The DL 92 is an output pentode which was specially developed for small (portable) battery sets. Accordingly, the maximum permissible voltages are low (67.5 V screen grid, 90 V anode). With 67.5 V on both anode and screen grid the output power is 180 mW; if the anode voltage is increased to 90 V the output power is 270 mW: for this output the total cathode-current consumption is nearly 9 mA.
The filament of the DL 92 is made in two identical sections, which can be connected either in series or in parallel. In the former arrangement the nominal filament voltage is 2.8 V and the nominal filament current 50 mA, in the latter arrangement 1.4 V and 100 mA. When the filament sections are connected in series, the filament as a whole can be connected in series with other valves in the circuit, which is important whether power is derived from an accumulator or from the mains.
In order to ensure that filaments connected in series will not be overloaded in the event of voltage fluctuations, it is advisable to adjust the voltage across each filament section to 1.3 V. Furthermore, a 250 to 300 ohm resistor must be connected across the negative half, to prevent the current emitted by the positive half from flowing through it. If necessary, another resistor may be connected across the whole of the filament, to provide a shunt for the cathode current from other valves.

**TECHNICAL DATA OF THE BATTERY OUTPUT PENTODE DL 92**

**Filament data**

Heating: direct, from battery, rectified A.C., or D.C.; series or parallel feed

A. *Both sections of filament connected in parallel*

a. In parallel with other valves

<table>
<thead>
<tr>
<th>Filament voltage $V_f$</th>
<th>=</th>
<th>1.4 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filament current $I_f$</td>
<td>=</td>
<td>100 mA</td>
</tr>
</tbody>
</table>

b. In series with other valves

| Filament voltage $V_f$ | = | 1.3 V |

B. *Both sections of filament connected in series*

a. In parallel with other valves

| Filament voltage $V_f$ | = | 2.8 V |
| Filament current $I_f$ | = | 50 mA |

b. In series with other valves

| Filament voltage $V_f$ | = | 2.6 V |
Capacitances (cold valve)

Input capacitance \( C_{g1} \) = 4.35 pF
Output capacitance \( C_a \) = 6.0 pF
Anode - control grid \( C_{ag1} \) < 0.4 pF

Fig. 2
Electrode arrangement, electrode connections and max. dimensions in mm.

Operating characteristics of a single valve in Class A
(base connections 5 (—) and 1 + 7 (+), \( V_f = 1.4 \) V, \( I_f = 100 \) mA)

Anode voltage \( V_a \) = 45 67.5 90 V
Screen grid voltage \( V_{g2} \) = 45 67.5 67.5 V
Grid bias \( V_{g1} \) = —4.5 —7 —7 V
Anode current \( I_a \) = 3.8 7.2 7.4 mA
Screen grid current \( I_{g2} \) = 0.8 1.5 1.4 mA
Mutual conductance \( S \) = 1250 1550 1570 \( \mu \)A/V
Internal resistance \( R_i \) = 0.1 0.1 0.1 MΩ
Amplification factor of grid 2 with respect to grid 1 \( \mu_{g2g1} \) = 5 5 5
Optimum load resistance \( R_o \) = 8 8 8 kΩ
Output power \( W_0 \) = 65 180 270 mW
Alternating input voltage \( V_i(W_0=\text{max}) \) = 3.5 5.5 5.5 V\(_{\text{RMS}}\)
Distortion \( d_{\text{tot}}(W_0=\text{max}) \) = 12 10 12 %
Sensitivity \( V_i(W_0=50\text{mW}) \) = 2.8 2.5 1.95 V\(_{\text{RMS}}\)
### Operating characteristics of a single valve in Class A

(base connections 1 (—) and 7 (＋), $V_f = 2.8$ V, $I_f = 50$ mA)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode voltage</td>
<td>$V_a$</td>
</tr>
<tr>
<td>Screen grid voltage</td>
<td>$V_{g2}$</td>
</tr>
<tr>
<td>Grid bias</td>
<td>$V_{gl}$</td>
</tr>
<tr>
<td>Anode current</td>
<td>$I_a$</td>
</tr>
<tr>
<td>Screen grid current</td>
<td>$I_{g2}$</td>
</tr>
<tr>
<td>Mutual conductance</td>
<td>$S$</td>
</tr>
<tr>
<td>Internal resistance</td>
<td>$R_i$</td>
</tr>
<tr>
<td>Amplification factor of grid 2</td>
<td>$\mu_{g2g1}$</td>
</tr>
<tr>
<td>Optimum load resistance</td>
<td>$R_a$</td>
</tr>
<tr>
<td>Output power</td>
<td>$W_0$</td>
</tr>
<tr>
<td>Alternating input voltage</td>
<td>$V_i(W_0=\text{max})$</td>
</tr>
<tr>
<td>Distortion</td>
<td>$d_{tot}(W_0=\text{max})$</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>$V_i(W_0=50\text{mW})$</td>
</tr>
</tbody>
</table>

### Operating characteristics of two valves in Class B push-pull

(base connections 5 (—) and 1 ＋ 7 (+), $V_f = 1.4$ V, $I_f = 100$ mA per valve)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery voltage</td>
<td>$V_b$</td>
</tr>
<tr>
<td>Anode voltage</td>
<td>$V_a$</td>
</tr>
<tr>
<td>Screen grid voltage</td>
<td>$V_{g2}$</td>
</tr>
<tr>
<td>Grid bias</td>
<td>$V_{gl}$</td>
</tr>
<tr>
<td>Optimum load resistance between the two anodes</td>
<td>$R_{aa}$</td>
</tr>
<tr>
<td>Alternating input voltage</td>
<td>$V_i$</td>
</tr>
<tr>
<td>Anode current</td>
<td>$I_a$</td>
</tr>
<tr>
<td>Screen grid current</td>
<td>$I_{g2}$</td>
</tr>
<tr>
<td>Output power</td>
<td>$W_0$</td>
</tr>
<tr>
<td>Distortion</td>
<td>$d_{tot}$</td>
</tr>
</tbody>
</table>

### Operating characteristics of two valves in Class B push-pull

(base connections 1 (—) and 7 (+), $V_f = 2.8$ V, $I_f = 50$ mA per valve)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery voltage</td>
<td>$V_b$</td>
</tr>
<tr>
<td>Anode voltage</td>
<td>$V_a$</td>
</tr>
<tr>
<td>Screen grid voltage</td>
<td>$V_{g2}$</td>
</tr>
<tr>
<td>Grid bias</td>
<td>$V_{gl}$</td>
</tr>
<tr>
<td>Optimum load resistance between the two anodes</td>
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<td>Alternating input voltage</td>
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<tr>
<td>Anode current</td>
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</tr>
<tr>
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<td>$I_{g2}$</td>
</tr>
<tr>
<td>Output power</td>
<td>$W_0$</td>
</tr>
<tr>
<td>Distortion</td>
<td>$d_{tot}$</td>
</tr>
</tbody>
</table>
Limiting values

Anode voltage \( V_a \) = max. 90 V
Anode dissipation \( W_a \) = max. 0.7 W
Screen grid voltage \( V_{g2} \) = max. 67.5 V
Screen grid dissipation without input signal \( W_{g2}(V_i=0) \) = max. 0.12 W
Screen grid dissipation at maximum output power \( W_{g2}(W_0=\text{max}) \) = max. 0.2 W
Grid current starting point \( V_{gl}(I_{gl}=+0.3 \, \mu\text{A}) \) = max. +0.2 V
Cathode current \( I_k \) = max. 11 mA
External resistance between control grid and cathode \( R_{gl} \) = max. 2 M\( \Omega \)

---

Fig. 3
Anode current \( I_a \) and screen grid current \( I_{g2} \) as functions of the grid bias \( V_{g1} \), at \( V_a = V_{g2} = 45 \, \text{V} \).

\( V_f = 14 \, \text{V} \)
\( V_a = V_{g2} = 45 \, \text{V} \)
Fig. 4
Anode current ($I_a$) as a function of the anode voltage ($V_a$) with grid bias ($V_{g1}$) as parameter, at a screen grid voltage ($V_{g2}$) = 45 V. Filament connections 5 (---) and 1 + 7 (+), $V_f$ = 1.4 V, $I_f$ = 100 mA.

Fig. 5
Anode current ($I_a$), screen grid current ($I_{g2}$), required alternating input voltage ($V_i$) and distortion ($d_{tot}$) as functions of the output power ($W_o$), at $V_a = V_{g2}$ = 45 V. Filament connections as for
Fig. 6
Anode current ($I_a$) and screen grid current ($I_{g2}$) as functions of the grid bias ($V_{g1}$), at $V_a = V_{g2} = 67.5 \text{ V}$. Filament connections $5 (-)$ and $1 + 7 (+)$, $V_f = 1.4 \text{ V}$, $I_f = 100 \text{ mA}$.

Fig. 7
$I_a/V_a$ characteristics; voltages and filament connections as for Fig. 6.
Fig. 8
Anode current ($I_a$), screen grid current ($I_g2$), required alternating input voltage ($V_f$) and distortion ($d_{tot}$) as functions of the output power ($W_o$), at $V_a = V_{r2} = 67.5$ V. Filament connections as for Fig. 6.

Fig. 9
As Fig. 8, but at $V_a = 90$ V and $V_{r2} = 67.5$ V.
Fig. 10
Anode current \( (I_a) \) and screen grid current \( (I_{sg}) \) as functions of the grid bias \( (V_{g1}) \), at \( V_a = V_{g2} = 45 \) V. Filament connections 1 (—) and 7 (±), \( V_f = 2.8 \) V, \( I_f = 50 \) mA.
Fig. 11
$I_a/V_a$ characteristics at $V_{ef}=45$ V. Filament connections 1 (—) and 7 (+), $V_f = 2.8$ V, $I_f = 50$ mA.

Fig. 12
Anode current ($I_a$), screen grid current ($I_{g2}$), required alternating input voltage ($V_i$) and distortion ($d_{tot}$) as functions of the output power ($W_p$), at $V_a = V_{ef} = 45$ V. Filament connections as for Fig. 11.
Fig. 13
Anode current ($I_a$) and screen grid current ($I_{g2}$) as functions of the grid bias ($V_{g1}$), at $V_0 = V_{g2} = 67.5$ V. Filament connections 1 (---) and 7 (---), $V_f = 2.8$ V, $I_f = 50$ mA.

Fig. 14
$I_a/V_a$ characteristics at $V_{g2} = 67.5$ V. Filament connections as for Fig. 13.
Fig. 15
Anode current ($I_a$), screen grid current ($I_{gs}$), required alternating input voltage ($V_i$) and distortion ($d_{tot}$) as functions of the output power ($P_o$), at $V_a = V_{gs} = 67.5$ V. Filament connections 1 (---) and 7 (+), $V_f = 2.8$ V, $I_f = 50$ mA.

Fig. 16
As Fig. 15, but at $V_a = 90$ V and $V_{gs} = 67.5$ V.