UBL 21 Double diode output pentode

The UBL 21, designed for use in AC/DC receivers and taking a heater current of 100 mA, comprises a double diode and a very sensitive 11 Watt output pentode. The diode and pentode sections employ a common cathode and the two diode anodes are both situated at the same height, at the lower end and opposite to the flat sides of the cathode; the pentode part of the valve is located at the upper end of the cathode. As the control grid of the pentode is connected through the base of the valve, this connection has been screened from the leads of the diodes and from the diodes themselves. This combination of pentode and two diodes places the receiver designer in a position to develop a large variety of receiver types, using only a limited number of valve types. The A.F. signal coming from the detection diode is frequently taken first to the grid of an A.F. amplifier before it is passed to the grid of the output pentode, but in this case it is essential for the detector diode to be sufficiently free from ripple to permit of adequate A.F. gain. In the design of the UBL 21 special precautions have had to be taken to ensure that the heater voltage, at the relatively low current consumption of 100 mA, would not be too high, and the heater power has therefore been kept as low as possible, whilst careful adjustment of the valve system (see below) has made it possible to limit this power to 5.5 W, that is a heater voltage of 55V. For the pentode section the available choice lay between the principle of the output pentode CL 4 in the AC/DC 200 mA series and that of the CL 6. In the first instance this would mean a screen voltage of 200 V, or the same for both anode and screen when operated on 200 V feed, i.e. screen grid fed direct from the source of anode voltage. Against this there is the fact that on low working voltages, for example 100 V, the output power is on the low side (about 0.8 W), whilst on the other hand, if the principle of the CL 6 were adopted, namely a valve with a low screen voltage (125 V), the output power on low working voltages would be considerably higher (about 2 W at 100 V). In that case it is necessary to feed the screen from a resistance or potentiometer when operating on 200 V feed. The UBL 21, however, is based on a compromise, the output power being 1.35 W on a working voltage of 100 V.

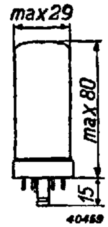
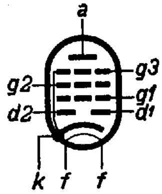


Fig. 1
Dimensions in mm.



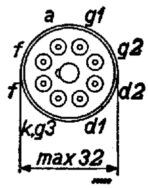


Fig. 2
Arrangement and sequence of connections.

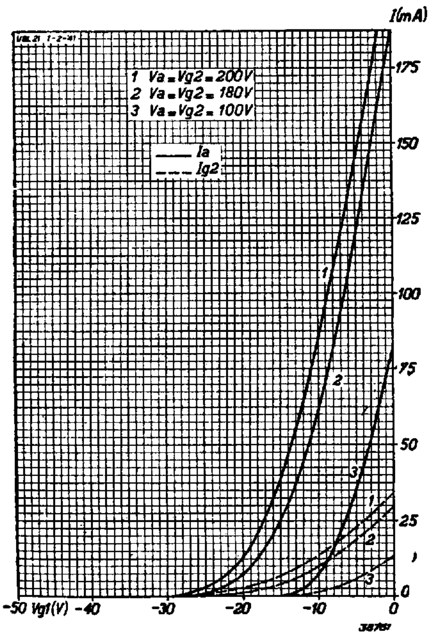


Fig. 3
Anode and screen current as a function of grid bias at $Va = Vg_2 = 200$ V, 180 V and 100 V.

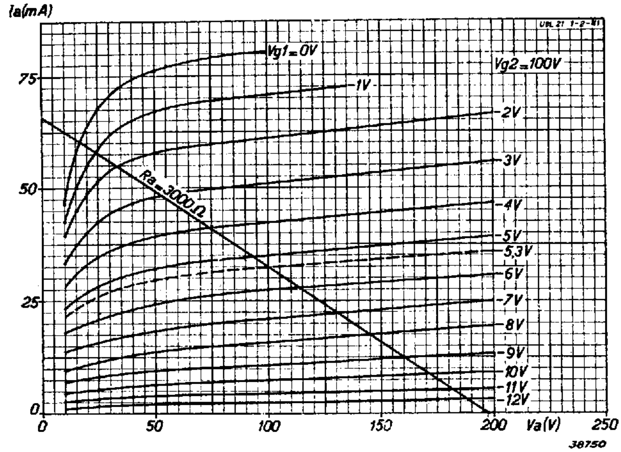


Fig. 4
Anode current as a function of anode voltage at Vg_2 = 100 V, with Vg_1 as parameter. The load line in respect of *Ra* = 3000 Ohms is also included in the diagram.

Owing, moreover, to the greater grid space and robust construction of this valve, at a working voltage of 200 V and 11 W anode dissipation it will deliver a power of not less than 4.8 W with 10 % distortion.

With an output valve to be employed in AC/DC receivers it is of practical importance that any change-over from one working voltage to another should be carried out in the simplest possible manner. In the case of the CL 4 it is not necessary to change cathode and anode resistances when transferring from 200 to 100 V mains, and the switch-over is consequently a very simple operation. When the CL 6 is used, the screen feed resistance of 27,000 Ohms, suitable for 200 V mains, has however to be short-circuited when the set is operated on 100 V, and the anode loading resistance reduced from 6000 to 2000 Ohms. The cathode resistance need not be changed. The higher power supplied by the CL 6 on 100 V is obtainable at the cost of the power on 200 V (2.6 W), besides necessitating much more complicated modification when transferred from one mains voltage to another.

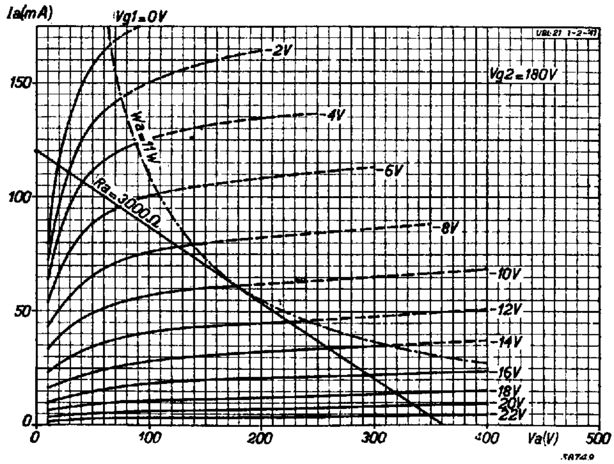


Fig. 5
Anode current as a function of anode voltage at $V g_2$ = 180 V, with Vg_1 as parameter. The load line for *Ra* = 3000 Ohms is also shown.

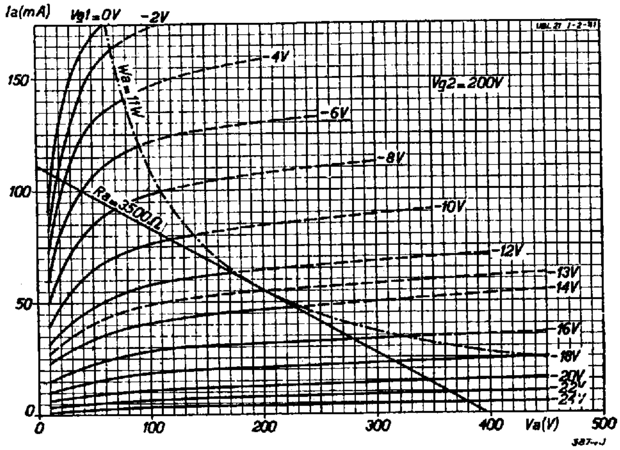


Fig. 6
Anode current as function of anode voltage at $Vg_2 = 200$ V, with Vg_1 as parameter. The load line for $Ra = 3{,}500$ Ohms is also given.

Since the UBL 21 can handle an anode dissipation of 11 W, it enables the set to be changed from one voltage to another without modification of the circuit, the output power being quite sufficient on 100 V mains. Two sets of operating data are given for this valve, at a fixed cathode resistance of 140 Ohms; one of these refers to a working voltage of 100 V and the other to 180 V, with a view to operation on 127 and 220 V respectively. (At a mains voltage of 127 V a voltage of 105 V is usually available for the output valve. Deducting the grid bias of 5.3 V, about 100 V remains for the anode voltage. On 220 V mains the feed voltage will be 190 V which, allowing for a drop of 10 V across the cathode resistance for the bias, corresponds to an anode voltage of about 180 V.)

At 180 V a cathode resistance of 140 Ohms just produces the maximum anode dissipation of 11 W (at a voltage of 100 V the same cathode resistance may be retained). The external anode resistance may be the same in both cases and the UBL 21 is therefore suitable for either 110/127 or 220 V mains without modification of the circuit.

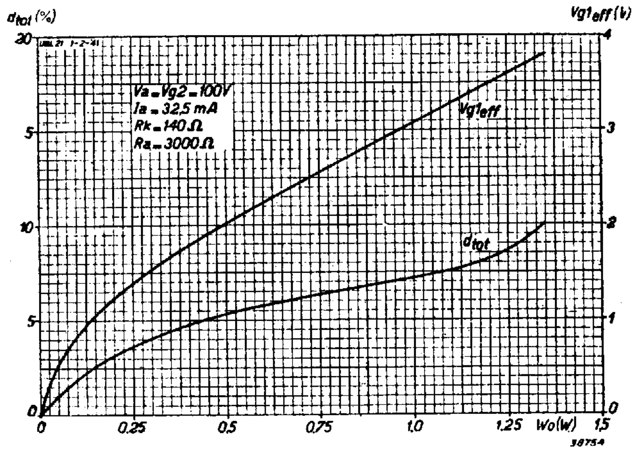


Fig. 7
Total distortion and required alternating grid voltage as a function of output power at $Va = Vg_2 = 100$ V and $Ra = 3{,}000$ Ohms.

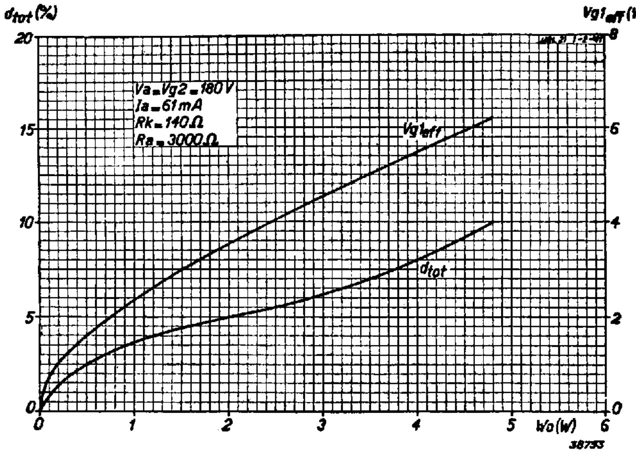


Fig. 8
Total distortion and required alternating grid voltage as a function of output power at $Va = Vg_2 = 180$ V and $Ra = 3{,}000$ Ohms.

Every care has been bestowed on the diode portion of the valve to ensure that ripple voltages occurring at the diodes shall be as low as possible. The design of the UBL 21 was based on the condition that a gain factor of 60 between the detector diode and the grid of the output pentode [1]) should be obtainable. In order to guarantee this very low ripple level at the detector diode, the heater voltage, in the first place, has been kept as low as possible (see above), whilst, secondly, effective screening is provided. The arrangement of the valve contacts also contributes in this direction, being such that the pilot pin screens the diode d_2, intended for detection, from the heater pins. Summarising, the UBL 21 offers the following advantages:

[1]) This figure is intended for guidance only; a higher factor may be obtained if the conditions imposed on the ripple are not so stringent.

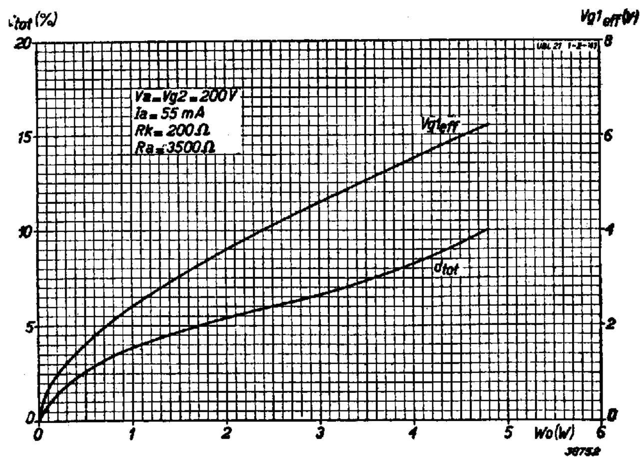


Fig. 9
Total distortion and required alternating grid voltage as a function of output power, at $Va = Vg_2 = 200$ V and $Ra = 3{,}500$ Ohms.

ADVANTAGES OF THE UBL 21

1) It provides adequate output power when the receiver is operated on a low mains voltage.
2) It is possible to run this valve at an anode dissipation of 11 W, thus giving very high output power on a higher mains voltage.
3) When changing from low voltage to high voltage mains, none of the resistances in the circuit, including the anode load resistance, need be altered.
4) Ripple voltage at the detector diode is very low, enabling a gain factor of 60 to be obtained between that electrode and the grid of the pentode.
5) The heater power and consequently the heater voltage also are relatively low.
6) The construction is very dependable and steps have been taken in the design to eliminate thermal emission from the grid.
7) The mutual conductance of the pentode section is high.
8) The combination of diodes with output pentode greatly reduces the number of valve types in the series, whilst still permitting of the design of any type of receiver.

HEATER RATINGS

Heating: indirect, AC or DC, series connection.

Heater voltage	V_f	= 55 V
Heater current	I_f	= 0.100 A

CAPACITANCES

a) Pentode section	C_{ag1}	< 1.2 pF
b) Diode section	C_{d1k}	= 1.8 pF
	C_{d2k}	= 2.0 pF
	C_{d1d2}	< 0.15 pF
c) Between diode and pentode	C_{d1a}	< 0.06 pF
	C_{d2a}	< 0.02 pF
	C_{d1g1}	< 0.1 pF
	C_{d2g1}	< 0.05 pF

OPERATING DATA: pentode section employed as single output valve.

Anode voltage	V_a	= 100 V	180 V	200 V
Screen grid voltage	V_{g2}	= 100 V	180 V	200 V
Cathode resistance	R_k	= 140 Ohms	140 Ohms	200 Ohms
Grid bias	V_{g1}	= —5.3 V	—10 V	—13 V
Anode current	I_a	= 32.5 mA	61 mA	55 mA
Screen grid current	I_{g2}	= 5.5 mA	10 mA	9.5 mA
Mutual conductance	S	= 7.5 mA/V	9 mA/V	8 mA/V
Internal resistance	R_i	= 25,000 Ohms	22,000 Ohms	25,000 Ohms
Recommended anode load	R_a	= 3000 Ohms	3000 Ohms	3500 Ohms
Output power	W_o	= 1.35 W	4.8 W	4.8 W
Total distortion	d_{tot}	= 10 %	10 %	10 %
Required alternating grid voltage at max. modulation	V_{g1eff}	= 3.8 V	6.2 V	6.2 V
Sensitivity (W_o = 50 mW)	V_{g1eff}	= 0.55 V	0.5 V	0.5 V

MAXIMUM RATINGS for the pentode section

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 250 V
Anode dissipation	W_a	= max. 11 W
Screen grid voltage in cold condition	V_{g2o}	= max. 550 V
Screen grid voltage	V_{g2}	= max. 250 V
Screen grid dissipation, valve not modulated ($V_{g1eff} = 0$)	W_{g2}	= max. 1.9 W
Screen grid dissipation at max. modulation (W_o = max.)	W_{g2}	= max. 3.5 W
Cathode current	I_k	= max. 75 mA
Grid current commences at ($I_{g1} = +0.3\ \mu A$)	V_{g1}	= max. —1.3 V
Max. external resistance between grid 1 and cathode	R_{g1k}	= max. 1 M Ohm
Max. external resistance between heater and cathode	R_{fk}	= max. 20,000 Ohms
Max. voltage between heater and cathode (D.C. voltage or effective value of the A.C. voltage)	V_{fk}	= max. 150 V

MAXIMUM RATINGS for the diode section

Peak voltage, diode 1	V_{d1}	= max. 200 V
Peak voltage, diode 2	V_{d2}	= max. 200 V
Max. direct current through resistor of diode 1	I_{d1}	= max. 0.8 mA
Max. direct current through resistor of diode 2	I_{d2}	= max. 0.8 mA
Diode current commences at ($I_{d1} = +0.3\ \mu A$)	V_{d1}	= max. —1.3 V
Diode current commences at ($I_{d2} = +0.3\ \mu A$)	V_{d2}	= max. —1.3 V

WORKING PRECAUTION

The same precautions must be taken with this valve as with the EBL 21 discussed on p.14. The lower heater pin shown in the base in Fig. 2 should be earthed, if possible, or at any rate connected to the point of lowest potential relative to chassis.