4699 Pentode

This pentode is an indirectly-heated 18 W output valve of extremely high mutual conductance, for A.C. heater-supply. It was designed especially for small amplifiers with Class AB output stages. In view of the high mutual conductance the valve is extremely useful for supersensitive amplifiers. For two 4699 used in class AB output stage with automatic grid bias an alternating input voltage of 17 V_{eff} is sufficient to obtain a power output of 29 W. Older types of amplifying valves such as the 4689 are supplied with an anode voltage of 375 V, with 275 V screen; owing to the necessity for feeding the screen from a potential divider for this type of valve, there is a considerable drop in output at maximum modulation as the current passing through the potential divider is not high enough. When the grid signal increases, the screen current also rises, so that when a high resistance potential divider is used the screen voltage and grid swing are reduced. In practice the decrease in output due to this potential divider is 10 to 20 %.

The maximum anode and screen voltages of the 4699 are such that the latter may be fed direct, without the use of any potential divider, and the advantages of equal anode and screen potentials may be listed as follows:

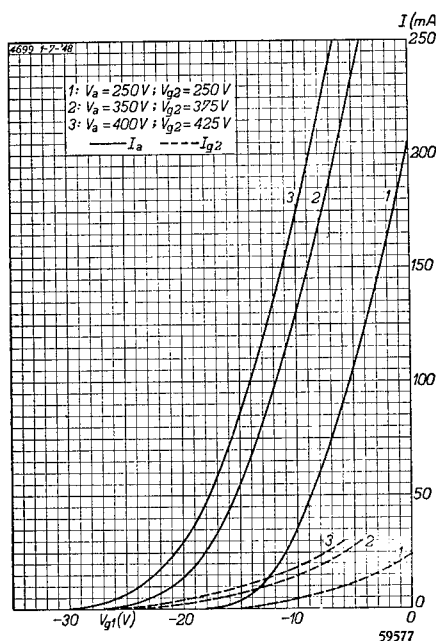a) Less costly circuit, since two fairly high-wattage resistors and a smoothing capacitor are then unnecessary.

b) Lower current consumption, in view of the absence of the potential divider.

c) No reduction in output at maximum modulation, such as exists when the screen is fed from a potential divider.

Fig. 1
Dimensions in mm.

Fig. 2
Arrangement of electrodes and base connections.

The 4699 gives good results on both high and low voltages ($V_b = 450$ V and $V_b = 375$ V respectively); in the latter instance it is possible to economise in the supply section of the amplifier, whilst in the other case the stages of pre-amplification may be made more sensitive.

For a valve with such high mutual conductance the 4699 has an unusually low heater consumption (about 6.3 W), this being due mainly to the special form of the cathode.

Fig. 3
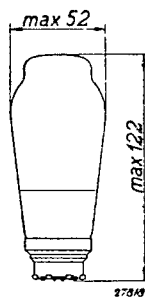Anode and screen current of the 4699 as functions of the grid bias for various values of anode and screen potential.
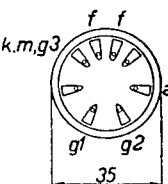
1: $V_a = 250$ V; $V_{g2} = 250$ V
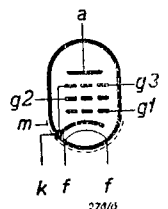2: $V_a = 350$ V; $V_{g2} = 375$ V
3: $V_a = 400$ V; $V_{g2} = 425$ V
—— I_a ---- I_{g2}

HEATER RATINGS

Heating: indirect by A.C.; parallel supply.

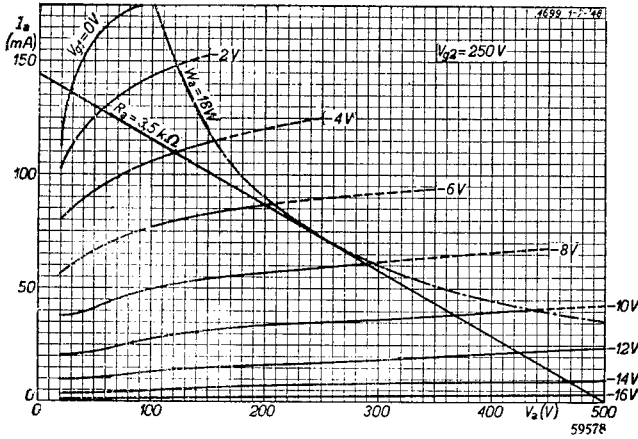Heater voltage . . . . . . $V_f = 6.3$ V
Heater current . . . . . $I_f = 1.0$ A

Fig. 4 Anode current as a function of the anode voltage for various values of grid bias with $V_{g_2} = 250$ V.

CAPACITANCES

Anode-grid . . . . $C_{ag1} < 0.7 \ \mu\mu$F

OPERATING DATA

The 4699 used as single output valve in class A

Anode voltage	V_a	=	250 V
Screen-grid voltage	V_{g2}	=	250 V
Cathode resistor	Rk	=	90 ohms
Anode current	I_a	=	72 mA
Screen-grid current	I_{g2}	=	8 mA
Mutual conductance	S	=	14.5 mA/V
Amplification factor; screen with respect to control grid	μ_{g2g1}	=	20 —
Internal resistance	R_i	=	20,000 ohms
Load resistor	R_a	=	3,500 ohms
Alternating input voltage $(I_{g1} = +0.3 \ \mu A)$	Vi	=	5.3 V_{eff}
Power output $(I_{g1} = +0.3 \ \mu A)$	W_o	=	8 W
Total distortion $(I_{g1} = +0.3 \ \mu A)$	d_{tot}	=	10 %
Alternating input voltage $(W_o = 50$ mW)	V_i	=	0.3 V_{eff}

The 4699 used in class AB output stage with auto. grid bias (two valves)

Supply voltage	V_b	=	425		375	V
Load resistor between anodes	R_{aa}	=	8,000		6,000	ohms
Common screen-grid series resistor	R_{g2}	=	2,200		700	ohms
Cathode resistor	R_k	=	170		125	ohms
Alternating input voltage	V_i	=	0	17	0	14 V_{eff}
Anode voltage	$V_a + V_{Rk}$	=	405	400	355	350 V
Anode current	I_a	=	2×46	2×58	2×52	2×64 mA
Screen-grid current	I_{g2}	=	2×5	2×14.5	2×6.5	2×16.5 mA
Power output	W_o	=	0	29	0	27.5 W
Total distortion	d_{tot}	=	—	5	—	4 %

The 4699 used in triode connection as single output valve class A (screen-grid connected to anode)

Supply voltage	V_b	=	375 V	Alternating input		
Cathode resistor	R_k	=	300 ohms	voltage	V_i =	11 V_{eff}
Load resistor	R_a	=	4,000 ohms	Power output	W_o =	4.5 W
Anode current	I_a	=	50 mA	Total distortion	d_{tot} =	9 %

The 4699 used in triode connection in class AB output stage with auto. grid bias (two valves)

Supply voltage	V_b	=		400	V
Load resistor between anodes	R_{aa}	=		5,500	ohms
Common cathode resistor	R_k	=		175	ohms
Alternating input voltage	V_i	=	0	13.5	V_{eff}
Anode current	I_a	=	2×48	2×54	mA
Power output	W_o	=	0	13	W
Total distortion	d_{tot}	=	—	1.5	%

MAXIMUM RATINGS

Anode voltage in cold condition	V_{ao}	= max.	800	V
Anode voltage	V_a	= max.	425	V
Anode dissipation	W_a	= max.	18	W
Screen-grid voltage in cold condition	V_{g2o}	= max.	650	V
Screen-grid voltage	V_{g2}	= max.	425	V
Screen dissipation without signal	W_{g2}	= max.	2	W
Screen dissipation at max. modulation	W_{g2}	= max.	5	W
Cathode current	I_k	= max.	90	mA
Grid voltage at grid current start (I_{g1} = + 0.3 μA)	V_{g1}	= max.	—1.3	V
External resistance between grid and cathode (auto. bias)	R_{g1}	= max.	0.7	M ohm
External resistance between grid and cathode (fixed bias)	R_{g1}	= max.	0.5	M ohm
External resistance between heater and cathode	R_{fk}	= max.	20,000	ohms
Voltage between heater and cathode	V_{fk}	= max.	50	V

The 4699 is operated with automatic grid bias; semi-automatic bias may be employed, provided that the cathode current in the output stage constitutes more than 50 % of the total current flowing in the resistor producing the bias. The value of R_{g1} must then be reduced in accordance with the following:

$$\frac{\text{Cathode current of output valve}}{\text{Total current passing through resistor producing the voltage drop}} \times R_{g1}.$$

Due to the high mutual conductance, a stopper resistor of about 1,000 ohms is included in the grid lead to prevent oscillation.
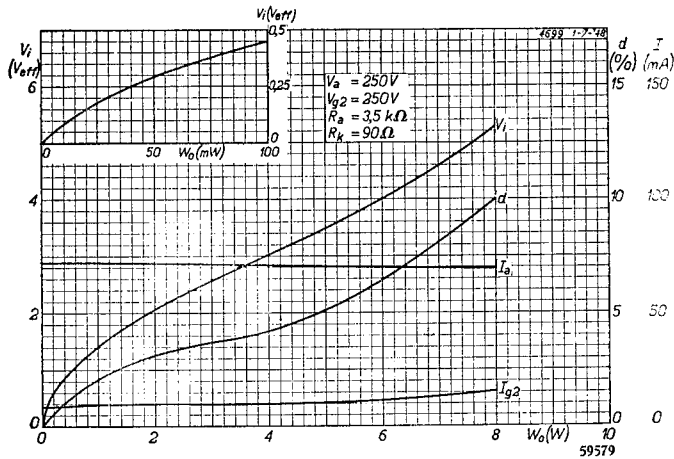
Fig. 5
Total distortion, anode and screen-grid current and alternating input
voltage as functions of the output power; the 4699 used as single
output valve class A with $Va = 250$ V and $Vg_2 = 250$ V.
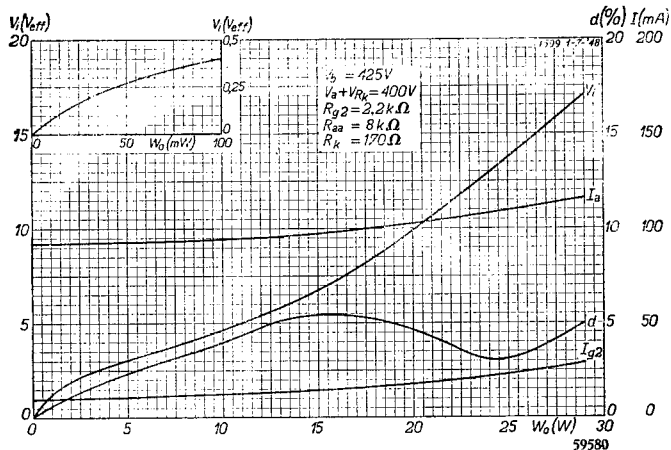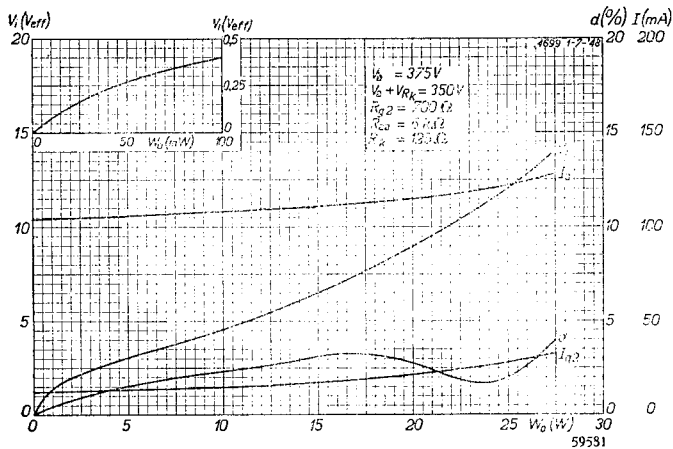

Fig. 6
Total distortion, anode and screen-grid current and alternating input
voltage as functions of the output power; 2 valves 4699 used in
class AB output stage with auto. grid bias, $Vb = 425$ V.

Fig. 7
Total distortion, anode and screen-grid current and alternating input
voltage as functions of the output power; 2 valves 4699 used in
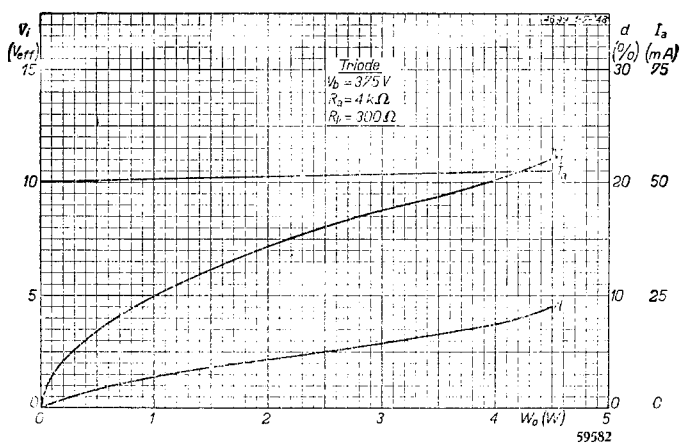class AB output stage with auto. grid bias, $Vb = 375$ V

Fig. 8
Total distortion, anode current and alternating input voltage as
functions of the output power; the 4699 used as single output
valve in triode connection (screen-grid connected to anode) class A
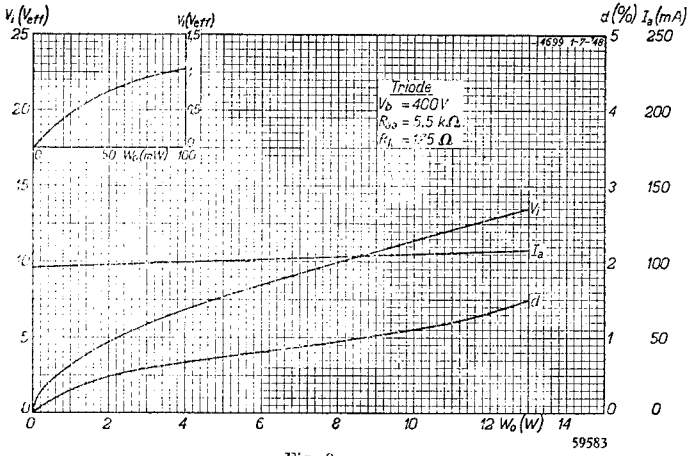with $Vb = 375$ V.

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Fig. 9

Total distortion, anode current and alternating input voltage as
functions of the output valve; 2 valves 4654 in triode connection
(screen-grid connected to anode) used in class AB output stage
with $Vb = 400$ V.