

RECEIVING VALVE

6BW6, 9BW6

APPLICATION REPORT VAD/507.8

The authors thank the following people for their contributions to this description: *David Pratt* (British Columbia), *William*

Standard Telephones and Cables Limited

FOOTSCRAY, KENT, ENGLAND

INTRODUCTION: The Brimar type 6BW6 is an indirectly heated beam tetrode. The heater is intended for operation in parallel with other valves in AC operated equipment. The 9BW6 is identical except that the heater is designed for use in series connected heater chains. The valve is designed for use as an output stage in receivers or in small public address amplifiers, either singly or in push-pull, and has the same characteristics and ratings as the 6V6GT.

HEATER DATA: The valve consists of a beam tetrode unit capable of an output of the order of 5 watts. The unit is mounted in a standard T6½ bulb and is based with a B9A (Noval) base.

This report contains characteristics of the valve and details of its use as a triode or a tetrode in push-pull and in single ended amplifiers.

CHARACTERISTICS:

Cathode:	Indirectly heated	6BW6	9BW6
	Voltage	6.3 volts*	9.0 volts (nominal)
	Current	0.45 ampere (nominal)	0.3 ampere †
	Max. Heater-Cathode potential (DC)	250 volts	250 volts

* The voltage should not vary by more than 5% of the rated value if the valve is used under Class AB2 conditions, or more than 7% if used under Class A or AB1 conditions.

† The current should not vary by more than ±5% of the rated value.

Dimensions:	Max. Overall Length	2-5/8 ins.
	Max. Diameter	7/8 in.
	Max. Seated Height	2-3/8 ins.

Base: B9A (Noval) Nine Pin

Basing Connections:	Pin 1 Internal Connection
	Pin 2 Control Grid g ₁
	Pin 3 Cathode
	Pin 4 Heater
	Pin 5 Heater
	Pin 6 No Connection
	Pin 7 Anode
	Pin 8 Screen g ₂
	Pin 9 Beam Plates

Ratings:

TETRODE CONNECTIONS:

Max. Anode Voltage	350 volts*
Max. Screen Voltage	310 volts*
Max. Anode Dissipation	13.2 watts*
Max. Screen Dissipation	2.2 watts*
Max. Bulb Temperature °C	250*
Max. DC Anode Current	70 mA

TRIODE CONNECTIONS (Pins 7 and 8 strapped)†:

Max. (anode and screen strapped) Voltages	310*
Max. (anode and screen strapped) Dissipation	12.5 watts*
Max. DC Anode Current	75 mA

† In order to avoid parasitic oscillation pins 7 and 8 should be connected together through a 100 ohms resistor or an RF choke of about 20 microhenries.

* These ratings are absolute and must not be exceeded under any circumstances.

Capacities (approx.):*

C_g, a	0.6 pF
C_{in}	8.5 pF
C_{out}	7.5 pF
C_h, k	7.0 pF

* Measured without shield.

Mounting: The valve may be mounted in any position.**Ventilation:** As this valve runs appreciably hot in operation the layout and design of equipment should be such that adequate ventilation is afforded to ensure a safe bulb temperature under all conditions. The bulb temperature of the hottest point on the surface should never exceed 250° C.**CHARACTERISTIC CURVES:** Curves are attached to this report which show:Anode current plotted against anode voltage for various values of grid voltage for the valve tetrode connected with a screen voltage of 250 volts (I_a/V_a) (Curve No. 307-271).Anode current plotted against anode voltage for various values of grid voltage for the valve tetrode connected with a screen voltage of 285 volts (I_a/V_a) (Curve No. 307-272).Anode current plotted against anode voltage for various values of grid voltage for the valve tetrode connected with a screen voltage of 225 volts (I_a/V_a) (Curve No. 307-281).Anode current plotted against anode voltage for various values of grid voltage for the valve connected as a triode (I_a/V_a) (Curve No. 307-273).**TYPICAL OPERATION****Class A Amplifier** (Single Ended):

TRIODE CONNECTION (Pins 7 and 8 strapped):

Heater Voltage	6.3	6.3	volts
Anode Voltage	250	285	volts
Grid Voltage	—13.5	—19	volts
Autobias Resistor (R_k)	300	470	ohms
Anode Impedance (r_a)	2090	2250	ohms
Anode Current (no signal)	45	40	mA
Amplification Factor (μ)	9.2	9.0	
Mutual Conductance	4.4	4.0	mA/V
Anode Load Resistor (R_a)	4000	4500	ohms
Peak AF Grid Voltage	13.5	19	volts
Total Harmonic Distortion	3.5	6.0	%
Power Output	0.75	1.35	watts

Curves are attached to this report which show the relation between power output, harmonic distortion and input signal voltage for autobias conditions at 250 volts HT (Curve No. 307-274) and at 285 volts HT (Curve No. 307-275).

Class A Amplifier (Push-Pull):

TRIODE CONNECTION (Pins 7 and 8 strapped):

Heater Voltage	6.3	6.3	volts
Anode Voltage	250	285	volts
Grid Voltage	—13.5	—19	volts
Autobias Resistor (R_k)	150	240	ohms
Anode Current (no signal)	90	78	mA
Output Load (anode-anode) (R_a, a)	4000	4500	ohms
Peak AF Grid Voltage (grid-grid)	27	38	volts
Total Harmonic Distortion	0.4	0.5	%
Power Output	1.7	3.1	watts

Note.—Values given are for two valves.

Curves are attached to this report which show the relation between power output, harmonic distortion and input signal voltage with autobias. Curve No. 307-276 at 250 volts HT and Curve No. 307-277 at 285 volts HT.

Class A Amplifier (Single Ended):

TETRODE CONNECTION:

Heater Voltage	6.3	6.3	6.3	6.3	6.3	6.3	volts
Anode Voltage	180	180	250	250	315	315	volts
Screen Voltage	180	180	250	250	225	225*	volts
Grid Voltage	-8.5	—	-12.5	—	-13	—	volts
Autobias Resistor	—	250	—	240	—	330	ohms
Anode Current	29	29	45	47	34	34	mA
Screen Current	3.0	3.0	4.5	5.0	2.2	2.2	mA
Anode Impedance (r_a)	58000	—	52000	—	77000	—	ohms
Mutual Conductance	3.7	—	4.1	—	3.75	—	mA/V
Anode Load Resistor	5500	5500	5000	5000	8500	8500	ohms
Peak AF Grid Voltage	8.5	9.0	12.5	13.5	13	13.5	volts
Total Harmonic Distortion	7.0	7.5	7.5	8	10	11.5	%
Power Output	2.0	1.7	4.5	4.5	5.2	5.0	watts

* The screen voltage, where lower than the anode voltage, should be obtained from a potentiometer across the HT line to chassis adequately by-passed to AF signals rather than by means of a series resistor to avoid fluctuation of the screen voltage as the current drives up near maximum output.

Curves are attached to this report which show the relation between power output, harmonic distortion and input signal voltage for autobias conditions at 180 volts (Curve No. 307-278), at 250 volts (Curve No. 307-279) and at 315 volts (Curve No. 307-280). Curves Nos. 307-290 and 307-291 are corresponding curves for fixed bias conditions.

Class A Amplifier (Push-Pull):

TETRODE CONNECTION:

Heater Voltage	6.3	6.3	6.3	volts
Anode Voltage	250	250	315	volts
Screen Voltage	250	250	250	volts
Grid Voltage	-12.5	—	—	volts
Autobias Resistor	—	120	125	ohms
Peak AF Grid-Grid Voltage	25	26	28	volts
No Signal Anode Current	90	94	98	mA
Max. Signal Anode Current	96	98	102	mA
No Signal Screen Current	9	9.5	8.5	mA
Max. Signal Screen Current	13.5	13.5	11.5	mA
Anode Impedance (r_a)	52000	—	—	ohms
Mutual Conductance	4.1	—	—	mA/V
Output Load (anode to anode)	10000	10000	10000	ohms
Total Harmonic Distortion	2	2.5	2.5	%
Power Output	9	9	12.5	watts

Note.—Values given are for two valves.

Curves are attached to this report which show the relation between power output, distortion and input signal for the 250 volt autobias conditions (Curve No. 307-282), for fixed bias (Curve No. 207-283) and for the 315 volt condition with autobias (Curve No. 307-284).

Class AB1 Amplifier (Push-Pull):

TETRODE CONNECTION:

Heater Voltage	6.3	6.3	6.3	6.3	volts
Anode Voltage	250	250	285	285	volts
Screen Voltage	250	250	285	285	volts
Grid Voltage	-15	—	-19	—	volts
Autobias Resistor	—	200	—	260	ohms
Peak AF Grid-Grid Voltage	30	34	38	45	volts
No Signal Anode Current	70	70	70	70	mA
Max. Signal Anode Current	80	74	94	78.5	mA
No Signal Screen Current	5	5	4	4	mA
Max. Signal Screen Current	11.5	11.5	11.5	10	mA
Load Resistance (anode-anode)	10000	10000	8000	8000	ohms
Total Harmonic Distortion	3	3.5	1.8	1	%
Power Output	10	10	13	12	watts

Note.—Values given are for two valves.

Curves are attached to this report which show the relation between power output, distortion and input signal voltage for the 250 volt conditions, Curve No. 307-285 for fixed bias and Curve No. 307-286 for automatic bias. For the 285 volt condition there are Curves No. 307-287 for fixed bias and No. 307-288 for automatic bias.

Class AB2 Amplifier (Push-Pull):

TETRODE CONNECTION:

Heater Voltage	6.3	volts
Anode Voltage	315	volts
Screen Voltage	285	volts
Grid Voltage	-19	volts
Peak AF Grid-Grid Voltage	80	volts
No Signal Anode Current	70	mA
Max. Signal Anode Current	155	mA
No Signal Screen Current	4	mA
Max. Signal Screen Current	16	mA
Peak Grid Input Power	400	Milliwatts
Load Resistor (anode-anode)	5000	ohms
Total Harmonic Distortion	7	%
Power Output	30	watts

Note.—Values given are for two valves.

It is essential for Class AB2 operation that the regulation of the anode, screen and grid bias supplies is such that the voltages remain constant within 5% between no signal and maximum signal conditions. The driver stage should be capable of supplying the grids of the two valves with the specified peak voltages with low distortion. The effective resistance per grid circuit represented by the driver valve and/or transformer should not exceed 500 ohms and the effective impedance represented by leakage inductance or equivalent at the highest desired response frequency should not exceed 700 ohms.

A curve (No. 307-289) is attached to this report which shows the relation between power output, distortion and input signal voltage for the above conditions.

GENERAL RECOMMENDATIONS:

Audio Frequencies: Due to the relatively high slope of this valve, trouble may be experienced due to parasitic oscillation, and it is advised that a resistor of 100 ohms is wired in series with the anode, directly connected to the valve holder contact.

This resistor should be reduced to 47 ohms in the case of Class AB2 operation.

A series grid resistor may also be employed, if necessary, wired directly to the valve holder grid contact, but the value must be carefully chosen bearing the frequency response in mind. Such a resistor should never exceed 100,000 ohms for Class A operation, and should not be employed for Class AB2 operation.

The type of input coupling used should not introduce too much resistance into the grid circuit. It is preferable that such resistance does not exceed 100,000 ohms except in the case of Class A operation under automatic bias conditions where the value may be as high as 500,000 ohms.

Radio Frequencies: Whilst these valves are not primarily intended for operation as an oscillator or as a frequency multiplier they may be used for such purpose up to a maximum frequency of 160 Mc/s.

The ratings given on page 2 must under no circumstances be exceeded nor may the DC grid current at any time exceed 3 mA.

It is preferable that the screen supply voltage should not be obtained via a series dropping resistor, and the DC bias should be obtained from a fixed bias or from a combination of grid leak bias and a cathode automatic bias resistor.

The bias required as a Class C frequency multiplier is of the order of —80 volts and the output with normal circuit practice is adequate at second or third harmonic to drive an RF amplifier employing valves such as the 807 (5B/250A) or 5763.

When these valves are used as crystal oscillators in a Tri-tet circuit care should be exercised to ensure a safe crystal current if the screen voltage is 180 volts or higher.

If this valve is used as a Class "B" or Class "C" RF amplifier neutralisation will normally be necessary at the higher frequencies. Power amplifier operation is not recommended above 100 Mc/s due to the relatively high input drive required. At this and higher frequencies it is more economical to use the valve as a frequency multiplier.

Keying should not be achieved by disconnection of the cathode unless a resistor of not more than 100,000 ohms is permanently connected between cathode and chassis earth.

Under no circumstances should the anode tank circuit of a Class "B" or "C" amplifier be tuned through resonance with the aerial or succeeding valve load disconnected. Such procedure causes a violent drop in the anode current and a corresponding increase in screen current which may damage the screen, together with a very high voltage between anode and other electrodes which is liable to break down the insulation of the button base.

TYPICAL OPERATION

RF Doubler. Continuous ratings as a doubler without modulation:

DC Anode Voltage	250	300	volts
DC Screen Voltage	250	250	volts
DC Screen Series Resistor	—	9100	ohms
DC Grid Voltage	—60	—70	volts
DC Grid Resistor	18000	21000	ohms
DC Cathode Resistor	100	100	ohms
Peak RF Grid Voltage	100	100	volts
DC Anode Current	52	46	mA
DC Screen Current	5.0	5.5	mA
DC Grid Current (approximately)	3.0	3.0	mA
Driving Power (approximately)	0.3	0.3	watt
Power Output	5.0	5.5	watts*

* Measured with typical tank coil doubling from 7—14 Mc/s.

RF Trebler. Continuous ratings as a trebler without modulation:

DC Anode Voltage	300	volts
DC Screen Voltage	250	volts
DC Screen Series Resistor	12500	ohms
DC Grid Voltage	—94	volts
DC Cathode Resistor	500	ohms
DC Grid Resistor	23000	ohms
Peak RF Grid Voltage	150	volts
DC Anode Current	46	mA
DC Screen Current	4	mA
DC Grid Current (approximately)	3	mA
Driving Power (approximately)	0.45	watt
Power Output	2.5	watts*

* Measured with typical tank coil trebling from 7—21 Mc/s.

Frame Time Base: A circuit showing the valve used for television frame time base output is given on VAD/307.55. The valve is triode connected, as this enables adequate linearity to be obtained without great difficulty. Tetrode connection has the advantage of greater sensitivity and power output, but much of this has to be sacrificed in the negative feed back necessary to linearise the trace.

The HT current consumption is between 25 and 30 mA when the time base is operated from a 250 volt HT rail. The output is adequate for cathode ray tubes with scanning angles up to 55°. For wide angle deflections of 65° or more the circuit may be operated from an HT rail of 300 volts; the bias resistor R11 should then be increased to 1000 ohms. Suitable wide angle scanning components and output transformer must be used.

In the circuit shown certain of the component values may require modification to suit individual applications.

R3, the charging resistor to the blocking oscillator, affects the output, a lower value giving greater output but poorer linearity.

R7 affects mainly the bottom of the picture, a lower value stretching out this region.

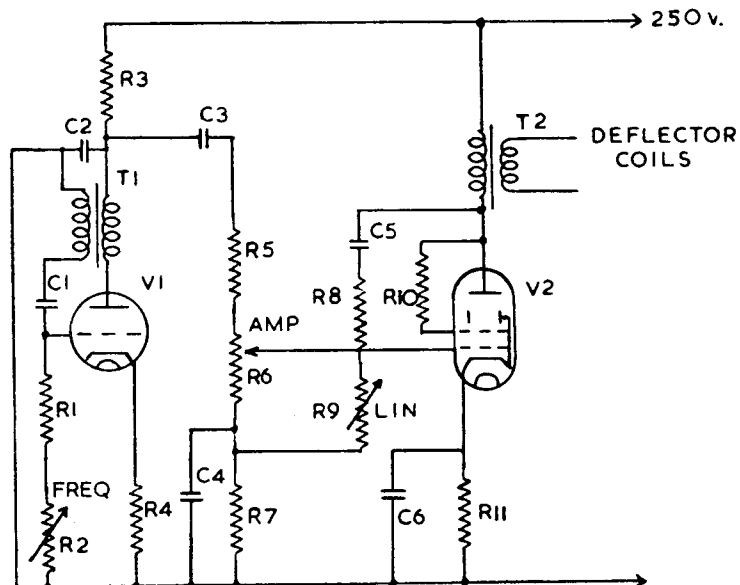
R11 should deliver the correct bias so that the 6BW6 operates in the centre of the linear part of its characteristic. Too high a bias causes compression of the end of the scan, too low a bias compression of the commencement as the valve draws grid current on the positive peaks.

R9, the linearity control closes the top of the picture as it is reduced in value.

C4 influences the feedback circuit, stretching the top of the picture as it is increased.

C5 affects both top and bottom of the picture, too high a value causing stretching of the top and cramping of the bottom.

Synchronising pulses may be fed either to the grid or to the anode of the blocking oscillator, depending whether their polarity is positive or negative.

BRIMAR 6BW6**FRAME TIME BASE**

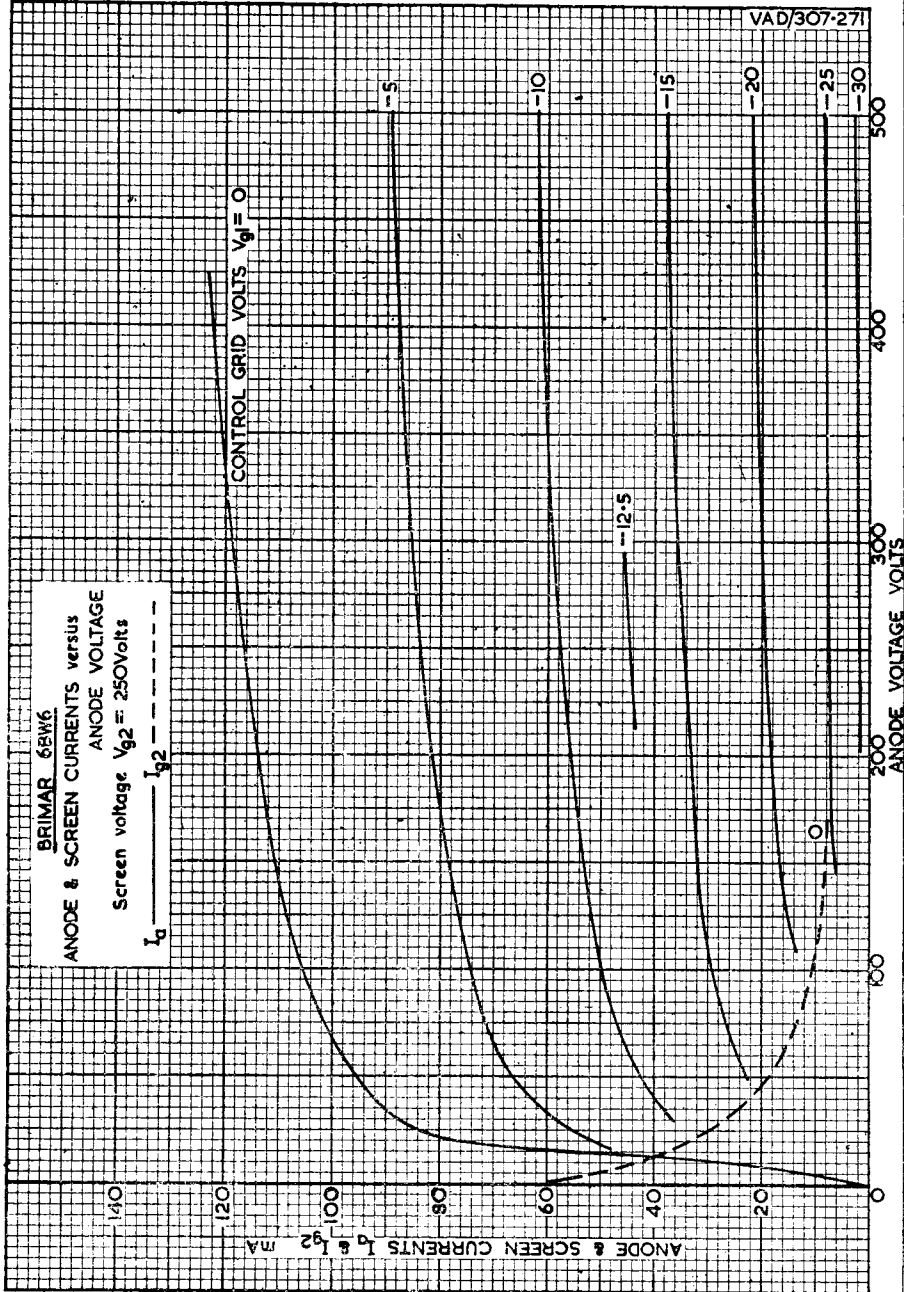
R ₁	47 k	C ₁	0.5
R ₂	100 k var.	C ₂	0.1
R ₃	470 k	C ₃	0.1
R ₄	220	C ₄	0.005
R ₅	330 k	C ₅	0.01
R ₆	1 M pot.	C ₆	30 Electrolytic
R ₇	470 k	T ₁	Frame Blocking Oscillator Transformer. Plessey CP92553
R ₉	250 k var.	T ₂	Frame Output Transformer. Plessey CP71956/1
R ₁₀	100		Deflector Coils, Plessey CP72419
R ₁₁	680		
V ₁	6C4 or 1/2 12AU7	V ₂	6BW6

BRIMAR 6BW6
 ANODE & SCREEN CURRENTS versus
 ANODE VOLTAGE
 Screen voltage $V_{g2} = 250\text{Volts}$
 I_a ——— I_{g2} - - - -

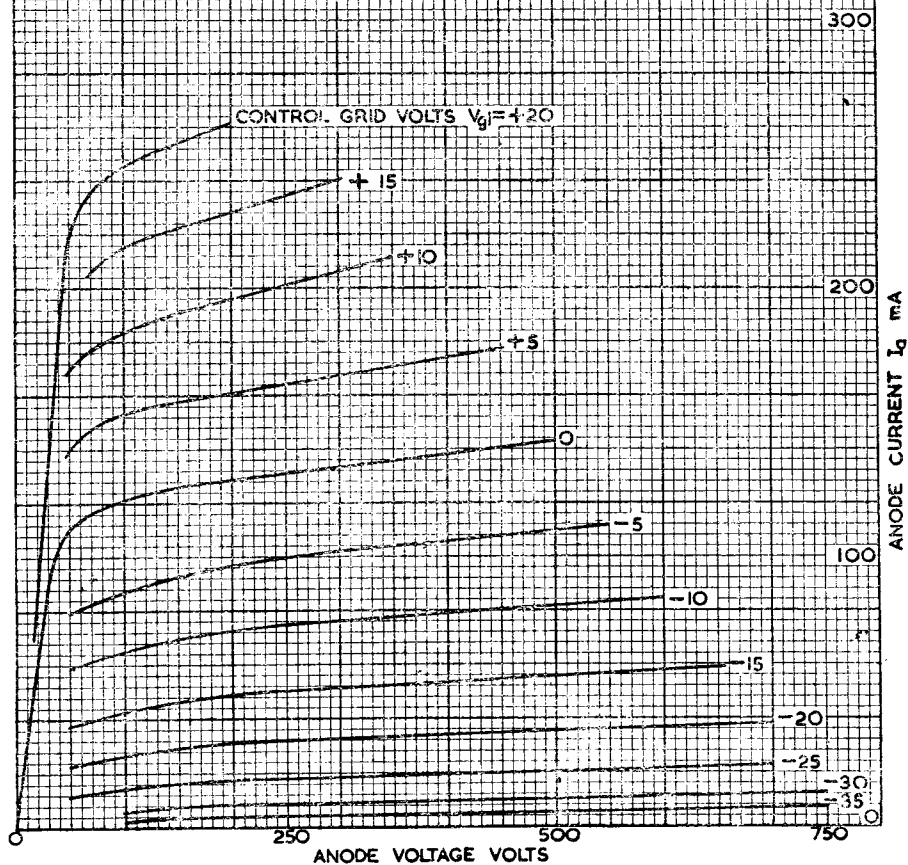
CONTROL GRID VOLTS $V_{g1} = 0$

ANODE & SCREEN CURRENTS I_a & I_{g2} mA

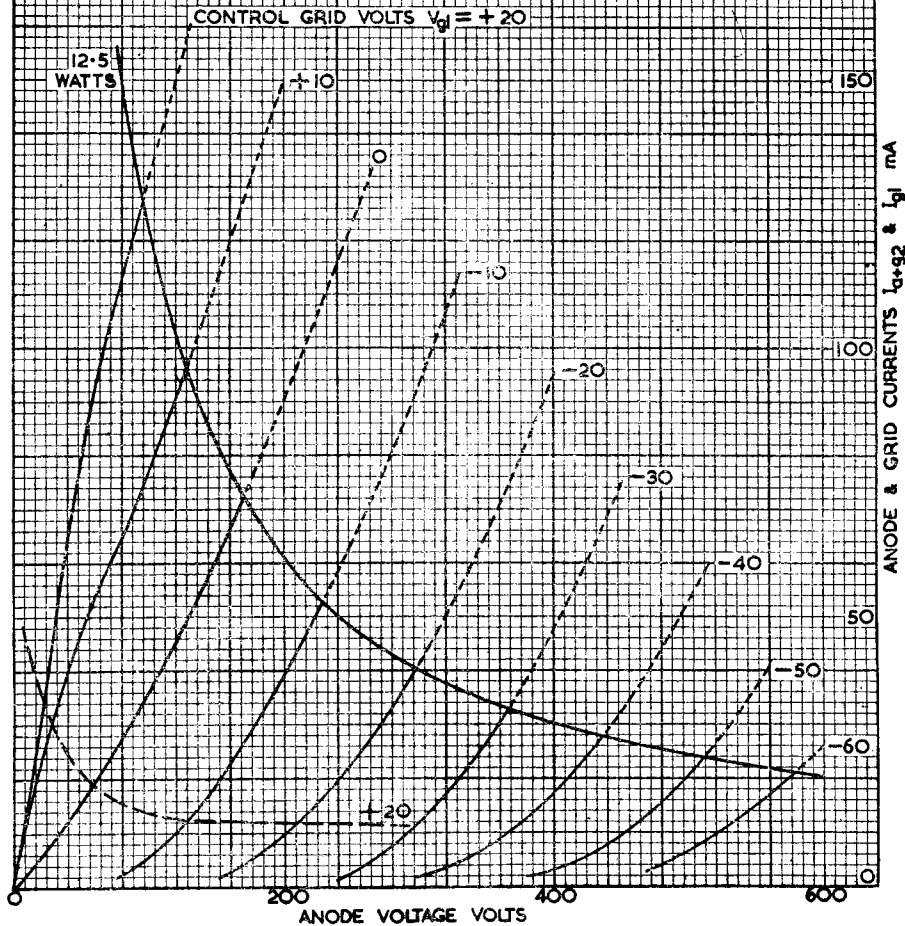
VAD/307-271

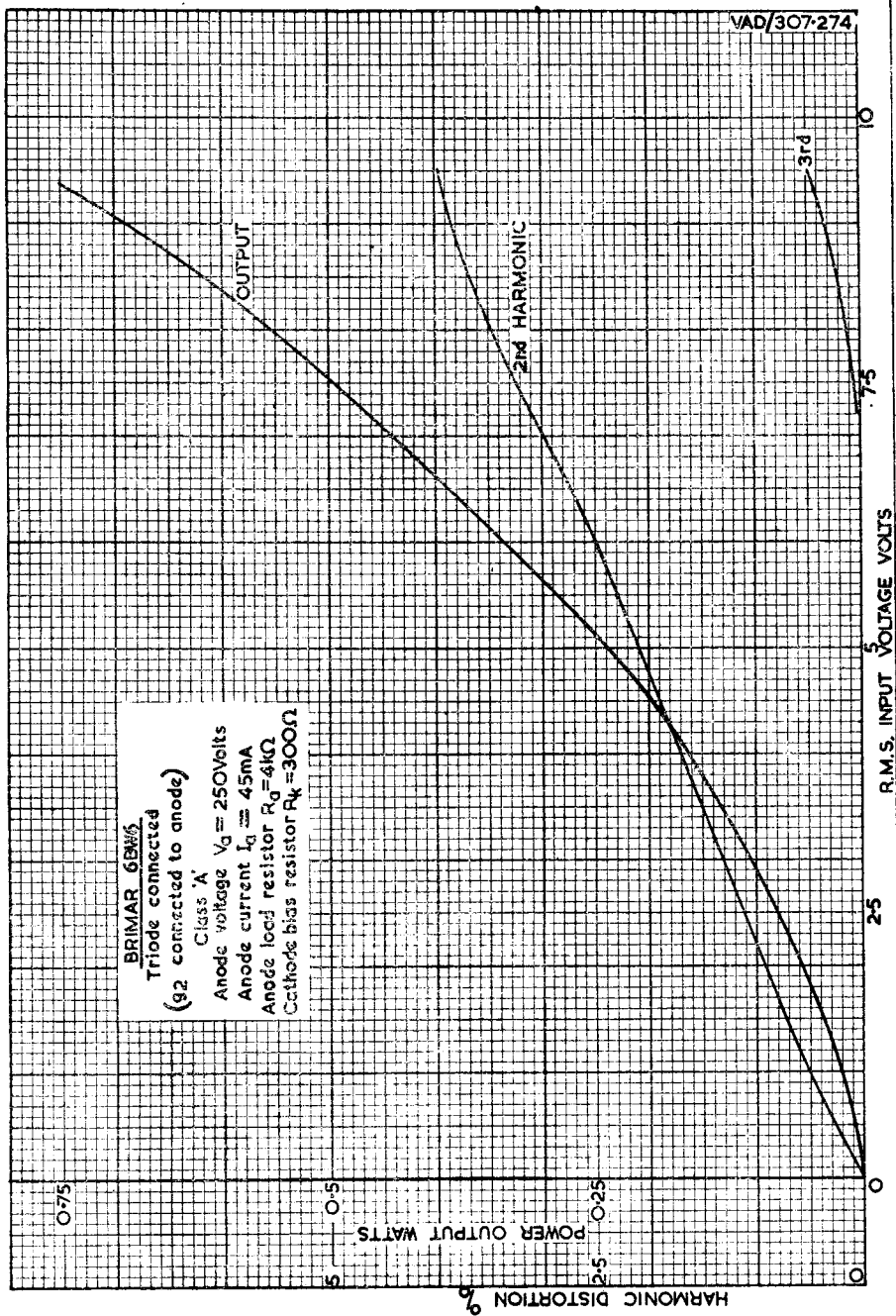


BRIMAR 6BW6
ANODE CURRENT versus ANODE VOLTAGE
Screen voltage $V_{g2} = 285\text{Volts}$

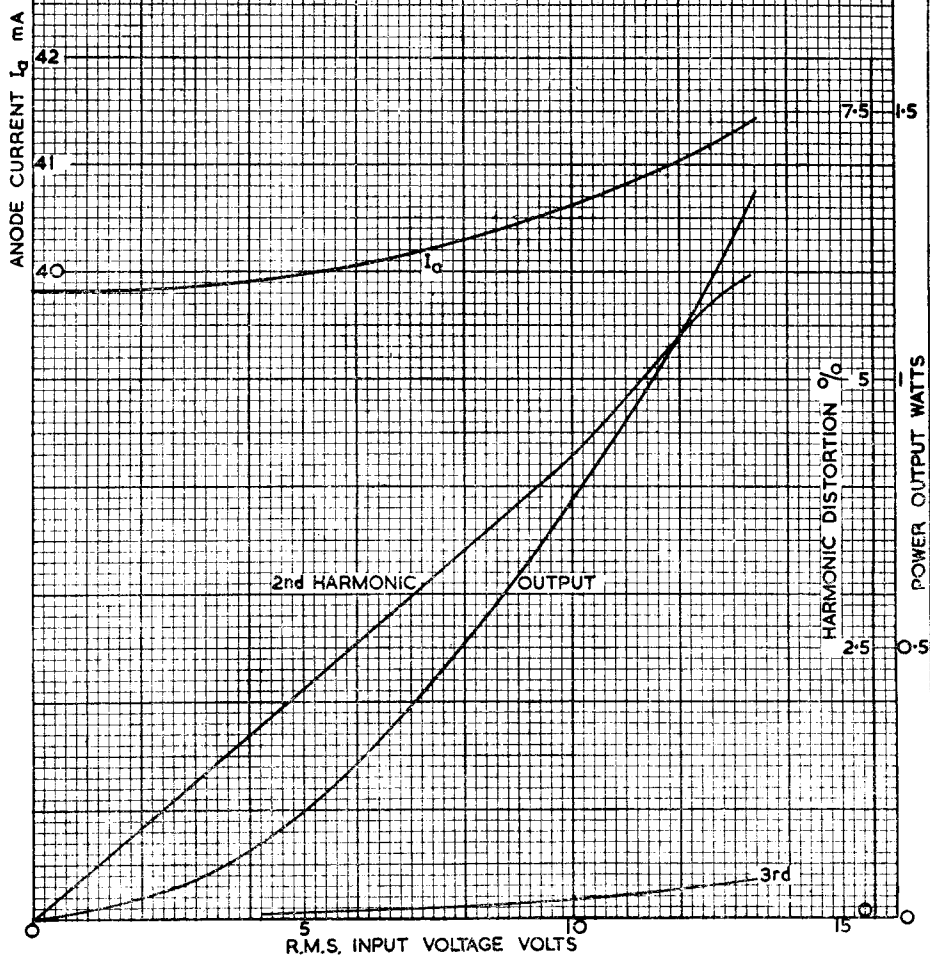


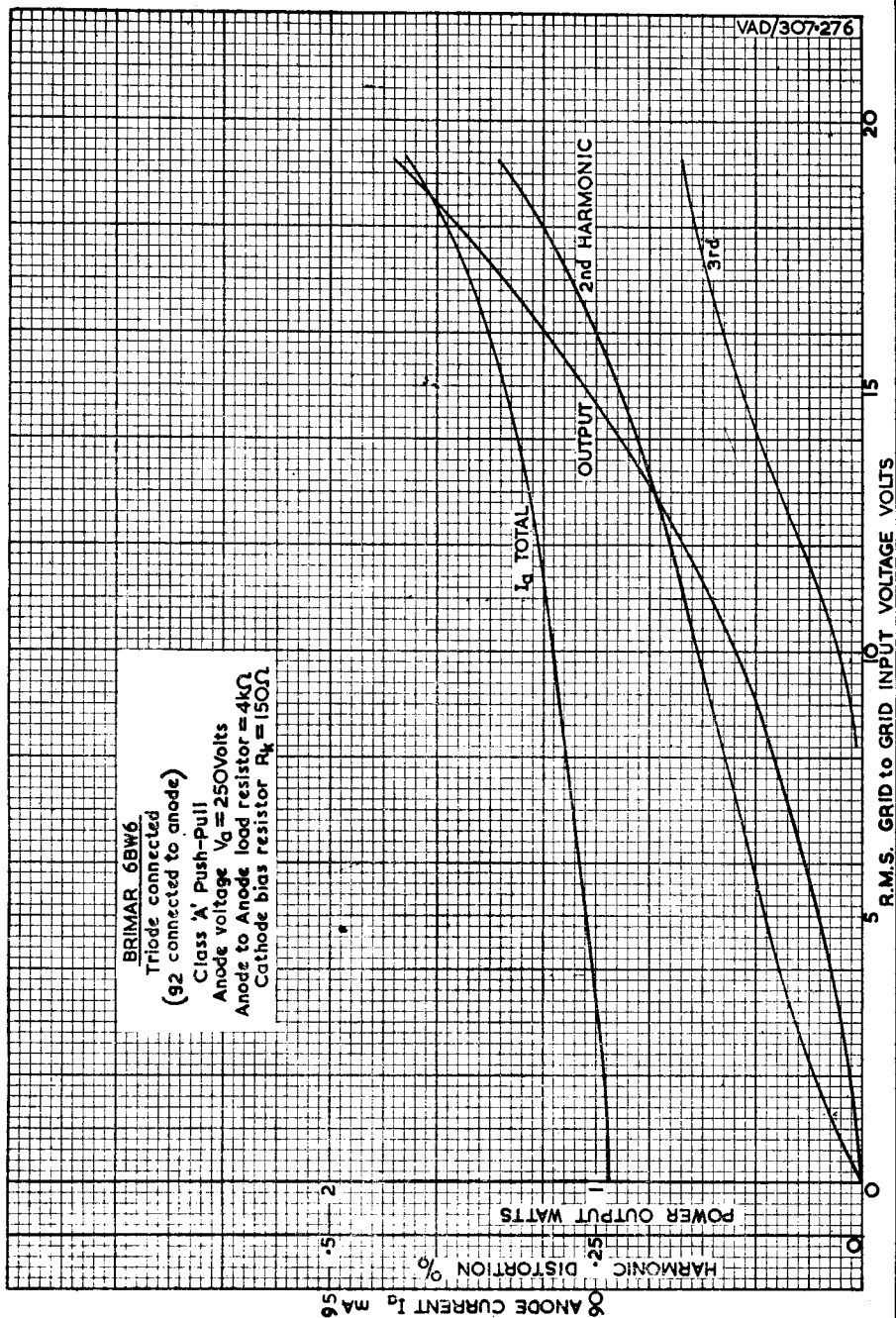
BRIMAR 6BW6
ANODE & GRID CURRENTS versus
ANODE VOLTAGE
Triode connected
(g2 connected to anode)
 I_{a+g2} ————— I_{g1} - - - - -





BRIMAR 6BW6
Triode connected
(g2 connected to anode)
Class 'A'
Anode voltage $V_a = 285$ Volts
Anode load resistor = $4.5k\Omega$
Cathode bias resistor = 470Ω





BRIMAR 6BW6
 Triode connected
 (g2 connected to anode)
 Class 'A' Push-Pull
 Anode voltage $V_a = 285$ Volts
 Anode to Anode load resistor $= 4.5k\Omega$
 Cathode bias resistor $R_k = 240\Omega$

ANODE CURRENT I_a mA

POWER OUTPUT WATTS

HARMONIC DISTORTION %

85

80

75

4

3

0.5

0.25

0

2nd HARMONIC

OUTPUT

3rd

I_a TOTAL

R.M.S. GRID to GRID INPUT VOLTAGE VOLTS

10

20

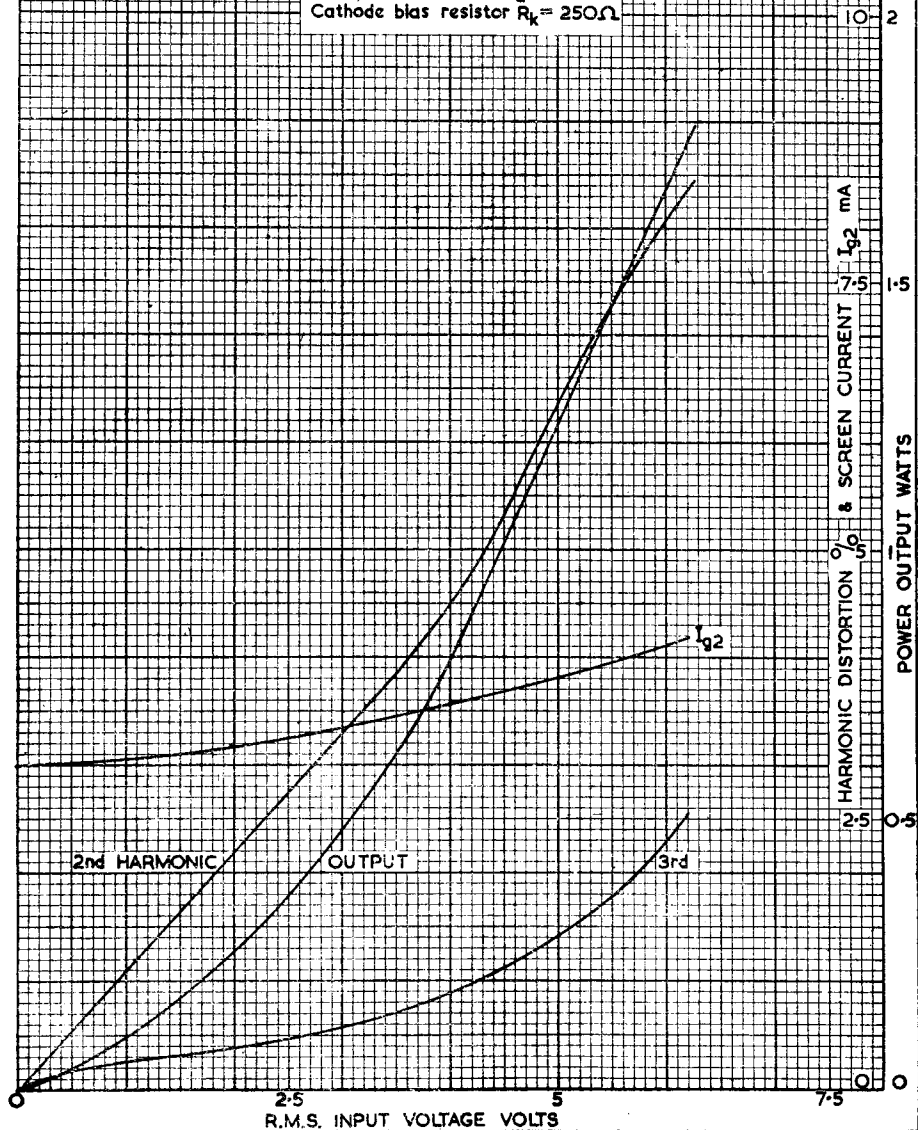
30

0

0

BRIMAR 6BW6

Class 'A'

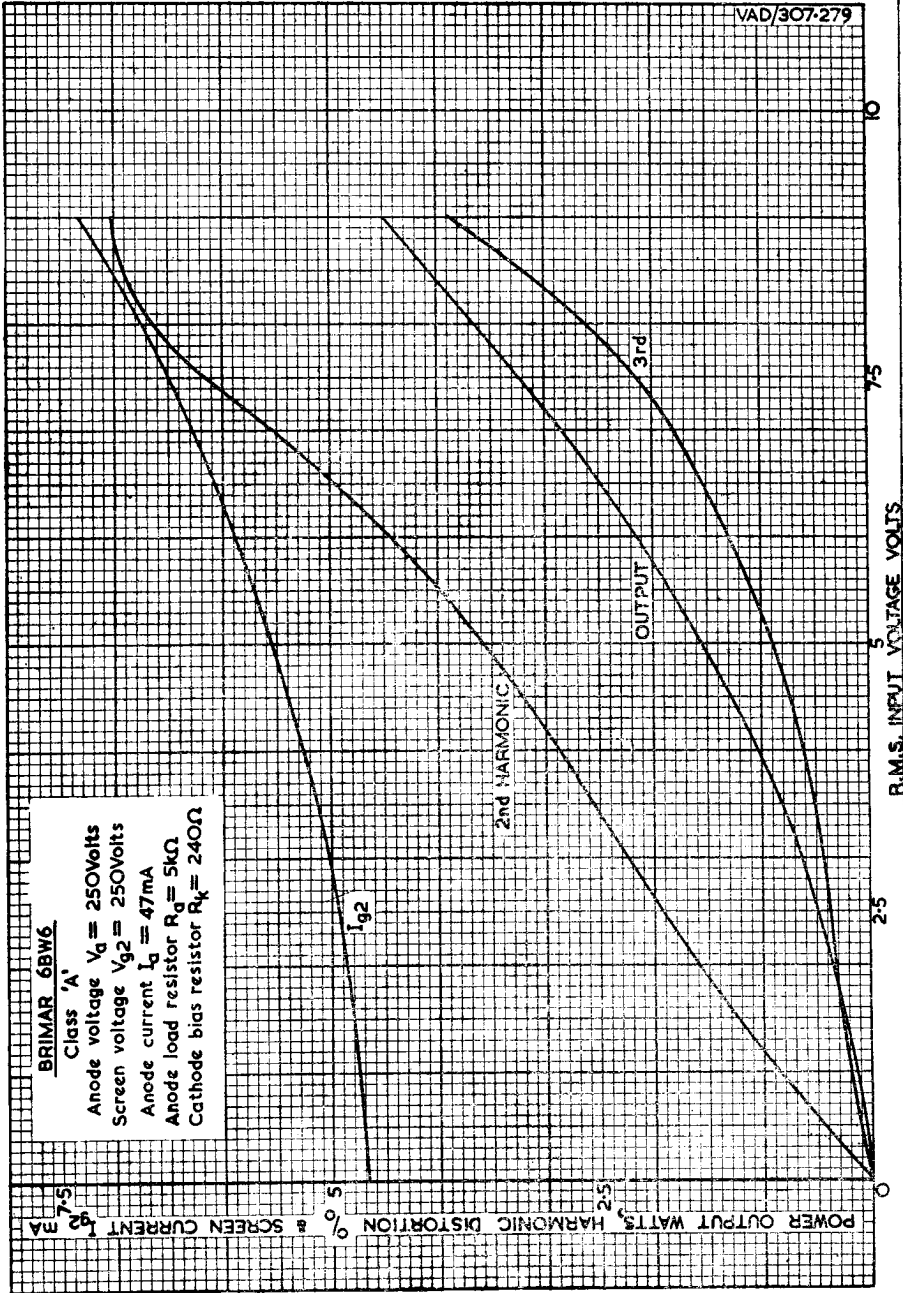
Anode voltage $V_a = 180$ VoltsScreen voltage $V_{g2} = 180$ VoltsAnode current $I_a = 29$ mAAnode load resistor $R_a = 5.5 k\Omega$ Cathode bias resistor $R_k = 250 \Omega$ 

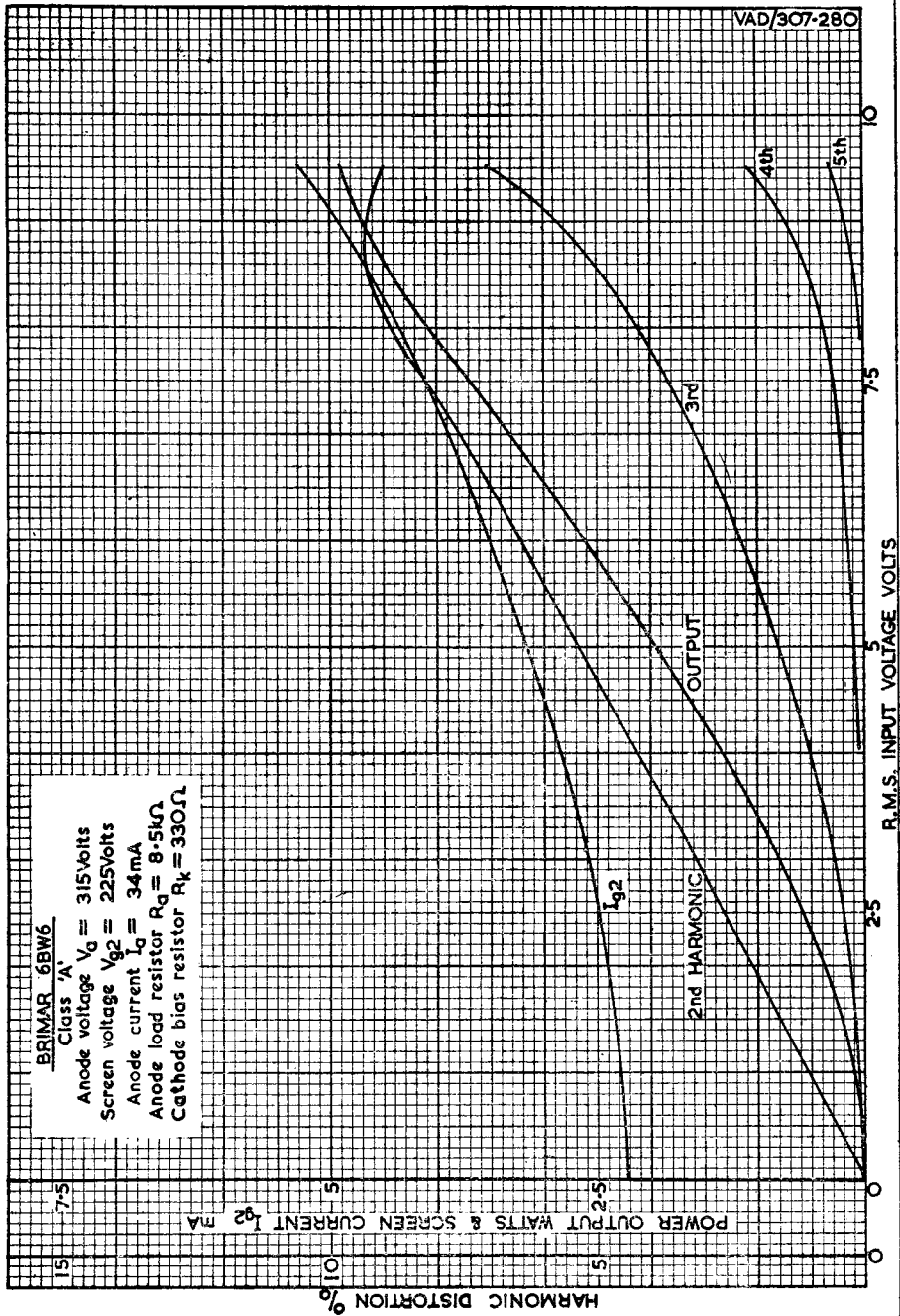
BRIMAR 6BW6

Class 'A'

Anode voltage $V_a = 250$ VoltsScreen voltage $V_{g2} = 250$ VoltsAnode current $I_a = 47$ mAAnode load resistor $R_a = 5k\Omega$ Cathode bias resistor $R_k = 240\Omega$ POWER OUTPUT WATTS, HARMONIC DISTORTION %, SCREEN CURRENT I_{g2} MA

R.M.S. INPUT VOLTAGE VOLTS

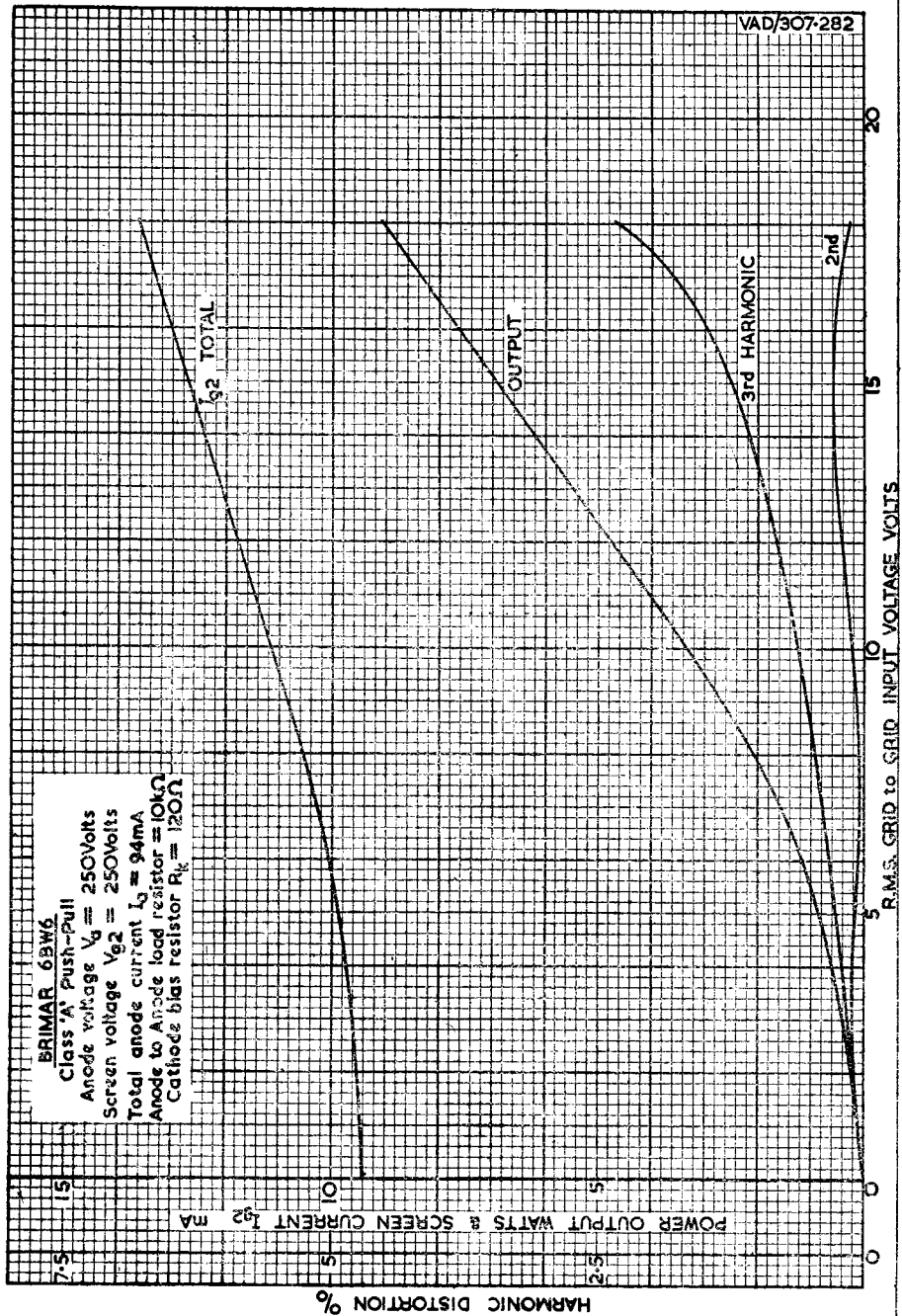


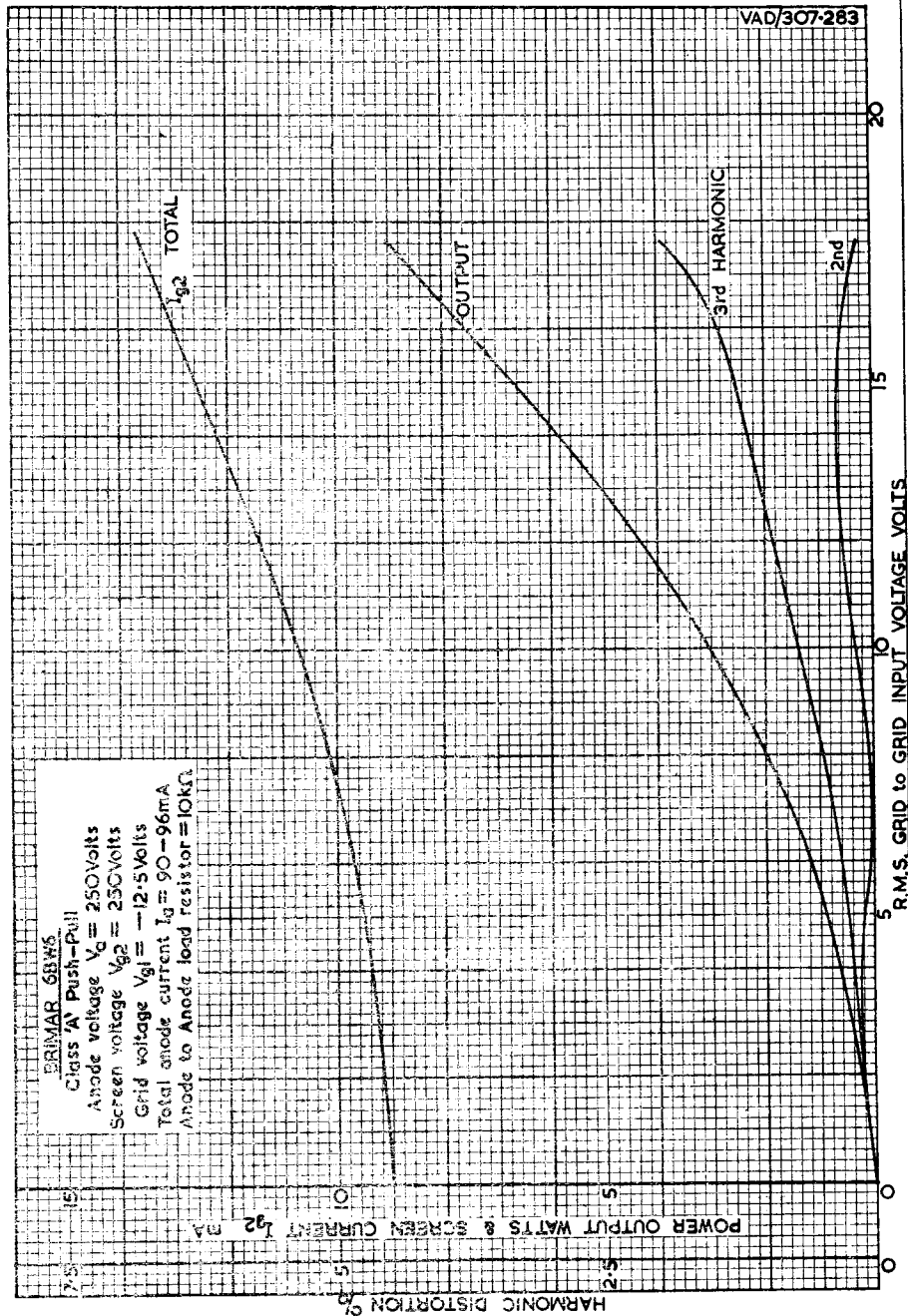


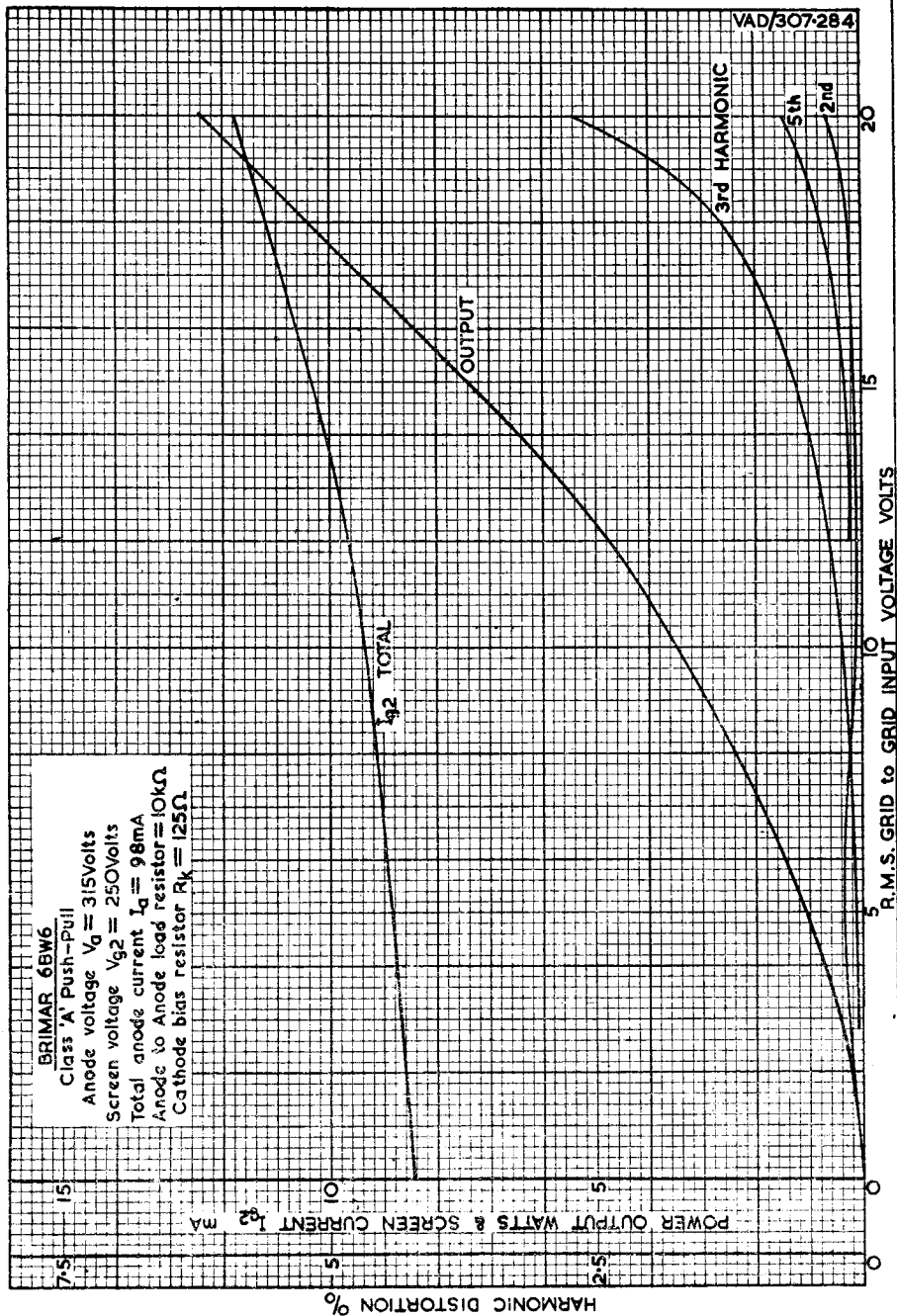
VAD/307-281

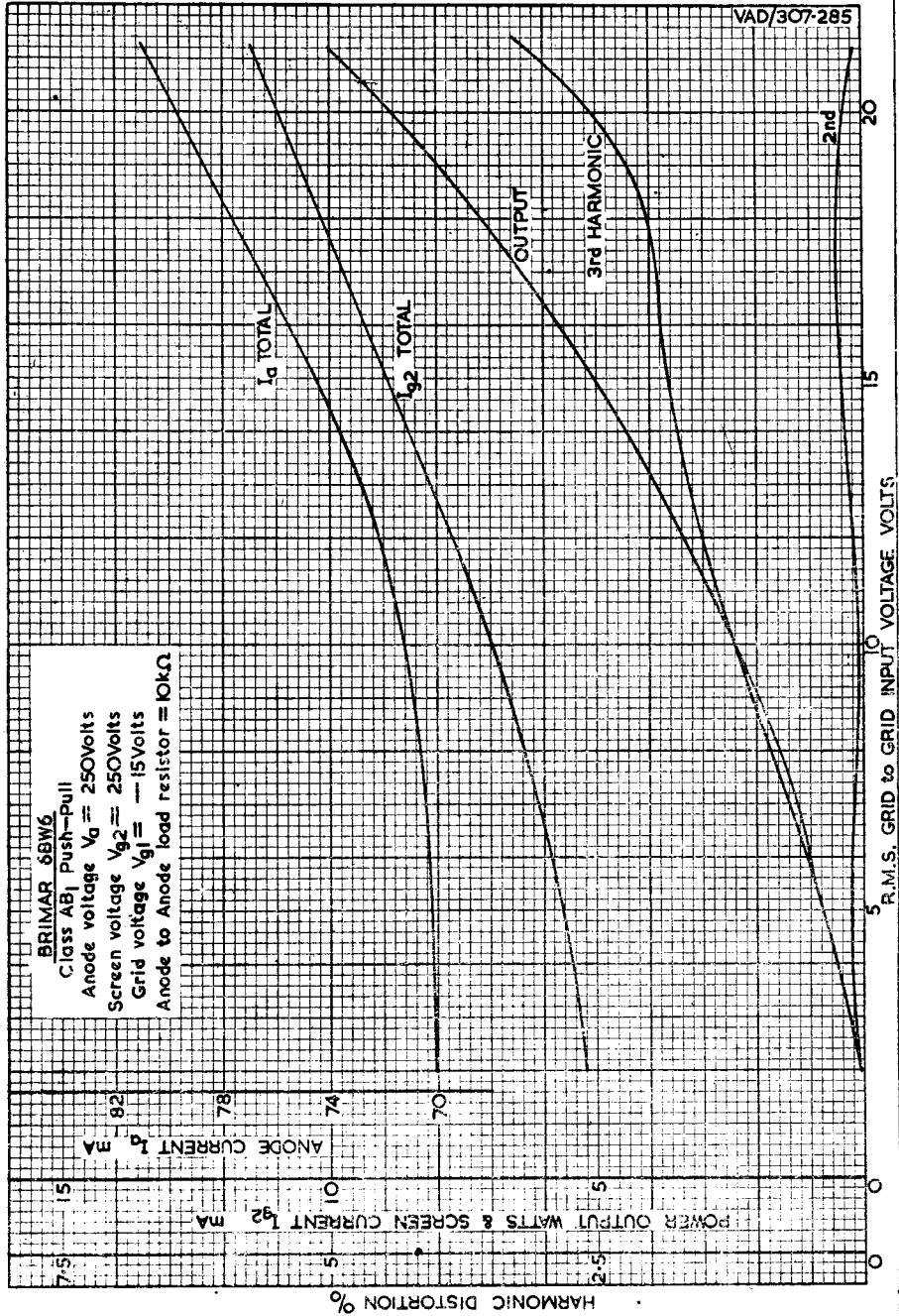
BRIMAR 6BW6
ANODE & SCREEN CURRENTS versus
ANODE VOLTAGE
Screen voltage $V_{g2} = 225$ Volts
 I_a ————— I_{g2} - - - - -



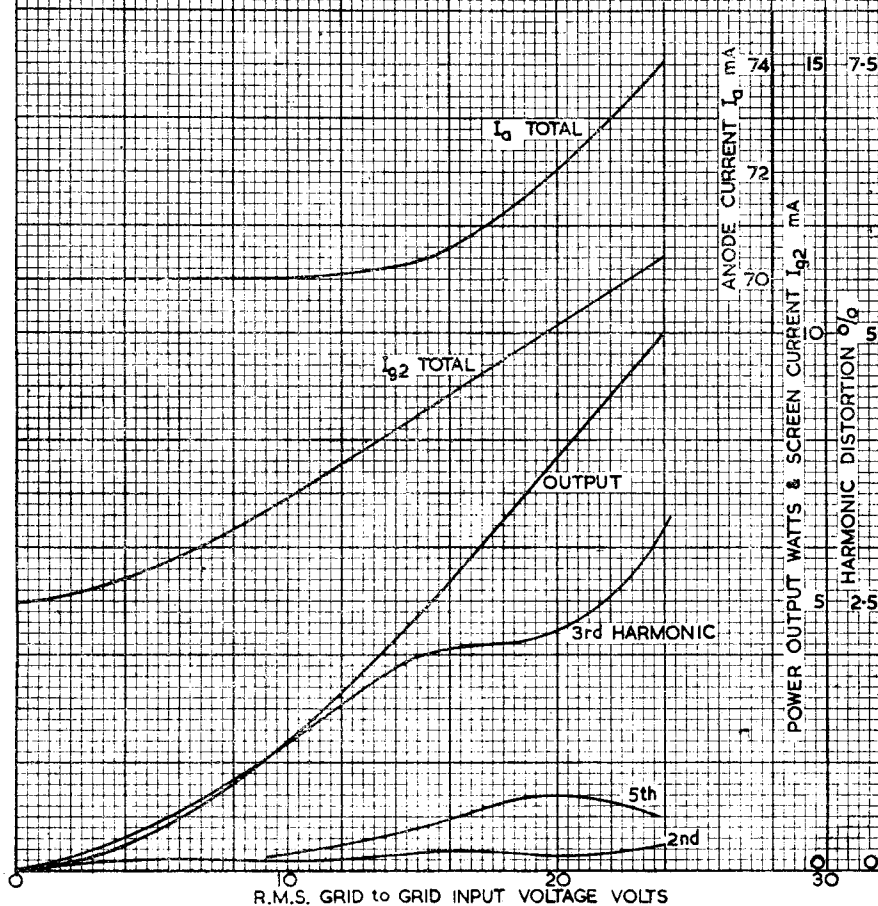






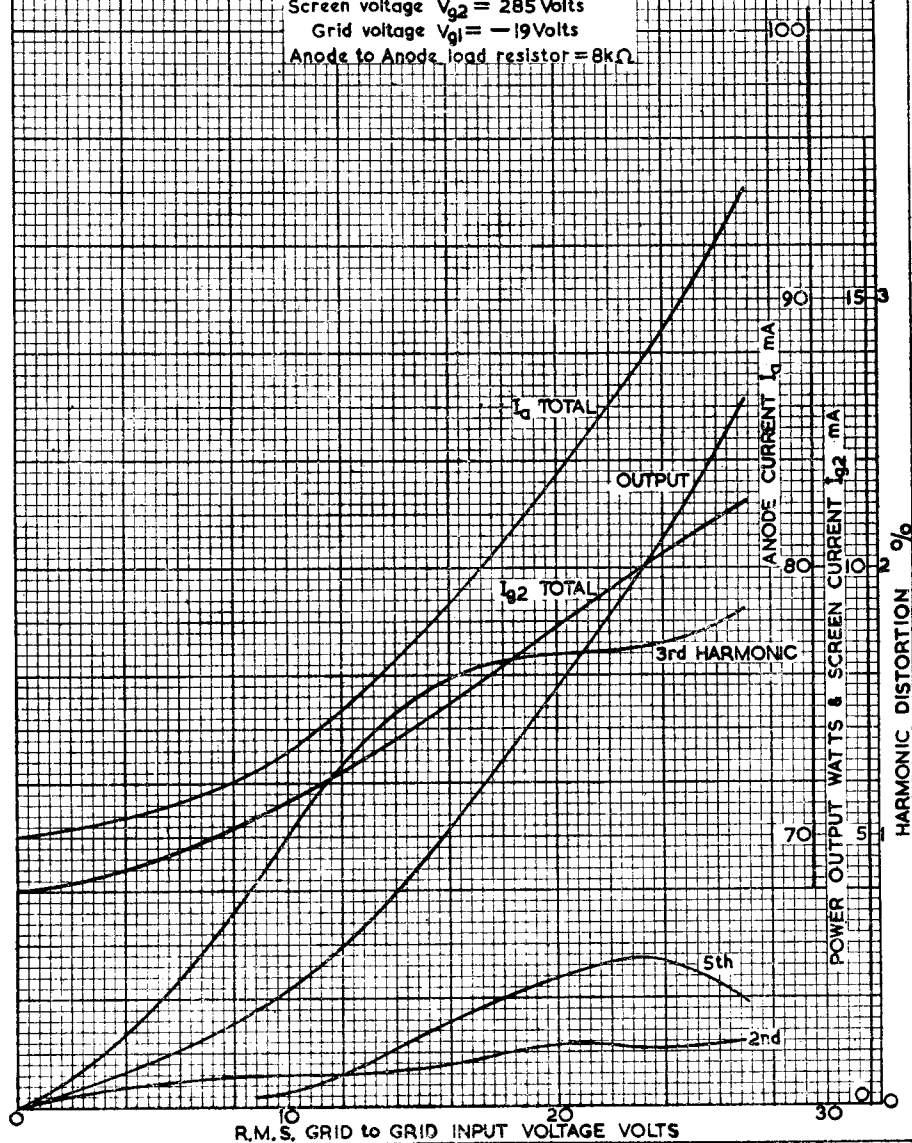


BRIMAR 6BW6
 Class AB₁ Push-Pull
 Anode voltage $V_a = 250$ Volts
 Screen voltage $V_{g2} = 250$ Volts
 Anode to Anode load resistor $= 10k\Omega$
 Cathode bias resistor $R_k = 200\Omega$

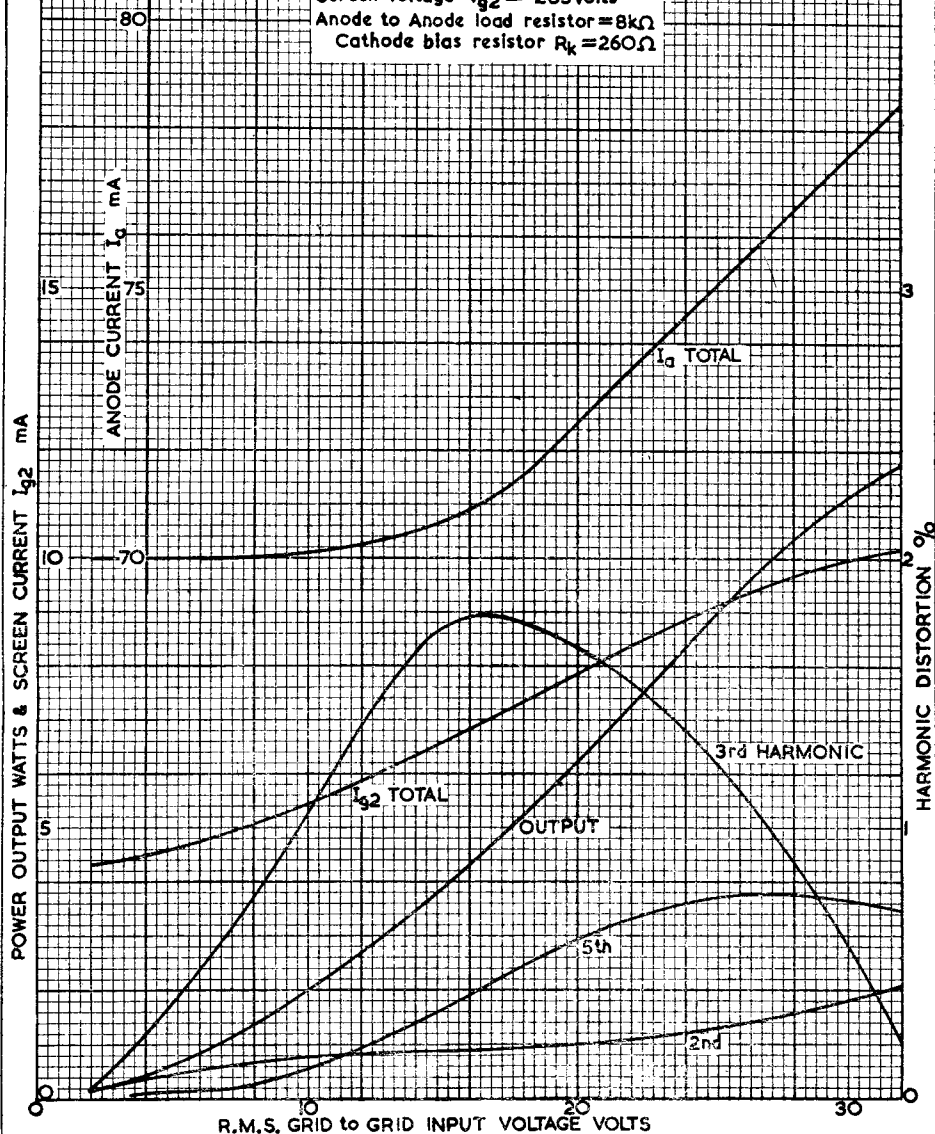


BRIMAR 6BW6

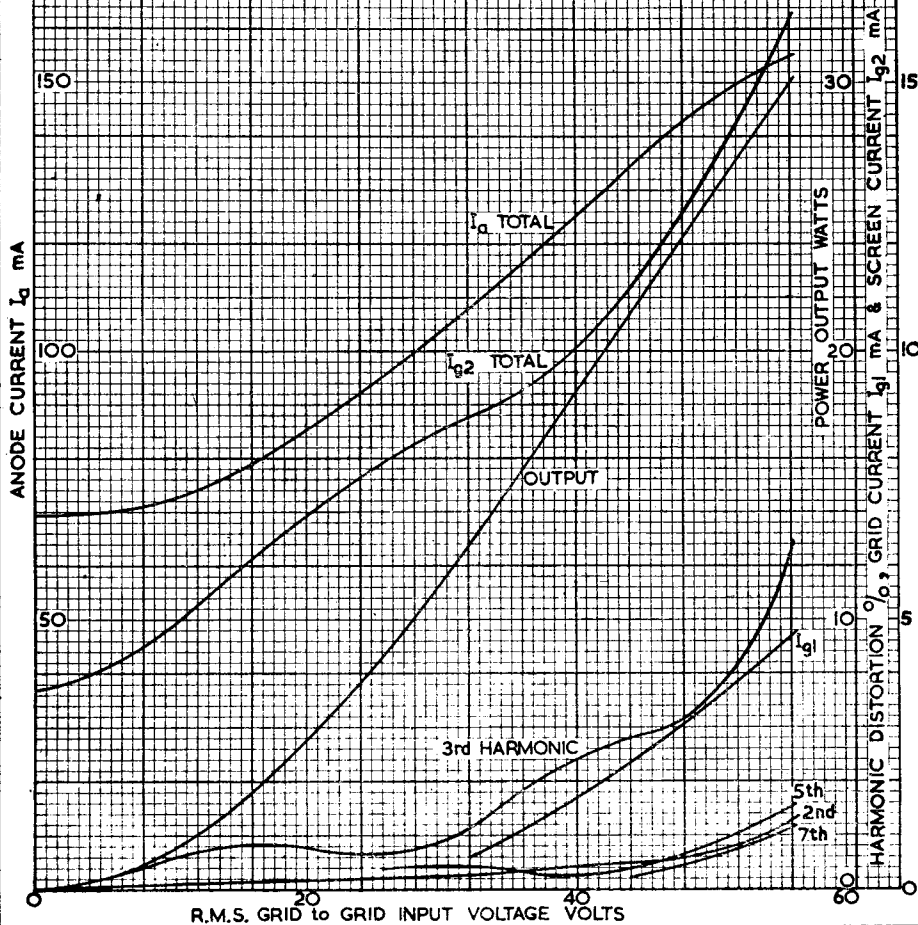
Class AB₁ Push-Pull
 Anode voltage $V_a = 285$ Volts
 Screen voltage $V_{g2} = 285$ Volts
 Grid voltage $V_{g1} = -19$ Volts
 Anode to Anode load resistor = $8k\Omega$



BRIMAR 68W6
 Class AB₁ Push-Pull
 Anode voltage $V_a = 285$ Volts
 Screen voltage $V_{g2} = 285$ Volts
 Anode to Anode load resistor $= 8k\Omega$
 Cathode bias resistor $R_k = 260\Omega$



BRIMAR 6BW6
 Class AB₂ Push-Pull
 Anode voltage $V_a = 315$ Volts
 Screen voltage $V_{g2} = 285$ Volts
 Grid voltage $V_{g1} = -19$ Volts
 Anode to Anode load resistor = $5k\Omega$



BRIMAR 6BW6.
 Class 'A'
 Anode voltage $V_a = 250$ Volts
 Screen voltage $V_{g2} = 250$ Volts
 Grid voltage $V_{g1} = -12.5$ Volts
 Anode current $I_a = 45-47$ mA
 Anode load resistor $R_a = 5k\Omega$

POWER OUTPUT WATTS, HARMONIC DISTORTION % & SCREEN CURRENT mA
 7.5
 5
 2.5
 0

OUTPUT
 3rd

2nd HARMONIC

I_{g2}

R.M.S. INPUT VOLTAGE VOLTS

10

7.5

5

2.5

0

BRIMAR 6BW6

Class 'A'

Anode voltage $V_a = 315$ Volts

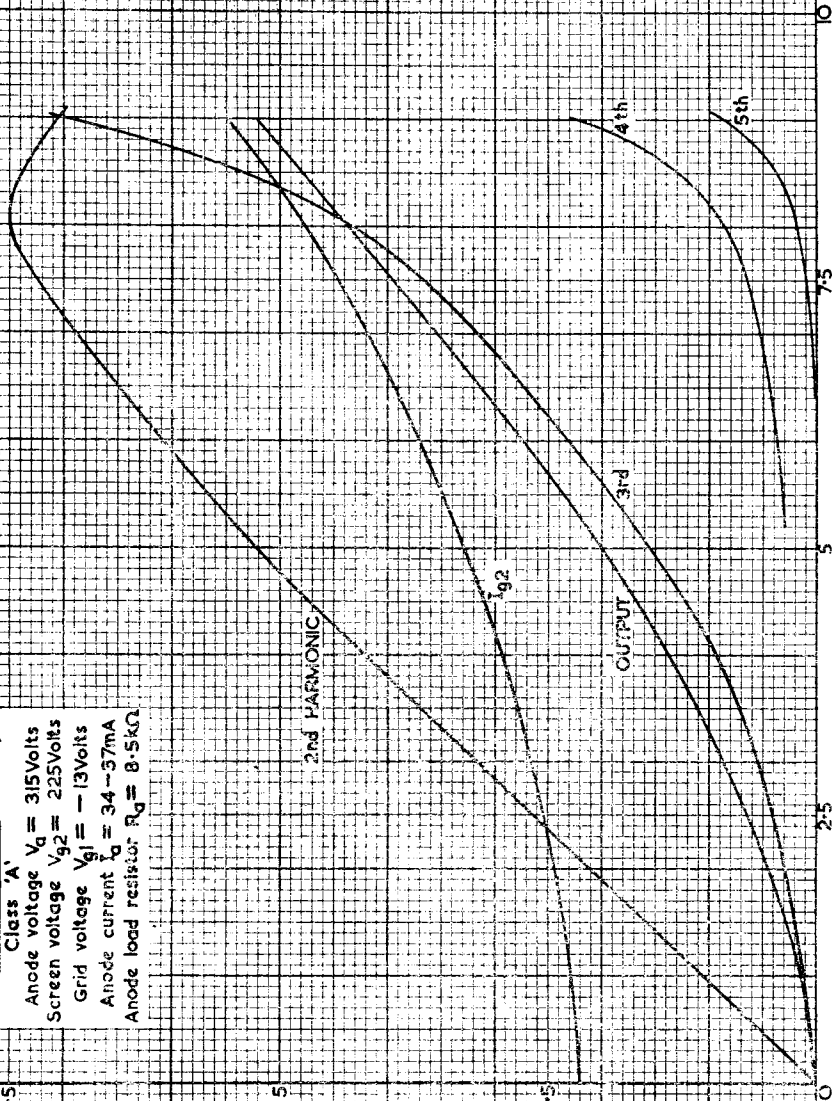
Screen voltage $V_{g2} = 225$ Volts

Grid voltage $V_{g1} = -13$ Volts

Anode current $I_a = 34-37$ mA

Anode load resistor: $R_a = 8.5k\Omega$

POWER OUTPUT WATTS, HARMONIC DISTORTION % & SCREEN CURRENT I_{g2} MA



VAD/307-291