High Power Magnetron

Ceramic-Metal Construction

CW Oscillator — **80% Efficiency**
30 Kilowatts at 915 MHz — **Liquid Cooled**

MAGNETRON

ELECTRICAL

Filament, Tungsten Coil
- AC Supply Voltage . . . . 12.5 V
- Current[a] at 12.5 volts . . . . 115 A
- Starting Current . . . . Must never exceed 250 amperes, even momentarily
- Cold resistance . . . . 0.010 Ω
- Minimum heating time at normal filament voltage before anode voltage is applied . . . . 10 s

Center Frequency . . . . 915 ± 15 MHz
Focusing[b] . . . . Electromagnet, using AJ2134, AJ2134V1, or equivalent

MECHANICAL

Operating Position . . . . Vertical, either end up
Maximum Overall Length. 18.25"
Maximum Diameter . . . . 4.94"
Terminal Connections . . . . See *Dimensional Outline*
Weight (Approx.) . . . . 16 lbs

THERMAL

Ceramic-Insulator Temperature . . . . 150 max. °C
Metal-Surface Temperature . . . . 100 max. °C

Air Cooling

It is important that the temperature of any external part of the tube should not exceed the specified values. Uniform forced-air cooling of the output ceramic dome is required; with an RCA-AJ2134 or -AJ2134V1 Waveguide Adapter, approximately 20 cfm at 2.5 inches of water is adequate. Forced-air cooling of filament-terminal stem is also required. Approximately 5 cfm at 2 inches of water is required when using the RCA-AJ2137 Filament Connector. The air flow must start before application of the filament voltage and preferably should continue for several minutes after removal of the voltage. Interlocking of the air flow with the filament power supply is recommended to prevent tube damage in case of failure of adequate air flow.

Liquid Cooling

Liquid cooling of the anode is required. The liquid flow must start before application of the filament voltage and preferably should continue for several minutes after removal of the voltage. Interlocking of the liquid flow with the filament power supply is recommended to prevent tube damage in case of failure of adequate liquid flow. When the liquid is water, the use of distilled or filtered deionized water is essential.

For information on the cooling system and quality of water, see *Cooling Considerations* under *RCA Transmitting Tube Operating Considerations* at front of this section.

Typical Water Flow to tube for 6 kW Anode Dissipation	3 gpm
Pressure Drop, at 3 gpm	25 psi
Maximum Outlet Water Temperature	70 °C
Maximum Inlet Water Pressure	100 psig

CW OSCILLATOR

Absolute-Maximum Ratings

DC ANODE VOLTAGE[c]	14 kV
ANODE CURRENT	3 A
ANODE DISSIPATION	15 kW
LOAD VSWR[d]	
At a Power Output of 30 kW	1.1:1
At a Power Output of 25 kW	2.5:1
At a Power Output of 20 kW	3.0:1

Typical Operation at 915 MHz

AC Filament Voltage	11.7	11.4	11.4	V
Filament Current[a]	105	100	100	A
DC Anode Voltage	7.0	12.5	12.6	kV
Anode Current	2.0	2.4	2.8	A
DC Electromagnet Current	1.8	3.1	3.1	A
Useful Power Output[e]	10	25	30	kW
Efficiency	78	84	86	%

[a]The filament is subjected to back bombardment during operation. This will increase the filament temperature and shorten tube life if left uncorrected. Therefore, the filament current should be reduced under operating conditions to a value that will give the same "hot filament resistance" as when no rf power is being generated. The operating filament current must be established in the following manner:

(1) With no anode voltage applied, set the filament current to 115 amperes without exceeding the starting current of 250 amperes. Calculate the "hot filament resistance" after the filament has stabilized (approximately 5 minutes) by dividing the applied filament voltage by the filament current.

(2) Apply power to the electromagnet (See *Magnetron Operating Considerations*, **Electromagnet Operation**), and then apply the desired anode voltage.

(3) Reduce the filament current in approximate 5-ampere steps until the "hot filament resistance" is the same as that calculated in Step 1. See *Typical Operation* data for approximate operating current.

(4) To restart the magnetron after the anode voltage has been removed, reset the filament current to 115 amperes, apply anode voltage and after the tube is generating power, reduce the filament current to the operating value determined in Step 3.

[b] The magnetic field must be turned "on" before application of the anode voltage and turned "off" only after removal of the anode voltage. For further details, see *Waveguide Adapter*.

[c] The anode is normally grounded.

[d] Refer to *Typical Rieke Diagram* for the effects of load VSWR on power output and frequency.

[e] At a load VSWR not exceeding 1.1:1.

MAGNETRON OPERATING CONSIDERATIONS

For considerations common to all RCA super-power tubes, see *Application Guide for RCA Super Power Tubes, ICE-279A.* **Additional considerations specifically for the 8684 are given below.**

Use of RF-Gasket

The rf connection between the magnetron and waveguide adapter is made by an rf gasket, RCA-AJ2138 or equivalent.

Harmonic Radiation Shielding

Harmonic energy may be radiated through the high-voltage and filament insulators. An rf shielded enclosure or suitable absorbing material may be required to reduce the harmonic radiation to acceptable levels.

Electromagnet Operation

To establish the electromagnet coil current when a tube is first installed, it is recommended that the electromagnet coil current be set at a value that will keep the magnetron anode current cut off when the anode voltage is applied. The typical electromagnet coil current necessary to achieve anode current cutoff with various anode potentials is shown in Fig.2. In no case should the coil current exceed 4.0 amperes. After the anode voltage has been applied, the electromagnet coil current should be gradually reduced to give the required magnetron rf power output. The magnetron anode current and rf power output will increase slowly as the magnet coil current is gradually reduced.

When the tube is restarted after it has been shut down, the electromagnet coil current may be reset at the value determined above provided the coil is not connected in series with the magnetron anode supply. See *Wave-Guide Adapter,* **Operating Considerations** for electromagnet and tube operation with the coil connected in series with the magnetron anode supply.

RF-RADIATION WARNING

Because the 8684 is designed to generate high rf power levels at high frequencies, care must be taken to protect personnel from possible injury due to rf-radiation leakage.

Care must be exercised by the equipment designer and tube operator to insure that the rf seals obtained between the tube RF Output Terminal Contact Surface (See *Dimensional Outline*) and *Waveguide Adapter*, between waveguide flanges, and between the waveguide and rf probes are adequate to limit the rf leakage radiation to safe values.

CONNECTORS

RCA-AJ2137 is a connector for contacting the **filament** terminal of the magnetron. It contains a duct to permit forced-air cooling of the filament terminal, filament insulator, and the filament-cathode connector. This connector includes a 10-inch long braided lead with connector lug for 3/8-inch bolt.

RCA-AJ2136 is a connector for contacting the **filament-cathode** terminal of the magnetron. This connector includes a 10-inch long braided lead with connector lug for 3/8-inch bolt.

RCA-AJ2136V1 is a variant of the AJ2136 described above. It features a molded material which suppresses spurious radiation from the high-voltage insulator area of the magnetron.

AJ2137		
AC or DC Current (typical)	115	A
Pressure Drop, at air flow of 5 ft^3/min	2 inches of water	
AJ2136		
AC or DC Current (typical)	115	A
AJ2136V1		
AC or DC Current (typical)	115	A
Spurious Radiation Attenuation:		
Minimum	10	dB
Typical	12	dB

WAVEGUIDE ADAPTER

RCA–AJ2134 and AJ2134V1 Waveguide Adapters include the necessary electromagnet and rf circuitry for coupling rf energy from the 8684 to WR975 waveguide. The AJ2134 and the AJ2134V1 are identical except for the waveguide connector flange.

ELECTRICAL

DC Coil Voltage	39	V
Coil Current at 39 volts	3.0	A
Voltage Transients Across Electromagnet	Must never exceed 500 volts, even momentarily	

MECHANICAL

Maximum Overall Length. . . . . 23.4"
Maximum Height . . . . 16.62"
Maximum Width . . . . 13.50"
Mounting Bracket . . . . See *Assembly Outline*
Electromagnet Electrical Terminal
Connection . . . . See *Assembly Outline*
Electromagnet Coolant Connections . . See *Assembly Outline*
Weight (Approx.) . . . . 145 lbs.

THERMAL

Liquid Cooling

Liquid Cooling of the electromagnet coil is required. The liquid flow must start before application of the electromagnet voltage and preferably should continue for several minutes after removal of the voltage. Interlocking of the liquid flow with the electromagnet and the magnetron high voltage supply is recommended to prevent damage to the electromagnet and/or tube in case of failure of adequate liquid flow.

Typical Water Flow for coil dissipation of
140 watts . . . . 0.25 gpm
Maximum Pressure Drop, at 0.25 gpm . . . . 10 psi
Maximum Outlet Water Temperature . . . . 70 °C
Maximum Inlet Water Pressure . . . . 100 psig

Absolute-Maximum Ratings

DC Electromagnet Voltage[f] . . . . 50 V
DC Electromagnet Power . . . . 190 watts

[f] A shunt protection circuit such as provided by a thyrite is recommended for protecting the electromagnet from high voltage transients.

WAVEGUIDE ADAPTER OPERATING CONSIDERATIONS

See RCA-8684 Ratings for Typical Operation and Magnetron Operating Considerations. The electromagnet may be operated with a separate current-regulated power supply or it may be connected in series with the anode of the RCA-8684 magnetron, as shown in Fig.1, to minimize the sensitivity of the rf power output to anode voltage variations. In the series connected mode a separate power supply must also be connected to the electromagnet to (1) allow setting the coil current to the level required for proper tube operation (2) allow slight compensation for changes in the electromagnet coil resistance due to heat, and (3) permit the application and interruption of the magnetron anode voltage without creating excessive transient voltages across unprotected electromagnet coils.

To prevent damage to a non-protected electromagnet in the series connected mode, the magnetron anode voltage must neither be applied nor removed without first increasing the electromagnet coil current to a level that will keep the magnetron anode current cut off. The typical electromagnet coil current necessary to achieve anode current cutoff with various anode potentials is shown in Fig.2. Once the anode voltage is applied, the electromagnet coil current may be reduced to the required level by adjusting the output of the electromagnet supply. The magnetron anode current and rf power output will increase slowly as the coil current is gradually reduced.

SERIES CONNECTED POWER SUPPLY FOR ELECTROMAGNET OPERATION

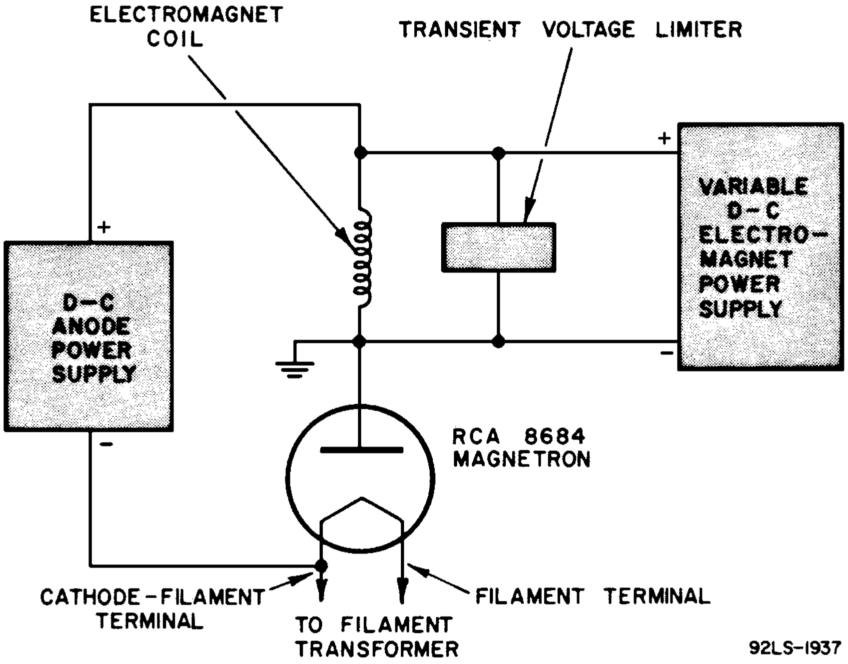
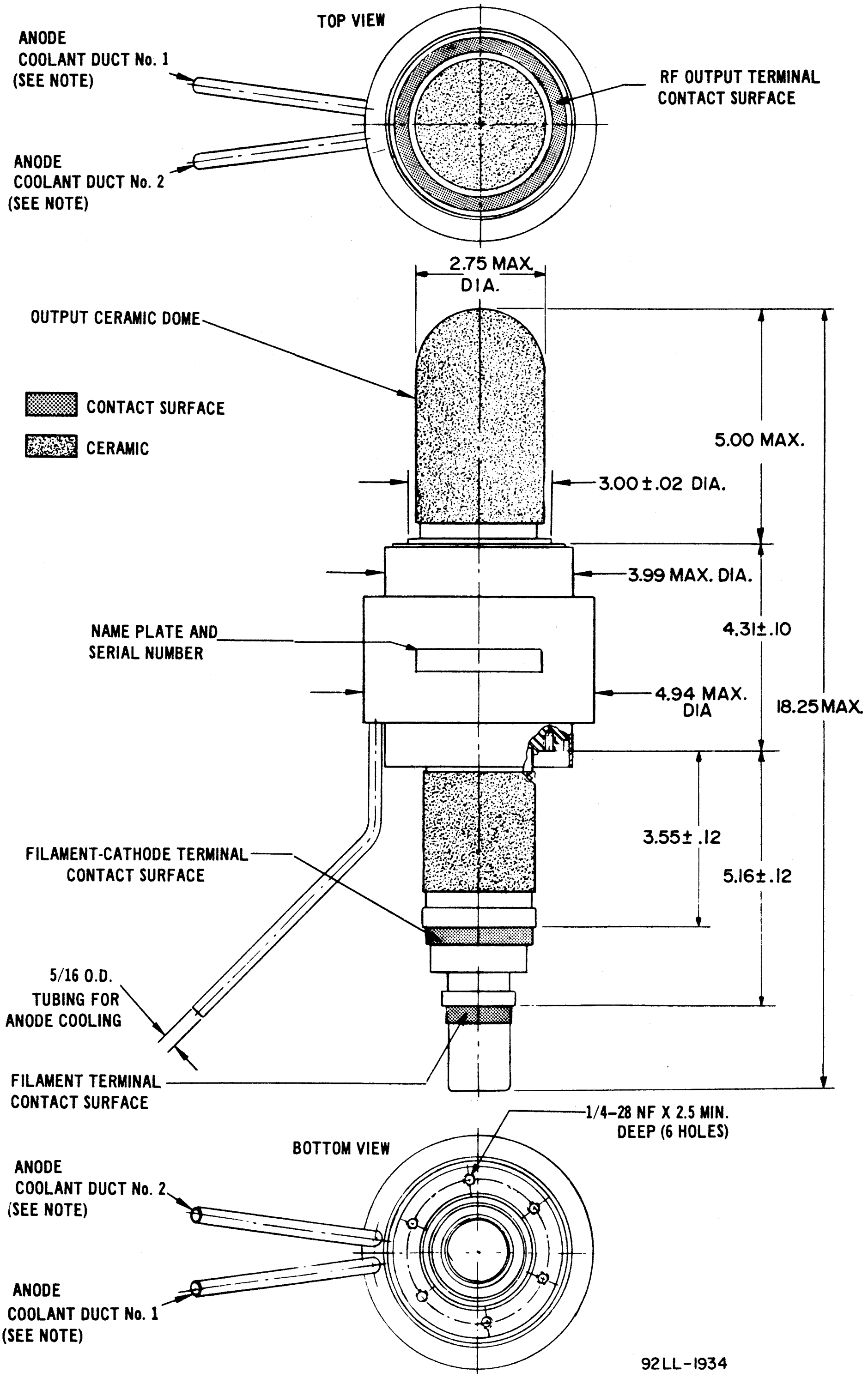


Fig.1

DIMENSIONAL OUTLINE



NOTE: Recommended direction of anode coolant flow: Duct #1 is "IN" and Duct #2 is "OUT" when tube is operated with Output Ceramic Dome UP. With Output Ceramic Dome DOWN, the flow should be reversed.

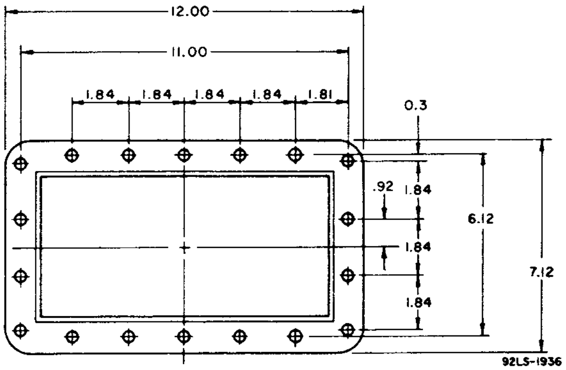
ACCESSORIES

RCA Type No.	Description
AJ2134	Waveguide Adapter; mates with EIA Standard CRP975F (WR975) Waveguide Flange.
AJ2134V1	Waveguide Adapter; mates with Alternate Waveguide Flange (See Flange on Assembly Outline.)
AJ2135	Magnetic Pole Piece
AJ2136	Filament-Cathode Connector
AJ2136V1	Filament-Cathode Connector with Molding
AJ2137	Filament Connector
AJ2138	RF Gasket
AJ2140	Accessory Kit including -AJ2135, -AJ2136, -AJ2137
AJ2141	Accessory Kit including -AJ2135, -AJ2136V1, -AJ2137.

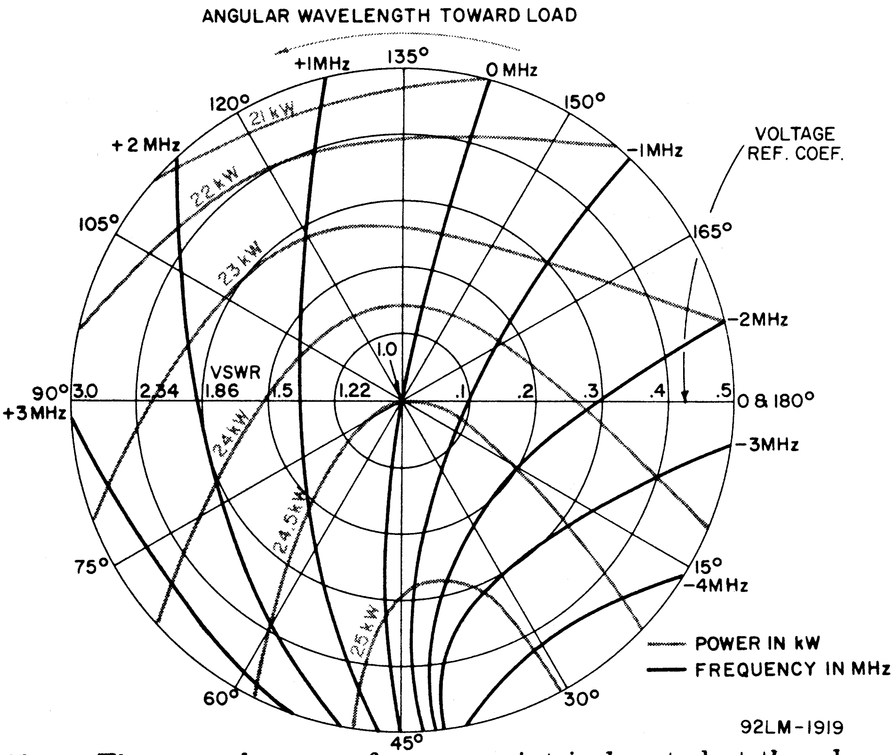
AJ2134 Waveguide Adapter flange mates with EIA standard CRP975F (WR975) waveguide flange

or

AJ2134V1 Waveguide Adapter flange mates with alternate flange shown below



TYPICAL RIEKE DIAGRAM



Note: The zero degree reference point is located at the plane of the waveguide connector flange on RCA-AJ2134 or -AJ2134V1 Waveguide Adapter.

COIL CURRENT vs. ANODE VOLTAGE

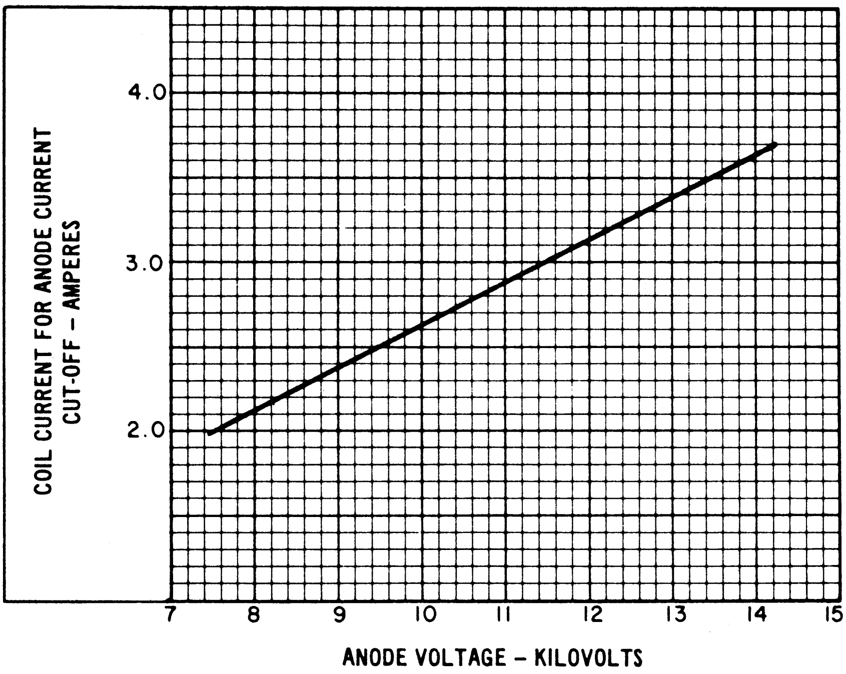


Fig.2

TYPICAL PERFORMANCE CHARACTERISTICS