DAH 50 Diode heptode with space-charge grid

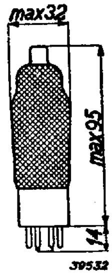
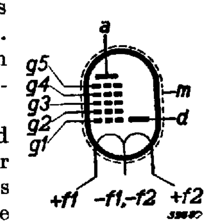


Fig. 1
Dimensions in mm.

As the type number indicates, the DAH 50 consists of a diode and a heptode. In contrast with existing combination valves in which the different electrode-systems are mounted one above the other, the diode and heptode of the DAH 50 are assembled side by side and separated from each other by a screen.

The heptode should be regarded as a pentode with two special grids (see Fig. 3): between the filament (1) and the first grid (6) of the pentode part there is an auxiliary electrode (2), consisting of two rods (connected to the filament), between which electrons are bunched and forced to travel along certain paths. The second grid (4) is a space-charge grid. As the reader will be aware, the latter makes it possible for the valve to operate on a very low anode voltage: this grid is maintained at the same potential as the anode and draws away electrons from the cathode, so that a virtual cathode (5) is established immediately in front of the control grid of the pentode. It has been found possible by this means to operate the valve at an anode voltage of at most 15 V, at which potential the mutual conductance is 0.65 mA/V.



Taking these two electrodes into account, the valve may be looked upon as a heptode. The diode and heptode systems each have their own filaments, the two being connected in series; one end of each is attached to one of the pins of the valve, and the other ends are joined inside the valve, the centre point being likewise connected to one of the pins.

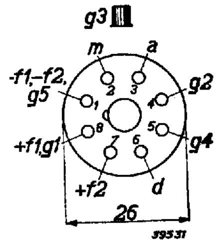


Fig. 2.
Arrangement and sequence of contacts.

The voltage per filament is 1.4 V and the current 25 mA; the filaments can accordingly be employed in series or in parallel, as desired. In parallel the filament voltage is 1.4 V and the current 50 mA, whilst in series the voltage is 2.8 V and the current 25 mA: however, if only one section of the valve is used, namely either the diode or the heptode, the filament voltage will be 1.4 V and the current only 25 mA.

The very low voltages on which the DAH 50 operates make it suitable for use in extremely small receivers; for example, a 15 V battery for the anode and a pencil battery of 1.4 V for the filament, or 4 pocket-torch batteries of 4.5 V for both filament and anode may be used. Naturally, the output is not sufficiently high to drive a loudspeaker.

The DAH 50 is quite suitable for short-wave reception, since the input impedance is still very good at wavelengths down to 6 metres. The valve is equipped with the 8-pin base, with centre pilot.

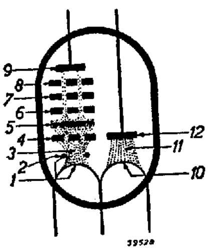


Fig. 3
Diagram showing the working of the DAH 50. 1) = filament, 2) = auxiliary electrode for bunching the electrons 3, 4) = space-charge grid, 5) = virtual cathode, 6) = control grid, 7) = screen grid, 8) = suppressor grid, 9) = anode of the heptode section, 10) = filament of the diode section, 11) = electron stream in the diode, 12) = anode of diode.

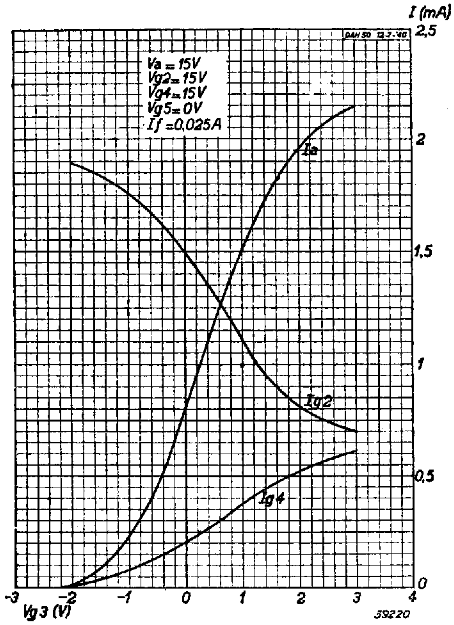


Fig. 4
Anode current, space-charge grid current and screen grid current as function of the grid bias on grid 3 (control grid), at $Va = Vg_2 = Vg_4 = 15$ V.

FILAMENT RATINGS

Heating: direct, by means of a battery; series or parallel.

Heptode section	pins 1 and 8	filament voltage	V_f = 1.4 V
		filament current	I_f = 0.025 A
Diode section	pins 1 and 7	filament voltage	V_f = 1.4 V
		filament current	I_f = 0.025 A
Diode-heptode	pins 1 and 7 + 8 (parallel)	filament voltage	V_f = 1.4 V
		filament current	I_f = 0.050 A
	pins 7 and 8 (series)	filament voltage	V_f = 2.8 V
		filament current	I_f = 0.025 A

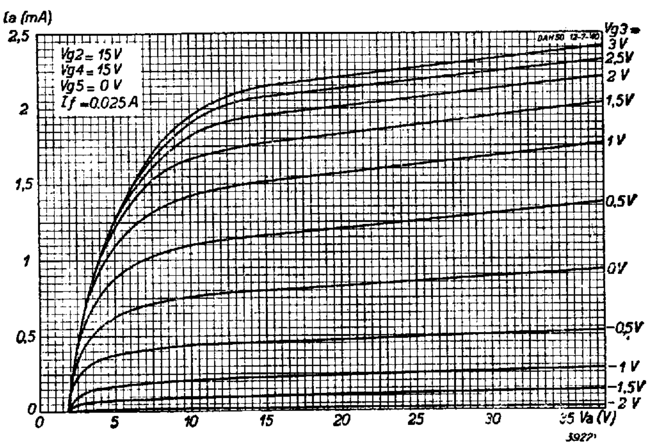


Fig. 5
Anode current as a function of anode voltage, with Vg_3 as parameter.

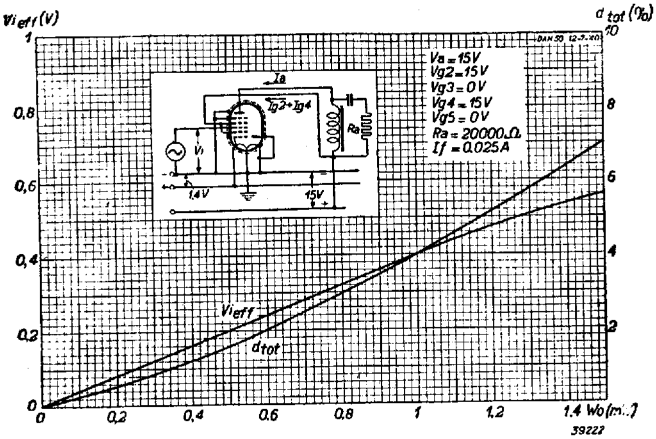


Fig. 6
Alternating input voltage and total distortion as function of output power; DAH 50 used as output valve.

CAPACITANCES

C_{ag3}	< 0.04 pF	C_{ad}	< 0.05 pF
C_a	$= 9.8$ pF	C_{g3d}	< 0.001 pF
C_{g3}	$= 7.3$ pF	C_{df}	$= 4.1$ pF

STATIC RATINGS

Anode voltage	V_a	= 15 V
Space-charge grid voltage.	V_{g2}	= 15 V
Grid bias	V_{g3}	= 0 V
Screen grid voltage	V_{g4}	= 15 V
Suppressor grid voltage	V_{g5}	= 0 V
Anode current	I_a	= 0.8 mA
Current to the space-charge grid.	I_{g2}	= 1.5 mA
Screen grid current.	I_{g4}	= 0.2 mA
Mutual conductance	S	= 0.65 mA/V
Internal resistance	R_i	= 0.09 M Ohms
Gain factor	μ	= 60

OPERATING DATA for use as A.F. amplifier valve

Anode voltage	V_a	= 15 V	
Suppressor grid voltage	V_{g5}	= 0 V	
Anode series resistance	R_a	= 0.05 M Ohm	0.1 M Ohm
Series resistance, space-charge and screen grids	$R_{(g2+g4)}$	= 4000 Ohms	6000 Ohms
Grid bias.	V_{g3}	= 0 V	0 V
Anode current	I_a	= 0.13 mA	0.07 mA
Current to space-charge and screen grids .	$I_{(g2+g4)}$	= 1.1 mA	0.9 mA
Gain factor.	V_o/V_i	= 12	15
Total distortion	d_{tot}	= 2.0 %	2.5 %
Alternating output voltage.	$V_{o\,eff}$	= 1 V	1 V

OPERATING DATA for use as output valve

Anode voltage	V_a	=		15 V	
Space-charge and screen grid voltage	$V_{(g2+g4)}$	=		15 V	
Suppressor grid voltage	V_{g5}	=		0 V	
Grid bias	V_{g3}	=		0 V	
Anode current	I_a	=		0.8 mA	
Current to space-charge and screen grids	$I_{(g2+g4)}$	=		1.5 mA	
Optimum value of matching resistance	R_a	=		20,000 Ohms	
Output power	W_o	=	0.5 mW	1 mW	1.5 mW
Required alternating grid voltage	$V_{i\,eff}$	=	0.2 V	0.4 V	0.56 V
Total distortion	d_{tot}	=	1.6 %	4 %	7 %

MAXIMUM RATINGS

Heptode section:

V_a	= max. 25 V
W_a	= max. 0.05 W
V_{g2}	= max. 15 V
W_{g2}	= max. 0.025 W
V_{g4}	= max. 25 V
W_{g4}	= max. 0.01 W
I_k	= max. 2.5 mA
V_{g3} (I_{g3} = +0.3 μA)	= max. —0.4 V
R_{g3f}	= max. 3 M Ohms

Diode section:

V_d	= max. 50 V
I_d	= max. 0.2 mA
V_d (I_d = +0.3 μA)	= max. —1 V

APPLICATIONS

The DAH 50 is especially useful in small portable receivers with headphones, in which it can be employed in all stages. In connection with the various applications of this valve the following will be of interest.

For reception by means of headphones in a quiet room an output of 1 mW may be considered sufficient, this being at a resistance of 4000 Ohms (the resistance value of standard headphones), the equivalent of an anode current of 0.5 mA. Used thus, the DAH 50 gives best results with automatic grid bias, as distortion due to grid current, which occurs at $I_a = 0.7$ mA, is avoided.

When used as A.F. amplifier with an anode coupling resistance of 100,000 Ohms, the valve gives a gain factor of 15 at the maximum supply voltage of 15 V.

For detection sensitivity of the diode unit the characteristics of other battery diodes in the D-series may be consulted.

In R.F. and I.F.amplification stages it must be remembered that the internal resistance of 0.1 M Ohm damps the tuned circuit; therefore, to ensure a satisfactory relation between selectivity and amplification, the anode may be connected to a tapping in the primary circuit of the I.F.bandfilter. Alternatively, the damping may be compensated by a moderately strong reaction back in the I.F.circuits. For example, if the anode is connected to a tapping half way down the anode coil, the I.F.circuit is damped to the extent of $2^2 \times 0.1 = 0.4$ M Ohms, but this need not necessarily affect the I.F. circuit too much, even if the impedance is, say, 0.3 M Ohms. When the bandfilter is

thus tapped on the primary side a gain factor of 30 may be obtained.
By means of slight reaction back, it is further possible to increase the I.F.gain by a factor of 2 or 3.
If required, the DAH 50 can also be employed as frequency-changer, mixing being achieved by inducing the auxiliary signal in the cathode circuit. The second grid is used as anode for the oscillator section. There is, however, a slight difficulty here, in that the cathode is directly-heated and each of the filament circuits must include a reaction coupling coil; these coils should be bifilar-wound and coupled to the tuning coil of the oscillator circuit. It is found that good results are obtained in this case only when the anode voltage is increased to 24 V, the nominal voltage of 15 V being insufficient. Employing rather tight coupling, a voltage of about 1.5 V can be obtained in the anode circuit.
As is the case when the valve is used as I.F.amplifier, it is advisable to have a tapping in the anode circuit of the mixer valve. The conversion gainfactor is 15. The circuit diagram No. VIII on p. 142 shows a practical application of this valve in a baby-midget set employing two such valves.

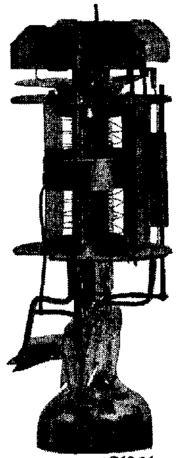


Fig. 4
The electrode system of the DAH 50; on the left the heptode, on the right the diode unit.