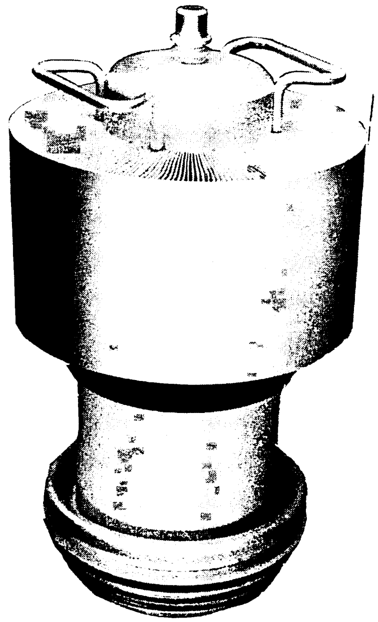
TECHNICAL DATA

Y546
HIGH VOLTAGE TETRODE

The EIMAC Y546 is a ceramic/metal forced-air cooled high voltage power tetrode intended for use in pulse modulator or regulator service. It is rated for 75 kVdc holdoff with a 100 ampere peak cathode current rating.

The forced-air cooled anode is rated at 35 kilowatts dissipation.



GENERAL CHARACTERISTICS[1]

ELECTRICAL

Filament: Thoriated Tungsten		
Voltage	10.0 ± 0.5	V
Current, at 10.0 volts	295	A
Amplification Factor (average)	4.5	
Direct Interelectrode Capacitance (grounded cathode)[2]		
Cin	440	pF
Cout	51	pF
Cgp	2.3	pF
Direct Interelectrode Capacitance (grounded grid)[2]		
Cin	175	pF
Cout	55	pF
Cpk	0.5	pF

1. Characteristics and operating values are based on 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 Electronic Industries Association Standard RS-191.

MECHANICAL

Maximum Overall Dimensions:	
Length	17.34 In; 44.04 cm
Diameter	9.75 In; 24.77 cm
Net Weight	50 lb; 22.7 kg
Operating Position	Vertical, base up or down
Maximum Operating Temperature, Anode Core or Ceramic/Metal Seals	250°C
Cooling	Forced Air
Base	Special, graduated rings
Recommended Air-System Socket	EIMAC SK-1500A or SK-1510A
Available Screen Grid Bypass Capacitor Components	2300 pF - EIMAC P/N 149089
	1100 PF - EIMAC P/N 149090
	Required Set of Insulator Bushings - EIMAC P/N 149088
Available Anode Connector Clip	EIMAC ACC-3

PULSE MODULATOR OR REGULATOR

ABSOLUTE MAXIMUM RATINGS:

DC PLATE VOLTAGE	60	KILOVOLTS
DC SCREEN VOLTAGE	2.5	KILOVOLTS
DC GRID VOLTAGE	-2.0	KILOVOLTS
DC PLATE CURRENT	15	AMPERES
PEAK CATHODE CURRENT	100	AMPERES
PLATE DISSIPATION #	35	KILOWATTS
SCREEN DISSIPATION	1750	WATTS
GRID DISSIPATION	500	WATTS

See PLATE DISSIPATION Application Note

TYPICAL OPERATION:

Plate Supply Voltage	50	kVdc
Plate Voltage During Conduction	3.0	kVdc
Screen Voltage	1500	Vdc
Grid Voltage	-900	Vdc
Plate Current During Pulse	35	a
Screen Current During Pulse *	1.0	a
Grid Current During Pulse	0	a
Peak Power to the Load	1640	kw
Peak Plate Dissipation #	105	kw

* Approximate
Note: See PULSE OPERATION Application Note

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Varian EIMAC / 301 Industrial Way / San Carlos, CA 94070 / U.S.A.

TYPICAL OPERATION values are obtained by calculation from published characteristic curves. To obtain the specified plate current at the specified bias, screen, and plate voltages, adjustment of the rf grid voltage is assumed. If this procedure is followed, there will be little variation in output power when the tube is replaced, even though there may be some variation in grid and screen currents. The grid and screen currents which occur when the desired plate current is obtained are incidental and vary from tube to tube. These current variations cause no performance degradation providing the circuit maintains the correct voltage in the presence of the current variations.

RANGE VALUES FOR EQUIPMENT DESIGN:	MIN.	MAX.	
Filament Current, at 10.0 Volts	280	310	A
Interelectrode Capacitance (grounded cathode connection)[1]			
Cin	410	470	pF
Cout	46	56	pF
Cgp	1.5	3.2	pF
Interelectrode Capacitance (grounded grid connection)[1]			
Cin	155	195	pF
Cout	50	60	pF
Cpk	---	0.6	pF

1 Measured in a specially shielded fixture in accordance with EIA Standard RS-191.

A P P L I C A T I O N

MECHANICAL

STORAGE - Any tube with a thoriated tungsten filament should always be protected from undue shock and vibration and if not installed in equipment should always be stored in its protective packing material in its shipping container.

MOUNTING - The Y546 must be operated with its axis vertical, base up or down at the option of the equipment designer.

SOCKET - The EIMAC air-system sockets SK-1500A and SK-1510A have been designed especially for the concentric base terminals of the Y546. The SK-1510A includes a tube seating & locking device. Special screen bypass capacitor dielectrics are available and the EIMAC part numbers are shown on Page 1.

COOLING - The maximum temperature rating for the external surfaces of the tube is 250°C. Sufficient forced-air cooling must be provided to maintain the anode at the base of the cooling fins, and the ceramic/metal seals, below 250°C.

Air flow requirements to maintain anode core temperature at 225°C with 40°C ambient cooling air are tabulated below (for operation below 30 MHz). This data is for flow in the base-to-anode direction; pressure drop figures are in inches of water, are for the anode cooler only, and are approximate.

	SEA LEVEL		10,000 FEET	
Plate Diss. (watts)	Air Flow (cfm)	Press. Drop	Air Flow (cfm)	Press. Drop
15,000	440	1.0	635	1.5
20,000	650	2.0	935	2.9
25,000	975	3.8	1400	5.5
30,000	1300	6.0	1870	8.6
35,000	1760	9.6	2535	13.8

The blower selected in any given application must be capable of supplying the desired air flow at a back pressure equal to the pressure drop shown above plus any drop(s) encountered in ducts and filters.

Separate cooling of the tube base is required and is accomplished by directing approximately 120 cfm of air horizontally through the socket from the side. It is preferable to direct this air through three equally spaced ducts.

The well in the center of the baseplate of the tube is a critical area which requires cooling to maintain envelope temperatures less than 250°C. For most applications, 1 to 2 cfm of air directed through the center of the socket is sufficient.

At other altitudes and ambient temperatures the flow rate must be modified to obtain equivalent cooling. The flow rate and corresponding pressure differential must be determined individually in such cases. The designer is reminded that it is considered good engineering practice to allow some safety factor so the tube is *not* operated at the absolute maximum temperature rating. Temperature sensitive paints are available for testing before any equipment design is finalized, and Application Bulletin #20 titled TEMPERATURE MEASUREMENTS WITH EIMAC POWER TUBES is available on request.

Air flow must be applied before or simultaneously with the application of power, including the tube filament, and should normally be maintained for a short period of time after power is removed to all for tube cooldown.

ELECTRICAL

ABSOLUTE MAXIMUM RATINGS - Values shown for each type of service are based on the "absolute system" and are not to be exceeded under any service conditions. These ratings are limiting values outside which serviceability of the tube may be impaired. In order not to exceed absolute ratings the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by a safety factor so that the absolute values will never be exceeded under any usual conditions of supply-voltage variation, load variation, or manufacturing variation in the equipment itself. It does not necessarily follow that combinations of absolute maximum ratings can be attained simultaneously.

HIGH VOLTAGE - Normal operating voltages used with this tube are deadly, and the equipment must be designed properly and operating precautions must be followed. Design all equipment so that no one can come in contact with high voltages. All equipment must include safety enclosures for high-voltage circuits and terminals, with interlock switches to open primary circuits of the power supply and to discharge high-voltage capacitors whenever access doors are opened. Interlock switches must not be bypassed or "cheated" to allow operation with access doors open. Always remember that HIGH VOLTAGE CAN KILL.

FILAMENT OPERATION - During turn-on the filament inrush current should be limited to 650 amperes.

At rated (nominal) filament voltage the peak emission capability of the tube may be many times that needed for the intended service. A reduction in voltage will lower the filament temperature, which will substantially increase life expectancy. The correct value of filament voltage should be determined for the particular application. It is recommended the tube be operated at full nominal voltage for an initial stabilization period of 100 to 200 hours before any action is taken to operate at reduced voltage. The voltage should gradually be reduced until there is a slight degradation in performance (such as output distortion). Voltage should then be increased a few tenths of a volt above the value where performance degradation was noted for operation. The operating point should be rechecked after 24 hours.

Filament voltage should be closely regulated when voltage is to be reduced below nominal in this manner, to avoid any adverse influence by normal line voltage variations.

Filament voltage should be measured at the tube base or socket, using an accurate rms-responding meter. This tube is designed for only one off/on filament cycle per day. If additional cycling is anticipated it is recommended the user contact Application Engineering at EIMAC.

BASE PLATE VOLTAGE - Any difference in potential between the base plate and the tube filament must be limited to 100 volts (peak).

GRID OPERATION - The maximum control grid dissipation is 500 watts, determined approximately by the product of the dc grid current and the peak positive grid voltage. A protective spark-gap device should be connected between the grid and the cathode to guard against excessive voltage.

SCREEN OPERATION - Maximum dissipation is 1750 watts. With no ac applied, dissipation is simply the product of dc screen voltage and the dc screen current. Plate voltage or bias voltage must never be removed while filament and screen voltages are present, since screen dissipation ratings will be exceeded. A protective spark-gap device should be connected between the screen grid and the cathode to guard against excessive voltage.

PLATE DISSIPATION - The anode is nominally rated for 35 kilowatts of dissipation capability. Average anode dissipation may be calculated as the product of pulse anode current, pulse tube-voltage drop during conduction, and the duty factor. The actual dissipation may often exceed the calculated value if pulse rise and fall times are appreciable compared to pulse duration. This occurs because long rise and fall times slow down plate voltage swing and allow plate current flow for a longer period in the high tube-voltage-drop region.

PULSE OPERATION - The thermal time constants of the internal tube elements vary from a few milliseconds in the case of the grids to about 200 milliseconds for the anode. For pulse lengths in excess of these thermal time constants, dissipations should be conidered as CW values.

In many applications the meaning of duty as applied to a pulse chain is lost because the interpulse period is very long. For pulse lengths greater than 10 milliseconds, where the interpulse period is more than 10 times the pulse duration, the element dissipations and required cooling are governed by the watt-seconds during the pulse. Provided the watt-seconds are less than the listed maximum dissipation rating and sufficient cooling is supplied, tube life will be protected.

FAULT PROTECTION - In addition to the normal plate over-current interlock, screen current interlock, and coolant interlock, the tube must be protected from internal damage caused by an internal plate arc which may occur at high plate voltage. A protective resistance should always be connected in series with each tube anode, to help absorb power supply stored energy if an internal arc should occur. An electronic crowbar, which will discharge power supply capacitors in a few microseconds after the start of an arc, is recommended. The protection criteria for each electrode supply is to short each electrode to ground, one at a time, through a vacuum relay switch and a 6-inch length of #30 AWG copper wire. The wire will remain intact if the protection is adequate.

EIMAC Application Bulletin #17 titled FAULT PROTECTION contains considerable detail; it is available on request.

X-RADIATION HAZARD - High-vacuum tubes operating at voltages higher than 15 kilovolts 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 source. Only limited shielding is afforded by the tube envelope. Moreover, the X-radiation level may increase significantly with tube aging and gradual deterioration, due to leakage paths or emission characteristics as they are effected by the high voltage. X-ray shielding may be required on all sides of tubes operating at these voltages to provide adequate protection throughout the life of the tube. Periodic checks on the X-ray level should be made, and the tube should never be operated without required shielding in place. If there is any question as to the need for or the adequacy of shielding, an expert in this field should be contacted to perform an equipment X-ray survey.

In cases where shielding has been found to be required operation of high voltage equipment with interlock switches "cheated" and cabinet doors open in order to be better able to locate an equipment malfunction can result in serious X-ray exposure.

INTERELECTRODE CAPACITANCE - The actual internal interelectrode capacitance of a 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 Military Services use a standard test procedure as described in Electronic Industries Association Standard RS-191. This requires use of a specially constructed test fixture which shields all external tube leads or contacts from each other and eliminates 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. The capacitance values shown in the technical data 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 the application. Measurements should be taken with the mounting which represents approximate final layout if capacitance values are highly significant in the design.

SPECIAL APPLICATIONS - When it is desired to operate this tube under conditions widely different from those listed here, write to Varian EIMAC; attn: Applications Engineering; 301 Industrial Way; San Carlos, CA 94070 U.S.A.

OPERATING HAZARDS

PROPER USE AND SAFE OPERATING PRACTICES WITH RESPECT TO POWER TUBES ARE THE RESPONSIBILITY OF EQUIPMENT MANUFACTURERS AND USERS OF SUCH TUBES. ALL PERSONS WHO WORK WITH OR ARE EXPOSED TO POWER TUBES OR EQUIPMENT WHICH UTILIZES SUCH TUBES MUST TAKE PRECAUTIONS TO PROTECT THEMSELVES AGAINST POSSIBLE SERIOUS BODILY INJURY. DO NOT BE CARELESS AROUND SUCH PRODUCTS.

The operation of this tube may involve the following hazards, any one of which, in the absence of safe operating practices and precautions, could result in serious harm to personnel:

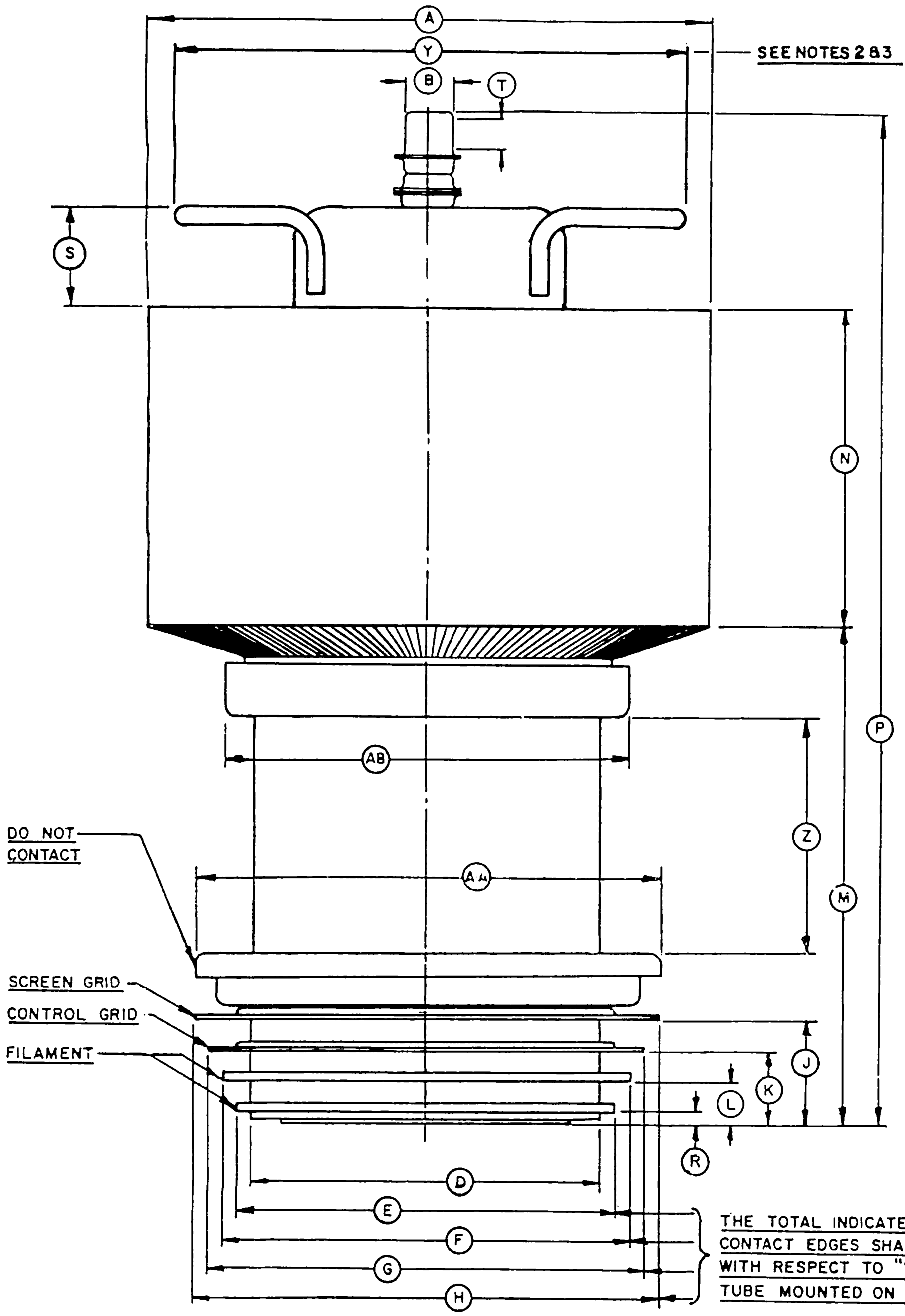
a. HIGH VOLTAGE - Normal operating voltages can be deadly. Remember that HIGH VOLTAGE CAN KILL.

b. LOW-VOLTAGE HIGH-CURRENT CIRCUITS - Personal jewelry, such as rings, should not be worn when working with filament contacts or connectors as a short circuit can produce very high current and melting, resulting in severe burns.

c. X-RAY RADIATION - High-voltage pulse modulator tubes are a potential source of dangerous X-Ray radiation and shielding may be required on all sides of the tube. A survey may be required by an expert in this field.

d. HOT SURFACES - Surfaces of tubes can reach temperatures of several hundred °C and cause serious burns if touched for several minutes after all power is removed.

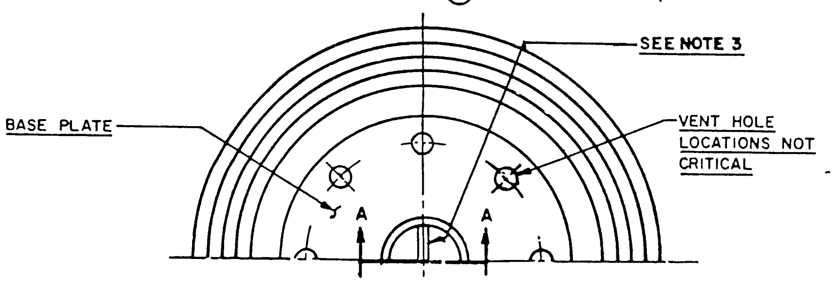
Please review the detailed operating hazards sheet enclosed with each tube, or request a copy from: Varian EIMAC, Power Grid Application Engineering, 301 Industrial Way, San Carlos CA 94070.

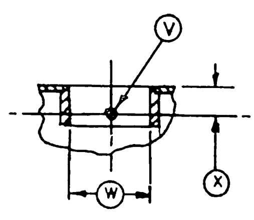


DIMENSIONAL DATA				
DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	9.500	9.750	241.30	247.65
B	0.860	0.890	21.84	22.60
D	5.980	6.020	151.89	152.91
E	6.510	6.560	165.35	166.62
F	6.980	7.020	177.29	178.31
G	7.480	7.520	189.99	191.01
H	7.975	8.015	202.57	203.58
J	1.750	1.800	44.45	45.72
K	1.220	1.270	30.99	32.26
L	0.690	0.740	17.53	18.80
M	8.442	8.692	214.43	220.78
N	5.375	5.625	136.52	142.88
P	17.070	17.340	433.58	440.44
R	0.173	0.213	4.40	5.41
S	1.750		44.45	
T	0.485	0.515	12.32	13.08
V	— —	0.135	— —	3.43
W	1.250	1.270	31.75	32.26
X	0.490	0.530	12.45	13.46
Y	— —	8.750	— —	222.25
Z	3.750		95.25	
AA	8.000		203.20	
AB	6.875		174.63	

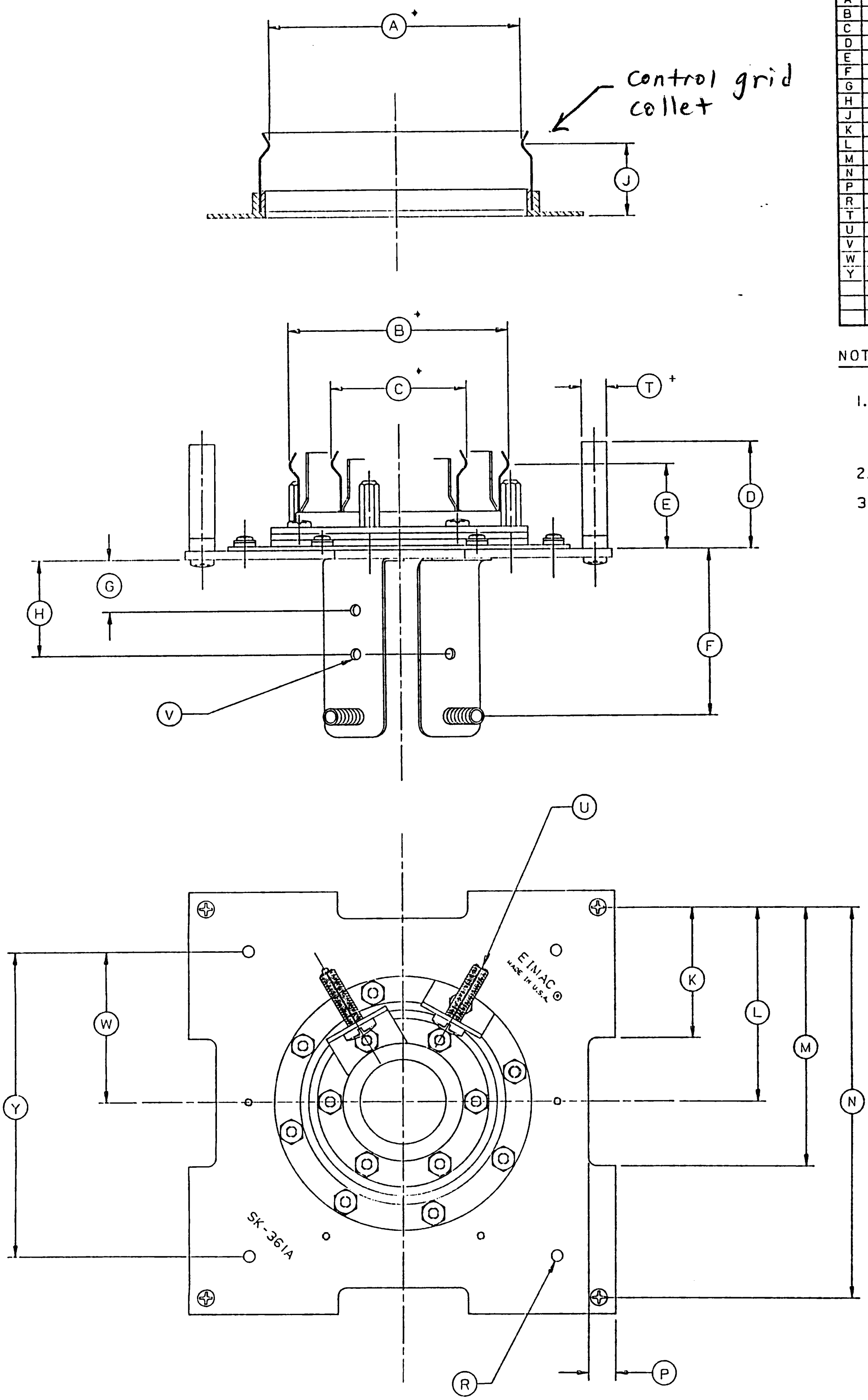
NOTES:

1. REFERENCE DIMENSIONS ARE FOR INFORMATION ONLY AND ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. DIM. Y IS MAXIMUM DIA. ACROSS CORNERS
3. HANDLE LATERAL AXIS ORIENTATION WITH BASE LOCK PIN IS AS SHOWN.





SECTION A–A



DIMENSIONAL DATA						
	INCHES			MILLIMETERS		
DIM.	MIN.	MAX.	REF.	MIN.	MAX.	REF.
A	3.672	3.372				
B	3.200	3.270				
C	2.001	2.061				
D			1.563			
E	1.222	1.272				
F			2.434			
G			.844			
H			1.494			
J			1.093			
K			1.925			
L			2.875			
M			3.825			
N			5.750			
P			.400			
R			.173 DIA.			
T			.375			
U			#1/4-20 THD.			
V			.166 DIA.			
W			2.250			
Y			4.500			

NOTES:

1. REF. DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.
2. + CONTACT DIMENSIONS.
3. + SOCKET MUST BE ACCOMPANIED BY 4 ADDITIONAL STANDOFFS & SPACERS WITH 1/2" O.D.

LTR	DESCRIPTION OF CHANGE	SCO	DATE	BY
	DRAWN ON CAD/CAM:ENTER IN SCO SYSTEM	20619	3/24/87	MH/

DRAWN: MARK II 3/24/87 — ENGR APPR: — CHK'D: 3/25/87 — SUPERSEDES: — SCALE: NONE

EIMAC, DIVISION OF VARIAN, SAN CARLOS, CALIFORNIA

CODE IDENT NO. 06980

PART NO. SK361A-60

OUTLINE: ELECTRON TUBE

NO. SK361A-60