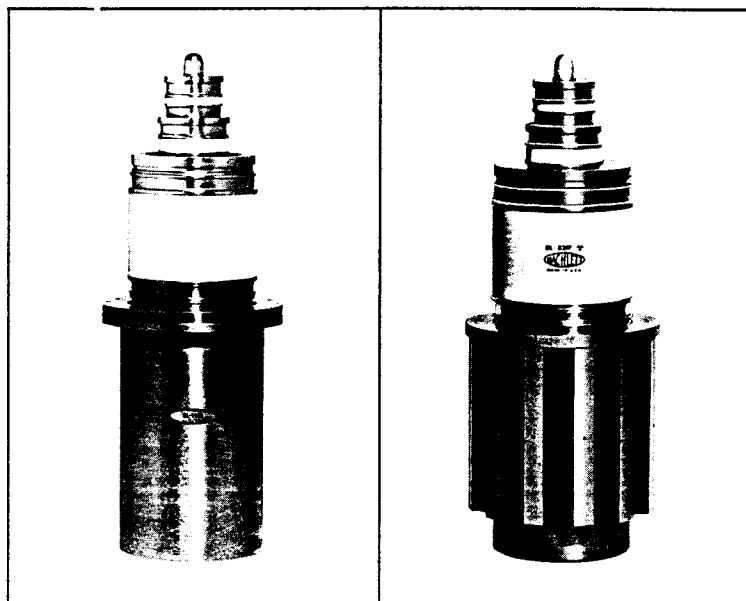




ML-7560 ML-8317

General Purpose Triodes

440 kW CW

15 Mw Pulse Power



ELECTRON TUBE SPECIALIST

DESCRIPTION

The ML-7560 and ML-8317 are general-purpose triodes suitable for various rf and pulse applications. These tubes feature rugged coaxial mounting structures providing high-dissipation, low-inductance rf electrode terminals. The cathode of each type consists of sturdy, self-supporting, stress-free, thoriated-tungsten filaments. Envelope construction employs low-loss ceramics. The ML-7560 has a water-cooled, heavy-wall anode capable of dissipating 175 kW. The

ML-8317 has a forced-air-cooled, heavy-wall anode with a high-efficiency copper fin structure capable of dissipating 60 kW. These tubes will operate with dc plate voltages up to 20 kV in CW operation or 50 kV in pulse modulator service. Maximum ratings apply at frequencies up to 30 Mc. Useful power output can be obtained at frequencies up to 110 Mc with reduced ratings.

GENERAL CHARACTERISTICS

Electrical

Filament Voltage	14.5	V*
Filament Current	450	A
Filament Starting Current, maximum	1200	A
Filament Cold Resistance	.0035	Ohms
Amplification Factor	45	
Interelectrode Capacitances		
Grid-Plate	75	pf
Grid-Filament	200	pf
Plate-Filament	4	pf

Mechanical

Mounting Position	Vertical, anode down	
Type of Cooling — ML-7560	Water and forced-air	
Water flow on anode for 175 kW dissipation, minimum	40	gpm
Maximum outgoing water temperature	70	°C
Maximum water pressure	80	psi
Type of Cooling — ML-8317	Forced-air	
Air flow on anode for 60 kW dissipation, minimum	3000	cfm**
Maximum incoming air temperature	50	°C
Air Flow on Insulators and Seals, approximate	500	cfm***
Maximum Ceramic Temperature	165	°C
Net Weight, approximate		
ML-7560	110	lb
ML-8317	130	lb

*For cathode currents in excess of 350 amps, filament voltage must be 15.0 volts. For older tubes with serial numbers lower than 476,000, the filament must be operated at 16.5 volts for peak cathode currents up to 350 amps.

**When used with ML-8317 air distributor F-27836.

***At frequencies up to 15 Mc, air flow should be directed primarily on the filament seals and main ceramic insulator; at higher frequencies or high ambient temperatures, additional air flow may be required on the grid seals. Air flow should be distributed to maintain uniform temperature, not greater than 165°C, around the circumference of the seals.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

(Continuous Commercial Service)

VALUES APPLY TO BOTH TYPES UNLESS OTHERWISE SPECIFIED

**Audio-Frequency Power Amplifier and Modulator
Class B**

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
DC Plate Voltage	20000	20000	V
Max.-Signal DC Plate Current [▲]	30	20	A
Plate Dissipation [▲]	175	60	kW

Typical Operation (Values are for two tubes) ML-7560

DC Plate Voltage	15000	15000	V
DC Grid Voltage	-320	-320	V
Peak AF Grid-to-Grid Voltage	1740	1080	v
Peak AF Plate-to-Plate Voltage	25200	26000	v
Zero-Signal DC Plate Current	2	2	A
Max.-Signal DC Plate Current	56	23	A
Effective Load Resistance, Plate-to-Plate ...	570	1400	ohms
Max.-Signal Driving Power, approximate	5	1.1	kW
Max.-Signal Power Output, approximate	550	240	kW

**Linear RF Power Amplifier — Class AB
Single-Sideband Suppressed-Carrier Service**

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
DC Plate Voltage	20000	20000	V
Grid Dissipation	2500	2500	W
Plate Dissipation	175	60	kW

Typical Operation, Cathode-Drive, 2-tone ML-7560

DC Plate Voltage	20000	20000	V
DC Grid Voltage	-450	-450	V
Zero-Signal DC Plate Current	1	1	A
Maximum-Signal Peak Plate Current	54	27	a
Maximum-Signal Peak RF Grid Voltage	690	580	v
Maximum-Signal Driving Power	10	4	kW
Peak Envelope Power Output ‡	230	114	kW
Average Power Output, approximate	115	57	kW

Typical Operation Cathode-Drive, 16-tone†

DC Plate Voltage	20000	V
DC Grid Voltage	-450	V
Zero-Signal DC Plate Current	1	A
Maximum-Signal Peak Plate Current	135	a
Maximum-Signal Peak RF Grid Voltage	1100	v
Maximum-Signal Peak Driving Power	41	kw
Peak Envelope Power Output ‡	585	kw
Average Power Output, approximate	58	kW

**Plate-Modulated RF Power Amplifier
Class C Telephony**

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
DC Plate Voltage	15000	15000	V
DC Grid Voltage	-1500	-1500	V
DC Plate Current	20	15	A
DC Grid Current	4.0	3	A
Plate Dissipation	115	40	kW

Typical Operation

	ML-7560	
DC Plate Voltage	14000	V
DC Grid Voltage	-1000	V
Peak RF Grid Voltage	1630	v
Peak RF Plate Voltage	11800	v
DC Plate Current	20.5	A
DC Grid Current	3.5	A
RF Load Resistance	320	ohms
Driving Power, approximate	5.7	kW
Power Output, approximate	220	kW

Typical Operation, Cathode-Drive

DC Plate Voltage	12000	12000	V
DC Grid Voltage	—800	—800	V
Peak RF Grid Voltage	1350	1200	v
Peak RF Plate Voltage	10600	10400	v
DC Plate Current	13.5	11.5	A
DC Grid Current	3.5	2	A
RF Load Resistance	490	550	ohms
Driving Power, approximate	20	15	kW
Power Output, approximate ‡	145	120	kW

**RF Power Amplifier and Oscillator
Class C Telegraphy**

Key-down conditions per tube without amplitude modulation§

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
DC Plate Voltage	20000	20000	V
DC Grid Voltage	-1500	-1500	V
DC Plate Current	35	20	A
DC Grid Current	4.0	3	A
Plate Dissipation	175	60	kW

Typical Operation

DC Plate Voltage	20000	20000	V
DC Grid Voltage	—1000	—1000	V
Peak RF Grid Voltage	1680	1320	v
Peak RF Plate Voltage	17400	18000	v
DC Plate Current	29	11	A
DC Grid Current	3.4	1.3	A
RF Load Resistance	330	900	ohms
Driving Power, approximate	6	2	kW
Power Output, approximate	440	175	kW

**Plate-Pulsed RF Power Amplifier and Oscillator
Class C**

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
Peak Plate Pulse Supply Voltage	40	40	kv
DC Grid Voltage	-3500	-3500	V
Peak Cathode Current	550	550	a
Grid Dissipation	3000	3000	W
Plate Dissipation	175	60	kW
Pulse Duration#	500	500	μs
Duty Factor#	.10	.05	

Typical Operation

Peak Plate Pulse Supply Voltage	40	kv
DC Grid Voltage	-1400	V
Peak RF Grid Voltage	3000	v
Peak RF Plate Voltage	34	kv
Peak Plate Current from Pulse Supply	100	a
Peak Rectified Grid Current	16	a
RF Load Resistance	200	ohms
Driving Power during Pulse, approximate	45	kw
Power Output during Pulse, approximate	3.0	Mw

Typical Operation, Cathode-Drive

Peak Plate Pulse Supply Voltage	40	kv
DC Grid Voltage	-1400	V
Peak RF Grid Voltage	3000	v
Peak RF Plate Voltage	34	kv
Peak Plate Current from Pulse Supply	100	a
Peak Rectified Grid Current	16	a
RF Load Resistance	210	ohms
Driving Power during Pulse, approximate	310	kw
Power Output during Pulse, approximate ‡	3.2	Mw

Pulse Modulator or Pulse Amplifier

Maximum Ratings, Absolute Values	ML-7560	ML-8317	
DC Plate Voltage	50	50	kv
Peak Plate Voltage	55	55	kv
DC Grid Voltage	-3500	-3500	V
Pulse Cathode Current	550	550	a
Grid Dissipation	3000	3000	W
Plate Dissipation	175	60	kW
Pulse Duration #	1000	1000	μs
Duty Factor #	.01	.01	

Typical Operation

DC Plate Voltage	50	kv
DC Grid Voltage	-1800	V
Pulse Positive Grid Voltage	1600	v
Pulse Plate Current	350	a
Pulse Grid Current	80	a
Pulse Driving Power	275	kw
Pulse Power Output	15.7	Mw
Plate Output Voltage	45	kv

*Averaged over any audio-frequency cycle of sine-wave form.

†With peak-envelope to average power ratio of approximately 10.

‡Includes power transferred from driver stage.

§Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115% of the carrier conditions.

#For applications requiring longer pulse duration or higher duty factors, consult the Machlett Engineering Department.

WARNING: Operation of this tube may produce x-rays. Adequate rayproof shielding must therefore be provided in the equipment.

MAXIMUM FREQUENCY RATINGS

Maximum ratings apply up to 30 Mc except as noted. These tubes may be operated at higher frequencies provided the maximum value of plate voltage is reduced according to the tabulation below (other maximum ratings are the same as shown above). Special attention should be given to adequate ventilation of the bulb at the higher frequencies.

Frequency in Megacycles	30	70	110
Percent Maximum Rated Plate Voltage	100	80	60

TUBE PROTECTION

The handling of very high power requires particular attention to the removal of power from tubes during fault conditions (initiated by tube or circuit instabilities) since the larger amount of energy involved can cause tube damage if not properly controlled. The tube must, therefore, be protected by limiting the time elapsed from inception of a fault condition to diverting the energy from the tube, as well as the amount of energy expended in the tube during this interval.

In addition to the normal circuit breakers and overload relays, it is necessary that a fast-acting electronic protective device (crowbar) or equivalent be used. This device will in most cases be a triggered gaseous device connected across the output of the plate supply filter, if used, to dissipate the filter-circuit energy as well as the rectifier output. The complete energy source must be shorted out as quickly as possible after the inception of a "fault", and in most cases the time interval should not be allowed to exceed approximately ten microseconds. For some basic electronic-crowbar fault-protection circuit considerations, as well as test of the effectiveness of a protection device, refer to the references listed.

A nominal value of resistance must be placed in the plate lead of the tube being protected in order to be assured that the impedance of this tube under a flash arc condition is greater than that of the crowbar device when the latter is triggered. Critical damping is required for the crowbar discharge circuit. It is also recommended that a minimum of five to ten ohms resistance be connected in series with each rectifier tube in order to limit surge currents.

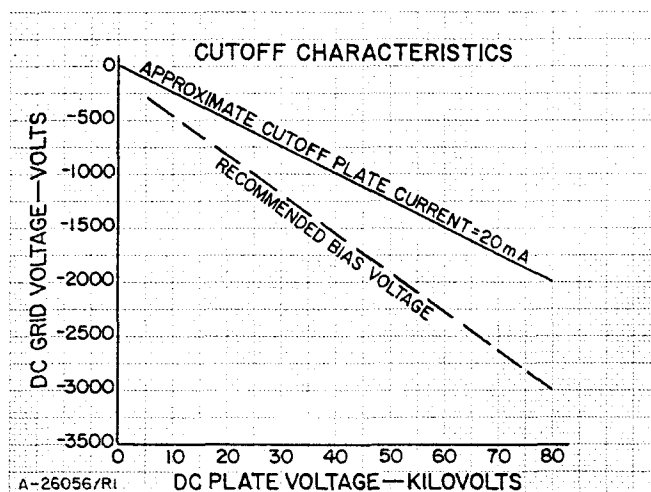
In circuits where high transient voltages may be developed due to a shorted load or other fault, special precautions are necessary to keep these excessive voltages from appearing at the tube electrodes.

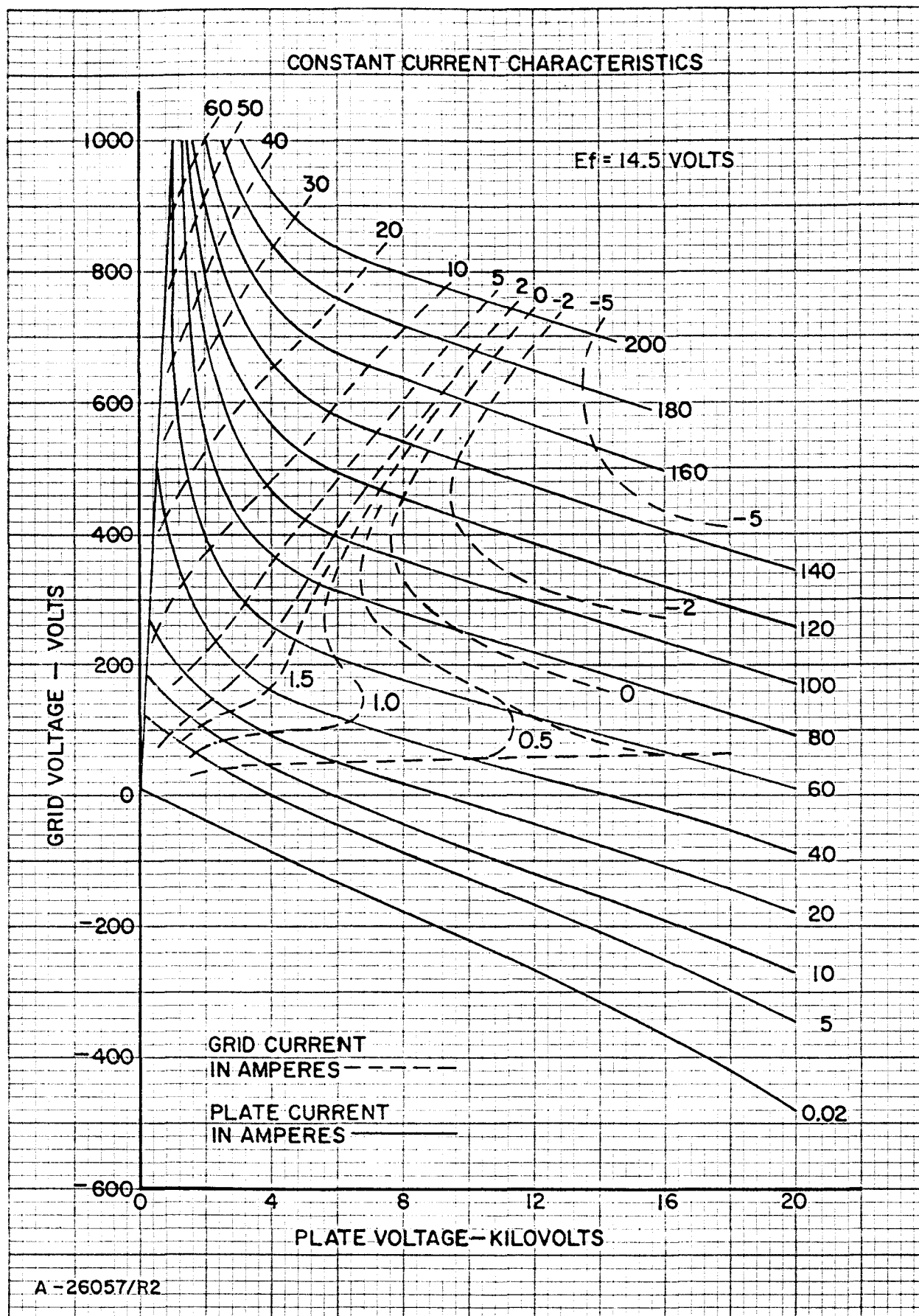
References:

1. W. N. Parker and M. V. Hoover, "Gas Tubes Protect High Power Transmitters", *Electronics*, 29, 144, January 1956.
2. H. D. Doolittle, "High Power Hydrogen Thyratrons", *Cathode Press*, 1, 6, 1954.

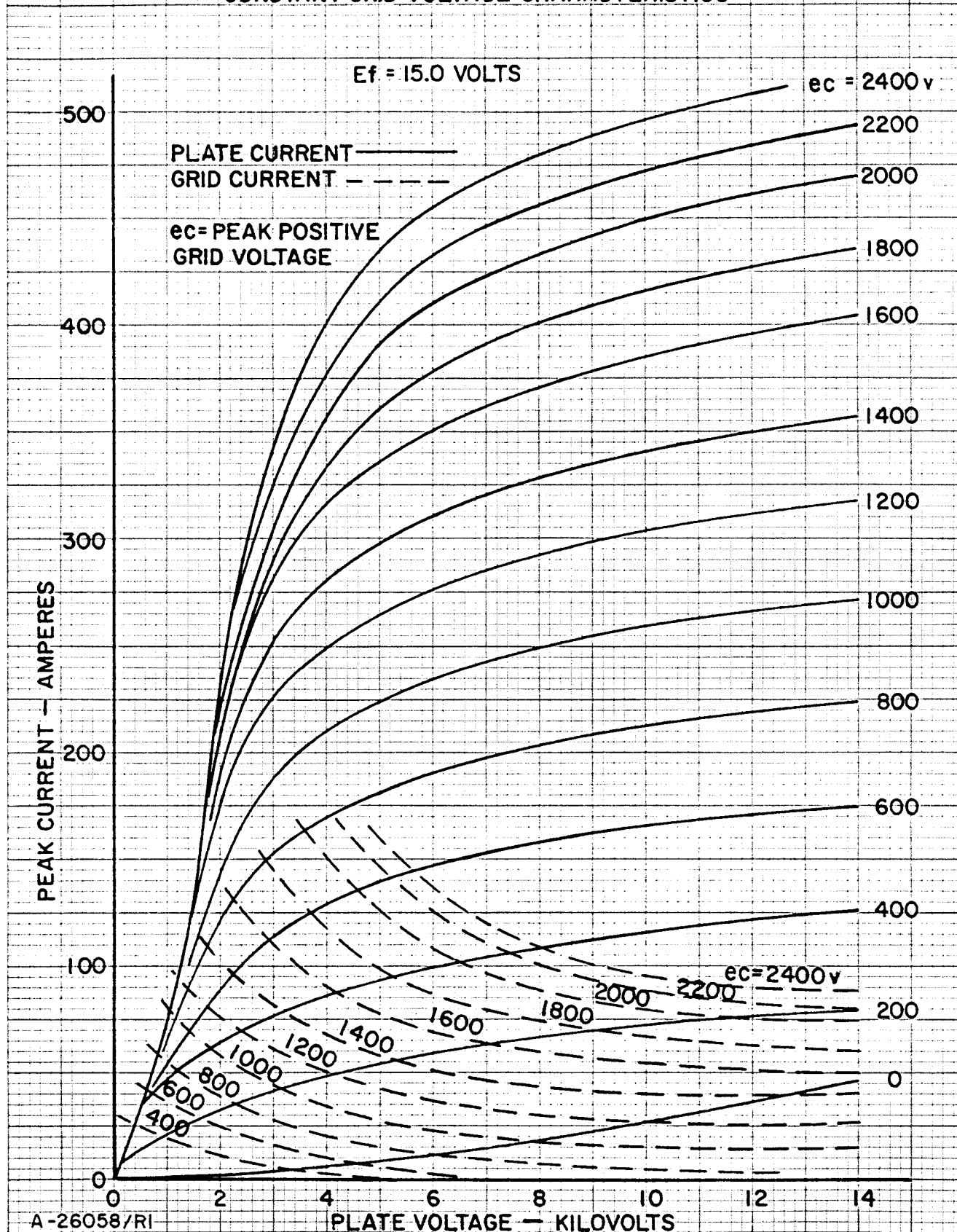
MAINTENANCE

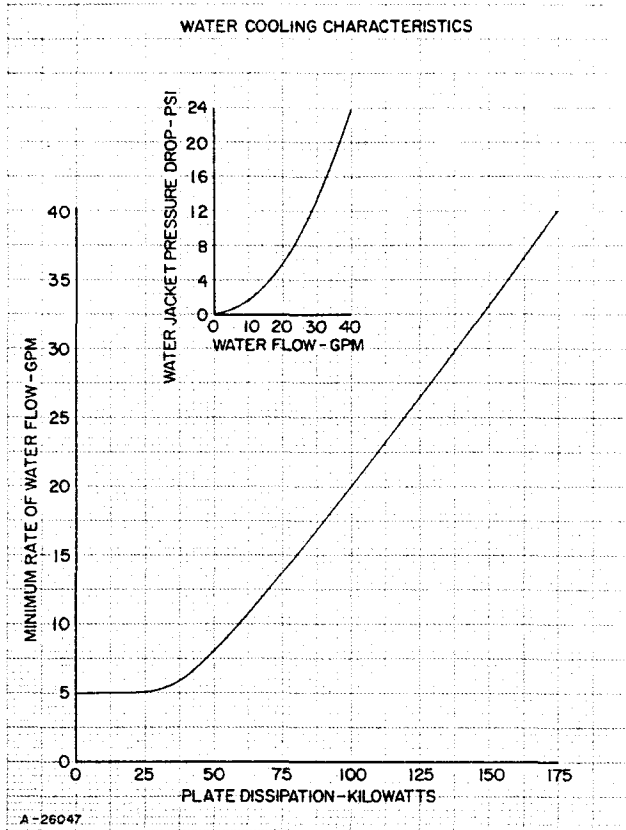
The anode cooling fins of the ML-8317 must be kept free from films of foreign materials, which will impair heat flow. To keep fins clean, it is suggested that ultrasonic cleaning or wire-brushing of the anode cooling surfaces be performed on a routine maintenance basis.



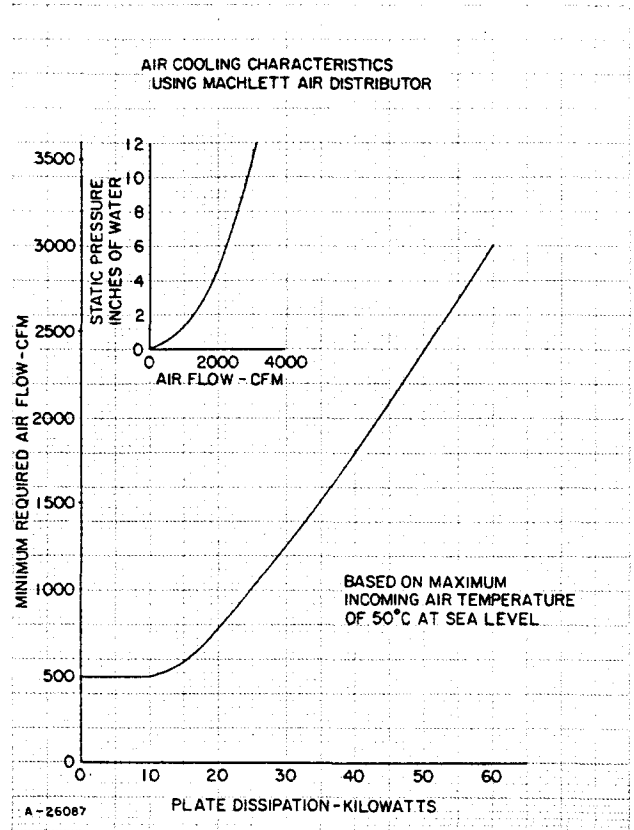


CONSTANT GRID-VOLTAGE CHARACTERISTICS

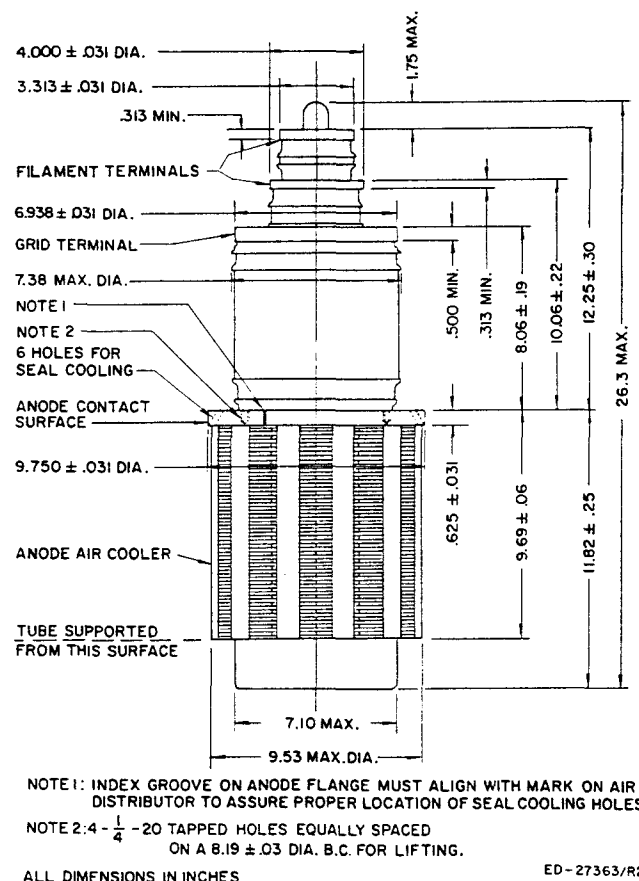
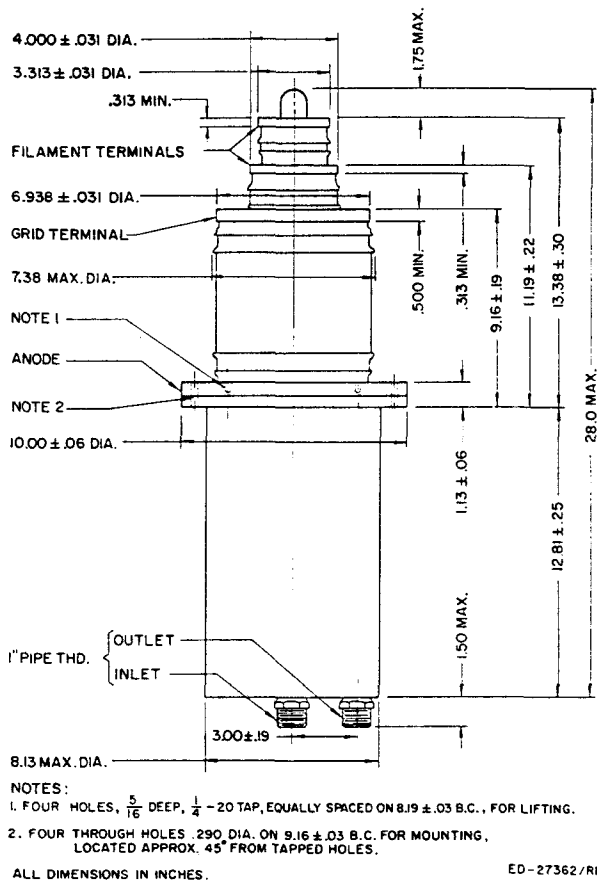




ML-7560



ML-8317



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