



EITEL-McCULLOUGH, INC.
SAN CARLOS · CALIFORNIA

4W20,000A

**RADIAL-BEAM
POWER TETRODE**

The Eimac 4W20,000A is a high-power, water-cooled transmitting tetrode having a maximum plate dissipation rating of 20 kilowatts. This tube will operate efficiently as a power-amplifier at frequencies up to 250 Mc. A single 4W20,000A operating as a television visual r-f amplifier will deliver a synchronizing power output of 26 kilowatts at 216 Mc., with a 5-Mc. bandwidth.

The coaxial terminal arrangement of the tube is ideally suited for use in cavity circuits. The cathode is a unipotential thoriated tungsten cylinder of rugged construction, heated by electron bombardment.

GENERAL CHARACTERISTICS

ELECTRICAL

Cathode: Unipotential, thoriated tungsten. Heated by electron bombardment.	
D-C Voltage (Approx.)	1400 volts
D-C Current (Approx.)	1.8 amperes
Filament: Thoriated Tungsten, Helical	
Voltage	10 volts
Current (without cathode bombardment)	30 amperes
Current (with cathode bombardment)	25 amperes
Maximum allowable starting current	50 amperes
Direct Interelectrode Capacitances (Average)	
Grid-Plate	0.5 $\mu\mu\text{f}$
Input	125 $\mu\mu\text{f}$
Output	23 $\mu\mu\text{f}$
Screen-Grid Amplification Factor (Average)	5.5
Transconductance ($I_b=6.6$ A., $E_b=3.0$ kV., $E_{c2}=1200$ V.)	75,000 μmhos



MECHANICAL

Base	- - - - -	Special, Concentric
Mounting Position	- - - - -	Vertical, base down or up
Cooling	- - - - -	Water and Forced Air
Maximum Over-all Dimensions		
Length	- - - - -	15.2 inches
Diameter	- - - - -	5.0 inches
Net Weight	- - - - -	7.6 pounds
Shipping Weight	- - - - -	40 pounds

RADIO FREQUENCY POWER AMPLIFIER MAXIMUM RATINGS (per tube)

D-C PLATE VOLTAGE	- - - - -	8 MAX. KV
D-C PLATE CURRENT	- - - - -	15 MAX. AMP
PLATE DISSIPATION	- - - - -	20 MAX. KW
SCREEN DISSIPATION	- - - - -	200 MAX. WATTS
GRID DISSIPATION	- - - - -	60 MAX. WATTS

TYPICAL OPERATION

Class-C Telegraphy or FM Telephony (Per tube—220 Mc.)					
D-C Plate Voltage	- - -	5000	6000	7000	volts
D-C Screen Voltage	- - -	1200	1200	1200	volts
D-C Grid Voltage	- - -	-350	-370	-400	volts
D-C Plate Current	- - -	3.6	3.6	3.4	amps
D-C Screen Current (approx.)*	- - -	167	167	167	ma
D-C Grid Current (approx.)	- - -	50	50	50	ma
Peak R-F Input Voltage	- - -	455	475	505	volts
Driving Power (approx.)*	- - -	750	780	830	watts
Screen Dissipation	- - -	200	200	200	watts
Plate Power Input	- - -	18	21.6	23.8	kw
Plate Dissipation	- - -	7.0	8.6	8.0	kw
Useful Power Output	- - -	9.2	11.5	13.0	kw

TYPICAL OPERATION

Class-B Linear Amplifier—Television Visual Service (Per tube, 5-Mc. Bandwidth up to 216 Mc.)			
Peak Synchronizing Level			
Load Impedance	- - - - -	650	ohms
Effective Length of Plate Line	- - - - -	1/4	wave
D-C Plate Voltage	- - - - -	7000	volts
D-C Screen Voltage	- - - - -	1200	volts
D-C Control Grid Voltage	- - - - -	-150	volts
D-C Plate Current	- - - - -	6.0	amps
D-C Screen Current (approx.)	- - - - -	230	ma
D-C Control Grid Current (approx.)	- - - - -	90	ma
Peak R-F Grid Input Voltage	- - - - -	280	volts
Driving Power (approx.)	- - - - -	500	watts
Plate Power Input	- - - - -	42	kw
Plate Dissipation	- - - - -	16	kw
Useful Plate Power Output	- - - - -	26	kw
Black Level			
D-C Plate Current	- - - - -	4.5	amps
D-C Screen Current	- - - - -	100	ma
D-C Control Grid Current (approx.)	- - - - -	45	ma
Peak R-F Grid Input Voltage	- - - - -	220	volts
Driving Power (approx.)	- - - - -	300	watts
Plate Power Input	- - - - -	32	kw
Plate Dissipation	- - - - -	16.5	kw
Useful Power Output	- - - - -	15.5	kw

*The performance figures listed above are obtained by calculation from the characteristic tube curves and confirmed by direct tests. The driving power and output power allow for losses associated with practical resonant circuits.

These 216 Mc. typical performance figures were obtained by direct measurement in test equipment. The output power is useful power measured in a load circuit. The driving power is that taken by the tube and a practical resonant grid circuit. These figures are subject to variation and in many cases, with further refinement and improved techniques, better performance might be obtained.



Note: Typical operation data are based on conditions of adjusting to a specified plate current, maintaining fixed conditions of grid bias, screen voltage, suppressor voltage and r-f grid voltage. It will be found that if this procedure is followed, there will be little variation in power output between tubes even though there may be some variation in grid, screen and suppressor currents. Where grid bias is obtained principally by means of a grid resistor, to control plate current it is necessary to make the resistor adjustable.

APPLICATION

Mounting—The 4W20,000A must be mounted vertically. Base-down or base-up mounting is optional.

The co-axial contact surfaces provided for connection to the filament, cathode, grid, screen, and anode are of successively larger diameters to facilitate removal and replacement of tubes.

Cavity circuits may be designed around the dimensions shown in the outline drawing. At very high frequencies the points of contact between the tube and the external circuit will be required to carry high values of charging current. It is, therefore, essential that the contactors make firm and uniform contact between the terminal surfaces of the tube and the external circuit. Particular care should be taken that the contactors are not inadvertently forced out of shape, and that all contact surfaces are maintained free from dust or other foreign matter which would prevent uniform electrical connection. At VHF, poor contact by one finger of a multi-finger collet can result in local overheating which may damage the tube seals.

Although contact fingers or slotted collets are often made an integral part of cavity circuits, there is some advantage to reversing the plan by providing contact-finger assemblies which are designed to be clamped firmly to the terminal surfaces of the tube itself and to make sliding contact with the cavity as the tube is inserted. This arrangement facilitates replacement of worn or damaged contactors and tends to remove incidental local heating from the vicinity of the tube seals. Tubes held in reserve for emergency replacement may be fitted with contact finger assemblies and water-line extensions to minimize lost time in making changes.

► **Cathode Heating Power** — The cathode of the 4W20,000A is a unipotential, thoriated tungsten cylinder, heated by electron bombardment of its inner surface. Bombardment is obtained by using the cylindrical cathode as the anode of a diode. A helical filament is mounted on the axis of the cathode cylinder to supply the bombarding electrons. A d-c potential of approximately 1400 volts is applied between the filament and the cathode cylinder, and the recommended cathode heating power of 2500 watts is obtained with approximately 1.8 amperes.

The inner filament is designed to operate under space-charge limited conditions so that the cathode temperature may be varied by changing the voltage applied between the inner filament and the cathode cylinder.

For maximum tube life the filament voltage, as measured directly at the filament terminals, must be reduced after the cathode has reached operating tem-

perature. The proper filament voltage for a given cathode bombardment power may be found in the table below. The filament voltage should remain at the 10.0-volt value until the cathode has reached operating temperature, an interval of approximately thirty seconds. The filament voltage should be maintained to within 5% of the proper operating value and the cathode bombardment power should be held within plus or minus 100 watts of the recommended value.

Cathode Bombardment Power	2000	2250	2500	2750	3000
Filament Voltage	6.0	5.2	4.3	3.2	2.0

A cathode bombardment power of 2250 watts is normal for average CW conditions. In applications requiring peak values of cathode current in excess of 75 amperes the cathode bombardment power may be increased to a value between 2250 and 3000 watts as required.

Further increases in cathode efficiency will result in a decrease in the cathode bombardment power requirements. The cathode bombardment power supply should, therefore, be capable of providing a minimum of approximately 2000 watts.

Caution: It must be kept in mind that the filament is at a potential of 1400 volts d-c with respect to ground. The filament transformer and voltmeter must be adequately insulated for this voltage.

Grid Voltage Regulation—The practice of designing grid voltage supplies to maintain adequate regulation under conditions of varying grid current is particularly desirable with the 4W20,000A. Because the cathode of the 4W20,000A is a complete cylinder, grid temperatures run higher than usual. For this reason, even with no excitation, control grid current reversal might conceivably be several milliamperes and safe design should allow for possible peaks on the order of 100 milliamperes.

► **Anode Cooling**—The water-cooled anode requires 8 gallons per minute of cooling water for the rated 20 kilowatts of plate dissipation. This corresponds to a pressure drop of 7 pounds per square inch across the water jacket. The inlet water pressure must not exceed a maximum of 50 pounds per square inch.

The outlet water temperature must not exceed a maximum of 70°C under any conditions.

► **Seal Cooling**—The grid and screen tube contact surfaces and adjacent glass and ceramic must be cooled by high-velocity air which may be accomplished by means of ring manifolds. The quantity, velocity and direction of air must be adjusted to limit the maximum seal temperatures to 150°C.

IF IT IS DESIRED TO OPERATE THIS TUBE UNDER CONDITIONS WIDELY DIFFERENT FROM THOSE GIVEN UNDER "TYPICAL OPERATION", POSSIBLY EXCEEDING THE MAXIMUM RATINGS GIVEN FOR CW SERVICE, WRITE EITEL-McCULLOUGH, INC., FOR INFORMATION AND RECOMMENDATIONS.

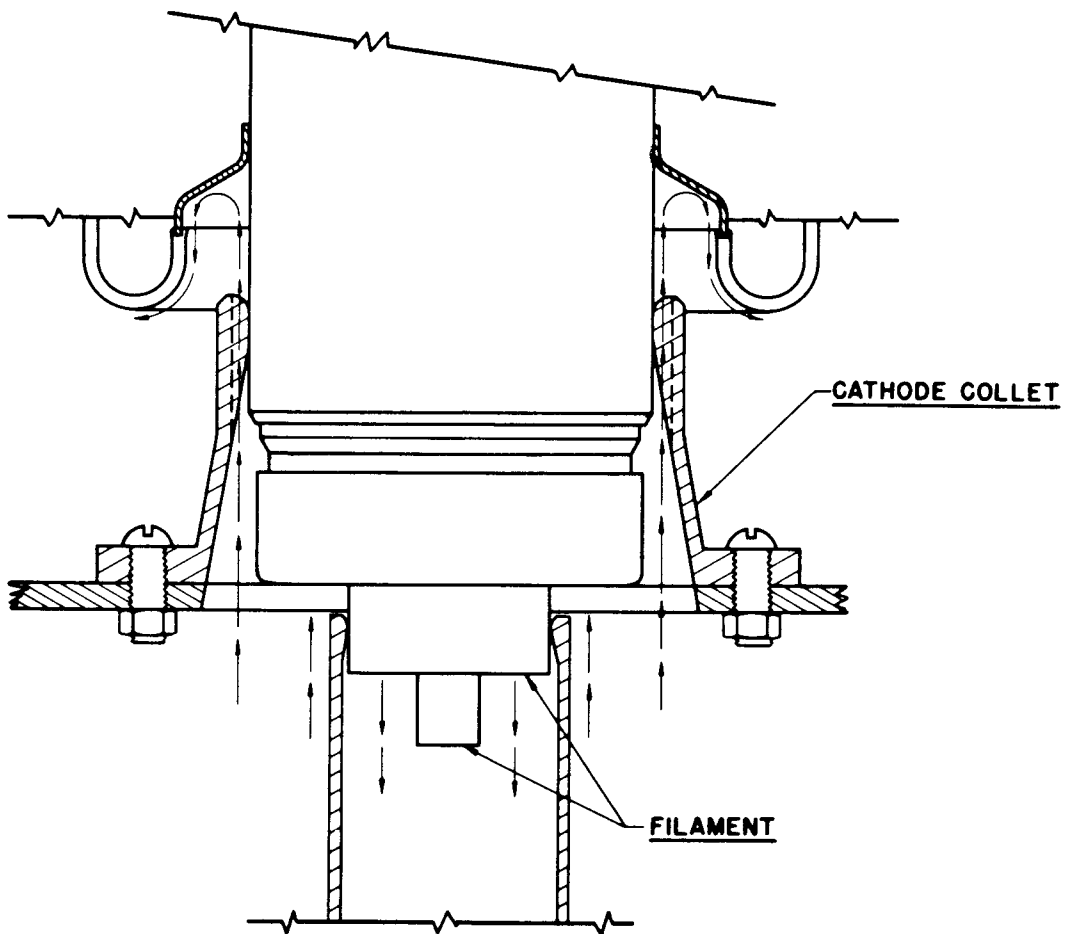
► Indicates change from sheet dated 2-27-54

The cathode and filament stem also require forced-air cooling in sufficient quantity so that the region on the cathode terminal opposite the glass of the grid terminal seal does not exceed a maximum of 150°C. The major portion of this air must be guided along the surface of the terminal sleeve. The remaining air flows through the nine holes inside the terminal sleeve, cools the filament stem and vents through the three holes in the tube base enclosed by the outer filament spring collet connection.

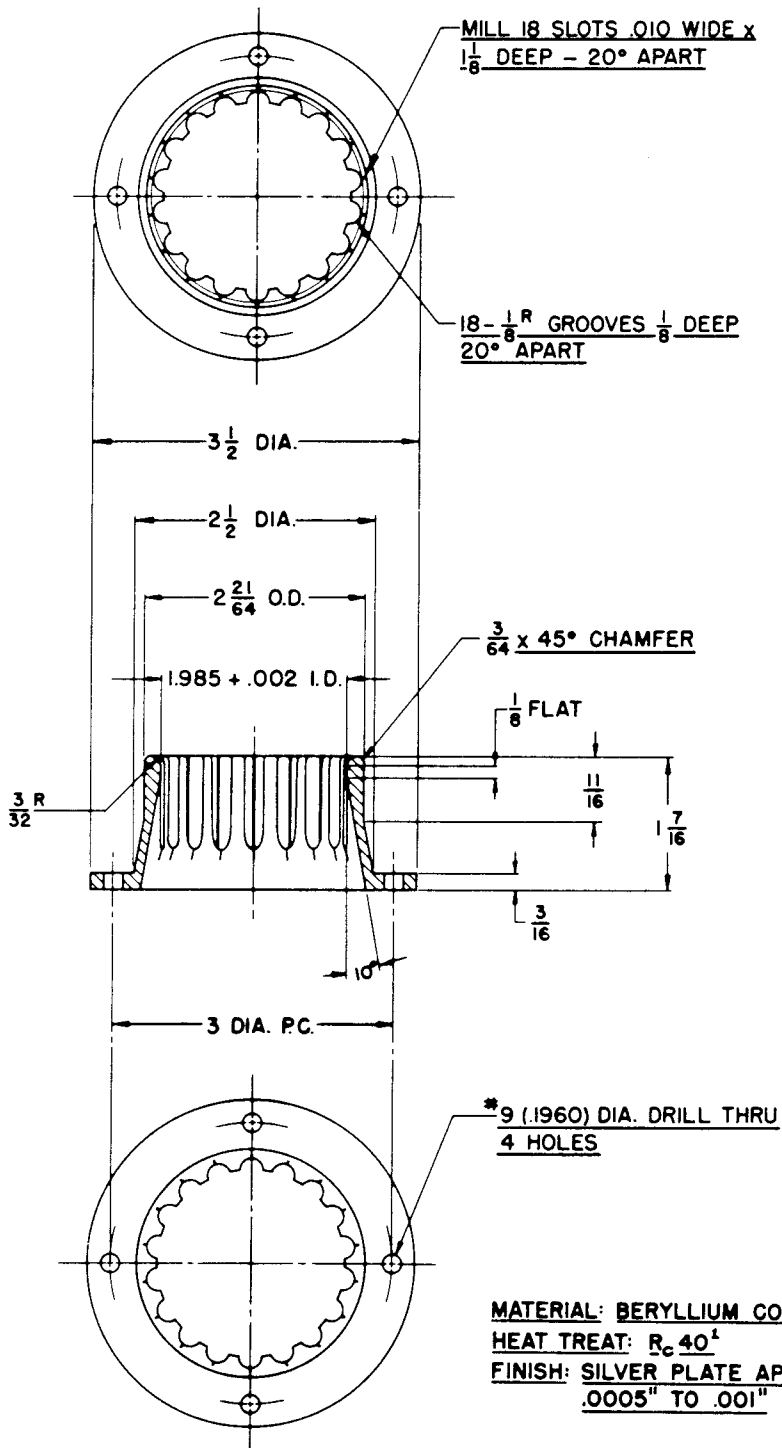
By employing a cathode collet such as is shown in the accompanying drawings, the recommended cooling requirements will be fulfilled with an air flow of 60 cubic feet per minute at a static manifold pressure of 2 inches of water column.

Air and water flow must be started before filament and cathode power are applied and maintained for at least two minutes after the filament and cathode power have been removed.

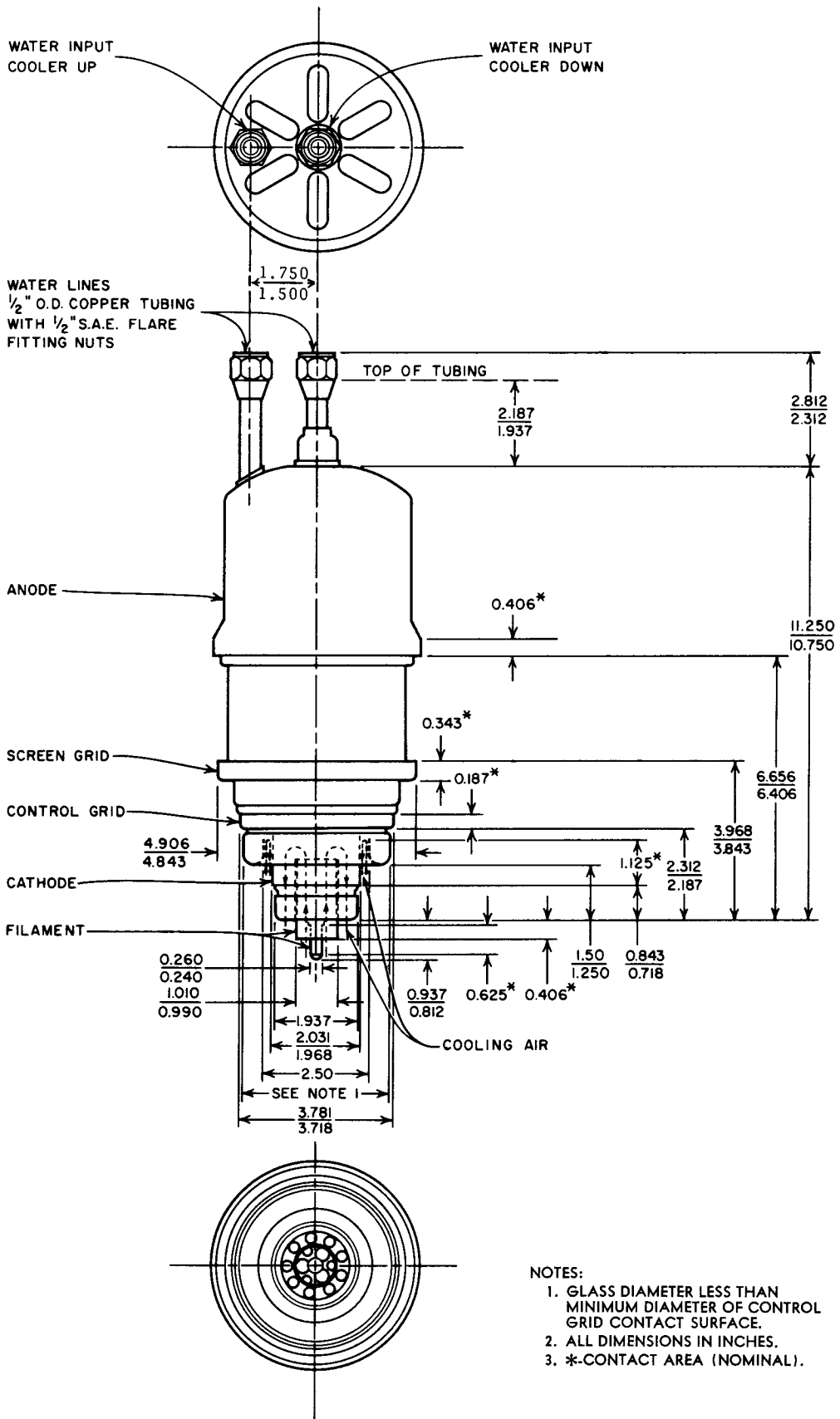
4W20,000A
SUGGESTED STEM AIR COOLING



4W20,000A
CATHODE COLLET



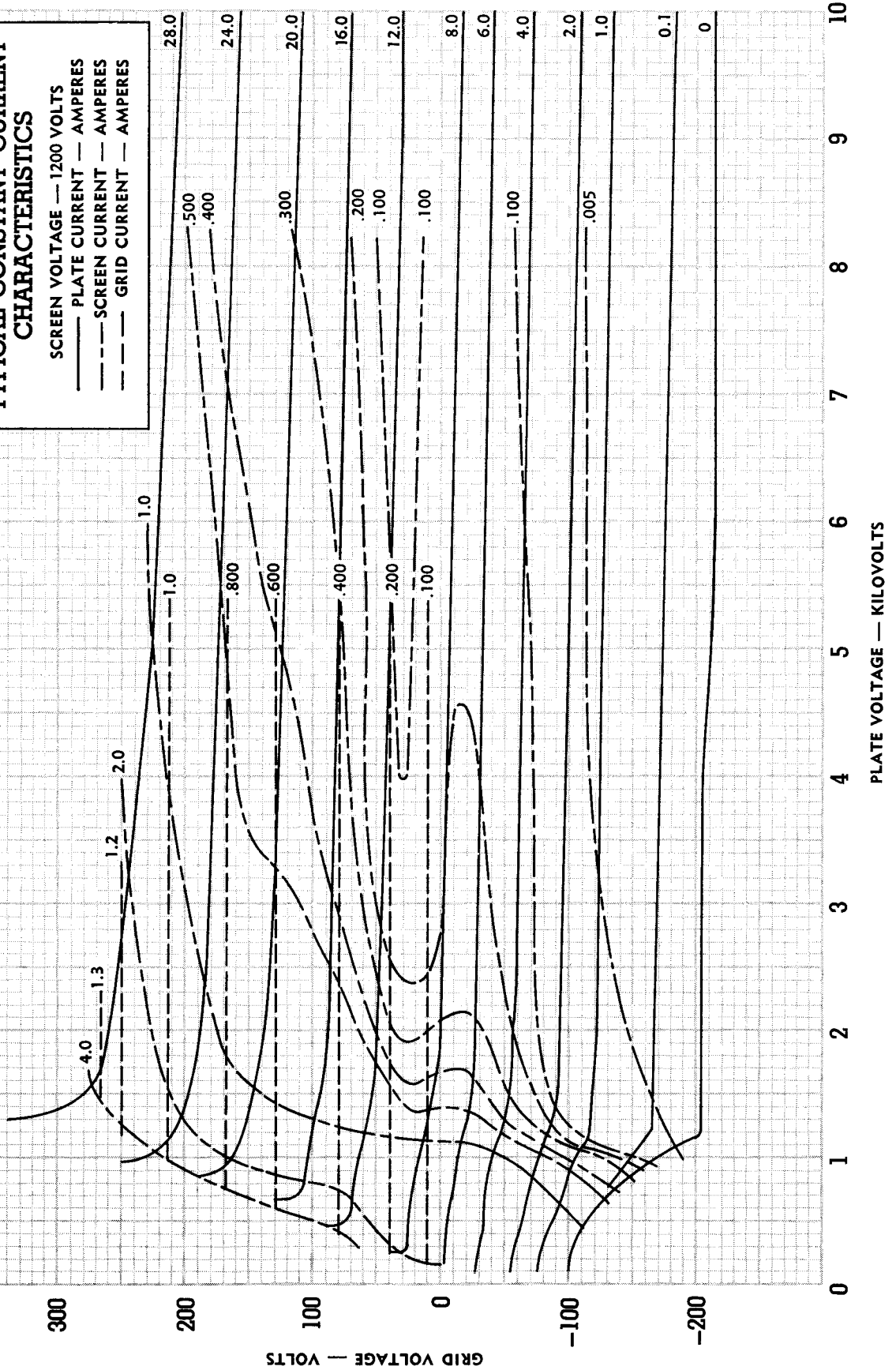
¹ 385°C FOR APPROX. 5-6 HRS.
IN NON-REDUCING ATMOSPHERE





EIMAC 4W20,000A TYPICAL CONSTANT CURRENT CHARACTERISTICS

SCREEN VOLTAGE — 1200 VOLTS
 ——— PLATE CURRENT — AMPERES
 - - - - SCREEN CURRENT — AMPERES
 - - - - GRID CURRENT — AMPERES



Indicates change from sheet dated 2-27-54