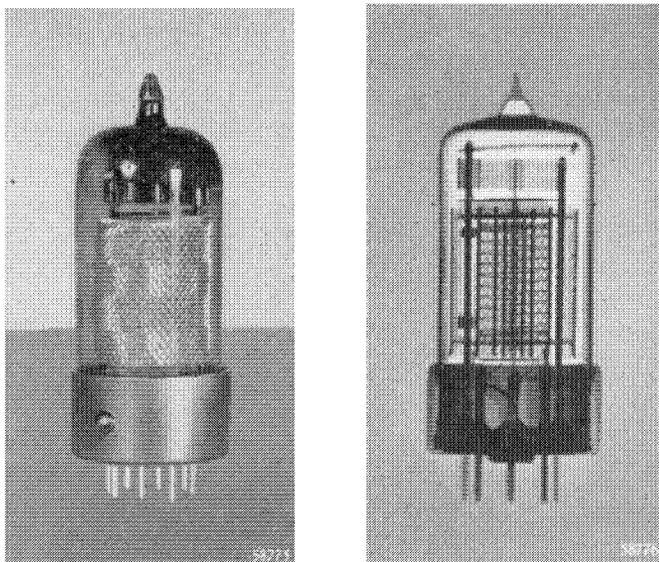# EAF 42 (EAF 41) Diode-Pentode

Fig. 1
Normal and X-ray photos of the EAF 42 (approximately actual size).

The EAF 42 is a diode-pentode having variable-mu characteristics, and can be used with a sliding screen grid voltage ; the pentode section is intended for use as a R.F., I.F., or A.F. amplifier, the slope at the working point being 2.15 mA/V (1.8 mA/V in the EAF 41) and the internal resistance 1.4 MΩ (EAF 41 - 1.2 MΩ). The diode part serves for detection or other purposes such as automatic gain control. There is no very great difference between the electrical characteristics of the EAF 41 and EAF 42 ; the main physical difference lies in the connection of the third grid, for in the EAF 41 this is connected internally to the cathode, whereas in the EAF 42 it has a separate pin in the valve base. This is a distinct advantage in small receivers having only four Rimlock valves, e.g. ECH 42 (or ECH 41) frequency changer, EAF 42 I.F. amplifier, detector and *delayed* gain control, EL 41 output valve and AZ 41 or EZ 40 rectifier. In spite of the small number of valves, a receiver of this type can be quite sensitive, its other qualities being improved by the delay on the gain control. Delay is obtained by employing the separately connected third grid of the EAF 42 as the so-called "delay diode". Further details are given in the following pages. If an EAF 41 be used instead of the EAF 42 in a receiver of this kind, the gain control cannot

be delayed, or at best only with difficulty, and the advantages of this arrangement are then lost[1]).

EAF 42 as I.F. amplifier

In the circuit of Fig. 2 the pentode section of the first valve EAF 42 is used as an I.F. amplifier with a sliding screen grid voltage; the optimum values for the series resistor are indicated in the table at the end of this section. In this circuit a control voltage of about 43 V applied to the control grid reduces the slope to 1/100 of the original value. If the EAF 42 and the ECH 41 or ECH 42 are employed together, the screen grids of the frequency changer
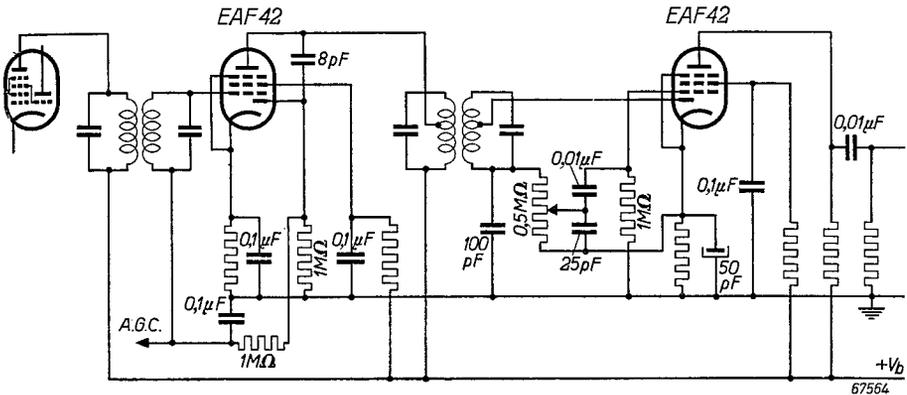

Fig. 2
Circuit diagram showing the EAF 42 as an I.F. amplifier (left-hand valve) and as a resistance-coupled A.F. amplifier (right-hand valve). The diode of the first valve is used for automatic gain control and that of the second as detector ; the values of the resistors not indicated above will be found in the tables at the end of this section.

valve and the I.F. amplifier EAF 42 can be fed from the same potentiometer, thus saving the extra components (see Fig. 3). Further particulars of such a circuit will be found in the description of the ECH 42, whilst data relating to the EAF 42 in this circuit are included among the tables and characteristics at the end of this section.

Adequate screening is ensured by a metal cage surrounding the pentode section of the valve; external screening is therefore unnecessary. Special attention has also been given to the screening between control grid and anode ; the

[1]) For this reason the EAF 41 in its original form is no longer being manufactured, but is replaced by the EAF 42. For replacement purposes in the re-valving of a set, the EAF 42 can take the place of the EAF 41, it being only necessary to short-circuit sockets 4 and 7 of the valveholder (see Fig. 8); in this way the connection between the third grid and the cathode (which is inside the EAF 41) is established externally of the EAF 42. In numerous receivers fitted with the EAF 41 this connection is already established.
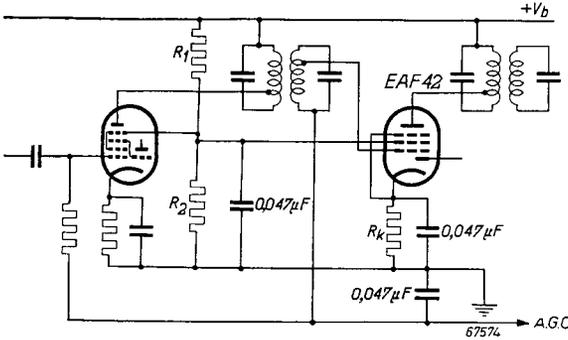
31

Fig. 3

Circuit in which the screen grids of the frequency changer (ECH 41 or ECH 42) and the I.F. amplifier (EAF 42) are fed from a common potentiometer, R_1, R_2.
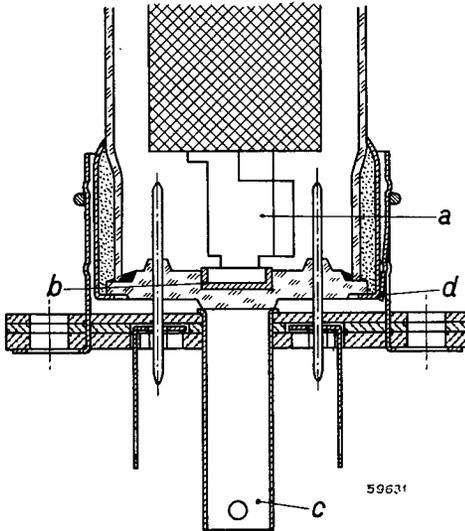

Fig. 4

Screening between anode and control grid in the EAF 42: a is a shield between the diametrically opposite anode and grid pins; b is a metal plate mounted in a recess in the glass base between the pins; c is a metal bush between the contacts of the valveholder.

respective pins are diametrically opposite each other on the base, and a shield is provided between these pins within the envelope (a, Fig. 4). This shield is continued underneath the base of the valve by a metal bush (c), connected to earth, which is fixed in the centre of the valveholder.

In order that the internal and external shielding shall be as continuous as possible, a further metal plate b is mounted in a small recess in the glass base, and is connected to the other shields in the valve. By this means it has been possible to reduce the anode-grid capacitance to something less than 0.002 pF, but in order to maintain this low capacitance it is essential to press the valve well home in the valveholder to minimize the gap between internal and external shields. It is also necessary to see that the metal skirt at the base of the valve is properly earthed (see note on page 18), by bending the lugs on the metal rim of the valveholder before inserting the valve, to ensure proper contact between this earthed rim and the skirt on the valve (see d in Fig. 4).

When calculating the amount of feedback to the grid circuit of the EAF 42 when it is used as an I.F. amplifier, it must be remembered that feedback occurs not only from the anode of the pentode but also from that of the diode. If the latter is employed for automatic gain control, it will usually be connected to the first tuned circuit of the I.F. transformer, to which the pentode anode is also connected. The I.F. voltages on the anodes of the

diode and pentode are thus in phase and of the same order of size, so that the effective feedback capacitance is roughly equal to the anode-to-grid capacitance plus the diode-grid capacitance ($C_{ag1} < 0.002$ pF, $C_{dg1} < 0.0015$ pF); on the other hand, if the diode is used for detection purposes, it is usually connected to the secondary of the I.F. transformer, in which case the diode voltage is $90°$ out of phase with the pentode anode voltage and will have a damping effect on the grid circuit.

In either case the feedback, even when high-quality coils are used ($Q = 180$ to 200), will not have any serious consequences, provided that wiring capacitances are kept as low as possible. This can be achieved by fitting a screening plate under the valveholder, between pins 3 and 4, 6 and 7 (see Figs. 7 and 8).

EAF 42 as A.F. amplifier

In Fig. 2 the second EAF 42 is shown connected as an A.F. amplifier; tables are included in the technical data at the end of this section indicating the amplification and distortion for a number of different circuits, with various combinations of resistors and for several value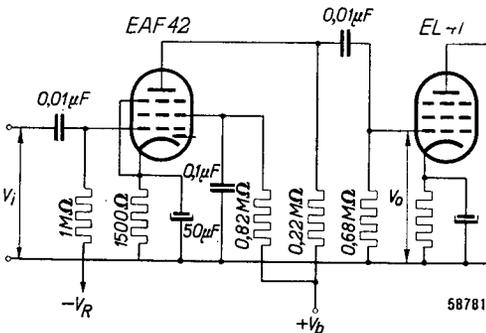s of the control voltage. Fig. 5 is an example of the circuits in question, but, before looking more closely at the details, it may be better to consider the question of hum in the EAF 42 when used as a voltage amplifier, and, in particular, the hum produced by the magnetic field of the heater. As the EAF 42 is a variable-mu valve, it has a variable pitch grid, which means that the pitch of part of the grid is relatively wide, and it would seem to be more especially those electrons that pass between the widely spaced turns of the grid which are affected by the magnetic field produced by the heater. The result is a higher hum voltage than otherwise, especially when gain control is applied, as the greater part of the electrons then find their way through the more widely spaced turns of the grid. It may therefore be concluded that control applied to the A.F. amplifier will generally increase the equivalent hum voltage on the control grid, whilst a variable-mu valve is, from the point of view of hum, not the best kind of valve to use for A.F. amplification.

Fig. 5

Circuit diagram showing the EAF 42 as a resistance-coupled A.F. amplifier with control ($-V_R$) on the grid.

From the tables on page 43 it will be seen that the maximum obtainable amplification is 120, but as such a high gain is not usually required, the reserve can be used for negative feedback purposes and the quality of reproduction thereby considerably improved. A feedback factor of 6 or 7, which will reduce the distortion by the same amount, still leaves a total effective gain of about 20 in the A.F. stage.

Another reason why the full extent of the gain should not be utilized in the case of the EAF 42 is related to the possibility of microphony ; in many cases it will be found necessary to take special precautions in this direction. Some idea of the A.F. gain that may be obtained from the EAF 42 without risk of microphony is given by the fact that a circuit driving a loudspeaker with an acoustic efficiency of 5% will not usually necessitate any special precautions to prevent microphony when the control grid of the EAF 42 requires an A.F. input of at least 10 mV for 50 mW to be delivered to the speaker.

To illustrate the practical significance of this value of 10 mV, let us take the case of a circuit using an EAF 42 as the A.F. pre-amplifier and an EL 41 as the output valve. To produce an output of 50 mW the EL 41 requires an alternating input voltage of 0.32 V: if the voltage amplifier has a gain of 20 — this being usually considered sufficient — it will require an input of 16 mV, and this is well above the minimum value of 10 mV.

In fixing this limit, above which no trouble from microphony is met with, external influences such as cabinet resonance, which impose heavy requirements on the microphonic properties of the valve, have not been taken into account.

In such cases, as also when still more gain is required, it will generally be found necessary to take steps to avoid microphony, such as the use of antimicrophonic valveholders, or a vibration-damping cover on the valve itself. In the table on page 45 the gain of the EAF 42 is given for a grid leak of 10 MΩ, with no cathode resistor. A grid leak of such high value may be used only if no extra source of grid bias is available; the reasons for this will be found in the description of the EBC 41.

Detection and automatic gain control

a. *Detection and A.G.C. using two EAF 42 valves*

In the circuit diagram of Fig. 2 the diode of the second EAF 42 functions as detector, whilst that of the first valve serves for the A.G.C.; the detector diode is connected to the secondary of the I.F. transformer and the A.G.C. diode to the primary. As the diodes are in different valves, there is no need to take any steps to minimize capacitance between them.

In the EAF 42 the diode anode is connected internally to the most suitable pin, to ensure a minimum of coupling between diode and pentode sections, but in order to keep the capacitance between the leads to the respective electrodes as low as possible, it is essential to fit a screening plate below the valveholder, between contacts 3 and 4, and 6 and 7, in the manner shown in Figs. 7 and 8.

Apart from the circuit under review, in which the diode of the A.F. amplifier is used for detection and that of the I.F. amplifier for A.G.C., it is also possible to reverse the functions of these diodes, although there is a disadvantage in so doing, in that, when the volume control is turned right back, any residual signal will be distorted. Such a signal is likely to occur, if only weakly, because the A.F. voltage on the diode of the EAF 42 used as A.F. amplifier tends to reach high values on strong input signals.

There need only be the slightest coupling between this diode and the pentode-anode to convey an A.F. signal to the latter, and, as this anode follows the volume control in the circuit, any such signal will be at once audible in the speaker. When the signal comes from the detector diode it is not distorted, since the A.F. voltage on that diode does not usually suffer from distortion, in contrast with the A.F. voltage on the A.G.C. diode which, owing to the bias voltage employed for the delaying action, is distorted and unpleasant to the ear.

In cases where the bias on the I.F. valve is derived from a cathode resistor, a further consequence of the interchange of the diode functions is that the control voltage increases less rapidly. When control is applied to the I.F. valve in the circuit shown in Fig. 2, the voltage across the cathode resistor, and therefore also the delay voltage for the diode, disappear, and the latter then supplies a higher control voltage.

b. *Detection and A.G.C. using one EAF 42*

As already mentioned, a receiver can be designed round the ECH 42 (or ECH 41), EAF 42, EL 41 and AZ 41 or EZ 40, which, despite the small number of valves, will still be reasonably sensitive. Since a circuit of this kind includes only one diode, this must serve for both detection and A.G.C. There is no objection to this, but, if the EAF 41 is used instead of the EAF 42, it is not a simple matter to delay the A.G.C., since a bias on the diode-anode, as frequently employed to produce the delaying effect, cannot then be used, as this prevents detection of weak signals. Moreover, neither the EAF 41 nor any of the other valves has an electrode suitable for use as so-called delay diode. (The action of such a diode will be explained in the follow-ing.) When the EAF 41 is used, therefore, the A.G.C. must be undelayed, but this involves certain difficulties, which are best illustrated by means of two extreme examples.

In the first case the whole of the rectified voltage from the diode is used for the A.G.C. This results in a very strong gain control and, also, noticeable attenuation of the weaker signals, which is not desirable. Further, with such control the output valve is driven fully only on strong signals. On the other hand, if only a small portion of the rectified voltage is taken for the purpose of A.G.C., these objections are certainly eliminated, but the control is then inadequate in the face of strong signals, and high I.F. voltages occur which, especially on deeply modulated signals, are likely to give rise to modulation distortion.

Naturally, a more or less satisfactory compromise can be made between these evils by allocating a suitable proportion of rectified voltage from the detector to the A.G.C., but better results are usually obtained when the control is delayed so as to attenuate the strong signals and not the weak ones; the output valve is then also able to deliver its full output on fairly weak signals.

The EAF 42 enables such delay to be applied quite conveniently, the separa-tely connected third grid being then employed as "delay diode"; the relative circuit diagram is shown in Fig. 6. A potentiometer comprising R_1 (20 MΩ),

EAF 42

R_2 (1.5 MΩ) and R_3 (2.7 MΩ) is introduced between the H.T. voltage V_b (250 V) and a voltage of —7 V obtained from the bias on the output valve EL 41. The junction A between resistors R_1 and R_2 is connected to the third grid of the EAF 42 and further, through R_4 (1.8 MΩ), to a point B in the detector circuit. From another point C at the junction of resistors R_2 and R_3 the necessary bias —V_R for the control grids of the frequency changer and I.F. amplifier is obtained. The various resistance values are so arranged as to give point A a small positive potential ($V_{g3} < 1$ V) with respect to cathode when no signal is being received.
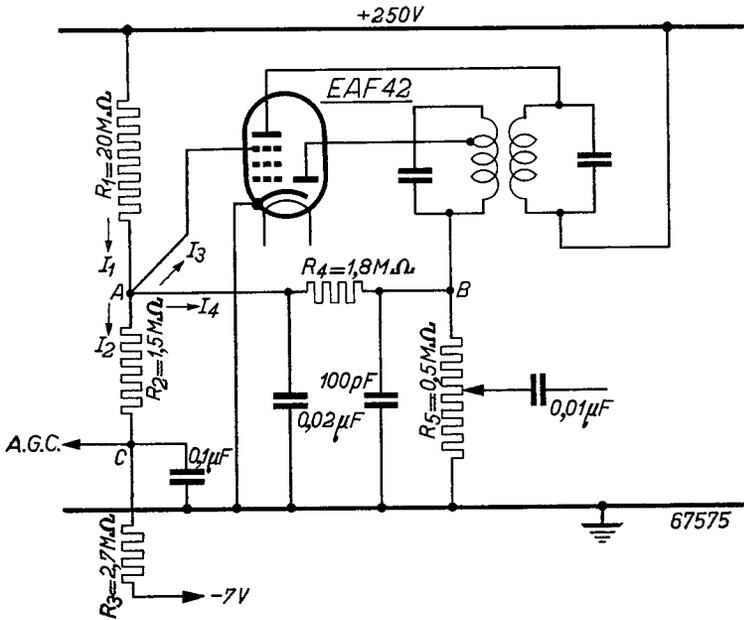
Fig. 6

Circuit diagram showing the EAF 42 used as an I.F. amplifier with the diode employed for detection and A.G.C., the third grid functioning as "delay diode".

By means of the given voltages and resistance values it is a simple matter to calculate that in this case the potential —V_R will be about —2 V. This determines the working point of the frequency changer and I.F. amplifier. The values of the currents to and from point A are also easily computed. It is found that the current I_1 flowing in resistor R_1 is 12.5 µA, the current I_2 in resistor R_2 is 1.9 µA and the current I_4 in resistor R_4 0.4 µA. Voltage V_{g3}, that is the potential at point A, can be expressed to a close approximation as $V_{g3} = V_{g3_0} + I_3 . R_{g3}$, in which V_{g3_0} is the contact potential of the

third grid with respect to cathode and R_{g3} the internal resistance of the third grid, also to cathode.

Now, when an I.F. signal of gradually increasing strength is applied to the diode, the effect of detection is to render point B negative with respect to earth; the current I_4 therefore increases. As current I_1 is kept practically constant by the high resistance of R_1 (20 MΩ), whilst I_2 — and therefore also the variation in I_2 — may be ignored at a first approximation, the increase in I_4 takes place at the cost of I_3. So long as the current I_3 exists, however, the potential at point A will differ but slightly from that of the cathode. If the I.F. signal increases so much that $I_3 = 0$, V_{g3} has decreased from its original small positive value to V_{g3_0}, which also differs only slightly from 0 V. Since the bias on the EL 41 remains unchanged at —7 V, the voltage $-V_R$ does not alter very much either. Thus no control is applied to the frequency changer and I.F. valve so long as the current I_3 flows. However, as soon as the I.F. signal becomes so strong that the current I_3 disappears altogether, the increase in I_4 takes place at the cost of I_2, since I_1 cannot undergo any great change owing to the presence of the series-resistor of 20 MΩ.

From the circuit diagram it will be clearly seen that a reduction in I_2 (whereby I_2 may also change direction) renders C still more negative, so that control is applied to the valves.

Let us now see at what point the control begins to take effect. As mentioned above, this occurs when the current I_3 drops to zero. Now, this current is 10.2 µA in the absence of a signal, which means that the control commences to operate when the current I_4 is increased to about 10 µA by the I.F. signal: in actual fact, I_4 is 10.8 µA at the moment when $I_3 = 0$. A current I_4 of 10.8 µA means that there is a direct voltage of $10.8 \times 1.8 = 19.4$ V across resistor R_4, and this voltage also occurs across the volume control R_5, corresponding at the same time to the peak carrier voltage of the detected I.F. signal. Assuming that the modulation depth of the I.F. signal is 30%, the volume control will carry an A.F. signal of which the R.M.S. voltage is 0.3. $19.4/\sqrt{2}$ $=4.1$ V. At this voltage, which is roughly what is required to load fully the output valve EL 41, the automatic gain control commences to operate. In the foregoing, the various resistance values are introduced without further elucidation; naturally there is a certain freedom of choice in fixing the resistance values, and, with slightly modified conditions, it is quite possible that values other than those indicated would give better results. This point is referred to again in the description of a receiver incorporating the circuit described above (see page 137).

TECHNICAL DATA OF THE DIODE-PENTODE EAF 41

Heater data

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

Heater voltage . . . . . V_f	=	6.3 V
Heater current . . . . . I_f	=	0.2 A

EAF 41

Capacitances (measured on the cold valve)

Pentode section

Input capacitance . . .	C_{g1}'	$=$	4.0 pF
Output capacitance	C_a	$=$	6.5 pF
Anode - control grid . . .	C_{ag1}	$<$	0.002 pF
Heater - control grid . . .	C_{g1f}	$<$	0.05 pF

Diode section

Anode - cathode	C_d	$=$	3.8 pF
Anode - heater	C_{df}	$<$	0.02 pF

Between diode and pentode sections

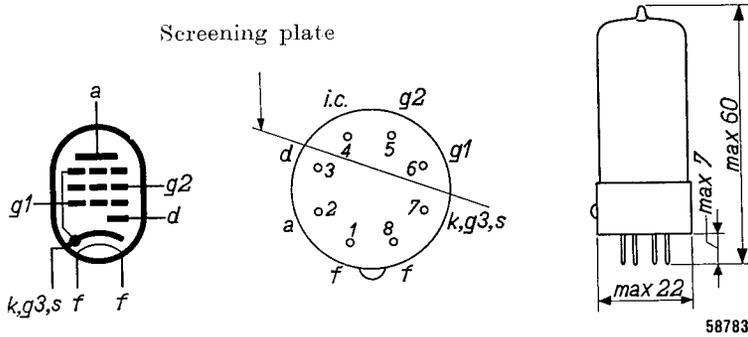|				
Diode anode - pentode control grid	C_{dg1}	$<$	0.0015 pF
Diode anode - pentode anode	C_{da}	$<$	0.15 pF

Fig. 7

Electrode arrangement, electrode connections and maximum dimensions in mm of the EAF 41. The screening plate, indicated by a line through the centre diagram, obviates undesirable coupling in the wiring. The letters i.c. at pin 4 indicate that this pin is internally connected to the electrode system and must not be connected to the external circuit.

Operating characteristics of the pentode section used as a R.F. or I.F. amplifier

(Circuit similar to that of the left-hand EAF 42 in Fig. 2)

Anode and supply voltage	$V_a = V_b$	=	250	V
Screen grid resistor	R_{g2}	=	95	kΩ
Cathode resistor	R_k	=	300	Ω
Grid bias	V_{g1}	=	−2 −40	V
Screen grid voltage	V_{g2}	=	100 250	V
Anode current	I_a	=	5.0 —	mA
Screen grid current	I_{g2}	=	1.6 —	mA
Mutual conductance . . .	S	=	1800 18	μA/V
Internal resistance	R_i	=	1.2 >10	MΩ
Equivalent noise resistance .	R_{eq}	=	9.0 —	kΩ
Amplification factor of grid 2 with respect to grid 1 . .	μ_{g2g1}	=	19 —	

Operating characteristics of the pentode section used as a resistance-coupled A.F. amplifier (circuit similar to Fig. 5)

A. Supply voltage V_b=250 V   Anode resistor R_a=0.2 MΩ
   Cathode resistor R_k=1.6 kΩ   Screen grid resistor R_{g2}=0.8 MΩ

Control voltage −V_R(V)	Anode current I_a(mA)	Screen grid current I_{g2} (mA)	Amplification V_o/V_i	Distortion (%) for an output of		
				3 V$_{RMS}$	5 V$_{RMS}$	10 V$_{RMS}$
0	0.86	0.28	105	1.0	1.5	2.7
5	0.68	0.22	33	1.0	1.6	3.5
10	0.56	0.18	21	1.1	1.8	3.9
18	0.39	0.12	12	1.3	2.0	5.0
25	0.24	0.08	8	1.8	2.8	7.5

B. Supply voltage V_b=250 V   Anode resistor R_a=0.1 MΩ
   Cathode resistor R_k=900 Ω   Screen grid resistor R_{g2}=0.4 MΩ

Control voltage −V_R(V)	Anode current I_a(mA)	Screen grid current I_{g2} (mA)	Amplification V_o/V_i	Distortion (%) at an output of		
				3 V$_{RMS}$	5 V$_{RMS}$	10 V$_{RMS}$
0	1.57	0.50	85	0.9	1.3	2.5
5	1.18	0.37	29	1.1	1.6	3.5
10	0.91	0.28	16	1.3	2.2	4.1
18	0.60	0.18	9.5	1.6	2.8	5.5
25	0.36	0.12	6	2.5	4.1	9.0

**Operating characteristics of the pentode section used as a resistance-coupled
A.F. triode** (screen grid connected to anode).

A. Supply voltage $V_b=250$ V   Anode resistor $R_a=0.1$ MΩ
   Cathode resistor $R_k=900$ Ω

Control voltage $-V_R(V)$	Anode current I_a+I_{g2}(mA)	Amplification V_o/V_i	Distortion (%) at an output of		
			3 V_{RMS}	5 V_{RMS}	10 V_{RMS}
0	1.96	15.5	1.4	2.0	5.2
5	1.40	8	1.0	1.7	3.8
10	1.10	6	0.9	1.4	3.0
18	0.75	4.5	1.2	1.6	3.3
25	0.45	3.3	1.6	2.2	5.2

B. Supply voltage $V_b=250$ V   Anode resistor $R_a=0.05$ MΩ
   Cathode resistor $R_k=500$ Ω

Control voltage $-V_R(V)$	Anode current I_a+I_{g2}(mA)	Amplification V_o/V_i	Distortion (%) at an output of		
			3 V_{RMS}	5 V_{RMS}	10 V_{RMS}
0	3.60	15.5	1.1	1.8	3.8
5	2.50	8	1.3	2.0	4.5
10	1.85	5.9	1.1	1.7	4.0
18	1.14	3.8	1.5	2.0	5.0
25	0.65	2.8	2.4	3.5	8.0

Limiting values of the pentode section

Anode voltage, valve biased to cut-off	V_{a_c}	= max.	550 V
Anode voltage	V_a	= max.	300 V
Anode dissipation	W_a	= max.	2 W
Screen grid voltage, valve biased to cut-off	V_{g2_0}	= max.	550 V
Screen grid voltage, with control	$V_{g2}(I_a<2.5$ mA)	= max.	300 V
Screen grid voltage, without control	$V_{g2}(I_a=5$ mA)	= max.	125 V
Screen grid dissipation . . .	W_{g2}	= max.	0.3 W
Cathode current	I_k	= max.	10 mA
Grid current starting point .	$V_{g1}(I_{g1}=+0.3$ μA)	= max.	—1.3 V
External resistance between grid 1 and cathode . . .	R_{g1}	= max.	3 MΩ
External resistance between heater and cathode . . .	R_{fk}	= max.	20 kΩ
Voltage between heater and cathode	V_{fk}	= max.	50 V

Limiting values of the diode section

Peak inverse anode voltage .	$V_{d \, inv \, p}$	$=$ max.	350 V
Diode current	I_d	$=$ max.	0.8 mA
Peak diode current	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.	50 V

TECHNICAL DATA OF THE DIODE-PENTODE EAF 42

Heater data

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

Heater voltage	V_f	$=$	6.3 V
Heater current	I_f	$=$	0.2 A

Capacitances

Pentode section

Input capacitance . . .	C_{g1}	$=$	4.1 pF
Output capacitance	C_a	$=$	5.2 pF
Anode - control grid . . .	C_{ag}	$<$	0.002 pF
Heater - control grid . . .	C_{g1f}	$<$	0.05 pF

Diode section

Anode - cathode	C_d	$=$	3.3 pF
Anode - heater	C_{df}	$<$	0.02 pF

Between diode and pentode sections

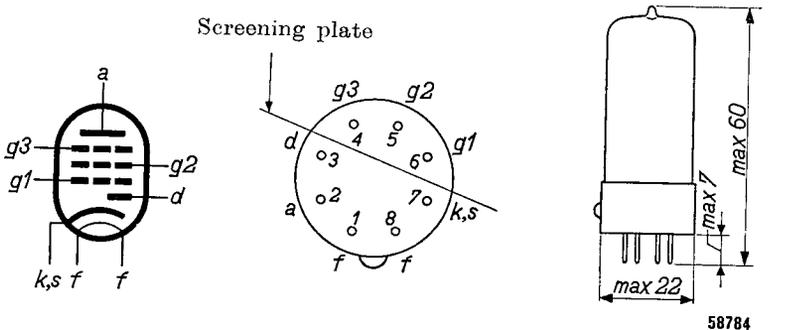|			
Diode anode - pentode control grid	C_{dg1}	$<$	0.0015 pF
Diode anode - Pentode anode	C_{da}	$<$	0.15 pF

Fig. 8
Electrode arrangement, electrode connections and maximum dimensions in mm of the EAF 42. The screening plate shown in the centre diagram serves to reduce unwanted coupling in the wiring.

EAF 42

Operating characteristics of the pentode section used as a R.F. or I.F. amplifier

(For circuit diagram see left-hand EAF 42 in Fig. 2.)

Anode and supply voltage	$V_a = V_b$	=	250	V
Voltage, third grid	V_{g3}	=	0	V
Screen grid resistor	R_{g2}	=	110	kΩ
Cathode resistor	R_k	=	310	Ω
Grid bias	V_{g1}	=	—2	—43 V
Screen grid voltage	V_{g2}	=	85	250 V
Anode current	I_a	=	5.0	— mA
Screen grid current	I_{g2}	=	1.5	— mA
Mutual conductance	S	=	2000	20 μA/V
Internal resistance	R_i	=	1.4	>10 MΩ
Equivalent noise resistance	R_{cq}	=	7.5	— kΩ
Amplification factor of grid 2 in respect of grid 1	μ_{g2g1}	=	16	—

Anode and supply voltage	$V_a = V_b$	=	250	V
Voltage, third grid	V_{g3}	=	0	V
Screen grid resistor	R_{g2}	=	68	kΩ
Cathode resistor	R_k	=	220	Ω
Grid bias	V_{g1}	=	—2	—43 V
Screen grid voltage	V_{g2}	=	105	— V
Anode current	I_a	=	6.9	— mA
Screen grid current	I_{g2}	=	2.1	— mA
Mutual conductance	S	=	2150	21.5 μA/V
Internal resistance	R_i	=	1.4	>10 MΩ
Equivalent noise resistance	R_{cq}	=	9	— kΩ
Amplification factor of grid 2 in respect of grid 1	μ_{g2g1}	=	16	—

Operating characteristics of the pentode section used as a R.F. or I.F. amplifier

(Screen grids of E AF 42 and ECH 41 fed by means of a common potentiometer; see Fig. 3, page 32. For details of the ECH 41 in this circuit, see page 69.)

Anode and supply voltage	$V_a = V_b$	=	250	V
Voltage, third grid	V_{g3}	=	0	V
Potentiometer for screen grid	R_1	=	18	kΩ
voltage supply	R_2	=	27	kΩ
Cathode resistor	R_k	=	220	Ω
Grid bias	V_{g1}	=	—2	—23.5 V
Screen grid voltage	V_{g2}	=	105	147 V
Anode current	I_a	=	6.9	— mA
Screen grid current	I_{g2}	=	2.1	— mA
Mutual conductance	S	=	2150	21.5 μA/V
Internal resistance	R_i	=	1.4	>10 MΩ
Equivalent noise resistance	R_{cq}	=	9	— kΩ
Amplification factor of grid 2 with respect to grid 1	μ_{g2g1}	=	16	—

Operating characteristics of the pentode section used as a R.F. or I.F. amplifier
(Screen grids of the EAF 42 and ECH 42 fed by means of a common poten-
tiometer, see Fig. 3, page 32. For details of the ECH 42 in this circuit, see
page 80.)

Anode and supply voltage .	$V_a = V_b$	= 250	V
Voltage, third grid	V_{g3}	= 0	V
Potentiometer for screen grid ⎰ R_1		= 22	kΩ
voltage supply . . . . ⎱ R_2		= 27	kΩ
Cathode resistor	R_k	= 310	Ω
Grid bias	V_{g1}	= −2 −20.5	V
Screen grid voltage . . .	V_{g2}	= 85 137	V
Anode current	I_a	= 5.0 —	mA
Screen grid current	I_{g2}	= 1.5 —	mA
Mutual conductance . . .	S	= 2000 20	μA/V
Internal resistance	R_i	= 1.4 >10	MΩ
Equivalent noise resistance .	R_{eq}	= 7.5 —	kΩ
Amplification factor of grid 2			
in respect of grid 1 . . .	μ_{g2g1}	= 16 —	

**Operating characteristics of the pentode section used as a resistance-coupled
A.F. amplifier** (Fig. 5)

A. Supply voltage V_b=250 V   Anode resistor R_a=0.22 MΩ
   Cathode resistor R_k=1.5 kΩ   Screen grid resistor R_{g2}=0.82 MΩ

Control voltage −V_R(V)	Anode current I_a (mA)	Screen grid current I_{g2} (mA)	Amplification V_o/V_i	Distortion (%) at an output of		
				3 V_{RMS}	5 V_{RMS}	8 V_{RMS}
0	0.80	0.26	120	0.9	1.0	1.2
5	0.65	0.20	40	1.3	1.5	2.5
10	0.52	0.17	23	1.3	1.6	2.7
15	0.41	0.14	16	1.5	2.0	3.2
20	0.31	0.11	11	1.8	2.7	5.5

B. Supply voltage V_b=250 V   Anode resistor R_a=0.1 MΩ
   Cathode resistor R_k=680 Ω   Screen grid resistor R_{g2}=0.39 MΩ

Control voltage −V_R(V)	Anode current I_a (mA)	Screen grid current I_{g2} (mA)	Amplification V_o/V_i	Distortion (%) at an output of		
				3 V_{RMS}	5 V_{RMS}	8 V_{RMS}
0	1.52	0.53	100	0.8	0.9	1.0
5	1.20	0.40	35	1.0	1.4	2.4
10	0.94	0.30	20	1.2	2.0	3.2
15	0.70	0.23	13	1.4	2.3	3.7
20	0.52	0.17	9	1.8	3.0	6.0

Operating characteristics of the pentode section used as a resistance-coupled A.F. amplifier triode (screen grid connected to anode)

A. Supply voltage $V_b = 250$ V   Anode resistor $R_a = 0.1$ MΩ
     Cathode resistor $R_k = 680$ Ω

Control voltage $-V_R(V)$	Anode current $I_a + I_{g2}$(mA)	Ampli- fication V_o/V_i	Distortion (%) at an output of		
			3 V_{RMS}	5 V_{RMS}	8 V_{RMS}
0	2.00	15	0.9	1.1	1.2
5	1.50	8.5	1.1	1.6	2.4
10	1.17	6	1.1	1.6	2.4
15	0.90	5	1.1	1.6	2.4
20	0.68	4	1.2	1.7	2.6

B. Supply voltage $V_b = 250$ V   Anode resistor $R_a = 0.05$ MΩ
     Cathode resistor $R_k = 390$ Ω

Control voltage $-V_R(V)$	Anode current $I_a + I_{g2}$(mA)	Ampli- fication V_o/V_i	Distortion (%) at an output of		
			3 V_{RMS}	5 V_{RMS}	8 V_{RMS}
0	3.80	14	0.7	0.9	1.1
5	2.70	9	1.1	1.6	2.6
10	2.00	6.5	1.1	1.6	2.6
15	1.44	5	1.1	1.6	2.6
20	1.05	4	1.4	2.2	3.4

Operating characteristics of the pentode section used as a resistance-coupled A.F. amplifier, with a large leak resistance in the grid circuit
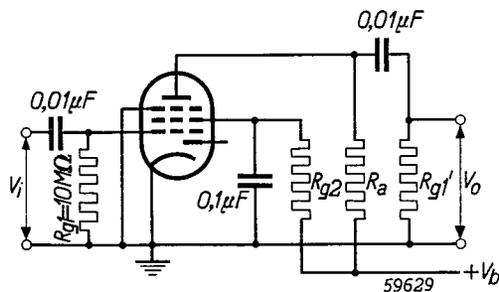
Fig. 9

A. *Pentode connection*

Supply voltage	V_b	=	250	250 V
Anode resistor	R_a	=	0.22	0.1 MΩ
Screen grid resistor	R_{g2}	=	1.0	0.39 MΩ
Grid leak	R_{g1}	=	10	10 MΩ
Grid leak of output valve	R_{g1}'	=	0.68	0.33 MΩ
Anode current	I_a	=	0.76	1.60 mA
Screen grid current	I_{g2}	=	0.23	0.56 mA
Amplification	V_o/V_i	=	160	100
Distortion at an output of				
3 V_{RMS}	$d_{tot}(V_o=3\ V_{RMS})$	=	0.55	0.35 %
5 V_{RMS}	$d_{tot}(V_o=5\ V_{RMS})$	=	0.75	0.55 %
8 V_{RMS}	$d_{tot}(V_o=8\ V_{RMS})$	=	1.0	0.7 %

B. *Triode connection* (screen grid connected to anode)

Supply voltage	V_b	=	250	250 V
Anode resistor	R_a	=	0.1	0.047 MΩ
Grid leak	R_{g1}	=	10	10 MΩ
Grid leak of output valve	R_{g1}'	=	0.33	0.15 MΩ
Anode current	I_a	=	2.15	4.50 mA
Amplification	V_o/V_i	=	14	13.5
Distortion at an output of				
3 V_{RMS}	$d_{tot}(V_o=3\ V_{RMS})$	=	0.7	0.5 %
5 V_{RMS}	$d_{tot}(V_o=5\ V_{RMS})$	=	1.2	0.8 %
8 V_{RMS}	$d_{tot}(V_o=8\ V_{RMS})$	=	2.0	1.4 %

Limiting values of the pentode section

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.	2 W
Screen grid voltage, valve biased to cut-off	V_{g2_0}	= max.	550 V
Screen grid voltage, controlled valve	$V_{g2}(I_a<2.5\ mA)$	= max.	300 V
Screen grid voltage, without control	$V_{g2}(I_a=5\ mA)$	= max.	125 V
Screen grid dissipation	W_{g2}	= max.	0.3 W
Cathode current	I_k	= max.	10 mA
Grid current starting point	$V_{g1}(I_{g1}=+0.3\ \mu A)$	= max.	—1.3 V
External resistance between grid 1 and cathode	R_{g1}	= max.	3 MΩ[1])

[1]) If the working point of the valve is determined only by the potential difference across the grid leak (R_{g1}), i.e. no separate source of bias and no cathode resistor, the maximum value of R_{g1} may be increased to 22 MΩ.

EAF 42

External resistance between
grid 3 and cathode . . . R_{g3} = max. 3 MΩ
External resistance between
heater and cathode . . . R_{fk} = max. 20 kΩ
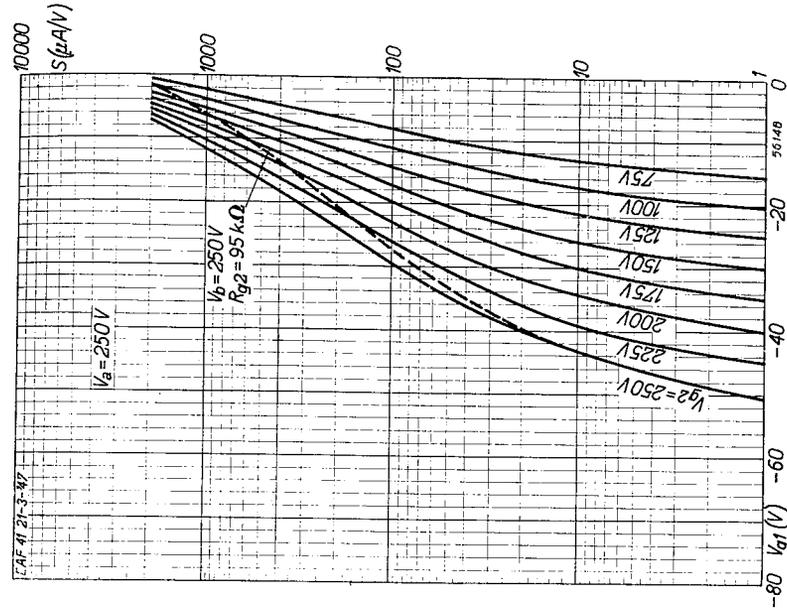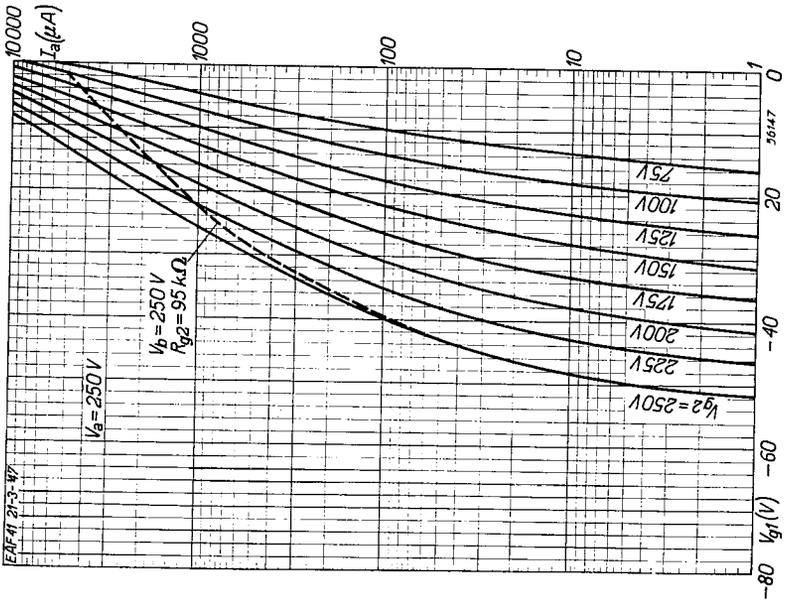Voltage between heater and
cathode . . . . . V_{fk} = max. 100 V

Limiting values of the diode section

Peak inverse anode voltage . $V_{d\,\text{inv}\,p}$ = max. 350 V
Diode current . . . . . I_d = max. 0.8 mA
Peak diode current . . . . I_{dp} = max. 5 mA
Diode current starting point $V_d(I_d = +0.3\ \mu\text{A})$ = 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

Fig. 11

Fig. 10

Anode current (Fig. 10) and mutual conductance (Fig. 11) of the EAF 41 as functions of the grid bias for different screen grid voltages. The broken lines represent the anode current and slope with a 95 kΩ-resistor in series with the screen grid.
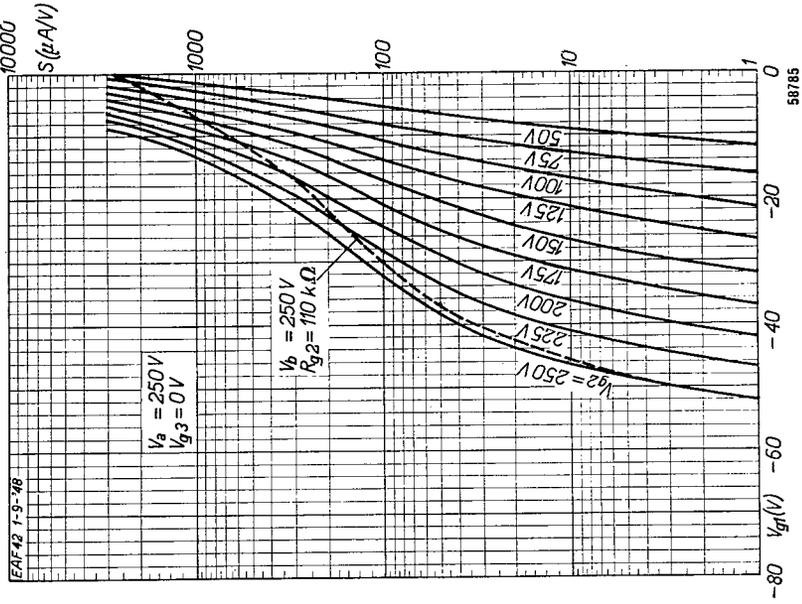
Fig. 12

Fig. 13

Anode current (Fig. 12) and mutual conductance (Fig. 13) of the EAF 42 as functions of the grid bias for various screen grid voltages. The broken lines represent the anode current and slope of the I.F. valve EAF 42 in the circuit of Fig. 2.

EAF42 1-9-'48

$V_b = 250 V$
$R_{g2} = 110 k\Omega$
$V_{g3} = 0 V$

10000
$S (\mu A/V)$
$I (\mu A)$
$R_i (M\Omega)$
$R_{eq} (k\Omega)$

1000

I_a

I_{g2}

S

100

R_{eq}

10

R_i

1

−80 $V_{g1}(V)$ −60 −40 −20 0

58786
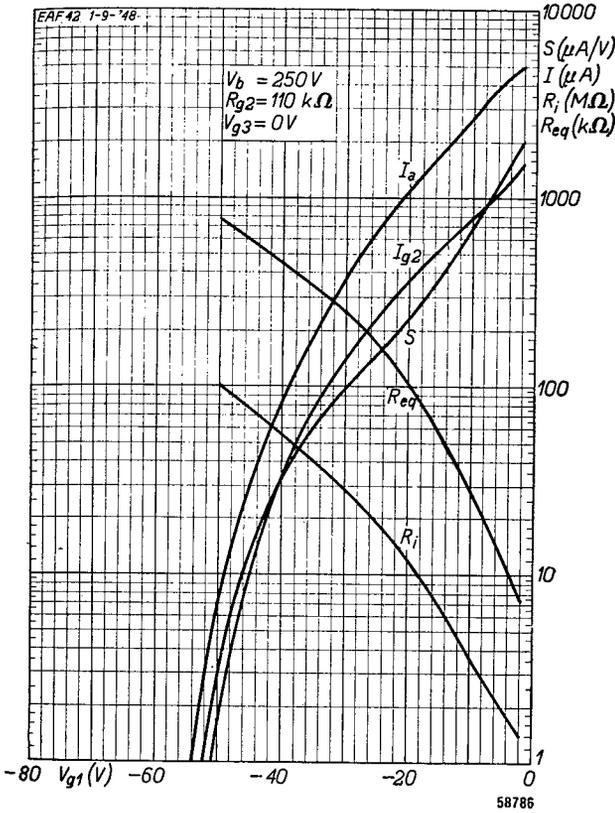
Fig. 14
Anode current (I_a), screen grid current (I_{g2}), mutual conductance (S), internal resistance (R_i) and equivalent resistance (R_{eq}) of the pentode section of the EAF 42 as functions of the grid bias, measured in the I.F. circuit shown in Fig. 2.

Fig. 15
R.M.S. voltage (V_i) of an interfering signal at the grid of the EAF 42, producing 1% cross modulation (curve $K = 1\%$), together with the R.M.S. value (V_i) of a hum voltage at the grid, resulting in 1% modulation hum (curve $m_b = 1\%$), measured as a function of the mutual conductance in the I.F. circuit shown in Fig. 2.

V_i
(mV_{eff})
10000

64158
EAF 42 11-11-'49

$V_b = 250V$
$R_{g2} = 110 k\Omega$
$V_{g3} = 0V$

1000

$K = 1\%$

100

$mb = 1\%$

10

1 10 100 1000 $S (\mu A/V)$ 10000

49
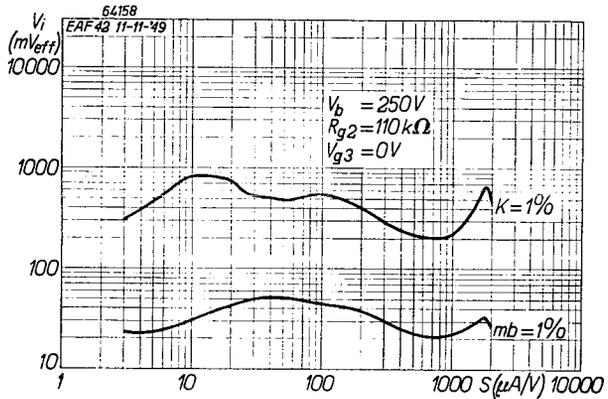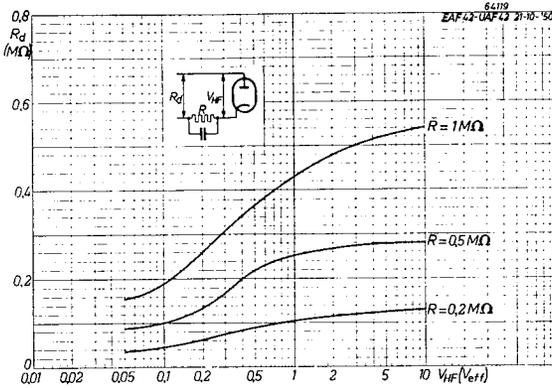
Fig. 16
Diode damping as a function of the applied R.F.
voltage, for different values of the diode load
resistance. This applies equally well to the
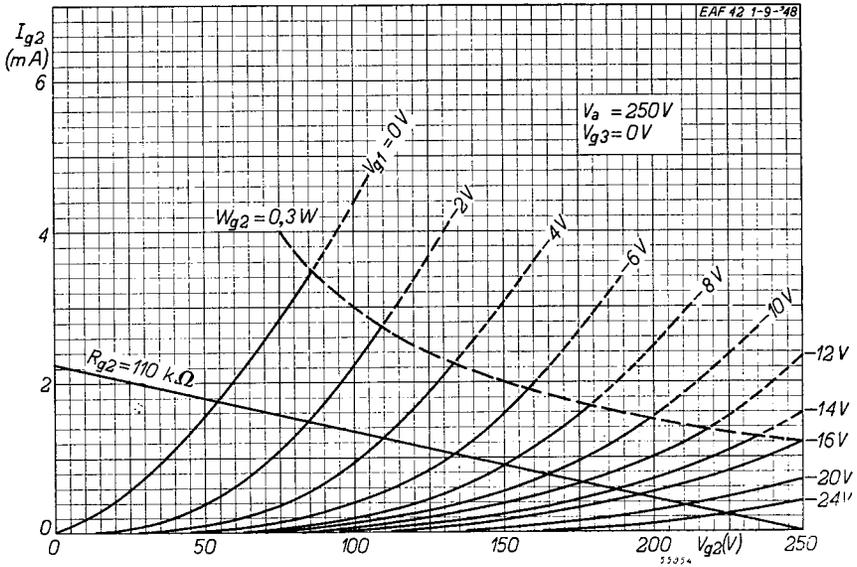diodes of the EAF 41 and the EAF 42.

Fig. 17
Screen grid current (I_{g2}) of the pentode section of the EAF 42
as a function of the screen grid voltage (V_{g2}), with grid bias (V_{g1})
as parameter. The broken line indicates the maximum screen grid
dissipation (0.3 W). The straight line refers to a series resistor of
110 kΩ in the screen grid circuit (see Fig. 2).
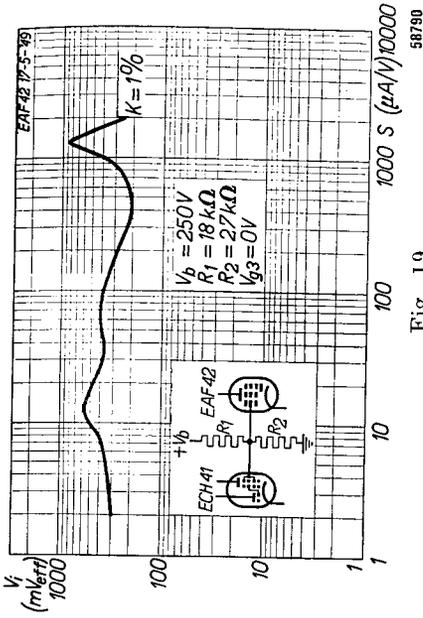
Fig. 19
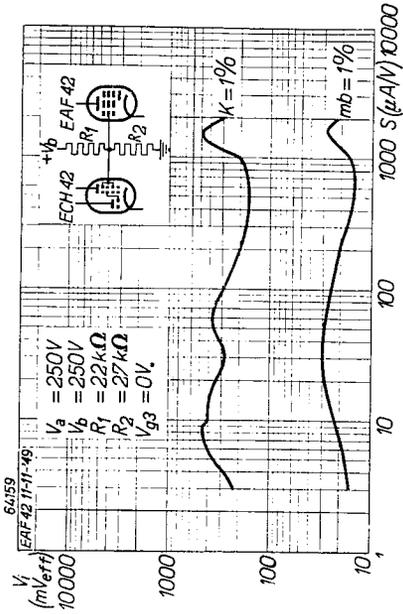
Fig. 18

Fig. 20
As Fig. 15. The screen grids of the EAF 42
and frequency changer ECH 41 (Fig. 19) or
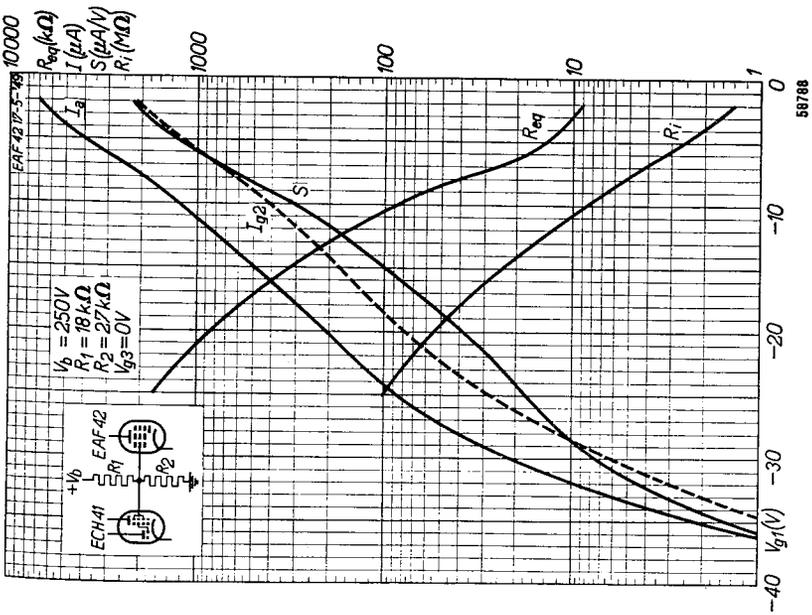ECH 42 (Fig. 20) are fed by means of a common
potentiometer.

As Fig. 14. In this case the screen grid volt-
age for the EAF 42 is derived from a poten-
tiometer together with that of the ECH 41
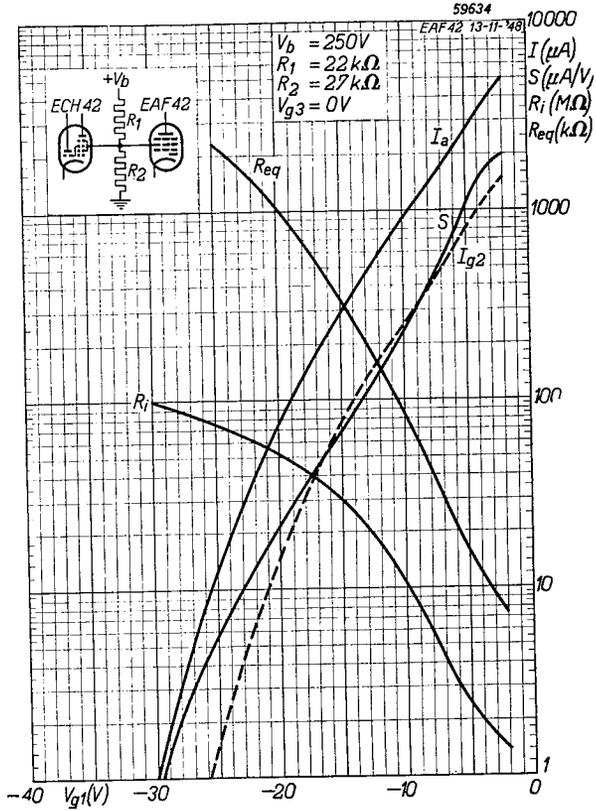(see Fig. 3).

Fig. 21
As Fig. 14, but with the screen grids of the
EAF 42 and frequency changer ECH 42
fed by means of a common potentiometer
(see Fig. 3).