UCH 4 Triode-heptode

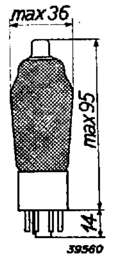

Fig. 1
Dimensions in mm.

The UCH 4 is a triode-heptode the characteristics of which correspond almost entirely to those of the UCH 21, and reference should be made to the description of that valve. In the UCH 4, too, the triode grid and the third grid of the heptode are quite separate, with individual outside connection, making the valve systems suitable for various functions, such as:

1) mixer valve;
2) combined I.F. and A.F. amplifier;
3) A.F. amplifier and phase inverter.

In the following pages the operating data and characteristics are given in reference to these three types of application.

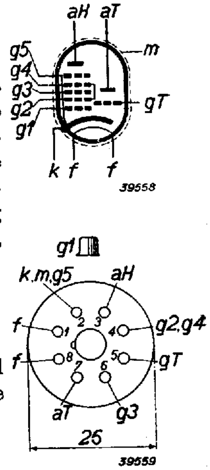

Fig. 2.
Arrangement of electrodes and contacts.

HEATER RATINGS

Heater feed: indirect by AC or DC; series supply.

Heater voltage	V_f	= 20 V
Heater current	I_f	= 0.100 A

CAPACITIES

Heptode section:	C_{g1}	= 4.8 pF	C_{g1g3}	< 0.2 pF
	C_a	= 8.0 pF	C_{g3}	= 9.1 pF
	C_{ag1}	< 0.002 pF	C_{g1f}	< 0.0015 pF
Triode section:	C_g	= 5.9 pF	C_{ak}	= 2.4 pF
	C_a	= 5.2 pF	C_{ag}	= 2.1 pF
	C_{gk}	= 2.8 pF	C_{gf}	< 0.3 pF
Between heptode and triode:				
	C_{gTg1H}	< 0.1 pF	$C_{(gT+g3)g1H}$	< 0.25 pF
	$C_{(gT+g3)}$	= 13.8 pF	$C_{(gT+g3)aH}$	< 0.1 pF

OPERATING DATA FOR THE HEPTODE SECTION when used as mixer valve

Third grid connected to triode grid, sliding screen grid voltage

Anode and supply voltage	$V_a = V_b$	=	100 V		200 V		
Screen grid resistance . .	$R_{(g2+g4)}$	=	15,500 Ohms		15,500 Ohms		
Cathode resistance . . .	R_k	=	150 Ohms		150 Ohms		
Grid leak: third and triode grids	$R_{(gT+g3)}$	=	50,000 Ohms		50,000 Ohms		
Current to third and triode grids	$I_{(gT+g3)}$	=	95 μA		190 μA		
Grid bias	V_{g1}	=	—1[1])	—13.5[2])	—2[1])	—26.5[2])	V
Screen grid voltage . . .	$V_{(g2+g4)}$	=	53	100	100	200	V
Anode current	I_a	=	1.5	—	3.0	—	mA
Screen grid current . . .	$I_{(g2+g4)}$	=	3.0	—	6.5	—	mA
Conversion conductance .	S_c	=	600	6.0	750	7.5	μA/V
Internal resistance . . .	R_i	=	1.0	> 10	1.3	> 10	M Ohm
Equivalent noise resistance	R_{eq}	=	40,000	—	55,000	—	Ohms

OPERATING DATA FOR THE HEPTODE SECTION when used as I. F. amplifier

Third grid not connected to triode grid; sliding screen grid voltage.

Anode and supply voltage	$V_a = V_b$	=	100 V			200 V			
Third grid voltage	V_{g3}	=	0 V			0 V			
Screen grid resistance.	$R_{(g2+g4)}$	=	30,000 Ohms			30,000 Ohms			
Grid bias . . .	V_{g1}	=	—1.0[1])	—13[2])	—18[3])	—2.0[1])	—27[2])	—35[3])	V
Screen grid voltage	$V_{(g2+g4)}$	=	50	—	98	94	—	200	V
Anode current .	I_a	=	2.6	—	—	5.2	—	—	mA
Screen grid current	$I_{(g2+g4)}$	=	1.9	—	—	3.5	—	—	mA
Mutual conductance.	S	=	2100	21	2.1	2200	22	2.2	µA/V
Internal resistance.	R_i	=	0.7	>10	>10	0.7	>10	>10	MOhm
Gain factor in respect of the screen	μ_{g2g1}	=	18	—	—	18	—	—	
Equivalent noise resistance. . .	R_{eq}	=	4900	—	—	9000	—	—	Ohms

[1]) Valve not controlled.
[2]) Mutual or conversion conductance controlled to 1/100.
[3]) Mutual or conversion conductance controlled to 1/1000.

TRIODE RATINGS

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	=	22

OPERATING DATA FOR THE TRIODE SECTION when used as oscillator valve

Supply voltage	V_b	=	100 V	200 V
Anode resistance.	R_a	=	20,000 Ohms	20,000 Ohms
Anode voltage	V_a	=	62 V	116 V
Grid leak.	$R_{(gT+g3)}$	=	50,000 Ohms	50,000 Ohms
Current passing through grid leak during oscillation	$I_{(gT+g3)}$	=	95 µA	190 µA
Anode current during oscillation . .	I_a	=	1.9 mA	4.1 mA
Effective mutual conductance . . .	S_{eff}	=	0.44 mA/V	0.45 mA/V

OPERATING DATA FOR THE TRIODE SECTION when used as A.F. amplifier

Supply voltage V_b (V)	Anode resistance R_a (MOhm)	Anode current I_a (mA)	Grid bias V_g (V)	Gain factor $\frac{V_{o\,eff}}{V_{i\,eff}}$ —	Alternating output voltage $V_{o\,eff}$ (V)	Total distortion d_{tot} (%)
200	0.2	0.8	—2	10	7.5	2.8
100	0.2	0.37	—1	10	7.5	6.0
200	0.1	1.5	—2	10.5	7.5	2.8
100	0.1	0.68	—1	10.5	7.5	5.8
200	0.05	2.8	—2	11	7.5	2.2
100	0.05	1.3	—1	11	7.5	5.4

OPERATING DATA: valve employed as phase inverter for modulation of a push-pull output stage

(With feedback, see Fig. 16).

Supply voltage	V_b	= 200 V	200 V	100 V	100 V
Anode resistance; heptode section	R_{aH}	= 0.2	0.1	0.2	0.1 MOhm
Anode resistance; triode section	R_{aT}	= 0.1	0.1	0.1	0.1 MOhm
Screen grid resistance . . .	$R_{(g_2+g_4)}$	= 0.18	0.1	0.18	0.1 MOhm
Total anode current: triode and heptode	$I_{aH}+I_{aT}$	= 2.1	2.7	1.1	1.3 mA
Screen grid current	$I_{(g_2+g_4)}$	= 0.8	1.3	0.4	0.65 mA
Cathode resistance	R_k	= 700	500	700	500 Ohms
Voltage gain	$\frac{V_{o\,eff}}{V_{i\,eff}}$	= 75	70	65	55
Alternating output voltage	$V_{o\,eff}$	= 10	10	10	10 V
Alternating input voltage .	$V_{i\,eff}$	= 0.13	0.14	0.155	0.18 V
Total distortion	d_{tot}	= 2.5	2.3	3.1	2.4 %

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, cold.	$V_{(g_2+g_4)o}$	= max. 550 V
Screen grid voltage, valve uncontrolled (I_a = 3 mA)	$V_{(g_2+g_4)}$	= max. 100 V
Screen grid voltage, valve controlled (I_a < 1 mA)	$V_{(g_2+g_4)}$	= max. 250 V
Screen grid dissipation.	$W_{(g_2+g_4)}$	= max. 1 W
Cathode current.	I_k	= max. 15 mA
Grid current commences at (I_{g1} = +0.3 μA). .	V_{g1}	= max. —1.3 V
Grid current commences at (I_{g3} = +0.3 μA). .	V_{g3}	= max. —1.3 V
Max. external resistance between grid 1 and cathode.	R_{g1k}	= max. 3 MOhm
Max. external resistance between grid 3 and cathode.	R_{g3k}	= max. 3 MOhm
Max. external resistance between filament and cathode.	R_{fk}	= max. 20,000 Ohms
Max. voltage between filament and cathode (D.C. or effective value of A.C.)	V_{fk}	= max. 150 V

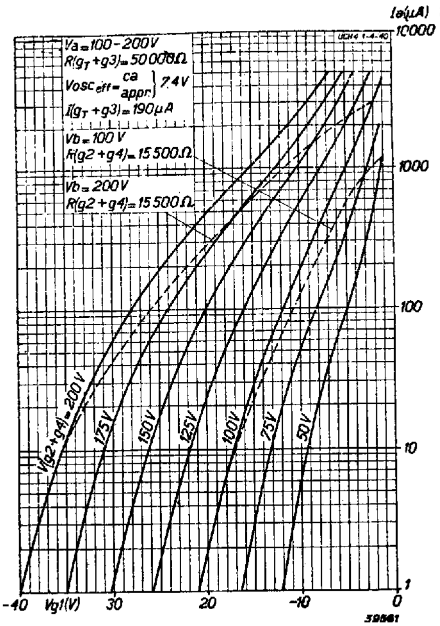

Fig. 3
Anode current as a function of grid bias at $Va = 100 - 200$ V, R $(gT + g_3) = 50{,}000$ Ohms, $I(gT + g_3) = 190$ μA, with $V(g_2 + g_4)$ as parameter.

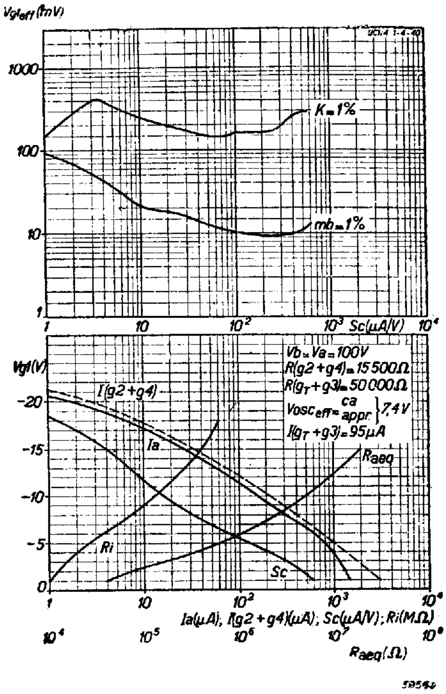

Fig. 5
Upper diagram; Maximum permissible effective value of R.F. alternating voltage at 1 % cross modulation (K = 1 %) and also for 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of conversion conductance. Screen grid fed through a resistance of 15,500 ohms from the 100 V line.
Lower diagram; Conversion conductance *Sc*, anode current *Ia*, screen grid current $I(g_2 + g_4)$, internal resistance *Ri* and equivalent noise resistance *Raeq* as a function of grid bias.

MAXIMUM RATINGS FOR THE TRIODE SECTION

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage .	V_a	= max. 100 V
Anode dissipation	W_a	= max. 0.5 W
Grid current commences at ($I_g = +0.3$ μA)	V_g	= max. —1.3 V
Maximum external resistance in grid circuit . .	R_{gk}	= max. 3 MOhm

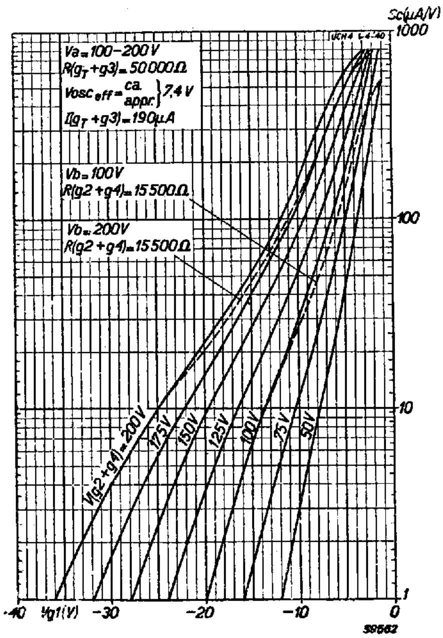

Fig. 4
Conversion conductance as a function of the grid bias at $Va = 100 - 200$ V, $R(gT + g_3) = 50{,}000$ Ohms, $I\ (gT + g_3) = 190$μA, with $V\ (g_2 + g_4)$ as parameter.

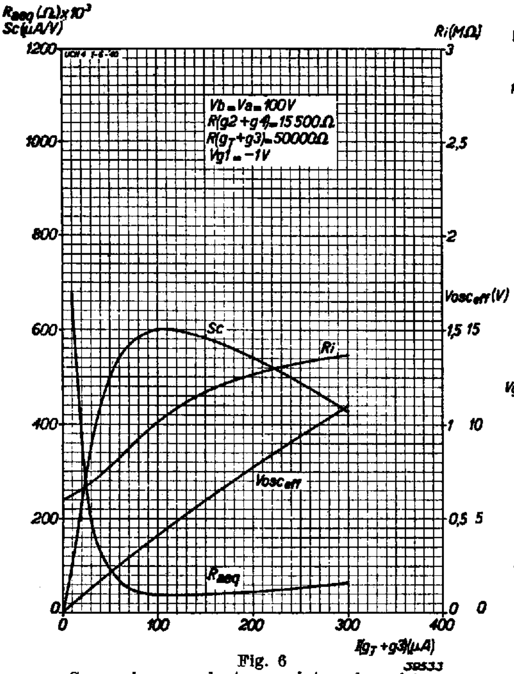

Fig. 6
Conversion conductance, internal resistance, alternating oscillator voltage and equivalent noise resistance as a function of oscillator current, with screen grid fed through a 15,500 Ohm resistance from 100 V, at $Vg_1 = -1$ V.

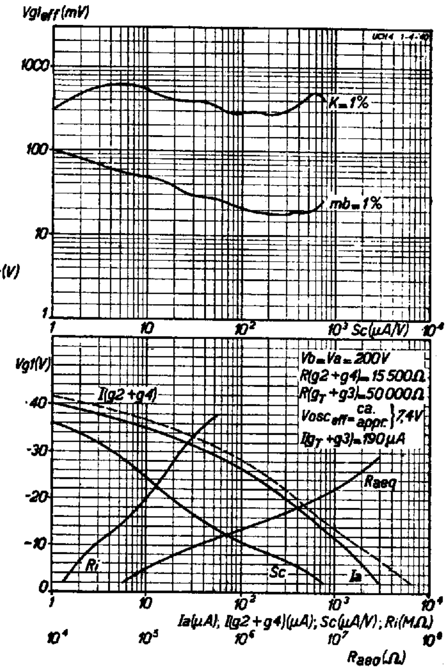

Fig. 7
Upper diagram; Maximum permissible effective value of R.F. alternating voltage at 1 % cross modulation ($K = 1$ %) and also at 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of conversion conductance, with screen grid fed through a resistance of 15,500 ohms from the 200 V line.
Lower diagram; Conversion conductance *Sc*, screen grid current I ($g_2 + g_4$), internal resistance *Ri* and equivalent noise resistance *Raeq* as a function of grid bias.

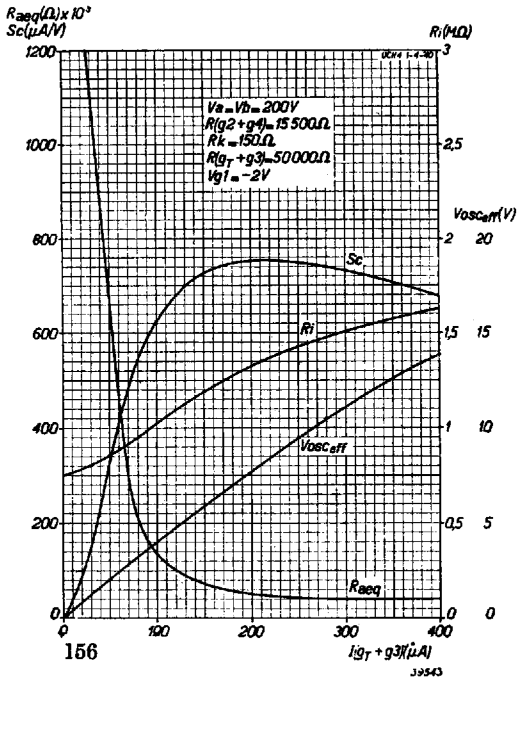

Fig. 8
Conversion conductance, alternating oscillator voltage and equivalent noise resistance as a function of oscillator current, with screen grid fed through a 15,500 ohm resistance from the 200 V line, at $Vg_1 = -2$ V

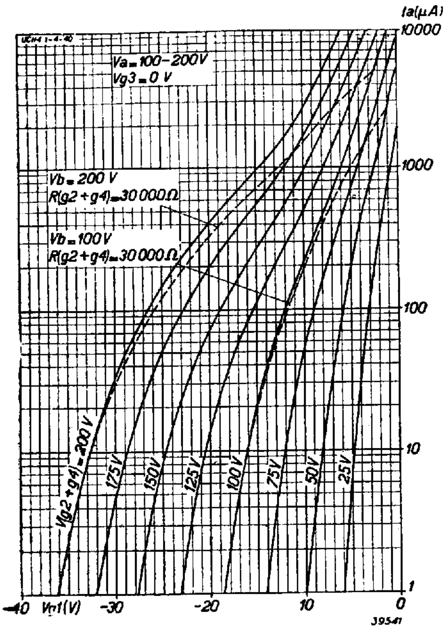

Fig. 9.
Anode current of the heptode section used as I.F. amplifier, as a function of grid bias, at Va = 100—200 V, Vg_3 = 0 V and screen grid fed through a 30,000 ohm resistance, with $V(g_2 + g_4)$ as parameter.

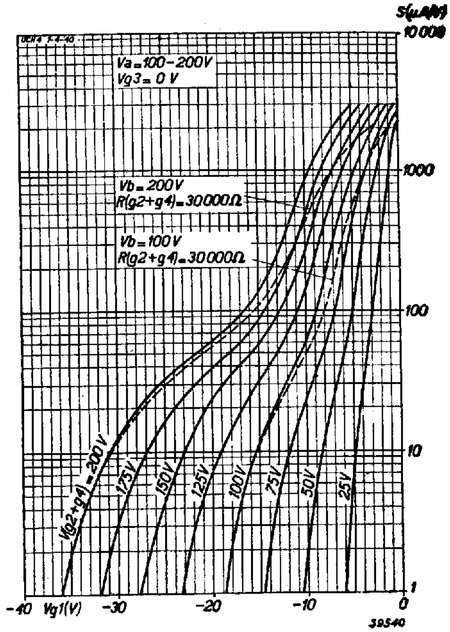

Fig. 10
Mutual conductance of the heptode section as a function of grid bias at Va = 100—200 V, Vg_3 = 0 V and screen grid fed through a 30,000 ohm resistance, with $V(g_2 + g_4)$ as parameter.

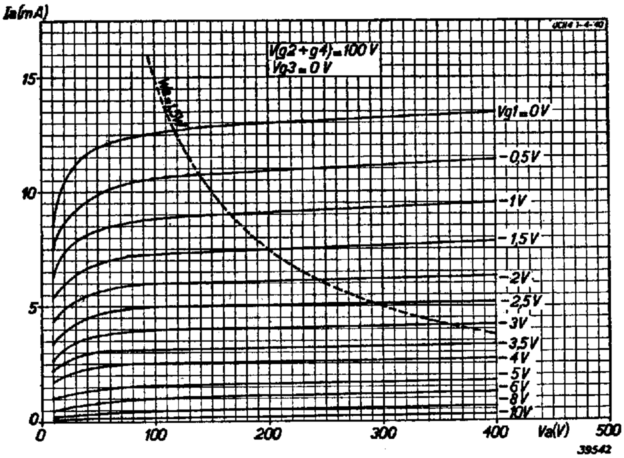

Fig. 11
Anode current as a function of anode voltage at $V(g_2 + g_4)$ = 100 V and $V g_3$ = 0 V, with grid bias as parameter.

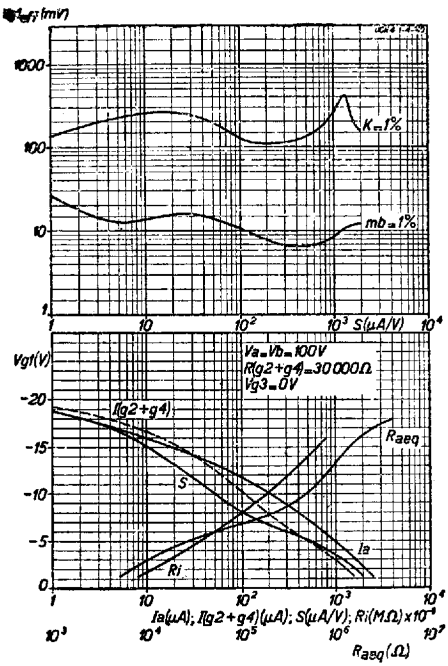

Fig. 12

Upper diagram; Maximum permissible effective value of R.F. alternating voltage at 1 % cross modulation ($K = 1$ %) and also at 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of grid bias, with screen grid fed through a 30,000 ohm resistance from the 100 V line. *Lower diagram;* Mutual conductance S, anode current Ia, screen grid current I ($g_2 + g_4$), internal resistance Ri and equivalent noise resistance $Raeq$ as a function of grid bias.

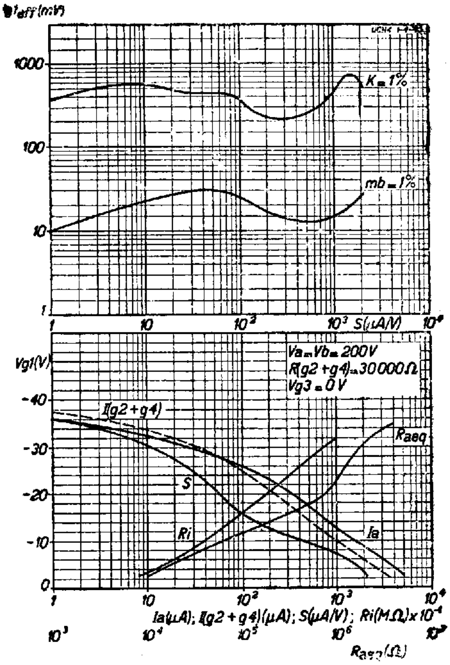

Fig. 13

Upper diagram; Maximum permissible effective value of the R.F. alternating voltage at 1 % cross modulation ($K = 1$ %) and also at 1 % modulation hum ($mb = 1$ %), both in respect of the interfering signal at the grid, as a function of grid bias, with screen grid fed through a 30,000 ohm resistance from the 200 V line. *Lower diagram;* Mutual conductance S, anode current Ia, screen grid current I ($g_2 + g_4$), internal resistance Ri and equivalent noise resistance $Raeq$ as a function of grid bias.

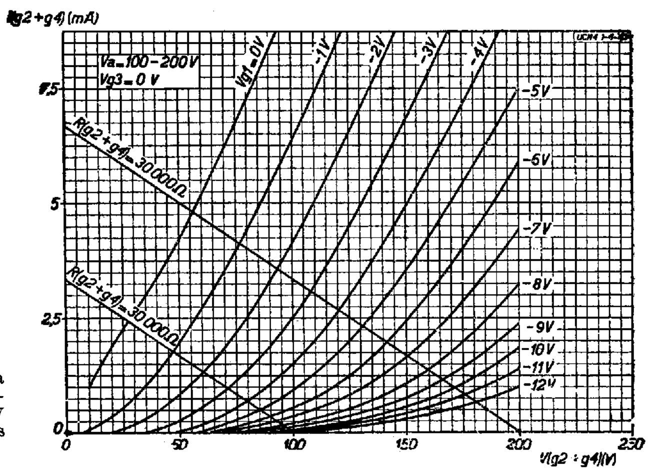

Fig. 14

Screen grid current as a function of screen grid voltage at Va = 100—200 V and $Vg_3 = 0$ V, with Vg_1 as parameter.

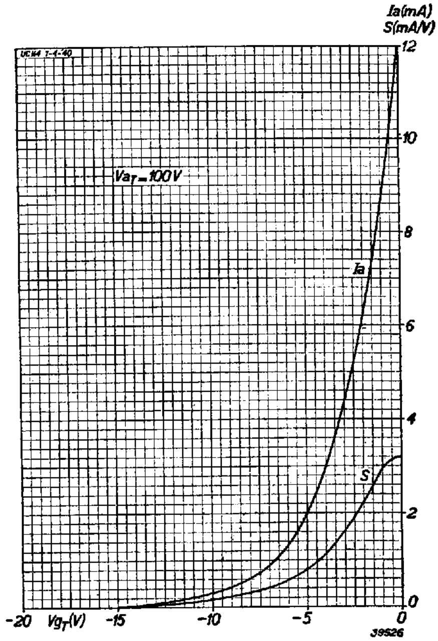

Fig. 15
Anode current and mutual conductance of the triode part as functions of the negative grid bias at $VaT = 100$ V.

APPLICATIONS

When the valve is employed as mixer the following points should be observed.

(I) The heptode can be connected in the usual way, the screen grids being fed through a resistance of 15,500 ohms from the source of anode voltage.

(II) In receivers which are to be operated on 220 V, 127 V or 110 V mains the most suitable bias resistance is 150 ohms, which serves both the high and the low supply voltages, as also does the screen grid resistance; none of the resistances need therefore be changed when the receiver is transferred from one mains voltage to another.

(III) On a supply voltage of 100 V and with the 150 ohm cathode resistance, the grid bias is 1 V and there is a possibility of running into grid current, but the demands to be met by a receiver are usually not so high when working on 110 V mains as on 220 V, so this tendency will be accepted as inevitable, but not very serious since the voltage produced by the automatic gain control will to a certain extent counteract this grid current.

The oscillator voltage is obtained in the normal manner, but it is advisable, in order to suppress frequency drift and "pulling" of the oscillator tuning by the R.F. circuit, to connect the tuned oscillator circuit to the anode and the reaction coupling coil to the grid of the triode in the manner shown in Fig. 17. The triode anode is fed through a 20,000 ohms resistance, the tuned circuit being coupled to that anode through a condenser of 100 to 150 pF, i.e. by parallel feed. The grid leak is 50,000 ohms and the grid condenser 50 pF, these being the best values for average conditions, whilst excluding the possibility of over-oscillation.

At a supply voltage of 100 V, parallel feed can be employed only when the reaction coupling is extremely tight, and the best practical results are obtained with an anode resistance of 20,000 ohms. As a rule, however, series-feed will be given preference (see Fig. 18). A resistance of 28,500 ohms is then used for the triode anode and this method of feed can be maintained for 200 V supply voltage as well. It is recommended that the reaction coupling should be tighter for series than for parallel feed, especially on 100 V supply voltage and for reception on long waves.

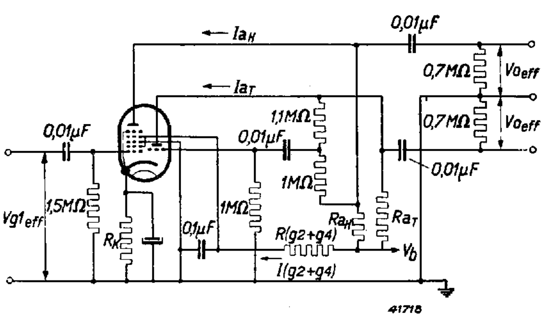

Fig. 16
Circuit diagram showing the UCH 4 employed as phase inverter with negative feedback.

Tighter coupling can also be obtained by means of a combination of inductive and capacitive coupling through the padding condenser. Fig. 18 shows a condenser C_p employed as decoupling capacitance for the series

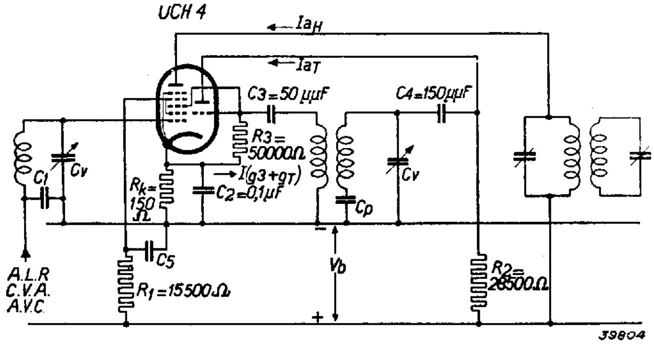

Fig. 17
Circuit diagram for employing the UCH 4 as mixer in AC/DC sets for a working voltage of 200 V.

resistance R_2. A blocking condenser C_4 of about 0.1 μF is also included, to prevent developement of a voltage at the rotor of the variable condenser, and the resistance

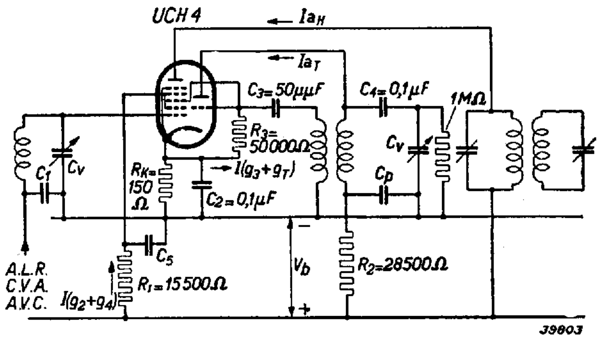

Fig. 18
Circuit diagram showing the UCH 4 used as mixer in AC/DC receivers to work on 100 V and 200 V mains supply voltage.

of 1 megohm further prevents the tuning condenser C_v from being under a potential produced by the currents through C_4. The circuit in which the tuned oscillator circuit is coupled to the grid of the triode is undoubtedly a much simpler proposition, but in that case the frequency drift will be considerably greater.