

SPECIAL QUALITY, LONG LIFE, SHOCK AND VIBRATION RESISTANT DOUBLE TRIODE with anti-microphonic construction for use in R.F. or A.F. circuits as cascode amplifier, cathode follower, etc.

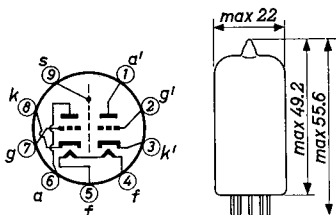
The E188CC has separate cathodes and will maintain its emission capabilities after long periods of operation under cut-off conditions.

### HEATING

Indirect by A.C. or D.C.; parallel supply

Heater voltage  $V_f = 6.3$  V

Heater current  $I_f = 335$  mA



Base: NOVAL with gold plated pins  
(Dimensions in mm)

### CHARACTERISTICS

- Column I: Setting of the tube and typical (average) measuring results of new tubes  
 II: Characteristics range values for equipment design  
 III: Data indicating the end of life

#### Heater current

	I	II	III
Heater voltage	$V_f = 6.3$		V
Heater current	$I_f = 335$	318-352	318-352 mA

#### Capacitances (without external shield)

	I	II
Anode to all other elements except grid		
$C_a(k+f+s)$	1.75	1.55-1.95 pF
$C_a'(k'+f+s)$	1.65	1.45-1.85 pF
Anode to cathode and heater		
$C_a(k+f)$	0.5	0.4-0.6 pF
$C_a'(k'+f)$	0.4	0.3-0.5 pF

## CHARACTERISTICS (continued)

## Capacitances (continued)

		I	II	
→ Grid to all other elements except anode	$C_{g(k+f+s)}$	= 3.3	2.7-3.9	pF
	$C_{g'(k'+f+s)}$	= 3.3	2.7-3.9	pF
→ Grid to cathode and heater	$C_{g(k+f)}$	= 3.3	2.7-3.9	pF
	$C_{g'(k'+f)}$	= 3.3	2.7-3.9	pF
Anode to grid	$C_{ag}$	= 1.4	1.2-1.6	pF
	$C_{a'g'}$	= 1.4	1.2-1.6	pF
Anode to all other elements except cathode	$C_a(g+f+s)$	= 3.0	2.7-3.3	pF
	$C_{a'(g'+f+s)}$	= 2.9	2.6-3.2	pF
Cathode to all other elements except anode	$C_k(g+f+s)$	= 6.0	5.1-6.9	pF
	$C_{k'(g'+f+s)}$	= 6.0	5.1-6.9	pF
Anode to cathode	$C_{ak}$	= 0.18	0.14-0.22	pF
	$C_{a'k'}$	= 0.18	0.14-0.22	pF
Anode to screen	$C_{as}$	= 1.3	1.1-1.5	pF
	$C_{a's}$	= 1.3	1.1-1.5	pF
Cathode to heater	$C_{kf}$	= 2.6		pF
	$C_{k'f}$	= 2.7		pF
→ Anode to anode of other section	$C_{aa'}$	= 0.025	< 0.045	pF
Grid to grid of other section	$C_{gg'}$	=	< 0.005	pF
Anode to grid of other section	$C_{ag'}$	=	< 0.005	pF
	$C_{a'g}$	=	< 0.005	pF
Grid to cathode of other section	$C_{gk'}$	=	< 0.005	pF
	$C_{g'k}$	=	< 0.005	pF

CHARACTERISTICS (continued)Typical characteristics

		I	II	III
Anode supply voltage	$V_{ba} = 100$			V 1)
Grid supply voltage	$V_{bg} = +9$			V 1)
Cathode resistor	$R_k = 680$			$\Omega$ 1)
Anode current	$I_a = 15$	14.2-15.8	13.5	mA
Mutual conductance	$S = 12.5$	10.5-14.5	9	mA/V
Amplification factor	$\mu = 33$			
Equivalent noise resistance	$R_{eq} = 250$			$\Omega$ 2)
Noise factor	$F = 4.6$			dB 3)
Input damping at $f = 100$ Mc/s	$r_g = 3$			k $\Omega$

		I	II	III
Anode supply voltage	$V_{ba} = 90$			V
Cathode resistor	$R_k = 120$			$\Omega$
Anode current	$I_a = 12$			mA
Mutual conductance	$S = 11.5$			mA/V

Hum voltage (referred to grid)

Measured with straight response curve filter; frequency of heater supply voltage 50 c/s + 3% 500 c/s; tubeholder fully screened.

		I	II
Anode supply voltage	$V_{ba} = 90$		V
Anode current	$I_a = 15$		mA
Cathode resistor	$R_k = 80$		$\Omega$
Cathode capacitor	$C_k = 1000$		$\mu$ F
Grid resistor	$R_g = 0.5$		M $\Omega$
Hum voltage	$V_{ghum} =$		< 50 $\mu$ V

1) Operation of the tube under these conditions is recommended because of the small spread in characteristics

2) Measured at  $f = 45$  Mc/s

3) Measured in a cascode circuit matched for minimum noise at  $f = 200$  Mc/s

## CHARACTERISTICS (continued)

Negative grid current

		I	II	III
Anode supply voltage	$V_{ba} =$	100		V
Grid supply voltage	$V_{bg} =$	+9		V
Cathode resistor	$R_k =$	680		$\Omega$
Grid resistor	$R_g =$	0.1		M $\Omega$
Negative grid current	$-I_g =$		< 0.1	1.0 $\mu$ A

Vibrational noise output

		I	II	III
Anode supply voltage	$V_{ba} =$	100		V
Anode resistor	$R_a =$	2		k $\Omega$
Grid supply voltage	$V_{bg} =$	+9		V
Cathode resistor	$R_k =$	680		$\Omega$
Cathode capacitor	$C_k =$	1000		$\mu$ F
Vibrational frequency	$f =$	10-50		c/s
Vibrational acceleration	$=$	2.5		$g$
Vibrational noise output	$V =$		< 100	mV

		I	II	III
Anode supply voltage	$V_{ba} =$	270		V
Anode resistor	$R_a =$	18		k $\Omega$
Grid resistor	$R_g =$	1		M $\Omega$
Cathode resistor	$R_k =$	180		$\Omega$
Cathode capacitor	$C_k =$	50		$\mu$ F
Vibrational frequency	$f =$	50-5000		c/s
Vibrational acceleration	$=$	0.5		$g$
Vibrational noise output	$V =$		< 140	mV

CHARACTERISTICS (continued)Heater to cathode insulation

		I	II	III
Heater voltage	$V_f$	= 6.3		V
Voltage between heater and cathode (cathode negative)	$V_{kf}$	= 60		V
Heater to cathode current	$I_{kf}$	=	< 6	12 $\mu$ A
		I	II	III
Heater voltage	$V_f$	= 6.3		V
Voltage between heater and cathode (cathode positive)	$V_{kf}$	= 120		V
Cathode to heater current	$I_{kf}$	=	< 6	12 $\mu$ A

Insulation between two arbitrary electrodes

When measured between an electrode and cathode, the cathode should be positive

		I	II	III
Voltage	V	= 200		V
Insulation resistance	$R_{isol}$	=	>100	20 M $\Omega$

SHOCK RESISTANCE: about 500 g<sup>1)</sup>

Forces as applied by the NRL impact machine for electronic devices caused by 5 blows of the hammer lifted over an angle of 30° in each of four different positions of the tube

VIBRATION RESISTANCE: 2.5 g<sup>1)</sup>

Vibrational forces for a period of 32 hours at a frequency of 50 c/s in each of the three main directions

LIFE EXPECTANCY: 10 000 hours under the following life-test conditions:

Heater voltage	$V_f$	= 6.3 V
Anode supply voltage	$V_{ba} = V_{ba}'$	= 100 V
Grid supply voltage	$V_{bg} = V_{bg}'$	= +9 V
Cathode resistor	$R_k = R_k'$	= 680 $\Omega$
Grid resistor	$R_g = R_g'$	= 47 k $\Omega$
Voltage between cathode and heater (cathode negative)	$V_{kf} = V_{kf}'$	= 60 V

The data indicating the end point of life are given in column III under the heading "Characteristics"

<sup>1)</sup> These test conditions are only given for evaluation of the ruggedness of the tube and should by no means be interpreted as suitable operating conditions

## OPERATING CHARACTERISTICS AS OUTPUT TUBE CLASS A

Anode voltage	$V_a =$	220	V
Load resistance	$R_{a\sim} =$	20	k $\Omega$
Grid bias	$V_g =$	-6.5	V
Input voltage	$V_i =$	0 1.5 4.5	V(RMS)
Anode current	$I_a =$	6.5 - 9.2	mA
Output power	$W_o =$	0 0.05 0.5	W
Total distortion	$d_{tot} =$	- - 7	%

OPERATING CHARACTERISTICS AS PUSH-PULL OUTPUT TUBE CLASS B  
(sinusoidal input voltage)

Anode voltage	$V_a =$	200	V
Load resistance	$R_{aa\sim} =$	22	k $\Omega$
Grid bias	$V_g =$	-6	V
Input voltage	$V_i =$	0 0.9 4.0	V(RMS)
Anode current	$I_a =$	2x5.0 - 2x9	mA
Output power	$W_o =$	0 0.05 1.2	W
Total distortion	$d_{tot} =$	- - 3	%

OPERATING CHARACTERISTICS AS PUSH-PULL OUTPUT TUBE CLASS B  
(speech and music signals)

These values have been measured with sinusoidal input voltage. With full drive, however, the maximum permissible anode dissipation is exceeded. Therefore, operation with a sinusoidal input voltage is not allowed in this setting. When, however, the tube is operated with normal speech and music signals, the RMS-value of the input voltage will generally be less than 4 V so that in this case no overload of the tube will occur

Anode voltage	$V_a =$	200	V
Load resistance	$R_{aa\sim} =$	10	k $\Omega$
Grid bias	$V_g =$	-6	V
Input voltage	$V_i =$	0 0.9 4.0	V(RMS)
Anode current	$I_a =$	2x5.0 - 2x13.5	mA
Output power	$W_o =$	0 0.05 1.5	W
Total distortion	$d_{tot} =$	- - 4	%

OPERATING CHARACTERISTICS AS ADDITIVE MIXER

Anode supply voltage	$V_{ba}$	= 60	90	150 V
Anode resistor	$R_a$	= 0	1	3.9 k $\Omega$
Grid resistor	$R_g$	= 1	1	1 M $\Omega$
Oscillator voltage	$V_{osc}$	= 2.0	2.5	3.0 V(RMS)
Anode current	$I_a$	= 4.7	7.7	11 mA
Conversion conductance	$S_c$	= 2.9	3.5	4.1 mA/V
Internal resistance	$R_i$	= 8.3	7.0	6.1 k $\Omega$

LIMITING VALUES (Absolute limits; each section)

Anode voltage in cold condition	$V_{a0}$	= max.	550 V
Anode voltage when anode current = 0 mA	$V_a(I_a = 0)$	= max.	400 V
Anode voltage	$V_a$	= max.	250 V
Anode dissipation	$W_a$	= max.	1.65 W
Anode dissipation	$W_a$	= max.	2.0 W <sup>1)</sup>
Grid dissipation	$W_g$	= max.	0.03 W
Negative grid voltage	$-V_g$	= max.	110 V
Peak negative grid voltage	$-V_{gp}$	= max.	200 V <sup>2)</sup>
Cathode current	$I_k$	= max.	22 mA
Peak cathode current	$I_{kp}$	= max.	110 mA <sup>2)</sup>
Heater to cathode voltage cathode positive	$V_{kf}$	= max.	150 V
Heater to cathode voltage cathode negative	$V_{kf}$	= max.	100 V
Heater voltage	$V_f$	=	6.3 V $\pm$ 5 %
Bulb temperature	$t_{bulb}$	= max.	165 $^{\circ}$ C

MAX.CCIRCUIT VALUES

Grid resistor with automatic bias	$R_g$	= max.	1 M $\Omega$
Grid resistor with fixed bias	$R_g$	= max.	0.5 M $\Omega$

<sup>1)</sup> When  $W_a + W_a'$  is less than 2.2 W

<sup>2)</sup> Pulse duration max. 200  $\mu$ sec, duty factor max. 10 %

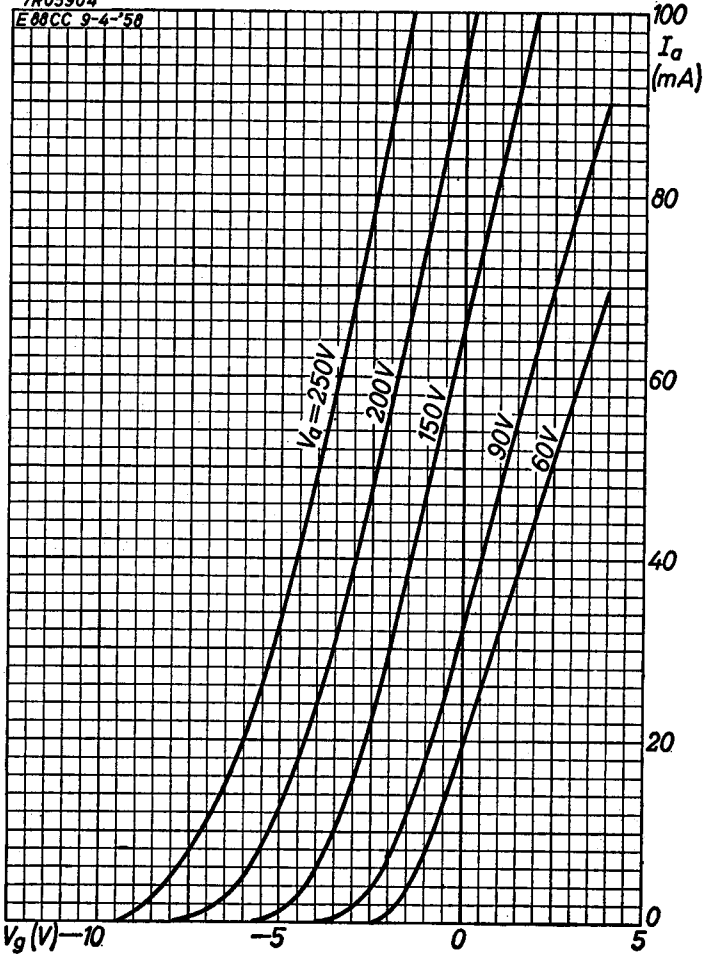
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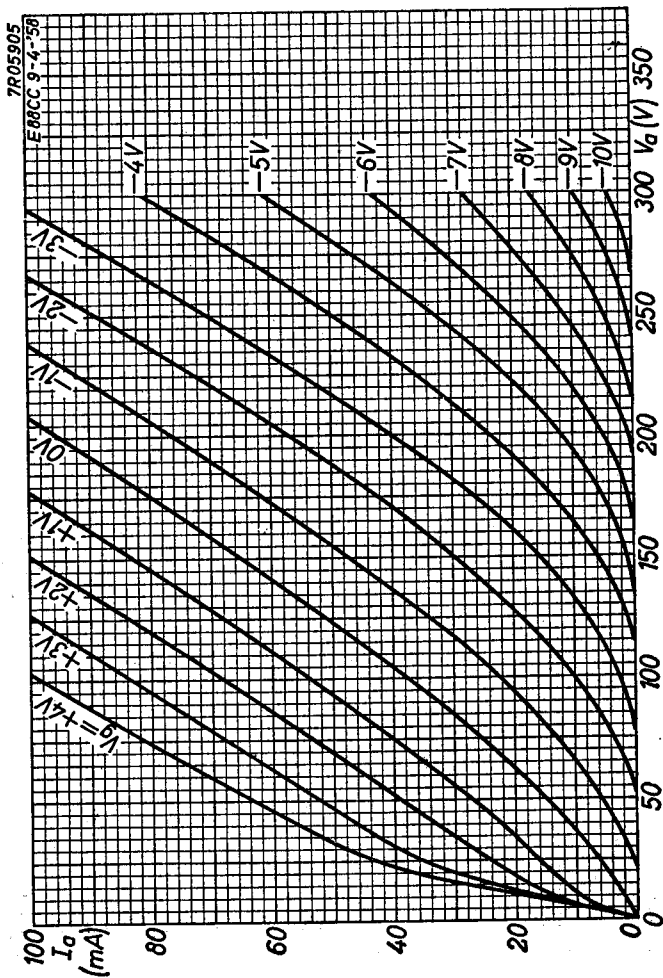
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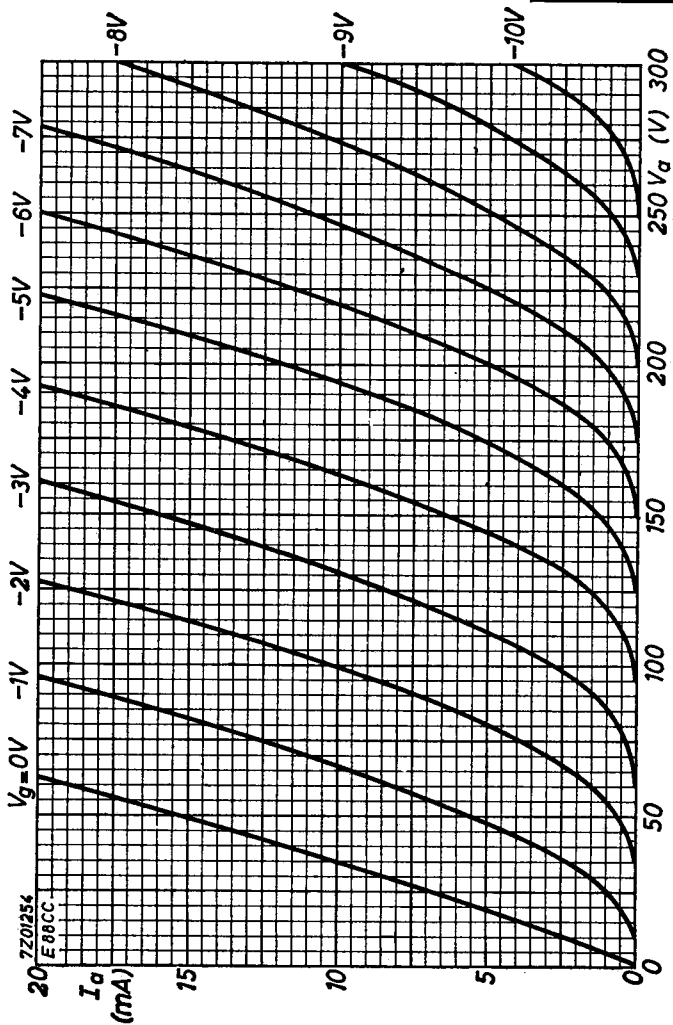
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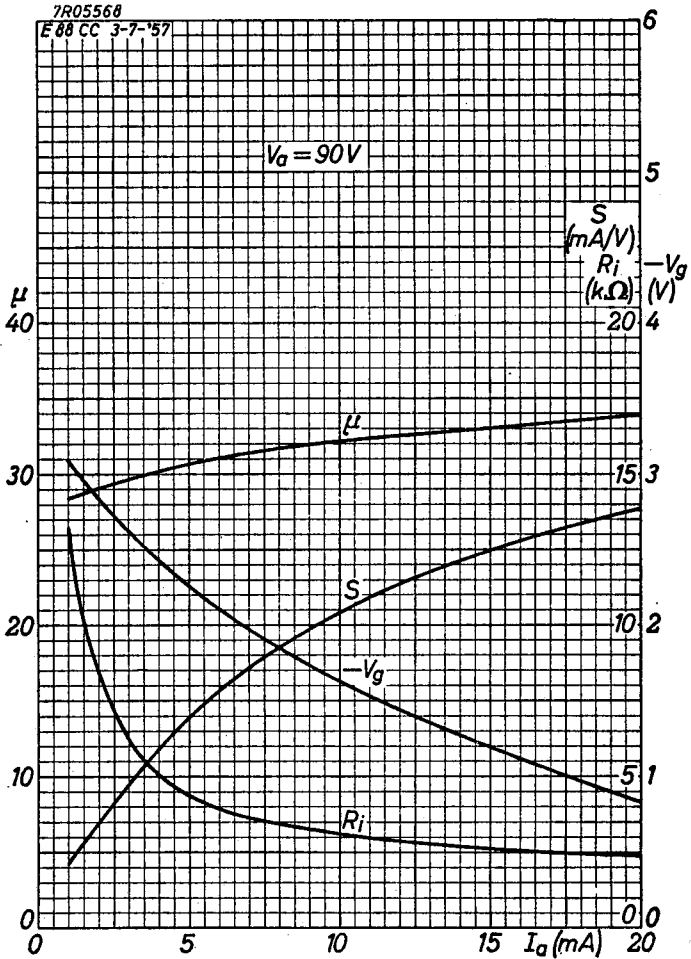
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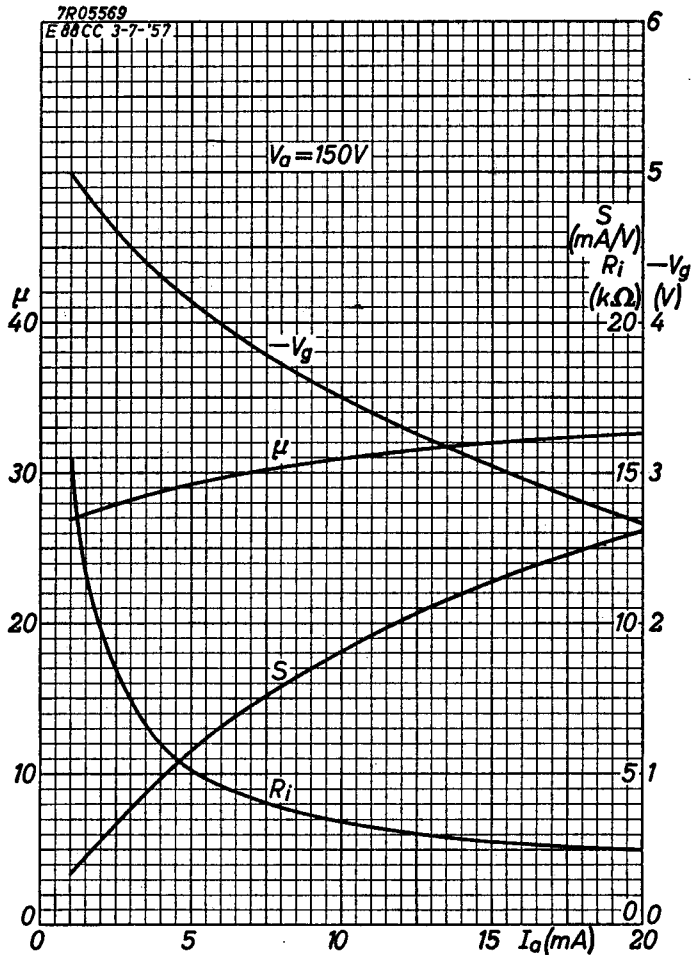
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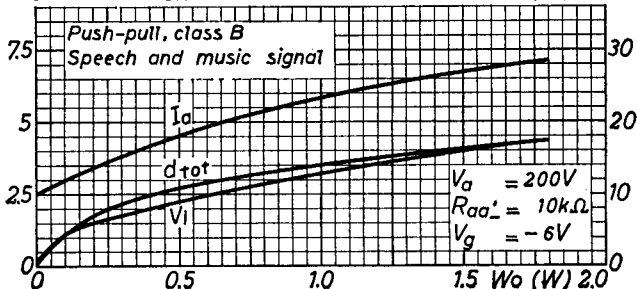
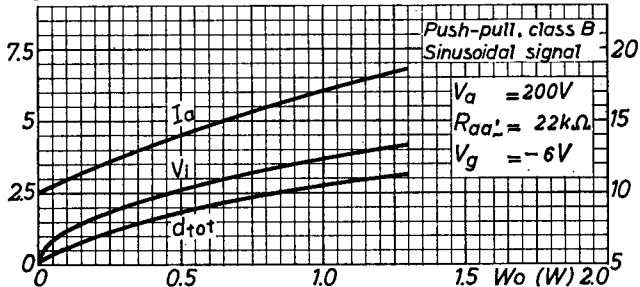
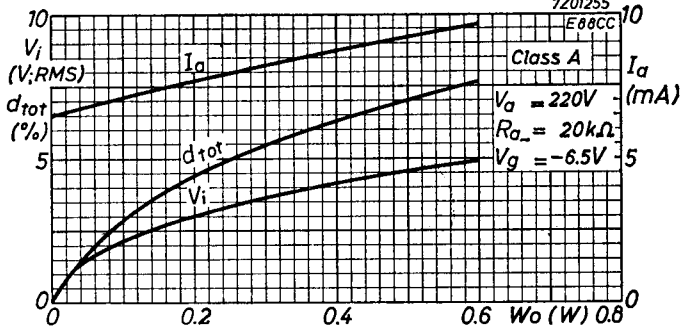
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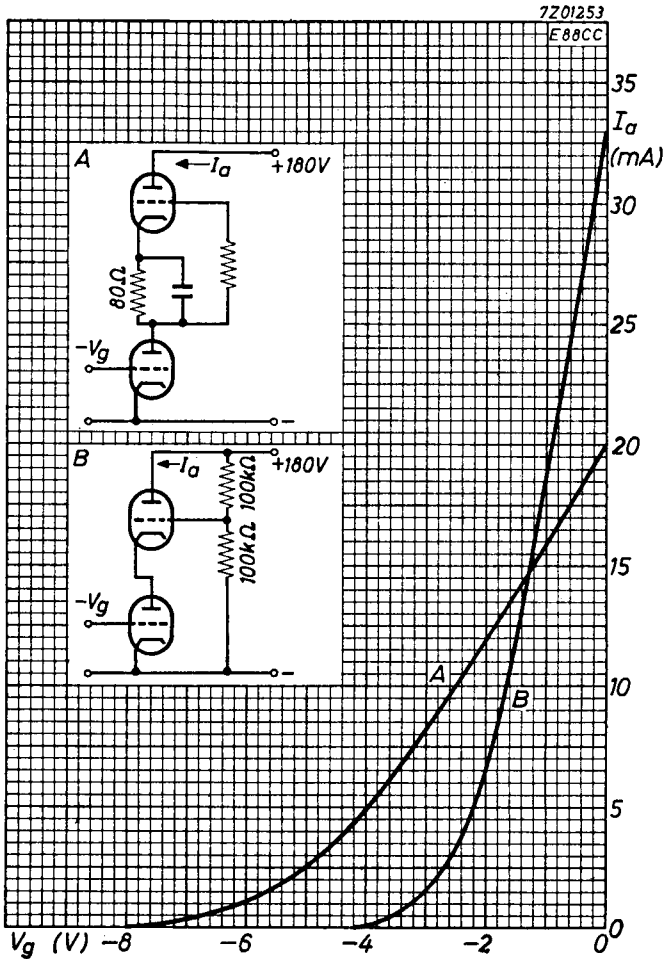
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*Electronic  
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**HANDBOOK**

	<b>E188CC</b>	
<b>page</b>	<b>sheet</b>	<b>date</b>
1	1	1962.12.12
2	2	1962.12.12
3	3	1962.12.12
4	4	1962.12.12
5	5	1962.12.12
6	6	1962.12.12
7	7	1962.12.12
8	A	1962.12.12
9	B	1962.12.12
10	C	1962.12.12
11	D	1962.12.12
12	E	1962.12.12
13	F	1962.12.12
14	G	1962.12.12
15	FP	1999.06.09