CL 6 Output pentode

The CL 6 is a highly sensitive output pentode designed for use in A.C./D.C. receivers operating on low-voltage mains. In such cases the screen voltage needs to be about 100 V, this being the reason why the CL 6, as well as the CL 2, has been designed on that basis. With $V_a = V_{g2} = 100$ V, the anode current is 50 mA, which gives the CL 6 an output of 5 W. The mutual conductance is then 8.5 mA/V and, when properly matched, the valve delivers 2.1 W with 10 % distortion. The alternating grid voltage under these conditions is 5.6 $V_{(eff)}$, the sensitivity being 0.62 $V_{(eff)}$.

The high mutual conductance of this valve is an advantage in that, in receivers designed to use the CL 4 as pre-amplifier valve, the CL 6 can also be employed without any modification to the circuit. In A.C./D.C. receivers for use on low-voltage mains, another advantage of the steep-slope pentode is that, owing to the high conductance, the alternating grid voltage is very much lower than in an average output valve. As the bias is produced by means of a cathode resistor, or by the voltage drop across a resistor in the negative H.T. line, and therefore reduces the amount of anode voltage available for the output valve, it is obviously an advantage to ensure that the grid bias takes the smallest possible proportion of the direct voltage available. The necessary bias for the CL 6 is —8.3 V, with $V_a = V_{g2} = 100$ V, as against —15 V in the case of the CL 2. The CL 6 thus ensures a voltage which is 6.7 V higher, this being a not inconsiderable difference, on low-voltage mains.

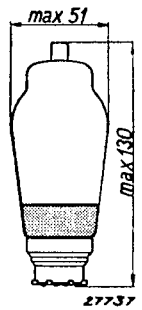
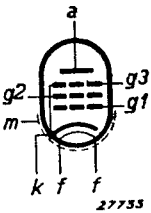


Fig. 1
Dimensions in mm.



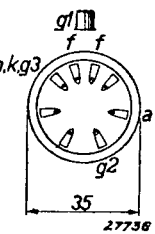


Fig. 2
Arrangement of electrodes and base connections.

A.C./D.C. receivers are often designed for switching over from high to low-voltage mains and vice versa, and in view of this the possibility of using an anode potential of 200 or 250 V has also been taken into account in the design of the valve; at the higher anode voltages it can be used as a 9 W output valve. The screen potential must in no case exceed 125 V and should, therefore, always be applied through a resistor or potential divider. For A.C./D.C. sets operating only on high-voltage mains it is more economical to use the CL 4. With 200 V on the anode and 100 V on the screen, the mutual conductance is

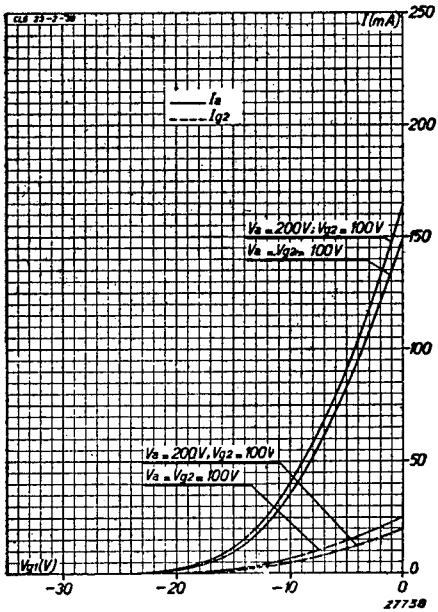


Fig. 3
Anode current and screen current as functions of the grid bias, with $Vg_2 = 100$ V and $Va = 100$ and 200 V.

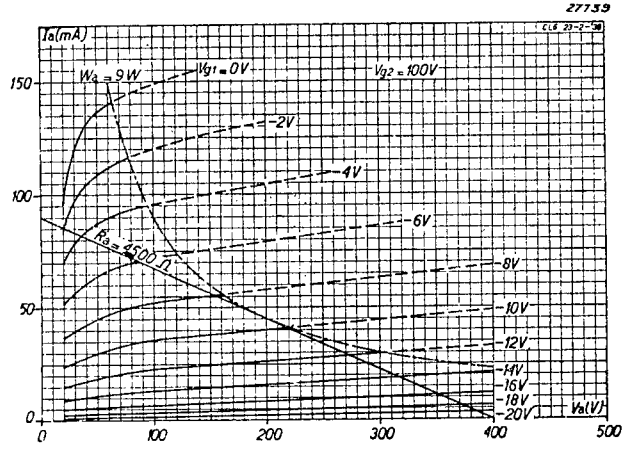


Fig. 4
Anode current as a function of the anode voltage at $Vg_2 = 100$ V, with grid bias as parameter.

8 mA/V, in which case the valve is similar to the CL 4. The output power with 10 % distortion is 4 W, the alternating grid voltage being 5.6 $V_{(eff)}$. As receivers designed for switching to either high or low-voltage mains generally give some trouble in the switching of the biasing (cathode) resistor, the same resistor is employed on a working voltage of 200 as on 100 V.
With a view to ensuring a low current, in order to obtain the least possible voltage drop in the rectifier smoothing circuit, it is usual to connect a resistor in series with the screen.
The bias resistor for a working voltage of 100 V, is 140 ohms, from which it follows that the resistance in series with the screen, on 200 V, should be 27,000 ohms, this giving an output of 2.6 W with 8 % distortion. In order to obtain a higher output, A.C./D.C. sets intended for use on low voltages are frequently provided with a balanced output stage, in which case the CL 6 delivers 4 W with 5 % distortion, on $V_a = V_{g2} = 100$ V; the alternating grid voltage is 6.7 $V_{(eff)}$ per grid. In small portable amplifiers for operation on all mains voltages the CL 6 in a balanced output stage is very useful in view of its suitability for switching over from high mains to low and vice versa. On anode voltages of 200 and 250 V the power is quite considerable, this being another feature in its favour in small amplifiers. A balanced circuit with 125 V on the screens and 200 V on the anodes will deliver a maximum of 12 W with 1.8 % distortion, whilst with an anode voltage of 250, 13.5 W with 6.3 % distortion can be obtained.
The grid connection of this valve is placed at the top of the envelope in order to keep hum at a minimum.

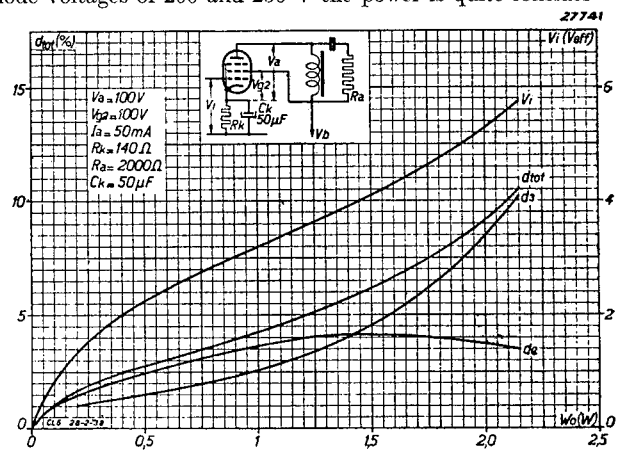


Fig. 5
Total distortion, 2nd and 3rd harmonic distortion and alternating grid voltage of the CL 6 when used as single output valve with automatic bias. $Va = Vg_2 = 100$ V.

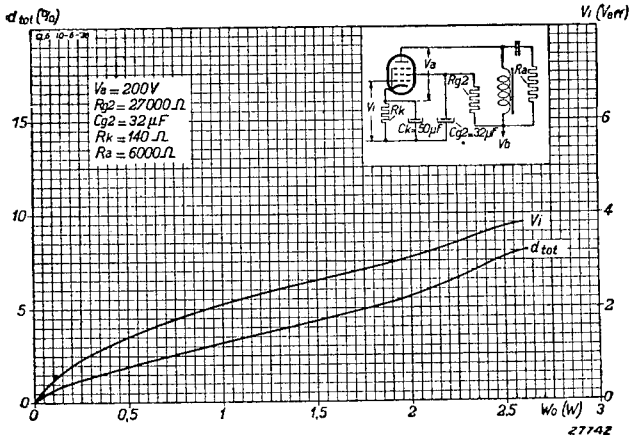


Fig. 6
Total distortion and alternating grid voltage; CL 6 used as single output valve with automatic bias. Va = 300 V, Rg = 27,000 ohms.

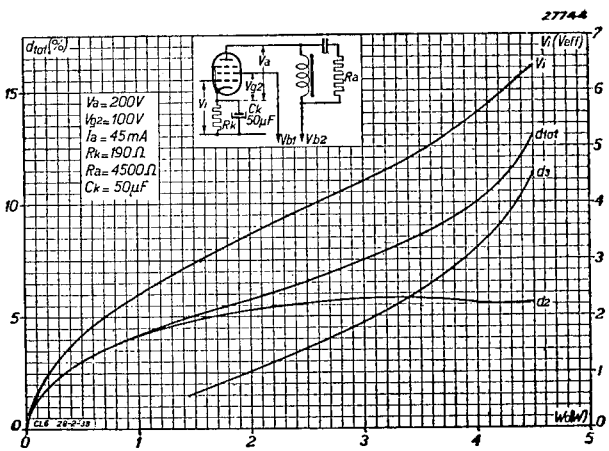


Fig. 7
Total distortion, 2nd and 3rd harmonic distortion and alternating grid voltage; CL 6 used as single output valve with automatic bias. Va = 200 V, Vg_2 = 100 V.

HEATER RATINGS

Heating: indirect by A.C. or D.C., series supply.

Heater voltage	$V_f = 35$ V
Heater current	$I_f = 0.200$ A

CAPACITANCES

Anode-grid	$C_{ag1} < 0.5$ $\mu\mu$F

OPERATING DATA: CL 6 used as single output valve

Anode voltage	V_a =	100 V	200 V	200 V
Screen-grid voltage	V_{g2} =	100 V	—	100 V
Screen series resistor	R_{g2} =	—	27,000 ohms	—
Screen decoupling capacitor	C_{g2} =	—	32 μF	—
Cathode resistor	R_k =	140 ohms	140 ohms	190 ohms
Grid bias	V_{g1} =	—8.3 V	—	—9.5 V
Anode current	I_a =	50 mA	45 mA	45 mA
Screen-grid current	I_{g2} =	9 mA	4.5 mA	5.5 mA
Mutual conductance	S =	8.5 mA/V	—	8 mA/V
Internal resistance	R_i =	12,000 ohms	—	22,000 ohms
Load resistor	R_a =	2,000 ohms	6,000 ohms	4,500 ohms
Output power	W_o =	2.1 W	2.6 W	4 W
Distortion	d_{tot} =	10 %	8 %	10 %
Alternating grid voltage	V_i =	5.6 V_{eff}	3.8 V_{eff}	5.6 V_{eff}
Sensitivity ($W_o = 50$ mW)	V_i =	0.62 V_{eff}	0.42 V_{eff}	0.47 V_{eff}
Amplification factor: grid 2 with respect to grid 1	μ_{g2g1} =	7.0	—	6.5

OPERATING DATA: CL 6 used in balanced stage (2 valves)

Anode voltage	V_a =	100 V	200 V	200 V	250 V
Screen-grid voltage	V_{g2} =	100 V	—	125 V	125 V
Common screen series resistor	R_{g2} =	—	10,000 ohms	—	—
Cathode resistor, per valve	R_k =	190 ohms	190 ohms	250 ohms	365 ohms
Anode current ($V_i = 0$ V)	I_{ao} =	2 × 42	2 × 45	2 × 45	2 × 36 mA
Anode current at max. modulation	$I_{a\,max}$ =	2 × 42	2 × 40	2 × 51	2 × 43 mA
Screen current ($V_i = 0$ V)	I_{g2o} =	2 × 7.5	2 × 5.2	2 × 5	2 × 4.1 mA
Screen current at max. modulation	$I_{g2\,max}$ =	2 × 12.5	2 × 6.2	2 × 11.7	2 × 12.5 mA
Load resistor between anodes	R_{aa} =	3,000	6,000	4,400	7,000 ohms
Output power	W_o =	4 W	6.8 W	12.1 W	13.5 W
Distortion at max. modulation	d_{tot} =	5.6 %	3.5 %	1.8 %	6.3 %
Alternating input voltage, per grid	V_i =	6.7 V_{eff}	5.9 V_{eff}	11 V_{eff}	13.7 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. 9 W
Screen-grid voltage in cold condition	V_{g2o}	= max. 550 V
Screen-grid voltage	V_{g2}	= max. 125 V
Screen dissipation (W_o = max.)	W_{g2}	= max. 1.5 W
Screen dissipation ($V_i = 0\,V$)	W_{g2}	= max. 1.0 W
Cathode current	I_k	= max. 70 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. 1 M ohm
External resistance between heater and cathode	R_{fk}	= max. 5,000 ohms
Peak value of voltage between heater and cathode	V_{fk}	= max. 175 V

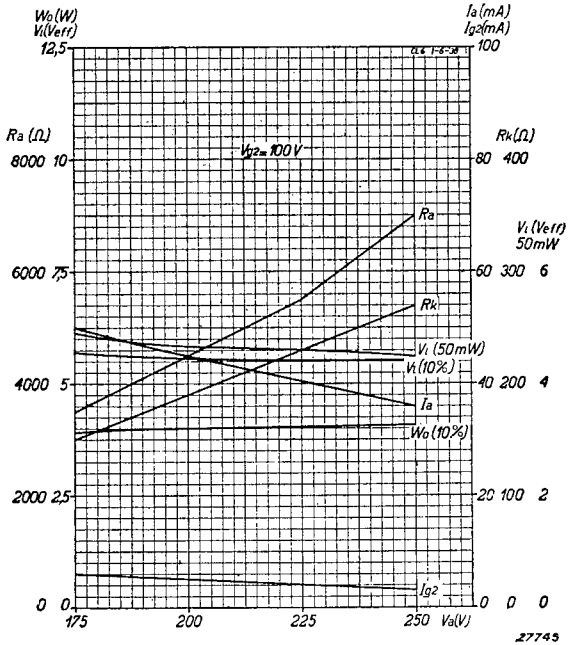


Fig. 8

Output power with 10 % distortion	Wo (10 %)	as functions of the anode voltage (within the range 175 to 250 V), for operation at Wa = 9 W, with constant screen voltage Vg_2 = 100 V.
Alternating grid voltage at 10 % distortion	Vi (10 %)	
Sensitivity	Vi (50 mW)	
Cathode resistor	Rk	
Anode current	Ia	
Screen-grid current	Ig_2	
Load resistor	Ra	

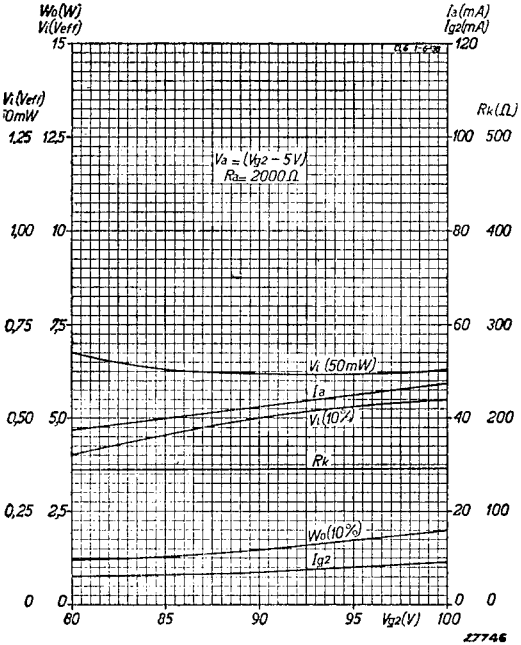


Fig. 9

Output power with 10 % distortion	*Wo* (10 %)	as functions of the screen voltage (in the range 80 to 100 V), with an anode voltage 5 V lower than that of the screen.
Alternating grid voltage at 10 % distortion	*Vi* (10 %)	
Sensitivity	*Vi* (50 mW)	
Cathode resistor	*Rk*	
Anode current	*Ia*	
Screen current	I_{g_2}	

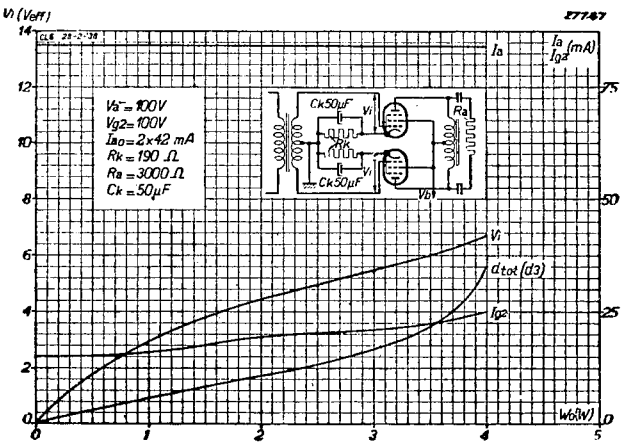


Fig. 10
Anode current *Ia*, screen current I_{g_2}, total distortion *dtot* (= d_3) and alternating grid voltage *Vi* as functions of the output power *Wo* for two type CL 6 valves in a balanced circuit with $Va = Vg_2 = 100$ V.

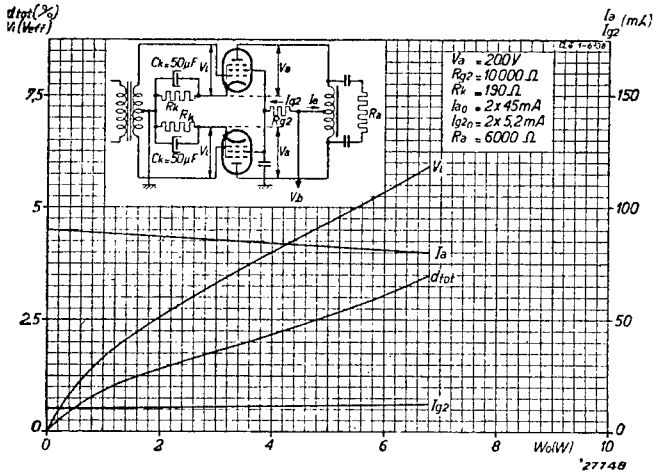


Fig. 11
Anode current Ia, screen current Ig_2, total distortion $dtot$ and alternating grid voltage Vi as functions of the output power of the CL 6 in a balanced circuit with $Va = 200$ V, using the same cathode resistor as for $Va = Vg_2 = 100$ V.

In order to show the performance of the CL 6 at other working voltages than those given in the standard data, various values have been included in the curves of Figs. 8 and 9, not only as functions of the anode voltage at a constant screen-grid potential with continuous anode dissipation, with respect to higher feed voltages, but also as plotted against V_{g_2} in the case of an anode voltage which is 5 V lower than that of the screen. In the latter instance an average voltage drop of 5 V in the output transformer has been taken into account.

Grid bias must be obtained by means of a cathode resistor only (auto. bias); semi-automatic bias is permissible only when the cathode current of the CL 6 is in excess of 50 % of the total current passing through the resistor that produces the voltage drop; the maximum value for the grid leak, as shown in the Maximum Ratings, must then be reduced in accordance with the following:

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

In this case, moreover, it must be remembered that the current in those valves which are subjected to control will affect the bias of the output valve; in other words, when the control is operating, the bias very quickly becomes too low and the anode current of the output valve too high.

The high mutual conductance of the valve must also be considered in the design of the receiver, as it may otherwise result in R.F. feed-back and oscillation. Leads to the valve contacts must be kept as short as possible, and a resistor of about 1,000 ohms in the control-grid lead is recommended. With 100 V on the anode, the optimum value of the load resistance is 2,000 ohms; with 200 V anode, 4,500 ohms. In A.C./D.C. receivers for both high and low-voltage mains operation a switch must be provided in the output transformer circuit that will ensure the best possible matching conditions on different anode voltages.

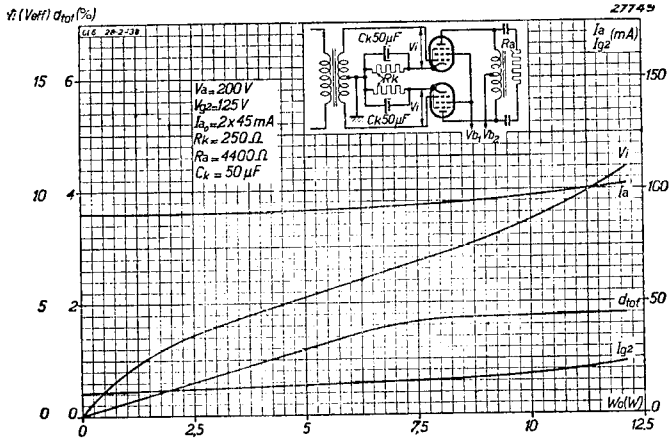


Fig. 12
Anode current *Ia*, screen-grid current Ig_2, total distortion *dtot* and alternating grid voltage *Vi*, as functions of the output power *Wo* for two CL 6 valves in a balanced circuit with $Va = 200$ V, and $Vg_2 = 125$ V.

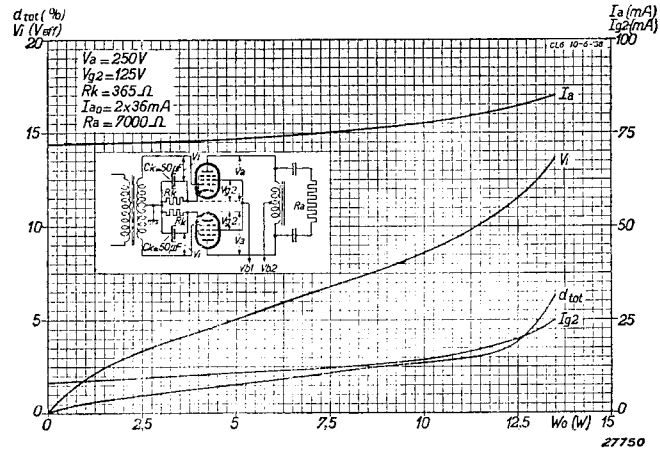


Fig. 13
Anode current *Ia*, screen current Ig_2, total distortion *dtot* and alternating grid voltage *Vi* as functions of the output power for two type CL 6 valves in a balanced circuit with $Va = 250$ V, and $Vg_2 = 125$ V.