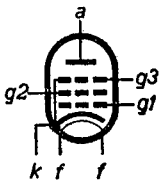
EL 5 Output Pentode



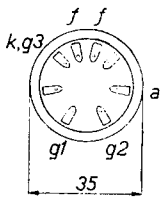


Fig. 2
Arrangement of electrodes and base connections.

The EL 5 is a steep-slope, 18 W output pentode. Using this valve it is possible to obtain greater output power than with two 9 W pentodes in a balanced circuit. Linear and non-linear distortion are considerably reduced by applying A. F. feedback.

Two of these 18 W pentodes in a balanced circuit will deliver an effective output of 20 W, in which case contrast expansion can be successfully employed. The particular form and dimensions of the 3rd grid ensure a very satisfactory upper bend in the dynamic characteristic. At full excitation it is possible for the anode voltage to drop to very low values, with the result that the distortion at 9 W output is extremely low, being 10 % when automatic bias is employed; at lower output powers the amount of 3rd harmonic distortion is very slight indeed. All the advantages of a triode are thus obtained, without its disadvantages, viz. that the output power with a given amount of distortion drops sharply when a loading resistance higher than the normal is used.

As the valve may be used with a screen voltage of 275 V this, in conjunction with an anode voltage of 250 V, will allow for a drop of about 25 V in the output transformer.

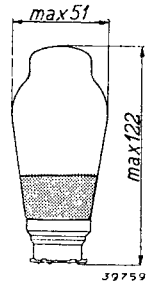


Fig. 1
Dimensions in mm.

HEATER RATINGS

Heating: indirect by A.C., parallel supply.
Heater voltage . . . . . $V_f = 6.3$ V
Heater current . . . . . $I_f = 1.3$ A

CAPACITANCES

Anode-grid $C_{ag1} < 0.8$ $\mu\mu$F

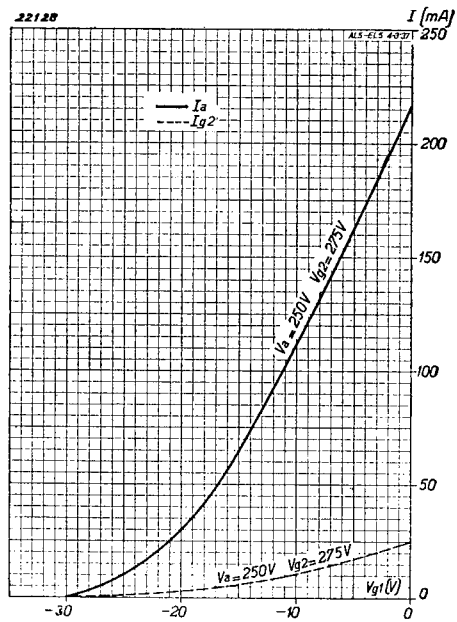


Fig. 3
Anode current and screen current as a function of the grid bias, at $Va = 250$ V, $Vg_2 = 275$ V.

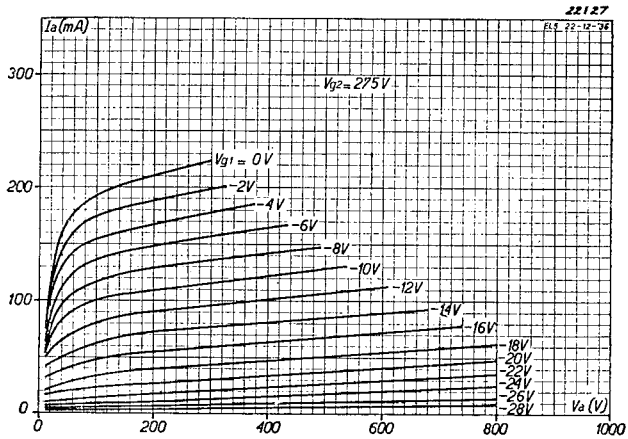


Fig. 4
Anode current as a function of the anode voltage at $Vg_2 = 275$ V, for different values of grid bias.

OPERATING DATA: El 5 used as normal output valve (single valve)

Anode voltage	V_a	= 250 V
Screen-grid voltage	V_{g2}	= 275 V
Cathode resistor	R_k	= 175 ohms
Grid bias	V_{g1}	= —14 V
Anode current	I_a	= 72 mA
Screen current	I_{g2}	= 7 mA
Mutual conductance	S	= 8.5 mA/V
Internal resistance	R_i	= 22,000 ohms
Load resistor	R_a	= 3,500 ohms
Output power ($d_{tot} = 10\,\%$)	W_o	= 8.8 W
Alternating input voltage with 10 % dist.	V_i	= 9.1 V_{eff}
Sensitivity ($W_o = 50$ mW)	V_i	= 0.5 V_{eff}

El 5 in a balanced output circuit (two valves), with automatic bias

Anode voltage	V_a	= 250 V
Screen-grid voltage	V_{g2}	= 275 V
Cathode resistor	R_k	= 120 ohms
Anode current (without signal)	I_{ao}	= 2 × 58 mA
Anode current at max. modulation	$I_{a\ max}$	= 2 × 65 mA
Screen current (without signal)	I_{g2o}	= 2 × 6.25 mA
Screen current at max. modulation	$I_{g2\ max}$	= 2 × 10.5 mA
Load resistor between anodes	R_{aa}	= 4,500 ohms
Output power ($I_{g1} = +0.3$ µA)	W_o	= 19.5 W
Total distortion ($I_{g1} = +0.3$ µA)	d_{tot}	= 5.1 %
Alternating input voltage ($I_{g1} = +0.3$ µA)	V_i	= 12.5 V_{eff}

MAXIMUM RATINGS

V_{ao}	= max. 550 V	I_k	= max. 90 mA
V_a	= max. 250 V	V_{g1} ($I_{g1} = +0.3$ µA)	= max. —1.3 V
W_a	= max. 18 W	R_{g1k} (auto. bias)	= max. 0.7 M ohm
V_{g2o}	= max. 550 V	R_{fk}	= max. 5,000 ohms
V_{g2}	= max. 275 V	V_{fk}	= max. 50 V
W_{g2}	= max. 3 W		

A. Single output Amplifier

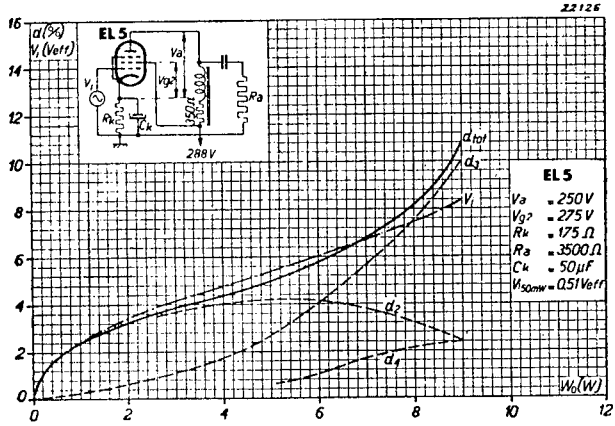


Fig. 5
Alternating grid voltage, total distortion and distortion constituents, as functions of the output power; EL 5 used normal output valve with appropriate anode voltage, 3,500 ohms load resistor and decoupled bias resistor.

Generally speaking, it is not advisable to couple the EL 5 directly to a diode. Figures 5 and 6 indicate the alternating grid input and distortion at V_a = 250 V, V_{g2} = 275 V and R_k = 175 ohms, corresponding to an anode current of 72 mA, as a function of the output power; Fig. 5 relates to a loading resistance of 3,500 ohms and Fig. 6 to 2,500 ohms. From these curves it is evident that when a load of 2,500 ohms is used the 3rd harmonic component is much smaller than in the case of the 3,500 ohms load, so that in all instances where this would be an important factor the smaller load deserves preference.

The suggested pre-amplifier for use with the EL 5 is the EL 6 or EBC 3. When the EL 6 is employed in conjunction with the EL 5 the distortion curve is almost identical to that of the EL 5 alone. With the combination EBC 3 + EL 5 the distortion curve, at a lower output than three-quarters of the maximum, is about 10 % lower, this low distortion figure being due to partial compensation of the 2nd harmonic in the EL 5 by that of the EBC 3. Owing to its high mutual conductance, the EL 5 is eminently suited to the application of negative A.F. feed-back for reduction of distortion. When feed-back is applied, using a factor of about 10, the result is as shown in Fig. 7, in which the EF 6 is represented as pre-amplifier, with the feed-back applied to both valves.

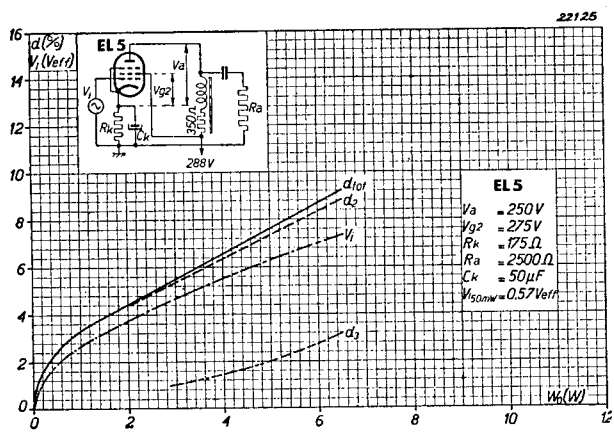


Fig. 6
Relation between alternating grid voltage, total distortion, distortion components and output power of the EL 5, with normal anode voltage, 2,500 ohms load resistor and decoupled bias resistor.

B. Balanced output Stages (2 Valves)

If greater output, or less distortion, is desired, two EL 5 valves can with advantage be coupled in a balanced circuit. With an anode voltage of 250 V and

screen voltage of 275 V, the common cathode resistor should be 120 ohms and distortion can be kept down by decoupling this resistor with a high capacitor (25 or 50 μF). The full line in Fig. 8 represents the distortion obtained with this arrangement, with a load resistor of 4,500 ohms (between anodes), as a function of the output power. The distortion is due to 3rd harmonic only.

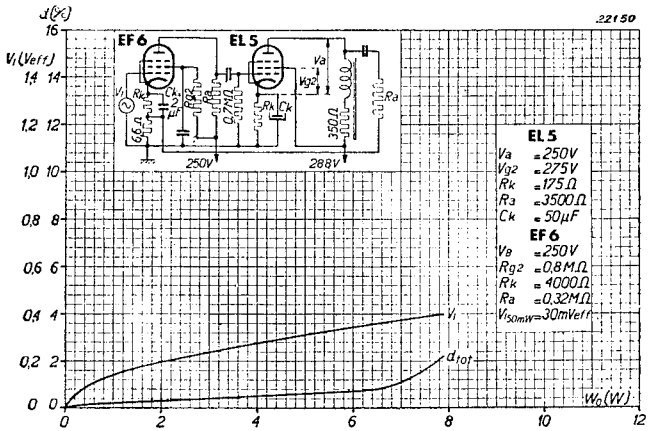


Fig. 7
Relation between alternating grid voltage *Vi*, total distortion *dtot* and output power; EL 5 with pre-amplifier EF 6 and negative feedback applied to the latter.

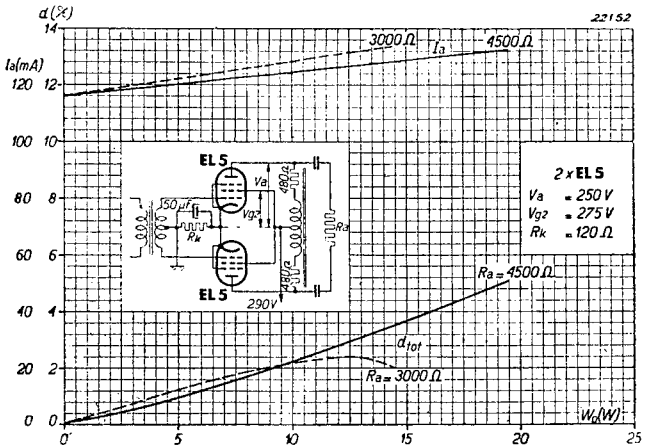


Fig. 8
Anode current and total distortion as a function of the output power; two EL 5 valves in balanced output stage without grid current, employing normal anode voltage and load resistor of 3,000 ohms or 4,500 ohms between anodes.