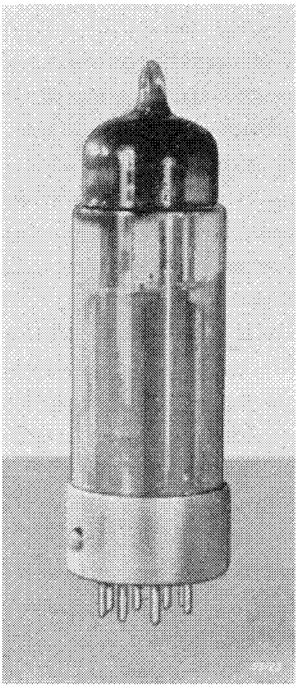
EL 41 9 W output pentode



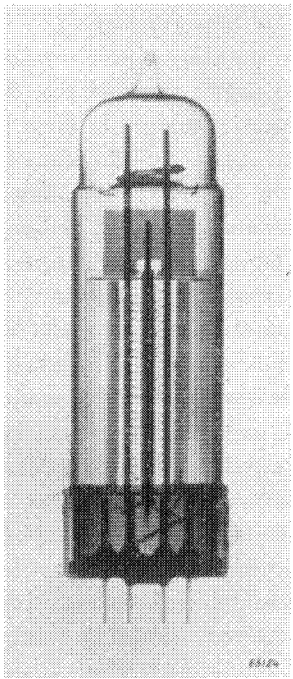


Fig. 1
Normal and X-ray photographs of the EL 41 (approximately actual size).

The EL 41 is an indirectly heated output pentode having a slope of 10 mA/V. The maximum permissible anode dissipation of this valve is 9 W and, for an A.C. grid voltage of only 3.8 V_{RMS}, the output power is 3.9 W, with 10% distortion. Owing to the fact that no current flows to the control grid at an A.C. voltage of this value (the grid bias is 7 V without input signal), the output can be raised considerably without very much increase in the distortion. Grid current does not commence to flow until the output reaches 4.8 W, at which point the distortion is 14.5 %, the required input signal being 5.1 V_{RMS}.
In a class A push-pull amplifier, with $V_a = V_{g2} = 250$ V, an output of 9.4 W with 4.6% distortion can be obtained for an alternating grid voltage of 5.6 V_{RMS}.
Connected as a triode (screen grid connected to anode), the EL 41 will deliver 1.55 W with 8% distortion on an anode voltage of 250 V. In either of these circuits, however, care should be taken that the leads to the various electrodes be kept short in order to avoid undesirable coupling and so ensure that no parasitic oscillation can occur in view of the high mutual conductance

of the valve. If oscillation does occur, owing to imperfect wiring, it can be suppressed by including in the control grid and/or screen grid circuits resistors of 1000 and 100 Ω respectively, without decoupling capacitor. These resistors should be connected as closely as possible to the valveholder. Grid bias for the EL 41 should be only of the automatic or semi-automatic kind, i.e. as provided by a resistor in the cathode circuit, or by a resistor in the common negative line of the receiver. In the latter case the cathode current of the EL 41 should constitute at least 50% of the total current flowing through the resistor.

With automatic bias, the external resistance between control grid and cathode must not exceed 1 MΩ; with semi-automatic bias this resistance should be lower, the maximum value being obtained from the formula :

$$Rg_1 = \text{max.} \frac{\text{cathode current of the EL 41}}{\text{total current flowing through the resistor}} R'g_1,$$

where $R'g_1$ is the maximum permissible external resistance between grid and cathode for automatic bias.

As previously stated, the maximum anode dissipation of the EL 41 is 9 W; to illustrate the full significance of this, certain points should be explained: As a rule, when the set is in operation, the anode dissipation in the output valve of a receiver is not constant, and among sets of the same type the anode dissipation of the output valve will be found to vary considerably. Several factors contribute to these differences, the most important of these being the tolerances on the various components and valves in the circuit, fluctuations in the mains voltage and, in some circuits, the effects of the A.G.C. If the grid bias of the output valve is of the semi-automatic kind (see previous paragraph), the bias will drop when the A.G.C. comes into operation because the currents flowing through the R.F. and I.F. valves are then reduced. In consequence, the anode dissipation in the output valve increases.

For a better understanding of the significance of "a maximum permissible anode dissipation of 9 W²² the following factors have been established :

If the anode dissipation of an average EL 41 valve in a receiver does not exeed 9 W when :

1) the valve is operating on nominal voltages,
2) the components of the circuit are of nominal value, and
3) no input signal is applied,

it is permissible :

a) to use any EL 41 valve in the set in question,
b) to allow the anode dissipation to exceed the specified 9 W by a maximum of 15%, by reason of deviating values of the components and the effects of the A.G.C.,
c) to allow fluctuations of at most +or—10% in the mains voltage.

As will be seen from the above, it is intended that the average anode dissipation of the EL 41 in a receiver shall be 9 W when no input signal is applied. There is then sufficient reserve: (a) to allow for the customary tolerances on components, voltages and valves without risk of the valve being overloaded, and (b) to avoid any difficulties when the A.G.C. comes into operation. If

abnormal deviations in voltages or values of components are anticipated, the average anode dissipation without input signal should be re-adjusted accordingly.
When the EL 41 is to be used as the output valve in a vibrator-driven set, the above condition no longer applies as far as the line voltage is concerned, since the voltage is then obtained from an accumulator, not from the mains, and large fluctuations are likely to occur. In such cases the average anode dissipation should be adjusted to 9 W (without input signal) for an accumulator voltage of 7 V. The voltage may then safely rise to 8 V without overloading the valve. In addition, an increase in the dissipation of 15% beyond the limit can be allowed as a maximum, to meet deviations of the components of the circuit, as well as the effects of the A.G.C.
The lower limit specified for the accumulator voltage should be 5.5 V: if the voltage is allowed to drop any further, the heater will be under-heated, which, in the long run, will impair the emissive properties of the cathode.

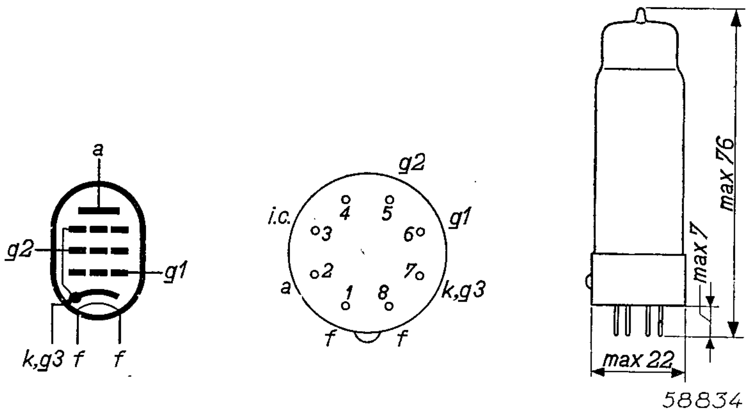


Fig. 2
Electrode arrangement, electrode connections and maximum dimensions in mm of the EL 41.

TECHNICAL DATA OF THE OUTPUT PENTODE EL 41

Heater data

Heating : indirect by A.C. or D.C. ; parallel feed

Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	0.71 A

Capacitances (measured at the cold tube)

Input capacitance	C_{g1}	=	10.2 pF
Output capacitance	C_a	=	7.8 pF
Anode-control grid	C_{ag1}	<	1 pF
Control grid-heater	C_{g1f}	<	0.15 pF

Operating characteristics as Class A output amplifier (see Fig. 7)

Anode voltage	V_a	=	250 V
Screen grid voltage	V_{g2}	=	250 V
Cathode resistor	R_k	=	170 Ω
Control grid bias	V_{g1}	=	—7 V
Anode current	I_a	=	36 mA
Screen grid current	I_{g2}	=	5.2 mA
Mutual conductance	S	=	10 mA/V
Internal resistance	R_i	=	40 kΩ
Amplification factor of the 2nd grid with respect to the 1st grid	μ_{g2g1}	=	22
Matching resistance	R_a	=	7 kΩ
Output power at 10% distortion	$W_o(d_{tot}=10\%)$	=	3.9 W
A.C. input voltage at 10% distortion	$V_i(d_{tot}=10\%)$	=	3.8 V_{RMS}
Output power at grid current starting point	$W_o(I_{g1}=+0.3\mu A)$	=	4.8 W
Sensitivity	$V_i(W_o=50\ mW)$	=	0.32 V_{RMS}

Operating characteristics of 2 valves as Class A push-pull amplifier

(without grid current) (see Fig. 8)

Anode voltage	V_a	=	250		V
Screen grid voltage	V_{g2}	=	250		V
Common cathode resistor	R_k	=	85		Ω
Matching resistance	R_{aa}	=	7		kΩ
A.C. input voltage	V_i	=	0	5.6	V_{RMS}
Anode current	I_a	=	2×36	2×39.5	mA
Screen grid current	I_{g2}	=	2×5.2	2×8	mA
Output power	W_o	=	0	9.4	W
Total distortion	d_{tot}	=	—	4.6	%

Operating characteristics of one valve as Class A output amplifier in triode connection (screen grid connected to anode) (see Fig. 9)

Anode voltage	V_a	=	250 V
Cathode resistor	R_k	=	250 Ω
Anode current	$I_a + I_{g2}$	=	33 mA
Matching resistance	R_a	=	3.5 kΩ
Output power	W_o	=	1.55 W
A.C. input voltage	V_i	=	6 V_{RMS}
Total distortion	d_{tot}	=	8 %

Limiting values

Anode voltage in cut-off condition	V_{a_0}	= max.	550 V
Anode voltage	V_a	= max.	300 V
Anode dissipation	W_a	= max.	9 W
Screen grid voltage in cut-off condition	V_{g2_0}	= max.	550 V
Screen grid voltage	V_{g2}	= max.	300 V
Screen grid dissipation without input signal	$W_{g2}(V_i=0)$	= max.	1.4 W
Screen grid dissipation at full modulation	$W_{g2}(W_o=\text{max.})$	= max.	3.3 W
Cathode current	I_k	= max.	55 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}	= max.	1 MΩ[1])
External resistance between cathode and heater	R_{fk}	= max.	20 kΩ
Voltage between cathode and heater	V_{fk}	= max.	100 V

[1]) With automatic grid bias, see page 98.

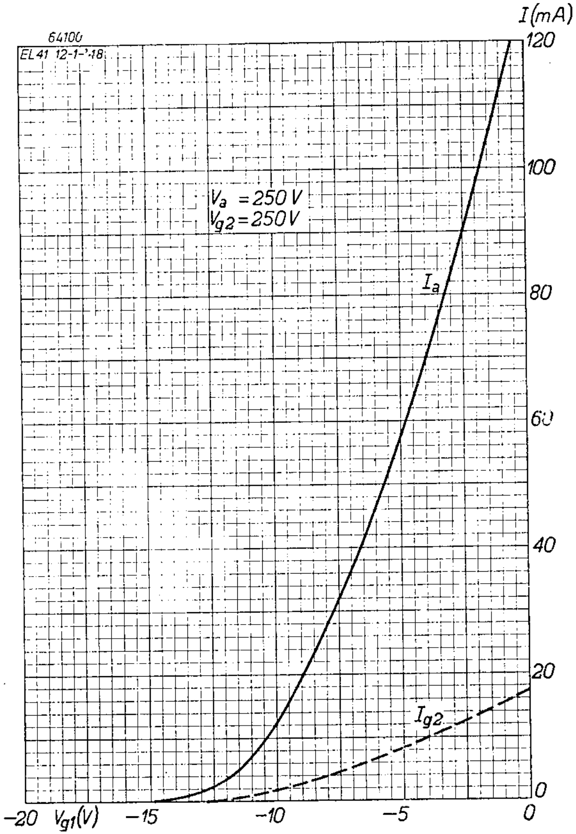


Fig. 3
Anode current I_a and screen grid current I_{g2} as functions of the grid bias V_{g1} at anode voltage V_a and screen grid voltage V_{g2} = 250 V.

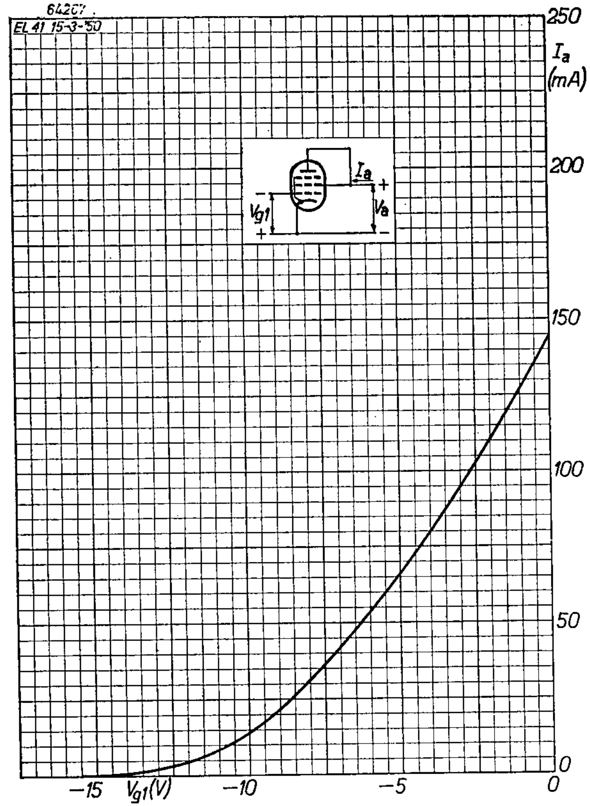


Fig. 4
EL 41 connected as triode (screen grid connected to anode). Anode current I_a (including screen grid current) as a function of the grid bias V_{g1}, for an anode voltage V_a of 250 V.

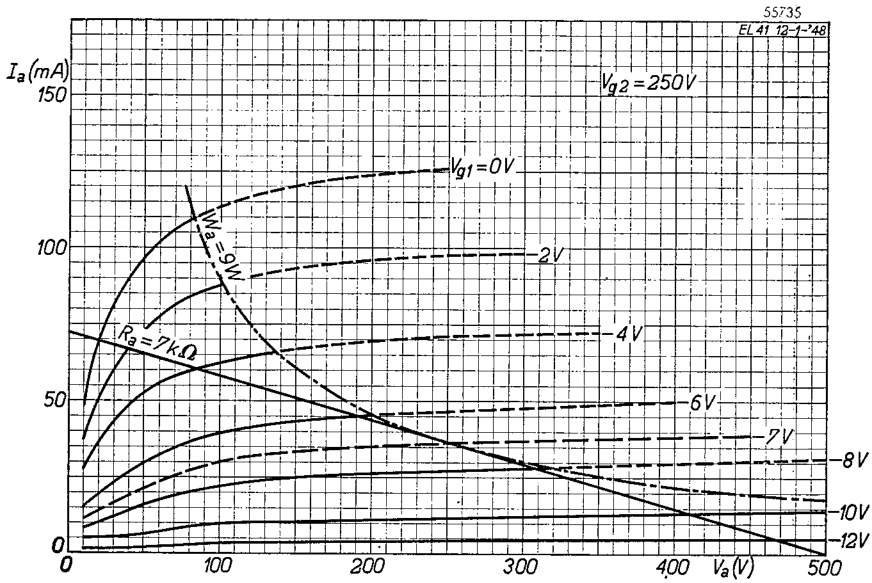


Fig. 5
Anode current I_a as a function of the anode voltage V_a with the grid bias V_{g1} as parameter. Screen grid voltage $V_{g2} = 250$ V. The straight characteristic is the load line for an anode resistance R_a of 7 kΩ. The dot-dash curve indicates the maximum permissible anode dissipation ($W_a = 9$ W).

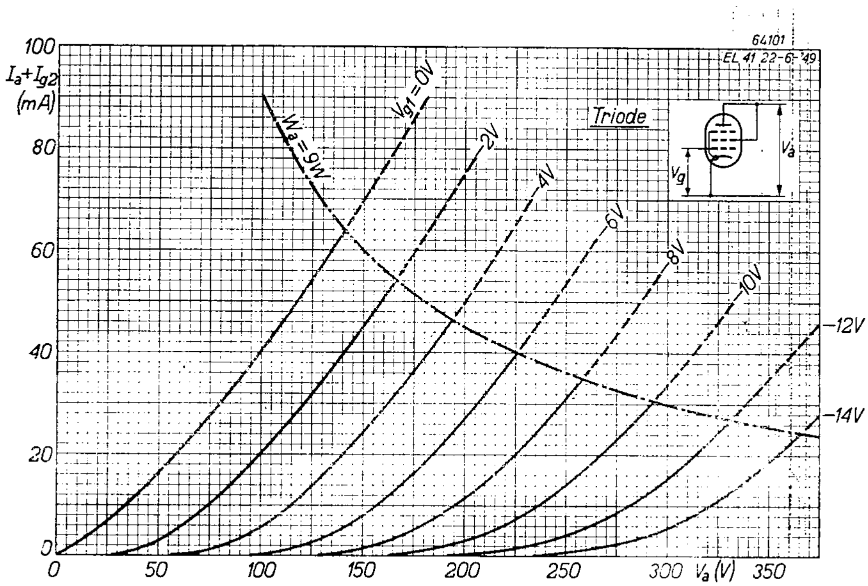


Fig. 6
EL 41 connected as triode (screen grid connected to anode). Anode current I_a (including screen grid current) as function of the anode voltage. The dot-dash curve indicates the maximum per-

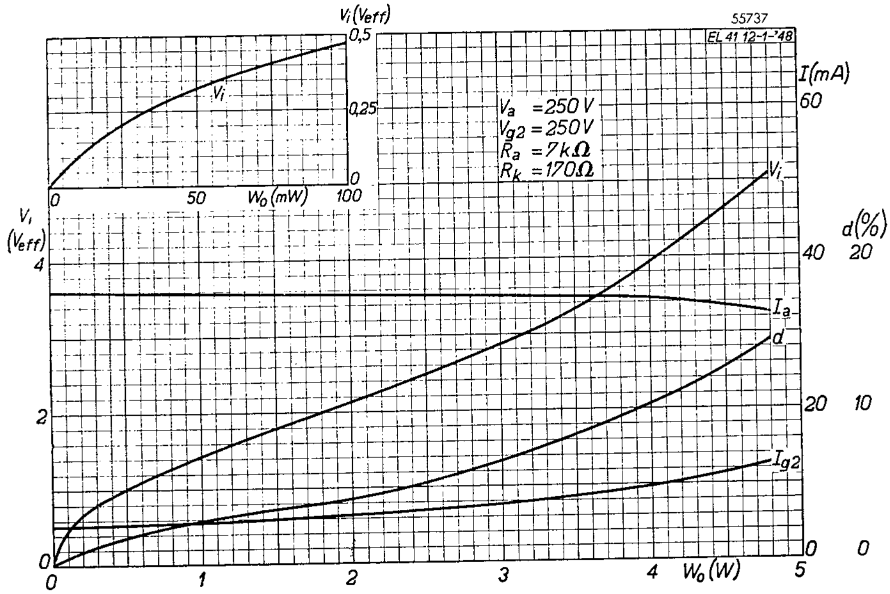


Fig. 7
Anode current I_a, screen grid current I_{g2}, distortion d and required input voltage V_i as functions of the output W_o. Upper-left inset : A.C. input voltage V_i as a function of the power output W_o for low values of W_o.

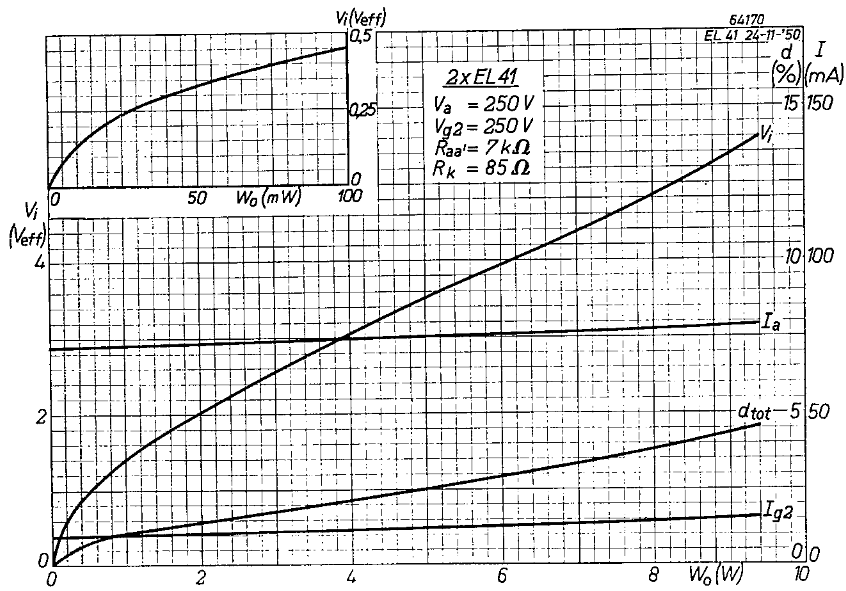


Fig. 8
As Fig. 7, for two EL 41 valves in Class A push-pull. I_a=total anode current, I_{g2}=total screen grid current, V_i=A.C. input voltage.

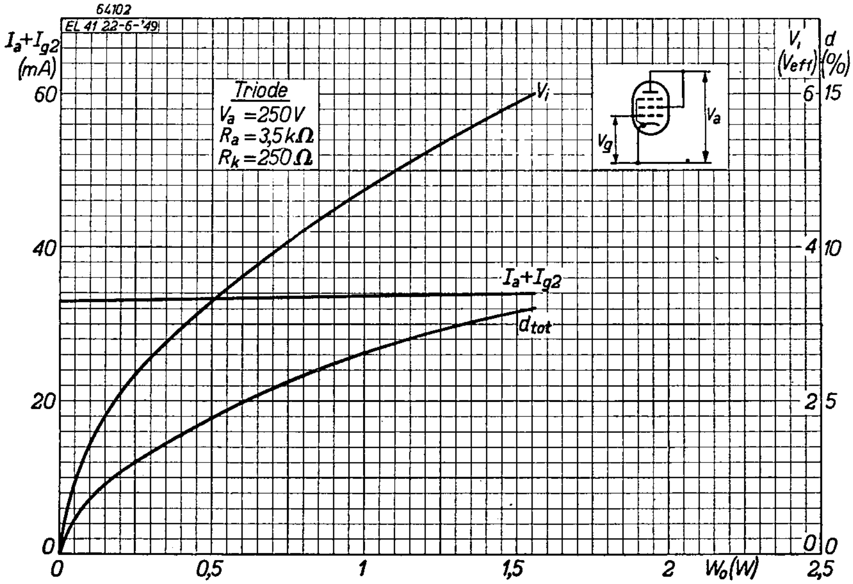


Fig. 9
As Fig. 7, for an EL 41 connected as a triode (screen grid connected to anode).

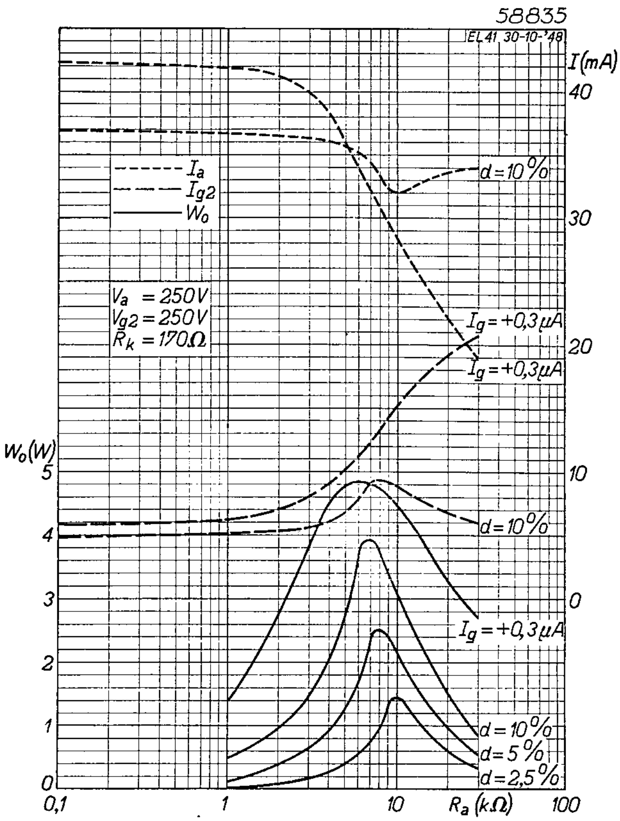


Fig. 10
Output power W_o of the EL 41 with $2\frac{1}{2}$, 5 and 10% distortion and at the grid current starting point ($I_{g1}= +0.3\ \mu A$), as a function of the anode load resistance (continuous curves). Also the anode current I_a (dotted lines) and screen grid current I_{g2} (long dashes) with 10% distortion and at the grid current starting point ($I_{g1}= +0.3\ \mu A$), as function of the anode-load resistance R_a.