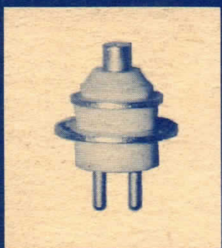
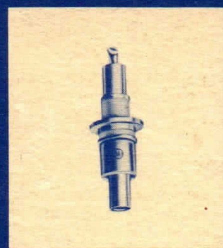
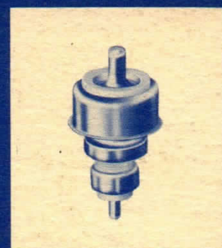
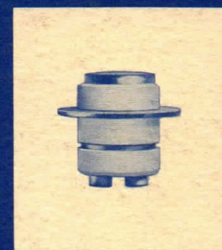
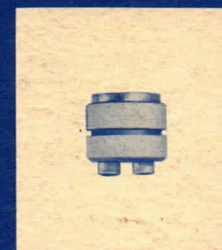
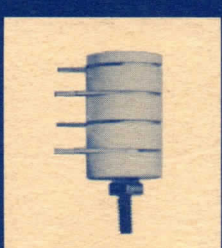
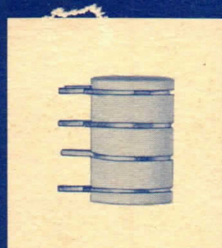
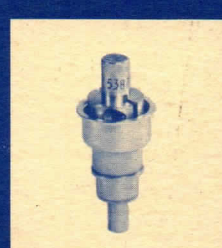
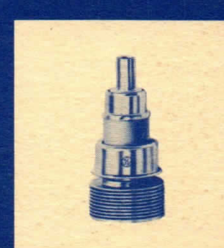
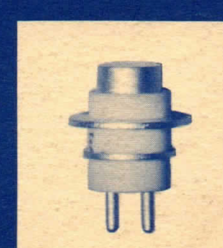
GENERAL ELECTRIC

Reference Data General Electric Ceramic Tubes

$5

Reference Data For General Electric Ceramic Tubes

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

Published January, 1965

FORWARD

This publication contains published data sheets and application notes on General Electric Ceramic tube types. Thirty-one of these types are registered EIA types, and are available from stock. Seventeen are developmental types and are available from stock or with several weeks lead time.

This line of tubes represent the state of the art in many areas. Major advantages offered by various types are as follows:

- Small Size
- Low Noise
- High Gain
- Large Gain-Band Width Products
- Operation to C and X Band
- High Temperature Tolerance, 400-500° C
- Tolerance to Shock and Vibration
- Radiation Resistance
- Long Pulse Ratings
- High Pulsed Duty Factors

These devices compete favorably in many applications with low power klystrons, TWT's, parametric amplifiers, varactors, and transistors.

This publication is revised periodically, but supplements are not distributed between publications. For the latest information on new developments or applications of General Electric Ceramic tubes, contact our Regional OEM Sales Manager in your area, or a franchised General Electric Industrial Tube Distributor.

RESEARCH AND DEVELOPMENT AREAS

1. High Current Density Cathodes
2. Lower Heater Power Designs
3. Fast Warm-Up Heater-Cathode Structures
4. High Dissipation Anodes
5. X Band (10 Gc.) CW and Pulse Triodes
6. Integral Tube-Cavity Microwave Oscillators
7. Tunnel Emission Cathodes
8. Radiation Environment Performance Evaluation

OTHER USES FOR CERAMIC TUBES

- Frequency Multipliers
- RF Power Source For Varactor Multipliers
- Microwave Mixers and Detectors
- Doppler Radars For Traffic Control and Motion Detection
- Broadband Amplifiers
- Video Amplifiers
- Audio, Servo, and Sub-Audio Amplifiers
- High-Voltage Rectifiers
- High-Voltage Regulators
- Microwave Modulators

CONTENTS

DATA FOR REGISTERED TYPES

DATA FOR DEVELOPMENTAL TYPES

SOCKETS AND CAVITIES

GENERAL TECHNICAL INFORMATION

General Electric

CERAMIC TUBE SELECTION CHART

Classification	Type	Approx. Envelope Diameter	Type of Terminals	Maximum Ratings Plate Dissipation (Watts)	Current (milliamperes)	G_m	u	Typical Application	Useful Frequencies Extend to **
Triode - Class A Operation	2C40*	1.3"	Octal	6.5Δ	$I_b = 25$	4850	36	UHF Amp.	3000 mc
	2C40A*	1.3"	Octal	6.5Δ	$I_b = 25$	5100	35	UHF Amp.	3000 mc
	6299	0.5"	Coax.	2.0Δ	$I_b = 12$	15000	110	Low-Noise UHF Amp.	3000 mc
	6771	0.5"	Coax.	6.25Δ	$I_b = 25$	23000	90	UHF Amp.	4000 mc
	7077	0.3"	Coax.	1.0	$I_k = 10$	10000	90	Low-Noise UHF Amp.	3000 mc
	7296	0.5"	Lug (T)	5.5	$I_k = 30$	16500	90	VHF Amp.	500 mc
	7462	0.3"	Lug	1.0	$I_k = 10$	10500	94	Low-Noise VHF Amp.	500 mc
	7588	0.5	Lug (T)	5.5	$I_k = 30$	45000	175	Low-Noise VHF Amp.	500 mc
	7625	0.3"	Lug	0.8	$I_k = 3.6$	1400	80	Low-Level AF Amp.	-------
	7644	0.5"	Coax.	2.0	$I_b = 12$	15000	110	Low-Noise UHF Amp.	3000 mc
	7768	0.5"	Coax.	5.5	$I_k = 30$	50000	225	Low-Noise VHF Amp.	3000 mc
	7784	0.5"	Coax.	2.0Δ	$I_b = 12$	15000	110	Low-Noise UHF Amp.	3000 mc
	8081	0.3"	Lug (T)	0.8	$I_k = 3.6$	1400	80	Low-Level AF Amplifier	-------
	8083	0.3"	Lug (T)	1.0	$I_k = 10$	10500	94	Low-Noise VHF Amp.	500 mc
	Y-1032	0.3"	Coax.	0.6	$I_k = 10$	10000	36	Low-mu, Low Plate Voltage Osc., Amp., or Mult.	3000 mc
	Z-2354	1.0"	Lug	12	$I_k = 100$	4300	8	Servo Power Amp.	-------
	Z-2835	0.5"	Coax.	5.5	$I_k = 30$	16500	90	UHF Amp.	3000 mc
Triode - Class B or C Operation	2C39B	1.3"	Coax.	100Δ	$I_k = 125$	24800	95	UHF Power Amp. Osc., or Freq. Mult.	2500 mc
	2C40A*	1.3"	Octal	6.5Δ	$I_b = 25$	5100	35	UHF Power Amp. or Osc.	3000 mc
	2C43*	1.3"	Octal	12Δ	$I_b = 40$	8100	50	UHF Power Amp. or Osc.	3000 mc
	3CX100A5	1.3"	Coax.	100Δ	$I_k = 125$	25000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	6442	0.5"	Coax.	8.0Δ	$I_b = 35$	16500	50	UHF Power Amp., Osc., or Freq. Mult.	5000 mc
	6771	0.5"	Coax.	6.25Δ	$I_b = 25$	23000	90	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	6897	1.3"	Coax.	100Δ	$I_k = 125$	24800	95	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	7289	1.0"	Coax.	100Δ	$I_k = 125$	25000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	7296	0.5"	Lug (T)	5.5	$I_k = 30$	16500	90	VHF Power Amp., Osc., or Freq. Mult.	500 mc
	7391	0.5"	Coax.	2.25Δ	$I_b = 15$	11000	62	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	7486	0.3"	Coax.	1.0	$I_k = 10$	10500	90	UHF Power Amp., Osc. or Freq. Mult.	3000 mc
	7720	0.3"	Lug	1.0	$I_k = 10$	10500	90	VHF Power Amp., Osc., or Freq. Mult.	500 mc
	7913	0.5"	Coax.	5.5	$I_k = 30$	40000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	8082	0.3"	Lug (T)	1.0	$I_k = 11$	10500	90	VHF Power Amp., Osc., or Freq. Mult.	500 mc
	A-0897	1.0"	Coax.	7.0Δ	$I_k = 100$	24800	95	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Y-1223	0.5"	Coax.	30.0	$I_k = 100$	40000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Y-1251	0.3"	Coax.	2.5	$I_p = 20$	13500	65	UHF Power Amp., Osc., or Freq. Mult.	6000 mc
	Y-1266	0.3"	Coax.	4.0	$I_k = 40$	8000	35	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Z-2835	0.5"	Coax.	5.5	$I_k = 30$	16500	90	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Z-5099A	1.6"	Coax.	100Δ	$I_k = 125$	24000	100	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
	Z-5317	0.5"	Coax.	8.0Δ	$I_b = 35$	16500	50	UHF Power Amp., Osc., or Freq. Mult.	5000 mc
	Z-5387	1.2"	Coax.	10Δ	$I_k = 125$	24800	95	UHF Power Amp., Osc., or Freq. Mult.	3000 mc
Tetrode - Class B or C Operation	Z-5267	1.8"	Coax.	140Δ	$I_k = 200$	60000	60 ($g_1 - g_2$)	UHF Power Amp. or Osc.	3000 mc

*Glass - Metal lighthouse tube.

**The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.

(T) Provision is made for mounting with T-bolt.

Δ At this dissipation level, anode cooling is usually necessary to prevent exceeding maximum permissible seal temperature.

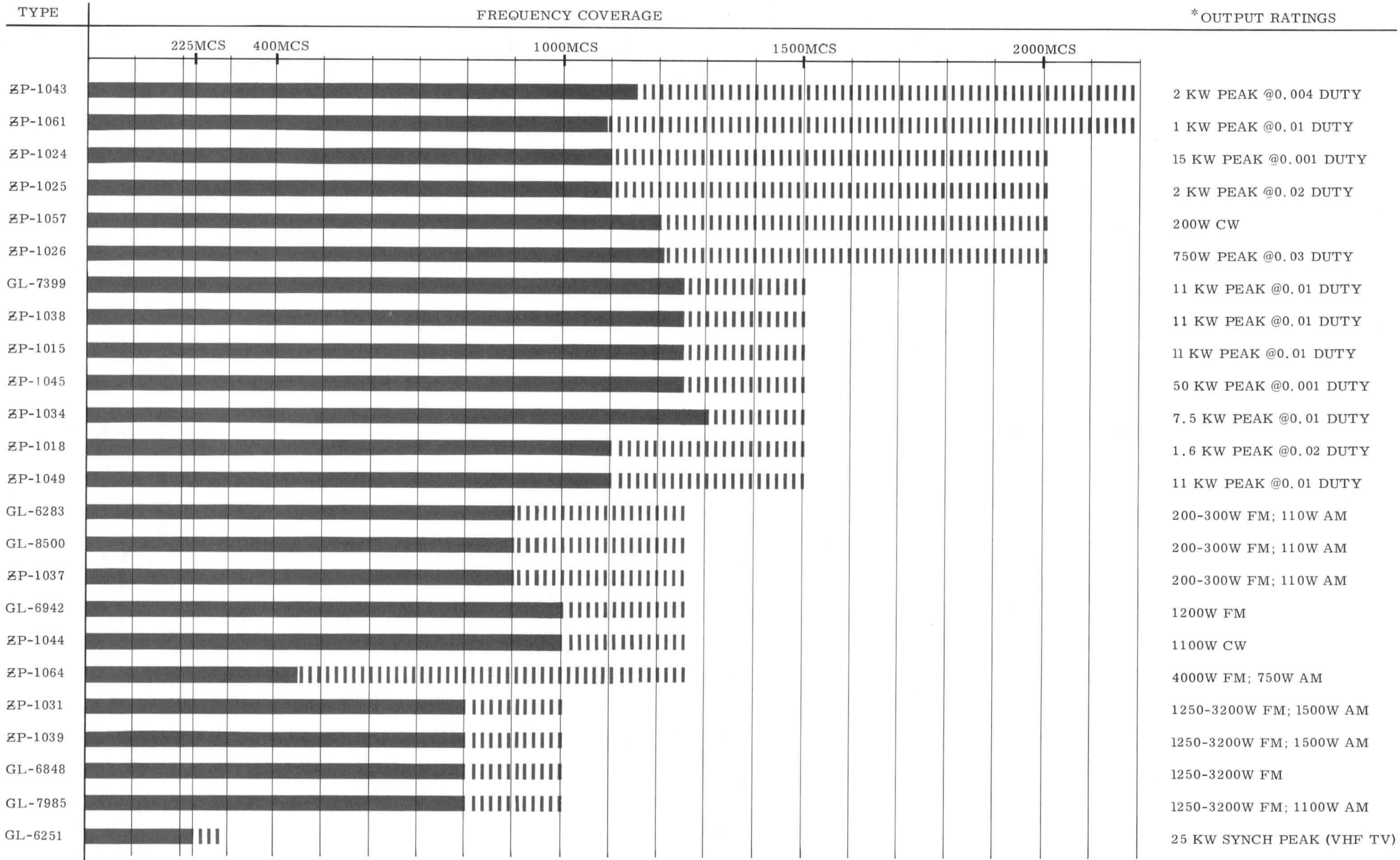
General Electric

CERAMIC TUBE SELECTION CHART

Classification	Type	Approx. Envelope Diameter	Type of Terminals	Maximum Ratings: Plate Dissipation (Watts)	Maximum Ratings: Current (milliamperes)	G_m	u	Typical Application	Useful Frequencies Extend to **
Triode Pulse Operation	2C40A*	1.3"	Octal	4.0Δ	$\hat{I}_p$ = 2000	5100	35	Pulsed Osc. or Amp.	3000 mc
	2C43	1.3"	Octal	6.0Δ	$\hat{I}_p$ = 2750	8100	50	Pulsed Osc. or Amp.	3370 mc
	6442	0.5"	Coax.	7.5Δ	$\hat{I}_p$ = 2500 $\hat{I}_g$ = 1250	16500	50	Pulsed Osc. or Amp.	6000 mc
	6771	0.5"	Coax.	5.0Δ	$\hat{I}_p$ = 1250 $\hat{I}_g$ = 700	23000	90	Pulsed Osc. or Amp.	6000 mc
	7815	1.2"	Coax.	10.0Δ	$\hat{I}_p$ 3000 $\hat{I}_g$ 1500			Pulsed Osc. or Amp.	3000 mc
	7910	0.3"	Coax.	1.5	$\hat{I}_p$ 600	16000	75	Pulsed Oscillator	7500 mc
	7911	0.5"	Coax.	6.5	$\hat{I}_p$ 2500	25000	58	Pulsed Osc. or Amp.	6000 mc
	Y-1124	0.3"	Coax.	2.6	$\hat{I}_p$ 400 $\hat{I}_g$ 100	12000	75	Pulsed Osc. or Amp.	6000 mc
	Y-1236	0.5"	Coax.	30.0Δ	$\hat{I}_p$ 2000	27000	55	Pulsed Oscillator	6000 mc
	Z-5387	1"	Coax.	10.0	$\hat{I}_k$ 3000	24800	95	Pulsed Osc. or Amp.	3000 mc
Diode Signal	2B22*	1.3"	Octal.	Tube Voltage Drop: 6.0 Volts @ I_b = 20 milliamperes I_b = 20 milliamperes maximum				Signal Detector	1500 mc
	7266	0.3"	Coax.	Tube Voltage Drop: 1 Volt @ I_b = 1.0 milliamperes I_b = 2 milliamperes maximum				Instrument Detector	3000 mc
	7841	0.3"	Coax.	Tube Voltage Drop: 2.6 Volts @ I_b = 5.0 milliamperes I_b = 5 milliamperes maximum				Signal Detector	3000 mc
	Y-1012	0.3"	Lug (T)	Tube Voltage Drop: 2.6 Volts @ I_b = 5.0 milliamperes I_b = 5 milliamperes maximum				Signal Detector	1500 mc
Diode Power	Z-2689	0.5"	Lug (T)	Tube Voltage Drop: 18 Volts @ I_b = 40 milliamperes I_b = 25 milliamperes maximum				Low Current Power Rectifier	-------
	Z-2731	1"	Lug (T)	Tube Voltage Drop: 20 Volts @ I_b = 120 milliamperes I_b = 70 milliamperes maximum				Power Rectifier	-------
Diode Cold-Cathode	Z-2692	0.5"	Lug (T)	Tube Voltage Drop: 88 Volts @ I_b = 5 milliamperes I_b = 1 milliampere minimum 10 milliamperes maximum				Voltage Reference	-------

* Glass - Metal lighthouse tube.
** The frequency listed is one at which significant application data are available or expected, and does not necessarily represent an absolute frequency limit.
(T) Provision is made for mounting with T-bolt.
Δ At this dissipation level, anode cooling is usually necessary to prevent exceeding maximum permissible seal temperature.

Power-Frequency Chart for Metal-Ceramic Triodes & Tetrodes



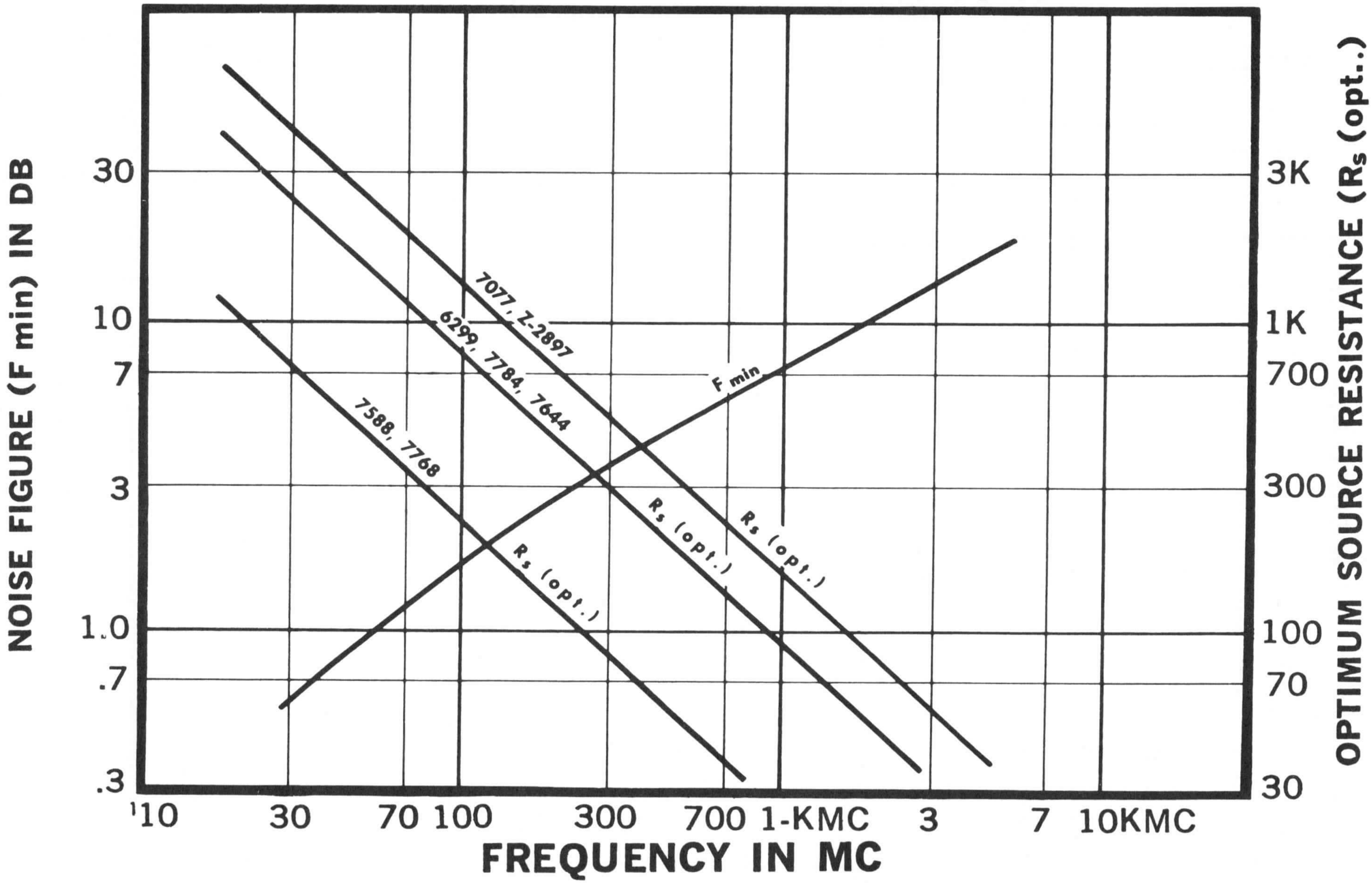
* RATINGS DO NOT INDICATE COMPLETE TUBE CAPABILITY: FOR PARTICULAR APPLICATION REQUIREMENTS REFER TO TUBE MANUFACTURER

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

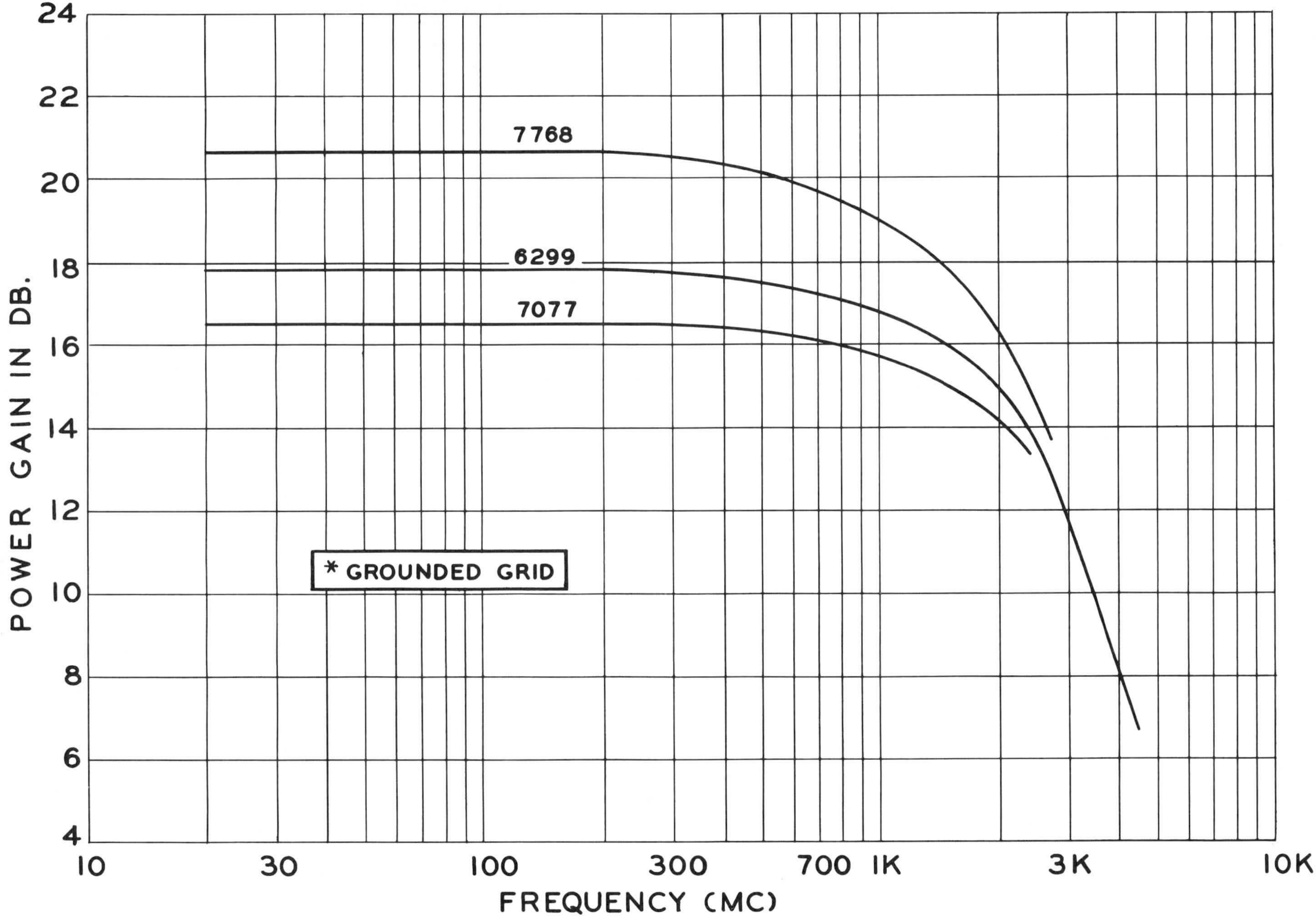
OPTIMUM NOISE CONDITIONS



It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

(FOR FURTHER DETAILS SEE ARTICLE ON NOISE IN THE GENERAL TECHNICAL INFORMATION SECTION)

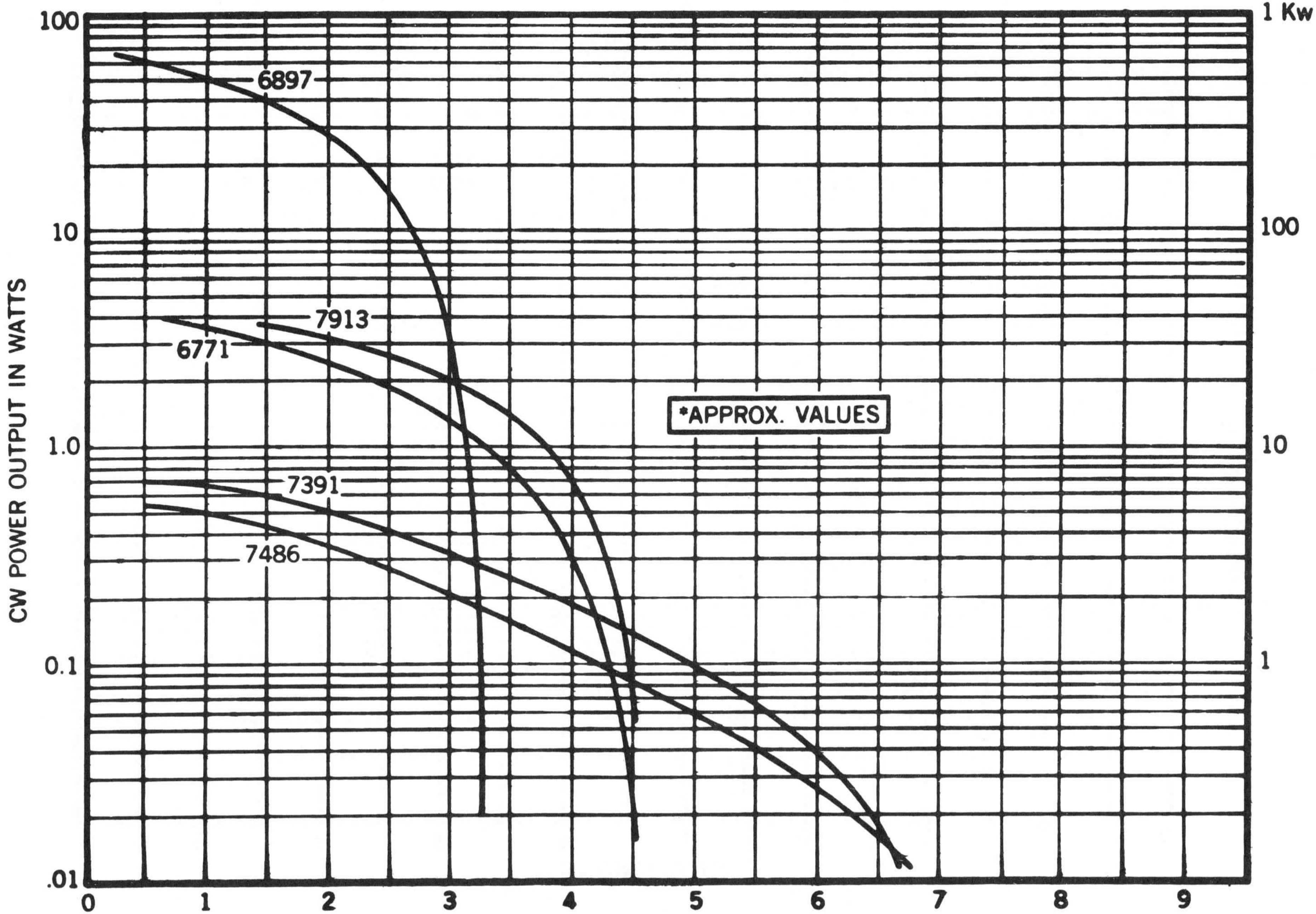
SMALL SIGNAL TRIODE GAIN*



OPERATING FREQUENCY

It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

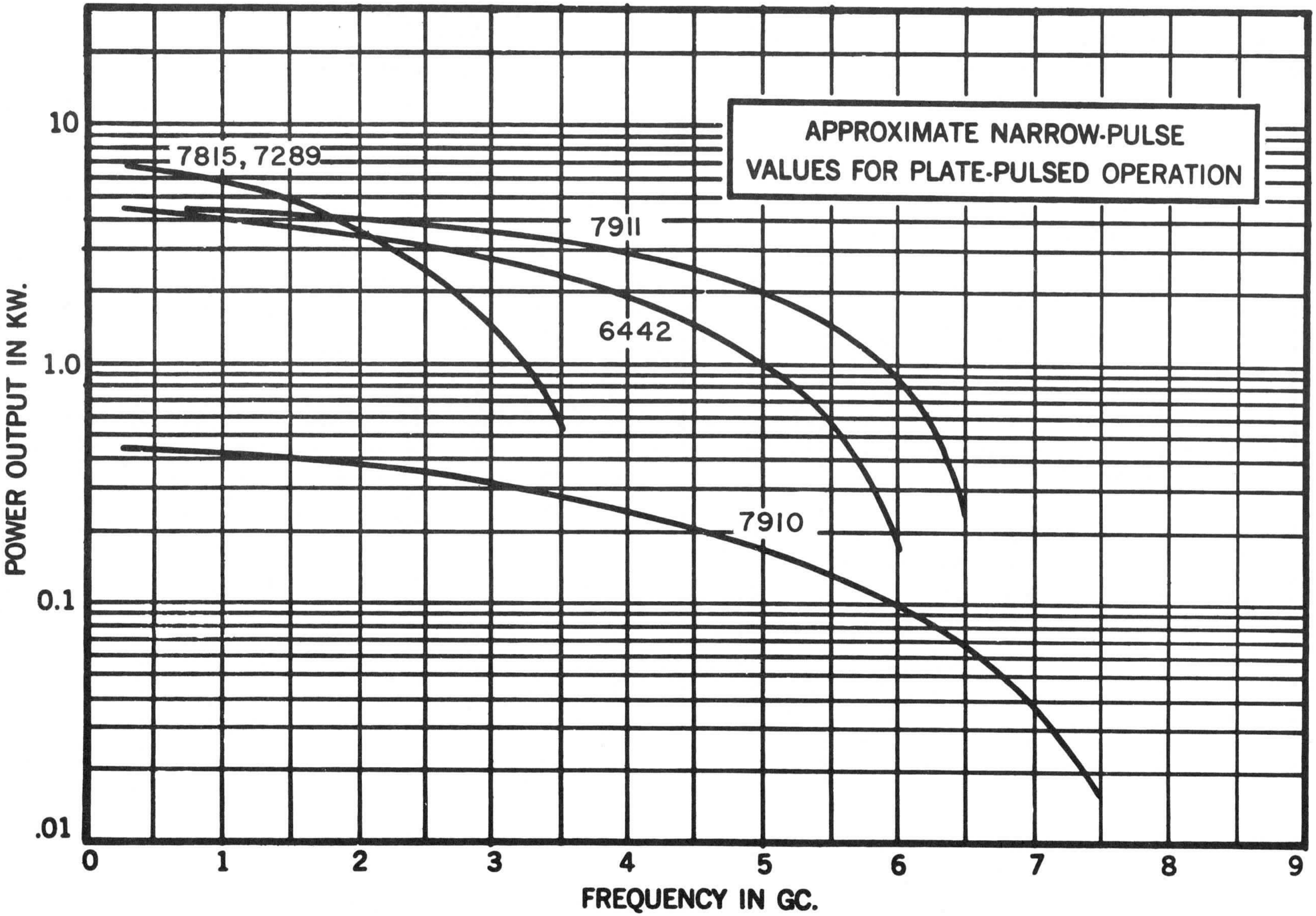
POWER OUTPUT VS. FREQUENCY*



USEFUL POWER OUTPUT - WATTS

It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

PULSE POWER OUTPUTS



PULSE POWER OUTPUT

It should be emphasized that these curves have been drawn merely to aid in the choice of tubes, not to be a clear-cut guide to performance capability. You are encouraged at all times to contact your GE field representative so that any particular application can be reviewed and the limitations of this chart can be taken into account.

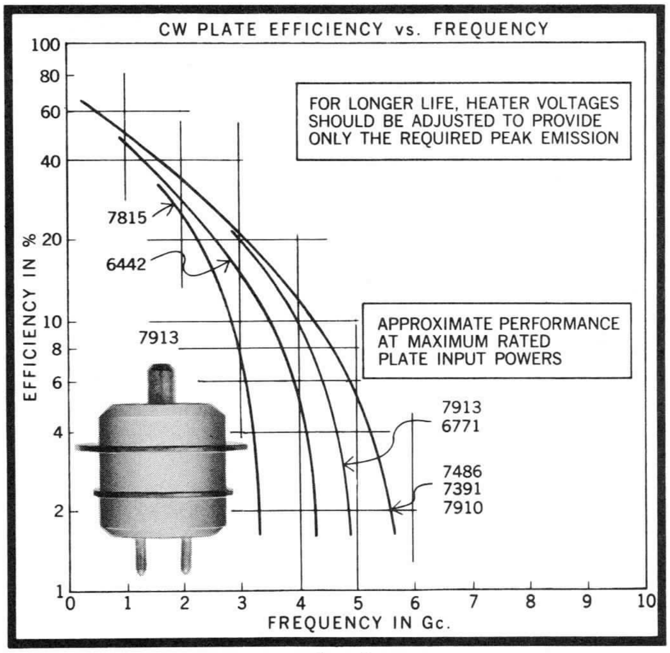


fig. 1

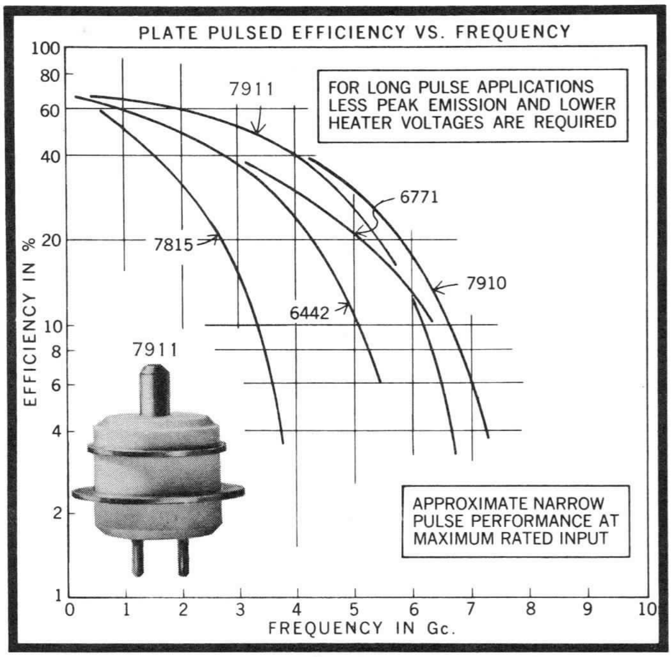


fig. 2

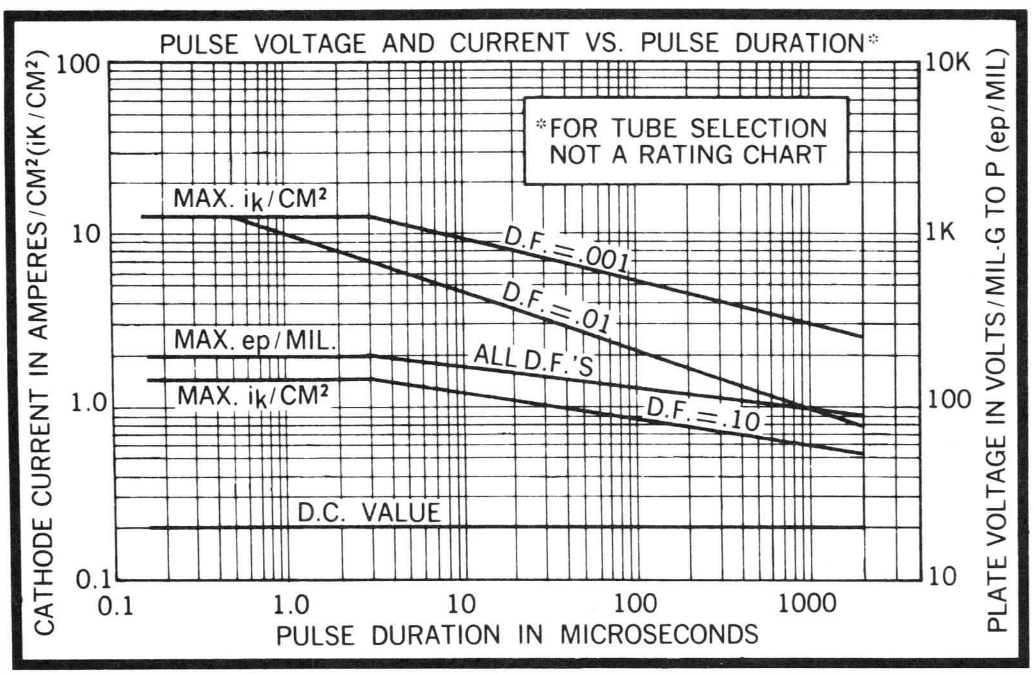


fig. 3

TUBE DEPARTMENT

GENERAL ELECTRIC

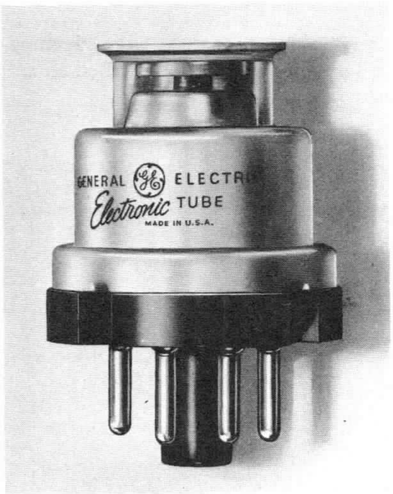
Owensboro, Kentucky

DATA FOR REGISTERED TYPES

ELECTRONICS

2B22

PLANAR DIODE



DESCRIPTION AND RATING

The 2B22 is a high-perveance diode of the disk-seal type. It is intended for use as a detector or monitor at frequencies as high as 1500 megacycles.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.75	Amperes
Direct Interelectrode Capacitances‡		
Plate to Cathode: (p to k)	2.18	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1	Ounce

Cooling—Convection

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Duty Factor§	0.05	
Peak Plate Voltage	100	Volts
Peak Inverse Plate Voltage	300	Volts
Average Cathode Current	20	Milliamperes
Peak Cathode Current§	0.7	Amperes
DC Output Voltage	150	Volts

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

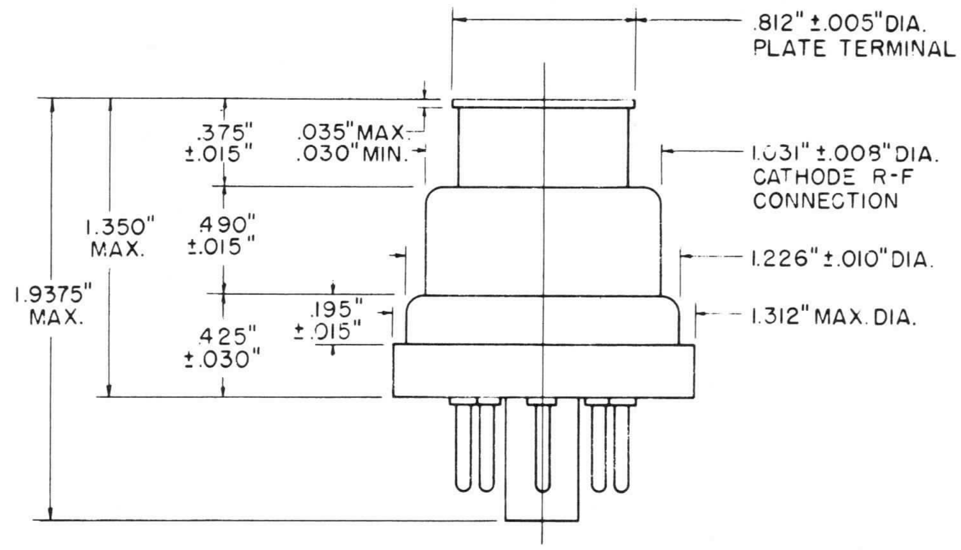
Supersedes ET-T1561 dated 9-49

AVERAGE CHARACTERISTICS

Tube Voltage Drop
Ib = 20 milliamperes . . . . 6.0 Volts

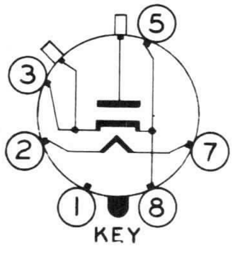
* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.
§ In any 100 microsecond interval.

PHYSICAL DIMENSIONS



NOTE 1
Glass will not protrude beyond edge of plate terminal.
NOTE 2
Maximum eccentricity of the center-line of the plate terminal with the center-line of the R-F cathode connection 0.020".

BASING DIAGRAM



Pin	Connection
1	Internal Connection
2	Heater
3	Cathode
5	Cathode
7	Heater
8	Cathode

2C39-B
PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Low Interelectrode Capacitances
High Transconductance — Shock Resistant

100 Watts Plate Dissipation

The 2C39-B is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

Features of the 2C39-B include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to Be Used as a Socket Stop and Clamp

Net Weight, approximate	2	Ounces

Cooling
Plate and Plate Seal—Conduction and Forced Air
Grid and Cathode Seals—Conduction and Forced Air
Recommended Air Flow Cowling—157-JAN
Recommended Air Flow on Plate Radiator at Sea Level
Incoming Air Temperature 25C, Plate Dissipation

100 Watts	12.5	Cubic Feet Per Minute

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point #	250	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage△		Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

RADIO FREQUENCY OSCILLATOR—CLASS C

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	−40	−22	Volts
Useful Power Output	40	17	Watts

‡ Measured in a special shielded socket.

§ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

\# Where long life and reliable operation are important, lower envelope temperatures should be used.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

△Adjusted for Ib = 75 milliamperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	−1.3	−2.5	−3.5	Volts
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	−7.0	−9.5	−15	Volts
Transconductance Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	.....	.....	3.0	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results Grid to Cathode at 500 volts d-c	50	.....	.....	Megohms
Interelectrode Capacitances Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

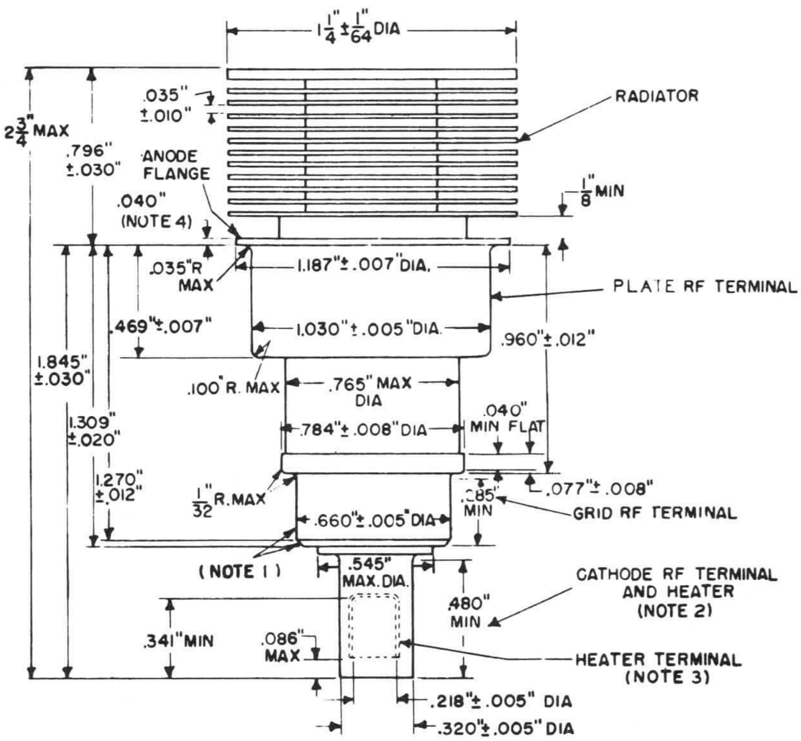
Shock

Statistical sample subjected to 5 input accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS

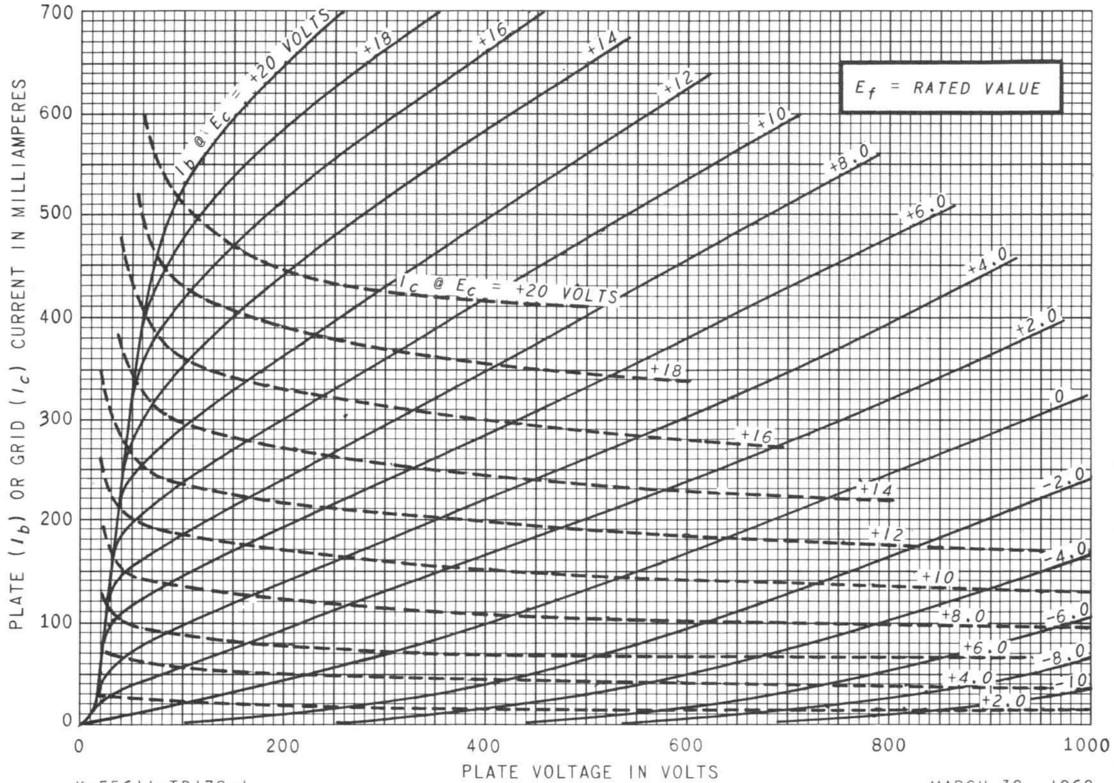


NOTES:

1. Solder not to extend radially beyond grid RF terminal.
2. Total indicated runout of the grid-contact surface and the cathode-contact surface with respect to the anode shall not exceed 0.020″.
3. Total indicated runout of the cathode-contact surface with respect to the heater-contact surface shall not exceed 0.012″.
4. Only this flange to be used as a socket stop and clamp.

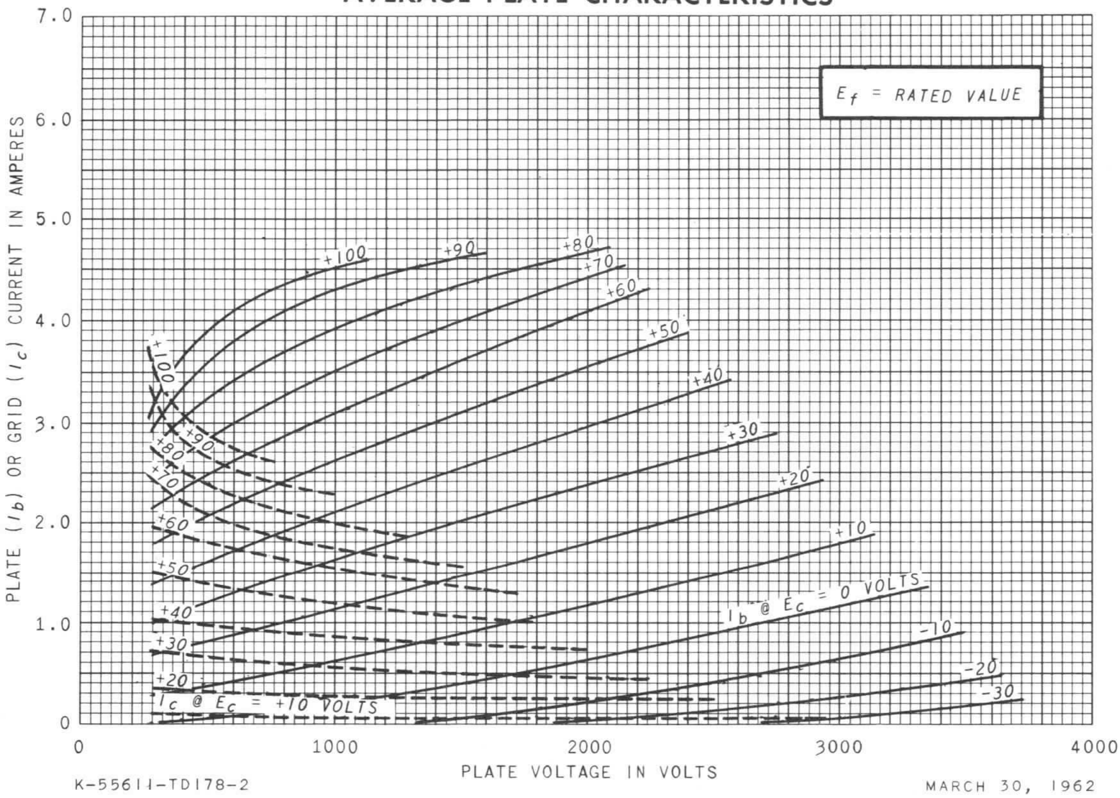
¶ New pages 3 to 6 supersede old pages 3 and 4 dated 12-61.

AVERAGE PLATE CHARACTERISTICS



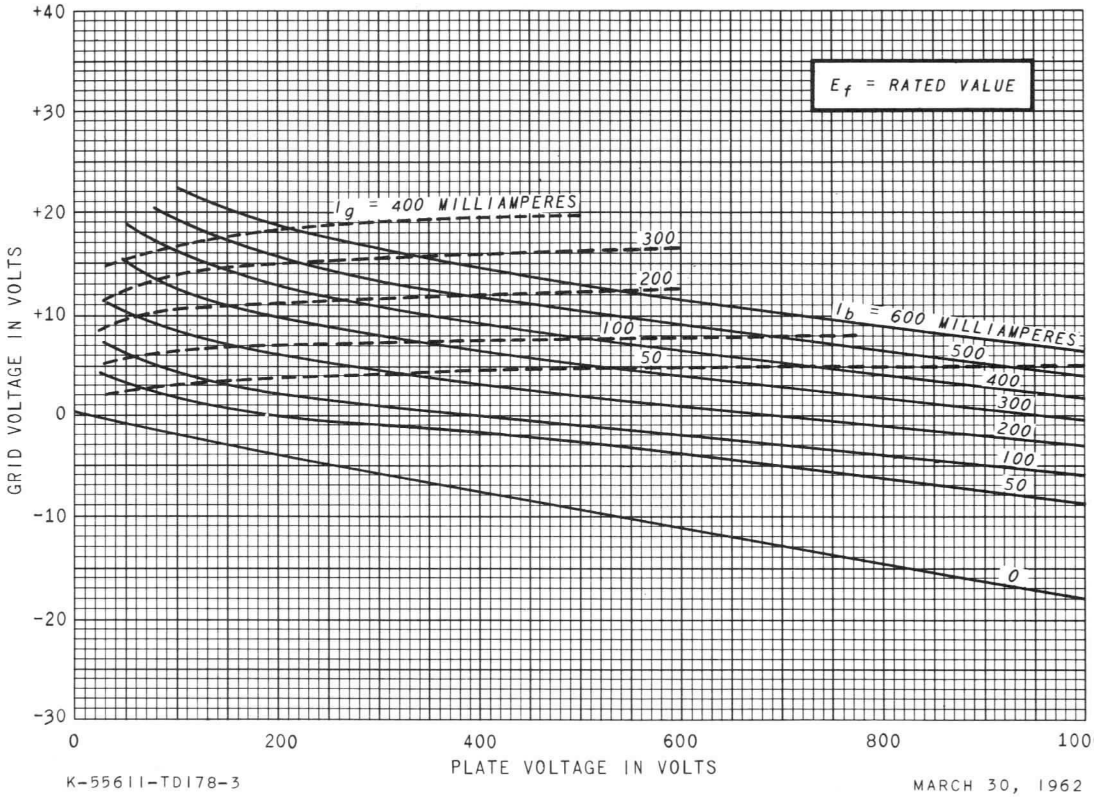
K-55611-TD178-1 MARCH 30, 1962

AVERAGE PLATE CHARACTERISTICS

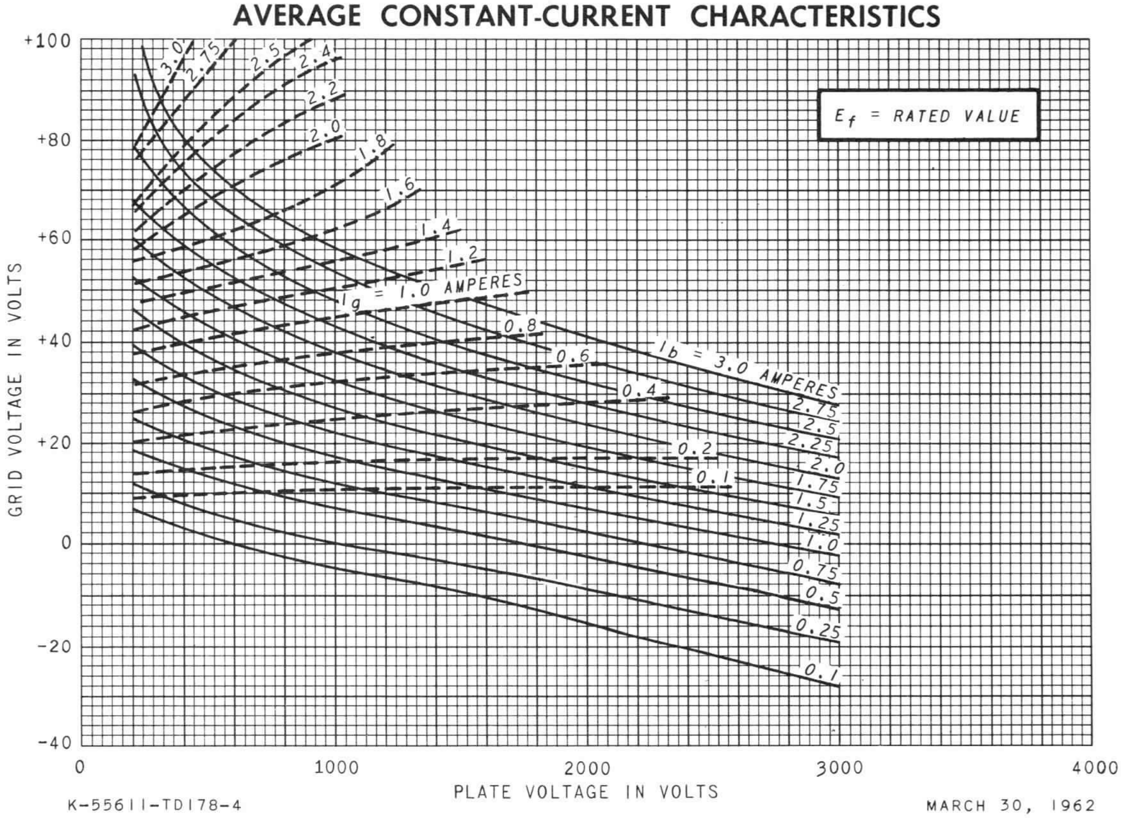


K-55611-TD178-2 MARCH 30, 1962

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

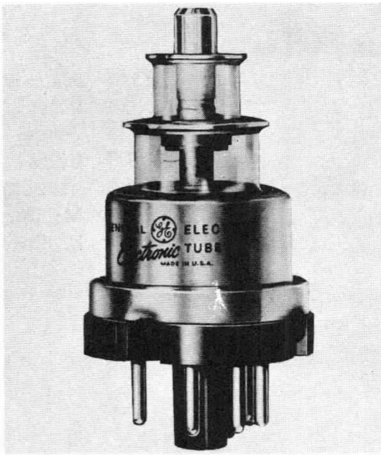
GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS

2C40

PLANAR TRIODE



DESCRIPTION AND RATING

The 2C40 is a triode of lighthouse construction designed for use as an oscillator or radio-frequency amplifier at frequencies as high as 3370 megacycles.

The radio-frequency cathode connection is made through a disk-type capacitor which is incorporated in the tube. This results in a low-impedance radio-frequency path from the cathode to the external circuit.

The envelope construction results in low losses, provides convenient electrode contact surfaces, and enables the tube to fit easily into coaxial circuits.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.75	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.3	pf
Grid to Cathode: (g to k)	2.15	pf
Plate to Cathode: (p to k), maximum	0.03	pf
Cathode RF Connection to Cathode	100	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1.2	Ounces

Cooling—Convection and Conduction

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Radio-Frequency Power Amplifier or Oscillator—Class C

Frequency	3370	Megacycles
DC Plate Voltage	500	Volts
DC Grid Voltage	−50	Volts
DC Plate Current	25	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	6.5	Watts
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Cathode-Cathode RF Connection Voltage		
Cathode RF Connection Positive with Respect to Cathode	90	Volts
Cathode RF Connection Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1461 dated 9-57

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

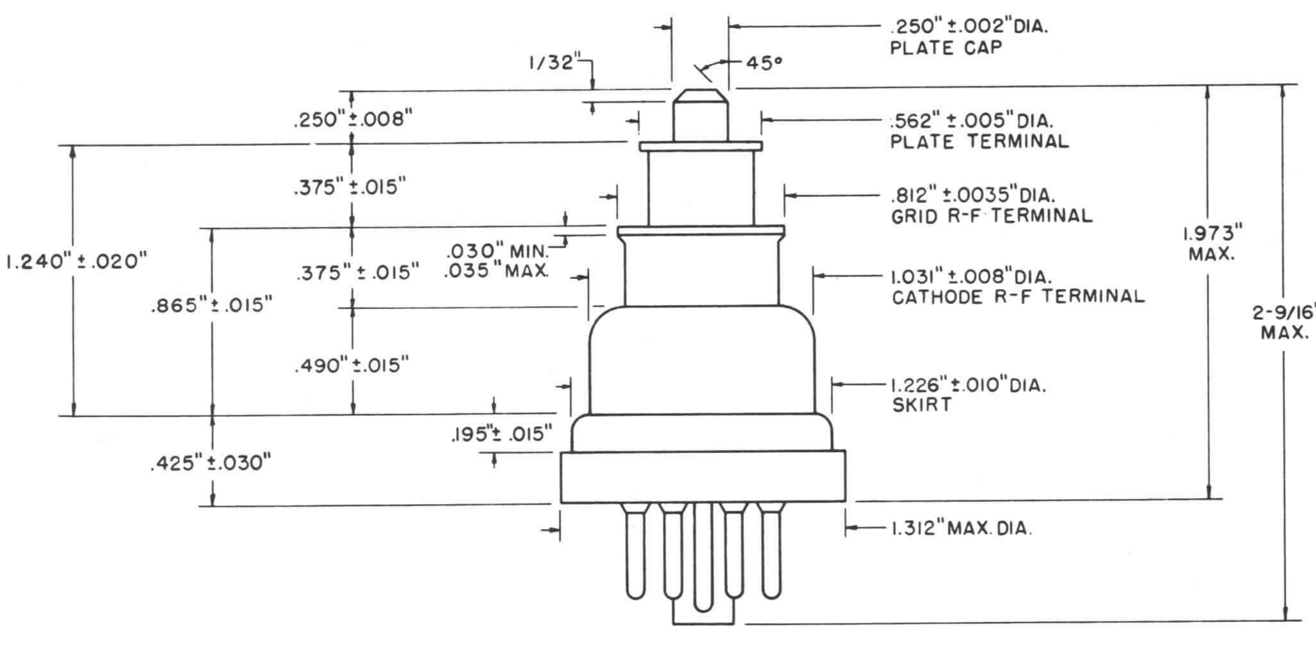
Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Cathode-Bias Resistor	200	Ohms
Amplification Factor	36	
Transconductance	4850	Micromhos
Plate Current	17	Milliamperes

RADIO-FREQUENCY OSCILLATOR

Frequency	3370	Megacycles
DC Plate Voltage	250	Volts
Grid Resistor	10000	Ohms
DC Grid Voltage	−5.0	Volts
DC Grid Current, approximate	0.5	Milliamperes
DC Plate Current	20	Milliamperes
Power Output	75	Milliwatts

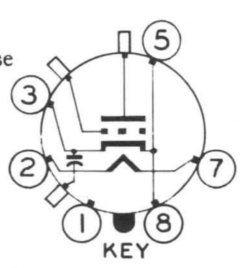
* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.

PHYSICAL DIMENSIONS



TERMINAL CONNECTIONS

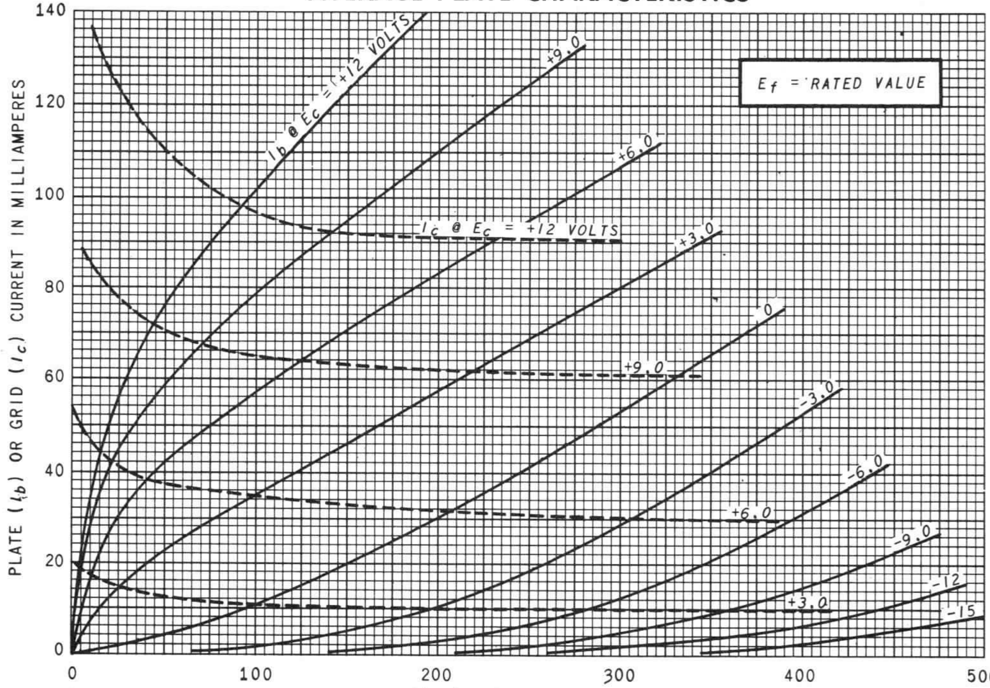
Pin 1—Internal Connection—Do Not Use
Pin 2—Heater
Pin 3—Cathode
Pin 5—Cathode
Pin 7—Heater
Pin 8—Cathode
Top Cap—Plate
Disk Terminal—Grid
Shell—Cathode RF Terminal



NOTES:

1. Glass shall not protrude beyond edge of anode RF terminal or grid RF terminal.
2. Plate cap and grid RF terminal to be concentric with respect to the cathode RF terminal within 1/64 inch (run-out of 1/32 inch maximum).

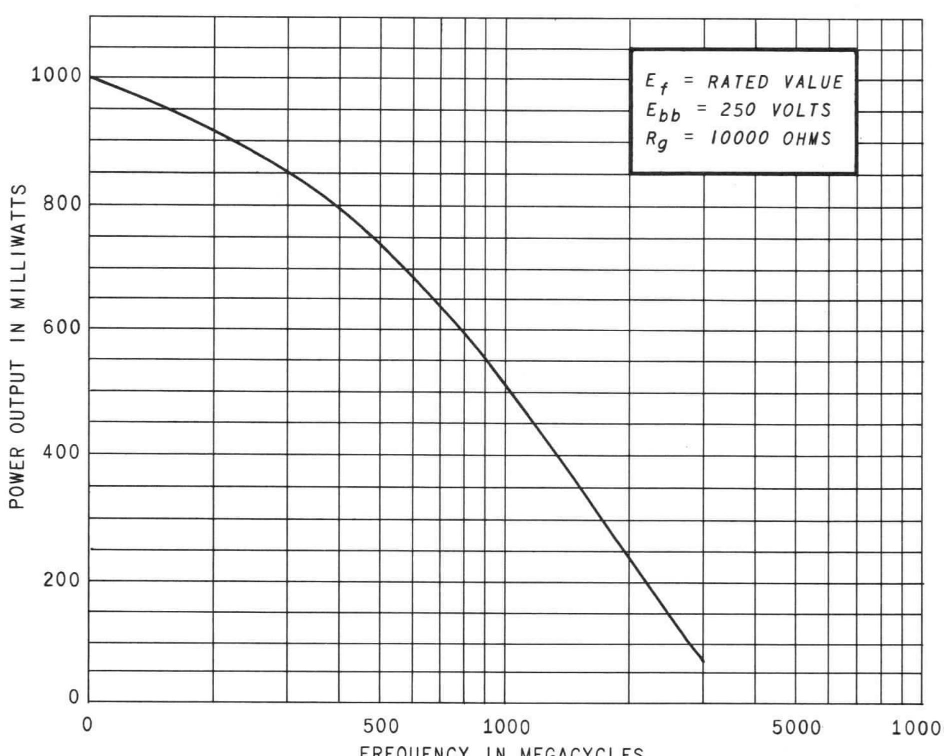
AVERAGE PLATE CHARACTERISTICS



K-55611-TD152-1

OCTOBER 10, 1961

POWER OUTPUT VS. FREQUENCY



K-55611-TD152-2

OCTOBER 10, 1961

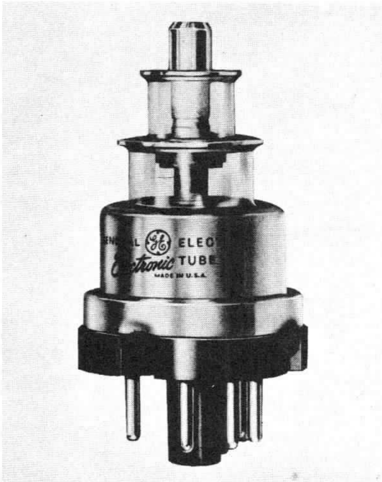
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS

2C40-A
PLANAR TRIODE



DESCRIPTION AND RATING

The 2C40-A is a triode of lighthouse construction designed for use as a CW oscillator, radio-frequency amplifier, or plate-pulsed oscillator at frequencies as high as 3370 megacycles.

The radio-frequency cathode connection is made through a disk-type capacitor which is incorporated in the tube. This results in a low-impedance radio-frequency path from the cathode to the external circuit.

The envelope construction results in low losses, provides convenient electrode contact surfaces, and enables the tube to fit easily into coaxial circuits.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.75	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.3	pf
Grid to Cathode: (g to k)	2.15	pf
Plate to Cathode	0.03	pf
Cathode RF Connection to Cathode	100	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1.2	Ounces

Cooling—Convection and Conduction

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Radio-Frequency Power Amplifier or Oscillator—Class C

Frequency	3370	Megacycles
DC Plate Voltage	500	Volts
DC Grid Voltage	−50	Volts
DC Plate Current	25	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	6.5	Watts
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Cathode-Cathode RF Connection Voltage		
Cathode RF Connection Positive with Respect to Cathode	90	Volts
Cathode RF Connection Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

PLATE-PULSED OSCILLATOR

Cathode Heating Time, minimum	60	Seconds
Frequency	3370	Megacycles
Peak Positive-Pulse Plate Supply Voltage	1400	Volts
Duty Factor of Plate Pulse§	0.002	
Pulse Duration	1.5	Microseconds
Plate Current		
Average§	3.0	Milliamperes
Average During Plate Pulse	2.0	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average§	1.5	Milliamperes
Average During Plate Pulse	1.0	Amperes
Plate Dissipation§	4.0	Watts
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Cathode-Cathode RF Connection Voltage		
Cathode RF Connection Positive with Respect to Cathode	90	Volts
Cathode RF Connection Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

Supersedes ET-T1212B dated 9-57

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Cathode-Bias Resistor	200	Ohms
Amplification Factor	35	
Transconductance	5100	Micromhos
Plate Current	17	Milliamperes

RADIO-FREQUENCY OSCILLATOR

Frequency	3370	Megacycles
DC Plate Voltage	250	Volts
Grid Resistor	10000	Ohms
DC Grid Voltage	−5.0	Volts
DC Grid Current, approximate	0.5	Milliamperes
DC Plate Current	20	Milliamperes
Power Output	75	Milliwatts

PLATE-PULSED OSCILLATOR

Frequency	3000	Megacycles
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Peak Positive-Pulse Plate Supply Voltage	1400	Volts
Plate Current, Average During Plate Pulse	1.0	Amperes
Useful Power Output, Average	0.3	Watts
Useful Power Output, Average During Plate Pulse	300	Watts

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

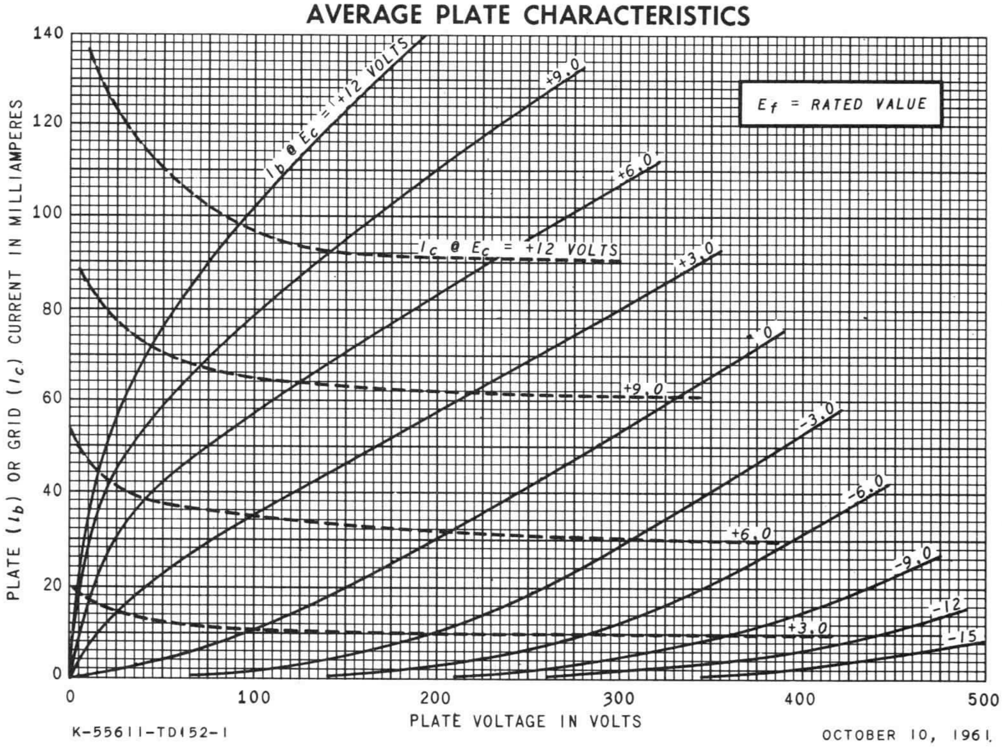
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.
§ In any 500 microsecond interval.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

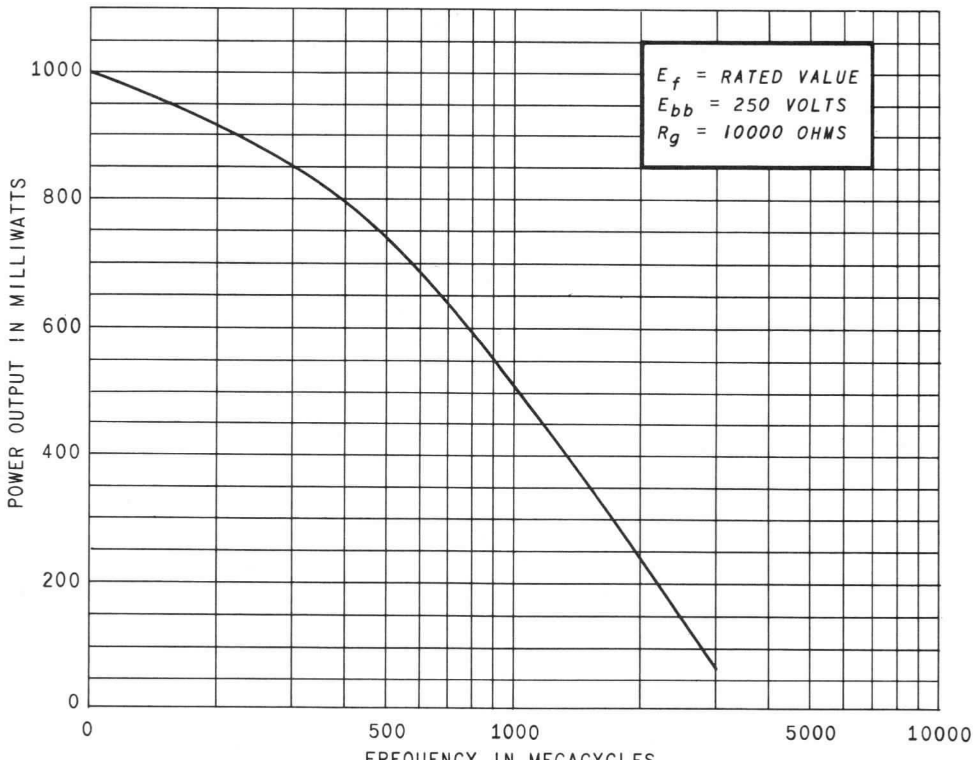
AVERAGE PLATE CHARACTERISTICS



K-55611-TD152-1

OCTOBER 10, 1961

POWER OUTPUT VS. FREQUENCY



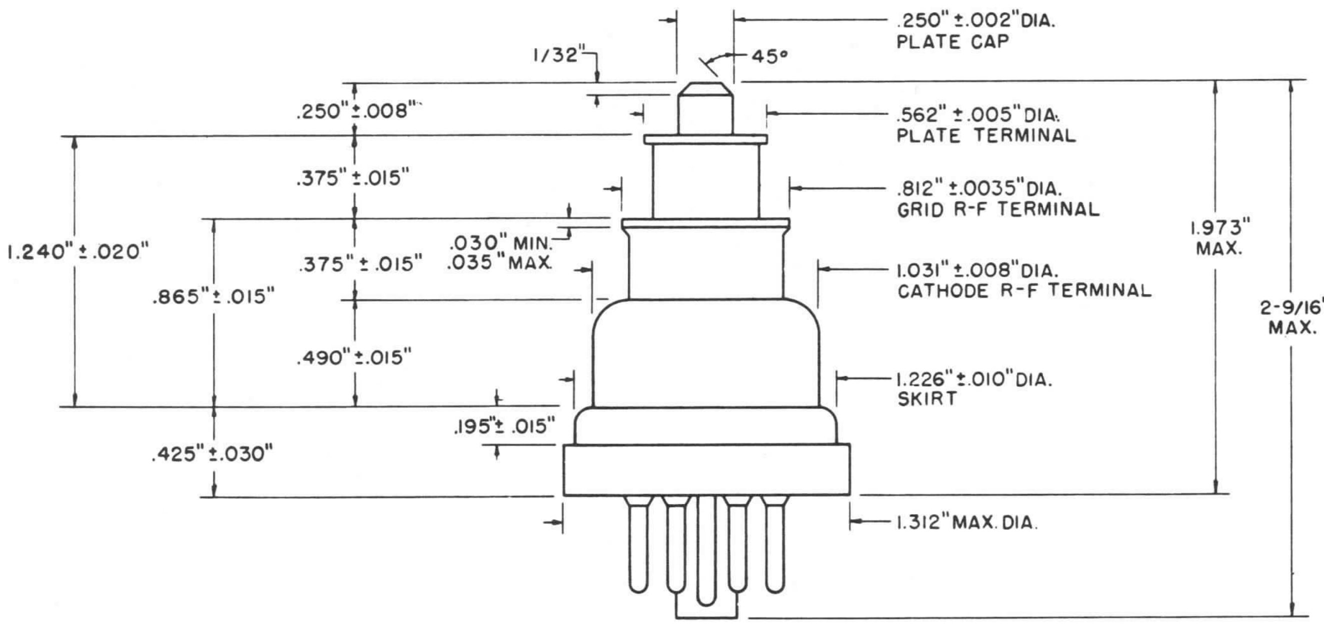
K-55611-TD152-2

OCTOBER 10, 1961

NOTES:

1. Glass shall not protrude beyond edge of anode RF terminal or grid RF terminal.
2. Plate cap and grid RF terminal to be concentric with respect to the cathode RF terminal within 1/64 inch (run-out of 1/32 inch maximum).

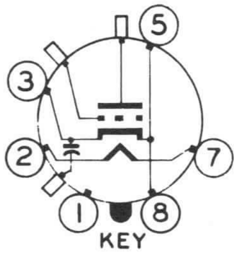
PHYSICAL DIMENSIONS



TERMINAL CONNECTIONS

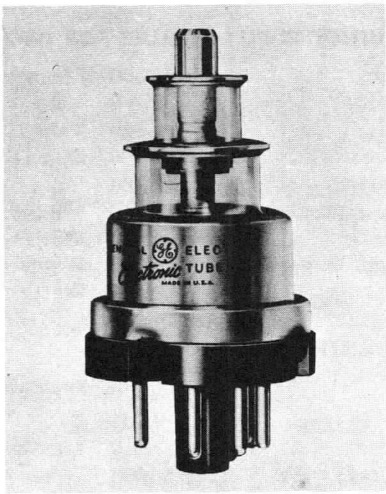
Pin 1—Internal Connection—Do Not Use
Pin 2—Heater
Pin 3—Cathode
Pin 5—Cathode
Pin 7—Heater
Pin 8—Cathode
Top Cap—Plate
Disk Terminal—Grid
Shell—Cathode RF Terminal

BASING DIAGRAM



ELECTRONICS

2C43
PLANAR TRIODE



DESCRIPTION AND RATING

The 2C43 is a triode of lighthouse construction designed for use as a Class C radio-frequency amplifier or pulsed oscillator at frequencies as high as 3370 megacycles.

The radio-frequency cathode connection is made through a disk-type capacitor which is incorporated in the tube. This results in a low-impedance radio-frequency path from cathode to the external circuit.

The envelope construction results in low losses, provides convenient contact surfaces, and enables the tube to fit easily into coaxial circuits.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	6.3 ± 0.3*	Volts
Heater Current	0.9†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.8	pf
Grid to Cathode: (g to k)	3.0	pf
Plate to Cathode: (p to k), maximum	0.04	pf
Cathode RF Connection to Cathode	100	pf

MECHANICAL

Mounting Position—Any
Net Weight, approximate . . . 1 Ounce
Cooling—Convection and Conduction

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C

Frequency	1500	Megacycles
DC Plate Voltage	500	Volts
DC Plate Current	40	Milliamperes
DC Cathode Current	55	Milliamperes
Plate Dissipation	12	Watts
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Cathode-Cathode RF Connection Voltage		
Cathode RF Connection Positive with Respect to Cathode	90	Volts
Cathode RF Connection Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

PLATE-PULSED OSCILLATOR

Cathode Heating Time, minimum	60	Seconds
Frequency	3370	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3500	Volts
Duty Factor of Plate Pulse	0.006	
Pulse Duration	10	Microseconds
Plate Current		
Average During Plate Pulse	2.75	Amperes
Cathode Current		
Average During Plate Pulse	4.0	Amperes
Plate Dissipation	12	Watts
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Cathode-Cathode RF Connection Voltage		
Cathode RF Connection Positive with Respect to Cathode	90	Volts
Cathode RF Connection Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	50	
Transconductance	8100	Micromhos
Plate Current	21	Milliamperes

PUSH-PULL CW OSCILLATOR, VALUES FOR TWO TUBES

Frequency	350	350	Megacycles
Heater Voltage	5.8	5.8	Volts
DC Plate Voltage	360	470	Volts
Grid Resistor	1000	1000	Ohms
DC Plate Current	28	38	Milliamperes
Power Output, approximate	4.7	9.0	Watts

PUSH-PULL RADIO-FREQUENCY POWER AMPLIFIER—CLASS C—PLATE MODULATED, VALUES FOR TWO TUBES

Frequency	300	Megacycles
Heater Voltage	5.8	Volts
DC Plate Voltage	350	Volts
Grid Resistor	1200	Ohms
DC Grid Voltage	−50	Volts
DC Grid Current, approximate	40	Milliamperes
DC Plate Current	48	Milliamperes
Driving Power, approximate	3	Watts
Power Output	10	Watts

PUSH-PULL FREQUENCY TRIPLER, VALUES FOR TWO TUBES

Output Frequency	300	Megacycles
Heater Voltage	5.8	Volts
DC Plate Voltage	350	Volts
Grid Resistor	2700	Ohms
DC Grid Voltage	−80	Volts
DC Grid Current, approximate	30	Milliamperes
DC Plate Current	50	Milliamperes
Driving Power, approximate	3	Watts
Power Output	4.4	Watts

PLATE-PULSED OSCILLATOR

Frequency	3370	Megacycles
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Grid-Bias Resistor	100	Ohms
Plate Current		
Average	2.5	Milliamperes
Average During Plate Pulse	2.5	Amperes
Power Output		
Average During Plate Pulse	1.75	Kilowatts

* The equipment designer should design the equipment so that the heater voltage is centered at a value suitable for the application. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on the other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

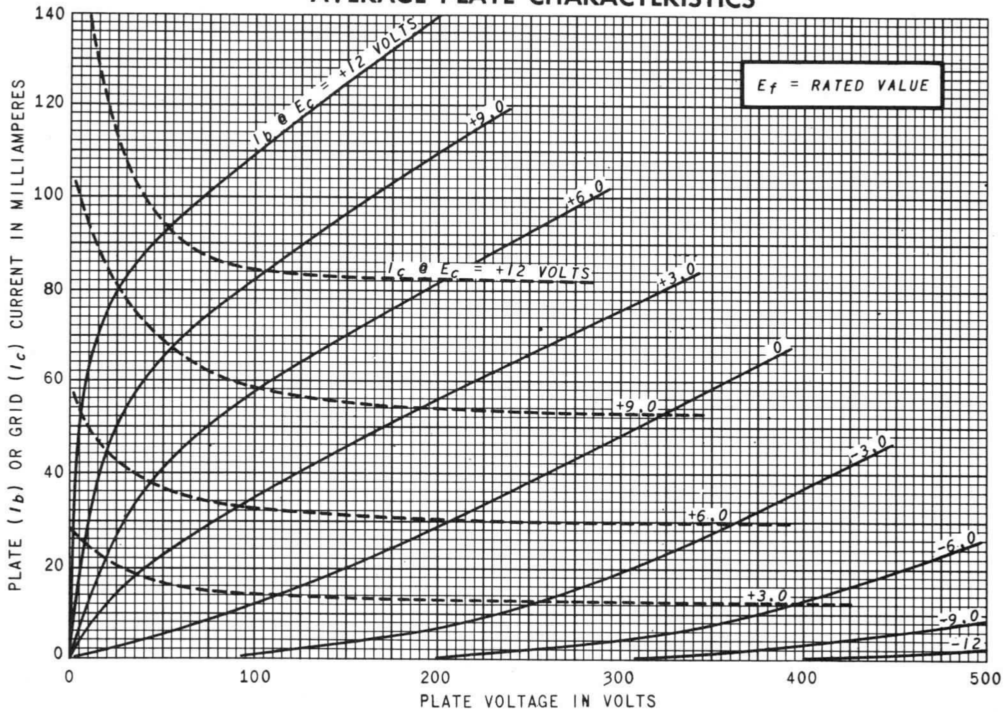
‡ Without external shield.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

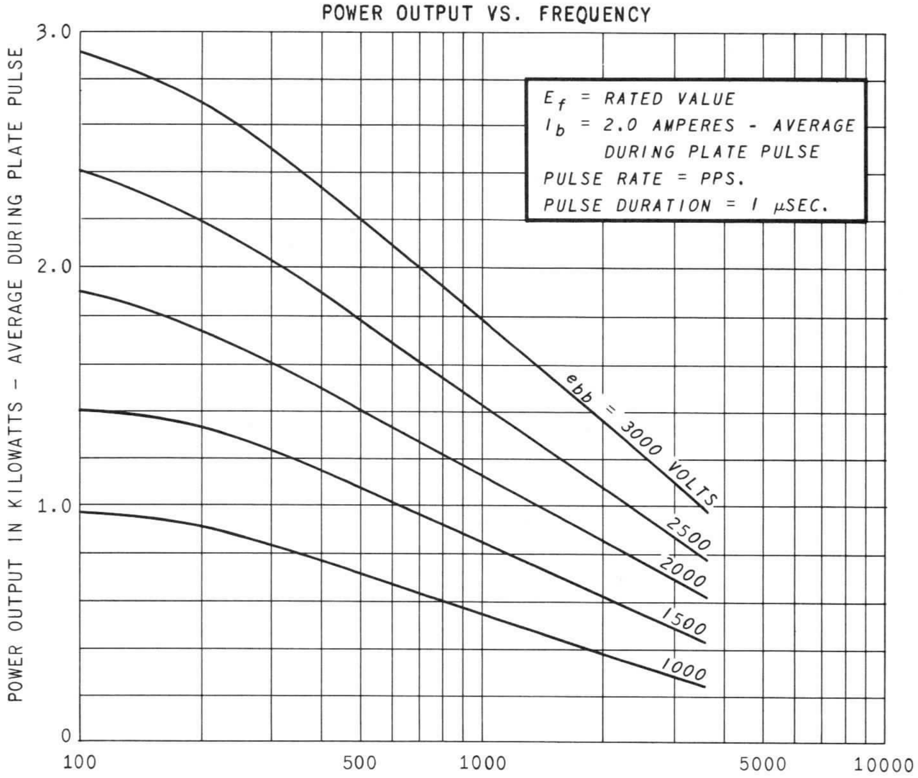
AVERAGE PLATE CHARACTERISTICS



OCTOBER 9, 1961

APPROXIMATE PLATE-PULSED OSCILLATOR PERFORMANCE

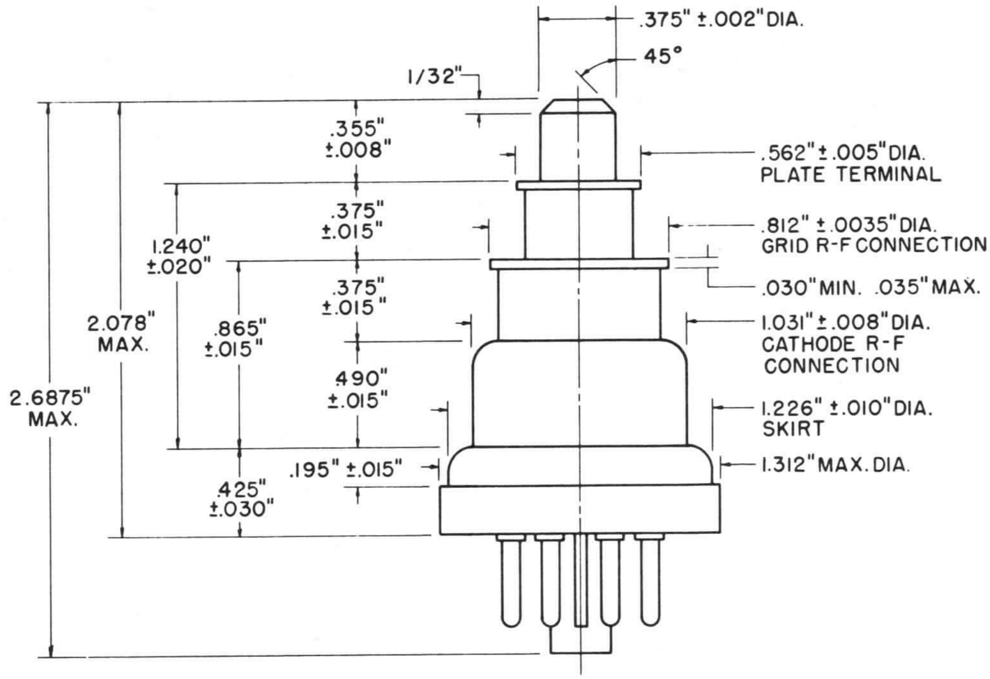
POWER OUTPUT VS. FREQUENCY



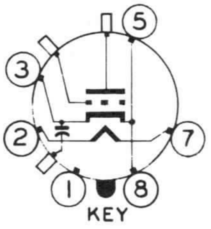
OCTOBER 9, 1961

NOTE 1
Glass shall not protrude beyond edge of plate terminal or grid RF connection.

NOTE 2
Plate terminal and grid RF connection to be concentric with respect to the cathode RF connection within 1/64 inch (runout 1/32 inch, maximum).



BASING DIAGRAM



TERMINAL CONNECTIONS

Pin	Connection
1	Internal Connection
2	Heater
3	Cathode
5	Cathode
7	Heater
8	Cathode

ELECTRONICS

3CX100A5

PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR, AMPLIFIER, AND FREQUENCY MULTIPLIER SERVICE

Metal and Ceramic — Pulse Rated
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 3CX100A5 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid CW oscillator, amplifier, or frequency multiplier at frequencies as high as 2500 megacycles. In addition, it may be used as a plate-pulsed oscillator or amplifier at frequencies as high as 3000 megacycles.

Features of the 3CX100A5 include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.0 volts	1.0†	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.0	pf
Grid to Cathode: (g to k)	6.3	pf
Plate to Cathode: (p to k), maximum	0.035	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to be Used as a Socket Stop and Clamp

Net Weight, approximate . . . 2.5 Ounces

Cooling
- Plate and Plate Seal—Conduction and Forced Air
- Grid and Cathode Seals—Conduction and Forced Air
- Recommended Air Flow Cowling—157-JAN
- Recommended Air Flow on Plate Radiator at Sea Level Incoming Air Temperature 25C, Plate Dissipation 100 Watts . . . 12.5 Cu.Ft.PerMin.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions Per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions Per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

PLATE-PULSED OSCILLATOR OR AMPLIFIER

Heater Voltage*	5.7 to 6.0	Volts
Frequency	3000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3500	Volts
Duty Factor of Plate Pulse # △	0.0025	
Pulse Duration	3.0	Microseconds
Plate Current Average During Plate Pulse △ **	3.0	Amperes
Negative Grid Voltage Average During Plate Pulse††	150	Volts
Grid Current Average During Plate Pulse	1.8	Amperes
Plate Dissipation △	27	Watts
Grid Dissipation △	2.0	Watts
Envelope Temperature at Hottest Point	300	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.0	Volts
Plate Voltage	600	Volts
Grid Voltage§§		Volts
Amplification Factor	100	
Transconductance	25000	Micromhos
Plate Current	70	Milliamperes

RADIO-FREQUENCY POWER AMPLIFIER

Frequency	500	Megacycles
DC Plate Voltage	900	Volts
DC Grid Voltage	−40	Volts
DC Plate Current	90	Milliamperes
DC Grid Current, approximate	30	Milliamperes
Driving Power, approximate	6	Watts
Useful Power Output	40	Watts

RADIO-FREQUENCY OSCILLATOR

Frequency	2500	Megacycles
DC Plate Voltage	900	Volts
DC Grid Voltage, approximate	−22	Volts
DC Plate Current	90	Milliamperes
DC Grid Current	10	Milliamperes
Useful Power Output	17	Watts

PLATE-PULSED OSCILLATOR

Frequency	3000	Megacycles
Heater Voltage	5.8	Volts
Duty Factor	0.0025	
Pulse Duration	3.0	Microseconds
Peak Positive-Pulse Plate-Supply Voltage	3500	Volts
Plate Current, Average During Plate Pulse	3.0	Amperes
Grid Current, Average During Plate Pulse	1.8	Amperes
Useful Power Output, Average During Plate Pulse	1.6	Kilowatts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.0 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.0 volts.

‡ Measured in a special shielded socket.

§ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

Applications with a duty factor greater than 0.0025 should be referred to your General Electric tube sales representative for recommendations.

△ In any 5000-microsecond interval.

**The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 30 amperes.

††The maximum instantaneous value should be within the range of +250 to −750 volts.

§§Adjusted for Ib = 70 milliamperes.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

INITIAL CHARACTERISTICS LIMITS

	Min.	Max.	
Heater Current			
Ef = 6.0 volts	0.90	1.05	Amperes
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 100 ma	−2.0	−7.0	Volts
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 1.0 ma	....	−25	Volts
Negative Grid Current			
Ef = 6.0 volts, Eb = 1000 volts, Ec adjusted for Ib = 100 ma	....	8.0	Microamperes
Interelectrode Leakage Resistance			
Ef = 6.0 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results			
Grid to Cathode at 500 volts d-c	50	....	Megohms
Interelectrode Capacitances			
Grid to Plate: (g to p)	1.95	2.15	Picofarads
Grid to Cathode: (g to k)	5.6	7.0	Picofarads
Plate to Cathode: (p to k)	....	0.035	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts
Pulsed-Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.8 volts; F = 3000 MC, min.; epy = 3500 volts; tp = 3.0 μsec. ±10%; Du = 0.0025 ±5%; Rg adjusted for Ib = 7.5 ma; Ec = −1.5 volts, max.; Ic = 4.5 ma, max.	4.0	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 54 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

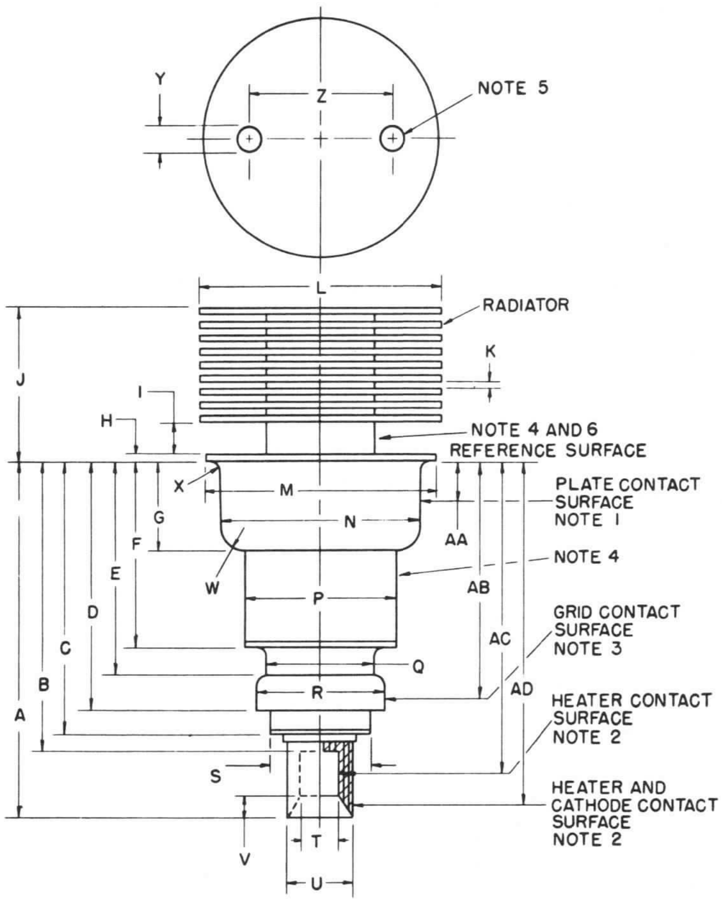
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 0.5 milliseconds duration in each of three positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS



DIMENSIONS FOR OUTLINE (INCHES)

Ref.	Minimum	Maximum
A	1.815	1.875
B	....	1.534
C	....	1.475
D	1.289	1.329
E	1.085	1.135
F	.880	.920
G	.462	.477
H	....	.040
I	.125	.185
J	.766	.826
K	.025	.046
L	1.234	1.264
M	1.180	1.195
N	1.025	1.035
P	.772	.792
Q	.541	.561
R	.655	.665
S	....	.545
T	.213	.223
U	.315	.325
V	....	.086
W	....	.100
X	....	.035
Y	.105	.145
Z	.650	.850

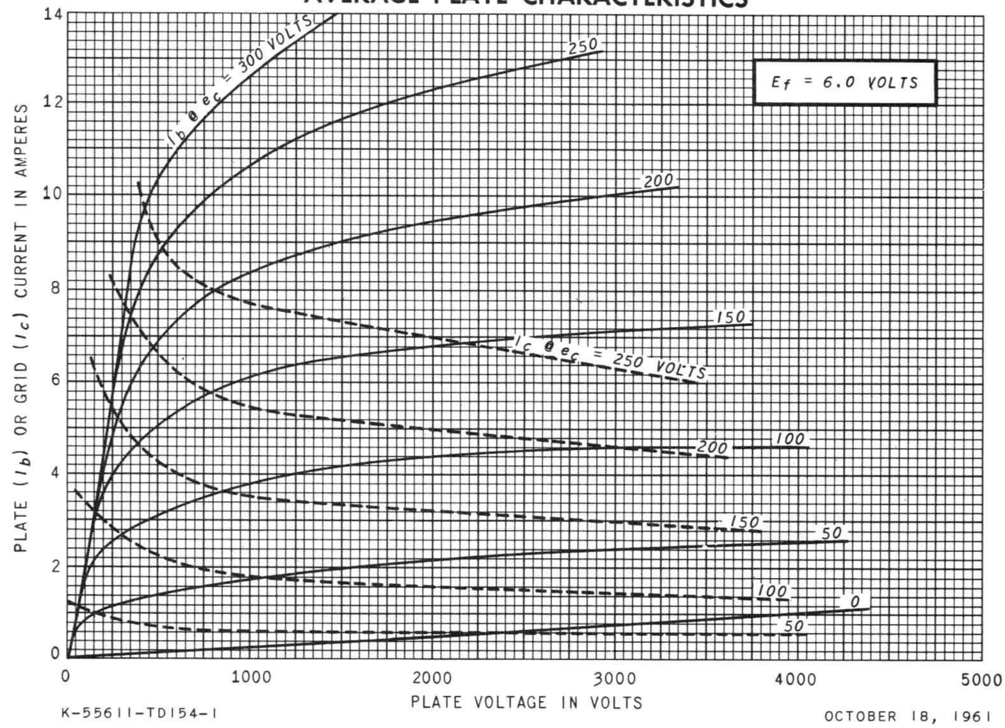
DIMENSIONS FOR ELECTRODE CONTACT AREA (INCHES)

Ref.	Dimension	Contact
AA	.198 ± .163	Plate
AB	1.225 ± .040	Grid
AC	1.631 ± .097	Heater
AD	1.645 ± .170	Cathode

NOTES

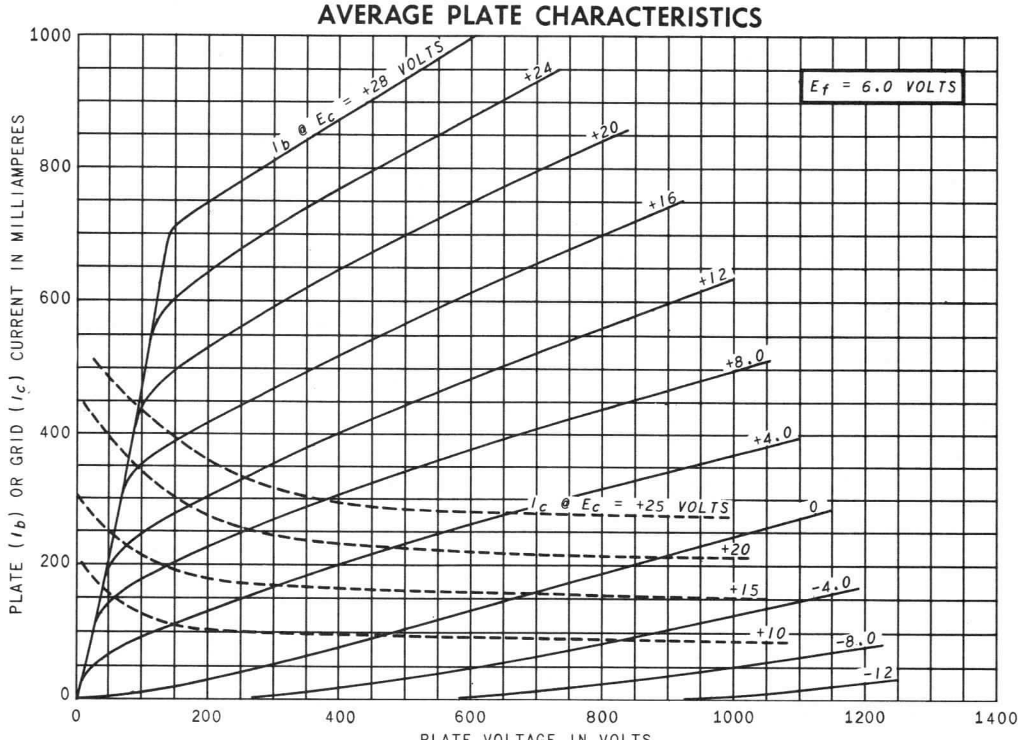
1. The total indicated runout of the plate contact surface with respect to the cathode contact surfaces will not exceed .020 inch.
2. The total indicated runout of the cathode contact surface with respect to the heater contact surfaces will not exceed .012 inch.
3. The total indicated runout of the grid contact surface with respect to the cathode contact surface will not exceed .020 inch.
4. Do not clamp or locate on this surface.
5. Hole provided for tube extractor through the top fin only.
6. Measure plate shank temperature on this surface.

AVERAGE PLATE CHARACTERISTICS



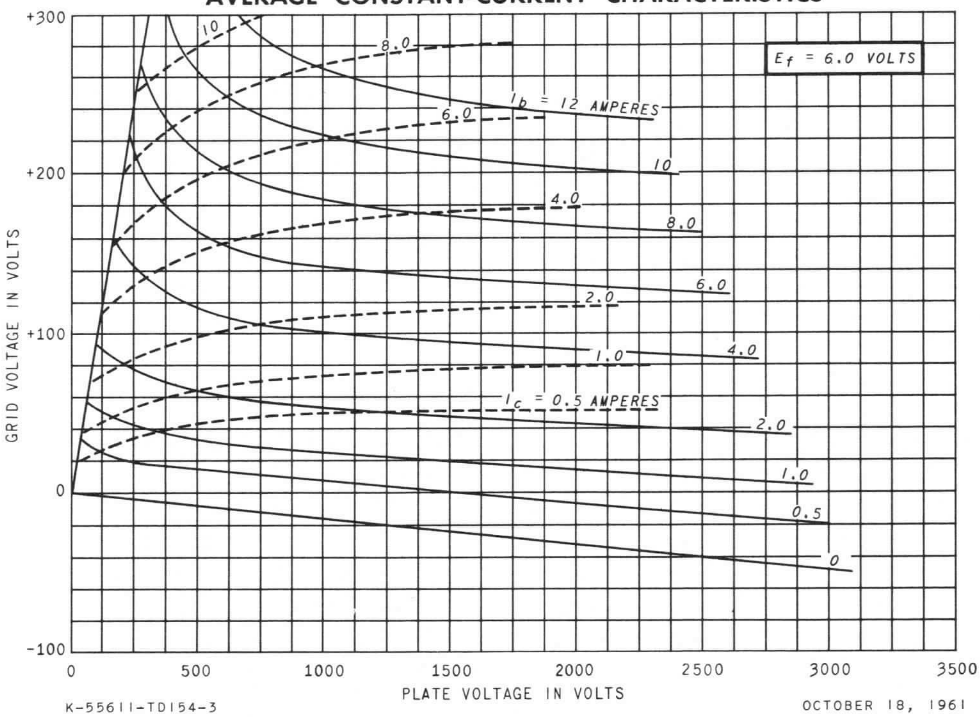
K-55611-TD154-1 OCTOBER 18, 1961

AVERAGE PLATE CHARACTERISTICS

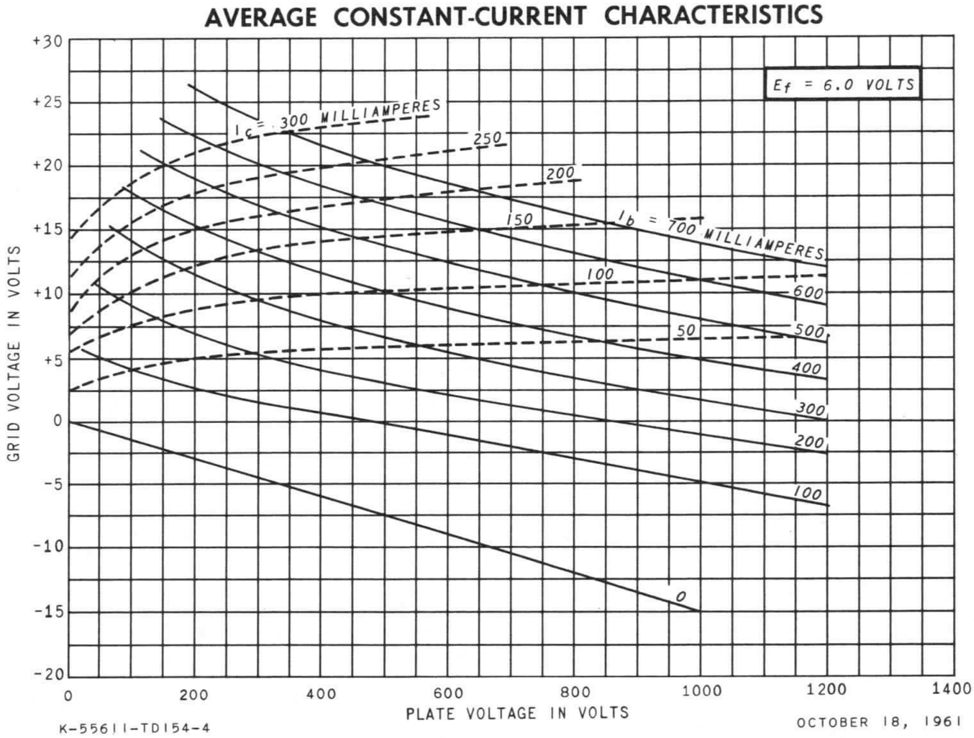


K-55611-TD154-2 OCTOBER 18, 1961

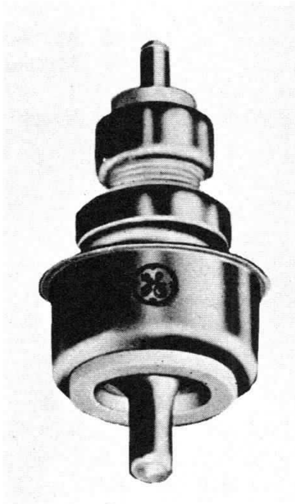
AVERAGE CONSTANT-CURRENT CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS



6299
PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

Metal and Ceramic — Small Size
Low Noise — Conduction Cooled

The 6299 is a high-mu metal-and-ceramic triode intended for operation as a grounded-grid, Class A radio-frequency amplifier at frequencies as high as 3000 megacycles.

Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

At 1200 megacycles a noise figure of less than 8.5 decibels may be obtained when the 6299 is used in a grounded-grid coaxial circuit.

In radar receivers, or similar applications, where the grid of the tube may be driven positive by leakage pulses, consideration should be given to use of the 7644 in place of the 6299.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.3	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.75	pf
Grid to Cathode and Heater: g to (h+k)	3.65	pf
Plate to Cathode and Heater: p to (h+k)	0.015	pf

MECHANICAL

Mounting Position—Any
Net Weight, approximate . . . . 1/6 Ounce
Cooling—Conduction§

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.0	Watts
DC Plate Current	12	Milliamperes
DC Grid Current//	0¶	Milliamperes
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage #	....	Volts
Amplification Factor	110	
Plate Resistance, approximate	7300	Ohms
Transconductance	15000	Micromhos
Plate Current	10	Milliamperes
Plate Voltage, approximate Ib = 10 Milliamperes, Ec = 0 Volts	125	Volts

CLASS A_1 RF AMPLIFIER
GROUNDED-GRID, COAXIAL-TYPE CIRCUIT

Frequency	450	1200	1200	1200	3000	Megacycles
Plate Voltage	△	.....	△	175	△	Volts
Plate-Supply Voltage**	....	300	....	....	....	Volts
Resistor in Plate Circuit (bypassed)	....	17500	....	....	....	Ohms
Grid Voltage††	0	0	0	§§	0	Volts
Plate Current	10	10	10	10	10	Milliamperes
Bandwidth, min.	9	10	10	10	10	Megacycles
Gain	17.5	17	17	17	11	Decibels
Noise Figure, Power-Matched	4.5	8.2	8.0	8.5	13.2	Decibels

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ Good thermal contact to the anode and cathode must be provided to conduct heat from the elements. The anode contact must be sufficiently flexible to keep lateral force on the anode terminal at a minimum.

//The 6299 is rated only for Class A amplifier service.

¶ Does not apply to initial-emission-velocity current.

#Adjusted for Ib = 10 milliamperes.

△Adjust for Ib = 10 milliamperes; range must be variable from 75 to 200 volts.

**Supply should be regulated.

††For operation above 1000 megacycles, the minimum noise figure will generally be obtained by operation at zero bias. For operation below 1000 megacycles, the use of a cathode resistor or grid bias should be evaluated for the particular application.

§§Adjusted for Ib = 10 milliamperes; 200 ohm variable cathode resistor recommended.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	280	300	320	Milliamperes
Plate Voltage				
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma	75	125	175	Volts
Transconductance				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	11500	15000	.....	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	85	110	140	
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to Cathode and Heater at 45 volts d-c	0.25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	5.0	.....	.....	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.5	1.75	2.0	Picofarads
Grid to Cathode and Heater: g to (h+k)	3.0	3.65	5.0	Picofarads
Plate to Cathode and Heater: p to (h+k)	.....	0.015	0.025	Picofarads

SPECIAL PERFORMANCE TESTS

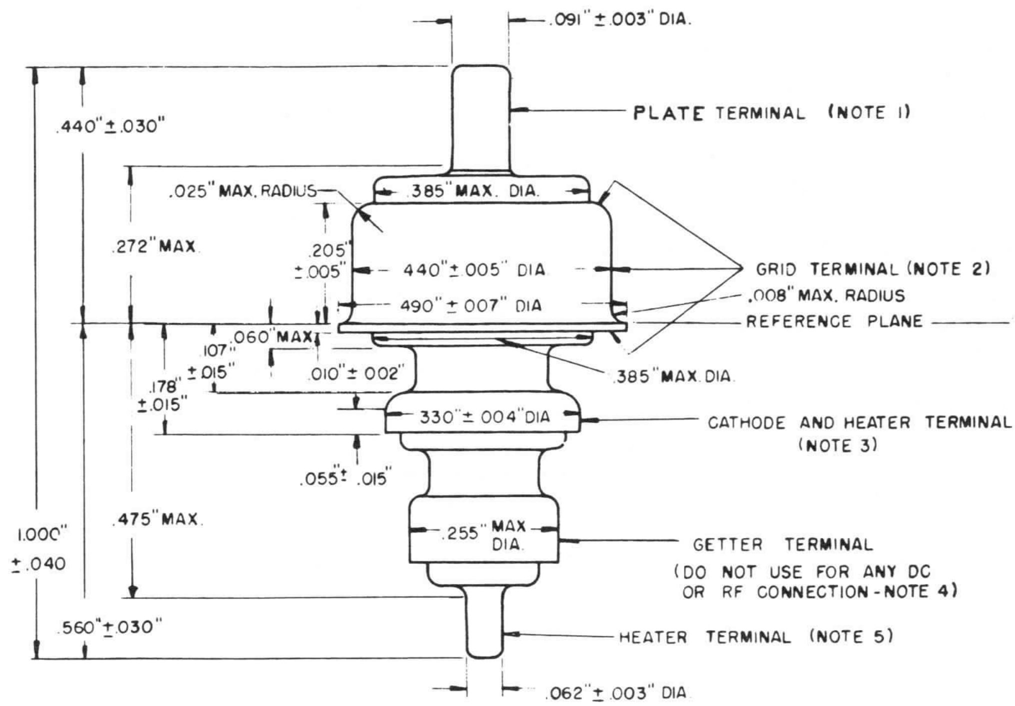
	Min.	Max.	
Noise Figure—450 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5 MC	.....	5.0	Decibels
Noise Figure—1200 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC	.....	8.5	Decibels
Noise Figure—3000 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000 ± 5 MC	.....	13.5	Decibels
Power Gain—450 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5MC, Bandwidth = 9 MC min.	15	.....	Decibels
Power Gain—1200 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC, Bandwidth = 10 MC min.	15	.....	Decibels
Power Gain—3000 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000 ± 5 MC, Bandwidth = 10 MC min.	10	.....	Decibels

DEGRADATION RATE TESTS

1000-Hour Life

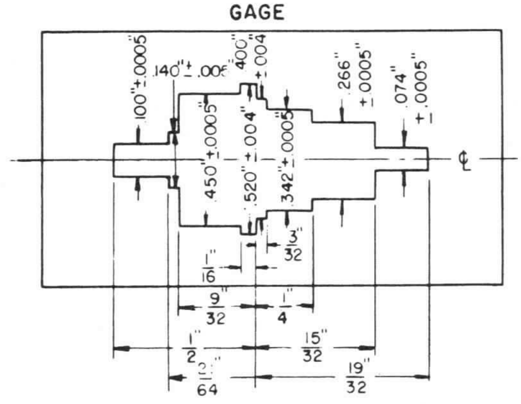
Statistical sample operated for 1000 hours to evaluate changes in transconductance and noise figure with life.

PHYSICAL DIMENSIONS



DIMENSIONAL TOLERANCES

GAGE



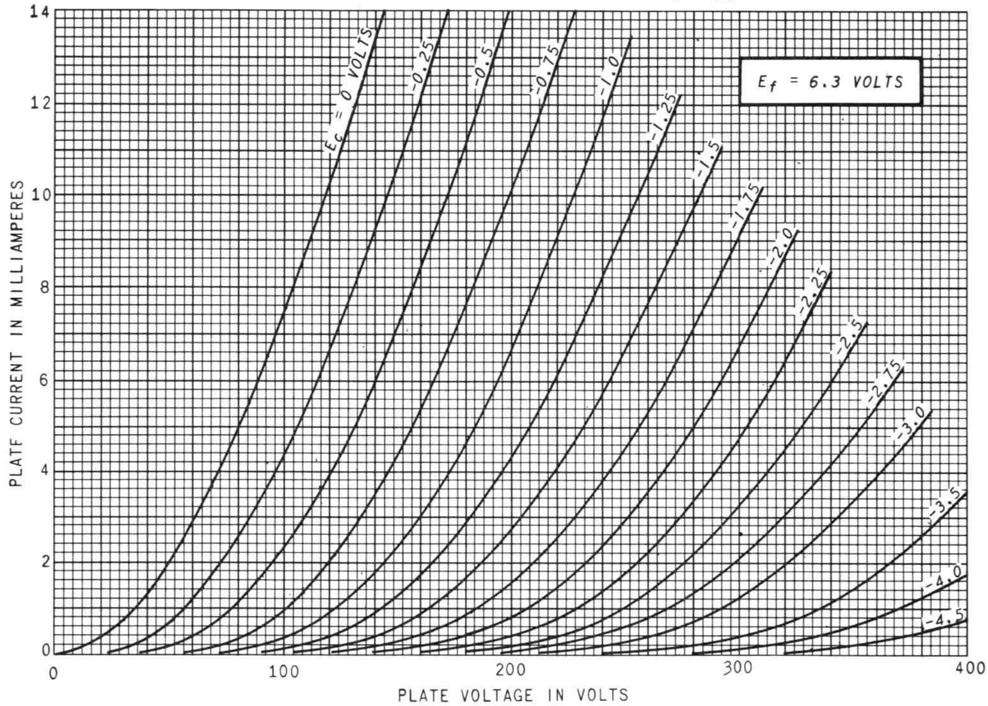
FRACTIONAL TOLERANCES
$\frac{1}{4}$" OR LESS ± .008" OVER $\frac{1}{4}$" ± .015"

NOTES:

1. Maximum eccentricity 0.007″ (runout 0.014″)
2. Maximum eccentricity 0.008″ (runout 0.016″)
3. Maximum eccentricity 0.010″ (runout 0.020″)
4. Maximum eccentricity 0.015″ (runout 0.030″)
5. Maximum eccentricity 0.010″ (runout 0.020″)

   Eccentricities measured with respect to center line through gage. Tube shall be rotated 360° in gage without binding.

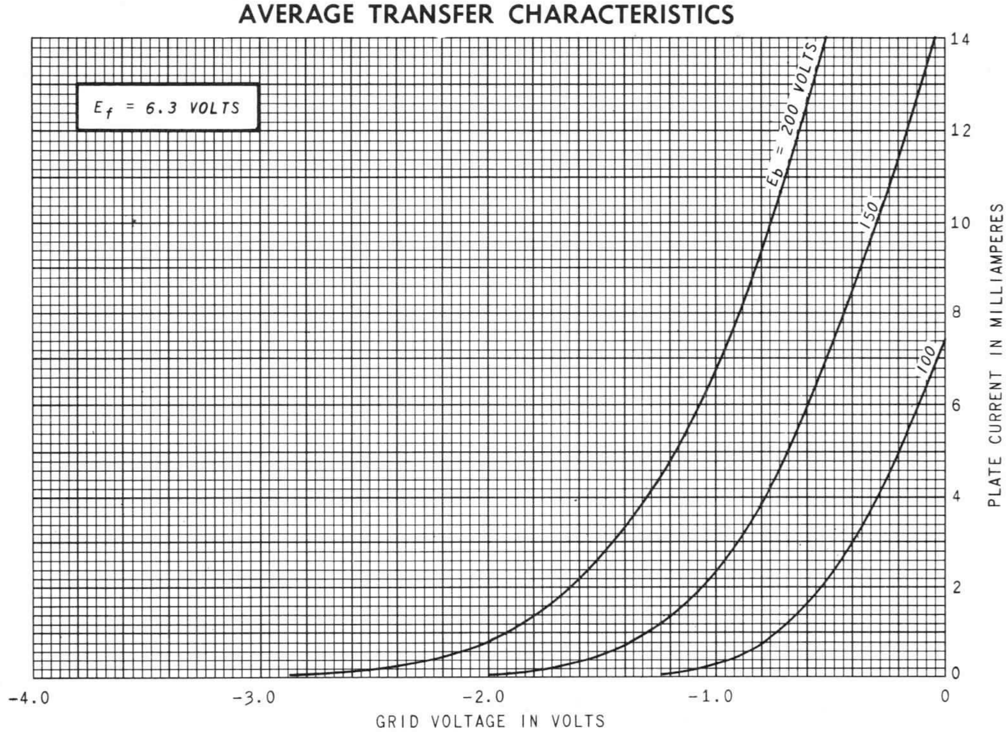
AVERAGE PLATE CHARACTERISTICS



K-55611-TD146-1

SEPTEMBER 8, 1961

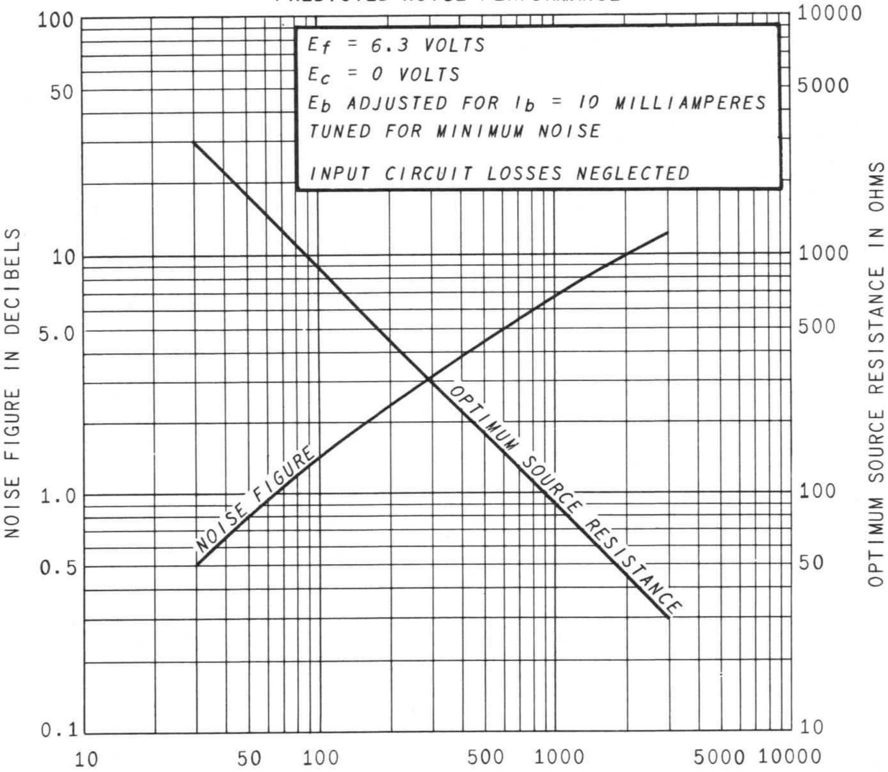
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD146-2

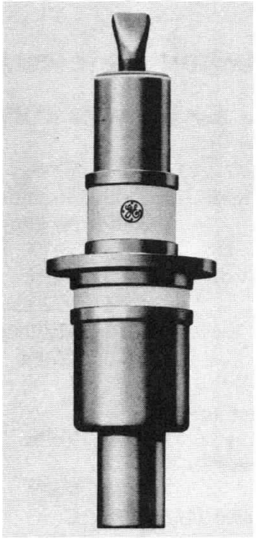
SEPTEMBER 8, 1961

PREDICTED NOISE PERFORMANCE



K-55611-TD146-3 SEPTEMBER 8, 1961

6442
PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Small Size

Two Kilowatts Useful Pulse Power Output

The 6442 is a high-mu, metal-and-ceramic triode intended for operation as a plate-pulsed, grounded-grid oscillator at frequencies as high as 5000 megacycles. The 6442 is also useful as a CW, radio-frequency power amplifier or frequency multiplier at frequencies as high as 2500 megacycles.

Features of the 6442 include small size, planar electrode construction with close spacing, inherent rigidity, an envelope structure convenient for coaxial circuit applications, and excellent resistance to vibration and shock.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	0.9†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.3	pf
Grid to Cathode: (g to k)	5.0	pf
Plate to Cathode: (p to k), max.	0.045	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1	Ounce

Cooling—Conduction and Convection

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES
PLATE-PULSED OSCILLATOR SERVICE

Heater Voltage*	5.7 to 6.3	Volts
Cathode Heating Time, minimum	60	Seconds
Frequency	5000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶ ⋇	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average ⋇	2.5	Milliamperes
Average During Plate Pulse△	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average ⋇	1.25	Milliamperes
Average During Plate Pulse	1.25	Amperes
Plate Dissipation ⋇	7.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS (Continued)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down Conditions per Tube Without Amplitude Modulation**

Heater Voltage*	4.5 to 5.7	Volts
Cathode Heating Time, minimum	30	Seconds
Frequency	2500	Megacycles
DC Plate Voltage	350	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	35	Milliamperes
DC Grid Current	15	Milliamperes
Plate Dissipation	8.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
Cathode Heating Time, minimum	30	Seconds
Frequency	2500	Megacycles
DC Plate Voltage	275	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	35	Milliamperes
DC Grid Current	15	Milliamperes
Plate Dissipation	6.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	350	Volts
Grid Voltage	−4.25	Volts
Amplification Factor	50	
Transconductance	16500	Micromhos
Plate Current	35	Milliamperes

PLATE-PULSED OSCILLATOR

Frequency	3500	5000	Megacycles
Heater Voltage	6.0	6.0	Volts
Duty Factor	0.001	0.001	
Pulse Duration	1.0	1.0	Microseconds
Pulse Repetition Rate	1000	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	3000	3000	Volts
Negative Grid Voltage Average During Plate Pulse	75	75	Volts
Grid-Bias Resistor	50	50	Ohms
Plate Current			
Average	2.5	2.5	Milliamperes
Average During Plate Pulse	2.5	2.5	Amperes
Grid Current			
Average	1.25	1.25	Milliamperes
Average During Plate Pulse	1.25	1.25	Amperes
Useful Power Output			
Average	2.0	0.5	Watts
Average During Plate Pulse	2.0	0.5	Kilowatts

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEGRAPHY

Frequency	1000	Megacycles
Heater Voltage	5.7	Volts
DC Plate Voltage	250	Volts
DC Plate Current	23	Milliamperes
DC Grid Current	6.0	Milliamperes
Driving Power	0.35	Watts
Useful Power Output	2.8	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.3 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

In any 5000 microsecond interval.

△ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

**Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	840	900	960	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 350 volts				
Ib = 35 ma	−2.5	−4.25	−5.75	Volts
Transconductance				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma	13500	16500	19000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma	35	50	65	
Negative Grid Current				
Ef = 6.3 volts, Eb = 350 volts				
Ec adjusted for Ib = 35 ma		.....	0.5	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 100 volts d-c	25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	250	.....	.....	Megohms
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode		.....	100	Microamperes
Heater Negative with Respect to Cathode		.....	100	Microamperes
Interelectrode Capacitances				
Grid to Plate: (g to p)	2.10	2.3	2.45	Picofarads
Grid to Cathode: (g to k)	4.60	5.0	5.45	Picofarads
Plate to Cathode: (p to k)		.....	0.045	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Pulsed-Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 6.0 volts; F = 3450 MC, min.; epy = 3000 volts; tp = 1.0 μsec. ± 10%; prr adjusted for Du = 0.001 ± 5%; Rg adjusted for Ib = 2.5 ma	1.75	.....	Watts
Pulse Emission Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts; tp = 1 to 3 μsec.; Du = 0.0005, min.; prr = 500 pps, max.; eb = ec and adjusted for is = 8 amp	....	175	Volts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 250 mm Hg. Tubes shall not give visual evidence of flashover when 3000 volts RMS, 60 cps, is applied between the plate and grid terminals

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 20 mm Hg. Tubes shall not give visual evidence of flashover when 500 volts RMS, 60 cps, is applied between the plate and grid terminals

DEGRADATION RATE TESTS

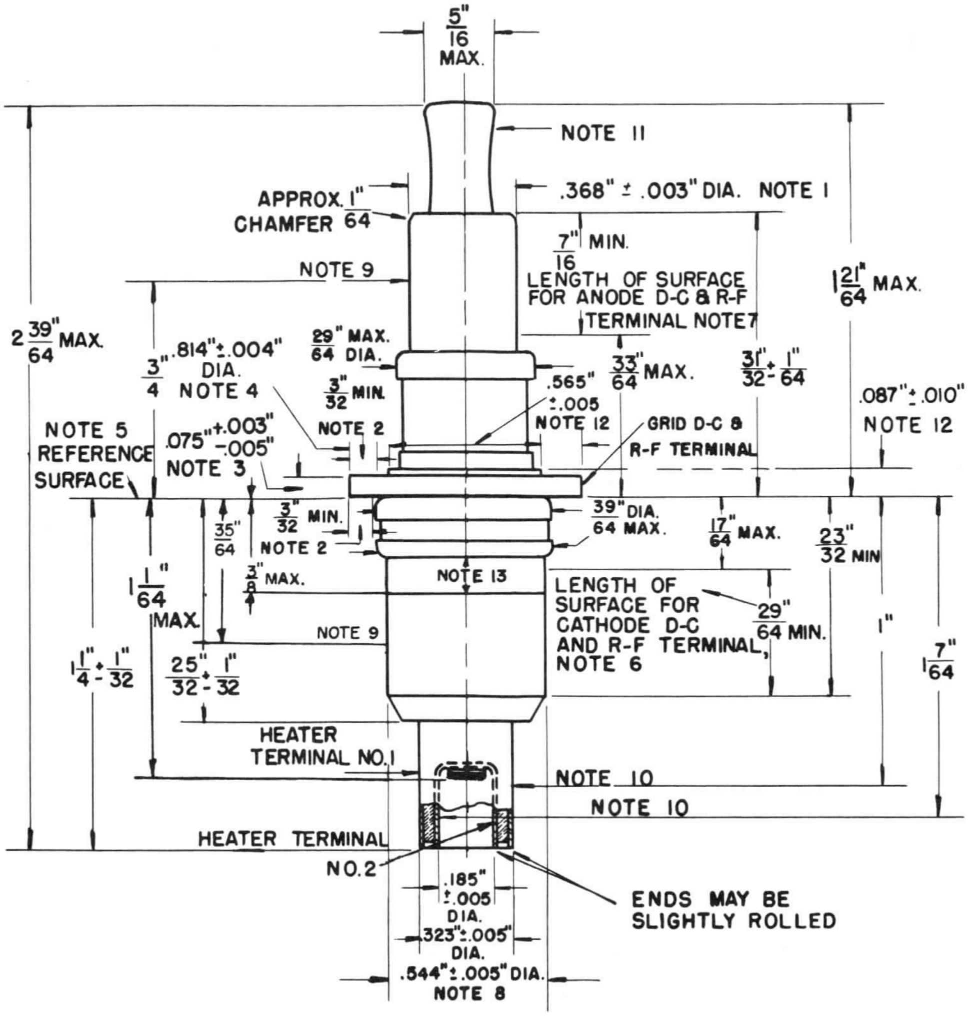
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as a pulsed oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS



K-69087-72A684 4-59

Note 1. Applies to minimum surface for anode d-c and r-f terminal only. Other surfaces must not be used for these terminal purposes.

Note 2. Applies to minimum surface for grid d-c and r-f terminal only. Other surfaces, except for Notes 3 and 4, must not be used for terminal purposes.

Note 3. Applies to minimum surfaces for grid d-c and r-f terminal only.

Note 4. The cylindrical surface of this diameter may be used for grid d-c and r-f terminal purposes.

Note 5. The surfaces defined by Notes 2, 3, and 4 shall be the only surfaces used for tube stops and clamping purposes.

Note 6. Other surfaces shall not be used for cathode d-c and r-f terminal purposes.

Note 7. Other surfaces shall not be used for anode d-c and r-f terminal purposes.

Note 8. Applies to surface designated for cathode d-c and r-f terminal. Solder at brazed joint will not exceed the maximum diameter.

Note 9. The maximum eccentricity of the anode and cathode with respect to the grid terminal in a prescribed jig is 0.010 (or maximum total runout of 0.020) and is measured by indicators at the points designated.

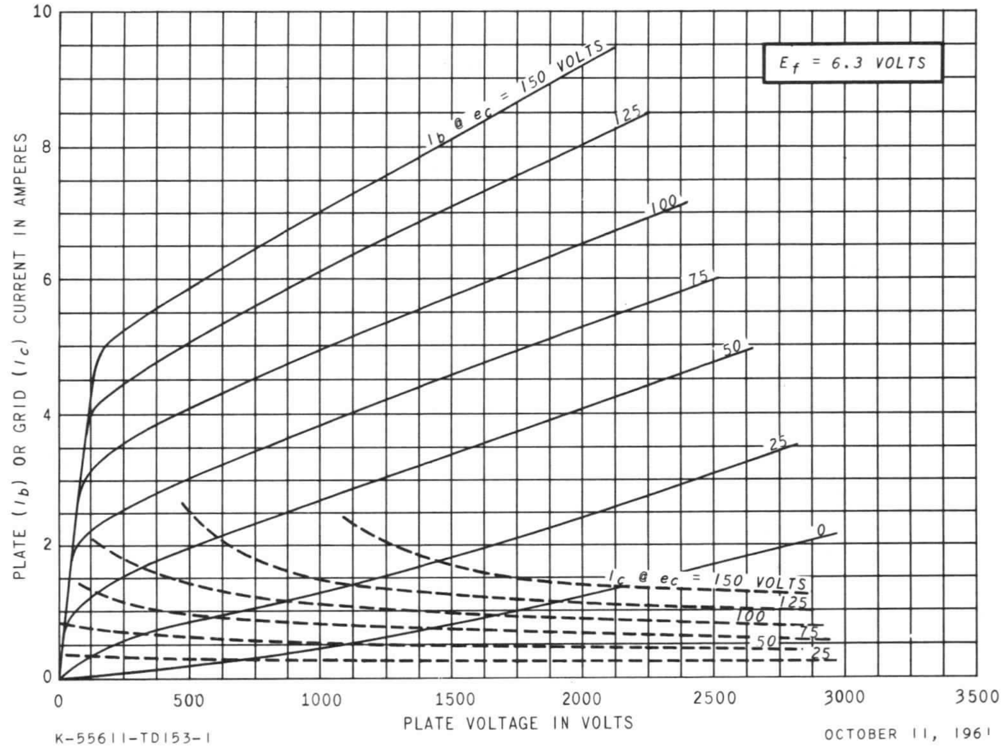
Note 10. The maximum eccentricity of heater-terminal No. 1 and heater-terminal No. 2 with respect to the grid terminal in a prescribed jig is 0.015 (or maximum total runout of 0.030) and is measured by indicators at the points designated.

Note 11. Exhaust tubulation must not be subjected to any mechanical stress.

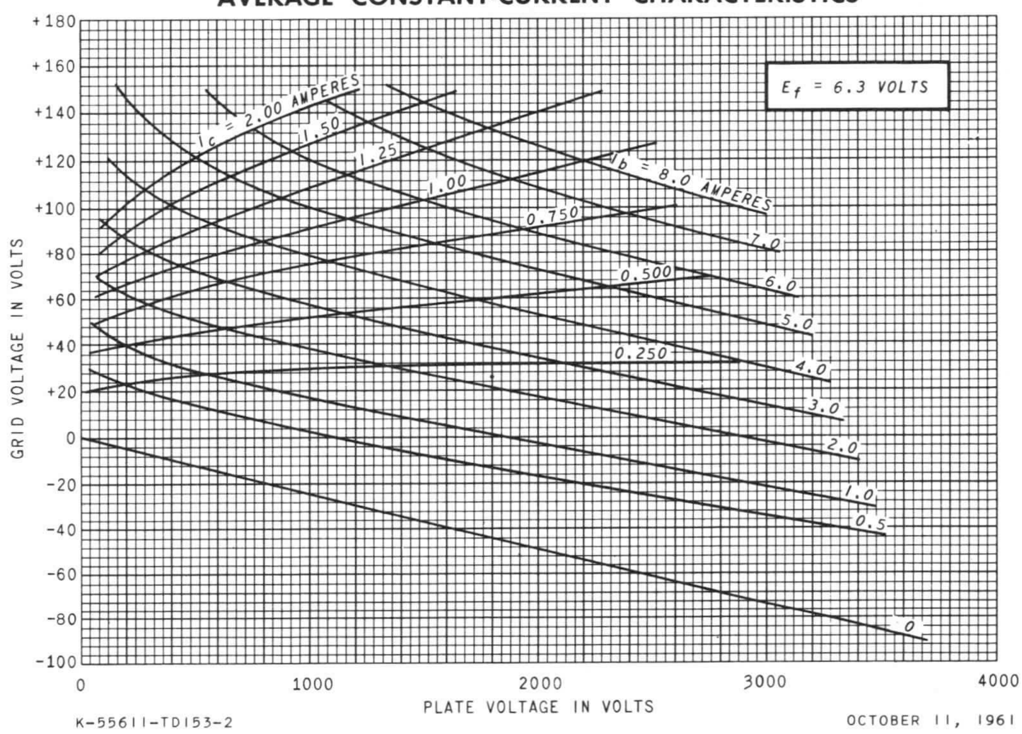
Note 12. For reference only. Dimension does not include any possible solder fillet.

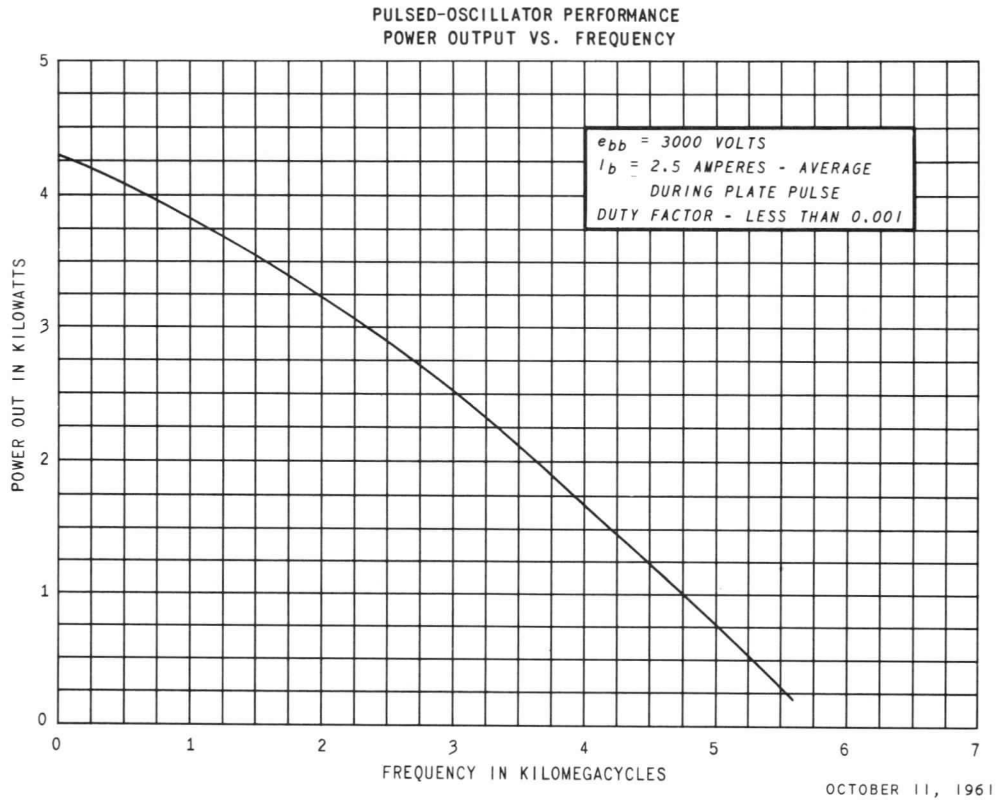
Note 13. This area is reserved for tube stamping and coding.

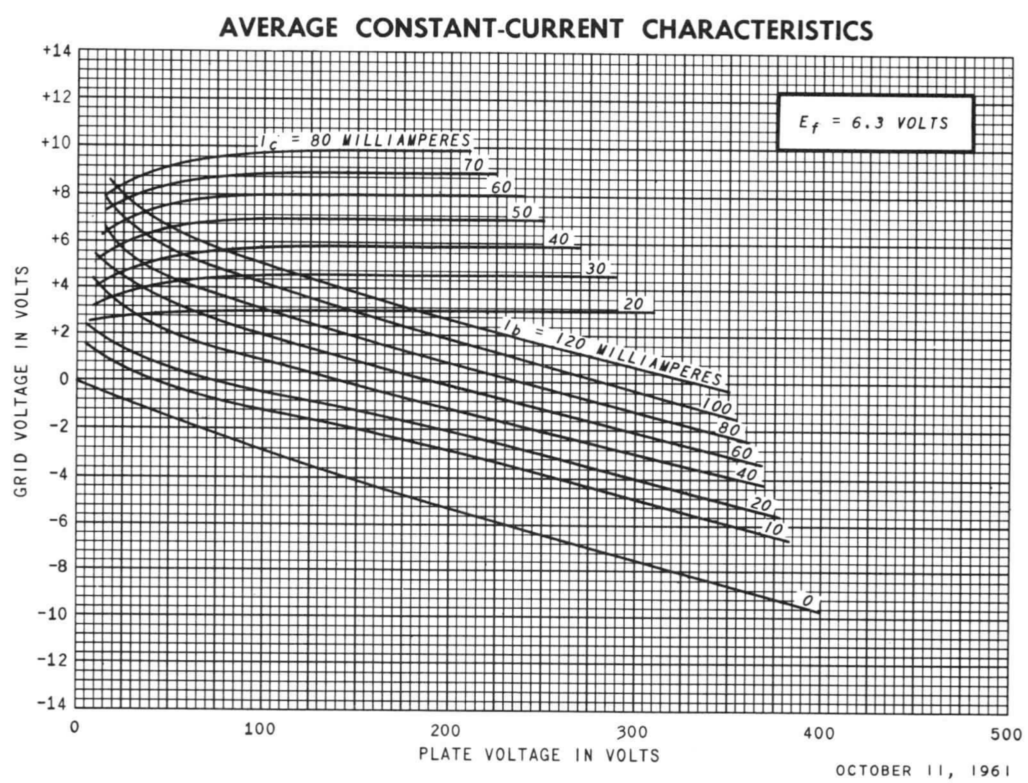
AVERAGE PLATE CHARACTERISTICS



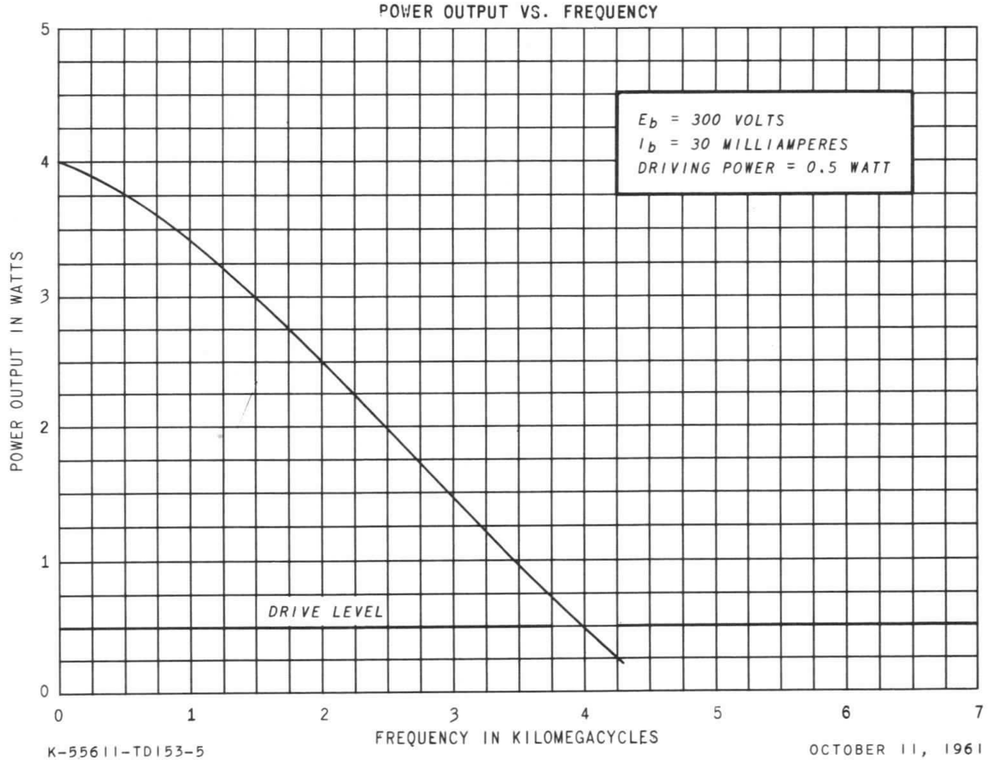
AVERAGE CONSTANT-CURRENT CHARACTERISTICS




PULSED-OSCILLATOR PERFORMANCE
POWER OUTPUT VS. FREQUENCY
e_bb = 3000 VOLTS
I_b = 2.5 AMPERES - AVERAGE DURING PLATE PULSE
DUTY FACTOR - LESS THAN 0.001
POWER OUT IN KILOWATTS
FREQUENCY IN KILOMEGACYCLES
OCTOBER 11, 1961

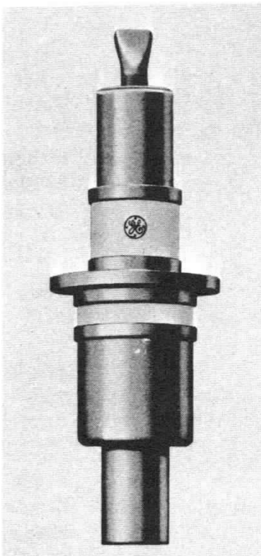

AVERAGE CONSTANT-CURRENT CHARACTERISTICS
E_f = 6.3 VOLTS
I_c = 80 MILLIAMPERES
I_b = 120 MILLIAMPERES
GRID VOLTAGE IN VOLTS
PLATE VOLTAGE IN VOLTS
OCTOBER 11, 1961

CW - AMPLIFIER PERFORMANCE
POWER OUTPUT VS. FREQUENCY



ELECTRONICS

6771
PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR, AMPLIFIER, AND FREQUENCY MULTIPLIER SERVICE

Metal and Ceramic — Small Size

The 6771 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid oscillator, radio-frequency power amplifier, or frequency multiplier at frequencies as high as 4000 megacycles. The 6771 is also useful as a plate-pulsed, grounded-grid oscillator at frequencies as high as 5000 megacycles.

Features of the 6771 include small size, planar electrode construction with close spacing, inherent rigidity, an envelope structure convenient for coaxial circuit applications, and excellent resistance to vibration and shock.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential		
Heater Characteristics and Ratings		
Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	0.575†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.03	pf
Grid to Cathode: (g to k)	4.05	pf
Plate to Cathode: (p to k)	0.018	pf

MECHANICAL

Mounting Position—Any		
Net Weight, approximate	0.9	Ounces
Cooling—Conduction and Convection		

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY AMPLIFIER—CLASS A

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	300	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	25	Milliamperes
Plate Dissipation	6.25	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.5	Megohms
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

Supersedes ET-T1518A dated 3-60

MAXIMUM RATINGS (Continued)

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	275	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	25	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	6.25	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	250	Volts
Negative DC Grid Voltage	25	Volts
DC Plate Current	22	Milliamperes
DC Grid Current	8.0	Milliamperes
Plate Dissipation	5.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

FREQUENCY MULTIPLIER

Heater Voltage*	4.5 to 5.7	Volts
DC Plate Voltage	250	Volts
Negative DC Grid Voltage	50	Volts
DC Plate Current	20	Milliamperes
DC Grid Current	5.0	Milliamperes
Plate Dissipation	5.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Grid Circuit Resistance	0.1	Megohms
Envelope Temperature at Hottest Point	175	C

PLATE-PULSED OSCILLATOR SERVICE

Heater Voltage*	5.7 to 6.3	Volts
Cathode Heating Time, minimum	60	Seconds
Frequency	5000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	1750	Volts
Duty Factor of Plate Pulse¶ ⋇	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average ⋇	1.25	Milliamperes
Average During Plate Pulse△	1.25	Amperes
Negative Grid Voltage		
Average During Plate Pulse	75	Volts
Grid Current		
Average ⋇	0.7	Milliamperes
Average During Plate Pulse	700	Milliamperes
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	250	Volts
Grid Voltage, approximate	−1.6	Volts
Amplification Factor	90	
Transconductance	23000	Micromhos
Plate Current	25	Milliamperes

RADIO-FREQUENCY OSCILLATOR

Frequency	4000	Megacycles
Heater Voltage	4.5	Volts
DC Plate Voltage	275	Volts
DC Plate Current	25	Milliamperes
Power Output	300	Milliwatts

FREQUENCY MULTIPLIER—DOUBLER TO 1000 MEGACYCLES

Heater Voltage	5.25	Volts
DC Plate Voltage	250	Volts
DC Plate Current	20	Milliamperes
DC Grid Voltage	−10	Volts
DC Grid Current	5.0	Milliamperes
Driving Power	300	Milliwatts
Power Output	2.0	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.3 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

§ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

\# In any 5000 microsecond interval.

△ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 12.5 amperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	530	575	620	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 250 volts, Ib = 25 ma	−0.90	−1.60	−2.65	Volts
Grid Voltage				
Ef = 6.3 volts, Eb = 250 volts, Ib = 2 ma	−2.00	−3.50	−5.40	Volts
Transconductance				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	18500	23000	27500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	60	90	120	
Negative Grid Current				
Ef = 6.3 volts, Eb = 250 volts, Ec adjusted for Ib = 25 ma	.....	.....	0.35	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 100 volts d-c	25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	250	.....	.....	Megohms
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	100	Microamperes
Heater Negative with Respect to Cathode	.....	.....	100	Microamperes
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.75	2.03	2.30	Picofarads
Grid to Cathode: (g to k)	3.60	4.05	4.55	Picofarads
Plate to Cathode: (p to k)	0.012	0.018	0.024	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 4.5 volts; F = 4000 MC, min.; Eb = 275 volts, Ec adjusted for Ib = 25 ma	200	...	Milliwatts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 20 mm Hg. Tubes shall not give visual evidence of flashover when 500 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

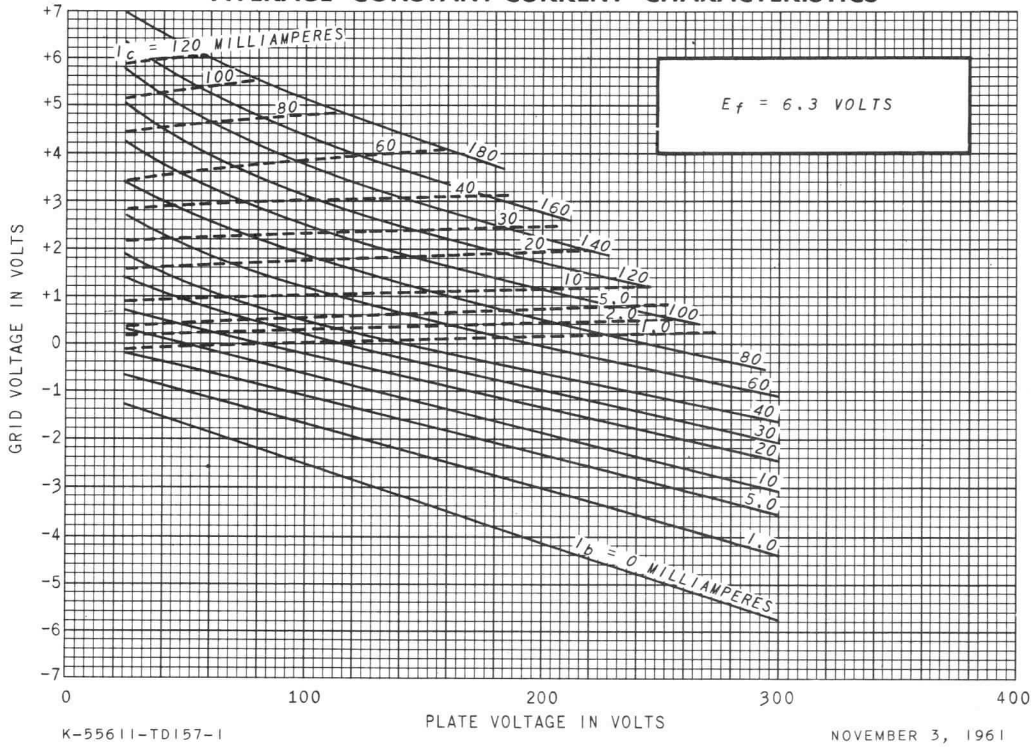
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

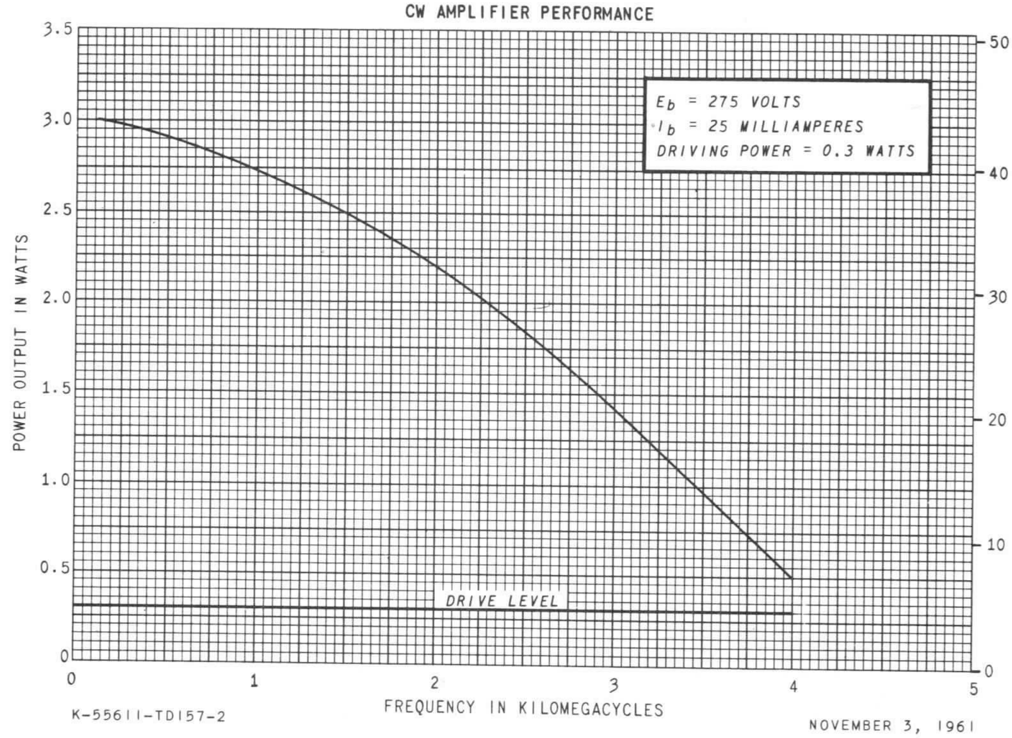
1000-Hour Life Test

Statistical sample operated for 1000 hours as an oscillator to evaluate changes in power output with life.

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



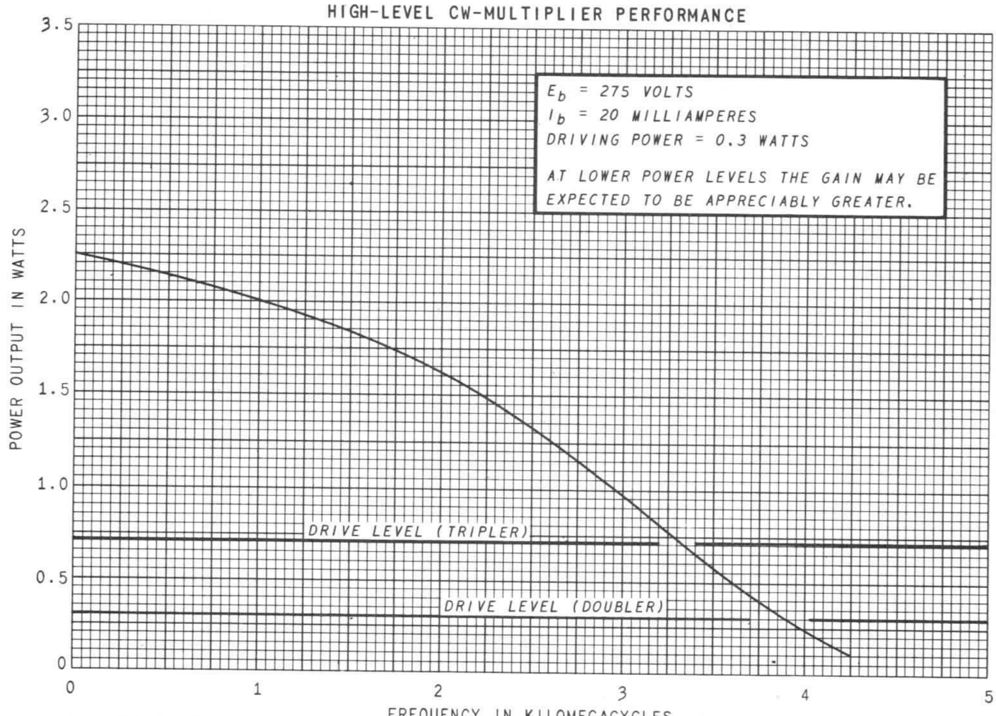
CW AMPLIFIER PERFORMANCE



K-55611-TD157-2

NOVEMBER 3, 1961

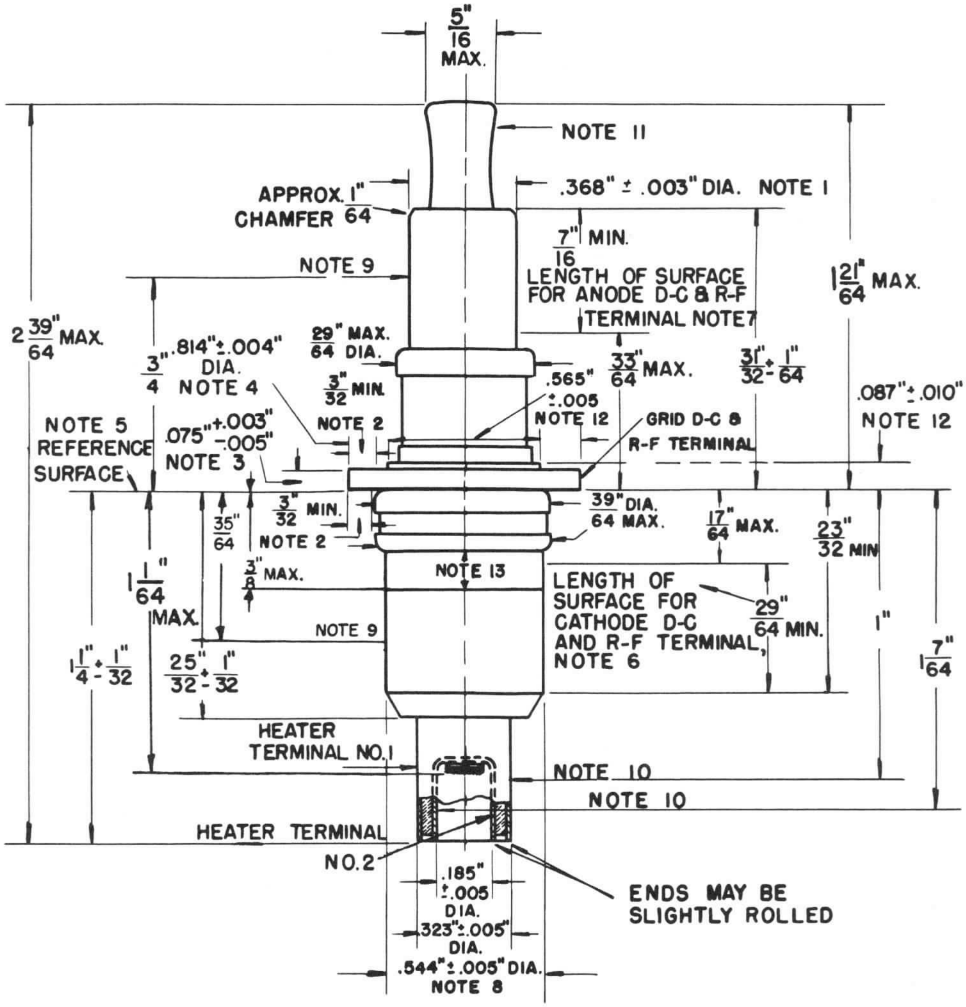
HIGH-LEVEL CW-MULTIPLIER PERFORMANCE



K-55611-TD157-3

NOVEMBER 3, 1961

PHYSICAL DIMENSIONS



K-69087-72A684 4-59

Note 1. Applies to minimum surface for anode d-c and r-f terminal only. Other surfaces must not be used for these terminal purposes.

Note 2. Applies to minimum surface for grid d-c and r-f terminal only. Other surfaces, except for Notes 3 and 4, must not be used for terminal purposes.

Note 3. Applies to minimum surfaces for grid d-c and r-f terminal only.

Note 4. The cylindrical surface of this diameter may be used for grid d-c and r-f terminal purposes.

Note 5. The surfaces defined by Notes 2, 3, and 4 shall be the only surfaces used for tube stops and clamping purposes.

Note 6. Other surfaces shall not be used for cathode d-c and r-f terminal purposes.

Note 7. Other surfaces shall not be used for anode d-c and r-f terminal purposes.

Note 8. Applies to surface designated for cathode d-c and r-f terminal. Solder at brazed joint will not exceed the maximum diameter.

Note 9. The maximum eccentricity of the anode and cathode with respect to the grid terminal in a prescribed jig is 0.010 (or maximum total runout of 0.020) and is measured by indicators at the points designated.

Note 10. The maximum eccentricity of heater-terminal No. 1 and heater-terminal No. 2 with respect to the grid terminal in a prescribed jig is 0.015 (or maximum total runout of 0.030) and is measured by indicators at the points designated.

Note 11. Exhaust tubulation must not be subjected to any mechanical stress.

Note 12. For reference only. Dimension does not include any possible solder fillet.

Note 13. This area is reserved for tube stamping and coding.

ELECTRONICS

6897

PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR AND AMPLIFIER SERVICE

Metal and Ceramic — Low Interelectrode Capacitances
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 6897 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

Features of the 6897 include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03†	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to be Used as a Socket Stop and Clamp

Net Weight, approximate .... 2 Ounces

Cooling
- Plate and Plate Seal—Conduction and Forced Air
- Grid and Cathode Seals—Conduction and Forced Air
- Recommended Air Flow Cowling—157-JAN
- Recommended Air Flow on Plate Radiator at Sea Level
  - Incoming Air Temperature 25C,
    - Plate Dissipation
      - 100 Watts .... 12.5 Cu. Ft./Min.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR —CLASS C TELEGRAPHY

Key-down Conditions per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point ⋇	250	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR —CLASS C TELEPHONY

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point ⋇	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage△	.....	Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

RADIO-FREQUENCY OSCILLATOR—CLASS C

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	−40	−22	Volts
Useful Power Output	40	17	Watts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured in a special shielded socket.

§ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

\# Where long life and reliable operation are important, lower envelope temperatures should be used.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

△Adjusted for Ib = 75 milliamperes.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	−1.3	−2.5	−3.5	Volts
Grid Voltage Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	−7.0	−9.5	−15	Volts
Transconductance Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	.....	.....	3.0	Microamperes
Interelectrode Leakage Resistance Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results Grid to Cathode at 500 volts d-c	50	.....	.....	Megohms
Interelectrode Capacitances Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts
Low Pressure Voltage Breakdown Test Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals			

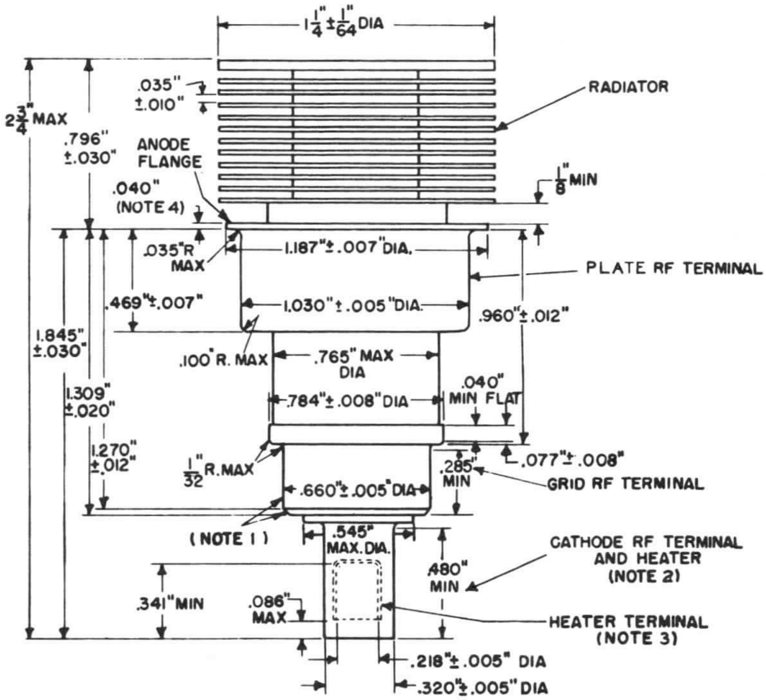
DEGRADATION RATE TESTS

Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 1.0 milliseconds duration in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

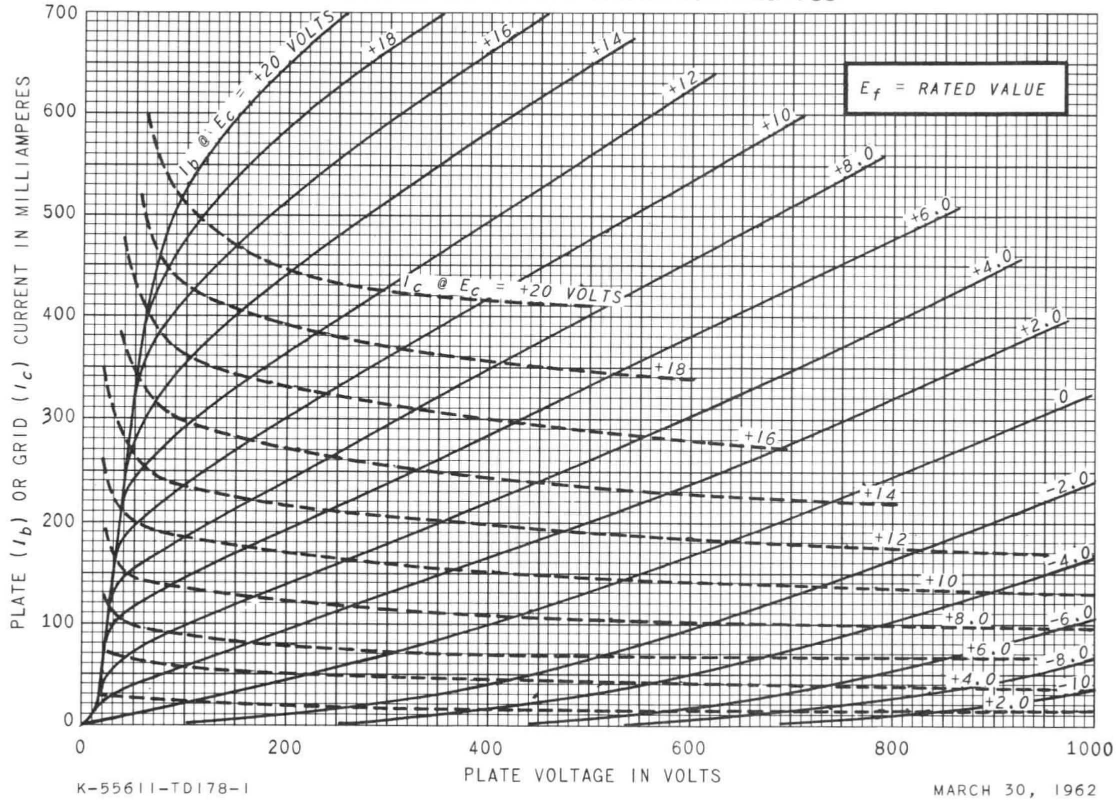


NOTES:

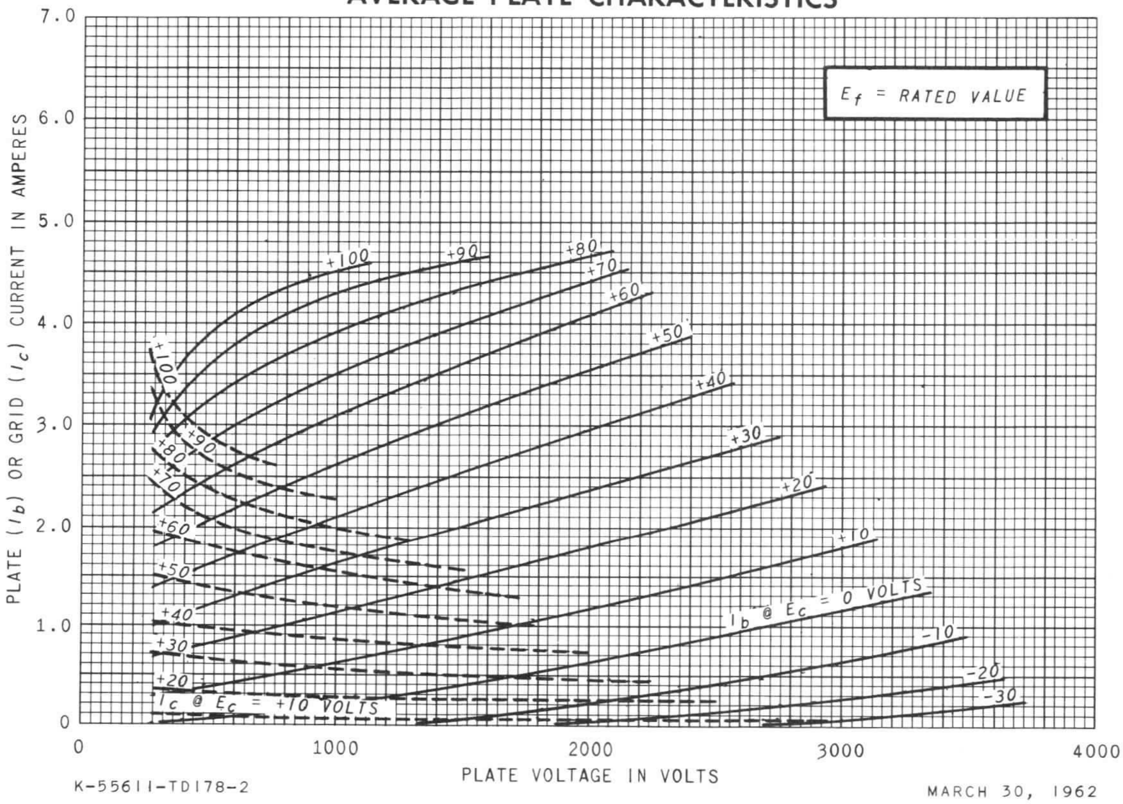
1. Solder not to extend radially beyond grid RF terminal.
2. Total indicated runout of the grid-contact surface and the cathode-contact surface with respect to the anode shall not exceed 0.020".
3. Total indicated runout of the cathode-contact surface with respect to the heater-contact surface shall not exceed 0.012".
4. Only this flange to be used as a socket stop and clamp.

¶ New pages 3 to 6 supersede pages 3 and 4 dated 12-61.

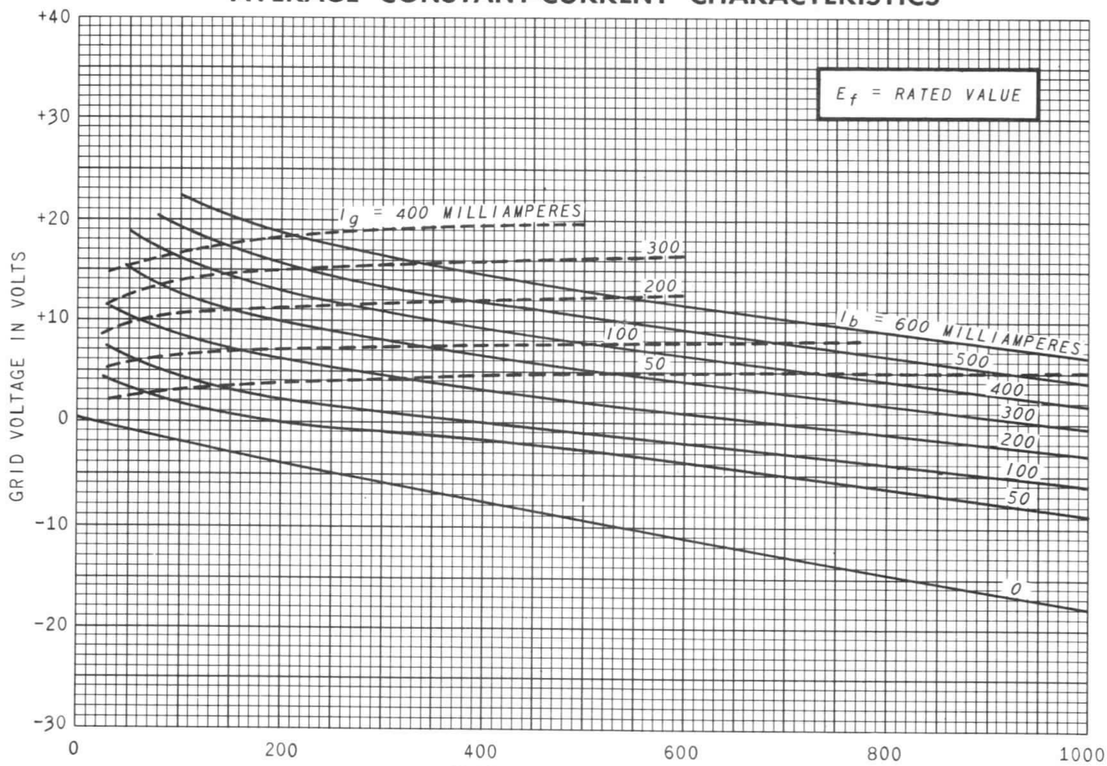
AVERAGE PLATE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



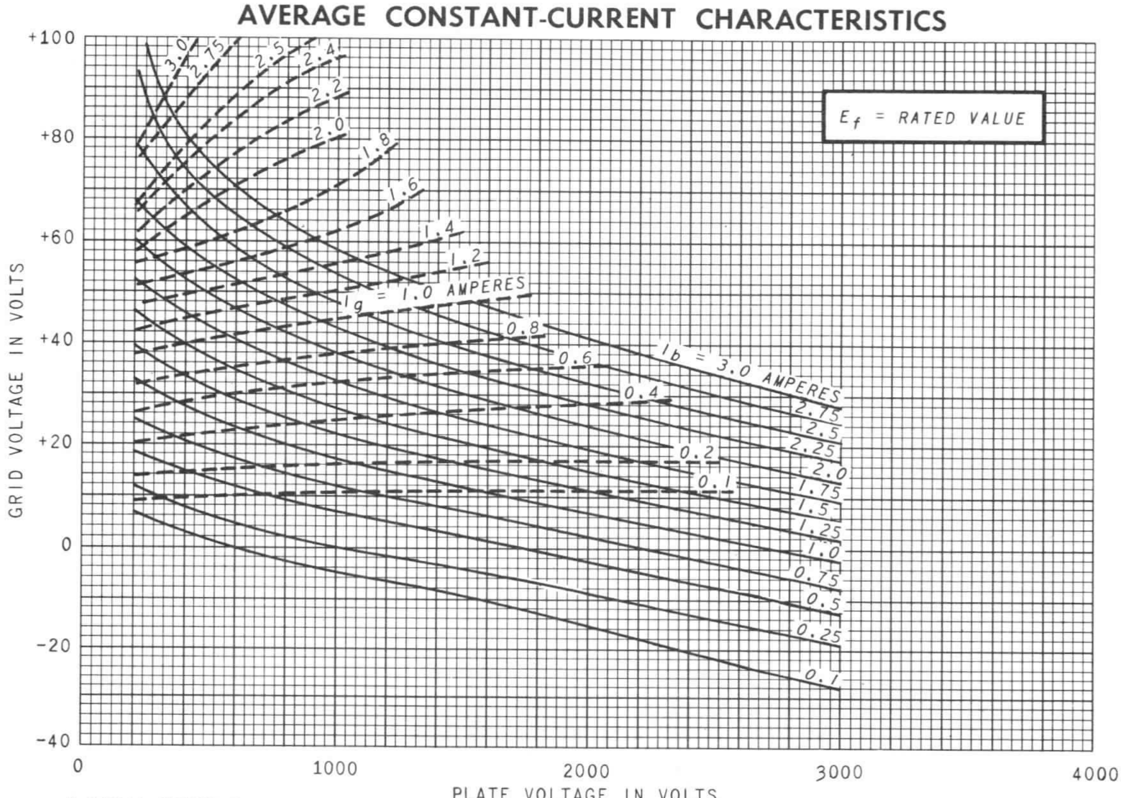
AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD178-3

MARCH 30, 1962

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD178-4

MARCH 30, 1962

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

METAL-CERAMIC TRIODE

FOR UHF AMPLIFIER APPLICATIONS

DESCRIPTION AND RATING

The 7077 is a high-mu triode of ceramic and metal planar construction primarily intended for use as an r-f amplifier in the UHF range. It features an extremely low noise figure throughout its frequency range. The 7077 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h+k)	1.7	pf
Output: p to (h+k)	0.01	pf
Heater to Cathode: (h to k)	1.1	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	1.1	Watts
DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature§	250	C
Grid-Circuit Resistance	0.01	Megohms

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

Supersedes ET-T1488 dated 3-58 and 10-59

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Supply Voltage	250	Volts
Resistor in Plate Circuit (bypassed)	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Amplification Factor	90	
Plate Resistance, approximate	9000	Ohms
Transconductance	10000	Micromhos
Plate Current	6.5	Milliamperes
Grid Voltage, approximate Gm = 50 Micromhos	−5	Volts

GROUNDED-GRID AMPLIFIER—450 MEGACYCLES

Plate Supply Voltage¶	250	Volts
Resistor in Plate Circuit (bypassed)¶	18000	Ohms
Cathode-Bias Resistor	82	Ohms
Plate Current	6.5	Milliamperes
Bandwidth, approximate	7.5	Megacycles
Power Gain, approximate	14.5	Decibels
Noise Figure (Measured with power-matched input, using argon lamp noise source), approximate	5.5	Decibels

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

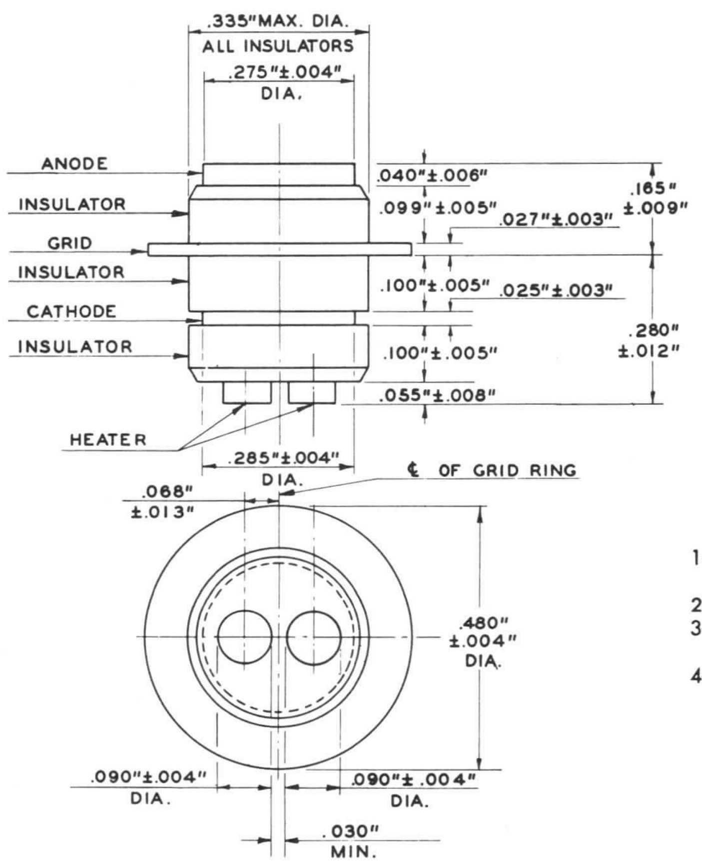
† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured using a grounded adapter that provides shielding between external terminals of tube.

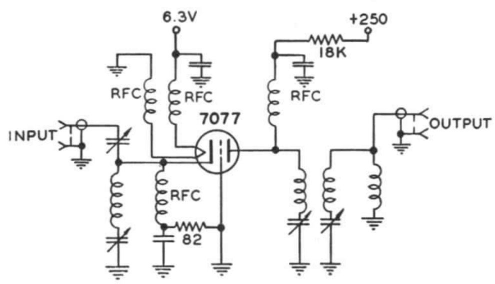
§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7077 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

¶ Lower supply voltage and a lower value of resistor may be used in the plate circuit with some sacrifice in uniformity of performance.

OUTLINE DRAWING



TYPICAL GROUNDED-GRID AMPLIFIER CIRCUIT USING THE 7077



1—Maximum eccentricity of anode, grid, and cathode 0.005" from center line.
2—Maximum eccentricity of insulators 0.010" from center line.
3—Center line of grid ring used as reference line for horizontal tolerances.
4—Bottom surface of grid ring used as reference line for vertical tolerances.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
$Ef = 6.3$ volts	222	240	258	Milliamperes
Plate Current				
$Ef = 6.3$ volts, $Ebb = 250$ volts, $R_L = 18000$ ohms, $Rk = 82$ ohms (bypassed)	4.5	6.5	8.5	Milliamperes
Transconductance				
$Ef = 6.3$ volts, $Ebb = 250$ volts, $R_L = 18000$ ohms (bypassed), $Rk = 82$ ohms (bypassed)	7000	10000	13000	Micromhos
Transconductance Change with Heater Voltage				
Difference between Transconductance measured at $Ef = 6.3$ and $Ef = 6.0$ volts (other conditions the same) expressed as a percentage	....	.....	20	Percent
Amplification Factor				
$Ef = 6.3$ volts, $Ebb = 250$ volts, $R_L = 18000$ ohms (bypassed), $Rk = 82$ ohms (bypassed)	65	90	115	
Interelectrode Capacitances				
Grid to Plate: (g to p)	0.84	1.00	1.16	Picofarads
Input: g to (h+k)	1.25	1.70	2.15	Picofarads
Output: p to (h+k)	0.004	0.010	0.016	Picofarads
Heater to Cathode: (h to k)	0.80	1.10	1.40	Picofarads
Heater-Cathode Leakage Current				
$Ef = 6.3$ volts, $Ehk = 100$ volts				
Heater Positive with Respect to Cathode	....	.....	20	Microamperes
Heater Negative with Respect to Cathode	....	.....	20	Microamperes
Interelectrode Leakage Resistance				
$Ef = 6.3$ volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
$Ef = 7.0$ volts, $Ebb = 250$ volts, $Ecc = -20$ volts, $Rk = 82$ ohms (bypassed), $Rg = 0.1$ meg, $R_L = 18000$ ohms (bypassed)	....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Noise Figure				
$Ef = 6.3$ volts, $Ebb = 250$ volts, $Rk = 82$ ohms, $R_L = 18000$ ohms, $F = 450$ mc	....	5.5	6.6	Decibels
Noise Figure at Reduced Heater Voltage				
$Ef = 6.0$ volts, $Ebb = 250$ volts, $Rk = 82$ ohms, $R_L = 18000$ ohms, $F = 450$ mc	....	.....	8.1	Decibels
Power Gain				
$Ef = 6.3$ volts, $Ebb = 250$ volts, $Rk = 82$ ohms, $R_L = 18000$ ohms, $F = 450$ mc	12.5	14.5	.....	Decibels

SPECIAL PERFORMANCE TESTS (Continued)

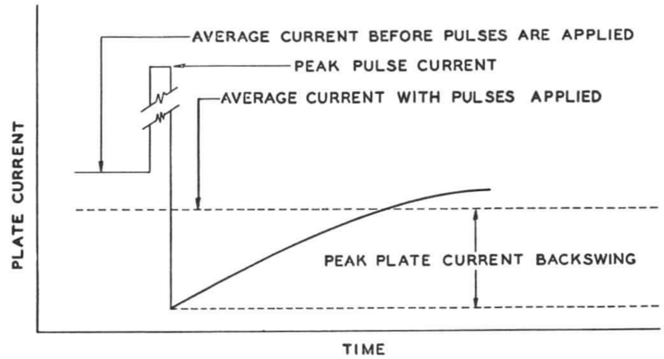
Grid Recovery

Change in Average Plate Current	....	.....	0.6 Milliamperes
Peak Plate Current Backswing	....	.....	1.0 Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7077 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5 volts positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

PLATE CURRENT VS. TIME
—GRID RECOVERY TEST



	Min.	Bogey	Max.
Low Frequency Vibrational Output	....	.....	10 Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 15 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of 96 hours, 48 hours in each of two planes, at a peak acceleration of 10G. Frequency is 60 cps. Tubes are operated during the test with Ef = 6.3 volts (no other voltages applied). Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, noise figure, and gain.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency

DEGRADATION RATE TESTS (Continued)

vibrational output, heater-cathode leakage, heater current, noise figure, and gain.

Stability Life Test

Statistical sample operated under Intermittent Life Test conditions is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

Statistical sample operated under Intermittent Life Test conditions is evaluated for shorted and open elements, transconductance, and noise figure following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 300 volts, Ehk = +70 volts d-c, Rk = 82 ohms, R_L = 18000 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, noise figure, gain, heater-cathode leakage, and interelectrode leakage resistance.

High-Temperature Intermittent Life Test

Statistical sample operated for 1000 hours under Intermittent Life Test conditions except that minimum envelope temperature shall be 250C. Tubes are evaluated, following 500 and 1000 of life test, for shorted or open elements, heater current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

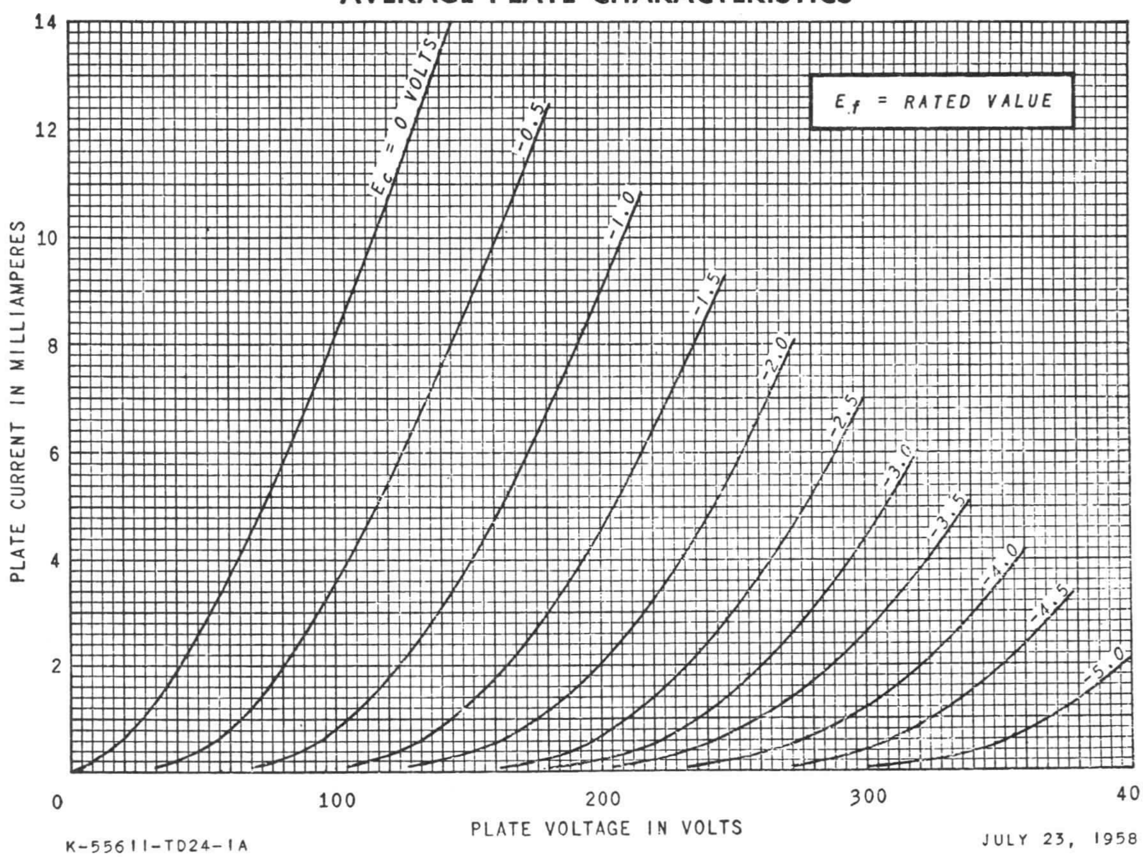
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

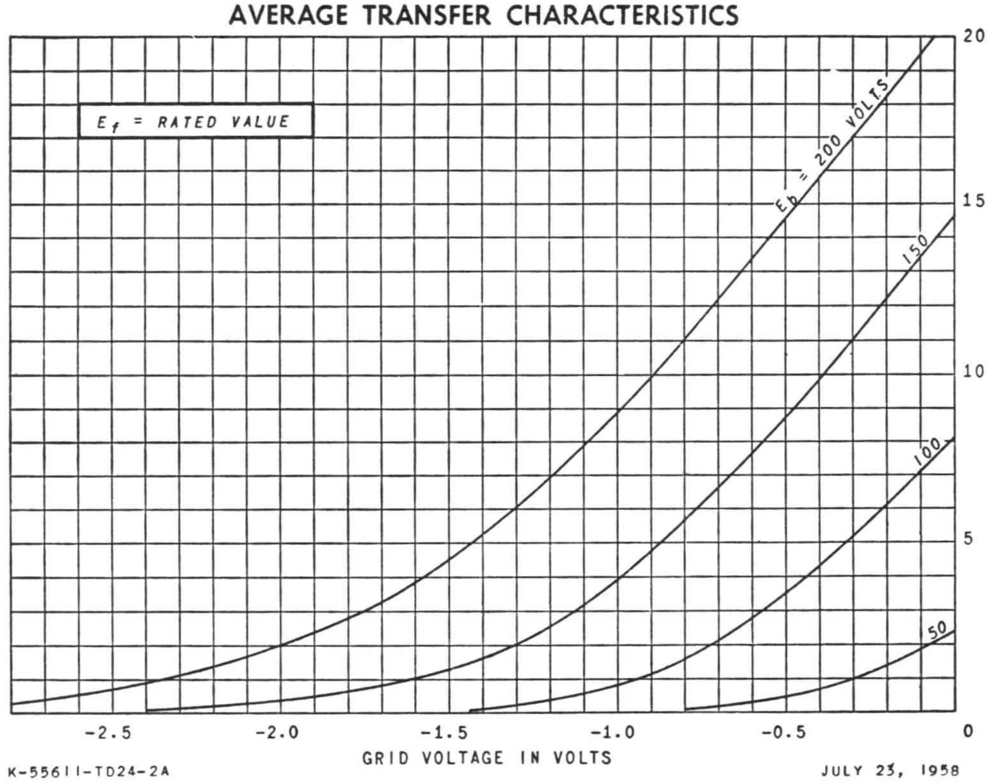
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable operating conditions.

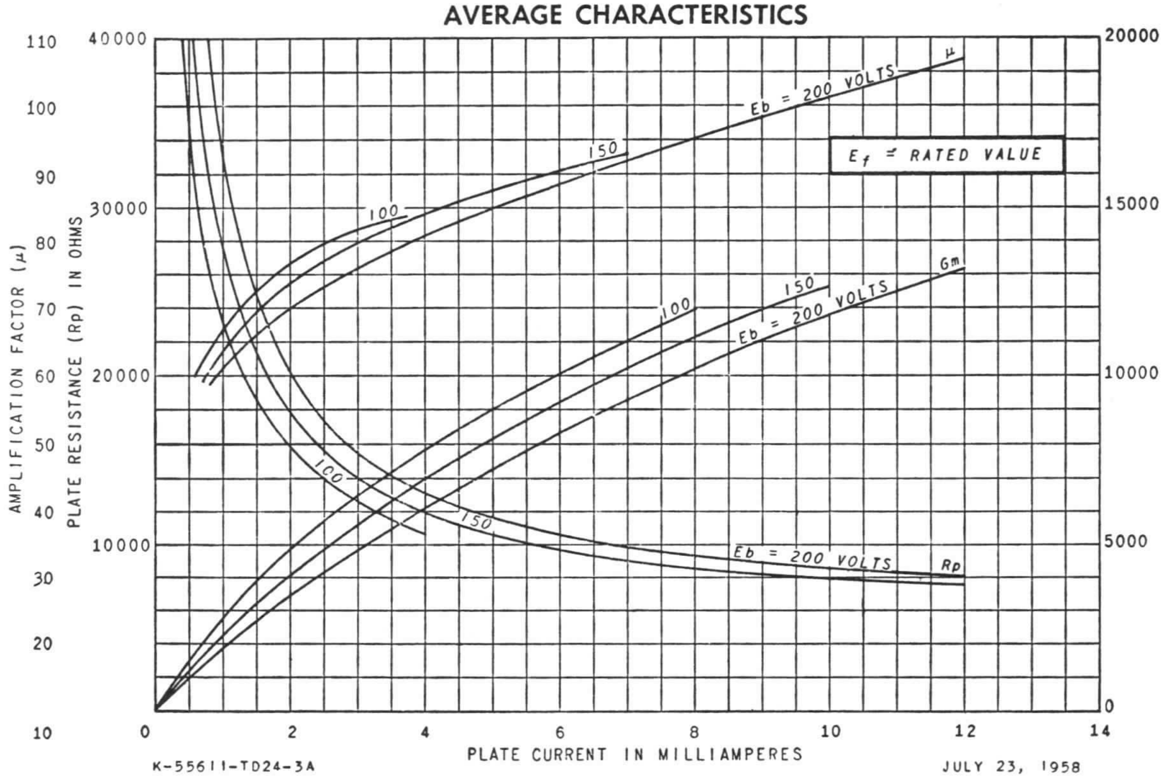
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



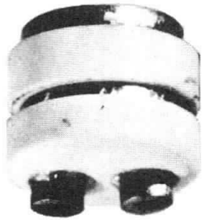
TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7266

METAL-CERAMIC DIODE



DESCRIPTION AND RATING

The 7266 is a cathode-type diode of ceramic-and-metal planar construction. It is intended for detector, high-frequency instrument probe, and low-current rectifier applications. The 7266 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.215	Amperes
Direct Interelectrode Capacitances‡		
Plate to Cathode: (p to k)	1.0	pf
Heater to Cathode: (h to k)	1.3	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Peak Inverse Plate Voltage	600	Volts
Steady-State Peak Plate Current	11	Milliamperes
DC Output Current	2.2	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point§	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop

Ib = 1.0 Milliamperes DC	1.0	Volts

AVERAGE CHARACTERISTICS (Continued)

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Measured using a grounded adapter that provides shielding between external terminals of tube.
§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7266 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	198	215	232	Milliamperes
Tube Voltage Drop				
Ef = 6.3 volts, Eb adjusted for Ib = 1.0 ma	0.4	1.0	2.0	Volts
Tube Voltage Drop at Reduced Heater Voltage				
Ef = 5.7 volts, Eb adjusted for Ib = 1.0 ma	...	...	2.3	Volts
Emission				
Ef = 6.3 volts, Eb = 9 volts d-c	10	...	...	Milliamperes
Plate Current				
Ef = 6.3 volts, Ebb = 0 volts, R_L = 40000 ohms	2	8	16	Microamperes
Interelectrode Capacitances				
Plate to Cathode: (p to k)	0.7	1.0	1.3	Picofarads
Heater to Cathode: (h to k)	0.9	1.3	1.7	Picofarads
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	...	...	20	Microamperes
Heater Negative with Respect to Cathode	...	...	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode omission results.				
Plate to A11 at 500 volts d-c	10000	...	...	Megohms

SPECIAL PERFORMANCE TESTS

Low Pressure Voltage Breakdown Test
Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and cathode terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts and Ehk = +100 volts. Following the test, tubes are evaluated for heater-cathode leakage and heater current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts and Ehk = +100 volts. Following the test, tubes are evaluated for heater-cathode leakage and heater current.

Survival Rate Life Test

The combined statistical samples subjected to the Intermittent and Standby Life Tests are evaluated for shorted and open elements and tube voltage drop following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 220 volts RMS, Ehk = −70 volts d-c, R_L = 0.13 meg, C_L = 1.0 μf, and Rs = 1300 ohms. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, tube voltage drop, heater-cathode leakage, interelectrode leakage resistance, and emission.

Standby Life Test

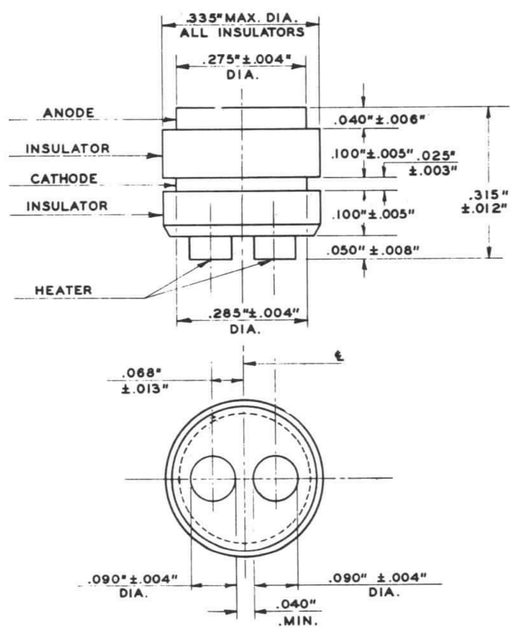
Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour) no other voltages applied. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, tube voltage drop, heater-cathode leakage, interelectrode leakage resistance, and emission.

Heater-Cycling Life Test

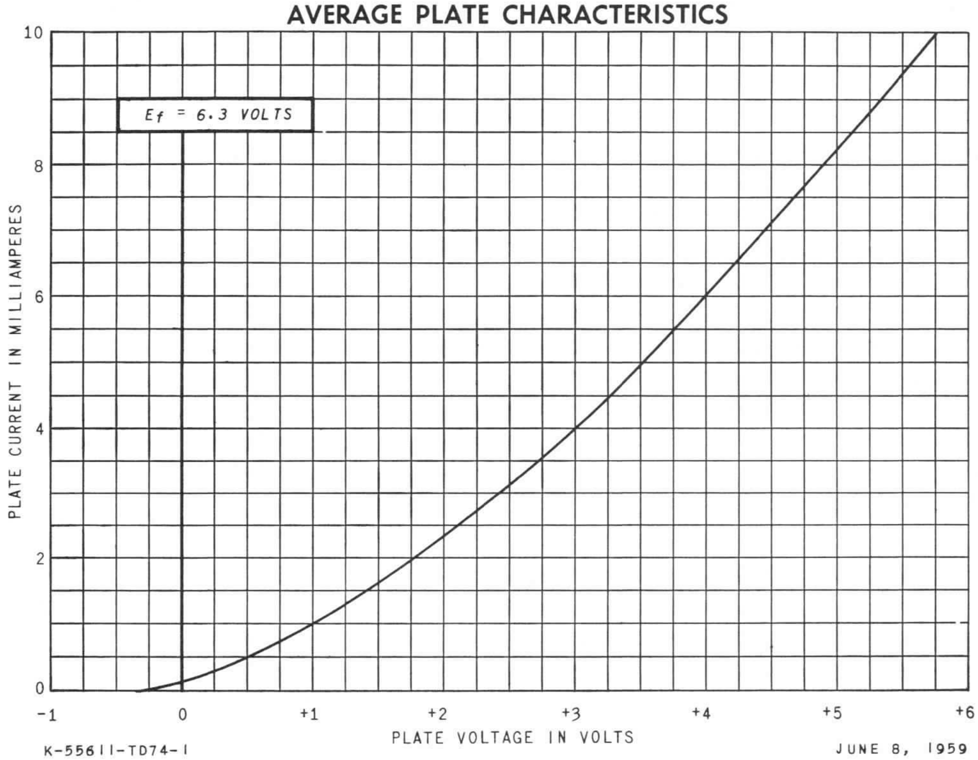
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable operating conditions.

OUTLINE DRAWING



AVERAGE PLATE CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7289
PLANAR TRIODE

DESCRIPTION AND RATING

FOR GROUNDED-GRID OSCILLATOR, AMPLIFIER, AND FREQUENCY MULTIPLIER SERVICE

Metal and Ceramic — Pulse Rated
High Transconductance — Shock Resistant
100 Watts Plate Dissipation

The 7289 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid CW oscillator, amplifier, or frequency multiplier at frequencies as high as 2500 megacycles. In addition, it may be used as a plate-pulsed oscillator or amplifier at frequencies as high as 3000 megacycles.

Features of the 7289 include planar electrode construction, high plate dissipation capability, excellent electrode isolation, low radio-frequency losses, high transconductance, and low interelectrode capacitances.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.0 volts	1.0†	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	2.0	pf
Grid to Cathode: (g to k)	6.3	pf
Plate to Cathode: (p to k), maximum	0.035	pf

MECHANICAL

Mounting Position—Any—Only Plate Flange to be Used as a Socket Stop and Clamp

Net Weight, approximate	2.5	Ounces

Cooling

Plate and Plate Seal—Conduction and Forced Air
Grid and Cathode Seals—Conduction and Forced Air
Recommended Air Flow Cowling—157-JAN
Recommended Air Flow on Plate Radiator at Sea Level

Incoming Air Temperature 25C, Plate Dissipation 100 Watts	12.5	Cu.Ft.Per Min.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions Per Tube Without Amplitude Modulation§

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEPHONY

Carrier Conditions Per Tube For Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 5.7	Volts
Frequency	2500	Megacycles
DC Plate Voltage¶	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point	300	C

PLATE-PULSED OSCILLATOR OR AMPLIFIER

Heater Voltage*	5.7 to 6.0	Volts
Frequency	3000	Megacycles
Peak Positive-Pulse Plate Supply Voltage	3500	Volts
Duty Factor of Plate Pulse # △	0.0025	
Pulse Duration	3.0	Microseconds
Plate Current Average During Plate Pulse △**	3.0	Amperes
Negative Grid Voltage Average During Plate Pulse††	150	Volts
Grid Current Average During Plate Pulse	1.8	Amperes
Plate Dissipation △	27	Watts
Grid Dissipation △	2.0	Watts
Envelope Temperature at Hottest Point	300	C

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Heater Voltage	6.0	Volts
Plate Voltage	600	Volts
Grid Voltage§§		Volts
Amplification Factor	100	
Transconductance	25000	Micromhos
Plate Current	70	Milliamperes

RADIO-FREQUENCY POWER AMPLIFIER

Frequency	500	Megacycles
DC Plate Voltage	900	Volts
DC Grid Voltage	−40	Volts
DC Plate Current	90	Milliamperes
DC Grid Current, approximate	30	Milliamperes
Driving Power, approximate	6	Watts
Useful Power Output	40	Watts

RADIO-FREQUENCY OSCILLATOR

Frequency	2500	Megacycles
DC Plate Voltage	900	Volts
DC Grid Voltage, approximate	−22	Volts
DC Plate Current	90	Milliamperes
DC Grid Current	10	Milliamperes
Useful Power Output	17	Watts

PLATE-PULSED OSCILLATOR

Frequency	3000	Megacycles
Heater Voltage	5.8	Volts
Duty Factor	0.0025	
Pulse Duration	3.0	Microseconds
Peak Positive-Pulse Plate-Supply Voltage	3500	Volts
Plate Current Average During Plate Pulse	3.0	Amperes
Grid Current Average During Plate Pulse	1.8	Amperes
Useful Power Output Average During Plate Pulse	1.6	Kilowatts

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 5.7 volts for CW operation, or 5.7 to 6.0 volts for pulse operation. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

† Heater current of a bogey tube at Ef = 6.0 volts.

‡ Measured in a special shielded socket.

§ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

Applications with a duty factor greater than 0.0025 should be referred to your General Electric tube sales representative for recommendations.

△ In any 5000-microsecond interval.

**The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 30 amperes.

††The maximum instantaneous value should be within the range of +250 to −750 volts.

§§Adjusted for Ib = 70 milliamperes.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

INITIAL CHARACTERISTICS LIMITS

	Min.	Max.	
Heater Current			
Ef = 6.0 volts	0.90	1.05	Amperes
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 100 ma	−2.0	−7.0	Volts
Grid Voltage			
Ef = 6.0 volts, Eb = 1000 volts, Ib = 1.0 ma	....	−25	Volts
Negative Grid Current			
Ef = 6.0 volts, Eb = 1000 volts, Ec adjusted for Ib = 100 ma	....	8.0	Microamperes
Interelectrode Leakage Resistance			
Ef = 6.0 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results			
Grid to Cathode at 500 volts d-c	50	....	Megohms
Interelectrode Capacitances			
Grid to Plate: (g to p)	1.95	2.15	Picofarads
Grid to Cathode: (g to k)	5.6	7.0	Picofarads
Plate to Cathode: (p to k)	....	0.035	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min.; Eb = 1000 volts; Ib = 90 ma	15	....	Watts
Pulsed-Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.8 volts; F = 3000 MC, min.; epy = 3500 volts; tp = 3.0 μsec. ± 10%; Du = 0.0025 ± 5%; Rg adjusted for Ib = 7.5 ma; Ec = −1.5 volts, max.; Ic = 4.5 ma, max.	4.0	....	Watts

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 54 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

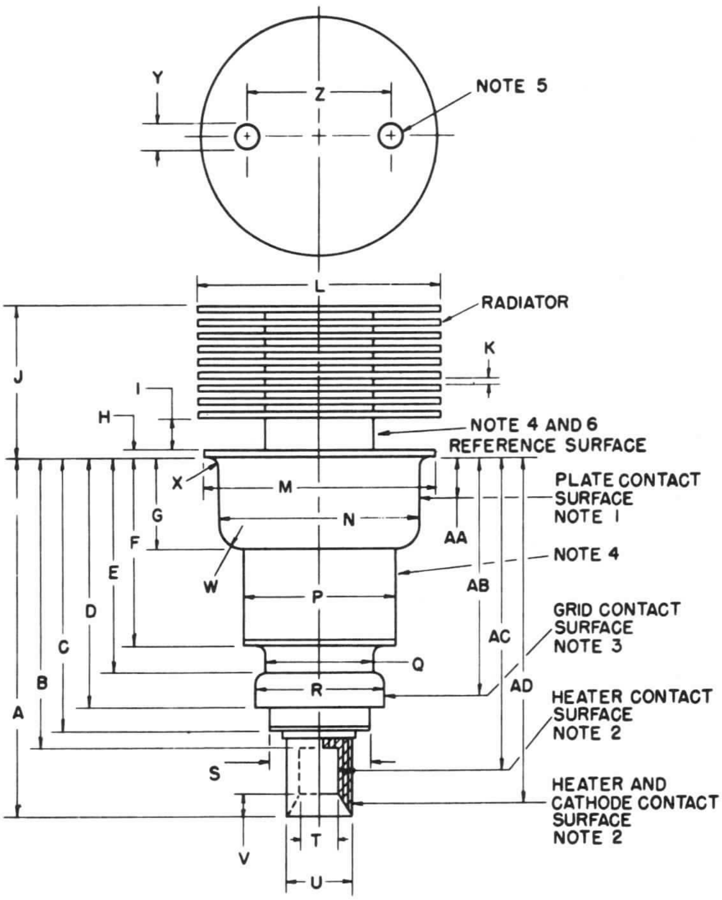
Shock

Statistical sample subjected to 5 impact accelerations of approximately 400 G and 0.5 milliseconds duration in each of three positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine.

500-Hour Life Test

Statistical sample operated for 500 hours as an oscillator to evaluate changes in power output with life.

PHYSICAL DIMENSIONS



DIMENSIONS FOR OUTLINE (INCHES)

Ref.	Minimum	Maximum
A	1.815	1.875
B	....	1.534
C	....	1.475
D	1.289	1.329
E	1.085	1.135
F	.880	.920
G	.462	.477
H	....	.040
I	.125	.185
J	.766	.826
K	.025	.046
L	1.234	1.264
M	1.180	1.195
N	1.025	1.035
P	.772	.792
Q	.541	.561
R	.655	.665
S	....	.545
T	.213	.223
U	.315	.325
V	....	.086
W	....	.100
X	....	.035
Y	.105	.145
Z	.650	.850

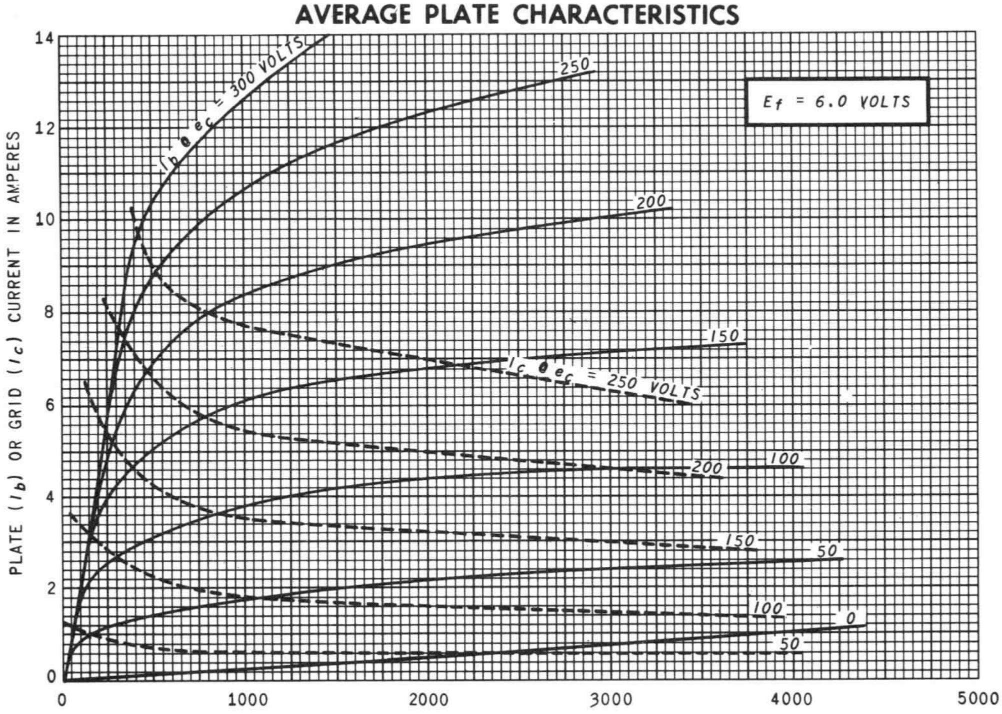
DIMENSIONS FOR ELECTRODE CONTACT AREA (INCHES)

Ref.	Dimension	Contact
AA	.198 ± .163	Plate
AB	1.225 ± .040	Grid
AC	1.631 ± .097	Heater
AD	1.645 ± .170	Cathode

NOTES

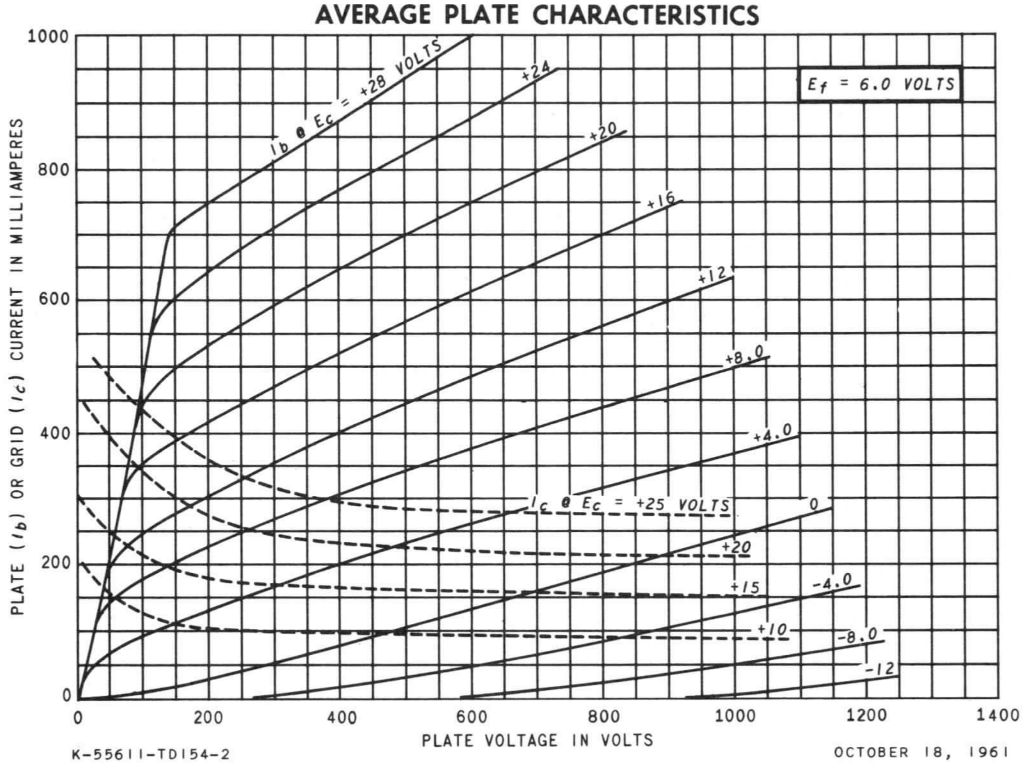
1. The total indicated runout of the plate contact surface with respect to the cathode contact surfaces will not exceed .020 inch.
2. The total indicated runout of the cathode contact surface with respect to the heater contact surfaces will not exceed .012 inch.
3. The total indicated runout of the grid contact surface with respect to the cathode contact surface will not exceed .020 inch.
4. Do not clamp or locate on this surface.
5. Hole provided for tube extractor through the top fin only.
6. Measure plate shank temperature on this surface.

AVERAGE PLATE CHARACTERISTICS



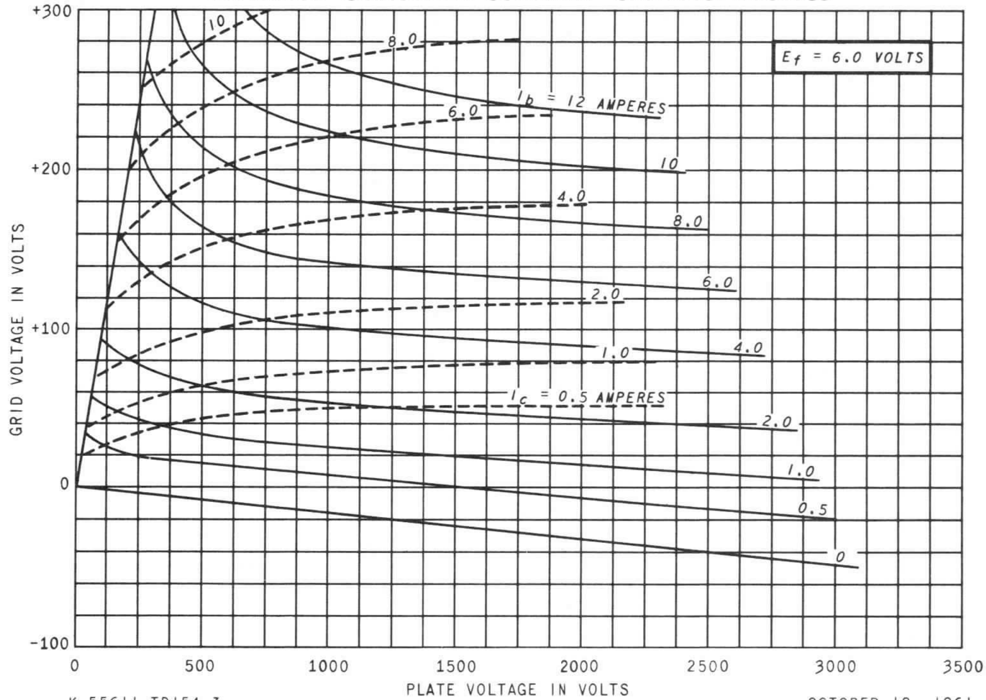
K-55611-TD154-1 OCTOBER 18, 1961

AVERAGE PLATE CHARACTERISTICS



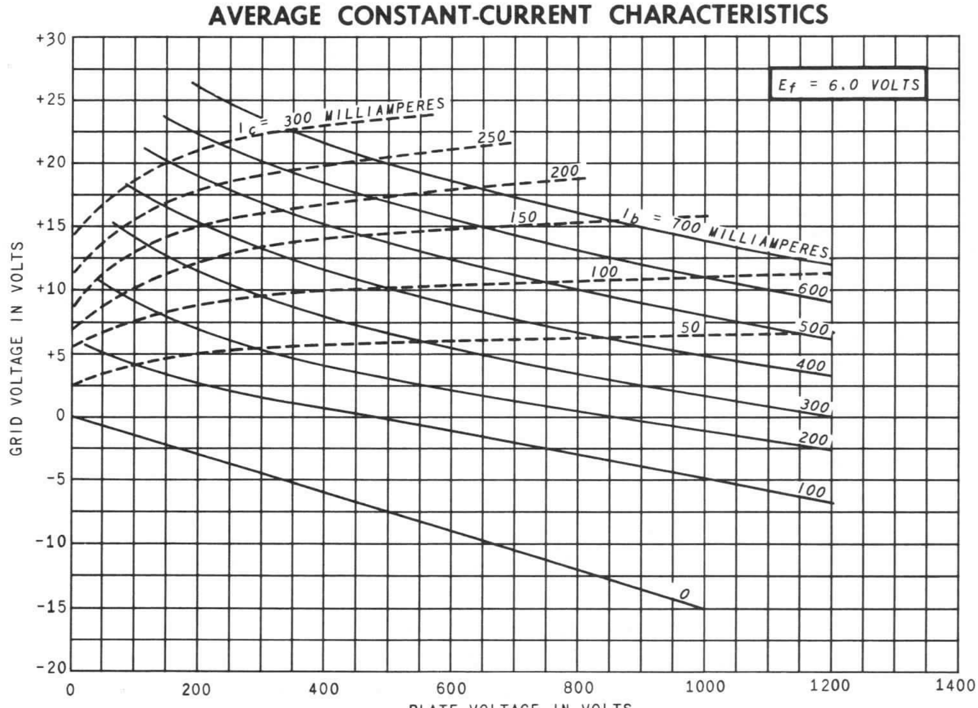
K-55611-TD154-2 OCTOBER 18, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD154-3 OCTOBER 18, 1961

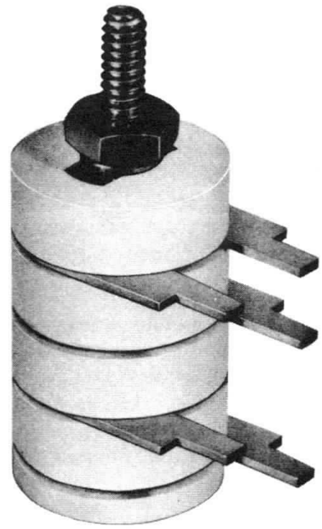
AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD154-4 OCTOBER 18, 1961

GE ELECTRONICS

7296
METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

FOR VHF OSCILLATOR AND AMPLIFIER APPLICATIONS

The 7296 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator, broadband radio-frequency amplifier, or VHF power amplifier. The 7296 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Voltage, AC or DC *	6.3 ± 0.3	Volts
Heater Current +	0.4	Amperes
Direct Interelectrode Capacitances ‡		
Grid to Plate: (g to p)	2.2	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.075	pf
Heater to Cathode: (h to k)	2.8	pf

MECHANICAL

Mounting Position—Any §

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	5.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance		
With Fixed Bias	0.1	Megohms
With Cathode Bias	0.18	Megohms
Envelope Temperature at Hottest Point #		
Plate Dissipation not over 3.3 Watts	300	C
Plate Dissipation up to 5.5 Watts	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1538A dated 2-60

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	68	Ohms
Amplification Factor	90	
Plate Resistance, approximate	5450	Ohms
Transconductance	16500	Micromhos
Plate Current	17	Milliamperes
Grid Voltage, approximate Ib = 10 Microamperes	−5.5	Volts

* The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ One method of mounting the 7296 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 4-40 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

※ Operation below the rated maximum envelope temperatures is recommended for applications requiring the longest possible tube life. The 7296 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)	10	17	24	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 200 volts, Rk = 68 ohms (bypassed)	13000	16500	20000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 100 volts, Rk = 68 ohms (bypassed)	65	90	115	
Zero-Bias Transconductance				
Ef = 6.3 volts, Eb = 100 volts, Ec = 0 volts	13000	20000	.....	Micromhos
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 200 volts, Ib = 10 μa	.....	−5.5	−9.5	Volts
Interelectrode Capacitances				
Grid to Plate (g to p)	1.9	2.2	2.5	pf
Input: g to (h + k)	3.7	5.0	6.3	pf
Output: p to (h + k)	0.05	0.075	0.1	pf
Heater to Cathode: (h to k)	2.1	2.8	3.5	pf
Negative Grid Current				
Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 68 ohms (bypassed), Rg = 0.18 meg	.....	.....	0.5	Microamperes
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.18 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

Test	Min.	Bogey	Max.	
400 Megacycle Oscillator Power Output	1.6	2.0	.....	Watts

Tubes are tested for power output as an oscillator under the following conditions: F = 400 mc, Ef = 6.3 volts, Eb = 300 volts, Rg = 1400 ohms, Ib = 20 ma maximum, Ic = 6.0–9.0 ma.

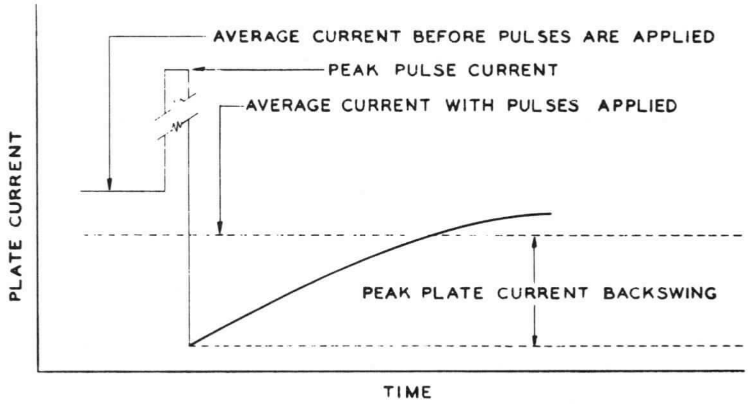
Test	Min.	Bogey	Max.	
Pulse Emission	320	.....	.....	Milliamperes

Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts, Eb = 200 volts, Ec = −20 volts, egk = +12 volts, prr = 1000 pps, duty cycle 1%. Pulse cathode current is measured.

Test	Min.	Bogey	Max.	
Grid Recovery ..... Change in Average Plate Current	.....	.....	1.0	Milliamperes
Peak Plate Current Backswing	.....	.....	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7296 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 10 ma.

Upon application to the grid of a pulse driving it 3 volts positive with respect to cathode (prr = 60 pps, duty cycle = 0.12%) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current—time relationship for a tube (with poor grid recovery) subjected to this test:



Test	Min.	Bogey	Max.	
Low Frequency Vibrational Output	.....	.....	15	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15 G. Tube is operated with Ef = 6.3 volts, Ebb = 200 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 100 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10 G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 200 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 600 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 42° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 200 volts, Ehk = +100 volts, Rg = 0.1 Meg, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

Dynamic Life Test

Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, zero-bias transconductance, oscillator power output, and heater-cathode leakage.

Pulse Life Test

Statistical sample operated with 400 ma peak cathode current, 1% duty cycle, for 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse emission, and heater-cathode leakage.

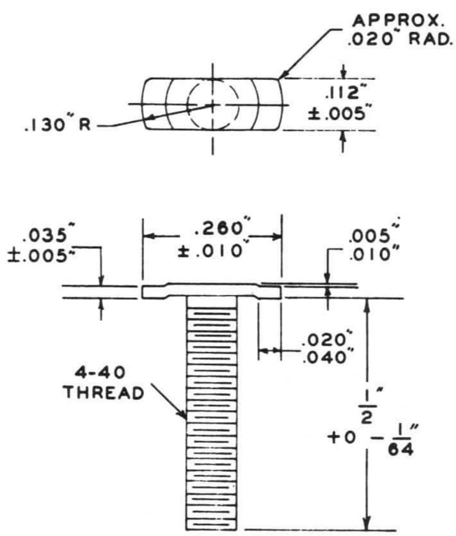
Interface Life Test

Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

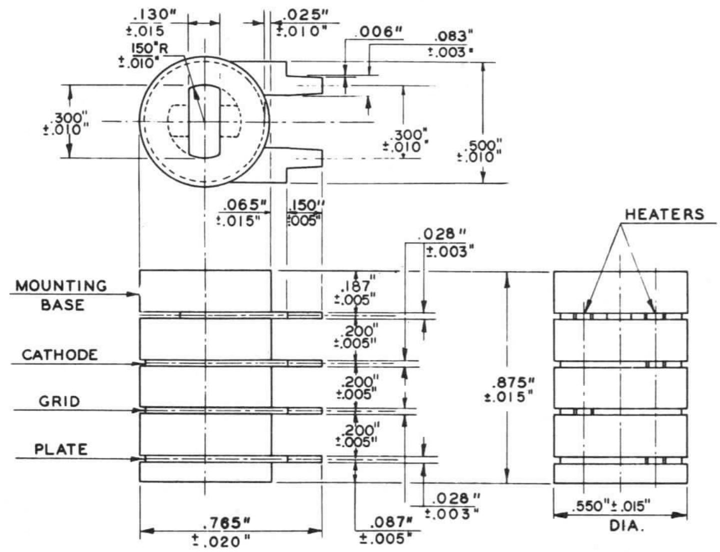
Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

MOUNTING BOLT

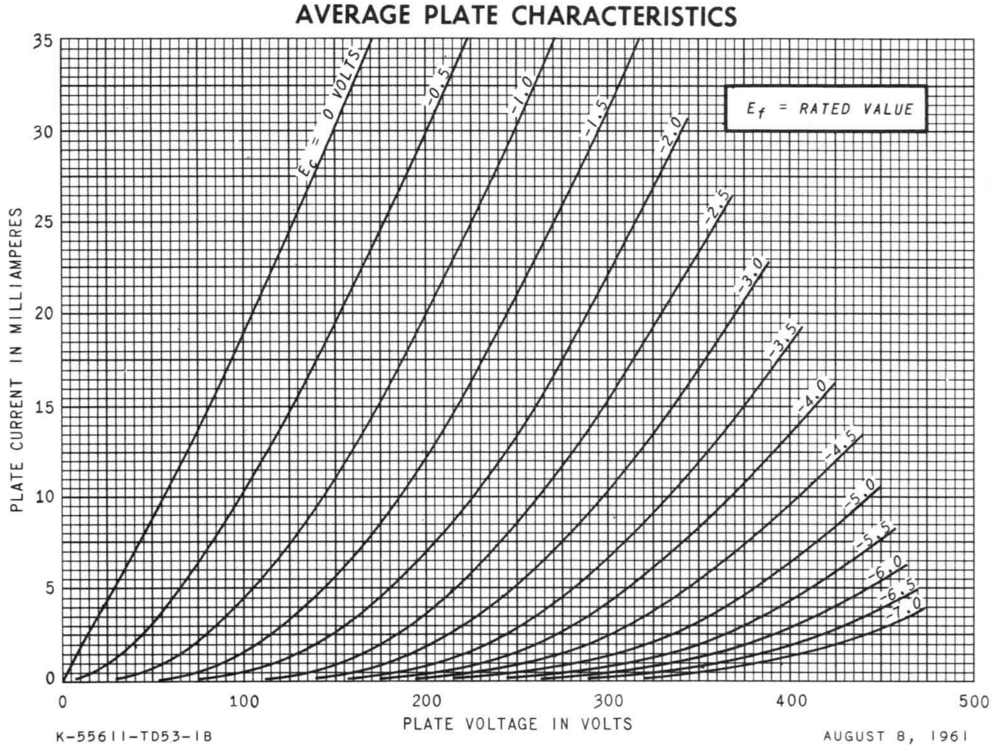


PHYSICAL DIMENSIONS

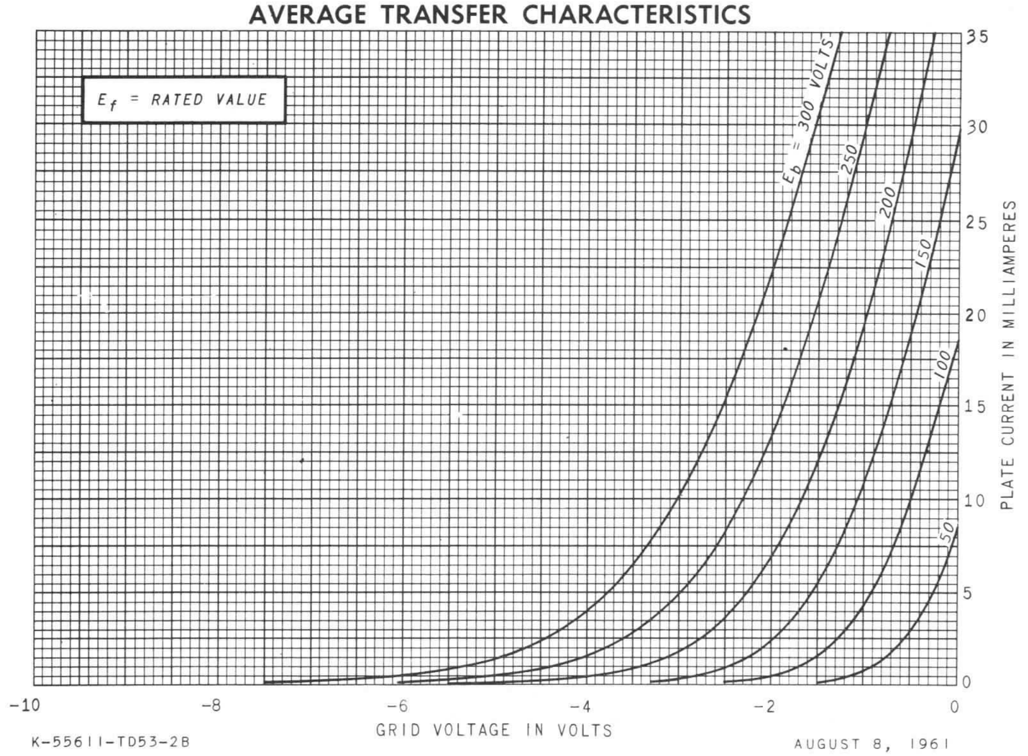


Maximum eccentricity of insulators 0.015 in. from center line.

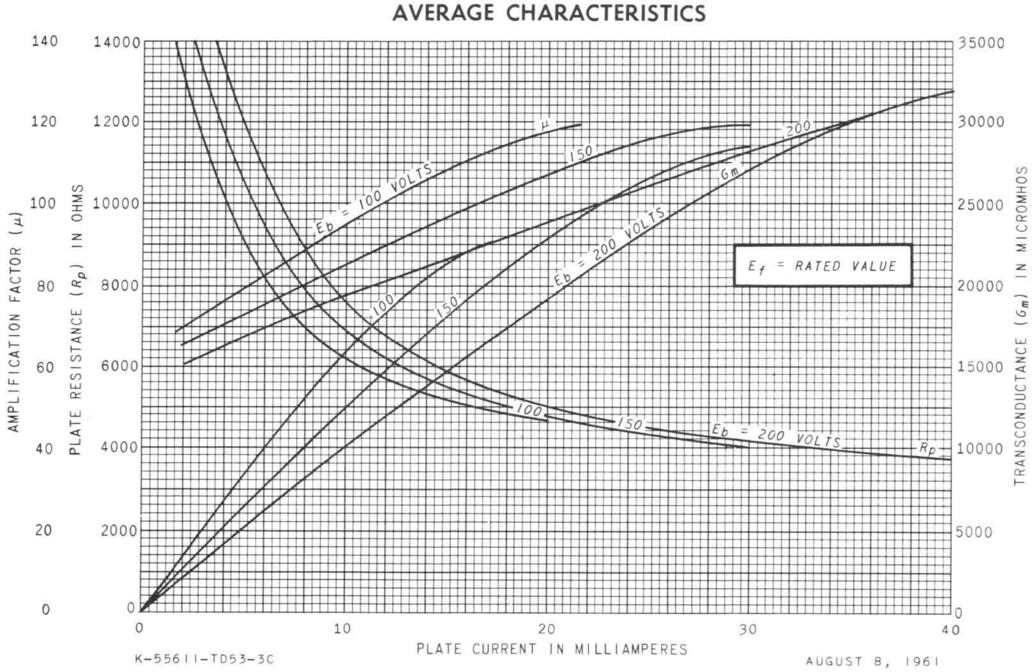
AVERAGE PLATE CHARACTERISTICS



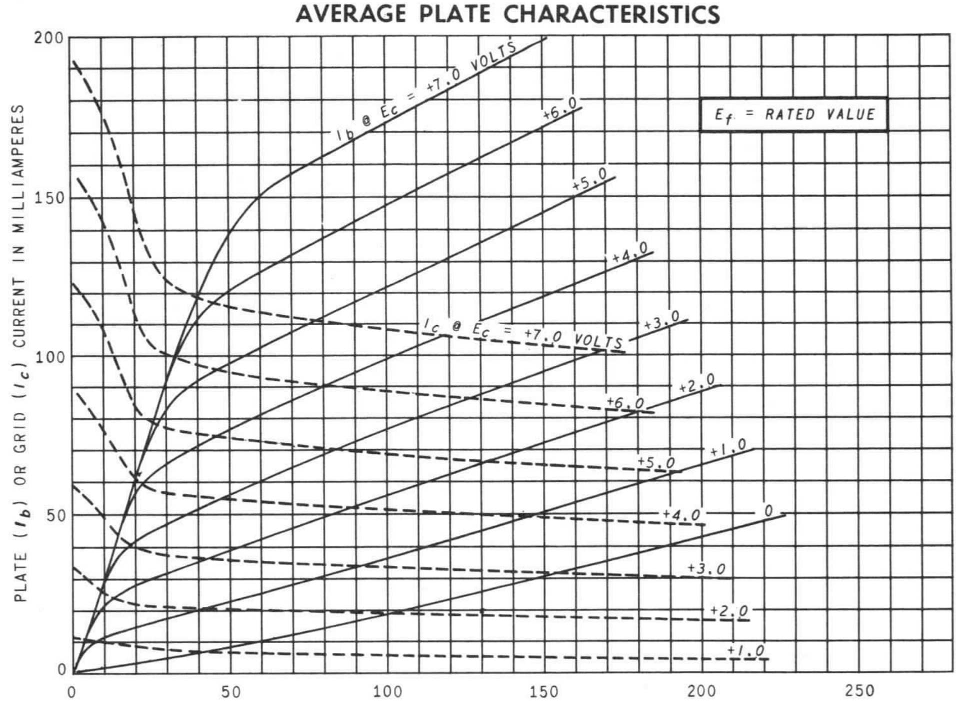
AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



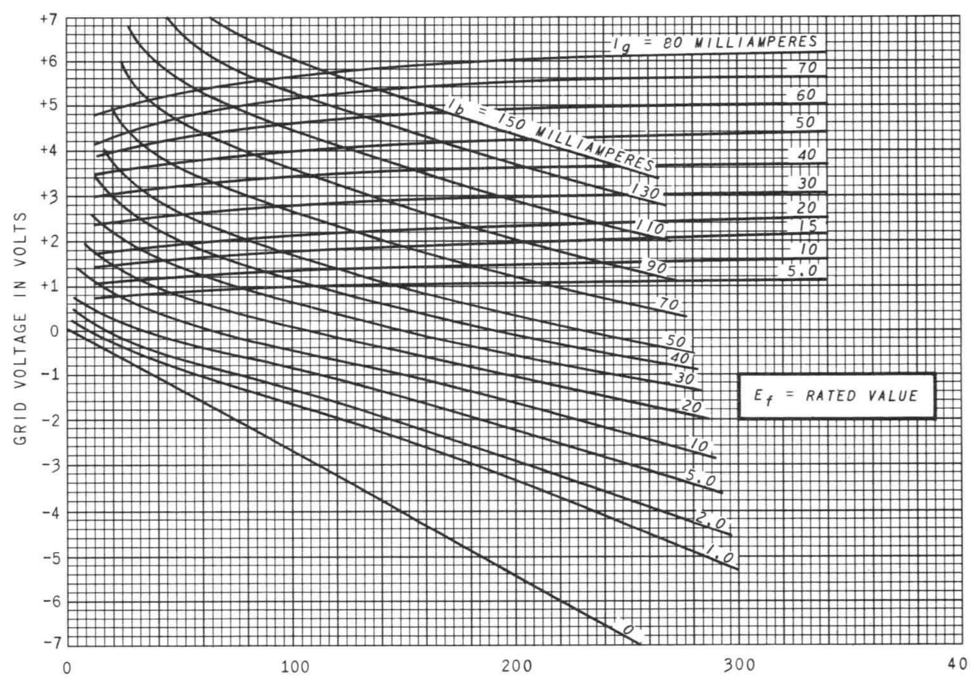
AVERAGE PLATE CHARACTERISTICS



K-55611-TD53-4

AUGUST 8, 1961

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD53-5

AUGUST 8, 1961

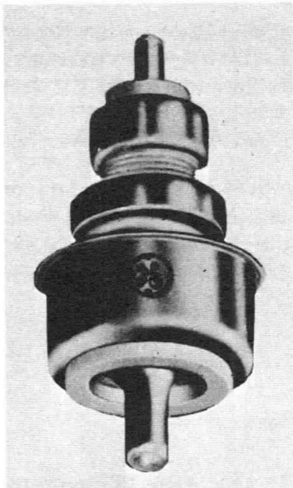
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7391

PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID CLASS C OSCILLATOR APPLICATIONS

Metal and Ceramic — Low Power
Small Size — Conduction Cooled

The 7391 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid, Class C oscillator at frequencies as high as 6000 megacycles.

Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

The physical appearance and dimensions of the 7391 are identical to those of the 6299.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.38	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.58	pf
Grid to Cathode and Heater: g to (h+k)	3.25	pf
Plate to Cathode and Heater: p to (h+k)	0.0158	pf

MECHANICAL

Mounting Position—Any

Net Weight, approximate	1/6	Ounce

Cooling—Conduction§

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.25	Watts
DC Plate Current	15	Milliamperes
DC Grid Current	3.0	Milliamperes
DC Cathode Current	15	Milliamperes
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

Supersedes ET-T1614 dated 6-60

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage	−1.5	Volts
Amplification Factor	62	
Transconductance	11000	Micromhos
Plate Current	10	Milliamperes

CLASS C CW OSCILLATOR
GROUNDED-GRID COAXIAL-TYPE CIRCUIT

Frequency	500	1000	5400	Megacycles
Plate Voltage	150	150	150	Volts
Plate Current	12	12	12	Milliamperes
Grid Current	3.0	3.0	3.0	Milliamperes
Power Output	500	250	65	Milliwatts

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ The electrical connections to the plate and cathode must provide good thermal conductivity from these electrodes. The plate contact must be sufficiently flexible to keep the lateral force on the plate terminal at a minimum.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	360	380	400	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 175 volts, Ib = 10 ma	−0.7	−1.5	−2.55	Volts
Transconductance				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	8000	11000	13500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	46	62	80	
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 175 volts, Ib = 100 μa	−2.4	−4.2	−7.0	Volts
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to Cathode and Heater at 45 volts d-c	0.25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	5.0	.....	.....	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.40	1.58	1.80	pf
Grid to Cathode and Heater: g to (h+k)	2.60	3.25	3.95	pf
Plate to Cathode and Heater: p to (h+k)	0.010	0.0158	0.023	pf

SPECIAL PERFORMANCE TESTS

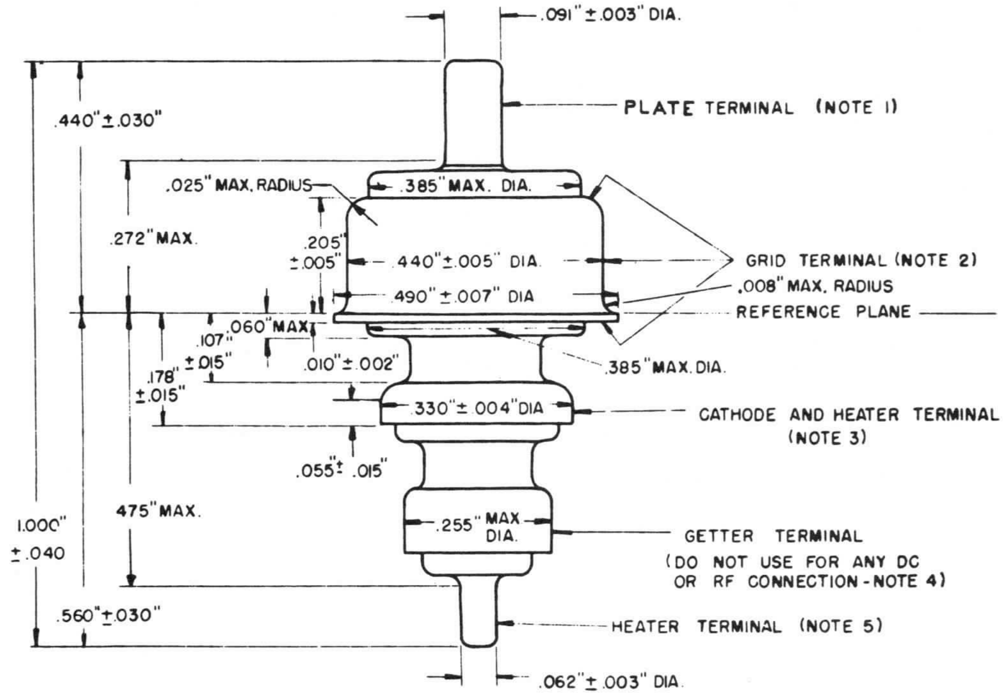
	Min.	Bogey	Max.	
5400 Megacycle Oscillator				
Power Output				
Ef = 6.3 volts, Eb = 150 volts, Rg = 2000 ohms, Ib = 15 ± 0.5 ma, F = 5400 MC, min.	30	65	.....	Milliwatts

DEGRADATION RATE TESTS

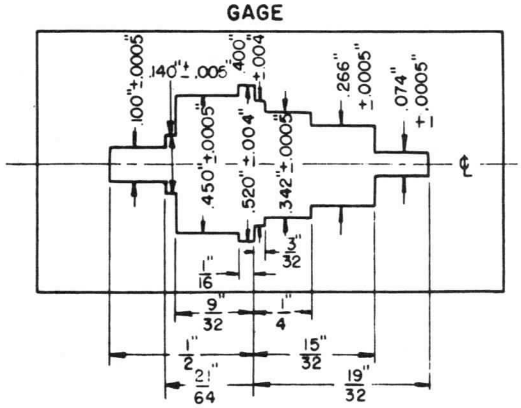
500-Hour Life

Statistical sample operated for 500 hours to evaluate changes in power output and transconductance with life.

PHYSICAL DIMENSIONS



DIMENSIONAL TOLERANCES



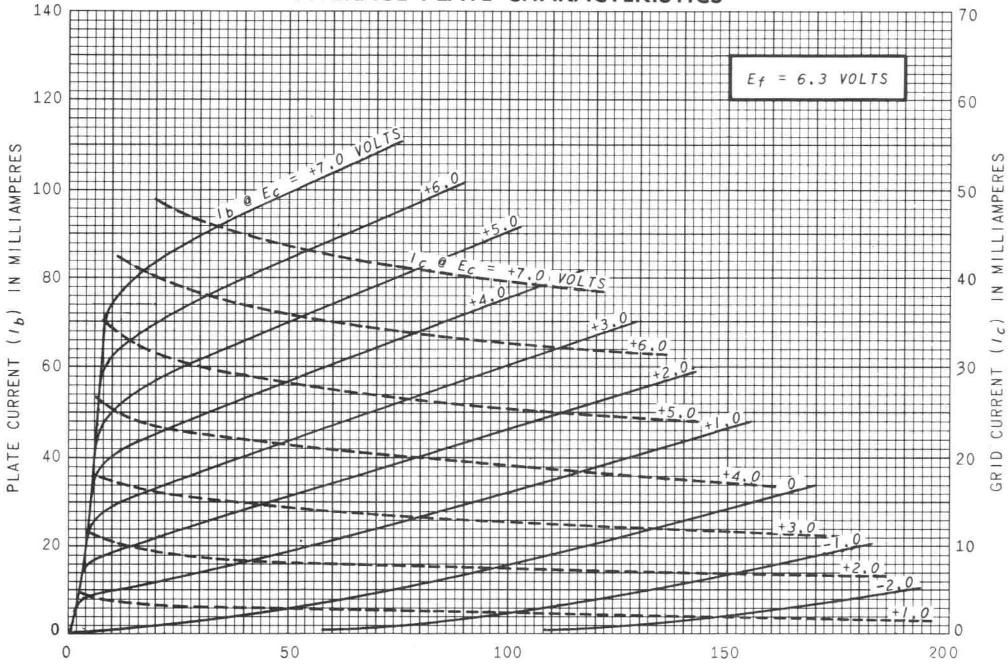
FRACTIONAL TOLERANCES
1/4" OR LESS ±.008" OVER 1/4" ±.015"

NOTES:

1. Maximum eccentricity 0.007″ (runout 0.014″)
2. Maximum eccentricity 0.008″ (runout 0.016″)
3. Maximum eccentricity 0.010″ (runout 0.020″)
4. Maximum eccentricity 0.015″ (runout 0.030″)
5. Maximum eccentricity 0.010″ (runout 0.020″)

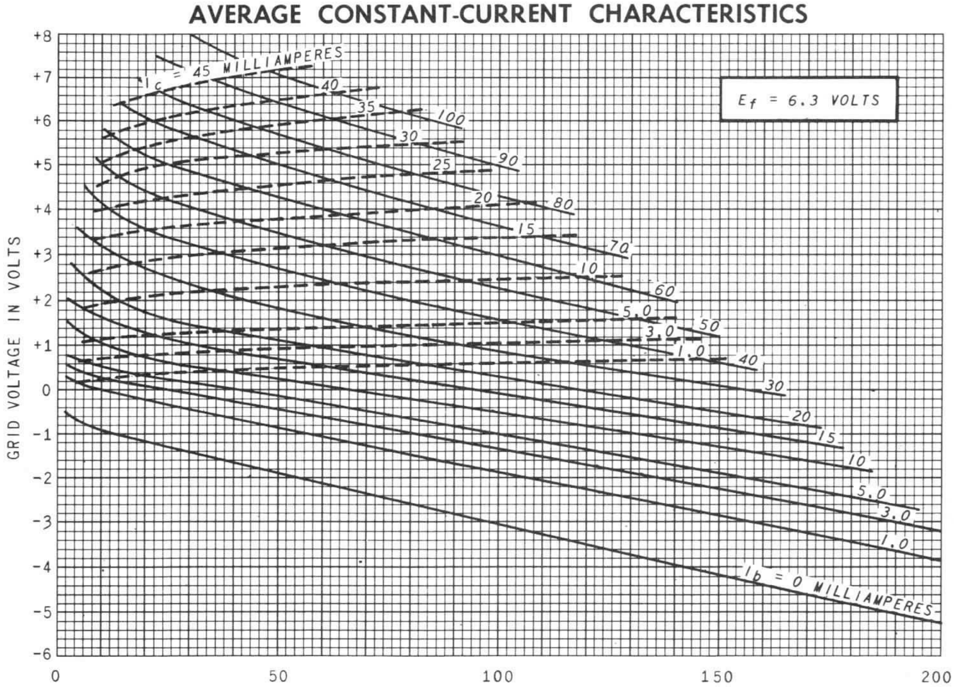
Eccentricities measured with respect to center line through gage. Tube shall be rotated 360° in gage without binding.

AVERAGE PLATE CHARACTERISTICS



K-55611-TD147-1 SEPTEMBER 11, 1961

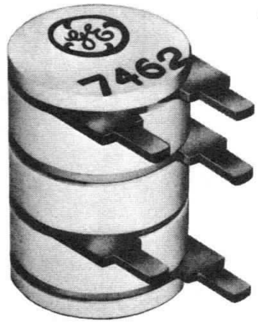
AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD147-2 SEPTEMBER 11, 1961

ELECTRONICS 7462

METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

The 7462 is a high-mu triode of ceramic-and-metal planar construction primarily intended for radio-frequency amplifier service from low frequencies into the ultra-high-frequency range. It is similar to the 7077 in characteristics but differs in having terminal lugs for use in print-board circuits.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.25	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	1.1	Watts
DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance, with Fixed Bias§	0.01	Megohms
Bulb Temperature at Hottest Point¶	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

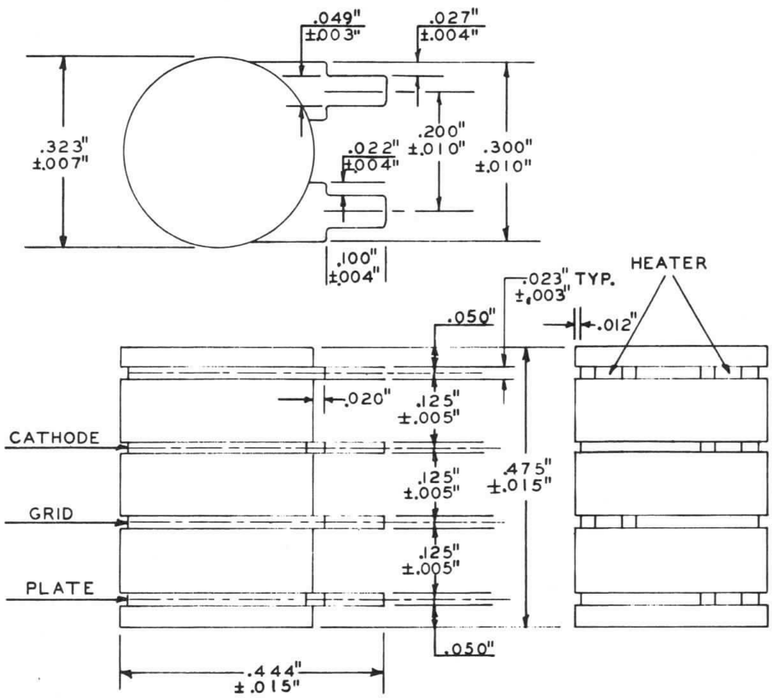
Plate Voltage	150	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	910	Ohms
Amplification Factor	94	
Plate Resistance, approximate	9000	Ohms
Transconductance	10500	Micromhos
Plate Current	7.2	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	−2.4	Volts

GENERAL ELECTRIC

Supersedes 7462 D & R sheet ET-T1540A, dated 2-60

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.
§ If a cathode bias resistor is used, the grid-circuit resistance may be as high as (10,000 + 100 Rk + R_L) ohms, where Rk is the value of the cathode-bias resistor in ohms and R_L is the value of the plate-load resistor in ohms.
¶ For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.



NOTE: Maximum eccentricity of insulators 0.010 in. from center line.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	222	240	258	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	4.5	7.5	11	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 150 volts, Ec = +6 volts, Rk = 910 ohms (bypassed)	8000	10500	13000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 150 volts, Ec = +6 volts, Rk = 910 ohms (bypassed)	65	94	115	

INITIAL CHARACTERISTICS LIMITS (Continued)

	Min.	Bogey	Max.	
Transconductance Change with Heater Voltage				
Difference between transconductance at Ef = 6.3 volts and transconductance at Ef = 6.0 volts (other conditions the same) expressed as a percentage of transconductance at Ef = 6.3 volts	.....	.....	15	Percent
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 150 volts, Ib = 100 μa	.....	−2.4	−4.5	Volts
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.05	1.25	1.45	pf
Input: g to (h+k)	1.25	1.8	2.25	pf
Output: p to (h+k)	0.013	0.032	0.045	pf
Heater to Cathode: (h to k)	1.1	1.5	1.9	pf
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All of 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 100 volts, Ecc = −10 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

Low Frequency Vibrational Output				
Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15 G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms	.....	.....	10	Millivolts RMS
Variable Frequency Vibrational Output				
Statistical sample is subjected to vibration according to the procedure given below. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed) R_L = 10000 ohms	.....	.....	15	Millivolts RMS

The variable-frequency vibration test shall be performed as follows:

1. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.
2. The tube shall be vibrated with simple harmonic motion in each of two planes: first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug. At all frequencies from 100 to 2000 cps, the total harmonic distortion of the acceleration waveform shall be less than 5%.
3. The peak acceleration shall be maintained at 10 ± 1.0 G throughout the test.
4. The value of the alternating voltage produced across the load resistor (R_L), as a result of the vibration, shall be measured with a suitable device having a response to the RMS value of the voltage to within ±0.5 db of the response at 400 cps for the frequency range of 100 to 3000 cps, and having a band-pass filter with an attenuation rate of 24 db per octave below the low frequency cutoff point of 50 cps and above the high frequency cutoff point of 5000 cps. The meter shall have a dynamic response characteristic equivalent to or faster than a VU meter (operated in accordance with ASA Standard No. C16.5-1954).

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, Rg = 0.1 meg, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements, and transconductance, following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated 1000 hours under the following conditions: Ef = 6.3 volts, Eb = 150 volts, Ecc = +6 volts, Ehk = −70 volts, Rk = 910 ohms, Rg = 0.1 meg. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

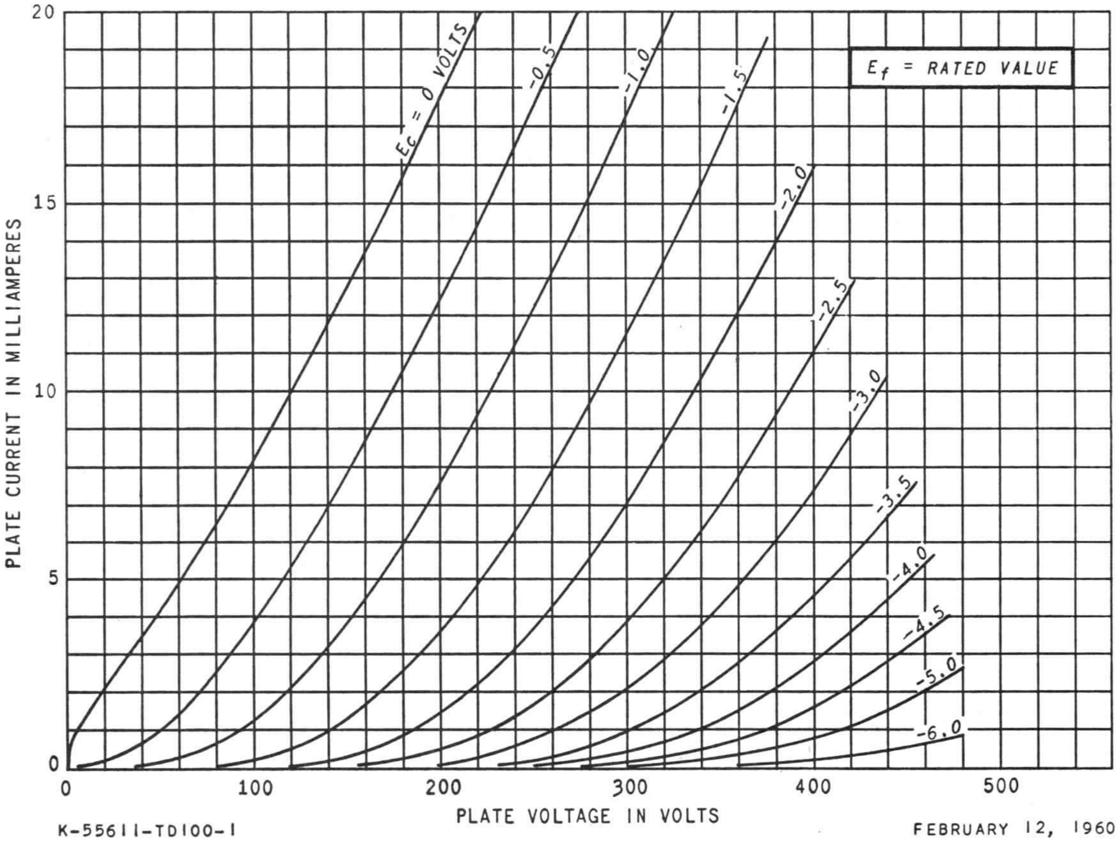
Interface Life Test

Statistical sample operated for 500 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following the test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage.

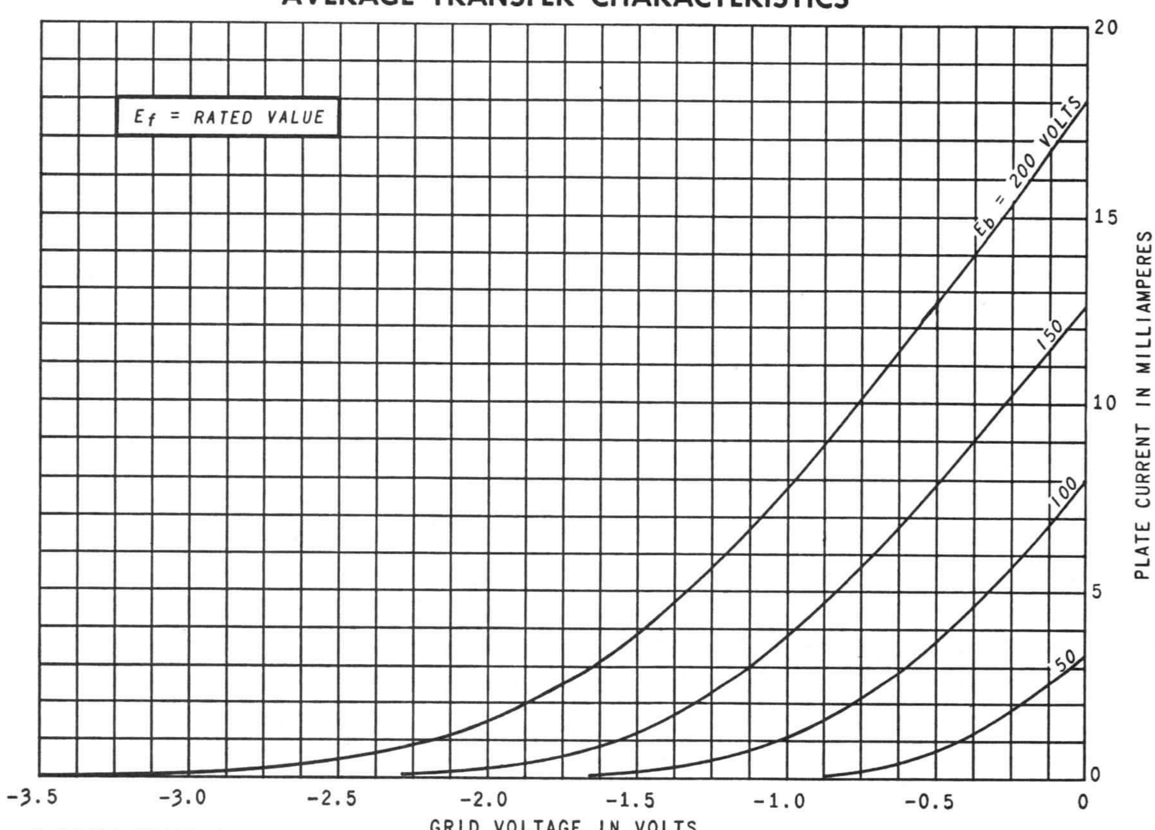
AVERAGE PLATE CHARACTERISTICS



K-55611-TD100-1

FEBRUARY 12, 1960

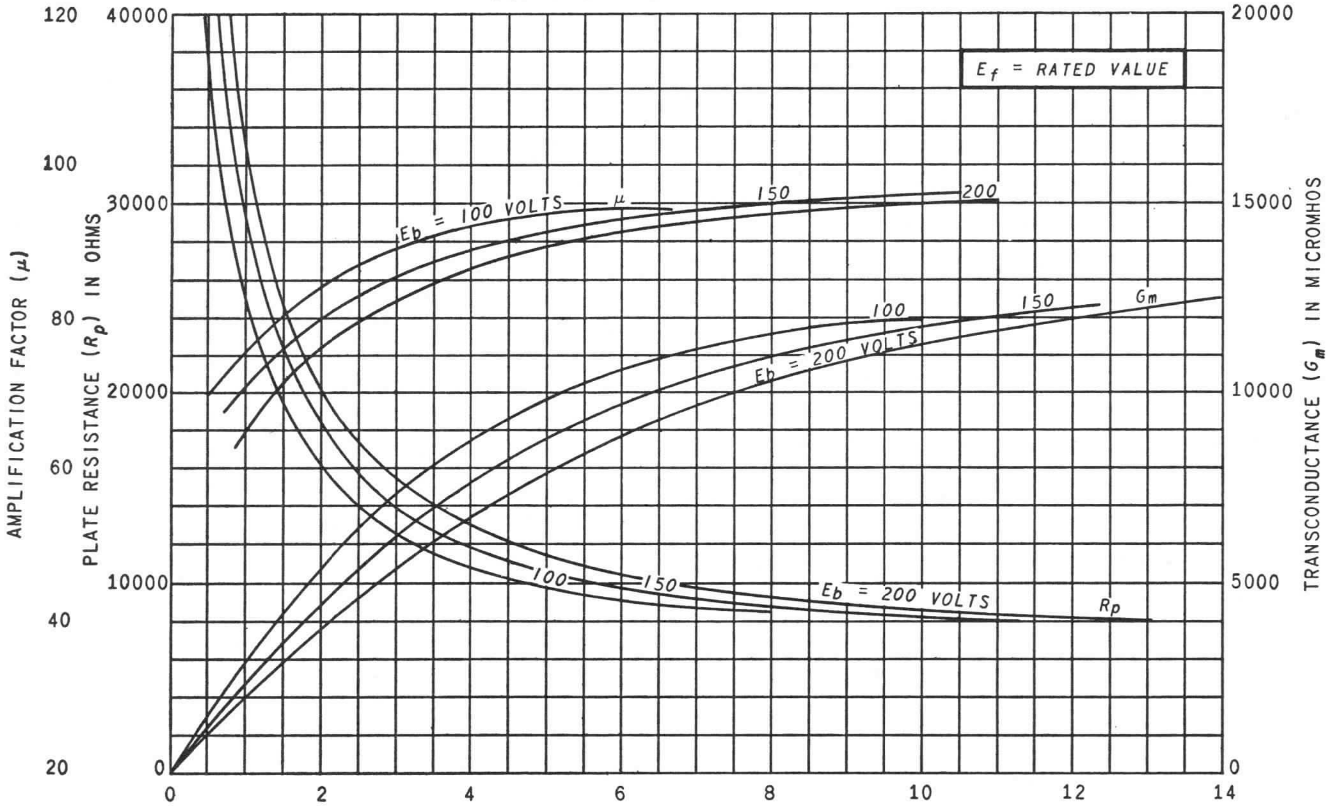
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD100-2

FEBRUARY 12, 1960

AVERAGE CHARACTERISTICS



K-55611-TD100-3

FEBRUARY 12, 1960

ELECTRONICS

7486

METAL-CERAMIC TRIODE

FOR UHF OSCILLATOR AND POWER AMPLIFIER APPLICATIONS

DESCRIPTION AND RATING

The 7486 is a high-mu triode of ceramic-and-metal planar construction intended for use as an oscillator or radio-frequency power amplifier in the ultra-high-frequency range. The 7486 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current	0.24	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h+k)	1.7	pf
Output: p to (h+k)	0.01	pf
Heater to Cathode: (h to k)	1.1	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	1.0	Watts
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point§	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

GENERAL ELECTRIC

Supersedes ET-T1531 dated 6-59

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	100	150	Volts
Grid Voltage	0	.....	Volts
Cathode-Bias Resistor	.....	82	Ohms
Amplification Factor	.....	90	
Transconductance	11500	10500	Micromhos
Plate Current	8.0	7.5	Milliamperes

UHF Oscillator Service

Plate Voltage	150	150	Volts
Grid Resistor	1000	1000	Ohms
Plate Current	8.0	8.0	Milliamperes
Grid Current	2.0	2.0	Milliamperes
Frequency	450	1200	Megacycles
Power Output, approximate	450	300	Milliwatts

Class C RF Amplifier

Plate Voltage	150	Volts
Grid Resistor	3000	Ohms
Plate Current	5.0	Milliamperes
Grid Current	1.0	Milliamperes
Frequency	450	Megacycles
Power Output, approximate	300	Milliwatts

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Measured using a grounded adapter that provides shielding between external terminals of tube.

§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7486 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current Ef = 6.3 volts	222	240	258	Milliamperes
Plate Current Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	4.5	.....	11	Milliamperes
Zero-Bias Transconductance Ef = 6.3 volts, Eb = 100 volts, Ec = 0 volts	8000	11500	.....	Micromhos
Transconductance Change with Heater Voltage Difference between Zero-Bias Transconductance measured at Ef = 6.3 volts and Ef = 6.0 volts (other conditions the same) expressed as a percentage	.....	.....	20	Percent
Amplification Factor Ef = 6.3 volts, Eb = 150 volts, Rk = 82 ohms (bypassed)	65	90	115	
Grid Voltage Cutoff Ef = 6.3 volts, Eb = 150 volts, Ib = 100 μa	.....	−2.4	−4.5	Volts
Interelectrode Capacitances				
Grid to Plate: (g to p)	0.84	1.00	1.16	Picofarads
Input: g to (h+k)	1.25	1.70	2.15	Picofarads
Output: p to (h+k)	0.004	0.010	0.016	Picofarads
Heater to Cathode: (h to k)	0.80	1.10	1.40	Picofarads

INITIAL CHARACTERISTICS LIMITS (Continued)

	Min.	Bogey	Max.	
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	100	.....	.....	Megohms
Plate to All at 300 volts d-c	100	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 150 volts, Ecc = −20 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
1200 Megacycle Oscillator Power Output	200	.....	.....	Milliwatts

Tubes are tested for power output as an oscillator under the following conditions: F = 1200 mc ± 50 mc, Ef = 6.3 volts, Eb = 150 volts, Rg = 1000 ohms, Ib = 8.0 ma maximum, Ic = 1.6 − 2.0 ma

	Min.	Bogey	Max.	
Pulse Emission	90	.....	.....	Milliamperes

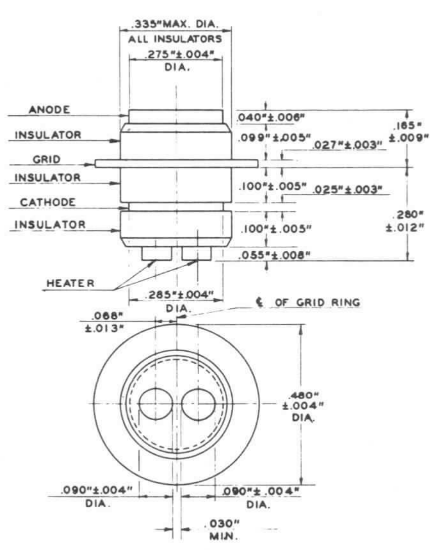
Tubes are tested for pulse emission under the following conditions: Ef = 6.3 volts, Eb = 150 volts, Ec = −10 volts, egk = +7 V, prr = 1000 pps, duty factor = 0.01. Pulse cathode current is measured

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current	.....	.....	0.6	Milliamperes
Peak Plate Current Backswing	.....	.....	1.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7486 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5-volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

OUTLINE DRAWING



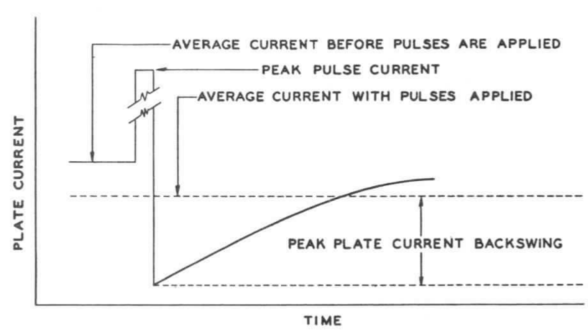
1—Maximum eccentricity of anode, grid, and cathode 0.005″ from center line.

2—Maximum eccentricity of insulators 0.010″ from center line.

3—Center line of grid ring used as reference line for horizontal tolerances.

4—Bottom surface of grid ring used as reference line for vertical tolerances.

PLATE CURRENT VS TIME— GRID RECOVERY TEST



SPECIAL PERFORMANCE TESTS (Continued)

	Min.	Bogey	Max.	
Low Frequency Vibrational Output	.....	.....	10	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 150 volts, Rk = 82 ohms (bypassed), R_L = 10000 ohms.

Variable Frequency Vibrational Output

The tube is designed to be free of vibrational outputs in excess of 15 mv RMS at any frequency within the range 100–2000 cps, when vibrated in either of two planes at 10G peak acceleration. Electrical conditions for this test are the same as for Low Frequency Vibrational Output.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8 mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Stability Life Test

The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

Dynamic Life Test

Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, oscillator power output, zero-bias transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Pulse Life Test

Statistical sample operated with 120 ma peak cathode current, 0.01 duty factor, for 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse cathode current, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

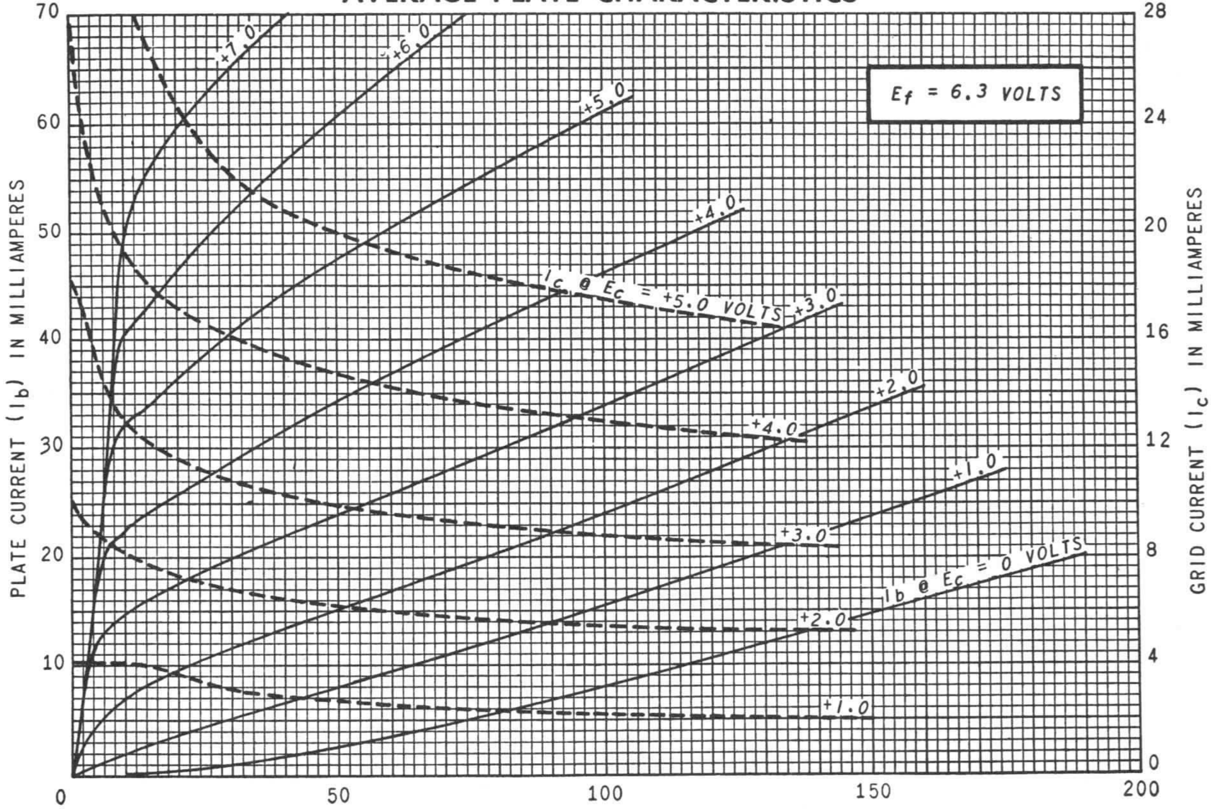
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

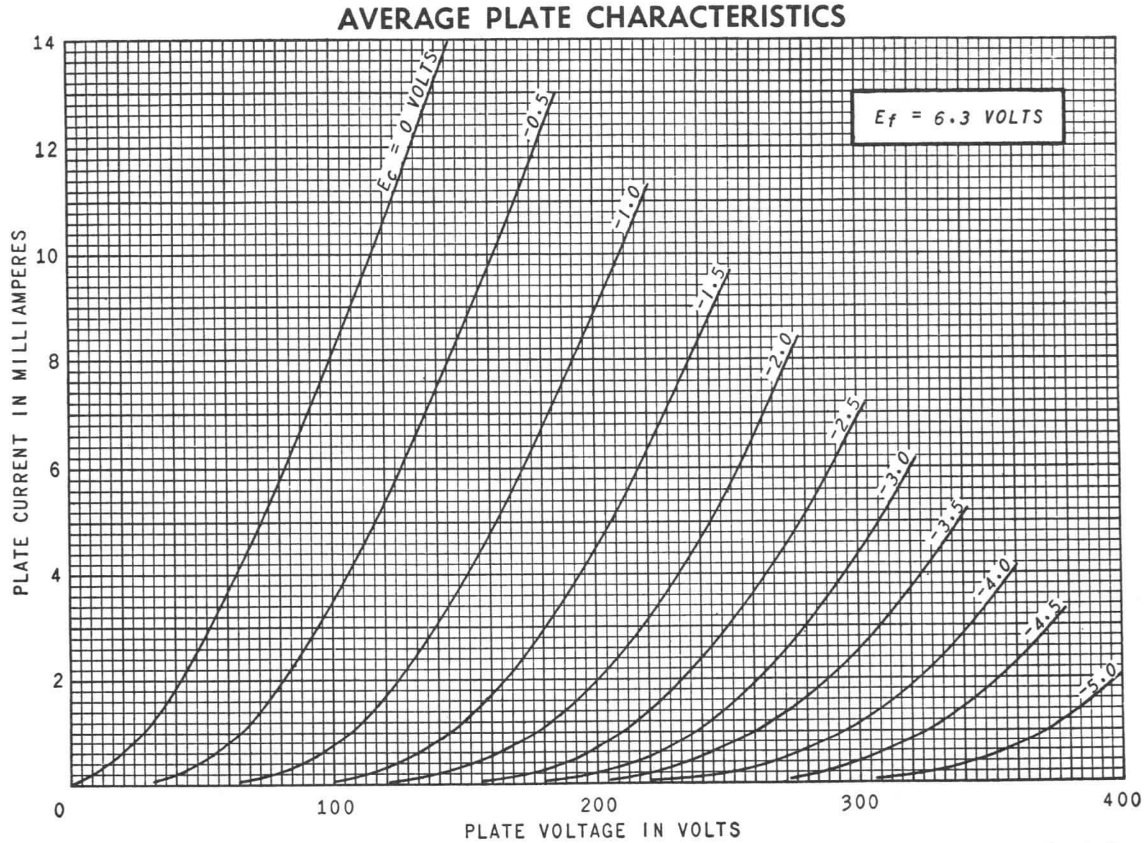
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

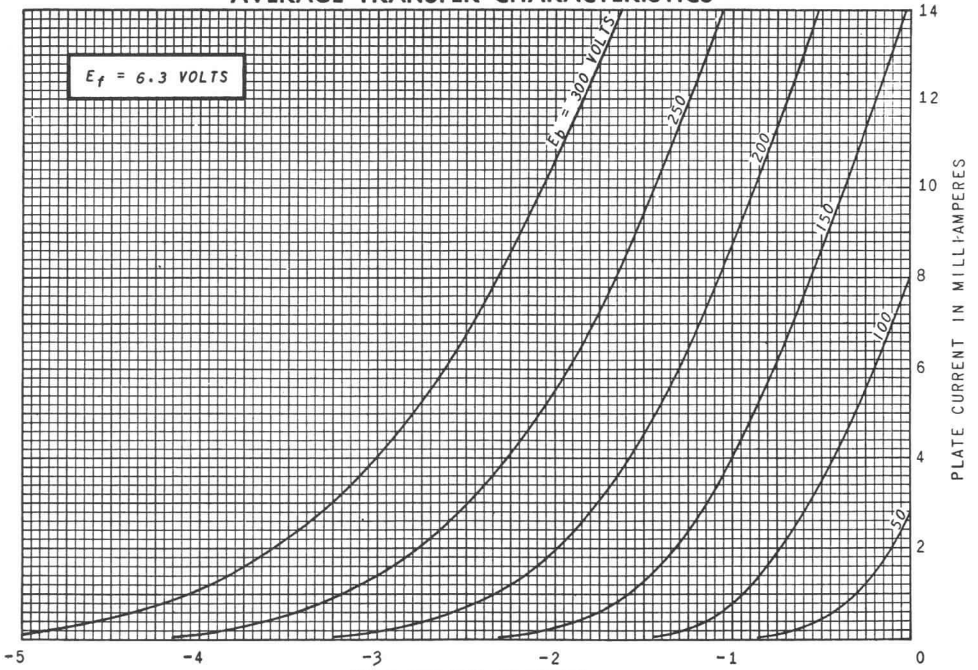
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-2

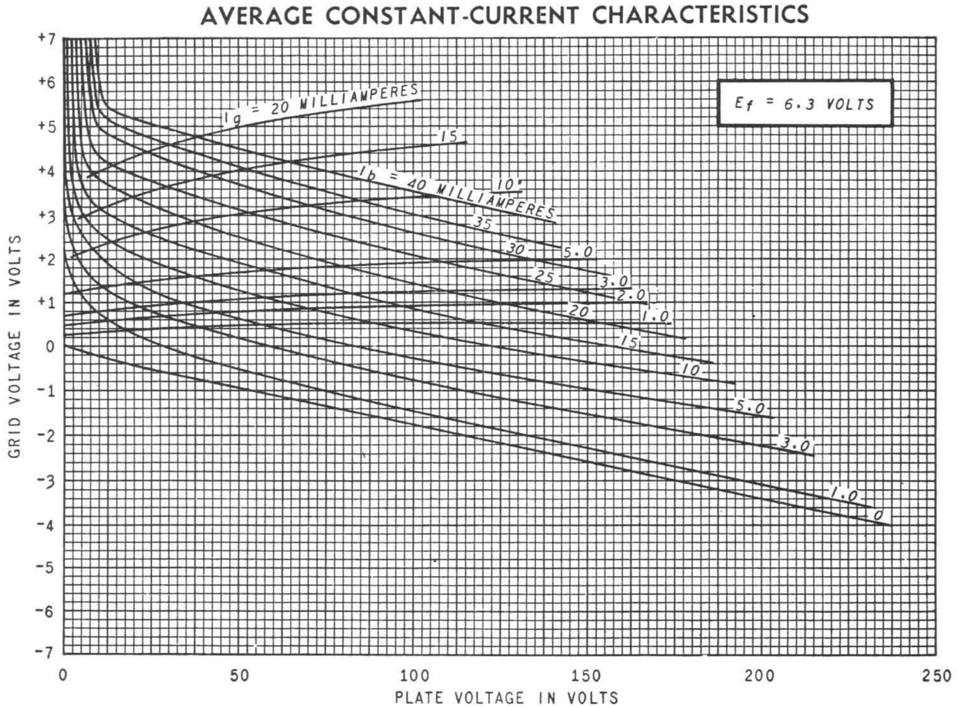
JUNE 3, 1959

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD73-3 JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS

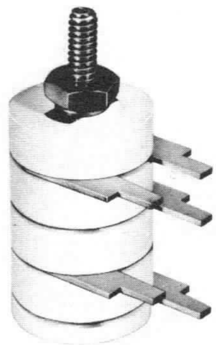


CONSTANT-CURRENT CURVES

K-55611-TD73-4 JUNE 3, 1959

GE ELECTRONICS

7588
METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

The 7588 is a high-mu triode of ceramic-and-metal planar construction. The tube is intended for use as a broadband radio-frequency amplifier at frequencies up to 500 megacycles.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings
Heater Voltage, AC or DC* .... 6.3 ± 0.3 Volts
Heater Current† .... 0.4 Amperes
Direct Interelectrode Capacitances‡
Grid to Plate: (g to p) .... 2.8 pf
Input: g to (h+k) .... 6.5 pf
Output: p to (h+k) .... 0.075 pf
Heater to Cathode: (h to k) .... 2.6 pf

MECHANICAL

Mounting Position—Any§
See Physical Dimensions on page 4 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage .... 300 Volts
Positive DC Grid-to-Cathode Voltage .... 0 Volts
Negative DC Grid Voltage .... 50 Volts
Plate Dissipation .... 5.5 Watts
DC Cathode Current .... 30 Milliamperes

Heater-Cathode Voltage
Heater Positive with Respect to Cathode. 50 Volts
Heater Negative with Respect to Cathode. 50 Volts
Grid Circuit Resistance
With Fixed Bias .... 0.025 Megohms
With Cathode Bias .... 0.1 Megohms
Envelope Temperature at Hottest Point ... 250 C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage .... 200 Volts
Positive Grid Voltage .... 6.0 Volts
Cathode-Bias Resistor .... 270 Ohms
Amplification Factor 175
Plate Resistance, approximate .... 3900 Ohms
Transconductance .... 45000 Micromhos
Plate Current .... 24 Milliamperes
Grid Voltage, approximate
Ib = 100 Microamperes .... −5 Volts
Noise Figure¶ .... 3.0 Decibels

GENERAL ELECTRIC

Supersedes 7588 D & R Sheet ET-T1620, dated 6-60

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ One method of mounting the 7588 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 4-40 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

¶ Measured at 200 megacycles in a grounded-grid amplifier and corrected for second-stage noise figure and diode temperature.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms	17	25	33	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 200 volts, Ec = +6 volts, Rk = 270 ohms (bypassed)	35000	45000	55000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 200 volts, Ec = +6 volts, Rk = 270 Ohms (bypassed)	140	175	210	
Transconductance Change with Heater Voltage				
Difference between transconductance at Ef = 6.3 volts and transconductance at Ef = 5.7 volts (other conditions the same) expressed as a percentage of transconductance at Ef = 6.3 volts	.....	.....	20	Percent
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 200 volts, Ib = 100 μa	.....	−5.0	−8.0	Volts
Noise Figure				
Ef = 6.3 volts, Ebb = 265 volts, Ec = 0 volts, R_L = 3300 ohms, (bypassed), Rk = 22 ohms, F = 200 ± 10 MC	.....	3.0	4.8	Decibels
Interelectrode Capacitances				
Grid to Plate: (g to p)	2.1	2.8	3.5	pf
Input: g to (h+k)	5.1	6.7	8.3	pf
Output: p to (h+k)	0.05	0.075	0.1	pf
Heater to Cathode: (h to k)	1.9	2.6	3.3	pf
Negative Grid Current				
Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 22 ohms (bypassed), Rg = 0.1 meg		.....	0.5	Microamperes
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode		.....	20	Microamperes
Heater Negative with Respect to Cathode		.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	50	.....	.....	Megohms
Plate to All at 300 volts d-c	50	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.1 meg		.....	2.0	Microamperes

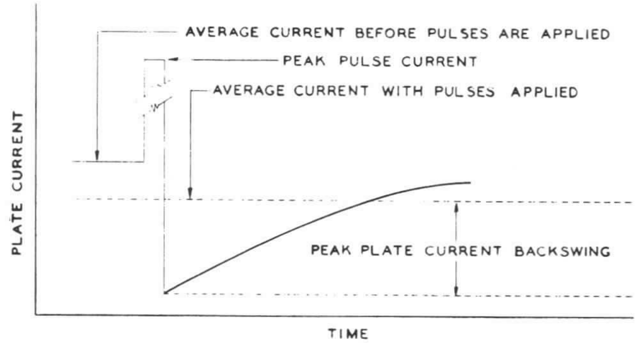
SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current		....	1.0	Milliamperes
Peak Plate Current Backswing		....	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type but is unimportant in many applications. In the majority of 7588 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. EC is adjusted for Ib = 10 ma.

Upon application to the grid of a pulse driving it 3 volts positive with respect to cathode (prr = 60 pps, duty cycle = 0.12%) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test:

PLATE CURRENT VS TIME —GRID RECOVERY TEST



	Min.	Bogey	Max.	
Low Frequency Vibrational Output Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms	....	......	25	Millivolts RMS
Variable Frequency Vibrational Output Statistical sample is subjected to vibration according to the procedure given below. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms	....	......	75	Millivolts RMS

The variable-frequency vibration test shall be performed as follows:

1. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.
2. The tube shall be vibrated with simple harmonic motion in each of two planes: first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug. At all frequencies from 100 to 2000 cps, the total harmonic distortion of the acceleration wave form shall be less than 5%.
3. The peak acceleration shall be maintained at 10 ± 1.0 G throughout the test.
4. The value of the alternating voltage produced across the load resistor (R_L), as a result of the vibration, shall be measured with a suitable device having a response to the RMS value of the voltage to within ±0.5 db of the response at 400 cps for the frequency range of 100 to 3000 cps, and having a band-pass filter with an attenuation rate of 24 db per octave below the low frequency cutoff point of 50 cps and above the high frequency cutoff point of 5000 cps. The meter shall have a dynamic response characteristic equivalent to or faster than a VU meter (operated in accordance with ASA Standard No. C16.5–1954).

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

DEGRADATION RATE TESTS (Continued)

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 250 volts, Ehk = +100 volts, Rg = 0.1 meg, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements, and transconductance, following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated 1000 hours under the following conditions: Ef = 6.3 volts, Eb = 200 volts, Ecc = +6 volts, Ehk = −70 volts, Rk = 270 ohms, Rg = 0.1 meg. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, transconductance, negative grid current, noise figure, heater-cathode leakage, and interelectrode leakage resistance.

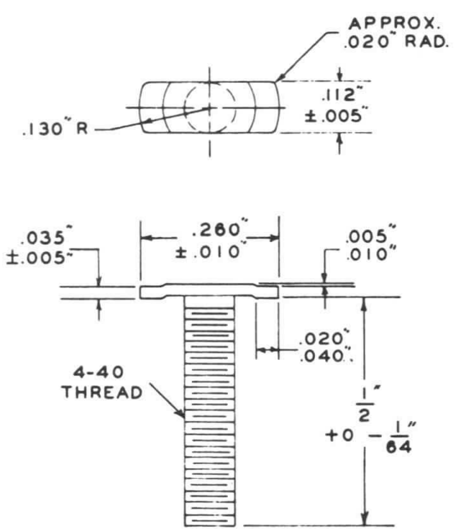
Interface Life Test

Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

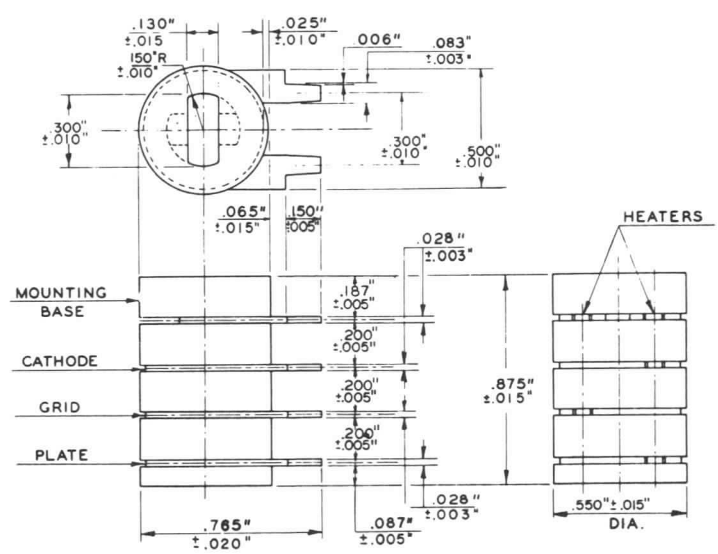
Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

MOUNTING BOLT

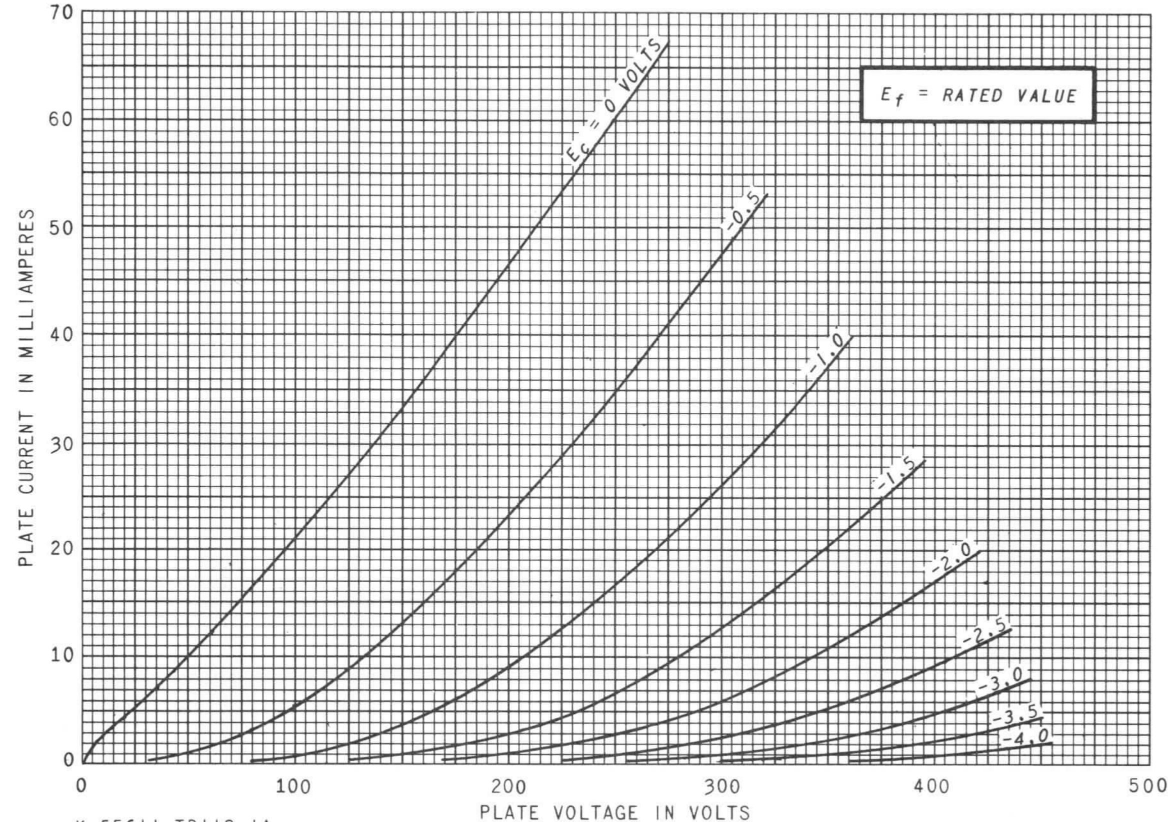


PHYSICAL DIMENSIONS



Maximum eccentricity of insulators 0.015 in. from center line.

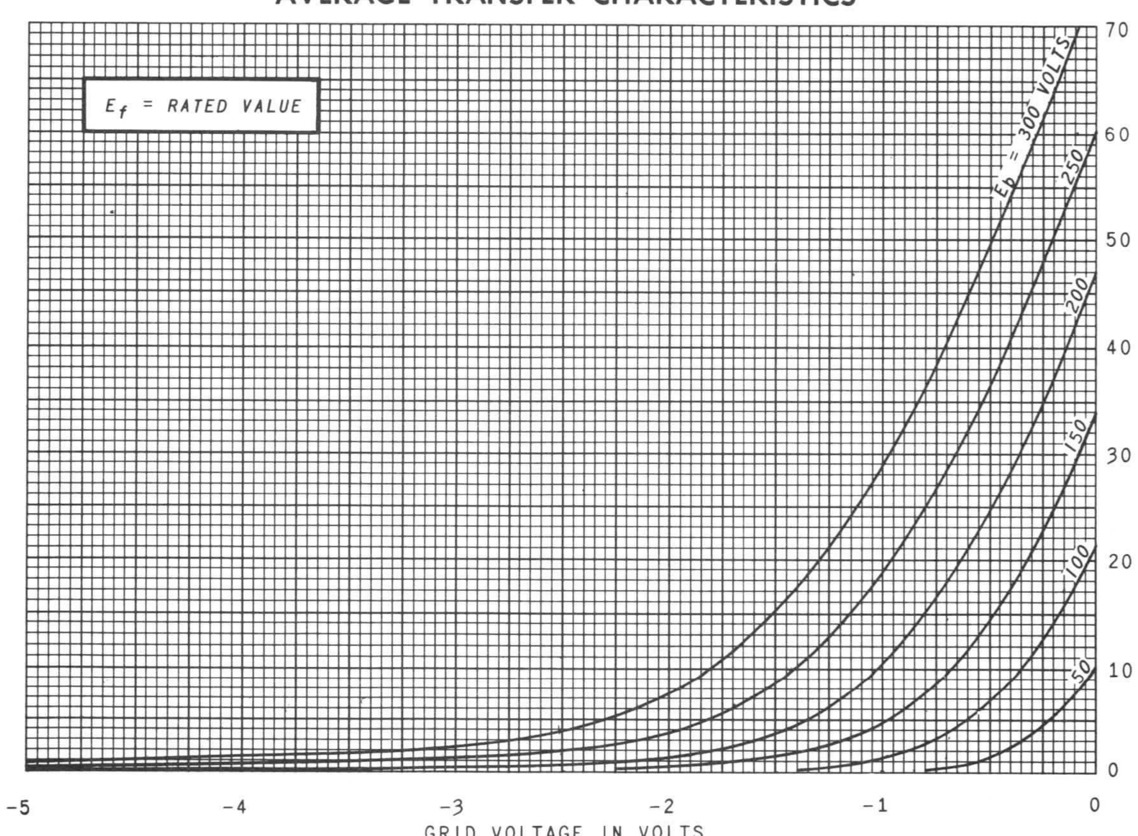
AVERAGE PLATE CHARACTERISTICS



K-55611-TD118-1A

FEBRUARY 17, 1961

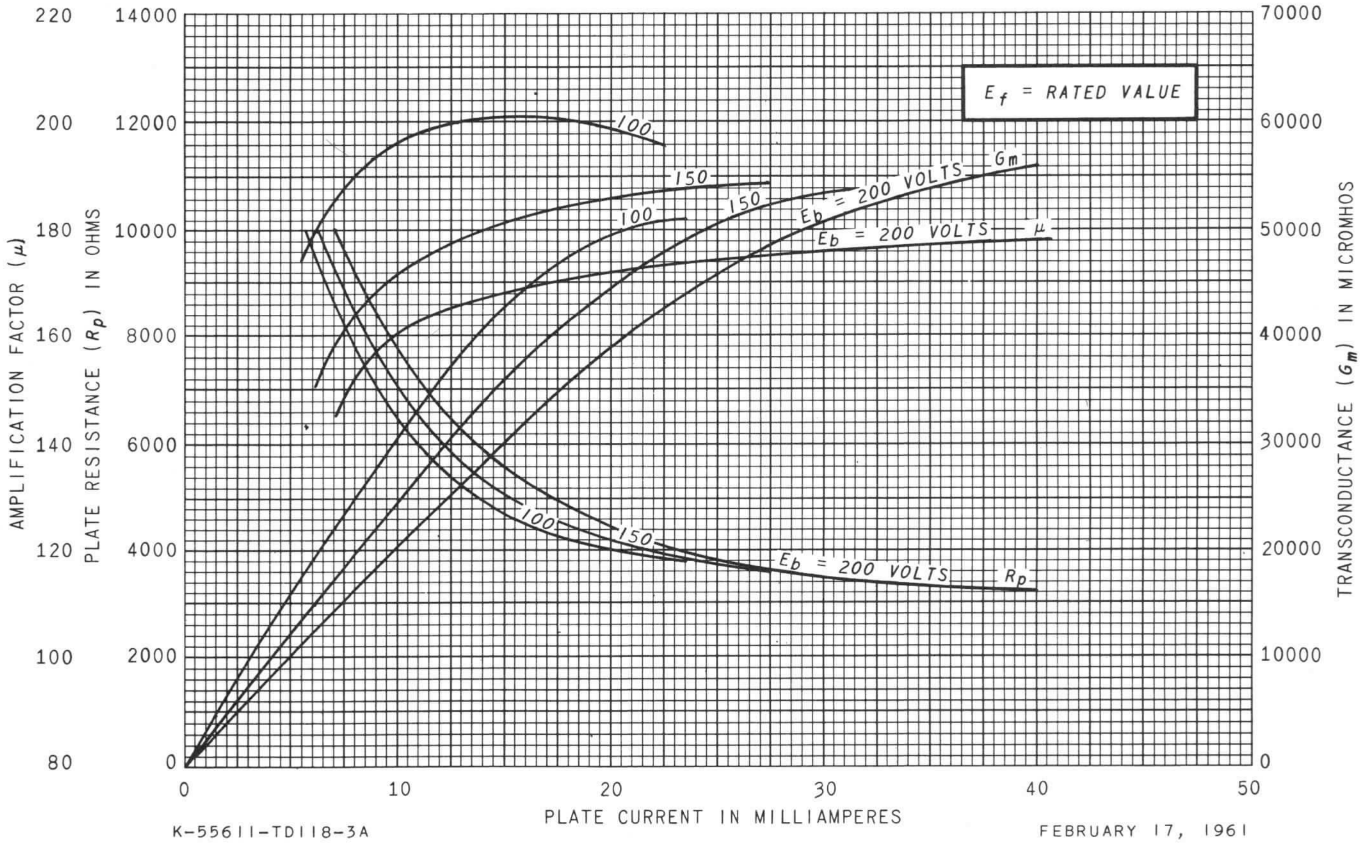
AVERAGE TRANSFER CHARACTERISTICS

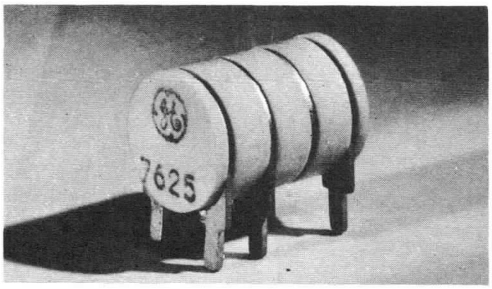


K-55611-TD118-2A

FEBRUARY 17, 1961

AVERAGE PLATE CHARACTERISTICS





METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7625 is a high-mu triode of ceramic-and-metal planar construction primarily intended for low-level audio-frequency amplification.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current†	0.215	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.5	pf
Output: p to (h+k)	0.03	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

DC Plate Voltage	275	Volts
Peak Plate Voltage	400	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	0.85	Watts
DC Cathode Current	3.8	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance, with Fixed Bias§	0.2	Megohms
Envelope Temperature at Hottest Point¶	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	150	Volts
Cathode-Bias Resistor	1000	Ohms
Amplification Factor	80	
Plate Resistance, approximate	57000	Ohms
Transconductance	1400	Micromhos
Plate Current	0.95	Milliamperes
Grid Voltage, approximate		
Ib = 10 Microamperes, Eb = 250 Volts	−4.6	Volts

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ If resistance is used in the cathode or plate circuits, the grid-circuit resistance may be high as (200,000 + 500 RK + 10 RL) ohms, where RK is the cathode-bias resistance in ohms, and RL is the DC plate load resistance in ohms.

¶ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 7625 is also capable of operation at envelope temperatures much higher than the rated maximum values. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

SPECIAL PERFORMANCE TESTS

	Maximum	
Variable-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (bypassed), R_L = 10000 ohms; Note 1	15	Millivolts peak to peak
Low-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (bypassed), R_L = 10000 ohms, G = 15, F = 40 cps; Note 2	0.75	Millivolts RMS

Low Pressure Voltage Breakdown Test
Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

Note 1: The variable-frequency vibration test shall be performed as follows:
- a. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.
- b. The tube shall be vibrated with simple harmonic motion in each of two planes; first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug.
- c. The peak acceleration shall be maintained at 10 ± 1 G throughout the test.
- d. The vibrational output produced across R_L as a result of the vibration shall be coupled to a low-pass filter that has the following characteristics:
  - (1) A response within ± 1 db of the response at 1000 cps over the frequency range of 100 to 17000 cps.
  - (2) The response shall be down at least 1.5 db at 20000 cps and have a cut-off rate of at least 18 db per octave above 20000 cps.

Note 2: The tube shall be vibrated with harmonic motion in each of two planes, (1) parallel to the cylindrical axis and (2) perpendicular to the cyclindrical axis and perpendicular to a line through the major axis of a terminal lug.

DEGRADATION RATE TESTS

Fatigue
Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10 G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, transconductance, and negative grid current.

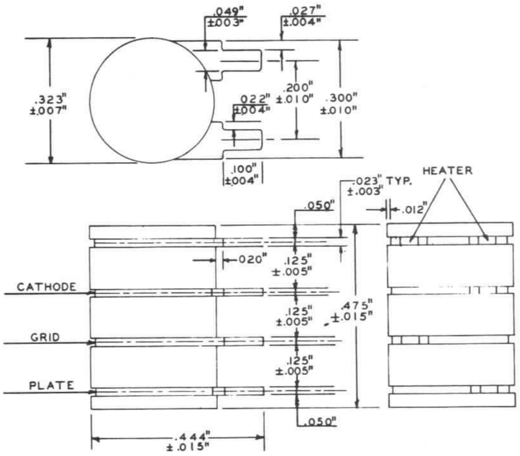
Shock
Statistical sample subjected to 5 impact accelerations of approximately 450 G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, Rg = 0.1 Meg, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, transconductance, and negative grid current.

Stability Life Test
The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial readings to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test
The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements and transconductance following approximately 100 hours of life test.

Intermittent Life Test
Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 300 volts, Ehk = +70 volts d-c, Rk = 82 ohms, R_L = 18000 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, grid current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

DEGRADATION RATE TESTS (Continued)



Maximum eccentricity of insulators 0.010 in. from center line.

Interface Life Test

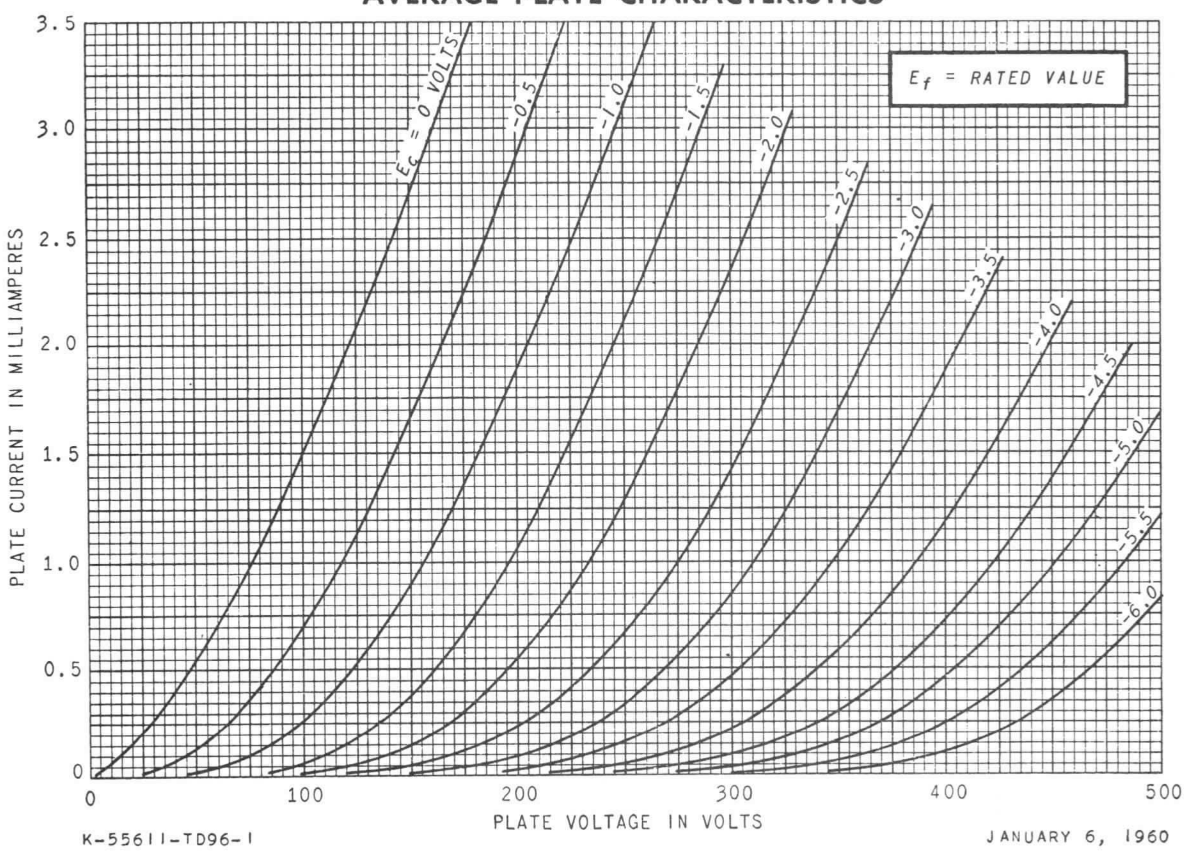
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

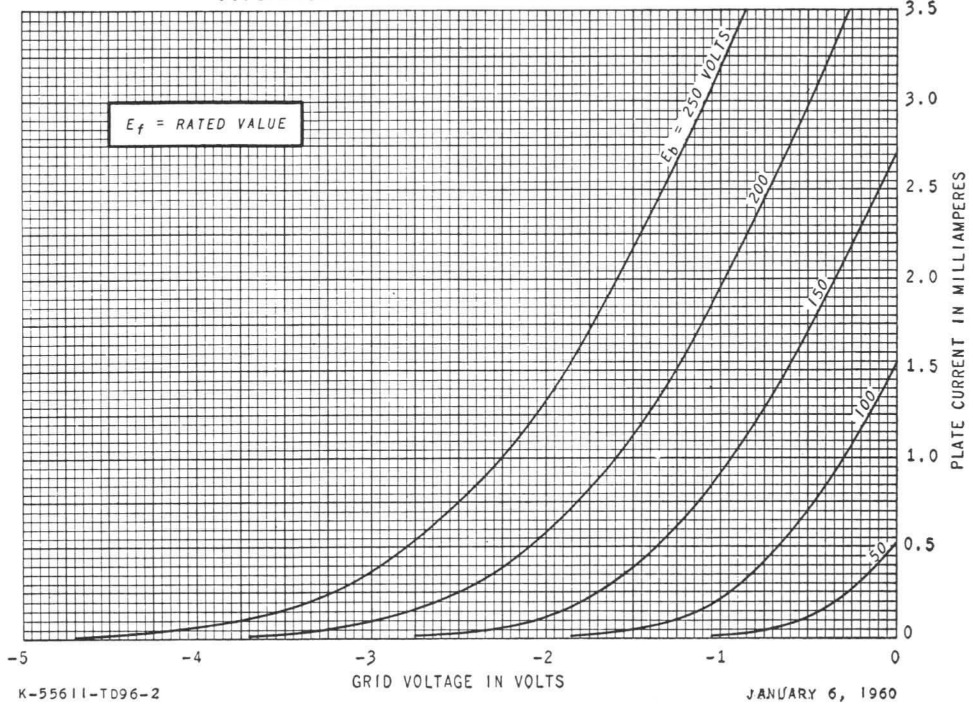
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

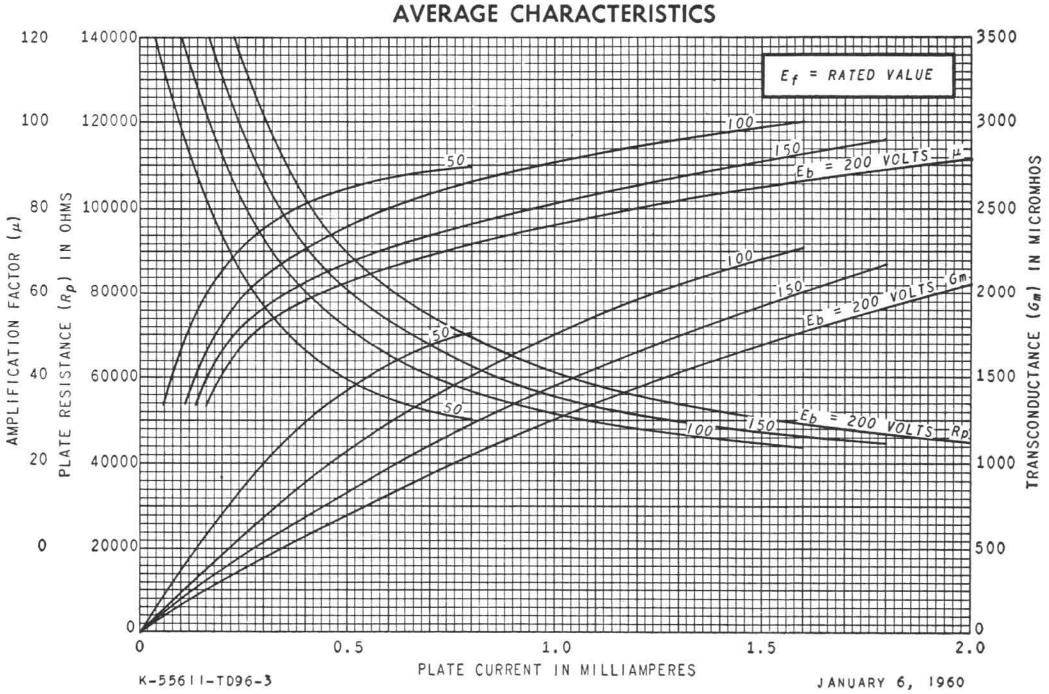
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS

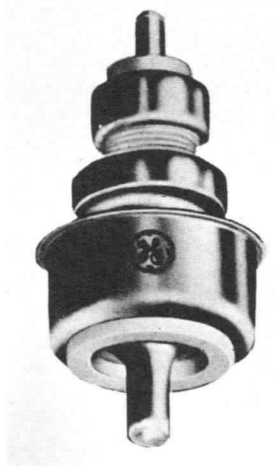


RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7644
PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

Metal and Ceramic | Small Size
Low Noise | Conduction Cooled

The 7644 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid, Class A, radio-frequency amplifier at frequencies as high as 3000 megacycles.

Features of the tube included small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

Within the limitations of its ratings, the 7644 may be used in radar receivers, or similar applications, where the grid of the tube may be driven positive by leakage pulses. The physical appearance and dimensions of the 7644 are identical to those of the 6299, and the electrical characteristics are nearly identical.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ±0.13	Volts
Heater Current†	0.3	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.75	pf
Grid to Cathode and Heater: g to (h+k)	3.65	pf
Plate to Cathode and Heater: p to (h+k)	0.015	pf

MECHANICAL

Mounting Position—Any		
Net Weight, approximate	1/6	Ounce
Cooling—Conduction§		

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.0	Watts
DC Plate Current	12	Milliamperes
Leakage Pulse		
Duty Cycle	0.0011	
Pulse Width	15	Microseconds
Peak RF Grid Voltage¶	7.0	Volts
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage ⋇	....	Volts
Amplification Factor	110	
Plate Resistance, approximate	7300	Ohms
Transconductance	15000	Micromhos
Plate Current	10	Milliamperes
Plate Voltage, approximate Ib = 10 Milliamperes, Ec = 0 volts	125	Volts

CLASS A_1 RF AMPLIFIER—GROUNDED-GRID, COAXIAL-TYPE CIRCUIT

Frequency	450	1200	3000	Megacycles
Plate-Supply Voltage△	300	300	300	Volts
Resistor in Plate Circuit (bypassed)	17500	17500	17500	Ohms
Grid Voltage**	0	0	0	Volts
Plate Current	10	10	10	Milliamperes
Bandwidth, min.	10	10	10	Megacycles
Gain	17.5	17	11	Decibels
Noise Figure, Power-Matched	4.5	8.2	13.2	Decibels

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ Good thermal contact to the anode and cathode must be provided to conduct heat from the elements. The anode contact must be sufficiently flexible to keep lateral force on the anode at a minimum.

¶ The 7644 is rated only for Class A amplifier service.

⋇ Adjusted for Ib = 10 milliamperes.

△ Supply should be regulated.

**For operation above 1000 megacycles, the minimum noise figure will generally be obtained by operation at zero bias. For operation below 1000 megacycles, the use of a cathode resistor or grid bias should be evaluated for the particular application.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	280	300	320	Milliamperes
Plate Voltage				
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma	75	125	175	Volts
Transconductance				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	11500	15000	20000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	85	110	140	
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode and Heater at 45 volts d-c	2.5	.....	.....	Megohms
Grid to Plate at 500 volts d-c	25	.....	.....	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.5	1.75	2.0	Picofarads
Grid to Cathode and Heater: g to (h+k)	3.0	3.65	5.0	Picofarads
Plate to Cathode and Heater: p to (h+k)	.....	0.015	0.025	Picofarads

SPECIAL PERFORMANCE TESTS

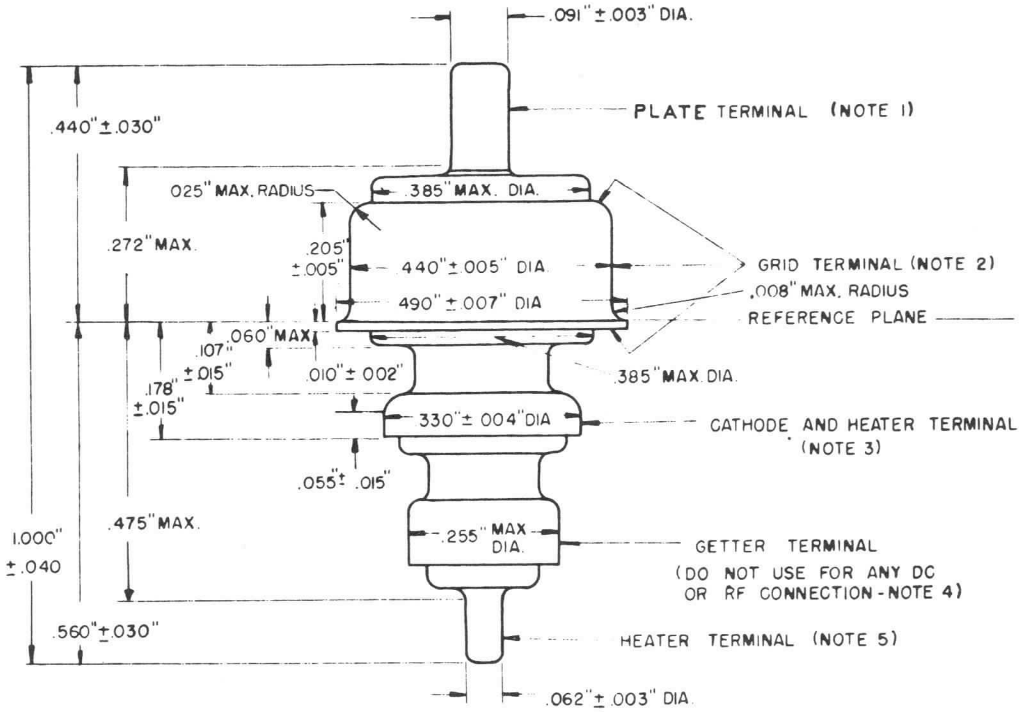
	Min.	Max.	
Noise Figure—450 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5 MC	.....	5.0	Decibels
Noise Figure—1200 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC	.....	8.5	Decibels
Power Gain—450 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5 MC, Bandwidth = 9 MC min.	15	.....	Decibels
Power Gain—1200 MC Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC, Bandwidth = 10 MC min.	15	.....	Decibels

DEGRADATION RATE TESTS

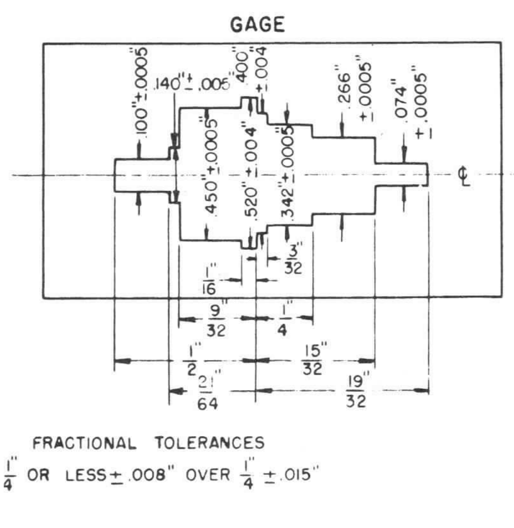
1000-Hour Life

Statistical sample operated for 1000 hours to evaluate changes in transconductance and noise figure with life.

PHYSICAL DIMENSIONS



DIMENSIONAL TOLERANCES

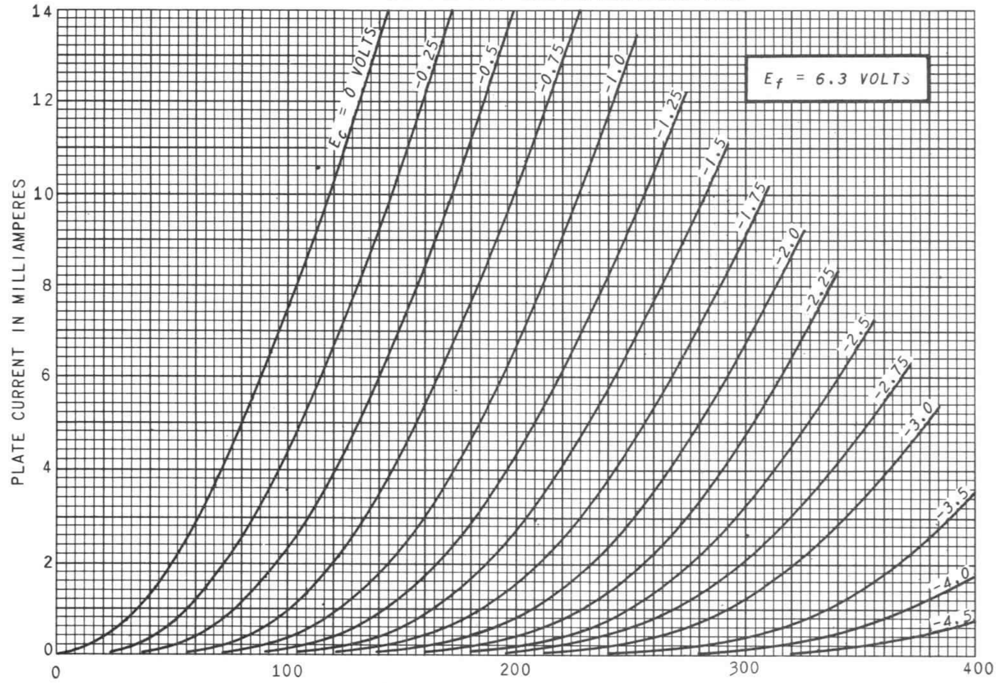


NOTES:

1. Maximum eccentricity 0.007″ (runout 0.014″)
2. Maximum eccentricity 0.008″ (runout 0.016″)
3. Maximum eccentricity 0.010″ (runout 0.020″)
4. Maximum eccentricity 0.015″ (runout 0.030″)
5. Maximum eccentricity 0.010″ (runout 0.020″)

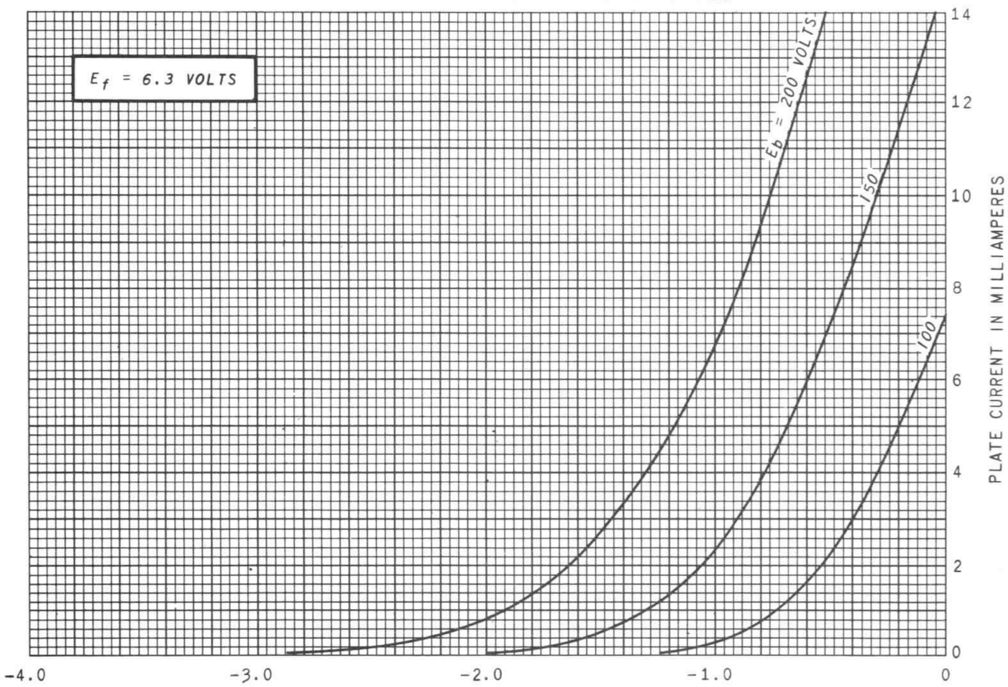
   Eccentricities measured with respect to center line through gage. Tube shall be rotated 360° in gage without binding.

AVERAGE PLATE CHARACTERISTICS



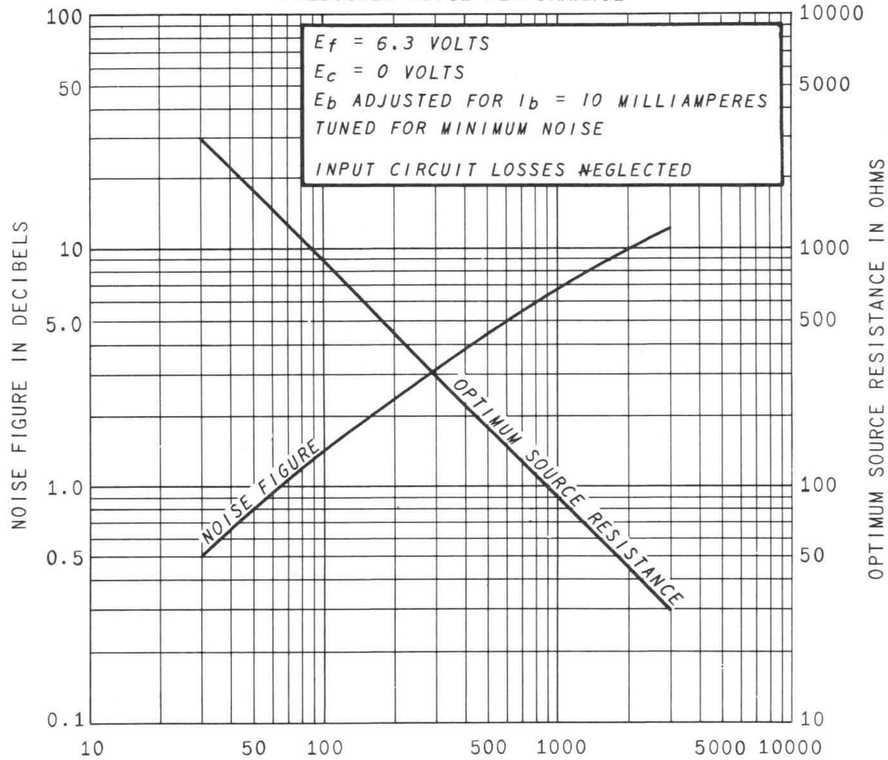
K-55611-TD146-1 SEPTEMBER 8, 1961

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD146-2 SEPTEMBER 8, 1961

PREDICTED NOISE PERFORMANCE

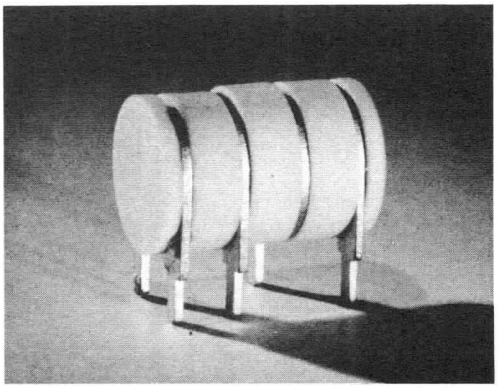


K-55611-TD146-3 SEPTEMBER 8, 1961

ELECTRONICS

7720

METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

The 7720 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator in the ultra-high-frequency range.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.24	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any
See outline drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Peak Negative Grid Voltage	50	Volts
Plate Dissipation	1.0	Watt
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes

Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance	10,000	Ohms
Bulb Temperature at Hottest Point**	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	100	150	Volts
Grid Voltage	0	——	Volts
Cathode-Bias Resistor	——	82	Ohms
Amplification Factor	——	90	
Transconductance	11,500	10,500	Micromhos
Plate Current	9.0	7.5	Milliamperes

UHF OSCILLATOR SERVICE

Plate Voltage	150	Volts
Grid Resistor	7000	Ohms
Plate Current	4.0	Milliamperes
Frequency	450	Megacycles
Grid Current	0.5	Milliamperes
Power Output, approximate	100	Milliwatts

FOOTNOTES

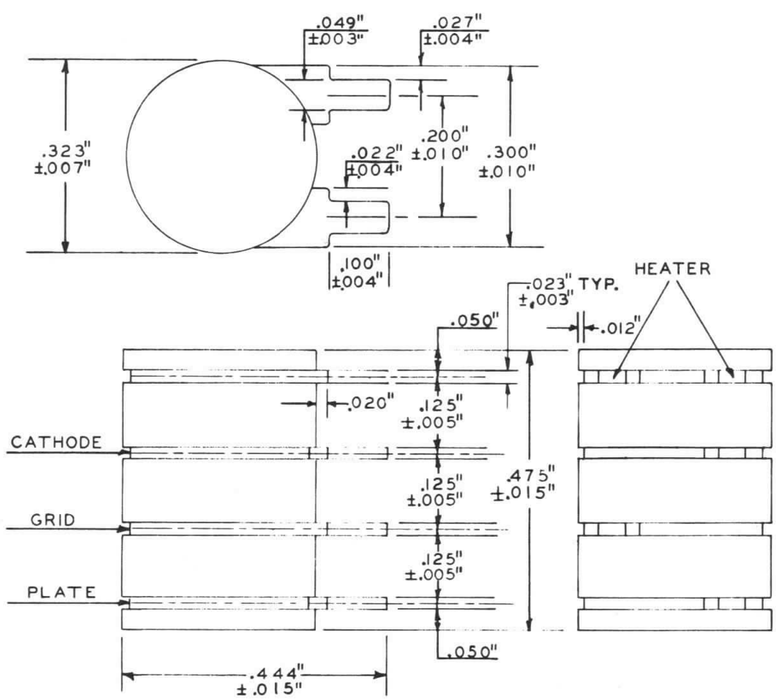
* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

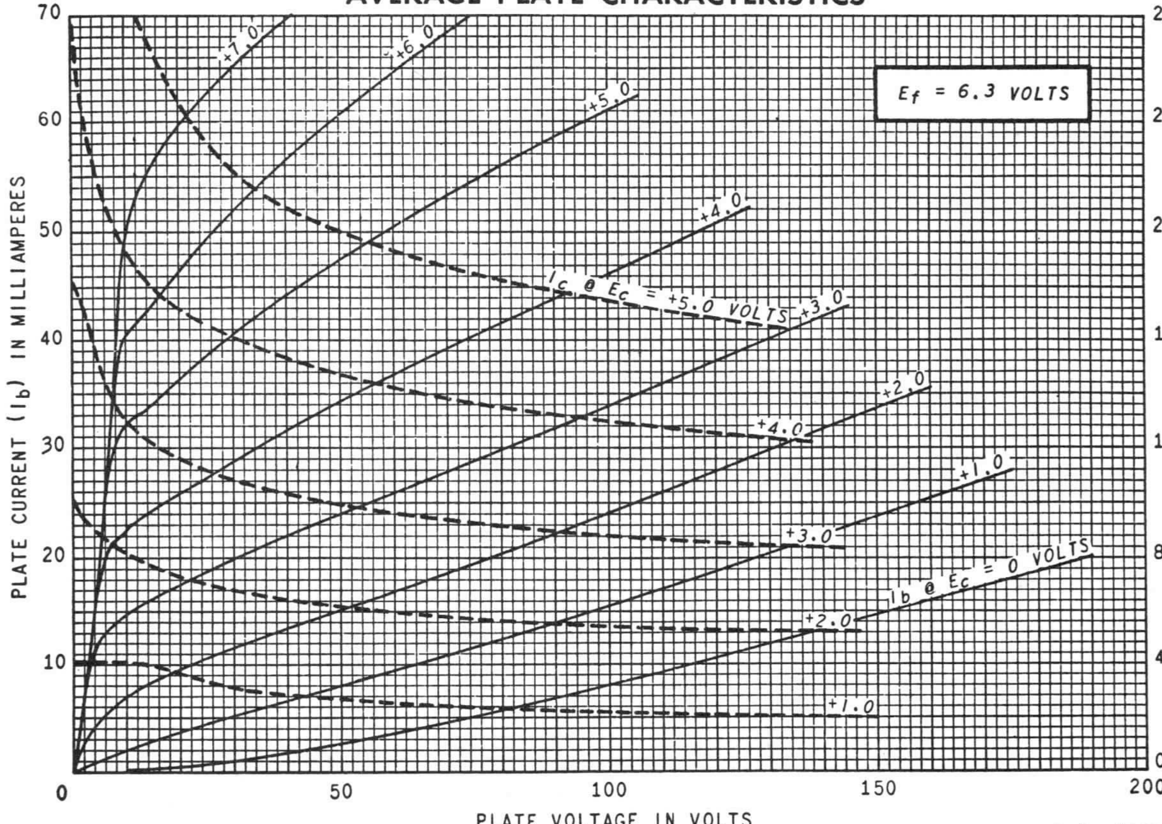
**For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.

OUTLINE DRAWING



NOTE: Maximum eccentricity of insulators 0.010 in. from center line.

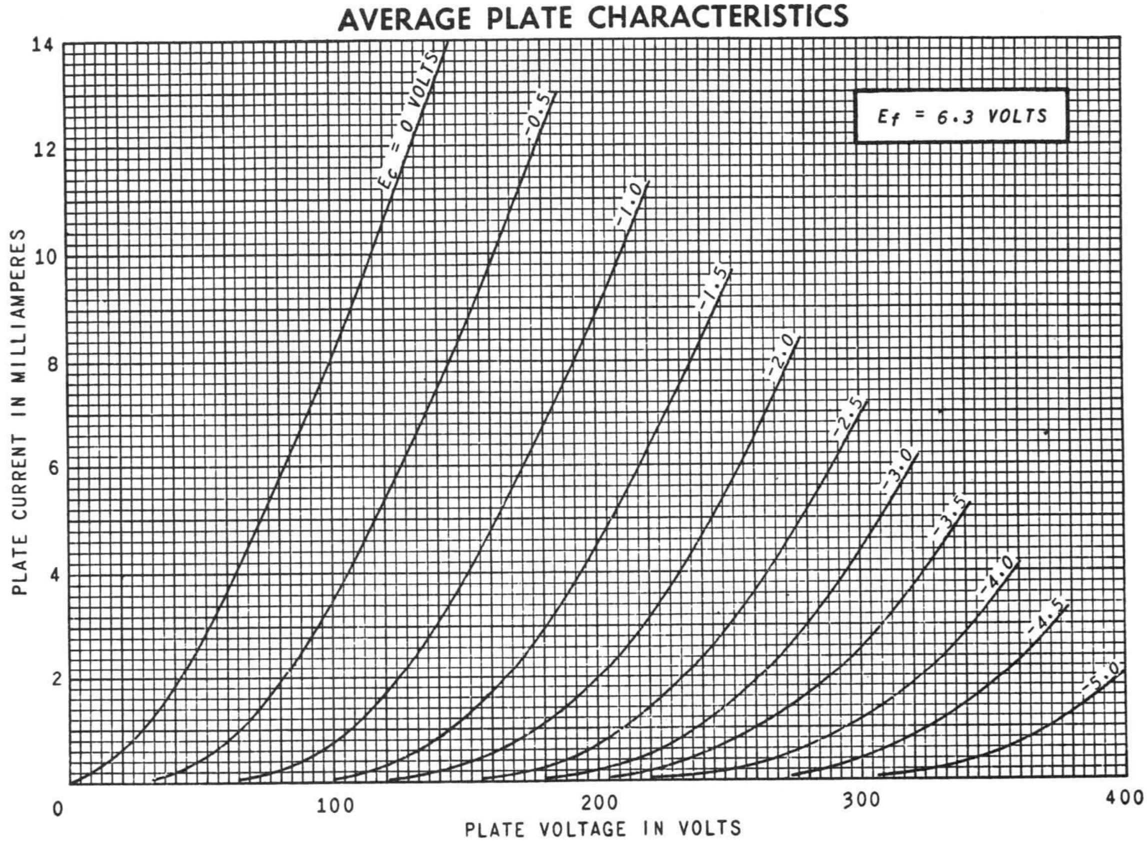
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-1

JUNE 3, 1959

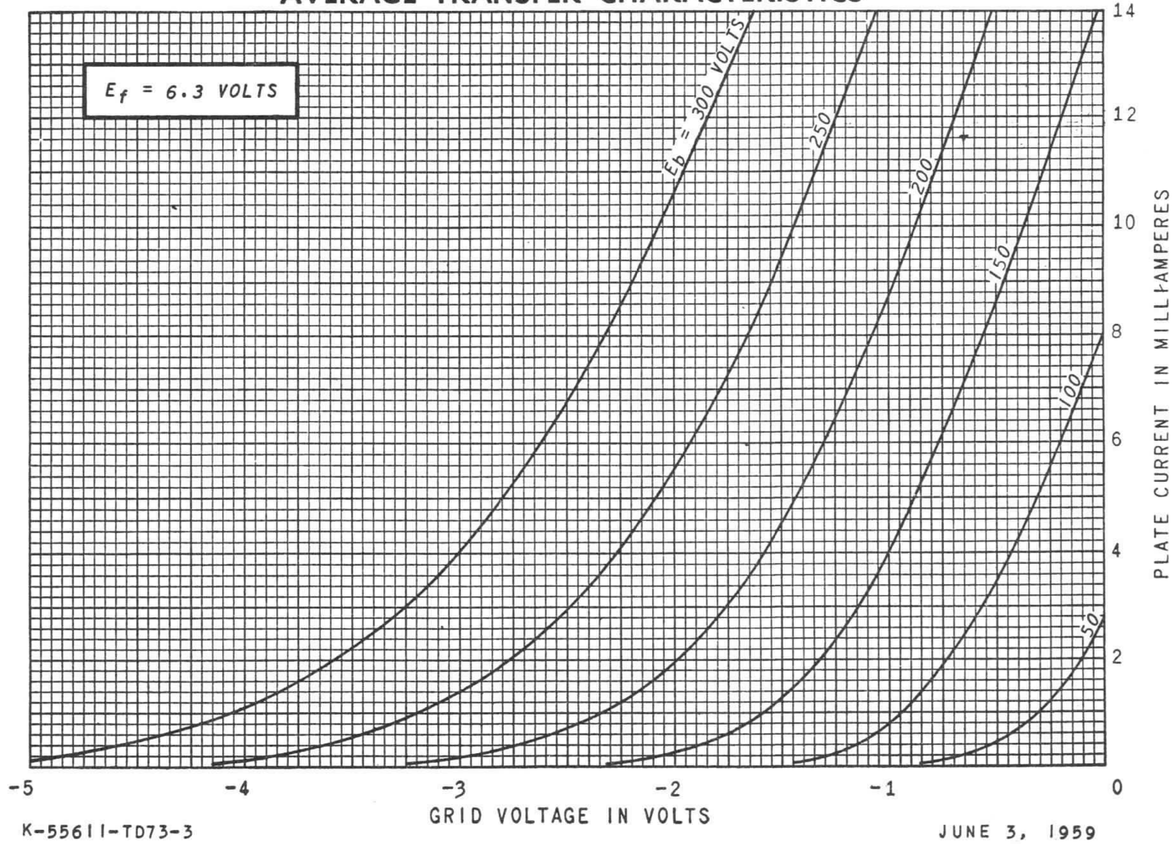
AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-2

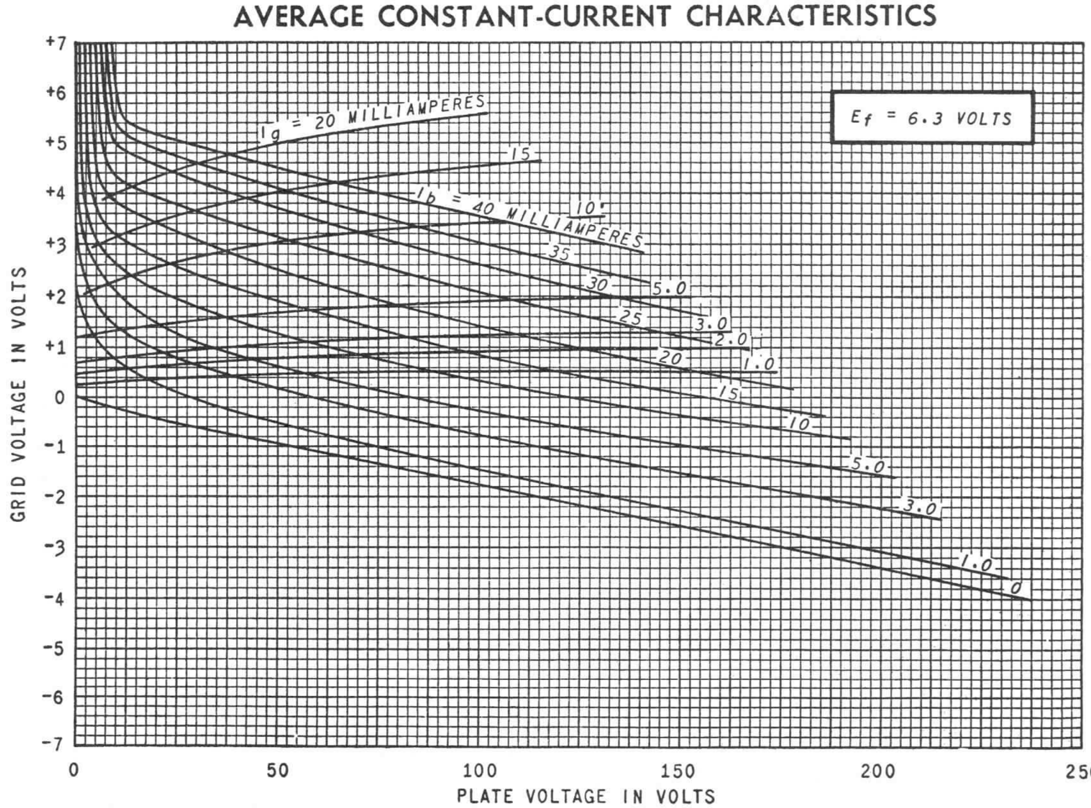
JUNE 3, 1959

AVERAGE TRANSFER CHARACTERISTICS



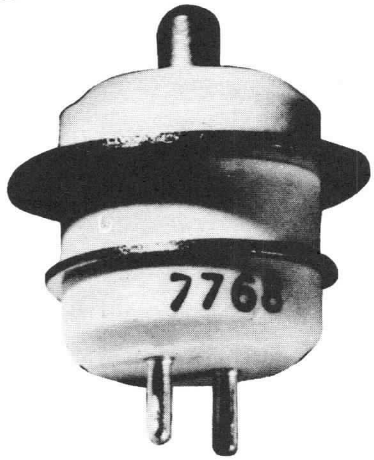
K-55611-TD73-3 JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



CONSTANT-CURRENT CURVES

K-55611-TD73-4 JUNE 3, 1959



METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

FOR BROADBAND RADIO-FREQUENCY AMPLIFIER APPLICATIONS

The 7768 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as a broadband radio-frequency amplifier. The 7768 is especially suited for use where unfavorable conditions of mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.4	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.7	pf
Input: g to (h+k)	6.0	pf
Output: p to (h+k)	0.018	pf
Heater to Cathode: (h to k)	2.4	pf

MECHANICAL

Mounting Position—Any

See Outline Drawing on page 3 for dimensions and electrical connections

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	5.5	Watts
DC Cathode Current	30	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance With Cathode Bias	0.01	Megohms
Envelope Temperature at Hottest Point§	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	270	Ohms
Amplification Factor	225	
Plate Resistance, approximate	4500	Ohms
Transconductance	50000	Micromhos
Plate Current	24	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	−3	Volts

FOOTNOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

† Heater current of a bogey tube at Ef = 6.3 volts.

‡ Without external shield.

§ Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	370	400	430	Milliamperes
Plate Current				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	14	22	30	Milliamperes
Transconductance				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	40000	50000	60000	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 200 volts, Rk = 22 ohms (bypassed)	170	225	280	
Grid Voltage Cutoff				
Ef = 6.3 volts, Eb = 200 volts, Ib = 100 μa	.....	−3.0	−5.0	Volts
Noise Figure				
Ef = 6.3 volts, Ebb = 280 volts, R_L = 3300 ohms, Rk = 22 ohms (bypassed), F = 200 MC ± 10 mc	.....	3.0	4.8	Decibels
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.3	1.7	2.1	pf
Input: g to (h+k)	4.5	6.0	7.5	pf
Output: p to (h+k)	0.01	0.018	0.026	pf
Heater to Cathode: (h to k)	1.5	2.4	3.3	pf
Negative Grid Current				
Ef = 6.3 volts, Eb = 200 volts, Ecc = −1.0 volts, Rk = 22 ohms (bypassed), Rg = 0.1 meg	.....	.....	0.5	Microamperes
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 100 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts. Polarity of applied d-c interelectrode voltage is such that no cathode emission results.				
Grid to All at 100 volts d-c	50	.....	.....	Megohms
Plate to All at 300 volts d-c	50	.....	.....	Megohms
Grid Emission Current				
Ef = 7.0 volts, Eb = 200 volts, Ecc = −15 volts, Rg = 0.1 meg	.....	.....	2.0	Microamperes

SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current	.....	.....	1.0	Milliamperes
Peak Plate Current Backswing	.....	.....	2.0	Milliamperes

Tubes with poor grid recovery affect circuit operation when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 7768 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg. Ec is adjusted for Ib = 10 ma.

Upon application to the grid of a 3 volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

	Min.	Bogey	Max.	
Low Frequency Vibrational Output	.....	.....	50	Millivolts RMS

Statistical sample is subjected to vibration in each of two planes at 40 cps, with peak acceleration 15G. Tube is operated with Ef = 6.3 volts, Ebb = 250 volts, Rk = 68 ohms (bypassed), R_L = 2000 ohms

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

OUTLINE DRAWING

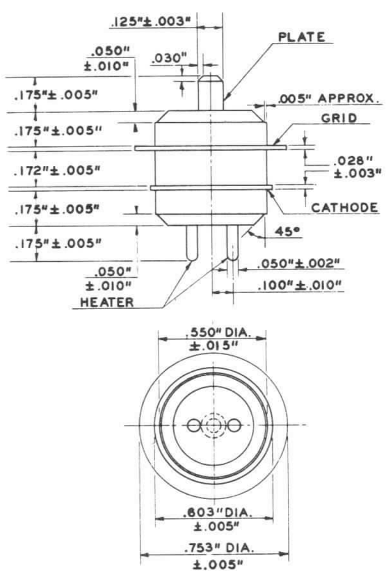
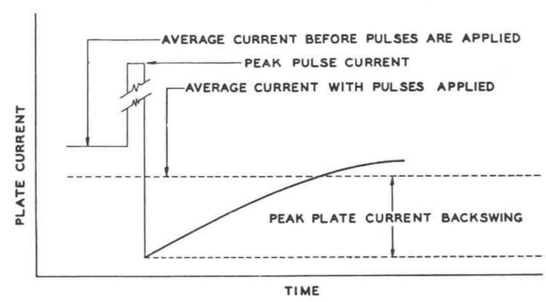


PLATE CURRENT VS. TIME —GRID RECOVERY TEST



DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 250 volts, Ehk = +100 volts, and Rk = 68 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements and transconductance following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Eb = 200 volts, Ecc = +7 volts, Ehk = −70 volts d-c, Rk = 270 ohms, and Rg = 0.01 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, grid current, transconductance, noise figure, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

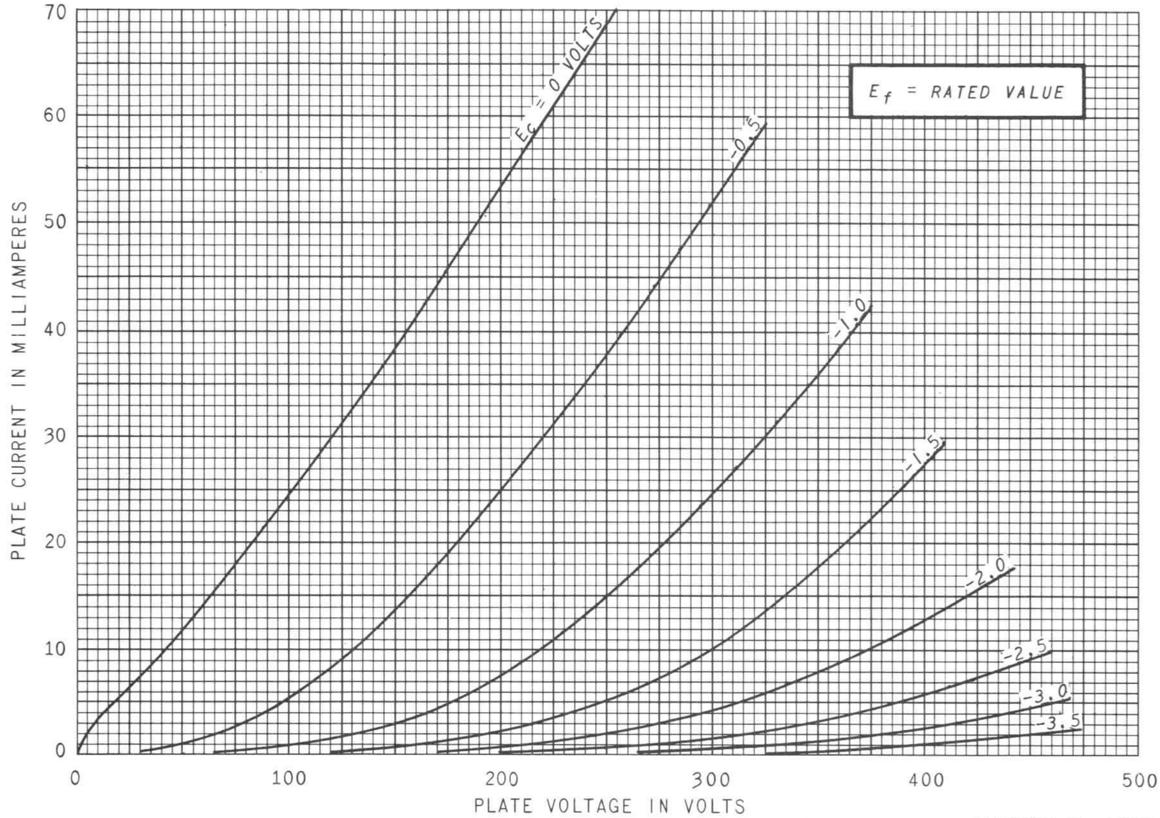
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

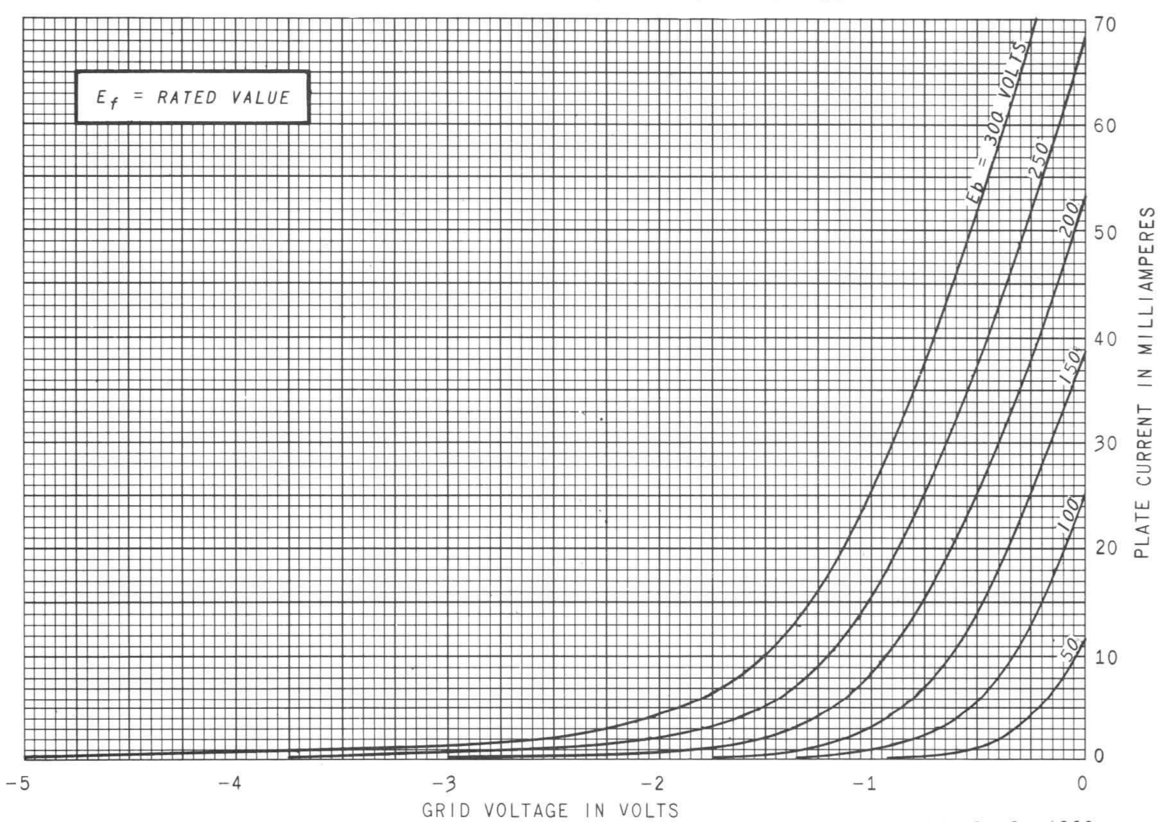
Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

AVERAGE PLATE CHARACTERISTICS



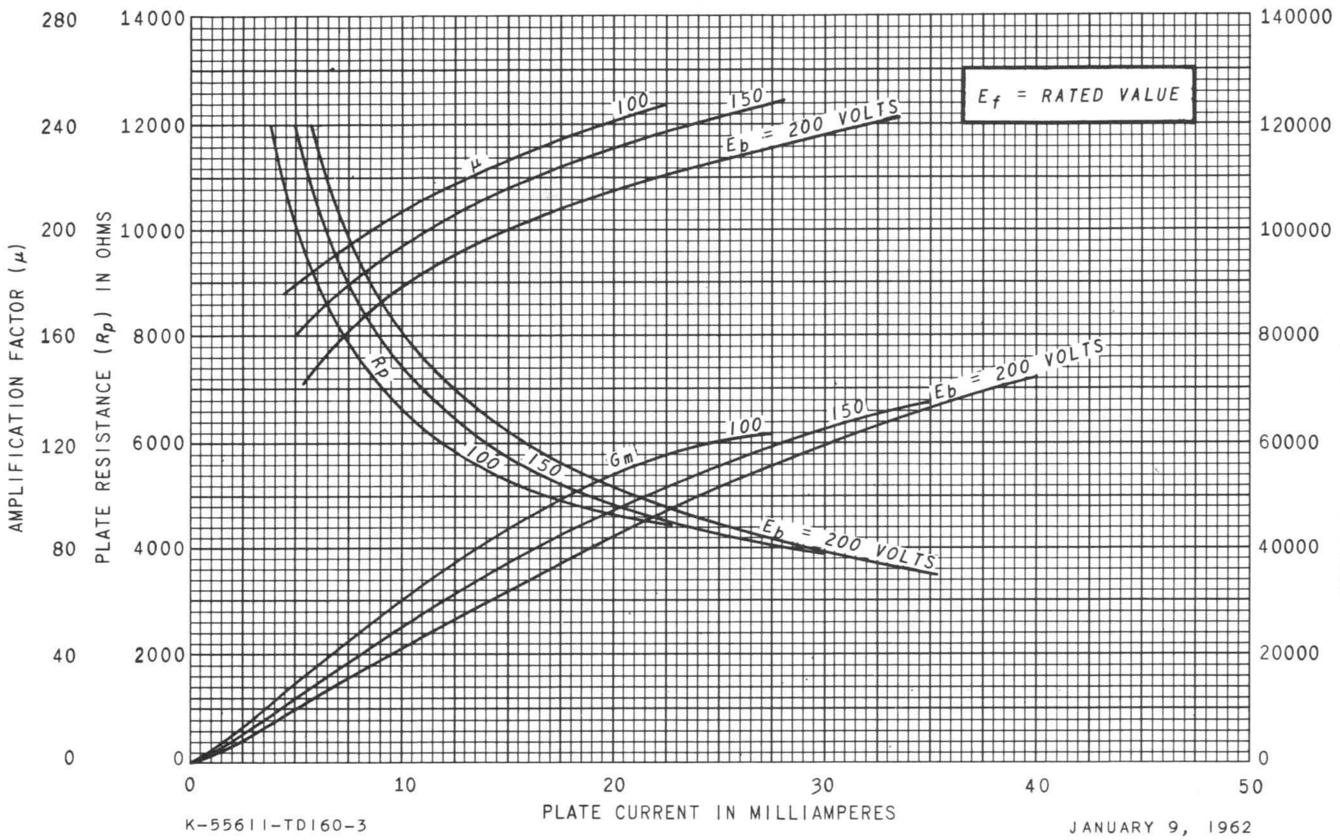
K-55611-TD160-1 JANUARY 9, 1962

AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD160-2 JANUARY 9, 1962

AVERAGE CHARACTERISTICS

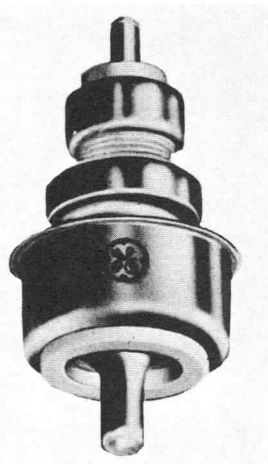


RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

7784
PLANAR TRIODE



DESCRIPTION AND RATING

FOR GROUNDED-GRID CLASS A UHF AMPLIFIER APPLICATIONS

Metal and Ceramic — Small Size
Low Noise — Conduction Cooled

The 7784 is a high-mu, metal-and-ceramic triode intended for operation as a grounded-grid, Class A, radio-frequency amplifier at frequencies as high as 3000 megacycles.

Features of the tube include small size, planar electrode construction with close spacing, inherent rigidity, and an envelope structure convenient for coaxial circuit applications.

At 1200 megacycles a noise figure of less than 8.5 decibels may be obtained when the 7784 is used in a grounded-grid coaxial circuit.

The 7784 differs from the 6299 only in having an isolated heater.

GENERAL

ELECTRICAL

Cathode Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.3	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate: (g to p)	1.75	pf
Grid to Cathode and Heater: g to (h+k)	3.65	pf
Plate to Cathode and Heater: p to (h+k)	0.015	pf

MECHANICAL

Mounting Position—Any

Net Weight . . . 1/6 Ounce

Cooling—Conduction§

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	200	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	15	Volts
Plate Dissipation	2.0	Watts
DC Plate Current	12	Milliamperes
DC Grid Current//	0¶	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	150	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	175	Volts
Grid Voltage ✱	....	Volts
Amplification Factor	110	
Plate Resistance, approximate	7300	Ohms
Transconductance	15000	Micromhos
Plate Current	10	Milliamperes
Plate Voltage, approximate Ib = 10 Milliamperes, Ec = 0 Volts	125	Volts

CLASS A_1 RF AMPLIFIER
GROUNDED-GRID, COAXIAL-TYPE CIRCUIT

Frequency	450	1200	1200	1200	3000	Megacycles
Plate Voltage	△	.....	△	175	△	Volts
Plate-Supply Voltage**	....	300	....	....	....	Volts
Resistor in Plate Circuit (bypassed)	....	17500	....	....	....	Ohms
Grid Voltage††	0	0	0	§§	0	Volts
Plate Current	10	10	10	10	10	Milliamperes
Bandwidth, min.	9	10	10	10	10	Megacycles
Gain	17.5	17	17	17	11	Decibels
Noise Figure, Power Matched	4.5	8.2	8.0	8.5	13.2	Decibels

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.
† Heater current of a bogey tube at Ef = 6.3 volts.
‡ Without external shield.
§ The electrical connections to the plate and cathode must provide good thermal conductivity from these electrodes. The plate contact must be sufficiently flexible to keep the lateral force on the plate terminal at a minimum.
// The 7784 is rated only for Class A amplifier service.
¶ Does not apply to initial-emission-velocity current.
✱ Adjusted for Ib = 10 milliamperes.
△ Adjust for Ib = 10 milliamperes; range must be variable from 75 to 200 volts.
** Supply should be regulated.
†† For operation above 1000 megacycles, the minimum noise figure will generally be obtained by operation at zero bias. For operation below 1000 megacycles, the use of a cathode resistor or grid bias should be evaluated for the particular application.
§§ Adjusted for Ib = 10 milliamperes; 200-ohm variable cathode resistor recommended.

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	280	300	320	Milliamperes
Plate Voltage				
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma	75	125	175	Volts
Transconductance				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	11500	15000	.....	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 175 volts, Ec adjusted for Ib = 10 ma	85	110	140	
Heater-Cathode Leakage Current				
Ef = 6.3 volts, Ehk = 50 volts				
Heater Positive with Respect to Cathode	.....	.....	20	Microamperes
Heater Negative with Respect to Cathode	.....	.....	20	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 45 volts d-c	0.25	.....	.....	Megohms
Grid to Plate at 500 volts d-c	5.0	.....	.....	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.5	1.75	2.0	Picofarads
Grid to Cathode and Heater: g to (h+k)	3.0	3.65	5.0	Picofarads
Plate to Cathode and Heater: p to (h+k)	.....	0.015	0.025	Picofarads

SPECIAL PERFORMANCE TESTS

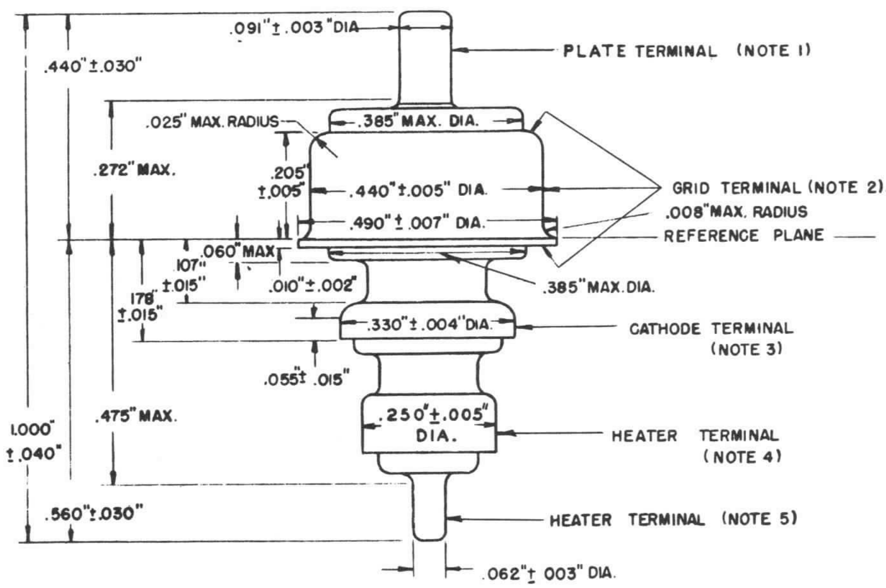
	Min.	Max.	
Noise Figure—450 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5 MC	.....	5.0	Decibels
Noise Figure—1200 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC	.....	8.5	Decibels
Noise Figure—3000 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000 ± 5 MC	.....	13.5	Decibels
Power Gain—450 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 450 ± 5 MC, Bandwidth = 9 MC min.	15	.....	Decibels
Power Gain—1200 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 1200 ± 5 MC, Bandwidth = 10 MC min.	15	.....	Decibels
Power Gain—3000 MC			
Ef = 6.3 volts, Ec = 0 volts, Eb adjusted for Ib = 10 ma, F = 3000 ± 5 MC, Bandwidth = 10 MC min.	10	.....	Decibels

DEGRADATION RATE TESTS

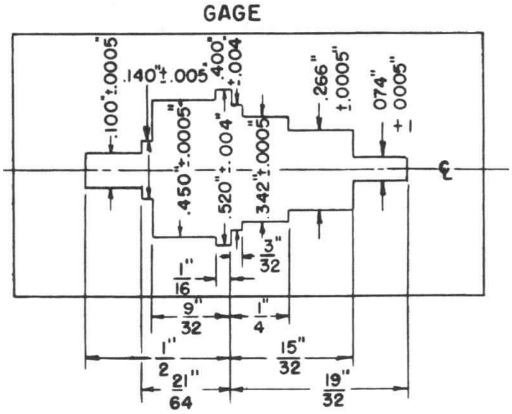
1000-Hour Life

Statistical sample operated for 1000 hours to evaluate changes in transconductance and noise figure with life.

PHYSICAL DIMENSIONS



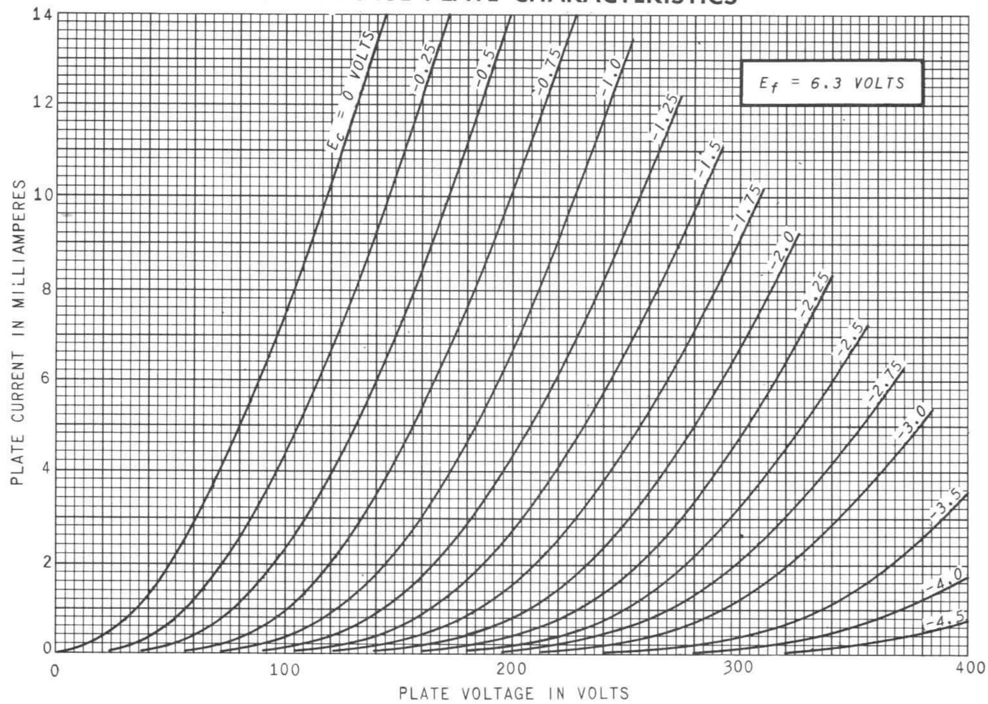
DIMENSIONAL TOLERANCES



NOTES:

1. Maximum eccentricity 0.007″ (runout 0.014″)
2. Maximum eccentricity 0.008″ (runout 0.016″)
3. Maximum eccentricity 0.010″ (runout 0.020″)
4. Maximum eccentricity 0.015″ (runout 0.030″)
5. Maximum eccentricity 0.010″ (runout 0.020″)
   Eccentricities measured with respect to center line through gage. Tube shall be rotated 360° in gage without binding.

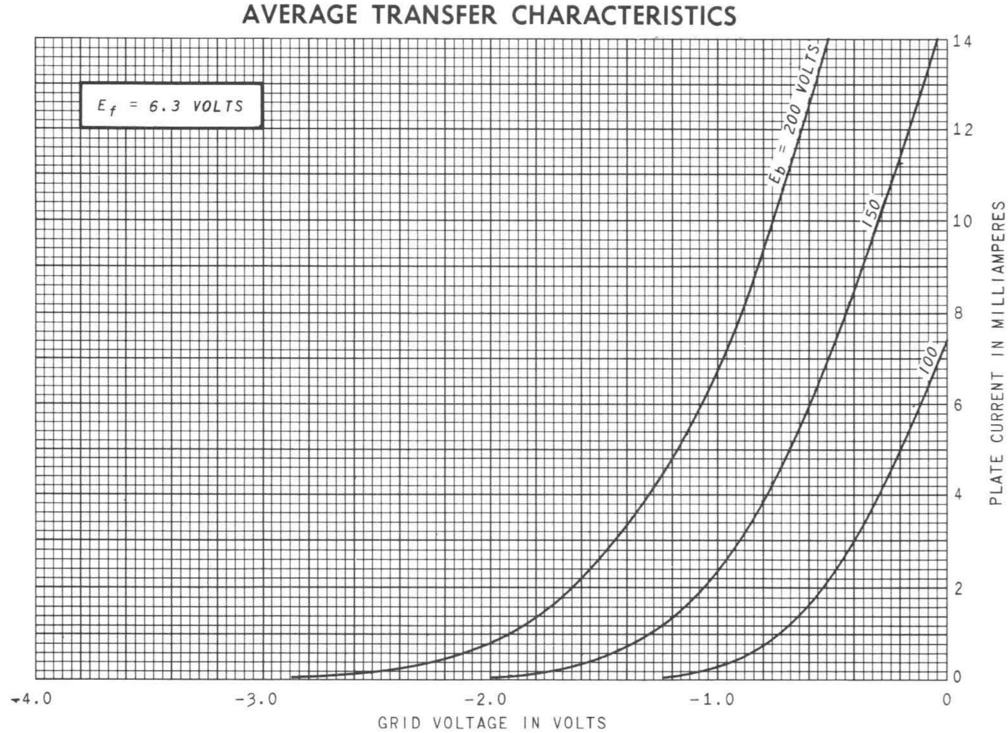
AVERAGE PLATE CHARACTERISTICS



K-55611-TD146-1

SEPTEMBER 8, 1961

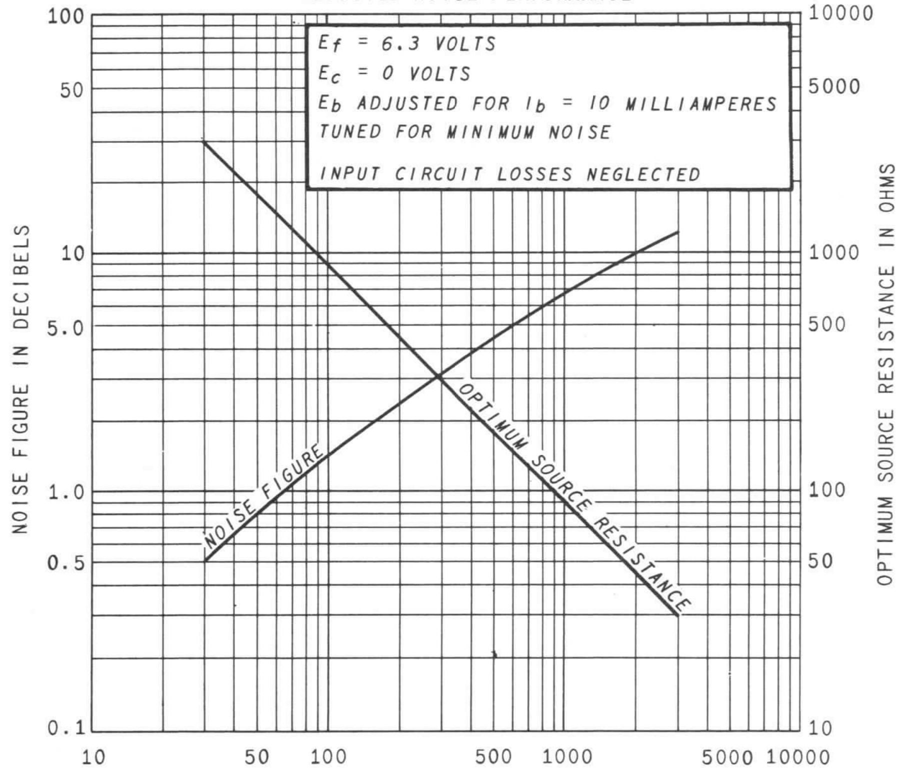
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD146-2

SEPTEMBER 8, 1961

PREDICTED NOISE PERFORMANCE



K-55611-TD146-3 SEPTEMBER 8, 1961

7815

PLANAR TRIODE

The 7815 is a high-mu, ceramic-and-metal, planar triode designed for use as a grid-pulsed or plate-pulsed oscillator, frequency multiplier, or power amplifier at frequencies up to 3000 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC	*	Volts
Heater Current+	1.0	Amperes
Direct Interelectrode Capacitances‡		
Grid to Plate	2.05	pf
Grid to Cathode	6.3	pf
Plate to Cathode, maximum	0.035	pf

Mechanical

Mounting Position - Any		
Cooling	Conduction and Convection	
Net Weight	1.7	Ounces
Maximum Anode Temperature	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS AND TYPICAL OPERATION

Plate-Pulsed Oscillator and Amplifier - Class C

Maximum Ratings
Absolute-Maximum Values

Peak Pulse-Plate-Supply Voltage	3500	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

Typical Operation - Oscillator - 2500 Megacycles

Heater Voltage	5.8	Volts
Peak Plate Supply Voltage	3500	Volts
Pulse Length	5	Microseconds
Duty Factor	0.0030	
Peak Plate Current	3.0	Amperes
Average Plate Current	9.0	Milliamperes
Average Grid Current	3.0	Milliamperes
Peak Useful Power Output, approximate	2000	Watts

Grid-Pulsed Oscillator and Amplifier - Class C

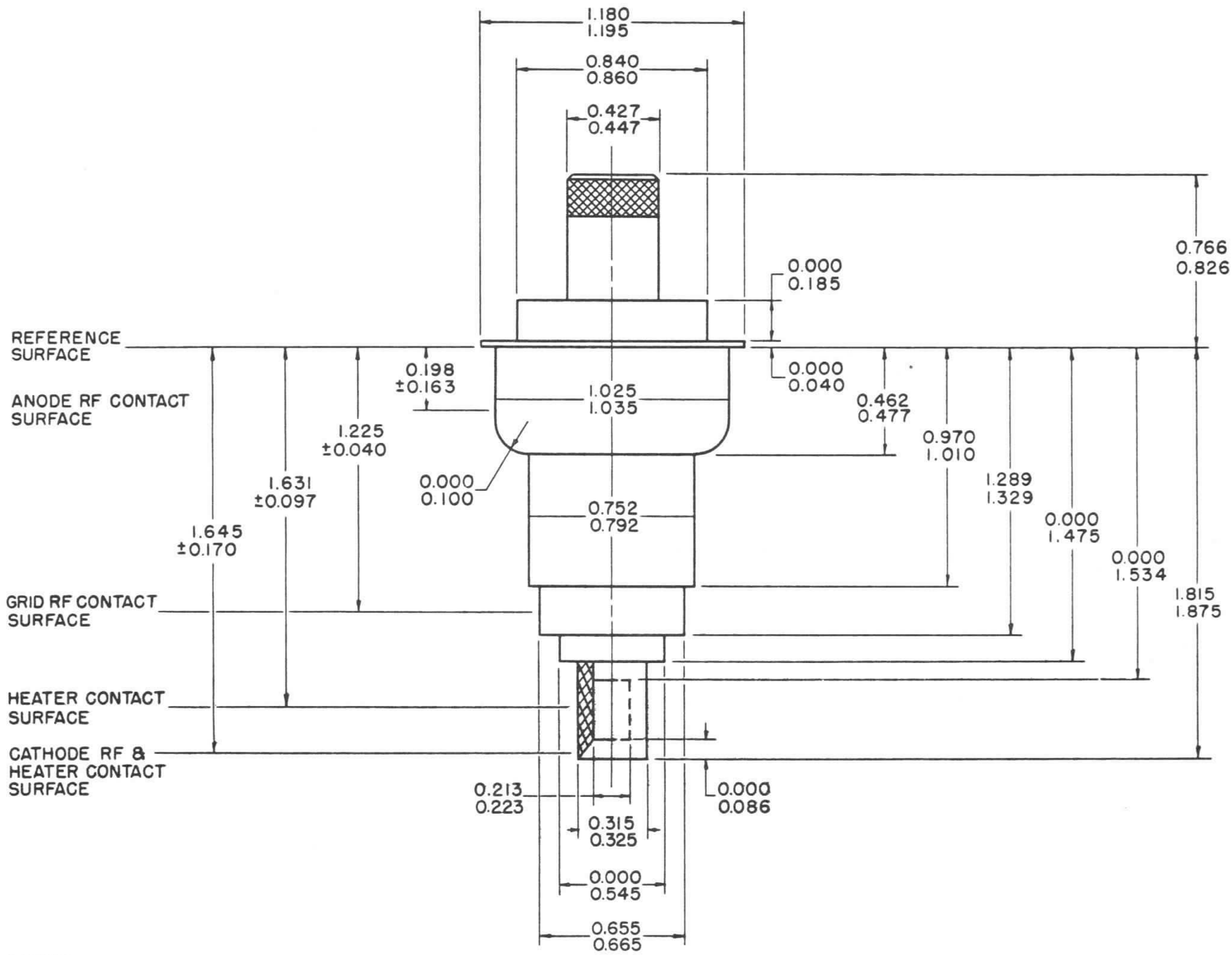
Maximum Ratings
Absolute-Maximum Values

DC Plate Voltage	2000	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

MAXIMUM RATINGS AND TYPICAL OPERATION (Continued)

Typical Operation - Amplifier - 1100 Megacycles

Heater Voltage	6.0	Volts
DC Plate Voltage	1700	Volts
DC Grid Voltage	-45	Volts
Pulse Length	3.5	Microseconds
Duty Factor	0.001	
Peak Plate Current	1.9	Amperes
Peak Grid Current	1.1	Amperes
Driving Power during Pulse, approximate	400	Watts
Peak Useful Power Output, approximate	1500	Watts



NOTES:

1. THE TOTAL INDICATED RUNOUT OF THE ANODE AND GRID CONTACT SURFACES WITH RESPECT TO THE CATHODE CONTACT SURFACE WILL NOT EXCEED 0.020 INCH.

2. THE TOTAL INDICATED RUNOUT OF THE CATHODE CONTACT SURFACE WITH RESPECT TO THE HEATER CONTACT SURFACE WILL NOT EXCEED 0.012 INCH.

3. UPPER DIM. MIN., LOWER DIM. MAX. MIN. 0.000 / MAX. 0.000 ALL DIM. IN INCHES.

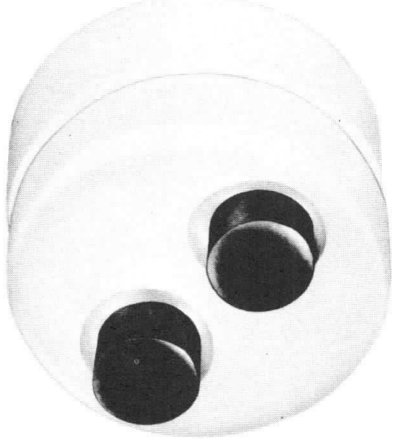
* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 5.0 to 6.0 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

\+ Heater current of a bogey tube at Ef = 6.0 volts.

‡ Measured without heater voltage.

ELECTRONICS

7841
METAL-CERAMIC DIODE



DESCRIPTION AND RATING

The 7841 is a cathode-type diode of ceramic-and-metal planar construction intended for detector and low-current rectifier applications.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3 ± 0.3	Volts
Heater Current†	0.215	Amperes
Direct Interelectrode Capacitances§		
Plate to Cathode: (p to k)	1.1	pf
Heater to Cathode: (h to k)	1.2	pf

MECHANICAL

Mounting Position—Any
See outline drawing on page 2 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE MAXIMUM VALUES

Peak Inverse Plate Voltage	350	Volts
Steady-State Peak Plate Current	22	Milliamperes
DC Output Current	55	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point**	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop		
Ib = 5.0 Milliamperes DC	2.6	Volts

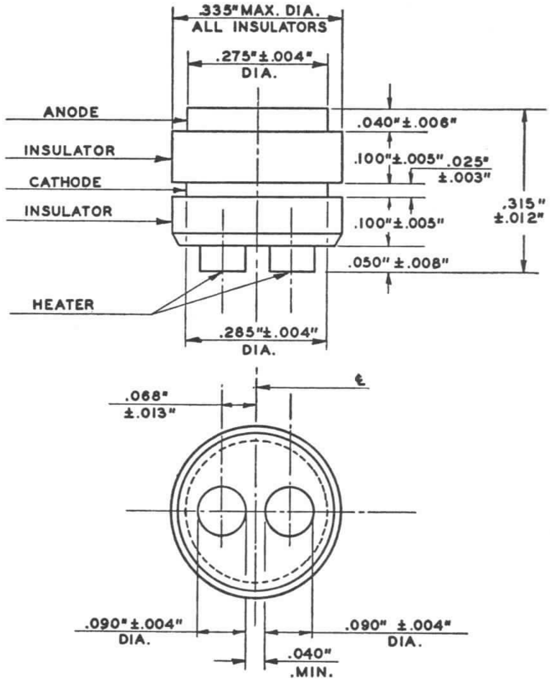
FOOTNOTES

* The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

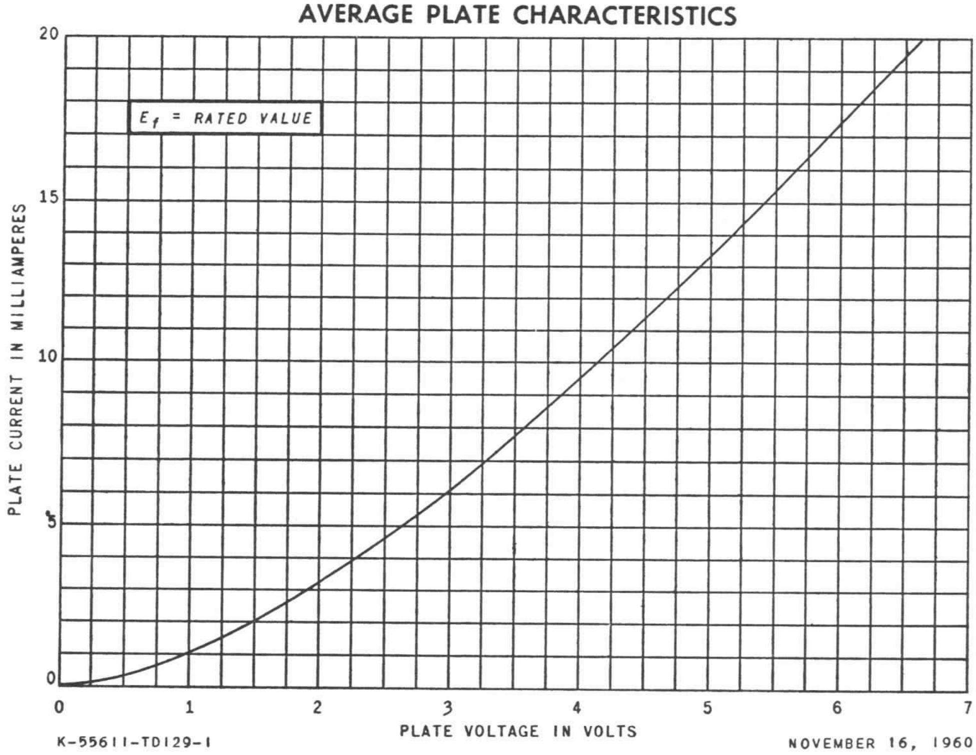
† Heater current of a bogey tube at Ef = 6.3 volts.

§ Measured using a grounded adapter that provides shielding between external terminals of tube.

**For applications where long life is a primary consideration, it is recommended that the envelope temperature be maintained below 175 C.



AVERAGE PLATE CHARACTERISTICS



RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS

7910

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7910 is a triode of ceramic-and-metal planar construction primarily intended for use as a plate-pulsed oscillator or amplifier at frequencies up to 7500 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.275	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.0	pf
Input: g to (h + k)	2.1	pf
Output: p to (h + k)	0.02	pf
Heater to Cathode: (h to k)	1.15	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

PLATE-PULSED OSCILLATOR OR AMPLIFIER SERVICE

Peak Positive-Pulse Plate Supply Voltage	1200	Volts
Duty Factor of Plate Pulse¶#	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average#	0.6	Milliamperes
Average During Plate PulseΔ	0.6	Amperes
Negative Grid Voltage		
Average During Plate Pulse	50	Volts
Grid Current		
Average#	0.2	Milliamperes
Average During Plate Pulse	0.2	Amperes
Plate Dissipation#	1.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	125	Volts
Cathode-Bias Resistor	82	Ohms
Amplification Factor	75	
Transconductance	16000	Micromhos
Plate Current	11.5	Milliamperes

PLATE-PULSED OSCILLATOR SERVICE

Frequency	5900	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	1000	Volts
Plate Current		
Average	0.6	Milliamperes
Average During Plate Pulse	600	Milliamperes
Grid Current		
Average	0.2	Milliamperes
Average During Plate Pulse	200	Milliamperes
Useful Power Output		
Average	0.1	Watts
Average During Plate Pulse	100	Watts

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

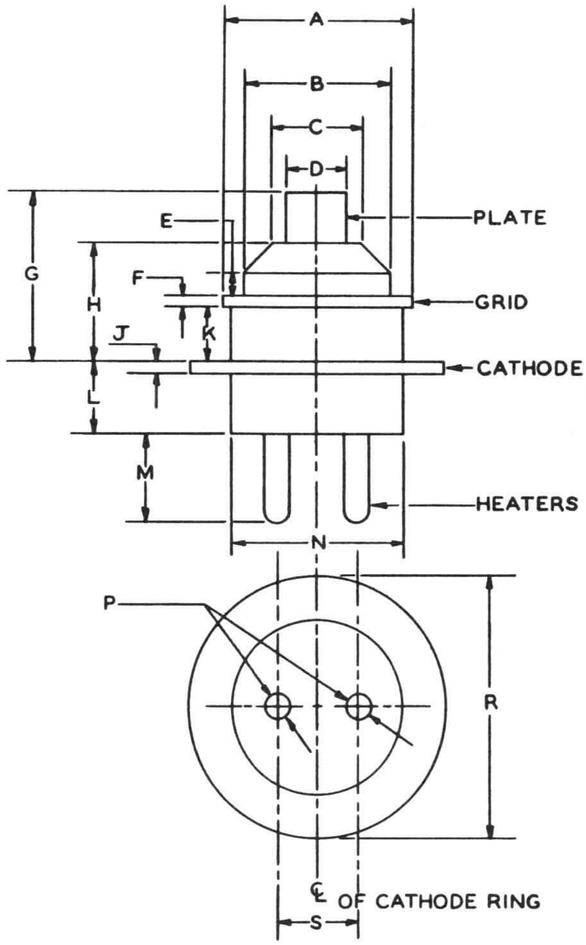
§ Measured with a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendations.

In any 5000 microsecond interval.

Δ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered as short circuit, to a maximum of 6.0 amperes.

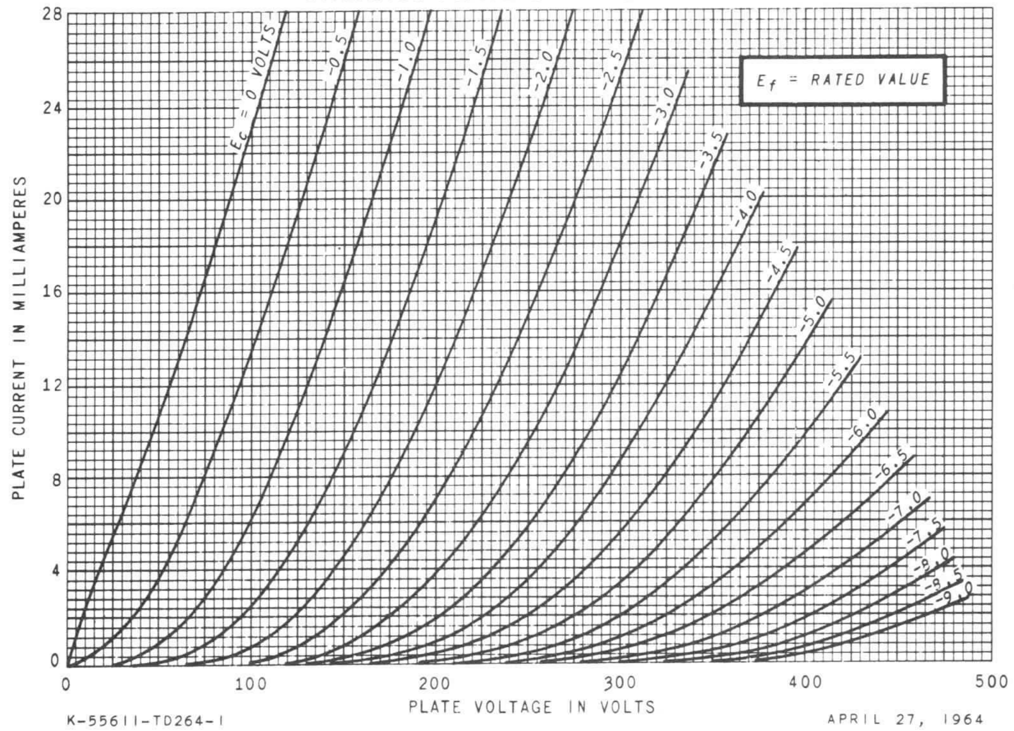
PHYSICAL DIMENSIONS



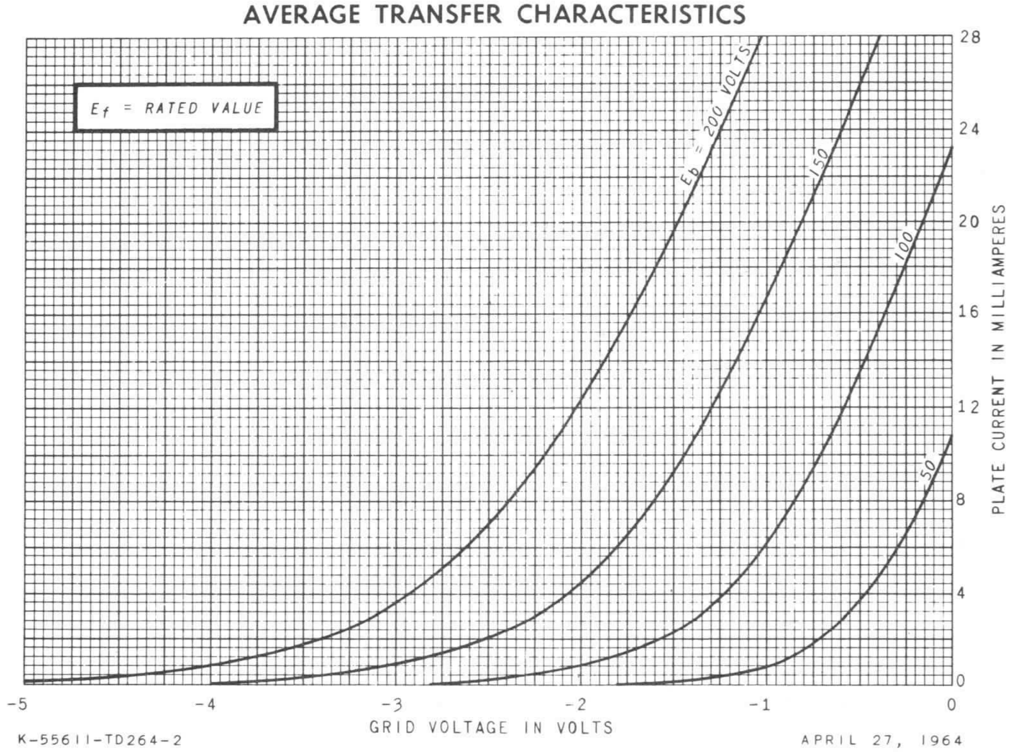
Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.357		0.363	9.068		9.220
B			0.285			7.24
C		0.180			4.57	
D	0.108		0.112	2.743		2.845
E		0.040			1.02	
F	0.025		0.031	0.635		0.787
G	0.315		0.335	8.00		8.51
H	0.216		0.232	5.49		5.89
J	0.025		0.031	0.635		0.787
K	0.094		0.102	2.388		2.591
L	0.143		0.157	3.63		3.99
M	0.165		0.185	4.19		4.70
N			0.330			8.38
P	0.048		0.054	1.219		1.372
R	0.476		0.484	12.090		12.294
S	0.130		0.142	3.30		3.61

Note: The millimeter dimensions are derived from the original inch dimensions.

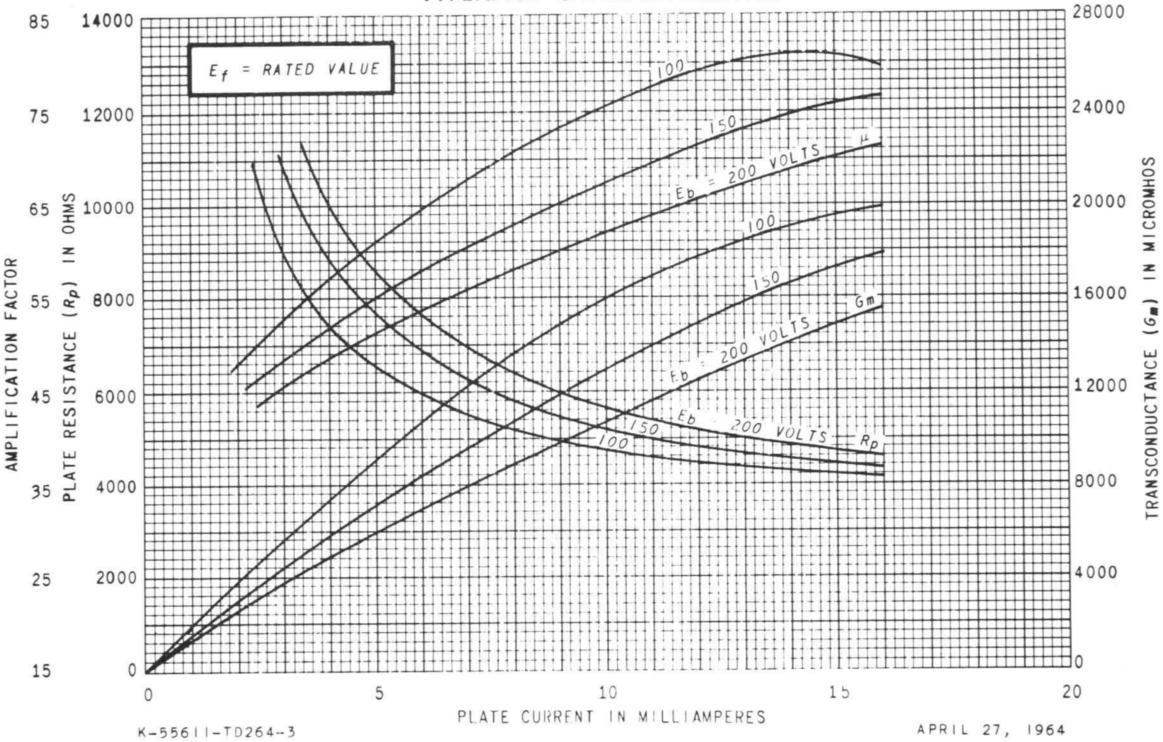
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS

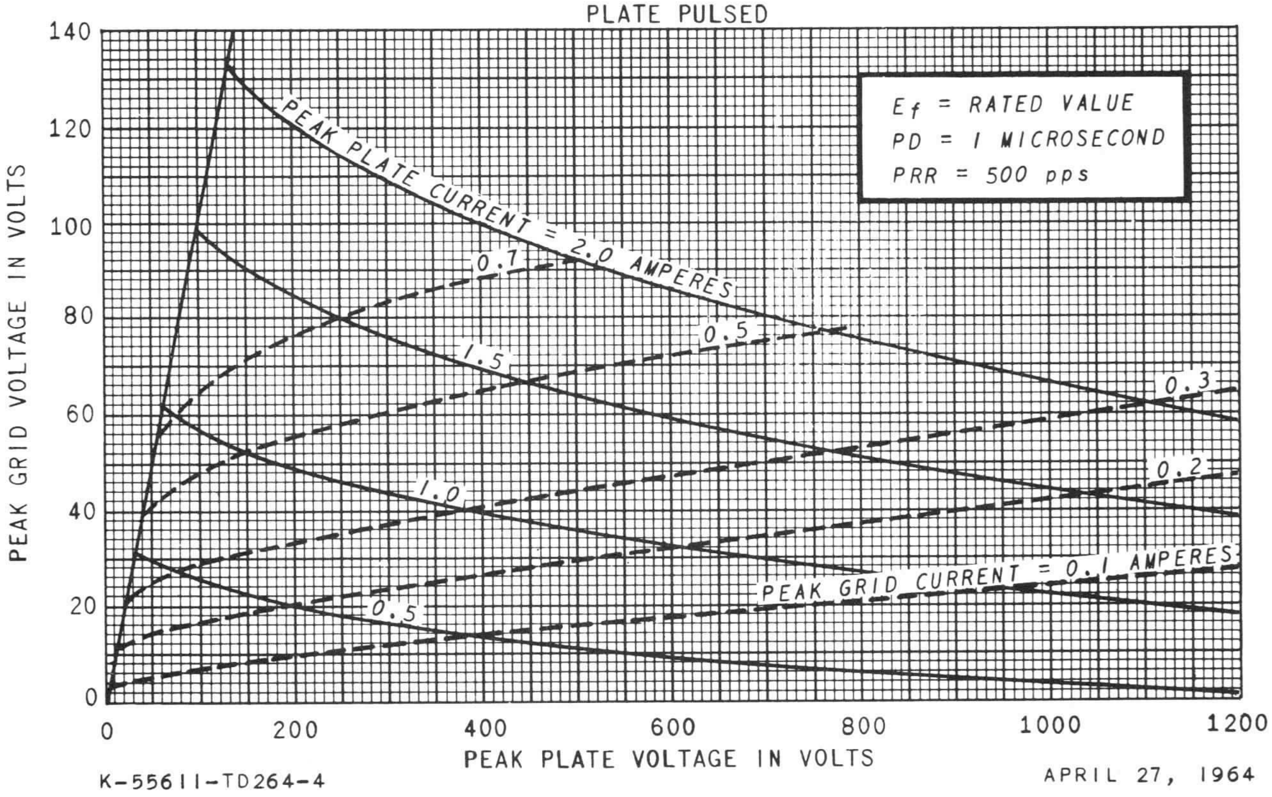


AVERAGE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS

PLATE PULSED



TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

ELECTRONICS

7911

METAL-CERAMIC TRIODE

FOR PLATE-PULSED OSCILLATOR OR AMPLIFIER APPLICATIONS

DESCRIPTION AND RATING

The 7911 is a high-mu triode of ceramic and metal planar construction intended for use as a plate-pulsed oscillator or amplifier at frequencies up to 6000 megacycles.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.55	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.4	pf
Input: g to (h + k)	5.0	pf
Output: p to (h + k)	0.05	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

PLATE-PULSED OSCILLATOR OR AMPLIFIER SERVICE—ABSOLUTE-MAXIMUM VALUES

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶#	0.001	
Pulse Duration	2.0	Microseconds
Plate Current		
Average#	2.5	Milliamperes
Average During Plate PulseΔ	2.5	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average#	1.0	Milliamperes
Average During Plate Pulse	1.0	Amperes
DC Cathode Current	20	Milliamperes
Plate Dissipation#	6.5	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	58	
Plate Resistance, approximate	2300	Ohms
Transconductance	25000	Micromhos
Plate Current	23	Milliamperes
Grid Voltage, approximate		
Ib = 100 Microamperes	-5	Volts

PLATE-PULSED OSCILLATOR SERVICE

Frequency	4100	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Positive-Pulse Supply Voltage	3000	Volts
Plate Current		
Average	2.5	Milliamperes
Average During Plate Pulse	2.5	Amperes
Grid Current		
Average	0.3	Milliamperes
Average During Plate Pulse	0.3	Amperes
Useful Power Output		
Average	2.2	Watts
Average During Plate Pulse	2.2	Kilowatts

NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

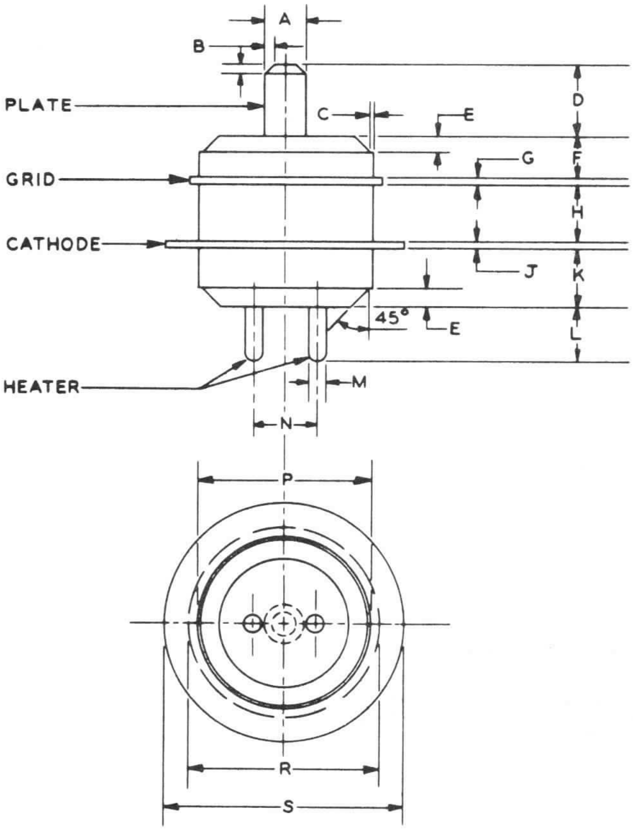
§ Measured using a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.001 should be referred to your General Electric tube sales representative for recommendation.

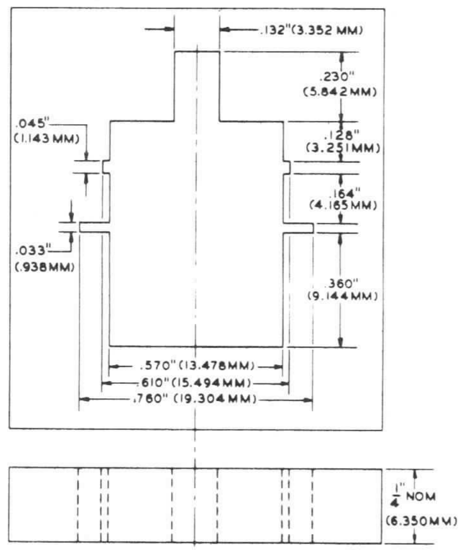
In any 5000 microsecond interval.

Δ The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE



Note: Gauge tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.220		0.230	5.59		5.84
E	0.040		0.060	1.02		1.52
F	0.120		0.130	3.05		3.30
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

GE ELECTRONICS

7913

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 7913 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator or radio-frequency power amplifier.

GENERAL

ELECTRICAL

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC*	6.3±0.3	Volts
Heater Current‡	0.4	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.4	pf
Input: g to (h + k)	6.0	pf
Output: p to (h + k)	0.03	pf
Heater to Cathode: (h to k)	2.4	pf

MECHANICAL

Operating Position - Any

See Outline Drawing on page 3 for dimensions and electrical connections.

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	330	Volts
Plate Dissipation	5.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance		
With Fixed Bias	0.025	Megohms
With Cathode Bias	0.1	Megohms
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	200	Volts
Cathode-Bias Resistor	47	Ohms
Amplification Factor	100	
Plate Resistance, approximate	2500	Ohms
Transconductance	40000	Micromhos
Plate Current	25	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	-4.5	Volts

UHF OSCILLATOR SERVICE

Frequency	400	Megacycles
Plate Voltage	300	Volts
Grid Resistor	1500	Ohms
Plate Current	25	Milliamperes
Grid Current, approximate	5	Milliamperes
Power Output, approximate	4	Watts

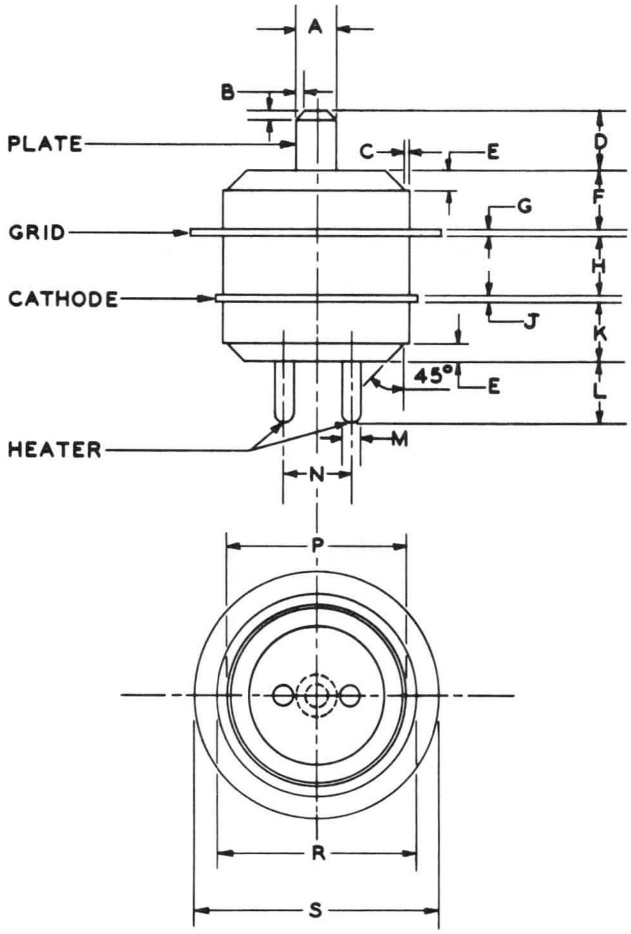
NOTES

* The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

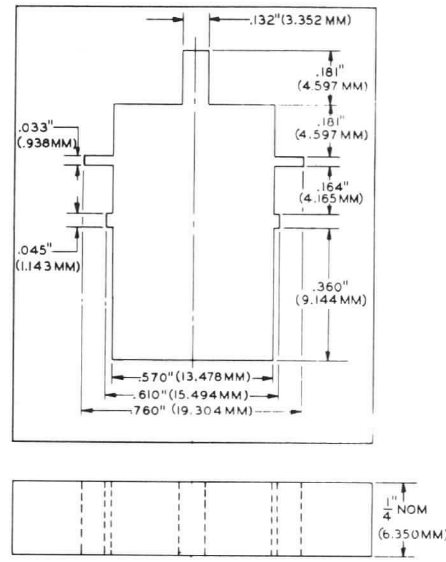
‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

PHYSICAL DIMENSIONS



ALIGNMENT GAUGE

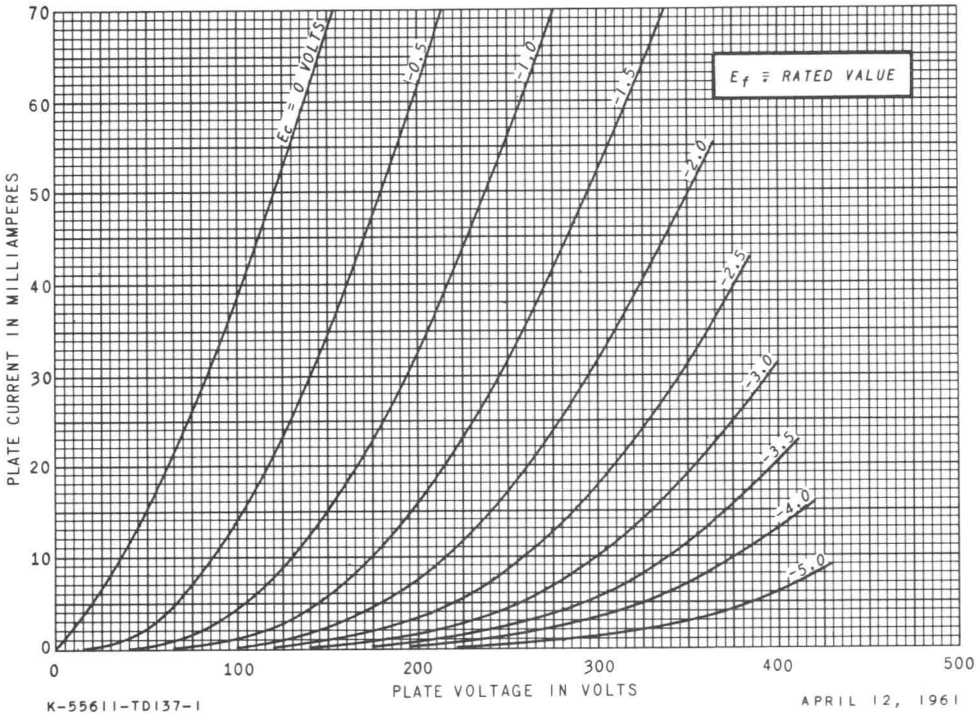


Note: Tolerances are ±0.001 inches or ±0.025 millimeters, unless otherwise indicated.

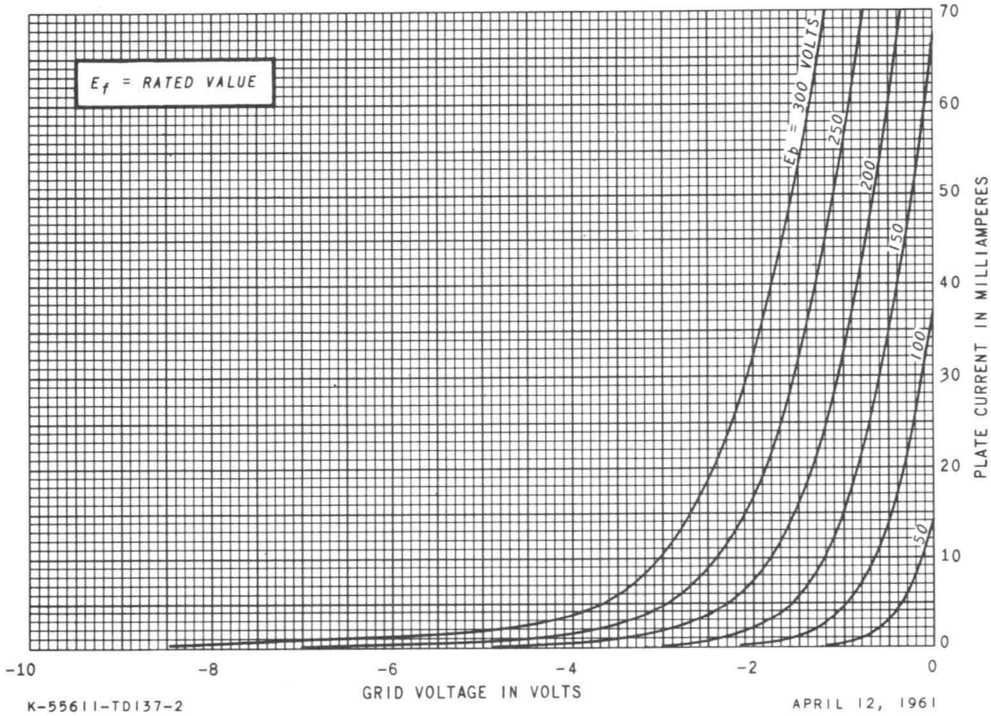
Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.122		0.128	3.099		3.251
B		0.030			0.76	
C		0.005			0.13	
D	0.170		0.180	4.32		4.57
E	0.040		0.060	1.02		1.52
F	0.165		0.175	4.19		4.45
G	0.025		0.031	0.635		0.787
H	0.167		0.177	4.24		4.50
J	0.025		0.031	0.635		0.787
K	0.170		0.180	4.32		4.57
L	0.170		0.180	4.32		4.57
M	0.047		0.053	1.194		1.346
N	0.185		0.215	4.70		5.46
P	0.535		0.565	13.59		14.35
R	0.598		0.608	15.19		15.44
S	0.748		0.758	19.00		19.25

Note: The millimeter dimensions are derived from the original inch dimensions.

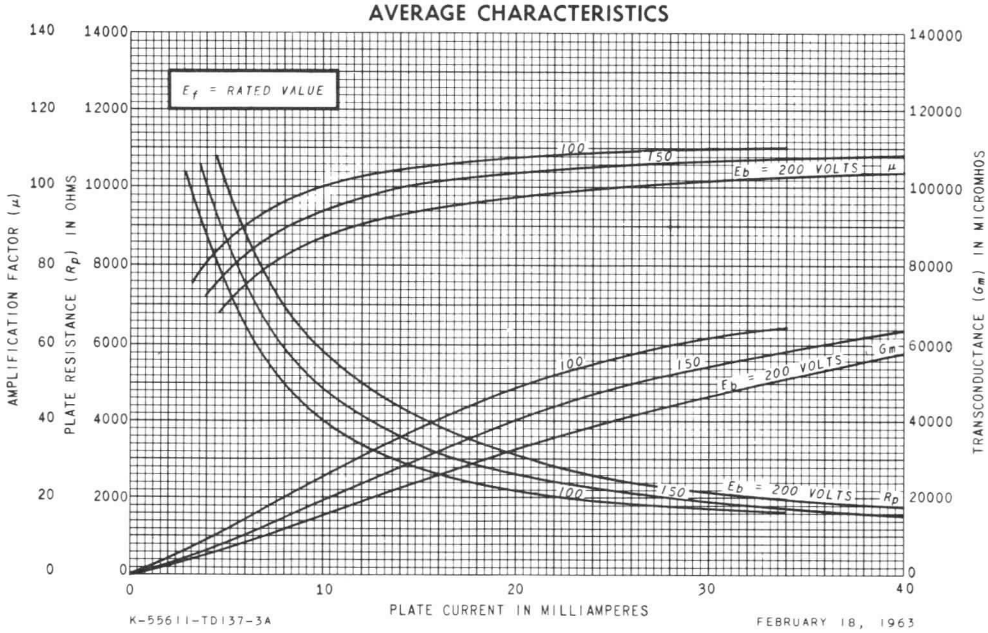
AVERAGE PLATE CHARACTERISTICS



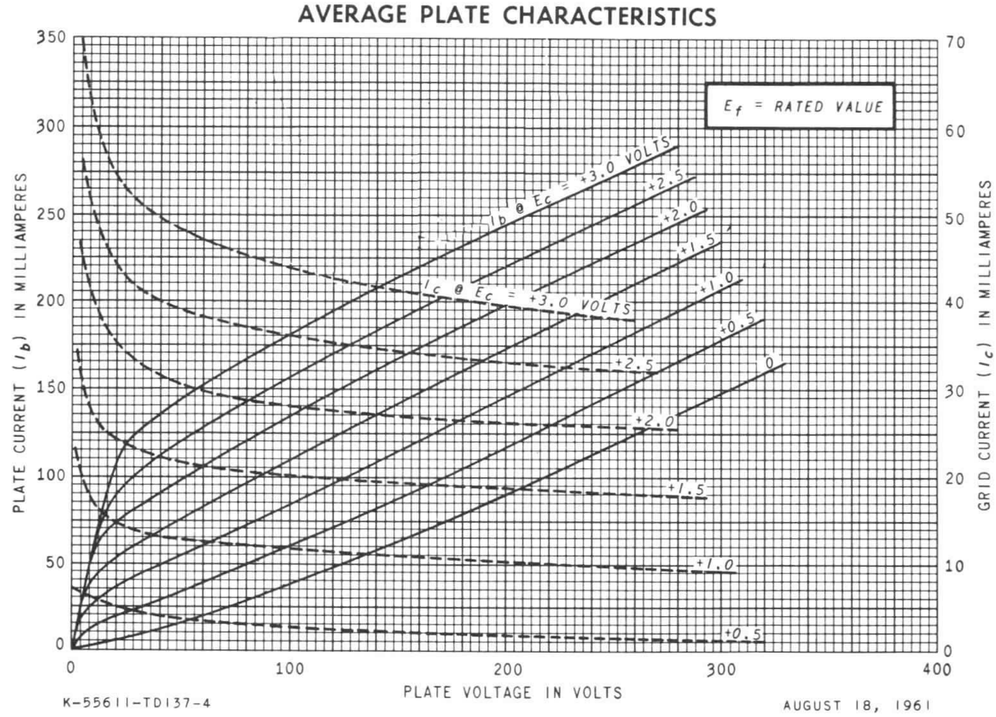
AVERAGE TRANSFER CHARACTERISTICS



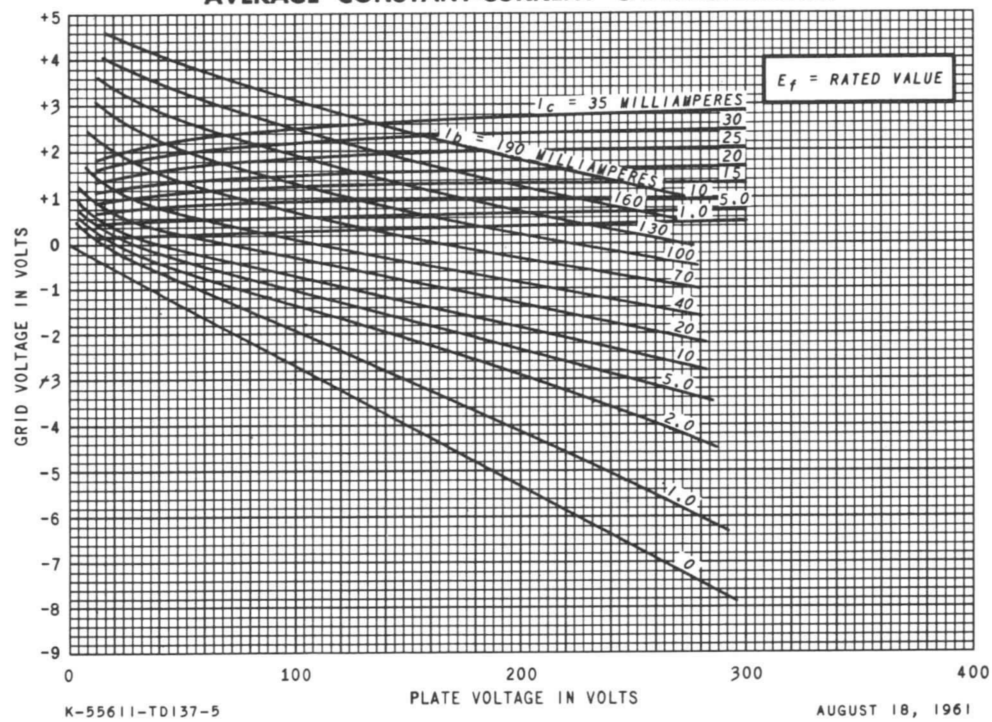
AVERAGE CHARACTERISTICS



AVERAGE PLATE CHARACTERISTICS



AVERAGE CONSTANT-CURRENT CHARACTERISTICS

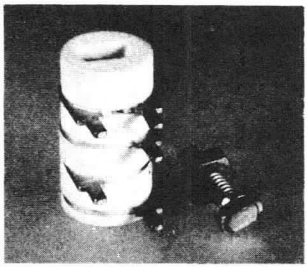


TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ELECTRONICS



8081

METAL-CERAMIC TRIODE

DESCRIPTION AND RATING

The 8081 is a high-mu triode of ceramic-and-metal planar construction primarily intended for low-level audio-frequency amplification.

GENERAL

ELECTRICAL

Cathode—Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC†	6.3 ± 0.3	Volts
Heater Current‡	0.215	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.5	pf
Output: p to (h+k)	0.03	pf
Heater to Cathode: (h to k)	1.5	pf

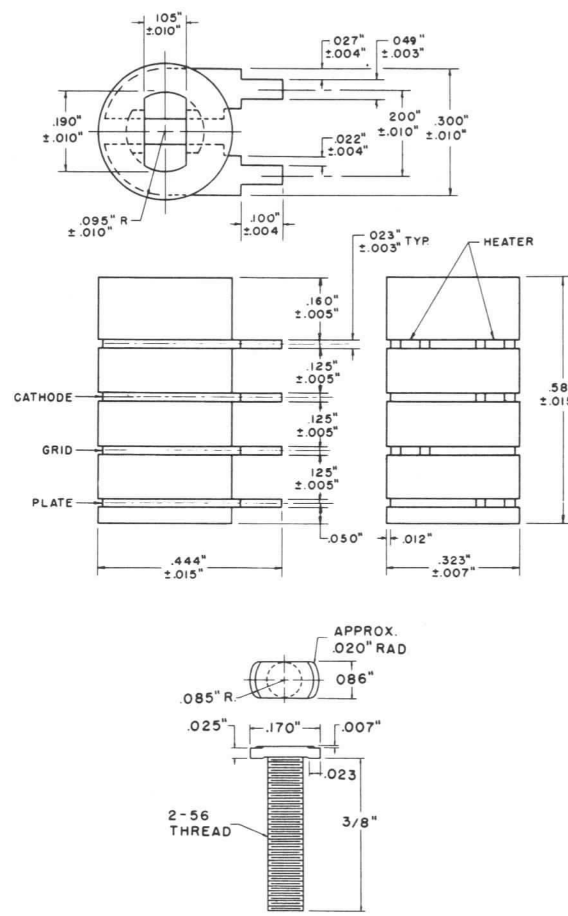
MECHANICAL

Mounting Position—Any¶

MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

DC Plate Voltage	275	Volts
Peak Plate Voltage	400	Volts
Positive Peak and DC Grid Voltage	0	Volts
Negative Peak and DC Grid Voltage	50	Volts
Plate Dissipation	0.85	Watts
DC Cathode Current	3.8	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance, with Fixed Bias △	0.2	Megohms
Envelope Temperature at Hottest point#	250	C



Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	150	Volts
Cathode-Bias Resistor	1000	Ohms
Amplification Factor	80	
Plate Resistance, approximate	57000	Ohms
Transconductance	1400	Micromhos
Plate Current	0.95	Milliamperes
Grid Voltage, approximate Ib = 10 Microamperes, Eb = 250 Volts	−4.6	Volts

FOOTNOTES

† The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ One method of mounting the 8081 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

△ If resistance is used in the cathode or plate circuits, the grid-circuit resistance may be as high as (200,000 + 500 RK + 10RL) ohms, where RK is the cathode-bias resistance in ohms, and RL is the DC plate load resistance in ohms.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 8081 is also capable of operation at envelope temperatures much higher than the rated maximum value. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

SPECIAL PERFORMANCE TESTS

	Maximum	
Variable-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (by-passed), R_L = 10000 ohms; Note 1	15	Millivolts peak to peak
Low-Frequency Vibration Ef = 6.3 volts, Ebb = 150 volts, Ec = 0 volts d-c, Rk = 1000 ohms (by-passed), R_L = 10000 ohms, G = 15, F = 40 cps; Note 2	0.75	Millivolts RMS

Note 1: The variable-frequency vibration test shall be performed as follows:

a. The frequency shall be increased from 100 to 2000 cps with approximately logarithmic progression in 3 ± 1 minutes. The return sweep (2000 to 100 cps) is not required.

b. The tube shall be vibrated with simple harmonic motion in each of two planes; first, parallel to the cylindrical axis; second, perpendicular to the cylindrical axis and parallel to a line through the major axis of a terminal lug.

c. The peak acceleration shall be maintained at 10 ± 1 G throughout the test.

d. The vibrational output produced across R_L as a result of the vibration shall be coupled to a low-pass filter that has the following characteristics:

(1) A response within ± 1 db of the response at 1000 cps over the frequency range of 100 to 17000 cps.

(2) The response shall be down at least 1.5 db at 20000 cps and have a cut-off rate of at least 18 db per octave above 20000 cps.

Note 2: The tube shall be vibrated with simple harmonic motion in each of two planes, (1) parallel to the cylindrical axis and (2) perpendicular to the cylindrical axis and perpendicular to a line through the major axis of a terminal lug.

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, transconductance, and negative grid current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, Rg = 0.1 Meg, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, transconductance, and negative grid current.

DEGRADATION RATE TESTS (Continued)

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial readings to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements and transconductance following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Ebb = 300 volts, Ehk = +70 volts d-c, Rk = 82 ohms, R_L = 18000 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, grid current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

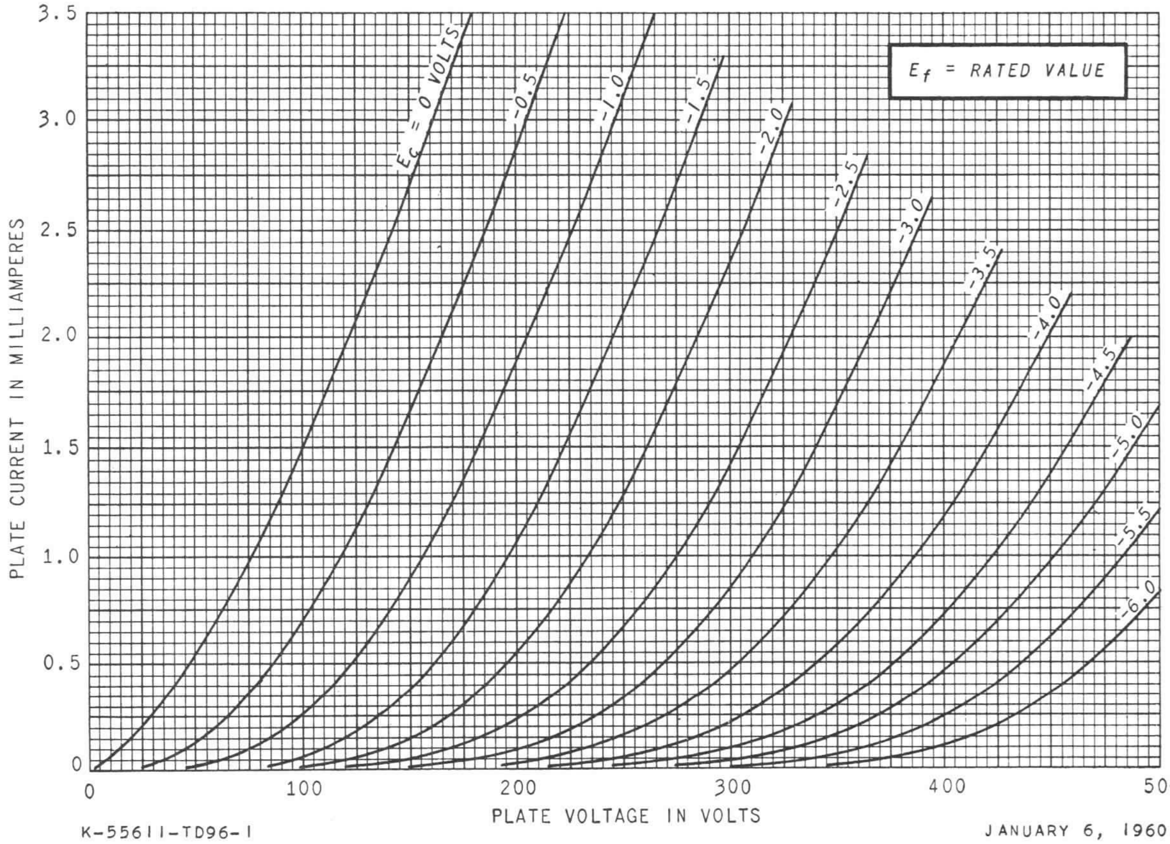
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

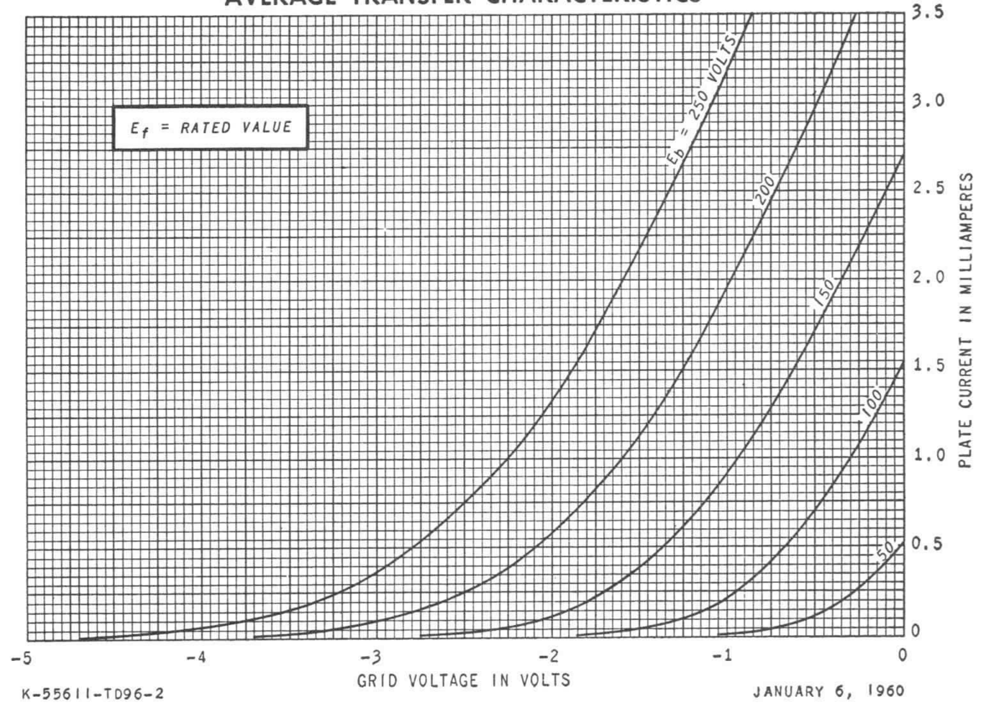
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

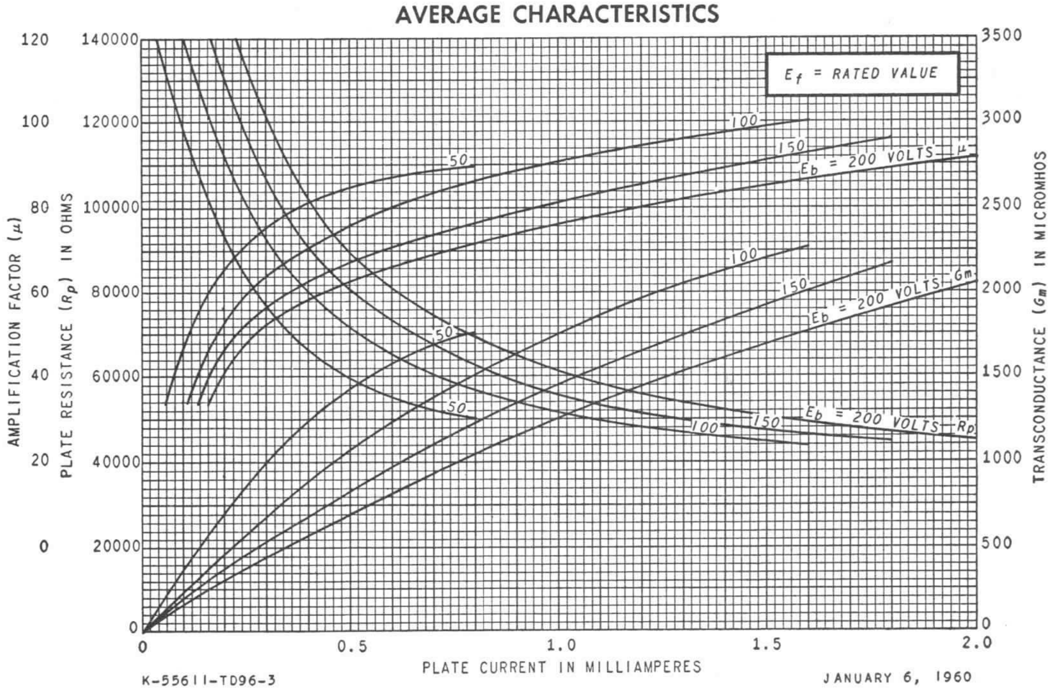
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



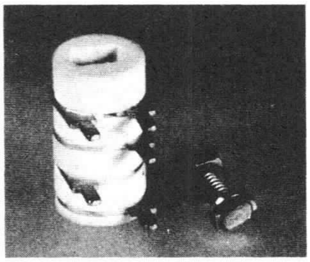
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

8082

METAL–CERAMIC TRIODE



DESCRIPTION AND RATING

The 8082 is a high-mu triode of ceramic-and-metal planar construction primarily intended for use as an oscillator in the ultra-high-frequency range.

GENERAL

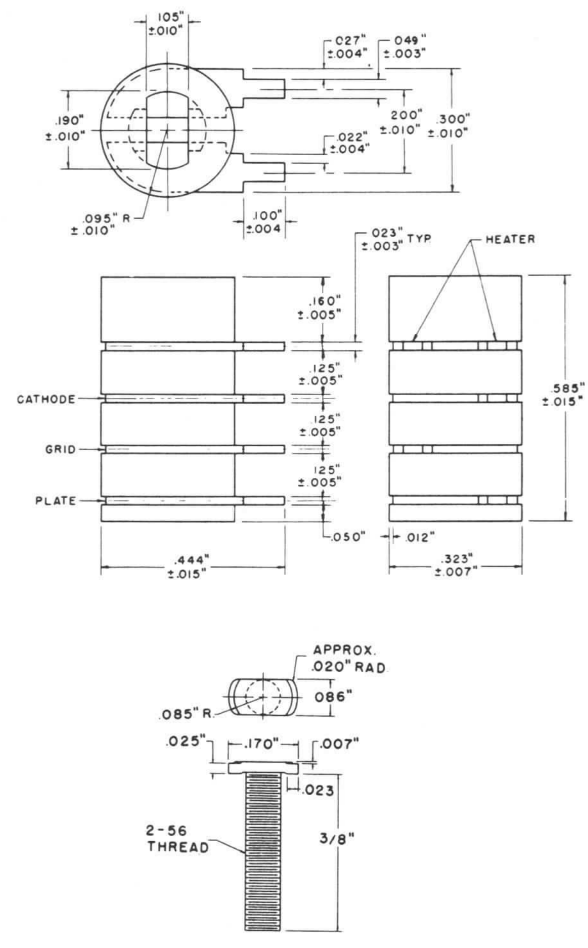
ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC†	6.3 ± 0.3	Volts
Heater Current‡	0.24	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.3	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any ¶



MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Peak Negative Grid Voltage	50	Volts
Plate Dissipation	1.0	Watt
DC Grid Current	2.2	Milliamperes
DC Cathode Current	11	Milliamperes
Peak Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point#	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	100	150	Volts
Grid Voltage	0		Volts
Cathode-Bias Resistor	....	82	Ohms
Amplification Factor	....	90	
Transconductance	11500	10500	Micromhos
Plate Current	9.0	7.5	Milliamperes

UHF OSCILLATOR SERVICE

Plate Voltage	150	Volts
Grid Resistor	7000	Ohms
Plate Current	4.0	Milliamperes
Frequency	450	Megacycles
Grid Current	0.5	Milliamperes
Power Output, approximate	100	Milliwatts

FOOTNOTES

† The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ One method of mounting the 8082 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 8082 is also capable of operation at envelope temperatures much higher than the rated maximum value. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

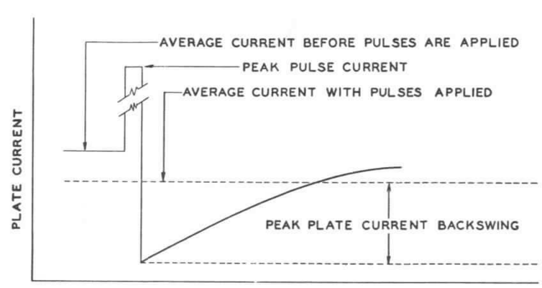
SPECIAL PERFORMANCE TESTS

	Min.	Bogey	Max.	
Grid Recovery				
Change in Average Plate Current	....	....	0.6	Milliamperes
Peak Plate Current Backswing	....	....	1.0	Milliamperes

Tubes with poor grid recovery affect circuit operation when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 8082 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, $R_L = 0.01$ meg, Ec adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5-volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

PLATE CURRENT VS. TIME —GRID-RECOVERY TEST



	Min.	Bogey	Max.	
Pulse Cathode Current Ef = 6.3 volts, Eb = 150 volts, Ec = −10 volts. Grid is driven 7 volts positive with a pulse having a prr of 1000 pps and a duty factor of 0.01	90	....	....	Milliamperes

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulate an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, and heater current.

Stability Life Test

The statistical sample subjected to the Dynamic Life Test is evaluated for percent change in zero-bias transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The combined statistical samples subjected to the Dynamic and Pulse Life Tests are evaluated for shorted and open elements following approximately 100 hours of life test.

Dynamic Life Test

Statistical sample operated, with a 60 cps grid signal, at maximum rated DC grid current and cathode current for a period of 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, zero-bias transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Pulse Life Test

Statistical sample operated with 120 ma peak cathode current, 0.01 duty factor, for 1000 hours. Heater voltage is cycled (on 1¾ hours, off ¼ hour). Tubes are evaluated, following 500 and 1000 hours of life test, for shorted or open elements, heater current, pulse emission, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

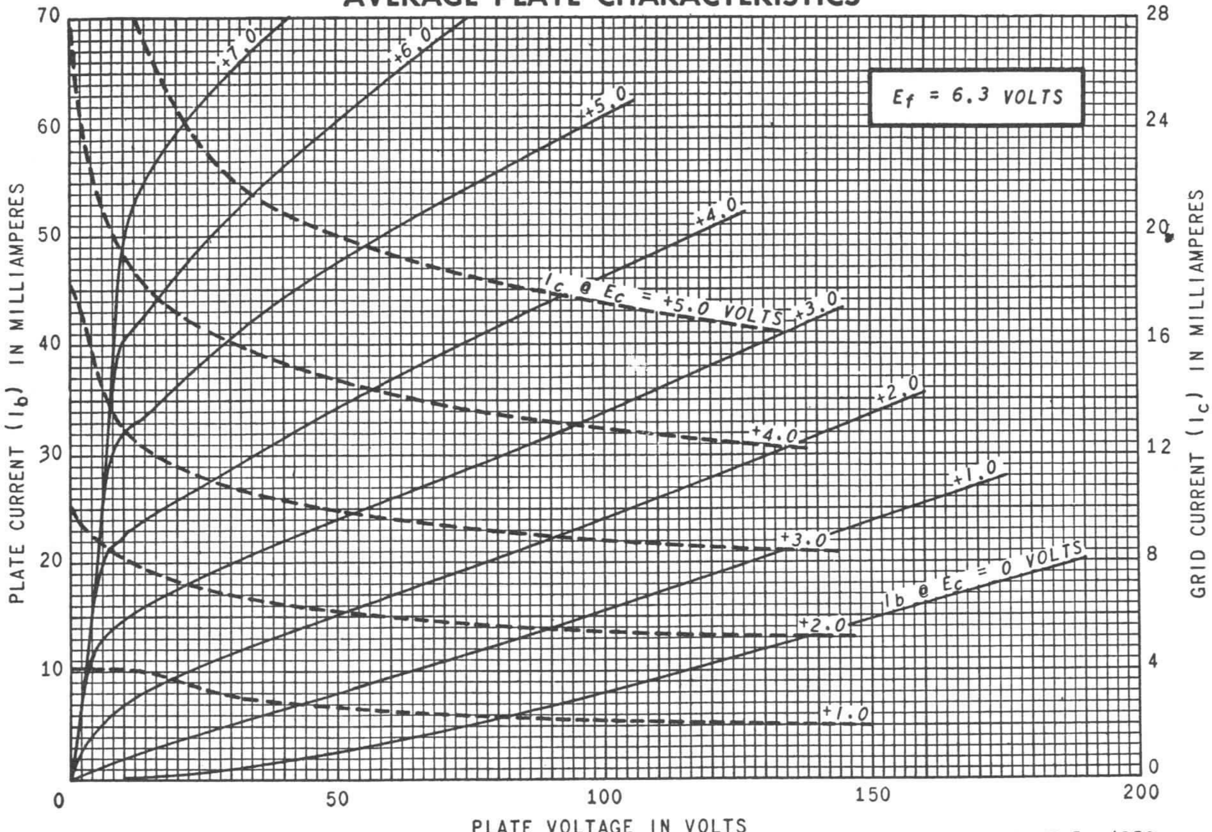
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

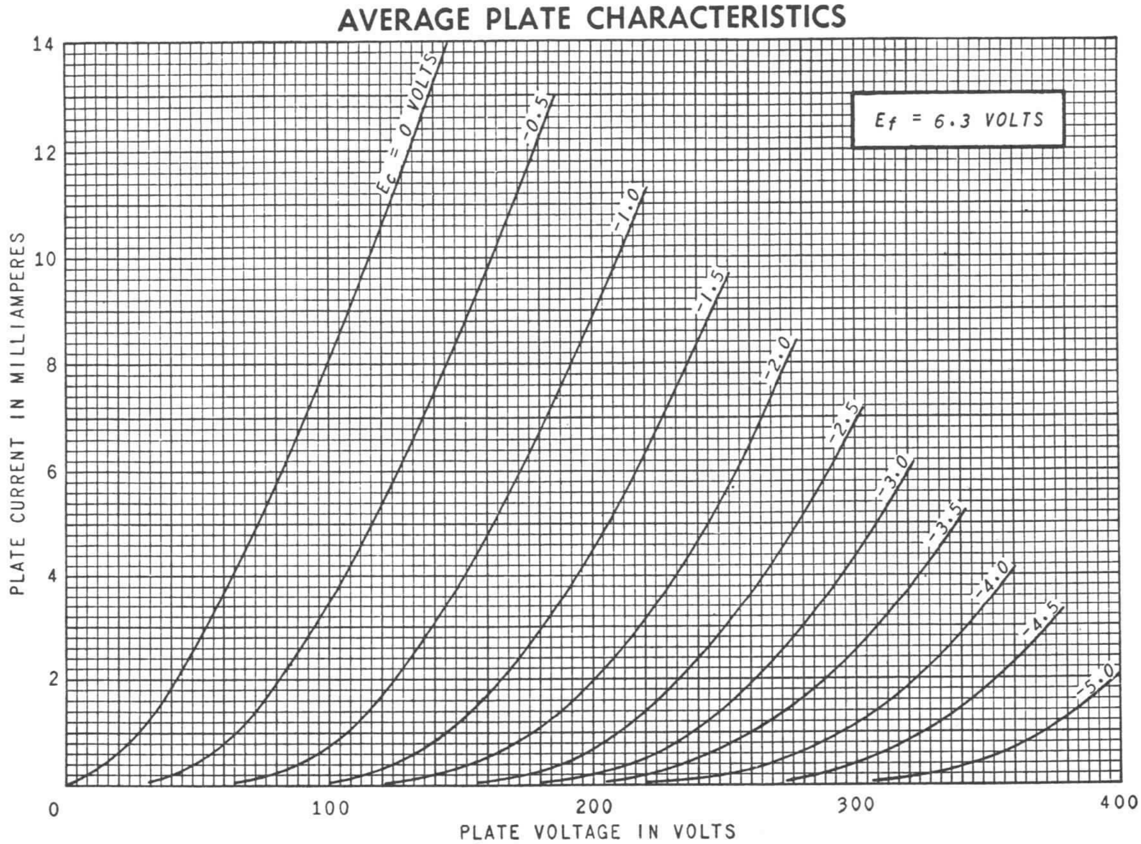
Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

AVERAGE PLATE CHARACTERISTICS



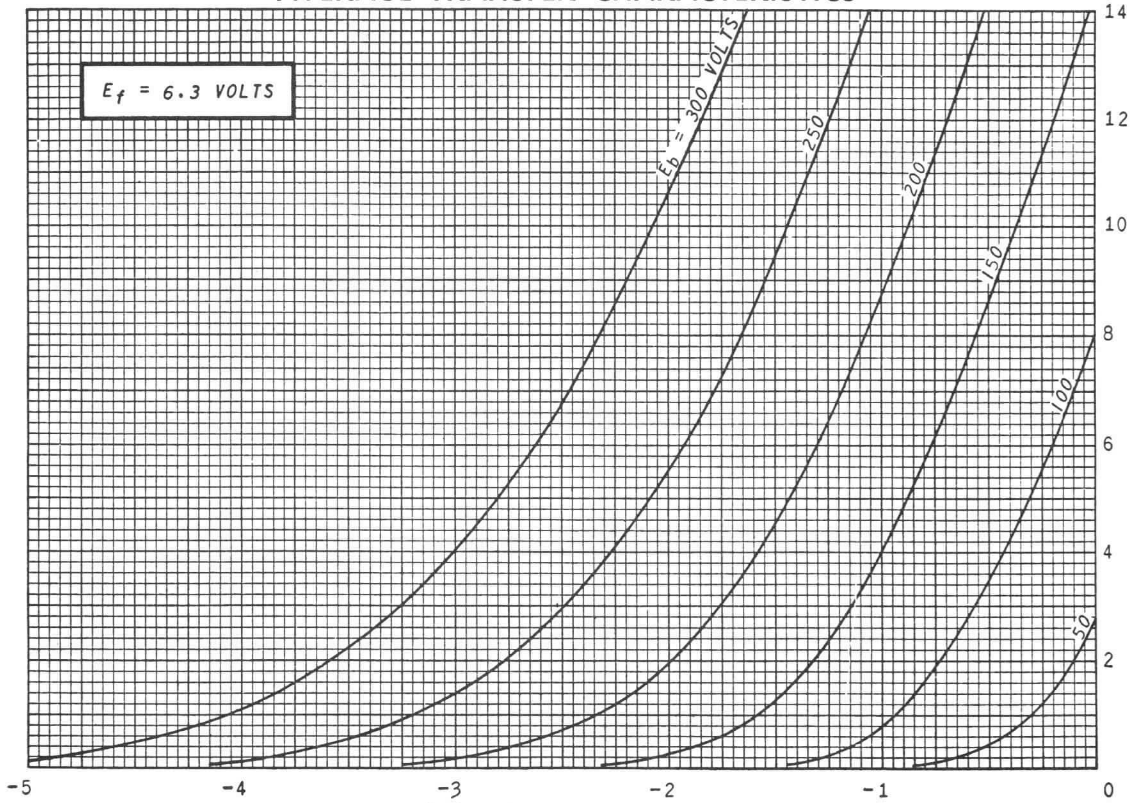
K-55611-TD73-1 JUNE 3, 1959

AVERAGE PLATE CHARACTERISTICS



K-55611-TD73-2 JUNE 3, 1959

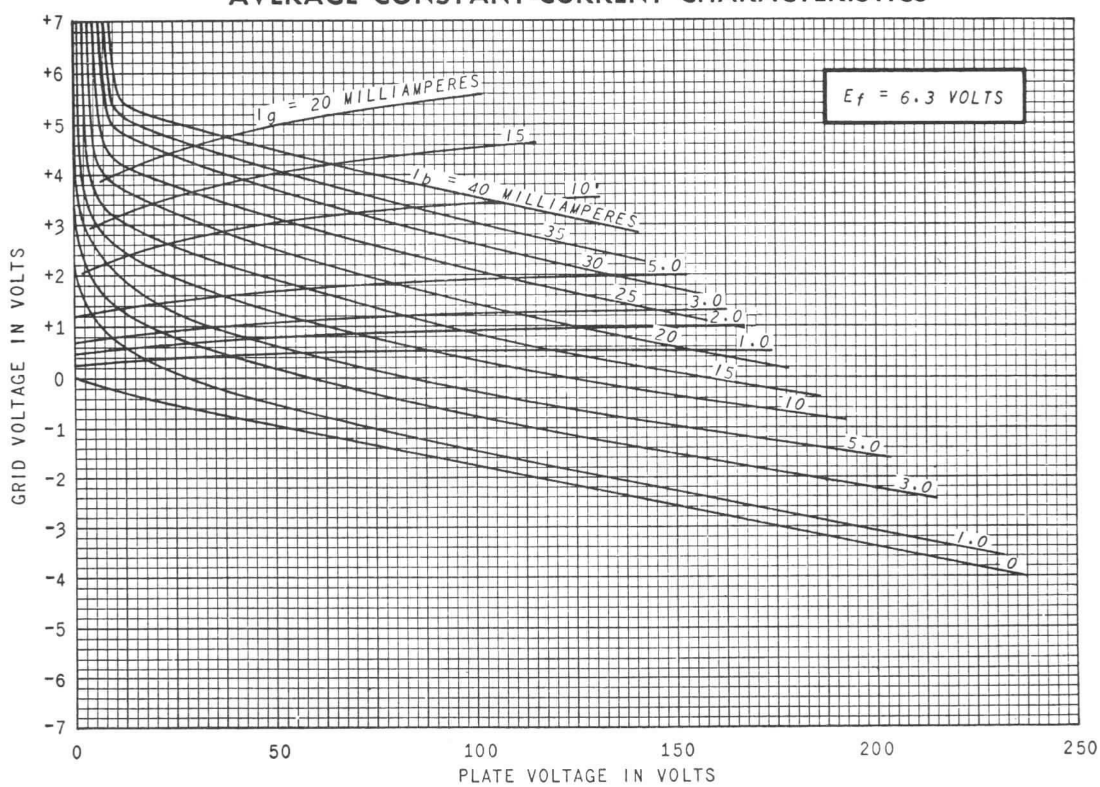
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD73-3

JUNE 3, 1959

AVERAGE CONSTANT-CURRENT CHARACTERISTICS



CONSTANT-CURRENT CURVES

K-55611-TD73-4

JUNE 3, 1959

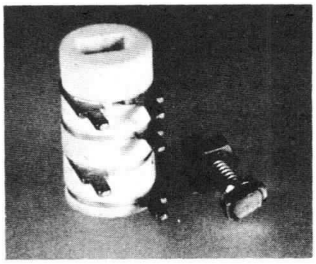
RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

8083

METAL-CERAMIC TRIODE



DESCRIPTION AND RATING

The 8083 is a high-mu triode of ceramic-and-metal planar construction primarily intended for radio-frequency amplifier service from low frequencies into the ultra-high frequency range.

GENERAL

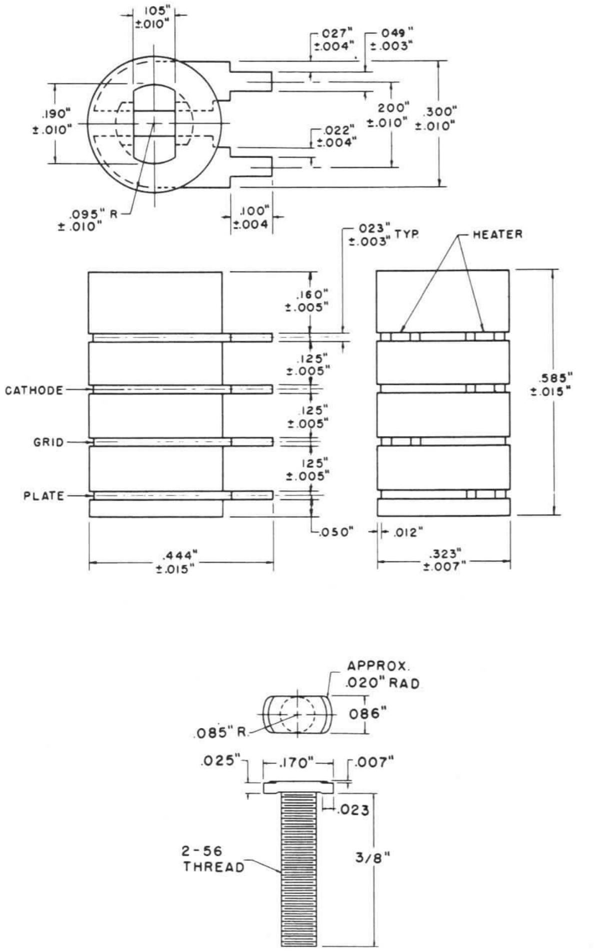
ELECTRICAL

Cathode—Coated Unipotential
Heater Characteristics and Ratings

Heater Voltage, AC or DC†	6.3 ± 0.3	Volts
Heater Current‡	0.24	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.2	pf
Input: g to (h+k)	1.8	pf
Output: p to (h+k)	0.032	pf
Heater to Cathode: (h to k)	1.5	pf

MECHANICAL

Mounting Position—Any ¶



MAXIMUM RATINGS

ABSOLUTE-MAXIMUM VALUES

Plate Voltage	250	Volts
Peak Plate Voltage	400	Volts
Positive Peak and DC Grid-to-Cathode Voltage	0	Volts
Negative Peak and DC Grid-to-Cathode Voltage	50	Volts
Plate Dissipation	1.1	Watts
DC Cathode Current	11	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid-Circuit Resistance, with Fixed Bias △	0.01	Megohms
Envelope Temperature at Hottest Point#	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

AVERAGE CHARACTERISTICS

Plate Voltage	150	Volts
Grid Voltage	+6.0	Volts
Cathode-Bias Resistor	910	Ohms
Amplification Factor	94	
Plate Resistance, approximate	9000	Ohms
Transconductance	10500	Micromhos
Plate Current	7.2	Milliamperes
Grid Voltage, approximate Ib = 100 Microamperes	−2.2	Volts

FOOTNOTES

† The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ One method of mounting the 8083 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

△ If resistance is used in the cathode or plate circuits, the grid-circuit resistance may be as high as (10000 + 100 RK + 10RL) ohms, where RK is the cathode-bias resistance in ohms, and RL is the DC plate load resistance in ohms.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life. The 8083 is also capable of operation at envelope temperatures much higher than the rated maximum value. For specific recommendations concerning higher temperature operation, contact your General Electric tube sales representative.

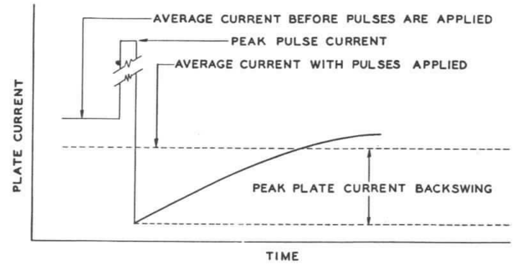
SPECIAL PERFORMANCE TESTS

	Maximum	
Noise Figure		
Ef = 6.3 volts, Ebb = 250 volts, Rk = 82 ohms, R_L = 18000 ohms, F = 200 mc	5.5	Decibels
Grid Recovery		
Change in Average Plate Current	0.6	Milliamperes
Peak Plate Current Backswing	1.0	Milliamperes

Tubes with poor grid recovery affect circuit operation, when the grid is driven positive by a pulse of signal or noise, somewhat as if a parallel RC circuit were in series with the grid. This effect may occur in tubes of any type, but is unimportant in many applications. In the majority of 8083 tubes the effect is negligible, but to eliminate the few in which it may be excessive, tubes are tested under the following conditions: Ef = 6.3 volts, Ebb = 250 volts, R_L = 0.01 meg, Ec adjusted for Ib = 3.0 ma.

Upon application to the grid of a 5 volt positive pulse (prr = 60 pps, duty factor = 0.0012) the change in average plate current is noted, and the peak plate current backswing is measured. The following diagram shows qualitatively the plate current-time relationship for a tube (with poor grid recovery) subjected to this test.

PLATE CURRENT VS. TIME —GRID RECOVERY TEST



SPECIAL PERFORMANCE TESTS (Continued)

Low Pressure Voltage Breakdown Test

Statistical sample tested for voltage breakdown at a pressure of 8mm Hg, to simulated an altitude of 100,000 feet. Tubes shall not give visual evidence of flashover or corona when 300 volts RMS, 60 cps, is applied between the plate and grid terminals.

DEGRADATION RATE TESTS

Fatigue

Statistical sample vibrated for a total of six hours, three hours in each of two planes, at a peak acceleration of 10G. Frequency is continuously varied from 30 cps to 2000 cps and back to 30 cps, with a period of ten minutes. Tubes are operated during the test with Ef = 6.3 volts, Eb = 150 volts, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Shock

Statistical sample subjected to 5 impact accelerations of approximately 450G in each of four positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine using a 30° hammer angle. Tubes are mounted by T-bolt with 3 inch-pounds torque, and operated during the test with Ef = 6.3 volts, Eb = 150 volts, Ehk = +100 volts, Rg = 0.1 Meg, and Rk = 82 ohms. Following the test, tubes are evaluated for low frequency vibrational output, heater-cathode leakage, heater current, and transconductance.

Stability Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for percent change in transconductance of individual tubes, from the initial reading to readings following 2 hours and 20 hours of the life test.

Survival Rate Life Test

The statistical sample subjected to the Intermittent Life Test is evaluated for shorted and open elements and transconductance following approximately 100 hours of life test.

Intermittent Life Test

Statistical sample operated for 1000 hours under the following conditions: Ef = 6.3 volts (cycled—on 1¾ hours, off ¼ hour), Eb = 150 volts, Ecc = +6.0 volts, Ehk = −70 volts d-c, Rk = 910 ohms, and Rg = 0.1 meg. Tubes are evaluated, following 500 and 1000 hours of life test, for shorted and open elements, heater current, transconductance, heater-cathode leakage, and interelectrode leakage resistance.

Interface Life Test

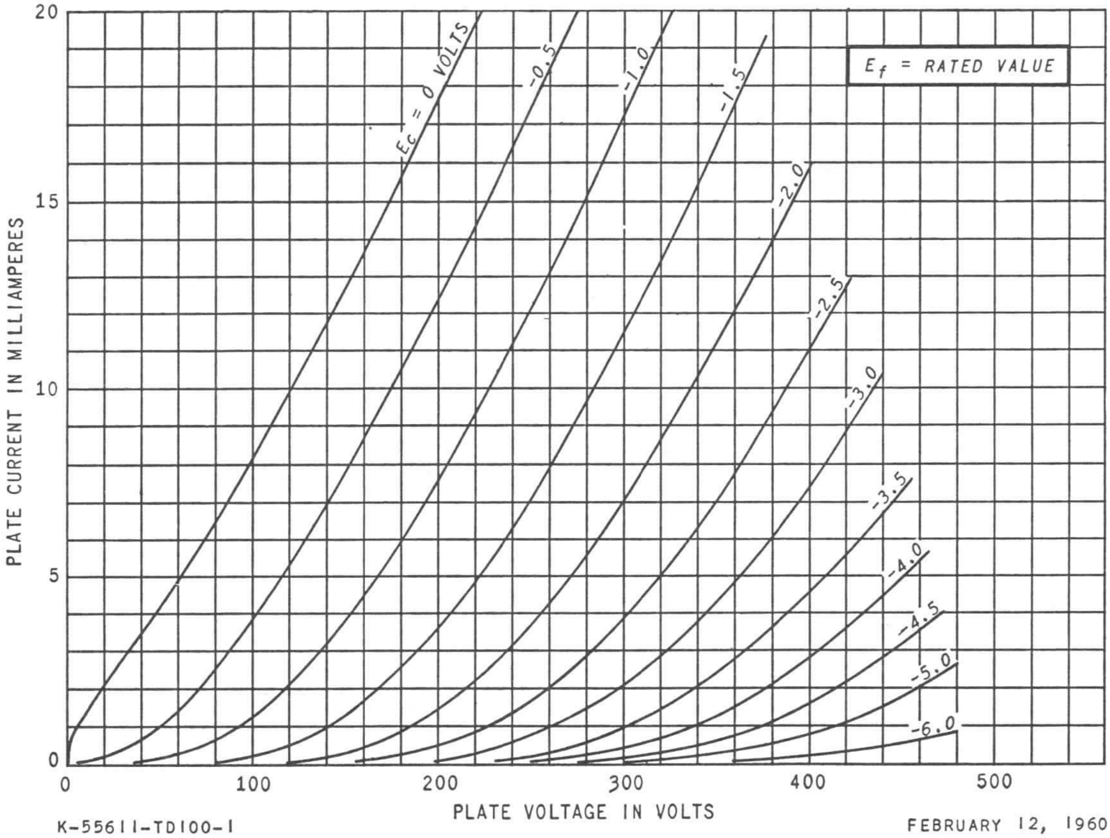
Statistical sample operated for 1000 hours with Ef = 6.6 volts, no other voltages applied, and evaluated for cathode interface resistance following the life test.

Heater-Cycling Life Test

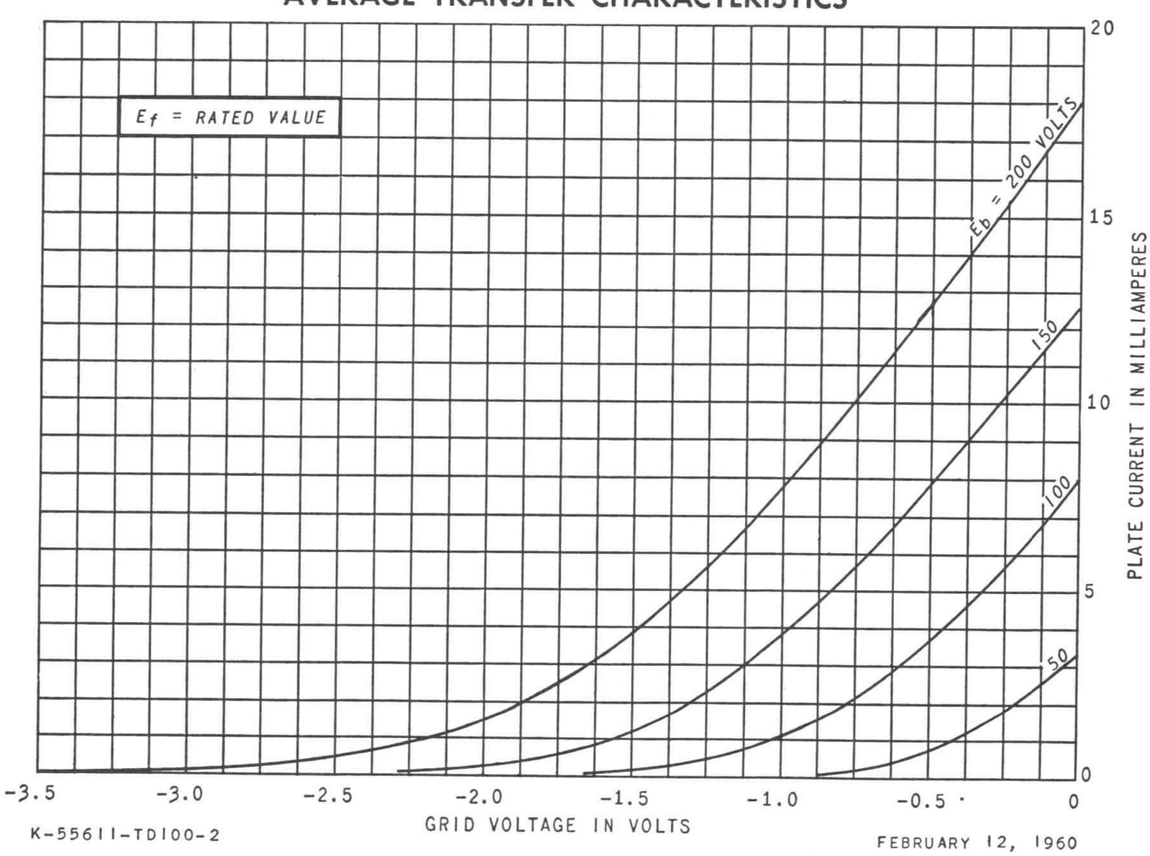
Statistical sample operated for 2000 cycles minimum to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.0 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 70 volts with heater positive with respect to cathode. Following this test, tubes are evaluated for open heaters, heater-cathode shorts, and heater-cathode leakage current.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

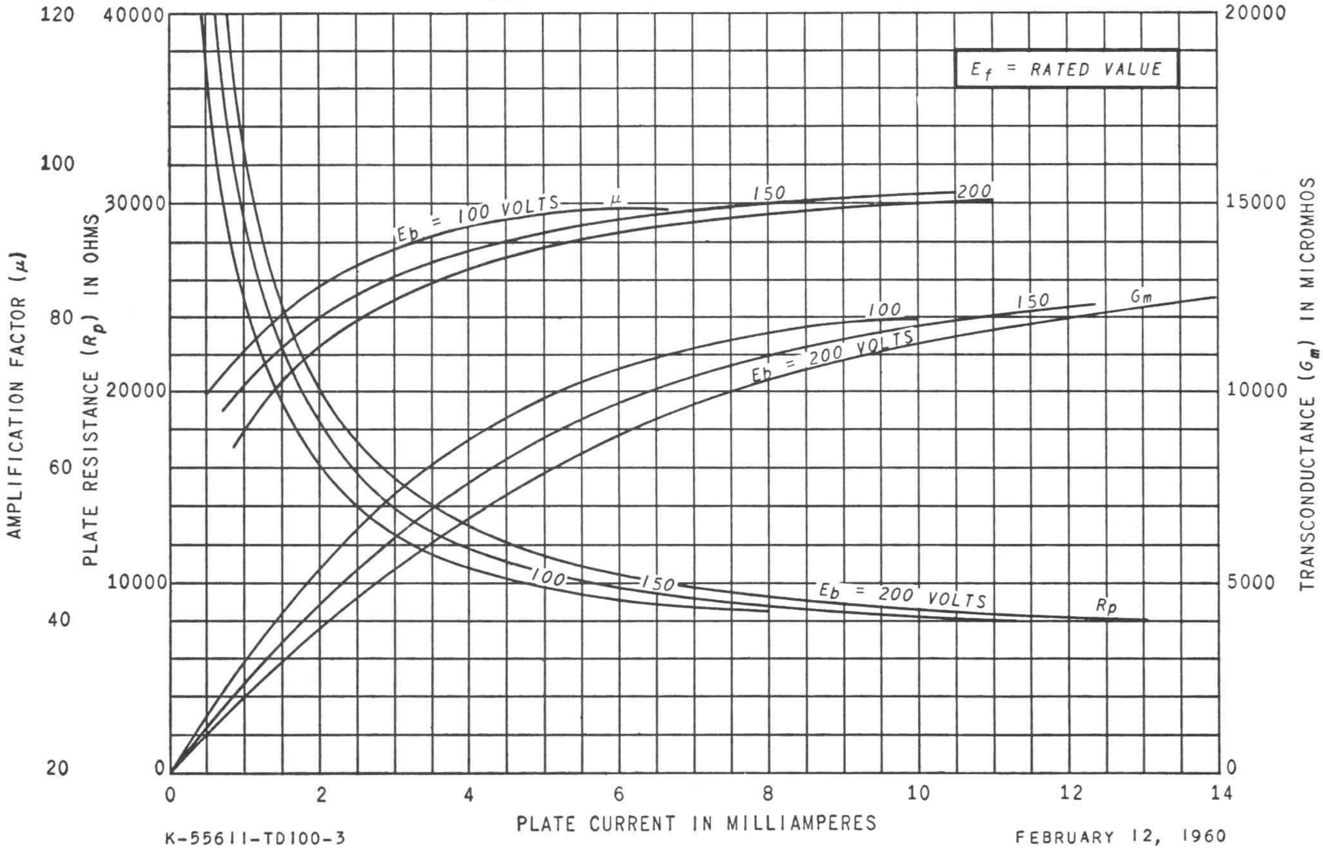
AVERAGE PLATE CHARACTERISTICS



AVERAGE TRANSFER CHARACTERISTICS



AVERAGE CHARACTERISTICS



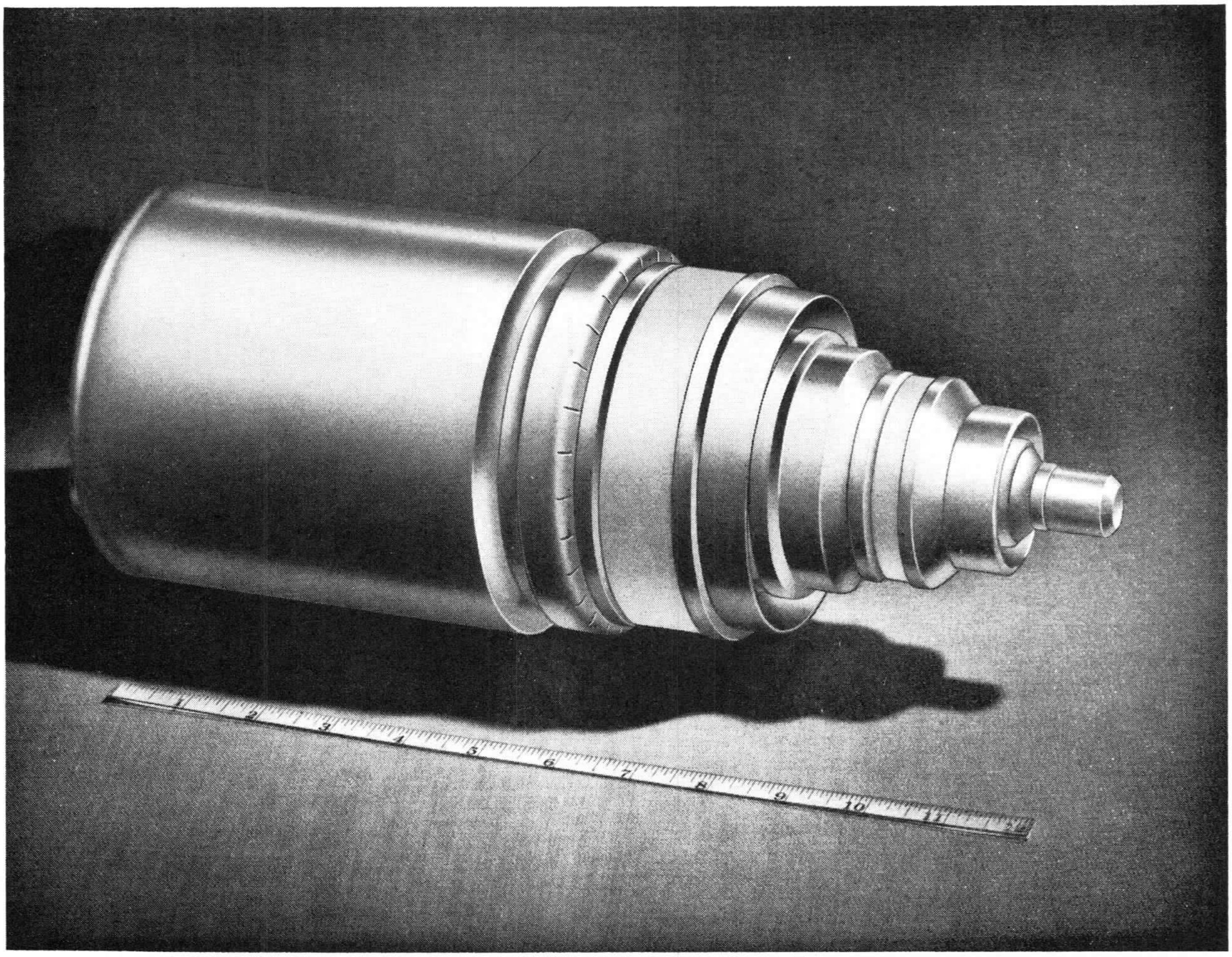
K-55611-TD100-3

FEBRUARY 12, 1960

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky



TETRODE

25-KILOWATTS VHF TELEVISION OUTPUT
VHF TETRODE
GROUNDED-GRID CIRCUITS

WATER COOLED
METAL AND CERAMIC
GAIN IN EXCESS OF 10

The GL-6251 is a four-electrode, water-and-forced-air-cooled transmitting tube for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating twenty-five kilowatts. The cathode is a thoriated-tungsten filament. Maximum ratings apply up to 220 megacycles.

In Class B grounded-grid broadband television amplifier service this tube has a useful synchronizing peak-power output of twenty-five kilowatts at 220 megacycles. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulator. The ring-seal design permits quick plug-in installation. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit.

TECHNICAL INFORMATION

GENERAL

Electrical

	Minimum	Bogey	Maximum	
⊕ Filament Voltage	5.1	5.5	5.75	Volts
Filament Current at 5.5 Volts	....	190	....	Amperes
Filament Starting Current	....	....	360	Amperes
Filament Cold Resistance	....	0.004	....	Ohms
Filament Heating Time	30	....	....	Seconds
Amplification Factor, G_2 to G_1				
E_b=1000 Volts, I_b=0.1 Amperes	....	20	...	
Peak Cathode Current*	....	....	30	Amperes
Direct Interelectrode Capacitances§				
Grounded-Grid Circuit				
Cathode-Plate†	....	0.06	....	μμf
Input	....	75	....	μμf
Output	....	27	....	μμf

Mechanical

Mounting Position—Vertical, anode down
Net Weight, approximate .... 15 Pounds

Thermal

Type of Cooling—Water and Forced Air
Water Cooling
Water Flow
Anode .... 12 Min Gallons per Minute
Water Pressure .... 80 Max Pounds per Square Inch
Pressure Drop at Rated Flow, approximate .... 13 Pounds per Square Inch
Outlet Water Temperature .... 70 Max C
Air Cooling
Air Flow
Anode Seal .... 30 Min Cubic Feet per Minute
Filament Seal .... 15 Min Cubic Feet per Minute
Grid-to-Grid Seal .... 10 Min Cubic Feet per Minute
Ceramic Temperature .... 200 Max C
□ Seal and Terminal Temperature .... 180 Max C

MAXIMUM RATINGS AND TYPICAL OPERATION

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions Per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage .... 7000 Max Volts
⊕ DC Grid-No. 2 Voltage .... 700 Max Volts
DC Plate Current .... 8 Max Amperes
Plate Input .... 50 Max Kilowatts
Grid-No. 2 Input‡ .... 350 Max Watts
⊕ DC Grid-No. 2 Current
Pedestal Level .... 0.200 Max Amperes
Plate Dissipation .... 25 Max Kilowatts
Grid-No. 1 Dissipation .... 150 Max Watts
⊕ DC Grid-No. 1 Current .... 1.0 Max Amperes

Typical Operation—Grounded-Grid Circuit up to 216 Megacycles

Bandwidth 7 Megacycles, 1 Decibel Voltage
DC Plate Voltage .... 6800 Volts
⊕ DC Grid-No. 2 Voltage// .... 600 Volts
DC Grid-No. 1 Voltage .... −20 Volts
Peak RF Plate Voltage
Synchronizing Level .... 4800 Volts
Pedestal Level .... 3600 Volts
Peak RF Driving Voltage
Synchronizing Level .... 350 Volts
Pedestal Level .... 250 Volts

TECHNICAL INFORMATION (CONT'D)

Typical Operation (Cont'd)

DC Plate Current		
Synchronizing Level	7.5	Amperes
Pedestal Level	5.8	Amperes
DC Grid-No. 2 Current//		
Pedestal Level	0.05	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.90	Amperes
Pedestal Level	0.55	Amperes
Driving Power at Tube, approximate		
Synchronizing Level	2.3	Kilowatts
Pedestal Level	1.3	Kilowatts
Power Output, approximate¶		
Synchronizing Level	25	Kilowatts
Pedestal Level	15	Kilowatts

* Maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Control grid and screened grid are connected together.

† Measured with 12-inch diameter flat metal disk attached to the screen-grid terminal and grounded.

‡ Calculated from characteristic curve only. This value includes dissipation transferred from driving power. Maximum allowable screen input as indicated by measured d-c current and voltage is much lower because of secondary screen emission.

//DC Grid-No. 2 voltage and current should be held at the minimum values consistent with proper circuit operation. Negative values of screen current are frequently encountered but are not detrimental.

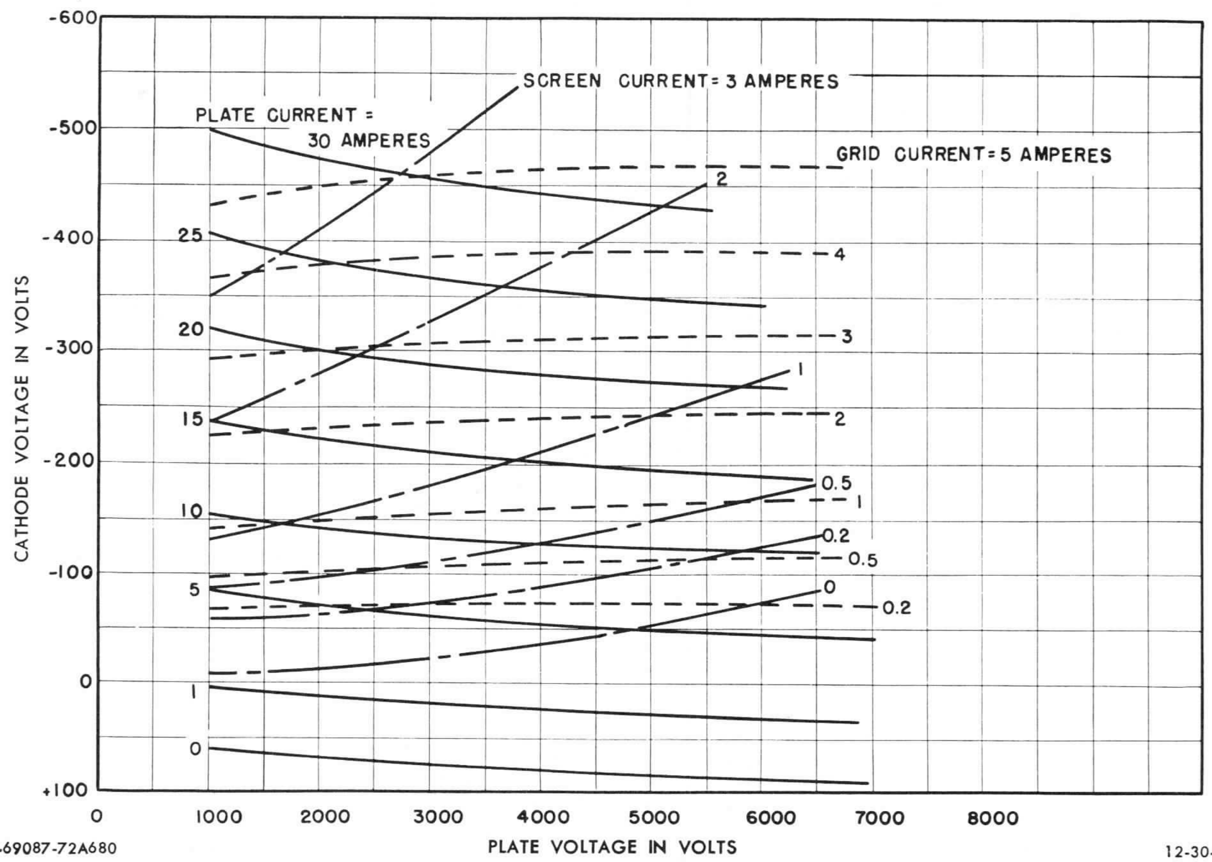
¶ Useful power output including power transferred from driver stage.

⊕ Denotes a change.

□ Denotes an addition.

CONSTANT CURRENT CHARACTERISTICS

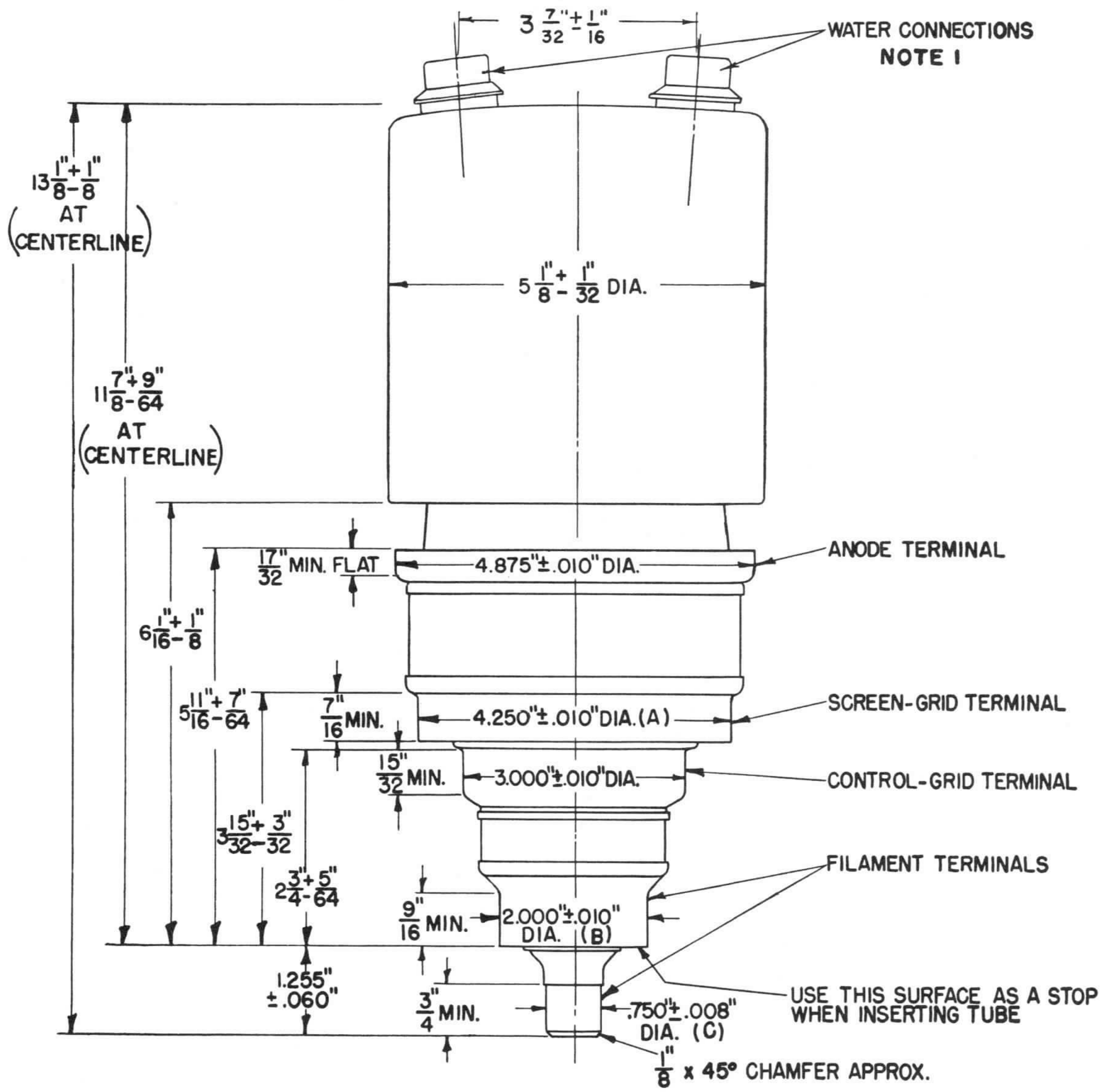
SCREEN VOLTAGE=700 VOLTS, CONTROL-GRID GROUNDED
ELECTRODE VOLTAGES MEASURED TO GROUND



K-69087-72A680

12-30-54

▲Supersedes pages 3 and 4 dated 9-57



(A) MAX. ECCENTRICITY .040"
(B) MAX. ECCENTRICITY .040"
(C) MAX. ECCENTRICITY .050"
WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE TERMINAL & CONTROL-GRID TERMINAL.

NOTE 1: MATES WITH WIGGINS SOCKET NO. BC-323B OR EQUIVALENT.
E. B. WIGGINS OIL TOOL COMPANY, INC., LOS ANGELES, CALIFORNIA

N-20726AZ—Outline Revised 1-6-59

GL-6848
TETRODE

VHF-UHF — **FORCED-AIR COOLED**
RING-SEAL CONSTRUCTION — **METAL AND CERAMIC**
GROUNDED-GRID CIRCUIT

The GL-6848 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 2 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-6848 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	μμf
Input, G_2 tied to G_1	—	27.8	—	μμf
Output, G_2 tied to G_1¶	—	6.4	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate .... 6.0 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow				
Through Radiator				
Percentage Rated Plate Dissipation	100	80	60	Percent
Air Flow	120	70	48	Cubic Feet per Minute
Static Pressure	3.2	1.5	0.8	Inches
Screen-grid to Control-grid Seals			15	Min Cubic Feet per Minute
Heater-to-Cathode Seals			7.5	Min Cubic Feet per Minute
Anode Ceramic			10	Min Cubic Feet per Minute

Incoming Air Temperature	45 Max C
Anode Hub Temperature	180 Max C
Ceramic Temperature at Any Point	200 Max C
Temperature at Any Other Point	200 Max C

Forced-air cooling to be applied before and during the application of any voltage. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The air duct can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	2.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	2.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

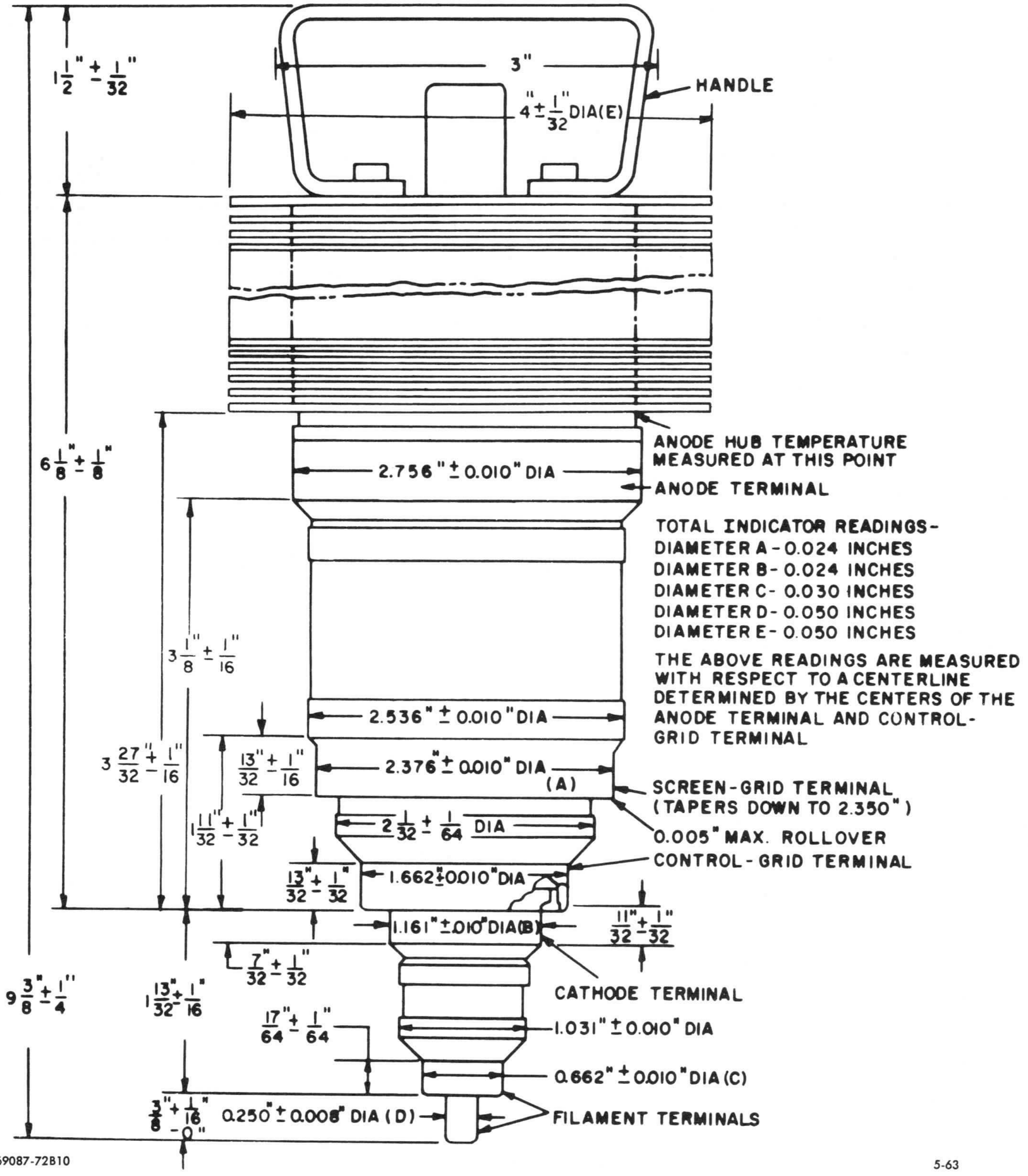
* The cathode of the GL-6848, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

‡ Represents maximum usable cathode current.(plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.



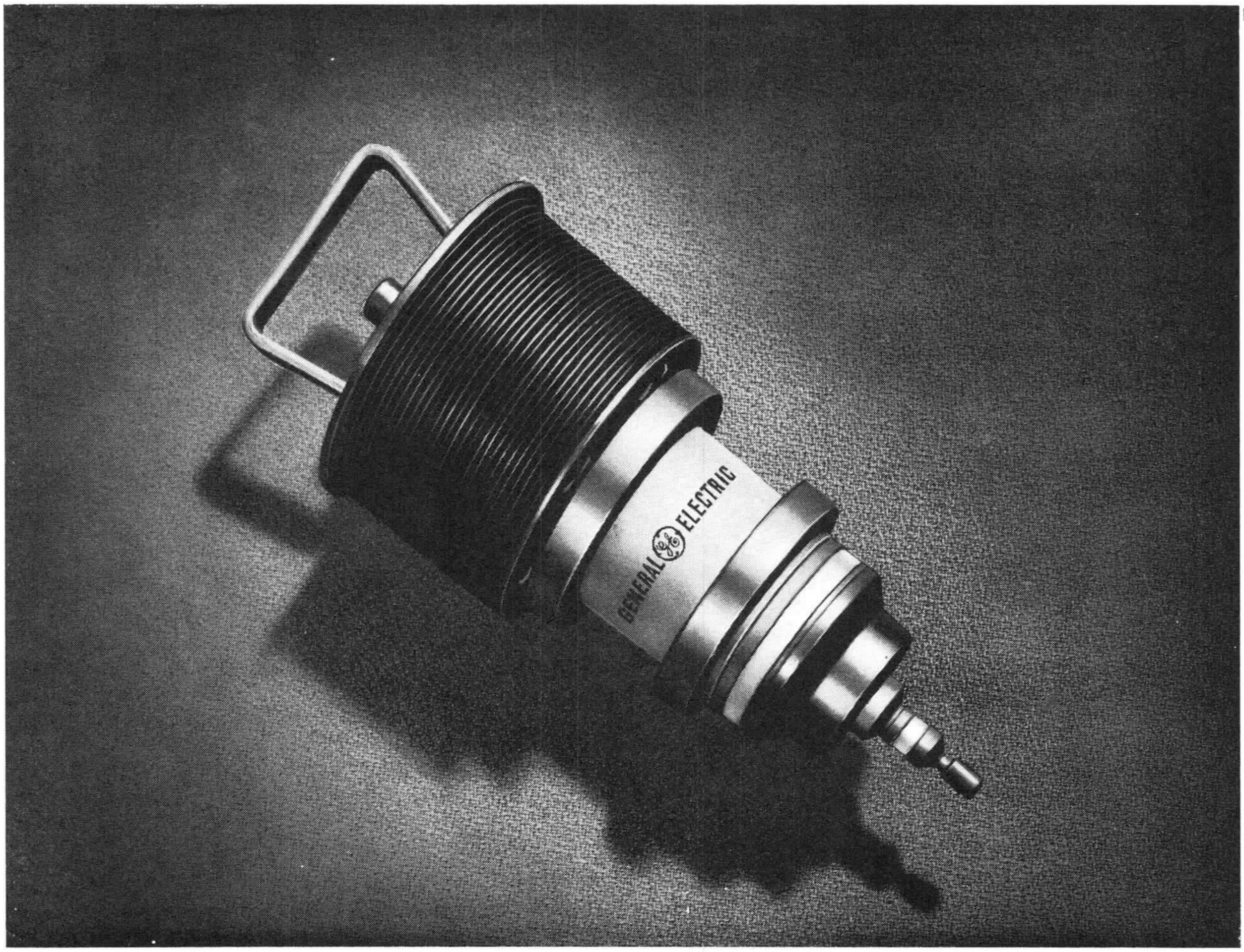
K-69087-72B10

5-63

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky



TETRODE

ONE KILOWATT UHF TELEVISION OUTPUT UHF TETRODE GROUNDED-GRID CIRCUITS

FORCED-AIR COOLED METAL AND CERAMIC INTEGRAL RADIATOR

THORIATED-TUNGSTEN CATHODE

The GL-6942 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope designed for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating one and one-half kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is indirectly heated thoriated tungsten. Maximum ratings apply up to 1000 megacycles.

When used as a Class B grounded-grid broadband television amplifier this tube has a useful synchronizing peak-power output of one kilowatt at 900 megacycles; in narrow band Class C service the output is one kilowatt of continuous power as an amplifier or oscillator. Because of its ratings, the tube is also well adapted to use in dielectric-heating equipment.

High operating efficiency is assured because of the small size and close spacing of the tube electrodes, the ring-seal construction, and the low-loss factor due to the silver-plated external parts and the ceramic insulators. In addition, the grounded-grid construction eliminates the necessity for neutralization in a properly designed circuit. The small size of the GL-6942 permits compact mounting, and the ring-seal construction allows quick plug-in installation.

GENERAL ELECTRIC

TECHNICAL INFORMATION

GENERAL

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	....	5.7	6.0	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	....	....	36	Amperes
Heater Cold Resistance	....	0.02	....	Ohms
Cathode Heating Time	1	....	....	Minutes
Amplification Factor, G_2 to G_1				
$Eb=2000$ Volts, $I_b=0.200$ Ampere, $E_c2=475$ Volts	12	17	22	
Peak Cathode Current†	....	....	3.0	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	....	....	0.006	$\mu\mu f$
Input, G_2 tied to G_1	15.5	17.0	18.5	$\mu\mu f$
Output, G_2 tied to G_1§	5.0	5.5	6.0	$\mu\mu f$

Mechanical

Mounting Position—Vertical

Net Weight, approximate	3.6	Pounds

Thermal

Air Flow¶

Through Radiator—See drawing for air duct form on page 4.

Plate Dissipation	1.5	Kilowatts
Air Flow	60 Min	Cubic Feet per Minute
Static Pressure	1.5	Inches Water
Heater-to-Cathode Seals	8 Min	Cubic Feet per Minute
Screen-Grid to Control-Grid Seals	4 Min	Cubic Feet per Minute
Anode to Screen-Grid Ceramic Insulator	6 Min	Cubic Feet per Minute
Incoming Air Temperature	45 Max	C
Radiator Hub Temperature at Fin Adjacent to Anode Seal	180 Max	C
Ceramic Temperature at Any Point	200 Max	C

Forced-air cooling to be applied before and during the application of any voltages. Forced-air cooling must be maintained for one minute after the removal of all voltages.

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

RADIO-FREQUENCY AMPLIFIER—CLASS B TELEVISION SERVICE

Synchronizing-Level Conditions per Tube Unless Otherwise Specified

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Plate Current	0.7 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

Typical Operation—Grounded-Grid Circuit up to 900 Megacycles

Bandwidth 6 Megacycles, measured to 1 decibel point

DC Plate Voltage	3500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−40	Volts
Peak RF Plate Voltage		
Synchronizing Level	2500	Volts
Pedestal Level	1875	Volts
Peak RF Driving Voltage		
Synchronizing Level	110	Volts
Pedestal Level	70	Volts
DC Plate Current		
Synchronizing Level	0.520	Amperes
Pedestal Level	0.360	Amperes
DC Grid-No. 2		
Pedestal Level	0.035	Amperes
DC Grid-No. 1 Current		
Synchronizing Level	0.110	Amperes
Pedestal Level	0.035	Amperes

TECHNICAL INFORMATION (CONT'D)

Driving Power at Tube, approximate		
Synchronizing Level	100	Watts
Pedestal Level	25	Watts
Power Output, approximateϕ		
Synchronizing Level	1000	Watts
Pedestal Level	560	Watts

PLATE-MODULATED RADIO-FREQUENCY POWER AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	3200 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−120 Max	Volts
DC Plate Current	0.35 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	1.12 Max	Kilowatts
Grid-No. 2 Input	10 Max	Watts
Plate Dissipation	1200 Max	Watts

Typical Operation, Grounded-Grid Circuit up to 900 Megacycles

DC Plate Voltage	3000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2300	Volts
Peak RF Driving Voltage	137	Volts
DC Plate Current	0.25	Amperes
DC Grid-No. 2 Current	0.01	Amperes
DC Grid-No. 1 Current, approximate	0.047	Amperes
Driving Power, approximate♦	38	Watts
Power Outputϕ	565	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-Down Conditions per Tube without Amplitude Modulation▲

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	−150 Max	Volts
DC Plate Current	0.7 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

Typical Operation — Grounded-Grid Circuit at 1000 Megacyles*, ¼ λ Output

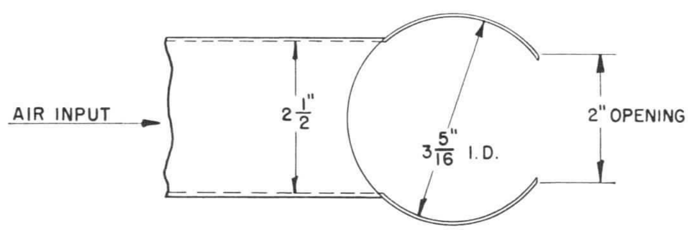
DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−110	Volts
DC Plate Current	0.042	Amperes
DC Grid-No. 2 Current	0.011	Amperes
DC Grid-No. 1 Current, approximate	0.055	Amperes
Driving Power, approximate	65	Watts
Power Output, usefulϕ	1000	Watts

* The cathode of the GL-6942 because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the heater input to prevent overheating of the cathode with resulting short life. For long life, the GL-6942 should be put in operation with rated heater voltage. After the circuit has been adjusted for proper tube operation the heater voltage should be reduced to a value slightly above that at which circuit performance is affected. At a frequency of 900 megacycles and with typical operating conditions the heater voltage can be reduced to approximately 5.3 volts. At lower frequencies, the reduction will be less. Minor circuit readjustment may be necessary after this adjustment.

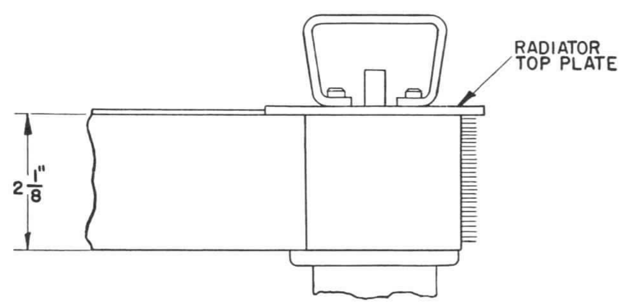
TECHNICAL INFORMATION (CONT'D)

† Represents maximum useable cathode current (plate current plus current to each grid) for any condition of operation.
‡ Measured with complete external shielding between cathode and anode.
§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.
¶ The volume of cooling air indicated for the various seals is for sea-level conditions and approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most satisfactory operation the maximum temperature of any point on the tube should be below 200 C.
φ Useful power output including power transferred from driver stage.
♦ The carrier of the driver modulated 100 percent.
▲Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

BLOWER DUCT

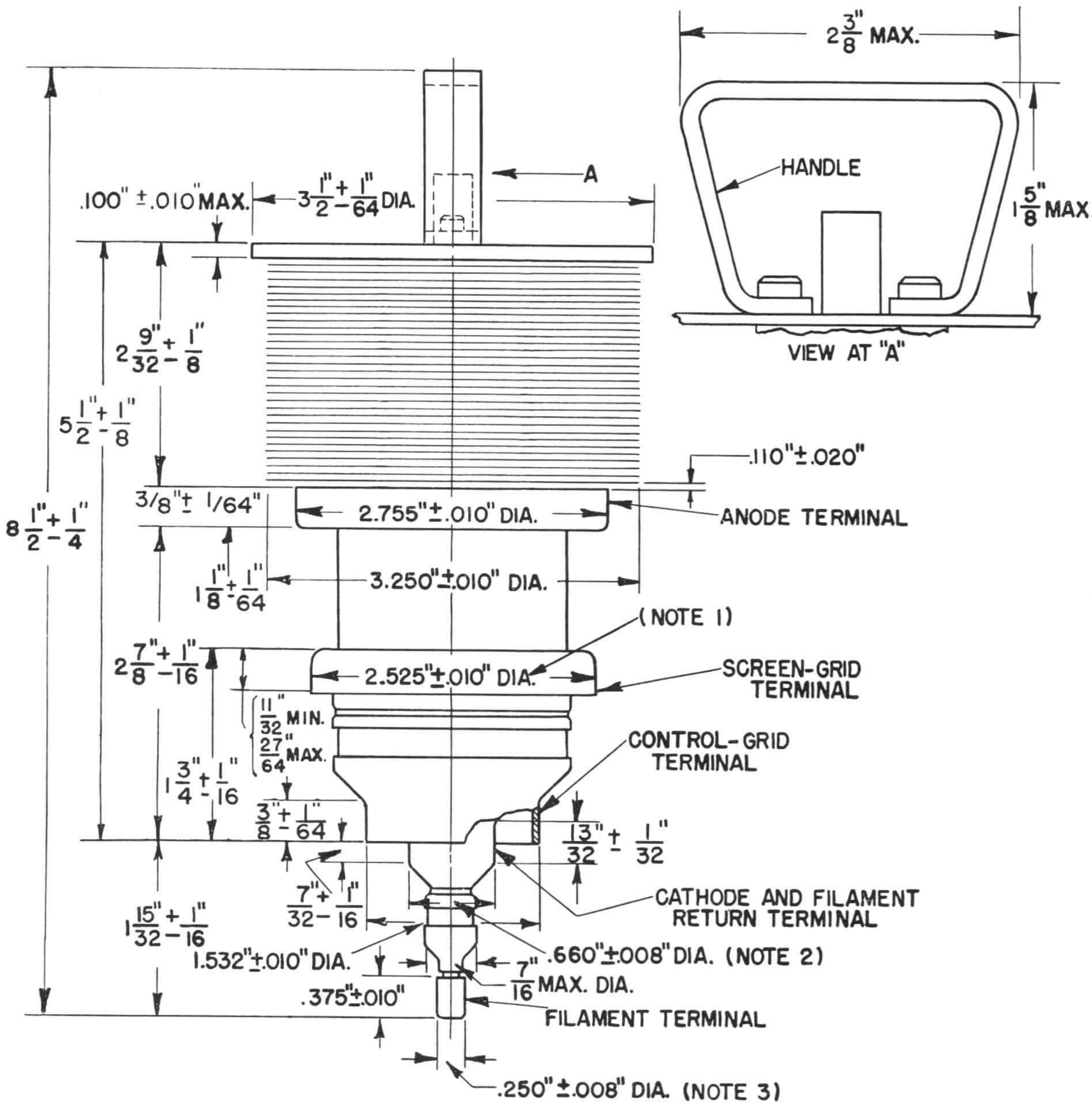


TOP VIEW



SIDE VIEW (WITH TUBE IN PLACE)

K-69087-72A592 8-29-55



TOTAL INDICATOR RATINGS

NOTE 1. 0.020"

NOTE 2. 0.030"

NOTE 3. 0.060"

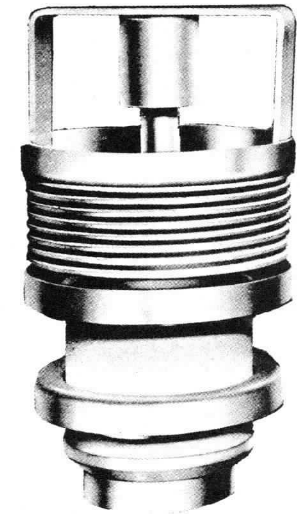
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

PRINTED IN U.S.A.



GL-7399

TETRODE

PULSED SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC

INTEGRAL RADIATOR

The GL-7399 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier or -oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne or ground-based radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the GL-7399 include long life and reliability, long pulse width, high peak power and high gain, broad-banding capability, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage (See Note 1)	—	6.3	6.8	Volts
Heater Current	...	5.6		Amperes
Amplification Factor, G_2 to G_1	...	10.5		
E_{g2} = 275 Volts DC, E_b = 1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1			Minute
Direct Interelectrode Capacitances*				
Cathode to Plate†		0.012		μμf
Input		24.0		μμf
Output		9.3		μμf

Mechanical

Mounting Position—Any		
Net Weight	1.0	Pounds

Thermal

Cooling—Forced Air‡				
Radiator§				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C incoming air temperature	17.0	12.0	6.5	Min Cubic Feet per Minute
Static Pressure, approximate anode at room temperature	0.9	0.5	0.2	Inches-Water
Anode Hub Temperature▲			250	Max C
Seals				
Screen and Control Grid, approximate			1	Cubic Foot per Minute
Heater and Cathode, approximate			1	Cubic Foot per Minute
Ceramic Temperature at any Point			200	Max C

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Maximum Ratings

Plate- and Screen-Grid Pulsed, 500 Megacycles

DC Plate Voltage, during pulse	10	Kilovolts
DC Plate Current, during pulse	10	Amperes
DC Grid-No. 2 Voltage, during pulse	2000	Volts
DC Grid-No. 2 Input♣	15	Watts
Plate Dissipation♣	500	Watts
DC Grid-No. 1 Voltage, not pulsed	−175	Volts
DC Grid-No. 1 Current, during pulse	2.5	Amperes
Pulse Width♥♦	15	Microseconds
Duty Factor♥φ	0.0012	

Typical Operation

Grounded-grid Circuit, 500 Megacycles

DC Plate Voltage, during pulse	9	Kilovolts
DC Grid-No. 2 Voltage, during pulse	1400	Volts
DC Grid-No. 1 Voltage, not pulsed	−125	Volts
Peak RF Plate Voltage	7000	Volts
Peak RF Grid Voltage	300	Volts
DC Plate Current, during pulse	9.2	Amperes
DC Grid-No. 1 Current, during pulse	1.1	Amperes
DC Grid-No. 2 Current, during pulse	0.47	Amperes
Driving Power at Tube, during pulse	2.6	Kilowatts
Power Output, during pulse (useful)	52	Kilowatts
Pulse Width♦	15	Microseconds
Duty Factor	0.001	

Note 1: Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	−225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation	500	Watts
Pulse Width ♥♦	15	Microseconds
Duty Factor ♥ϕϕ	0.01	

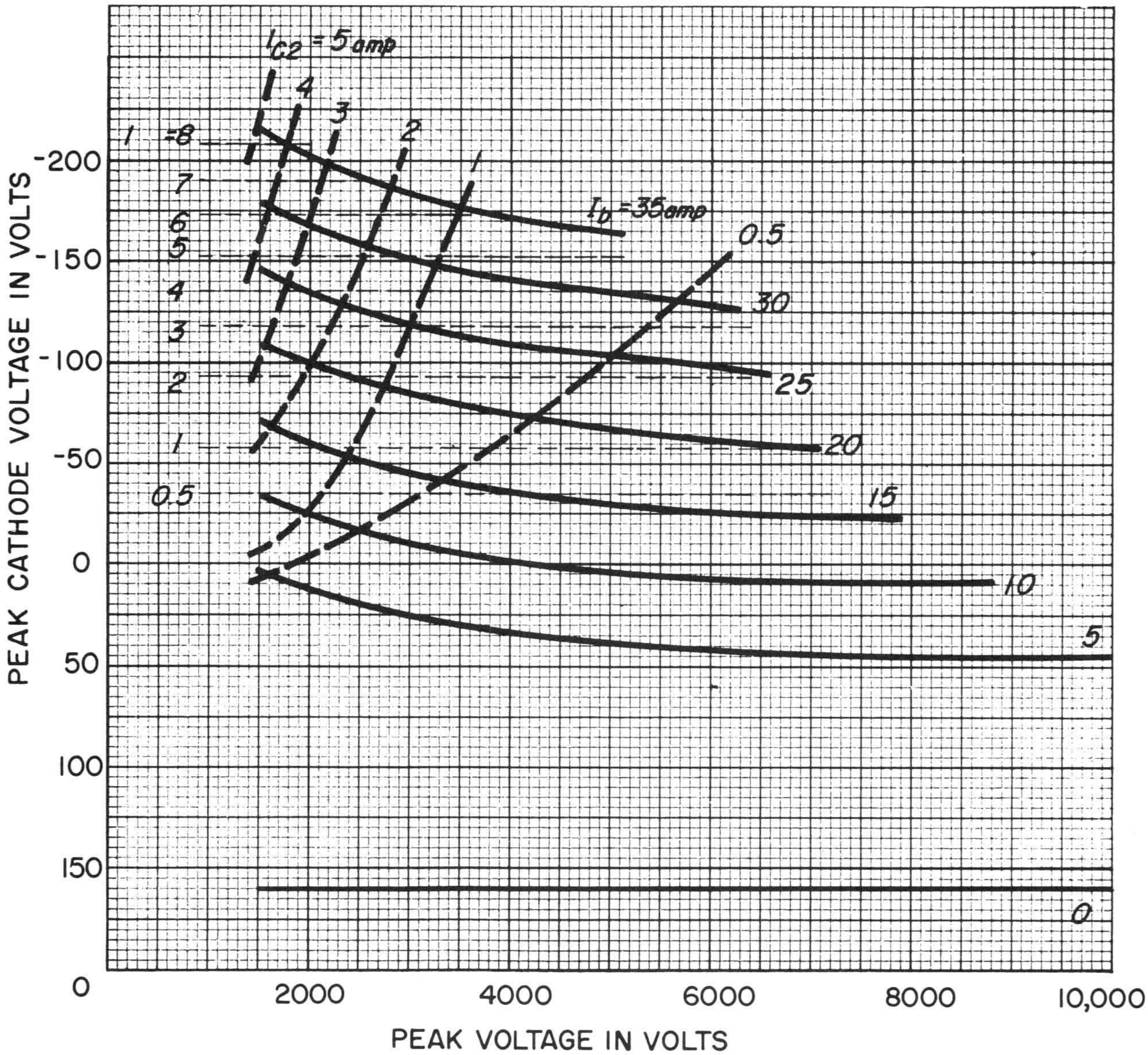
Typical Operation

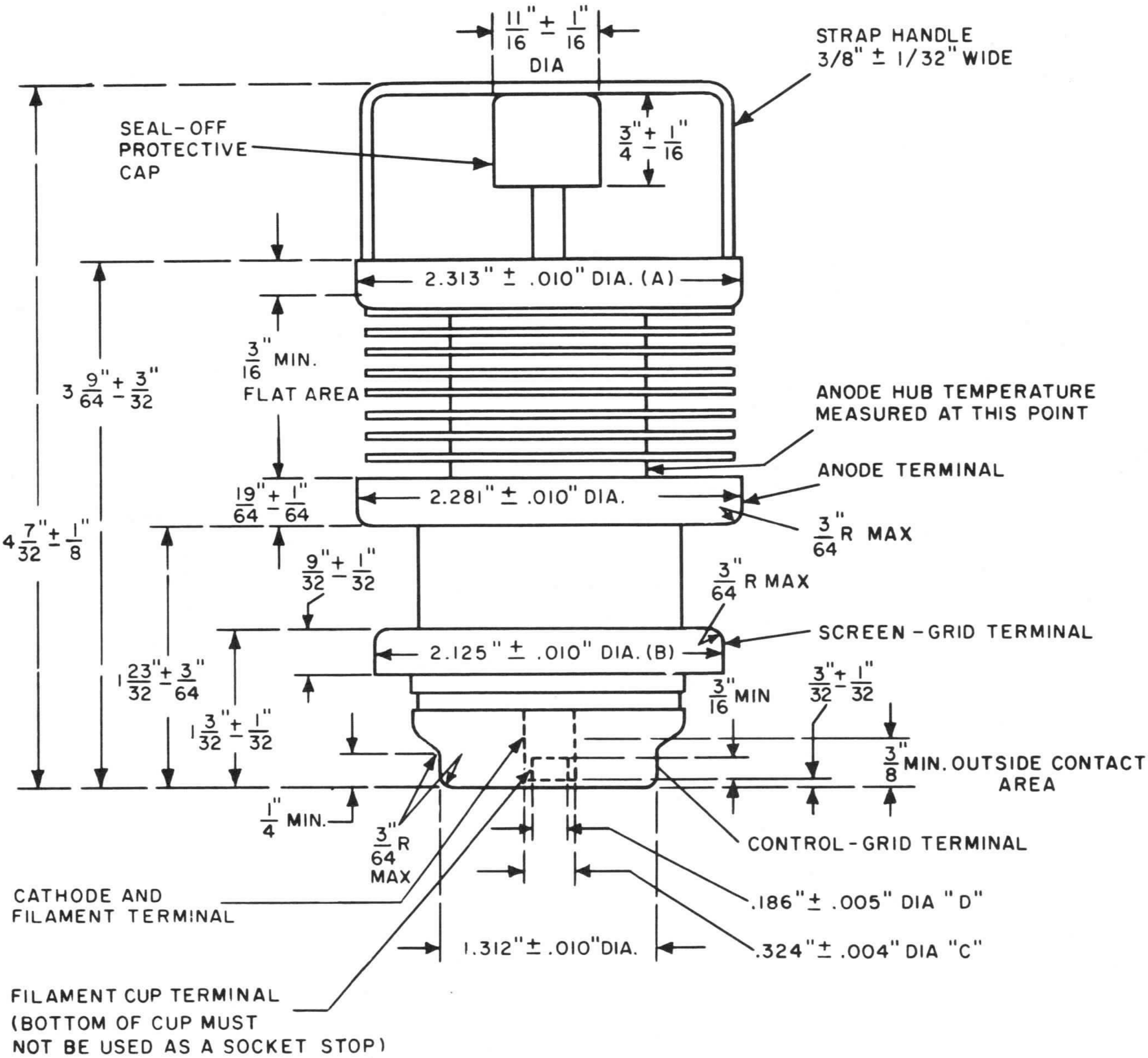
Grounded-grid Circuit at 1100 Megacycles, ¾λ Output Circuit

DC Plate Voltage**	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	−200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width♦	15	Microseconds
Duty Factor	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced air cooling should be applied during the application of any voltages.
§ Provision must be made for unobstructed passage of cooling air between radiator fins, and between the anode terminal and adjacent fins.
▲Measured at the base of the fin adjacent to the plate terminal. See outline drawing on page 4.
♣Maximum average value.
♥For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
♦ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ϕ Maximum ratio of on-time to elapsed time during any 12.5-millisecond period.
ϕϕMaximum ratio of on-time to elapsed time during any 1.5-millisecond period.
**A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.

CONSTANT CURRENT CHARACTERISTIC
GROUNDED-GRID OPERATION
VOLTAGES MEASURED TO GROUND
SCREEN VOLTAGE=1400 VOLTS





CONCENTRICITIES

THE FOLLOWING TOTAL INDICATOR READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL GRID TERMINAL

DIAMETER A — 0.030 INCHES
DIAMETER B — 0.016 INCHES
DIAMETER C — 0.036 INCHES
DIAMETER D — 0.042 INCHES

TOTAL INDICATOR READING OF FILAMENT CUP TERMINAL DIAMETER (D) MEASURED WITH RESPECT TO CENTER OF CATHODE AND FILAMENT TERMINAL DIAMETER (C) — 0.016 INCHES

GL-7985
TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION
GROUNDED-GRID CIRCUIT

WATER COOLED
METAL AND CERAMIC
INTEGRAL WATER JACKET

The GL-7985 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 3½ kilowatts. Cooling is accomplished by water and forced air with the water jacket an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megaycles, although higher frequency operation is possible.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-7985 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3.0 kilowatts of continuous power as an amplifier or oscillator.

As a Class B radio-frequency power amplifier, the tube is capable of delivering 1100 watts of power with 20 watts of drive at carrier level.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	—	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	—	14.5	—	Amperes
With 150 Watts Cathode Bombarding	—	13.5	—	Amperes
Heater Starting Current	—	—	25	Amperes
Heater Cold Resistance	—	0.041	—	Ohms
Cathode Bombarding Power*	—	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	—	650	—	Volts
For 195 Watts Bombarding Power	—	700	—	Volts
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, $E_b = 4000$ volts, $I_b = 0.5$ Ampere	—	20	—	
Peak Cathode Current‡	—	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	—	0.01	—	$\mu\mu f$
Input, G_2 tied to G_1	—	27.8	—	$\mu\mu f$
Output, G_2 tied to G_1¶	—	6.4	—	$\mu\mu f$

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate . . . 2.0 Pounds

Thermal

Type of Cooling—Water and Forced Air

Water Flow
- Anode . . . 3.0 Min Gallons per Minute
- Pressure Drop at Rated Flow . . . 20 Max Pounds per Square Inch
- Water Pressure . . . 80 Max Pounds per Square Inch
- Outlet Water Temperature . 70 Max C

Air Flow
- Screen-grid to Control-grid Seals . . . 15 Min Cubic Feet per Minute
- Heater-to-Cathode Seals . . . 7.5 Min Cubic Feet per Minute
- Anode Ceramic . . . 10 Min Cubic Feet per Minute

Temperature at Any Point . . . 200 Max C

Water and forced-air cooling to be applied before and during the application of any voltages. Water cooling may be discontinued with removal of all voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	0.600	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage, approximate	−35	Volts
Peak RF Plate Voltage, approximate	5500	Volts
Peak RF Grid-No. 1 Voltage, approximate	105	Volts
DC Plate Current	0.475	Ampere
Zero Signal DC Plate Current	0.115	Ampere
$E_b = 7000$ volts, $E_{c2} = 600$ volts, E_{c1} adjusted for $I_b = 0.115$ amperes		
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.025	Ampere
Driving Power, approximate	80	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1100	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2300	Watts
Cathode Bombarding Power*	160	Watts
Cathode Bombarding Voltage	610	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions With a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	3.5	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approx.	630	Volts
Cathode Bombarding Current, approx.	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	3.5	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-7985, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

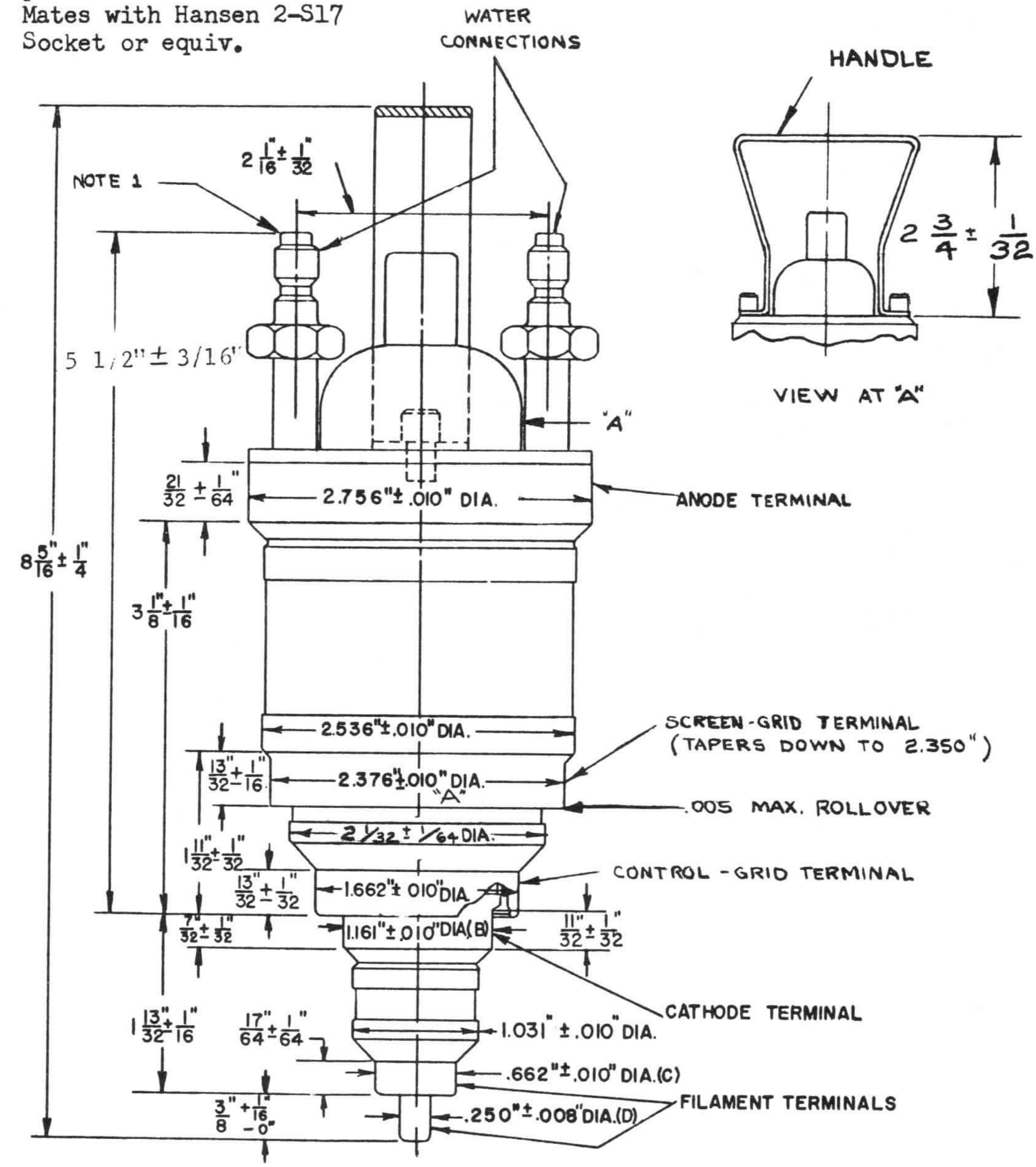
‡ Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

§ Measured with complete isolation between cathode and plate.

¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.

NOTE 1: Top portion same as top portion of Hansen B2T16 Mates with Hansen 2-S17 Socket or equiv.

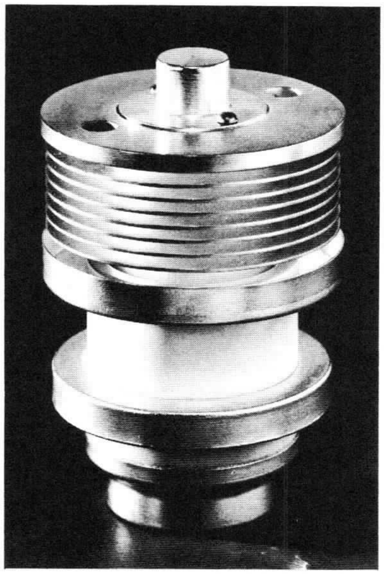


The following indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Total Indicator Readings -
Diameter A - 0.024 inches
Diameter B - 0.024 "
Diameter C - 0.030 "
Diameter D - 0.050 "

A-69087-72B70

5-63



GL-8500

TETRODE

RADIO-FREQUENCY AMPLIFIER
CW SERVICE
GROUNDED-GRID OPERATION

FORCED-AIR COOLED
METAL AND CERAMIC
INTEGRAL RADIATOR

The GL-8500 is a reliable power tetrode that delivers useful output to 1250 megacycles or higher. This tube is particularly suitable for application in the final output or driver stage of military-communications systems.

As a Class B linear amplifier in the 225–400-megacycle range, the tube will deliver 110 watts of carrier power modulated up to 100 percent. Since a power gain of 20 may be realized, drive requirements are low—approximately 5 watts at carrier level.

Operating as a Class C CW amplifier at 900 megacycles, the gain is approximately 15 at the 200-watt level.

Features of the GL-8500 include long life and reliability, high gain, high linearity, and resistance to shock and vibration.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

Electrical

	Minimum	Bogey	Maximum	
Heater Voltage*	—	6.3	6.8	Volts
Heater Current	—	3.8	—	Amperes
Cathode Heating Time	1	—	—	Minutes
Amplification Factor, G_2 to G_1, E_b=1000V DC; E_{g2}=275V DC; I_b=0.2 A DC	—	14	—	
Peak Cathode Current†	—	—	1.75	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate‡	—	0.006	—	μμf
Input, G_2 tied to G_1	—	19.5	—	μμf
Output, G_2 tied to G_1♦	—	6.4	—	μμf

Mechanical

Mounting Position—Any		
Net Weight, approximate	1.0	Pounds

Thermal

Cooling—Forced Air§				
Through Radiator, at Sea Level**				
Plate Dissipation	500	400	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	17.0	12.0	6.5	Cubic Feet per Minute
Static Pressure, approximate	0.9	0.5	0.2	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal	—	—	250	C
Seals				
Screen-Grid to Control-Grid, approximate	—	—	1	Cubic Feet per Minute
Heater to Cathode, approximate	—	—	1	Cubic Feet per Minute
Ceramic Temperature at Any Point, maximum	—	—	200	C

GENERAL ELECTRIC

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B LINEAR

Carrier conditions per tube for use with a maximum modulation factor of 1.0

Maximum Ratings

DC Plate Voltage	2000	Volts
DC Grid-No. 2 Voltage	320	Volts
DC Plate Current	0.250	Amperes
Plate Input	500	Watts
Grid-No. 2 Input	5	Watts
Plate Dissipation	500	Watts

Typical Operation

Grounded-Grid Circuit at 225–400 Megacycles

DC Plate Voltage	1750	Volts
DC Grid-No. 2 Voltage	250	Volts
DC Grid-No. 1 Voltage, approximate	−20	Volts
Peak RF Plate Voltage #, approximate	1250	Volts
Peak RF Grid-No. 1 Voltage #, approximate	40	Volts
DC Plate Current	0.200	Amperes
Zero Signal DC Plate Current (E_{c1} adjusted)	0.020	Amperes
DC Grid-No. 2 Current	0.005	Amperes
DC Grid-No. 1 Current	0.010	Amperes
Driving Power, approximate	5	Watts
Power Output ♥	110	Watts

RADIO-FREQUENCY POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without amplitude modulation△

Maximum Ratings

	900 Megacycles	400 Megacycles	
DC Plate Voltage	1600	2000	Volts
DC Grid-No. 2 Voltage	320	320	Volts
DC Grid-No. 1 Voltage	−100	−100	Volts
DC Plate Current	0.300	0.300	Ampere
DC Grid-No. 1 Current	0.050	0.050	Ampere
Plate Input	480	600	Watts
Grid-No. 2 Input	15	15	Watts
Plate Dissipation	500	500	Watts
Grid-No. 1 Dissipation	2	2	Watts

Typical Operation

Grounded-Grid Circuit at 900 Megacycles

DC Plate Voltage	1500	2000	Volts
DC Grid-No. 2 Voltage	210	225	Volts
DC Grid-No. 1 Voltage	−40	−40	Volts
DC Plate Current	0.300	0.250	Ampere
DC Grid-No. 2 Current, approximate	0.010	0.010	Ampere
DC Grid-No. 1 Current, approximate	0.020	0.020	Ampere
Driving Power, approximate	14	15	Watts
Power Output, approximate¶	205	300	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater-voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

‡ Measured with a 6-inch minimum diameter flat metal disk attached to the screen-grid ring. Control grid connected to the screen grid.

♦ Output capacitances measured between anode and screen grid. Control grid connected directly to screen grid.

§ Forced-air cooling to be applied before and during the application of any voltages.

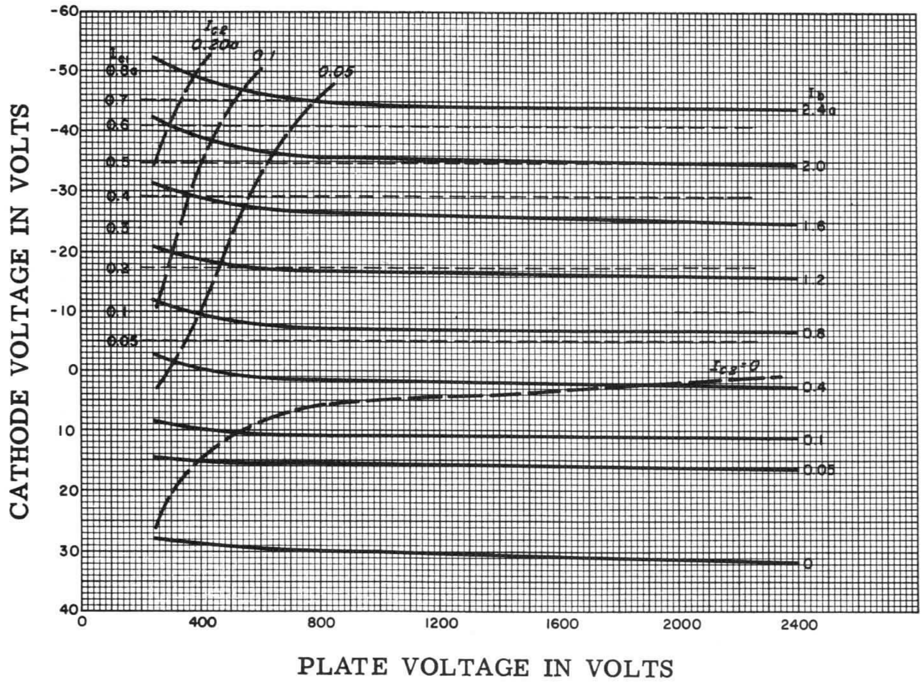
**Provision must be made for unobstructed passage of cooling air between radiator fins and between the anode terminal and adjacent radiator fin.

♥Useful power output as measured in output-circuit load.

¶ Useful power output including power transferred from driver stage. Output circuit efficiency approximately 80 percent.

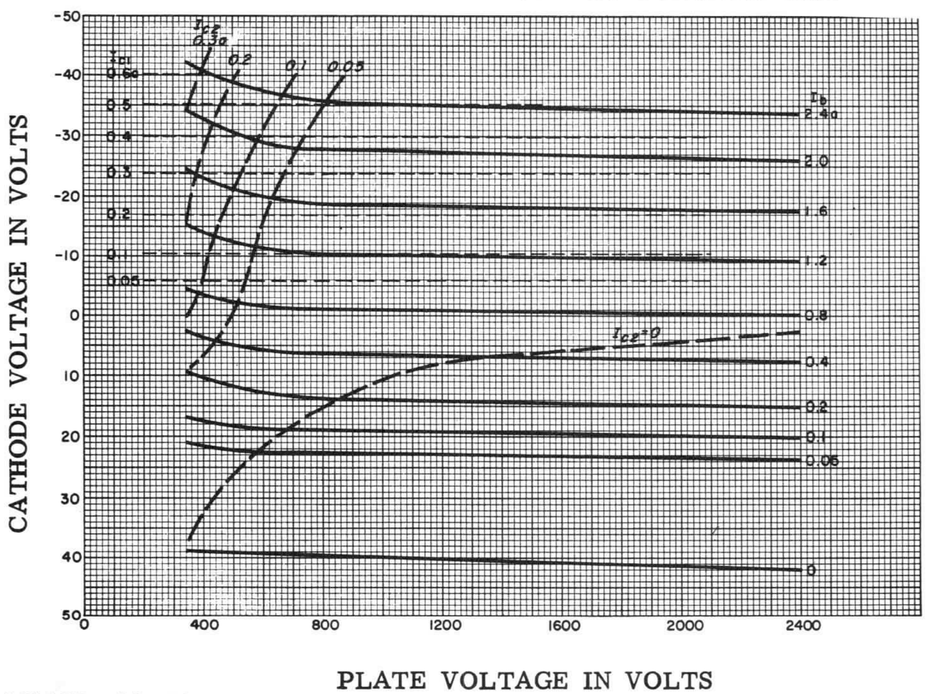
△Modulation essentially negative may be used if the positive peak of the envelope does not exceed 115 percent of the carrier conditions.

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 250 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID

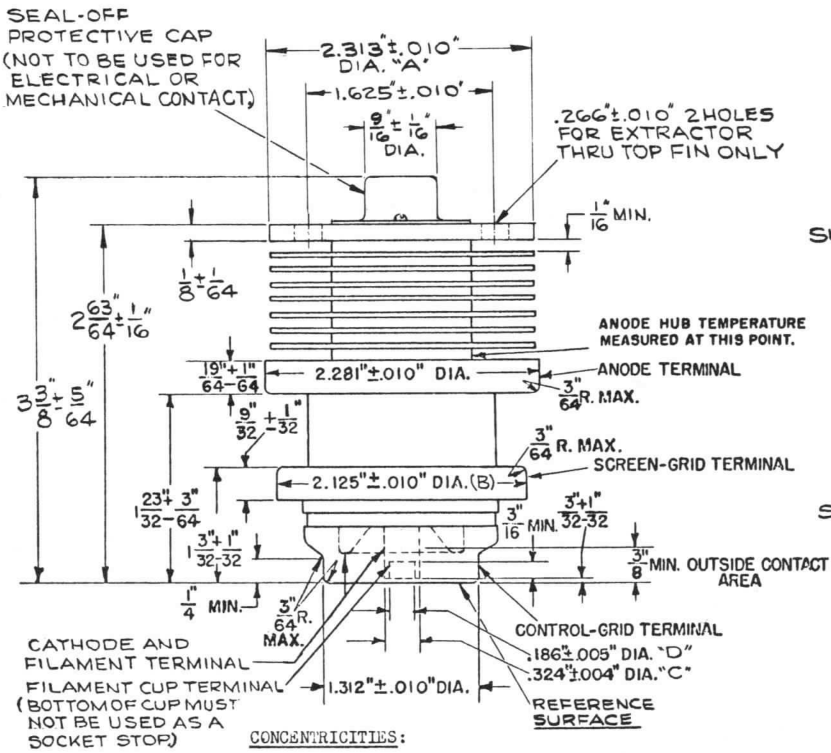


A69087 - 72B67 1-30-63

CONSTANT CURRENT CHARACTERISTIC
SCREEN VOLTAGE = 350 VOLTS
ALL VOLTAGES REFERENCED TO CONTROL GRID



A69087 - 72B68 1-30-63

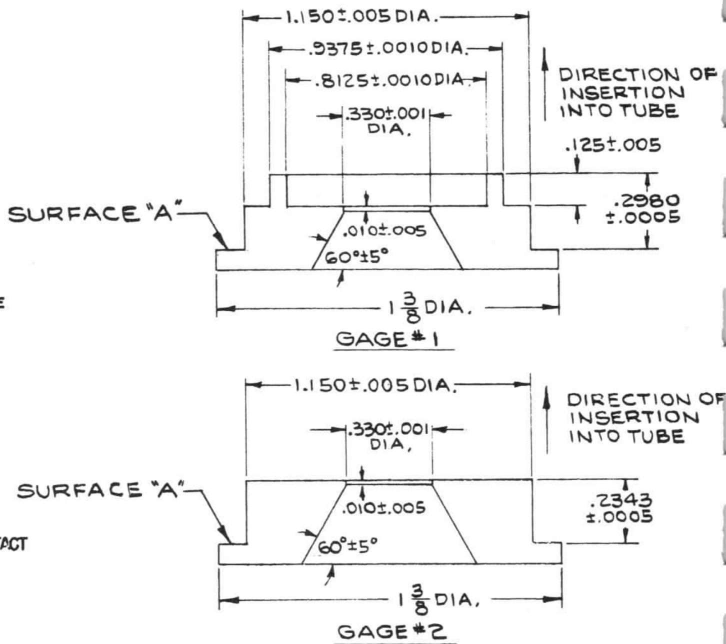


CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.



ZP-1030
CATHODE AND FILAMENT TERMINAL GAGES

When inserted over the cathode and filament terminal, gage #1 shall not contact the tube REFERENCE SURFACE at gage SURFACE "A".

When inserted over the cathode and filament terminal, gage #2 shall contact the tube REFERENCE SURFACE at gage SURFACE "A".

A-69087 - 72B58

12-31-62

GL-8513
TETRODE

VHF-UHF
RING-SEAL CONSTRUCTION

GROUNDED-GRID CIRCUIT

FORCED-AIR COOLED
METAL AND CERAMIC

The GL-8513 is a four-electrode transmitting tube featuring a metal-and-ceramic envelope for use as a power amplifier or oscillator in grounded-grid circuits with both grids maintained at radio-frequency ground potential. The output circuit is connected between the anode and the screen grid. The anode is capable of dissipating 4 kilowatts. Cooling is accomplished by forced air with the radiator an integral part of the anode. The cathode is a unipotential thoriated-tungsten cylinder, heated by electron bombardment. Maximum ratings apply up to 800 megacycles, although higher frequency operation is possible.

As a Class B linear power amplifier the tube will deliver 1500 watts at carrier level.

In narrow band, Class C, grounded-grid, amplitude-modulated service, the GL-8513 has a useful carrier-power output in excess of one kilowatt. In Class C Telegraphy, it has a useful power output of 3 kilowatts of continuous power as an amplifier or oscillator.

Electrical

	Minimum	Bogey	Maximum	
Cathode				
Heater Voltage	–	6.7	7.0	Volts
Heater Current at 7.0 Volts				
Without Cathode Bombarding	–	14.5	—	Amperes
With 150 Watts Cathode Bombarding	–	13.5	—	Amperes
Heater Starting Current	–	—	25	Amperes
Heater Cold Resistance	–	0.041	—	Ohms
Cathode Bombarding Power*	–	170	195	Watts
Cathode Bombarding Voltage, DC				
For 170 Watts Bombarding Power	–	650	—	Volts
For 195 Watts Bombarding Power	–	700	—	Volts
Cathode Heating Time	1	—	—	Minute
Amplification Factor, G_2 to G_1; $E_b = 4000$ volts; $I_b = 0.5$ ampere	–	20	—	
Peak Cathode Current†	–	—	6	Amperes
Direct Interelectrode Capacitances				
Cathode to Plate§	–	0.01	—	μμf
Input, G_2 tied to G_1	–	27.8	—	μμf
Output, G_2 tied to G_1¶	–	6.7	—	μμf

Mechanical

Mounting Position—Vertical, Anode-end Up
Net Weight, approximate ... 12.5 Pounds

Thermal

Type of Cooling—Forced Air

Air Flow Through Radiator, at Sea Level

Plate Dissipation	Air Flow	Static Pressure
4.0 Kw	135 CFM	2.8 In.

Seals

Screen-grid to Control-grid, minimum	15	Cubic Feet per Minute
Heater-to-cathode, minimum	7.5	Cubic Feet per Minute
Anode Ceramic, minimum	10	Cubic Feet per Minute
Incoming Air Temperature, maximum	55	C
Anode Hub Temperature, maximum	250	C
Temperature of Anode Ceramic and Seals, maximum	250	C
Temperature at Any Other Point, maximum	200	C

Forced-air cooling to be applied before and during the application of any voltages. Air flow on heater-to-cathode seals must be maintained for one minute after removal of heater voltage. The radiator air ducting can be constructed so that air is forced along the anode seal and ceramic through the anode contact fingers and additional holes in the plate contact ring to accomplish the anode ceramic and anode seal cooling. The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with configuration of the cavity about the tube.

RADIO-FREQUENCY POWER AMPLIFIER—CLASS B

Carrier Conditions per Tube for Use with a Maximum Modulation Factor of 1.0

Maximum Ratings, Absolute Values

DC Plate Voltage	9000	Volts
DC Grid-No. 2 Voltage	800	Volts
DC Plate Current	0.800	Ampere
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit, 225–400 Megacycles

DC Plate Voltage	8000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 1 Voltage, approximate	−50	Volts
DC Plate Current	0.600	Ampere
DC Grid-No. 2 Current	0.010	Ampere
DC Grid-No. 1 Current	0.060	Ampere
Driving Power, approximate	160	Watts
Measured at crest of audio-frequency cycle with modulation factor of 1.0		
Power Output#	1500	Watts
Circuit Efficiency	90	Percent
Plate Dissipation	2500	Watts
Cathode Bombarding Power*	170	Watts
Cathode Bombarding Voltage	650	Volts
Cathode Bombarding Current	0.260	Ampere

PLATE MODULATED RADIO-FREQUENCY AMPLIFIER—CLASS C TELEPHONY

Carrier Conditions with a Maximum Modulation Factor of 1.0, Screen Modulation Required

Maximum Ratings, Absolute Values

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	−120	Volts
DC Plate Current	0.80	Ampere
DC Grid-No. 1 Current	0.120	Ampere
Plate Input	3.60	Kilowatts
Grid-No. 2 Input	25	Watts
Plate Dissipation	4.0	Kilowatts

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4000	Volts
DC Grid-No. 2 Voltage	400	Volts
DC Grid-No. 1 Voltage	−100	Volts
Peak RF Plate Voltage	2500	Volts
Peak RF Driving Voltage	120	Volts
DC Plate Current	0.570	Ampere
DC Grid-No. 2 Current	0.020	Ampere
DC Grid-No. 1 Current, approximate	0.100	Ampere
Driving Power, approximate	100	Watts
Power Output#	1250	Watts
Output Circuit Efficiency	90	Percent
Cathode Bombarding Power*	165	Watts
Cathode Bombarding Voltage, approximate	630	Volts
Cathode Bombarding Current, approximate	0.260	Ampere

RADIO-FREQUENCY AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key Down Conditions per Tube Without Amplitude Modulation

Maximum Ratings, Absolute Values

DC Plate Voltage	7000	Volts
DC Grid-No. 2 Voltage	750	Volts
DC Plate Current	1.0	Amperes
Plate Input	6.0	Kilowatts
Grid-No. 2 Input	40	Watts
Plate Dissipation	4.0	Kilowatts
DC Grid-No. 1 Voltage	120	Volts
DC Grid-No. 1 Current	0.150	Ampere

Typical Operation

Grounded-grid Circuit at 400 Megacycles

DC Plate Voltage	4500	6500	Volts
DC Grid-No. 2 Voltage	600	700	Volts
DC Grid-No. 1 Voltage	−120	−100	Volts
Peak RF Plate Voltage, approximate	3000	—	Volts
Peak RF Grid-No. 1 Voltage	140	140	Volts
DC Plate Current	0.6	0.8	Ampere
DC Grid-No. 2 Current	0.018	0.025	Ampere
DC Grid-No. 1 Current	0.080	0.100	Ampere
Driving Power, approximate	100	100	Watts
Power Output, approximate#	1800	3200	Watts
Output Circuit Efficiency	90	90	Percent
Cathode Bombarding Power*	160	165	Watts
Cathode Bombarding Voltage, approximate	610	630	Volts
Cathode Bombarding Current, approximate	0.260	0.260	Ampere

Grounded-grid Circuit at 800 Megacycles

DC Plate Voltage	4500	Volts
DC Grid-No. 2 Voltage	600	Volts
DC Grid-No. 1 Voltage	−120	Volts
Peak RF Plate Voltage, approximate	3000	Volts
Peak RF Grid-No. 1 Voltage	140	Volts
DC Plate Current	0.6	Ampere
DC Grid-No. 2 Current	0.018	Ampere
DC Grid-No. 1 Current	0.080	Ampere
Driving Power, approximate	90	Watts
Power Output, approximate#	1250	Watts
Output Circuit Efficiency	83	Percent
Cathode Bombarding Power*	150	Watts
Cathode Bombarding Voltage, approximate	600	Volts
Cathode Bombarding Current, approximate	0.250	Ampere

* The cathode of the GL-8513, because of transit-time effects which raise the temperature of the cathode, is subjected to considerable back bombardment in ultra-high-frequency service. The amount of heating due to bombardment is a function of the operating conditions and frequency, and must be compensated for by a reduction of the cathode power input to prevent overheating of the cathode with resulting short life. In any case it is important from a tube life standpoint to keep the cathode power at as low a level as possible consistent with required performance. Bombarder power should be monitored by a suitable wattmeter or DC voltmeter and milliammeter arrangement. For long life, the tube should be put in operation with about 180 watts bombarding power. After the circuit has been adjusted for proper tube operation, bombarding voltage should be reduced to a value slightly above that at which circuit performance is affected. Minor circuit readjustment may be necessary after the above adjustment. The procedure for determining proper bombarding power should be repeated periodically.

† Represents maximum usable cathode current (plate current plus current to each grid) for any condition of operation.

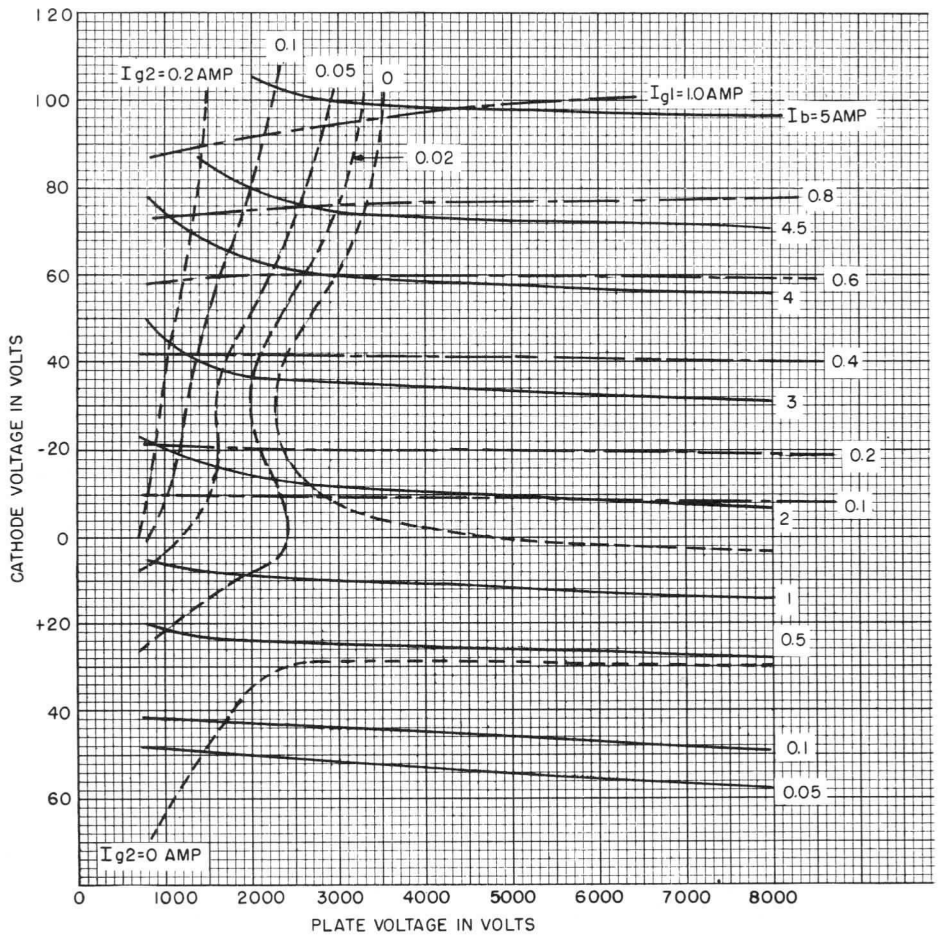
§ Measured with complete isolation between cathode and plate.

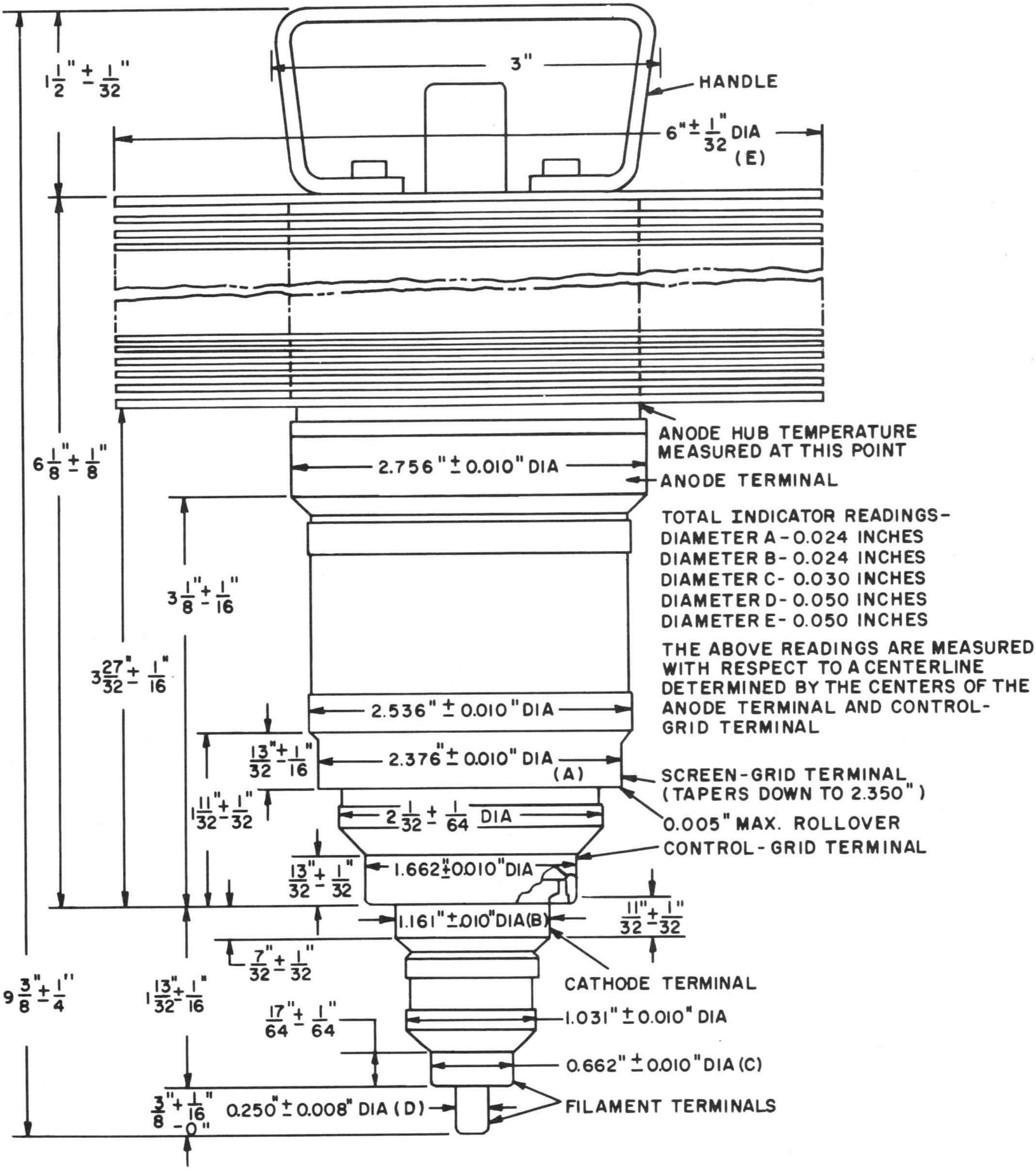
¶ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

Useful power output including power transferred from driver stage.

TYPICAL CHARACTERISTICS

Eg2 = 750 Volts, Ef = 7 Volts AC
Bombarding Power = 180 Watts
All Voltages Referenced to Grid




3"
HANDLE
1 1/2" ± 1/32"
6" ± 1/32" DIA (E)
6 1/8" ± 1/8"
ANODE HUB TEMPERATURE MEASURED AT THIS POINT
2.756" ± 0.010" DIA
ANODE TERMINAL
TOTAL INDICATOR READINGS-
DIAMETER A - 0.024 INCHES
DIAMETER B - 0.024 INCHES
DIAMETER C - 0.030 INCHES
DIAMETER D - 0.050 INCHES
DIAMETER E - 0.050 INCHES
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL
3 1/8" ± 1/16"
3 27/32" ± 1/16"
2.536" ± 0.010" DIA
13/32" ± 1/16"
2.376" ± 0.010" DIA (A)
SCREEN-GRID TERMINAL (TAPERS DOWN TO 2.350")
1 11/32" ± 1/32"
2 1/32" ± 1/64" DIA
0.005" MAX. ROLLOVER
CONTROL-GRID TERMINAL
13/32" ± 1/32"
1.662" ± 0.010" DIA
1.161" ± .010" DIA (B)
11/32" ± 1/32"
7/32" ± 1/32"
CATHODE TERMINAL
9 3/8" ± 1/4"
1 13/32" ± 1/16"
17/64" ± 1/64"
1.031" ± 0.010" DIA
0.662" ± 0.010" DIA (C)
3/8" + 1/16" - 0"
0.250" ± 0.008" DIA (D)
FILAMENT TERMINALS

DATA FOR DEVELOPMENTAL TYPES

NOTE:

Both electrical and mechanical characteristics of developmental types are subject to change: therefore, it is recommended that designers consult with their General Electric field representative before designing equipment around development types. (See inside back cover)

A-0897

PLANAR TRIODE

DESCRIPTION AND RATING

For Grounded-Grid Oscillator And Amplifier Service

The A-0897 is a metal-and-ceramic, high-mu triode designed for use as a grounded-grid oscillator or amplifier at frequencies as high as 2500 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC	*	Volts
Heater Current at Ef = 6.3 volts	1.03‡	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	2.01	pf
Grid to Cathode: (g to k)	6.5	pf
Plate to Cathode: (p to k)	0.023	pf

Mechanical

Operating Position - Any

Net Weight, approximate	2	Ounces

MAXIMUM RATINGS

Absolute-Maximum Values

Radio-Frequency Power Amplifier and Oscillator - Class C Telegraphy

Key-down Conditions per Tube Without Amplitude Modulation¶

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage	1000	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	125	Milliamperes
Plate Dissipation#	10	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point‡‡	250	C

MAXIMUM RATINGS (Continued)

Radio-Frequency Power Amplifier and Oscillator - Class C Telephony

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage*	4.5 to 6.3	Volts
DC Plate Voltage**	600	Volts
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
DC Cathode Current	100	Milliamperes
Plate Dissipation∆	7.0	Watts
Grid Dissipation	2.0	Watts
Envelope Temperature at Hottest Point‡‡	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics§§

Heater Voltage	6.3	Volts
Plate Voltage	600	Volts
Grid Voltage¶¶	---	Volts
Amplification Factor	95	
Transconductance	24800	Micromhos
Plate Current	75	Milliamperes

Radio-Frequency Oscillator - Class C§§

Frequency	500	2500	Megacycles
Heater Voltage	6.0	5.0	Volts
DC Plate Voltage	900	900	Volts
DC Plate Current	90	90	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	-40	-22	Volts
Useful Power Output	40	17	Watts

INITIAL CHARACTERISTICS LIMITS

	Min.	Bogey	Max.	
Heater Current				
Ef = 6.3 volts	950	1030	1100	Milliamperes
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 75 ma	-1.3	-2.5	-3.5	Volts
Grid Voltage				
Ef = 6.3 volts, Eb = 600 volts, Ib = 1.0 ma	-7.0	-9.5	-15	Volts
Transconductance				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	22000	24800	27500	Micromhos
Amplification Factor				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	75	95	115	
Negative Grid Current				
Ef = 6.3 volts, Eb = 600 volts, Ec adjusted for Ib = 75 ma	---	---	3.0	Microamperes
Interelectrode Leakage Resistance				
Ef = 6.3 volts, Polarity of applied d-c interelectrode voltage is such that no cathode emission results				
Grid to Cathode at 500 volts d-c	50	---	---	Megohms
Interelectrode Capacitances				
Grid to Plate: (g to p)	1.89	2.01	2.13	Picofarads
Grid to Cathode: (g to k)	6.0	6.5	7.0	Picofarads
Plate to Cathode: (p to k)	0.018	0.023	0.029	Picofarads

SPECIAL PERFORMANCE TESTS

	Min.	Max.	
Oscillator Power Output			
Tubes are tested for power output as an oscillator under the following conditions: Ef = 5.0 volts; F = 2500 MC, min; Eb = 1000 volts; Ib = 90 ma	15	---	Watts
Low Pressure Voltage Breakdown Test			
Statistical sample tested for voltage breakdown at a pressure of 27 mm Hg. Tubes shall not give visual evidence of flashover when 1000 volts RMS, 60 cps, is applied between the plate and grid terminals			

* The equipment designer should design the equipment so that heater voltage is centered at some value within the range of 4.5 to 6.3 volts. Heater voltage variations about the center value should be kept as small as practical and should not, in any case, exceed ±5%. The optimum center value of heater voltage depends on the cathode current and on other parameters of circuit design and operation. For specific recommendations, contact your General Electric tube sales representative.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Measured in a special shielded socket.

¶ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

With an adequate heat sink, the maximum dissipation rating is 100 watts.

Δ With an adequate heat sink, the maximum dissipation rating is 70 watts.

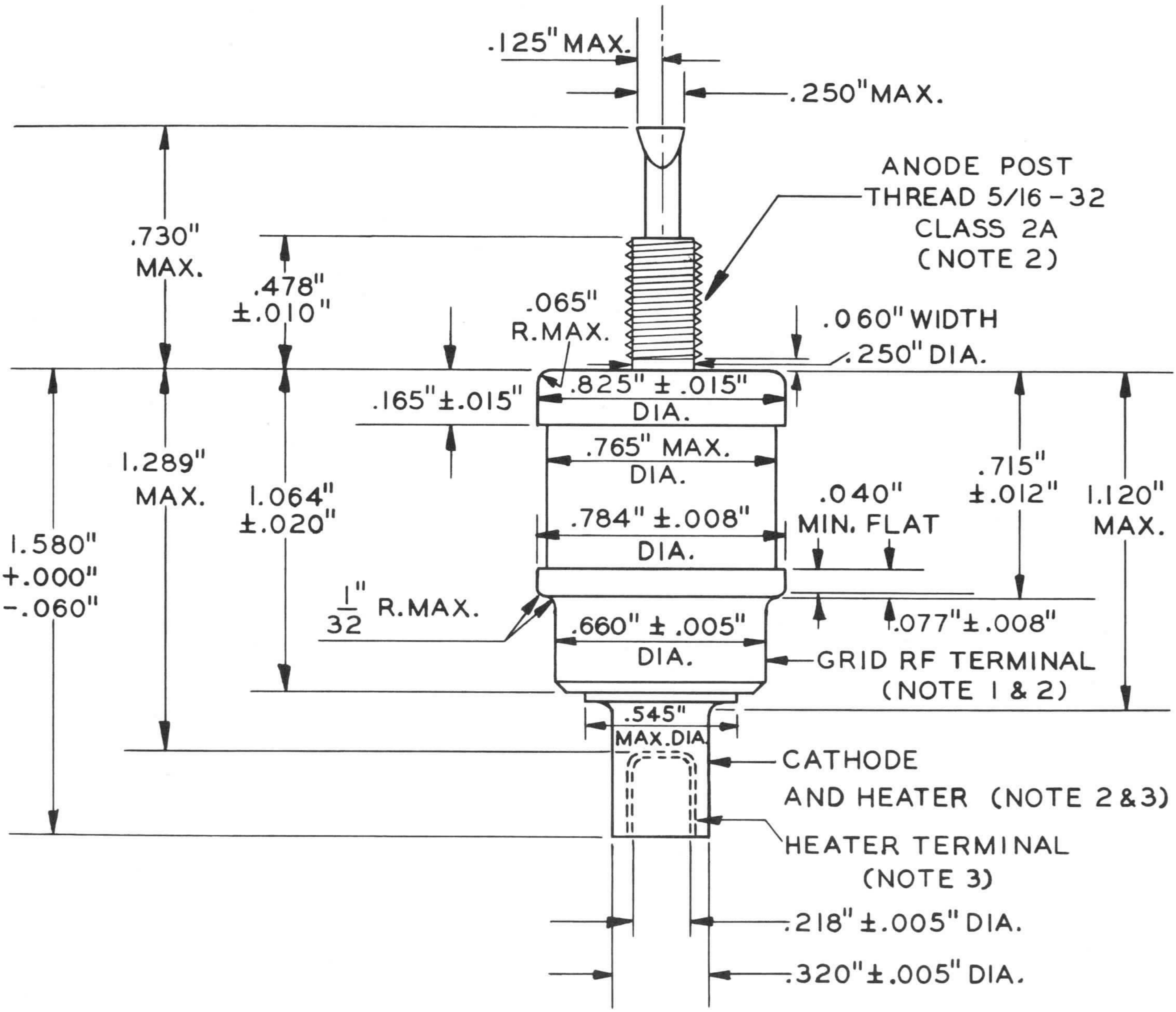
§§ An adequate heat sink must be provided.

‡‡ Where long life and reliable operation are important, lower envelope temperatures should be used.

** For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

¶¶ Adjusted for Ib = 75 milliamperes.

OUTLINE
A-0897



NOTES:

1. Solder not to extend radially beyond grid RF terminal.
2. Axis of threaded section shall be concentric with surface of Cathode-Fil. and Grid to within .020" T.I.R.. T.I.R. to be measured on cathode and grid contact areas within ±.040" of center of each area.

3. Total indicated runout of the heater-contact surface with respect to the cathode-contact surface shall not exceed 0.012".

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1012*

DIODE

The Y-1012 is a cathode-type diode of ceramic-and-metal planar construction intended for computer service.

GENERAL

Electrical

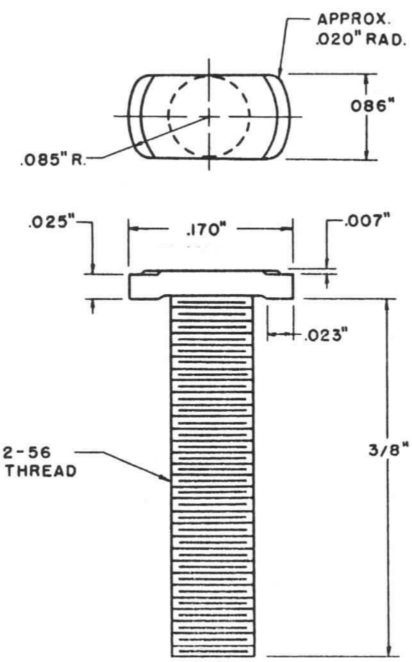
Cathode - Coated Unipotential

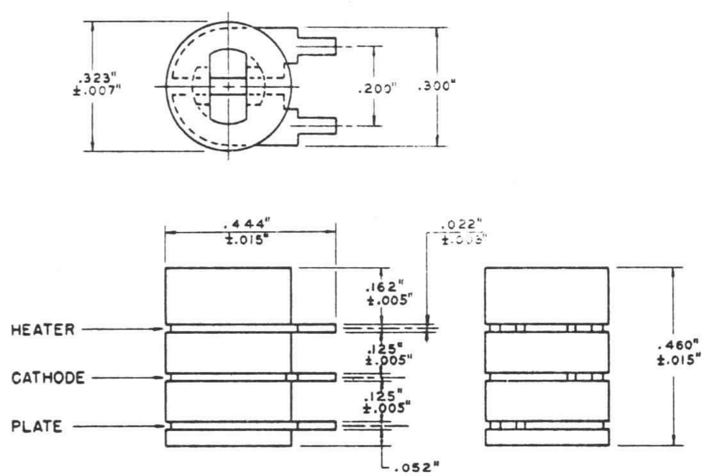
Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.215	Amperes
Direct Interelectrode Capacitances§		
→ Plate to Cathode: (p to k)	1.3	pf
→ Heater to Cathode	1.5	pf

Mechanical

Operating Position - Any

→ Outline Drawing





MAXIMUM RATINGS

Absolute-Maximum Values

Peak Inverse Plate Voltage	350	Volts
Steady-State Peak Plate Current	20	Milliamperes
DC Output Current	5.0	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point#	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop		
Ib = 5.0 Milliamperes DC	2.6	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

+ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

¶ One method of mounting the Y-1012 is to use a stainless-steel "T" bolt (see drawing) to attach the mounting base of the tube to a chassis or circuit board. The "T" bolt should be inserted in the slot in the base of the tube, turned 90 degrees, and attached to the chassis or circuit board with a 2-56 nut and lock washer. Torque used to tighten the nut should not exceed 3 inch-pounds.

Operation below the rated maximum envelope temperature is recommended for applications requiring the longest possible tube life.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1032*

PLANAR TRIODE

The Y-1032 is a medium-mu triode of ceramic and metal planar construction primarily intended for radio-frequency amplifier service well into the UHF range. A feature of the tube is its operation at low values of plate voltage.

GENERAL

Electrical

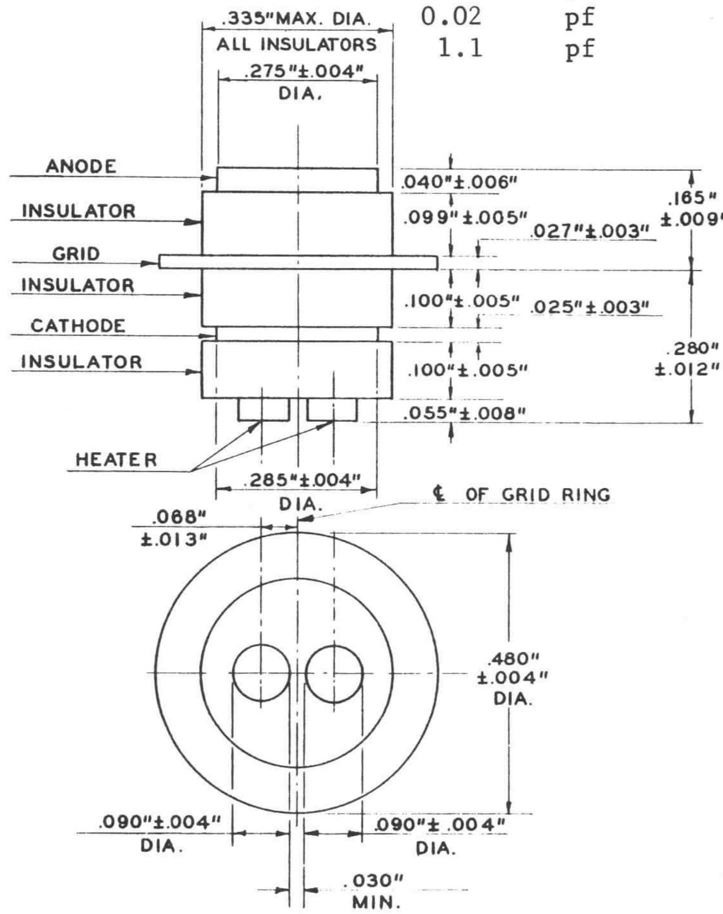
Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.24	Amperes
→ Direct Interelectrode Capacitances		
Grid to Plate	1.4	pf
Input	1.7	pf
Output	0.02	pf
Heater to Cathode	1.1	pf

Mechanical

Operating Position - Any

→ Outline Drawing



MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	60	Volts
Positive DC Grid Voltage	0	Volts
Plate Dissipation	0.6	Watts
DC Cathode Current	10	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
→ Grid Circuit Resistance	0.01	Megohms
→ Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	50	26.5	Volts
Cathode-Bias Resistor	68	33	Ohms
Amplification Factor	37	36	
Plate Resistance, approximate	3400	3600	Ohms
Transconductance	11000	10000	Micromhos
Plate Current	7.5	4.7	Milliamperes

Typical Operation

Grounded-Grid Amplifier - 450 Megacycles

Plate Voltage	26.5	Volts
Cathode-Bias Resistor	33	Ohms
Plate Current	4.7	Milliamperes
Bandwidth, approximate	7.5	Megacycles
Power Gain, approximate (Measured with power-matched input)	11	Decibels
Noise Figure (Meausred with noise-matched input, using argon lamp noise source), approximate	5.4	Decibels

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1124*

TRIODE

The Y-1124 is a triode of ceramic and metal planar construction primarily intended for use as a grid-pulsed oscillator at frequencies up to 6000 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
→ Heater Current‡	0.225	Amperes
Cathode Warm-up Time§	3	Seconds
Direct Interelectrode Capacitances¶		
Grid to Plate	1.0	pf
Input	2.1	pf
→ Output	0.02	pf
Heater to Cathode	1.7	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Grid-Pulsed Oscillator and Amplifier - Class C

DC Plate Voltage	425	Volts
Peak Positive-Pulse Grid Voltage	100	Volts
Duty Factor	0.001	
Pulse Duration	2.0	Microseconds
Plate Dissipation	2.6	Watts
Grid Current		
Average	0.1	Milliamperes
Average During Grid Pulse	100	Milliamperes

MAXIMUM RATINGS (Continued)

Plate Current		
Average	0.4	Milliamperes
Average During Grid Pulse	400	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

	Plate Voltage	125	Volts
	Cathode-Bias Resistor	82	Ohms
	Amplification Factor	75	
→	Transconductance	12000	Micromhos
→	Plate Current	10	Milliamperes

→ Grid-Pulsed Oscillator Service

Frequency	6000	Megacycles
Duty Factor	0.001	
Pulse Duration	1.0	Microseconds
Pulse Repetition Rate	1000	Pulses per Second
Peak Grid Drive Voltage	8.0	Volts
Plate Voltage	400	Volts
Plate Current		
Average	0.4	Milliamperes
Average During Grid Pulse	400	Milliamperes
Grid Current		
Average	0.1	Milliamperes
Average During Grid Pulse	100	Milliamperes
Power Output		
Average	0.025	Watts
Average During Grid Pulse	25	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

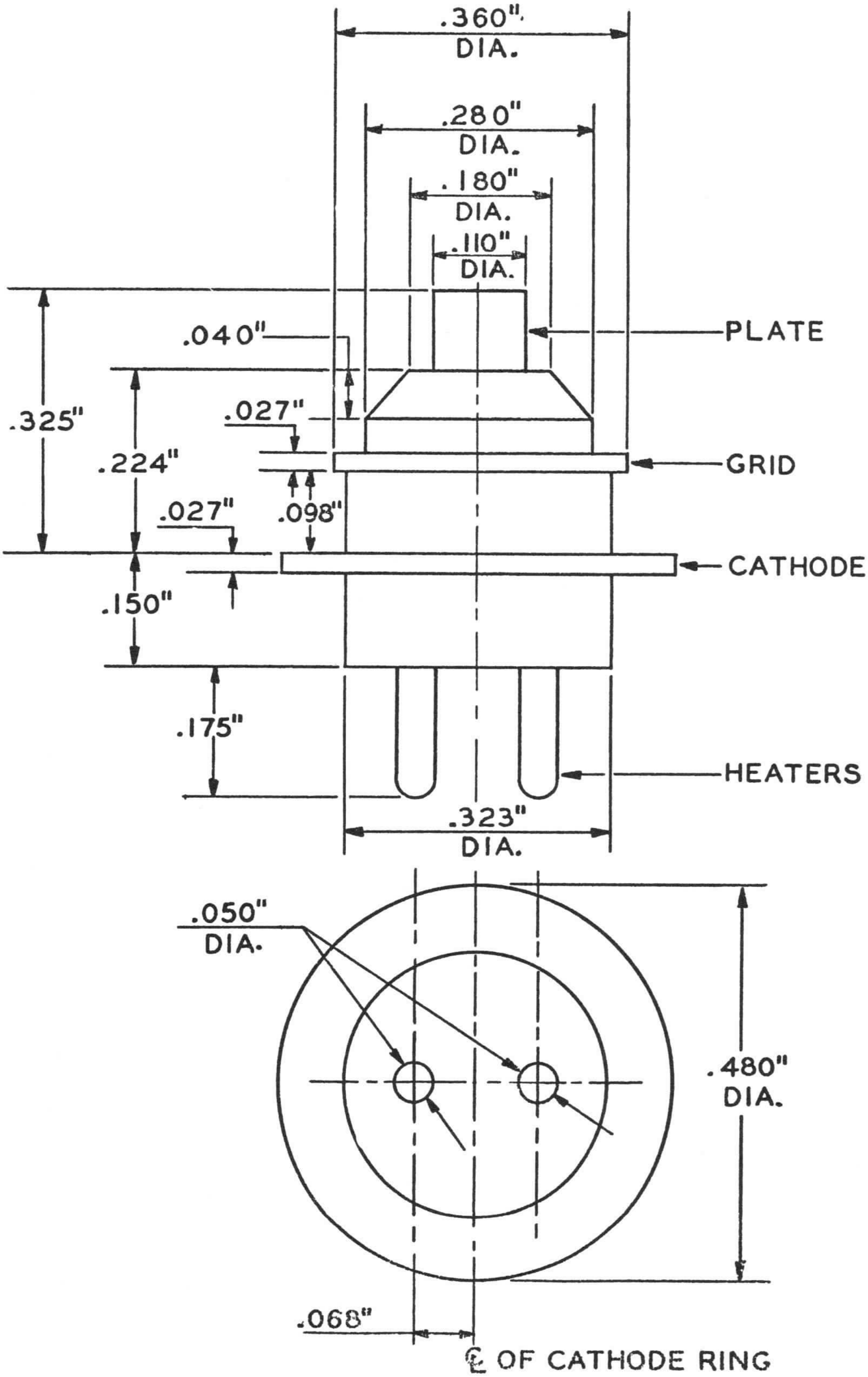
+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Time required for plate current to reach 80% of its steady-state value.

¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

2/18/63 (B)
Supersedes 1/18/63 (B)


.360" DIA.
.280" DIA.
.180" DIA.
.110" DIA.
.040"
PLATE
.325"
.224"
.027"
GRID
.027"
.098"
CATHODE
.150"
.175"
HEATERS
.323" DIA.
.050" DIA.
.480" DIA.
.068"
℄ OF CATHODE RING

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1223*

PLANAR TRIODE

The Y-1223 is a triode of ceramic-and-metal planar construction intended for use as a radio-frequency amplifier or oscillator at frequencies up to 2500 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings

Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.4	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	3.2	pf
Input: g to (h + k)	6.2	pf
Output: p to (h + k)	0.03	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	600	Volts
Plate Dissipation#	30	Watts
Grid Current	∅	Milliamperes
Cathode Current	100	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

MAXIMUM RATINGS (Continued)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	47	Ohms
Amplification Factor	100	
Plate Resistance, approximate	2500	Ohms
Transconductance	40000	Micromhos
Plate Current	25	Milliamperes

Class C Amplifier

Frequency	400	Megacycles
DC Plate Voltage	400	Volts
DC Grid Voltage	∅	Volts
DC Plate Current	80	Milliamperes
DC Grid Current, approximate	∅	Milliamperes
Driving Power, approximate	∅	Watts
Power Output, approximate	20	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

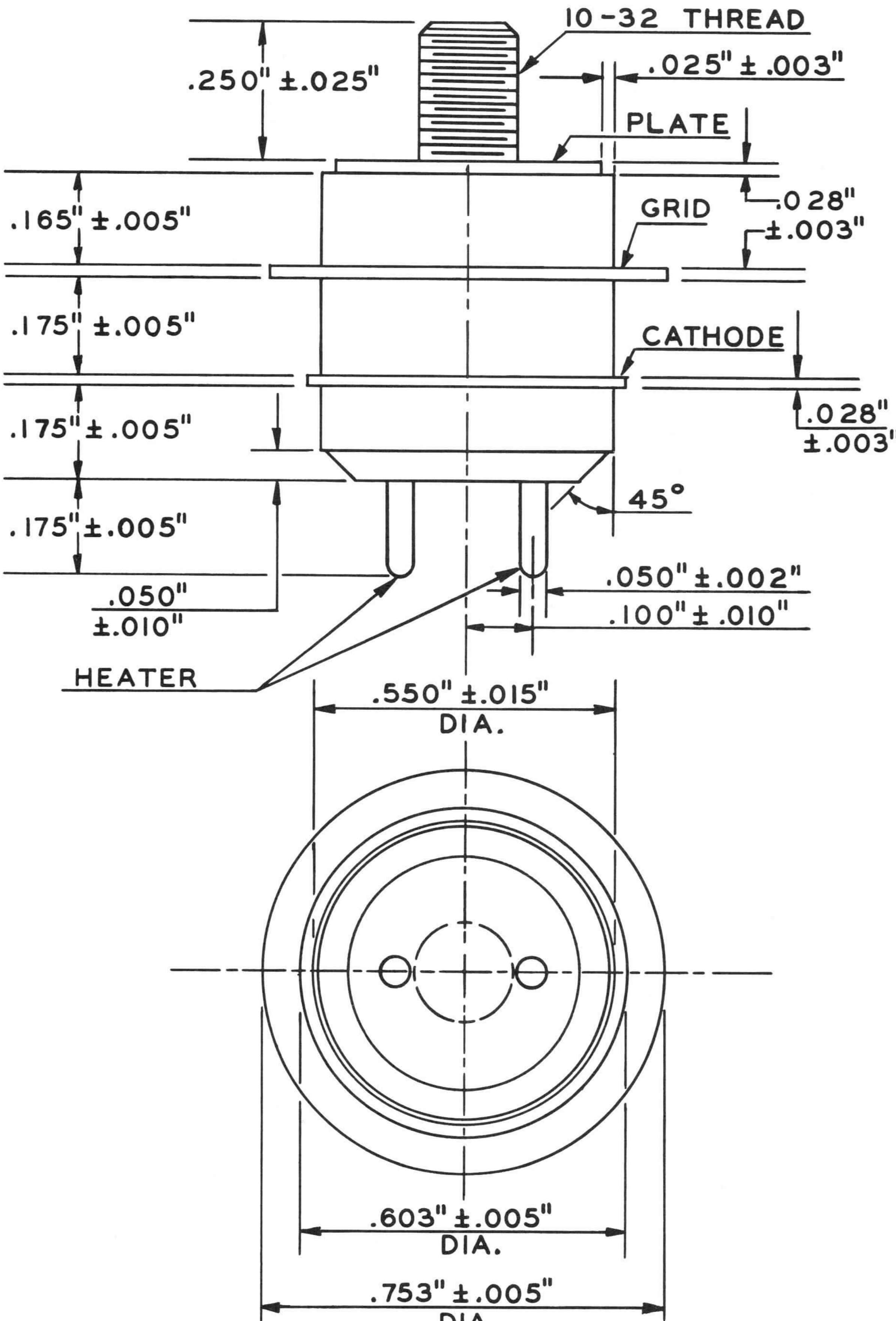
¶ Without external shield.

With adequate heat sink attached to threaded plate stud.

∅ To be determined.

11-25-64 (B)

Supersedes 10-29-63 (B)



10-32 THREAD
.025" ± .003"
.250" ±.025"
PLATE
.165" ±.005"
GRID
.028"
±.003"
.175" ±.005"
CATHODE
.175" ±.005"
.028"
±.003"
.175" ±.005"
45°
.050"
±.010"
.050" ±.002"
.100" ± .010"
HEATER
.550" ±.015"
DIA.
.603" ±.005"
DIA.
.753" ±.005"
DIA.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1236*

PLANAR TRIODE

The Y-1236 is a triode of ceramic and metal planar construction intended for use as a plate-pulsed oscillator at frequencies up to 4300 megacycles. In addition, it may be used as a CW oscillator at frequencies up to 2500 megacycles. Features of the Y-1236 are small size and high plate dissipation capability.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC†	6.3±0.3	Volts
Heater Current‡	0.5	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	1.5	pf
Input: g to (h+k)	5.0	pf
Output: p to (h+k)	0.05	pf

Mechanical

Operating Position - Any

Maximum Ratings

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

MAXIMUM RATINGS (Continued)

Absolute-Maximum Values

Plate-Pulsed Oscillator or Amplifier Service

Cathode Heating Time, minimum	60	Seconds
Peak Positive-Pulse Plate Supply Voltage	3000	Volts
Duty Factor of Plate Pulse¶	0.01	
Pulse Duration	2.0	Microseconds
Plate Current		
Average	20	Milliamperes
Average During Plate Pulse#	2.0	Amperes
Negative Grid Voltage		
Average During Plate Pulse	100	Volts
Grid Current		
Average	10	Milliamperes
Average During Plate Pulse	1.0	Amperes
Plate Dissipation∆	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

CW Oscillator Service

Plate Voltage	600	Volts
Plate Current	90	Milliamperes
Grid Current	30	Milliamperes
Cathode Current	120	Milliamperes
Plate Dissipations∆	30	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Envelope Temperature at Hottest Point	300	C

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	100	Ohms
Amplification Factor	55	
Plate Resistance, approximate	2040	Ohms
Transconductance	27000	Micromhos
Plate Current	25	Milliamperes

Plate-Pulsed Oscillator Service

Frequency	1200	Megacycles
Heater Voltage	6.3	Volts
Duty Factor	0.01	
Pulse Duration	1.0	Microseconds
Pulse Repetition Plate	10000	Pulses per Second
Peak Positive-Pulse Plate Supply Voltage	2000	Volts
Plate Current		
Average	20	Milliamperes
Average During Plate Pulse	2.0	Amperes
Grid Current		
Average	Ø	Milliamperes
Average During Plate Pulse	Ø	Amperes
Useful Power Output		
Average	20	Watts
Average During Plate Pulse	2.0	Kilowatts

CW Oscillator Service

Frequency	2300	Megacycles
Plate Voltage	600	Volts
Grid Voltage	Ø	
Plate Current	80	Milliamperes
Grid Current	25	Milliamperes
Power Output, approximate	20	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Measured using a grounded adapter that provides shielding between external terminals of tube.

¶ Applications with a duty factor greater than 0.01 should be referred to your General Electric tube sales representative for recommendation.

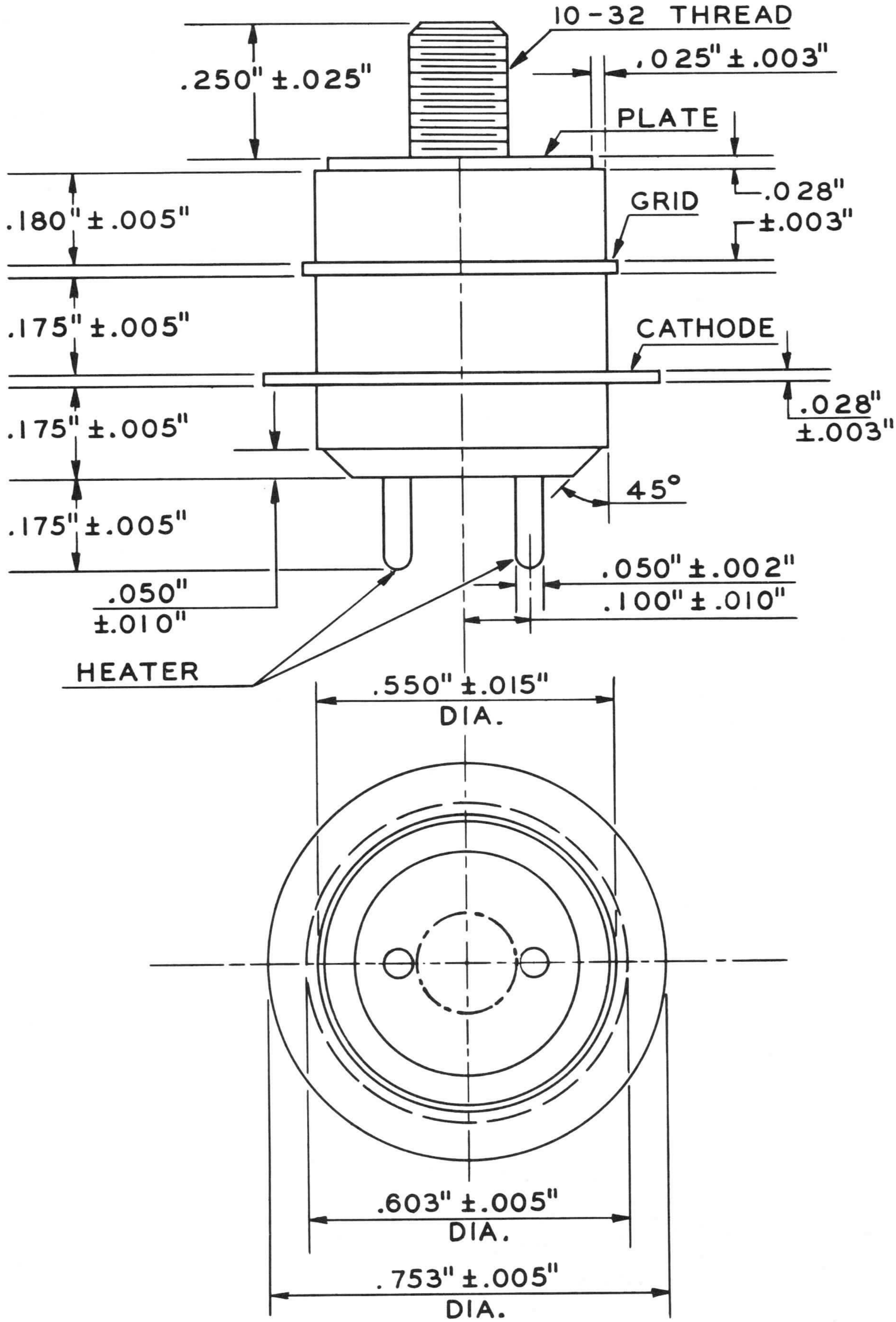
\# The regulation and/or series plate-supply impedance must be such as to limit the peak current, with the tube considered a short circuit, to a maximum of 25 amperes.

Δ With adequate heat sink attached to threaded plate stud.

Ø To be determined.

11/25/64 (B)
Supersedes 4/26/63

Y-1236



10-32 THREAD
.025" ±.003"
.250" ±.025"
PLATE
.028"
±.003"
GRID
.180" ±.005"
.175" ±.005"
CATHODE
.175" ±.005"
.028"
±.003"
45°
.175" ±.005"
.050" ±.002"
.100" ±.010"
.050"
±.010"
HEATER
.550" ±.015"
DIA.
.603" ±.005"
DIA.
.753" ±.005"
DIA.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1251*

PLANAR TRIODE

The Y-1251 is a high-mu triode of ceramic-and-metal planar construction intended for use as an oscillator or radio-frequency power amplifier up to 6000 megacycles.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.24	Amperes
Direct Interelectrode Capacitances¶		
Grid to Plate: (g to p)	1.1	pf
Input: g to (h + k)	1.2	pf
Output: p to (h + k)	0.012	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	200	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	2.5	Watts
DC Grid Current	5.0	Milliamperes
DC Cathode Current	20	Milliamperes
Peak Cathode Current	80	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	10000	Ohms
Envelope Temperature at Hottest Point	250	C

MAXIMUM RATINGS (Continued)

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	100	150	Volts
Grid Voltage	0	---	Volts
Cathode-Bias Resistor	---	82	Ohms
Amplification Factor	---	65	
Transconductance	15500	13500	Micromhos
Plate Current	18	13.4	Milliamperes

Oscillator Service

Plate Voltage	150	Volts
Grid Resistor - Adjusted for a plate current of 15 milliamperes		
Plate Current	15	Milliamperes
Grid Current	Ø	Milliamperes
Frequency	5900	Megacycles
Power Output, approximate	20	Milliwatts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

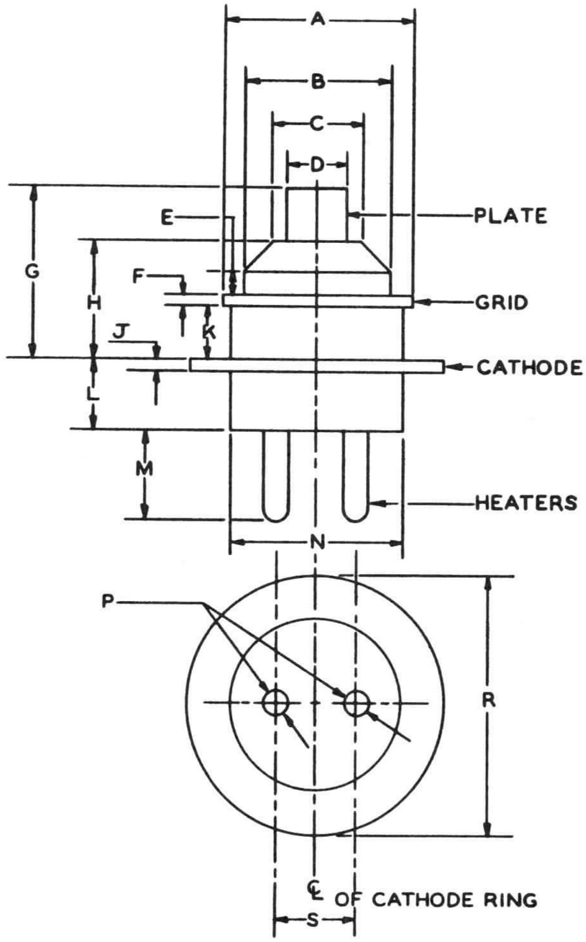
‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Measured using a grounded adapter that provides shielding between external terminals of tube.

Ø To be determined.

PHYSICAL DIMENSIONS



Ref.	INCHES			MILLIMETERS		
	Minimum	Nominal	Maximum	Minimum	Nominal	Maximum
A	0.357		0.363	9.068		9.220
B			0.285			7.24
C		0.180			4.57	
D	0.108		0.112	2.743		2.845
E		0.040			1.02	
F	0.025		0.031	0.635		0.787
G	0.315		0.335	8.00		8.51
H	0.216		0.232	5.49		5.89
J	0.025		0.031	0.635		0.787
K	0.094		0.102	2.388		2.591
L	0.143		0.157	3.63		3.99
M	0.165		0.185	4.19		4.70
N			0.330			8.38
P	0.048		0.054	1.219		1.372
R	0.476		0.484	12.090		12.294
S	0.130		0.142	3.30		3.61

Note: The millimeter dimensions are derived from the original inch dimensions.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Y-1266*

METAL-CERAMIC TRIODE

For UHF Oscillator Applications

The Y-1266 is a medium-mu triode of ceramic-and-metal planar construction primarily intended for use as a UHF oscillator.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC‡	6.3±0.3	Volts
Heater Current§	0.24	Amperes
Direct Interelectrode Capacitances¶		
→ Grid to Plate: (g to p)	1.4	pf
Input: g to (h + k)	1.4	pf
Output: p to (h + k)	0.018	pf

Mechanical

Operating Position - Any

MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	350	Volts
Plate Dissipation	4.0	Watts
DC Grid Current	15	Milliamperes
DC Cathode Current	40	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance	Ø	
Envelope Temperature at Hottest Point	250	C

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	150	Volts
Grid Voltage	0	Volts
Amplification Factor	35	
Transconductance	8000	Micromhos
Plate Current	25	Milliamperes

UHF Oscillator Service

Plate Voltage	200	Volts
Grid Resistor	Ø	
Plate Current	30	Milliamperes
Grid Current	Ø	
Frequency	400	Megacycles
Power Output, approximate	3	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

‡ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

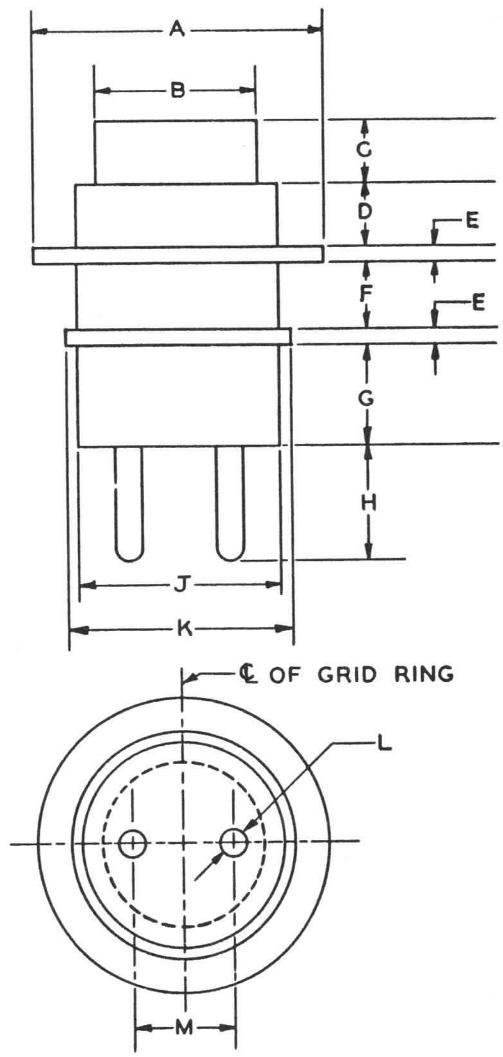
§ Heater current of a bogey tube at Ef = 6.3 volts.

¶ Without external shield.

Ø To be determined.

11/25/64 (B)
Supersedes 4/20/64 (B)

Y-1266



Ref.	Inches		
	Minimum	Nominal	Maximum
A	0.477		0.438
B	0.246		0.254
C	0.092		0.108
D	0.095		0.103
E	0.025		0.031
F	0.094		0.102
G	0.120		0.128
H	0.165		0.185
J	---		0.330
K	0.357		0.363
L	0.048		0.052
M	0.130		0.142

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2354*

CERAMIC TRIODE

For Military and Industrial Applications

The Z-2354 is a low-mu triode of ceramic and metal planar construction. The tube is intended for use as an audio-frequency or radio-frequency power-amplifier or as a series regulator, in applications where unfavorable conditions of temperature, mechanical shock, mechanical vibration, and nuclear radiation are encountered.

GENERAL

Electrical

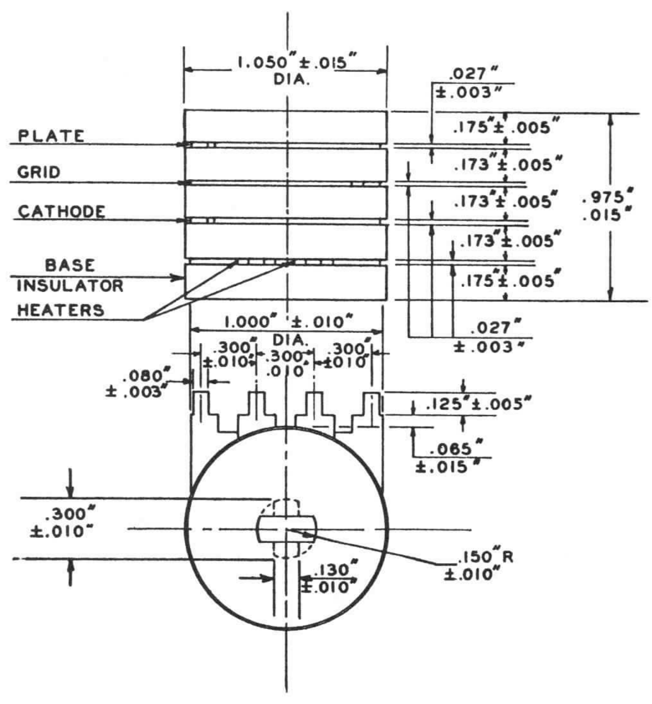
Cathode - Coated Unipotential

Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.85	Amperes
Direct Interelectrode Capacitances§		
Grid to Plate: (g to p)	Ø	pf
Input: g to (h + k)	Ø	pf
Output: p to (h + k)	Ø	pf

Mechanical

Operating Position - Any

→ Outline Drawing



MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	100	Volts
Plate Dissipation	12	Watts
DC Cathode Current	100	Milliamperes
Heater-Cathode		
Heater Positive with Respect to Cathode		
DC Component	100	Volts
Total DC and Peak	200	Volts
Heater Negative with Respect to Cathode		
Total DC and Peak	200	Volts
Grid Circuit Resistance		
With Fixed Bias	0.25	Megohms
With Cathode Bias	1.0	Megohms
Envelope Temperature at Hottest Point	400	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should de ign so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

	Plate Voltage	250	Volts
	Cathode-Bias Resistor	330	Ohms
	Amplification Factor	8.0	
→	Plate Resistance, approximate	1330	Ohms
→	Transconductance	6000	Micromhos
→	Plate Current	60	Milliamperes
	Grid Voltage, approximate		
	Ib = 100 Microamperes	-52	Volts

SPECIAL TESTS AND RATINGS

Stability Life Test
Statistical sample operated for twenty hours to evaluate and control initial variations in transconductance.

Survival Rate Life Test
Statistical sample operated for one hundred hours to evaluate and control early-life electrical and mechanical inoperatives.

Heater-Cycling Life Test
Statistical sample operated for 2000 cycles to evaluate and control heater-cathode defects. Conditions of test include Ef = 7.5 volts cycled for one minute on and one minute off, Eb = Ec = 0 volts, and Ehk = 135 volts with heater positive with respect to cathode.

Shock Rating - 600 G
Statistical sample subjected to five impact accelerations of 600 G in each of four different positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine for Electronic Devices or its equivalent.

Fatigue Rating - 10 G
Statistical sample subjected to vibrational acceleration of 10 G for 48 hours minimum in each of two different positions. The sinusoidal vibration is applied at a fixed frequency between 25 and 60 cycles per second.

Altitude Rating - 100000 Feet
Statistical sample subjected to pressure of 8.0 millimeters of mercury to evaluate and control arcing and corona.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

Ø To be determined.

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2689*

PLANAR DIODE

The Z-2689 is a cathode-type diode of ceramic and metal planar construction intended for use as a low-current rectifier.

GENERAL

Electrical

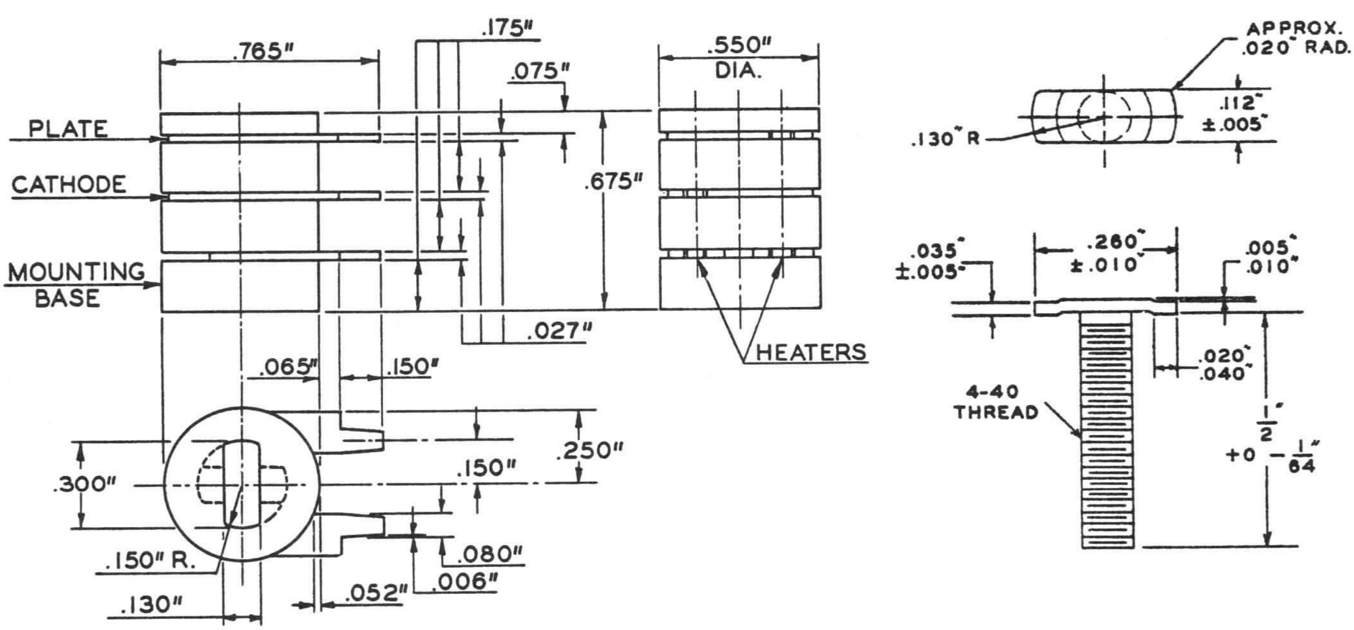
Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.6	Volts
Heater Current‡	0.4	Amperes
Direct Interelectrode Capacitances§		
Plate to Cathode	2.5	pf
Heater to Cathode	2.6	pf

Mechanical

Operating Position - Any

→ Outline Drawing



MAXIMUM RATINGS

Design-Maximum Values

Peak Inverse Plate Voltage	1000	Volts
Steady-State Peak Plate Current	150	Milliamperes
DC Output Current	25	Milliamperes
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode		
DC Component	175	Volts
Total DC and Peak	225	Volts
Heater Negative with Respect to Cathode		
DC Component	175	Volts
Total DC and Peak	225	Volts
Envelope Temperature at Hottest Point	300	C

Design-Maximum ratings are limiting values of operating and environmental conditions applicable to a bogey electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making allowance for the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration.

The equipment manufacturer should design so that initially and throughout life no design-maximum value for the intended service is exceeded with a bogey tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Tube Voltage Drop		
Ib = 40 Milliamperes DC	15	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

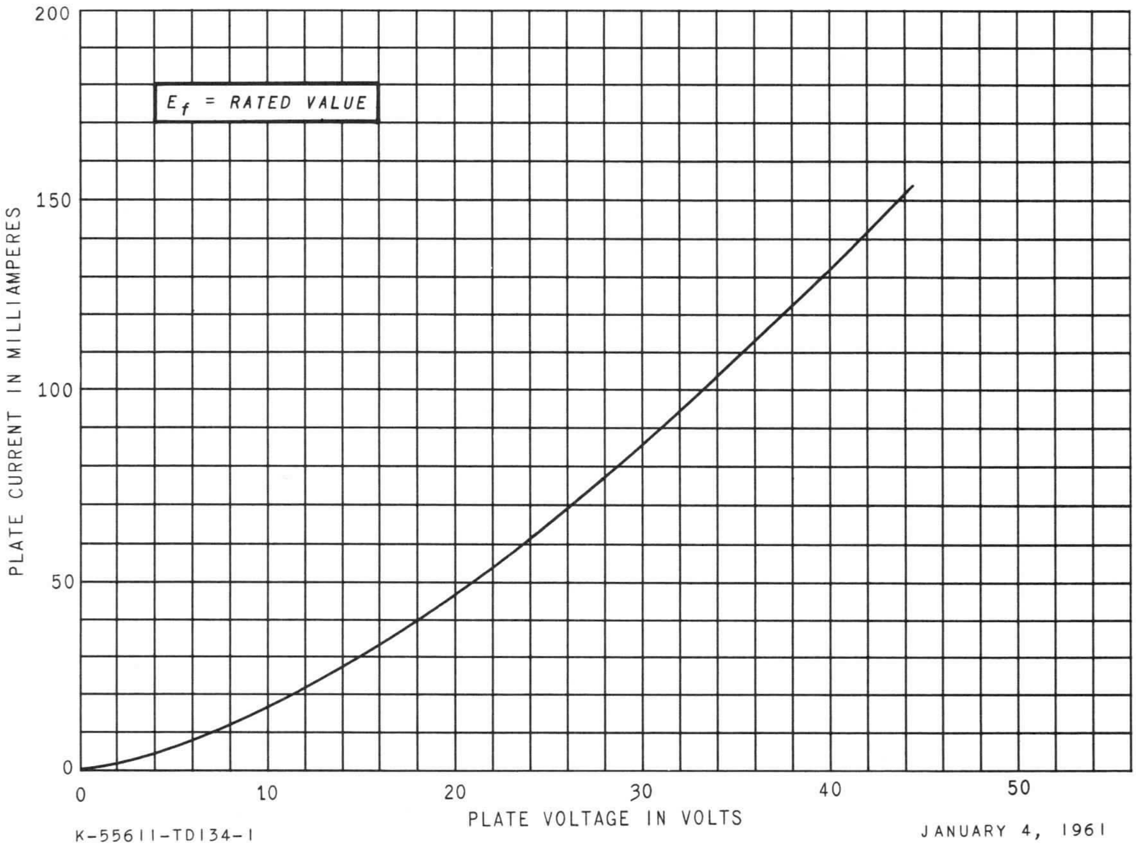
\+ The equipment designer should design the equipment so that heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

2/18/63 (B)
Supersedes 11/29/62 (B)

AVERAGE PLATE CHARACTERISTICS



K-55611-TD134-1

JANUARY 4, 1961

RECEIVING TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2692*

CERAMIC-GLOW DISCHARGE DIODE

For Voltage-Reference Applications

The Z-2692 is a ceramic, cold-cathode, glow-discharge diode designed for voltage-reference service in electronically regulated d-c power supplies. The Z-2692 is especially suited for use where unfavorable conditions of temperature, mechanical shock, and mechanical vibration are encountered.

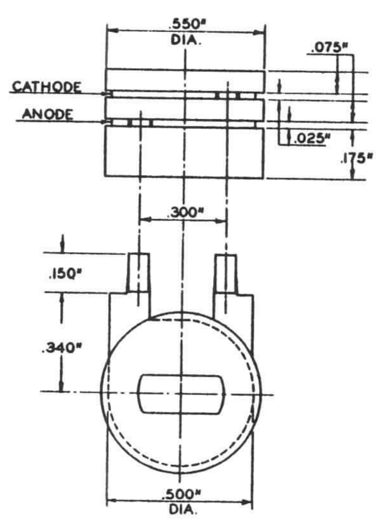
GENERAL

Electrical

Cathode - Cold

Mechanical

Mounting Position - Any
Outline Drawing



MAXIMUM RATINGS

Absolute-Maximum Values

DC Cathode Current		
Maximum	10	Milliamperes
Minimum	1.0	Milliamperes
Envelope Temperature	300	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

AVERAGE CHARACTERISTICS

Anode Voltage Drop		
Anode Current 1.5 Milliamperes	83.0±0.5	Volts
Anode Current 2.5 Milliamperes	83.5±0.5	Volts
Anode Current 3.5 Milliamperes	84.0±0.5	Volts
Anode Current 5.0 Milliamperes	85.0±0.5	Volts
Anode Current 10 Milliamperes	87.0±0.5	Volts
Anode Breakdown Voltage		
In Ambient Light, maximum	125	Volts
In Total Darkness, maximum	125	Volts
Regulation, maximum		
Anode Current 1.0 to 10 Milliamperes	5	Volts
Anode Current 1.5 to 3.5 Milliamperes	1.0	Volts
Voltage Jump, maximum+		
Anode Current 1.0 to 10 Milliamperes	5	Millivolts

Drift, maximum			
Envelope Temperature	50C	300C	
During First 24 Hours of Operation			
Anode Current			
2.5 Milliamperes	100	100	Millivolts
5.0 Milliamperes	100	1000	Millivolts
From 24 Hours to 100 Hours of Operation			
Anode Current			
2.5 Milliamperes	50	50	Millivolts
5.0 Milliamperes	50	250	Millivolts

AVERAGE CHARACTERISTICS (Continued)

	50C	300C	
From 100 Hours to 1000 Hours of Operation			
Anode Current			
2.5 Milliamperes	200	200	Millivolts
5.0 Milliamperes	250	500	Millivolts
From 1000 Hours to End of Life			
2.5 Milliamperes	100	500	Millivolts per 1000 Hours
5.0 Milliamperes	150	1000	Millivolts per 1000 Hours
Repeatability, maximum‡			
Anode Current 5.0 Milliamperes		100	Millivolts
Temperature Coefficient of Operating Voltage, average			
-50C to +25C		-10	Millivolts per Degree C
25C to 300C		-3	Millivolts per Degree C
300C to 500C		-3	Millivolts per Degree C

SPECIAL TESTS AND RATINGS

Shock Rating - 720G
Statisitcal sample subjected to five impact accelerations of 720G in each of four different positions. The accelerating forces are applied by the Navy-type, High Impact (flyweight) Shock Machine for Electronic Devices or its equivalent.

Fatigue Rating - 10G
Statistical sample subjected to vibrational acceleration of 10G for 48 hours minimum in each of two different positions. The sinusoildal vibration is applied at a fixed frequency between 25 and 60 cycles per second.

Altitude Rating - 100000 Feet
Statistical sample subjected to pressure of 8.0 millimeters of mercury to evaluate and control arcing and corona.

Note: The conditions for some of the indicated tests have deliberately been selected to aggravate tube failures for test and evaluation purposes. In no sense should these conditions be interpreted as suitable circuit operating conditions.

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

+ Voltage jump is defined as a sudden jump in anode voltage drop when the operating current is varied slowly over the specified operating range.

‡ Repeatability is defined as the maximum change in anode voltage drop between successive firings of the tube.

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2731*

DIODE

The Z-2731 is a single, heater-cathode diode of ceramic and metal planar construction. The tube is intended for application as a power rectifier.

GENERAL

Electrical

Cathode - Coated Unipotential

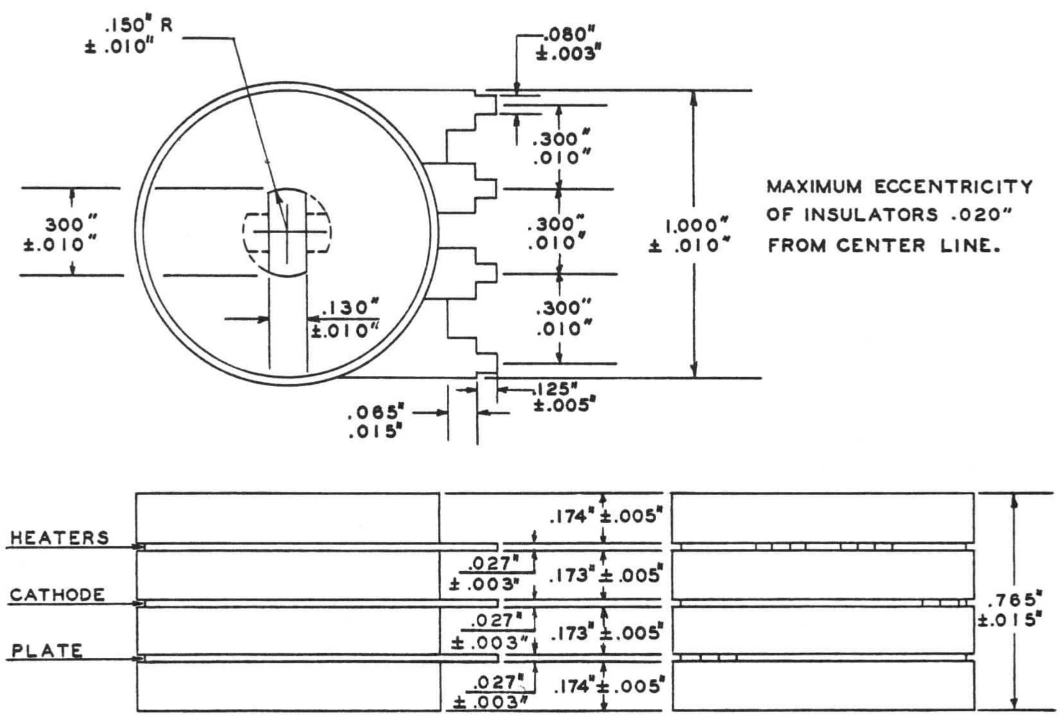
Heater Characteristics and Ratings

Heater Voltage, AC or DC	6.3 ± 0.6	Volts
→ Heater Current	1.0	Amperes

Mechanical

Operating Position - Any

→ Outline Drawing



MAXIMUM RATINGS

Rectifier Service - Absolute-Maximum Values+

Peak Inverse Plate Voltage	1000	Volts
AC Plate-Supply Voltage per Plate - See Rating Chart I		
→ Steady-State Peak Plate Current per Plate	1.1	Amperes
→ Transient Peak Plate Current per Plate, Maximum Duration 0.2 Second	5.5	Amperes
DC Output Current - See Rating Chart I		
Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	300	Volts
Heater Negative with Respect to Cathode	300	Volts
Envelope Temperature at Hottest Point	∅	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

→ Half-Wave Rectifier with Capacitor-Input Filter

AC Plate-Supply Voltage, RMS	250	Volts
Filter Input Capacitor	50	Microfarads
Total Plate-Supply Resistance	18	Ohms
DC Output Current	125	Milliamperes
DC Output Voltage at Filter Input	260	Volts
→ Tube Voltage Drop		
Ib = 300 Milliamperes	37	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ To simplify the application of the maximum ratings to circuit design, the Absolute-Maximum ratings are presented in chart form as Rating Charts I, II, and III. Rating Chart I presents the maximum ratings for a-c plate-supply voltage and d-c output current. Rating Chart II provides a convenient method for checking conformance with the maximum steady-state peak-plate-current rating. Rating Chart III offers a convenient method for checking conformance with the maximum transient peak-plate-current rating. Rating Chart I applies to both capacitor-input and choke-input filters, while Rating Charts II and III apply to capacitor-input filters only.

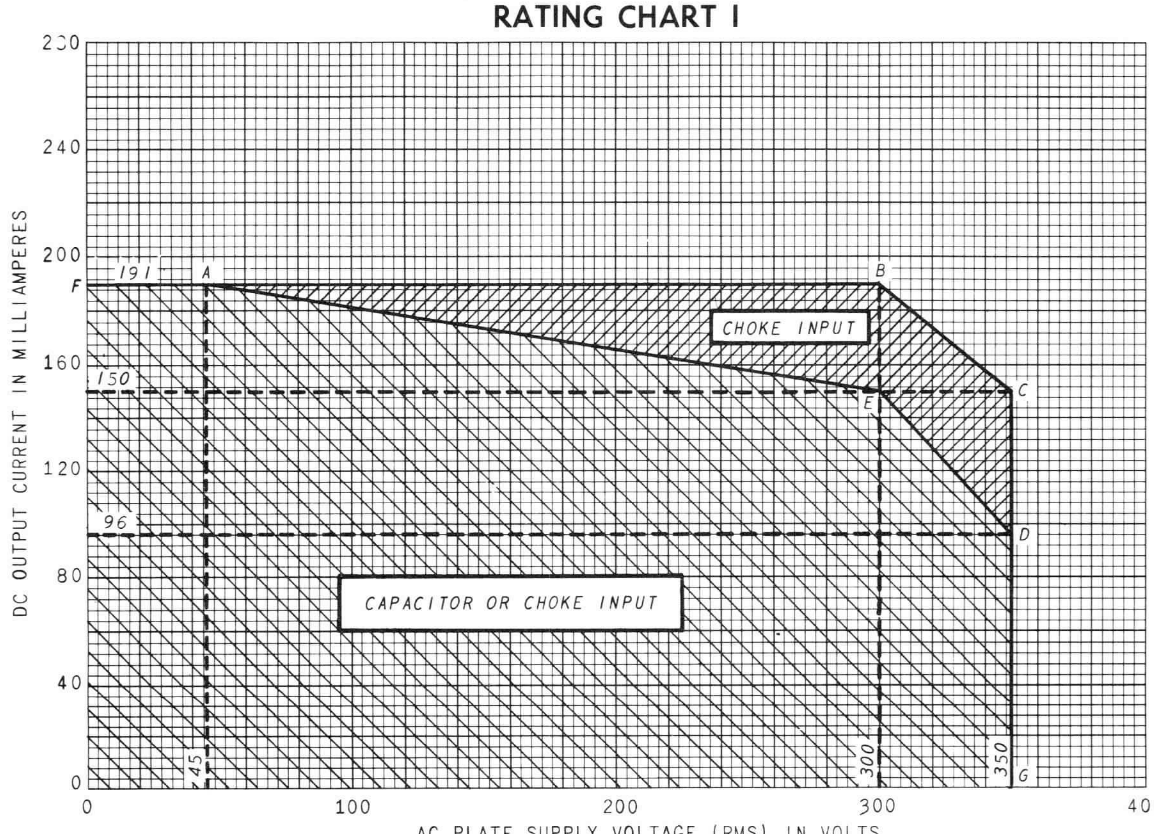
Operating points should be so selected that the boundary limits of a-c plate-supply voltage and d-c output current on Rating Chart I, and maximum d-c output current per plate and rectification efficiency on Rating Chart II, are not exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, and environmental conditions. On Rating Chart I the boundary FAEDG defines the limits for capacitor-input filter operation, and the boundary FABCDG defines the limits for choke-input filter operation.

Rating Chart III shows the minimum value of plate-supply resistance (Rs) required to remain within the transient peak-plate-current rating. The value of Rs should be such that it lies to the left of the line on Rating Chart III at the highest probable value of line voltage.

Ø To be determined.

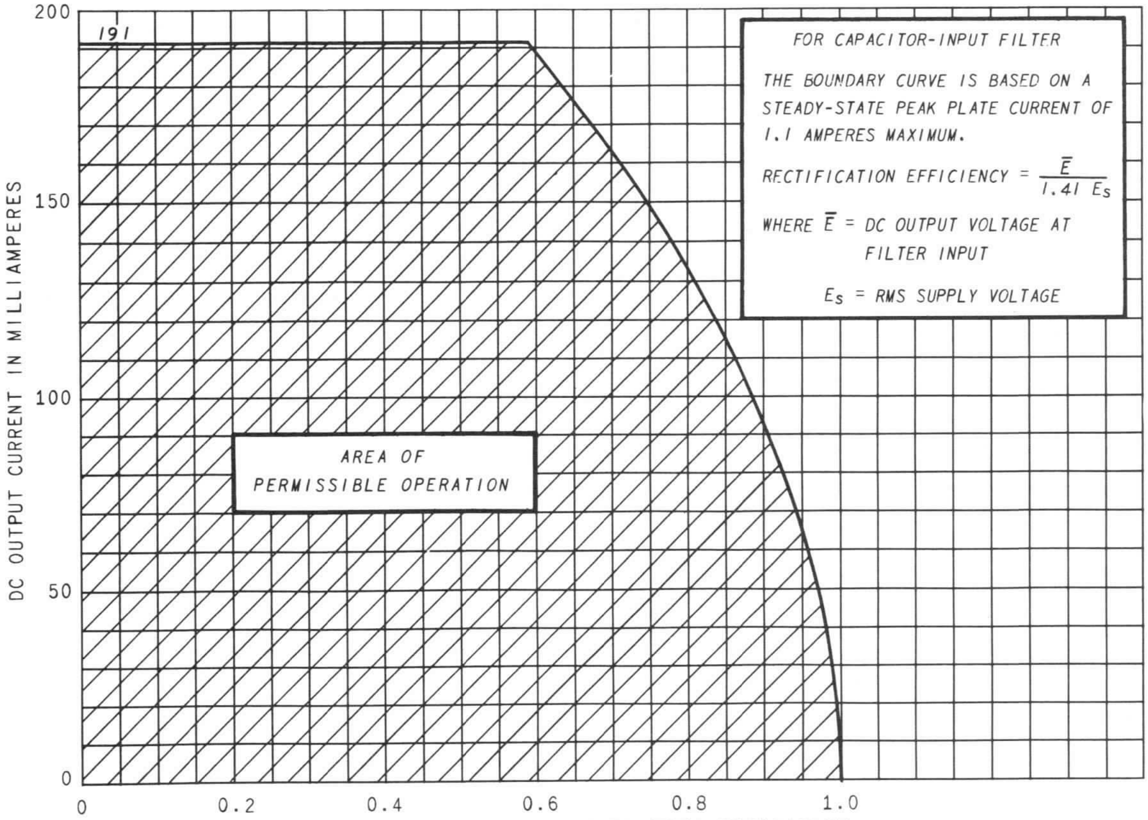
2/19/63 (B)
Supersedes 12/7/61 (B)

RATING CHART I



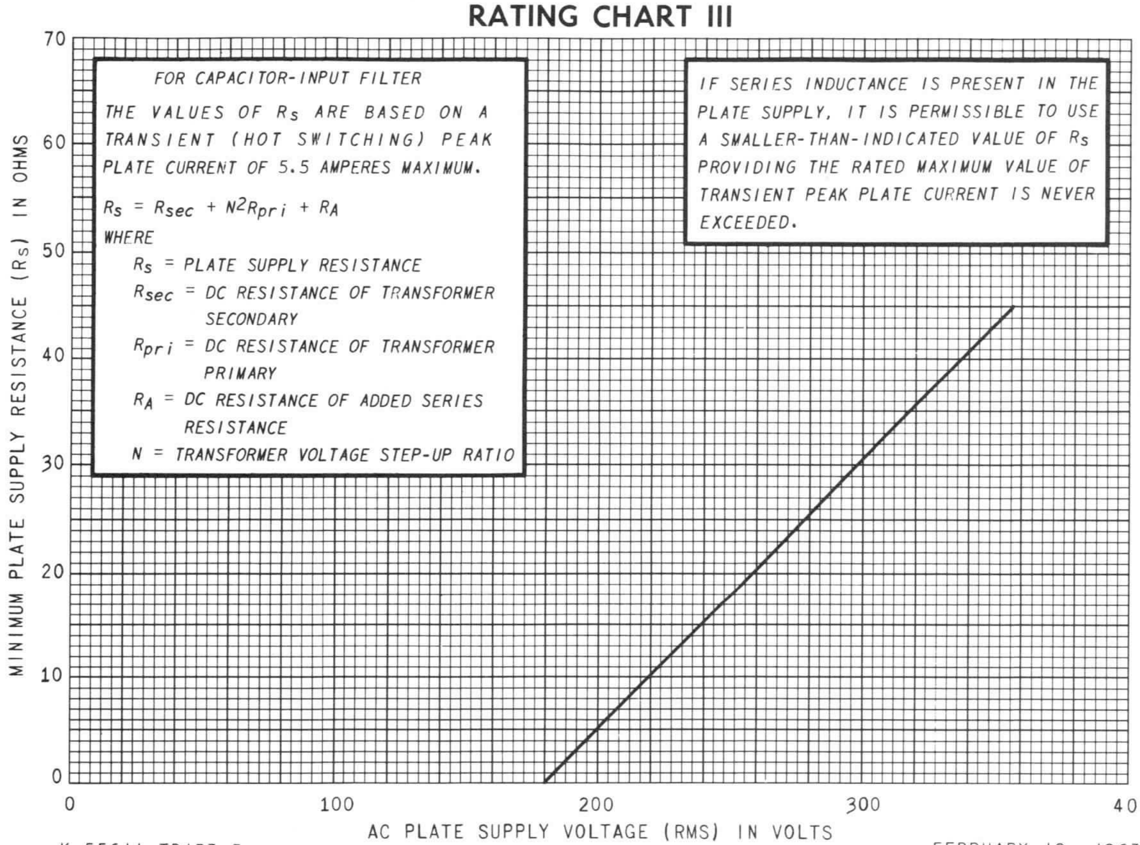
K-55611-TD133-1 FEBRUARY 19, 1963

RATING CHART II



K-55611-TD133-2 FEBRUARY 19, 1963

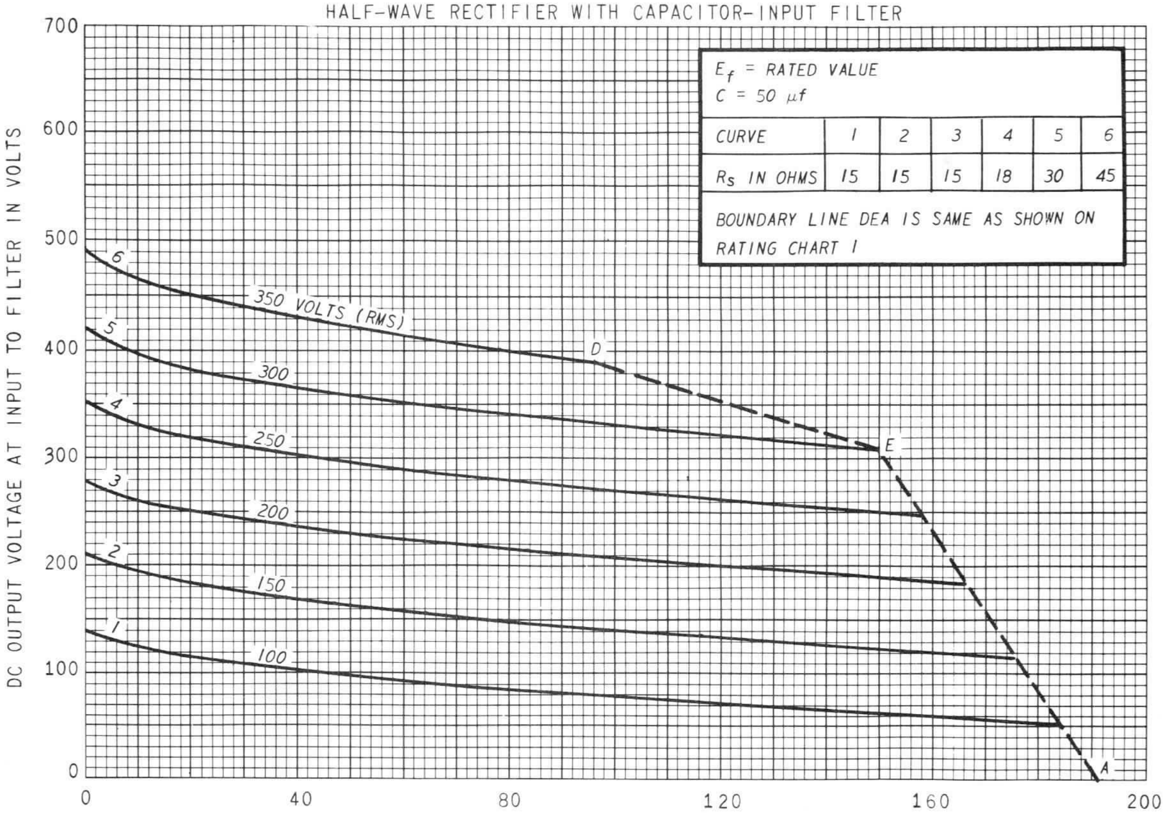
RATING CHART III



K-55611-TD133-3 FEBRUARY 19, 1963

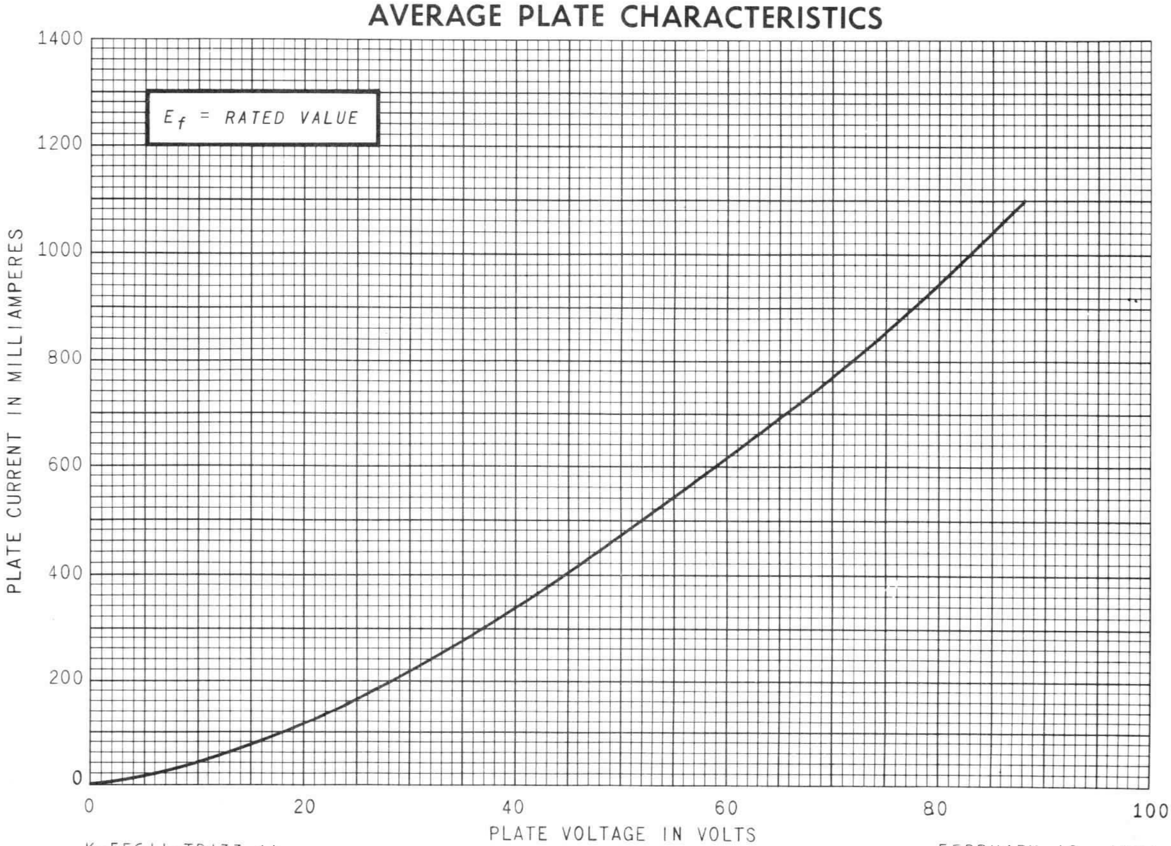
OPERATION CHARACTERISTICS

HALF-WAVE RECTIFIER WITH CAPACITOR-INPUT FILTER



K-55611-TD133-5 FEBRUARY 19, 1963

AVERAGE PLATE CHARACTERISTICS



K-55611-TD133-4A FEBRUARY 19, 1963

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-2835*

TRIODE

The Z-2835 is a high-mu triode of ceramic-and-metal planar construction. The tube is intended for radio-frequency oscillator and power-amplifier applications.

GENERAL

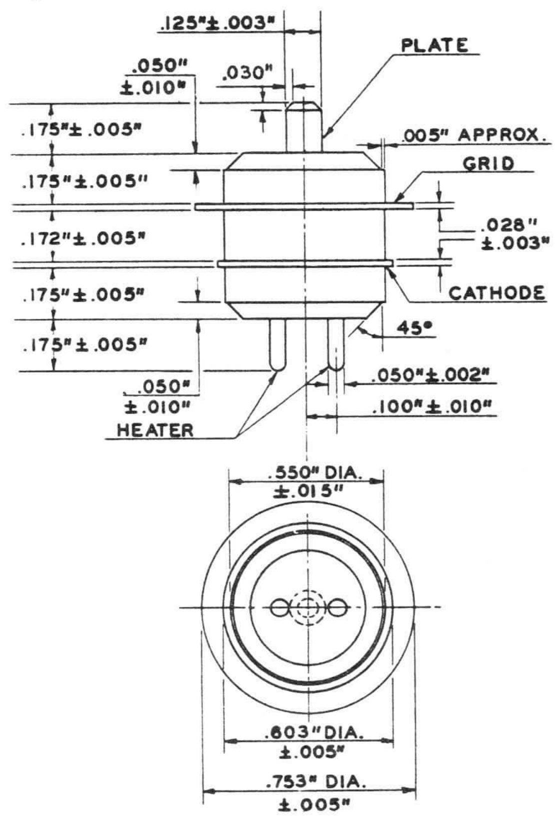
Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	0.4	Amperes
Direct Interelectrode Capacitances§		
→ Grid to Plate: (g to p)	1.4	pf
→ Grid to Cathode and Heater: g to (h + k)	5.1	pf
Plate to Cathode and Heater: p to (h + k)	0.03	pf
Heater to Cathode: (h to k)	2.4	pf

Mechanical

Operating Position - Any



MAXIMUM RATINGS

Absolute-Maximum Values

Plate Voltage	330	Volts
Positive DC Grid Voltage	0	Volts
Negative DC Grid Voltage	50	Volts
Plate Dissipation	5.5	Watts
DC Grid Current	10	Milliamperes
DC Cathode Current	30	Milliamperes
Peak Cathode Current	120	Milliamperes
eater-Cathode Voltage		
Heater Positive with Respect to Cathode	50	Volts
Heater Negative with Respect to Cathode	50	Volts
Grid Circuit Resistance		
With Fixed Bias	0.1	Megohms
With Cathode Bias	0.18	Megohms
Bulb Temperature at Hottest Point	250	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	200	Volts
Cathode-Bias Resistor	68	Ohms
Amplification Factor	90	
Plate Resistance, approximate	5450	Ohms
Transconductance	16500	Micromhos
Plate Current	17	Milliamperes
Grid Voltage, approximate		
Ib = 10 Microamperes	-5.5	Volts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

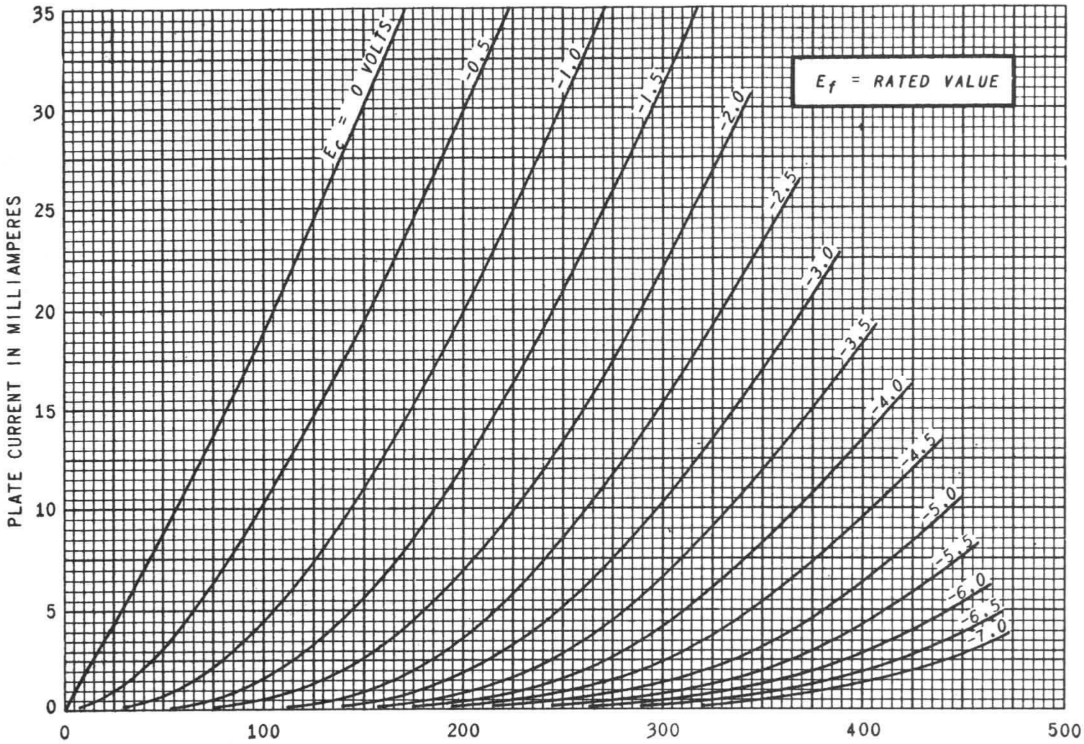
+ The equipment designer should design the equipment so that the heater voltage is centered at the specified bogey value, with heater supply variations restricted to maintain heater voltage within the specified tolerance.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

2/15/63 (B)
Supersedes 12/7/61 (B)

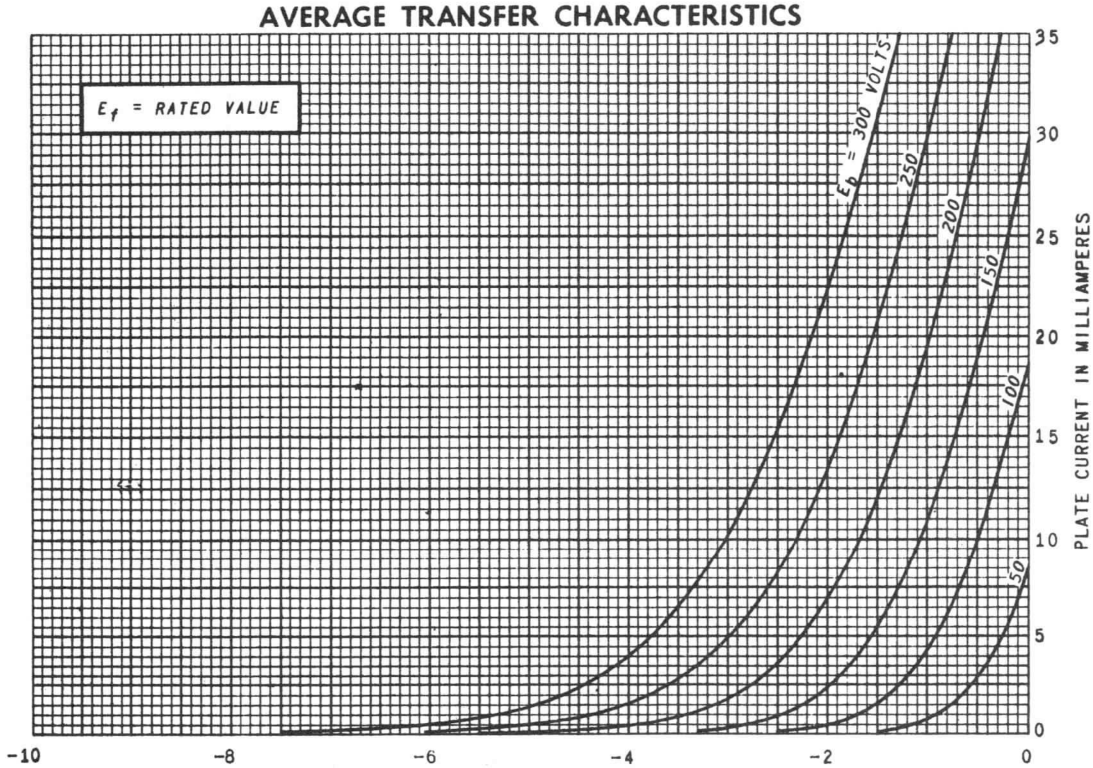
AVERAGE PLATE CHARACTERISTICS



K-55611-TD53-1B

AUGUST 8, 1961

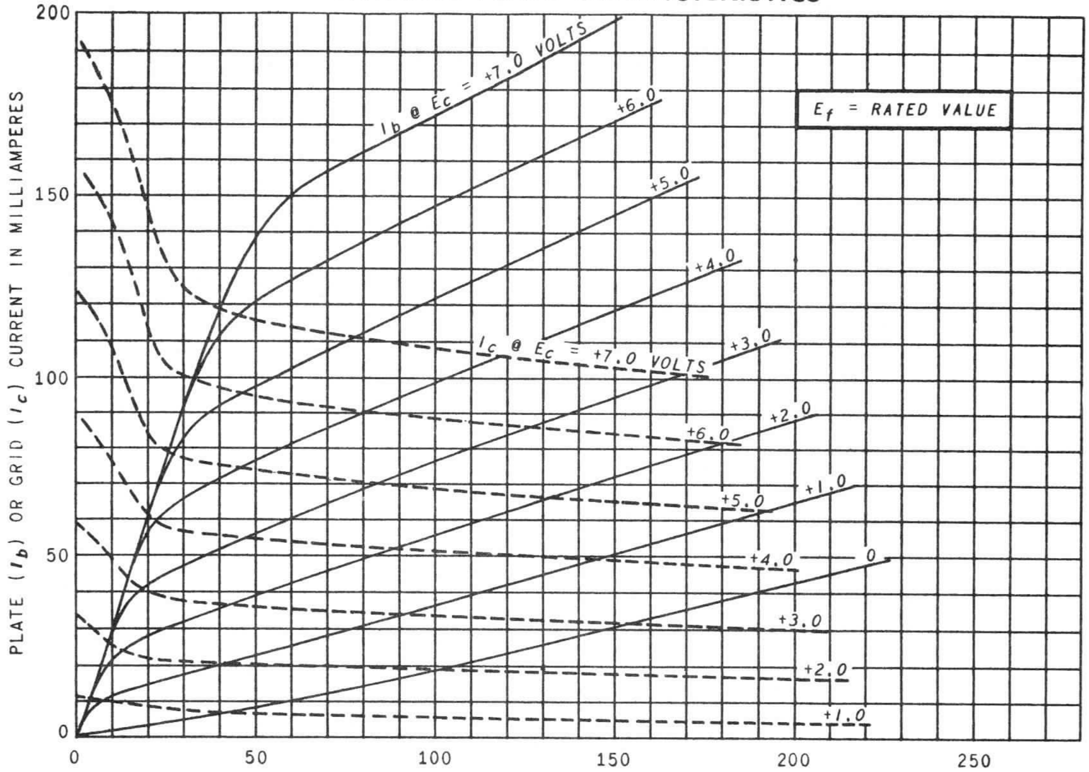
AVERAGE TRANSFER CHARACTERISTICS



K-55611-TD53-2B

AUGUST 8, 1961

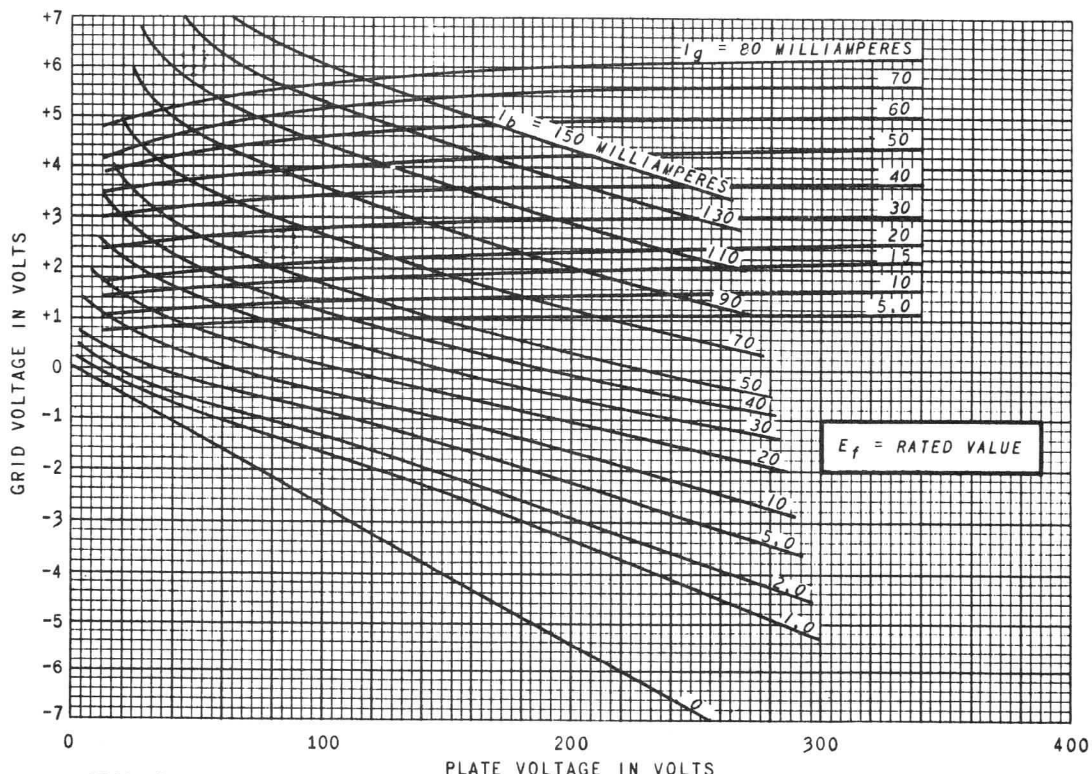
AVERAGE PLATE CHARACTERISTICS



K-55611-TD53-4

AUGUST 8, 1961

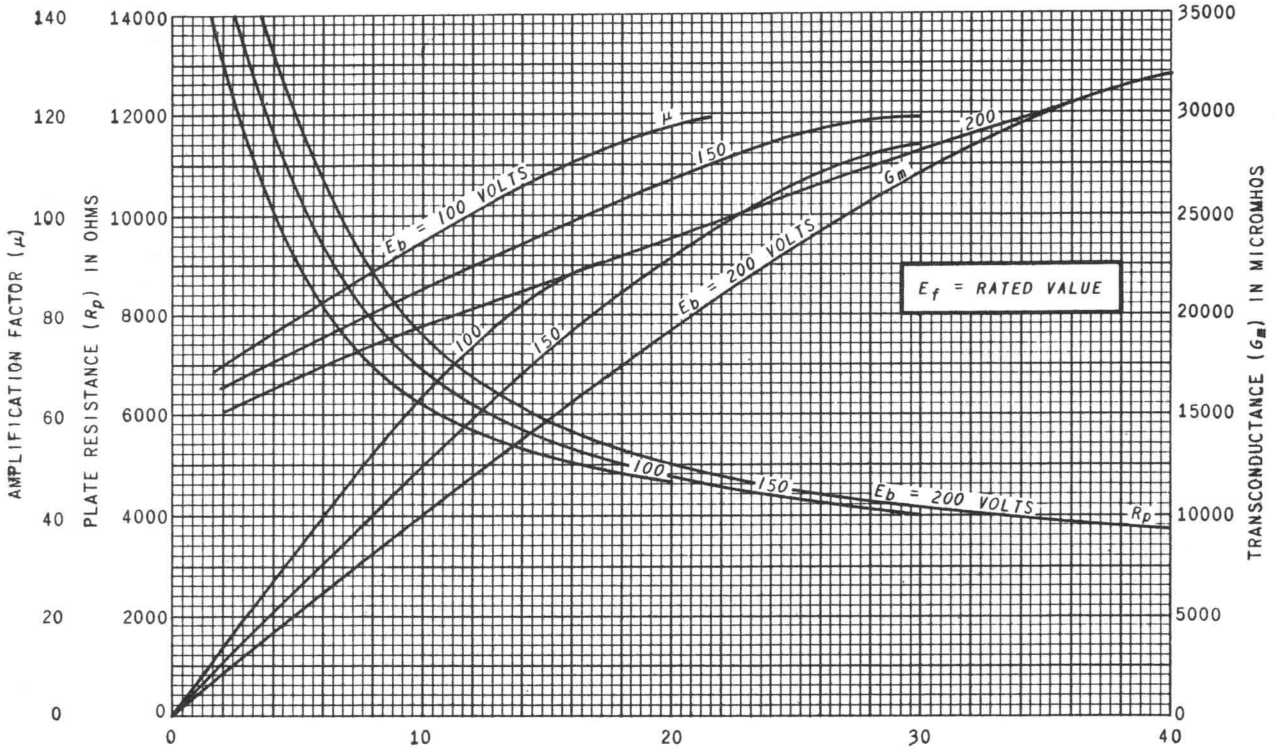
AVERAGE CONSTANT-CURRENT CHARACTERISTICS



K-55611-TD53-5

AUGUST 8, 1961

AVERAGE CHARACTERISTICS



K-55611-TD53-3C

AUGUST 8, 1961

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-5099-A*

PLANAR TRIODE

The Z-5099-A is a high-mu triode for use in grounded-grid Class C power amplifiers, oscillators, or frequency multipliers at frequencies up to 2500 megacycles. Typical power output is 19 watts at 2500 megacycles and 40 watts at 500 megacycles. The metal-ceramic construction permits the tube to withstand shock tests at 400G. The specially designed radiator enables the plate to dissipate 100 watts with conduction cooling when a heat sink sufficient to limit the seal temperature to 200 C maximum is used.

The Z-5099-A features graduated-diameter disk seals for maximum efficiency in cavity and parallel-line circuits thus assuring both low lead inductances and electrode isolation. Other features include high transconductance and low interelectrode capacitances.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3	Volts
Heater Current‡	1.0	Amperes
Cathode Heating Time, minimum	60	Seconds
Direct Interelectrode Capacitances§		
Grid to Plate	2.0	pf
Grid to Cathode	6.5	pf
Plate to Cathode, maximum	0.029	pf

Mechanical

Mounting Position - Any

Maximum Diameter	1 59/64	Inches
Maximum Over-all Length	2 43/64	Inches

Radiator may be used as a mounting flange. Plate, grid, cathode finger contacts, and radiator mounting must be sufficiently flexible to allow for maximum eccentricities and tilt.

Net Weight, approximate	3.5	Ounces

Cooling
Plate and Plate Seal - Conduction or Forced Air
Grid and Cathode Seals - Conduction or Forced Air
Radiator must be securely fastened to an appropriate heat sink to limit seal to maximum temperature under operating conditions.

Maximum Temperature of Any Seal	200	C

MAXIMUM RATINGS

Absolute-Maximum Values

Radio-Frequency Power Amplifier or Oscillator - Class C Telegraphy

Key-Down Conditions per Tube Without Amplitude Modulation

Heater Voltage	+	
DC Plate Voltage	1000	Volts
DC Cathode Current	125	Milliamperes
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
Plate Dissipation	100	Watts
Grid Dissipation	2.0	Watts
Frequency	2500	Megacycles

Radio-Frequency Power Amplifier or Oscillator - Class C Telephony

Carrier Conditions per Tube for Use With a Maximum Modulation Factor of 1.0

Heater Voltage	+	
DC Plate Voltage¶	600	Volts
DC Cathode Current	100	Milliamperes
Negative DC Grid Voltage	150	Volts
Peak Positive RF Grid Voltage	30	Volts
Peak Negative RF Grid Voltage	400	Volts
DC Grid Current	50	Milliamperes
Plate Dissipation	70	Watts
Grid Dissipation	2.0	Watts
Frequency	2500	Megacycles

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	600	Volts
Plate Current	70	Milliamperes
Amplification Factor	100	
Transconductance	24000	Micromhos

CHARACTERISTICS AND TYPICAL OPERATION (Continued)

Class C Oscillator, Grid Return Circuit

Frequency	500	2500	Megacycles
DC Plate Voltage	900	1000	Volts
DC Cathode Current	120	117	Milliamperes
DC Grid Current	30	27	Milliamperes
DC Grid Voltage	-40	-22	Volts
Useful Power Output	40	19	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

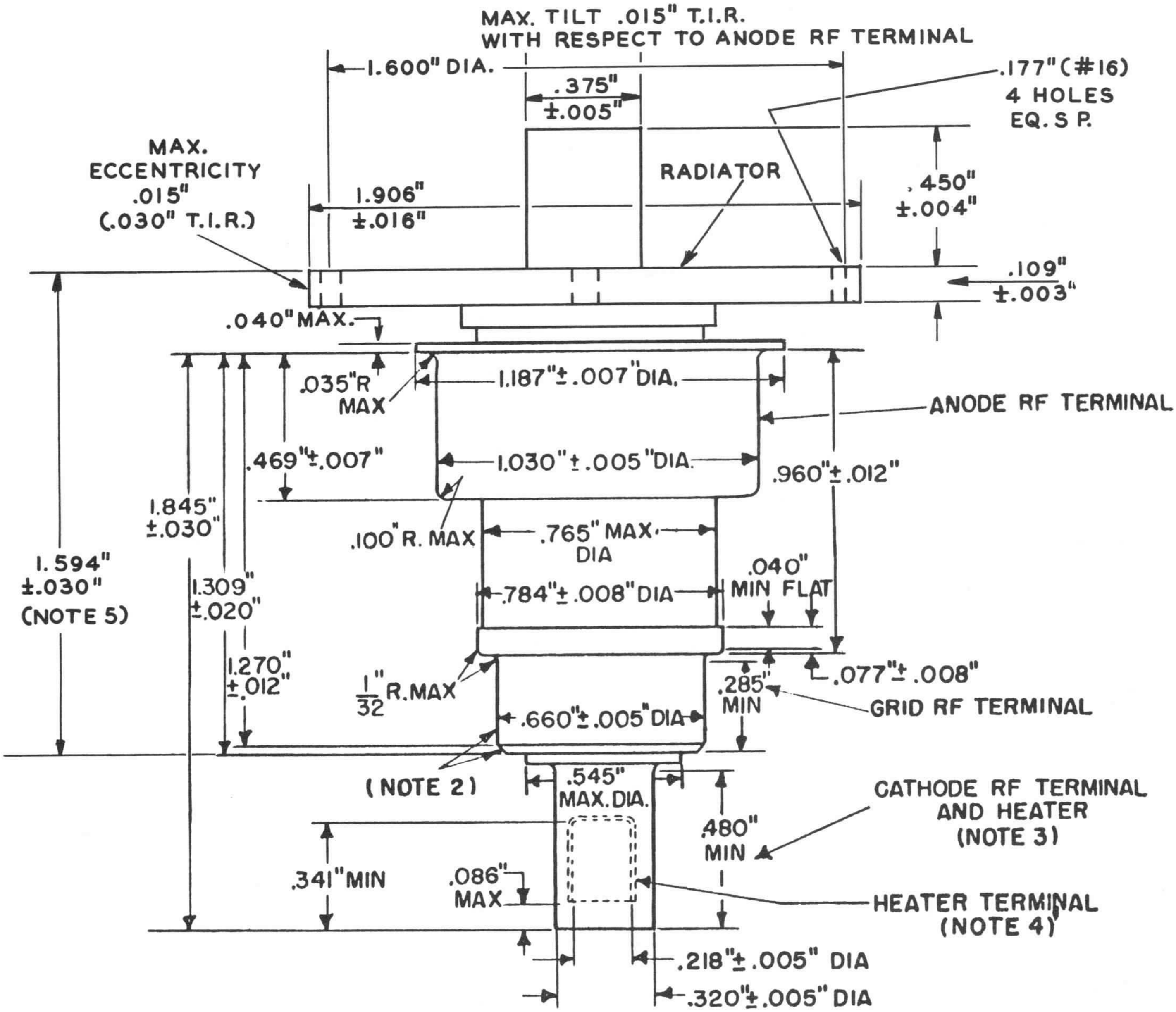
+ The Z-5099-A operates at frequencies where it is necessary to consider transit-time effects of the electron current. The principal effects influencing tube operation are the decrease in power output and operating efficiency with increase in frequency, and the bombardment and heating of the cathode by electrons from the region of the grid, which can be severe enough to result in short tube life and erratic operation. Operating frequency, circuit design and adjustment, grid bias, and grid current contribute to the degree of cathode bombardment. There is an optimum heater voltage which will maintain the cathode at the correct operating conditions. If the conditions of operation result in appreciable cathode back-heating, it may be necessary to start dynamic tube operation at normal heater voltage, followed by a reduction of heater voltage to the proper value. A maximum variation of plus or minus five percent in heater voltage is recommended where extended tube life is a factor.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Measured in a special shielded socket.

¶ For modulation factors less than 1.0, a higher d-c plate voltage may be used if the sum of the peak positive audio voltage and the d-c plate voltage does not exceed 1200 volts.

2/15/63 (B)
Supersedes 9/20/62 (B)



NOTES:

1. External metal parts plated with 30 MSI minimum of copper and/or silver.
2. Solder not to extend radially beyond RF terminal.
3. The cathode RF terminal and grid RF terminal concentric with respect to the anode terminal within 0.020" (runout within 0.040").
4. The heater terminal concentric with respect to the cathode RF terminal within 0.012" (runout within 0.024").
5. Measure at two diametrically opposite points and average reading.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-5267*

PLANAR TETRODE

The Z-5267 is a planar tetrode primarily designed for grounded-grid radio-frequency power amplifier or oscillator service at frequencies to 3000 mc and beyond.

The Z-5267 combines small interelectrode spacings with a thermally stable electrode structure and low lead inductance. The envelope and electrode terminals are designed for efficient utilization of cavity resonators at the higher frequencies and of line-type and lumped-constant circuits at the lower frequencies.

GENERAL

Electrical

Cathode - Coated Unipotential

Heater Characteristics and Ratings		
Heater Voltage, AC or DC+	6.3±0.3	Volts
Heater Current‡	1.9	Amperes
Cathode Heating Time, minimum	2	Minutes
Direct Interelectrode Capacitances, approximate§		
Grid-Number 2 to Plate	4	pf
Grid-Number 1 to Cathode	18	pf
Grid-Number 1 to Grid-Number 2	30	pf

Mechanical

Mounting Position - Any		
Net Weight, approximate	4	Ounces
→ Envelope Temperature, maximum	300	C
Cooling-Forced Air		

MAXIMUM RATINGS

Absolute-Maximum Values
Radio-Frequency Power Amplifier and Oscillator - Class C Telegraphy

DC Plate Voltage	1000	Volts
DC Screen Voltage	325	Volts
DC Grid-Number 1 Voltage	-20	Volts
DC Plate Current	175	Milliamperes
DC Grid-Number 1 Current	35	Milliamperes
DC Cathode Current	200	Milliamperes
Plate Input	175	Watts
Plate Dissipation	140	Watts
Screen Dissipation	3.0	Watts

Pulsed Operation

Ratings have not been determined. As a guide, peak plate voltages up to 3 kilovolts and peak cathode currents up to 7.5 amperes may be considered, depending upon duty cycle. For grid-pulsed operation care should be taken that the maximum screen dissipation is not exceeded. The screen may be pulsed up to 800 volts positive.

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Average Characteristics

Plate Voltage	1000	Volts
Screen Voltage	300	Volts
Grid-Number 1 Voltage	-1.2	Volts
Transconductance	60000	Micromhos
Amplification Factor (G_1 to G_2)	60	
Plate Current	160	Milliamperes

Radio-Frequency Power Amplifier - 3000 Megacycles

DC Plate Voltage	1000	800	800	Volts
DC Screen Voltage	300	250	250	Volts
DC Grid-Number 1 Voltage	-6.0	-3.0	-2.0	Volts
DC Plate Current	160	160	160	Milliamperes
DC Screen Current	8.0	6.0	7.0	Milliamperes
DC Grid-Number 1 Current, approximate	25	10	8	Milliamperes
Driving Power, approximate	7	2.3	0.8	Watts
Useful Power Output, approximate	40	20	10	Watts
Bandwidth, approximate	25	---	---	Megacycles

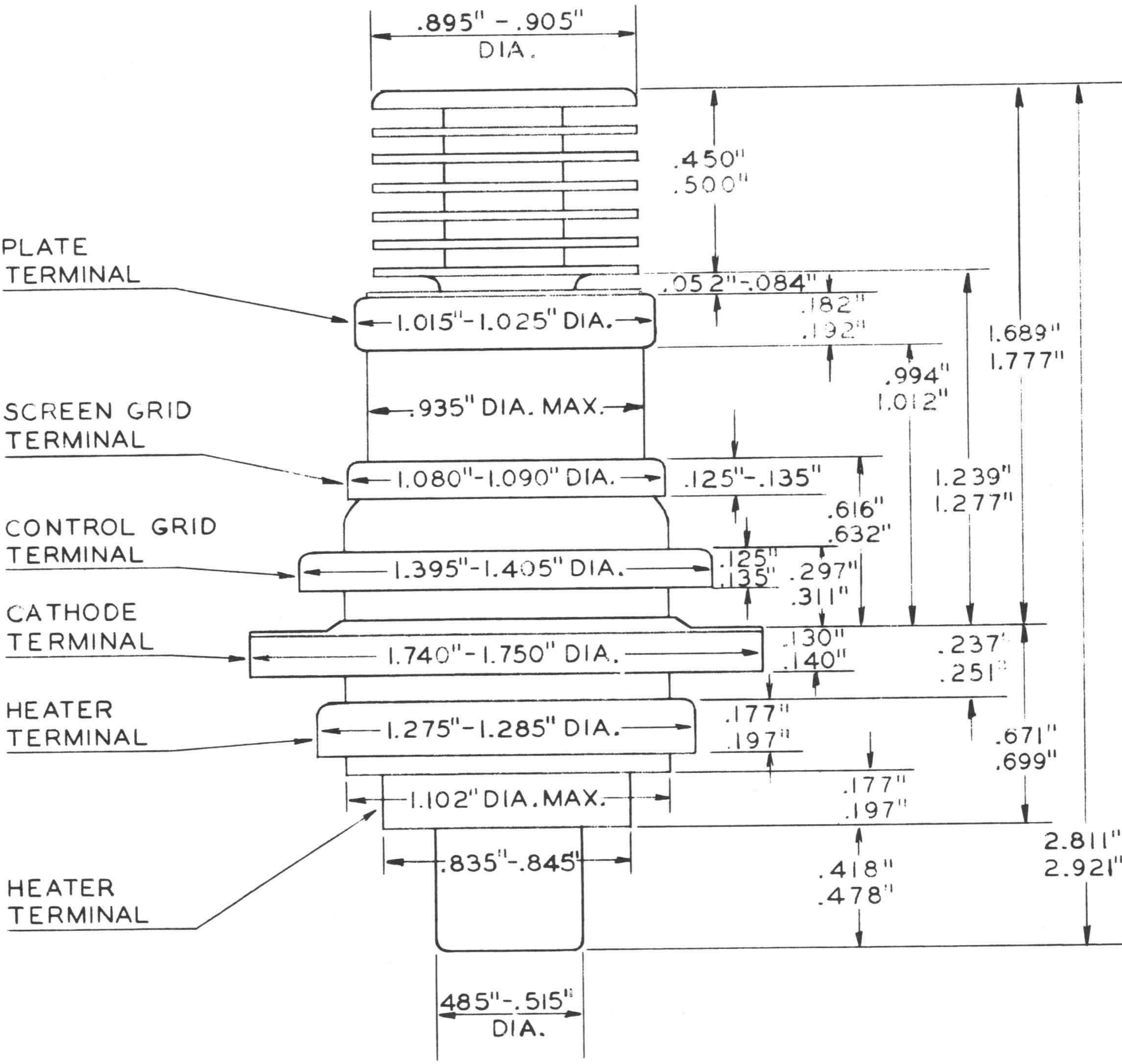
* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

+ Lower voltages may be used to improve the life at low-cathode-current levels. For specific recommendations, contact your General Electric tube sales representative.

‡ Heater current of a bogey tube at Ef = 6.3 volts.

§ Without external shield.

8/14/62 (B)
Supersedes 7/30/62 (B)


.895" - .905" DIA.
.450" .500"
PLATE TERMINAL
.052"-.084"
.182" .192"
1.015"-1.025" DIA.
1.689" 1.777"
.994" 1.012"
SCREEN GRID TERMINAL
.935" DIA. MAX.
1.080"-1.090" DIA.
.125"-.135"
1.239" 1.277"
.616" .632"
CONTROL GRID TERMINAL
1.395"-1.405" DIA.
.125" .135"
.297" .311"
CATHODE TERMINAL
1.740"-1.750" DIA.
.130" .140"
.237" .251"
HEATER TERMINAL
1.275"-1.285" DIA.
.177" .197"
.671" .699"
1.102" DIA. MAX.
.177" .197"
2.811" 2.921"
.835"-.845"
.418" .478"
HEATER TERMINAL
485"-.515" DIA.

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-5317*

PLANAR TRIODE

The Z-5317 is a high-mu, metal-and-ceramic planar triode intended for operation as a CW, radio-frequency power amplifier or frequency multiplier. The Z-5317 is a low-frequency, CW version of the 6442.

GENERAL

Electrical

Cathode-Indirectly Heated

Heater Characteristics and Ratings

Heater Voltage, AC or DC	$6.3^{+5\%}_{-10\%}$	Volts
Heater Current	0.75	Amperes

Direct Interelectrode Capacitances, approximate

	Minimum	Bogey	Maximum	
Grid to Plate	2.10	2.3	2.45	pf
Grid to Cathode, Eh = 0	4.60	5.1	5.45	pf
Plate to Cathode, Eh = 0	---	0.035	0.045	pf

Mechanical

Operating Position - Any

Cooling - Conduction and Convection

Envelope Temperature	175	C
Net Weight, approximate	1	Ounces

MAXIMUM RATINGS

Absolute-Maximum Values

Radio-Frequency Power Amplifier and Oscillator - Class C Telegraphy

Key-down Conditions per Tube Without Amplitude Modulation+

Frequency	1000	Megacycles
DC Plate Voltage	350	Volts
Negative DC Grid Voltage	50	Volts

MAXIMUM RATINGS (Continued)

DC Plate Current	35	Milliamperes
DC Grid Current	15	Milliamperes
Plate Dissipation	8.0	Watts
Peak Heater-Cathode Voltage		
Heater Positive with Respect to Cathode	90	Volts
Heater Negative with Respect to Cathode	90	Volts
Envelope Temperature at Hottest Point	175	C

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Class A_1 Amplifier

	Minimum	Bogey	Maximum	
Plate Voltage	---	---	350	Volts
DC Grid Bias, approximate	-1.5	-3.5	-5.25	Volts
Amplification Factor, approximate, Ec/Ib = 35 ma d-c	35	50	65	
Transconductance	13500	16500	19000	Micromhos
Plate Current	---	---	35	Milliamperes

Radio-Frequency Power Amplifier - Class C Telegraphy

Frequency	1000	Megacycles
DC Plate Voltage	350	Volts
DC Plate Current	35	Milliamperes
DC Grid Current	8.0	Milliamperes
Useful Power Output	5.0	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

\+ Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115 percent of the carrier conditions.

2/19/63 (B)
Supersedes 5/22/59 (B)

REFERENCE NOTES FOR OUTLINE DRAWING

Note 1. Applies to minimum surface for anode d-c and r-f terminal only. Other surfaces must not be used for these terminal purposes.

Note 2. Applies to minimum surface for grid d-c and r-f terminal only. Other surfaces, except for Notes 3 and 4, must not be used for terminal purposes.

Note 3. Applies to minimum surfaces for grid d-c and r-f terminal only.

Note 4. The cylindrical surface of this diameter may be used for grid d-c and r-f terminal purposes.

Note 5. The surfaces defined by Notes 2, 3, and 4 must be the only surfaces used for tube stops and clamping purposes.

Note 6. Other surfaces must not be used for cathode d-c and r-f terminal purposes.

Note 7. Other surfaces must not be used for anode d-c and r-f terminal purposes.

Note 8. Applies to surface designated for cathode d-c and r-f terminal. Solder at brazed joint will not exceed the maximum diameter.

Note 9. The maximum eccentricity of the anode and cathode with respect to the grid terminal in a prescribed jig is 0.010 (or maximum total runout of 0.020) and is measured by indicators at the points designated.

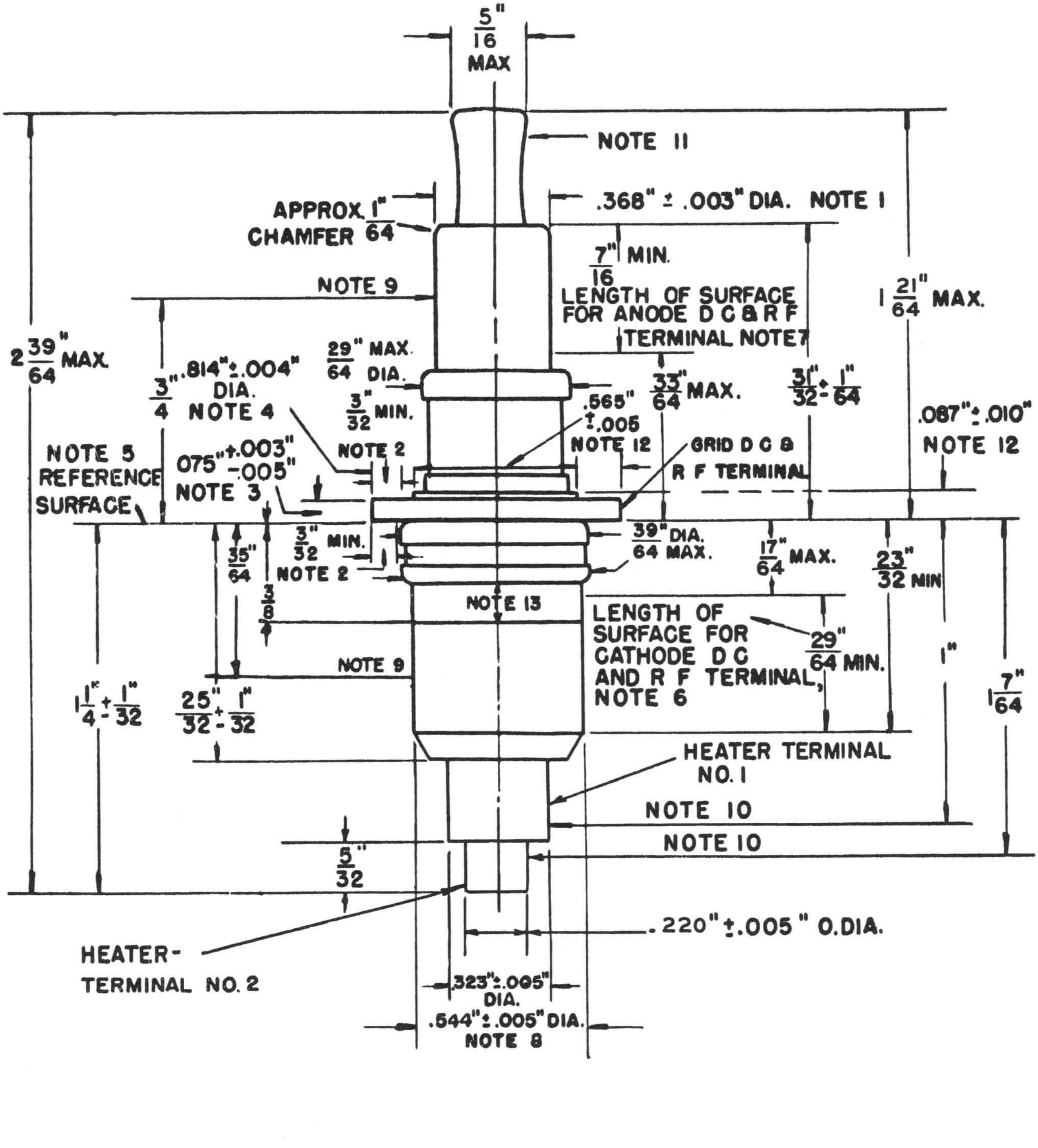
Note 10. The maximum eccentricity of heater-terminal No. 1 and heater-terminal No. 2 with respect to the grid terminal in a prescribed jig is 0.015 (or maximum total runout of 0.030) and is measured by indicators at the points designated.

Note 11. Exhaust tubulation must not be subjected to any mechanical stress.

Note 12. For reference only. Dimension does not include any possible solder fillet.

Note 13. This area is reserved for tube stamping and coding.

Z-5317



5" / 16 MAX
NOTE 11
APPROX. 1"/64 CHAMFER
.368" ± .003" DIA. NOTE 1
7"/16 MIN.
LENGTH OF SURFACE FOR ANODE D C & R F TERMINAL NOTE 7
1 21"/64 MAX.
NOTE 9
2 39"/64 MAX.
3"/4
.814" ± .004" DIA.
NOTE 4
29"/64 MAX. DIA.
3"/32 MIN.
33"/64 MAX.
31" ± 1"/32 - 64
.565" ± .005 NOTE 12
.087" ± .010" NOTE 12
NOTE 5 REFERENCE SURFACE
075" +.003" -.005" NOTE 3
NOTE 2
GRID D C & R F TERMINAL
39"/64 DIA. MAX.
17"/64 MAX.
23"/32 MIN
35"/64
3"/32 MIN.
NOTE 2
3/8
NOTE 13
LENGTH OF SURFACE FOR CATHODE D C AND R F TERMINAL, NOTE 6
29"/64 MIN.
NOTE 9
1"
1 7"/64
1 1"/4 + 1"/- 32
25"/32 + 1"/- 32
HEATER TERMINAL NO. 1
NOTE 10
NOTE 10
5"/32
HEATER-TERMINAL NO. 2
.220" ± .005" O.DIA.
.323" ± .005" DIA.
.544" ± .005" DIA. NOTE 8

OBJECTIVE FOR DEVELOPMENTAL TYPE

Z-5387*

PLANAR TRIODE

The Z-5387 is a high-mu, metal-and-ceramic planar triode for use at very-high and ultra-high frequencies in grounded-grid, Class C CW or pulsed, power-amplifier, oscillator, or frequency-multiplier circuits. In such service it will operated from the low frequencies to above 3000 megacycles. Cooling of the tube envelope is accomplished by conduction from the contact circuit members with sufficient additional forced air to limit the maximum temperature at 250 C.

The tube has an oxide-coated indirectly-heated cathode of planar-electrode construction. The metal-and-ceramic envelope holds concentricity to extremely close limits. The strength inherent in the structural design allows shock-testing at 400 g. Graduated-diameter disk seals assure maximum efficiency in the use of cavity and parallel-line circuits with the resultant desirable features of both low lead inductances and electrode isolation. Radio-frequency losses in the tube are kept to a minimum by the special techniques and materials used. Other features of the tube are high transconductance and low interelectrode capacitances.

GENERAL

Electrical

Cathode-Indirectly Heated				
Heater Voltage, dependent upon operating conditions+			6.3	Volts
Heater Current			1.05	Amperes
Cathode Heating Time, minimum			1.0	Minutes

	Minimum	Bogey	Maximum	
Transconductance, I_p = 75 ma, Ep = 600 volts	22,000	24,800	27,500	Micromhos
Amplification Factor	75	95	115	
Direct Interelectrode Capacitances				
With External Shield, Heater Voltage = 0 volts				
Grid to Plate	1.89	2.01	2.13	pf
Grid to Cathode	6.0	6.5	7.00	pf
Plate to Cathode, maximum	0.018	0.023	0.029	pf

GENERAL (Continued)

Mechanical
Mounting Position - Any
Only Anode Flange to be used as a Socket Stop and Clamp

Net Weight, approximate	2	Ounces

Thermal
Cooling
Anode and Anode Seal-Conduction and Forced Air
Grid and Cathode Seals-Conduction and Forced Air

Maximum Temperature of Any Seal Under Any Condition+	250	C

MAXIMUM RATINGS

Plate-Pulsed Oscillator and Amplifier - Class C

Maximum Ratings
Absolute-Maximum Values

Peak Pulse-Plate-Supply Voltage	3500	Volts
Pulse Length	6	Microseconds
Duty Factor	0.0033	
Negative DC Grid Voltage	150	Volts
Positive Peak Grid Voltage	250	Volts
Negative Peak Grid Voltage	750	Volts
Plate Dissipation	10	Watts
Grid Dissipation	2.0	Watts
Average Plate Current	10	Milliamperes
Peak Plate Current	3.0	Amperes
Average Grid Current	5.0	Milliamperes
Frequency	3000	Megacycles

Absolute-Maximum ratings are limiting values of operating and environmental conditions applicable to any electron tube of a specified type as defined by its published data and should not be exceeded under the worst probable conditions.

The tube manufacturer chooses these values to provide acceptable serviceability of the tube, making no allowance for equipment variations, environmental variations, and the effects of changes in operating conditions due to variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

The equipment manufacturer should design so that initially and throughout life no absolute-maximum value for the intended service is exceeded with any tube under the worst probable operating conditions with respect to supply-voltage variation, equipment component variation, equipment control adjustment, load variation, signal variation, environmental conditions, and variations in the characteristics of the tube under consideration and of all other electron devices in the equipment.

CHARACTERISTICS AND TYPICAL OPERATION

Amplifier - 1100 Megacycles

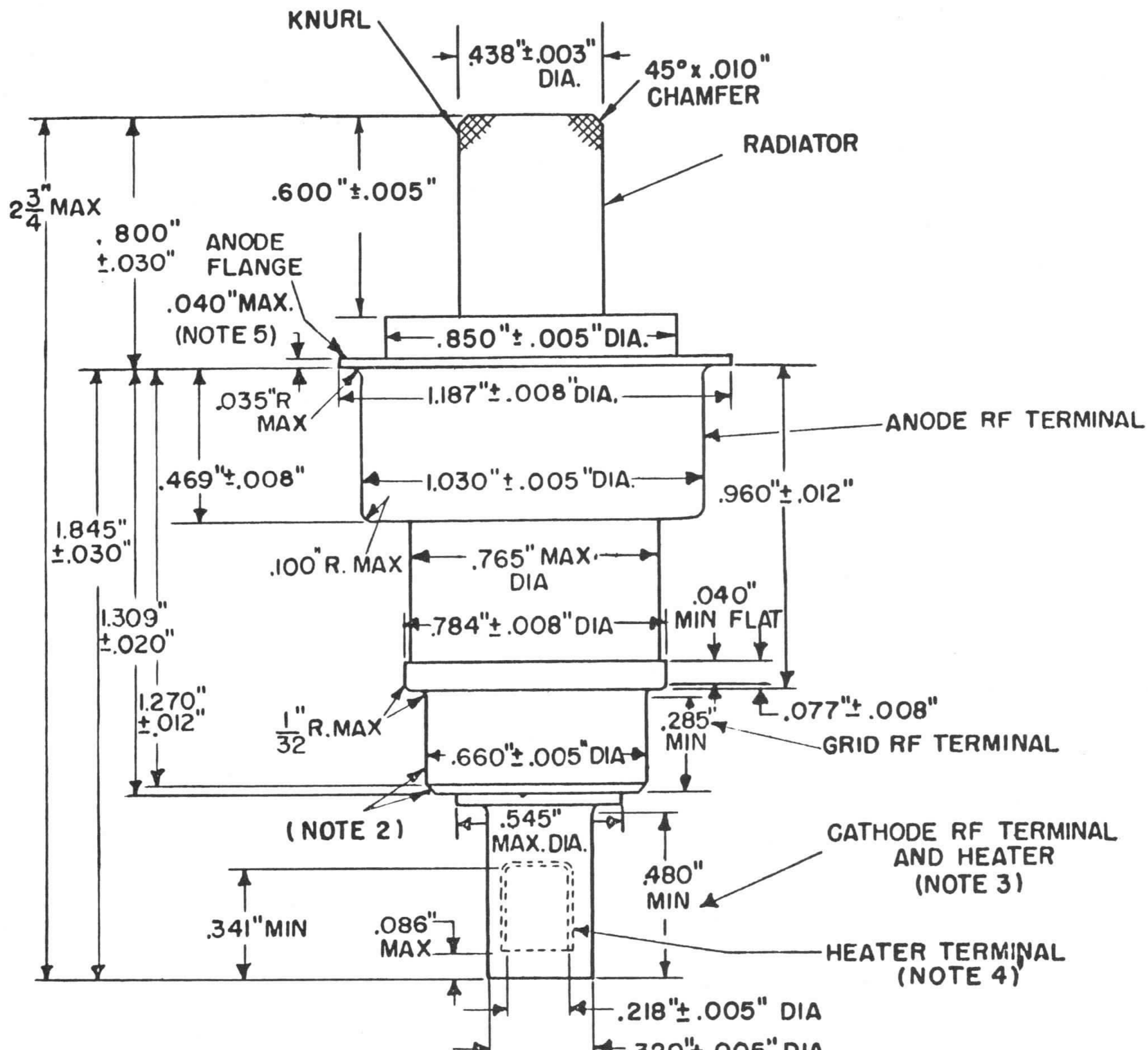
Heater Voltage	6.0	Volts
DC Plate Voltage	1700	Volts
DC Grid Voltage	-45	Volts
Pulse Length	3.5	Microseconds
Duty Factor	0.001	
Peak Plate Current	1.9	Amperes
Peak Grid Current	1.1	Amperes
Driving Power during Pulse, approximate	400	Watts
Peak Useful Power Output, approximate	1500	Watts

* Publication of these data does not obligate the General Electric Company to manufacture a tube with these characteristics.

+ The Z-5387 operates at frequencies where it is necessary to consider transit-time effects of the electron current. The principal effects influencing tube operation are the decrease in power output and operating efficiency with increase in frequency, and the bombardment and heating of the cathode by electrons from the region of the grid which can be severe enough to result in short tube life and erratic operation. Operating frequency, circuit design and adjustment, grid bias, and grid current contribute to the degree of cathode bombardment. There is an optimum heater voltage which will maintain the cathode at the correct operating temperature for a particular set of operating conditions. If the conditions of operation result in appreciable cathode back heating, it may be necessary to start dynamic tube operation at normal heater voltage followed by a reduction of heater voltage to the proper value. A maximum variation of plus or minus five percent in heater voltage is recommended where extended tube life is a factor. Under all other conditions, the variation in heater voltage should not exceed plus or minus ten percent. For application above 400 megacycles, recommendations are to be obtained from the tube manufacturer regarding the heater voltage to be used under a specific set of operating conditions.

‡ Where long life and reliable operation are important, lower tube envelope temperatures should be used.

2/19/63 (B)
Supersedes 4/22/60 (B)



NOTES:

1. External metal parts (except radiator) plated with 30 msi of copper and /or silver.
2. Solder not to extend radially beyond grid RF terminal.
3. Total indicated runout of the grid-contact surface and the cathode-contact surface with respect to the anode shall not exceed 0.020"
4. Total Indicated runout of the cathode-contact surface with respect to the heater-contact surface shall not exceed 0.012".
5. Only this flange to be used as a socket stop and clamp.

ZP-1015

Tetrode

Grid-Pulsed Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1015 is a heat-sink-cooled version of the GL-7399 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne IFF radar equipment.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1015 include long life and reliability, long pulse width and high gain.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	-	5.6	-	Amperes
Amplification Factor, G_2 to G_1	-	10.5	-	
E_{g2}=275 Volts DC, E_b=1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	-	0.012	-	μμf
Input	-	24	-	μμf
Output	-	9.3	-	μμf

MECHANICAL

Mounting Position - Any
Net Weight, approximately . . . 11 Ounces

THERMAL

Cooling - Heat-sink and Forced-Air ‡		
Anode Temperature Δ, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	200	C

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles		
DC Plate Voltage**	5	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C (CONT'D)

Maximum Ratings (Cont'd)

Pulsed Drive, 1250 Megacycles (Cont'd)

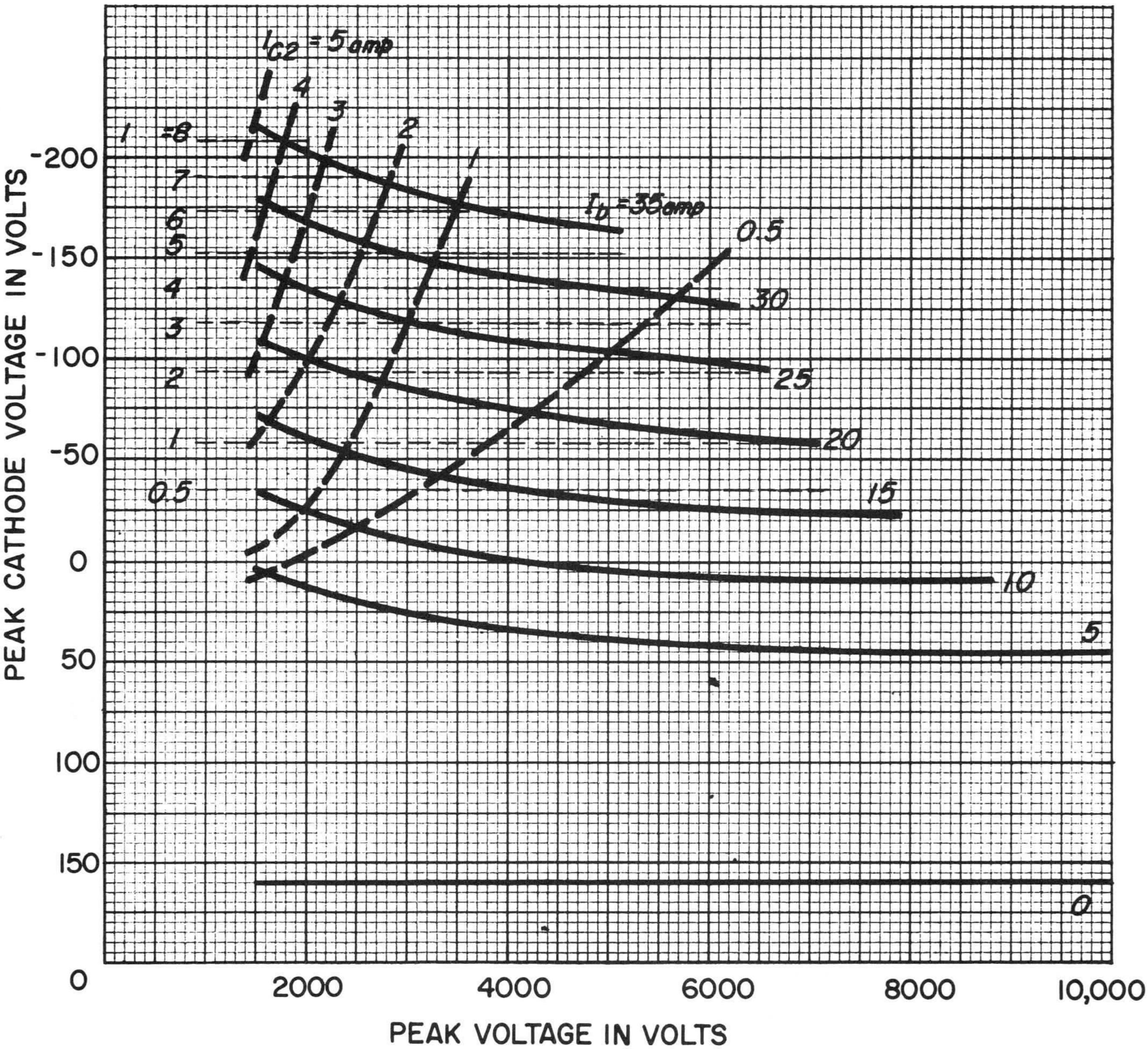
Plate Dissipation	150	Watts
Pulse Width ♥ ◊	15	Microseconds
Duty Factor ♥ ϕ	0.01	

Typical Operation

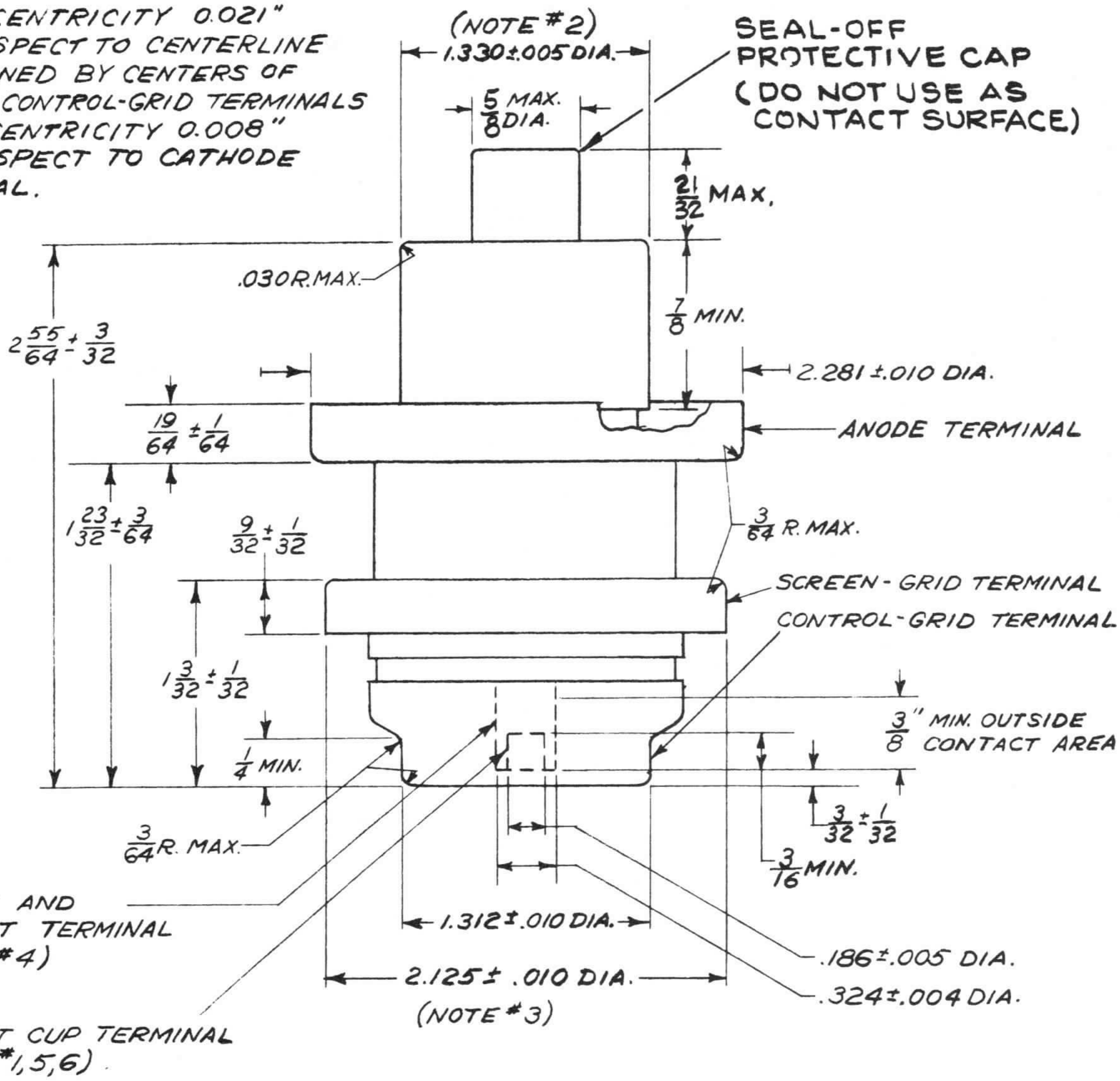
Grounded-grid Service at 1100 Megacycles,	$3/4\lambda$	Output Circuit
DC Plate Voltage	4.8	Kilovolts
DC Plate Current, during pulse	4.2	Amperes
DC Grid-No. 2 Voltage	1	Kilovolt
DC Grid-No. 2 Current, during pulse	100	Milliamperes
DC Grid-No. 1 Voltage	-200	Volts
DC Grid-No. 1 Current, during pulse	200	Milliamperes
Driving Power at Tube, during pulse	1.5	Kilowatts
Power Output, during pulse (useful)	11	Kilowatts
Pulse Width ◊	15	Microseconds
Duty Factor ϕ	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
‡ Forced-air cooling should be applied during the application of any voltages.
Δ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.
** A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.
♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ϕ Maximum ratio of on-time to elapsed time during any 15 millisecond period.

CONSTANT CURRENT CHARACTERISTIC
GROUNDED-GRID OPERATION
VOLTAGES MEASURED TO GROUND
SCREEN VOLTAGE = 1400 VOLTS



NOTES:
1. BOTTOM OF CUP MUST NOT BE USED AS A SOCKET STOP.
2. MAX. ECCENTRICITY 0.015"
3. MAX. ECCENTRICITY 0.008"
4. MAX. ECCENTRICITY 0.018"
5. MAX. ECCENTRICITY 0.021" WITH RESPECT TO CENTERLINE DETERMINED BY CENTERS OF ANODE & CONTROL-GRID TERMINALS
6. MAX. ECCENTRICITY 0.008" WITH RESPECT TO CATHODE TERMINAL.



ZP-1018

Grid-Pulsed Service
Grounded-Grid Operation

Tetrode

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1018 is a reduced-size heat-sink-cooled version of the GL-6283 especially designed for pulsed-amplifier or oscillator service at L-band frequencies. This tetrode is particularly well suited for use in airborne radar equipment such as IFF transponders.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1018 include long life and reliability, long pulse width and high gain.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	-	3.8	-	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances**				
Cathode to Plate †	-	.006	-	μμf
Input	-	20	-	μμf
Output	-	8.9	-	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximately	9	Ounces

THERMAL

Cooling – Heat-sink and Forced-Air ‡		
Anode Temperature §, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	200	C

RADIO-FREQUENCY POWER AMPLIFIER – CLASS C

Maximum Ratings

Pulsed Drive, 1250 Megacycles

DC Plate Voltage	3.5	Kilovolts
DC Plate Current, during pulse	5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Input	5	Watts
DC Grid-No. 1 Voltage	-200	Volts
Plate Dissipation	150	Watts
Pulse Width♥◊	15	Microseconds
Duty Factor♥ φ	.02	

Typical Operation

Grounded-Grid Service at 1100 Megacycles, 1/4 λ Output Circuit

DC Plate Voltage	2.5	2.5	Kilovolts
DC Plate Current, during pulse	1.4	1.0	Amperes

ET-J38
8-62

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C (CONT'D)

Typical Operation (Cont'd)

DC Grid-No. 2 Voltage	600	600	Volts
DC Grid-No. 2 Current, during pulse	50	0	Milliamperes
DC Grid-No. 1 Voltage	-70	-70	Volts
DC Grid-No. 1 Current, during pulse	90	80	Milliamperes
Driving Power at the Tube, during pulse	165	95	Watts
Power Output, during pulse (useful)	1.6	1.0	Kilowatts
Pulse Width	6	6	Microseconds
Duty Factor	.02	.02	

* Under the typical operating conditions shown the filament voltage should be reduced to approximately 6.0 volts because of back-heating resulting from transit time effects.

** Control grid connected directly to screen grid.

† Complete external shielding between cathode and plate.

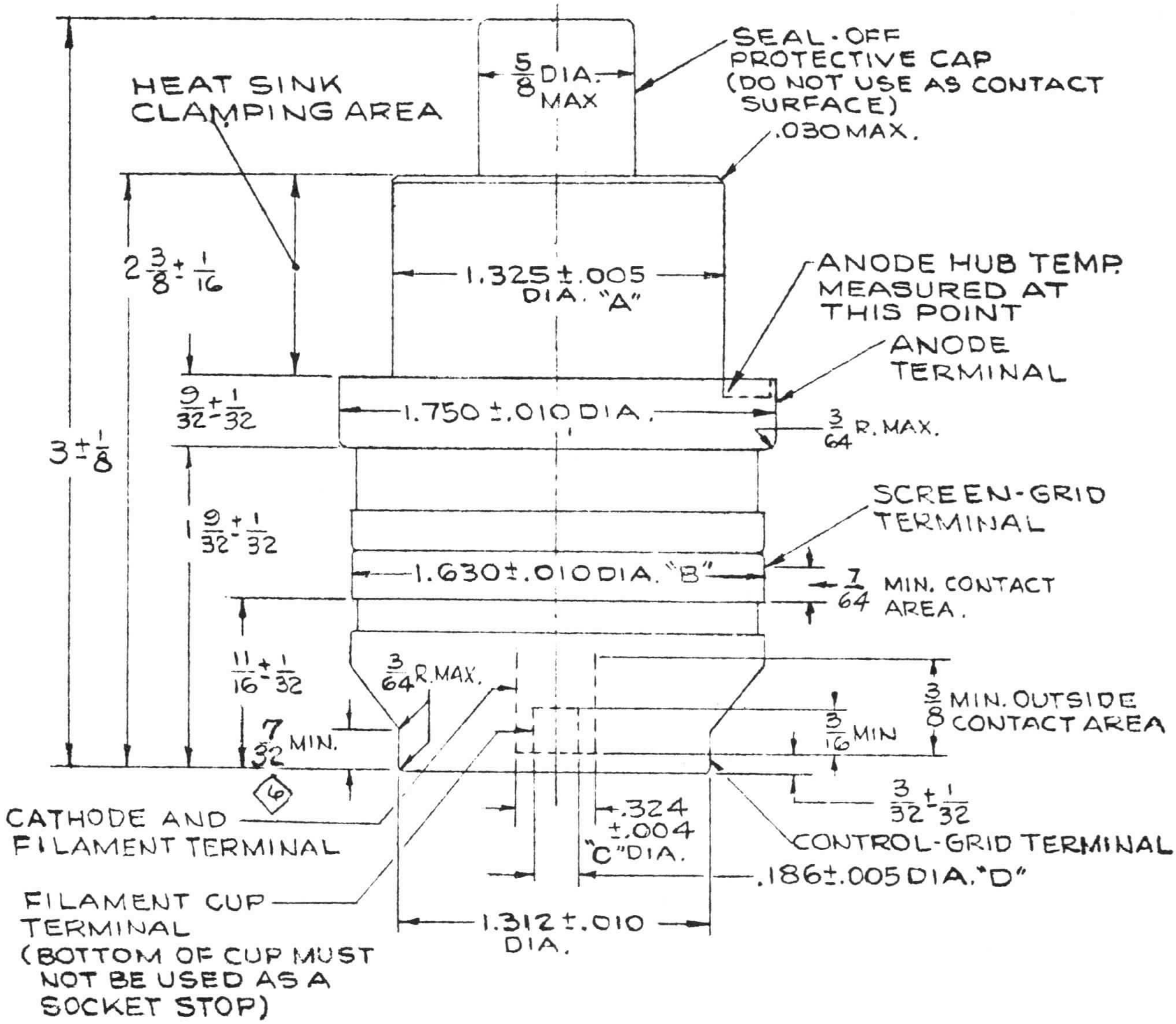
‡ Forced-air cooling should be applied during the application of any voltages.

§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.

♥ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.

◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

ϕ Maximum ratio of on-time to elapsed time during any 7.5 millisecond period.



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.016 inches
Diameter C - 0.036 inches
Diameter D - 0.042 inches

Total indicator reading of filament cup terminal diameter (D) measured with respect to center of cathode and filament terminal diameter (C) - 0.016 inches.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

GENERAL ELECTRIC
POWER TUBE DEPARTMENT
Schenectady 5, N. Y.

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1024

TRIODE

Internal Feedback for Oscillator Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1024 is a heat-sink-cooled triode especially designed for pulsed-oscillator service in L-band, providing useful output at frequencies up to approximately 1700 megacycles.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service.

Other features of the ZP-1024 are long life and reliability, long pulse width and high power output capability.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage	–	6.3	–	Volts
Heater Current	–	3.8	–	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances				
Cathode to Plate †	–	0.5	–	μμf
Input	–	20	–	μμf
Output	–	7.8	–	μμf

MECHANICAL

Mounting Position – Any		
Net Weight, approximately	9	Ounces

THERMAL

Cooling – Heat-sink and Forced-Air ‡		
Anode Temperature §, maximum	250	C
Seals		
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at Any Point, maximum	200	C

PLATE-PULSED OSCILLATOR – CLASS C

Maximum Ratings

DC Plate Voltage, during pulse	6.5	Kilovolts
DC Plate Current, during pulse	6.5	Amperes
DC Grid Voltage, during pulse	-400	Volts
Plate Dissipation	150	Watts
Pulse Width◇	1	Microsecond
Duty Factor♥ φ	.001	

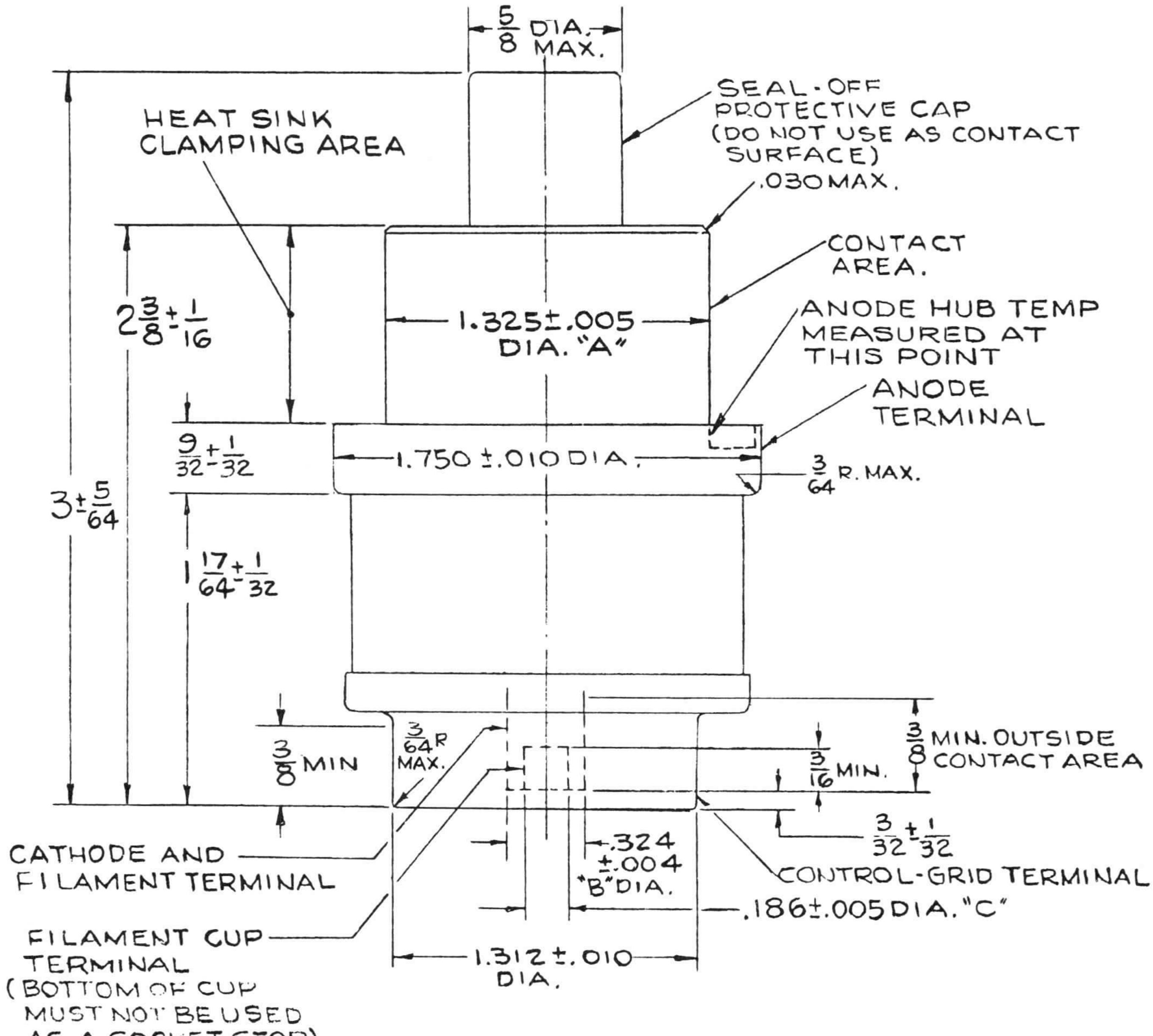
PLATE-PULSED OSCILLATOR - CLASS C (Cont'd)

Typical Operation

Grounded-Grid Service at 1100 Megacycles, 3/4 λ Output Circuit

DC Plate Voltage, during pulse	6.0	Kilovolts
DC Plate Current, during pulse	6.25	Amperes
DC Grid Current, during pulse	2.5	Amperes
Power Output, during pulse (useful)	15	Kilowatts
Pulse Width	1	Microsecond
Duty Factor	.001	

† Complete external shielding between cathode and plate.
‡ Forced-air cooling should be applied during the application of any voltages.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified; the temperature is measured at the point indicated on the outline drawing.
∀ For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
ϕ Maximum ratio of on-time to elapsed time during any 1-millisecond period.



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

PRELIMINARY
TECHNICAL INFORMATION

These ratings represent those of current samples of this type. Refer to the Objective Technical Information sheet for design-objective ratings.

ZP-1025

TRIODE

Internal Feedback for Oscillator Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1025 is a heat-sink-cooled triode especially designed for pulsed oscillator service in L-band. This tube is particularly well suited for use in airborne radar equipment such as IFF transponders.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service.

Other features include small size, long pulse width capability, long life and reliability.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage*	–	6.3	–	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	–	–	Minute
Direct Interelectrode Capacitances				
Cathode to Plate	–	0.45	–	μμf
Input	–	15.5	–	μμf
Output	–	5.9	–	μμf

MECHANICAL

Mounting Position – Any
Net Weight, approximately . . . 3 1/4 Ounces

THERMAL

Cooling – Heat-Sink and Forced-Air
Anode Temperature § . . . 250 C
Ceramic Temperature at Any Point, maximum . . . 200 C

PLATE-PULSED OSCILLATOR-CLASS C

Maximum Ratings

DC Plate Voltage, During Pulse	6.0	Kilovolts
DC Plate Current, During Pulse	10.0	Amperes
DC Grid Voltage, During Pulse	–400	Volts
DC Grid Current, During Pulse	5.0	Amperes
Plate Dissipation §	110	Watts
Pulse Width ♦	10	Microseconds
Duty Factor ϕ	0.001	

Typical Operation

Grounded-Grid Service at 1300 Megacycles, ¾ λ Output Circuit

DC Plate Voltage, During Pulse	6.0	Kilovolts
DC Plate Current, During Pulse	7.0	Amperes
DC Grid Current, During Pulse (Grid Resistor = 50 Ohms)	4.3	Amperes
Power Output, During Pulse (Useful)	24.0	Kilowatts
Pulse Width	10	Microseconds
Duty Factor	0.001	

GRID-PULSED OSCILLATOR-CLASS C

Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, During Pulse	3.0	Amperes
DC Grid Voltage	−200	Volts
Plate Dissipation	110	Watts
Pulse Width♦	15	Microseconds
Duty Factor ϕ	0.02	

Typical Operation

Grounded-Grid Circuit at 1100 Megacyles, ¼ λ Output

DC Plate Voltage	1750	1950	2200	Volts
DC Plate Current, During Pulse	2.2	2.6	2.7	Amperes
DC Grid Voltage Supply**	−97	−104	−104	Volts
DC Grid Current, During Pulse	1.05	1.2	1.25	Amperes
Power Output, During Pulse (Useful)	1.5	2.0	2.4	Kilowatts
Pulse Width	10	10	10	Microseconds
Duty Factor	.02	.02	.02	

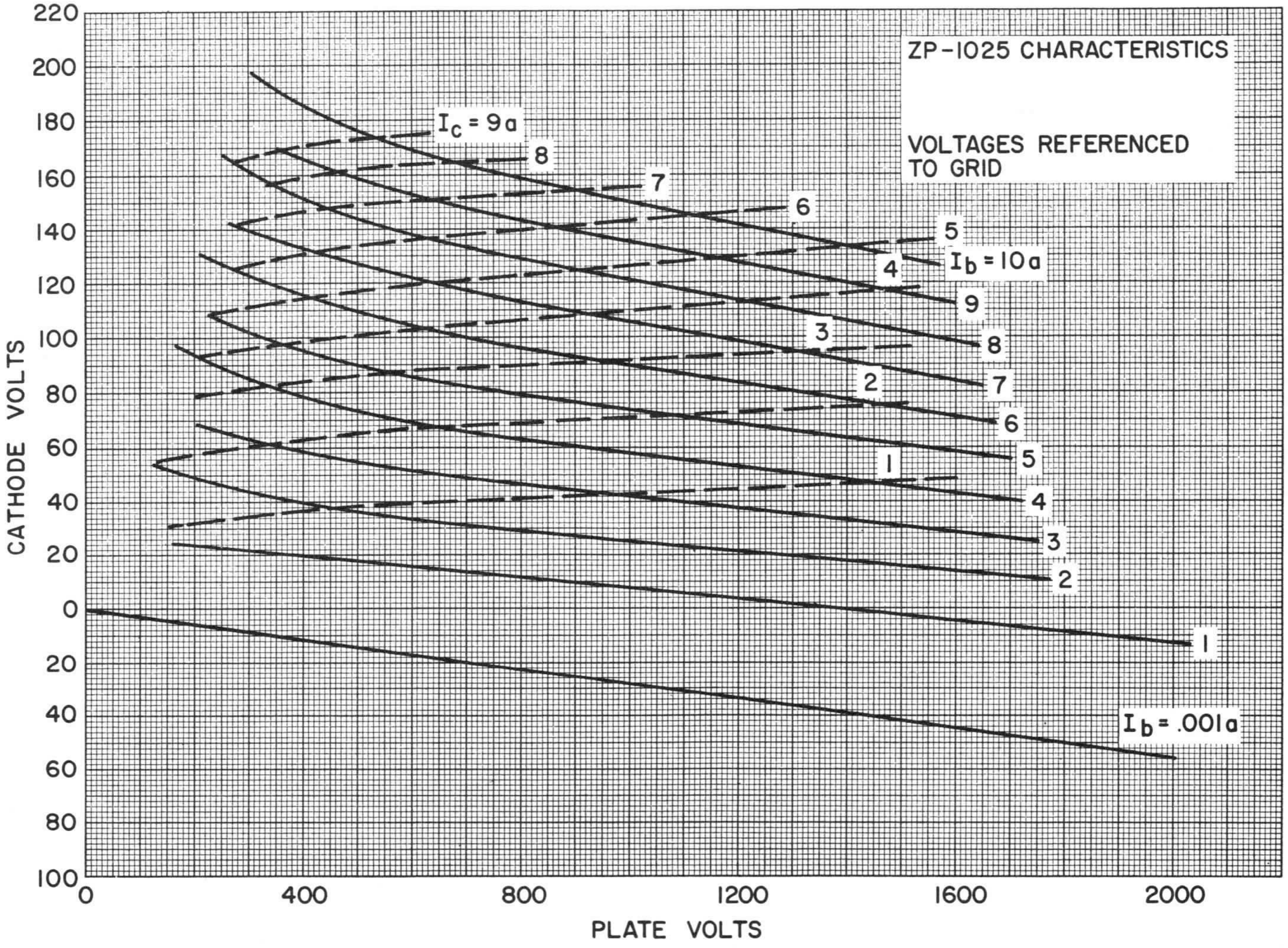
* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage. For the 1100 mcs, 2 kw, .02 duty condition, the typical heater voltage is 5.5 volts.

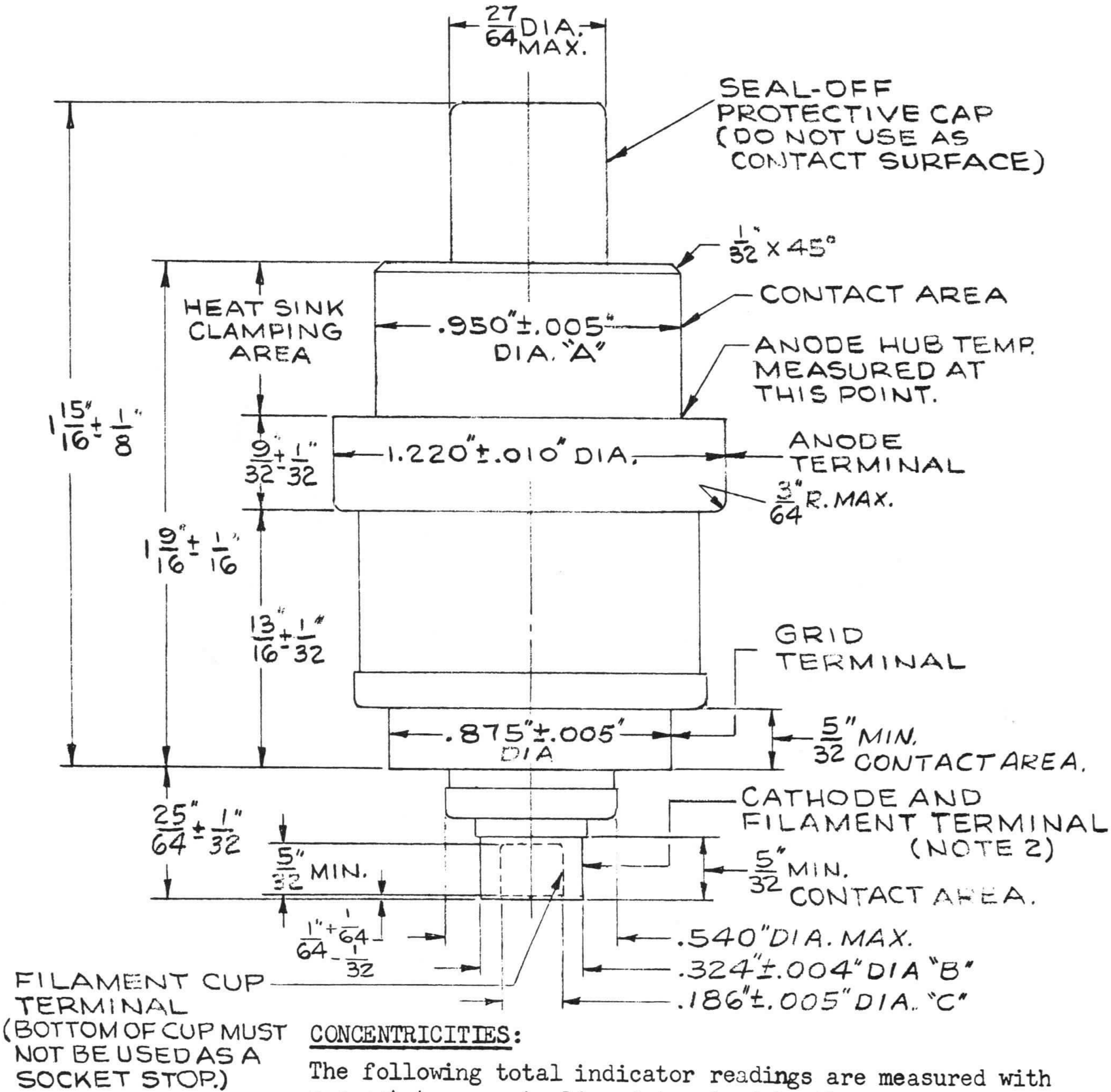
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.

◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

ϕ Maximum ratio of on-time to elapsed time during any 1-millisecond period.

** With a series grid resistance of 50 ohms.





<u>CONCENTRICITIES:</u>

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1026

TRIODE

Grid-Pulsed Amplifier Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1026 is a heat-sink-cooled triode especially designed for grid-pulsed amplifier service in L-band. This tube is particularly well suited for use in navigational aid beacons (TACAN). Features include small size, high gain, long pulse width and high duty capability, long life and reliability.

ELECTRICAL

Heater Voltage*	6.3	Volts
Heater Current	3.8	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	15.5	μμf
Output	5.9	μμf
Plate-Cathode	0.13	μμf

MECHANICAL

Mounting Position – Any		
Net Weight, approximately	3 1/4	Ounces

THERMAL

Cooling – Heat-sink and Forced-air		
Anode Temperature §	250	C
Ceramic Temperature at Any Point	200	C

GRID-PULSED AMPLIFIER – CLASS AB_2

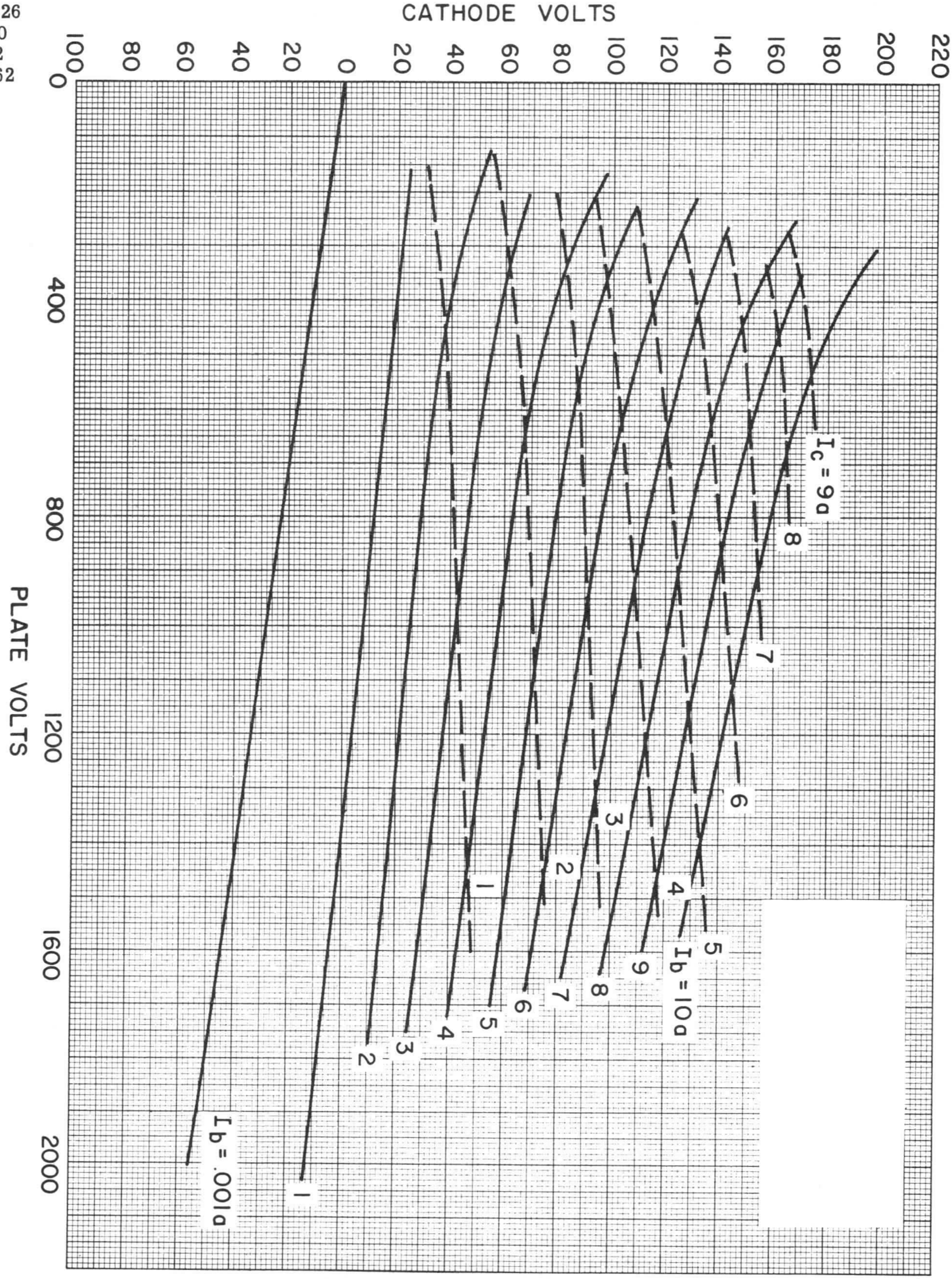
Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	2.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	110	Watts
Pulse Width	10	Microseconds
Duty Factor ∅	.04	

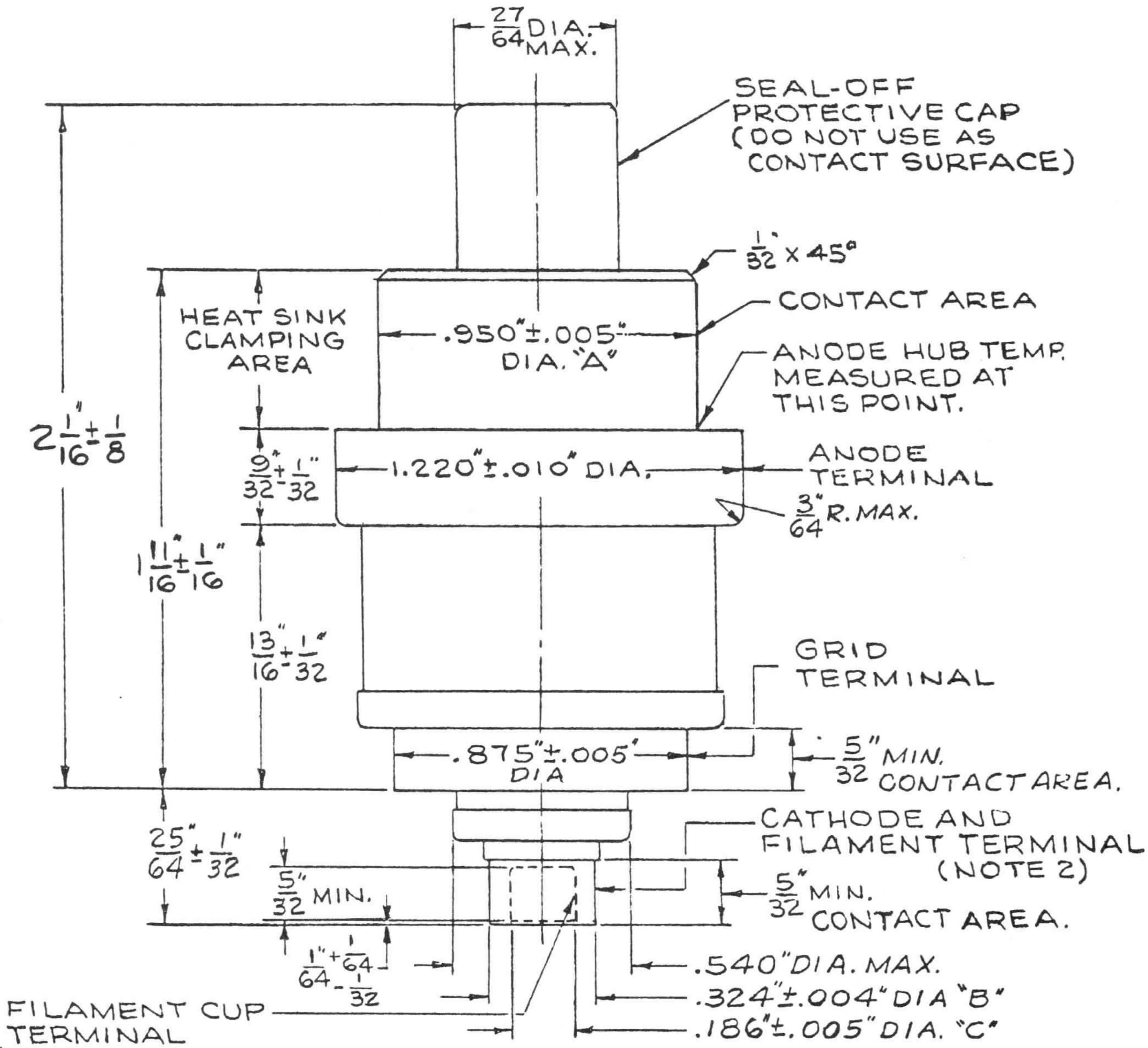
Typical Operation
Grounded-Grid Circuit at 1215 mcs, 3/4 λ Output

DC Plate Voltage	2000	Volts
DC Plate Current, during pulse	1.6	Amperes
DC Grid Voltage	-75	Volts
DC Grid Voltage, during pulse	0	Volts
DC Grid Current, during pulse	.5	Amperes
Power Output, during pulse (useful)	750	Watts
Drive Power, during pulse	95	Watts
Pulse Width ◊	8	Microseconds
Duty Factor	.03	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.
∅ Maximum ratio of on-time to elapsed time during any 250 microsecond period.
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.



Voltages Referenced to Grid



CONCENTRICITIES:

The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.030 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

TUBE DEPARTMENT
GENERAL ELECTRIC
Owensboro, Kentucky

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1034

TETRODE

Pulsed Service
Grounded-Grid Operation

Water Cooled
Metal and Ceramic

Integral Water Jacket

The ZP-1034 is a small-size, four-electrode transmitting tube especially designed for pulsed-amplifier service at L-band frequencies. This tetrode is particularly well suited for use in ground-based equipment such as steerable array radar.

The tube is capable of providing useful output at frequencies up to approximately 1500 megacycles.

Features of the ZP-1034 include long life and reliability, long pulse width, high gain and broad-banding capability.

These together with such design factors as an oxide-coated cathode, coaxial elements, and metal-ceramic construction make the tube well adapted to application in modern systems where performance and reliability are important.

ELECTRICAL

	Minimum	Bogey	Maximum	
Heater Voltage	6.0	6.3	6.8	Volts
Heater Current	--	5.5	--	Amperes
Amplification				
Factor, G_2 to G_1	--	10.5	--	
E_{g2} = 275 Volts DC, E_b = 1000 Volts DC, I_b = 200 Milliamperes DC				
Cathode Heating Time	1	--	--	Minute
Direct Interelectrode Capacitances*				
Cathode to Plate †	--	0.012	--	uuf
Input	--	24.0	--	uuf
Output	--	9.8	--	uuf

MECHANICAL

Mounting Position – Any

Net Weight, approximate	13	Ounces

THERMAL

Cooling – Water and Forced Air ø

Water Flow		
Anode	0.5	Minimum Gallons per Minute
Outlet Temperature	70	Maximum C

THERMAL (Cont'd.)

Air Flow

Anode Ceramic, approximate	1	Cubic Foot per Minute
Screen and Control Grid, approximate	1	Cubic Foot per Minute
Heater and Cathode, approximate	1	Cubic Foot per Minute
Ceramic Temperature at any Point	200	Maximum C

RADIO-FREQUENCY POWER AMPLIFIER - CLASS C

Maximum Ratings

Pulsed Drive, 1300 Megacycles

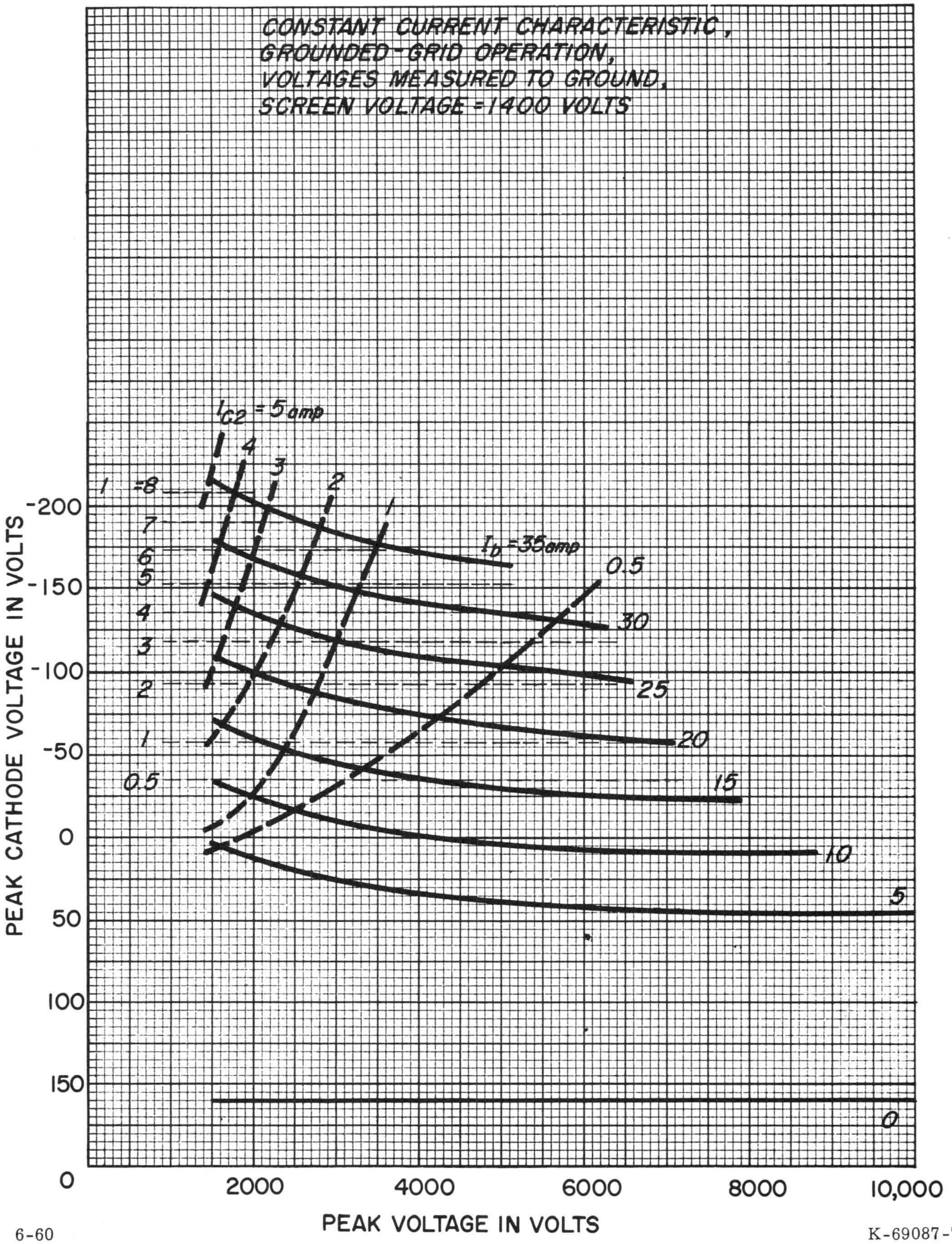
DC Plate Voltage	4	Kilovolts
DC Plate Current, during pulse	6	Amperes
DC Grid-No. 2 Voltage	1.1	Kilovolts
DC Grid-No. 2 Input #	5	Watts
DC Grid-No. 1 Voltage	-225	Volts
DC Grid-No. 1 Current	1.5	Amperes
Plate Dissipation #	750	Watts
Pulse Width ** ††	15	Microseconds
Duty Factor ** øø	0.01	

Typical Operation

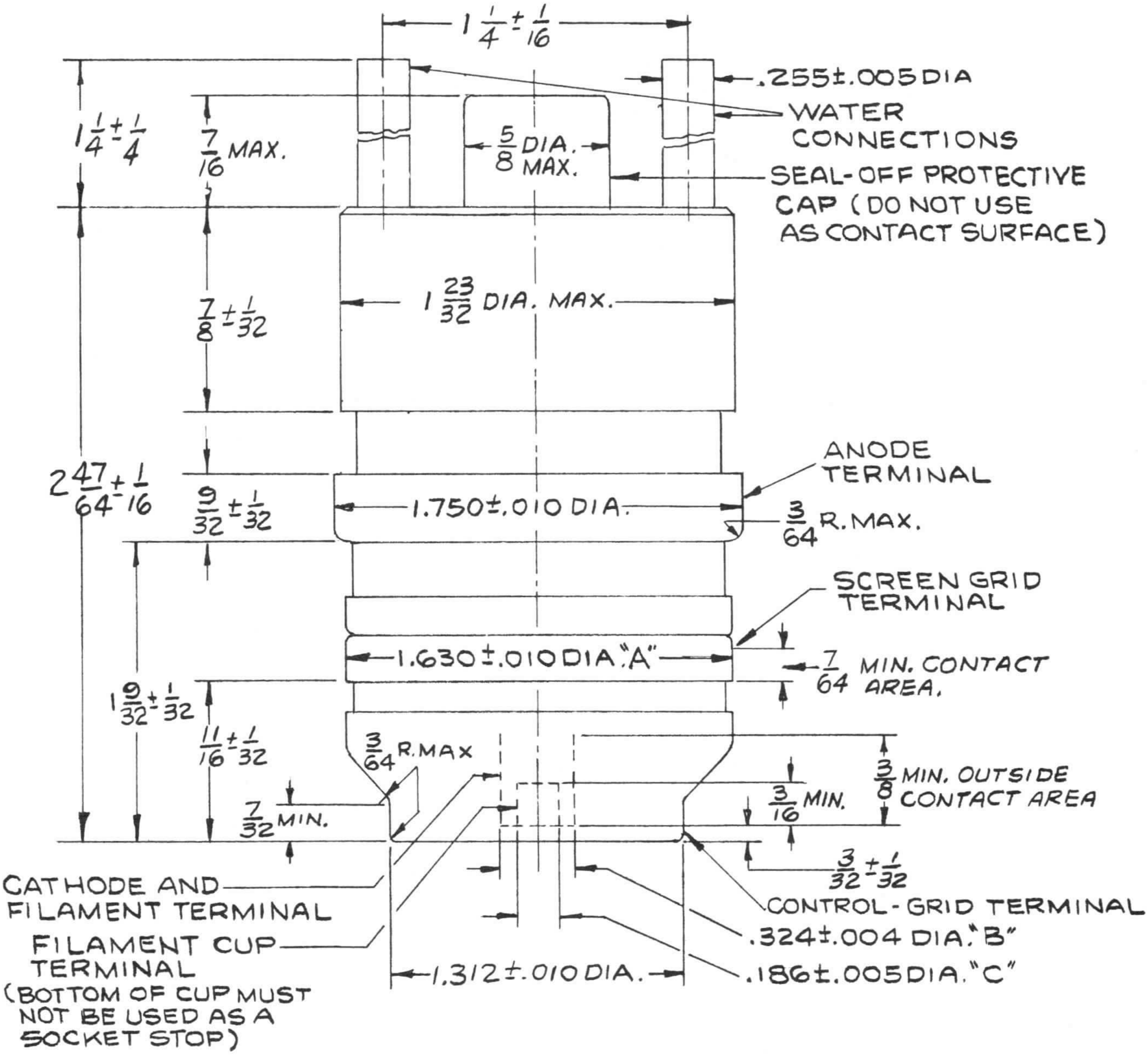
Grounded-grid Circuit at 1300 Megacycles, λ/4 Output Circuit

DC Plate Voltage ##	4.0	Kilovolts
DC Plate Current during pulse	3.5	Amperes
DC Grid-No. 2 Voltage	750	Volts
DC Grid-No. 2 Current, during pulse	75	Milliamperes
DC Grid-No. 1 Voltage	-150	Volts
DC Grid-No. 1 Current, during pulse	150	Milliamperes
Driving Power at Tube, during pulse	750	Watts
Power Output, during pulse (useful)	7.5	Kilowatts
Pulse Width ††	15	Microseconds
Duty Factor	0.01	

* Control grid connected directly to screen grid.
† Complete external shielding between cathode and plate.
ø Water and forced air cooling to be applied during the application of any voltages.
\# Maximum average value.
** For applications that require longer pulses or higher duty refer to the tube manufacturer for recommendations.
†† Pulse duration measured between points at 70 percent of peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
øø Maximum ratio of on-time to elapsed time during any 1.5-millisecond period.
\## A minimum surge-limiting resistance of 50 ohms must be placed between the plate of the tube and the B+ power supply at steady-state voltages greater than 3.5 kilovolts.



 K-69087-72A872



<u>CONCENTRICITIES</u>: The following total indicator readings are measured with respect to a centerline determined by the centers of the anode terminal and control grid terminal.

Diameter A - 0.016 inches
Diameter B - 0.036 inches
Diameter C - 0.042 inches

Total indicator reading of filament cup terminal diameter (C) measured with respect to center of cathode and filament terminal diameter (B) - 0.016 inches.

ZP-1043

TRIODE

Grid-Pulsed Amplifier Service
Grounded-Grid Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1043 is a heat-sink-cooled triode especially designed for grid-pulsed amplifier service in L-band. This tube is particularly well suited for use in navigational aid application. Features include small size, long pulse width and high duty capability, long life and reliability.

ELECTRICAL

Heater Voltage*	5.0	Volts
Heater Current	2.4	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	16.5	μμf
Output	4.0	μμf
Plate-Cathode	0.1	μμf

MECHANICAL

Mounting Position – Any

Net Weight, approximately	2-1/2	Ounces

THERMAL

Cooling – Heat-sink or Forced air

Maximum Anode Temperature §	250	C
Maximum Ceramic Temperature at Any Point	200	C

GRID-PULSED AMPLIFIER – CLASS C

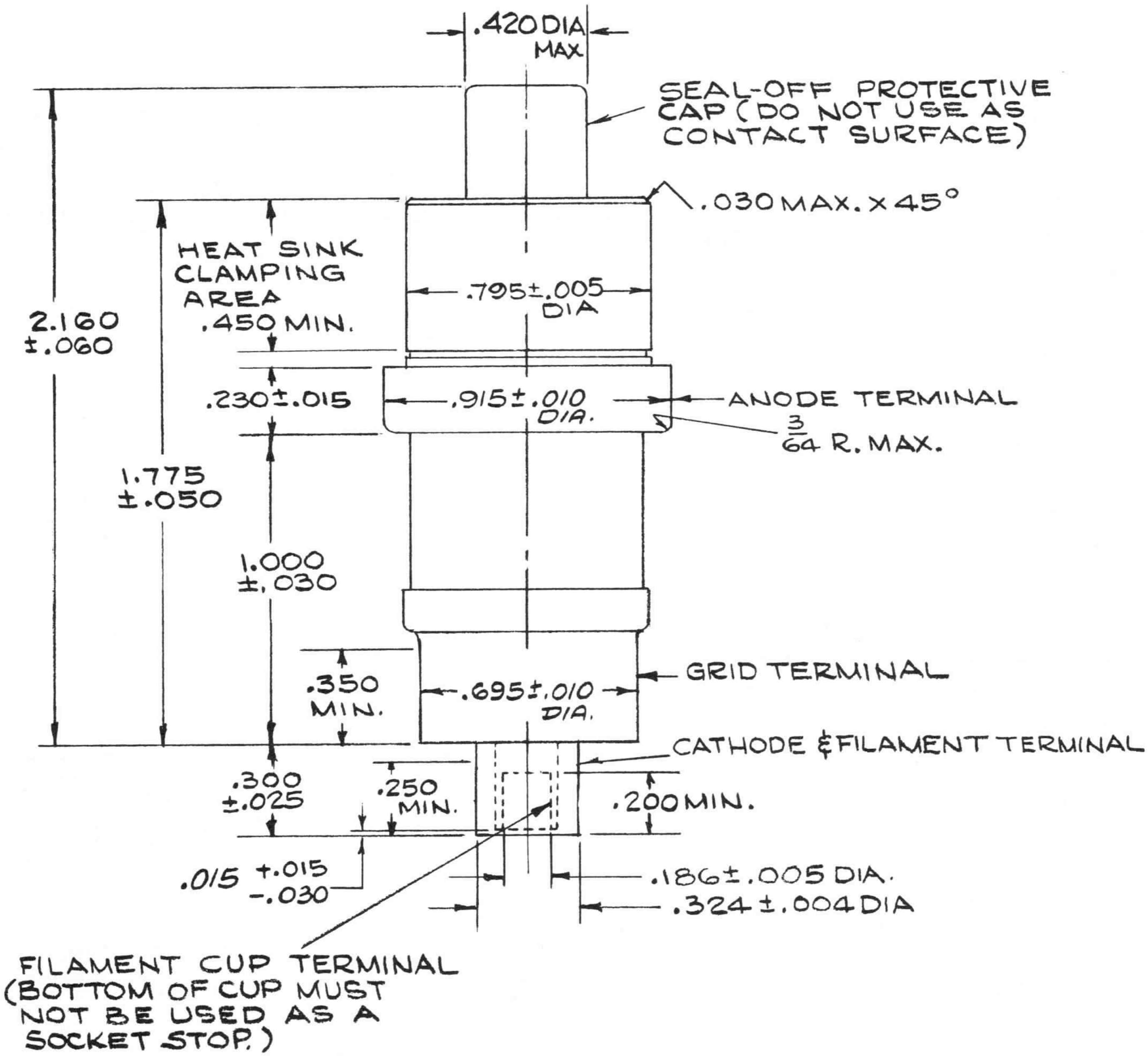
Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	3.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	50	Watts
Pulse Width ¶	10	Microseconds
Duty Factor ø¶	0.01	

Typical Operation
Grounded-Grid Circuit at 1150 mcs, 1/4 λ Output

DC Plate Voltage	2000	2000	Volts
DC Plate Current, during pulse	1.1	2.25	Amperes
DC Grid Voltage	-80	-80	Volts
DC Grid Current, during pulse	0.35	0.75	Amperes
Power Output, during pulse (useful)	1000	2000	Watts
Drive Power, during pulse	200	350	Watts
Pulse Width ◊	10	10	Microseconds
Duty Factor	0.01	0.004	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.
§ A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.
ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.
◊ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined as the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.
¶ For recommendations on longer pulse width and higher duty factor refer to the manufacturer.


.420 DIA MAX
SEAL-OFF PROTECTIVE CAP (DO NOT USE AS CONTACT SURFACE)
.030 MAX. x 45°
HEAT SINK CLAMPING AREA .450 MIN.
.795±.005 DIA
2.160 ±.060
.230±.015
.915±.010 DIA.
ANODE TERMINAL
3/64 R. MAX.
1.775 ±.050
1.000 ±.030
.350 MIN.
.695±.010 DIA.
GRID TERMINAL
CATHODE & FILAMENT TERMINAL
.300 ±.025
.250 MIN.
.200 MIN.
.015 +.015 -.030
.186±.005 DIA.
.324±.004 DIA
FILAMENT CUP TERMINAL (BOTTOM OF CUP MUST NOT BE USED AS A SOCKET STOP.)

ZP-1044
TETRODE

Internal Feedback for CW Oscillator Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1044 is a forced-air cooled power tetrode especially designed for CW oscillator service through approximately 1250 megacycles. This tube is particularly well suited for use in special applications such as a high level RF power source operating over the range of 200 to 1000 megacycles.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service. This special feature greatly simplifies cavity design, construction, and operation, particularly where very broad frequency coverage is required.

Other features include metal and ceramic construction, an integral radiator capable of dissipating 1500 watts and an indirectly heated thoriated tungsten cathode.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage*	-	5.7	6.0	Volts
Heater Current at 5.7 Volts	22	24	26	Amperes
Heater Starting Current	-	-	36	Amperes
Heater Cold Resistance	-	0.02	-	Ohms
Cathode Heating Time	1	-	-	Minutes
Direct Interelectrode Capacitances				
Input, G_2 tied to G_1	-	17.0	-	μμf
Output, G_2 tied to G_1 §	-	5.5	-	μμf

MECHANICAL

Mounting Position - Vertical
Net Weight, approximate .... 3.6 Pounds

THERMAL

Air Flow ¶
Through Radiator, at Sea Level

Plate Dissipation	1.5	Kilowatts
Air Flow, 45 C Incoming Air Temperature, Minimum	60 Min	Cubic Feet per Minute
Static Pressure	1.5	Inches-Water
Heater-to-Cathode Seals	8 Min	Cubic Feet per Minute

THERMAL (CONTD.)

Screen-Grid to Control-Grid Seals	4 Min	Cubic Feet per Minute
Anode to Screen-Grid Ceramic Insulator	6 Min	Cubic Feet per Minute
Radiator Hub Temperature at Fin Adjacent to Anode Seal ..	180 Max	C
Ceramic Temperature at Any Point	200 Max	C

CW RADIO-FREQUENCY OSCILLATOR - CLASS C

Maximum Ratings, Absolute Values

DC Plate Voltage	4000 Max	Volts
DC Grid-No. 2 Voltage	600 Max	Volts
DC Grid-No. 1 Voltage	-150 Max	Volts
DC Plate Current	0.7 Max	Amperes
DC Grid-No. 1 Current	0.10 Max	Amperes
Plate Input	2.5 Max	Kilowatts
Grid-No. 2 Input	25 Max	Watts
Plate Dissipation	1.5 Max	Kilowatts

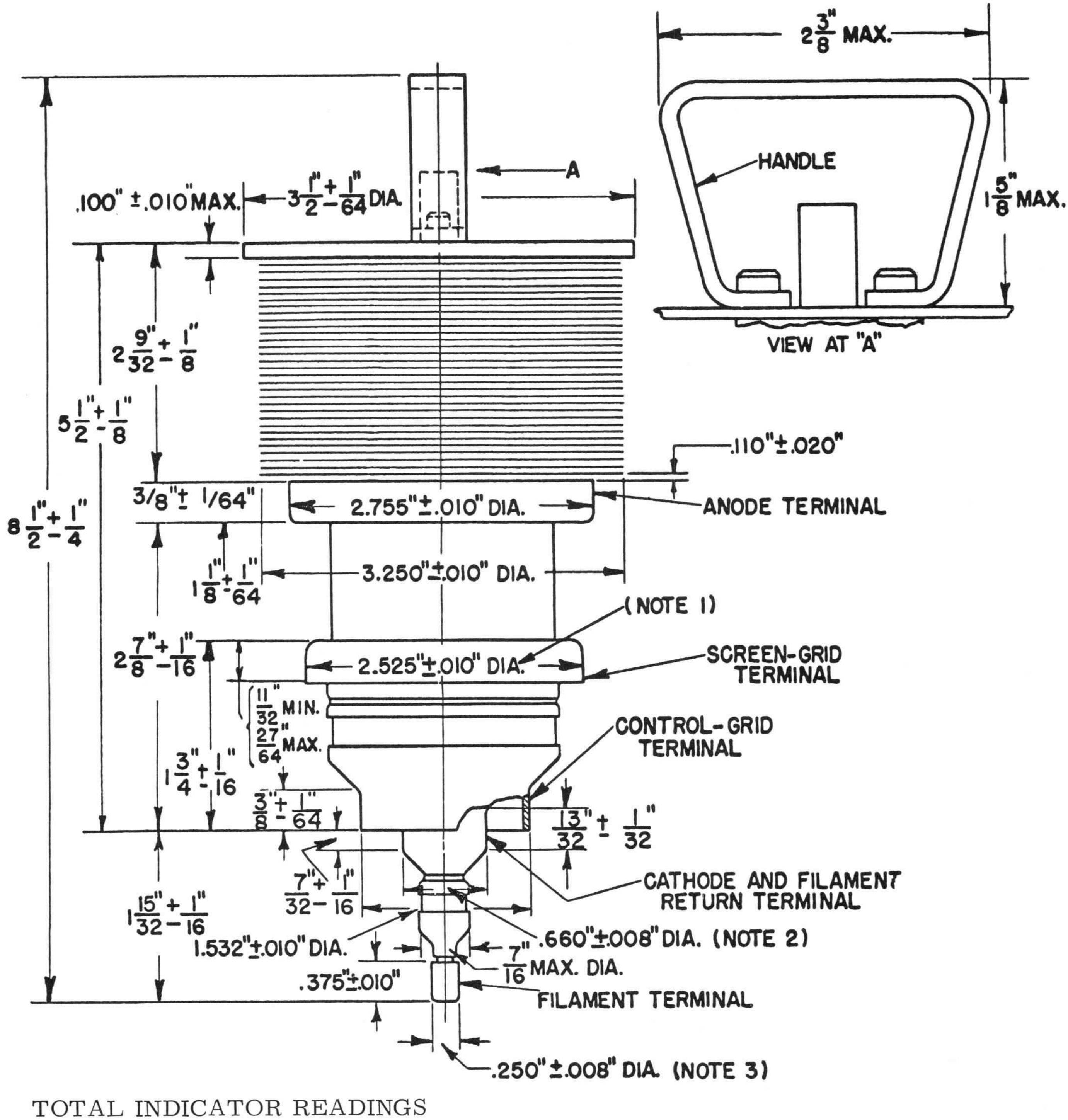
Typical Operation - Grounded-Grid Circuit up to 1000 Megacycles

DC Plate Voltage	3800	Volts
DC Grid-No. 2 Voltage	500	Volts
DC Grid-No. 1 Voltage	-120	Volts
DC Plate Current	0.500	Amperes
DC Grid-No. 2 Current	0.022	Amperes
DC Grid-No. 1 Current, approximate	0.075	Amperes
Power Output, approximate (useful)	1100	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions.

§ Output capacitance measured between anode and screen grid. Control grid connected directly to screen grid.

¶ The volume of cooling air indicated for the various seals is approximate only. Distribution of cooling air will vary with the cavity configuration about the tube. For most satisfactory operation the maximum temperature of any point on the tube should be below 200 C. Cooling is to be provided before and during the application of any voltages.



TOTAL INDICATOR READINGS
NOTE 1. 0.020"
NOTE 2. 0.030"
NOTE 3. 0.060"
THE ABOVE READINGS ARE MEASURED WITH RESPECT TO A CENTERLINE DETERMINED BY THE CENTERS OF THE ANODE TERMINAL AND CONTROL-GRID TERMINAL

K-69087-72A475

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

OBJECTIVE
TECHNICAL INFORMATION

These ratings represent the design objective for this product. Refer to the Preliminary Technical Information sheet for ratings currently achieved in the progression towards design objectives. If PTI sheets do not exist, consult your local Tube Department Regional Sales Office.

ZP-1057
TRIODE

Internal Feedback for CW Oscillator Service
Grounded-Grid Operation

Forced-Air Cooled
Metal and Ceramic

The ZP-1057 is a forced-air cooled triode especially designed for CW oscillator service through approximately 2000 megacycles. This tube is particularly well suited for use in special applications such as high level microwave signal generators operating over an extremely wide frequency range.

The tube features internal feedback which eliminates the need for the complicated external circuit arrangements normally required in oscillator service. This special feature greatly simplifies cavity design, construction and operation, particularly where very broad frequency coverage is required.

Other features include small size metal and ceramic construction, a high efficiency radiator, and an oxide-coated cathode with inherent long life.

ELECTRICAL	Minimum	Bogey	Maximum	
Heater Voltage*	-	6.3	-	Volts
Heater Current	3.5	3.8	4.0	Amperes
Cathode Heating Time	1	-	-	Minute
Direct Interelectrode Capacitances				
Input	-	15.5	-	μμf
Output	-	6.5	-	μμf

MECHANICAL

Mounting Position - Any		
Net Weight, approximately	5 3/4	Ounces

THERMAL

Cooling - Forced Air		
Through Radiator, at Sea Level		
Plate Dissipation	300	Watts
Air Flow, 45 C Incoming Air Temperature, minimum	7	Cubic Feet per Minute
Static Pressure, approximate	0.7	Inches-Water
Radiator Hub Temperature, at Point Adjacent to Anode Seal@	250	C
Ceramic Temperature at Any Point, maximum	200	C

CW RADIO-FREQUENCY OSCILLATOR - CLASS C

Maximum Ratings

DC Plate Voltage	1750	Volts
DC Plate Current	0.300	Amperes
DC Grid Voltage	-150	Volts
DC Grid Current	0.050	Amperes
Plate Dissipation	300	Watts

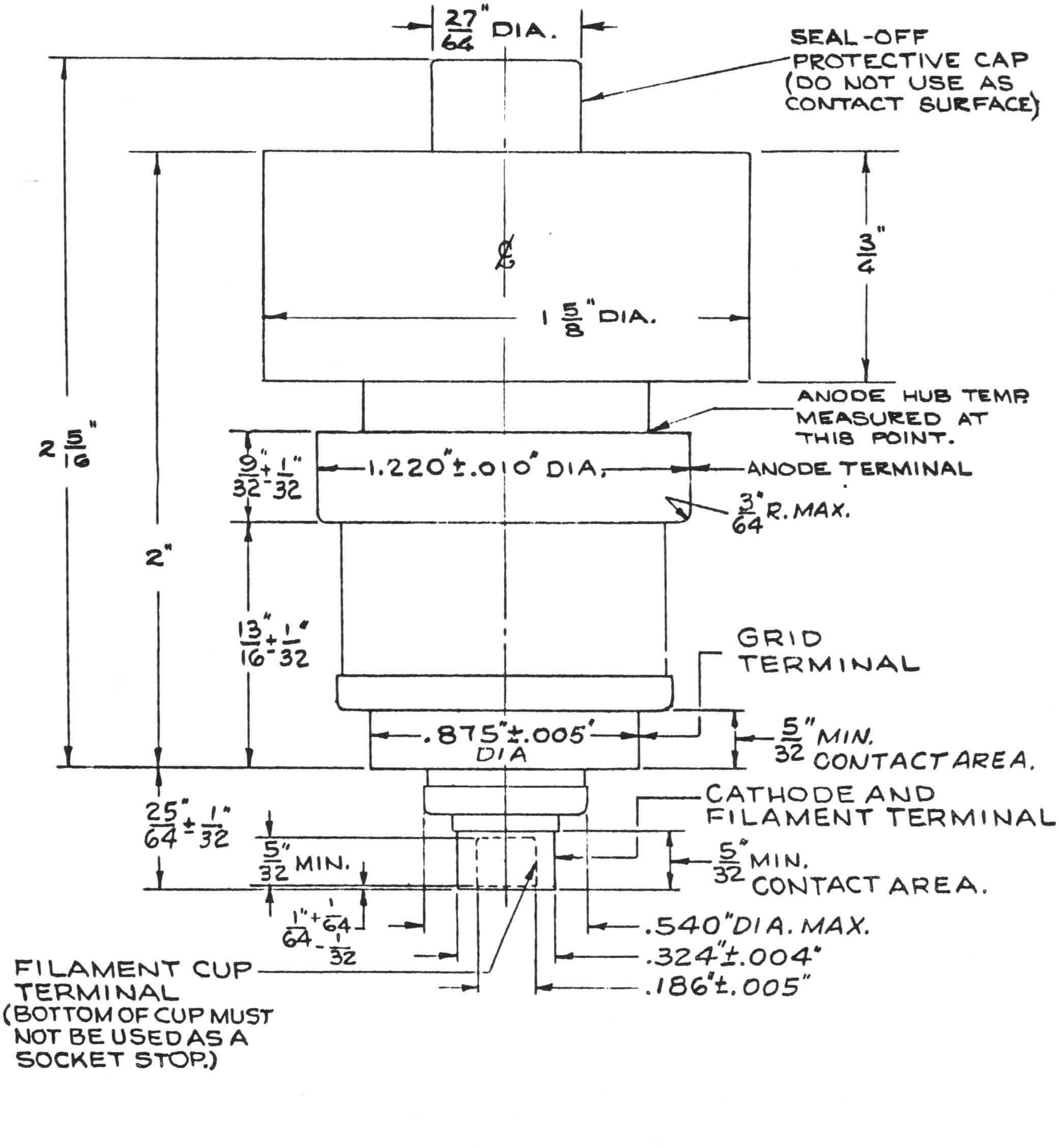
Typical Operation

Grounded-Grid Circuit at 1200 Megacycles, 3/4λ Output

DC Plate Voltage	1500	Volts
DC Plate Current	0.275	Amperes
DC Grid Voltage	-125	Volts
DC Grid Current	0.045	Amperes
Power Output, approximate (useful)	200	Watts

* Because the temperature of the cathode is increased by back bombardment of electrons at UHF, required heater voltage for optimum life decreases with increasing frequency. The amount of heater voltage reduction is dependent on operating conditions. However, this voltage should not be less than 5.5 volts.

∂ Forced-air cooling to be provided before and during the application of any voltages to limit the anode hub temperature to the value specified.



A-69087-72B116

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

ZP-1061
TRIODE

Internal Feedback for Oscillator Service
Grid-Pulsed or Plate-Pulsed Operation

Heat-Sink and Forced-Air Cooled
Metal and Ceramic

The ZP-1061 is a heat-sink-cooled triode especially designed for grid-pulsed oscillator service in L-band. The tube is particularly well suited for use in navigational aid applications.

The ZP-1061 features all necessary feedback within the tube envelope, which eliminates the need for the complicated external-circuit arrangements normally required in oscillator service.

Other features include small size, long pulse width, high duty capability, and long life and reliability.

ELECTRICAL

Heater Voltage*	5.0	Volts
Heater Current	2.4	Amperes
Cathode Heating Time, minimum	1	Minute
Direct Interelectrode Capacitances		
Input	16.0	uuf
Output	4.3	uuf

MECHANICAL

Mounting Position - Any

Net Weight, approximate	2-1/2	Ounces

THERMAL

Cooling - Heat-sink or Forced Air

Maximum Anode Temperature#	250	C
Maximum Ceramic Temperature at Any Point	200	C

GRID-PULSED OSCILLATOR - CLASS C **

Maximum Ratings

DC Plate Voltage	2.5	Kilovolts
DC Plate Current, during pulse	2.0	Amperes
DC Grid Voltage	-200	Volts
Plate Dissipation	50	Watts
Pulse Width&	10	Microseconds
Duty Factorø&	0.01	

Typical Operation

Grounded-Grid Circuit at 1090 mcs, 1/4λ Output

DC Plate Voltage	1750	Volts
DC Plate Current, during pulse	1.25	Amperes
DC Grid Voltage	-80	Volts
DC Grid Current, during pulse	0.75	Amperes
Power Output, during pulse (useful)	1000	Watts
Pulse Widthø	0.5	Microseconds
Duty Factor	0.01	

* Because of back-heating due to transit time effects, it may be necessary to reduce the heater voltage.

A suitable heat-sink clamping arrangement must be provided to limit the anode hub temperature to the value specified.

ø Maximum ratio of on-time to elapsed time during any 250 microsecond period.

¢ Pulse duration is measured between points at 70 percent of the peak value. The peak value is defined at the maximum value of a smooth curve through the average of the fluctuations over the top portion of the pulse.

& For recommendations on longer pulse width and higher duty factor refer to the manufacturer.

** Plate-pulsed oscillator operation may be used for considerably higher peak power output than that indicated under typical operation. For recommendations refer to the manufacturer.

CERAMIC TUBE SOCKETS AND CAVITIES

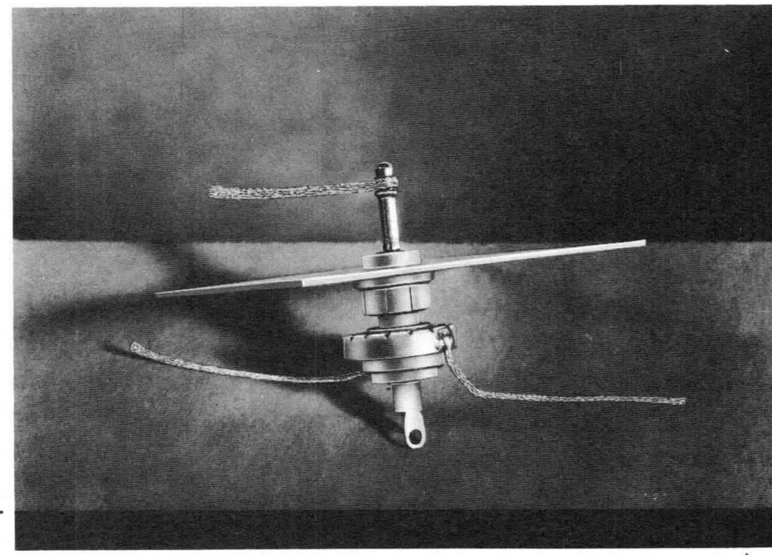
The following pages are a partial summary of sockets and cavities that are available from typical socket and cavity manufacturers. This summary is by no means all inclusive, but rather is intended to show typical availability only.

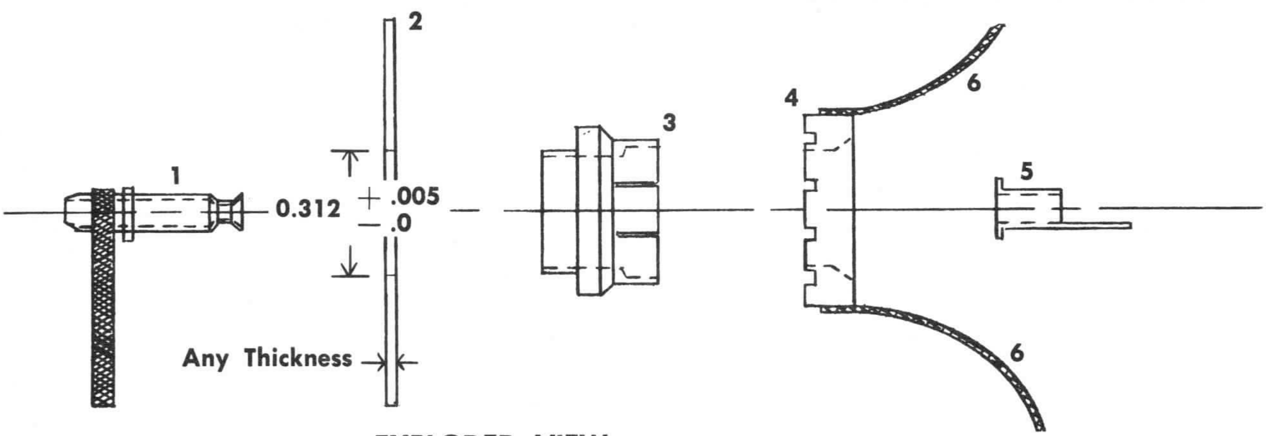
The tubes, sockets, cavities, and other arrangements disclosed herein may be covered by patents of General Electric Company or others. Neither the disclosure of any information herein, nor the sale of tubes by General Electric Company, conveys any license under patent claims covering combinations of tubes with such sockets, cavities, or other devices or arrangements. In the absence of an express written agreement to the contrary, General Electric Company assumes no liability for patent infringement or other liability arising out of any use of the tubes with sockets, cavities, or other devices by any purchaser of tubes or others.

Since the information presented in this manual is industry-wide in scope, the inclusion of a tube, socket, cavity, or other device in this manual does not necessarily imply or guarantee its availability.

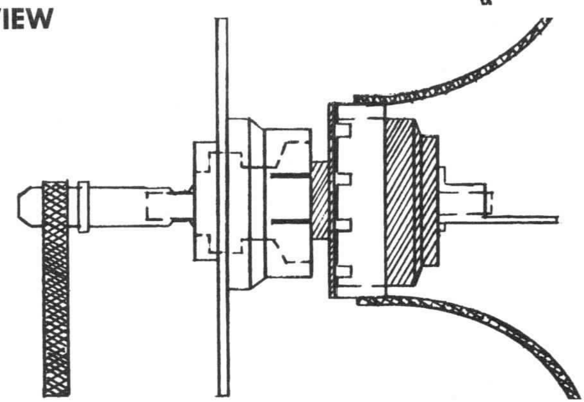
SOCKET CM-9

cathode mount for type GL-6299 GL-7391 GL-7644 CERAMIC TRIODES





EXPLODED VIEW



ASSEMBLED VIEW
(tube in place)

Scale - 2″ = 1″

1. Heater contact
2. Mounting surface
3. Cathode contact (multiple fingers)
4. Grid contact (multiple fingers)
5. Plate contact
6. Connection leads (1 inch long, tinned copper braid)

Mount socket by soldering (3) into 0.312 $^{+.005}_{-.0}$ diameter hole in mounting surface.

All contacts silver plated for minimum contact resistance.

Specifications subject to change without notice.

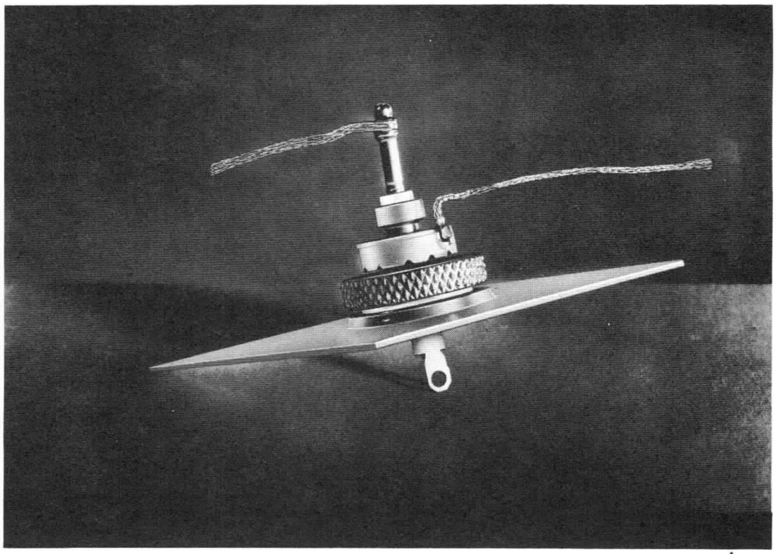
Printed in U.S.A.

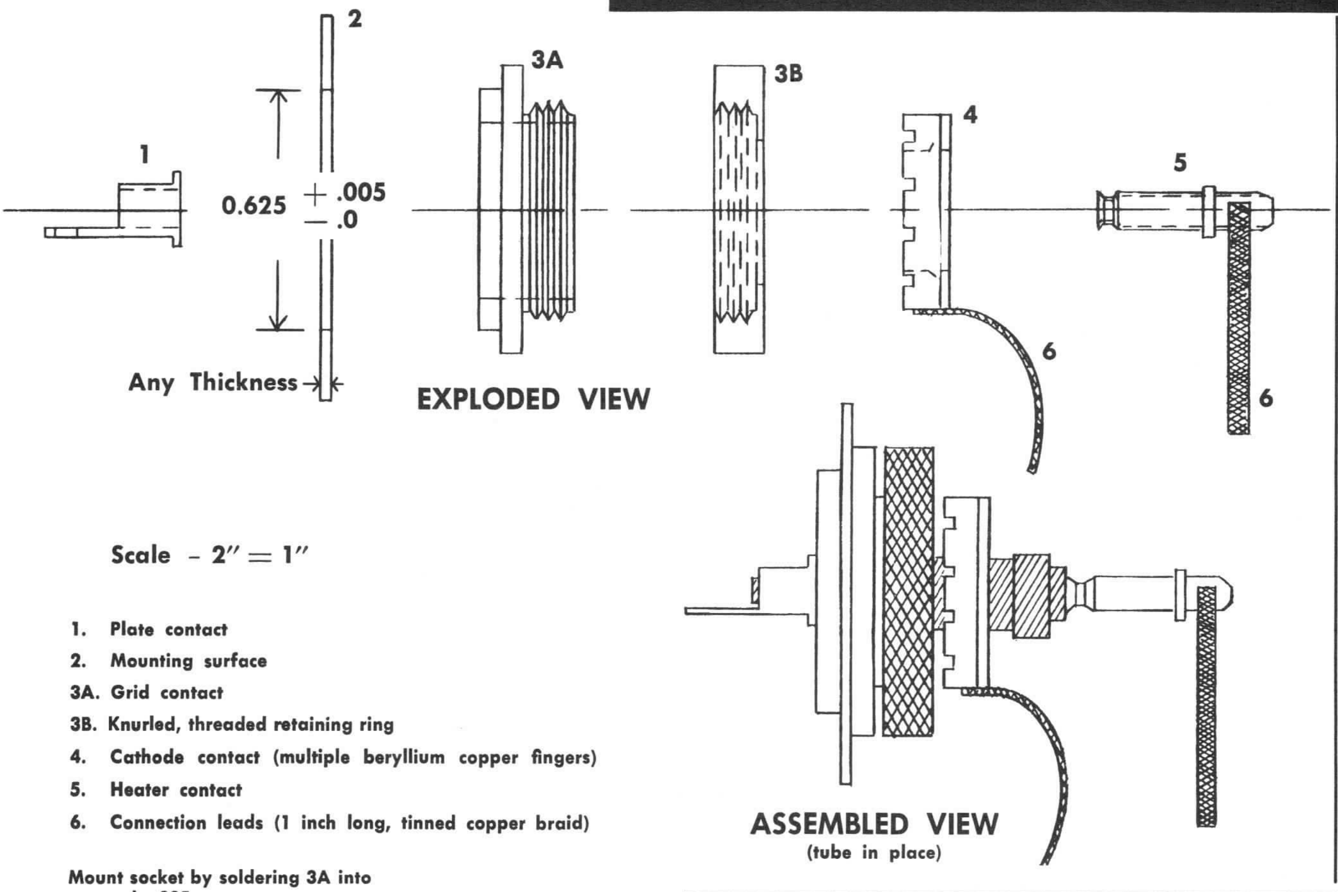
Community Engineering Corporation

STATE COLLEGE, PENNSYLVANIA
Telephone AD 8-2461
Area Code 814

SOCKET GG-9

grounded grid for type GL-6299 GL-7391 GL-7644 CERAMIC TRIODES





Scale - 2" = 1"

1. Plate contact
2. Mounting surface
3A. Grid contact
3B. Knurled, threaded retaining ring
4. Cathode contact (multiple beryllium copper fingers)
5. Heater contact
6. Connection leads (1 inch long, tinned copper braid)

Mount socket by soldering 3A into 0.625 $^{+.005}_{-.0}$ diameter hole in mounting surface.

All contacts silver plated for minimum contact resistance.

Weight less than ½ ounce.

Specifications subject to change without notice.

Community Engineering Corporation

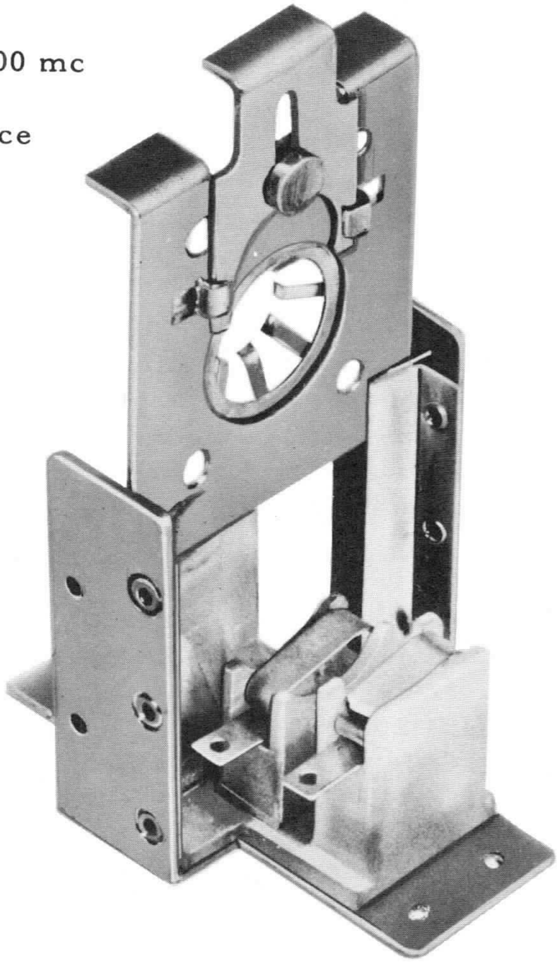
STATE COLLEGE, PENNSYLVANIA
Telephone AD 8-2461
Area Code 814

Printed in U.S.A.

Instruments For Industry, Inc. . . 101 New South Road, Hicksville, N.Y.
OVerbrook 1-7100 • Cable Address: Electronic, Plainview, N.Y.

XV100/6299 VHF TUBE SOCKET

- Rapid tube replacement to identical position
- High frequency applications
- No resonances to 1000 mc
- Grounded grid service
- Meets Mil Specs



This tube socket, designed specifically for use with the 6299 triode, was developed for use in IFI countermeasures systems and has proven to be most rugged and reliable. Removal and replacement of the triode are permitted with positive seating each time to assure identical electrical characteristics.

The socket is small enough to retain the electrical characteristics for high frequency applications and sturdy enough to meet military service conditions. Problems of poor grounding and varying circuit values resulting from the shift of contacts and circuit parts encountered in other tube mounts have been completely overcome.

Careful engineering and design make the model XV100/6299 useable to 1000 mc or higher under the most severe temperature, humidity, shock and vibration conditions. With this socket, it is possible to quickly realize practical UHF lumped constant circuitry with absolute assurance of bandpass stability as tubes are changed.

Since the 6299 is intended primarily for grounded grid service, this socket provides a minimum of inductance for the grid return path to ground. In a suitably designed chassis, this ground plane will provide isolation between input and output for amplifier stability.

The slide assembly permits quick replacement of tubes without disturbing any of the associated circuitry. This is accomplished by the use of spring contacts which are directly connected to the circuit and maintain their position in the molded plastic mount. Removal of the tube cannot cause any shift of circuit elements. For those applications at ultra high frequencies with lumped constants, this is a major advancement.

IFI has in production at the present time various equipments using this tube socket. A few of the applications include:

AN/MLQ-26	Signal Corps	Mil Std 169, 170
AN/TLQ-14 (XN-1)	BuShips	Mil E 16400
AN/ALQ3448 (XN-1)	BuAer	Mil E 5400
AN/MLQ-8	Signal Corps	Mil Std 169, 170

In addition, the XV100/6299 tube socket has found wide acceptance in numerous industrial applications.

Figure 1 (opposite) is a plot of the tube seal temperature vs. ambient temperature and various levels of plate dissipation on the 6299. For ambient temperatures up to and including 85°C, the tube seal temperature is a minimum of 30° below the maximum allowable temperature as published by the manufacturer. For plate dissipations up to and including 2.1 watts, the IFI socket permits the use of the tube at these

Instruments For Industry, Inc. . . 101 New South Road, Hicksville, N.Y.
OVerbrook 1-7100 • Cable Address: Electronic, Plainview, N.Y.

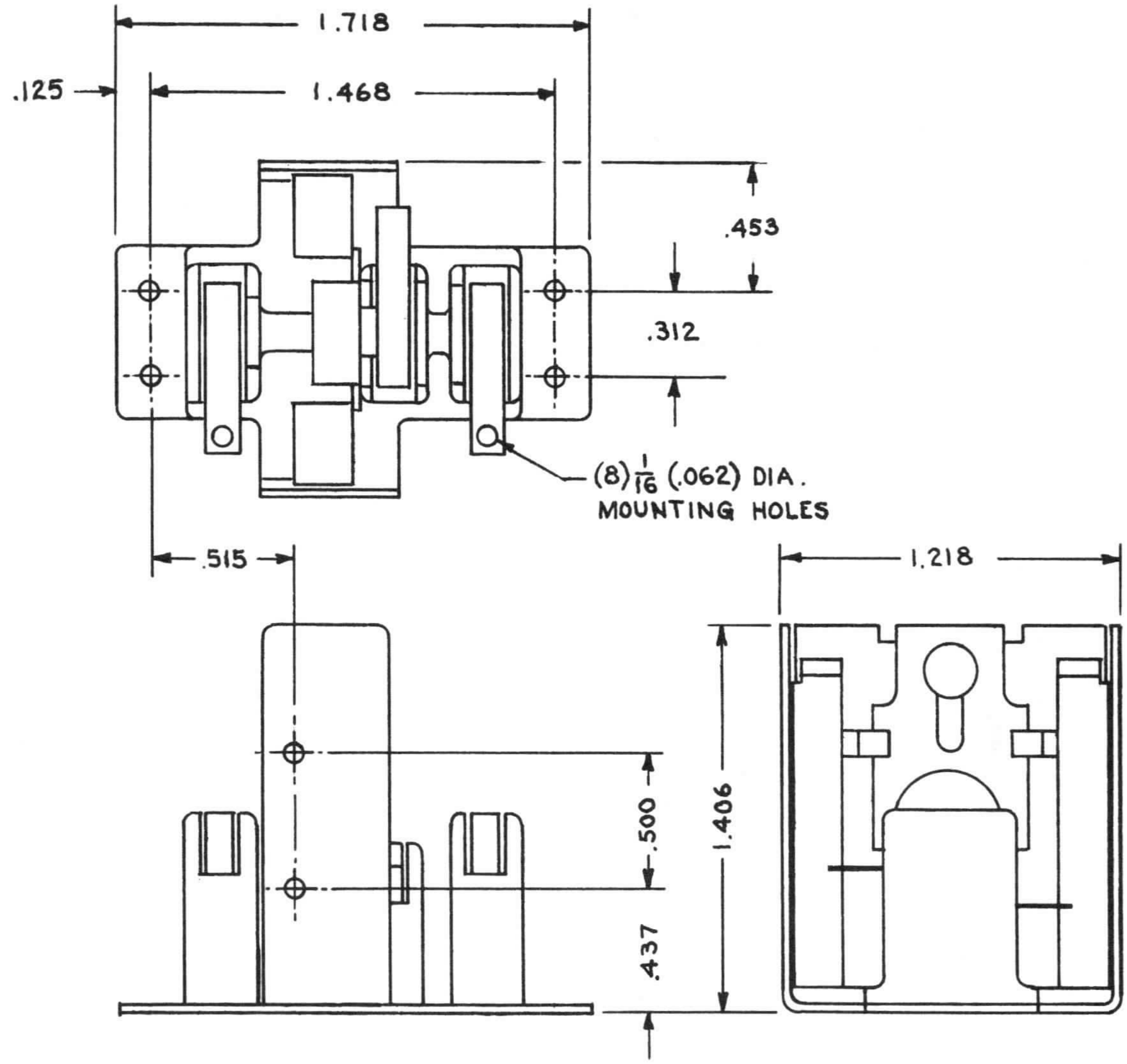


FIGURE 2

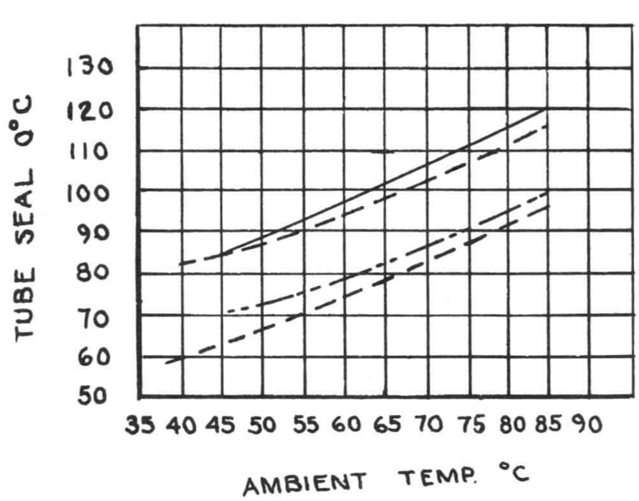


FIGURE 1

elevated temperatures. For all ground equipments, the 85^{o}C limit shown is beyond Mil Std. 169. For those applications requiring even higher ambient temperatures, a modified socket will be supplied to meet the most stringent requirements.

Figure 2 is an outline drawing of the XV100/6299. The .453 dimension, overall width and mounting surface may be modified on order for specialized applications.

Material is brass, gold flashed for rf conductivity. Dielectric is cross linked styrene copolymer for low loss and low capacitance. The spring contacts are beryllium copper, gold flashed.

Other versions of this socket are:

XV101	for 6442 tubes
XV103	for 7077 tubes

Instruments For Industry, Inc. . . 101 New South Road, Hicksville, N.Y.
OVerbrook 1-7100 • Cable Address: Electronic, Plainview, N.Y.

REGISTERED TYPES

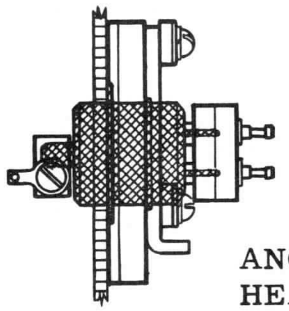
2C39-B 76-020 Grd. Grid Coax.
76-030 Same as 76-020 (Separate
76-046 H.T. Pump Connector
2C40-A No Socket
2C43 No Socket
6299 85-040 Gr'd. Grid, Thru Barrier
85-050 Same as 85-040 (with Radiator on Anode Contact)
6442 82-010 Gr'd. Grid Coax, UHF
82-011 Specials -(Similar to 82-010 for Sandwiched Chassis)
82-046 H.T. Pump Connector
82-015 Special Kit
6771 Same Sockets as for 6442
6897 Same Sockets as for 2C39
7077 86-000 Low Freq.
86-001 Same as 86-000 (With Heater Support Block)
86-002 Printboard
86-005 Printboard
86-020 Same as 86-001 (with Base and Heater Block of FS-5)
86-040 UHF, Grd. Grid, Thru Barrier
86-041 Same as 86-040 (With Stainless Steel Hardware)
86-042 Same as 86-040 (For 1/16 Chassis)
86-060 Test, Octal Base
86-070 Gr'd. Grid (Sometimes Soldered Onto Barrier)
86-071 Same as 86-070 (with Heater Support Block)
86-076 Same as 86-071 (With Base of FS-5)
86-080 Printboard Ass'y.
86-085 Printboard (Kit)
7266 66-000 Low Freq., Low Capacitance
66-080 Printboard Ass'y.
66-081 Printboard Ass'y. (Special)
66-085 Printboard (Kit)
86-110 Hi-Temp, UHF (Special)
7296 87-010 Low Freq. Ceramic
87-015 Ultra High Temp. Alum. Ceramic Base
87-020 Low Freq. Low Loss (KEL-F) Base
87-025 Grd. Grid, Thru Barrier
7391 Same Sockets as for 6299
7462 87-000 Low Freq.
87-001 Gr'd. Grid Thru Barrier
87-002 Same as 87-000 (With KEL-F Base)
87-005 Test, Octal Base
7486 Same Sockets as for 7077
7588 Same Sockets as for 7296
7625 Same Sockets as for 7462
7644 Same Sockets as for 6299
7720 Same Socket as 7462
7768 86-102 UHF, Gr'd. Grid
86-104 Low Freq.
86-107 Test, Octal Base
7784 None
7841 Same Sockets as 7266
8081 Same Sockets as 7462
8082 Same Sockets as 7462
8083 Same Sockets as 7462

DEVELOPMENTAL TYPES

Z-2354 None
Z-2689 (See 7296 - Diode Version - Use 87-010, -015, -020)
Z-2692 None
Z-2731 None
Z-2823 (See 7768)
Z-2835 Same Sockets as 7768 (Z-2823)
Z-2866 **86-099 Test, Octal Base**
Z-2867 Same Sockets as 7768 (Z-2823)
Z-2868 Same Sockets as 7296
Z-2869 Same Sockets as 7768 (Z-2823)
Z-2870 Same Sockets as 7296
Z-2897 **86-108**
Z-5099-A Same Sockets as 2C39-B
Z-5267 No Socket
Z-5317 None
Z-5387 Same Sockets as 2C39B
Z-5450 None
Z-5457 None
Z-5460 None

DATA SHEETS ON REQUEST
THIS IS A PARTIAL LISTING OF JETTRON SOCKETS FOR GE TUBES --- PLEASE CONTACT OUR HOME OFFICE FOR MORE COMPLETE INFORMATION.

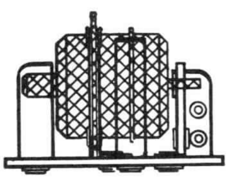
NEW PRODUCTS



86-102
7768
Z-2823
Z-2835
Z-2867
Z-2869
ANODE #8790
HEATER #8785

APPLICATION SOCKET - UHF, GR'D. GRID.
- Tube Stop and Bushing = KEL-F (Alternate Glass-filled Teflon)
- Base Insulator = G-10
- Heater Contacts = Be. Cu., Silver and Gold Plated
- Grid and Cathode Contact = Be. Cu., Silver Plated
- Plate Contact = Brass, Silver Plated

Note (Heater or Anode Contact Ass'y. May be Purchased Separately).

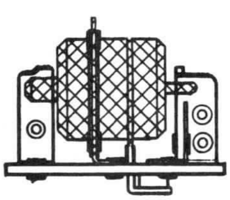


86-104
7768
Z-2823
Z-2835
Z-2867
Z-2869

APPLICATION SOCKET for G.E. 7768 Tube and Z-2835, Z-2867, and Z-2869 Developmental Types.
- Base Insulator = Glass Silicone G-7
- Heater Contacts = Be. Cu., Silver and Gold Plated.
- Grid and Cathode Contacts = Silver Plated
- Plate Contact = Inconel-X, Silver Plated

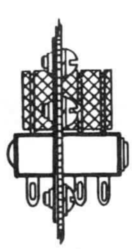
86-110
7266

APPLICATION SOCKET - HI TEMP. - UHF for G.E. 7266
- Base Insulator = Alumina-Alsimag 614
- All Contact = Inconel "X" Gold Plate over Nickel
- Mounting Bracket = Alum. alloy
- Washers = #505E Teflon
- Screws = Stainless Steel
- All Leads = #24 AWG Stranded Wire, Teflon Insul.



86-114
Z-2869-1

APPLICATION SOCKET for G.E. Developmental Tube Z-2869-1.
- Base Insulator = Glass Silicone G-7
- Heater Contacts = Be. Cu., Silver and Gold Plated
- Grid and Cathode Contacts = Silver Plated
- Plate Contact = Inconel-X, Silver Plated



87-001
7462
7625

APPLICATION SOCKET - UHF - GR'D. GRID for G.E. 7462 and 7625 Tubes
- Base Insulator = KEL-F
- All Contacts = Be. Cu., Silver and Gold Plated
- Grid Plates = Brass, Silver Plated

* Virtually Complete Isolation is Provided Through the Inbuilt Barrier

CERAMIC TUBE CAVITY MANUFACTURERS

The following is a partial summary of cavities available from typical manufacturers. It is not intended to be all-inclusive and should not be construed as an endorsement of the products by General Electric Company. Information below was submitted by the several companies to indicate their capabilities in the ceramic tube cavity field.

MANUFACTURER INFORMATION	Description of Products
ACF INDUSTRIES, INCORPORATED 11 Park Place Paramus, New Jersey Phone: COlfax 1-4100	ACF manufacturers a line of cavity oscillators utilizing planar triodes operating in the frequency range from 900 MC to 6000 MC in CW and plate pulsed service. A grid pulsed oscillator is also available in S-band. These tubes are also operated as frequency multipliers with input frequencies from 200 MC to 3000 MC.
Microwave Components Division AERO GEO ASTRO CORPORATION Alexandria, Virginia Contact: C. Beaty Phone: (703) 354-2000	A new line of miniature oscillators and amplifiers for pulse and CW is available operating from L through X-band. GE metal ceramic tubes coupled with the use of new materials and techniques result in superior performance and improved temperature characteristics without resorting to the use of bimetallic compensators.
AMERAC INCORPORATED Dunham Road Beverly, Mass. Phone: Boston HA 6-3190 (617) Beverly 922-8611 TWX 617-922-0879	Founded: 1946. Frequency ranges UHF to X-band. Product Lines: Cavity Oscillators, Tube Type Amplifiers, Mixers, Multipliers; Wavemeters, Diode Mixers, Modulators, Test Equipment G. E. Tube Types: 2C39, 6897, Z-5099, 6771, 6442, 7077, 7266 are available in standard units. Many Other G.E. tubes are used in custom designs. Sales Applications: Contact plant direct.
APPLIED MICROWAVE LABORATORY, INC. 106 Albion Street Wakefield, Mass. Contact: Frank Lane Phone: 245-9393 (617)	Applied Microwave Laboratory, Inc. (AML) has developed CW and pulse cavity oscillators using the following G.E. tubes: 3CX100A5, 6442, 6771, 7296, 7486, 7815, Y1171, Z2866, and Z2867. Various models are available from 200 MC to 6.5 GC in three tuning ranges: 2, 10 and 30%. Tuning is accomplished either by a screw-driver adjustment, shaft and knob, a 4 numeral digital dial with calibration chart or a direct reading tape dial.
GOMBOS MICROWAVE INCORPORATED Webro Road Clifton, New Jersey Contact: H. J. Schatz	Gombos Microwave Incorporated manufactures a line of triode cavity oscillators both pulsed and CW covering the frequency range of 900 MC to 5.9 GC. Typical is the model 151-C, applicable for use in C-band and as a signal source for X-band applications. Power output at 4.2 GC. 75 MW minimum using GE tube 7391.

MANUFACTURER INFORMATION	Description of Products
MICRODOT INC. 220 Pasadena Avenue South Pasadena, California Contact: Ed French Phone: MU 2-3351 SY 9-9171	Off-the-shelf building blocks for quick assembly of power amplifiers, oscillators, and frequency multipliers covering the 10-5000 MC range. All are miniaturized, conservatively rated, and weigh about one pound. Single modules will multiply as high as 9; can be cascaded for even higher multiplication. Power output ranges from several milliwatts to 150 watts.
MICROWAVE CAVITY LABORATORIES 2603 West Lake Street Melrose Park, Illinois Phone: MU 1-1800	Standard cavities are primarily available in two general types...narrow tuning range and extended tuning range. The Series N Units tune essentially 10% while the Series E Units can be designed to tune much greater ranges. Design criteria of the standard MCL cavity includes small size, light-weight, ruggedness and overall stability of operation.
RANTEC CORPORATION 23999 Ventura Boulevard Calabasas, California Contact: Mel Marcus, AMM Western Region Phone: DIamond 7-5446 (213)	Designed for mounting directly on the antenna, the Rantec R-F Preamplifiers provide high gain low noise amplification. Weighing less than five pounds including a built in solid state regulated power supply, these amplifiers are available in ranges from 134 to 410 MC.
TRAK MICROWAVE CORPORATION 5006 N. Coolidge Avenue Tampa 3, Florida Contact: R. J. Sloan Phone: 876-6422 or 876-6407	TRAK Microwave Corporation, Tampa, Florida, specializes in engineering and manufacture of microwave oscillators, harmonic generators and amplifiers. Frequency coverage is 400 MC to 12 GC for CW, grid and plate pulse operation. Power output up to 250 KW at UHF decreasing to approximately 300 MW at 12 GC.

General Electric Company invites legitimate manufacturers of ceramic tube cavities to submit approximate 50-word product summaries for future editions of this publication. The right to reject information that is not in the best interests of General Electric Company or its customers is specifically reserved.

GENERAL TECHNICAL INFORMATION

GENERAL TECHNICAL INFORMATION

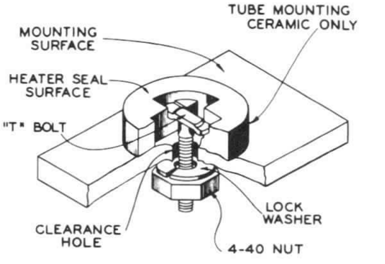
SOCKETLESS TUBE CIRCUIT TECHNIQUES

J. W. Rush, Jr.
Receiving Tube Dept.
GENERAL ELECTRIC COMPANY
Owensboro, Kentucky

In most VHF, UHF, and microwave applications non-conventional vacuum tube structures are essential. Examples of such structures are the door knob tube, the acorn tube, the rocket tube, the pencil tube, the lighthouse tube, and the more recent metal-ceramic tube structures. Designing and manufacturing efficient and reliable sockets for these tubes has been a problem. To minimize this problem many circuit designers have used "semi-socket" designs combined with soldering directly to the tube elements. In most cases separate socket-like assemblies to which connections could be soldered, were built and attached to the tube. In addition to making connection to the tube elements some means of tube support was also necessary.

It has been the circuit designer's desire to solder directly to the tube. Until recently this has not been practical because the tube envelope or seals could not tolerate soldering temperatures or the tube element was not physically strong enough to be used for tube support. This latter socket requirement was a particular problem for circuitry to be subjected to high shock and vibration.

Recent tube manufacturing techniques have permitted the introduction of a line of planar ceramic vacuum tubes* that are both tolerant to soldering temperatures and can be physically mounted by the tube elements themselves. In addition to the several coaxial cavity designs for microwave service other types** were also introduced that were designed specifically for direct soldering. The tubes feature solder lugs and "T" bolt mounting of the tube envelope to a print-board or metal chassis. (See Fig. 1 and 2 illustrating the mechanical features of the "T" bolt.) Other lead attachment procedures such as wire wrap, spot welding, brazing and mechanical clips can also be used.



CUTAWAY VIEW SHOWING "T" BOLT TUBE MOUNTING

Fig. 1

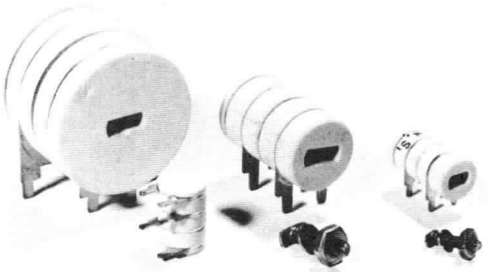


Fig. 2

* EIA type number 7077, 7266, 7486, 7481
GE Development types Z-2823, Z-2835, Z-2869, Z-2866, Z-2897

** EIA numbers: 7462, 7720, 7625, 7588, 7296, 8081, 8082, 8083
GE Development types: Z-2868, Z-2354, Z-2870, Z-2731, Z-2692

For coaxial circuits it is feasible to solder cavity components directly to the tube elements (See Fig. 3). This procedure not only provides physical support in some cases but also reduces the problem of obtaining good RF contact between tube and cavity elements. With proper care the tube-circuit assembly can be replated after assembly.

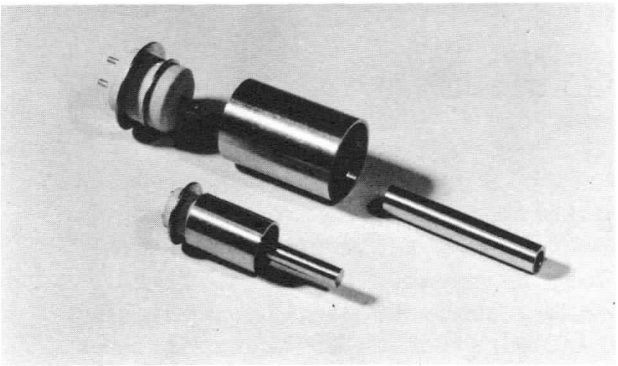


Fig. 3

The application of coaxial resonant circuits soldered directly to the tube elements is illustrated by an assembled, small tube-cavity combination, and an unassembled, larger tube-cavity, tube-circuit combination. This particular combination would be useful for a half-wave grid resonator cavity for a re-entrance oscillator. The two tubes shown are designed for grounded cathode usage.

THEORETICAL ADVANTAGES

By eliminating tube sockets in their usual form, several theoretical performance advantages are obtained. In most cases, for reasons of economy or moldability, the insulator portion of a tube socket is usually a higher loss factor material. With the elimination of the socket insulator losses, higher circuit "Q's" can be realized. Higher unloaded "Q's" lead to better circuit performance through higher circuit efficiency.

In many modern electronic circuits maximum gain-bandwidth must be obtained to process the high definition and complex signal pulse. The more general relation for broadband gain in a vacuum tube is:

$$G \cong g_m R_o$$

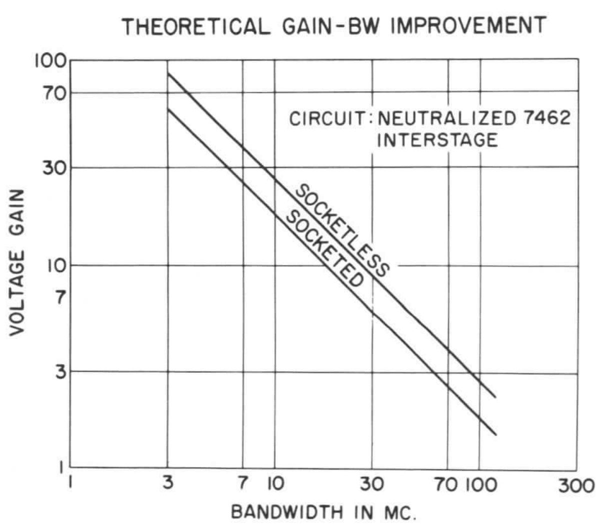


Fig. 4

The gain, G, depends most upon tube transconductance, gm, and the circuit load resistance, R_o (See Fig. 4). For a simple interstage circuit the bandwidth, BW, can be estimated to be:

$$BW = \frac{1}{2\pi R_o C_t}$$

C_t is the total shunt interstage capacitance. If we then construct the expression for gain-bandwidth product:

$$G\text{-}BW = \frac{gm}{2\pi C_t}$$

This relationship shows that for wide band amplification maximum available transconductance and minimum tube and circuit capacitances are essential. The available tube transconductances are high, up to 50,000 micromhos, and this is obtained with relatively small tube capacitances. To use the resulting high tube gain-bandwidth product the applied circuitry must have a low value of shunt capacitance. The use of direct soldering connections to the tube or soldering to clamps or clips supported by the tube assures maximum tube-circuit gain-bandwidth.

In addition to better gain-bandwidth products at any given center frequency, lower tube circuit capacitances permit operation at higher frequencies. By using resonant elements that clamp or solder to the tube itself, lumped constant circuitry may be used up to 1500 mc. Similar application of slab or flat parallel line elements provides efficient performance up to at least 3000 mc (See Fig. 5 and 6).

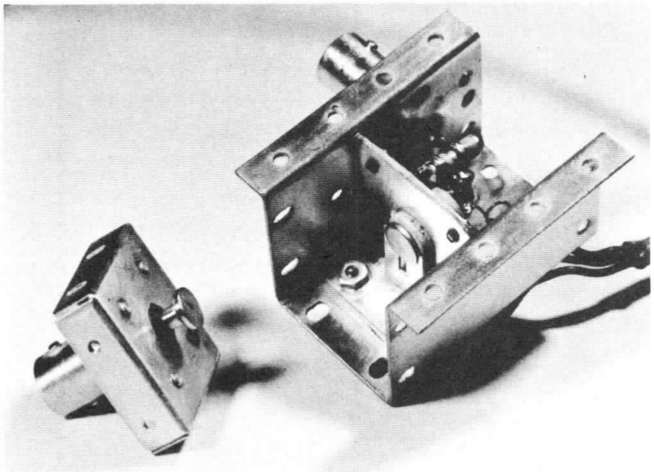


Fig. 5

A 2700-mc grounded-grid amplifier featuring the socketless techniques to obtain good performance into the kilomegacycle region. The tube anode is resonated by a short section of strip line functioning as a parallel tuned plate circuit. The base of this plate line is by-passed for RF at the bottom of the amplifier chassis. Power is coupled out by means of an adjustable series output capacitor (shown removed from the amplifier). A clip-on connector (not visible) is used to connect an input coupling capacitor to the tube cathode. Heater chokes have been soldered directly to the tube heater buttons. The grid is grounded by a flat washer held down by four 4-40 screws.

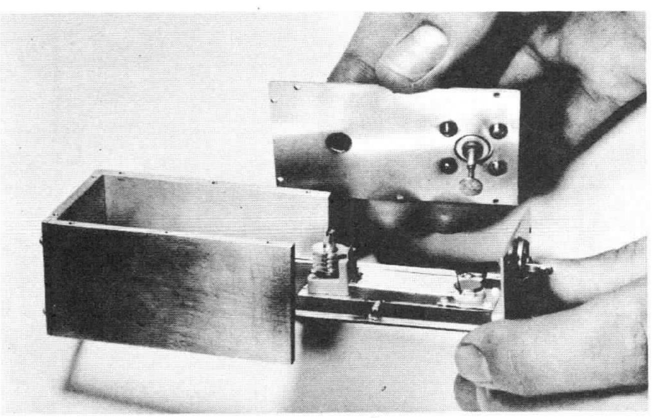


Fig. 6

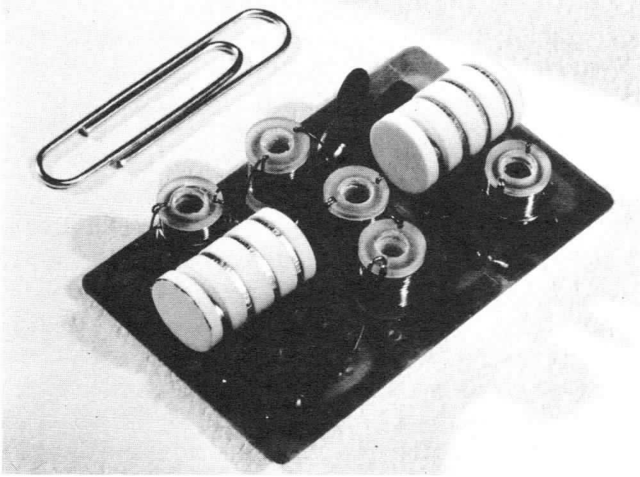
A 1200 mc oscillator featuring snap-on slab-line resonators and screwed-down grid clamps. This circuit is a modified Colpitts configuration. The grid line is an un-etched portion of the print board base. The tube fore-shortens the half wave line on one end and the tuning capacitor fore-shortens the other. A grid leak resistor is soldered at a low impedance point.

For many years the degenerative effect of cathode lead inductance has limited the high-frequency capabilities for conventional vacuum tubes as much as transit time effects. For this reason and others, the non-conventional structures of microwave tubes are used. The very low value of lead inductances in many cases was wasted by using high socket lead inductances. For the same reason tube instability was often due to poor grid grounding.

PRACTICAL ADVANTAGES

The use of socketless circuit techniques provides several practical advantages. Better system reliability is one of the more important. Since the socket can be eliminated, troubles due to contact wear, failure or corrosion are reduced. No socket insulators are present which may crack or deteriorate. Very low contact resistances can be obtained using direct soldering techniques. Better tube reliability can be obtained if known and consistent heat sinks are established for the tube. In some cases tubes have failed as a result of additional acceleration forces resulting from poor socket designs. Physical clamping of the tube directly to the chassis assures that the tube sees no more shock and vibration than the chassis itself. The increased performance gained by socketless circuitry means fewer stages for the same system gain. In some cases tubes in sockets being easy to remove, are selected to compensate for the loss of performance due to a faulty component. This repair procedure usually leads to a more catastrophic failure later on. Screwed-on or soldered connections to the tube are more easily inspected and do not depend upon assumed contact pressure.

Many of the microwave triodes are made very small to obtain low capacitance and transit time characteristics. Often the sockets for these tubes are much larger than the tubes themselves. This means that system size and weight can be lowered if alternate connection techniques are used (See Fig. 7). In some cases the tube itself also serves as a terminal strip for the connection and support of other circuit components such as resistors and capacitors. Socketless techniques also reduce the cost and design time associated with a socket design. Some of the ceramic triodes are fitted with mounting hardware requiring only a hole in a chassis or printboard. These tubes can be used with all connections being made on one side of the board or chassis. This leads to simplified circuitry or permits the use of dip-soldering techniques. (See Fig. 8 for suggested connectors for the coaxial types.)



A complete cascode circuit showing two soldered-in titanium metal ceramic triodes. This circuit features small size and weight through the elimination of sockets and the use of printed circuit techniques.

Fig. 7

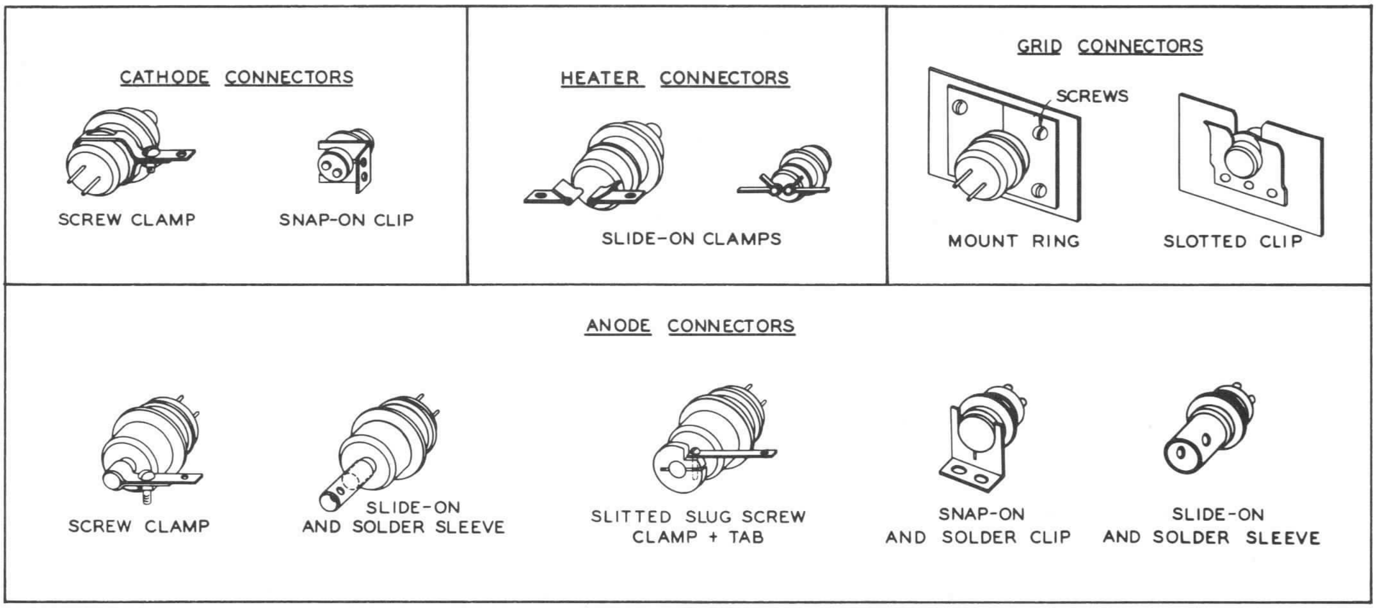


Fig. 8

SOLDERING TECHNIQUES

The use of socketless circuitry with good reliability usually requires soldering either to a tube clamp or tube element. When soldering to an auxiliary clamp or to the tube itself the usual care should be taken. If soldering directly to the tube is attempted on non-tolerant tube structures, failure can result from damaged seals. Although the use of high temperature seals and ceramic insulators greatly reduces the chance of this happening, the tubes are not indestructable. Ceramic tube structures are tolerant to soldering temperature as evidenced by tube life tests at temperatures up to 450°C. However, due to their small sizes, very large thermal gradients across the tube seals can and do cause tube failures and a resulting loss of reliability.

To reduce the possibility of tube damage a few precautions should be taken:

1. Use a solder with as low a melting point as possible for the intended tube circuit ambient operating temperature.

2. Use small wattage soldering irons to reduce the thermal inertia of the soldering heat.

3. Preheat the tube whenever possible to reduce further the thermal in-rush when heat is applied. Ovens, hot plates, I-R lamps, etc. can be used to preheat the tube prior to soldering. If these are not available, thermal shock can be reduced by operating the tube filaments for several minutes before soldering.

These precautions are most important on the smaller coaxial types since the thermal mass of these designs is small and very little thermal resistance is present between the solder surface and the tube seals. The use of solder-forms is highly recommended. The lug versions can be used with no more than the usual precaution and can be treated as any other solder-in circuit component. It should be noted that the suggested soldering procedures are conducive to cold soldering joints. This is true and care must be taken in this respect.

The basic tube structure used for these solderable tubes is made of titanium metal and ceramic. The titanium is essential for several reasons but its most important feature is the almost identical thermal coefficient of expansion when compared to good RF ceramic materials. Titanium on the other hand is very difficult to plate and no ordinary techniques have yet been devised to plate in the usual fashion. To provide solderable surfaces the titanium is first nickel plated and a thin gold layer is then applied. This gold layer is consumed by amalgamation into the solder. The nickel undercoat is the surface to which the solder connection is actually made. After many solderings, this nickel plating can be consumed. When this happens, the titanium base metal is exposed and one is confronted with the difficult task of soldering to titanium.

The thickness of the nickel plating must be carefully controlled between two limits. If the plating is too thin only a limited number of solderings can readily be made. If the plating is too thick peeling results. In development work where tubes are removed or resoldered many times increased difficulty may be expected in soldering operations.

TUBE REMOVAL

When it becomes necessary to remove the soldered-in tube the usual techniques apply. The tube can be treated as any other soldered-in component.

If the coaxial tube outline is used, it becomes expedient to use auxiliary clamps not only for soldering connections in some cases but also for the mechanical support of the tube. At microwave frequencies most circuits use the tube in a grounded grid configuration and the tube is mounted by clamping the grid element to a chassis shield or wall. In most cases DC "floating" of the grid is not essential and by-passing is not necessary. Where by-passing is required, mica or suitable spacers can be used without loss of mechanical support. Due to the physical location of the cathode of the coaxial designs, cathode clamps are usually used to provide connections and soldering surfaces at more convenient distances from the tube. Such clamps also greatly improve the ease of tube removal. Soldering or clamping is usually optional on the heater and anode terminals. Soldering is desirable for the heater connections since contact resistance at these points may seriously lower the tube heater voltage.

EXAMPLE EQUIPMENT

Figure 9 shows a 10-frequency crystal controlled "STALO" developed by the Light Military Electronics Department of General Electric Co. Socketless circuit techniques are used to reduce size and weight, to obtain mechanical and electrical stability, and to fulfill the need for maximum gain-bandwidths for the broadbanded multipliers and amplifiers. Small "T" bolt ceramic triodes are used in each of the 10 crystal channels and frequency selection is made by applying B+ to the desired channel. At the center of the 10 oscillators a "clamp-on" cathode connector is used as a common input to a grounded grid stage and connections are made around the

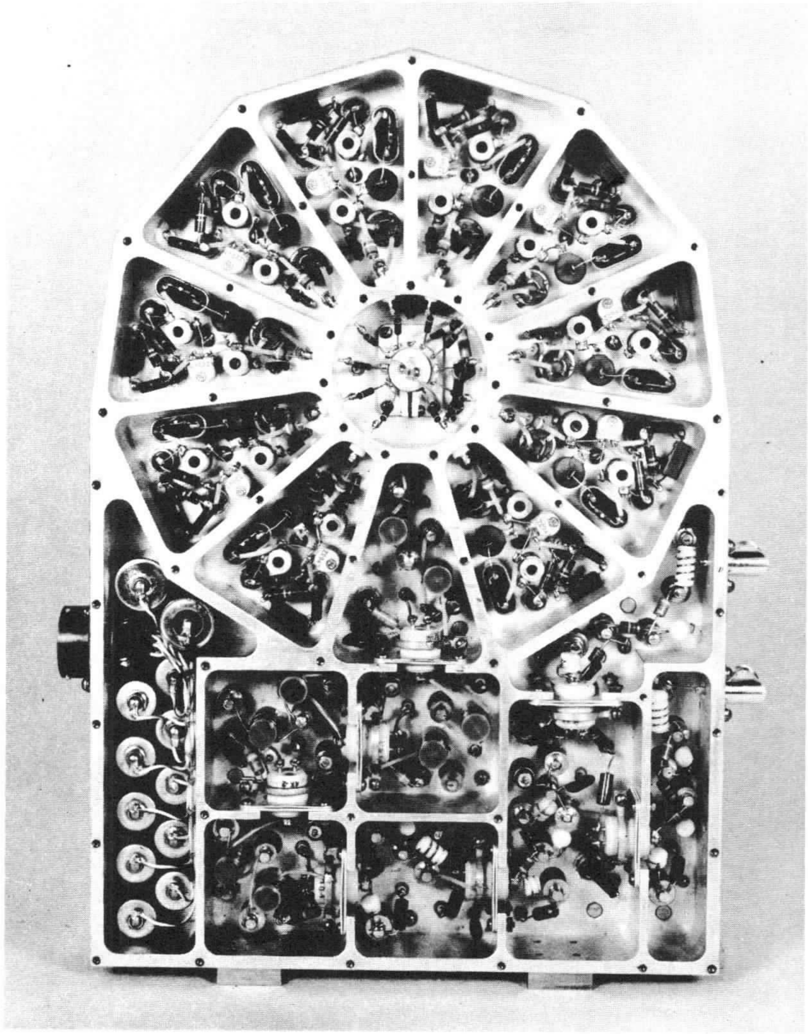


Fig. 9

circumference of the cathode clamp. The grid of this tube and the remaining larger coaxial triodes, eight in all, use flat sandwich or surface clamps. The same cathode clamp is used for all the coaxial outline tubes. The wide bandwidths were essential to provide multiplying and amplification over about a 10% bandwidth at near 500mc center frequency. The maximum gain per stage was essential to keep the total number of stages to a minimum for maximum reliability. Multiplying at wide band-widths is traditionally difficult and high transconductance triodes as well as socketless circuitry were required for acceptable performance.

CONCLUSION

With the advent of new vacuum tube manufacturing techniques it has become practical to use new socketless circuit techniques. Where sockets are not specified, circuit performance and reliability are improved. Such techniques permit the use of vacuum tubes at higher frequencies as well as providing a companion component to improve the state-of-the art for lumped constant and slab line circuitry.

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

NOISE FIGURE AND THE GRIDDED VACUUM TUBE

The three most important types of noise in the gridded triode vacuum tube are shot noise, flicker noise, and induced grid noise.

Shot noise is characterized by its independence from frequency effects and its dependence upon tube currents and transconductance.

Flicker noise or one-over-frequency-noise usually follows the simple rule of varying inversely with frequency at the rate of three decibels per octave. Flicker noise usually limits the sensitivity of very low frequency amplifiers and produces instability in DC amplifiers. The exact cause of flicker noise is not well defined but reduction of this effect can be best obtained by using triodes with high transconductance at low plate currents. To reduce both shot and flicker noise effects, triodes with maximum transconductance to plate current ratios should be used. The planar ceramic triode is outstanding in this respect.

Induced grid noise is caused by transit-time effects which induce shot noise into the signal grid. This source of noise is characterized by its six decibels per octave increase with frequency. Figure 1 is an approximate representation of these three noise sources as a function of frequency.

Johnson or thermal noise can also be generated by tube and circuit losses or if any unbypassed resistances are used. This noise source is usually not a serious problem if proper components and circuitry are used.

When a tube is subjected to shock or vibration, another source of noise called microphonics can occur. The frequency profile of this noise varies greatly with tube structure. Although microphonics usually produce AM signals in audio amplifiers, some AM and FM effects can occur in RF amplifiers. The planar ceramic tubes are usually less microphonic than other competing tube structures and the use of bonded-heater techniques has practically eliminated this source of noise.

Equivalent Noise Circuits

Figure 2 shows two simplified forms of a commonly used noise figure equation[1]. An equivalent noise circuit is also shown. The noise figure equation can be solved for minimum noise figure with respect to R_s or G_s. This relationship is:

$$NF_{min} = 1 + 2\sqrt{5G_t \, Req}$$

The resulting optimum source resistance equation is:

$$R_s \text{ opt.} = \sqrt{Req. \div 5\, G_t}$$

To calculate the minimum available noise figure and the source resistance required to obtain this, the absolute values of Req and G_t must be known. The above equations assume G_c to be insignificant and in most cases this condition exists. Req can be estimated by the equation:

$$\text{Req} = 2.5 \div \text{triode transconductance}$$

G_t results from transit time effects which produce out-of-phase grid currents and voltages and has a noise output five times thermal.

A second equivalent noise circuit[2] has been developed using Req and a new term G_n. See Figure 3. Req is identical to the Req used in Figure 2 and G_n is equal to 5 G_t. The equations for minimum noise figure and optimum source resistance are then simplified as shown in Figure 3. This simplified equivalent circuit technique leads directly to the measurement of Req and G_n. If an input conductance tuning curve is obtained as described, the equation of this curve is:

$$G_{tot} - G_n = W^2 \quad \Delta C^2 \text{ Req}$$

G_n is obtained immediately as shown and the above equation can then be solved for Req. G_{tot} and ΔC are obtained for two points A and B on the curve. The curve shown in Figure 3 can be generated from tests conducted on a circuit similar to the one shown in Figure 7. L_1 can be calibrated for an equivalent capacitance change or a tuning capacitor can be added in shunt with the input inductor. R_s is omitted.

The measured values of Req can be checked against the previous approximate equation. The factor of 2.5 appears to vary from about 2 to 3.5 depending on the tube size and geometric configuration. The approximate value of G_t can be obtained by dividing G_n by five. This value of G_t can then be used to determine input circuit bandwidths if all loading is due to transit-time effects.

Measured Results

The procedure outlined in Figure 3 was used to determine the equivalent noise parameters for several low noise planar ceramic triodes:

Type	Req (ohms)	G_n at 90 MC (mohms)
6299	170	160
7077	300	100
7462	300	100
7588	45	500
7644	170	160
7768	40	500
7784	170	160
8083	300	100

It should be noted that minimum noise figure is a function of the product of Req and G_n. For similar cathode current densities, grid wire sizes, grid wire spacing, and grid to cathode spacing, this ratio appears to be relatively constant. These geometric and electrical conditions exist on the low noise planar triodes and similar noise figures are quoted for all types. See the "Optimum Noise Condition vs Frequency" curves shown at the front of the ceramic tube reference manual. The value of optimum source resistance varies directly with the ratio of Req and G_n. The larger triodes provide more transconductance and lower values of Req. The larger tubes also have higher values of transit-time conductance and G_n. These conditions result in much lower values of optimum source resistance for the larger tubes, 7588 and 7768, at any given frequency.

Noise Parameters vs Frequency

The table shown above records measured values of G_n at 90 megacycles. The value of Req has been described to be independent of frequency and G_n to be a function of frequency squared. Using the values of Req and Gn measured at f_o equal to 90 mcs, minimum noise figures and optimum source resistance at any other frequency, f, can be calculated. See Figure 4. Reasonably good correlation between measured and calculated performance has been obtained between frequencies from 30 to 3000 megacycles.[3]

Tube Selction

One might ask, why use the larger tubes if similar noise figures can be obtained with the smaller tubes? For minimum over-all noise figures, the gain of the first stage and noise figure of the second stage are important. The noise figures previously discussed apply only to the first stage of an amplifier chain. The relationships are equated as follows:

$$NF_{1,2} = NF_1 + \frac{NF_2 - 1}{GL}$$

The noise figure subscripts apply to the first and second stages and G_1 is the available gain of the first stage. Wide bandwidths are usually required in most modern low noise amplifiers. For wideband circuits, the larger tubes are desirable to obtain both maximum gain and lower values of optimum source resistance. The smaller tubes can be used most effectively for narrow-band low noise circuits where their size, weight, low-input powers, and economy are more important. In both cases, the second stage should also be a low noise tube if lowest noise figures are desired.

Noise Performance vs Operating Conditions

The low noise triode must be properly applied if optimum noise performance is desired. Tests have shown that variations in heater voltage within rated values produce little effect on noise figure. The voltage changes normally associated with plate voltage supplies are also unimportant if the initial value is properly chosen. Generally speaking, the triode should be operated under those conditions which provide a maximum transconductance to plate current ratio, produce no grid currents, and provide suitable gain to reduce second stage noise effects. In most cases, the tube is operated with about .5 volt bias, rated heater voltage, and maximum rated plate dissipation if maximum noise performance is required.

There are three acceptable methods of biasing the triode and these are shown in Figure 5. Condition "a" is the simplest and uses a low value of cathode resistor and a fixed plate voltage. This method produces the widest variation in operating conditions from tube to tube. The type shown in Figure 5 is the 7462 and each small square represents one tube. Condition "b" uses the same value of cathode resistor but more constant plate currents are obtained through the use of a large plate dropping resistor. Higher plate voltages must be used and the power loss in R_B must be tolerated. Referring to Figure 6, it can be seen that minimum noise figures are obtained along a bias line slightly less than .5 volts. These curves were taken on the type 7588. In Figure 5, condition "b" gives the smallest variation in bias and the level is maintained near the desired value of about .5 volts. For this reason, condition "b" is the best bias method for obtaining good initial noise performance from tube to tube and maintenance of low noise with life. Condition "c" uses a fixed value of plate voltage and a large cathode resistor to maintain constant plate currents. A negative voltage at the cathode or a positive voltage at the grid is necessary to provide the proper bias between the grid and cathode. This bias method results in wide variations in bias from tube to tube with a large percentage of the tubes operating at very low bias. Three reject 7462's were purposely included in Figure 5. These three tubes required zero bias to maintain the recorded plate currents near 6.5 ma. for condition "c". These same three tubes were the three highest noise figure tubes shown for condition "c" but gave lower noise figures using condition "b" bias.

High Current Density Effects

To improve the noise performance of the triode at RF frequencies the effect of transit-time must be reduced. This can be done with closer grid to cathode spacing or by increasing the accelerating forces on the electron. In some cases closer grid to cathode spacings are practical but noise figure tests show no significant improvements. Most types are designed to make maximum use of cathode space-charge smoothing and this is not always the closest grid to cathode spacing. The second method, using greater accelerating potentials, is present when the tube is operated at higher current densities. In addition to reducing the transit times, much higher transconductance result and lower values of Req are present. The type 7077 triode is normally tested at about .15 amperes per sq cm and noise figures around 8 db are measured at 1200 mcs. Noise tests were made at .6 a/cm^2 and an over-all noise figure of 4.8 db was measured. Some of the ceramic tubes listed in the reference manual have good life at .6 a/cm^2 and lower than published noise figures can be obtained.

Circuit Considerations

The neutralized grounded cathode and grounded grid stage are most used for low noise amplifiers. The input impedances for these two circuits are radically different and require different noise considerations. In theory, both circuits have similar minimum noise figure, and optimum source resistance. The theory also predicts that power match and minimum noise figure conditions cannot exist at the same time. Therefore, the effect of mismatch between the source and tube input becomes important. The grounded cathode circuit is most useful at lower frequencies because less mismatch exists. For wide band circuits the lower optimum source resitance types should be used as previously discussed. Figure 8 shows the measured input bandwidth, measured over-all noise figures, and calculated first stage noise figure for a cascoded pair of 7462 triods at 30 mcs. The results on this grounded cathode input circuit also shows that relatively large changes in source resistance result in small changes in noise figure if values near the optimum value are initially chosen.

At higher frequencies much lower source resistances are required and the grounded grid stage provides less mismatch under optimum noise conditions. In most cases above about 800 mcs, for all practical purposes, minimum noise is obtained under minimum VSWR adjustments. It is very difficult to determine the frequency at which similar noise results are obtained for both circuit arrangements. Calculations are complicated and various assumptions are necessary. The best method of obtaining minimum noise figures uses commercially available automatic noise figure test equipment. This equipment continuously reads noise figure as a circuit is adjusted and both circuits can be easily compared. The curves shown in Figure 6 were obtained using an automatic noise figure test set. Although under power match conditions the theoretical noise figure is over 5 db, a measured figure of slightly over 3 db was obtained. The tube input was about 25 ohms and the optimum source resistance is over 200 ohms. The automatic test set permitted an optimum low noise adjustment between conjugate and optimum source resistance conditions.

Conclusions

To assist the designer of low noise circuits simplified techniques have been developed for triodes. Both theoretical and measured results confirm that lowest noise figures require the best tube choice for a given frequency and bandwidth, proper DC operation, and proper circuit arrangements and adjustments. State-of-the-art results are very seldom if ever obtained without careful and laborious procedure.

References:

1. Vacuum Tube Amplifiers Valley and Wallman, pp 634
2. "Theory of Noisy Four Poles" Rothe and Dalke Proc. of IRE, June 1956
3. "A Comparison of Domestic and Foreign RF Amplifier Tubes for UHF-TV" C. Metelman Die Telefunken Rohre, 1959.

VACUUM TUBE NOISE

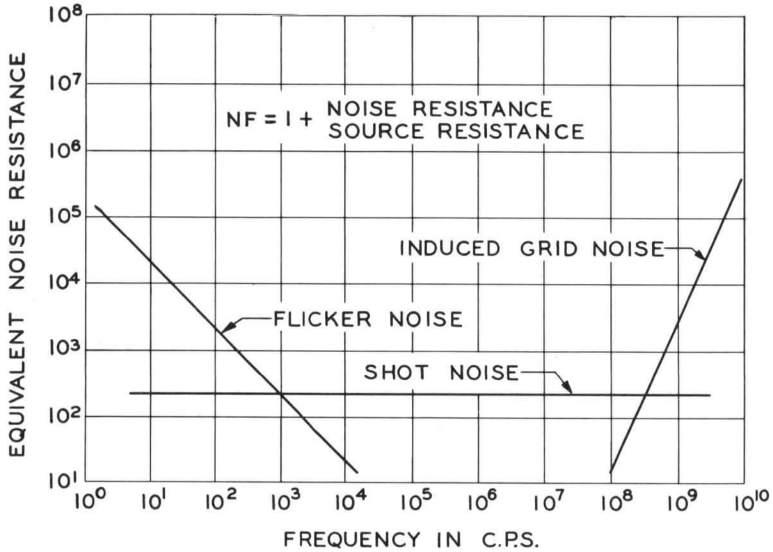


Fig. 1

Noise Figure Equations

Referred to tube input:- $NF_1 = 1 + \frac{G_C}{G_S} + \frac{5G_\tau}{G_S} + \frac{R_{EQ}\left|G_S + G_\tau\right|^2}{G_S}$

or:-

$$NF_1 = 1 + \frac{R_S}{R_C} + \frac{5R_S}{R_\tau} + \frac{R_{EQ}}{R_S}\left|\frac{R_S + R_\tau}{R_\tau}\right|^2$$

Where:-
NF_1 = First stage noise figure (power ratio)
NF_1 in db. = 10 log NF_1
$R_S - G_S$ = Source resistance or conductance transformed to input grid
$R_\tau - G_\tau$ = Transit time loading or conductance
$R_C - G_C$ = Cold input resistance or conductance
R_{EQ} = Equivalent shot noise resistance

Equivalent noise circuit:-

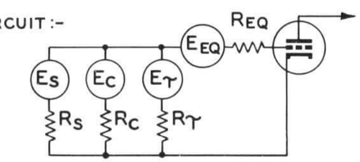
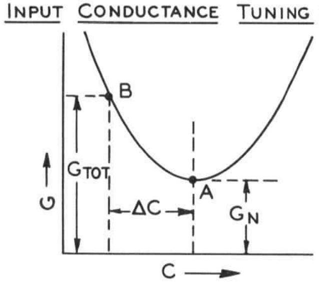


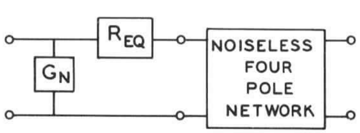
Fig. 2

Equivalent Input Noise Parameters

Input Conductance Tuning Curve



Equivalent Noise Parameters Input Circuit



G_N = $20I_D$ at minimum input conductance (A)
G_{TOT} = $20I_D$ at detuned point (B)
ΔC = Change in total input shunt capacitance between A and B
I_D = Noise diode current to double noise output of tube under test

$$G_{TOT} - G_N = \omega^2 \Delta C^2 R_{EQ}$$

$$NF_1 - 1 = 2\sqrt{G_N R_{EQ}}$$

$$R_{S(OPT)} = \sqrt{\frac{R_{EQ}}{G_N}}$$ (If circuit losses are not considered)

Fig. 3

$$R_s\ (\text{optimum}) = \frac{f_o}{f}\sqrt{\frac{R_{eq}}{G_n}}$$

Where: R_s (optimum) = Optimum source resistance in ohms
f_o = Frequency in megacycles at which G_n was measured
f = Desired frequency of operation in megacycles

Minimum attainable noise figure in decibels may be calculated with the following formula:

$$NF\ min = 10 \log\left(1 + 2\frac{f}{f_o}\sqrt{R_{eq} G_n}\right)$$

Fig. 4

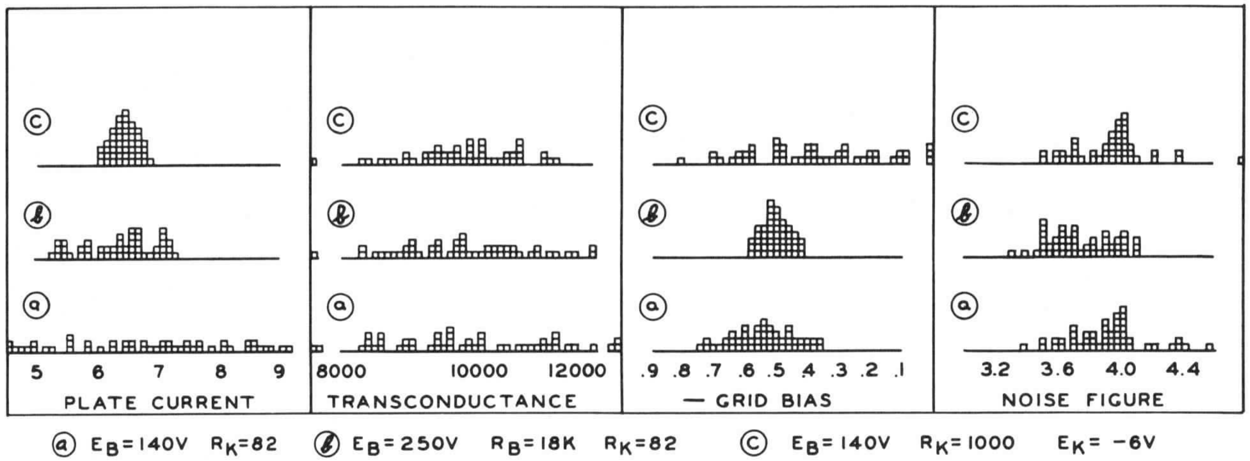


Fig. 5

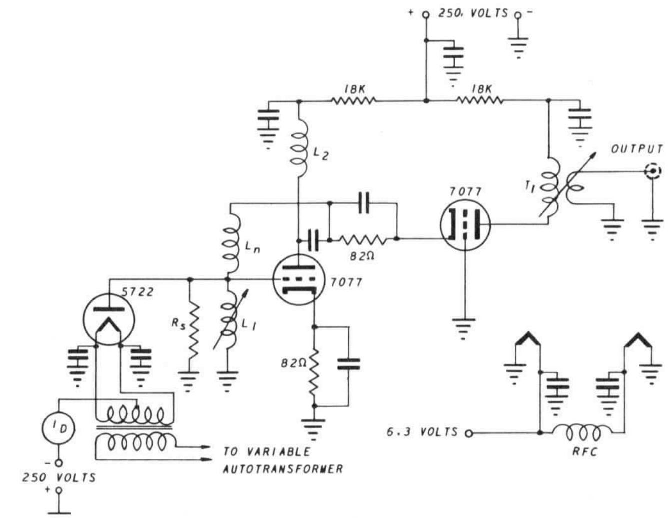


Fig. 7

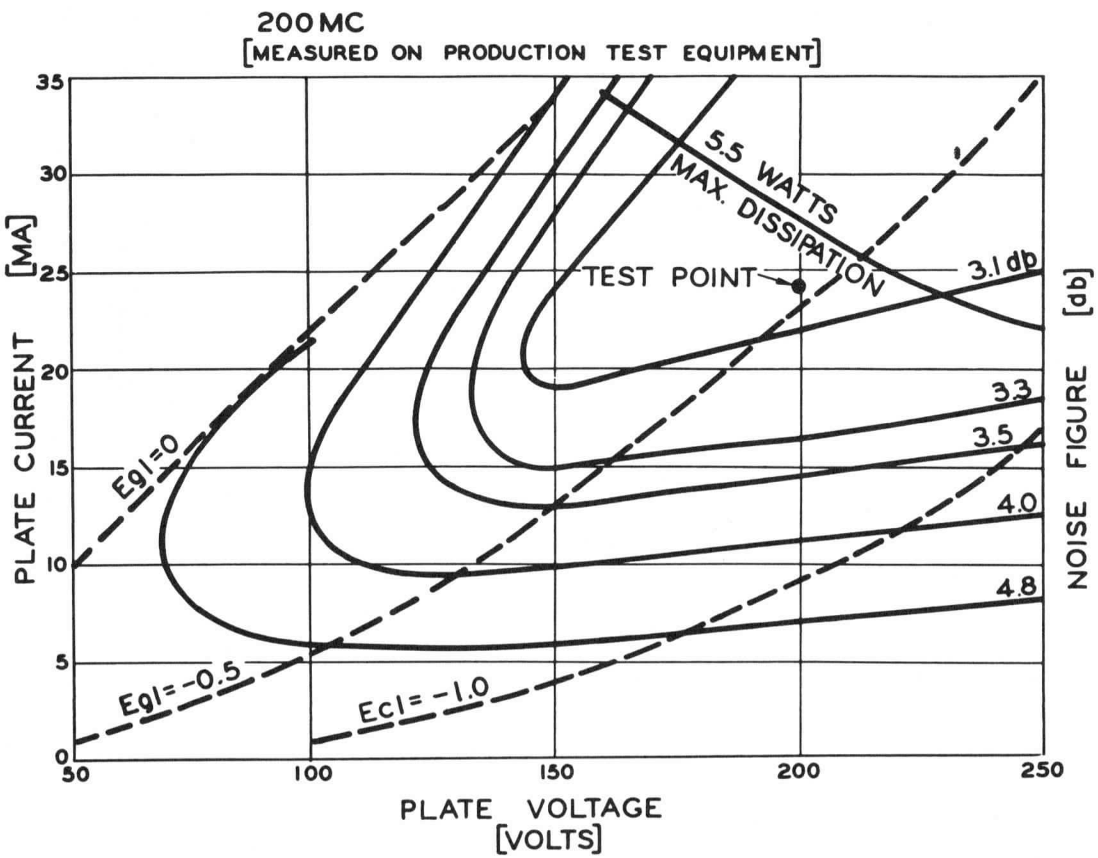


Fig. 6

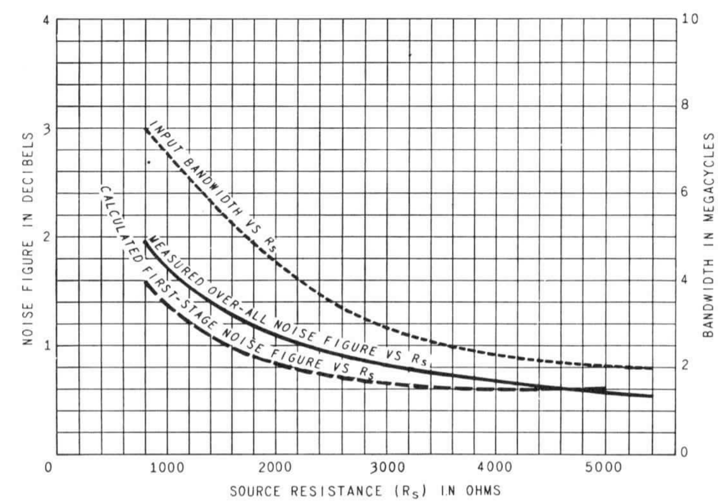


Fig. 8

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

THE USE OF GRIDDED CERAMIC VACUUM TUBES IN PHASED-ARRAY LONG-PULSE UHF RADARS

J. W. Rush
Application Engineering
General Electric Company
Owensboro, Kentucky

Introduction

Until recently, existing radars have been able to handle the traffic of satellites, space probes, and missiles. To handle the expected traffic resulting from the stepped-up space efforts, new radars are being conceived and designed.

Many of these recent radar designs feature electronically steerable, phased arrays to obtain the high pulse powers, beam definition, and efficient low noise reception necessary for long range, three dimensional, multitarget tracking.

System studies have been made, [1] and operating frequencies in the low UHF and/or high VHF spectrum appear to be attractive. Part of this conclusion was based on the simplicyty, ease of application, cost per kilowatt of power, stability, and the wide type and size selection associated with the gridded vacuum tube. It is the purpose of this paper to display the approximate performance capabilities of the gridded tube, and only limited comparison with competing devices is attempted. This is necessary because of the lack of available data, either known or unknown.

This paper is principally concerned with the radar functions of pulsed power generation and low noise reception. The requirements of extreme phase fidelity and the desire for rapid frequency shift dictate the use of broadband amplifiers in both the transmitting and receiving functions. Broadband performance from 425 mc. to 1400 mc. is presented and amplifier bandwidths up to 15% are discussed. Power levels from thermal to kilowatts are assumed.

Transmitter

The vacuum tube appears to be one of the most useful and economical sources[2] of RF power for the frequencies being considered. Since both high

---

[1] "Phased Arrays selected for New Generation Radars" Manfred Meisels July 1962 Microwaves

[2] See article "Array Radars - A Survey of their Potential and their Limitations" J. L. Allen (Note excellent bibliography) May 1962, Microwave Journal

power and long pulses are desired, the radar performance depends primarily upon the long life and performance capabilities of the vacuum tube chosen.

The most important requirements for the transmitter are:

1. High pulse power outputs.
2. Long duration pulsing.
3. Broadband amplification for phase fidelity.
4. Long life.

Long Pulse Derating:

Tube manufacturers have been reluctant to provide tube performance data and ratings for long pulses, greater than about 10 microseconds, without specific life testing. To provide a preliminary design derating curve, all available long pulse data was collected and the curves shown in Figure 1 were plotted.

Due to the lack of actual life test data over the wide range of pulse widths shown, the data plotted was taken from several sources. The data plotted up to about 6 µsec has been published by several tube companies and represents earlier and presently used pulse widths for UHF gridded tubes. In the 10 to 1000 µsec region only limited data was available. Video pulse life tests, at about 20 µsec have been made by one company active in the phased array field. One tube company[3] has been running some life tests at 100 µsecs and most of the 1000 µsec data was taken on pulse life tests run on computer tubes.[4]

The data shown in Figure 1 was purposely plotted in terms of unit cathode area and unit grid-to-plate spacing to make the curves applicable to all tubes. It is impractical to present this data on one tube or even on a family of tubes. Using the chart all tube sizes and spacings can be "tested" for their intended application. The transmitter designer must obtain the required dimensions from the tube manufacturer.

These ratings have not been proven with exhaustive life tests and should be used only as a guide in the early choice of tube sizes and configurations. The curves apply only for plate pulsing and additional derating is necessary for grid and/or cathode pulsing. This derating will apply both for input video and RF pulsing. A rule-of-thumb for plate voltage derating might be one-half to three-fifths of the permissible peak plate-pulsed value. This rule generally

---

[3] Private communication from D. W. Hawkins, GE Company, Bldg. 269, Schenectady, N. Y.

[4] Subminiature Electron Tube Life Factors: Edwards, Lammers & Zoellner Reinhold Pub. Corp.

applies to oxide coated cathodes. Current deratings are unknown factors and usually do not require the degree of derating necessary for plate voltages. This is generally true because excessive and damaging arcing occurs at the steady state high stress conditions common for input pulsing. In both input and plate pulsing applications the current derating is more dependent upon the long life capabilities of the cathode. Cathode life also depends on other factors in addition to current loading and voltage stresses.

Tube Choice:

Using the design curves shown in Figure 1 the circuit designer can work backwards to obtain the appropriate tube area and spacings for a given desired power output. For maximum efficiency the tube should be used near these rated conditions. However, when this is done, power gain usually suffers and the final operating point must be selected with both efficiency and desired power gain in mind. In practice, an optimum approach to the proper tube complement would use the tube at least in one stage at its maximum rating for maximum efficiency and the same tube in previous stages for increased stage gain. This philosophy can be applied until the efficiency becomes so low that a smaller tube would be more practical from the standpoint of size, cost, and/or power consumption.

Tube Characteristics:

It is interesting to note the effect of normal tube characteristics upon power outputs and power gains for a given input power. To determine this, special engineering tubes were built with a wide variety of both mu and transconductance values. Test results on these tubes, given on Figure 2, show that although mu and transconductance are not important considerations where power output and efficiency are concerned, they are important with respect to power gain. The curve clearly shows the desirability of both high mu and high transconductance.

The curves shown on Figure 2 were developed from performance measured on about forty tubes. The various mu's and transconductances were obtained by varying such things as grid wires per inch, plate to grid spacing, grid wire sizes and grid configurations. There would be other variables such as tube capacitances but at 425 mc the different values obtained on the relatively small tubes evaluated were not important. On larger tubes the capacitances would be more important. Actually the higher mu tubes, which were also the higher transconductance tubes, had the lowest plate to grid capacitance.

Gain vs Power Output:

It is difficult to determine the theoretical gain as a function of drive level and one must usually resort to actual measurements. Figure 3 shows the test results obtained on two different ceramic triodes, Z-2869 and 7768, when driven at various levels. These data were taken using the triodes as class C amplifiers and gating the tube "on" with an RF pulse of 500 microseconds duration. The measured values of power output, efficiency, and power gain were recorded as a function of cathode loading in ma. per square centimeter of active cathode surface. The mu's are different with similar transconductances. The Z-2869 has a mu of about 100 and the 7768 has a mu of about 225. Although these results would not apply to all triodes, they would be useful in predicting at least qualitative results. The tests were made at 425 mc using single-tuned plate circuits and narrow bandwidths.

Wide Band Performance:

As stated previously, it is important that the tube performance be determined at the desired bandwidths. To do this, a lumped-constant, double-tuned plate circuit, grounded-grid amplifier was constructed and the test results are shown in Figure 4. It is difficult to accurately establish the broadband high level pulsed characteristics due to the lack of suitable sweep generators. The results shown here represent bandwidths obtained by point to point measurements and for a double tuned circuit optimized near the anticipated required bandwidths. The cathode loading was approximately 1.2 amperes per square centimeter. At lower drive levels one would expect higher gains and lower power outputs. The available power gains would increase to the values obtainable for class A conditions. The performance of the 7768 under these conditions will be discussed later.

Grid and/or Cathode Plate Pulsing:

For simplicity, the performance data shown in Figures 2, 3, and 4 were taken on RF cathode pulsed class C stages. However, as previously discussed, the tube must be operated at plate voltages lower than permissible using pulsed plate voltages. Where maximum power output is most important more pulsed power can be obtained from the plate pulsed stage. This latter method, however, requires higher voltages and more elaborate modulating equipment. Another factor in favor of plate pulsing would be the reduction in transit-time effects with the higher voltages. This may be important for the larger tubes which have wider element to element spacings. These various factors, plus others which may not be so obvious, suggest that the individual designer must make his own decision as to the type of amplifier gating he should use.

Triodes vs Multi-Grid Structures:

Available test results do not clearly define the comparative UHF performance between the tetrode (or pentode) and an equivalent triode. The performance advantages of the multigrid tube, where they exist, must be weighed against the extra cost and circuit complexity.

Using the design curves shown in Figure 1 and substituting the plate-to-screen-grid spacing for plate-to-control-grid values, the resultant ratings were spot checked on a power tetrode, the 7399, and the measured power outputs agree basically with predicted values using plate efficiencies common for this tube size and at the test frequency. The spacing between the screen and control grids must also be considered to prevent arcing between these two grids. Although this spacing is usually much less than the spacing from screen grid to anode, the voltages are also much lower. Data on the 7399 has been taken at about 400 mc using plate pulses of 100 microseconds and operating at a duty factor of .005. Good life test results have been obtained out to at least 5000 hours. Life also depends upon other factors such as cathode and envelope temperatures. This sort of information must be obtained from the individual tube manufacturer.

If the broadbanded triode and multigrid structures are compared in a simplified theoretical fashion, the advantages of the multigrid tube may be questionable. For example, the voltage gain for the tetrode or pentode can be estimated by:

$|A| = gmRo$ where Ro is the load resistance and gm is the tube transconductance. The gain-bandwidth product is:

$|A| \Delta f = \frac{gm}{2\pi Ct}$ where Δf is the

half-power bandwidth and Ct is the total interstage shunt capacitance. When the grounded grid triode stage is considered, the broad-band gain is approximately the same as the multigrid tube when Ro is much less than the tube's plate resistance. For the equivalent interstage circuitry, the grounded grid triode gain-bandwidth product is theoretically approximately equal to the multigrid tube. At narrow band the very high plate resistance values of the multigrid tube make this tube parameter relatively unimportant. This is not true for triodes.[5]

Available Cathode Sizes:

The curves shown in Figure 1 suggest that available power outputs are limited only by cathode areas and tube spacings. This is true except for the usual limitations applied to vacuum tubes used at low UHF. Large areas and wide spacings cannot be used and only the well-designed high-frequency structures are applicable. Cathode areas up to about 10 square centimeters have been designed into efficient ceramic tube structures and useful peak powers up to 100 kilowatts are obtainable at pulse widths of around 100 microseconds.

Life vs Performance:

Tube manufacturers have known for years that efficiency can be improved by running the tube's cathode at high current densities. The resultant high performance is short lived, and for long life applications the tube must be used more conservatively. In an effort to determine the performance versus life capabilities, life tests have and are being conducted and in some cases by the systems design people themselves. Significant life tests have been conducted

[5] Chap. 7 Electronic Designers Handbook Landee, Davis, and Albrecht McGraw Hill

at about two to three amperes per square centimeters loading at pulse lengths of useful value. The results obtained on the 7399 have been mentioned. Figure 5 shows the early results obtained on the Z-2869 and 7768 previously mentioned. These life tests are being run at about 1.5 amps peak video per square centimeter with a duty factor of .005 and for a pulse duration of 500 microseconds. For simplicity, the tubes are being life tested as grid-pulsed oscillators.

Receiver

The most desirable performance features for the receiver are:

1. Low noise.
2. High broadband gain.
3. Long life.
4. Wide dynamic range.
5. Tolerance to overloads.

The metal ceramic planar triode can best provide all of these features. In view of the low noise figures obtainable from competing devices it is important that the best available tube be used that can operate efficiently at UHF.

Preamplifier Design and Performance:

From a theoretical standpoint, since maximum gain-bandwidth is desirable, multituned interstages should be used. For example, if equal "Q" double-tuned interstage circuits are assumed and the primary and secondary capacitances are equal, a double-tuned circuit will give $\sqrt{2}$ more gain-bandwidth than a single tuned interstage. Triple tuning and so on will give additional performance. For multistage amplifiers, alignment becomes very difficult and practical designs might limit themselves to double and triple tuned interstages. It should be noted from a theoretical standpoint that the maximum available gain-bandwidth product in multituned circuits can be obtained only if the required conditions of circuit "Q", coefficient of coupling, primary and secondary capacitances, and so on, are used.

Using two 7768's as cascaded grounded grid amplifiers, a 425 mc. amplifier has been constructed using lumped constant circuitry and double tuned interstages between the two tubes and at the amplifier output plate circuit. A typical performance of 35 db gain and a 4.0 to 4.5 db noise figure was obtained with a 3 db bandwidth of about 7.5%. This measured gain-bandwidth product of about 1600 mc. per stage agrees with the theoretical value. Similar products have been measured at 1000 and 1350 mc.

Dynamic Signal Range:

To permit simultaneous tracking of close-in targets as well as threshold return signals, it is important that the receiver have a wide dynamic signal range. Figure 6 shows the power gain of the 7768 measured for input signals from noise level to distortion due to overdrive. A useful dynamic range of about 100 db is evident.

Tolerance to Over-signals:

Two types of signal overload can be present in any radar. One of these is the ever-present transmitter power leakage due to poor or inadequate TR techniques. This leakage tends to reduce receiver life and represents a problem of operating cost. Another type of signal overload is a transitory one and results from either TR failures or intentional power jamming. In both cases the most logical solution is the use of tolerant receiver components. This results in less stringent TR requirements and better protection against unpredictable signal levels.

The exact signal overload tolerances of the various receiver components are difficult to find and in most cases to measure. To illustrate the relative tolerances of the various receiver techniques, best available results are shown in Figure 7.

If gating voltages are available, additional protection can be obtained by turning the receivers off during the transmitted pulse period. This resulting mismatch reflects energy normally received. This type of extra protection is usually more effective using vacuum tubes because of the larger obtainable mismatches without such problems as reverse bias breakdown and burnout.

Some degree of mismatch and resulting reflection of unwanted signals exists when the receiver is overdriven due to changes in device input impedances. This would only be permissible if the overdrive does not shorten the receiver life.

Long Life and Reliability:

Previously mentioned transmitting tube life test results and the results shown in Figure 8 demonstrate the high performance obtainable from the vacuum tube. If similar tube structures with proven pulse capabilities are used in the receiver the survival under high pulsed conditions due to signal overload is assured.

Conclusion

Preliminary evaluation of the usefulness of the vacuum tube in the phased-array long-pulse radar concept has been made. Test results show power outputs sufficient to provide very large radiated pulsed powers. With the simplicity and low cost of the vacuum tube approach these powers can be obtained economically. Life test results both in the transmitting and receiving function have demonstrated tube life sufficiently long to minimize the maintenance problems present in such a large and complicated radar concept.

Gridded vacuum tubes are easier to apply in the receiver function than other devices and are much more tolerant to over-signals both anticipated and unanticipated. Broadband gains of sufficient value have been demonstrated to reduce the problem of second stage noise contribution. The measured overall low UHF noise figures are sufficiently close to values obtained from competing solid-state devices to warrant the serious consideration of vacuum tubes. With the extra protection necessary for the solid-state receiver and the insertion losses and costs of the required additional circuitry, the performance differentials most often quoted between the solid state and vacuum tube approaches should be carefully evaluated.

The writer wishes to thank W. P. Kimker and C. E. Finley of the Receiving Tube Department and R. P. Watson of the Power Tube Department of the General Electric Company for their assistance in the preparation of this paper and in obtaining the test results shown therein.

JW Rush/ka

PULSE VOLTAGE AND CURRENT VS. PULSE DURATION*

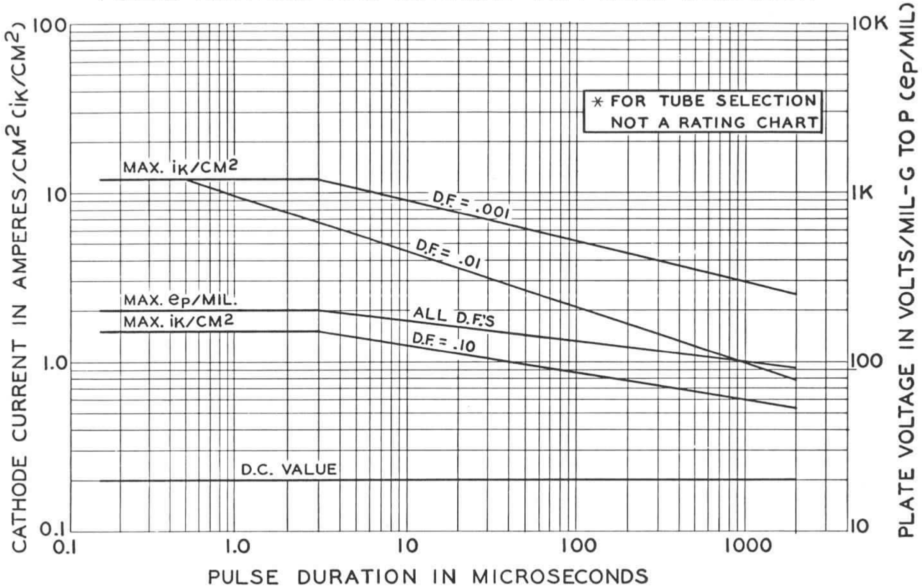


FIG. 1

PULSED PERFORMANCE AS A FUNCTION OF TRIODE CHARACTERISTICS

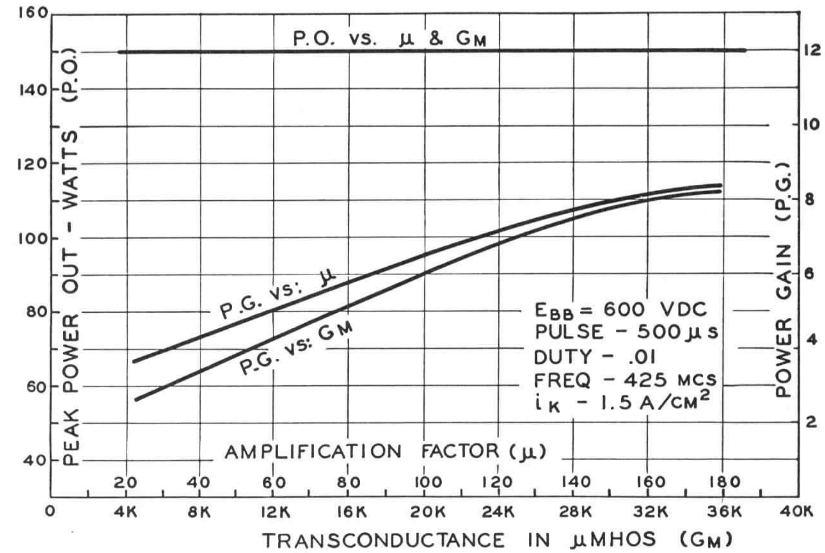


FIG. 2

PULSED PERFORMANCE AS A FUNCTION OF CATHODE LOADING

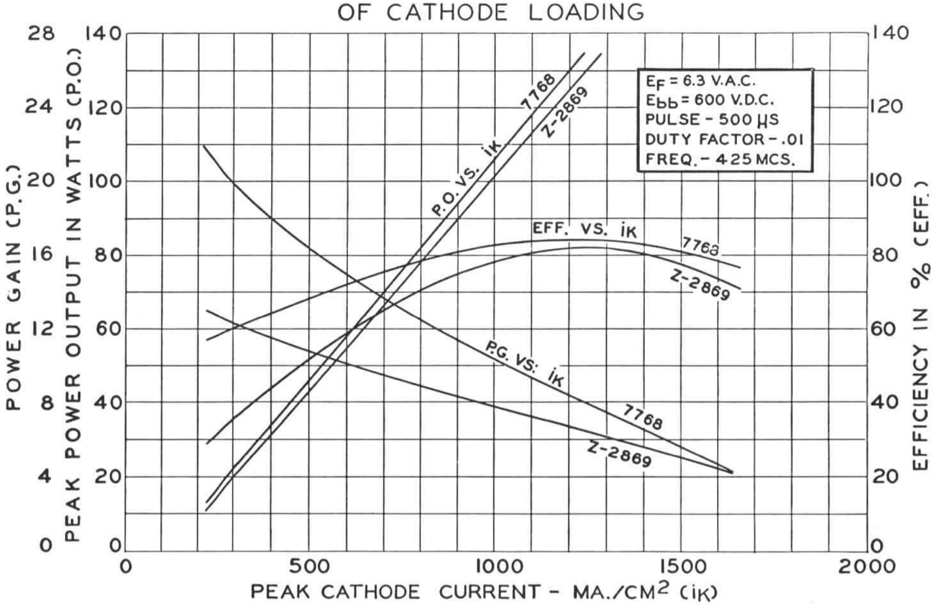


FIG. 3

PULSED CLASS C PERFORMANCE

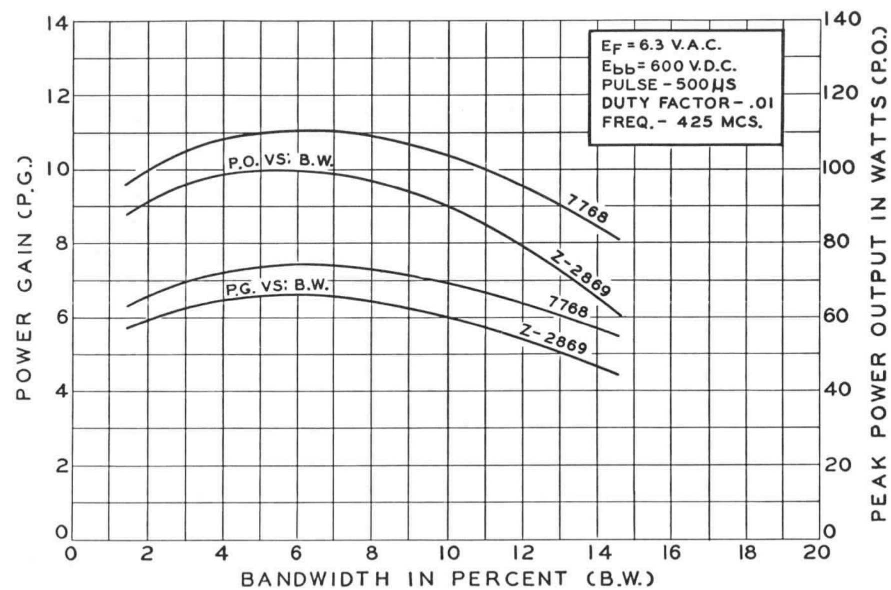


FIG. 4

GRID PULSED OSCILLATOR LIFE TEST

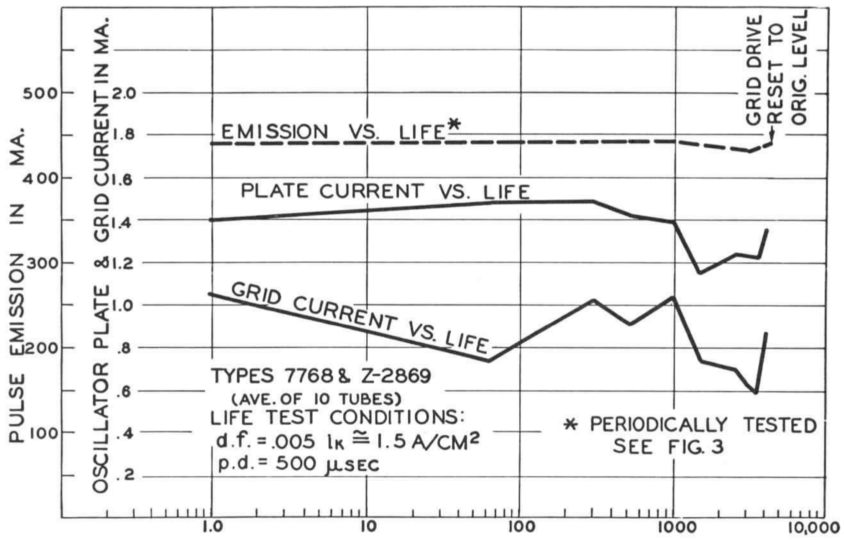


FIG. 5

USEFUL CLASS A DYNAMIC RANGE

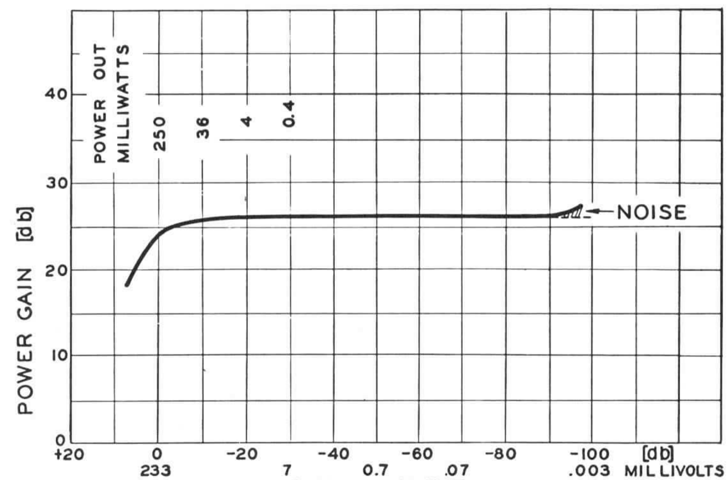


FIG. 6

TOLERANCES TO SIGNAL OVERLOADS

(ESTIMATED BURN-OUT)

CRYSTAL MIXERS AND DETECTORS	- 10 ERGS
TUNNEL DIODE	- 100 ERGS
LOW NOISE PARAMETRIC DIODES	- 1000 ERGS
EPITAXIAL PARAMETRIC DIODES	- 10^{+4} ERGS
CERAMIC VACUUM TUBE	- 10^{+8} ERGS

FIG. 7

NOISE FIGURE VS. LIFE

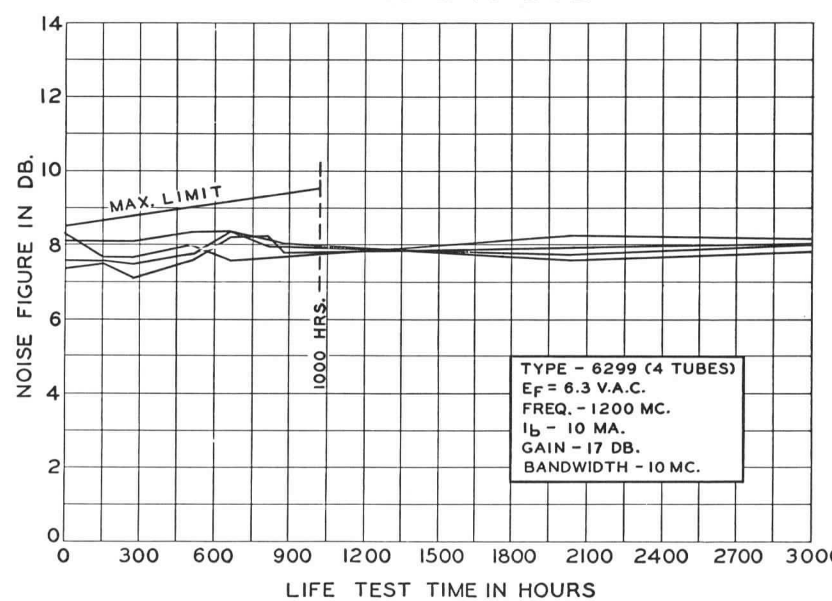


FIG. 8

EI-43A
November 29, 1962

LIFE TEST SUMMARY OF CERAMIC TYPES UNDER HIGH TEMPERATURE AND HIGH HUMIDITY CONDITIONS

High Temperature Life Tests

There has been a continuous interest in the high temperature capabilities of ceramic tubes at temperatures above those permitted by the published ratings. Through our regular lot acceptance life testing, considerable data have been accumulated which substantiate the published temperature ratings. However, other special life tests have been conducted to evaluate the tubes at higher-than-rated temperatures and a summary of some of these tests is presented in this report. Attached are life test data consisting of Plate Current and Transconductance medians versus time for the following tests:

Type	Lot	Amb. Temp.	Env. Temp.	Ef*	L.T. Duration	n
7296	472	400°C	450°C	5.4 V	2000 Hrs.	10
7296	305	500°C	550°C	4.3 V	4000 Hrs.	10
7296	45	240°C	300°C	6.3 V	15000 Hrs.	10
7296	46	240°C	300°C	6.3 V	15000 Hrs.	10
Z-2354	253	400°C	450°C	5.0 V	17000 Hrs.	10

* Note that lots 472 and 305 of the 7296, and lot 253 of the Z-2354, were life-tested at reduced heater voltage. This was done to obtain longer tube life by keeping the cathode temperature within bounds. However, the particular value of heater voltages used in these tests are not necessarily the optimum values. The lower plate current and transconductance values of lot 305, as compared with lot 472, are caused, at least in part, by the higher envelope temperature of lot 305. Higher envelope temperature increases the spacings between the tube elements, thus reducing the transconductance and plate current. It may be that with the particular heater voltage used, the cathode temperature was lower for lot 305, causing part of the difference in characteristics. However, this was not verified by measuring cathode temperatures.

Humidity Test

In addition to the high ambient life test operation summary, test data of a special humidity test are included. This test was performed to investigate the effect on tube properties due to absorption of moisture into the ceramic and seal areas. The test consisted of type 7768 tubes placed in a chamber and subjected to a steam vapor of approximately 100°C and 95-100 percent relative humidity for an extended period. These test conditions are in accordance with MIL-E-1, Par. 4.9.9, with the exception of a longer duration. The tubes were taken out of the chamber at various intervals, conditioned at room ambient for several hours, and read for heater current and plate current characteristics to detect any air leaks or other degradation in electrical characteristics. Of the two lots being tested, one has completed 1030 hours and the other has completed 466 hours. The results indicate no significant change in plate current or heater current throughout the test. These readings are good indicators of tube condition and it is evident that the tubes have withstood the humidity environment without deleterious effects.

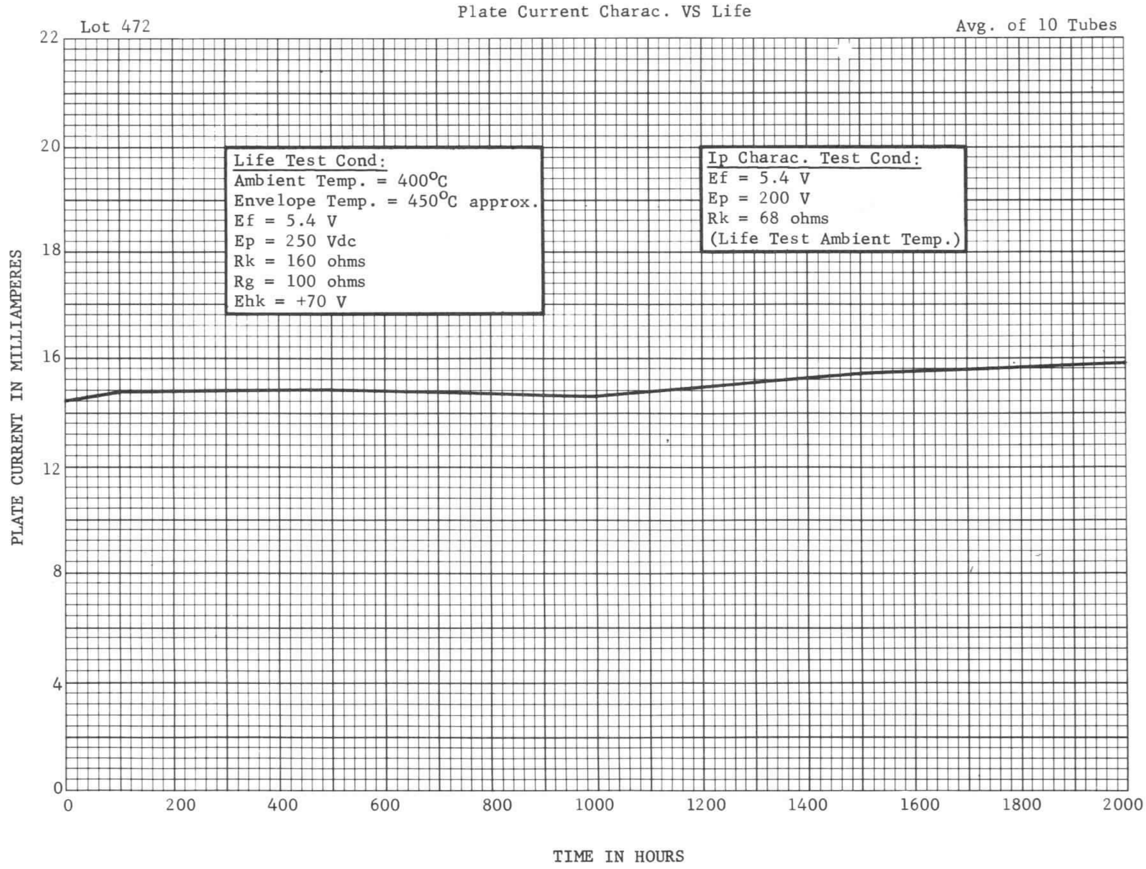
These data, of course, are insufficient to provide a great deal of statistical proof, but the long-duration life performance data do present an encouraging indication of reliable operation under high ambient and high humidity conditions.

This material was prepared by W. H. Lemaster, Specification Development, General and I&M Tubes, Receiving Tube Engineering, and distributed by Technical Data Unit, Receiving Tube Department.

TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

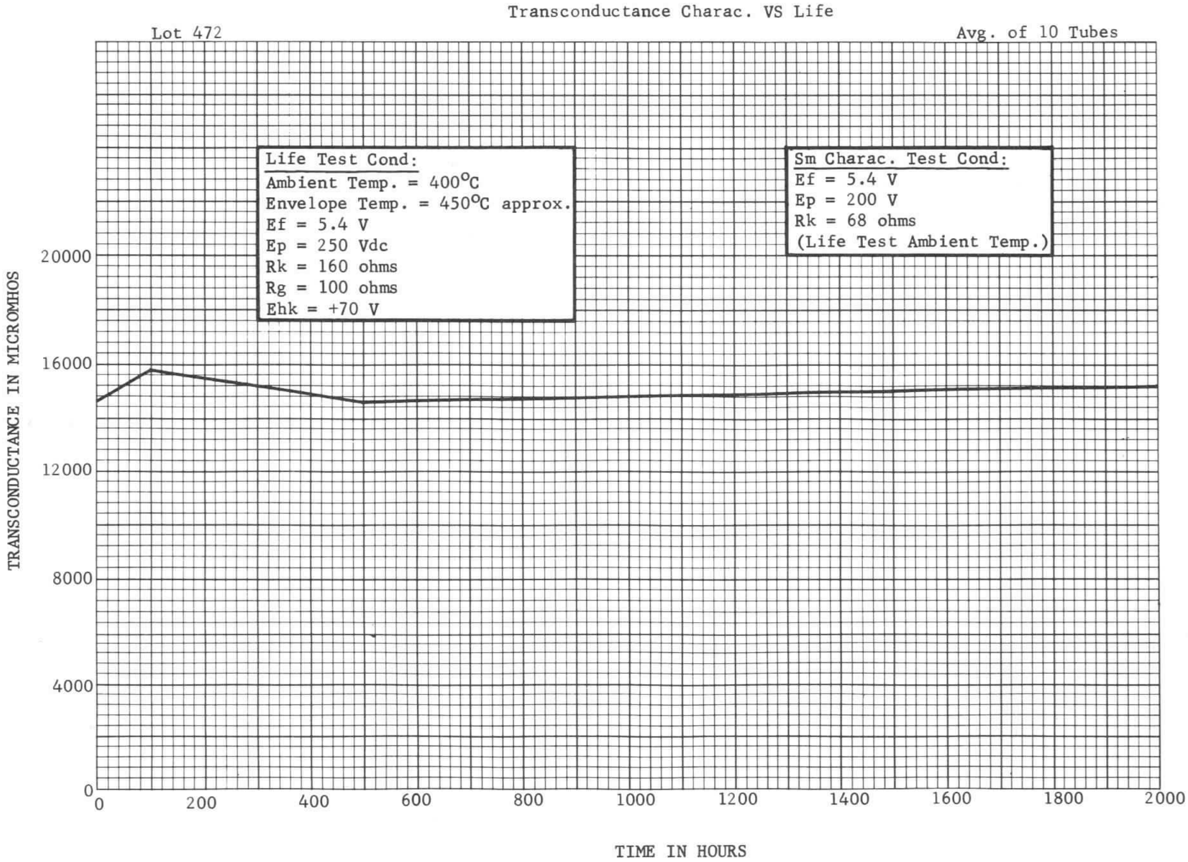
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

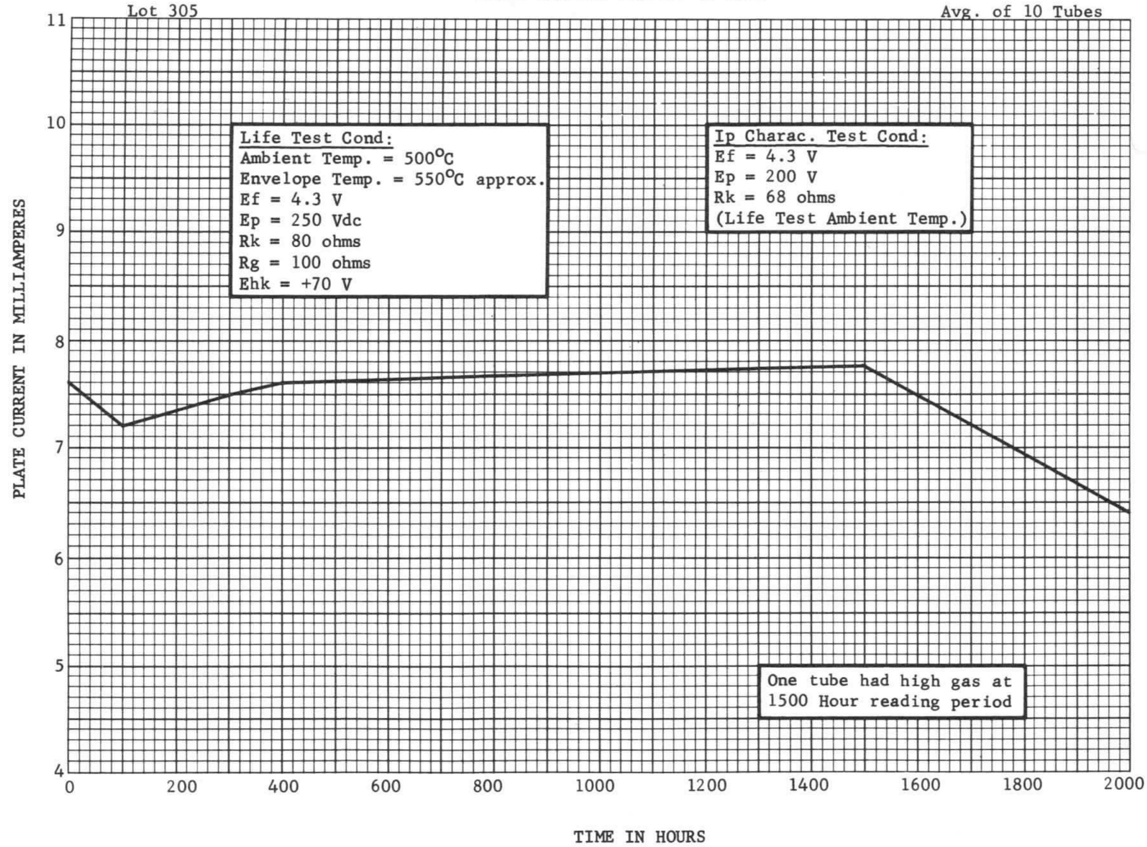
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

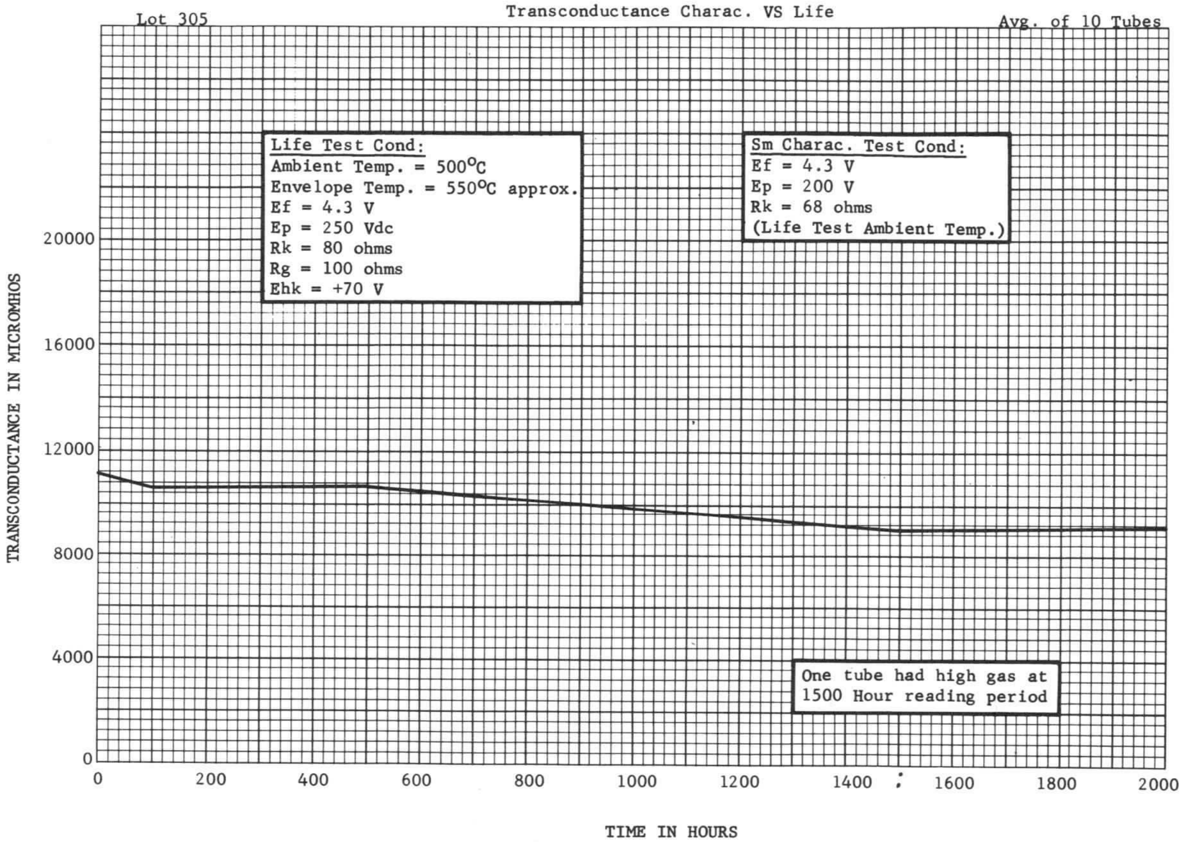
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

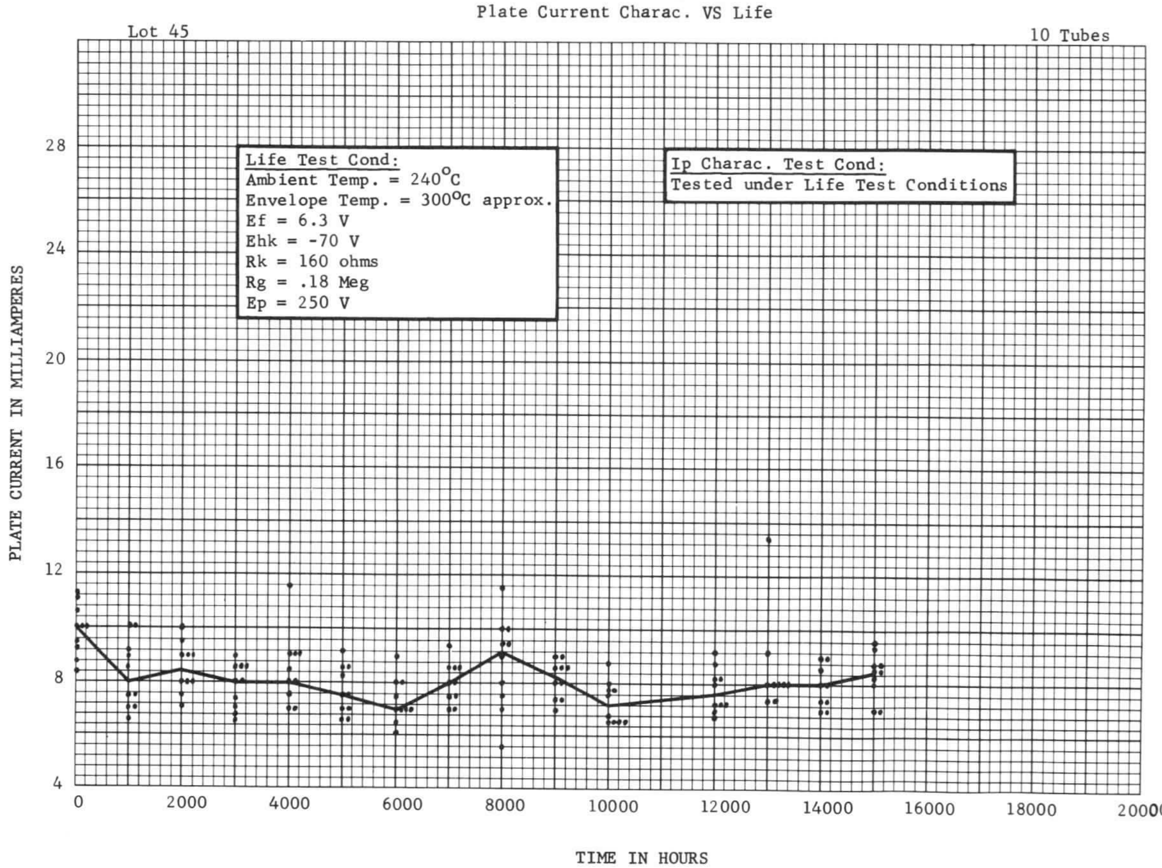
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

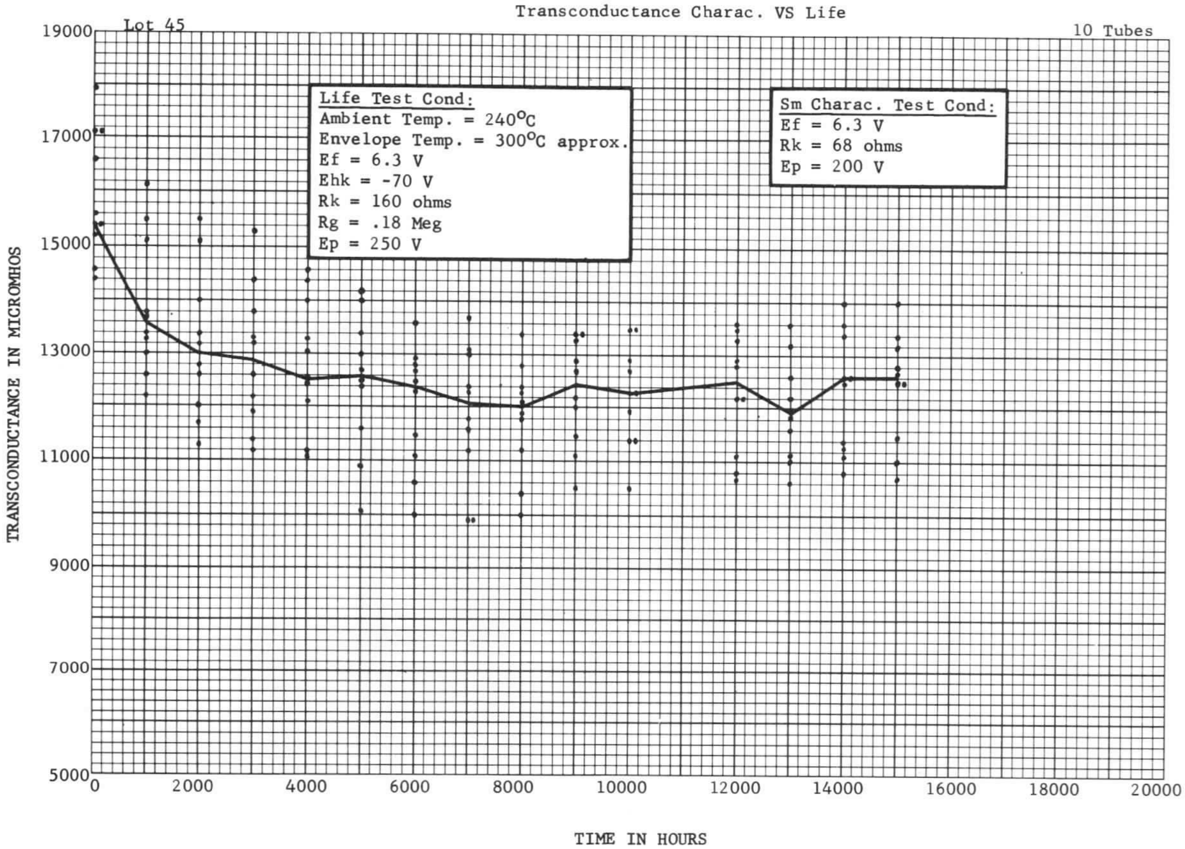
Plate Current Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

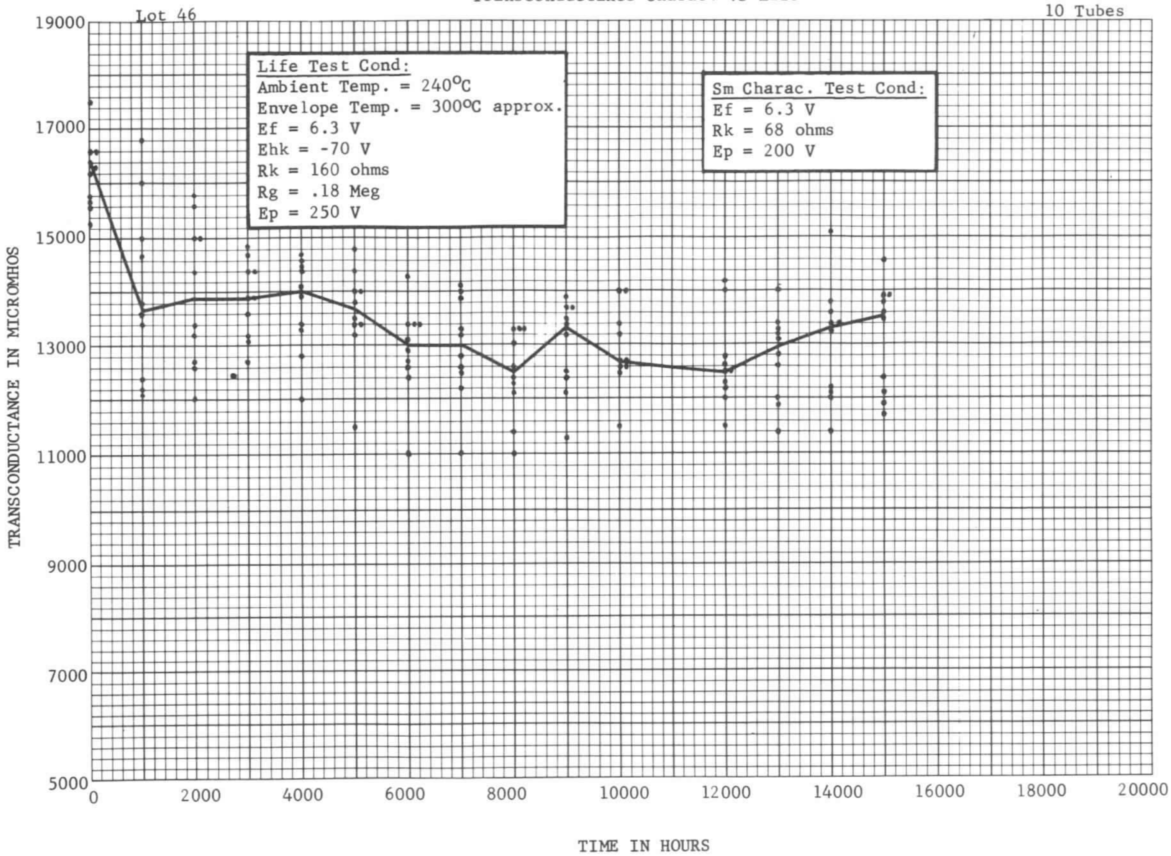
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

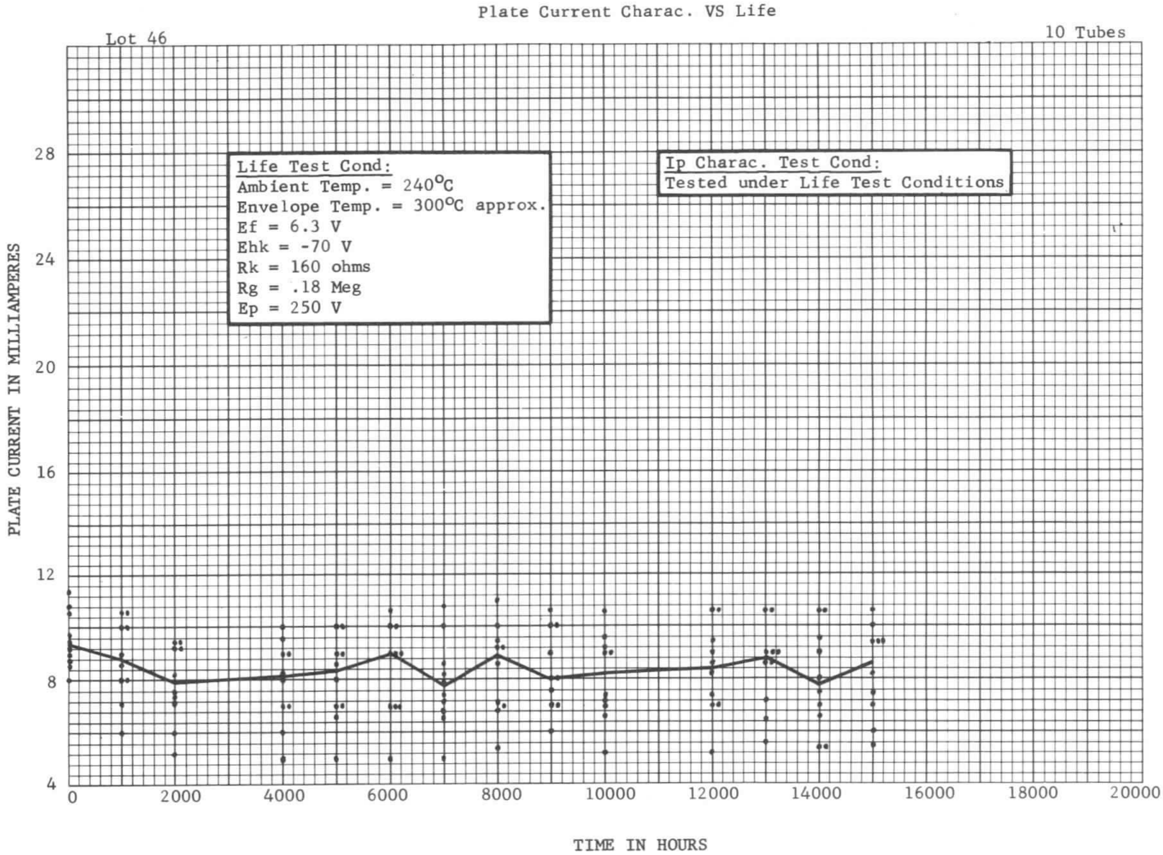
Transconductance Charac. VS Life



TYPE - 7296

HIGH TEMPERATURE LIFE TEST DATA

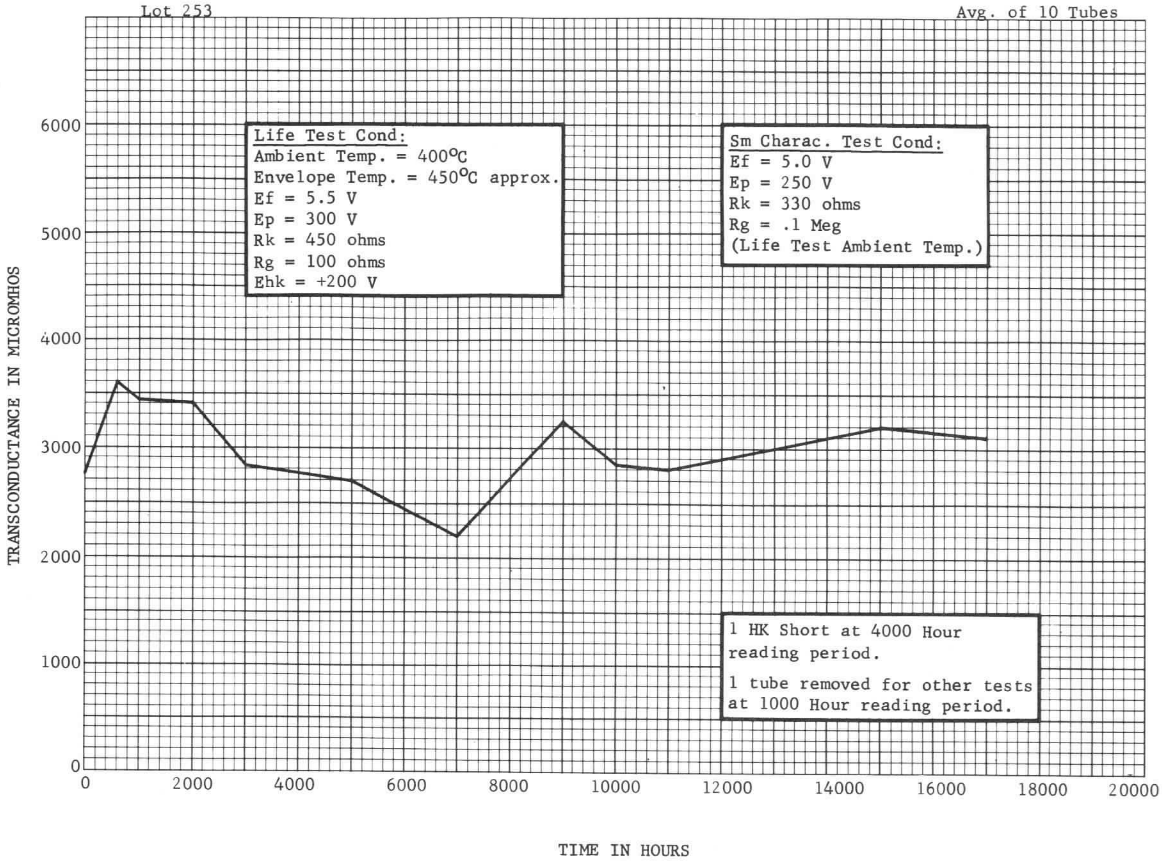
Plate Current Charac. VS Life



TYPE Z-2354

HIGH TEMPERATURE LIFE TEST DATA

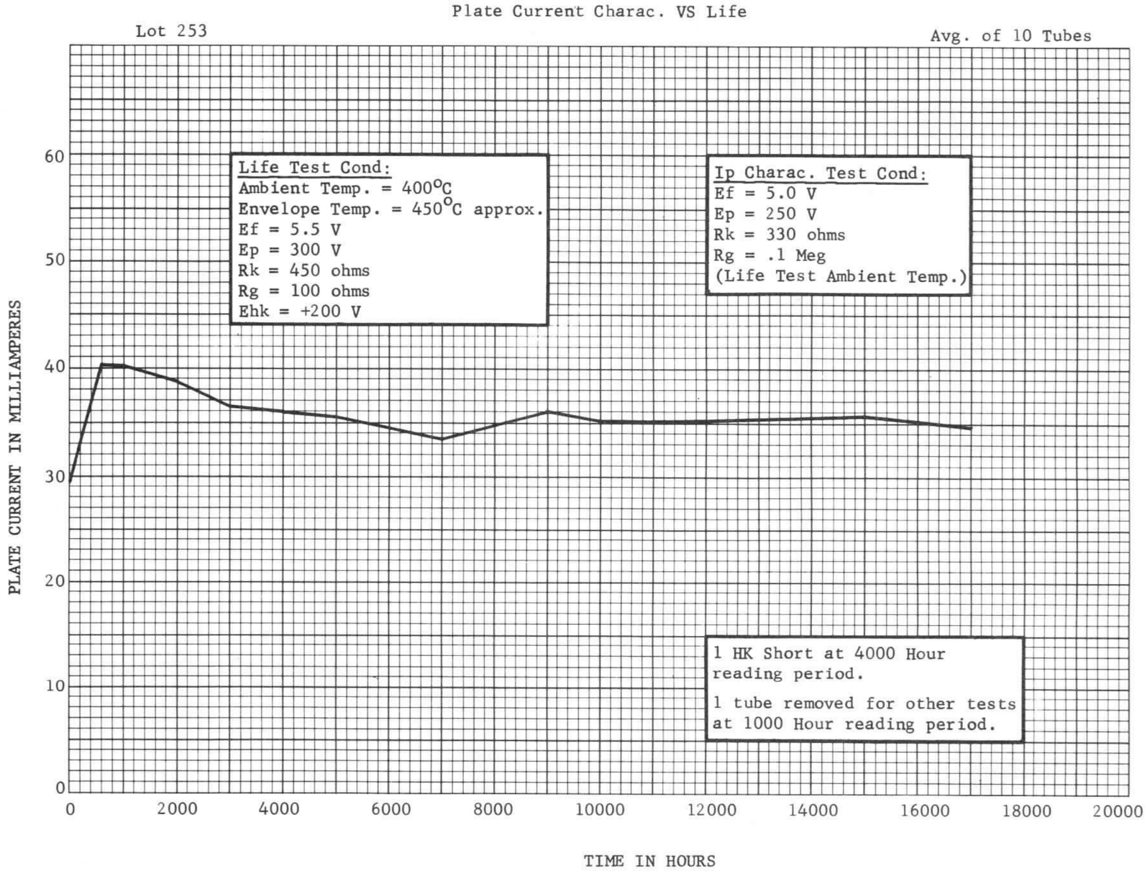
Transconductance Charac. VS Life



TYPE - Z-2354

HIGH TEMPERATURE LIFE TEST DATA

Plate Current Charac. VS Life



Humidity Test Results of Ceramic Type 7768

Test Conditions Per MIL-E-1 4.9.9

Group #1

Tube #		0 Hr.	92 Hr.	261 Hr.	404 Hr.	568 Hr.	706 1/2 Hr.	845 Hr.	1031 Hr
1P-26	If(mA)	---	400	399	400	400	400	400	400
	Ip(mA)	32.0	31.5	31.0	32.8	31.8	34.0	32.2	34.9
1P-28		---	400	400	400	400	400	400	390
		24.0	27.0	27.0	28.0	27.0	38.0	27.5	26.0
1P-41		---	400	402	401	401	402	402	402
		24.5	26.5	27.0	27.0	26.9	27.8	26.9	26.5
1P-43		---	419	420	419	420	420	420	415
		25.0	25.0	25.0	26.0	28.0	29.0	29.0	28.8
1P-49		---	399	400	395	400	400	400	398
		21.0	23.5	23.5	24.5	24.5	25.0	24.0	25.0
1P-68		---	402	400	400	405	400	402	400
		18.0	22.5	21.0	22.0	23.0	21.0	20.8	21.5
1P-72		---	398	399	395	399	399	398	398
		24.0	30.0	30.0	30.0	30.9	30.0	27.2	30.2
1P-77		---	399	399	399	399	399	399	395
		26.0	28.0	27.0	27.5	26.9	27.0	27.5	28.9
1S-10		---	405	405	405	408	405	405	405
		25.0	29.0	28.0	29.0	30.0	30.0	29.9	29.0

Group #2

Tube #		0 Hr.	138 1/2 Hr.	280 Hr.	466 Hr.
1L-1	If(mA)	400	400	400	395
	Ip(mA)	21.0	21.0	21.0	21.0
1L-13		392	395	398	395
		28.0	29.0	28.0	29.0
1L2-13		409	410	410	405
		26.0	26.5	25.9	25.8
1K4-23		400	402	405	400
		19.5	20.0	19.5	19.5
1K6-3		410	410	400	398
		21.5	20.9	20.0	19.0
1K6-7		395	405	400	400
		26.8	27.0	26.0	26.0
1P-59		402	402	405	400
		24.1	25.0	24.0	24.0
1P-65		405	405	405	405
		25.5	25.0	25.0	26.0
1P-75		398	400	400	399
		26.0	26.8	26.0	26.2
1P-78		400	400	400	400
		24.0	24.5	23.0	24.5

EI-48
March 18, 1963

RESULTS OF RECENT TESTS OF CERAMIC TUBES DURING EXPOSURE TO NUCLEAR RADIATION

A number of General Electric ceramic tubes were recently operated in the field of a nuclear reactor with provisions made for periodic monitoring of the tube and circuit performance before, during, and after exposure to nuclear radiation.

Five type 6442's, 5 type 7588's, and 5 type 7077's were operated with the tubes, sockets, and connecting wires only adjacent to the reactor and all other circuitry removed from the vicinity of the reactor, while 18 type 7462's were operated in three 60-megacycle intermediate-frequency amplifiers, adjacent to the reactor. In addition, one tube of each type and one 60-megacycle amplifier were operated simultaneously away from the reactor to provide readings for comparison.

The reactor was operated for 128 hours, achieving a 3-megawatt level at 20 hours, and maintaining it to the end of the test. At intervals, measurements were made of plate current, plate current versus grid voltages, and plate current at reduced heater voltage for all tubes not in the 60-megacycle amplifiers; and plate current of each tube, gain, bandwidth, and tangential noise for the four 60-megacycle amplifiers.

During the test, there was very little change in average plate current of any of the tubes. However, two of the 60-megacycle amplifiers failed at approximately 57 hours, without plate current changes. Within two hours after shutdown of the reactor, both of the amplifiers that failed had recovered and would perform approximately as well as they did initially.

It is believed that coaxial cables carrying r-f signals to and from the amplifiers were severly affected by the heat from a hot-air line, and that this accounts for the amplifier failures, since there was no significant difference between the plate current readings for the tubes in the non-operative amplifiers and those in the amplifier that continued to function.

Detailed results of the tests are presented below in graphical form with explanatory notes.

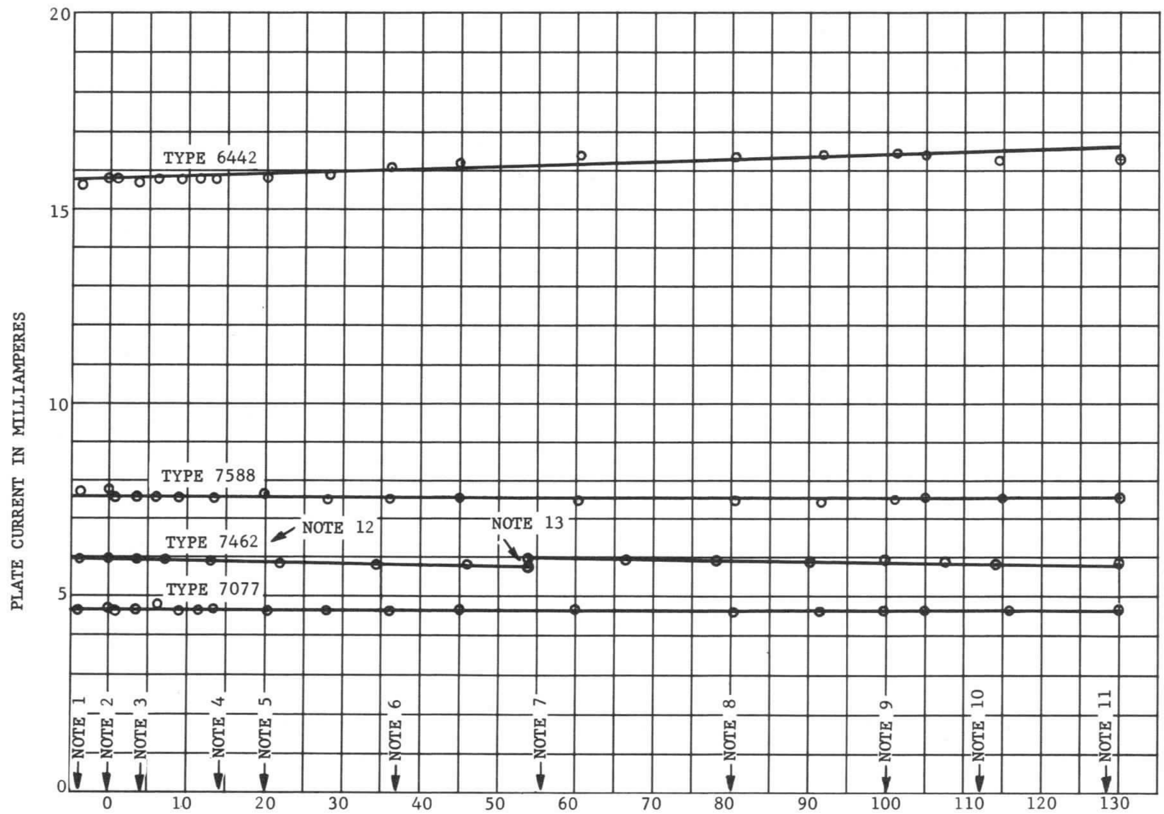


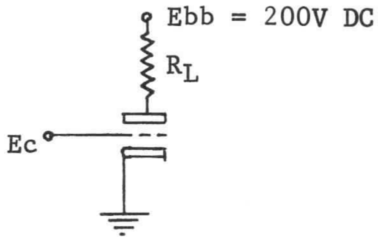
FIGURE 1

Notes:

1. Reactor output level = 0 Kilowatts
2. Reactor output level = 50 Kilowatts
3. Reactor output level = 150 Kilowatts
4. Reactor output level = 1 Megawatt
5. Reactor output level = 3 Megawatts
6. Estimated dosage = 1.5×10^{-16} NVT ($E > 0.3$ Mev) and 1.8×10^{10} Ergs/GM(c) All dosages are estimated on the basis of previous dosimetry of the source.

7. Estimated dosage = $3x10^{16}$ NVT (E > 0.3 Mev) and $3x10^{10}$ Ergs/GM(c)
8. Estimated dosage = $5.5x10^{16}$ NVT (E > 0.3 Mev) and $5x10^{10}$ Ergs/GM(c)
9. Estimated dosage = $7.5x10^{16}$ NVT (E > 0.3 Mev) and $7x10^{10}$ Ergs/GM(c)
10. Final estimated dosage = $1x10^{17}$ NVT (E > 0.3 Mev) and $9x10^{10}$ Ergs/GM(c)
11. Reactor shut down at 128 hours.
12. The 7462's were approximately 10 inches further away from the reactor than the other tubes. Therefore, for these tubes divide both neutron dose and gamma dose by 2.
13. The bias battery for the amplifiers was changed at this point.

Test Circuit



No. of Tubes	Type	Test Conditions Ec	Test Conditions R_L
5	6442	-1.0V	3.3K
5	7588	-0.5V	10K
5	7077	-0.5V	20K

Plate current of the 18 type 7462's in the 60 MC amplifiers was obtained by measuring voltage drop across each cathode-bias resistor.

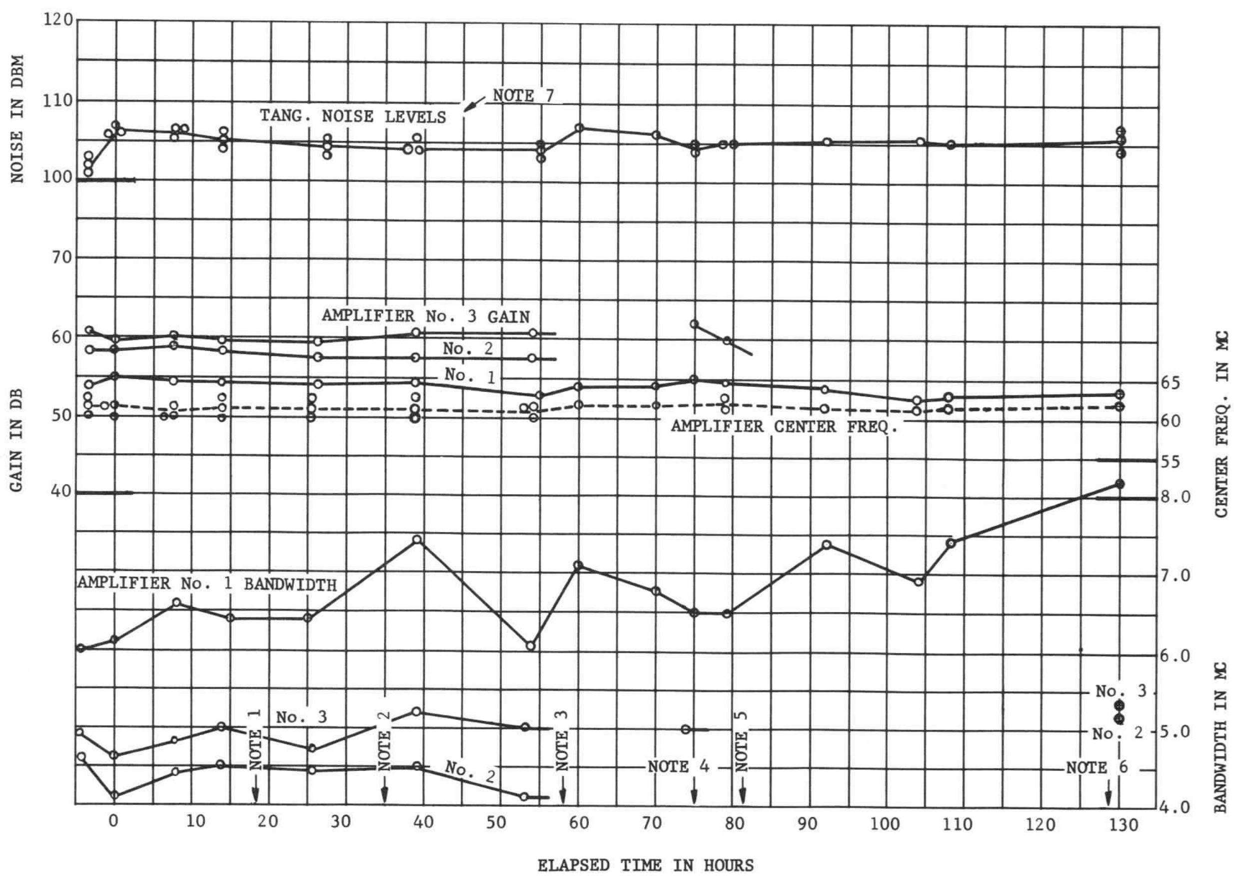


FIGURE 2

Notes:

1. Design and test gamma dosage goal - 3×10^9 Ergs/GM(c)
2. Design and test gamma dosage goal - 1×10^{16} NVT (E > 0.3 Mev)
3. Amplifiers #2 and #3 failed. Estimated dosage - 2.5×10^{16} NVT (E > 0.3 Mev) and 3×10^{10} Ergs/GM(c)
4. Amplifier #3 operating again and stable
5. Amplifier #3 intermittent from here to shutdown
6. Reactor shut down at 128 hours. All three amplifiers operating within two hours after shutdown.
7. Noise levels not best obtainable. Amplifier inputs were loaded with 2.2K grid resistors and matched to a 50-ohm input cable for desired bandwidth and minimum VSWR.

Gain - Insertion gain was measured using a small-signal r-f pulse.

Noise - Tangential noise is the DBM level of small-signal r-f pulse equal in amplitude to the noise. This does not show the low noise capabilities of the 7462, because the shunt resistor used in the input of the 60-MC amplifier was chosen to obtain the desired bandwidth and low VSWR rather than minimum noise.

Center Frequency and Bandwidth - These were both measured by observing, with an oscilloscope, the swept response of the 60-megacycle amplifiers. The length of coaxial cable required (200 feet) between the amplifiers and the measuring equipment, and its exposure to the reactor environment, are believed responsible for most of the variations in bandwidth recorded.

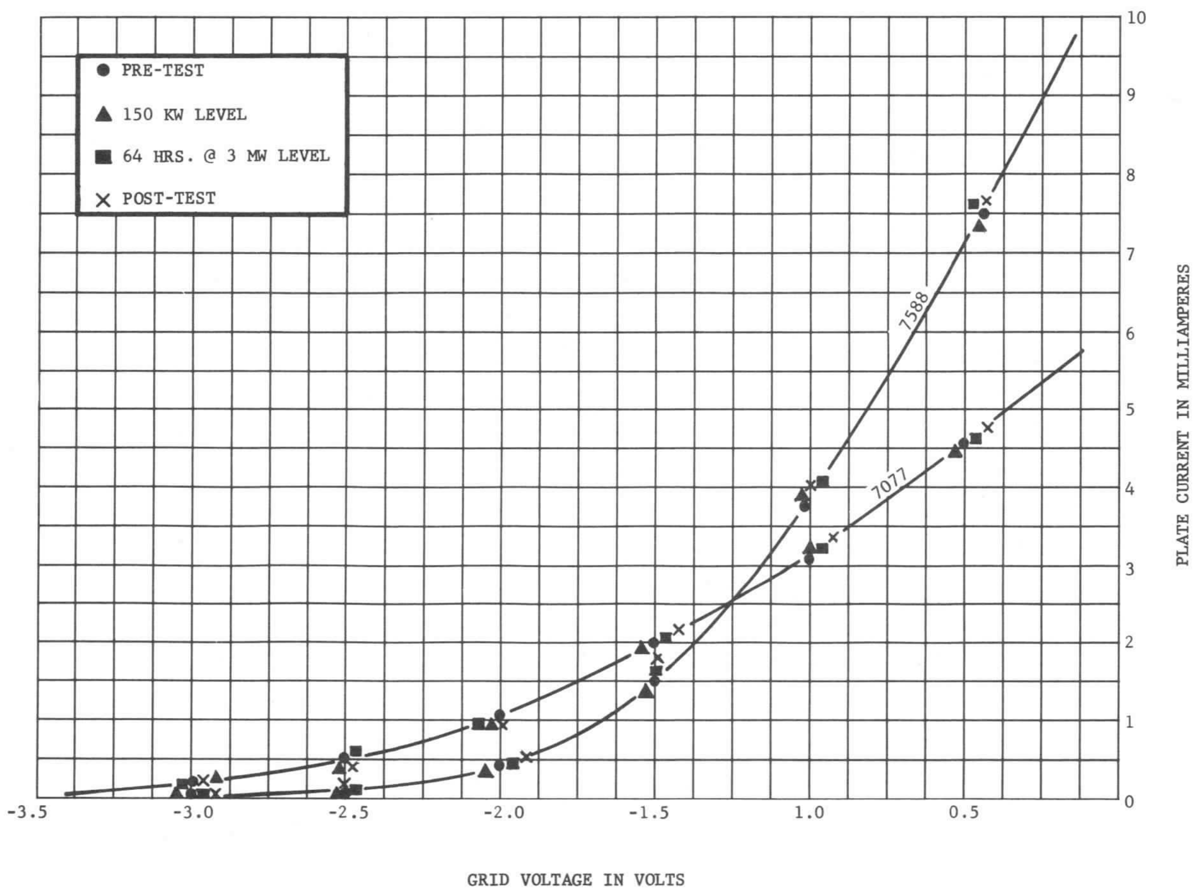


FIGURE 3

Figure 3 shows the average variation in plate current with bias for 5-tube samples of the 7077 and 7588. These measurements were made four times during the tests. Where the four readings are shown in line with the curve, they were so close together that they could not be distinguished when the curve was plotted.

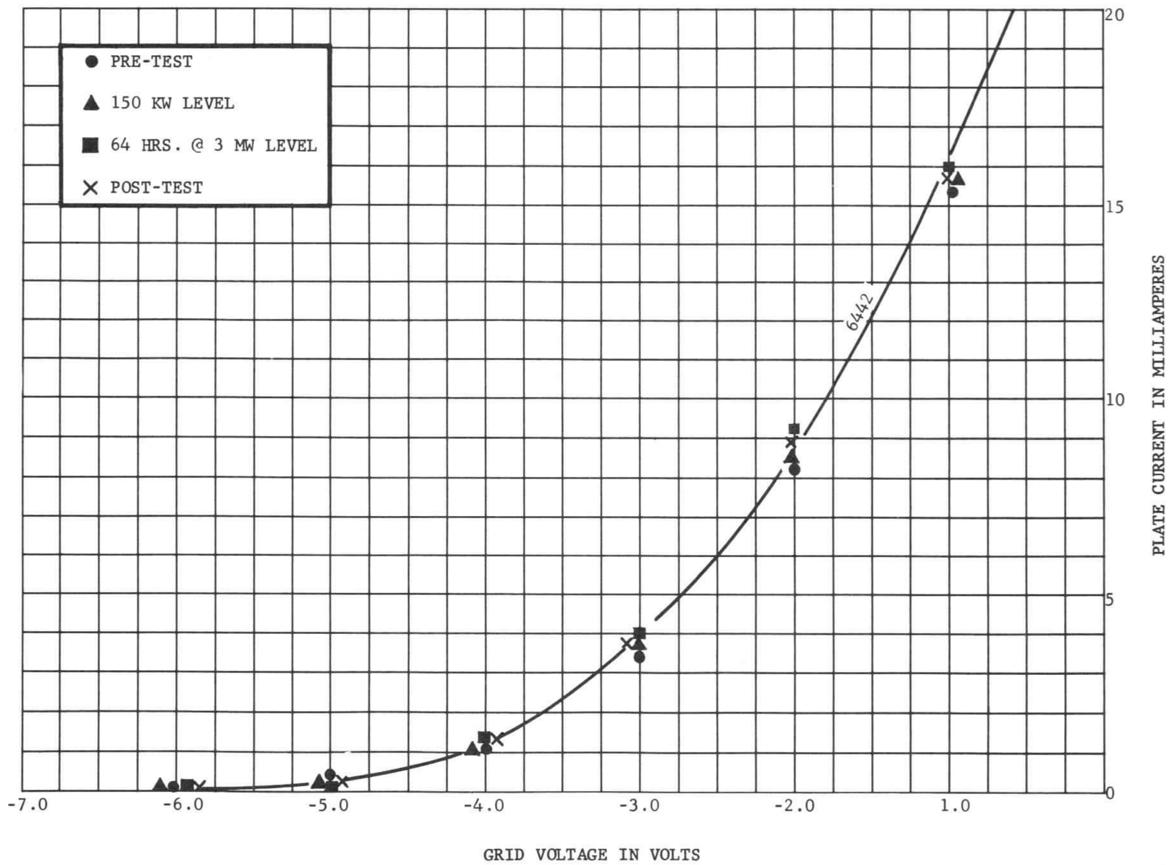


FIGURE 4

Figure 4 presents data for the 6442, similar to that presented in Figure 3 for the 7077 and 7588.

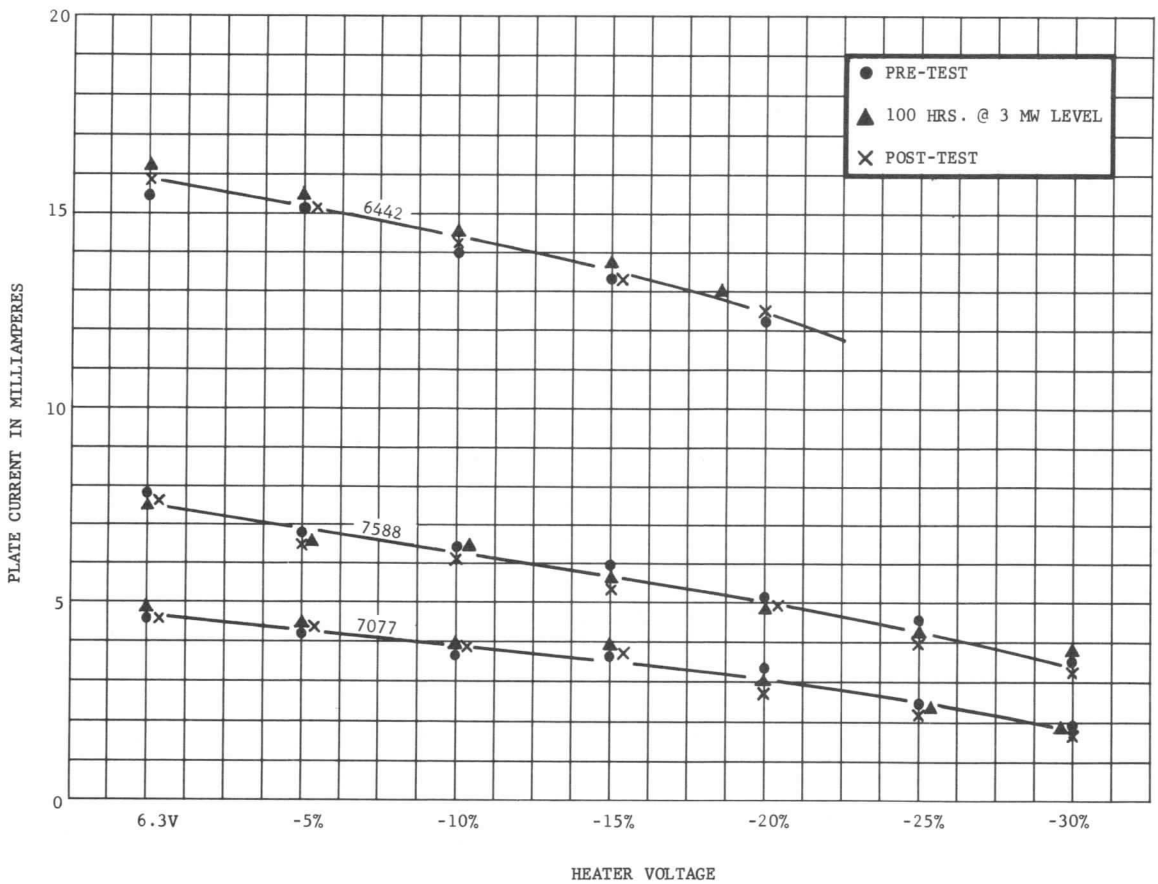


FIGURE 5

Figure 5 shows changes in plate current resulting from variation in heater voltage for the 6442, 7077, and 7588. A ten-minute period was allowed between each heater voltage change in order to stabilize the readings.

Prepared and distributed by Technical Data Unit, Receiving Tube Engineering, Owensboro, Kentucky on the basis of information obtained in tests that were made under Air Force Contract AF33(657) 8686 for which a manufacturer other than General Electric was the prime contractor.

APPLICATION NOTES ON A NEW 50,000 MICROMHO PLANAR CERAMIC TRIODE

J. W. Rush
General Electric Company
Owensboro, Kentucky

Introduction

More recent electronic systems feature performance that demands maximum gain at wide bandwidths and state-of-the-art noise figures. Compromises have been made in system performance because the best active components, vacuum tubes for example, could not operate reliably in the required environments. Recent advances in vacuum tube technology have in fact, constituted a breakthrough which provides structures yielding both high electrical performance and tolerance to high shock and vibration, high temperature and strong nuclear radiation.

To provide maximum performance the planar ceramic triode, 7768, was designed for maximum transconductance, minimum capacitance, and minimum transit times. The use of planar structures, ceramic insulators, high temperature seals, and a newly developed grid structure makes these high performance features useful in almost all military and commercial applications. The 7768 triode is about one inch long and about three quarters of one inch in diameter. See Figure 1. This figure shows the grounded grid configuration chosen for the tube. The cutaway view illustrates the internal planar structure. The most significant internal dimensions of the 7768 are its hot grid to cathode spacing of about 1.3 mils, its 768 turns per inch grid with .4 mil grid wires, and .34 square centimeters of active cathode surface.

For low microphonics and resistance to shock and vibration the grid structure has two support wires wound at right angles to the smaller grid wires. Each .4 mil wire is brazed to the larger support wires to obtain a reliable grid as well as provide more efficient heat flow from the grid. These features greatly increase the tube's tolerance to abnormal signal overloads.

The 7768 has been subjected to 450 G's in three planes without damage in a Mil Spec test. Other development types similar to the 7768 have survived centrifuge testing up to 20,000 G's when properly oriented for maximum tolerance. Soft moon-landings have been simulated and the 7768 structure has survived 3,000 G's for 3 to 5 milliseconds. The structure has also survived pressures greater than found at the deepest known ocean depths.

Input Impedance

It is difficult to accurately define the equivalent input circuit for a tube designed for grounded grid service. Existing measuring techniques are not very accurate and the transit time loading is masked by the low dynamic input resistance of this mode of tube operation. To minimize measurement errors, a special slotted line was built to maintain a constant Zo to the tube cathode ring. Since the input impedance is affected by the tube plate load short-circuited input impedance measurements were made by by-passing the tube grid and anode at the measured frequencies. The results of these measurements are shown in Figure 2, for a cold tube and an operating tube drawing rated plate currents. The "C_{in}-cold" curve represents the passive input reactance of the tube. The "R_{in}-cold" plot is definitive of both the input ceramic losses and the tube's cold cathode coating loss. To minimize ceramic losses both low loss ceramics and built-in sublimation shields are used. The "C_{in}-hot" plot illustrates the rise in input capacitance due to space charge effects and the thermal expansion of the cathode support cylinder. The latter effect has been minimized by the proper selection of materials. No Miller effect is present since the tube anode is at RF ground.

The "R_{in}-hot" curve illustrates the low dynamic input resistance of the grounded grid stage. At low frequencies this is approximately equal to the reciprocal of the tube's transconductance. The reduction in input resistance with increasing frequency can be used to estimate transit time loading. One normally assumes the input resistance consists of the parallel combination of $1/gm$ and the transit time resistance. The results shown here agree approximately with the determination of transit time loading from the noise contributed by induced grid noise.* One would normally assume that the tube's input reactance would be independent of frequency and the changes in input capacitances at the highest frequencies would be questioned. The rise in cold capacitance and the fall in hot capacitance is assumed to be due to series inductances in the test jig and the internal tube parts.

RF Performance

One of the major design objectives for the 7768 was low noise figure. To obtain minimum noise figures, the circuit designer must remember that low loss circuitry must be used and the tube cathode must see the tube's optimum source resistance. Figure 3 shows the optimum source impedance for the 7768 as a function of frequency. The plotted minimum available noise figures assume no circuit losses, no second stage noise, and optimum source impedance for the tube.

It must also be remembered that minimum noise figures also require proper DC biasing. Figure 4 shows noise figure contours drawn over the tube's plate characteristics. Minimum noise figure is obtained at maximum transconductance and bias levels sufficient to prevent any grid current flow.

Figure 5 shows the 7768 small signal power gain compared to the smaller planar ceramic triodes, the 6299 and 7077. The active cathode surfaces of the 7768, being much larger than that of the two smaller types, provides higher

*Rothe, H. and Dahlke, W. "Theory of Noisy Four Poles", Proceedings of the I.R.E. June 1956.

levels of transconductance at lower values of cathode current density. The high transconductance and high mu, about 225, of the 7768 provides state-of-the-art gain figures. The low transit times obtainable from planar structures provide useful gains well into the kilomegacycle region.

Tube to Tube Variation

The extremely close spacings necessary for efficient use of available emitting surfaces and high frequency performance require mechanical tolerances much smaller than practical for conventional tube structures. Even though extreme care is used in the mechanical construction of the 7768, tube-to-tube variations may still occur due to other causes such as cathode activity. Reasonable production maximum and minimum limits are used based on both economical and acceptable performance spread considerations. To provide additional reduction in the variation of performance from tube to tube and to permit use of the tube near its maximum ratings, various biasing methods can be used.

Figure 6 shows three typical biasing methods. Method A uses a fixed E_{bb} and a cathode biasing resistor. Method B uses a higher value of E_{bb}, a plate dropping resistor, and the same value of cathode resistor used in Method A. Method C is called a buck-boost circuit. The same E_{bb} voltage shown in Method A is used with a cathode resistor much larger than before. To provide the proper tube bias, an external bias voltage is required. Method A represents the simpliest bias circuit. To prevent limit tubes from drawing excessive plate current, the average tube must be operated at relatively low plate currents. This results in a lower average transconductance. Method B requires no external bias source to obtain a narrower plate current spread but does so at the expense of higher E_{bb} values and the power loss in the plate dropping resistor. Method B provides almost constant bias from tube to tube. Method C is the most efficient bias method. A very narrow spread in plate currents is obtained and a similar tight control of plate dissipation results. Methods B and C would also provide more uniform performance with life when compared to Method A. Figure 6 also serves to illustrate the approximate quantitative characteristic spreads from tube to tube. The plotted data represents about fifty tubes from two production lots.

Socketing

The mechanical configuration of the 7768 was chosen to permit tube usage from low frequencies to maximum usable frequencies limited only by tube transit time effects. At lower frequencies commercially available sockets can be used. At strip-line and coaxial circuit frequencies, connection can be made directly to the tube elements. At higher frequencies the use of socketless techniques are recommended since the tube's latent performance can be seriously degraded by socket loss and capacitance. The 7768 construction, being of temperature tolerant metal and ceramic, also permits solder-in circuit techniques. This feature can offer advantages of more reliable connections, socketless circuitry, and rigid tube mounting for extreme mechanical environments. Although the structure is tolerant to temperatures much higher than used for normal soldering, care must be taken to minimize excessive thermal transients at the tube seals. Figure 7 suggests several methods of connection to the 7768 triode. These techniques are useful at all frequencies where the lead inductances are not critical and where maximum gain-bandwidth performance is desired.

Measured Performance

Although the high value of gain-bandwidth product available from the 7768 makes it most attractive in wide-band circuitry, its usefulness is not limited to these applications alone. The tubes have seen usage at sub-audio frequencies where flicker noise predominates and the basic structure has been evaluated to C band frequencies.

Most of the established performance has been determined in VHF and lower UHF regions. Figure 8 shows the measured gain and noise figures for a two stage 7768 amplifier covering the complete VHF telemetering band from 225 to 260 mc. Figure 9 shows the triple tuned interstage circuit used. A broadband single-tuned input circuit is used to present the optimum source resistance to the first stage. Figure 10 shows a top and bottom view of a similar two stage amplifier.* These photographs illustrate the use of commercially available sockets and the relative simplicity of the triple-tuned circuitry used. This particular amplifier is broadbanded from 225 to 245 mc. and uses a passive resistive network to provide three identical outputs.

Figure 11 is a photograph of a two stage double-tuned 1000 mc. amplifier. This circuit features socketless circuitry and the use of flat resonant lines foreshortened with variable capacitors. Coupling between resonant elements is obtained by means of two small ceramic bypass capacitors placed thru two small holes in the inter-section shields. An overall gain of 38 db. at a 3 db. bandwidth of 15 mc. was measured. A single stage double-tuned 7768 amplifier was constructed using similar techniques. Various gains were measured as a function of amplifier bandwidths. An approximate calculation of tube-circuit bandwidth can be determined by:

$$G\text{-}BW = \frac{gm}{2\pi C_T}$$

where C_T is the total interstage grounded grid capacitance. Estimating the stray capacitances, one obtains a C_T of about 5 pf including the tube's grid to plate capacitance. This gives a G-BW product of about 1600 mc. Actual measurements on the single stage 1000 mc. amplifier gave the following results:

Gain	3 db BW	G-BW
12.0 db	100 mc	1600 mc
14.5 db	50 mc	1400 mc
17.0 db	20 mc	1000 mc
19.0 db	10 mc	800 mc

These results show among other things the effect of poorer circuit efficiency at narrower bandwidths. Power gain is estimated to be equal to:

$$G = gmR_L$$

*Photo courtesy of the U. S. Naval Avionics Facility in Indianapolis, Indiana.

where R_L is the plate circuit load. This is an approximation assuming broadband conditions where $R_L \ll r_p$ of the tube which is about 4500 ohms.

Life Tests

Although extensive life tests have not been completed for the 7768, its lug type counterpart has been life tested in excess of 5000 hours. Figure 12 illustrates the excellent life characteristic obtained from this tube construction. The cathode temperature is designed for long life at rated heater voltage, 6.3 volts, and this temperature has been found to be sufficient for all Class A service and optimum for minimum noise figure. Tests at lower and higher heater voltages have shown no useful improvements in noise performance when operated at rated Class A conditions.

Conclusion

The 7768, a new metal-ceramic triode, has demonstrated the excellent RF performance predicted on the basis of the tube's very high transconductance and efficient high frequency construction. High gain and low noise figures can be obtained under conditions of long life and high reliability.

The writer wishes to thank W. P. Kimker, Coy Jackson and J. D. Campbell of the General Electric Company, Receiving Tube Department, for their assistance in the preparation of this paper and the test results shown therein.

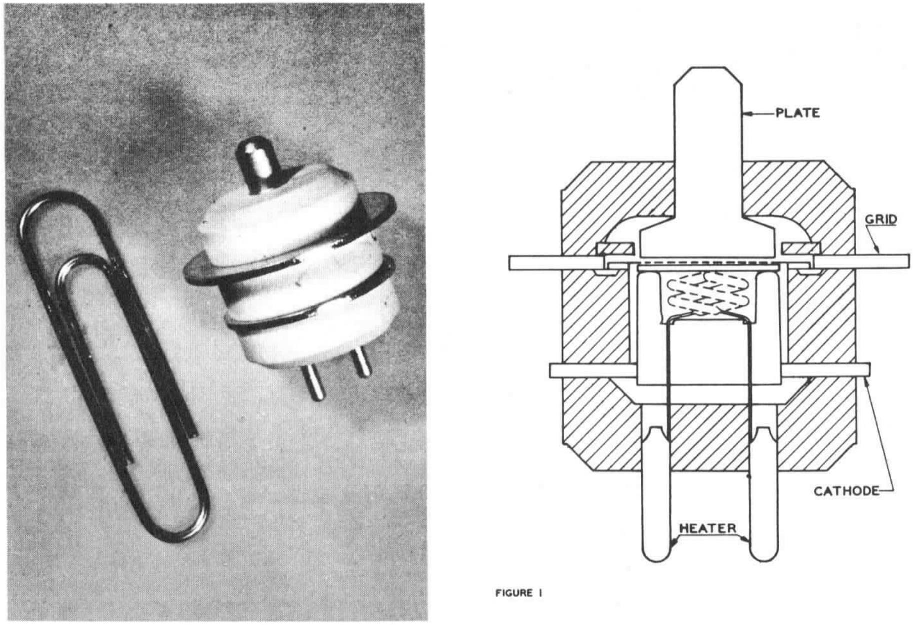


FIGURE 1

7768 INPUT CHARACTERISTICS

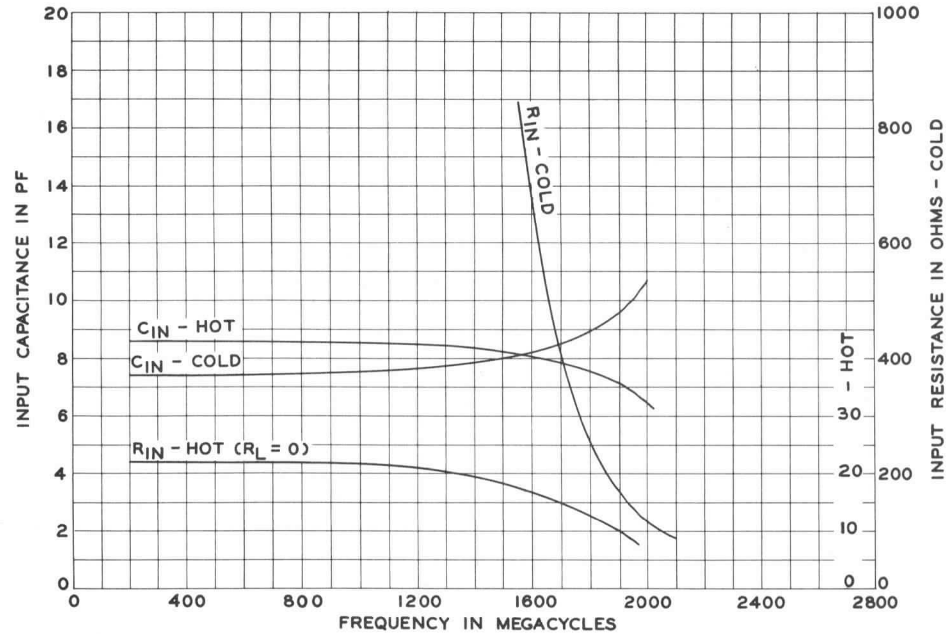


FIGURE 2

7768 NOISE PERFORMANCE

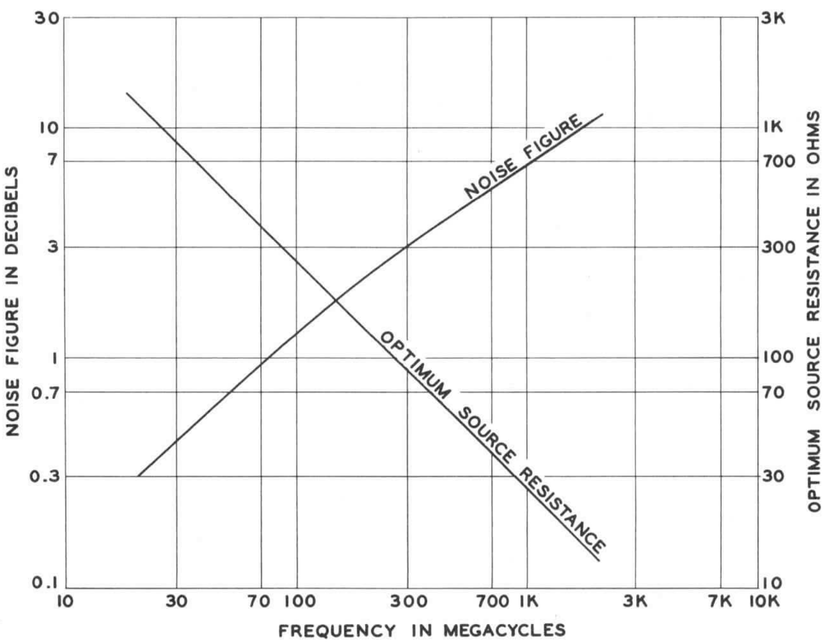


FIGURE 3

TYPE 7768

AVERAGE PLATE CHARACTERISTICS

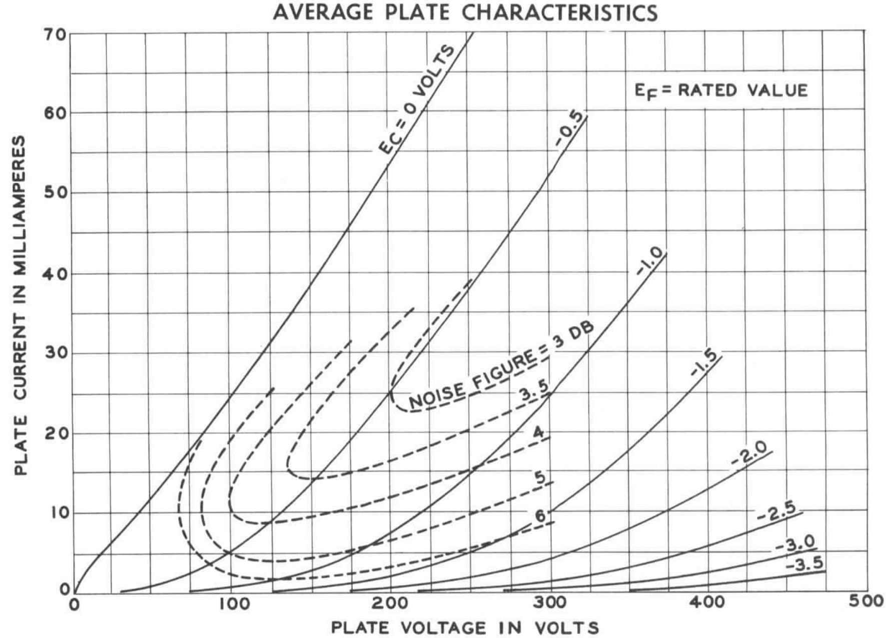


FIGURE 4

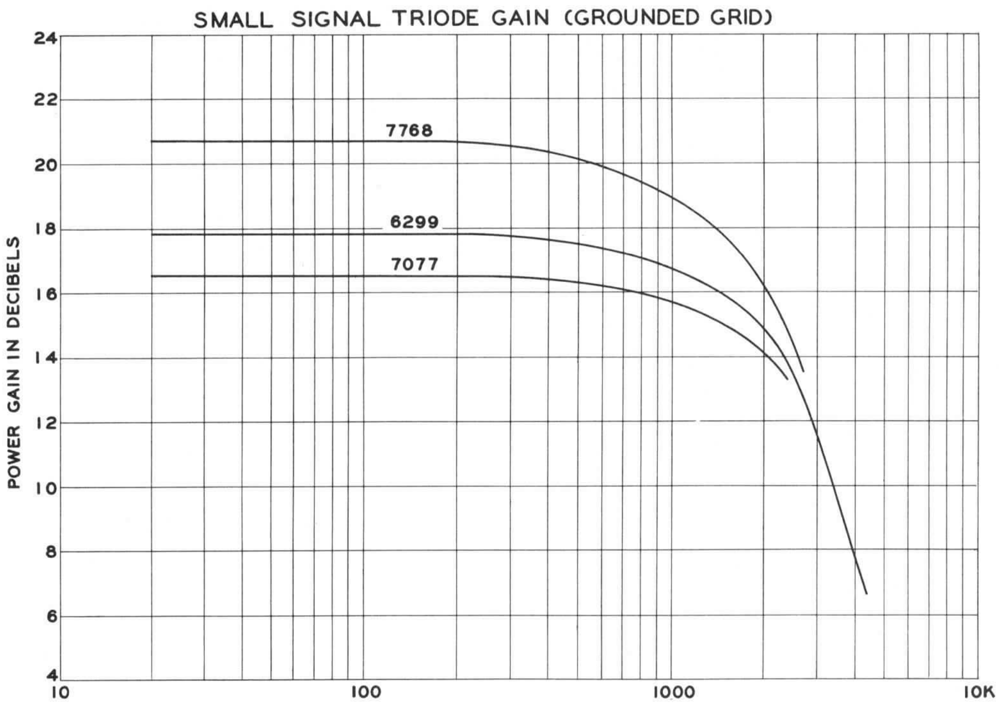


FIGURE 5

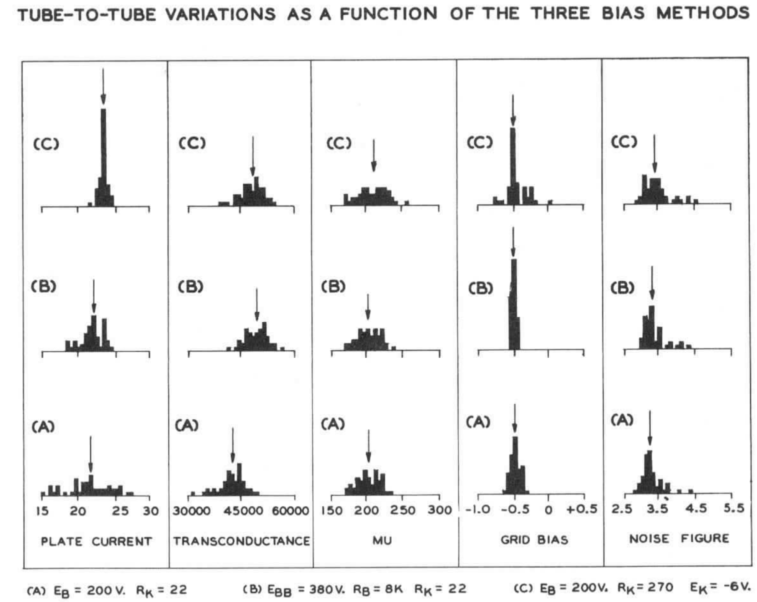


FIGURE 6

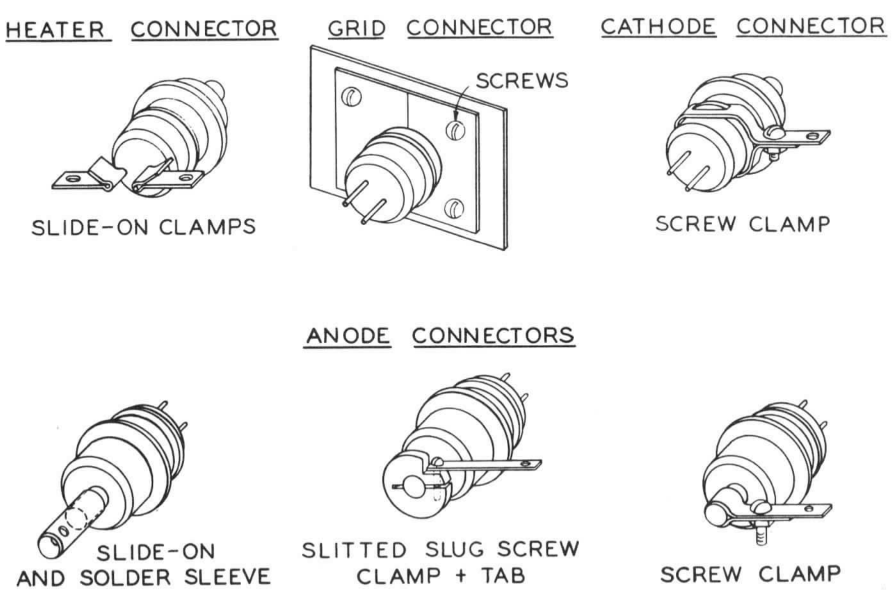


FIGURE 7

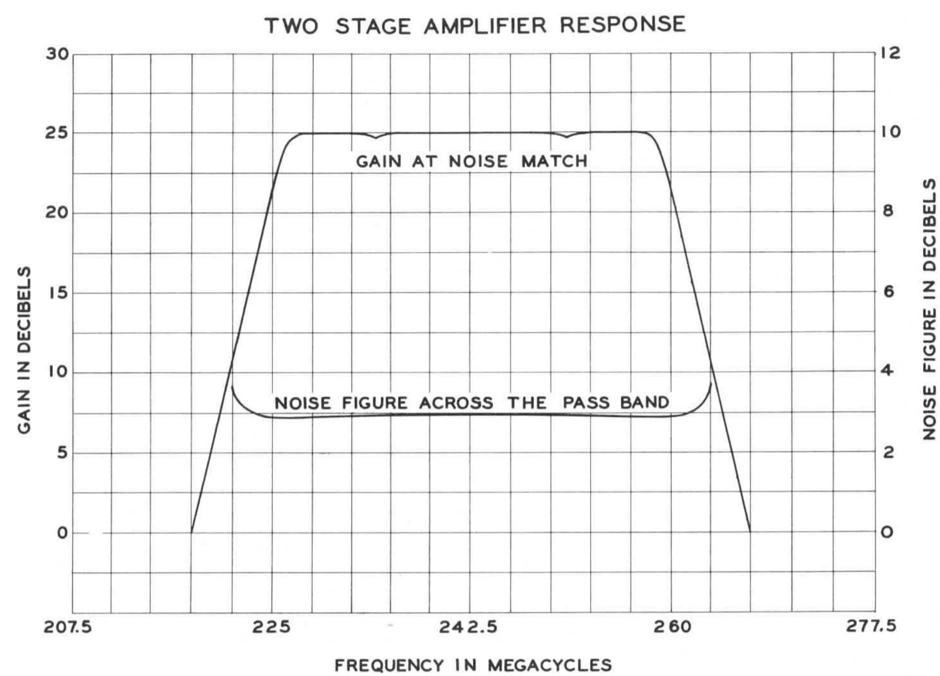


FIGURE 8

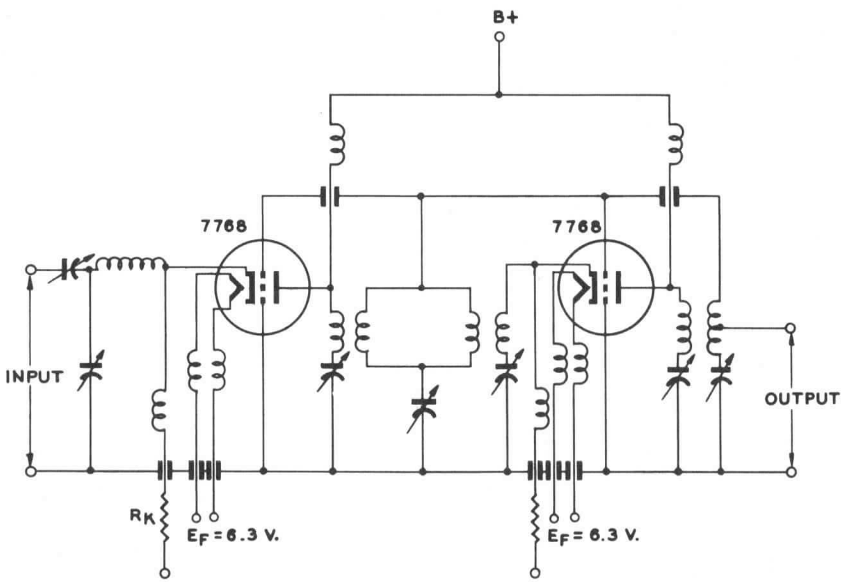


FIGURE 9

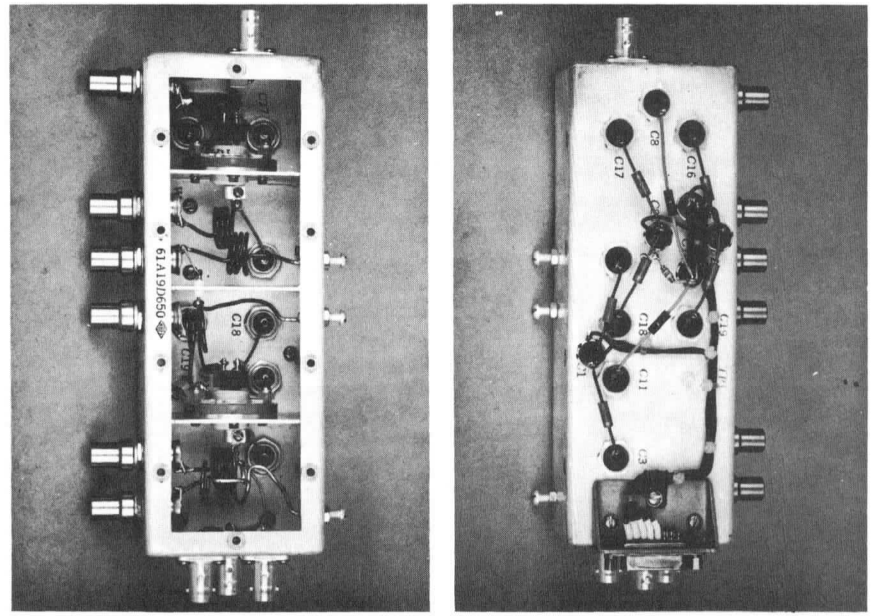


FIGURE 10

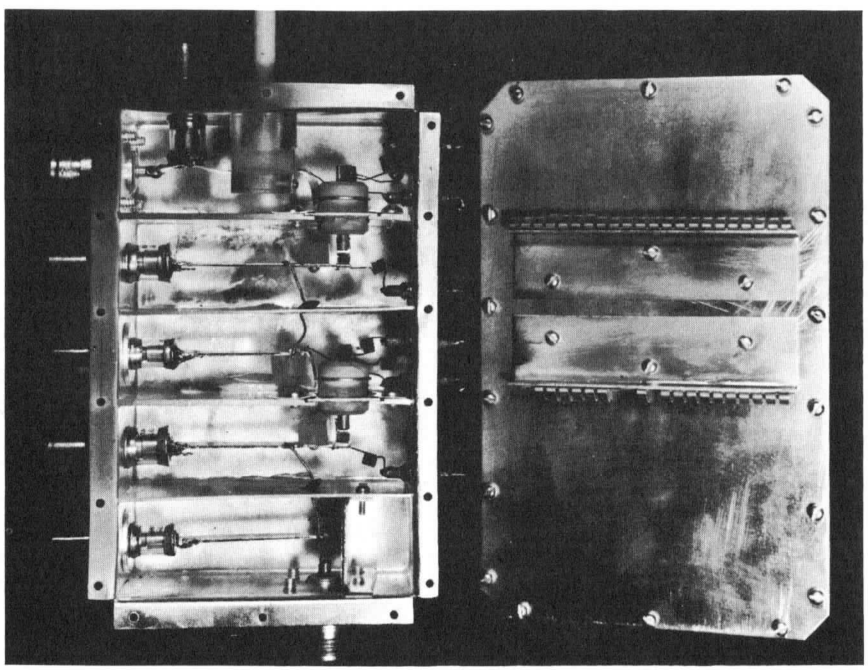


FIGURE 11

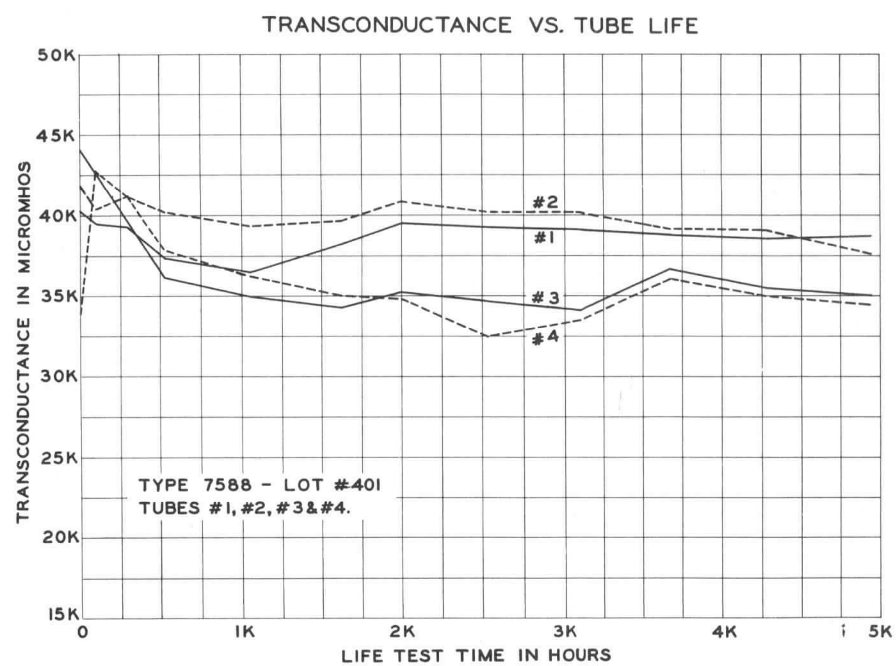


FIGURE 12

EI-49
March 27, 1963

PRECAUTIONS TO BE OBSERVED IN TESTING HIGH-FREQUENCY PLANAR TUBES

Introduction - Testing of close-spaced, high-performance, high-frequency planar tubes presents difficulties that may be overlooked and may account for misleading results or damage to the tubes being tested. Many commercially available tube checkers are not satisfactory for checking these tubes, and an effort should be made to determine if the checkers meet the requirements listed below before they are used.

Short and Leakage Tests - When grid-to-cathode leakage and shorts are checked, the maximum voltage applied between grid and cathode should be 100 volts, with the grid negative with respect to the cathode. Some checkers use a neon bulb in series with an a-c source and a capacitor to check for shorts and leakage, and apply peak-to-peak voltages as high as 250 volts between grid and cathode. This type of circuit can indicate shorts and leakage when it should not, and its use may permanently damage the tube being tested.

Test Conditions - In order to obtain values of plate current and transconductance comparable to those listed on the tube data sheets as "Initial Characteristics Limits", it is necessary that the tubes be tested under the conditions given on these sheets. This includes using the indicated values of heater voltage, plate voltage, and grid voltage.

Oscillation - When high-Gm tubes are tested, radio-frequency tank circuits are often formed by the leads external to the tube, and oscillation often results. This oscillation will give misleading results and is usually manifest by variations in plate current as leads external to the tube are moved or a hand is brought near the tube. This oscillation can usually be stopped with chokes and bypass capacitors at the test socket.

Cooling - It is important that the envelope temperature rating is not exceeded during testing. If testing is prolonged, some means of cooling may be required. This may be accomplished by means of a heat sink or with forced air.

Sockets for Testing - Sockets suitable for use in fabricating adapters, and complete adapters for some tube types, may be obtained from several socket manufacturers. The following manufacturers may be contacted for information on sockets and adapters:

Community Engineering Corporation
State College, Pennsylvania

Instruments for Industry, Inc.
101 New South Road
Hicksville, New York

Jettron Products, Inc.
56 Route 10
Hanover, New Jersey

In Case of Difficulty - If your results in testing planar tubes are unsatisfactory, contact your General Electric Sales Representative, giving details of your test.

Prepared and distributed by Technical Data Unit, Receiving Tube Engineering, Owensboro, Kentucky, on the basis of information supplied by Mr. S. E. Peach of Application Engineering.

A NEW MICROWAVE TRIODE FOR PULSED OSCILLATOR SERVICE

J. D. Campbell J. W. Rush
General Electric Company

Introduction

Many types of microwave equipment require a few kilowatts of pulsed power output where small size, light weight, and low power consumption are important. Typical examples of these kinds of equipments are altimeters, radar beacon transponders, and distance measuring equipment. While existing pulse triodes were designed primarily for service up to 3500 megacycles, many applications require a performance range including frequencies up to 6000 megacycles.

The most important requirements for a tube in this service are low power consumption, small size, low interelectrode capacitances, low loss insulators, low inductance connectors and low transit-time loading. The planar metal-ceramic structure of the Z-2867 incorporates an optimum combination of these design requirements. Its size is smaller than either of the pulse triode types 6442 or 7815 as shown in Figure 1. However, the Z-2867 is larger than the Z-2866, a 100 watt pulsed triode shown for comparison. The Z-2867 has a maximum contact ring diameter of 3/4" and is 7/8" long including heater pins and anode connector.

Tube Design Features

The configuration and spacing of the electrode contacts (Figure 2) were chosen to present acceptable impedance values and feedback in a reentrant cavity oscillator. The anode diameter is reduced in the seal area to compensate for the dielectric constant of the ceramic and reduce the discontinuity in the impedance of the grid-anode circuit. The anode insulator was made as thin as possible, consistent with anode dissipation requirements, so that the short grid cylinder required for 6000 Mc operation would have a relatively small portion of its volume occupied by ceramic material and thereby minimize losses. The ceramic material used is especially designed for low dielectric loss at UHF frequencies.

All external contacts are titanium base material which is first nickel plated and then gold plated to provide the best possible contact to cavity components. Losses may be further reduced by soldering the components directly to the tube contacts. This practice is especially desirable for the heater supply voltage connection, since this will eliminate any voltage drop due to contact oxidation during life. The resulting stability of cathode temperature serves to assure longer life. However, the life tests described in this paper were not conducted with soldered connections since the test cavities were not subjected to a corrosive atmosphere.

The high peak cathode currents required for best performance of pulsed oscillators generally require higher cathode temperature than for CW operation. Therefore, maximum heat transfer from heater to cathode should be employed to hold heater power consumption to a minimum. In addition, good heat transfer would allow the heater to operate at a low temperature, thus improving life expectancy. The flat spiral heater-cathode structure shown in Figure 2 requires 20% less power for the same cathode temperature than is required by the more commonly employed helical coil. A heat shield which holds the coil in place reflects heat to the coated cathode cup and conducts heat to the outer perimeter of the cup.

A ceramic sublimation shield prevents changes in insulation and capacitance between grid and anode during life. This provides good frequency stability and holds RF losses to a minimum.

The cathode support cylinder of this tube is uniformly welded to the cathode and cathode contact so that no deformation will occur at acceleration levels up to 4000 G, with no voltages applied. If the tube is mounted in the preferred position so that the acceleration places the support in tension, levels up to 15,000 G will give only slight distortion of the cathode. The other tube components will survive even higher accelerations.

The component parts of this tube are vacuum fired prior to assembly to remove residual gases. The tube is sealed by aligning all the parts in a jig which applies axial pressure. The tube assembly is pumped to a high vacuum and baked out to remove gases and water vapor. As the temperature is further raised, cathode activation gases escape between the unsealed surfaces of the tube. The tube is finally sealed at about 1000° C by a nickel titanium eutectic. The high temperature of these parts during sealing results in a relatively gas free tube which should not suffer emission slump during life due to gas poisoning.

Other pulse triodes have frequently employed active cathode base material to obtain maximum initial pulse capability. It is well known that active materials allow emission to deteriorate and interface resistance to form more rapidly during life than do passive materials. The Z-2867 uses passive cathode nickel with an optimum processing schedule to achieve the required pulse emission capability. This insures more stable performance on life due to a slower cathode activation rate.

Test Cavity

To determine the pulsed power outputs available from the Z-2867 a laboratory test cavity was developed (see Figure 3). During the development of the Z-2867 it was necessary to test a wide variety of development samples and the test cavity design required as many adjustable features as practical. The basic design is the familiar re-entrant configuration. The frequency of operation is determined principally by the length of the grid cylinder and the position of the anode by-pass plunger or choke. The feedback is principally adjusted by the position of the cathode with respect to the short circuit at the cathode end of the cavity. This distance is about 1/4 of an inch for optimum feedback at about 4200 megacycles. This length was determined by substituting an adjustable cathode assembly not shown. The cavity loading is optimized by sliding the complete center assembly with respect to the fixed output probe. Best results were obtained with relatively close coupling to the grid cylinder, approximately at the position shown in Figure 3.

To obtain maximum power output at other frequencies, optimum adjustment of feedback, grid cylinder length, output probe coupling and anode choke position were necessary. The anode choke is basically a single frequency device and three different lengths were required to obtain the performance from about 4000 to 6000 megacycles. For reference, the cavity body is about five inches long and the inside diameter is one inch. The scaled cavity drawing can be used to estimate the size of the remaining cavity components. A practical production cavity at 4200 megacycles need not be as large as the development cavity shown.

Construction Studies

One objective of this tube development was to obtain maximum utilization of the cathode current by designing for a high plate-to-grid current ratio. This could be achieved by increasing the transparency or percent open area of the grid, but consideration must be given to other characteristics for maximum plate efficiency. Test lots were made with grid wire diameters of .0004" and .001" and grid turns-per-inch from 400 to 750. The grid-to-plate spacing was varied from .0007" to .015", resulting in tubes with Mu's ranging from 13 to 225. The curve in Figure 4 verifies that for the selected test conditions the current division is directly proportional to the transparency, and wire size has a negligible effect. For a given transparency, power output increased as grid wire size decreased, and .0004" diameter wire was selected as the smallest practical wire for the required mechanical strength and dissipation rating. A transparency of 84% was selected for the point of best efficiency.

Transit time loading in plate pulsed triodes where high cathode current densities exist is not as difficult to overcome as in CW operation. However, at microwave frequencies transit time is important even in pulse tubes. The minimum grid-to-cathode spacing of .0025" was chosen, since a closer spacing would have increased the possibility of arcing at the high voltages employed in a typical plate pulsed oscillator.

The original development tubes had an anode insulator of the same thickness as the cathode and heater insulators, which gave a maximum oscillation frequency of about 5200 megacycles with the test cavity described. A reduction in thickness of the anode insulator from .175" to .125" improved performance slightly at the lower frequencies and made it possible for the tube to produce approximately 1.0 kilowatt at 6000 megacycles.

Figure 5 is a plot of power output as a function of frequency for the Z-2867. The performance from 4000 to over 6000 megacycles was measured in the cavity shown in Figure 3. The performance below 4000 megacycles was estimated assuming that the efficiencies at lower frequencies would be similar to that of other pulse triodes. The pulsed input was 3Kv for 1 microsecond at a pulse rate of 1000 pulses per second, thereby providing a duty factor of .001. The peak anode current from the pulse driver was adjusted to 2.5 amperes, and typical peak grid current was .3 ampere, representing a significant improvement in plate-to-grid current ratio over existing pulse triodes. Peak plate voltages and currents were measured using an oscilloscope. The peak grid current was measured by using a milliamp meter in the grid circuit and applying the duty factor to the average meter reading to determine the peak value. The high efficiency at higher frequencies can be attributed directly to the unique design features of the Z-2867 previously discussed.

Life Tests

Tubes were evaluated on the life test units shown in Figure 6.

The pulse driver unit employs conventional lumped-constant delay line circuitry working into a stepup transformer. Pulse output wave shape is relatively flat on top and has rise and fall time characteristics normally found in this type of pulse generator. The one microsecond pulse output is coupled to a 50 ohm 30 db attenuating load from which power output may be measured without disturbing the oscillator circuit.

Life tests were conducted at several levels of heater power in order to select the optimum cathode temperature for longest life (Figure 7). The peak current delivered to the anode by the modulator was held at the rated 2.5 amperes by adjustment of grid bias. A heater power of approximately 3.2 watts (.5 ampere at 6.3 volts) was selected as that required for the optimum cathode temperature for most stable life performance even though initial power output was slightly lower than for the 3.5 watt condition. Visual observation of the cathode coating on the tubes that operated at 3.5 watts showed excessive sintering at 700 hours. Although this life data on the most recent design modifications represents only about 700 hours life, its stability and data on interim design tubes indicate that good performance can be expected to a minimum of 1000 hours. Grid pulse life tests will also be conducted on this tube to give an indication of expected performance in grid pulsed oscillators.

Stability of power output with change in heater voltage was observed in the region of the heater power selected for best life stability (Figure 8). It will be noted that the curve for a fixed grid bias resistor has only a slightly greater slope than for constant plate current.

Plate versus Cathode and/or Grid Pulsing

All of the peak power outputs presented in this paper are plate pulsed values. For maximum available power outputs plate pulsing is essential. The plate pulsed tube can accept more peak voltage for short periods of time without destructive arcing than a tube used with a steady state DC plate voltage pulsed "on" at the cathode or grid. However, input pulsing, grid pulsing, or cathode pulsing, requires considerably less modulating power and where suitable power outputs can be obtained this method of pulsing can be used.

To determine the input pulsed capabilities of the Z-2867, the tube-cavity combination was tested at lower plate-pulsed voltages. Oscillation started at about 800 volts and at 1500 volts about one kilowatt of peak power was measured at 4200 megacycles. At 1500 volts and optimum cavity adjustments, the peak cathode currents observed were considerably less than the maximum rated value using simple grid leak bias. Power outputs in excess of one kilowatt can be obtained by driving the Z-2867 towards zero bias and into the positive grid region. This would require a "stiff" driving pulse, and other problems such as "squegging" and/or "CW-moding" might occur if care is not used. These problems are usually less prevalent when plate or putput pulsing is used.

Conclusion

The Z-2867, a new triode for plate pulsed oscillators, has demonstrated its capability of delivering higher outputs at higher frequencies than other similar devices. Its improved heater and plate efficiency, plus its small size resulting from this advanced design, make a very small pulsed oscillator package possible for the power capability of 1 to 3 kilowatts in the frequency range from 4000 to 6000 megacycles. The high processing temperatures employed in making this tube and the gas clean-up properties of the titanium parts can be expected to contribute to a long-life, reliable tube.

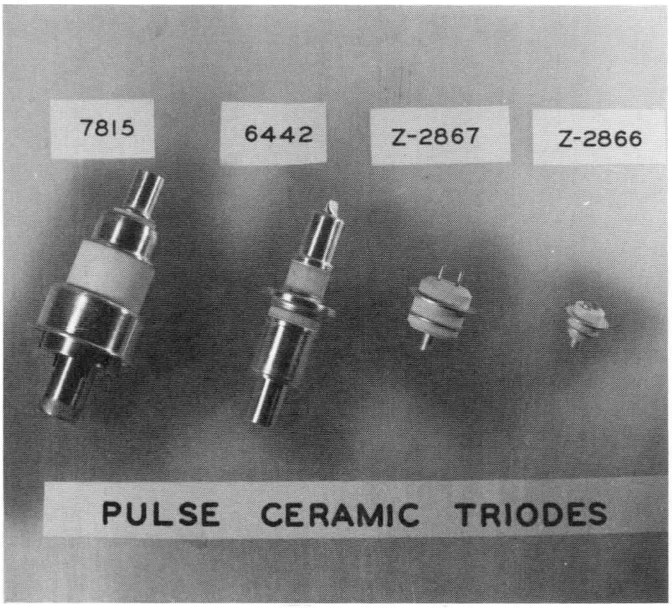
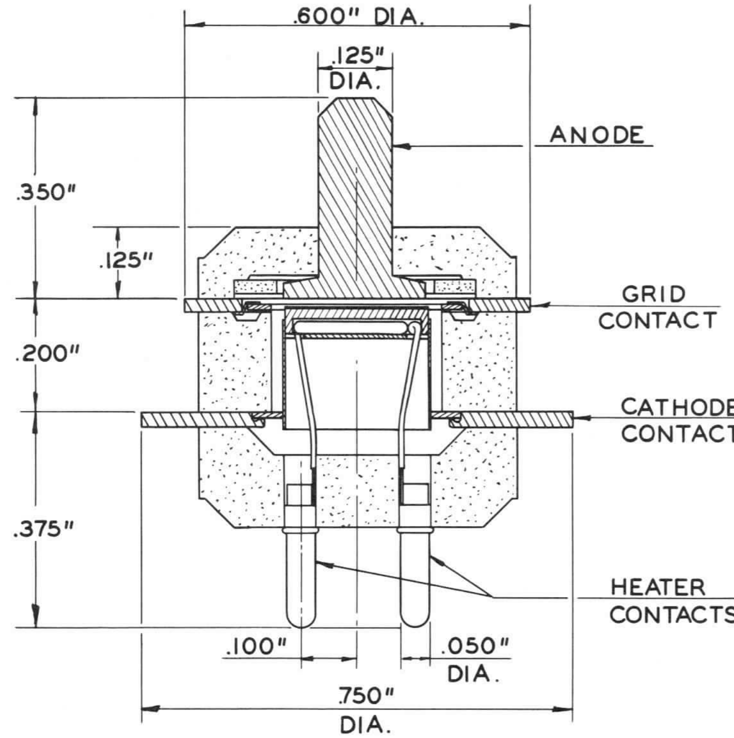
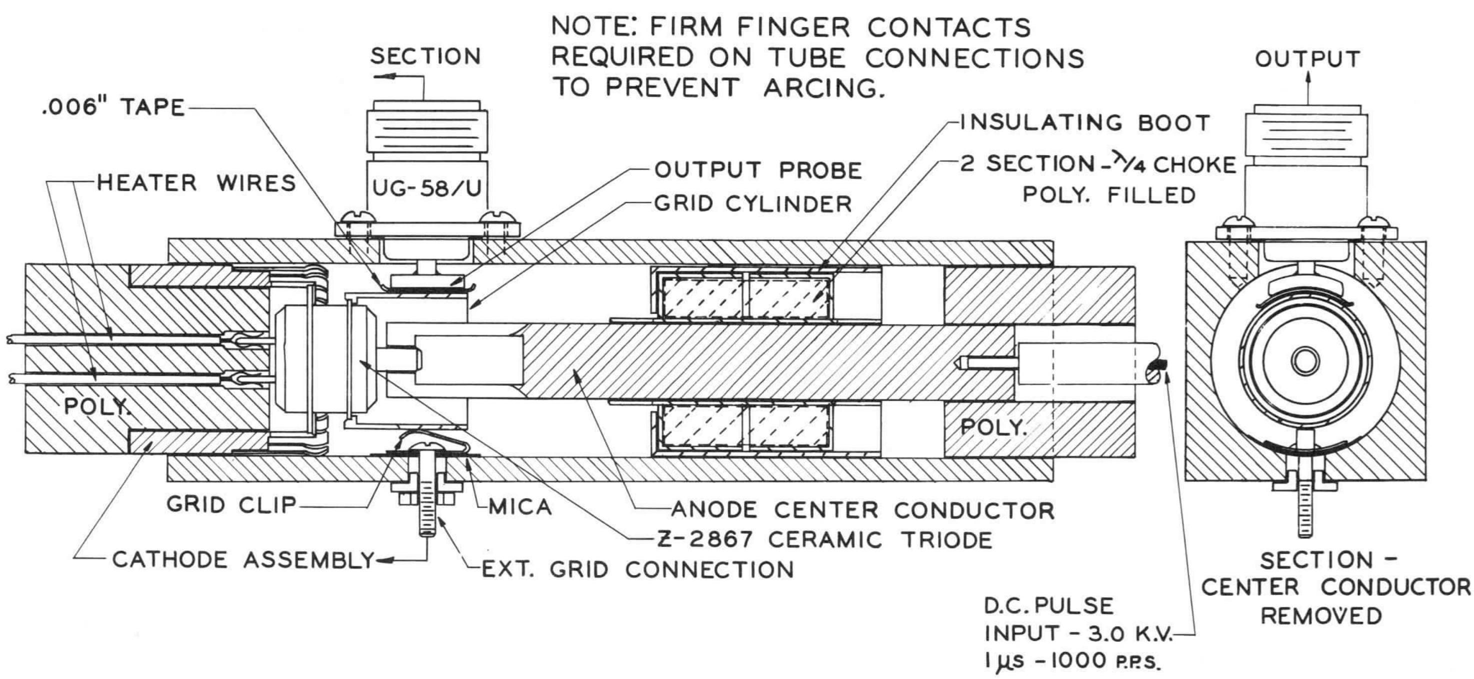


FIGURE 1



Z-2867 CROSS SECTION

FIGURE 2



Z-2867 4200 MC. COAXIAL TEST CAVITY

FIGURE 3

CATHODE CURRENT DIVISION VS: GRID TRANSPARENCY

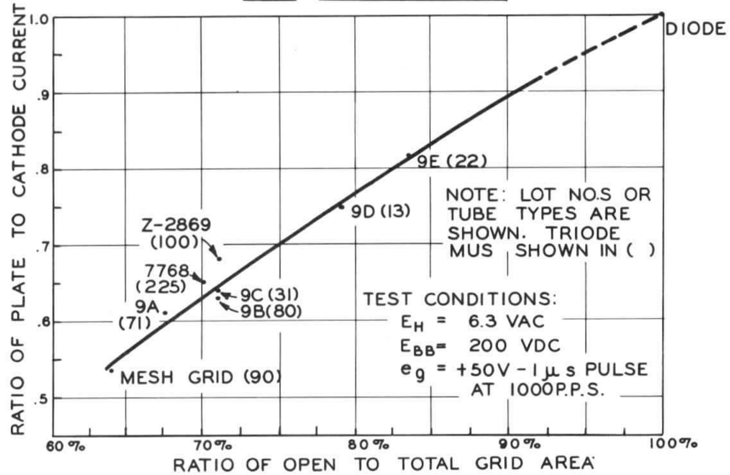


FIGURE 4

Z-2867 PULSED POWER OUTPUT VS: FREQUENCY

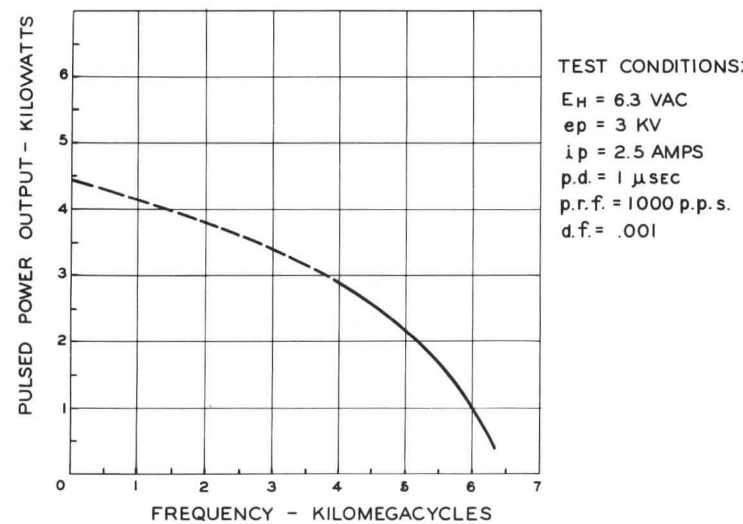


FIGURE 5

FIGURE 6

Z-2867 PULSED OSCILLATOR LIFE

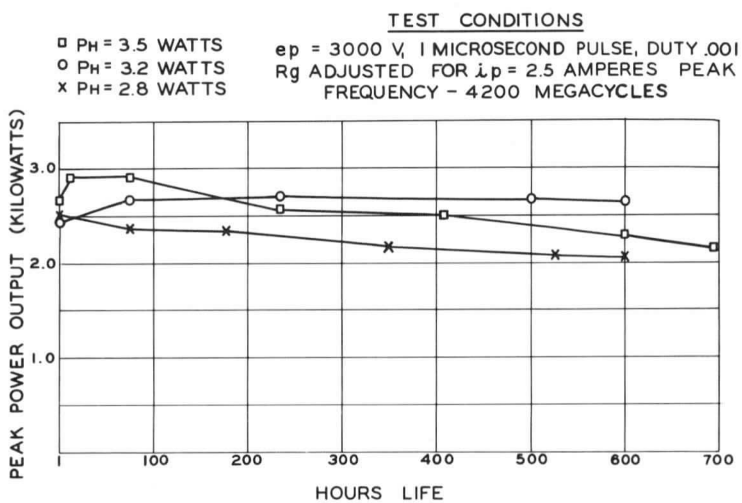


FIGURE 7

TYPE Z-2867

PULSED POWER OUTPUT VS. HEATER VOLTAGE

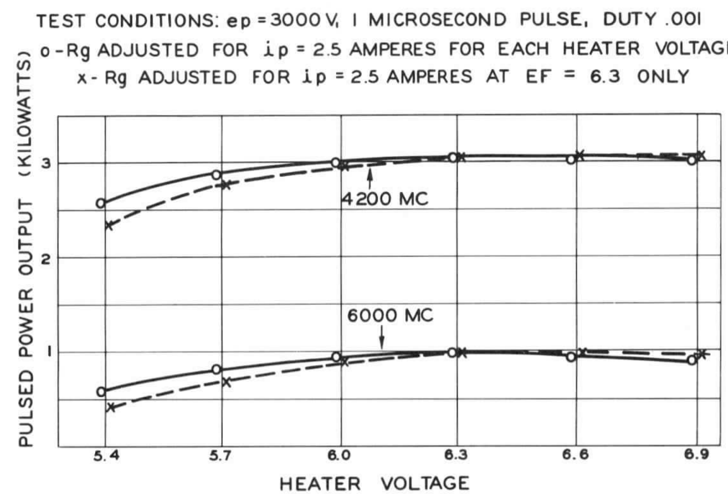


FIGURE 8

Literature, sales information, or technical assistance can be obtained from the following Technical Information and Product Service (TIPS) office, General Electric Company, Tube Department:

OWENSBORO, KENTUCKY

316 East 9th Street, MUrray 3-2401 (Central Office)

TUBE DEPARTMENT

GENERAL ELECTRIC

Owensboro, Kentucky

If additional copies of the data sheets bound in this book, or the complete book are needed, use the handy post cards found inside the front cover.

Reference Data General Electric Ceramic Tubes

GENERAL ELECTRIC

TUBE DEPARTMENT, OWENSBORO, KENTUCKY

ETG 2713D