HARD TUBE PULSE MODULATOR TYPE WL-8461

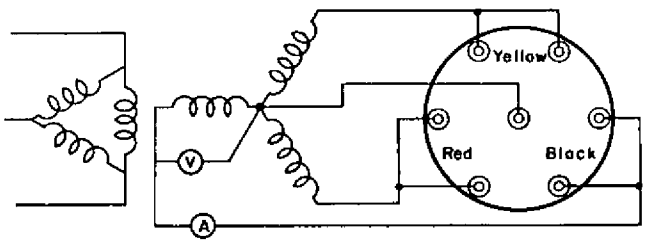
The WL-8461 is a large, three-electrode, immersion cooled tube designed for service as a hard-tube modulator or series regulator. The anode is capable of dissipating 30 Kilowatts, exclusive of filament heating power, when oil cooled or 200 Kilowatts when water cooled. The cathode is a multiple-stand, thoriated-tungsten filament operated 3 phase.

ELECTRICAL

Cathode	Thoriated-Tungsten Filament	
Filament:		
Voltage:		
3 Phase (to neutral)	15	Volts
Current:		
3 Phase (per phase)	200	Amperes
Min. Filament Heating Time	60	Seconds
Filament Starting Current, Max.	600	Amps.
Filament Cold Resistance	.0065	Ohms
Amplification Factor	25	
Direct Interelectrode Capacitances:		
Grid to Plate	72	$\mu\mu f$
Grid to Filament	180	$\mu\mu f$
Plate to Filament	3	$\mu\mu f$

FILAMENT CONNECTIONS

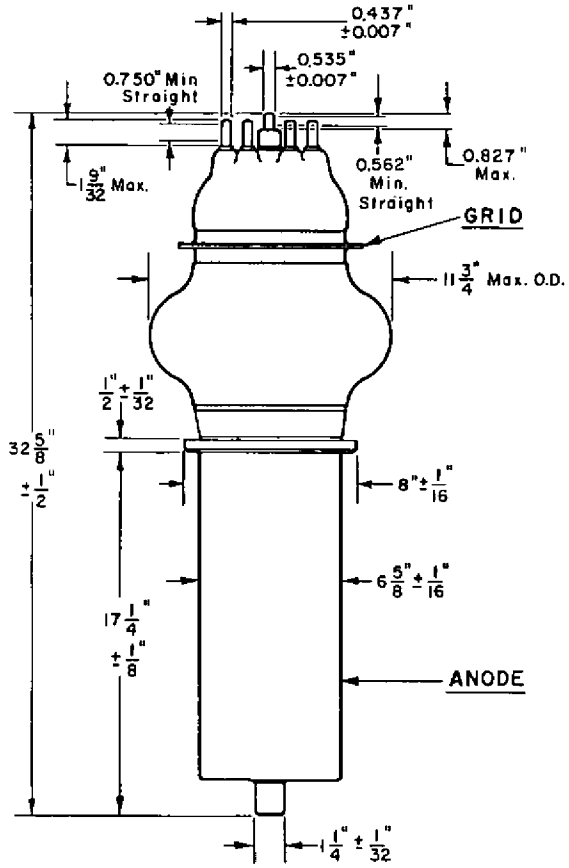
V = 15 Volts to Neutral
A = 200 Amperes per Phase



CE-A2061

MECHANICAL

Mounting Position	Vertical, Anode Down		
Net Weight (Approx.)	48 Pounds		
Cooling:			
Type	Oil	Water	
Maximum Fluid Temp.	80	45	°C
Maximum Bulb & Seal Temp.	180	180	°C
Minimum Water Flow	–	40	G.P.M.
Min. Air Flow on Bulb & Seals	–	75	C.F.M.



ACCESSORIES

NAME	QUANTITY	PART NO.
Water Jacket	1	WL-22688
Gasket	1	43-203
Filament Connector	6	WL-22677
Filament CT Connector	1	WL-22682
Grid Connector	1	WL-22689

PULSE MODULATOR SERVICE

MAXIMUM RATINGS

Absolute Maximum Values

DC Plate Voltage	80 max.	Kilovolts
DC Grid Voltage	–5000 max.	Volts
Peak Pulse Plate Current	600 max.	Amperes
Peak Pulse Grid Current	150 max.	Amperes
Plate Dissipation:		
Oil Cooled	30 max.	Kilowatts
Water Cooled	200 max.	Kilowatts
Grid Dissipation	3.6 max.	Kilowatts
Pulse Length	1000 max.	μseconds
Duty Factor	0.01 max.	–
Peak Pulse Cathode Current	750 max.	Amperes

TYPICAL OPERATION

DC Plate Voltage	55	65	75	Kilovolts
DC Grid Voltage	-2750	-3350	-3750	Volts
Pulse Positive Grid Voltage	3500	3500	3500	Volts
Pulse Plate Current	600	600	600	Amperes
Pulse Grid Current	92	92	92	Amperes
Pulse Driving Power	575	630	665	Kilowatts
Pulse Power Output	28.5	34.5	40	Megawatts
Plate Output Voltage	47.5	57.5	67.5	Kilovolts

SERIES REGULATOR SERVICE

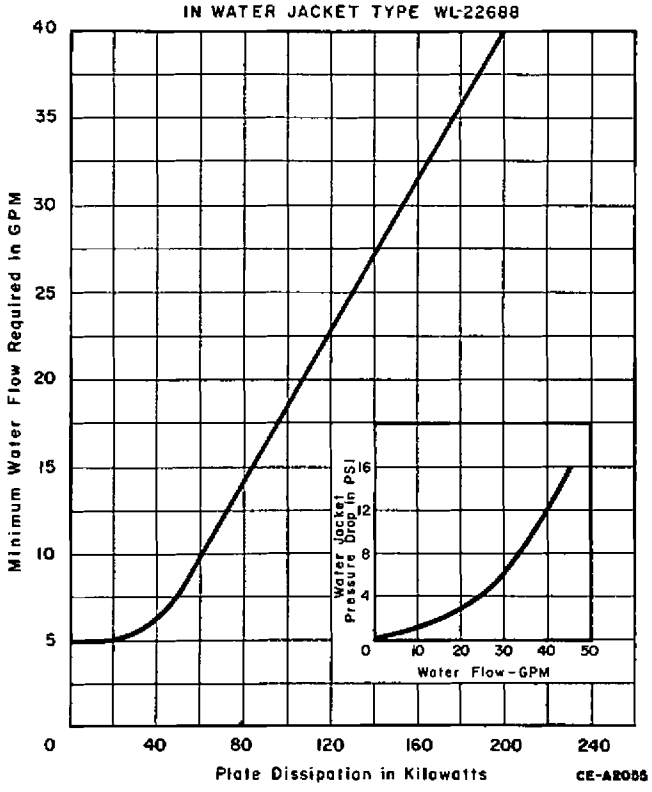
MAXIMUM RATINGS

Absolute Maximum Values

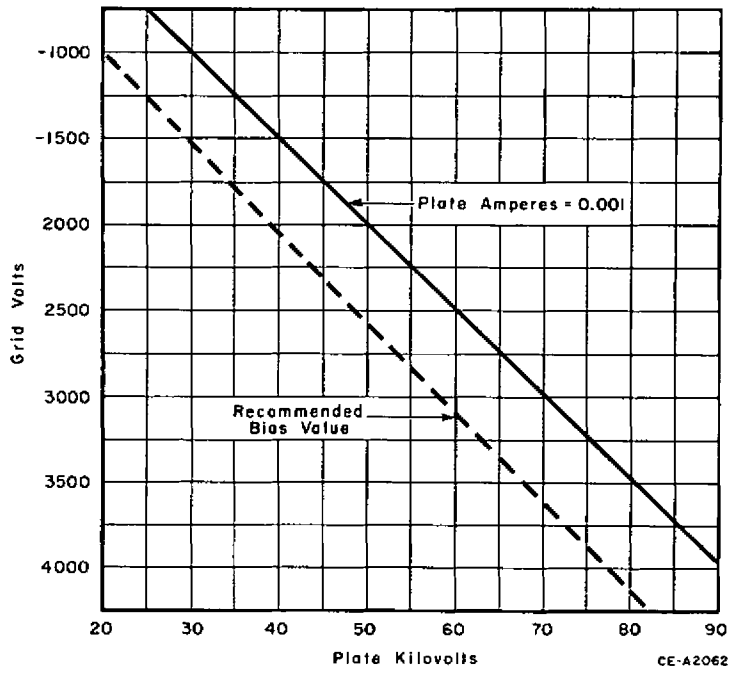
DC Plate Voltage	75 max.	Kilovolts
DC Grid Voltage	-5 max.	Kilovolts
DC Plate Current (Regulated)	50 max.	Amperes
Grid Dissipation	3.6 max.	Kilowatts
Plate Dissipation (Water Cooled)	200 max.	Kilowatts

X-Ray Warning: The Maximum Ratings of the WL-8461 permit operation at voltage in excess of 16 KV. Therefore equipment design consideration should include the generation of x-rays.

COOLING CHARACTERISTICS
IN WATER JACKET TYPE WL-22688



CUT-OFF CHARACTERISTIC



COOLING SYSTEMS

The water system should be the closed type using distilled or deionized water to preclude the possibility of scale formation and corrosion, both of which can be expected with tap water. Scale restricts water flow and prevents proper transfer of heat from the anode to the cooling water, and corrosion may damage the elements and pasages. The rates of scale formation and corrosion depend on the electrical conductivity of the water. To minimize the formation of scale and corrosion, the use of a coolant having an initial resistance of at least 100,000 ohms per cubic centimeter is recommended. Since a very small amount of contamination can change the conductivity of distilled water, frequent measurement is desirable. The water should be changed when its resistance falls below 20,000 ohms per cubic centimeter. A filter should be placed in the water supply line to the tube to trap foreign particles likely to impair the flow. It is suggested that a filter with a 100-mesh screen (0.005" openings) be used.

The water-cooling system must function properly at all times since even a momentary failure of flow will damage the WL-8461. Without cooling water, the heat of the filament alone is sufficient to cause serious harm. It is necessary to keep the water-flow interlocks in correct adjustment and never to set them to operate below the recommended level. The flow of water and air must start before the application of any tube voltages; it is recommended that the flow of coolants continue for 5 minutes after the removal of all tube voltages. In the event of emergency or fault conditions, however, the simultaneous shut down of all power will not damage the tube. Specific water-flow data are given in the Water-Cooling Characteristics. Under no circumstances should the outlet water temperature exceed 70°C nor should the temperature of the entering water be permitted to fall below 10°C with plate potential on. Water pressure at the tube socket should never exceed 100 psi.

Forced-air cooling of the cathode terminals, the grid flange, and the glass envelope is required, and the cooling should be uniformly distributed around the circumference of the seals. Air flow of 75 cfm provides adequate cooling.

TUBE PROTECTION NOTES

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 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.

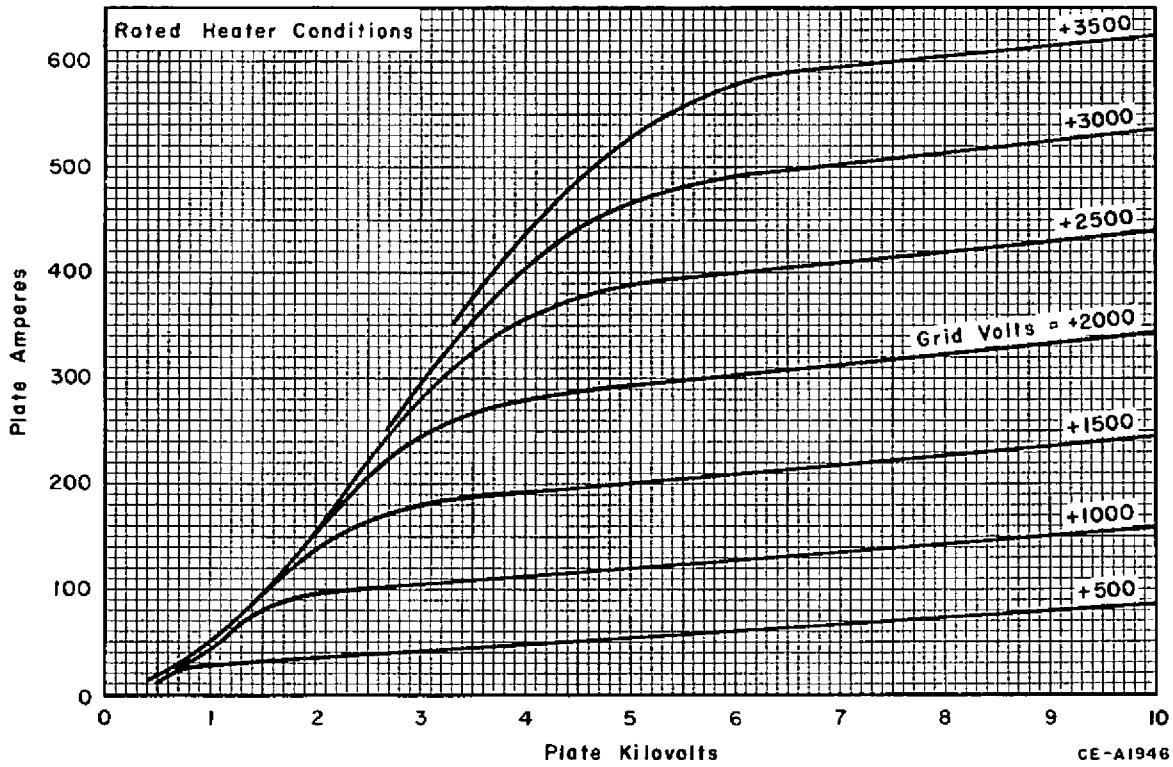
A nominal value of resistance must be placed inthe plate lead of the tube being protected in order to be assured that the impedance of this tube under a flash arc condition is greater than that of the crowbar device when the latter is triggered. Critical damping is required for the crowbar discharge 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. A. J. Morris and J. P. Swanson, "The High Speed Protection of Microwave Tubes and Systems", The Microwave Journal, Vol. V, No 11, Nov. 1962.

AVERAGE PLATE CHARACTERISTICS



AVERAGE GRID CHARACTERISTICS