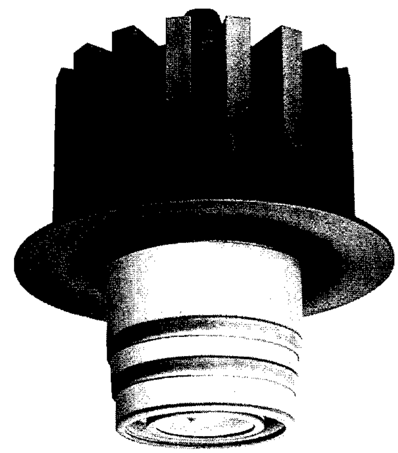
TECHNICAL DATA

4CV35,000A

VAPOR-COOLED RADIAL-BEAM POWER-TETRODE

The EIMAC 4CV35,000A is a ceramic-metal power tetrode intended for use as a Class C amplifier in radio-frequency applications. If features a type of internal mechanical structure which results in higher rf operating efficiency. Low rf losses in this mechanical structure permit operation of the 4CV35,000A at full ratings up to 110 megahertz. The 4CV35,000A is also recommended for Class AB audio-frequency and radio-frequency linear power amplifier service. The vapor-cooled anode is rated at 35 kilowatts of plate dissipation, making the tube attractive for low efficiency applications.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten

Voltage	6.3 ± 0.3	V
Current @ 6.3 V	160	A

Amplification Factor, average

Grid to Screen	4.5

Direct Interelectrode Capacitances (cathode grounded):[2]

Cin	160.0	pF
Cout	24.5	pF
Cgp	1.5	pF

Direct Interelectrode Capacitances (grid and screen grounded):[2]

Cin	67.0	pF
Cout	25.5	pF
Cpk	0.2	pF

Maximum Frequency Ratings

CW	110	MHz

1. Characteristics and operating values are based on 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. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

MECHANICAL

Base	Special, concentric
Maximum Seal Temperature	250°C
Maximum Anode Flange Temperature (see Outline Drawing)	110°C
Recommended Socket	EIMAC, SK-310
Boiler	EIMAC, BR-200
Operating Position	Vertical, Anode Down

3994 (Effective 8-15-79) Printed in U.S.A.

Maximum Dimensions:

Height	9.50 In; 24.13 cm
Diameter	7.90 In; 20.07 cm
Base Cooling	Forced Air
Net Weight (approximate)	23 lb; 10.5 kg
Shipping Weight (approximate)	36 lb; 16.4 kg

RADIO FREQUENCY LINEAR AMPLIFIER
Grid Driven, Class AB $_1$

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

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

TYPICAL OPERATION
Peak Envelope or Modulation Crest Conditions

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	1,500	1,500	Vdc
Grid Voltage[1]	-350	-370	Vdc
Zero-Signal Plate Current	1.0	1.0	Adc
Single-Tone Plate Current	4.0	4.25	Adc
Single-Tone Screen Current[2]	170	150	mAdc
Peak rf Grid Voltage[2]	330	340	v
Plate Dissipation	12.2	14.0	kW
Single-Tone Plate Output Power	20.8	28.5	kW
Resonant Load Impedance	865	1,260	Ω

RADIO FREQUENCY POWER AMPLIFIER OR OSCILLATOR
Class C Telegraphy or FM
(Key-down Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	5.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

TYPICAL OPERATION

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-510	-550	Vdc
Plate Current	4.65	4.55	Adc
Screen Current[1]	0.59	0.54	Adc
Grid Current[1]	0.30	0.27	Adc
Peak rf Grid Voltage[1]	730	790	v
Calculated Driving Power	220	220	W
Plate Dissipation	8.1	9.0	kW
Plate Output Power	26.7	36.5	kW

1. Approximate value.

PLATE MODULATED RADIO FREQUENCY POWER AMPLIFIER - Grid Driven
Class C Telephony
(Carrier Conditions)

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	8000	VOLTS
DC SCREEN VOLTAGE	1,500	VOLTS
DC PLATE CURRENT	4.0	AMPERES
PLATE DISSIPATION	23,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

1. Approximate value.

TYPICAL OPERATION

Plate Voltage	6,000	8,000	Vdc
Screen Voltage	750	750	Vdc
Grid Voltage	-600	-640	Vdc
Plate Current	3.75	3.65	Adc
Screen Current[1]	0.45	0.43	Adc
Grid Current[1]	0.18	0.18	Adc
Peak af Screen Voltage[1] 100% modulation	740	710	v
Peak rf Grid Voltage[1]	800	840	v
Calculated Driving Power	150	150	W
Plate Dissipation	5.1	5.8	kW
Plate Output Power	17.4	23.5	kW

AUDIO FREQUENCY POWER AMPLIFIER OR MODULATOR - Grid Driven
Class AB $_1$ (Sinusoidal Wave)

ABSOLUTE MAXIMUM RATINGS: (Per Tube)

DC PLATE VOLTAGE	10,000	VOLTS
DC SCREEN VOLTAGE	2,000	VOLTS
DC PLATE CURRENT	6.0	AMPERES
PLATE DISSIPATION	35,000	WATTS
SCREEN DISSIPATION	450	WATTS
GRID DISSIPATION	200	WATTS

1. Adjust for specified zero-signal plate current.
2. Approximate value.
3. Per Tube.

TYPICAL OPERATION (Two Tubes)

Plate Voltage	7,500	10,000	Vdc
Screen Voltage	1,500	1,500	Vdc
Grid Voltage[1]	-350	-370	Vdc
Zero-Signal Plate Current[3]	1.00	1.00	Adc
Maximum Signal Plate Current	8.80	8.50	Adc
Maximum Signal Screen Current[2]	0.34	0.30	Adc
Peak af Grid Voltage[2]	330	340	v
Maximum Signal Plate Dissipation[3]	12.2	14.0	kW
Plate Output Power	41.6	57.0	kW
Load Resistance (plate to plate)	1,730	2,520	Ω

NOTE: TYPICAL OPERATION values are obtained by calculations from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations. If grid bias is obtained principally by means of a grid resistor, the resistor must be adjustable to produce the required bias voltage when the correct rf grid voltage is applied.

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater Current @ 6.3 volts	152	168	A
Interelectrode Capacitances (grounded cathode)[1]			
Cin	154.0	167.0	pF
Cout	22.0	27.0	pF
Cgp	---	2.0	pF
Interelectrode Capacitances (grounded grid and screen)[1]			
Cin	62.0	72.0	pF
Cout	23.0	28.0	pF
Cpk	---	0.3	pF

1. Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronic Industries Association Standard RS-191.

APPLICATION

MECHANICAL

MOUNTING - The 4CV35,000A must be operated with its axis vertical, base up in an EIMAC BR-200 boiler. Care must be exercised when installing to insure that the boiler is level, the water is at the proper level and that the flange of the tube makes a vapor tight seal against the rubber O-ring and boiler.

SOCKET - The EIMAC SK-310 socket is available for use with the 4CV35,000A. Filament, control grid and screen grid connections are made to this socket.

COOLING - Cooling is accomplished by immersing the anode in distilled water in a BR-200 boiler. The energy dissipated at the anode causes the water to boil at the surfaces of the anode, be converted into steam and be carried away to the condenser. The boiling action keeps the anode surfaces at approximately 100°C. In a properly designed boiler-tube system (such as the 4CV35,000A and BR-200), it is extremely unlikely that the anode surfaces will ever exceed 100°C — well below the 250°C maximum rating — at full dissipation ratings.

The water in the boiler must be maintained at a constant level, just below the top of the fins on the anode cooler. This is normally accomplished automatically in the vapor cooling system. Condensate from the condenser is returned to the boiler to maintain this constant fluid level. Any losses or drops in liquid level are sensed by the control box CB-202. A low water level in the control box activates the solenoid water valve, allowing make-up water from teh reservoir to enter the boiler. When the proper level is reached, the control box de-energizes the solenoid, stopping the flow from the reservoir. A second switch in the control box is energized if the water level drops to a lower level because of an empty reservoir or a constriction in the line. This switch may be used to shut down the equipment or activate an alarm.

For reliable operation, it is important that the control box and boiler be mounted so that the level sensed by the control box is exactly the same as the level in the boiler.

Careful attention to maintenance of water purity is essential to proper operation and long tube life. Ordinary tap water does not meet these requirements and distilled or deionized water should be used. EIMAC Application Bulletin #16, titled "WATER PURITY REQUIREMENTS IN LIQUID COOLING SYSTEMS" is available on request, and contains considerable information on water purity and its maintenance.

Air cooling of the tube base is required. 100 CFM minimum should be directed straight down toward the center of the SK-310 socket from a blower or duct, not more than 5½ inches from the socket.

ELECTRICAL

FILAMENT OPERATION - The rated filament voltage is 6.3 volts. Filament voltage, as measured at the socket, should be maintained at this value to obtain maximum tube life. In no case should it be allowed to deviate by more than plus or minus five percent from the rated value.

ELECTRODE DISSIPATION RATINGS - The maximum dissipation ratings for the 4CV35,000A must be respected to avoid damage to the tube. An exception is the plate dissipation which may be permitted to rise above the rated maximum during brief periods, such as may occur during tuning.

GRID OPERATION - The control grid has a maximum dissipation rating of 200 watts. Precautions should be observed to avoid exceeding this rating. The grid bias and driving power should be kept near the values shown in the "Typical Operation" sections of the data sheet whenever possible. The maximum grid circuit resistance should not exceed 100,000 ohms per tube.

SCREEN OPERATION - The power dissipated by the screen must not exceed 450 watts.

Screen dissipation, in cases where there is no AC applied to the screen, is the simple product of the screen voltage and the screen current. If the screen voltage is modulated, the screen dissipation will depend upon loading, driving power, and carrier screen voltage.

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 the screen dissipation to 450 watts in the event of circuit failure.

PLATE DISSIPATION - The plate-dissipation rating for the 4CV35,000A is 15,000 watts.

When the tube is operated as a plate-modulated rf power amplifier, the input power is limited by conditions not connected with the plate efficiency, which is quite high. Therefore, except during tuning there is little possibility that the 35,000 watt maximum plate dissipation rating will be exceeded.

HIGH VOLTAGE - Normal operating voltages used with these tubes are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all 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 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.

RADIO FREQUENCY RADIATION - Avoid exposure to strong rf fields even at relatively low frequency. Absorption of rf energy by human tissue is dependent on frequency. Under 30 MHz, most of the energy will pass completely through the human body with little attenuation or heating effect. Public health agencies are concerned with the hazard, however, even at these frequencies, and it is worth noting that some commercial dielectric heating units actually operate at frequencies as low as the 13 and 27 MHz bands.

Many EIMAC power tubes, such as these, are specifically designed to generate or amplify radio frequency power. There may be a relatively strong rf field in the general proximity of the power tube and its associated circuitry--the more power involved, the stronger the rf field. Proper enclosure design and efficient coupling of rf energy to the load will minimize the rf field in the vicinity of the power amplifier unit itself.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects. To control the actual capacitance values within the tube, as the key component involved, the industry and the Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminates any capacitance reading to "ground". The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time, even when the tube may be made by different manufacturers.

The capacitance values shown in the manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

FAULT PROTECTION - In addition to normal plate overcurrent interlock and screen current interlock, it is good practice to protect the tube from internal damage which could result from a plate arc at high voltage. In all cases some protective resistance, 10 to 50 ohms, should be used in series with the tube anode to absorb power supply stored energy in case a tube arc should occur. If power supply stored energy is very high, some form of electronic crowbar which will discharge power supply capacitors in a few microseconds following indication of start of a tube arc is recommended.

EIMAC Application Bulletin #17 titled, "FAULT PROTECTION" is available on request and includes detailed information on the subject.

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.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of power tubes involves one or more of the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

a. *HIGH VOLTAGE* - Normal operating voltages can be deadly.

b. *RF RADIATION* - Exposure to strong rf fields should be avoided, even at relatively low frequencies. The dangers of rf radiation are more severe at UHF and microwave frequencies and can cause serious bodily and eye injuries. CARDIAC PACEMAKERS MAY BE AFFECTED.

c. *X-RAY RADIATION* - High voltage tubes can produce dangerous and possibly fatal x-rays.

d. *BERYLLIUM OXIDE POISONING* - Dust or fumes from BeO ceramics used as thermal links with some conduction-cooled power tubes are highly toxic and can cause serious injury or death.

e. *GLASS EXPLOSION* - Many electron tubes have glass envelopes. Breaking the glass can cause an implosion, which will result in an explosive scattering of glass particles. Handle glass tubes carefully.

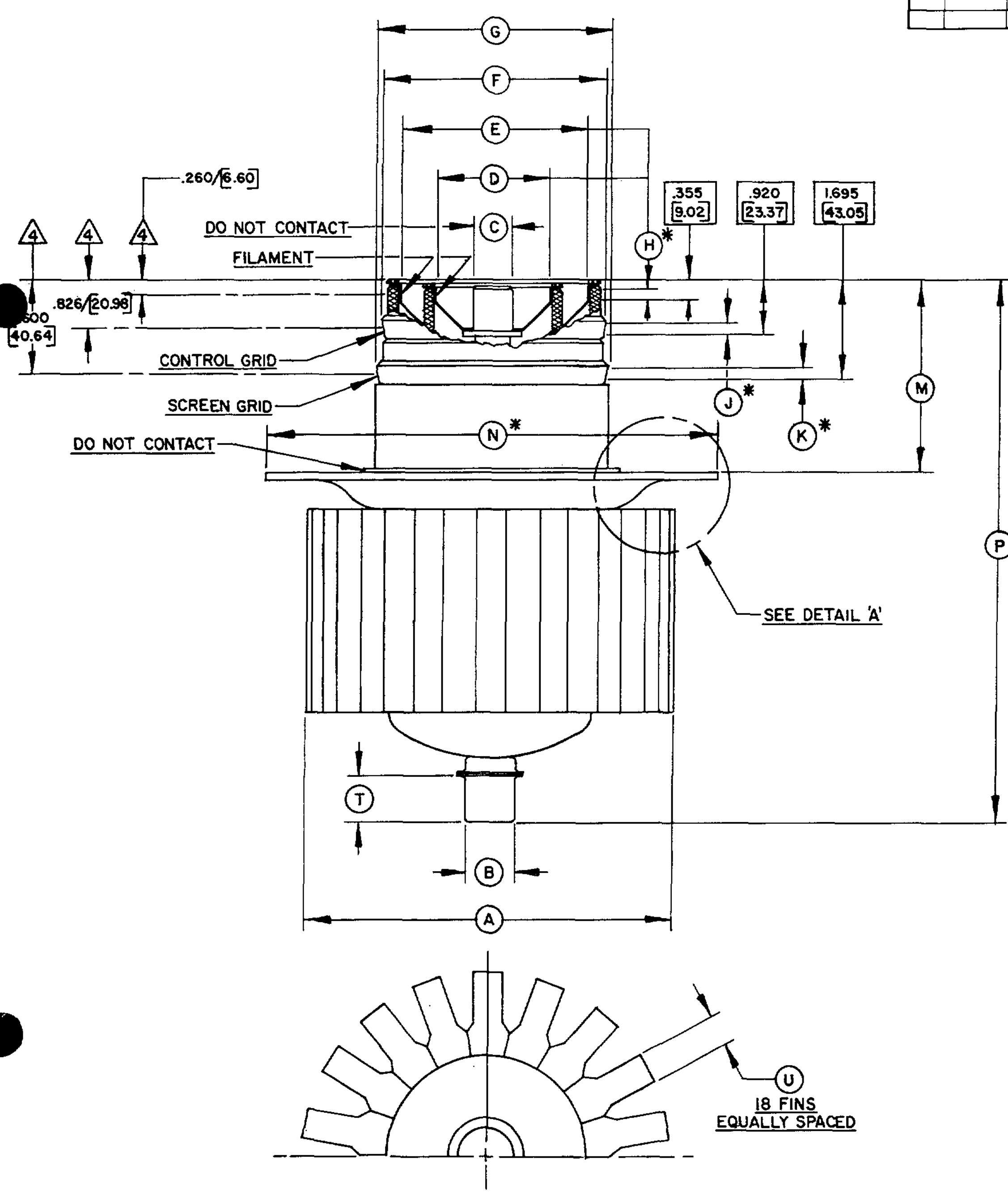
f. *HOT WATER* - Water used to cool tubes may reach scalding temperatures. Touching or rupture of the cooling system can cause serious burns.

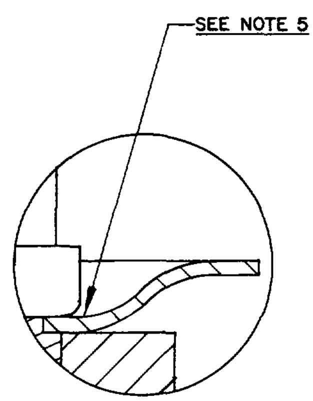
g. *HOT SURFACES* - Surfaces of air-cooled radiators and other parts of tubes can reach temperatures of several hundred degrees centigrade and cause serious burns if touched.

Please review the detailed operating hazards sheet enclosed with each tube or request a copy from the address shown below: Power Grid Tube Division, EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.

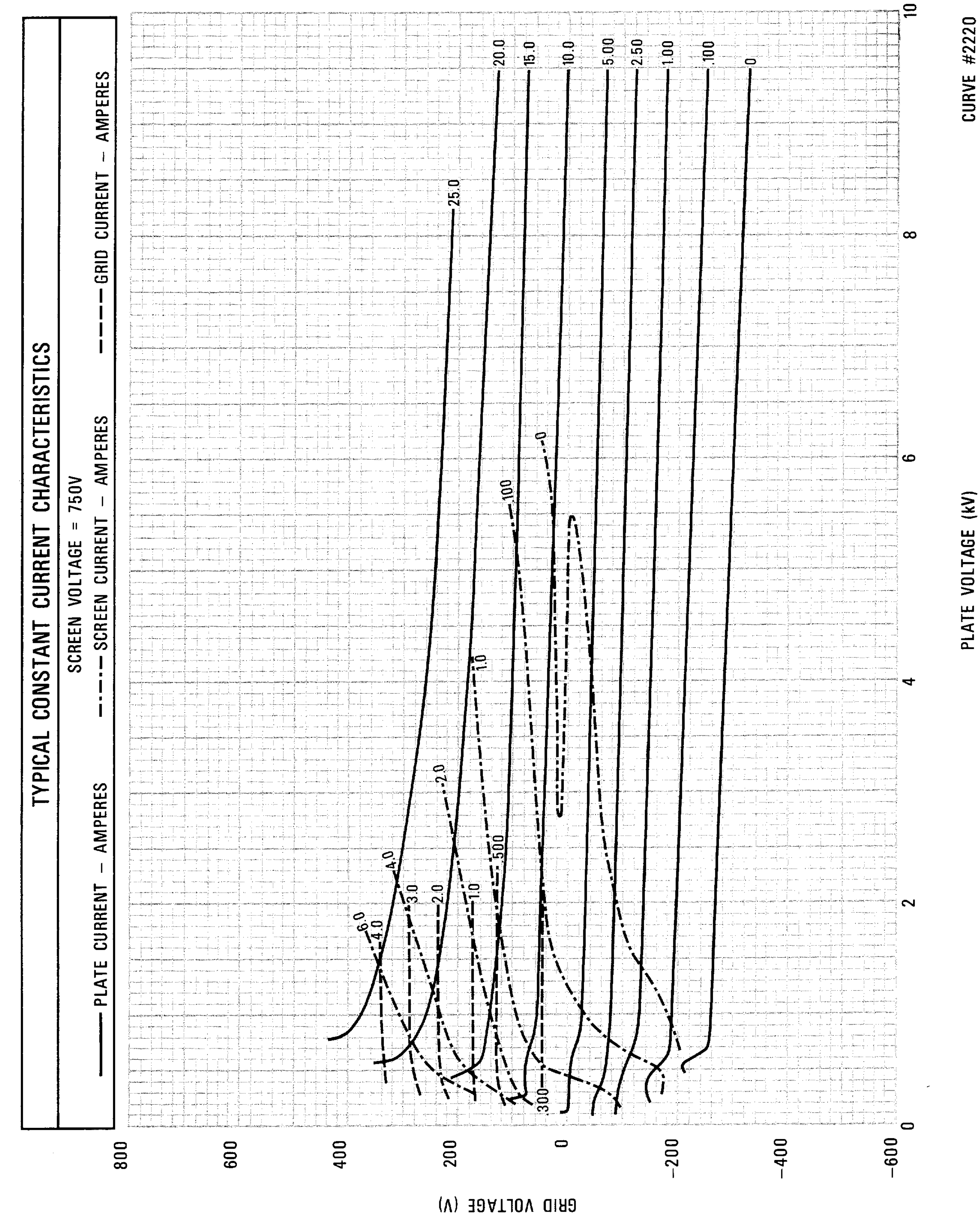
4CV35,000A

DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	6.220	6.280		157.99	159.91	
B	.855	.895		21.72	22.73	
C	.600	.760		15.24	19.30	
D	1.896	1.936		48.16	49.17	
E	3.133	3.173		79.58	80.59	
F	3.792	3.832		96.32	97.33	
G	3.980	4.020		101.09	102.11	
H	.188			4.78		
J	.188			4.78		
K	.188			4.78		
M			3.273			83.13
N			7.750			196.85
P	9.000	9.500		228.60	241.30	
T	.375			9.53		
U			.500			12.70

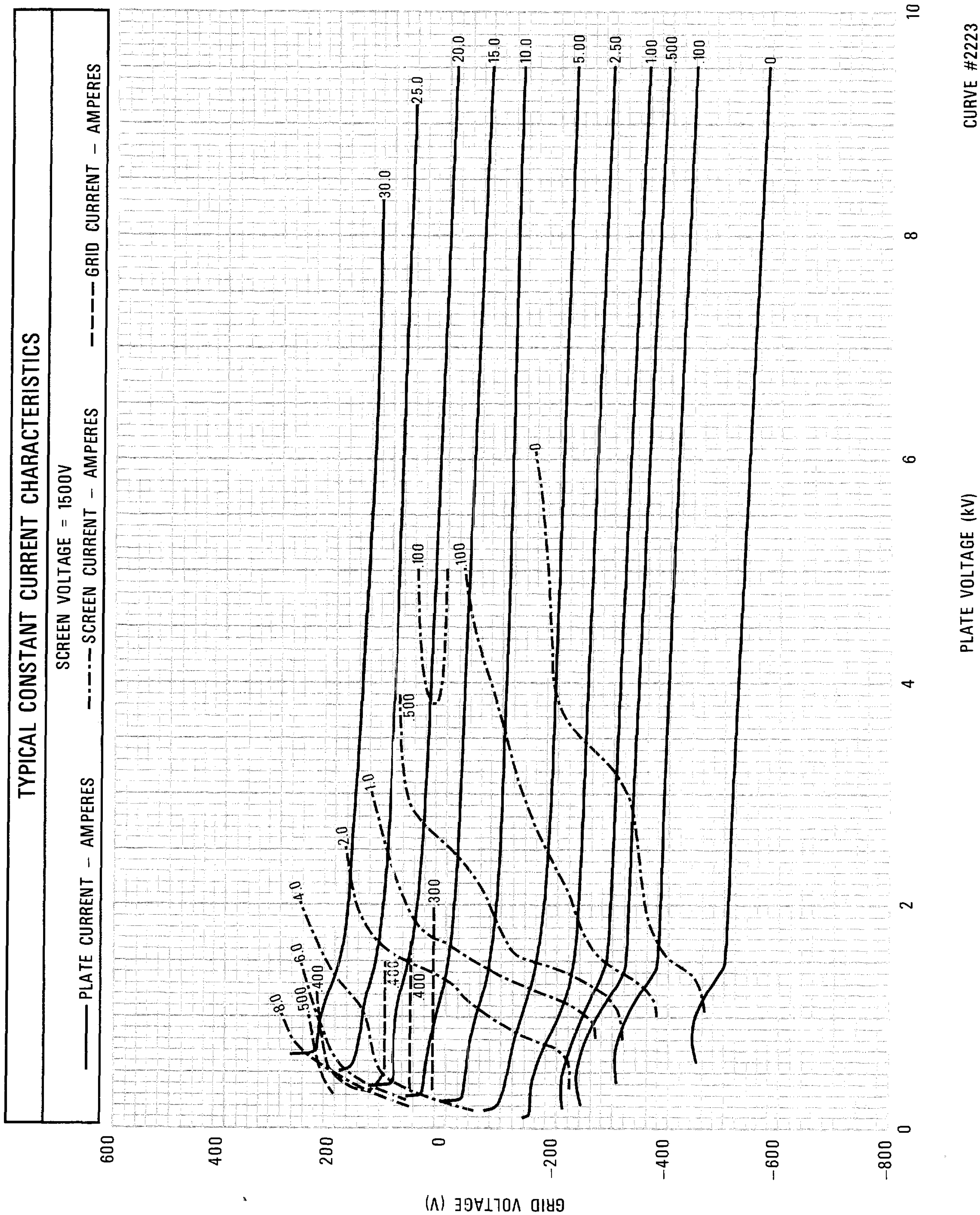




DETAIL 'A'


TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 750V
PLATE CURRENT – AMPERES
SCREEN CURRENT – AMPERES
GRID CURRENT – AMPERES
GRID VOLTAGE (V)
800
600
400
200
0
-200
-400
-600
PLATE VOLTAGE (kV)
0
2
4
6
8
10
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.100
0
6.0
4.0
4.0
3.0
2.0
2.0
1.0
1.0
2.0
.500
.100
0
.300
CURVE #2220

4CV35,000A


TYPICAL CONSTANT CURRENT CHARACTERISTICS
SCREEN VOLTAGE = 1500V
PLATE CURRENT - AMPERES
SCREEN CURRENT - AMPERES
GRID CURRENT - AMPERES
30.0
25.0
20.0
15.0
10.0
5.00
2.50
1.00
.500
.100
0
8.0
6.0
4.0
2.0
1.0
.500
.100
.300
.400
.200
GRID VOLTAGE (V)
600
400
200
0
-200
-400
-600
-800
PLATE VOLTAGE (kV)
0
2
4
6
8
10
CURVE #2223