EL 2 Output pentode

The EL 2 is an indirectly-heated, 8 W output pentode for use in car-radio receivers; the low heater-power consumption makes this valve very suitable for this purpose. With an anode and screen potential of 250 V, the mutual conductance is 2.8 mA/V at the working point. The cathode attains its full working temperature in a very short time, namely 18 seconds. The control-grid connection is at the top of the envelope.

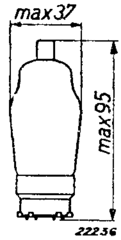

Fig. 1
Dimensions in mm.

HEATER RATINGS

Heating: Indirect by battery current; series or parallel supply.

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

CAPACITANCES

Anode to grid 1	$C_{ag1} < 0.6$ μμF

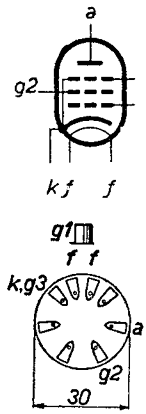

Fig. 2
Arrangement of electrodes and base connections.

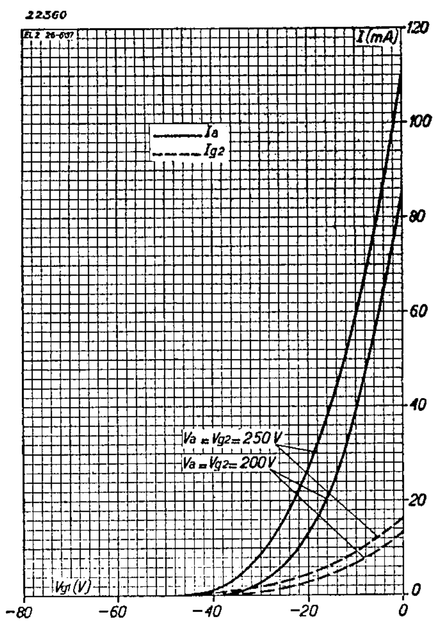

Fig. 3
Anode and screen current as functions of the grid bias for equal anode and screen voltages of 200 V and 250 V.

OPERATING DATA: EL 2 used as Class A output valve (single valve)

Anode voltage	V_a	=	200 V	250 V
Screen-grid voltage	V_{g2}	=	200 V	250 V
Cathode resistor	R_k	=	480 ohms	485 ohms
Grid bias	V_{g1}	=	—14 V	—18 V
Anode current	I_a	=	25 mA	32 mA
Screen-grid current	I_{g2}	=	4 mA	5 mA
Mutual conductance	S	=	3 mA/V	2.8 mA/V
Internal resistance	R_i	=	70,000 ohms	70,000 ohms
Load resistor	R_a	=	8,000 ohms	8,000 ohms
Output with 10 % distortion	W_o	=	2.3 W	3.6 W
Alternating grid voltage with 10 % distortion	V_i	=	8.5 V_{eff}	10 V_{eff}
Alternating grid voltage for 50 mW output	V_i	=	1 V_{eff}	0.9 V_{eff}

OPERATING DATA: EL 2 used as output valve in balanced circuit (2 valves)

			Automatic grid bias	
Anode voltage	V_a	=	200 V	250 V
Screen-grid voltage	V_{g2}	=	200 V	250 V
Common cathode resistor	R_k	=	320 ohms	305 ohms
Anode current (without signal)	I_{ao}	=	2 × 21 mA	2 × 27.5 mA
Anode current at full modulation	I_{amax}	=	2 × 24.5 mA	2 × 32.5 mA
Screen current (without signal)	I_{g2o}	=	3.5 mA	2 × 4.5 mA
Screen current at full modulation	I_{g2max}	=	2 × 6 mA	2 × 8 mA
Load resistor between the two anodes	R_{aa}	=	9,000 ohms	8,000 ohms
Output power	W_{omax}	=	5 W	8 W
Total distortion at full modulation	d_{tot}	=	1.5 %	1.4 %
Alternating grid voltage at full modulation	V_i	=	14 V_{eff}	17 V_{eff}

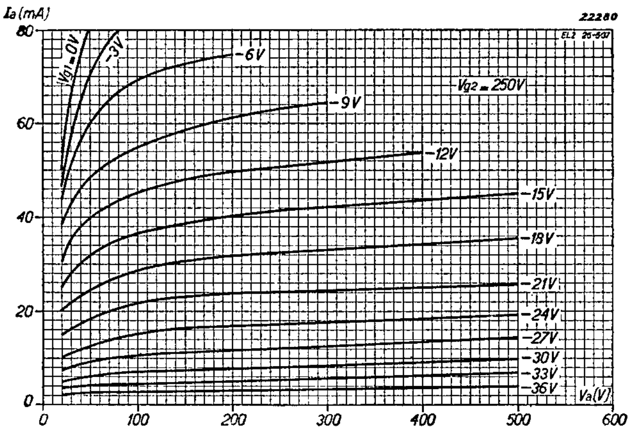

Fig. 4
Anode current as a function of the anode voltage with Vg_1 as parameter, at Vg_2 = 250 V.

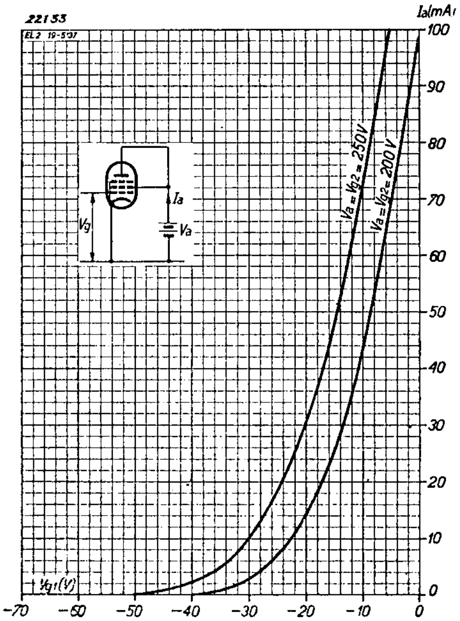

Fig. 5
EL 2 used as triode. Anode current as a function of the grid bias at $Va = 200$ and 250 V.

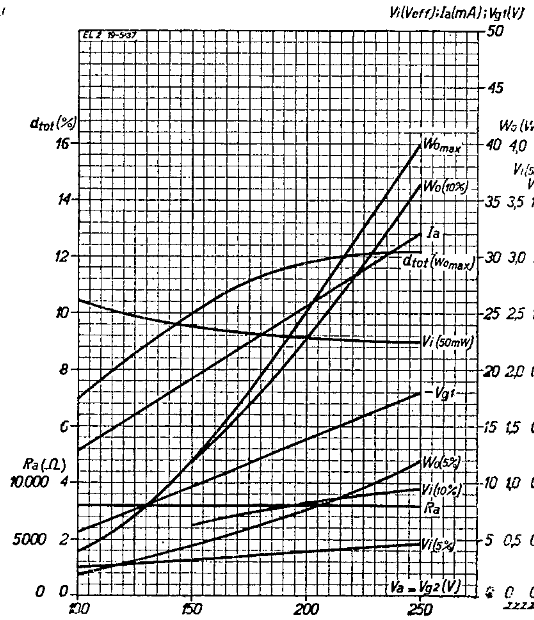

Fig. 6
EL 2 used as triode. Anode current as a function of the anode voltage for different values of grid bias.

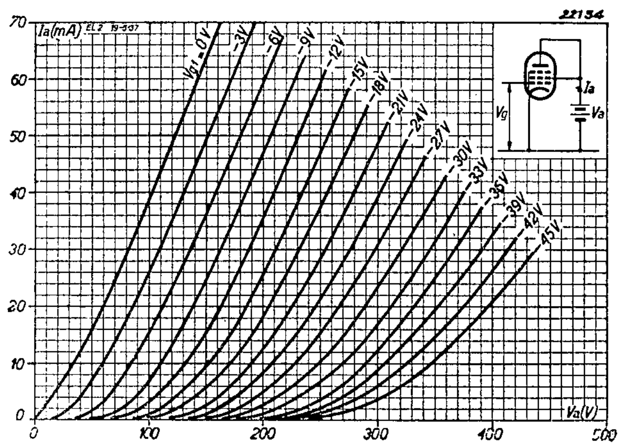

Fig. 7
Various data as function of anode and screen voltage of the EL 2.

OPERATING DATA: EL 2 used as triode (grid 2 connected to anode)

Anode and screen-grid voltage	V_a	= 250 V	250 V
Grid bias	V_{g1}	= —27 V	—20 V
Anode current	I_a	= 15 mA	30 mA
Mutual conductance	S	= 1.7 mA/V	2.6 mA/V
Internal resistance	R_i	= 4,100 ohms	3,100 ohms
Amplification factor	μ	= 7	8

MAXIMUM RATINGS

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 250 V
Anode dissipation	W_a	= max. 8 W
Screen-grid voltage in cold condition	V_{g2o}	= max. 550 V
Screen-grid voltage	V_{g2}	= max. 250 V
Screen-grid dissipation	W_{g2}	= max. 1.6 W
Cathode current	I_k	= max. 45 mA
Grid voltage at grid current start (I_{g1} = + 0.3 μA)	V_{g1}	= max. —1.3 V
Resistance between grid and cathode with automatic bias	R_{g1k}	= max. 1 M ohm
Resistance between grid and cathode with fixed bias	R_{g1k}	= max. 0.6 M ohm
Resistance between filament and cathode	R_{fk}	= max. 5,000 ohm
Voltage between filament and cathode (direct voltage or effective value of alternating voltage)	V_{fk}	= max. 50 V

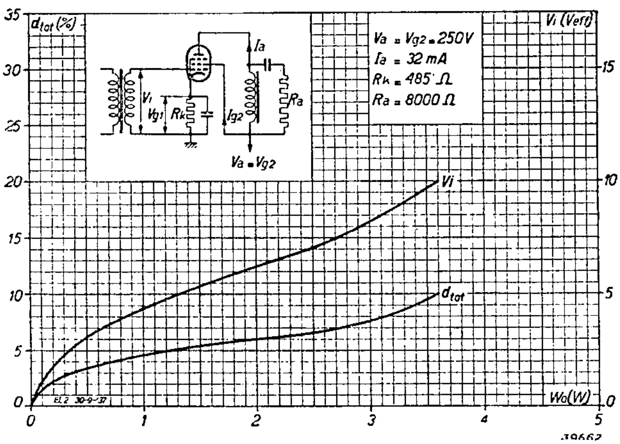

Fig. 8
Alternating grid voltage and total distortion as a function of the output power. EL 2 used as single output valve, with $V_a = V_{g2}$ = 250 V.

This valve can be used in a single or balanced output stage in car radio sets. For 12 V batteries the heaters of two of these valves can be connected in series, or, alternatively, one EL 2 may be placed in series with another valve in the same series, for example the EBC 3 or EF 6. The cathode must be decoupled with respect to the earth line through a capacitor of at least 2 μF, but an even higher capacitor of 25 or 50 μF is better. When used in balanced output circuits (two

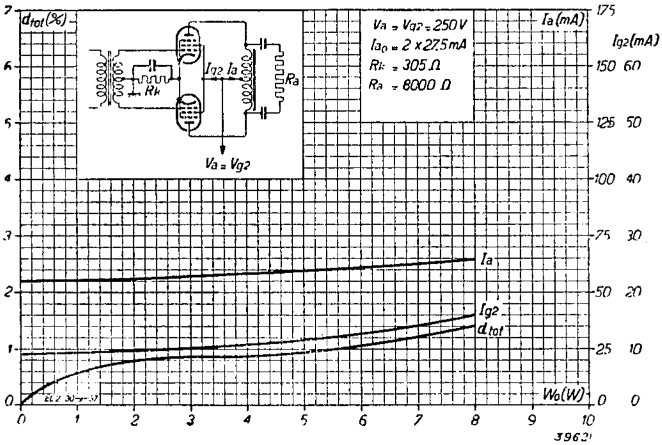

Fig. 9
Anode current, screen current and total distortion as a function of the output power for two EL 2 valves in a balanced circuit, with automatic grid bias, with $V_a = V_{g_2} = 250$ V.

valves), the bias should preferably be automatic and the EBC 3 or EL 2, connected as triode, may be employed as driver. Bearing in mind the cost of the driver transformer and the required reproduction of low audio frequencies, the designer will find a transformation ratio of 1 : (2 + 2) quite suitable, but if the EL 2 is used, connected as triode, the ratio may be somewhat higher.

Tables I and II furnish particulars of the EL 2 for the single output valve, allowing for the voltage drop across the output transformer; the values for output power refer to the effective power at the output side of the valve and in this case the transformer losses should be deducted.

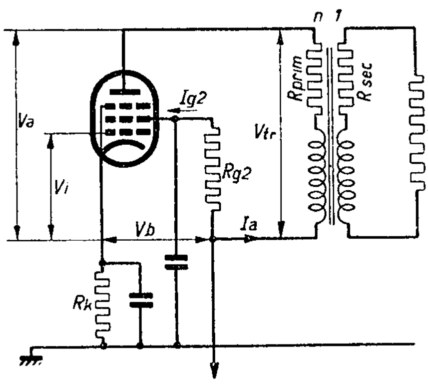

Fig. 10
Circuit diagram of the EL 2 as employed for the measurements the results of which are given in Table I. Loading resistance
$Ra = Rprim + n^2Rsec + n^2Rl = Rtr + n^2Rl.$
Output power
$Wo = ia^2\ (Rprim + n^2Rsec + n^2Rl)$
$= ia^2\ (Rtr + n^2Rl) = ia^2Ra.$
Direct voltage on the anode = $Va = Vb – Ia\ Rprim$.
Power loss in output transformer =
$ia^2\ (Rprim + n^2\ Rsec) = ia^2\ Rtr = Wo\ \frac{Rtr}{Ra}$

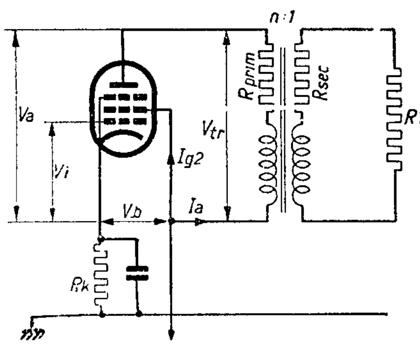

Fig. 11
Circuit diagram of the EL 2 as used for the measurements the results of which are given in Table II. For the symbols and formulae employed see text, Fig. 10

TABLE I

EL 2. Output power and alternating voltage across grid leak as a function of the voltage drop across the output transformer, at an anode voltage of 250 V.

$I_a = 32$ mA

Anode voltage Va (V)	Supply voltage Vb (V)	Screen resistor Rg_2 (ohm)	Voltage drop in output transf. Vtr (V)	With 10 % distortion: Anode load resistor Ra (ohm)	With 10 % distortion: Alternating grid voltage Vi ($Veff$)	With 10 % distortion: Output power Wo (W)	At 5 % distortion: Anode load resistor Ra (ohm)	At 5 % distortion: Alternating grid voltage Vi ($Veff$)	At 5 % distortion: Output power Wo (W)	Power loss in output transformer $\frac{Wtr}{Wo}$ 100 %
250	250	0	0	8,000	9.4	3.65	8,000	4.7	1.3	—
250	260	1,600	10	8,000	9.4	3.5	8,000	4.5	1.1	8
250	270	3,300	20	8,000	9.3	3.3	8,000	4.4	1.1	16
250	280	4,900	30	8,000	9.0	3.2	8,000	4.4	1.1	24
250	300	8,400	50	8,000	8.5	2.95	8,000	4.3	1.0	40

TABLE II

EL 2. Output power and peak alternating grid voltage as a function of the voltage drop across the output transformer at 250 V supply and screen voltages.

$I_a = 32$ mA

Anode voltage Va (V)	Supply voltage Vb (V)	Screen voltage Vg_2 (V)	Voltage drop in output transf. Vtr (V)	With 10 % distortion: Anode load resistor Ra (ohm)	With 10 % distortion: Alternating grid voltage Vi ($Veff$)	With 10 % distortion: Output power Wo (W)	At 5 % distortion: Anode load resistor Ra (ohm)	At 5 % distortion: Alternating grid voltage Vi ($Veff$)	At 5 % distortion: Output power Wo (W)	Power loss in output transformer $\frac{Wtr}{Wo}$ 100 %
250	250	250	0	8,000	9.4	3.65	8,000	4.7	1.3	—
250	250	250	10	7,500	9.6	3.55	7,500	4.7	1.2	8
250	250	250	20	7,000	9.6	3.35	7,000	4.7	1.1	18
250	250	250	30	7,000	9.5	3.15	7,000	5.2	1.3	27
250	250	250	50	6,000	9.8	2.9	6,000	5.1	1.1	52

Note: In calculating the power loss due to the resistance of the output transformer windings, it was assumed that the losses in primary and secondary windings were equal.