93 SEP Rec'd

TECHNICAL DATA

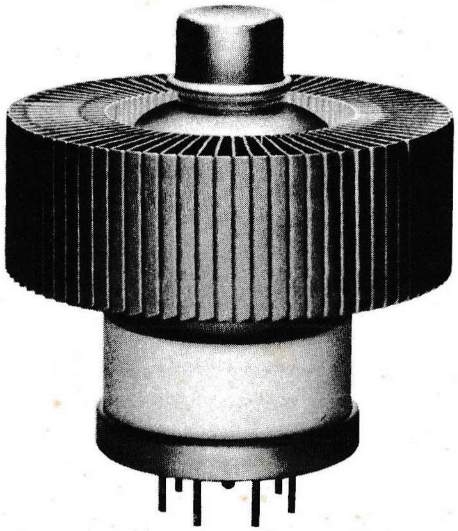
Y-870

High-mu
Power Triode

The EIMAC Y-870 is a rugged ceramic/metal high-mu triode, designed with beam-forming cathode and control-grid geometry to allow the simplicity of design and circuit advantages of a triode with the gain of a tetrode.

The Y-870 is intended for pulse modulator or pulse regulator service, with a pulse plate current rating of 50 amperes, and a voltage hold-off rating of 10,000 volts in air, with forced-air cooling of the anode, or 30,000 volts when immersed in a suitable dielectric liquid which is also used for tube cooling.

An Air-System Socket (EIMAC SK-2200) and an Air Chimney (EIMAC SK-2216) are available for applications requiring forced-air cooling.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Cathode: Oxide-coated, Unipotential

Heater: Voltage	5.5 ± 0.25 V
Current, at 5.5 volts	11.2 A
Transconductance (average, with I_b = 1.0 Adc)	55,000 umhos
Amplification Factor (average)	200
Direct Interelectrode Capacitance (grounded cathode)[2]	
C_{in}	38.5 pF
C_{out}	0.1 pF
C_{gp}	10 pF

[1]Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. Varian EIMAC should be consulted before using this information for final equipment design.

[2]Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronics Industries Association Standard RS-191.

Rev. 9/89

MECHANICAL

Maximum Overall Dimensions:

Length	4.02 in; 102 mm
Diameter	3.38 in; 86 mm
Net Weight	26 oz; 735 gm
Operating Position	Any
Maximum Operating Temperature, Ceramic/Metal Seals or Anode core	250°C
Cooling	Forced Air or Liquid Immersion
Base	Special 7-pin
Recommended Air-System Socket	EIMAC SK-2200
Recommended Air Chimney	EIMAC SK-2216

RANGE VALUES FOR EQUIPMENT DESIGN

	Min.	Max.	
Heater (current at 5.5 volts)	10.2	12.2	A
Cathode Warm-up Time	90	---	Sec
Interelectrode Capacitance (grounded cathode connection)[1]			
C_{in}	36.0	41.0	pF
C_{out}	----	0.2	pF
C_{gp}	9.2	11.2	pF

[1]Capacitance values are for a cold tube as measured in a special shielded fixture in accordance with Electronics Industries Association Standard RS-191.

PULSE MODULATOR OR SWITCH TUBE SERVICE

Absolute Maximum Ratings

	In Air	In Oil	
Heater Voltage	5.5±5%	5.5±5%	V
DC Plate Voltage	10.0	30	kV
DC Grid Voltage	-200	-200	V
Peak Plate Current[1]	50	50	A
Pulse Length & Duty[1]	See Derating Chart		
Plate Dissipation[2]	1500	1500	W
Grid Dissipation	25	25	W

TYPICAL OPERATION/Pulse Modulator Service

Plate Voltage	10.0	30	kVdc[4]
Pulse Plate Current	40	20	a
Grid Voltage	-125	-200	Vdc
Pulse Positive Grid Voltage[3]	340	200	v
Pulse Grid Current[3]	1.5	1.5	a
Pulse Duration	2.0	2.0	us
Duty	0.0006	0.0006	
Pulse Driving Power[3]	697	600	w
Pulse Output Power[3]	306	520	kw

[1]Pulse length, pulse plate current and duty are interrelated; see Derating Chart.

[2]Plate dissipation values shown are nominal; capability is dependent on cooling technique and equipment design. In all cases the ABSOLUTE MAXIMUM temperature ratings should not be exceeded, and for best life and consistent performance, operation at lower temperatures is normally beneficial.

[3]Approximate value.

[4]In an insulating medium such as FC-77.

MOUNTING: The EIMAC Y-870 may be operated in any position. The SK-2200 socket is designed to hold the tube and make all base contacts, and for applications with forced-air cooling, the matching air chimney, SK-2216, is available.

COOLING: The EIMAC Y-870 may be either forced-air or liquid-immersion cooled in a suitable dielectric coolant fluid. The maximum temperature limit for external tube surfaces and the anode core is 250°C, but it should be noted that where long life and consistent performance are important design factors, operation at somewhat lower temperatures is normally beneficial. The air-cooling data shown will maintain tube temperatures below 225°C with 50°C cooling air.

When the tube is liquid-immersed, circulation of the dielectric fluid will normally be required and the designer is cautioned to assure sufficient tube cooling for the maximum dissipation level likely to ever be reached with some safety factor allowance.

Base-to-Anode Air Flow (sea level)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H_2O
500	7.5	0.10
1000	22.5	0.20
1500	35	0.41
Base-to-Anode Air Flow (10,000 ft.)		
Anode Dissipation (watts)	Air Flow (CFM)	Pressure Drop In./H_2O
500	11.0	0.15
1000	32.5	0.29
1500	51	0.60

Note: 1) Tube mounted in SK-2200 socket with SK-2216 Chimney.
2) An allowance of 25 watts has been made for grid dissipation and 50 watts for filament power.

FILAMENT/CATHODE OPERATION: Pulse current capability of the Y-870 is dependent on cathode temperature, which in turn is dependent on heater voltage. When the full-rated anode current (ib=50 amps max) is required, the heater voltage should be operated at 5.5 volts and not deviate from this nominal value by more than +/- 5%.

When a lower value of anode current (ib=24 amps max.) is adequate for the application, the heater voltage should be reduced to 5.0 volts, plus or minus five percent, and tube life expectancy will be greatly improved. In cases where better life expectancy and consistent performance are factors, regulation to better than five percent will normally be beneficial at either heater voltage level. Voltage should be measured with a known-accurate rms-responding meter.

ANODE CURRENT: For pulse service, either as a switch tube or modulator, or for voltage regulator applications, an anode current (during the pulse) of up to 50 amps is available, with Ef=5.5 volts, or up to 24 amps with Ef=5.0 volts. Peak current capability, pulse length and duty factor are interrelated and the PULSE DERATING DATA should be consulted. For pure dc service, the anode current should be limited to 1 ampere.

HIGH VOLTAGE: For air operation, anode voltage should not exceed 10 kVdc at sea level. This value allows some safety factor, but does assume a clean tube with no buildup of dirt or grime across the insulating ceramic. At higher altitudes a reduction in voltage may be required to preclude the possibility of external tube flashover. When the tube is immersed in a liquid dielectric coolant with suitable insulating properties, the allowable anode voltage is 15 kVdc at any altitude.

The operating voltages for this tube must be considered as potentially lethal and the equipment must be designed properly and operating precautions must be followed. The equipment must include safety enclosures for the high-voltage circuits and terminals, with interlock switches to open the primary circuits of the power supplies and to discharge high voltage condensers whenever access doors or covers are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

PLATE SURGE-LIMITING IMPEDANCE: Tubes such as the EIMAC Y-870 are built with closely spaced electrodes. This results in high voltage gradients even at normal operating voltages. A high energy arc-over between electrodes may be destructive, and therefore a series impedance in the anode lead is recommended, or the anode supply should be designed so that it has sufficient self-impedance to limit the short-circuit current to ten times the maximum pulse-current rating. Normal overload protection techniques should also be used in the anode circuit to prevent tube damage, in the event of a fault condition.

X-RAY RADIATION HAZARD: High vacuum tubes operating at voltages higher than 15 kV produce progressively more dangerous x-ray radiation as the voltage is increased. This tube, operating at its rated voltages and currents, is a potential x-ray hazard. Only limited shielding is afforded by the tube envelope.

Moreover, the x-ray radiation level may increase significantly with aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding must be provided on all sides of a tube operating at these voltages to provide adequate protection throughout the tube's life. The amount of shielding required will vary with tube usage and therefore is beyond Varian's control.

Periodic checks on the x-ray level should be made and the tube should never be operated without adequate shielding in place. Lead glass attenuates x-rays and is available for viewing windows. If there is any doubt as to the adequacy of shielding, an expert in this field should be contacted to perform an x-ray survey of the equipment.

Useful information on this subject can be found in Reports 33 and 39 of the National Council on Radiation Protection, 7910 Woodmont Ave., Suite 1016, Bethesda, MD 20814; telephone (301) 657-2652.

Operation of high voltage equipment with interlock switches rendered inoperative and cabinet doors open in order to better locate an equipment malfunction can result in serious x-ray exposure.

The amount of x-ray radiation is dependent upon the particular tube operating conditions. When tested per EIA TEPAC Publication #181, the maximum radiation measured 12 inches from the tube surface is 37.5 R/Min.

GRID OPERATION: The maximum rated dc grid bias voltage for the Y-870 is -200 Vdc and the maximum grid dissipation rating is 25 watts. In normal applications the grid dissipation will not approach the maximum rating.

PLATE OPERATION: The anode of the Y-870 tube is nominally rated for the dissipation values shown on Page 2, depending on the type of cooling used. When the tube is immersed in a liquid dielectric coolant, with proper circulation, and (if required) provisions for dielectric fluid cooling, dissipation capability is actually limited only by tube temperature, especially in the seal areas and the anode core.

In pulse service, average anode dissipation may be calculated as the roduct of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. Actual dissipation may often exceed the calculated value, however, if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times allow plate current to flow for longer periods in the high tube-voltage-drop region.

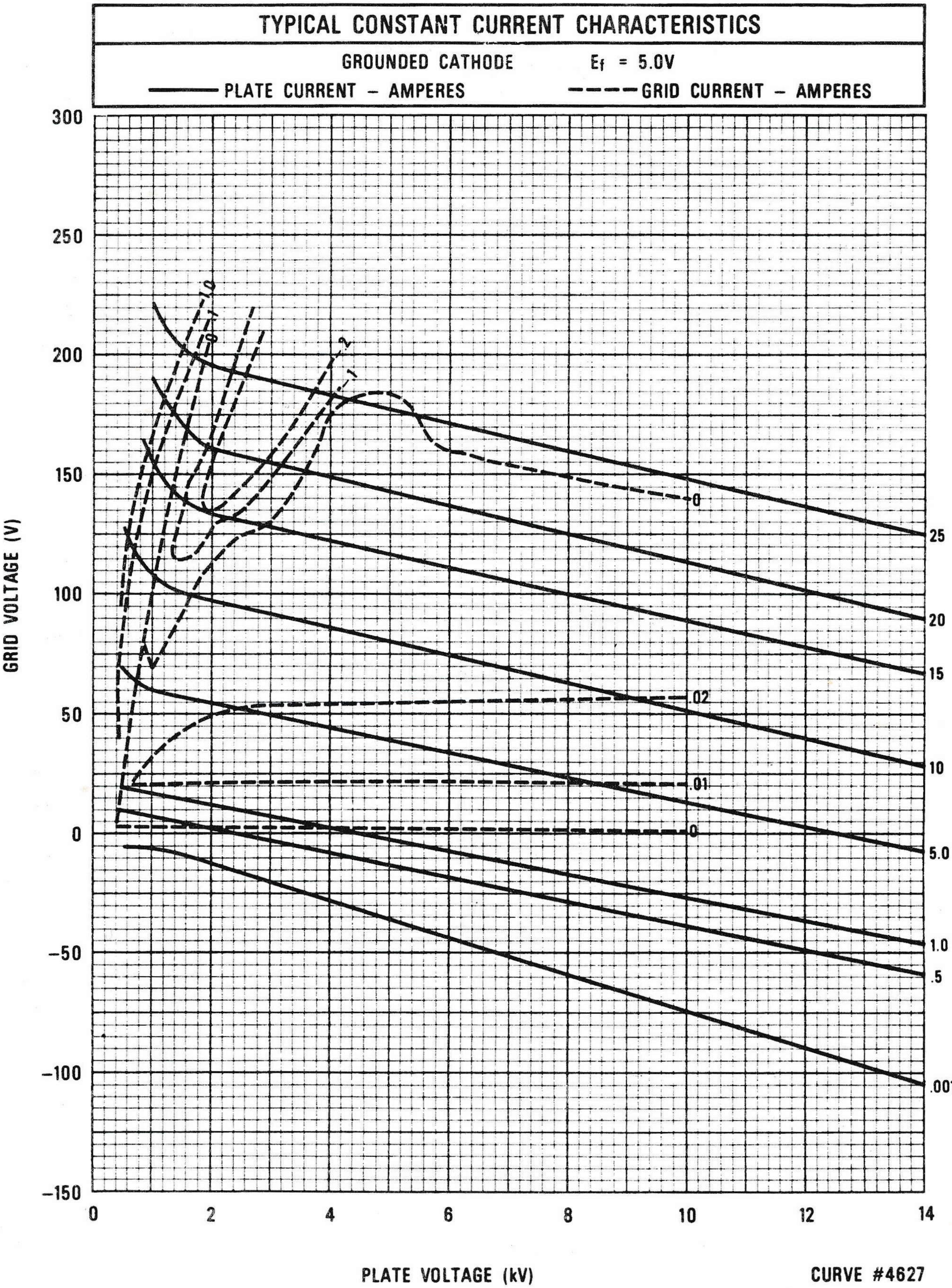
INTERELECTRODE CAPACITANCE: The actual internal interelectrode capacitance of the tube is influenced by many variables in most applications, such as stray capacitance to the chassis, capacitance added by the socket used, stray capacitance between tube terminals, and wiring effects.

To control the actual capacitance values within the tube (as the key component involved) the industry and the military services use a standard test procedure as described in Electronic Industries Ass'n Standard RS-191. This requires the use of specially constructed test fixtures which effectively shield all external tube leads from each other and eliminate any capacitance reading to "ground." The test is performed on a cold tube. Other factors being equal, controlling internal tube capacitance in this way normally assures good interchangeability of tubes over a period of time. Manufacturer's technical data, or test specifications, normally are taken in accordance with Standard RS-191.

The equipment designer is therefore cautioned to make allowance for the actual capacitance values which will exist in any normal application. Measurements should be taken with the socket and mounting which represent approximate final layout if capacitance values are highly significant in the design.

GENERAL: For general application information, please refer to the Planar Triode Operating Instructions booklet. These operating instructions should be consulted prior to the designing of new equipment around this tube type.

For unusual or special applications, consult the nearest Varian Electron Device Group Sales Office, or the product manager, Varian EIMAC, 1678 Pioneer Road, Salt Lake City, Utah 84104; telephone (801) 972-5000.

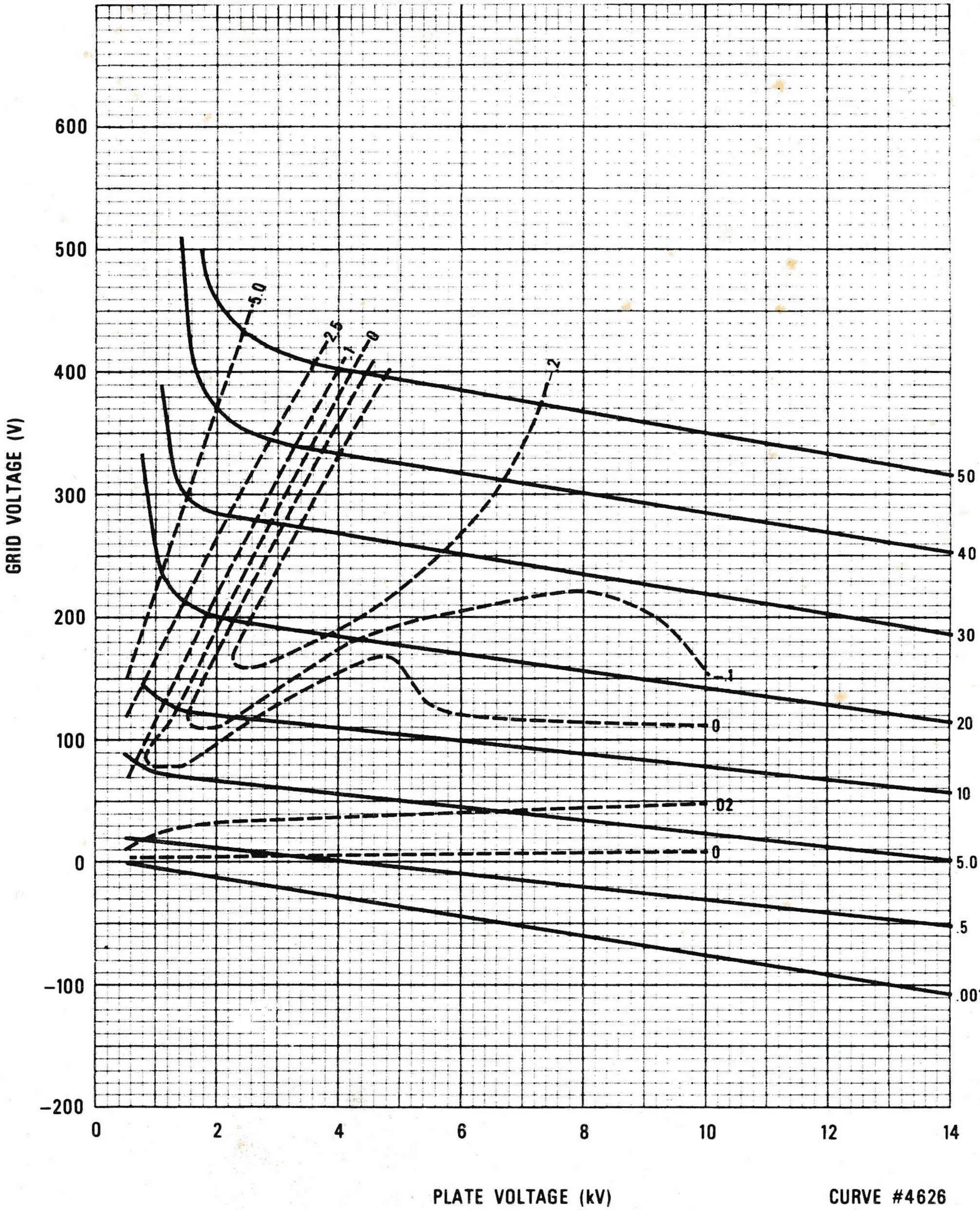

TYPICAL CONSTANT CURRENT CHARACTERISTICS
GROUNDED CATHODE
E_f = 5.0V
PLATE CURRENT – AMPERES
GRID CURRENT – AMPERES
300
250
200
150
100
50
0
−50
−100
−150
GRID VOLTAGE (V)
0
2
4
6
8
10
12
14
PLATE VOLTAGE (kV)
25
20
15
10
5.0
1.0
.5
.001
1.0
0.1
.2
.1
0
.02
.01
0

CURVE #4627

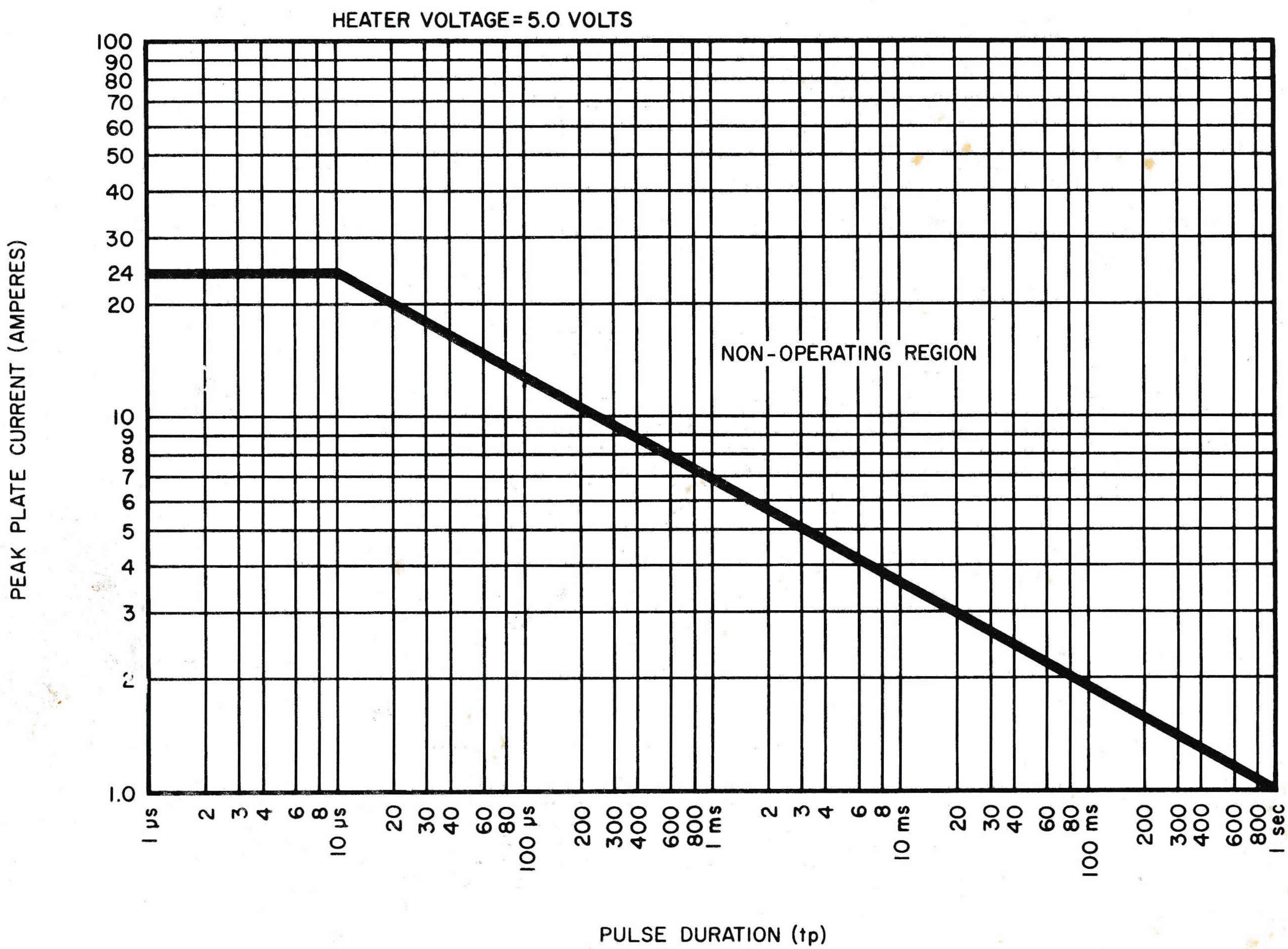
TYPICAL CONSTANT CURRENT CHARACTERISTICS

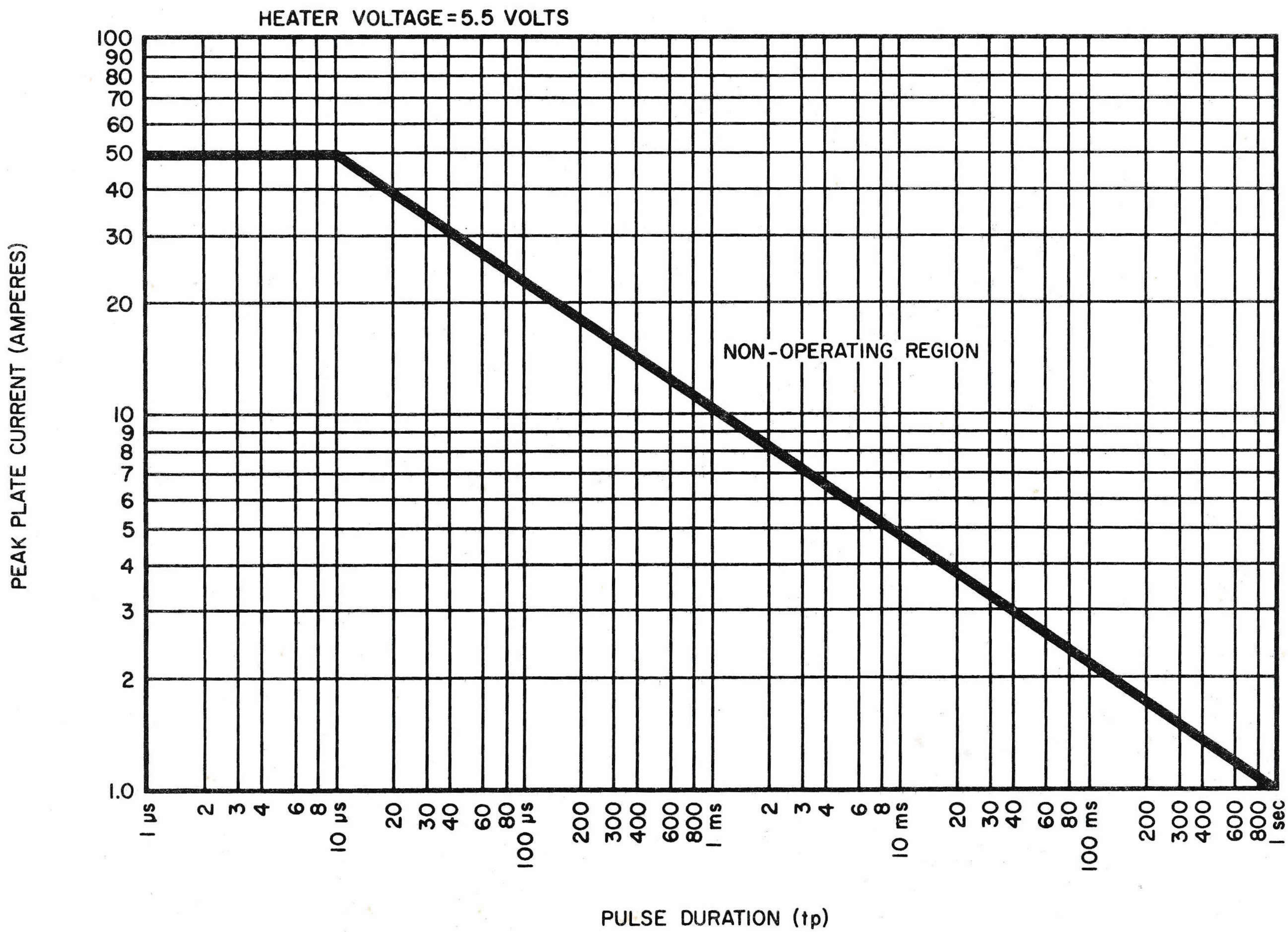
GROUNDED CATHODE $E_f = 5.5V$

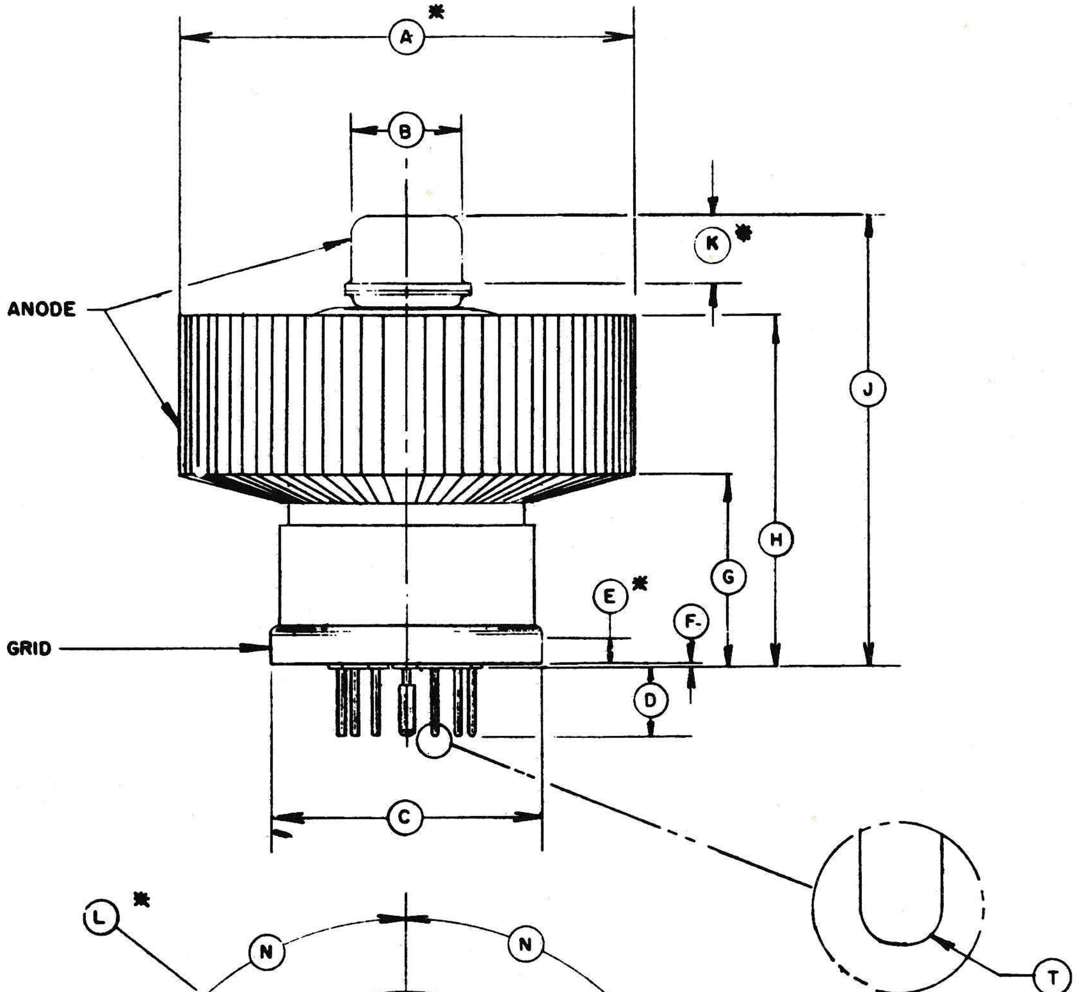
—— PLATE CURRENT – AMPERES   - - - - GRID CURRENT – AMPERES

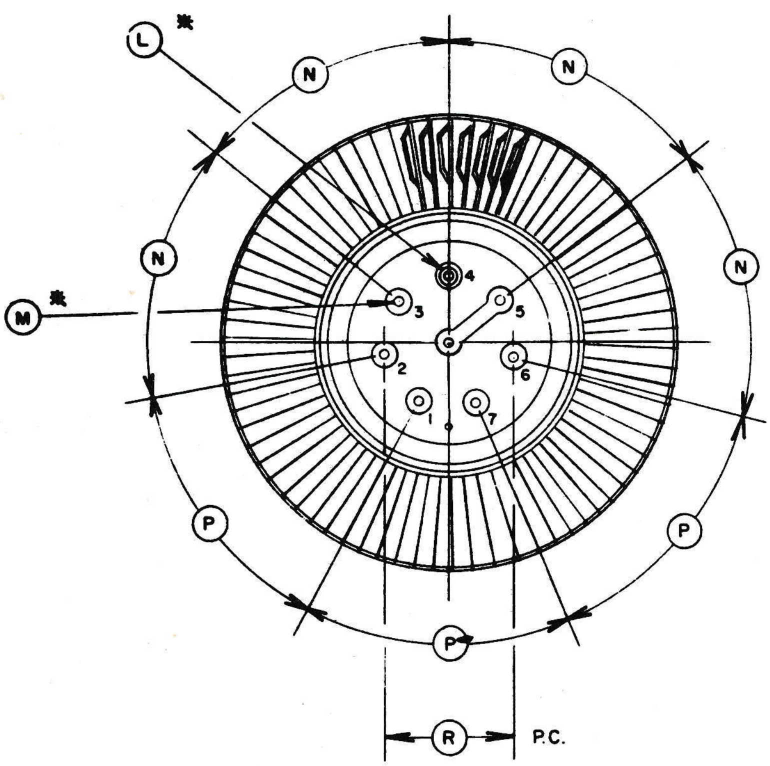


CURVE #4626


HEATER VOLTAGE = 5.0 VOLTS
NON-OPERATING REGION
PEAK PLATE CURRENT (AMPERES)
100
90
80
70
60
50
40
30
24
20
10
9
8
7
6
5
4
3
2
1.0
1 μs
2
3
4
6
8
10 μs
20
30
40
60
80
100 μs
200
300
400
600
800
1 ms
2
3
4
6
8
10 ms
20
30
40
60
80
100 ms
200
300
400
600
800
1 sec
PULSE DURATION (tp)


HEATER VOLTAGE = 5.5 VOLTS
NON-OPERATING REGION
PEAK PLATE CURRENT (AMPERES)
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1.0
1 μs
2
3
4
6
8
10 μs
20
30
40
60
80
100 μs
200
300
400
600
800
1 ms
2
3
4
6
8
10 ms
20
30
40
60
80
100 ms
200
300
400
600
800
1 sec
PULSE DURATION (tp)





PIN CONNECTIONS

1 - HEATER
5 - HEATER
2 - 3 - 4 - 6 - 7 CATHODE

DIMENSIONAL DATA						
DIM	INCHES			MILLIMETERS		
	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.350	3.380	- -	85.09	85.85	- -
B	0.810	0.820	- -	20.57	20.83	- -
C	1.995	2.015	- -	50.67	51.18	- -
D	0.438	0.562	- -	11.13	14.27	- -
E	0.235	- -	- -	5.97	- -	- -
F	0.000	0.040	- -	0.00	1.02	- -
G	1.350	1.475	- -	34.29	37.46	- -
H	2.550	2.675	- -	64.77	67.94	- -
J	3.250	3.420	- -	82.55	86.87	- -
K	0.470	0.530	- -	11.94	13.46	- -
L	0.120	0.127	- -	3.05	3.23	- -
M	0.056	0.062	- -	1.42	1.57	- -
N	- -	- -	51°	- -	- -	51°
P	- -	- -	52°	- -	- -	52°
R	- -	- -	1.000	- -	- -	25.40
T	0.020R	- -	- -	0.51 R	- -	- -

NOTES:

1. REF. DIMENSIONS ARE FOR INFO. ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. * CONTACT SURFACE
3. DIMENSION T APPLIES TO ALL BUT CENTER PIN.