EF 9 Variable-MU R.F. pentode

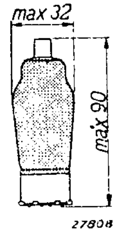


Fig. 1
Dimensions in mm.

This is an R.F. or I.F. variable-mu pentode that can also be used as a resistance-coupled A.F. amplifier, with or without control of the amount of gain (A.G.C. operating also on the A.F. stage). The design of this valve differs from that of the EF 5 in that in place of a fixed screen potential the latter is made to vary on an increasing bias. Instead of taking the screen voltage from a potential divider the screen may be fed via a resistor. Without control the screen potential is adjusted, by means of the voltage drop across this resistor, to about 100 V. Due to the application of gain control the screen current drops and therefore also the potential difference across the resistor; the screen voltage thus rises again until, under full control, it approaches the value of the supply voltage. This varying voltage on the screen is referred to as "self-adjusting" or "sliding" screen voltage. The advantage of using a screen-grid series resistor is to be found in the fact that, assuming roughly equal cross-modulation conditions, the anode current without control is lower and the mutual conductance higher than in a valve with fixed screen voltage. For example, the anode current of the EF 9, at —2.5 V and 100 V screen, in the uncontrolled condition is 6 mA and the mutual conductance 2.2 mA/V, whereas in the case of the EF 5, at V_{g1} = —3 V and V_{g2} = 100 V, the anode current is 8 mA and the mutual conductance 1.7 mA/V.

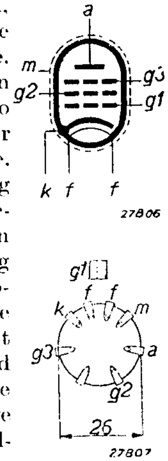


Fig. 2
Arrangement of electrodes and base connections.

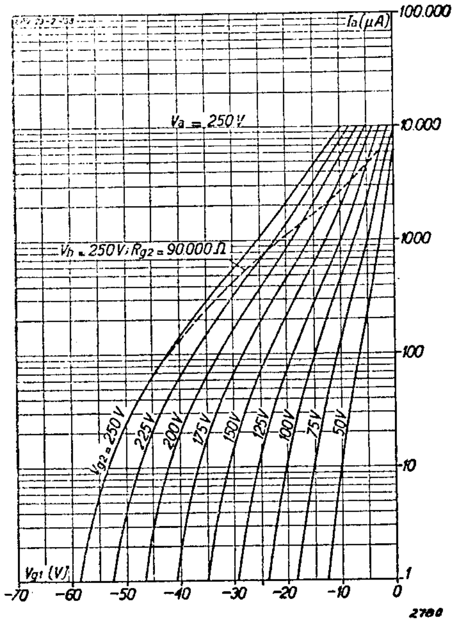


Fig. 3
Ia/Vg_1 characteristics using Vg_2 as parameter. The broken line shows the anode current with control applied to the valve, with the screen fed through a resistance of 90,000 ohms from a supply voltage of 250 V.

When the screen voltage rises the I_a/V_{g1} characteristic is displaced to the left and, if the curve has a short "tail" when the valve is in the uncontrolled condition, this will steadily increase in size as the screen voltage rises: the logarithmic I_a/V_{g1} characteristics with respect to different screen potentials shown in Fig. 3 will confirm this fact. Arising from these circumstances it may be said that, although the I_a/V_{g1} characteristic for the uncontrolled valve has only a short tail, the cross-modulation properties during the time that control is applied are considerably better than if the screen voltage were constant.

On a supply voltage of 250 V the screen-grid series resistor must be 90,000 ohms in order to obtain 100 V on the screen without control. As there is a different screen voltage for

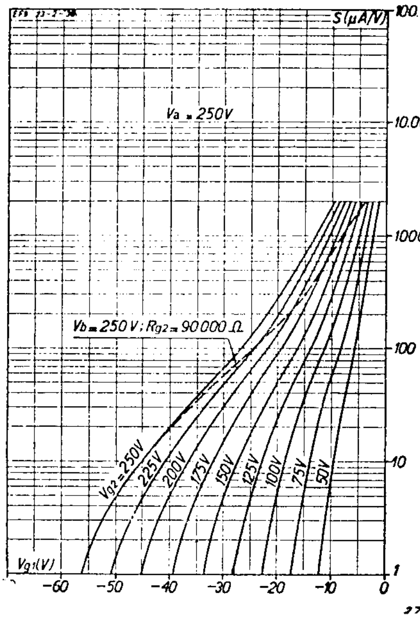


Fig. 4
Mutual conductance as a function of the grid bias, with V_{g2} as parameter. The broken line represents the mutual conductance of the valve when under control, with a screen-grid series resistor of 90,000 ohms and a supply voltage of 250 V.

every value of the grid bias, the anode current plotted against grid bias is shown by a broken line. An alternating grid voltage does not affect the screen voltage, since the screen is decoupled with a capacitor and in this case the anode current varies in accordance with the I_a/V_{g1} characteristic relating to the appropriate grid bias.

According to Fig. 3, the screen voltage at 12.5 V bias is 175 V, so that at this bias value the I_a/V_{g1} characteristic refers to $V_{g2} = 175$ V.

On other supply voltages the screen-grid resistor must be adjusted accordingly and the control curve is thereby slightly modified; for instance on a 200 V supply (as in A.C./D.C. sets) 60,000 ohms will be required to produce 110 V screen voltage without control. The anode voltage will then fall rather more rapidly. On a supply of 100 V, however, the sliding screen voltage no longer functions and the valve has therefore to be used with a fixed screen potential. In this case the I_a/V_{g1} characteristic for $V_{g2} = 100$ V shown in Fig. 3 applies. If a potential divider is used for feeding the screen it is possible to obtain a more rapid controlling effect than with fixed screen potential by a judicious arrangement of the resistance values in the network, but it should be borne in mind that the cross-modulation characteristic is then not quite so good. By means of the I_{g2}/V_{g2} curves in Fig. 10 the various values can be determined for each particular case in advance.

A suitable choice of control curve will also guarantee excellent modulation-hum characteristics, this being of especial importance when dealing with A.C./D.C. mains receivers.

A special feature of the EF 9 is the very low interelectrode capacitance; the anode-to-grid capacitance is less than 0.002 $\mu\mu$F and the valve therefore gives very good results

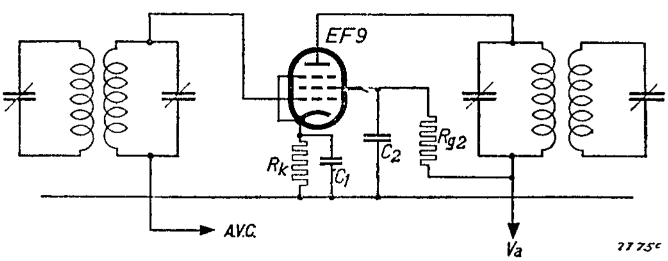


Fig. 5
Theoretical circuit diagram of an I.F. valve employing the principle of the "sliding" screen voltage.

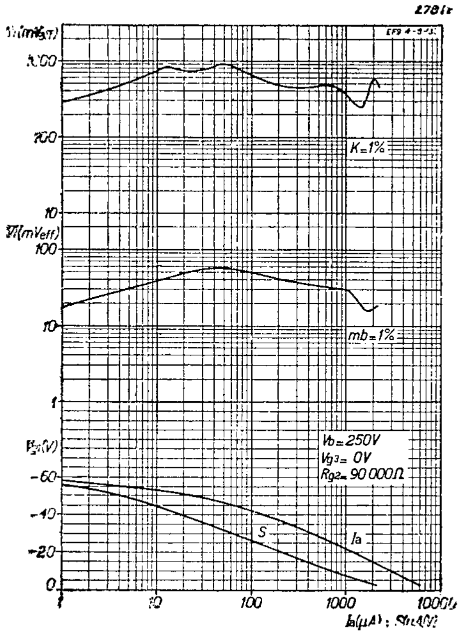


Fig. 6

Upper diagram. Effective alternating grid voltage as a function of the mutual conductance, with 1 % cross-modulation; screen fed via a resistor of 90,000 ohms from 250 V supply.
Centre diagram. Effective alternating grid voltage as a function of the mutual conductance, with 1 % modulation hum.
Lower diagram. Mutual conductance S and anode current Ia as a function of the grid bias.

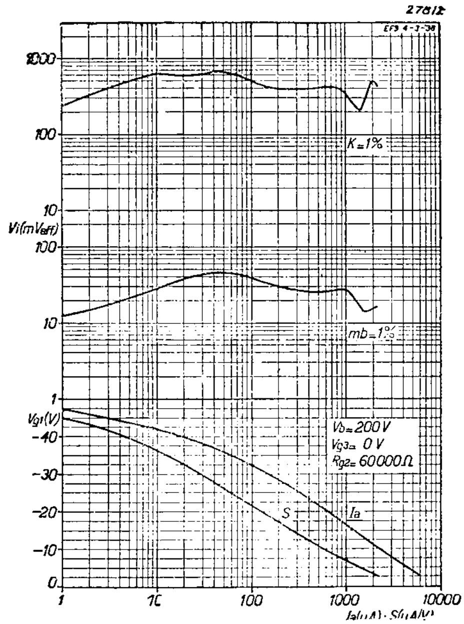


Fig. 7

Upper diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % cross-modulation; screen grid fed via a resistor of 60,000 ohms from a 200 V supply.
Centre diagram. Effective alternating grid voltage as a function of the mutual conductance, with 1 % modulation hum.
Lower diagram. Mutual conductance S and anode current Ia as a function of the grid bias.

in the short-wave range. Although in this range the magnification of the circuits is usually only fair, the EF 9 will ensure a high degree of amplification.
As already mentioned, the EF 9 can also be employed as a resistance-coupled A.F. amplifier; by applying a control voltage to the grid the amplifier may be so regulated that the performance of the A.G.C. of the receiver is enhanced by the A.F. stage. The relevant data will be found in the table on page 276.

HEATER RATINGS

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

Heater voltage	$V_f = 6.3$ V
Heater current	$I_f = 0.200$ A

CAPACITANCES

$C_{ag1} < 0.002\ \mu\mu$F
$C_{g1} = 5.5\ \mu\mu$F
$C_a = 7.2\ \mu\mu$F

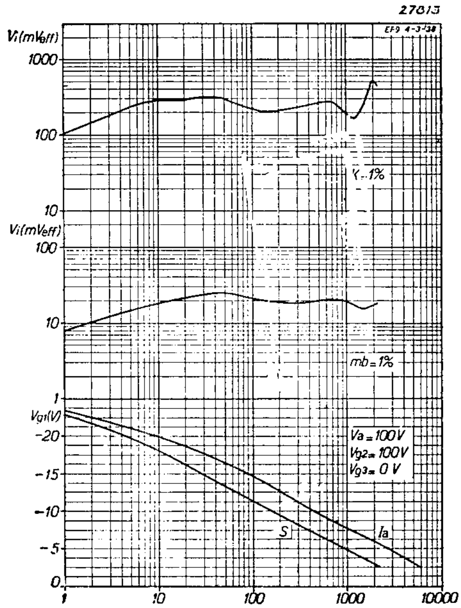


Fig. 8

Upper diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % cross-modulation, at V_a = 100 V, V_{g_2} = 100 V (fixed).
Centre diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % modulation hum.
Lower diagram. Mutual conductance S and anode current I_a as a function of the grid bias.

OPERATING DATA: EF 9 used as R.F. or I.F. amplifier

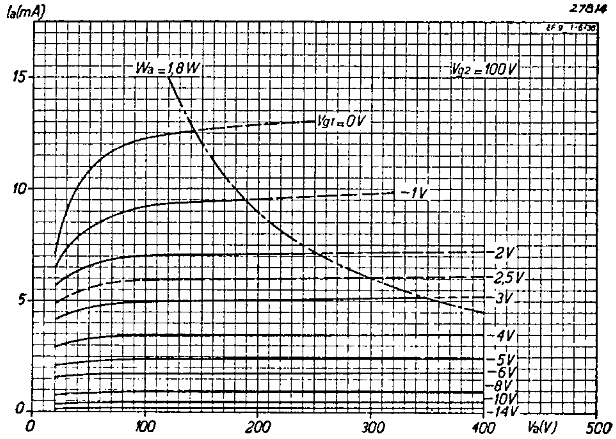
Anode voltage	V_a	= 250 V		
Suppressor grid voltage	V_{g3}	= 0 V		
Screen-grid series resistor	R_{g2}	= 90,000 ohms		
Cathode resistor	R_k	= 325 ohms		
Grid bias	V_{g1}	= —2.5 V [1]	—39 V [2]	—49 V [3]
Screen voltage	V_{g2}	= 100 V	—	250 V
Anode current	I_a	= 6 mA	—	—
Screen current	I_{g2}	= 1.7 mA	—	—
Mutual conductance	S	= 2,200	22	4.5 μA/V
Internal resistance	R_i	= 1.25	> 10	> 10 M ohms

Anode voltage	V_a	= 200 V		
Suppressor grid voltage	V_{g3}	= 0 V		
Screen-grid series resistor	R_{g2}	= 60,000 ohms		
Cathode resistor	R_k	= 325 ohms		
Grid bias	V_{g1}	= —2.5 V [1]	—32 V [2]	—39 V [3]
Screen voltage	V_{g2}	= 100 V	—	200 V
Anode current	I_a	= 6 mA	—	—
Screen current	I_{g2}	= 1.7 mA	—	—
Mutual conductance	S	= 2,200	22	5.5 μA/V
Internal resistance	R_i	= 0.9	> 10	> 10 M ohms

Anode voltage	V_a	= 100 V		
Suppressor-grid voltage	V_{g3}	= 0 V		
Screen-grid voltage	V_{g2}	= 100 V		
Cathode resistor	R_k	= 325 ohms		
Grid bias	V_{g1}	= —2.5 V [1]	—16 V [2]	—19 V [3]
Anode current	I_a	= 6 mA	—	—
Screen current	I_{g2}	= 1.7 mA	—	—
Mutual conductance	S	= 2,200	22	7 μA/V
Internal resistance	R_i	= 0.4	> 10	> 10 M ohms

[1]) Without control. [2]) Mutual conductance reduced to one-hundredth of uncontrolled value. [3]) Extreme limit of control range.

Fig. 9
Anode current as a function of the anode voltage at different values of the grid bias, with a fixed screen voltage of 100 V.



MAXIMUM RATINGS

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 300 V
Anode dissipation	W_a	= max. 2 W
Screen voltage in cold condition	V_{g2o}	= max. 550 V
Screen voltage at I_a = 6 mA	V_{g2}	= max. 125 V
Screen voltage at I_a = 3 mA	V_{g2}	= max. 300 V
Screen-grid dissipation	W_{g2}	= max. 0.3 W
Cathode current	I_k	= max. 10 mA
Grid voltage at grid current start (I_{g1} = + 0.3 μA)	V_{g1}	= max. —1.3 V
Resistance between grid and cathode	R_{g1k}	= max. 3 M ohms
Resistance between filament and cathode	R_{fk}	= max. 20,000 ohms
Voltage between filament and cathode (direct voltage or effective value of alternating voltage)	V_{fk}	= max. 100 V

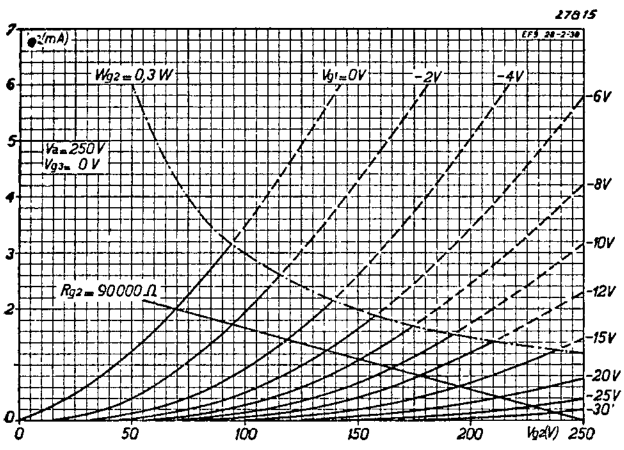


Fig. 10
Screen current as a function of the screen voltage at different values of the grid bias. These curves also apply as an approximation to anode voltages between 100 and 250 V.

For data referring to the use of the valve as a resistance-coupled A. F. amplifier **see Table on p. (272).**

The EF 9 is used as amplifier valve with manually or automatically controlled amplification. The heating-up time is shorter than usual and the cathode insulation is rated to carry 100 V direct voltage or effective value of the alternating voltage; this value should not be exceeded.

OPERATING DATA: EF 9 used as resistance-coupled A.F. amplifier with controlled amplification

(in amplifiers or A.C. receivers)

Supply voltage	Anode coupling res.	Screen series res.	Cathode res.	Control voltage on control grid	Anode current	Screen current	Alternating input volts	Alternating output volts	Voltage gain	Total distortion.
Vb (V)	*Ra* (M ohm)	Rg_2 (M ohm)	*Rk* (ohm)	*VR* (V)	*Ia* (mA)	Ig_2 (mA)	Vi (*Veff*)	Vo (*Veff*)	$\frac{Vo}{Vi}$	*dtot* (%)
250	0.2	0.8	1,750	0	0.87	0.26	0.028	3	106	0.8
250	0.2	0.8	1,750	—5	0.69	0.21	0.075	3	40	0.8
250	0.2	0.8	1,750	—10	0.55	0.17	0.13	3	23	1.1
250	0.2	0.8	1,750	—18	0.37	0.11	0.27	3	11.6	1.5
250	0.2	0.8	1,750	—25	0.17	0.05	0.45	3	6.7	2.7
250	0.2	0.8	1,750	0	0.87	0.26	0.047	5	106	2.4
250	0.2	0.8	1,750	—5	0.69	0.21	0.125	5	40	2.4
250	0.2	0.8	1,750	—10	0.55	0.17	0.22	5	23	1.9
250	0.2	0.8	1,750	—18	0.37	0.11	0.42	5	11.6	2.4
250	0.2	0.8	1,750	—25	0.17	0.05	0.75	5	6.7	4.4
250	0.2	0.8	1,750	0	0.87	0.26	0.094	10	106	2.7
250	0.2	0.8	1,750	—5	0.69	0.21	0.25	10	40	2.7
250	0.2	0.8	1,750	—10	0.55	0.17	0.43	10	23	3.7
250	0.2	0.8	1,750	—18	0.37	0.11	0.86	10	11.6	4.8
250	0.2	0.8	1,750	—25	0.17	0.05	1.46	10	6.7	8.8
250	0.1	0.4	1,000	0	1.6	0.45	0.035	3	85	0.8
250	0.1	0.4	1,000	—5	1.22	0.36	0.083	3	36	0.8
250	0.1	0.4	1,000	—10	0.92	0.28	0.15	3	20	1.2
250	0.1	0.4	1,000	—18	0.57	0.18	0.33	3	9.2	1.8
250	0.1	0.4	1,000	—25	0.36	0.11	0.55	3	5.5	2.8
250	0.1	0.4	1,000	0	1.6	0.45	0.059	5	85	1.3
250	0.1	0.4	1,000	—5	1.22	0.36	0.14	5	36	1.4
250	0.1	0.4	1,000	—10	0.92	0.28	0.25	5	20	2.1
250	0.1	0.4	1,000	—18	0.57	0.18	0.55	5	9.2	3.1
250	0.1	0.4	1,000	—25	0.36	0.11	0.91	5	5.5	4.8
250	0.1	0.4	1,000	0	1.6	0.45	0.118	10	85	2.5
250	0.1	0.4	1,000	—5	1.22	0.36	0.28	10	36	2.7
250	0.1	0.4	1,000	—50	0.92	0.28	0.49	10	20	4.1
250	0.1	0.4	1,000	—18	0.57	0.18	1.08	10	9.2	6.1
250	0.1	0.4	1,000	—25	0.36	0.11	1.83	10	5.5	9.5

Note. The values for the voltage gain relate to cases where the grid leak of the next valve is 0.7 megohm. The control voltage on the grid must not be interchanged with the grid bias, which consists of the control voltage augmented by the voltage drop across the cathode resistor.