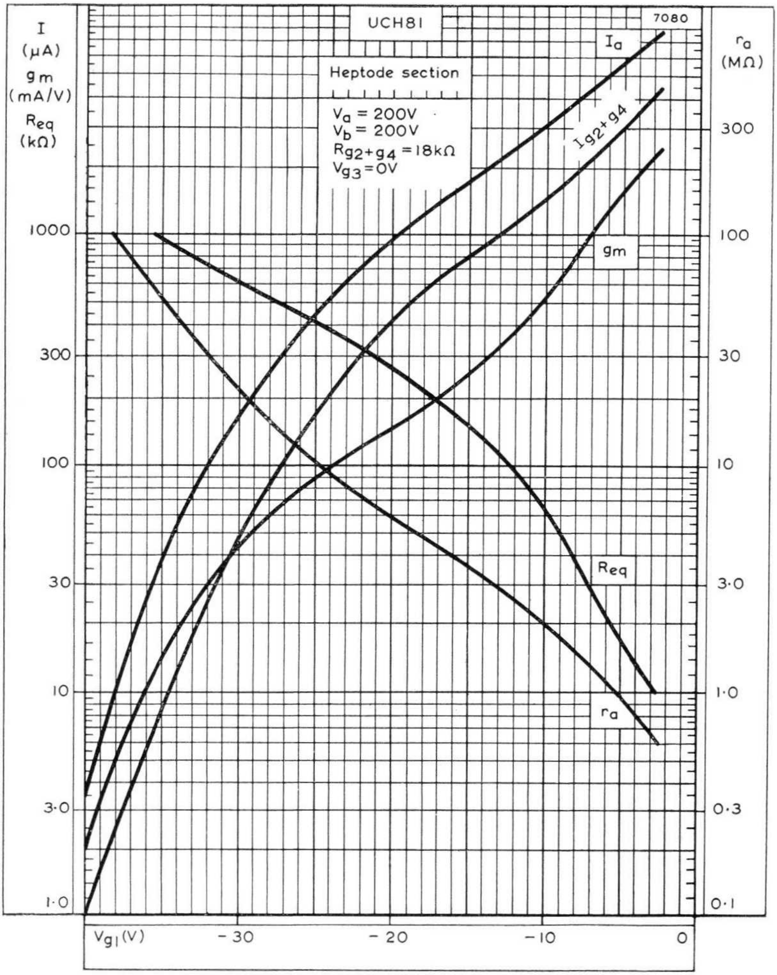
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION



MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION

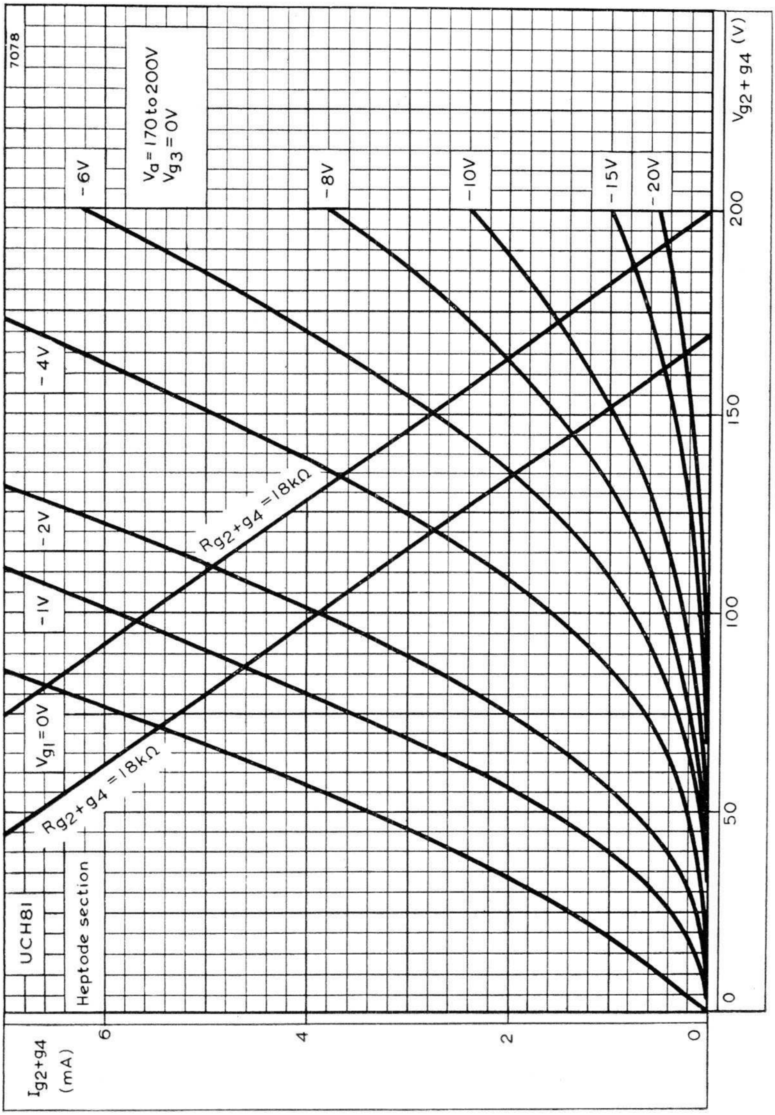


ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION.
V_a = 170V

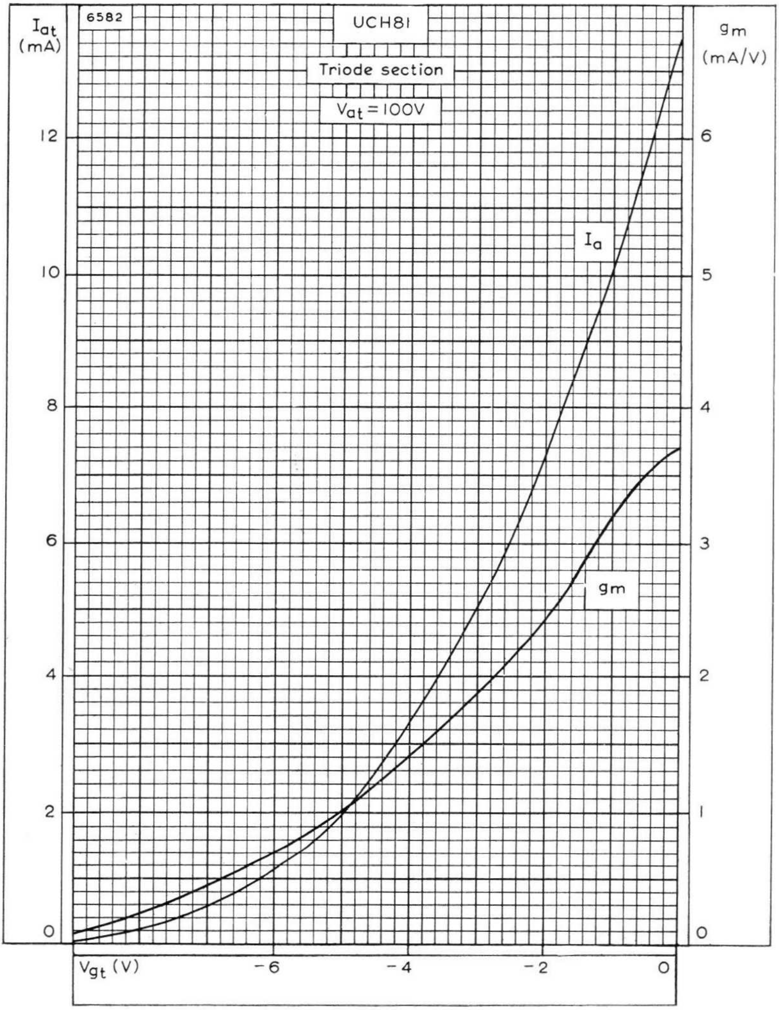


ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR HEPTODE SECTION

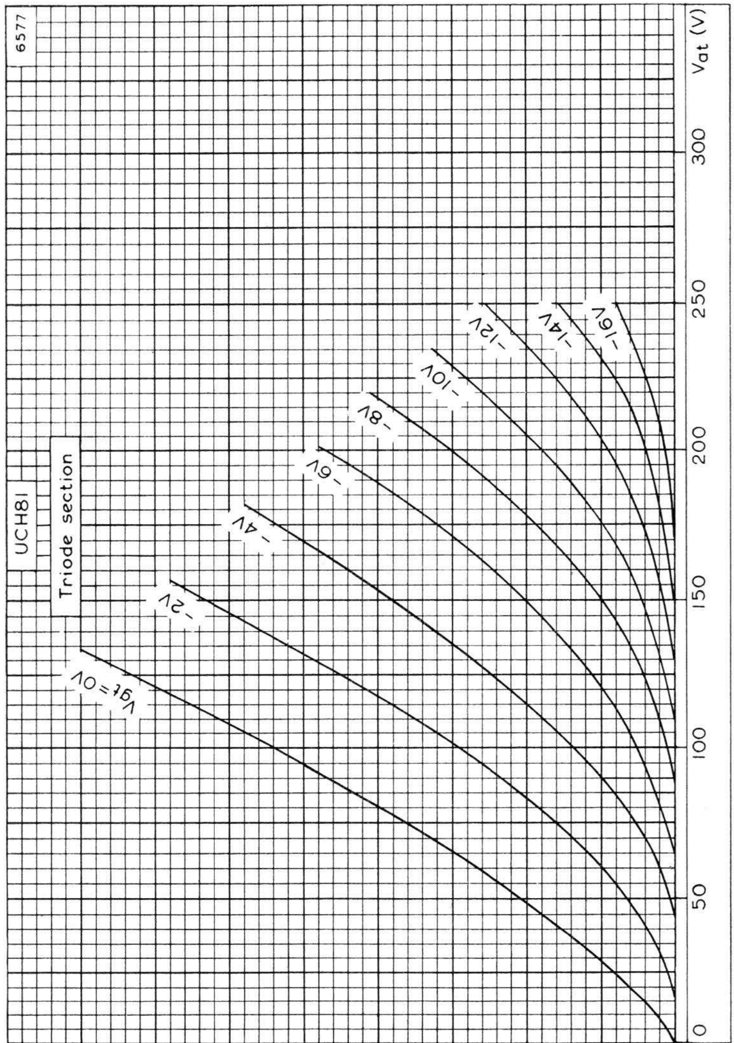
$V_a = 200V$



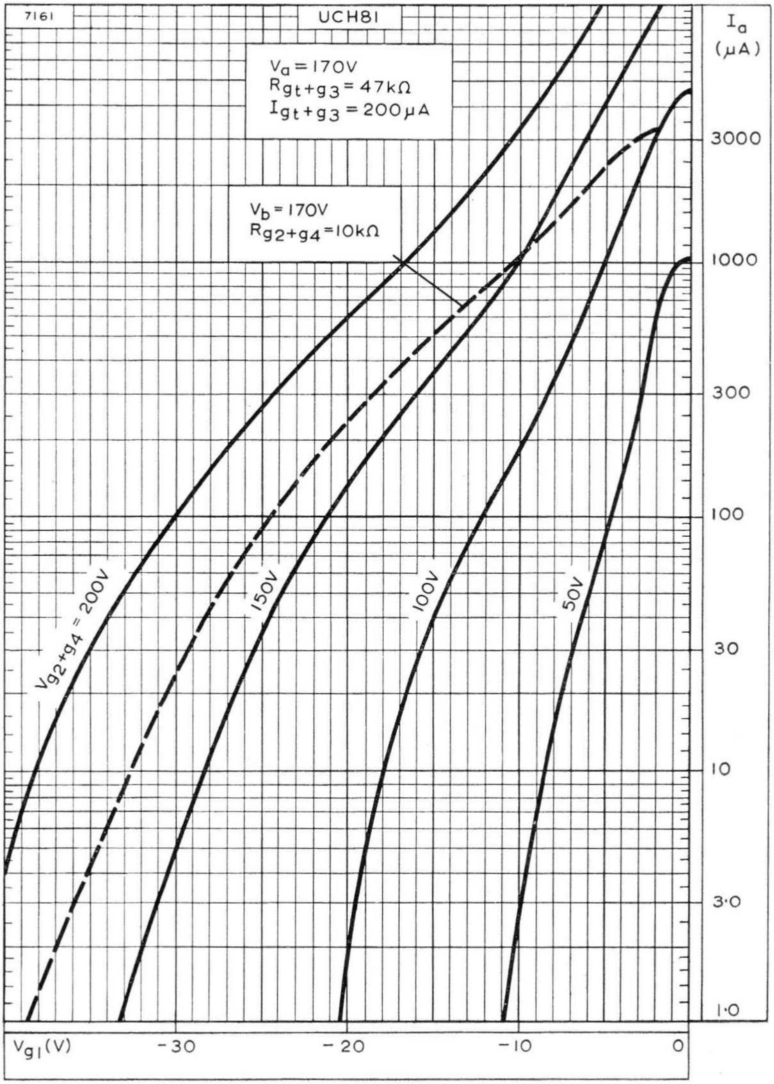
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER FOR HEPTODE SECTION



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST GRID VOLTAGE FOR TRIODE SECTION

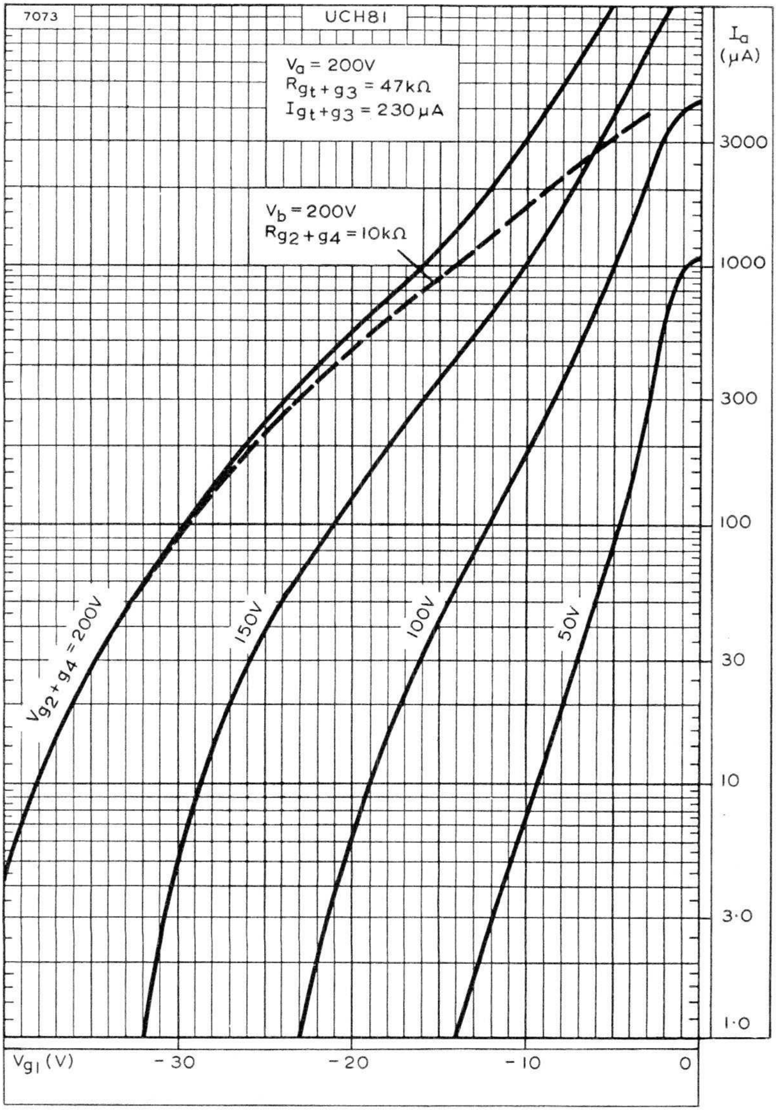


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR TRIODE SECTION

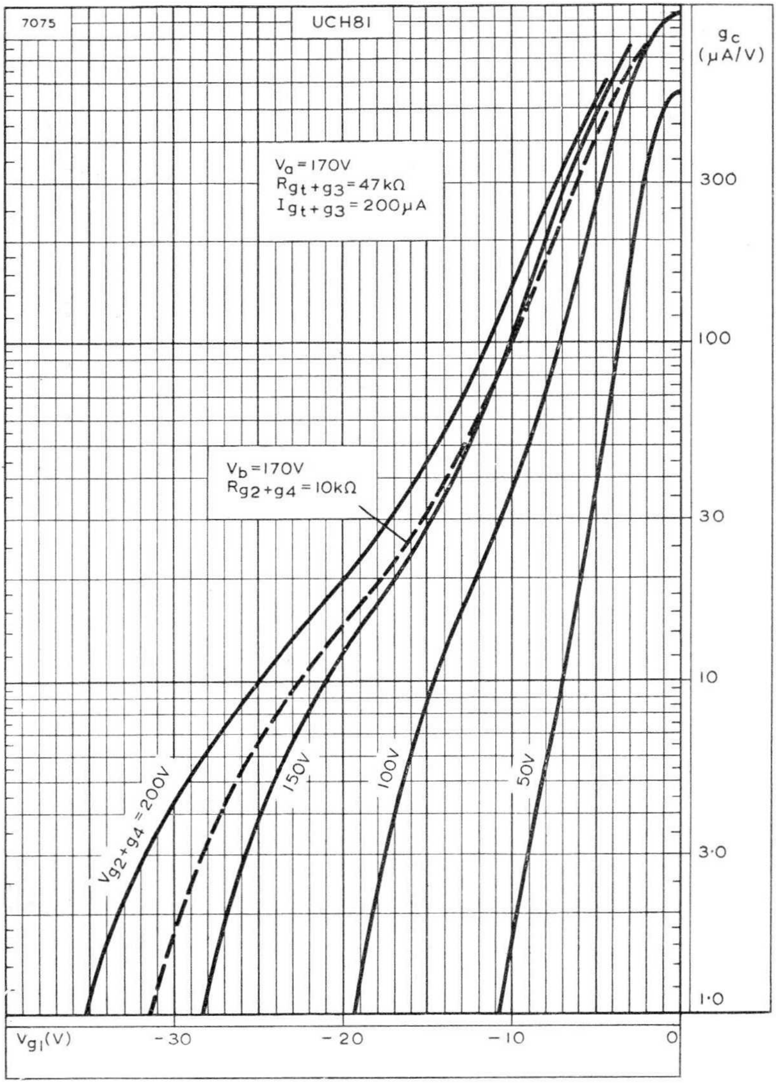


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER.

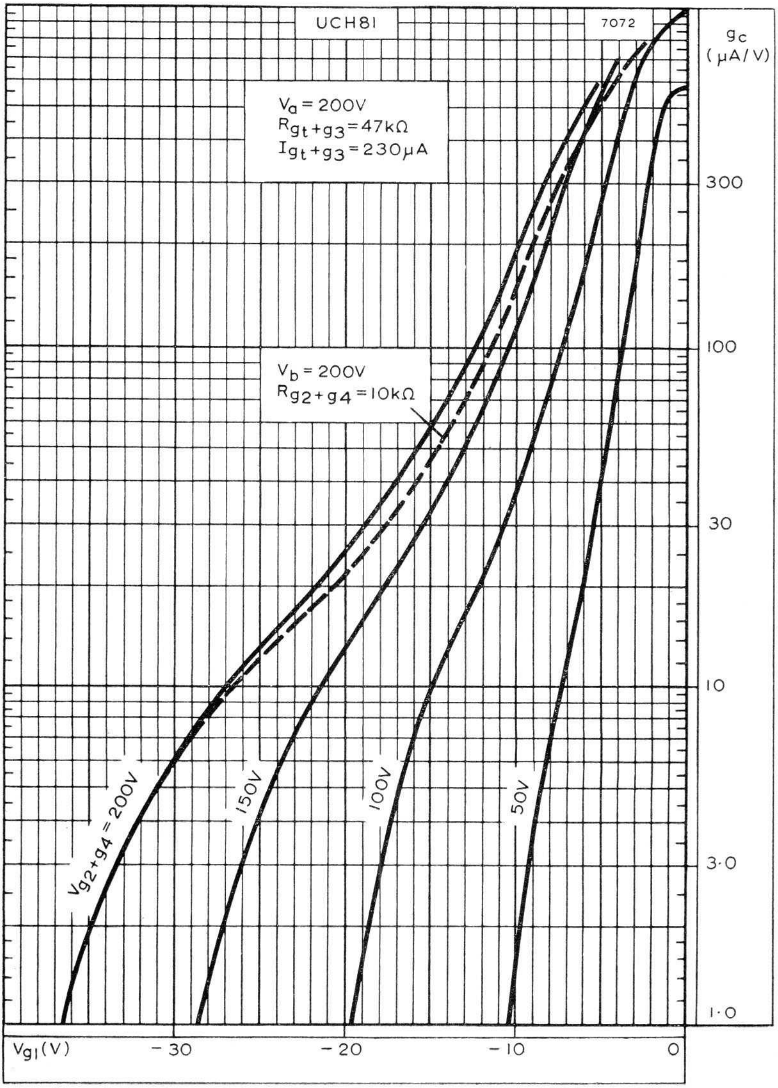
$V_a = 170V$



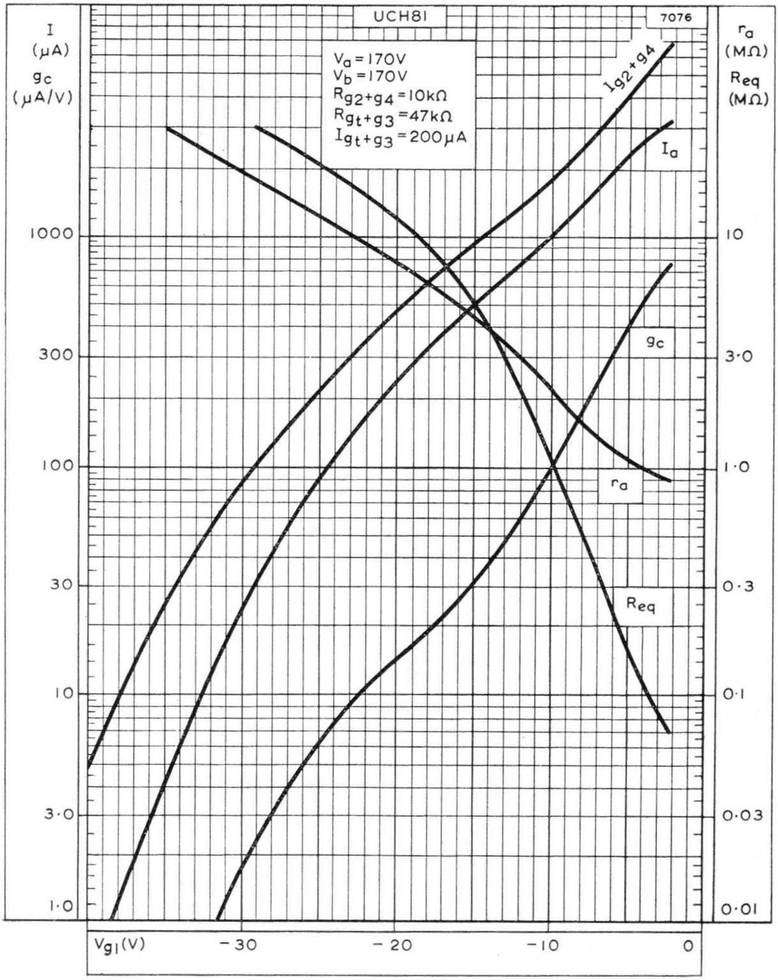
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS FREQUENCY CHANGER.
$V_a = 200V$



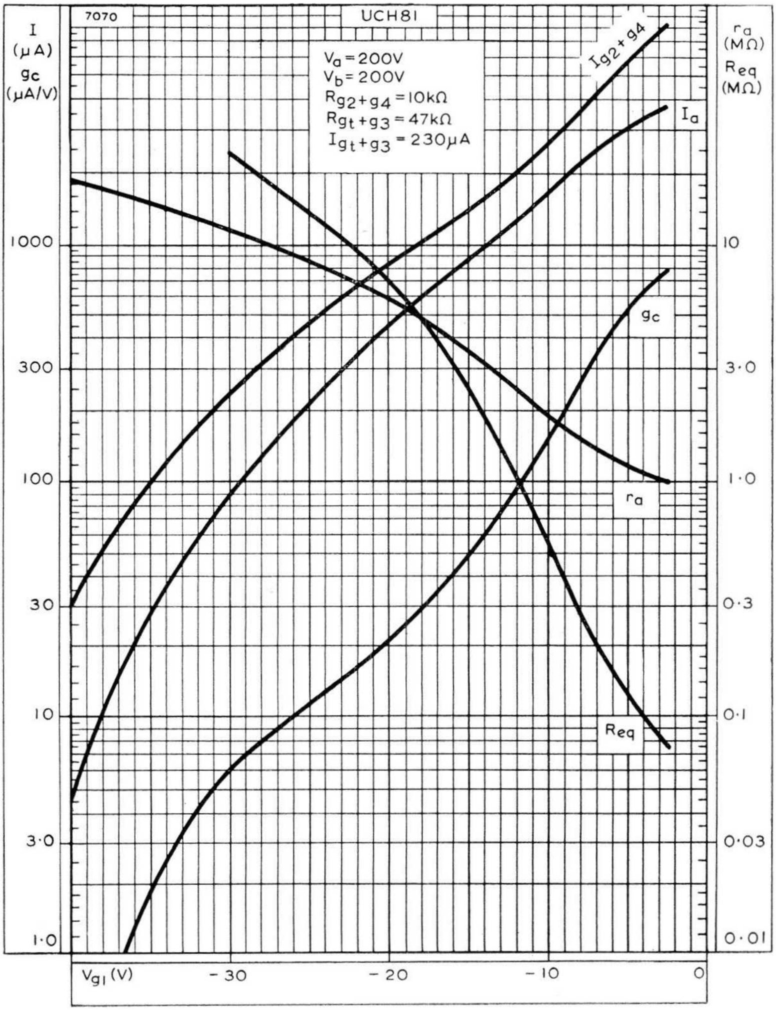
CONVERSION CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER.
V_a = 170V



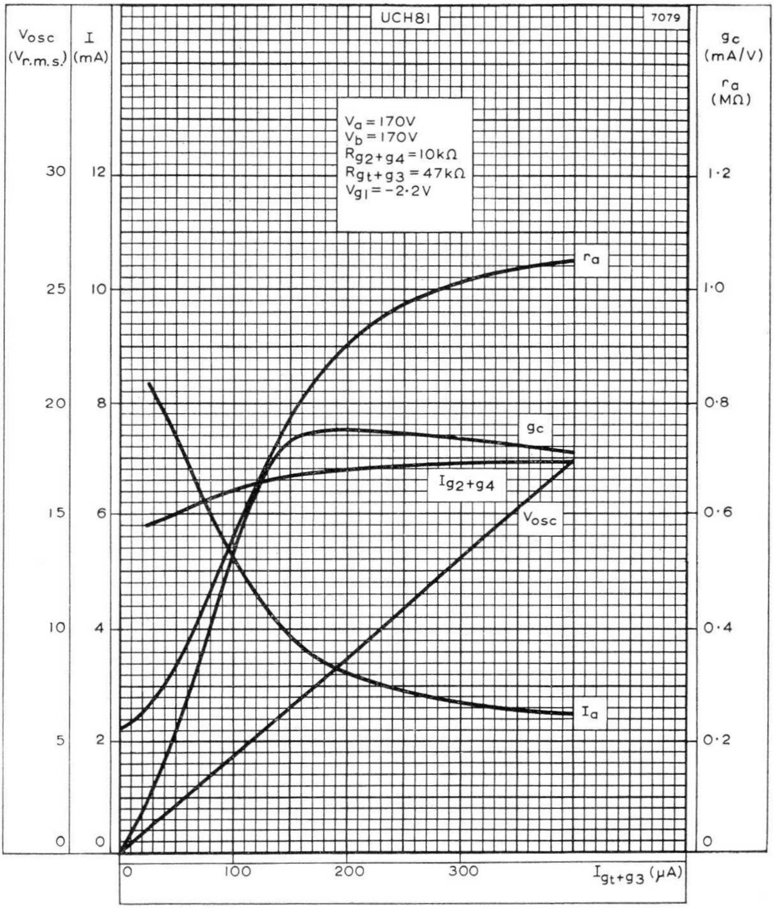
CONVERSION CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER.
$V_a = 200V$



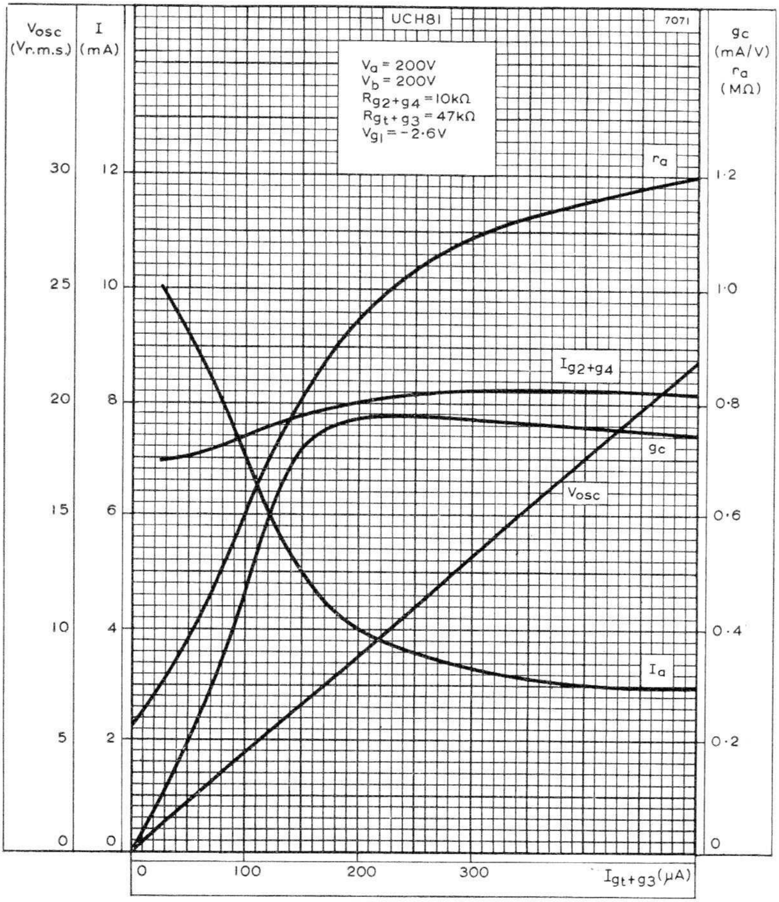
ANODE AND SCREEN-GRID CURRENTS, CONVERSION CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER. $V_a = 170V$



ANODE AND SCREEN-GRID CURRENTS, CONVERSION CONDUCTANCE, ANODE IMPEDANCE AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WHEN USED AS A FREQUENCY CHANGER. $V_a = 200V$



ANODE AND SCREEN-GRID CURRENTS, CONVERSION CONDUCTANCE, ANODE IMPEDANCE AND OSCILLATOR VOLTAGE PLOTTED AGAINST OSCILLATOR-GRID CURRENT.
V_a = 170V



ANODE AND SCREEN-GRID CURRENTS, CONVERSION CONDUCTANCE, ANODE IMPEDANCE AND OSCILLATOR VOLTAGE PLOTTED AGAINST OSCILLATOR-GRID CURRENT.
$V_a = 200V$

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

HEATER

Suitable for series operation a.c. or d.c.

I_h	100	mA
V_h	50	V

MOUNTING POSITION

Any

CAPACITANCES (measured without external shield)

c_{at-g1p}	<0.02	pF
c_{gt-ap}	<0.02	pF
c_{gt-g1p}	<0.025	pF
c_{at-ap}	<0.25	pF

Pentode section

c_{in}	9.3	pF
c_{out}	8.0	pF
c_{a-g1}	<0.3	pF
c_{g1-h}	<0.3	pF

Triode section

c_{a-k+h}	4.3	pF
c_{g-k+h}	2.7	pF
c_{a-g}	4.2	pF
c_{g-h}	<0.02	pF

CHARACTERISTICS

Pentode section

V_a	100	200	V
V_{g2}	100	200	V
I_a	26	35	mA
I_{g2}	5.0	7.0	mA
V_{g1}	−6.0	−16	V
g_m	6.8	6.4	mA/V
r_a	15	20	kΩ
μ_{g1-g2}	10	9.5	

Triode section

V_a	100	V
I_a	3.5	mA
V_g	0	V
g_m	2.5	mA/V
r_a	28	kΩ
μ	70	

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

PENTODE SECTION AS AUDIO OUTPUT VALVE

Single valve class 'A'

V_a	100	200	V
V_{g2}	100	200	V
V_{g1}	−6.0	−16	V
$I_{a(o)}$	26	35	mA
$I_{g2(o)}$	5.0	7.0	mA
$V_{in(r.m.s.)}$ P_{out}=50mW	650	600	mV
R_a	3.9	5.6	kΩ
$V_{in(r.m.s.)}$	3.8	6.6	V
*P_{out}	1.0	3.5	W
D_{tot}	9.0	10	%

Two valves in class 'AB' push-pull

V_a	100	200	V
V_{g2}	100	200	V
†R_k	150	190	Ω
$I_{a(o)}$	2×20	2×35	mA
I_a (max. sig.)	2×22.5	2×39.5	mA
$I_{g2(o)}$	2×4.0	2×7.0	mA
I_{g2} (max. sig.)	2×7.0	2×16.5	mA
R_{a-a}	5.0	6.0	kΩ
$V_{in(g1-g1)r.m.s.}$	12.4	25	V
P_{out}	2.3	9.8	W
D_{tot}	4.0	4.0	%

†Common cathode bias resistor.

*P_{out} and D_{tot} are measured at fixed bias and therefore represent the power output available during the reproduction of speech and music.

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

TRIODE SECTION AS A.F. AMPLIFIER

V_b (V)	R_a (kΩ)	I_a (mA)	R_k (kΩ)	R_g (MΩ)	Z_{source} (kΩ)	$\frac{V_{out}}{V_{in}}$	D_{tot} (%)	R_{g1}* (kΩ)
200	100	0.85	1.5	3.3	0	47	1.0	330
150	100	0.6	1.8	3.3	0	45	1.9	330
100	100	0.38	1.8	3.3	0	41	6.0	330
200	100	0.85	1.5	3.3	220	43	0.85	330
150	100	0.6	1.8	3.3	220	41	1.05	330
100	100	0.38	1.8	3.3	220	34	3.6	330
200	220	0.52	2.2	3.3	0	54.5	1.0	680
150	220	0.36	2.7	3.3	0	52	1.85	680
100	220	0.23	2.7	3.3	0	47	4.25	680
200	220	0.52	2.2	3.3	220	50	0.5	680
150	220	0.36	2.7	3.3	220	47	1.0	680
100	220	0.23	2.7	3.3	220	38	3.75	680
200	100	1.05	0	22	0	48.5	0.7	330
150	100	0.7	0	22	0	46	1.55	330
100	100	0.37	0	22	0	44	8.0	330
200	100	1.05	0	22	220	44	2.1	330
150	100	0.7	0	22	220	42.5	1.6	330
100	100	0.37	0	22	220	37	5.9	330
200	220	0.59	0	22	0	56	0.8	680
150	220	0.4	0	22	0	53	1.7	680
100	220	0.21	0	22	0	46	5.6	680
200	220	0.59	0	22	220	51	2.0	680
150	220	0.4	0	22	220	48.5	1.4	680
100	200	0.21	0	22	220	42	3.1	680

$\frac{V_{out}}{V_{in}}$ measured with an input voltage of 100mV

D_{tot} measured for $V_{out}=10V$

*Grid resistor of following valve.

MICROPHONY

The triode section can be used without special precautions against microphony in circuits in which the input voltage is $\geqq 10mV_{(r.m.s.)}$ for an output of 50mW from the output stage.

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

LIMITING VALUES

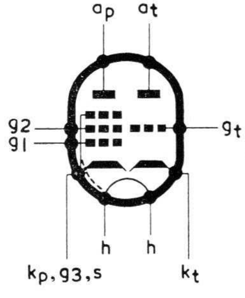
Pentode Section

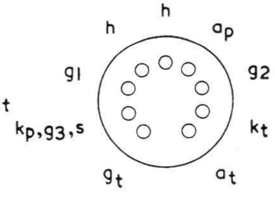
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	7.0	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	1.8	W
p_{g2} max. (max. sig. speech and music)	3.2	W
I_k max.	50	mA
R_{g1-k} max. (self bias)	2.0	MΩ
R_{g1-k} max. (fixed bias)	1.0	MΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

Triode Section

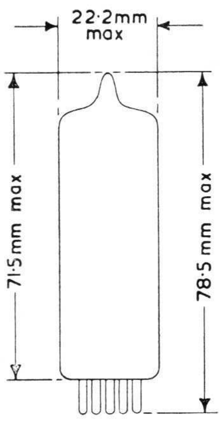
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	1.0	W
I_k max.	15	mA
R_{g-k} max. (self bias)	3.0	MΩ
R_{g-k} max. (fixed bias)	1.0	MΩ
R_{g-k} max. (grid current biasing)	22	MΩ
Z_{g-k} max. (f=50c/s)	500	kΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

2324





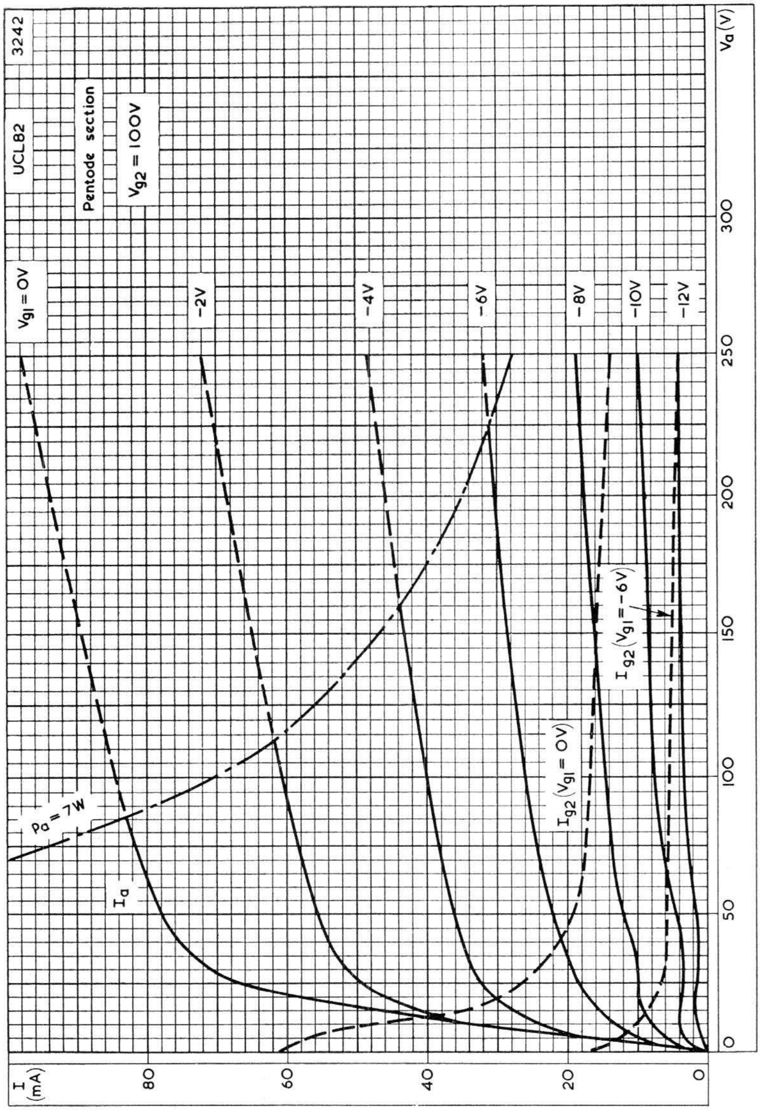
B9A Base



TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

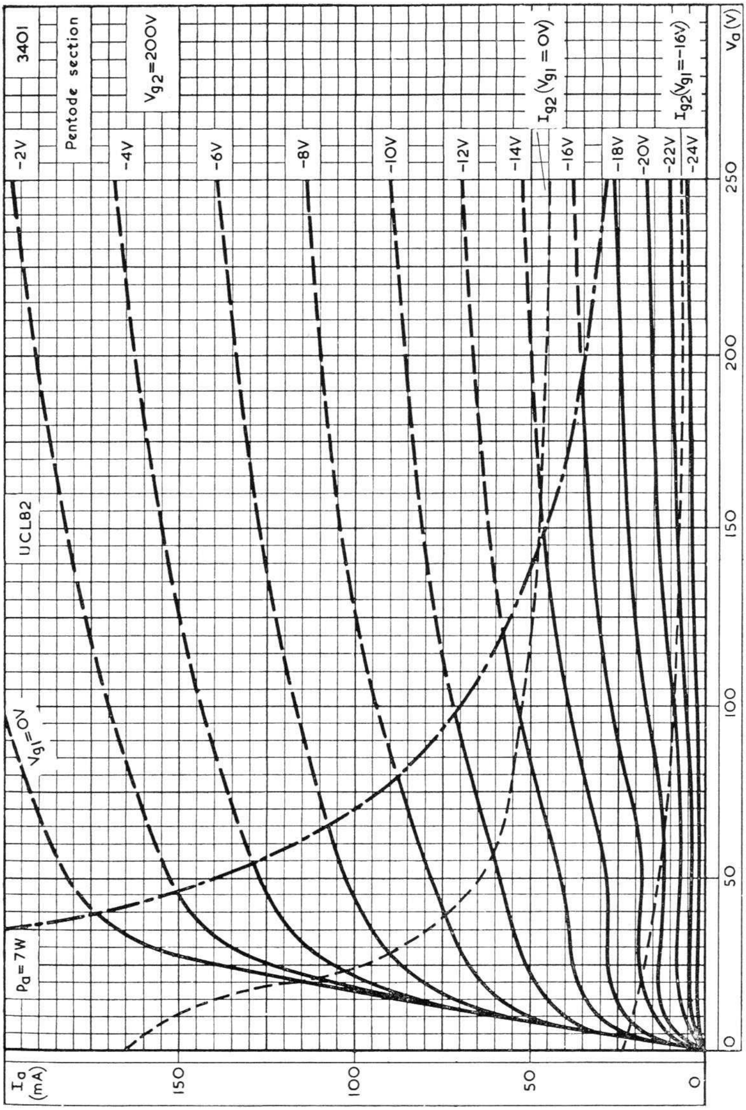


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 100V

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

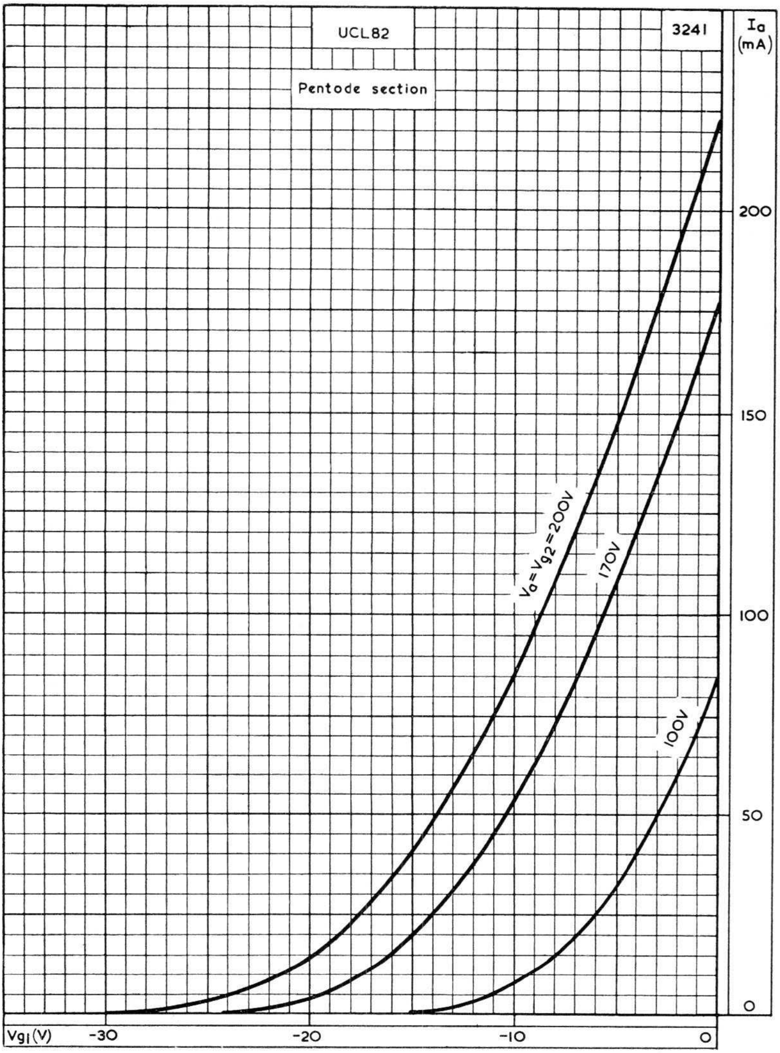


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2}=200V

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

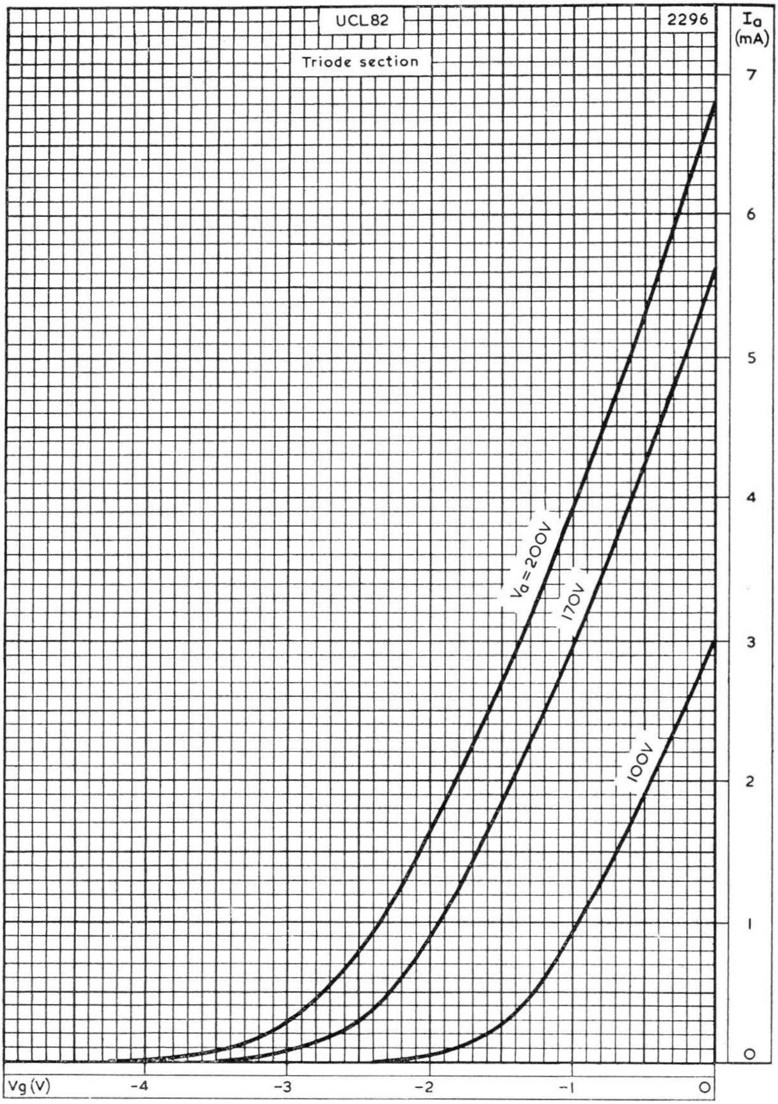


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR VARIOUS VALUES OF ANODE AND SCREEN-GRID VOLTAGE

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

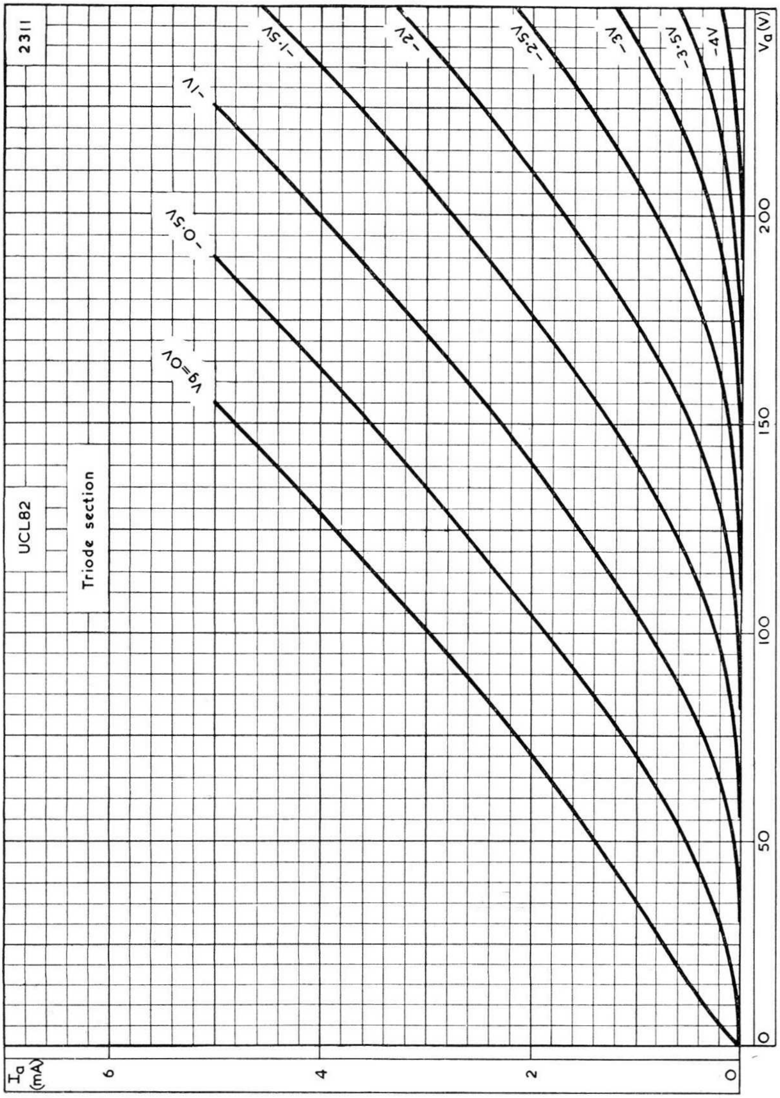


ANODE CURRENT OF THE TRIODE SECTION PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR VARIOUS VALUES OF ANODE VOLTAGE

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

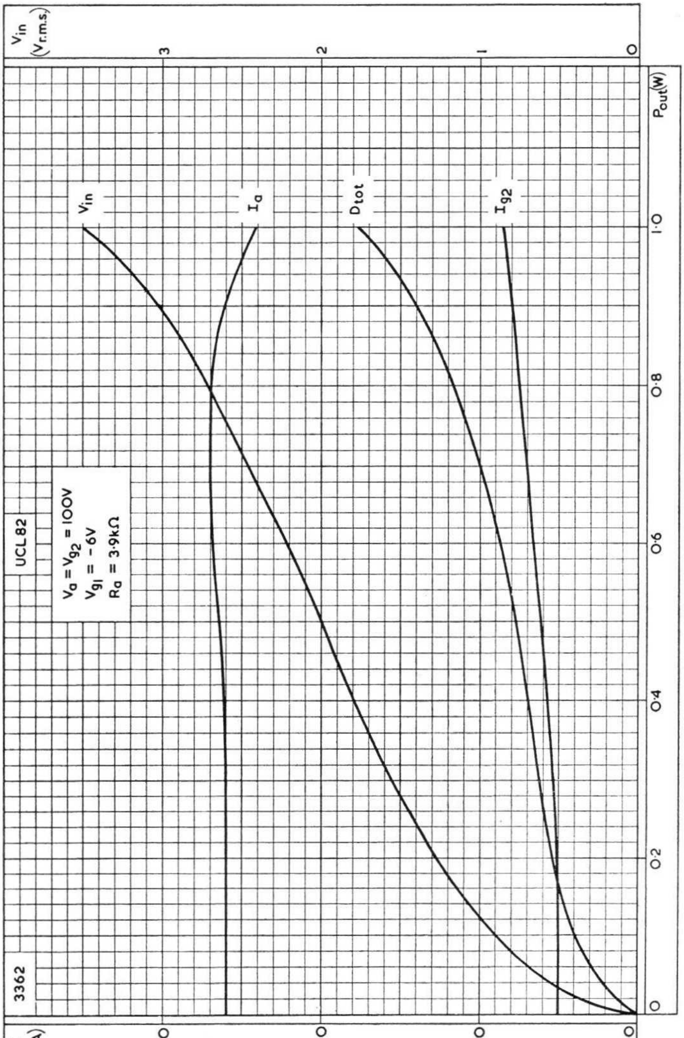


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR VARIOUS VALUES OF GRID VOLTAGE

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

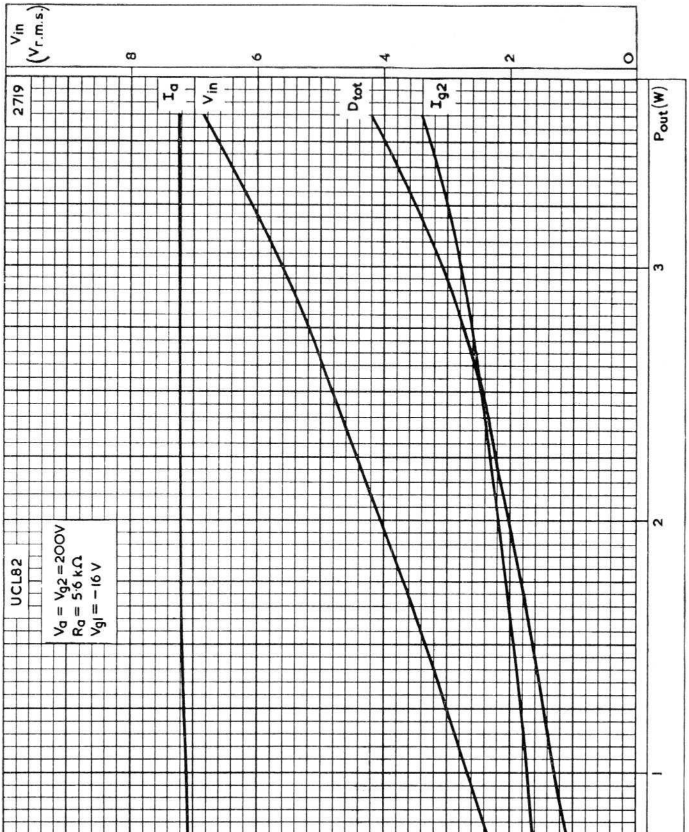


PERFORMANCE OF SINGLE UCL82 CLASS 'A' AMPLIFIER. $V_a = V_{g2} = 100V$

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.



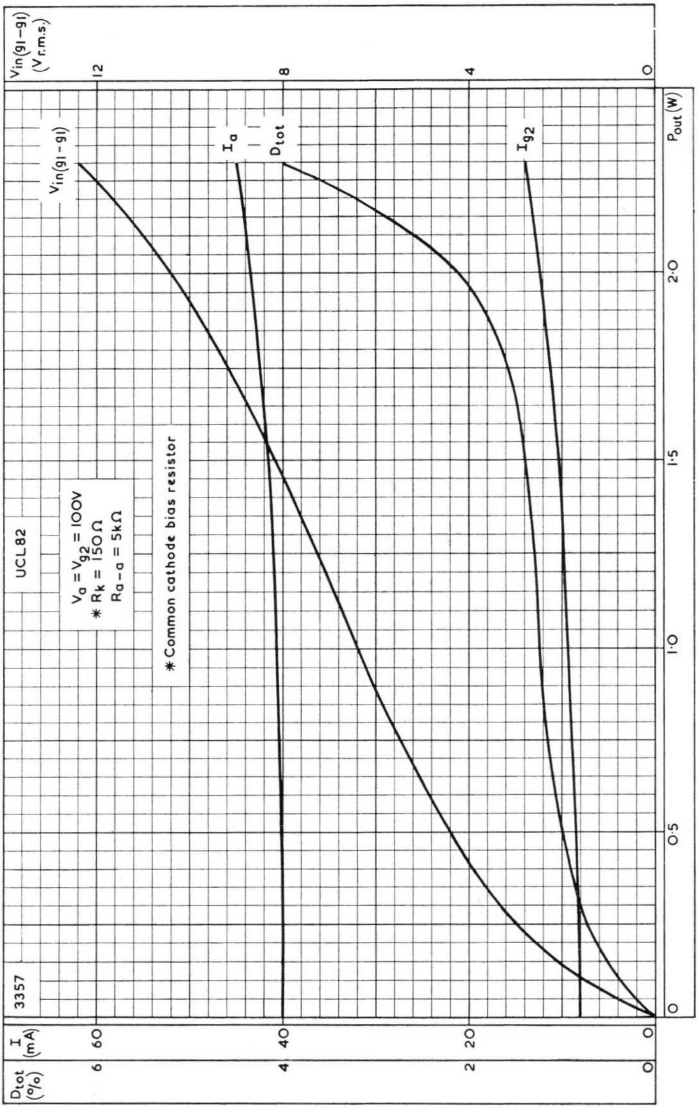
PERFORMANCE OF SINGLE UCL82 CLASS 'A' AMPLIFIER. $V_a = V_{g2} = 200V$

Mullard

UCL82

TRIODE PENTODE

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.

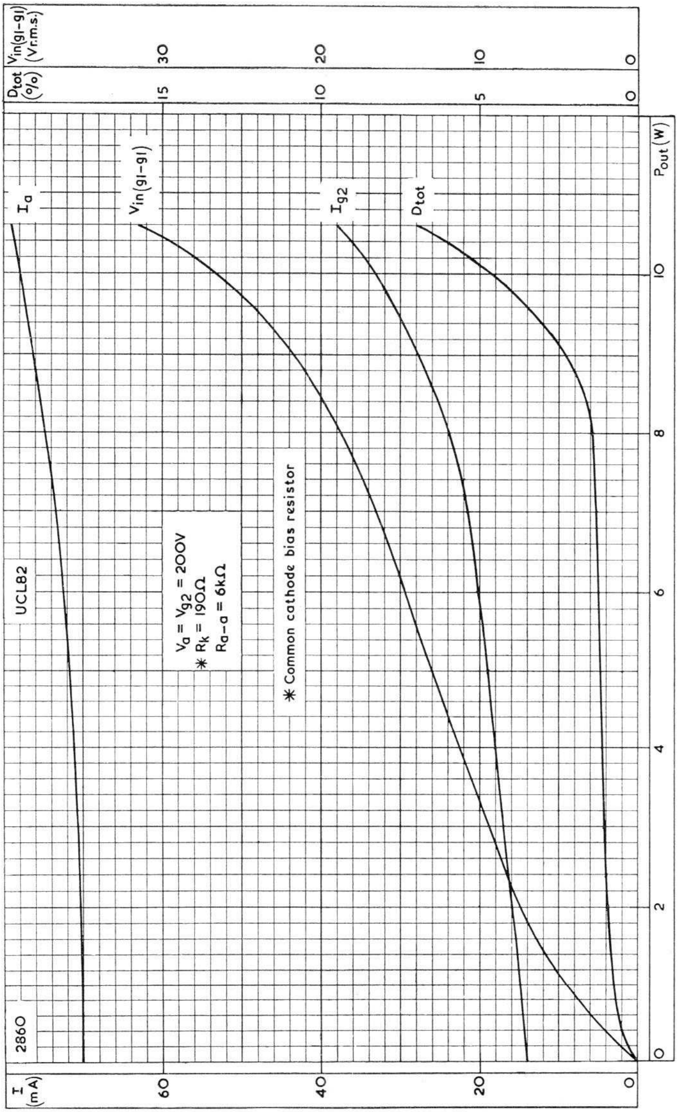


PERFORMANCE OF UCL82 IN PUSH-PULL. $V_a = V_{g_2} = 100V$

TRIODE PENTODE

UCL82

Combined triode and output pentode with separate cathodes and 100mA heater intended for use in audio frequency applications.



PERFORMANCE OF UCL82 IN PUSH-PULL. $V_a = V_{g2} = 200V$

VARIABLE-MU R.F. PENTODE

UF89

Variable-mu pentode for use as r.f. or i.f. amplifier in f.m./a.m. receivers with series connected heaters.

HEATER

I_h	100	mA
V_h	12.6	V

CAPACITANCES

c_{in}	5.5	pF
c_{out}	5.1	pF
c_{a-g1}	<2.0	mpF
c_{g1-h}	50	mpF
c_{g1-g2}	2.1	pF

CHARACTERISTICS

V_a	170	170	V
V_{g3}	0	0	V
V_{g2}	100	110	V
V_{g1}	−1.2*	−2.0	V
I_a	12	12	mA
I_{g2}	4.4	3.9	mA
g_m	4.4	3.8	mA/V
r_a	400	525	kΩ
μ_{g1-g2}	21	—	

*At this voltage, grid current may occur. If this is not acceptable the negative bias should be increased to −2.0V.

OPERATING CONDITIONS

$V_a = V_b$	170	170	200	200	V
V_{g3}	0	0	0	0	V
R_{g2}	22	15	33	24	kΩ
V_{g1}	−0.5*	−2.0	−0.5*	−2.0	V
R_k	—	130	—	130	Ω
R_{g1}	10	—	10	—	MΩ
I_a	11.8	11	11.3	11.1	mA
I_{g2}	4.3	3.9	3.9	3.8	mA
g_m	5.2	3.8	5.15	3.85	mA/V
r_a	400	450	475	550	kΩ
R_{eq}	2.6	4.5	2.5	4.2	kΩ
g_m ($V_{g1} = -20V$)	110	110	150	160	μA/V
r_g (f=50Mc/s)	—	10	—	10	kΩ

*This voltage is produced by the grid current flowing through the grid resistor and the steady current of the diode. If this condition is not acceptable the negative grid bias should be increased to −2.0V.

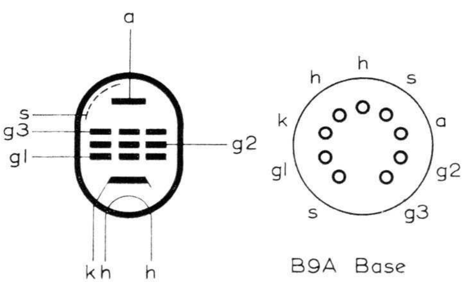
UF89

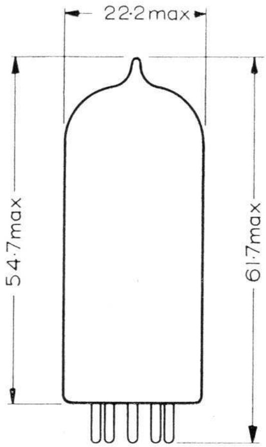
VARIABLE-MU R.F. PENTODE

LIMITING VALUES

$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	2.25	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	250	V
p_{g2} max.	450	mW
I_k max.	16.5	mA
*R_{g1-k} max.	3.0	MΩ
R_{g3-k} max.	10	kΩ
V_{h-k} max.	150	V
R_{h-k} max.	20	kΩ

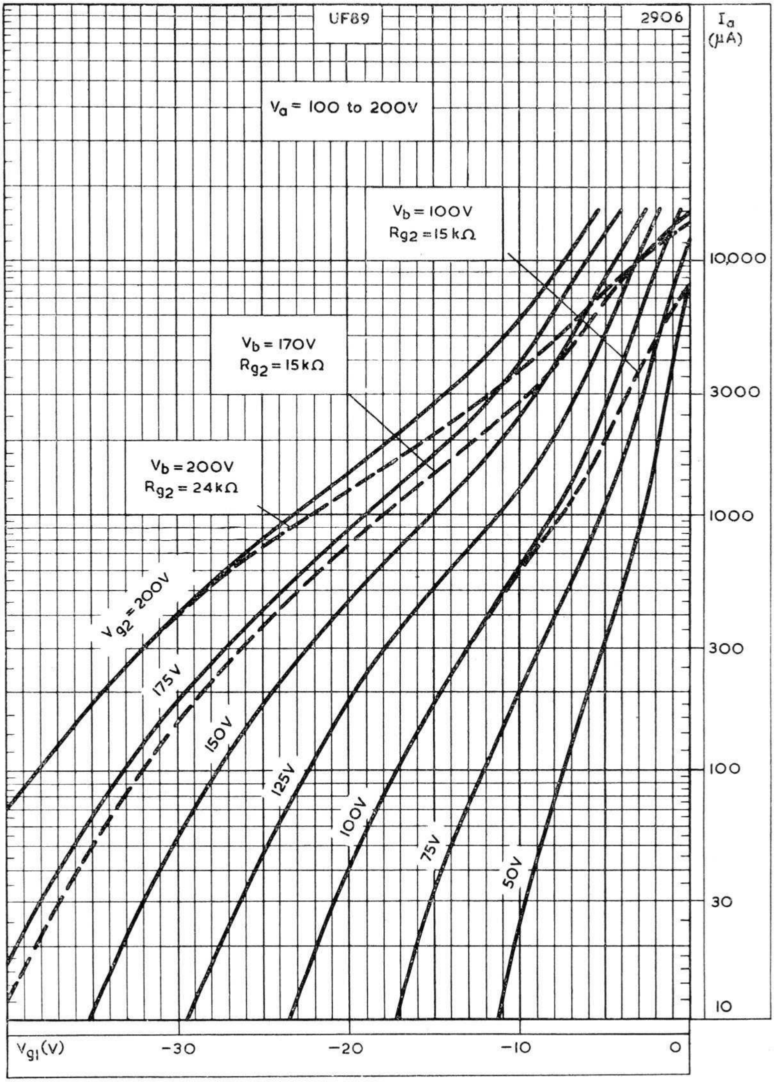
*With grid current biasing R_{g1-k} max. = 22MΩ.



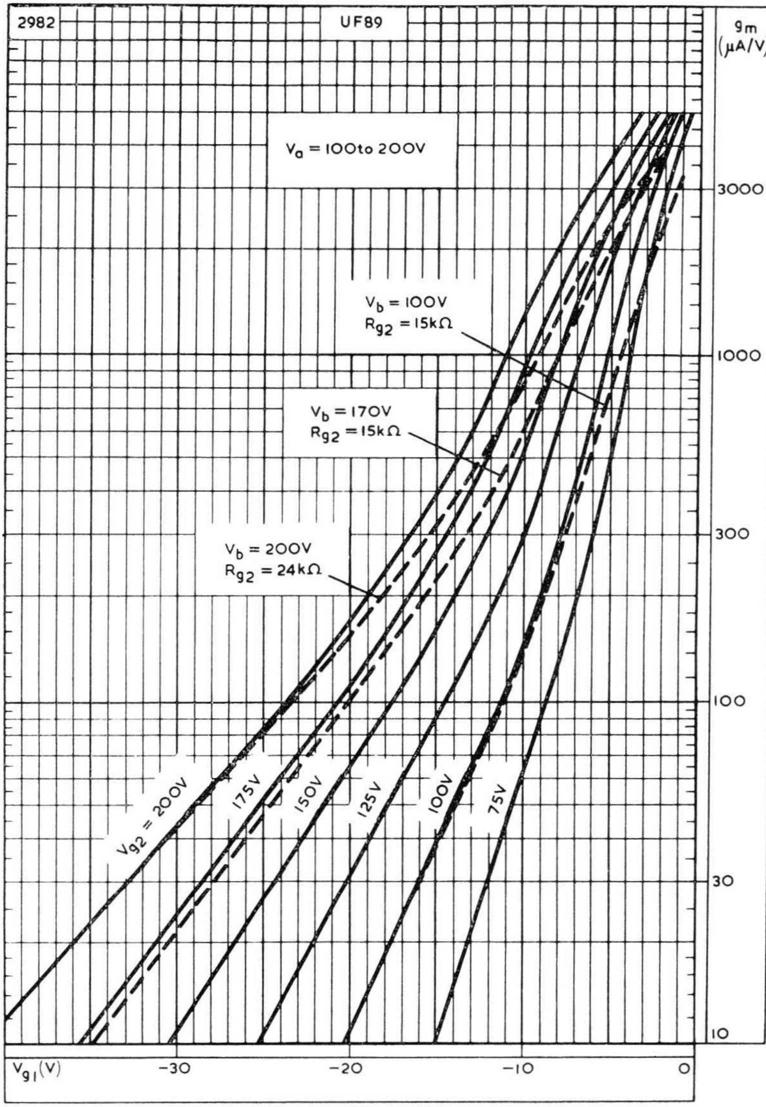


6394

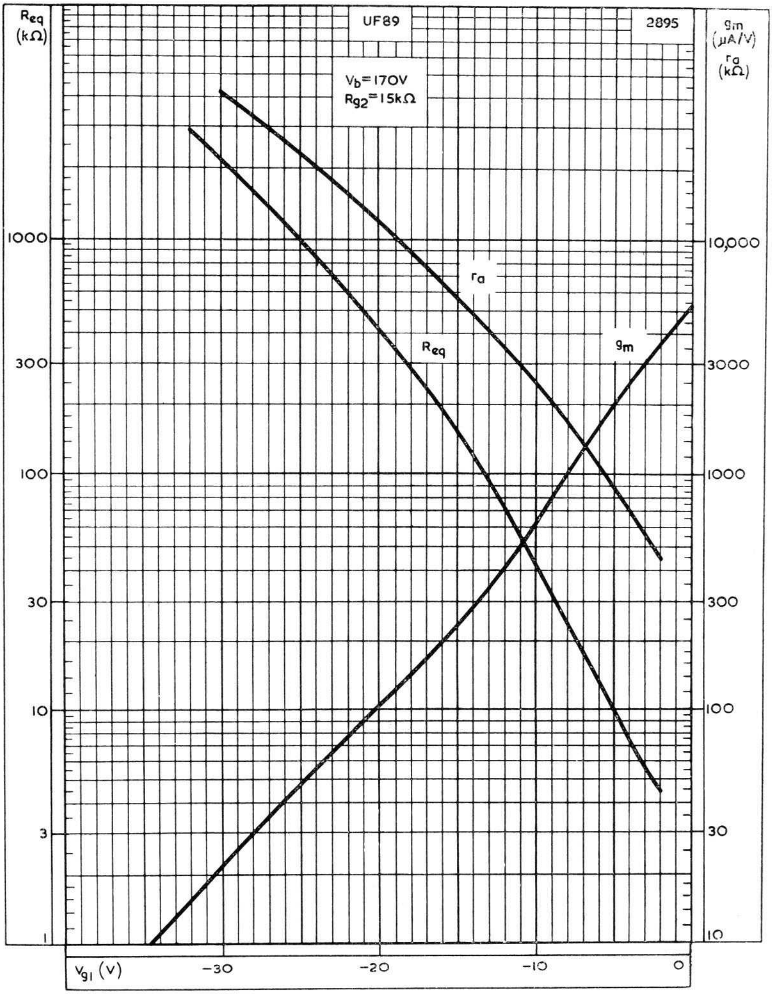
All dimensions in mm



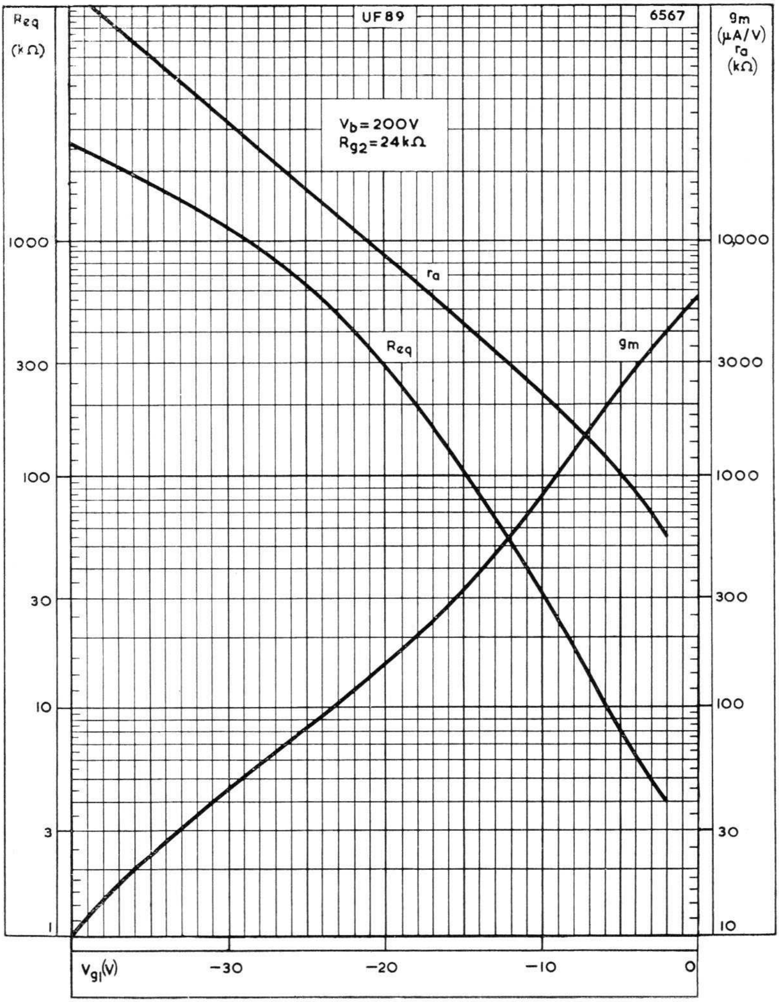
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE
WITH SCREEN-GRID VOLTAGE AS PARAMETER



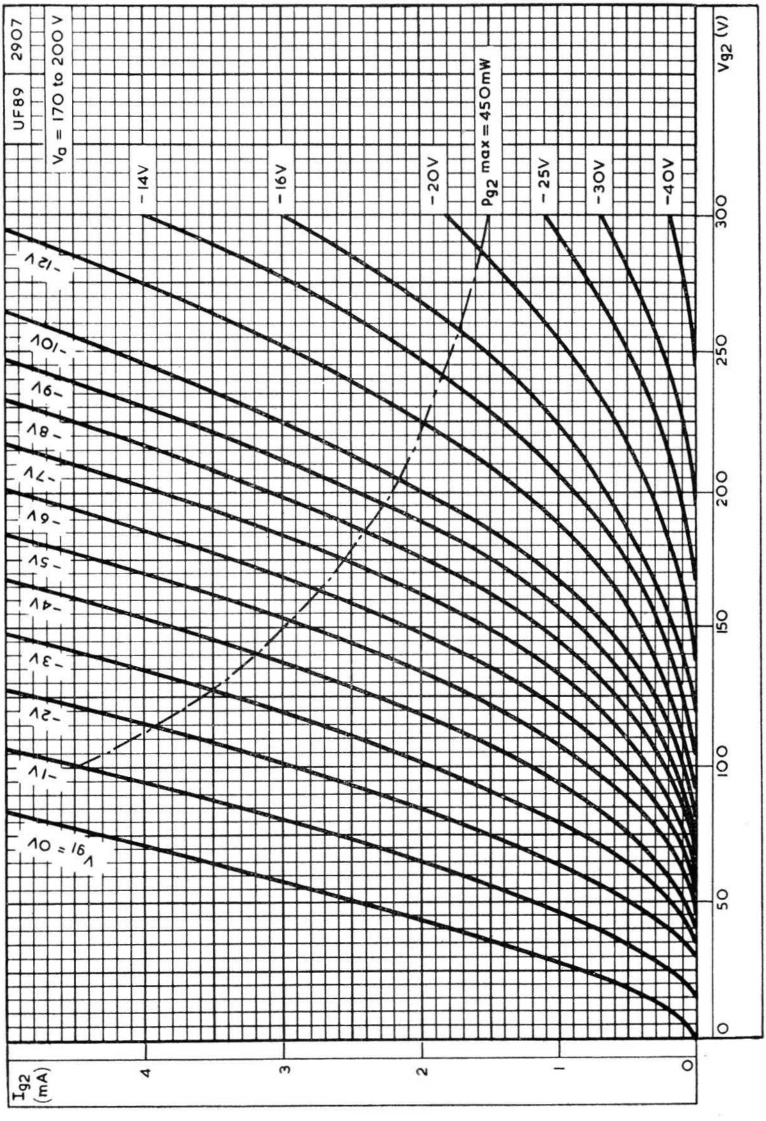
MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



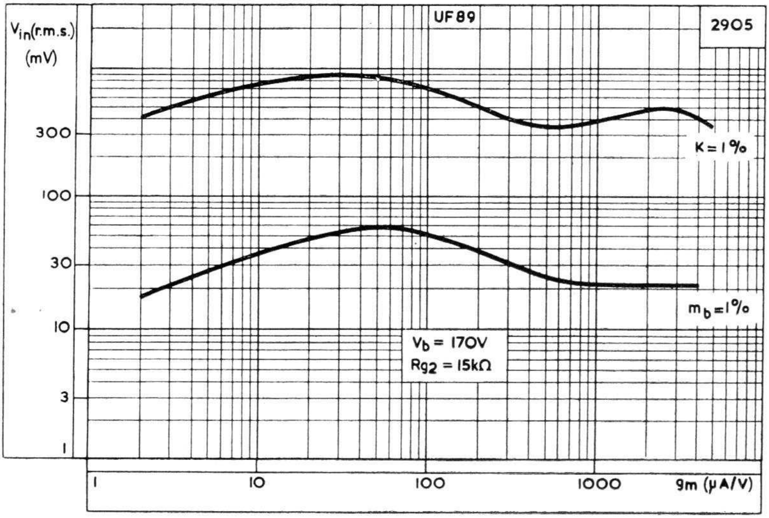
MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE
V_b=170V

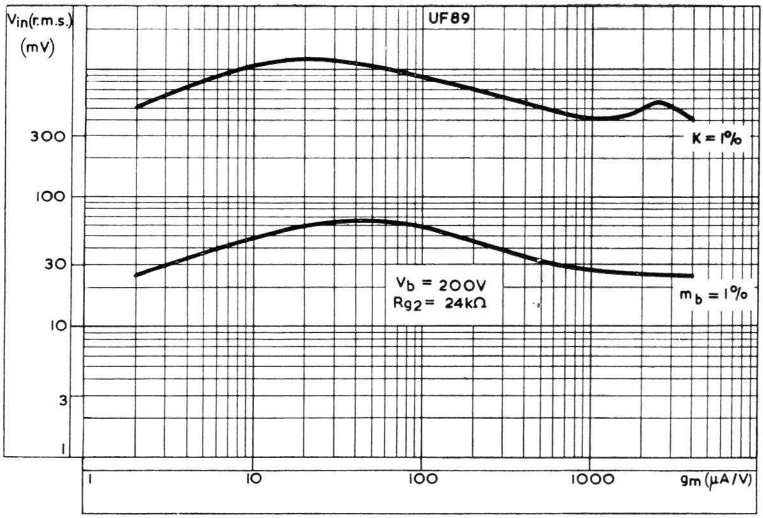


MUTUAL CONDUCTANCE, ANODE IMPEDANCE, AND EQUIVALENT NOISE RESISTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE $V_b = 200V$



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER





CROSS MODULATION AND MODULATION HUM CURVES

OUTPUT PENTODE

UL84

Output pentode rated for 12W anode dissipation and with 100mA heater for use in equipment with series connected heaters.

HEATER

I_h	100	mA
V_h	45	V

CAPACITANCES

c_{in}	12	pF
c_{out}	6.5	pF←
c_{a-g1}	<600	mpF
c_{g1-h}	<250	mpF

CHARACTERISTICS

V_a	100	170	200	V
V_{g2}	100	170	*	V
I_a	43	70	60	mA
I_{g2}	3.0	5.0	4.1	mA
V_{g1}	−6.7	−12.5	−17.3	V
g_m	9.0	10	8.8	mA/V
r_a	23	23	28	kΩ
μ_{g1-g2}	8.0	8.0	8.0	

$^*V_{g2(b)} = 200V$, $R_{g2} = 470\Omega$

OPERATING CONDITIONS AS SINGLE VALVE AMPLIFIER

V_a	100	170	200	V
V_{g2}	100	170	*	V
R_k	145	170	270	Ω
R_a	2.4	2.4	2.4	kΩ
I_a	43	70	60	mA
$I_{g2\ (0)}$	3.0	5.0	4.1	mA
$V_{in(r.m.s.)}$ (P_{out}=50mW)	500	500	550	mV
$V_{in(r.m.s.)}$	4.3	7.0	7.8	V
P_{out}	1.9	5.6	5.2	W
D_{tot}	10	10	10	%
$I_{g2\ (max.\ sig.)}$	11	22	12.5	mA

$^*V_{g2(b)} = 200V$, $R_{g2} = 470\Omega$ undecoupled.

P_{out} and D_{tot} are measured at fixed bias and therefore represent the power output available during the reproduction of speech and music. When a sustained sine wave is applied to the control grid the bias across the cathode resistor will readjust itself as a result of the increased anode and screen-grid currents. This will result in approximately 10% reduction in power output.

UL84

OUTPUT PENTODE

OPERATING CONDITIONS FOR TWO VALVES IN PUSH-PULL

Pentode connection

V_a	100	170	200	V
V_{g2}	100	170	200	V
R_k (per valve)	270	240	300	Ω
R_{a-a}	3.5	3.5	3.5	kΩ
$I_{a(o)}$	2×29	2×56.5	2×55	mA
$I_{g2(o)}$	2×1.6	2×3.0	2×2.8	mA
$V_{in(g1-g1)r.m.s.}$	14	26	29	V
P_{out}	3.6	13	15	W
D_{tot}	3.0	4.5	3.5	%
$I_{a(max.\ sig.)}$	2×31	2×57.5	2×60	mA
$I_{g2(max.\ sig.)}$	2×7.0	2×20.5	2×15	mA

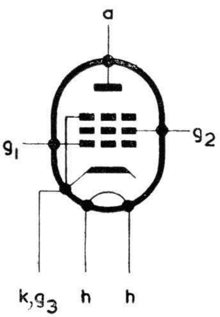
Distributed load conditions with screen-grid tapping at 20% of primary turns

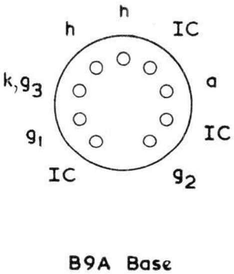
$V_a + V_{Rk}$	200	V
$V_{g2} + V_{Rk}$	200	V
R_k (per valve)	300	Ω
R_{a-a}	3.5	kΩ
$I_{k(o)}$	2×56.5	mA
$V_{in(g1-g1)r.m.s.}$	23	V
P_{out}	10	W
D_{tot}	0.8	%
$I_{k(max.\ sig.)}$	2×65	mA

LIMITING VALUES

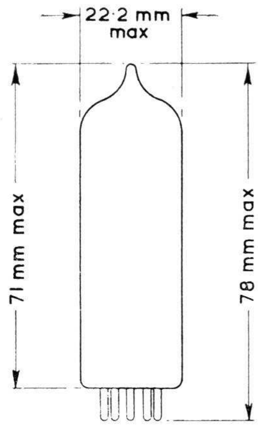
$V_{a(b)}$ max.	550	V
V_a max.	250	V
p_a max.	12	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	200	V
p_{g2} max.	1.75	W
I_k max.	100	mA
R_{g1-k} max.	300	kΩ
V_{h-k} max.	200	V
R_{h-k} max.	20	kΩ

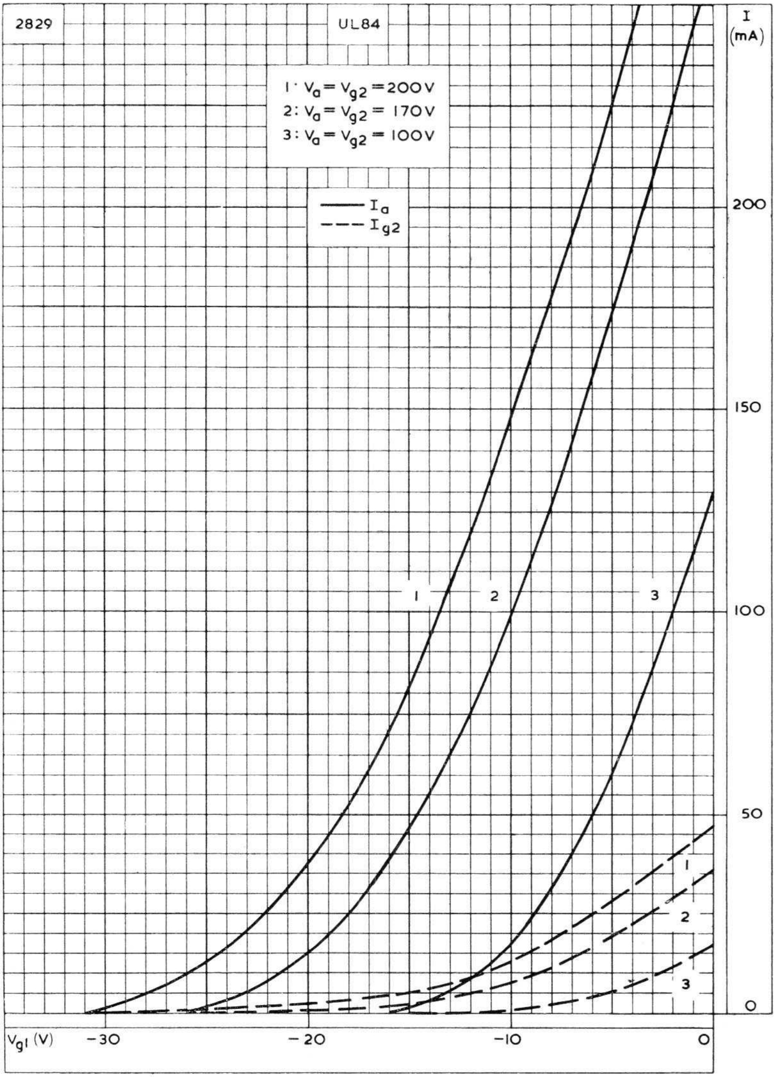
2834





B9A Base

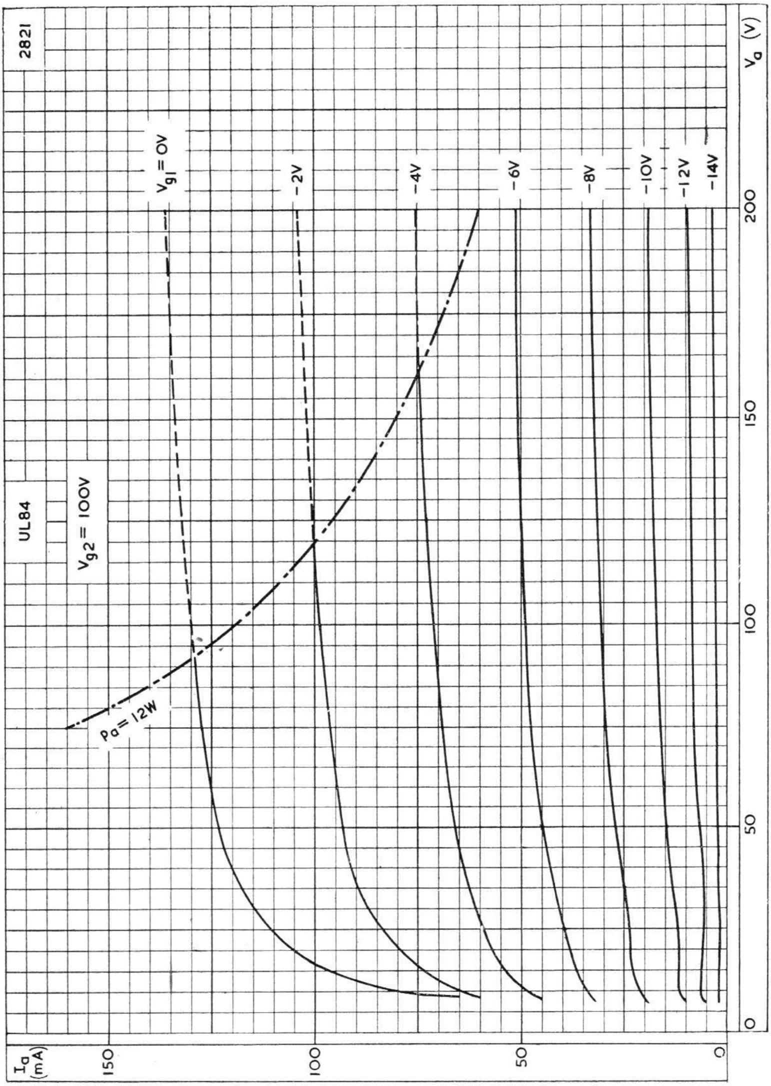




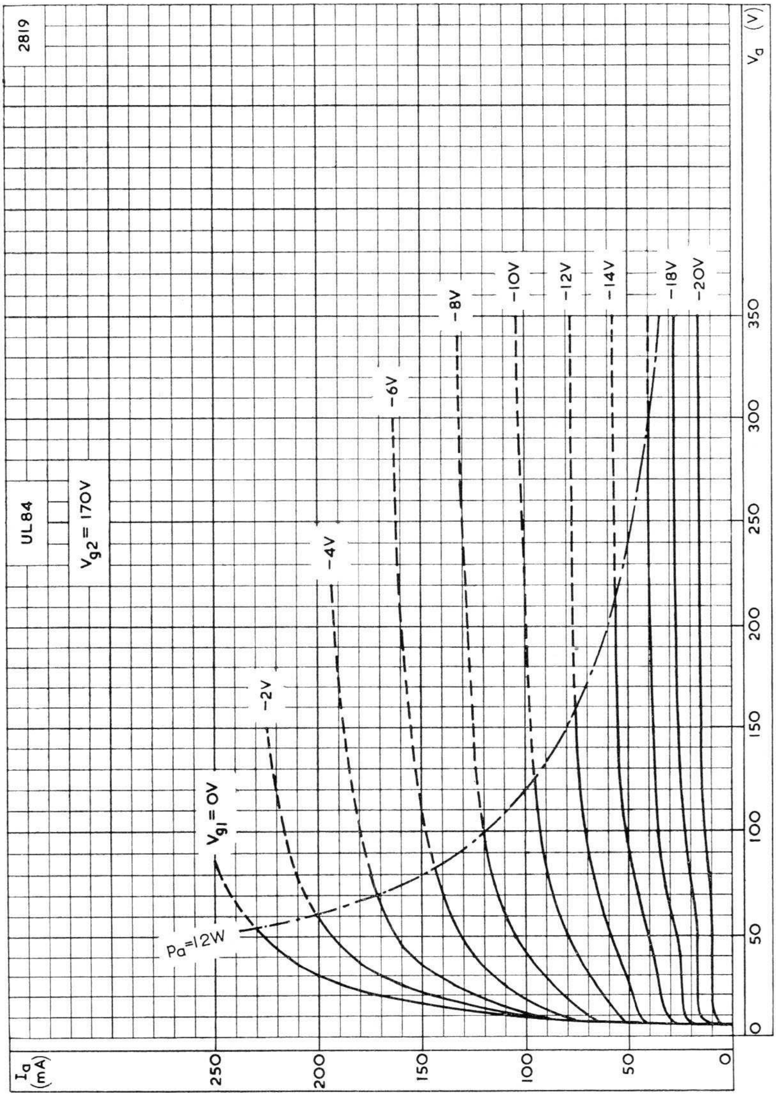
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE FOR VARIOUS ANODE AND SCREEN-GRID VOLTAGES

UL84

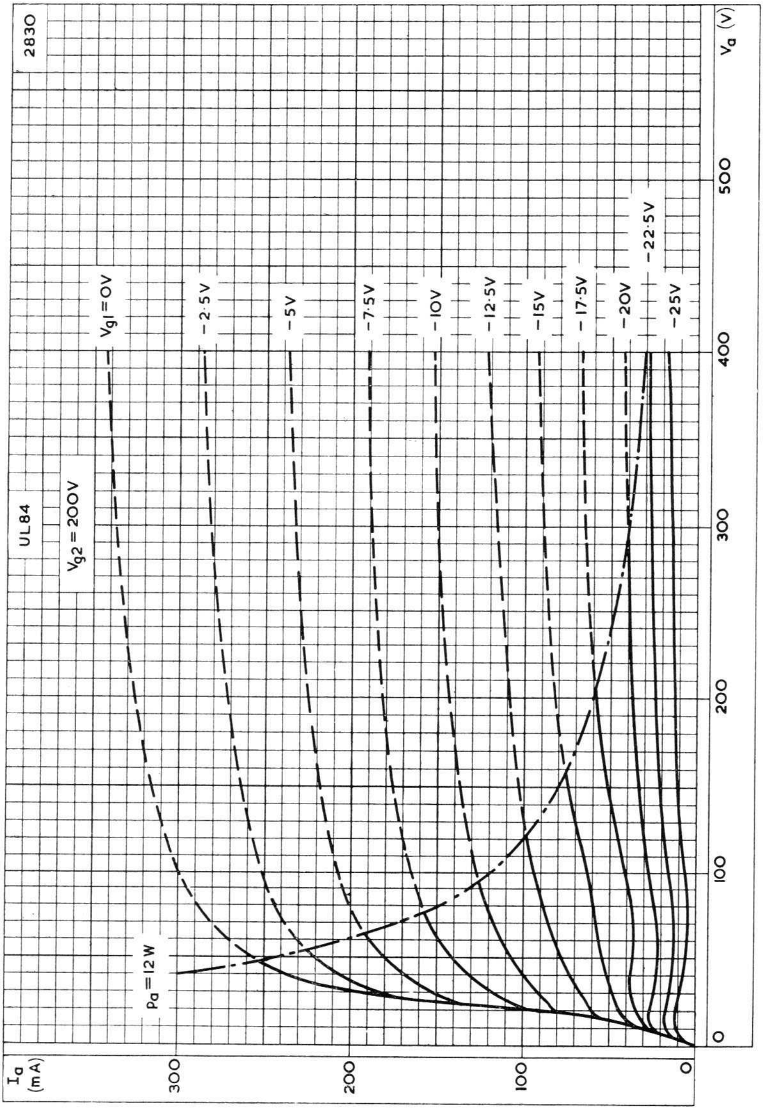
OUTPUT PENTODE



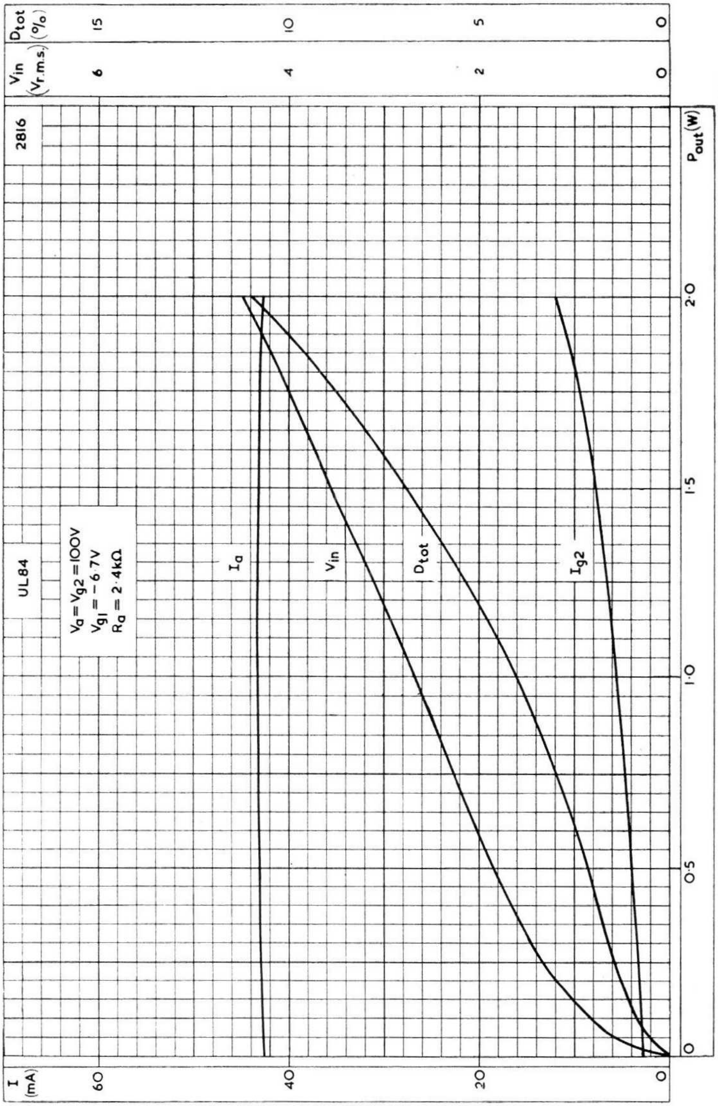
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 100V



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 170V



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$

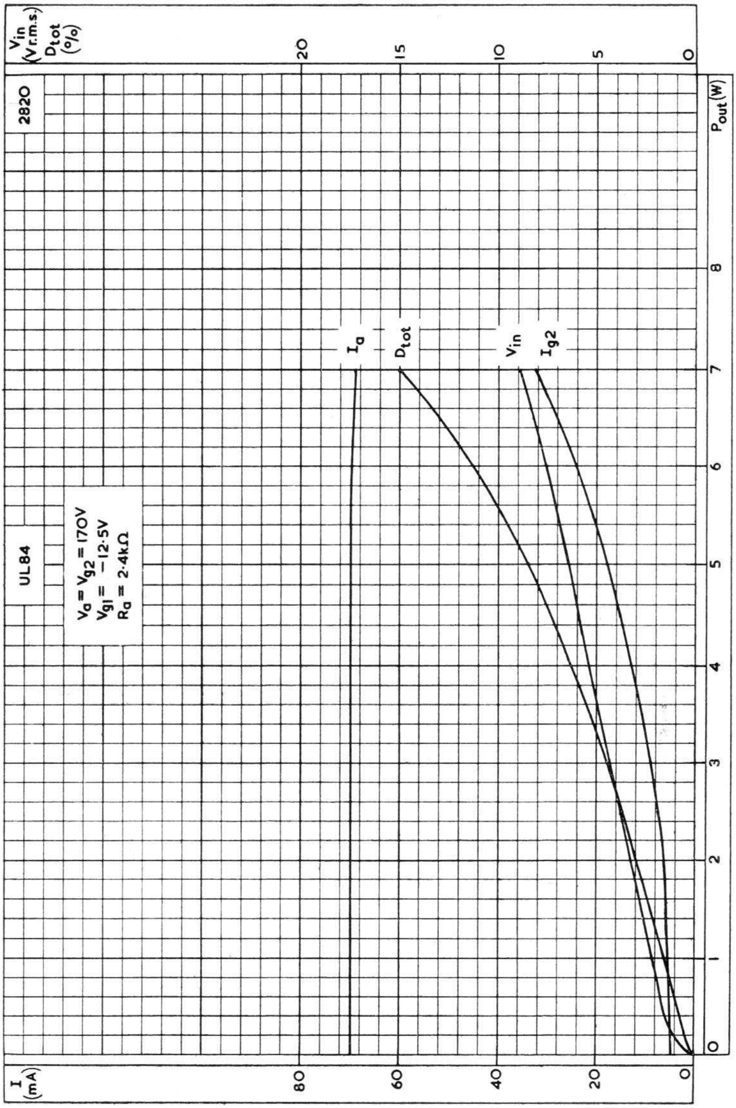


PERFORMANCE OF UL84 WHEN USED AS SINGLE VALVE AMPLIFIER

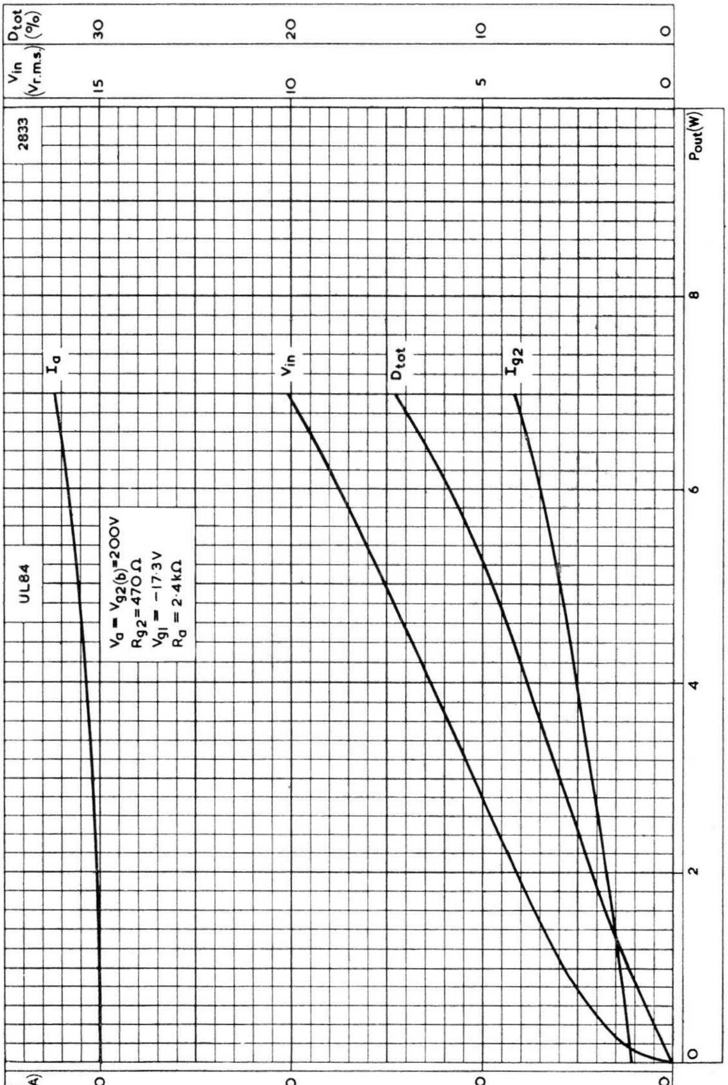
$V_a = V_{g2} = 100V$

UL84

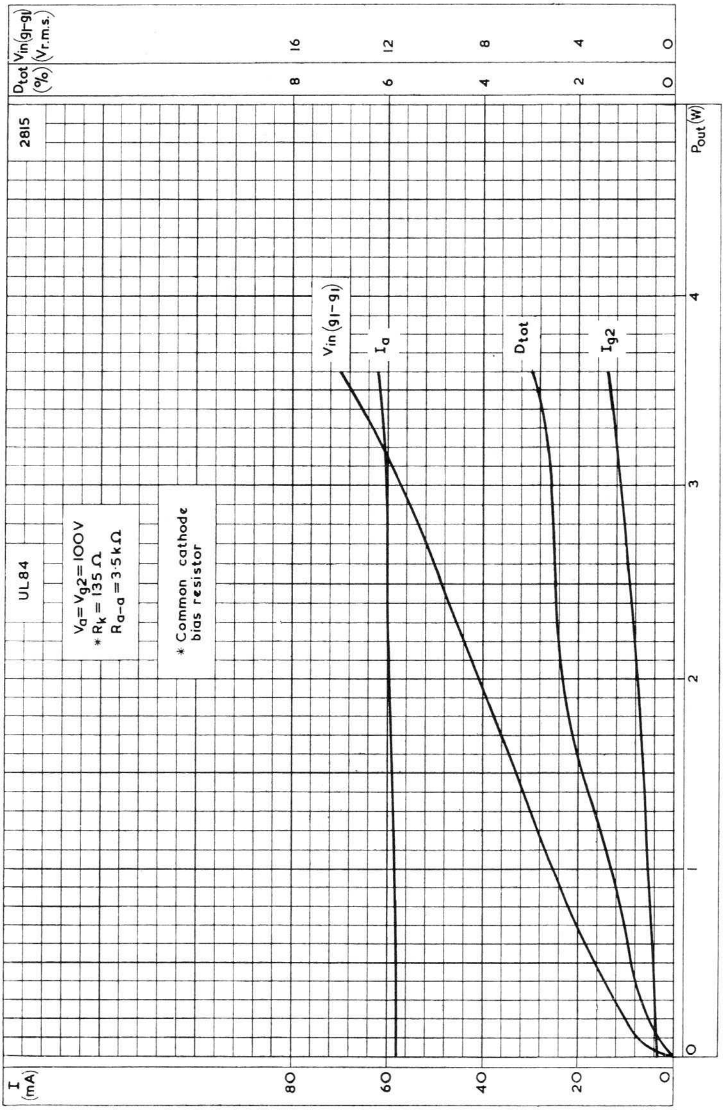
OUTPUT PENTODE



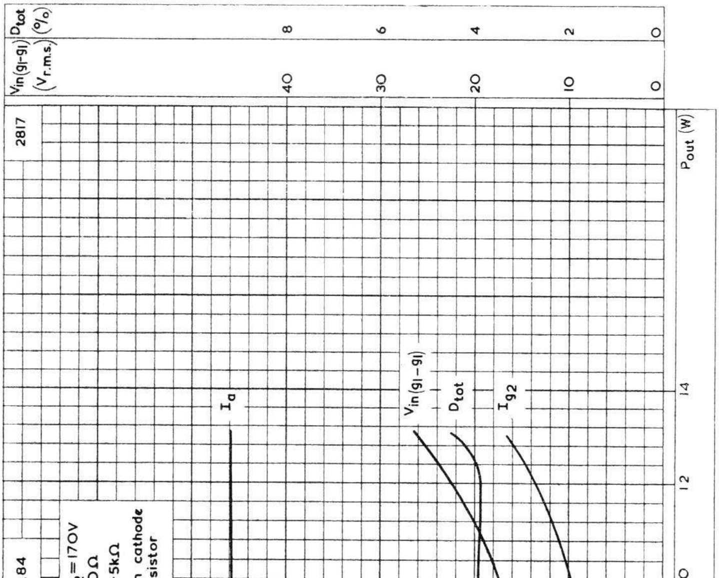
PERFORMANCE OF UL84 WHEN USED AS SINGLE VALVE AMPLIFIER
$V_a = V_{g2} = 170V$



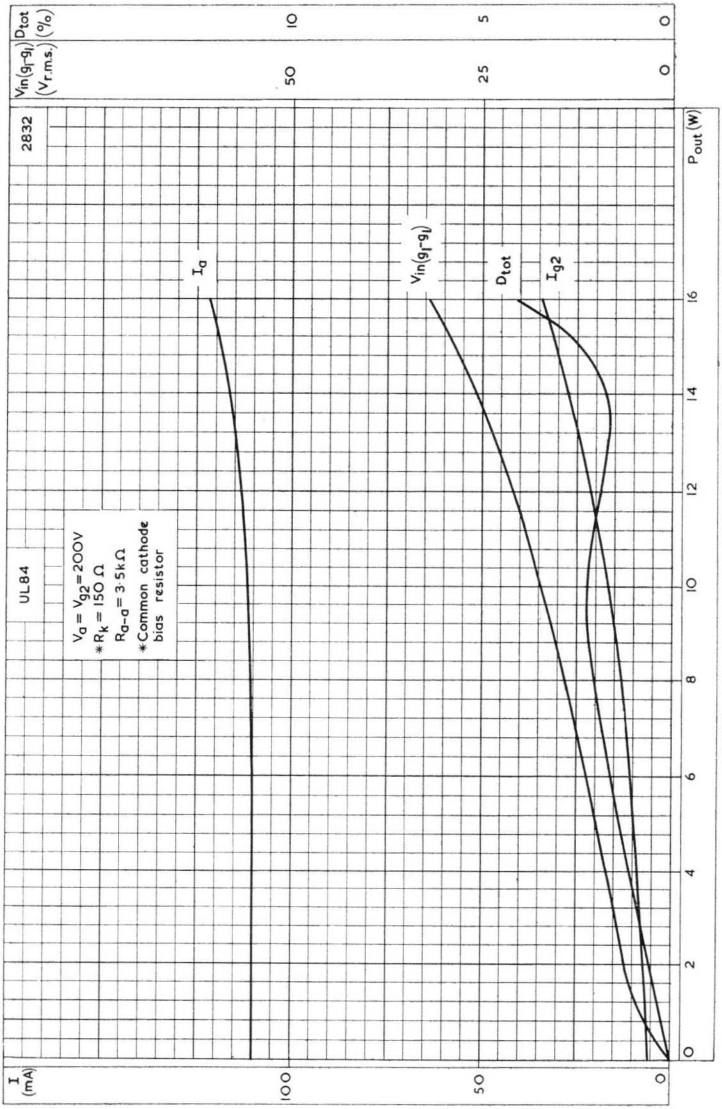
PERFORMANCE OF UL84 WHEN USED AS SINGLE VALVE AMPLIFIER
$V_a = V_{g2(b)} = 200V$



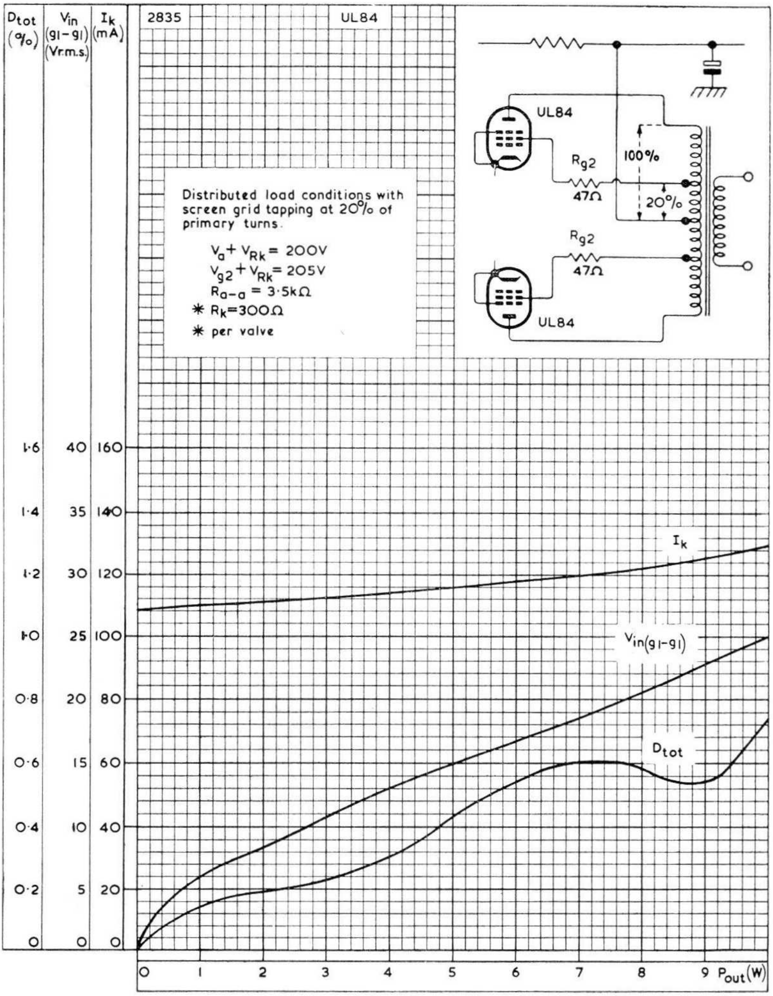
PERFORMANCE OF TWO UL84 IN PUSH-PULL. $V_a = V_{g2} = 100V$



PERFORMANCE OF TWO UL84 IN PUSH-PULL. $V_a = V_{g2} = 170V$



PERFORMANCE OF TWO UL84 IN PUSH-PULL. $V_a = V_{g2} = 200V$



PERFORMANCE OF TWO UL84 IN PUSH-PULL WITH DISTRIBUTED LOAD CONDITIONS. SCREEN-GRID TAPPING AT 20% OF PRIMARY TURNS

HALF-WAVE RECTIFIER

UY85

Indirectly heated half-wave rectifier with 100mA heater for use in equipment with series connected heaters.

HEATER

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

I_h	100	mA
V_h	38	V

LIMITING VALUES

P.I.V. max.	700	V
$V_{a(r.m.s.)}$ max.	250	V
I_{out} max.	110	mA
$i_{a(pk)}$ max.	660	mA
$v_{h-k(pk)}$ max. (cathode positive)	550	V

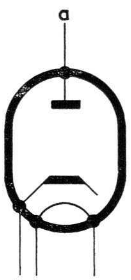
OPERATING CONDITIONS

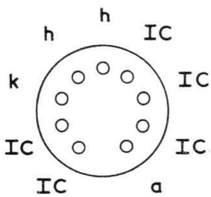
$V_{in(r.m.s.)}$	110	220	250	V
V_{out}	112	215	245	V
R_{lim} min.	0	90	100	Ω
I_{out}	110	110	110	mA
C	100	100	100	μF

UY85

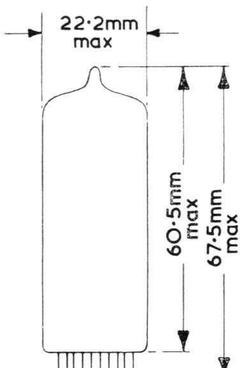
HALF-WAVE RECTIFIER

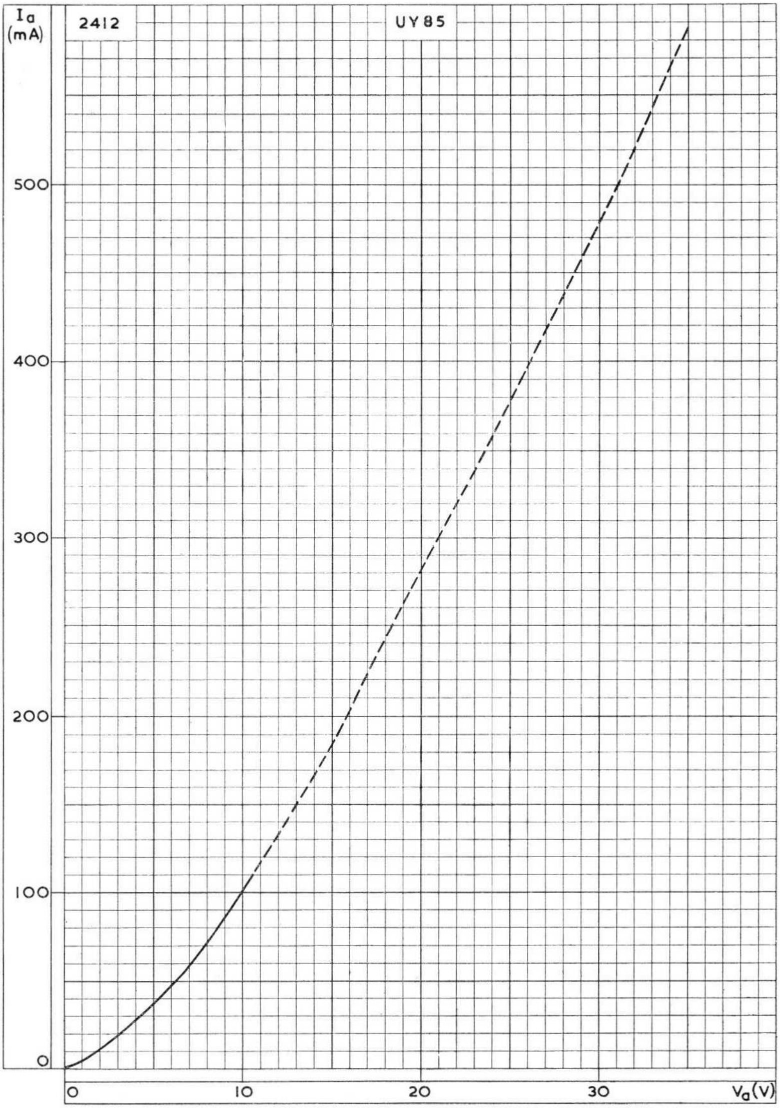
2442



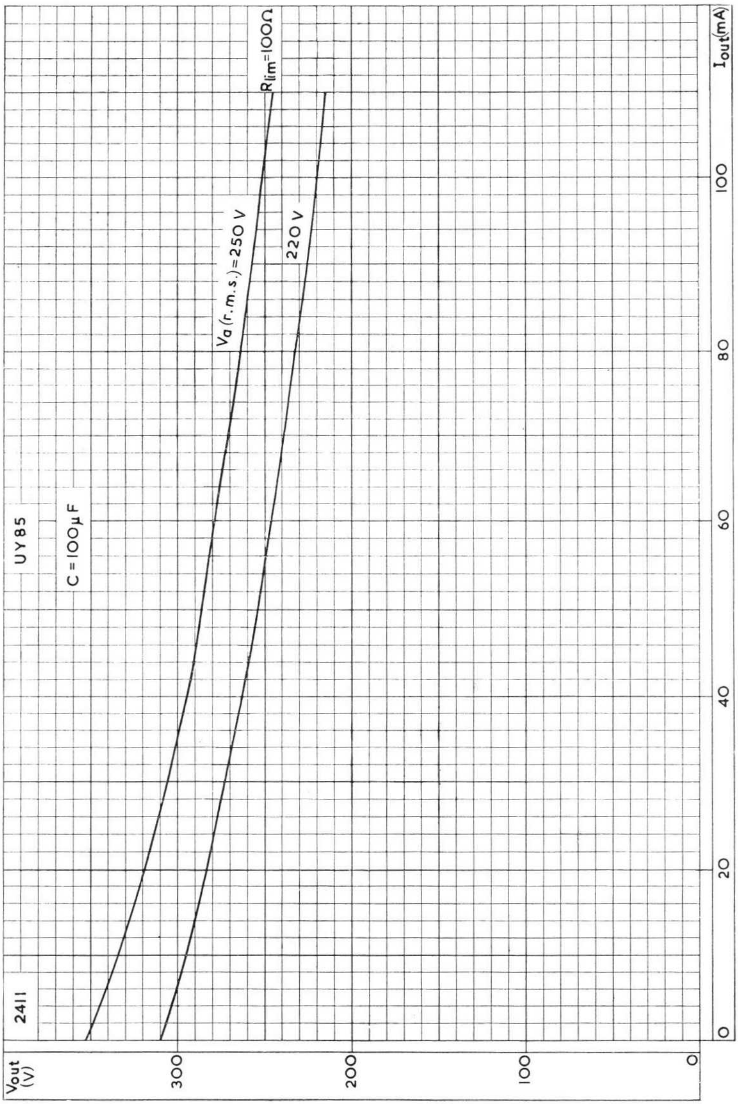


B9A
Noval Base





ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE



REGULATION CURVES

V.H.F. POWER PENTODE

YL1000

Directly heated v.h.f. power pentode for use as a power amplifier or frequency multiplier in portable and mobile equipment.

FILAMENT (parallel operation only)

V_f	1.1 (±15%)	V
I_f	880	mA
t_h max. (P_{out} = 70% of final value)	0.5	s

CAPACITANCES (unshielded)

c_{a-g1}	< 150	mpF
c_{in}	6.0	pF ←
c_{out}	3.5	pF ←
c_{g1-f}	1.5	pF

CHARACTERISTICS

V_a	120	V
V_{g2}	120	V
V_{g1}	−6.5	V
I_a	30	mA
I_{g2}	2.3	mA
g_m	4.3	mA/V
μ_{g1-g2}	7.0	

RATINGS (DESIGN CENTRE SYSTEM)

$V_{a(b)}$ max.	500	V
V_a max.	300	V
p_a max.	5.0	W
$V_{g2(b)}$ max.	500	V
V_{g2} max.	300	V
p_{g2} max.	1.0	W
V_{g1} max.	−100	V
$+v_{g1(pk)}$ max.	25	V
I_k max.	50	mA
R_{g1-f} max.	2.0	MΩ
T_{bulb} max.	200	°C
V_f max. (absolute)	1.27	V
V_f min. (absolute)	0.93	V

CLASS 'C' OPERATION F.M. TELEPHONY

Maximum recommended operating conditions

These conditions are based on reaching either the maximum electrode ratings or the point where load efficiency (η_{load}) begins to fall rapidly. The conditions for 175Mc/s were measured in a circuit with a parallel tuned output circuit. If a series tuned output circuit is used at this frequency with the same operating conditions, approx. 10% higher P_{load} figures are obtained.

CLASS 'C' OPERATION F.M. TELEPHONY AT f = 50Mc/s

Power amplifier

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max. (mA)
300	150	–35	40
250	150	–35	40
200	150	–35	40
150	150	–35	32
100	100	–23	22

Frequency doubler

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max. (mA)
300	150	–90	40
250	150	–90	40
200	150	–90	38
150	150	–90	32
100	100	–60	20

Frequency trebler

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max. (mA)
300	150	–100	29
250	150	–100	35
200	150	–100	32
150	150	–100	28
100	100	–100	20

CLASS 'C' OPERATION F.M. TELEPHONY AT f = 175Mc/s

Power amplifier

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max (mA)
300	150	–35	30
250	150	–35	37
200	150	–35	40
150	150	–35	40
100	100	–23	28

Frequency doubler

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max. (mA)
300	150	–90	26
250	150	–90	32
200	150	–90	38
150	150	–90	32
100	100	–90	20

Frequency trebler

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a max. (mA)
250	150	–100	27
200	150	–100	32
150	150	–100	28
100	100	–100	20

TYPICAL OPERATION CLASS 'C' OPERATION F.M. TELEPHONY

Amplifier at f = 50Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	$+V_{g1(pk)}$ (V)	P_{load} (W)	η_{load} (%)
300	150	−35	10	1.45	0.006	−4.5	1.68	56
			20	2.6	0.045	2.5	3.8	63.3
			30	3.0	0.45	9.0	6.1	67.8
			40	3.5	0.85	14.5	8.0	66.6
250	150	−35	10	1.62	0.008	−2.0	1.5	60
			20	3.1	0.08	3.5	3.3	65
			30	4.0	0.55	10	5.1	68
			40	5.0	0.95	17	6.7	67
200	150	−35	10	1.95	0.025	−1.5	1.3	65
			20	3.8	0.20	5.5	2.75	69
			30	5.0	0.75	12	4.1	68
			40	6.0	1.05	18	5.2	65
150	150	−35	10	2.6	0.038	−1.0	1.0	67
			20	4.3	0.24	6.0	2.05	68
			30	6.0	0.85	13.5	2.95	65.5
100	100	−23	10	2.1	0.09	1.5	0.6	60
			20	3.4	0.7	9.0	1.22	61
			25	4.5	1.2	13	1.45	57.6

Frequency doubler at f_{out} = 50Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	$+V_{g1(pk)}$ (V)	P_{load} (W)	η_{load} (%)
300	150	−90	10	1.38	0.015	0.5	1.58	52.7
			20	2.15	0.28	8.5	3.42	57
			30	2.6	0.73	15	5.15	57.2
			40	3.4	0.95	21	6.62	55.1
250	150	−90	10	1.6	0.024	1.2	1.36	54.4
			20	2.4	0.38	9.5	3.0	60
			30	3.2	0.80	15.5	4.45	59.3
			40	4.2	1.02	22	5.6	56
200	150	−90	10	2.05	0.04	2.0	1.16	58
			20	2.9	0.45	10	2.5	62.5
			30	3.6	0.85	16.5	3.5	58.3
150	150	−90	10	2.4	0.05	2.5	0.86	57.3
			20	3.8	0.56	11	1.8	60
			30	4.5	0.95	18	2.48	55.2
100	100	−60	10	1.95	0.26	6.0	0.53	53
			20	3.1	0.92	13	0.94	47

Frequency trebler at f_{out} = 50Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	$+v_{g1(pk)}$ (V)	P_{load} (W)	η_{load} (%)
300	150	–100	10	1.0	0.01	0.8	1.2	40
			20	1.75	0.26	9.5	2.6	43.3
250	150	–100	10	1.16	0.012	1.0	1.05	42
			20	1.9	0.3	10	2.24	44.8
			30	2.3	0.7	17	3.2	42.7
200	150	–100	10	1.4	0.015	1.3	0.9	45
			20	2.05	0.35	10.5	1.88	47
			30	2.45	0.72	17.5	2.7	45
150	150	–100	10	1.7	0.027	1.9	0.67	44.7
			20	2.35	0.39	11	1.44	48
100	100	–100	10	1.1	0.29	7.5	0.47	47
			20	2.2	1.02	17	0.8	40

Amplifier at f = 175Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	P_{load} (W)	η_{load} (%)
300	150	–35	15	0.9	0	0.98	21.7
			20	1.34	0	1.66	27.7
			25	1.56	0.01	2.48	33.1
			30	2.08	0.07	3.3	36.7
250	150	–35	15	1.0	0	0.91	24.3
			20	1.42	0	1.48	29.4
			25	1.96	0.01	2.17	34.7
			30	2.25	0.1	2.88	38.5
			35	2.42	0.2	3.6	41.1
200	150	–35	15	1.3	0	0.81	27
			20	1.96	0	1.37	32.5
			25	2.12	0.02	1.9	38
			30	2.4	0.11	2.5	41.7
			35	2.64	0.28	3.08	44
			40	3.0	0.5	3.69	46.1
150	150	–35	15	1.74	0	0.7	31.1
			20	2.14	0.01	1.14	38
			25	2.5	0.03	1.56	41.7
			30	2.9	0.12	2.0	44.5
			35	3.2	0.3	2.42	46.1
			40	3.5	0.55	2.82	47
100	100	–23	15	1.28	0.04	0.56	37.3
			20	1.5	0.22	0.89	44.5
			25	1.82	0.54	1.18	47.2

Frequency doubler at f_{out} = 175Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	P_{load} (W)	η_{load} (%)
300	150	−90	15	0.84	0	0.82	18.2
			20	1.1	0.12	1.46	24.3
			25	1.22	0.34	2.1	28
250	150	−90	15	0.98	0.02	0.8	21.3
			20	1.26	0.15	1.35	27
			25	1.4	0.4	1.88	30
			30	1.62	0.6	2.4	32
200	150	−90	15	1.2	0.04	0.73	24.3
			20	1.4	0.22	1.2	30
			25	1.6	0.42	1.7	34
			30	1.85	0.66	2.15	35.9
			35	2.0	0.8	2.55	36.5
150	150	−90	15	1.58	0.06	0.66	29.4
			20	1.76	0.26	1.04	34.7
			25	2.07	0.46	1.42	37.9
			30	2.25	0.72	1.78	39.5
			35	2.36	0.88	2.1	40
100	100	−60	15	1.0	0.38	0.54	36
			20	1.36	0.7	0.74	37

Frequency trebler f_{out} = 175Mc/s

V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	I_{g2} (mA)	I_{g1} (mA)	P_{load} (W)	η_{load} (%)
250	150	−100	15	0.88	0.04	0.6	16
			20	1.12	0.18	0.95	19
			25	1.26	0.4	1.29	20.7
200	150	−100	15	1.02	0.05	0.55	18.3
			20	1.24	0.22	0.86	21.5
			25	1.42	0.42	1.15	23
			30	1.66	0.6	1.42	23.7
150	150	−100	15	1.26	0.07	0.49	21.8
			20	1.42	0.30	0.76	25.3
			25	1.64	0.44	0.99	26.4
100	100	−100	15	0.94	0.52	0.4	26.7
			20	1.5	0.84	0.5	25

CLASS 'C' A.M. TELEPHONY

Maximum carrier conditions for 100% modulation

Output tuned circuit

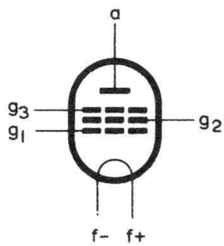
	Single valve operation			Push-pull operation		
	Parallel	Parallel	Series			
f	50	175	175	50	175	Mc/s
V_a	250	200	200	250	200	V
V_{g2}	150	150	150	150	150	V
V_{g1}	–35	–35	–35	–35	–35	V
I_a	32	31	32	2×32	2×32	mA
I_{g2}	4.2	2.45	2.5	2×4.2	2×2.5	mA
I_{g1}	0.62	0.14	0.18	2×0.62	2×0.18	mA
P_{load}	5.4	2.65	3.05	12	6.2	W
η	67.5	42	47	75	48.5	%
For 100% modulation						
P_{mod}	4.2	3.2	3.3	8.4	6.4	W
$v_{g2}(pk)$	135	120	120	135	120	V

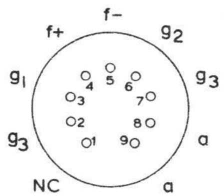
Maximum carrier conditions for anode and screen-grid modulation for various modulation depths. f = 175Mc/s

m (%)	V_a (V)	I_a (mA)	p_a (max.) (W)	p_{g2} (max.) (W)	P_{load}* (W)	Output tuned circuit
100	200	31	3.3	0.67	2.65	Parallel
	200	32	3.3	0.67	3.05	Series
	200	64	2×3.3	2×0.67	6.2	Push-Pull
75	220	34	3.9	0.78	3.2	Parallel
	220	35	3.9	0.78	3.65	Series
	220	70	2×3.9	2×0.78	7.4	Push-Pull
50	235	35	4.45	0.89	3.47	Parallel
	235	36	4.45	0.89	3.96	Series
	235	72	2×4.45	2×0.89	8.0	Push-Pull
25	245	37	4.85	0.97	3.82	Parallel
	245	38	4.85	0.97	4.37	Series
	245	76	2×4.85	0.97	8.8	Push-Pull
0	250	38	5.0	1.0	4.02	Parallel
	250	39	5.0	1.0	4.55	Series
	250	80	2×5.0	2×1.0	9.6	Push-Pull

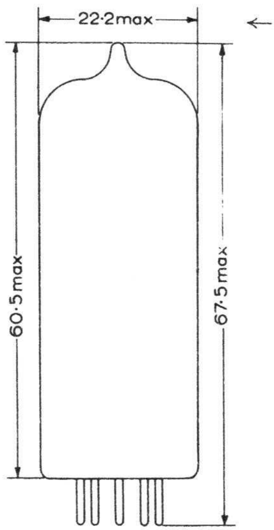
*Estimated value

These conditions may be varied for operation at lower frequencies. Operation at 100% modulation with $V_a > 250V$, $I_a > 32mA$ is not permitted and the p_a max. and p_{g2} max. limits shown above must never be exceeded.



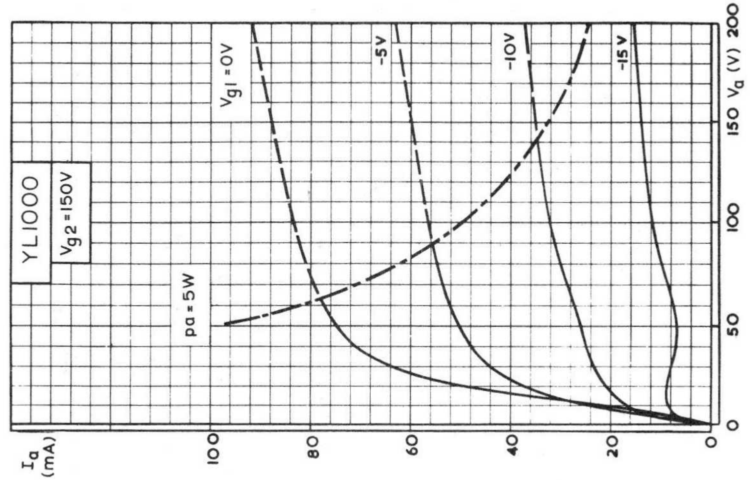


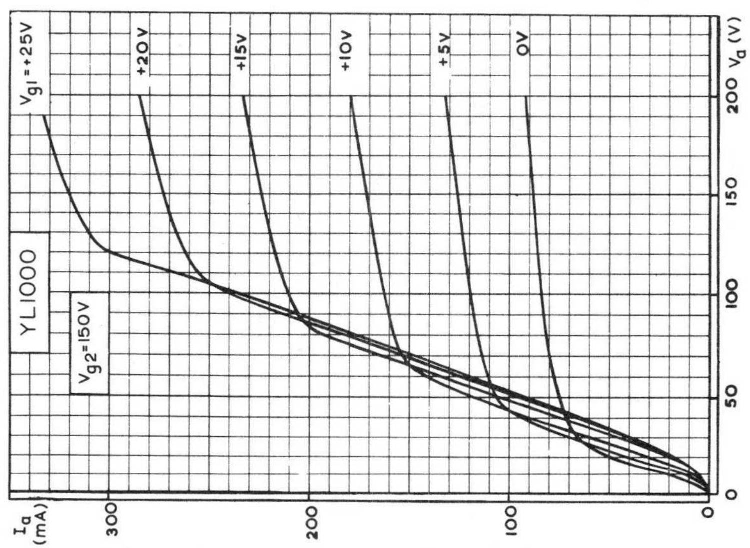
B9A Base



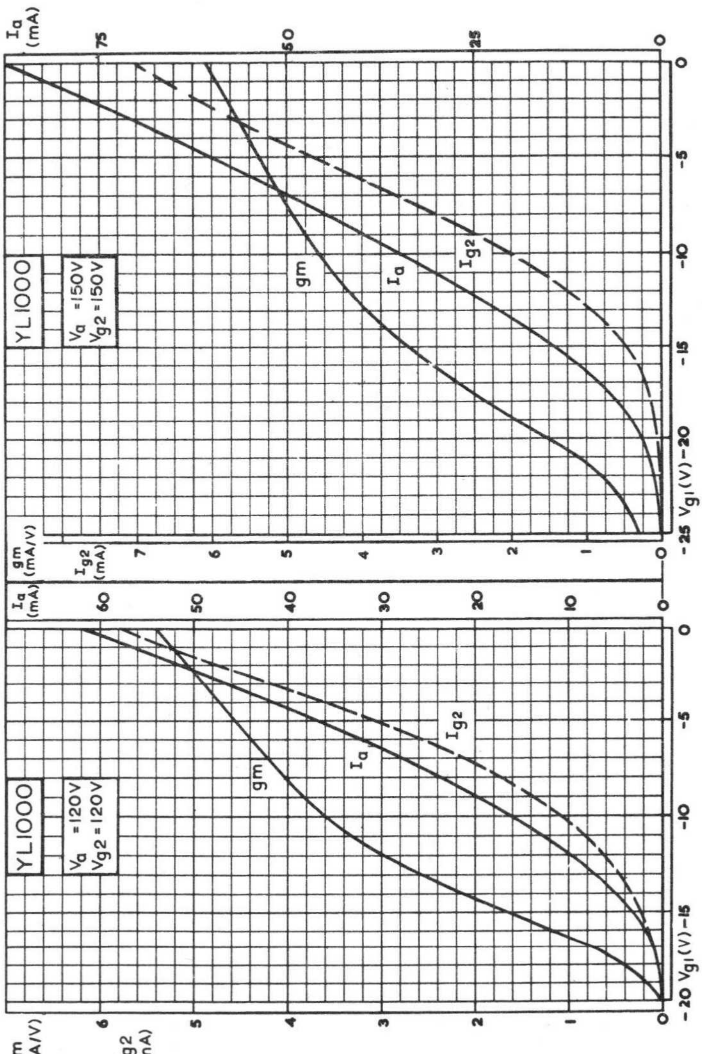
All dimensions in mm

B 4662

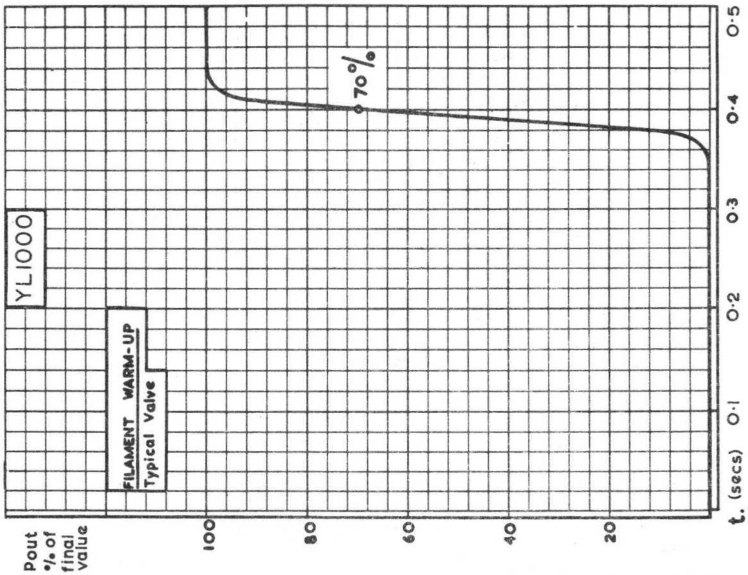


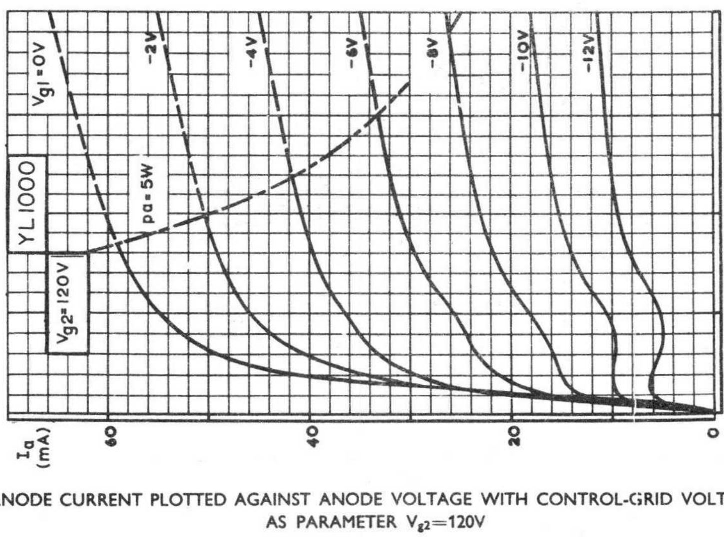


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER V_{g2}=150V



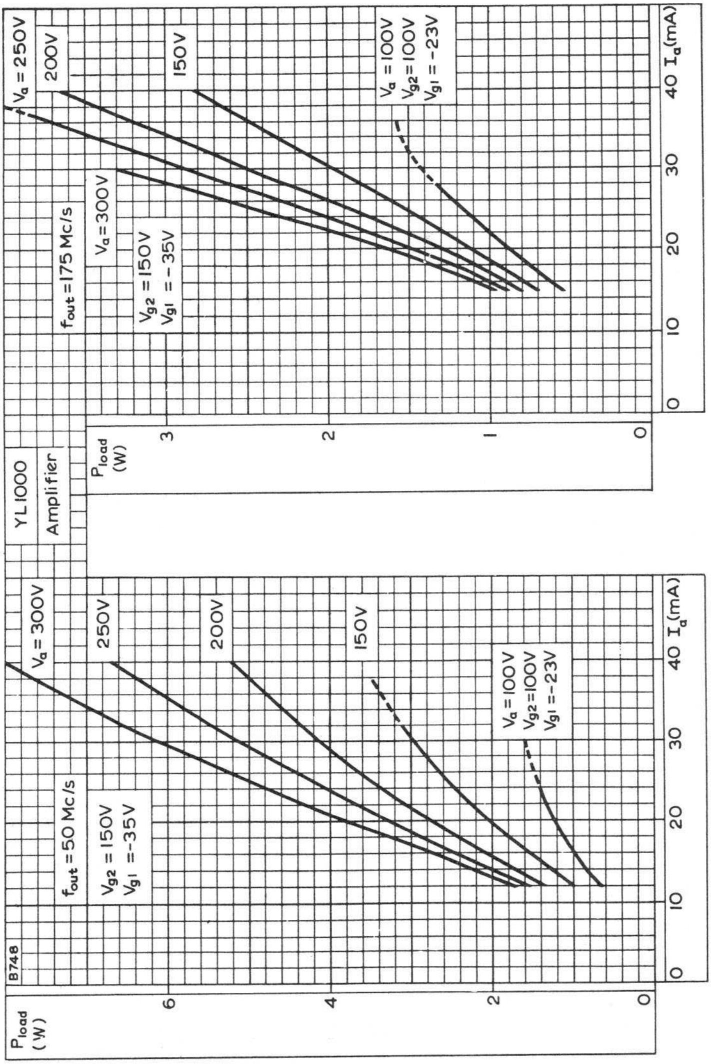
ANODE CURRENT, SCREEN-GRID CURRENT, AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE



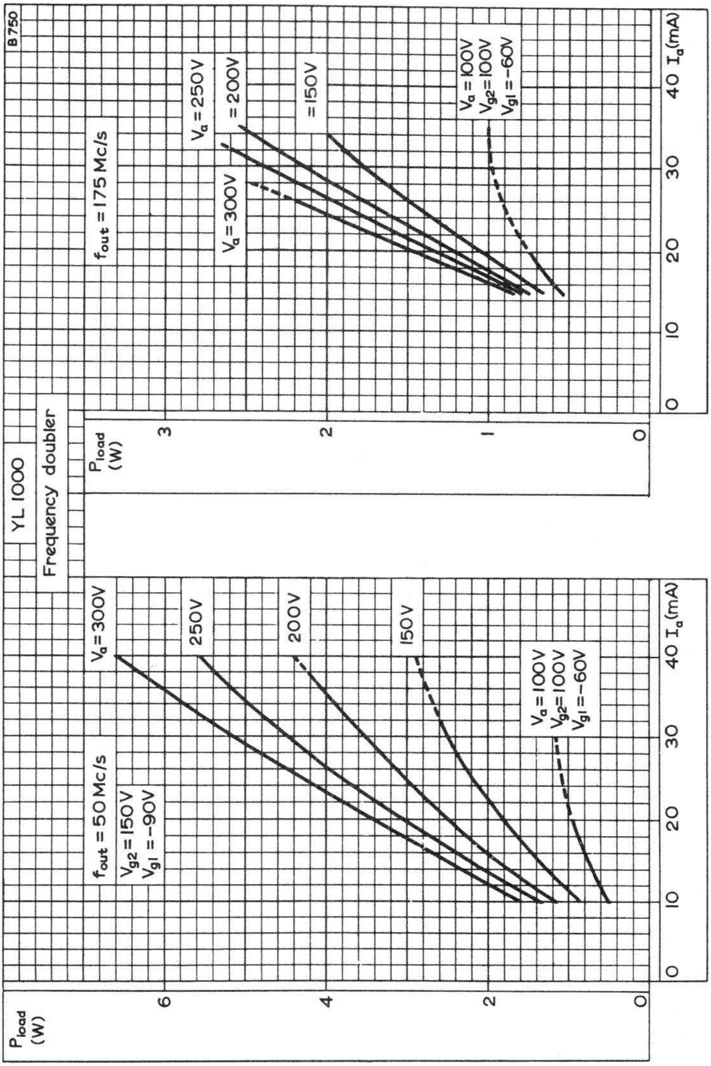


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER V_{g2}=120V

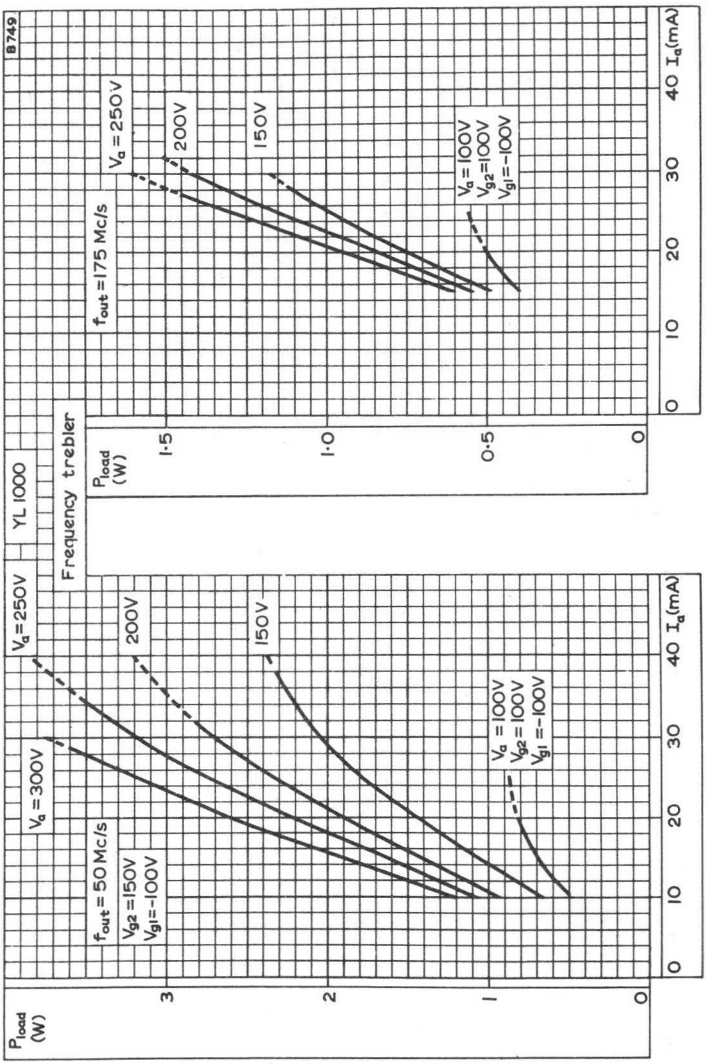
FILAMENT WARM-UP TIME



LOAD POWER AS AN AMPLIFIER PLOTTED AGAINST ANODE CURRENT FOR VARIOUS ANODE VOLTAGES



LOAD POWER AS A FREQUENCY DOUBLER PLOTTED AGAINST ANODE CURRENT FOR VARIOUS ANODE VOLTAGES



LOAD POWER AS A FREQUENCY TREBLER PLOTTED AGAINST ANODE CURRENT FOR VARIOUS ANODE VOLTAGES

DOUBLE DIODE

6AL5

Double diode with separate cathodes and internal screening between sections.

HEATER

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

V_h	6.3	V
I_h	300	mA

MOUNTING POSITION

Any

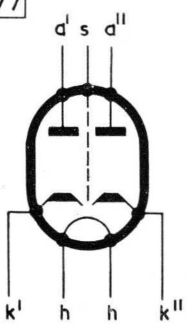
CAPACITANCES

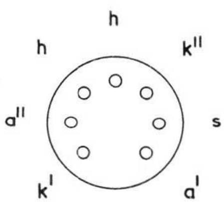
	Shielded	Unshielded	
$c_{a'-k'+h+s}$	3.1	2.5	pF
$c_{a''-k''+h+s}$	3.1	2.5	pF
$c_{k'-a'+h+s}$	3.9	3.4	pF
$c_{k''-a''+h+s}$	3.9	3.4	pF
$c_{a'-a''}$	<0.026	<0.068	pF

LIMITING VALUES (each section)

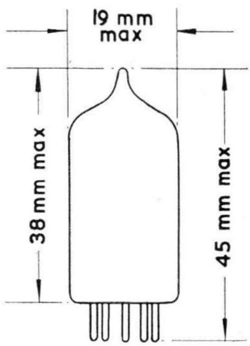
P.I.V. max.	330	V
I_a max.	9.0	mA
$i_{a(pk)}$ max.	54	mA
V_a max. ($I_a = +0.3\mu A$)	−1.3	V
$v_{h-k(pk)}$ max.	330	V

3577





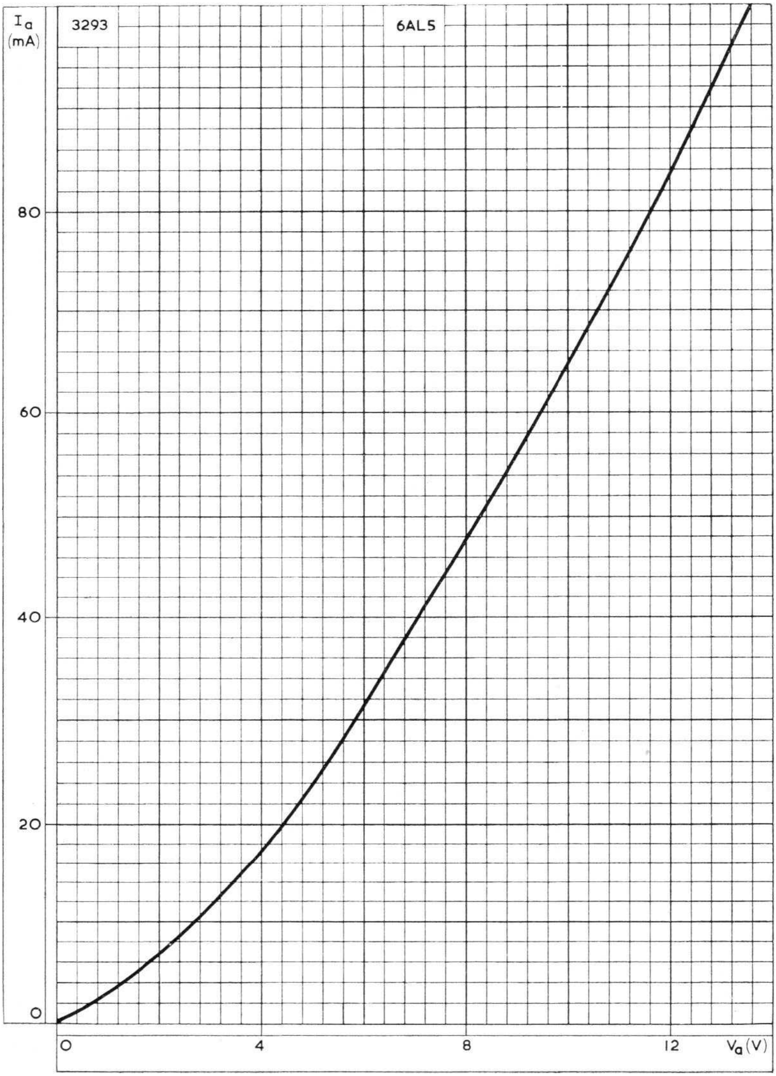
B7G Base



6AL5

DOUBLE DIODE

Double diode with separate cathodes and internal screening between sections.

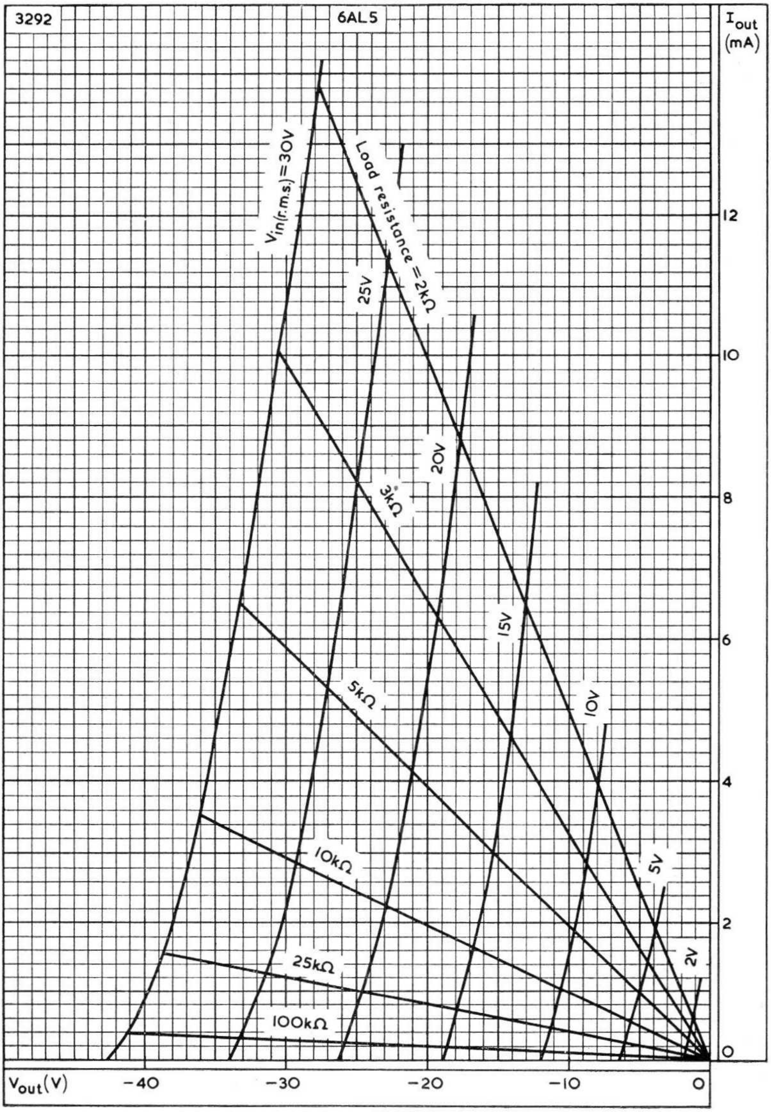


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

DOUBLE DIODE

Double diode with separate cathodes and internal screening between sections.

6AL5



OUTPUT CURRENT PLOTTED AGAINST OUTPUT VOLTAGE WITH INPUT VOLTAGE AS PARAMETER

PENTODE

6AS6

Dual control pentode for switching or gating control or for use as a frequency changer.

HEATER

V_h	6.3	V
I_h	175	mA

MOUNTING POSITION

Any

CAPACITANCES

	Shielded	*Unshielded*	
c_{a-g1}	<20	<25	mpF
c_{a-g3}	700	700	mpF
c_{in}	4.0	3.9	pF
c_{g3-all}	3.4	3.3	pF
c_{out}	3.0	2.2	pF
c_{g1-g3}	<150	<150	mpF

CHARACTERISTICS

V_a	120	120	V
V_{g2}	120	120	V
V_{g3}	−3.0	0	V
I_a	3.5	5.1	mA
I_{g2}	4.8	3.5	mA
V_{g1}	−2.0	−2.0	V
$g_{m(g1-a)}$	2.0	3.2	mA/V
$g_{m(g3-a)}$	660	450	μA/V
r_a	—	150	kΩ
$V_{g1}(I_a = 100\mu A)$	—	<−7.5	V
$V_{g3}(I_a = 20\mu A)$	−10	<−15	V

OPERATING CONDITIONS

Frequency changer with oscillator voltage on g_3

V_a	120	V
V_{g2}	120	V
V_{g1}	−2.0	V
I_a	2.1	mA
I_{g2}	5.8	mA
$V_{osc(r.m.s.)}$	6.0	V
I_{g3}	70	μA
R_{g3}	100	kΩ
g_c	1.0	mA/V
r_a	130	kΩ
R_{eq}	12	kΩ

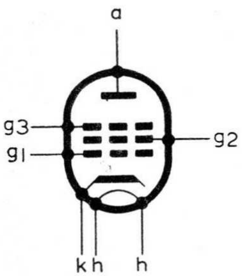
DESIGN CENTRE RATINGS

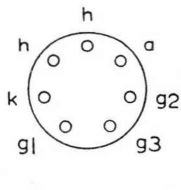
$V_{a(b)}$ max.	300	V
V_a max.	180	V
p_a max.	1.7	W
$V_{g2(b)}$ max.	300	V
V_{g2} max.	140	V
p_{g2} max.	750	mW
V_{g3} max.	27	V
R_{g1-k} max.	4.0	MΩ←
I_k max.	18	mA
V_{h-k} max.	90	V

6AS6

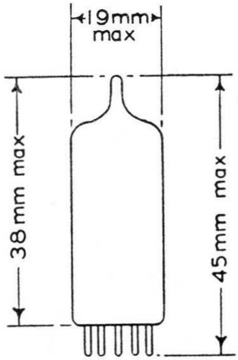
PENTODE

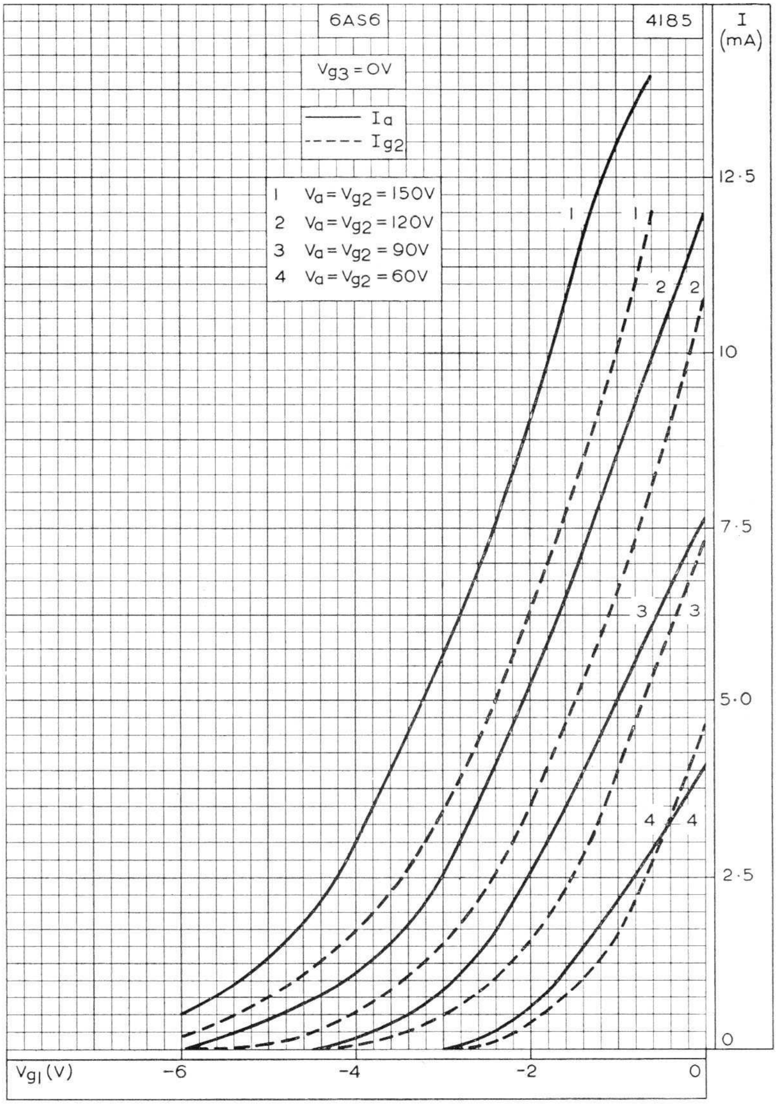
4491



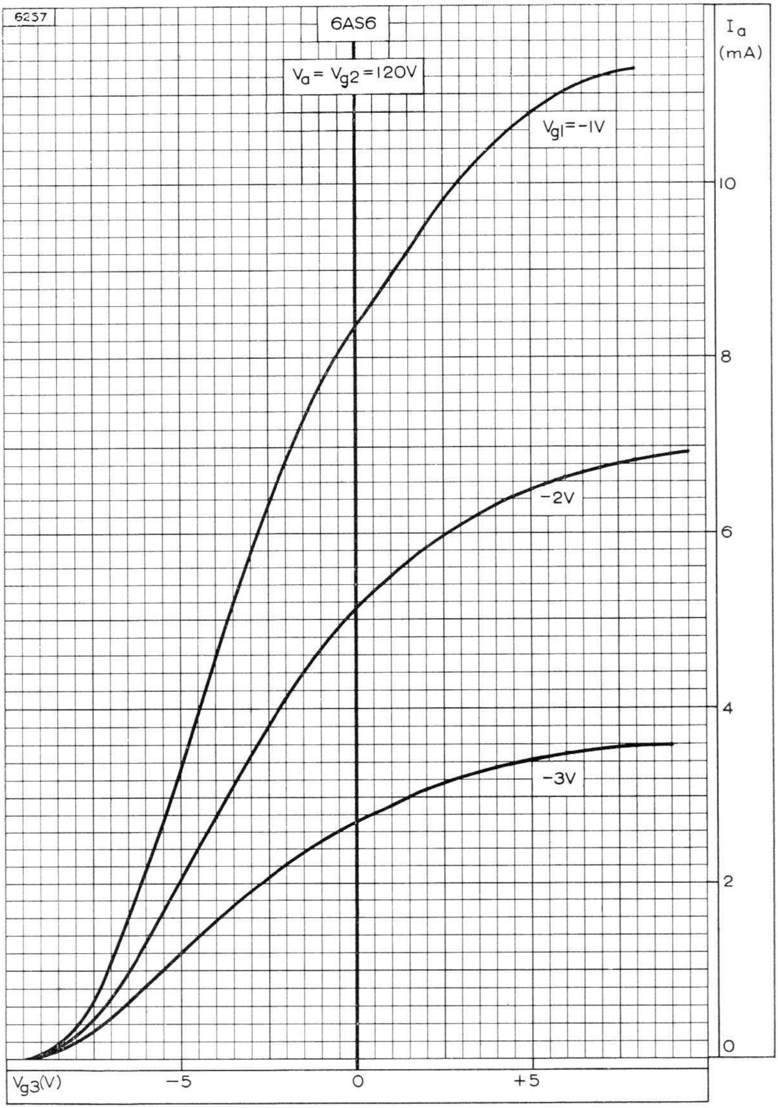


B7G Base

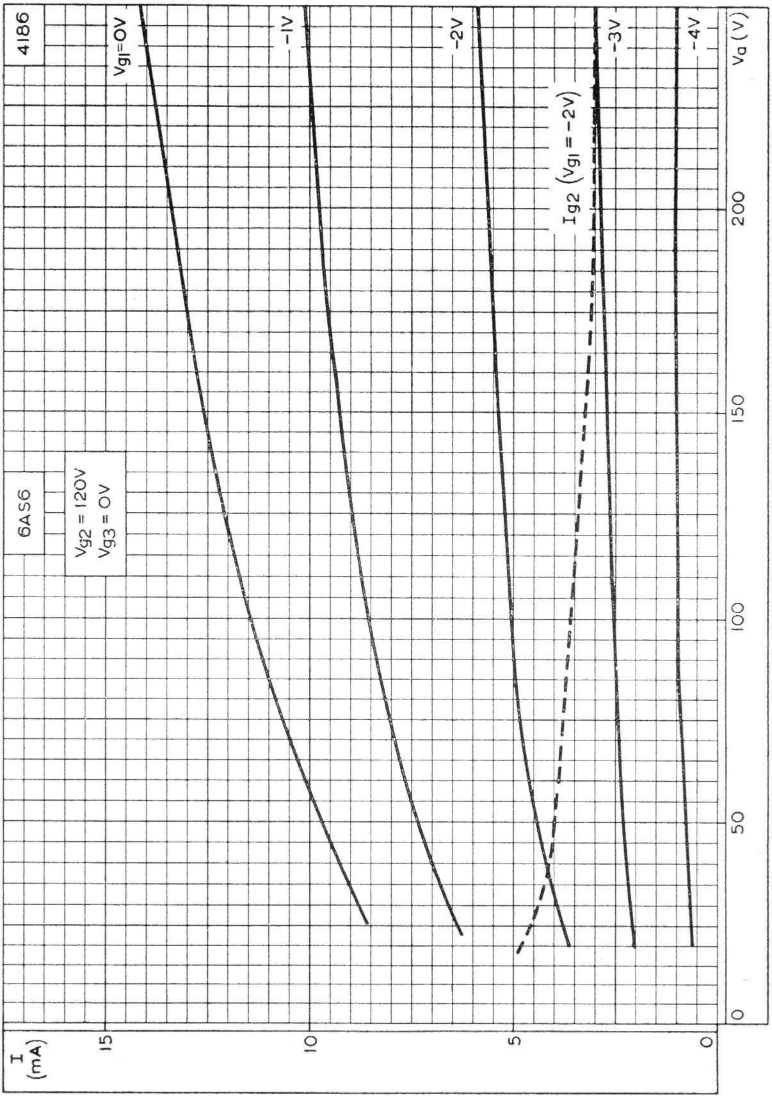




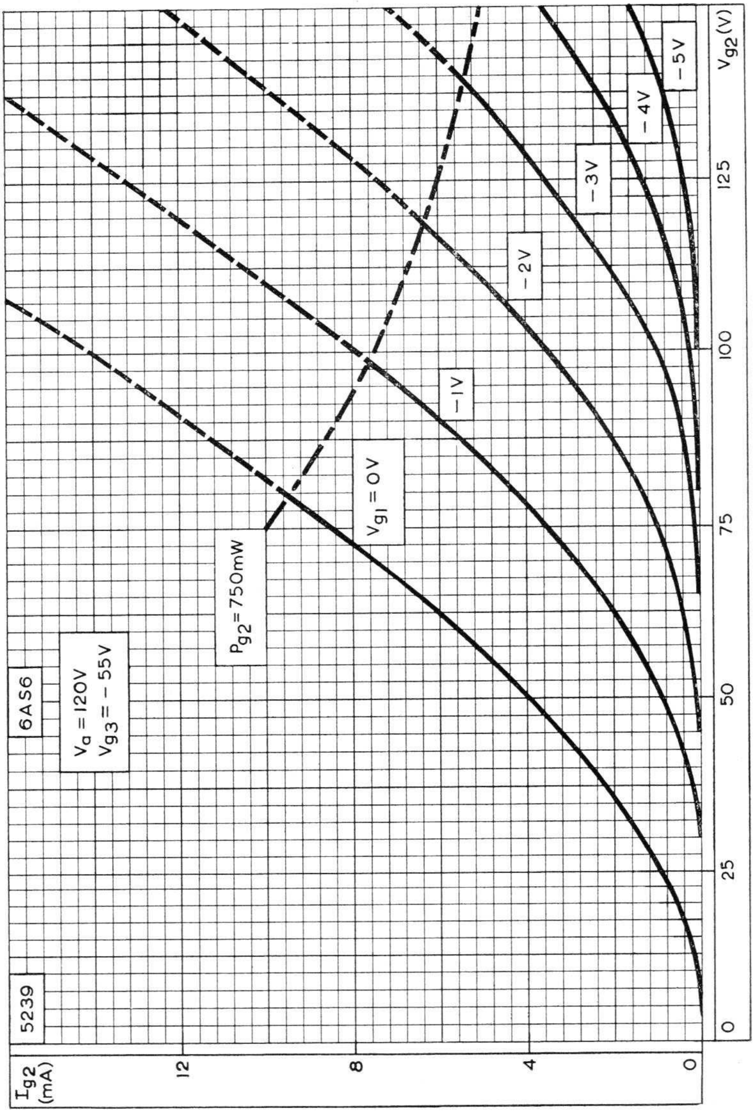
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETERS



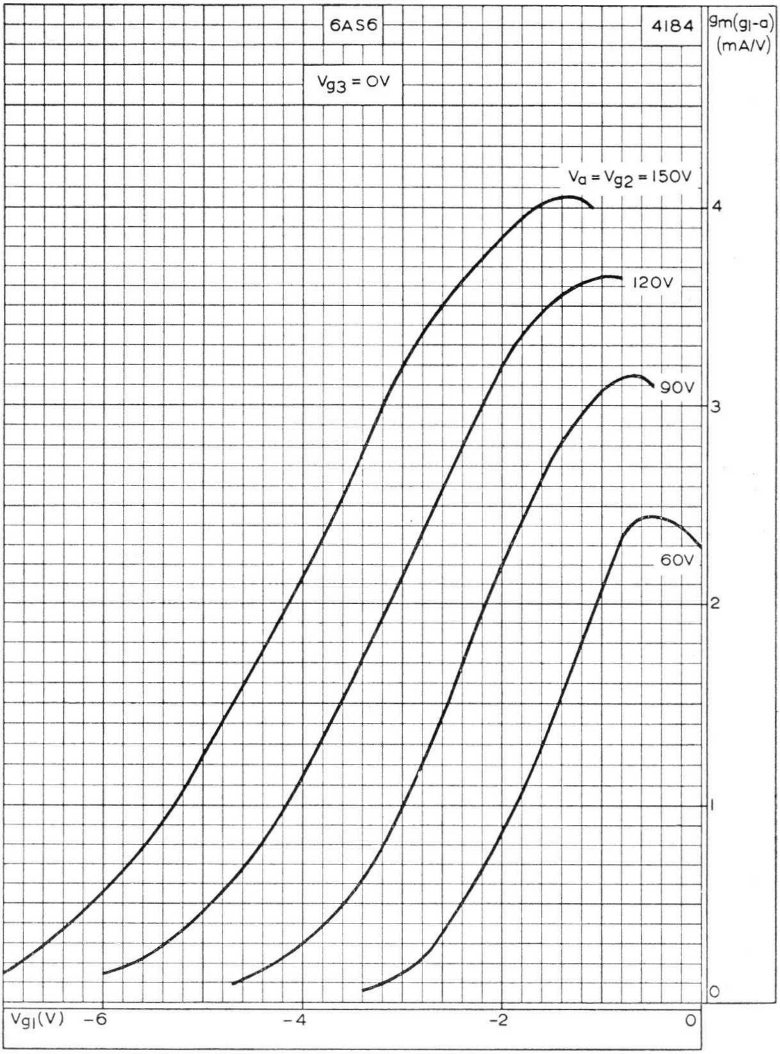
ANODE CURRENT PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



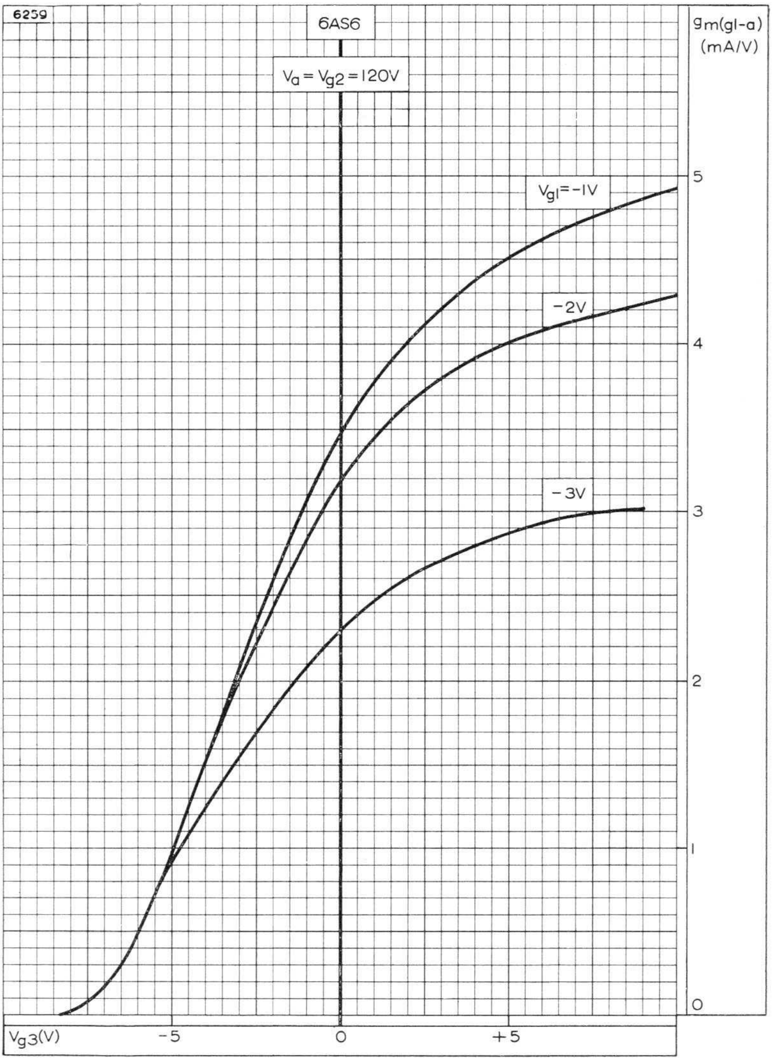
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



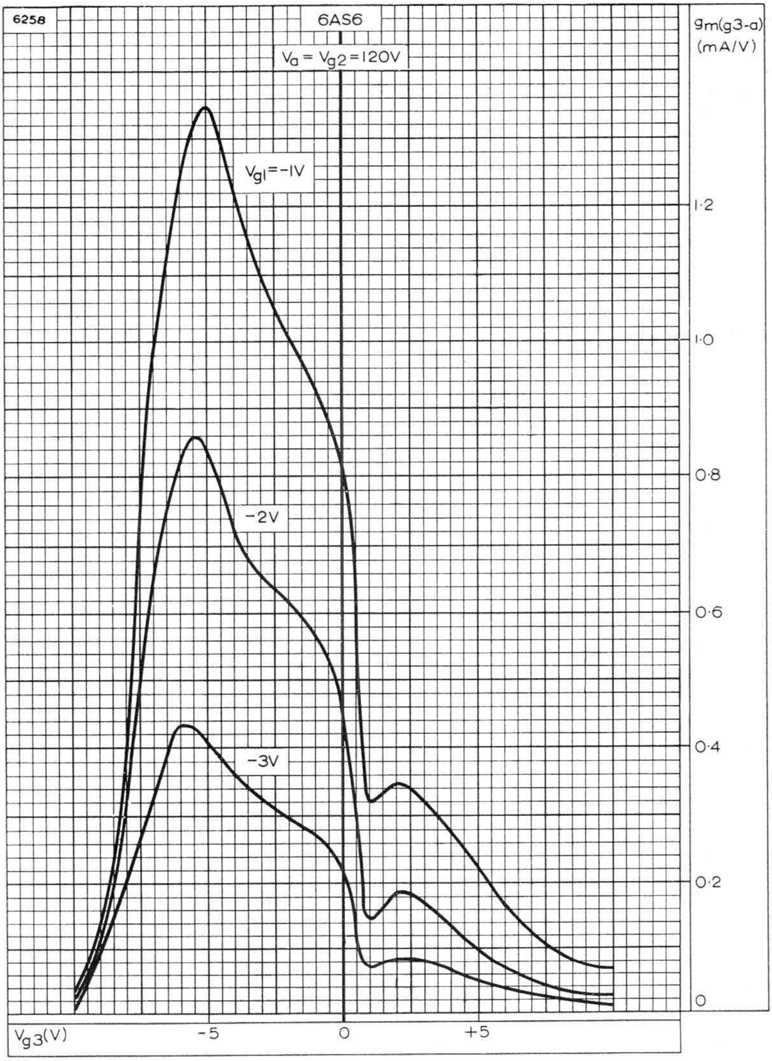
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



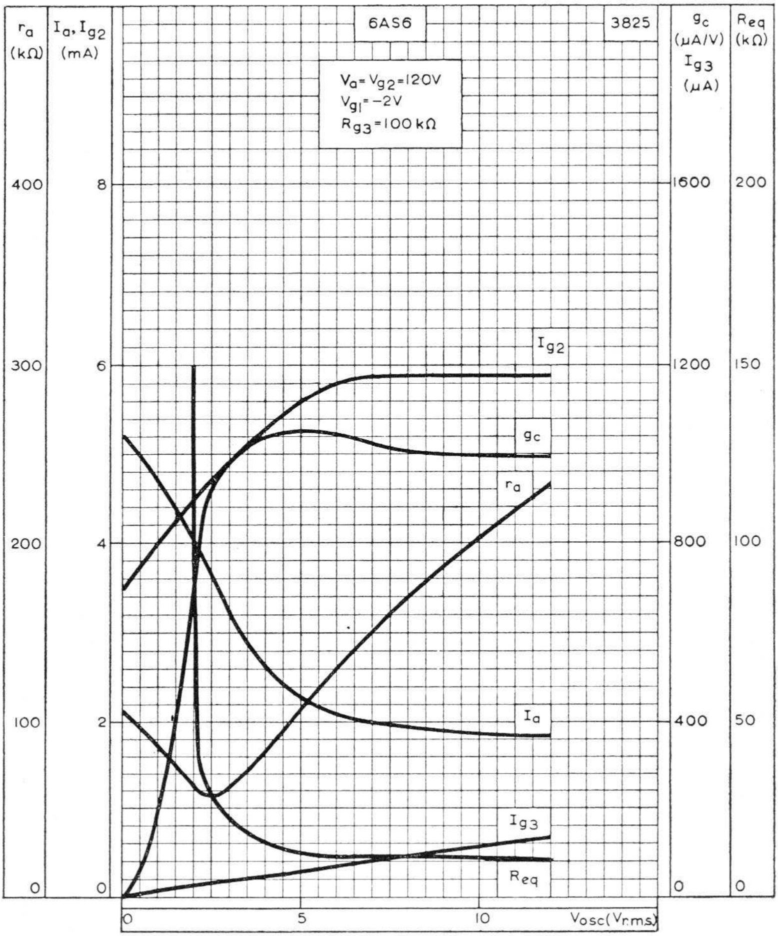
MUTUAL CONDUCTANCE (g_{1-a}) PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETERS



MUTUAL CONDUCTANCE (g_{1-a}) PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



MUTUAL CONDUCTANCE (g_{3-a}) PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER

SPECIAL QUALITY
RECEIVING VALVES

These general notes include definitions and general test procedures. They should be read in conjunction with the data sheets for Special Quality Valves. 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.[10]

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. The tolerance quoted includes variations in the supply voltage.

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. *Electrode voltages.* The reference point for electrode voltages is normally the cathode, and the symbols V_a, V_{g2} etc., are used to indicate the anode and screen-grid voltages with respect to the cathode.

   In some cases however, a cathode resistor is used when measuring characteristics, and in such cases the symbols V_{a-k}, V_{g2-k} are used when voltages are measured with respect to the cathode and V_{a-e}, V_{g2-e}, when the voltages are measured with respect to the negative end of the cathode resistor.

4. *Limiting values.* Unless otherwise stated the Limiting Values of Special Quality Valves 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.

The life expectancy may be reduced if conditions other than those specified for life test are imposed on the valve and will be reduced appreciably if absolute maximum ratings are exceeded.

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.

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

6. *Maximum and minimum values for the individuals* are the limits to which valves are tested.

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

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

9. *Bogey value* is the target value.

10. *Group quality level.* This is the A.Q.L. (Acceptable quality level) 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.

11. *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.

12. *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.

13. *Lead fragility test.*
 (*A*) This test is carried out on a sampling basis and consists of holding the valves vertically and having a 1-lb weight freely suspended from the lead under test. The valves are inclined slowly so as to bend the weighted lead through 45°, brought to 45° in the other direction, back again to 45° in the first direction and finally returned to the vertical, the entire action taking place in one vertical plane. The valves are examined for cracks and broken leads.
 (*B*) This test is carried out on a sampling basis and consists of holding the valves vertically and having a 1-lb weight freely suspended from the lead under test. The valves are inclined slowly so as to bend the weighted lead through 90° and then returned 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 valves are examined for broken leads.

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

15. *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.

16. *Inoperatives.* An inoperative is defined as a valve having an open or short circuited electrode, an air leak or a broken pin.

SPECIAL QUALITY WIDEBAND OUTPUT PENTODE

E55L

Special quality high slope output pentode intended for general industrial applications where stability of characteristics and long life are required.

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

HEATER

V_h[1]	6.3	V
I_h	600	mA

CAPACITANCES[2]

Pentode connected

Shielded

	Minimum	Average	Maximum	
c_{a-g1}	—	80	120	mpF
c_{in}	15	18	21	pF
c_{in} (w) (I_k = 55.5mA)	—	28	—	pF
c_{out}	5.8	6.5	7.2	pF

Unshielded

	Minimum	Average	Maximum	
c_{a-g1}	—	110	150	mpF
c_{in}	15	18	20	pF
c_{in} (w) (I_k = 55.5mA)	—	28	—	pF
c_{out}	3.6	4.0	4.4	pF

Triode connected

Shielded

	Minimum	Average	Maximum	
c_{a-g}	5.5	6.2	6.9	pF
c_{in}	10	11.8	13.6	pF
c_{out}	9.4	10.5	11.6	pF
c_{h-k}	—	6.0	—	pF

Unshielded

	Minimum	Average	Maximum	
c_{a-g}	5.6	6.3	7.0	pF
c_{in}	10	11.8	13.6	pF
c_{out}	7.0	7.8	8.6	pF
c_{h-k}	—	6.0	—	pF

E55L

SPECIAL QUALITY WIDEBAND OUTPUT PENTODE

CHARACTERISTICS[3]

Pentode connected

V_a	125	V
V_{g2}	125	V
V_{g3}	0	V
V_{g1}	−3.0	V
R_k	0	Ω
I_a	50	mA
I_{g2}	5.5	mA
g_m	45	mA/V
r_a	20	kΩ
μ_{g1-g2}	30	
r_{g1} (f = 50Mc/s)	1.0	kΩ

Triode connected

V_a	125	V
I_a	55.5	mA
V_g	−3.0	V
g_m	50	mA/V
μ	30	
r_a	600	Ω

OPERATING CONDITIONS

V_{a-e}	140	V
V_{g2-e}	140	V
V_{g3-k}	0	V
V_{g1-e}	+12	V
R_k	270	Ω
I_a	50	mA
I_{g2}	5.5	mA
g_m	45	mA/V

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN ←

	Average	*Initial range*	*End of life**	
Anode Current at V_{a-e} = 140V, V_{g2-e} = 140V, V_{g1-e} = +12V, R_k = 270Ω	50	48 to 52	—	mA←
Grid-cathode voltage at V_{a-e} = 140V, V_{g2-e} = 140V, V_{g1-e} = +12V, R_k = 270Ω	−3.0	−2.3 to −3.7	−1.8	V←
Screen-grid current at V_{a-e} = 140V, V_{g2-e} = 140V, V_{g1-e} = +12V, R_k = 270Ω	5.5	4.5 to 6.5	—	mA←
Mutual conductance at V_{a-e} = 140V, V_{g2-e} = 140V, V_{g1-e} = +12V, R_k = 270Ω	45	38 to 52	Δg_m max. = 25%	mA/V←
Negative control-grid current (max.) at V_{a-e} = 140V, V_{g2-e} = 140V, V_{g1-e} = +12V, R_k = 270Ω —	—	—	2.0	μA←

*To allow for valve deterioration during life, circuits should be designed to function with a valve in which one or more of the characteristics have changed to the values stated.

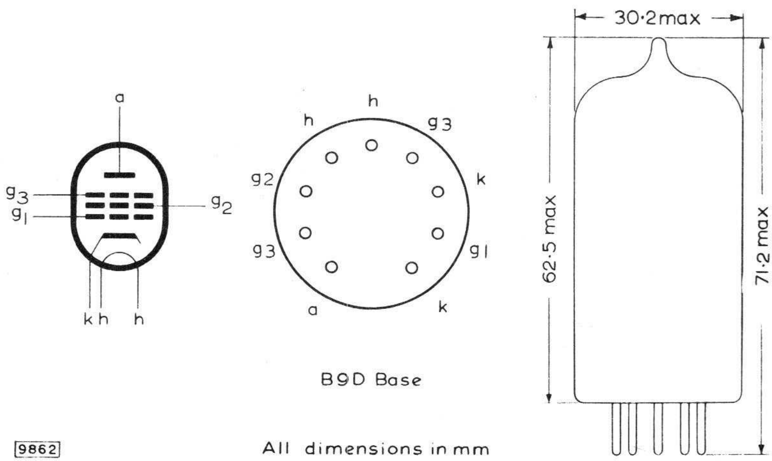
SPECIAL QUALITY WIDEBAND OUTPUT PENTODE

E55L

ABSOLUTE MAXIMUM RATINGS[4]

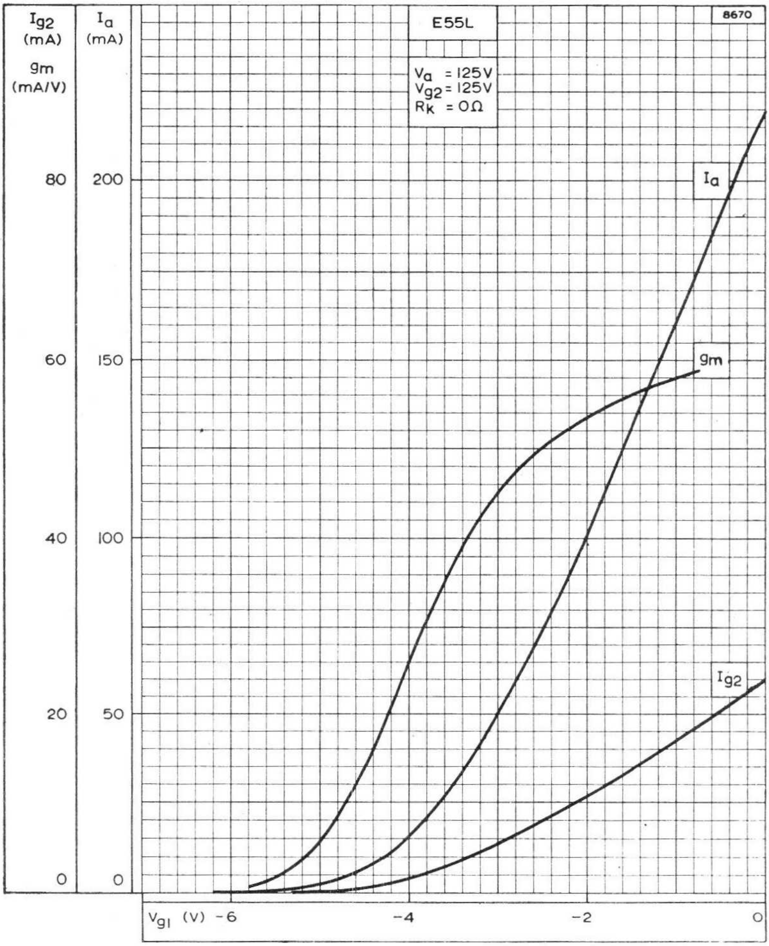
$V_{a(b)}$ max.	400	V
V_a max.	200	V
p_a max.	10	W
$V_{g2(b)}$ max.	350	V
V_{g2} max.	175	V
p_{g2} max.	1.5	W
$-V_{g1}$ max.	55	V
$+V_{g1}$ max.	0	V
*I_k max.	75	mA
R_{g1-k} max.	125	kΩ
V_{h-k} max.	200	V
*T_{bulb} max.	180	°C

*In applications where a long life is not required, I_k max. can be increased to 100mA and T_{bulb} max. to 220°C.



9862

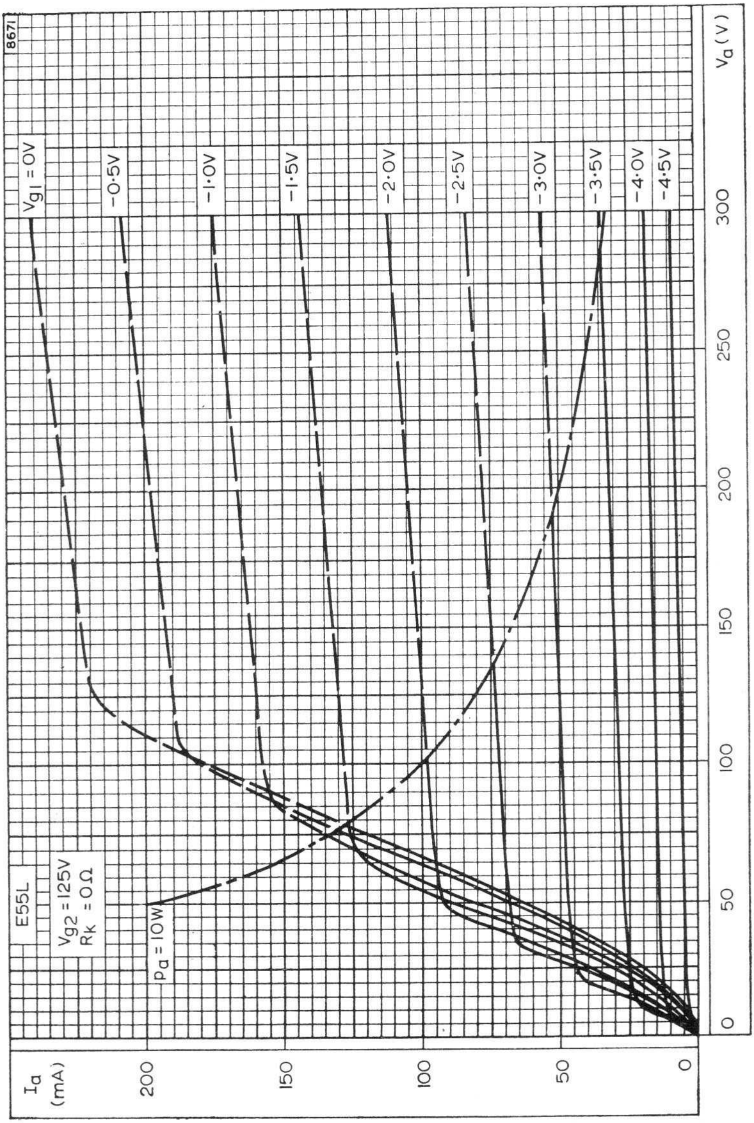
All dimensions in mm



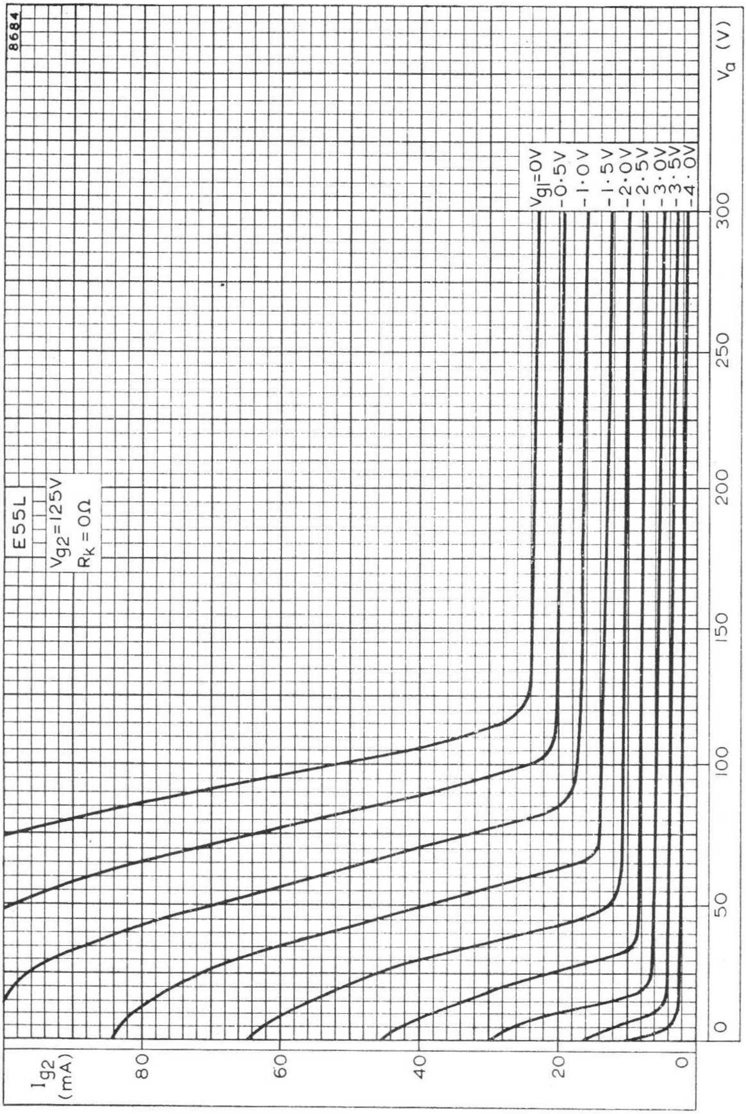
ANODE AND SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_{g2} = 125V$

E55L

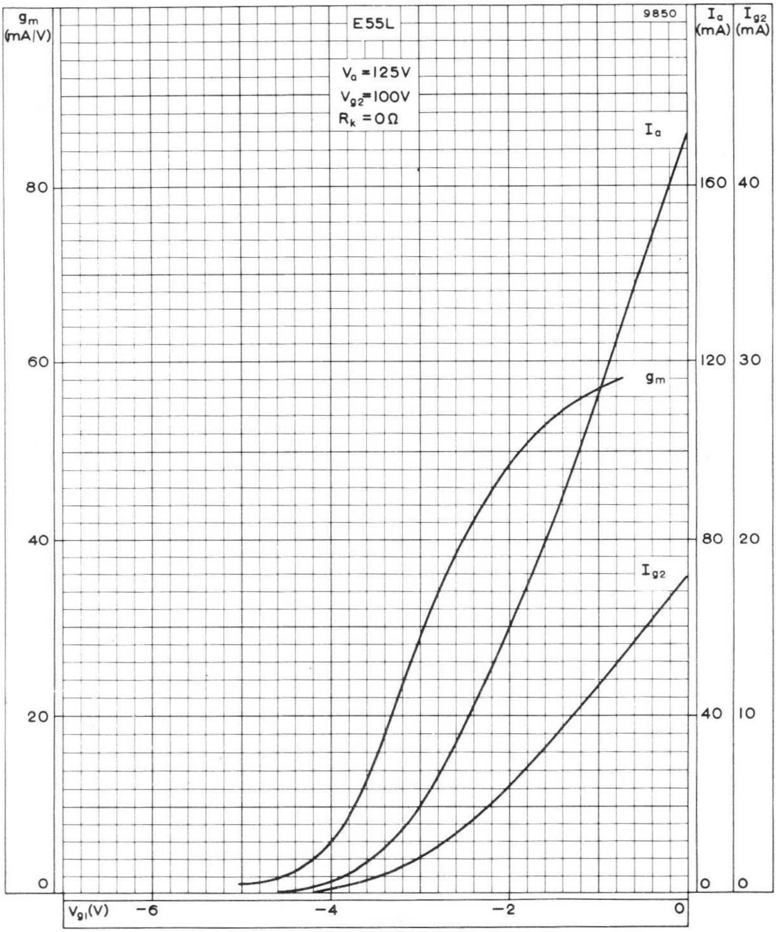
SPECIAL QUALITY WIDEBAND OUTPUT PENTODE



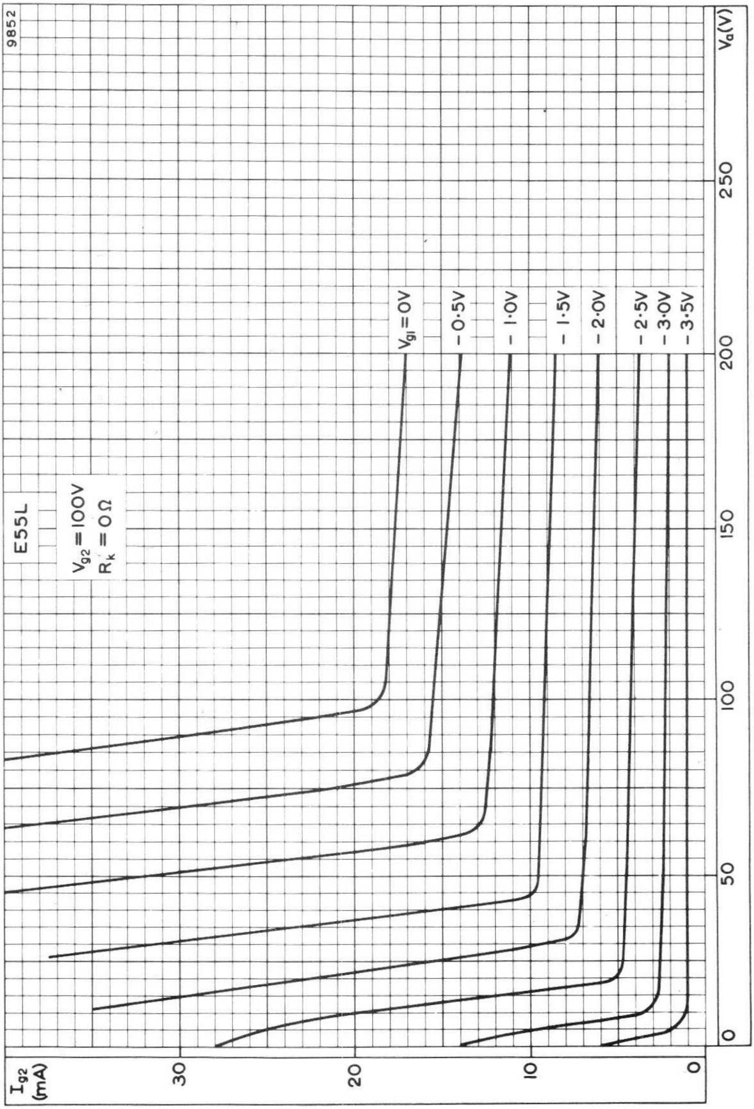
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



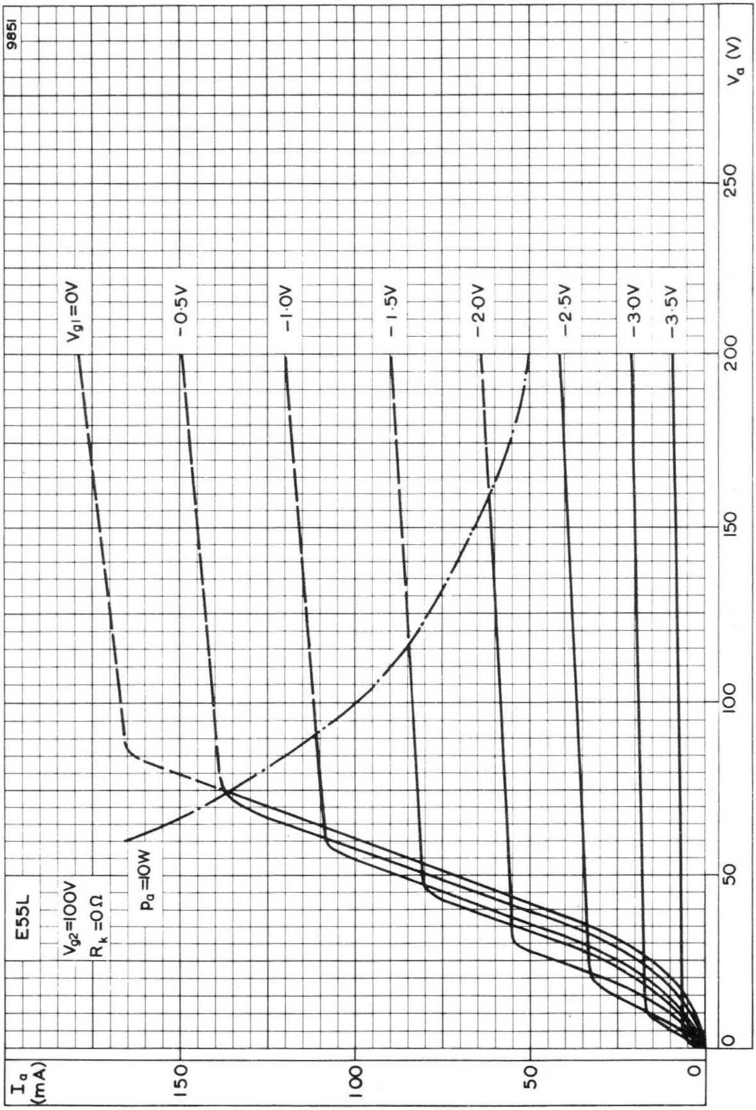
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 125V



ANODE AND SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. V_{g2} = 100V

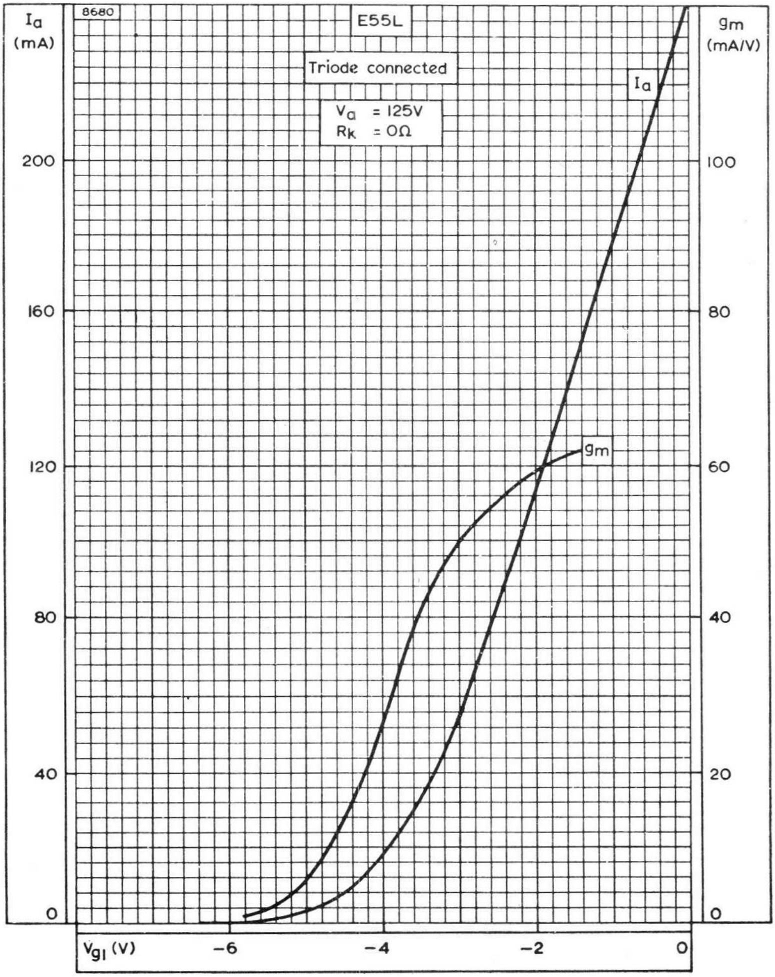


SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 100V



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 100V

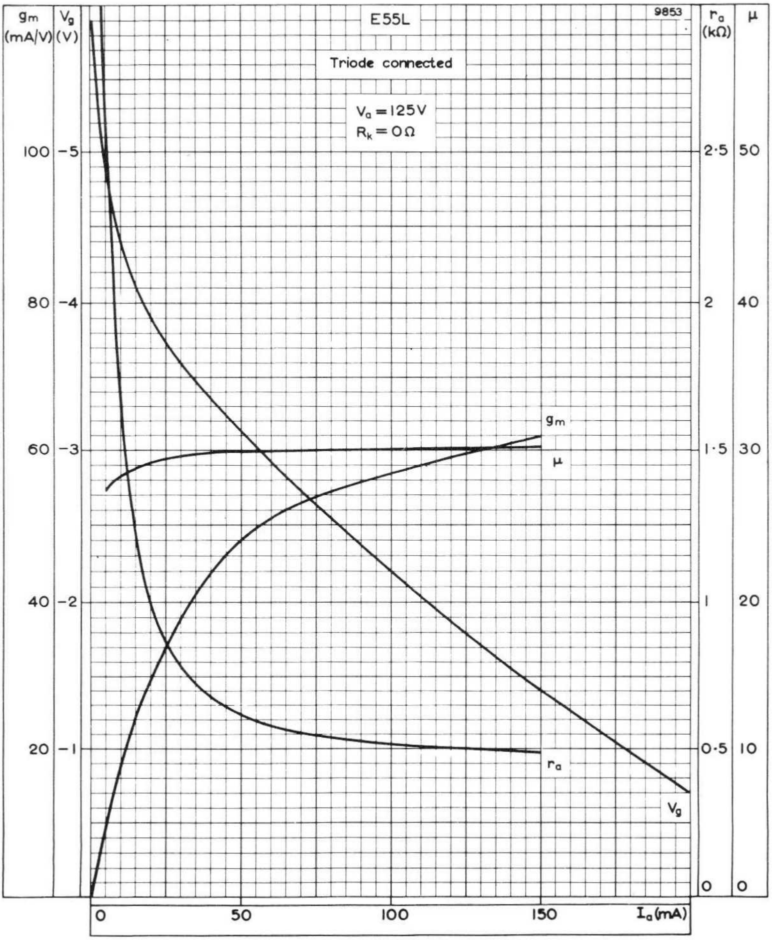
Mullard



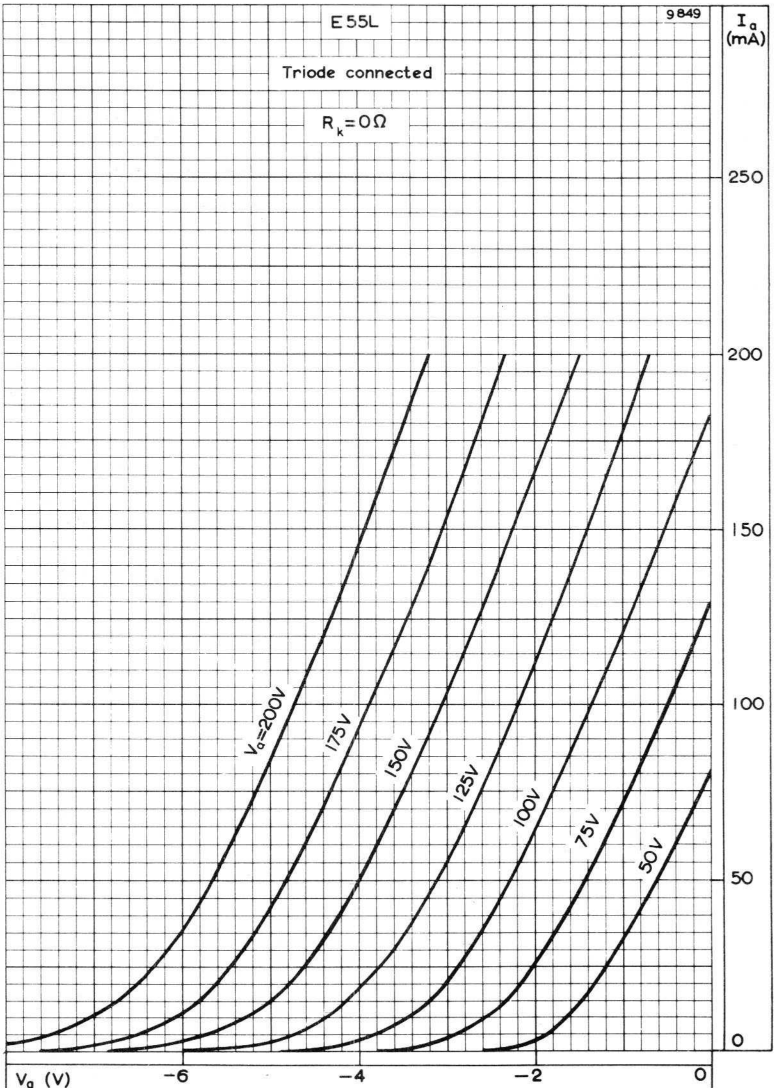
ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE, WHEN TRIODE CONNECTED

E55L

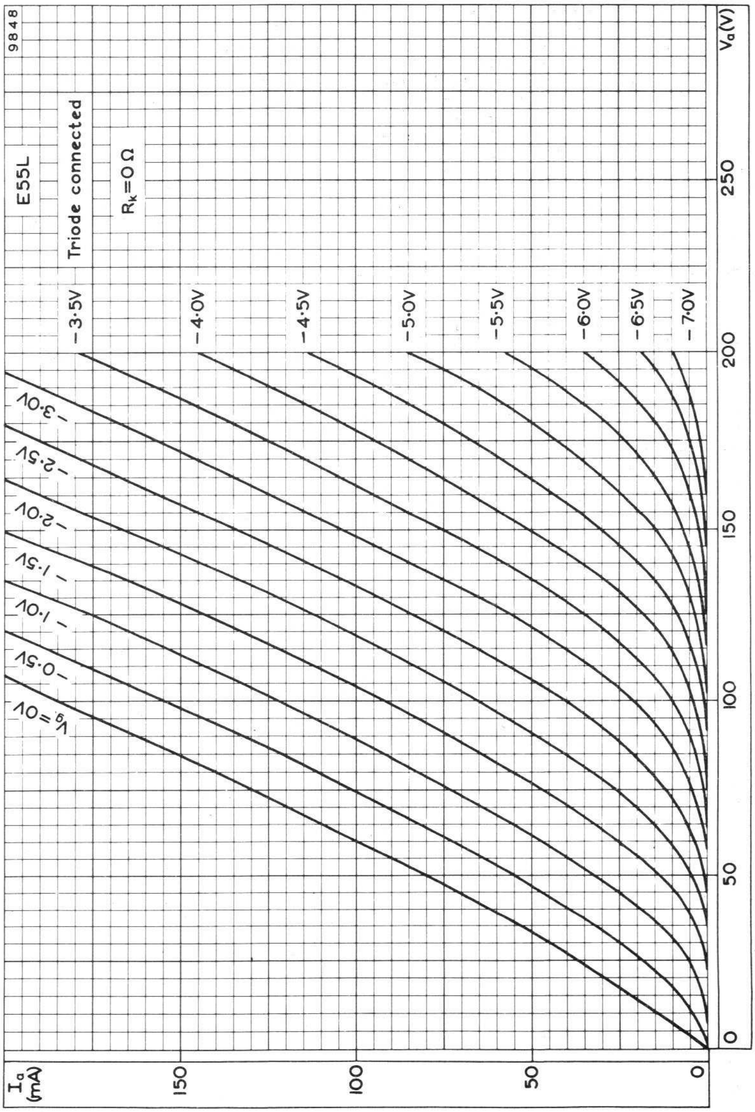
SPECIAL QUALITY WIDEBAND OUTPUT PENTODE



ANODE IMPEDANCE, AMPLIFICATION FACTOR, MUTUAL CONDUCTANCE AND GRID VOLTAGE PLOTTED AGAINST ANODE CURRENT, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

SPECIAL QUALITY TRIODE PENTODE

E80CF

Special quality triode pentode with separate cathodes for use in general industrial applications, where stability of characteristics and long life are required. This valve will maintain its emission capabilities after long periods of operation under cut-off conditions.

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

HEATER

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

V_h[1]	6.3	V
I_h	330	mA

The maximum variation of heater current at 6.3V is ±16.5 mA←

CAPACITANCES[2] (measured without an external shield) ←

	Minimum	Average	Maximum	
c_{ap-at}	—	—	70	mpF
c_{ap-gt}	—	—	20	mpF
c_{g1-at}	—	—	160	mpF
Pentode section				
c_{a-g1}	—	—	25	mpF
c_{in}	5.2	5.6	6.0	pF
c_{out}	3.0	3.4	3.8	pF
c_{g1-h}	—	—	160	mpF
Triode section				
c_{a-k+h}	1.2	1.5	1.8	pF
c_{g-k+h}	2.2	2.5	2.8	pF
c_{a-g}	1.2	1.5	1.8	pF
c_{g-h}	—	—	220	mpF

CHARACTERISTICS[3]

Pentode section

V_{a-e}	170	V
V_{g2-e}	170	V
R_k	155	Ω
I_a	10	mA
I_{g2}	2.8	mA
g_m	6.2	mA/V
r_a	400	kΩ
μ_{g1-g2}	40	

Triode section

V_{a-e}	100	V
R_k	120	Ω
I_a	14	mA
g_m	5.0	mA/V
r_a	3.6	kΩ
μ	18	

E80CF SPECIAL QUALITY TRIODE PENTODE

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN←

Pentode section

	Average	Initial Range	End of Life*	
Anode current at $V_{a-e} = V_{g2-e} = 170V$, $R_k = 155\Omega$	10	7.5 to 12.5	6.0	mA
Screen-grid current at $V_{a-e} = V_{g-e} = 170V$, $R_k = 155\Omega$	2.8	1.55 to 4.05	—	mA
Mutual conductance at $V_{a-e} = V_{g2-e} = 170V$, $R_k = 155\Omega$	6.2	5.2 to 7.2	4.3	mA/V
Control-grid current at $V_{a-e} = V_{g2-e} = 170V$, $R_k = 155\Omega$		< 0.5	< 1.0	μA

Triode Sèction

	Average	Initial Range	End of Life*	
Anode current at $V_{a-e} = 100V$, $R_k = 120\Omega$	14	10 to 18	8.4	mA
Mutual conductance at $V_{a-e} = 100V$, $R_k = 120\Omega$	5.0	4.0 to 6.0	3.5	mA/V
Control-grid current at $V_{a-e} = 100V$, $R_k = 120\Omega$		< 0.3	< 1.0	μA

*To allow for valve deterioration during life, circuits should be designed to function with a valve in which one or more of the characteristics have changed to the values stated.

OPERATING CONDITIONS

Pentode section as r.f. amplifier

V_{a-e}	170	V
V_{g2-e}	170	V
R_k	155	Ω
I_a	10	mA
I_{g2}	2.8	mA
g_m	6.2	mA/V
μ_{g1-g2}	40	
r_a	400	kΩ
r_{in} (f = 50Mc/s)	10	kΩ
R_{eq}	1.5	kΩ

Pentode section as frequency changer

V_{a-e}	170	V
V_{g2-e}	170	V
R_k	330	Ω
R_{g1}	100	kΩ
I_a	8.0	mA
I_{g2}	2.5	mA
I_{g1}	12	μA
$V_{osc\ (r.m.s.)}$	3.5	V
g_c	2.4	mA/V
r_a	500	kΩ

LIMITING VALUES[4] (absolute ratings)

Pentode section

$V_{a(b)}$ max.	550	V
V_a max.	275	V
p_a max.	2.15	W
$V_{g2(b)}$ max.	550	V
V_{g2} max. ($I_k > 10mA$)	200	V
V_{g2} max. ($I_k < 10mA$)	225	V
p_{g2} max. ($p_a > 1.2W$)	700	mW
p_{g2} max. ($p_a < 1.2W$)	800	mW
$-V_{g1}$ max.	100	V
p_{g1} max.	100	mW
I_k max.	18	mA
R_{g1-k} max.	500	kΩ
V_{h-k} max.	100	V
T_{bulb} max.	170	°C

Note—If the triode is used as a v.h.f. oscillator then it is recommended that a Colpitt's circuit should be used.

Triode section

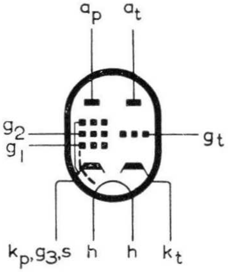
$V_{a(b)}$ max.	550	V
V_a max.	275	V
p_a max.	1.75	W
$-V_g$ max.	100	V
‡$v_{g(pk)}$ max.	30	V
p_g max.	100	mW
I_k max.	18	mA
‡$i_{k(pk)}$ max.	100	mA
R_{g-k} max.	500	kΩ
V_{h-k} max.	100	V
T_{bulb} max.	170	°C

‡Maximum pulse duration = 4% of one cycle with maximum of 800µs

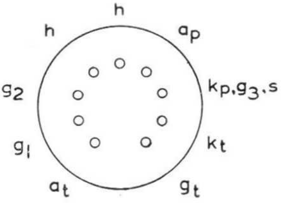
SHOCK AND VIBRATION

The E80CF can withstand vibrations of 2.5g and 50c/s for 96 hours and is proof against impact accelerations of approximately 500g.

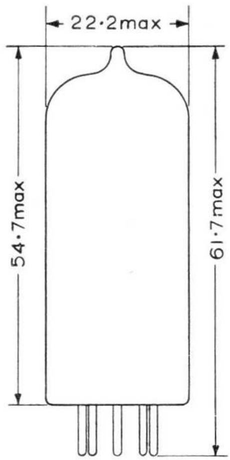
E80CF SPECIAL QUALITY TRIODE PENTODE



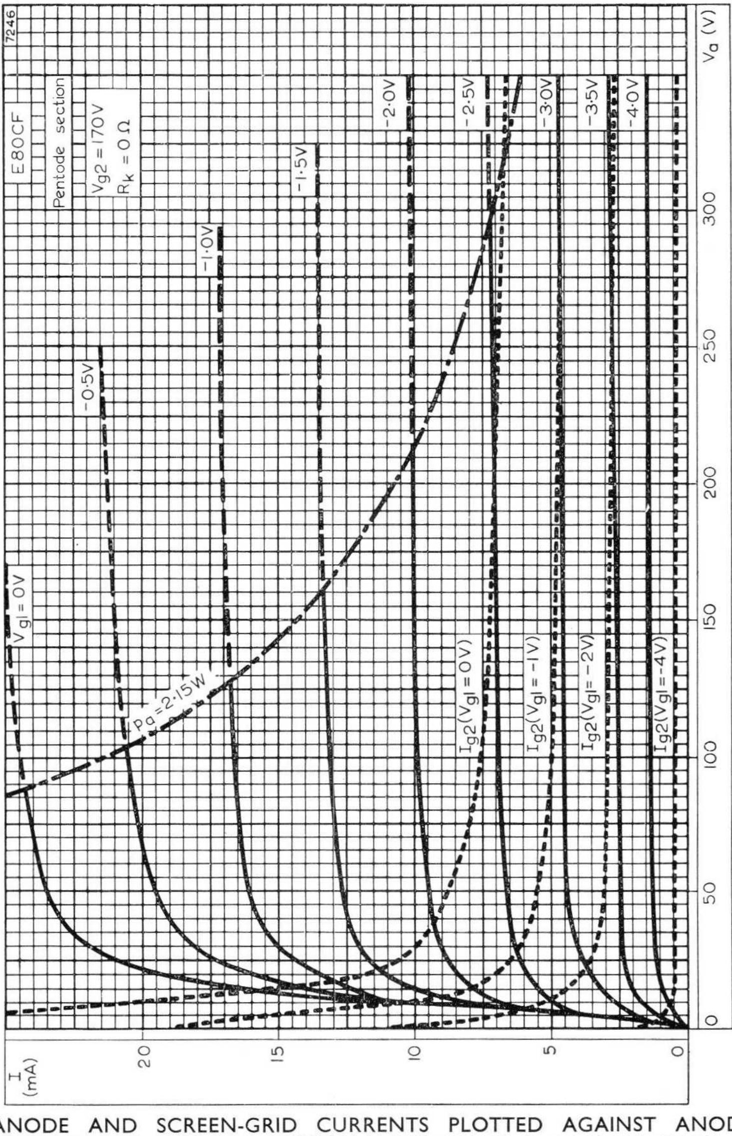
7092



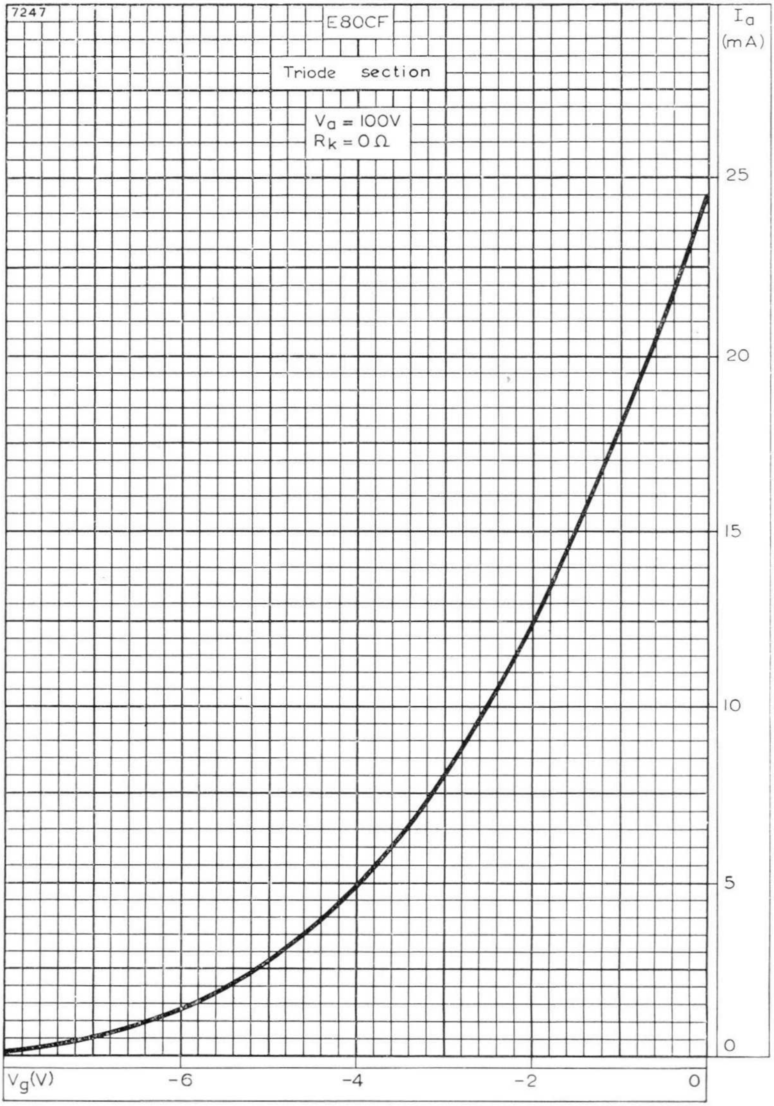
B9A Base



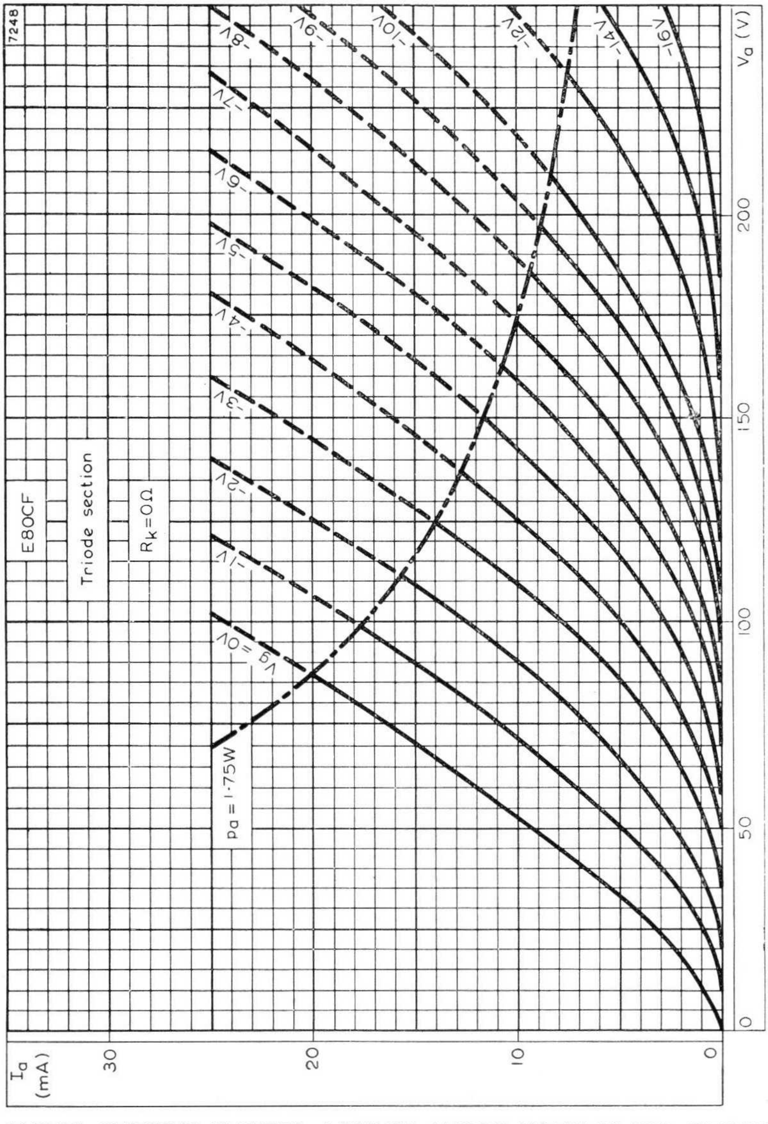
All dimensions in mm



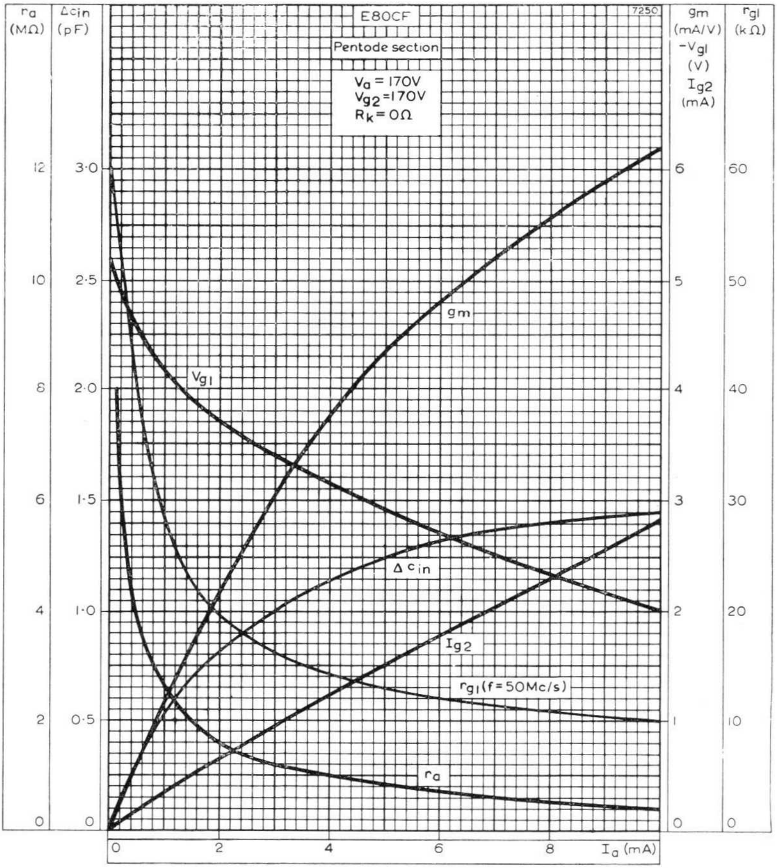
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE FOR PENTODE SECTION WITH CONTROL-GRID VOLTAGE AS PARAMETER



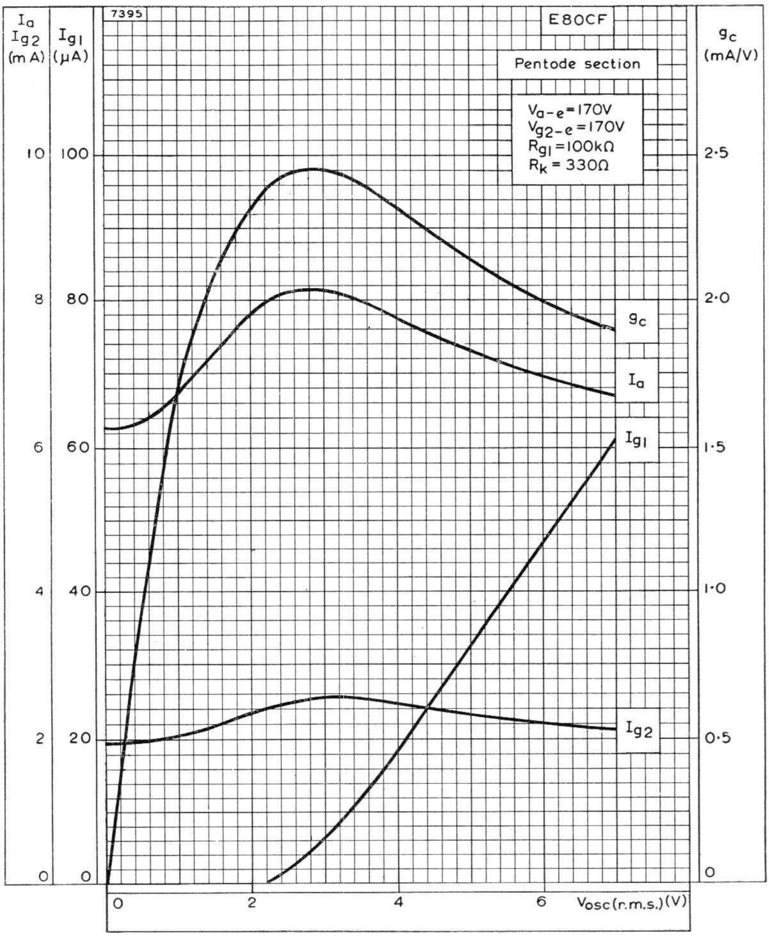
ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE FOR TRIODE SECTION



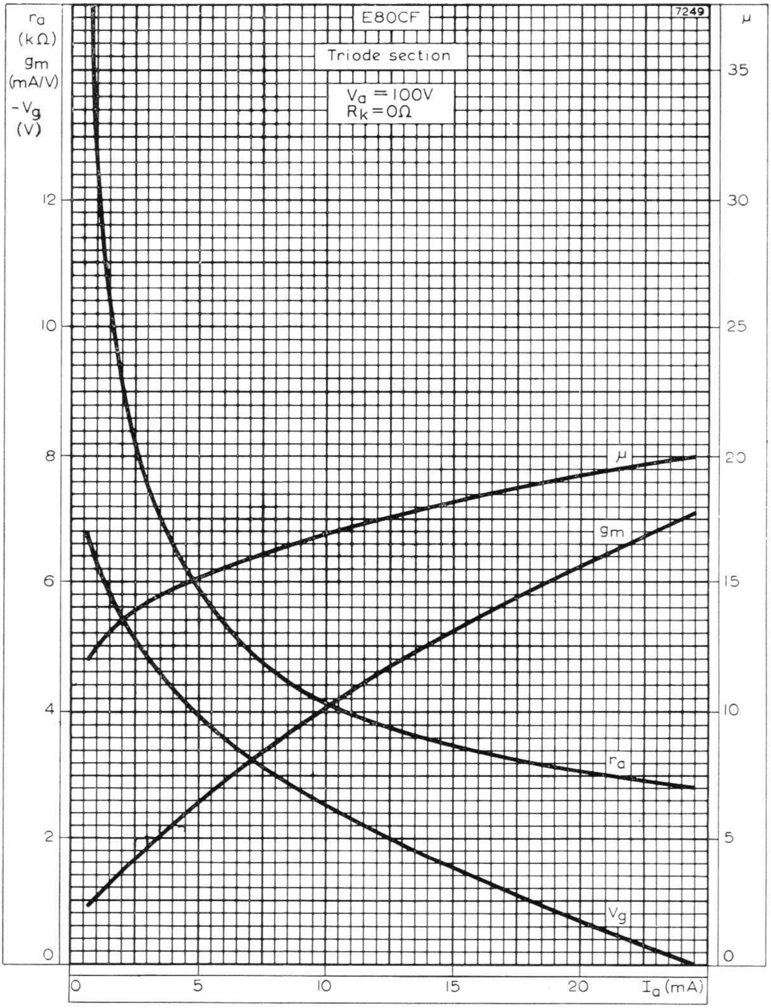
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE FOR TRIODE SECTION WITH GRID VOLTAGE AS PARAMETER



ANODE IMPEDANCE, CHANGE IN INPUT CAPACITANCE, MUTUAL CONDUCTANCE, CONTROL-GRID VOLTAGE, SCREEN-GRID CURRENT AND INPUT RESISTANCE PLOTTED AGAINST ANODE CURRENT FOR PENTODE SECTION



PERFORMANCE CURVES FOR USE AS A FREQUENCY CHANGER



ANODE IMPEDANCE, MUTUAL CONDUCTANCE, GRID VOLTAGE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT FOR TRIODE SECTION

SPECIAL QUALITY TRIODE

E88C

Special quality U.H.F. triode for use as a grounded grid r.f. amplifier or mixer at frequencies up to 1000Mc/s where stability of characteristics and long life are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	155	mA

CAPACITANCES[2] ←

	Min.	Av.	Max.	
Unshielded				
c_{a-g}	0.9	1.1	1.3	pF
Shielded (shield connected to grid)				
c_{a-g+s}	1.4	1.7	2.0	pF
$c_{k+h-g+s}$	3.2	3.8	4.4	pF
c_{a-k+h}	35	50	65	mpF

CHARACTERISTICS[3]

V_a	160	V
I_a	12.5	mA
V_g	−1.25	V
g_m	13.5	mA/V
μ	70	
r_a	5.2	kΩ
$-V_g$ max. ($I_g = +0.3\mu A$)	1.3	V

OPERATING CONDITIONS

Grounded-grid r.f. amplifier

V_{a-e}	160	170	V
V_{g-e}	0	+9.0	V
R_k	100	820	Ω
I_a	12.5	12.5	mA
g_m	13.5	13.5	mA/V
R_{eq} (r.f.)	240	—	Ω
N.F. (f = 850Mc/s)	10	—	dB

E88C

SPECIAL QUALITY TRIODE

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN ←

	Min.	Av.	Max.	
Anode current				
$V_{a-e} = 170V$, $V_{g-e} = 9V$, $R_k = 820\Omega$	—	12.5	—	mA
$V_{a-e} = 160V$, $V_{g-e} = 0V$, $R_k = 100\Omega$	9.5	12.5	16.1	mA
Mutual conductance				
$V_{a-e} = 170V$, $V_{g-e} = 9V$, $R_k = 820\Omega$	10.5	13.5	16.5	mA/V
$V_{a-e} = 160V$, $V_{g-e} = 0V$, $R_k = 100\Omega$	—	13.5	—	mA/V
Negative grid current				
$V_{a-e} = 160V$, $V_{g-e} = 0V$, $R_k = 100\Omega$	—	—	0.1	µA
Heater-cathode insulation				
$V_{h-k} = 125V$	—	—	15	µA
Heater current				
$V_h = 6.3V$	147	155	163	mA

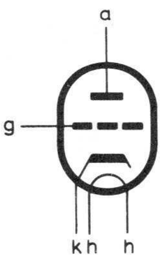
SHOCK AND VIBRATION ←

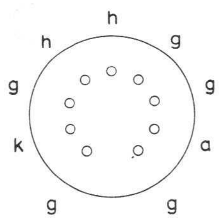
The E88C can withstand vibrations of 2.5g and 50c/s for 96 hours and is proof against impact accelerations of approximately 500g.

ABSOLUTE MAXIMUM RATINGS[4]

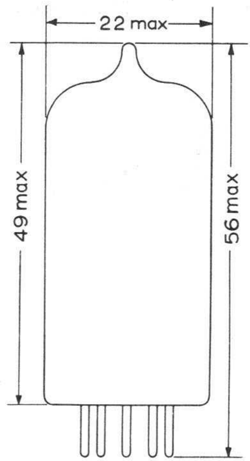
$V_{a(b)}$ max.	400	V	
V_a max.	200	V	
p_a max.	2.6	W	←
$-V_{g1}$ max.	50	V	
I_k max.	16.5	mA	←
R_{g-k} max.	0.5	MΩ	
V_{h-k} max. (k positive)	125	V	
V_{h-k} max. (k negative)	60	V	
T_{bulb} max.	170	°C	
V_h max.	6.6	V	
V_h min.	6.0	V	

B381

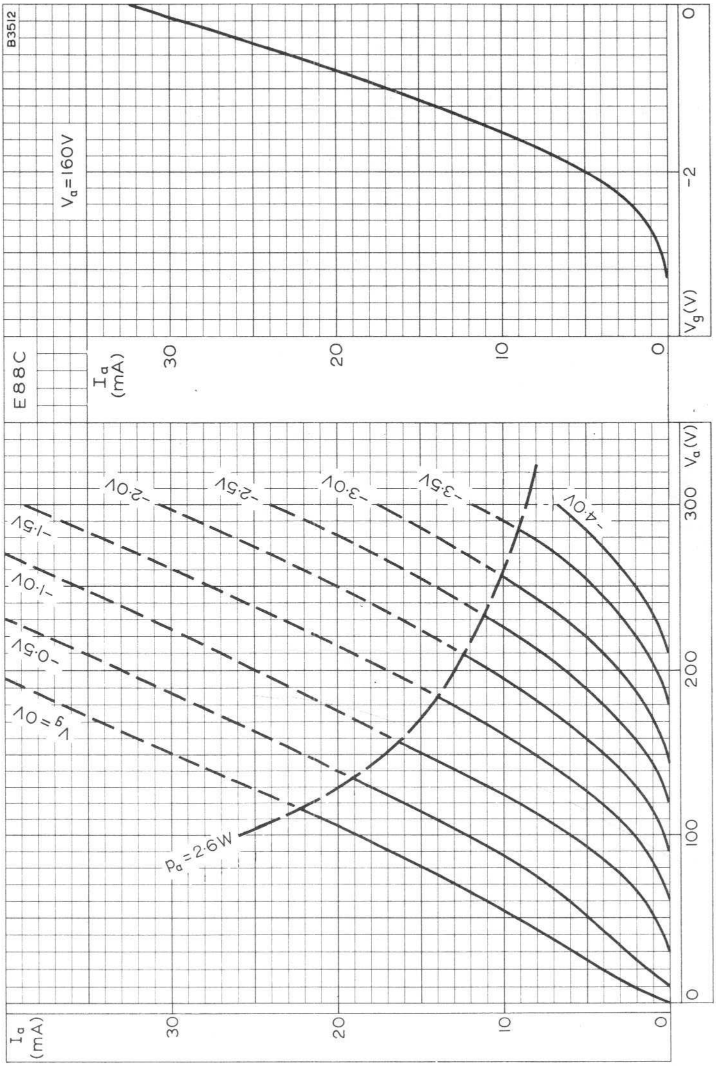




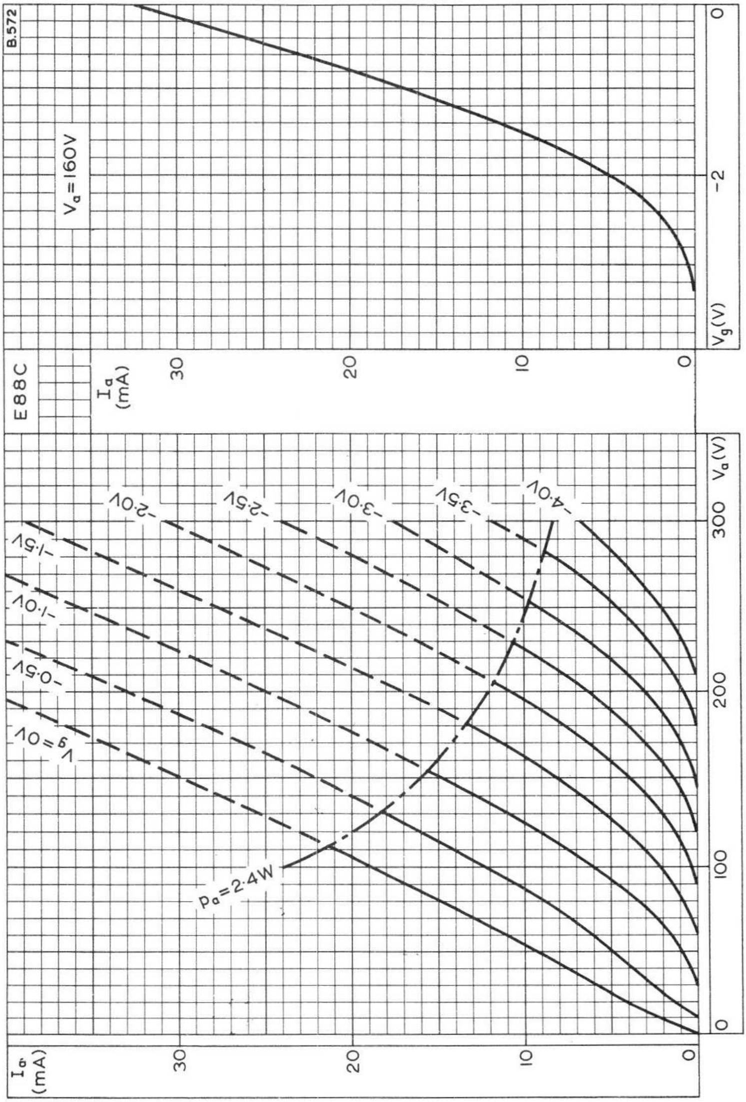
B9A Base



All dimensions in mm



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE AT $V_a = 160V$.
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE AT $V_a = 160V$.
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

SPECIAL QUALITY DOUBLE TRIODE

E88CC

Special quality double triode, having separate cathodes, for use in cascode circuits and in computers, where stability of characteristics and long life are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	300	mA

The maximum variation of heater current at $V_h = 6.3V$ is $\pm 15mA$

MOUNTING POSITION

Any

CAPACITANCES[2] (measured without an external shield)

	Minimum	Average	Maximum	
*c_{a-g}	1.2	1.4	1.6	pF
*c_{a-k}	130	180	230	mpF
*c_{a-s}	1.1	1.3	1.5	pF
*$c_{g-k+h+s}$	2.7	3.3	3.9	pF
*c_{g-k+h}	2.7	3.3	3.9	pF
$c_{k'-h}$	—	2.6	—	pF
$c_{k''-h}$	—	2.7	—	pF
$c_{a'-k'+h+s}$	1.55	1.75	1.95	pF
$c_{a'-k'+h}$	400	500	600	mpF
$c_{a''-k''+h+s}$	1.45	1.65	1.85	pF
$c_{a''-k''+h}$	300	400	500	mpF
$c_{a'-a''}$	—	30	45	mpF
$c_{g'-g''}$	—	—	5.0	mpF
$c_{a'-g''}$	—	—	5.0	mpF
$c_{a''-g'}$	—	—	5.0	mpF
$c_{g'-k''}$	—	—	5.0	mpF
$c_{g''-k'}$	—	—	5.0	mpF

Grounded grid operation

	Minimum	Average	Maximum	
$c_{a'-g'+h+s}$	2.6	2.9	3.2	pF
$c_{a''-g''+h+s}$	2.5	2.8	3.1	pF
*$c_{k-g+h+s}$	5.1	6.0	6.9	pF

*Each section.

E88CC

SPECIAL QUALITY DOUBLE TRIODE

CHARACTERISTICS[3] (each section)

V_a	90	V
I_a	15	mA
g_m	12.5	mA/V
μ	33	
r_a	2.65	kΩ
V_g	–1.2	V
R_k	0	Ω

OPERATING CONDITIONS (each section)

V_{a-e}	90	100	V
V_{g-e}	0	+9.0	V
R_k	120	680	Ω
I_a	12	15±0.8	mA
g_m	11.5	10.5 to 15	mA/V
Noise factor (f = 200Mc/s)	—	4.6	dB
$V_{g(r.m.s.)}$ ($I_g = +0.3\mu A$)		750	mV
$R_{eq(r.f.)}$		300	Ω

EQUIPMENT DESIGN DATA FOR COMPUTER OPERATION
(each section)

$V_{a(b)}$	60	150	V
R_a	2.5	2.5	kΩ
$V_{g(b)}$	60	150	V
R_g	300	300	kΩ
I_a	>9.0	33±5.0*	mA

*This condition exceeds the maximum cathode current rating for continuous operation and measurements must be limited to a period of 1s.

BALANCE AND CUT-OFF CHARACTERISTICS

V_a	150	V
V_g (I_a=100μA)	–7.0±1.5	V
V_g (I_a=5μA)	–15	V
$V_{g'} \sim V_{g''}$ (I_a=100μA)	<2.0	V

REVERSE GRID CURRENT

$-I_g$	<0.1	μA

Measured at (V_h = 6.3V, V_a = 90V, I_a = 15mA, R_{g-k} = 100kΩ)

INSULATION

Between heater and cathode

V_h	6.3	V
V_{h-k} (cathode negative)	60	V
V_{h-k} (cathode positive)	120	V
Leakage current	<6.0	μA

SPECIAL QUALITY DOUBLE TRIODE

E88CC

LIMITING VALUES[4] (design centre ratings) each section

$V_{a(b)}$ max.	400	V
V_a max.	220	V
V_a max. (p_a <800mW)	250	V
†p_a max.	1.5	W←
†p_a max. ($p_{a'} + p_{a''} \leqq 2$W)	1.8	W←
$p_{a'} + p_{a''}$ max.	3.0	W←
p_g max.	30	mW
†R_{g-k} max.	1.0	MΩ
$-V_a$ max.	100	V
*$-v_{g(pk)}$ max.	200	V
I_k max.	20	mA
*$i_{k(pk)}$ max.	100	mA
V_{h-k} max. (cathode positive)	120	V
V_{h-k} max. (cathode negative)	60	V
T_{bulb} max.	170	°C

*Maximum duty factor = 0.1, Maximum pulse duration = 200μs.

†Operation with fixed bias is only permitted for I_a<5mA.

SHOCK AND VIBRATION RATINGS

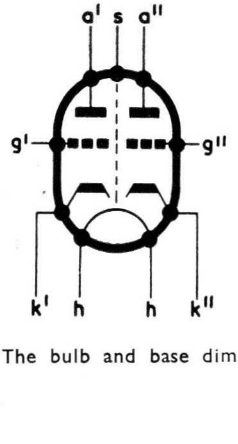
The E88CC can withstand vibrations of 2.5g and 50c/s for 96 hours and is proof against impact accelerations of about 500g.

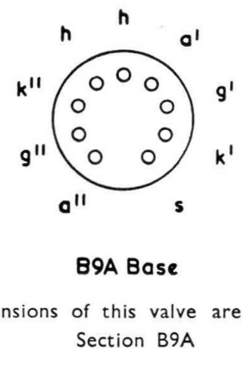
OPERATING NOTES

The hum voltage referred to g′ has a maximum value of 50μV and is measured with the centre tap of the heater winding earthed, at a supply frequency of 50c/s (including 3% at 500c/s), with a fully screened valve holder and a linear band-pass characteristic under the following conditions:—

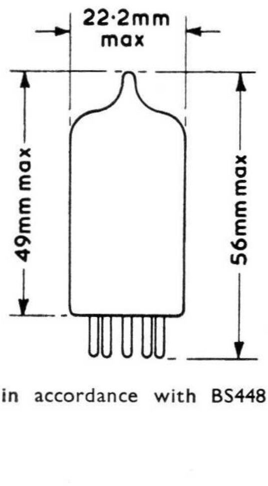
V_{a-k}	90	V
I_a	15	mA
R_k	80	Ω
C_k	1000	μF
R_{g-k}	500	kΩ

3499





B9A Base



The bulb and base dimensions of this valve are in accordance with BS448 Section B9A

SPECIAL QUALITY OUTPUT PENTODE

E130L

Special quality high slope output pentode intended for general industrial applications.

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

HEATER

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

V_h [1]	6.3	V
I_h	1.7	A

The maximum variation of heater voltage at $I_h = 1.7A$ is $\pm 5\%$.

CAPACITANCES[2]

c_{in}	35	pF
c_{out}	17	pF
c_{a-g1}	<2.0	pF

CHARACTERISTICS[3]

V_a	250	V
V_{g2}	150	V
V_{g1}	-15.5	V
I_a	100	mA
I_{g2}	4.0	mA
g_m	27.5	mA/V
μ_{g1-g2}	6.5	
r_a	10	kΩ

OPERATING CONDITIONS AS CLASS 'A' AMPLIFIER

V_a	250	V
V_{g2}	150	V
V_{g1}	-15.5	V
R_a	2.7	kΩ
$V_{in(r.m.s.)}$	3.82	V
$I_{a(o)}$	100	mA
$I_{g2(o)}$	4.0	mA
P_{out}	11.5	W
D_{tot}	10	%

OPERATING CONDITIONS AS CLASS 'AB' AMPLIFIER - PUSH-PULL

V_a	300	V
V_{g2}	150	V
V_{g1}	-17	V
R_{a-a}	1.6	kΩ
$V_{in(r.m.s.)}$	9.0	V
$I_{a(o)}$	2 × 80	mA
$I_{g2(o)}$	2 × 2.5	mA
P_{out}	60	W
D_{tot}	5	%
$I_{a(max.sig.)}$	2 × 182	mA
$I_{g2(max.sig.)}$	2 × 22	mA

RATINGS (ABSOLUTE MAXIMUM SYSTEM)[4]

$V_{a(b)}$ max.	2.0	kV
V_a max.	900	V
V_{g2} max.	250	V
$-v_{a(pk)}$ max.	2.0	kV
$+v_{a(pk)}$ max.	8.0	kV
p_a max.	27.5	W
p_{a+g2} max.	27.5	W
$V_{g2(b)}$ max.	550	V

SPECIAL QUALITY OUTPUT PENTODE

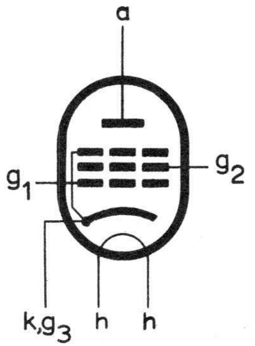
E130L

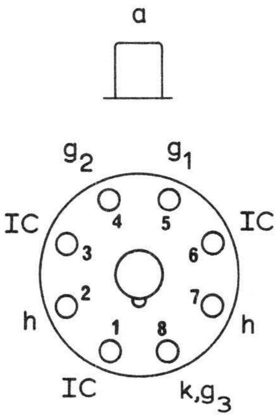
P_{g2} max.	5.0	W
$-V_{g1}$ max.	150	V
$+V_{g1}$ max.	15	V
$-p_{g1}$ max.	0.1	W
R_{g1} max.	0.5	MΩ
I_k max.	300	mA
$^{*}i_{k(pk)}$ max.	1.5	A
$^{**}i_{k(pk)}$ max.	4.6	A
V_{h-k} max. (cathode negative)	100	V
V_{h-k} max. (cathode positive)	200	V

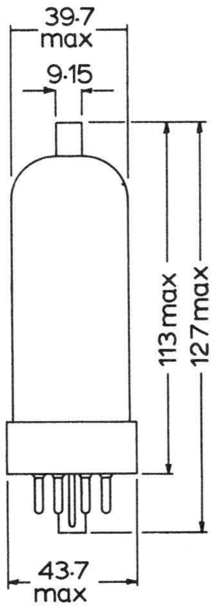
*Max. duration 4ms, I_k max. = 150mA.

**Max. duration 1.5μs, I_k max. = 14mA.

B4678



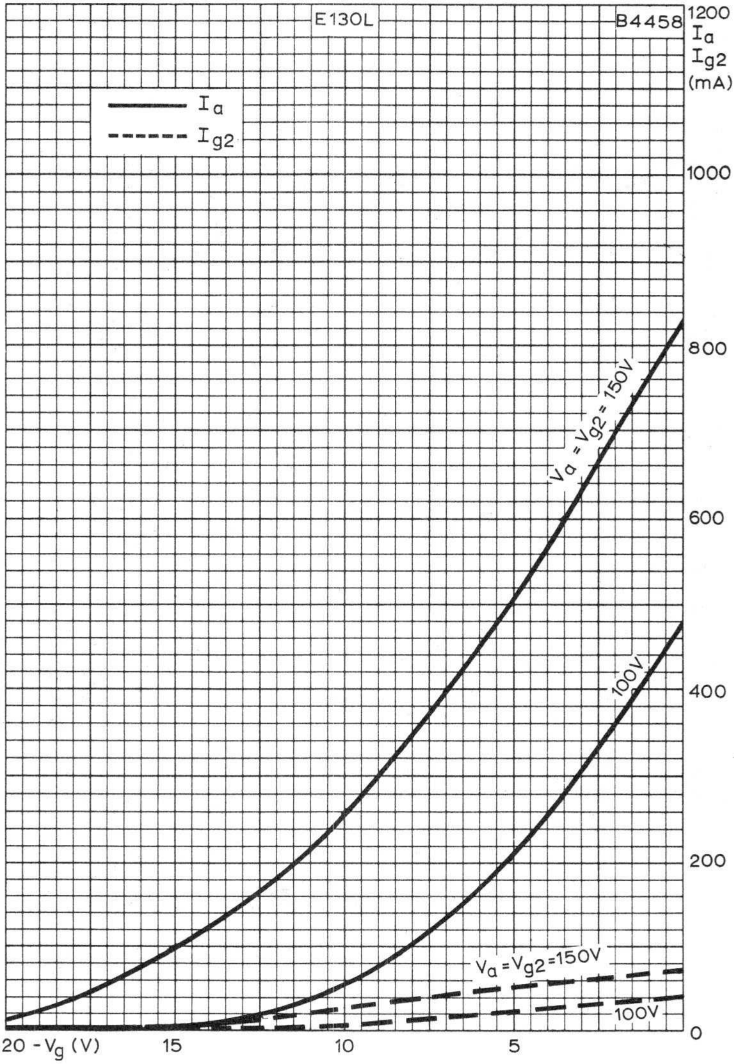




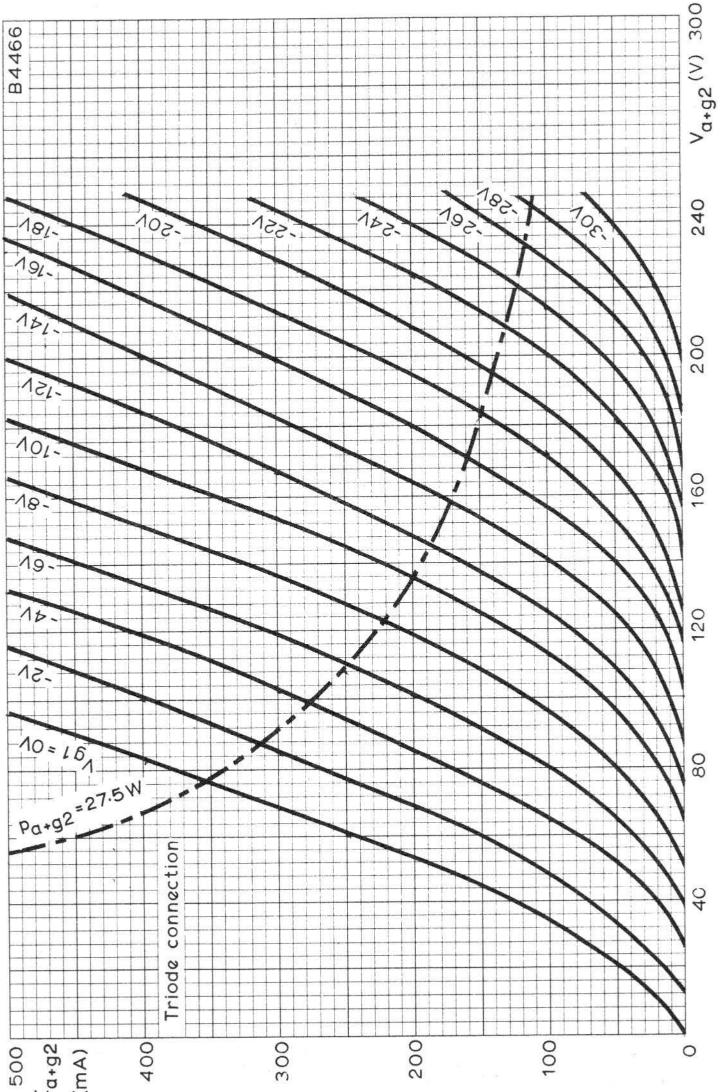
Octal Base

CT2 Top Cap

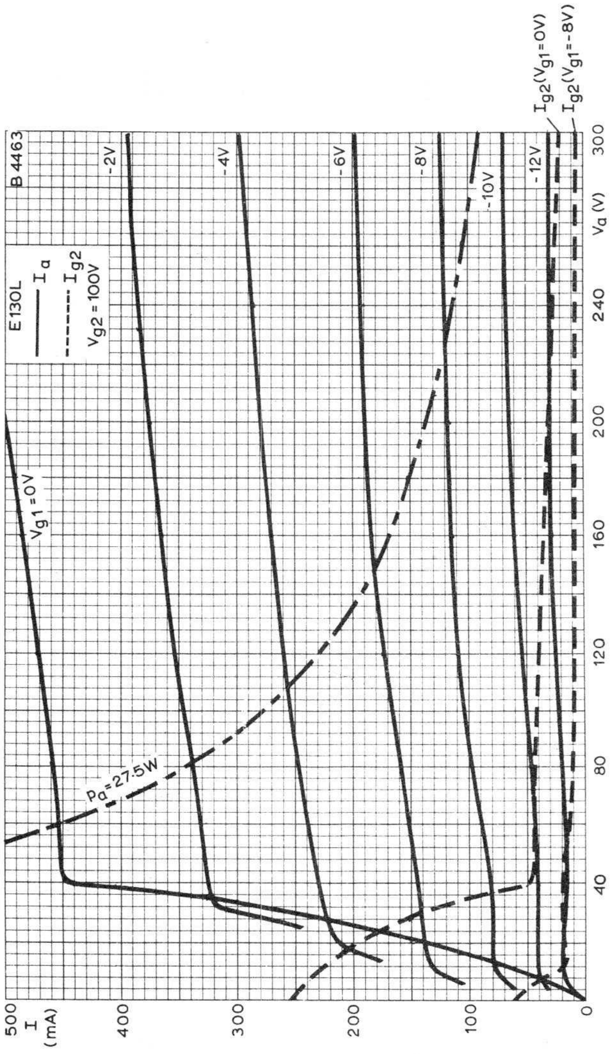
All dimensions in mm



ANODE AND SCREEN CURRENTS PLOTTED AGAINST
CONTROL-GRID VOLTAGE WITH ANODE AND
SCREEN VOLTAGES AS PARAMETERS

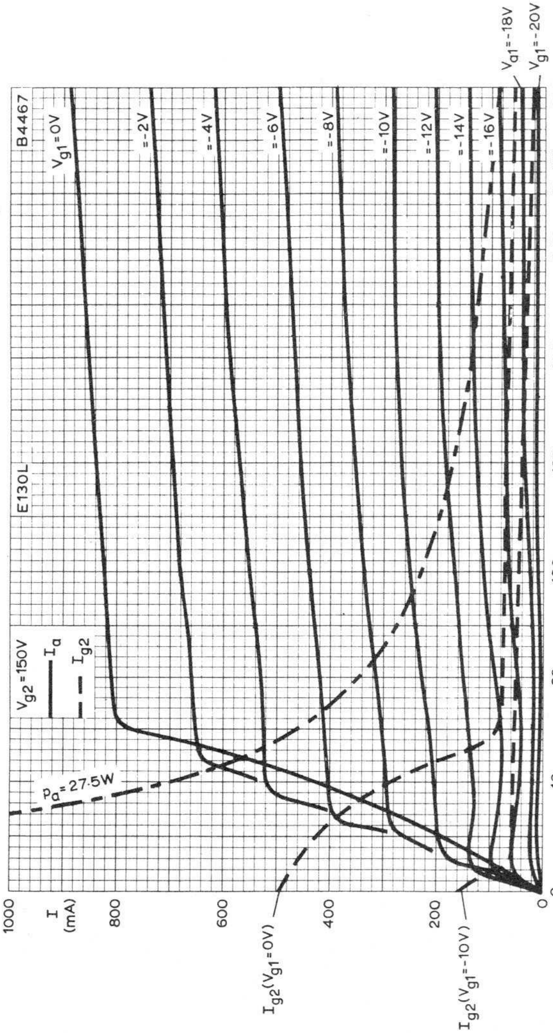


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE
WITH CONTROL-GRID VOLTAGE AS PARAMETER

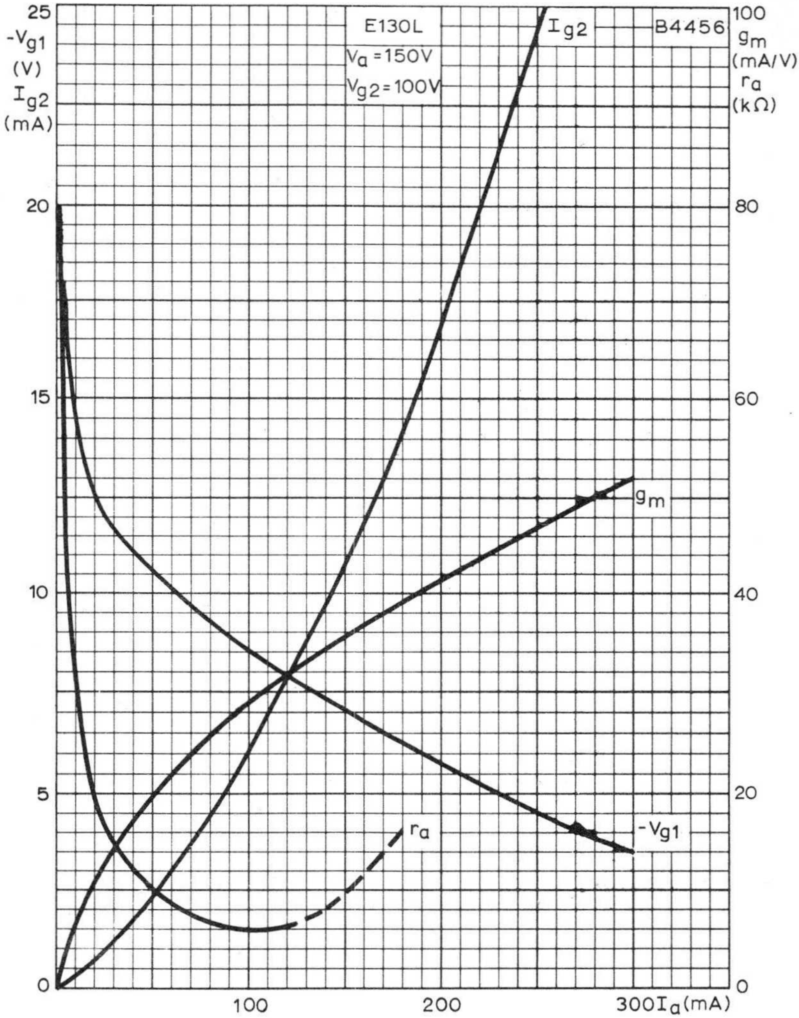


ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

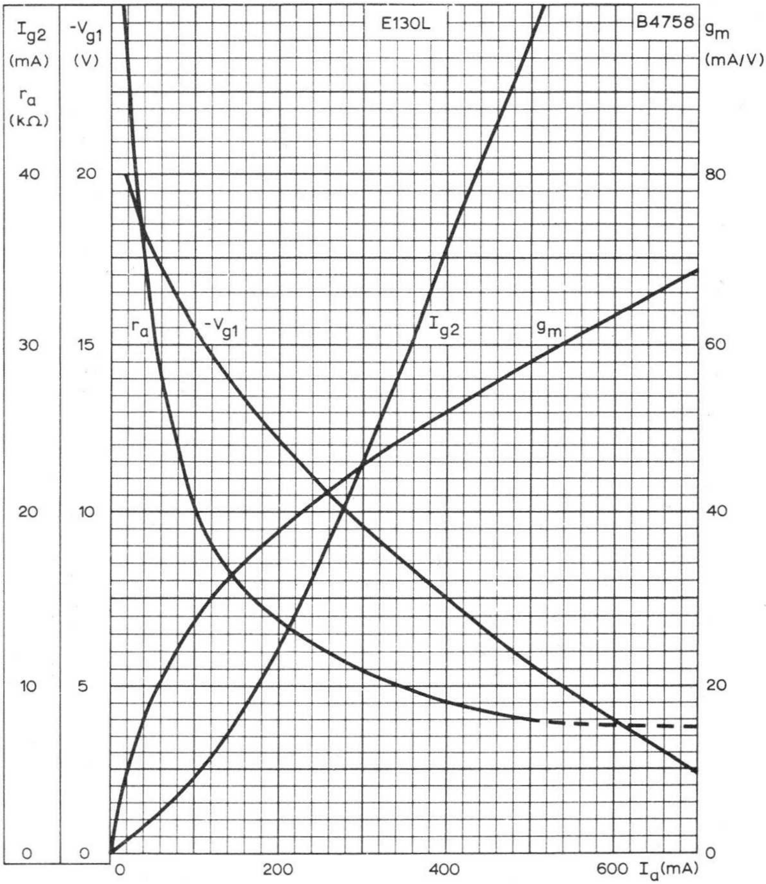
$V_{g2} = 100V$



ANODE AND SCREEN CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER $V_{g2}=150V$



SCREEN CURRENT, CONTROL-GRID VOLTAGE,
MUTUAL CONDUCTANCE AND ANODE IMPEDANCE
PLOTTED AGAINST ANODE CURRENT
V_a = 150V, V_{g2} = 100V



SCREEN CURRENT, CONTROL-GRID VOLTAGE
MUTUAL CONDUCTANCE AND ANODE IMPEDANCE
PLOTTED AGAINST ANODE CURRENT
$V_a = 250V$, $V_{g2} = 150V$

SPECIAL QUALITY V.H.F. TRIODE

EC1000

Special quality subminiature triode primarily intended for use as an input valve in measurement probes.

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

HEATER

Suitable for parallel supply a.c. or d.c.

V_h[1]	6.3	V
I_h	185	mA

MOUNTING POSITION

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 2mm from the seal.

CAPACITANCES[2] (unshielded)

	Min.	Av.	Max.	
c_{a-g}	1.4	1.7	2.0	pF
c_{a-h}	185	270	355	mpF
c_{a-k}	325	450	575	mpF
c_{g-k}	2.9	3.5	4.1	pF
c_{g-h}	23	33	43	mpF
c_{h-k}	2.3	2.8	3.3	pF

CHARACTERISTICS[3]

V_a	80	V
I_a	14	mA
V_g	-2.0	V
g_m	14.5	mA/V
μ	27.5	
r_{g1} (f = 250Mc/s)	300	Ω

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

	Av.	Initial range	End of life	
Anode current				
$V_{a\ (b)} = 90V$				
$R_k = 680\Omega$				
$V_{g\ (b)} = 7.5V$	14	-	-	mA
$V_{a\ (b)} = 82V$				
$R_k = 143\Omega$				
$V_{g\ (b)} = 0V$	14	11.2 to 16.8	8.2	mA
Mutual conductance				
$V_{a\ (b)} = 90V$				
$R_k = 680\Omega$				
$V_{g\ (b)} = 7.5V$	14.5	12.9 to 16.1	9.2	mA/V
$V_{a\ (b)} = 82V$				
$R_k = 143\Omega$				
$V_{g\ (b)} = 0V$	14.5	-	-	mA/V
Negative grid current				
$V_{a\ (b)} = 92V$				
$R_k = 680\Omega$				
$V_{g\ (b)} = 7.5V$	-	<10	<10	nA ←
Heater current				
$V_h = 6.3V$	185	175 to 195	-	mA
Heater-cathode insulation				
$V_{h-k} = 55V$	-	<5.0	<10	μA

SHOCK AND VIBRATION

The EC1000 can withstand vibrations of 2.5g and 50c/s for 96 hours and is proof against impact accelerations of approximately 500g.

ABSOLUTE MAXIMUM RATINGS[4]

$V_{a\ (b)}$ max.	275	V
V_a max.	110	V
p_a max.	1.5	W
I_k max.	22	mA
$-V_g$ max.	55	V
$*R_{g-k}$ max.	48	MΩ
V_{h-k} max.	55	V
V_h max.	6.6	V

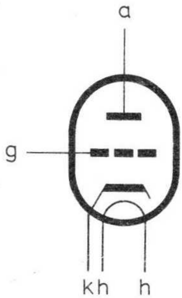
SPECIAL QUALITY V.H.F. TRIODE

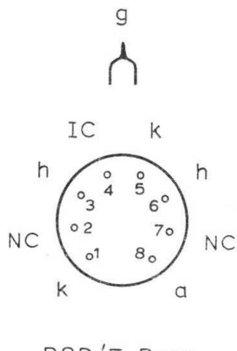
EC1000

V_h min.	6.0	V
T_{bulb} max.	170	°C

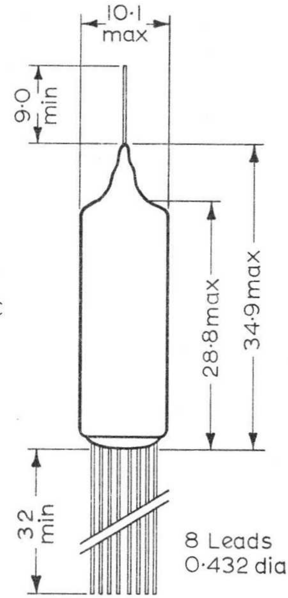
*R_{g-k} max. should be restricted to that value at which no absolute maximum rating is exceeded at $-I_g$ = 10nA. In practice the maximum R_{g-k} will also be determined by the required current stability and the permissible hum level.

In calculating the maximum permissible R_{g-k} to be safe from thermal runaway, the d.c. feedback factor of the circuit should be taken into account.



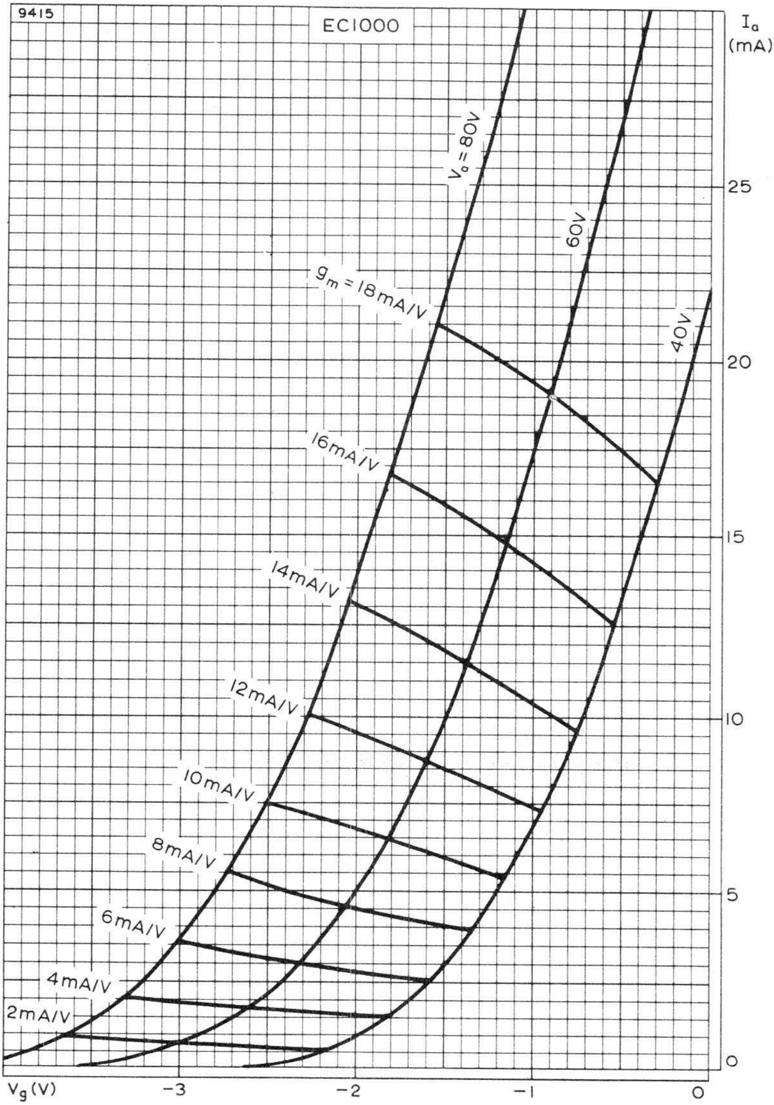


B8D/F Base

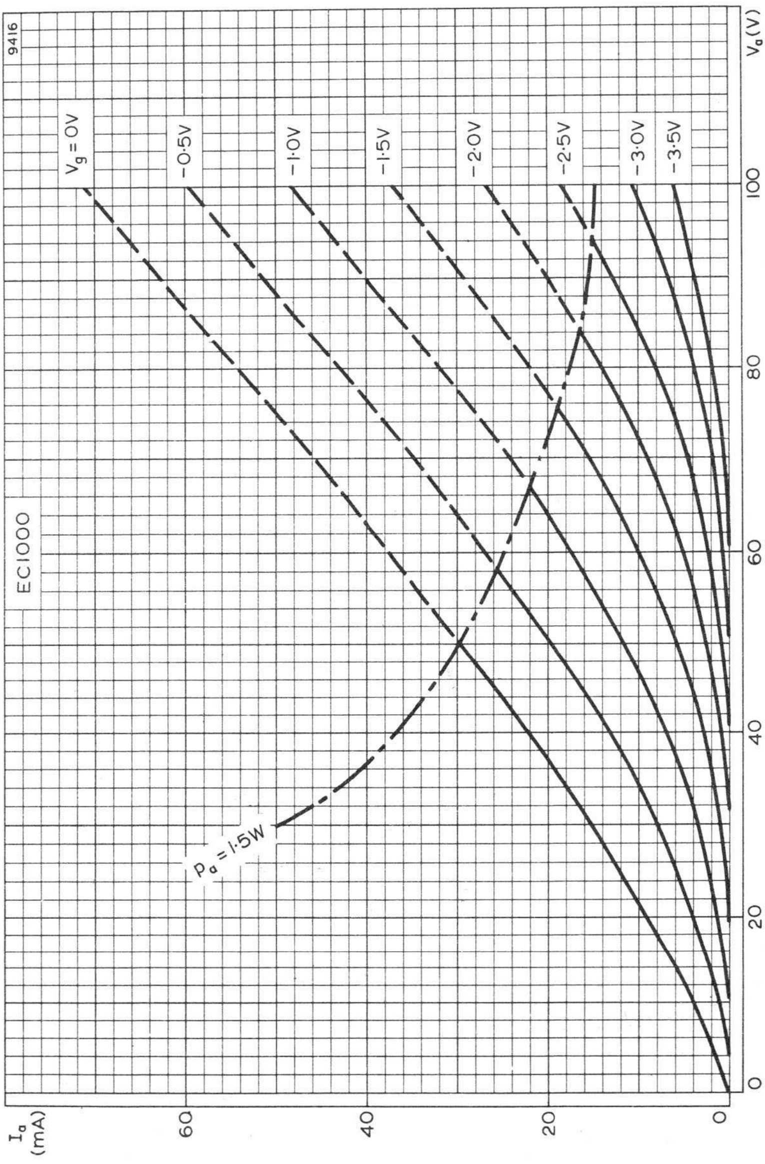


All dimensions in mm

B4421



ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER AND WITH MUTUAL CONDUCTANCE CONTOURS



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

SPECIAL QUALITY PENTODE

E186F

Special quality high slope pentode for use as a wide band amplifier where stability of characteristics and long life are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	320	mA

The maximum variation of heater current at $V_h = 6.3V$ is $\pm 20mA$.

CAPACITANCES[2] (shielded)

c_{a-g1} max.	30	mpF
c_{in}	7 6	pF
c_{out}	3·45	pF

CHARACTERISTICS[3]

V_a	180	V
V_{g3}	0	V
V_{g2}	150	V
V_{g1}	−1.25	V
I_a	13	mA
I_{g2}	3.3	mA
g_m	16.5	mA/V
μ_{g1-g2}	53	
r_a	100	kΩ
$-V_{g1}$ max. ($I_{g1} = +0.3\mu A$)	0.5	V

OPERATING CONDITIONS AS R.F. AMPLIFIER

V_{a-e}	180	190	V
V_{g3-k}	0	0	V
V_{g2-e}	150	160	V
V_{g1-e}	0	+9.0	V
R_k	100†	630	Ω
I_a	11.5	13	mA
I_{g2}	2.9	3.3	mA
g_m	15.9	16.5	mA/V
R_{eq} (r.f.)	—	330	Ω

†Recommended minimum value for $V_{g2-e} = 150V$.

CHARACTERISTIC RANGE VALUES FOR EQUIPMENT DESIGN

	Average	*Initial range*	*End of life**	
Anode current	13	12.2 to 13.8	> 11.5	mA
V_{a-e} = 190V, V_{g2-e} = 160V, V_{g1-e} = +9V, R_k = 630Ω				
Anode Current	—	< 0.8	—	mA
V_{a-k} = 180V, V_{g2-k} = 150V, V_{g1} = −4.5V				
Screen-grid current	3.3	2.9 to 3.7	—	mA
V_{a-e} = 190V, V_{g2-e} = 160V V_{g1-e} = +9V, R_k = 630Ω				
Mutual conductance	16.5	14.2 to 18.8	> 11	mA/V
V_{a-e} = 190V, V_{g2-e} = 160V, V_{g1-e} = +9V, R_k = 630Ω				
Negative control-grid current	—	< 0.2	< 0.5	μA
V_{a-e} = 190V, V_{g1-e} = +9V, V_{g2-e} = 160V, R_k = 630Ω, R_{g1-k} = 100kΩ				
Insulation resistance	—	> 100	> 50	MΩ
anode to all other electrodes $V_{d.c.}$ 300V				
grid to all other electrodes $V_{d.c.}$ 100V	—	> 100	> 50	MΩ
Heater-cathode insulation (I_{h-k})	—	< 10	< 20	μA
V_{h-k} = 100V				
Heater current	320	300 to 340	300 to 340	mA
V_h = 6.3V				

*To allow for valve deterioration during life, circuits should be designed to function with a valve on which one or more of the characteristics have changed to the values stated.

SHOCK AND VIBRATION RATINGS

The E186F can withstand vibrations of 2.5g and 50c/s for 96 hours and is proof against impact accelerations of approximately 500g.

ABSOLUTE MAXIMUM RATINGS[4]

$V_{a(b)}$ max.	400	V
V_a max.	210	V
p_a max.	3.0	W
$V_{g2(b)}$ max.	400	V
V_{g2} max.	175	V
p_{g2} max.	700	mW
$+V_{g1}$ max.	0	V
$-V_{g1}$ max.	50	V
$-v_{g1(pk)}$ max.	100	V
I_k max.	25	mA
R_{g1-k} max.	250	kΩ
V_{h-k} max.	60	V
R_{h-k} max.	20	kΩ
T_{bulb} max.	165	°C
V_h max.	6.6	V
V_h min.	6.0	V

OPERATING NOTES

1. Hum

The hum voltage referred to g_1 has a maximum value of 100μV and is measured with the centre tap of the heater winding earthed, a supply frequency of 50c/s (including 3% at 500c/s) and a linear band-pass characteristic under the following conditions:

V_h	6.3	V
V_b	207	V
V_{g3}	0	V
V_{g2-e}	150	V
R_a	2.0	kΩ
R_k	78	Ω
C_k	1000	μF
R_{g1-k}	500	kΩ

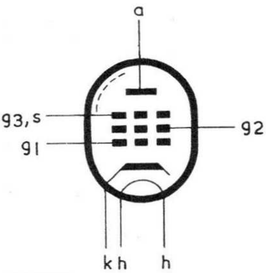
2. Microphony

The microphonic noise voltage measured at the anode has a maximum value of 500mV over the frequency range 50 to 2000c/s and has a maximum value of 200mV at a frequency of 50c/s measured under the following conditions:

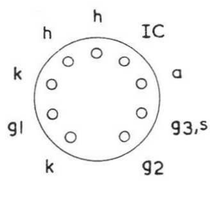
V_h	6.3	V
V_b	216	V
V_{g3}	0	V
V_{g2-e}	160	V
V_{g1-e}	+9.0	V
R_a	2.0	kΩ
R_k	630	Ω
peak acceleration	10	g

E186F

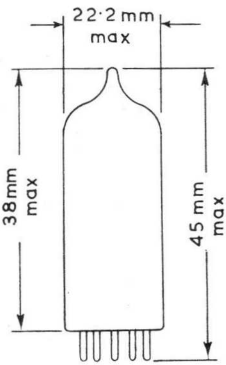
SPECIAL QUALITY PENTODE

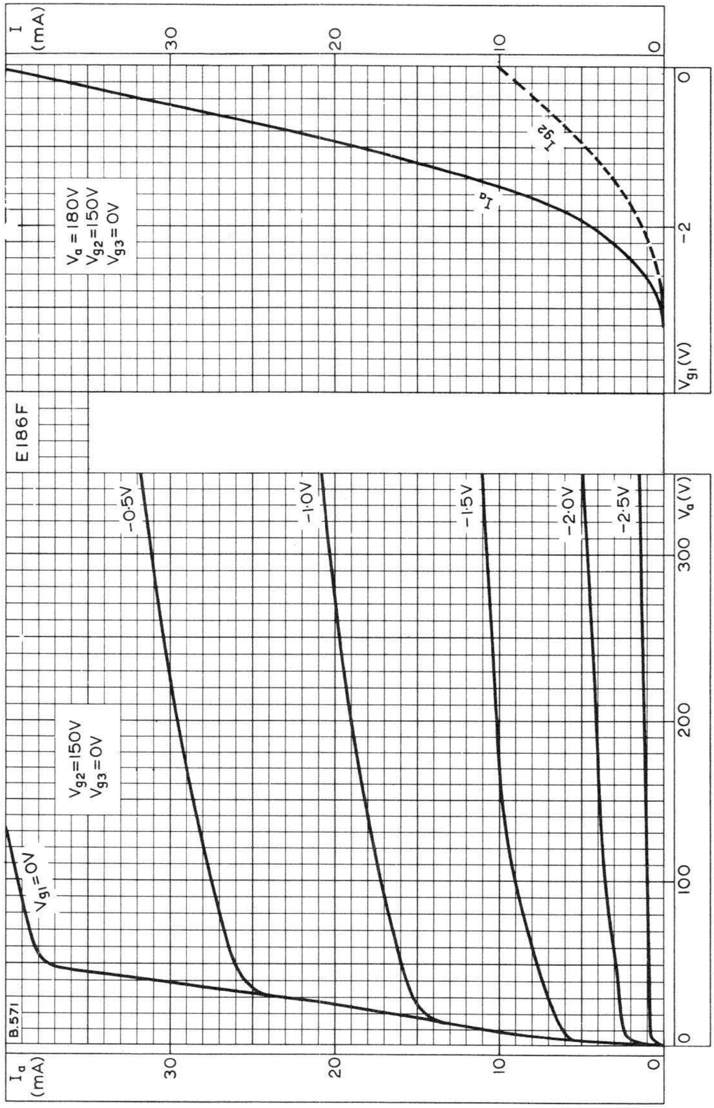


B562



B9A Base





ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$

ANODE CURRENT AND SCREEN-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE

SPECIAL QUALITY WIDEBAND R.F. PENTODE

E810F

Special quality high slope pentode designed for use in industrial equipment where stability of characteristics and long life are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	340	mA

The maximum variation of heater current at 6.3V is ±20mA. ←

CAPACITANCES[2] ←

Shielded

	Minimum	*Average*	*Maximum*	
c_{a-g1}	—	—	32	mpF
c_{in}	13	14.5	16	pF
$c_{in(w)}$ (I_k = 40mA)	22	24	26	pF
c_{out}	3.9	4.1	4.3	pF
c_{a-k}	26	33	40	mpF
c_{g1-h}	35	55	75	mpF
c_{a-h}	12	20	28	mpF
c_{h-k}	4.2	5.2	6.2	pF

Unshielded

	Minimum	*Average*	*Maximum*	
c_{a-g1}	—	—	6	mpF
c_{in}	13	14.5	16	pF
$c_{in(w)}$ (I_k = 40mA)	22	24	26	pF
c_{out}	3.2	3.5	3.8	pF
c_{a-k}	53	60	67	mpF
c_{g1-h}	40	60	80	mpF
c_{a-h}	26	31	36	mpF

CHARACTERISTICS[3]

V_a	120	V
V_{g3}	0	V
V_{g2}	150	V
V_{g1}	−1.9	V
R_k	0	Ω
I_a	35	mA
I_{g2}	5.0	mA
g_m	50	mA/V
r_a	42	kΩ ←
μ_{g1-g2}	57	←
r_{g1} (f = 100Mc/s)	420	Ω
R_{eq} (f = 40Mc/s)	110	Ω ←

CHARACTERISTIC RANGE VALUE FOR EQUIPMENT DESIGN

	Average	*Initial range*	*End of Life**	
Anode current				
at $V_{a-e} = 135V$, $V_{g2-e} = 165V$, $V_{g1-e} = 0V$, $R_k = 47\Omega$	35	31 to 39	25	mA
at $V_{a-e} = 135V$, $V_{g2-e} = 165V$, $V_{g1-e} = +12.5V$, $R_k = 360\Omega$	35	34 to 36	—	mA
Screen-grid current				
at $V_{a-e} = 135V$, $V_{g2-e} = 165V$, $V_{g1-e} = +12.5V$, $R_k = 360\Omega$	5	4.4 to 5.6	—	mA
Mutual conductance				
at $V_{a-e} = 135V$, $V_{g2-e} = 165V$, $V_{g1-e} = +12.5V$, $R_k = 360\Omega$	50	42 to 58	35	mA/V
Negative control-grid current				
at $V_{a-e} = 135V$, $V_{g2-e} = 165V$, $V_{g1-e} = +12.5V$, $R_k = 360\Omega$	—	0.1	<0.2	µA

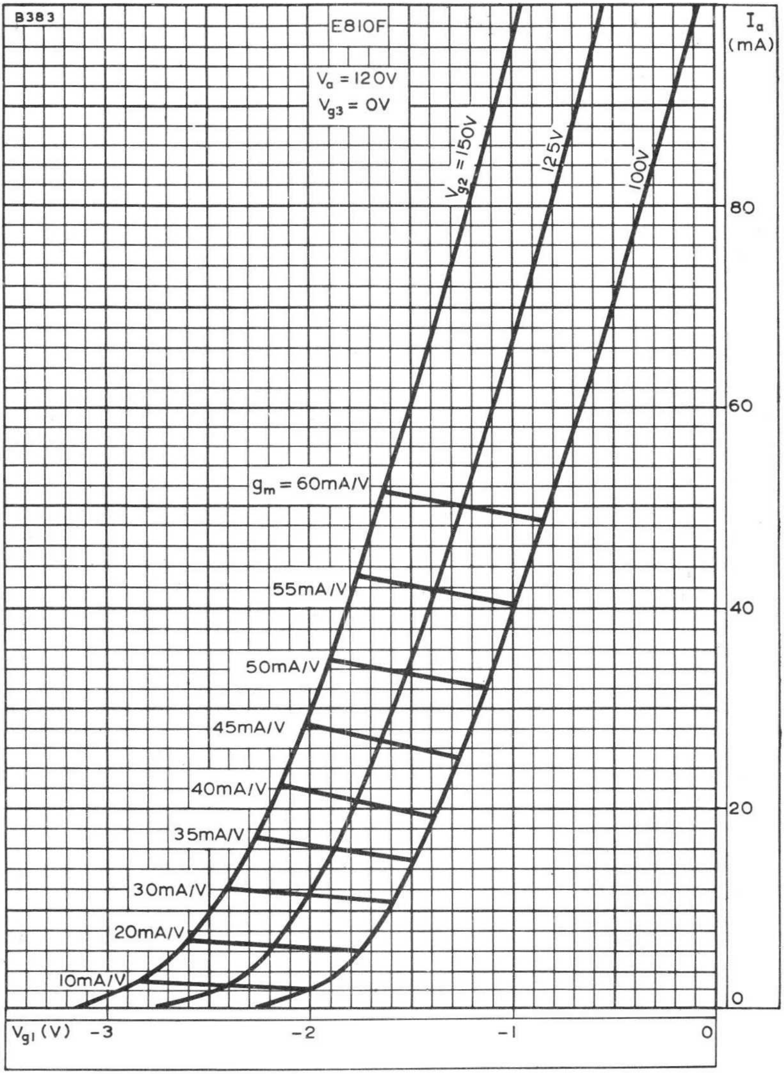
*To allow for valve deterioration during life, circuits should be designed to function with a valve in which one or more of the characteristics have changed to the values stated.

OPERATING CONDITIONS

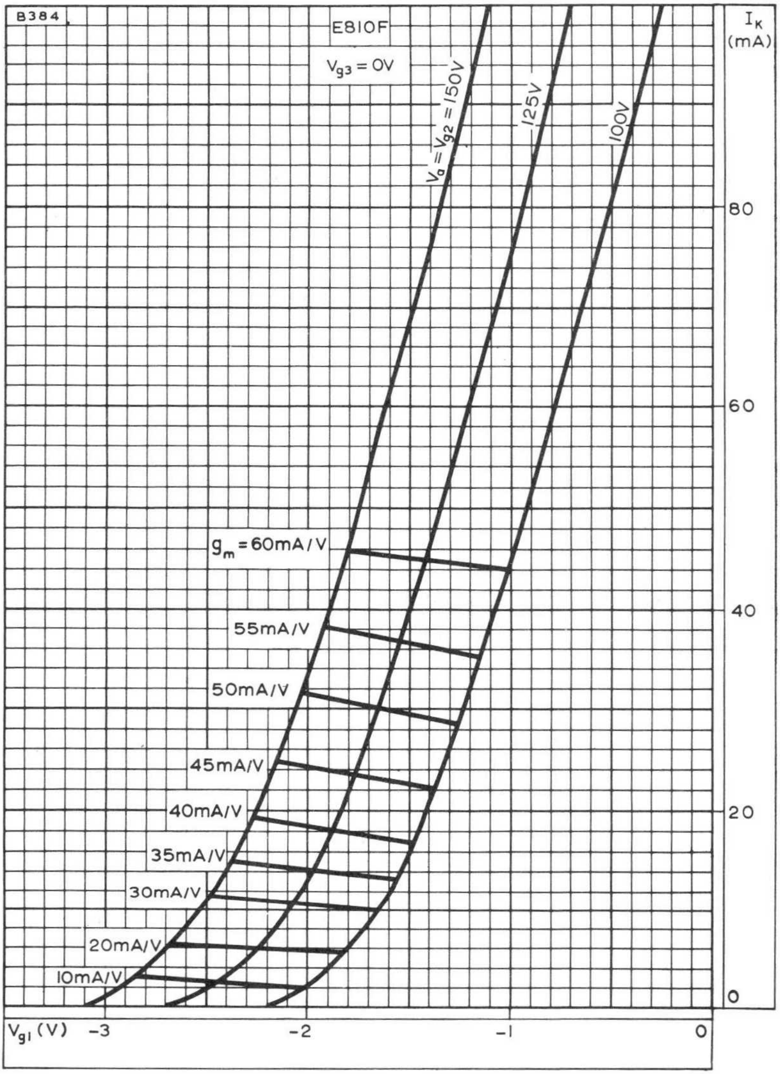
V_{a-e}	135	V
V_{g3-e}	0	V
V_{g2-e}	165	V
V_{g1-e}	+12.5	V
R_k	360	Ω
I_a	35	mA
I_{g2}	5.0	mA
g_m	50	mA/V

INSULATION

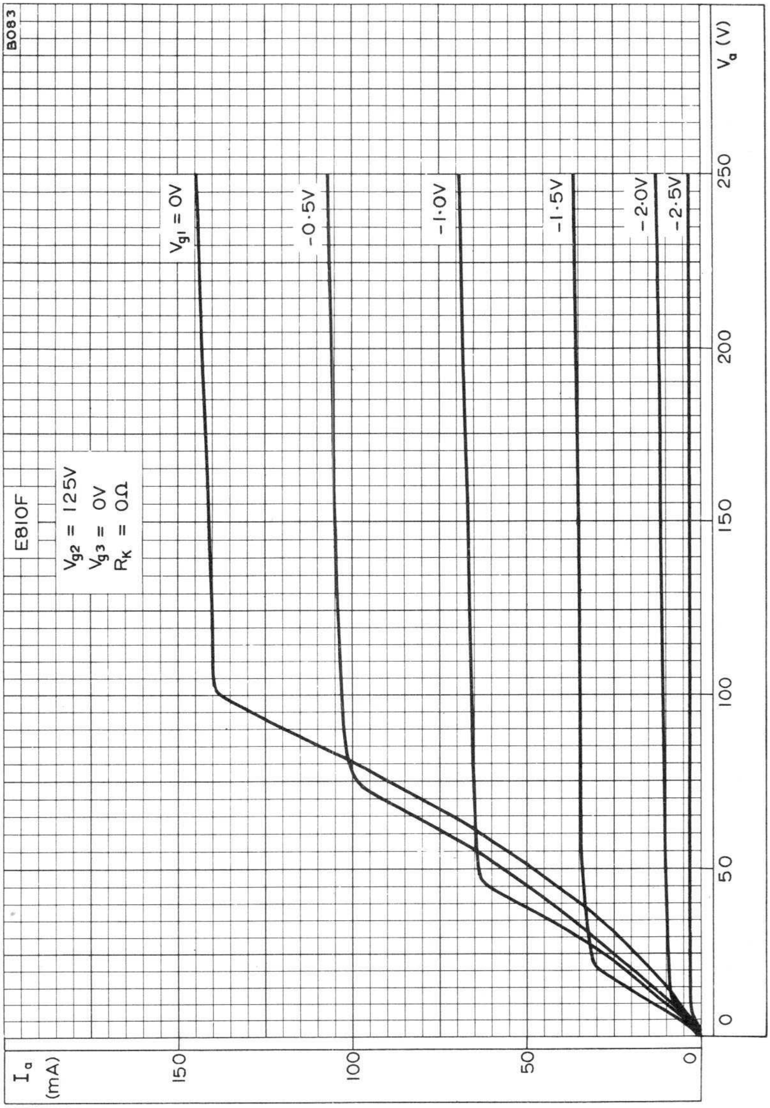
	Initial Range	*End of life*	
Between heater and cathode measured at $V_{h-k} = 100V$ Leakage current	<10	<20	µA
Between any two arbitrary electrodes except k–g1 measured at 250V	<100	<40	MΩ



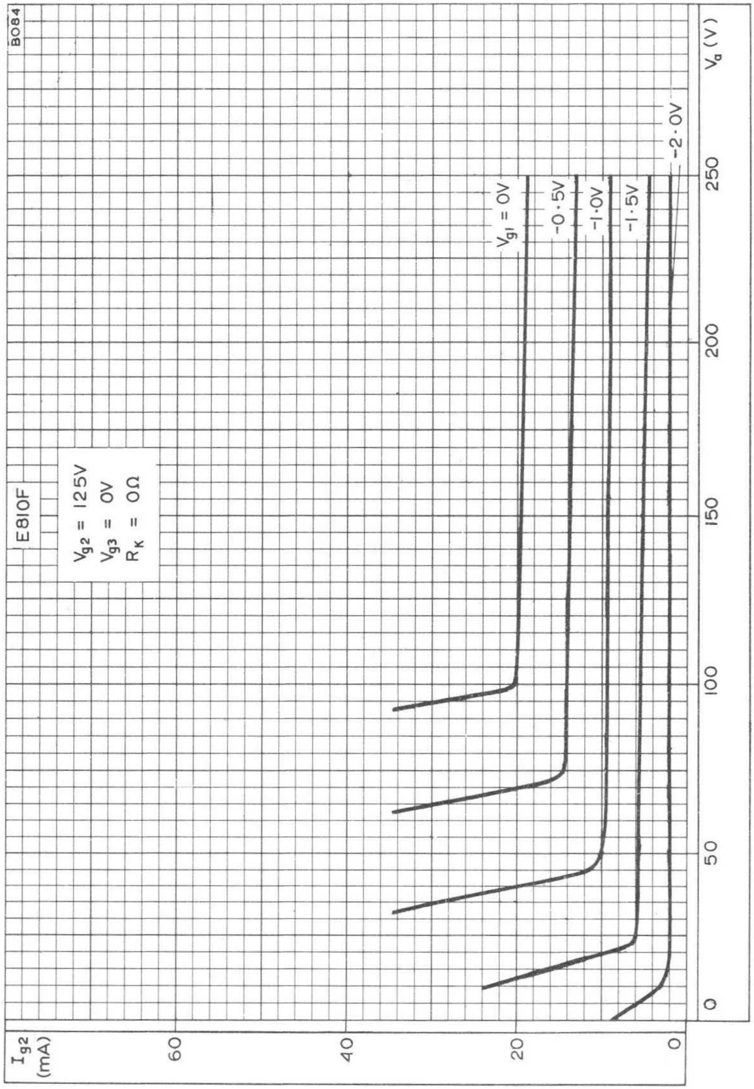
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE ←
WITH SCREEN-GRID VOLTAGE AS PARAMETER AND WITH MUTUAL CONDUCTANCE CONTOURS



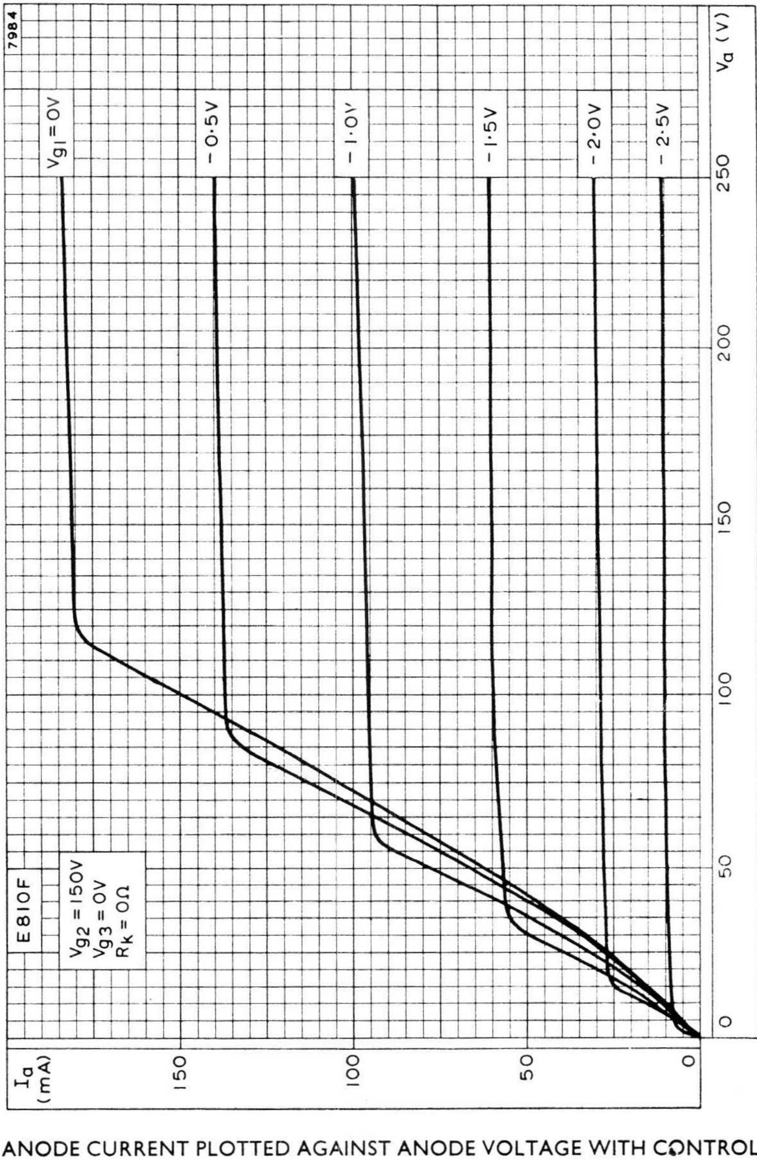
CATHODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER AND WITH MUTUAL CONDUCTANCE CONTOURS



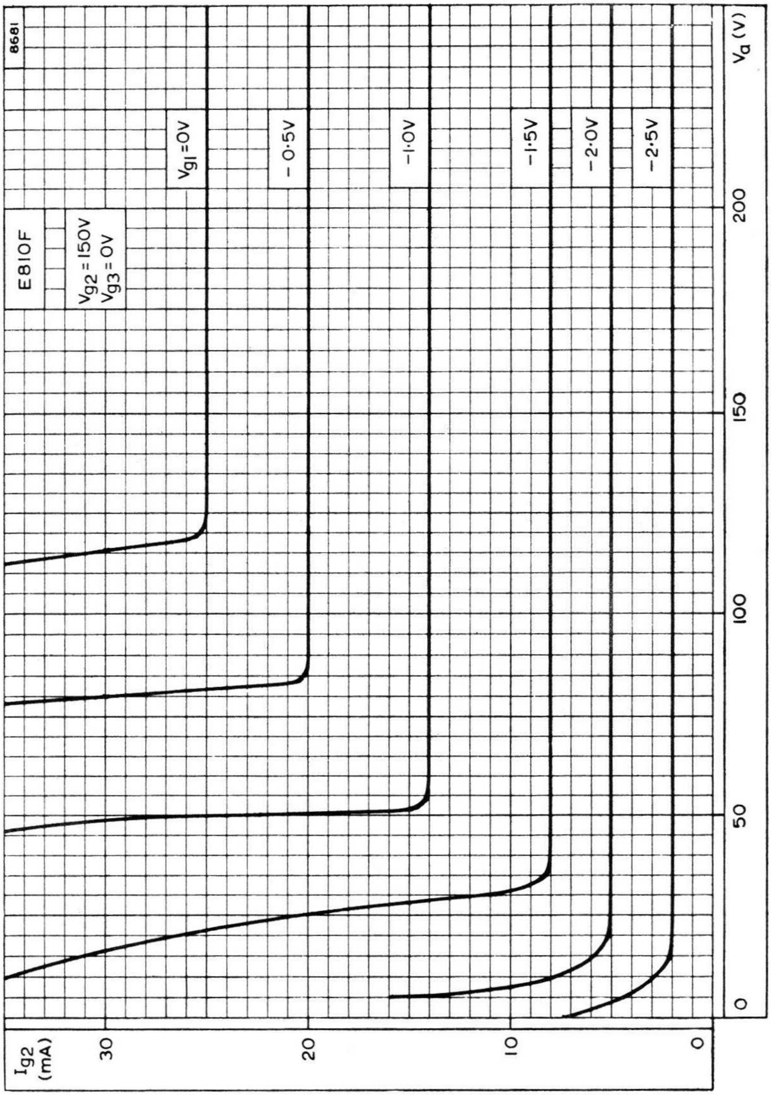
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 125V$



SCREEN GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 125V$



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$

SPECIAL QUALITY DOUBLE DIODE

M8079

Special quality miniature double diode with separate cathodes and internal screening between sections for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	300	mA

CAPACITANCES[2] (measured with an external shield)

$c_{a'-k'+h+s+S}$	3.2	pF
$c_{a''-k''+h+s+S}$	3.2	pF
$c_{k'-a'+h+s+S}$	3.9	pF
$c_{k''-a''+h+s+S}$	3.9	pF
$c_{a'-a''}$	<26	mpF

LIMITING VALUES[4] (absolute ratings) each section

P.I.V. max.	460	V
I_a max.	10	mA
$i_{a(pk)}$ max.	60	mA
V_{h-k} max.	360	V
$V_{in(r.m.s.)}$ max.	165	V
R_{lim} min. (per anode)	600	Ω
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	165	°C

M8079 SPECIAL QUALITY DOUBLE DIODE

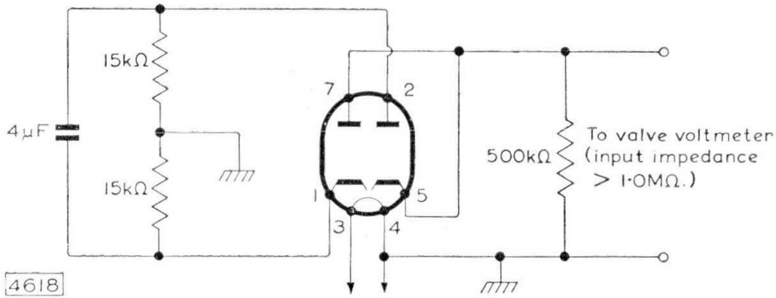
TEST CONDITIONS (unless otherwise specified)

V_h (V)	$V_{a(r.m.s.)}$ (V)	R_{load} (kΩ)	C (μF)
6.3	165	11	8.0

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP A								
Insulation								
a-rest, screen-rest measured at −300V	0.25	—	100	—	—	—	—	MΩ
GROUP B								
Heater current	0.65	—	275	325	—	—	—	mA
Heater to cathode leakage current	0.65	—	—	—	—	—	—	
$V_{h-k} = 100V$ (cathode negative)	—	—	—	5.0	—	—	—	μA
$V_{h-k} = 100V$ (cathode positive)	—	—	—	5.0	—	—	—	μA
Output current	0.65	18	16	—	—	—	—	mA
Emission $V_a = 10V$	0.65	—	40	—	—	—	—	mA
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Anode current. $V_a = 0V$, $R_a = 40k\Omega$	2.5	—	2.0	20	—	—	—	µA
Anode current difference between sections $V_a = 0V$, $R_a = 40k\Omega$	2.5	—	—	5.0	—	—	—	µA
Change in emission $V_h = 5.7V$, $V_a = 7.0V$	2.5	—	—	15	—	—	—	%
Hum $V_h = 7.0V$ Tested in circuit shown below	2.5	—	—	10	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	



4618

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances (shielded). No applied voltages	6.5	—	—	—	—	—	—	
$c_{a'-a''}$	—	—	—	26	—	—	—	mpF
$c_{a'-k'+h+s+S}$	—	—	2.4	4.0	—	—	—	pF
$c_{a''-k''+h+s+S}$	—	—	2.4	4.0	—	—	—	pF
$c_{k'-a'+h+s+S}$	—	—	2.5	5.0	—	—	—	pF ←
$c_{k''-a''+h+s+S}$	—	—	2.5	5.0	—	—	—	pF ←

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
$V_h = 6.9V$, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	15	—	—	—	μA
Output current	2.5	—	14	—	—	—	—	mA
Microphonic noise measured at the cathode with both sections in parallel. 50c/s, 2.0g min. peak acceleration, $R_k = 4.7k\Omega$, $I_a = 20mA$	2.5	—	—	5.0	—	—	—	mV (r.m.s.)
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	15	—	—	—	μA
Output current	2.5	—	14	—	—	—	—	mA
Microphonic noise (conditions as above)	—	—	—	5.0	—	—	—	mV (r.m.s.)

GROUP F

Intermittent life test

The valve is connected in a full-wave rectifier circuit with a load resistor of 11kΩ and a reservoir capacitor of 8μF. The supply impedance is adjusted so that the peak anode current is not less than 60mA for a nominal valve, the total output current being approximately 18mA.

The cathode to heater voltage is provided by the output voltage in series with 117Vr.m.s.

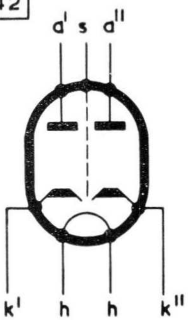
Intermittent life test end points		*A.Q.L.*[5] (%)	*Min.*	*Max.*	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	275	325	mA
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	10	μA
	1000 hours	4.0	—	10	μA
Emission $V_a = 10V$	500 hours	2.5	35	—	mA
	1000 hours	4.0	30	—	mA
Sub-group (b)					
Change in emission $V_h = 5.7V$, $V_a = 7.0V$	500 hours	4.0	—	20	%
Anode current $V_a = 0V$, $R_a = 40k\Omega$	500 hours	4.0	1.0	20	μA
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	50	—	MΩ
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

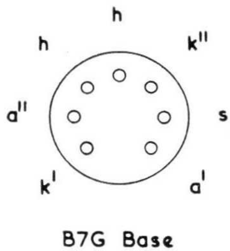
GROUP G

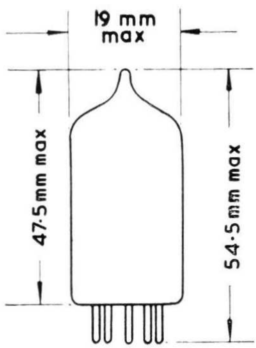
Valves are held for 28 days and retested for Inoperatives[14]	0.5	—	—

M8079 SPECIAL QUALITY DOUBLE DIODE

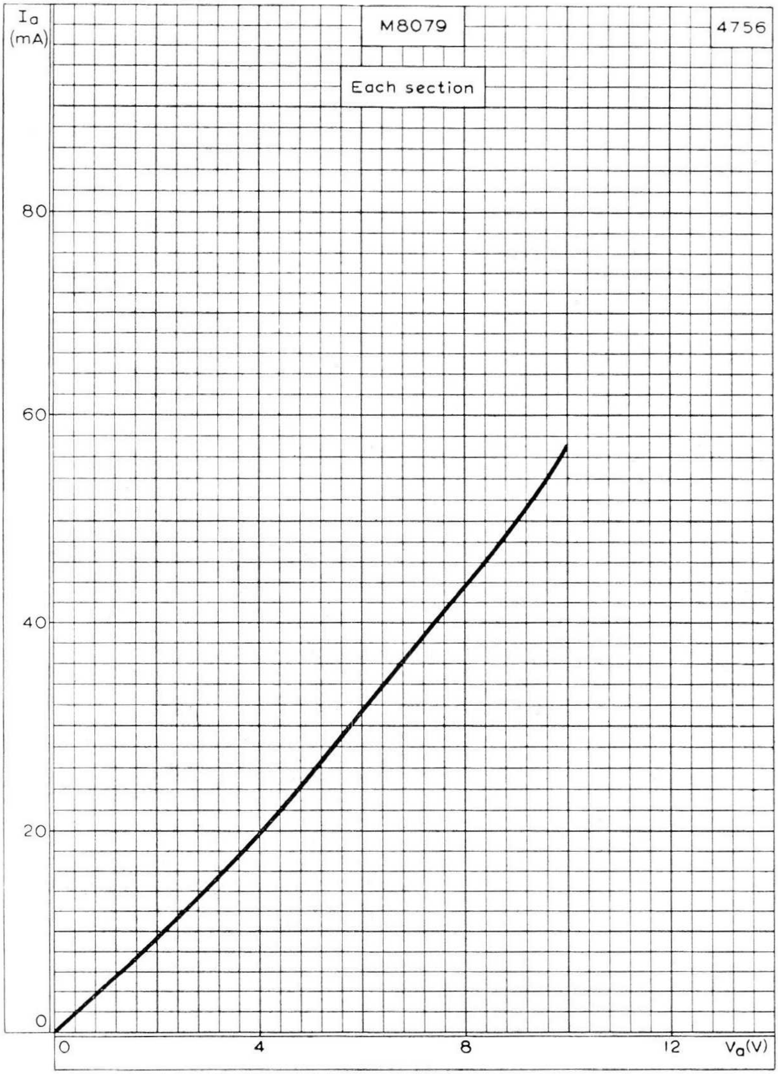
4942







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



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

SPECIAL QUALITY OUTPUT PENTODE

M8082

Special quality output pentode for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	200	mA

MOUNTING POSITION

Any

CAPACITANCES[2] (measured with an external shield)

c_{in}	3.8	pF
c_{out}	6.5	pF
c_{a-g1}	<300	mpF

CHARACTERISTICS[3]

V_a	250	V
V_{g2}	250	V
I_a	16	mA
I_{g2}	2.3	mA
g_m	2.5	mA/V
r_a	130	kΩ
μ_{g1-g2}	12	
R_k	0	Ω
V_{g1}	−13.5	V

ABSOLUTE MAXIMUM RATINGS[4]

f max.	100	Mc/s
$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	4.75	W
$V_{g2(b)}$ max.	550	V
V_{g2} max.	275	V
p_{g2} max.	800	mW
$-V_{g1}$ max.	110	V
V_{g1-g2} max.	300	V
I_{g1} max.	3.3	mA
I_k max.	23	mA
R_{g1-k} max. (fixed bias)	220	kΩ
V_{h-k} max.	150	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	180	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	$V_{a(b)}$ (V)	V_{g2-e} (V)	V_{g1-e} (V)	R_k (Ω)	R_{g1} (Ω)	C_k (μF)
6.3	250	250	0	740	0	1000

TESTS	*A.Q.L.*[5] (%)	*Individuals*[6] *Bogey*[9]	*Min.*	*Max.*	*Lot average*[7] *Min.*	*Max.*	*Lot standard deviation*[8] *Max.*	
GROUP A								
Insulation								
a-rest, g_2-rest measured at −300V; g_1-rest measured at −100V	0.25	—	100	—	—	—	—	MΩ
Reverse control-grid current R_{g1} max. = 500kΩ	0.25	—	—	0.5	—	—	—	μA
GROUP B								
Heater current	0.65	—	184	216	—	—	—	mA
Heater to cathode leakage current								
V_{h-k} = 100V cathode alternately positive and negative	0.65	—	—	10	—	—	—	μA
V_{h-k} = 100V cathode positive		—	—	—	—	3.0	—	μA
Anode current	0.65	15	12	18	—	—	—	mA
	—	—	—	—	13.9	16.1	0.86	mA
Screen-grid current	0.65	2.0	1.3	2.7	—	—	—	mA
	—	—	—	—	1.74	2.26	0.2	mA
Mutual conductance	0.65	2.55	1.95	3.15	—	—	—	mA/V
	—	—	—	—	2.33	2.77	0.17	mA/V
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Anode current. $V_{g1-e} = -50V$	2.5	—	—	50	—	—	—	µA
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Reverse control-grid current. $V_h = 6.9V$, $V_{a-e} = 300V$, $V_{g2-e} = 235V$	2.5	—	—	1.0	—	—	—	µA
Microphonic noise at the anode at 50c/s 2.0g min. peak acceleration, $V_{a(b)} = 250V$, $R_a = 2k\Omega$, $V_{g2-e} = 250V$.	2.5	—	—	15	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	3.5	5.0	—	—	—	pF
c_{out}	—	—	5.8	7.2	—	—	—	pF
c_{a-g1}	—	—	—	300	—	—	—	mpF
Amplification factor (μ_{g1-g2})	6.5	—	10	14	—	—	—	

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals Min.	Individuals Max.	Lot average[7] Min.	Lot average Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
V_h = 6.9V, 1 minute on, 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s, for 33 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse control-grid current R_{g1} max = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	1.8	3.2	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	4.0	—	—	—	—	—	—	
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse control-grid current R_{g1} max = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	1.8	3.2	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	4.0	—	—	—	—	—	—	

GROUP F

Stability life test[14]

Running conditions. $R_{g1} = 100k\Omega \pm 20\%$, $R_k = 740\Omega \pm 10\%$, $V_{h-k} = 150V$ (cathode negative)

Stability life test end point

Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%

Intermittent life test

Running conditions. $R_{g1} = 100k\Omega \pm 20\%$, $R_k = 740\Omega \pm 10\%$, $V_{h-k} = 150V$ (cathode negative)

Intermittent life test end points

		A.Q.L.[5] (%)	*Min.*	*Max.*	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	184	216	mA
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	30	μA
	1000 hours	4.0	—	30	μA
Reverse control-grid current. R_{g1} max $= 500k\Omega$	500 hours	2.5	—	1.0	μA
	1000 hours	4.0	—	1.0	μA
Mutual conductance	500 hours	2.5	1.7	3.2	mA/V
	1000 hours	4.0	1.6	3.2	mA/V
Average change in mutual conductance	500 hours	—	—	15	%
Sub-group (b)					
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	30	—	MΩ
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

M8082

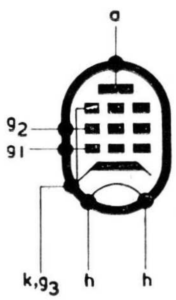
SPECIAL QUALITY OUTPUT PENTODE

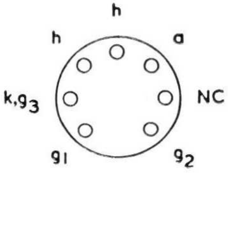
	A.Q.L.[5] (%)	Min.	Max.	
Dynamic life test 100 hours				
Running conditions as a trebler. $V_b = 300V$, decoupling resistor $= 1.0k\Omega$ $I_a + I_{g2} = 20mA$, $I_{g1} = 1.6mA$, $f = 70$ to $75Mc/s$ $P_{out} = 900mW$				
Dynamic life test end point				
Change in P_{out}	—	—	20	%

GROUP G

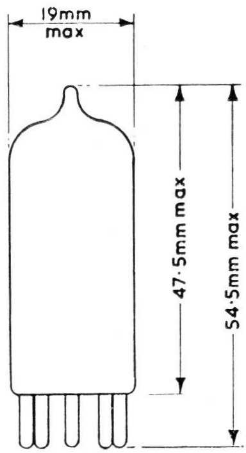
	A.Q.L. (%)	Min.	Max.	
Valves are held for 28 days and retested for Inoperatives[16]	0.5	—	—	
Reverse control-grid current. R_{g1} max. $= 500k\Omega$	0.5	—	0.75	μA

2831

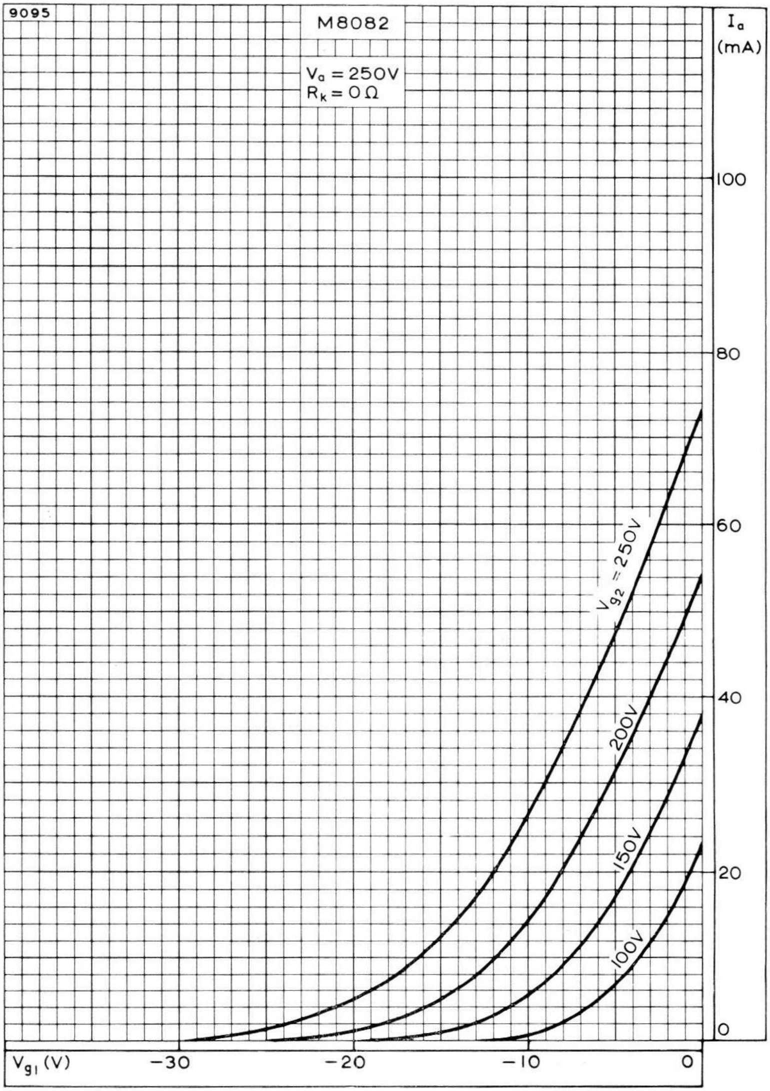




B7G Base



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

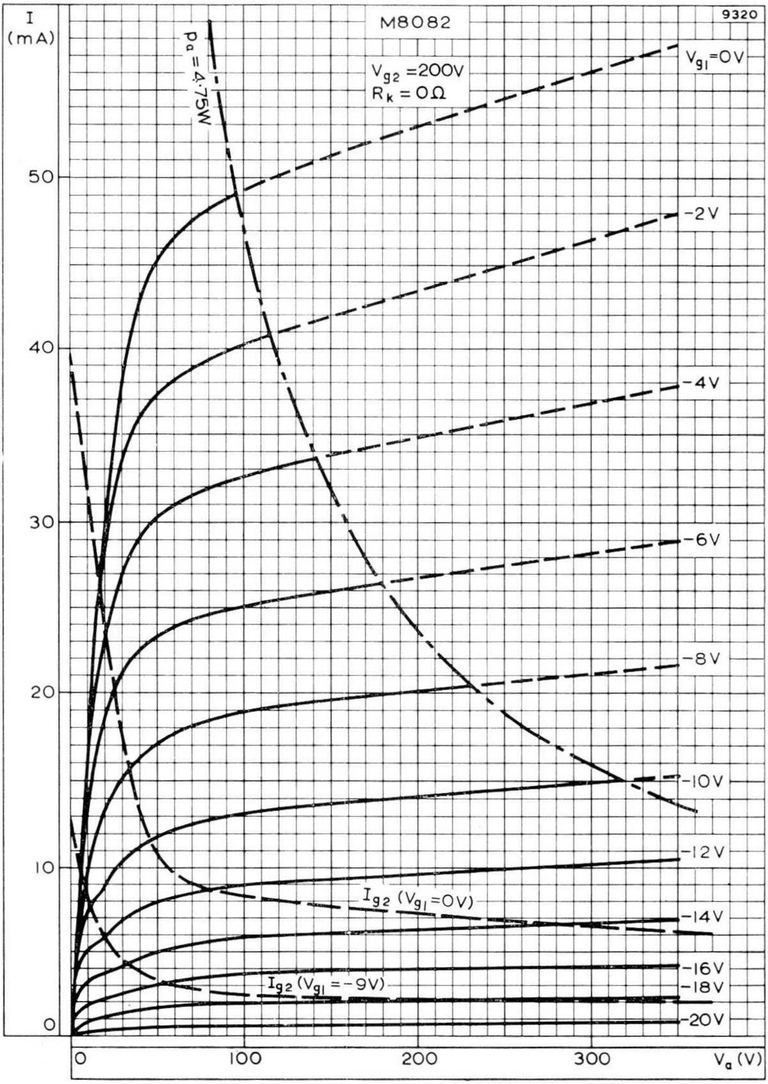


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER

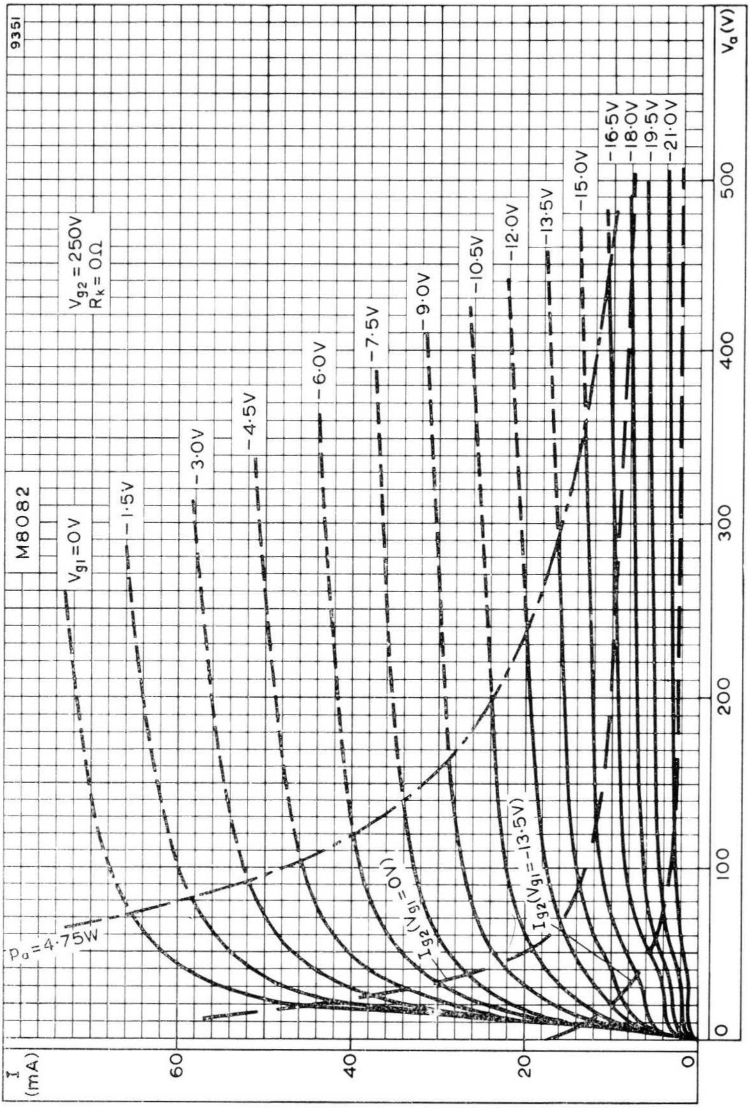
M8082

SPECIAL QUALITY OUTPUT PENTODE

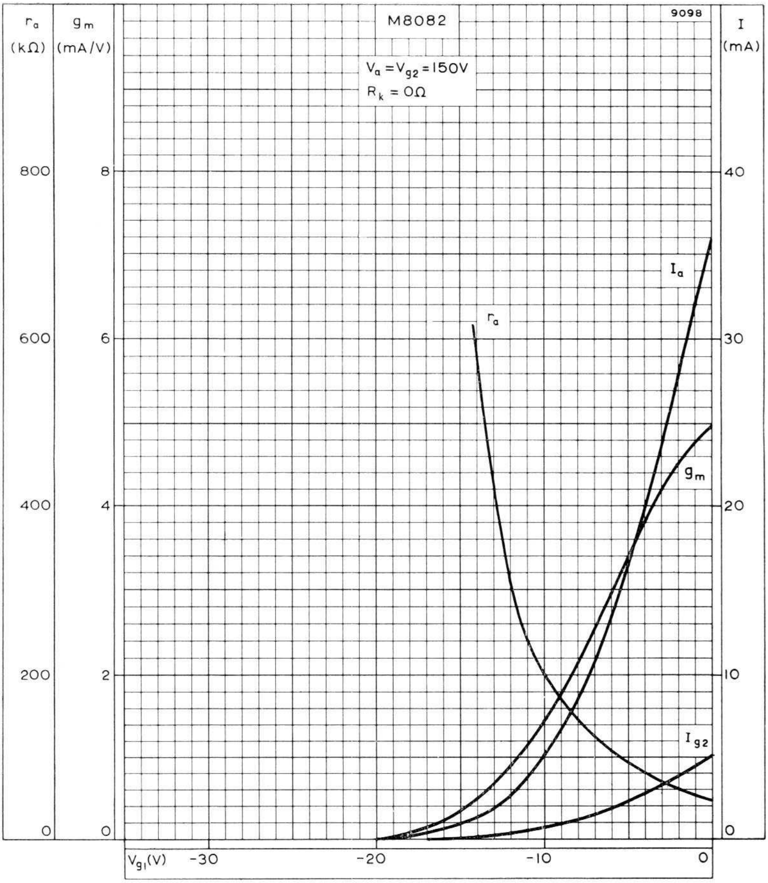
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 150V



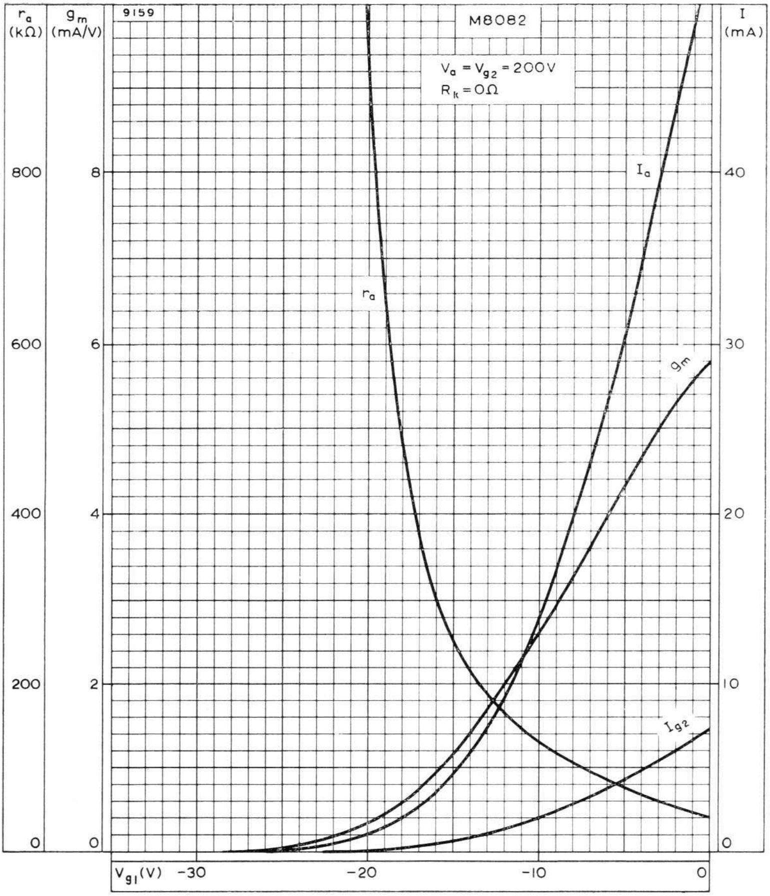
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$



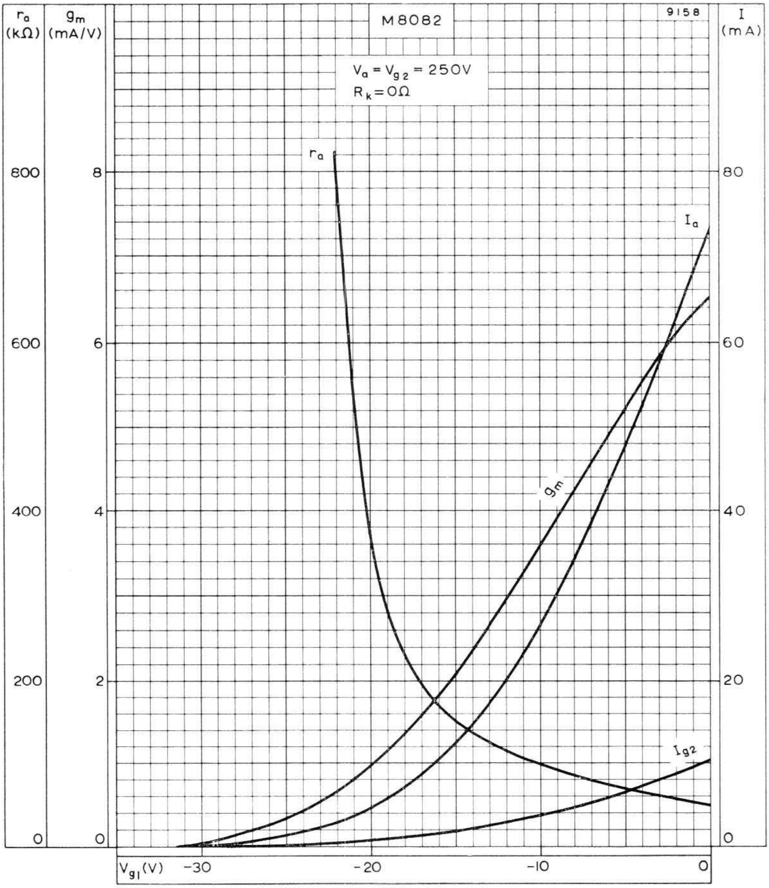
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 250V



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE



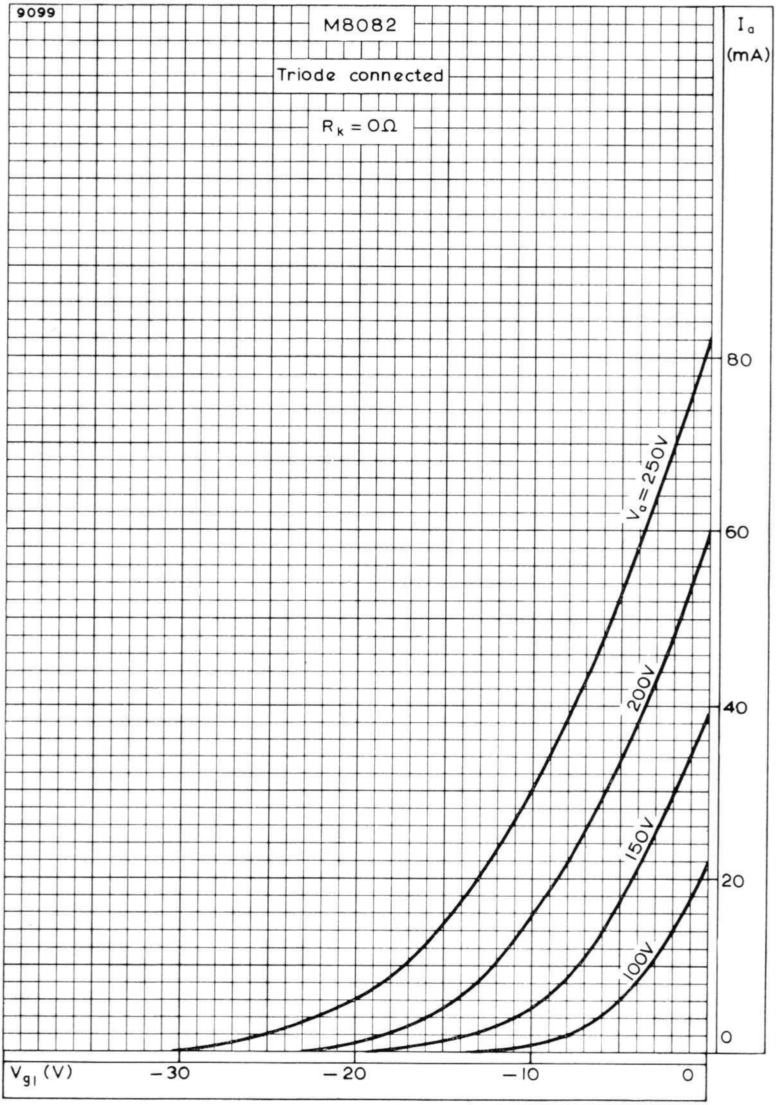
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 200V$



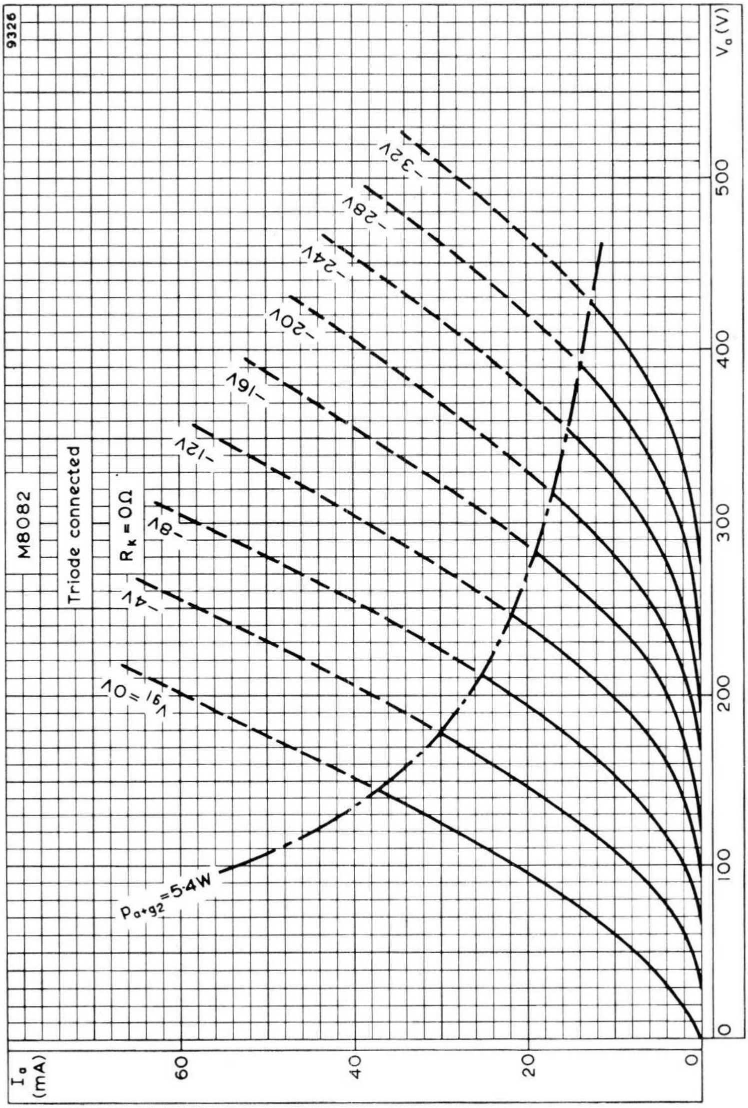
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE.
$V_a = V_{g2} = 250V$

M8082

SPECIAL QUALITY OUTPUT PENTODE



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

SPECIAL QUALITY R.F. PENTODE

M8083

Special quality r.f. pentode for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	300	mA

MOUNTING POSITION

Any

CAPACITANCES[2] (measured with an external shield)

c_{in}	7.1	pF ←
c_{out}	3.4	pF ←
c_{a-g1}	<10	mpF

CHARACTERISTICS[3]

V_a	250	V
V_{g3}	0	V
V_{g2}	250	V
I_a	10	mA
I_{g2}	2.6	mA
V_{g1}	–2.0	V
g_m	7.6	mA/V
r_a	>500	kΩ
μ_{g1-g2}	70	
R_k	0	Ω

LIMITING VALUES[4] (absolute ratings)

$V_{a(b)}$ max.	550	V
V_a max.	300	V
p_a max.	3.0	W
$V_{g2(b)}$ max.	450	V ←
V_{g2} max.	300	V
p_{g2} max.	900	mW
$-V_{g1}$ max.	55	V
I_k max.	16.5	mA
R_{g1-k} max.	500	kΩ ←
V_{h-k} max.	150	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	200	°C

M8083

SPECIAL QUALITY R.F. PENTODE

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_{a-e} (V)	V_{g3-k} (V)	V_{g2-e} (V)	V_{g1-e} (V)	R_k (Ω)	R_{g1} (Ω)	C_k (μF)
6.3	250	0	250	0	160	0	1000

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP A								
Insulation								
a-rest, g_2-rest measured at –300V; g_1-rest measured at –100V	0.25	—	100	—	—	—	—	MΩ
Reverse control-grid current R_{g1} max. = 500kΩ	0.25	—	—	0.5	—	—	—	μA
GROUP B								
Heater current	0.65	—	275	325	—	—	—	mA
Heater to cathode leakage current V_{h-k} = 100V cathode negative	0.65	—	—	10	—	—	—	μA
V_{h-k} = 100V cathode positive	0.65	—	—	10	—	—	—	μA
	—	—	—	—	—	2.0	—	μA
Anode current	0.65	9.85	7.5	12.2	—	—	—	mA
	—	—	—	—	8.7	11	0.91	mA
Screen-grid current	0.65	2.6	1.8	3.4	—	—	—	mA
	—	—	—	—	—	3.0	—	mA
Mutual conductance	0.65	7.6	6.0	9.25	—	—	—	mA/V ←
	—	—	—	—	6.81	8.43	0.63	mA/V
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Anode current. $V_{g1-e} = -8.0V$	2.5	—	—	100	—	—	—	µA
Reverse control-grid current. $V_{g1-e} = -50V$	2.5	—	—	1.0	—	—	—	µA
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Reverse control-grid current. $V_h = 6.9V$, $V_{a-e} = 300V$, $V_{g2-e} = 300V$, $R_k = 250\Omega$	2.5	—	—	1.0	—	—	—	µA
Microphonic noise at the anode at 50c/s and 2.0g min. peak acceleration. $V_b = 250V$, $R_a = 2k\Omega$, $R_k = 0\Omega$, $V_{g1} = -2V$	2.5	—	—	15	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	6.5	8.7	—	—	—	pF
c_{out}	—	—	2.75	3.75	—	—	—	pF
c_{a-g1}	—	—	—	10	—	—	—	mpF
Grid 3 cut-off voltage $V_{g1-e} = -3.5V$, $I_a = 50\mu A$	6.5	—	-70	-120	—	—	—	V
Amplification factor (μ_{g1-g2})	—	—	60	89	—	—	—	

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
V_h = 6.9V, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s, for 33 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse control-grid current. R_{g1} max = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	5.5	9.25	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	4.0	—	—	—	—	—	—	
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse control-grid current. R_{g1} max. = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	5.5	9.25	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	4.0	—	—	—	—	—	—	

GROUP F

Stability life test[14]

Running conditions. $R_{g1} = 100k\Omega \pm 20\%$, $R_k = 180\Omega \pm 10\%$, $V_{h-k} = 100V$ (cathode negative)

Stability life test end point

Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%

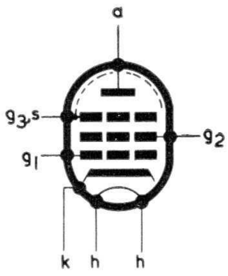
Intermittent life test

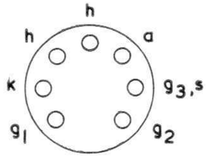
		A.Q.L.[5] (%)	Min.	Max.	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	275	325	mA
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	20	µA
	1000 hours	4.0	—	20	µA
Reverse coutrol-grid current. R_{g1} max $= 500k\Omega$	500 hours	2.5	—	0.75	µA
	1000 hours	4.0	—	1.0	µA
Mutual conductance	500 hours	2.5	5.2	9.25	mA/V
	1000 hours	4.0	4.9	9.25	mA/V
Average change in mutual conductance	500 hours	—	—	10	%
Sub-group (b)					
Anode current	500 hours	4.0	6.8	12.2	mA
	1000 hours	6.5	5.25	—	mA
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	30	—	MΩ
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

M8083 SPECIAL QUALITY R.F. PENTODE

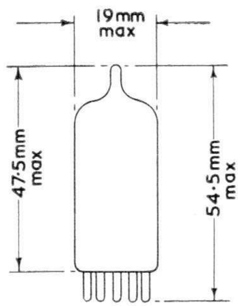
GROUP G	A.Q.L.[5] (%)	Min.	Max.	
Valves are held for 28 days and retested for				
Inoperatives[16]	0.5	—	—	
Reverse control-grid current. $R_{g1}max = 500k\Omega$	0.5	—	0.75	μA

3594

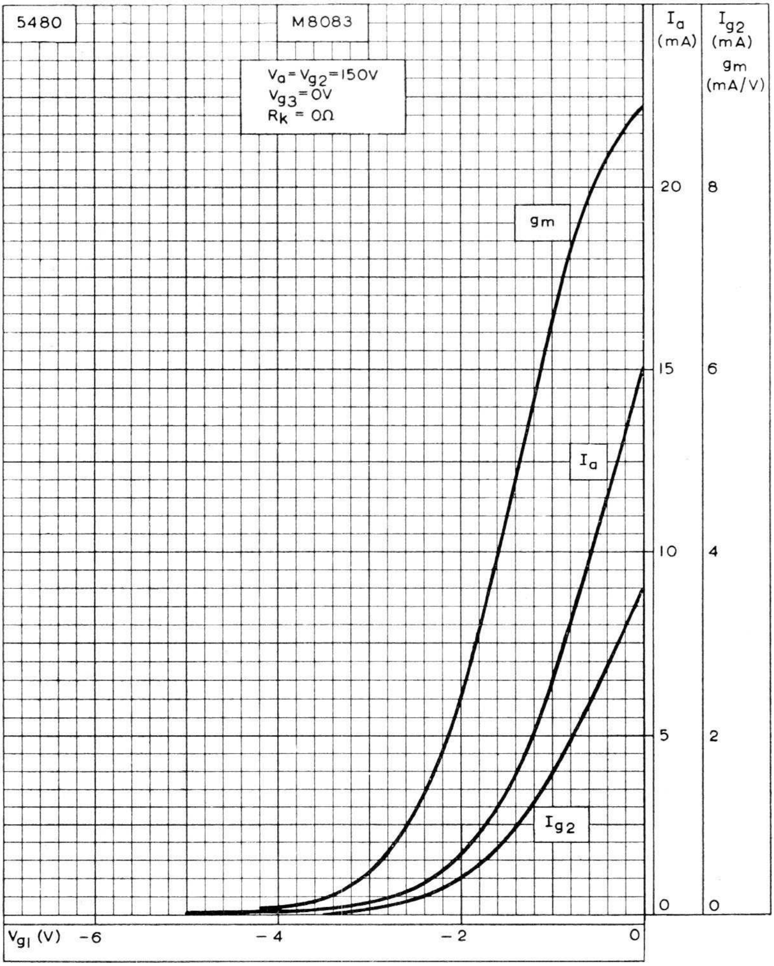




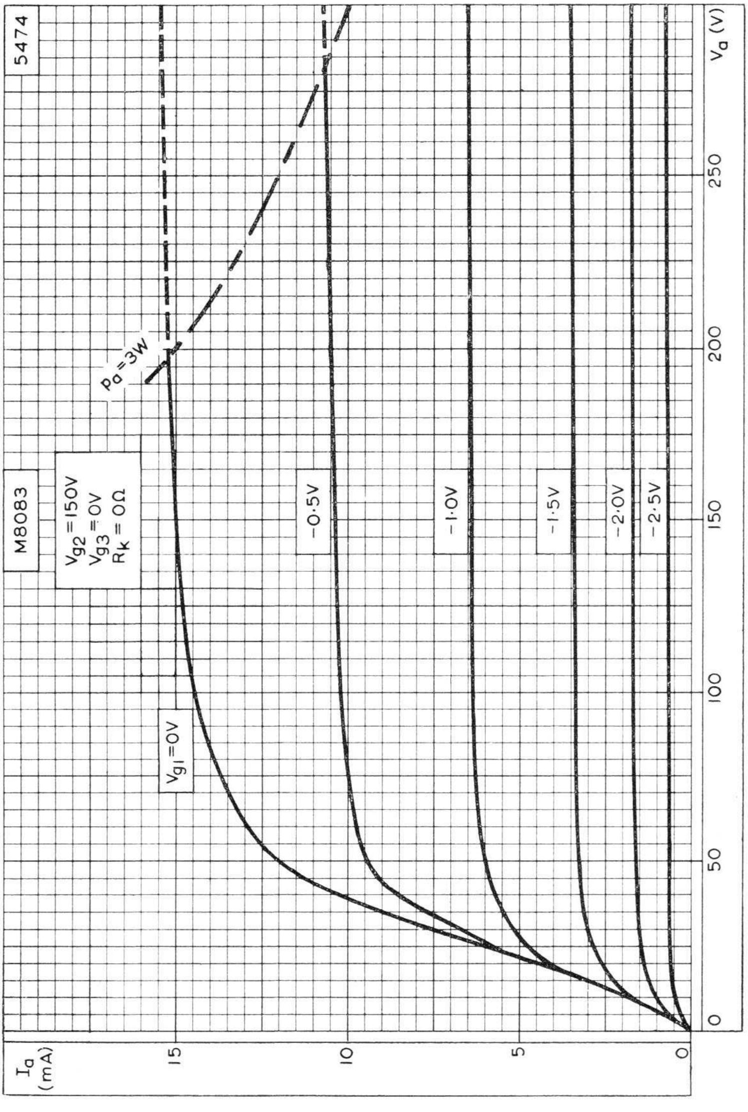
B7G Base



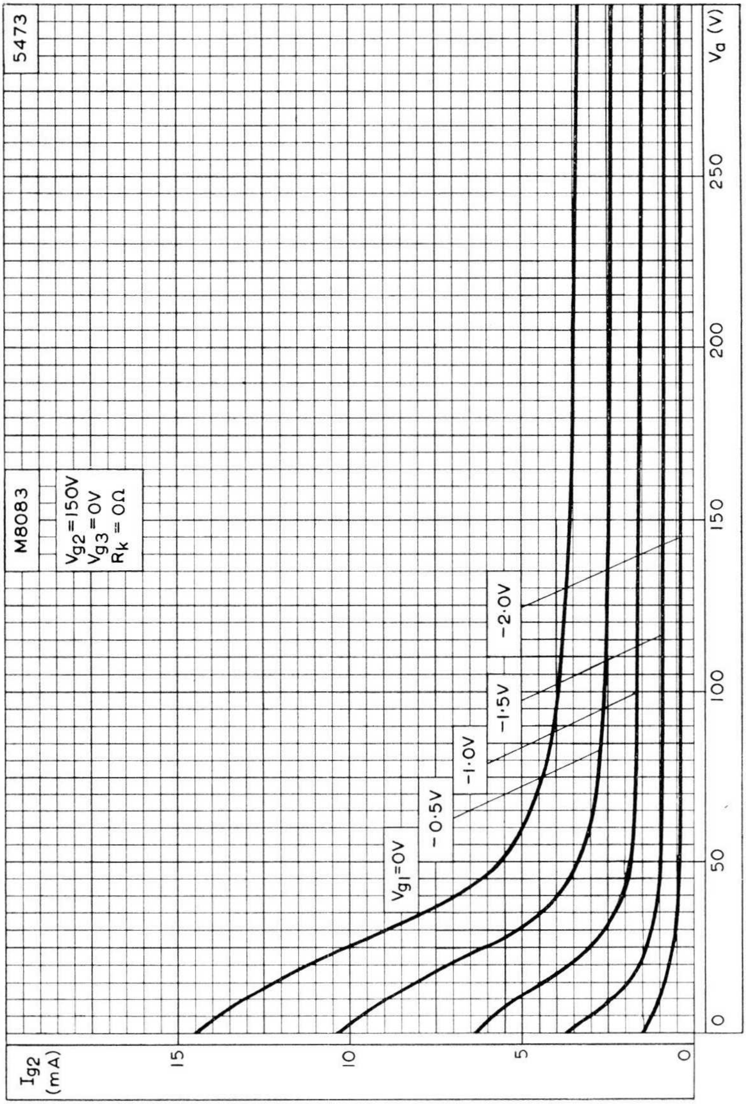
The bulb and base dimensions of this valve are in accordance with BS448, Section B7G



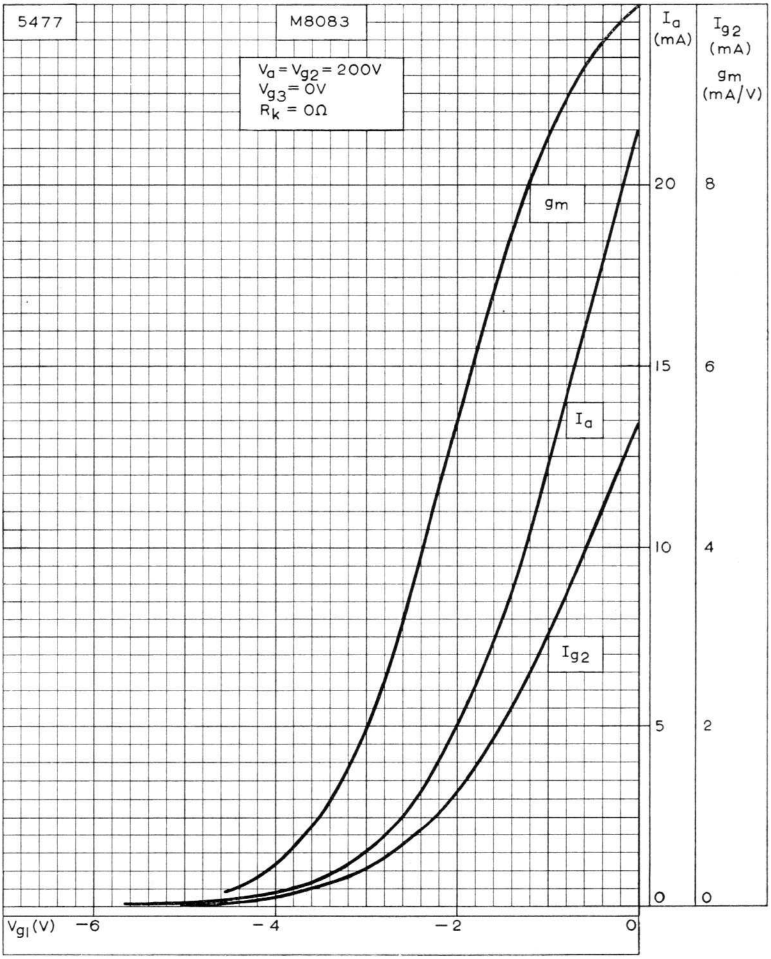
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 150V$



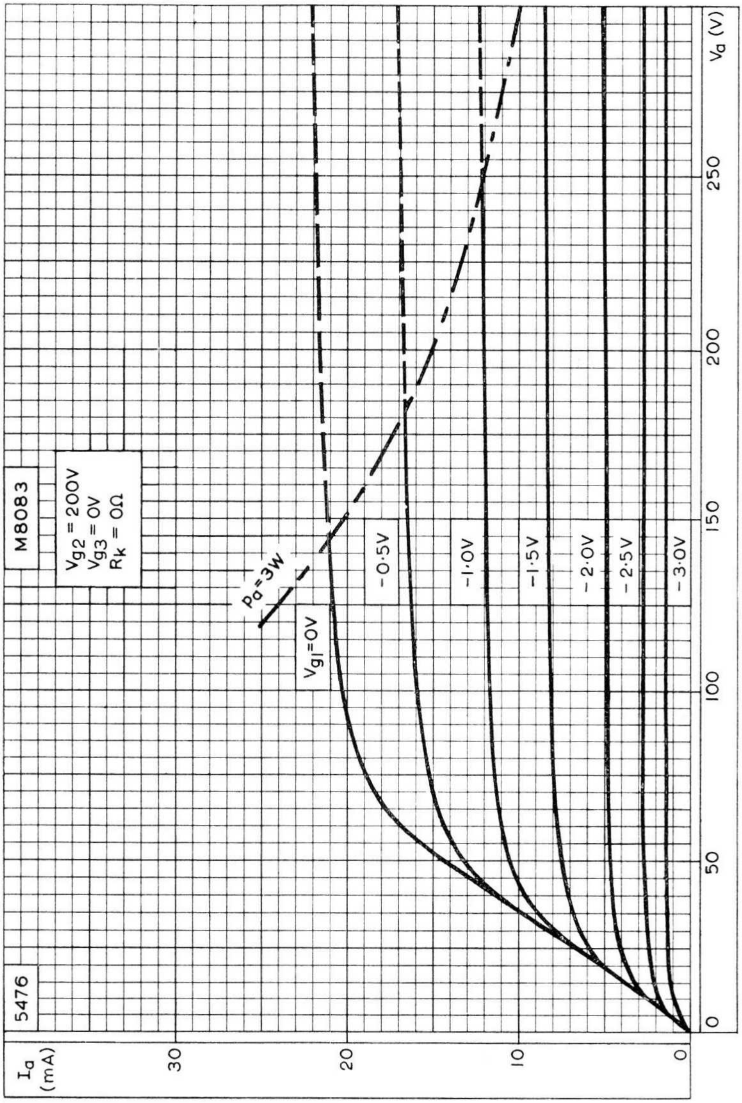
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$



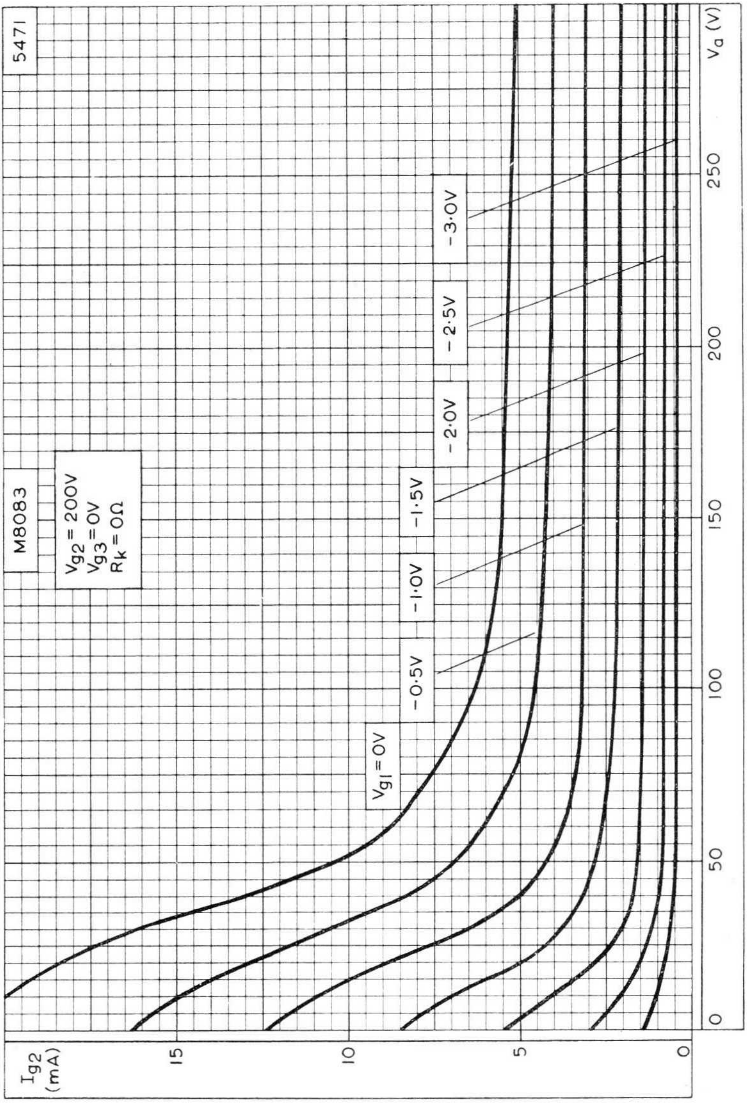
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 150V$



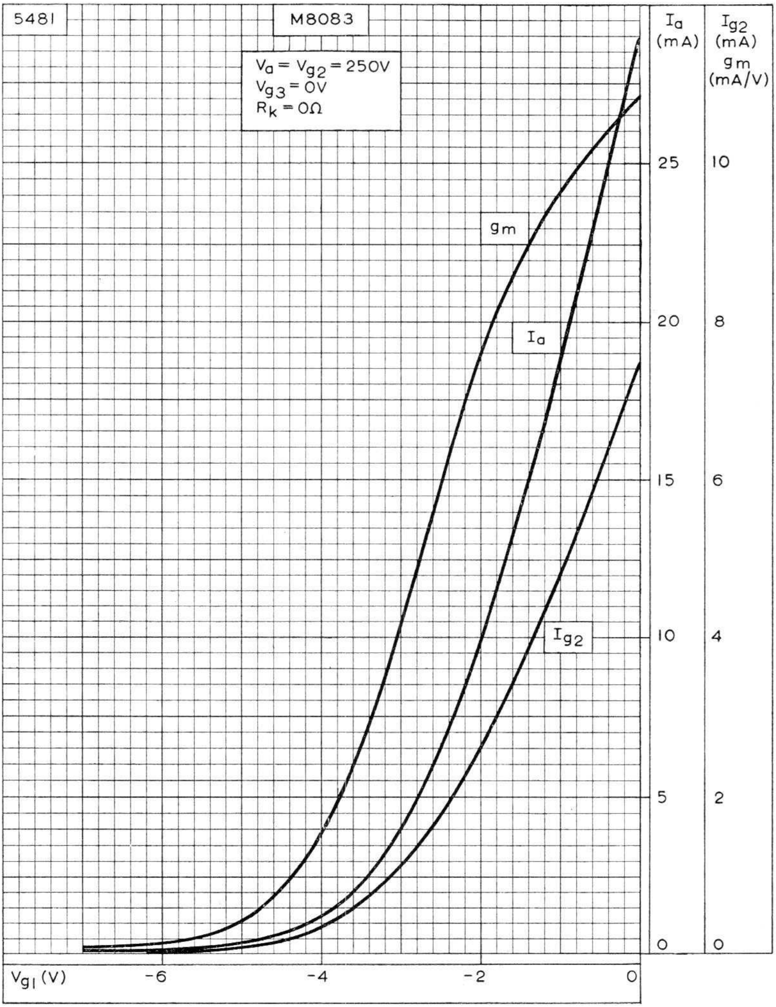
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 200V$



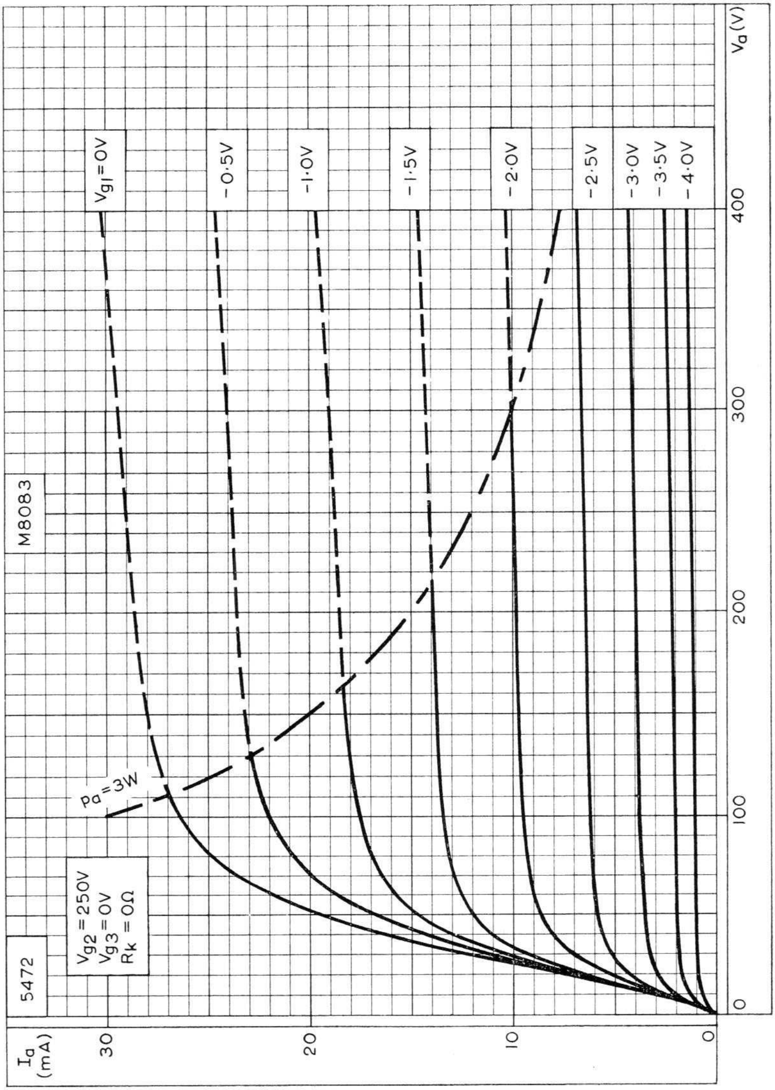
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$



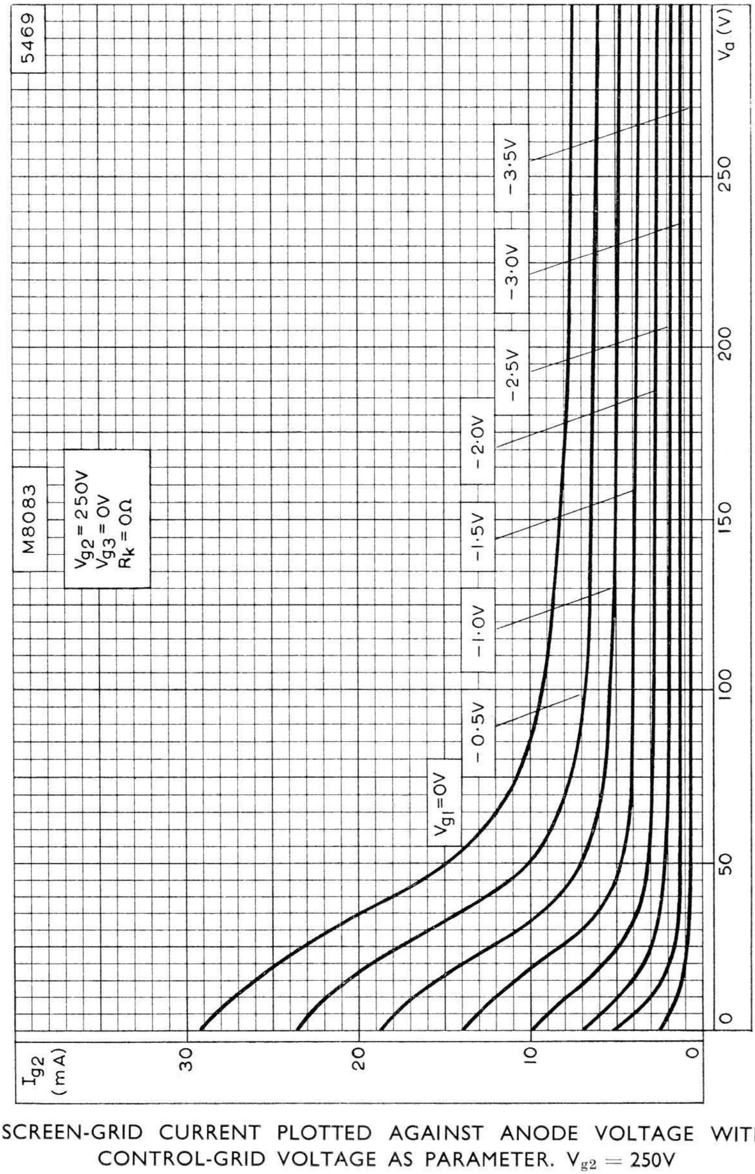
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 200V$



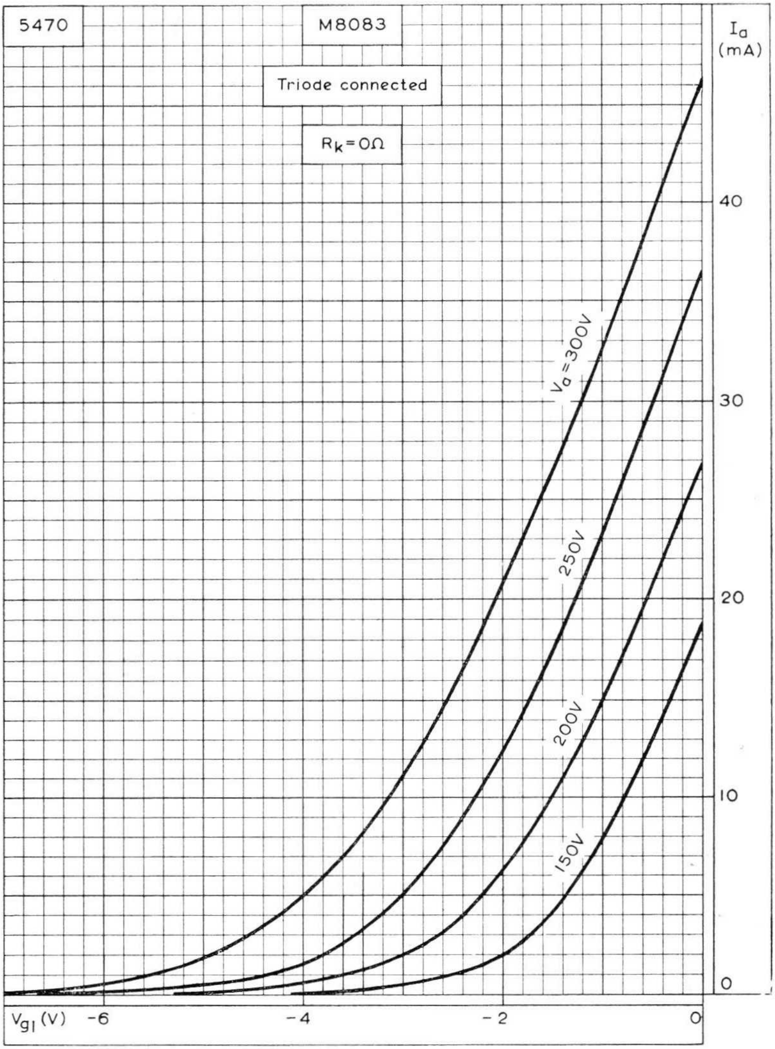
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 250V$



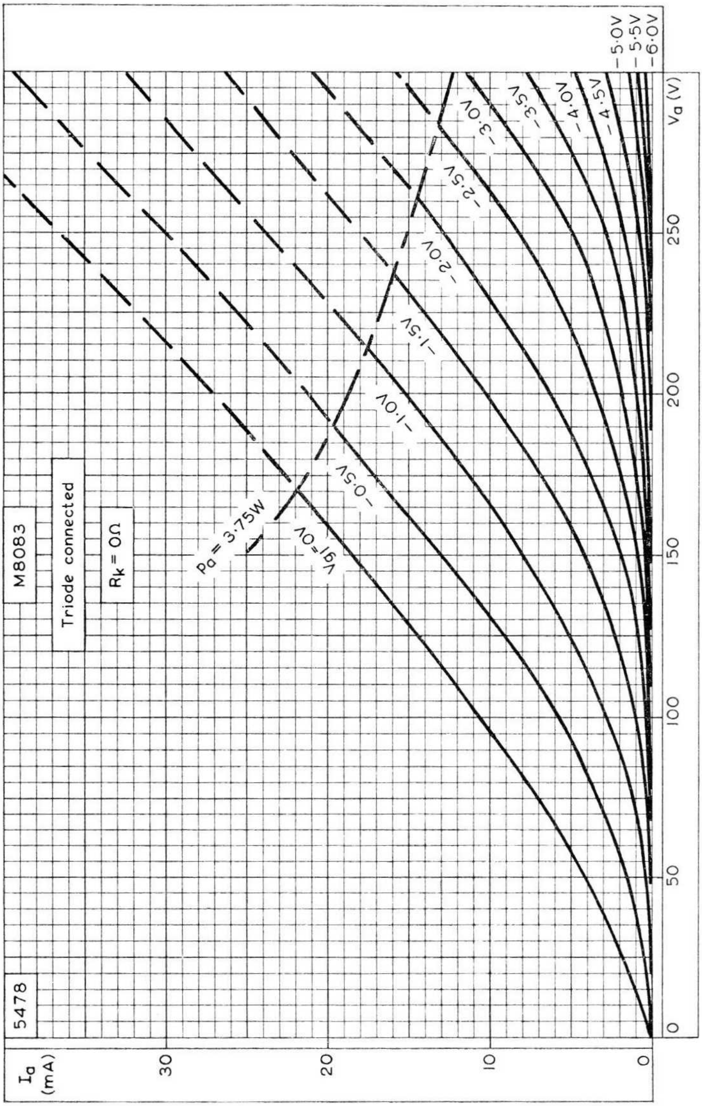
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 250V



SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$

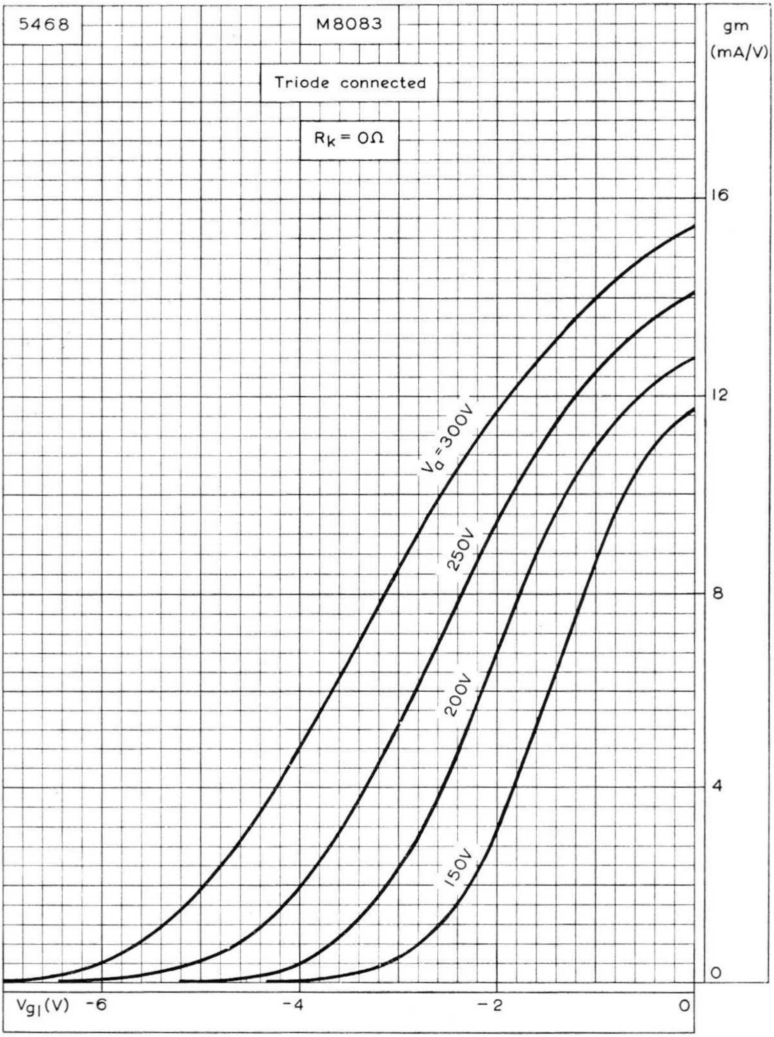


ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

M8083 SPECIAL QUALITY R.F. PENTODE



MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED

SPECIAL QUALITY HALF-WAVE RECTIFIER

M8091

Special quality half-wave rectifier primarily intended for operation at high altitudes in equipment where mechanical vibration and shocks are unavoidable.

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

HEATER

V_h[1]	6.3	V
I_h	1.15	A

MOUNTING POSITION

Any

LIMITING VALUES[4] (absolute ratings)

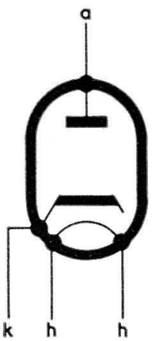
P.I.V. max.	2.0	kV
$i_{a(pk)}$ max.	900	mA
V_{h-k} max.	650	V
Maximum altitude for full P.I.V. rating	60,000	ft
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	220	°C

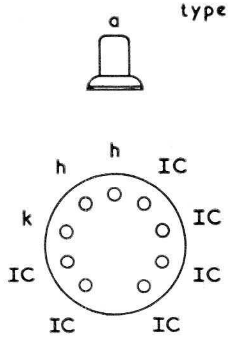
TYPICAL OPERATION OF TWO M8091 AS FULL-WAVE RECTIFIER

Capacitor input

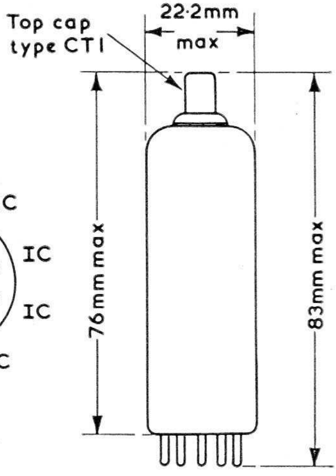
$V_{in(r.m.s.)}$	2 × 500	2 × 625	V
R_{lim} min. (per anode)	150	250	Ω
C max.	16	16	µF
I_{out} max.	300	250	mA

3367





B9A Base



TEST CONDITIONS (unless otherwise specified)

V_h (V)	$V_{in(r.m.s.)}$ (V)	R_{load} (kΩ)	C (μF)
6.3	625	5	8

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Min.	Max.	
GROUP A					
Voltage breakdown	0.25	—	—	—	
GROUP B					
Heater current	0.65	—	0.9	1.4	A
Heater to cathode leakage current. $V_{h-k} = 330V$ (cathode positive)	0.65	—	—	150	μA
Anode voltage. $I_a = 150mA$	0.65	—	18	26	V
Output current	0.65	—	120	—	mA
Group quality level[10]	1.0	—	—	—	
GROUP C					
Output current. $V_{in(r.m.s.)} = 500V$, $R_{load} = 3k\Omega$	2.5	—	145	—	mA
†Hot switch	2.5	—	—	—	
†Hot switch. f = 1.5 to 2.4kc/s C reduced to suit frequency	6.5	—	—	—	

†The anode voltage is switched on and off six times and no arcing must occur within the valve.

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	

GROUP E

***Fatigue*[14]**

$V_h = 7.0V$, 1 minute on 3 minutes off. No other voltages applied, minimum peak acceleration = 5g, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes.

Post fatigue tests

Heater to cathode leakage current. $V_{h-k} = 330V$ (cathode positive)	2.5	—	—	200	μA
Output current	2.5	—	120	—	mA

***Shock*[15]**

No applied voltages, 500g.

Post shock tests

Heater to cathode leakage current. $V_{h-k} = 330V$ (cathode positive)	2.5	—	—	200	μA
Output current	2.5	—	120	—	mA
Voltage breakdown	2.5	—	—	—	
Group quality level[10]	6.5	—	—	—	

GROUP F

Life[14]

Running conditions. $V_{in(r.m.s.)} = 500V$, $R_{load} = 3k\Omega$
$V_{h-k} = V_{out} + 150V$ r.m.s., $C = 8\mu F$

	A.Q.L.[5] (%)	Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	
Stability life test end point					
Change in anode voltage after 1 hour. $I_a = 150mA$	1.0	—	—	10	%

Intermittent life test

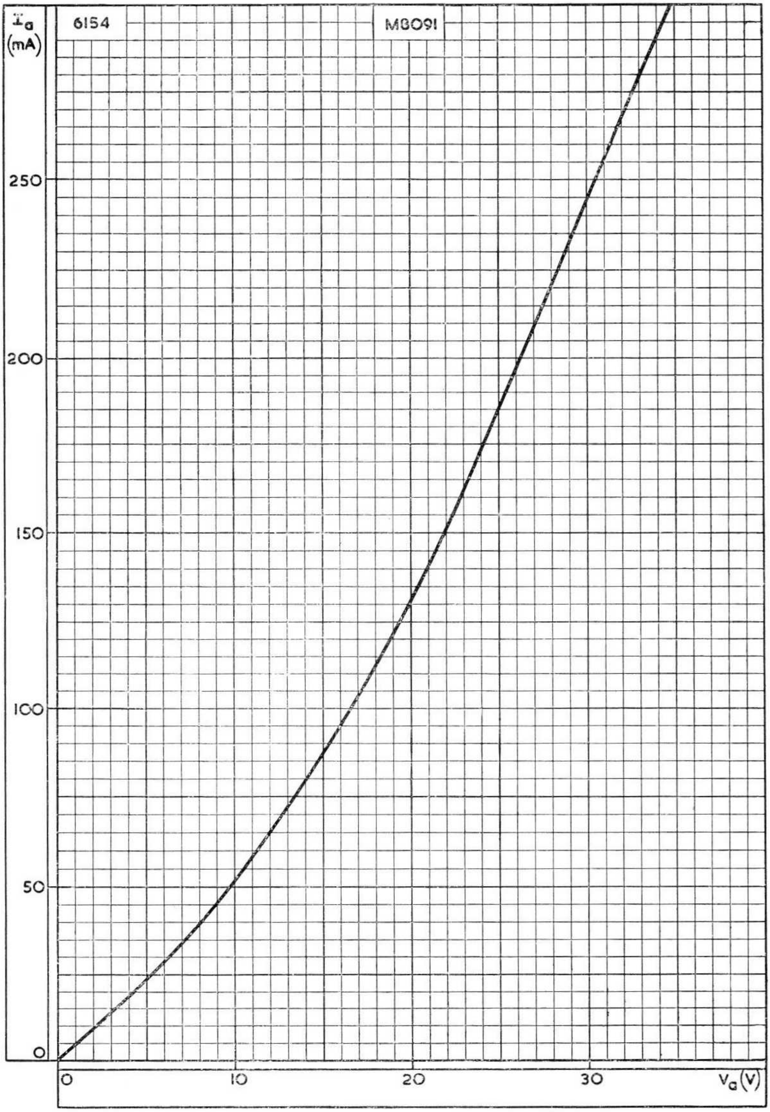
Running conditions. $V_{in(r.m.s.)} = 500V$, $R_{load} = 3k\Omega$
$V_{h-k} = V_{out} + 150V$ r.m.s., $C = 8\mu F$

Intermittent life test end points		A.Q.L.[5] (%)	Min.	Max.	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	0.9	1.4	A
Heater to cathode leakage current. $V_{h-k} = 300V$ (cathode positive)	500 hours	2.5	—	150	µA
	1000 hours	4.0	—	150	µA
Sub-group (b)					
Output current	500 hours	4.0	120	—	mA
	1000 hours	6.5	120	—	mA
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

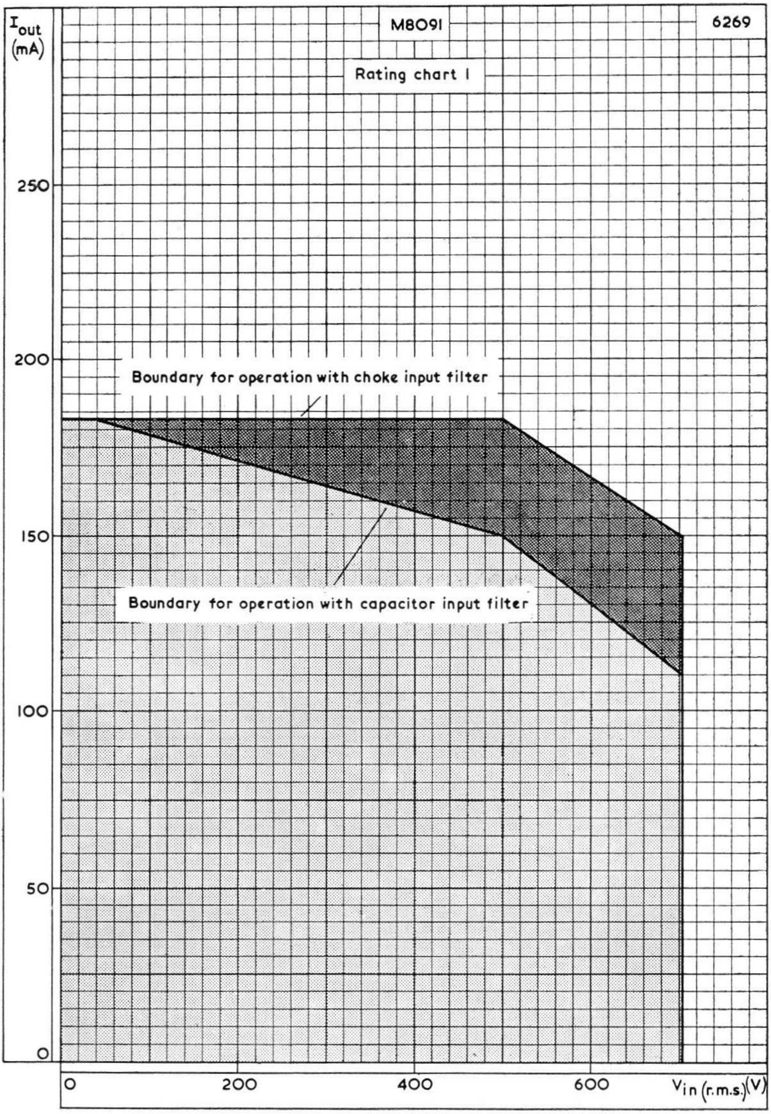
GROUP G

	A.Q.L.[5] (%)	Min.	Max.
Valves are held for 28 days and retested for Inoperatives[16]	0.5	—	—

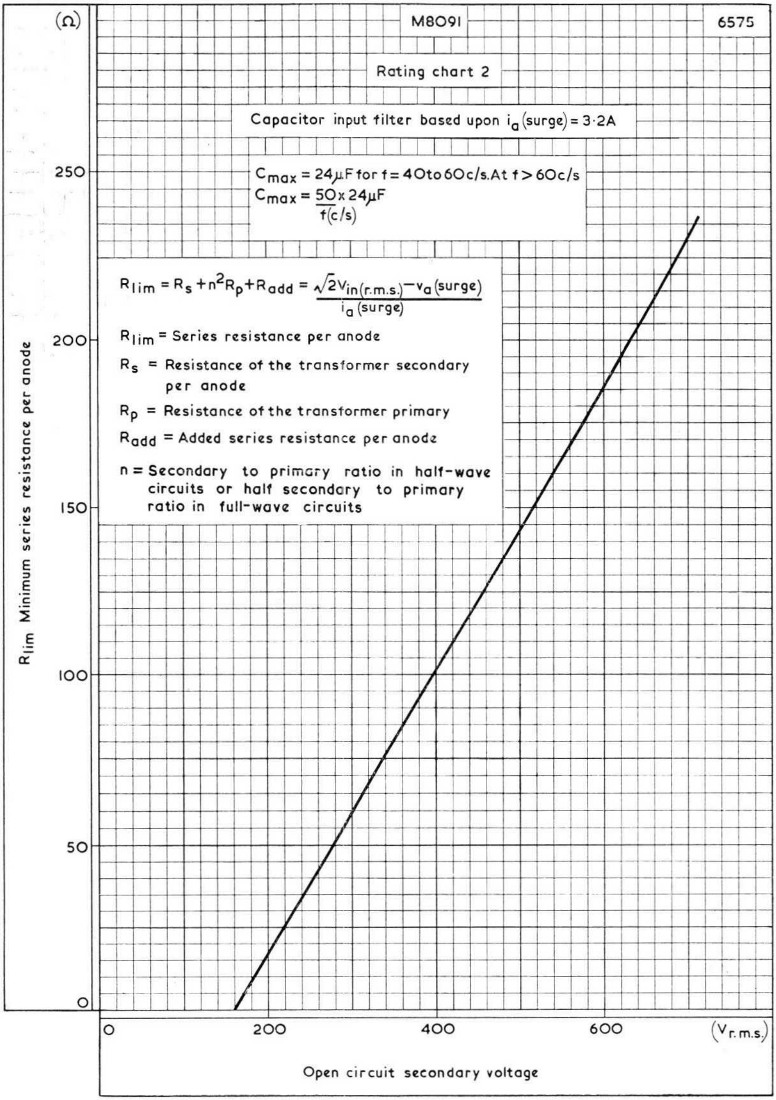
M8091



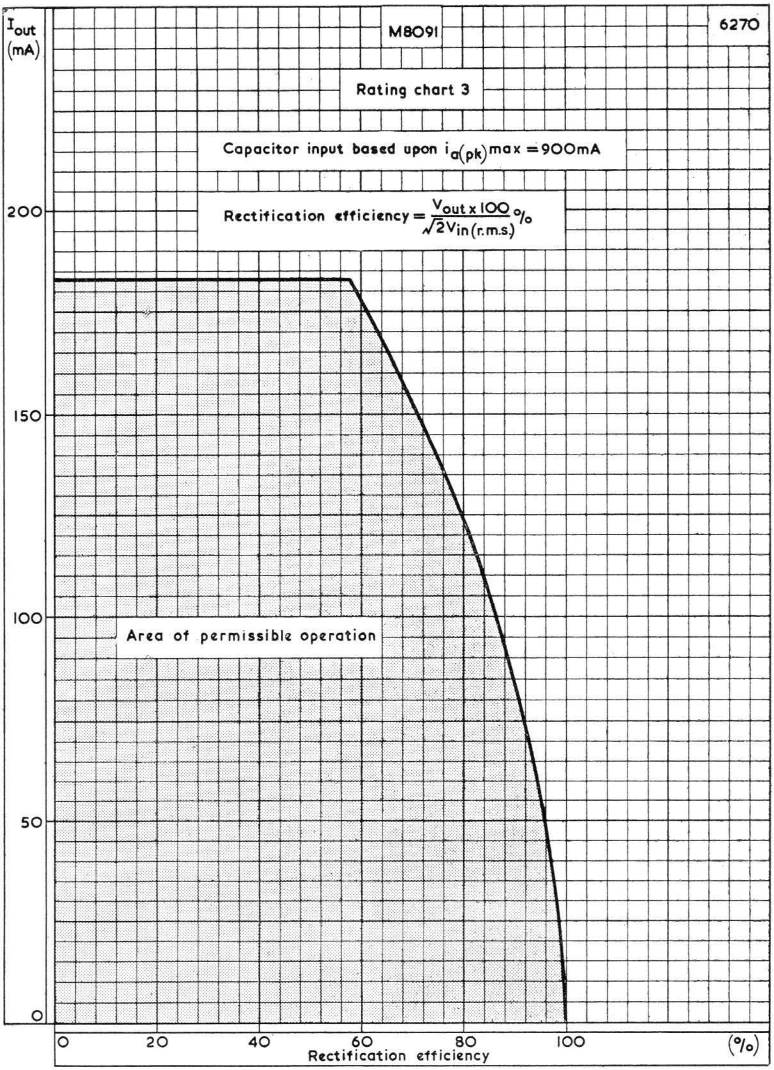
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE



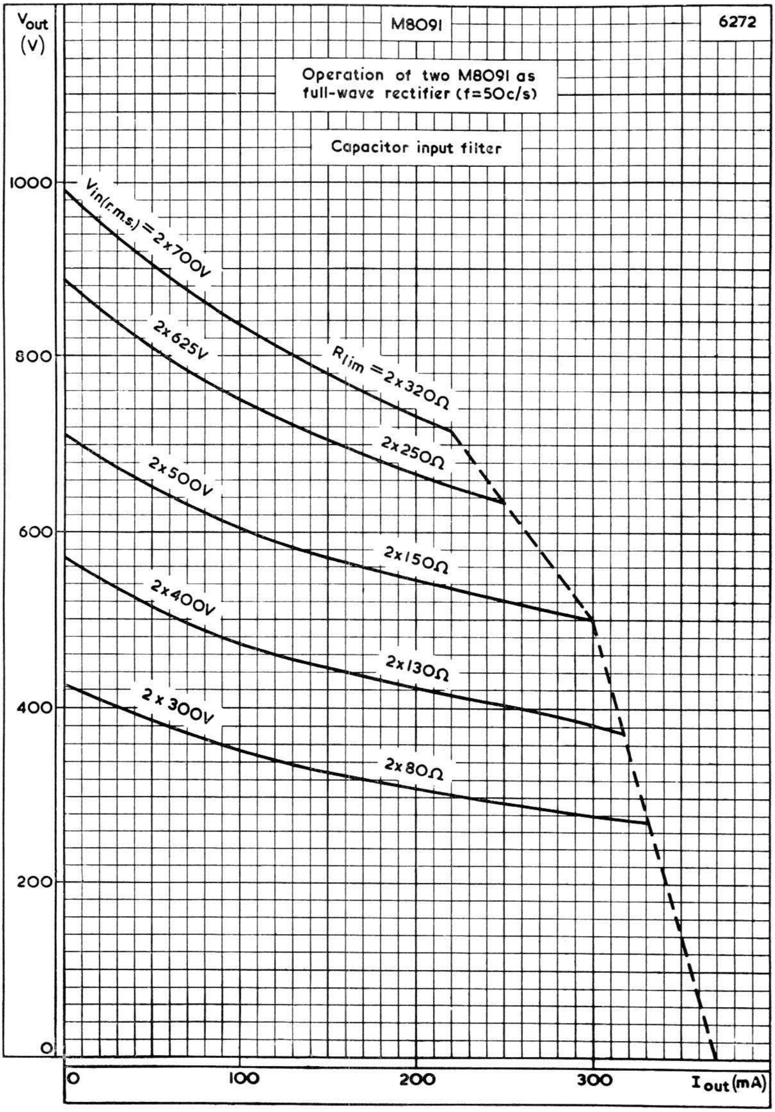
BOUNDARY OF OPERATION WITH CAPACITOR OR CHOKE INPUT FILTER



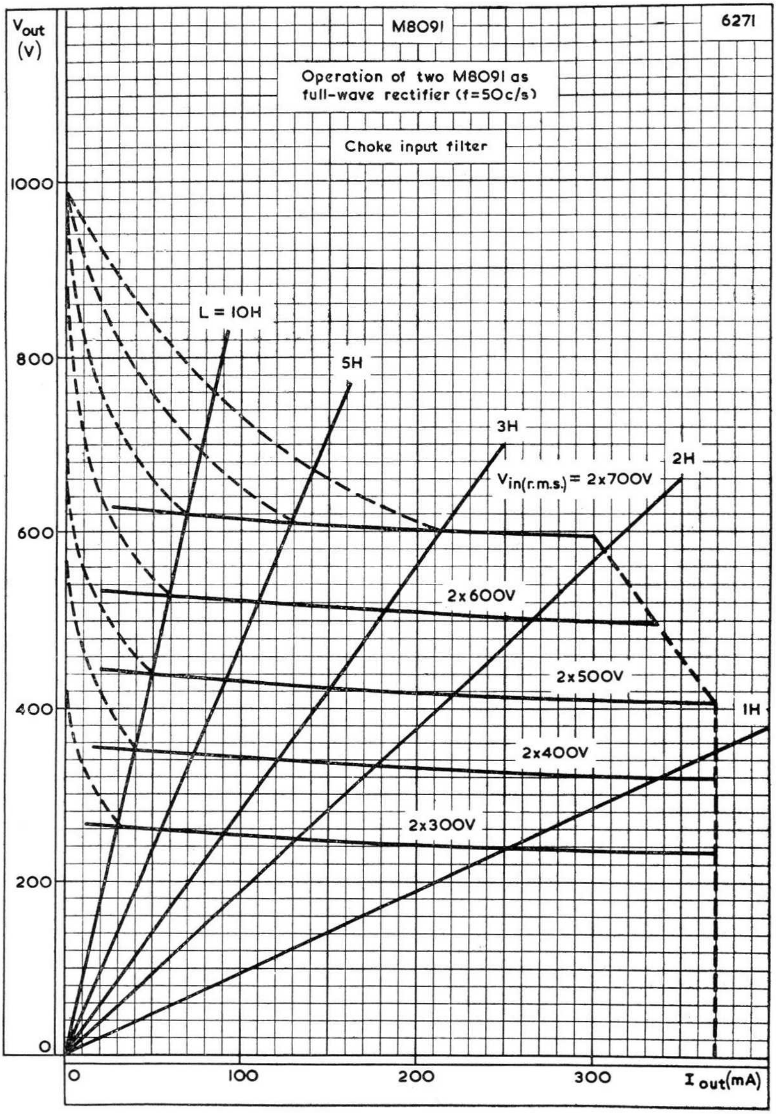
MINIMUM SERIES ANODE RESISTANCE PLOTTED AGAINST OPEN CIRCUIT SECONDARY VOLTAGE



OUTPUT CURRENT PLOTTED AGAINST RECTIFICATION EFFICIENCY



CAPACITOR INPUT FILTER REGULATION CURVES



CHOKE INPUT FILTER REGULATION CURVES

SPECIAL QUALITY V.H.F. POWER TETRODE

M8096

Special quality r.f. beam power tetrode for use at frequencies up to 175Mc/s in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.0	V
I_h	750	mA

CAPACITANCES[2] (measured without an external shield)

c_{a-g1}	<300	mpF
c_{in}	9.5	pF
c_{out}	4.5	pF

CHARACTERISTICS[3]

V_a	250	V
V_{bp}	0	V
V_{g2}	250	V
V_{g1}	–7.5	V
I_a	45	mA
I_{g2}	4.5	mA
g_m	7.0	mA/V
μ_{g1-g2}	16	
R_k	0	Ω

LIMITING VALUES[4] (absolute ratings)

f max.	175	Mc/s
$V_{a(b)}$ max.	500	V
V_a max.	300	V
$V_{g2(b)}$ max.	500	V
V_{g2} max.	250	V
$-V_{g1}$ max.	125	V
p_a max.	12	W
p_{g2} max.	2.0	W
I_k max.	60	mA
$i_{k(pk)}$ max.	550	mA
V_{h-k} max.	100	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	250	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_a (V)	V_{bp} (V)	V_{g2} (V)	V_{g1} (V)	R_k (Ω)	V_{h-k} (V)
6.0	250	0	250	-7.5	0	0

TESTS	*A.Q.L.*[5] (%)	*Individuals*[6] *Bogey*[9]	*Min.*	*Max.*	*Lot average*[7] *Min.*	*Max.*	*Lot standard deviation*[8] *Max.*	
GROUP A								
Insulation								
a-rest, g_2-rest measured at –300V	0.25	—	100	—	—	—	—	MΩ
g_1-rest measured at –100V	0.25	—	100	—	—	—	—	MΩ
Reverse grid-current								
R_{g1} max. = 100kΩ	0.25	—	—	2.5	—	—	—	µA
GROUP B								
Heater current	0.65	—	690	810	—	—	—	mA
Heater to cathode leakage current	0.65	—	—	—	—	—	—	
V_{h-k} = 100V (cathode negative)	—	—	—	20	—	—	—	µA
V_{h-k} = 100V (cathode positive)	—	—	—	20	—	—	—	µA
†Anode current	0.65	45	33	57	—	—	—	mA
	—	—	—	—	39	51	4.6	mA
Screen-grid current	0.65	—	—	7.0	—	—	—	mA
Mutual conductance	0.65	7.0	5.6	9.0	—	—	—	mA/V
	—	—	—	—	6.3	7.7	0.54	mA/V
Group quality level[10]	1.0	—	—	—	—	—	—	

When V_{g1} is applied in turn to pins 8 and 9,

†no change in anode current should result.

GROUP C									
Anode current. $V_{g1} = -15V$	2.5	—	—	15	—	—	—	mA
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Microphonic noise at the anode at 50c/s and 2.5g min. peak acceleration, $V_b = 250V$, $R_a = 2.0k\Omega$, $V_g = -15V$.	2.5	—	—	250	—	—	—	mV (r.m.s.)
Amplification factor (μ_{g1-g2})	2.5	—	13	20	—	—	—	
*Beam plate continuity test. $V_{bp} = 250V$	2.5	—	—	—	—	—	—	
Group quality level[10]	6.5	—	—	—	—	—	—	
GROUP D								
Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances (unshielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{a-g}	—	—	—	300	—	—	—	mpF
c_{in}	—	—	7.9	11.1	—	—	—	pF
c_{out}	—	—	3.0	6.0	—	—	—	pF
Reverse grid current. $V_h = 6.6V$, $V_a = 300V$, $V_{g2} = 250V$, $I_a = 40mA$	6.5	—	—	2.5	—	—	—	μA
Power oscillation. $V_{a(b)} = 300V$, $I_a = 50mA$, $R_{g1} = 16k\Omega$, f = 135Mc/s	6.5	—	1.5	—	—	—	—	W
Reverse screen-grid current. $V_a = 0V$, $I_{g2} = 10mA$, $V_{g2} = 170V_{r.m.s.}$	6.5	—	—	500	—	—	—	μA
*Peak cathode current. $v_{a(pk)} = v_{g1(pk)} = v_{bp(pk)} = 200V$	6.5	—	4.5	—	—	—	—	A

*The anode and screen-grid currents should change from the values obtained in group B

*The voltage waveform should be a half-sine wave. P.R.F. = 50p/s., t_p max. = 12.5μs.

	A.Q.L.[5]	*Individuals*[6]			*Lot average*[7]		*Lot standard deviation*[8]	
	(%)	*Bogey*[9]	*Min.*	*Max.*	*Min.*	*Max.*	*Max.*	
GROUP E								
Fatigue[14]								
V_h = 6.6V, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	40	—	—	—	µA
Reverse grid current. R_{g1} max. = 100kΩ	2.5	—	—	5.0	—	—	—	µA
Power oscillation as in group D	2.5	—	1.0	—	—	—	—	W
Microphonic noise as in group C	2.5	—	—	500	—	—	—	mV (r.m.s.)
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	40	—	—	—	µA
Reverse grid current. R_{g1} max. = 100kΩ	2.5	—	—	5.0	—	—	—	µA
Power oscillation as in group D	2.5	—	1.0	—	—	—	—	W
Microphonic noise as in group C	2.5	—	—	500	—	—	—	mV (r.m.s.)

GROUP F

Stability life test[14]

Running conditions. $R_{g1} = 100k\Omega \pm 20\%$, $R_k = 150\Omega \pm 10\%$, $V_{h-k} = 100V$ (cathode negative), $C_k = 1000\mu F$

Stability life test end points

Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%

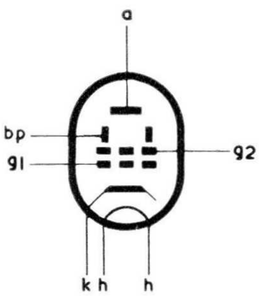
Intermittent life test

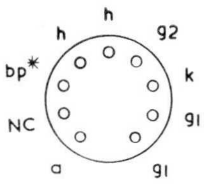
Running conditions. $R_{g1} = 100k\Omega \pm 20\%$, $R_k = 150\Omega \pm 10\%$, $V_{h-k} = 100V$ (cathode negative) $C_k = 1000\mu F$

Intermittent life test end points

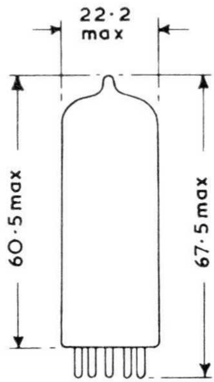
		A.Q.L.[5] (%)	*Min.*	*Max.*	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	640	810	mA
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	30	μA
	1000 hours	4.0	—	40	μA
Reverse grid current. R_{g1} max. = 100kΩ	500 hours	2.5	—	3.0	μA
	1000 hours	4.0	—	4.0	μA
Mutual conductance	500 hours	2.5	4.8	—	mA/V
	1000 hours	4.0	4.5	—	mA/V
Average change in mutual conductance	500 hours	—	—	15	%
Sub-group (b)					
Anode current	500 hours	4.0	28	57	mA
	1000 hours	6.5	25	—	mA
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	30	—	MΩ
Power oscillation as in group D	500 hours	4.0	1.0	—	W
	1000 hours	6.5	0.8	—	W
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

GROUP G	*A.Q.L.*[5] (%)	*Min.*	*Max.*	
Valves are held for 28 days and retested for Inoperatives[16]	0.5	—	—	
Reverse grid current. R_{g1} max. = 100kΩ	0.5	—	2.5	μA





B9A Base

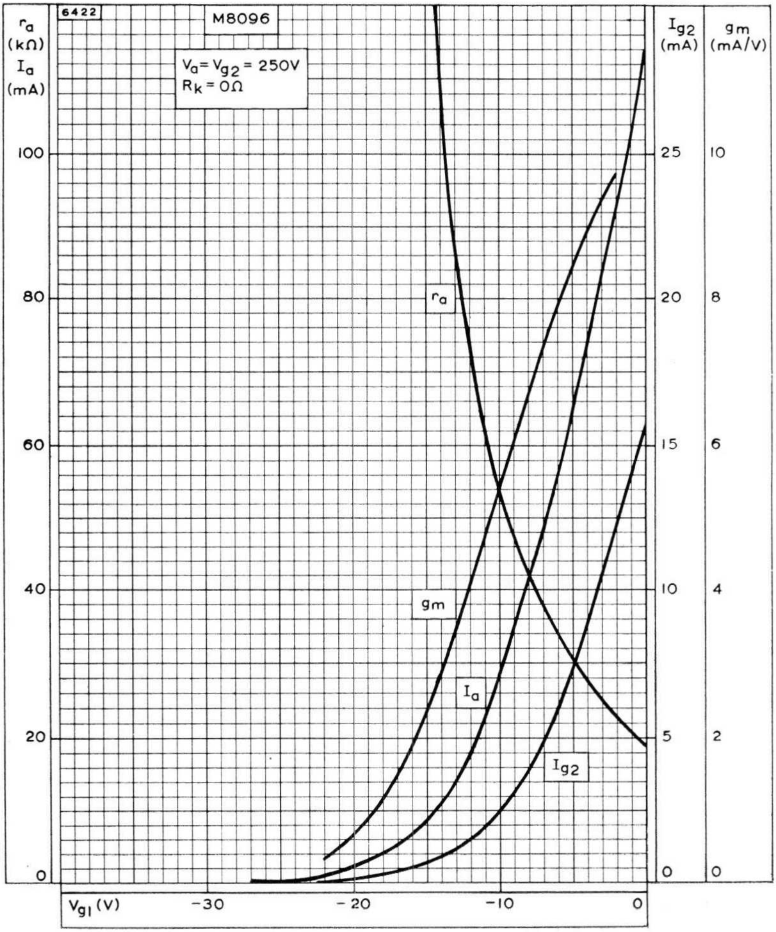


All dimensions in mm

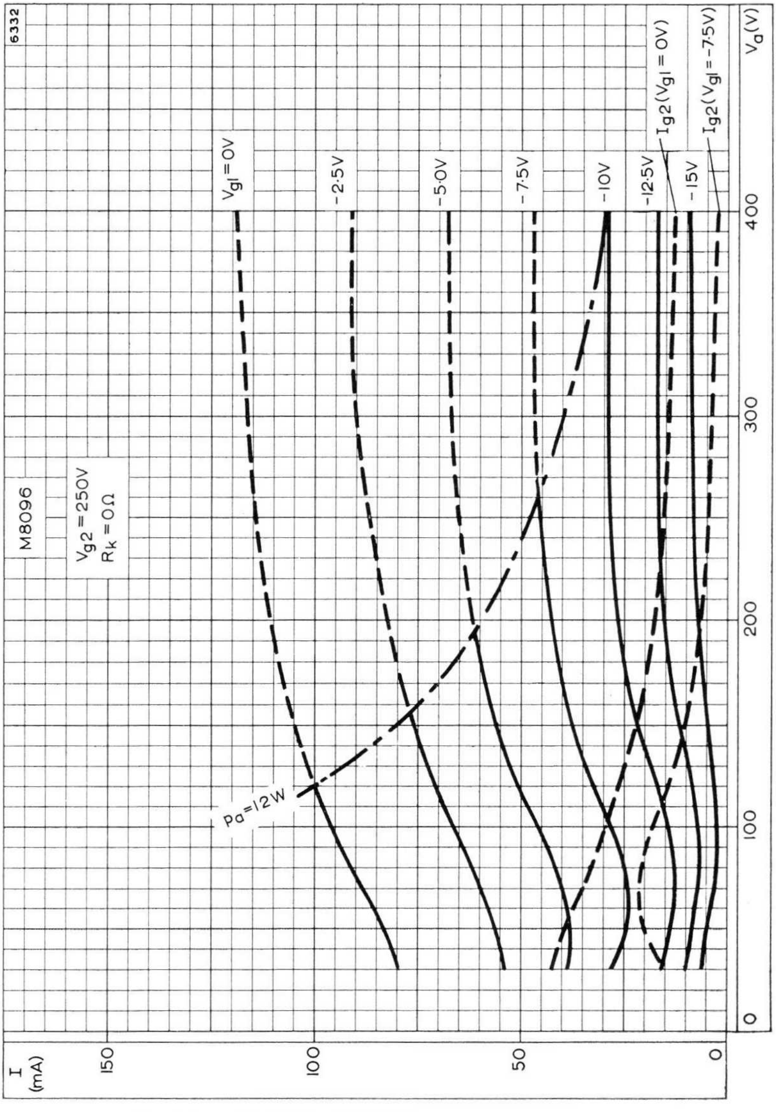
* Connect contact 3 to contact 7 at socket. Contacts 8 and 9 should be connected to external circuit with leads of equal length.

6309

The bulb and base dimensions of this valve are in accordance with BS448, Section B9A



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

SPECIAL QUALITY V.H.F. PENTODE

M8100

Special quality low noise, high slope r.f. pentode for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	175	mA

CAPACITANCES[2] (measured with an external shield)

c_{a-g1}	<20	mpF
c_{in}	4.0	pF
c_{out}	3.1	pF

CHARACTERISTICS[3]

V_a	120	180	V
V_{g2}	120	120	V
I_a	7.5	7.7	mA
I_{g2}	2.5	2.4	mA
V_{g1}	−2.0	−2.0	V
g_m	5.0	5.1	mA/V
r_a	250	400	kΩ
μ_{g1-g2}	35	35	
R_k	0	0	Ω

ABSOLUTE MAXIMUM RATINGS[4]

f max.	400	Mc/s
$V_{a(b)}$ max.	400	V
V_a max.	200	V
p_a max.	1.65	W
$V_{g2(b)}$ max.	310	V
V_{g2} max.	155	V
p_{g2} max.	550	mW
$-V_{g1}$ max.	55	V
I_{g1} max.	4.0	mA
R_{g1-k} max.	3.0	MΩ ←
I_k max.	20	mA
V_{h-k} max.	130	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	165	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_a (V)	V_{g2} (V)	V_{g1} (V)	R_k (Ω)	V_{h-k} (V)
6.3	120	120	-2.0	0	0

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP A								
Insulation								
a-rest, g_2-rest measured at –300V	0.25	—	100	—	—	—	—	MΩ
g_1-rest measured at –100V	0.25	—	100	—	—	—	—	MΩ
Reverse grid current								
R_{g1} max. = 500kΩ	0.25	—	—	0.1	—	—	—	μA
GROUP B								
Heater current	0.65	—	160	190	—	—	—	mA
Heater to cathode leakage current	0.65	—	—	—	—	—	—	
V_{h-k} = 100V (cathode negative)	—	—	—	10	—	—	—	μA
V_{h-k} = 100V (cathode positive)	—	—	—	10	—	—	—	μA
Anode current	0.65	7.5	5.0	11	—	—	—	mA
	—	—	—	—	6.5	8.5	0.87	mA
Screen-grid current	0.65	2.5	0.8	4.0	—	—	—	mA
	—	—	—	—	1.8	3.2	0.52	mA
Mutual conductance	0.65	5.0	4.0	6.25	—	—	—	mA/V
	—	—	—	—	4.525	5.475	0.357	mA/V
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Anode current. $V_{g1} = -10V$	2.5	—	—	200	—	—	—	µA
Anode current. $V_{g1} = -5.5V$	2.5	—	5.0	—	—	—	—	µA
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Reverse grid current. $V_h = 7.0V$, $R_{g1} = 100k\Omega$	2.5	—	—	0.5	—	—	—	µA
Microphonic noise at the anode at 50c/s and 2.0g min. peak acceleration, $V_b = 135V$, $R_a = 2k\Omega$, $R_{g2} = 10k\Omega$, $C_{g2} = 2\mu F$, $R_{g1} = 100k\Omega$	2.5	—	—	45	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances[2] (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	3.4	4.6	—	—	—	pF
c_{out}	—	—	2.45	3.25	—	—	—	pF
c_{a-g1}	—	—	—	20	—	—	—	mpF
Noise factor	4.0	—	—	2.5	—	—	—	dB

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Min.	Max.	Lot average[7] Min.	Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
V_h = 6.3V, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s, for 33 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	30	—	—	—	μA
Reverse grid current. R_{g1} max. = 500kΩ	2.5	—	—	0.2	—	—	—	μA
Mutual conductance	2.5	—	3.5	—	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	90	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	6.5	—	—	—	—	—	—	
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	30	—	—	—	μA
Reverse grid current. R_{g1} max. = 500kΩ	2.5	—	—	0.2	—	—	—	μA
Mutual conductance	2.5	—	3.5	—	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	90	—	—	—	mV (r.m.s.)
Sub-group quality level[10]	6.5	—	—	—	—	—	—	

GROUP F

Stability life test[14]

Running conditions. V_a = 150V, V_{g2} = 125V, R_{g1} = 100kΩ, R_k = 130Ω, V_{h-k} = 135V (cathode negative).

Stability life test end points

Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%

Intermittent life test

Running conditions. $V_a = 150V$, $V_{g2} = 125V$, $R_{g1} = 100k\Omega$, $R_k = 130\Omega$, $V_{h-k} = 135V$ (cathode negative).

Intermittent life test end points

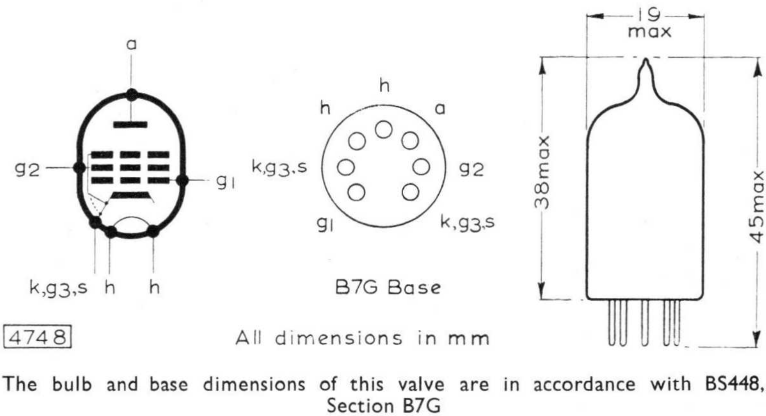
		A.Q.L.[5] (%)	*Min.*	*Max.*	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	160	190	mA
	1000 hours	4.0	160	190	mA
Heater to cathode leakage current. $V_{h-k} = \pm100V$	500 hours	2.5	—	10	μA
	1000 hours	4.0	—	10	μA
Reverse grid current. R_{g1} max. = 500kΩ	500 hours	2.5	—	0.1	μA
	1000 hours	4.0	—	0.1	μA
Mutual conductance	500 hours	2.5	3.75	6.25	mA/V
	1000 hours	4.0	3.5	6.25	mA/V
Average change in mutual conductance	500 hours	—	—	15	%
Sub-group (b)					
Anode current	500 hours	4.0	4.5	11	mA
	1000 hours	6.5	4.0	11	mA
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	30	—	MΩ
Noise factor	500 hours	4.0	—	2.7	dB
	1000 hours	6.5	—	2.8	dB
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

GROUP G

Valves are held for 28 days and retested for

	A.Q.L. (%)	Min.	Max.	
Inoperatives[16]	0.5	—	—	
Reverse grid current. R_{g1} max. = 500kΩ	0.5	—	0.15	μA

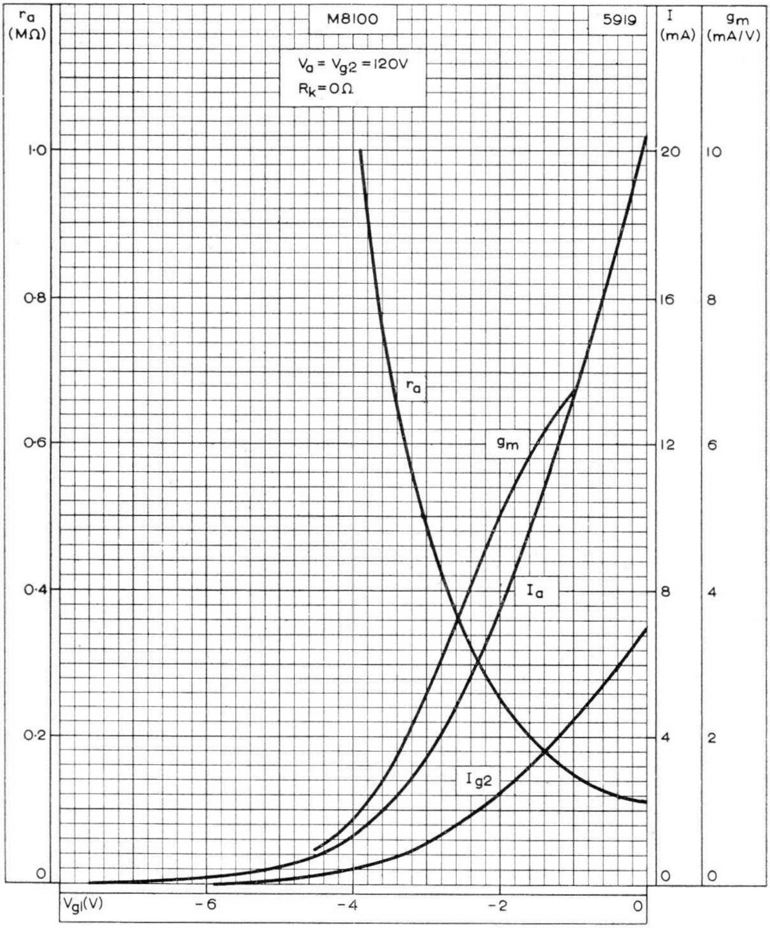
M8100 SPECIAL QUALITY V.H.F. PENTODE



4748

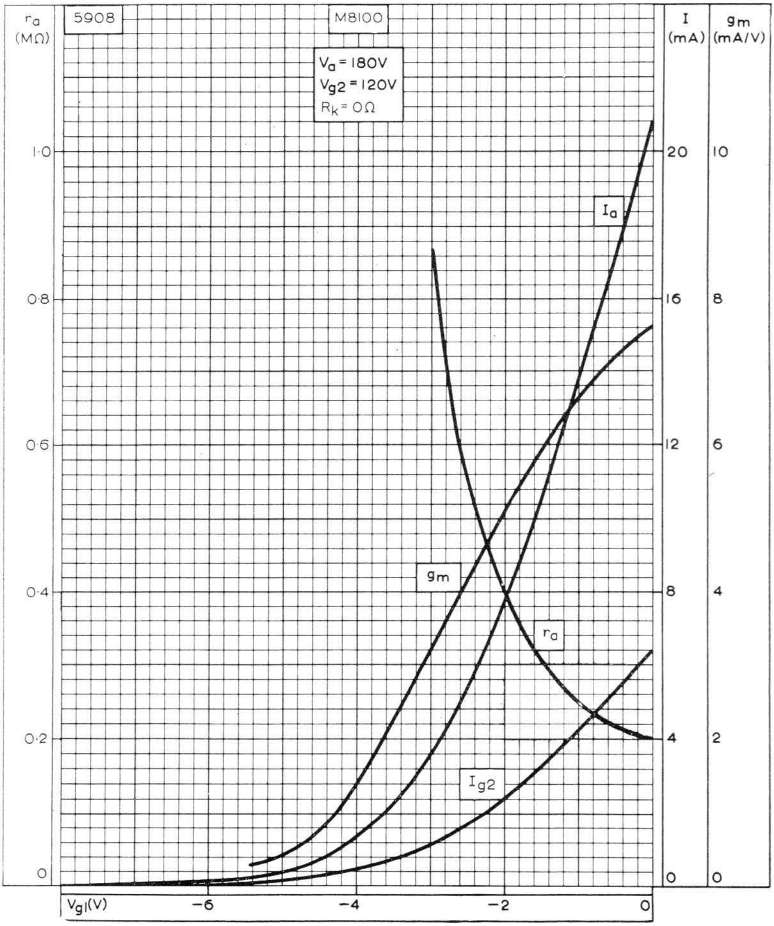
All dimensions in mm

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

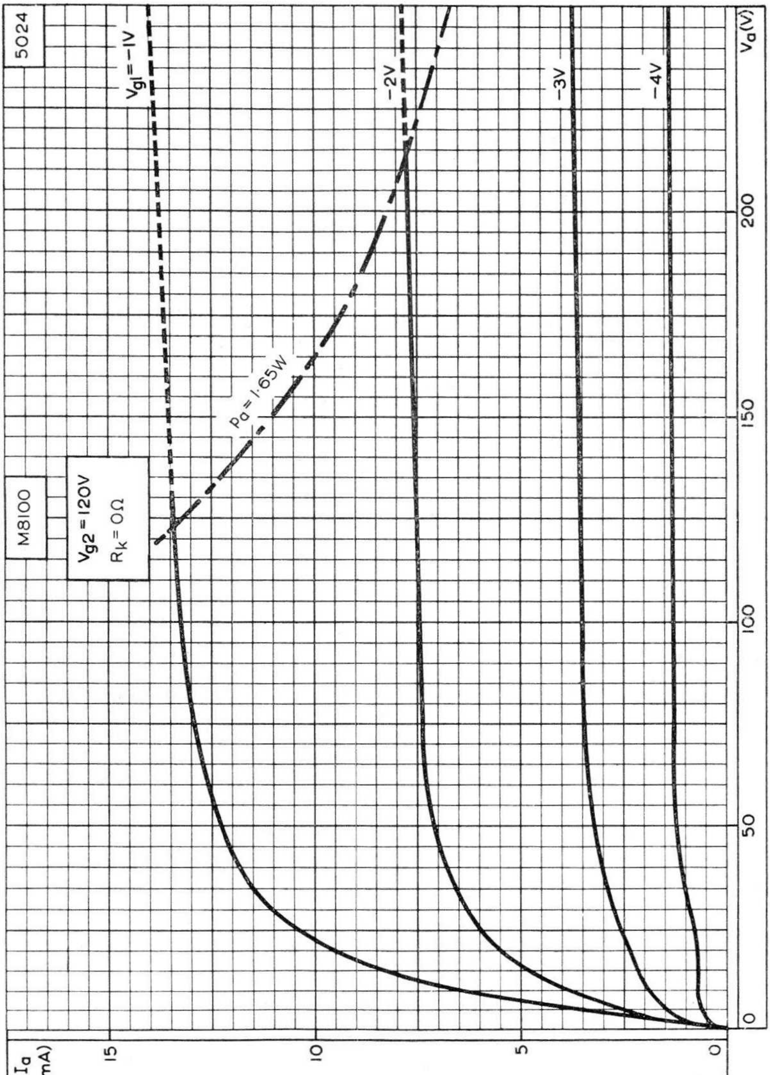


ANODE CURRENT, SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 120V$

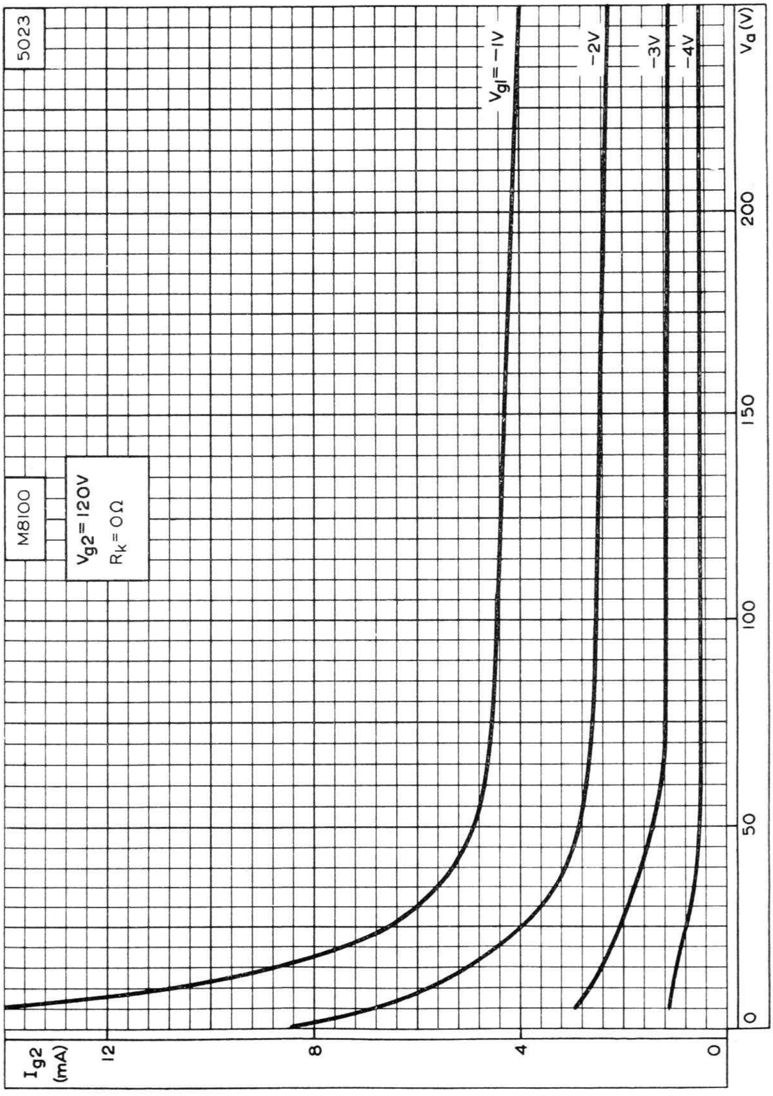
M8100 SPECIAL QUALITY V.H.F. PENTODE



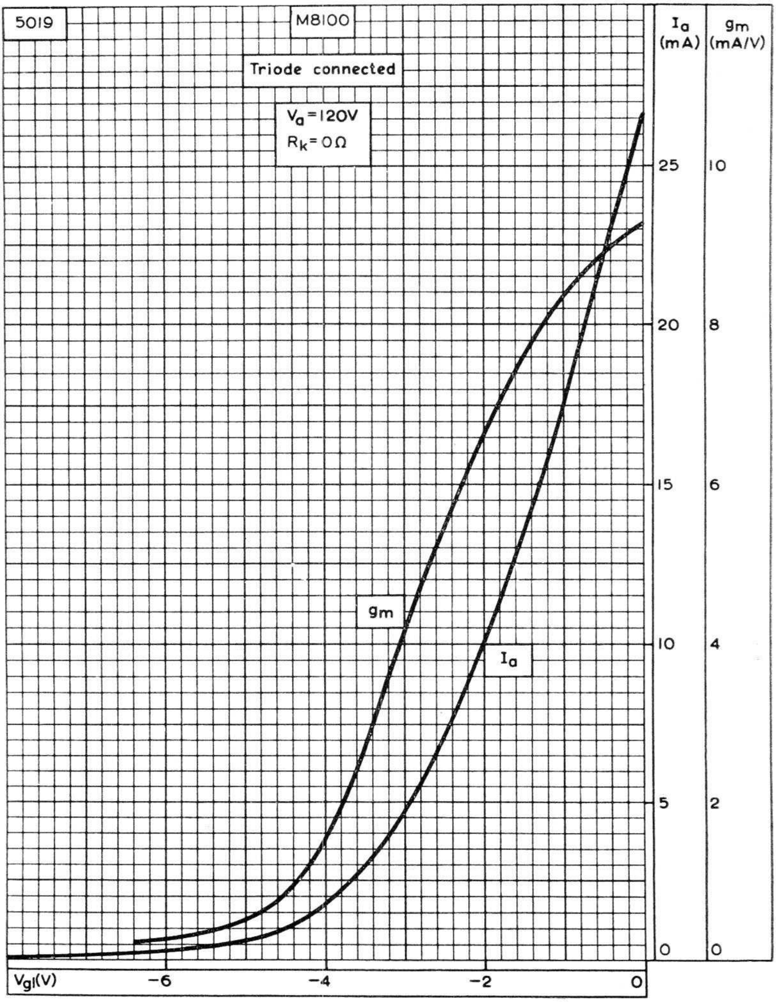
ANODE CURRENT, SCREEN-GRID CURRENT, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. V_a = 180V



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.

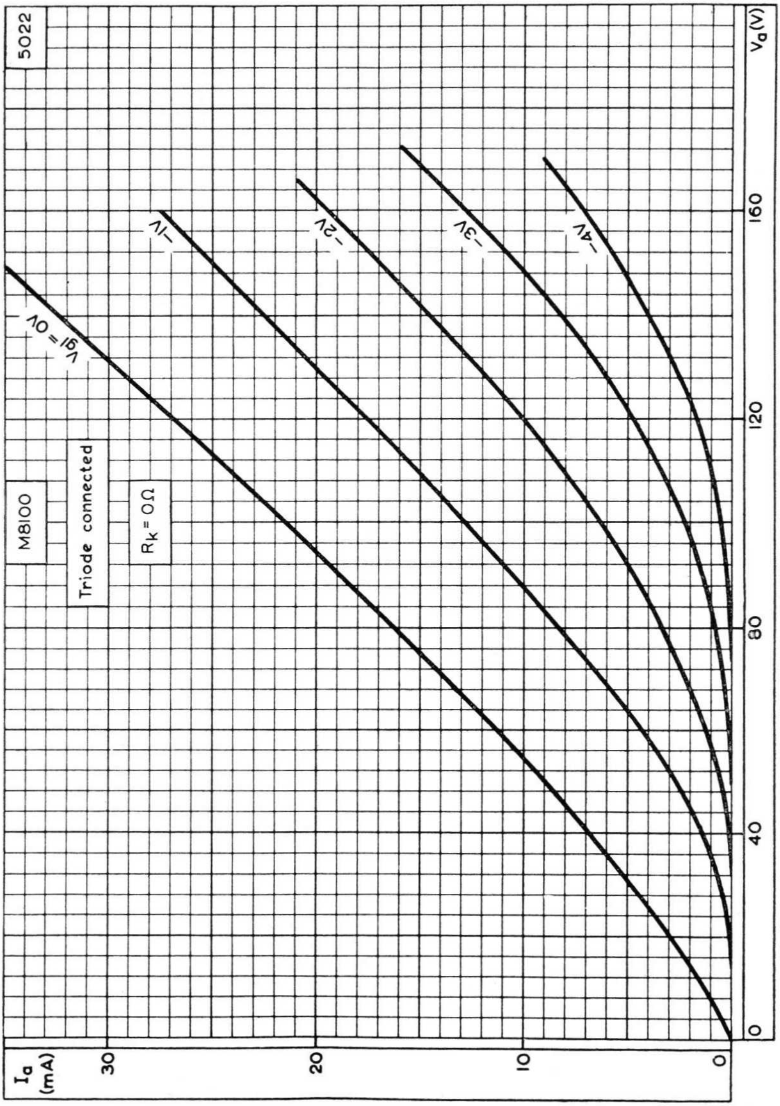


SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER.



ANODE CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE, WHEN TRIODE CONNECTED.

M8100 SPECIAL QUALITY V.H.F. PENTODE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED.

SPECIAL QUALITY VARIABLE-MU R.F. PENTODE

M8161

Special quality variable-mu r.f. pentode for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	200	mA

MOUNTING POSITION

Any

CAPACITANCES[2]

	Unshielded	Shielded	
c_{in}	4.8	5.0	pF
c_{out}	6.3	6.5	pF
c_{a-g1}	<15	<10	mpF
c_{h-k}	2.3	2.3	pF

CHARACTERISTICS[3]

V_a	200	V
V_{g2}	200	V
V_{g3}	0	V
I_a	8.25	mA
I_{g2}	2.1	mA
V_{g1}	−2.5	V
g_m	2.45	mA/V
r_a	900	kΩ←
μ_{g1-g2}	30	
R_k	0	Ω
V_{g1} (for 100 : 1 reduction in g_m)	−27	V

ABSOLUTE MAXIMUM RATINGS[4]

$V_{a(b)}$ max.	500	V
V_a max.	300	V
p_a max.	3.0	W
$V_{g2(b)}$ max.	300	V
V_{g2} max.	300	V
p_{g2} max.	700	mW
$-V_g$ max.	55	V←
I_k max.	14	mA
R_{g1-k} max. (cathode bias)	500	kΩ
R_{g1-k} max. (fixed bias)	100	kΩ
V_{h-k} max.	150	V
Maximum fatigue (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	200	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_a (V)	V_{g3} (V)	V_{g2} (V)	V_{g1} (V)	R_k (Ω)	V_{h-k} (V)
6.3	200	0	200	−2.5	*0	0

TESTS

	A.Q.L.[5]	Individuals[6]			Lot average[7]		Lot standard deviation[8]	
GROUP A	(%)	Bogey[9]	Min.	Max.	Min.	Max.	Max.	
Insulation								
a-rest, g_2-rest, g_3-rest measured at −300V	0.25	—	100	—	—	—	—	MΩ
g_1-rest measured at −100V	0.25	—	100	—	—	—	—	MΩ
Reverse grid current R_{g1} max. = 500kΩ	0.25	—	—	0.5	—	—	—	μA
GROUP B								
Heater current	0.65	—	184	216	—	—	—	mA
Heater-to-cathode leakage current V_{h-k} = 100V cathode positive / cathode negative	0.65	—	—	10	—	—	—	μA
V_{h-k} = 100V cathode positive	—	—	—	—	—	3.0	—	μA
Anode current	0.65	8.25	6.0	10.5	—	—	—	mA
	—	—	—	—	7.6	8.9	0.77	mA
Screen-grid current	0.65	—	1.2	3.0	—	—	—	mA
	—	—	—	—	—	2.4	—	mA
Mutual conductance	0.65	2.45	1.8	3.1	—	—	—	mA/V
	—	—	—	—	2.25	2.65	0.23mA/V	
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Mutual conductance. $V_{g1} = -26V$	2.5	—	4.0	60	—	—	—	µA/V
Reverse grid current. $V_{g1} = -50V$	2.5	—	—	1.0	—	—	—	µA
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Reverse grid current. $V_h = 6.9V$, $V_{a-e} = 300V$, $V_{g2-e} = 200V$, $R_k = 240\Omega$	2.5	—	—	1.0	—	—	—	µA
Microphonic noise at the anode at 50c/s and 2.5g min. peak acceleration, $V_{a(b)} = 200V$, $R_a = 2.0k\Omega$	2.5	—	—	15	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	

GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances[2] (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	3.8	5.2	—	—	—	pF
c_{out}	—	—	5.0	7.4	—	—	—	pF ←
c_{a-g1}	—	—	—	10	—	—	—	mpF
Grid 3 cut-off voltage. $V_{g1} = -7.0V$, $I_a = 50\mu A$	6.5	—	-55	-125	—	—	—	V
Amplification factor (μ_{g1-g2})	6.5	—	23	39	—	—	—	

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
$V_h = 6.9V$, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, $f = 170 \pm 5$c/s for 33 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Heater-to-cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse grid current. R_{g1} max. = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	1.6	3.1	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater-to-cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	20	—	—	—	μA
Reverse grid current. R_{g1} max. = 500kΩ	2.5	—	—	1.0	—	—	—	μA
Mutual conductance	2.5	—	1.6	3.1	—	—	—	mA/V
Microphonic noise as in group C	2.5	—	—	25	—	—	—	mV (r.m.s.)

GROUP F

Stability life test[14]

Running conditions. $R_{g1} = 100k\Omega$, $V_a = 250V$, $V_{h-k} = 135V$ (cathode negative), $R_k = 160\Omega$, $V_{g1-e} = 0V$

Stability life test end point

Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%

Intermittent life test

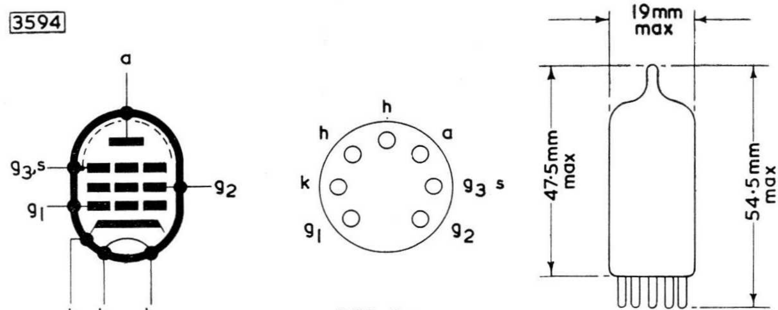
Running conditions. $R_{g1} = 100k\Omega$, $V_a = 250V$, $V_{h-k} = 135V$ (cathode negative), $R_k = 160\Omega$

Intermittent life test end points

		A.Q.L.[5] (%)	*Min.*	*Max.*	
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	184	216	mA
Heater-to-cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	20	µA
	1000 hours	4.0	—	30	µA
Reverse grid current. R_{g1} max. $= 500k\Omega$	500 hours	2.5	—	0.75	µA
	1000 hours	4.0	—	1.0	µA
Mutual conductance	500 hours	2.5	1.6	3.1	mA/V
	1000 hours	4.0	1.5	3.1	mA/V
Average change in mutual conductance	500 hours	—	—	15	%
Sub-group (b)					
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	30	—	MΩ
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

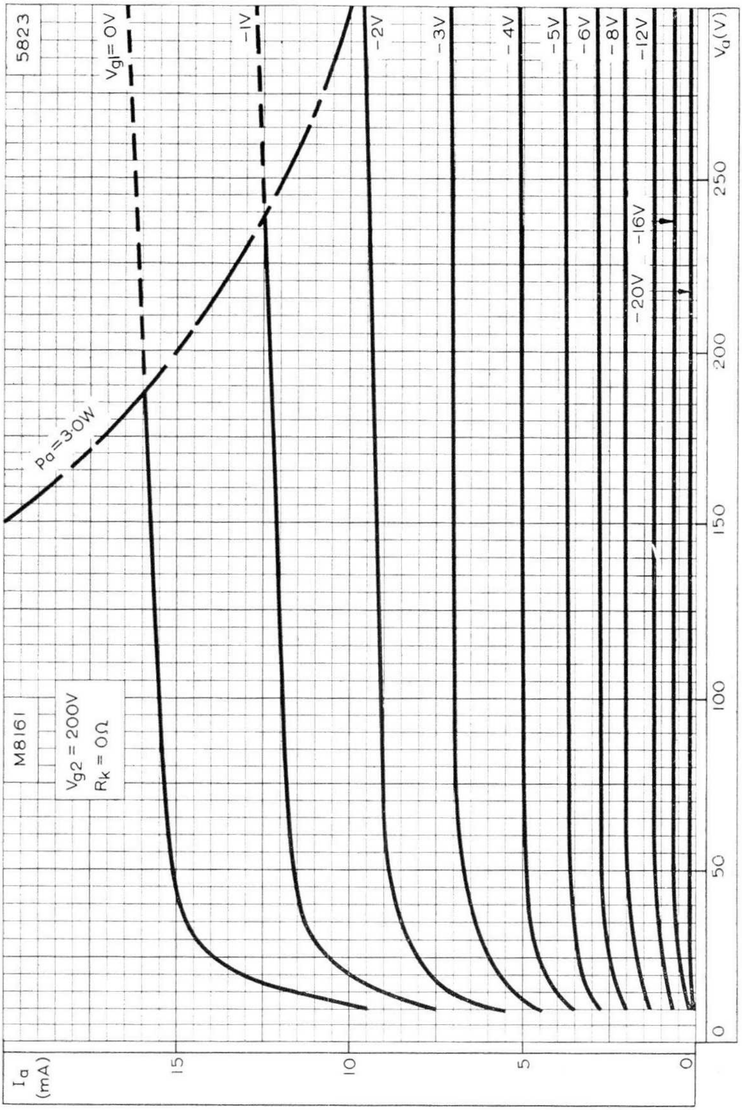
	A.Q.L.[5] (%)	Min.	Max.	
GROUP G				
Valves are held for 28 days and retested for				
Inoperatives[16]	0.5	—	—	
Reverse grid current. R_{g1} max. = 500kΩ	0.5	—	0.75	μA

3594



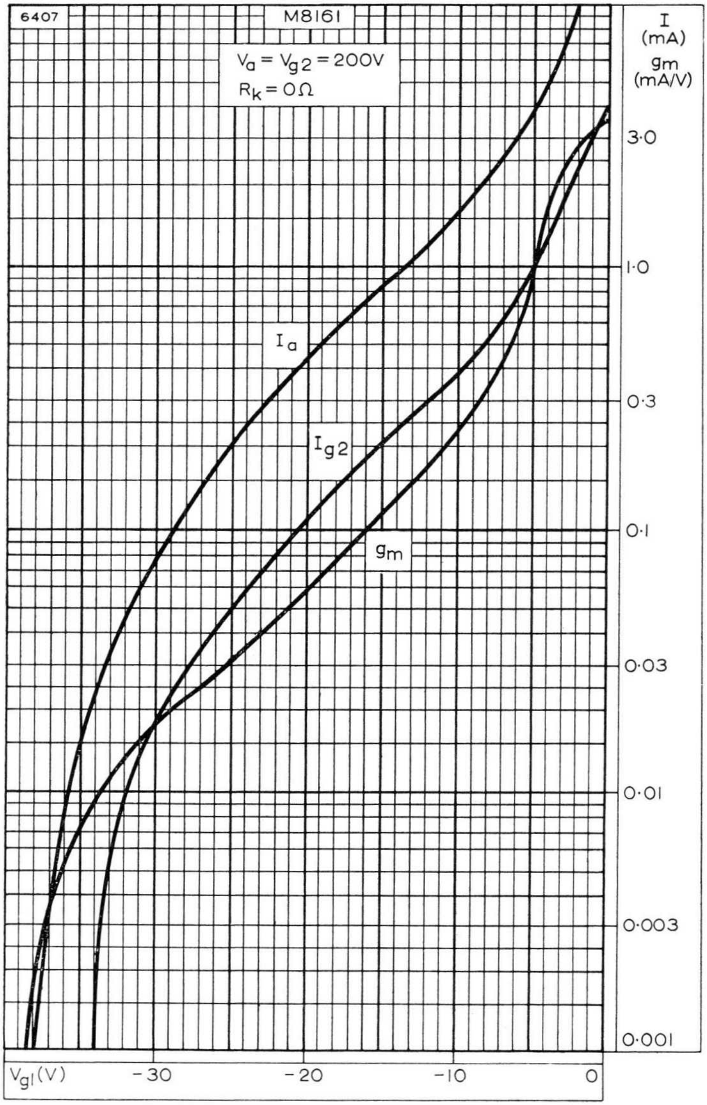
B7G Base

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

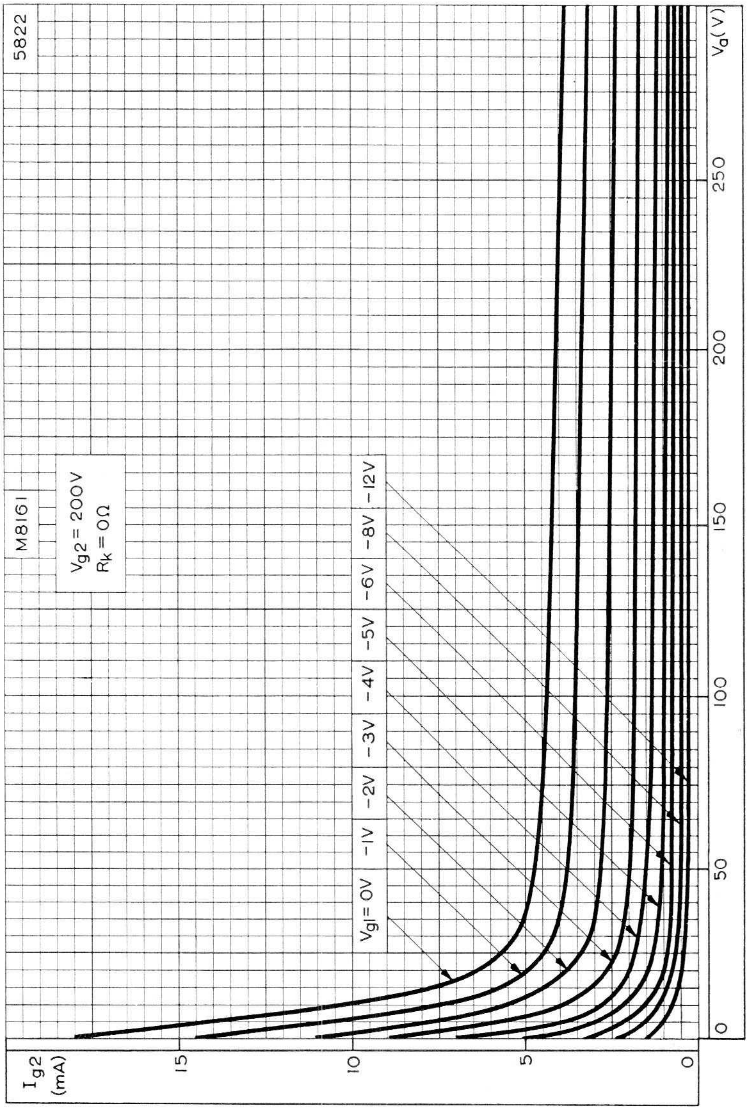


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V.

SPECIAL QUALITY VARIABLE-MU R.F. PENTODE



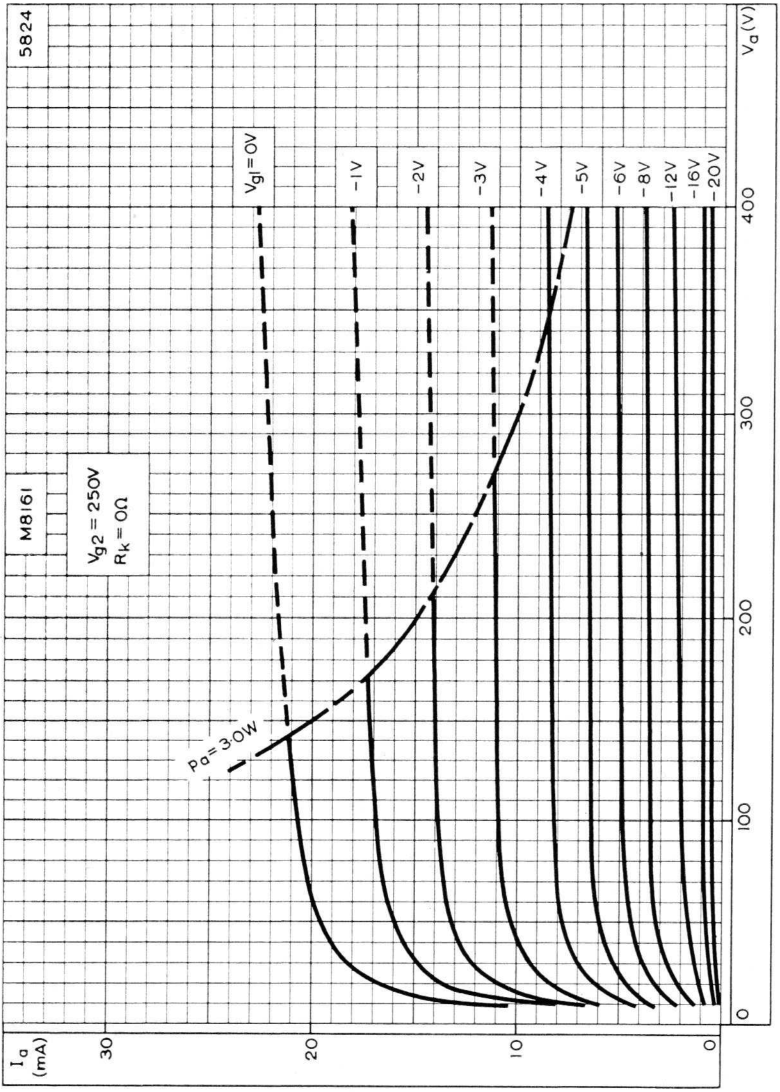
ANODE CURRENT, SCREEN-GRID CURRENT AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 200V$.



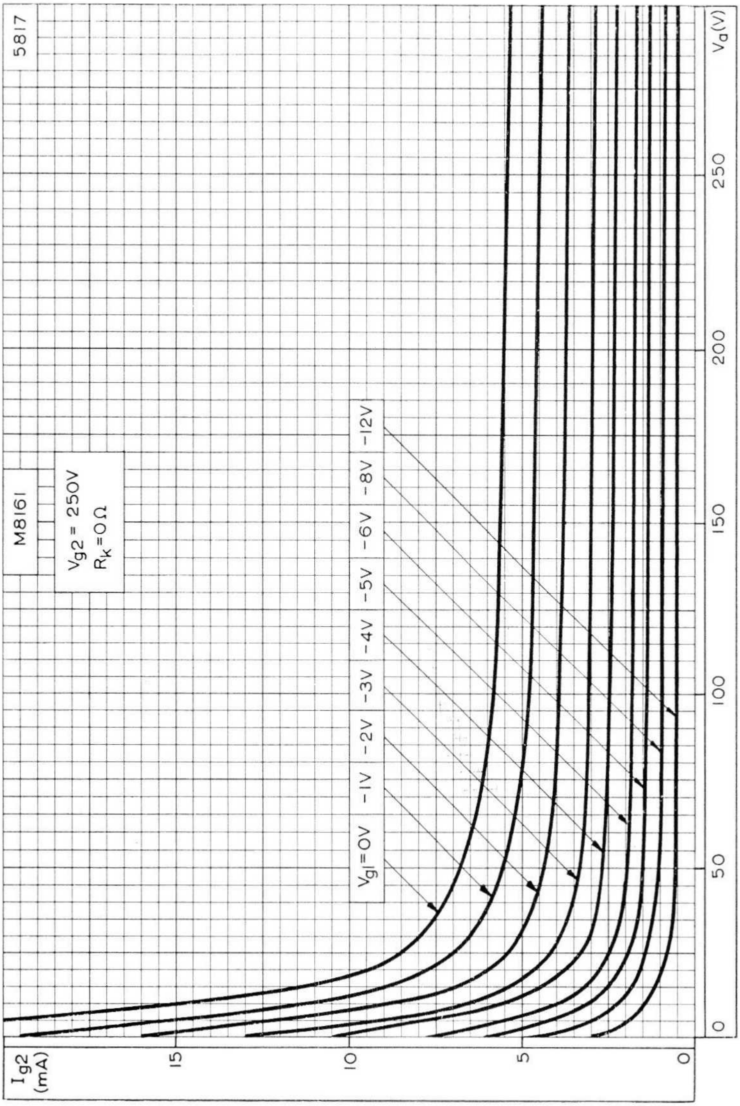
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 200V.

M8161

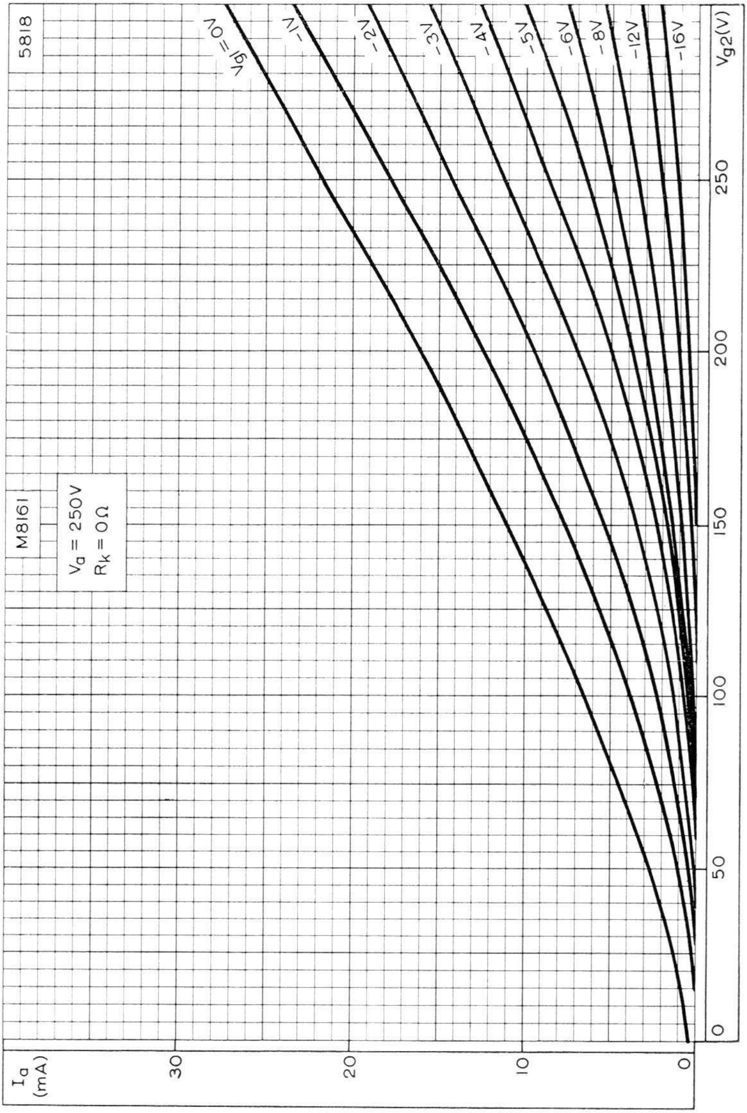
SPECIAL QUALITY VARIABLE-MU R.F. PENTODE



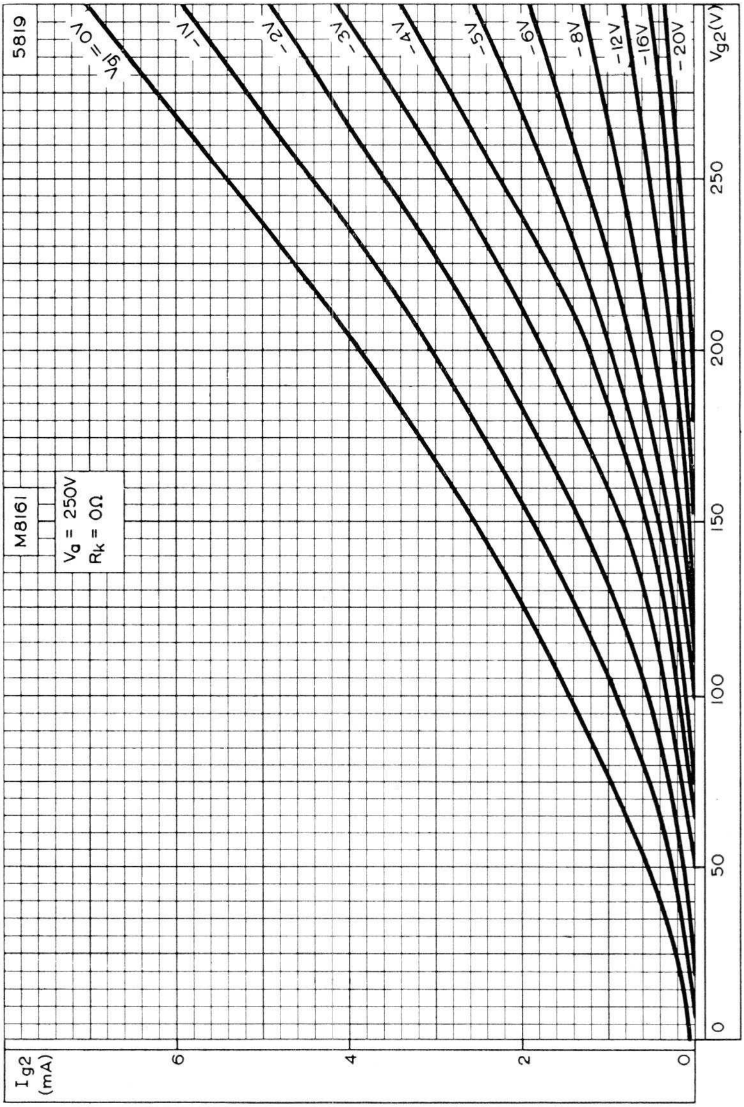
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 250V.



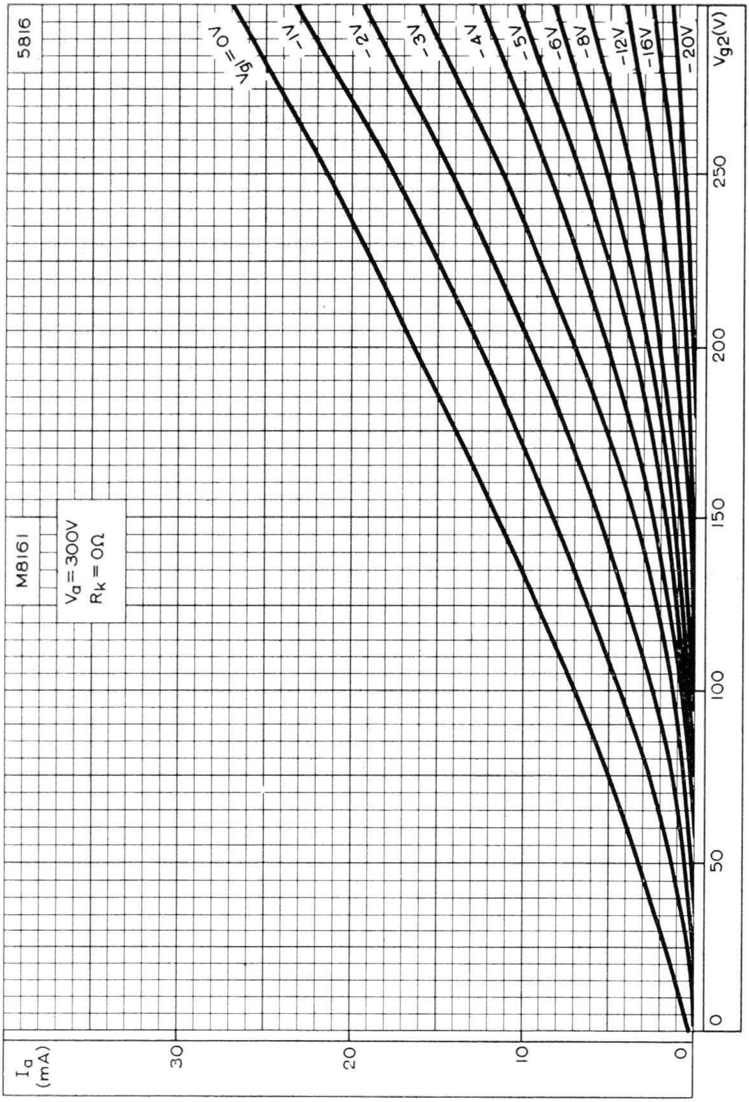
SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 250V$.



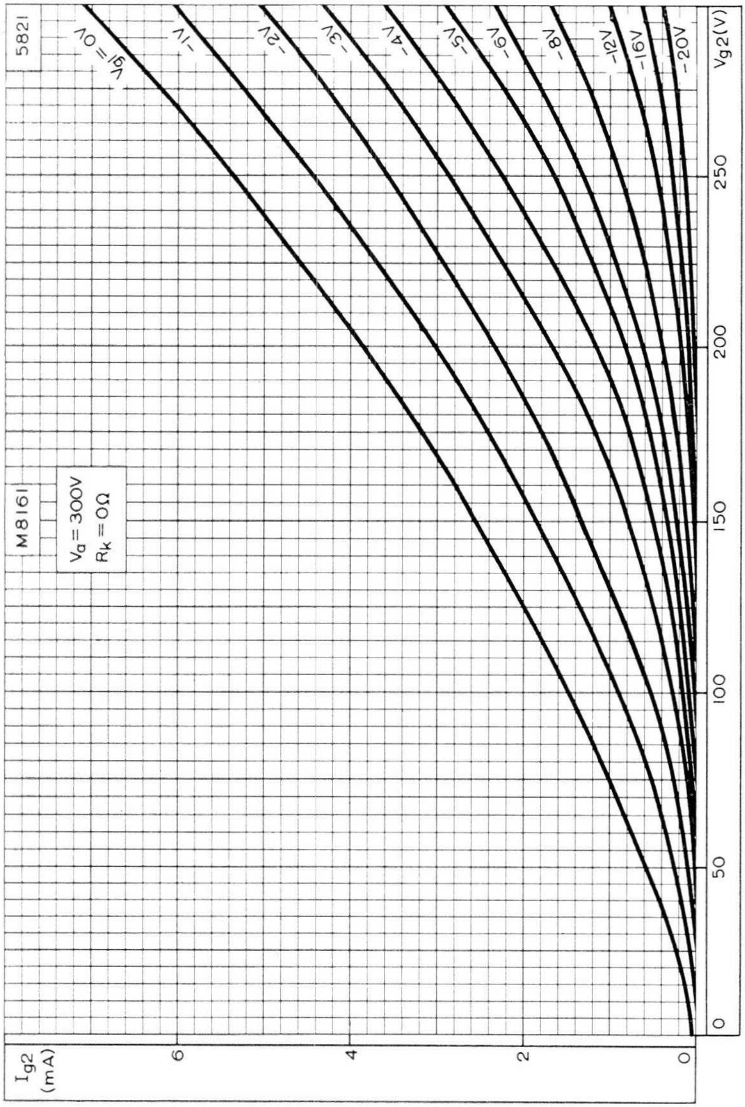
ANODE CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_a = 250V$.



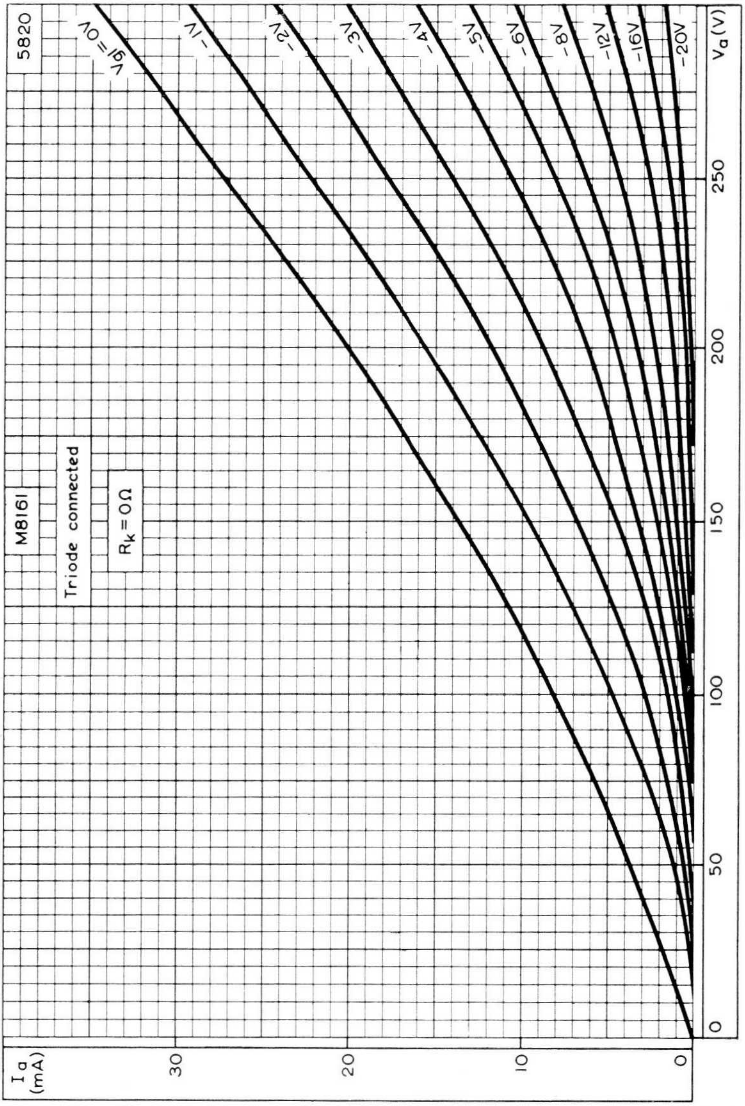
SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_a = 250V.



ANODE CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_a = 300V$.



SCREEN-GRID CURRENT PLOTTED AGAINST SCREEN-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_a = 300V$.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER, WHEN TRIODE CONNECTED.

SPECIAL QUALITY PENTODE

M8196

Special quality dual control pentode for use in equipment where mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	175	mA

MOUNTING POSITION

Any

CAPACITANCES[2] (measured with an external shield)

c_{a-g1}	<20	mpF
c_{in}	4.2	pF
c_{out}	3.2	pF

CHARACTERISTICS[3]

V_a	120	120	V
V_{g2}	120	120	V
V_{g3}	−3.0	0	V
I_a	3.5	5.1	mA
I_{g2}	4.8	3.5	mA
V_{g1}	−2.0	−2.0	V
$g_{m(g1-a)}$	2.0	3.2	mA/V
$g_{m(g3-a)}$	660	450	µA/V
r_a	—	150	kΩ
$V_{g1}(I_a = 100\mu A)$	—	<−7.5	V
$V_{g3}(I_a = 20\mu A)$	−10	<−15	V
R_k	0	0	Ω

ABSOLUTE MAXIMUM RATINGS[4]

$V_{a(b)}$ max.	400	V
V_a max.	200	V
V_{g3} max.	30	V
$-V_{g3}$ max.	55	V
$V_{g2(b)}$ max.	310	V
V_{g2} max.	155	V
p_a max.	1.65	W
p_{g2} max.	550	mW
R_{g1-k} max.	4.0	MΩ←
I_k max.	20	mA
V_{h-k} max.	100	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	450	g
T_{bulb} max.	165	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_a (V)	V_{g3} (V)	V_{g2} (V)	V_{g1} (V)	R_k (Ω)	V_{h-k} (V)
6.3	120	0	120	−2.0	0	0

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP A								
Heater current	0.65	175	160	190	—	—	—	mA
	—	—	—	—	168	182	4.87	mA
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	0.65	—	—	10	—	—	—	μA
Reverse grid current, $R_{g1} = 100k\Omega$	0.65	—	0	0.1	—	—	—	μA
Anode current	0.65	5.2	2.5	9.0	—	—	—	mA
	—	—	—	—	4.2	6.2	0.8	mA
Mutual conductance	0.65	3.2	2.5	4.5	—	—	—	mA/V
	—	—	—	—	2.9	3.5	0.26	mA/V
Sub-group quality level[10]	1.0	—	—	—	—	—	—	
Inoperatives[16]	0.4	—	—	—	—	—	—	
GROUP B								
Insulation								
a-rest, measured at −300V	2.5	—	100	—	—	—	—	MΩ
g_1-rest, measured at −100V		—	100	—	—	—	—	MΩ
g_3-rest, measured at −300V		—	100	—	—	—	—	MΩ

Anode current								
$V_{g1} = -3V, V_{g3} = -10V$	2.5	—	—	200	—	—	—	μA
$V_{g1} = -3V, V_{g3} = -6V$	2.5	—	5.0	—	—	—	—	μA
$V_{g1} = -8V$	2.5	—	—	200	—	—	—	μA
$V_{g1} = -6V$	2.5	—	5.0	—	—	—	—	μA
Screen-grid current	2.5	—	1.5	5.5	—	—	—	mA
Change in mutual conductance, $V_h = 5.7V$	2.5	—	—	15	—	—	—	%
Reverse grid current								
$V_h = 7.5V, V_{g1} = -10V, R_{g1} = 100k\Omega$	2.5	—	0	1.0	—	—	—	μA
†R.F. noise at anode, $V_{g1} = 0V$, $R_k = 200\Omega$, $V_{sig} = 15mV$, $C_k = 0.2\mu F$	2.5	—	—	—	—	—	—	
Vibration, 2.5g min. peak acceleration, $f = 50c/s$, $R_a = 10k\Omega$	6.5	—	—	150	—	—	—	mV
Mutual conductance (g_3–a), $V_{g3} = -3V$	6.5	—	0.35	1.05	—	—	—	mA/V
Mutual conductance (g_1–a), $V_{g3} = -5V$	6.5	—	0.7	1.7	—	—	—	mA/V
Capacitances[2] (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	3.5	4.5	—	—	—	pF
c_{out}	—	—	2.6	3.4	—	—	—	pF
c_{a-g1}	—	—	—	20	—	—	—	mpF
Low pressure voltage breakdown Pressure = 55±5mm Hg Voltage = $500V_{r.m.s.}$. No other applied voltages.	6.5	—	—	—	—	—	—	
Microphonic noise at the anode at 50c/s, 15g min. peak acceleration, $V_{a(b)} = V_{g2(b)} = 200V$, $R_a = 100k\Omega$, $R_{g2} = 500k\Omega$, $C_{g2} = 2\mu F$, $V_{g1} = 0V$, $R_k = 1k\Omega$, $C_k = 1000\mu F$, $V_{g(sig)} = 175mV$	2.5	—	—	—	—	—	—	

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

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP C								
Base strain test[12]	—	—	—	—	—	—	—	
Glass strain test[11B]. No applied voltages	2.5	—	—	—	—	—	—	
Fatigue[14]								
V_h = 6.3V. No other voltage applied. 2.5g min. peak acceleration, fixed frequency f = 25c/s min. 60c/s max. for 32 hours in each of 3 mutually perpendicular planes.								
Post fatigue tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	—	—	—	30	—	—	—	μA
Mutual conductance	—	—	2.2	—	—	—	—	mA/V
Reverse grid current, $R_{g1} = 100k\Omega$	—	—	0	0.4	—	—	—	μA
Vibration as in group B	—	—	—	300	—	—	—	mV
Sub-group quality level[10]	6.5	—	—	—	—	—	—	
Shock[15]								
V_{h-k} = 100V, No other applied voltages, 500g.								
Post shock tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	—	—	—	30	—	—	—	μA
Mutual conductance	—	—	2.2	—	—	—	—	mA/V
Reverse grid current, $R_{g1} = 100k\Omega$	—	—	0	0.4	—	—	—	μA
Vibration as in group B	—	—	—	300	—	—	—	mV

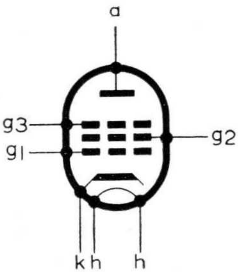
GROUP D

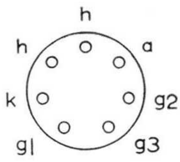
Heater cycling life test								
$V_h = 7.5V$ 1 minute on 4 minutes off								
$V_{h-k} = 135V$. No other applied voltages								
Heater cycling life test end point								
Heater to cathode leakage current $V_{h-k} = \pm 100V$	—	—	—	20	—	—	—	μA
Stability life test[14]								
Running conditions. $R_{g1} = 100k\Omega$, $R_k = 130\Omega$, $V_{a-e} = 180V$, $V_{g2-e} = 125V$, $V_{g1-e} = 0V$, $V_{h-k} = 135V$, $T_{ambient}$ = Room temperature.								
Stability life test end points								
Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%
Intermittent life test								
Running conditions. $R_{g1} = 100k\Omega$, $R_k = 130\Omega$, $V_{a-e} = 180V$, $V_{g2-e} = 125V$, $V_{g1-e} = 0V$, $V_{h-k} = 135V$, T_{bulb} min. = 165°C.								

Intermittent life test end points

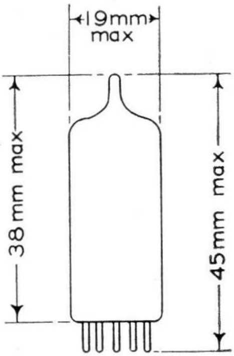
		A.Q.L.[5] (%)	Min.	Max.	
Inoperatives[6]	500 hours	—	—	—	
	1000 hours	—	—	—	
Heater current	500 hours	4.0	160	190	mA
	1000 hours	6.5	160	190	mA
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	500 hours	4.0	—	10	μA
	1000 hours	6.5	—	10	μA
Reverse grid current, $R_{g1} = 100k\Omega$	500 hours	4.0	0	0.1	μA
	1000 hours	6.5	0	0.1	μA
Change in mutual conductance (individuals)	500 hours	4.0	—	20	%
	1000 hours	6.5	—	25	%
Change in mutual conductance, $V_h = 5.7V$	500 hours	6.5	—	15	%
Insulation as in group B	500 hours	6.5	50	—	MΩ
Average change in mutual conductance	500 hours	—	—	15	%
Sub-group quality level[10]	500 hours	10	—	—	
	1000 hours	15	—	—	

4491

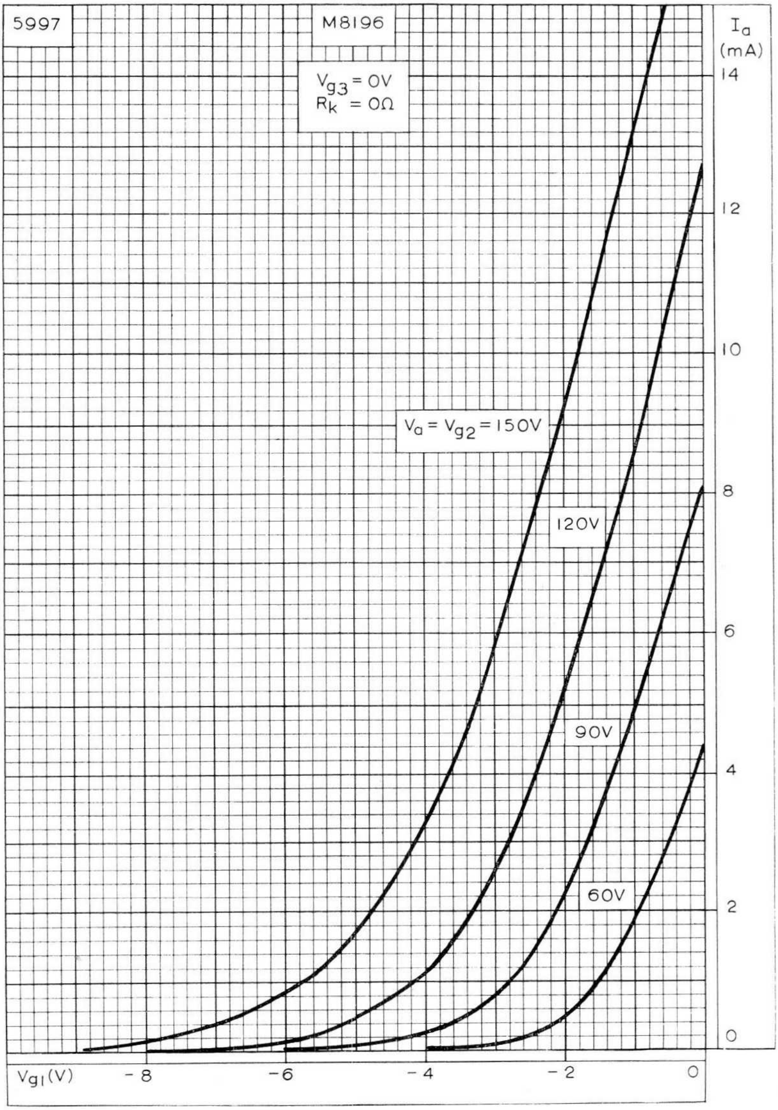




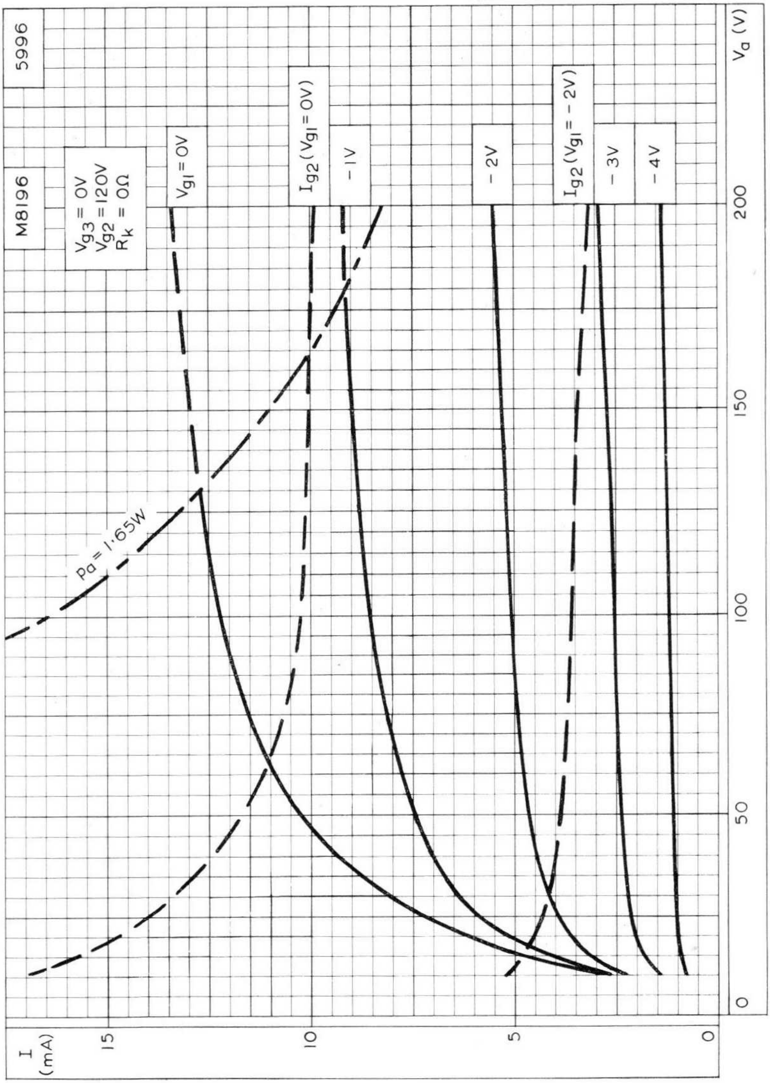
B7G Base



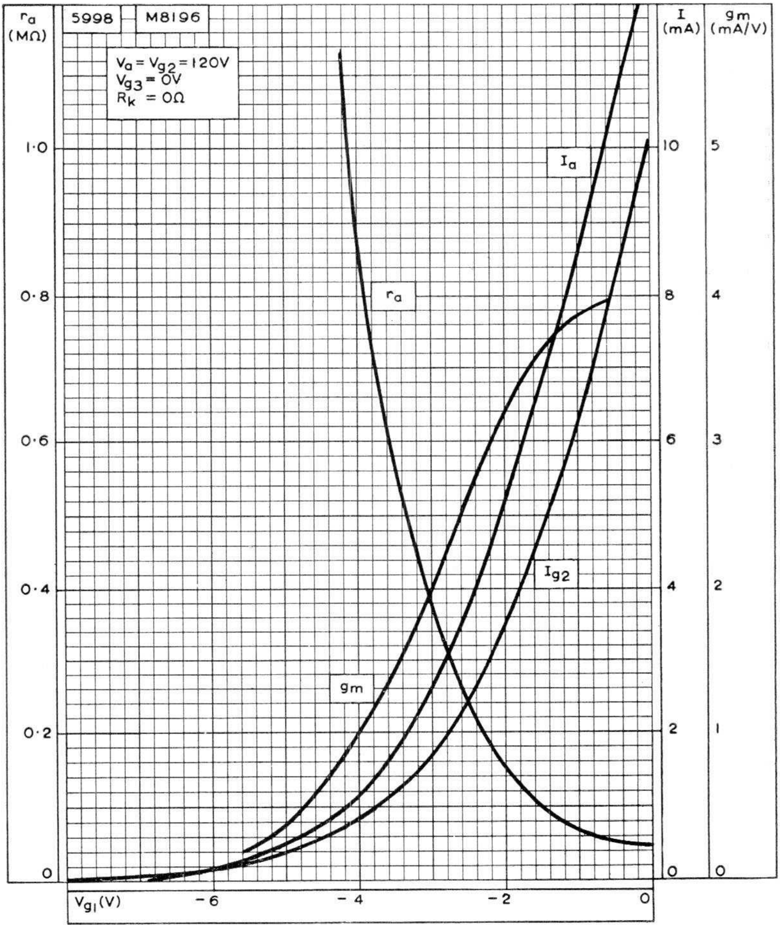
The bulb and base dimensions of this valve are in accordance with BS448, Section B7G.



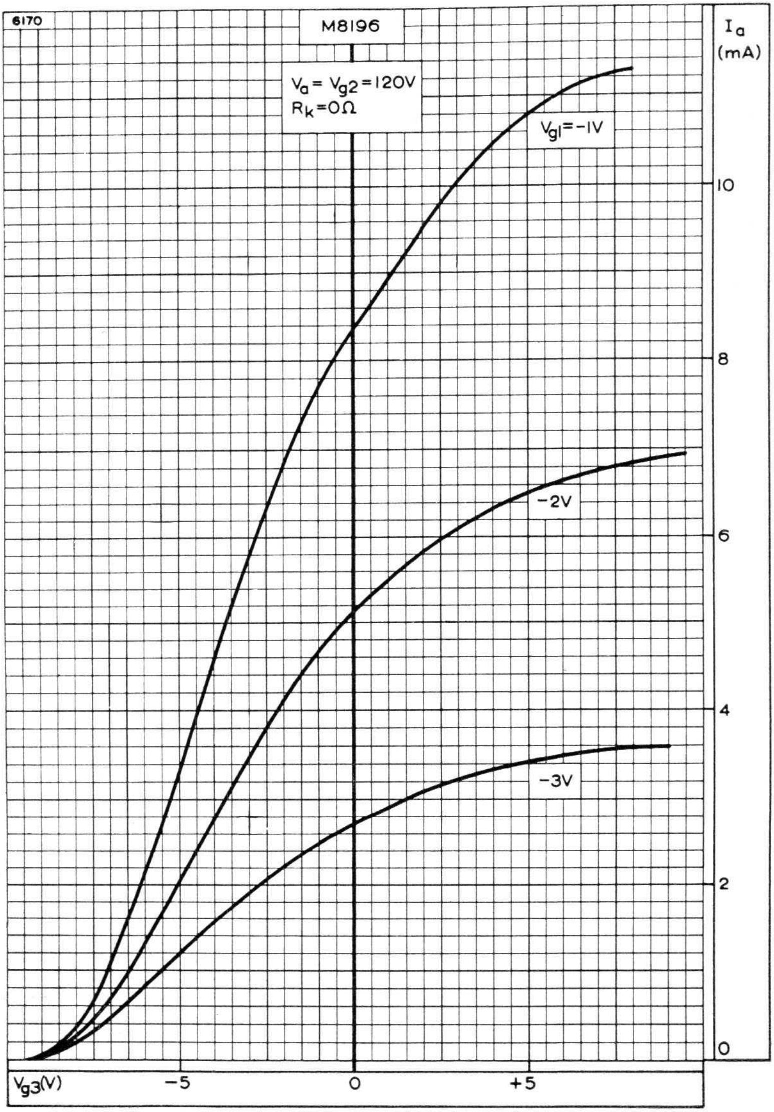
ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE AND SCREEN-GRID VOLTAGES AS PARAMETER



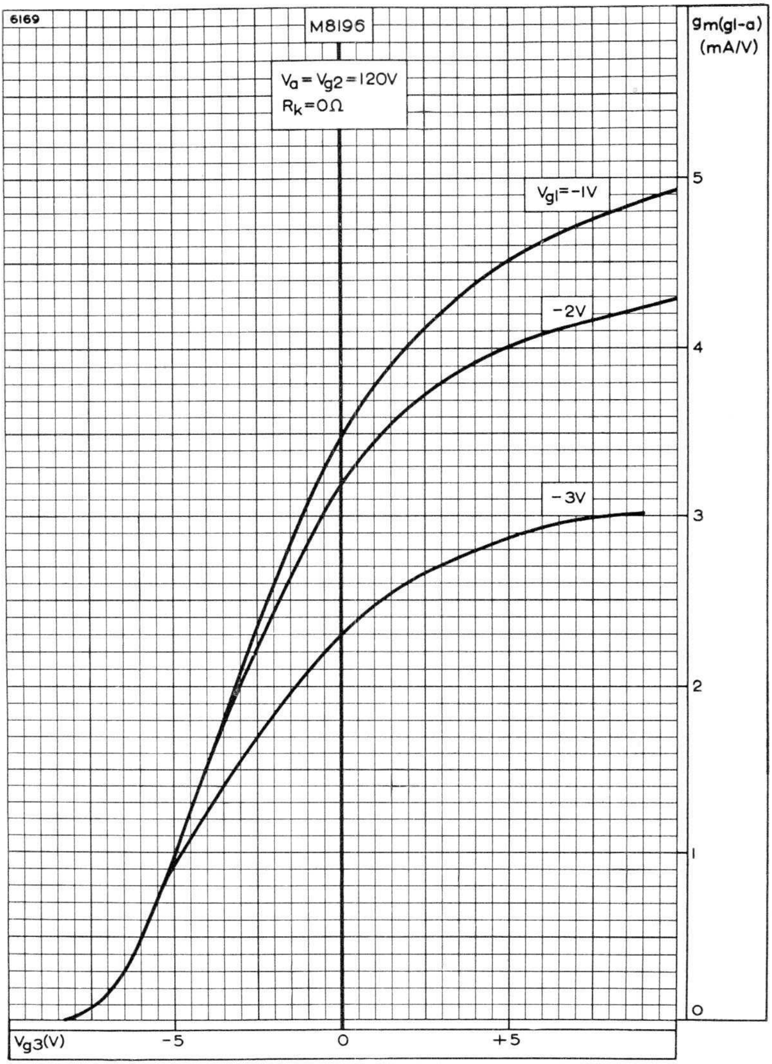
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



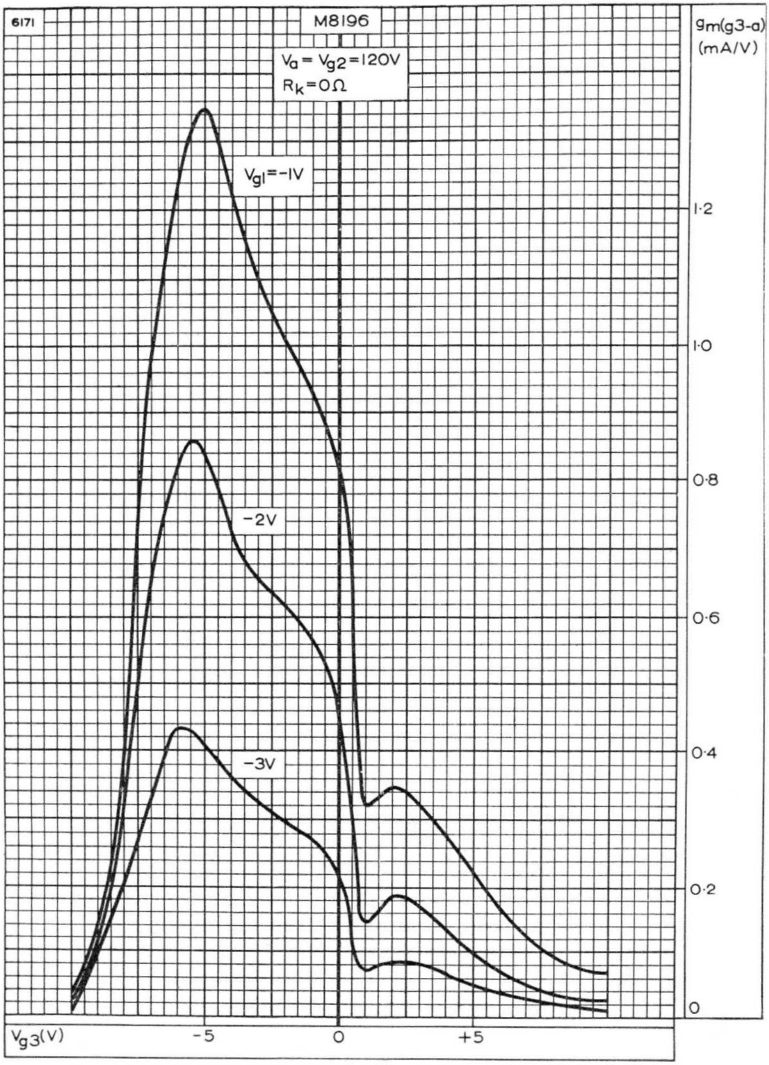
ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE



ANODE CURRENT PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



MUTUAL CONDUCTANCE (g_{1-a}) PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



MUTUAL CONDUCTANCE (g_{3-a}) PLOTTED AGAINST SUPPRESSOR-GRID VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER

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 VALVES 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[4] (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

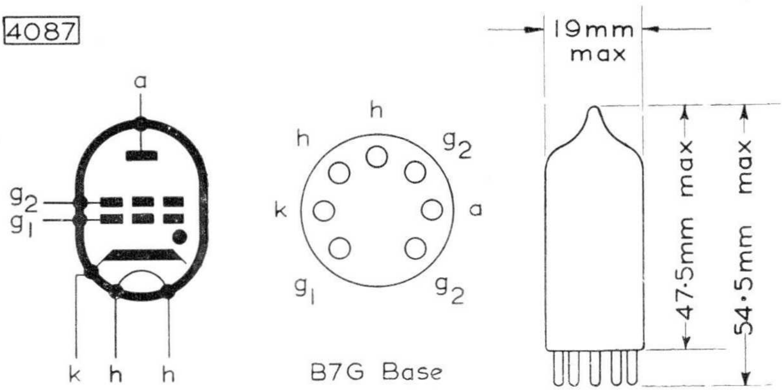
SPECIAL QUALITY TETRODE THYRATRON

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.

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.

4087



The bulb and base dimensions of this valve are in accordance with BS 448, Section B7G

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.

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_{g2} (V)
6.3	0

TESTS GROUP A	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] 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,	{0.65	−3.7	−2.9	−5.6	—	—	V
R_a = 3.0kΩ		—	—	—	−3.4	−4.9	V
*Grid 1 voltage V_a = 460V r.m.s., R_{g1} = 10MΩ, R_a = 3.0kΩ	0.65	−4.2	—	−5.2	—	—	V
*Anode voltage V_{g1} = 0V, R_{g1} = 100kΩ, R_a = 1.0kΩ	{0.65	22	—	30	—	—	V
		—	—	—	—	30	V
Anode voltage V_h = 0V, V_{g1} = −100V, R_a = 1.0kΩ							
No breakdown must occur	0.65	—	650	—	—	—	V
Operation. i_{load} $V_{a(b)}$ = 500V, $v_{a(pk)}$ = 1.0kV,							
$v_{g1(pk)}$ = 100V, V_{g1} = −50V, R_{g1} = 10kΩ,							
R_{g2} = 25kΩ							
P.R.F. = 500p/s, 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.	0.65	—	16	—	—	—	A

M8204

SPECIAL QUALITY TETRODE THYRATRON

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.

	A.Q.L[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] 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 = 0.5μs max. Pulse fall time = 1.0μs max. P.R.F. = 100±5p/s. Pulse applied across valve and 10Ω resistor in series. Voltage measured across valve	0.65	—	—	76	—	—	V
		—	—	—	—	65	V
Group quality level[10]	1.0	—	—	—	—	—	
*Adjust voltage to initiate conduction							
GROUP B							
Inoperatives[16]	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

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.

GROUP D

Shock[15]

No applied voltages, 750g.

Post shock tests

Heater to cathode leakage current							
V_{h-k} = 25V cathode negative	20	—	—	40	—	—	µA
V_{h-k} = 100V cathode positive		—	—	40	—	—	µA
Anode voltage as in Group A clause 5		—	—	50	—	—	V
Pulse emission as in Group A		—	—	76	—	—	V
Grid voltage as in Group A clause 3		—	−2.9	−4.5	—	—	V

Fatigue[14]

V_h = 6.3V, no other applied voltages, 2.5g acceleration, f = 25±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	20	—	—	40	—	—	µA
V_{h-k} = 100V cathode positive		—	—	40	—	—	µA
Anode voltage as in Group A clause 5		—	—	50	—	—	V
Pulse emission as in Group A		—	—	76	—	—	V
Grid voltage as in Group A clause 3		—	−2.9	−4.5	—	—	V
Glass strain test[11]	2.5	—	—	—	—	—	
Base strain test[12]	6.5	—	—	—	—	—	

M8204

SPECIAL QUALITY TETRODE THYRATRON

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.

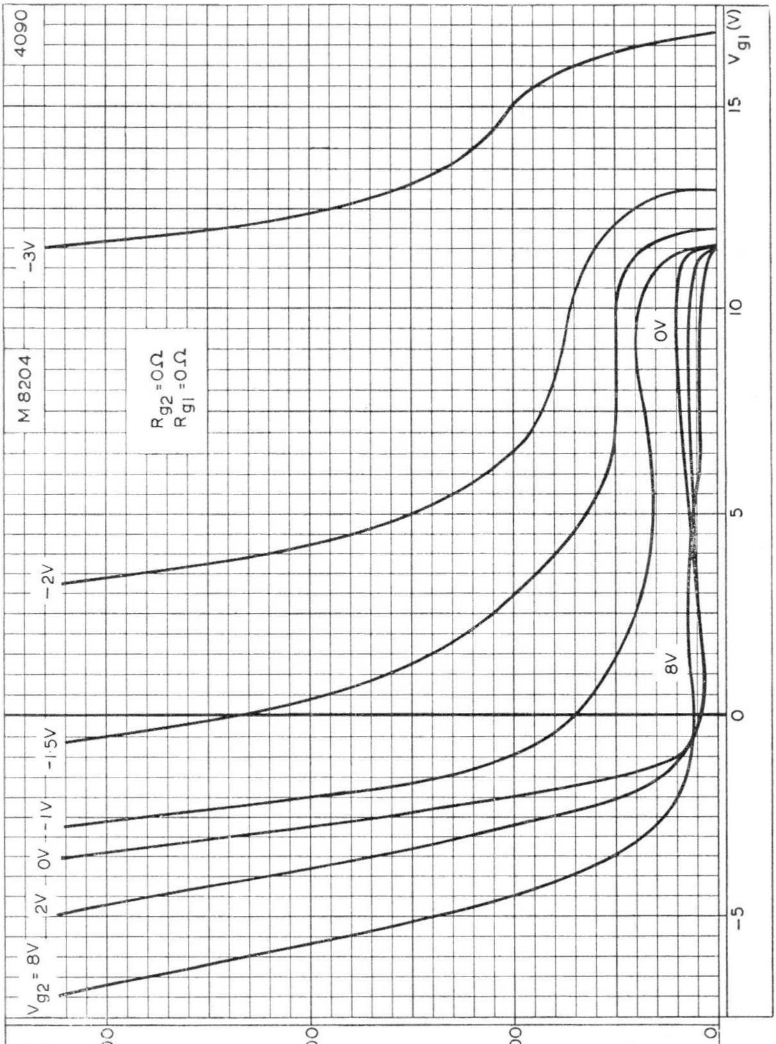
	A.Q.L.[5] (%)	Individuals[6] Min.	Individuals[6] Max.	
GROUP E				
Heater cycling tests $V_h = 7.5V$, 1 minute on, 1 minute off, 2000 cycles. $V_{h-k} = 100V$ cathode positive. No other applied voltages	1.0	—	—	
Heater cycling life test end points				
Heater to cathode leakage current				
$V_{h-k} = 25V$ cathode negative	—	—	20	µA
$V_{h-k} = 100V$ cathode positive	—	—	20	µA
Intermittent life[14]				
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[16]				
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 clause 5	—	—	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[14]				
Adjust $v_{a(pk)}$ for $i_{load} = 20A$ 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. = 1000p/s. Modulator line impedance $Z_o = 12.5\Omega$ Load resistance $= 7.5\Omega$. $t_p = 2 \pm 0.2\mu s$				
Life test end point				
i_{load} average life 180 hours	—	16	—	A
Pulse emission as in Group A	—	—	100	V

Mullard

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.

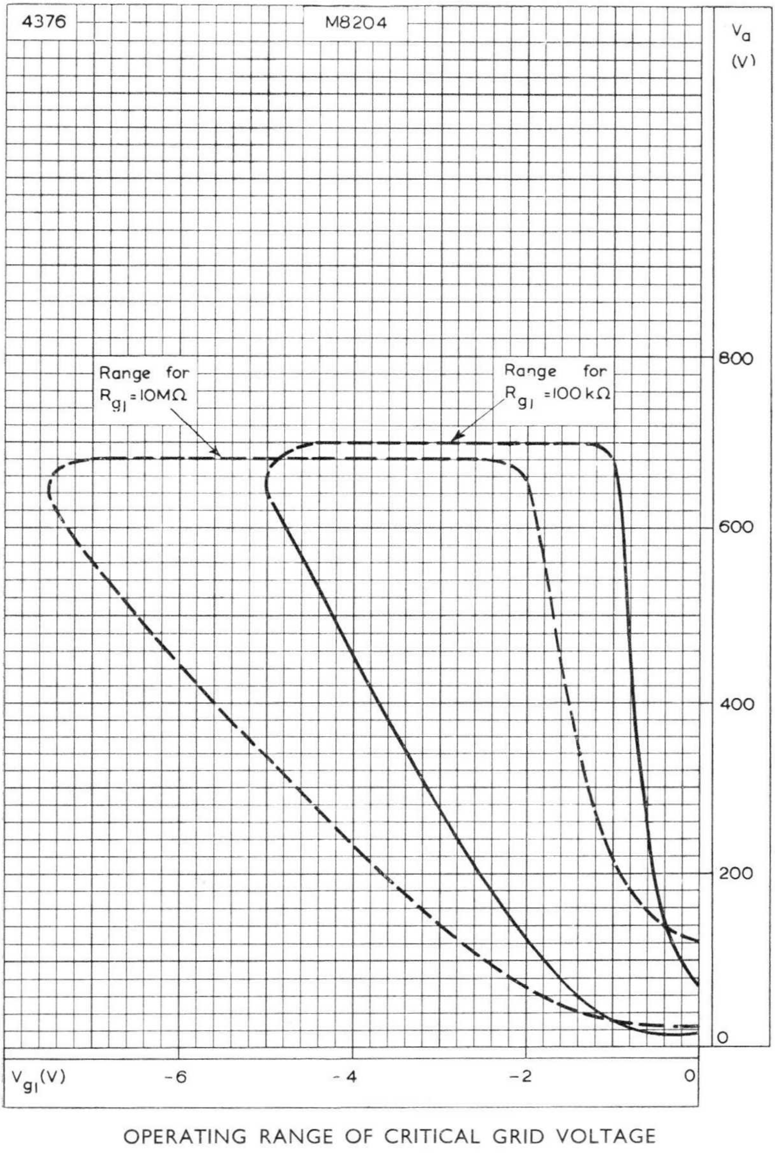


CONTROL CHARACTERISTIC

M8204

SPECIAL QUALITY TETRODE THYRATRON

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.

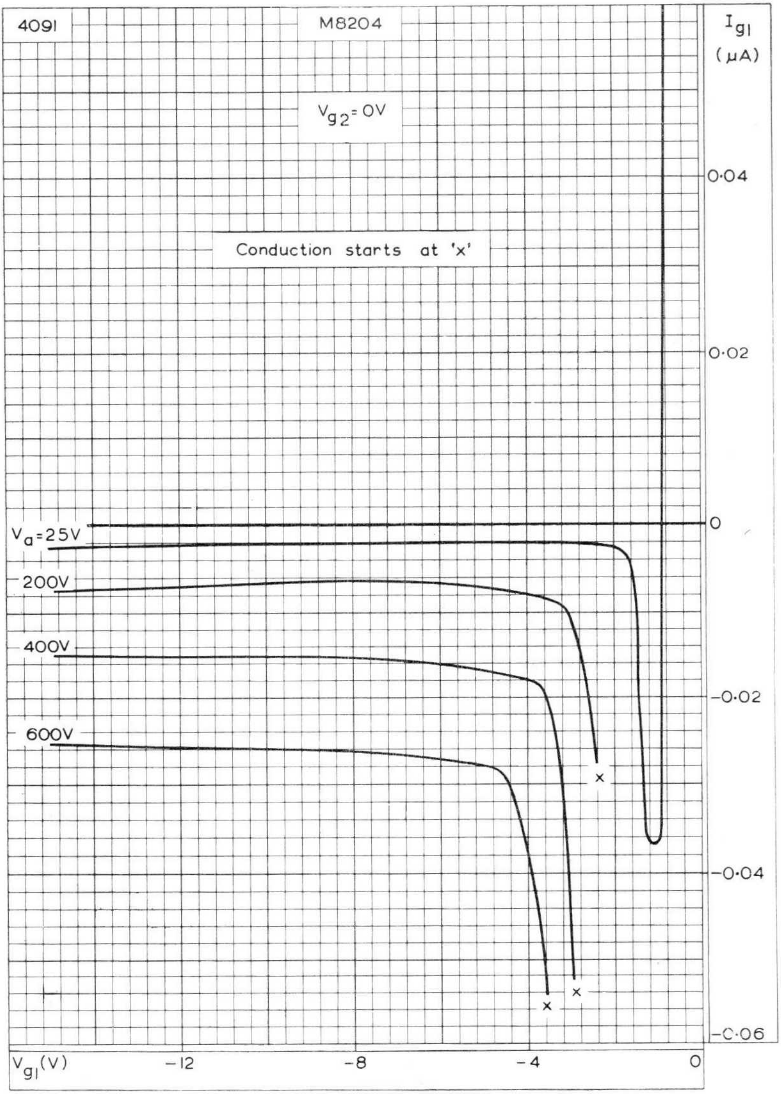


OPERATING RANGE OF CRITICAL GRID VOLTAGE

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.

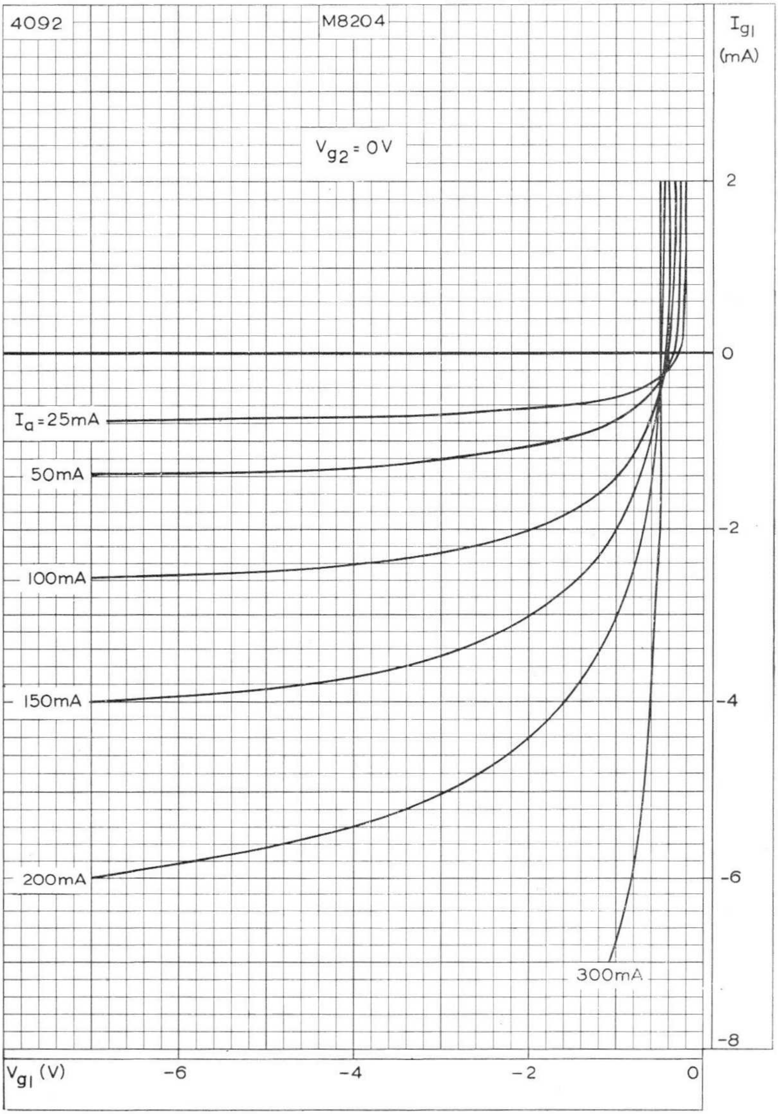


CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE BEFORE CONDUCTION

M8204

SPECIAL QUALITY TETRODE THYRATRON

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.



CONTROL-GRID CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE DURING CONDUCTION

SPECIAL QUALITY DOUBLE DIODE

M8212

Special quality double diode with separate cathodes and internal screening between sections for use in equipment where mechanical vibrations and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

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

V_h[1]	6.3	V
I_h	300	mA

CAPACITANCES[2] (measured with an external shield)

$c_{a'-k'+h+s+S}$	3.2	pF
$c_{a''-k''+h+s+S}$	3.2	pF
$c_{k'-a'+h+s+S}$	3.9	pF
$c_{k''-a''+h+s+S}$	3.9	pF
$c_{a'-a''}$	<26	mpF

LIMITING VALUES[4] (absolute ratings) each section

P.I.V. max.	360	V
I_a max.	10	mA
$i_{a(pk)}$ max.	60	mA
$i_{a(surge)}$ max.	350	mA
V_{h-k} max.	360	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	165	°C

M8212 SPECIAL QUALITY DOUBLE DIODE

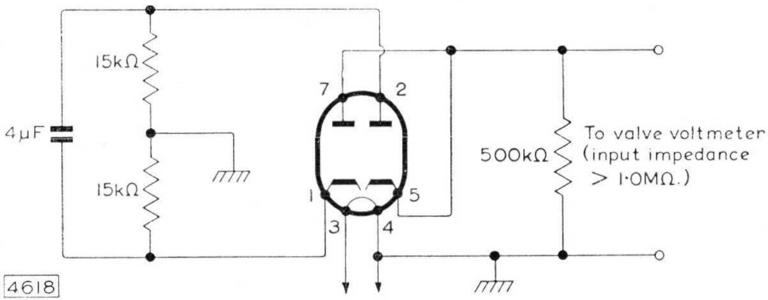
TEST CONDITIONS (unless otherwise specified)

V_h (V)	$V_{a(r.m.s.)}$ (V)	R_{load} (kΩ)	C (μF)
6.3	165	11	8.0

TESTS	*A.Q.L.*[5] (%)	*Individuals*[6] *Bogey*[9]	*Min.*	*Max.*	*Lot average*[7] *Min.*	*Max.*	*Lot standard deviation*[8] *Max.*	
GROUP A								
Insulation								
a-rest, screen-rest measured at –300V	0.25	—	100	—	—	—	—	MΩ
GROUP B								
Heater current	0.65	—	275	325	—	—	—	mA
Heater to cathode leakage current	0.65	—	—	—	—	—	—	
$V_{h-k} = 100V$ (cathode negative)	—	—	—	5.0	—	—	—	μA
$V_{h-k} = 100V$ (cathode positive)	—	—	—	5.0	—	—	—	μA
Output current	0.65	18	16	—	—	—	—	mA
Emission $V_a = 10V$	0.65	—	40	—	—	—	—	mA
Group quality level[10]	1.0	—	—	—	—	—	—	

GROUP C

Anode current. $V_a = 0V$, $R_a = 40k\Omega$	2.5	—	2.0	20	—	—	—	µA
Anode current difference between sections $V_a = 0V$, $R_a = 40k\Omega$	2.5	—	—	5.0	—	—	—	µA
Change in emission $V_h = 5.7V$, $V_a = 7.0V$	2.5	—	—	15	—	—	—	%
Hum $V_h = 7.0V$ Tested in circuit shown below	2.5	—	—	10	—	—	—	mV (r.m.s.)
Group quality level[10]	6.5	—	—	—	—	—	—	



GROUP D

Glass strain test[11A]. No applied voltages	6.5	—	—	—	—	—	—	
Base strain test[12]. No applied voltages	6.5	—	—	—	—	—	—	
Capacitances (shielded). No applied voltages	6.5	—	—	—	—	—	—	
$c_{a'-a''}$	—	—	—	26	—	—	—	mpF
$c_{a'-k'+h+s+S}$	—	—	2.4	4.0	—	—	—	pF
$c_{a''-k''+h+s+S}$	—	—	2.4	4.0	—	—	—	pF
$c_{k'-a'+h+s+S}$	—	—	2.5	5.0	—	—	—	pF←
$c_{k''-a''+h+s+S}$	—	—	2.5	5.0	—	—	—	pF←

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP E								
Fatigue[14]								
V_h = 6.9V, 1 minute on 3 minutes off. No other voltages applied, 5g min. peak acceleration, f = 170c/s for 33 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	15	—	—	—	μA
Output current	2.5	—	14	—	—	—	—	mA
Shock[15]								
No applied voltages, 500g								
Post shock tests								
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	2.5	—	—	15	—	—	—	μA
Output current	2.5	—	14	—	—	—	—	mA
Group quality level[10]	6.5	—	—	—	—	—	—	

GROUP F

Intermittent life test

The valve is connected in a full wave rectifier circuit with a load resistor of 11kΩ and a reservoir capacitor of 8μF. The supply impedance is adjusted so that the peak anode current is not less than 60mA for a nominal valve, the total output current being approximately 18mA.

The cathode to heater voltage is provided by the output voltage in series with 117Vr.m.s.

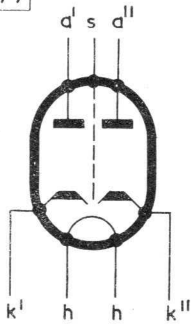
		A.Q.L.[5] (%)	Min.	Max.	
Intermittent life test end points					
Sub-group (a)					
Inoperatives[16]	500 hours	2.5	—	—	
	1000 hours	4.0	—	—	
Heater current	500 hours	2.5	275	325	mA
	1000 hours	4.0	275	325	mA
Heater to cathode leakage current. $V_{h-k} = \pm 100V$	500 hours	2.5	—	10	μA
	1000 hours	4.0	—	10	μA
Emission $V_a = 10V$	500 hours	2.5	35	—	mA
	1000 hours	6.5	30	—	mA
Sub-group (b)					
Change in emission $V_h = 5.7V$, $V_a = 7.0V$	500 hours	4.0	—	20	%
Anode current $V_a = 0V$, $R_a = 40k\Omega$	500 hours	4.0	1.0	20	μA
Insulation as in group A	500 hours	4.0	50	—	MΩ
	1000 hours	6.5	50	—	MΩ
Group quality level[10]	500 hours	6.5	—	—	
	1000 hours	10	—	—	

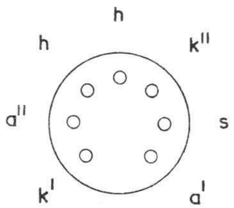
GROUP G

	A.Q.L. (%)	Min.	Max.
Valves are held for 28 days and retested for Inoperatives[16]	0.5	—	—

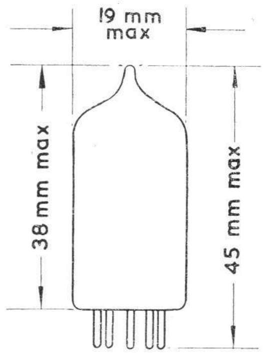
M8212 SPECIAL QUALITY DOUBLE DIODE

3577

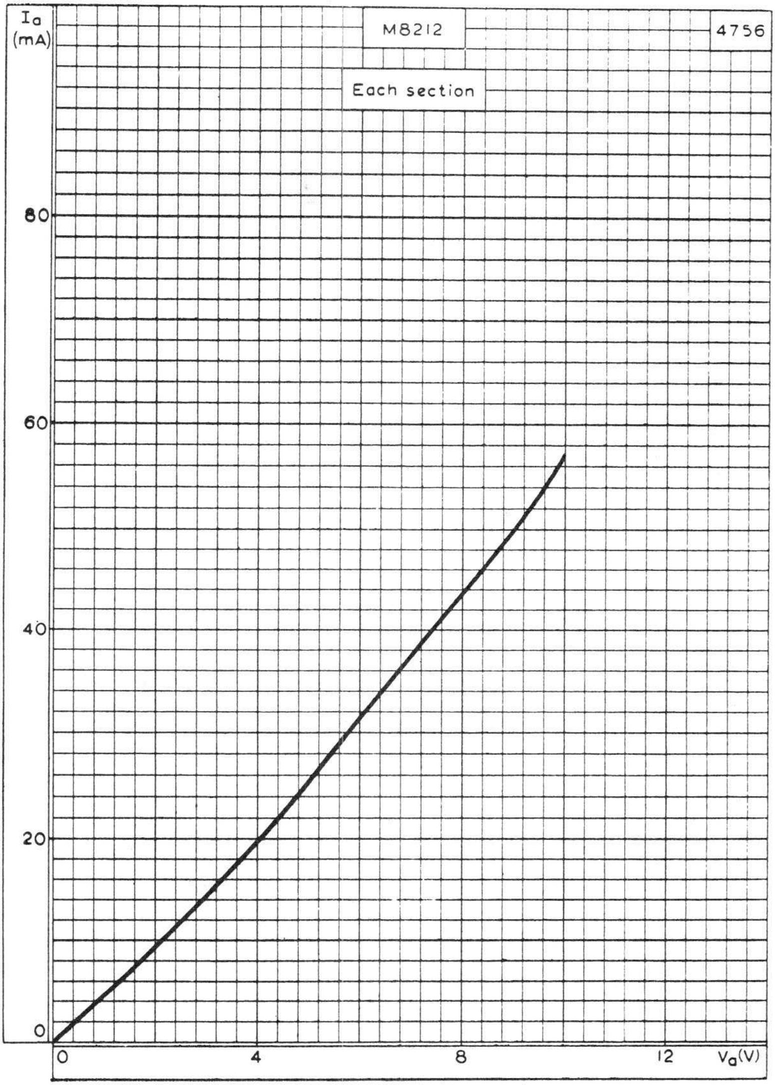




B7G Base



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



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE

SPECIAL QUALITY R.F. PENTODE

5840

Special quality r.f. pentode for use in equipment where high ambient temperatures, mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	150	mA

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.

CAPACITANCES[2] (measured with external shield)

c_{a-g1}	$<$15	mpF
c_{in}	4.2	pF
c_{out}	3.4	pF

CHARACTERISTICS[3]

V_a	100	V
V_{g2}	100	V
V_{g1}	−1.5	V
I_a	7.5	mA
I_{g2}	2.4	mA
g_m	5.0	mA/V
r_a	$>$175	kΩ
R_k	0	Ω
V_{g1} ($I_a < 50\mu A$)	−9.0	V

LIMITING VALUES[4] (absolute ratings)

V_h max.	6.6	V
V_h min.	6.0	V
$V_{a(b)}$ max.	330	V
V_a max.	165	V
p_a max.	800	mW
$V_{g2(b)}$ max.	310	V
V_{g2} max.	155	V
p_{g2} max.	350	mW
$+V_{g1}$ max.	0	V ←
$-V_{g1}$ max.	55	V
I_k max.	16.5	mA
R_{g1-k} max.	1.1	MΩ
V_{h-k} max.	200	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	220	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_{a-e} (V)	V_{g2-e} (V)	V_{g1-e} (V)	R_k (Ω)	C_k (μF)
6.3	100	100	0	150	1000

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP A								
Heater current	0.65	150	140	160	—	—	—	mA
	—	—	—	—	144	156	4.2	mA
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	0.65	—	—	5.0	—	—	—	μA
Reverse grid current $R_{g1} = 1.0M\Omega$	0.65	—	0	0.3	—	—	—	μA
Anode current	0.65	7.5	5.5	9.5	—	—	—	mA
	—	—	—	—	6.7	8.3	0.8	mA
Anode current $V_{g1} = -9.0V$, $R_k = 0\Omega$	0.65	—	—	50	—	—	—	μA
Screen-grid current	0.65	—	1.5	3.3	—	—	—	mA
Mutual conductance	0.65	5.0	4.2	5.8	—	—	—	mA/V
	—	—	—	—	4.7	5.3	0.31	mA/V
Sub-group quality level[10]	1.0	—	—	—	—	—	—	
Inoperatives[16]	0.4	—	—	—	—	—	—	

GROUP B

Insulation								
a-rest, measured at –300V	2.5	—	100	—	—	—	—	MΩ
g_1-rest, measured at –100V	2.5	—	100	—	—	—	—	MΩ
Change in mutual conductance $V_h = 5.7V$	2.5	—	—	10	—	—	—	%
Reverse grid current $V_h = 7.5V$, $V_{g1} = -9.0V$, $R_{g1} = 1.0M\Omega$, $R_k = 0\Omega$. Measured after 5 minutes preheat under standard test conditions, except $V_h = 7.5V$, $R_{g1} = 1.0M\Omega$	2.5	—	0	0.5	—	—	—	µA
†A.F. noise at anode, $V_{g2-e} = 19V$, $R_{g1} = 100k\Omega$, $R_{g2} = 1.0k\Omega$, $R_a = 200k\Omega$, $C_k = 1000\mu F$	2.5	—	—	70	—	—	—	mV
Anode impedance	6.5	—	175	—	—	—	—	kΩ
Capacitances[2] (shielded). No applied voltages	6.5	—	—	—	—	—	—	
c_{in}	—	—	3.5	4.9	—	—	—	pF
c_{out}	—	—	2.9	3.9	—	—	—	pF
c_{a-g1}	—	—	—	15	—	—	—	mpF
Low pressure voltage breakdown Pressure = 55±5mm Hg Voltage = $300V_{r.m.s.}$ No other applied voltages	6.5	—	—	—	—	—	—	
Microphonic noise at the anode at 50c/s, 15g min peak acceleration, $R_a = 10k\Omega$	—	—	—	60	—	—	—	mV (r.m.s.)

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

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP C								
Lead fragility test[13B]. 4 arcs	2.5	—	—	—	—	—	—	
Fatigue[14]								
$V_h = 6.3V$. No other voltages applied. 2.5g min. peak acceleration, fixed frequency f = 25c/s min 60c/s max. for 32 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	6.5	—	—	20	—	—	—	μA
Change in mutual conductance	6.5	—	—	20	—	—	—	%
Microphonic noise as in group B	6.5	—	—	200	—	—	—	mV (r.m.s.)
Shock[15]								
$V_{h-k} = 100V$ (cathode negative) $R_{g1} = 100k\Omega$, 500g								
Post shock tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	20	—	—	20	—	—	—	μA
Change in mutual conductance	20	—	—	20	—	—	—	%
Microphonic noise as in group B	20	—	—	200	—	—	—	mV (r.m.s.)
Glass strain test[11B]. No applied voltages	6.5	—	—	—	—	—	—	

GROUP D

Heater cycling life test								
$V_h = 7.0V$. 1 minute on, 4 minutes off, 2000 switchings. $V_{h-k} = 140V_{r.m.s.}$ (continuous)								
No other applied voltages	2.5	—	—	—	—	—	—	
Stability life[14]								
Running conditions: $R_{g1} = 1.0M\Omega$, $V_{h-k} = 200V$ (cathode negative), $T_{ambient}$ = Room temperature								
Stability life end points								
Change in mutual conductance after 1 hour	1.0	—	—	10	—	—	—	%
Survival rate life test[14]								
Running conditions $R_{g1} = 1.0M\Omega$, $V_{h-k} = 200V$ (cathode negative), $T_{ambient}$ = Room temperature								
Survival rate life test end points (100 hours)								
Inoperatives[16]	0.65	—	—	—	—	—	—	
Mutual conductance	1.0	—	3.75	—	—	—	—	mA/V

Intermittent life test

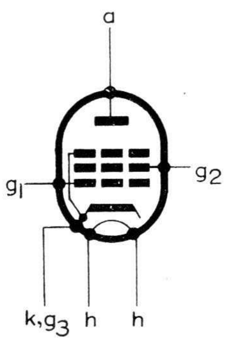
Running conditions: $R_{g1} = 1.0M\Omega$,
$V_{h-k} = 200V$ (cathode negative),
T_{bulb} min = 220°C

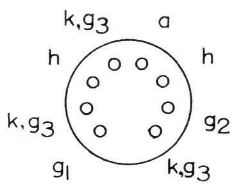
Intermittent life test end points (500 hours)	*A.Q.L.*[5] (%)	*Min.*	*Max.*	
Inoperatives[16]	2.5	—	—	
Heater current	4.0	138	164	mA
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	4.0	—	10	µA
Reverse grid current $R_{g1} = 1.0M\Omega$	2.5	0	0.8	µA
Change in mutual conductance (individuals)	2.5	—	20	%
Change in mutual conductance $V_h = 5.7V$	4.0	—	15	%
Insulation as in group B	4.0	50	—	MΩ
Average change in mutual conductance	—	—	15	%
Sub-group quality level[10]	10	—	—	

5840

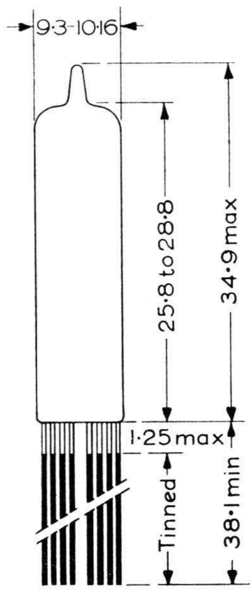
SPECIAL QUALITY R.F. PENTODE

5494



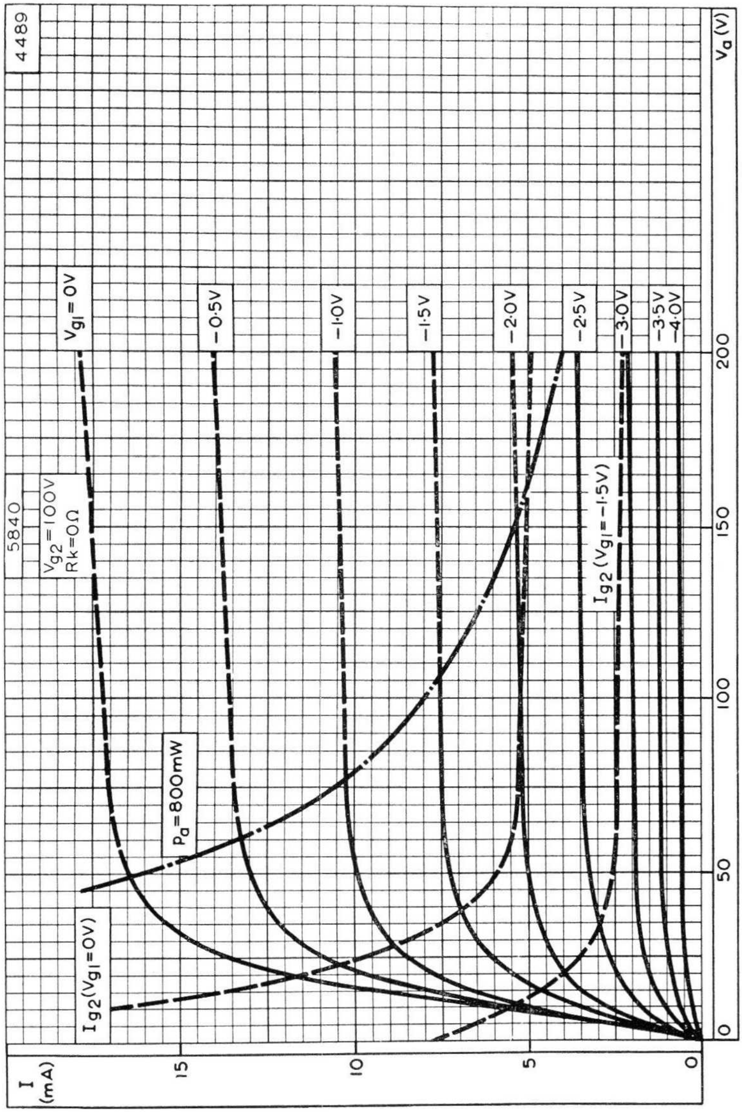


B8D/F Base

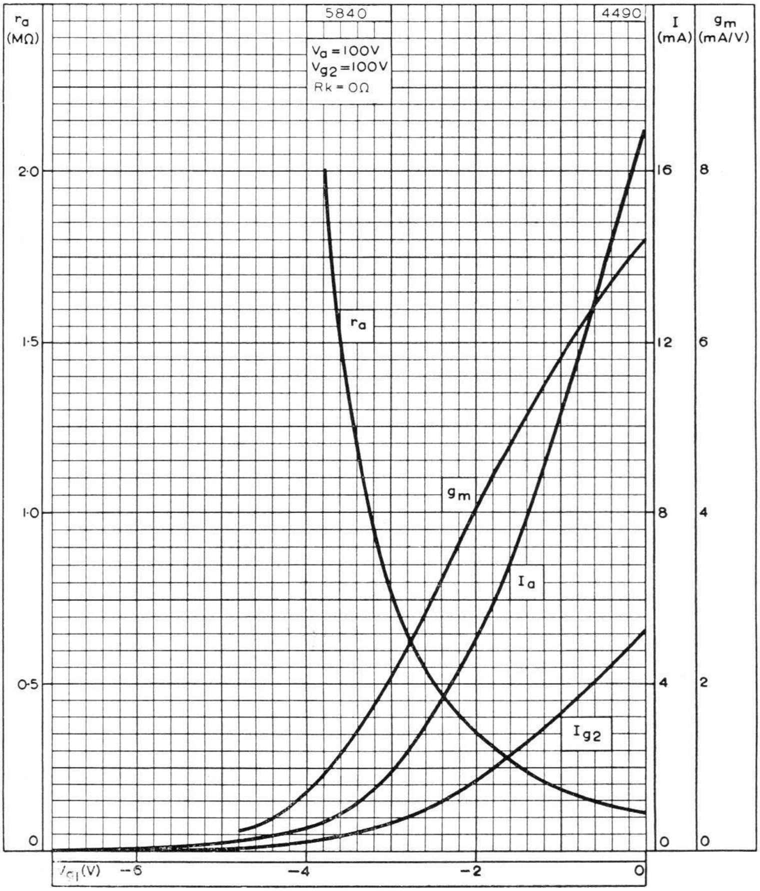


All dimensions in mm

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



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER



ANODE AND SCREEN-GRID CURRENTS, MUTUAL CONDUCTANCE AND ANODE IMPEDANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE

SPECIAL QUALITY DOUBLE TRIODE

6021

Special quality subminiature medium-μ double triode for use in equipment where high ambient temperatures, mechanical vibration and shocks are unavoidable and where statistically controlled major electrical characteristics are required.

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

HEATER

V_h[1]	6.3	V
I_h	300	mA

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.

CAPACITANCES[2] (measured without an external shield)

$c_{a'-a''}$	<520	mpF
*c_{a-g}	1.6	pF
$c_{g'-g''}$	<15	mpF
*c_{in}	2.4	pF
$c_{out'}$	300	mpF
$c_{out''}$	350	mpF

*Each section

CHARACTERISTICS[3] (each section)

V_a	100	V
V_g	−1.0	V
I_a	6.5	mA
g_m	5.4	mA/V
r_a	6.5	kΩ
μ	35	
R_k	0	Ω
V_g (I_a < 100μA)	−6.5	V

LIMITING VALUES[4] (absolute ratings) each section

V_h max.	6.6	V
V_h min.	6.0	V
$V_{a(b)}$ max.	330	V
V_a max.	165	V
p_a max.	700	mW
I_a max.	22	mA
$+V_g$ max.	0	V ←
$-V_g$ max.	55	V
I_g max.	5.5	mA
R_{g-k} max.	1.1	MΩ
V_{h-k} max.	200	V
Maximum acceleration (continuous operation)	2.5	g
Maximum shock (short duration)	500	g
T_{bulb} max.	220	°C

TEST CONDITIONS (unless otherwise specified)

V_h (V)	V_{a-e} (V)	V_{g-e} (V)	R_k (Ω)	C_k (μF)	V_{h-k} (V)
6.3	100	0	150	1000	0

TESTS The measurements apply to each section unless otherwise stated.

GROUP A

	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
Heater current	0.65	300	280	320	—	—	—	mA
	—	—	—	—	288	312	8.4	mA
Heater-to-cathode leakage current. $V_{h-k} = \pm 100V$	0.65	—	—	5.0	—	—	—	μA
Reverse grid current. $R_g = 1.0M\Omega$, $R_k = 300\Omega$, $V_{a-e} = 150V$	0.65	—	0	0.3	—	—	—	μA
Anode current	0.65	6.5	4.5	8.5	—	—	—	mA
	—	—	—	—	5.6	7.3	0.8	mA
Anode current. $V_g = -6.5V$, $R_k = 0\Omega$	0.65	—	—	100	—	—	—	μA
Mutual conductance	0.65	5.4	4.45	6.35	—	—	—	mA/V
	—	—	—	—	5.0	5.8	0.38	mA/V
Sub-group quality level[10]	1.0	—	—	—	—	—	—	
Inoperatives[16]	0.4	—	—	—	—	—	—	

GROUP B

Insulation									
a-rest, measured at −300V	2.5	—	100	—	—	—	—	—	MΩ
g-rest, measured at −100V	2.5	—	100	—	—	—	—	—	MΩ
Change in mutual conductance. $V_h = 5.7V$	2.5	—	—	15	—	—	—	—	%
Reverse grid current. $V_h = 7.5V$, $V_g = -7.5V$, $V_a = 150V$, $R_g = 1.0M\Omega$, $R_k = 0\Omega$. Measured after 5 minutes preheat under these conditions but $R_k = 500\Omega$, $V_{g-e} = 0V$	2.5	—	0	0.5	—	—	—	—	μA
†A.F. noise at anode, both sections connected in parallel $R_g = 100k\Omega$, $R_a = 10k\Omega$, $R_k = 75\Omega$	2.5	—	—	65	—	—	—	—	mV
Anode current difference between sections	2.5	—	—	1.6	—	—	—	—	mA
Capacitances[2] (unshielded). No applied voltages	6.5	—	—	—	—	—	—	—	
*c_{in}	—	—	1.8	3.0	—	—	—	—	pF
$c_{out'}$	—	—	200	360	—	—	—	—	mpF
$c_{out''}$	—	—	220	420	—	—	—	—	mpF
*c_{a-g}	—	—	1.2	1.8	—	—	—	—	pF
$c_{a'-a''}$	—	—	—	520	—	—	—	—	mpF
$c_{g'-g''}$	—	—	—	13	—	—	—	—	mpF
*Each section									
Low pressure voltage breakdown Pressure = 55±5mmHg, Voltage = $300V_{r.m.s.}$ No other applied voltages	6.5	—	—	—	—	—	—		
Microphonic noise at the anode at 50c/s, 15g min. peak acceleration, $R_a = 10k\Omega$	2.5	—	—	50	—	—	—	—	mV (r.m.s.)
Pulse, cathode current $V_h = 6.0V$, $V_{a+g(pulse)} = 50V$, $t_p = 25\mu s$, p.r.f. = 200p.p.s.	6.5	—	300	—	—	—	—	—	mA
Amplification factor	6.5	—	30	40	—	—	—	—	

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

TESTS	A.Q.L.[5] (%)	Individuals[6] Bogey[9]	Individuals[6] Min.	Individuals[6] Max.	Lot average[7] Min.	Lot average[7] Max.	Lot standard deviation[8] Max.	
GROUP C								
Lead fragility test[13B]. 4 arcs	2.5	—	—	—	—	—	—	
Fatigue[14]								
V_h = 6.3V. No other voltages applied. 2.5g min. peak acceleration, fixed frequency f = 25c/s min. 60c/s max for 32 hours in each of 3 mutually perpendicular planes								
Post fatigue tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	6.5	—	—	20	—	—	—	μA
Change in mutual conductance	6.5	—	—	20	—	—	—	%
Microphonic noise as in group B	6.5	—	—	200	—	—	—	mV
Shock[15]								
V_{h-k} = 100V (cathode negative), R_g = 100kΩ, 500g								
Post shock tests								
Heater-to-cathode leakage current $V_{h-k} = \pm 100V$	20	—	—	20	—	—	—	μA
Change in mutual conductance	20	—	—	20	—	—	—	%
Microphonic noise as in group B	20	—	—	200	—	—	—	mV
Glass strain test[11B]. No applied voltages	6.5	—	—	—	—	—	—	

GROUP D

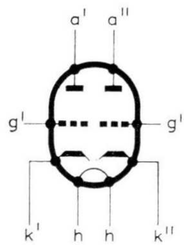
Heater cycling life test								
$V_h = 7.0V$, 1 minute on, 4 minutes off. $V_{h-k} = 140V_{r.m.s.}$ (continuous). No other applied voltages	2.5	—	—	—	—	—	—	
Stability life test[14]								
Running conditions: $R_g = 1.0M\Omega$, $V_{h-k} = 200V$ (cathode negative), $T_{ambient}$ = Room temperature								
Stability life test end point								
Change in mutual conductance after 1 hour	1.0	—	—	15	—	—	—	%
Survival rate life test[14]								
Running conditions $R_g = 1.0M\Omega$, $V_{h-k} = 200V$ (cathode negative), $T_{ambient}$ = Room temperature								
Survival rate life test end points (100 hours)								
Inoperatives[16]	0.65	—	—	—	—	—	—	
Mutual conductance	1.0	—	4.0	—	—	—	—	mA/V

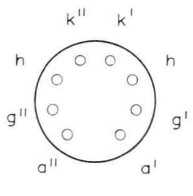
Intermittent life test

Running conditions: $R_g = 1.0M\Omega$, $V_{h-k} = 200V$ (cathode negative), T_{bulb} min = 220°C

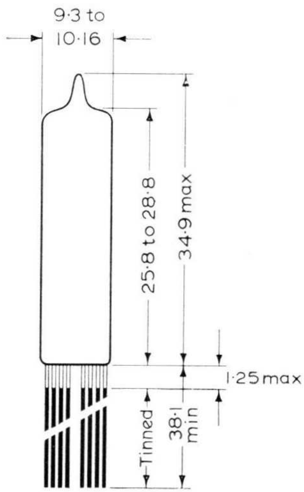
Intermittent life test end points (500 hours)	*A.Q.L.*[5] (%)	*Min.*	*Max.*	
Inoperatives[16]	2.5	—	—	
Heater current	4.0	276	328	mA
Heater-to-cathode leakage current. $V_{h-k} = \pm 100V$	4.0	—	10	µA
Reverse grid current. $R_g = 1.0M\Omega$	2.5	0	0.9	µA
Change in mutual conductance (individuals)	2.5	—	25	%
Change in mutual conductance, $V_h = 5.7V$	4.0	—	15	%
Insulation as in group B	4.0	50	—	MΩ
Average change in mutual conductance	—	—	15	%
Sub-group quality level[10]	10	—	—	

6021 SPECIAL QUALITY DOUBLE TRIODE





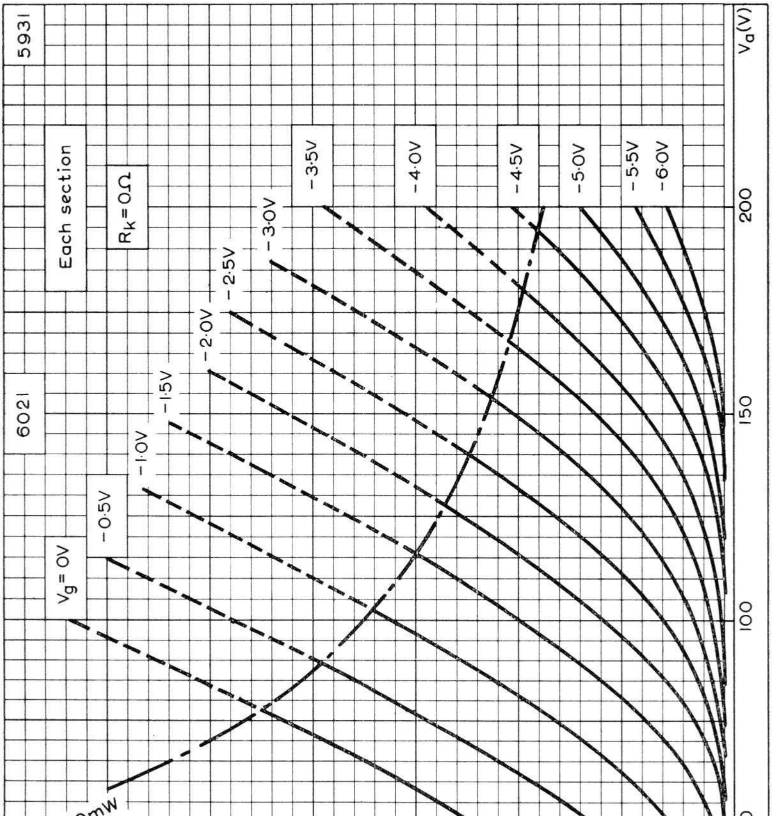
B8D/F Base



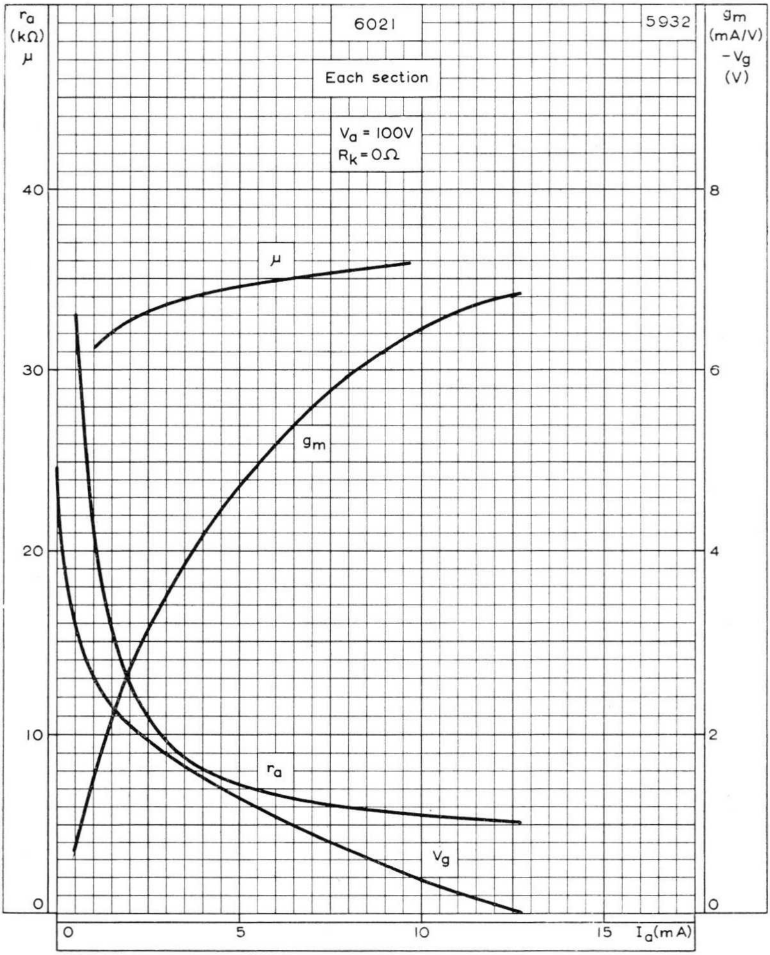
8184

All dimensions in mm

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



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER FOR EACH SECTION



ANODE IMPEDANCE, MUTUAL CONDUCTANCE, GRID VOLTAGE AND AMPLIFICATION FACTOR PLOTTED AGAINST ANODE CURRENT FOR EACH SECTION

TELEVISION
PICTURE TUBES

PICTURE TUBE NOMENCLATURE

TYPE NUMBER SYSTEM

Mullard cathode ray tubes are registered by Pro-Electron. The type number consists of a single letter followed by two sets of figures and ending with a letter.

The first letter indicates the prime application of the tube:—
A—Television picture tube for domestic application.

The first group of figures indicates the diameter or diagonal of the screen in cm.

The second group of figures is a two- or three-figure serial number indicating a particular design or development.

The concluding letter indicates the properties of the phosphor screen:—
W—White screen for television picture tubes
X—Three colour screen for television picture tubes.

Example

A56-120X

A	56	120	X
T.V. Picture Tube for domestic application	Screen Diagonal (56cm)	Serial Number	Three-colour screen

Mullard cathode ray tubes are normally registered with Pro-Electron. The type number consists of a single letter followed by two sets of figures ending with one or two letters.

The first letter indicates the primary application of the tube:

A — television display tube for domestic applications.
D — oscilloscope tube—single trace.
E — oscilloscope tube—multiple trace.
F — radar display tube—direct viewing.
L — display storage tube.
M — professional television or display tube (except radar) —direct viewing.
P — professional display tube—projection.
Q — flying spot scanner.

The first group of figures indicates the diameter or diagonal of the luminescent screen in cm:

Thus 7 represents a 7cm (3in) screen.
13 represents a 13cm (5in) screen.
47 represents a 47cm (19in) screen.
59 represents a 59cm (23in) screen.

The second group of figures is a two- or three-figure serial number indicating a particular design or development.

The second group of letters indicates the properties of the phosphor screen.

The first letter denotes the colour of the fluorescence (or phosphorescence in the case of long or very long afterglow screens) according to the regions of the Kelly Chart of Colour Designations for Lights, where applicable:

A — Reddish-purple, purple, bluish-purple.
B — Purplish-blue, blue, greenish-blue.
D — Blue-green.
G — Bluish-green, green, yellowish-green.
K — Yellow-green.
L — Orange, orange-pink.
R — Reddish-orange, red, pink, purplish-pink, purplish-red, red-purple.
W — White.
X — Tri-colour screen.
Y — Greenish-yellow, yellow, yellowish-orange.

The second letter is a serial letter to denote particular phosphors. For the 'standard' television picture tube phosphors, the letters 'W' and 'X' are used without a second letter. The current Mullard phosphors are listed overleaf.

An **internal graticule** is indicated by a two-figure suffix separated from the final letter by an oblique stroke, for example, D13–45GH/01.

Examples:

A47-26W Domestic television picture tube with 47cm (19in) screen.
D7-19GH Single trace oscilloscope tube having 7cm screen with phosphor 'GH'.

OLD SYSTEM

Some earlier cathode ray tubes have type numbers consisting of two letters followed by two sets of figures.

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 a particular phosphor. Letters in use are listed below.

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

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

Examples:

AW53-88 Cathode ray tube of 53cm screen diagonal having a 'W' phosphor and employing magnetic deflection and electrostatic focusing.

DH3-91 Cathode ray tube of 3cm screen diameter having an 'H' phosphor and employing electrostatic deflection and focusing.

DESIGNATION OF MULLARD PHOSPHORS

Pro-Electron designation	*Old system*	*Fluorescent colour*	*Phosphorescent colour*	*Persistence*	*Equivalent JEDEC designation*
BA	C	Purplish-blue	—	Very short	—
BC	V	Purplish-blue	—	Killed	—
BD	A	Blue	—	Very short	—
BE	B	Blue	Blue	Medium short	P11
BF	U	Blue	—	Medium short	—
GB	M	Purplish-blue	Yellowish-green	Long	P32
GE	K	Green	Green	Short	P24
GH	H	Green	Green	Medium short	P31
GJ	G	Yellowish-green	Yellowish-green	Medium	P1
GK	G*	Yellowish-green	Yellowish-green	Medium	—
GL	N	Yellowish-green	Yellowish-green	Medium short	P2
GM	P	Purplish-blue	Yellowish-green	Long	P7
GN	J	Blue	Green (Infra-red excited)	Medium short — (fluorescence)	
GP	—	Bluish-green	Green	Medium short	P2
KA	—	Yellow-green	Yellow-green	Medium	P20
LA	D	Orange	Orange	Medium	—
LB	E	Orange	Orange	Long	—
LC	F	Orange	Orange	Very Long	—
LD	L	Orange	Orange	Very Long	P33
W	W	White	—	—	P4
X	X	Tri-colour screen	—	—	P22
YA	Y	Yellowish-orange	Yellowish-orange	Medium	—

*Used in projection tubes.

GENERAL OPERATIONAL RECOMMENDATIONS

The following recommendations should be interpreted in conjunction with British Standard Code of Practice No. CP1005: (1962), 'The Use of Electronic Valves', upon which these notes have, in part, been based.

RATING SYSTEMS (in accordance with I.E.C. Publication 134)

Note: Limiting conditions may be either maxima or minima.

Absolute maximum rating system

Absolute maximum ratings are limiting values of operating and environmental conditions applicable to any electronic device of a specified type as defined by its published data, which should not be exceeded under the worst probable conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device, taking no responsibility for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the device under consideration and of all other electronic 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 device under the worst probable operating conditions with respect to supply voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions and variations in characteristics of the device under consideration and of all other electronic devices in the equipment.

Design-maximum rating system

Design-maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device 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 device manufacturer to provide acceptable serviceability of the device, taking responsibility for the effects of changes in operating conditions due to variations in the characteristics of the electronic device under consideration.

The equipment manufacturer should design so that, initially and throughout life, no design-maximum value for the intended service is exceeded with a bogey device under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, variation in characteristics of all other devices in the equipment, equipment control adjustment, load variation, signal variation and environmental conditions.

Design-centre rating system

Design-centre ratings are limiting values of operating and environmental conditions applicable to a bogey electronic device of a specified type as defined by its published data, and should not be exceeded under normal conditions.

These values are chosen by the device manufacturer to provide acceptable serviceability of the device in average applications, taking responsibility for

normal changes in operating conditions due to rated supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all electronic devices.
The equipment manufacturer should design so that, initially, no design-centre value for the intended service is exceeded with a bogey electronic device in equipment operating at the stated normal supply-voltage.

HEATER

Parallel Operation

The heater voltage must be within ±7% of the rated value when the supply voltage is at its nominal rated value, and when a tube having the published heater characteristics is employed.
This figure is permissible only if the voltage variation is dependent upon more than one factor. In these circumstances the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effects of the tolerances of the separate factors, providing no one of these deviations exceeds ±5%. Should the voltage variation depend on one factor only, the voltage variation must not exceed ±5%.

Series Operation

The heater current must be within ±5% of the rated value when the supply voltage is at its nominal rated value, and when a tube having the published heater characteristics is employed.
This figure is permissible only if the current variation is dependent upon more than one factor. In these circumstances, the total tolerance may be taken as the square root of the sum of the squares of the individual deviations arising from the effects of the tolerances of the separate factors, providing no one of these deviations exceeds ±3·5%. Should the total current variation depend upon one factor only, the current variation must not exceed ±3·5%.
When calculating the tolerances of associated components, the ratio of the change of heater voltage to the change of heater current in a typical series chain including a cathode ray tube is taken as 1·8, both deviations being expressed as percentages.
With certain combinations of valves and tube, differences in the thermal inertia may result in particular heaters being run at exceedingly high temperature during the warming-up period. During this period, unless otherwise stated in the published data, it is permissible for the heater voltage of the tube to rise to a maximum value of 50% in excess of the nominal rated value when using a tube with the published heater characteristics. A surge limiting device may be necessary in order to meet this requirement. When measuring the surge value of heater voltage, it is important to employ a peak reading device, such as an oscilloscope.

Mains Variations

In addition to the tolerances quoted above, fluctuations in the mains supply voltage not exceeding ±10% are permissible. These conditions are, however, the worst which are acceptable and it is better practice to maintain the heater as close as possible to its published nominal, 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.

Stand-by Operation

It is permissible to operate picture tubes in the 'stand-by' condition (for 'instant on' applications). In order to ensure satisfactory life the heater voltage should be decreased to 75% of its nominal value.

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 and should be less than $20V_{r.m.s.}$. When the heater is in a series chain or earthed, the 50Hz 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 should 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.
However, no electrode should be connected directly to a high energy source such as the h.t. line. When such a connection is required, it should be made via a series resistor of not less than 1kΩ.

Grid

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 5V (peak). In order to ensure that this limit is not exceeded it is suggested that an unbypassed resistor of 10kΩ is inserted in series with the lead to the control grid.

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 care should be taken

(a) not to operate the tube with a stationary picture at high beam currents for extended periods

(b) not to operate the tube with a stationary or slowly moving spot except at extremely low beam currents

(c) that immediately after switching off the equipment the screen be discharged. This can be effected by choosing the time constants of the grid and the first anode circuits such that a beam current is maintained during a period sufficiently long to discharge the screen.

EXTERNAL CONDUCTIVE COATING

Picture tubes are provided with an external conductive layer which, in conjunction with the internal conductive layer, forms a high voltage capacitor of specified value. This capacitor is intended to provide smoothing for the e.h.t. supply.

In making contact with the external coating it is necessary to take into account large currents which flow during a discharge inside the picture tube. In order not to exceed the current carrying capacity of the coating, the contact should be made over a large area. As a minimum requirement, a copper braid should be stretched diagonally across the cone and a connection taken from its centre to the receiver.

A further improvement would be to provide two diagonal braids, connected at their point of crossing. Since the coating is not a perfect conductor, a well executed connection helps to reduce r.f. radiation.

During a flashover, large voltages are expected to be produced across the coating. In order to minimise circulating currents in the chassis, there should be only one point connection between the coating and chassis. The coating itself should be well insulated from the rest of the receiver. See section headed 'Flashover'.

FINAL ANODE

Every care should be taken to prevent discharges from the e.h.t. line. During such occurrences, currents of high amplitude are injected into the chassis and these can significantly alter the operating conditions of the devices employed. With semiconductor devices there is a risk of permanent damage. In addition a repeated discharge of this nature may damage the contact between the internal conductive coating of the tube and the final anode connector, thus impairing performance.

In applications where it is not possible to ensure complete freedom from discharges, a series resistor of not less than 10 kΩ should be fitted to the final anode connector. The resistor and its mounting should be able to withstand full e.h.t. voltage.

Similarly, when it is required to discharge the picture tube capacity, connection should be made via a resistor of not less than 10kΩ, capable of handling high voltages.

MOUNTING BAND

An appreciable capacity is formed between the metal mounting band and the internal conductive layer of the tube; its value is quoted in the individual data sheets. In order to avoid a possibility of electric shock, a d.c. connection should be provided between the metal band and the rest of the receiver.
In receivers where the chassis can be connected directly to the mains there is a risk of electric shock if access is gained to the metal band through the mask at the front of the receiver. In order to reduce the magnitude of the shock to the safe limit, it is suggested that a 2MΩ resistor, capable of handling peak voltages of full e.h.t. value, be inserted between the metal band and the point of contact to the external coating. This safety arrangement will provide the necessary isolation from the mains but in the event of flashover, high voltages of low energy will be induced on the metal band. Any electric shock is within safe limits if the above precautions have been adopted but it is normally desirable to avoid access to the band.

FLASHOVER

Picture tubes, in common with other high voltage vacuum devices, are prone to internal flashover. During a breakdown, an arc is established between an electrode connected to the e.h.t. capacitor and an electrode terminated in a pin on the foot of the tube. Resulting transient currents and voltages produced in external circuits may be of sufficient magnitude to cause damage to various components on the chassis. The discharge is terminated when the e.h.t. capacitor is unloaded and during the subsequent recharging period an additional load is imposed on the e.h.t. generator. It is of vital importance to provide protective measures, particularly when semiconductor devices are employed.
A sufficient degree of protection against transients can be obtained by connecting suitable spark-gaps between each pin and a common point. From this common point a direct connection should be made to the external coating of the tube. In place of the normal connection between the coating and the chassis a connection should be made between the chassis and the common point. In addition, resistors should be fitted in series with each supply lead to the pins of the tube. These resistors should be able to handle high voltages; their value is a function of the degree of protection needed. As a guide, the following values are suggested: cathode—1·5kΩ, grid—8·2kΩ, first anode—22kΩ, focus electrode (monochrome)—22kΩ, focus electrode (colour)—100kΩ. The resistors and the spark-gaps should be mounted close to the tube socket.
In the case of transistor circuits, protection against overload of the e.h.t. generator may consist of a resistor placed in series with the supply line to the output transformer. Its value should be adjusted to limit the increase in the peak collector voltage to, say, 20%. Similar results can be obtained with desaturated line output transformers, provided that a small coupling capacitor is used.

HANDLING

A large amount of potential energy is stored in the picture tube by virtue of its vacuum. Modern tubes are provided with integral implosion protection

which conforms with internationally agreed standards. With these tubes no additional protection is needed.
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.
All tubes should be handled by the bulb end. Stresses on the neck should be avoided.
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.
For discharging the capacitor see the section 'Final Anode'.

MOUNTING

Unless otherwise specified there is no restriction on the mounting position.
Picture tubes with integral implosion protection are provided with mounting lugs. Published data give tolerances of the positioning of the lugs with respect to each other and with respect to the place they expect to occupy. This information should be taken into account in the design of suitable supports.
The deflection coils and other ancillary components should be mounted directly on the neck of the tube, care being taken to avoid scratches. No support is required for the neck which should be allowed to assume its own position.
Similarly, the tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

STRAY MAGNETIC FIELDS

Picture tubes are sensitive to any magnetic fields in their vicinity (including the earth's magnetic field). In a television receiver, stray magnetic fields may be generated by such components as the loudspeaker, mains transformers, chokes, field output transformer etc. Under influence of these fields there may be distortion in the raster geometry and in some cases they may be responsible for the astigmatic appearance of the focused spot. With colour tubes there can be additional difficulties with purity and convergence. Thus, every effort should be made to reduce stray magnetic fields to an acceptable level.

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

Unless otherwise stated, picture tubes for television applications are designed not to exceed the permissible limit dose rate of 0·5mr/h as measured in the manner specified by the I.E.C. This is provided that they are operated within their published data limits and in applications for which they are primarily intended.

X-radiation from a picture tube increases very rapidly with applied voltage. This should be taken as a warning for any experiments involving potentials in excess of values quoted in the published data.

CORNER CUTTING OR NECK SHADOWING

Corner cutting is caused by a direct interception of the deflected electron beam before it reaches the screen and results in a non-scanned corner of the raster. It may be avoided by applying an appropriate deflection unit.

RASTER CENTRING (see also Colour Tube Notes)

To centre the raster on the screen it is recommended that either a magnetic field just behind (viewed from the screen) the deflection coils be used or a direct current be passed through the deflection coils.

The centring device should provide a shift to allow for non-centrality of the spot with respect to the geometric centre of the screen. In addition, the centring device should provide the shift needed to allow for non-centrality of the visible raster (i.e. to compensate for line blanking and also time base non-linearity, if any) and the earth's magnetic field.

COLOUR TUBE NOTES

INTRODUCTION

Mullard 90° shadow-mask colour television tubes are capable of displaying pictures in full colour or in black and white. They have reinforced envelopes and therefore do not need any additional implosion protection. Integral mounting lugs are provided on the tubes.

OPERATING PRINCIPLES

The tube has three electron guns, spaced 120° apart, with their axes tilted towards the screen. Because of the different angles at which the electron beams from the three guns reach the shadow-mask, the beam from one gun lands only on phosphor dots of one primary colour. Thus three colour signals applied to the three guns produce three superimposed colour pictures in the primary colours. These colour pictures are integrated by the eye, and are seen as one picture either in full colour or in black and white.

The beams from the three guns are made to converge at the screen by means of external magnetic convergence components. The radial convergence assembly provides radial adjustment of the three beams, whilst the lateral convergence assembly provides lateral adjustment of the blue beam relative to the red and green beams.

The three electron guns have tri-potential focus lenses, and focusing of the beams is carried out by adjusting the voltage on the common focus pin.

Correct landing of the electron beams on phosphor dots of the intended colour is accomplished by means of a purity magnet external to the tube neck, together with correct positioning of the deflection coil assembly.

It is essential that the tube is shielded from extraneous magnetic fields (including the earth's magnetic field) and that both the tube and the shielding are effectively degaussed.

APPLICATION NOTES

Magnetic shielding

The colour tube should be provided with a magnetic shield on the cone of the tube. Essential dimensions of this shield are shown in the data. It should be constructed from cold-rolled mild steel of minimum thickness 0·5mm, annealed at 850°C. Since the tube reinforcing band is an essential part of the magnetic circuit used for degaussing, the air gap between the band and the shield should be as small as possible and should not exceed 10mm. Degaussing is described under 'Adjustment Procedures'.

Raster centring

Contrary to common practice with black and white television, where centring of the raster on the screen is accomplished by means of centring magnets which are mounted on the deflection coil, with a shadow-mask type of colour tube such magnets would impair colour purity and convergence. Raster centring is therefore attained by passing direct current of the required value through each pair of deflection coils. The values of raster displacement given in the data apply when all components are correctly adjusted.

Component considerations

For optimum purity, the electrical centre of deflection of the deflection coil must coincide with that used for the positioning of the phosphor dots on the screen during manufacture of the tube. The coil must, therefore, be designed so that axial adjustment of its position on the tube neck is provided.
The radial convergence assembly has to be positioned so that its pole pieces are opposite the internal pole pieces which form part of the gun structure. (See drawings in the data). Small rotational adjustment of the radial convergence assembly may be used during adjustment of the blue lateral positioning to obtain optimum lateral convergence.

The purity magnets should be positioned over the gap between the focus electrodes and the final anodes of the electron gun structure. Placing them nearer than this to the cathodes of the gun may adversely affect tube performance (due to a deterioration of spot shape, and in some cases to beam shadowing resulting in lower brightness and poor grey scale tracking).
The blue lateral convergence assembly should be placed as near as possible to the rear side of the purity magnets, and should always be nearer to the screen than the centre of the focus electrodes.

Convergence

Static convergence, i.e. convergence of the three beams at the centre of the screen, is usually accomplished with permanent magnets which are part of the radial convergence assembly, or with direct currents through the convergence coils, in combination with the lateral magnet.

The strength of the magnetic field that is coupled to the radial convergence pole pieces of the gun should be such that each beam can be moved radially over the distance given in the data at the centre of the screen. The static lateral convergence magnet should provide a magnetic field adjustable in magnitude and polarity. This field causes a movement of the blue beams and simultaneously a movement in the opposite direction of the green and red beams.
The maximum lateral displacement of the blue beam opposite to the movement of the red and green beams is given in the data. With these four adjustable magnetic fields, static convergence of the three beams can be attained.
For convergence over the entire screen, dynamic radial convergence is required together with a small amount of dynamic blue lateral convergence in line direction.

The radial convergence assembly consists fundamentally of three cores with associated windings. Through the windings are passed the necessary convergence currents for maintaining convergence when the beams are deflected over the screen. The required form of the currents can be obtained by adding a parabolic current waveform to one with a sawtooth waveform. Two separate windings per core are required for correction in horizontal and vertical directions. The parabolic and sawtooth currents should be adjustable in amplitude, and the sawtooth currents and the vertical blue parabola should also be adjustable in polarity.

The lateral convergence assembly, with a core and associated windings, provides dynamic blue lateral convergence in the line direction.

Purity

Optimum purity is achieved by means of adjustments to both the purity magnet and the deflection coil.

(a) *Purity magnet*
This magnet is required to compensate for the effects of extraneous magnetic fields, including the earth's magnetic field, and manufacturing variations within the shadow-mask picture tube, which could cause purity errors. The magnet should be designed to provide a field which is adjustable in both strength and direction.

(b) *Deflection coil*
The deflection coil should be free to move a minimum of 13mm axially along the tube neck in order to achieve optimum purity on all tubes. If purity is to be set by the 'Red ball' method (see section 'Purity adjustment') this movement is required to be 20mm.

Drive requirements

In order to calculate the voltages which should be supplied by the drive output stages in a colour television receiver, the following points should be taken into consideration:

(a) The equation for the luminance signal is given by $Y = 0{\cdot}30R + 0{\cdot}59G + 0{\cdot}11B$. The two chrominance signals, after subcarrier detection, give colour difference signals of R–Y, G–Y and B–Y, which, when combined with the luminance signal in a matrixing circuit, give the red, green and blue signals. This matrixing may be performed either (i) by the tube itself (this is known as colour difference drive) or (ii) by means of a separate matrixing circuit (R, G, B drive). Method (i) can be achieved by driving the cathodes with the luminance signal and the control grids with the colour difference signals. However, there is a difference in slope between grid drive and cathode drive, and to compensate for this, higher drive voltages are required for grid drive. The relationships between drive voltage (V_{dr}) and beam current (I) for both cathode drive and grid drive are given by the following equations:

(i) for grid drive

$$I = k\frac{V_{dr}^3}{V_{co}^{\frac{3}{2}}} \quad \text{(where } V_{co} \text{ is the cut-off voltage for grid drive),}$$

(ii) for cathode drive

$$I = \frac{k(1+D)^3 V_{dr}^3}{\left[1 + D\frac{V_{dr}}{V_{co}}\right]^{\frac{3}{2}} V_{co}^{\frac{3}{2}}} \quad \text{(where D is the penetration factor).}$$

These equations illustrate that there is a difference in slope between the two driving methods, and also that the relationships are slightly non-linear. As in practice only a constant ratio between grid and cathode drive can be achieved a compromise has to be chosen, and the most favourable results are obtained when the grid signals are made 20% larger than the corresponding cathode signals for the nominal tube.

For method (ii) a separate matrixing circuit is required which delivers red, green and blue signals to the picture tube. These signals may be applied either to the cathodes or to the grids, but if to the latter, higher drive voltages are required.

(*b*) There are 3 spreads in picture tube properties which influence the drive requirements. These are perveance, penetration and phosphor efficiences. Perveance has a nominal value of 3·0, with a spread of 2·6 to 3·1. Penetration has a nominal value of 0·29 with a spread of 0·18 to 0·40. The spread in phosphor efficiencies is shown by the ratios of cathode currents to produce white of colour co-ordinates x = 0·281, y = 0·311:

$$\frac{I_R}{I_G} = 0{\cdot}9 \text{ nominal, } 0{\cdot}65 \text{ min, } 1{\cdot}25 \text{ max.}$$

$$\frac{I_R}{I_B} = 1{\cdot}0 \text{ nominal, } 0{\cdot}75 \text{ min, } 1{\cdot}35 \text{ max.}$$

By reference to the equation for the luminance signal given in *(a)*, it is possible to calculate the maximum voltage ranges for the colour difference signals. These are reached when the primary colours and the complementaries are produced at maximum brightness. These values are tabulated below. All values are referred to the maximum value Y = R = G = B = 1 for peak white and are considered as positive if they cause an increase in beam current.

Colour	R	G	B	Y	R–Y	G–Y	B–Y
Red	1	0	0	0·3	0·7	−0·3	−0·3
Green	0	1	0	0·59	−0·59	0·41	−0·59
Blue	0	0	1	0·11	−0·11	−0·11	0·89
Cyan	0	1	1	0·7	−0·7	0·3	0·3
Magenta	1	0	1	0·41	0·59	−0·41	0·59
Yellow	1	1	0	0·89	0·11	0·11	−0·89

Signal	Minimum	Maximum	Total Range
R–Y	−0·7	0·7	1·4
G–Y	−0·41	0·41	0·82
B–Y	−0·89	0·89	1·78

Raster shape correction

Unlike black and white television, where correction for raster shape can be obtained by adding small permanent magnets to the deflection coil, with colour television such magnets would cause an unacceptable deterioration of purity and convergence. Raster shape correction can therefore be obtained by dynamic correction of the scanning current waveforms.

ADJUSTMENT PROCEDURES

Initial adjustments

The following procedures are recommended to provide optimum colour purity and convergence of the three beams over the entire screen area, and to provide correct grey-scale tracking.
Before any adjustments are carried out, the tube and its surroundings must be degaussed. This can be achieved either by an automatic degaussing circuit built into the receiver, or by manual degaussing. If it is to be done manually a suitable coil for 240 $V_{r.m.s.}$ consists of 840 turns of 0·7mm dia. enamelled copper wire wound on a former of approximately 300mm diameter. The coil should be moved so that the entire screen and the magnetic shield are subjected to its magnetic field, and after about 10 seconds it should be moved away from the tube to a distance of at least 2·5 metres before it is disconnected from the a.c. supply. All ferrous material in the vicinity of the tube must also be degaussed in a similar manner, with the receiver switched on.
Before deflection power and high voltage are applied to the tube, the bias control should be set to cut-off. After deflection power and high voltage are applied, the bias should be gradually reduced to minimise the possibility of tube damage in the event of circuit faults. Whilst the tube is reaching a stable operating temperature (which takes about 15 minutes at 25kV and the recommended average current) initial adjustment of focus, height, width, linearity and raster centring can be made.

Static convergence adjustment

A crosshatch pattern is the most suitable signal for convergence adjustments, and for maximum accuracy it should be displayed at medium brightness.
It is recommended that the red and green beams are converged first, with the blue gun biased off, followed by convergence of the blue beam on to the yellow pattern formed by the coincident red and green lines. The red and green lines are made to converge in the centre by means of the permanent magnets (or direct current through the coils) of the radial convergence assembly. The blue lines are then made to converge in a vertical direction on to the yellow lines formed by red and green, by means of the blue control on the radial convergence assembly. Any residual horizontal displacement of the blue lines is corrected by means of the blue lateral control situated further back on the tube neck. When these adjustments have been properly carried out, all three patterns will be converged in the centre of the screen, resulting in a white crosshatch. (See fig. 1).

Purity adjustment

Purity adjustments are best carried out on an unmodulated raster, and the sequence of operation is (i) adjustment of the purity magnet and (ii) axial adjustment of the position of the deflection coil. Adjustment of the purity magnet may be carried out by one of two methods:

Method 1

A microscope is used to observe the landing of the electron beam triads relative to the screen phosphor dot triads. The phosphor dots may be illuminated by means of an external light source, shining on the screen at an angle of approximately 10° to 15°. With all three guns on, a microscope with a magnification of 40× to 50× is used to observe the relative positions of the electron beam triads and the phosphor dot triads at the centre of the screen. The purity magnet should be adjusted so that the geometric centres of the two triads coincide. (It should be noted that for optimum overall purity, the colour tube is manufactured with a centre landing such that the electron spots are slightly inset from the phosphor dots in each triad.)

Method 2 (Red ball method)

The green and blue guns are biased off and the deflection coil is pulled back towards the base until a red area of approximately 100mm diameter is visible on the screen, surrounded by discoloured and blue and green areas. This requires a movement of the deflection coil of approximately 20mm from its most forward position when it is in contact with the cone of the tube. The purity magnet is then adjusted so that the centre of the red area is positioned approximately 20mm in the 8 o'clock direction from the screen centre (i.e. in the direction of the red gun).

After the purity magnet has been adjusted by either of the two methods given above, the red gun only is turned on, and the deflection coil is positioned so that a pure red raster is achieved all over the screen area. The green and blue rasters should now be checked, and very slight adjustments of the deflection coil position should be made, if necessary, to obtain pure red, green and blue rasters. If this cannot be achieved, the procedure should be repeated.

Note:

Purity adjustment by means of a microscope affords direct visual indication of the beam landings within phosphor dots. In addition, the results can be accurately checked when the deflection coils are adjusted for the best overall purity. Hence, any errors arising out of repositioning of deflection coils are eliminated.

In contrast, the 'red ball' method is an indirect approach to the problem of purity adjustment. There is no way of offsetting the errors which may be produced when the coils are moved to the position giving overall purity. For the majority of tubes the total errors thus generated may be small but with some, however, they can reach significant proportions.

Dynamic convergence adjustment

As with static convergence, a crosshatch pattern at medium brightness is recommended. During the dynamic convergence adjustment, it may be found that static convergence needs re-adjusting to maintain correct convergence.

The actual procedure for dynamic convergence depends upon the receiver circuitry, but it is recommended that vertical convergence be carried out first, using the centre vertical line of the pattern as the criterion (see fig. 2), followed by horizontal convergence, using the horizontal line as the criterion. By repeated adjustments of the controls, the lines in the three colours on these two axes ultimately become parallel to each other, and can be made to coincide by means of the static controls. After convergence on these two axes is obtained, the maximum misconvergence in the corners of the screen area

should not exceed 2.5mm. Slight re-adjustment may be tried to improve the overall convergence (see fig. 3).
After dynamic convergence has been completed, purity should again be checked, and re-adjusted, if necessary, by means of the purity magnet.

Grey scale tracking

This adjustment takes place last of all, and again the detailed procedure for the adjustments depends upon the receiver circuitry.
The general sequence of operations is as follows:—

(a) With the cathode-to-grid voltages of all three guns set to the potential which corresponds to black level, adjust the a_1 voltages of each gun so that each of the three rasters is just not visible.

(b) Increase the brightness, and adjust the drive voltages to obtain white.

(c) Reduce the brightness so that the picture just remains visible. Re-adjust the cut-off voltages to obtain the same white as in *(b)*.

(d) Repeat *(b)* and *(c)* until passage through the whole black-to-white scale ceases to affect the colour.

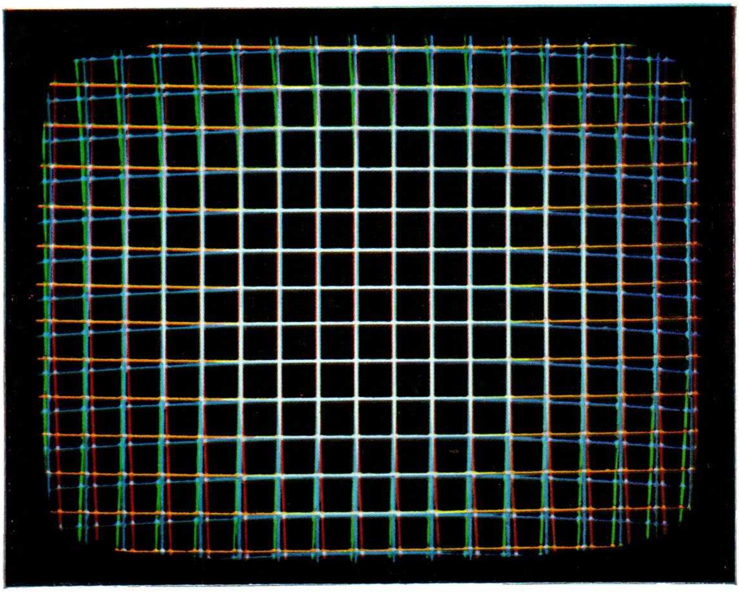


Fig. 1

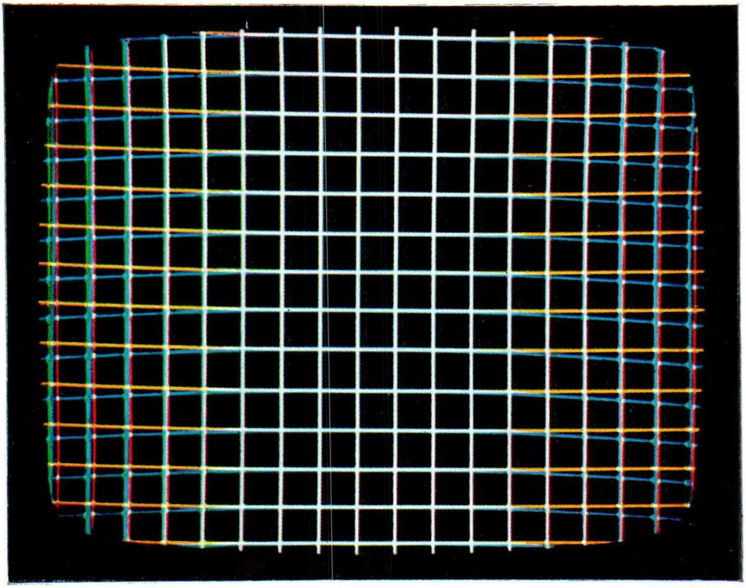


Fig. 2

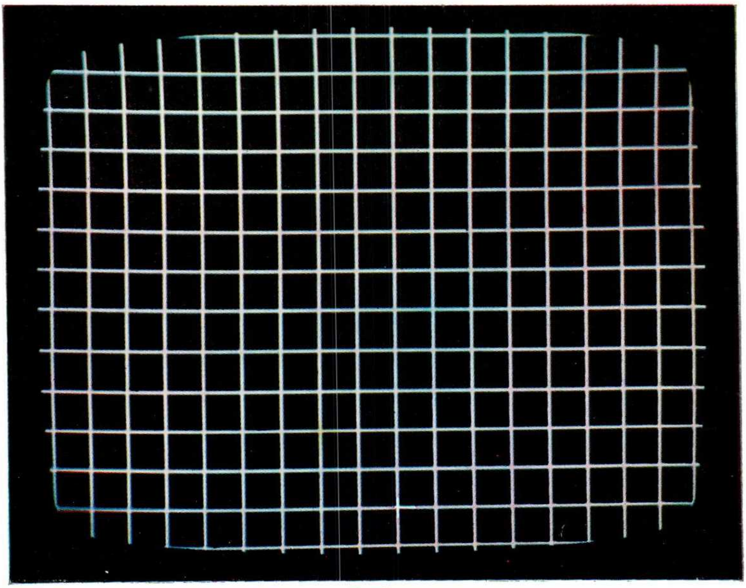
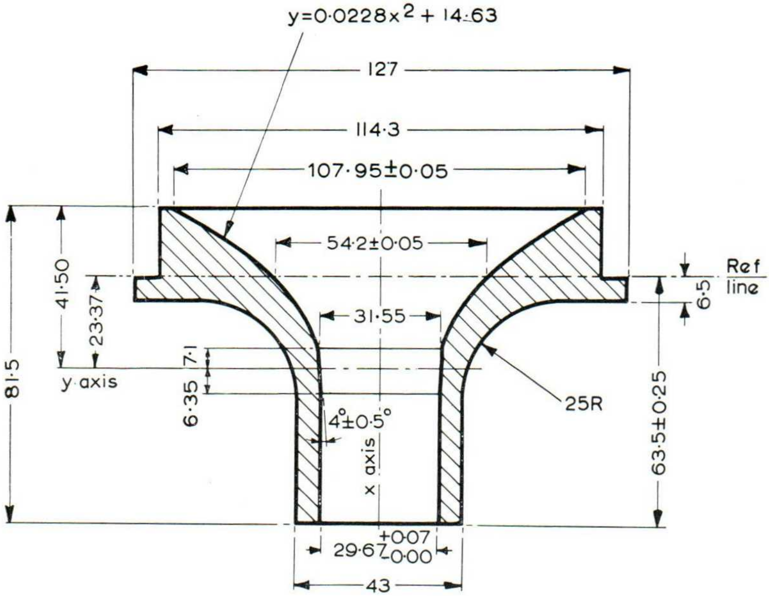


Fig. 3

REFERENCE LINE GAUGES

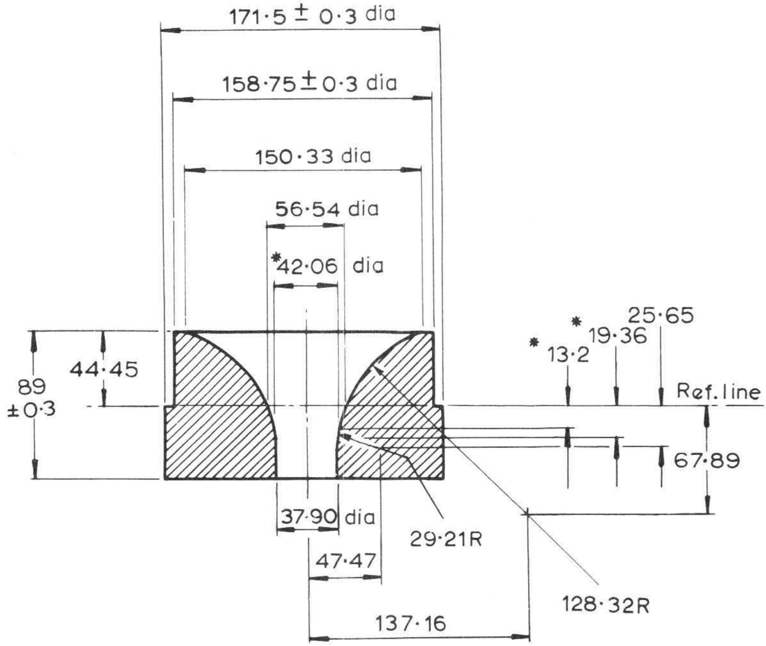


All dimensions in mm.

5697

REFERENCE LINE GAUGE J.E.D.E.C. 126 FOR MONOCHROME CATHODE RAY TUBES HAVING 110° SCANNING ANGLES AND A NECK DIAMETER OF 28·6mm

B6084

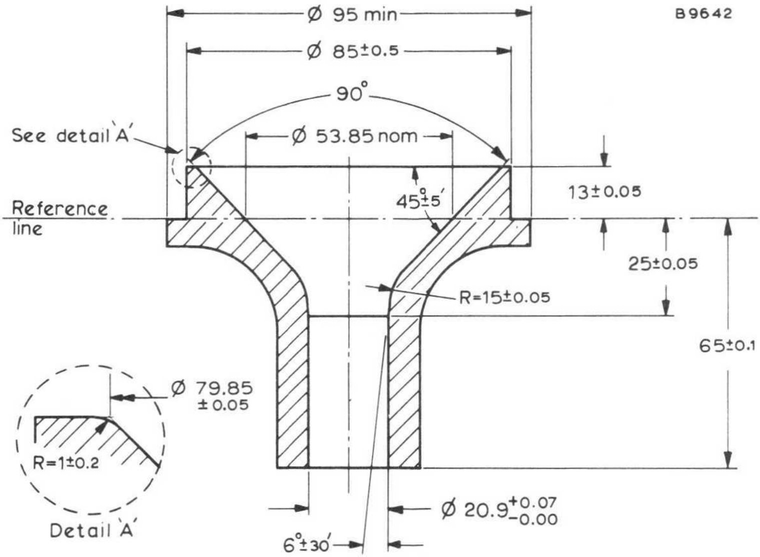


Reference line gauge

* These dimensions define extent of 29·21R

All dimensions in mm.

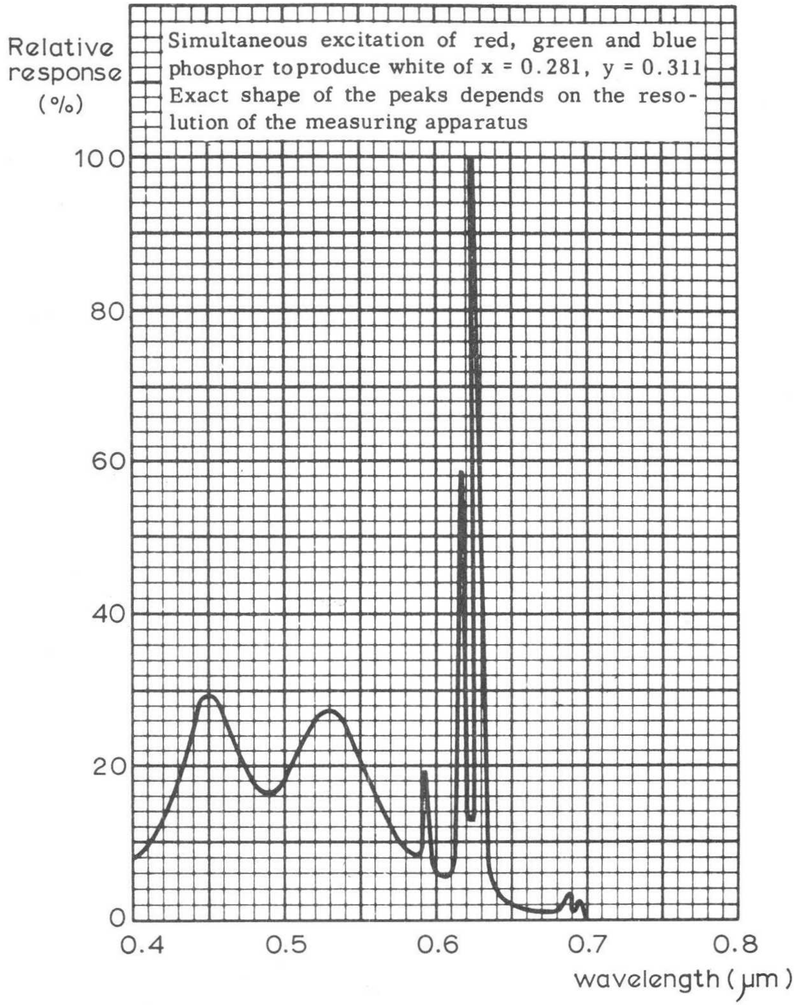
REFERENCE LINE GAUGE FOR COLOUR CATHODE RAY TUBES HAVING 90° SCANNING ANGLES AND A NECK DIAMETER OF 36·5mm



REFERENCE LINE GAUGE

All dimensions in mm.

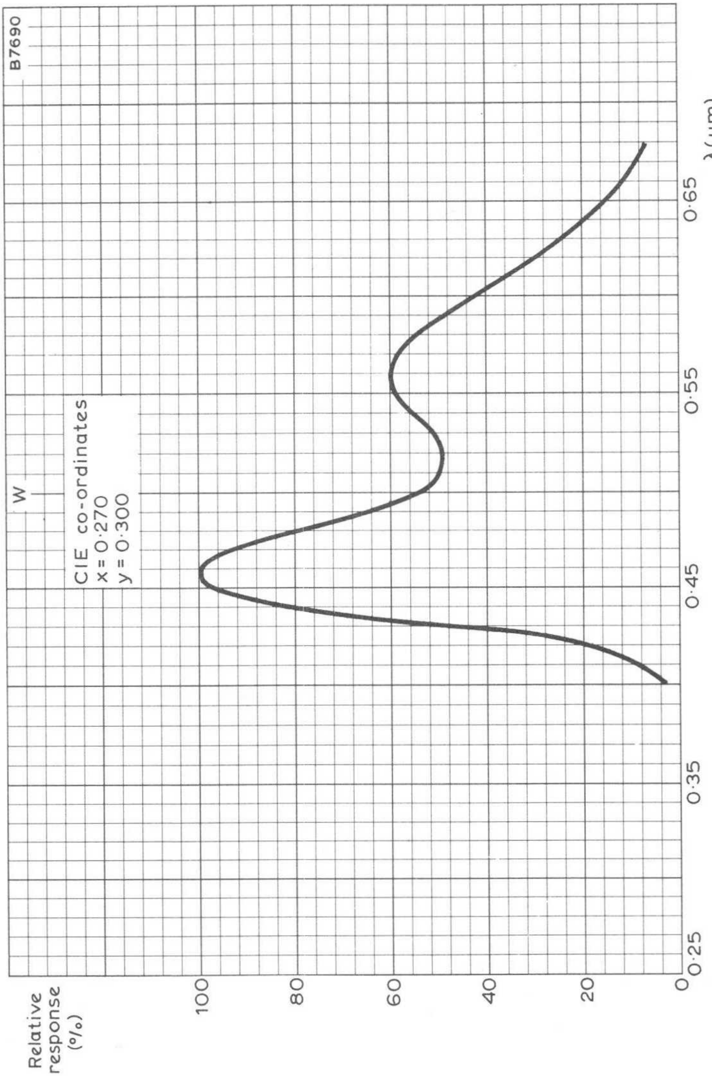
REFERENCE LINE GAUGE FOR MONOCHROME CATHODE RAY TUBES HAVING 90° SCANNING ANGLES AND A NECK DIAMETER OF 20mm



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE X LUMINESCENT SCREEN

	Colour coordinates	
	x	y
Red	0.630	0.340
Green	0.315	0.600
Blue	0.150	0.060

CATHODE RAY TUBE
SCREEN TYPE W



RELATIVE SPECTRAL ENERGY DISTRIBUTION CURVE
FOR TYPE W LUMINESCENT SCREEN

TENTATIVE DATA

QUICK REFERENCE DATA		
28cm (11in) rectangular direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Especially for use in portable receivers with push-through presentation.		
Deflection angle	90	deg
Focusing	Electrostatic	
Light transmission	55	%
Maximum overall length	25	cm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

V_h	11	V
I_h	68	mA

The heater supply circuit should provide a nominal voltage of 11V, either d.c. or a.c.
For supply from a.c. mains, see General Operational Recommendations - Cathode Ray Tubes.
For supply direct from a battery, the heater voltage cycle must be within the limits of the graph on page C1. In any discharge cycle, the time of V_h above 13V must not exceed 30 minutes.

OPERATING CONDITIONS

V_{a2+a4}	11	kV
V_{a3} (focus electrode control range)	0 to 350	V
V_{a1}	250	V
V_g for visual extinction of focused raster	-35 to -69	V
*V_k for visual extinction of focused raster	approx. 45	V

*For cathode modulation, all voltages are measured with respect to grid.

SCREEN

Metal backed		
Fluorescent colour	White	
Light transmission (approx.)	55	%
Useful screen area	see page D7	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 100μA.

DEFLECTION

Double magnetic

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page D10.

CAPACITANCES

$c_{g\text{-all}}$	7.0	pF
$c_{k\text{-all}}$	3.0	pF
$c_{a2+a4\text{-}M}$	550 to 850	pF
$c_{a2+a4\text{-}B}$	150	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See notes under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	55	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE see page D10

QUICK REFERENCE DATA		
28cm (11in) rectangular direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Especially for use in portable receivers with push-through presentation.		
Deflection angle	90	deg
Focusing	Electrostatic	
Light transmission	50	%
Maximum overall length	250	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

V_h	11	V
I_h	68	mA

The heater supply circuit should provide a nominal voltage of 11V, either d.c. or a.c.
For supply from a.c. mains, see General Operational Recommendations - Television Picture Tubes.
For supply direct from a battery, the heater voltage cycle must be within the limits of the graph on page 11. In any discharge cycle, the time of V_h above 13V must not exceed 30 minutes.

OPERATING CONDITIONS

V_{a2+a4}	11	kV
V_{a3} (focus electrode control range)	0 to 350	V
V_{a1}	250	V
V_g for visual extinction of focused raster	-35 to -69	V
*V_k for visual extinction of focused raster	approx. 45	V

*For cathode modulation, all voltages are measured with respect to grid.

SCREEN

Metal backed		
Fluorescent colour	White	
Light transmission (approx.)	50	%←
Useful screen area	see page 7	

FOCUSING

Electrostatic
The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 100μA.

DEFLECTION

Magnetic		
Diagonal deflection angle	90	deg
Horizontal deflection angle	80	deg
Vertical deflection angle	63	deg

The deflection coils should be designed so that their internal contour is in accordance with the reference line gauge shown on page 10.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	3.0	pF
$c_{a2+a4-M}$	550 to 850	pF
$c_{a2+a4-B}$	150	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See notes under this heading in 'General Operational Recommendations - Television Picture Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	55	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE see page 10

MOUNTING POSITION Any

The tube socket should not be rigidly mounted but should have flexible leads and be allowed to move freely.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after the installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM unless otherwise stated)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	12	kV
V_{a2+a4} min. (absolute limit)	7.5	kV
$+V_{a3}$ max.	500	V
$-V_{a3}$ max.	50	V
V_{a1} max.	350	V
V_{a1} min.	200	V
$-v_{g(pk)}$ max. (see note 2)	350	V
$-V_g$ max. (see note 3)	100	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5.0	μA
V_{h-k}		
d.c. max.	110	V
pk max.	130	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

Notes

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the tube.
2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

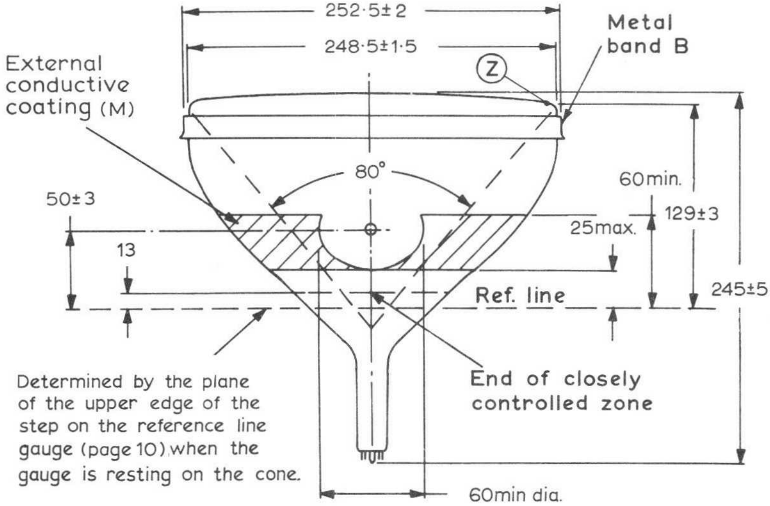
3. The d.c. value of bias must not be such as to allow the grid to become positive with respect to the cathode, except during the period immediately after switching the receiver on or off when it may be allowed to rise to +1.0V. It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

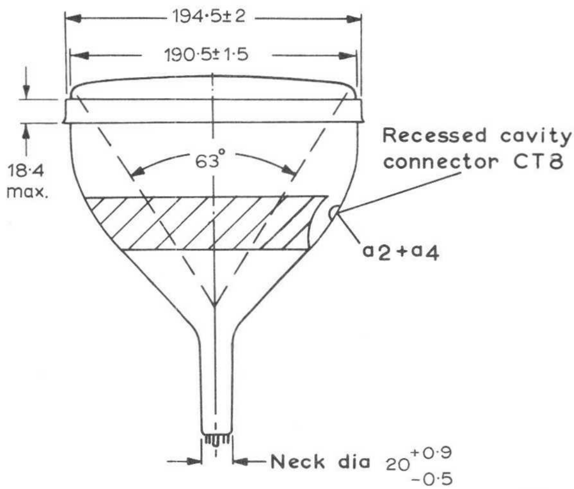
4. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2MΩ.

   The mounting lugs will be in electrical contact with the metal band.

WEIGHT

Tube alone (approx.)	2.2	kg

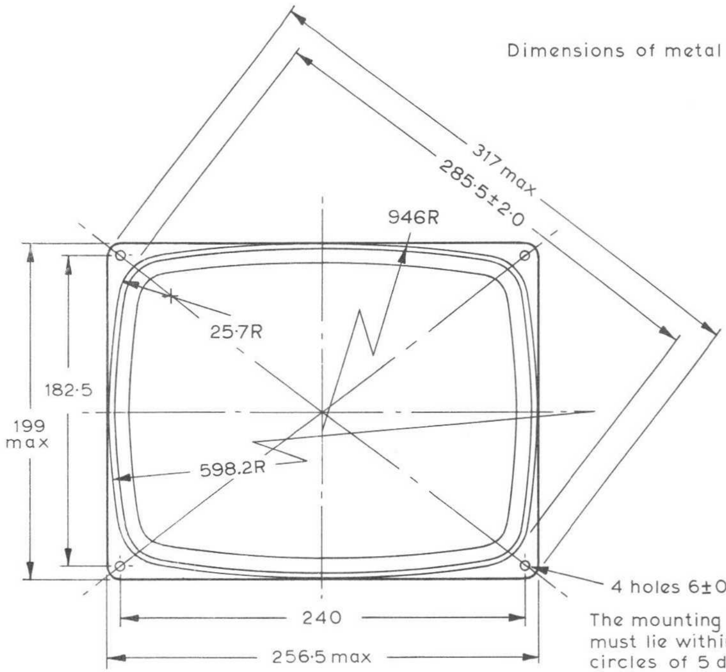




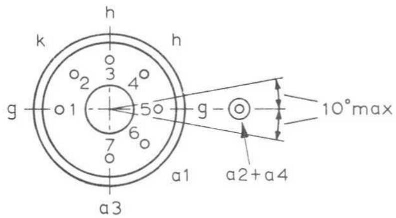
All dimensions in mm

B7707

Dimensions of metal band

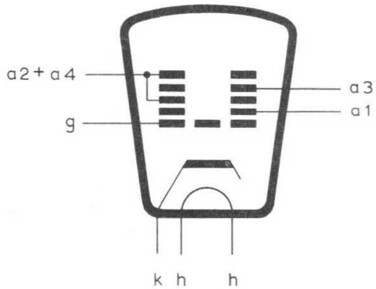


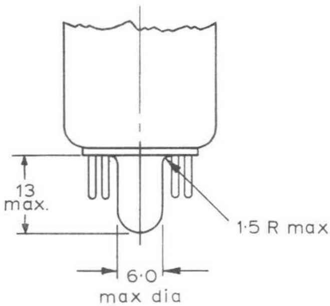
The mounting bolts must lie within circles of 5 dia. centred on the true geometric position of these holes.



Pin dimensions as in B7G base.

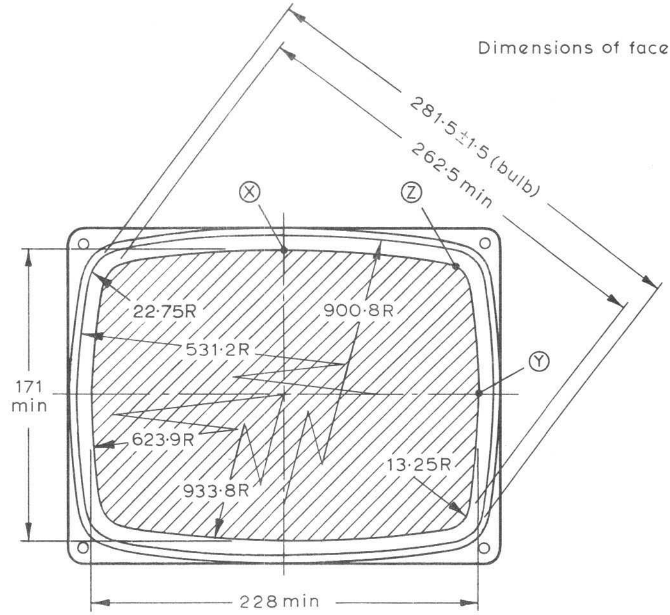
The centre of the socket must allow entry of the pump stem.



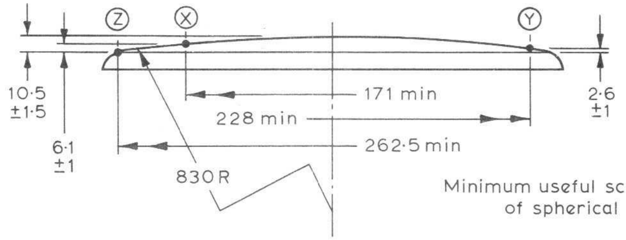


All dimensions in mm

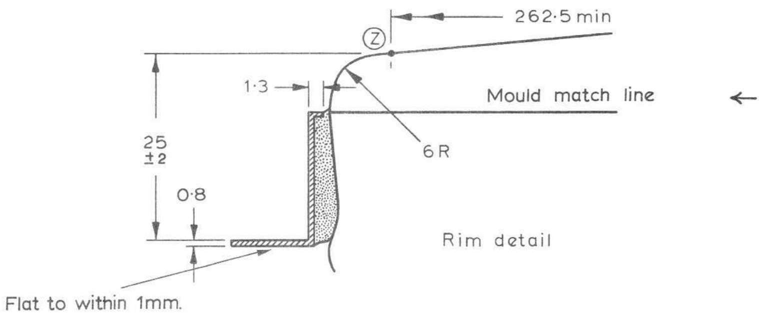
B7708



Dimensions of face



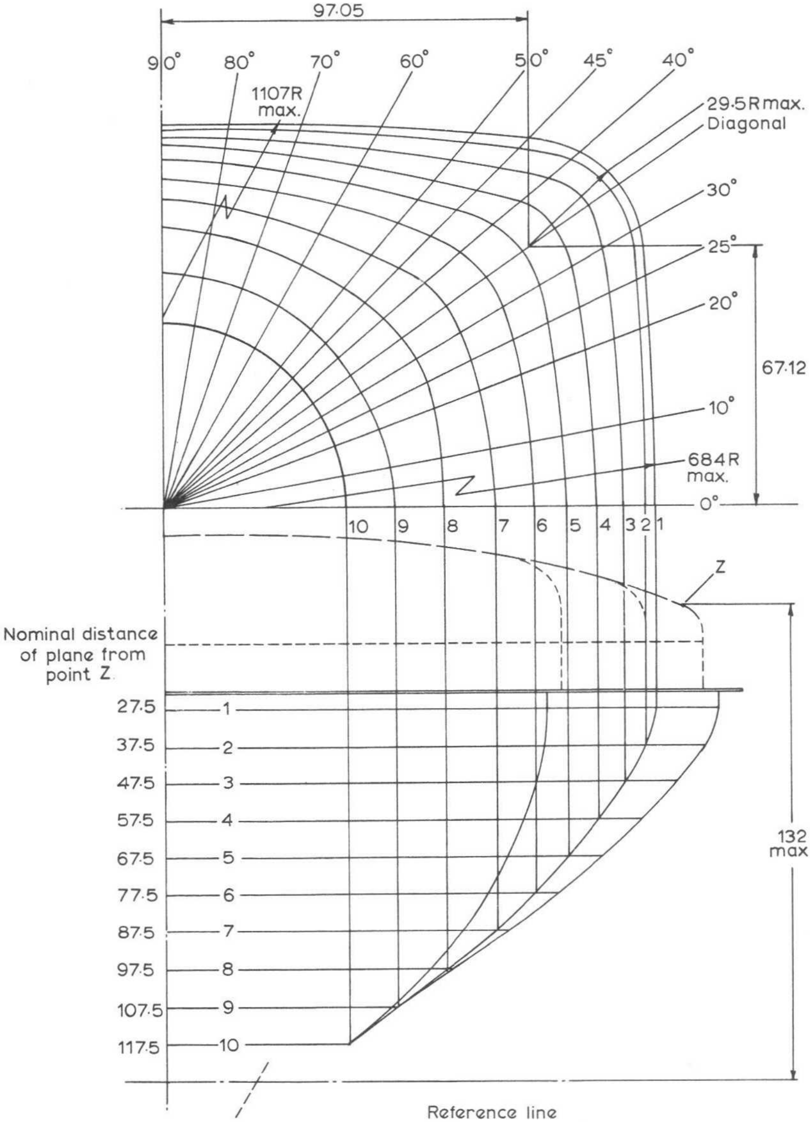
Minimum useful screen area of spherical face



Rim detail

All dimensions in mm

B7709



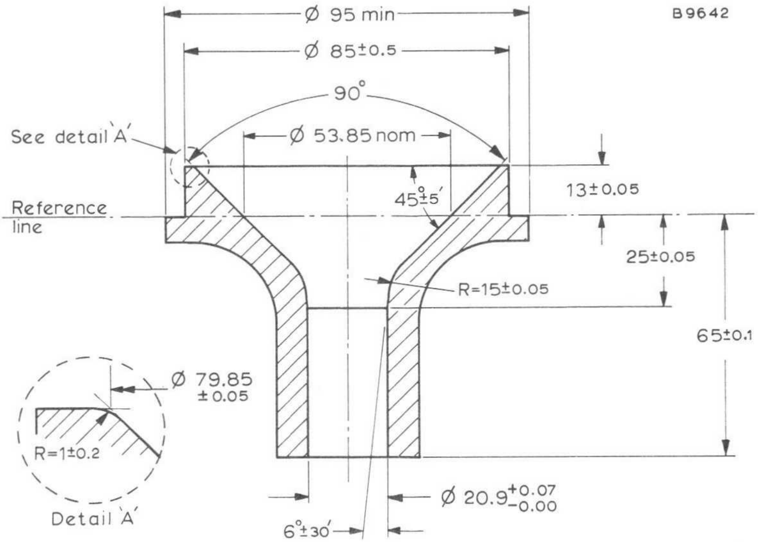
All dimensions in mm.

DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING

Distance from centre

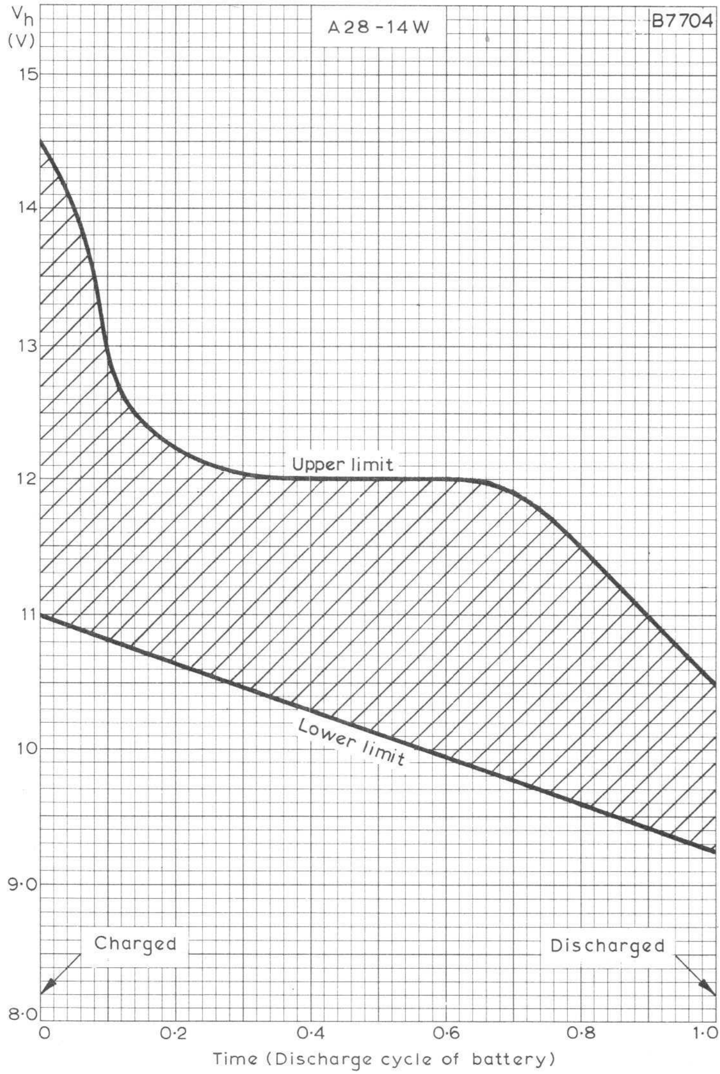
Section	0^{o} long	10^{o}	20^{o}	25^{o}	30^{o}	$34^{o}40'$ diagonal	40^{o}	45^{o}	50^{o}	60^{o}	70^{o}	80^{o}	90^{o} short
1	130.0	131.6	136.6	140.6	145.5	147.5	144.9	136.8	127.9	114.9	106.8	102.4	101.0
2	127.4	128.9	133.8	137.7	142.4	144.9	141.8	133.3	124.8	112.6	105.2	101.2	99.9
3	121.1	122.6	126.8	130.4	134.7	137.6	133.9	125.6	118.4	108.2	102.0	99.0	97.9
4	114.0	115.2	118.7	121.6	125.2	127.3	124.5	117.5	111.6	103.1	98.1	95.8	95.2
5	106.4	107.2	110.0	112.2	114.8	116.4	114.2	108.8	104.0	97.2	93.5	92.0	91.8
6	97.6	98.2	100.0	101.4	103.3	104.4	102.8	98.8	95.1	90.0	87.4	86.8	87.0
7	87.4	87.8	88.8	89.7	90.7	91.4	90.2	87.7	85.2	81.7	80.4	80.5	81.0
8	75.0	75.4	76.2	76.7	77.0	76.8	76.0	74.9	73.8	72.4	72.2	72.8	73.4
9	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.6	60.4	60.2	60.6	61.0	61.4
10	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0	48.0

All dimensions in mm

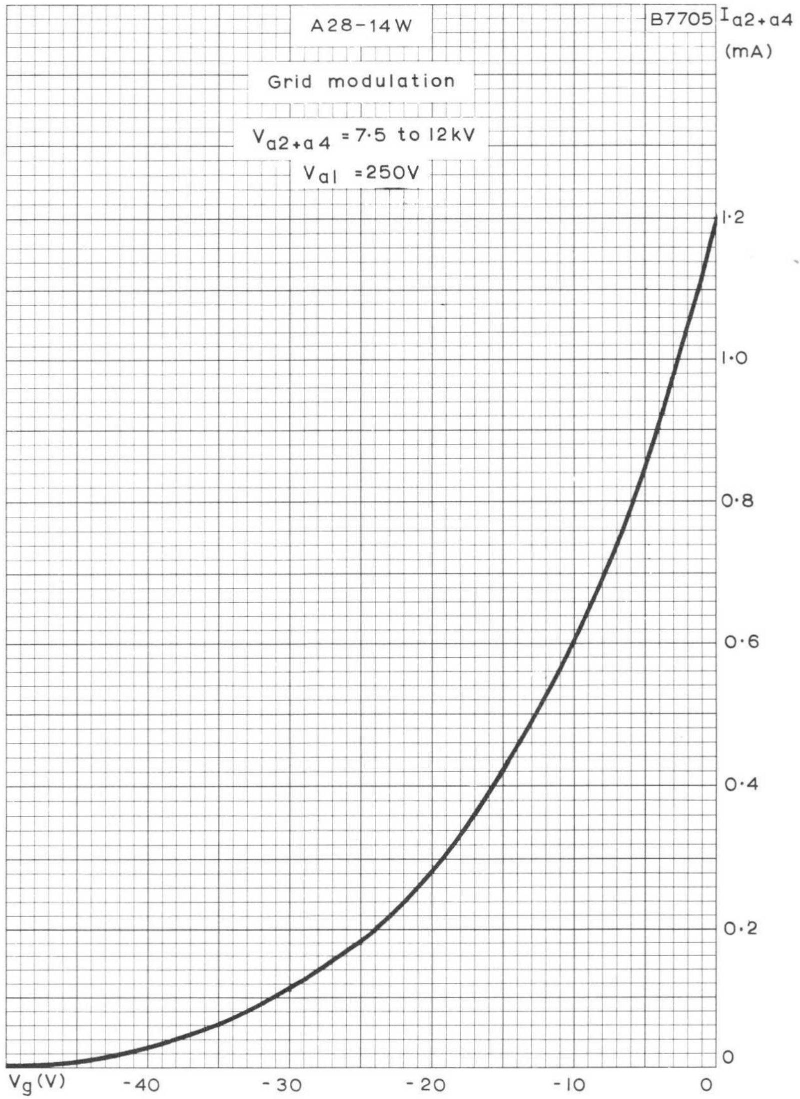


REFERENCE LINE GAUGE

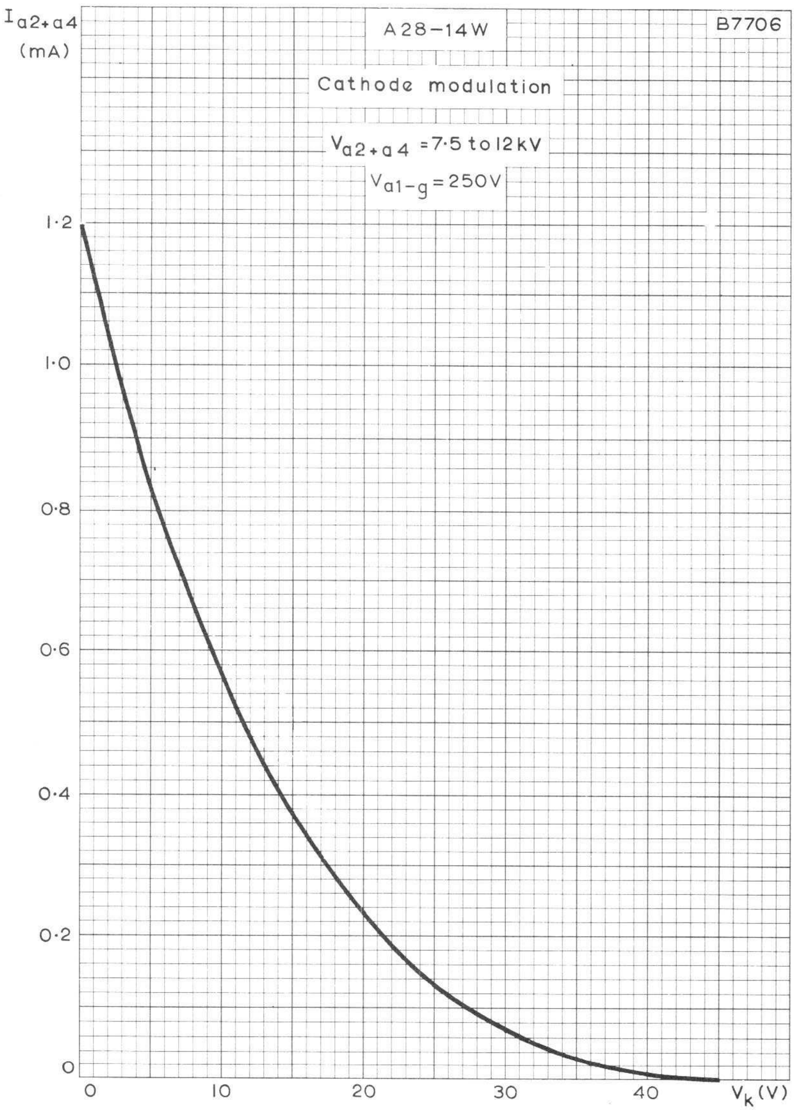
All dimensions in mm



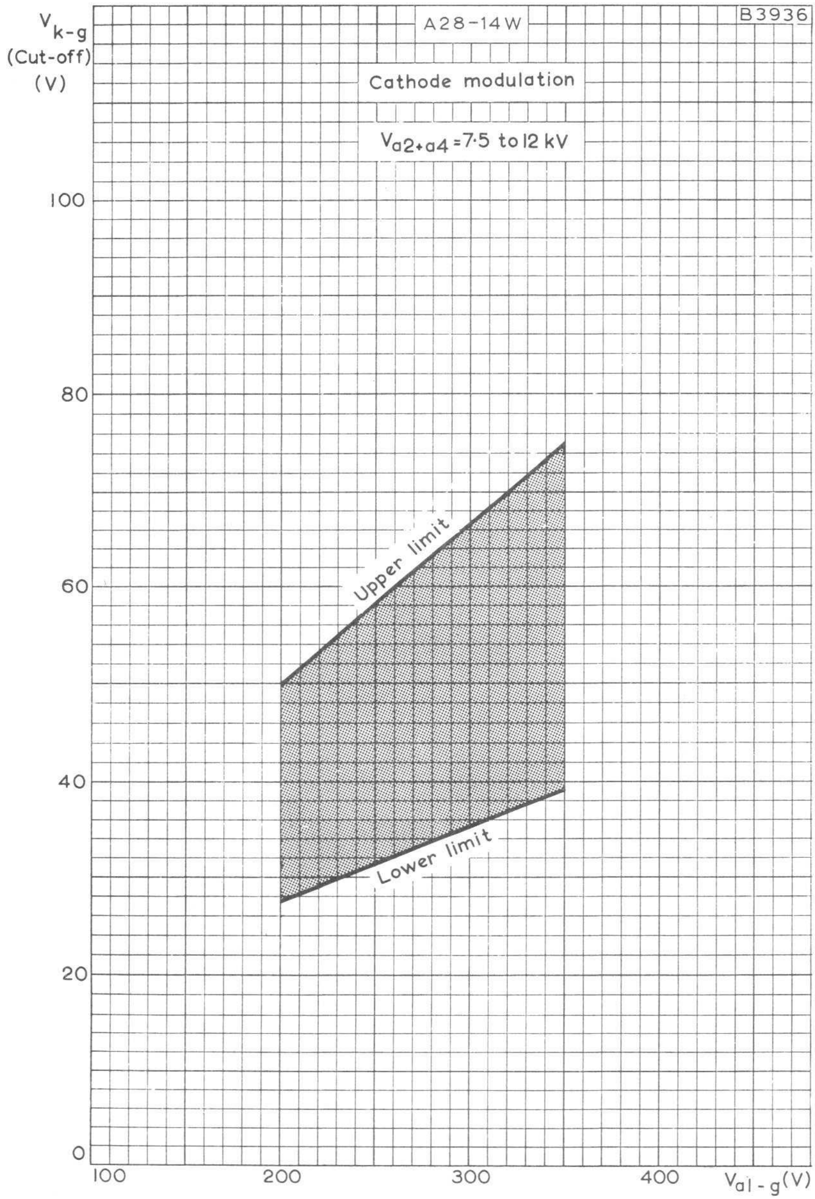
HEATER VOLTAGE PLOTTED AGAINST BATTERY DISCHARGE CYCLE



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
GRID MODULATION



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.

TELEVISION TUBE A44-120W/R

QUICK REFERENCE DATA		
44cm (17in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Suitable for use in receivers with push-through presentation. This tube is fitted with a ring trap base.		
Deflection angle	110	deg
Focusing		Electrostatic
Light transmission	48	%
Maximum overall length	291	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS-CATHODE RAY TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations-Cathode Ray Tubes'.

Note:- (Applies to series operation only)

The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	18	kV
V_{a3} (focus electrode control range)	0 to 400	V
V_{a1}	400	V
V_g for visual extinction of focused raster	-40 to -77	V
*V_k for visual extinction of focused raster	36 to 66	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (Metal backed)

Fluorescent colour		White
Light transmission	48	%
Useful screen area		See page 6

FOCUSING (Electrostatic)

The range of focus voltage shown in 'Operating Conditions' results in optimum overall focus at a beam current of 250μA.

DEFLECTION (Magnetic)

Diagonal deflection angle	110	deg
Horizontal deflection angle	100	deg
Vertical deflection angle	83	deg

CAPACITANCES

$c_{g\text{-all}}$	7.0	pF
$c_{k\text{-all}}$	5.0	pF
$c_{a2+a4\text{-}M}$	700 to 1300	pF
$c_{a2+a4\text{-}B}$	200	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RING TRAP

For flashover protection to the receiver, parallel spark gaps are included for all the pins in the base of this tube, and the common connection is made to pin 5. These spark gaps are intended as part of a system for full flashover protection. A direct connection must always be made from pin 5 to the external conductive coating. Any electrode supplied directly from a high energy source (such as the H.T. line) should be provided with a series resistor.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations-Cathode Ray Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance between centre of centring field and reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations-Cathode Ray Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred on the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	18	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_g$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f=50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f=50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to + 5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds, $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

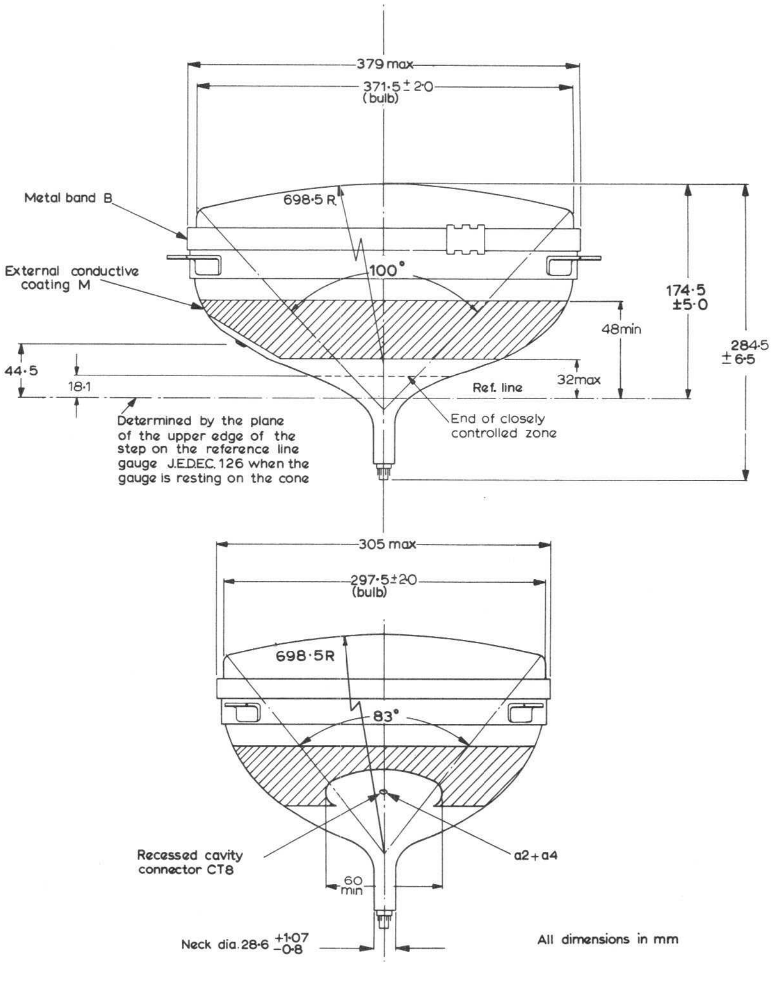
   The mounting lugs will be in electrical contact with the metal band.

WARNING

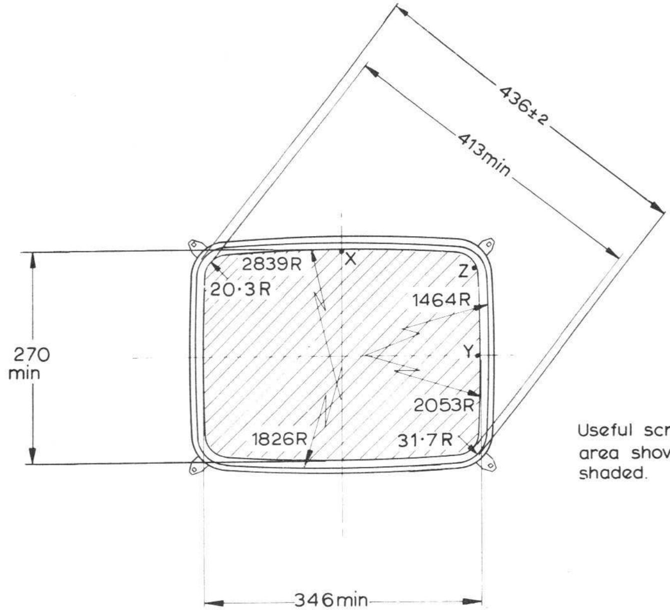
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 18kV.

WEIGHT

Tube alone (approx.)	5.5	kg



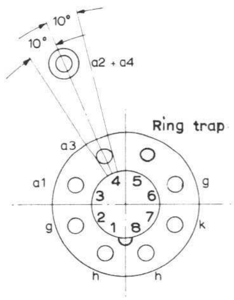
379 max
371·5 ± 2·0 (bulb)
Metal band B
698·5 R
External conductive coating M
100°
174·5 ±5·0
284·5 ±6·5
48min
44·5
18·1
32max
Ref. line
Determined by the plane of the upper edge of the step on the reference line gauge J.E.D.E.C. 126 when the gauge is resting on the cone
End of closely controlled zone
305 max
297·5±2·0 (bulb)
698·5R
83°
Recessed cavity connector CT8
a2+a4
60 min
Neck dia. 28·6 +1·07 −0·8
All dimensions in mm



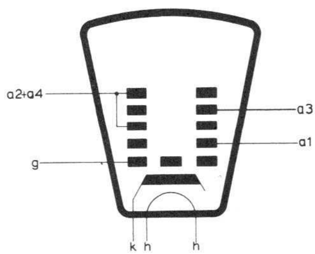
Useful screen area shown shaded.

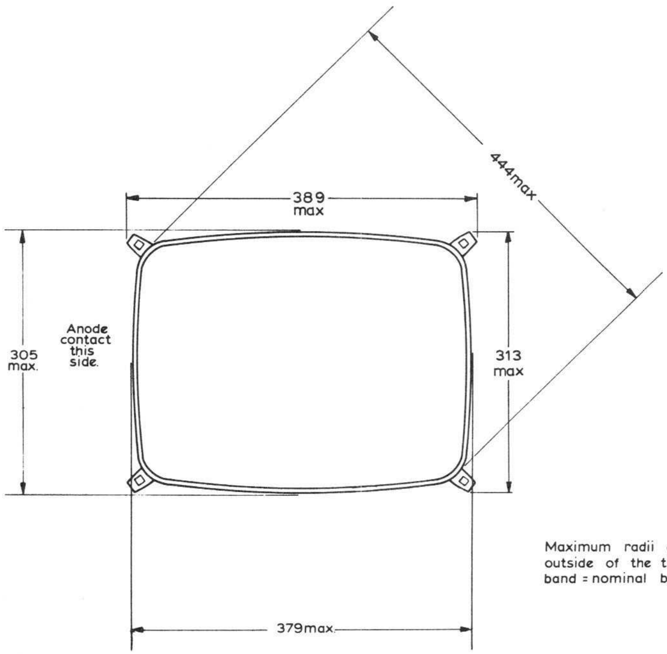
Bulb dimensions

All dimensions in mm

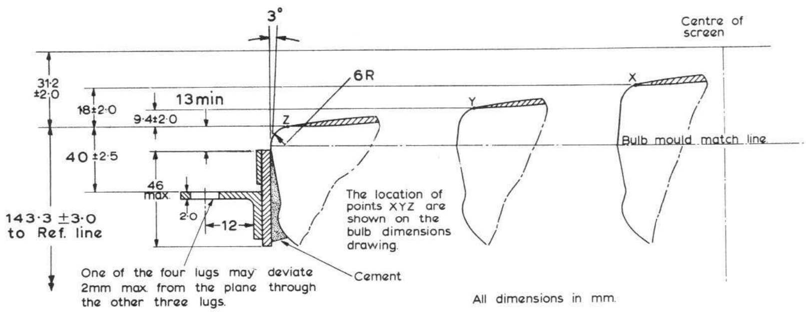


B8H Base



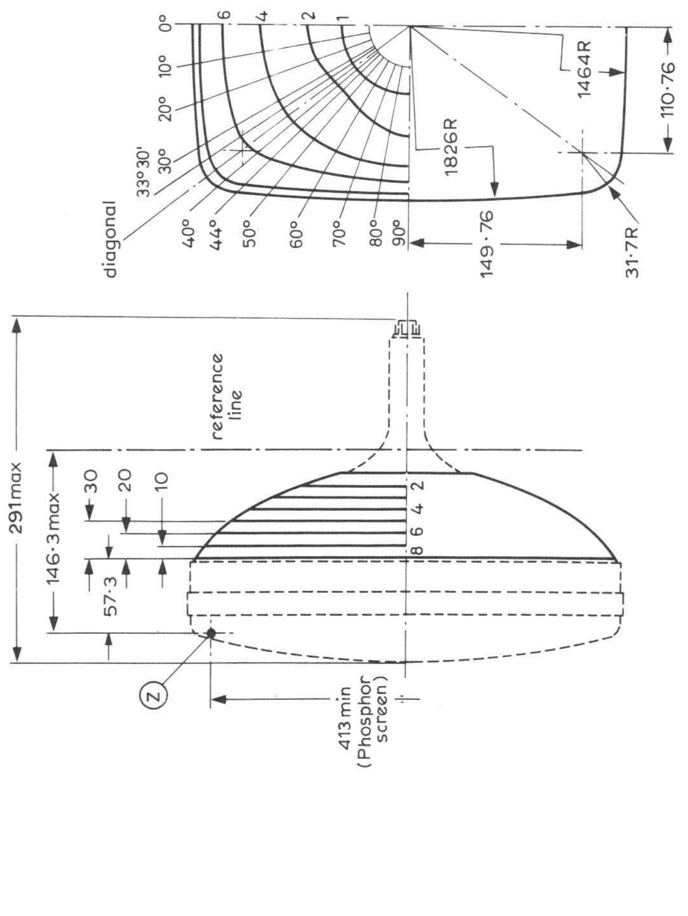


Maximum radii of the outside of the tension band = nominal bulb radius + 4·0



All dimensions in mm.

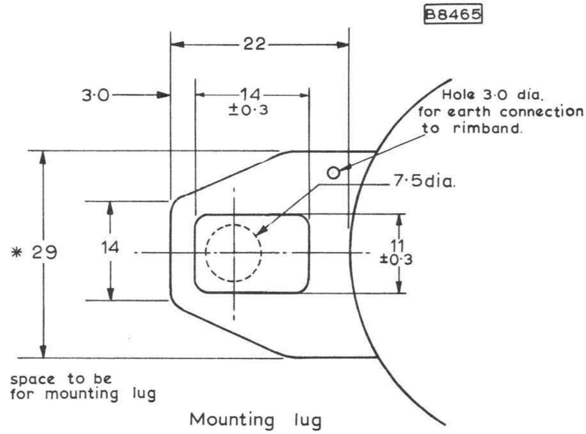
MAXIMUM CONE CONTOURS



DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page 8)

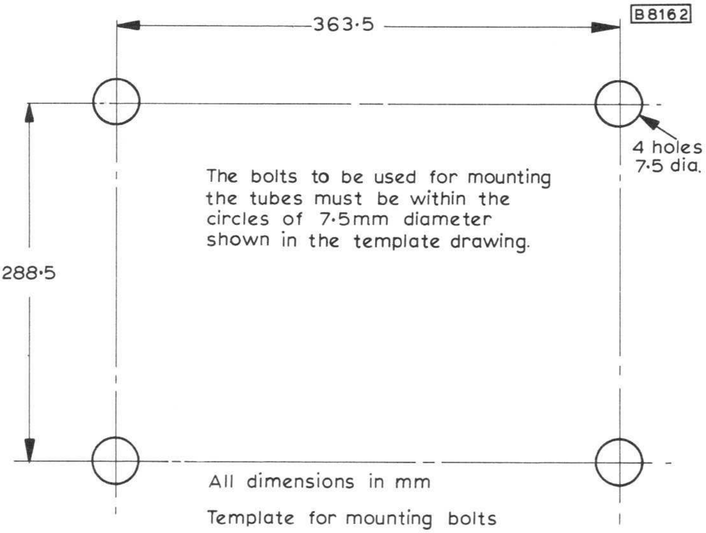
Section	Nominal distance from point "Z"	Distance from centre (max. values) 0° Long axis	10°	20°	30°	33°30'	36°30' Diagonal	40°	44°	50°	60°	70°	80°	90° Short axis
1	128	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0	60.0
2	117.3	95.9	95.2	93.0	92.3	92.1	92.1	92.3	92.6	93.1	93.8	94.6	94.9	95.1
3	107.3	118.1	117.8	118.3	118.3	118.6	119.2	117.8	117.7	117.2	115.5	113.3	111.2	109.8
4	97.3	135.0	136.1	138.3	139.9	141.0	141.6	141.1	138.5	135.4	130.5	125.6	121.8	120.8
5	87.3	149.5	151.1	155.1	159.1	161.3	162.0	161.5	157.5	151.0	142.0	135.8	130.8	129.5
6	77.3	162.5	164.0	168.8	176.0	179.0	179.5	178.0	173.5	163.4	150.8	143.3	138.3	136.4
7	67.3	172.5	174.4	180.1	190.0	194.1	196.3	194.9	186.8	174.5	159.1	149.3	143.9	141.7
8	57.3	179.7	183.1	189.3	201.1	207.4	210.9	206.1	196.0	182.8	165.5	154.0	147.9	145.6

All dimensions in millimetres



* Minimum space to be
reserved for mounting lug
= 33

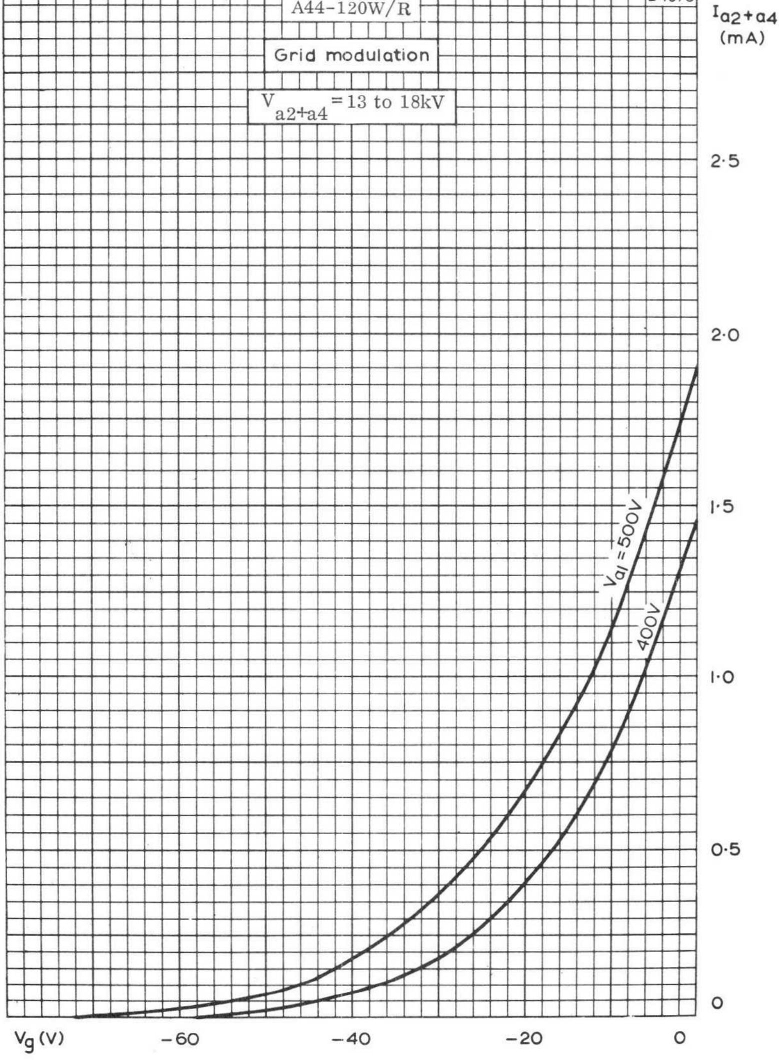
Mounting lug



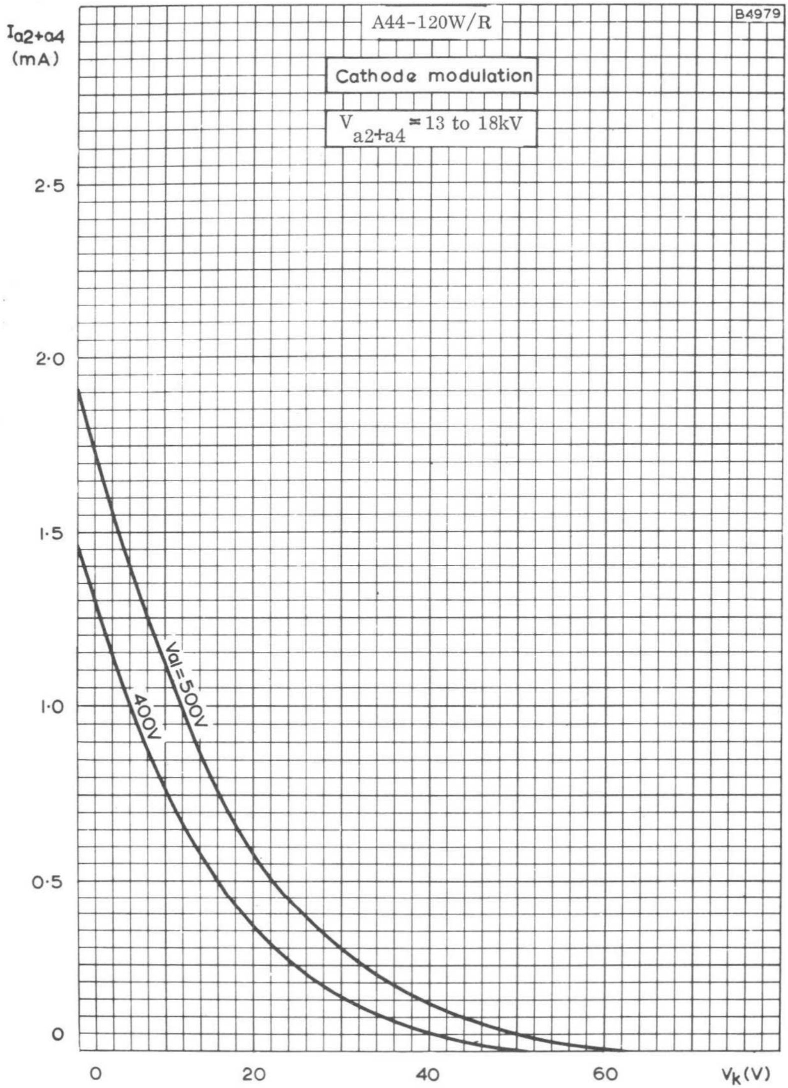
The bolts to be used for mounting the tubes must be within the circles of 7·5mm diameter shown in the template drawing.

All dimensions in mm

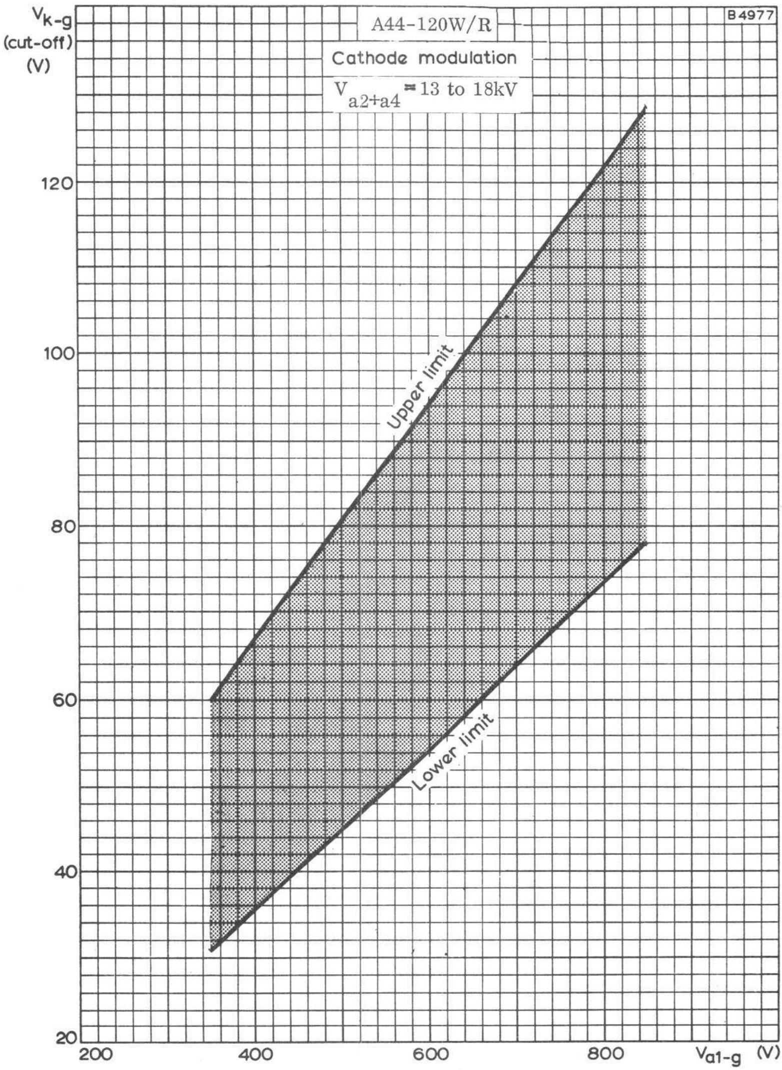
Template for mounting bolts



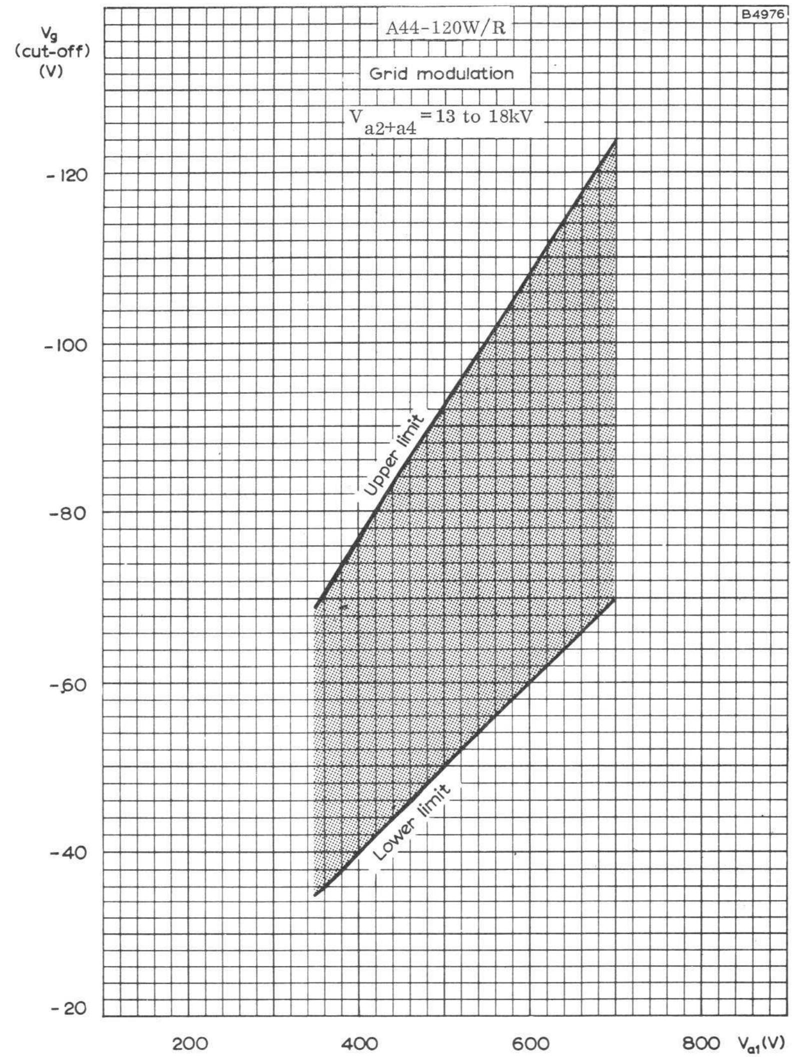
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE
CATHODE MODULATION



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE.
CATHODE MODULATION



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

TELEVISION TUBE A47-11W

QUICK REFERENCE DATA		
47cm (19 in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is electrically identical to the A47-14W.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	%
Maximum overall length	30.9	cm

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

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV ←
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed		
Fluorescent colour	White	
Light transmission (approx.)	50	%
Useful screen area	see page D6	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION

Double magnetic

The deflection coils should be designed so that their internal contour is in accordance with J.E.D.E.C. gauge 126, and should provide a pull-back of 4mm on a nominal tube.

CAPACITANCES

$c_{g\text{-all}}$	6.0	pF
$c_{k\text{-all}}$	4.0	pF
$c_{a2+a4\text{-M}}$	1000 to 1500	pF
$c_{a2+a4\text{-B}}$	250	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be earthed, and the capacitance of this to the final anode is 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.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION Any

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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV ←
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_g$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	µA
$\pm I_{a1}$ max.	5	µA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h\text{-}k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h\text{-}k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) must be connected to the chassis via a 2MΩ resistor. Soldering tags are provided for this purpose.

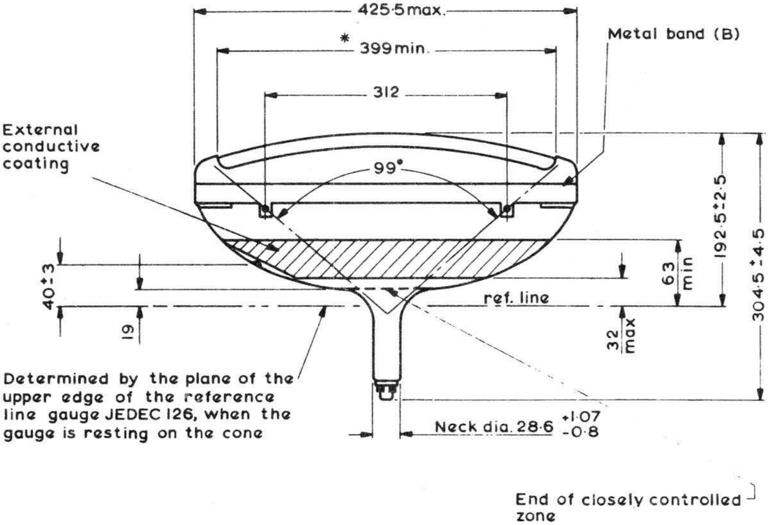
   The mounting lugs will not necessarily be in electrical contact with the metal band.

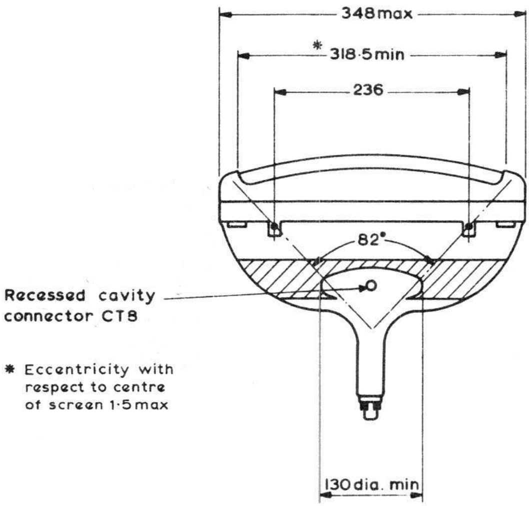
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV. ←

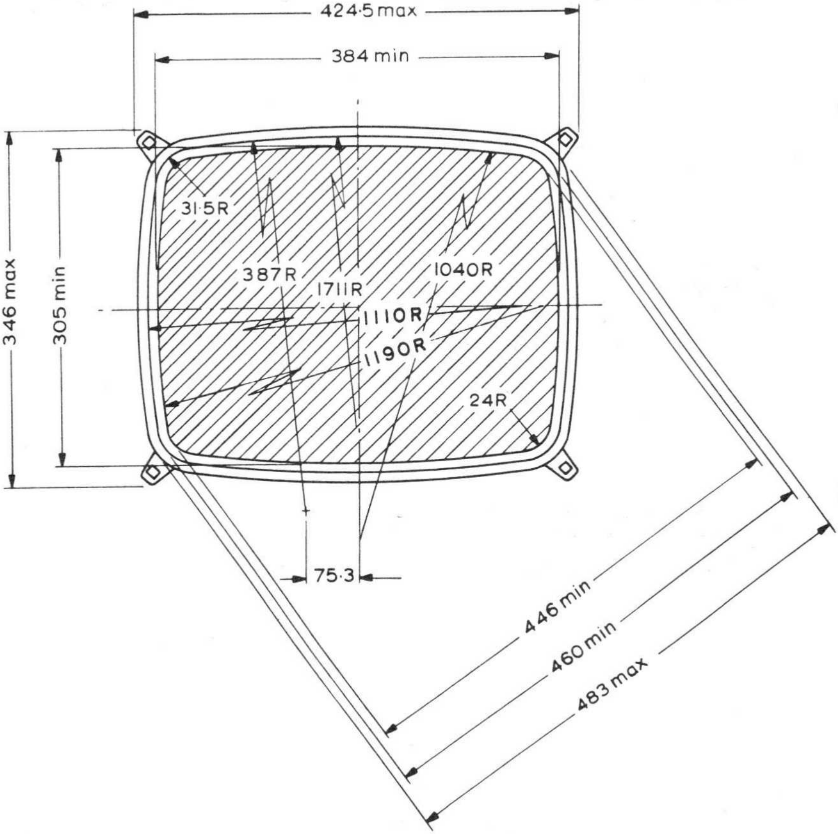
WEIGHT

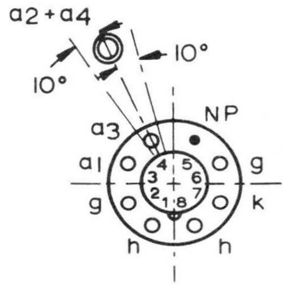
Tube alone	7.5	kg
	16.5	lb



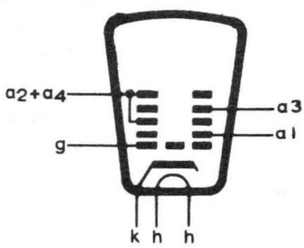


All dimensions in mm.

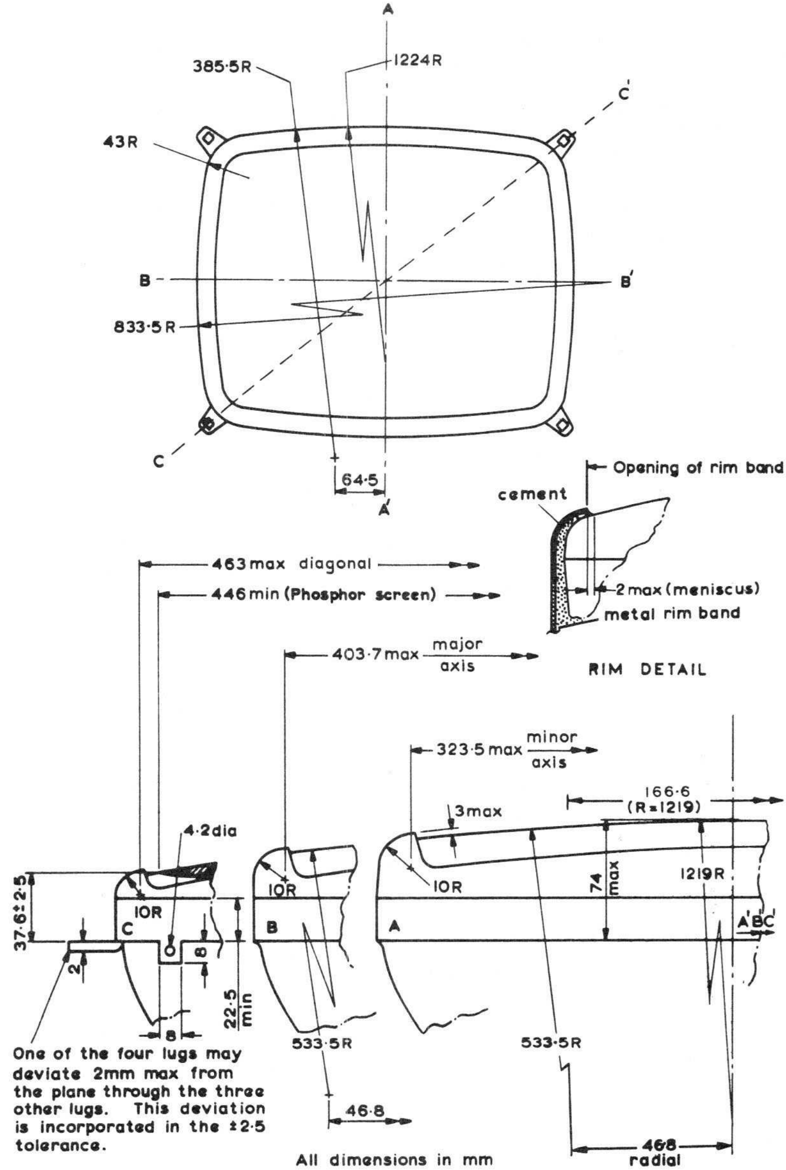


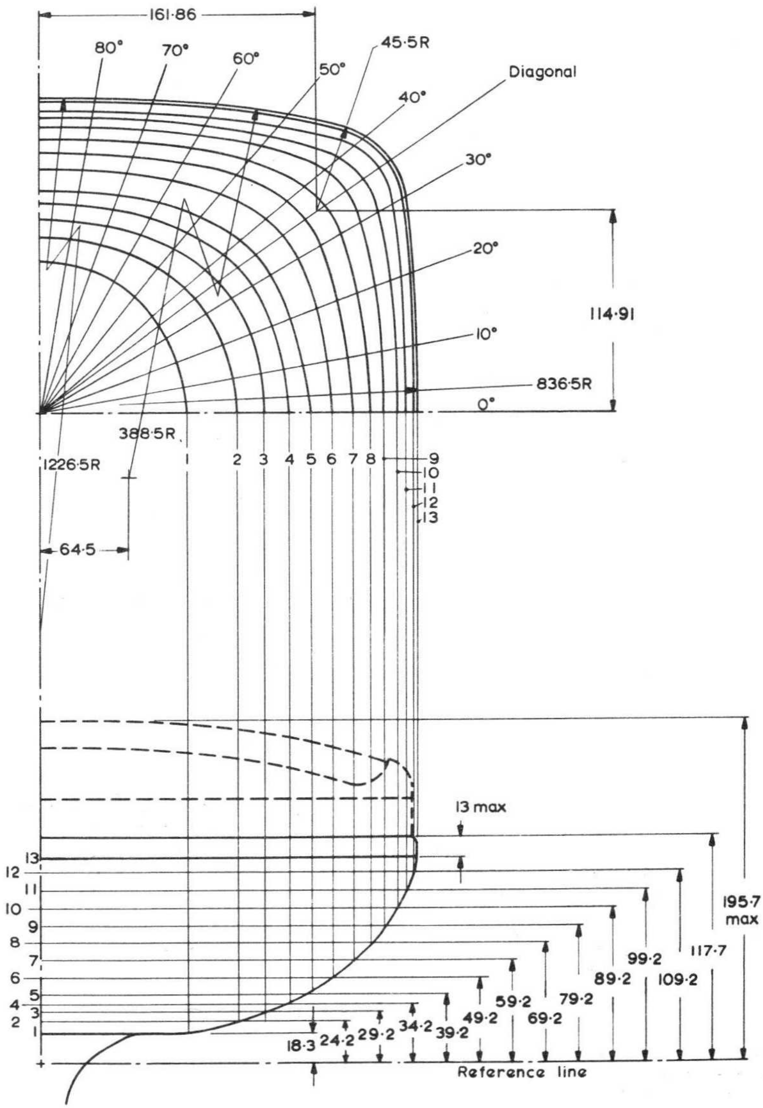


B8H Base



All dimensions in mm


A
385·5R
1224R
C'
43R
B
B'
833·5R
C
64·5
A'
Opening of rim band
cement
2 max (meniscus)
metal rim band
RIM DETAIL
463 max diagonal
446 min (Phosphor screen)
403·7 max major axis
323·5 max minor axis
166·6 (R=1219)
3 max
4·2 dia
37·6±2·5
10R
C
2
8
22·5 min
8
10R
B
10R
A
74 max
1219R
A' B C'
533·5R
533·5R
46·8
468 radial
One of the four lugs may deviate 2mm max from the plane through the three other lugs. This deviation is incorporated in the ±2·5 tolerance.
All dimensions in mm

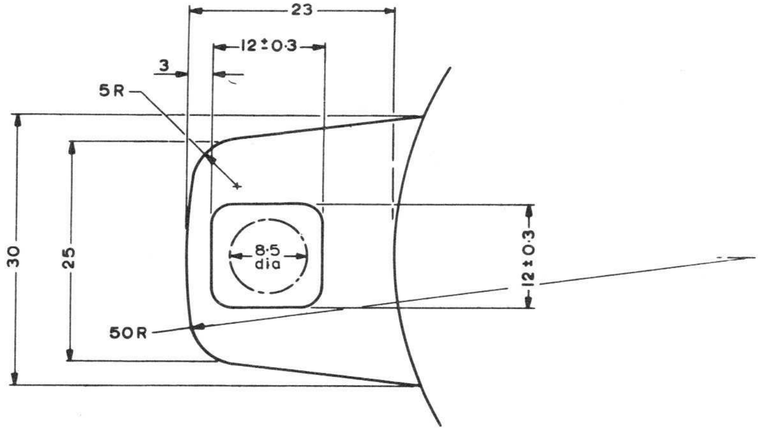


MAXIMUM CONE CONTOURS

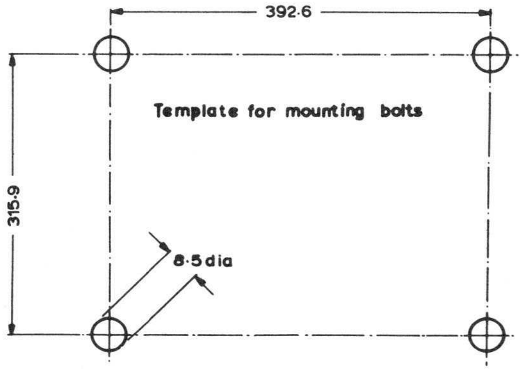
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page D8)

Section	0^o long	10^o	20^o	30^o	$35^o 22'$ diagonal	40^o	50^o	60^o	70^o	80^o	90^o short
1	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
2	111.2	111.2	110.8	108.8	107.7	106.3	103.7	100.6	98.1	96.2	95.6
3	128.5	182.5	127.3	125.5	124.0	122.2	117.9	113.2	108.9	106.6	106.2
4	142.2	141.1	140.3	138.8	137.5	135.9	130.6	124.4	119.0	115.8	115.3
5	152.1	151.1	150.9	150.6	149.5	147.6	140.6	133.4	127.2	123.6	122.7
6	166.7	166.6	167.6	169.5	169.1	167.0	158.1	148.2	140.9	136.5	134.9
7	178.1	178.6	180.6	184.7	185.7	183.1	172.1	160.7	151.7	146.3	144.7
8	187.5	188.3	191.6	198.0	200.1	197.2	183.7	170.3	160.2	154.4	152.5
9	195.4	196.6	201.7	210.3	213.7	210.1	194.1	178.8	167.9	161.4	159.3
10	202.1	203.9	210.1	221.2	225.3	221.1	202.8	185.8	174.4	167.5	165.4
11	208.4	210.4	217.8	230.5	235.3	231.2	209.9	192.0	180.0	172.7	170.5
12	213.6	216.1	223.9	237.0	241.8	238.1	215.4	197.2	184.6	177.3	175.0
13	215.8	218.2	225.8	239.2	244.0	240.4	218.1	199.7	186.6	179.3	177.0

All dimensions in mm

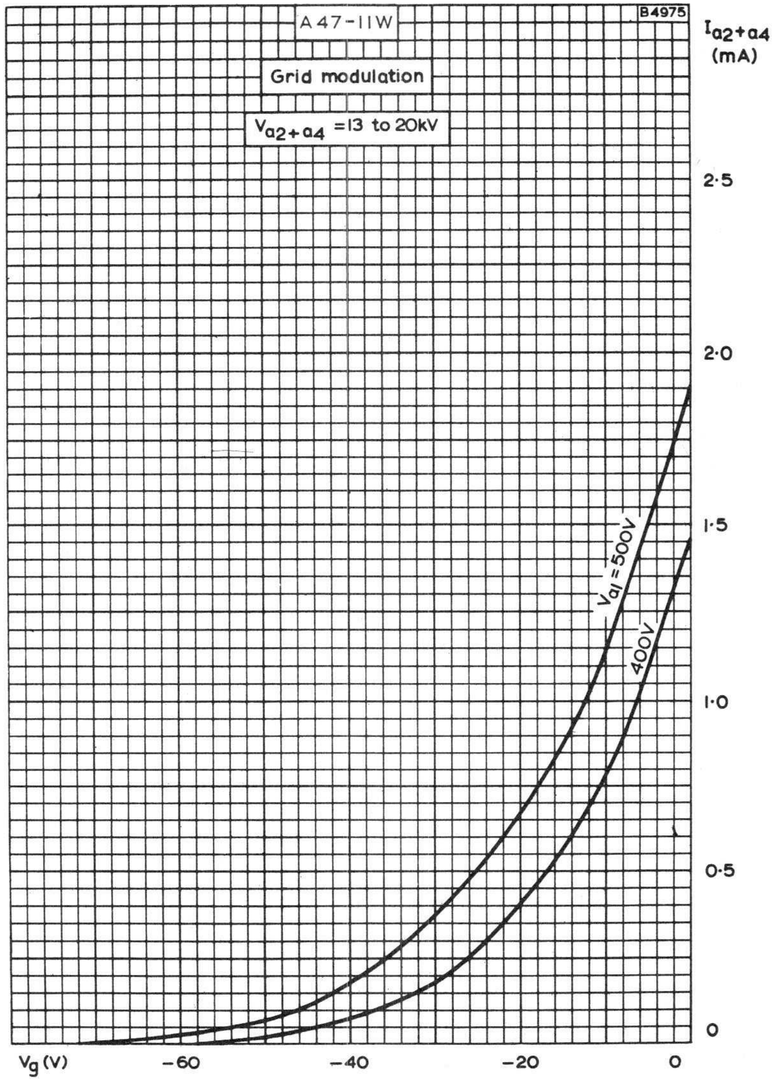


Mounting lug

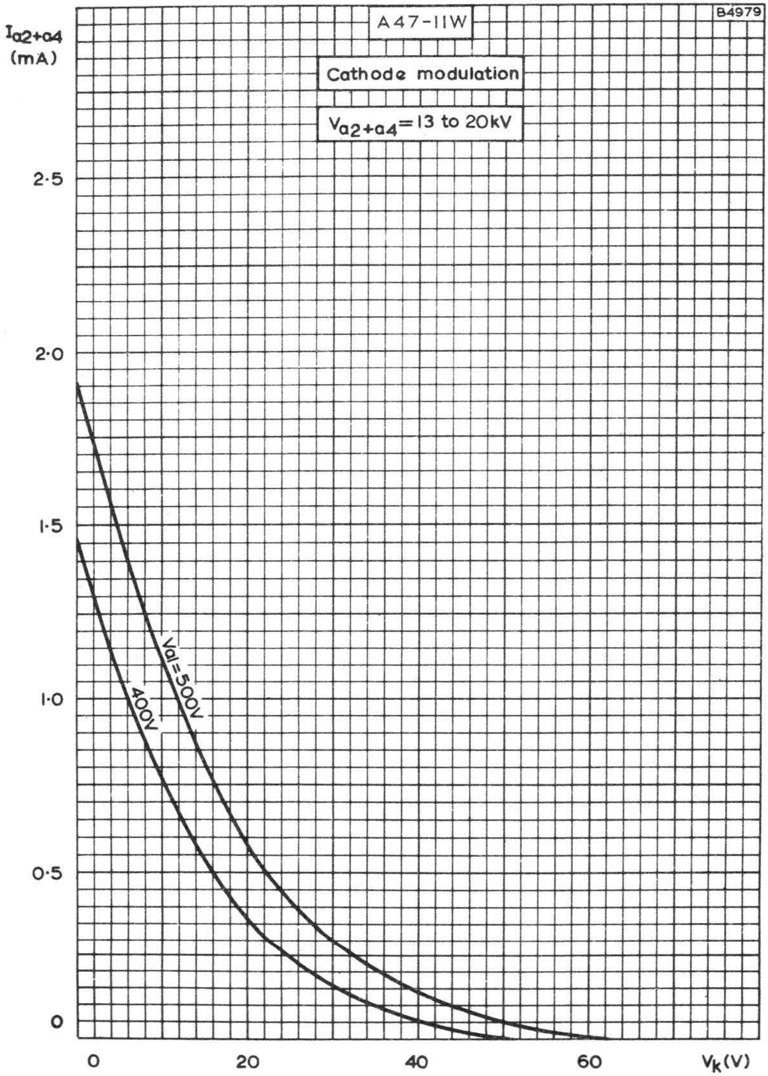


All dimensions in mm.

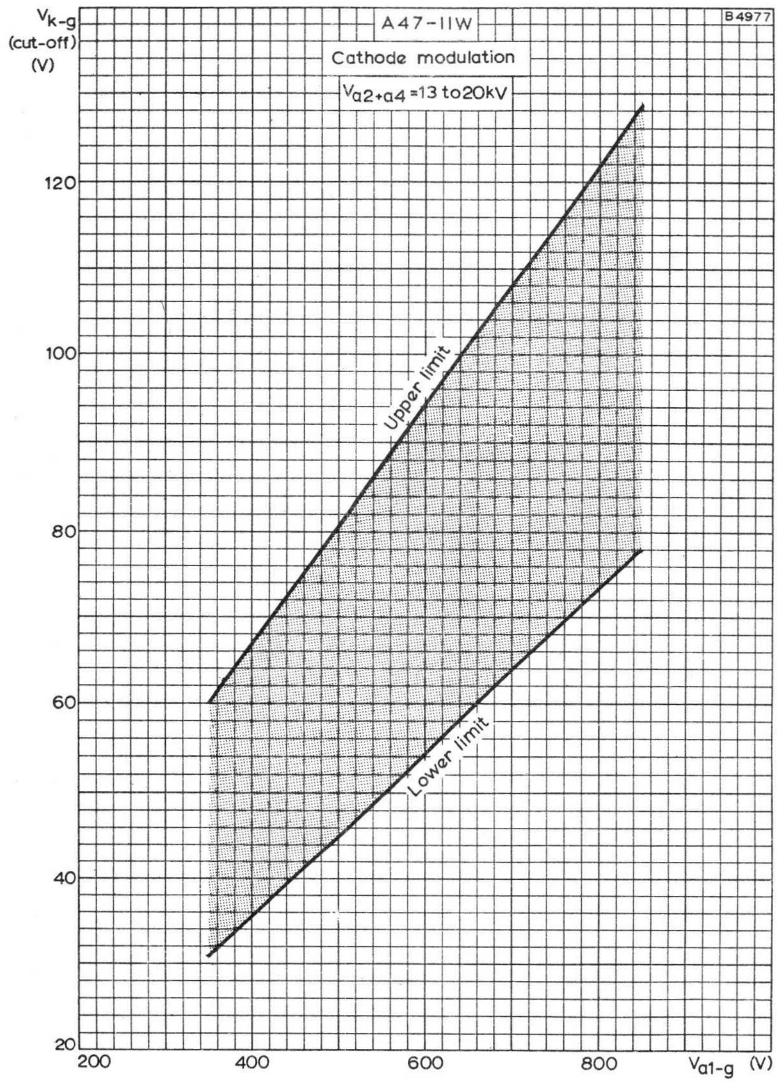
The bolts to be used for mounting the tube must be within the circles of 8.5mm diameter shown in the template drawing.



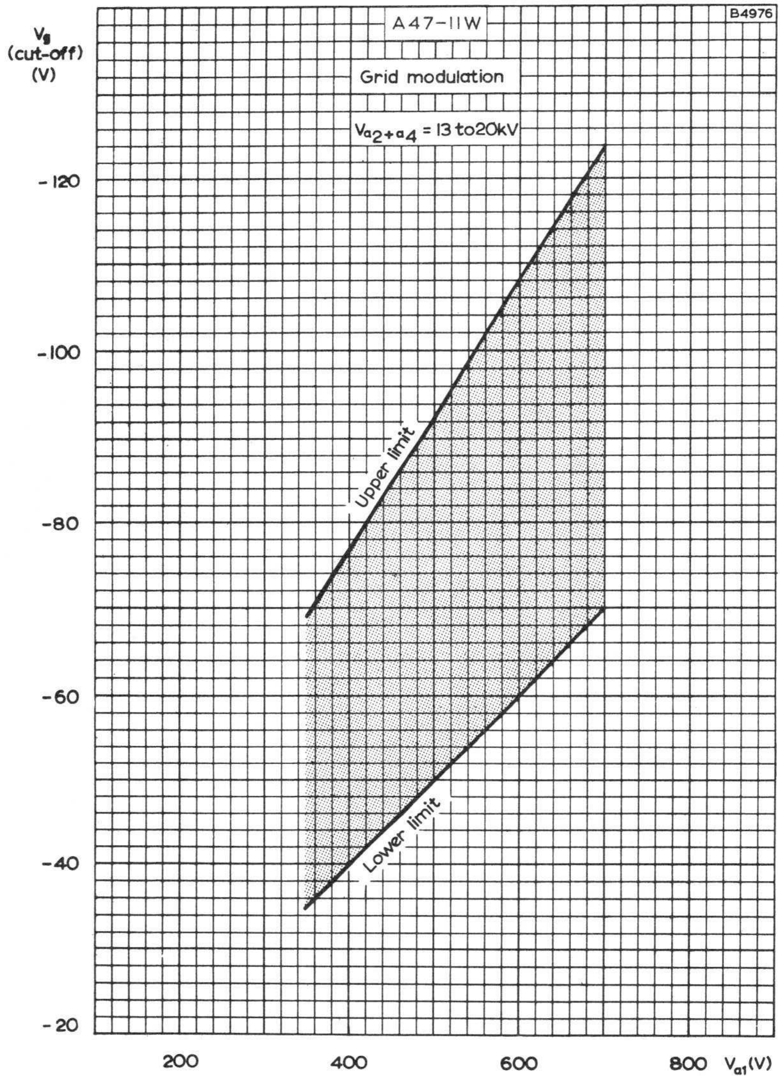
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE A47-14W

QUICK REFERENCE DATA		
47cm (19in) direct viewing television tube with metal backed screen. This tube is electrically identical to the A47-11W.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	%
Maximum overall length	30.9	cm

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

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White	
Light transmission (approx.)	50	%
Useful screen area	see page D6	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION

Double magnetic

The deflection coils should be designed so that their internal contour is in accordance with J.E.D.E.C. gauge 126, and should provide a pull-back of 4mm on a nominal tube.

CAPACITANCES

$c_{g\text{-}all}$	6.0	pF
$c_{k\text{-}all}$	4.0	pF
$c_{a2+a4\text{-}M}$	1000 to 1500	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be earthed, and the capacitance of this to the final anode is 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.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION Any

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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_g$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.
2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.
3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

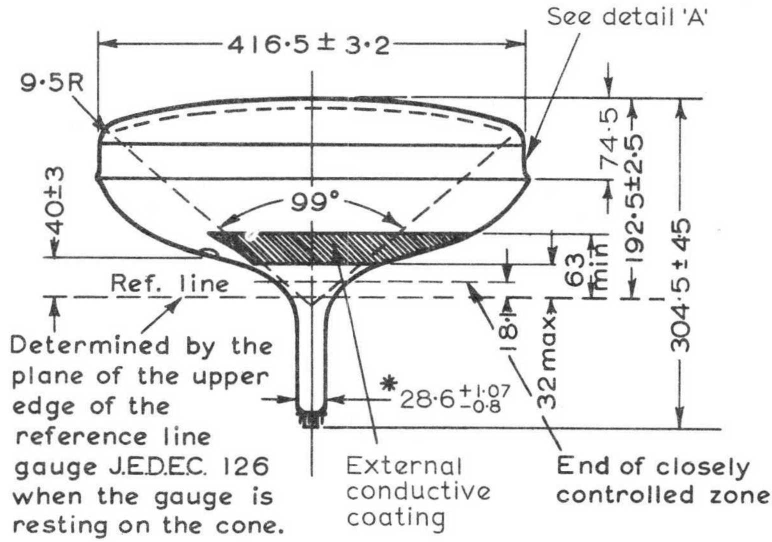
   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.
4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

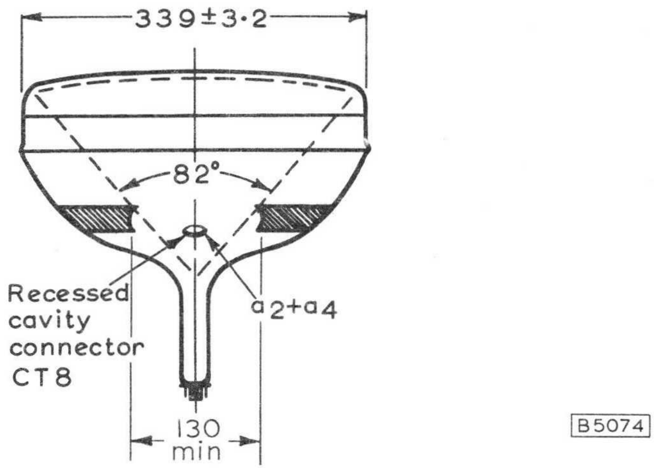
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

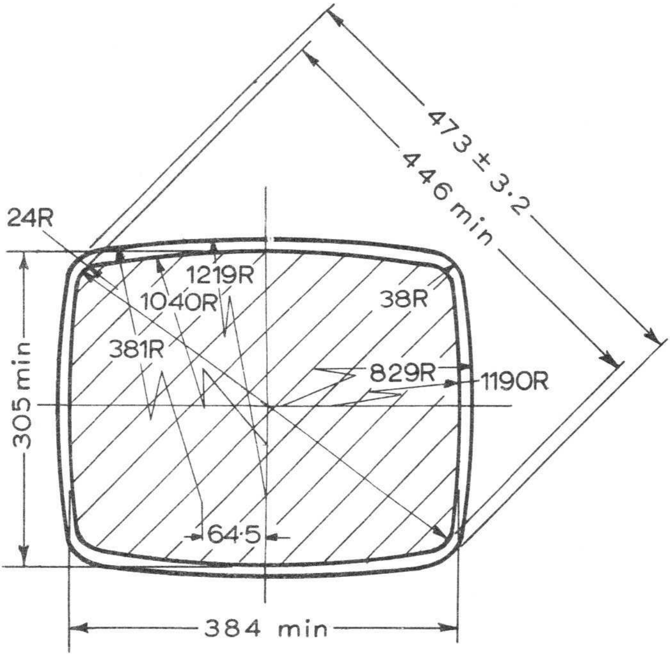
WEIGHT

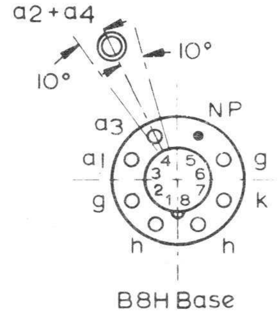
Tube alone	7.0	kg
	15.4	lb

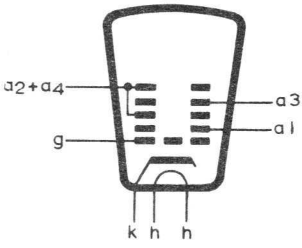




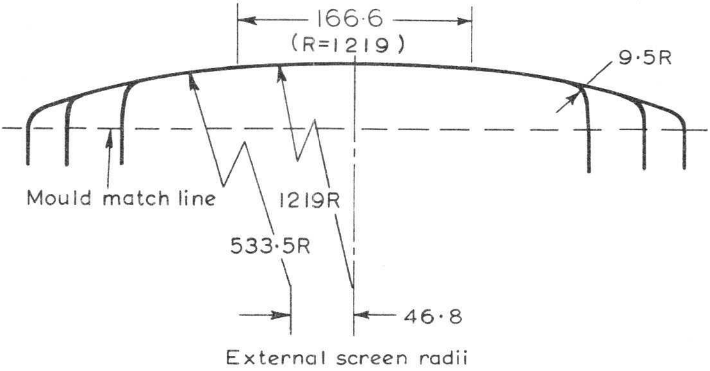
*The maximum value is determined by the reference line gauge



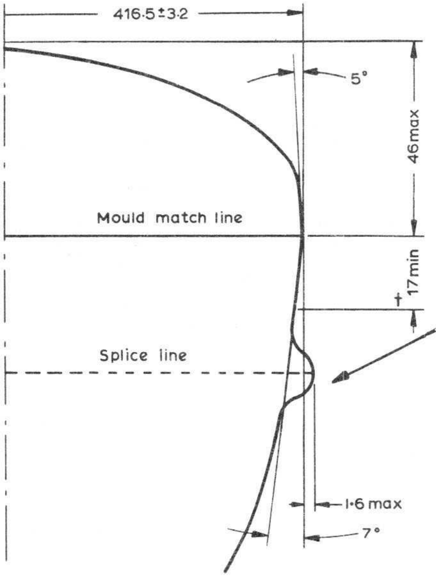




All dimensions in mm



Detail 'A'



†Undisturbed area between mould match line and splice line

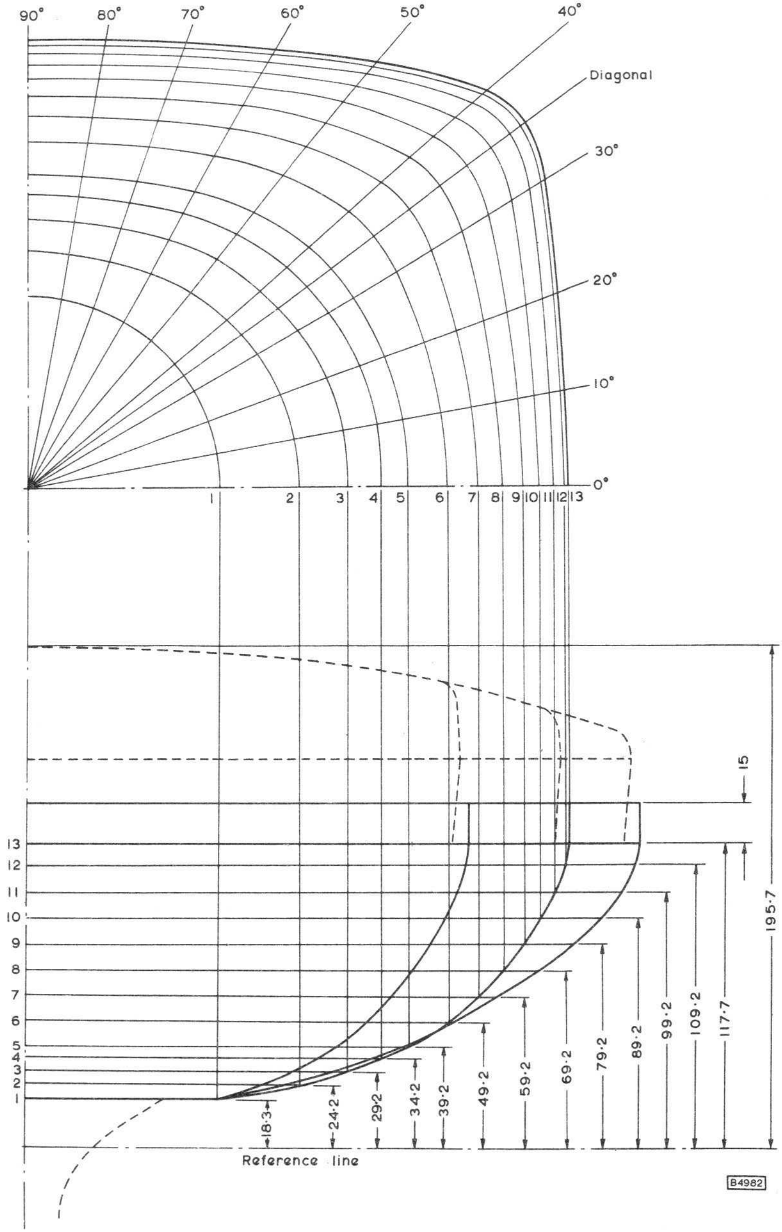
All dimensions in mm

B5009

The bulge at the splice line seal may increase the indicated maximum values for envelope width, diagonal and height by not more than 3.2mm, but at any point around the seal, the bulge will not protrude more than 1.6mm beyond the envelope surface at the mould match line.

The mounting arrangement should be designed such that for satisfactory clamping it does not depend on the presence of a bulge at the splice line.

The undisturbed area between mould match line and splice line is 15mm minimum. This should be the width of the tube support band.

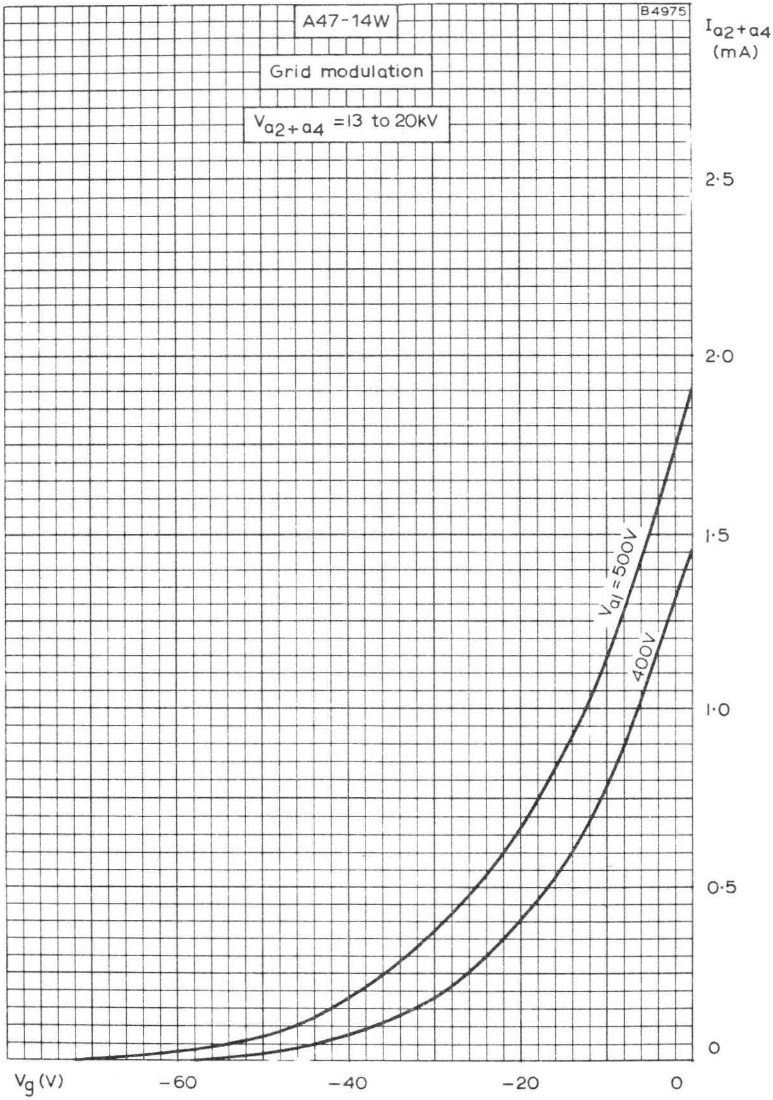


MAXIMUM CONE CONTOURS

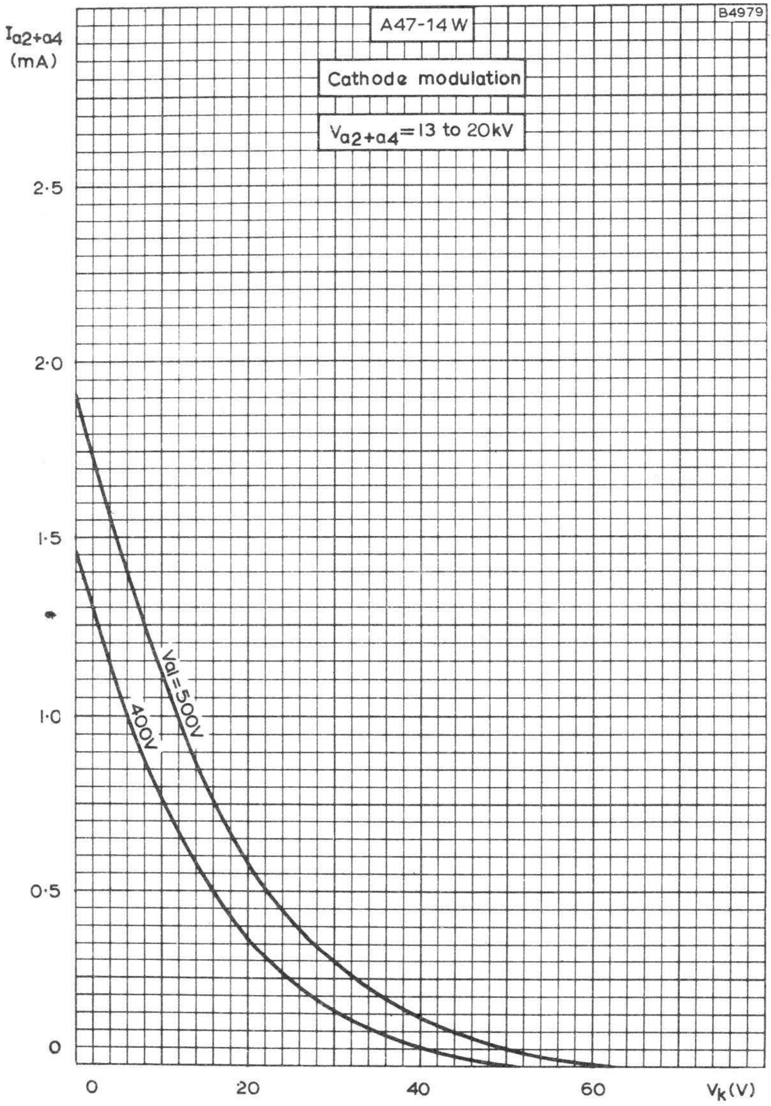
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page D8)

Section	Nominal height above Ref. line	0° long	10°	20°	30°	Diagonal	40°	50°	60°	70°	80°	90° short
1	18.3	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
2	24.2	106.1	105.6	105.6	103.8	102.7	101.6	99.1	96.2	93.7	92.4	92.4
3	29.2	125.3	125.7	124.6	122.3	120.6	118.9	115.1	111.0	106.7	104.2	103.9
4	34.2	138.2	138.9	137.8	136.0	134.3	132.3	127.5	121.8	117.0	113.7	113.0
5	39.2	148.6	149.0	148.5	147.7	146.3	144.2	138.0	131.3	125.2	121.6	120.6
6	49.2	164.5	164.6	165.2	167.3	166.8	164.6	156.0	146.8	139.0	134.5	133.1
7	59.2	176.5	176.6	178.7	183.4	184.0	181.4	170.2	158.9	149.8	144.6	142.9
8	69.2	186.3	186.5	190.3	197.0	198.9	195.8	182.3	169.0	158.9	152.8	151.1
9	79.2	194.2	195.0	200.2	209.1	212.0	208.6	192.5	177.5	166.2	159.8	157.9
10	89.2	200.7	202.1	208.4	219.6	223.5	219.7	200.4	184.2	172.3	165.8	163.4
11	99.2	206.0	208.0	215.0	227.9	232.8	228.6	206.6	189.2	176.9	170.0	167.9
12	109.2	210.0	212.3	219.6	233.0	238.1	233.9	210.9	193.2	180.5	173.6	171.3
13	117.7	212.2	214.6	221.8	234.9	240.5	236.0	213.1	195.1	182.6	175.7	173.5

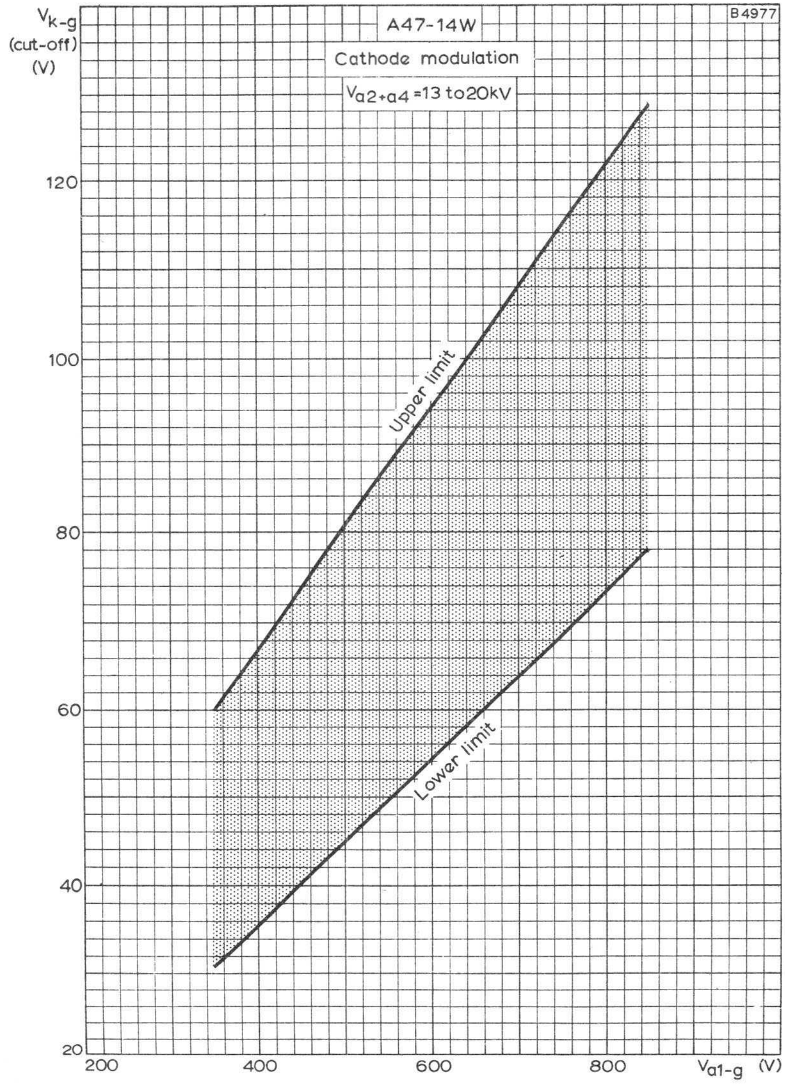
All dimensions in mm.



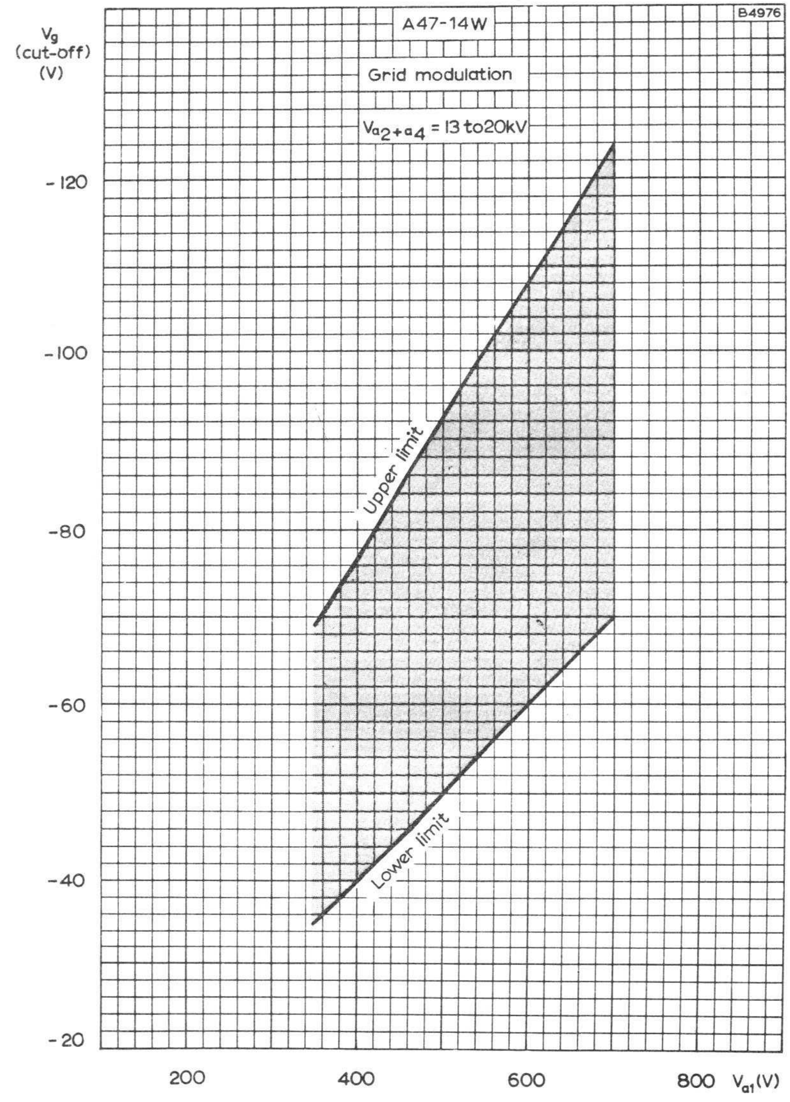
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION



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

TELEVISION TUBE A47-26W

TENTATIVE DATA

QUICK REFERENCE DATA		
47cm (19in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is electrically identical to the A47-11W. Suitable for use in receivers with push-through presentation.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	%
Maximum overall length	30.9	cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White	
Light transmission (approx.)	50	%
Useful screen area	See page D6	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION

Magnetic

Diagonal deflection angle	110	deg
Horizontal deflection angle	99	deg
Vertical deflection angle	82	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

$c_{g\text{-all}}$	6.0	pF
$c_{k\text{-all}}$	4.0	pF
$c_{a2+a4\text{-M}}$	1000 to 1500	pF
$c_{a2+a4\text{-B}}$	250	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flash-over within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

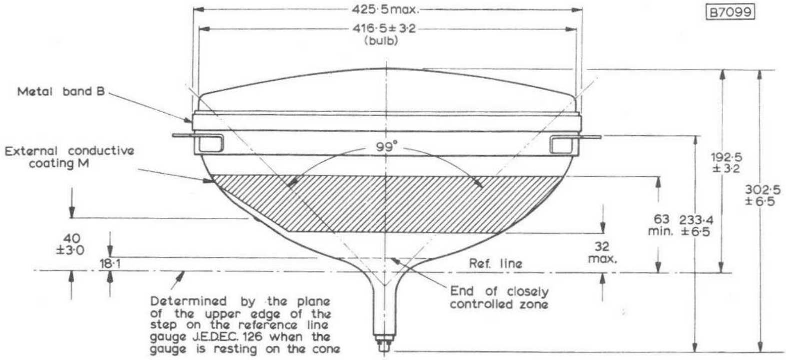
   The mounting lugs will be in electrical contact with the metal band.

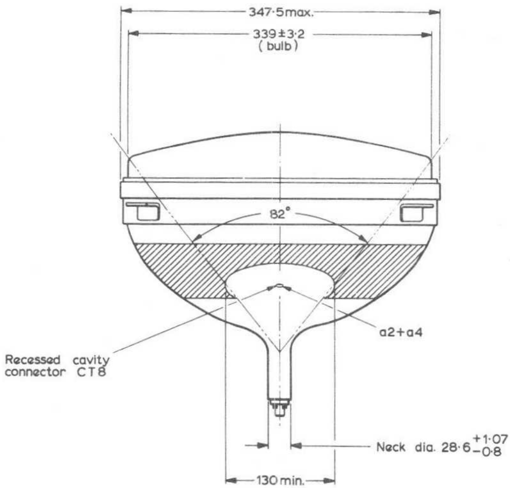
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

WEIGHT

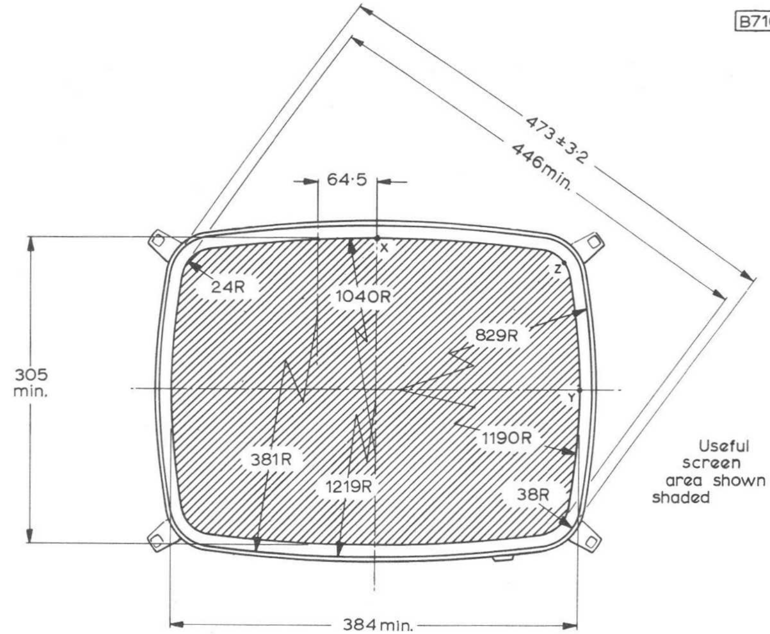
Tube alone (approx.)	8.0	kg



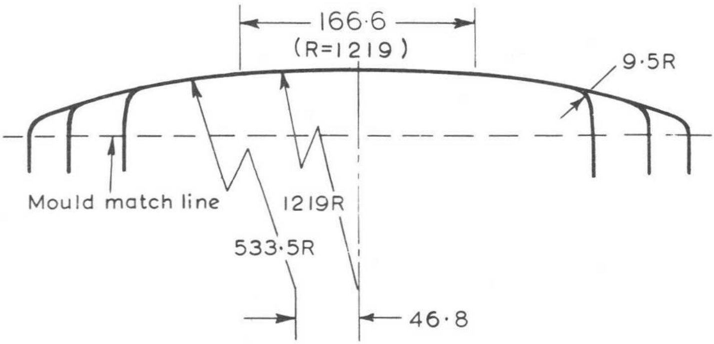


All dimensions in mm

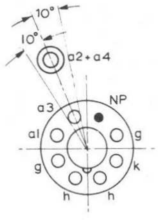
B7100



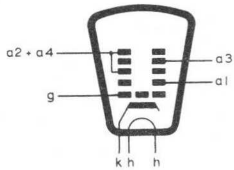
Bulb dimensions

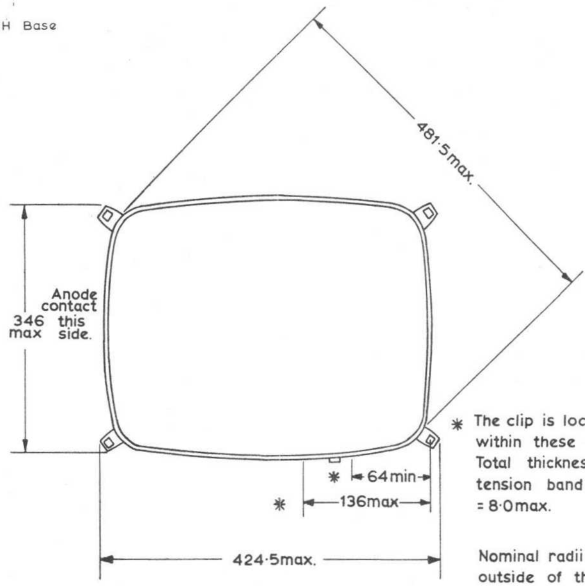


External screen radii



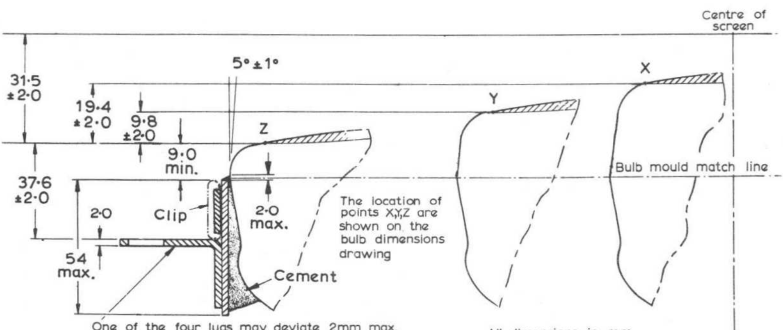
B8H Base





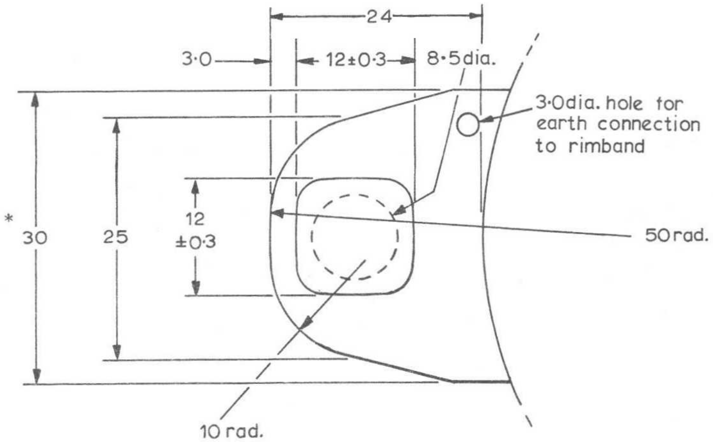
* The clip is located within these dimensions. Total thickness of rimband tension band and clip = 8·0max.

Nominal radii of the outside of the tension band = bulb radius+2·5



One of the four lugs may deviate 2mm max. from the plane through the three other lugs

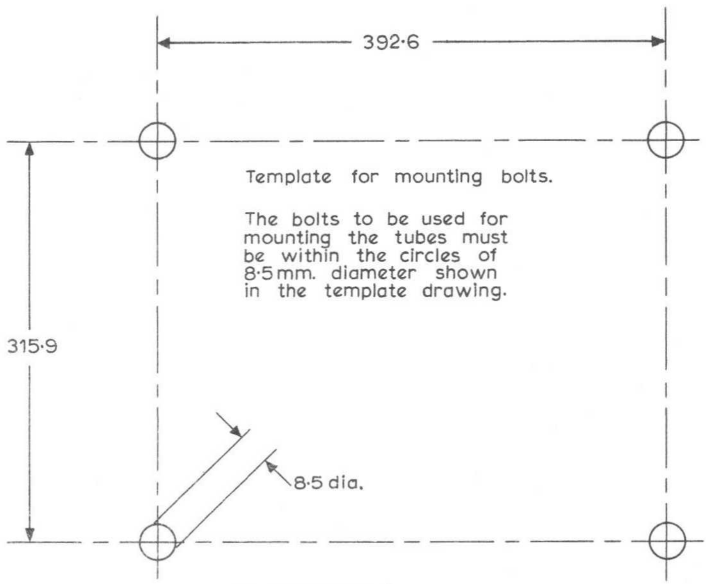
All dimensions in mm



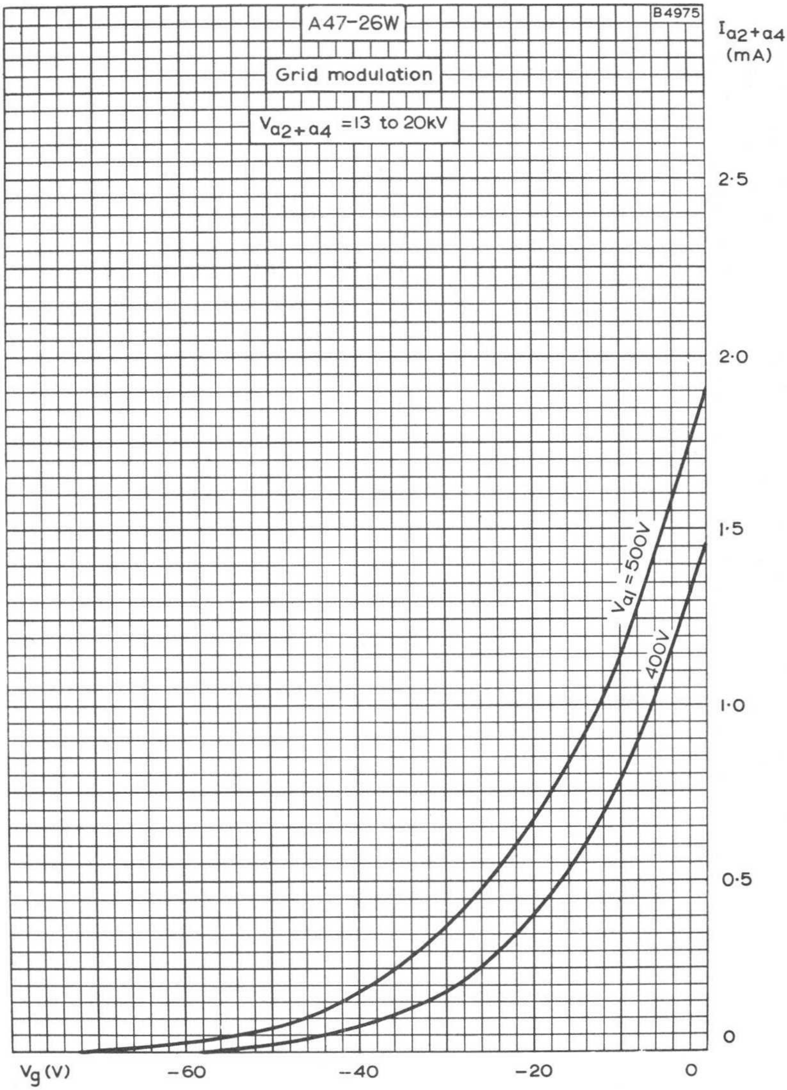
* Minimum space to be reserved for mounting lugs = 37mm.

Mounting lug

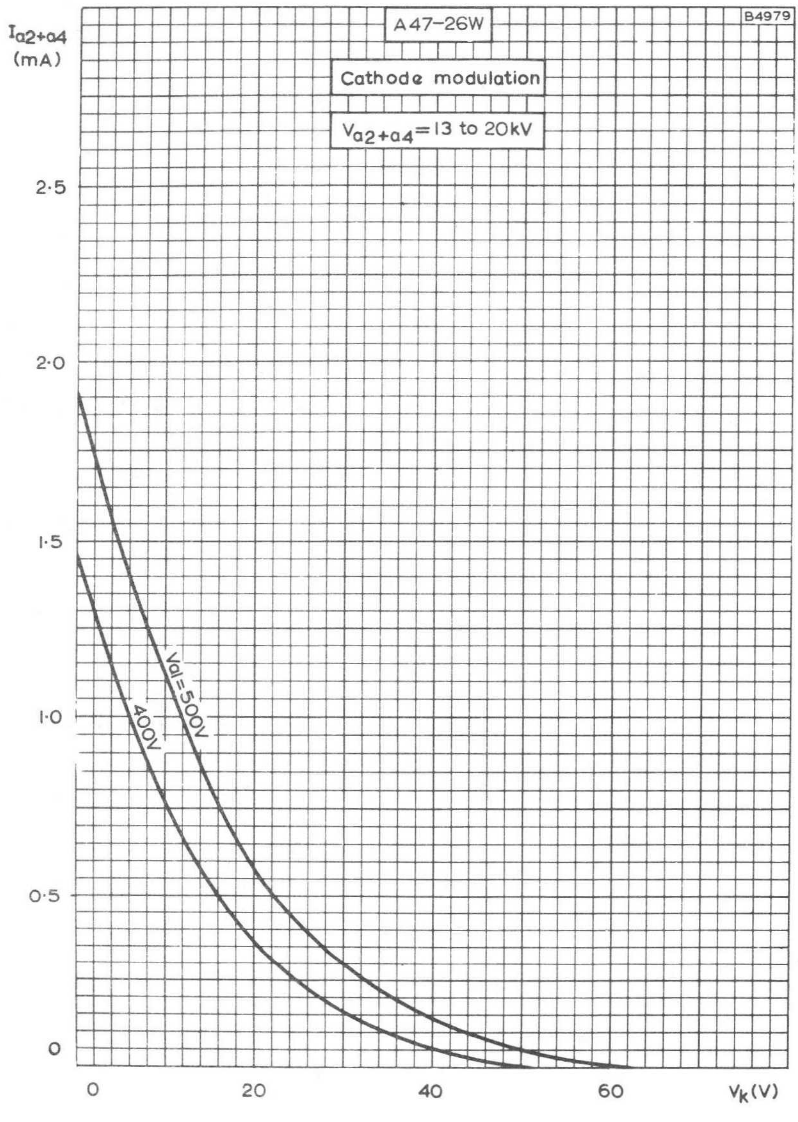
B7746



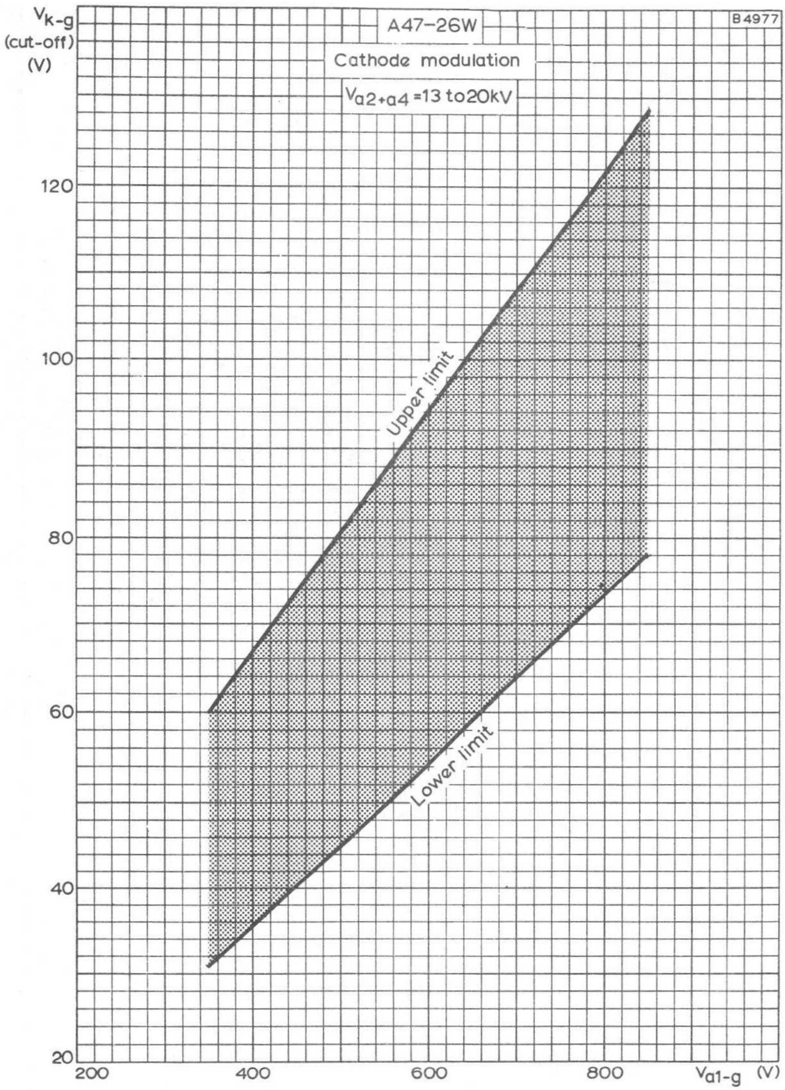
All dimensions in mm.



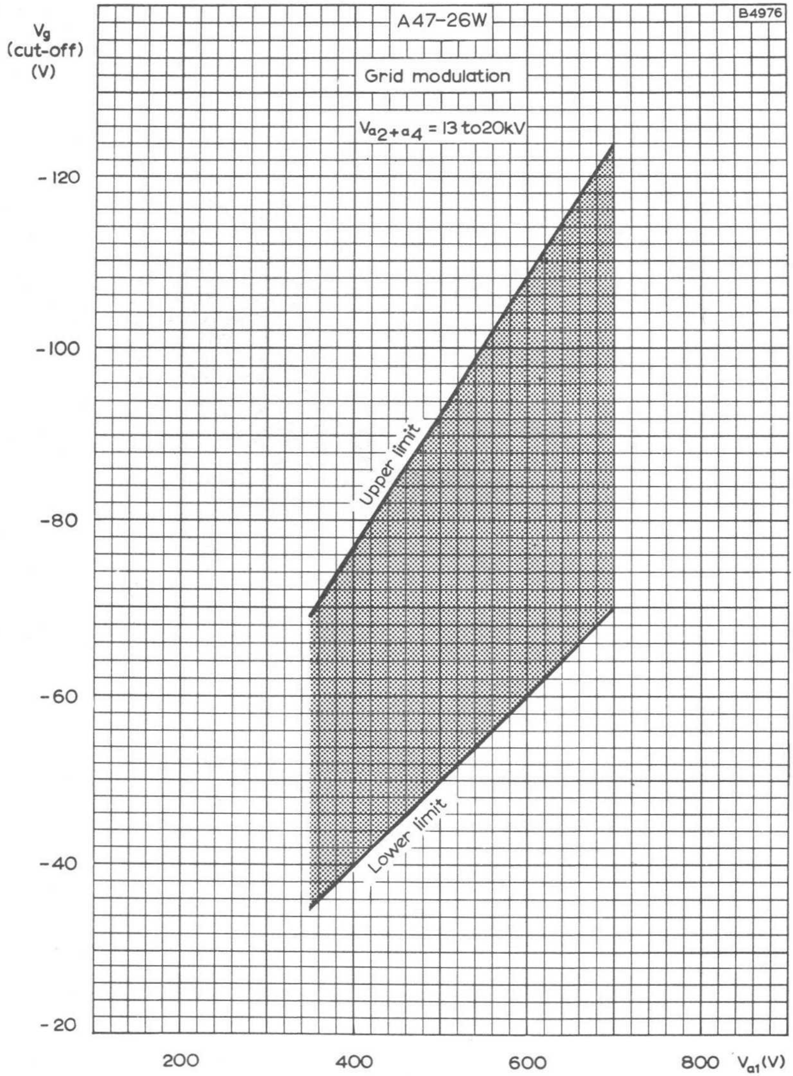
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE A47-26W/R

QUICK REFERENCE DATA		
47cm (19in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is fitted with a ring trap base but in all other respects is electrically identical to the A47-11W. Suitable for use in receivers with push-through presentation.		
Deflection angle	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	48	%
Maximum overall length	309	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (Metal backed)

Fluorescent colour		White
Light transmission (approx.)	48	%
Useful screen area		See page 6

FOCUSING (Electrostatic)

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION (Magnetic)

Diagonal deflection angle	110	deg
Horizontal deflection angle	99	deg
Vertical deflection angle	82	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	1000 to 1500	pF
$c_{a2+a4-B}$	400	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RING TRAP

For flashover protection to the receiver, parallel spark gaps are included for all the pins in the base of this tube, and the common connection is made to pin 5. These spark gaps are intended as part of a system for full flashover protection. A direct connection must always be made from pin 5 to the external conductive coating. Any electrode supplied directly from a high energy source (such as the H.T. line) should be provided with a series resistor.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations-Cathode Ray Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations-Cathode Ray Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flash-over within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

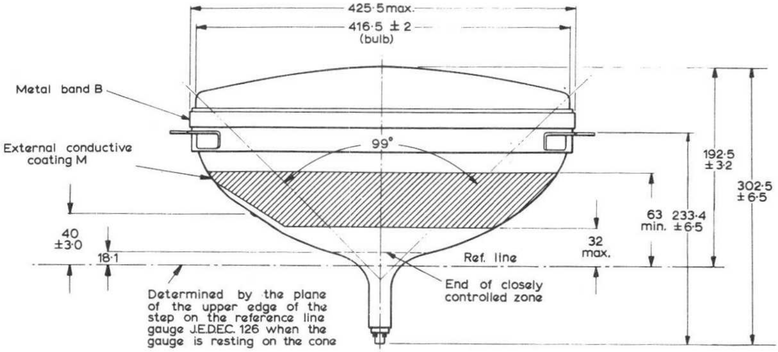
   The mounting lugs will be in electrical contact with the metal band.

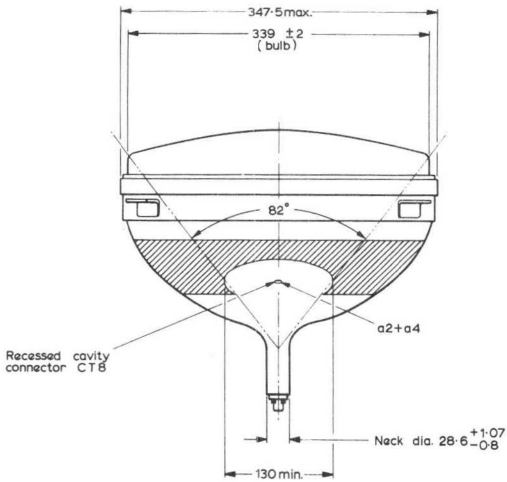
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

WEIGHT

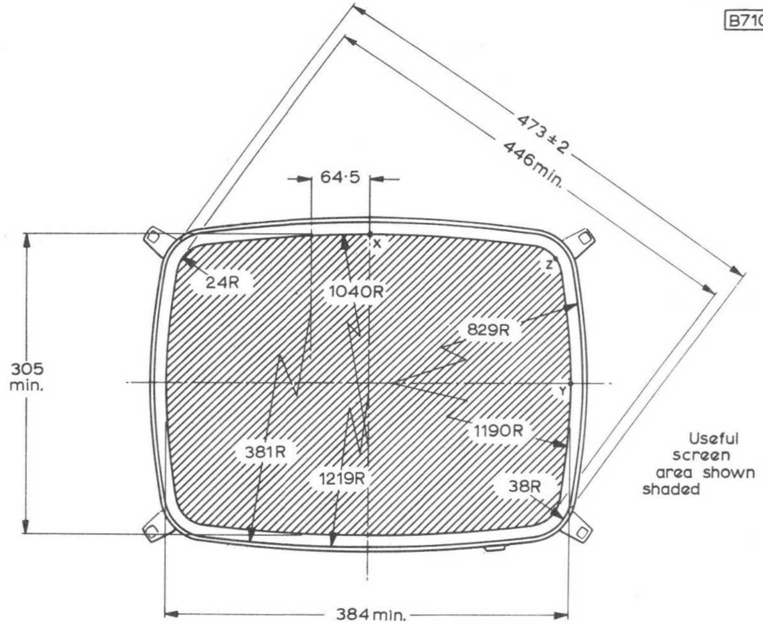
Tube alone (approx.)	8.0	kg



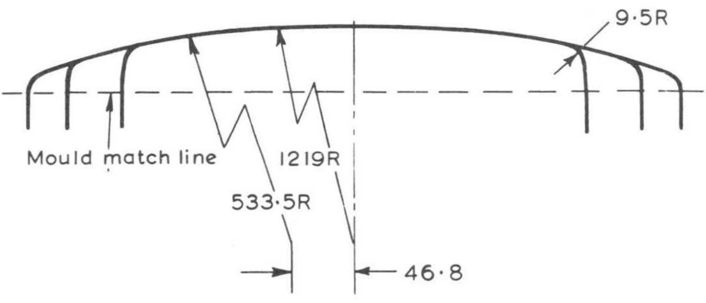


All dimensions in mm

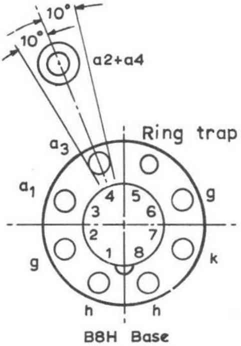
B7100

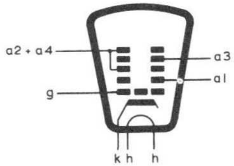


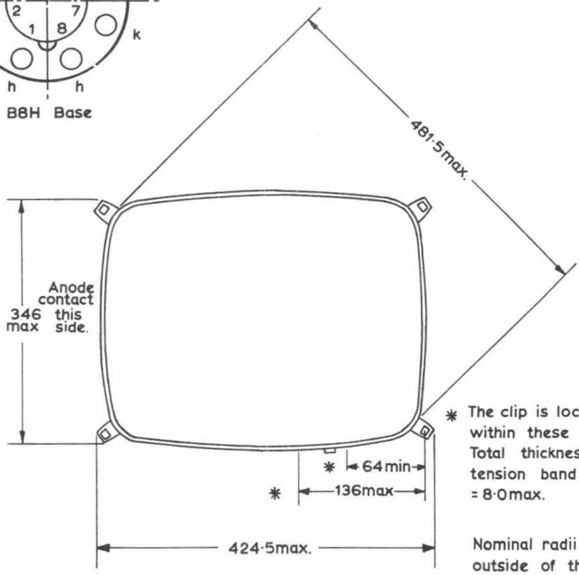
Bulb dimensions



External screen radii

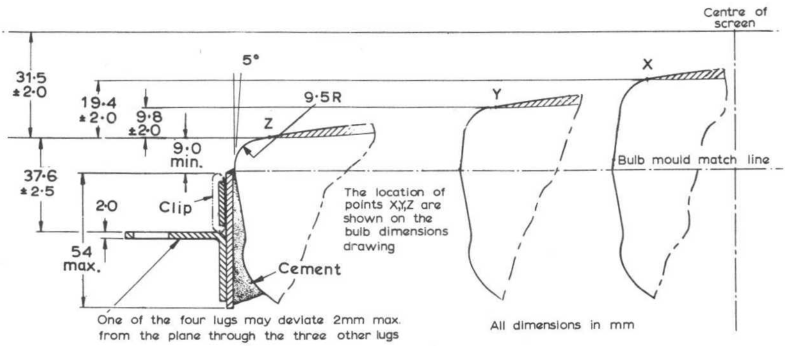






✱ The clip is located within these dimensions. Total thickness of rimband tension band and clip = 8·0max.

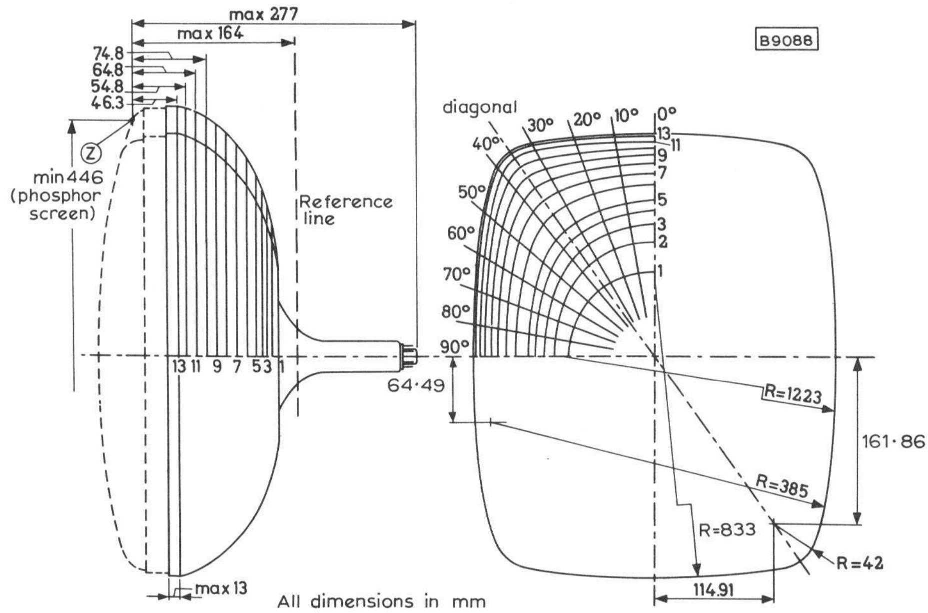
Nominal radii of the outside of the tension band = bulb radius + 2·5



One of the four lugs may deviate 2mm max. from the plane through the three other lugs

All dimensions in mm

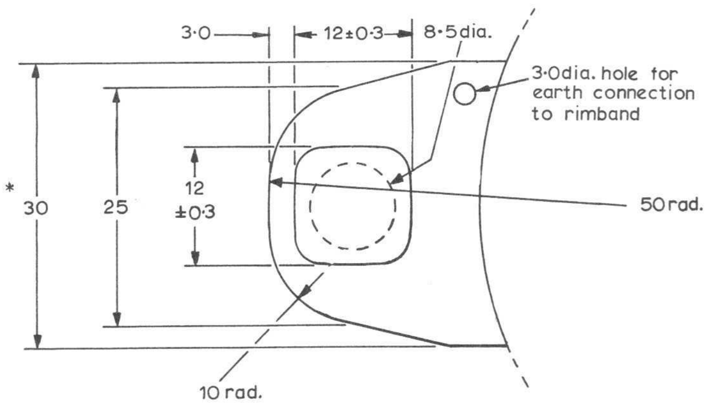
MAXIMUM CONE CONTOURS



DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page 8)

Section	Nominal distance from point "Z"	Distance from centre (max. values) 0° Long axis	10°	20°	30°	$35^{\circ}22'$ Diagonal	40°	50°	60°	70°	80°	90° Short axis
1	145.7	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
2	139.8	106.1	105.6	105.6	103.8	102.7	101.6	99.1	96.2	93.7	92.4	92.4
3	134.8	125.3	125.7	124.6	122.3	120.6	118.9	115.1	111.0	106.7	104.2	103.9
4	129.8	138.2	138.9	137.8	136.0	134.3	132.3	127.5	121.8	117.0	113.7	113.0
5	124.8	148.6	149.0	148.5	147.7	146.3	144.2	138.0	131.3	125.2	121.6	120.6
6	114.8	164.5	164.6	165.2	167.3	166.8	164.6	156.0	146.8	139.0	134.5	133.1
7	104.8	176.5	176.6	178.7	183.4	184.0	181.4	170.2	158.9	149.8	144.6	142.9
8	94.8	186.3	186.5	190.3	197.0	198.9	195.8	182.3	169.0	158.9	152.8	151.1
9	84.8	194.2	195.0	200.2	209.1	212.0	208.6	192.5	177.5	166.2	159.8	157.9
10	74.8	200.7	202.1	208.4	219.6	223.5	219.7	200.4	184.2	172.3	165.8	163.4
11	64.8	206.0	208.0	215.0	227.9	232.8	228.6	206.6	189.2	176.9	170.0	167.9
12	54.8	210.0	212.3	219.6	233.0	238.1	233.9	210.9	193.2	180.5	173.6	171.3
13	46.3	212.3	214.7	222.2	235.5	240.5	236.7	214.1	195.8	183.0	175.8	173.5

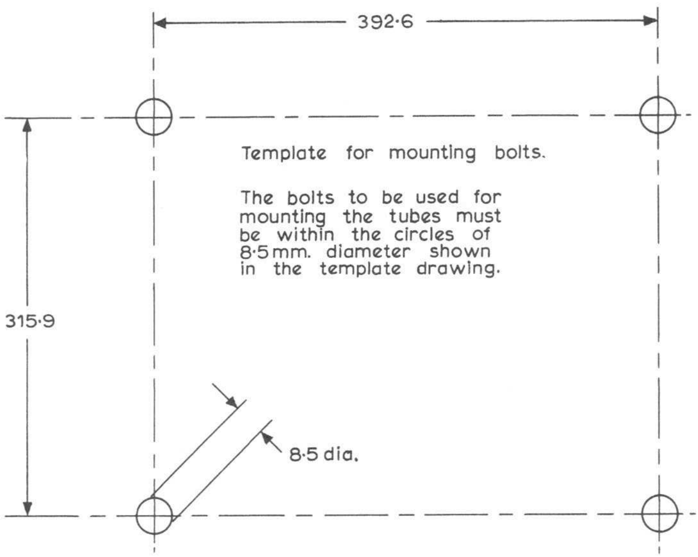
All dimensions in mm.



* Minimum space to be reserved for mounting lugs = 37mm.

Mounting lug

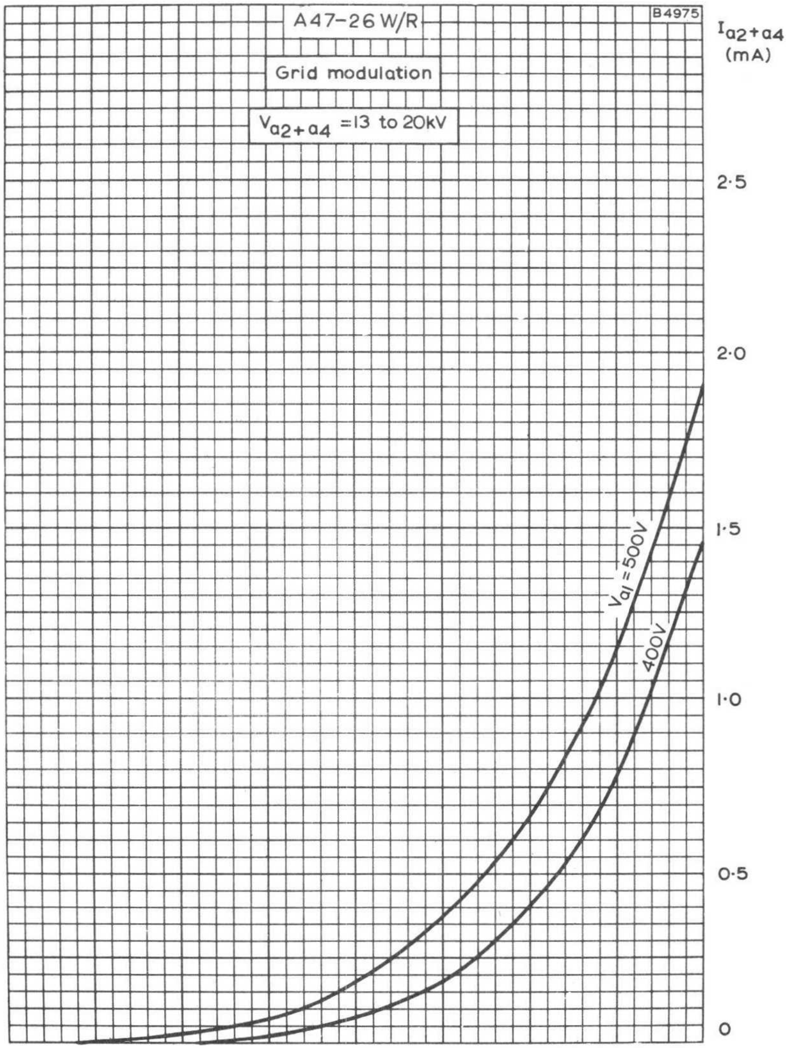
B7746



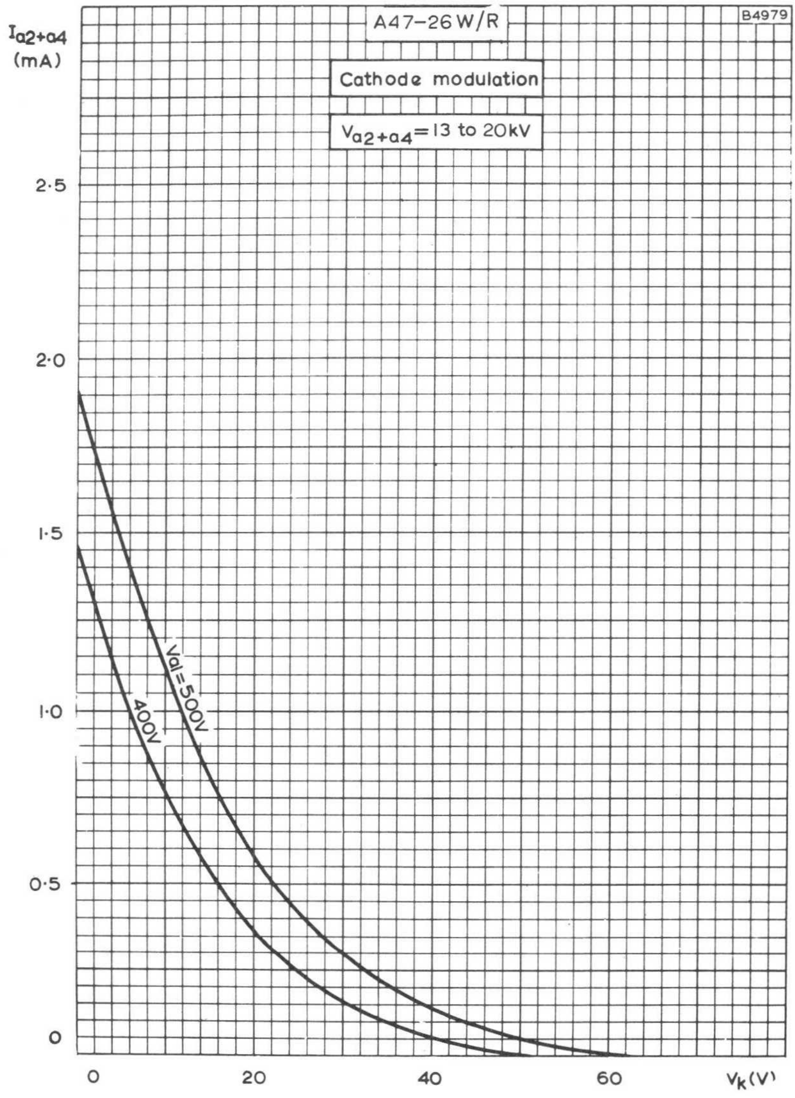
Template for mounting bolts.

The bolts to be used for mounting the tubes must be within the circles of 8·5mm. diameter shown in the template drawing.

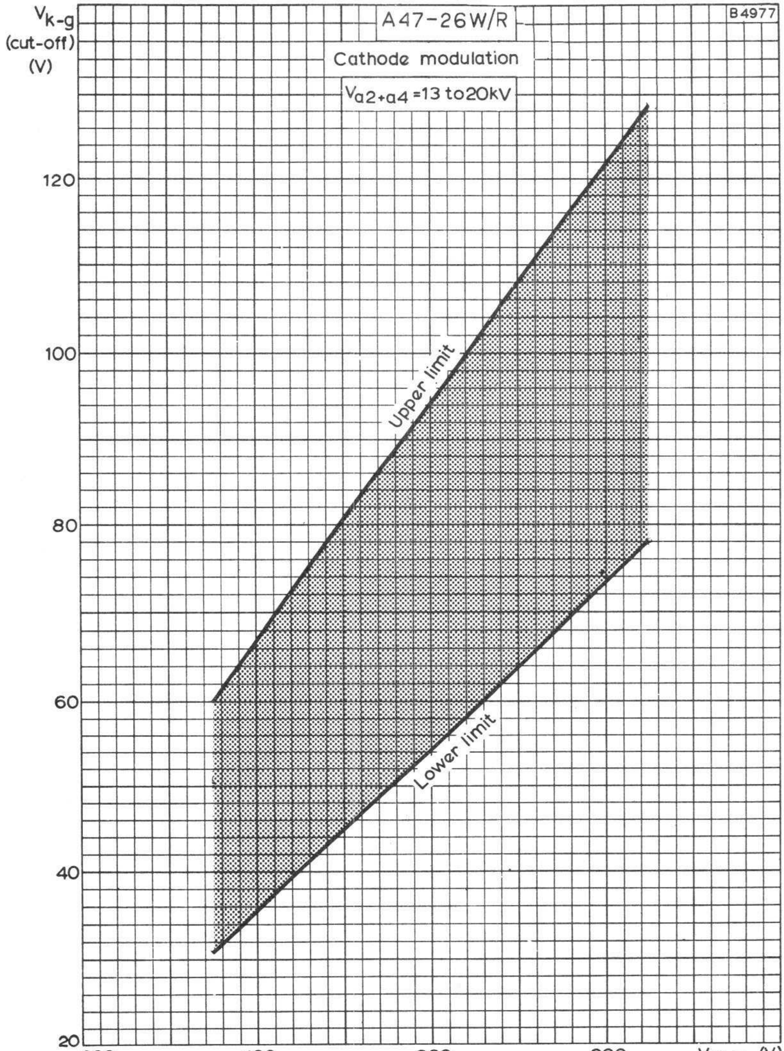
All dimensions in mm.



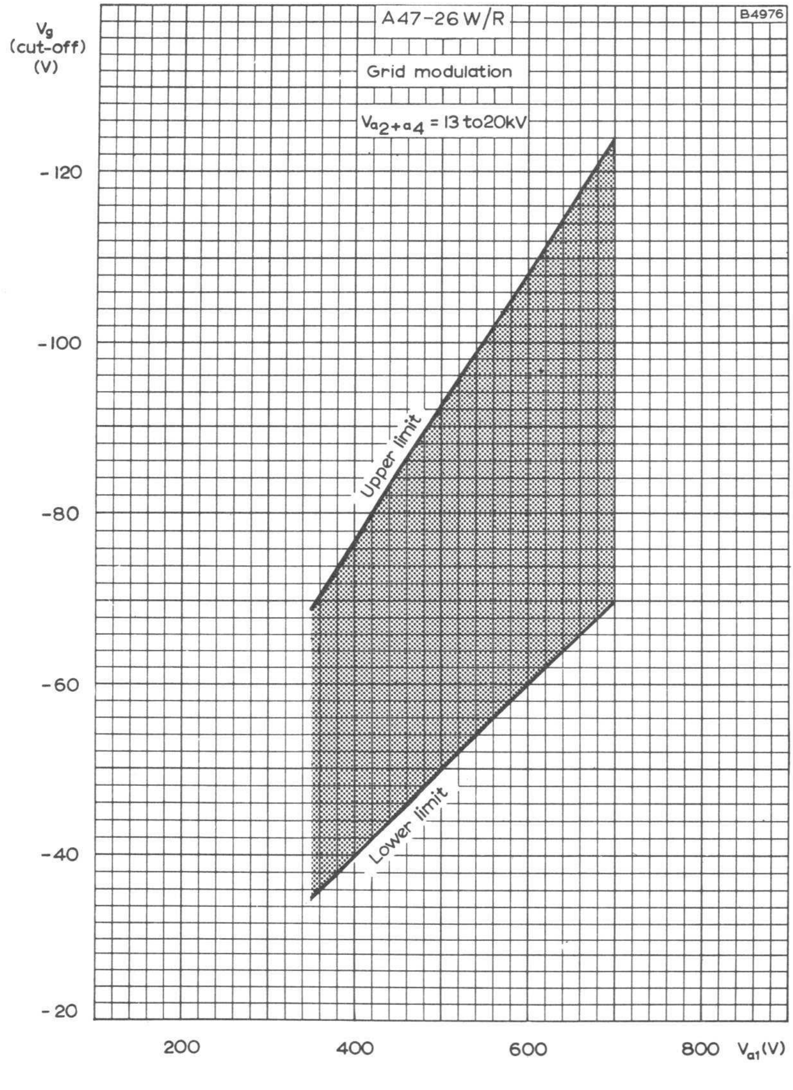
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

COLOUR TELEVISION TUBE

A49-11X

TENTATIVE DATA

QUICK REFERENCE DATA

49cm (19in) rectangular shadow-mask colour television tube incorporating three guns and a metal-backed three-colour phosphor dot screen.

Advanced red phosphor, europium activated. ←

Increased white brightness. ←

Unity current ratio for white point x=0.281, y=0.311 ←

Temperature compensated shadow-mask maintains purity during warm-up. Shadow-mask optimised for minimum moiré effect on 625 line system. ←

Reinforced tube envelope-separate safety screen not required.

Deflection angle	90	deg
Focusing	Electrostatic	
Light transmission (approx.)	54	%
Maximum overall length	458	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

V_h (see note 1)	6.3	V
I_h	900	mA

The limits of heater voltage and current are contained in General Operational Recommendations - Television Picture Tubes.

OPERATING CONDITIONS (each gun)

V_{a3+a4}	25	kV
V_{a2} (focus electrode control range)	4.2 to 5.0	kV
V_{a1} (at V_g -100V for visual extinction of focused raster)	210 to 495	V
V_g (at V_{a1} = 300V for visual extinction of focused raster)	-65 to -135	V
*Light output at screen centre (at I_{a3+a4} = 750µA)	130	cd/m^2 (nits)

*To product white of colour co-ordinates x=0.281, y=0.311 with a focused raster size of 39.6 × 31.0cm

SCREEN

Metal backed

Phosphor types for separate fluorescent colours:

Red	Europium activated rare earth
Green	Sulphide
Blue	Sulphide

Useful screen area (approx.)	1160	cm^2
Spacing between centres of adjacent phosphor dot triads (approx.)	0.63	mm
Light transmission (approx.)	54	%

FOCUSING

Electrostatic

DEFLECTION

Magnetic

Diagonal deflection angle	90	deg
Horizontal deflection angle	79	deg
Vertical deflection angle	62	deg

CONVERGENCE

Magnetic

CAPACITANCES (approx.)

c_{g-all} (each gun)	7.0	pF
$c_{(kR+kG+kB)-all}$	15	pF
c_{kR-all}	5.0	pF
c_{kG-all}	5.0	pF
c_{kB-all}	5.0	pF
c_{a2-all}	7.0	pF
$c_{a3+a4-M}$	1500 to 2000	pF
$c_{a3+a4-B}$	300	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

REFERENCE LINE GAUGE

See page 10.

MOUNTING POSITION

Any. 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 of 52.5mm diameter which is centred upon the perpendicular from the centre of the face.

MAGNETIC SHIELDING

Magnetic shielding must be provided to minimise the effects of extraneous magnetic fields, including the earth's magnetic field. This shielding, in the form of a metal shell extending 22cm over the cone of the tube measured from the centre of the screen, should be constructed of cold-rolled mild steel of 0.5mm minimum thickness. The magnetic shield should be connected to the outer conductive coating. See page 10 for physical dimensions.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a3+a4} max. (absolute rating) (see notes 2 and 3)	27.5	kV
V_{a3+a4} min. (absolute rating) (see note 4)	20	kV
I_{a3+a4} (long term average max. for three guns: see note 5)	750	μA
V_{a2} max. (see note 3)	6.0	kV
v_{a1} (pk) max.	1.0	kV
$-V_g$ max.	400	V
V_g max.	0	V
V_{h-k} max. (see note 6)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{g-k} max.	750	kΩ

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for V_{a3+a4} = 20 to 27.5kV

V_{a2}		16.8 to 20% of V_{a3+a4}			
V_{a1}		see page 14			
V_g		see page 14			
Variation in cut-off voltage between guns		Minimum value is at least 65% of the maximum value.			
I_{a2}		-15 to +15			μA
I_{a1}		-5 to +5			μA
I_g at V_g = -150		-5 to +5			μA
To produce white of colour co-ordinates:	x	0.310	0.265	0.281	←
	y	0.316	0.290	0.311	
Percentage of total anode current supplied by each gun (typical)					←
Red gun		43.5	27.9	32.2	%
Green gun		30.0	34.9	35.6	%
Blue gun		26.5	37.2	32.2	%
Ratio of cathode currents					←
Red gun to green gun	min.	1.05	0.60	0.65	
	av.	1.45	0.80	0.90	
	max.	2.00	1.10	1.25	
Red gun to blue gun	min.	1.20	0.55	0.75	
	av.	1.65	0.75	1.00	
	max.	2.25	1.05	1.35	

Maximum electron beam shift required from purity magnets	±0.11	mm
Maximum required raster shift	±12	mm
Maximum lateral convergence shift of blue beam with respect to the converged red and green beams	±5.5	mm
Maximum radial convergence shift, excluding effects of dynamic convergence (each beam, see note 8)	±8.0	mm

WEIGHT

Tube alone (approx.)	11	kg

NOTES·

1. For maximum cathode life, it is recommended that the heater supply be regulated at 6.3V.

2. The tube does not emit X-radiation above the internationally accepted maximum dosage rate if it is operated from an e.h.t. source supplying an absolute maximum voltage of 27.5kV at zero beam current and with an internal impedance ≥500kΩ.

3. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube. In view of the high voltage on a2, adequate precautions should be taken to ensure freedom from flashover on all connections to this electrode.

4. Operation at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

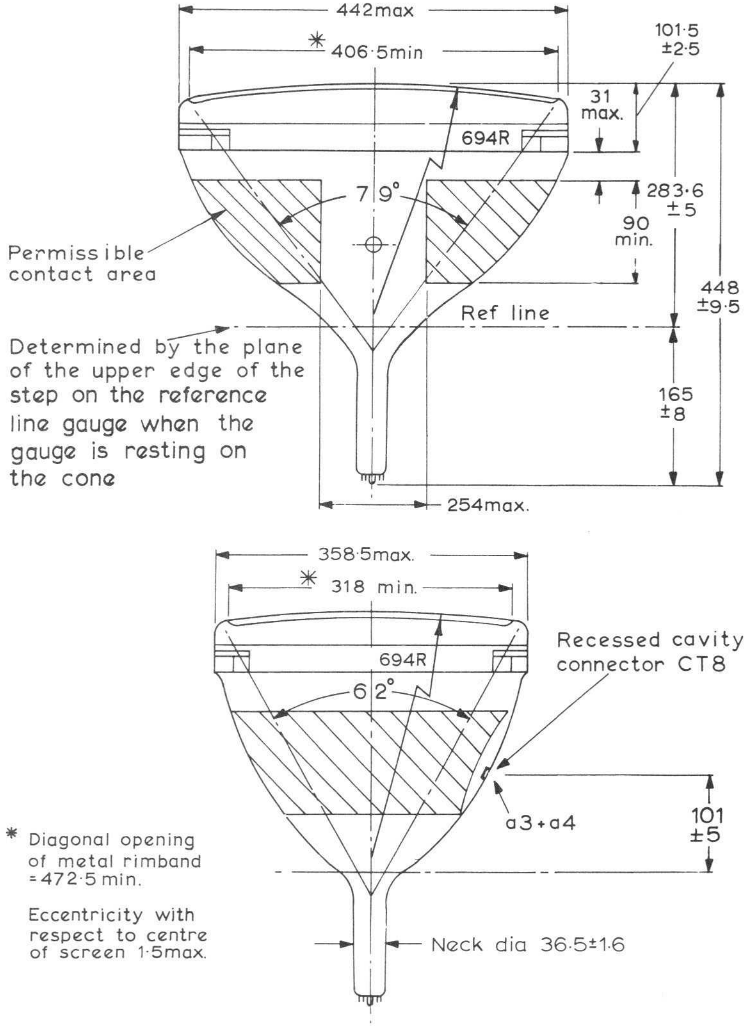
5. The limiting value "long term average maximum current" of 750µA will be met provided a device is incorporated in the circuit to limit the short term average current to 1.1mA.

6. 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 an equipment warm-up period not exceeding 15 seconds v_{h-k} (pk) max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in v_{h-k} (pk) max. (cathode positive) proportional with time from 410 to 250V is permissible.

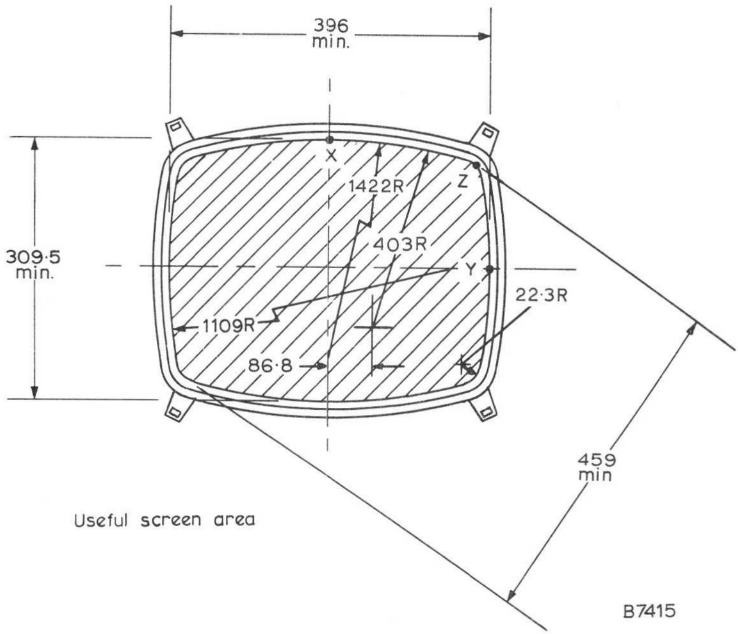
7. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver.

8. The dynamic convergence to be effected by currents of approximately parabolic waveshape synchronised with scanning.

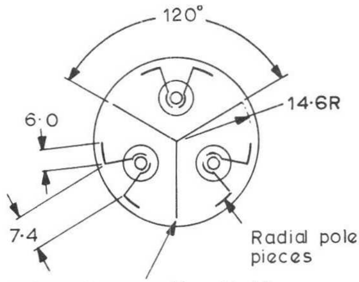


All dimensions in mm

B7414



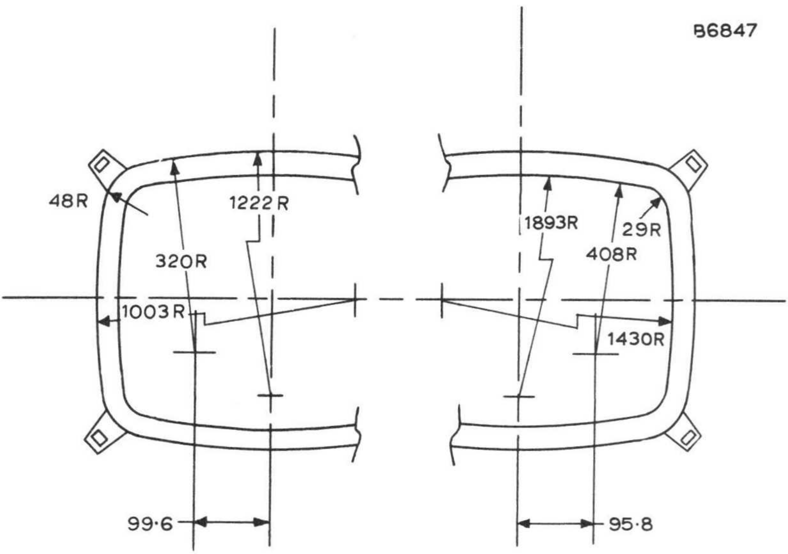
Useful screen area



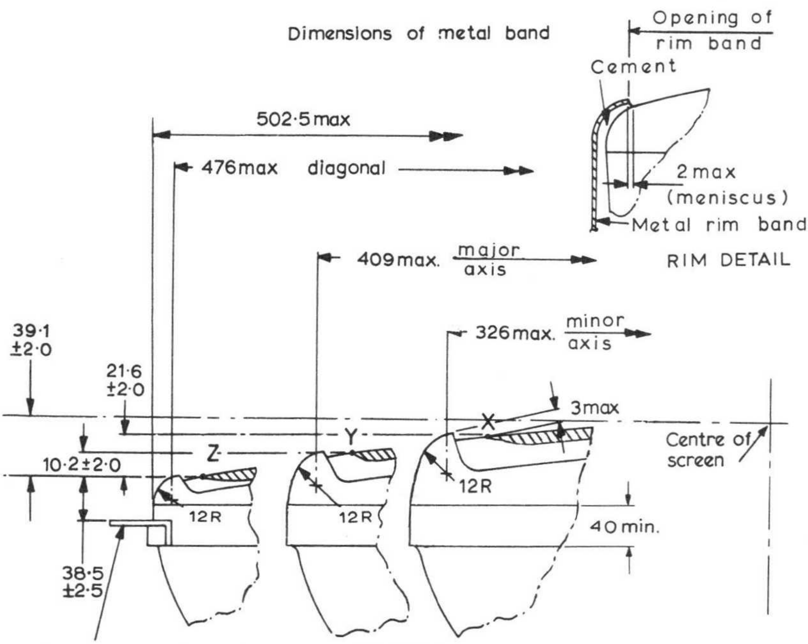
Location of radial convergence pole pieces viewed from screen end of guns

All dimensions in mm

B6847



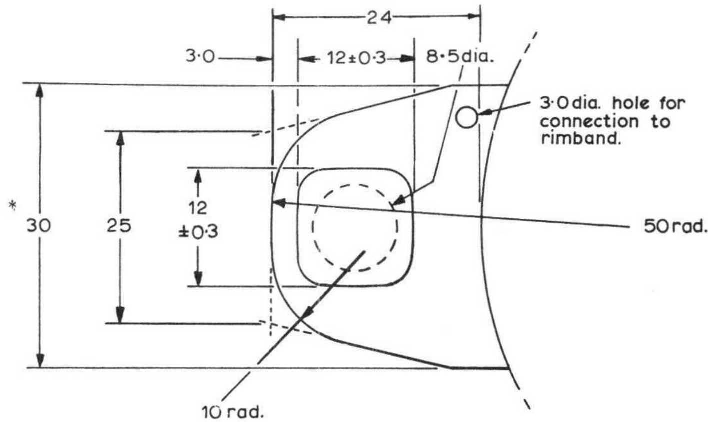
Dimensions of metal band



One of the four lugs may deviate 2mm max. from the plane through the three other lugs This deviation is incorporated in the ±2·5 tolerance.

All dimensions in mm

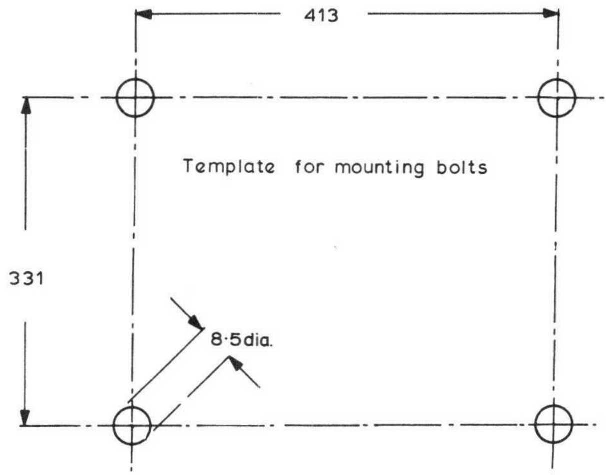
B7416



* Minimum space to be reserved for mounting lugs = 37mm.

Mounting lug

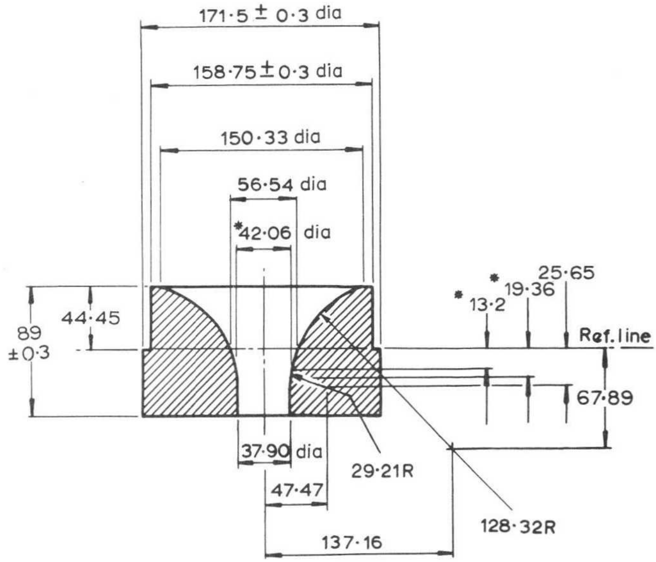
B7746



All dimensions in mm

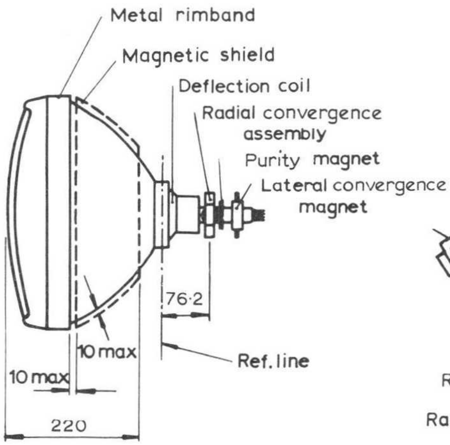
The bolts to be used for mounting the tube must be within the circles of 8.5mm diameter shown in the template drawing.

B7830

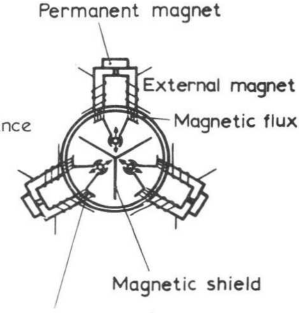


Reference line gauge

* These dimensions define extent of 29·21R

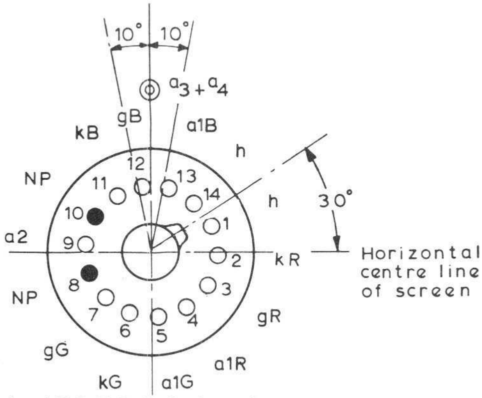


Outline of tube with components

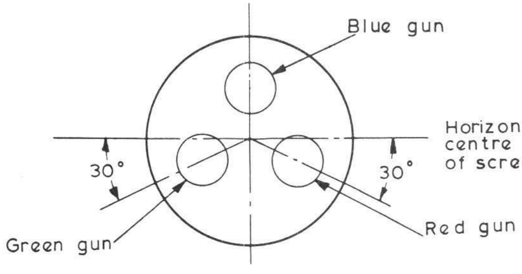


Radial convergence system

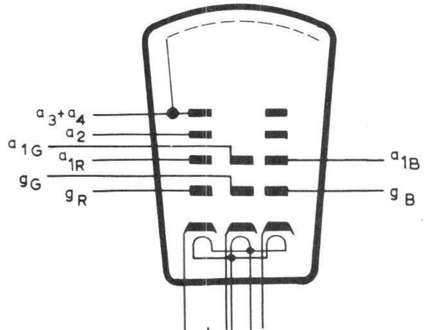
All dimensions in mm

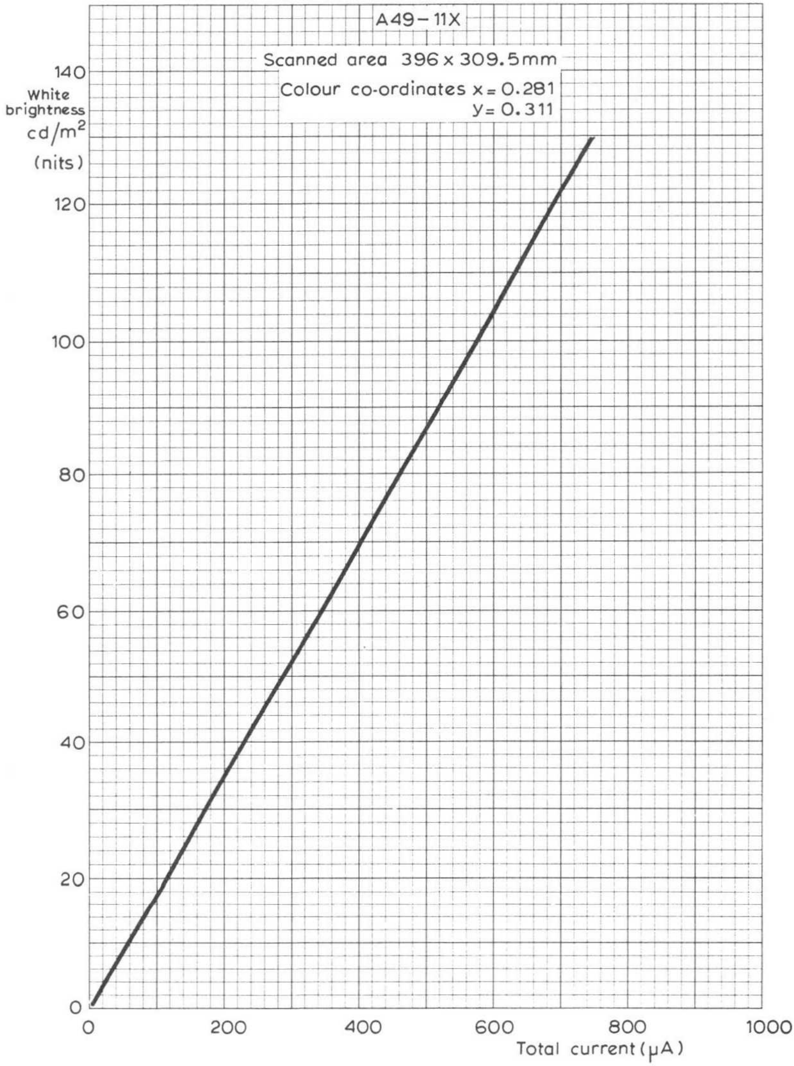


As J.E.D.E.C. B12-244 Base but with shorter spigot

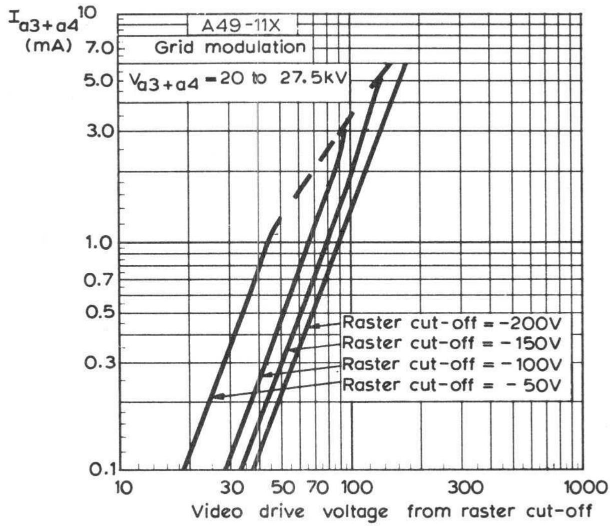


View looking from base

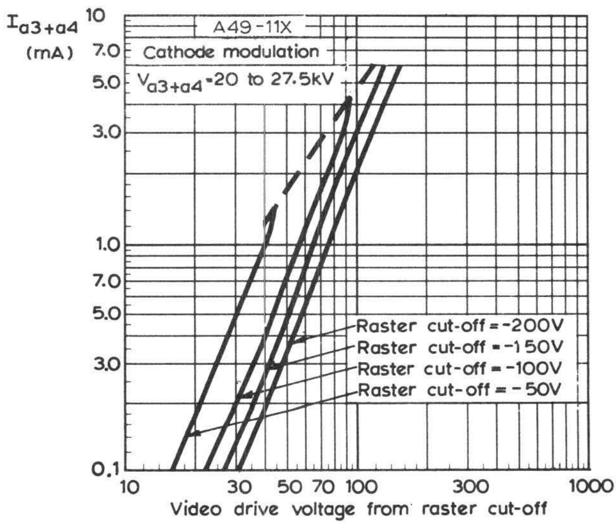




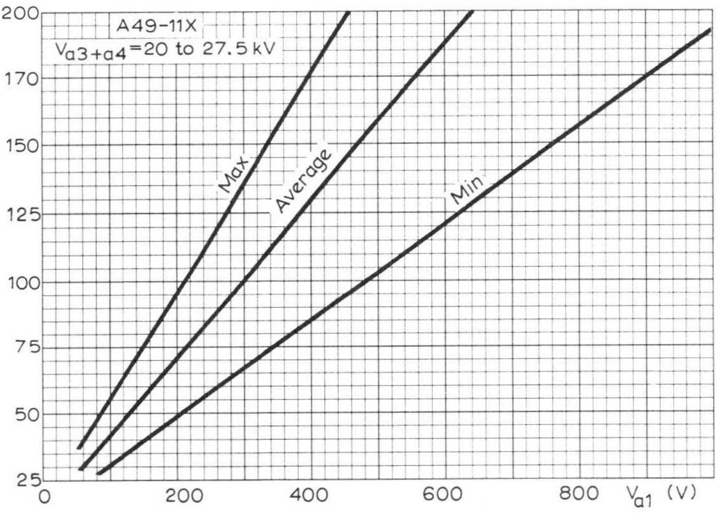
BRIGHTNESS AT CENTRE OF SCREEN PLOTTED AGAINST TOTAL CURRENT FOR WHITE OF COLOUR COORDINATES x = 0.281, y = 0.311



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE
GRID MODULATION



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID
VOLTAGE. CATHODE MODULATION



CUT-OFF DESIGN CHART

TELEVISION TUBE A50-120W/R

QUICK REFERENCE DATA		
50cm (20in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Suitable for use in receivers with push-through presentation. This tube is fitted with a ring trap base.		
Deflection angle	110	deg
Focusing		Electrostatic
Light transmission (approx.)	45	%
Maximum overall length	319	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Television Picture Tubes.

Note - applies to series operation only

The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (metal backed)

Fluorescent colour		White
Light transmission (approx.)	45	%
Useful screen area		See page 6

FOCUSING (Electrostatic)

The range of focus voltage shown in 'Operating Conditions' results in optimum overall focus at a beam current of 250μA. In general, acceptable resolution will be obtained with a fixed focus voltage.

DEFLECTION (Magnetic)

Diagonal deflection angle	110	deg
Horizontal deflection angle	98	deg
Vertical deflection angle	81	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	1100 to 1600	pF
$c_{a2+a4-B}$	500	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RING TRAP

For flashover protection to the receiver, parallel spark gaps are included for all the pins in the base of this tube, and the common connection is made to pin 5. These spark gaps are intended as part of a system for full flashover protection. A direct connection must always be made from pin 5 to the external conductive coating. Any electrode supplied directly from a high energy source (such as the H.T. line) should be provided with a series resistor.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations-Television Picture Tubes.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in the brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations-Television Picture Tubes.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred on the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.
2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.
3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.
4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.
5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

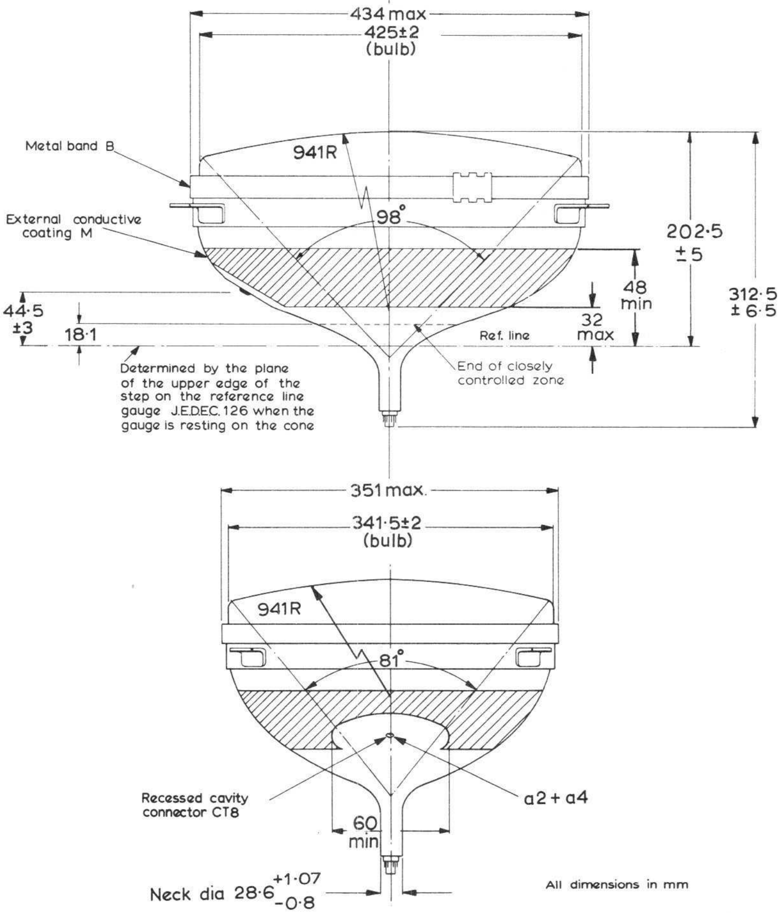
   The mounting lugs will be in electrical contact with the metal band.

WARNING

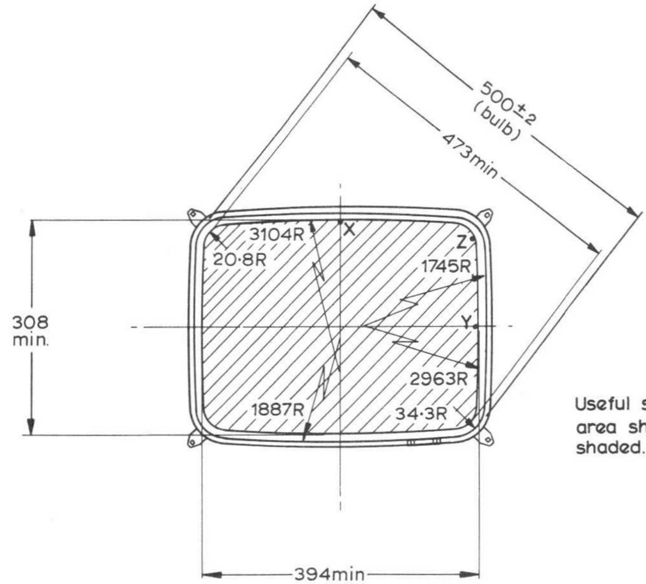
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

WEIGHT

Tube alone (approx.)	8.5	kg



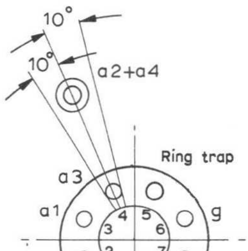
434 max
425±2
(bulb)
Metal band B
941R
External conductive
coating M
98°
202·5
±5
48
min
312·5
±6·5
44·5
±3
18·1
32
max
Ref. line
Determined by the plane
of the upper edge of the
step on the reference line
gauge J.E.D.E.C. 126 when the
gauge is resting on the cone
End of closely
controlled zone
351 max.
341·5±2
(bulb)
941R
81°
Recessed cavity
connector CT8
a2 + a4
60
min
Neck dia 28·6 +1·07 −0·8
All dimensions in mm



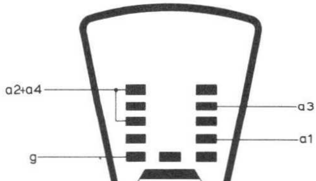
Useful screen area shown shaded.

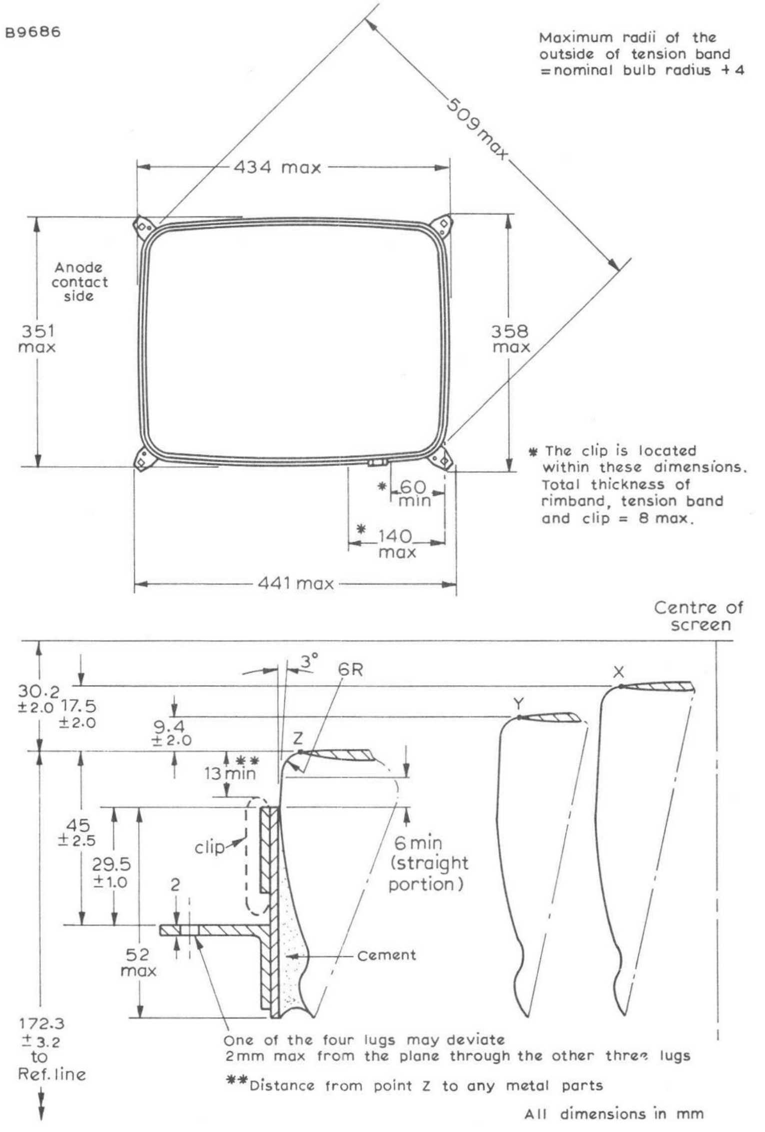
Bulb dimensions

All dimensions in mm



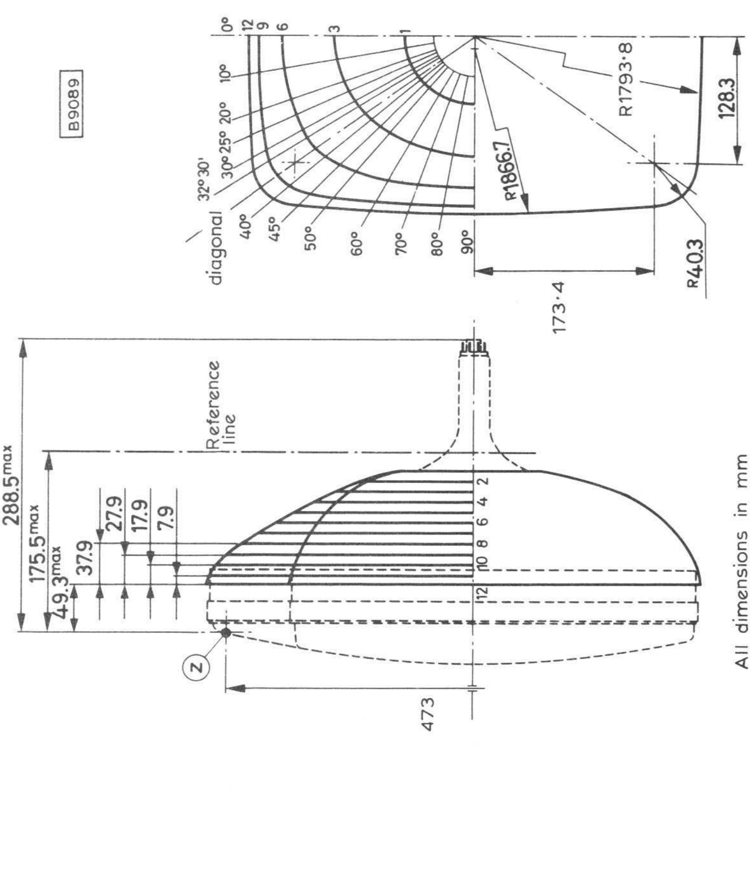
B8H Base





B9686
Maximum radii of the outside of tension band = nominal bulb radius + 4
509 max
434 max
Anode contact side
351 max
358 max
* The clip is located within these dimensions. Total thickness of rimband, tension band and clip = 8 max.
* 60 min
* 140 max
441 max
Centre of screen
30.2 ±2.0
17.5 ±2.0
9.4 ±2.0
3°
6R
X
Y
Z
** 13 min
45 ±2.5
29.5 ±1.0
clip
2
6 min (straight portion)
52 max
Cement
172.3 ±3.2 to Ref. line
One of the four lugs may deviate 2mm max from the plane through the other three lugs
**Distance from point Z to any metal parts
All dimensions in mm

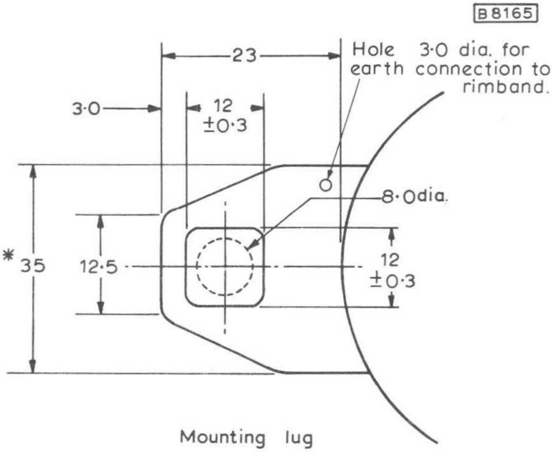
MAXIMUM CONE CONTOURS



DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page 8)

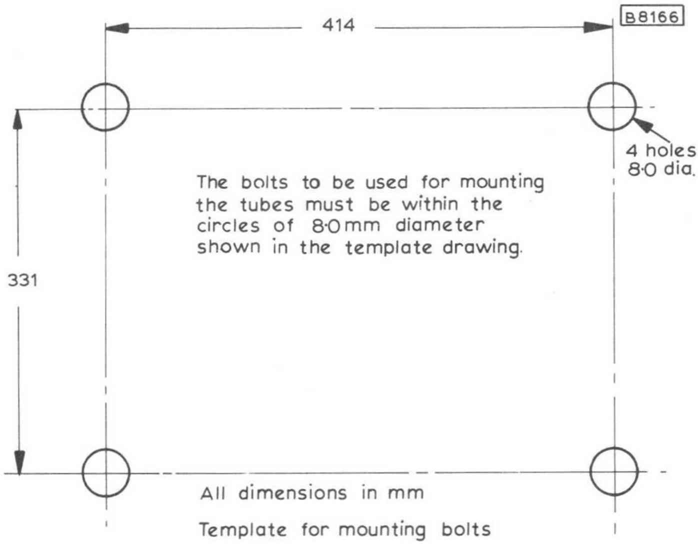
Section	Section distance from point "Z"	Distance from centre (max. values) 0° Long axis	10°	20°	25°	30°	32° 30'	36° 30' Diagonal	40°	45°	50°	60°	70°	80°	90° Short
1	157.2	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0	69.0
2	147.2	109.2	107.8	107.1	106.4	106.0	105.9	105.5	105.0	104.5	103.9	102.8	102.6	102.8	103.4
3	137.2	136.7	134.5	133.7	133.0	132.3	131.8	130.7	129.3	127.5	125.3	121.9	120.7	120.2	120.2
4	127.2	157.2	156.5	155.7	154.8	153.8	153.0	151.5	150	147.5	144.7	138.7	134.9	133.4	132.5
5	117.2	174.2	174.0	174.4	174.3	173.4	172.8	171.0	169.3	165.7	160.8	152.0	146.5	143.7	142.3
6	107.2	185.8	186.3	188.4	190.0	191.2	191.2	189.5	186.7	181.7	174.7	163.2	156.0	151.7	150.4
7	97.2	194.5	195.7	202.2	203.8	206.9	207.3	206.4	203.5	196.4	187.4	173.0	163.5	158.6	156.9
8	87.2	201.7	203.8	210.2	215.4	220.6	222.1	222.2	218.8	210.5	198.8	181.2	170.3	174.7	162.7
9	77.2	208.2	210.6	218.5	224.8	231.4	234.8	236.5	233.5	222.2	208.5	188.5	176.6	169.9	167.9
10	67.2	213.1	215.9	225.2	231.9	239.8	244.3	248.5	244.8	230.3	216.0	194.7	181.6	174.5	172.0
11	57.2	215.6	219.0	228.2	235.4	244.5	249.6	253.7	250.2	235.7	220.5	198.6	184.8	177.2	174.7
12	49.3	217.0	219.8	229.3	236.6	246.0	251.2	254.5	251.7	237.2	222.0	199.6	185.6	177.8	175.7

All dimensions in mm.



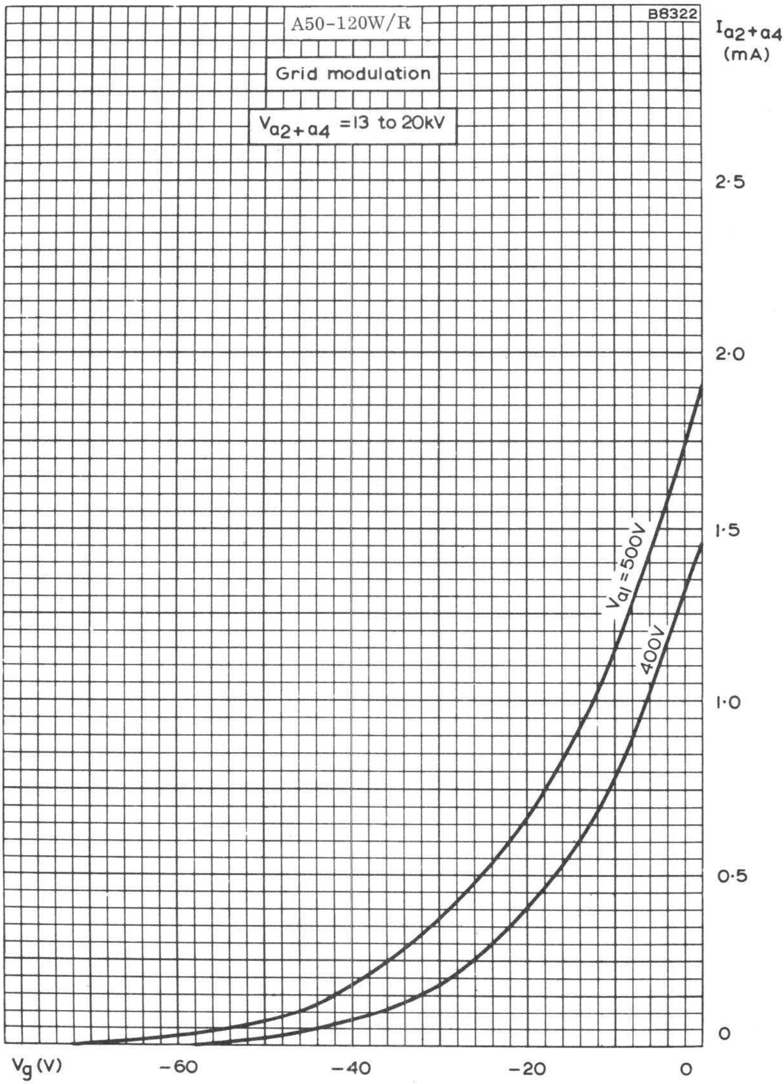
Mounting lug

* Minimum space to be reserved for mounting lug = 39

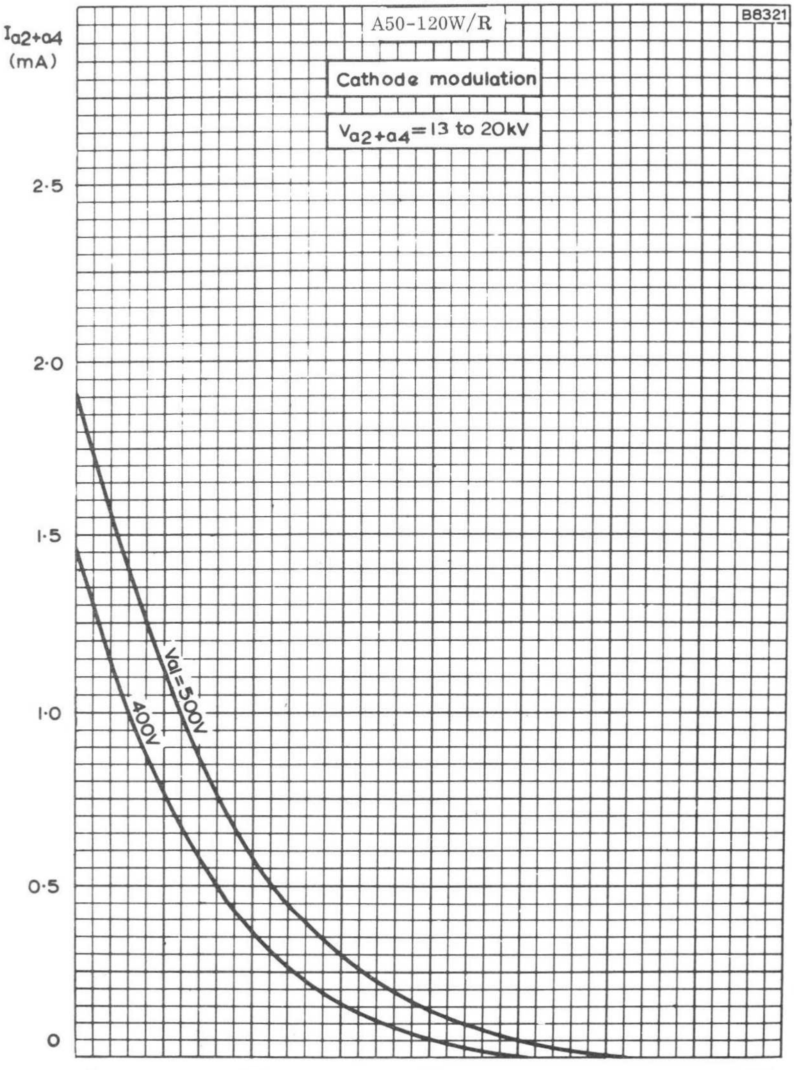


All dimensions in mm

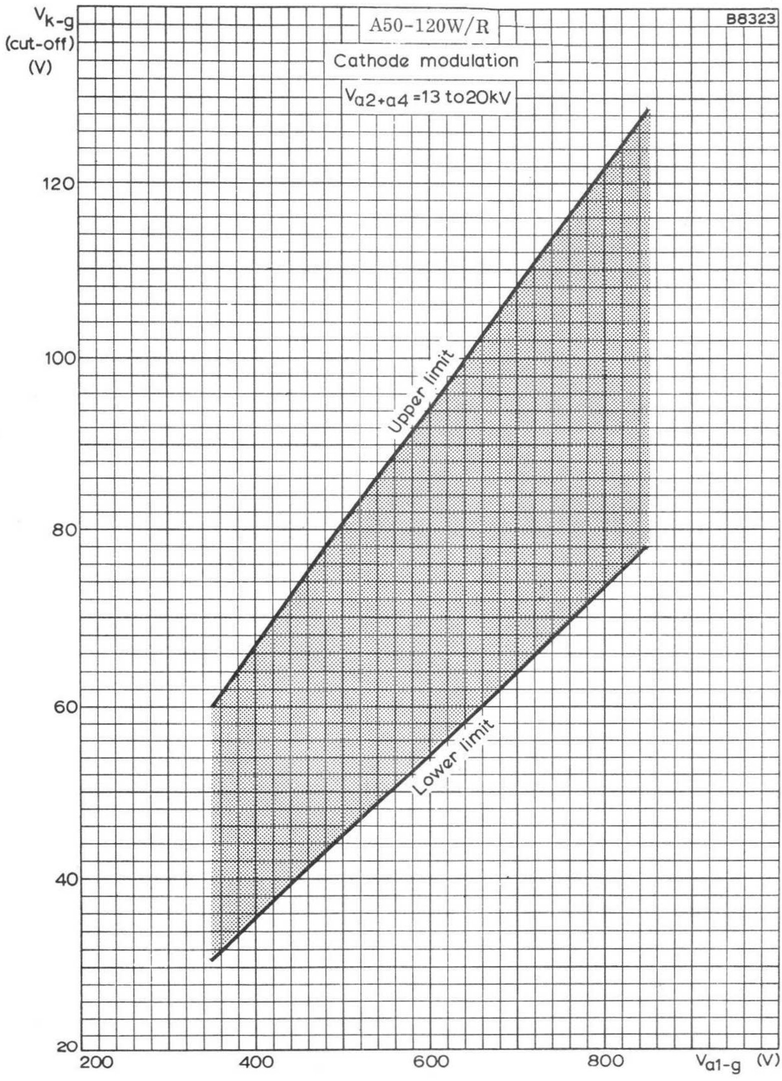
Template for mounting bolts



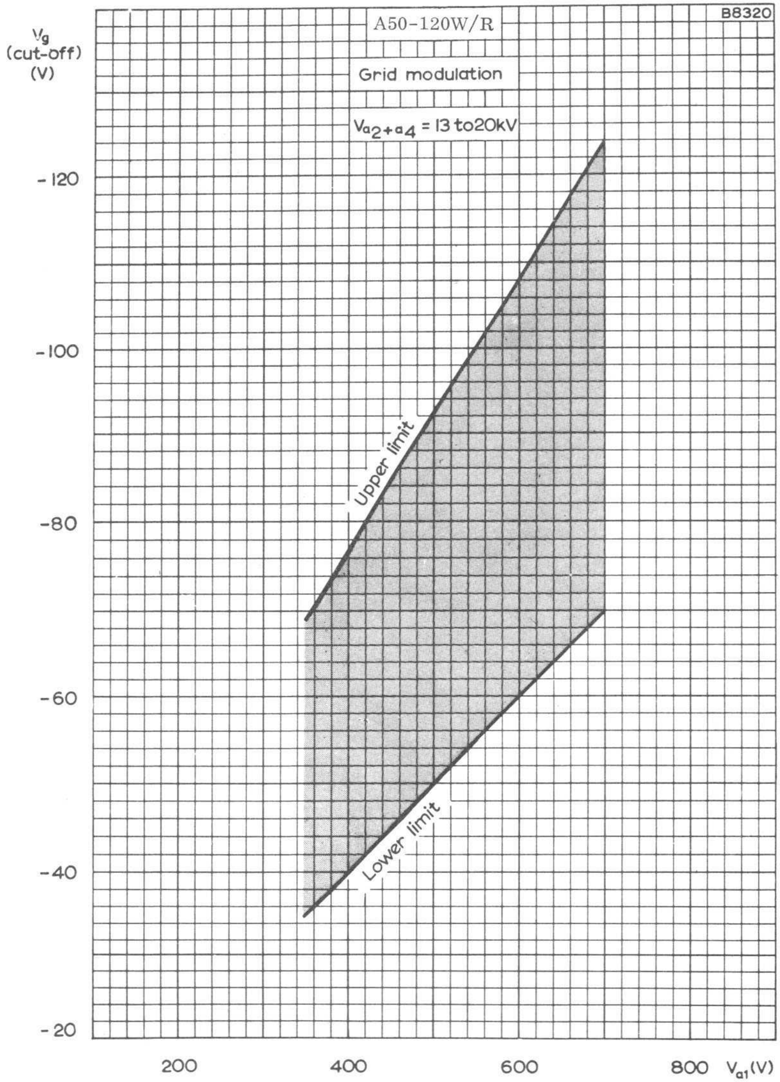
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION



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

COLOUR TELEVISION TUBE

A56-120X

TENTATIVE DATA

QUICK REFERENCE DATA

56cm (22in) rectangular shadow-mask colour television tube incorporating three guns and a metal-backed three-colour phosphor dot screen.
Advanced red phosphor, europium activated.
Increased white brightness.
Unity current ratio for white point x = 0.281, y = 0.311
Temperature compensated shadow-mask maintains purity during warm-up. Shadow-mask optimised for minimum moiré effect on 625 line system.
Reinforced tube envelope-separate safety screen not required.

Deflection angle	92	deg
Focusing	Electrostatic	
Light transmission (approx.)	53	%
Maximum overall length	482	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

V_h (see note 1)	6.3	V
I_h	900	mA

The limits of heater voltage and current are contained in General Operational Recommendations - Television Picture Tube.

OPERATING CONDITIONS (each gun)

V_{a3+a4}	25	kV
V_{a2} (focus electrode control range)	4.2 to 5.0	kV
V_{a1} (at V_g = -100V for visual extinction of focused raster)	210 to 495	V
V_g (at V_{a1} = 300V for visual extinction of focused raster)	-65 to -135	V
*Light output at screen centre (at I_{a3+a4} = 800µA)	120	cd/m^2(nits)

*To produce white of colour co-ordinates x = 0.281, y = 0.311 with a focused raster size of 447 × 337mm.

SCREEN

Metal backed

Phosphor types for separate fluorescent colours:

Red	Europium activated rare earth
Green	Sulphide
Blue	Sulphide
Useful screen area	See page 7

Spacing between centres of adjacent phosphor dot triads (approx.)	0.68	mm
Light transmission (approx.)	53	%

FOCUSING

Electrostatic

DEFLECTION

Magnetic

Diagonal deflection angle	92	deg
Horizontal deflection angle	79	deg
Vertical deflection angle	61	deg

CONVERGENCE

Magnetic

CAPACITANCES (approx.)

c_{g-all} (each gun)	7.0	pF
$c_{(kR+kG+kB)-all}$	15	pF
c_{kR-all}	5.0	pF
c_{kG-all}	5.0	pF
c_{kB-all}	5.0	pF
c_{a2-all}	7.0	pF
$c_{a3+a4-M}$	1700 to 2300	pF
$c_{a3+a4-B}$	400	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

REFERENCE LINE GAUGE

See page 10

MOUNTING POSITION

Any. 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 of 55mm diameter which is centred upon the perpendicular from the centre of the face.

MAGNETIC SHIELDING

Magnetic shielding must be provided to minimise the effects of extraneous magnetic fields, including the earth's magnetic field. This shielding, in the form of a metal shell extending 250mm over the cone of the tube measured from the centre of the screen, should be constructed of cold-rolled mild steel of 0.5mm minimum thickness. The magnetic shield should be connected to the outer conductive coating. See page 10 for physical dimensions.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a3+a4} max. (absolute rating) (see notes 2 and 3)	27.5	kV
V_{a3+a4} min. (absolute rating) (see note 4)	20	kV
I_{a3+a4} (long term average max. for three guns: see note 5)	1.0	mA
V_{a2} max. (see note 3)	6.0	kV
$v_{a1(pk)}$ max.	1.0	kV
$-V_g$ max.	400	V
V_g max.	0	V
V_{h-k} max. (see note 6)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{g-k} max.	750	kΩ

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for V_{a3+a4} = 20 to 27.5kV

V_{a2}		16.8 to 20% of V_{a3+a4}			
V_{a1}		see page 14			
V_g		see page 14			
Variation in cut-off voltage between guns		Minimum value is at least 65% of the maximum value.			
I_{a2}			-15 to +15		µA
I_{a1}			-5 to +5		µA
I_g at V_g = -150V			-5 to +5		µA
To produce white of colour	x	0.310	0.265	0.281	
co-ordinates:	y	0.316	0.290	0.311	
Percentage of total anode current supplied by each gun (typical)					
Red gun		43.5	27.9	32.2	%
Green gun		30.0	34.9	35.6	%
Blue gun		26.5	37.2	32.2	%
Ratio of cathode currents					
Red gun to green gun	min.	1.05	0.60	0.65	
	av.	1.45	0.80	0.90	
	max.	2.00	1.10	1.25	
Red gun to blue gun	min.	1.20	0.55	0.75	
	av.	1.65	0.75	1.00	
	max.	2.25	1.05	1.35	
Maximum electron beam shift required from purity magnets				±0.115	mm
Maximum required raster shift			±13		mm
Maximum lateral convergence shift of blue beam with respect to the converged red and green beams			±6		mm
Maximum radial convergence shift, excluding effects of dynamic convergence (each beam)			±9		mm

WEIGHT

Tube alone (approx.)	15	kg

NOTES

1. For maximum cathode life, it is recommended that the heater supply be regulated at 6.3V.

2. The tube does not emit X-radiation above the internationally accepted maximum dosage rate if it is operated from an e.h.t. source supplying an absolute maximum voltage of 27.5kV at zero beam current and with an internal impedance ≥500kΩ.

3. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube. In view of the high voltage on a2, adequate precautions should be taken to ensure freedom from flashover on all connections to this electrode.

4. Operation at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

5. The limiting value "long term average maximum current" of 1.0mA will be met provided a device is incorporated in the circuit to limit the short term average current to 1.5mA.

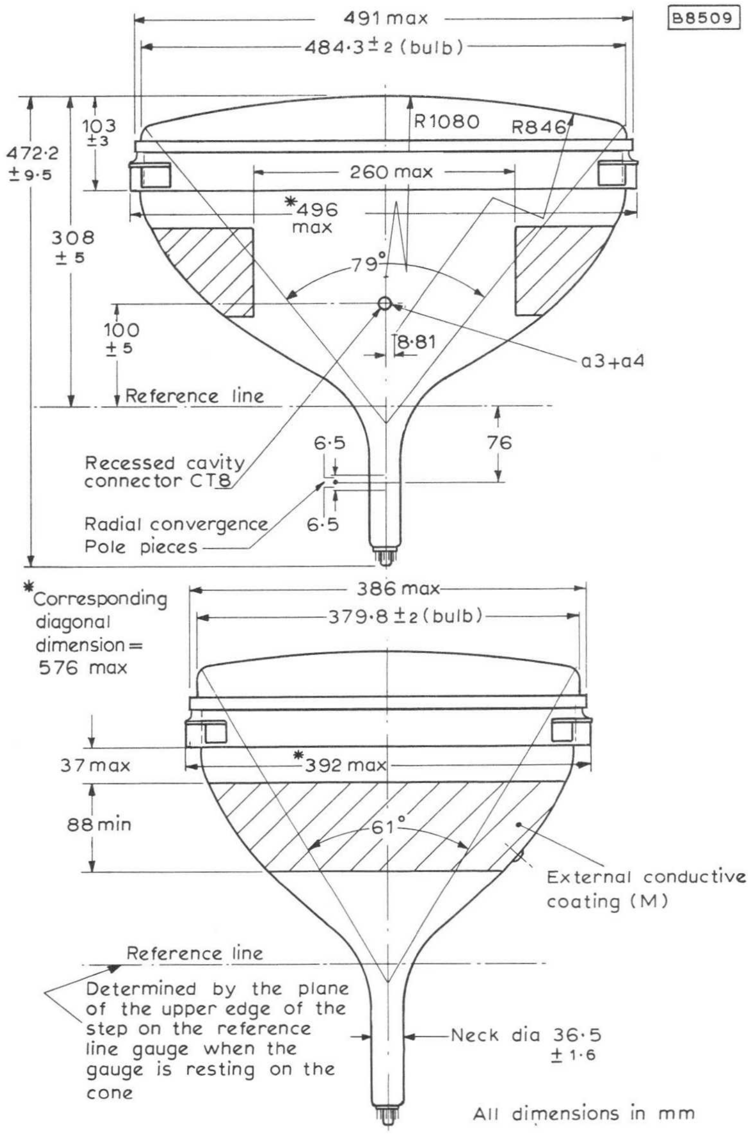
6. In order to avoid excessive hum the a.c. component of V_{h-k} should be as low as possible (≤20Vr.m.s.)

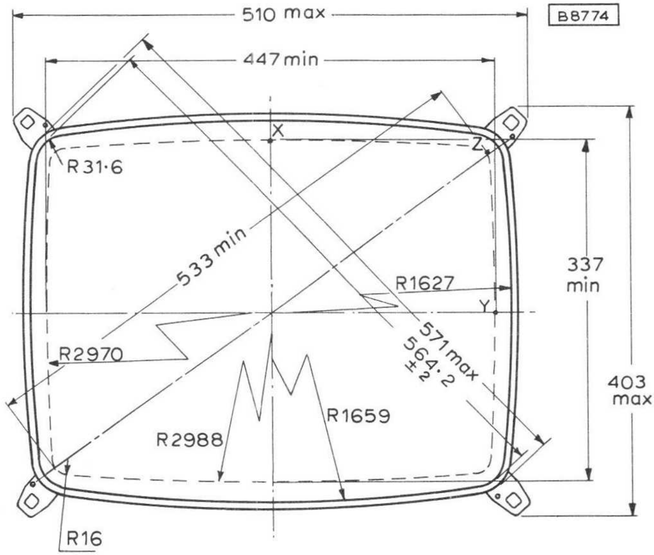
   During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410 to 250V is permissible.

7. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver.

8. The dynamic convergence to be effected by currents of approximately parabolic waveshape synchronised with scanning.

OUTLINE DRAWING

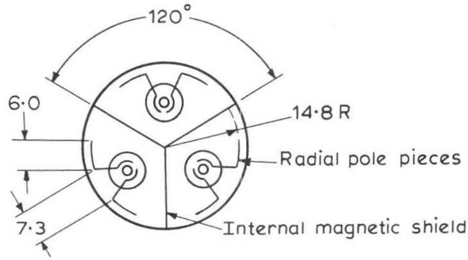




Useful screen area within dotted line.

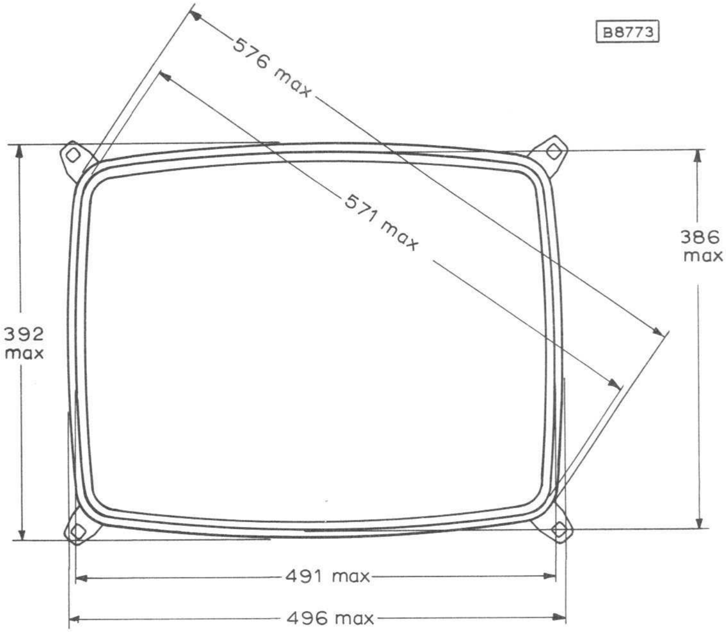
All dimensions in mm

Bulb dimensions

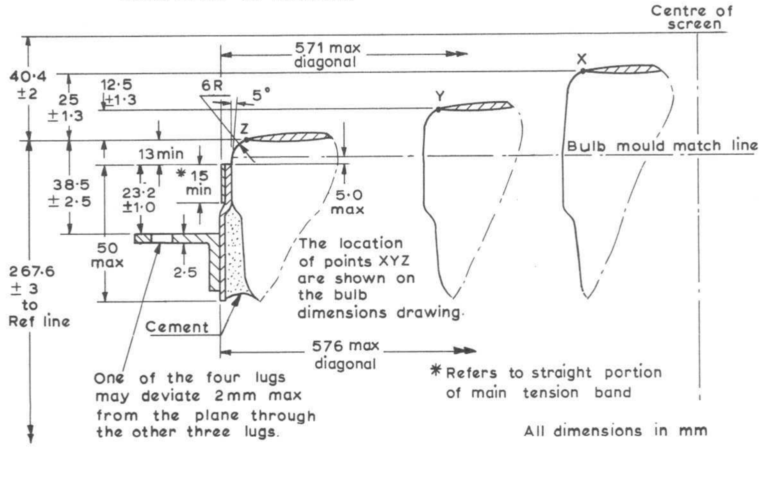


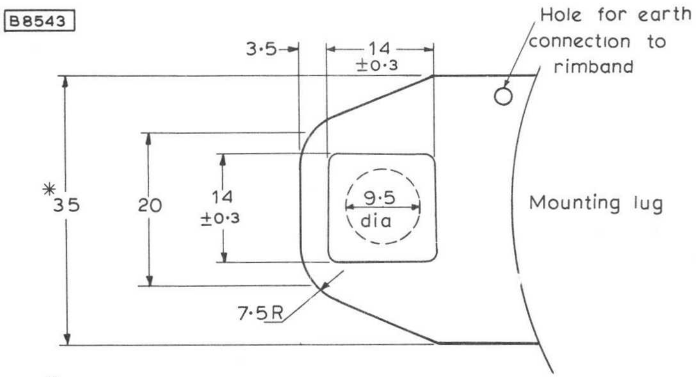
Location of radial convergence pole pieces viewed from screen end of guns.

All dimensions in mm

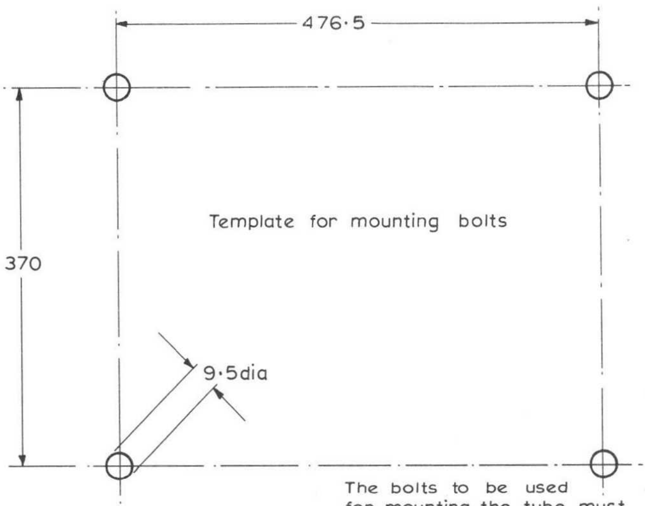


Dimensions of rimband





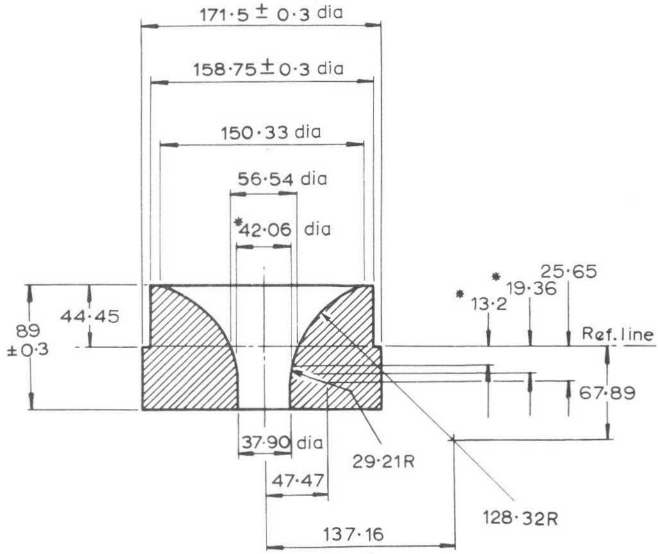
*Minimum space to be reserved for mounting lugs = 40 mm



The bolts to be used for mounting the tube must be within the circles of 9·5mm diameter shown in the template drawing.

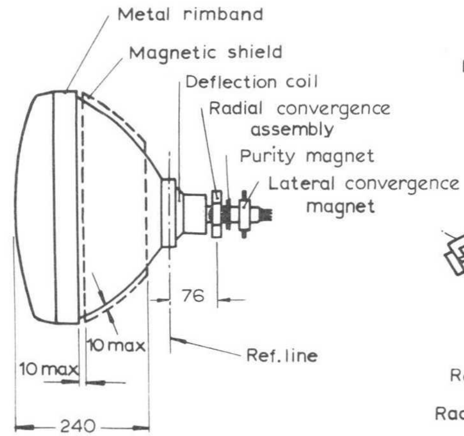
All dimensions in mm

B8468

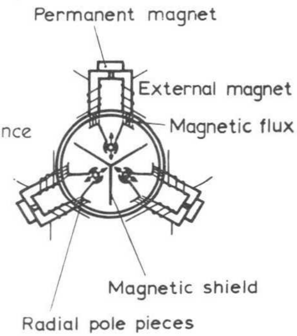


Reference line gauge

* These dimensions define extent of 29·21R



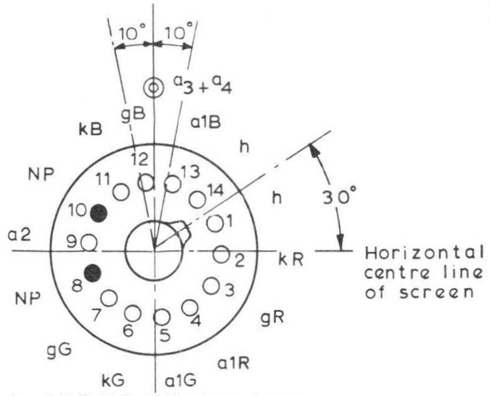
Outline of tube with components



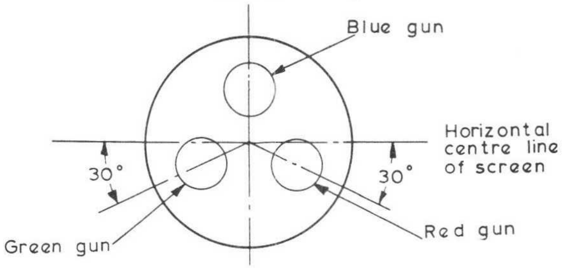
Radial convergence system

All dimensions in mm

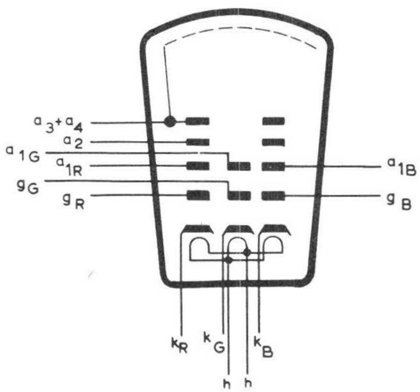
B8469



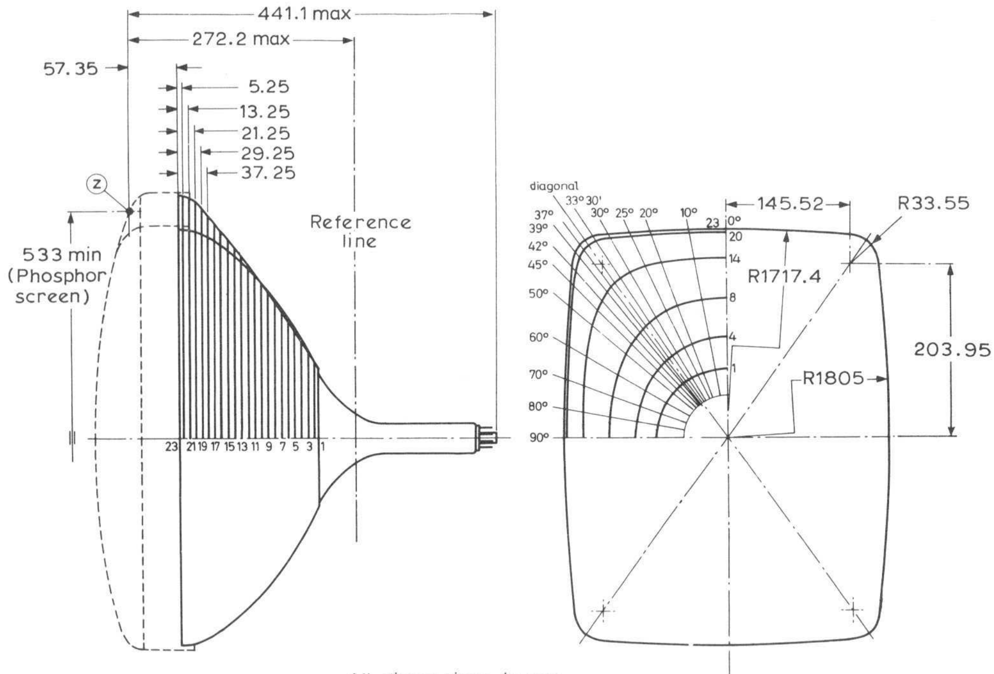
As J.E.D.E.C. B12-244 Base but with shorter spigot



View looking from base



MAXIMUM CONE CONTOURS

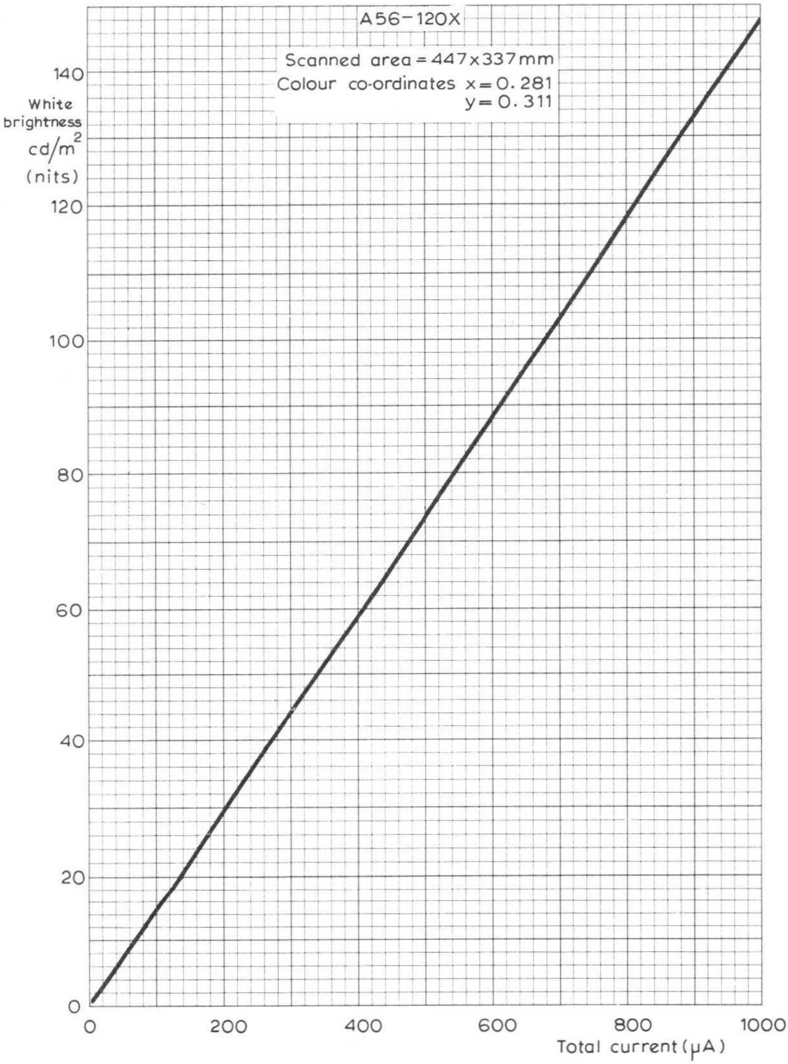


All dimensions in mm

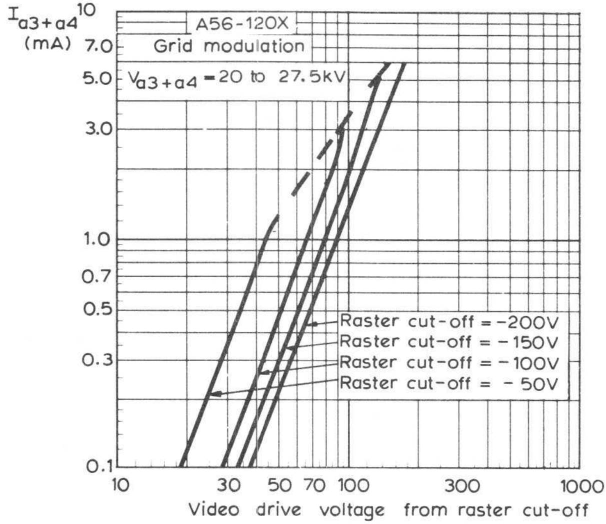
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page 12)

Section	Nominal distance from point 'Z'	Distance from centre (max. values) 0° Long axis	10°	20°	25°	30°	33°30′	35°30′ Diagonal	37°	39°	42°	45°	50°	60°	70°	80°	90° Short axis
1	227·2	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9	79·9
2	222·6	87·7	87·7	87·6	87·6	87·5	87·5	87·5	87·4	87·4	87·4	87·4	87·3	87·2	87·2	87·1	87·1
3	214·6	103·3	103·0	102·1	101·6	101·0	100·6	100·4	100·2	100·0	99·6	99·3	98·9	93·1	97·5	97·4	97·3
4	206·6	118·0	117·5	116·0	115·1	114·1	113·3	112·9	112·6	112·2	111·6	101·0	110·0	108·3	107·1	106·4	106·2
5	198·6	131·0	130·5	129·0	127·9	126·6	125·7	125·1	124·7	124·1	123·2	122·4	120·9	118·3	116·2	114·9	114·4
6	190·6	142·7	142·4	141·1	140·1	138·8	137·7	137·0	136·5	135·8	134·7	133·5	131·6	127·9	124·8	122·8	122·1
7	182·6	153·3	153·3	152·6	151·7	150·5	149·3	148·6	148·0	147·2	145·8	144·4	142·0	137·1	132·9	130·1	129·2
8	174·6	163·0	163·4	163·4	162·9	161·8	160·7	159·9	159·3	158·3	156·8	155·0	152·0	145·8	140·5	137·0	135·8
9	166·6	172·1	172·8	173·7	173·6	172·8	171·7	170·9	170·2	169·2	167·4'	165·4	161·6	154·0	147·6	143·4	141·9
10	158·6	180·6	181·6	183·5	183·9	183·5	182·5	181·7	180·9	179·8	177·7	175·3	170·9	161·7	154·2	149·4	147·7
11	150·6	188·6	190·0	192·7	193·7	193·8	193·0	192·2	191·4	190·1	187·8	185·0	179·7	169·0	160·3	154·9	153·1
12	142·6	196·2	197·8	201·6	203·2	203·8	203·3	202·5	201·6	200·2	197·5	194·3	188·1	175·8	166·0	160·1	158·1
13	134·6	203·3	205·3	209·9	212·2	213·5	213·3	212·5	211·6	210·1	206·9	203·1	196·1	182·1	171·4	164·9	162·8
14	126·6	210·1	212·3	217·8	220·8	222·9	223·1	222·3	221·4	219·7	216·0	211·6	203·5	187·9	176·3	169·4	167·2
15	118·6	216·4	218·9	225·3	229·0	231·9	232·6	231·9	231·0	229·0	224·7	219·6	210·4	193·2	180·8	173·6	171·2
16	110·6	222·5	225·1	232·3	236·8	240·6	241·9	241·4	240·3	238·1	233·0	227·1	216·7	198·1	184·3	177·4	175·0
17	102·6	228·2	231·0	239·0	244·2	249·0	251·0	250·6	249·4	247·0	241·0	234·1	222·5	202·5	188·3	181·0	178·5
18	94·6	233·4	236·3	245·0	250·9	256·9	259·9	259·6	258·4	255·6	248·5	240·6	227·8	206·4	192·2	184·3	181·7
19	86·6	237·4	240·5	249·7	256·5	264·0	268·3	268·4	267·3	264·2	255·7	246·6	232·3	209·9	195·3	187·2	184·6
20	78·6	240·3	243·5	253·2	260·7	269·8	276·1	276·9	275·9	272·6	262·4	251·7	236·1	212·8	193·1	189·9	187·3
21	70·6	242·3	245·5	255·4	263·3	273·2	280·6	281·8	281·0	277·6	266·4	254·9	238·6	214·9	200·1	191·9	189·3
22	62·6	243·4	246·6	256·6	264·5	274·7	282·4	283·7	283·0	279·5	268·2	256·4	240·0	216·2	201·3	193·1	190·4
23	57·35	243·9	247·1	257·1	265·0	275·2	282·8	284·2	283·4	280·0	268·7	257·0	240·5	216·7	201·8	193·5	190·9

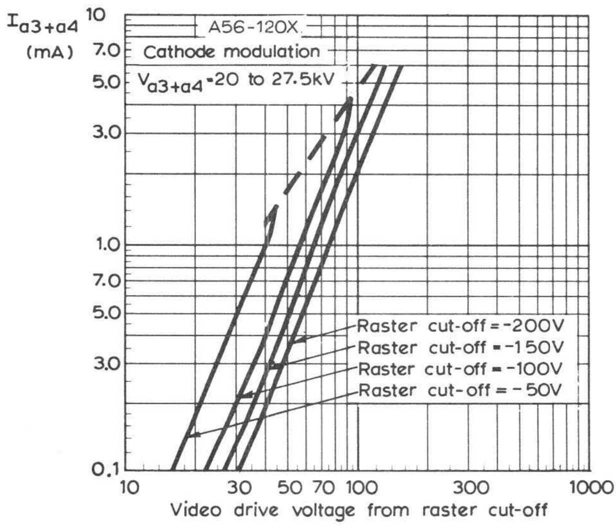
All dimensions in mm



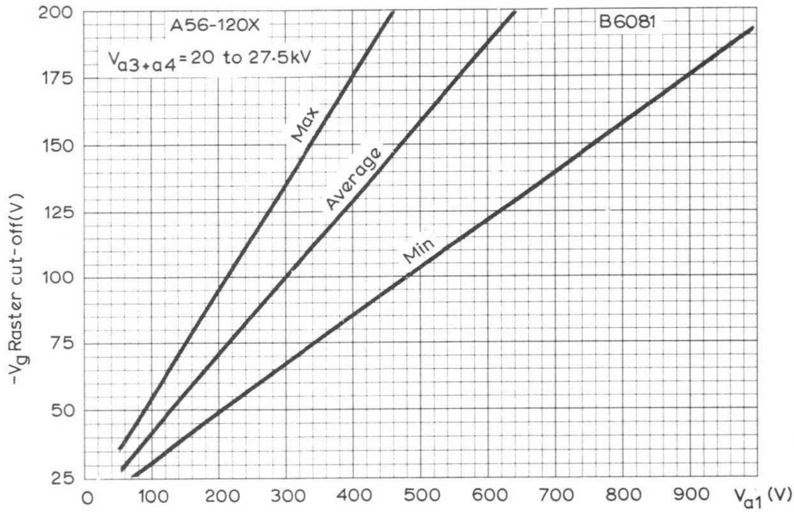
BRIGHTNESS AT CENTRE OF SCREEN PLOTTED AGAINST TOTAL CURRENT FOR WHITE OF COLOUR COORDINATES x = 0.281, y = 0.311



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID
VOLTAGE. CATHODE MODULATION



CUT-OFF DESIGN CHART

TELEVISION TUBE A59-11W

QUICK REFERENCE DATA		
59cm (23 in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is electrically identical to the A59-15W.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	% ←
Maximum overall length	36.7	cm

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

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV ←
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed		
Fluorescent colour	White	
Light transmission (approx.)	50	% ←
Useful screen area	see page D6	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA. ←

DEFLECTION

Double magnetic

The deflection coils should be designed so that their internal contour is in accordance with J.E.D.E.C. gauge 126, and should provide a pull-back of 4mm on a nominal tube.

CAPACITANCES

$c_{g\text{-}all}$	6.0	pF
$c_{k\text{-}all}$	4.0	pF
$c_{a2+a4\text{-}M}$	1700 to 2500	pF
$c_{a2+a4\text{-}B}$	350	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating M, which must be earthed, and the capacitance of this to the final anode is 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.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION — Any

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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV ←
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) must be connected to the chassis via a 2MΩ resistor. Soldering tags are provided for this purpose.

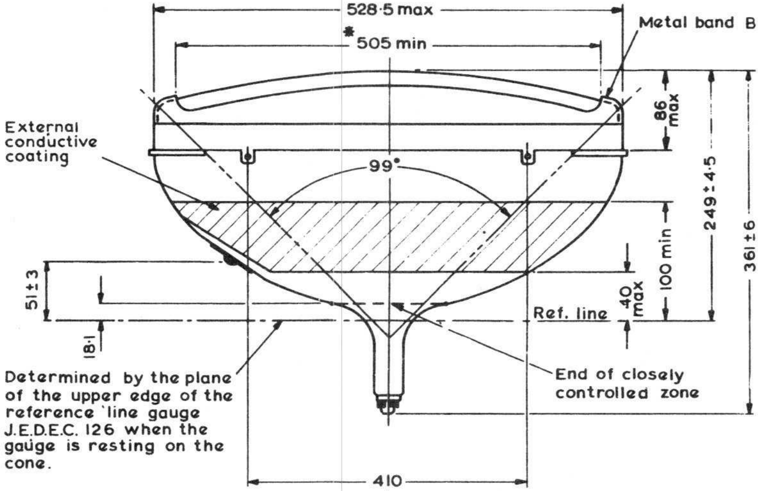
   The mounting lugs will not necessarily be in electrical contact with the metal band.

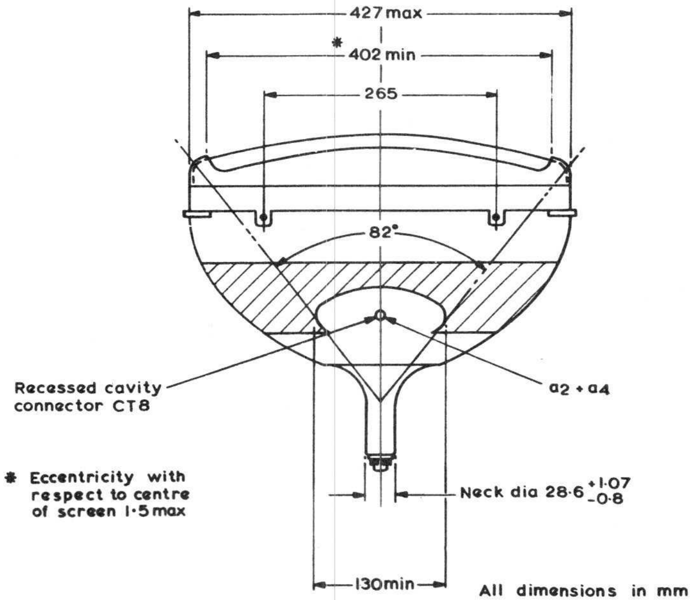
WARNING ←

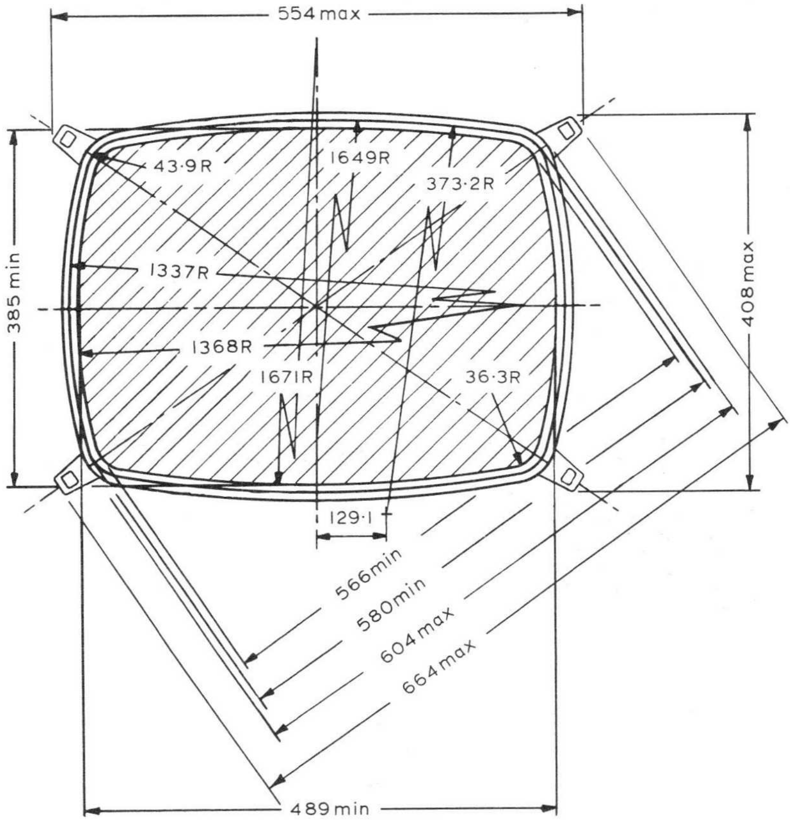
X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

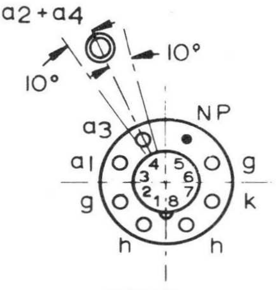
WEIGHT ←

Tube alone	13	kg
	28.7	lb

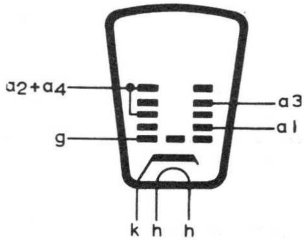

528·5 max
* 505 min
Metal band B
External conductive coating
99°
86 max
249 ± 4·5
361 ± 6
100 min
40 max
51 ± 3
18·1
Ref. line
Determined by the plane of the upper edge of the reference line gauge J.E.D.E.C. 126 when the gauge is resting on the cone.
End of closely controlled zone
410


427 max
* 402 min
265
82°
Recessed cavity connector CT8
a2 + a4
* Eccentricity with respect to centre of screen 1·5 max
Neck dia 28·6 +1·07 −0·8
130min
All dimensions in mm

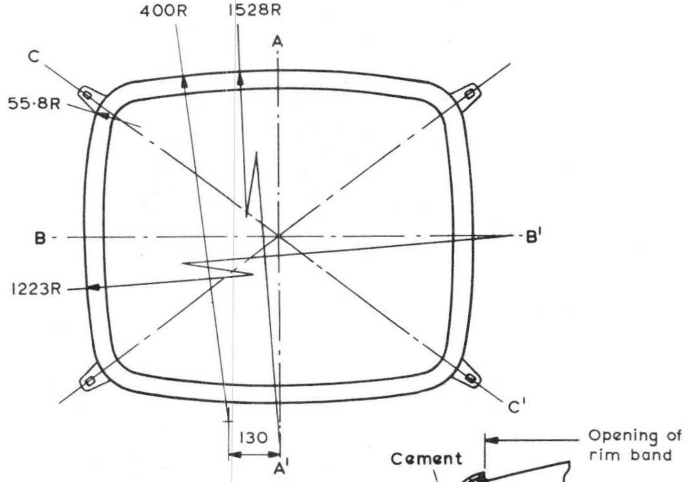




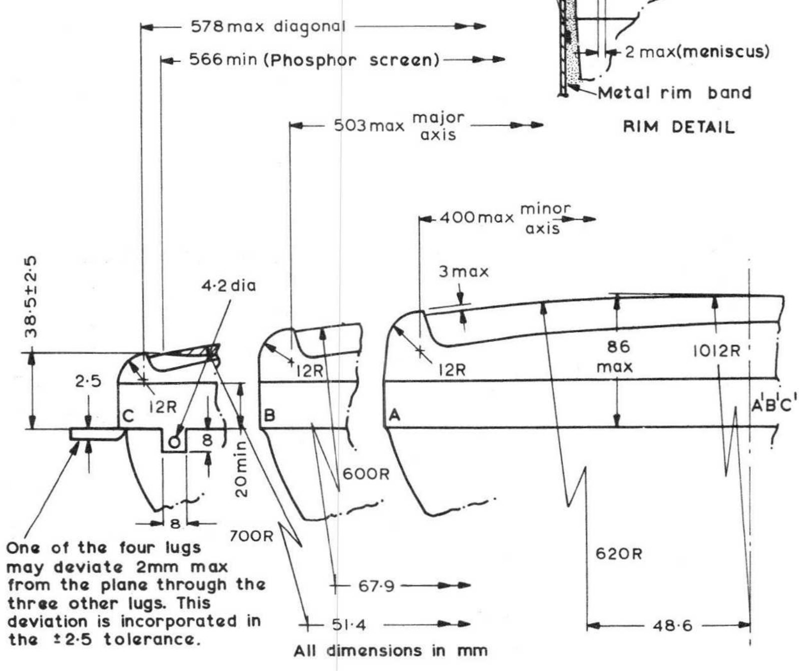
B8H Base



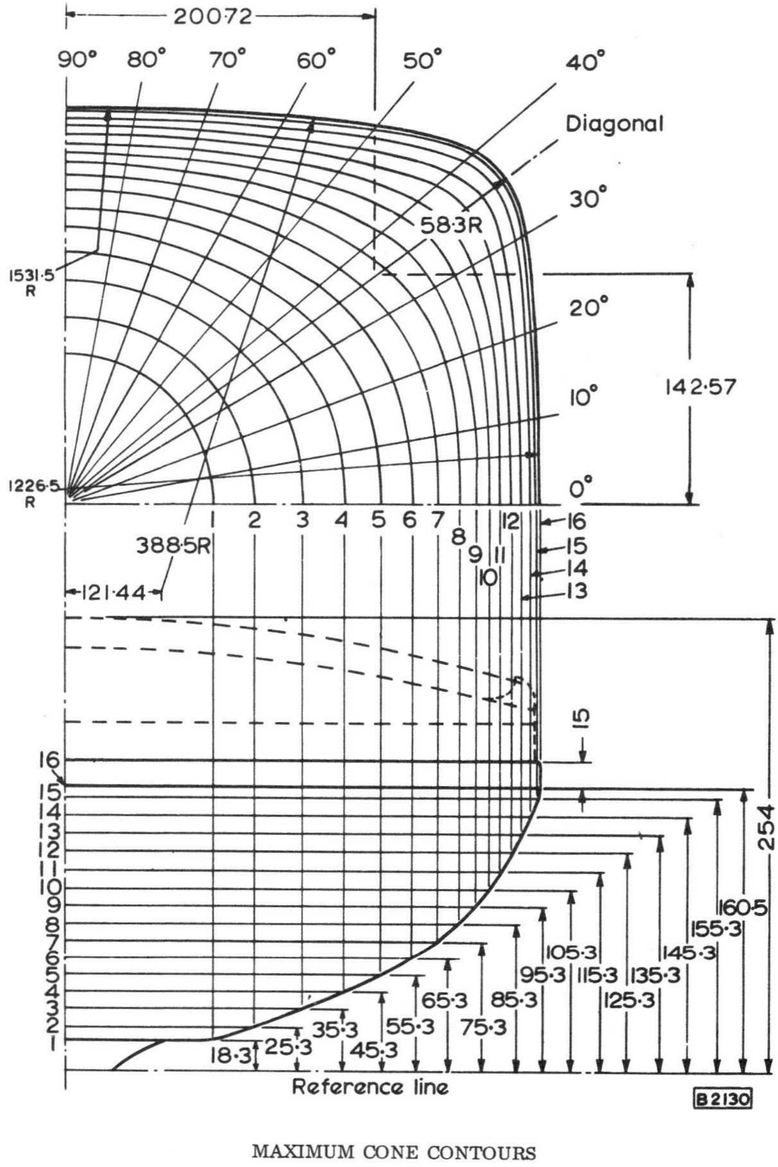
All dimensions in mm



400R
1528R
A
C
55·8R
B
B'
1223R
C'
130
A'
Opening of rim band
Cement
2 max(meniscus)
Metal rim band
RIM DETAIL



578 max diagonal
566 min (Phosphor screen)
503 max major axis
400 max minor axis
3 max
38·5±2·5
4·2 dia
2·5
12R
C
B
A
86 max
1012R
A'B'C'
8
20 min
600R
700R
620R
67·9
51·4
48·6
One of the four lugs may deviate 2mm max from the plane through the three other lugs. This deviation is incorporated in the ±2·5 tolerance.
All dimensions in mm

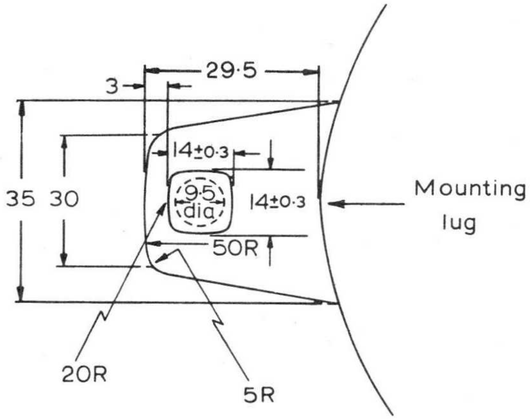


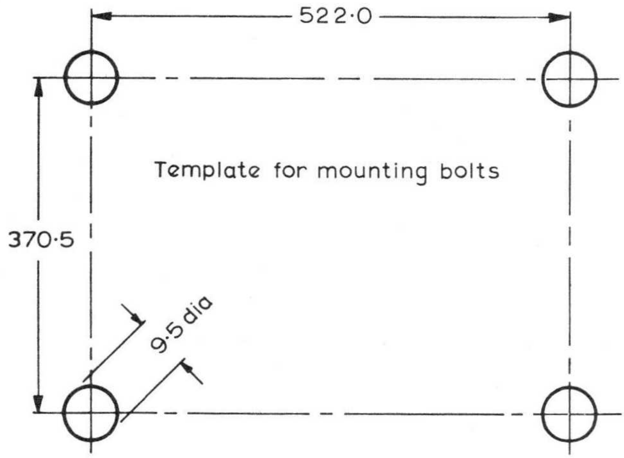
MAXIMUM CONE CONTOURS

DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page D8)

Section	0^{o} long	10^{o}	20^{o}	30^{o}	$35^{o}23'$ diagonal	40^{o}	50^{o}	60^{o}	70^{o}	80^{o}	90^{o} short
1	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
2	107.3	107.2	106.7	105.5	105.0	104.6	104.0	103.6	102.8	102.3	102.3
3	135.0	135.3	135.2	132.9	131.3	129.6	127.2	124.9	123.9	123.9	123.9
4	158.0	158.4	158.8	155.1	152.1	149.8	144.6	141.1	139.5	139.3	139.3
5	178.4	179.0	179.1	175.6	171.6	168.4	161.4	156.6	153.8	152.5	152.2
6	196.0	197.0	197.3	194.6	190.0	186.0	177.7	171.1	166.3	164.0	163.1
7	210.8	212.0	213.4	211.6	206.7	202.2	192.6	183.7	177.4	174.0	172.4
8	223.3	225.1	228.1	227.2	222.8	217.9	206.1	194.4	187.0	182.3	180.4
9	233.2	235.2	240.1	240.7	238.0	232.7	217.8	203.9	194.4	189.3	187.1
10	240.8	243.3	249.4	253.2	252.5	246.8	228.6	212.4	200.9	195.1	192.8
11	247.2	249.7	257.0	264.9	266.2	259.9	238.3	219.9	206.7	200.2	197.7
12	253.1	255.8	264.0	275.5	278.8	272.3	247.4	226.5	212.4	205.2	202.7
13	258.4	261.4	270.4	285.4	290.2	283.5	255.7	232.9	217.8	209.9	207.5
14	263.2	266.3	276.0	293.4	299.5	293.3	263.2	238.6	222.9	214.6	211.9
15	267.0	270.3	280.3	297.8	303.7	299.3	268.9	243.7	227.6	218.9	216.1
16	267.8	271.0	280.9	298.6	304.5	300.2	270.2	244.9	228.8	219.9	217.0

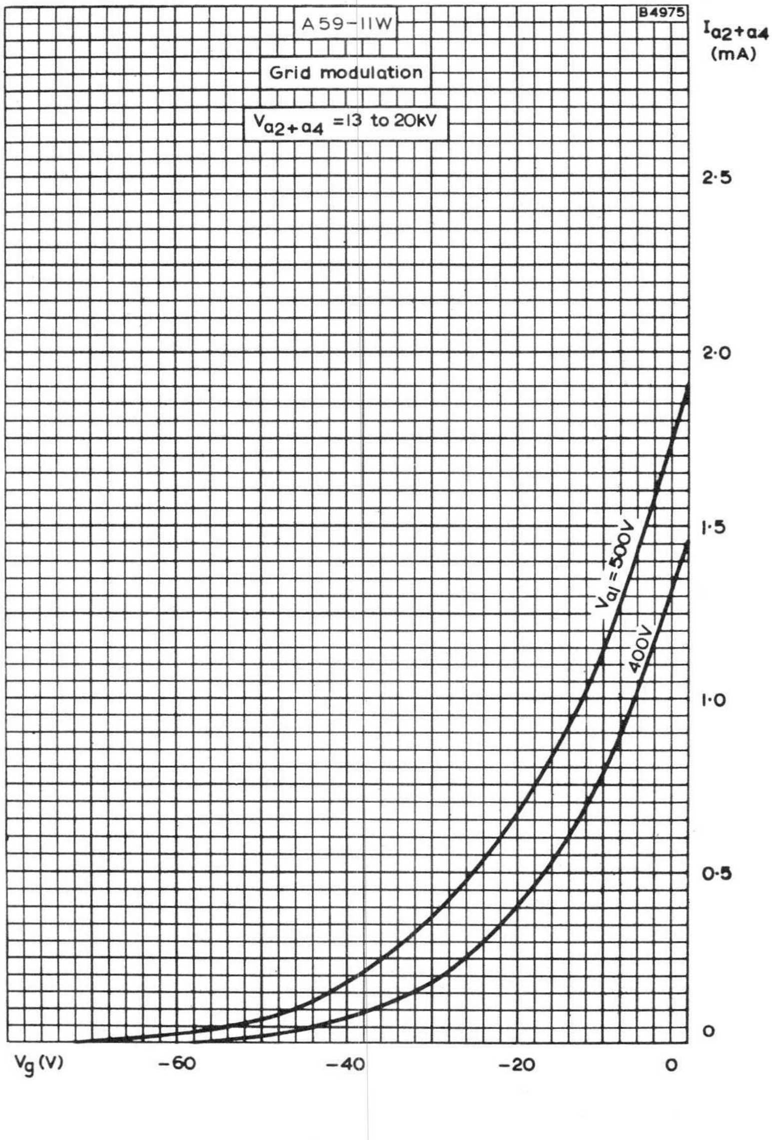
All dimensions in mm



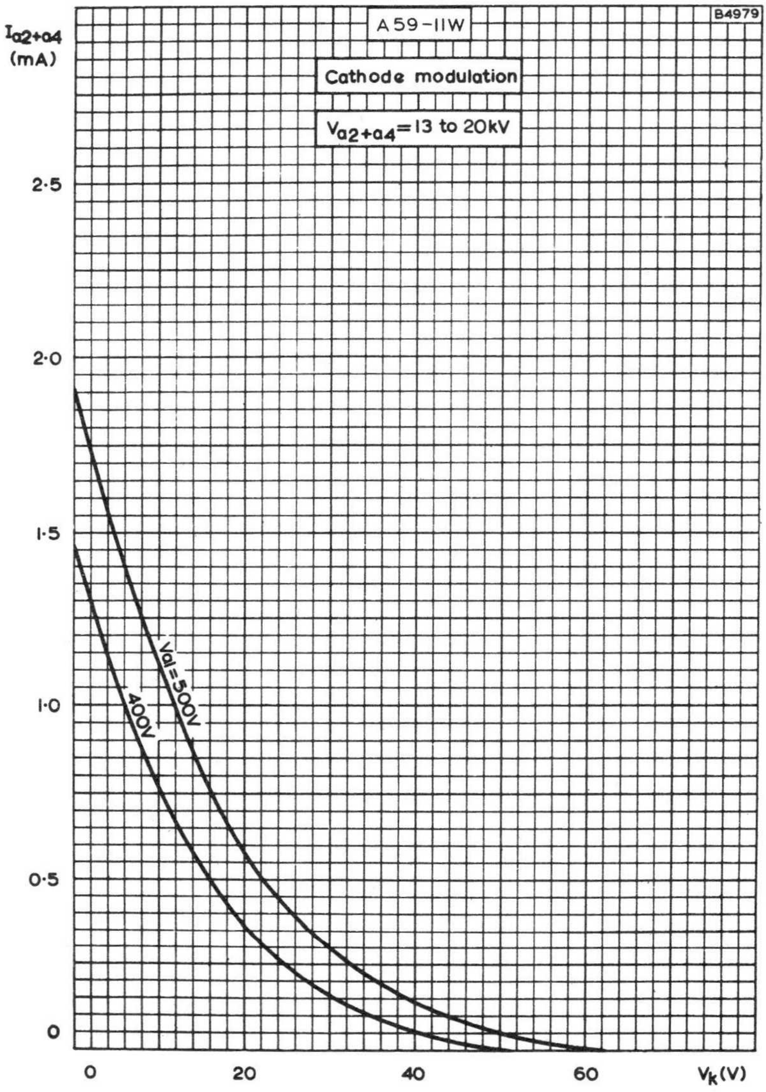


All dimensions in mm

The bolts to be used for mounting the tube must be within the circles of 9.5mm diameter shown in the template drawing.

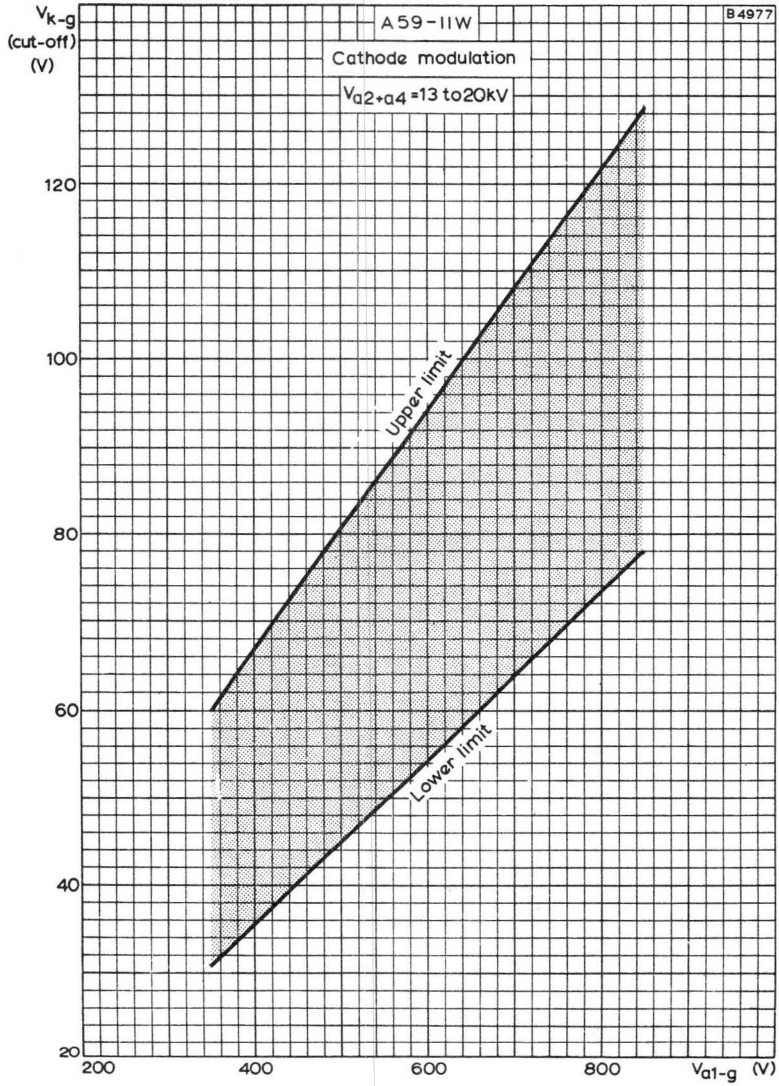


FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.

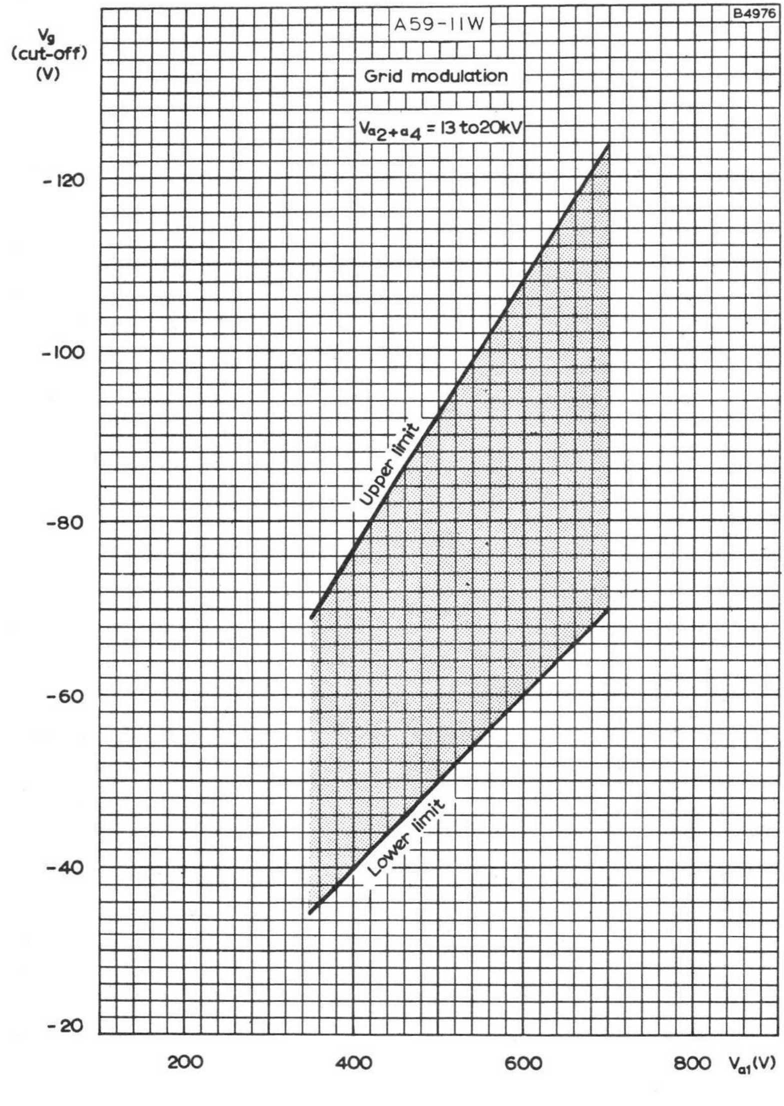


FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.

←



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE A59-15W

QUICK REFERENCE DATA		
59cm (23in) direct viewing television tube with metal backed screen. This tube is electrically identical to the A59-11W.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	%
Maximum overall length	36.7	cm

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

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White
Light transmission (approx.)	50%
Useful screen area	see page D6

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION

Double magnetic

The deflection coils should be designed so that their internal contour is in accordance with J.E.D.E.C. gauge 126, and should provide a pull-back of 4mm on a nominal tube.

CAPACITANCES

$c_{g\text{-all}}$	6.0	pF
$c_{k\text{-all}}$	4.0	pF
$c_{a2+a4\text{-}M}$	1700 to 2500	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating M, which must be earthed, and the capacitance of this to the final anode is 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.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION Any

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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4} = 0$) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_g$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

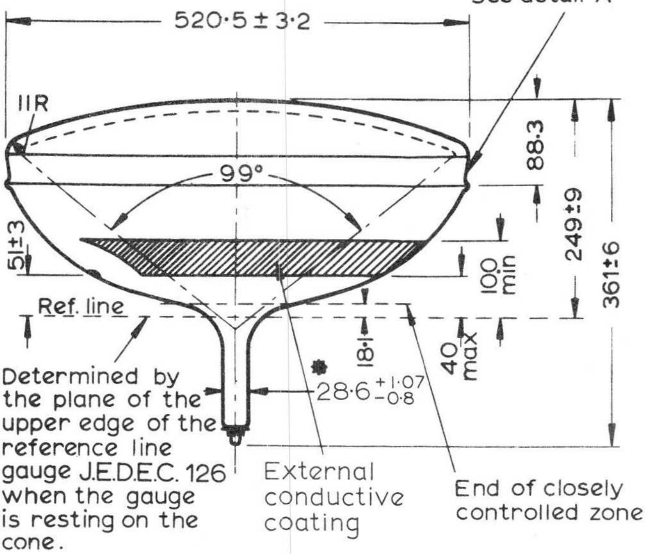
4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

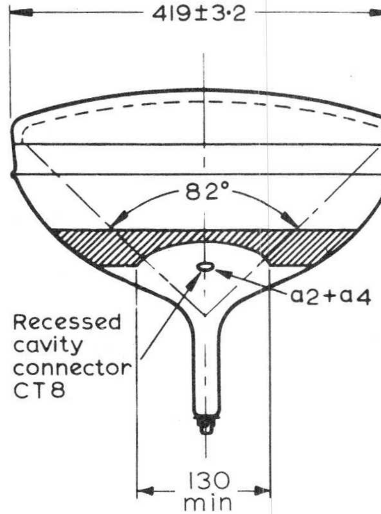
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

WEIGHT

Tube alone	12	kg
	26.5	lb

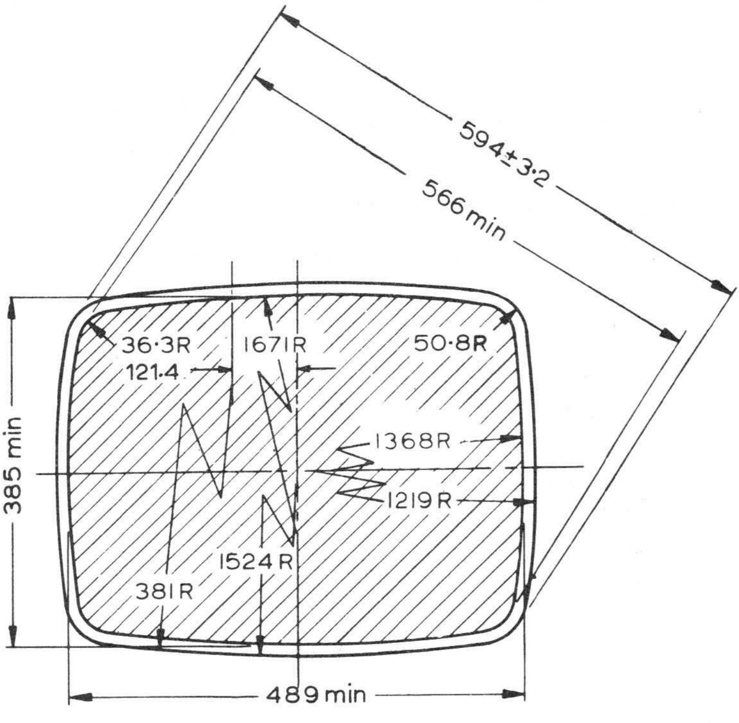


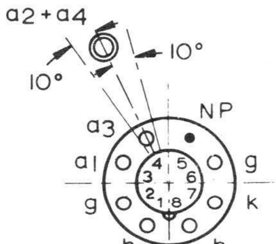


* The maximum value is determined by the reference line gauge

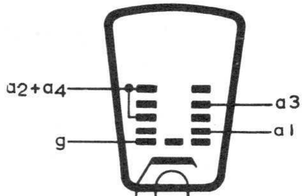
All dimensions in mm

B5073

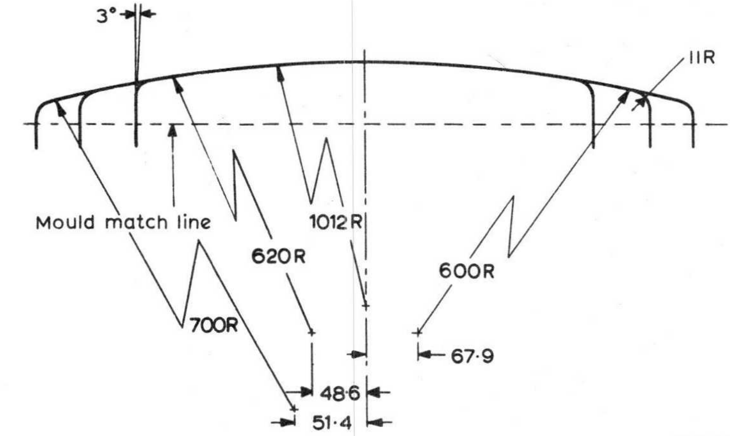




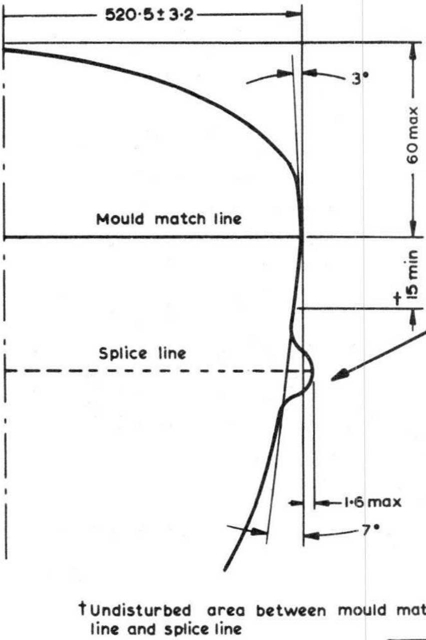
B8H Base



All dimensions in mm



Detail 'A'



†Undisturbed area between mould match line and splice line

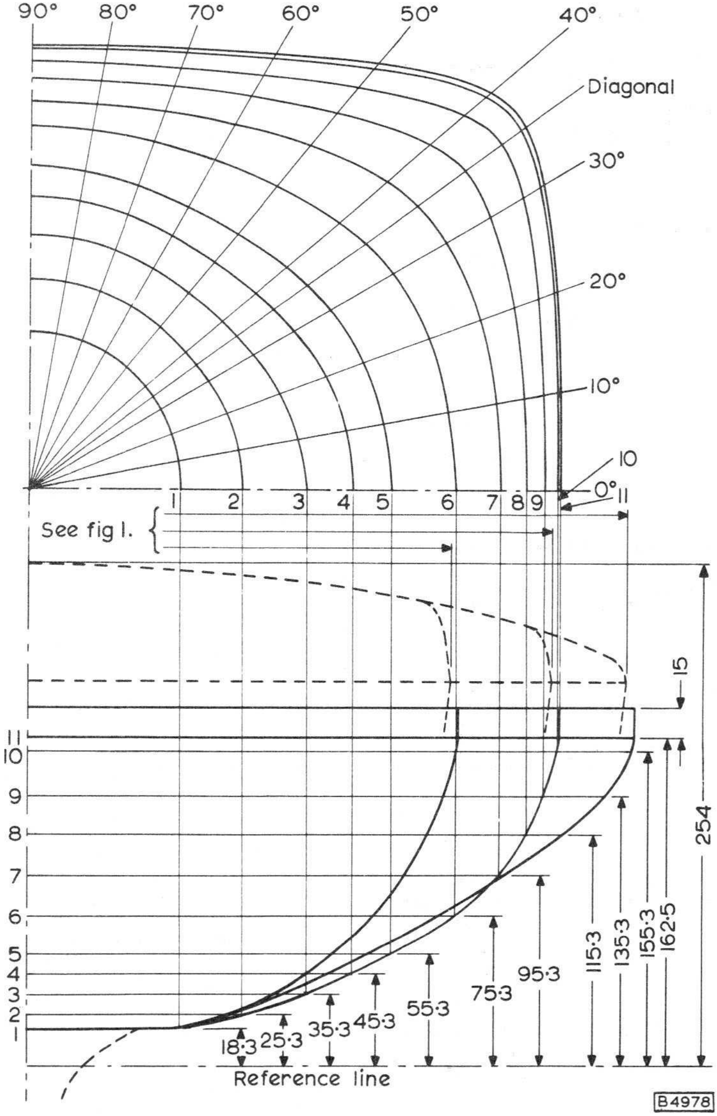
All dimensions in mm

B5021

The bulge at the splice line seal may increase the indicated maximum values for envelope width, diagonal and height by not more than 3.2mm, but at any point around the seal, the bulge will not protrude more than 1.6mm beyond the envelope surface at the mould match line.

The mounting arrangement should be designed such that for satisfactory clamping it does not depend on the presence of a bulge at the splice line.

The undisturbed area between mould match line and splice line is 15mm minimum. This should be the width of the tube support band.

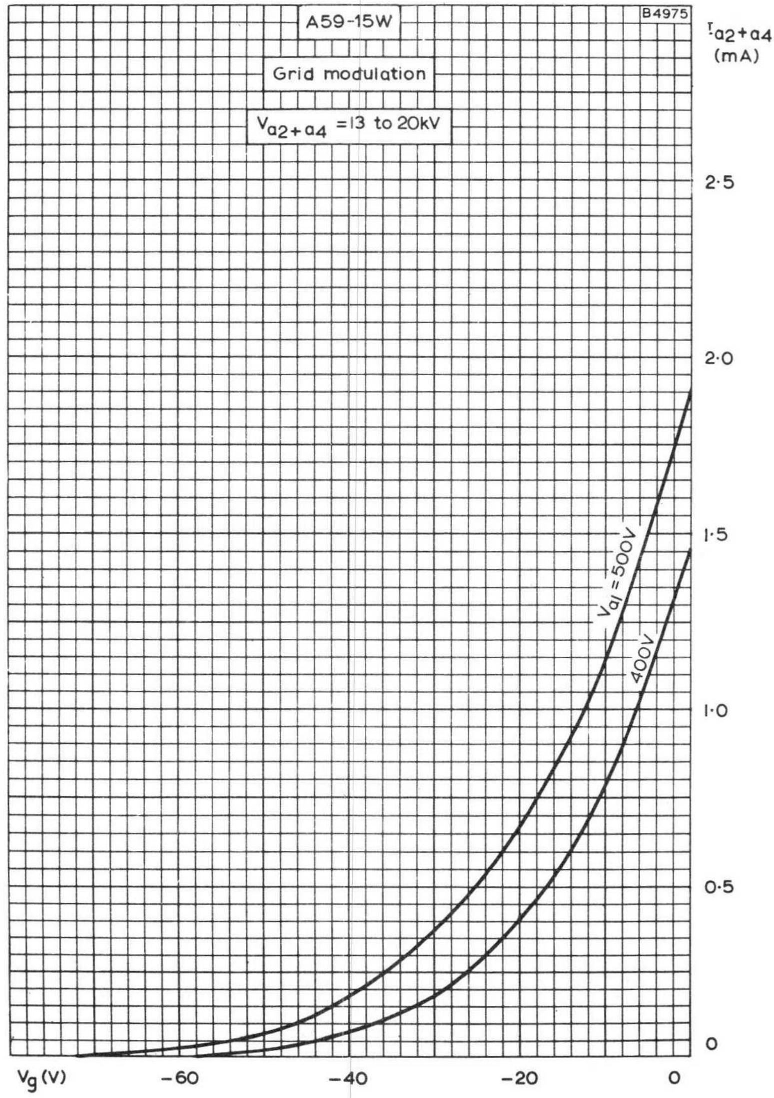


MAXIMUM CONE CONTOURS

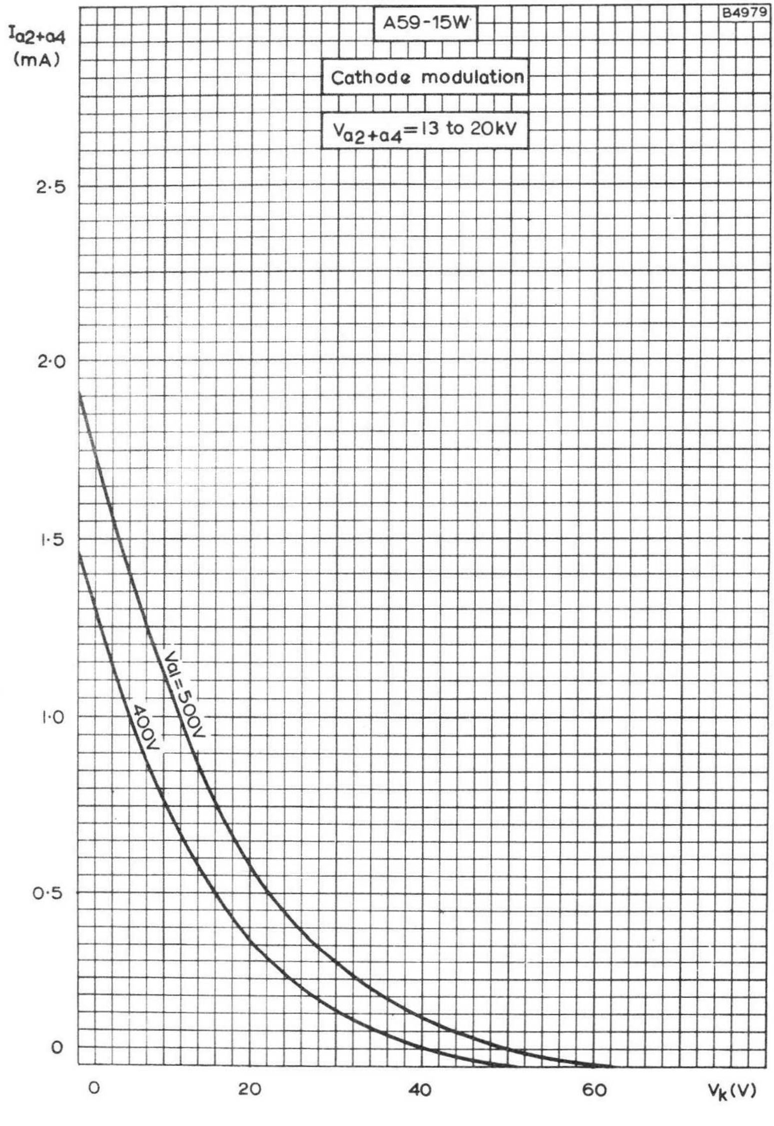
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page D8)

Section	Nominal height above Ref. line	0^{o} long	10^{o}	20^{o}	30^{o}	Diagonal	40^{o}	50^{o}	60^{o}	70^{o}	80^{o}	90^{o} short
1	18.3	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0	75.0
2	25.3	106.0	104.4	102.4	101.6	101.0	101.0	101.0	101.0	101.0	101.0	101.0
3	35.3	137.7	136.0	132.0	128.6	126.4	125.3	123.2	122.1	121.8	121.6	122.5
4	45.3	160.8	160.0	155.9	151.2	148.6	146.7	142.6	140.0	138.5	138.5	138.8
5	55.3	180.0	179.0	176.5	172.2	168.5	165.8	159.8	155.3	152.8	152.0	151.6
6	75.3	211.8	211.0	210.9	208.3	204.3	200.2	190.7	182.5	176.4	172.8	172.0
7	95.3	233.8	234.6	237.8	238.5	235.7	230.9	215.9	202.2	193.1	188.0	187.0
8	115.3	247.0	249.0	255.6	263.3	263.6	258.3	236.2	218.0	206.2	199.7	198.0
9	135.3	256.5	259.0	267.8	282.1	287.0	280.4	252.0	230.1	216.0	208.5	206.5
10	155.3	263.0	266.0	275.1	292.5	299.2	294.8	263.6	239.0	223.2	214.8	212.2
11	162.5	264.2	267.5	277.0	294.2	301.5	298.0	266.2	241.2	225.2	216.2	213.5

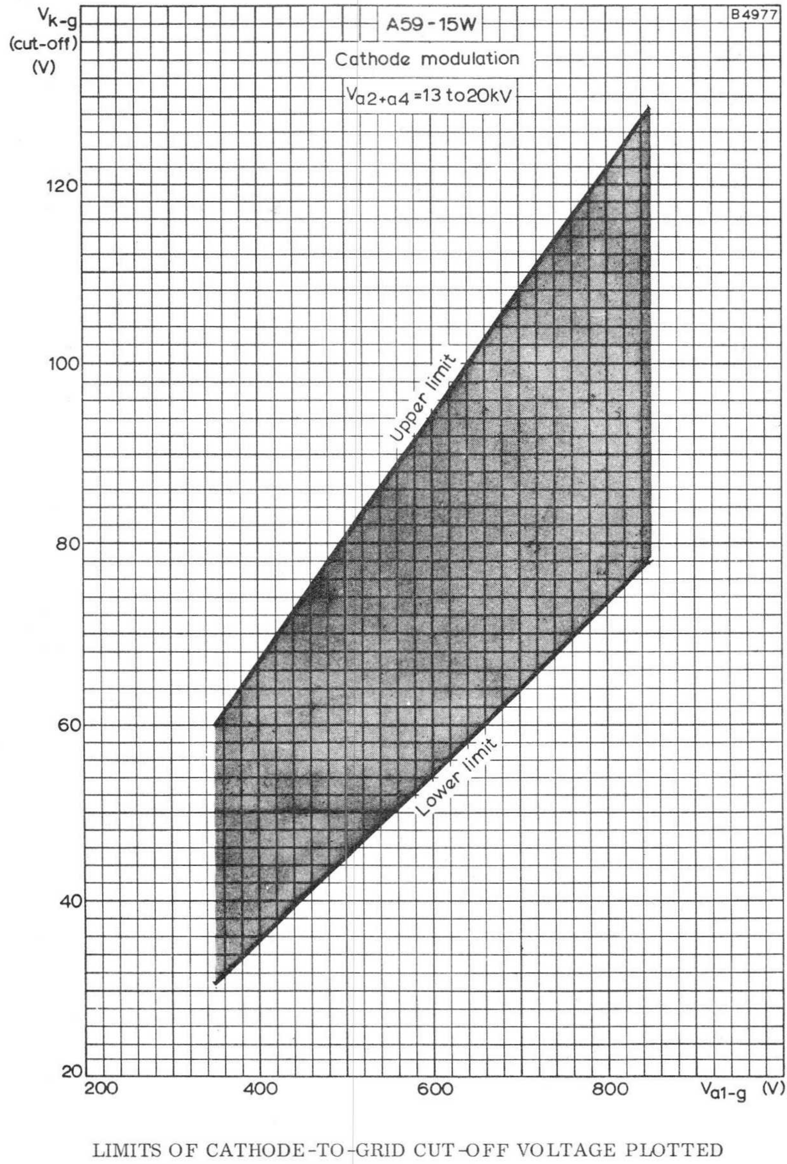
All dimensions in mm



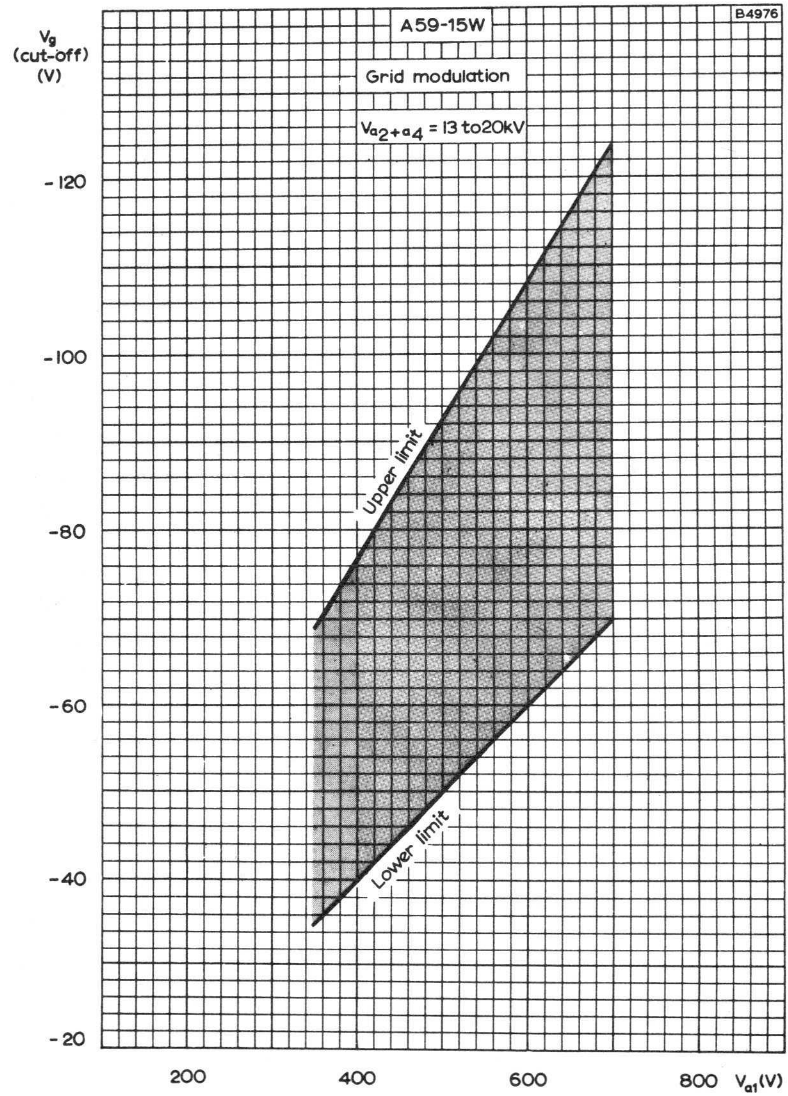
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE A59-23W

TENTATIVE DATA

QUICK REFERENCE DATA		
59cm (23in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is electrically identical to the A59-11W. Suitable for use in receivers with push-through presentation.		
Deflection	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	50	%
Maximum overall length	36.7	cm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN

Metal backed

Fluorescent colour	White	
Light transmission (approx.)	50	%
Useful screen area	See page D6	

FOCUSING

Electrostatic

The range of focus voltages shown in 'OPERATING CONDITIONS' results in optimum overall focus at a beam current of 250μA.

DEFLECTION

Magnetic

Diagonal deflection angle	110	deg
Horizontal deflection angle	99	deg
Vertical deflection angle	82	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

$c_{g\text{-}all}$	6.0	pF
$c_{k\text{-}all}$	4.0	pF
$c_{a2+a4\text{-}M}$	1700 to 2500	pF
$c_{a2+a4\text{-}B}$	350	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 10	Gs
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations - Cathode Ray Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f=50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f=50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flash-over within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver.

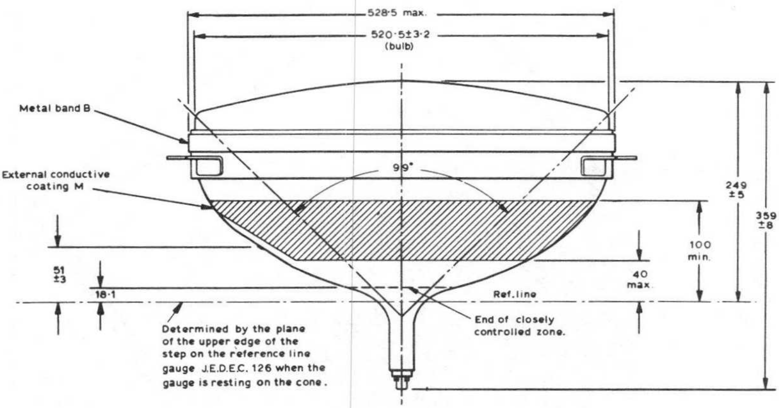
   The mounting lugs will be in electrical contact with the metal band.

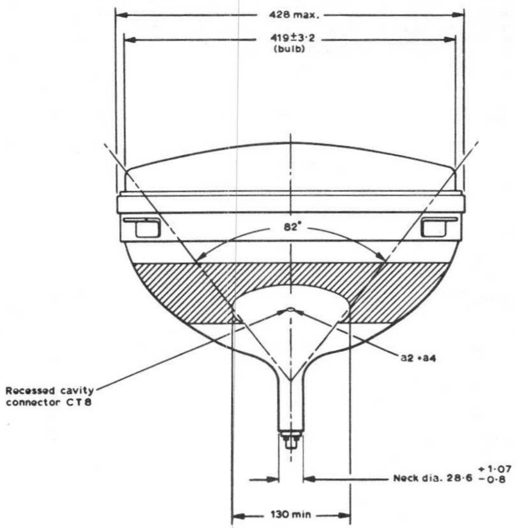
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

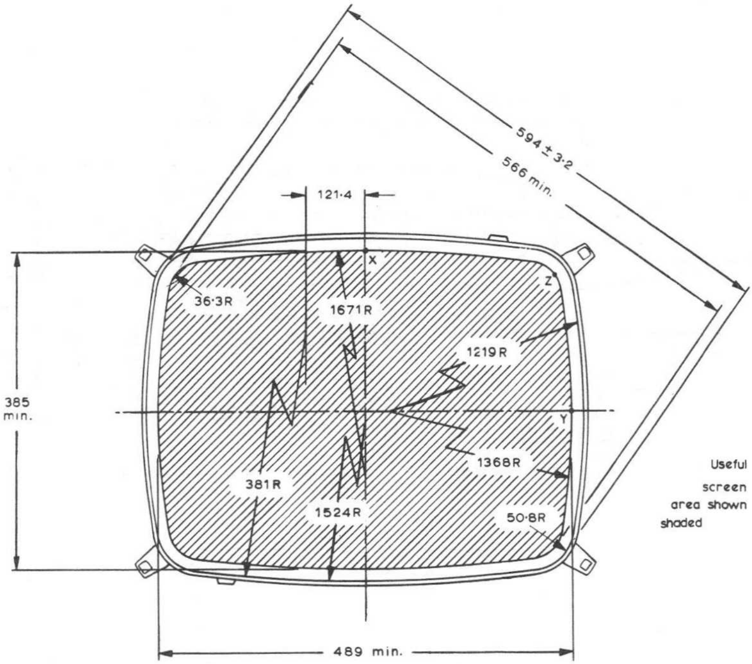
WEIGHT

Tube alone (approx.)	13	kg

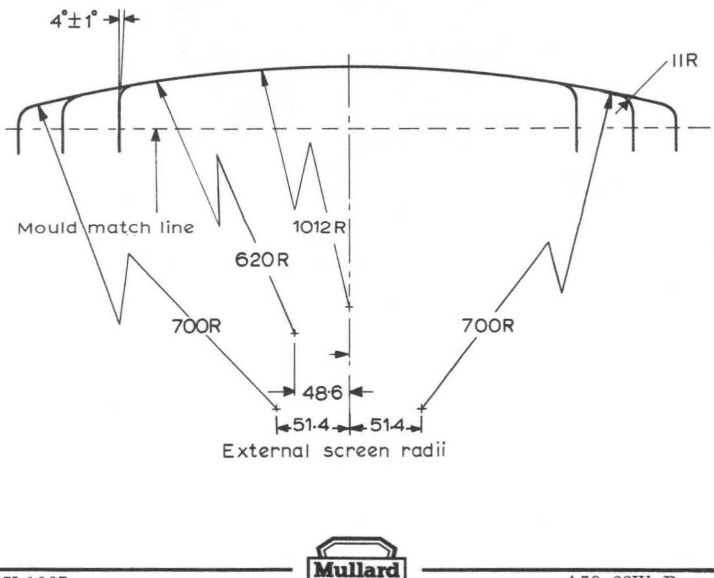




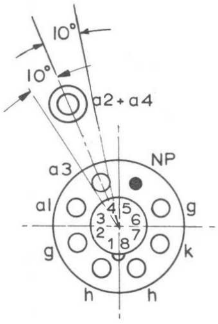
All dimensions in mm.



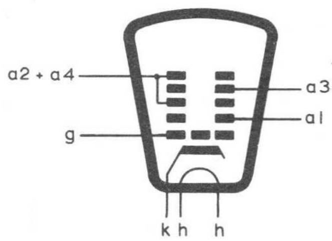
Bulb dimensions

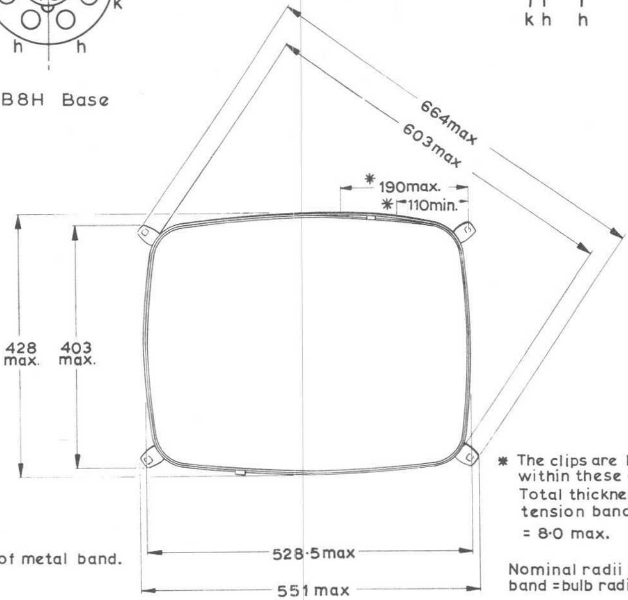


External screen radii



B8H Base

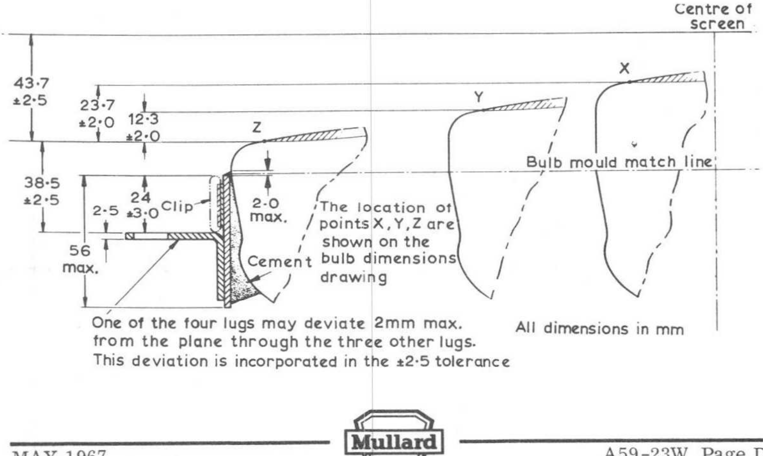




Dimensions of metal band.

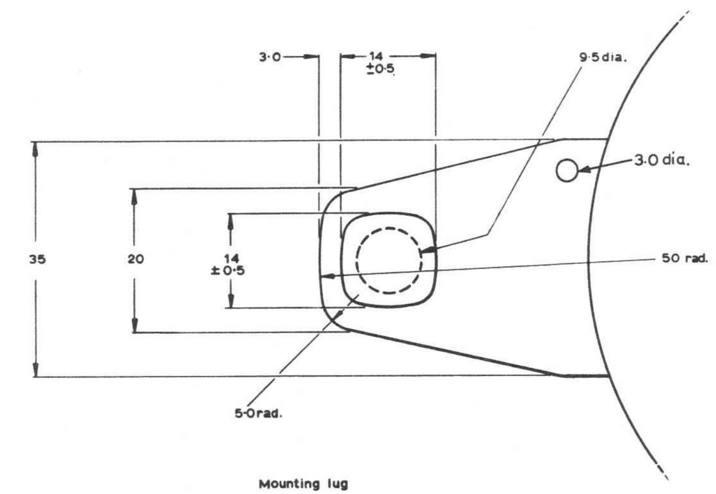
* The clips are located within these dimensions. Total thickness of rimband, tension bands and clip = 8·0 max.

Nominal radii of tension band = bulb radius + 2·5mm

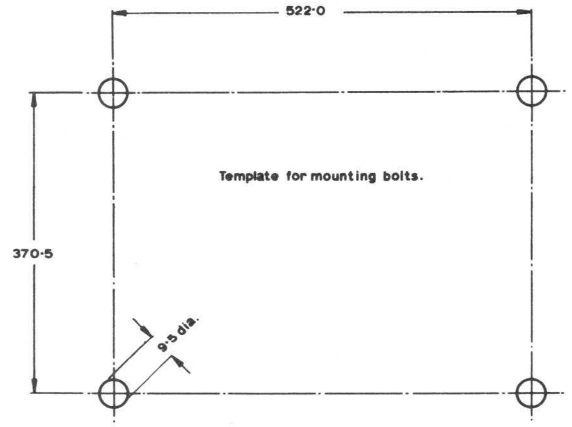


One of the four lugs may deviate 2mm max. from the plane through the three other lugs. This deviation is incorporated in the ±2·5 tolerance

All dimensions in mm



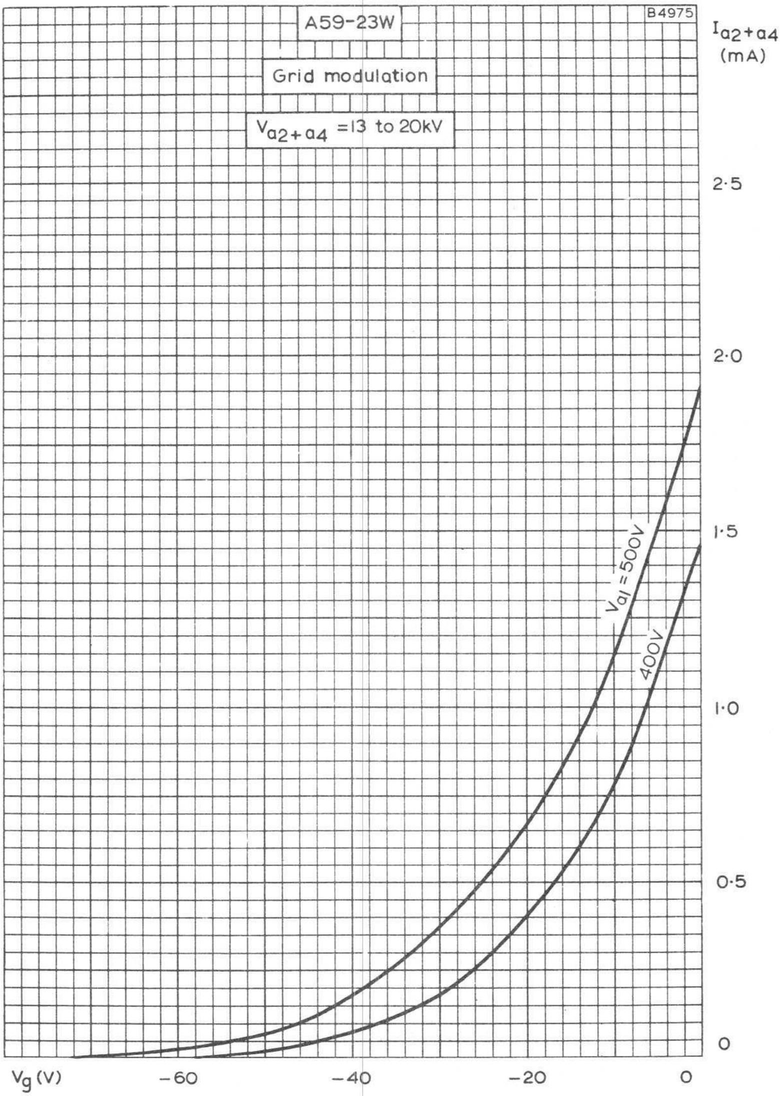
Mounting lug



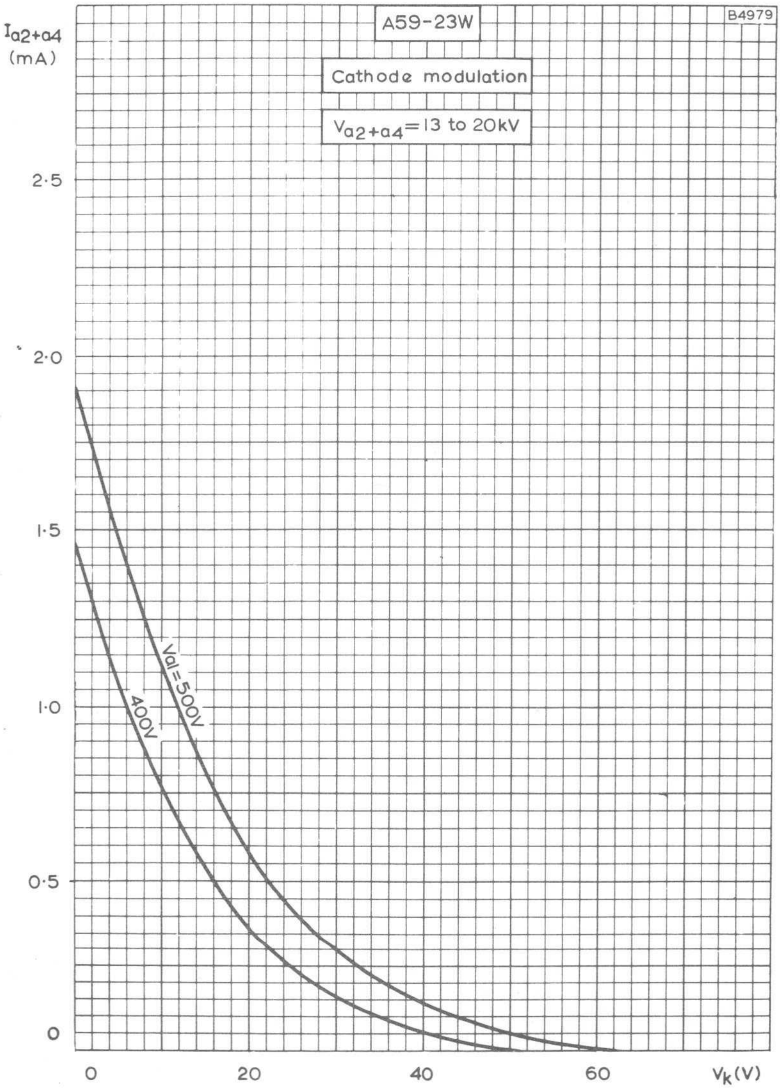
Template for mounting bolts.

All dimensions in mm.

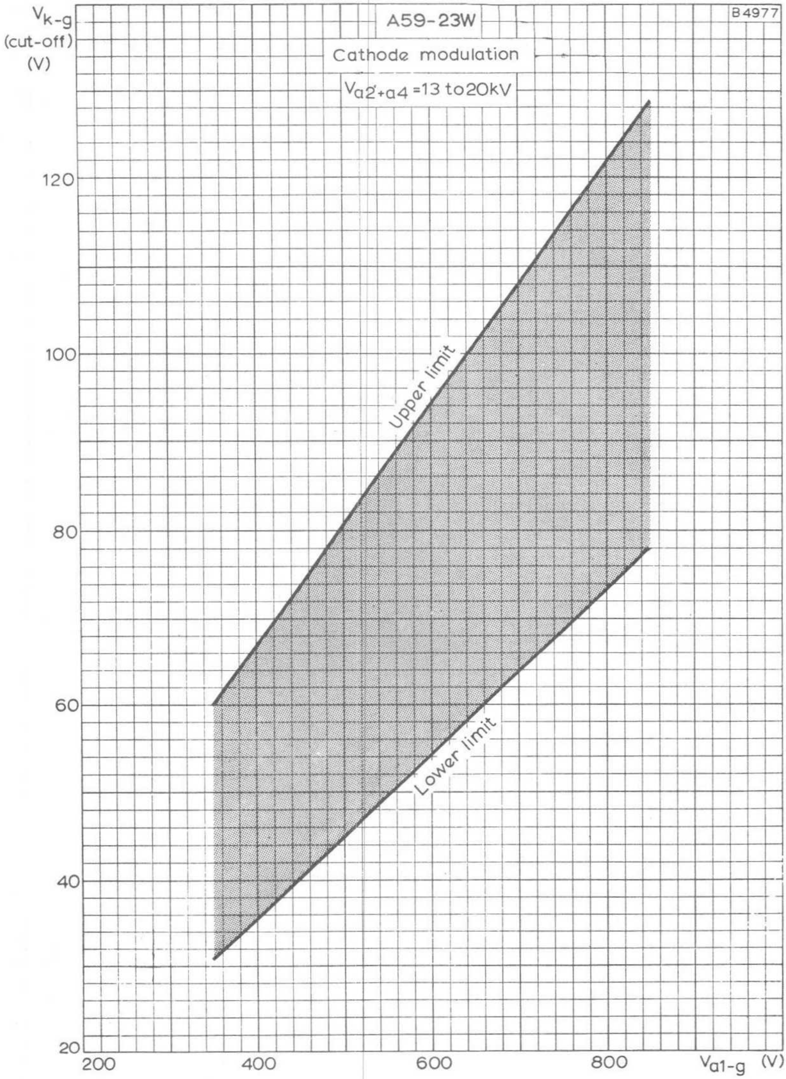
The bolts to be used for mounting the tube must be within the circles of 9·5mm diameter shown in the template drawing.



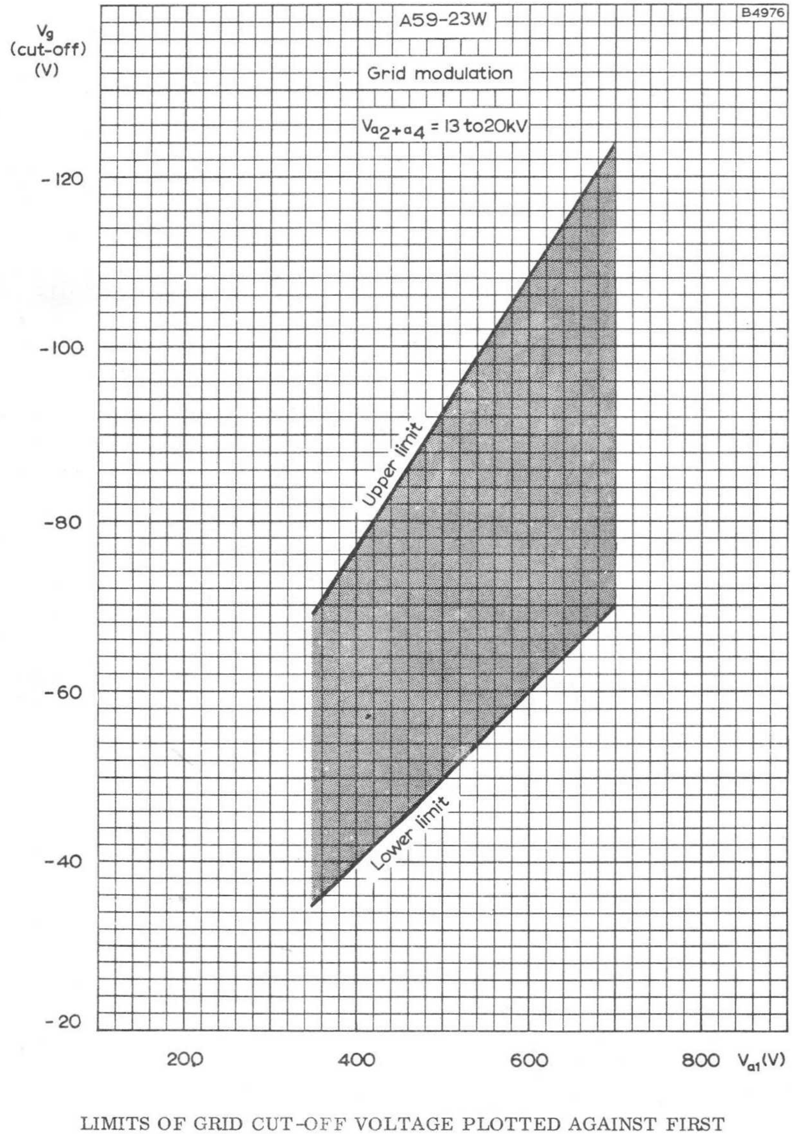
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE

A59-23W/R

QUICK REFERENCE DATA		
59cm (23in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. This tube is fitted with a ring trap base but in all other respects is electrically identical to the A59-11W. Suitable for use in receivers with push-through presentation.		
Deflection angle	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	45	%
Maximum overall length	367	mm

This data should be read in conjunction with
GENERAL OPERATIONAL RECOMMENDATIONS - CATHODE RAY TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Cathode Ray Tubes'.

Note - (applies to series operation only). The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (Metal backed)

Fluorescent colour		White
Light transmission (approx.)	45	%
Useful screen area		See page 6

FOCUSING (Electrostatic)

The range of focus voltages shown in 'OPERATING CONDITIONS" results in optimum overall focus at a beam current of 250μA. In general, acceptable resolution will be obtained with a fixed focus voltage.

DEFLECTION (Magnetic)

Diagonal deflection angle	110	deg
Horizontal deflection angle	99	deg
Vertical deflection angle	82	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	1700 to 2500	pF
$c_{a2+a4-B}$	450	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

RING TRAP

For flashover protection to the receiver, parallel spark gaps are included for all the pins in the base of this tube, and the common connection is made to pin 5. These spark gaps are intended as part of a system for full flashover protection. A direct connection must always be made from pin 5 to the external conductive coating. Any electrode supplied directly from a high energy source (such as the H.T. line) should be provided with a series resistor.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Cathode Ray Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations-Cathode Ray Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at $I_{a2+a4}=0$) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

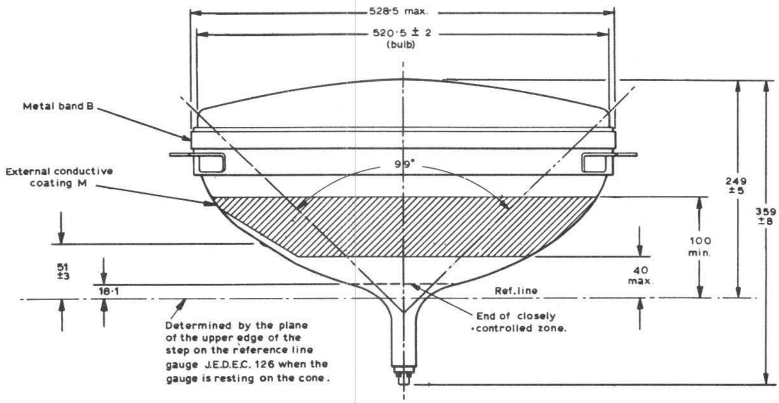
   The mounting lugs will be in electrical contact with the metal band.

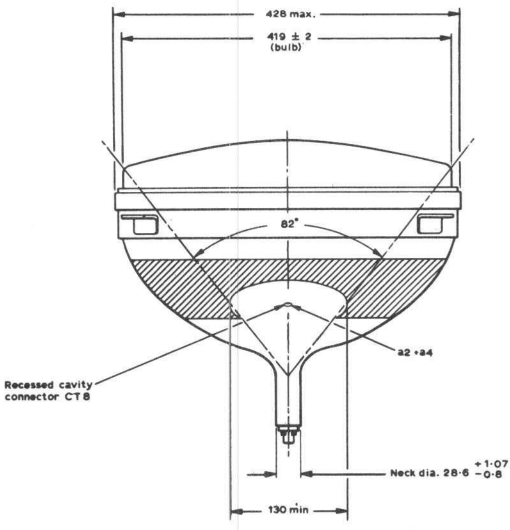
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

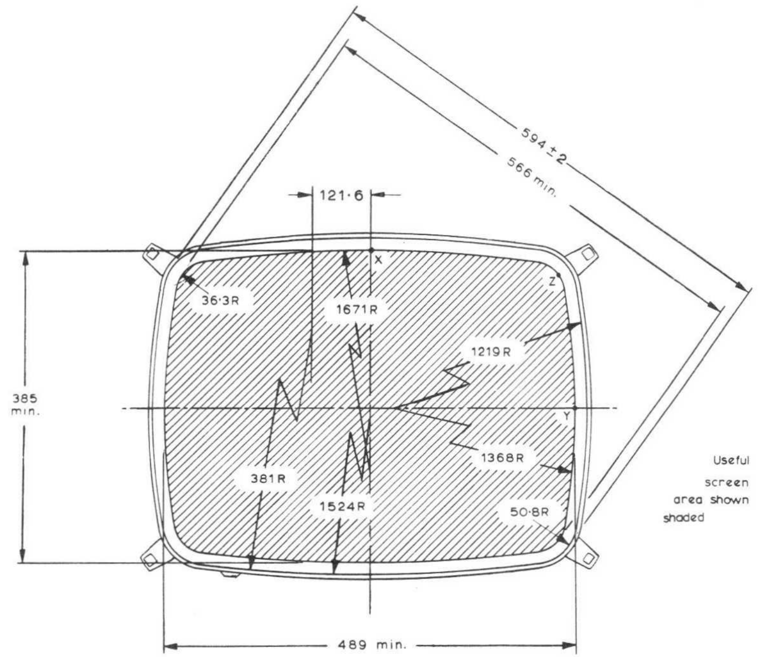
WEIGHT

Tube alone (approx.)	13	kg

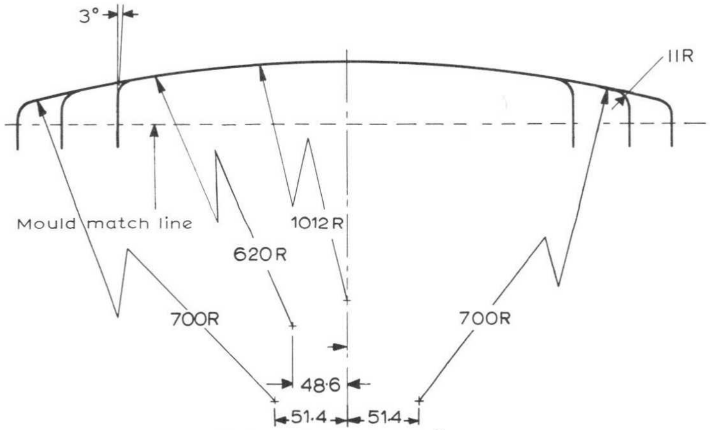




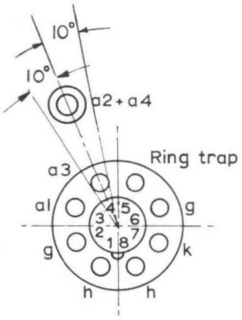
All dimensions in mm.



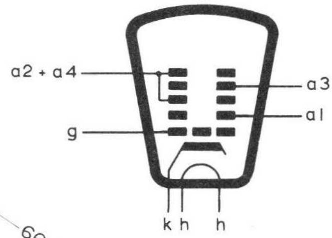
Bulb dimensions

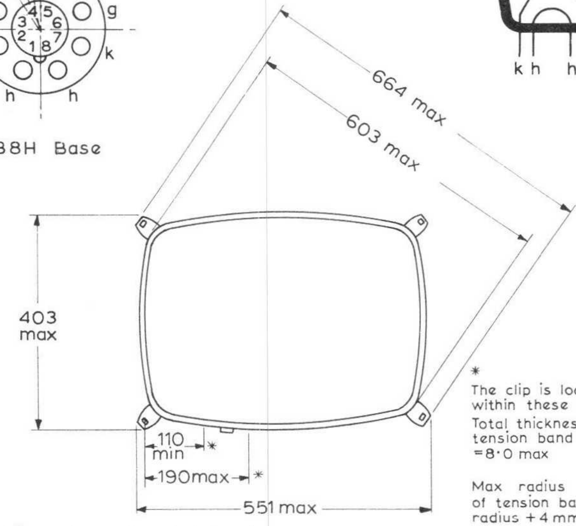


External screen radii



B8H Base

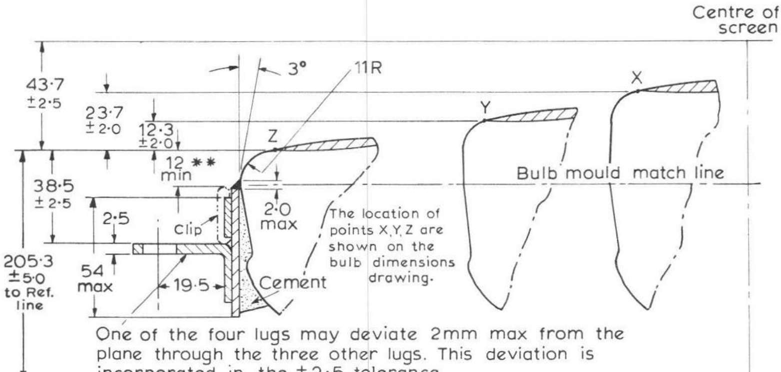




*
The clip is located within these dimensions
Total thickness of rimband, tension band and clip =8·0 max

Max radius of outside of tension band = bulb radius + 4 mm

Dimensions of metal band

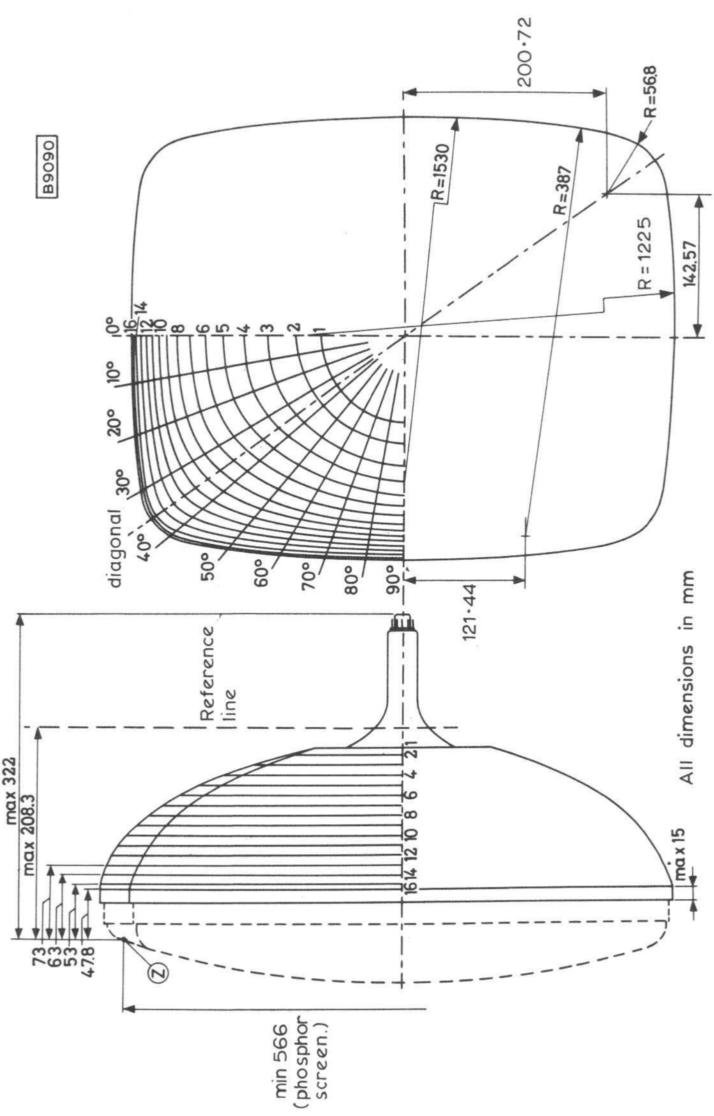


One of the four lugs may deviate 2mm max from the plane through the three other lugs. This deviation is incorporated in the ±2·5 tolerance.

** Distance from point Z to any metal parts

All dimensions in mm

MAXIMUM CONE CONTOURS

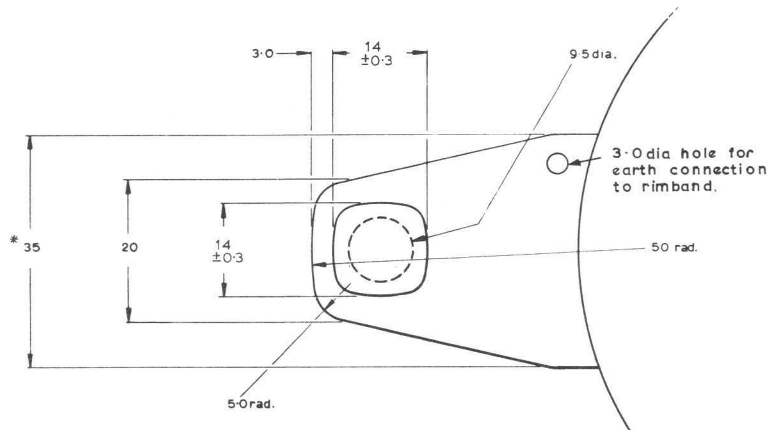


All dimensions in mm

DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page 8)

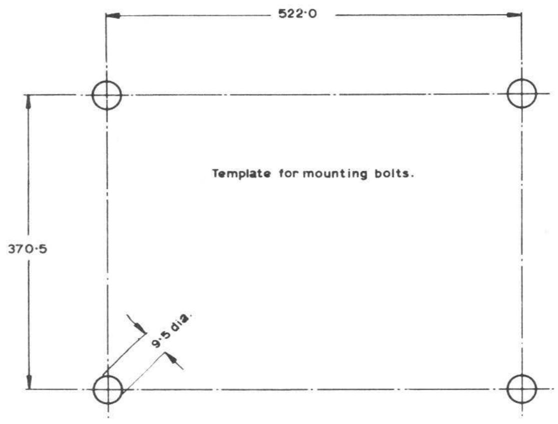
Section	Nominal distance from point "Z"	Distance from centre (max.) 0^{o} Long axis	10^{o}	20^{o}	30^{o}	$35^{o}23'$ Diagonal	40^{o}	50^{o}	60^{o}	70^{o}	80^{o}	90^{o} Short axis
1	190	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5
2	183	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2	101.2
3	173	130.3	131.0	131.1	129.6	127.9	126.3	123.5	121.8	121.1	120.7	121.1
4	163	154.5	155.0	155.8	152.0	149.1	146.6	142.1	138.6	136.8	136.4	136.8
5	153	175.0	175.7	176.1	172.9	168.8	165.6	159.3	154.2	151.0	149.7	149.8
6	143	192.7	193.7	194.3	191.9	187.2	183.1	175.4	168.7	164.4	161.5	161.0
7	133	207.9	209.4	210.9	209.0	204.1	199.3	190.2	181.8	176.2	171.9	170.5
8	123	221.0	222.8	225.4	224.6	220.3	215.0	203.9	193.8	186.5	181.2	178.8
9	113	231.8	233.8	238.1	239.2	235.7	230.3	216.5	204.4	195.7	189.5	186.9
10	103	241.5	243.6	248.7	252.6	250.3	244.7	228.3	214.4	203.7	196.8	194.1
11	93	249.6	252.0	258.5	264.4	263.9	258.2	239.1	223.2	211.0	203.3	200.9
12	83	255.9	258.7	266.2	274.9	276.3	271.0	249.0	230.6	217.1	208.8	206.5
13	73	260.7	263.7	272.3	284.4	287.6	282.8	257.7	236.3	221.7	213.2	210.7
14	63	264.0	267.1	276.6	292.0	297.2	292.7	264.4	240.3	224.8	216.3	213.7
15	53	265.9	269.1	279.0	296.2	302.3	297.7	267.7	242.8	226.7	218.0	215.2
16	47.8	266.3	269.5	279.4	297.1	303.0	298.7	268.5	243.3	227.3	218.4	215.5

All dimensions in mm.



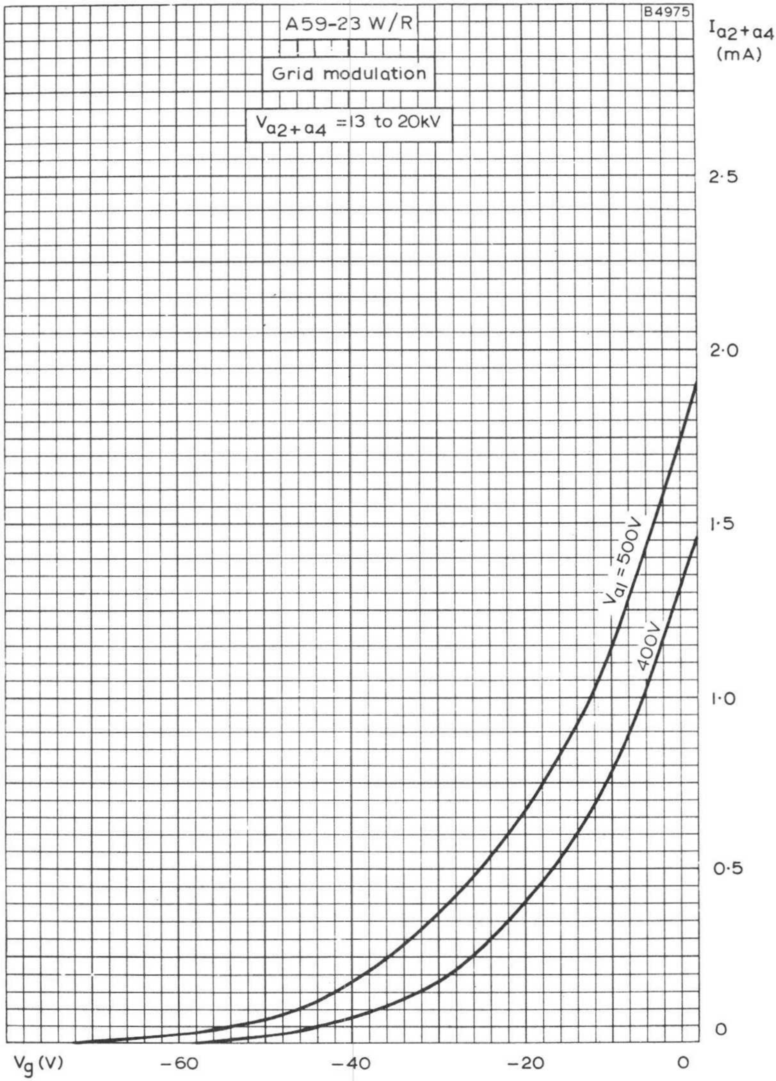
* Minimum space to be reserved for mounting lug = 44

Mounting lug

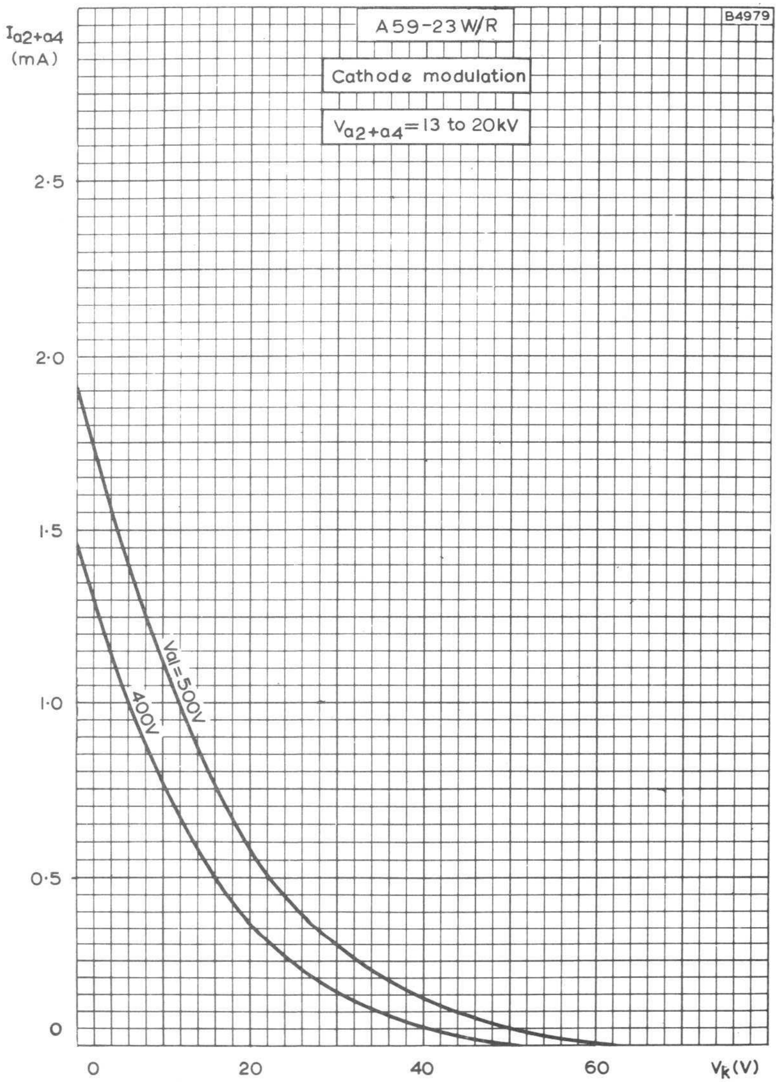


All dimensions in mm.

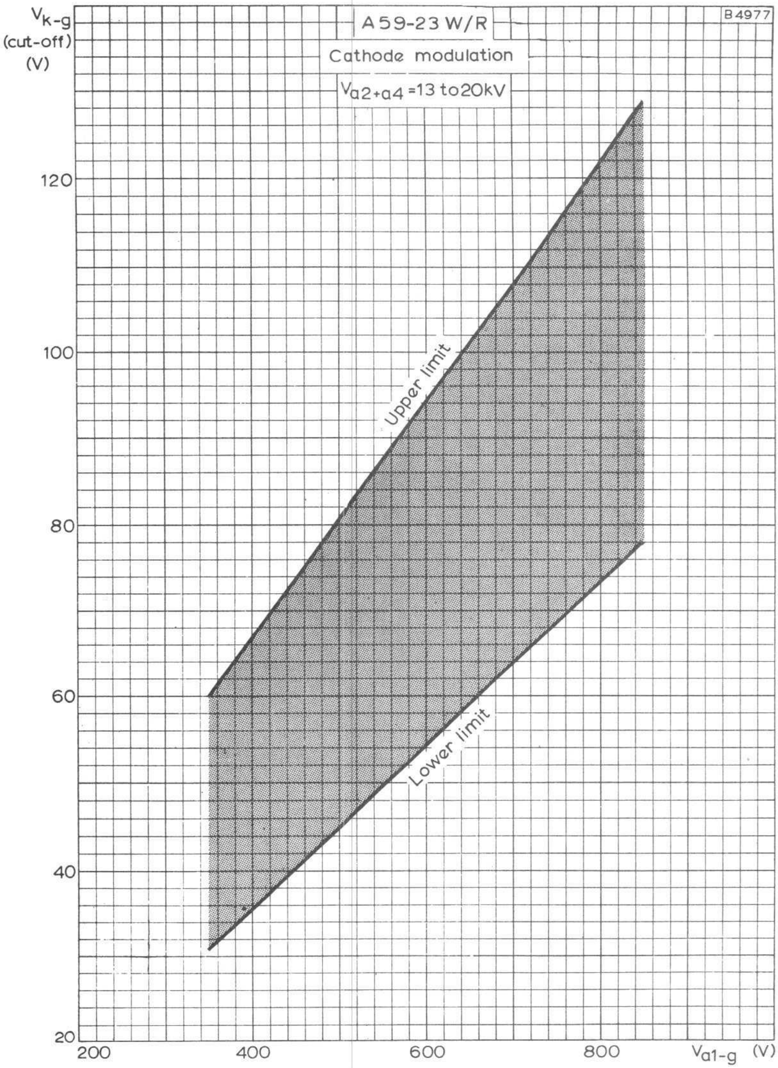
The bolts to be used for mounting the tube must be within the circles of 9·5mm diameter shown in the template drawing.



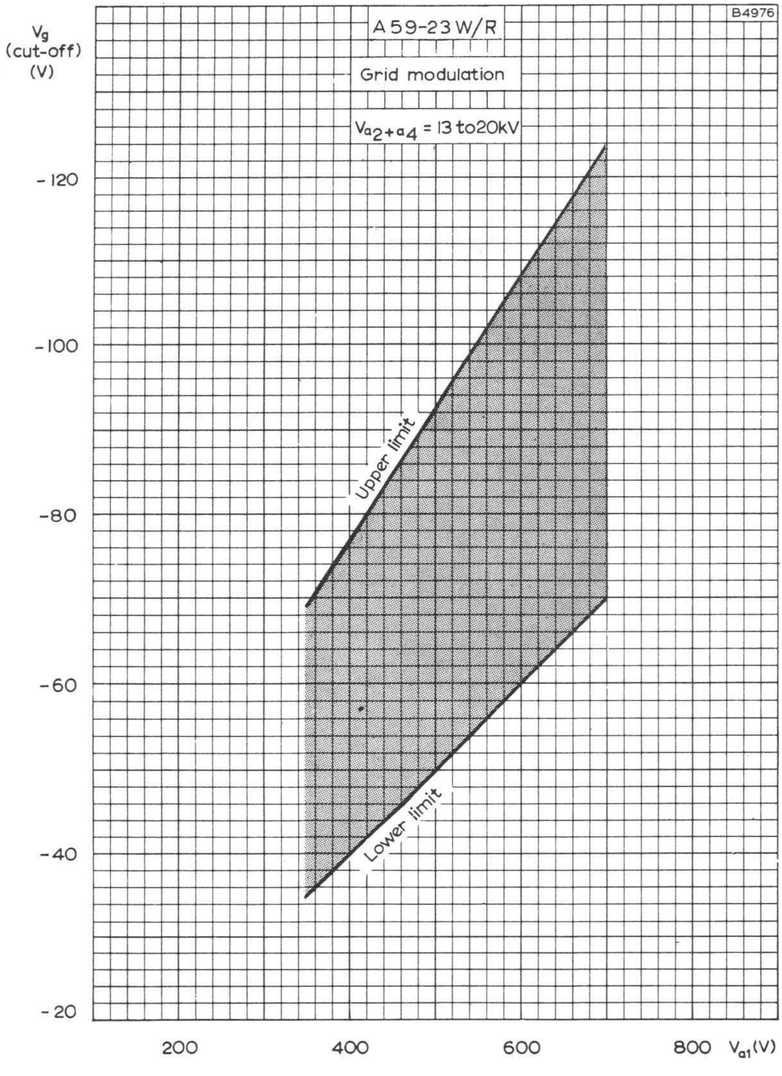
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE A61-120W/R

TENTATIVE DATA

QUICK REFERENCE DATA		
61 cm (24in) direct viewing television tube with metal backed screen and reinforced envelope. A separate safety screen is not required. Suitable for use in receivers with push-through presentation. This tube is fitted with a ring trap base.		
Deflection angle	110	deg
Focusing	Electrostatic	
Light transmission (approx.)	42	%
Maximum overall length	370	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

Suitable for series or parallel operation

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General Operational Recommendations - Television Picture Tubes.

Note - applies to series operation only

The surge heater voltage must not exceed 9.5V r.m.s. when the supply is switched on. A current limiting device may be necessary in the circuit, to ensure that this voltage is not exceeded.

OPERATING CONDITIONS

V_{a2+a4}	20	20	kV
V_{a3} (focus electrode control range)	0 to 400	0 to 400	V
V_{a1}	400	500	V
V_g for visual extinction of focused raster	-40 to -77	-50 to -93	V
*V_k for visual extinction of focused raster	36 to 66	45 to 80	V

*For cathode modulation, all voltages are measured with respect to the grid.

SCREEN (metal backed)

Fluorescent colour		White
Light transmission (approx.)	42	%
Useful screen area		See page 6

FOCUSING (Electrostatic)

The range of focus voltage shown in 'Operating Conditions' results in optimum overall focus at a beam current at 250μA.

DEFLECTION (Magnetic)

Diagonal deflection angle	110	deg
Horizontal deflection angle	98	deg
Vertical deflection angle	81	deg

The deflection coils should be designed to provide a pull-back of 4.0mm on a nominal tube.

CAPACITANCES

c_{g-all}	7.0	pF
c_{k-all}	5.0	pF
$c_{a2+a4-M}$	1700 to 2500	pF
$c_{a2+a4-B}$	600	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, and in accordance with the General Operating Recommendations this should be connected directly to pin 5 and not to chassis. The electrical connection to this coating must be made within the area specified on the tube outline drawing. The capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply.

RING TRAP

For flashover protection of the receiver, parallel spark gaps are included for all the electrodes in the base of this tube, and the common connection is made to pin 5. These spark gaps are intended as part of a system for full flashover protection. A direct connection must always be made from pin 5 to chassis, and the external conductive coating returned to chassis only via pin 5, using short leads. Any electrode supplied directly from a high energy source (such as the h.t. line) should be provided with a series resistor.

RASTER CENTRING

See note under this heading in 'General Operational Recommendations - Television Picture Tubes'.

Centring magnet field intensity	0 to 800	A/m
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in the brightness of the raster occurs.

REFERENCE LINE GAUGE

J.E.D.E.C. 126. For details see 'General Operational Recommendations-Television Picture Tubes'.

MOUNTING POSITION

Any. 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 of 40mm diameter which is centred on the perpendicular from the centre of the face.

This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.

It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_g$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50Hz)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50Hz)	500	kΩ

NOTES

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.

   It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on, a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

5. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver, for example 2.0MΩ.

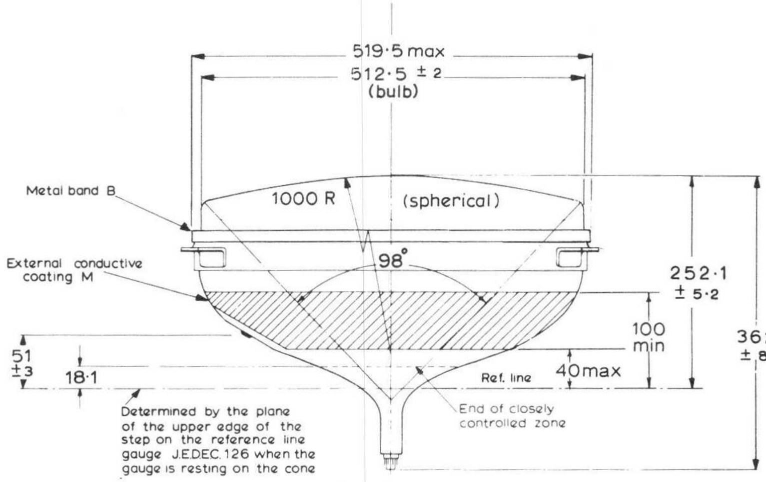
   The mounting lugs will be in electrical contact with the metal band.

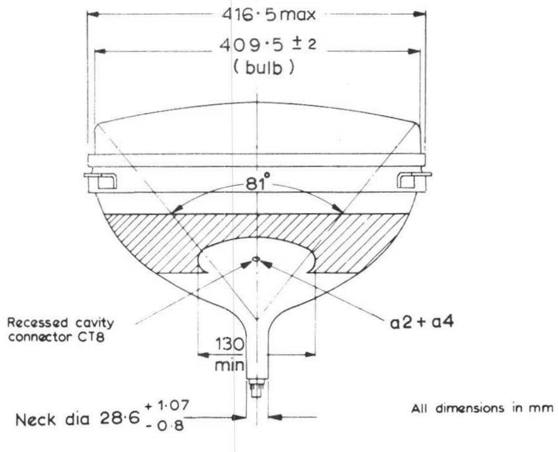
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

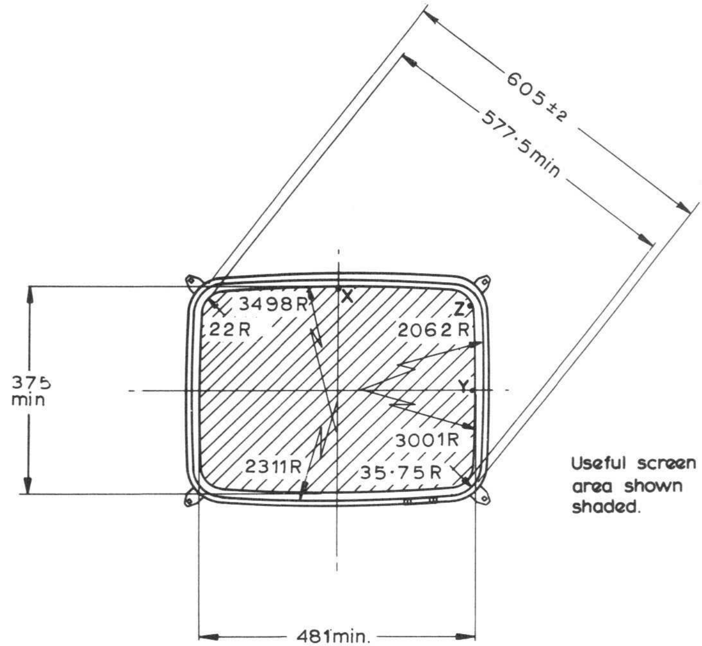
WEIGHT

Tube alone (approx.)	13.5	kg





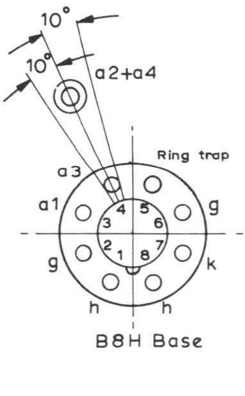
All dimensions in mm

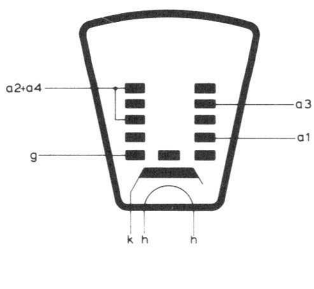


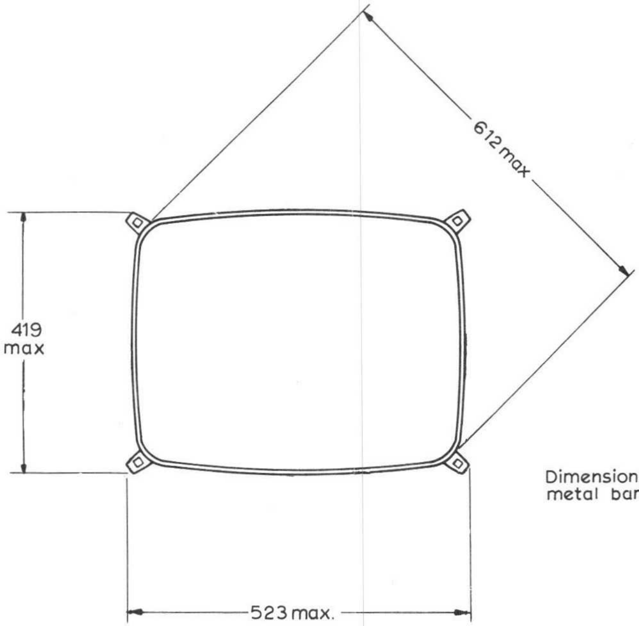
Useful screen area shown shaded.

Bulb dimensions

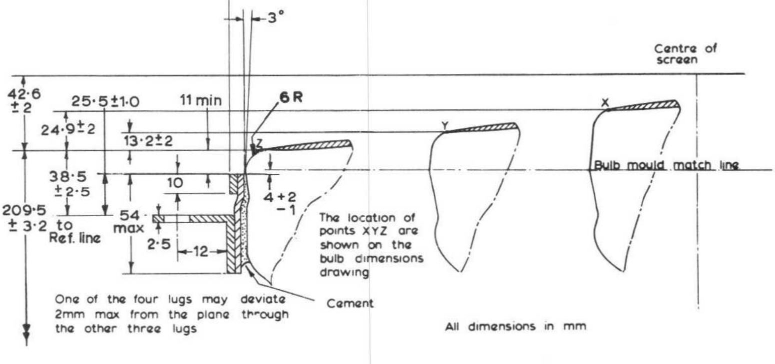
All dimensions in mm

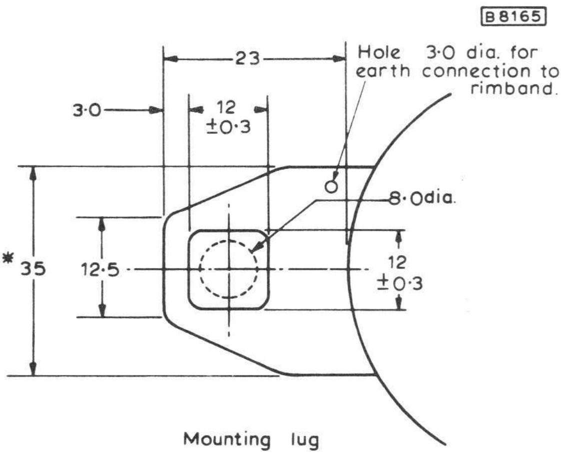






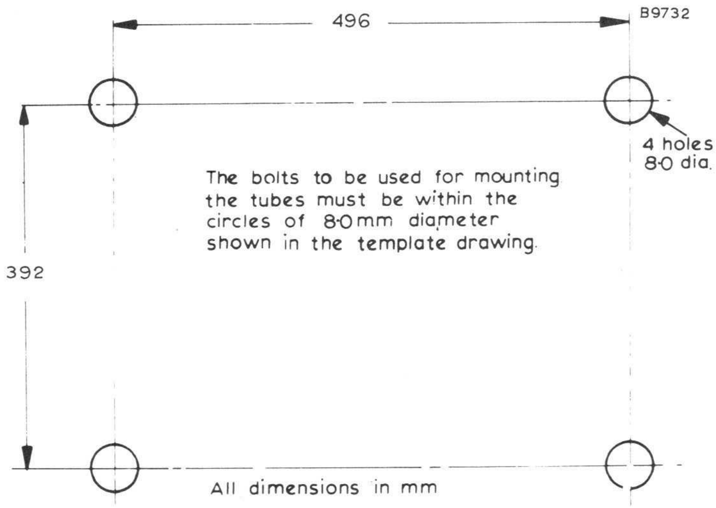
Dimensions of metal band





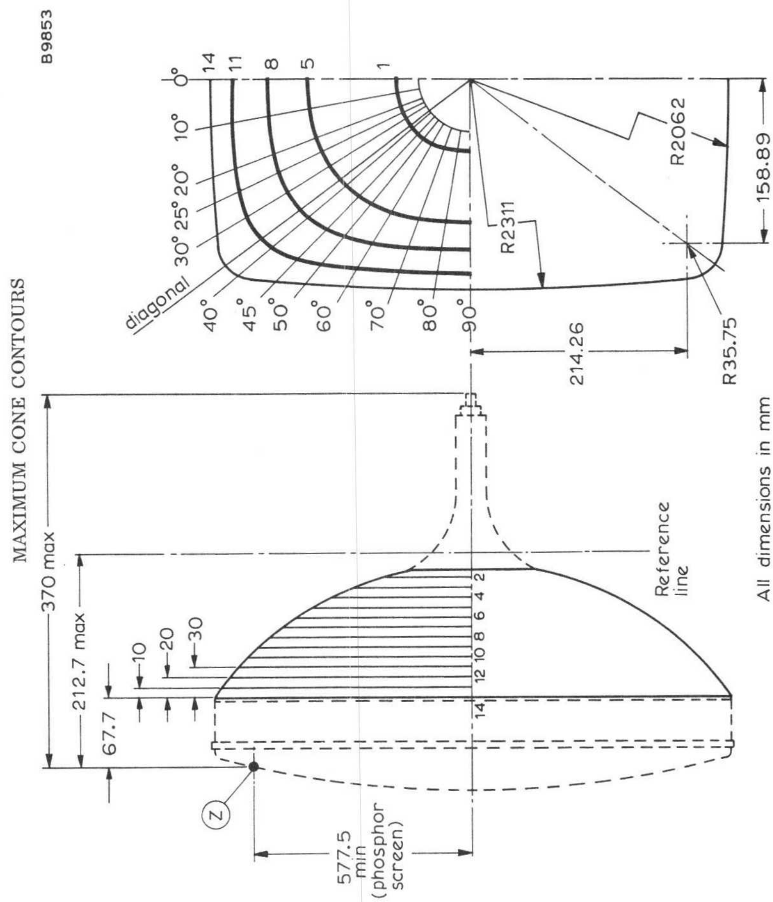
Mounting lug

* Minimum space to be reserved for mounting lug - 39



All dimensions in mm

Template for mounting bolts

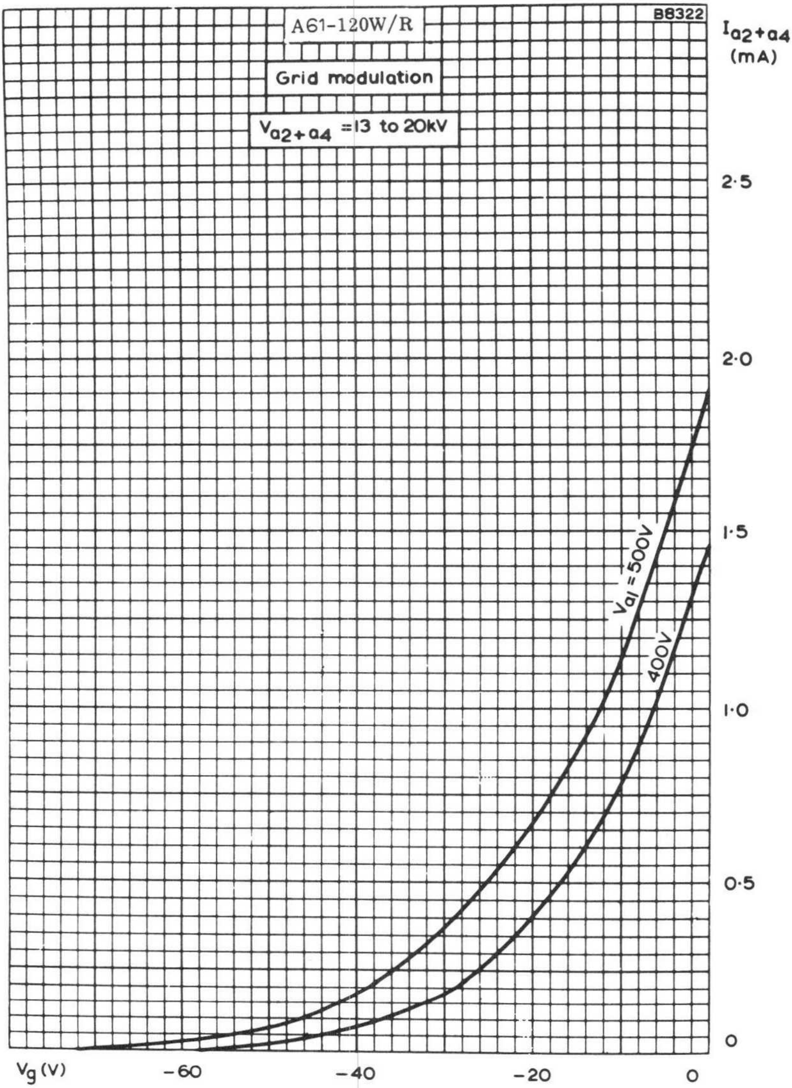

B9853
MAXIMUM CONE CONTOURS
diagonal
0°
10°
20°
25°
30°
40°
45°
50°
60°
70°
80°
90°
14
11
8
5
1
R2062
R2311
158.89
214.26
R35.75
370 max
212.7 max
67.7
10
20
30
2
4
6
8
10
12
14
Reference line
Z
577.5 min (phosphor screen)
All dimensions in mm

DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING

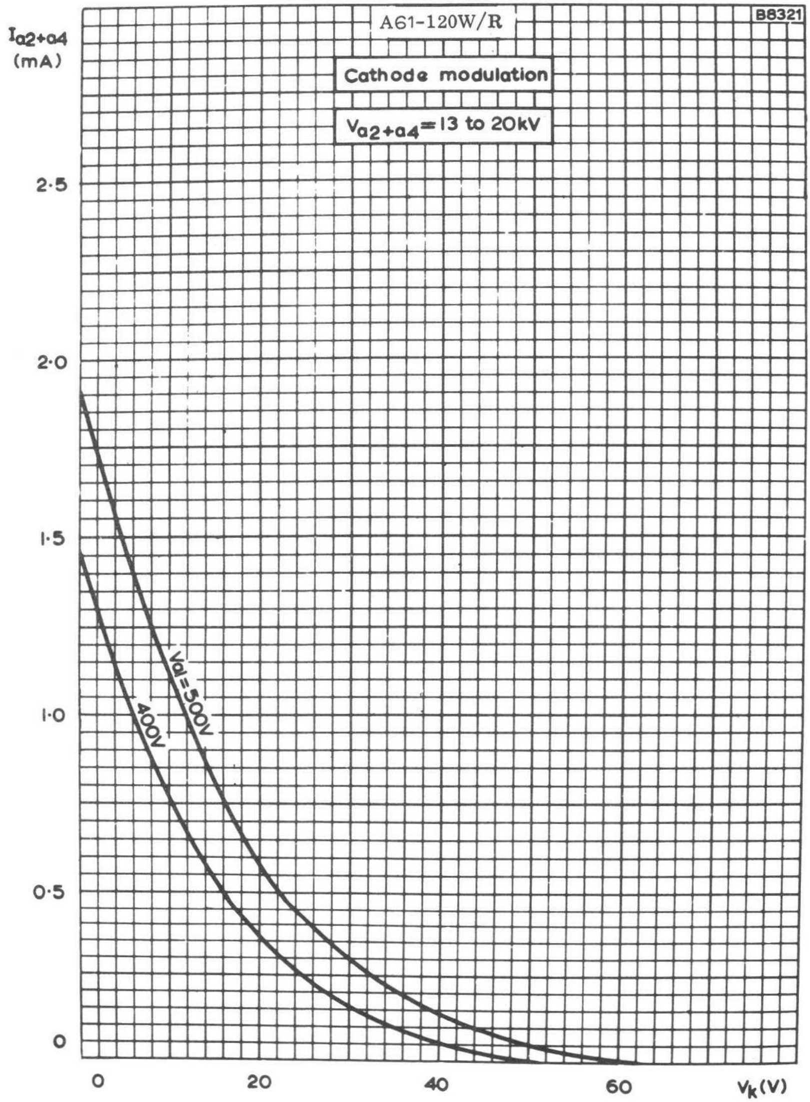
Distance from centre (max. values)

Section	Nominal distance from point 'Z'	0^o Long axis	10^o	20^o	25^o	30^o	$36^o34'$ Diagonal	40^o	45^o	50^o	60^o	70^o	80^o	90^o Short axis
1	194.4	74.6	72.5	71.1	70.8	70.3	70.6	70.9	71.4	72.1	73.3	72.3	73.0	72.8
2	187.7	100.0	95.6	93.1	92.0	91.3	91.2	91.0	91.0	90.8	90.7	91.8	93.2	95.5
3	177.7	130.4	126.5	121.3	119.6	118.2	117.1	116.4	115.1	114.1	114.3	114.7	115.8	118.0
4	167.7	152.8	149.8	145.0	143.1	141.8	140.0	138.8	137.0	135.3	133.4	131.9	132.4	133.7
5	157.7	172.1	169.2	165.6	164.3	163.1	160.4	158.8	156.2	153.8	150.3	146.9	145.6	146.0
6	147.7	188.1	186.4	184.8	183.9	182.7	179.4	177.3	173.8	170.7	163.9	158.6	156.0	155.8
7	137.7	202.1	201.2	201.8	201.8	201.3	197.0	194.1	190.1	185.2	176.2	168.7	164.9	164.2
8	127.7	214.0	214.5	217.0	217.9	217.8	213.3	210.0	205.0	198.6	187.3	177.6	172.8	171.5
9	117.7	223.7	225.1	229.0	231.3	233.0	229.1	225.3	219.2	211.2	197.6	185.8	180.2	178.2
10	107.7	231.9	233.0	239.0	242.9	246.4	243.9	240.2	232.8	223.6	206.7	193.6	186.8	184.3
11	97.7	238.6	240.2	247.6	253.0	258.7	258.6	255.1	245.7	234.8	215.2	200.5	193.1	190.1
12	87.7	244.6	246.9	256.4	262.4	269.4	272.6	268.9	257.7	244.5	222.3	206.7	198.6	195.5
13	77.7	250.6	253.4	263.4	270.8	279.2	286.0	282.6	268.5	253.0	228.5	212.2	203.4	200.2
14	67.7	255.6	259.1	269.6	278.0	288.4	298.6	294.9	277.2	259.3	233.3	216.3	207.2	204.2

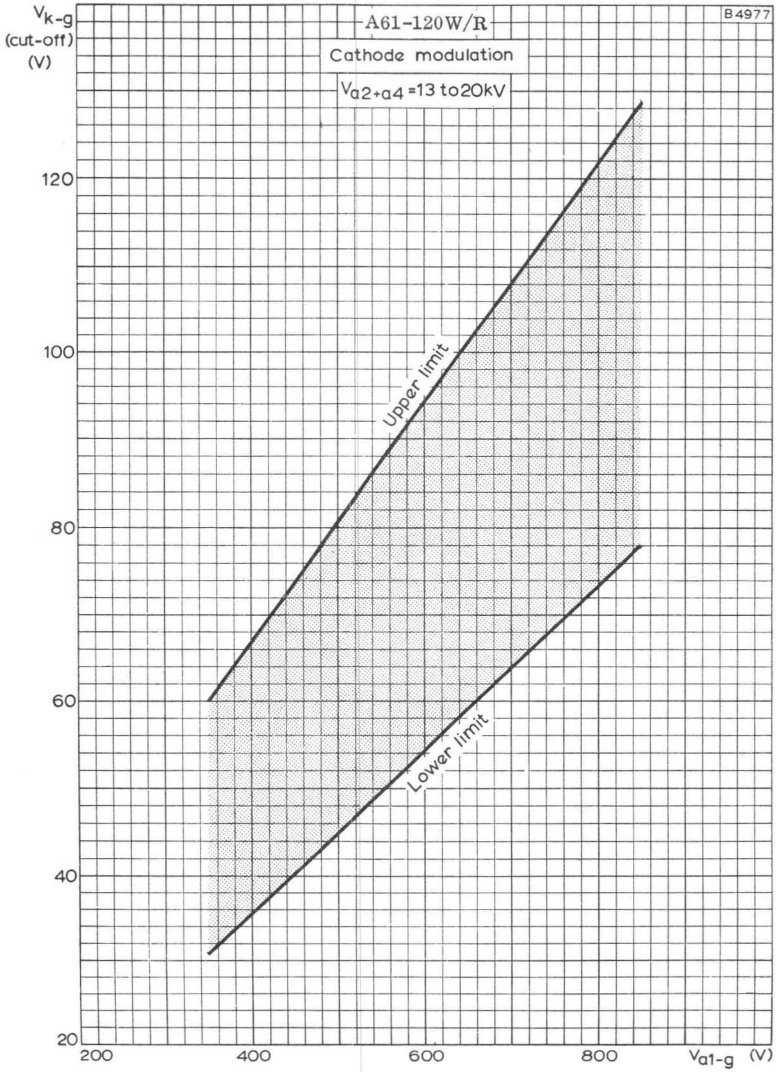
All dimensions in mm



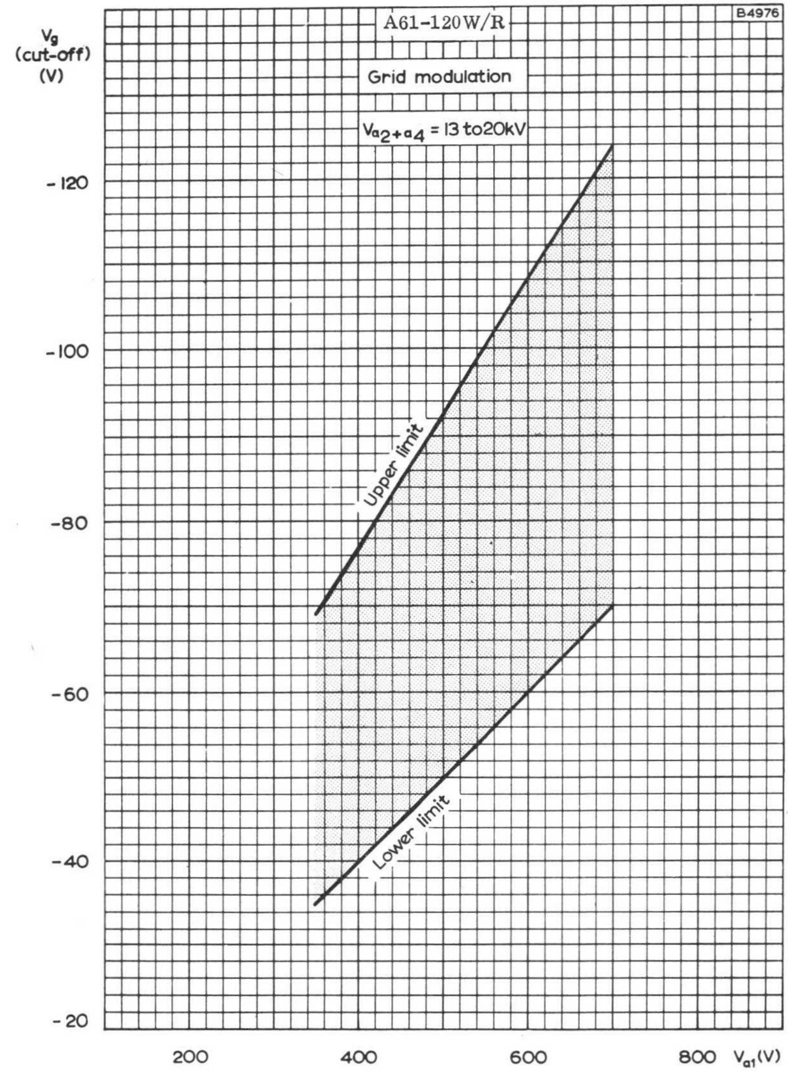
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

QUICK REFERENCE DATA		
63cm (25in) rectangular shadow-mask colour television tube incorporating three guns and a metal-backed three-colour phosphor dot screen.		
Advanced red phosphor, europium activated. ←		
Increased white brightness. ←		
Unity current ratio for white point x = 0.281, y = 0.311 ←		
Temperature compensated shadow-mask maintains purity during warm-up. Shadow-mask optimised for minimum moiré effect on 625 line system. ←		
Reinforced tube envelope-separate safety screen not required.		
Deflection angle	90	deg
Focusing	Electrostatic	
Light transmission (approx.)	52	%
Maximum overall length	531	mm

This data should be read in conjunction with GENERAL OPERATIONAL RECOMMENDATIONS - TELEVISION PICTURE TUBES

HEATER

V_h (see note 1)	6.3	V
I_h	900	mA

The limits of heater voltage and current are contained in General Operational Recommendations - Television Picture Tubes.

OPERATING CONDITIONS (each gun)

V_{a3+a4}	25	kV
V_{a2} (focus electrode control range)	4.2 to 5.0	kV
V_{a1} (at V_g = -100V for visual extinction of focused raster)	210 to 495	V
V_g (at V_{a1} = 300V for visual extinction of focused raster)	-65 to -135	V
*Light output at screen centre (at I_{a3+a4} = 800μA)	90	cd/m^2(nits) ←

*To produce white of colour co-ordinates x = 0.281, y = 0.311 with a focused raster size of 50.4 x 39.6cm.

SCREEN

Metal backed

Phosphor types for separate fluorescent colours:

Red	Europium activated rare earth	
Green	Sulphide	
Blue	Sulphide	
Useful screen area (approx.)	1905	cm^2
Spacing between centres of adjacent phosphor dot triads (approx.)	0.81	mm ←
Light transmission (approx.)	52	%

FOCUSING

Electrostatic

DEFLECTION

Magnetic

Diagonal deflection angle	90	deg
Horizontal deflection angle	79	deg
Vertical deflection angle	62	deg

CONVERGENCE

Magnetic

CAPACITANCES (approx.)

c_{g-all} (each gun)	7.0	pF
$c_{(kR+kG+kB)-all}$	15	pF
c_{kR-all}	5.0	pF
c_{kG-all}	5.0	pF
c_{kB-all}	5.0	pF
c_{a2-all}	7.0	pF
$c_{a3+a4-M}$	2000 to 2500	pF
$c_{a3+a4-B}$	500	pF

EXTERNAL CONDUCTIVE COATING

This tube has an external conductive coating, M, which must be connected to chassis, and the capacitance of this coating to the final anode is used to provide smoothing for the e.h.t. supply. The electrical connection to this coating must be made within the area specified on the tube outline drawing.

REFERENCE LINE GAUGE

See page 10.

MOUNTING POSITION

Any. 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 of 55mm diameter which is centred upon the perpendicular from the centre of the face.

MAGNETIC SHIELDING

Magnetic shielding must be provided to minimise the effects of extraneous magnetic fields, including the earth's magnetic field. This shielding, in the form of a metal shell extending 28cm over the cone of the tube measured from the centre of the screen, should be constructed of cold-rolled mild steel of 0.5mm minimum thickness. The magnetic shield should be connected to the outer conductive coating. See page 10 for physical dimensions.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a3+a4} max. (absolute rating) (see notes 2 and 3)	27.5	kV
V_{a3+a4} min. (absolute rating) (see note 4)	20	kV
I_{a3+a4} (long term average max. for three guns: see note 5)	1.0	mA
V_{a2} max. (see note 3)	6.0	kV
$v_{a1(pk)}$ max.	1.0	kV
$-V_g$ max.	400	V
V_g max.	0	V
V_{h-k} max. (see note 6)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{g-k} max.	750	kΩ

EQUIPMENT DESIGN VALUES (each gun if applicable)

Valid for V_{a3+a4} = 20 to 27.5kV

V_{a2}		16.8 to 20% of V_{a3+a4}			
V_{a1}		See page 16.			
V_g		See page 16.			
Variation in cut-off voltage between guns		Minimum value is at least 65% of the maximum value.			
I_{a2}			-15 to +15		μA
I_{a1}			-5 to +5		μA
I_g at V_g = -150V			-5 to +5		μA
To produce white of colour co-ordinates:	x	0.310	0.265	0.281	←
	y	0.316	0.290	0.311	
Percentage of total anode current supplied by each gun (typical)					←
Red gun		43.5	27.9	32.2	%
Green gun		30.0	34.9	35.6	%
Blue gun		26.5	37.2	32.2	%
Ratio of cathode currents					←
Red gun to green gun	min.	1.05	0.60	0.65	
	av.	1.45	0.80	0.90	
	max.	2.00	1.10	1.25	
Red gun to blue gun	min.	1.20	0.55	0.75	
	av.	1.65	0.75	1.00	
	max.	2.25	1.05	1.35	
Maximum electron beam shift required from purity magnets			±0.13		mm
Maximum required raster shift			±15		mm
Maximum lateral convergence shift of blue beam with respect to the converged red and green beams			±6.5		mm
Maximum radial convergence shift, excluding effects of dynamic convergence (each beam)			±9.5		mm

WEIGHT

Tube alone (approx.)	18.8	kg

NOTES

1. For maximum cathode life, it is recommended that the heater supply be regulated at 6.3V.

2. The tube does not emit X-radiation above the internationally accepted maximum dosage rate if it is operated from an e.h.t. source supplying an absolute maximum voltage of 27.5kV at zero beam current and with an internal impedance ≥500kΩ.

3. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube. In view of the high voltage on a2, adequate precautions should be taken to ensure freedom from flashover on all connections to this electrode.

4. Operation at lower voltages impairs brightness and resolution and may have a detrimental effect on colour purity.

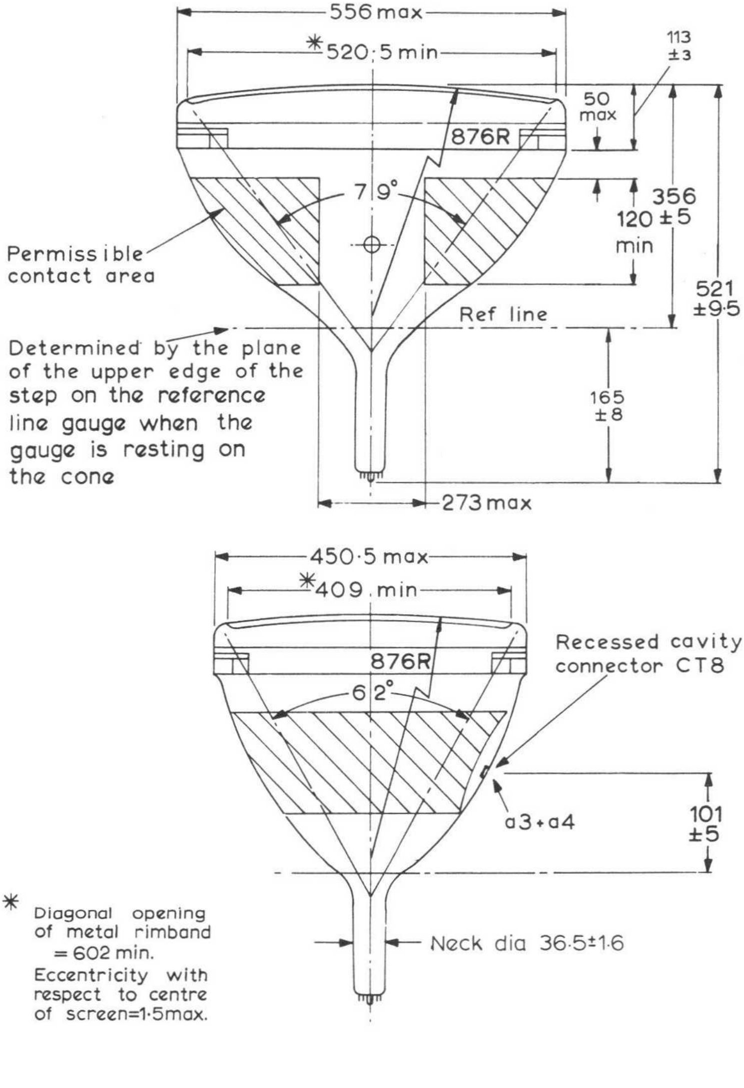
5. The limiting value "long term average maximum current" of 1.0mA will be met provided a device is incorporated in the circuit to limit the short term average current to 1.5mA.

6. 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 an equipment warm-up period not exceeding 15 seconds v_{h-k}(pk) max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in v_{h-k}(pk) max. (cathode positive) proportional with time from 410 to 250V is permissible.

7. The metal band (B) should be connected directly to the chassis in an a.c. receiver operating from an isolating transformer, or via a suitable leakage path in an a.c./d.c. receiver.

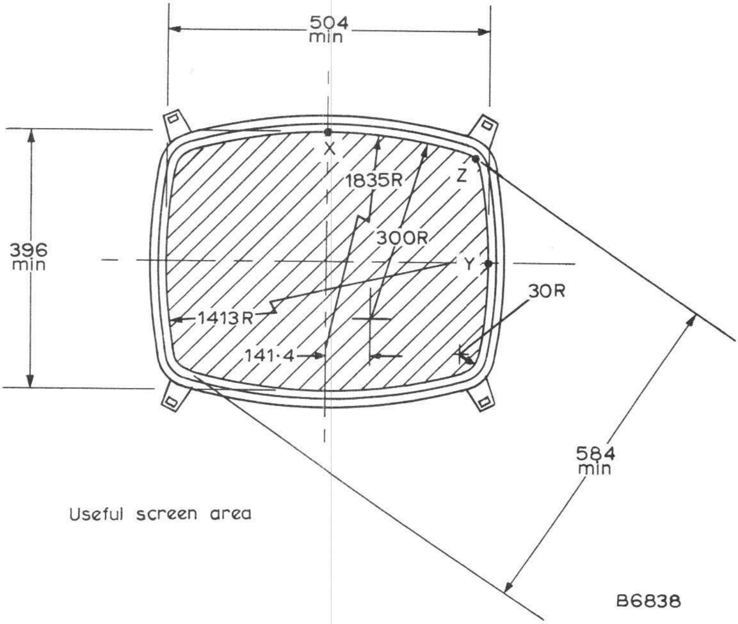
8. The dynamic convergence to be effected by currents of approximately parabolic waveshape synchronised with scanning.

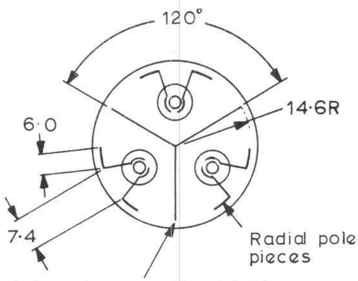


* Diagonal opening of metal rimband = 602 min. Eccentricity with respect to centre of screen = 1·5 max.

All dimensions in mm

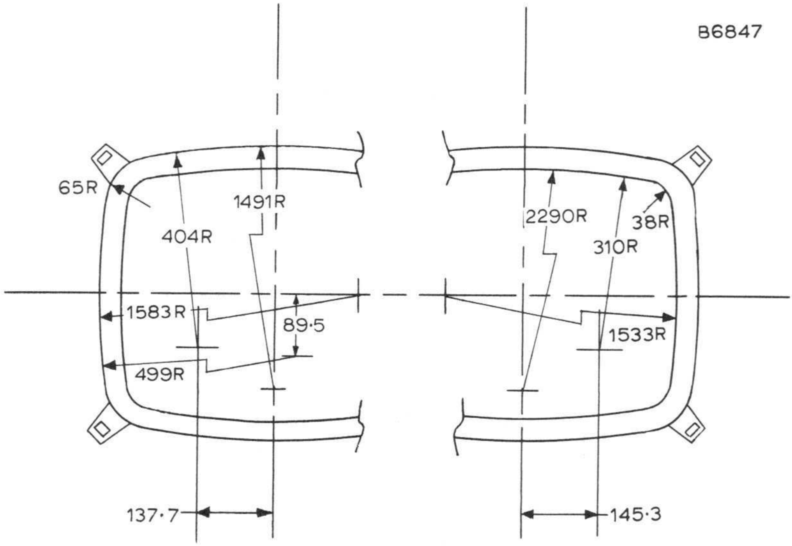
B7413



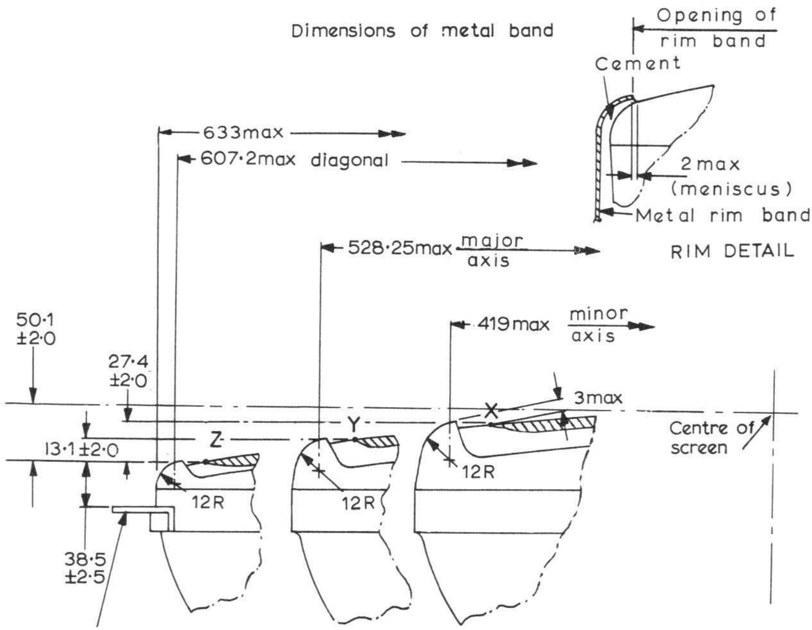


Location of radial convergence pole pieces viewed from screen end of guns

All dimensions in mm



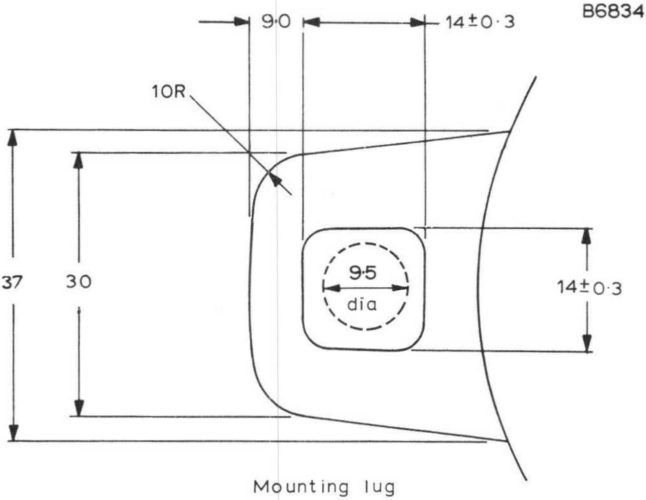
Dimensions of metal band



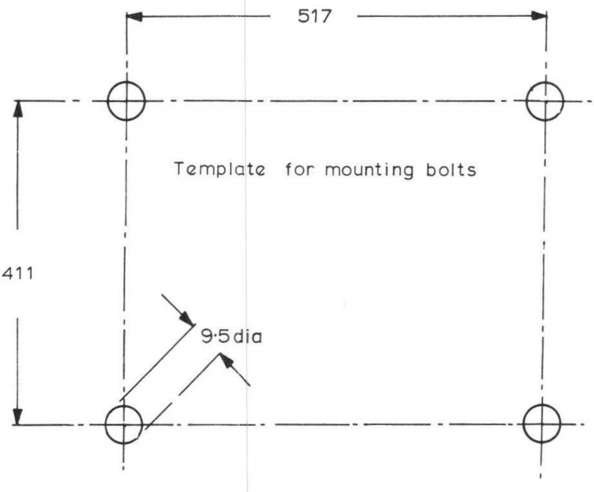
One of the four lugs may deviate 2mm max. from the plane through the three other lugs. This deviation is incorporated in the ±2·5 tolerance.

All dimensions in mm

B7412

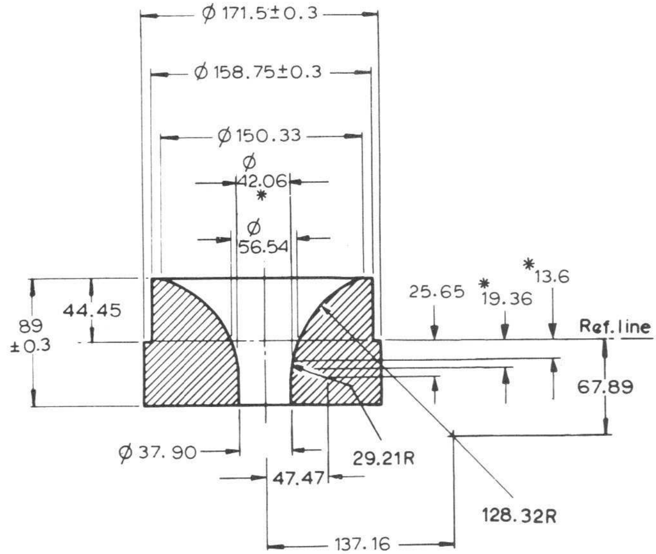


Mounting lug



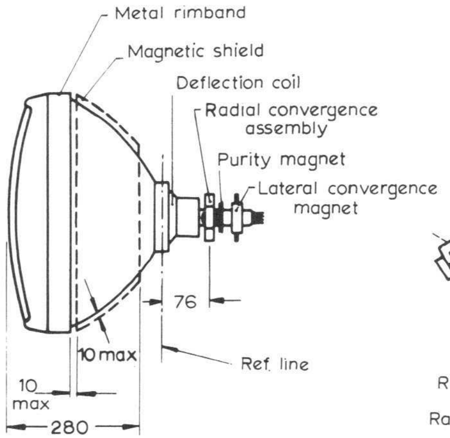
All dimensions in mm

The bolts to be used for mounting the tube must be within the circles of 9.5mm diameter shown in the template drawing.

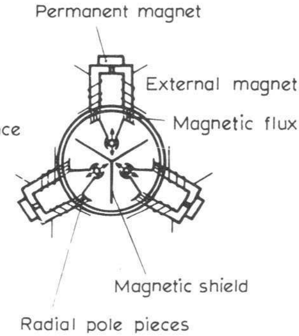


Reference line gauge

* These dimensions define extent of 29.21R

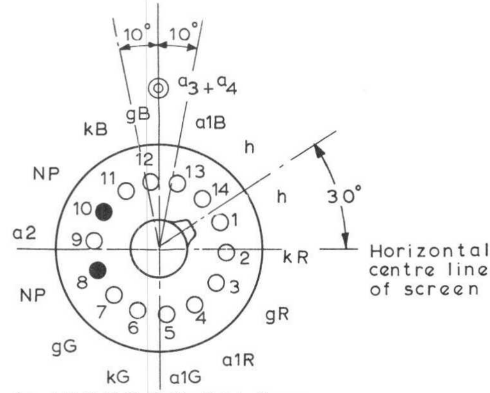


Outline of tube with components

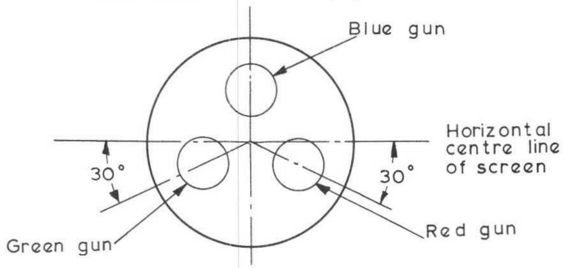


Radial convergence system

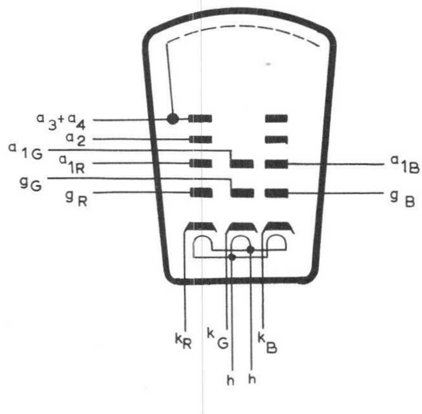
All dimensions in mm

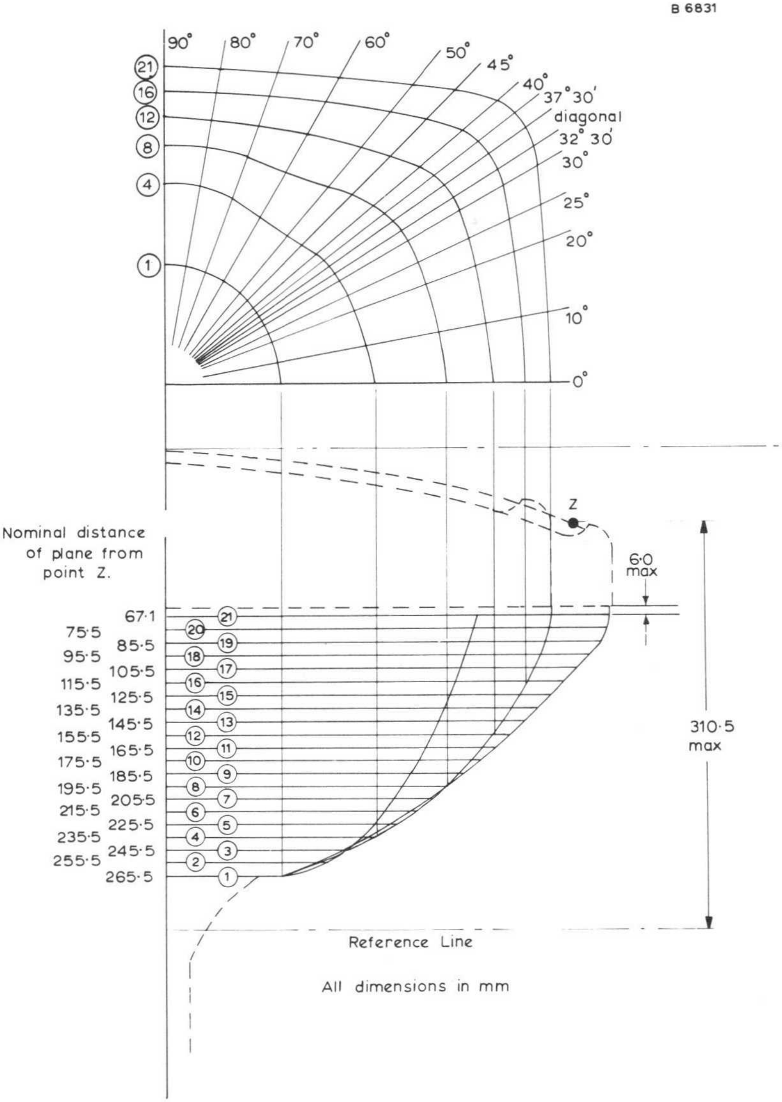


As J.E.D.E.C. B12-244 Base
but with shorter spigot



View looking from base



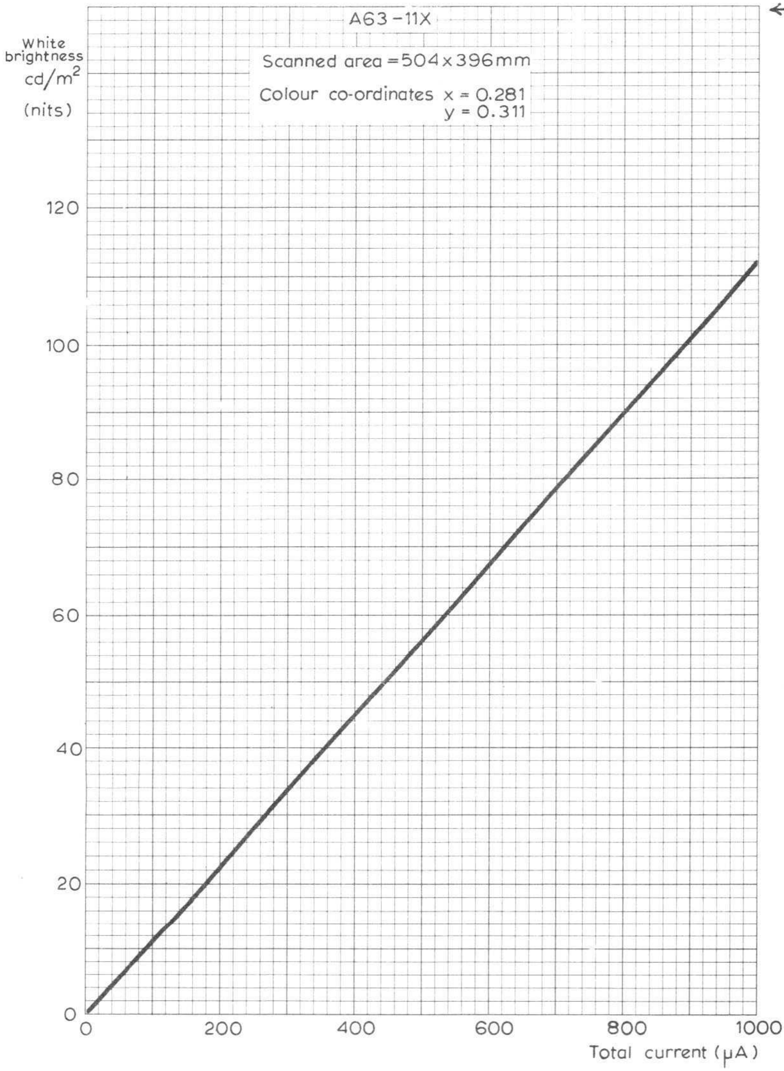


MAXIMUM CONE CONTOURS

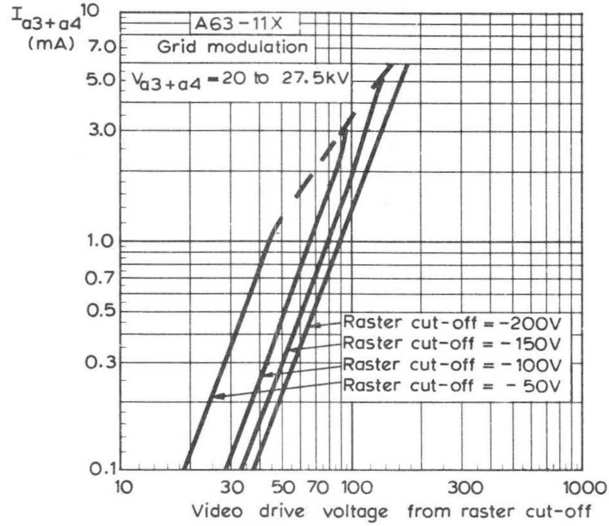
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING

Section	0° long axis	10°	20°	25°	30°	32°30'	35°22' diagonal	37°30'	40°	45°	50°	60°	70°	80°	90° short axis
1	82.5	82.6	83.0	83.0	83.0	83.0	83.0	83.0	83.0	83.3	83.5	83.5	83.0	82.8	82.8
2	107.6	107.4	106.7	106.1	105.7	105.5	105.2	105.1	105.0	104.7	104.5	106.3	111.0	115.0	115.5
3	129.3	128.5	128.0	127.3	126.6	125.8	124.8	124.0	123.2	122.2	121.4	122.5	126.9	129.9	130.2
4	147.4	147.2	146.0	145.0	144.8	144.2	142.6	141.2	139.6	137.2	135.4	134.7	138.0	140.0	140.0
5	162.8	162.8	161.6	160.7	160.3	159.4	157.7	156.2	154.3	150.4	147.7	145.0	146.4	148.2	148.0
6	176.3	176.3	175.4	175.0	174.3	173.5	171.6	169.9	167.9	163.1	159.0	154.4	154.0	155.4	155.3
7	188.2	188.2	187.8	187.6	187.2	186.6	185.2	183.4	181.1	175.4	169.9	163.5	161.2	161.6	161.5
8	198.8	199.0	199.2	199.4	199.6	199.1	197.8	196.1	193.4	186.9	180.3	171.9	170.0	167.4	167.2
9	208.2	208.8	209.6	210.3	211.1	210.9	209.7	207.8	205.3	197.9	190.3	179.7	174.4	172.9	172.7
10	216.9	217.9	219.2	220.5	222.2	222.2	221.3	213.9	216.1	208.0	199.4	187.2	180.8	178.2	178.1
11	224.7	225.6	227.7	229.7	231.9	232.2	231.6	229.6	226.4	217.5	208.0	194.4	186.9	183.5	182.9
12	231.9	232.9	233.9	238.5	241.4	242.1	241.9	240.1	237.0	226.9	216.4	201.5	191.5	188.6	187.7
13	238.2	239.7	243.6	246.8	250.5	251.7	251.9	250.4	247.0	236.0	224.5	208.3	198.0	193.4	192.3
14	244.4	246.3	251.0	254.8	259.5	261.3	261.8	260.5	257.1	245.3	238.6	214.8	203.4	198.2	196.8
15	250.3	252.2	258.0	262.3	268.1	270.5	271.3	270.1	266.3	254.0	240.4	220.9	208.5	202.4	200.3
16	256.1	258.2	264.9	270.0	276.6	279.6	280.7	279.3	275.4	262.4	247.8	226.8	213.7	206.6	204.1
17	260.0	263.4	270.8	276.8	284.7	287.9	289.3	287.9	283.9	270.0	254.7	232.3	218.5	210.5	207.7
18	265.6	268.3	276.4	283.3	292.4	296.7	297.6	296.3	292.1	276.0	261.0	237.6	223.1	214.3	211.2
19	269.4	272.4	281.5	289.0	299.0	302.8	305.2	304.2	299.5	283.4	266.7	242.5	227.2	217.9	214.7
20	272.0	275.2	285.4	293.6	303.8	308.8	311.1	310.3	305.5	288.4	271.2	246.0	229.8	220.9	217.8
21	273.2	276.6	287.3	295.6	306.3	311.3	313.3	312.2	308.0	290.0	272.7	247.3	231.1	222.2	219.3

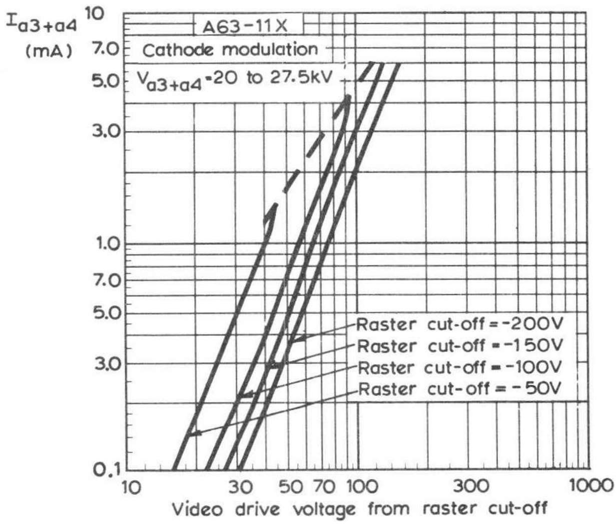
All dimensions in mm



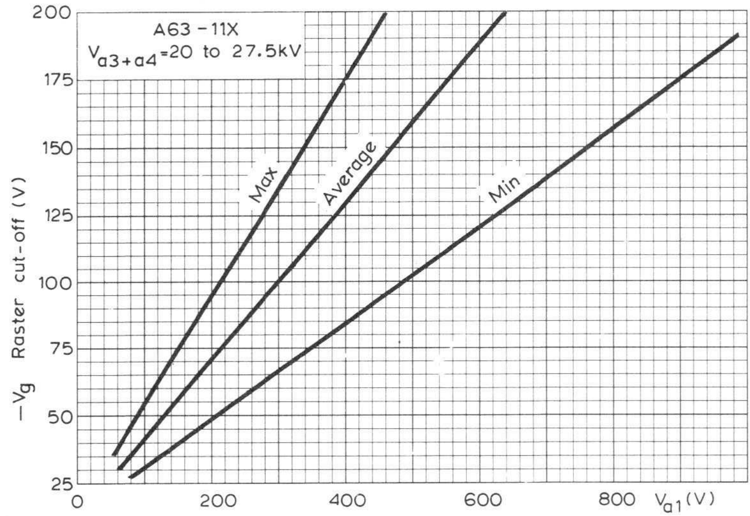
BRIGHTNESS AT CENTRE OF SCREEN AS A FUNCTION OF TOTAL CURRENT FOR WHITE OF COLOUR COORDINATES x=0.281, y=0.311



FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE. GRID MODULATION



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION



CUT-OFF DESIGN CHART

MOUNTING POSITION

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 of 40mm diameter which is centred upon the perpendicular from the centre of the face.
This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.
It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in any equipment.

RATINGS (DESIGN CENTRE SYSTEM)

V_{a2+a4} max. (at I_{a2+a4} = 0) (see note 1)	20	kV
V_{a2+a4} min.	13	kV
$+V_{a3}$ max.	1.0	kV
$-V_{a3}$ max.	500	V
$+v_{a3(pk)}$ max. (see note 2)	2.5	kV
V_{a1} max.	700	V
V_{a1} min.	350	V
$-v_{g(pk)}$ max. (see note 2)	400	V
$-V_{g}$ max. (see note 3)	150	V
$\pm I_{a3}$ max.	25	μA
$\pm I_{a1}$ max.	5	μA
V_{h-k} (see note 4)		
Cathode positive		
d.c. max.	250	V
pk max.	300	V
Cathode negative		
d.c. max.	135	V
pk max.	180	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f = 50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f = 50c/s)	500	kΩ

1. Adequate precautions should be taken to ensure that the receiver is protected from damage which may be caused by a possible high voltage flashover within the cathode ray tube.

2. Maximum pulse duration 22% of one cycle with a maximum of 1.5ms.

3. The d.c. value of bias must not be such as to allow the grid 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 +2V.
It is advisable to limit the positive excursion of the video signal to +5V(pk) max. This may be achieved automatically by the series connection of a 10kΩ resistor.

4. During an equipment warm-up period not exceeding 15 seconds $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V. Between 15 and 45 seconds after switching on a decrease in $v_{h-k(pk)}$ max. (cathode positive) proportional with time from 410V to 250V is permissible.

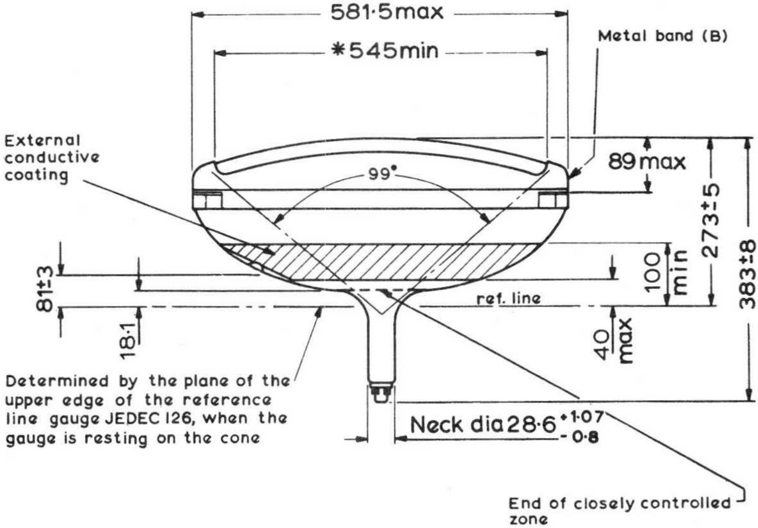
5. The metal band (B) must be connected to the chassis via a 2MΩ resistor. The mounting lugs have electrical contact with the metal band.

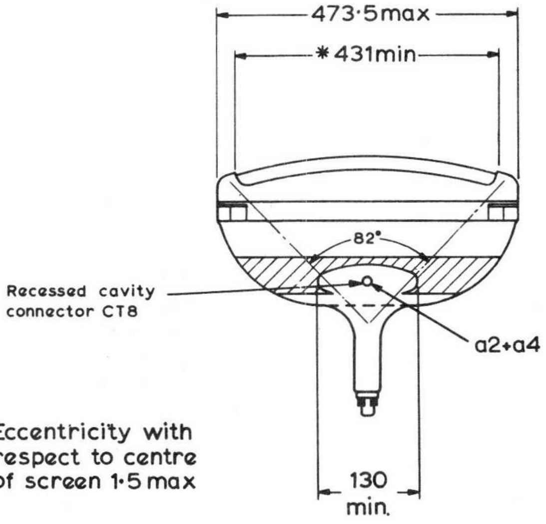
WARNING

X-ray shielding is advisable to give protection against possible danger of personal injury arising from prolonged exposure at close range to this tube when operated above 20kV.

WEIGHT

Tube alone	18	kg
	40	lb

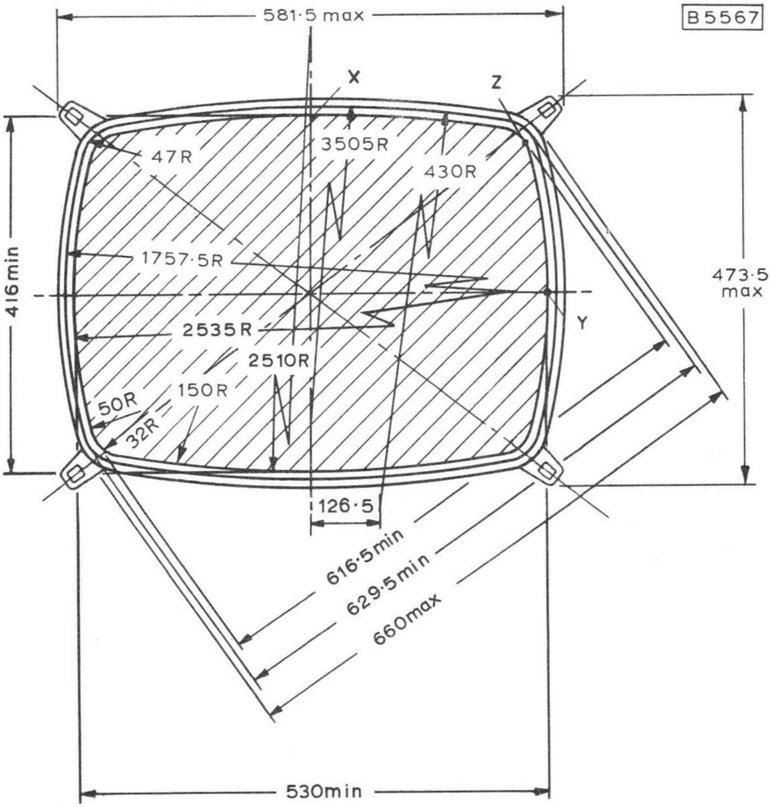


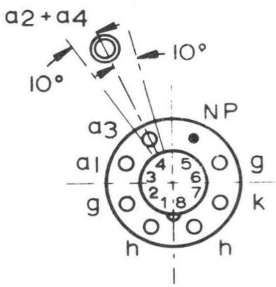


*Eccentricity with respect to centre of screen 1·5 max

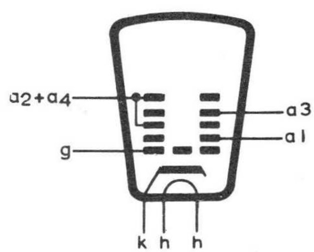
All dimensions in mm.

B5563

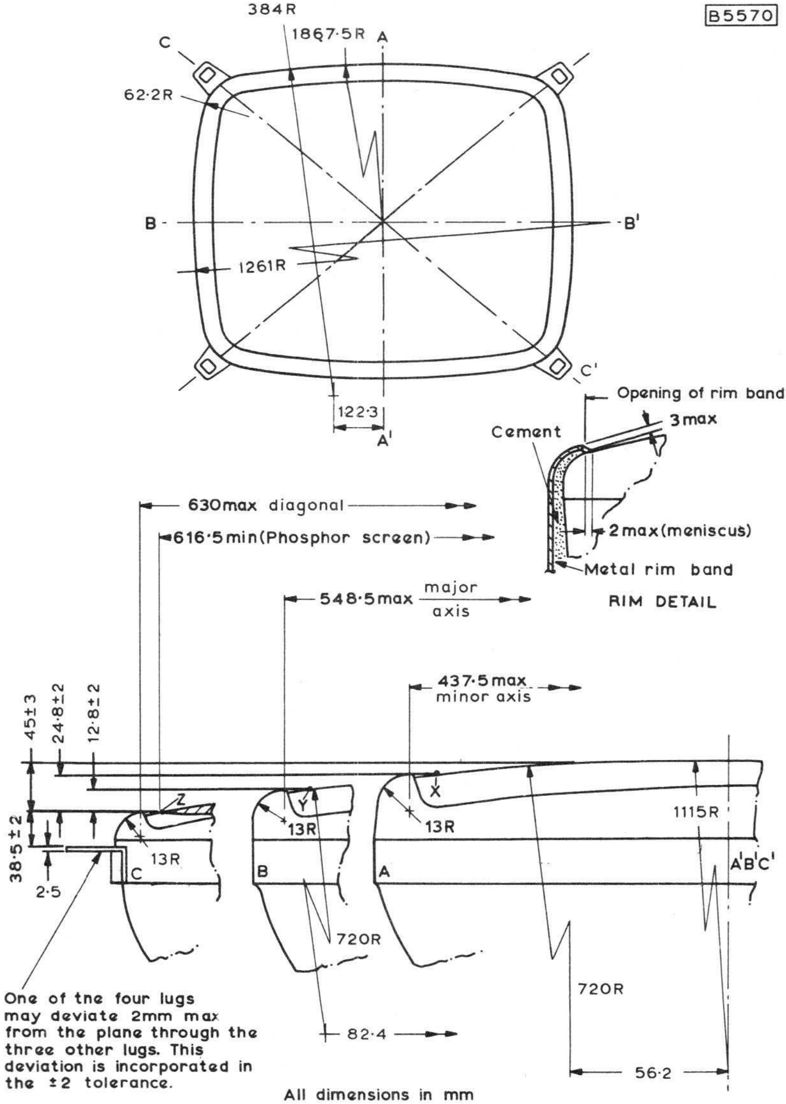




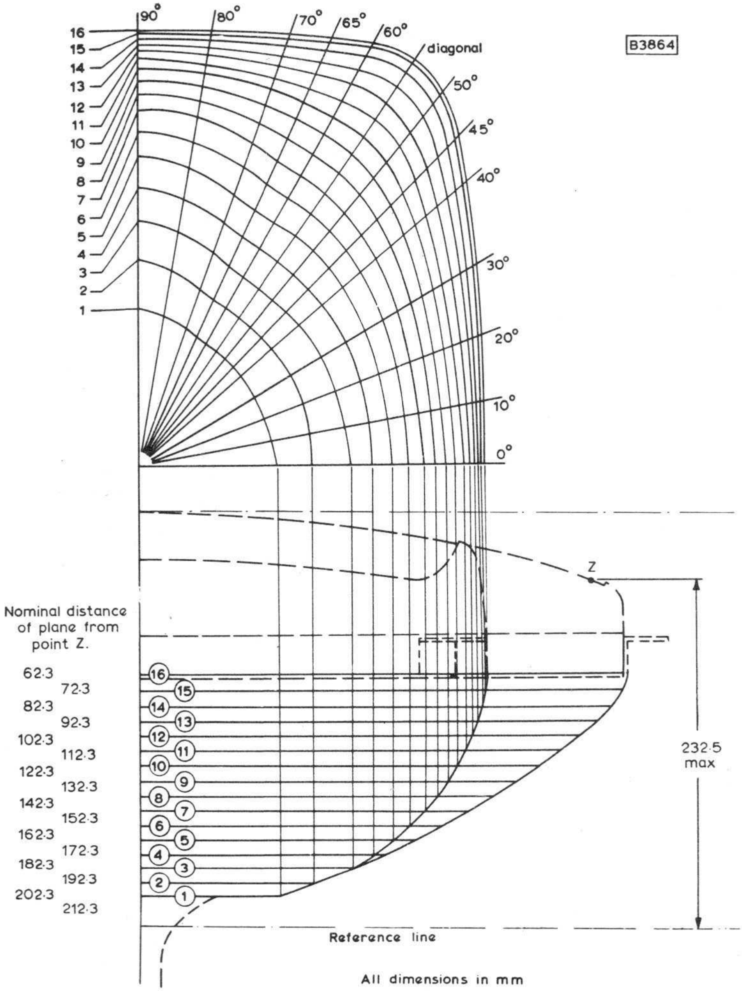
B8H Base



All dimensions in mm



All dimensions in mm

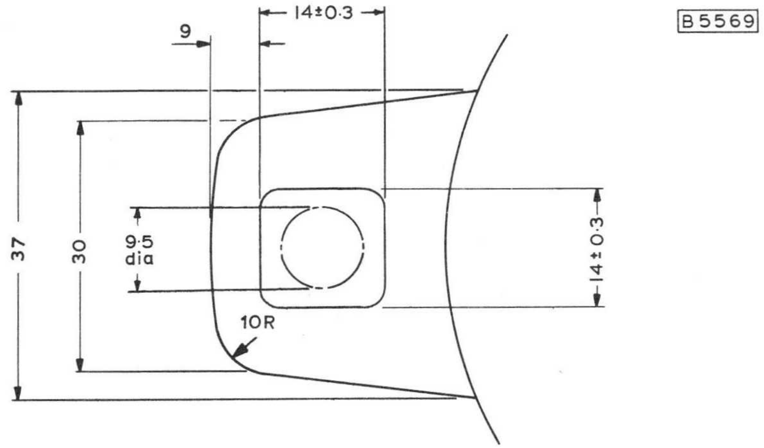


MAXIMUM CONE CONTOURS

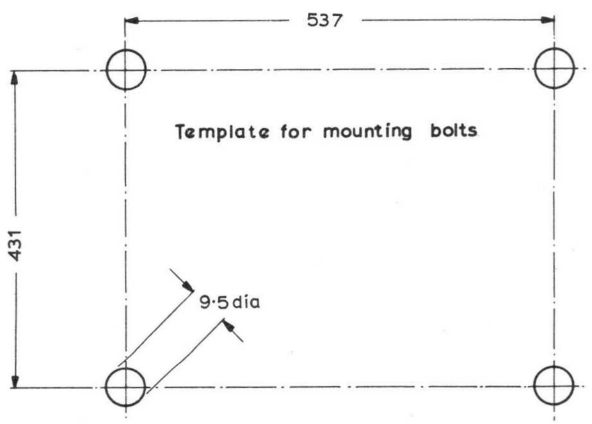
DIMENSIONS FOR MAXIMUM CONE CONTOUR DRAWING (Page D8)

Section	0^o short	10^o	20^o	30^o	40^o	45^o	50^o	$54^o41'$ diagonal	60^o	65^o	70^o	80^o	90^o long
1	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.2	92.5	93.4	94.7	100.4	104.7
2	119.9	119.9	119.9	119.9	119.9	119.9	119.9	119.9	120.4	121.8	124.1	132.3	137.8
3	143.5	143.6	143.7	143.9	144.2	144.4	144.5	144.5	145.1	146.9	149.8	159.2	164.6
4	161.0	161.2	161.9	163.1	164.8	165.7	166.5	166.8	167.5	169.6	173.0	182.7	187.7
5	174.8	175.2	176.5	179.0	182.7	184.7	186.6	187.2	188.0	190.3	194.1	203.8	208.1
6	186.2	186.8	188.9	192.7	198.6	201.9	205.1	206.1	207.0	209.4	213.6	222.2	225.2
7	195.8	196.7	199.5	204.7	212.9	217.6	222.2	223.8	224.7	227.3	230.9	236.6	238.5
8	204.0	205.1	208.7	215.4	225.9	232.0	238.3	240.3	241.2	243.1	245.2	248.4	249.4
9	211.1	212.4	216.8	224.9	237.9	245.5	253.3	255.9	256.2	256.7	257.3	258.2	258.6
10	217.2	218.8	223.8	233.5	248.9	258.0	267.5	270.7	269.9	268.7	267.8	266.7	266.3
11	222.4	224.2	230.1	241.2	259.1	269.8	280.9	284.6	282.6	279.4	276.9	273.8	272.9
12	226.8	228.9	235.6	248.2	268.5	280.8	293.6	298.0	294.4	289.0	284.9	279.9	278.4
13	230.5	232.8	240.3	254.5	277.3	291.1	305.7	310.6	305.3	297.7	292.0	285.2	283.1
14	233.5	236.1	244.4	260.2	285.6	300.9	317.1	322.6	315.6	305.5	298.2	289.6	287.0
15	235.9	238.8	247.9	265.3	292.2	307.8	324.0	329.5	322.5	311.9	303.6	293.3	290.2
16	237.7	240.8	250.5	268.2	295.1	310.7	327.0	332.4	325.4	314.8	306.5	295.9	292.5

All dimensions in mm

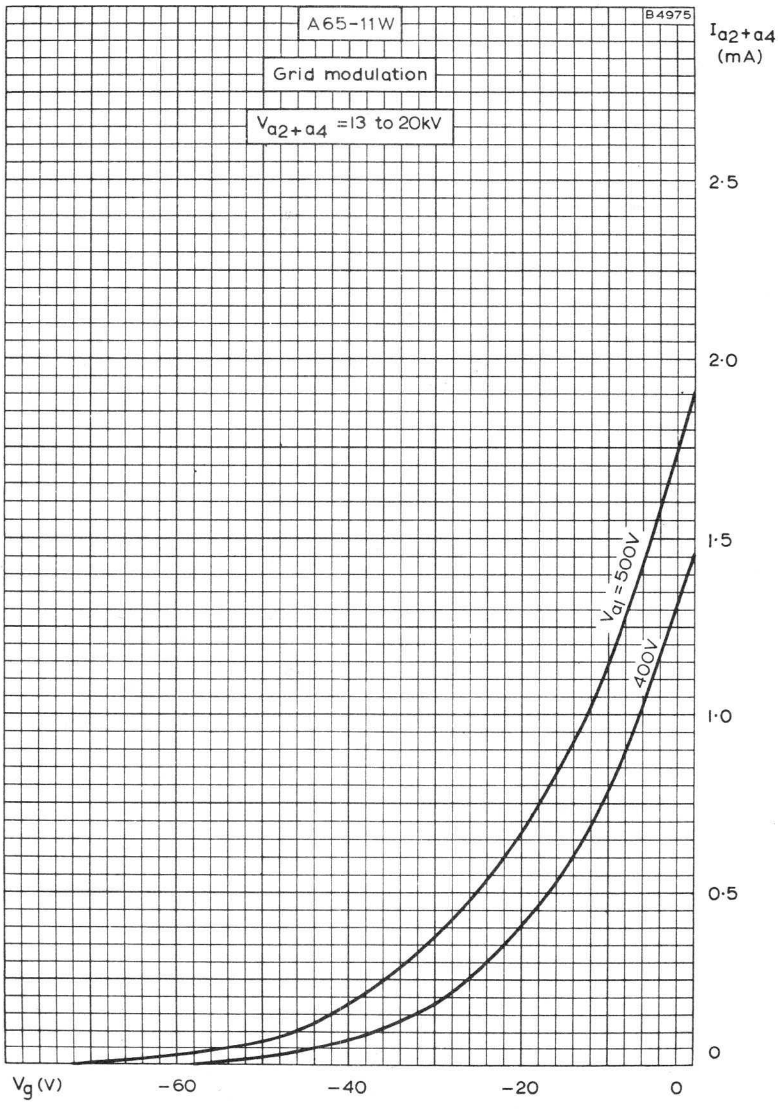


Mounting lug

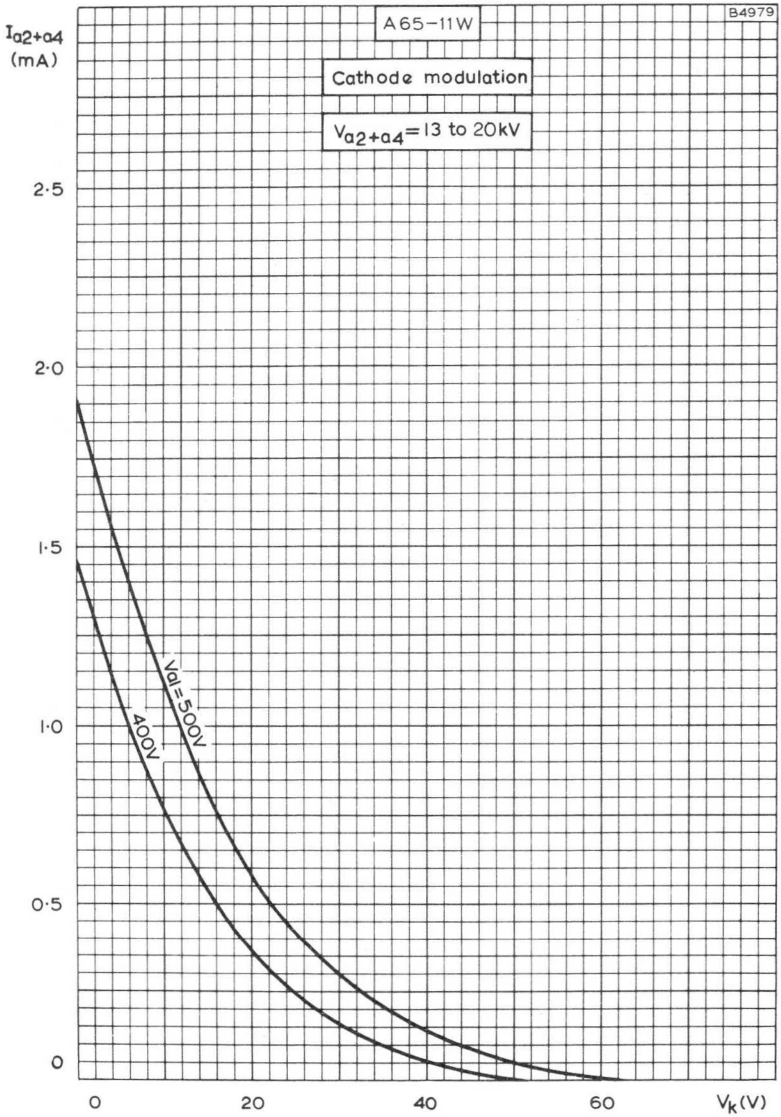


All dimensions in mm.

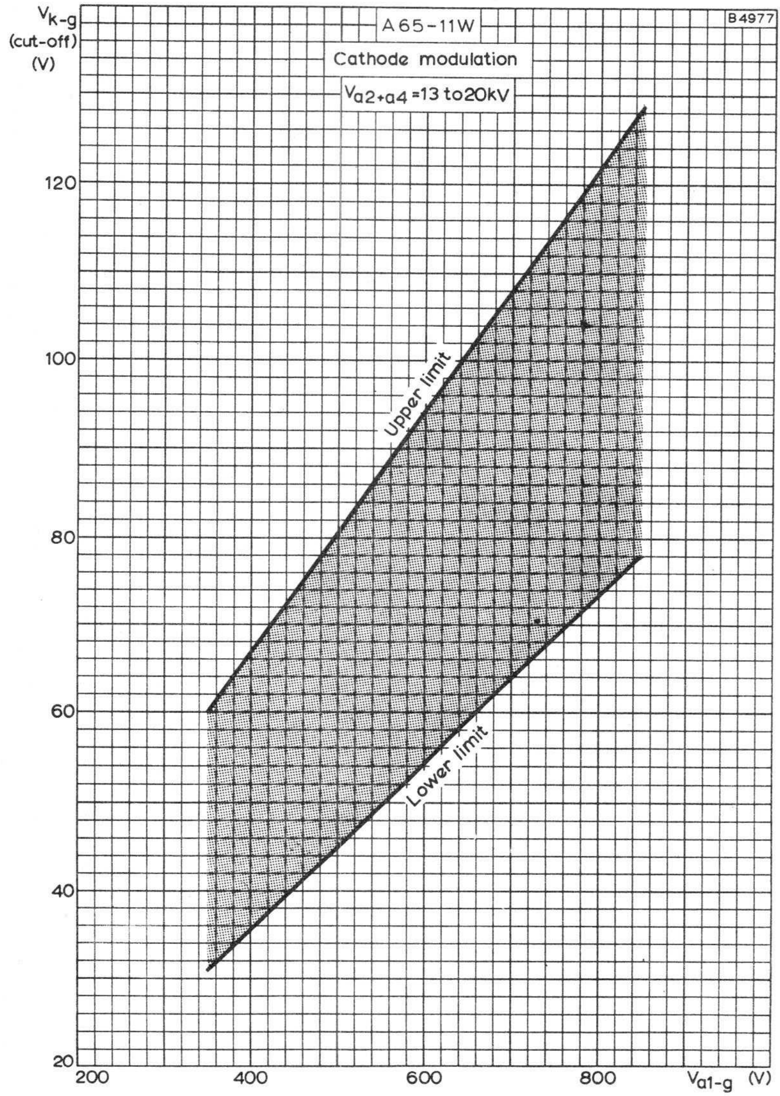
The bolts to be used for mounting the tube must be within the circles of 9.5mm diameter shown in the template drawing.



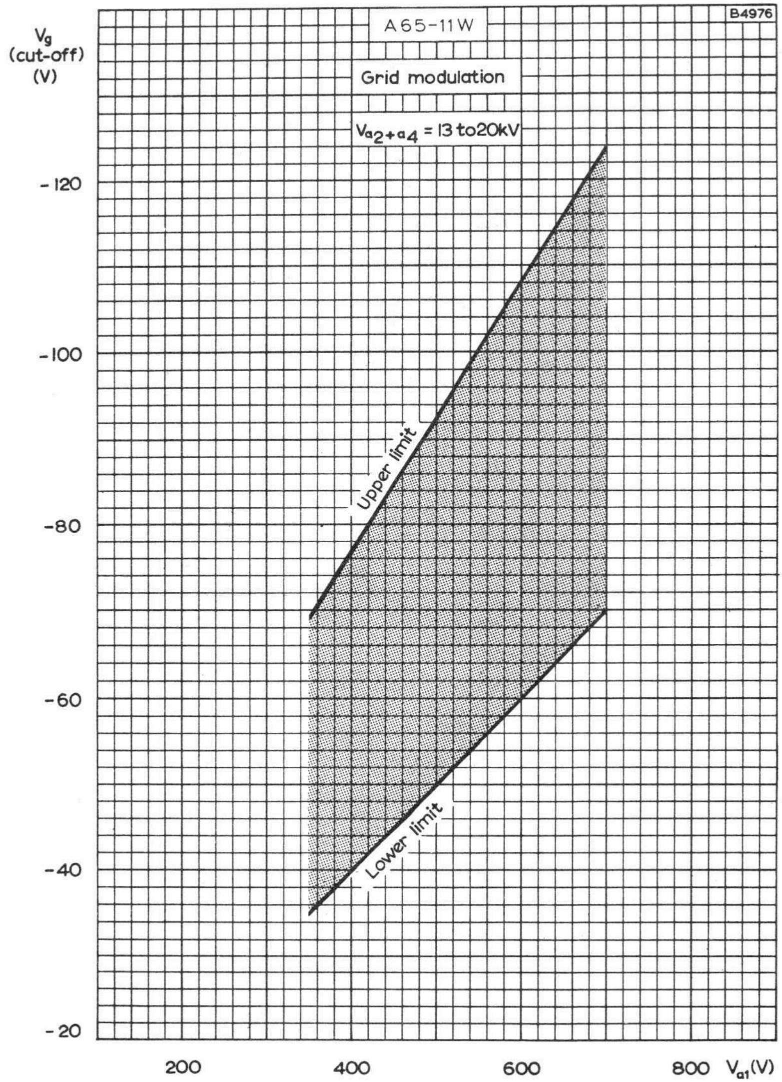
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION.



FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE. CATHODE MODULATION.



LIMITS OF CATHODE-TO-GRID CUT-OFF VOLTAGE PLOTTED AGAINST FIRST ANODE-TO-GRID VOLTAGE. CATHODE MODULATION.



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

TELEVISION TUBE

AW53-89

Direct viewing television tube with 21in. diagonal metal-backed rectangular grey glass screen. This tube is electrostatically focused and has a 110° deflection angle. An ion trap magnet is not 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 series or parallel operation.

V_h	6.3	V
I_h	300	mA

The limits of heater voltage and current are contained in 'General operational recommendations—cathode ray tubes'

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, which must be earthed, and the capacitance of this to the final anode is 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}	7.0	pF
c_{k-all}	5.0	pF
c_{a3-M}	1850	pF

SCREEN

Metal backed		
Fluorescent colour	white	
Light transmission (approx.)	75	%
Useful screen area	see drawing on page D4	

FOCUSING

Electrostatic

The range of focus voltage shown in the curves results in optimum centre focus at a beam current of 100μA.

AW53-89 TELEVISION TUBE

DEFLECTION

Double magnetic
For timebase designs the following spreads in the useful screen area should be considered

	Min.	*Max.*	
Picture height	382.5	388	mm
Picture width	484	490	mm
Picture diagonal	514.5	520	mm

The spread in the cone length can be obtained from the outline drawin g. The deflection coils should be designed so that their internal contour is in accordance with JETEC gauge 126.

REFERENCE LINE GAUGE

JETEC 126. For details see 'General operational recommendations—cathode ray tubes'.

RASTER CENTRING

See notes under this heading in 'General operational recommendations—cathode ray tubes'.

Centring magnet field intensity	0 to 15	G
Maximum distance of centre of centring field from reference line	57	mm

Adjustment of the centring magnet should not be such that a general reduction in brightness or shading of the raster occurs.

MOUNTING POSITION Any

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 40mm which is centred upon the perpendicular from the centre of the face.
This tube is fitted with a pin protector in order to avoid damage to the glass base due to bending of the base pins whilst handling the tube.
It is advisable to keep this pin protector on the base until it can be replaced by the socket after installation of the tube in an equipment.

OPERATING CONDITIONS

	**Grid modulation*	**Cathode modulation*	
V_{a3}	16	16	kV
V_{a2} (focus electrode control range)	0 to 400	40 to 440	V
V_{a1}	500	540	V
V_g for visual extinction of focused raster	−35 to −75	—	V
V_k for visual extinction of focused raster	—	35 to 69	V

*For grid modulation, all voltages are measured with respect to the cathode; for cathode modulation, all voltages are measured with respect to the grid.

LIMITING VALUES (design centre ratings)

V_{a3} max.	16	kV
V_{a3} min.	13	kV
$+V_{a2}$ max.	750	V
$-V_{a2}$ max.	500	V
V_{a1} max.	700	V
V_{a1} min.	500	V
$-v_{g(pk)}$ max.	400	V
$-V_g$ max.	150	V
$\pm I_{a2}$ max.	15	μA
$\pm I_{a1}$ max.	5.0	μA
†V_{h-k}		
Cathode positive		
d.c. max.	200	V
pk max.	300	V
Cathode negative		
d.c. max.	125	V
pk max.	250	V
R_{h-k} max.	1.0	MΩ
Z_{k-e} max. (f=50c/s)	100	kΩ
R_{g-k} max.	1.5	MΩ
Z_{g-k} max. (f=50c/s)	500	kΩ

*The d.c. value of bias must not be such as to allow the grid 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 excursion of the video signal must not exceed +2V and at this voltage the grid current may be expected to be approximately 2mA.

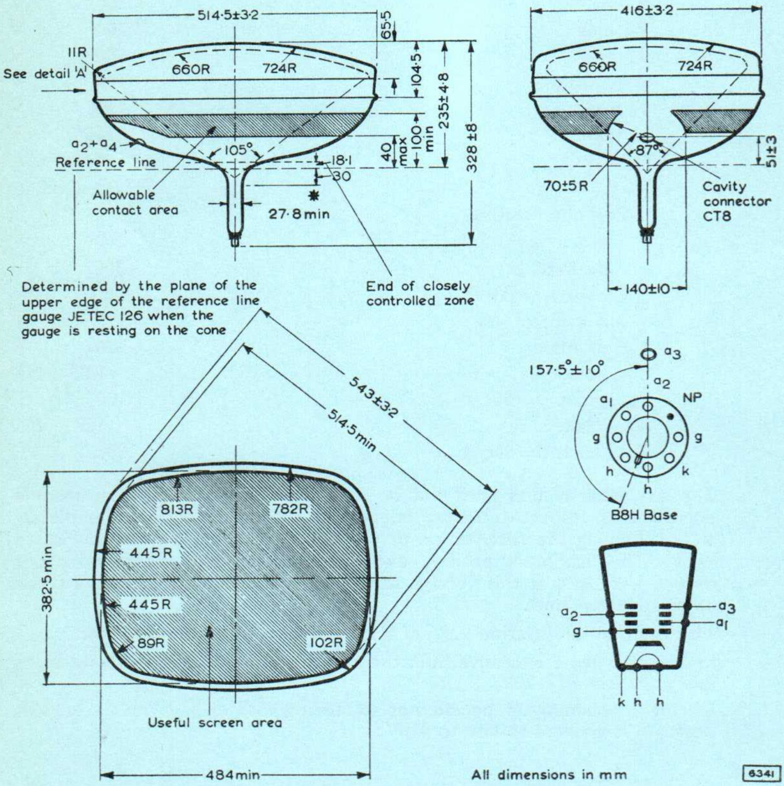
**Maximum pulse duration 22% of a cycle with a maximum of 1.5ms.

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

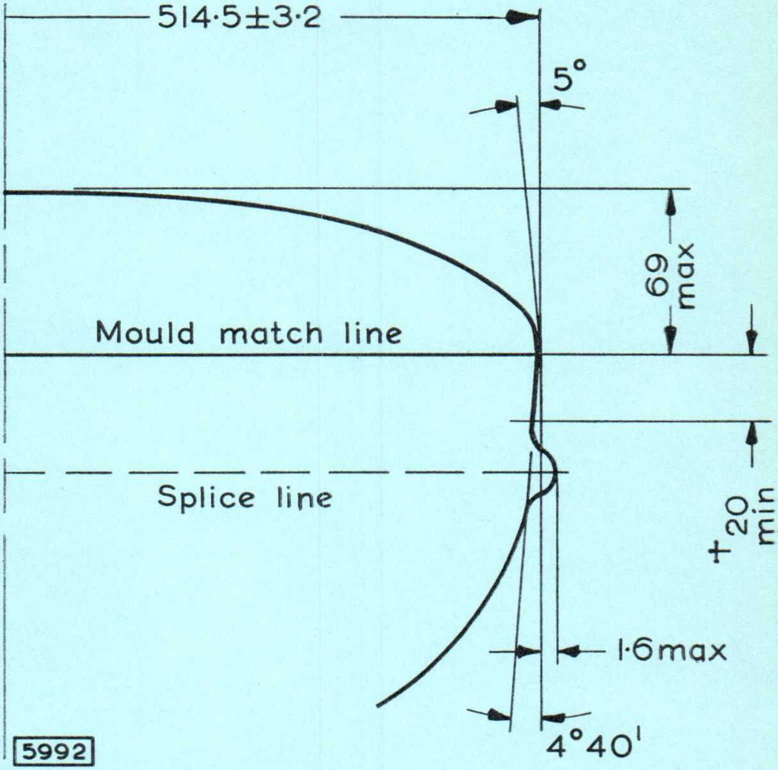
During a warming-up period not exceeding 45s, $v_{h-k(pk)}$ max. (cathode positive) is allowed to rise to 410V.

WEIGHT

Tube alone	10	kg
	22	lb



*The maximum value is determined by the reference line gauge.

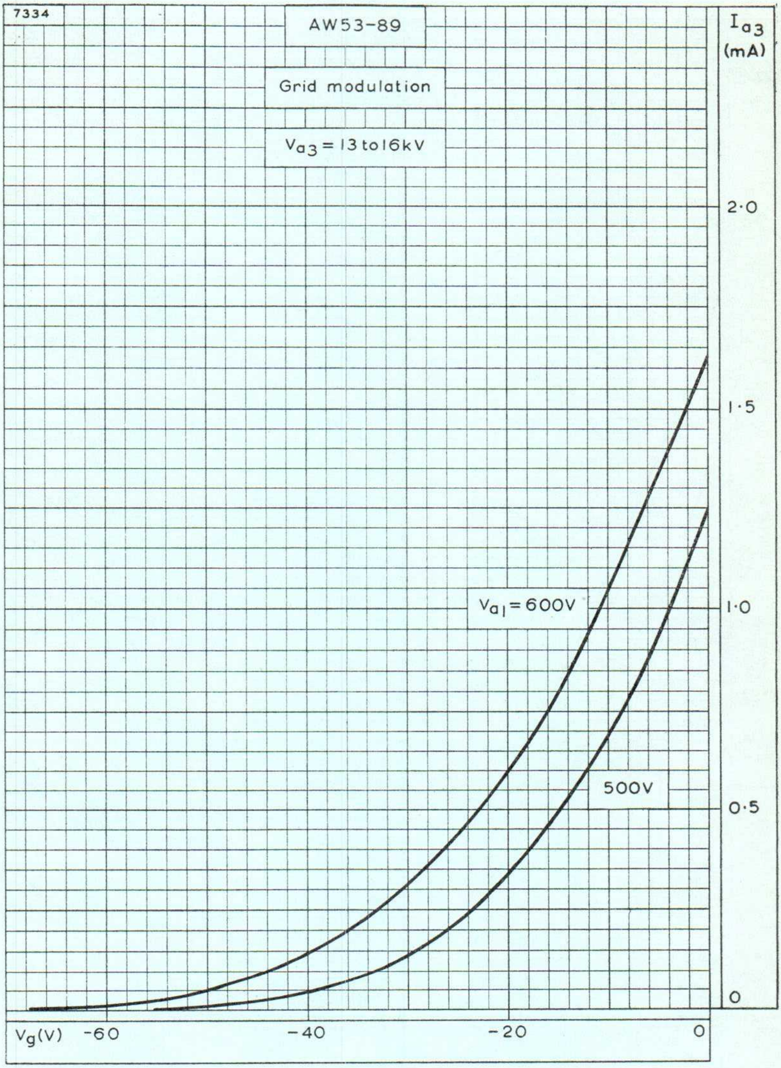


+ Undisturbed area between mould match line and splice line.

Detail 'A'

The bulge at the splice line seal may increase the indicated maximum value for envelope width, diagonal and height by not more than 3.2mm, but at any point around the seal the bulge will not protrude more than 1.6mm beyond the envelope surface at the mould match line.

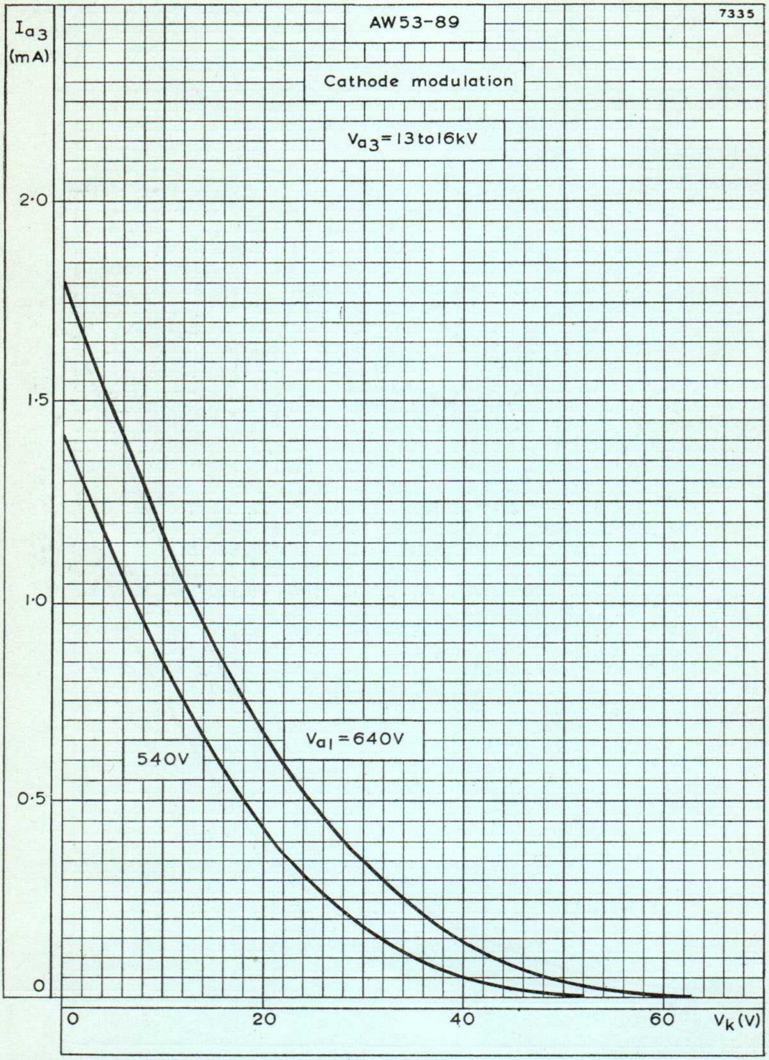
The undisturbed area between mould match line and splice line is 20mm minimum. This should be the width of the tube support band.



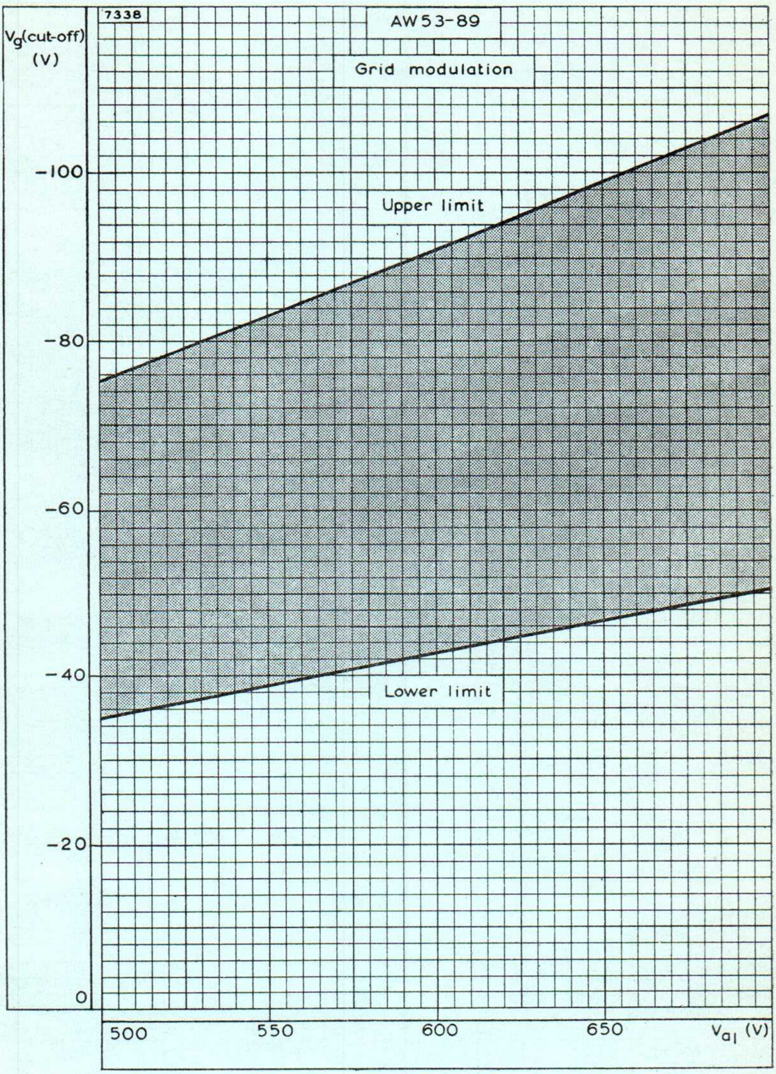
FINAL ANODE CURRENT PLOTTED AGAINST GRID VOLTAGE.
GRID MODULATION

AW53-89

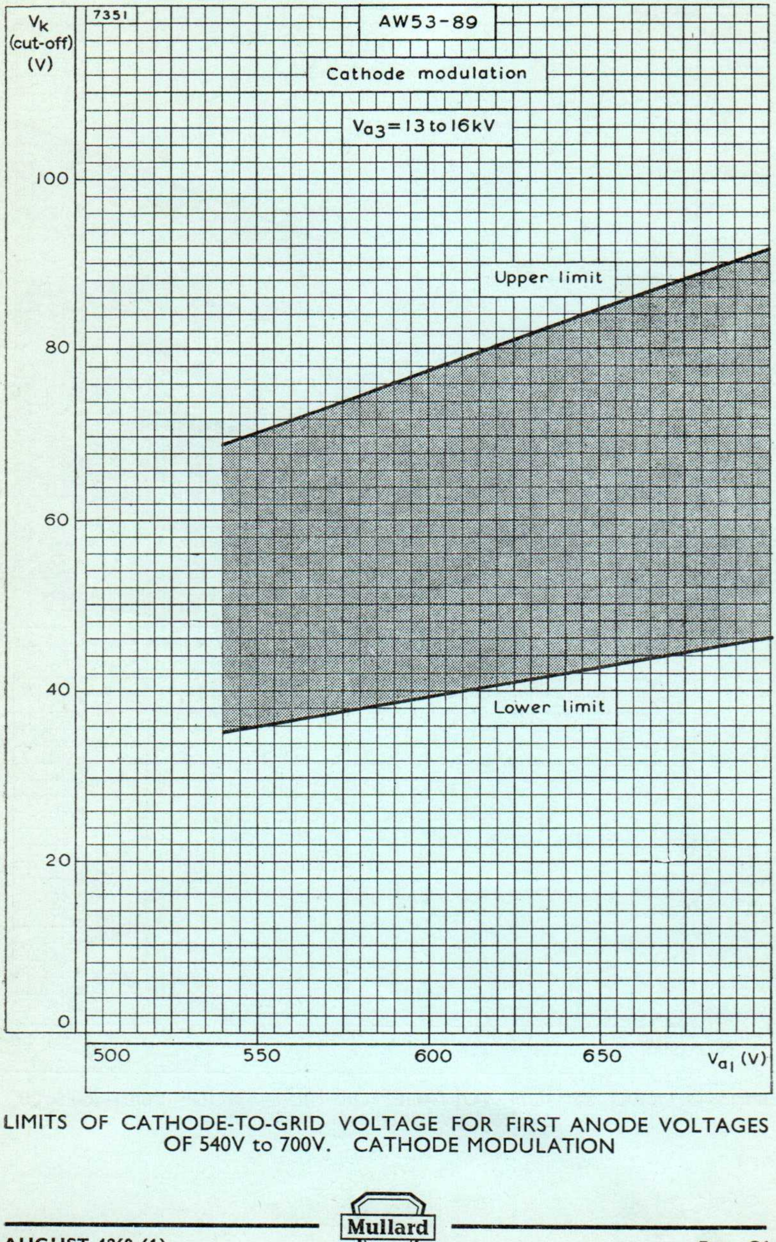
TELEVISION TUBE



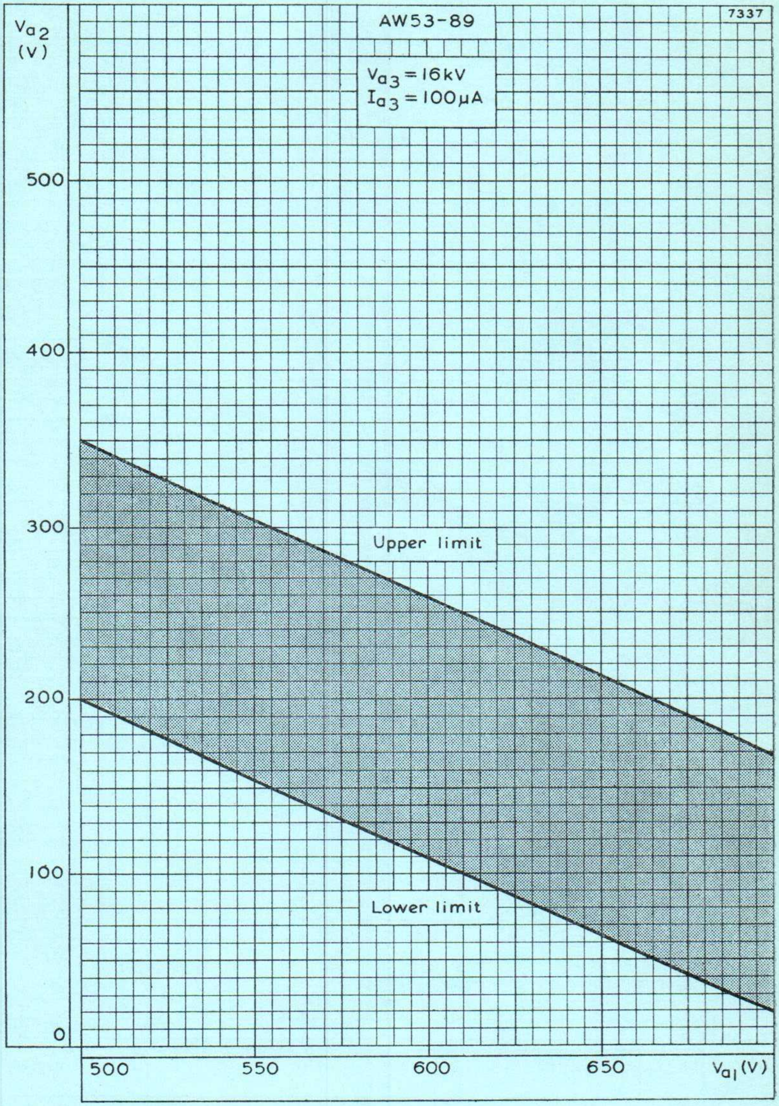
FINAL ANODE CURRENT PLOTTED AGAINST CATHODE-TO-GRID VOLTAGE.
CATHODE MODULATION



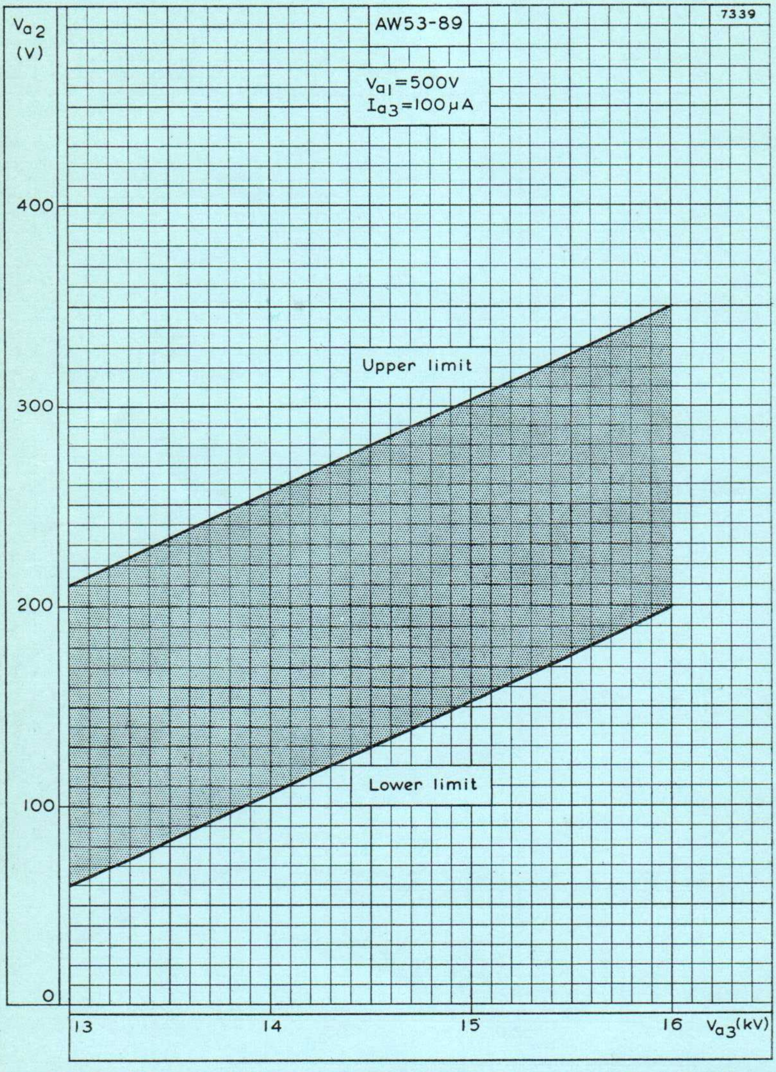
LIMITS OF GRID CUT-OFF VOLTAGE FOR FIRST ANODE VOLTAGES OF 500V to 700V. GRID MODULATION



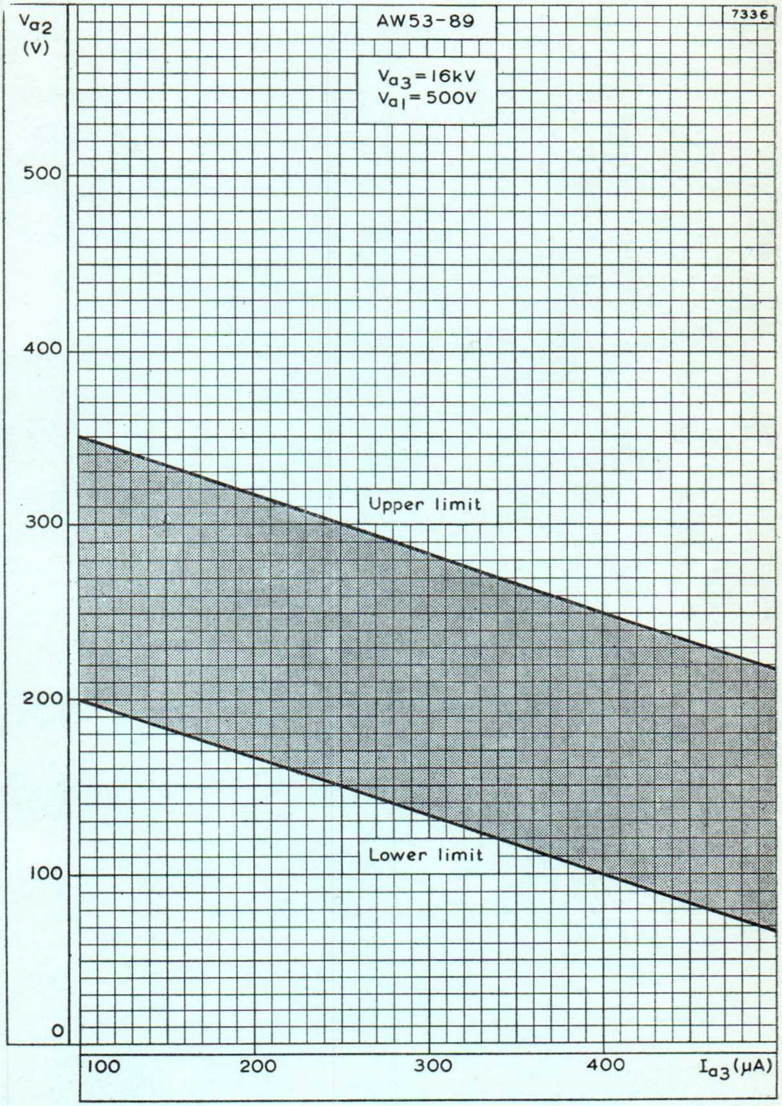
LIMITS OF CATHODE-TO-GRID VOLTAGE FOR FIRST ANODE VOLTAGES OF 540V to 700V. CATHODE MODULATION



RANGE OF FOCUS VOLTAGE PLOTTED AGAINST FIRST ANODE VOLTAGE



RANGE OF FOCUS VOLTAGE PLOTTED AGAINST FINAL ANODE VOLTAGE



RANGE OF FOCUS VOLTAGE PLOTTED AGAINST FINAL ANODE CURRENT

MISCELLANEOUS
VALVES

ELECTROMETER PENTODE

ME1400

Pentode suitable for use in high resistance circuits for applications such as pH meters, photocell units and valve voltmeters.

HEATER

V_h	$4.5 \pm 5\%$	V
I_h	160	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{a-g1}	<20	mpF
c_{in}	5.5	pF
c_{out}	8.5	pF

CHARACTERISTICS

Pentode connected

Measured at $V_h = 4.5V$, $V_a = V_{g2} = 45V$ and $I_a = 80\mu A$

	Min.	*Av.*	*Max.*	
I_h	150	160	170	mA
V_{g1}	−1.6	−2.0	−2.4	V
g_m	160	240	320	μA/V
I_{g2}	—	20	—	μA
I_{g1}	—	-5.0×10^{-12}	-10^{-11}	A
r_a	—	>5.0	—	MΩ
*V_{g1} (crossover)	—	−0.8	−1.3	V

Triode connected (g_2 connected to a, g_3 connected to k)

Measured at $V_h = 4.5V$, $V_a = 45V$ and $I_a = 100\mu A$

	Min.	*Av.*	*Max.*	
I_h	150	160	170	mA
V_{g1}	−1.6	−2.0	−2.4	V
g_m	200	300	400	μA/V
I_{g1}	—	-5.0×10^{-12}	-10^{-11}	A
r_a	—	65	—	kΩ
μ	—	20	—	
*V_{g1} (crossover)	—	−0.8	−1.3	V

*'Crossover' is the point at which the polarity of the grid current is reversed.

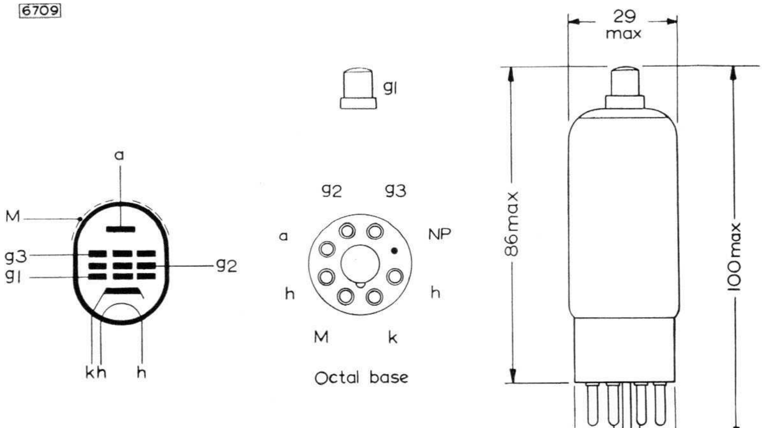
LIMITING VALUES

V_a max.	90	V
V_{g2} max.	90	V
I_k max.	1.0	mA
V_{h-k} max.	10	V

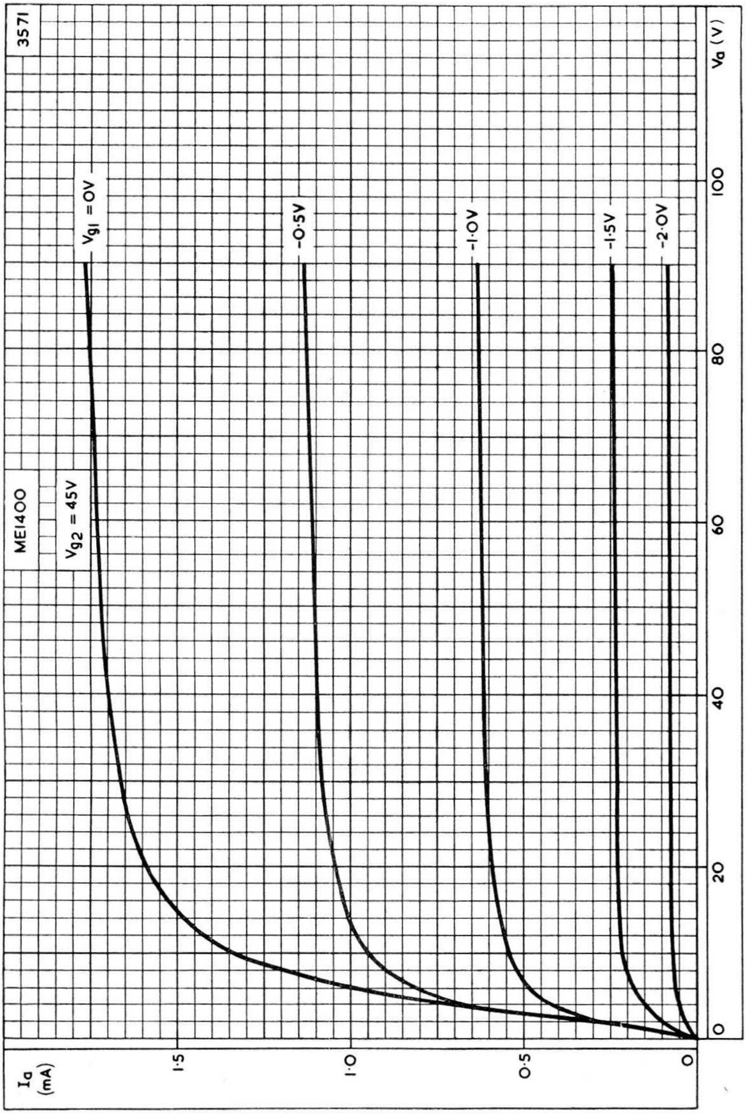
ME1400

ELECTROMETER PENTODE

6709



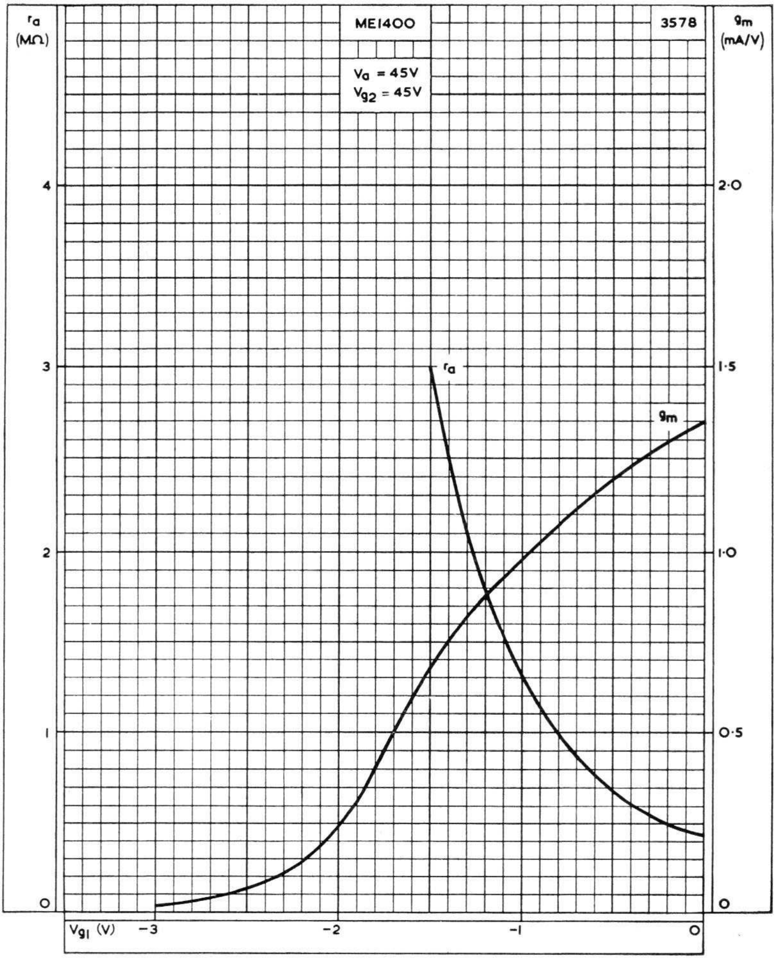
All dimensions in mm



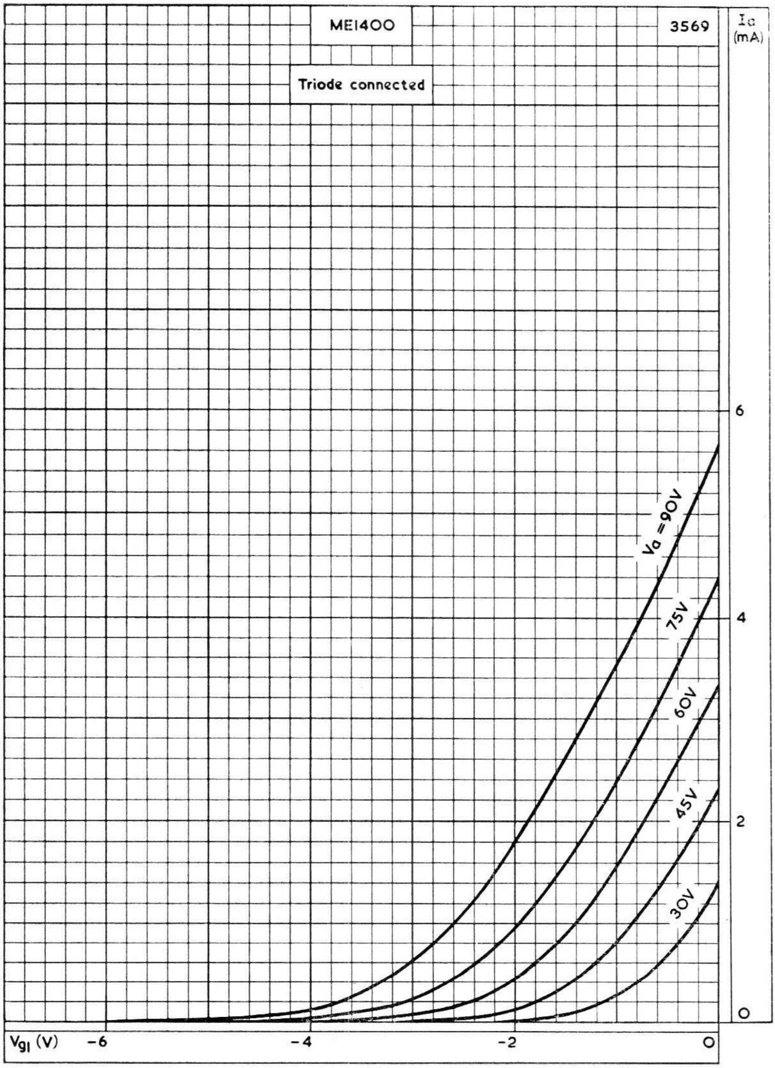
ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 45V$

ME1400

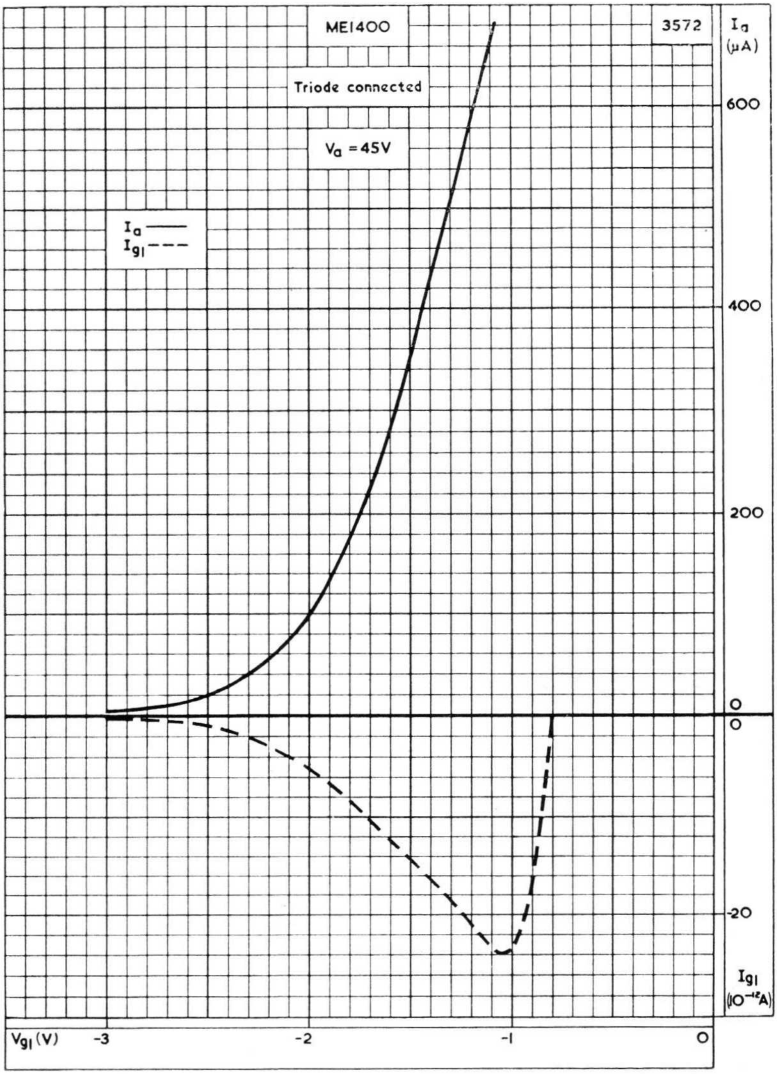
ELECTROMETER PENTODE



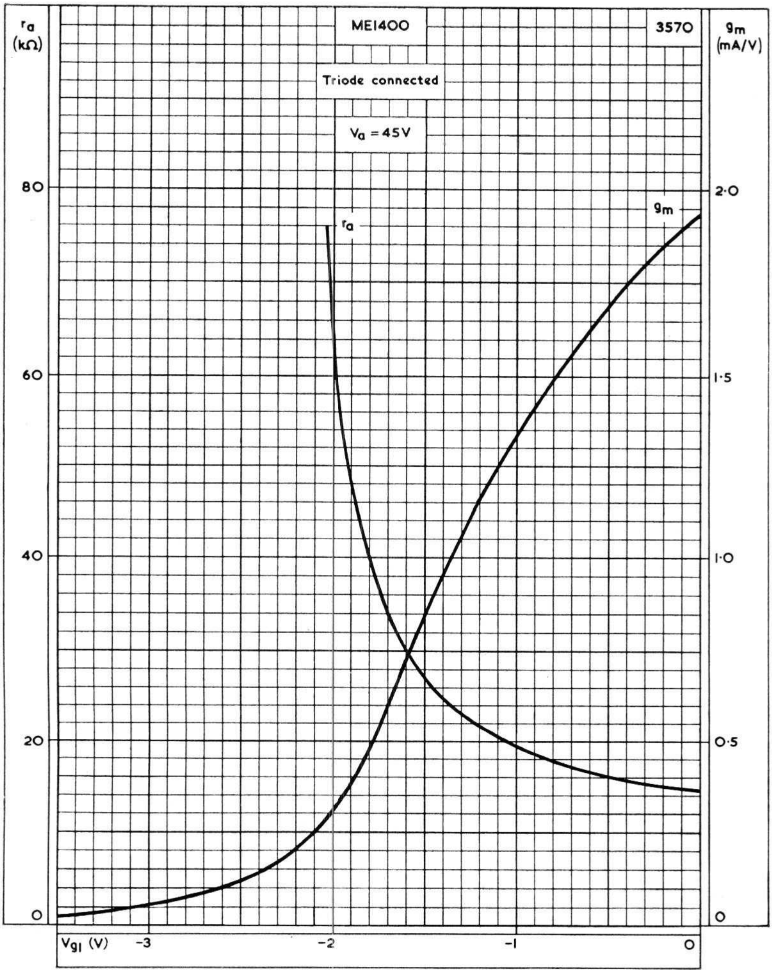
ANODE IMPEDANCE AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = V_{g2} = 45V$



ANODE CURRENT PLOTTED AGAINST CONTROL-GRID VOLTAGE WITH ANODE VOLTAGE AS PARAMETER. TRIODE CONNECTED



ANODE AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. TRIODE CONNECTED. $V_a = 45V$



ANODE IMPEDANCE AND MUTUAL CONDUCTANCE PLOTTED AGAINST CONTROL-GRID VOLTAGE. TRIODE CONNECTED. $V_a = 45V$

SUBMINIATURE ELECTROMETER TRIODE

ME1401

Subminiature electrometer triode with a grid current of 10^{-13}A.

FILAMENT

Suitable for d.c. operation only.

V_f	1.25	V
I_f	13	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{a-g}	2.0	pF
c_{g-f}	0.6	pF
c_{a-f}	0.8	pF

CHARACTERISTICS (All voltages are with respect to the negative end of the filament)

Measured at $V_f = 1.25V$, $V_a = 9V$, $I_a = 100\mu A$

	Min.	*Av.*	*Max.*	
V_g	−2.0	−2.5	−3.75	V
g_m	70	80	90	µA/V
μ	1.7	2.0	2.7	
*I_g	—	-8.5×10^{-14}	-12.5×10^{-14}	A
†V_g (crossover)	—	−1.3	−1.6	V
†I_a (crossover)	160	—	—	µA

*The quoted grid current characteristics will only be obtained if the tube is operated in complete darkness.

†'Crossover' is the point at which the polarity of the grid current is reversed.

LIMITING VALUES

V_a max.	25	V
I_a max.	250	µA
V_f limits	1.1 to 1.5	V

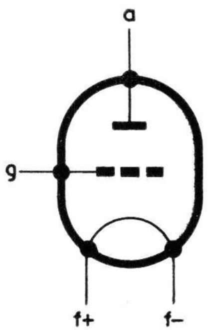
OPERATING NOTES

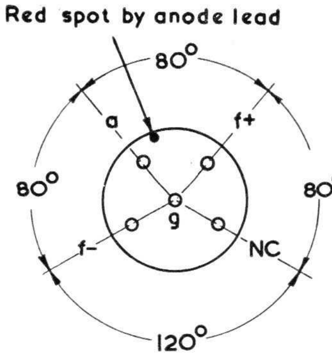
1. In order to avoid excessive drift the filament voltage must be applied before the anode voltage.
2. To avoid contamination of the glass, the valve should not be removed from its protective envelope until it is fitted into the equipment.
3. Direct soldered connections to the leads of this valve must be at least 13mm from the seal, and any bending of the valve leads must be at least 1.5mm from the seal.

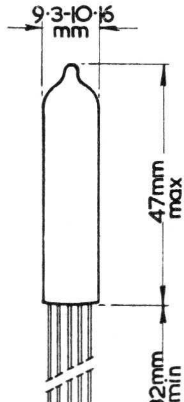
ME1401

SUBMINIATURE ELECTROMETER TRIODE

Subminiature electrometer triode with a grid current of 10^{-13}A.







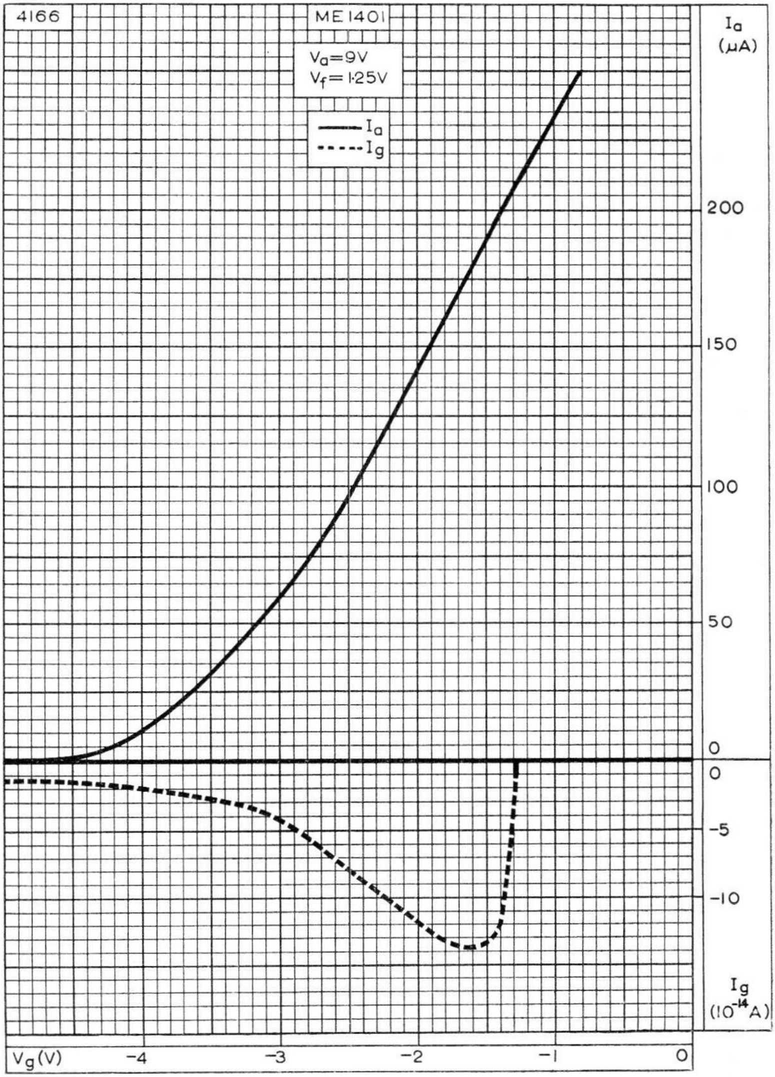
4377

BSJ/F Base

SUBMINIATURE ELECTROMETER TRIODE

ME1401

Subminiature electrometer triode with a grid current of 10^{-13}A.

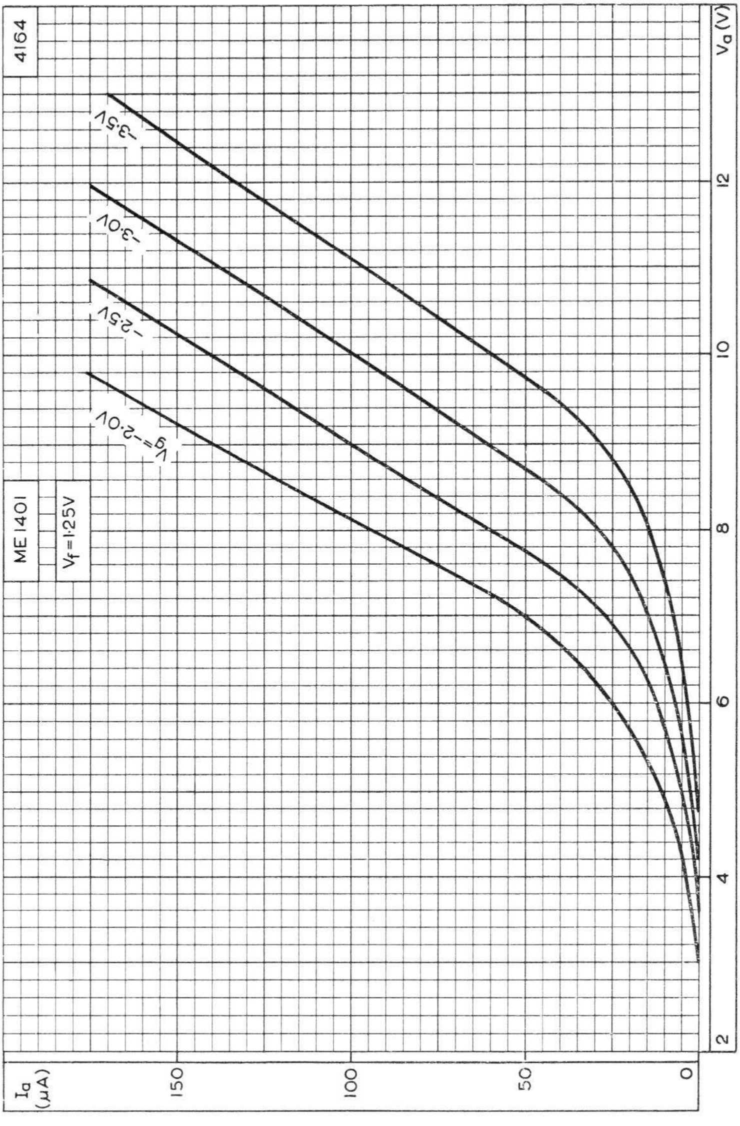


ANODE AND GRID CURRENTS PLOTTED AGAINST GRID VOLTAGE

ME1401

SUBMINIATURE ELECTROMETER TRIODE

Subminiature electrometer triode with a grid current of 10^{-13}A.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

SUBMINIATURE ELECTROMETER TETRODE

ME1402

Subminiature electrometer tetrode with a grid current of 3×10^{-15}A.

FILAMENT

Suitable for d.c. operation only.

V_f	1.25	V
I_f	13	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{a-g}	2.5	pF
c_{in}	0.3	pF
c_{out}	0.8	pF

CHARACTERISTICS (All voltages are with respect to the negative end of the filament)

Measured at $V_f = 1.25$V, $V_a = 4.5$V, $I_a = 20\mu$A, $I_{g1} = 250\mu$A
g_2 is the control-grid, g_1 being used as an accelerator grid.

	Min.	*Av.*	*Max.*	
V_{g1}	2.0	3.0	4.0	V
V_{g2}	−2.0	−3.2	−4.5	V
$g_{m(g2-a)}$	10	17	24	µA/V
$\mu_{(g2-a)}$	0.7	1.2	1.4	
$*I_{g2}$	—	-2.5×10^{-15}	-6.0×10^{-15}	A
†V_{g2} (crossover)	—	−1.75	—	V

*The quoted grid current characteristics will only be obtained if the tube is operated in complete darkness.

†'Crossover' is the point at which the polarity of the grid current (I_{g2}) is reversed.

LIMITING VALUES

V_a max.	10	V
I_k max.	300	µA ←
V_f limits	1.1 to 1.5	V

OPERATING NOTES

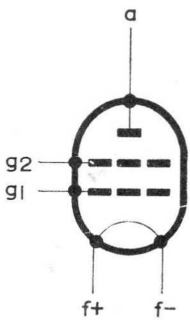
1. In order to avoid excessive drift of characteristics the filament voltage must be applied before the anode voltage.
2. To avoid contamination of the glass, the valve should not be removed from its protective envelope until it is fitted into the equipment.
3. Direct soldered connections to the leads of the valve must be at least 13mm from the seal and any bending of the leads must be at least 1.5mm from the seal.

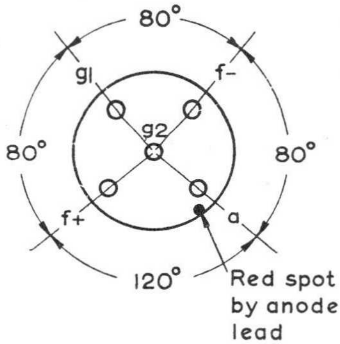
ME1402

SUBMINIATURE ELECTROMETER TETRODE

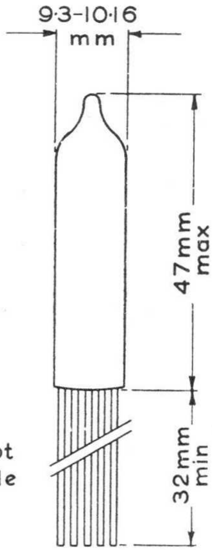
Subminiature electrometer tetrode with a grid current of 3×10^{-15}A.

4388





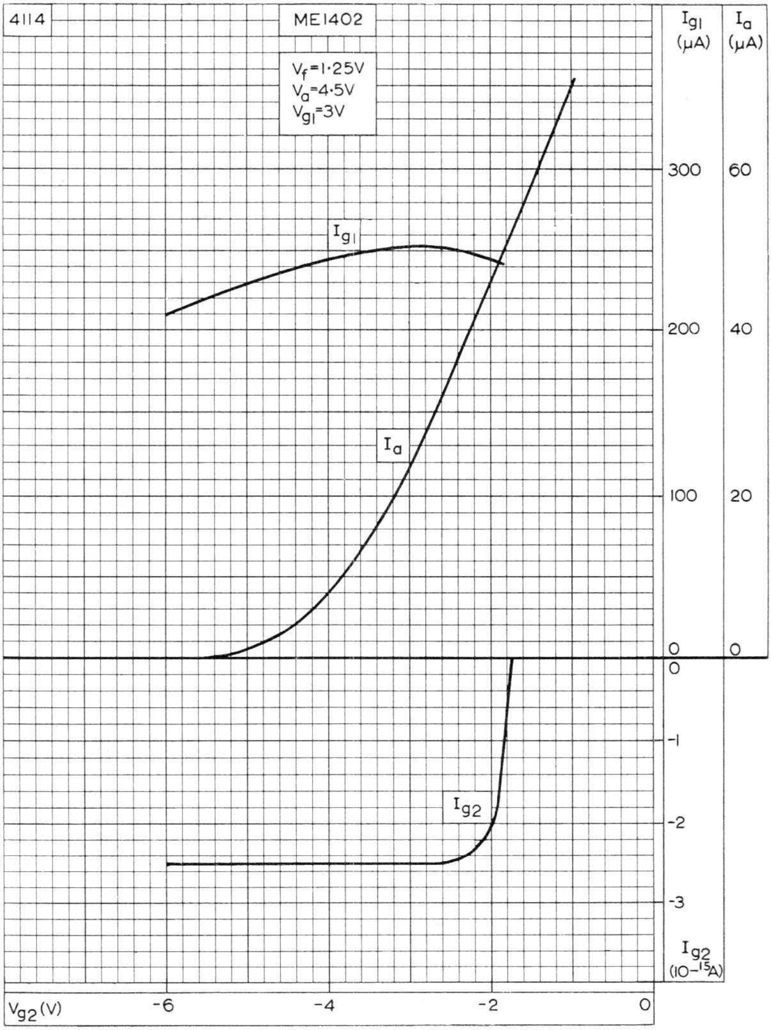
B5J/F Base



SUBMINIATURE ELECTROMETER TETRODE

ME1402

Subminiature electrometer tetrode with a grid current of 3×10^{-15}A.

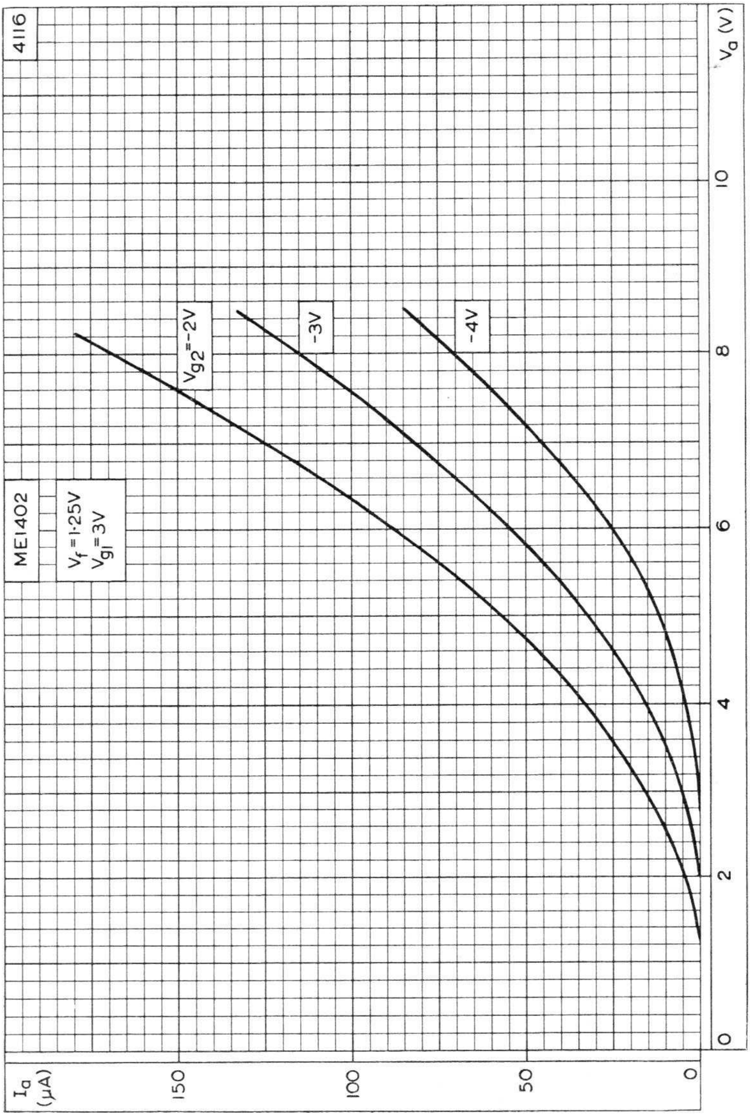


ANODE, ACCELERATOR GRID (g_1) AND CONTROL-GRID (g_2) CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE

ME1402

SUBMINIATURE ELECTROMETER TETRODE

Subminiature electrometer tetrode with a grid current of 3×10^{-15}A.

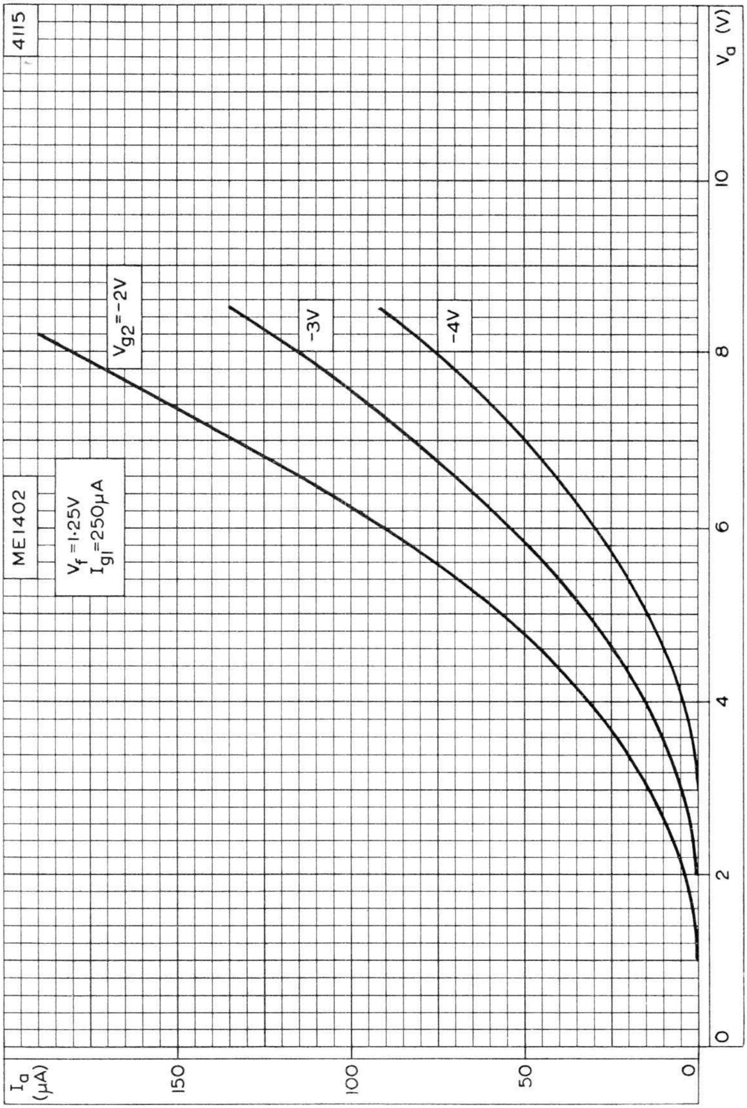


ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID (g_2) VOLTAGE AS PARAMETER AT ACCELERATOR GRID (g_1) VOLTAGE OF 3V

SUBMINIATURE ELECTROMETER TETRODE

ME1402

Subminiature electrometer tetrode with a grid current of 3×10^{-15}A.



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID (g_2) VOLTAGE AS PARAMETER AT ACCELERATOR GRID (g_1) CURRENT OF 250μA

SUBMINIATURE ELECTROMETER PENTODE

ME1403

Subminiature electrometer pentode with a grid current of 3×10^{-15}A.

FILAMENT

Suitable for d.c. operation only

V_f	1.25	V
I_f	8.2	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{a-g1}	0.2	pF
c_{in}	3.0	pF
c_{out}	4.0	pF

CHARACTERISTICS (All voltages are with respect to the negative end of the filament)

Measured at $V_f = 1.25$V, $V_a = 10$V, $I_a = 5.0\mu$A, $V_{g1} = -2.5$V

	Min.	*Av.*	*Max.*	
V_{g2}	5.0	6.5	7.5	V
g_m	8.0	10.5	15	μA/V
r_a	—	10.5	—	MΩ
$\mu_{(g1-a)}$	80	110	—	
*I_{g1}	—	-3.0×10^{-15}	-8.0×10^{-15}	A
I_{g2}	1.5	2.2	3.0	μA
†V_{g1}(crossover)	—	−1.15	—	V

*The quoted grid current characteristics will only be obtained if the tube is operated in complete darkness.

†'Crossover' is the point at which the polarity of the grid current is reversed (measured at $V_f = 1.25$V, $V_a = 10$V, V_{g2} = the value which gives $I_a = 5\mu$A when $V_{g1} = -2.5$V)

LIMITING VALUES

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	180	μA
V_f limits	1.1 to 1.5	V

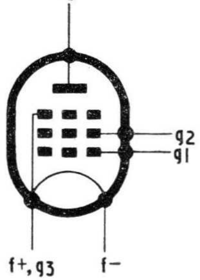
OPERATING NOTES

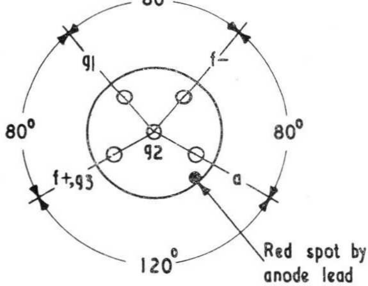
1. In order to avoid excessive drift of characteristics the filament voltage must be applied before the anode voltage.
2. To avoid contamination of the glass, the valve should not be removed from its protective envelope until it is fitted into the equipment.
3. Direct soldered connections to the leads of the valve must be at least 13mm from the seal and any bending of the valve leads must be at least 1.5mm from the seal.

ME1403

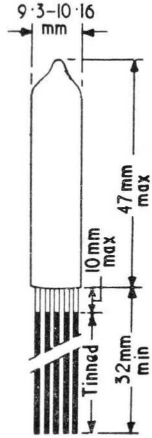
SUBMINIATURE ELECTROMETER PENTODE

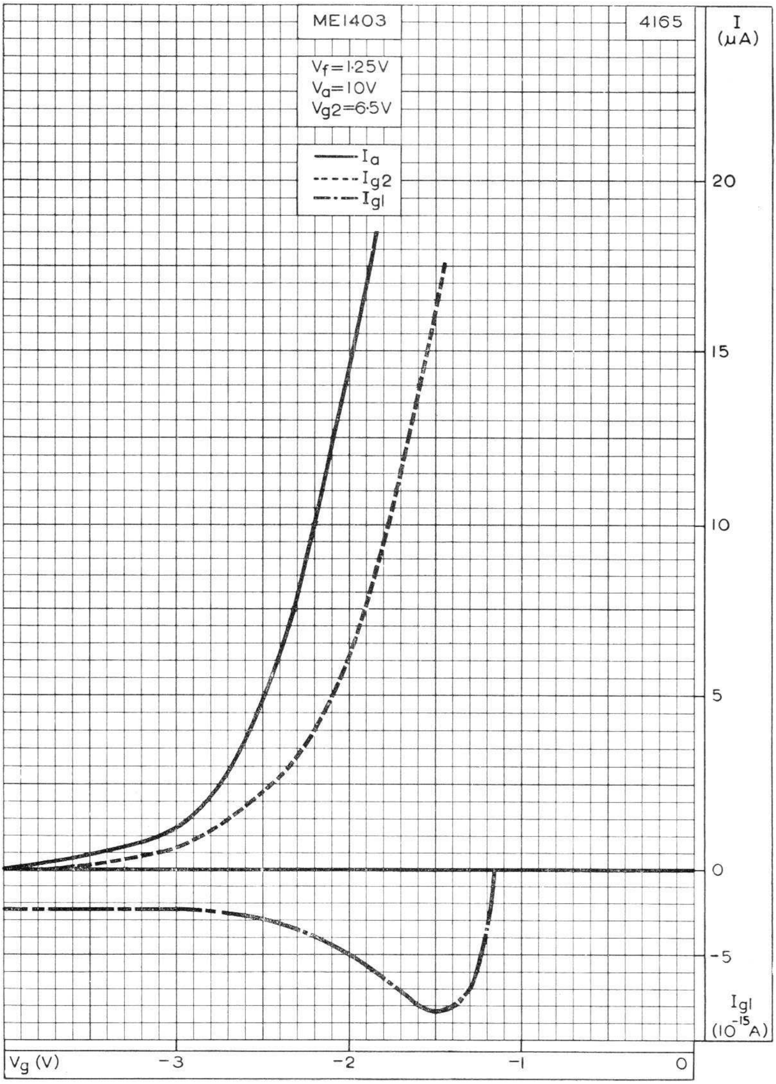
5525





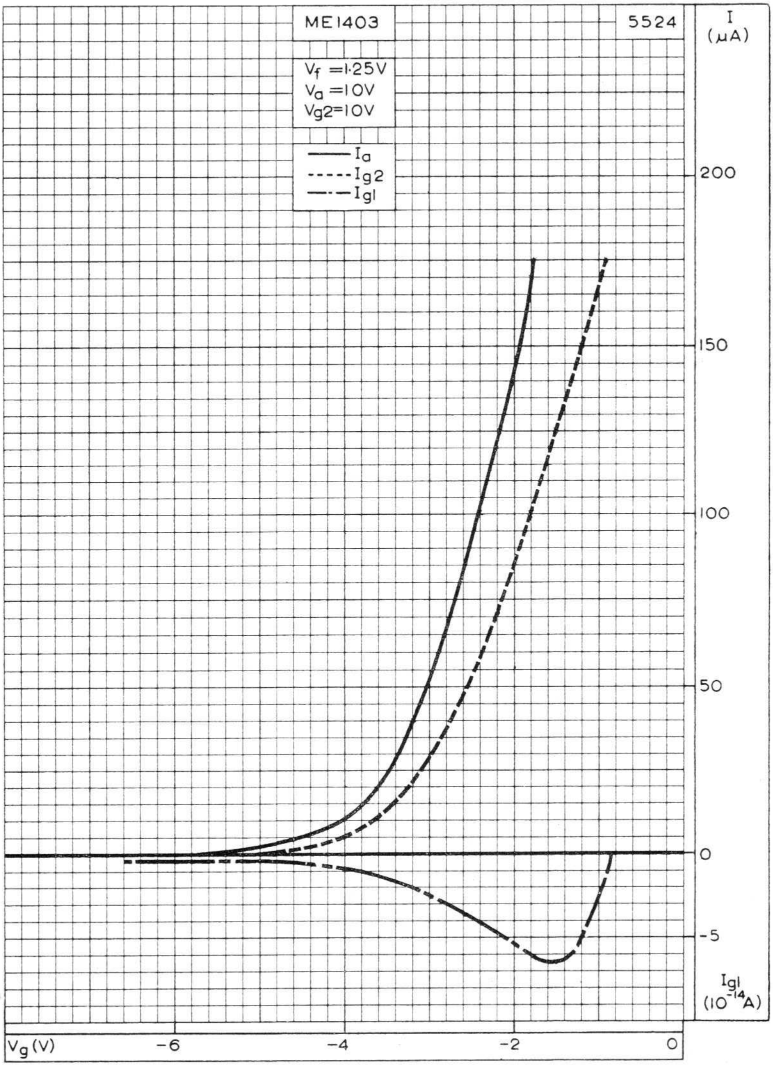
B5J/F Base





ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 10V$, $V_{g2} = 6.5V$

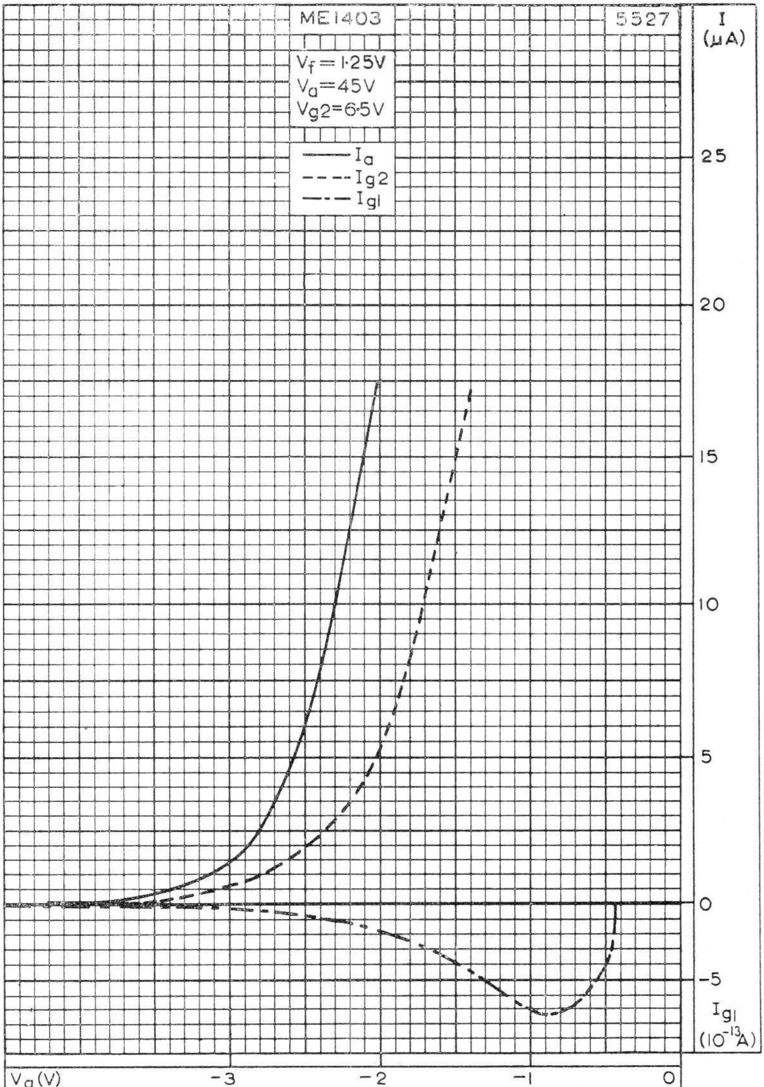
ME1403 SUBMINIATURE ELECTROMETER PENTODE



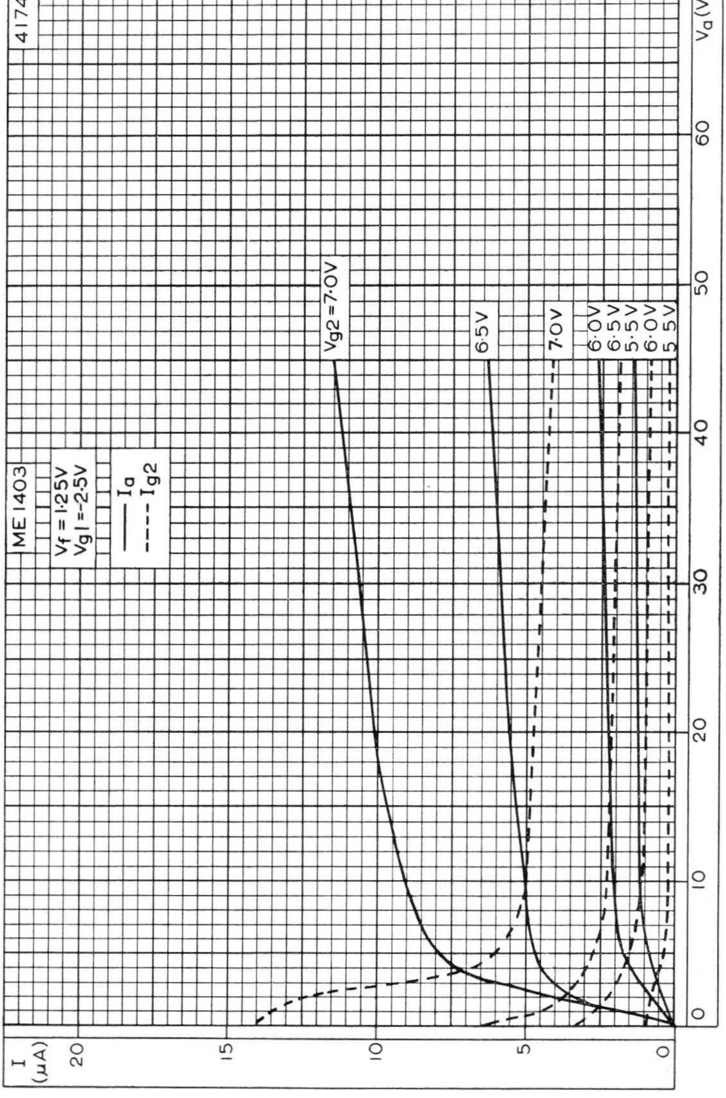
ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 10V$, $V_{g2} = 10V$

SUBMINIATURE ELECTROMETER PENTODE

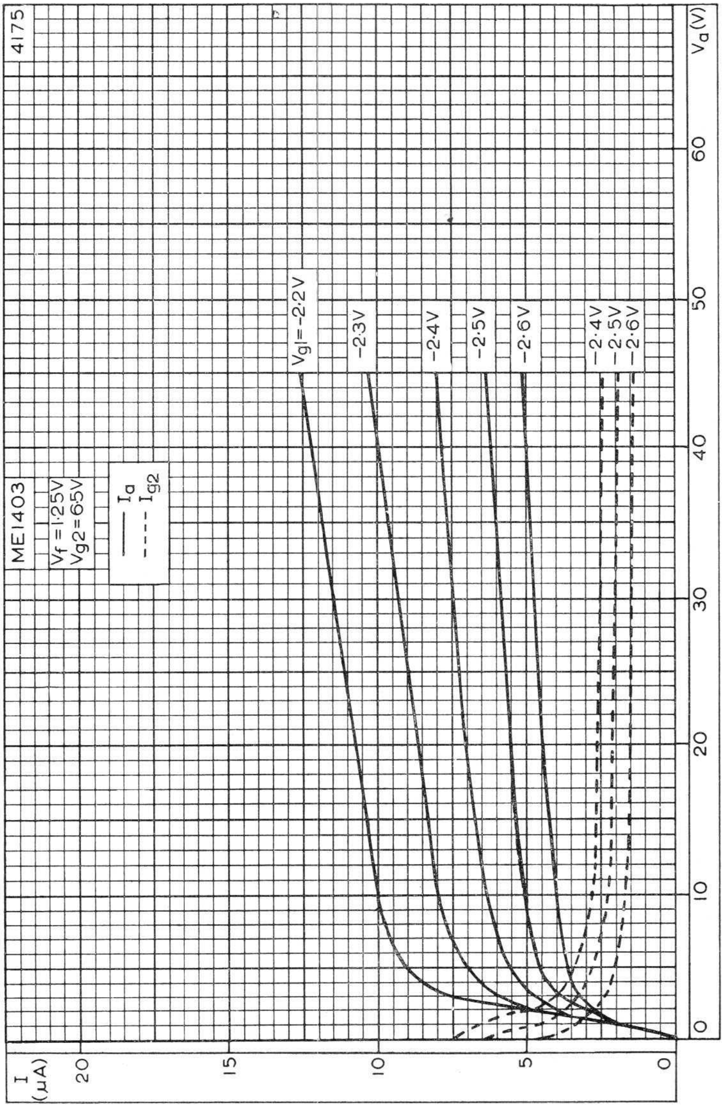
ME1403



ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 45V$, $V_{g2} = 6.5V$

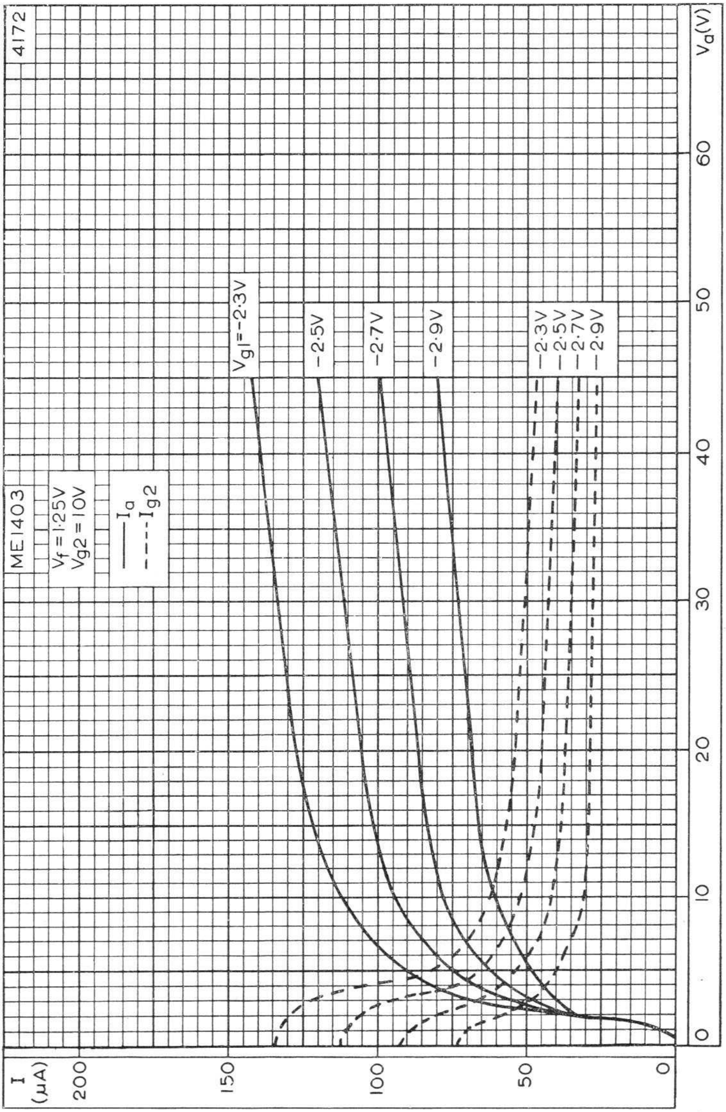


ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 6.5V$

ME1403 SUBMINIATURE ELECTROMETER PENTODE



ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. $V_{g2} = 10V$

SUBMINIATURE ELECTROMETER TRIODE

ME1404

Subminiature electrometer triode for linear and logarithmic use with a controlled logarithmic relationship between positive grid current and anode current, and a grid current of 2×10^{-13}A.

FILAMENT

Suitable for d.c. operation only

V_f	1.25	V
I_f	14	mA

CAPACITANCES

c_{a-g}	2.0	pF
c_{in}	0.5	pF
c_{out}	0.8	pF

CHARACTERISTICS (for linear operation with all voltages measured with respect to the negative end of the filament)

Measured at $V_f = 1.25$V, $V_a = 9.0$V, $I_a = 100\mu$A

	Minimum	*Typical*	*Maximum*	
V_g	−2.0	−2.7	−3.75	V
g_m	60	80	90	μA/V
μ	1.6	2.0	2.7	
I_g	—	-1.6×10^{-13}	-10×10^{-13}	A
†V_g (crossover)	—	−1.4	−1.7	V
†I_a (crossover)	145	—	—	μA

†'Crossover', measured at $V_a = 9.0$V, is the point at which the polarity of the grid current is reversed.

LIMITING VALUES

V_a max.	25	V
I_a max.	250	μA
V_f limits	1.1 to 1.5	V

Notes for operation with logarithmic characteristic

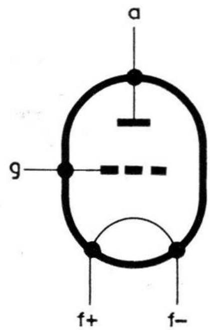
This valve has a controlled linear relationship between the anode current and the logarithm of the positive grid current. This relationship holds good over a range of at least three decades of positive grid current i.e. from 3×10^{-12}A to 3×10^{-9}A. Conditions can be established such that this change in grid current always produces a fall in anode current of 50μA.

With a positive grid current of 3×10^{-9}A, the anode voltage should be set to some value (nominal 4.4V) such that when the grid current is reduced to 3×10^{-12}A the anode current falls by 50μA. It will be found that the anode voltage lies in the approx. range 3 to 6V, whilst the initial anode current is in the range 65 to 100μA.

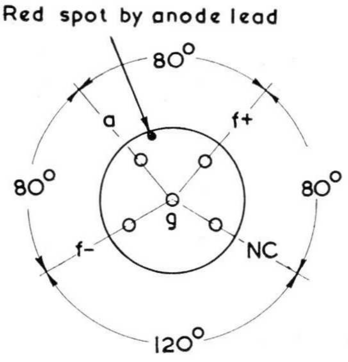
ME1404 SUBMINIATURE ELECTROMETER TRIODE

OPERATING NOTES

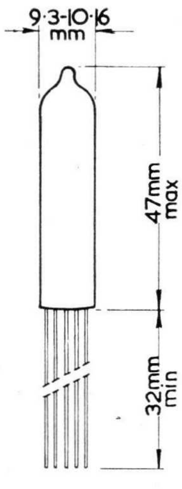
1. In order to avoid excessive drift of characteristics the filament voltage must be applied before the anode voltage.
2. To avoid contamination of the glass the valve should not be removed from its protective envelope until it is fitted into the equipment. Great care should be taken not to handle the valve within 13mm of the base.
3. Direct soldered connections to the leads of the valve must be at least 13mm from the seal and any bending of the leads must be 1.5mm from the seal.
4. To prevent photoemission from the grid, the valve should be operated in darkness or at a low ambient light level.

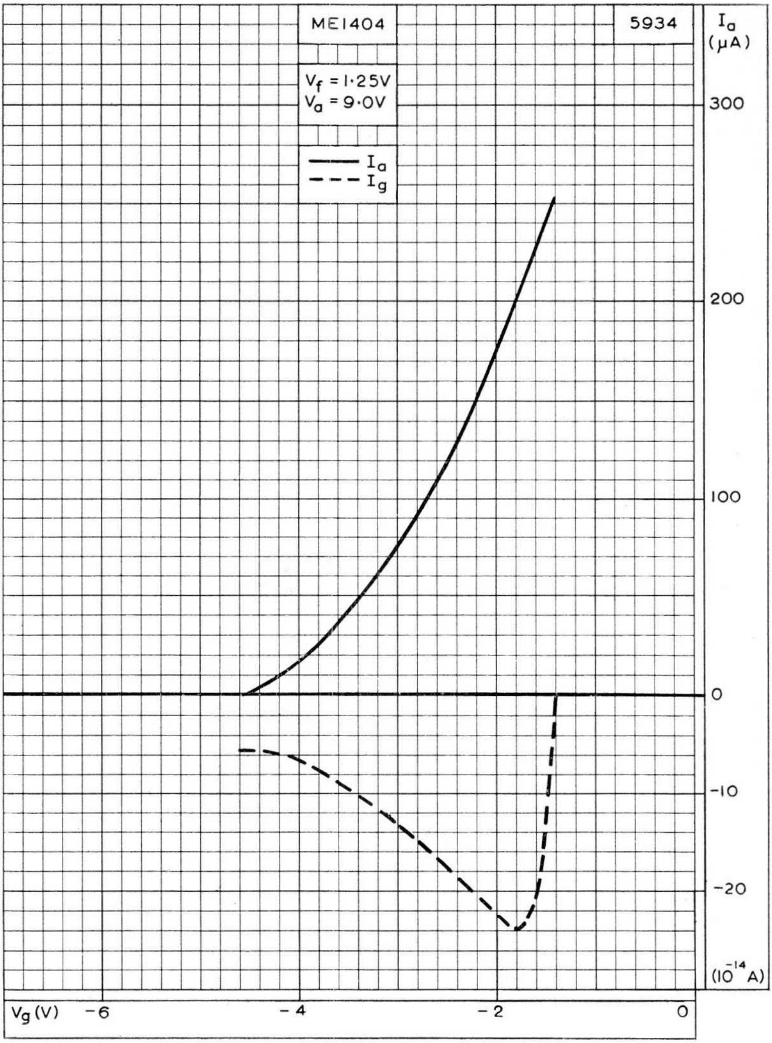


4377



B5J/F Base

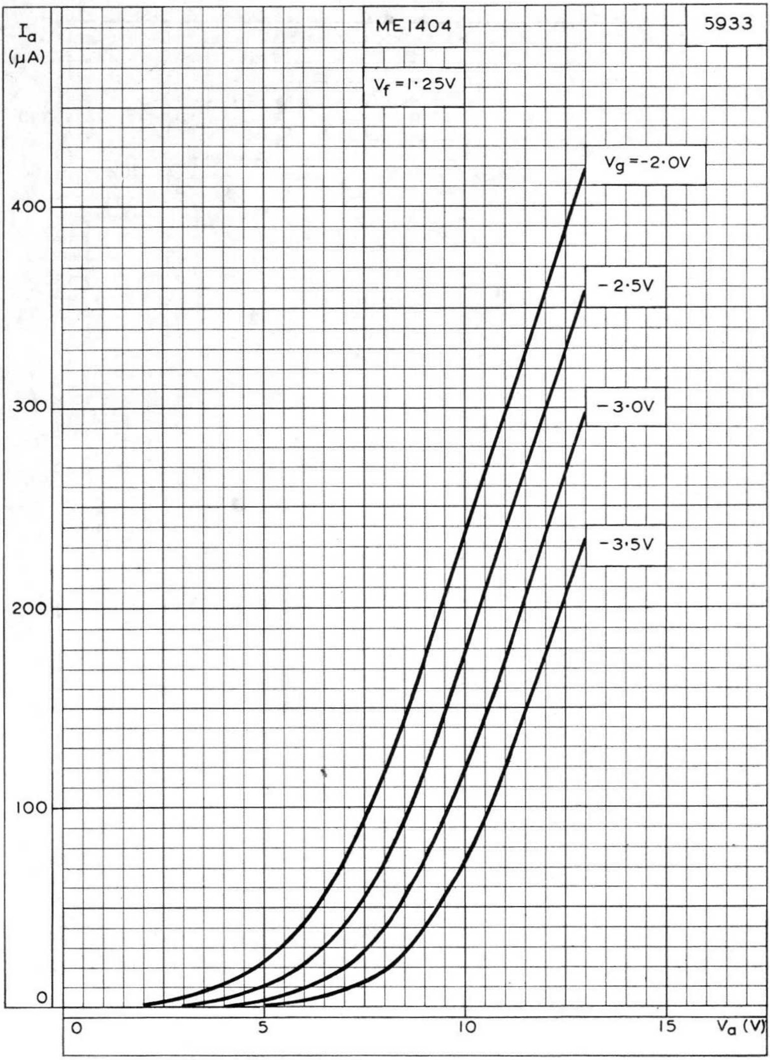




ANODE AND GRID CURRENTS PLOTTED AGAINST GRID VOLTAGE

ME1404

SUBMINIATURE ELECTROMETER TRIODE



ANODE CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH GRID VOLTAGE AS PARAMETER

SUBMINIATURE ELECTROMETER PENTODE

ME1406

Low cost subminiature electrometer pentode with a grid current of 3×10^{-14}A←

FILAMENT

Suitable for d.c. operation only

V_f	1.25	V
I_f	8.2	mA

MOUNTING POSITION

Any

CAPACITANCES

c_{a-g1}	0.2	pF
c_{in}	3.0	pF
c_{out}	4.0	pF

CHARACTERISTICS (measured at V_f=1.25V, V_a=10V, I_a=5.0μA, V_{g1}=-2.5V)

All voltages are measured with respect to the negative end of the filament

	Min.	Av.	Max.	
V_{g2}	5.0	6.5	7.5	V
g_m	8.0	10.5	15	μA/V
r_a	-	10.5	-	MΩ
μ_{g1-a}	80	110	-	
*I_{g1}	-	-3×10^{-14}	-5×10^{-14}	A←
I_{g2}	1.5	2.2	3.0	μA
**$V_{g1(crossover)}$	-	-1.0	-	V←

*The quoted grid current characteristics will only be obtained if the tube is operated in complete darkness.

**'Crossover' is the point at which the polarity of the grid current is reversed (measured at V_f=1.25V, V_a=10V, V_{g2}=the value which gives I_a=5μA when V_{g1}=-2.5V).

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

V_a max.	45	V
V_{g2} max.	45	V
I_k max.	180	μA
V_f max.	1.5	V
V_f min.	1.1	V

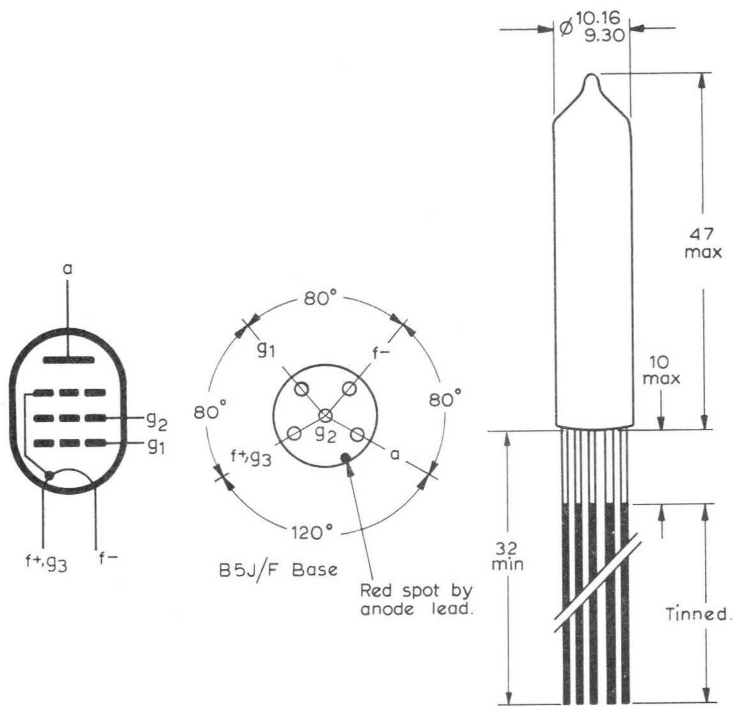
OPERATING NOTES

1. In order to avoid excessive drift of characteristics the filament voltage must be applied before the anode voltage.

2. To avoid contamination of the glass, the valve should not be removed from its protective envelope until it is fitted into the equipment.

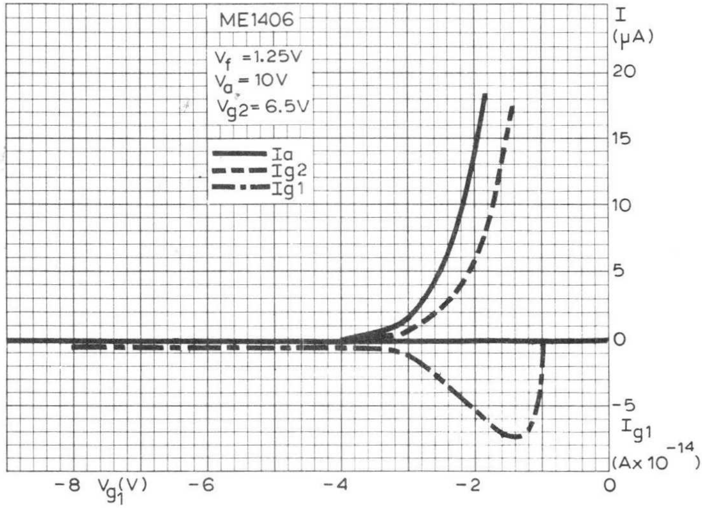
3. Direct soldered connections to the leads of the valve must be at least 13mm from the seals and any bending of the leads must be at least 1.5mm from the seals.

Outline drawing
ME1406



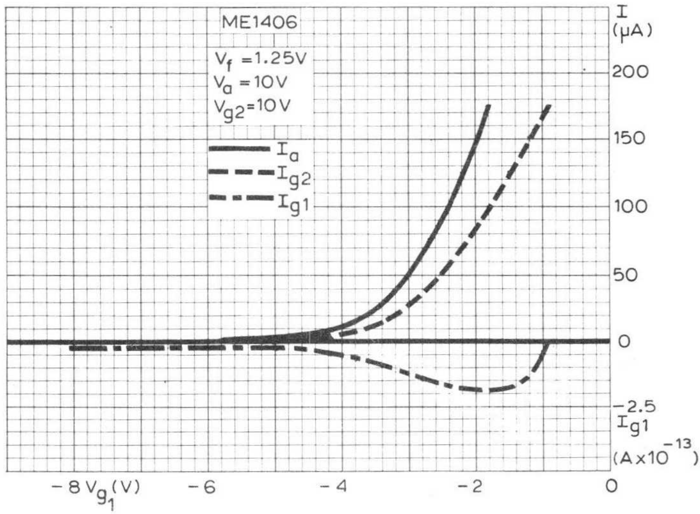
All dimensions in mm

←

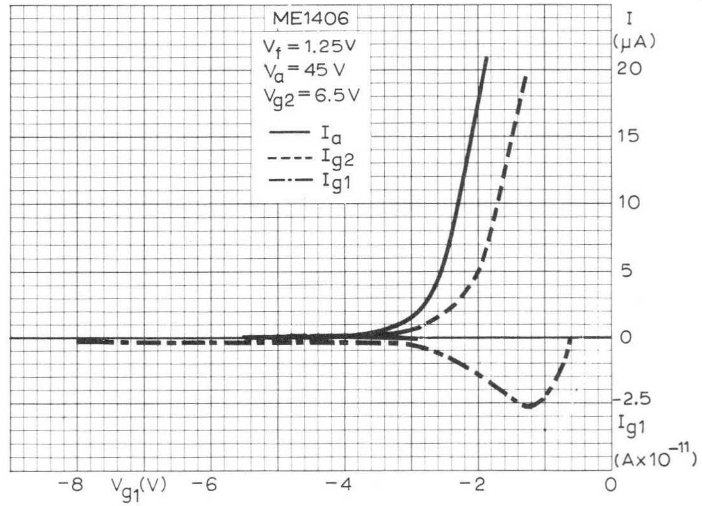


ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. V_a = 10V, V_{g2} = 6.5V

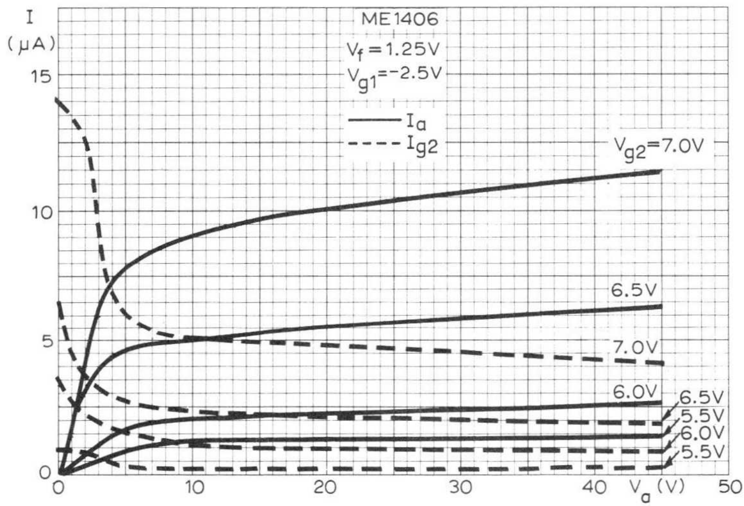
←



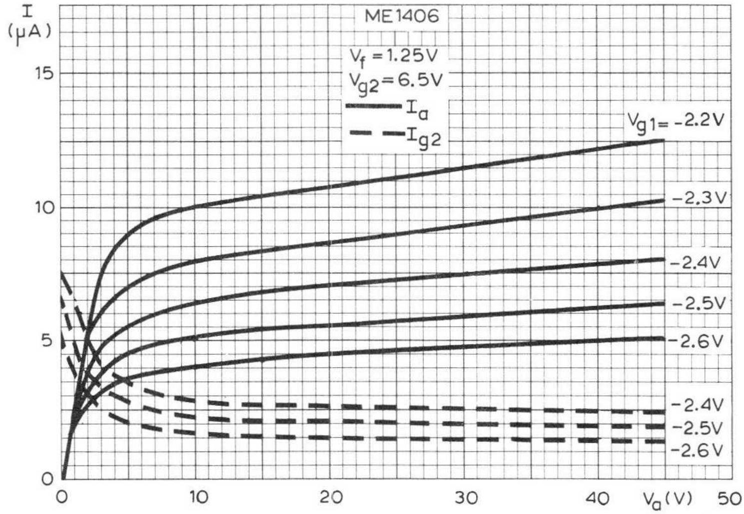
ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. V_a = 10V, V_{g2} = 10V



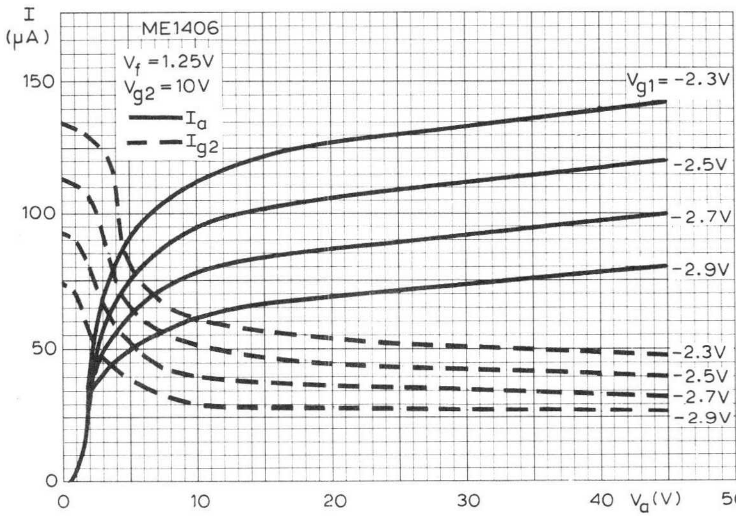
ANODE, SCREEN-GRID AND CONTROL-GRID CURRENTS PLOTTED AGAINST CONTROL-GRID VOLTAGE. $V_a = 45V$, $V_{g2} = 6.5V$



ANODE AND SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH SCREEN-GRID VOLTAGE AS PARAMETER



ANODE AND SCREEN-GRID CURRENT PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 6.5V



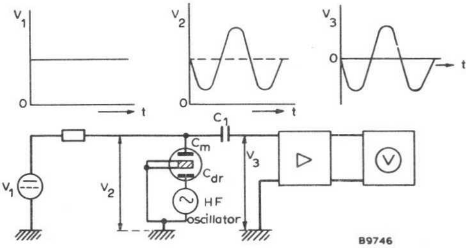
ANODE AND SCREEN-GRID CURRENTS PLOTTED AGAINST ANODE VOLTAGE WITH CONTROL-GRID VOLTAGE AS PARAMETER. V_{g2} = 10V.

VIBRATING CAPACITOR

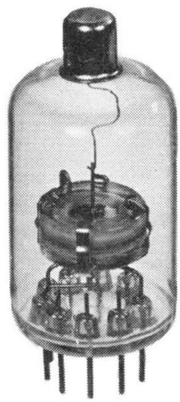
XL7900

QUICK REFERENCE DATA		
Vibrating membrane capacitor in an evacuated envelope for use as a d.c./a.c. converter, for example in dosimeters, pH meters and electrometer equipment, where a very high input resistance is of paramount importance. Equipment capable of measuring currents as low as 500 electrons per second (8×10^{-17}A) has been constructed, using this device.		
Contact potential	-50 to +50	mV
Short term drift of contact potential	100	μV
Minimum insulation resistance	10^{15}	Ω
Maximum overall length	64.7	mm
Maximum diameter	30.2	mm

PRINCIPLE OF OPERATION (D.C. measurement)



The direct voltage to be measured is connected to capacitor C_m (measuring capacitor). The earthed membrane vibrates at its own resonance frequency (about 6kHz), due to a high frequency electric field between the electrodes of capacitor Cdr (driving capacitor). Thus the direct voltage on C_m is modulated at the resonance frequency of the membrane. Capacitor C_1 blocks the direct voltage from the a.c. amplifier. The output alternating voltage is proportional to the input direct voltage.



CHARACTERISTICS

Contact potential over measuring capacitor	-50 to +50	mV
Short term drift (within one day)	100	μV
Long term drift (within one month)	1.0	mV
Temperature coefficient	20	μV/degC

Conversion efficiency

At any given driving voltage the ratio $\frac{\text{R.M.S. output voltage}}{\text{D.C. input voltage}}$ will show a maximum spread of ±60%.

Driving voltage

A value of high frequency driving voltage can always be found at which all capacitors have a conversion efficiency between 10 and 40% (see note 1).

Minimum insulation resistance between any two capacitor terminals (see note 2)	10^{15}	Ω
Resonance frequency of the membrane	5.3 to 6.3	kHz
Drift	1.5	%
Temperature coefficient	±1.0	Hz/degC
Capacitances of measuring and driving capacitors	35	pF
Temperature drift	1.0	pF

RATINGS (ABSOLUTE MAXIMUM SYSTEM)

Maximum direct voltage on measuring capacitor	25	V
Maximum conversion efficiency	40	%

(Above 40% it is possible that the two capacitor plates will touch each other and will be damaged.)

SHOCK AND VIBRATION RESISTANCE

The following tests are applied to assess the mechanical quality of the tube. These conditions are not intended to be used as normal operating conditions.

Shock

The tube is subjected five times in each of four positions to an acceleration of 500g supplied by an NRL shock machine with the hammer lifted over an angle of 30°.

Vibration

The tube is subjected to a vibration of 15 to 1500Hz with an acceleration of 2.5g.

MOUNTING POSITION — Any

NOTES

1. For instance, in apparatus constructed from the circuit shown in Fig. 2, it was found that all capacitors have a conversion efficiency between 10 and 40% with a voltage across L_1 of 1V r.m.s.

NOTES (contd.)

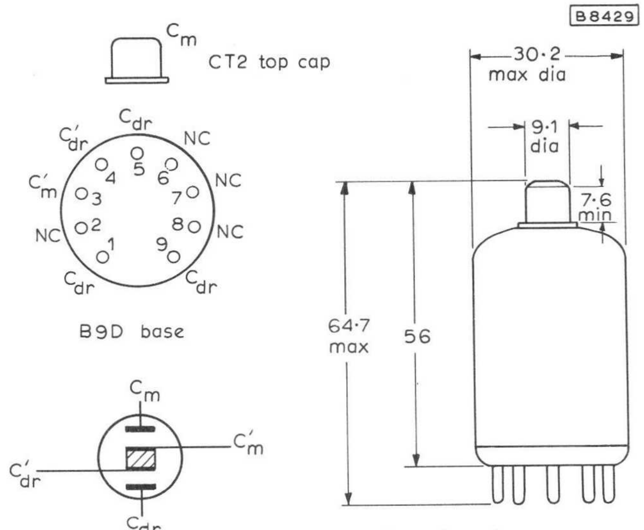
2. Under standard atmospheric conditions as defined in I.E.C. publication 68-1, i.e. any combination of temperature, humidity and pressure within the following limits:

Temperature	+15 to +35	^{o}C
Relative humidity	45 to 75	%
Pressure	860 to 1060	mbar

3. The capacitive drive opens the possibility to use as driving signal for the membrane a high frequency signal, amplitude modulated with the resonance frequency of the vibrating membrane.

   Since in this case there is a great difference between the frequency of the driving signal and the modulation frequency of the voltage to be measured, the stray influences of the driving signal can easily be kept away from the measuring amplifier. In addition, a high frequency drive simplifies the design and construction of the driving oscillator.

OUTLINE DRAWING



All dimensions in mm

EXAMPLE OF A DRIVING OSCILLATOR

Operating principle

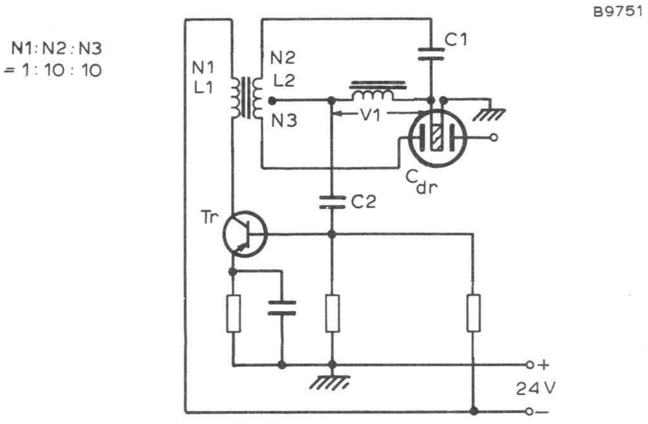


Fig. 1

The driving capacitor C_{dr} is incorporated in an impedance bridge that determines the feedback to the amplifier transistor. Capacitor C_1 has been given a slightly larger value than that of capacitor C_{dr} in its quiescent state. Due to this, the fed-back alternating voltage V_1 has the correct phase and amplitude to cause the circuit to oscillate at a frequency that is mainly determined by the network $L_2C_1C_{dr}$.

The electric attractive force between the capacitor plates of C_{dr} makes the membrane move towards the fixed plate of C_{dr}, as a result of which its capacitance increases, the transistor receives less feedback, and the oscillator voltage decreases.

The phases and amplitudes of the electrical and mechanical forces on the membrane, and of the feedback factor, are such that the membrane begins to vibrate at its resonance frequency and the h.f. voltage is amplitude modulated with this frequency.

Since it is very difficult to construct this circuit in such a way that stable operation is ensured, it is advisable to add components for automatic control of C_1, as in the following circuit.

Practical circuit

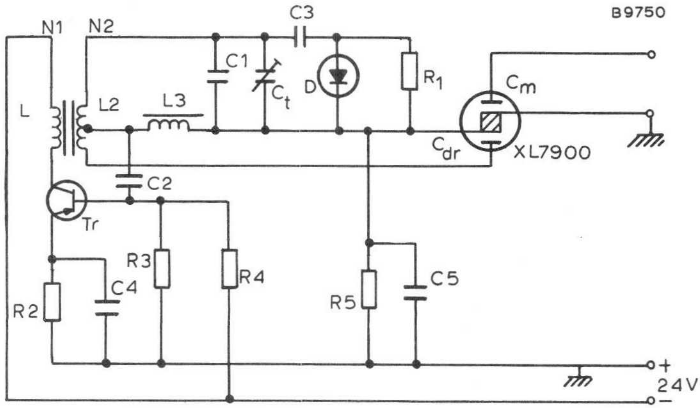


Fig. 2

C_1 = 12pF mica	R_1 = 68kΩ	L_2 = 1.3mH
C_2 = 1.5nF	R_2 = 3.3kΩ	L_3 = 1.3mH R.F. choke
C_3 = 10pF mica	R_3 = 4.7kΩ	N_2/N_1 = 20
C_4 = 2.2nF	R_4 = 1kΩ	T_r = BCY70
C_5 = 0.1μF	R_5 = 1MΩ	D = BA102 (variable capacitance diode)
C_t = 25pF max.		