EF 6 Pentode

This valve is particularly suitable for A.F. amplification and either anode-bend or grid detection. The EF 6 works only on a fixed bias and therefore finds no application in practice as an R.F. or I.F. amplifier. The degree of A.F. amplification, however, is very high indeed, the ultimate signal voltage on the anode being so great that practically distortionless modulation is possible in any kind of output stage. Used as a grid detector, this valve has many advantages when good reception of local stations is required.

It is also a very useful valve in special circuits, for instance as an amplifier for the control voltage in an automatic gain control circuit and so on. The EF 6 will also give very good results on the short-wave ranges, where the mutual conductance is the same as in the broadcast wave-bands.

As the R.F. impedance of anode and grid in the 12 to 60 m range, with respect to the impedance of normal tuned circuits, is extremely high, the gain obtainable from this valve is equal to the product of mutual conductance and impedance. In the short-wave range, the impedance, which replaces the anode-to-grid capacitance on long waves (anode feed-back), is also very high, so that the maximum permissible amplification may be obtained without risk of parasitic oscillation.

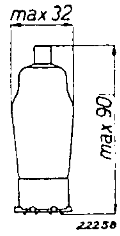


Fig. 1
Dimensions in mm.

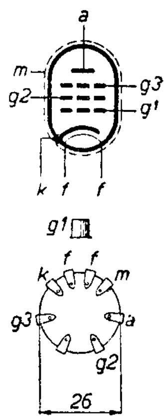


Fig. 2
Arangement of electrodes and base connections.

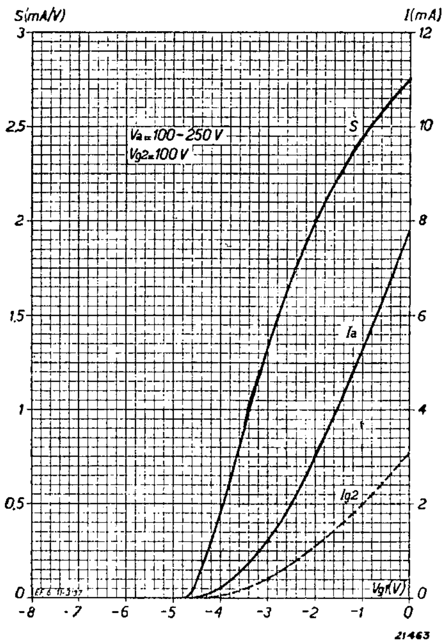


Fig. 3
Anode current, screen-grid current and mutual conductance as a function of the grid bias at $Vg_2 = 100$ V. The curves also apply as an approximation at all anode voltages from 100 V upwards.

In part, the excellent short-wave qualities of the EF 6 are due to the use of the P-type side-contact base and separate suppressor-grid connection. Cross-modulation and modulation hum are both very slight indeed, especially at the maximum permissible screen-grid voltage and, for this reason, the valve gives good results in A.C./D.C. receivers; in view of the high alternating voltages occurring between the heater and earth, and induced on the grid, in this type of receiver it is important that modulation hum should be as low as possible.

HEATER RATINGS

Heating, indirect, A.C. or D.C., parallel supply.

Heater voltage . . . . . $V_f = 6.3$ V

Heater current . . . . . $I_f = 0.200$ A

CAPACITANCES

$C_{ag1} < 0.003$ $\mu\mu$F

$C_{g1} = 5.2$ $\mu\mu$F

$C_a = 6.9$ $\mu\mu$F

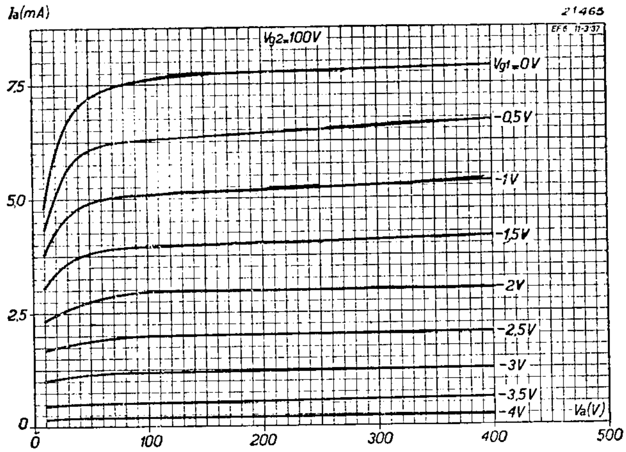


Fig. 4
Anode current as a function of the anode voltage at V_{g_2} = 100 V, for different values of grid bias.

OPERATING DATA

Anode voltage	V_a =	100 V	200 V	250 V
Screen-grid voltage	V_{g2} =	100 V	100 V	100 V
Suppressor-grid voltage	V_{g3}	0 V	0 V	0 V
Grid bias	V_{g1} =	—2 V	—2 V	—2 V
Anode current	I_a =	3 mA	3 mA	3 mA
Screen grid current	I_{g2} =	0.8 mA	0.8 mA	0.8 mA
Amplification factor	μ =	1800	3600	4500
Mutual conductance	S =	1.8 mA/V	1.8 mA/V	1.8 mA/V
Internal resistance	R_i =	1.0 M ohm	2.0 M ohms	2.5 M ohms

MAXIMUM RATINGS

V_{ao}	= max. 550 V
V_a	= max. 300 V
W_a	= max. 1 W
V_{g2o}	= max. 550 V
V_{g2}	= max. 125 V
W_{g2}	= max. 0.3 W
I_k	= max. 6 mA
V_{g1} (I_{g1} = + 0.3 μA)	= max. —1.3 V
R_{g1k} (auto. grid bias)	= max. 1.5 M ohms
R_{g1k} (fixed bias)	= max. 1 M ohm
R_{fk}	= max. 20,000 ohms
V_{fk}	= max. 75 V [1]

[1] Direct voltage or effective value of alternating voltage.

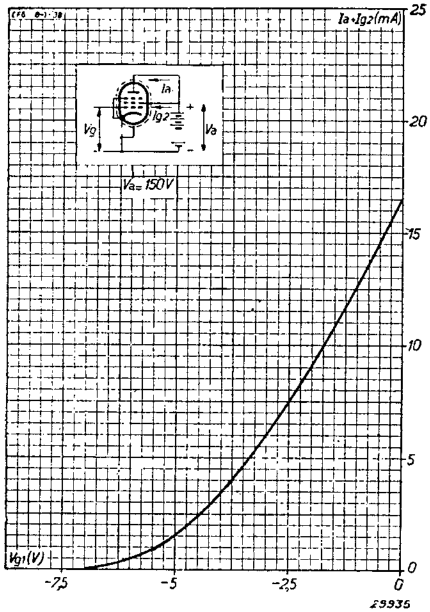


Fig. 5
EF 6 employed as triode. Anode current as a function of the grid bias for $V_a = 150$ V.

The valve is metallized and no additional screening is necessary, but the separate base contact to which the metallizing is connected internally must be effectively connected to the chassis. If in special circuits the cathode is negative with respect to the chassis, the metallizing should be connected to the cathode. The suppressor grid also has its own separate base contact for direct connection to earth.

Care must be taken when using the EF 6 as detector or A.F. amplifier in A.C./D.C. receivers, however, to see that the heater of the valve, in the heater circuit, is connected as closely as possible to the chassis end, in order to avoid hum.

1) GRID DETECTOR WITH RESISTANCE COUPLING

For grid detection it is advisable to feed the screen from a resistor and not from a potential divider, since in that case the grid swing will increase with signal strength. In A.C./D.C. receivers for use on 110 V mains the EF 6 is not generally satisfactory, as the output voltage is usually insufficient to load the output valve fully at low modulation depths. Table 1 gives the results to be obtained with the EF 6 when employed as grid detector.

2) A.F. AMPLIFIER WITH RESISTANCE COUPLING

The EF 6 is eminently suitable for A. F. amplification since it provides considerable gain with only very moderate distortion; the screen should preferably be fed through a resistor, for which a suitable value is indicated in tables II and III.

The A.F. signal applied to the grid must not be too strong, as this tends towards microphony when the loudspeaker used is of a sensitive type. This valve can be used only in circuits having not more than one stage of A.F. amplification and must therefore in every case be followed immediately by the output valve.

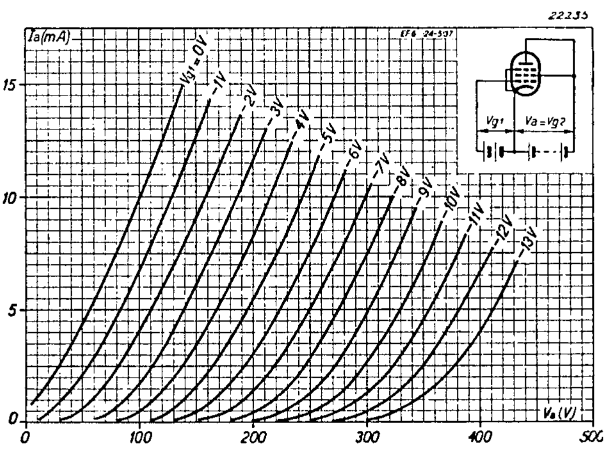
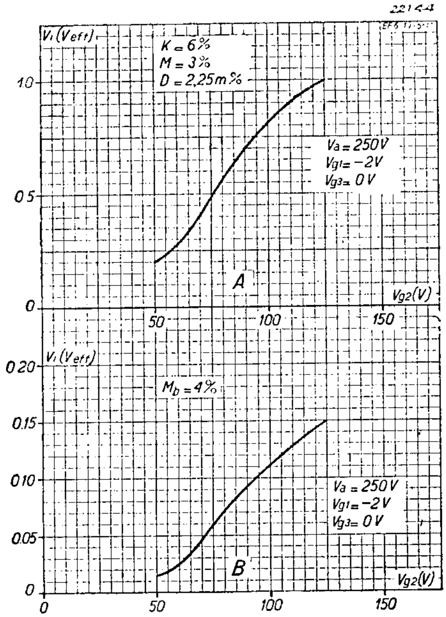


Fig. 6
EF 6 employed as triode. Anode current as a function of the anode voltage, for different values of grid bias.



Generally speaking, the A.F. sensitivity at the grid of the EF 6 should not be less than 5 mV.

Fig. 7
Curve A: Effective alternating grid voltage as a function of the screen-grid voltage of the EF 6, with 6 % cross-modulation (3 % increase in modulation depth + 2.25 *m* % modulation distortion, *m* = modulation depth). 6 % cross-modulation corresponds to 0.5 % third harmonic.
Curve B. Effective value of the alternating grid voltage as a function of the screen-grid voltage with 4 % modulation hum (corresponding to 1 % second harmonic).

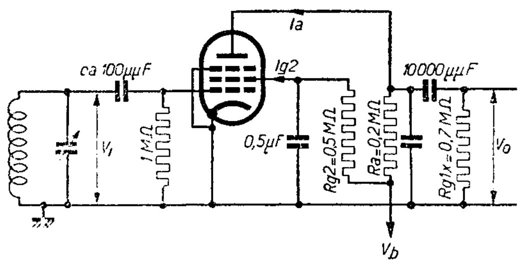


Fig. 8
Circuit driagram of the EF 6 employed as grid detector with resistance coupling.

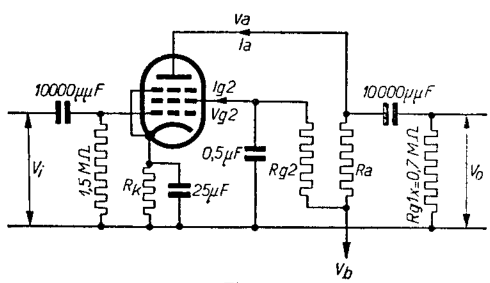


Fig. 9
Circuit diagram of the EF 6 employed as A. F. amplifier with resistance coupling.

TABLE I

EF 6 employed as grid detector with resistance coupling in A.C. receivers.

Heaters fed in parallel in A.C. receivers; detector grid leak = 1 megohm; grid capacitor = 100 $\mu\mu$F. Grid leak of next (output) valve Rg_{1x} = 0.7 megohm. Modulation depth m = 0.3 (30 %). Screen fed through series resistor; Ia and Ig_2 measured without signal.

Supply volt-age	Anode Coup-ling res.	Anode cur-rent	Screen-grid series resistor	Screen cur-rent	Max. alter-nating output	Used with EL 2 as next (output) valve. $Va = Vg_2$ = 250 V				Used with EL 3 as next (output) valve. $Va = Vg_2$ = 250 V				Used with EL 5 as next (output) valve. Va = 250 V; Vg_2 = 275 V			
						For 50 mW output		For full excitation		For 50 mW output		For full excitation		For 50 mW output		For full excitation	
						Output volts	Input volts	Output volts	Input volts	Output volts	Input volts	Output volts	Input volts	Output volts	Input volts	Output volts	Input volts
Vb (V)	Ra (M ohm)	Ia (mA)	Rg_2 (M ohm)	Ig_2 (mA)	Vomax[1] ($Veff$)	Vo ($Veff$)	Vi ($mVeff$)	Vo ($Veff$)	Vi ($Veff$)	Vo ($Veff$)	Vi ($mVeff$)	Vo ($Veff$)	Vi ($Veff$)	Vo ($Veff$)	Vi ($mVeff$)	Vo ($Veff$)	Vi ($Veff$)
300	0.2	1.35	0.6	0.45	19	0.9	63	11.2	0.35	0.33	35	3.7	0.14	0.5	43	8.5	0.27
300	0.2	1.15	0.8	0.35	17	0.9	58	11.2	0.35	0.33	33	3.7	0.13	0.5	41	8.5	0.26
300	0.2	1.0	1.0	0.30	15	0.9	58	11.2	0.42	0.33	33	3.7	0.14	0.5	41	8.5	0.28
250	0.2	1.15	0.6	0.35	16	0.9	60	11.2	0.35	0.33	33	3.7	0.14	0.5	40	8.5	0.27
250	0.2	0.95	0.8	0.28	14	0.9	60	11.2	0.35	0.33	33	3.7	0.13	0.5	40	8.5	0.26
250	0.2	0.8	1.0	0.23	11.5	0.9	65	11.2	0.42	0.33	33	3.7	0.14	0.5	40	8.5	0.28
300	0.1	2.6	0.3	0.85	23	0.9	58	11.2	0.43	0.33	38	3.7	0.14	0.5	50	8.5	0.35
300	0.1	2.2	0.4	0.65	20	0.9	58	11.2	0.43	0.33	38	3.7	0.14	0.5	50	8.5	0.35
300	0.1	1.8	0.5	0.55	17	0.9	58	11.2	0.48	0.33	38	3.7	0.15	0.5	50	8.5	0.35
250	0.1	2.1	0.3	0.7	19	0.9	70	11.2	0.43	0.33	38	3.7	0.14	0.5	50	8.5	0.35
250	0.1	1.8	0.4	0.55	16	0.9	70	11.2	0.43	0.33	38	3.7	0.14	0.5	50	8.5	0.35
250	0.1	1.5	0.5	0.45	14	0.9	70	11.2	0.48	0.33	38	3.7	0.15	0.5	50	8.5	0.35
300	0.05	4.6	0.15	1.5	24	0.9	77	11.2	0.6	0.33	44	3.7	0.25	0.5	56	8.5	0.45
300	0.05	3.9	0.2	1.2	20	0.9	77	11.2	0.6	0.33	44	3.7	0.25	0.5	56	8.5	0.45
300	0.05	2.9	0.3	0.9	15	0.9	79	11.2	0.7	0.33	46	3.7	0.25	0.5	59	8.5	0.60
250	0.05	3.7	0.15	1.3	18	0.9	80	11.2	0.6	0.33	42	3.7	0.25	0.5	55	8.5	0.45
250	0.05	3.1	0.2	1.0	16	0.9	80	11.2	0.6	0.33	42	3.7	0.25	0.5	55	8.5	0.45
250	0.05	2.4	0.3	0.65	12	0.9	84	11.2	0.7	0.33	45	3.7	0.25	0.5	60	8.5	0.60

[1]) In these values for the alternating output the distortion in the detector is less than 5 %.

TABLE II

The EF 6 as resistance-coupled A.F. amplifier in A.C. mains receivers

For use in A.C. mains receivers with heaters in parallel; grid leak of the following (output) valve Rg_1x = 0.7 megohm; cathode decoupling capacitor = 50 μF. Screen grid fed through a resistor; Ia and Ig_2 measured without signal.

Supply voltage	Anode coupling resistor	Anode current	Screen-grid series resistor	Screen-grid current	Cathode resistor	Voltage gain	Used with EL 3 as output valve $Va = Vg_2 = 250$ V		Used with EL 5 as output valve $Va = 250$ V; $Vg_2 = 275$ V		Used with EL 2 as output valve $Va = Vg_2 = 250$ V		Used with AD 1 as output valve $Va = 250$ V	
							Output voltage	Total distortion	Output voltage	Total distortion	Output voltage	Total distortion	Output voltage	Total distortion
Vb (V)	Ra (megohm)	Ia (mA)	Rg_2 (megohm)	Ig_2 (mA)	Rk (ohms)	$\frac{Vo}{Vi}$	Vo [1] (Veff)	$d$tot [2] (%)	Vo [1] (Veff)	$d$tot [2] (%)	Vo [1] (Veff)	$d$tot [2] (%)	Vo [1] (Veff)	$d$tot [2] (%)
300	0.3	0.7	0.8	0.25	4,000	175	3.7	< 1.0	8.5	1.0	11.2	1.4	31	4.4
250	0.3	0.6	0.8	0.20	4,000	165	3.7	< 1.0	8.5	1.6	11.2	2.2	31	5.0
300	0.2	1.1	0.4	0.40	3,000	150	3.7	< 1.0	8.5	1.0	11.2	< 1.0	31	2.7
250	0.2	0.9	0.4	0.35	3,000	140	3.7	< 1.0	8.5	1.3	11.2	1.8	31	2.4
300	0.1	1.9	0.25	0.65	1,600	115	3.7	< 1.0	8.5	1.0	11.2	1.0	31	2.0
250	0.1	1.6	0.25	0.30	1,600	110	3.7	< 1.0	8.5	1.0	11.2	1.0	31	2.7

[1]) For the A.F. amplifier with fully loaded output valve.

[2]) In the A.F. amplifier with fully loaded output valve.

TABLE III

The EF 6 used as resistance-coupled A. F. amplifier in A.C./D.C. mains receivers

Used in A.C./D.C. receivers with heaters in series (heater current 200 mA); grid leak of the next (output) valve $Rg_{1}x$ = 0.7 megohm. Cathode decoupling capacitor = 50 μF; screen fed through a resistor. Ia and Ig_2 measured without signal.

Supply voltage	Anode coupling resistor	Anode current	Screen-grid series resistor	Screen current	Cathode resistor	Voltage gain	Used with CL 1 as output valve $Va = Vg_2$ = supply voltage		Used with CL 2 as output valve Va = supply voltage; Vg_2 = 100 V		Used with CL 4 as output valve $Va = Vg_2$ = supply voltage	
							Output voltage	Total distortion	Output voltage	Total distortion	Output voltage	Total distortion
Vb (V)	Ra (Mohm)	Ia (mA)	Rg_2 (M ohm)	Ig_2 (mA)	Rk (ohm)	$\frac{Vo}{Vi}$	Vo [1] ($Veff$)	$dtot$ [2] (%)	Vo [1] ($Veff$)	$dtot$ [2] (%)	Vo [1] ($Veff$)	$dtot$ [2] (%)
200	0.3	0.45	0.6	0.17	6,400	130	9.6	2.8	10	3.0	5.0	1.8
150	0.3	0.35	0.6	0.13	6,400	120	—	—	10	2.5	4.0	1.3
100	0.3	0.22	0.6	0.08	6,400	105	—	—	10	3.5	2.4	< 1.0
200	0.2	0.60	0.4	0.23	5,000	115	9.6	2.0	10	2.1	5.0	1.0
150	0.2	0.45	0.4	0.17	5,000	110	—	—	10	2.6	4.0	0.9
100	0.2	0.30	0.4	0.12	5,000	100	—	—	10	4.2	2.4	0.9
200	0.1	1.2	0.2	0.4	3,000	95	9.6	1.5	10	1.6	5.0	< 1.0
150	0.1	0.85	0.2	0.3	3,000	90	—	—	10	2.1	4.0	1.1
100	0.1	0.60	0.2	0.2	3,000	85	—	—	10	3.3	2.4	< 1.0

[1]) For the A.F. amplifier with fully loaded output valve.

[2]) In the A.F. amplifier with fully loaded output valve.