Amdt 1.

VALVE ELECTRONIC

CV4519

MINISTRY OF AVIATION - D.L.R.D.(T) RREE Amdt 1

Specification MOA/CV4519	SECURITY	
Issue 1 dated 1st April 1960	Specification	Valve
To be read in conjunction with K1001, B.S.448 and B.S.1409	UNCLASSIFIED	UNCLASSIFIED

⟶ Indicates a change

TYPE OF VALVE - Reliable Sub-Miniature Pentode with Flying Leads

CATHODE - Indirectly - heated

ENVELOPE - Glass

PROTOTYPE - CV2387, VX8124

RATINGS (Note A)

(All limiting values are absolute)

			Note
Heater Voltage	(V)	5.0	B
Heater Current	(mA)	185	
Max. Operating Anode Voltage (pa max)	(V)	100	
Max. Operating Screen Voltage (pg2 max)	(V)	100	
Max. Anode Voltage (Ia = 0)	(V)	200	
Max. Screen Voltage (Ig2 = 0)	(V)	200	
Max. Cathode Current	(µA)	250	
Max. Heater-Cathode Voltage	(V)	± 50	C
Max. Positive Suppressor Voltage	(V)	0	
Max. Negative Suppressor Voltage	(V)	50	
Max. Negative Grid Voltage	(V)	50	
Max. Bulb Temperature	(°C)	100	
Max. Anode Dissipation	(mW)	20	
Max. Screen Dissipation	(mW)	7	
Max. Vibration (100 hrs. duration max.)	(g)	5	D
(10 mins. duration max.)	(g)	20	E
Max. Shock (short duration)	(g)	500	
Min. Operating Pressure	(mm. Hg)	55	
Max. Ambient Storage Temperature Range	(°C)	-60/+85	

Typical Operating Conditions

Measured at Va=Vg2=50V; Ia 75 uA			
Screen Current	(µA)	35	
Amplification Factor	(µglg2)	19	F
Mutual Conductance	(µA/V)	200	F
Max. Reverse Grid Current	(µµA)	50	G, H

CAPACITANCES (pF)

C in (Nom.) Shielded	3.8
Cout (Nom.) Shielded	4.8
Cagl (Max.) Shielded	0.3

MARKING

See K.1001/4

BASE

See B.S.448/B8D/F/1.1

CONNECTIONS

Lead	Electrode	
1	Grid	g^1
2	Suppressor	g^3
3	Heater	h
4	Anode	a
5	Screen	g^2
6	Heater	h
7	Cathode	k
8	Anode	a

DIMENSIONS

See B.S.448/B8D/F/2.1
Size Ref. No.2

Dimensions (mm)	Min.	Max.
A. Seated Height	29.0	32.0
B Overall Length	-	38.1
C Diameter	9.3	10.16
Lead Length (Note C)	38.1	-

MOUNTING POSITION

Any

TYPE APPROVAL

See K1001/15.

Minimum quantity for submission 225.
See Note I.

APPLICATIONS DATA

Issue 1 - See section following Page 6 Amdt 1.

NOTES

See next page

NOTES

A. Caution to Electronic Equipment Design Engineers: Special attention should be given to the temperature of valves to be operated in Guided Weapons and Aircraft. Reliability will be seriously impaired if the maximum bulb temperature is exceeded. 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. Both reliability and performance will be jeopardized if heater voltage ratings are exceeded; life and reliability performance are directly related to the degree that regulation of the heater voltage is maintained at its centre-rated value.

B. Under no circumstances should the heater voltage supply be allowed to deviate more than ± 5% from the rated value.

C. For greater reliability, the potential between heater and cathode, when cathode is negative with respect to heater, should not be allowed to exceed 10 volts.

D. The maximum peak acceleration under the continuous random vibration conditions specified assumes that the vibration frequency components are varying continuously over the band 10 to 1,000 cycles/sec. in a random manner.

E. The maximum peak acceleration under the short term random vibration conditions specified assumes that the vibration frequency components are varying continuously over the band 10 to 1,000 cycles/sec. in a random manner.

F. Measured with Va = Vg2 = 50V; Ia = 75 uA.

G. Care must be taken to avoid contamination of the base when handling these valves and particularly when soldering into equipment. Direct soldered connections to the leads must be at least 5 mm. from the seal. Any bending of the leads must be at least 1.5 mm. from the seal.

H. Measured under the test conditions in Note F. If the valves have not been operated for some days, it may be necessary to allow 20 minutes running at operating conditions before this limit is met For optimum performance the valve should be screened from external light.

I. When submitting for Type Approval the samples must be drawn from a lot which has met the requirements of the specification. The manufacturer shall provide the lot results, together with detailed measurements on the samples as required by the Type Approval Authority.

CV4519

TESTS

TO BE PERFORMED IN ADDITION TO THOSE APPLICABLE IN K.1001

TESTS IN ANY ONE GROUP SHALL BE PERFORMED IN THE SPECIFIED ORDER

TEST CONDITIONS - UNLESS OTHERWISE SPECIFIED

Vh(V)	Va(V)	Vg2(V)	Ia(μA)	Vg3(V)
5.0	50	50	75	0

K1001	TEST	TEST CONDITIONS	AQL %	INSP. LEVEL	SYMBOL	LIMITS MIN.	LAL	BOGEY	UAL	MAX.	ALD	UNITS
AIX/2.1	GROUP A											
	Visual Inspection	Notes: 1, 2 No voltages		100%								
5.14	Inoperatives			100%								
	Insulation	Va-all = -150V		100%	R	200	-	-	-	-	-	M
		Vg2-all = -150V		100%	R	200	-	-	-	-	-	M
		Vg1-all = - 50V		100%	R	200	-	-	-	-	-	M
	Reverse Grid Current	Note: 3		100%	Ig1	-	-	-	-	50	-	μA
	Vibration Noise (1)	Notes: 2, 4		100%								
		Acceleration = 15g peak min. Frequency = 50 c/s Rk = 27 K Ck = 1000 uF min Rg1 = 0 Va(b) = 50V Vg2 = 50V										
		Ra = 22K			Vout	-	-	-	-	10	-	mV rms
AIX/2.2		Note: 5										
AIX/2.3												
	GROUP B											
5.3	Heater-Cathode Leakage Current	Vhk= ± 50V	0.4	II	Ihk	-	-	-	-	5	-	μA
				V2	Ihk	-	-	-	1.0	-	-	μA
	Screen Current		0.4	II	Ig2	5	-	-	-	65	-	μA
	Negative Grid Voltage		0.4	II	Vg	1.9	-	-	-	3.5	-	V
				V2	Vg	-	2.42	2.7	2.98	-	0.62	V
	Mutual Conductance		0.4	II	gm	130	-	-	-	270	-	μa/V
				V2	gm	-	175	200	225	-	55	μa/V
	GROUP C											
	Heater Current		1.0	I	Ih	170	-	-	-	200	-	mA
	GROUP D											
	Capacitances	Measured on a 1 Mc/s bridge, valve mounted in a fully screened socket. Shielded. Note: 6	2.5	Code G	Cin	3.0	-	-	-	4.6	-	pF
					Cout	4.2	-	-	-	5.4	-	pF
					Cag1	-	-	-	-	0.3	-	pF

K1001	TEST	TEST CONDITIONS	AQL %	INSP. LEVEL	SYMBOL	LIMITS MIN.	LAL	BOGEY	UAL	MAX.	ALD	UNITS
	GROUP E											
AIX/ 2.4.2.3	Lead Fragility	No voltages	1.0	Code I								
AIX/ 2.4.2.1	Glass Strain	No voltages Note: 7	2.5	Code G								
	Vibration Noise (2)	Notes: 4, 8		V3	Vout	-	-	-	2.5	-	-	mV rms
	Vibration Fatigue	Acceleration = 5g peak min. Time = 200 hrs. Note: 9		Code L								
	Vibration Noise (3)	Note: 10 Amdt 1		Code L								
		Acceleration = 20g peak min. Rk = 27 K Ck = 1000 µF min. Rg1=0; Ra=22 K Va(b) = 50V Vg2 = 50V										
		Frequency = (1) 60-120 c/s			Vout	-	-	-	50	-	-	mV (pk-pk)
		(2) 120-250 c/s			Vout	-	-	-	50	-	-	mV (pk-pk)
		(3) 250-500 c/s			Vout	-	-	-	50	-	-	mV (pk-pk)
		(4) 500-1000 c/s			Vout	-	-	-	50	-	-	mV (pk-pk)
		(5) 1000-2000 c/s			Vout	-	-	-	75	-	-	mV (pk-pk)
	Post Vibration Noise (3) Tests:	Combined AQL	2.5									
	Heater-Cathode Leakage Current	Vhk = ± 50V	1.0		Ihk	-	-	-	-	5	-	µA
	Reverse Grid Current	Note: 3	0.25		Igl	-	-	-	-	200	-	µµA
	Mutual Conductance		1.0		gm	100	-	-	-	-	-	µA/V
	Vibration Noise (1)	As in Group A Note: 3	1.0		Vout	-	-	-	-	25	-	mV rms
	Catastrophics	Note: 11	0.25									
AIX/ 2.4.2.4.3	Shock	Hammer Angle = 30° No voltages (T/A only)										
	Post Shock Tests:	As for Post Vibration Noise (3) Tests (T/A only)										

TESTS (Contd.)

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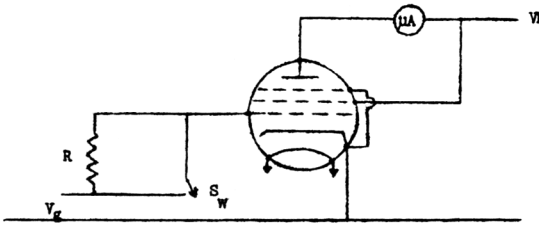
K1001	TEST	TEST CONDITIONS	AQL %	INSP. LEVEL	SYMBOL	LIMITS MIN.	LAL	BOGEY	UAL	MAX.	ALD	UNITS
	GROUP F											
AVI/5	Life	Vg1 = 0V Vhk = 50V heater positive Rg1 = 1M; Rk = 27 K										
AVI/5.1	Stability Life											
	Change in Mutual Conductance		1.0	I	Δgm	-	-	-	-	10	-	%
AVI/5.3	Intermittent Life											
	Test Point 200 hours	Combined AQL	4.0	Code I								
5.14	Inoperatives	Note: 12.	0.25									
	Heater Cathode Leakage Current	Vhk = ± 50V	1'.5		Ihk	-	-	-	-	5	-	μA
	Reverse Grid Current	Note: 3	1.0		Ig1	-	-	-	-	50	-	μμA
	Mutual Conductance		1.0		gm	130	-	-	-	270	-	μA/V
	Average Change of Mutual Conductance				$\overline{\Delta gm}$	-	-	-	-	10	-	%
	Insulation	Va-all=-150V Vg2_all=-150V	2.5		R R	100 100	- -	- -	- -	- -	- -	M M
	Test Point 1000 hrs.	Combined AQL	6.5	Code II								
5.14	Inoperatives		1.5									
	Heater Cathode Leakage Current	Vhk= ± 50V	4.0		Ihk	-	-	-	-	5	-	μA
	Reverse Grid Current	Note: 3	1.5		Ig1	-	-	-	-	100	-	μμA
	Mutual Conductance		1.5		gm	100	-	-	-	-	-	μA/V
	Insulation	Va-all=-150V	4.0		R	50	-	-	-	-	-	M
	Group G											
AIX/2.5	Electrical Re-Test after 28 days holding period			100%								
5.14	Inoperatives		0.5									
	Reverse Grid Current	Note: 3	0.5		Ig1	-	-	-	-	50	-	μμA
	Mutual Conductance				gm	130	-	-	-	270	-	μA/V

NOTES

1. The valve shall be visually inspected for good workmanship, using a visual aid having a X10 magnification. Particular attention shall be paid to the following:-
Structure quality, quality of welds, quality of lead tinning, external dimensions and shape, and freedom from harmful loose particles

2. This test may be done alternatively in Group C, at the discretion of the manufacturer.

3. To be measured on an approved equipment. The conditions of Note H on Page 2 should be applied.
A typical test circuit is shown below:



Operating Details

R is a known resistance (of the order of 10^{10} ohms). With Sw closed adjust Vg for Ia = 75 µA, note Vg. Open Sw readjust Vg for Ia = 75 µA.

Then $\frac{\Delta Vg}{R} = -Igl$

4. The valve shall be mounted so that the direction of vibration is parallel to the minor axis of the electrode structure. The test shall be of sufficient duration to obtain a steady reading of noise output.

5. At this stage the lot shall be formed. It shall be an identifiable lot not exceeding 5,000 valves and shall be manufactured in a period not exceeding 20 consecutive working days. Normal Sampling (Single) shall apply.

6. The Capacitance Test Jig connections shall be as follows:-

Test	Links to H.P.	Links to L.P.	Links to E
Cin	1	2, 3, 5, 6, 7 Sh.	4, 8
Cout	4, 8	2, 3, 5, 6, 7 Sh.	1
Cagl	1	4, 8	2, 3, 5, 6, 7 Sh.

7. This is a destructive test and valves used for this test will not be accepted for delivery.

8. Test conditions as for Vibration Noise (1) in Group A.

9. The valves shall be randomly mounted on the vibrator mount in such a manner that each valve experiences an acceleration of at least 5g peak.
The frequency of vibration shall be swept continuously over the range 60-1000 c/s at a rate of change of frequency not greater than 1 octave per minute.
The heater supply shall be 5.0 V and switched approximately 8 minutes on 16 minutes off throughout the duration of the test.
No other voltages are to be applied.

10. This test is to be applied to the total sample previously subjected to the Vibration Fatigue test. Each valve shall be mounted so that the direction of vibration is parallel to the minor axis of the electrode structure and shall be vibrated over the frequency range 60 - 2000 c/s swept once only at a rate of change of frequency not greater than 1 octave per 30 seconds. The maximum vibration output in each of the specified frequency bands shall be recorded and all valves in the sample will be taken into consideration when computing the median.
Measurements of Vibration Noise (3) will be taken in terms of peak to peak voltage using an approved equipment, details of which are given on Page 7 ~~of this specification~~. and 8 of CV4501.

Amdt 1

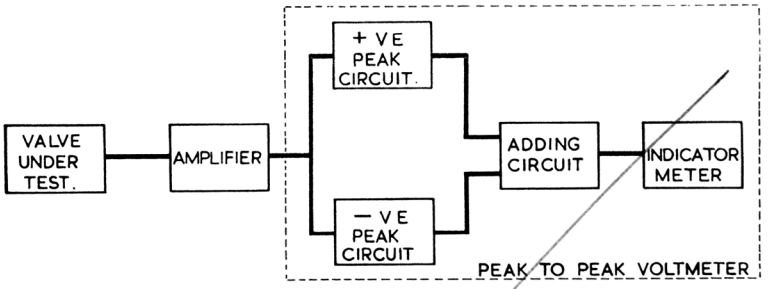
11. A valve shall be deemed to be a catastrophic if it is either an inoperative as defined in K1001 para. 5.14 or has the following defect:-

Vibration noise output, as measured in Group A, greater than 250 mV.

12. Accept lot if 0 inoperatives in sample, reject lot if 2 or more inoperatives. If 1 inoperative, take further sample of 50 and accept if no further inoperatives.

Test Circuit for Measurement of Peak-to-Peak Noise Output

1. Basic Circuit



ARRANGEMENT OF APPARATUS.

FIG.1.

2. Amplifier. The Input Impedance shall be 1M coupled through a 0.1μF capacitor to the valve under test. From 60c/s to 50Kc/s the frequency response shall be within ± 1dB. of the reference voltage at 1000 c/s. At 60Kc/s it shall be -3dB. ± 0.5dB. and at 100Kc/s it shall be -15dB ± 1dB.

3. Peak-to-Peak Voltmeter. This shall comprise of the Charging Circuits, Adding Circuit and an Indicator Meter. Its sensitivity shall be such that a signal of 25V R.M.S. applied to its input terminals shall produce full-scale deflection on the Indicator Meter. An approved circuit for the peak-to-peak Voltmeter is given in Fig.2.

3.1 Charging Circuits. The positive peak and negative peak charging circuits shall each consist of a diode in series with the capacitor to be charged, or alternatively be such that the combined circuit will develop a peak-to-peak charge equal to that which would have been indicated had these specified circuits been employed. The two time constants shall be the same and shall be such that a single pulse of 25 micro-seconds duration, applied to the input of the amplifier, will result in an indicated reading of not less than 63% of the pulse amplitude. This is equivalent to saying that a 100 micro-second pulse will give a reading of not less than 98% of the pulse amplitude. The leakage rate shall not exceed that which would cause the meter reading at full scale deflection to decay by more than 1% per minute.

3.2 Adding Circuit The adding circuit shall be capable of summing accurately the voltages developed across the respective charging circuit capacitors.

3.3 Indicator Meter. The Indicator Meter shall be such that it will show the magnitude of the total voltage developed in the adding circuit and shall be calibrated to give the peak-to-peak voltage value of the microphony developed at the anode of the valve under test.

4. Calibration. Overall calibration of the test circuit shall be effected by applying a 1000 c/s sinusoidal waveform of known amplitude to the input of the amplifier. The overall sensitivity shall be controlled by varying the Amplifier gain.

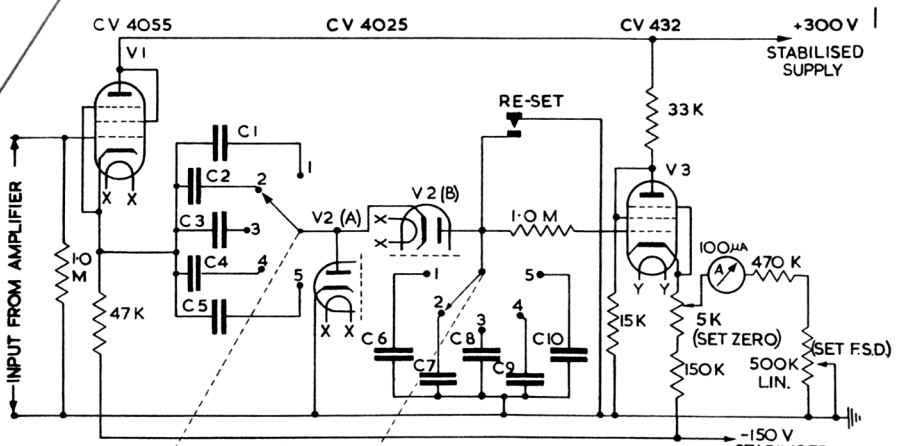


FIG. 2.

ELECTRONIC VALVE SPECIFICATIONS
SPECIFICATION NOA/CV4519
ISSUE 1 DATED 1ST APRIL 1960

AMENDMENT NO.1

Page 1 Amend 'No. of Pages' to read '6'
Amend Specification Authority to read 'D.L.R.D.(T)/R.E.E.
In 'Applications Data' box amend 'Page 7' to read 'Page 6'

Page 4 Group E Vibration Noise (3) Amend 'Inspection Level' column to read 'Code L'

Page 6 Note 10 Amend last sentence to read '..... details of which are given on page 7 and 8 of CV4504'

Page 7 Remove and destroy page 7

May 1962 D.L.R.D.(T)

NP.40491

AAS. 13/9/62

APPLICATIONS DATA

FOR

VALVE TYPE

CV4519

This information is intended for the guidance of users and does not form part of the procurement specification

ISSUE 1 SEPTEMBER 1960

ISSUED BY:-

MINISTRY OF AVIATION T.L.5. (B)

CASTLEWOOD HOUSE,

77-91 NEW OXFORD STREET

LONDON, W.C.1.

AMENDMENTS

No:	Date	Page

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CONTENTS.

STATISTICAL ASPECTS OF CV4500 SPECIFICATIONS

These test specifications have been drawn up on a statistical basis involving the following considerations:-

1. The use of 100% testing on its own does not, with presently known methods, and with reasonable economy, result in 100% perfect items reaching the customer, because reliability cannot be tested into a product.

2. To control the average and spread of the characteristics of a batch of valves is a better guarantee that the product is under control, than to accept all of a product solely on the basis that the characteristics lie within certain limits. In general it is true to say that a valve which is just inside a limit is neither better nor more reliable than one which is just outside that limit.

3. It may be demonstrated that the main characteristics of valves fairly closely follow normal or log-normal Gaussian distributions.

The inspection of these valves when submitted for acceptance is therefore carried out in two complementary stages.

Acceptance Sampling by Attributes.

Each Attribute sampling test in the specification has two conditions which define the inspection which must be made in order to ensure that the corresponding characteristic meets the required standard. The conditions are:-

(a) The Inspection Level, which defines, directly or indirectly, the size of the sample which must be taken.

(b) The Acceptance Quality Level (AQL), which defines, indirectly, the number of rejects which can be tolerated in the sample.

These conditions also define the Operating Characteristic of the sampling scheme (Page 5), which gives the relationship between the quality of the submitted lot and the probability of its acceptance. In general the levels are so calculated that if lots containing a percentage of rejects equal to the AQL were constantly submitted, then approximately 95% of the lots would be accepted.

It can be seen that the above scheme only defines the permissible percentage of valves outside the specified test limits, and not the distribution of the values of the characteristic within those limits. Theoretically therefore, it would be possible for all the values to lie just within a limit and the product would still be accepted.

To ensure that this situation does not occur on the major electrical characteristics, Variables sampling is introduced.

Acceptance Sampling by Variables

Each Variables sampling test in the specification has one condition which defines the inspection which must be made in order to ensure that the corresponding characteristic meets the required standard. This condition is the Inspection Level, which defines the size of the sample which must be taken.

The sample is divided into groups of five and the required characteristics are recorded. From these results the average value of each characteristic for the whole sample, and the average of the individual ranges for each group of five, are calculated. These values define the location and the dispersion of the characteristic distribution, respectively. The average must lie between the Lower Acceptance Limit (LAL) and the Upper Acceptance Limit (UAL), and the average range must not exceed the Acceptance Limit for Dispersion (ALD)

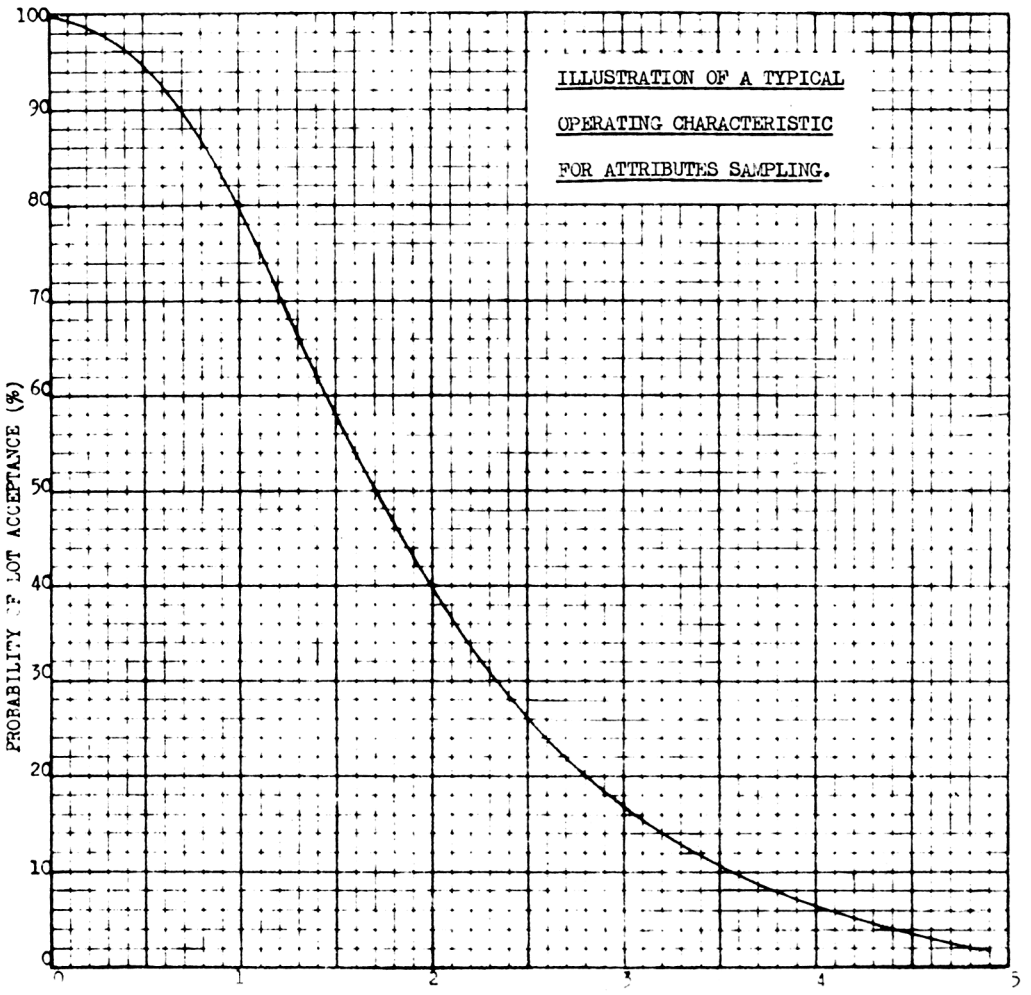
Illustrations of the limiting distributions for this valve, which would be just accepted by the above controls, are given on Pages 6 and 7. These show normal curves with the maximum permissible spread allowed by the ALD, centered on the LAL and UAL, respectively, and the maximum spread distributions, centered on the bogey value.

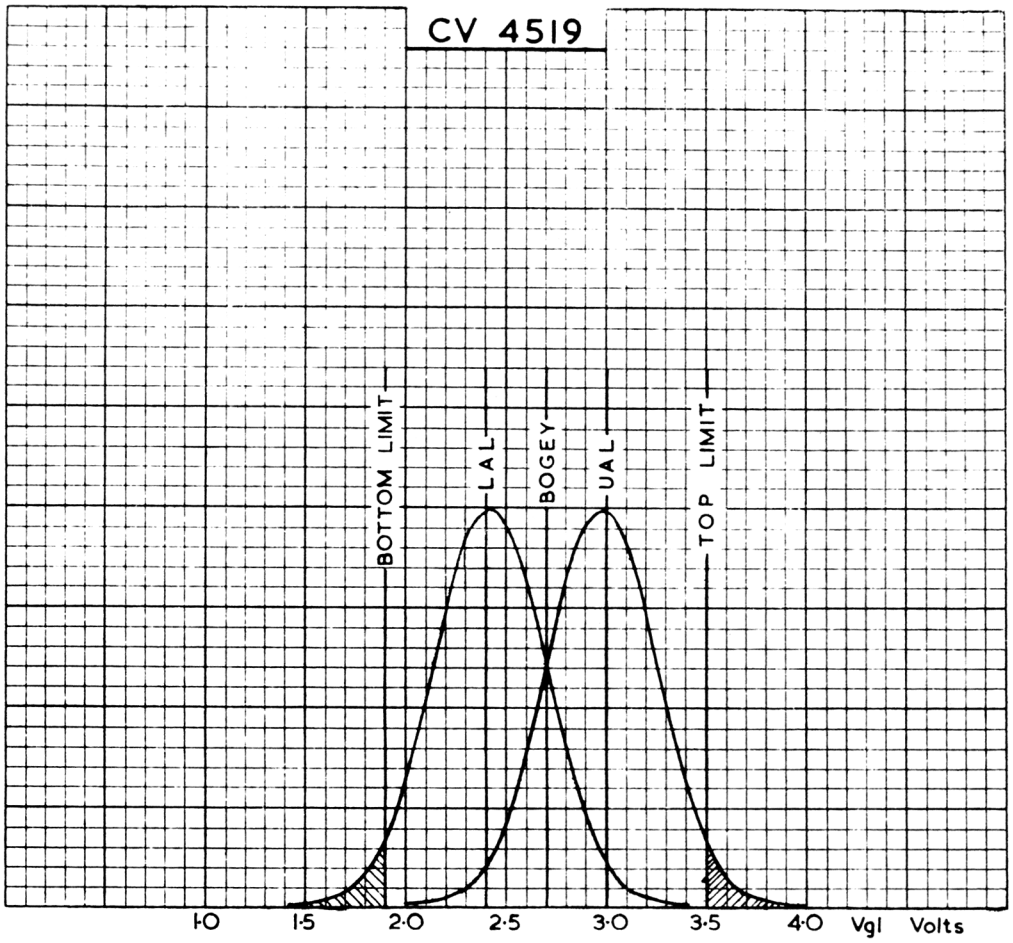
For further details of sampling inspection procedures for Attributes and Variables, reference should be made to K1001, Appendix XI, and MIL Standard 105A, Sampling Procedures and Tables for Inspection by Attributes.

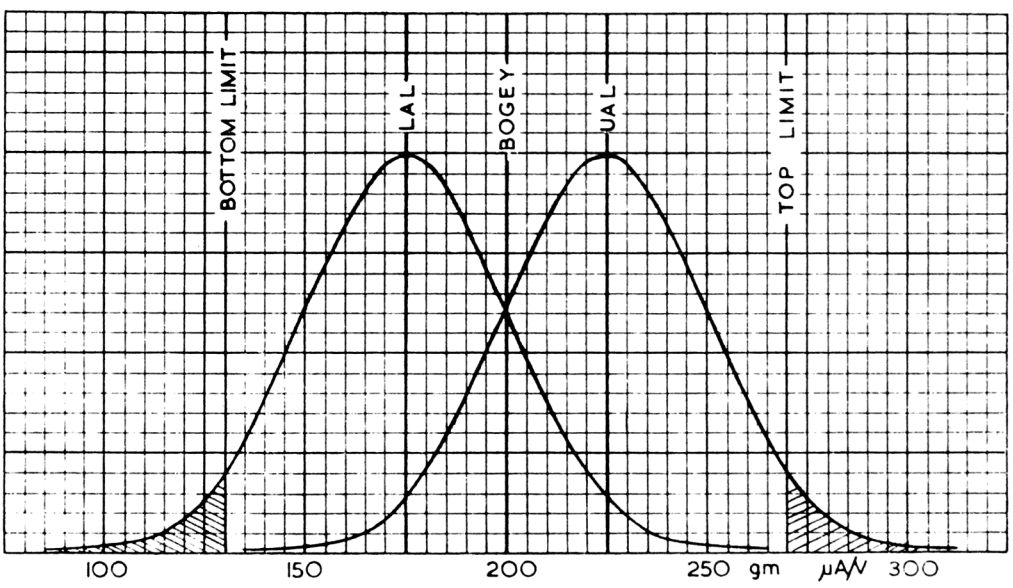
Typical Operating Characteristic

The following curve gives a typical Operating Characteristic for:-

Lot Size of between 1301 and 3200
Inspection Level II (Code Letter L, Sample size 150)
An AQL of 0.4% (Accept on 2, reject on 3).

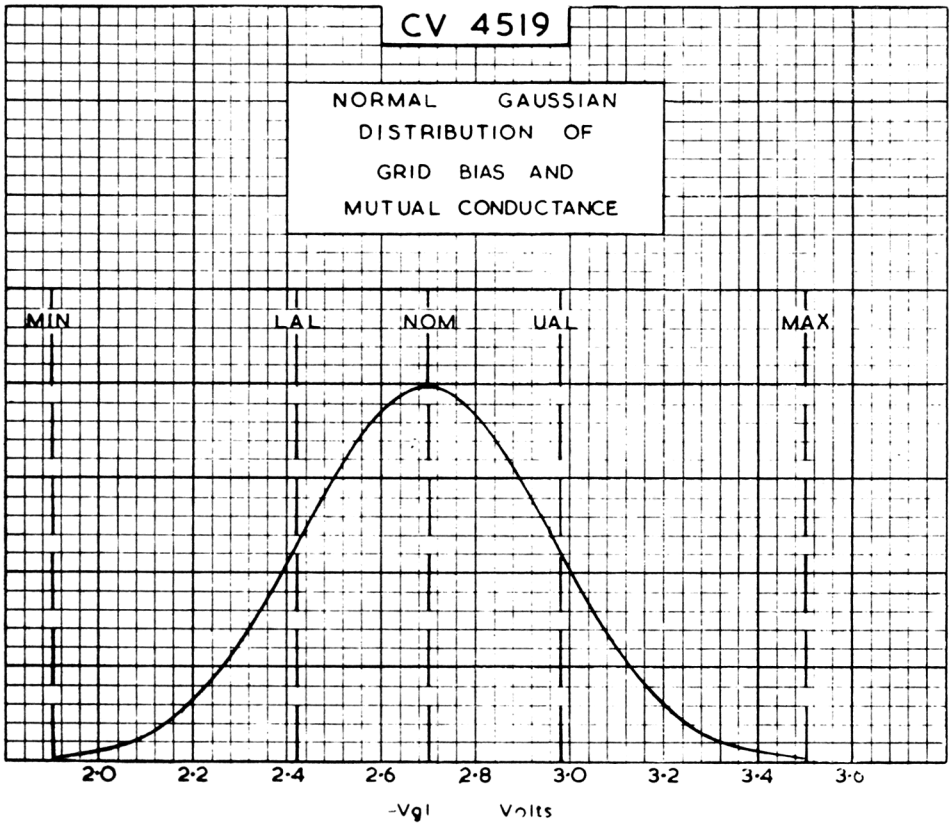


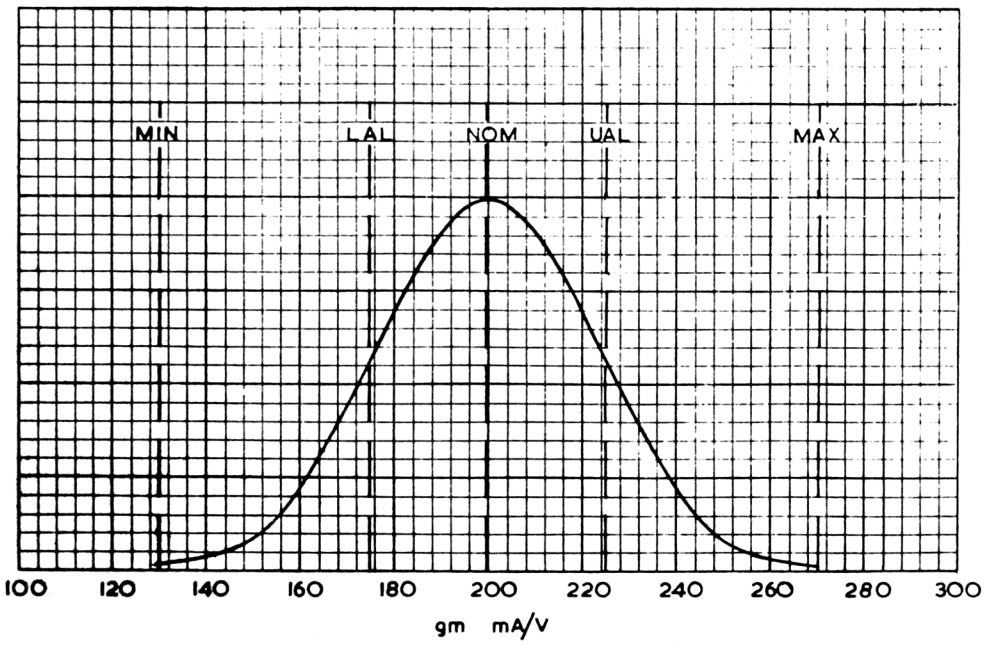


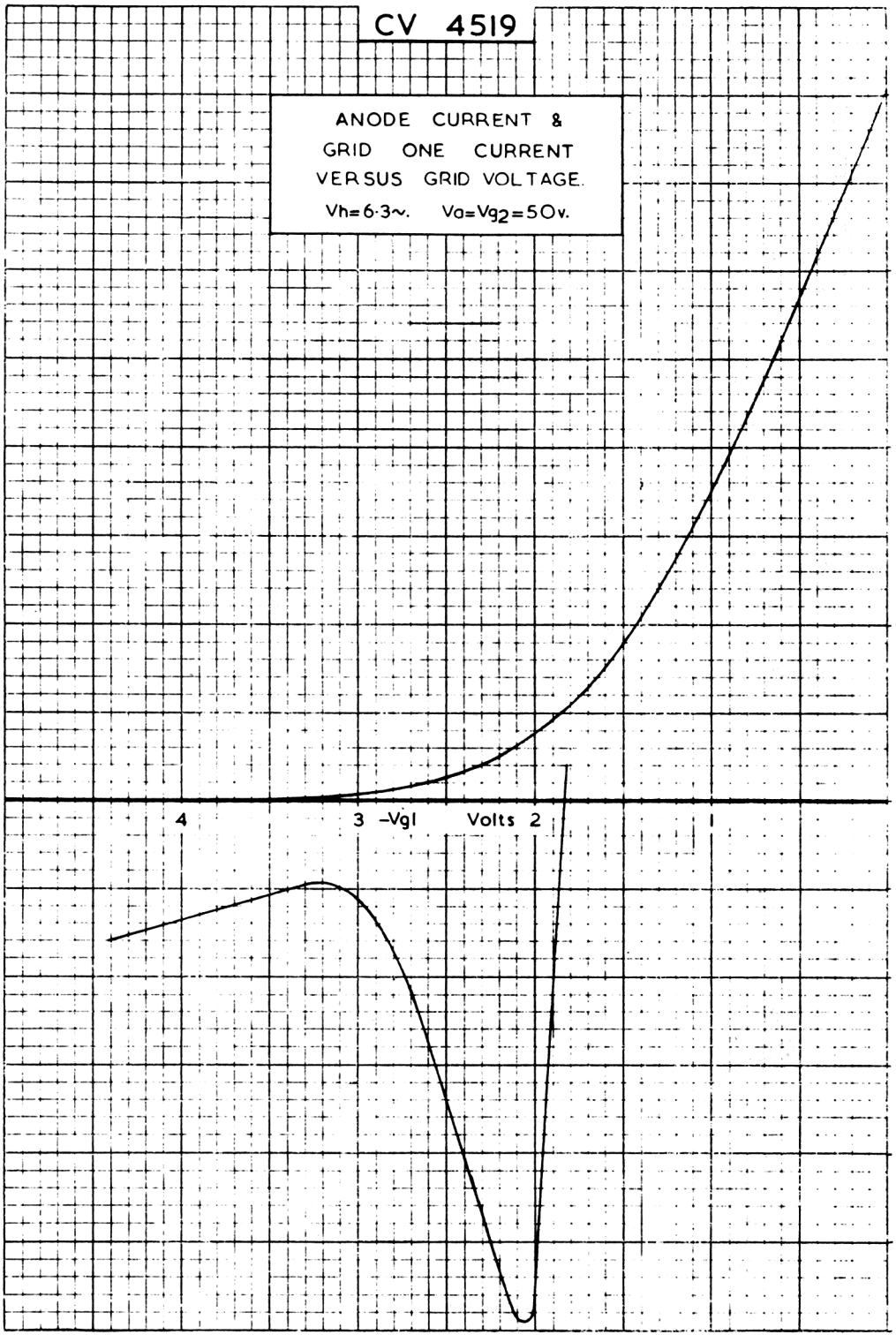


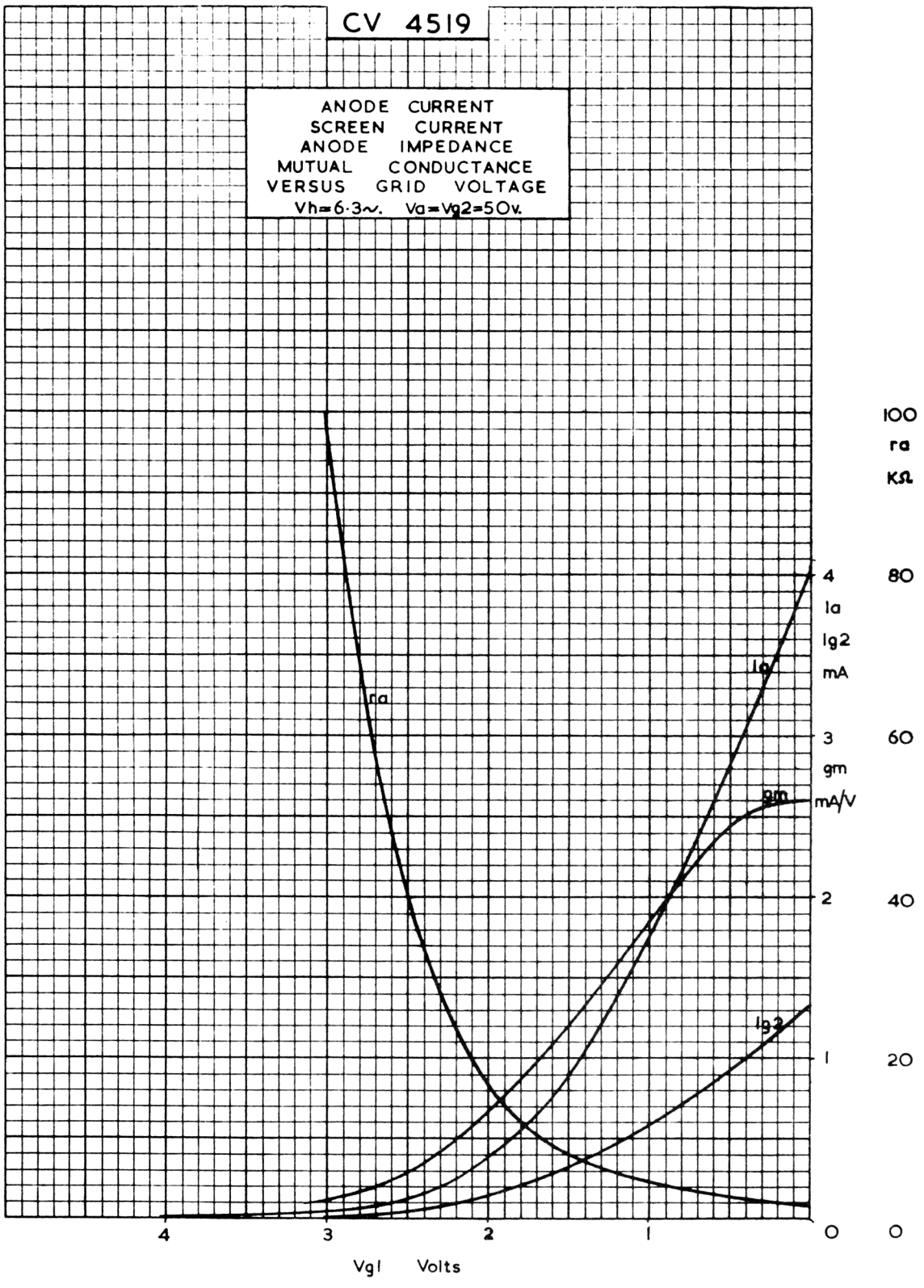
LIMITING DISTRIBUTION OF MAJOR CHARACTERISTICS

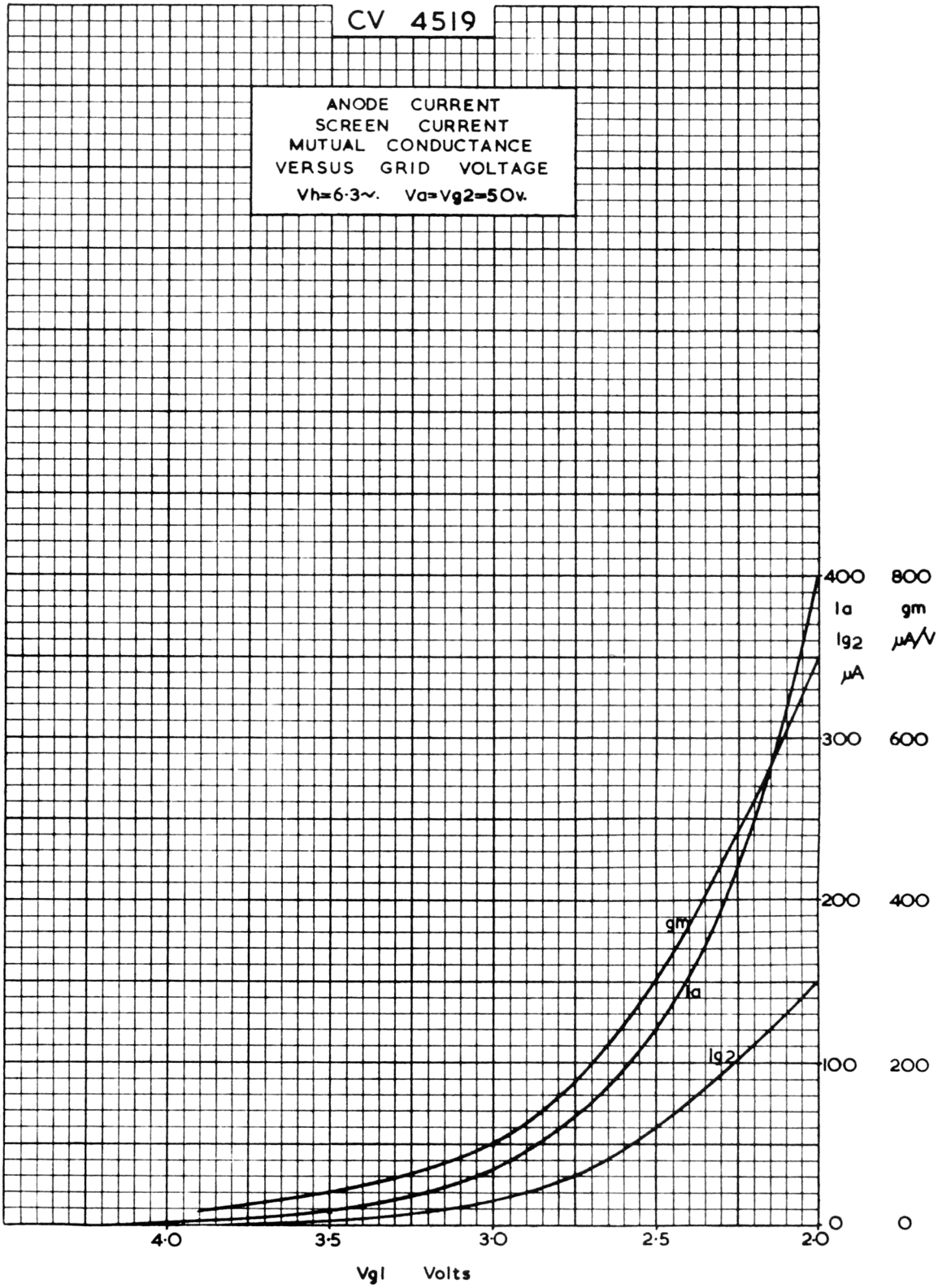
CV4519


CV 4519
NORMAL GAUSSIAN DISTRIBUTION OF GRID BIAS AND MUTUAL CONDUCTANCE
MIN
LAL
NOM
UAL
MAX
2·0
2·2
2·4
2·6
2·8
3·0
3·2
3·4
3·6
-Vg1 Volts

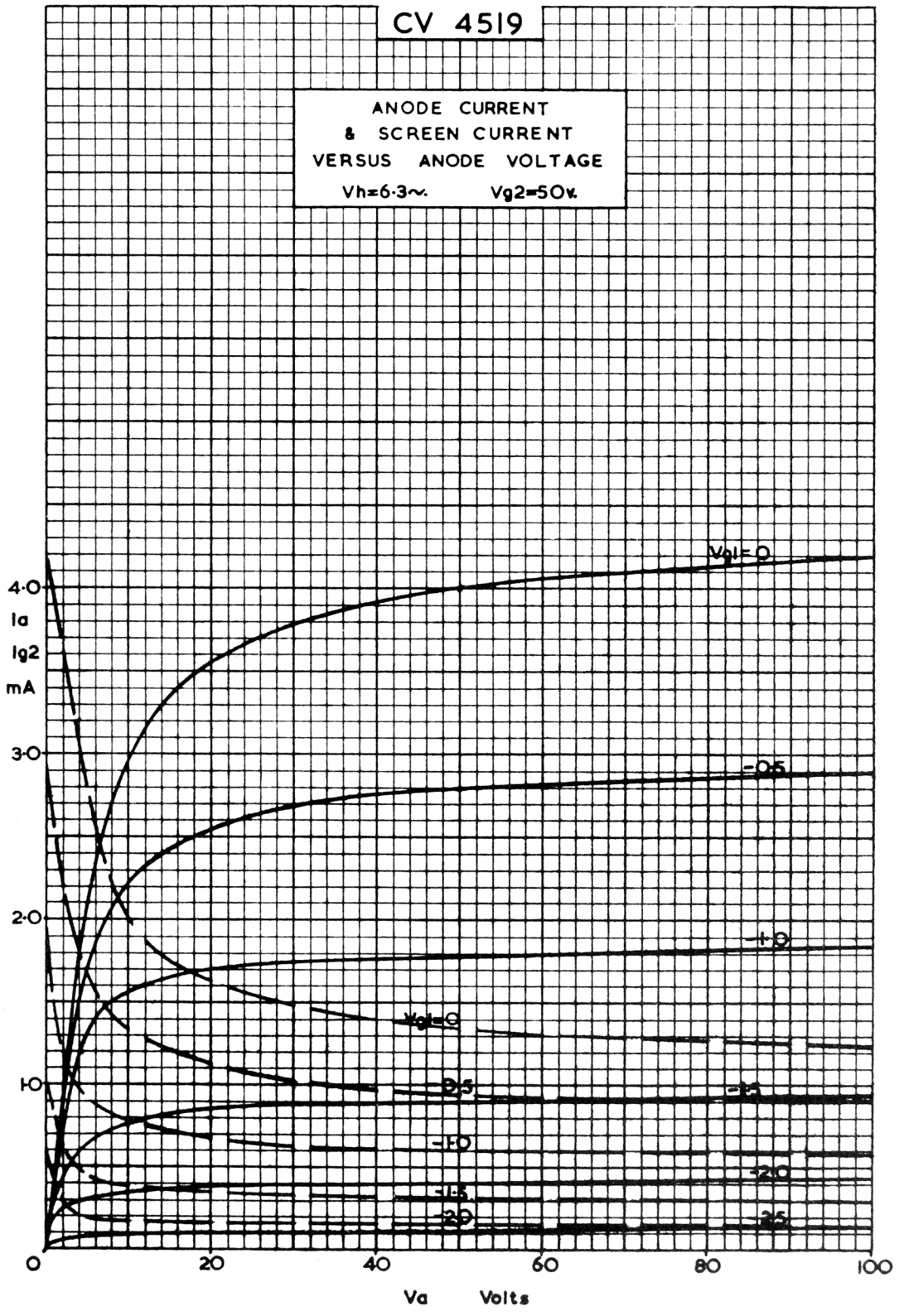

MIN
LAL
NOM
UAL
MAX
100
120
140
160
180
200
220
240
260
280
300
gm mA/V

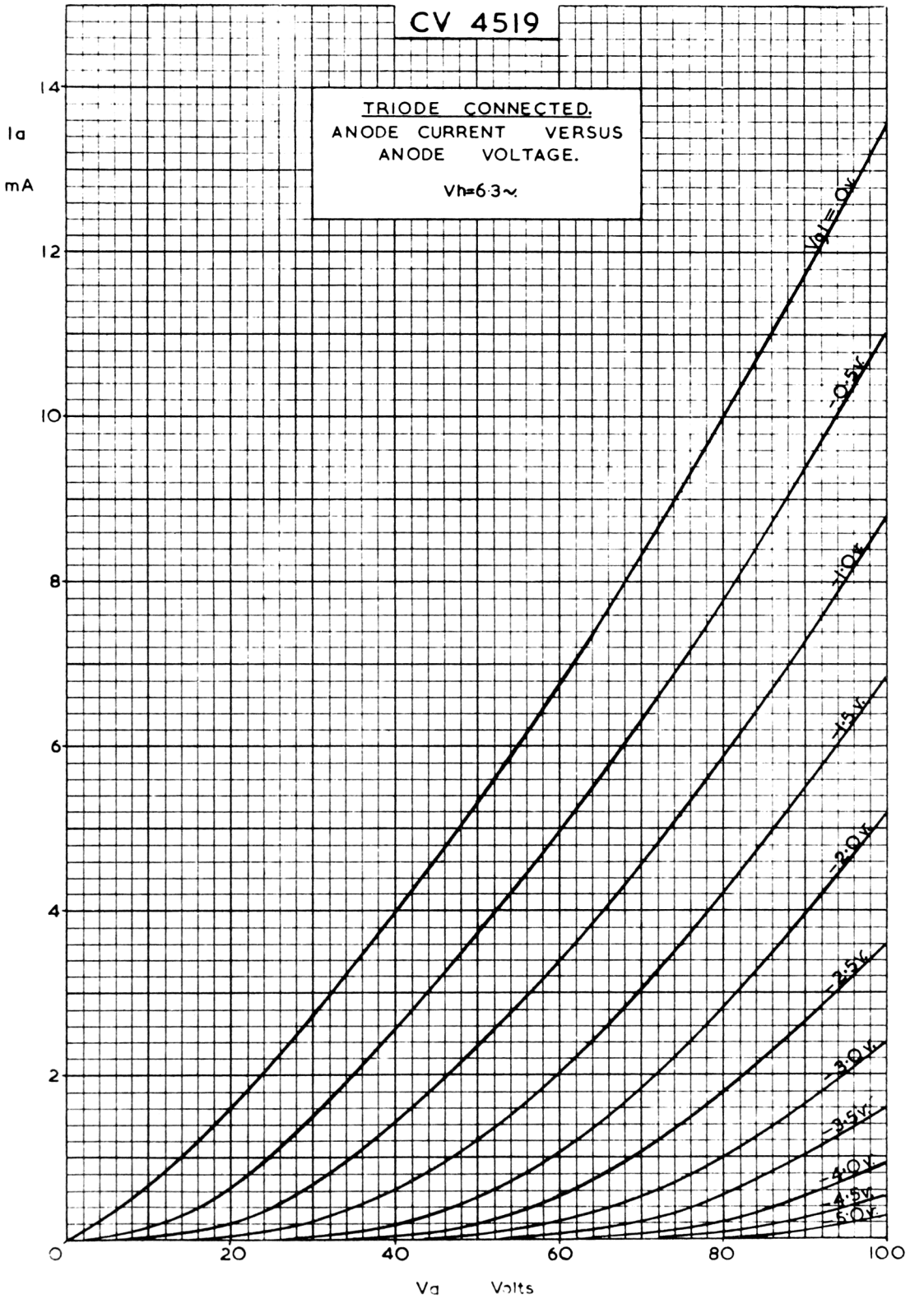

CV 4519
ANODE CURRENT &
GRID ONE CURRENT
VERSUS GRID VOLTAGE.
Vh=6·3~. Va=Vg2=50v.
4·0
3·0
Ia
mA
2·0
1·0
0
4
3 -Vg1 Volts 2
1
10
-Ig1
20
μμA
30
40
50
60

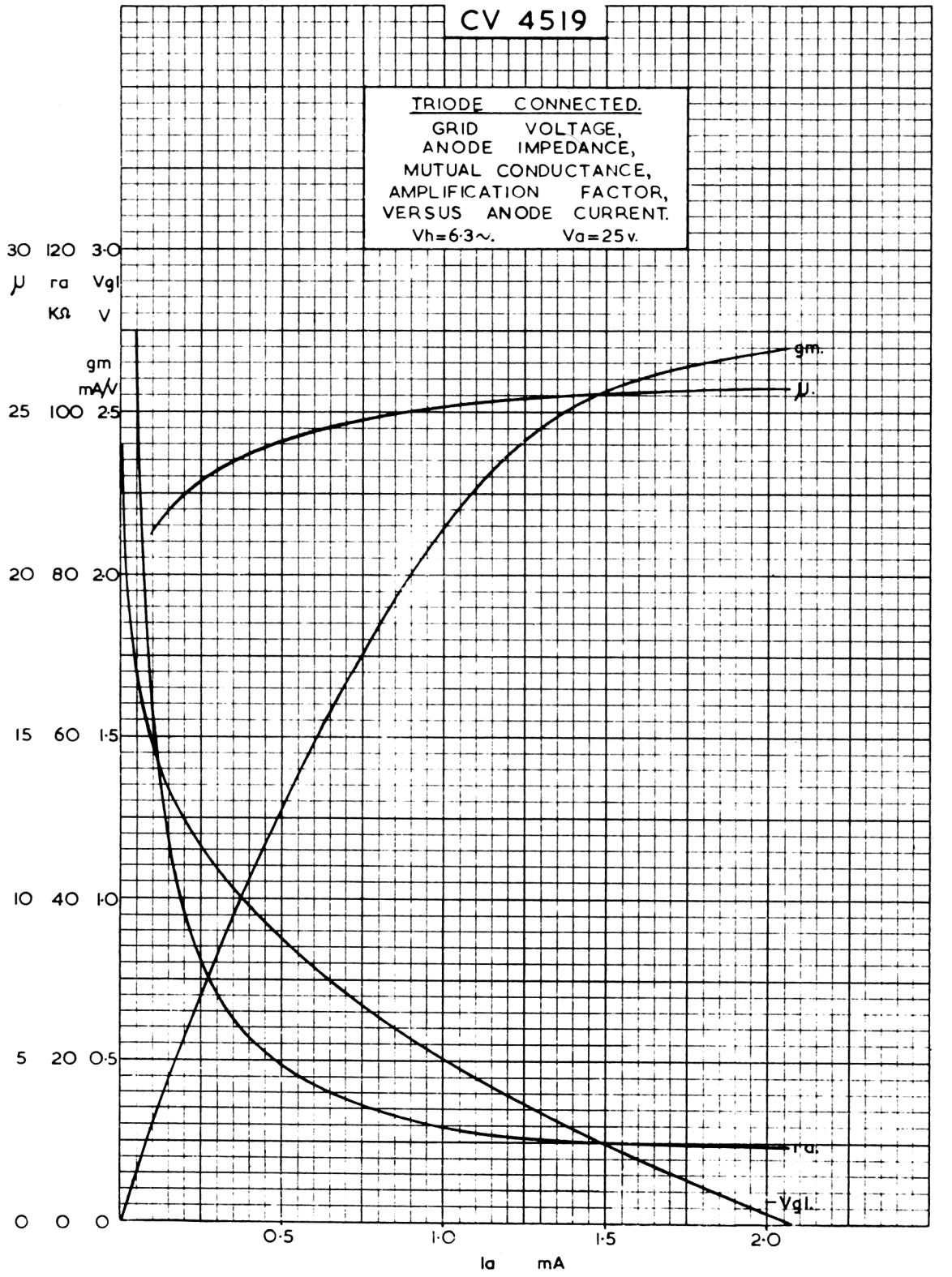

CV 4519
ANODE CURRENT
SCREEN CURRENT
ANODE IMPEDANCE
MUTUAL CONDUCTANCE
VERSUS GRID VOLTAGE
Vh=6·3~. Va=Vg2=50v.
100
ra
KΩ
4
80
Ia
Ig2
mA
Ia
3
60
gm
gm
mA/V
2
40
Ig2
1
20
ra
0
0
4
3
2
1
Vg1 Volts

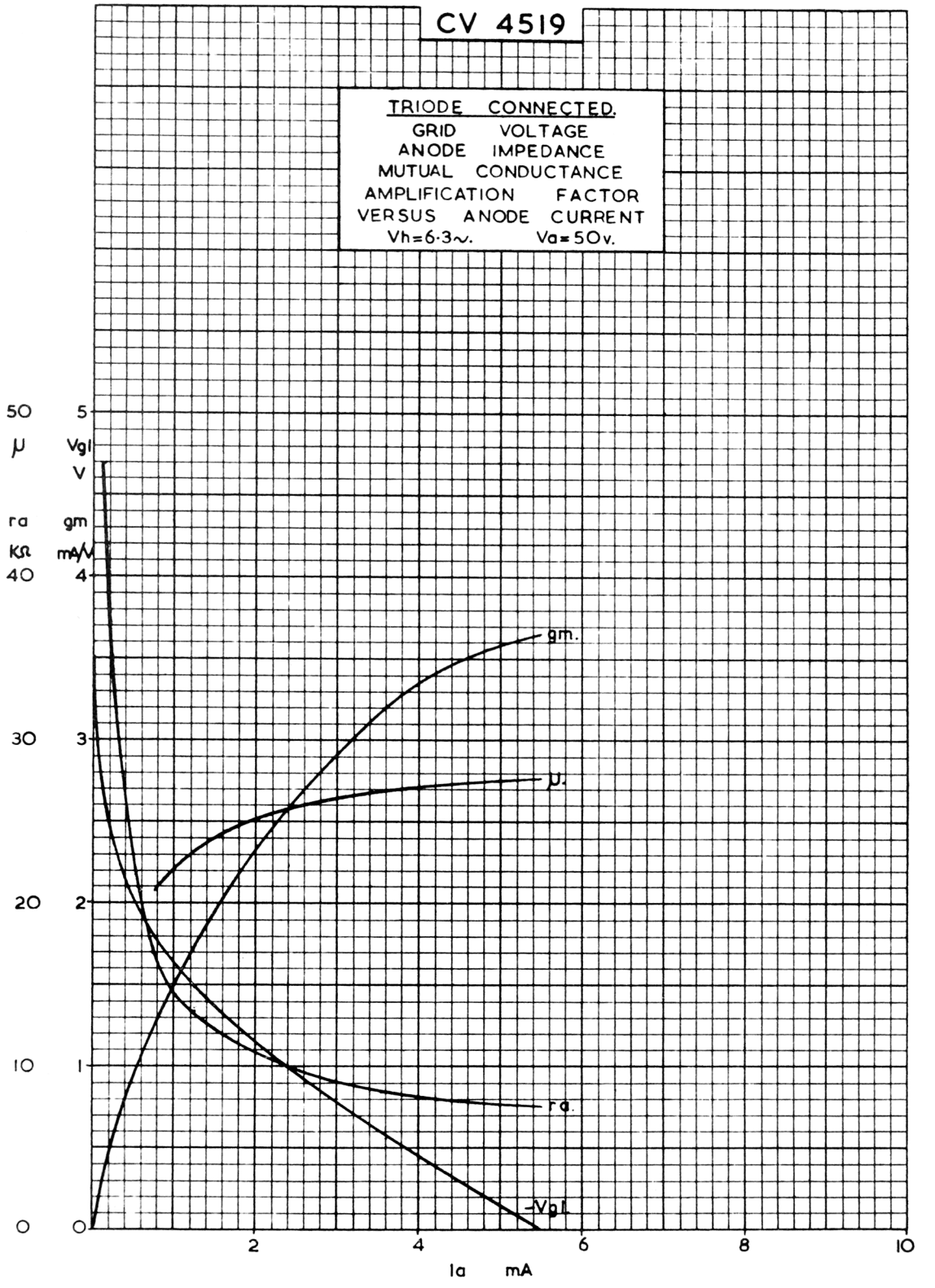

CV 4519
ANODE CURRENT
SCREEN CURRENT
MUTUAL CONDUCTANCE
VERSUS GRID VOLTAGE
Vh=6·3~. Va=Vg2=50v.
400
800
Ia
gm
Ig2
μA/V
μA
300
600
200
400
100
200
0
0
gm
Ia
Ig2
4·0
3·5
3·0
2·5
2·0
Vg1 Volts

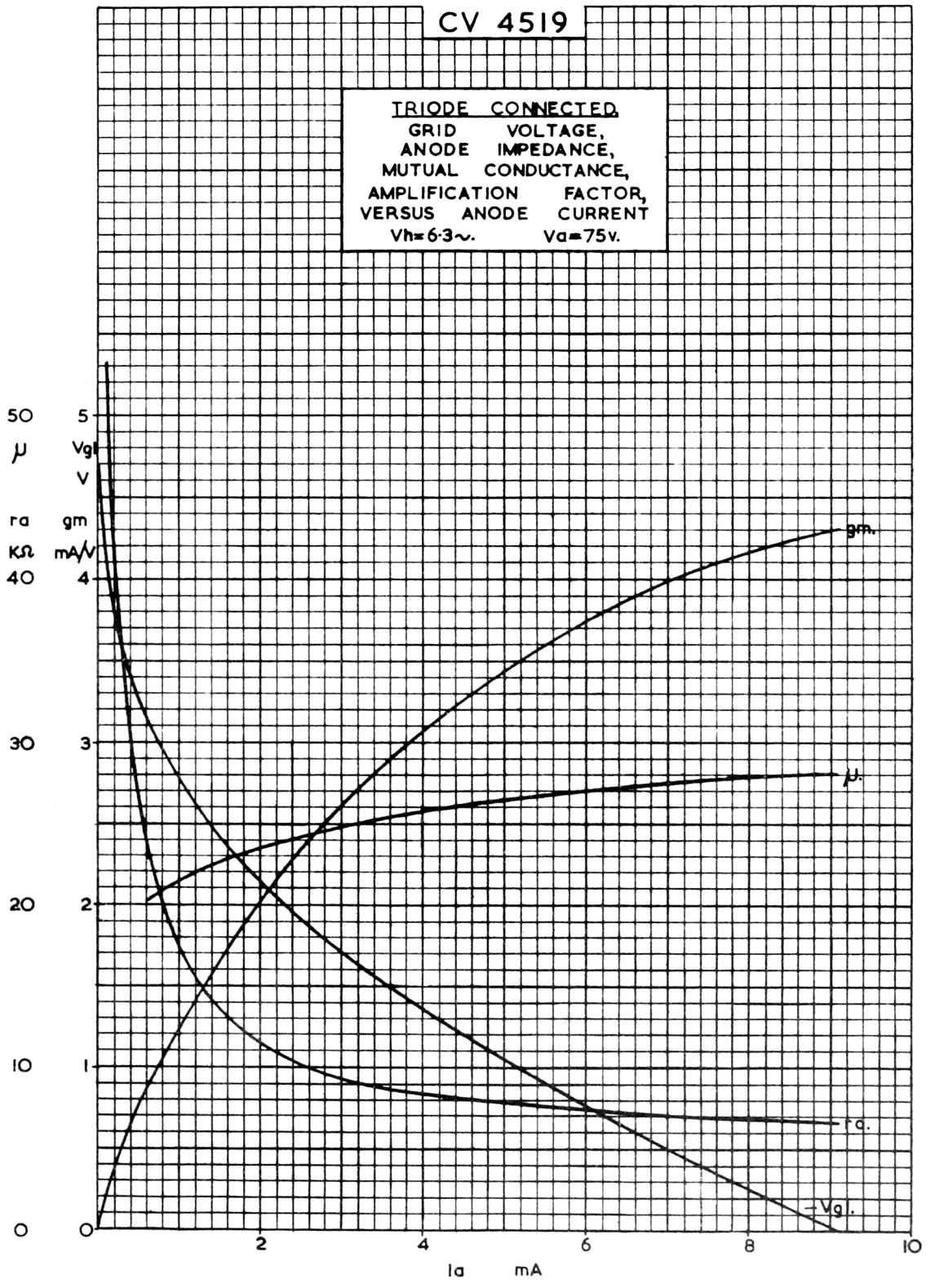
CV4519

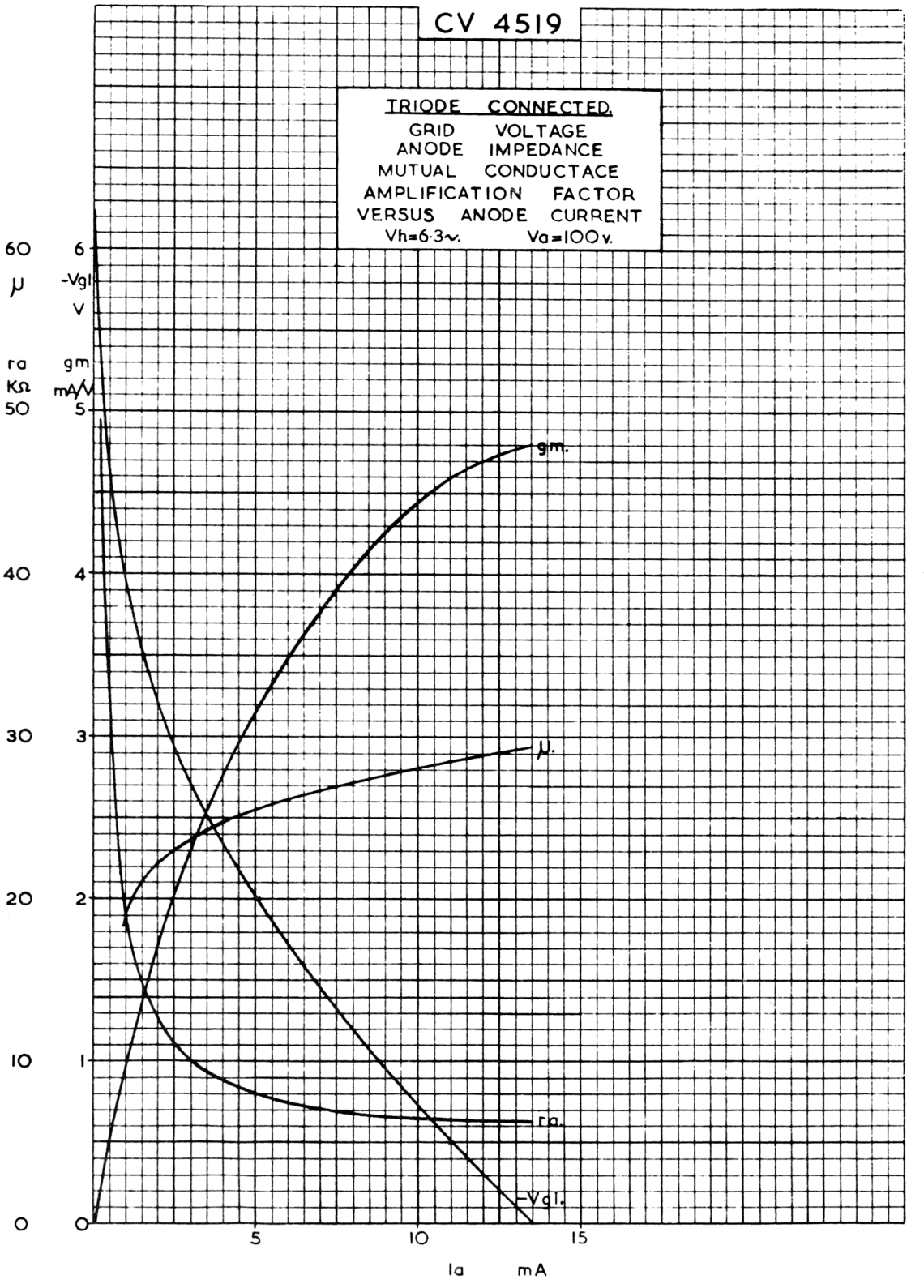

CV 4519
ANODE CURRENT
& SCREEN CURRENT
VERSUS ANODE VOLTAGE
Vh=6·3~. Vg2=50v.
Ia
Ig2
mA
4·0
3·0
2·0
1·0
0
20
40
60
80
100
Va Volts
Vg1=0
-0·5
-1·0
-1·5
-2·0
-2·5


CV 4519
TRIODE CONNECTED.
ANODE CURRENT VERSUS
ANODE VOLTAGE.
Vh=6·3~
Ia
mA
14
12
10
8
6
4
2
0
20
40
60
80
100
Va Volts
Vg1 = 0V.
-0·5V.
-1·0V.
-1·5V.
-2·0V.
-2·5V.
-3·0V.
-3·5V.
-4·0V.
-4·5V.
-5·0V.


CV 4519
TRIODE CONNECTED.
GRID VOLTAGE,
ANODE IMPEDANCE,
MUTUAL CONDUCTANCE,
AMPLIFICATION FACTOR,
VERSUS ANODE CURRENT.
Vh=6·3~. Va=25 v.
30 120 3·0
μ ra Vg1
KΩ V
gm
mA/V
25 100 2·5
20 80 2·0
15 60 1·5
10 40 1·0
5 20 0·5
0 0 0
gm.
μ.
ra.
Vg1.
0·5
1·0
1·5
2·0
Ia mA


CV 4519
TRIODE CONNECTED.
GRID VOLTAGE
ANODE IMPEDANCE
MUTUAL CONDUCTANCE
AMPLIFICATION FACTOR
VERSUS ANODE CURRENT
Vh=6·3~. Va=50v.
50 μ
5 Vgl V
ra KΩ
gm mA/V
40
4
30
3
20
2
10
1
0
0
gm.
μ.
ra.
-Vgl.
2
4
6
8
10
Ia mA


CV 4519
TRIODE CONNECTED.
GRID VOLTAGE,
ANODE IMPEDANCE,
MUTUAL CONDUCTANCE,
AMPLIFICATION FACTOR,
VERSUS ANODE CURRENT
Vh=6·3~. Va=75v.
50
μ
ra
KΩ
40
30
20
10
0
5
Vg1
V
gm
mA/V
4
3
2
1
0
gm.
μ.
ra.
-Vg1.
2
4
6
8
10
Ia mA


CV 4519
TRIODE CONNECTED.
GRID VOLTAGE
ANODE IMPEDANCE
MUTUAL CONDUCTACE
AMPLIFICATION FACTOR
VERSUS ANODE CURRENT
Vh=6·3v. Va=100v.
60
μ
ra
KΩ
50
40
30
20
10
0
6
-Vgl
V
gm
mA/V
5
4
3
2
1
0
gm.
μ.
ra.
-Vgl.
5
10
15
Ia mA

MAXIMUM VALUE OF GRID-TO-CATHODE RESISTOR

The value of the external grid to cathode resistor which can be used with a valve in circuit is limited by the negative grid current of the valve and the D.C. effective mutual conductance of the valve in the circuit.

In simple circuits, the maximum safe value of grid to cathode resistor can be obtained with the aid of the curves given on the next page, by taking the working slope from characteristic curves and calculating the value of the effective cathode resistor from the following equations:-

For Triodes:- $$Rk\ eff. = Rk + \frac{Ra}{\mu}$$

For Pentodes:- $$Rk\ eff. = \frac{Ik \times Rk}{Ia} + \frac{Ig2 \times Rg2}{Ia \times \mu(g1 - g2)}$$

Example

CV4502 operating as a voltage amplifier with Va(b)=250V, Ra=100K, Rg2=330K, Rk=560. Ia=2.0mA, Ig2=0.67mA, gm working=3.5mA/V.

$$\text{Then Rk eff.} = \frac{2.67 \times 560}{2.0} + \left(\frac{0.67}{2.0} \times \frac{330,000}{28}\right)$$

$$= 4715 \text{ ohms.}$$

From the curves for these values of Rk eff. and gm working:-

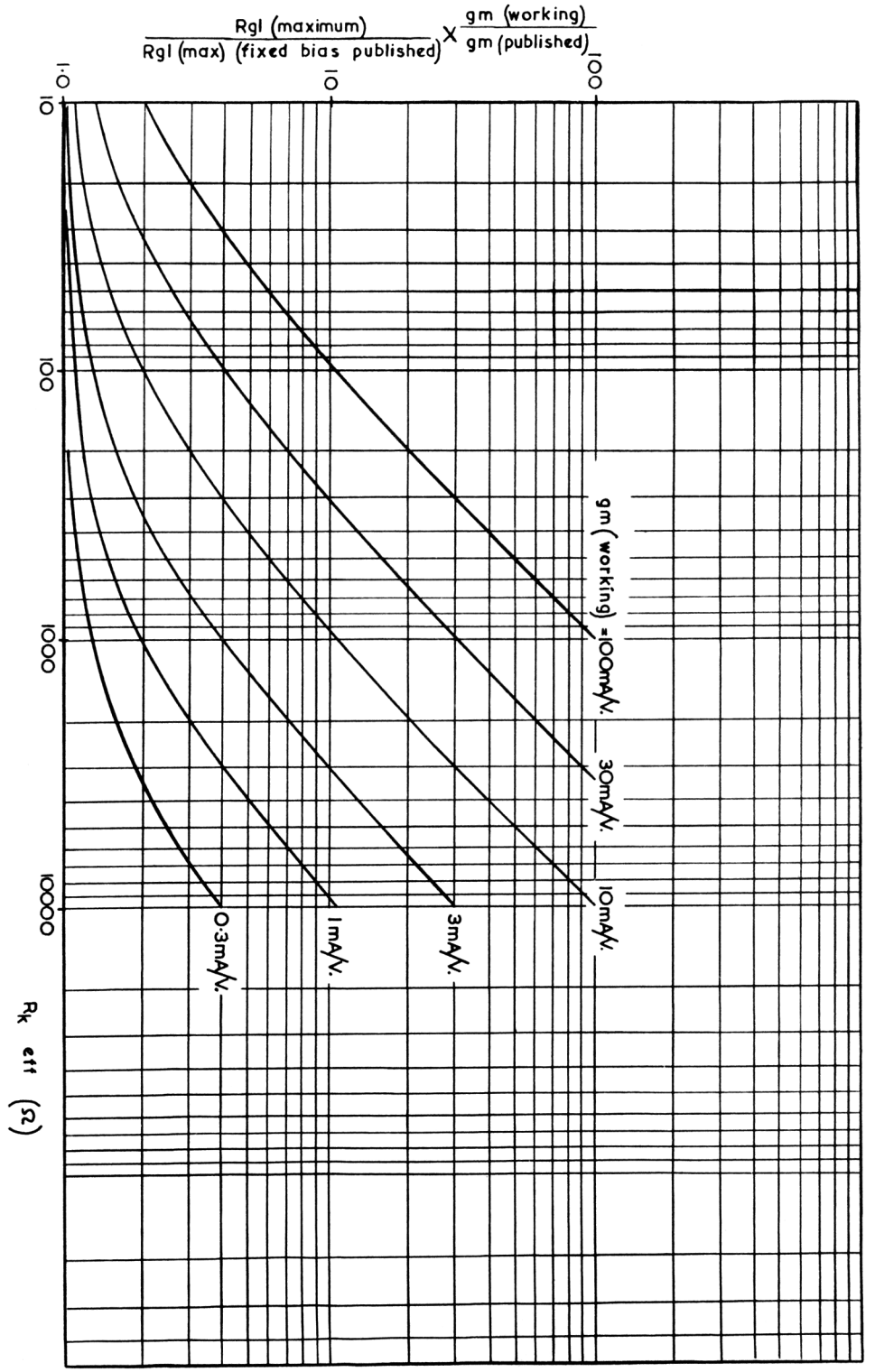
$$\frac{Rg1\ (maximum)}{Rg1(max)\ (Fixed\ bias\ published)} \times \frac{gm\ (working)}{gm\ (published)} = 16$$

$$\text{Therefore Rg1 maximum} = 16 \times 0.25 \times 10^6 \times \frac{5.2}{3.5} = 6M.$$

In more complex circuits, for example, those employing feedback additional to that given by a cathode, anode or screen grid resistor, or those having large signals and driven into positive grid current, the working slope and effective cathode resistor are difficult to assess. For these cases the maximum value of grid to cathode resistor in circuit is given by the following relationship:-

$$\frac{Rg1\ (maximum)}{Rg1\ (max)\ (fixed\ bias\ published)} = \frac{gm\ (published)}{gm\ (w:\ eff.)}$$

where the effective working mutual conductance gm (w: eff:) is obtained by measurement in the circuit and is the change of anode current that would occur in that circuit for unit change of grid voltage, where this change of voltage is that which would be caused by a change of negative grid current within the valve.


Rgl (maximum) / Rgl (max) (fixed bias published) X gm (working) / gm (published)
0·1
1·0
10
100
1000
10000
Rk eff (Ω)
gm (working) = 100mA/V.
30mA/V.
10mA/V.
3mA/V.
1mA/V.
0·3mA/V.