EL 6 Output Pentode

This is another 18 W, indirectly-heated, high conductance output pentode, the need for which arose from a demand for a "larger" output valve which, fully excited, would take about the same grid input as the EL 3. The advantage of this valve is that receivers having a 9 W or 18 W output stage, apart from the rectifier, may be developed along exactly the same lines. At the working point the EL 6 has the unusually high mutual conductance of 14.5 mA/V. With 10 % distortion the maximum obtainable output is 8 W. The peak alternating grid voltage for this output is only 4.8 $V_{(eff)}$ whilst the sensitivity (for 50 mW output) is 0.3 $V_{(eff)}$.

The valve can also figure in balanced output stages, although the output obtainable is then not so high as in the case of two EL 5 type valves. On the other hand, the EL 6 has the advantage of a higher mutual conductance. The optimum output power is 14.5 W with 2.2 % distortion at an alternating grid voltage of 7.3 $V_{(eff)}$ per grid. Taking into account an average voltage drop of 15 V across the output transformer, the output at V_a = 250 V with V_{g2} = 265 V is somewhat higher, viz. 16 W, with 1.4 % distortion with a grid input of 8.5 $V_{(eff)}$. The maximum distortion is roughly 3 %, which occurs at approximately 10 W output.

The very high mutual conductance is due to the special construction of the cathode, with its relatively low heater power: at 6.3 V the current consumed is 1.2 A.

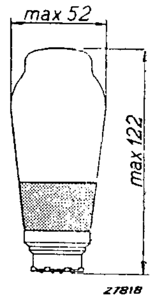

Fig. 1
Dimensions in mm.

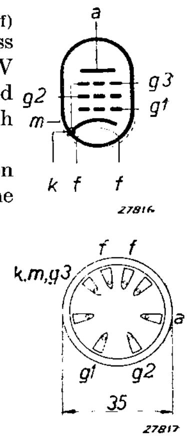

Fig. 2
Arrangement of electrodes and base connections.

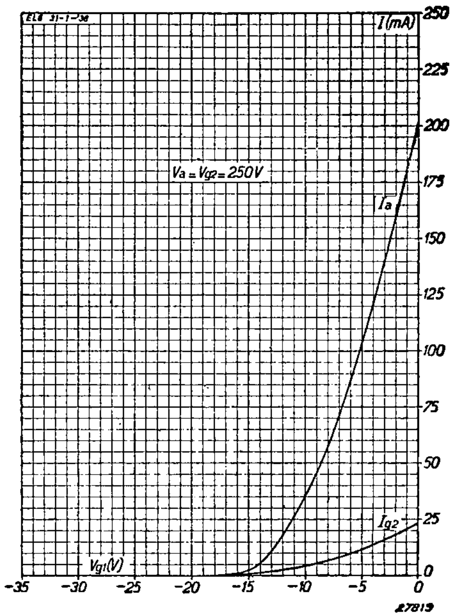

Fig. 3
Anode and screen current as a function of the grid bias, at $Va = Vg_2$ = 250 V.

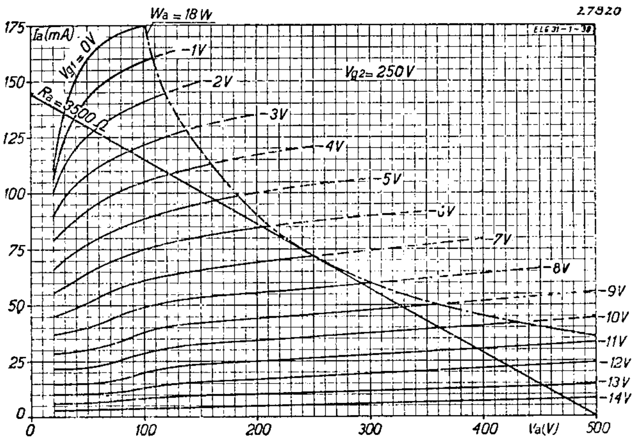

Fig. 4
Anode current as a function of the anode voltage at $V_{g_2} = 250$ V with V_{g_1} as parameter.

HEATER RATINGS

Heating: indirect by A.C., parallel supply.
Heater voltage . . . . $V_f = 6.3$ V
Heater current . . . . $I_f = 1.2$ A

CAPACITANCES

Anode-grid . . . . $C_{ag_1} < 0.7\ \mu\mu$F

OPERATING DATA: EL 6 used as a normal output valve (single valve)

Anode voltage	V_a	=	250 V
Screen-grid voltage	V_{g_2}	=	250 V
Grid bias	V_{g_1}	=	—7 V
Cathode resistor	R_k	=	90 ohms
Anode current	I_a	=	72 mA
Screen-grid current	I_{g_2}	=	8.0 mA
Mutual conductance	S	=	14.5 mA/V
Internal resistance	R_i	=	20,000 ohms
Load resistor	R_a	=	3,500 ohms
Output power with 10 % distortion	W_o	=	8 W
Alternating input voltage for $W_o = 8$ W	V_i	=	4.8 V_{eff}
Sensitivity ($W_o = 50$ mW)	V_i	=	0.3 V_{eff}
Amplification factor, screen with respect to grid 1	$\mu_{g_2g_1}$	=	20

OPERATING DATA: EL 6 used as an output valve in balanced circuits (two valves) with automatic grid bias.

Anode voltage	V_a	= 250 V	250 V
Screen-grid voltage	V_{g2}	= 250 V	265 V
Cathode resistor	R_k	= 90 ohms	97 ohms
Anode current (without signal)	I_{ao}	= 2 × 45	2 × 45 mA
Anode current at max. modulation	$I_{a\,max}$	= 2 × 53	2 × 54 mA
Screen current (without signal)	I_{g2o}	= 2 × 5.1	2 × 5.1 mA
Screen current at max. modulation	$I_{g2\,max}$	= 2 × 8.5	2 × 9.9 mA
Load resistor between anodes	R_{aa}	= 5,000 ohms	5,000 ohms
Output power	W_o	= 14.5 W	16 W
Distortion	d_{tot}	= 2.2 %	1.7 %
Alternating grid voltage per grid	V_i	= 7.3 V_{eff}	8.2 V_{eff}

MAXIMUM RATINGS

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 250 V
Anode dissipation	W_a	= max. 18 W
Screen voltage in cold condition	V_{g2o}	= max. 550 V
Screen voltage	V_{g2}	= max. 275 V
Screen dissipation (V_i = o)	W_{g2}	= max. 2 W
Screen dissipation (W_o = max.)	W_{g2}	= max. 3 W
Cathode current	I_k	= max. 90 mA
Grid voltage at grid current start ($I_{g1} = +0.3\ \mu A$)	V_{g1}	= max. —1.3 V
External resistance between grid and cathode	R_{g1k}	= max. 0.7 M ohm
External resistance between heater and cathode	R_{fk}	= max. 5,000 ohms
Voltage between heater and cathode (D.C. voltage or effective value of alternating voltage)	V_{fk}	= max. 50 V

Fig. 6 gives a number of useful data plotted against the screen voltage in the range 250—275 V. With an anode voltage of 250 V by means of these characteristics any voltage drop in the output transformer from 0 to 25 V can be taken into account in investigating the operation of the valve. Dynamic characteristics of the EL 6 as a function of the screen voltage, in the case of receivers in which the available anode voltage is less than 250 V and whereby the anode voltage is less than that of the screen by 15 V, are given in Fig. 8. Allowance is made for an average voltage drop of 15 V across the output transformer.

In the case of Class A and A/B amplification the grid bias must be automatic (cathode resistor); semi-automatic bias may be employed so long as the cathode current of the EL 6 is in excess of 50 % of the total current flowing through the biasing resistor. The maximum value of the grid leak, as indicated in the Maximum Ratings should then be reduced in accordance with the following:

$$\frac{\text{Cathode current of the output valve}}{\text{Total current passing through the resistor producing the voltage drop}} \times R_{g1k}$$

It should be noted, further, that the current of those valves to which automatic gain control is applied will affect the bias on the output valve, so that when the control voltage rises the bias quickly becomes too low and the anode current too high.

The high mutual conductance of this valve should be taken into consideration in the design of receiver circuits, in view of the resultant tendency towards R.F. feed-back and oscillation. Leads to the valve contacts should therefore be as short as possible, and a resistor of about 1,000 ohms in the grid lead is indispensable.

For the use of the valve in balanced circuits employing automatic bias the necessary data will be found in Figs 8 and 9: the former gives the distortion and alternating grid voltage at $V_a = 250$ V and $V_{g2} = 250$ V, whilst Fig. 9 shows various data, such as the biasing resistor, output power, etc. as functions of the screen voltage when the anode current is 2 × 24 mA with a constant voltage of 250 V on the anode. Using the curves it is possible for the designer to obtain the appropriate operating conditions with respect to almost any voltage drop across the output transformer. In balanced output stages care should be taken, if the anode current (without signal) is more than 45 mA per valve, to see that each valve has its own biasing resistor. This precaution is advisable in all cases where a possibility exists that one of the valves may be removed while the set is in operation, as this will otherwise result inevitably in damage to the other valve.

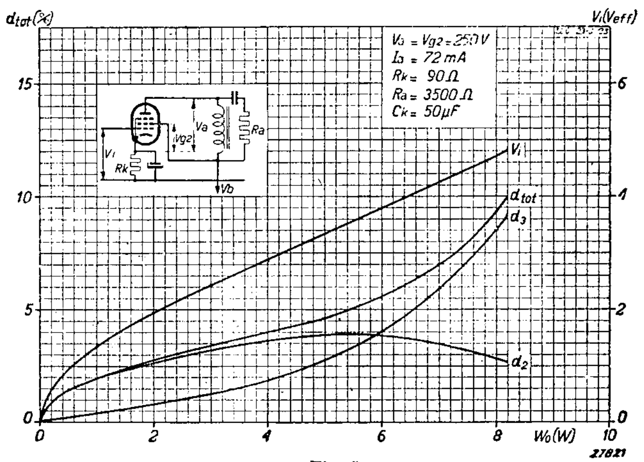

Fig. 5
Total distortion, and 2nd and 3rd harmonic distortion; EL 6 used as normal output pentode with auto. bias and decoupling capacitor in the cathode circuit ($Va = Vg_2 = 250$ V).

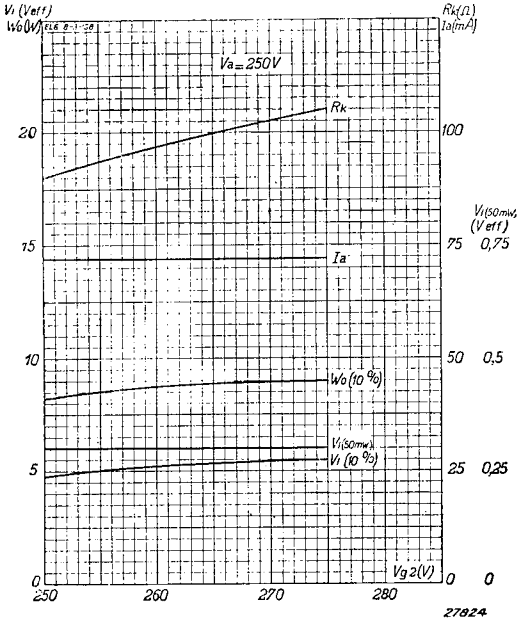

Fig. 6

Output power with 10 % distortion . . . *Wo* (10 %)
Alternating grid voltage at 10 % distortion . . . . . *Vi* (10 %)
Sensitivity . . . . *Vi* (50 mW)
Cathode resistor . . . . . . *Rk*
Anode current . . . . *Ia*

as functions of the screen voltage (in the range 250–275 V) with a constant anode voltage (Va = 250 V).

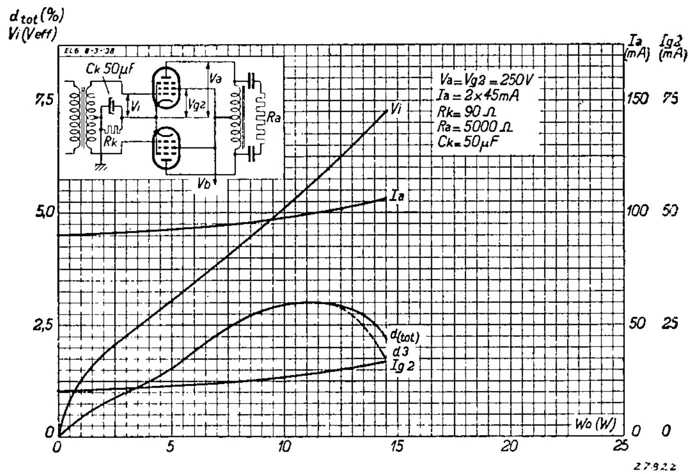

Fig. 7

Total anode current Ia, total screen current Ig_2, total distortion $dtot$, 3rd harmonic distortion and alternating grid voltage per grid Vi, as functions of the output power Wo when using two EL 6 valves in a balanced circuit with $Va = Vg_2 = 250$ V.

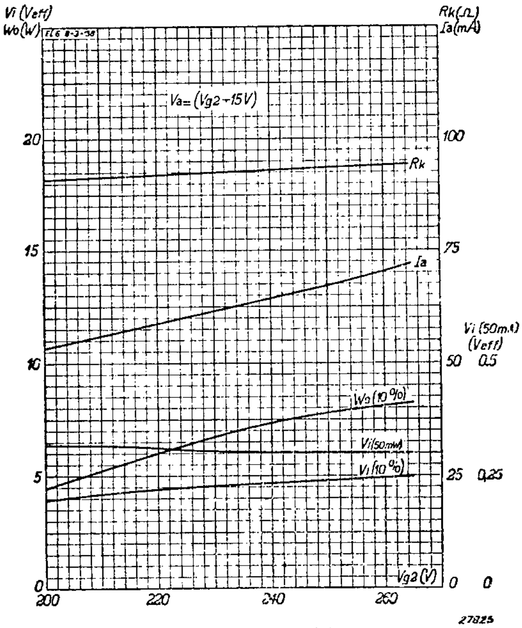

Fig. 8

Output power with 10 % distortion. . .	*Wo* (10 %)	as functions of the screen-grid voltage (in the range 200–265 V) where the voltage of the anode is 15 V lower than that of the screen.
Alternating grid voltage with 10 % distortion. . .	*Vi* (10 %)	
Sensitivity	*Vi* (50 mW)	
Cathode resistor	*Rk*	
Anode current.	*Ia*	

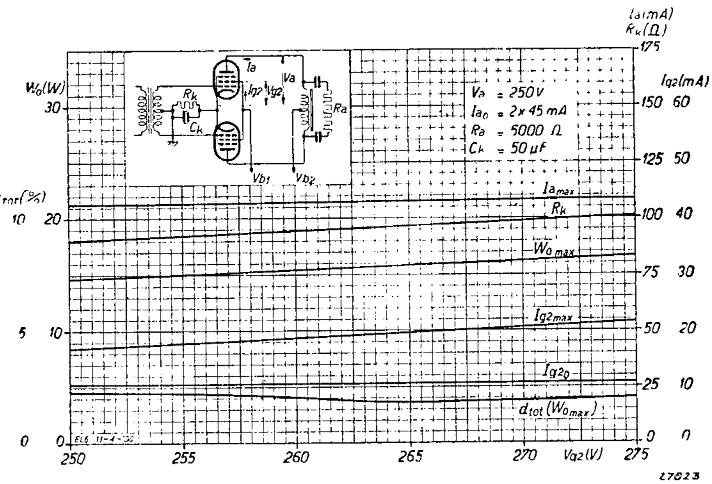

Fig. 9

Output power at max. modulation . . .	*Wo*max	as functions of the screen-grid voltage (in the range 250–275 V), at constant anode voltage ($Va = 250$ V)
Total distortion	*d*tot (*Wo*max)	
Anode current at max. modulation . . .	*Ia*max	
Screen current (without signal)	Ig_2o	
Screen current at max. modulation . . .	Ig_2max	
Cathode resistor (*Iao* = 45 mA per valve)	*Rk*	