Amperex

4-400C/6775

Radial Beam Power Tetrode

The Amperex 4-400C/6775 is a compact, ruggedly constructed, broadcast quality 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 4-400C/6775 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 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.[1]

The 4-400C/6775 is especially recommended for applications where long life and consistent performance are of prime consideration. [2]

GENERAL CHARACTERISTICS[3]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	5.0 ± 0.25	V
Current, at 5.0 volts	14.7	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)[4]		
Cin	12.5	pF
Cout	4.7	pF
Cgp	0.12	pF
Frequency of Maximum Rating:		
CW	110	MHz

1. Guarantee applies only when the 4-400C is used as specified with adequate cooling air in the SK-400 or SK-410 Air-System Socket and associated chimney, or equivalents.
2. See FILAMENT VOLTAGE section for recommended operating conditions when long life and consistent performance are of prime concern.
3. Characteristics and operating values are based on performance tests. These figures may change without notice as the result of additional data or product refinement. Richardson Electronics should be consulted before using this information for final equipment design.
4. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

Richardson Electronics
industrial.rell.com
40W267 Keslinger Rd.
PO Box 393, LaFox, IL USA
800-348-5580 (US & Canada)
630-208-2200 ▲ edg@rell.com

MECHANICAL

Maximum Overall Dimensions:	
Length	6.375 in; 161.93 mm
Diameter	3.563 in; 90.50 mm
Net Weight	9.0 oz; 255 gm
Operating Position	Any
Maximum Operating Temperature:	
Plate Seal	225°C
Base Seals	200°C
Cooling	Radiation and forced air
Base	Special 5-pin
Recommended Socket	SK-400 Series
Recommended Chimney	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	3000	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.

TYPICAL OPERATION (Frequencies to 75 MHz, Continuous Service)

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

2. Average, with or without modulation.

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	14.0	15.3 A
Interelectrode Capacitances [1]		
(Grounded filament connection):		
Cin……	10.7	14.5 pF
Cout……..	4.2	5.6 pF
Cgp……...	—	0.17 pF

1. In shielded fixture, per EIA standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4-400C may be operated in any position. 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 SK-400 and SK-410 Air System Sockets. A flexible connecting strap should be provided between the 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 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 standby periods. Tube temperatures may be measured with a temperature sensitive paint, spray or crayon.

ELECTRICAL

FILAMENT VOLTAGE - Filament voltage should be measured at the tube base with an accurate meter. When operating at the nominal voltage, variations of ± 5% are tolerable and should have little effect on electrical performance of the tube. However, when very long life and consistent performance are factors, voltage can often be reduced to a value lower than the nominal voltage, but should be regulated and held to ±1% when this is done. To achieve a regulated voltage and still have it adjustable, a typical procedure would involve a one-to-one regulating transformer, feeding a variable ratio transformer (such as a POW E R S TAT or a VARIAC), which in turn feeds the filament transformer. The equipment is first operated with nominal filament voltage applied, and when stable operation is achieved, the voltage is then reduced in small steps (about 0.2 volt at a time) until the point is reached where performance of the tube is clearly affected. The voltage is then raised to a few tenths of a volt above this level for operation. Periodically (every 500 to 1000
hours) this procedure should be repeated and the operating value of the filament voltage readjusted if necessary.

BIAS VOLTAGE - The de bias voltage for the 4-400C 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 SO MHz, it is advisable to keep the bias voltage as low as is practicable.

SCREEN VOLT AGE - The de screen voltage for the 4-400C 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 4-400C should not exceed 4000 volts in CW and audio applications. In plate-modulated telephony service the de 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 4-400c should not be allowed to exceed 10 watts. Grid dissipation may be calculated from the following expression:

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

where P_g = Grid dissipation

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

Ic = de grid current

SCREEN DISSIPATION - The power dissipated by the screen of the 4-400C 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 4-400C should not be allowed to exceed 400 watts. The anode 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.

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 Amperex 4-400C 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.

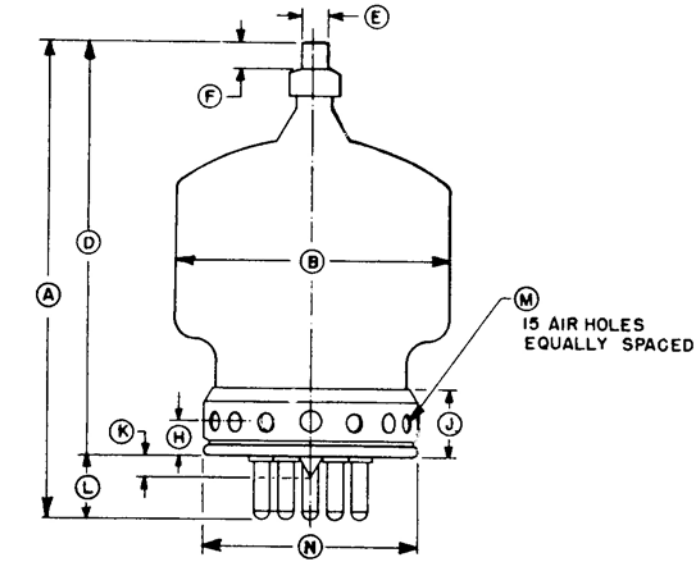
CAUTION-HIGH VOLTAGE - Operating voltage for the 4-400C can be deadly, so the equipment must be designed properly and operating precautions must be followed. Design equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high voltage circuits 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.

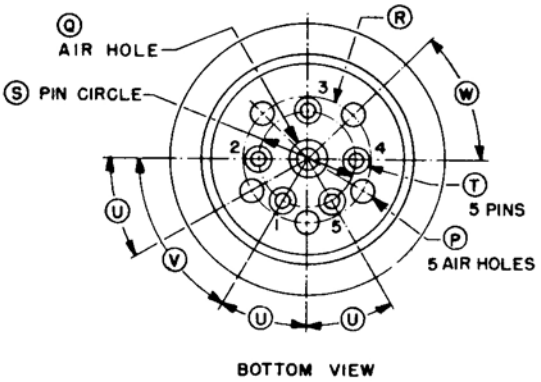
SPECIAL APPLICATION - If it is desired to operate this tube under conditions widely different from those listed here, please contact your local Richardson Electronics representative for information and recommendations.

DIMENSIONAL DATA

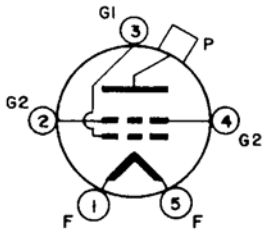
DIM.	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	5.875	6.375	--	149.23	161.93	--
B	--	3.563	--	--	90.50	--
D	5.125	5.625	--	130.18	142.88	--
E	0.350	0.365	--	8.89	9.27	--
F	0.328	--	--	8.33	--	--
H	--	--	0.438	--	--	11.13
J	--	0.969	--	--	24.61	--
K	--	0.250	--	--	6.35	--
L	--	--	0.750	--	--	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.

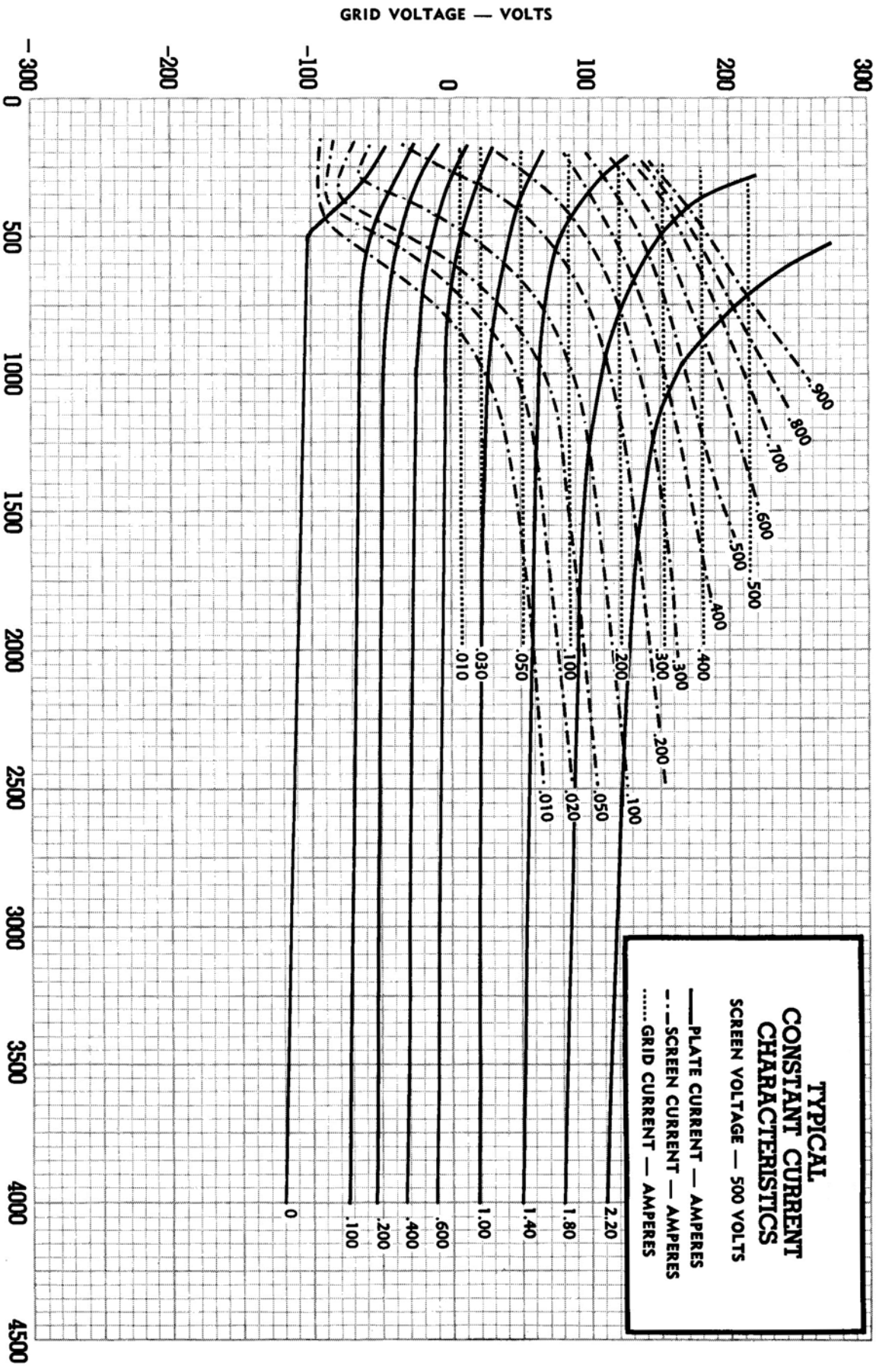




BOTTOM VIEW



NOTE:
Base pins T and K are so alined that they can be freely inserted in a gage 1/4" (6.35 mm) thick with hole diameters of 0.204 (5.18 mm), respectively, located on the true centers by the given dimensions S, U, V.


TYPICAL
CONSTANT CURRENT
CHARACTERISTICS
SCREEN VOLTAGE — 500 VOLTS
——PLATE CURRENT — AMPERES
- - —SCREEN CURRENT — AMPERES
..... GRID CURRENT — AMPERES
GRID VOLTAGE — VOLTS
PLATE VOLTAGE — VOLTS
300
200
100
0
−100
−200
−300
0
500
1000
1500
2000
2500
3000
3500
4000
4500
900
800
700
600
500
500
400
400
300
300
200
200
100
050
030
010
100
050
020
010
2.20
1.80
1.40
1.00
.600
.400
.200
.100
0