EBC 41 Double diode-triode

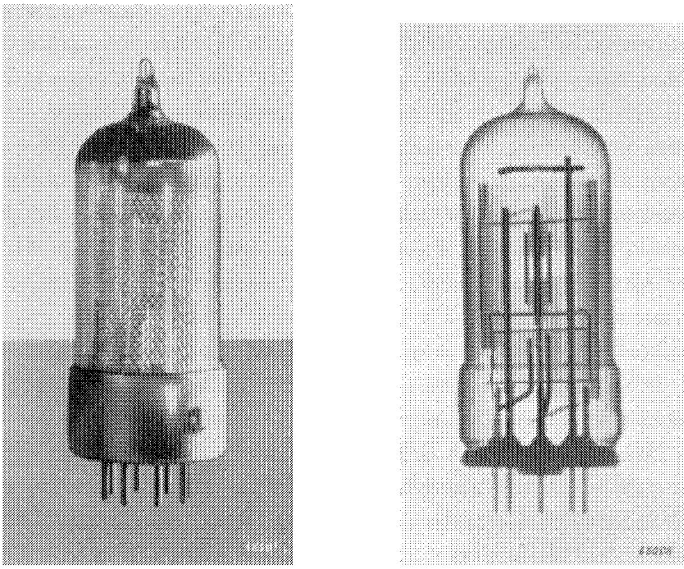

Fig. 1
Normal and X-ray photographs of the EBC 41 (approximately actual size).

The EBC 41 combines a triode with two diodes, having a common cathode ; the diodes can be used for detection and A.G.C., whilst the triode is suitable for A.F. amplification. Owing to the high amplification factor of the triode ($\mu=70$), an A.F. gain of about 50 is obtainable, with roughly 1% distortion. An A.F. gain of this value is rather higher than that generally required for ordinary broadcast receivers, and a certain gain reserve is therefore available to the set designer. This reserve can be utilized very effectively for feedback purposes, since the distortion introduced by the output stage can thus be considerably reduced.
To give an example, when the EL 41 is used as output valve, the EBC 41 should deliver 5.1 V to load fully the EL 41. If the gain of the EBC 41 is 20, the input voltage for this valve would have to be 0.26 V.
If it is intended to use the EBC 41 to furnish a higher gain than is normally required for broadcast receivers, it is essential to take into account that certain undesirable effects — such as hum and microphony — may be encountered, and that appropriate measures must then be taken. Naturally, the gain of the EBC 41 is not the only deciding factor ; the output stage following this valve is also important in this respect and must therefore be taken into account as well. Two factors determine the effect of the output stage on the microphony, namely the electrical gain from input to loudspeaker and the acoustic efficiency of the speaker. Here we are obviously dealing

with the total gain of both the A.F. stage and the output stage ; the amount contributed by each stage to the total gain being immaterial.
When the EBC 41 is used as an A.F. amplifier in conjunction with any particular output stage, the following rule is useful in ascertaining the extent to which the amplification can be increased without involving microphony. The actual value associated with this rule is mentioned in the description of the EAF 42, on page 34.
If the acoustic efficiency of the speaker is 5%, the EBC 41 can be used, without taking steps to prevent microphony, in circuits in which the alternating input voltage necessary to produce an output of 50 mW is not less than 10 mV. If this condition is satisfied, both the input signal and the volume can be increased without any risk of microphony. Assuming that microphony is caused by acoustic feedback from speaker to A.F. amplifier, it thus follows that the occurrence or absence of microphony is dependent only on the total A.F. amplification, and not on the presence of a strong or weak signal.
If the EL 41 be employed as an output valve, the EBC 41 — with the above-mentioned gain of 20 — must deliver 0.32 V to produce an output power of 50 mW ; this necessitates an input voltage of 16 mV, which, according to the foregoing remarks, is generally sufficient to prevent microphony.
Should a higher overall gain be required, it is usually necessary to take certain precautions, e.g. by placing the EBC 41 in an anti-microphonic valveholder, or by providing the valve with an acoustic screen.
In order to prevent undesirable hum voltages from reaching either the control grid or the detector diode (diode d_2), the arrangement and screening of the leads to the valveholder must be given careful attention. The internal capacitances between heater and control grid, and between heater and detector diode, are less than 0.05 pF, and any increase in these capacitances brought about by coupling in the wiring will naturally have an adverse effect on the amount of hum.
The gain for various resistance values is given in the table on page 61. In one of the circuits represented the biasing resistor is omitted, and a grid leak of 10 MΩ is recommended, this circuit being sometimes employed to save components, viz. the biasing resistor and the necessary de-coupling capacitor. The grid bias is then controlled by the grid current. A grid leak of not more than 22 MΩ may be used in this arrangement. A further condition to be observed is that, when a grid leak of such a high value is employed, the valve must not be biased in any other way, since traces of gas are always present in any valve; a flow of ions would otherwise be set up, which, in turn, would produce a voltage across the grid leak, opposed to the applied voltage. Moreover, owing to the fact that the actual quantities of residual gas in different valves vary considerably, the characteristics of the circuit would become very unstable. If the grid bias is obtained from a separate source, the grid leak should not exceed 3 MΩ, so that the variations in question may be kept within reasonable bounds.
In order to avoid hum when a large grid leak is used, it is most important to ensure that the hum voltage impedance in the grid circuit is as low as possible. To this end, a capacitor whose impedance will ensure this should

be connected in parallel with the grid leak. Usually, the coupling capacitor for the detector circuit, in series with the volume control, is sufficient for this purpose.

Of the two diodes in the EBC 41, that which is marked d_2 in the diagram is the most suitable for detection, since the capacitance of this diode with respect to the heater is lower than that of the other ; the hum voltage is thus also lower.

As already mentioned, it is essential so to arrange the diode and heater leads as to reduce the capacitance between them to a minimum.

Diode d_1 can be used for A.G.C. In view of the fact hat this diode is usually connected to the primary of the second I.F. transformer, and the detector diode to the secondary, the capacitance between these diodes and their leads must also be kept as low as possible, to avoid excessive capacitive coupling between the two circuits.

In order to limit as much as possible the effect on the triode section of the A.C. voltages in the diode section, a screen is provided in the envelope between the two sections. Another screen is fitted round the whole of the system, to shield the valve systems from external influences.

TECHNICAL DATA OF THE DOUBLE DIODE-TRIODE EBC 41

Heater data

Heating : indirect, A.C. or D.C., parallel feed

Heater voltage	V_f	=	6.3 V
Heater current	I_f	=	0.23 A

Capacitances (cold valve)

a) *Triode section*

Input capacitance	C_g	=	2.5 pF
Output capacitance	C_a	=	1.7 pF
Anode - grid	C_{ag}	=	1.5 pF
Heater - grid	C_{gf}	<	0.05 pF

b) *Diode section*

Input capacitance, diode 1	C_{d1}	=	0.8 pF
Input capacitance, diode 2	C_{d2}	=	0.7 pF
Between the two diodes	C_{d1d2}	<	0.3 pF
Diode 1 - heater	C_{d1f}	<	0.1 pF
Diode 2 - heater	C_{d2f}	<	0.05 pF

c) *Between diode and triode sections*

Between grid and diode 1	C_{gd1}	<	0.007 pF
Between grid and diode 2	C_{gd2}	<	0.03 pF
Between anode and diode 1	C_{ad1}	<	0.01 pF
Between anode and diode 2	C_{ad2}	<	0.01 pF

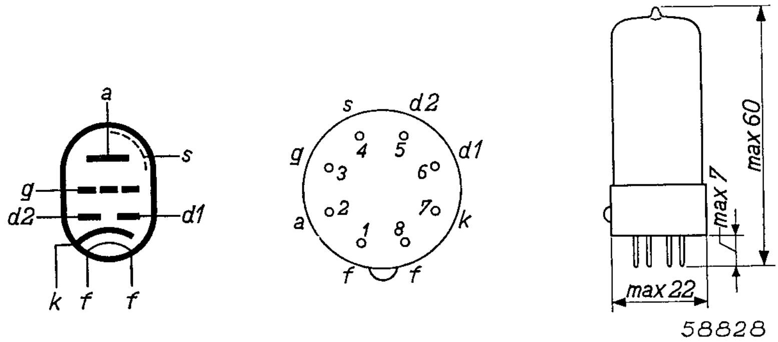

Fig. 2
Electrode arrangement, electrode connections and maximum dimensions of the EBC 41 (dimensions in mm).

Typical characteristics (see Figs. 4 and 5)

Anode voltage	V_a	=	250 V
Grid voltage	V_g	=	—3 V
Anode current	I_a	=	1.0 mA
Slope	S	=	1.2 mA/V
Amplification factor	μ	=	70
Internal resistance	R_i	=	58 kΩ

Operating characteristics of the triode system as A.F. amplifier

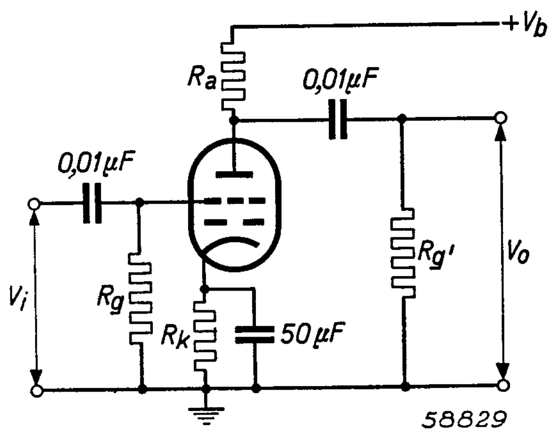

Fig. 3
The EBC 41 used as A.F. amplifier with resistance coupling. R'_g represents the grid leak of the next valve.

For particulars concerning microphony, see page 57.
Supply voltage V_b=250 V.

Anode resistor R_a (MΩ)	Cathode resistor R_k (kΩ)	Grid resistor R_g (MΩ)	Grid resistor of output valve R'_g (MΩ)	Anode current I_a (mA)	Amplification V_o/V_i	Distortion d_{tot} (%) with output voltage V_0 of	
						5 V_{RMS}	10V_{RMS}
0.22	1.8	1	0.68	0.70	51	0.55	0.9
0.1	1.2	1	0.33	1.15	43	0.6	1.1
0.22	0	10	0.68	0.76	52	0.5	0.75
0.1	0	10	0.33	1.40	44	0.7	0.9

Limiting values of the triode system

Anode voltage, valve biased to cut-off	V_{a_0}	= max.	550 V
Anode voltage	V_a	= max.	300 V
Anode dissipation	W_a	= max.	0.5 W
Cathode current	I_k	= max.	5 mA
Grid current starting point	$V_g(I_g=+0.3\mu A)$	= max.	—1.3 V
External resistance between grid and cathode	R_g	= max.	3 MΩ[1]
External resistance between heater and cathode	R_{fk}	= max.	20 kΩ
Voltage between heater and cathode	V_{fk}	= max.	100 V

Limiting values of the diode system

Peak inverse voltage both anodes	$V_{d\,inv\,p}$	= max.	350 V
Current flowing to each anode	I_d	= max.	0.8 mA
Peak current flowing to each anode	I_{dp}	= max.	5 mA
Diode current starting point	$V_d(I_d=+0.3\mu A)$	= max.	—1.3 V
External resistance between heater and cathode	R_{fk}	= max.	20 kΩ
Voltage between heater and cathode	V_{fk}	= max.	100 V

[1]) The value of 3 MΩ is applicable only if the grid bias is obtained from a biasing resistor in the cathode lead. If the grid bias is derived only from a resistor in the grid circuit, the maximum value for R_g is 22 MΩ.

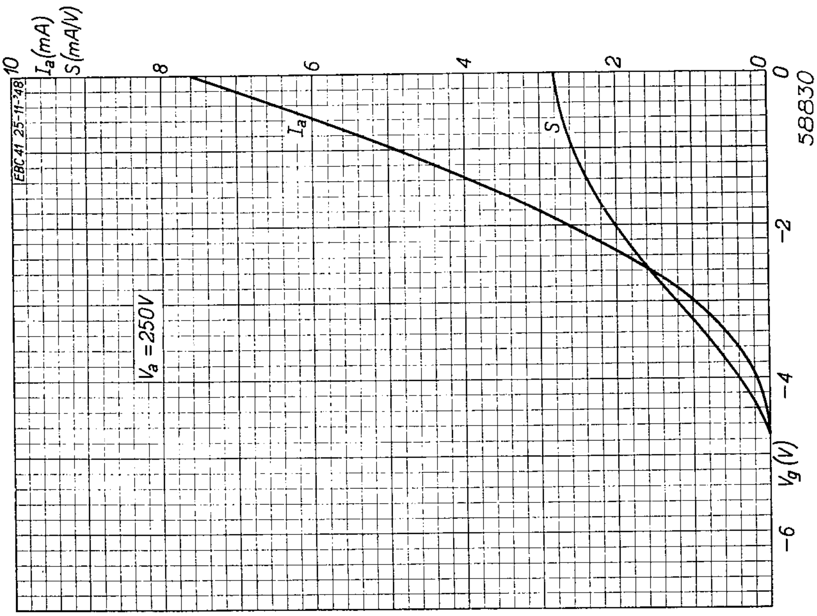

Fig. 4
I_a/V_g and S/V_g characteristics of the EBC 41 for an anode voltage of 250 V.

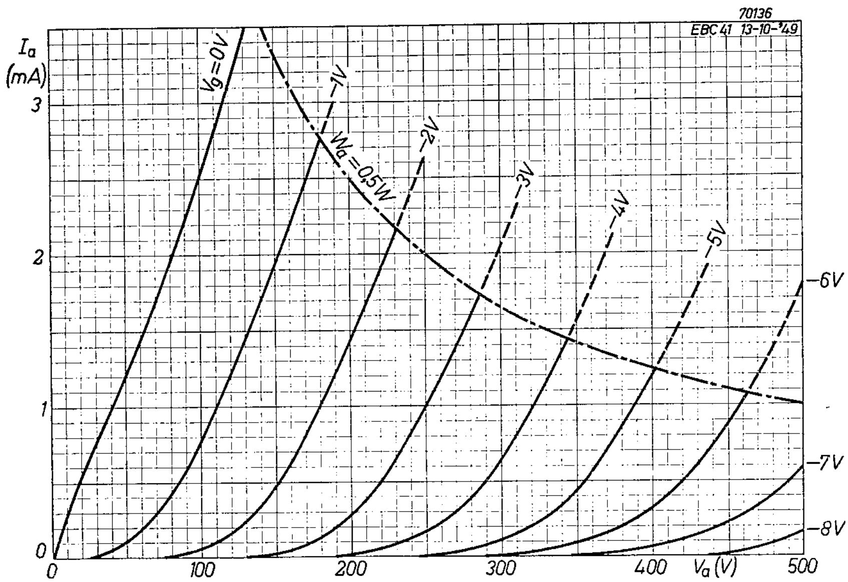

Fig. 5
I_a/V_a characteristics of the EBC 41 for different values of the grid bias V_g. The dotted line indicates the maximum permissible anode dissipation.

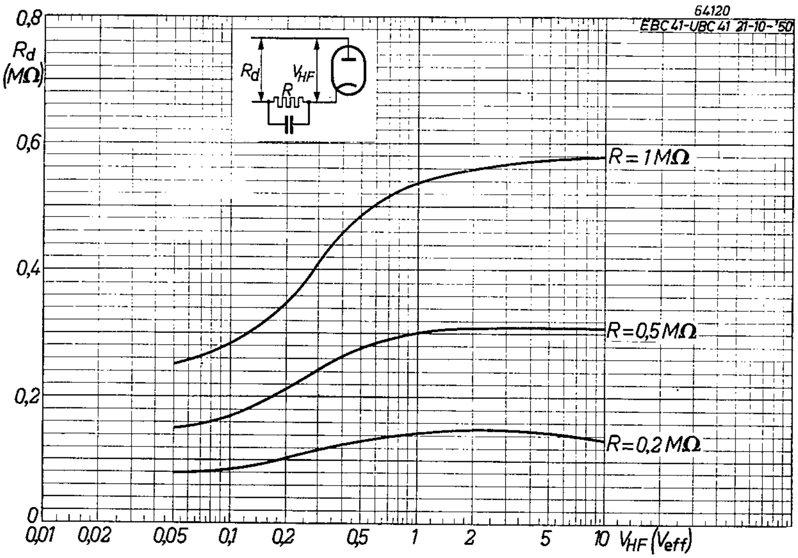

Fig. 6
Diode damping resistance as a function of the R.F. input signal for different values of the diode load resistance.

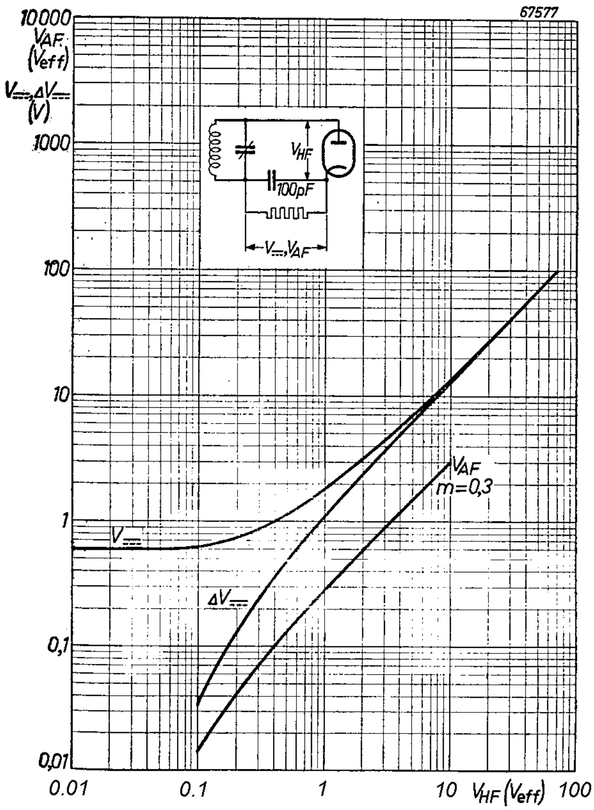

Fig. 7
The D.C. voltage $V=$ and the increase in the D.C. voltage $\Delta V=$ across the resistor in the diode circuit, as a function of the unmodulated R.F. voltage (V_{HF}) on a diode of the EBC 41. Also the A.F. voltage (V_{AF}) across this resistor, as a function of the R.F. voltage moludated to 30% (V_{AF}; $m=0.3$). These characteristics are applicable with resistors of 0.1 to 1 MΩ.