# DL 21 Output pentode

This is an output pentode for battery sets, operating on a filament voltage of 1.4 V. The output power which this valve is capable of supplying is large, taking into consideration the fact that when economical feeding from a dry battery is employed only a very small amount of filament power is available. The sensitivity of the DL 21 is very good: on a filament current of only 50 mA and an anode voltage of 90 V, the output power is 170 mW at an anode current of only 4 mA (10 % distortion). The efficiency (47 %) may thus be regarded as excellent, especially when it is remembered that it is much more difficult to attain satisfactory efficiency in low-current valves than with larger, mains-operated output valves. The output power of 170 mW is naturally a compromise between the rating of the available batteries, their life and the desired volume of sound and this compromise is admirably met by the particular construction of the valve. At a higher anode voltage the DL 21 will supply a greater amount of power; at 120 V, on an anode current of 5 mA, the output is 270 mW (10 % distortion). The screen current is very low and for practical purposes may be ignored; the efficiency, then, remains on the high side (40 %). The sensitivity (for $W_0 = 50$ mW) is 1.0—1.1 V.

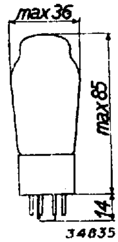
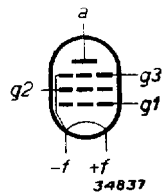



Fig. 1
Dimensions in mm.




An advantage of the low filament current of 50 mA is that it enables economical receivers to be designed, with the filaments of the valves connected in series. The current in the filament circuit is determined by the valve taking the most current (usually the output valve) and 50 mA circuits can therefore be employed with the DL 21, since the preceding valves can be selected from the same series of 1.4 V battery types, having this same current of 50 mA or even less (25 mA). The filament of the DL 21 may be connected either in series or in parallel with the other valves (for example in AC/DC-battery sets). To avoid anode ripple, the DL 21 should be connected to the negative end of the filament circuit when series-coupled. With a view to heating the filament from a dry battery, with consequent voltage-drop during the life of the latter, the valve has been specially constructed to be relatively insensitive to under-heating.

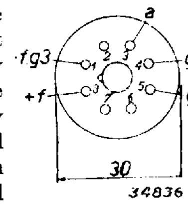



Fig. 2.
Arrangement and sequence of contacts.

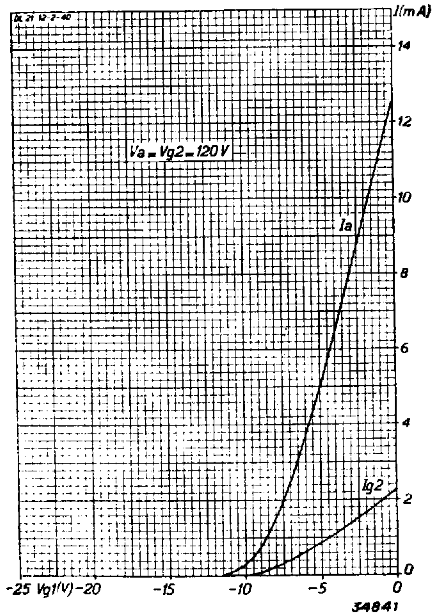



Fig. 3
Anode and screen current as a function of the grid bias at $Va = Vg_2 = 120$ V.

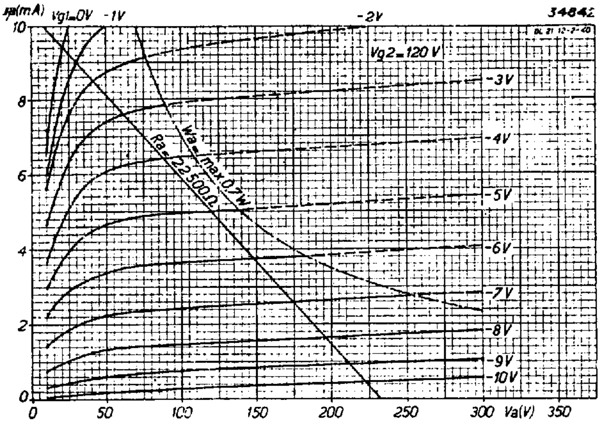



Fig. 4
Anode current as a function of the anode voltage at $Vg_2 = 120$ V, with $Vg_1$ as parameter.

## FILAMENT RATINGS

Heating: direct, with battery, rectified A.C., or direct current, series or parallel feed.

| | | | |
|---|---|---|---|
| Filament voltage . . . . . . . . . . . . . . . . . . . . . . . . | $V_f$ | = | 1.4 A |
| Filament current . . . . . . . . . . . . . . . . . . . . . . . . | $I_f$ | = | 0.050 A |
| Capacity anode - control grid . . . . . . . . . . . . . . . | $C_{ag1}$ | = | max. 0.5 pF |

## OPERATING DATA: valve employed as single output valve

| | | | | |
|---|---|---|---|---|
| Anode voltage . . . . . . . . . . . | $V_a$ | = | 90 V | 120 V |
| Screen grid voltage . . . . . . . . . | $V_{g2}$ | = | 90 V | 120 V |
| Grid bias. . . . . . . . . . . . . . | $V_{g1}$ | = | —3.0 V | —4.8 V |
| Anode current . . . . . . . . . . . | $I_a$ | = | 4 mA | 5 mA |
| Screen grid current . . . . . . . . . | $I_{g2}$ | = | 0.7 mA | 0.9 mA |
| Mutual conductance . . . . . . . . . | $S$ | = | 1.3 mA/V | 1.4 mA/V |
| Internal resistance. . . . . . . . . . | $R_i$ | = | 0.3 M Ohm | 0.35 M Ohm |
| Optimum value of matching resistance | $R_a$ | = | 22,500 Ohms | 24,000 Ohms |
| Output power . . . . . . . . . . . | $W_o$ | = | 165 mW | 270 mW |
| Total distortion. . . . . . . . . . . | $d_{tot}$ | = | 10 % | 10 % |
| Required alternating grid voltage . . | $V_{ieff}$ | = | 2.1 V | 3.2 V |
| Sensitivity . . . . . . | $V_{ieff}$ ($W_o$ = 50 mW) | = | 1.1 V | 1.0 V |

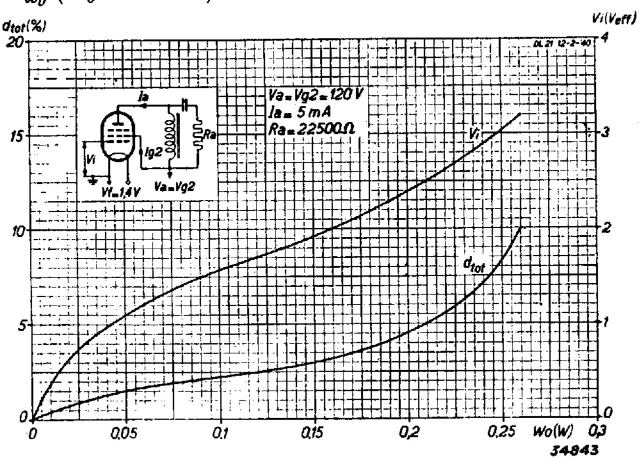



Fig. 5
Total distortion and required alternating grid voltage as function of output power at $Va = Vg_2 = 120$ V.

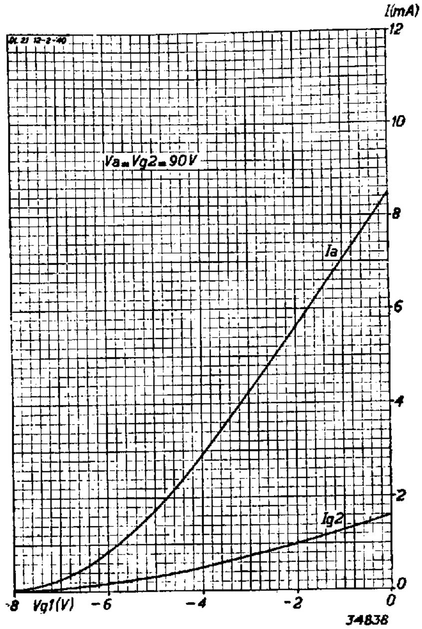



Fig. 6
Anode and screen current as a function of grid bias at $Va = Vg_2 = 90$ V.

## MAXIMUM RATINGS

| | | |
|---|---|---|
| Anode voltage . . . . . . . . . . . . . . . . . . . . . | $V_a$ | = max. 135 V |
| Anode dissipation . . . . . . . . . . . . . . . . . . . | $W_a$ | = max. 0.7 W |
| Screen grid voltage . . . . . . . . . . . . . . . . . . | $V_{g_2}$ | = max. 135 V |
| Screen grid dissipation . . . . . . . . . . . . . . . . | $W_{g_2}$ | = max. 0.2 W |
| Cathode current . . . . . . . . . . . . . . . . . . . . | $I_k$ | = max. 7 mA |
| Grid current commences at ($I_{g1} = + 0.3\ \mu$A). . . . . | $V_{g1}$ | = max. —0.2 V |
| Max. external resistance between grid 1 and filament . | $R_{g1f}$ | = max. 2 M Ohms |
| Minimum limit for filament voltage . . . . . . . . . | $V_f$ | = min. 1.1 V |
| Maximum limit for filament voltage . . . . . . . . . | $V_f$ | = max. 1.5 V |

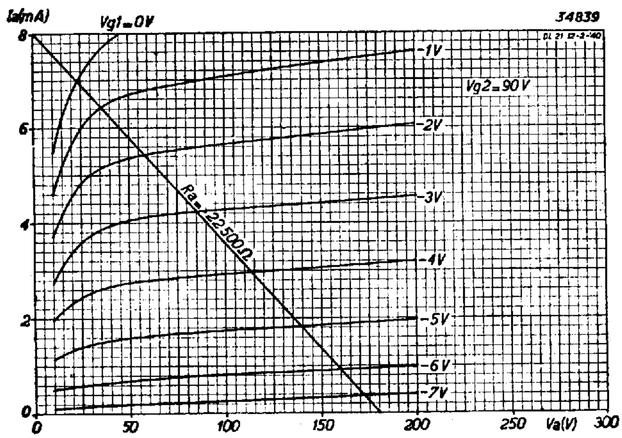



Fig. 7
Anode current as a function of anode voltage at $Vg_2 = 90$ V, with $Vg_1$ as parameter.

## APPLICATIONS

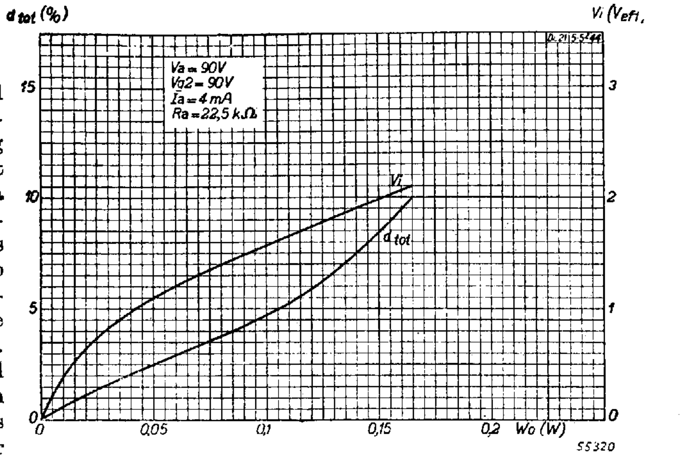



Fig. 8
Total distortion and required alternating grid voltage as a function of output power at $Va = Vg_2 = 90$ V.

The DL 21 is intended as output valve for battery receivers working with a very low filament current and giving a comparatively high output. For receivers which are required to give higher output power, the double pentode DLL 21 should be used. The value of the grid leak must not be in excess of 2 Megohms and grid bias should for preference be supplied by means of a resistance between the negative side of the filament voltage and the negative terminal of the H.T.battery. In the case of a fixed bias, the grid leak may not be greater than 1 Megohm. As explained at the commencement of this section, the very low filament current of the valves in this D-series, as compared with that of the K-type, is due to the use of an extremely thin filament wire, and the reduction in the thickness in some cases necessitates special precautions against possible damage to the filament: such precautions will now be explained in reference to Fig. 9.

Before the anode and filament voltages are switched on, the potential between the grid and filament of the output valve will be equal to $V_g$; in circuits in which grid bias is obtained in a manner other than that indicated it is then zero, or, at any rate, very small indeed. As soon as the voltage is switched on, a voltage surge, $+ V_a$, occurs however at the grid of the output valve across $R_1$ and $C$. Usually $R_1$ is low as compared with $R_2$, so that, at the first moment, practically the whole anode voltage $V_a$ occurs at the grid. Condenser $C$ then gradually charges across $R_2$ and ultimately absorbs the whole voltage $V_a$, with the result that the grid is restored to its initial potential ($V_g$). The curve in respect of this voltage at the grid of the output valve is shown in Fig. 10 as a function of the time, for the conditions where $C = 5000$ pF and $R_2 = 1$ Megohm. Although the duration of the excess voltage is only quite short (of the order of 0.01 seconds), it is nevertheless sufficient to cause a flashover which is immediately followed by an even greater discharge in the anode circuit, and the very thin filament is, generally speaking, unable to withstand such discharges. At the same time, if the same voltage be applied to the "cold" valve the flashover will not occur. It may be concluded that despite the warming up period of about 0.01 seconds the temperature of the filament is increased very considerably in a very much shorter time.

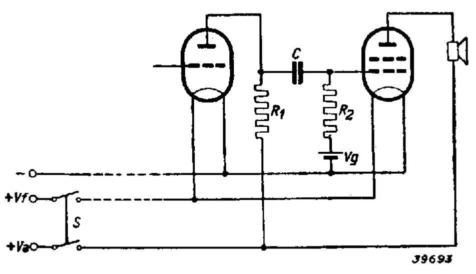



Fig. 9
Circuit diagram of the A.F. section of a battery receiver.

This phenomenon can be avoided in

several ways, the simplest method being to bridge the switch in the anode circuit with a resistance of some Megohms: the anode voltage will then be already applied to the valve when the filament current is switched on and, when the resistance is shorted out by the closing of the switch, no further voltage surges are possible.

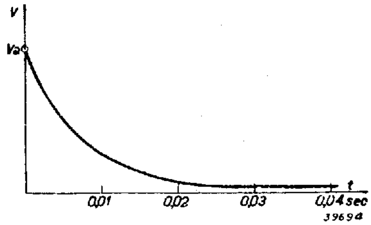



Fig. 10
Voltage on the grid of the output valve as a function of charging time of the grid condenser C in Fig. 9.

Moreover, if for any reason a short circuit should occur in the receiver when not in use, the resistance across the switch will sufficiently limit the anode current.

If, however, a potentiometer is fitted on the other side of the switch, between the positive and negative anode leads, the method of protection described in the foregoing cannot be adopted, but this will not often be the case, since battery operated receivers to limit anode current do not usually include a potentiometer. Nevertheless, if a potentiometer is provided, one solution is to fit a double-pole switch, so arranged that anode and filament voltage are not switched on simultaneously. Fig. 10 shows that it is only necessary to close the switch for the anode voltage some hundredths of a second before applying the filament voltage, in order to avoid surges.

Another method is to smooth the anode voltage of the penultimate valve by means of a resistance and relatively large condenser, so that the surge occurring at $R_1$ takes place very slowly when the set is switched on, and is reproduced only very weakly by the condenser $C$. The time-constant of this smoothing circuit should therefore be high in comparison with that of $R_2$—$C$, the method necessarily involving use of an extra condenser and resistance.

Finally, it should be noted that the phenomenon in question can also take place in other than output stages, in fact in every case where the valve is coupled capacitively to the anode of the preceding valve, but as far as these other valves are concerned the consequences are always less serious, in view of the lower anode voltages involved.