G.E.C. VALVES

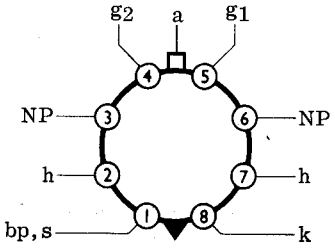
BEAM TETRODES

TT21 TT22

ISSUE 2

Beam tetrodes with oxide coated cathodes, the TT21 and TT22 are identical except for their heater ratings. They are designed for use as r. f. power amplifiers with full ratings at frequencies up to 30Mc/s and are also useful as audio output valves, pulse modulators and shunt and series stabilisers.

BASE CONNECTIONS AND VALVE DIMENSIONS



View from underside of base

Base: Octal (B8-0)
Bulb: Dome top tubular
Top cap: CT2 (9. 14mm dia. nom.)
Max. overall length: 131mm
Max. seated length: 116mm
Max. diameter: 52mm

HEATER	TT21	TT22	
V_h	6.3	12.6	V
I_h	1.6(approx)	0.8 (approx)	A

MAXIMUM RATINGS (Absolute)

	*CCS	†ICAS	
V_a	1.25	1.25	kV
V_a (I_a=0)	3.5	3.5	kV
V_{g2}	600	600	V
$-V_{g1}$	200	200	V
p_a	37.5	45	W
p_{g2}	6	6	W
p_{g1}	2	2	W
I_k	230	230	mA
$i_{k(pk)}$ (r.f.)	2	2	A
$i_{a(pk)}$ (pulse)	7.5	7.5	A
V_{h-k}	150	150	V
R_{g1-k} (fixed bias)	100	100	kΩ
R_{g1-k} (cathode bias)	220	220	kΩ
T_{bulb}	250	250	°C

*Continuous Commercial Service is defined as that type of service in which long life and reliability of performance under continuous operating conditions are the prime considerations.

†Intermittent Commercial and Amateur Service is defined as that type of service where minimum size, light weight and maximum power output are more important than long life.

Intermittent operation implies that no 'on' period exceeds 5 minutes and an 'on' period is followed by an 'off' period of the same or longer duration.

THE M-O VALVE CO. LTD . BROOK GREEN WORKS . LONDON . W.6
a subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND

MARCH 1965

TT21 TT22

CAPACITANCES

c_{a-g1} :0.25pF; $c_{g1\text{-all less a}}$:17pF; $c_{a\text{-all less g1}}$: 13.5pF

CHARACTERISTICS

V_a	250	V
V_{g2}	250	V
I_a	140	mA
g_m	11	mA/V
r_a	12	kΩ
μ_{g1-g2}	8	-

OPERATING DATA

A. F. POWER AMPLIFIER - CLASS AB1

The TT21 may be used as an alternative to the KT88 in any existing audio designs and the following conditions are typical:

Push-Pull. Cathode Bias. Tetrode Connection

$V_{a(b)}$	560	V
$V_{a(o)}$	521	V
V_{g2}	300	V
$I_{a(o)}$	2 x 64	mA
$I_{a(max.\ sig.)}$	2 x 73	mA
$I_{g2(o)}$	2 x 1.7	mA
$I_{g2(max.\ sig.)}$	2 x 9	mA
$R_{L(a-a)}$	9	kΩ
*R_k	2 x 460	Ω
$-V_{g1}$	30 (approx)	V
P_{out}	50	W
D_{tot}	3	%
†IM	11	%
$p_{a(o)}$	2 x 33	W
$p_{a(max.\ sig.)}$	2 x 12	W
$p_{g2(o)}$	2 x 0.5	W
$p_{g2(max.\ sig.)}$	2 x 2.7	W
$v_{in(g1-g1)(pk)}$	60	V

*It is essential to use two separate cathode bias resistors.

†Intermodulation distortion; measured using two input signals at 50 and 6000c/s (ratio of amplitudes 4:1).

Push-Pull. Fixed Bias. Tetrode Connection

$V_{a(b)}$	560	V
$V_{a(o)}$	552	V
V_{g2}	300	V
$I_{a(o)}$	2 x 60	mA
$I_{a(max.\ sig.)}$	2 x 145	mA
$I_{g2(o)}$	2 x 1.7	mA
$I_{g2(max.\ sig.)}$	2 x 15	mA
$R_{L(a-a)}$	4.5	kΩ
*$-V_{g1}$	34 (approx)	V
P_{out}	100	W
D_{tot}	2.5	%
†IM	10	%
$p_{a(o)}$	2 x 33	W
$p_{a(max.\ sig.)}$	2 x 28	W
$p_{g2(o)}$	2 x 0.5	W
$p_{g2(max.\ sig.)}$	2 x 4.5	W
$v_{in(g1-g1)(pk)}$	67	V

*It is essential to provide two separately adjustable bias voltage sources, having a voltage adjustment range of ±25%.

†Intermodulation distortion; measured using two input signals at 50 and 6000c/s (ratio of amplitudes 4:1).

Push-Pull. Cathode Bias. Ultra-Linear Connection
(40% Tapping Points)

$V_{a,g2(b)}$	500	375	V
$V_{a,g2(o)}$	436	328	V
$I_{a+g2(o)}$	2 x 87	2 x 87	mA
$I_{a+g2(max.\ sig.)}$	2 x 99	2 x 96	mA
$R_{L(a-a)}$	6	5	kΩ
*R_k	2 x 600	2 x 400	Ω
$-V_{g1}$	52 (approx)	35 (approx)	V
P_{out}	50	30	W
D_{tot}	1.5	1	%
†IM	4	3	%
$p_{a+g2(o)}$	2 x 38	2 x 28.5	W
$p_{a+g2(max.\ sig.)}$	2 x 17	2 x 16	W
$v_{in(g1-g1)(pk)}$	104	71	V
Z_{out}	4.8	4.5	kΩ

*It is essential to use two separate cathode bias resistors.

†Intermodulation distortion; measured using two input signals at 50 and 6000c/s (ratio of amplitudes 4:1).

TT21 TT22

Push-Pull. Fixed Bias. Ultra-Linear Connection
(40% Tapping Points)

$V_{a,g2(b)}$	560	460	V
$V_{a,g2(o)}$	553	453	V
$I_{a+g2(o)}$	2 x 50	2 x 50	mA
$I_{a+g2(max.\ sig.)}$	2 x 157	2 x 140	mA
$R_{L(a-a)}$	4.5	4	kΩ
*$-V_{g1}$	75 (approx)	59 (approx)	V
P_{out}	100	70	W
D_{tot}	2	2	%
†IM	11	10	%
$p_{a+g2(o)}$	2 x 27.5	2 x 22.5	W
$p_{a+g2(max.\ sig.)}$	2 x 33	2 x 27	W
$V_{in(g1-g1)(pk)}$	140	114	V
Z_{out}	7	6.5	kΩ

*It is essential to provide two separately adjustable bias voltage sources, having a voltage adjustment range of ±25%.
†Intermodulation distortion; measured using two input signals at 50 and 6000c/s (ratio of amplitudes 4:1).

Push-Pull. Cathode Bias. Triode Connection

$V_{a,g2(b)}$	400	485	V
$V_{a,g2(o)}$	349	422	V
$I_{a+g2(o)}$	2 x 76	2 x 94	mA
$I_{a+g2(max.\ sig.)}$	2 x 80	2 x 101	mA
$R_{L(a-a)}$	4	4	kΩ
$-V_{g1}$	40 (approx)	50 (approx)	V
P_{out}	17	31	W
D_{tot}	1.5	1.5	%
*IM	5.6	5.6	%
$p_{a+g2(o)}$	2 x 26.5	2 x 40	W
$p_{a+g2(max.\ sig.)}$	2 x 19	2 x 27	W
R_k	2 x 525	2 x 525	Ω
$V_{in(g1-g1)(pk)}$	78	114	V
Z_{out}	2	1.9	kΩ

*Intermodulation distortion; measured using two input signals at 50 and 6000c/s (ratio of amplitudes 4:1).

A.F. POWER AMPLIFIER AND MODULATOR - CLASS AB1 - FIXED BIAS
(Tetrode Connection)
Maximum Permissible Conditions - CCS

V_a	1.25	kV
V_{g2}	600	V
p_a	37.5	W
p_{g2}	6	W

Typical Operation
Performance in an amplifier at various signal levels.

$V_{a(b)}$	1000	1000	1000	1000	V
V_a	996	993	990	989	V
$V_{g2(b)}$	300	300	300	300	V
V_{g2}	300	300	299	298	V
*-$V_{g1(approx)}$	40	40	40	40	V
$V_{in(g1-g1)(pk)}$	0	32	51	64	V
I_a	2 x 35	2 x 55	2 x 79	2 x 90	mA
I_{g2}	2 x 0.35	2 x 1.2	2 x 4.5	2 x 11.5	mA
P_{out}	0	40	100	140	W
$R_{L(a-a)}$	16800	16800	16800		Ω
D	1.25	1.5	4.8		%

*Must be separately adjusted on each valve with no signal. Bias supply should have an adjustment range of 30-50V.

R.F. POWER AMPLIFIER - CLASS C TELEGRAPHY
Maximum Permissible Conditions

	CCS	ICAS	
V_a	1.25	1.25	kV
V_{g2}	600	600	V
-V_{g1}	200	200	V
I_a	200	200	mA
p_a	37.5	45	W
P_{in}	200	220	W
p_{g2}	6	6	W
p_{g1}	2	2	W

TT21 TT22

Typical Operation - CCS

V_a	500	800	1000	1250	V
V_{g2}	300	300	300	300	V
$-V_{g1}$	115	115	115	115	V
I_a	192	182	175	160	mA
I_{g2}	20	20	20	20	mA
I_{g1}	8.5	7	5.5	4.5	mA
p_a	37.5	37.5	37.5	37.5	W
p_{g2}	6	6	6	6	W
P_{out}	58.5	108.5	137.5	162.5	W
Efficiency	61	75	78	81	%
*P_L	52	95	115	132	W
P_{out} (driver)	2.1	1.9	1.8	1.6	W

*Measured at 30Mc/s.

Typical Operation - ICAS

			*	*		
V_a	500.	800	1000	1000	1250	V
V_{g2}	300	300	300	300	300	V
$-V_{g1}$	115	115	115	60	115	V
I_a	200	200	190	175	175	mA
I_{g2}	20	20	20	20	20	mA
I_{g1}	9	9	7.5	4	6	mA
p_a	40	43	45	45	45	W
p_{g2}	6	6	6	6	6	W
P_{out}	60	117	145	130	174	W
Efficiency	59	74	76.5	74.5	79.5	%
†P_L	52	103	126	106	146	W
P_{out} (driver)	2.1	2.1	2	0.65	1.9	W

*These operating conditions demonstrate the effect of reduced bias and driving power on power output.
†Measured at 30Mc/s.

R.F. POWER AMPLIFIER - CLASS C - ANODE MODULATED (Carrier Conditions)
Maximum Permissible Conditions

	CCS	ICAS	
V_a	1	1	kV
V_{g2}	600	600	V
$-V_{g1}$	200	200	V
I_a	160	180	mA
p_a	25	30	W
P_{in}	130	150	W
p_{g2}	6	6	W
p_{g1}	2	2	W
Modulation	100	100	%

Typical Operation - CCS

V_a	550	700	850	1000	V
V_{g2}	300	300	300	300	V
$-V_{g1}$	115	115	115	115	V
I_a	160	150	140	130	mA
I_{g2}	20	20	20	20	mA
I_{g1}	5	3.5	3	2.5	mA
p_a	25	25	25	25	W
p_{g2}	6	6	6	6	W
P_{out}	63.5	80	95	105	W
Efficiency	72	76	80	81	%
*P_L	54	70	82	87	W
P_{out} (driver)	1.5	1.4	1.2	1.1	W
P_{mod}	50	60	68	75	W

*Measured at 30Mc/s.

Typical Operation - ICAS

V_a	550	700	850	1000	V
V_{g2}	300	300	300	300	V
$-V_{g1}$	115	115	115	115	V
I_a	180	175	165	150	mA
I_{g2}	20	20	20	20	mA
I_{g1}	6.5	5.5	5	3.5	mA
p_a	30	30	30	30	W
p_{g2}	6	6	6	6	W
P_{out}	69	92	110	123	W
Efficiency	70	75.5	78.5	82	%
*P_L	61	82	94	101	W
P_{out} (driver)	1.8	1.7	1.5	1.2	W
P_{mod}	55	68	80	85	W

*Measured at 30Mc/s.

R.F. POWER AMPLIFIER - CLASS AB1 - SSB
Maximum Permissible Conditions

	CCS	ICAS	
V_a	1.25	1.25	kV
V_{g2}	600	600	V
$-V_{g1}$	200	200	V
p_a	37.5	45	W
p_{g2}	6	6	W
p_{g1}	2	2	W

TT21 TT22

Typical Operation

	CCS		ICAS		ICAS † (Speech Only)		
V_a	800		1000		1250		V
V_{g2}	300		300		300		V
*-V_{g1}	38		40		45		V
$v_{g1(pk)}$	38		40		45		V
$I_{a(o)}$	40		35		28		mA
$I_{g2(o)}$	0.5		0.3		-		mA
$P_{a(o)}$	32		35		35		W
	2-tone	1-tone	2-tone	1-tone	2-tone	1-tone	
$I_{a(max)}$	86	122	82	116	85	136	mA
$I_{g2(max)}$	4.5	11	5	10	4	8	mA
$I_{g1(max)}$	0	0	0	0	0	0	
$P_{a(max)}$	34	30	42	34.5	42	62	W
$P_{g2(max)}$	1.4	3.3	1.5	3.0	1.2	2.4	W
P_{out} (mean)	34	68	40	80	54	108	W
PEP_{out}	68		80		108		W
Z_a	4.5	4.5	6.5	6.5	6.5	6.5	kV
Efficiency	46.5	63	49	69	51	61.5	%
P_{load} (mean)	32	64	38	76	50	100	W
PEP_{load}	64		76		100		W
‡D_3	34		32		25		dB
‡D_5	49		46		38		dB

*Adjust to obtain specified value of $I_{a(o)}$

†This condition only permissible with speech or similar waveforms having a peak to mean ratio greater than 3:1

‡Measured with reference to either of the two tones.

PULSE MODULATOR SERVICE
Maximum Permissible Conditions

V_a	3.5	kV
V_{g2}	600	V
-V_{g1}	200	V
P_a	37.5	W
P_{g2}	6	W
P_{g1}	2	W
$i_{a(pk)}$	7.5	A

Typical Operation

V_a	3.5	kV
V_{g2}	600	V
$-V_{g1}$	150	V
$v_{g1(pk)}$	380	V
$i_{a(pk)}$	6	A
$i_{g2(pk)}$	2.1	A
$i_{g1(pk)}$	2.3	A
R_a	460	Ω
t_p	2	μs
PRF	1500	p/s

INSTALLATION

The valve may be mounted either vertically or horizontally.

When a pair of valves is mounted vertically it is recommended that the centres of the valveholders are not less than 4in. apart and that pins 4 and 8 of each valve are in line.

When a pair of valves is mounted horizontally it is recommended that the centres of the valveholders are not less than 4in. apart and that pins 4 and 8 of each valve are in the same vertical line.

Free air circulation around the valve is desirable.

Certain valves of early manufacture have the beam plates connected internally to cathode.

OPERATING NOTES

In order to prevent parasitic oscillation, it is desirable to use a grid stopper resistor mounted close to the valveholder. In Class AB1 audio circuits this may have a value up to 10kΩ reducing to about 100Ω in r.f. circuits, when an anode stopper consisting of a 100Ω $\frac{1}{4}$W resistor overwound with $2\frac{1}{2}$ turns of 18 s. w. g. copper wire may also be necessary. The usual practice of using a single chassis point for all earth returns should always be adopted in r. f. equipment.

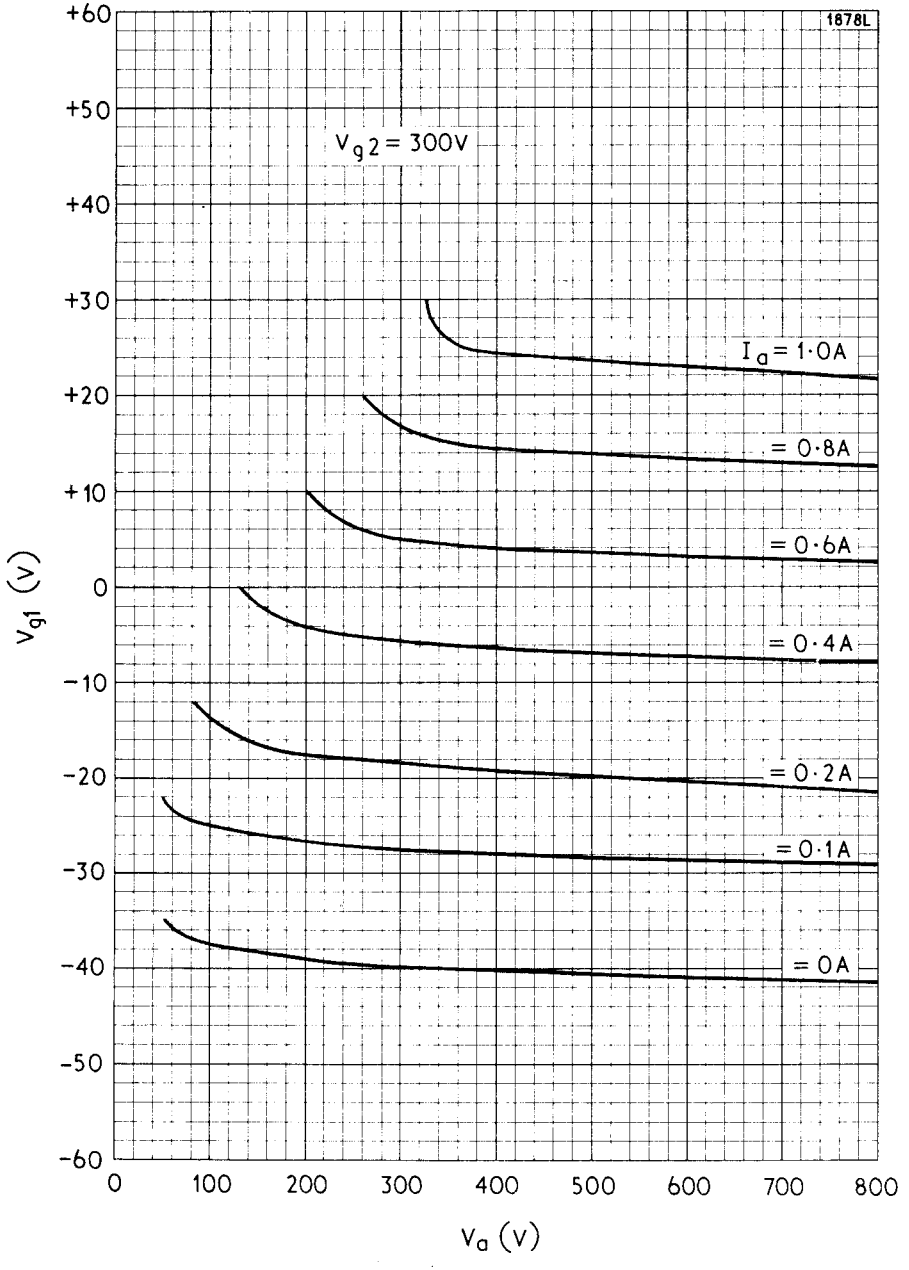


Fig. 1. Constant anode current curves at V_{g2}= 300V

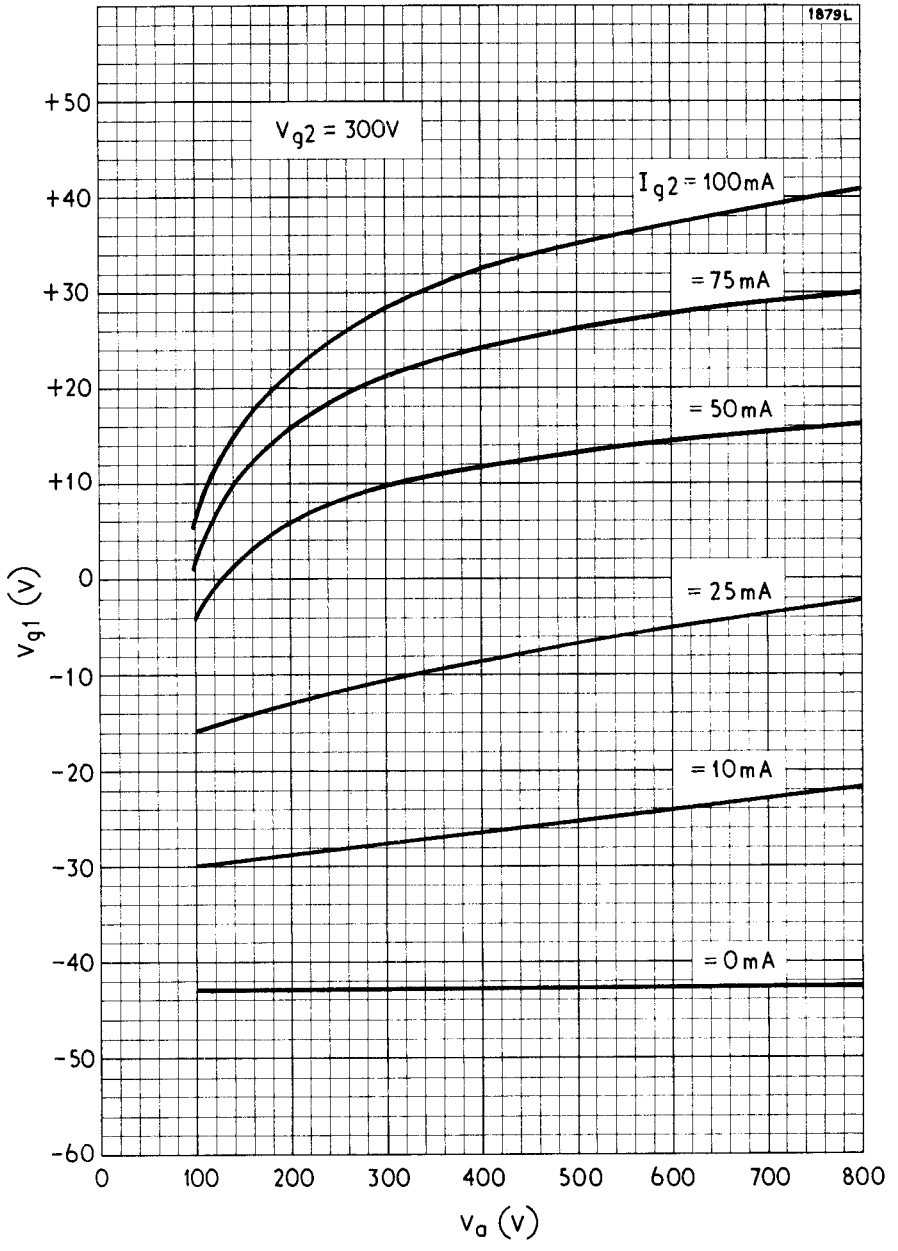


Fig. 2. Constant screen current curves at V_{g2}= 300V

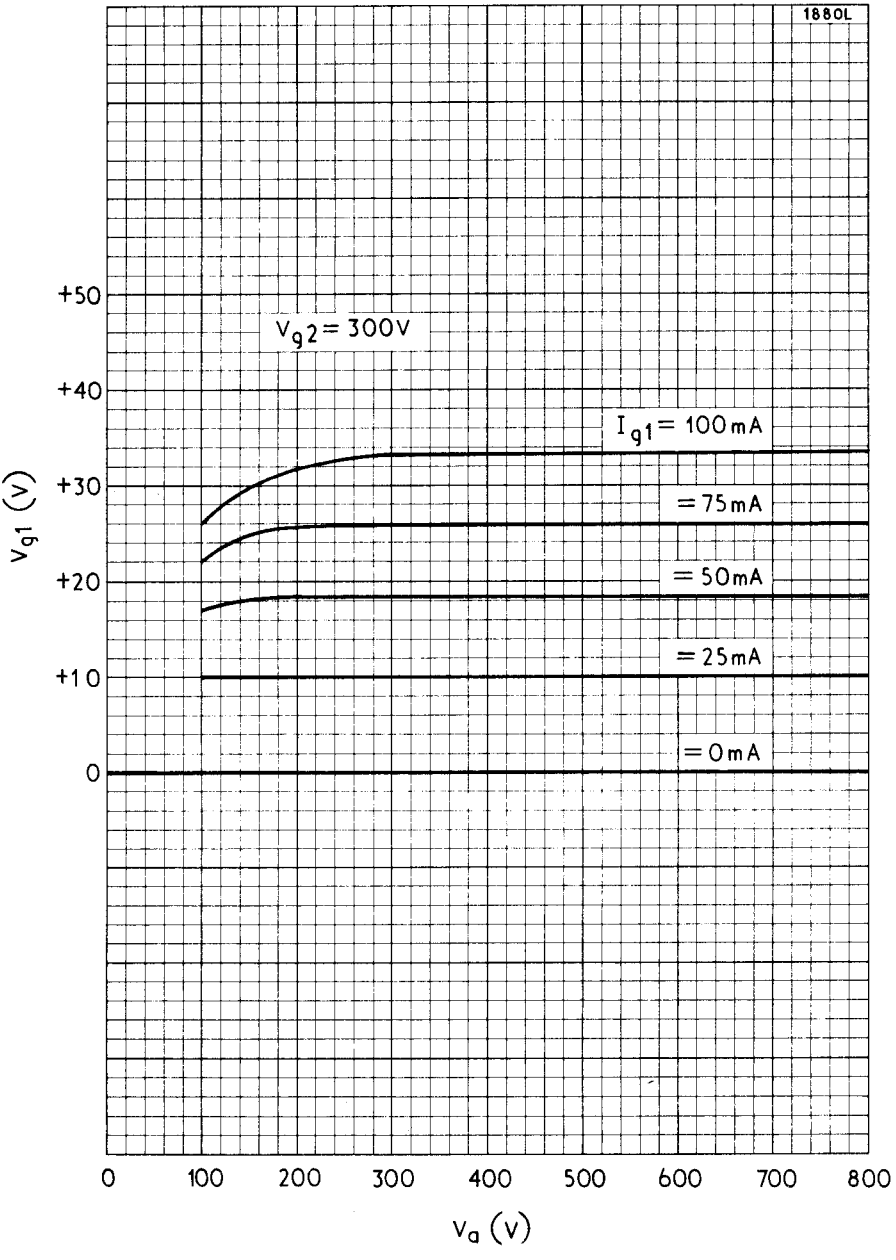


Fig. 3. Constant grid current curves at V_{g2}= 300V

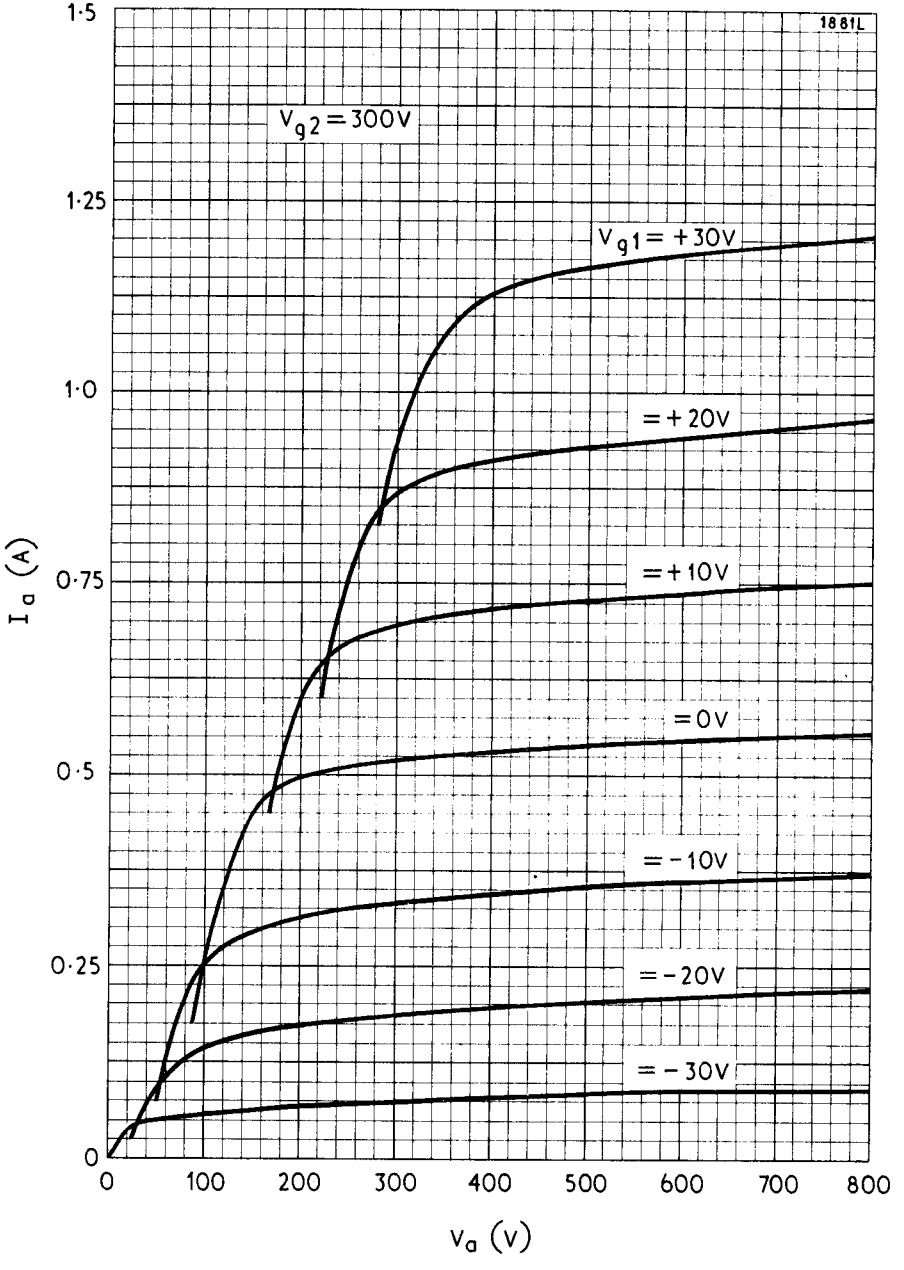


Fig. 4. Anode current curves at V_{g2}=300V

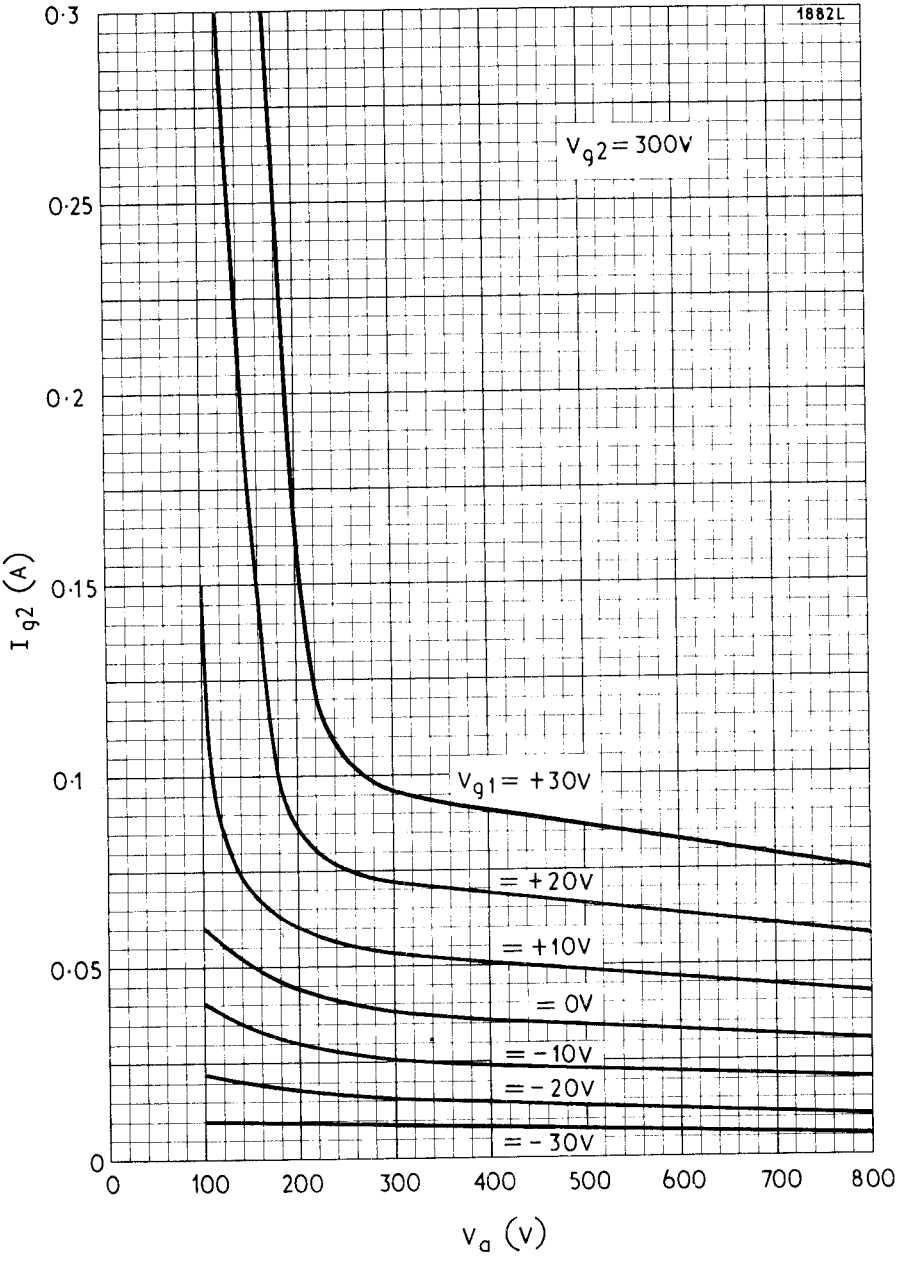


Fig. 5. Screen current curves at V_{g2}= 300V

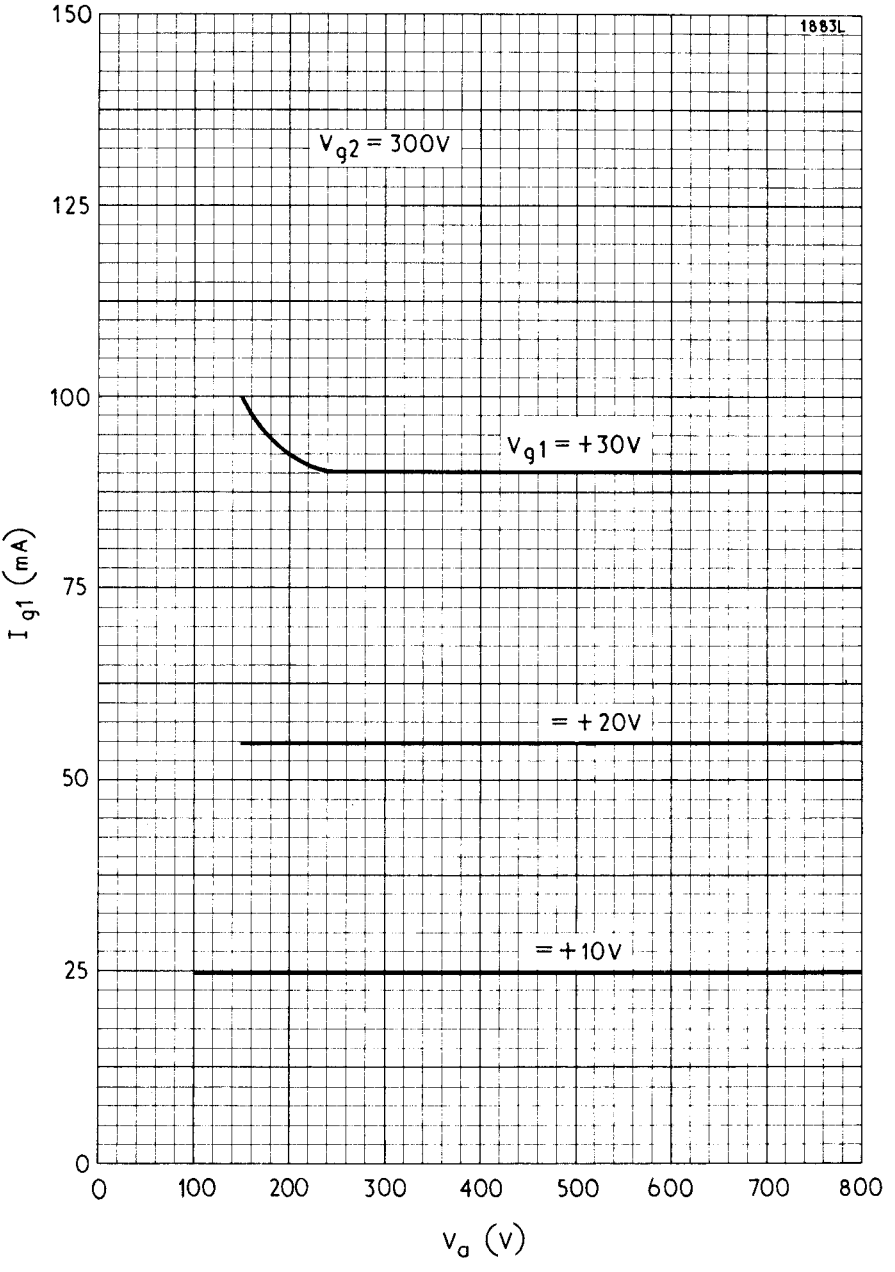


Fig. 6. Grid current curves at V_{g2}= 300V

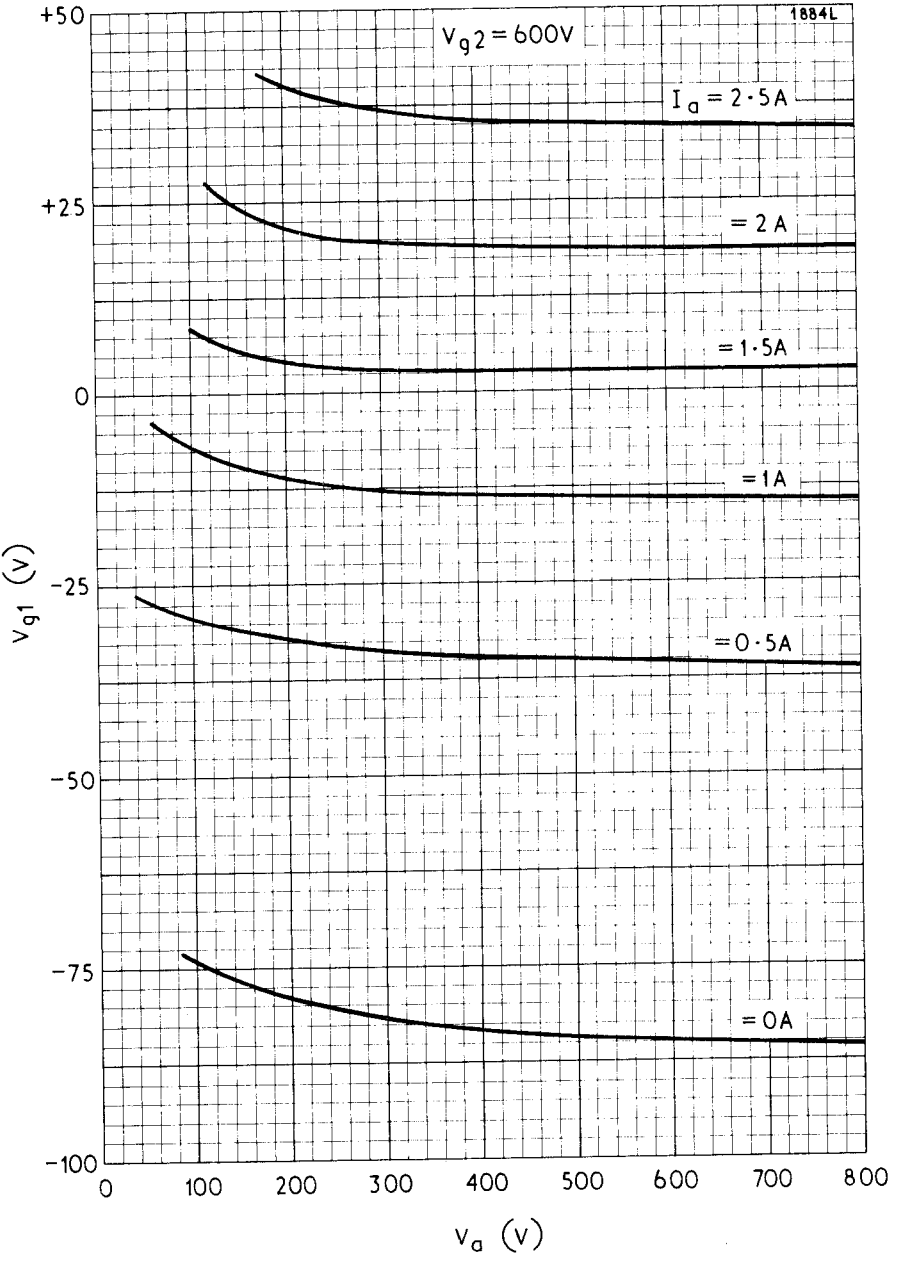


Fig. 7. Constant anode current curves at V_{g2}= 600V

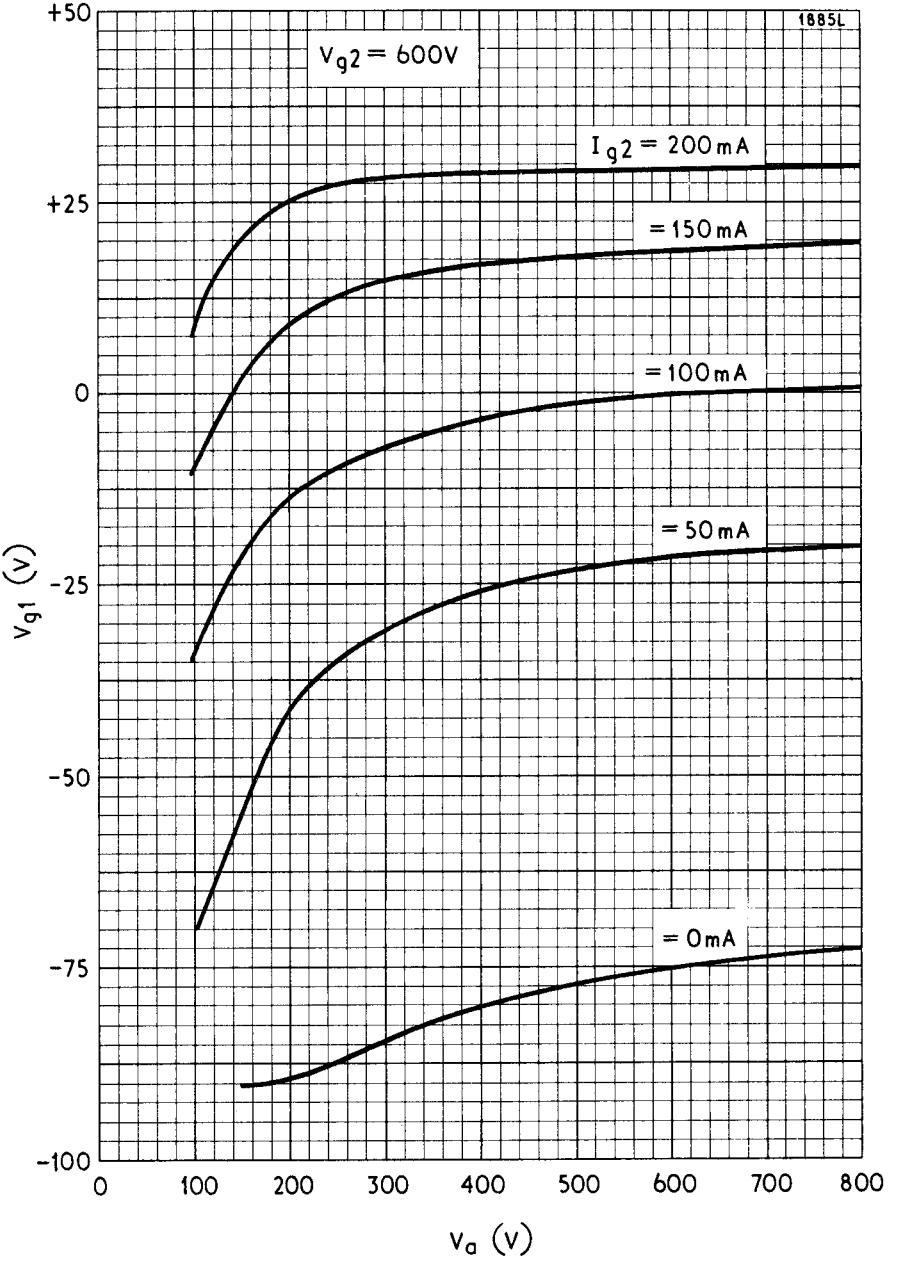


Fig. 8. Constant screen current curves at V_{g2}= 600V

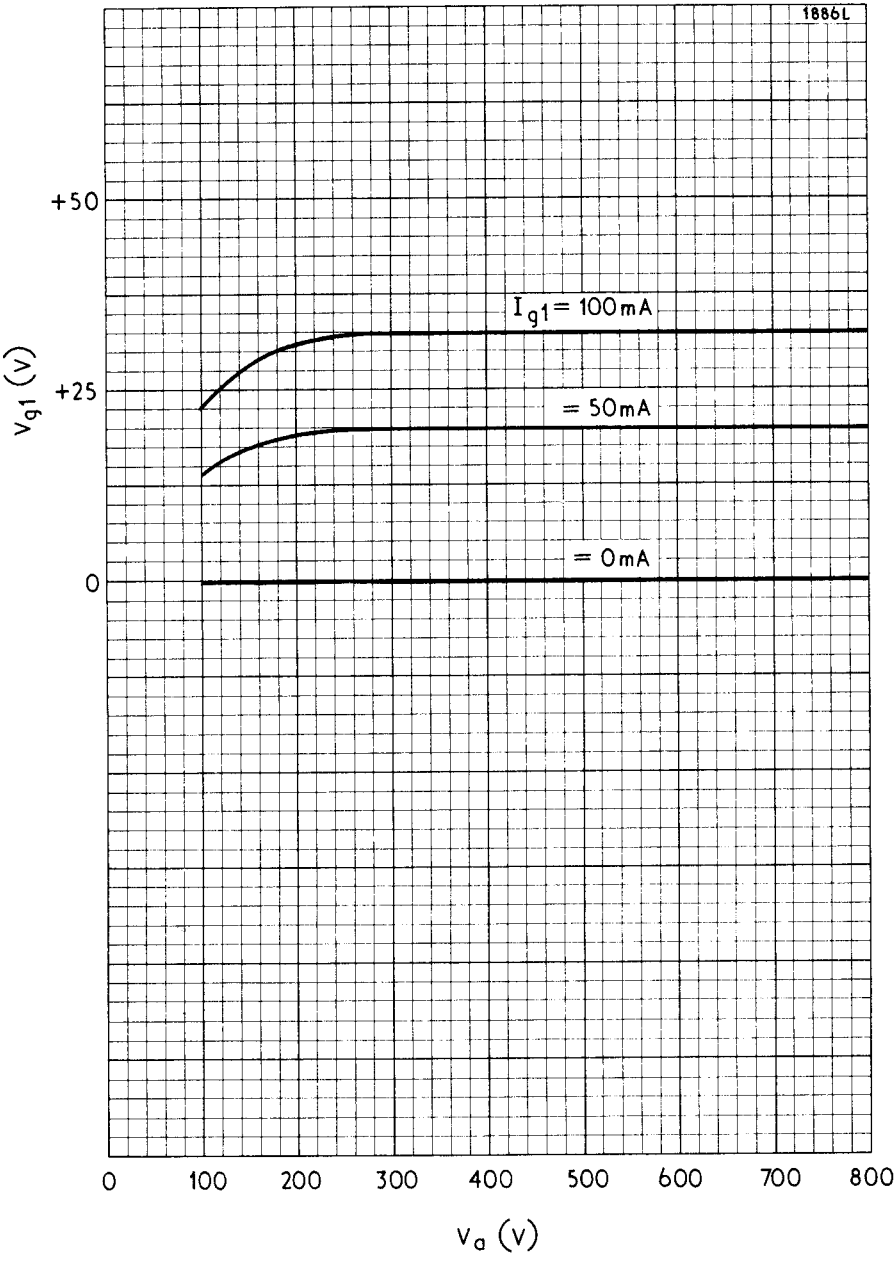


Fig. 9. Constant grid current curves at V_{g2}= 600V

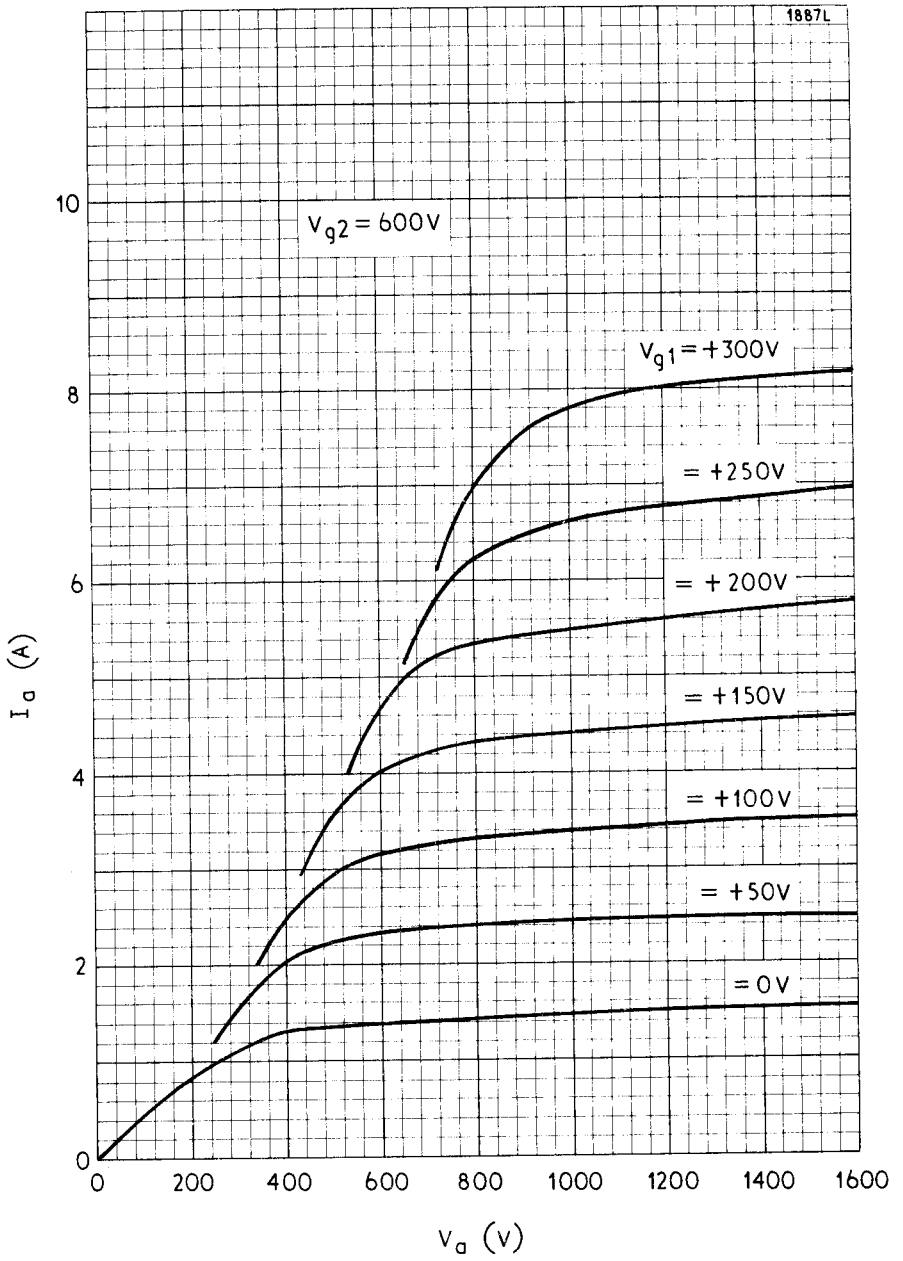


Fig. 10. Anode current curves for pulse modulator applications

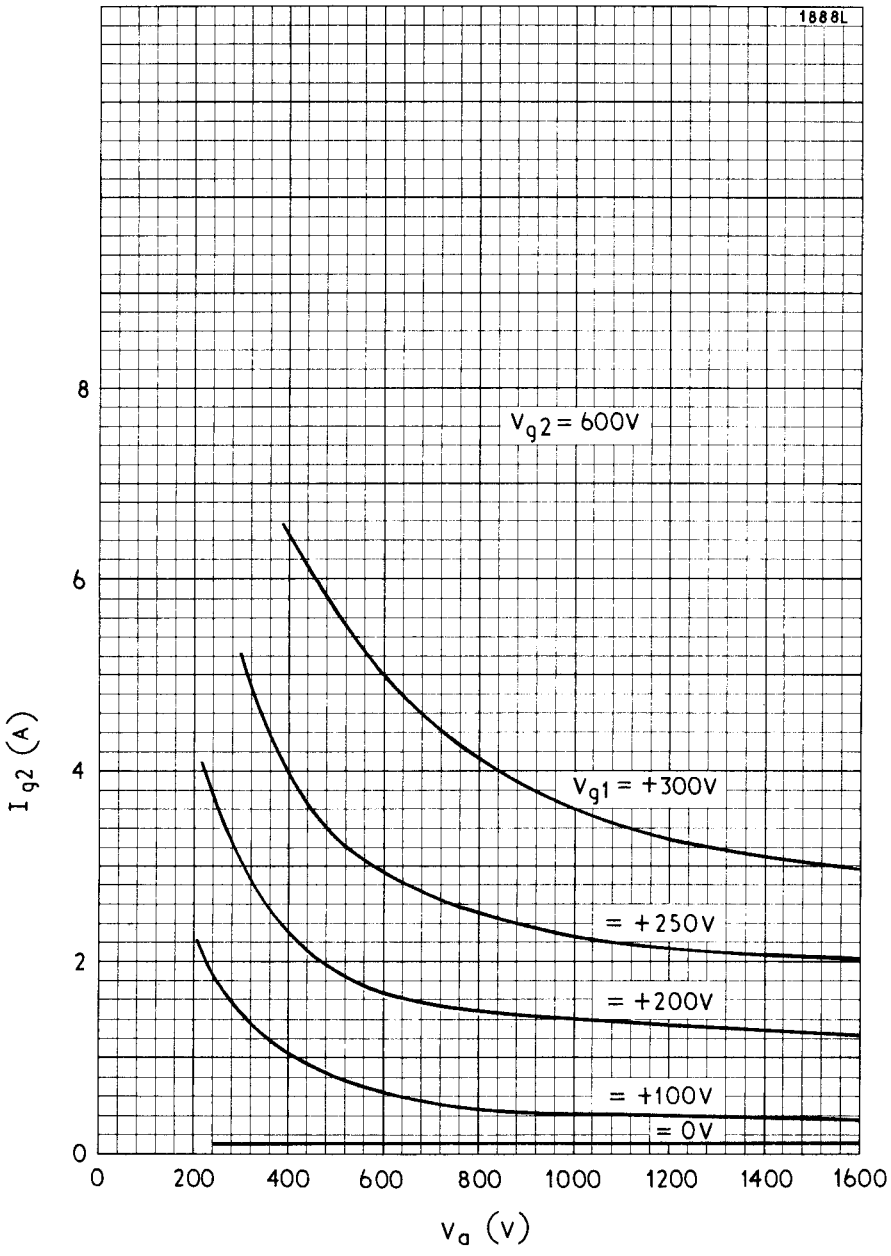


Fig. 11. Screen current curves for pulse modulator applications

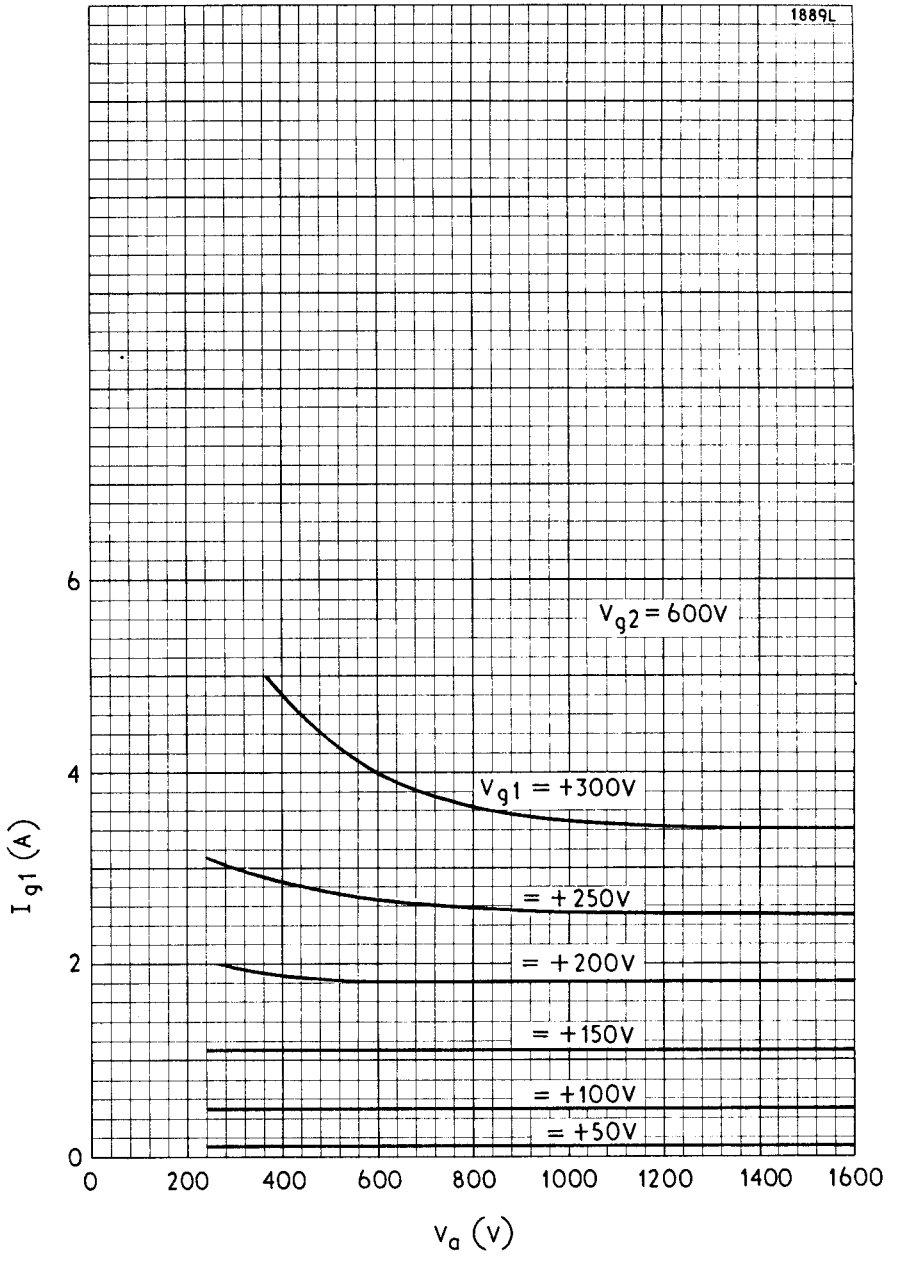


Fig. 12. Grid current curves for pulse modulator applications

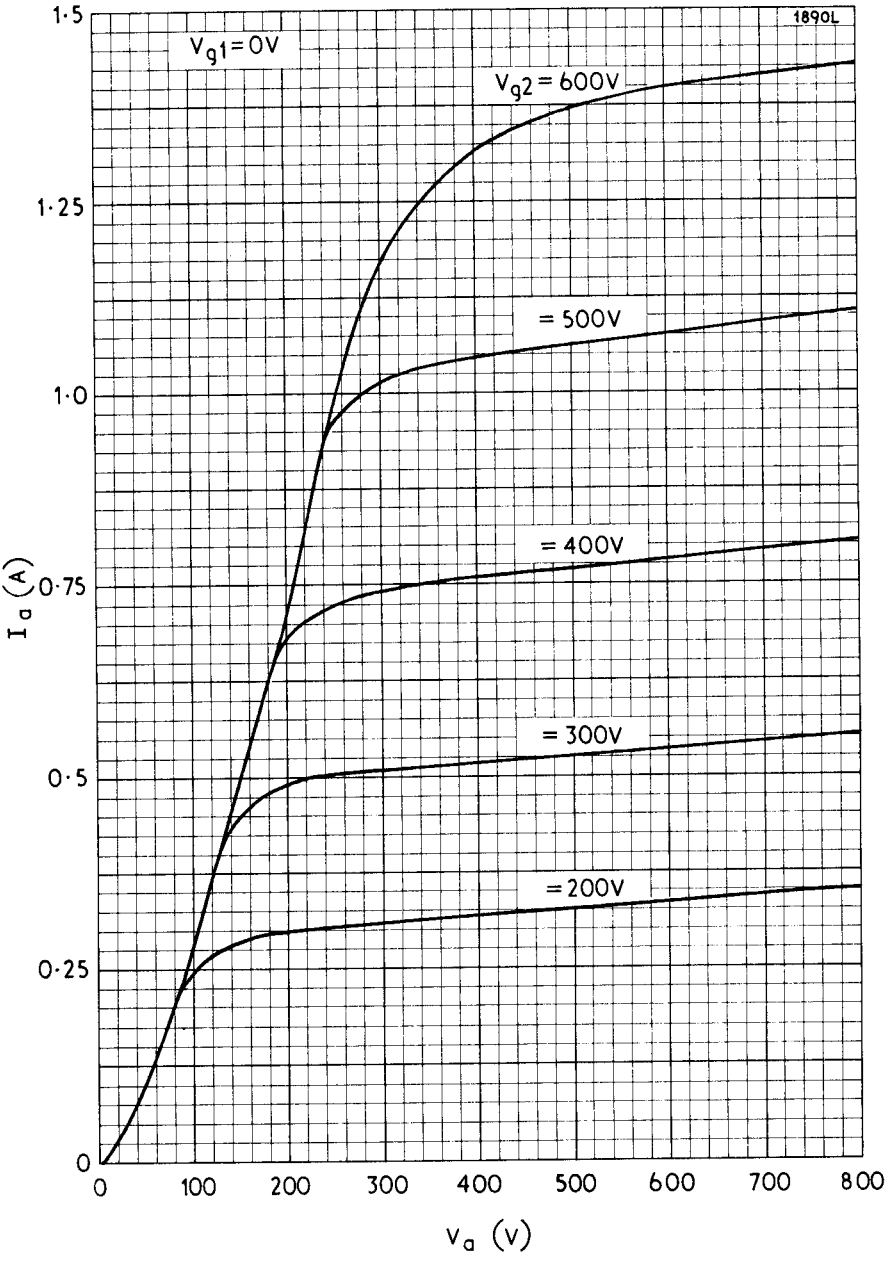


Fig. 13. Anode current curves for V_{g1}= 0V with V_{g2} as parameter

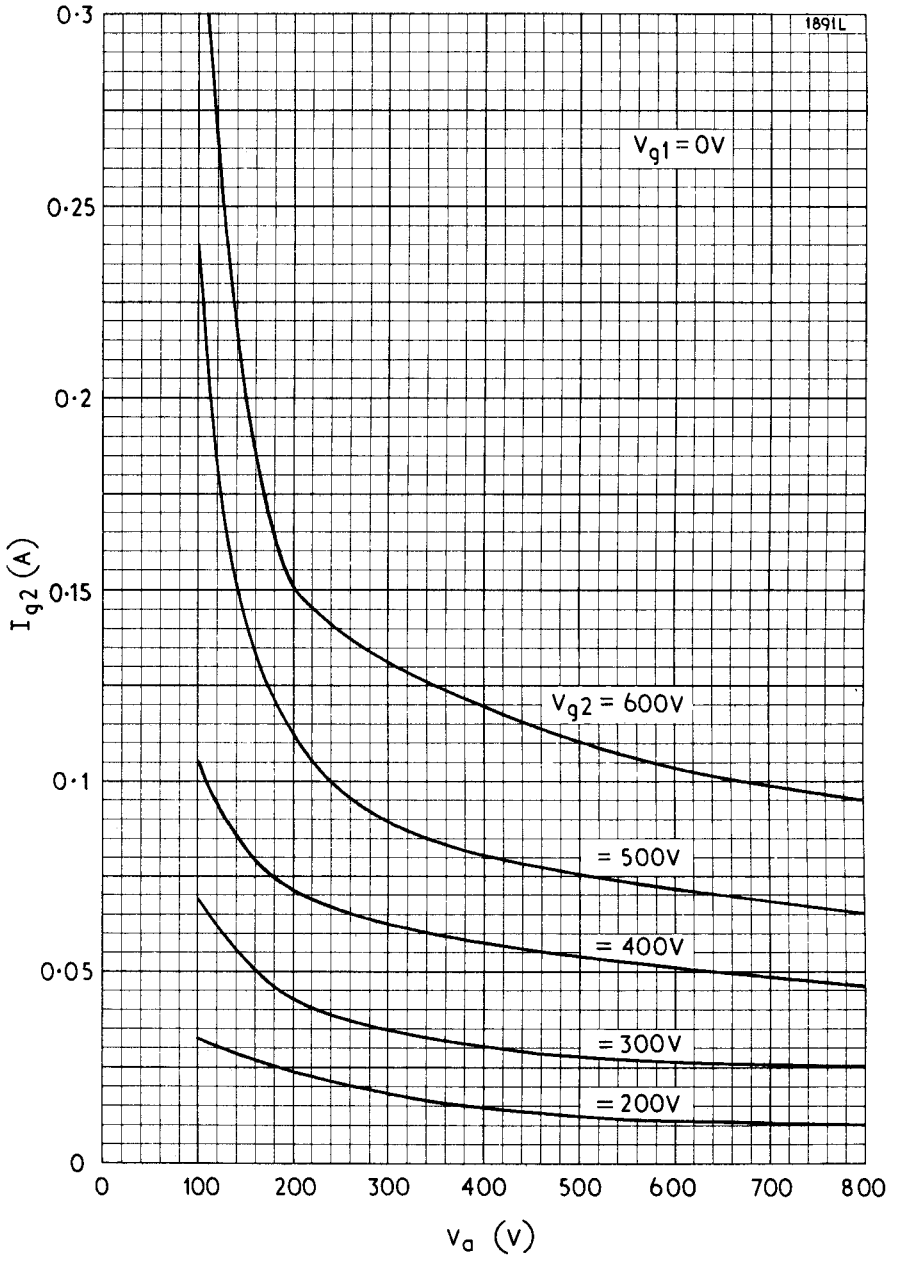


Fig. 14. Screen current curves for V_{g1}= 0V with V_{g2} as parameter

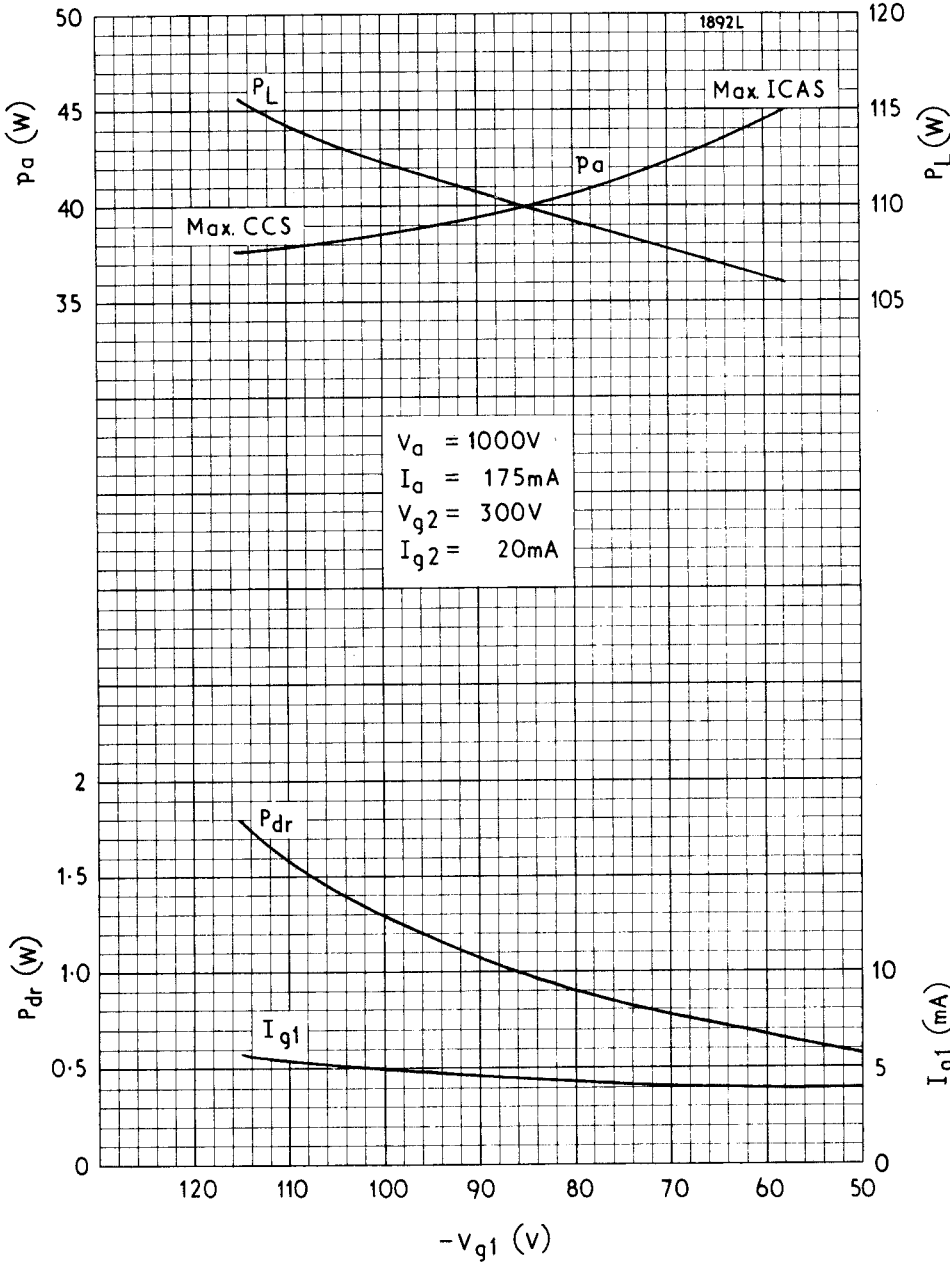


Fig. 15. Class C Telegraphy. Bias variation curves

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