ELECTRONIC INDUSTRIES ASSOCIATION

2001 EYE STREET, N. W.
WASHINGTON, D. C. 20006

TELEPHONE: (202) 457-4900
CABLES: ELECTRON WASHINGTON DC

Correction Notice

of

Electron Device Type Registration

Release No. 6734

May 30, 1978

The Joint Electron Device Engineering Council announced the registration of the following electron device designation

8988

on April 18, 1978.

The data is now revised as follows:

ITEM	AS REGISTERED	AS CORRECTED
1/ Page 1, second paragraph,	...4.5 kW aural power output required for a 17.5 kW TV Xmitter.	...5.0 kW aural power output required for a 25 kW TV transmitter.
2/ General Data: Current Typical value at 5.7 V	115 V	115 A
3/ Direct Interelectrode Capacitances:		
Grid No. 1 to Plate	0.40 pf (max)	0.20 pf (max)
Grid No. 1 to Filament	70 pf	76 pf
Plate to Filament	0.05 pf (max)	0.02 pf (max)
Grid No. 1 to Grid No. 2	95 pf	86 pf
Grid No. 2 to Filament	2.5 pf (max)	1.5 pf (max)

Category 4

2 + 4 ATT

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Announcement

of

Electron Device Type Registration

Release No. 6734

April 18, 1978

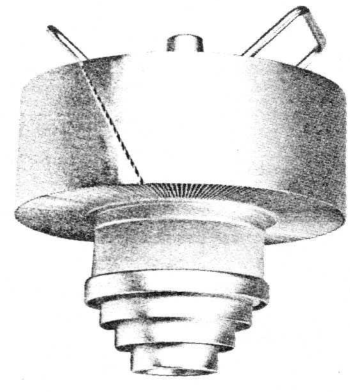
The Joint Electron Device Engineering Council announces the registration of the following electron device designations

8984
8985
8986
8988

according to the ratings and characteristics found on the attached data sheets on the application of

RCA Corporation
Lancaster, Pennsylvania

VHF Linear Beam Power Tube


L-916

- **Full Input to 300 MHz**
  Forced-Air Cooled
- **55 kW Peak Sync. Output**
  VHF-TV Band
  16 dB Gain
- **FM Broadcast Service**
  55 kW Output
  16 dB Gain

The RCA 8984 is designed specifically for use in high-gain, high-linearity equipments for VHF-TV and FM service.

Rated for full input to 300 MHz, the tube is easily circuited to this frequency. The terminals are coaxial for operation in the TEM mode and the radiator location avoids restricting the resonant cavity circuits in VHF operation. This assures high gain-bandwidth products for the full VHF-TV band. In addition, it is well suited for other applications such as single sideband, CW or pulsed RF, modulator service, and translator service.

Its sturdy, coaxial CERMOLOX construction and thoriated-tungsten mesh filament minimize tube inductances and feed-thru capacitances. They make possible the use of simple, economical, broadband circuit techniques in VHF operation. Additional information of a general nature applicable to tubes of this type is given in the following publications:

1CE-279A	Application Guide for RCA Large Power Tubes
1CE-300	Application Guide for RCA Power Tubes
AN-4020	Screen-Grid Current, Loading and Bleeder
AN-4865	Handling and Operating Considerations
AN-4869	Application Guide for Forced Air Cooling
AN-4872	Broadcast-Tube Handling and Installation

Close attention to the instructions contained in these publications will assure longer tube life, safer operation, less equipment downtime and fewer tube handling accidents.

Formerly RCA Type 4690.

General Data

Electrical:

Filamentary Cathode, Thoriated-Tungsten Mesh Type:			
Voltage[a] (AC or DC)	14.0	typ.	V
	15.0	max.	V
Current:[b]			
Typical	170		A
Instantaneous peak value during startups[s]	350	max.	A
Cold resistance	0.01		Ω
Minimum heating time[c]	120		s
Mu-Factor[d] (Grid No.2 to Grid No.1)	15		
Direct Interelectrode Capacitances:			
Grid No.1 to plate[e]	0.7		pF
Grid No.1 to filament	200		pF
Plate to filament[e]	0.5		pF
Grid No.1 to grid No.2	250		pF
Grid No.2 to plate	30		pF
Grid No.2 to filament[e]	5		pF

Mechanical:

Operating Attitude	Vertical, anode up		
Overall Length (Max.)	11.3		in
Greatest Diameter (Max.)	10.3		in
Radiator	Integral part of tube		
Weight (Approx.)	60		lbs

Thermal:

Seal Temperature[f] (Plate, Grid-No.2, Grid-No.1, Cathode-Filament, and Filament)	250	max.	°C
Average Plate-Core Temperature[g]	250	max.	°C

For further information or application assistance on this device, contact your RCA Sales Representative or write Power Tube Marketing, RCA, Lancaster, PA 17604.

Printed in U.S.A./2-78

RF Power Amplifier-Class B Television Service[h]

Synchronizing-level conditions per tube unless otherwise specified.

Maximum CCS Ratings, Absolute-Maximum Values:

DC Plate Voltage[j]	15,000	max.	V
DC Grid-No.2 Voltage[k]	2000	max.	V
DC Grid-No.1 Voltage[q]	−600	max.	V
DC Plate Current	12	max.	A
Plate Dissipation[m]	40,000	max.	W
Grid-No.2 Input	500	max.	W
Grid-No.1 Input	300	max.	W

Typical CCS Operation:

In a cathode-drive circuit at 216 MHz and bandwidth of 6.3 MHz[r]

DC Plate Voltage	10,500	V
DC Grid-No.2 Voltage	1200	V
DC Grid-No.1 Voltage[n]	−75	V
Zero-Signal DC Plate Current	1.5	A
DC Plate Current:		
Synchronizing level	8.4	A
Blanking level	6.4	A
DC Grid-No.2 Current:		
Synchronizing level	0.3	A
Blanking level	0.1	A
DC Grid-No.1 Current:		
Synchronizing level	0.25	A
Blanking level	0.12	A
Driver Power Output:[p]		
Synchronizing level	1250	W
Blanking level	700	W
Useful Power Output:		
Synchronizing level	55,000	W
Blanking level	30,800	W
Power Gain, Including Circuit Losses	16.4	dB

RF Power Amplifier & Osc. — Class AB Telegraphy and RF Power Amplifier — Class AB FM Telephony[h]

Maximum CCS Ratings, Absolute-Maximum Values:

	Up to 300 MHz		
DC Plate Voltage[j]	15,000	max.	V
DC Grid-No.2 Voltage[k]	2000	max.	V
DC Grid-No.1 Voltage[q]	−600	max.	V
DC Plate Current	12	max.	A
Grid-No.1 Input	300	max.	W
Grid-No.2 Input	500	max.	W
Plate Dissipation[m]	40,000	max.	W

Maximum Circuit Values:

Grid-No.1-Circuit Resistance Under Any Conditions:

With fixed bias	1000	max.	Ω
With cathode bias	Not recommended		

Typical, Grid Driven, Class B, CCS Operation:

	At 7.0 MHz	
DC Plate Voltage	10,000	V
DC Grid-No.2 Voltage	1250	V
DC Grid-No.1 Voltage[n]	−95	V
Zero-Signal DC Plate Current	0.5	A
DC Plate Current	8.4	A
DC Grid-No.2 Current	0.3	A
DC Grid-No.1 Current	1.1	A
Driver Power Output (Approx.)[p]	200	W
Grid Loading Resistance	750	Ω
Useful Power Output	55,000	W

Typical CCS Operation:

In a Grid-Drive Circuit at 108 MHz

DC Plate Voltage	10,800	V
DC Grid-No.2 Voltage	1300	V
DC Grid-No.1 Voltage	−250	V
DC Plate Current	6.5	A
DC Grid-No.2 Current	0.28	A
DC Grid-No.1 Current	0.01	A
Driver Power Output (Approx.)[p]	1400	W
Useful Power Output	55,000	W

a Measured at the tube terminals. For accurate data the ac filament voltage should be measured using an accurate RMS type meter such as an iron-vane or the thermocouple type meter. The dc voltage should be measured using a high input impedance type meter.

For high-current, low-voltage filaments such as are used in this tube, it is recommended that the filament current be monitored since very small changes in resistance can produce misleading changes in voltage. For maximum life, the filament power should be regulated at the lowest value that will give stable performance. For those applications where hum is a critical consideration, dc filament or hum bucking circuits are recommended. See also Application Note AN-4865.

b It is recommended that additional current be available to allow for both product variation and the normal reduction of filament resistance with life. Thus the filament supply adjustment should be designed for capability of 205 amperes at 14.0 volts. A minimum setting is 13.5 volts.

c Recommended starting procedure for maximum stability and longest life.

(1) Standard: Filament heating time of 120 seconds followed by grid-No.1, plate, grid-No.2, and rf drive.

(2) Emergency: Filament heating time of 15 seconds followed by grid-No.1, plate, grid-No.2, and rf drive. In addition, grid-No.1 voltage and rf drive must be changed proportionally to reduce plate current to 75% of its normal value for the first 15 seconds to prevent tripping plate overcurrent devices.

d For plate voltage = 2000 V, grid-No.2 voltage = 1250 V, and plate current = 15 A.

e No external shield.

f See Dimensional Outline for Temperature Measurement Points. For good contact-finger life, a maximum temperature of 180° C at the terminal is recommended when using commercially-available beryllium-copper socket contacts.

g The value of 250° C is the average of 4 readings taken 90° apart around the anode core. No one reading may exceed 275° C.

h See Section V.C of 1CE-300. At the 3 dB points, the maximum recommended Q is 30.

j See Section V.B and V.B.1 of 1CE-300.

The maximum voltage ratings must be modified for operation at altitudes higher than sea level and for temperatures in excess of 20° C in accordance with the curves of **Figure 1**. For altitude derating of the plate voltage, use the voltage difference between plate and grid No.2.

The maximum fault energy that can be dissipated within the tube is approximately 100 joules. Therefore, the energy available for a high-voltage arc or fault must be limited to this value by means of current limiting resistors or fault-protection circuitry such as spark gaps and electronic "crow bars". This is especially important where high, stored energy and large capacitors are used. In typical 55 kW TV transmitters, the series resistors used are:

Plate — Thirty ohm minimum is required in high capacitance power supplies for video service.

Grid No.2 — Fifty ohms minimum.

Grid No.1 — Fifty ohms.

For additional information see VI.B of 1CE-279A, "Application Guide for RCA Large Power Tubes".

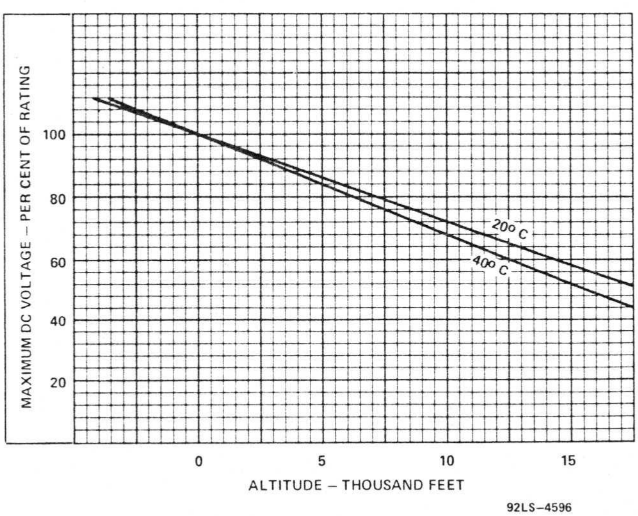


Figure 1 — Maximum DC Voltage with Respect to Altitude

k See Section V.B.2 of 1CE-300 and AN-4020. Protection devices such as spark gaps should be used.

m Permitted plate dissipation is a function of cooling. For specific ratings see Forced Air Cooling information in this data sheet.

n Adjusted for specified zero-signal dc plate current.

p Driver power output represents circuit losses in the driver output circuit and the grid input circuit in addition to the power necessary to drive the tube.

q See Section V.B.3 of 1CE-300. Protection devices such as spark gaps or positive clamping diodes should be used.

r The bandwidth of 6.3 MHz is calculated at the −0.72 dB power points of a doubled-tuned output circuit using two times the tube output capacity and a damping factor of $\sqrt{1.5}$ as shown in **Figure 2**.

s Use an oscilliscope in system checkout. Systems such as auto-transformers, step transformers, shortable limiting resistors, saturable reactors, or combinations thereof must be used.

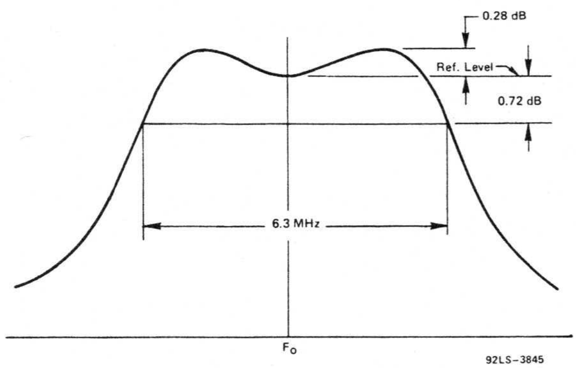


Figure 2 — Bandwidth Characteristics

Operating Considerations

Safety Precautions

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube in the event of abnormal circuit operation, and protection of the tube circuits in the event of abnormal tube operation.

> **Warning — Personal Safety Hazards**
>
> **Electrical Shock** — Operating voltages applied to this device present a shock hazard.
>
> **X-Ray Warning** — This device in operation produces X-rays which can constitute a health hazard unless the device is adequately shielded for radiation.
>
> **RF Radiation** — This device in operation produces rf radiation which may be harmful to personnel.

Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores much energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as a thyratron or ignitron, depending on the amount of energy to be handled.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

The screen circuit requires special attention because the heating power of the current and voltage on this electrode is not the algebraic product of the current and voltage elements as observed at the terminal. For analysis of the circuit, review AN-4020.

A time-delay relay must be provided in the grid-No.1 supply circuit to delay application of this voltage until the filament has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high plate current may cause excessive plate dissipation with consequent damage to the tube. RF load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashover. The load VSWR should be monitored and the detected signal used to actuate the interlock system to remove the plate voltage in less than 10 milliseconds after the fault occurs.

Filament-Voltage Adjustment

The life of the filament can be conserved by adjusting to the lowest filament supply voltage that will give the desired performance. Follow the filament voltage adjustment procedure below.

1. Before the application of any other voltages to a new tube, the filament voltage should be adjusted to 14.2 volts at the tube socket. A true RMS voltmeter should be used for accurate measurement. It may be more convenient to make the measurement at other contacts in the equipment, but the value will be higher because of increased impedance such as wire loss or contact resistance.
2. Apply voltages and adjust tuning controls as necessary for proper operation as described in the appropriate instruction manual.
3. Reduce the filament voltage in 0.1-volt increments—repeating the procedures in Steps 1 and 2—until performance degradation such as a decrease in plate current or power output is noted. Then increase the heater voltage 0.2 volt above this point. Typically depending upon the application, this voltage will be in the range of 13.8 to 14.2 volts.

During life when evidence is observed that a tube is becoming emission limited, increasing the filament voltage may extend the useful life of the tube. However, never increase filament voltage to compensate for a decrease in other circuit parameters such as rf drive or video modulating voltage!

Forced Air Cooling

Cooling air flow is necessary to limit the anode-core and terminal-seal temperatures to values that will assure long reliable life. A sufficient quantity of air should be directed past each of these terminals so that its temperature does not approach the absolute-maximum limit. The absolute-maximum temperature rating for this tube is 275 C with a maximum average temperature around the anode of 250 C. It is recommended that a safety factor of 25° to 50° be applied, to compensate for all probable system and component variations throughout life.

The cooling air must be delivered by the blower through the radiator and at the terminal seals during the application of power and for a minimum of three minutes after the power has been removed.

To Cathode-Filament and Filament Terminals—A sufficient quantity of air should be blown directly at these terminals so that their temperature does not approach the absolute-maximum limit of 250° C. A value of at least 100 cfm is recommended.

The Cooling Characteristic Curve indicates the air flow and pressure requirements of a system sufficient to limit the core temperature to specific values for various levels of plate dissipation.

Incoming air is at Standard Temperature and Pressure (STP) (22.5 C and 760 mm Hg). Pressure drop values are for the anode only and do not include any losses which may occur with specific sockets or cavities. When the tube base is not directly in the anode cooling air stream, special provisions must be made for separate base cooling.

Because the cooling capacity of air varies with its density, factors must be applied to the air flow to compensate for operation at altitude or in high temperature environments.

During Standby Operation — Cooling air is required when only the filament voltage is applied to the tube.

For further information on forced air cooling, see Section IV.C of 1CE-300 and also AN-4869 "Application Guide for Forced Air Cooling of RCA Power Tubes".

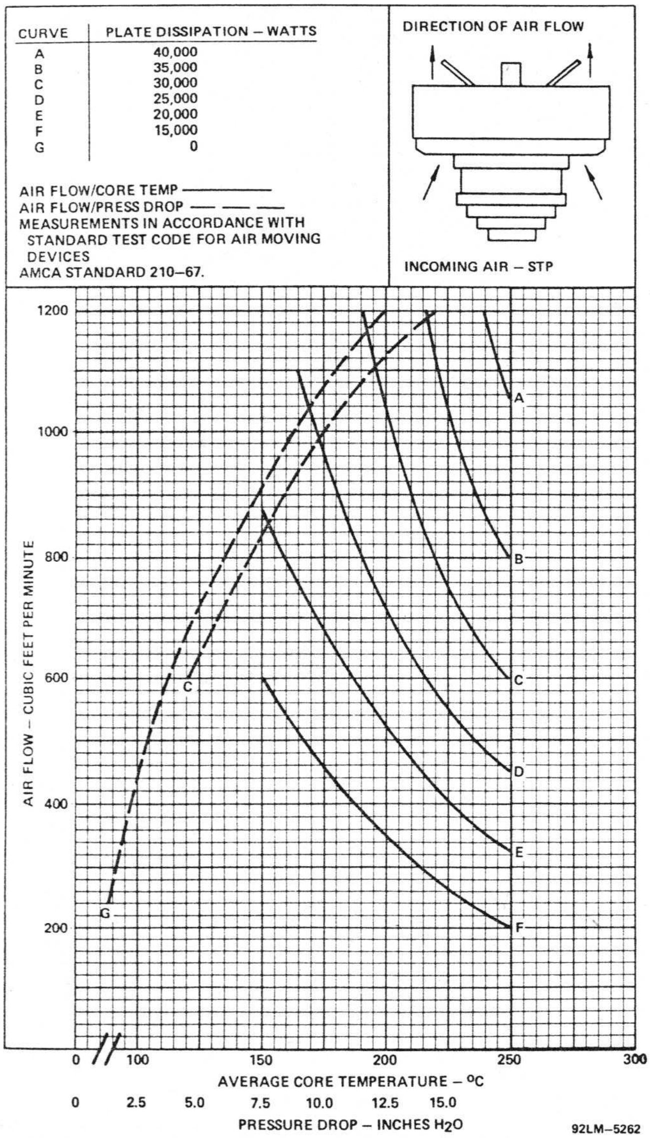


Figure 3 — Typical Cooling Characteristics

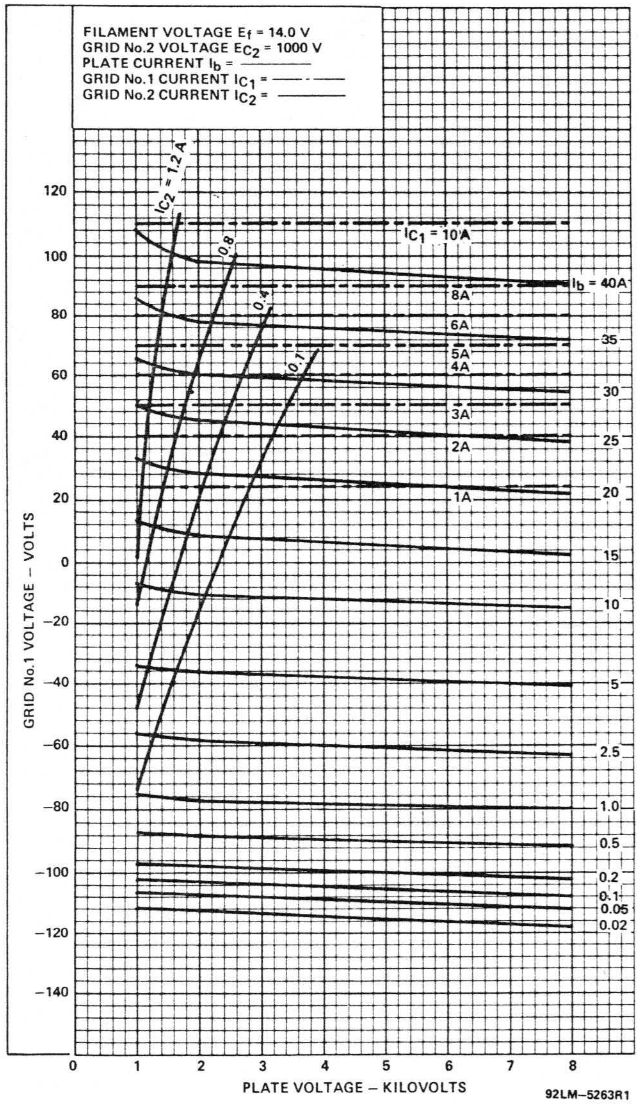


Figure 4 — Typical Constant Current Characteristics

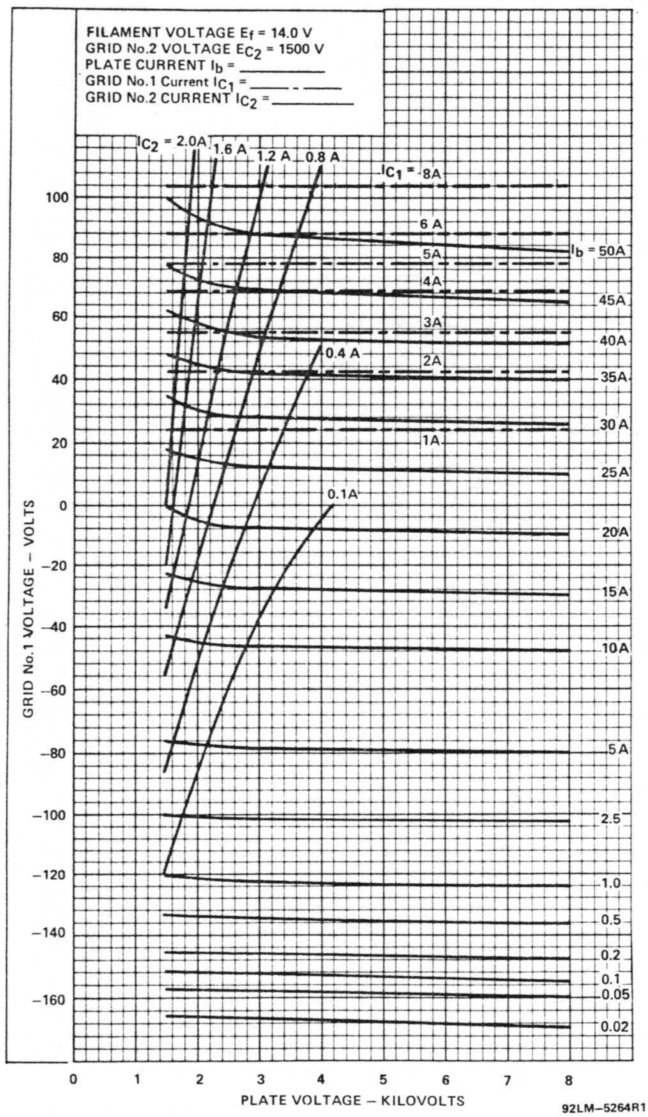
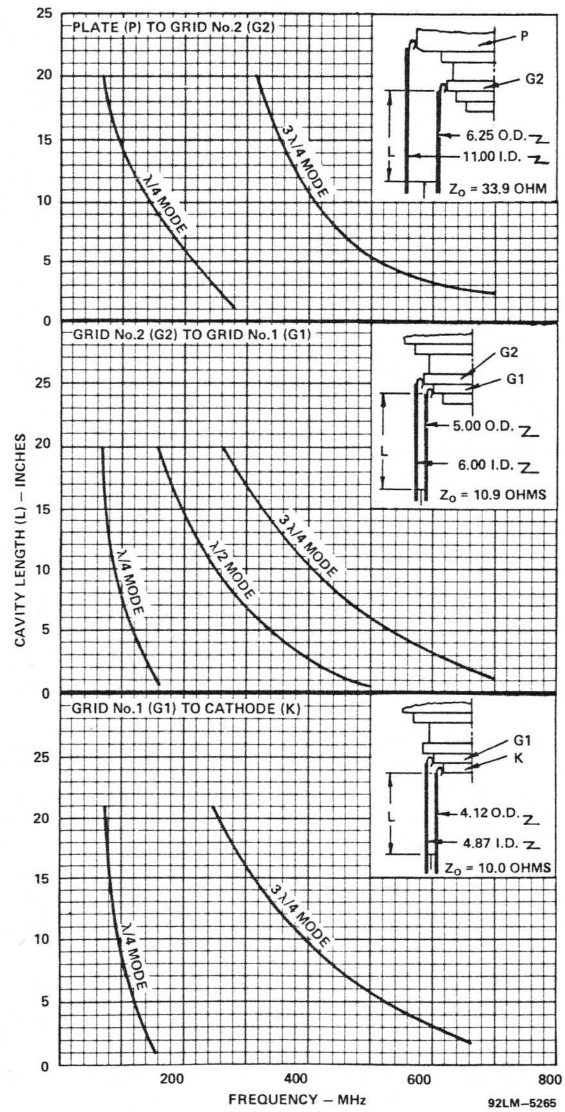
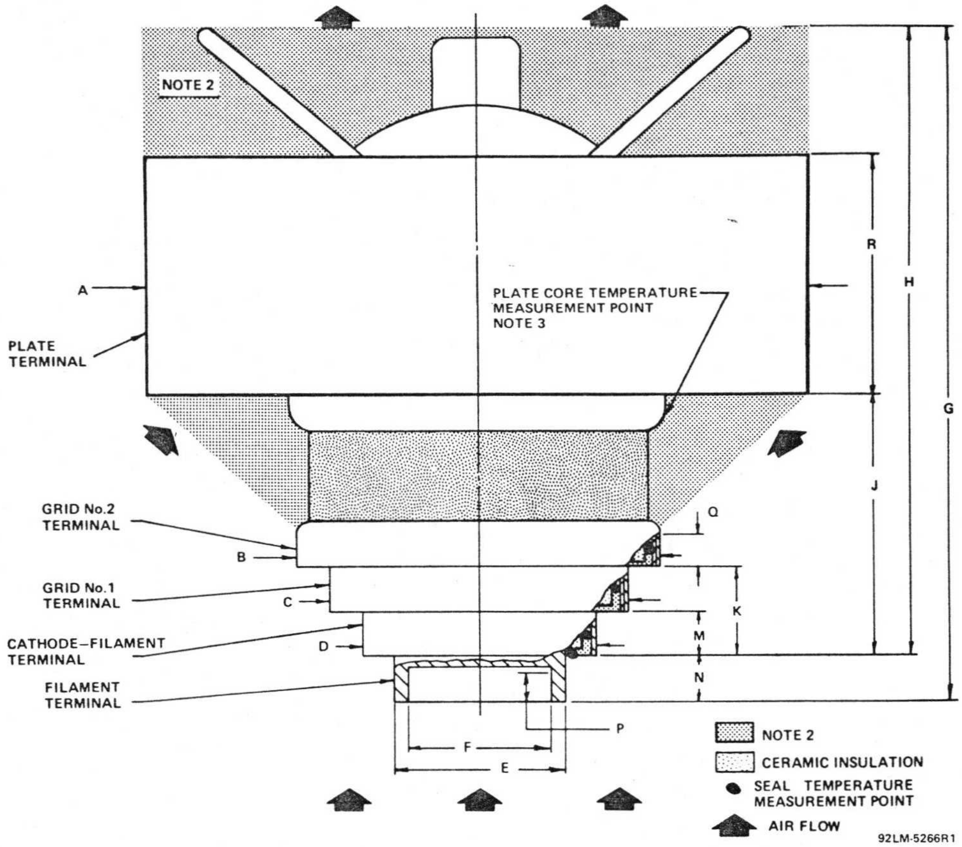


Figure 5 — Typical Constant Current Characteristics



Maximum rated frequency is 300 MHz. However, the tube is capable of amplification to beyond 2 GHz and care must be taken by the circuit designer to prevent parasitic oscillations at high frequencies. Tuning curves above 300 MHz are provided for circuit design assistance to prevent oscillation in the TE_{11} mode.

Figure 6 — Electrode Cavity Tuning Characteristics



Tabulated Dimensions

Dim.	Inches	Millimeters	Notes
A Dia.	10.175 ± .040	258.44 ± 1.02	1, 4
B Dia.	5.590 ± .020	141.97 ± .51	1, 4
C Dia.	4.590 ± .020	116.59 ± .51	1, 4
D Dia.	3.590 ± .020	91.19 ± .51	1, 4
E Dia.	2.600 ± .010	66.04 ± .25	1, 4
F Dia.	2.100 ± .010	53.34 ± .25	1, 4
G	11.300 max.	287.02 max.	
H	10.500 max.	266.70 max.	
J	4.075 ± .100	103.51 ± 2.54	
K	1.430 ± .060	36.32 ± 1.52	
M	.750 ± .060	19.05 ± 1.52	
N	.710 ± .030	18.03 ± .76	
P	.500 min.	12.70 min.	
Q	.400 min.	10.16 min.	
R	3.650 ref.	92.71 ref.	

Note 1 — The diameter of each terminal is maintained only over the indicated minimum length of its contact surface.

Note 2 — Keep all stippled regions clear. In general do not allow contacts to protrude into these annular regions. If special connectors are required which may intrude on these regions, contact RCA Power Tube Application Engineering, Lancaster, PA 17604.

Note 3 — Plate core temperature measurement point is located on the plate itself and not at the fins.

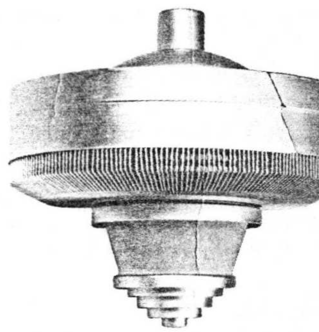
Note 4 — With the plate terminal and the cathode-filament terminal used as reference, the other terminals will measure less than 0.060 (1.52 mm) total indicator run-out (TIR).

Dimensions are in inches unless otherwise stated. Metric dimensions are derived from the basic inch dimensions (One inch = 25.4 millimeters).

Figure 7 — Dimensional Outline

RCA|Solid State Division|Electro Optics and Devices|Lancaster, PA 17604

Beam Power Tube



L-919

- **FM Broadcast Service**
  - 25 kW Output
  - 20 dB Gain
  - 80% Efficiency
- **High Efficiency-Low Pressure Radiator**

The RCA 8985 is designed specifically for use in high-gain, high-efficiency FM service.

Rated for full input to 230 MHz, the tube is easily circuited to this frequency. The terminals are coaxial for operation in the TEM mode and the radiator location avoids restriction of the resonant cavity circuits in VHF operation.

Its sturdy, coaxial construction and thoriated-tungsten mesh filament minimize tube inductances and feed-thru capacitances. They make possible the use of simple, economical, broadband circuit techniques in VHF operation.

This data sheet gives application information unique to the RCA-8985. It is to be used in conjunction with the publication, "Application Guide for RCA Power Tubes", 1CE-300, for general application information for tubes of this type.

Additional information of a general nature applicable to tubes of this type is given in the following publications:

1CE-279A	Application Guide for RCA Large Power Tubes
AN-4020	Screen-Grid Current, Loading and Bleeder Considerations
AN-4865	Handling and Operating Considerations when Using RCA Tetrodes
AN-4869	Application Guide for Forced Air Cooling RCA Power Tubes
AN-4872	Broadcast-Tube Handling and Installation Instructions.

Close attention to the instructions contained in these publications will assure longer tube life, safer operation, less equipment downtime and fewer tube handling accidents. For copies of these publications, specific information or application assistance, contact your nearest RCA Representative or write RCA, New Holland Avenue, Lancaster, PA 17604.

Typical data was measured in the simple, economical circuit cavity illustrated in **Figure 5.** Prototype or production cavity assistance is available.

General Data

Electrical:

All voltages referenced to cathode, unless otherwise specified.

Filamentary Cathode, Thoriated-Tungsten Mesh Type:

Voltage[a] (ac or dc)	9.5 typ. / 10.0 max.	V / V
Current:		
Typical value at 9.5 volts[b]	140	A
Maximum value for starting, even, momentarily[a]	300	A
Cold resistance	0.01	Ω
Recommended heating time[c]	2	min.
Mu-Factor[d], (Grid No.2 to grid No.1)	12	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[e]	0.65	pF
Grid No.1 to filament	78	pF
Plate to filament[e]	0.09	pF
Grid No.1 to grid No.2	89	pF
Grid No.2 to plate	17	pF
Grid No.2 to filament[f]	3.7	pF

For further information or application assistance on this device, contact your RCA Sales Representative or write Power Marketing, RCA, Lancaster, PA 17604.

Printed in U.S.A./3-78

General Data (Cont'd)

Mechanical:

Operating Attitude	Vertical, anode up
Overall Length (Max.)	(210.82 mm) 8.3 in
Greatest Diameter	(210.82 mm) 8.3 in
Socket	CD89-0859 or equivalent
Radiator	Integral part of tube
Weight (Approx.)	(10 kg) 22 lbs

Thermal:

Seal Temperature[h] (Plate, Grid No.2, Grid No.1, Cathode-Filament, and Filament)	250	max.	°C
Plate-Core Temperature[h]	250	max.	°C

RF Power Amplifier — Class C, FM Telephony

Maximum CCS Ratings, Absolute-Maximum Values:

	Up to 150 MHz		
DC Plate Voltage[j]	13,000	max.	V
DC Grid-No.2 Voltage[k]	2000	max.	V
DC Grid-No.1 Voltage[p]	–600	max.	V
DC Plate Current	5	max.	A
DC Grid-No.1 Current	0.3	max.	A
Grid-No.1 Input	150	max.	W
Grid-No.2 Input	350	max.	W
Plate Dissipation[m]	17,500	max.	W

Grid Driven, Class C, CCS Operation:

Typical Data at 108 MHz

DC Plate Voltage	9000	V
DC Grid-No.2 Voltage	1200	V
DC Grid-No.1 Voltage	–450	V
DC Plate Current	3.5	A
DC Grid-No.2 Current	0.15	A
DC Grid-No.1 Current	0.05	A
Driver Power Output	237	W
Useful Power Output	25,200	W
Overall Plate Eff.	80	%
Gain	20.3	dB

Notes

a Measured at the tube terminals. For accurate data the ac filament voltage should be measured using an accurate RMS type meter such as an iron-vane or the thermocouple type meter. The dc voltage should be measured using a high input impedance type meter.

For high-current, low-voltage filaments such as are used in this type, it is recommended that the filament current be monitored since very small changes in resistance can produce misleading changes in voltage. For maximum life, the filament power should be regulated at the lowest value that will give stable performance. For those applications where hum is a critical consideration, dc filament or hum-bucking circuits are recommended. See also Application Note AN-4865.

b It is recommended that additional current be available to allow for both product variation and the normal reduction of filament resistance with life. Thus the filament supply adjustment should be designed for a capability of 167 amperes at 9.5 volts. A minimum setting is 8.85 volts.

c Recommended starting procedure for maximum stability and longest life:

Standard: Filament heating time of 2 minutes followed by grid-No.1, plate, grid-No.2, and rf drive.

Emergency: Filament heating time of 15 seconds followed by grid-No.1, plate, grid-No.2, and rf drive.

d For plate voltage = 2000 V, grid-No.2 voltage = 1000 V, and plate current = 5 A.

e With external flat metal shield 8" (200 mm) in diameter having a center hole 3" (76 mm) in diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

f With external flat metal shield 8" (200 mm) in diameter having a center hold 2-3/8" (60 mm) in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

g As manufactured by: Jettron Products Inc.
56 Route Ten
Hanover, NJ 07936

h See Dimensional Outline for Temperature Measurement Points. For good contact-finger life, a maximum temperature of 180° C at the terminal is recommended when using commercially-available beryllium-copper socket contacts.

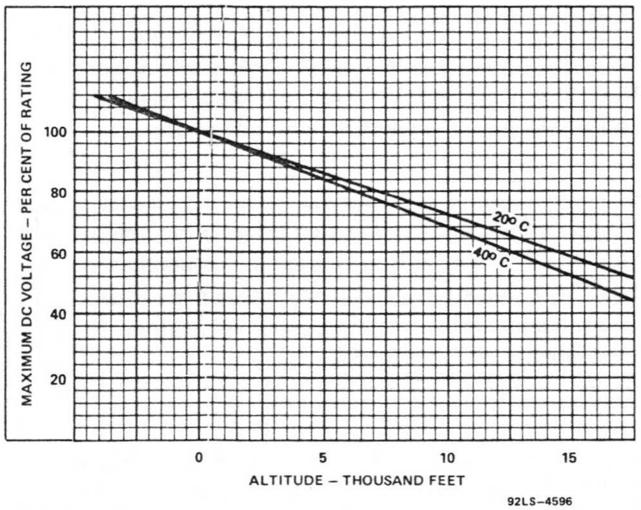


Figure 1 — Maximum DC Voltage with Respect to Altitude

j See Section V.B and V. B.1 of 1CE-300.

The maximum voltage ratings must be modified for operation at altitudes higher than sea level and for temperatures in excess of 20° C in accordance with the curves of **Figure 1**. For altitude derating of the plate voltage, use the voltage difference between plate and grid No.2.

The fault energy dissipated within the tube during a high-voltage arc or fault must be limited by resistors or fault protection

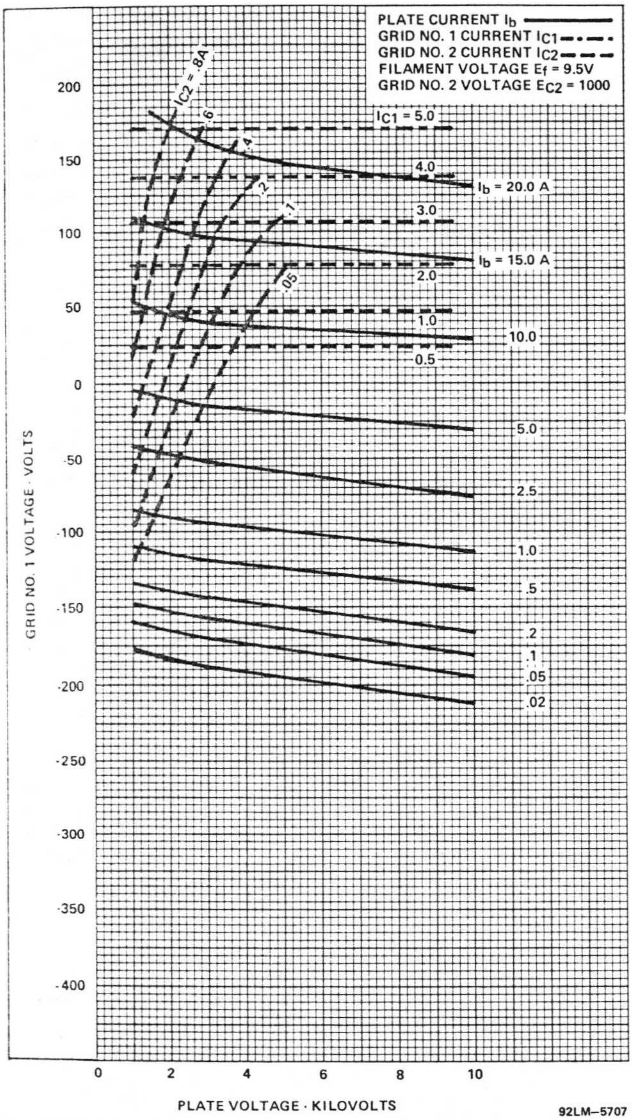


Figure 2 — **Typical Constant Current Characteristics**

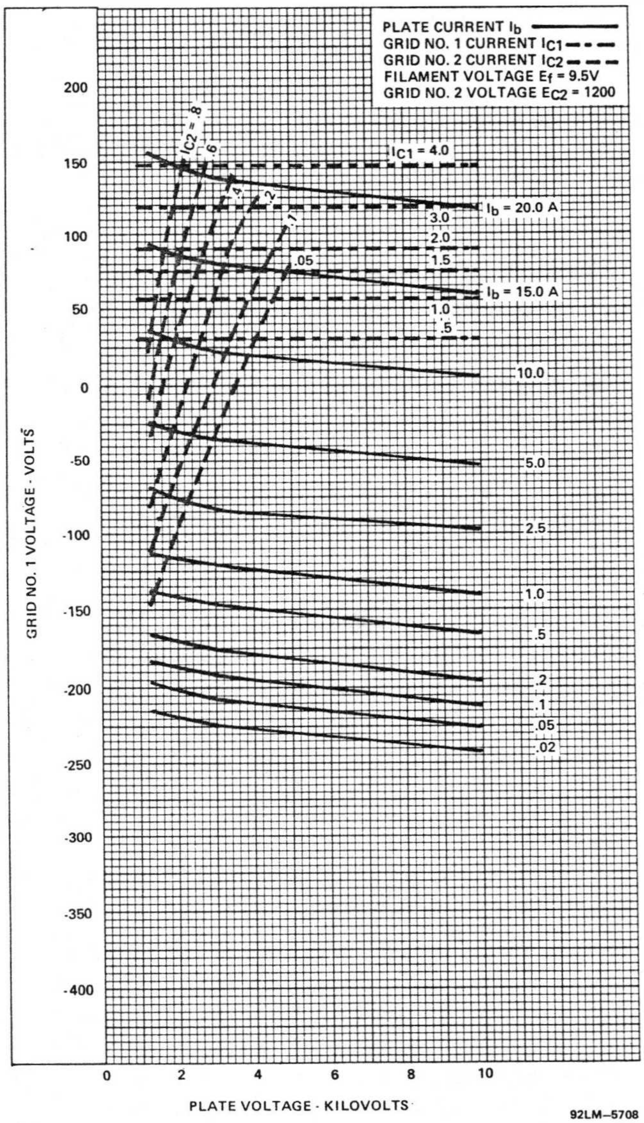


Figure 3 — **Typical Constant Current Characteristics**

Notes (Cont'd)

circuitry such as spark gaps or electronic "crowbars". This is especially important where large capacitors storing high energy are used. The following current limiting resistance values are recommended:

Plate — 10 to 50 ohms
Grid No.2 — Fifty ohms minimum
Grid No.1 — Fifty ohms minimum

For additional information see VI.B of 1CE-279A, "Application Guide for RCA Large Power Tubes".

k See Section V.B.2 of 1CE-300 and AN-4020. Protection devices such as spark gaps should be used.

m Permitted plate dissipation is a function of cooling. For specific ratings see Forced-Air Cooling information in this data sheet.

n Driver power output represents circuit losses in the grid input circuit in addition to the power necessary to drive the tube.

p See Section V.B.3 of 1CE-300. Protection devices such as spark gaps or positive clamping diodes should be used.

q To limit filament surge current, a series resistor is recommended; the resistor can then be shorted after 15 seconds.

Operating Considerations

Safety Precautions

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube in the event of abnormal circuit operation, and protection of the tube circuits in the event of abnormal tube operation.

> **Warning — Personal Safety Hazards**
>
> **Electrical Shock** — Operating voltages applied to this device present a shock hazard.
>
> **X-Ray Warning** — This device in operation produces X-rays which can constitute a health hazard unless the device is adequately shielded for radiation.
>
> **RF Radiation** — This device in operation produces rf radiation which may be harmful to personnel.

Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores much energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as a thyratron or ignitron, depending on the amount of energy to be handled.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

The screen circuit requires special attention because the heating power of the current and voltage on this electrode is not the algebraic product of the current and voltage elements as observed at the terminal. For analysis of the circuit, review AN-4020.

A time-delay relay should be provided in the grid-No.1 supply circuit to delay application of this voltage until the filament has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high plate current may cause excessive plate dissipation with consequent damage to the tube. RF load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashover. The load VSWR should be monitored and the detected signal used to actuate the interlock system to remove the plate voltage in less than 10 milliseconds after the fault occurs.

Filament-Voltage Adjustment

The life of the filament can be conserved by adjusting to the lowest filament supply voltage that will give the desired performance. Follow the filament voltage adjustment procedure below.

Regulated Filament Supplies:

1. Before the application of any other voltages to a new tube, the filament voltage should be adjusted to 9.5 volts at the tube socket. A true RMS voltmeter should be used for accurate measurement. It may be more convenient to make the measurement at other contacts in the equipment, but the value will be higher because of increased impedance such as wire loss or contact resistance.
2. Apply voltages and adjust tuning controls as necessary for proper operation as described in the appropriate instruction manual.
3. Reduce the filament voltage in 0.1 volt increments—repeating the procedures in Steps 1 and 2—until performance degradation is noted. Then increase the heater voltage 0.1 volt above this point. Typically depending upon the application, this voltage will be in the range of 9.2 to 9.5 volts.

Unregulated Filament Supplies:

1. If an unregulated filament supply is used, the above procedure for regulated supplies should be performed during low-line conditions to assure adequate tube performance during these periods. Then check during high-line conditions to assure that the 10.0 volt maximum is not exceeded.

During life when evidence is observed that a tube is becoming emission limited, increasing the filament voltage may extend the useful life of the tube. However, never increase filament voltage to compensate for a decrease in other circuit parameters such as rf drive or video modulating voltage!

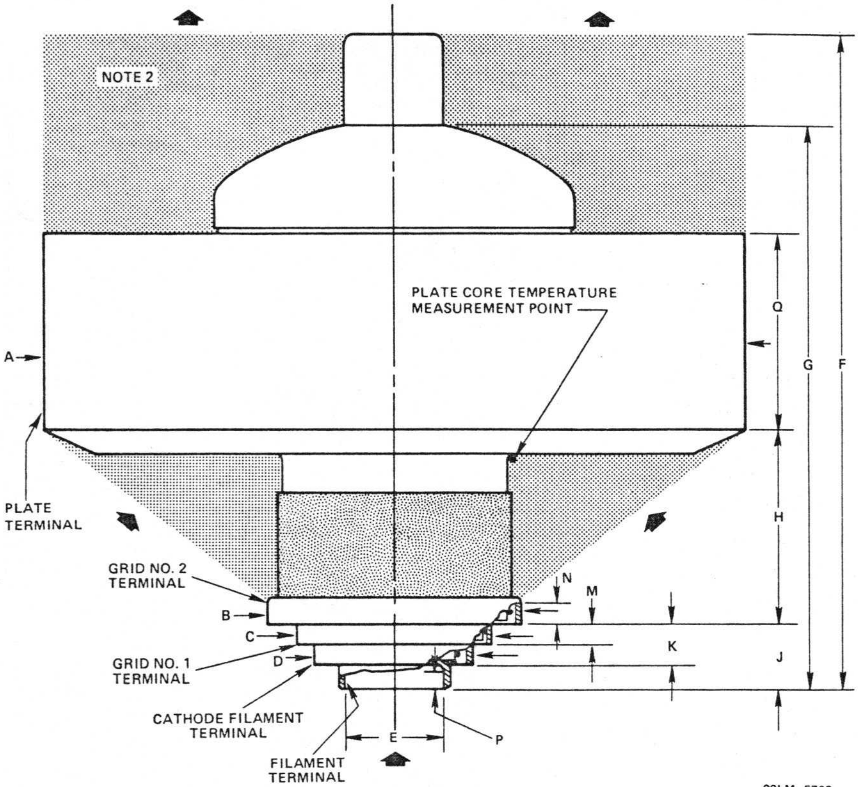


Figure 4 — Dimensional Outline

Tabulated Dimensions*

Dim.	Inches	Millimeters
A Dia.[1]	8.250 ± .040	209.55 ± 1.02
B Dia.[1]	3.028 ± .014	76.91 ± 0.36
C Dia.[1]	2.319 ± .012	58.90 ± 0.30
D Dia.[1]	1.850 ± .012	46.99 ± 0.30
E Dia.[1]	1.200 ± .010	30.48 ± 0.25
F	8.250 max.	209.55 max.
G	7.250 max.	184.15 max.
H	2.425 ± .100	61.60 ± 2.54
J	0.725 ± .040	18.42 ± 1.02
K	0.500 ± .030	12.70 ± 0.76
M	0.200 ± .025	5.08 ± 0.64
N	0.220 min.	5.59 min.
P	0.250 min.	6.35 min.
Q	2.250 ref.	57.15 ref.

NOTE 2 · CERAMIC INSULATION · • SEAL TEMPERATURE MEASUREMENT POINT · AIR FLOW

Note 1 — The diameter of each terminal is maintained only over the indicated minimum length of its contact surface.

Note 2 — Keep all stippled regions clear. In general, do not allow contacts to protrude into these annular regions. If special connectors are required which may intrude on these regions contact RCA Power Tube Applications Engineering, Lancaster, PA.

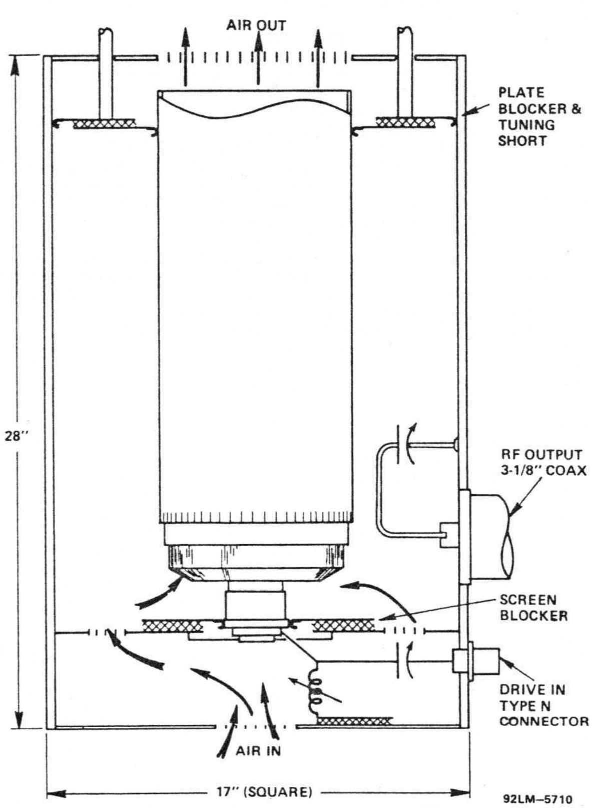


Figure 5 — Typical RF Circuit Cavity

Output Circuit .... Coaxial
Z_0 .... 45 ohm
Circuit eff .... 98 %
Rsh/Q 45
Cal. bandwidth:
9 kV oper. .... 3.8 MHz
Input Circuit .... Strip Line plus Lumped Capacity
No Resistive Swamping
Neutralizing .... Grid Neutralized, Capacity Bridge

*Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimetres and are derived from the basic inch dimensions (1 inch = 25.4 mm).

Forced Air Cooling

Cooling air flow is necessary to limit the anode-core and terminal-seal temperatures to values that will assure long reliable life. A sufficient quantity of air should be directed past each of these terminals so that its temperature does not approach the absolute-maximum limit. The absolute-maximum temperature rating for this tube is 250° C. It is recommended that a safety factor of 25° to 50° be applied, to compensate for all probable system and component variations throughout life.

The cooling air must be delivered by the blower through the radiator and at the terminal seals during the application of power and for a minimum of three minutes after the power has been removed.

To Cathode-Filament and Filament Terminals — A sufficient quantity of air should be blown directly at these terminals so that their temperature does not approach the absolute-maximum limit of 250° C. A value of at least 60 cfm is recommended.

The Cooling Characteristic Curve, **Figure 6**, indicates the air flow and pressure requirements of a system sufficient to limit the core temperature to specific values for various levels of plate dissipation.

Because the cooling capacity of air varies with its density, factors must be applied to the air flow to compensate for operation at altitude or in high temperature environments.

During Standby Operation — Cooling air is required when only the filament voltage is applied to the tube.

For further information on forced air cooling, see Section IV.C of 1CE-300 and also AN-4869 " Application Guide for Forced Air Cooling of RCA Power Tubes".

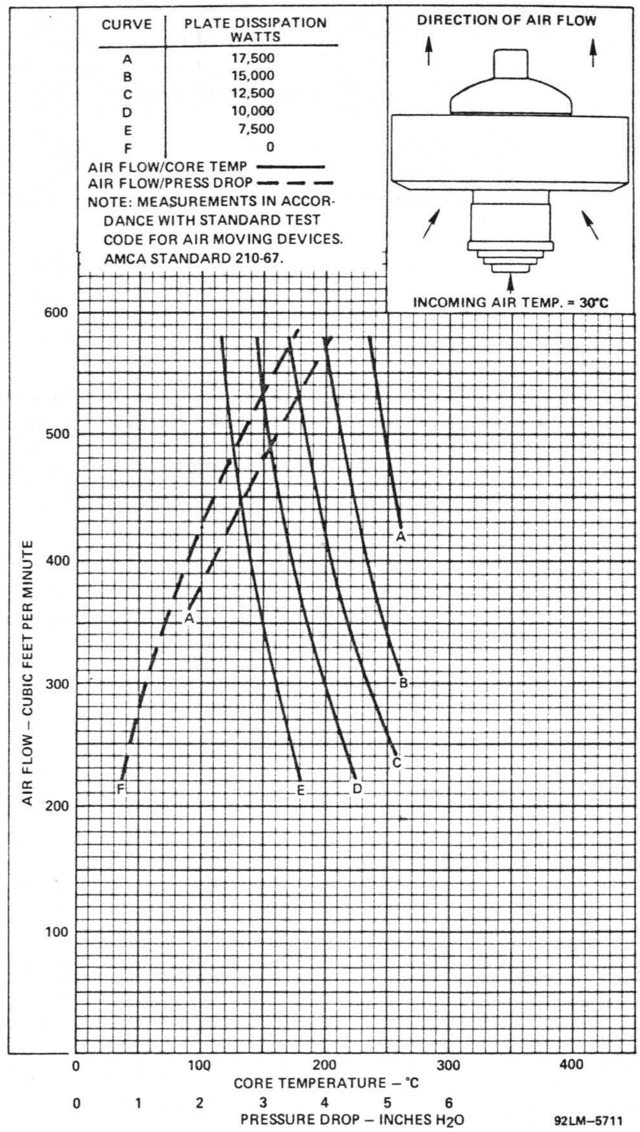


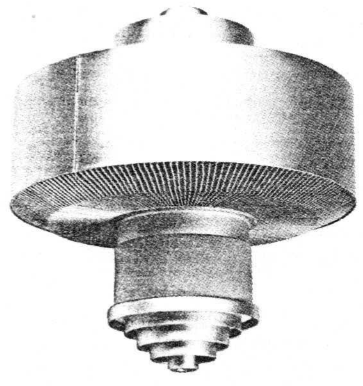
Figure 6 — Air Flow Characteristics

RCA ElectroOptics and Devices

Power Tube

8986

Beam Power Tube



L-918

- FM Broadcast Service
  - 15 kW Output
  - 20 dB Gain
  - 80% Efficiency
- High Efficiency-Low Pressure Radiator

The RCA 8986 is designed specifically for use in high-gain, high-efficiency FM service.

Rated for full input to 150 MHz, the tube is easily circuited to this frequency. The terminals are coaxial for operation in the TEM mode and the radiator location avoids restriction of the resonant cavity circuits in VHF operation.

Its sturdy, coaxial construction and thoriated-tungsten mesh filament minimize tube inductances and feed-thru capacitances. They make possible the use of simple, economical, broadband circuit techniques in VHF operation.

This data sheet gives application information unique to the RCA-8986. It is to be used in conjunction with the publication, "Application Guide for RCA Power Tubes", 1CE-300, for general application information for tubes of this type.

Additional information of a general nature applicable to tubes of this type is given in the following publications:

1CE-279A	Application Guide for RCA Large Power Tubes
AN-4020	Screen-Grid Current, Loading and Bleeder Considerations
AN-4865	Handling and Operating Considerations when Using RCA Tetrodes
AN-4869	Application Guide for Forced Air Cooling RCA Power Tubes
AN-4872	Broadcast-Tube Handling and Installation Instructions.

Close attention to the instructions contained in these publications will assure longer tube life, safer operation, less equipment downtime and fewer tube handling accidents. For copies of these publications, specific information or application assistance, contact your nearest RCA Representative or write RCA, New Holland Avenue, Lancaster, PA 17604.

Typical data was measured in the simple, economical circuit cavity illustrated in **Figure 5.** Prototype or production cavity assistance is available.

General Data

Electrical:

All voltages referenced to cathode, unless otherwise specified.

Filamentary Cathode, Thoriated-Tungsten Mesh Type:

Voltage[a] (ac or dc)	9.5 typ. / 10.0 max.	V / V
Current:		
Typical value at 9.5 volts[b]	105	A
Maximum value for starting, even, momentarily[g]	220	A
Cold resistance	0.01	Ω
Recommended heating time[c]	2	min.
Mu-Factor[d], (Grid No.2 to grid No.1)	12	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[e]	0.65	pF
Grid No.1 to filament	78	pF
Plate to filament[e]	0.09	pF
Grid No.1 to grid No.2	89	pF
Grid No.2 to plate	17	pF
Grid No.2 to filament[f]	3.7	pF

For further information or application assistance on this device, contact your RCA Sales Representative or write Power Marketing, RCA, Lancaster, PA 17604.

Printed in U.S.A./3-78

General Data (Cont'd)

Mechanical:

Operating Attitude	Vertical, anode up
Overall Length (Max.)	(199.39 mm) 7.85 in
Greatest Diameter	(180.20 mm) 7.1 in
Socket	CD89-085[g] or equivalent
Radiator	Integral part of tube
Weight (Approx.)	(5.5 kg) 12 lbs

Thermal:

Seal Temperature[h] (Plate, Grid No.2, Grid No.1, Cathode-Filament, and Filament)	250	max.	°C
Plate-Core Temperature[h]	250	max.	°C

RF Power Amplifier — Class C, FM Telephony

Maximum CCS Ratings, Absolute-Maximum Values:

	Up to 150 MHz		
DC Plate Voltage[j]	13,000	max.	V
DC Grid-No.2 Voltage[k]	1650	max.	V
DC Grid-No.1 Voltage[p]	−600	max.	V
DC Plate Current	3	max.	A
DC Grid-No.1 Current	0.3	max.	A
Grid-No.1 Input	100	max.	W
Grid-No.2 Input	250	max.	W
Plate Dissipation[m]	12,500	max.	W

Grid Driven, Class C, CCS Operation:

Typical Data at 108 MHz

DC Plate Voltage	9000	V
DC Grid-No.2 Voltage	1000	V
DC Grid-No.1 Voltage	−450	V
DC Plate Current	2.1	A
DC Grid-No.2 Current	0.10	A
DC Grid-No.1 Current	0.06	A
Driver Power Output[n]	135	W
Useful Power Output	15,200	W
Overall Plate Eff.	80	%
Gain	20.5	dB

Notes

a Measured at the tube terminals. For accurate data the ac filament voltage should be measured using an accurate RMS type meter such as an iron-vane or the thermocouple type meter. The dc voltage should be measured using a high input impedance type meter.

For high-current, low-voltage filaments such as are used in this type, it is recommended that the filament current be monitored since very small changes in resistance can produce misleading changes in voltage. For maximum life, the filament power should be regulated at the lowest value that will give stable performance. For those applications where hum is a critical consideration, dc filament or hum-bucking circuits are recommended. See also Application Note AN-4865.

b It is recommended that additional current be available to allow for both product variation and the normal reduction of filament resistance with life. Thus the filament supply adjustment should be designed for a capability of 130 amperes at 9.5 volts. A minimum setting is 8.85 volts.

c Recommended starting procedure for maximum stability and longest life:

Standard: Filament heating time of 2 minutes followed by grid-No.1, plate, grid-No.2, and rf drive.

Emergency: Filament heating time of 15 seconds followed by grid-No.1, plate, grid-No.2, and rf drive.

d For plate voltage = 2000 V, grid-No.2 voltage = 1000 V, and plate current = 5 A.

e With external flat metal shield 8" (200 mm) in diameter having a center hole 3" (76 mm) in diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

f With external flat metal shield 8" (200 mm) in diameter having a center hold 2-3/8" (60 mm) in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

g As manufactured by: Jettron Products Inc.
56 Route Ten
Hanover, NJ 07936

h See Dimensional Outline for Temperature Measurement Points. For good contact-finger life, a maximum temperature of 180° C at the terminal is recommended when using commercially-available beryllium-copper socket contacts.

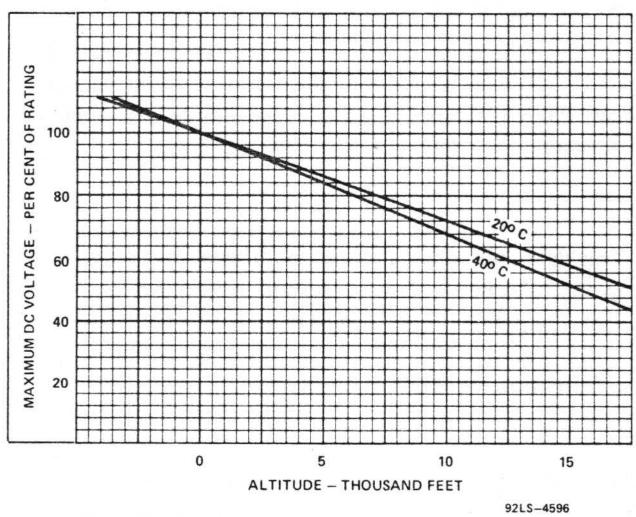


Figure 1 — Maximum DC Voltage with Respect to Altitude

j See Section V.B and V. B.1 of 1CE-300.

The maximum voltage ratings must be modified for operation at altitudes higher than sea level and for temperatures in excess of 20° C in accordance with the curves of **Figure 1**. For altitude derating of the plate voltage, use the voltage difference between plate and grid No.2.

The fault energy dissipated within the tube during a high-voltage arc or fault must be limited by resistors or fault protection

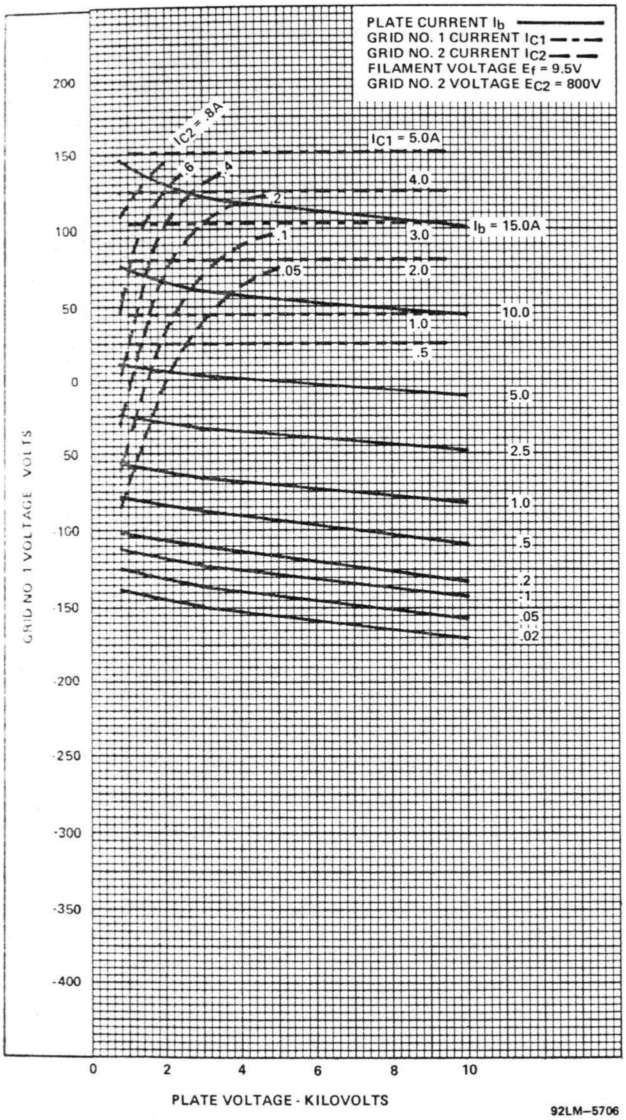


Figure 2 — Typical Constant Current Characteristics

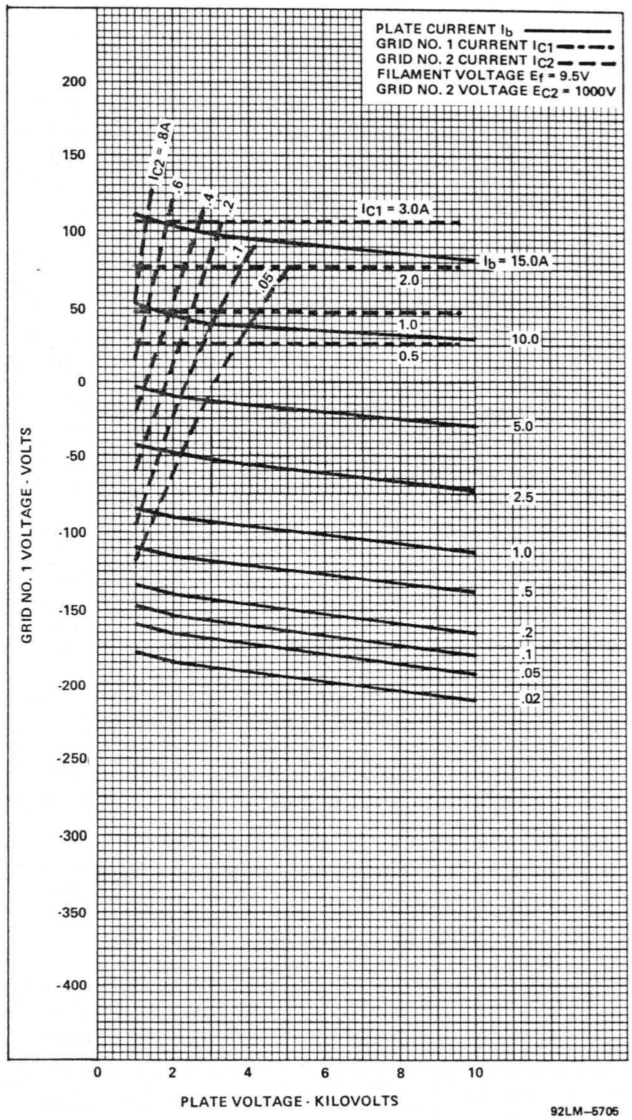


Figure 3 — Typical Constant Current Characteristics

Notes (Cont'd)

circuitry such as spark gaps or electronic "crowbars". This is especially important where large capacitors storing high energy are used. The following current limiting resistance values are recommended:

- Plate — 10 to 50 ohms
- Grid No.2 — Fifty ohms minimum
- Grid No.1 — Fifty ohms minimum

For additional information see VI.B of 1CE-279A, "Application Guide for RCA Large Power Tubes".

k See Section V.B.2 of 1CE-300 and AN-4020. Protection devices such as spark gaps should be used.

m Permitted plate dissipation is a function of cooling. For specific ratings see Forced-Air Cooling information in this data sheet.

n Driver power output represents circuit losses in the grid input circuit in addition to the power necessary to drive the tube.

p See Section V.B.3 of 1CE-300. Protection devices such as spark gaps or positive clamping diodes should be used.

q To limit filament surge current, a series resistor is recommended; the resistor can then be shorted after 15 seconds.

Operating Considerations

Safety Precautions

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube in the event of abnormal circuit operation, and protection of the tube circuits in the event of abnormal tube operation.

> **Warning — Personal Safety Hazards**
>
> **Electrical Shock** — Operating voltages applied to this device present a shock hazard.
>
> **X-Ray Warning** — This device in operation produces X-rays which can constitute a health hazard unless the device is adequately shielded for radiation.
>
> **RF Radiation** — This device in operation produces rf radiation which may be harmful to personnel.

Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores much energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as a thyratron or ignitron, depending on the amount of energy to be handled.

Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

The screen circuit requires special attention because the heating power of the current and voltage on this electrode is not the algebraic product of the current and voltage elements as observed at the terminal. For analysis of the circuit, review AN-4020.

A time-delay relay should be provided in the grid-No.1 supply circuit to delay application of this voltage until the filament has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high plate current may cause excessive plate dissipation with consequent damage to the tube. RF load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashover. The load VSWR should be monitored and the detected signal used to actuate the interlock system to remove the plate voltage in less than 10 milliseconds after the fault occurs.

Filament-Voltage Adjustment

The life of the filament can be conserved by adjusting to the lowest filament supply voltage that will give the desired performance. Follow the filament voltage adjustment procedure below.

Regulated Filament Supplies:

1. Before the application of any other voltages to a new tube, the filament voltage should be adjusted to 9.5 volts at the tube socket. A true RMS voltmeter should be used for accurate measurement. It may be more convenient to make the measurement at other contacts in the equipment, but the value will be higher because of increased impedance such as wire loss or contact resistance.
2. Apply voltages and adjust tuning controls as necessary for proper operation as described in the appropriate instruction manual.
3. Reduce the filament voltage in 0.1 volt increments—repeating the procedures in Steps 1 and 2—until performance degradation is noted. Then increase the heater voltage 0.1 volt above this point. Typically depending upon the application, this voltage will be in the range of 9.2 to 9.5 volts.

Unregulated Filament Supplies:

1. If an unregulated filament supply is used, the above procedure for regulated supplies should be performed during low-line conditions to assure adequate tube performance during these periods. Then check during high-line conditions to assure that the 10.0 volt maximum is not exceeded.

During life when evidence is observed that a tube is becoming emission limited, increasing the filament voltage may extend the useful life of the tube. However, never increase filament voltage to compensate for a decrease in other circuit parameters such as rf drive or video modulating voltage!

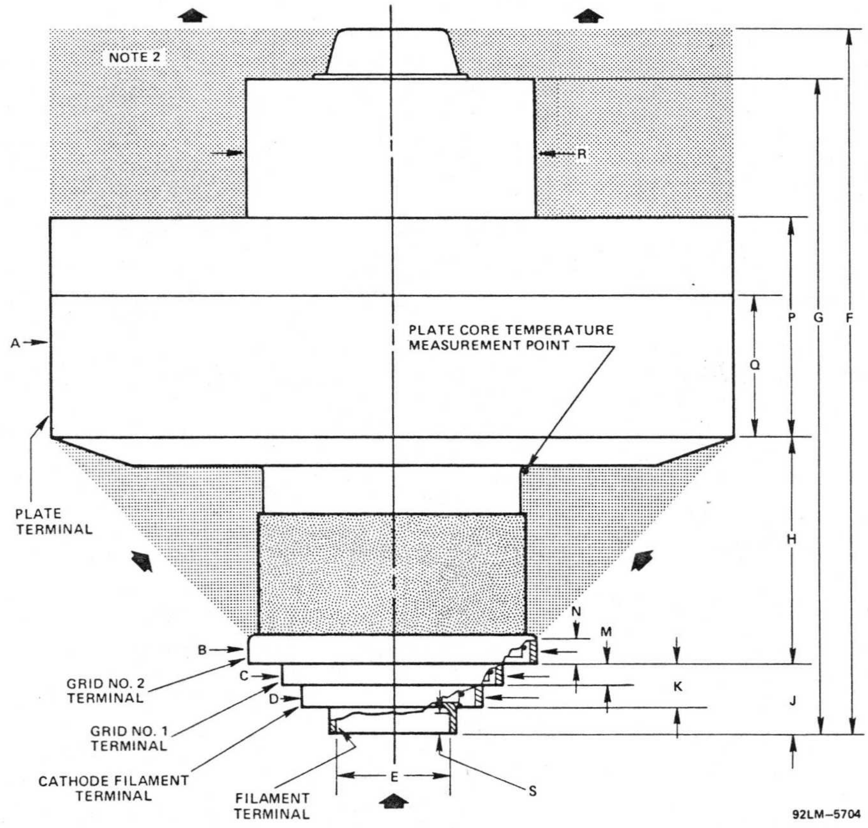


Figure 4 – Dimensional Outline

Tabulated Dimensions*

Dim.	Inches	Millimeters
A Dia.[1]	7.055 ± .040	179.20 ± 1.02
B Dia.[1]	3.028 ± .014	76.91 ± 0.36
C Dia.[1]	2.319 ± .012	58.90 ± 0.30
D Dia.[1]	1.850 ± .012	46.99 ± 0.30
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G	7.250 max.	184.15 max.
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K	0.500 ± .030	12.70 ± 0.76
M	0.200 ± .025	5.08 ± 0.64
N	0.220 min.	5.59 min.
P	2.250 ref.	57.15 ref.
Q	1.500 ref.	38.10 ref.
R Dia.	2.975 ref.	75.56 ref.
S	0.250 min.	6.35 min.

NOTE 2 • SEAL TEMPERATURE MEASUREMENT POINT
CERAMIC INSULATION AIR FLOW

Note 1 – The diameter of each terminal is maintained only over the indicated minimum length of its contact surface.

Note 2 – Keep all stippled regions clear. In general, do not allow contacts to protrude into these annular regions. If special connectors are required which may intrude on these regions contact RCA Power Tube Applications Engineering, Lancaster, PA.

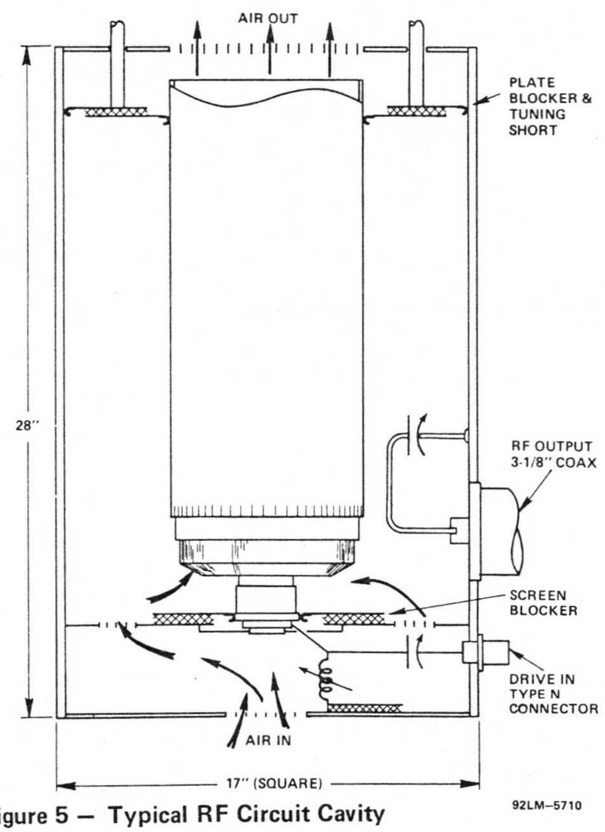


Figure 5 – Typical RF Circuit Cavity

Output Circuit	Coaxial	
Z_o	45	ohm
Circuit eff	98	%
Rsh/Q	45	
Cal. bandwidth:		
9 kV oper	2.3	MHz
Input Circuit	Strip Line plus Lumped Capacity No Resistive Swamping	
Neutralizing	Grid Neutralized, Capacity Bridge	

*Dimensions are in inches unless otherwise stated. Dimensions in parentheses are in millimetres and are derived from the basic inch dimension (1 inch = 25.4 mm).

Forced Air Cooling

Cooling air flow is necessary to limit the anode-core and terminal-seal temperatures to values that will assure long reliable life. A sufficient quantity of air should be directed past each of these terminals so that its temperature does not approach the absolute-maximum limit. The absolute-maximum temperature rating for this tube is 250° C. It is recommended that a safety factor of 25° to 50° be applied, to compensate for all probable system and component variations throughout life.

The cooling air must be delivered by the blower through the radiator and at the terminal seals during the application of power and for a minimum of three minutes after the power has been removed.

To Cathode-Filament and Filament Terminals — A sufficient quantity of air should be blown directly at these terminals so that their temperature does not approach the absolute-maximum limit of 250° C. A value of at least 60 cfm is recommended.

The Cooling Characteristic Curve, **Figure 6**, indicates the air flow and pressure requirements of a system sufficient to limit the core temperature to specific values for various levels of plate dissipation.

Because the cooling capacity of air varies with its density, factors must be applied to the air flow to compensate for operation at altitude or in high temperature environments.

During Standby Operation — Cooling air is required when only the filament voltage is applied to the tube.

For further information on forced air cooling, see Section IV.C of 1CE-300 and also AN-4869 " Application Guide for Forced Air Cooling of RCA Power Tubes".

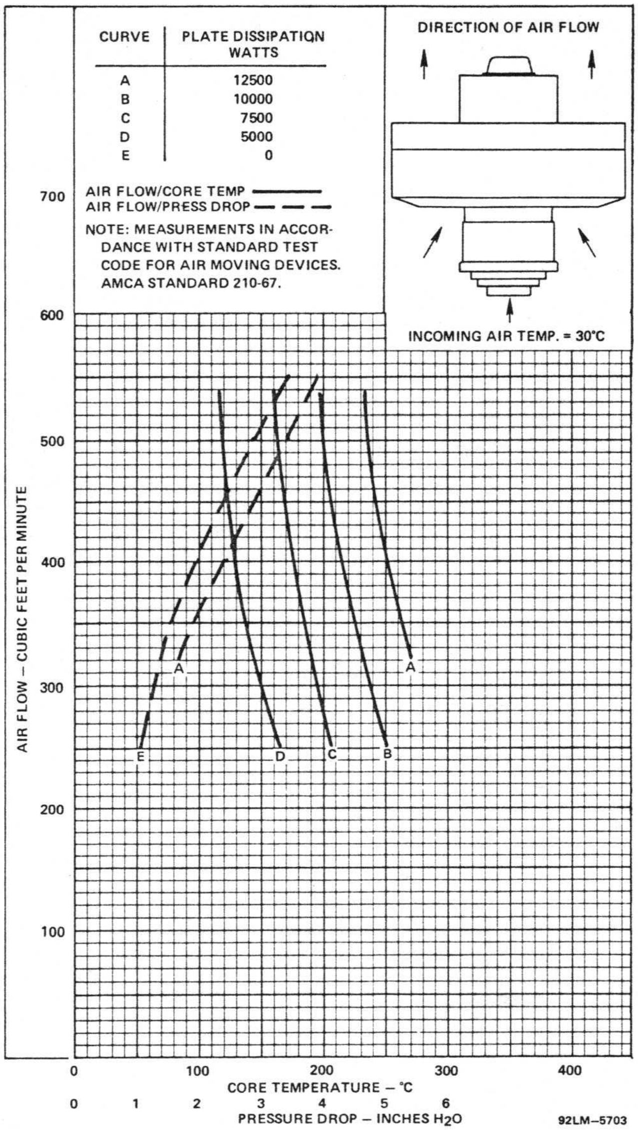
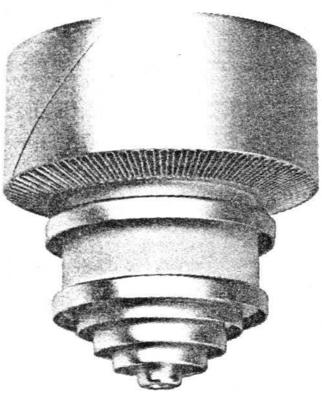


Figure 6 — Air Flow Characteristics



L-917

Linear Beam Power Tube

- CERMOLOX® Tube
- High Gain-Bandwidth Products
- Full Input to 400 MHz
- 7000 W Peak Sync. Output Through VHF-TV Band with 16 dB Gain

The RCA 8988 is designed specifically to meet the high linearity, high gain requirements of modern, reliable, VHF-TV and UHF linear amplifier equipments.

In VHF-TV service at 220 MHz, the 8988 will deliver a full 7.0 kW peak sync. output with 6.3 MHz bandwidth and 16 dB gain. At 220 MHz it can supply the 4.5 kW aural power output required for a 17.5 kW TV transmitter.

Rated for full input for the VHF-TV band and for other service to 400 MHz, the 8988 can be readily circuited for these frequencies. The 8988 and available variants are also well suited for other applications such as SSB, CW, pulsed RF, or modulator service.

Its sturdy, CERMOLOX construction and thoriated tungsten, mesh filament minimize tube inductances and feedthru capacitances. Its coaxial, forced-air-cooled radiator reduces noise to a minimum and insures against spurious outputs. These features make possible the use of simple, economical, broadband circuit techniques in VHF and UHf operation.

This data sheet gives application information unique to the RCA 8988. It is to be used in conjunction with the publication, "Application Guide for RCA Power Tubes", 1CE-300, for general application information for tubes of this type.

Additional information of a general nature applicable to tubes of this type is given in the following publications:

1CE-279A Application Guide for RCA Large Power Tubes
AN-4020 Screen-Grid Current, Loading and Bleeder
AN-4865 Handling and Operating Considerations
AN-4869 Application Guide for Forced Air Cooling
AN-4872 Broadcast-Tube Handling and Installation

Close attention to the instructions contained in these publications will assure longer tube life, safer operation, less equipment downtime and fewer tube handling accidents. For copies of publications, specific information or application assistance, contact your nearest RCA Representative or write RCA, New Holland Avenue, Lancaster, PA 17604.

General Data

Electrical:

Filamentary Cathode:		
Type	Thoriated-Tungsten Mesh	
Voltage[a] (ac or dc)	5.7 typ.	V
	6.0 max.	V
Current:		
Typical value at 5.7 volts[b]	115	V
Maximum value for starting even momentarily	300	A
Cold resistance	0.005	Ω
Minimum heating time[c]	15	s
Mu-Factor:[d]		
(Grid No.2 to grid No.1)	20	
Direct Interelectrode Capacitances:		
Grid No.1 to plate[e]	0.40 max.	pF
Grid No.1 to filament	70	pF
Plate to filament[e,f]	0.05 ma.x	pF
Grid No.1 to grid No.2	95	pF
Grid No.2 to plate	12	pF
Grid No.2 to filament[f]	2.5 max.	pF

For further information or application assistance on this device, contact your RCA Sales Representative or write Power Marketing, RCA, Lancaster, PA 17604.

General Data (Cont'd)

Mechanical:

Operating Attitude		Vertical, either end up	
Overall Length	(136.6 mm)	5.38 max.	in
Greatest Diameter	(116.1 mm)	4.57 max.	in
Terminal Connections		See Dimensional Outline	
Socket		CD 89-085[g], or equivalent	
Chimney		8822[g], or equivalent	
Radiator		Integral part of tube	
Weight (Approx.)		(2.7 kg) 6.0 lbs	

Thermal:

Seal Temperature[h] (Plate, grid No.2, grid No.1, filament-cathode and filament)	250	max.	°C
Plate-Core Temperature[h]	250	max.	°C

RF Power Amplifier — Class AB$_2$ Television Service[j]

Synchronized-level conditions per tube unless otherwise specified

Maximum CCS Ratings, Absolute-Maximum Values:

DC Plate Voltage[k,m]	8000	max.	V
DC Grid-No.2 Voltage[n]	1650	max.	V
DC Grid-No.1 Voltage[p]	–450	max.	V
DC Plate Current	5	max.	A
Plate Dissipation	5000	max.	W
Grid-No.2 Input	150	max.	W
Grid-No.1 Input	50	max.	W

Typical CCS Operation:

In a cathode-drive circuit at 216 MHz and a bandwidth of 6.3 MHz[r]

DC Plate Voltage	3000	4100	V
DC Grid-No.2 Voltage	1000	1000	V
DC Grid-No.1 Voltage	–40[s]	–28[t]	V
Zero Signal DC Plate Current	0.4	0.8	A
DC Plate Current:			
Synchronizing level	1.3	2.3	A
Blanking level	1.0	1.8	A
DC Grid-No.2 Current:			
Synchronizing level	–	100	mA
Blanking level	20	50	mA
DC Grid-No.1 Current:			
Synchronizing level	–	240	mA
Blanking level	2.0	110	mA
Driver Power Output:			
Synchronizing level	55	138	W
Blanking level	31	77	W
Plate Dissipation:			
Blanking level	–	4410	W
Output Circuit Efficiency	95	95	%
Useful Power Output:			
Synchronizing level	1700	5000	W
Blanking level	950	2820	W

RF Power Amplifier or Oscillator — Class B Telegraphy or FM Telephony[j]

Maximum CCS Ratings, Absolute-Maximum Values

	Up to 400 MHz		
DC Plate Voltage[k,m]	8000	max.	V
DC Grid-No.2 Voltage[n]	1650	max.	V
DC Grid-No.1 Voltage[p]	–450	max.	V
DC Plate Current	4.0	max.	A
DC Grid-No.1 Current	500	max.	mA
Grid-No.1 Input	50	max.	W
Grid-No.2 Input	150	max.	W
Plate Dissipation	5000	max.	W

Maximum Circuit Values:

Grid-No.1 Circuit Resistance Under Any Conditions:			
With fixed bias	5000	max.	Ω
With cathode bias	Not recommended		
Grid-No.2 Circuit Impedance	See note n		
Plate Circuit Impedance	See note k		

Notes

a Measured at the tube terminals. For accurate data the ac filament voltage should be measured using an accurate RMS type meter such as an iron-vane or thermocouple type meter. The dc voltage should be measured using a high input impedance type meter. For high-current, low-voltage filaments such as are used in this tube, it is recommended that the filament current be monitored, since very small changes in resistance can produce misleading changes in voltage. For maximum life, the filament power should be regulated at the lowest value that will give stable performance. For those applications where hum is a critical consideration, dc filament or hum-bucking circuits are recommended. See also Application Note AN-4865.

b The characteristic range of current at 5.7 volts is from 106 to 126 amperes. It is recommended that an additional six amperes be available to allow for the normal reduction of filament resistance with life. Thus, the filament supply should be designed for a mean value of 132 amperes at 5.7 volts.

c Sequence for applying voltage is as follows: Filament, Bias, Plate, Screen and RF Drive.

d For plate voltage = 2000 V, grid-No.2 voltage = 1375 V, and plate current = 6.0 A.

e With external flat metal shield 8" (200 mm) in diameter having a center hole 3" (76 mm) in diameter. Shield is located in plane of the grid-No.2 terminal, perpendicular to the tube axis, and is connected to grid No.2.

f With external flat metal shield 8" (200 mm) in diameter having center hole 2-3/8" (60 mm) in diameter. Shield is located in plane of the grid-No.1 terminal, perpendicular to the tube axis, and is connected to grid No.1.

g As manufactured by Jettron Products Inc., 56 Route Ten, Hanover, NJ 07936.

h See Dimensional Outline for Temperature Measurement points.

j See Section V.C of 1CE-300.

k See Section V. B and V.B.1 of 1CE-300.

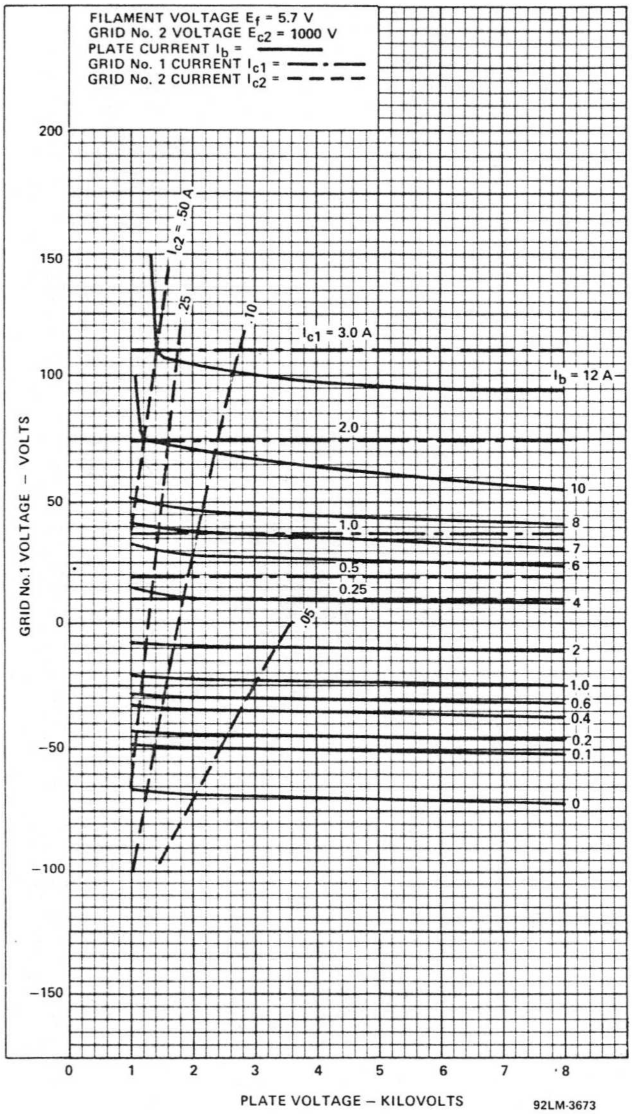


Figure 1 — Typical Constant Current Characteristics

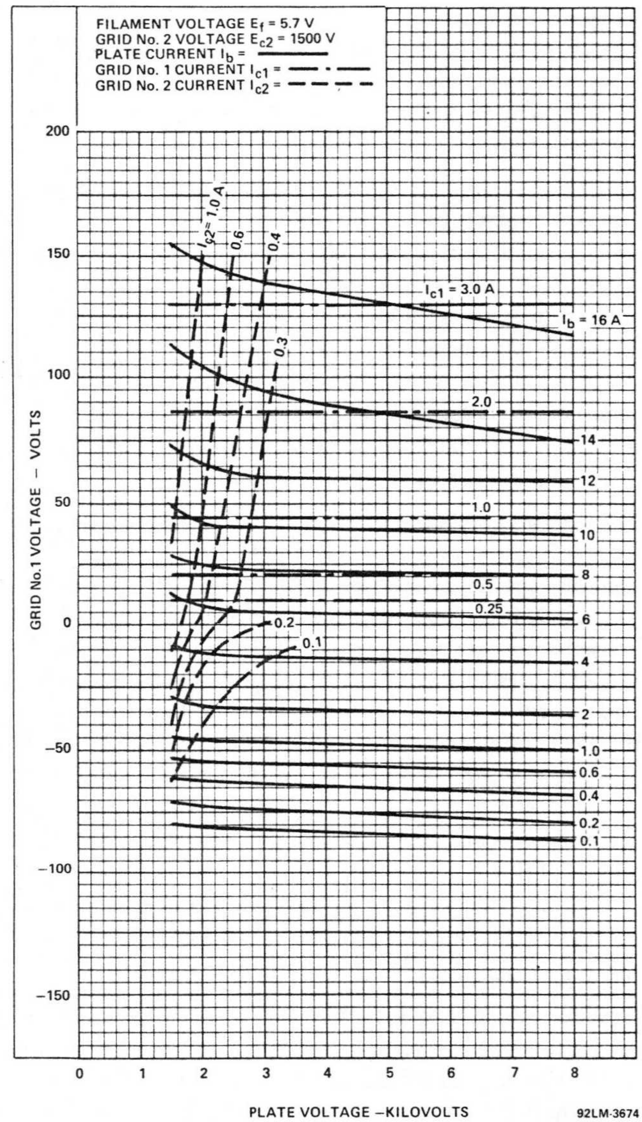


Figure 2 — Typical Constant Current Characteristics

m The maximum fault energy that can be dissipated within the tube is approximately 100 joules. Therefore, the energy available for a high-voltage arc or fault must be limited to this value by means of current limiting resistors or fault-protection circuitry. This is especially important in pulse service where high, stored energy and large capacitors are used. For typical 5000 watt TV transmitters, series resistor values are:

Plate = 10 Ω
Screen = 30 to 50 Ω
Grid = 50 Ω

For additional information see VI.B of 1CE-279 "Application Guide for RCA Large Power Tubes".

n See Section V.B.2 of 1CE-300.

p See Section V.B.3 of 1CE-300.

r The bandwidth of 6.3 MHz is calculated at the –0.72 dB power points of a double tuned output circuit using two times the tube output capacity and a damping factor of $\sqrt{1.5}$ as shown in **Figure 3.**

s Adjusted for I_{b_o} = 0.4 A.

t Adjusted for I_{b_b} = 0.8 A.

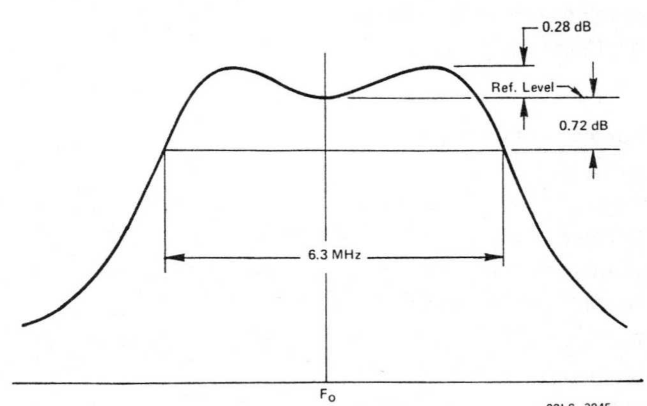


Figure 3 — Bandwidth Calculation

Protection Circuits

Protection circuits serve a threefold purpose: safety of personnel, protection of the tube in the event of abnormal circuit operation, and protection of the tube circuits in the event of abnormal tube operation.

Power tubes require mechanical protective devices such as interlocks, relays, and circuit breakers. Circuit breakers alone may not provide adequate protection in certain power-tube circuits when the power-supply filter, modulator, or pulse-forming network stores much energy. Additional protection may be achieved by the use of high-speed electronic circuits to bypass the fault current until mechanical circuit breakers are opened. These circuits may employ a controlled gas tube, such as a thyratron or ignitron, depending on the amount of energy to be handled.

The voltages applied to power tubes are extremely dangerous. Great care should be taken during the adjustment of circuits. The tube and its associated apparatus, especially all parts which may be at high potential above ground, should be housed in a protective enclosure. The protective housing should be designed with interlocks so that personnel can not possibly come in contact with any high-potential point in the electrical system. The interlock devices should function to break the primary circuit of the high-voltage supplies and discharge high-voltage capacitors when any gate or door on the protective housing is opened, and should prevent the closing of this primary circuit until the door is again locked.

A time-delay relay should be provided in the plate-supply circuit to delay application of plate voltage until the filament has reached normal operating temperature.

An interlocking relay system should be provided to prevent application of plate voltage prior to the application of sufficient bias voltage otherwise, with insufficient bias, the resultant high plate current may cause excessive plate dissipation with consequent damage to the tube. RF load shorts or other causes of high output VSWR may also cause high dissipations, excessive voltage gradients, or insulator flashover. The load VSWR should be monitored and the detected signal used to actuate the interlock system to remove the plate voltage in less than 10 milliseconds after the fault occurs.

Forced-Air Cooling

Air Flow:

Through radiator – Adequate air flow to limit the plate-core temperature to 250° C should be delivered by a blower through the radiator before and during the application of filament, plate, grid-No.2 and grid-No.1 voltage.

For a plate dissipation of 5000 watts and an incoming air temperature of 50° C, and air flow of 105 cfm is required in accordance with the Typical Cooling Characteristics as shown in **Figure 4**.

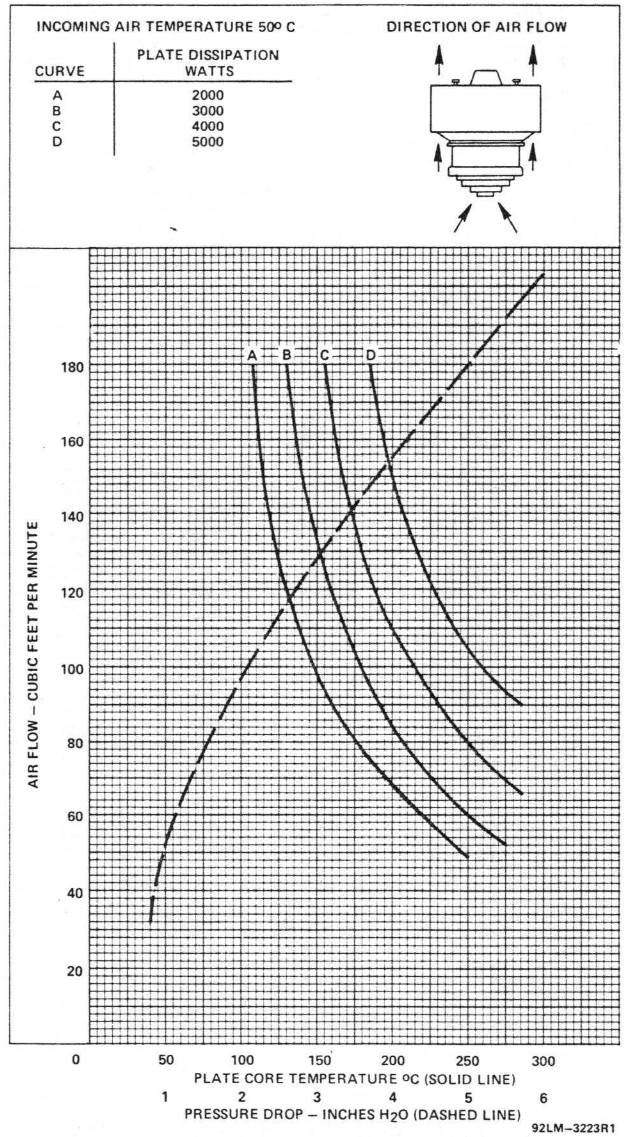


Figure 4 – Typical Cooling Characteristics

To Plate, Grid-No.2 and Grid-No.1 Terminals – A sufficient quantity of air should be allowed to flow past each of these terminals so that its temperature does not exceed the specified maximum value of 250° C.

To Cathode-Filament and Filament Terminals – A sufficient quantity of air should be blown directly at these terminals so that their temperature does not exceed the specified limit of 250° C. A value of at least 40 cfm is recommended.

During Standby Operation – Cooling air is required when only filament voltage is applied to the tube.

During Shutdown Operation – Air flow should continue for a few minutes after all electrode power is removed.

For further information on forced-air cooling, see Section IV.C of 1CE-300 and also AN-4869, "The Application Guide for Forced Air Cooling of RCA Power Tubes".

Tube Removal From Socket (Suggested Design)

The tube should not be removed from the socket by rocking the tube back and forth. This motion crushes the contact fingers and applies undue force to the internal structure of the tube.

It is recommended that the tube be removed from the socket with an assembly similar to that shown in **Figure 5.** The extractor portion should be constructed with the dimensions shown in **Figure 6.**

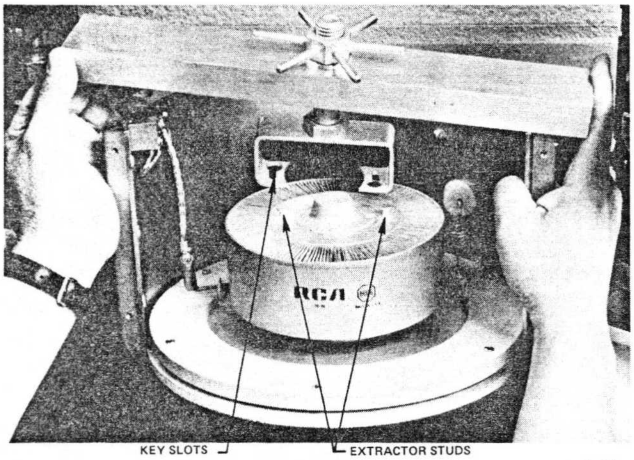


Figure 5 — Recommended Tube Puller

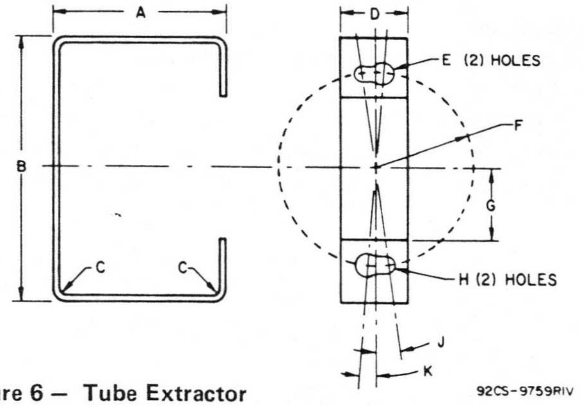


Figure 6 — Tube Extractor

Tabulated Dimensions*

Dim.	Inches	Millimeters
A	1.8	46
B	3.1	79
C	0.06	1.5
D	0.7	18
E Dia.	0.250	6.35
F Radius	1.175	29.85
G	0.9	23
H Dia.	0.140	3.56
J	8.3°	
K	4.5°	

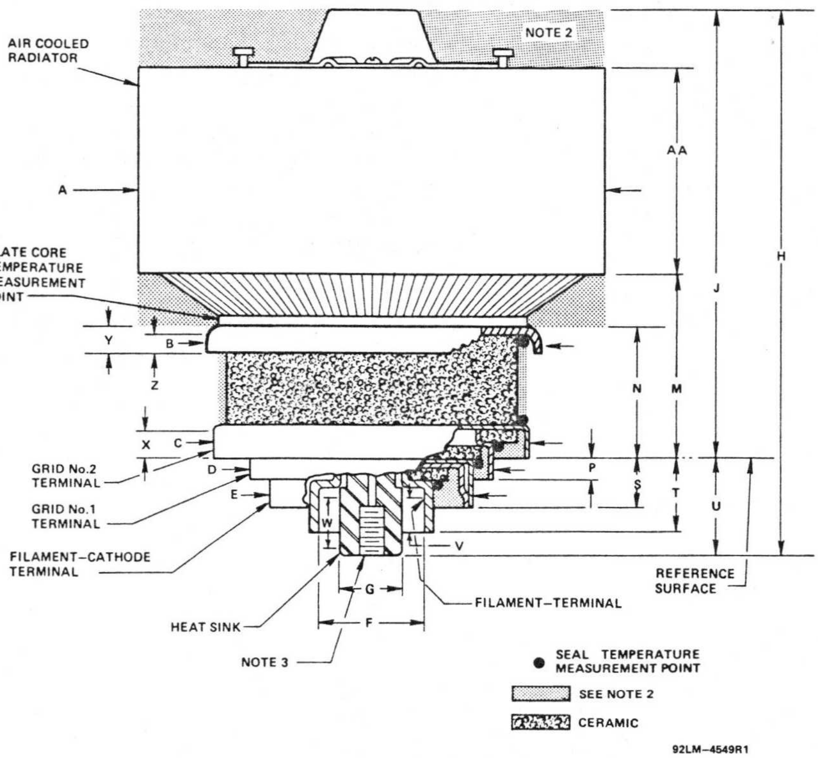
*Basic dimensions are in inches unless otherwise specified. Metric dimensions are derived from the basic inch dimensions. One inch equals 25.4 mm.

Notes

Material 1/16" CRS

Slot between holes

Round all edges



Note 1 — The diameter of each terminal is maintained only over the indicated minimum length of its contact surface.

Figure 7 — Dimensional Outline

Tabulated Dimensions*

Dim.	Inches	Millimeters
A Dia.[1]	4.510 ± .060	114.6 ± 1.5
B Dia.[1]	3.250 ± .015	82.55 ± 0.38
C Dia.[1]	3.028 ± .014	76.91 ± 0.36
D Dia.[1]	2.319 ± .012	58.90 ± 0.30
E Dia.[1]	1.850 ± .010	46.99 ± 0.25
F Dia.[1]	1.200 ± .010	30.48 ± 0.25
G Dia.[1]	0.617 ± .003	15.67 ± 0.08
H	5.300 ± .080	134.6 ± 2.0
J	4.345 ± .045	110.4 ± 1.1
M	1.790 ± .040	45.5 ± 1.0
N	1.330 ± .030	33.8 ± 0.8
P	0.200 ± .025	5.1 ± 0.6
S	0.475 ± .030	12.1 ± 0.8
T	0.725 ± .040	18.4 ± 1.0
U	0.955 ref.	24.3 ref.
V	0.250 min.	6.35 min.
W	0.375 min.	9.53 min.
X	0.220 min.	5.59 min.
Y	0.325 ref.	8.26 ref.
Z	0.160 min.	4.06 min.
AA	1.945 ref.	49.40 ref.

Note 2 — Keep all stippled regions clear. Do not allow contacts or circuit components to intrude into these annular volumes.

Note 3 — Tapped 1/4-20 NC x 0.5 inch (12.7 mm) deep.

*Basic dimensions are in inches unless otherwise specified. Metric dimensions are derived from the basic inch dimensions. One inch equals 25.4 mm.

Mounting

See the preferred mounting arrangement. For other arrangements, cavity-type mounting for multiple-ring terminal-type tubes, may be constructed by using either fixed or adjustable contact rings of finger contact strips in the transverse plane as described in Section IV.C.3 of 1CE-300.

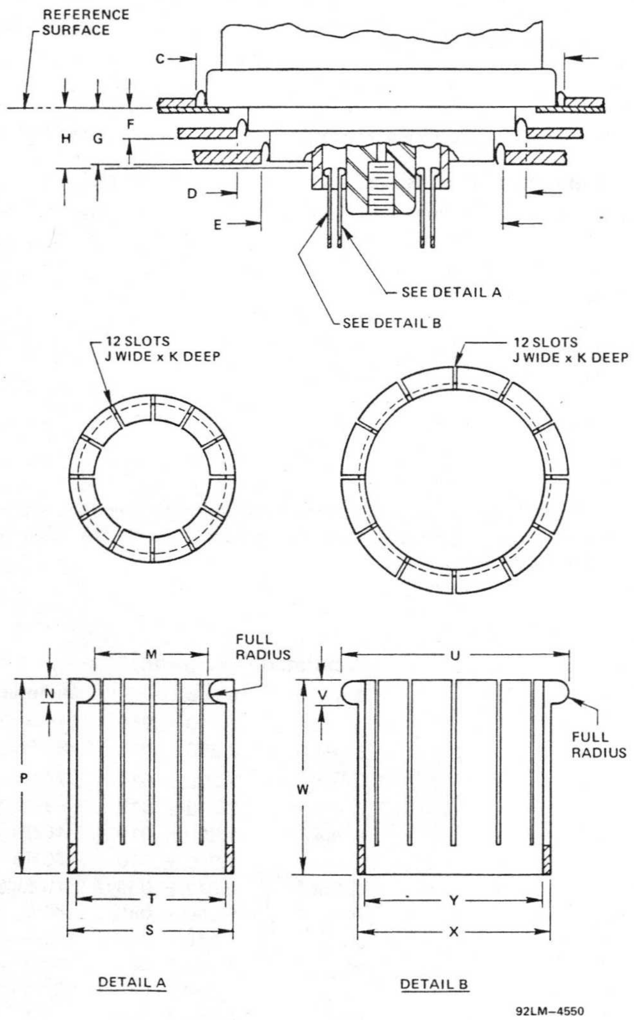


Figure 8 — Preferred Mounting Arrangement

Tabulated Dimensions*

Dimension	Inches	Millimeters	Notes
C Dia.	3.220	81.79	Note 1
D Dia.	2.510	63.75	Note 1
E Dia.	2.040	51.82	Note 1
F	0.215	5.46	
G	0.430	10.92	
H	0.475	12.07	
J	0.015	0.38	
K	0.800	20.32	
M Dia.	0.600	15.24	Note 2
N	0.125	3.18	
P	1.000 min.	25.40 min.	
S Dia.	0.850	21.59	
T Dia.	0.765	19.43	
U Dia.	1.220	30.99	Note 3
V	0.125	3.18	
W	1.000 min.	25.40 min.	
X Dia.	1.060	26.92	
Y Dia.	0.975	24.77	

*Basic dimensions are in inches unless otherwise specified. Metric dimensions are derived from the basic inch dimensions. One inch equals 25.4 mm.

Note 1 — The tolerance for the indicated dimension is:
plus 0.010 inch (0.25 mm)
minus 00 inch (00 mm)

Note 2 — The tolerance for the indicated dimension is:
plus 00 inch (00 mm)
minus 0.002 inch (0.05 mm)

Note 3 — The tolerance for the indicated dimension is:
plus 0.002 inch (0.05 mm)
minus 00 inch (00 mm)

Note 4 — Finger stock is No.97-135-A, as made by:
Instrument Specialties Company
Little Falls, NJ 07424

Note 5 — Sockets and chimneys are available and may be obtained in limited quantities from RCA and in production quantities from:
Jettron Products Inc.
56 Route Ten
Hanover, NJ 07936

Supplier	Socket No.	Chimney No.
RCA	J-15283	J-15286
Jettron	CD 89-085	8822