EF 40 A.F. pentode

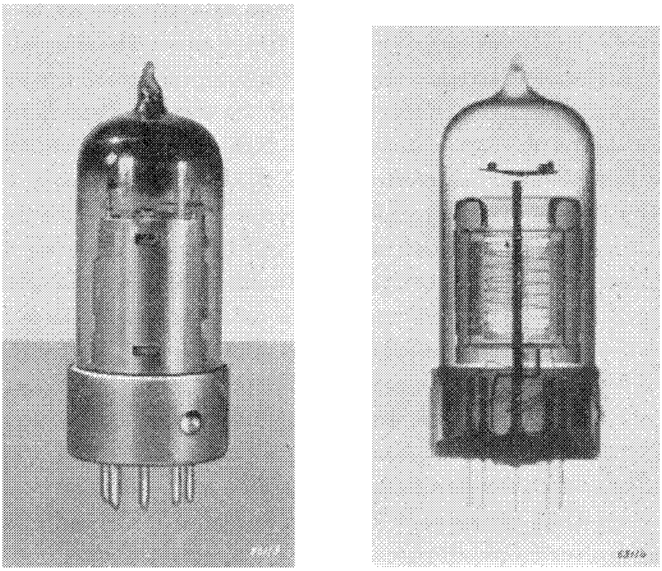

Fig. 1
Normal and X-ray photographs of the EF 40 (approximately actual size).

The EF 40 is an indirectly heated A.F. pentode with a straight characteristic and a slope of 1.85 mA/V. It is specially designed for A. F. amplification in high-sensitivity amplifiers and high-fidelity receivers; to this end, hum, valve noise and microphony have been reduced to the lowest possible level. The heater of the EF 40 can be either parallel or series fed, the heater current being 200 mA (A.C. or D.C.) at a voltage of 6.3 V.

A particularly rigid electrode system, incorporating twice the usual number of mica supports, is responsible for the pronounced reduction in microphony: to illustrate the gain obtainable without necessitating any special measures to avoid microphony, it may be said that, when the valve is used in an amplifier, the gain can be increased to a point at which the input required for maximum output power is not less then 5 mV. It is thereby assumed that the sound level in the region of the valve is the equivalent of that of a loudspeaker having an acoustic efficiency of 5%, and of which the input power is 5 W, located 10 cm from the valve.

In broadcast receivers, the maximum permissible amplification corresponds to an alternating input voltage of not less than 0.5 mV for an output of 50 mW, it being again assumed that the acoustic efficiency of the speaker is 5%, and the distance from the valve 10 cm. Comparison of the microphonic tendencies of the EF 40 with the EBC 41 (see page 58) shows that the above-mentioned input of 0.5 mV becomes 10 mV in the case of the EBC 41, which clearly demonstrates the high quality of the EF 40.

As already mentioned in the description of the EAF 42, the above values are intended only as a general guide; certain effects, such as cabinet resonance, may render the valve microphonic at lower amplification levels.

If it is intended to increase the sensitivity of the EF 40 beyond the point that corresponds to the above values, measures to prevent microphony will probably prove necessary; for example, an anti-microphonic valveholder and/or an acoustic screen round the valve may have to be fitted. If the equipment is likely to be subjected to shocks or vibration, some form of anti-vibration mounting is definitely recommended for the valve.

In view of the fact that the EF 40 is also suitable for use as first valve in a microphone amplifier, every effort has been made to eliminate hum; the equivalent hum voltage on the control grid is accordingly less than 5 μV, which means that the hum level is 60 db below the input signal required for the maximum output delivered by the output valve.

The main causes of hum include the magnetic field of the heater, leakage currents between the heater terminals and other electrodes, coupling between unscreened parts or the lead-in wires of the heater and other electrodes or lead-in wires, and emission from the extremities of the heater itself.

The effects of the magnetic field set up by the heater have already been discussed in the description of the EAF 42, where it appears that a straight characteristic is preferable to variable-mu conditions. To suppress this magnetic field as much as possible, the bifilar type of heater is used and the heater current is kept low (200 mA).

Leakage currents and coupling between heater and grid are minimized by keeping the connections to these electrodes as far apart as possible, and by providing appropriate screens in the valve. These also check emission from the ends of the heater and the consequent flow of electrons to other electrodes.

It is evident that in high-gain amplifiers certain precautions must be observed in connection with the circuit and wiring of the EF 40 in order to suppress hum; e.g. the valve should be placed as far as possible from transformers and chokes, to ensure that the strayfields of such components will not affect it. To avoid leakage currents in the valveholder, it is advisable to use one of good quality, and the Philips type 5904/03 is to be recommended.

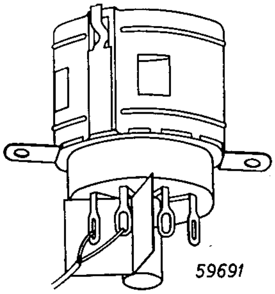

Fig. 2. Valveholder for the EF 40 with screening plate between contacts. This plate is soldered to the central bush.

Any residual hum can usually be reduced by connecting a wire-wound potentiometer of about 50 ohms in parallel with the heater, the sliding contact of the potentiometer being earthed and adjusted for minimum hum.

Further, to avoid hum due to coupling in the wiring, the heater contacts of the valveholder should be screened by a metal plate soldered the central bush (see Fig. 2).

The central bush must be earthed, and it is advisable to use this as the central earthing point of the input circuit.
The magnetic field of the heater leads can be reduced by twisting the leads.

TECHNICAL DATA OF THE A.F. PENTODE EF 40

Heater data

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

Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	0.2 A

Capacitances (cold valve)

Input capacitance	C_{g1}	=	4.5 pF
Output capacitance	C_a	=	5.2 pF
Between anode and control grid	C_{ag1}	$<$	0.04 pF
Between control grid and heater	C_{g1f}	$<$	0.002 pF

Typical characteristics

Anode voltage	V_a	=	250 V
Voltage, grid 3	V_{g3}	=	0 V
Screen grid voltage	V_{g2}	=	140 V
Grid bias	V_{g1}	=	—2 V
Anode current	I_a	=	3.0 mA
Screen grid current	I_{g2}	=	0.55 mA
Mutual conductance	S	=	1.85 mA/V
Internal resistance	R_i	=	2.5 MΩ
Amplification factor, grid 2 with respect to grid 1	μ_{g2g1}	=	38

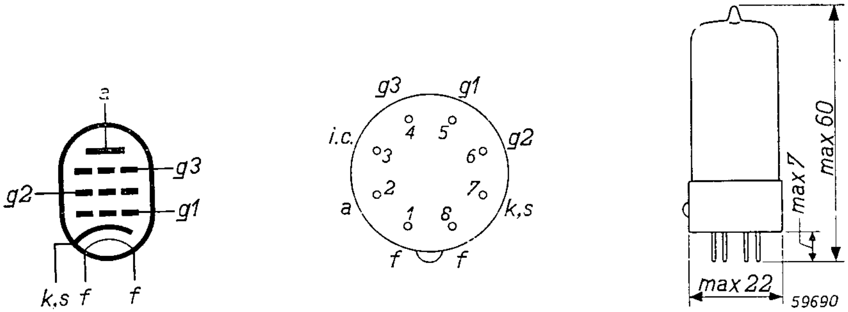

Fig. 3
Electrode arrangement, electrode connections and maximum dimensions in mm.

Operating characteristics of the EF 40 used as A.F. amplifier (see Fig. 4)

Supply voltage	V_b	=	250	250	100	100	V
Anode resistor	R_a	=	0.33	0.22	0.33	0.22	MΩ
Screen grid resistor	R_{g2}	=	1.5	1.0	1.2	1.0	MΩ
Grid leak	R_{g1}	=	1	1	1	1	MΩ
Grid leak of the next valve	R_{g1}'	=	1	1	1	1	MΩ
Cathode resistor	R_k	=	2.2	1.5	4.7	3.3	kΩ
Anode current	I_a	=	0.58	0.86	0.20	0.28	mA
Screen grid current	I_{g2}	=	0.12	0.18	0.05	0.06	mA
Amplification	V_o/V_i	=	210	180	125	120	
Distortion	$d_{tot}(V_o = 4\ \mathrm{V}_{RMS})$	=	0.6	0.5	1.1	1.1	%
	$d_{tot}(V_o = 8\ \mathrm{V}_{RMS})$	=	0.9	0.7	1.7	1.6	%
	$d_{tot}(V_o = 12\ \mathrm{V}_{RMS})$	=	1.2	1.0	2.6	2.5	%

Supply voltage	V_b	=	250	100	V
Anode resistor	R_a	=	0.22	0.22	MΩ
Screen grid resistor	R_{g2}	=	1.2	1.2	MΩ
Grid leak	R_{g1}	=	10	10	MΩ
Grid leak of the next valve	R_{g1}'	=	0.68	0.68	MΩ
Cathode resistor	R_k	=	0	0	kΩ
Anode current	I_a	=	0.9	0.3	mA
Screen grid current	I_{g2}	=	0.17	0.06	mA
Amplification	V_o/V_i	=	200	130	
Distortion	$d_{tot}(V_o = 4\ \mathrm{V}_{RMS})$		< 1	1.2	%
	$d_{tot}(V_o = 8\ \mathrm{V}_{RMS})$		< 1	1.8	%
	$d_{tot}(V_o = 12\ \mathrm{V}_{RMS})$		< 1	3.0	%

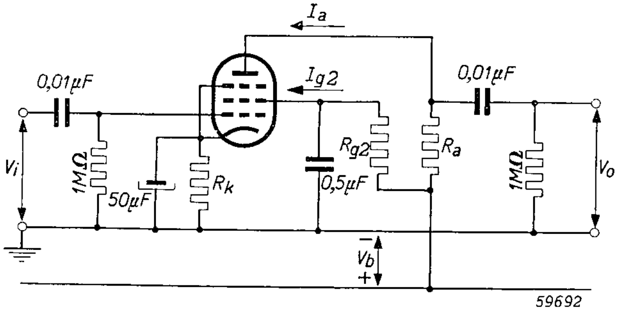

Fig. 4
The EF 40 used as A.F. amplifier.

Under the last-mentioned operating conditions the grid bias is obtained by means of the grid leak (the cathode resistor is omitted). The above data are valid when the internal resistance of the source of the input signal is zero; should this resistance be about 2 MΩ, the above values will still apply, except those of distortion, which are then increased by roughly 1%.

In order to compute the alternating input voltage for this arrangement when the source of the input voltage possesses internal resistance, it should be noted that the input damping of the EF 40 under such operating conditions is about 6 MΩ

Operating characteristics of the EF 40 used as A.F. triode (screen grid connected to anode)

Supply voltage	V_b	=	250	250	100	100	V
Anode resistor	R_a	=	0.22	0.1	0.22	0.1	MΩ
Grid leak	R_{g1}	=	1	1	1	1	MΩ
Grid leak of the next valve	R_{g1}'	=	1	1	1	1	MΩ
Cathode resistor	R_k	=	1.8	1.2	4.7	2.7	kΩ
Anode current	I_a	=	0.84	1.5	0.27	0.47	mA
Amplification	V_o/V_i	=	31	29	27	26	
$d_{tot}(V_o = 4\ V_{RMS})$		=	0.6	0.6	1.0	1.0	%
Distortion $d_{tot}(V_o = 8\ V_{RMS})$		=	0.8	0.7	1.5	1.7	%
$d_{tot}(V_o = 12\ V_{RMS})$		=	1.1	1.0	1.8	2.2	%

Limiting values

Anode voltage, valve biased to cut-off	V_{a_0}	= max.	550	V
Anode voltage	V_a	= max.	300	V
Anode dissipation	W_a	= max.	1	W
Screen grid voltage, valve biased to cut-off	V_{g2_0}	= max.	550	V
Screen grid voltage	V_{g2}	= max.	200	V
Screen grid dissipation	W_{g2}	= max.	0.2	W
Cathode current	I_k	= max.	6	mA
Grid current starting point	$V_{g1}(I_{g1} = +0.3\mu A)$	= max.	—1.3	V
External resistance between control grid and cathode	$R_{g1}(W_a < 0.2W)$	= max.	10	MΩ
	$R_{g1}(W_a > 0.2W)$	= max.	3	MΩ [1]
External resistance between heater and cathode	R_{fk}	= max.	20	kΩ
Voltage between heater and cathode	V_{fk}	= max.	100	V

---

[1] If the grid bias is obtained only by means of the grid leak, the maximum value for R_{g1} is 22 MΩ.

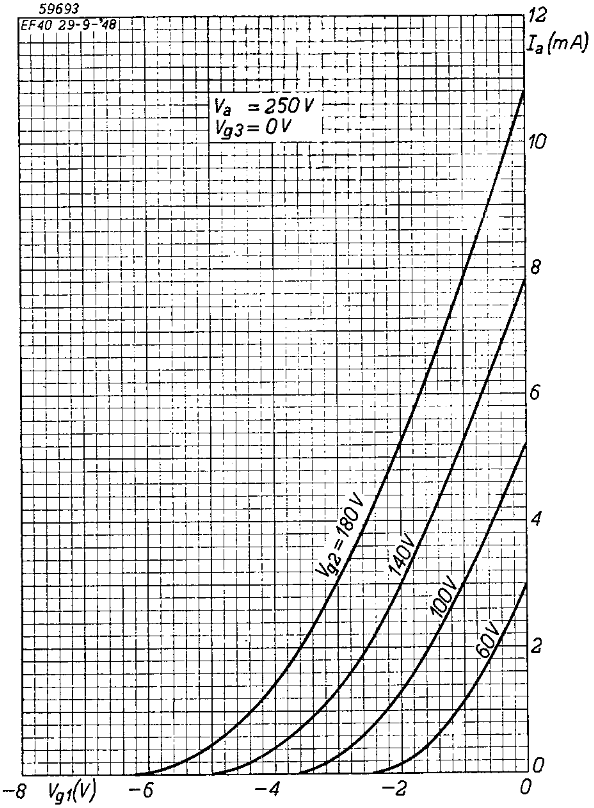

Fig. 5. Anode current (I_a) as a function of the grid bias (V_{g1}), at different screen grid voltages (V_{g2}). Anode voltage (V_a)=250V.

Fig. 6. Anode current (I_a), as a function of the anode voltage (V_a), at different values of the grid bias (V_{g1}). Screen grid voltage (V_{g2}) =140 V. The broken line indicates the maximum permissible anode dissipation (W_a=1 W).