

MULTI-PURPOSE TRIODE-PENTODE ECL 80

DESCRIPTION

In all stages of the picture channel and in the I.F. stages of the sound channel of a television receiver single tubes are used almost exclusively. In other stages, however, tubes with two electrode

supply, A.C. or D.C., the heater voltage and current being 6.3 V and 0.3 A respectively.

Some of the wide variety of functions for which the ECL 80 may be employed are listed below:

	Triode section	Pentode section
1	Frame-blocking oscillator	Frame output
2	Line-blocking oscillator	Frame output
3	A.F. voltage amplifier	Sound output
4	Frame or line oscillator	Sync. separator
5	Half of frame multivibrator	Frame output
6	Frame interlace tube	Sync. separator
7	One half of line multivibrator	Other half of line multivibrator

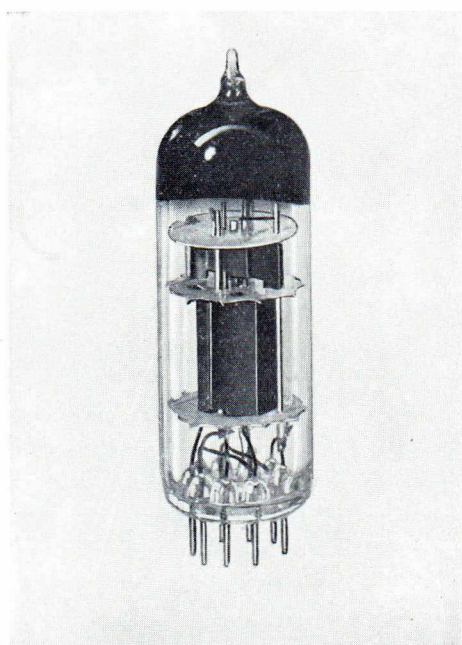


Fig. 72. The triode-pentode ECL 80 (actual size).

systems in one envelope are frequently used. This obviously reduces the total number of tubes to be employed, thus effecting economies in chassis space and also in the cost of the receiver. The most commonly used multiple tubes are double diodes and double triodes, but in some applications a pentode system would offer advantages. However, each section of a double pentode of small dimensions will normally be incapable of providing sufficient power to permit it to be used in the frame output stage or as the sound output tube. These considerations have led to the design of a triode-pentode, type ECL 80, which is not only suitable for a large number of functions but is also of small dimensions. The heater of this triode-pentode is suitable for either series or parallel

APPLICATION

1. TRIODE AS FRAME BLOCKING OSCILLATOR

PENTODE FOR FRAME OUTPUT (rectangular picture 7 kV)

Provided deflection coils of reasonable efficiency are available, the pentode section of the ECL 80 can be used as the frame output tube at a high-tension line voltage of 170 V to 200 V for a picture tube MW 31-16 or MW 22-16 operating with 7 kV E.H.T. and presenting a rectangular picture. Double-D scanning is also often used and, having regard to the larger picture area, it is advisable to employ a higher E.H.T., for example 9 kV. This increases the required deflection power quite considerably, and if the ECL 80 is again to be used as the frame output tube it is necessary to feed the anode of the pentode section from a higher supply voltage, which may well be the boosted high tension in the line output circuit. As previously shown, it is also possible in this case to use a PL 82 instead, which can be fed from the normal high-tension line.

Fig. 73 gives a circuit of the ECL 80 as frame blocking oscillator and frame output tube operating with a line voltage of 180 V. This circuit is suitable for the vertical deflection of a picture tube MW

31-16 or MW 22-16 provided the E.H.T. is not higher than 7 kV and a rectangular picture is used.

The pentode grid is supplied with a saw-tooth voltage from the grid circuit of the blocking oscillator, as a more linear saw-tooth is obtained for the same H.T. voltage than from an RC network in the

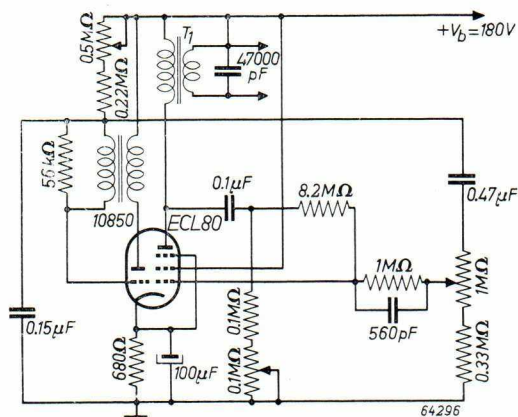


Fig. 73. Circuit for vertical scanning of a rectangular picture on a picture tube MW 22-16 or MW 13-16 operating at 7 kV second-anode voltage.

anode circuit. A blocking transformer type 10850 can be used, the turns ratio of which from the grid circuit to the anode is 2 : 1. The horizontal hold is effected with a potentiometer of 0.5 MΩ in the grid circuit. For the synchronization negative-going pulses can be applied to the anode of the triode section.

The data of the frame output transformer T_1 are not given in fig. 73 because these depend upon the characteristics of the deflection coils used. An output transformer can be calculated on the lines indicated in the application notes of the PL 82, but it should be realized that adequate primary self-inductance must be provided so that the peak anode current does not exceed about 26 mA at $V_a = 50$ V and $V_{g2} = 170$ V. As indicated in the diagram, a capacitor of 47,000 pF should be connected across the transformer secondary in order to prevent interference from the line coils.

Heavy negative feedback is applied across the pentode section of the ECL 80. This feedback prevents any tendency towards microphony, whilst, moreover, the time constant of the RC network feeding back the anode alternating voltage is so chosen that a parabolic component is added to the driving voltage. The amplitude of the parabolic component, and thus the linearity of the deflection current, can be regulated with the potentiometer of 0.1 MΩ. The component values indicated only

serve as a general guide and depend upon the primary self-inductance of the transformer used.

It will be noticed that the resistor between the pentode grid and the height control is shunted by a capacitor of 560 pF. This capacitor has practically no influence during the scan, but during the flyback it results in a negative pulse being supplied to the control grid and thus blocking the tube. Lengthening of the flyback by the flow of anode current is therefore prevented.

2. TRIODE AS FRAME BLOCKING OSCILLATOR

PENTODE FOR FRAME OUTPUT

(double-D picture 9 kV)

It has already been indicated that for a double-D picture on a picture tube operating at 9 kV second-anode voltage a higher deflection power is required than in the case of a rectangular picture and 7 kV E.H.T. It is then necessary either to feed the anode of the pentode section of the ECL 80 from a higher supply voltage or to use a PL 82 instead.

Fig. 74 gives a circuit in which the ECL 80 is used. This circuit is intended to operate in conjunction with the deflection and focusing unit type 10914, data of which are given in the application notes of the PL 81, where a line output circuit is described operating with a booster diode and giving a boosted H.T. voltage of 410 V. This voltage is also used to supply the anode of the frame output pentode. The circuit of fig. 74 is capable of providing the vertical deflection on a picture tube MW 22-16 or MW 31-16 for a double-D picture and 9 kV E.H.T.

The sync. signal is applied to the blocking oscillator via a double integration circuit, which gives a better interlace than with single integration. The charge capacitor C_4 in the triode grid circuit has been kept low so as to facilitate synchronization with the integrated sync. signal. A sync. signal of about 75 V peak-to-peak is required at the terminal S, and this can be obtained with the separator circuit given in fig. 75. A standard blocking transformer type 10850 with a turns ratio of 2 : 1 between L_2 and L_1 has been used. The potentiometer R_5 is the vertical hold control.

The saw-tooth voltage for driving the output pentode is obtained in the anode circuit of the triode section, which is supplied with 410 V. R_{13} and C_9 in series with the charge capacitor C_8 serve to give a negative peak during the flyback, which

blocks the pentode. In the circuit previously described this peak was obtained by reducing the negative feedback across the pentode for high frequencies. An advantage of the arrangement given here is that a high feedback factor is maintained

Deflection current peak-to-peak	540 mA
Average anode current of the pentode	9.6 mA
Peak anode current of the pentode	21.5 mA
Screen-grid current	2.2 mA
Cathode voltage	approx. 10.5 V

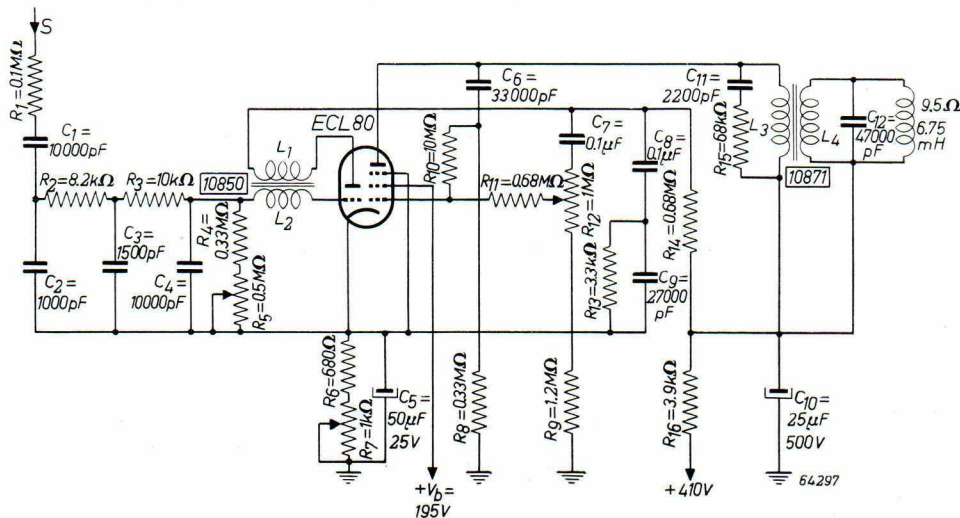


Fig. 74. Circuit for vertical scanning of a double-D picture on a picture tube MW 22—16 or MW 31—16 operating at 9 kV second-anode voltage. The anodes of the triode section and the pentode section are fed from the boosted high-tension supply of 410 V in the line output circuit (see fig. 98).

also for high frequencies, which is favourable with regard to microphony.

There are two possible arrangements for the height control. According to one arrangement the charge resistor can be varied, but this has the disadvantage that, owing to the high time constant of $R_{14}C_8$, there is a time delay in the adjustment of the picture height. The method represented in fig. 74, see R_{12} , does not possess this disadvantage.

Negative feedback is applied across the output pentode via C_6 and R_8 . The values of these components are so chosen that the required parabolic component is obtained in the anode current. It may be necessary, when large deviations in component values are to be expected, to make R_8 variable for adjusting the linearity. The linearity of the beginning of the scan is adjusted with the potentiometer R_7 in the cathode circuit.

A standard output transformer type 10871 is used in this circuit. Owing to the high supply voltage and the consequently high turns ratio of this transformer, a high positive voltage peak occurs across the primary during the flyback. This peak has been kept below 1200 V by the inclusion of the damping circuit $R_{15}C_{11}$.

The currents and voltages in the output circuit are as follows:

3. THE ECL 80 AS SYNCHRONIZATION AMPLIFIER AND CLIPPER

A circuit in which the ECL 80 is used as synchronization amplifier and clipper is given in fig. 75. The composite video signal, the sync. pulses of which are positive, is applied to the control grid of the pentode section via a normal blocking

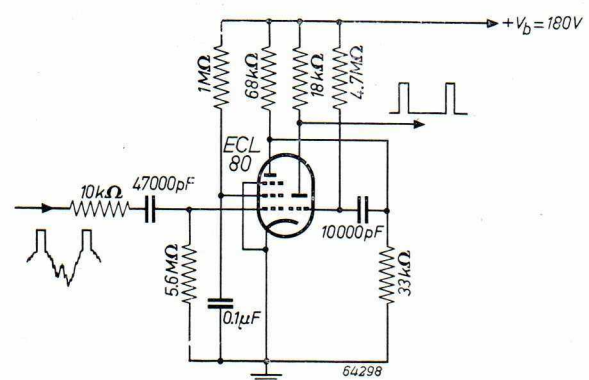


Fig. 75. Synchronization amplifier and clipper employing ECL 80.

capacitor and a resistor of 10 kΩ, the sole purpose of which is to prevent an undue increase of the capacitance in the anode circuit of the preceding video stage. The screen-grid voltage is chosen low, giving a grid base of only about 2 V, thus ensuring

effective separation of sync. and video signals. The average anode voltage is about 48 V and during the sync. pulses this drops below the knee in the I_a/V_a characteristic, so that the peaks of the sync. pulses are limited. At the anode of the pentode section negative-going sync. pulses of 45 V peak-to-peak are available, and these are applied to the triode grid for further amplification and limiting. Finally the output pulses of the triode section are positive-going and the amplitude is 75 V peak-to-peak.

4. TRIODE AS A.F. VOLTAGE AMPLIFIER PENTODE FOR SOUND OUTPUT

Extensive information referring to these uses are given under "Technical Data". The ECL 80 permits the design of an audio amplifier of higher sensitivity than that of a normal single audio stage. Precautions should be taken, however, to avoid two possible sources of oscillation.

Oscillation at a low audio frequency may occur due to feedback through the common cathode resistor circuit when a common cathode resistor, tapped for the triode, is used. This may be avoided by using a long time constant in the cathode circuit ($C_k = 100 \mu\text{F}$) and a short one for the coupling between the triode anode and the pentode grid

($C_{g1} = 5000 \text{ pF}$; $R_{g1} = 0.68 \text{ M}\Omega$). The A.C. earth return of the circuit feeding the triode grid should be connected to the cathode, as otherwise the time constant of $C_{g1}R_{g1}$ may have to be further reduced.

Oscillation at a high audio frequency may occur due to coupling through the capacitance between the pentode anode and the triode grid. The impedance in the triode grid circuit should therefore be kept as low as possible ($R_{gt} = 0.2 \text{ M}\Omega$). The output transformer primary should also be shunted with a high-frequency RC damping circuit to prevent a rise in the anode load impedance of the pentode at the higher frequencies. In extreme cases it may be necessary to use a capacitor between triode anode and triode grid, or between triode grid and earth.

The tendency towards oscillation at a high frequency as mentioned above may, however, most conveniently be reduced by applying negative feedback from the anode of the pentode section to the triode anode. A resistor of $0.68 \text{ M}\Omega$ will suffice for this purpose. The effect of this form of feedback on distortion and sensitivity is such that the sensitivity is reduced to about half that obtained without negative feedback whilst the distortion is considerably reduced, especially at low output; for example at 0.1 W without negative feedback $d_{\text{tot}} = 2.5\%$, and with negative feedback $d_{\text{tot}} = 0.5\%$.

TECHNICAL DATA

HEATER DATA

Heating: indirect by A.C. or D.C.;
series or parallel supply

Heater voltage	V_f	6.3 V
Heater current	I_f	0.3 A

BASE CONNECTIONS AND DIMENSIONS (in mm)

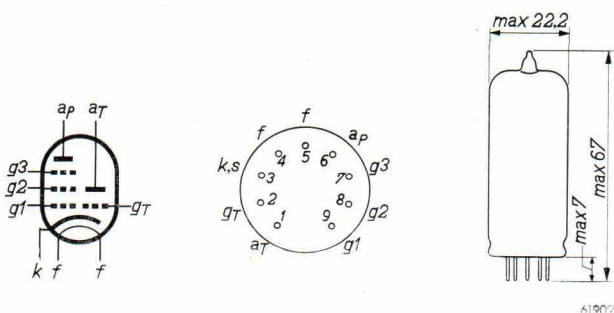


Fig. 76.

Mounting position: any

CAPACITANCES

Pentode section	C_a	5.0 pF
	C_{g1}	4.5 pF
	C_{ag1}	< 0.2 pF
	C_{g1f}	< 0.25 pF
	C_{kf}	3.7 pF
Triode section	C_a	0.8 pF
	C_g	2.1 pF
	C_{ag}	0.9 pF
	C_{gf}	< 0.05 pF
	C_{kf}	3.7 pF
Between sections	C_{gt-ap}	< 0.12 pF
	C_{at-ap}	< 1.2 pF
	C_{gt-g1p}	< 0.2 pF
	C_{at-g1p}	< 0.2 pF
	C_{gt-g1p}	< 0.2 pF

TYPICAL CHARACTERISTICS

Pentode section

Supply voltage	V_b	170	200	250 V
Anode voltage	V_a	170	200	250 V
Suppressor-grid voltage	V_{g3}	0	0	0 V
Screen-grid voltage	V_{g2}	170	200	V
Screen-grid resistor	R_{g2}	—	—	4.7 k Ω
Control-grid voltage	V_{g1}	-6.7	-8	-12.2 V
Anode current	I_a	15	17.5	14 mA
Screen-grid current	I_{g2}	2.8	3.3	2.6 mA
Mutual conductance	S	3.2	3.3	2.6 mA/V
Internal resistance	R_i	0.15	0.15	0.2 M Ω
Amplification factor between screen grid and control grid	μ_{g2g1}	14	14	14

Triode section

Anode voltage	V_a	100 V
Grid voltage	V_g	0 V
Anode current	I_a	8 mA
Mutual conductance	S	1.9 mA/V
Amplification factor	μ	20

OPERATING CONDITIONS AS SOUND

OUTPUT TUBE, pentode section

Supply voltage	V_b	170	200	250 V
Anode voltage	V_a	170	200	250 V
Suppressor-grid voltage	V_{g3}	0	0	0 V
Screen-grid voltage	V_{g2}	170	200	V
Screen-grid resistor	R_{g2}	—	—	4.7 k Ω
Control-grid voltage	V_{g1}	-6.7	-8	-12.2 V
Anode current	I_a	15	17.5	14 mA
Screen-grid current	I_{g2}	2.8	3.3	2.6 mA
Mutual conductance	S	3.2	3.3	2.6 mA/V
Internal resistance	R_i	0.15	0.15	0.2 M Ω
Matching resistance	R_a	11	11	17.5 k Ω
Power output ($d_{tot} = 10\%$)		1	1.4	1.55 W
Input signal ($d_{tot} = 10\%$)		3.7	4.1	5.3 V _{rms}
Power output ($\eta = 50\%$)		1.27	1.75	1.75 W
Input signal ($\eta = 50\%$)		4.4	5.1	5.9 V _{rms}
Input signal ($W_o = 50$ mW)		0.7	0.7	0.75 V _{rms}

OPERATING CONDITIONS AS SYNCHRONIZATION SEPARATOR, pentode section

Anode voltage	V_a	20	V
Suppressor-grid voltage	V_{g3}	0	V
Screen-grid voltage	V_{g2}	12	V
Control-grid voltage	V_{g1}	0	-1.45 V
Anode current	I_a	2	0.1 mA

OPERATING CONDITIONS AS A.F. VOLTAGE AMPLIFIER, triode section

V_b (V)	R_a (k Ω)	$R_g^{(1)}$ (k Ω)	$-V_g$ (V)	I_a (mA)	$V_o^{(2)}$ (V _{rms})	V_o/V_i	d_{tot} (%)
170	47	150	3.5	1.8	22	9.5	8.7
170	100	330	3.5	1.0	24	10.5	7.6
170	220	680	3.5	0.5	24.5	11	6.5
200	47	150	4.2	2.2	27	9.5	9.0
200	100	330	4.2	1.2	29	10.5	8.0
200	220	680	4.2	0.6	30	11	6.5
250	47	150	5.5	2.8	36	9.5	9.2
250	100	330	5.5	1.5	39	10.5	8.3
250	220	680	5.5	0.75	40	11	7.0

¹⁾ Grid resistor of next tube.²⁾ Output voltage at start of I_o . At lower output voltages the distortion is proportionately reduced.

LIMITING VALUES

Pentode section

Anode voltage at zero anode current	V_{a0}	max.	550 V
Anode voltage	V_a	max.	400 V
Positive peak anode voltage (10% of the duration of a cycle with a maximum of 2 m sec.)		max.	1200 V
Negative peak anode voltage		max.	500 V
Screen-grid voltage at zero screen-grid current	V_{g20}	max.	550 V
Screen-grid voltage	V_{g2}	max.	250 V
Control-grid voltage (grid current +0.3 μ A)	V_{g1}	max.	-1.3 V
Heater voltage during the warming-up period		max.	9.5 V
Voltage between heater and cathode	V_{kf}	max.	150 V
Cathode current	I_k	max.	25 mA

Peak cathode current (10% of the duration of a cycle with a maximum of 2 m sec.)	I_{kp}	max.	350 mA
Anode dissipation	W_a	max.	3.5 W
Screen-grid dissipation	W_{g2}	max.	1.2 W
External resistance between control grid and cathode	R_{g1}		
with fixed bias		max.	1 M Ω
with automatic bias		max.	2 M Ω
External resistance between heater and cathode	R_{kf}	max.	20 k Ω

To allow for inevitable spread between individual tubes and for deterioration during life in frame output applications, the circuit should be designed around a peak anode current not exceeding 26 mA at $V_a = 50$, $V_{g2} = 170$ V. At $V_a = 60$ V, $V_{g2} = 200$ V the corresponding value for the peak current is 31 mA and at $V_a = 70$ V, $V_{g2} = 250$ V it is 42 mA.

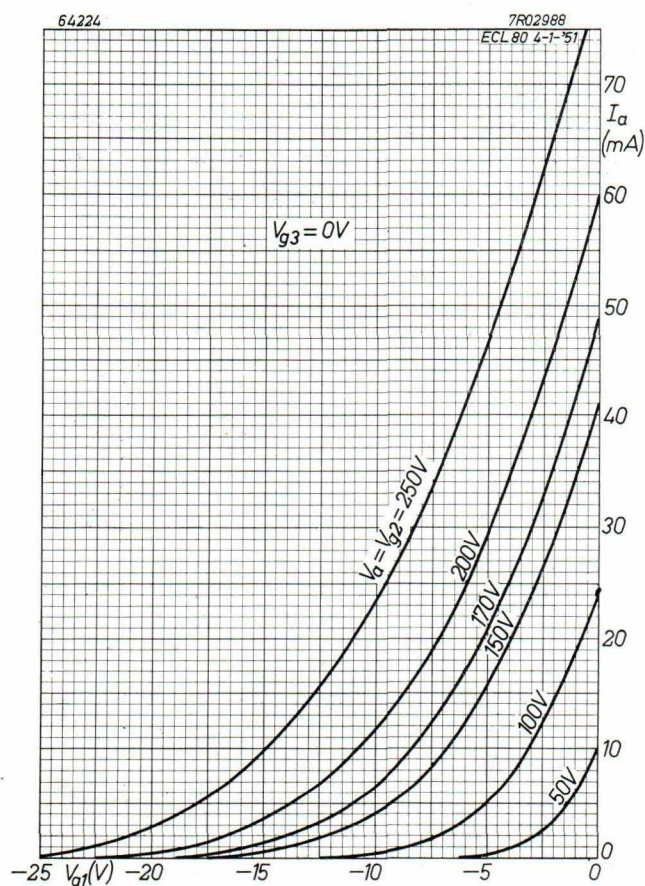


Fig. 77 Anode current of pentode section plotted against control-grid voltage for anode and screen-grid voltages between 50 V and 250 V.

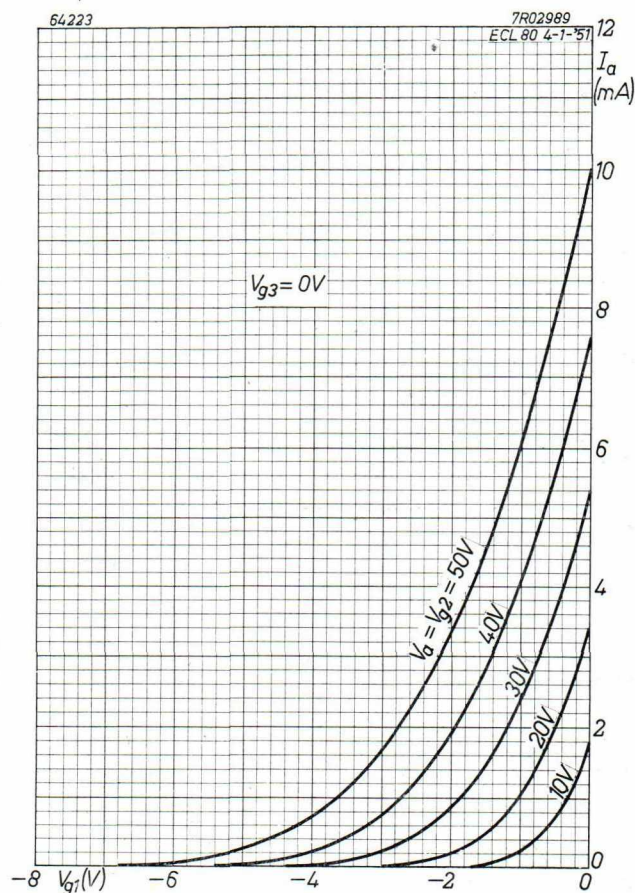


Fig. 78 Anode current of pentode section plotted against control-grid voltage for anode and screen-grid voltages between 10 V and 50 V.

Triode section

Anode voltage at zero anode current	V_{ao}	max.	550 V
Anode voltage	V_a	max.	200 V
Control-grid voltage (grid current +0.3 μ A)	V_g	max.	-1.3 V
Heater voltage during warming-up period		max.	9.5 V
Voltage between heater and cathode	V_{kf}	max.	150 V
Cathode current	I_k	max.	8 mA
Peak cathode current (10% of the duration of a cycle with a maximum of 2 m sec.)	I_{kp}	max.	200 mA
Anode dissipation	W_a	max.	1 W
External resistance between control grid and cathode	R_g		
with fixed bias		max.	1 M Ω
with automatic bias		max.	3 M Ω
External resistance between heater and cathode	R_{kf}	max.	20 k Ω

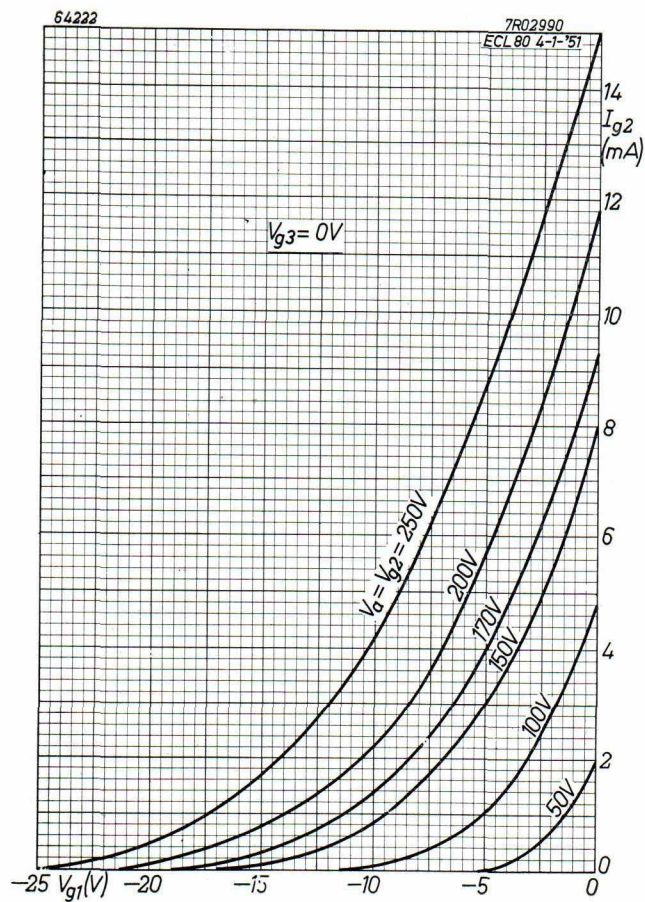


Fig. 79.
Screen-grid current of **pentode** section plotted against control-grid voltage for anode and screen-grid voltages between 50 V and 250 V.

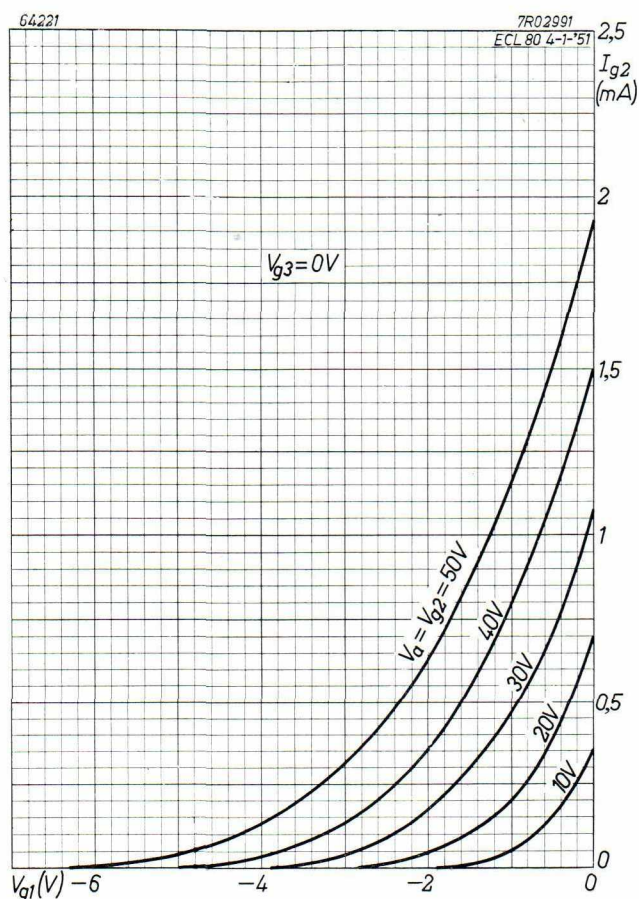
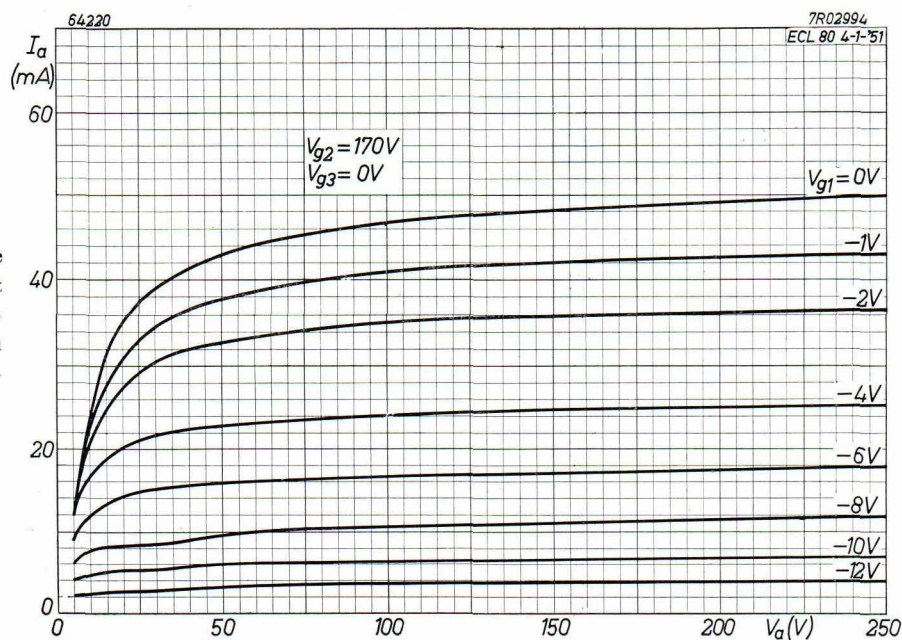


Fig. 80.
Screen-grid current of **pentode** section plotted against control-grid voltage for anode and screen-grid voltages between 10 V and 50 V.

Fig. 81.
Anode current of **pentode** section plotted against anode voltage for screen-grid voltage of 170 V, with control-grid voltage as parameter.



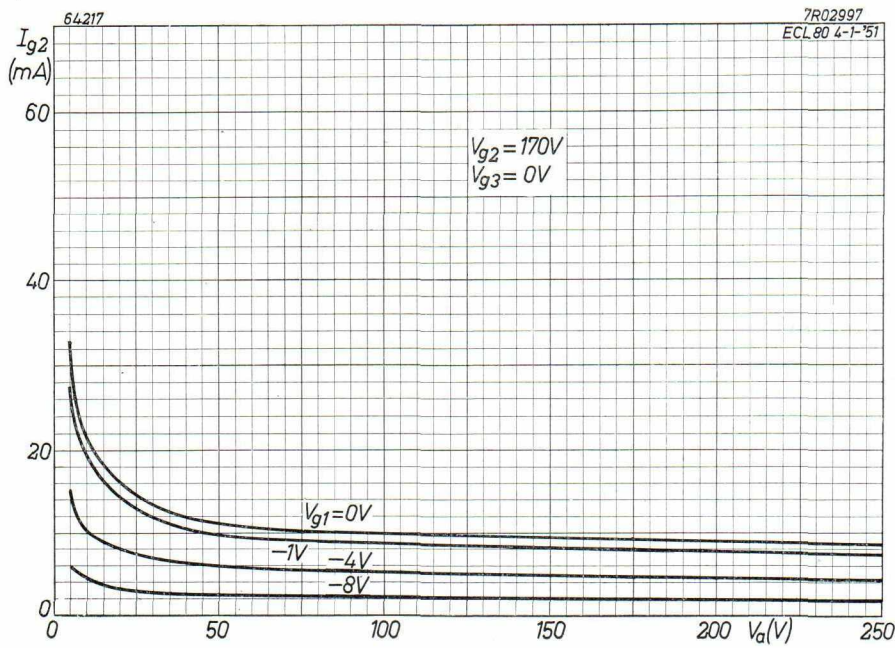


Fig. 82.
Screen-grid current of
pentode section plotted
against anode voltage for
screen-grid voltage of
170 V, with control-grid
voltage as parameter.

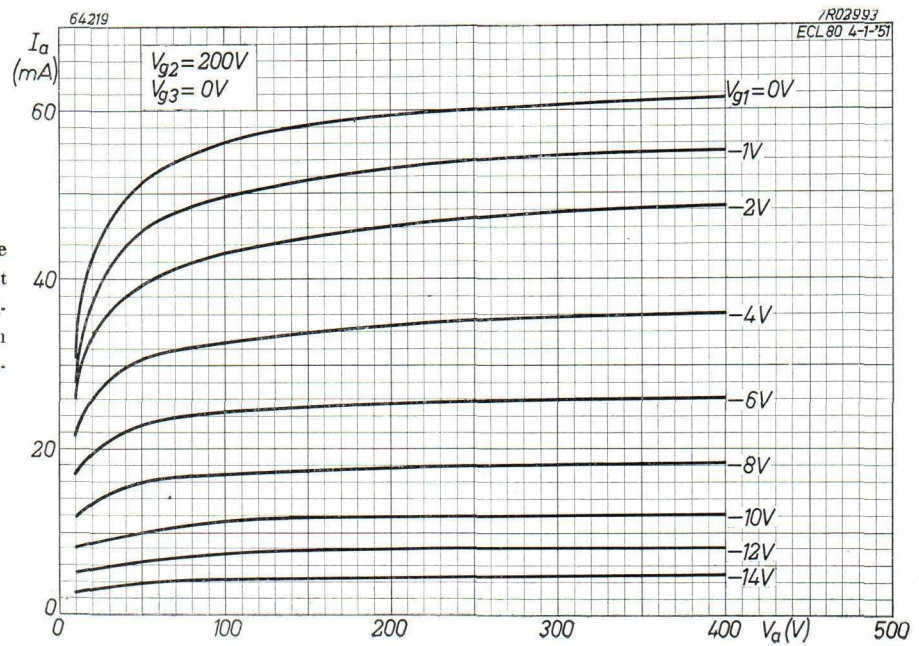


Fig. 83.
Anode current of pentode
section plotted against
anode voltage for screen-
grid voltage of 200 V, with
control-grid voltage as pa-
rameter.

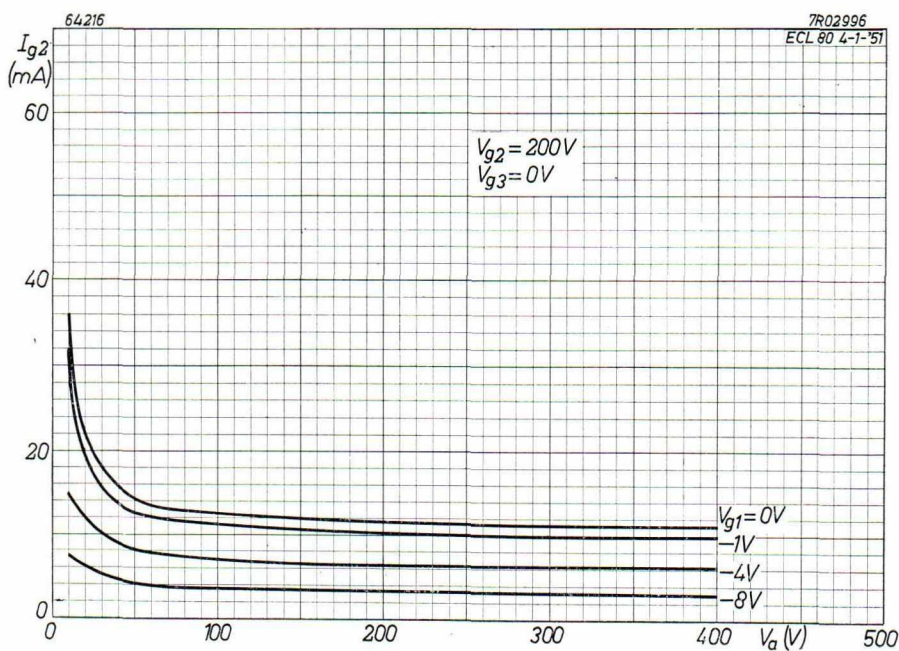


Fig. 84.
Screen-grid current of
pentode section plotted
against anode voltage for
screen-grid voltage of
200 V, with control-grid
voltage as parameter.

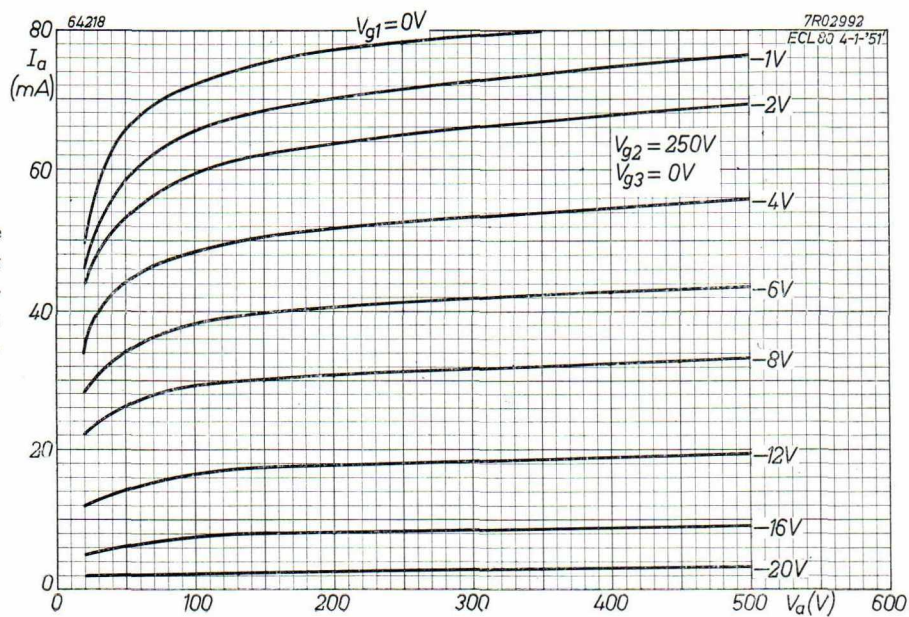


Fig. 85.
Anode current of pentode
section plotted against
anode voltage for screen-
grid voltage of 250 V, with
control-grid voltage as pa-
rameter.

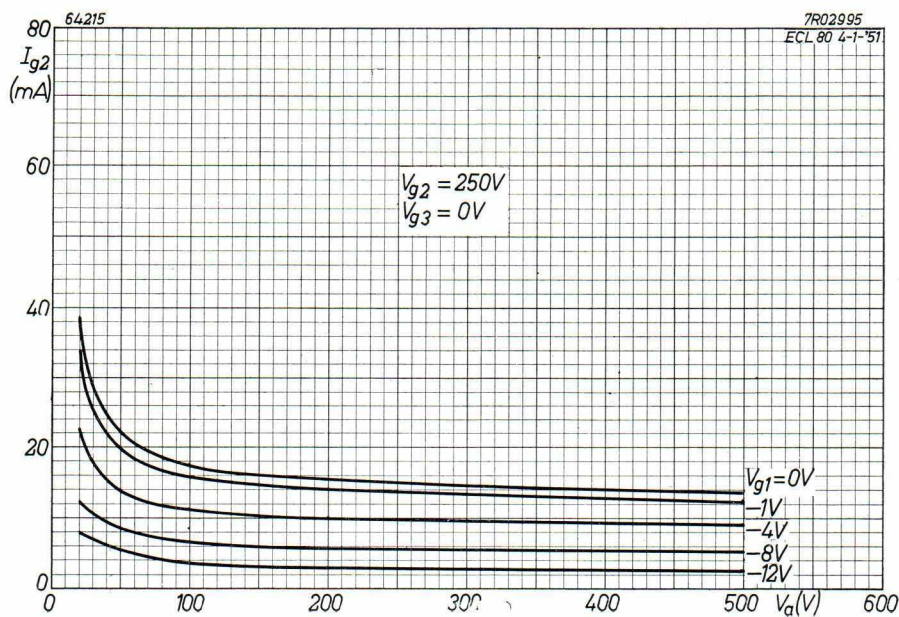


Fig. 86.
Screen-grid current of
pentode section plotted
against anode voltage for
screen-grid voltage of
250 V, with control-grid
voltage as parameter.

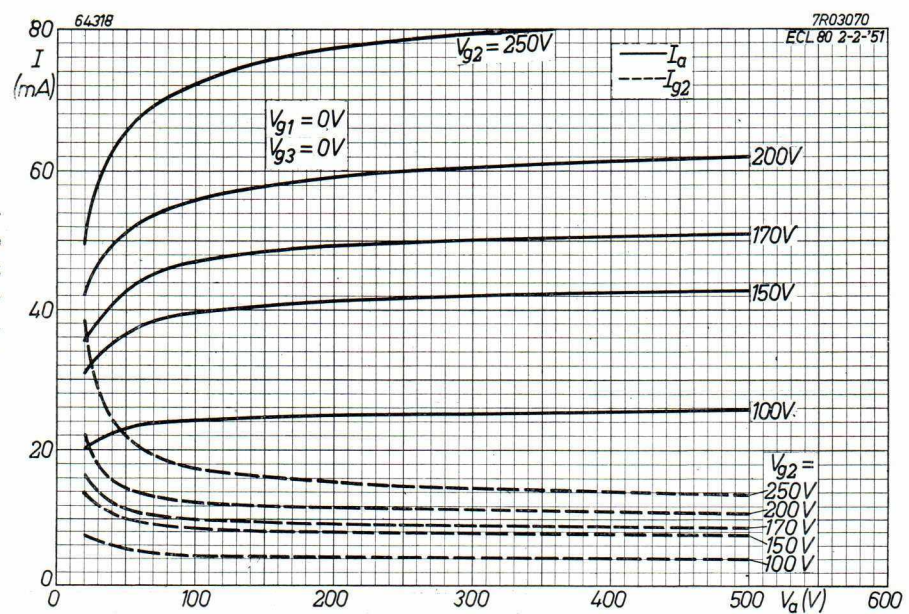


Fig. 87.
Anode current and screen-
grid current of pentode
section plotted against
anode voltage for control-
grid voltage of 0 V, with
screen-grid voltage as pa-
rameter.

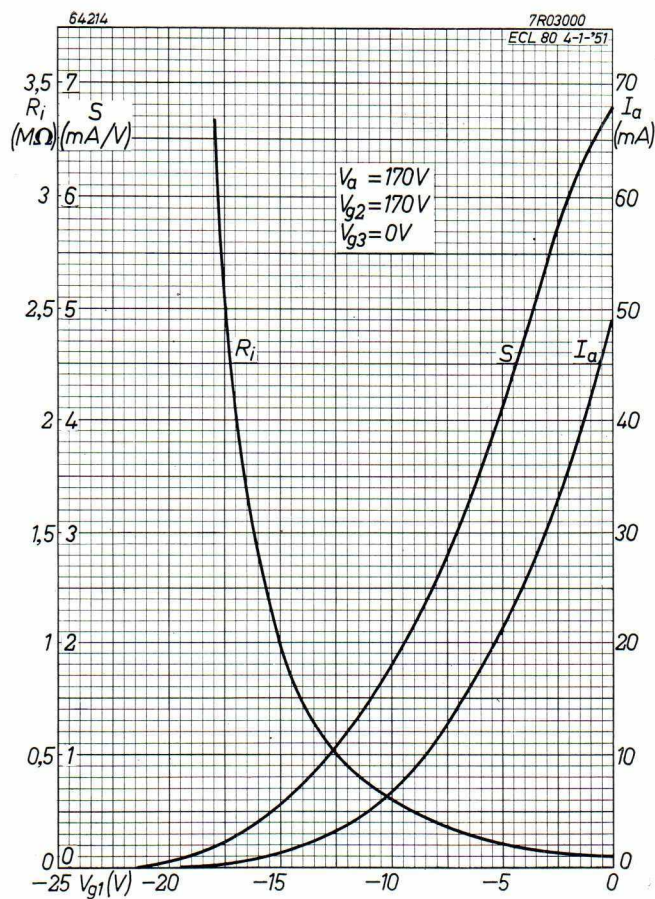


Fig. 88.

Anode current, mutual conductance and internal resistance of **pentode section** plotted against control-grid voltage for anode and screen-grid voltage of 170 V.

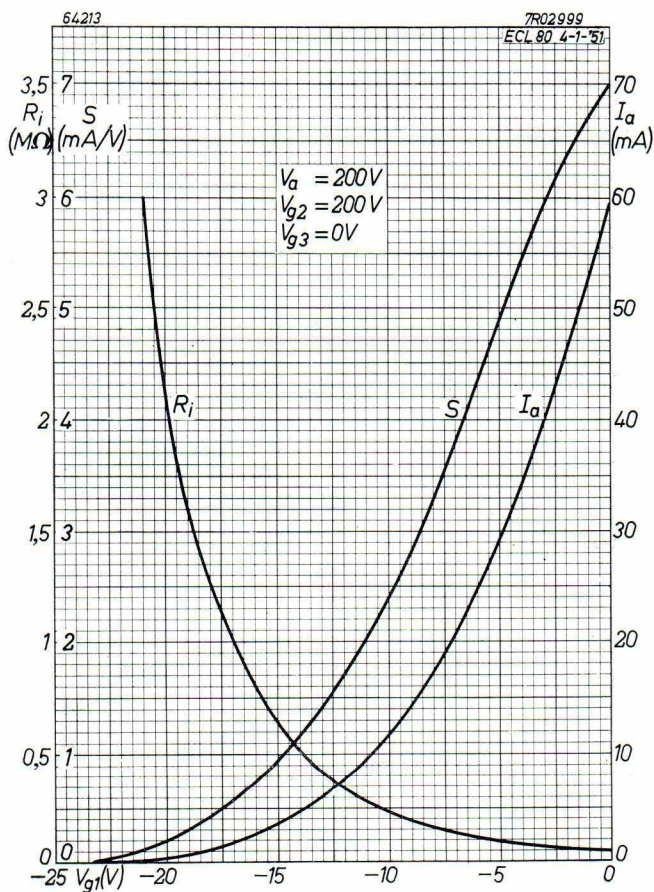


Fig. 89.

Anode current, mutual conductance and internal resistance of **pentode section** plotted against control-grid voltage for anode and screen-grid voltage of 200 V.

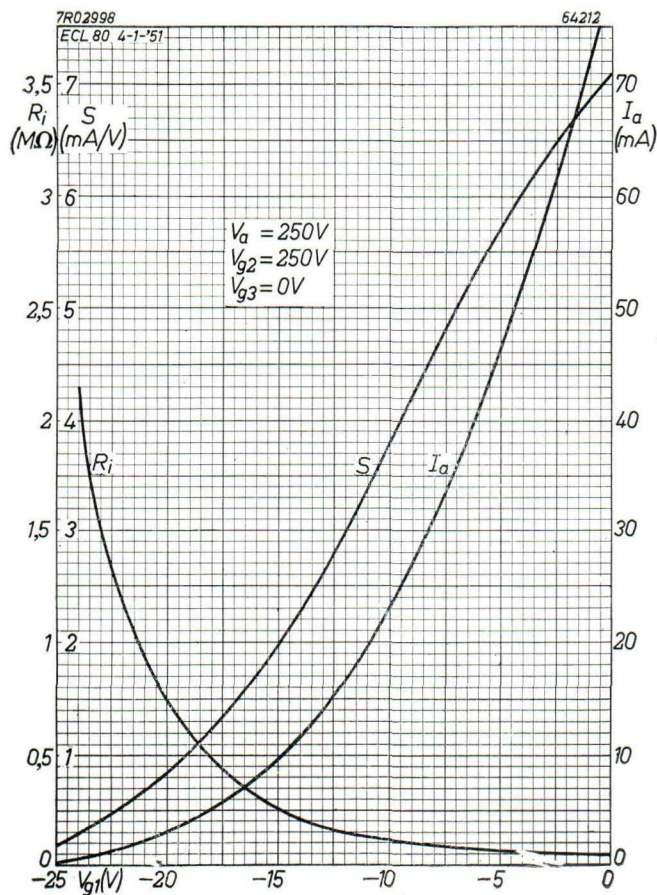
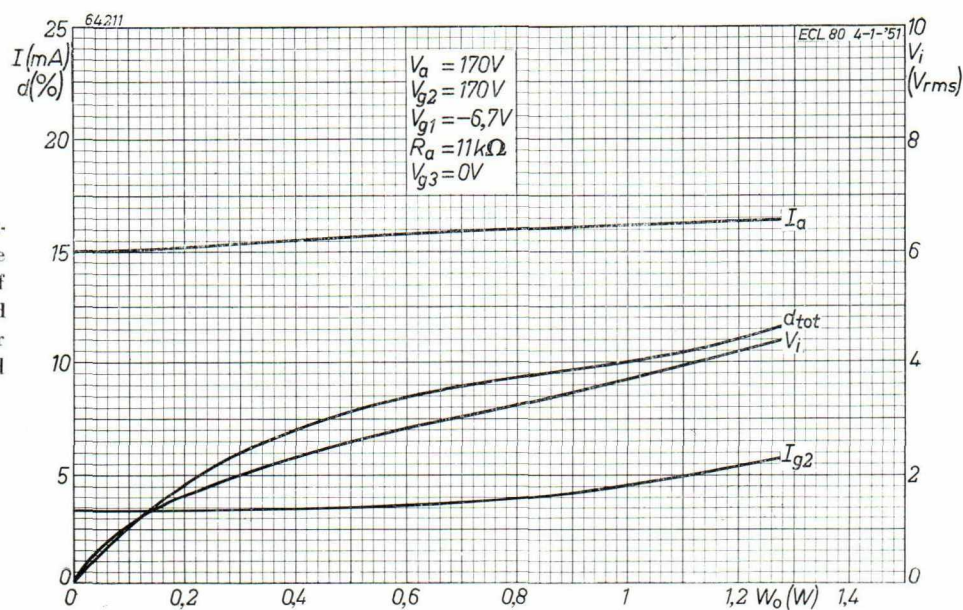


Fig. 90.
Anode current, mutual conductance and internal resistance of pentode section plotted against control-grid voltage for anode and screen-grid voltage of 250 V.

Fig. 91.
Anode current, screen-grid current, input voltage and total distortion of pentode section plotted against output power for anode and screen-grid voltage of 170 V.



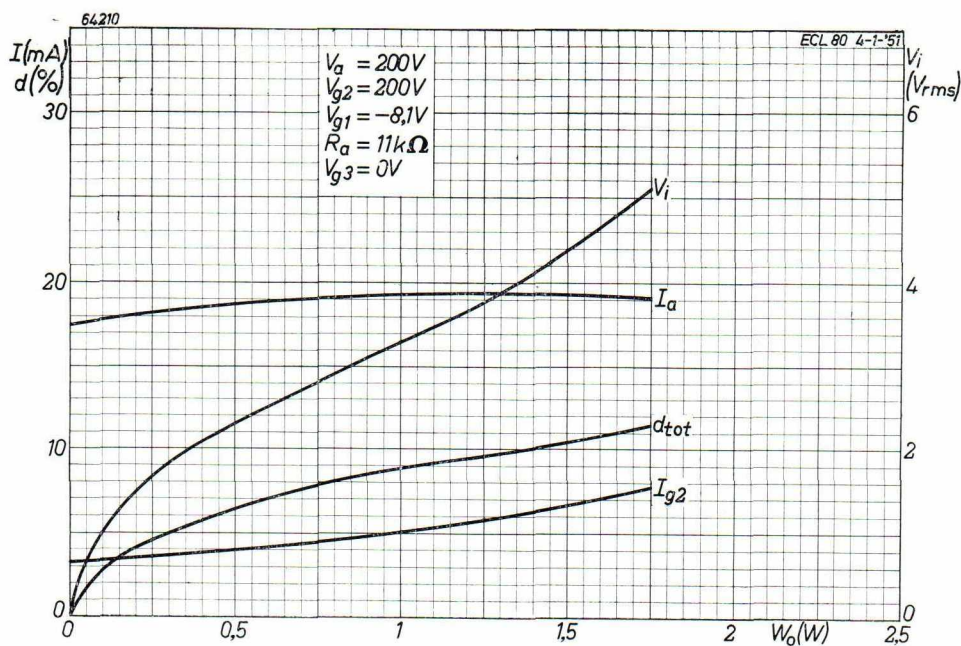


Fig. 92.

Anode current, screen-grid current, input voltage and total distortion of pentode section plotted against output power for anode and screen-grid voltage of 200 V.

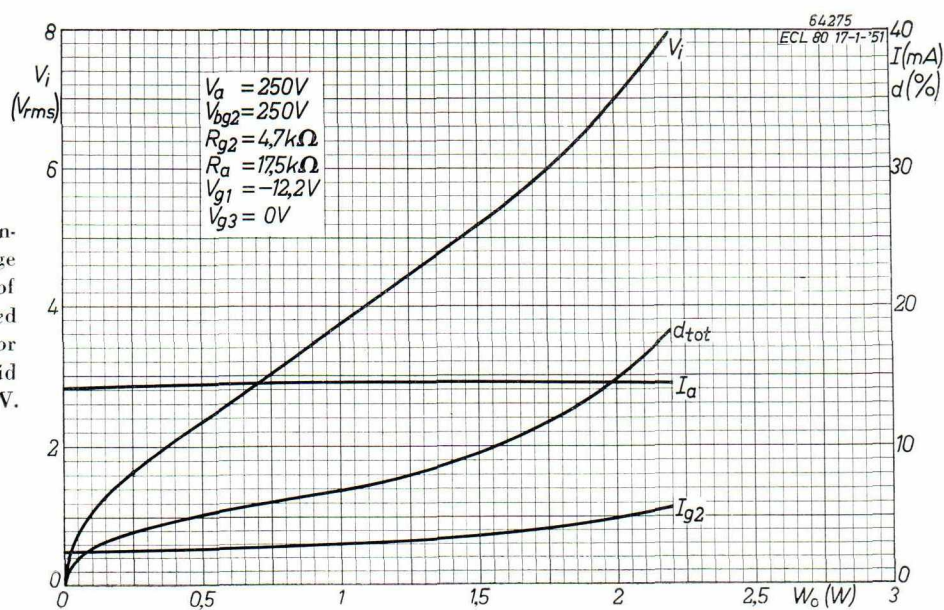


Fig. 93.

Anode current, screen-grid current, input voltage and total distortion of pentode section plotted against output power for anode and screen-grid supply voltage of 250 V.

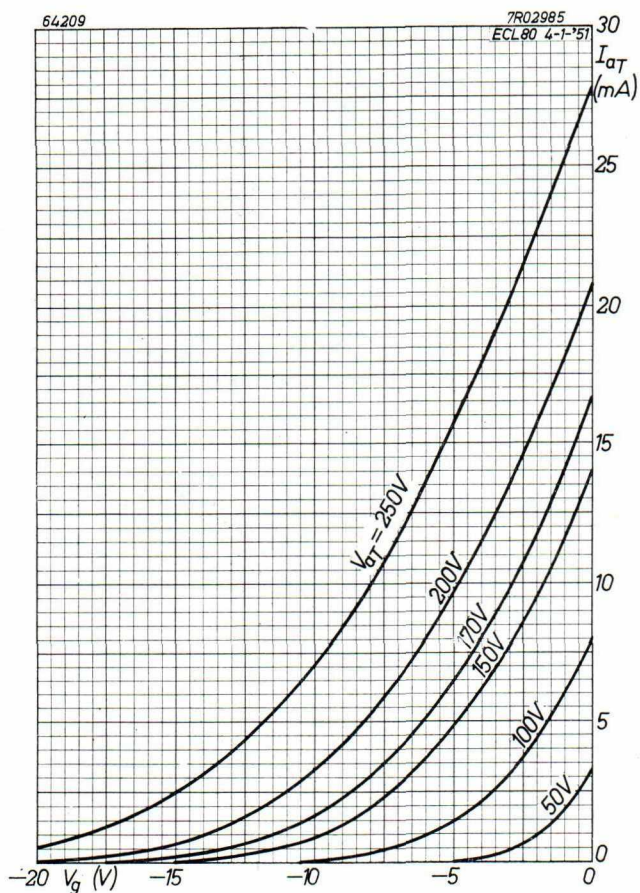


Fig. 94.

Anode current of triode section plotted against control-grid voltage for anode voltages between 50 V and 250 V.

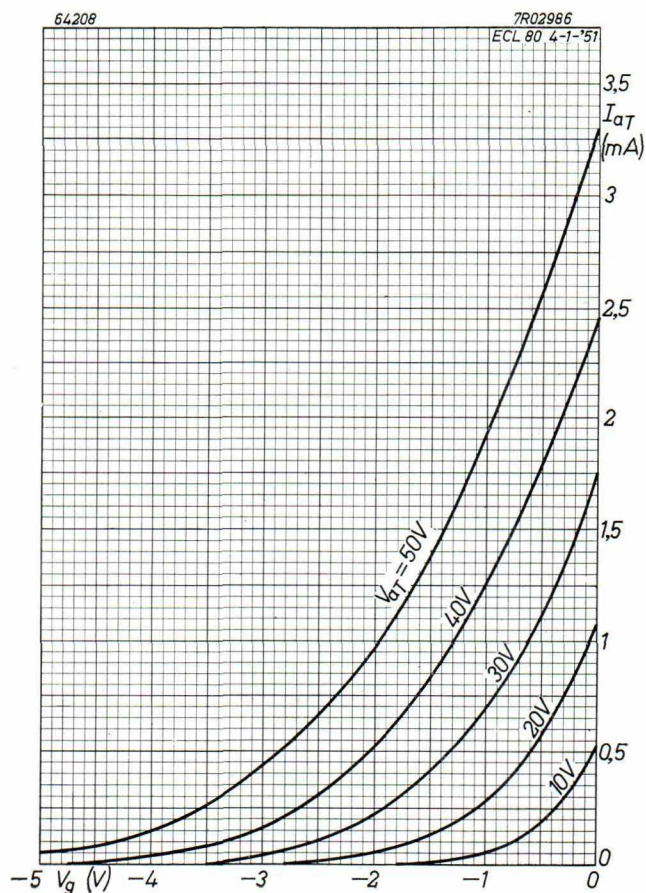


Fig. 95.

Anode current of triode section plotted against control-grid voltage for anode voltages between 10 V and 50 V.

Fig. 96.

Anode current of triode section plotted against anode voltage, with grid voltage as parameter.

