2 V Battery valves

KB 2 Indirectly-heated double-diode

The KB 2 is an indirectly-heated double-diode valve for battery receivers. The current consumption is very low indeed, being only about 95 mA on 2 V.

As the cathode is indirectly heated, sets in which this valve is used may be equipped with delayed automatic gain control; the delay may be regulated as desired by applying a positive potential from the H. T. battery to the cathode. The KB 2 can be employed as a detector preceding a stage of A.F. amplification using a valve such as the KF 4, or a driver, e.g. the KC 3, or it can be coupled directly to a pentode output valve.

The strong signals which in the latter case would inevitably occur on the KB 2 can be quite easily handled by this diode.

The capacitance between the two diodes has been kept as low as possible, as this is of importance when the second anode is used for the delayed A.G.C., and is accordingly connected to the primary side of the preceding band-pass filter. The characteristics of the D.C. voltage gain ($\triangle V$) across the load resistor as a function of the unmodulated R.F. signal, as well as that of the A.F. voltage (V_{LF}) across the resistor of 0.5 megohm as plotted against the 30 % modulated R.F. voltage on one of the diodes, are identical with those relating to the EB 4, to which reference may be made for details.

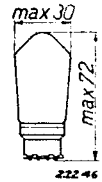


Fig. 1
Dimensions in mm.

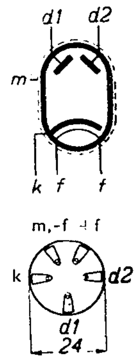


Fig. 2
Arrangement of electrodes and base connections.

HEATER RATINGS

Heating: indirect by battery, parallel supply.

Heater voltage	V_f =	2.0 V
Heater current	I_f =	0.095 A

CAPACITANCES

$C_{d_1d_2} < 0.25\ \mu\mu F$
$C_{kd_1} = 2.1\ \mu\mu F$
$C_{kd_2} = 1.7\ \mu\mu F$

MAXIMUM RATINGS

Voltage on diode (peak value)	$V_{d1} = V_{d2}$ =	max. 125 V
Diode current	$I_{d1} = I_{d2}$ =	max. 0.5 mA
Voltage between heater and cathode	V_{fk} =	max. 50 V
External resistance between heater and cathode . . .	R_{fk} =	max. 20,000 ohms

KBC 1 Double-diode triode

The KBC 1 is a directly-heated double-diode triode. This combination of triode with two diodes promotes a considerable saving in filament current, this being a matter of some importance in battery receivers.

This valve can be employed to advantage in "straight" circuits or in superheterodyne receivers; the triode unit may be used also as a driver in conjunction with the Class B output amplifier KDD 1, or as pre-amplifier for the output pentode KL 4.

The diode located at the negative end of the filament should be used as detector and the other diode, at the positive end, for the delayed A.G.C. In Fig. 2, the diode situated at the end of the filament marked f_1 is shown as d_1 and the other, at the extremity f_2, as d_2. If the filament extremity f_1 is positive, diode d_2 is employed as detector; otherwise weak signals are not properly rectified. The loading resistor on the diode should preferably be connected to the positive, not to the negative, end of the filament, as this gives a better detection characteristic.

The second diode is approximately 2 V negative with respect to the positive extremity of the filament, thus providing a similar amount of delay voltage; if a greater delay is desired, this can be obtained by the use of a special circuit (see Chapter XXV). The diode unit is separated from the triode section by a screen, which effectively prevents any coupling between the two.

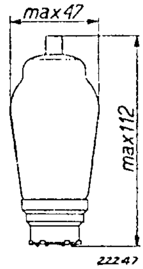


Fig. 1
Dimensions in mm

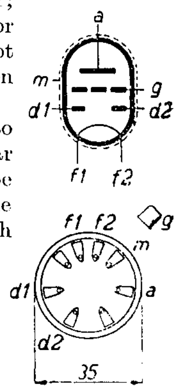


Fig. 2
Arrangement of electrodes and base connections

FILAMENT RATINGS

Heating: direct, by battery; parallel supply.
Filament voltage . . . . $V_f = 2$ V
Filament current . . . . $I_f = 0.115$ A

CAPACITANCES

Diode section:	C_{d_1}	$= 2.7\ \mu\mu F$	Triode section:	C_{ag}	$= 3.1\ \mu\mu F$
	C_{d_2}	$= 2.5\ \mu\mu F$		C_a	$= 6.5\ \mu\mu F$
	$C_{d_1d_2}$	$< 0.5\ \mu\mu F$		C_g	$= 3.0\ \mu\mu F$
	C_{d_1g}	$< 0.003\ \mu\mu F$			
	C_{d_2g}	$< 0.003\ \mu\mu F$			

STATIC DATA OF THE TRIODE SECTION

Anode voltage	V_a =	90	135 V
Grid bias	V_g =	—3.4	—4.5 V
Anode current	I_a =	1	2.5 mA
Amplification factor	μ =	16	16
Mutual conductance	S =	0.7	1 mA/V
Internal resistance	R_i =	23,000	16,000 ohms

MAXIMUM RATINGS

Triode section:

	V_a	= max. 150 V
	W_a	= max. 0.6 W
	I_k	= max. 6 mA
	V_g (I_g = + 0.3 μA)	= max. —0.2 V
	R_g	= max. 3 M ohms
Diode section:		
Voltage on diode (peak value) .	$V_{d1} = V_{d2}$	= max. 125 V
Diode current.	$I_{d1} = I_{d2}$	= max. 0.2 mA
Diode voltage at diode current start	(I_{d2} = + 0.3 μA) V_{d2}	= max. —0.4 V

When the triode section is to be employed as a resistance-coupled A.F. amplifier. the necessary data may be obtained from the following table:

TABLE

KBC 1 used as a resistance-coupled A.F. amplifier

Battery voltage V_a (V)	Coupling resistor R_a (M ohm)	Anode current I_a (mA)	Grid bias V_g (V)	Output voltage V_o (V_{eff})	Distor-tion d (%)	Stage gain $\frac{V_o}{V_i}$
135	0.2	0.35	—2.0	5 8	0.7 1.2	12.5
90	0.2	0.19	—2.0	3 5	0.8 1.3	11
135	0.1	0.69	—2.0	5 8	0.7 1.2	12
90	0.1	0.36	—2.0	3 5	0.8 1.3	11
135	0.05	1.25	—2.0	5 8	0.8 1.3	11
90	0.05	0.60	—2.0	3 5	1.0 1.6	10

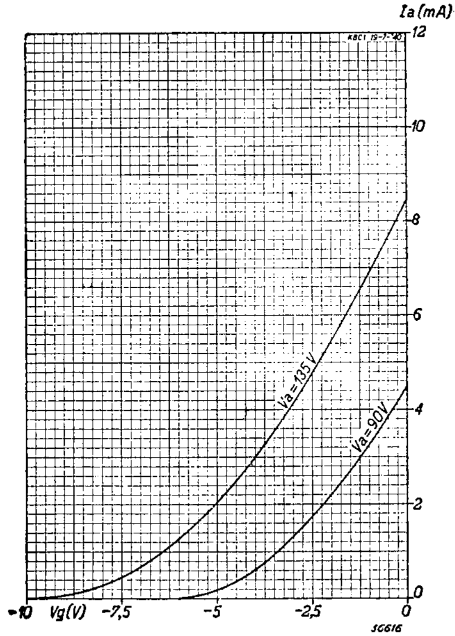


Fig. 3
Ia/Vg characteristics for the triode section of the KBC 1.

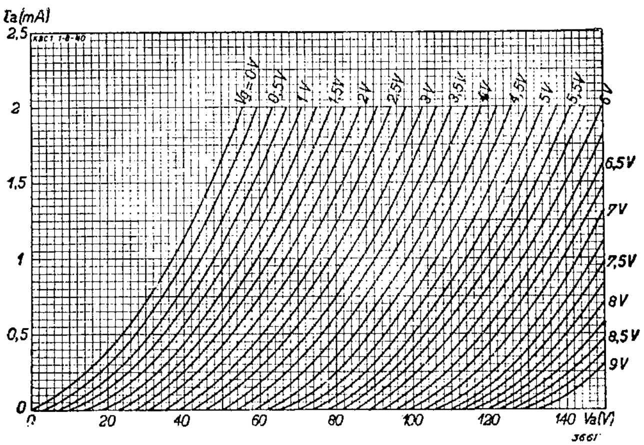


Fig. 4
Anode current of the triode section of the KBC 1 as a function of the anode voltage with grid bias as parameter.

KC 1 Triode

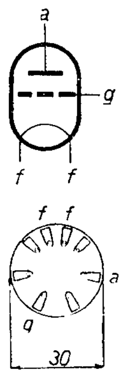


Fig. 2
Arrangement of electrodes and base connections.

This triode is useful as an A.F. amplifier valve, anode-bend detector, or oscillator in battery receivers. Its use as a grid detector is not recommended, since the maximum alternating output voltage is then usually insufficient for the output stage. In the case of A.F. amplification, care must be taken that the A.F. gain following the grid of this valve is not made too great, as this is liable to set up microphony.

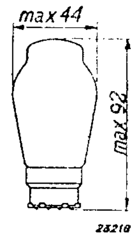


Fig. 1
Dimensions in mm.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.

Filament voltage	V_f = 2.0 V
Filament current	I_f = 0.065 A

CAPACITANCES

C_{ag} = 3.5 $\mu\mu$F
C_a = 2.0 $\mu\mu$F
C_g = 3.0 $\mu\mu$F

STATIC DATA

Anode voltage		
V_a	= 90 V	135 V
Anode current		
I_a	= 0.3 mA	1.2 mA
Grid bias		
V_g	= —1.5 V	—1.5 V
Internal resistance		
R_i	= 60,000 ohms	40,000 ohms
Amplification factor		
μ	= 25	25

MAXIMUM RATINGS

V_a	= max. 150 V
W_a	= max. 0.5 W
I_k	= max. 4 mA
V_g (I_g = + 0.3 μA)	= max. —0.2 V
R_{gf}	= max. 3 M ohms

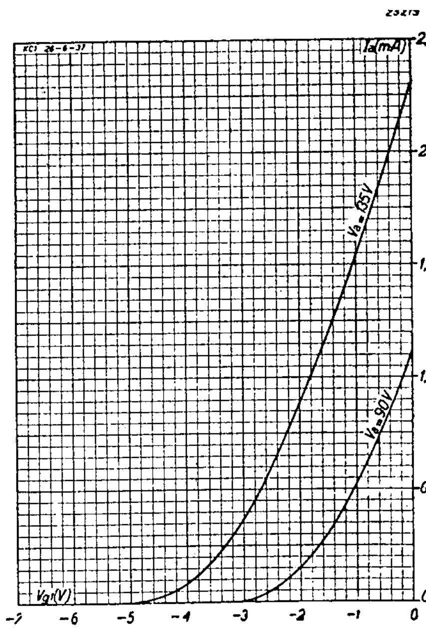


Fig. 3
Anode current as a function of the grid bias, with V_a = 90 V and 135 V.

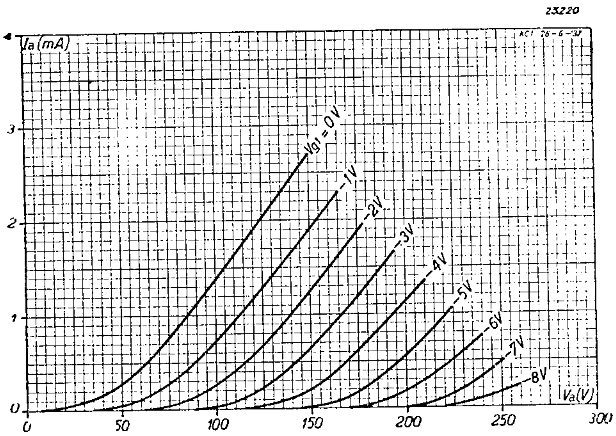


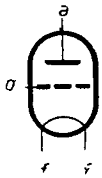
Fig. 4
Anode current as a function of the anode voltage with grid bias as parameter.

TABLE

KC 1 used as a resistance-coupled A.F. amplifier

Battery voltage V_b (V)	Coupling resistor R_a (megohms)	Anode current I_a (mA)	Grid bias V_g (V)	For an alternating output voltage of 7 Veff		For an alternating output voltage of 10 Veff	
				Gain $\frac{V_o}{V_i}$	Distortion d_{tot} (%)	Gain $\frac{V_o}{V_i}$	Distortion d_{tot} %
90	0.32	0.08	—1.5	14.6	2.7	—	—
90	0.32	0.13	—0.75	16.7	1.6	—	—
135	0.32	0.18	—1.5	—	—	19	1.0
135	0.32	0.23	—0.75	—	—	20	0.8
90	0.2	0.11	—1.5	14.3	4	—	—
90	0.2	0.17	—0.75	16.2	1.5	—	—
135	0.2	0.26	—1.5	—	—	18	1.0
135	0.2	0.32	—0.75	—	—	18.5	0.8

KC 3 Triode



This triode is a driver valve for Class B output stages in which the grid of the output valve passes a certain amount of current. In view of the high power required for the excitation of a Class B output circuit in which grid current flows, the filament consumption is on the high side.
The KC 3 should be employed only in conjunction with the Class B output valve KDD 1, using a driver transformer having a ratio of 2 : (1 + 1). The sensitivity of the combination of KC 3 and KDD 1 valves is so high that the KF 4, connected as A.F. amplifier or detector, may precede it only when operating below its maximum amplification; otherwise the receiver becomes microphonic.

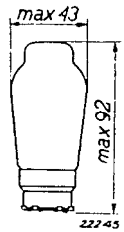


Fig. 1
Dimensions in mm

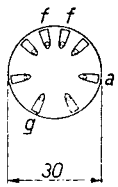


Fig. 2
Arrangement of electrodes and base connections.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . V_f = 2.0 V
Filament current . . . . I_f = 0.21 A

CAPACITANCES

C_{ag} = max. 6.3 $\mu\mu$F

STATIC DATA

Anode voltage	V_a	=	90	135 V
Grid bias	V_g	=	—1.6	—2.8 V
Anode current	I_a	=	2	3 mA
Mutual conductance	S	=	2.2	2.5 mA/V
Internal resistance	R_i	=	14,000	12,000 ohms
Amplification factor	μ	=	25	25

MAXIMUM RATINGS

V_a	= max. 150 V
W_a	= max. 1 W
I_k	= max. 7 mA
V_g (I_g = + 0.3 μA)	= max. —0.4 V
R_{gf}	= max. 3 M ohms

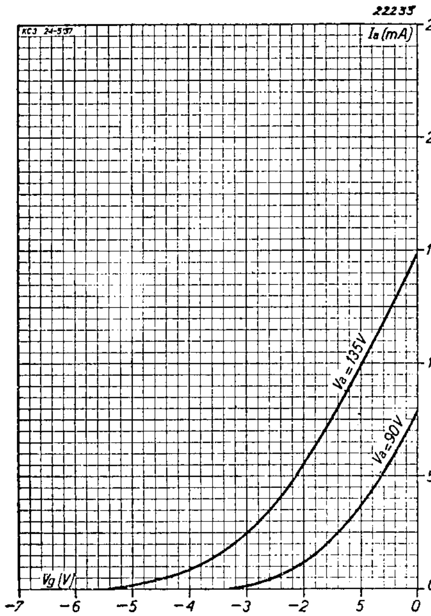


Fig. 3
Anode current as a function of the grid bias.

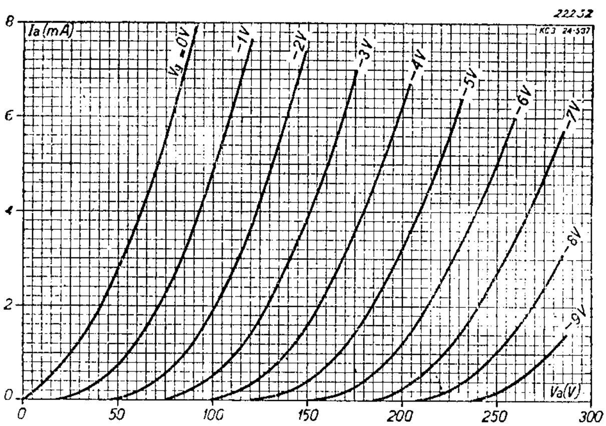


Fig. 4
Anode current as a function of the anode voltage fo different values of grid bias.

KC 4 Triode

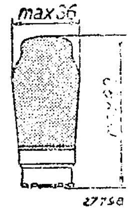


Fig. 1
Dimensions in mm

The triode KC 4 can be used either as oscillator valve for the frequency-changer KH 1, or as A.F. amplifier. In the last-mentioned case the total A.F. gain, as from the grid of the valve, should not be too high, as this may result in microphony.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . V_f = 2.0 V
Filament current. I_f = 0.1 A

CAPACITANCES

C_{ag} = 2.9 μμF
C_{gf} = 2.1 μμF
C_{af} = 5 μμF

STATIC DATA

Anode voltage	V_a	=	90	135 V
Grid bias	V_g	=	—1.5	—1.5 V
Anode current	I_a	=	0.5	2.2 mA
Amplification factor	μ	=	30	30
Internal resistance	R_i	=	37,500	21,500 ohms
Mutual conductance	S	=	0.8	1.4 mA/V

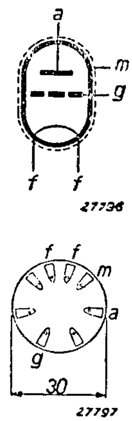


Fig. 2
Arrangement of electrodes and base connections

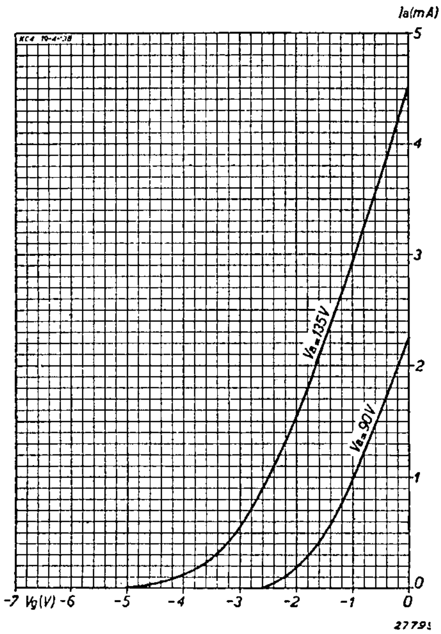


Fig. 3
Anode current as a function of the grid bias, with V_a = 90 and 135 V.

OPERATING DATA: KC 4 used as resistance-coupled A.F. amplifier

Battery voltage	Coupling resistor	Grid bias	Anode current	Stage gain	For valve KL 1		For valve KL 2		For valve KL 4	
					$Va = Vb$		$Va = Vb$		$Va = Vb$	
Vb (V)	(M ohms)	Vg (V)	Ia (mA)	$\frac{Vo}{Vi}$	Vo (Veff)	$d$tot (%)	Vo (Veff)	$d$tot (%)	Vo (Veff)	$d$tot (%)
135	0.2	—1.5	0.32	21.5	4.2	< 1	8	1.2	5	< 1
90	0.2	—1.5	0.15	18.5	3	1.5	5	2.3	3.3	1
135	0.1	—1.5	0.52	20	4.2	< 1	8	1.3	5	< 1
90	0.1	—1.5	0.23	16.5	3	1.7	5	2.9	3.3	1.1
135	0.05	—1.5	0.8	17.5	4.2	< 1	8	1.6	5	< 1
90	0.05	—1.5	0.32	13.5	3	2.8	5	4	3.3	1.5

MAXIMUM RATINGS

Anode voltage . . . . V_a = max. 150 V
Anode dissipation . . . . W_a = max. 0.5 W
Cathode current. I_k = max. 5 mA
Grid voltage at grid current start . . ($I_g = +0.3\ \mu$A) V_g = max. —0.2 V
External resistance between grid and filament . . . . . R_{gf} = max 3 M ohms

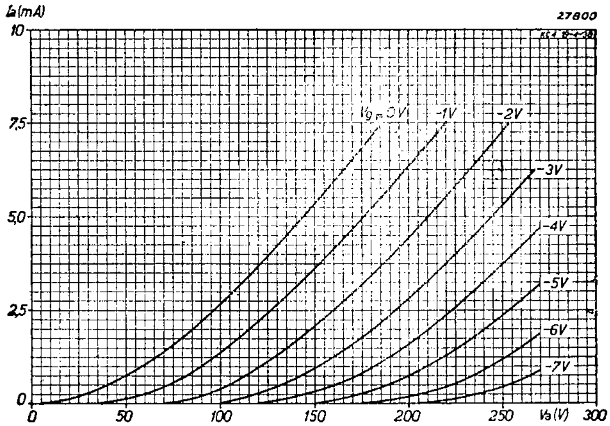


Fig. 4
Anode current as a function of the anode voltage for various values of grid bias.

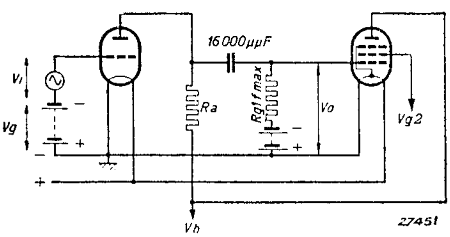


Fig. 5
Theoretical diagram of circuit employing resistance-coupled amplification and illustrating the symbols used in the data.

KCH 1 Triode-hexode

The KCH 1 is a frequency-changer for battery superheterodyne receivers. It consists of a combination of hexode for mixing the input signal with the signal generated by the oscillator, and a triode for use as the latter.

Every effort has been made in the development of this valve to attain the highest possible conversion conductance, with a low filament current consumption. The main object was to produce a mixer valve for battery receivers that would give a reliable performance on short waves and also permit of automatic gain control on that wave range, with a minimum of interference due to frequency drift and so on.

Because of the rapid control required in battery receivers, great care has been taken to ensure good characteristics from the aspect of cross-modulation. A variation in the grid bias of from —0.5 to —17 V, with an anode potential of 135 V and "sliding" screen voltage, is sufficient to reduce the conversion conductance to one-hundredth. Without control the conversion conductance is 325 μA/V. The screen-grid voltage of the hexode section of the KCH 1 may be arranged so as to be self-adjusting; this saves the current that would otherwise pass through the potential divider and operates the valve as economically as possible. On a battery voltage of 135 V, with a resistor of 67,000 ohms in series with the screen, the total load on the anode battery is only 5 mA. With a fixed screen potential, control of the conversion conductance is considerably more rapid, but the cross-modulation characteristics are not so favourable.

Further, when the valve is operated on a fixed screen voltage the internal resistance during the control period, even on a low battery voltage, increases rapidly, whereas if a screen series resistor is used the internal resistance commences to decrease. This is explained by the fact that the screen voltage, when self-adjusting, closely approaches the same value as the anode voltage when control is applied; due to secondary emission the internal resistance drops, until the anode voltage has decreased so far in response to

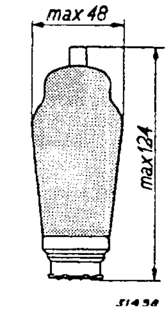


Fig. 1
Dimensions in mm.

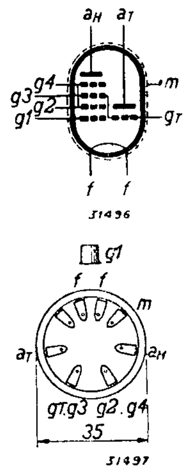


Fig. 2
Arrangement of electrodes and base connections.

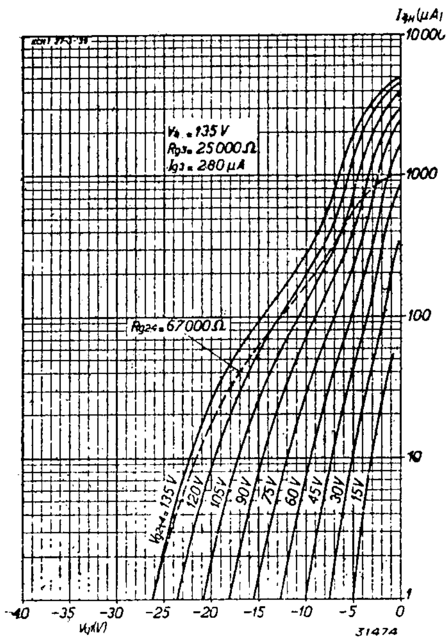


Fig. 3
Anode current of the hexode unit as a function of the grid bias, with the screen-grid voltage as parameter. The broken lines show the anode current in the case of the controlled valve, with the screen fed from the 135 V battery through a resistor of 67,000 ohms.

the control that the internal resistance again rises. The curve relating to the internal resistance of the valve when under control, as a function of the grid bias, shows a decrease at —5 V. At $V_a = 135$ V and $R_{g2,4} = 67{,}000$ ohms, the internal resistance diminishes to 0.5 megohm, whilst on $V_a = 90$ V and $V_{g2,4} = 29{,}000$ ohms the minimum is 0.1 megohm. Although a value of 0.5 megohm is still quite serviceable, 0.1 megohm must be regarded as too low, as the selectivity of the associated I.F. circuit is then reduced too much. On a low battery voltage, therefore, a fixed screen voltage will normally be preferred, or alternatively, potential-divider feed; the latter need take only a very small amount of current, viz. 0.5—1 mA.

Much attention has been given to the oscillator section of this valve to ensure reliable oscillation when the valve is to be used in conjunction with ordinary standard coils and circuits. Every effort has also been made to procure the highest possible conductance in the triode section at the threshold of oscillation; this is 1.3 mA/V at an anode potential of 70 V, and constant oscillation is thus guaranteed.

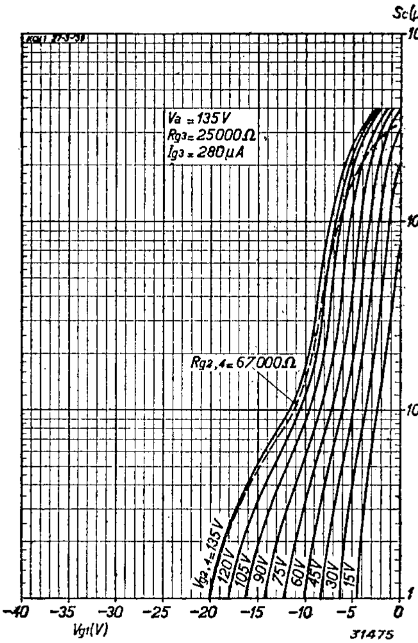


Fig. 4
Conversion conductance as a function of the grid bias, with the screen voltage as parameter. The broken line refers to the conductance when control is applied to the valve, with the screen fed from the 135 V battery through a resistor of 67,000 ohms.

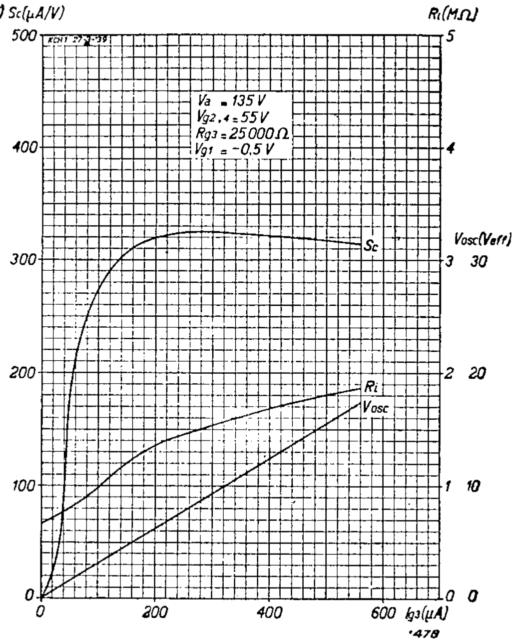


Fig. 5
Conversion conductance Sc, internal resistance Ri and effective oscillator voltage $Vosc$ as functions of the oscillator-grid current I_{g_3} (grid leak of oscillator, $Rg_3 = 25{,}000$ ohms), at $Va = 135$ V and a fixed screen voltage of 55 V.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.

Filament voltage	$V_f = 2.0$ V
Filament current	$I_f = 0.18$ A

CAPACITANCES

a. Hexode section.	b. Triode section.	Between hexode and triode.
$C_{g1} = 7\ \mu\mu F$	$C_{gf} = 13.5\ \mu\mu F$	$C_{gTg1H} < 0.4\ \mu\mu F$
$C_a = 16\ \mu\mu F$	$C_{af} = 3.6\ \mu\mu F$	
$C_{ag1} < 0.05\ \mu\mu F$	$C_{ag} = 3.5\ \mu\mu F$	

OPERATING DATA: Hexode section

a) FIXED SCREEN-GRID VOLTAGE

Anode voltage	V_a =	90 V			135 V		
Screen-grid voltage	$V_{g2,4}$ =	55 V			55 V		
Grid leak	R_{g3} =	25,000 ohms			25,000 ohms		
Oscillator-grid current	I_{g3} =	280 μA			280 μA		
Grid bias	V_{g1} =	—0.5 [1])	—8 [2])	—9.5 [3])	—0.5 [1])	—8 [2])	—9.5 [3])
Anode current	I_a =	1 mA	—	—	1 mA	—	—
Screen current	$I_{g2,g4}$ =	1.2 mA	—	—	1.2 mA	—	—
Conversion conductance	S_c =	320	3	1	325	3	1 μA/V
Internal resistance	R_i =	0.7	> 4	> 5	1.5	> 10	> 10 M ohms

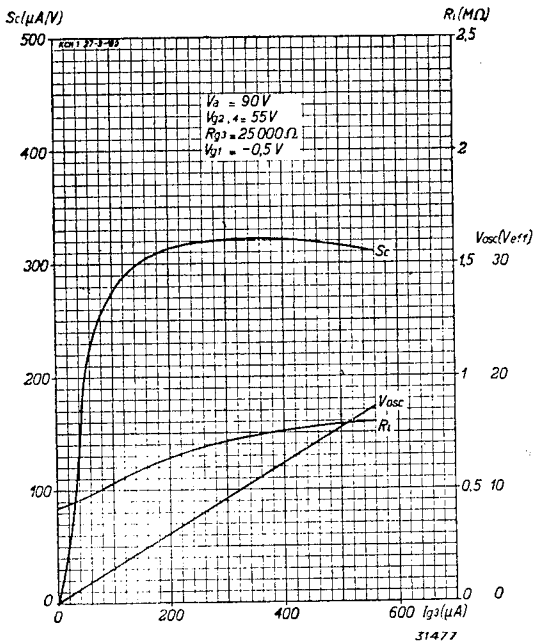


Fig. 6
Conversion conductance *Sc*, internal resistance *Ri* and effective oscillator voltage *Vosc* as functions of the oscillator-grid current Ig_3 (oscillator grid leak Rg_3 = 25,000 ohms), with Va = 90 V and fixed screen voltage of 55 V.

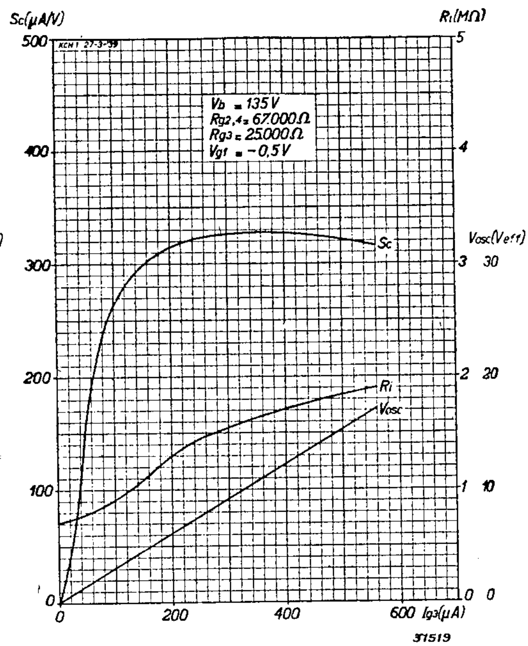


Fig. 7
Conversion conductance *Sc*, internal resistance *Ri* and effective oscillator voltage *Vosc* as functions of the oscillator-grid current Ig_3 (oscillator grid leak Rg_3 = 25,000 ohms), with Va = 135V and screen fed from 135 V battery through a resistor of 67,000 ohms.

b) WITH SCREEN SERIES RESISTOR

Anode voltage	V_a =	90 V			135 V		
Screen series resistor	$R_{g2,4}$ =	29,000 ohms			67,000 ohms		
Grid leak	R_{g3} =	25,000 ohms			25,000 ohms		
Oscillator grid current	I_{g3} =	280 μA			280 μA		
Grid bias	V_{g1} =	—0.5 [1]	—12 [2]	—15 [3]	—0.5 [1]	—17 [2]	—20 V [3]
Screen-grid voltage	$V_{g2,4}$ =	55	—	90	55	—	135 V
Anode current	I_a =	1	—	—	1	—	— mA
Screen-grid current	$I_{g2,g4}$ =	1.2	—	—	1.2	—	— mA
Conversion conductance	S_c =	320	3	1	325	3	1 μA/V
Internal resistance	R_i =	0.7 [4]	> 0.9	> 1	1.5 [5]	> 1	> 1.5 M ohms

For footnotes see next page.

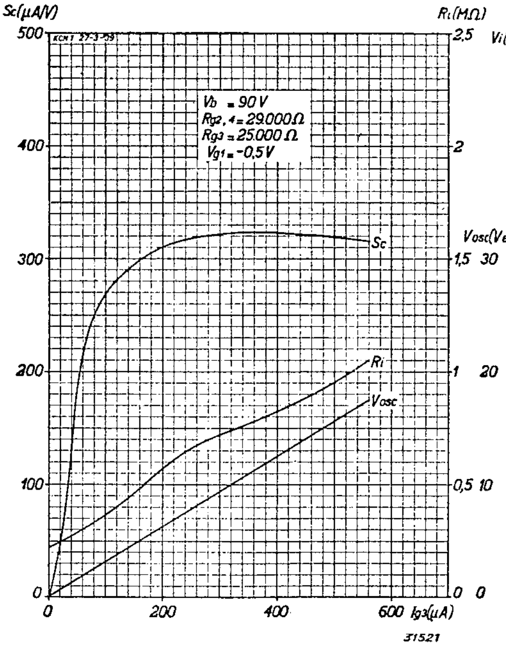


Fig. 8
Conversion conductance *Sc*, internal resistance *Ri* and effective oscillator voltage *Vosc* as functions of the oscillator-grid current Ig_3 (oscillator grid leak Rg_3 = 25,000 ohms), with Va = 90 V and screen fed from 90 V battery through a resistor of 29,000 ohms.

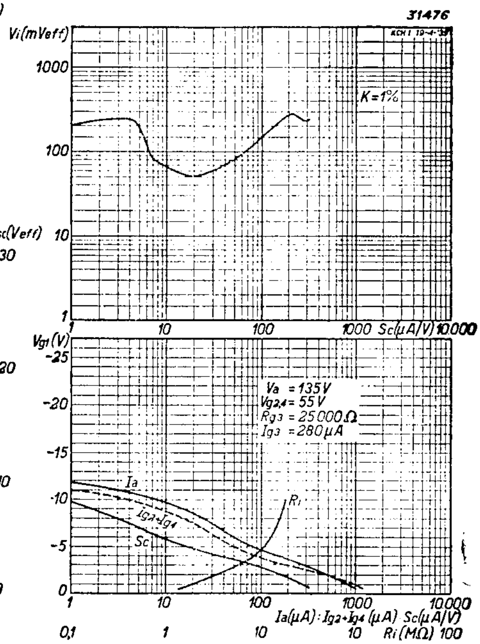


Fig. 9
With 135 V anode voltage and fixed screen voltage 55 V;
Upper diagram. Alternating grid voltage of interfering signal (effective value) as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance *Sc*, anode current *Ia*, screen current $Ig_2 + Ig_4$ and internal resistance *Ri* as functions of the grid bias Vg_1.

c) SCREEN FED FROM A POTENTIAL DIVIDER

Anode voltage	V_a =	90 V			90 V		
Potential divider resistor	R_1 [6]) =	16,000 ohms			22,000 ohms		
Potential divider resistor	R_2 [6]) =	55,000 ohms			110,000 ohms		
Potentiometer current	I_p =	1 mA			0.5 mA		
Grid leak	R_{g3} =	25,000 ohms			25,000 ohms		
Oscillator-grid current	I_{g3} =	280 μA			280 μA		
Grid bias	V_{g1} =	—0.5 [1])	—9.5 [2])	—11 V[3])	—0.5[1])	—10[2])	—12 [3]) V
Screen-grid voltage	$V_{g2,4}$ =	55	—	70 V	55	—	75 V
Anode current	I_a =	1	—	— mA	1	—	— mA
Screen current	$I_{g2,g4}$ =	1.2	—	— mA	1.2	—	— mA
Conversion conductance	S_c =	320	3	1	325	3	1 μA/V
Internal resistance	R_i =	0.7	> 2	> 3	0.7	> 1.5	> 2.5 M ohms

[1]) Without control
[2]) Conversion conductance controlled to 1 : 100
[3]) Limit of control
[4]) With a grid bias of –5 V the internal resistance is approx. 0.1 megohm
[5]) With a grid bias of –6 V the internal resistance is approx. 0.4 megohm
[6]) See circuit diagram, Fig. 16.

OPERATING DATA: triode section used as oscillator

Anode voltage	V_a =	70	—	— V
Battery voltage	V_b =	—	90	135 V
Anode series resistor	R_a =	—	22,000	22,000 ohms
Anode current with I_g = 280 μA and R_{g1} = 25,000 ohms	I_a =	3	2	3 mA
Anode current ($V_g = 0$, $I_g = 0$)	I_a =	2.4	—	— mA
Mutual conductance at threshold of oscillation ($V_g = 0$, $I_g = 0$)	S_o =	1.3	1.1	1.3 mA/V
Amplification factor, with $V_g = 0$, $I_g = 0$	μ =	28	28	28

MAXIMUM RATINGS: Hexode section

Anode voltage	V_a	= max. 135 V
Anode dissipation	W_a	= max. 1.5 W
Screen-grid voltage without control on the valve (I_a = 1 mA)	$V_{g2,4}$	= max. 60 V
Screen voltage, valve under control (I_a < 0.2 mA)	$V_{g2,4}$	= max. 135 V
Screen-grid dissipation	$W_{g2,4}$	= max. 1 W
Cathode current	I_k	= max. 8 mA
External resistance between control grid and cathode	R_{g1k}	= max. 3 M ohms
Grid voltage at grid current start (I_{g1} = + 0.3 μA)	V_{g1}	= max. —0.2 V

MAXIMUM RATINGS: Triode section

Anode voltage	V_a	= max. 80 V
Anode dissipation	W_a	= max. 0.5 W
Grid voltage at grid current start (I_g = + 0.3 μA)	V_g	= max. — 0.2 V
External resistance between grid and cathode	R_{gk}	= max. 50,000 ohms

APPLICATIONS

A few further remarks may be added to the above. In order to limit frequency drift as much as possible, the oscillator circuit should be connected to the anode of the triode unit of the KCH 1; the reaction coil is therefore connected to the grid. At a wavelength of 15 metres, the drift will then be 3 kc/s with a grid voltage variation of from —2 to —15 V, which means that this valve is quite suitable for automatic gain control in the short-wave range. For the medium and long waves, the "bottom" end of the reaction coil should be connected to the "top" of the padding capacitor; the inductive coupling will then be assisted by the capacitive reaction through the

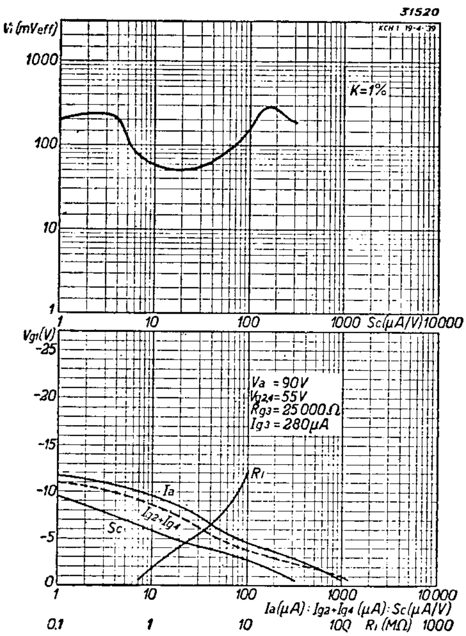


Fig. 10
With 90 V anode voltage and fixed-screen voltage of 55 V:
Upper diagram. Alternating grid voltage of the interfering signal (effective value) as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance Sc, anode current Ia, screen-grid current $Ig_2 + Ig_4$ and internal resistance Ri, as functions of the grid bias Vg_1.

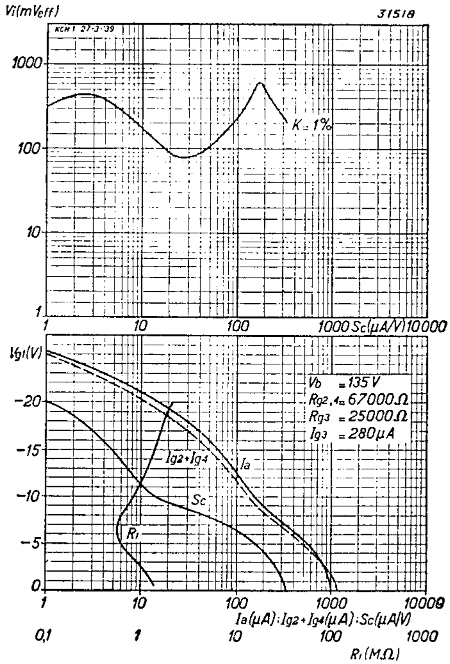


Fig. 11
With 135 V anode voltage and screen fed through a resistor of 67,000 ohms from a 135 V battery:
Upper diagram. Alternating grid voltage of the interfering signal (effective value) as a function of the conversion conductance with 1 % cross-modulation.
Lower diagram. Conversion conductance Sc, anode current Ia, screen-grid current $Ig_2 + Ig_4$ and internal resistance Ri as functions of the grid bias Vg_1.

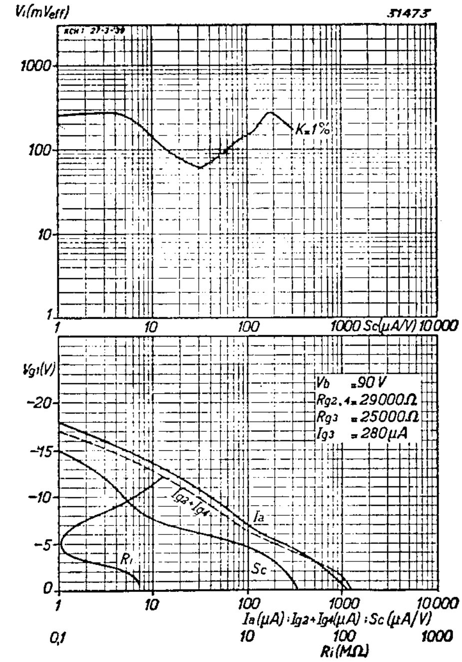


Fig. 12

With 90 V anode voltage and screen fed through a resistor of 29,000 ohms from a 90 V battery:
Upper diagram. Alternating grid voltage of the interfering signal (effective value) as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance *Sc*, anode current *Ia*, screen-grid current $Ig_2 + Ig_4$ and internal resistance *Ri* as functions of the grid bias Vg_1.

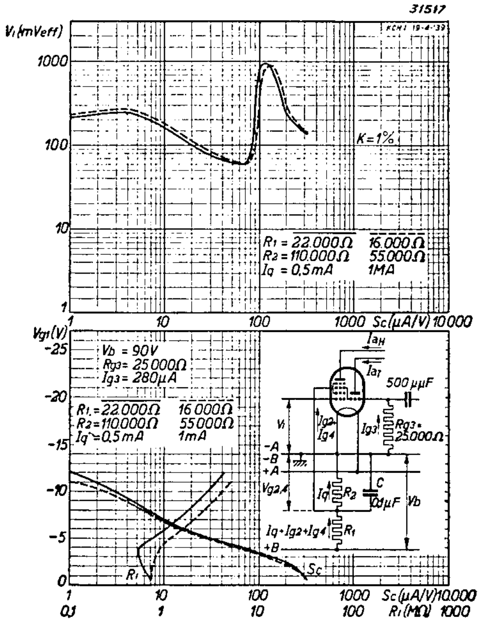


Fig. 13

With 90 V anode voltage and screen fed from a potential divider carrying a current of 0.5 mA (full line), or 1 mA (broken line):
Upper diagram. Alternating grid voltage of interfering signal (effective value), as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance *Sc*, and internal resistance *Ri*, as functions of the grid bias Vg_1.

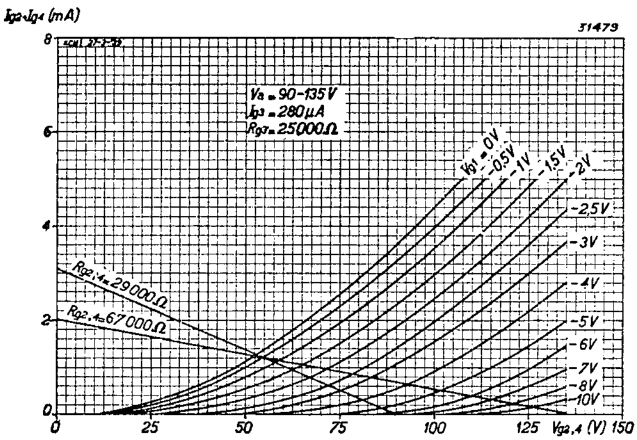


Fig. 14

Screen-grid current $Ig_2 + Ig_4$ as a function of the screen voltage $Vg_{2,4}$ with grid bias Vg_1 as parameter. The resistance lines for $Rg_{2,4}$ = 67,000 ohms for a battery voltage of 135 V, and for $Vg_{2,4}$ with reference to a 90 V battery are also given.

latter. This ensures more uniform oscillation throughout the whole wave-range. For short waves a padding capacitor is not usually employed. A grid capacitor of some 50 to 70 $\mu\mu$F will give reliable oscillation on long waves, with very little frequency drift on the short waves. A value of 25,000 ohms is recommended for the grid-leak resistor as this will prevent over-oscillation and will at the same time not damp the oscillator circuit too heavily. When a 135 V battery is used, it is advisable to feed the anode through a resistor of 22,000 ohms; this resistor is in parallel with the oscillator circuit for the high frequencies, thus slightly damping the circuit. Fig. 16 shows the circuit diagram of the KCH 1 when used on a 90 V or 135 V battery. If on a 90 V battery supply the resistor in series with the anode is any lower than 7,000 ohms, the damping of the oscillator circuit is considerably increased, but, on the other hand, if the 22,000 ohms resistor is used, the conductance at the threshold of oscillation will be reduced. With the last mentioned value, however, oscillation is more reliable, which is, of course, the more preferable result. To avoid any possibility of parasitic oscillation, a small resistor of 30 to 50 ohms can be included in the first grid circuit.

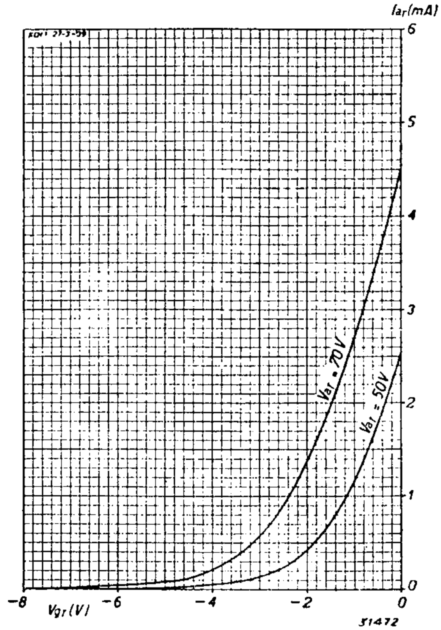


Fig. 15
Anode current of the triode section, I_{aT}, as a function of the grid bias V_{gT}, with V_{aT} = 50 and 70 V.

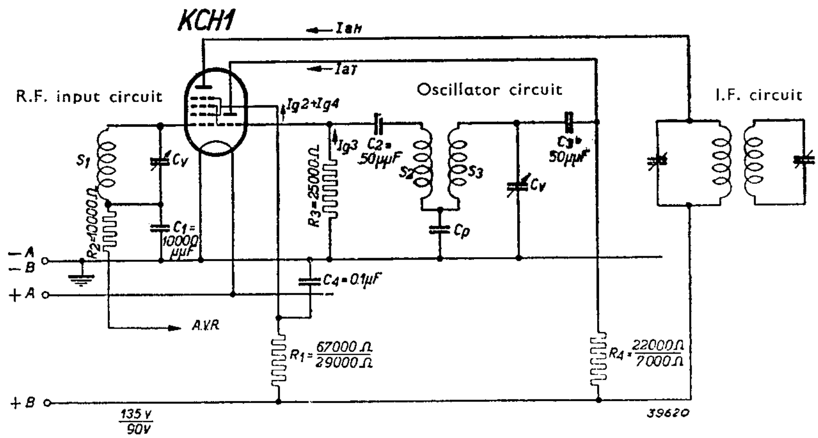


Fig. 16
Circuit diagram showing the KCH 1 employed as a frequency-changer in a battery receiver operated from a 135 V or 90 V battery.

KDD 1 Class B output valve

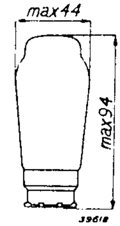


Fig. 1
Dimensions in mm

The KDD 1 is, in effect, two triodes housed in a single envelope; it is intended for use in Class B output circuits operating with grid current and, in conjunction with a suitable driver valve, it will deliver 2.2 W without too much drain on the H.T. battery. The valve is of a type that requires no grid bias; without bias, grid current flows during almost the whole of the cycle of grid signal, thus avoiding any sudden surges of grid current in the secondary winding of the transformer, which would produce severe distortion of a very unpleasant character by reason of the clearly audible higher harmonics.

When there is no signal on the grid the anode current is extremely low, being only about 3 mA for the two anodes together, on 135 V; the current becomes appreciable only when the signal is applied. Consumption of anode current is roughly proportional to the alternating grid voltage, which means that a considerable saving may be effected, since the average current is much less than with maximum excitation. It is also possible to relieve the drain on the H.T. battery somewhat by turning down the receiver volume control to a low level. With a signal present on the grid, grid current flows in both of the triodes, and the driver valve must be capable of supplying the input required to load the valve fully.

The construction of the grid is such that grid current is limited to a minimum, whilst ensuring the greatest economy and sensitivity in the driver stage.

A suitable driver transformer, of ratio 2 : (1 + 1), should be used with the KDD 1 and the optimum matching impedance between anodes will in this case be 10,000 ohms.

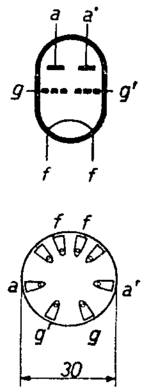


Fig. 2
Arrangement of electrodes and base connections.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.

Filament voltage	V_f	= 2.0 V
Filament current	I_f	= 0.22 A

OPERATING DATA

Anode voltage	V_a	= 90 V	135 V
Grid voltage	V_g	= 0	0 V
Anode current (without signal)	I_{a0}	= 2 × 0.8	2 × 1.5 mA
Anode current at max. modulation	$I_{a\,max}$	= 2 × 8.5	2 × 14 mA
Output power at max. modulation	W_o	= 0.72 [1])	2.0 W [1])
Load resistor between anodes	R_{aa}	= 10,000	10,000 ohms
Alternating grid voltage of the driver valve	V_i	= 1.5 [1])	1.9 V_{eff} [1])
Total distortion	d_{tot}	= 6 [1])	10 % [1])

[1]) Measured with KC 3 as driver: transformation ratio 2 : (1 + 1).

MAXIMUM RATINGS PER SYSTEM

Anode voltage	V_a	= max. 150 V
Anode dissipation ($V_i = 0$)	W_a	= max. 0.35 W
Anode dissipation (W_o = max.)	W_a	= max. 1.5 W
Direct current per anode (average value)	I_a	= max. 20 mA

TABLE
VALVES KC 3 + KDD 1

Ratio of driver transformer $\frac{\text{prim. wdg.}}{1/2\text{ sec. wdg.}}$	$\frac{5}{3} = \frac{1.67}{1}$					$\frac{2}{1}$					$\frac{7}{3} = \frac{2.33}{1}$				
Load resistor between anodes R_{aa} (ohms)	5,000	7,500	10,000	15,000	20,000	5,000	7,500	10,000	15,000	20,000	5,000	7,500	10,000	15,000	20,000
Max. output power (limited by grid current of KC 3) (W)	1.8	2.2	2.2	2.2	1.9	1.6	2.0	2.2	2.1	1.8	1.5	1.8	2.0	2.0	1.8
Distortion with that output (%)	10	11	13	19	22	7.2	8.2	10	15	20	5	5.7	8.0	13	18
Combined anode current of both anodes with that output (mA)	35	32	32	24	20	33	30	28	23	19	31	29	27	22	19
Alternating grid voltage V_i for 50 mW output (sensitivity) (V_{eff})	0.31	0.26	0.22	0.19	0.17	0.35	0.29	0.25	0.22	0.20	0.39	0.32	0.29	0.25	0.22

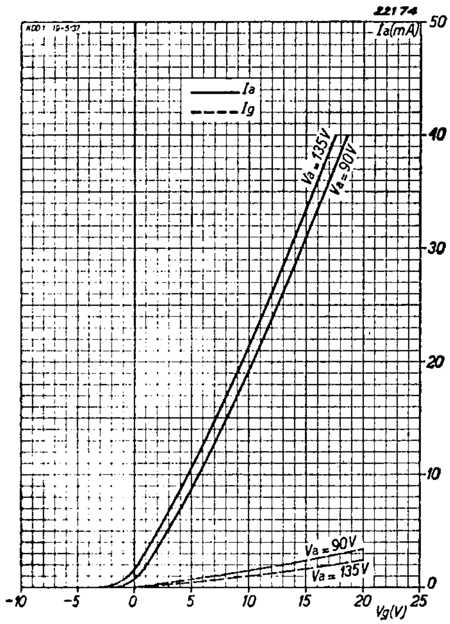


Fig. 3
Anode current and grid current as functions of the grid voltage.

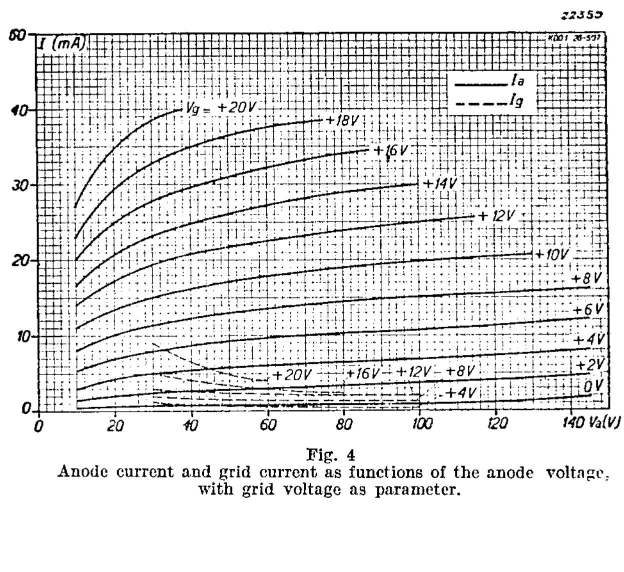


Fig. 4
Anode current and grid current as functions of the anode voltage, with grid voltage as parameter.

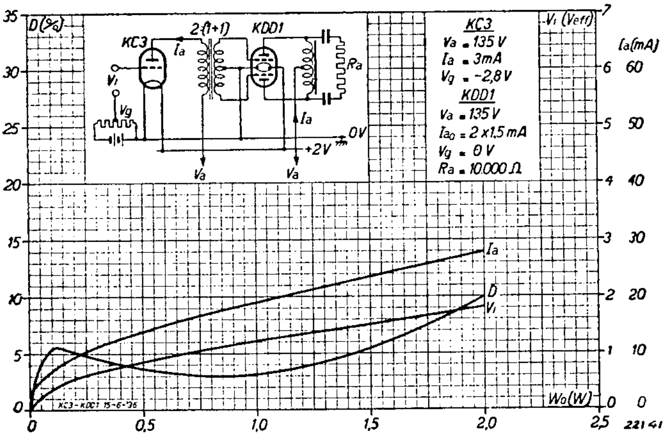


Fig. 5
Anode current, alternating grid voltage and total distortion d_{tot} as functions of the output power of the KDD 1 for an anode voltage of 135 V, using the KC 3 as driver valve.

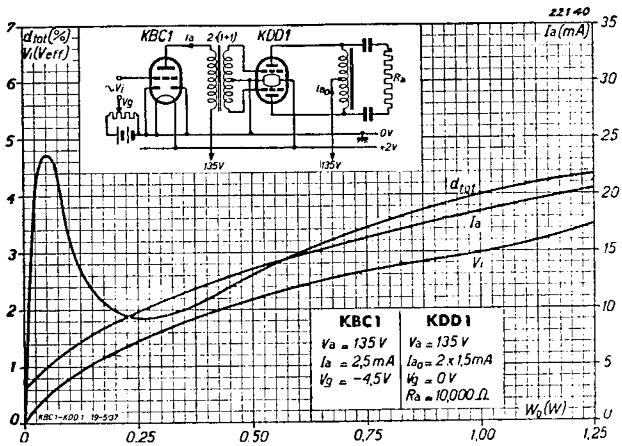


Fig. 6
Anode current, alternating grid voltage and total distortion d_{tot} as functions of the output power of the KDD 1 for an anode voltage of 135 V, using the KBC 1 as driver valve.

KF 3 Variable-MU R.F. pentode

The KF 3, a variable-mu R.F. pentode, offers excellent cross-modulation characteristics throughout the whole range of control on the valve. At the normal working point the anode current is very low; only a small control potential will completely quench the valve. These rapid control characteristics are of great importance in superhet. battery receivers that include a short-wave range and, although it is not generally advisable to apply control on that range, effective A.G.C. can nevertheless be obtained in the case of the KF 3.
This valve can be used only for R.F. and I.F. amplification; when employed in the former capacity it gives very good results also on short waves; not only are the low capacitances subject to very little variation when control is applied, but the input and output damping resistances are high and retroaction from the anode extremely slight. On short waves, especially, it is advisable to earth both the metallizing and the suppressor grid by means of the shortest possible (low inductive) leads.

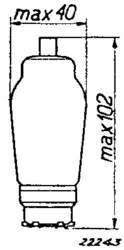


Fig. 1
Dimensions in mm.

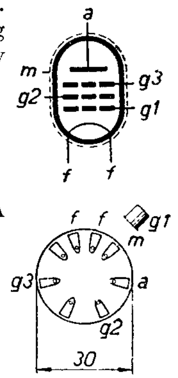


Fig. 2
Arrangement of electrodes and base connections.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . V_f = 2 V
Filament current . . . . I_f = 0.045 A

CAPACITANCES

$C_{ag1} < 0.006\ \mu\mu F$
$C_{g1} = 6.2\ \mu\mu F$
$C_a = 5.2\ \mu\mu F$

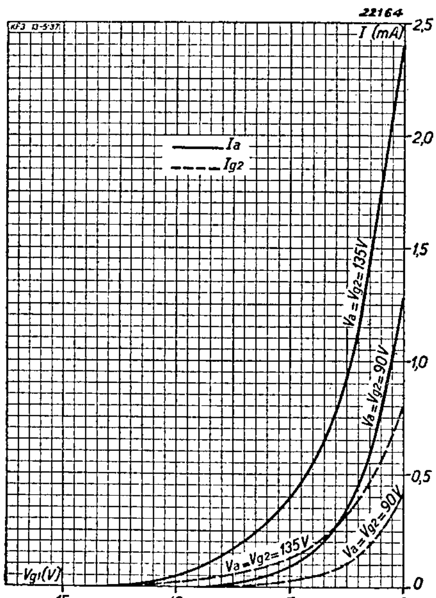


Fig. 3
Anode and screen-grid current as functions of the grid bias.

OPERATING DATA

Anode voltage	V_a	=	90		135 V	
Screen-grid voltage . . .	V_{g2}	=	90		135 V	
Suppressor grid voltage .	V_{g3}	=	0		0 V	
Grid bias	V_{g1}	=	—0.5	—9	—0.5	—13.5 V
Anode current	I_a	=	1	—	2	— mA
Screen-grid current . . .	I_{g2}	=	0.2	—	0.6	— mA
Amplification factor . .	μ	=	1000	—	850	—
Mutual conductance . .	S	=	500	5	650	6.5 μA/V
Internal resistance . . .	R_i	=	2	> 10	1.3	> 10 M ohms

MAXIMUM RATINGS

V_a = max. 135 V　　　V_{g2} = max. 135 V
W_a = max. 0.5 W　　　W_{g2} = max. 0.2 W
I_k = max. 5 mA　　　R_{g1} = max. 3 M ohms
V_{g1} (I_{g1} = + 0.3 μA) = max. —0.2 V

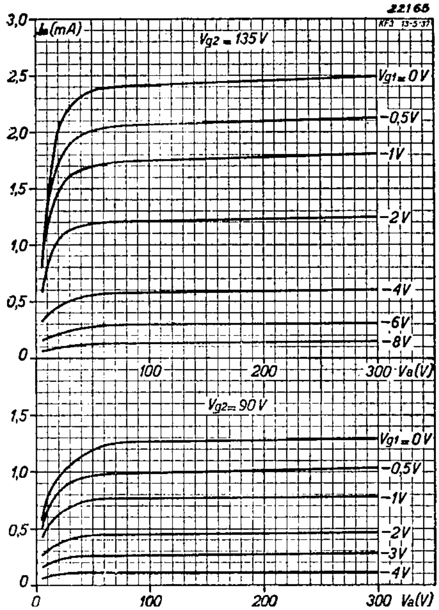


Fig. 4
Anode current as a function of the anode voltage with grid bias as parameter.

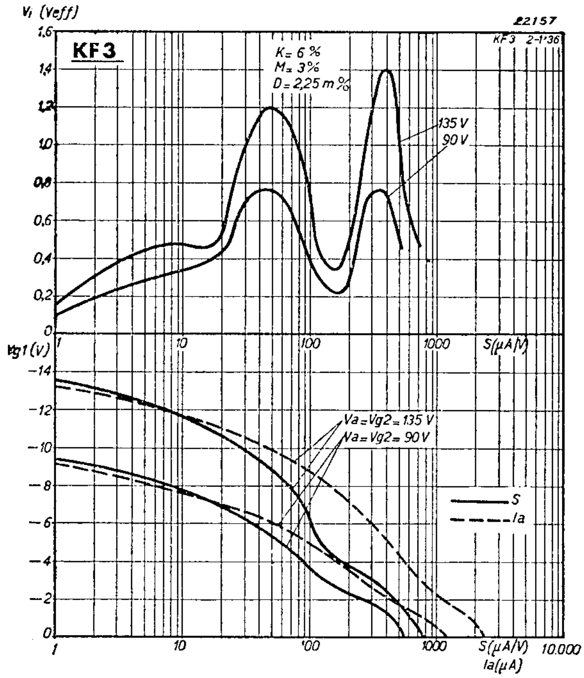


Fig. 5
Upper diagram. Max. permissible effective value of alternating grid voltage with 6 % cross-modulation (0.5 % 3rd harmonic) as a function of the mutual conductance.
Lower diagram. Mutual conductance and anode current as functions of the grid bias.

KF 4 R. F. pentode

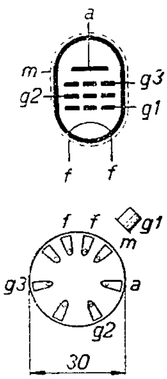


Fig. 2
Arrangement of base connections and electrodes.

The R.F. pentode KF 4 has no control characteristic; it can be employed for R.F. or I.F. amplification, anode-bend or grid detection, and as resistance-coupled A.F. amplifier.

When used for the last-mentioned function it should follow the indirectly-heated double-diode KB 2 for driving a Class A output stage using the pentode KL 4 or, with the necessary driver transformer, a Class B stage comprising two valves of the latter type.

The KF 4 gives excellent results on short waves; this is mainly due to the use of the P-type base with which it is fitted, and a separate contact for the suppressor grid connection. In the design of this valve output capacitances have been kept as low as possible.

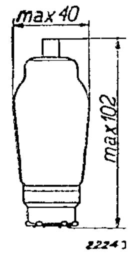


Fig. 1
Dimensions in mm.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . V_f = 2.0 V
Filament current . . . . I_f = 0.065 A

CAPACITANCES

$C_{ag_1} < 0.008\ \mu\mu F$
$C_{g_1} = 6.0\ \mu\mu F$
$C_a = 5.0\ \mu\mu F$

MAXIMUM RATINGS

V_a	= max. 135 V
W_a	= max. 0.5 W
V_{g_2}	= max. 135 V
W_{g_2}	= max. 0.25 W
I_k	= max. 5 mA
V_{g_1} (I_{g_1} = + 0.3 μA)	= max. —0.2 V
R_{g_1k}	= max. 3 M ohms

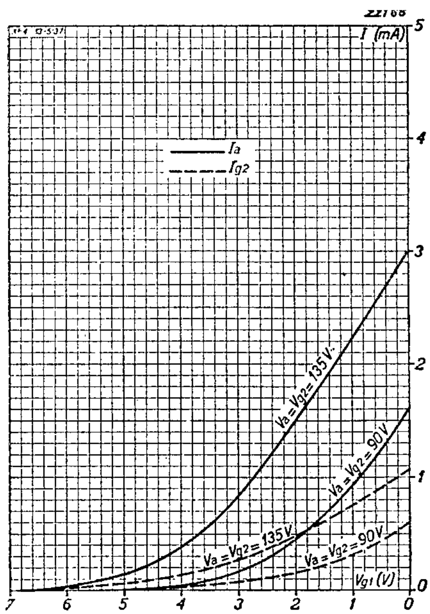


Fig. 3
Anode and screen-grid current as functions of the grid bias.

STATIC DATA

Anode voltage	V_a = 90 V	135 V
Screen-grid voltage	V_{g2} = 90 V	135 V
Suppressor-grid voltage	V_{g3} = 0	0 V
Grid bias	V_{g1} = —0.5 V	—0.5 V
Anode current	I_a = 1.2 mA	2.6 mA
Screen-grid current	I_{g2} = 0.4 mA	1.0 mA
Amplification factor	μ = 800	700
Mutual conductance	S = 0.7 mA/V	0.8 mA/V
Internal resistance	R_i = 0.9 M ohms	0.8 M ohms

TABLE I

KF 4 used as grid detector with resistance coupling (connected as pentode); grid leak of following valve = 1 megohm.

Battery voltage Vb (V)	Coupling resistor Ra (M ohm)	Anode current Ia (mA)	Screen-series resistor Rg_2 (M ohm)	Screen-grid current Ig_2 (mA)	Detector amplification; modulation depth 30 %: Altern. output voltage Vo (Veff)	Stage gain	Alternating output voltage; modulation depth 30 %: Altern. output voltage Vo (Veff)	Altern. grid voltage Vi (Veff)
135	0.32	0.37	0.64	0.15	2	6.6	4.8	0.64
90	0.32	0.24	0.5	0.11	2	4.8	2.6	0.56
135	0.10	1.05	0.5	0.16	2	7.3	6.4	1.0
90	0.04	2.1	0.032	1.05	2	4.4	5.1	1.6
135	0.10	0.71	0.10	0.41	2	4.9	4.5	1.0
90	0.04	1.5	0.016	0.75	2	3.9	3.8	1.1

TABLE II

KF 4 used as grid detector with reaction and resistance coupling (connected as triode).

Battery voltage Vb (V)	Coupling resistor Ra (Ohms)	Anode current Ia (mA)	Detector amplification at m = 0.3: Altern. output volts Vo (Veff)	Stage gain	Alternating output voltage at m = 0.3: Altern. output volts Vo (Veff)	Altern. grid volts Vi (Veff)	Distortion %	Alternating output voltage at m = 0.1: Altern. output volts Vo (Veff)	Altern. grid volts Vi (Veff)	Distortion %
135	20,000	2.6	0.5	1.9	2.2 [1]	1.1	2	0.85	1.5	0.9
135	40,000	1.8	0.5	2.2	2.2 [1]	1.0	3.6	0.86	1.5	2
90	20,000	1.5	0.5	1.6	1.4 [2]	0.95	5 [3]	—	—	—
90	40,000	1.1	0.5	2.0	1.4 [2]	0.8	4	—	—	—

[1]) Max. excitation of the stage KC 3 + KDD 1 at Va = 135 V is reached at an alternating grid voltage of 2.2V(*eff*)

[2]) Max. excitation of the stage KC 3 + KDD 1 at Va = 90 V is reached at an alternating grid voltage of 1.4 V(*eff*).

[3]) Maximum alternating output voltage.

TABLE III

KF 4 used as A.F. amplifier (connected as pentode). Grid leak of following valve 1 megohm.

Battery voltage V_b (V)	Coupling resistor R_a (M ohm)	Anode current I_a (mA)	Screen series resistor R_{g_2} (M ohm)	Screen-grid current I_{g_2} (mA)	Grid bias V_{g_1} (V)	With an alternating output voltage of 10 Veff: Gain factor	Distortion d (%)	With an alternating output voltage of 14 Veff: Gain factor	Distortion d (%)
135	0.32	0.30	0.64	0.11	—1.5	72	0.5	72	0.7
90	0.32	0.18	0.4	0.10	—1.5	52	1.5	52	1.8
135	0.20	0.41	0.4	0.15	—1.5	62	0.8	62	1.0
90	0.20	0.24	0.25	0.10	—1.5	48	1.2	48	1.9
135	0.10	0.64	0.2	0.23	—1.5	47	0.9	47	1.6
90	0.10	0.50	0.05	0.20	—1.5	37	0.9	37	1.8

TABLE IV

KF 4 used as A.F amplifier (connected as triode). Grid leak of the following valve 1 megohm.

Battery voltage V_b (V)	Coupling resistor R_a (M ohm)	Anode current I_a (mA)	Grid bias V_{g_1} (V)	With an alternating output voltage of 7 Veff: [1] Altern. grid volts V_i (Veff)	Stage gain	Distortion d (%)	With an alternating output voltage of 10 Veff: [2] Altern. grid volts V_i (Veff)	Stage gain	Distortion d (%)
135	0.32	0.25	—1.5	0.39	18	0.8	0.56	18	0.8
135	0.32	0.15	—3.0	0.43	16.2	1.5	0.62	16.2	2.8
90	0.32	0.13	—1.5	0.43	16.2	2	—	—	—
90	0.32	0.05	—3.0	0.62	11.5	10	—	—	—
135	0.20	0.35	—1.5	0.39	18	0.8	0.56	18	0.8
135	0.20	0.21	—3.0	0.45	16	1.7	0.63	16	3.0
90	0.20	0.17	—1.5	0.43	16.2	2	—	—	—
90	0.20	0.07	—3.0	0.65	10.5	13	—	—	—
135	0.10	0.56	—1.5	0.42	16.6	0.8	0.60	16.6	1.0
135	0.10	0.33	—3.0	0.48	14.5	2.4	0.70	14.5	4.0
90	0.10	0.28	—1.5	0.48	14.5	1.5	—	—	—
90	0.10	0.09	—3.0	0.76	9.5	18	—	—	—

[1]) Max. excitation of the KL 2 at $V_a = V_{g_2} =$ 90 V is reached at an alternating input of 7 Veff.
Max. excitation of the KL 4 at $V_a = V_{g_2} =$ 90 V is reached at an alternating input of 2 Veff.

[2]) Max. excitation of the KL 2 at $V_a = V_{g_2} =$ 135 V is reached at an alternating input of 10 Veff.
Max. excitation of the KL 4 at $V_a = V_{g_2} =$ 135 V is reached at an alternating input of 3.5 Veff.

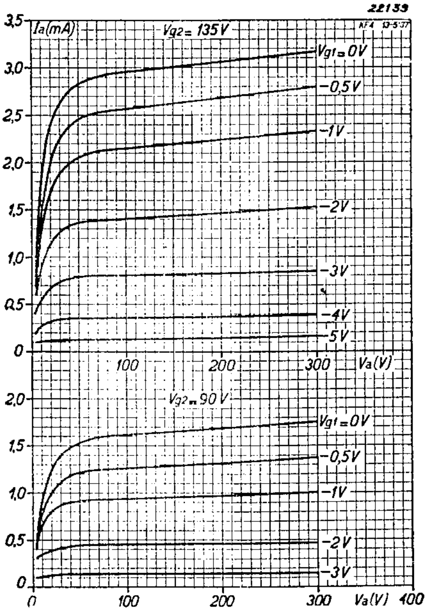


Fig. 4
Anode current as a function of the anode voltage, with grid bias as parameter, at Vg_2 = 90 V and 135 V.

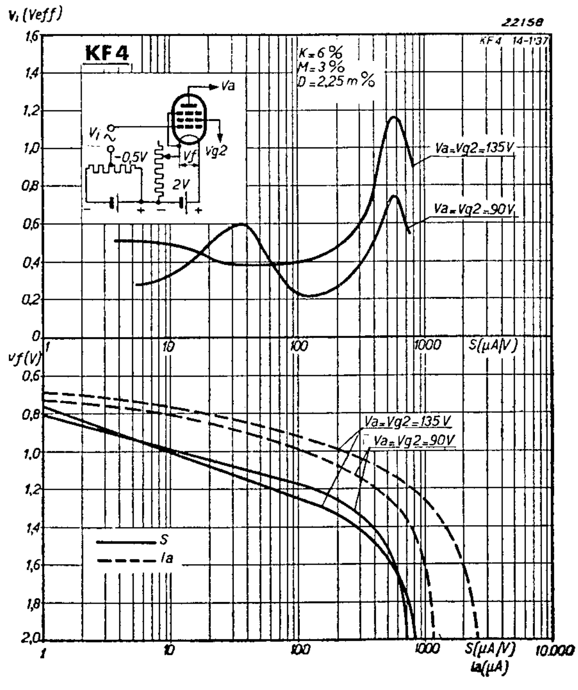


Fig. 5
Upper diagram. Maximum permissible effective value of the alternating grid voltage with 6 % cross-modulation (0.5 % 3rd harmonic), as a function of the mutual conductance controlled by varying the filament voltage.
Lower diagram. Mutual conductance and anode current as functions of the filament voltage.

KH 1 Hexode

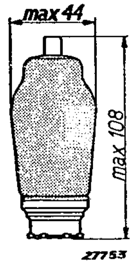


Fig. 1
Dimensions in mm.

This battery hexode can be utilized for three different purposes, viz:
1) As a frequency-changer with a separate oscillator valve, such as the KC 4 which was specially designed for the purpose. The R.F. signal is applied to the first grid and the oscillator signal to the third grid. The screens, grids two and four, are given a positive potential of 60 V. The pitch of the first grid is such that A.G.C. can be employed, with excellent cross-modulation characteristics; the conversion conductance, for a battery valve, is very high, being 450 μA/V.
2) As an R.F. vari-mu pentode in R.F. and I.F. amplifiers. The second and third grids are again given a potential of 60 V, whilst the fourth grid serves as suppressor and is accordingly earthed, this arrangement giving high mutual conductance (1.4 mA/V) with a low battery current (2.95 mA).
3) As a variable-mu R.F. tetrode in R.F. or I.F. amplifiers. The second and fourth grids are joined and supplied with 60 V and the third grid is earthed. In this case the mutual conductance is slightly higher than when the valve is used as a pentode (1.5 mA/V), and the anode current somewhat lower (2.8 mA); the control, however, is less rapid and the internal resistance is lower.

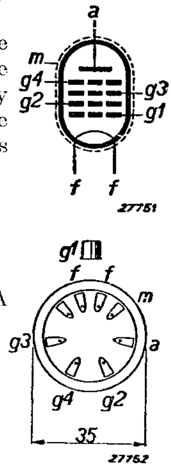


Fig. 2
Arrangement of electrodes and base connections.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . $V_f = 2.0$ V
Filament current . . . . $I_f = 0.135$ A

CAPACITANCES

$C_{g1} = 7.8\ \mu\mu F$
$C_{g3} = 12.5\ \mu\mu F$
$C_a = 16.3\ \mu\mu F$
$C_{g1g3} = 0.17\ \mu\mu F$
$C_{ag1} = < 0.002\ \mu\mu F$

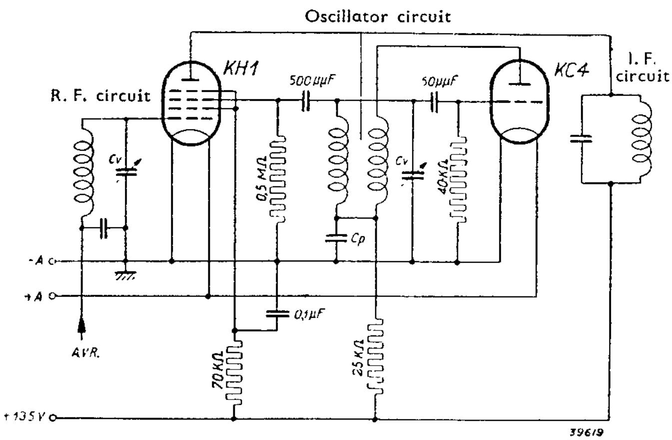


Fig. 3
Circuit diagram showing the KH 1 used as a frequency-changer.

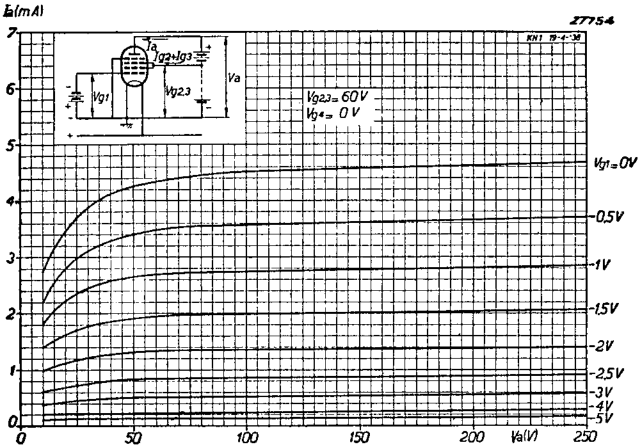


Fig. 4
Ia/Va characteristics of the KH 1 used as a pentode.

OPERATING DATA: KH 1 employed as a frequency-changer

Anode voltage	V_a	= 135 V		
Voltage on grid 2	V_{g2}	= 60 V		
Voltage on grid 4	V_{g4}	= 60 V		
Grid leak, grid 3	R_{g3}	= 0.5 M ohm		
Oscillator voltage, grid 3	V_{osc}	= 10 V_{eff}		
Grid bias	V_{g1}	= —1.5 V [1]	—8 V [2]	—9.5 V [3]
Anode current	I_a	= 1 mA	—	—
Screen-grid current	$I_{g2} + I_{g4}$	= 1.1 mA	—	—
Conversion conductance	S_c	= 450 μA/V	4.5 μA/V	1 μA/V
Internal resistance	R_i	= 1 M ohm	> 10 M ohms	> 10 M ohms

[1]) Without control. [2]) Conductance controlled to 1 : 100. [3]) Limit of control.

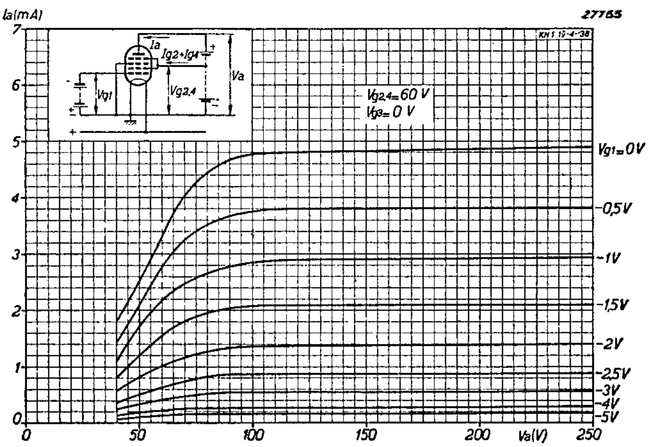


Fig. 5
Ia/Va characteristics of the KH 1 used as tetrode.

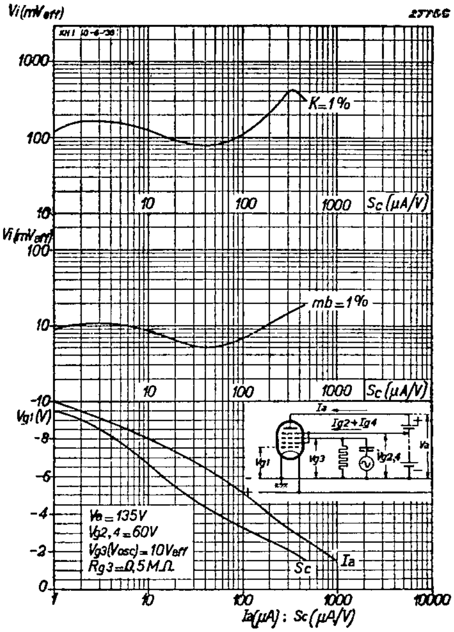


Fig.6
KH 1 as a frequency-changer.
Upper diagram. Effective value of the alternating grid voltage as a function of the conversion conductance, with 1 % cross-modulation.
Centre diagram. Effective value of the alternating grid voltage as a function of the conversion conductance, with 1 % modulation hum.
Lower diagram. Conversion conductance *Sc* and anode current *Ia* as funcitons of the grid bias.

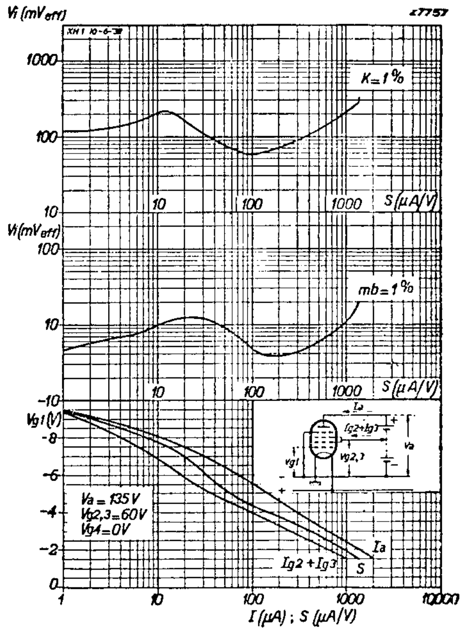


Fig. 7
KH 1 as a pentode.
Upper diagram. Effective value of the alternating grid voltage as a function of the mutual conductance, with 1 % cross-modulation.
Centre diagram. Effective value of the alternating grid voltage as a function of the mutual conductance, with 1 % modulation hum.
Lower diagram. Mutual conductance *S*, screen-grid current $I_{g_2} + I_{g_3}$, and anode current as functions of the grid bias.

OPERATING DATA: KH 1 connected as a pentode (R.F. or I.F. amplifier)

Anode voltage	V_a	= 135 V		
Voltage on grid 2.	V_{g2}	= 60 V		
Voltage on grid 3.	V_{g3}	= 60 V		
Voltage on grid 4.	V_{g4}	= 0 V		
Grid bias.	V_{g1}	= —1.5 V [1]	—7.5 V [2]	—9.3 V [3]
Anode current	I_a	= 2 mA	—	—
Screen-grid current . . .	$I_{g2} + I_{g3}$	= 0.95 mA	—	—
Mutual conductance	S	= 1,400 μA/V	14 μA/V	1 μA/V
Internal resistance	R_i	= 1.3 M ohms	> 10 M ohms	> 10 M ohms

OPERATING DATA: KH 1 connected as a tetrode (R.F. of I.F. amplifier)

Anode voltage	V_a	= 135 V		
Voltage on grid 2.	V_{g2}	= 60 V		
Voltage on grid 3.	V_{g3}	= 0 V		
Voltage on grid 4.	V_{g4}	= 60 V		
Grid bias.	V_{g1}	= —1.5 V [1]	—8.5 V [2]	—11 V [3]
Anode current	I_a	= 2.1 mA	—	—
Screen-grid current . . .	$I_{g2} + I_{g4}$	= 0.7 mA	—	—
Mutual conductance	S	= 1,500 μA/V	15 μA/V	1 μA/V
Internal resistance	R_i	= 0.7 M ohm	> 10 M ohms	> 10 M ohms

[1]) Without control. [2]) Conductance controlled to 1 : 100. [3]) Limit of control.

MAXIMUM RATINGS

Anode voltage		V_a	= max. 150 V
Anode dissipation		W_a	= max. 0.4 W
Voltage, grid 2		V_{g2}	= max. 60 V
Dissipation, grid 2		W_{g2}	= max. 0.1 W
Voltage, grid 3		V_{g3}	= max. 60 V
Dissipation, grid 3		W_{g3}	= max. 0.1 W
Voltage, grid 4		V_{g4}	= max. 60 V
Dissipation, grid 4		W_{g4}	= max. 0.1 W
Grid voltage at grid current start	($I_{g1} = +0.3\ \mu A$)	V_{g1}	= max. —0.2 V
	($I_{g3} = +0.3\ \mu A$)	V_{g3}	= max. —0.2 V
Cathode current		I_k	= max. 10 mA
External resistance between grid 1 and cathode		R_{g1k}	= max. 1 M ohm
External resistance between grid 3 and cathode		R_{g3k}	= max. 1 M ohm

TOLERANCES ON SCREEN-GRID CURRENT

a) valve used as a frequency-changer ($V_a = 135$ V, $V_{g2} = V_{g4} = 60$ V, $V_{g3} = 10$ V_{eff}, $V_{g1} = -1.5$ V).
   $I_{g2} + I_{g4}$ = max. 1.45 mA
   $I_{g2} + I_{g4}$ = min. 0.75 mA

b) valve used as a pentode ($V_a = 135$ V, $V_{g2} = V_{g3} = 60$ V, $V_{g4} = 0$, $V_{g1} = -1.5$ V).
   $I_{g2} + I_{g3}$ = max. 1.3 mA
   $I_{g2} + I_{g3}$ = min. 0.7 mA

c) valve used as a tetrode ($V_a = 135$ V, $V_{g2} = V_{g4} = 60$ V, $V_{g3} = 0$ V, $V_{g1} = -1.5$ V)
   $I_{g2} + I_{g4}$ = max. 0.9 mA
   $I_{g2} + I_{g4}$ = min. 0.5 mA

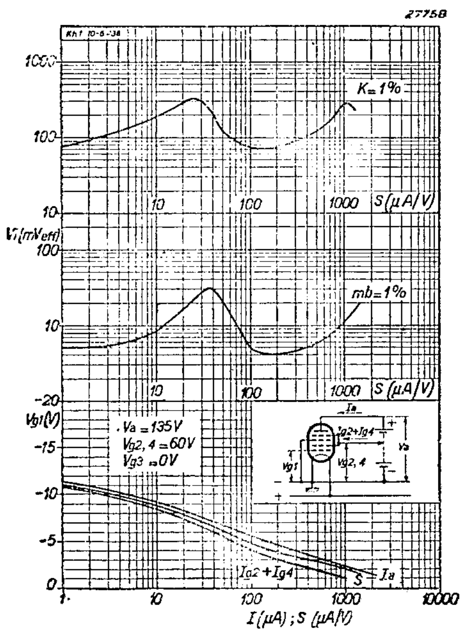


Fig. 8

KH 1 used as a tetrode:
Upper diagram. Effective value of the alternating grid voltage as a function of the mutual conductance, with 1 % cross-modulation.
Centre diagram. Effective value of the alternating grid voltage as a function of the mutual conductance, with 1 % modulalation hum.
Lower diagram. Mutual conductance S, screen-grid current $Ig_2 + Ig_4$, and anode current Ia as functions of the grid bias.

KK 2 Octode

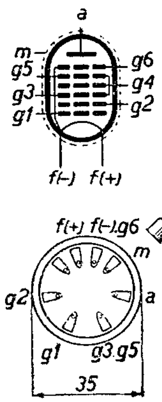


Fig. 2
Arrangement of electrodes and base connections.

The KK 2 is a directly-heated octode that can be used as a frequency-changer in battery superheterodyne receivers for medium and long waves as well as short-wave reception. This combination of oscillator and mixer valve, operating on a common anode current and sharing a single filament, ensures a considerable saving in current, this being an important factor in the design of battery sets. The filament current is only 0.13 A, with a total cathode current of 3.5 mA on medium and long waves and 4.3 mA on the short-wave range.

A superheterodyne receiver based on the use of the KK 2 will always be a reliable and foolproof proposition. For a battery valve, the conversion conductance and internal resistance are both very high, ensuring a high degree of conversion amplification; further, automatic gain control may be applied with success. A grid voltage variation of only —12 V is sufficient to reduce the conversion conductance from its maximum value to 0.002 mA/V.

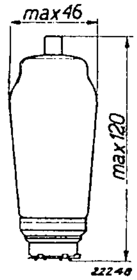


Fig. 1
Dimensions in mm.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.

Filament voltage	. .	$V_f = 2.0$ V
Filament current	. . .	$I_f = 0.13$ A

CAPACITANCES

$C_{g1} = 6.4\ \mu\mu F$	$C_{g1g4} < 0.2\ \mu\mu F$
$C_{g4} = 10\ \mu\mu F$	$C_{g2g4} < 0.4\ \mu\mu F$
$C_a = 14\ \mu\mu F$	$C_{ag4} < 0.07\ \mu\mu F$
$C_{g2} = 8\ \mu\mu F$	

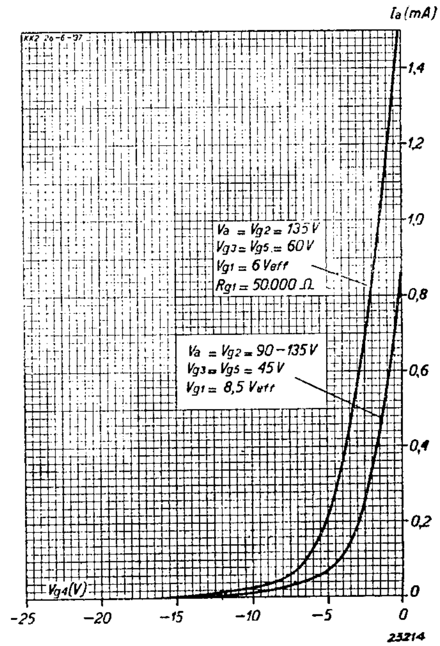


Fig. 3
Anode current as a function of the grid bias, at $V_{g3,5}$ = 45 V and 60 V.

OPERATING DATA

1. FOR MEDIUM AND LONG WAVE RECEPTION

Anode voltage	V_a	= 90	135 V
Oscillator-anode voltage	V_{g2}	= 90	135 V
Screen-grid voltage	$V_{g3,5}$	= 45	45 V
Grid bias (without oscillation)	V_{g1}	= 0	0 V
Oscillator voltage on control grid	V_{osc}	= 8.5	8.5 V_{eff}
Grid leak (control grid)	R_{g1}	= 50,000	50,000 ohms
Bias, grid 4	V_{g4}	= —0.5	—0.5 V
Anode current (V_{g4} = —0.5 V)	I_a	= 0.7	0.7 mA
Oscillator-anode current	I_{g2}	= 1.6	2.2 mA
Screen-grid current	$I_{g3,g5}$	= 1.0	1.0 mA
Conversion conductance (at V_{g4} = —0.5 V)	S_c	= 0.27	0.27 mA/V
Conversion conductance (at V_{g4} = —11 V)	S_c	< 0.0027	0.0027 mA/V
Internal resistance (at V_{g4} = —0.5 V)	R_i	= 2	2.5 M ohms
Internal resistance (at V_{g4} = —11 V)	R_i	> 10	> 10 M ohms

2. FOR SHORT WAVE RECEPTION

Anode voltage	V_a	= 135 V	
Oscillator-anode voltage	V_{g2}	= 135 V	
Screen-grid voltage	$V_{g3,5}$	= 60 V	
Control-grid bias (without oscillation)	V_{g1}	= 0 V	
Oscillator voltage at control grid	V_{osc}	= 6 V_{eff}	
Control grid leak	R_{g1}	= 50,000 ohms	
Bias, grid 4	V_{g4}	= —1.5	—15 V
Anode current	I_a	= 1.0 mA	—
Oscillator-anode current	I_{g2}	= 3.0 mA	—
Screen-grid current	$I_{g3,g5}$	= 1.4 mA	—
Conversion conductance	S_c	= 0.3	0.003 mA/V
Internal resistance	R_i	= 1.7	> 10 M ohms

MAXIMUM RATINGS

V_a	= max. 135 V	W_{g2}	= max. 0.6 W
W_a	= max. 0.5 W	I_k	= max. 10 mA
$V_{g3,5}$	= max. 100 V	V_{g4} (I_{g1} = ÷ 0.3 μA)	= max. —0.2 V
$W_{g3,5}$	= max. 0.4 W	R_{g4k}	= max. 3 M ohms
V_{g2}	= max. 135 V	R_{g1k}	= max. 0.1 M ohm

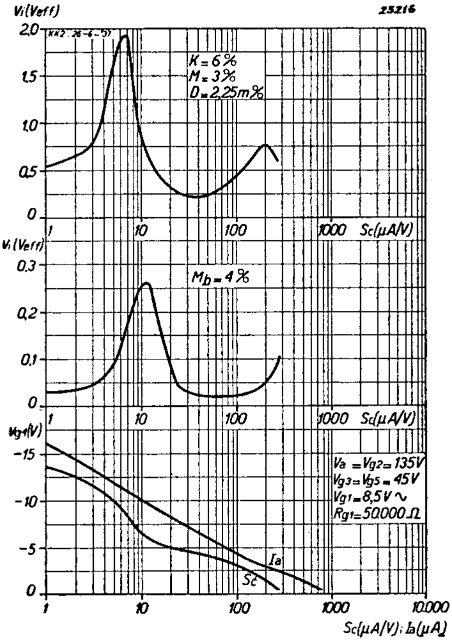


Fig. 4

Upper diagram. Alternating input voltage as a function of the conversion conductance (as controlled by the potential on the 4th grid), with 6 % cross-modulation (0.5 % 3rd harmonic), at $Vg_{3,5}$ = 45 V.
Centre diagram. Alternating input voltage as a function of the conversion conductance (as controlled by the potential on the 4th grid), with 4 % modulation hum, at $Vg_{3,5}$ = 45 V.
Lower diagram. Conversion conductance and anode current as functions of the bias on the 4th grid, at $Vg_{3,5}$ = 45 V

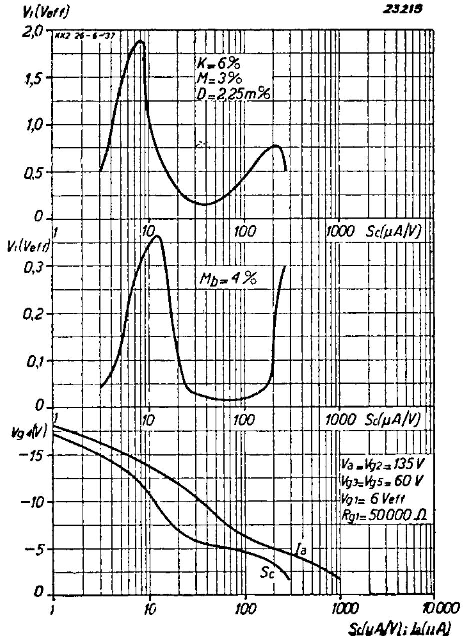


Fig. 5

Upper diagram. Alternating input voltage as a function of the conversion conductance (as controlled by the voltage on grid 4), with 6 % cross-modulation (0.5 % 3rd harmonic), at $Vg_{3,5}$ = 60 V.
Centre diagram. Alternating input voltage as a function of the conversion conductance (as controlled by the voltage on the 4th grid) with 4 % modulation hum, at $Vg_{3,5}$ = 60 V.
Lower diagram. Conversion conductance and anode current as functions of the grid bias (4th grid), at $Vg_{3,5}$ = 60 V.

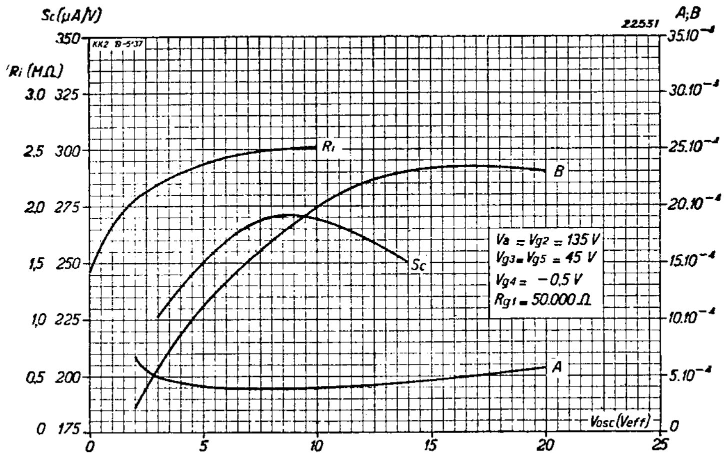


Fig. 6

Conversion conductance, internal resistance, factor A (governing the strength of the background noise) and factor B (strength of whistles) as functions of the oscillator voltage of the KK 2 when used on medium and long waves.

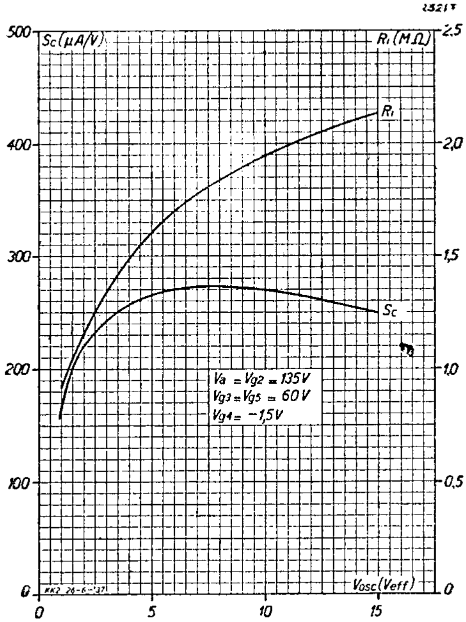


Fig. 7
Conversion conductance and internal resistance as functions of the oscillator voltage of the KK 2 when used on short waves.

APPLICATIONS

In connection with the applications of the valve, the following points should be taken into consideration. The coupling of the oscillator circuit must be tighter than is normally the case with A.C. valves, and should be so adjusted that the current passing through the grid leak R_2 is about 100 μA (see Fig. 8); in the short-wave range the average grid current is approximately 60 μA.

For the last-mentioned wave-range tighter coupling may be obtained by employing the circuit shown in Fig. 9 in which the inductive coupling is enhanced by capacitive coupling. The value of capacitor C_3 should be about 2,500 $\mu\mu$F.

Again, for short-wave work, improved results may be obtained in certain circumstances by selecting an oscillator frequency which is lower than that of the input. The conductance in the medium and long wave ranges may be varied by applying the control voltage to the 4th grid, but on short waves frequency drift precludes any alteration in the voltage on the 4th grid.

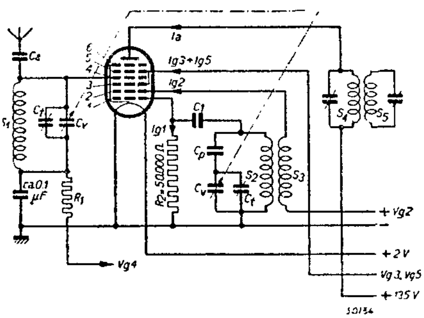


Fig. 8
Theoretical circuit of the KK 2 as used on medium and long waves.

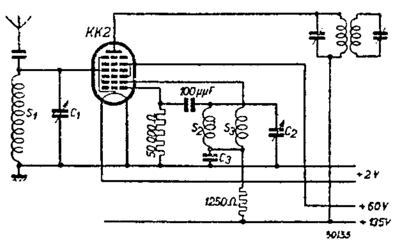


Fig. 9
The KK 2 in a short-wave circuit.

KL 4 Output pentode

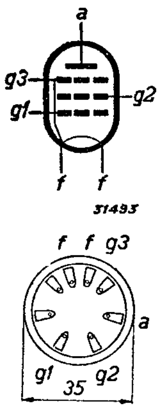


Fig. 2
Arrangement of electrodes and base connections.

The KL 4 is an output valve using a relatively small filament current (0.15 A). The sensitivity is very high, only a small input voltage being required for full excitation; with 135 V on anode and screen the KL 4 will deliver 0.47 W, with 11.2 % distortion. This valve is suitable for use only in balanced output stages operating without grid current; the quality of reproduction is then excellent and the output obtainable at the above-mentioned anode and screen voltage is approximately 0.8 W.

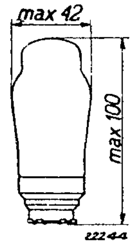


Fig. 1
Dimensions in mm.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.

Filament voltage . . . . $V_f = 2.0$ V

Filament current . . . . $I_f = 0.150$ A

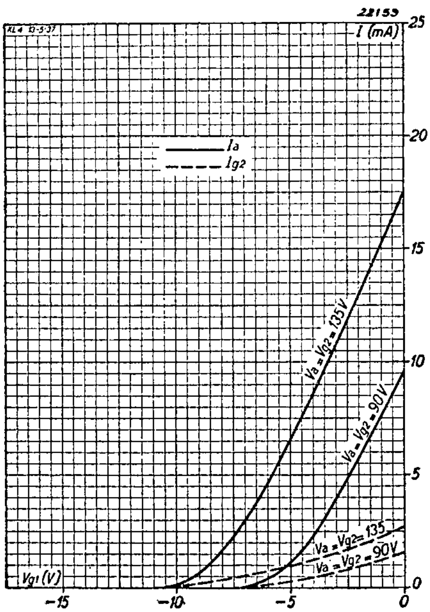


Fig. 3
Anode and screen-grid current as functions of the grid bias, with $Va = Vg_2 = 135$ and 90 V.

OPERATING DATA

Anode voltage		
V_a	= 90	135 V
Screen-grid voltage		
V_{g2}	= 90	135 V
Grid bias		
V_{g1}	= —2.6	—5 V
Anode current		
I_a	= 4.7	7 mA
Screen-grid current		
I_{g2}	= 0.8	1.1 mA
Mutual conductance		
S	= 1.8	2.1 mA/V
Internal resistance		
R_i	= 150,000	130,000 ohms
Load resistor		
R_a	= 19,000	19,000 ohms
Output power (10 % dist)		
W_o	= 0.16	0.44 W
Alternating input voltage		
V_i	= 1.9	3.3 V_{eff}

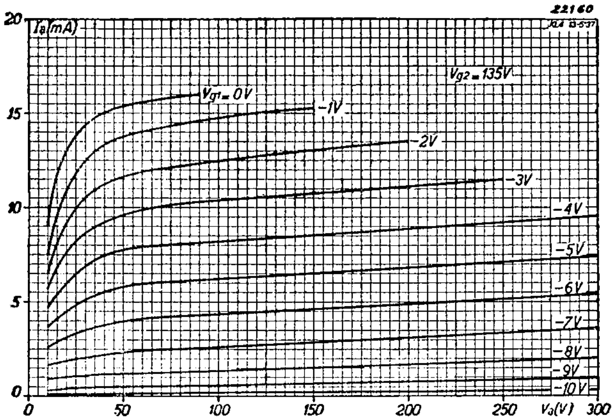


Fig. 4
Anode current as a function of the anode voltage, with grid bias as parameter, at a screen voltage of 135 V.

MAXIMUM RATINGS

V_a	= max. 135 V	W_{g2} (W_o = max)	= max. 0.30 W
W_a	= max. 1 W	I_k	= max. 10 mA
V_{g2}	= max. 135 V	R_{g1}	= max. 1 M ohm
W_{g2} ($V_i = 0$)	= max. 0.15 W	V_{g1} ($I_{g1} = +0.3\ \mu A$)	= max. —0.2 V

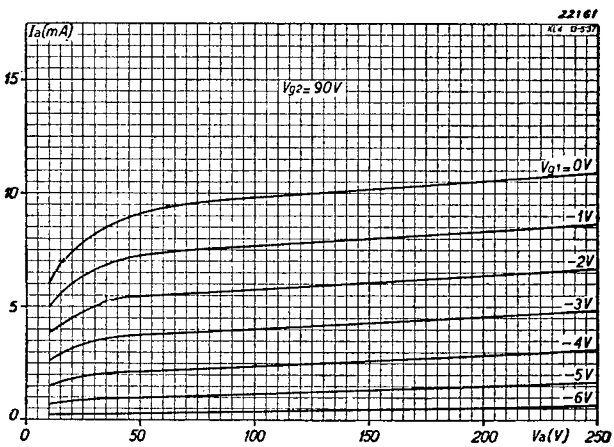


Fig. 5
Anode current as a function of the anode voltage, with grid bias as parameter, for a screen voltage of 90 V.

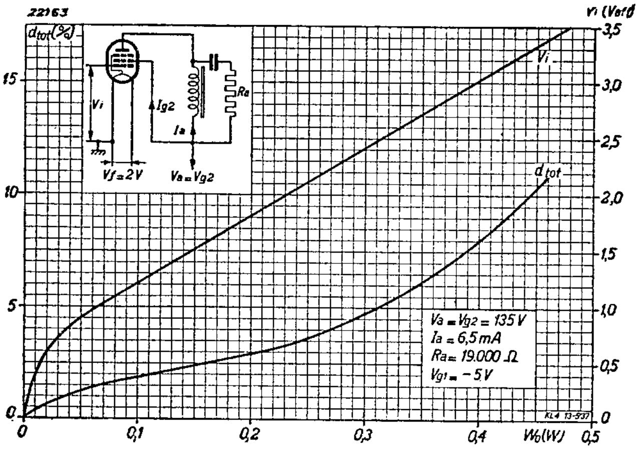


Fig. 6
Alternating grid voltage V_i and total distortion of the KL 4 as functions of the output power, on $V_a = V_g = 135$V.

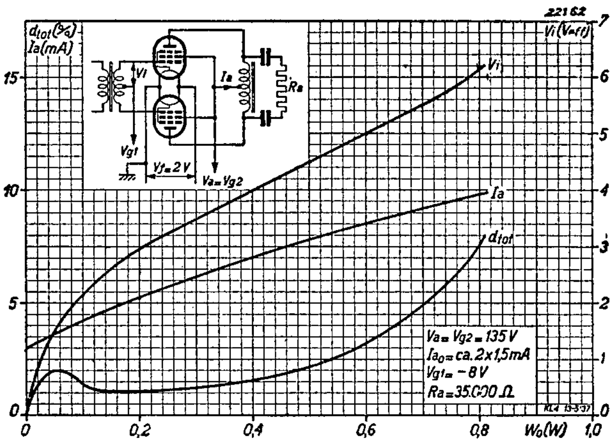


Fig. 7
Alternating grid voltage V_i, total distortion and combined anode current as functions of the output power of two KL 4 valves in a balanced circuit operating without grid current ($V_a = V_{g_2} = 135$ V).

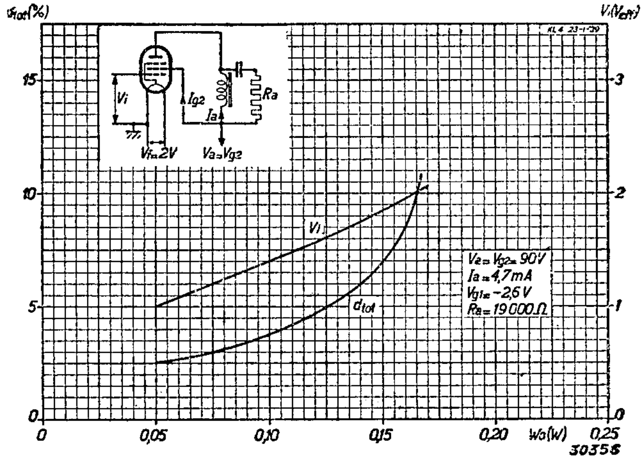


Fig. 8
Alternating grid voltage Vi and total distortion of the KL 4 as functions of the output power with $Va = Vg_2 =$ 90 V.

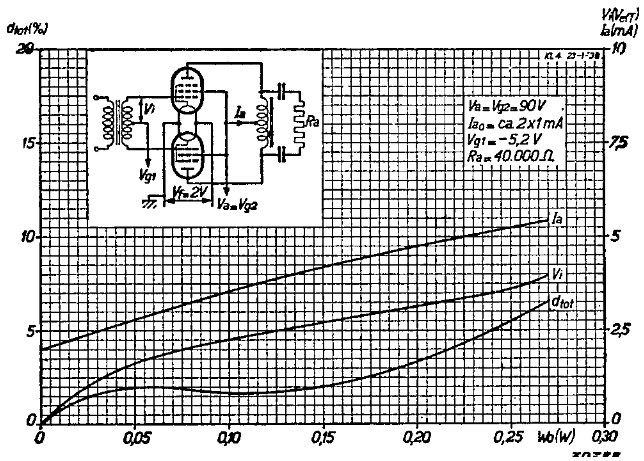


Fig. 9
Alternating grid voltage Vi, total distortion and combined anode current as functions of the output power of two KL 4 valves in a balanced circuit operating without grid current ($Va = Vg_2 = 90$ V).

KL 5 Output pentode

This is a directly-heated output valve for 2 V battery receivers, delivering a reasonably high output on a very low current consumption; with 135 V on the anode, passing a current of 8.5 mA, the output is 0.52 W with 10 % distortion.
In this valve an improvement has been introduced in the form of mica dampers on the filament, which greatly reduce any tendency towards microphony; in this respect, too, therefore, the KL 5 is an extremely reliable valve. Two of these valves in a balanced circuit will deliver an output which for battery receivers is quite high, with relatively little distortion. The low filament consumption in such circuits is another important feature; with an anode potential of 135 V, two KL 5 valves will give slightly more than 1 W, with about 7 % distortion, the combined filament current being only 0.2 A. The sensitivity is such that the valve can be fully excited with any normal A.F. valve, or with a pentode functioning as grid detector.

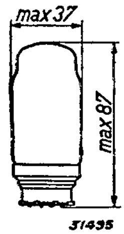


Fig. 1
Dimensions in mm.

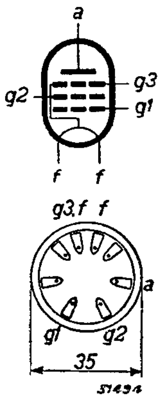


Fig. 2
Arrangement of electrodes and base connections.

FILAMENT RATINGS

Heating: direct by battery; parallel supply.
Filament voltage . . . . V_f = 2.0 V
Filament current . . . . I_f = 0.1 A

CAPACITANCES

Anode-grid . . . . C_{ag1} < 0.6 $\mu\mu$F

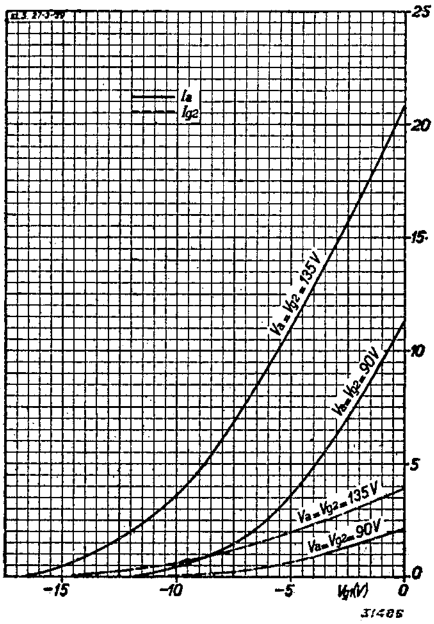


Fig. 3
Anode and screen-grid current as functions of the grid bias, with $Va = Vg_2$ = 135 and 90 V.

OPERATING DATA: KL 5 used as a single output valve

Anode voltage	V_a	= 90 V	135 V
Screen-grid voltage	V_{g2}	= 90 V	135 V
Grid bias	V_{g1}	= —4 V	—6.5 V
Anode current	I_a	= 4.8 mA	8.5 mA
Screen-grid current	I_{g2}	= 0.9 mA	1.5 mA
Mutual conductance	S	= 1.4 mA/V	1.7 mA/V
Internal resistance	R_i	= 180,000 ohms	135,000 ohms
Load resistor	R_a	= 19,000 ohms	16,000 ohms
Output power (10 % distortion)	W_o	= 0.2 W	0.53 W
Alternating grid voltage (10 % distortion)	V_i	= 2.6 V_{eff}	4.8 V_{eff}
Sensitivity (W_o = 50 mW)	V_i	= 0.7 V_{eff}	0.8 V_{eff}

OPERATING DATA: KL 5 used in a balanced output stage (2 valves)

Anode voltage	V_a	= 90 V	135 V
Screen-grid voltage	V_{g2}	= 90 V	135 V
Grid bias	V_{g1}	= —8.5 V	—12 V
Anode current (without signal)	I_{ao}	= 2 × 1 mA	2 × 2 mA
Anode current at max. modulation	$I_{a\ max}$	= 2 × 3.6 mA	2 × 6.25 mA
Screen-grid current (without signal)	I_{g2o}	= 2 × 0.1 mA	2 × 0.35 mA
Screen-grid current at max. modulation	$I_{g2\ max}$	= 2 × 1.0 mA	2 × 2.4 mA
Load resistor between anodes	R_{aa}	= 25,000 ohms	25,000 ohms
Output power at max. modulation	W_o	= 3.5 W	1.05 W
Alternating grid voltage at maximum modulation	V_i	= 6.5 V_{eff}	8.7 V_{eff}
Total distortion at maximum modulation	d_{tot}	= 3.8 %	7 %

MAXIMUM RATINGS

Anode voltage	V_a	= max. 200 V
Anode dissipation	W_a	= max. 2.0 W
Screen-grid voltage	V_{g2}	= max. 200 V
Screen-grid dissipation (V_i = 0 V)	W_{g2}	= max. 0.5 W
Screen-grid dissipation (W_o = max.)	W_{g2}	= max. 1.0 W
Cathode current	I_k	= max. 12 mA
Grid voltage at grid current start ($I_{g1} = +0.3\ \mu A$)	V_{g1}	= max. —0.2 V
External resistance between grid and cathode	R_{g1k}	= max. 1 M ohm

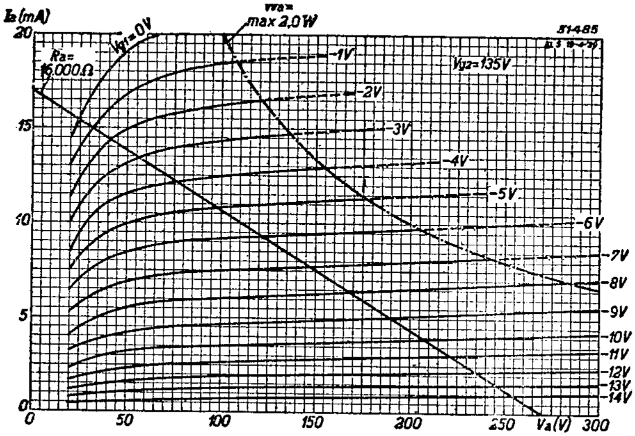


Fig. 4
Anode current as a function of the anode voltage, with grid bias as parameter, for a screen voltage of 135 V.

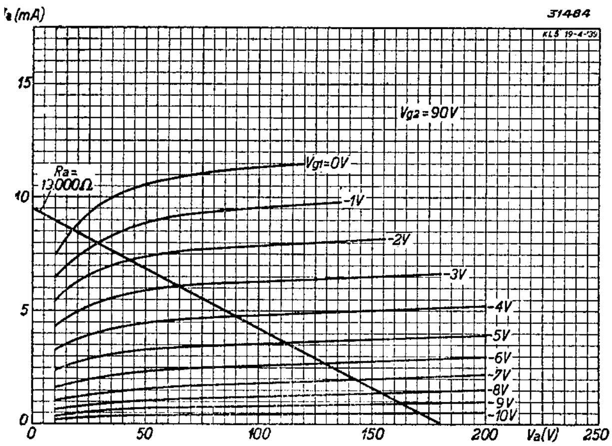


Fig. 5
Anode current as a function of the anode voltage, with grid bias as parameter, for a screen voltage of 90 V.

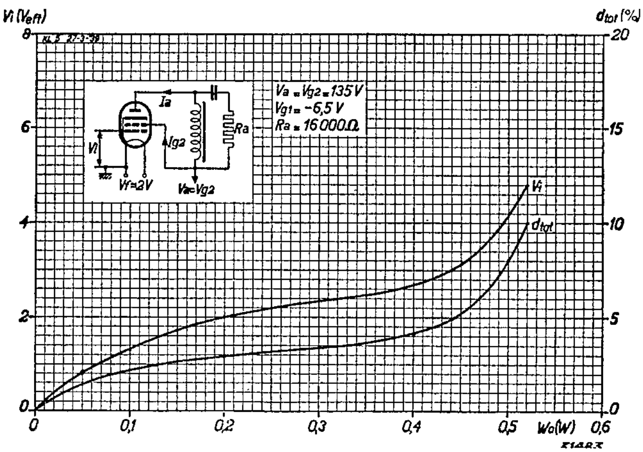


Fig. 6
Alternating grid voltage Vi and total distortion d_{tot} of the KL 5 as functions of the output power ($Va = Vg_2 = 135$ V).

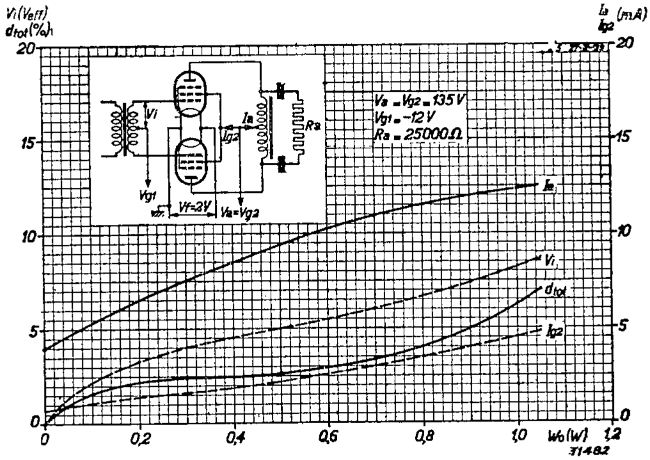


Fig. 7
Alternating grid voltage V_i, total distortion d_{tot}, combined anode current I_a and combined screen-grid current I_{g_2} as functions of the output power, for two KL 5 valves in a Class B output circuit without grid current ($V_a = V_{g_2} = 135$ V).

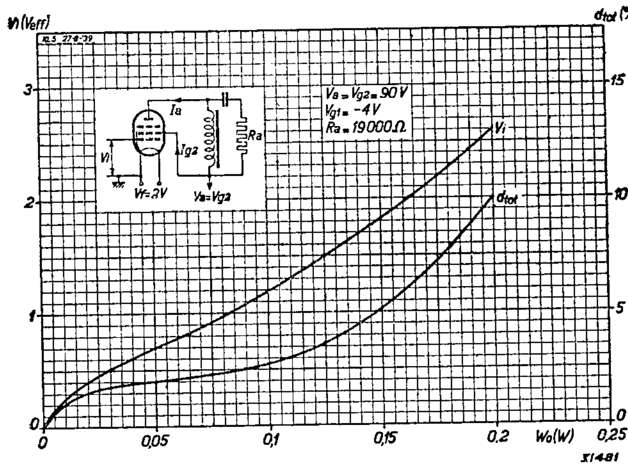


Fig. 8
Alternating grid voltage V_i and total distortion d_{tot} of the KL 5 as functions of the output power. $V_a = V_{g_2} = 90$ V.

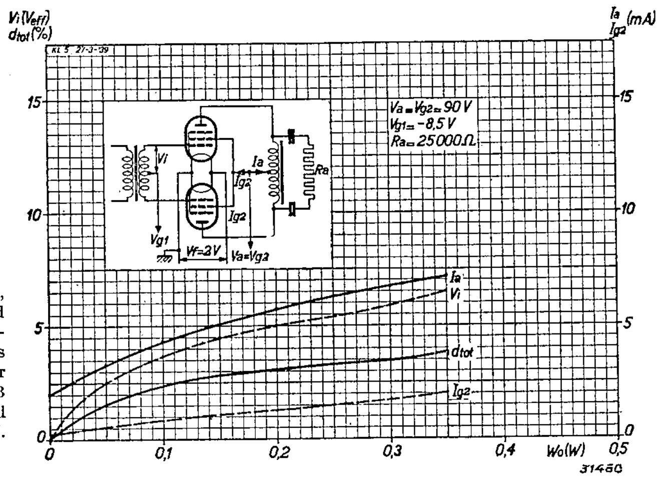


Fig. 9
Alternating grid voltage V_i, total distortion d_{tot}, combined anode current I_a and combined screen-grid current I_{g_2} as functions of the output power of two KL 5 valves in a Class B output circuit without grid current. $V_a = V_{g_2} = 90$ V.