EBF 2 Double-diode variable-mu pentode

This valve combines a pentode with two diodes, built round a common cathode. The pentode section has variable characteristics, sliding screen voltage having been adopted with a view to the use of the valve as an I.F amplifier; the anode current is accordingly low and the mutual conductance relatively high, but, since the cathode, which also serves the two diodes, is able to dissipate only 1.26 W, the slope is somewhat less than that of the EF 9. Without control (at — 2 V bias), the mutual conductance of the EBF 2 is 1.8 mA/V, which provides ample I.F. amplification.

The diode section is separated from the pentode by a very effective system of screening, to prevent any unwanted interaction between the two units. This combination of double diodes with an I.F. amplifier is very useful in all cases where an A.F. valve without diode is used, for example the EF 6, with or without feed-back.

The EBF 2 is particularly suitable for use in conjunction with the A.F. amplifier and electronic indicator EFM 1.

The latter arrangement permits of the design of a very simple receiver in which two valves do the work of I.F. amplifier and detector, at the same time producing the control voltage for automatic gain control, with A.F. amplification and electronic tuning indication.

Since both diodes are supplied by the same cathode as the pentode and, because the diode for the A.G.C. is delayed by the cathode potential of this valve, the delay voltage is limited, without the use of any special circuits, to the value of grid bias required by the pentode in the uncontrolled condition. By using special circuits it is possible to obtain a higher delay voltage for the A.G.C., but this merely tends to render the latter less effective.

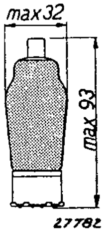

Fig. 1
Dimensions in mm.

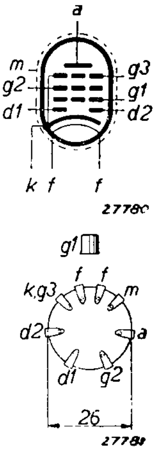

Fig. 2
Arrangement of electrodes and base connections.

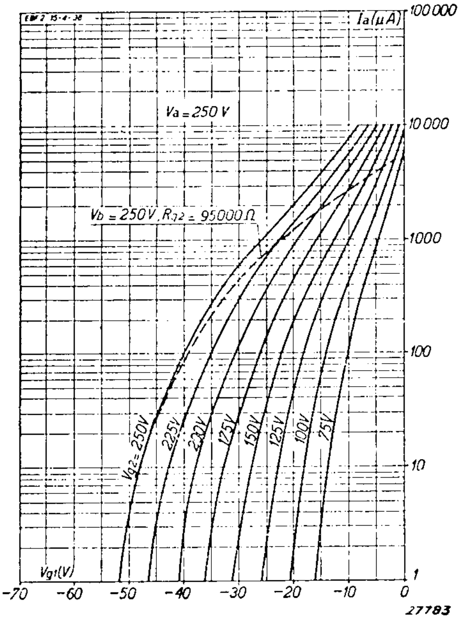

Fig. 3
Ia/Vg_1 characteristic of the EBF 2, with Vg_2 as parameter. The broken line shows the anode current of the controlled valve with a screen series resistor of 95000 ohms and a supply voltage of 250 V.

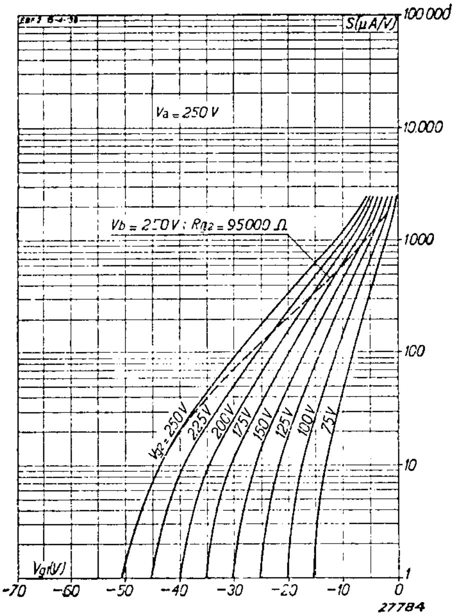

Fig. 4
S/V_{g1} characteristic of the EBF 2, with V_{g2} as parameter. The broken line gives the slope of the controlled valve with a screen series resistor of 95,000 ohms and a supply voltage of 250 V.

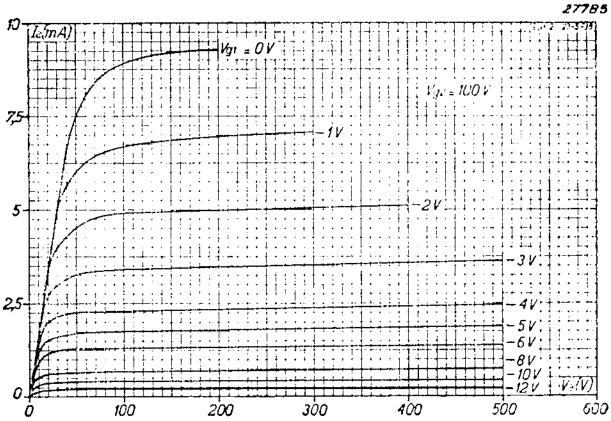

Fig. 5
Anode current as a function of the anode voltage at different values of grid bias and with a fixed screen potential of 100 V.

HEATER RATINGS

Heating: indirect, on A.C. or D.C.; series or parallel supply.

Heater voltage . . . . $V_f = 6.3$ V

Heater current . . . . $I_f = 0.200$ A

CAPACITANCES

$C_{ag1} < 0.002$ μμF
$C_{g1} = 4.4$ μμF
$C_a = 8.6$ μμF
$C_{d1g1} < 0.0005$ μμF
$C_{d2g1} < 0.0005$ μμF

$C_{(d1+d2)g1} < 0.001$ μμF
$C_{d1k} = 3$ μμF
$C_{d2k} = 3$ μμF
$C_{d1d2} < 0.3$ μμF
$C_{d1a} < 0.3$ μμF

$C_{d2a} < 0.25$ μμF
$C_{(d1+d2)a} < 0.4$ μμF
$C_{g1f} < 0.01$ μμF

OPERATING DATA: pentode section employed as I.F. amplifier

250 V

Anode voltage	V_a	= 250 V	
Screen-grid series resistor (at 250 V)	R_{g2}	= 95,000 ohms	
Cathode (bias) resistor	R_k	= 300 ohms	
Grid bias	V_{g1}	= —2 V 1)	—38 V 2)
Screen voltage	V_{g2}	= 100 V	250 V
Anode current	I_a	= 5 mA	—
Screen current	I_{g2}	= 1.6 mA	—
Mutual conductance	S	= 1800 μA/V	18 μA/V
Internal resistance	R_i	= 1.3 M ohms	> 10 M ohms

200 V

Anode voltage	V_a	= 200 V	
Screen-grid series resistor (at 200 V)	R_{g2}	= 60,000 ohms	
Cathode resistor	R_k	= 300 ohms	
Grid bias	V_{g1}	= —2 V 1)	—32.5 V 2)
Screen voltage	V_{g2}	= 100 V	200 V
Anode current	I_a	= 5 mA	—
Screen current	I_{g2}	= 1.6 mA	—
Mutual conductance	S	= 1800 μA/V	18 μA/V
Internal resistance	R_i	= 1 M ohm	> 10 M ohms

100 V

Anode voltage	V_a	= 100 V	
Screen-grid voltage	V_{g2}	= 100 V	
Cathode resistor	R_k	= 300 ohms	
Grid bias	V_{g1}	= —2 V 1)	—16.5 V 2)
Anode current	I_a	= 5 mA	—
Screen current	I_{g2}	= 1.6 mA	—
Mutual conductance	S	= 1800 μA/V	18 μA/V
Internal resistance	R_i	= 0.4 M ohm	> 10 M ohms

1) valve not controlled.

2) Mutual conductance controlled to 1 : 100 and to limit of control.

MAXIMUM RATINGS

a) Pentode section

Anode voltage in cold condition	V_{ao}	= max. 550 V
Anode voltage	V_a	= max. 300 V
Anode dissipation	W_a	= max. 1.5 W
Screen-grid voltage in cold condition	V_{g2o}	= max. 550 V
Screen voltage at $I_a = 5$ mA	V_{g2}	= max. 125 V
Screen voltage at $I_a < 2$ mA	V_{g2}	= max. 300 V
Screen-grid dissipation	W_{g2}	= max. 0.3 W
Cathode current	I_k	= 10 mA
Grid voltage at grid current start ($I_{g1} = + 0.3\ \mu$A)	V_{g1}	= max. —1.3 V
Resistance between grid and cathode	R_{g1k}	= max. 3 M ohms
Resistance between filament and cathode	R_{fk}	= max. 20,000 ohms
Voltage between filament and cathode (direct voltage or effective value of alternating voltage)	V_{fk}	= max. 100 V

b) Diode section

Voltage on diode d_1 (peak value)	V_{d1}	= max. 200 V
Voltage on diode d_2 (peak value)	V_{d2}	= max. 200 V
Direct current to diode d_1	I_{d1}	= max. 0.8 mA
Direct current to diode d_2	I_{d2}	= max. 0.8 mA
Voltage on diode at diode current start ($I_{d1} = + 0.3\ \mu$A)	V_{d1}	= max. —1.3 V
Voltage on diode at diode current start ($I_{d2} = + 0.3\ \mu$A)	V_{d2}	= max. —1.3 V

APPLICATIONS

The EBF 2 is used mainly in I.F. stages with the two diodes serving as detector and for automatic gain control. The data and characteristics apply both to A.C. receivers operating on mains of about 250 V and A.C./D.C. sets on mains of approximately 200 or 100 volts. At mains voltages other than 250 or 200 V, the required screen potential can be calculated from the screen current of 1.6 mA and the potential difference between the supply voltage and the screen voltage of 100 V.

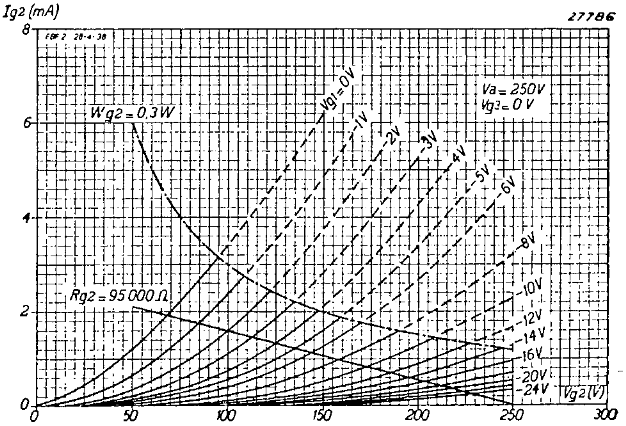

Fig. 6
Screen current as a function of the screen voltage at different values of grid bias. The curves apply roughly to all anode voltages between 100 and 250 V. The diagram also includes the limit line for the maximum continuous load on the screen and the resistance line with respect to a series resistor R_{g2} = 95,000 ohms, at 250 V supply voltage

The characteristics in Figs 3, 4, 7 and 8 relating to I_a and S will then be no longer fully applicable; at 100 V supply voltage the sliding-screen-potential principle is not valid and the screen must be maintained at 100 V. The modulation distortion curve is then certainly less satisfactory, but the valve is none the less quite effective as a normal A.F. amplifier, following a diode detector.

If a potential divider is used instead of a series resistor, careful adjustment of the resistance values will produce a more or less steep mutual conductance curve; the modulation distortion curve is then somewhat modified.

The bias resistor should be decoupled with an electrolytic capacitor of about 25 μF; if this is not done, the rectification, due to the curvature of the I_a/V_{g1} characteristic, produces an A.F. voltage which, when the volume control is turned down, would be applied to the grid of the A.F. amplifier valve. This involves a residual signal and makes it impossible to render the receiver mute.

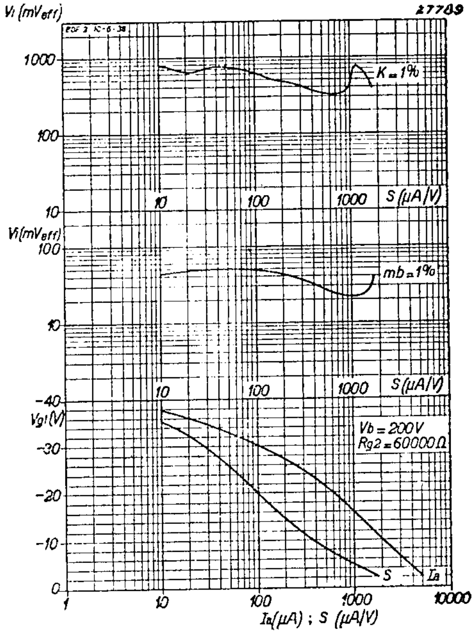

Fig. 8

Upper diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % cross modulation, with a screen series resistor of 60,000 ohms and a supply voltage of 200 V.

Centre diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % modulation hum.

Lower diagram. Mutual conductance S and anode current Ia as a function of the grid bias.

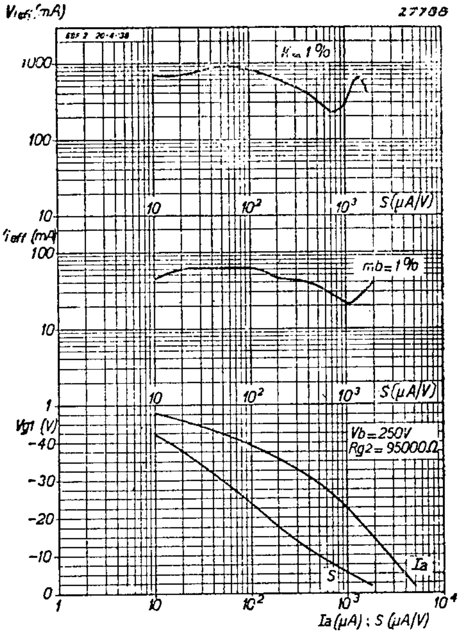

Fig. 7

Upper diagram. Effective alternating grid voltage as a function of the mutual conductance, with 1 % cross modulation, a screen-grid series resistor of 95,000 ohms and a supply voltage of 250 V.

Centre diagram. Effective alternating grid voltage as a function of the mutual conductance, with 1 % modulation hum.

Lower diagram. Mutual conductance S and anode current Ia as a function of the grid bias.

Diode d_2 is preferably used for detection and diode d_1 as rectifier for the A.G.C. In the circuit diagram of Fig. 10 the A.G.C. diode receives its delay voltage from the cathode potential of the EBF 2. To ensure optimum amplification in the uncontrolled condition this voltage should always be kept as low as possible (according to the data it is about 2 V), whereby the A.F. amplification should be such that the strength of the signal on the A.G.C. diode is below the threshold of the delay, with a fully driven output valve.

At the same time, a lower A.F. gain may

be desired, or it may be impossible to obtain the high amplification referred to above, so that special steps have to be taken to provide a higher delay voltage for the A.G.C. if the latter is not to be operative on signals which are insufficient to drive the output valve fully. For the characteristics of the diode section, reference should be made to the relative curves for the EAB 1 and EB 4, which apply also to these valves.

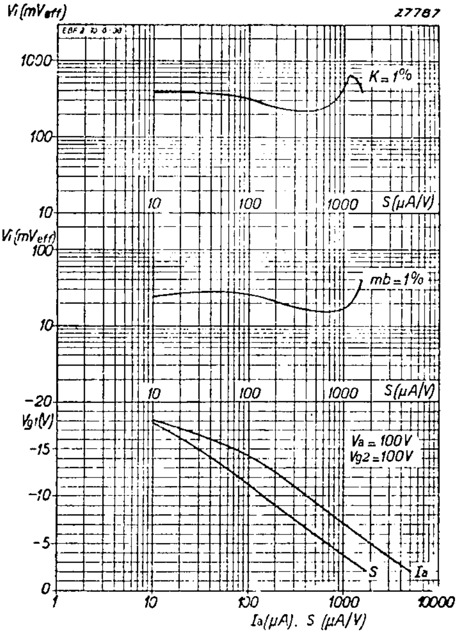

Fig. 9
Upper diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % cross modulation, at $Va = 100$ V; $Vg_2 = 100$ V (fixed screen potential).
Centre diagram. Effective alternating grid voltage as a function of the mutual conductance with 1 % modulation hum.
Lower diagram. Mutual conductance S and anode current Ia as a function of the grid bias.

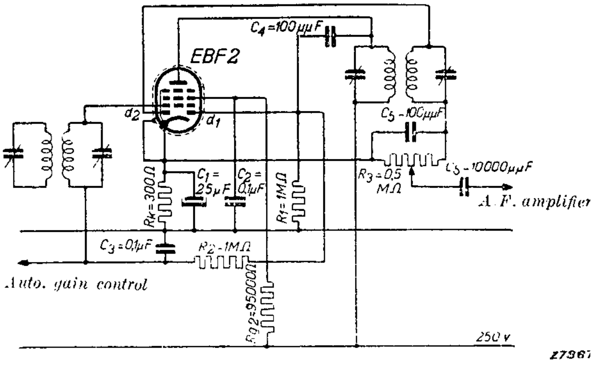

Fig. 10
Circuit diagram showing the EBF 2 employed as I.F. amplifier. Diode d_2 is used for detection and diode d_1 as rectifier for the A.G.C.