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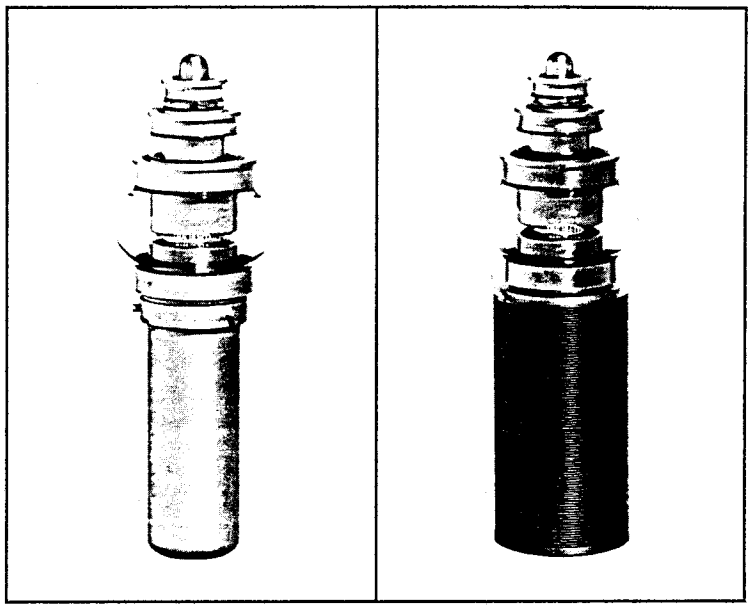
ISSUED 4-68



ML-8772
ML-8773

MACHLETT

Pulse Modulating Triodes

4.5 Mw Pulse Power

DESCRIPTION

The ML-8772 and ML-8773 are triodes which are rated to operate as switch tubes in hard-tube pulse modulators for radar and similar applications. These tubes feature rugged coaxial mounting structures providing high-dissipation, low-inductance electrode terminals. The cathode of each type consists of sturdy, self-supporting, stress-free, thoriated-tungsten filaments.

The ML-8772 has a water-cooled, heavy-wall anode capable of dissipating 60 kW. The ML-8773 has a forced-air-cooled, heavy-wall anode with high-effciency disc fins capable of dissipating 35 kW.

These tubes will operate with plate voltages up to 40 kV in pulse modulator service. In a typical application these tubes are capable of switching 4.5 Mw.

GENERAL CHARACTERISTICS

Electrical

Filament Voltage	13.0 V
Filament Current	205 A
Filament Starting Current, maximum	800 A
Filament Cold Resistance	.0073 Ohm
Amplification Factor	20
Interelectrode Capacitances	
Grid-Plate	55 pf
Grid-Filament	76 pf
Plate-Filament	2.7 pf

Mechanical

Mounting Position	Vertical, anode down
Type of Cooling — ML-8772	Water and forced-air†
Water flow on anode for 60 kW dissipation, approx.	18 gpm
Maximum outgoing water temperature	70 °C
Type of Cooling — ML-8773	Forced-air
Air flow on anode for 35 kW dissipation — Pressure:	1700 cfm at 7.8" water*
Exhaust:	1970 cfm at 8.4" water*
Maximum incoming air temperature	50 °C
Maximum Envelope Temperature	165 °C†
Net Weight, approximate	
ML-8772	17 lb
ML-8773	43 lb

*When used with ML-8773 air distributor F-17759.

†Auxiliary air flow of 50-100 cfm is required and should be distributed to maintain a uniform glass temperature, not greater than 165°C, around the circumference of the seals. At high ambient temperature, additional air flow may be required.

WARNING: This electron tube when operating at peak voltages in excess of 15 kv may give off x rays, which can be harmful unless adequately shielded by the enclosure within which the tube is used. Instructions for protective installation are given in National Bureau of Standards Handbook 93, "Safety Standards for Non-Medical X-Ray and Sealed Gamma-Ray sources."

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

(Continuous Commercial Service)

VALUES APPLY TO BOTH TYPES UNLESS OTHERWISE SPECIFIED

Pulse Modulator or Pulse Amplifier

Maximum Ratings, Absolute Values‡		
DC Plate Voltage	40	kV
Peak Plate Voltage	45	kv
Peak Negative Grid Voltage	−7500	v
Pulse Cathode Current	175	a
Grid Dissipation	1000	W
Plate Dissipation		
ML-8772	60	kW
ML-8773	35	kW
Pulse Duration, approximate	1000	μs#
Duty Factor	.01	#
Typical Operation		
DC Plate Voltage	35	kV
DC Grid Voltage	−2700	V
Pulse Positive Grid Voltage	1500	v
Pulse Plate Current	150	a
Pulse Grid Current	25	a
Pulse Driving Power	105	kw
Pulse Power Output	4.5	Mw
Plate Output Voltage	30	kv

‡All given maximum ratings may not apply simultaneously. Due to the possibility of instantaneous overheating of electrodes during the pulse, it may be necessary to restrict some of the parameters, e.g., peak plate current, tube drop, pulse duration, duty or average dissipation, in order not to adversely affect the performance of the tube. Because of the many possible combinations of operating conditions, all restrictions cannot be delineated here, and it is suggested to review new applications with the Machlett Engineering Department.

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

ACCESSORIES

Item	Part No.
Small Filament Connector	F-17489
Large Filament Connector	F-17488
Grid Connector	F-17397
Water Jacket for ML-8772	F-17393
O-Ring Gasket for ML-8772 Water Jacket	P-17494
Mounting Clamp for ML-8772 Water Jacket	P-15198
Mounting Plate for ML-8772 Water Jacket	F-15196
Air Distributor for ML-8773	F-17759
Tube Support for ML-8773	F-17795
Tube Lifting Handle	F-27776

NOTE: For additional information on accessories, refer to Accessory Data Sheet No. ST-1295

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 tests 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.

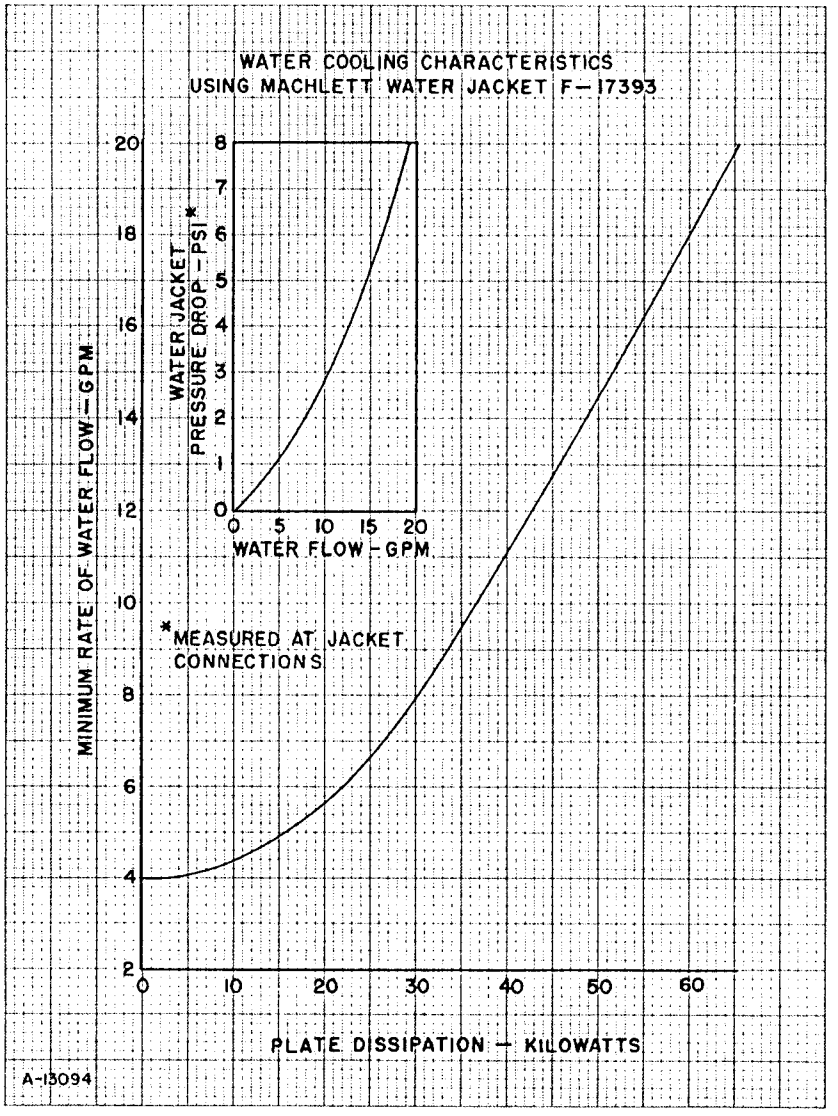
In circuits where high transient voltages may be developed due to a shorted load or other fault, special precautions are necessary to keep these excessive voltages from appearing at the tube electrodes.

References:

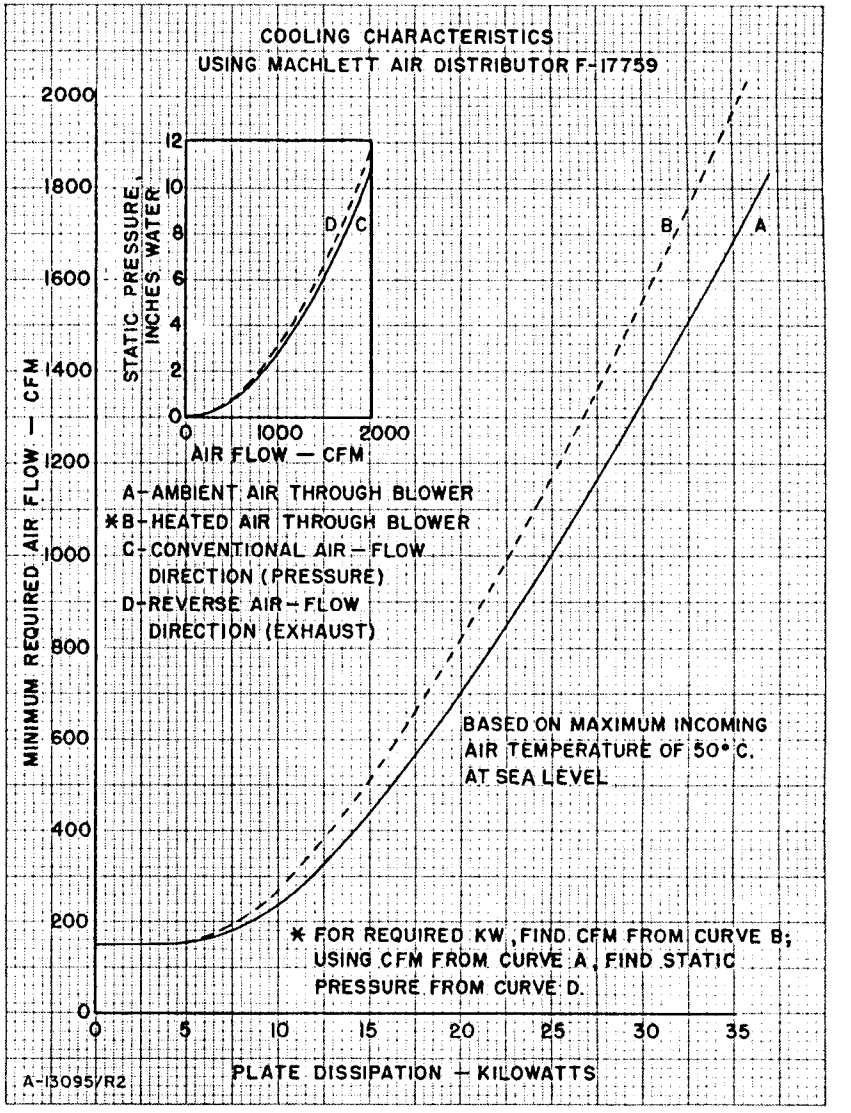
1. W. N. Parker and M. V. Hoover, "Gas Tubes Protect High Power Transmitters", *Electronics, 29,* 144, January 1956.
2. H. D. Doolittle, "High Power Hydrogen Thyratrons", *Cathode Press, 1, 6,* 1954.

MAINTENANCE

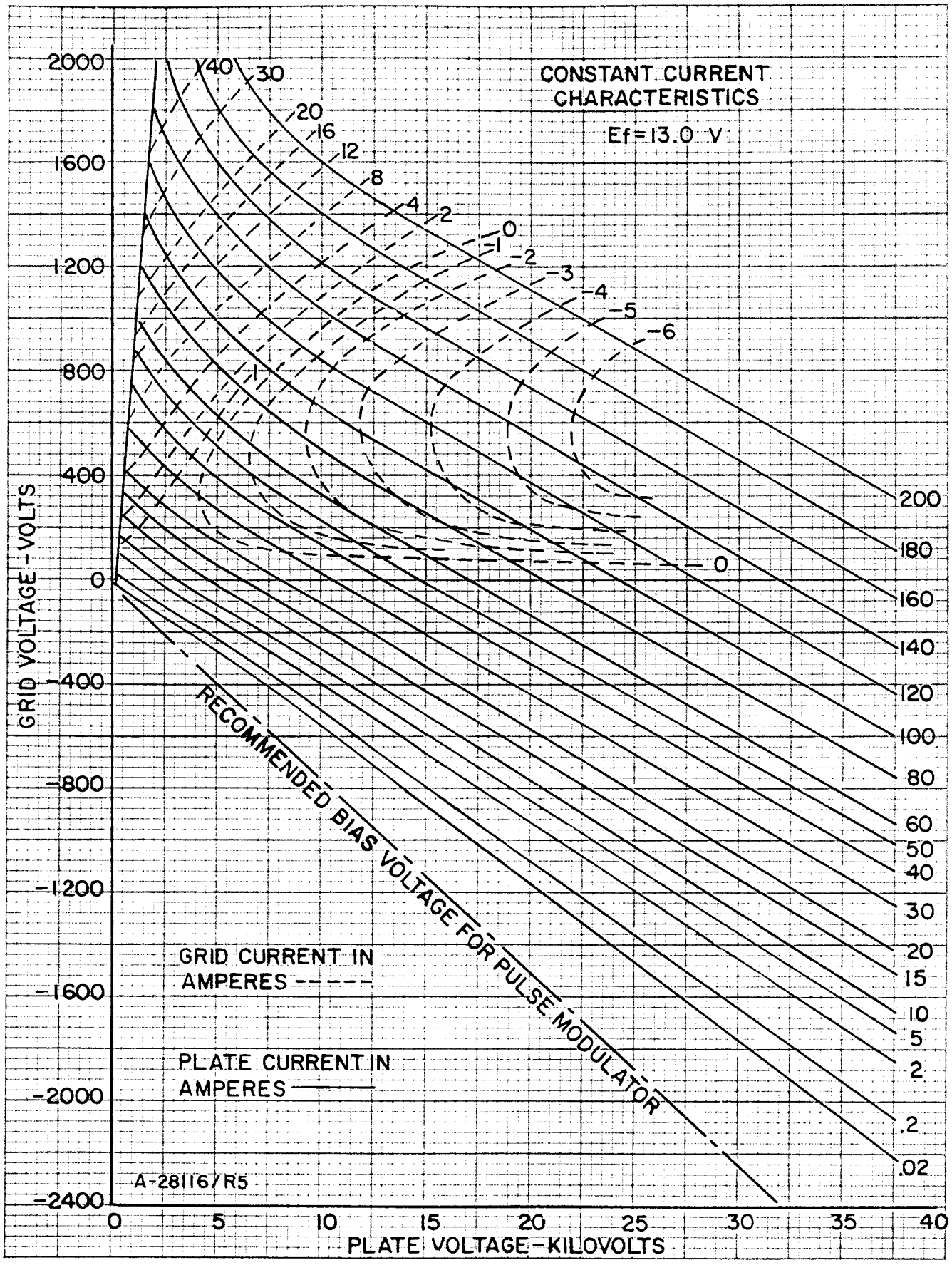
The anode cooling fins of the ML-8773 must be kept free from films of foreign materials, which will impair heat flow. To keep fins clean, it is suggested that ultrasonic cleaning or wire-brushing of the anode cooling surfaces be performed on a routine maintenance basis.

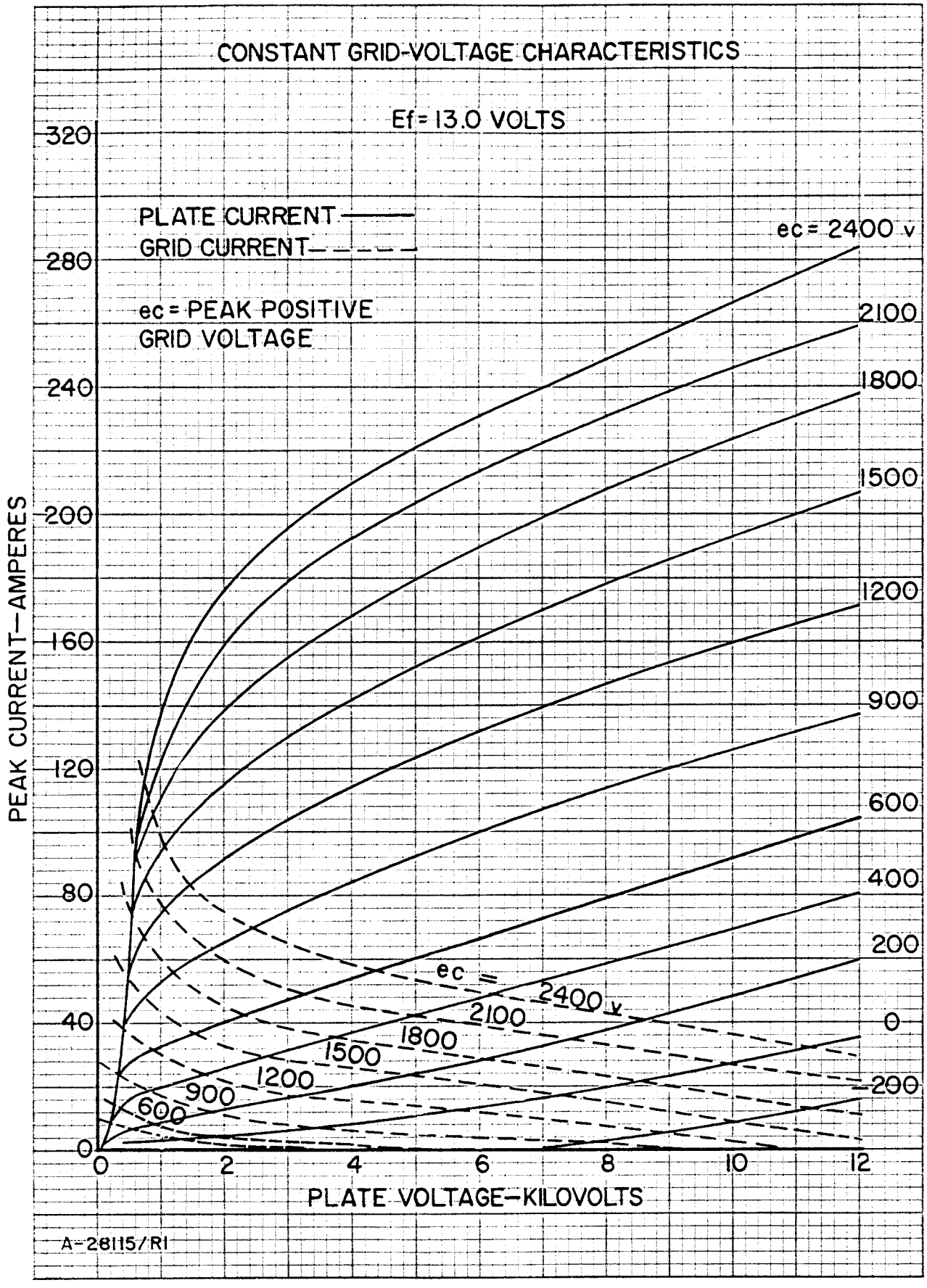


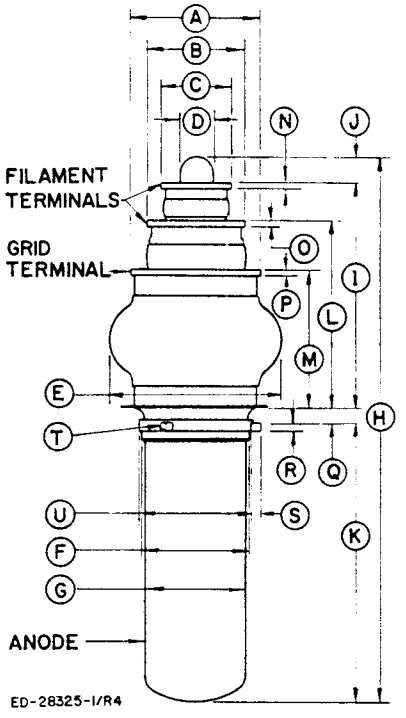
COOLING CHARACTERISTICS — ML-8772



COOLING CHARACTERISTICS — ML-8773


CONSTANT CURRENT CHARACTERISTICS
Ef=13.0 V
GRID VOLTAGE - VOLTS
2000
1600
1200
800
400
0
-400
-800
-1200
-1600
-2000
-2400
40
30
20
16
12
8
4
2
0
-1
-2
-3
-4
-5
-6
200
180
160
140
120
100
80
60
50
40
30
20
15
10
5
2
.2
.02
RECOMMENDED BIAS VOLTAGE FOR PULSE MODULATOR
GRID CURRENT IN AMPERES - - - -
PLATE CURRENT IN AMPERES ——
A-28116/R5
0
5
10
15
20
25
30
35
40
PLATE VOLTAGE - KILOVOLTS


CONSTANT GRID-VOLTAGE CHARACTERISTICS
Ef = 13.0 VOLTS
PLATE CURRENT
GRID CURRENT
ec = PEAK POSITIVE GRID VOLTAGE
ec = 2400 v
2100
1800
1500
1200
900
600
400
200
0
-200
PEAK CURRENT—AMPERES
320
280
240
200
160
120
80
40
0
0
2
4
6
8
10
12
PLATE VOLTAGE—KILOVOLTS
A-28115/R1

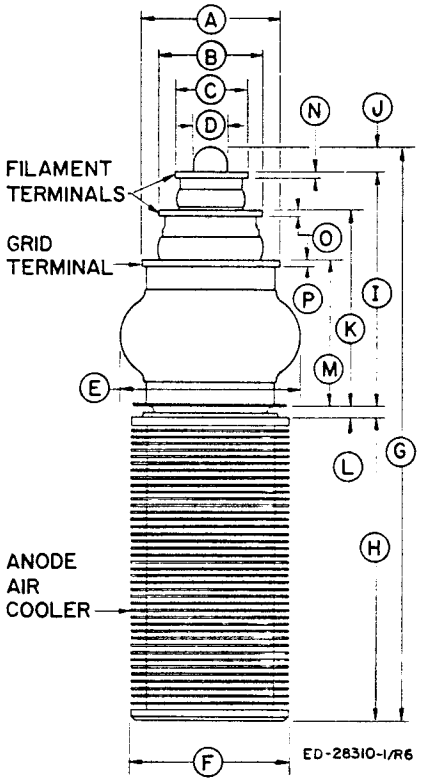


ML-8772

DIMENSIONS FOR OUTLINE OF ML-8772

Ref.	Inches			Notes
	Minimum	Nominal	Maximum	
A	4.619	4.650	4.681	
B	3.469	3.500	3.531	
C	2.469	2.500	2.531	
D	—	1.12	1.19	
E	—	5.94	6.13	
F	3.990	3.995	4.000	
G	3.485	3.500	3.515	
H	—	19.16	19.38	
I	7.75	7.88	8.00	
J	—	.94	1.00	
K	9.75	9.87	10.00	
L	6.50	6.62	6.75	
M	4.81	4.88	4.94	
N	.12	.18	—	
O	.12	.18	—	
P	.12	.18	—	
Q	.40	.44	.47	
R	.300	.310	.320	1
S	.28	.31	.35	1
T	—	120°	—	1
U	4.00	4.03	4.06	

NOTES:
1. Three bayonet pins for water jacket connection, diameter (R), length (S), nominally (T) degrees apart.



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A	4.619	4.650	4.681	
B	3.469	3.500	3.531	
C	2.469	2.500	2.531	
D	—	1.12	1.19	
E	—	5.94	6.13	
F	5.219	5.250	5.281	
G	—	19.36	19.88	
H	10.00	10.12	10.25	
I	7.75	7.88	8.00	
J	—	.94	1.00	
K	6.50	6.62	6.75	
L	.31	.45	—	
M	4.81	4.88	4.94	
N	.12	.18	—	
O	.12	.18	—	
P	.12	.18	—	

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