SYLVANIA

engineering data service 5902

MECHANICAL DATA

Bulb	T-3
Base	E8-10, Subminiature Button Flexible Leads
Outline	JETEC 3-3
Basing	8DL
Cathode	Coated Unipotential
Mounting Position	Any

RATINGS[1] (Absolute Maximum)

Impact Acceleration	450 G
Uniform Acceleration	1000 G
Fatigue (Vibrational Acceleration for Extended Periods)	2.5 G
Bulb Temperature	220° C
Altitude[2]	80000 Ft.

ELECTRICAL DATA

HEATER CHARACTERISTICS

	Min.	Bogey	Max.
Heater Voltage[3]	6.0	6.3	6.6 V
Heater Current		450	mA

DIRECT INTERELECTRODE CAPACITANCES

	Shielded[4]	Unshielded
Grid No. 1 to Plate	0.11	0.15 μμf
Input	6.5	6.5 μμf
Output	7.5	4.5 μμf

RATINGS[1 & 5] (Absolute Maximum)

Plate Voltage	165 Vdc
Peak Plate Forward Voltage[6]	330 v
Grid No. 2 Voltage	155 Vdc
Plate Dissipation	4.0 W
Grid No. 2 Dissipation	1.0 W
Cathode Current	50 mAdc
DC Grid No. 1 Voltage	
Positive Value	0 Vdc
Negative Value	55 Vdc
Heater-Cathode Voltage	
Heater Positive with Respect to Cathode	200 v
Heater Negative with Respect to Cathode	200 v
Grid No. 1 Circuit Resistance	
Self Bias	0.55 Meg
Fixed Bias	0.1 Meg

CHARACTERISTICS

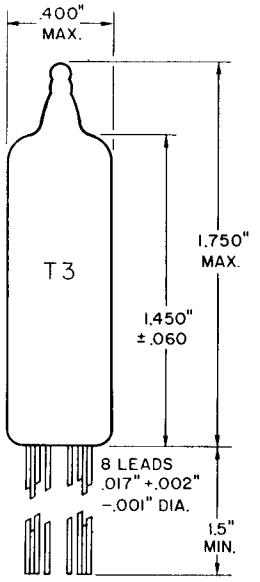
Plate Voltage	110 Vdc
Grid No. 2 Voltage	110 Vdc
Cathode Resistor	270 Ohms
Plate Current	30 mAdc
Grid No. 2 Current	2.2 mAdc
Transconductance	4200 μmhos
Plate Resistance	150000 Ohms
Grid Voltage for Ib = 100 μAdc Max.	−40 Vdc

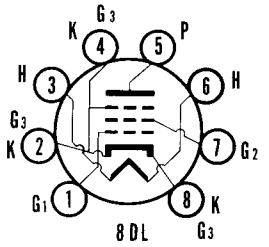
NOTES:

1. *Limitations beyond which normal tube performance and tube life may be impaired.*
2. *If altitude rating is exceeded, reduction of instantaneous voltages (Ef excluded) may be required.*
3. *Tube life and reliability of performance are directly related to the degree of regulation of the heater voltage to its center rated value of 6.3 volts.*
4. *External shield of 0.405 inch diameter connected to cathode.*
5. *Values shown are as registered with RETMA.*
6. *Per MIL-E-1C Par. 6.5 and General Section of this Sylvania Subminiature Tube Manual titled Specifications and Ratings.*

QUICK REFERENCE DATA

The Premium Subminiature Type 5902 is a beam power pentode designed for use as an audio amplifier. It is intended for operation under conditions of severe shock, vibration, high temperature and high altitude. The Sylvania Type 5902 is manufactured and inspected to meet the applicable MIL-E-1 specification for reliable operation.





SYLVANIA ELECTRIC PRODUCTS INC.

RADIO TUBE DIVISION
EMPORIUM, PA.

Prepared and Released By The
TECHNICAL PUBLICATIONS SECTION
EMPORIUM, PENNSYLVANIA
FEBRUARY 1957

ACCEPTANCE CRITERIA

Test Conditions

Heater Voltage	6.3 V	Grid No. 2 Voltage	110 Vdc
Plate Voltage	110 Vdc	Heater-Cathode Voltage MIL-E-1 Par. 3.2.2.1	0 V
Grid No. 1 Voltage	0 V	Cathode Resistor MIL-E-1 Par. 3.2.2.1	270 Ohms

For the purposes of inspection, use applicable reliable paragraphs of MIL-E-1 and Inspection Instructions for Electron Tubes.

MIL-E-1 Ref.	Test	AQL (%)	Limits					Units
			Min.	LAL	Bogey	UAL	Max.	
Measurements Acceptance Tests, Part 1, Note 1								
4.1.1.7 4.10.8	(Method A) Heater Current: ALD = 36	—	—	432	450	468	—	mA
4.10.8	Heater Current:	0.65	420	—	—	—	480	mA
4.10.15	Heater-Cathode Leakage:	0.65	—	—	—	—	—	
	Ehk = +100 Vdc	—	—	—	—	—	15	μAdc
	Ehk = -100 Vdc	—	—	—	—	—	15	μAdc
4.10.6.1	Grid Current: Rg1 = 1.0 Meg	0.65	0	—	—	—	-1.0	μAdc
4.1.1.7 4.10.4.1	(Method A) Plate Current (1): ALD = 8.0	—	—	27.0	30.0	33.0	—	mAdc
4.10.4.1	Plate Current (1):	0.65	23.0	—	—	—	37.0	mAdc
4.10.4.1	Plate Current (2): Ec1 = -40 Vdc; Rk = 0 Ohms	0.65	—	—	—	—	100	μAdc
4.10.16.1	Power Output (1): Po Esig = 6.4 Vac; Rp = 3000 Ohms	0.65	0.75	—	—	—	—	W
4.7.5	Continuity and Shorts (Inoperatives):	0.4	—	—	—	—	—	
4.9.1	Mechanical: Envelope (8-4)	—	—	—	—	—	—	
Measurements Acceptance Tests, Part 2								
4.8.2	Insulation of Electrodes:	2.5	—	—	—	—	—	
	g1-all	—	50	—	—	—	—	Meg
	p-all	—	50	—	—	—	—	Meg
4.10.4.3	Screen Grid Current: Ic2	2.5	0	—	—	—	4.0	mAdc
4.1.1.7 4.10.9	(Method A) Transconductance: ALD = 950	—	—	3850	4200	4550	—	μmhos
4.10.9	Transconductance:	2.5	3500	—	—	—	4900	μmhos
4.10.6.2	Grid Emission: Note 4 Ef = 7.5 V; Ec1 = -40 Vdc; Rg1 = 1.0 Meg; Rk = 0 Ohms	2.5	0	—	—	—	-2.0	μAdc
4.10.16.1	Power Output (2): $\triangle \frac{Po}{Ef}$ Ef = 5.7 V; Esig = 6.4 Vac; Rp = 3000 Ohms	2.5	—	—	—	—	15	%
4.10.3.2	AF Noise: Esig = 150 Vac; Ecc2 = 110 Vdc; Ec1 = -8.7 Vdc; Rk = 0 Ohms; Rp = 2000 Ohms; Rg1 = 0.5 Meg; Rg2 = 10,000 Ohms; Cg2 = 4.0 μf	2.5	—	—	—	—	17	VU
4.10.14	Capacitance:	6.5	—	—	—	—	—	
	0.405 In. Dia. Shield Cg1p	—	—	—	—	—	0.20	μμf
	0.405 In. Dia. Shield Cin	—	5.5	—	—	—	7.5	μμf
	0.405 In. Dia. Shield Cout	—	6.5	—	—	—	8.5	μμf
4.10.10	Plate Resistance:	6.5	0.01	—	—	—	—	Meg

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Limits					Units
			Min.	LAL	Bogey	UAL	Max.	
Measurements Acceptance Tests, Part 2 (Continued)								
4.9.12.1	Low Pressure Voltage Breakdown: Pressure = 20 ±5 mm Hg.; Voltage = 300 Vac	6.5	—	—	—	—	—	
4.9.20.3	Vibration (1): No Voltages; Post Shock and Fatigue Test End Points Apply	10.0	—	—	—	—	—	
4.9.19.1	Vibration (2): Rp = 2000 Ohms; Ck = 1000 μf; F = 40 cps; G = 15	2.5	—	—	—	—	75	mVac
4.9.19.1	White Noise: Note 5; Rp = 10,000 Ohms; Ck = 1000 μf; Peak Acceleration = 15 G	2.5 2.5	— —	— —	— —	— —	1500 200	mv pk-pk mVac
Degradation Rate Acceptance Tests, Note 2								
4.9.5.3	Subminiature Lead Fatigue:	2.5	4	—	—	—	—	arcs
4.9.20.5	Shock: Hammer Angle = 30°; Ehk = +100 Vdc; Rg1 = 0.1 Meg	20	—	—	—	—	—	
4.9.20.6	Fatigue: G = 2.5; Fixed Frequency; F = 25 min., 60 max	6.5	—	—	—	—	—	
- - - -	Post Shock and Fatigue Test End Points: Vibration (2) Heater-Cathode Leakage Ehk = +100 Vdc Ehk = -100 Vdc Change in Power Output (1) of Individual Tubes Δ Po$_t$	— — — —	— — — —	— — — —	— — — —	— — — —	300 40 40 20	mVac μAdc μAdc %
4.9.6.3	Glass Strain:	6.5	—	—	—	—	—	

MIL-E-1 Ref.	Test	AQL (%)	Allowable Defectives per Characteristic		Limits		Units
			1st Sample	Combined Samples	Min.	Max.	
Acceptance Life Tests, Note 2							
4.11.3.1	Stability Life Test: (1 Hour) Eb = Ec2 = 100 Vdc; Ehk = +200 Vdc; Rg1 = 0.47 Meg; Rk = 220 Ohms; TA = Room.	1.0	—	—	—	—	
- - - - -	Stability Life Test End Points: Change in Power Output (1) of Individual Tubes Δ Po$_t$	—	—	—	—	10.0	%
4.11.3.1 4.11.3.1.1	Survival Rate Life Test: (100 Hours) Stability Life Test Conditions or Equivalent; TA = Room	—	—	—	—	—	
- - - - -	Survival Rate Life Test End Points: Continuity and Shorts (Inoperatives) Power Output (1) Po	0.65 1.0	— —	— —	— 0.65	— —	 W
4.11.7	Heater Cycling Life Test: Ef = 7.0 V; 1 min. on, 4 min. off; Ehk = 140 Vac; Ec1 = Ec2 = Eb = O V	2.5	—	—	—	—	

ACCEPTANCE CRITERIA (Continued)

MIL-E-1 Ref.	Test	AQL (%)	Allowable Defectives per Characteristic: 1st Sample	Allowable Defectives per Characteristic: Combined Samples	Limits: Min.	Limits: Max.	Units
Acceptance Life Tests, Note 2 (Continued)							
4.11.5 4.11.3.1	Intermittent Life Test: Note 3 Stability Life Test Conditions; T Envelope = +220°C min.; 1000 Hour Requirements Do Not Apply	—	—	—	—	—	
4.11.3.1 4.11.4	Intermittent Life Test End Points: (500 Hours)						
	Inoperatives	—	1	3	—	—	
	Heater Current	—	2	5	414	492	mA
	Grid Current	—	1	3	0	-2.0	μAdc
	Change in Power Output (1) of Individual Tubes From Initial $\Delta \frac{Po}{t}$	—	1	3	—	20	%
	Power Output (2) $\Delta \frac{Po}{Ef}$	—	2	5	—	15	%
	Heater-Cathode Leakage	—	2	5	—	—	
	Ehk = +100 Vdc	—	—	—	—	60	μAdc
	Ehk = -100 Vdc	—	—	—	—	60	μAdc
	Insulation of Electrodes	—	2	5	—	—	
	g1-all	—	—	—	25	—	Meg
	p-all	—	—	—	25	—	Meg
	Total Defectives	—	4	8	—	—	

ACCEPTANCE CRITERIA NOTES:

1: The AQL for the combined defectives for attributes in Measurements Acceptance Tests. Part 1, excluding inoperatives and mechanical shall be one (1) percent. A tube having one (1) or more defects shall be counted as one (1) defective.

2: Tubes subjected to the following destructive tests are not to be accepted under this specification.

4.9.5.3	Subminiature lead fatigue
4.9.20.5	Shock
4.9.20.6	Fatigue
4.11.7	Heater cycling life test
4.11.5	Intermittent life test

3: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of #40 BS or smaller diameter elements welded to a ring of 0.025 inch diameter phosphor bronze in contact with the envelope. Envelope temperature requirement will be satisfied if a tube, having bogey Ib (±5%) under normal test conditions, is determined to operate at maximum specified temperature at any position on the life test rack.

4: Prior to this test tubes shall be preheated five (5) minutes at conditions indicated below. Test within three (3) seconds after preheating. Three-minute test is not permitted. Grid Emission shall be the last test performed on the sample selected for the Grid Emission Test.

Ef	Ec1	Ec2	Ec3	Eb	Rk	Rg1
V	Vdc	Vdc	Vdc	Vdc	Ohms	Meg
7.5	0	100	0	100	220	0.47

5: The tube shall be rigidly mounted on a table vibrating such that the instantaneous values of acceleration shall constitute approximately a "White Noise" spectrum which is free from discontinuities from 100 cps to 5000 cps. The spectrum of instantaneous acceleration shall be such that each octave of bandwidth delivers 2.3 G's rms acceleration. With this the case, the rms value of acceleration for any bandwidth within the specified spectrum is equal to

$$G\ rms = 2.3\ G \sqrt{3.32 \log_{10} (f2/f1)}$$

f2 and f1 are the upper and lower frequencies respectively of the band under consideration. The degree of clipping of the peak accelerations shall be such that the peak value of acceleration is at least 15 G's.

The voltage (ep) produced across the resistor (Rp) as a result of vibration shall be coupled through a compensating amplifier to a low pass filter. The compensating amplifier shall have a high input impedance (0.25 megohm or more) and shall be adjusted to compensate for any insertion losses in the filter. The combined frequency response of amplifier and filter shall be flat within ±0.5 db from 50 cps to 8000 cps, shall be down no more than 5 db at 10,000 cps and at 20 cps, and down at least 40 db at 13,000 cps. For reading the peak to peak value of output voltage the filter output shall be fed directly to the input of a Ballantine Model 305 peak to peak electronic voltmeter or equal, while the rms value shall be measured with a Hewlett-Packard Model 400C or equal.

APPLICATION DATA

The 5902 is a Premium Subminiature beam power audio pentode having a relatively high power sensitivity. It is capable of efficient operation at low supply voltages. In Class A audio service a single tube will deliver one watt under normal operating conditions.

This type is well suited to application as a series regulator in electronically regulated power supplies. A typical circuit employing two 5902's in parallel and subminiature types 5718 and 6308 is shown in Figure 1.

The 5902 is also useful in many pulse applications including Class C service at low radio frequencies.

Triode connected the 5902 displays the low mu, high perveance qualities desirable in servo control circuits. In this application, when utilizing an ac plate supply, precautions should be taken to insure against poor tube and circuit reliability.

Since conduction occurs for only one-half cycle high plate supply voltage is often deemed necessary in order

APPLICATION DATA (Continued)

to realize sufficient output. Excessive positive plate voltage, however, causes an appreciable increase in secondary emission. In addition, presence of the negative half-cycle of plate encourages primary emission by the plate and grids.

The effects of back emission can be minimized by (1) employing a low value grid resistor, (2) inserting series diodes, such as the Sylvania 5641, in the plate circuits, (3) operate the tubes conservatively with respect to supply voltage, peak currents, element dissipation and bulb temperature. Back emission approximates an exponential curve with increasing plate voltage swing and plate disc dissipation. For further discussion the reader is referred to the frontal section of this manual or "Effects of AC Plate Voltages on Tube Performance", Sylvania Engineering Information Service, Vol. 1, No. 10, May 1954.

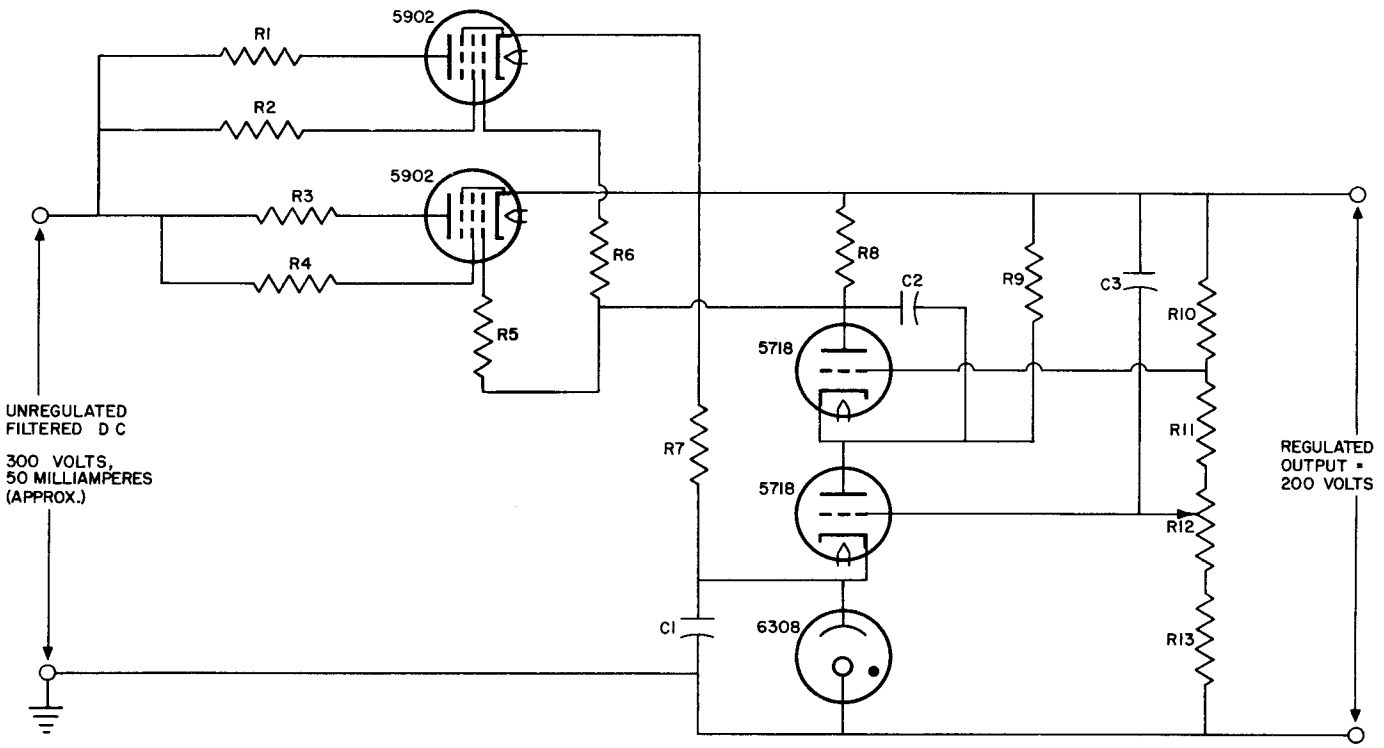
To insure correlation with actual field conditions and thereby enhance equipment reliability, vibrational noise output is controlled by the "white noise test" as shown in the acceptance criteria. Briefly, this test consists of subjecting the tube to a white noise vibration spectrum covering the frequency band of 100 to 5000 cps at a rms level of 2.3 g's per octave. Lmits are specified for peak and rms output. A further discussion of the white noise vibrational test is included in the frontal section of this manual.

The 5902 is characterized by long life and stable performance under conditions of severe vibration, shock, high temperature and high altitude and is manufactured and inspected to meet the applicable MIL-E-1 specification for reliable operation.

Life expectancy is described by the life tests, specified on the attached pages and/or individual MIL-E-1 specifications. The actual life expectancy of the tubes in an operating circuit is affected by both the operating and environmental conditions involved. Likewise, the life tests specified indicate performance under certain operating criteria to a set of specified end points. Performance at conditions other than those specified can usually be estimated only roughly as giving better or poorer life expectancy. For further discussion of life expectancy, reference should be made to the frontal section of this manual.

When operated under conditions common to on-off control applications the tube exhibits freedom from the development of interface resistance. The heater-cathode construction is designed to withstand intermittent operation.

FIGURE 1. ELECTRONIC VOLTAGE REGULATOR CIRCUIT

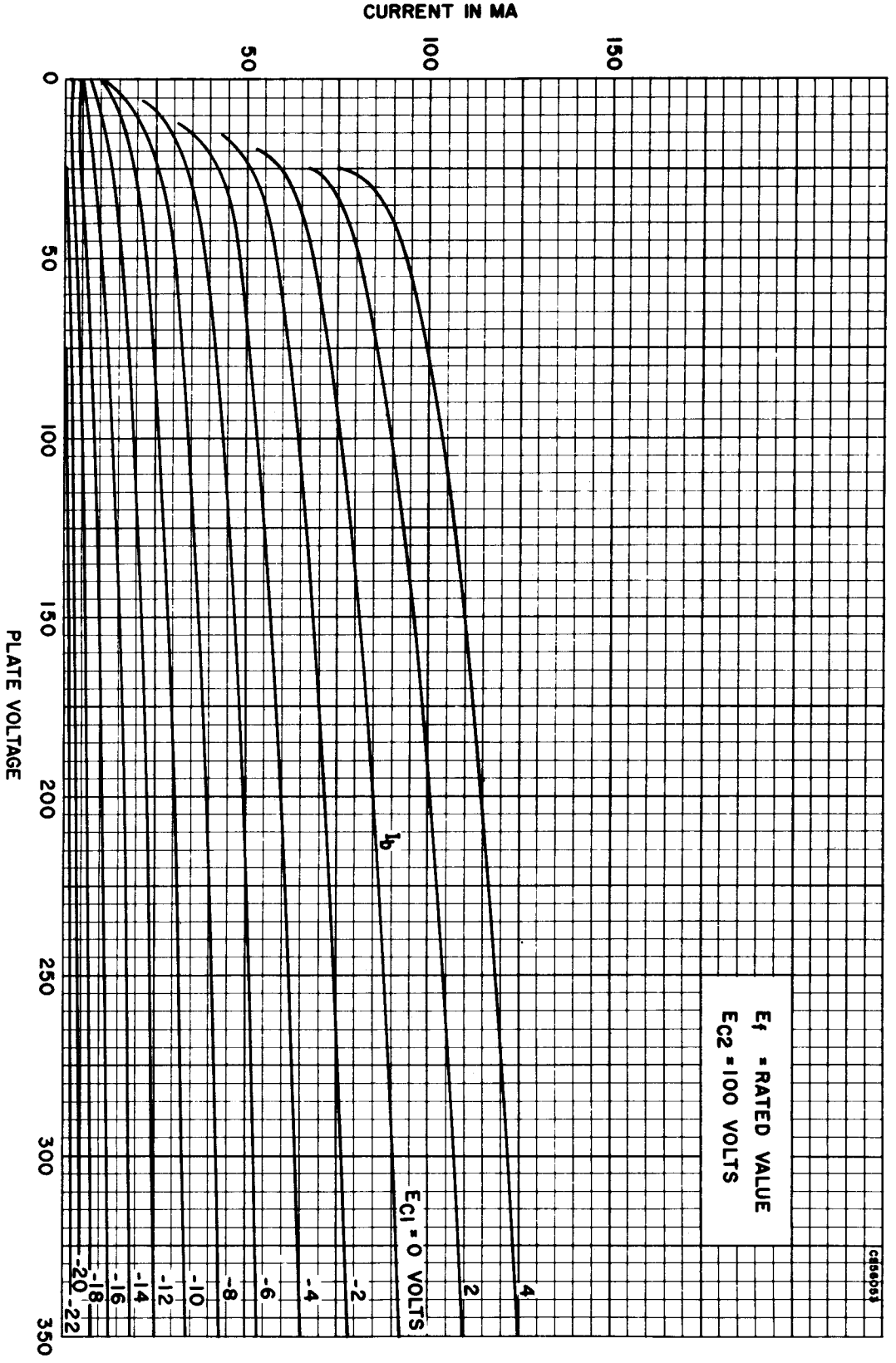


R_1 = 200 Ohms
R_2 = 500 Ohms
R_3 = 200 Ohms
R_4 = 500 Ohms
R_5 = 200 Ohms
R_6 = 200 Ohms
R_7 = 50,000 Ohms
R_8 = 490,000 Ohms
R_9 = 200,000 Ohms
R_{10} = 200,000 Ohms
R_{11} = 150,000 Ohms
R_{12} = 50,000 Ohm, 1 Watt, Pot.
R_{13} = 250,000 Ohms
C_1 = 0.01 μf, 200 V
C_2 = 510 μμf, 500 V
C_3 = 0.05 μf, 200 V

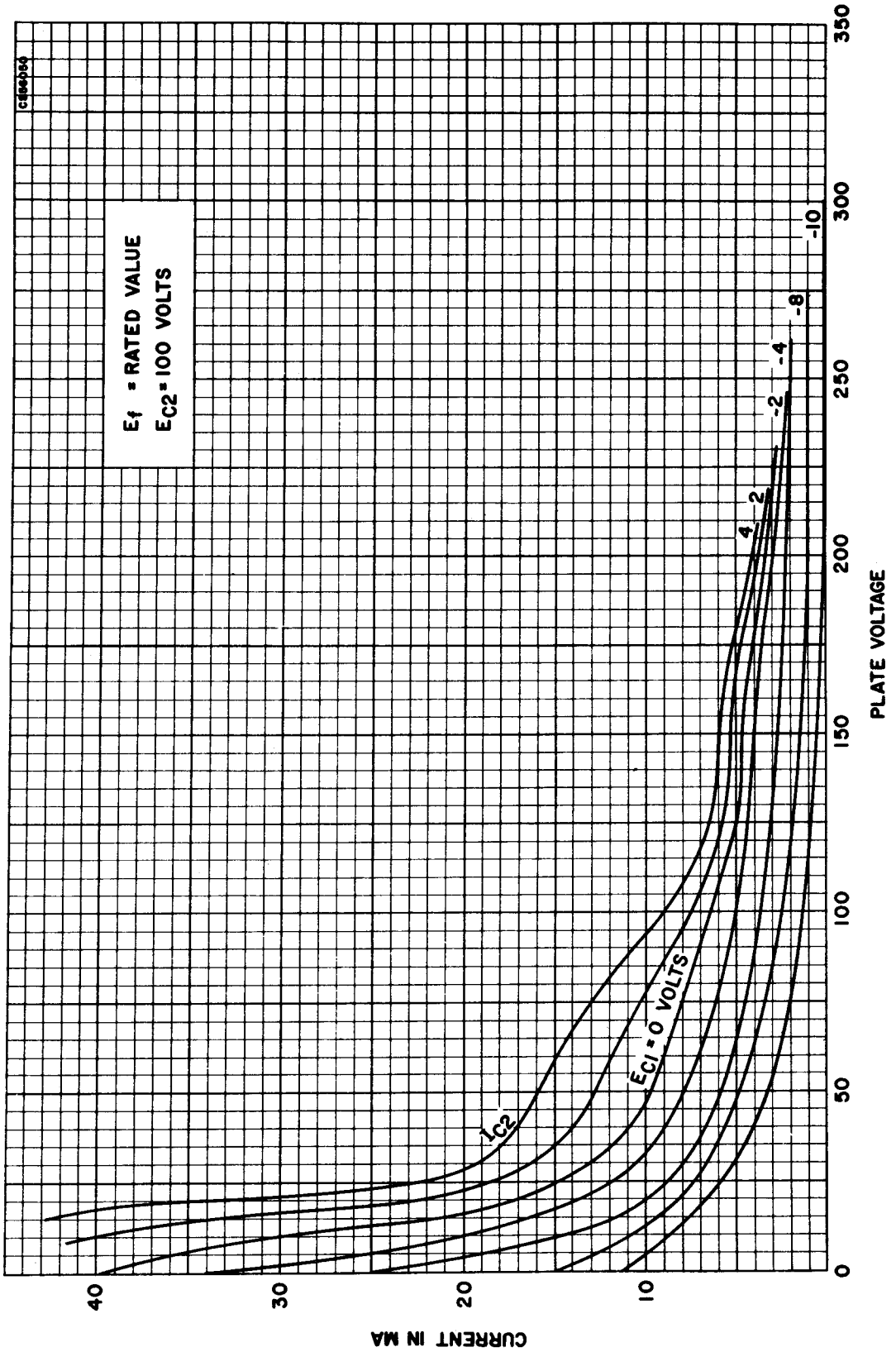
All resistors are 0.5 watt, except the potentiometer.

AVERAGE PLATE CHARACTERISTICS

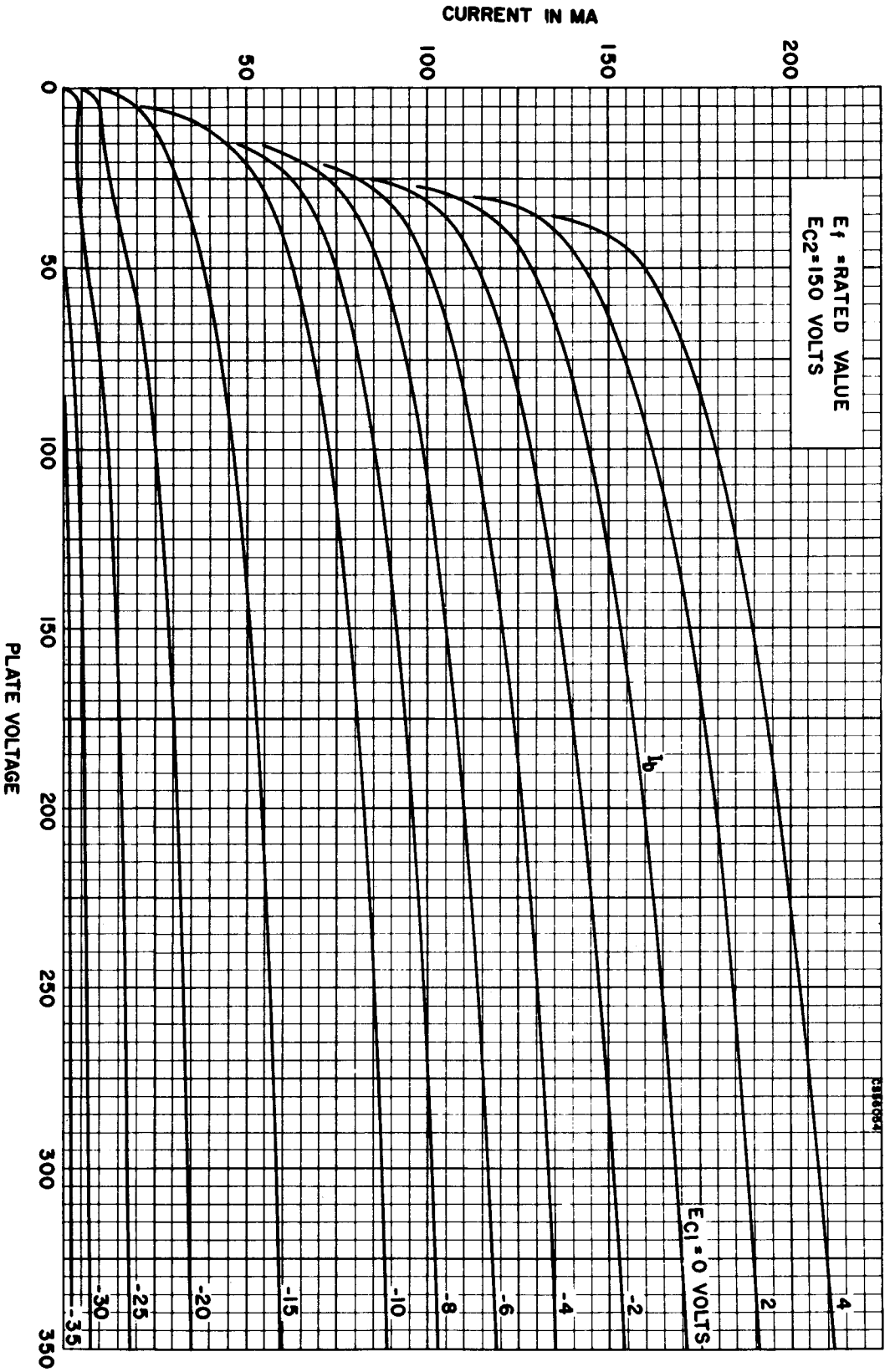
(PENTODE CONNECTED)



AVERAGE GRID No. 2 CHARACTERISTICS
(PENTODE CONNECTED)

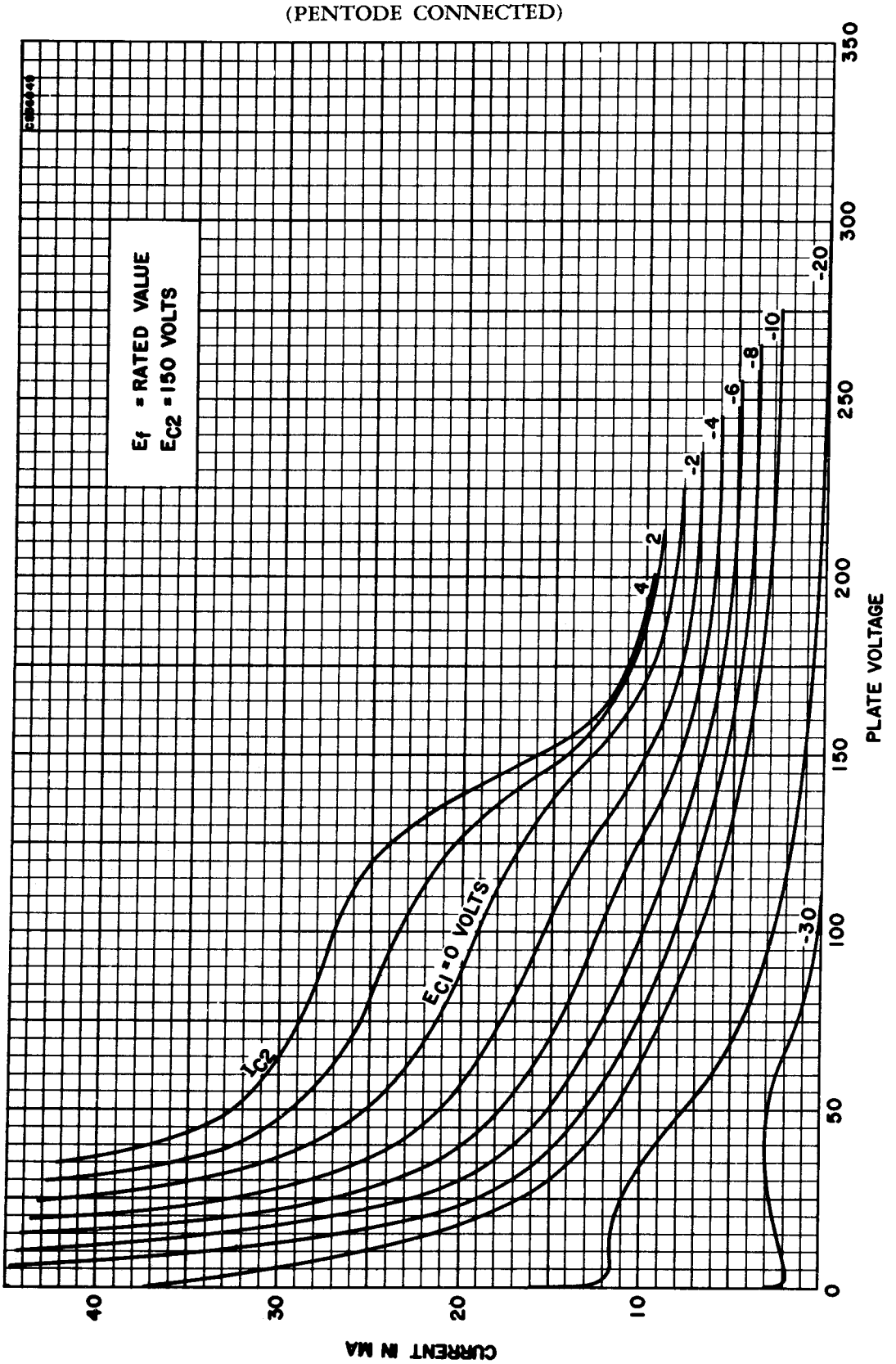


AVERAGE PLATE CHARACTERISTICS
(PENTODE CONNECTED)

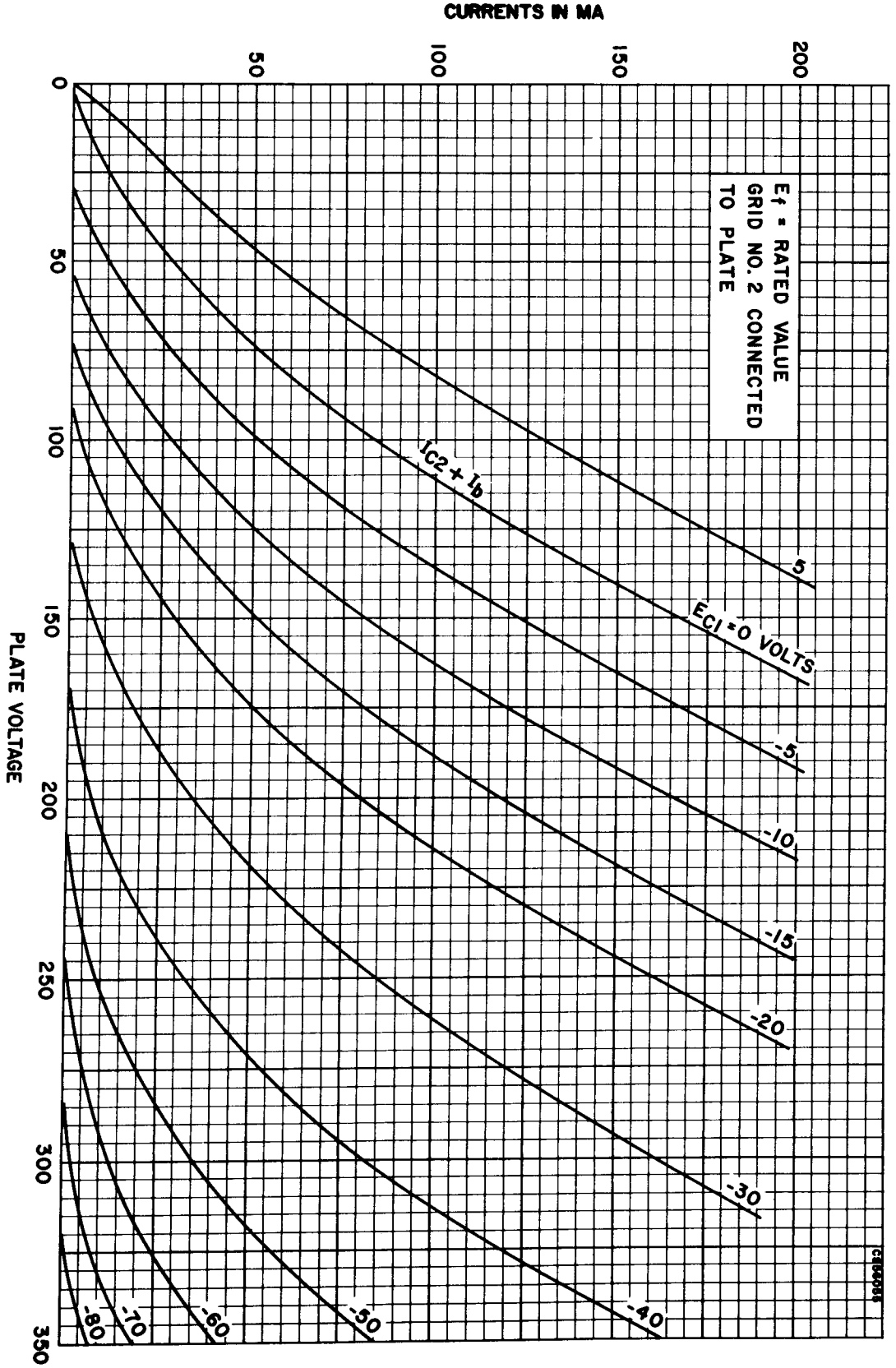


AVERAGE GRID No. 2 CHARACTERISTICS

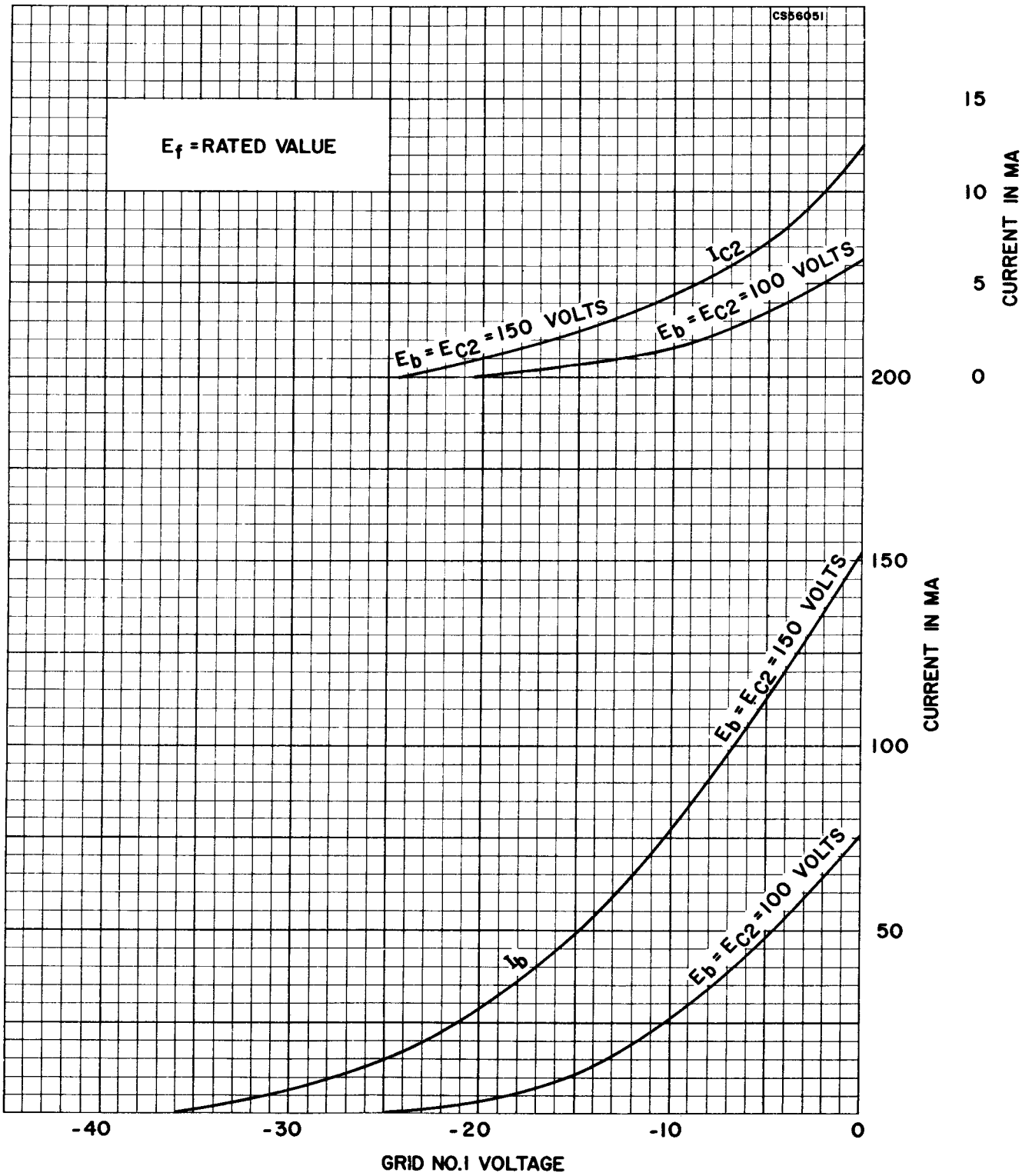
(PENTODE CONNECTED)



AVERAGE PLATE CHARACTERISTICS
(TRIODE CONNECTED)



AVERAGE TRANSFER CHARACTERISTICS
(PENTODE CONNECTED)



AVERAGE TRANSFER CHARACTERISTICS
(PENTODE CONNECTED)