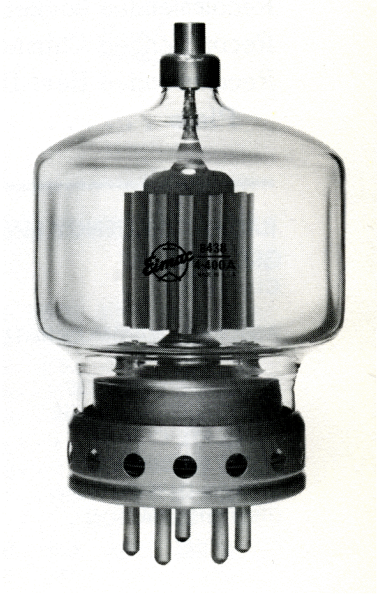
TECHNICAL DATA

8438
4-400A

RADIAL BEAM
POWER TETRODE

The EIMAC 8438/4-400A is a compact, ruggedly constructed power tetrode having a maximum plate dissipation rating of 400 watts. It is intended for use as an amplifier, oscillator or modulator. The low grid-plate capacitance of this tetrode coupled with its low driving-power requirement allows considerable simplification of the associated circuit and driver stage.

The 8438/4-400A is cooled by radiation from the plate and by circulation of forced-air through the base, around the envelope, and over the plate seal. Cooling can be greatly simplified by using an EIMAC SK-400 Series Air System Socket and its accompanying glass chimney. This socket is designed to maintain the correct balance of cooling air between the component parts of the tube.[3]



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten	
Voltage	5.0 ± 0.25 V
Current, at 5.0 volts	14.5 A
Transconductance (Average):	
I_b = 100 mA, E_{c2} = 500 volts	4000 μmhos
Amplification Factor (Average):	
Grid to Screen	5.1
Direct Interelectrode Capacitances (grounded filament)[2]	
Input	12.5 pF
Output	4.7 pF
Feedback	0.12 pF
Frequency of Maximum Rating:	
CW	110 MHz

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment design.
2. In Shielded Fixture.
3. Guarantee applies only when the 4-400A is used as specified with adequate air in the SK-400 or SK-410 Air-System Socket and associated chimney or equivalent.

MECHANICAL

Maximum Overall Dimensions:	
Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm

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Net Weight	9.0 oz; 255 gm
Operating Position	Vertical, base down or up
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	EIMAC SK-400 Series
Recommended Chimney	EIMAC SK-406
Recommended Heat-Dissipating Connectors:	
Plate	HR-6

RADIO FREQUENCY LINEAR AMPLIFIER GRID DRIVEN

Class AB_1

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)
Class AB_1, Grid Driven, Peak Envelope or Modulation Crest Conditions

Plate Voltage	3000	Vdc
Screen Voltage	750	Vdc
Grid Voltage[1]	-130	Vdc
Zero-Signal Plate Current	80	mAdc
Single Tone Plate Current	290	mAdc
Single-Tone Screen Current[2]	13	mAdc
Useful Output Power	470	W
Resonant Load Impedance	5000	Ω

1. Adjust to specified zero-signal dc plate current.
2. Approximate value.

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR

Class C Telegraphy or FM Telephony (Key-Down Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2500	3000	4000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-200	-220	-220	Vdc
Plate Current	350	350	350	mAdc
Screen Current[1]	46	46	40	mAdc
Screen Dissipation	23	23	20	W
Grid Current[1]	18	19	18	mAdc
Peak rf Grid Voltage[1]	300	320	320	v
Grid Dissipation	1.8	1.9	1.8	W
Calculated Driving Power[2]	5.4	6.1	5.8	W
Plate Input Power	875	1050	1400	W
Plate Dissipation	235	250	300	W
Plate Output Power	640	800	1100	W

1. Approximate value.
2. Driving Power increases with frequency. At 75 MHz driving power is approximately 12 watts.

TYPICAL OPERATION (110 MHz, two tubes)

Plate Voltage	3500	4000	Vdc
Screen Voltage	500	500	Vdc
Grid Voltage	-170	-170	Vdc
Plate Current	500	540	mAdc
Screen Current	34	31	mAdc
Grid Current	20	20	mAdc
Driving Power[1]	20	20	W
Plate Output Power[1]	1300	1600	W
Useful Output Power	1160	1440	W

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER-GRID DRIVEN Class C Telephony (Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	3200	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

1. Corresponds to 400 watts at 100% sine-wave modulation.
2. Average, with or without modulation.

TYPICAL OPERATION (Frequencies to 75 MHz)

Plate Voltage	2000	2500	3000	Vdc
Screen Voltage	500	500	500	Vdc
Grid Voltage	-220	-220	-220	Vdc
Plate Current	275	275	275	mAdc
Screen Current[1]	30	28	26	mAdc
Screen Dissipation	15	14	13	W
Grid Current[1]	12	12	12	mAdc
Grid Dissipation	1.1	1.1	1.1	W
Peak af Screen Voltage[1] (100% modulation)	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	v
Calculated Driving Power[1]	3.5	3.5	3.5	W
Plate Input Power	550	688	825	W
Plate Dissipation	170	178	195	W
Plate Output Power	380	510	630	W

1. Approximate value.

MAXIMUM RATINGS (Frequencies to 30 MHz, Intermittent Service

ABSOLUTE MAXIMUM RATINGS

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	600	VOLTS
DC GRID VOLTAGE	-500	VOLTS
DC PLATE CURRENT	0.275	AMPERE
PLATE DISSIPATION[1]	270	WATTS
SCREEN DISSIPATION[2]	35	WATTS
GRID DISSIPATION[2]	10	WATTS

TYPICAL OPERATION (Frequencies to 30 MHz, Intermittent Service)

Plate Voltage	2000	2500	3000	3650	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage	-220	-220	-220	-225	Vdc
Plate Current	275	275	275	275	mAdc
Screen Current[1]	30	28	26	23	mAdc
Screen Dissipation	15	14	13	12	W
Grid Current[1]	12	12	12	13	mAdc
Grid Dissipation	1.1	1.1	1.1	1.2	W
Peak Screen Voltage (100% modulation)	350	350	350	350	v
Peak rf Grid Voltage[1]	290	290	290	315	v
Calculated Driving Power[1]	3.5	3.5	3.5	4.0	W
Plate Input Power	550	688	825	1000	W
Plate Dissipation	170	178	195	235	W
Plate Output Power	380	510	630	765	W

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR Class AB, Grid Driven (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS (Per Tube)

DC PLATE VOLTAGE	4000	VOLTS
DC SCREEN VOLTAGE	800	VOLTS
DC PLATE CURRENT	0.350	AMPERE
PLATE DISSIPATION	400	WATTS
SCREEN DISSIPATION	35	WATTS
GRID DISSIPATION	10	WATTS

TYPICAL OPERATION (Two Tubes) Class AB_1

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	750	750	750	750	Vdc
Grid Voltage[1/4]	-130	-137	-145	-150	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	635	635	610	585	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current[1]	28	26	32	40	mAdc
Peak af Grid Voltage[2]	130	137	145	150	v
Peak Driving Power[3]	0	0	0	0	w
Max Signal Plate Dissipation[2]	370	400	400	400	W
Plate Output Power	850	1100	1330	1540	W
Load Resistance (plate to plate)	6800	8900	11,500	14,000	Ω

TYPICAL OPERATION (Two Tubes) Class AB_2

Plate Voltage	2500	3000	3500	4000	Vdc
Screen Voltage	500	500	500	500	Vdc
Grid Voltage[1/4]	-75	-80	-85	-90	Vdc
Zero-Signal Plate Current	190	160	140	120	mAdc
Max. Signal Plate Current	700	700	700	638	mAdc
Zero-Signal Screen Current	0	0	0	0	mAdc
Max. Signal Screen Current	50	40	38	32	mAdc
Peak af Grid Voltage[2]	133	140	145	140	v
Peak Driving Power[3]	8.6	9.0	10.2	7.0	W
Max. Signal Plate Dissipation[2]	320	363	400	400	W
Plate Output Power	1110	1375	1650	1750	W
Load Resistance (plate to plate)	7200	9100	10,800	14,000	Ω

1. Approximate value.
2. Per tube.
3. Nominal drive power is one-half peak power.
4. Adjust to give stated zero-signal plate current.

NOTE: TYPICAL OPERATION data are obtained from direct measurement or by calculation from published characteristic curves. Adjustment of the rf grid voltage to obtain the specified plate current at the specified bias, screen and plate voltages is assumed. If this procedure is followed, there will be little variation in output power when the tube is changed, even though there may be some variation in grid and screen current. The grid and screen currents which result when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no difficulty so long as the circuit maintains the correct voltage in the presence of the variations in current. In the case of Class C Service, if grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to obtain the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Filament: Current at 5.0 volts	13.5	14.7	A
Interelectrode Capacitances [1](grounded filament connection):			
Input	10.7	14.5	pF
Output	4.2	5.6	pF
Feedback	----	0.17	pF

1. In Shielded Fixture.

APPLICATION

MECHANICAL

MOUNTING - The 4-400A must be mounted vertically, base up or down. The socket must be constructed so as to allow an unimpeded flow of air through the holes in the base of the tube and must also provide clearance for the glass tip-off which extends from the center of the base. The metal tube-base shell should be grounded by means of suitable spring fingers. The above requirements are met by the EIMAC SK-400 and SK-410 Air-System Sockets. A flexible connecting strap should be provided between the EIMAC HR-6 cooler on the plate terminal and the external plate circuit. The tube must be protected from severe vibration and shock.

COOLING - Adequate forced-air cooling must be provided to maintain the base seals at a temperature below 200°C, and the plate seal at a temperature below 225°C.

When the EIMAC SK-400 or SK-410 Air-System Socket is used, a minimum air flow of 14 cubic feet per minute at a static pressure of 0.25 inches of water or less, as measured in the socket or plenum chamber at sea level, is required to provide adequate cooling under all conditions of operation. Seal temperature limitations may require that cooling air be supplied to the tube even when the filament alone is on during stand-by periods.

In the event an Air-System Socket is not used, provision must be made to supply equivalent cooling of the base, the envelope, and the plate lead.

Tube temperatures may be measured with a temperature sensitive paint, spray or crayon, such as manufactured by Tempil Division, Big Three Industrial Gas & Equipment Co., Hamilton Blvd., So. Plainfield, N.J. 07080.

ELECTRICAL

FILAMENT VOLTAGE - For maximum tube life the filament voltage, as measured directly at the filament pins, should be the rated voltage of 5.0 volts. Variations in filament voltage must be kept within the range from 4.75 to 5.25 volts.

BIAS VOLTAGE - The dc bias voltage for the 4-400A should not exceed 500 volts. If grid resistor bias is used, suitable means must be provided to prevent excessive plate or screen dissipation in the event of loss of excitation, and the grid resistor should be made adjustable to facilitate maintaining the bias voltage and plate current at the desired values from tube to tube. In operation above 50 MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLTAGE - The dc screen voltage for the 4-400A should not exceed 800 volts. The screen voltages shown under Typical Operation are representative voltages for the type of operation involved.

PLATE VOLTAGE - The plate-supply voltage for the 4-400A should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the dc plate-supply voltage should not exceed 3200 volts, except below 30 MHz, intermittent service, where 4000 volts may be used.

GRID DISSIPATION - Grid dissipation for the 4-400A should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

$$P_g = e_{gk} \times I_c$$

where P_g = Grid dissipation

e_{gk} = Peak positive grid to cathode voltage, and

I_c = dc grid current

e_{cmp} may be measured by means of a suitable peak voltmeter connected between filament and grid.

SCREEN DISSIPATION - The power dissipated by the screen of the 4-400A must not exceed 35 watts. Screen dissipation is likely to rise to excessive values when the plate voltage, bias voltage or plate load are removed with filament and screen voltages applied. Suitable protective means must be provided to limit screen dissipation to 35 watts in event of circuit failure.

PLATE DISSIPATION - Under normal operating conditions, the plate dissipation of the 4-400A should not be allowed to exceed 400 watts. The anode of the 4-400A operates at a visibly red color at its maximum rated dissipation of 400 watts.

In plate modulated amplifier applications, the maximum allowable carrier-condition plate dissipation is 270 watts. The plate dissipation will rise to 400 watts under 100% sinusoidal modulation.

Plate dissipation in excess of the maximum rating is permissible for short periods of time, such as during tuning procedures.

PULSE SERVICE - For pulse service, the EIMAC 4PR400A should be used.

MULTIPLE OPERATION - To obtain maximum power output with minimum distortion from tubes operated in multiple, it is desirable to adjust individual screen or grid bias voltages so that the peak plate current for each tube is equal at the crest of the exciting voltage. Under these conditions, individual dc plate currents will be approximately equal for full input signal for class AB_1 operation.

CAUTION - GLASS IMPLOSION - The EIMAC 4-400A is pumped to a very high vacuum, which is contained by a glass envelope. When handling a glass tube, remember that glass is a relatively fragile material, and accidental breakage can result at any time. Breakage will result in flying glass fragments, so safety glasses, heavy clothing, and leather gloves are recommended for protection.

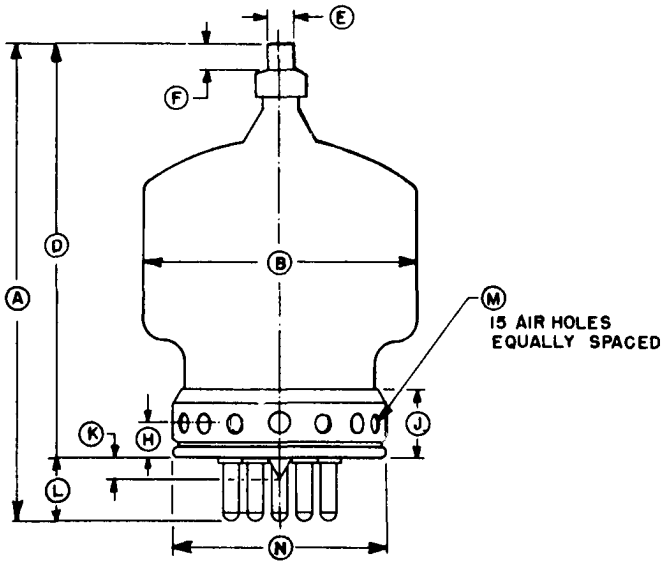
CAUTION-HIGH VOLTAGE - Operating voltage for the 4-400A can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits and terminals, with interlock switches to open the primary circuits of the power supply and to discharge high voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

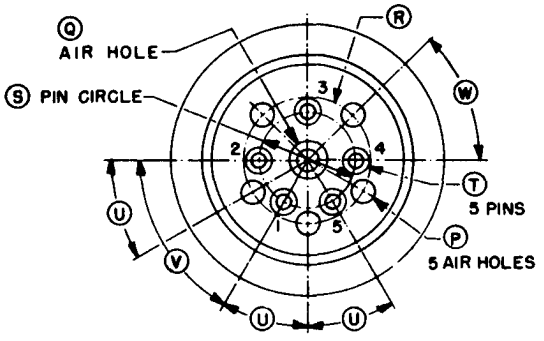
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, write to Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, for information and recommendations.

DIMENSIONAL DATA

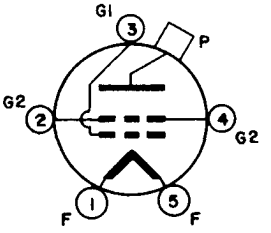
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	19.05
M	--	--	0.250	--	--	6.35
N	--	2.750	--	--	69.85	--
P	--	--	0.312	--	--	7.92
Q	--	--	0.500	--	--	12.70
R	--	--	1.625	--	--	41.28
S	--	--	1.250	--	--	31.75
T	0.185	0.191	--	4.70	4.85	--
U	--	--	30°	--	--	30°
V	--	--	60°	--	--	60°
W	--	--	45°	--	--	45°

NOTES:
1. REF DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

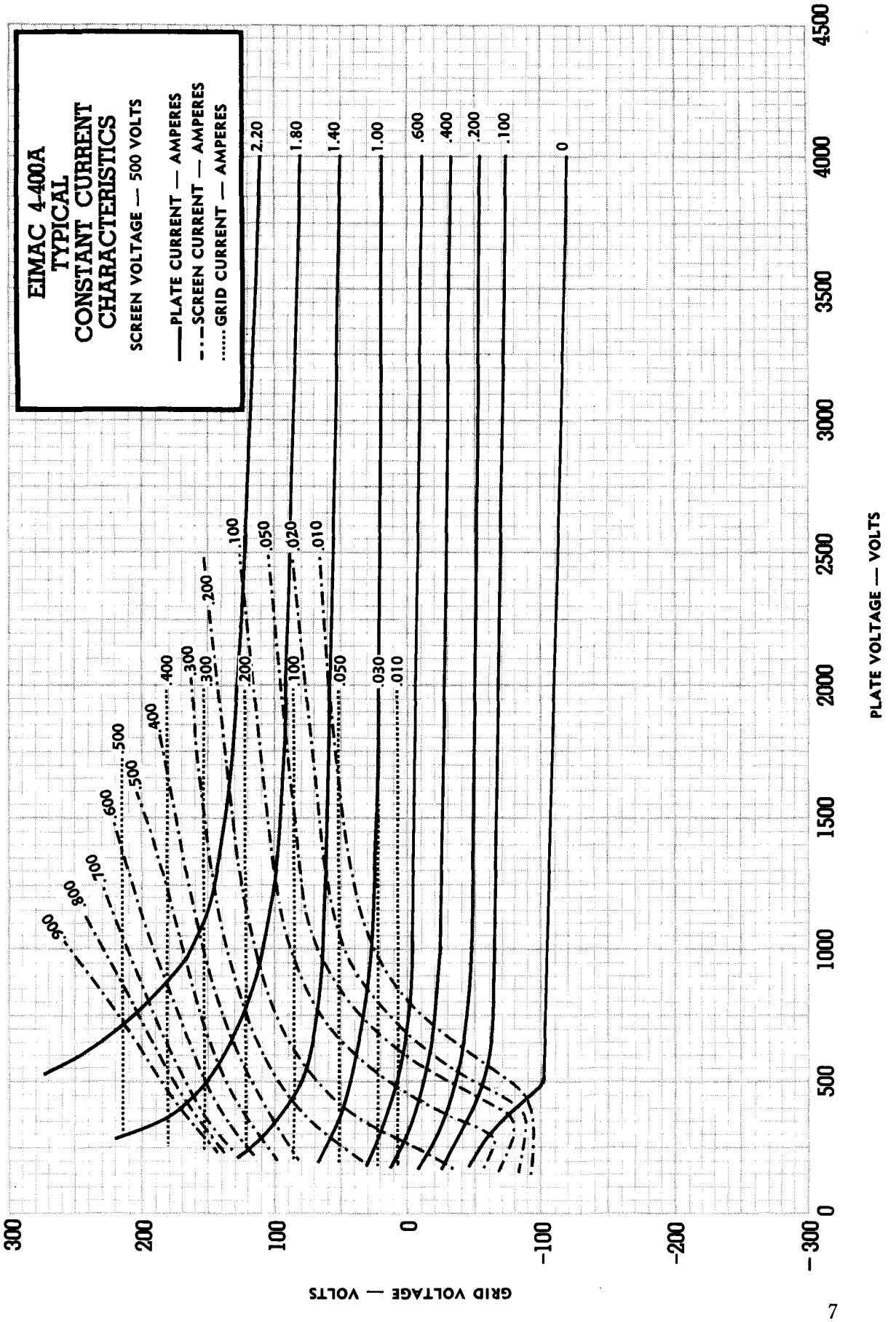




BOTTOM VIEW



NOTE:
Base pins T and tubulation K are so alined that they can be freely inserted in a gage ¼ inch (6.35 mm) thick with hole diameters of .204 (5.18 mm) and .500 (12.70 mm), respectively, located on the true centers by the given dimensions S, U, V.


EIMAC 4-400A
TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
PLATE CURRENT — AMPERES
SCREEN CURRENT — AMPERES
GRID CURRENT — AMPERES
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0
.100
.050
.020
.010
.200
.100
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2000
2500
3000
3500
4000
4500
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS