UCH 21 Triode-heptode

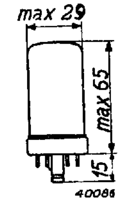

Fig. 1
Dimensions in mm.

This is an AC/DC triode heptode consuming 100 mA heater current, which can be employed as variable-mu frequency changer. It is also suitable for use as a combined I.F. and A.F. amplifier and as A.F. amplifier and phase inverter for driving push-pull output stages without transformer. Except for the heater ratings, the UCH 21 is identical with the ECH 21 in the A.C. series of valves, to which reference may be made for further description.

In this connection it should be added that in comparison with other frequency changers this valve has very excellent properties on low working voltages. On a voltage of 100 V the conversion conductance is 580 μA/V, whilst, due to the provision of a suppressor grid, the internal resistance is very high (1 MOhm).

It is moreover an extremely simple matter, when using this valve as frequency changer, to transfer the set from 100 V to 200 V operation. The screen feed and cathode resistances need not be changed and the anode resistance of the triode may also be retained. In other words, the circuit of the receiver section needs no modification whatsoever when a change-over is made. Owing to the high mutual conductance, oscillation of the triode is fully reliable, even on low working voltages, making this section of the valve very satisfactory for short-wave work.

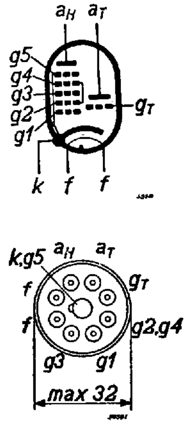

Fig. 2.
Arrangement and sequence of connections.

The grid of the triode and third grid of the heptode sections are not inter-connected and the two systems can therefore be employed for different purposes; the heptode can for example function as I.F. amplifier with the triode as resistance-capacitance coupled A.F. amplifier, in which case, again, no modification of the circuit is necessary when changing from low voltage to high voltage mains, except that the grid bias of both triode and heptode should be —2 V instead of —1 V. This modification usually takes place automatically in the receiver, since the total current consumed by the output valve UBL 21, as well as that of the UCH 21 used as frequency changer, is doubled when operated on 200 V instead of 100 V, so that the voltage drop across the resistance in the negative feed line from which the grid bias is derived is also roughly doubled.

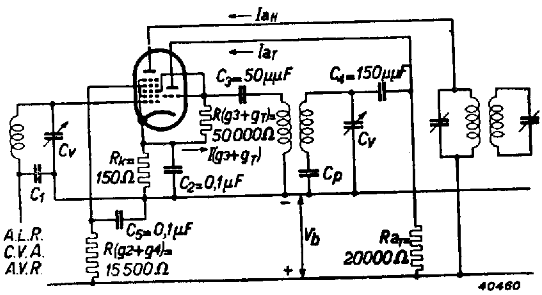

Fig. 3
Circuit diagram showing the UCH 21 employed as frequency changer.

HEATER RATINGS

Heating: indirect, AC or DC, series supply.

Heater voltage . . . . $V_f = 20$ V

Heater current . . . . $I_f = 0.100$ A

CAPACITANCES

a) Heptode section:

C_{g1}	= 6.5 pF	C_{g1g3}	< 0.3 pF
C_a	= 8 pF	C_{g3}	= 8 pF
C_{ag1}	< 0.002 pF	C_{g1f}	< 0.007 pF

b) Triode section:

C_g	= 3.8 pF	C_{ak}	= 1.6 pF
C_a	= 3.1 pF	C_{ag}	= 1.1 pF
C_{gk}	= 2.7 pF	C_{gf}	< 0.1 pF

c) Between heptode and triode, and both combined:

C_{gTg1H}	< 0.1 pF	$C_{(gT+g3)g1H}$	< 0.35 pF
$C_{(gT+g3)}$	= 12.3 pF	$C_{(gT+g3)aH}$	< 0.1 pF

OPERATING DATA: Heptode section employed as frequency changer (third grid connected to triode grid)

200 V and 100 V operation, with sliding screen voltage.

Anode and supply voltage	$V_a = V_b$	=	200 V		100 V	
Screen grid resistance . .	$R_{(g2+g4)}$	=	15,500 Ohms		15,500 Ohms	
Cathode resistance . . .	R_k	=	150 Ohms		150 Ohms	
Grid leak, 3rd grid and triode grid	$R_{(g3+gT)}$	=	50,000 Ohms		50,000 Ohms	
Third grid and triode grid current.	$I_{(g3+gT)}$	=	190 μA		95 μA	
Grid bias.	V_{g1}	=	—2 V[1])	—28 V[2])	—1 V[1])	—14 V[2])
Screen grid voltage . . .	$V_{(g2+g4)}$	=	100 V	200 V	53 V	100 V
Anode current	I_a	=	3.5 mA	—	1.5 mA	—
Screen grid current . . .	$I_{(g2+g4)}$	=	6.5 mA	—	3 mA	—
Conversion conductance .	S_c	=	750 μA/V	7.5 μA/V	580 μA/V	5.8 μA/V
Internal resistance. . . .	R_i	=	1 MOhm	>10	1 MOhm	>10 MOhm
Equivalent noise resistance	R_{aeq}	=	55,000	—	40,000	— Ohms

[1]) Valve not controlled.

[2]) Conversion conductance controlled to 1/100.

OPERATING DATA: Heptode section employed as I.F. amplifier (third grid not connected to triode grid)

200 V and 100 V operation, with sliding screen voltage.

Anode and supply voltage $V_a = V_b$ =	200 V			100 V		
Voltage, third grid V_{g3} =	0 V			0 V		
Screen grid resistance $R_{(g2+g4)}$ =	30,000 Ohms			30,000 Ohms		
Grid bias V_{g1}	= —2 V[1])	—28 V[2])	—36 V[3])	—1 V[1])	—15 V[2])	—20 V[3])
Screen grid voltage $V_{(g2+g4)}$	= 94 V	—	200 V	50 V	—	98 V
Anode current I_a	= 5.2 mA	—	—	2.6 mA	—	—
Screen current $I_{(g2+g4)}$	= 3.5 mA	—	—	1.9 mA	—	—
Mutual conductance S	= 2200 μA/V	22 μA/V	2.2 μA/V	2000 μA/V	20 μA/V	2.0 μA/V
Internal resistance R_i	= 0.7	>10	>10	0.7	>10	>10 M Ohms
Gain factor from screen μ_{g2g1}	= 19	—	—	19	—	—
Equivalent noise resistance R_{aeq}	= 9000	—	—	4900	—	— Ohms

[1]) Valve not controlled.
[2]) Mutual conductance controlled to 1/100.
[3]) Mutual conductance controlled to 1/1000 (extreme limit of control).

STATIC DATA: TRIODE SECTION

Anode voltage	V_a	= 100 V
Grid bias.	V_g	= 0 V
Anode current	I_a	= 12 mA
Mutual conductance	S	= 3.2 mA/V
Gain factor.	μ	= 19

OPERATING DATA: TRIODE SECTION employed as oscillator valve (third grid of heptode connected to triode grid)

Supply voltage	V_b	= 100 V	200 V
Anode series resistance	R_a	= 20,000 Ohms	20,000 Ohms
Grid leak.	$R_{(g3+gT)}$	= 50,000 Ohms	50,000 Ohms
Current through grid leak to be adjusted to	$I_{(g3+gT)}$	= 95 μA	190 μA
Anode current	I_a	= 1.9 mA	4.1 mA
Effective mutual conductance	S_{eff}	= 0.44 mA/V	0.45 mA/V

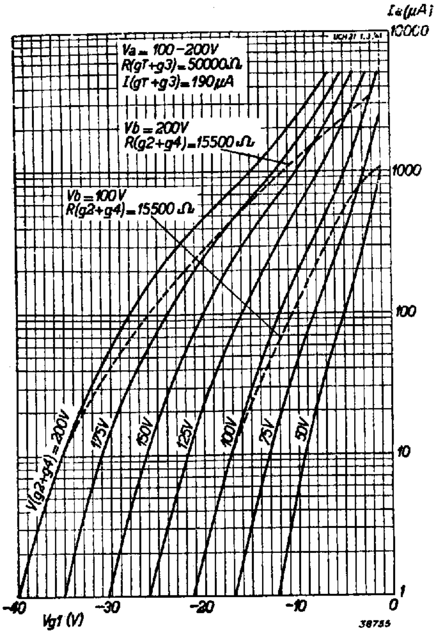

Fig 4
Anode current of the heptode section of the UCH 21 employed as frequency changer, as a function of grid bias, with screen grid voltage as parameter, at an anode voltage of 100—200 V. Broken lines: screen fed through a resistance of 15,500 Ohms.

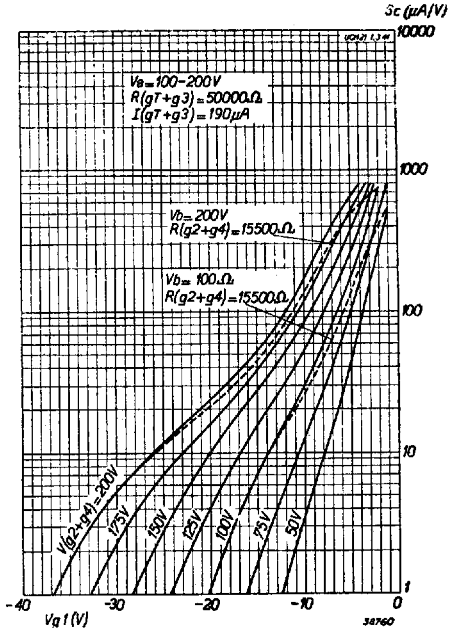

Fig. 5
Conversion conductance *Sc* as a function of grid bias Vg_1 at an anode voltage of 100—200 V, with screen grid voltage as parameter. Broken lines: sceen grid fed through a resistance of 15,500 Ohms.

OPERATING DATA: TRIODE SECTION employed as A.F. amplifier, resistance-capacitance coupled (third grid not connected to triode grid)

Supply voltage V_b (V)	Anode resistance R_a (Mohms)	Grid bias V_g (V)	Anode current I_a (mA)	Alternating output voltage V_{oeff} (V)	Total distortion d_{tot} (%)	Voltage gain $\frac{V_{oeff}}{V_{g1eff}}$
200	0.2	—2	0.8	7.5	2.8	10
100	0.2	—1	0.37	7.5	6	10
200	0.1	—2	1.5	7.5	2.8	10.5
100	0.1	—1	0.68	7.5	5.8	10.5
200	0.05	—2	2.8	7.5	2.2	11
100	0.05	—1	1.3	7.5	5.4	11

OPERATING DATA FOR THE UCH 21 employed as phase inverter for the modulation of a push-pull output stage (third grid not connected to triode grid)

(With feedback, see Fig. 6)

Supply voltage . . .	V_b	= 200 V		100 V	
Anode resistance (heptode).	R_{aH}	= 0.2 MOhm	0.1 MOhm	0.2 MOhm	0.1 MOhm
Anode resistance (triode).	R_{aT}	= 0.1 MOhm	0.1 MOhm	0.1 MOhm	0.1 MOhm
Screen grid resistance	$R_{(g2+g4)}$	= 0.18 MOhm	0.1 MOhm	0.18 MOhm	0.1 MOhm
Cathode resistance .	R_k	= 700 Ohms	500 Ohms	700 Ohms	500 Ohm
Combined anode current, triode and heptode	$I_{(aH+aT)}$	= 2.1 mA	2.7 mA	1.1 mA	1.3 mA
Screen grid current .	$I_{(g2+g4)}$	= 0.8 mA	1.3	0.4	0.65 mA
Alternating input voltage to give an output of 10 V_{eff}. . .	V_{g1eff}	= 0.13 V	0.14 V	0.155 V	0.18 V
Voltage gain	V_{oeff}/V_{g1eff}	= 75	70	65	55
Totale distortion . .	d_{tot}	= 2.5 %	2.3 %	3.1 %	2.4 %

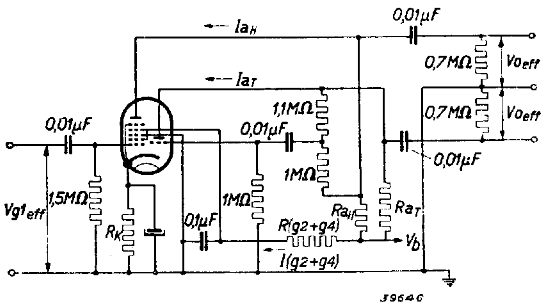

Fig. 6
Circuit diagram showing the UCH 21 employed as A.F. amplifier and phase inverter with feedback, for a push-pull output stage.

MAXIMUM RATINGS FOR THE HEPTODE SECTION

Anode voltage, in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 250 V
Anode dissipation	W_a	= max. 1.5 W
Screen grid voltage, in cold condition.	$V_{(g2+g4)o}$	= max. 550 V
Screen grid voltage, valve not controlled ($I_a = 3$ mA)	$V_{(g2+g4)}$	= max. 100 V
Screen grid voltage, valve controlled ($I_a < 1$ mA)	$V_{(g2+g4)}$	= max. 250 V
Screen grid dissipation.	$W_{(g2+g4)}$	= max. 1 W
Cathode current.	I_k	= max. 15 mA
Grid current commences at ($I_{g1} = +0.3\,\mu$A) .	V_{g1}	= max. —1.3 V
Grid current commences at ($I_{g3} = +0.3\,\mu$A) .	V_{g3}	= max. —1.3 V
Max. external resistance between grid 1 and cathode	R_{g1k}	= max. 3 MOhms
Max. external resistance between grid 3 and cathode	R_{g3k}	= max. 3 MOhms
Max. external resistance between heater and cathode	R_{fk}	= max. 20,000 Ohms
Max. voltage between heater and cathode (D.C. voltage or eff. value of the alternating voltage)	V_{fk}	= max. 150 V

MAXIMUM RATINGS FOR THE TRIODE SECTION

Anode voltage, in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 175 V
Anode dissipation	W_a	= max. 0.5 W
Grid current commences at ($I_g = +0.3\,\mu$A) . .	V_g	= max. —1.3 V
Max. external resistance in grid circuit	R_{gk}	= max. 3 M Ohms

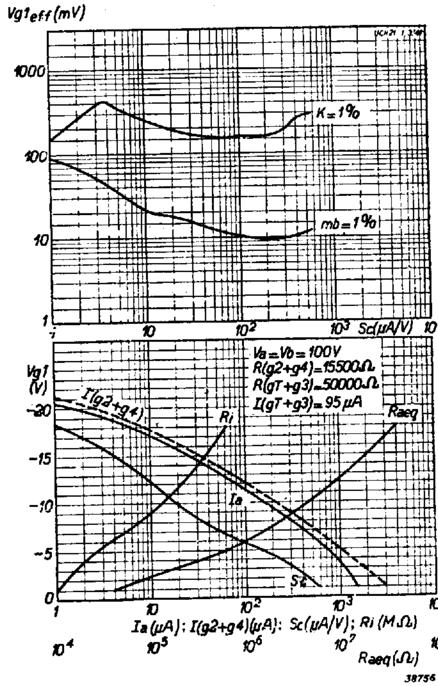

Fig. 7

At an anode or working voltage of 100 V, with screen fed through a resistance of 15,500 Ohms.
Upper diagram; Highest permissible effective value of R.F. alternating voltage with 1 % cross modulation ($K = 1$ %) and with 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of conversion conductance.
Lower diagram; Anode current *Ia*, screen current $I\ (g_2 + g_4)$, conversion conductance *Sc*, internal resistance *Ri*, and equivalent noise resistance *Raeq* as a function of grid bias Vg_1.

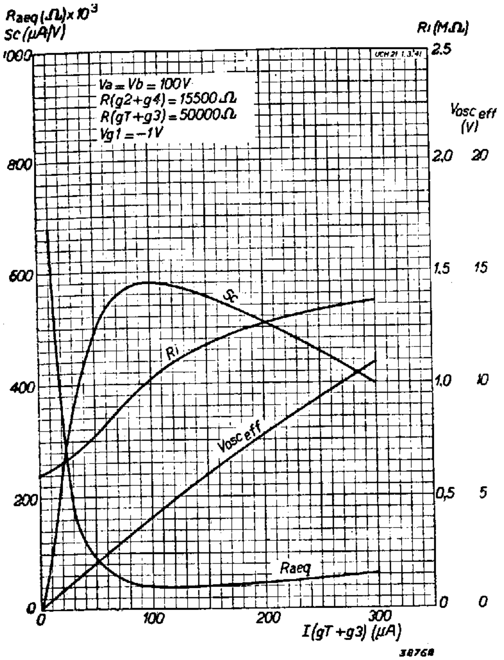

Fig. 8
Conversion conductance *Sc*, internal resistance *Ri*, effective A.C. oscillator voltage *Vosc* and equivalent noise resistance *Raeq* as a function of oscillator grid current $I\ (gT + g_3)$, at $Va = Vb = 100$ V and $R(g_2 + g_4) = 15{,}500$ Ohms.

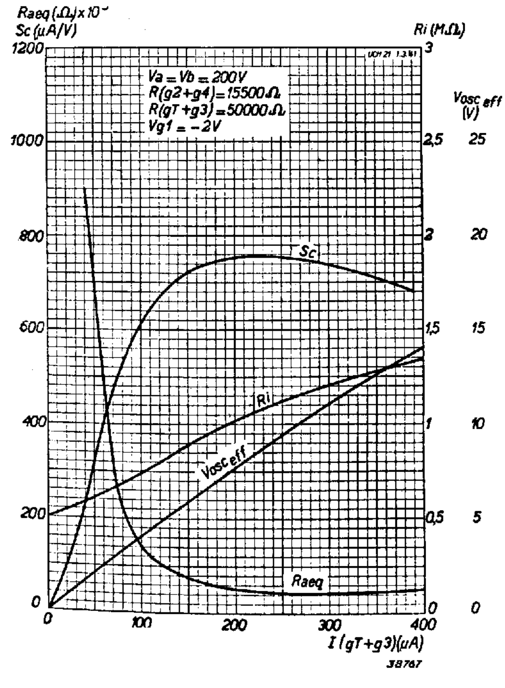

Fig. 10
Conversion conductance *Sc*, internal resistance *Ri*, effective A.C. oscillator voltage *Vosc* and equivalent noise resistance *Raeq* as a function of oscillator grid current $I\ (gT + g_3)$, with $Va = Vb = 200$ V and $R(g_2 + g_4) = 15{,}500$ Ohms.

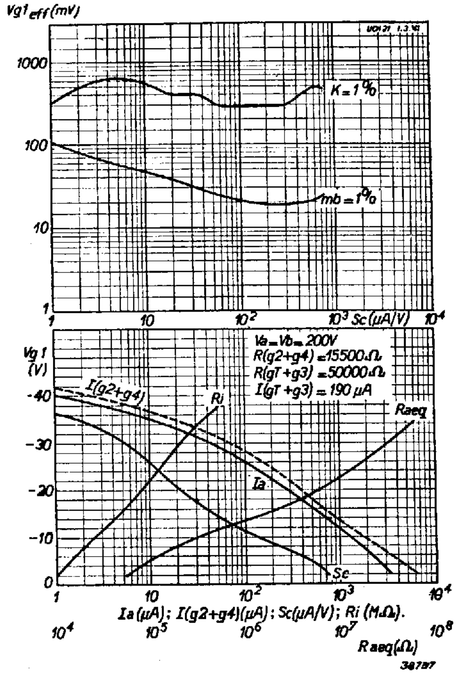

Fig. 9
At an anode and feed voltage of 200 V and with screen grid fed through a resistance of 15,500 Ohms:
Upper diagram; Highest permissible effective value of R.F. alternating voltage with 1 % cross modulation ($K = 1$ %) and with 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of conversion conductance.
Lower diagram; Anode current *Ia*, screen grid current $I\ (g_2 + g_4)$, conversion conductance *Sc*, internal resistance *Ri* and equivalent noise resistance *Raeq* as a function of grid bias Vg_1.

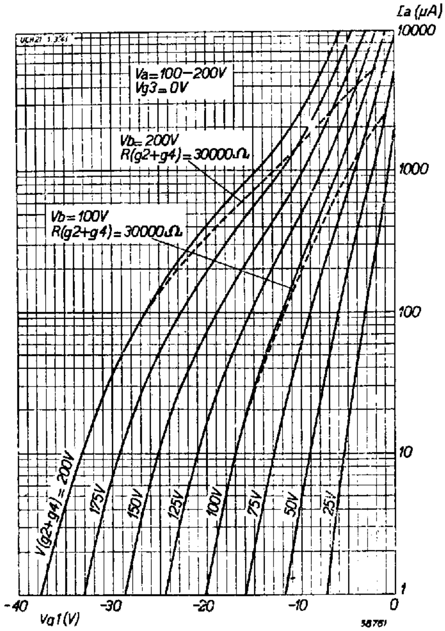

Fig. 11
Anode current as a function of grid bias at $Va = 100$— 200 V and $Vg_3 = 0$ V, with screen grid voltage as parameter: valve employed as I.F. amplifier (heptode). Broken lines: screen fed through a resistance of 30,000 Ohms.

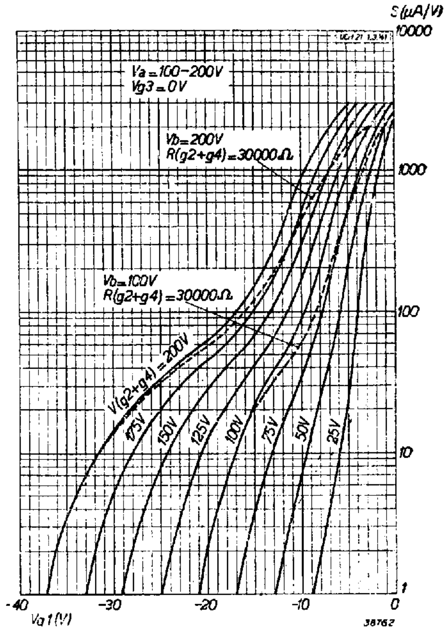

Fig. 12
Mutual conductance of the heptode section as a function of grid bias at $Va = 100$—200 V and $Vg_3 = 0$ with screen voltage as parameter: (valve employed as I.F. amplifier). Broken lines: screen fed through a resistance of 30,000 Ohms.

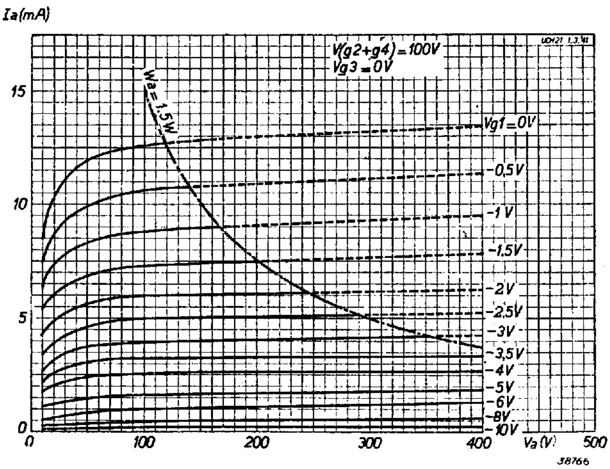

Fig. 13
Anode current as function of anode voltage at $V\ (g_2 + g_4) = 100$ V and $Vg_3 = 0$ V, with grid voltage as parameter.

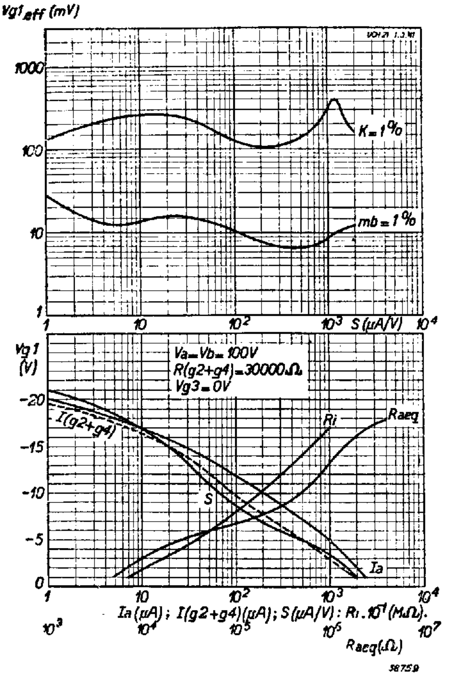

Fig. 14

At $Va = Vb = 100$ V and $Vg_3 = 0$ V, with screen grid fed through a resistance of 30,000 Ohms: valve employed as I.F. amplifier (heptode).

Upper diagram; maximum permissible effective value of R.F. alternating voltage with 1 % cross modulation ($K = 1$ %), and with 1 % modulation hum ($mb = 1$ %), in each case in respect of interfering signal at the control grid, as a function of mutual conductance.

Lower diagram; Anode current *Ia*, screen grid current $I\ (g_2 + g_4)$, mutual conductance *S*, internal resistance *Ri* and equivalent noise resistance *Raeq*, as a function of grid bias Vg_1.

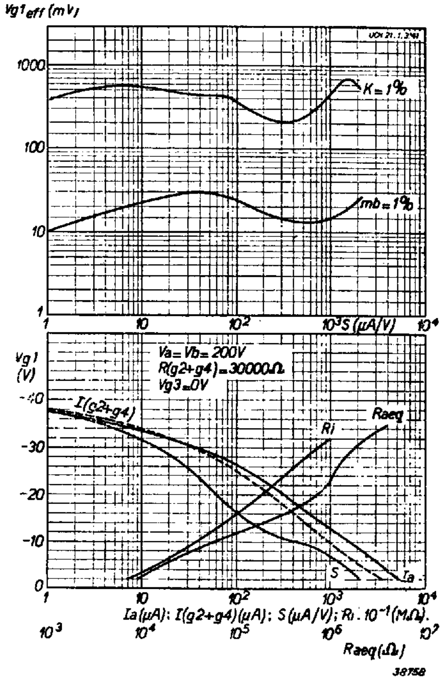

Fig. 15

At $Va = Vb = 200$ V, $Vg_3 = 0$ V and screen fed through a resistance of 30,000 Ohms; heptode employed as I.F. amplifier.

Upper diagram; Maximum permissible effective value of R.F. alternating voltage with 1 % cross modulation ($K = 1$%) and with 1 % modulation hum, ($mb = 1$ %), in each case in respect of interfering signal at the control grid, as a function of mutual conductance.

Lower diagram; Anode current *Ia*, screen grid current $I(\ g_2 + g_4)$, mutual conductance *S*, internal resistance *Ri* and equivalent noise resistance *Raeq* as function of grid bias Vg_1.

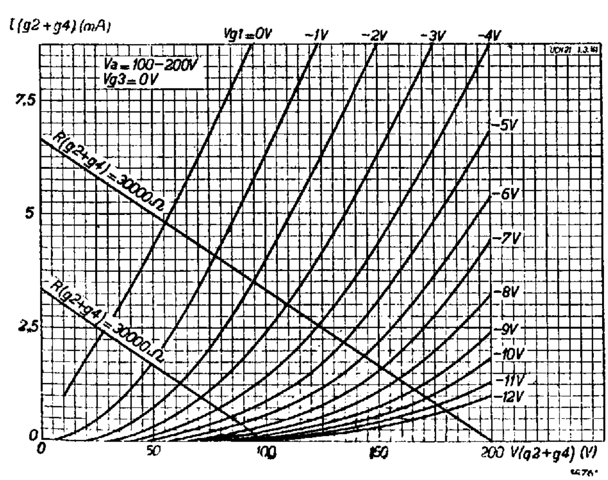

Fig. 16

Screen grid current as a function of screen voltage at $Va = 100$—200 V and $Vg_3 = 0$ V, with grid bias as parameter.

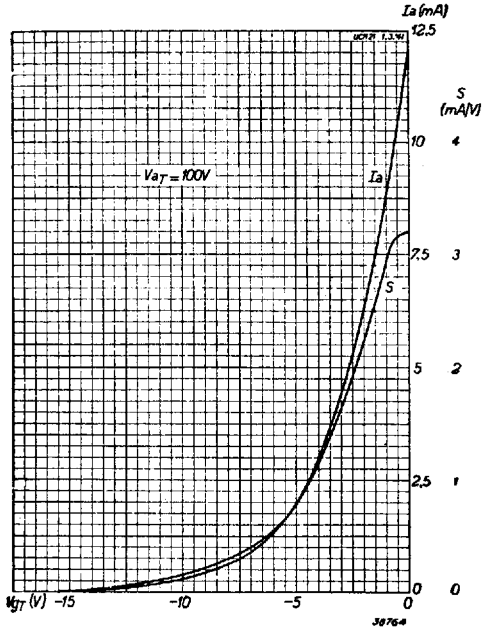

Fig. 17
Anode current and mutual conductance of the triode as function of grid bias at $V_{aT} = 100$ V.

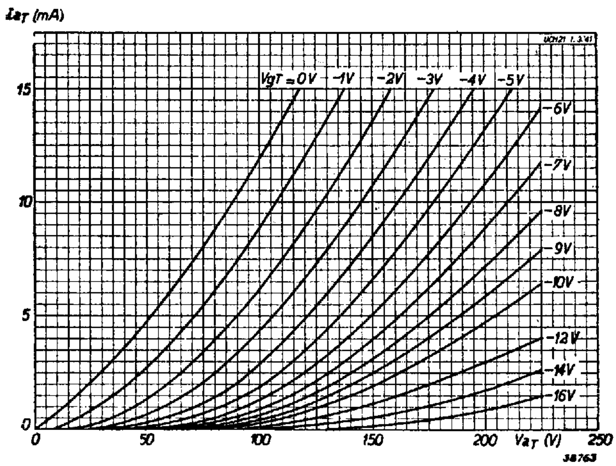

Fig. 18
Anode current of the triode section as a function of anode voltage, with grid bias as parameter.