

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 $325 \mu\text{A/V}$. 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

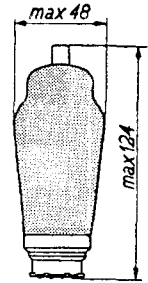


Fig. 1
Dimensions in mm.

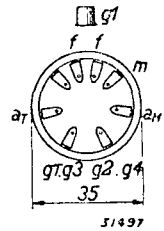
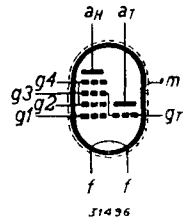


Fig. 2
Arrangement of electrodes and base connections.

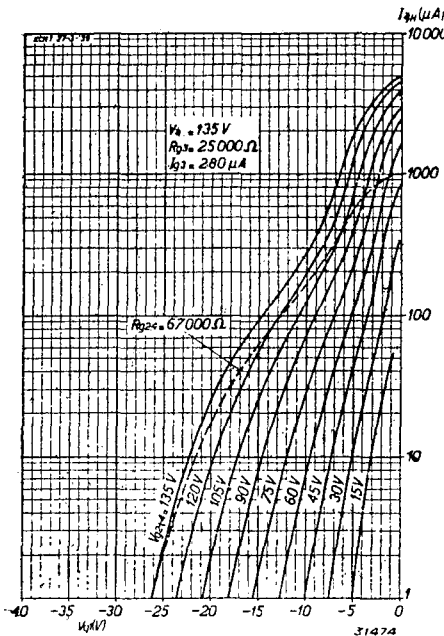


Fig. 3
Anode current of the hexode unit as a function of the grid bias, with the screen-grid voltage as parameter. The broken lines show the anode current in the case of the controlled valve, with the screen fed from the 135 V battery through a resistor of 67,000 ohms.

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.

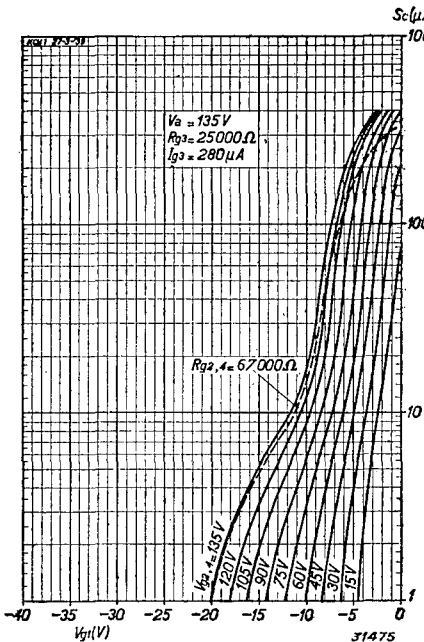


Fig. 4

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.

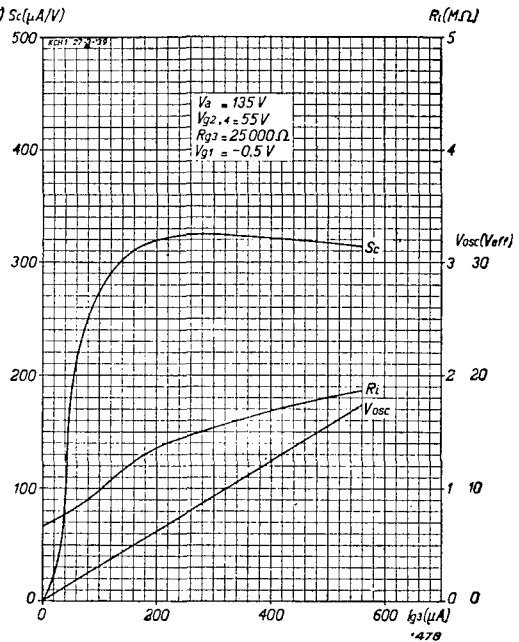


Fig. 5

Conversion conductance Sc , internal resistance Ri and effective oscillator voltage $Vosc$ as functions of the oscillator-grid current I_{g3} (grid leak of oscillator, $R_{g3} = 25,000$ ohms), at $V_a = 135$ 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.
$C_{g1} = 7 \mu\mu\text{F}$	$C_{gf} = 13.5 \mu\mu\text{F}$	$C_{gTg1H} < 0.4 \mu\mu\text{F}$
$C_a = 16 \mu\mu\text{F}$	$C_{af} = 3.6 \mu\mu\text{F}$	
$C_{ag1} < 0.05 \mu\mu\text{F}$	$C_{ag} = 3.5 \mu\mu\text{F}$	

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 . . . $I_{g2,4} =$	1.2 mA	1.2 mA
Conversion conductance . . . $S_c =$	320 3 1	325 3 1 $\mu\text{A/V}$
Internal resistance . . . $R_i =$	0.7 > 4 > 5	1.5 > 10 > 10 M ohms

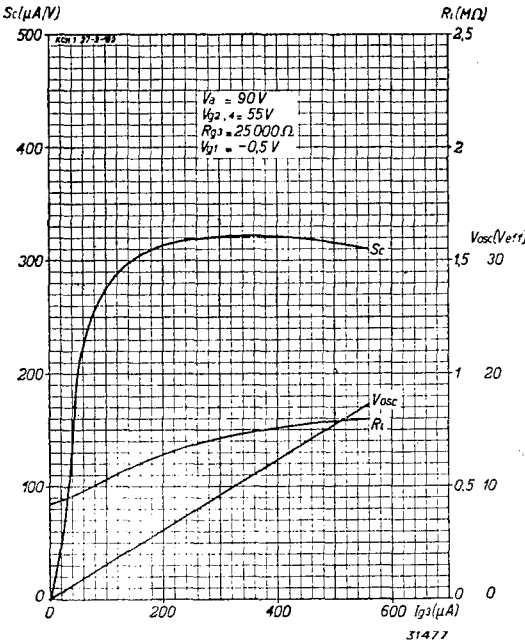


Fig. 6
Conversion conductance S_c , internal resistance R_i and effective oscillator voltage V_{osc} as functions of the oscillator-grid current I_{g3} (oscillator grid leak $R_{g3} = 25,000$ ohms), with $V_a = 90 \text{ V}$ and fixed screen voltage of 55 V .

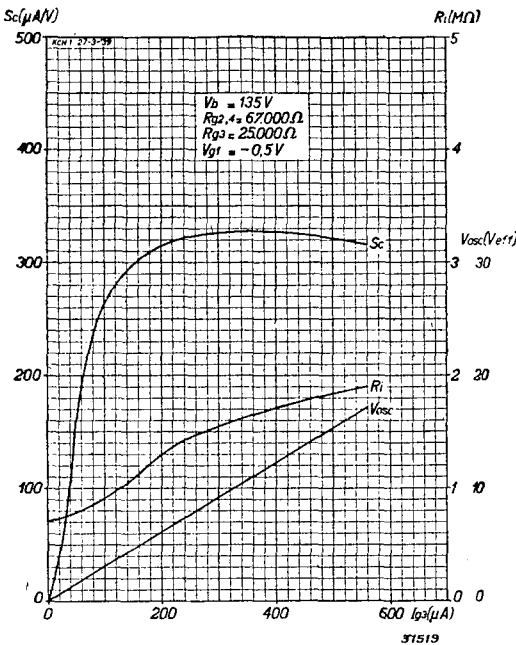


Fig. 7
Conversion conductance S_c , internal resistance R_i and effective oscillator voltage V_{osc} as functions of the oscillator-grid current I_{g3} (oscillator grid leak $R_{g3} = 25,000$ ohms), with $V_a = 135 \text{ V}$ and screen fed from 135 V battery through a resistor of $67,000$ ohms.

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 μ A	280 μ A
Grid bias . . . V_{g1} =	$-0.5^1)$ $-12^2)$ $-15^3)$	$-0.5^1)$ $-17^2)$ $-20^3)$
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 μ A/V
Internal resistance . . . R_i =	$0.7^4)$ > 0.9 > 1	$1.5^5)$ > 1 > 1.5 M ohms

For footnotes see next page.

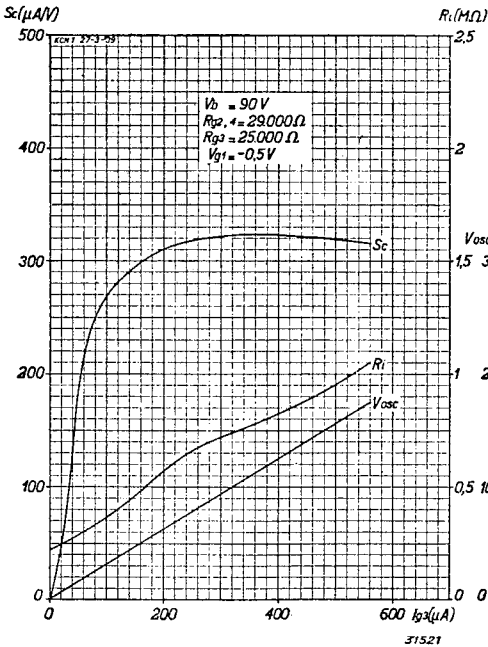


Fig. 8

Conversion conductance S_c , internal resistance R_i and effective oscillator voltage V_{osc} as functions of the oscillator-grid current I_{g3} (oscillator grid leak $R_{g3} = 25,000$ ohms), with $V_a = 90$ V and screen fed from 90 V battery through a resistor of 29,000 ohms.

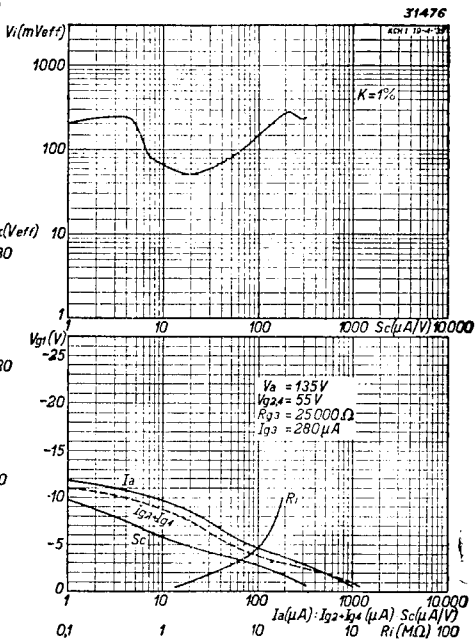


Fig. 9

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 S_c , anode current I_a , screen current $I_{g2} + I_{g4}$ and internal resistance R_i as functions of the grid bias V_{g1} .

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 μ A			280 μ A	
Grid bias	$V_{g1} =$	-0.5 ¹⁾	-9.5 ²⁾	-11 V ³⁾	-0.5 ¹⁾	-10 ²⁾ -12 ³⁾ V
Screen-grid voltage	$V_{g2,1} =$	55	—	70 V	55	— 75 V
Anode current	$I_a =$	1	—	— mA	1	— mA
Screen current	$I_{g2,g1} =$	1.2	—	— mA	1.2	— mA
Conversion conductance	$S_c =$	320	3	1	325	3 1 μ A/V
Internal resistance	$R_i =$	0.7	> 2	> 3	0.7	> 1.5 > 2.5 M ohms

¹⁾ Without control²⁾ Conversion conductance controlled to 1 : 100³⁾ Limit of control⁴⁾ With a grid bias of -5 V the internal resistance is approx. 0.1 megohm⁵⁾ With a grid bias of -6 V the internal resistance is approx. 0.4 megohm⁶⁾ 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 $I_g = 280 \mu$ A 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 $V_g = 0, I_g = 0$	$\mu =$	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)	$V_{g2,1} =$	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 ($I_{g1} = +0.3 \mu$ A)	$V_{g1} =$	max. -0.2 V

MAXIMUM RATINGS: Triode section

Anode voltage	V_a	= max. 80 V
Anode dissipation	P_a	= max. 0.5 W
Grid voltage at grid current start ($I_g = +0.3 \mu A$)	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

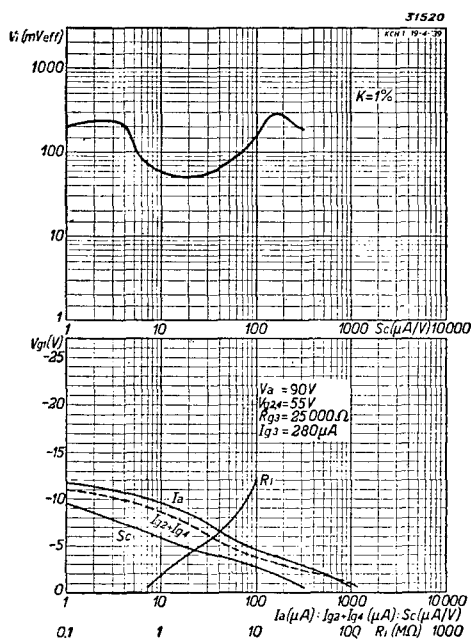


Fig. 10

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 S_c , anode current I_a , screen-grid current $I_{g2} + I_{g4}$, and internal resistance R_i , as functions of the grid bias V_{g1} .

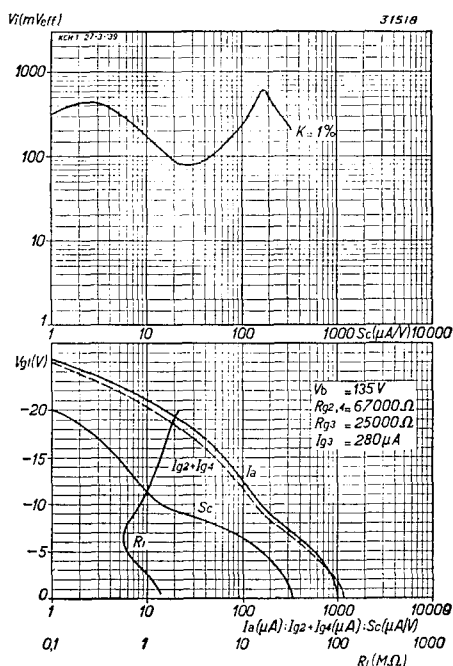


Fig. 11

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 S_c , anode current I_a , screen-grid current $I_{g2} + I_{g4}$, and internal resistance R_i as functions of the grid bias V_{g1} .

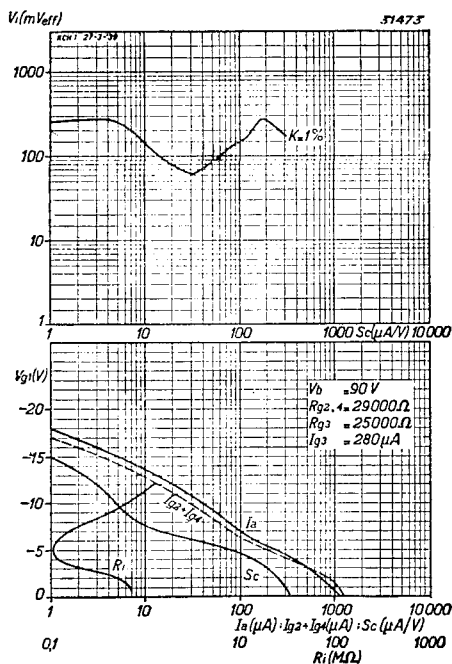


Fig. 12
With 90 V anode voltage and screen fed through a resistor of 29,000 ohms from a 90 V battery: *Upper diagram.* Alternating grid voltage of the interfering signal (effective value) as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance Sc , anode current Ia , screen-grid current $I_{g2} + I_{g4}$ and internal resistance Ri as functions of the grid bias V_{g1} .

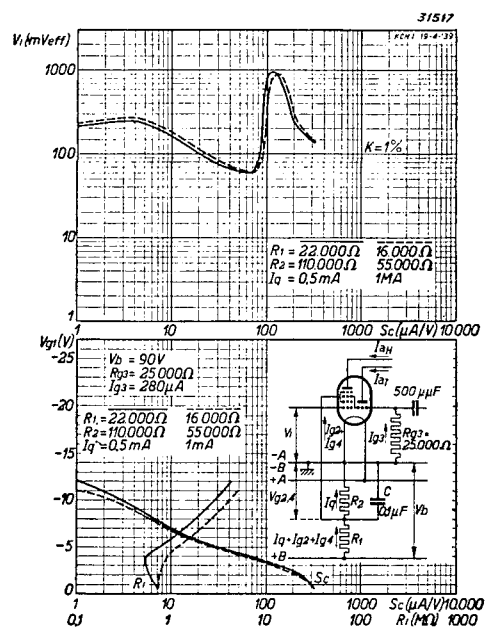


Fig. 13
With 90 V anode voltage and screen fed from a potential divider carrying a current of 0.5 mA (full line), or 1 mA (broken line): *Upper diagram.* Alternating grid voltage of interfering signal (effective value), as a function of the conversion conductance, with 1 % cross-modulation.
Lower diagram. Conversion conductance Sc , and internal resistance Ri , as functions of the grid bias V_{g1} .

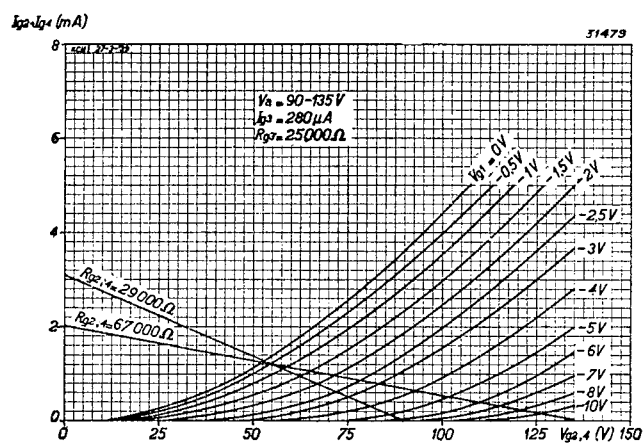


Fig. 14
Screen-grid current $I_{g2} + I_{g4}$ as a function of the screen voltage V_{g2+4} with grid bias V_{g1} as parameter. The resistance lines for $R_{g2+4} = 67,000$ ohms for a battery voltage of 135 V, and for V_{g2+4} with reference to a 90 V battery are also given.

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 μF 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.

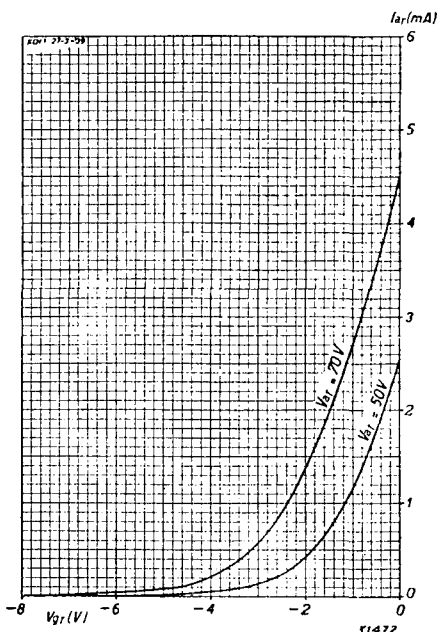


Fig. 15
Anode current of the triode section, I_{aT} , as a function of the grid bias V_{gT} , with $V_{aT} = 50$ and 70 V.

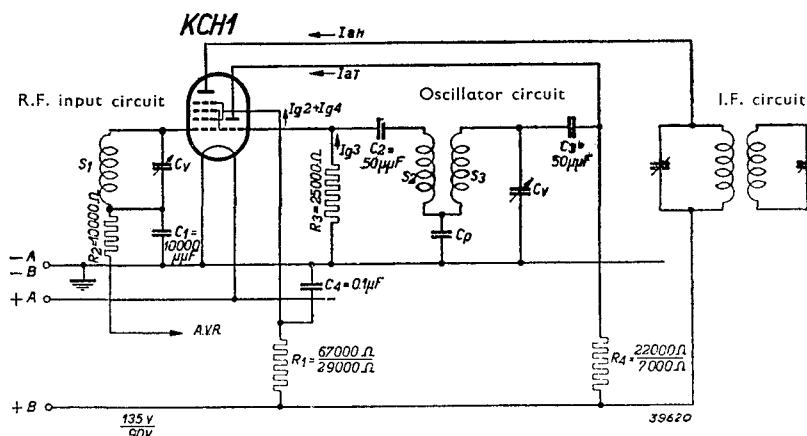


Fig. 16
Circuit diagram showing the KCH 1 employed as a frequency-changer in a battery receiver operated from a 135 V or 90 V battery.