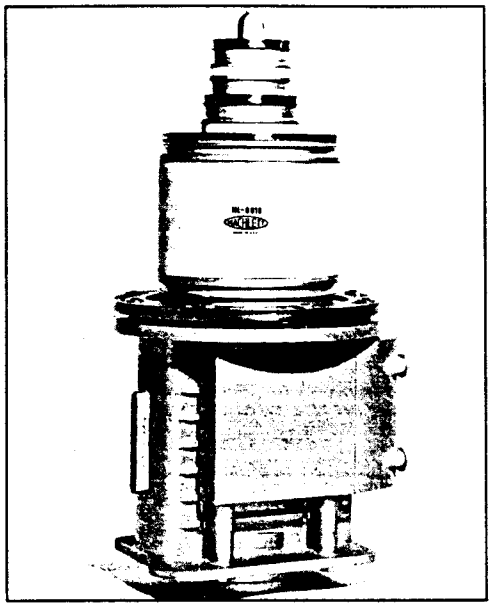
ISSUED 7-73



ML-8618
ML-8618V

MACHLETT

High Power-Gain Triodes
200 kW, CW
8 Mw Pulse Power

DESCRIPTION

The ML-8618 and ML-8618V are magnetically beamed, high-power, general-purpose, water-cooled triodes. Their unique design, using a magnetic field to beam electron flow, produces extremely favorable plate-grid current division, which results in minimum drive-power requirements and high overall operating efficiency. The cathode of each type consists of sturdy thoriated-tungsten filaments. Parallel plane anode construction reduces filament power requirements by utilizing both sides of the filaments. The coaxial terminals have low inductance and high heat dissipation capability. Insulating members are low-loss ceramic. The ML-8618V is identical to the ML-8618 except that it is provided with an ion getter pump.

When operated as a class C amplifier or oscillator, these tubes are capable of a continuous output of up to 200 kW with about 700 W driving power. When used as switch tubes in hard-tube pulse modulators for radar, particle accelerators, or similar applications, they can deliver 8 Mw pulse output. Since the magnetic beaming reduces the grid dissipation, the tubes are capable of operating with much longer pulses and higher duty factors than conventional tubes of similar size.

The water-cooled anodes of these tubes are capable of dissipating up to 80 kW. The tubes can be operated in air at maximum plate voltage ratings. Maximum ratings apply at frequencies up to 30 MHz. Useful power output can be obtained at higher frequencies with a reduction in plate voltage.

GENERAL CHARACTERISTICS

Electrical		
Filament Voltage (AC)	7.5	V
Filament Current	320	A
Filament Starting Current, maximum	700	A
Filament Cold Resistance	.0028	ohm
Amplification Factor	25	
Interelectrode Capacitances, approximate		
Grid-Plate	50	pf
Grid-Filament	145	pf
Plate-Filament	9	pf
Strapped Resonant Frequencies		
Grid-Plate, approximate	135	MHz
Grid-Cathode, approximate	120	MHz
Mechanical		
Mounting Position	Vertical, Anode down	
Type of Cooling	Water & Forced-Air	
Maximum water inlet pressure	30	psi†
Maximum outgoing water temperature	70	°C
Water flow on anode for 80 kW dissipation	45	gpm††
Water jacket pressure drop for 45 gpm flow	10	psi
Maximum Envelope Temperature	200	°C
Net Weight, approximate		
Tube only	56	lb
Water jacket and magnet	90	lb

†A 30 psi pressure relief valve should be connected to the water jacket.

††Additional forced-air cooling of the grid and filament terminals will be required. This should consist of an air flow of about 200 cfm uniformly distributed on the ceramic bulb and the terminal assembly.

WARNING: This electron tube may give off x-rays when operating at peak voltages in excess of 15 kv, which can be harmful unless adequately shielded by the enclosure within which it 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".

ACCESSORIES

Item	Part No.
Small Filament Connector	F-27218*
Large Filament Connector	F-27219*
Grid Connector	F-27220*
Water Jacket and Magnet Assembly	F-535437
Water Jacket Assembly with O-Ring Gasket	F-512759
Magnet	P-511165

*For additional information on these accessories, refer to Accessory Data Sheet No. ST-2097.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

(Continuous Commercial Service)

Pulse Modulator or Pulse Amplifier

Maximum Ratings, Absolute Values‡

DC Plate Voltage	45	kV
Peak Plate Voltage	50	kV
DC Grid Voltage	−5000	V
Pulse Cathode Current	200	a
Grid Dissipation	500	W
Plate Dissipation	80	kW
Pulse Duration	10000	μs#
Duty Factor	.06	#

Typical Operation

DC Plate Voltage	40	kV
Pulse Output Voltage	37	kv
DC Grid Voltage	−3600	V
Pulse Positive Grid Voltage	1500	v
Pulse Plate Current	150	a
Pulse Grid Current	2.5	a
Pulse Driving Power	12.8	kw
Pulse Output Power	5.5	Mw
Duty Factor	.06	

‡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.

RF Power Amplifier and Oscillator Class C Telegraphy §

Keydown conditions per tube without amplitude modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	17	kV
DC Grid Voltage	−4000	V
DC Plate Current	15	A
Grid Dissipation	500	W
Plate Dissipation	80	kW

Typical Operation

DC Plate Voltage	16	kV
DC Grid Voltage	−2000	V
Peak RF Plate Voltage	14.4	kv
Peak RF Grid Voltage	3000	v
DC Plate Current	13	A
DC Grid Current, approximate	.2	A
RF Load Resistance	595	Ohms
Driving Power, approximate	600	W
Plate Dissipation	35	kW
Grid Dissipation	200	W
Power Output	175	kW
Power Gain	290	

§Consult The Machlett Laboratories Engineering Department for this application.

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.

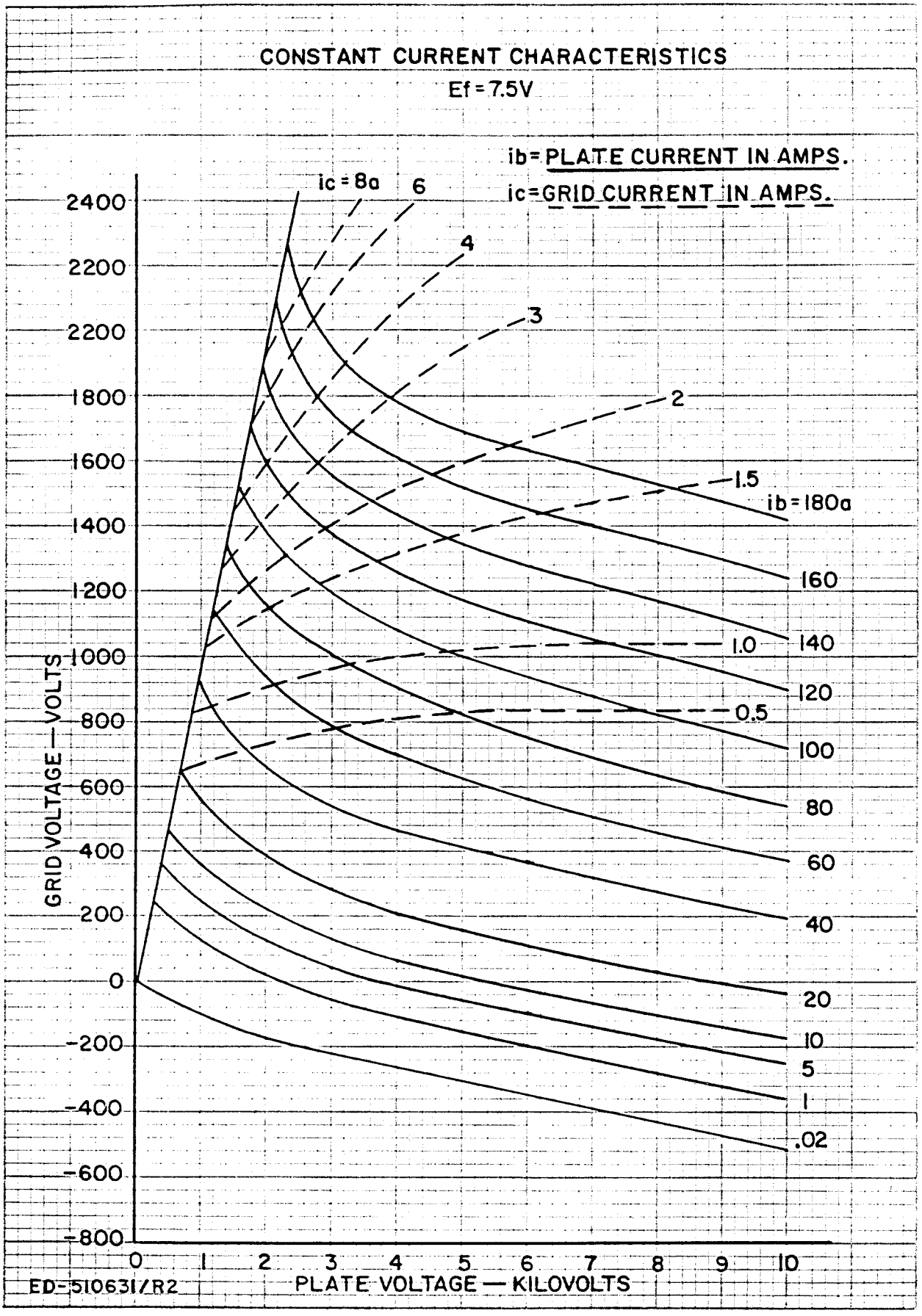
In addition to the normal circuit breakers and overload relays, it is necessary that a fast-acting electronic protective device (crowbar) or equivalent be used. This device will in most cases be a triggered gaseous device connected across the output of the plate supply filter, if used, to dissipate the 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.

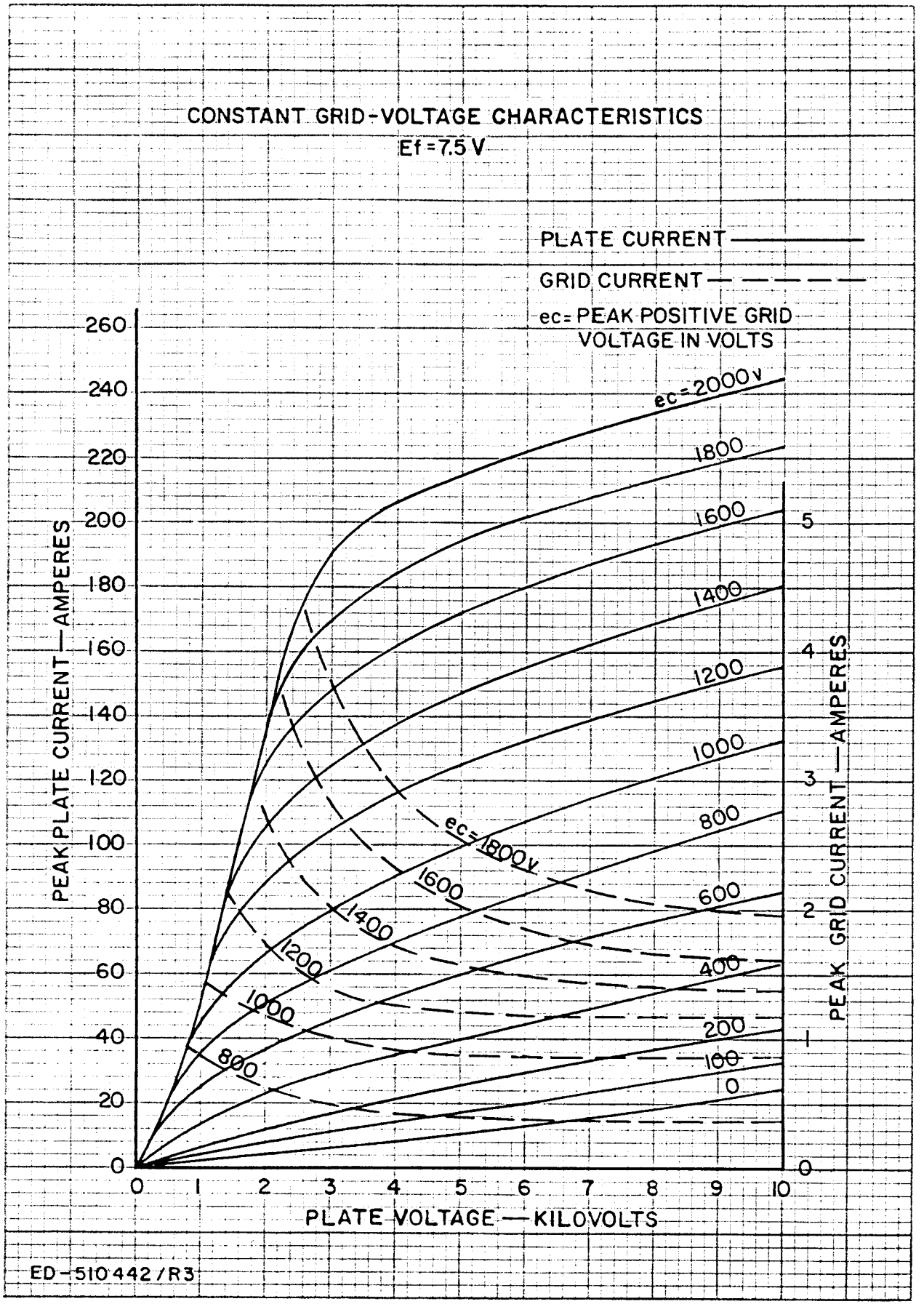
A nominal value of resistance must be placed in the plate lead of the tube being protected in order to be assured that the impedance of this tube under a flash arc condition is greater than that of the crowbar device when the latter is triggered. Critical damping is required for the crowbar discharge 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.

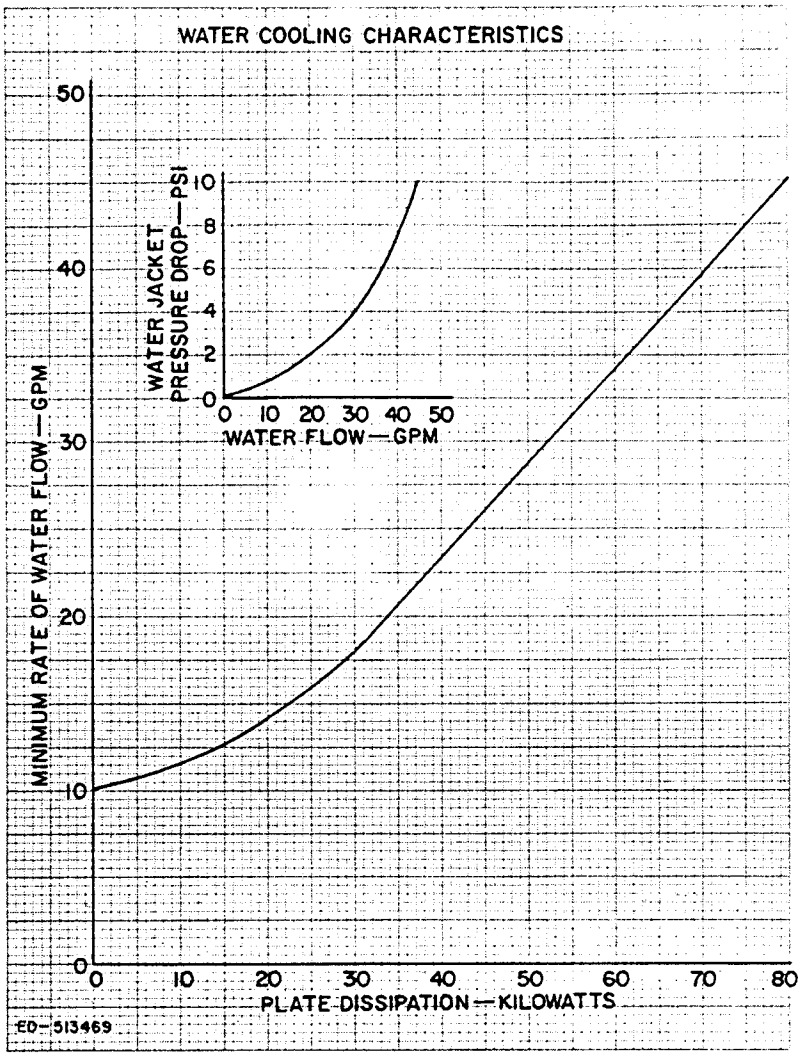
In circuits where high transient voltages may be developed due to a shorted load or other fault, special precautions are necessary to keep these excessive voltages from appearing at the tube electrodes.

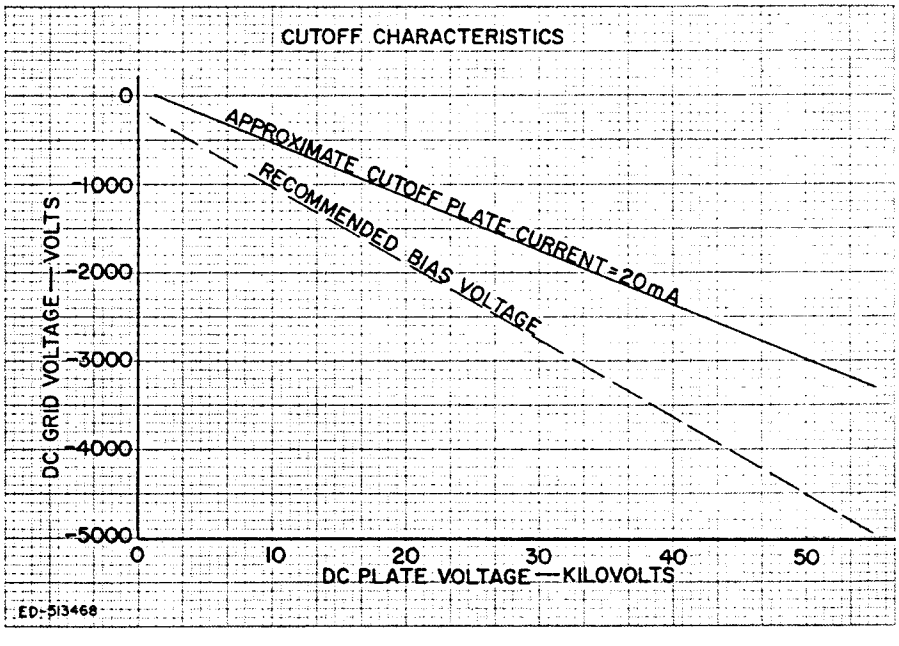
References:

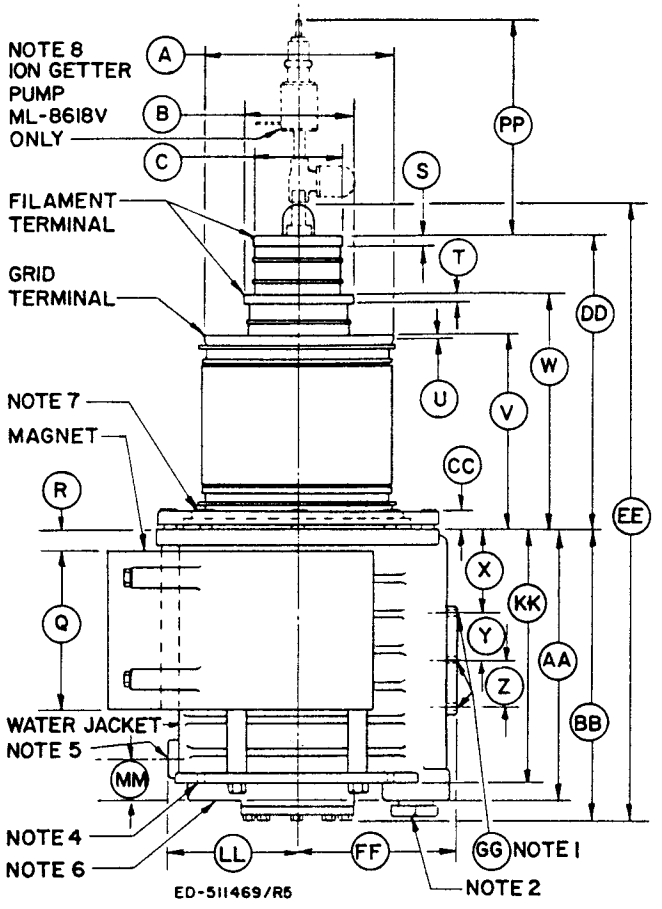
1. W. N. Parker and M. V. Hoover, "Gas Tubes Protect High Power Transmitters", *Electronics, 29,* 144, January 1956.
2. H. D. Doolittle, "High Power Hydrogen Thyratrons", *Cathode Press, 1,* 6, 1954.

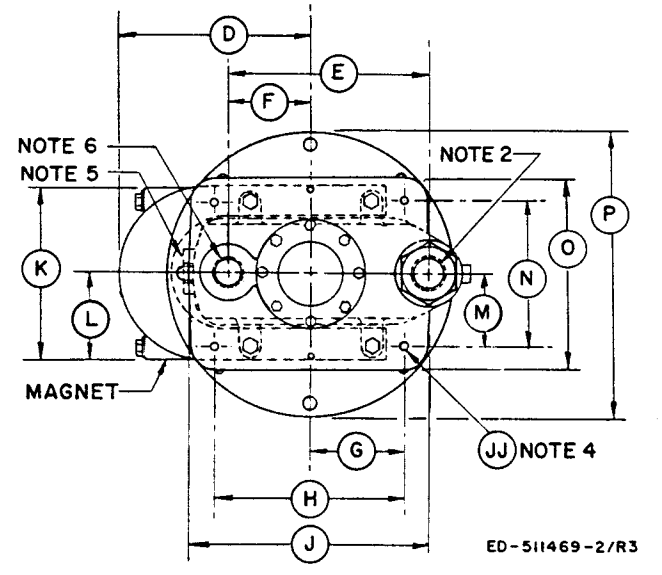

CONSTANT CURRENT CHARACTERISTICS
Ef = 7.5V
ib = PLATE CURRENT IN AMPS.
ic = GRID CURRENT IN AMPS.
ic = 8a
6
4
3
2
1.5
ib = 180a
160
140
1.0
120
0.5
100
80
60
40
20
10
5
1
.02
2400
2200
2200
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
GRID VOLTAGE — VOLTS
0 1 2 3 4 5 6 7 8 9 10
PLATE VOLTAGE — KILOVOLTS
ED-510631/R2


CONSTANT GRID-VOLTAGE CHARACTERISTICS
Ef = 7.5 V
PLATE CURRENT
GRID CURRENT
ec = PEAK POSITIVE GRID VOLTAGE IN VOLTS
ec = 2000 V
1800
1600
1400
1200
1000
800
600
400
200
100
0
ec = 1800 V
1600
1400
1200
1000
800
PEAK PLATE CURRENT — AMPERES
PEAK GRID CURRENT — AMPERES
PLATE VOLTAGE — KILOVOLTS
0
20
40
60
80
100
120
140
160
180
200
220
240
260
0
1
2
3
4
5
6
7
8
9
10
ED-510442/R3


WATER COOLING CHARACTERISTICS
MINIMUM RATE OF WATER FLOW—GPM
0
10
20
30
40
50
PLATE DISSIPATION—KILOWATTS
0
10
20
30
40
50
60
70
80
WATER JACKET PRESSURE DROP—PSI
0
2
4
6
8
10
WATER FLOW—GPM
0
10
20
30
40
50
ED-513469


CUTOFF CHARACTERISTICS
DC GRID VOLTAGE—VOLTS
0
-1000
-2000
-3000
-4000
-5000
APPROXIMATE CUTOFF PLATE CURRENT=20mA
RECOMMENDED BIAS VOLTAGE
0
10
20
30
40
50
DC PLATE VOLTAGE—KILOVOLTS
ED-513468





DIMENSIONS FOR OUTLINE OF ML-8618 AND ML-8618V

Ref	Inches			Notes
	Minimum	Nominal	Maximum	
A	6.917	6.937	6.957	3
B	3.985	4.005	4.025	3
C	3.298	3.318	3.338	3
D	—	7.00	7.50	
E	7.28	7.34	7.40	
F	2.94	3.00	3.06	
G	3.47	3.50	3.53	
H	6.97	7.00	7.03	
J	—	8.88	9.10	
K	—	6.75	6.95	
L	—	3.38	3.48	
M	2.66	2.69	2.72	
N	5.35	5.38	5.41	
O	—	7.00	7.20	
P	—	10.56	10.80	
Q	—	6.00	6.20	
R	.62	.82	1.02	
S	.31	.38	—	
T	.31	.38	—	
U	.10	.13	—	
V	7.17	7.27	7.37	
W	8.61	8.76	8.91	
X	2.75	2.95	3.15	
Y	1.66	1.69	1.72	
Z	1.66	1.69	1.72	
AA	9.90	10.10	10.30	
BB	10.53	10.73	10.93	
CC	.64	.69	.74	
DD	10.74	10.94	11.14	
EE	—	22.86	23.20	
FF	5.72	5.92	6.12	
GG	.30	.38	—	1
JJ	.302	.312	.322	4
KK	9.40	9.60	9.80	
LL	4.49	4.69	4.89	
MM	1.21	1.41	1.61	
PP	—	8.25	8.75	

NOTES:

1. Three holes, ¼-20 tap, (GG) inches deep, for plate connection.
2. Water outlet, 1″ NPT tap.
3. Add ± .01″ to maximum and minimum for out-of-roundness.
4. Four through holes diameter (JJ) for stand-off insulator mounting.
5. Connection for pressure relief valve, ½″ NPT tap.
6. Water inlet, 1″ NPT tap.
7. Hold-down ring holds tube in water jacket. Fastened by eight screws.
8. Vac Ion pump, Varian No. 913-0035 (modified) or equivalent and magnet, Varian No. 913-0011 supplied with ML-8618V tube only.

OUTLINE OF ML-8618 AND ML-8618 V

MACHLETT
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